

Study Unit

Learning Strategies



As you progress through your program, you may find yourself wondering what's the most effective way to go about studying. You may already be asking yourself some of these questions: How long should I study? How often should I study? How can I retain information I read? What aids should I be using?

This study unit gives you the information you need to plan successful learning strategies—action plans to get the most out of the time you spend on your assignments. In this unit you'll find a variety of different skills and techniques to use as you progress through the program. Because everyone learns in different ways and at different paces, it's up to you to decide which ones are appropriate for you—and then to use them regularly.

Studying is a skill. To be proficient at it, you have to practice. You may already have some effective strategies. This unit helps you build on those and gives you additional pointers for improving the skills you already have.

When you complete this study unit, you'll be able to

- Explain the advantages of your program
- Explain how you can get help during your studies
- Describe the study materials you'll receive with your program and how they're shipped to you
- Access our Web site
- Identify what kind of learner you are
- Explain how to establish a study schedule, organize your materials, and choose an appropriate place to study
- Describe the SQ3R study method
- Develop a procedure for building your vocabulary as you study
- Explain a proper procedure for preparing for and taking an examination

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Learning Strategies

A GLIMPSE AT YOUR PROGRAM

The Advantages

You're about to begin a program of study right from your own home. During your program, you'll be reading and studying books just like this one as you improve your education and work toward a career in a different field or advancement in your current occupation.

One of the greatest advantages of this program is that it enables you to study at your own pace. If you're having difficulty with a particular section of material, you don't have to worry about keeping up with the rest of your class. You can take your time and study the material until you understand it. On the other hand, if you find certain material easy and you understand it quickly, you don't have to be held back by others in your class. You can move on as soon as you feel comfortable with the material.

You'll also be able to study when you want to and when it's convenient for you (Figure 1). In a traditional school setting, you must attend classes when they're scheduled. With the program you're about to begin, you can choose when you study, based on your work and family schedule and on when you're most alert.

Whether you're preparing for a new career, working to advance in your present job, or just taking a course for enjoyment or self-enrichment, this program can provide you with a method to accomplish your goals without interrupting your present schedule.



Many of your study materials are available as PDFs when you log in as a student at www.pennfoster.edu.

FIGURE 1—Your new program allows you the freedom to study when and where it's convenient for you.



Bridging the Gap

As a student in one of our programs, you may be physically separated from your teacher, but you still have one-to-one communication with people at your school. The best way to find information you need or to communicate with the school is through the Penn Foster Web site at

<http://www.pennfoster.edu>

When you log on to this site as a Penn Foster student, you can take an exam, check your student record, make a payment, use the library, and much more. You'll learn how to log on to the Web site later in this study unit.

Another service available to Penn Foster students is DIAL-A-QUESTION®. Although not as fast and as easy as the Web site, DIAL-A-QUESTION® can provide answers to customer service questions—that is, questions not specifically related to your instructional materials. Most importantly, through DIAL-A-QUESTION® you can speak to an instructor about your lessons. If you have a question about something you don't understand in your study materials or if you find a particular concept difficult, instructors can provide guidance and answer your questions. Your student handbook gives the times that instructors are available to answer your questions.

Program Design

Your program is divided into a number of modules that are shipped to you as you progress through your studies. You've already received your first shipment, which includes all of the materials to get you started.

Your program has been developed so that each new unit builds on the material of previous units. Therefore, you must study the materials in the order in which they're listed on the Program Outline. (You should have received a Program Outline with this shipment. If you haven't reviewed it yet, do so before proceeding.)

Study Materials

In your program, you may use a variety of different study materials (Figure 2), many of which are available as PDFs on the Penn Foster Web site. Once you log on to the site, you can access any online material in your program. (You'll receive instructions for logging on to the Web site later in this study unit.)

The following paragraphs present a brief description of each of the various types of study materials.

- A *study unit* is a short booklet that contains information related to the subject you're studying. The booklet you're reading now is a study unit. At various points throughout a unit, you'll be required to stop and complete a self-check to test your understanding of the material you've just read. You can check your answers to these quizzes by comparing them to the ones provided at the back of the unit. The self-checks are for your benefit only. You don't have to submit them to the school for evaluation,



FIGURE 2—These are the types of study materials you'll be using throughout your program.

and they don't count toward your grade in the program. However, we strongly urge you to complete each one. They're a good review tool, and they help you to identify key concepts in your reading and studying.

When you complete the material in one study unit, you must take the examination at the back of the booklet and submit it to the school for grading. Most of these examinations consist of multiple-choice questions. We'll grade each examination and let you know your score. Your grades on the examinations count toward your final grade for each subject in the high school program.

- A *study guide* is a booklet designed to guide you through a separate textbook, which you receive as part of your program. The main purpose of a study guide is to help you understand the materials in the textbook. It breaks the textbook content into small blocks of study material, highlighting important details and providing explanations of basic concepts. The study guide contains introductions to each lesson and assignment, self-checks similar to those in the study units, and examinations that you must submit to the school for grading. *Note:* Whenever you receive a subject, such as Reading Skills, that contains a study guide and a textbook, *always read the study guide first.*
- A *textbook* contains material related to the subject you're studying. It's exactly like the books used in traditional classrooms. As a student with our school, however, you'll receive a study guide to help you through the material in the textbook.
- Another type of booklet you may use during your program is called a *practical exercise*. This type of booklet includes suggested activities that are tailored to help you apply the material you're studying to real-life situations. The suggested activities are optional. You don't have to complete them to finish your program. However, each practical exercise booklet also contains a multiple-choice examination that you must complete and submit for grading. The questions in the examination cover material you've already learned in previous study units.

- A *graded project* is a very short booklet that includes practical application questions and exercises. The examination for a graded project is generally not multiple choice. Instead, you may have to write a paragraph, make a decision based on a scenario, study and explain a diagram, or identify and explain something you've just learned in a study unit. These graded projects are a required part of your program. You must complete and submit them to the school for grading.
- A *supplement* is similar to, but smaller than, a study unit. It deals with some specific aspect of the program not covered in detail in the study units. Basically, a supplement provides enrichment information. It has no self-checks or examination.
- *Learning aids* are tools you receive with your program. Generally, they're items used by professionals in the field in which you're studying. For example, if you're taking an art program, you may receive oil paints, pastels, watercolors, drawing tablets, pencils, ink, and erasers. (See Figure 3.) In the jewelry repair technician program, you may receive pliers, files, paste solder, and brass. These learning aids are yours to keep and use while you're studying and when you begin to work in the field that you're pursuing.



FIGURE 3—These are some of the learning aids you receive with our art program.

Examinations

As we've already mentioned, each study unit includes one examination that you must complete and submit for evaluation. Each study guide, however, contains several exams. Most of these examinations consist of multiple-choice questions. The examinations are designed with a particular purpose in mind: They're open-book exercises that help you learn not by just understanding what you've read, but by knowing where to look for information.

Here's an example of a multiple-choice question from the Dog Obedience Trainer/Instructor program.

1. The main purpose of a crate is to serve as a tool for
 - A. confinement.
 - B. punishment.
 - C. traveling.
 - D. security.

This item offers you four clear choices. You must identify the one *best* answer, which you can find in the material you've already studied.

Sometimes you'll immediately know the correct answer to a question. At other times, you'll have to go back to the text to search for the correct answer. In fact, our multiple-choice items are constructed to encourage you to review the study material to discover the answers. The process of reviewing your study material for the answer is a form of self-teaching.

When you complete a lesson exam, submit it to the school for grading. You can choose from three different methods: (1) online at our Web site, (2) Tel-Test, or (3) Exam Express.

- Online exam submission is the best, fastest, and easiest option available. To submit your exam online, you must have access to the Internet. Once you submit the exam, you immediately receive the results. (*Note:* To submit an examination online, you must first log on to the Web site. On your homepage is a link to instructions for using the site.)
- With Tel-Test, you can take your exams with a touch-tone telephone and get your results within minutes.
- For the Exam Express option, you must submit your exams using the scanner cards and envelopes provided in your first shipment.

Occasionally, some subjects require you to submit an examination that must be graded by hand. For example, you may have to create a drawing for an art assignment or develop a paragraph for a writing assignment. You must submit such examinations by mail.

Using Our Web Site

The Penn Foster Web site is your connection to the school. The site is faster, easier, and better than other means of communication. As a student in our school, you can access information regarding your program, shipments, payments, grades, and so on. You also have access to an extensive online library, and best of all, you can submit your examinations through this site.

To log on to the Web site for the first time, follow these steps:

1. Go to the Web site at

<http://www.pennfoster.edu>

2. At the top left of the screen, click on **STUDENT LOGIN**.
3. For complete instructions for logging in for the first time, click on **Login Help** and follow the online explanation.

When you complete the steps in Login Help, you'll be registered in the Web site. To enter the site from then on, simply enter your Login ID and password when prompted to do so.

When you enter the site, you're immediately taken to your personal homepage. On that page are two valuable resources for helping you get the most from the site:

1. Click on **Click here to take a tour of your student experience!** for a video demonstration of using the Web site. (This link is at the top right of your personal homepage.)
2. Click on **How to Use This Web Site** for written instructions that you can print for handy reference. (This link is at the right of your personal homepage.)

If you plan to use the Web site, you should take some time to become familiar with it before you begin your studies. Then when you really need some help or information, you'll know just where to find it. The Web site is the best and fastest source of information and service.

Shipments of Program Materials

Shortly after you enroll in one of our programs, you'll receive your first shipment of materials, which includes everything you need to get started in your studies. As you progress through the program, you'll receive additional shipments of study materials. You're the one who controls how often a shipment is sent.

Here's how it works. When you complete and submit a certain number of examinations from one shipment, your next shipment will automatically be mailed to you. While you're waiting for a shipment to arrive, continue to work on the remaining material in your current shipment. In that way, you'll always have materials on hand to study. Your progress should never be held up for lack of material to work on.

The remainder of this study unit presents study aids and suggestions to help you get the most from your program. Before you go on to that material, please take time to complete *Self-Check 1*.



Self-Check 1

At the end of each section of *Learning Strategies*, you'll be asked to pause and check your understanding of what you've just read by completing a "Self-Check" exercise. Answering these questions will help you review what you've studied so far. Please complete *Self-Check 1* now.

Indicate whether the following statements are True or False.

- 1. Your new program allows you to study at your own pace.
- 2. The fastest and easiest way to submit examinations for grading is to submit them online using the Penn Foster Web site.
- 3. You must submit your self-check answers to the school for evaluation.
- 4. Most examinations in your program consist of multiple-choice questions.
- 5. After you enroll in a program, you'll receive a shipment of materials every month.

Check your answers with those on page 33.

STUDY SKILLS

What Kind of Learner Are You?

To get the most out of your studies, you should find out how you learn best—that is, what kind of learner you are.

- An *auditory learner* learns by listening. If you're an auditory learner, you should find friends to study with, so you can ask questions and discuss the text (Figure 4). If you have to study alone, you can reinforce your learning by reciting key concepts out loud or reading them into a tape machine and listening to the tape later. Or you can explain what you're learning to your friends or family.



FIGURE 4—If you're an auditory learner, find someone you can talk to about your lessons.

- A *visual learner* learns by reading. If you learn best this way, you should concentrate on finding a quiet place where you can focus on the material you're reading (Figure 5).



FIGURE 5—If you're a visual learner, find a place where you won't be distracted by nearby noises and movement.

- A *kinesthetic learner* learns by doing. If you learn best by doing something, you're going to have to be creative in the way in which you study. For example, highlight your text or take notes as you read (Figure 6). Think about practical ways to apply the material you're reading.



FIGURE 6—If you're a kinesthetic learner, taking notes as you study helps you to remember what you've read.

To help you determine what kind of a learner you are, take a few moments to complete the exercise in Figure 7. While a short quiz like this can't pinpoint perfectly how you learn, it can provide insights into how you see yourself and the learning process. Once you know what kind of a learner you are, you'll be better able to plan your study procedure.

Note: You may discover that you have strong scores in more than one learning style. That's okay; it means you learn in more than one way. Take advantage of every technique that helps you to learn.

Check yes or no beside each of the following statements to reflect how you learn best.

	YES	NO
1. I learn a lot from listening to instructors and other knowledgeable people.	_____	_____
2. I figure things out best by trial and error.	_____	_____
3. Books are easy for me to learn from.	_____	_____
4. Give me a map and I can find my way.	_____	_____
5. I like to have directions explained to me orally.	_____	_____
6. I can often assemble something I just bought without looking at the instructions.	_____	_____
7. I learn a lot from discussions.	_____	_____
8. I'd rather watch an expert first and then try a new skill.	_____	_____
9. The best way for me to learn how something works is to take it apart and put it back together.	_____	_____
10. I can remember most of what is said in classes and meetings without taking notes.	_____	_____
11. In school, the classes in which I did best involved physical activity.	_____	_____
12. Diagrams and drawings help me understand new concepts.	_____	_____

A "yes" answer to questions 1, 5, 7, and 10 indicates that you learn by hearing information: you're a strong *auditory learner*.

A "yes" answer to questions 3, 4, 8, and 12 indicates that you learn by reading, watching, and studying diagrams: you're a strong *visual learner*.

A "yes" answer to questions 2, 6, 9, and 11 indicates that you learn by doing things: you're a strong *kinesthetic learner*.

FIGURE 7—Use this exercise to help you determine how you learn best.

Study Schedules

Schedules put you in control of your time and your life. If you were attending a traditional school, you would have to be present in class at certain times, hand in assignments by their due dates, and take examinations when the teacher scheduled them. Since you don't have a schedule set up by a teacher or school official, you must create your own schedule so you can stay on track with your goals.

As we mentioned before, one of the advantages of your program is being able to study at your own pace and on your own schedule. And you're the only one who knows what that schedule should be like.

Start with the big picture. Do you have a target date for completing your program? If so, start with that date. Then, plan how long you have to complete each module or study unit within your program. Lay out your schedule accordingly.

Quarterly Schedule

Suppose your overall plan calls for completing the first four study units during the first three months. Buy or make a calendar with squares large enough to write in the information you need to remember. Set a deadline for completing each unit and mark that date on your calendar. That's the day you should submit the examination for the unit.

Keep your calendar on your desk, on the wall near your desk, or some other place where you'll see it every day.

Weekly Schedule

To make your schedule a little more manageable, break down your quarterly schedule into weekly segments. Each week contains 168 hours. To plan your week, use the chart in Figure 8 to estimate the number of hours you spend each week on certain activities.

FIGURE 8—Fill in the blanks with the number of hours you spend each week on each activity.

Activity	Hours Spent per Week
1. Working	_____
2. Sleeping	_____
3. Dressing, showering, and so on	_____
4. Eating	_____
5. Traveling to and from work	_____
6. Shopping, cooking, and preparing meals	_____
7. Studying	_____
8. Watching TV	_____
9. Engaging in leisure activities	_____
10. Caring for family	_____
11. Cleaning and doing laundry	_____
12. Socializing	_____
13. Other	_____
Total hours spent	_____

After you've completed the chart, subtract your total from 168. Your answer is the number of free hours you have each week. Is it more than you need for your studies? If so, great. Just decide how many of those hours you're going to devote to your education. If you don't have enough free hours for your studies, you may have to make some changes in your lifestyle. For example, suppose you indicate that you watch television 25 hours each week. You may decide to eliminate an hour or more every day and devote that time to studying. To help you analyze your allotment of time, ask yourself questions like these—and then answer them honestly:

1. On what activity do I spend the most time?
2. On what activity do I spend the least time?
3. Do I spend too much time on any one activity?
4. Do I need to spend more time on any activity?

5. Is the amount of time I spend studying producing the results I want?
6. Overall, am I satisfied with the way I spend my time? Why or why not?
7. If I could make some changes, what would they be?

Schedules make your life easier, not harder, because they help you organize your time. A well-organized and planned schedule can in a sense “add hours to your day.”

If you find that your weekly schedule isn’t working, try completing the chart in Figure 9. Transfer the numbers from Figure 8 into the “Estimated Time” column in Figure 9. Then, on a separate piece of paper, keep track of the actual hours you spend on the activities during the next week. Write down the actual hours *as you spend them*. Don’t put it off until later in the day, because it’s easy to forget the correct amounts by then. When the week is over, total the times for each activity and complete the chart in Figure 9.

Activity	Estimated Time	Actual Time
1. Working	_____	_____
2. Sleeping	_____	_____
3. Dressing, showering, and so on	_____	_____
4. Eating	_____	_____
5. Traveling to and from work	_____	_____
6. Shopping, cooking, and preparing meals	_____	_____
7. Studying	_____	_____
8. Watching TV	_____	_____
9. Engaging in leisure activities	_____	_____
10. Caring for family	_____	_____
11. Cleaning and doing laundry	_____	_____
12. Socializing	_____	_____
13. Other	_____	_____
Total hours spent	_____	_____

FIGURE 9—Comparison Chart for Weekly Activities

Once you've filled in the chart in Figure 9, list the activities in which you spent more time than you originally estimated. Then list the activities in which you spent less time than you estimated. How can you use this information to revise your weekly schedule?

How Long Should You Study?

Consider these three important points when planning the amount of time you study during one sitting:

- You don't have to study for hours at a time to be effective.

If your daily schedule is such that you can spend only a short time studying, that's okay. In fact, you'll probably benefit more by studying every day for 30 to 45 minutes than you would by studying for several hours once a week. You must decide what works best for you in terms of your schedule for other activities and in terms of your own preferences.

- You need to take breaks from intensive study.

Regular breaks can help you stay on task and focused. Set limits for yourself. In general, you should try to schedule study times of one to two hours. When you notice you're becoming bored, distracted, or tired, take a break. Give yourself 10 minutes to stretch, walk around, or get a snack (Figure 10).

In the beginning, set a time limit of 30 minutes. Study for that length of time, take a 10-minute break, and then go back to your studies. You'll be surprised how refreshed you feel after just a quick break to increase your concentration. Walking and stretching exercises are good ways to spend your break time.

- Each person is different in terms of how long he or she can focus on information in a text.

Although we've given you some guidelines, they're only suggestions. Because you're a unique individual, with unique abilities and a unique lifestyle, you must decide for yourself the best time and the amount of time that's appropriate for you.

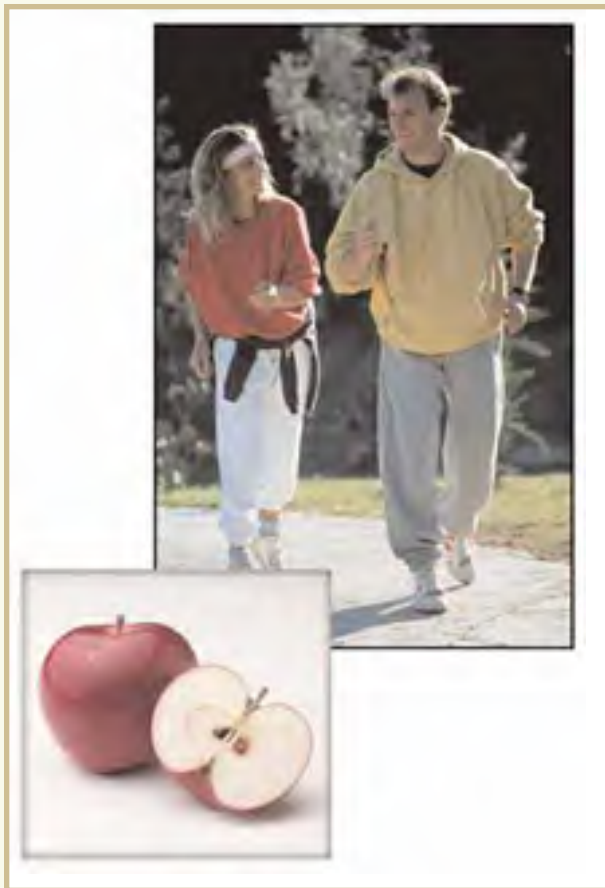


FIGURE 10—A short break to have a snack or take a short walk or jog may help you to stay focused on your studies.

At the end of each study time, take a few minutes to plan your next session. In that way, when you begin to study again, you'll know exactly where you ended and what you have to accomplish next. If you study on, say, Monday, and you're unable to study again until Friday, you may not remember where you were and how much you had read. Making a list of things to do in your next session can save a lot of time.

You might also find it helpful to make a list of things to do outside your study time. These things may include items related to your program and items related to other daily activities. For example, here's one student's daily list of things to do:

1. Return reference book to library.
2. Look for book recommended by author of study unit.
3. Pick up milk, eggs, tomatoes, and cheese.
4. Pick up clothes at dry cleaners.
5. Spend one hour studying program materials.

For these lists, you can use something as simple as a piece of scrap paper or something more elaborate like a daily planner or appointment book available in most drugstores or bookstores (Figure 11). The important thing is to use them to help you plan your time in the best possible way.

FIGURE 11—For you, a sheet of scrap paper or a notepad may be sufficient for a daily to-do list. Others may prefer a more formal daily planner like the one shown in the lower half of this illustration. If a purchased planner motivates you to schedule your time and stay on schedule, it's worth the purchase price.



Where Should You Study?

Your study place doesn't have to be elaborate. A desk or small table in your bedroom or guest room will do. It's not a good idea to study in bed, however. That location may be a little *too* comfortable, and you'll find yourself falling asleep.

If possible, use your study area only for studying. Try to keep your study area separate from the areas where you take care of other responsibilities, like paying bills and managing household expenses. For one thing, you may get distracted from your studies by thinking about the electric bill. For another, you may lose phone bills or other important papers among your textbooks and notes.

If you can, avoid high-traffic areas such as the kitchen or family room where you may be distracted and interrupted by family members. Find a study area away from the noise of the television and children's play (Figure 12). If you don't have a bedroom or spare room to use for study, choose the quietest corner of the family room or living room, and arrange your desk so you're facing the wall. You can create a simple desk by placing a large board over milk crates, cinderblocks, or even two-drawer filing cabinets. Make sure you have an adequate light source over your desk—a floor lamp, an overhead light, or a desk lamp—to illuminate the material you're working on.



FIGURE 12—Find a study area that's away from household noises.

If you have a family, let them know that studying is like a job and that you need quiet time to do your work. Schedule a regular time for studying at home and make it a routine. Soon your family will get used to the idea that when you're in your study place, you're unavailable except for an emergency. Let your family know how long you plan to study. Tell them you'll be unavailable for that period of time. Then stick to it. If your children know when you'll be available to listen, read, or play, they're more likely to be patient and understanding. Better yet, arrange to study when your children are asleep or when no one is at home. If your children are very young, study during their nap time or after they've gone to bed at night. If you're a morning person, get up an hour earlier than anyone else in the family and study then. An hour of concentrated work early in the morning can sometimes be more valuable than two hours late at night when you're tired.

The telephone can be a tremendous distraction. While you're studying, have someone else answer the phone and take messages for you. If you have an answering machine or voice mail, let the caller leave a message. If the phone really becomes a problem, leave it off the hook during the time that you're studying (Figure 13).

FIGURE 13—*Don't let the telephone become a problem for you. If you find that your study time is interrupted by the telephone, take it off the hook during that time.*



Some learners—for example, auditory learners—find they can study best with some background noise, such as the television, radio, or stereo. Others—for example, visual learners—find such noise to be a distraction. Experiment with your own study area. If you find you study best with music in the background, by all means use it as a study aid. If you find that background noise, such as the telephone, radio, or stereo, is a distraction, find a quiet place to do your studying. You're in control of how and when you study, and it's up to you to learn how you study best.

If you're unable to study at home, consider going to your local public or university library. Plan your time carefully and take all your necessary study materials with you. You should be able to find a quiet, well-lighted study space at

your public library (Figure 14). Most libraries have evening and weekend hours that may coincide with your study schedule. The feature that makes libraries a perfect study area is their atmosphere. Most of the people there are reading and spending time quietly.



FIGURE 14—A library may be just the place for you to study. It's quiet, you'll have no interruptions, and you have lots of reference materials on hand if you need them.

Organizing Your Materials and Tools

Organizing your study time is an important key to successfully completing your program. However, organizing your study materials and tools is equally as important. In fact, the two go hand in hand. If you don't have a regular study time that you stick to, having neatly organized materials won't help you very much. On the other hand, if you have to spend the first part of your study time organizing your materials or looking for lost papers and tools, your study schedule will be of little value.

Keep all of your materials in one convenient place. A sturdy cardboard box or plastic crate is a good storage place for your study units, study guides, textbooks, other program materials, and any correspondence related to your program.

To make the most of your time, make sure your study place has everything you need to get the job done. Here are some standard items you should keep at your desk or table:

- Ballpoint pens (Felt-tip markers tend to bleed through paper.)
- Pencils
- Highlighters to mark important items or passages in your text
- Lined notebook paper
- Typing or printer paper
- Three-ring binder, notebooks, or folders
- Dictionary
- Good desk lamp

Use the notebook paper for jotting down important points, things you want to read more about, questions for your instructor, and so on. Use the typing or computer paper to make sketches or diagrams, if appropriate, or to print out information you locate on the Internet.

Before you begin to study the materials related to your program, determine how you're going to keep track of your notes and other important papers. Ideally, you should create a separate folder for each study unit. Label the folder with the title of the unit, and keep all related papers in the folder.

A dictionary is an invaluable reference tool for any serious student. If you have one, keep it handy while you're reading so you can look up the meanings of any unfamiliar words you encounter in the text. If you have access to the Internet, search for online dictionaries. Add your favorite online dictionary to your list of Internet bookmarks.

Your study units carefully define and explain all new terms relating to the subject you're studying. However, you may encounter a general term that's unfamiliar to you. Get into the habit of looking up each word you don't understand. Consider starting a notebook specifically for vocabulary words. Review it occasionally, and make a deliberate effort to use the words in your conversations. (You'll be reading more about vocabulary notebooks in the next section of this study unit.)

Finally, make sure you have adequate lighting at your study area. Without proper lighting, you may become tired quickly, and you may find yourself rereading passages before you fully understand them.

In the final section of this study unit, you're going to examine some specific suggestions on how you can make your study time more profitable. Before you go on to that section, please complete *Self-Check 2*.



Self-Check 2

1. A person who learns best by reading is called a(n) _____ learner.
2. Where should you keep the calendar you use for scheduling your time?

3. *True or False?* Breaks during study times tend to interrupt your train of thought.
4. *True or False?* Some people study better if they have some background noise.
5. What is one advantage of studying at the library?

Check your answers with those on page 33.

Challenge Exercise

Have you thought about the time you're going to spend on studying the materials in your program? Have you established a schedule for yourself? Why not take some time to complete the chart in Figure 9. Doing so will help you get off on the right foot in your studies.

LEARNING SKILLS

In this final section, you're going to examine some specific suggestions on how you can make your study time more valuable. Not every method will be appropriate for your study habits. Choose those that you think will help you, or adapt some to fit your needs. Ignore those that you feel won't contribute to your understanding of the materials.

SQ3R: Survey, Question, Read, Recite, Review

SQ3R was developed in 1941 by Francis P. Robinson of Ohio State University. It's an old system, but it still works. Millions of students have successfully used this system, or a variation of it, to improve their reading and studying. SQ3R stands for *Survey, Question, Read, Recite, Review*. Let's take a look at each one of these elements.

Survey

The purpose of the *survey* step in SQ3R is to help you become familiar with your textbook organization. To survey material you're about to read, look quickly at the following types of features:

- Titles and other headings
- Illustrations, photos, charts, and graphs
- Text printed in highlighted boxes
- Boldface and italic type
- Self-check questions
- Summary, if appropriate

Scanning these features will give you a good idea of what topics you're about to study.

Question

The next step in the SQ3R method is *question*. This step requires you to leaf through the pages you're about to read and turn the headings into questions. Doing this helps direct your reading and your thinking. Then, as you read and study

the material, you can look for answers to your questions. For example, look at the first few heads at the beginning of this study unit. Here's how you can turn them into questions:

- What are the advantages of my program?
- What is the gap and how can I bridge it?
- How is my program designed?
- What study materials will I be using?
- What kind of examinations will I have to take?
- How can I log on to the Web site?

The better your questions are, the better will be your understanding of the material.

Read

Begin to read the material slowly and carefully, one section at a time. Don't worry about how long it takes. As you read, look for answers to the questions you've just asked. Highlight things you want to remember, make notes in the margins, and look up any words you don't understand. If you've completed the first two steps (survey and question), the material should seem familiar to you. You're prepared to read the new material more efficiently. You have an idea of the information you're required to learn and you're able to read with clearer intent. You know *why* you're reading a section and *what* to focus on.

Use a highlighter or a ballpoint pen to mark important points. If you use a highlighter, choose a color that won't bleed through the page. Don't use a pencil. A pencil with a sharp point may tear the page, and a mark made with a dull pencil point will smudge and fade.

Underline or highlight only important words or phrases. Try to avoid marking entire sentences. If you highlight too many things, nothing will stand out when you're reviewing, and your highlighting will be meaningless.

Specifically, mark definitions, examples, names, dates, and events. Also, mark principles, rules, and characteristics. Highlight words in boldface or italics. These are terms the author is emphasizing and wants you to remember.

Recite

Every time you come to a new heading in the text, stop and repeat, either silently or aloud, the main points of what you've just read. Recite it from memory or refer to your marginal notes or the information you've highlighted. If you have trouble with this step, reread the section until it becomes clear to you. Reciting the material in your own words is a tremendous aid to learning. It makes it easier to retain the information.

Review

Review any material you read as soon as you can. Review it again before you complete a self-check and again before you prepare the examination. This part of SQ3R helps to keep information fresh in your mind.

One way to review is to resurvey the material you've read. Or go over the notes you've made to see if they still make sense. Reread any passages that you've underlined or highlighted.

Another method you can use in the review step is to go back over the questions you developed for each head. See if you can answer them. If not, look back and refresh your memory about that particular topic. Then continue with your review until you're satisfied that you know the material well.

Building Your Vocabulary

Vocabulary Notebook

You may decide to create two separate vocabulary notebooks, one for terms relating specifically to the subject of your program and one for general vocabulary terms. Here's a good procedure to follow for increasing your vocabulary:

1. As you read, whether it's the newspaper, a magazine, a novel, or your textbooks, stop and write down every word you don't know.
2. Below the word, copy the phrase or sentence that contains the word.
3. Look for context clues. (This method is explained next.)

4. Look up the word in a dictionary and write down its definition.
5. Write a sentence of your own, using the new word.
6. Review the words periodically as your list grows.
7. Make it a point to use the word in your daily conversations. After you use it a few times, it will be part of your speaking vocabulary.

Context Clues

Before you look up a word in the dictionary, try to determine the meaning on your own. If someone were to ask you, “What does *loquacious* mean?” you might not know the answer. However, sometimes you can read the sentence or sentences around the word to get an idea of what it means. Clues you get from these sentences about the meaning of a word are called *context clues*. For example, the word *loquacious* occurs in the following sentence. Read it and see if you can figure out what *loquacious* means without looking it up in the dictionary.

Someone told me Carol was a loquacious individual, but I found her to be rather quiet.

Based on this sentence, you can assume that *loquacious* is the opposite of quiet. Therefore, it must mean talkative.

You can’t always determine the meaning of a word from its context. However, you can often get a good idea of what it means by carefully reading the sentence that contains the word and maybe a sentence or two before and after the word. Try it the next time you encounter an unfamiliar word. Then look the word up in a dictionary to see if you’re correct.

Prefixes and Suffixes

Another way to get a clue to the meaning of new words is to understand *prefixes* and *suffixes*. A prefix comes at the beginning of a word. Being familiar with the meaning of prefixes helps you to decipher the meaning of words. For example, the prefixes *im-*, *in-*, and *un-* mean *not*. Here are some words that contain these prefixes, along with the meaning of the words:

<i>impolite</i>	not polite
<i>improper</i>	not proper
<i>indefinite</i>	not definite
<i>inhuman</i>	not human
<i>unimportant</i>	not important
<i>unnecessary</i>	not necessary

The prefix *re-* means *again*. Some examples of words beginning with this prefix are

<i>reappear</i>	appear again
<i>recopy</i>	copy again
<i>repack</i>	pack again

A *suffix* comes at the end of a word. One common suffix is *-ly*. When this suffix is added to a word, it changes the word into an adverb that means *in a specified manner*. Carefully study the following words that end in *-ly*:

<i>slowly</i>	in a slow manner
<i>kindly</i>	in a kind manner
<i>tenderly</i>	in a tender manner

The suffix *-like* means *having the characteristics of*. Here are some examples of words ending in this suffix:

<i>catlike</i>	having the characteristics of a cat
<i>childlike</i>	having the characteristics of a child
<i>bulblike</i>	having the characteristics of a bulb

When you see an unfamiliar word in anything you read, check to see if it contains a prefix or a suffix. If you know the meaning of part of the word, you may be able to decipher the meaning of it all.

Dictionary

A dictionary will probably be your most important reference tool for this program or any other program you may take. Whenever you begin to use a new dictionary, survey it to become familiar with what it has to offer you. Most dictionaries include

- The pronunciation of the word
- The part of speech (noun, verb, adjective, adverb, pronoun, conjunction, or interjection)

- The etymology, or history, of the word
- The date the word first appeared in English
- The definition of the word

Get to know your dictionary and use it. A dictionary is much more than a place to look up the meanings of words you don't know. It's one of your most important study tools.

Completing Self-Checks

At the end of each section in your study units, you'll find self-checks. These quizzes are designed to test you on the material you've just read. Don't skip over these checks. If you go on without completely understanding what you've read, you may become more confused.

Before you complete any self-check, review the notes you've made in the margins and the material you've highlighted. Reread any notes you've made.

When you're confident that you've grasped the material in that section of the study unit, take out a clean sheet of paper and write the answers to the self-check questions. By writing the answers on a separate sheet of paper, you can take the quiz again when you're preparing for the examination.

When you finish a self-check, compare your answers with those provided at the end of the study unit. If you make a mistake on any question, go back to the page in the study unit where that particular material is covered. Reread the material until you're sure you understand it. Don't go on to the next section until you thoroughly understand the material in the section you're working on.

As a final review of the material, you may wish to locate the answer to each self-check question and highlight it in the study unit. This process is an important way to focus on what you need to know.

Preparing for Examinations

If you follow the suggestions in this study unit, you should have no difficulty reviewing the material for an examination. Use these tools, along with the answers to the self-checks, to prepare for the exam. Remember that the examination is an open-book test, which is designed as an additional learning tool. However, this doesn't mean that you shouldn't prepare. Familiarity with and understanding of the text material will make taking the examination that much easier.

Taking Examinations

Begin by surveying the examination questions. Read the directions carefully and be sure to follow them exactly. Do the easy questions first. Skip any you're unsure of.

While taking the examination, maintain a positive attitude. If you feel negative thoughts creeping in, say to yourself, "I've studied hard and I'm doing fine." Take a break if you feel you're not making any progress with the questions.

If you really get stuck on some questions, put the exam away until another day. When you come back to those questions, you may understand them better. When you're finished with all of the questions, check your work carefully. If you're still not sure about any question, locate the material in the study unit that explains the topic. Reread the material to see if you've selected the correct response. Change an answer *only if you're absolutely sure your first answer is wrong*. Double-check to make sure you've answered all of the questions.

When you feel certain you've done the best you can, submit your examination to the school. Remember: Using our Web site is the best, fastest, and easiest option available for submitting exams.

It's time now to apply some of the things you've learned in this study unit. First complete *Self-Check 3*. Then review the entire unit in preparation for the examination.

Good luck and much success in your studies.



Self-Check 3

1. Why should you turn a text heading into a question?

2. Why should you highlight boldface and italicized words as you read them in your text?

3. List three things a dictionary tells you about a word.

4. *True or False?* When you begin to take an examination, you should do the easy questions first.

5. *True or False?* A suffix comes at the beginning of a word.

Check your answers with those on page 33.

NOTES

Self-Check 1

1. True
2. True
3. False
4. True
5. False

Self-Check 2

1. visual
2. Keep your calendar some place where you'll see it every day.
3. False
4. True
5. You'll have a quiet atmosphere in which to study, and you'll be with other people who are reading and/or studying. In a library, you have a lot of reference materials available at your fingertips.

Self-Check 3

1. Turning a text heading into a question helps direct your reading and your thinking.
2. Boldface and italicized words are the key terms the author wants you to remember.
3. For each entry, most dictionaries give the pronunciation, part of speech, etymology, date the word first appeared in English, and the definition.
4. True
5. False

**A
N
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W
E
R
S**

NOTES

Learning Strategies

Whichever testing option you choose for your answers, you must use this

EXAMINATION NUMBER:

14700803

When you feel confident that you have mastered the material in this study unit, go to <http://www.takeexamsonline.com> and submit your answers online. If you don't have access to the Internet, you can phone in or mail in your exam. Submit your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–15: Select the one best answer to each question.

1. In which one of the following situations would a kinesthetic learner learn best?
 - A. Attending a lecture
 - B. Reading a book in a library
 - C. Participating in a hands-on workshop
 - D. Listening to a tape
2. While reading your study materials, what items should you mark by highlighting or underlining?
 - A. Every sentence under the section heading
 - B. Definitions, important events, and rules
 - C. Just graphs and charts
 - D. Only the words you understand

3. What is one advantage of the program you're just beginning?
- A. You can interact with other students.
 - B. You don't have any homework.
 - C. You don't have to take any examinations.
 - D. You can study when it's convenient for you.
4. If you've been working on a particular examination question and you can't figure out the answer, what should you do?
- A. Leave the answer blank when you submit the exam.
 - B. Call your instructors and ask for the answer or a page reference.
 - C. Guess at the correct answer.
 - D. Put the exam away for a day or two and then review it again.
5. Before you look up an unfamiliar word in the dictionary, you should first try to determine its meaning as you read by
- A. looking closely at the context in which you find the word.
 - B. looking at the title of the book you're reading.
 - C. rereading the entire book.
 - D. phrasing the word in the form of a question.
6. Most of the examinations in your program consist of
- A. essay questions.
 - B. practical exercises.
 - C. multiple-choice questions.
 - D. suggested activities.
7. Which one of the following actions should become an important part of your study schedule?
- A. Eliminating the activity in which you spend the most time
 - B. Taking regular breaks from your studies to keep focused
 - C. Finding out what works for others and then following the exact same schedule
 - D. Studying only in large blocks of time at one sitting
8. Which one of the following study materials contains self-checks?
- A. Supplement
 - B. Practical exercise
 - C. Graded project
 - D. Study unit
9. The best way for you to communicate with the school is through
- A. U.S. mail.
 - B. DIAL-A-QUESTION.
 - C. the Penn Foster Web site.
 - D. Tel-Test.

10. You've started using the SQ3R method of learning. After *surveying* a reading assignment, you go to the next step, which is *question*. What does this step involve?
- A. Asking yourself why you're taking the course
 - B. Asking yourself how the material relates to your friend's life
 - C. Reading the headings and turning them into questions
 - D. Reviewing the exam questions and looking for the answers without reading the study material
11. Which one of the following booklets includes activities designed to help you apply your study material to real-life situations?
- A. Practical exercise
 - B. Study unit
 - C. Study guide
 - D. Supplement
12. Which one of the following study materials is designed for use with a separate textbook?
- A. Dictionary
 - B. Study guide
 - C. Practical exercise
 - D. Supplement
13. Suppose you're just beginning to study the information in your third shipment of material. When can you expect the next shipment to be sent?
- A. In approximately one month
 - B. When you call and request it
 - C. When you submit a certain number of examinations in your current shipment
 - D. After your instructor has evaluated all of your work in the current shipment
14. What should you do *first* when you begin to study a new text or study unit?
- A. Read only the boldface type or italicized print.
 - B. Dive right into the first page and read the assigned section.
 - C. Don't worry about words you don't understand; you don't have to look them up.
 - D. Survey the material in the text using the technique called SQ3R.
15. Which one of the following prefixes means "again"?
- A. re-
 - B. im-
 - C. in-
 - D. un-

Study Unit

Locksmithing: An Expanding Career Field

Program Preview

Welcome to the Education Direct Professional Locksmith program. Locksmithing is a growing field that can provide a fascinating career, a good income, job security, and self-fulfillment to anyone with a desire to work hard and succeed. The professional locksmith possesses highly specialized skills that few others have, so a skilled locksmith is always in demand. As a locksmith, you'll do interesting work while you're helping people. For this reason, a professional locksmith is always highly regarded in the community and commands the respect of friends and business associates.

We designed this practical program to teach you all the basic skills you need to start working as a professional locksmith. You can start using your new skills right away so that you can get the most out of your investment in training. You'll learn at your own pace (as fast or slow as you wish) through step-by-step instruction. The lessons include hands-on exercises with real locks and professional-quality locksmithing tools. You'll get all the benefits of professional instruction and training with none of the hassles of the formal classroom. In addition, all the valuable tools that come with your program are yours to keep and to use when you start your professional career!

Many professional locksmiths have started successful careers with much less information than you'll get in this program. With a willingness to learn and a little hard work, you can soon establish yourself as a first-rate locksmith in your community.

As you begin this program, you'll see why there's a growing need for locksmiths. You'll discover all types of locks and security devices and you'll learn how to repair and install all of them. You'll learn what types of tools locksmiths use and how to set up a proper workbench the way the professionals do. Later in the program, you'll learn about locksmithing specialties like auto work, safe work, and electronic security. We'll even show you how to open your own business when you complete the program.

Just about everyone has thought about what it would be like to have their own business. When you own a business, you work for yourself—you're the boss. Your creativity and good ideas won't go to waste. You're the most important person in the company and no one can fire you. All of the profits of the business are yours; you can feel that your hard work is really paying off. In this program, you'll learn how you can start your own business and become self-employed, if you choose. You'll also learn professional locksmithing methods that will save you time and maximize your profits.

On the other hand, you may prefer to work for someone else. Perhaps you only want to work part-time, or even as a sub-contractor performing repairs only occasionally. Well, there are many excellent opportunities in locksmithing for you too! You may choose to work for an established locksmith, a security installation company, or even part-time in your own home. We'll provide you with plenty of information about where to look for jobs when you complete the program.

Your Program Diploma



Upon completing all your program requirements, you'll receive a professional diploma from the school recording your achievement. You'll be proud to display your well-earned diploma in your home or in your business.

Home study provides millions of people with the opportunity to learn new skills, earn diplomas, and start new careers. These achievements represent dreams come true for people of all ages. Anyone who has the desire to succeed can find personal satisfaction through home study programs. By making the commitment to complete this program and earn your diploma, you're making a valuable investment in your own future.

Remember that each and every skill you'll be learning in this program has a real-life, hands-on application that can help you earn money and improve your job outlook. This fact alone should keep you working hard at your lessons!

Now, take a look at all the items in this first package of materials. You'll see the books containing your lessons (called study units), the program glossary, and a specially designed lock to use as a hands-on learning aid. You'll also find your Student Handbook. The handbook contains valuable information on how to get help from your instructor, how to take exams, and how to get customer service assistance. Refer to the handbook whenever you have questions about the school.

The program glossary is a locksmithing "dictionary." It contains many terms that you'll hear all the time as a locksmith. It would be a good idea to skim through the glossary now to become familiar with it. Then, when you start your first lesson, keep the glossary handy to look up any words you need to remember. This is the fastest way to learn the special "lingo" of the locksmithing field.

In conclusion, remember that we want you to succeed. *Your success is our success.* Follow the instructions in your Student Handbook to write or phone in your questions.

Now, let's take a look at your learning goals for this first study unit. When you complete this study unit, you'll be able to

- Define locksmith
- Name several tasks that locksmiths routinely perform
- Explain why today's world needs locksmiths
- Discuss the security industry and how the locksmith fits into it
- List several employment opportunities for locksmiths
- Discuss the type of certification, licensing, and registration that may be required of locksmiths
- Name several personal qualities of a good locksmith

- Describe the mission of a locksmith and explain why professional ethics are important
- List several ways you can offer outstanding service to customers

Now, get ready to start your first lesson. We'll begin with an introduction to the expanding career field of locksmithing. Let's turn the key and open the door to an exciting new career! Good luck with your studies!

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Locksmithing: An Expanding Career Field

LOCKSMITHING: AN INTRODUCTION

What Is a Locksmith?

Locksmithing is an ancient skill that has been around for thousands of years. From the earliest days of humankind, people have needed some way to protect their valuables. Today, we use locks to protect our cars and cash; thousands of years ago, our ancestors protected their food supplies and farm animals in the same way. Ancient paintings on Egyptian walls show a lock being used to protect a king's treasure. The early locksmith who made that lock was as important and highly respected as modern locksmiths are today.

The locksmithing profession is an honorable one, and locksmiths have held a position of trust in the community for hundreds of years (Figure 1). Professional locksmiths are guardians of security. For this reason, locksmiths must be exceptionally honest, trustworthy, and of good character. A good reputation is essential to maintain the confidence of your customers.

FIGURE 1—*The professional locksmith holds a position of trust in the community.*



In the past, a typical locksmith installed, repaired, and replaced locks and keys (Figure 2). In more recent years, however, the development of new security devices has expanded the locksmithing field. A typical locksmith may now install and service a variety of electric and electronic security devices in homes, businesses, and cars, as well as traditional mechanical locks. As populations grow and crime rates continue to rise, we expect the need for residential and commercial security to increase.



FIGURE 2—Locks and security devices come in many shapes and sizes.

Locksmiths Are Needed

Everyone needs a locksmith sooner or later! Our world is filled with locks (Figure 2). We protect our homes, our cars, our property, and our loved ones with them. Think about all the uses for locks — in cars, in homes, in hotels, and in schools, just to name a few. Now think about how many new homes and cars people purchase each year. Your front door probably has at least two locks on it (maybe more if you live in a large city). The average car may have as many as eight locks on it—ignition, doors, trunk, glove compartment, and gas cap. Offices, factories, retail stores, and other businesses have locks on file cabinets, desks, toolboxes, cash registers, employee lockers, and safes. Most commercial buildings (and many homes) have state-of-the-art electronic security systems, burglar alarms, motion detectors, and security lighting. You may even have a lock on your bike, firearm, briefcase, or mailbox.

Locks give us a wonderful feeling of security—when they're working efficiently. But what if a lock breaks? What if you lose your keys, or lock them inside your car with the engine running? What if a burglar violates your home? Who can help you?

The answer is the *professional locksmith*. The locksmith gets you back on schedule when you lock yourself out of your car. The locksmith protects your family and property from burglars and intruders. The locksmith protects millions of dollars' worth of cash, documents, equipment, and merchandise in banks, factories, offices, and retail stores from theft and vandalism.

In a sense, therefore, locksmiths sell security and peace of mind to their customers (Figure 3). A skilled professional locksmith can build a successful career and earn a comfortable living from keeping customers, their families, and their property safe.

FIGURE 3—A
*locksmith helps
people feel safe at
home.*



The Jobs Locksmiths Do

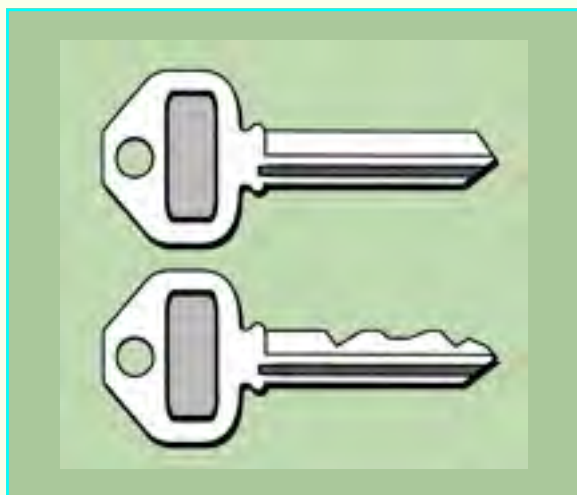
The average locksmith performs a variety of skilled jobs, depending on the needs and requests of their customers. Some locksmiths specialize in working on just one type of lock (such as auto locks or safes). Others work on all kinds of locks. Let's take a closer look at the typical jobs that most locksmiths do. (*Note: As you read through the following section, pay special attention to the words in italics. We'll use italic type throughout your program to help you notice important terms*

you'll want to remember. These terms are everyday words you'll hear often in the locksmith business, so it's important to learn them well.)

Duplicating keys. One of the most common locksmithing tasks is key duplication. Customers will frequently bring in a key and ask you to make copies. This simple service can make up a large part of a locksmith's income. In fact, a medium-sized shop may sell as many as six hundred duplicate keys per week! It's important for a locksmith to be able to provide fast service and a copy that works as well as the original key.

When you make a new copy of an old key, the new key must have the same basic shape and characteristics as the old key. For this reason, a locksmith keeps a large selection of different *key blanks*, or uncut keys, on hand to match up with the key the customer has (Figure 4). One of the most important skills a locksmith acquires is the ability to quickly recognize and identify the key blanks used by different manufacturers.

FIGURE 4—This figure shows a customer's original key and a matching blank.



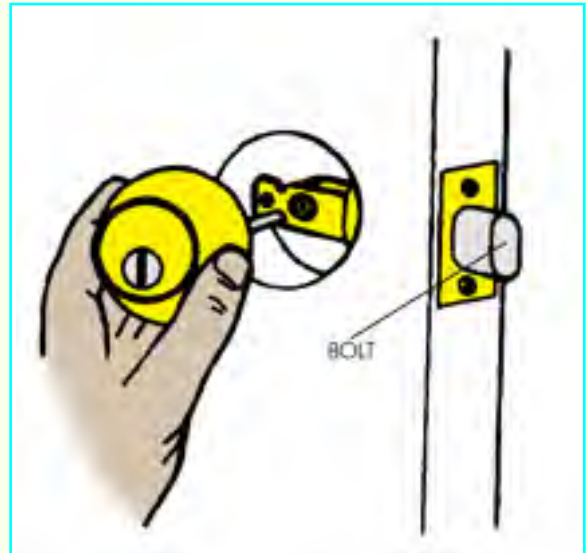
While many hardware stores and drugstores offer key duplicating, few stores keep a wide variety of key blanks in stock, so they'll usually only be able to copy the simplest and most common key types. Also, a professional locksmith is much more skilled at making copies that fit and work perfectly.

Occasionally, a locksmith may need to make a special key *by hand* for an old-fashioned or obsolete lock. For example, a customer may have lost the key to an antique desk or cabinet. In this situation, it may be impossible to replace the old lock without damaging the piece of furniture. So, the locksmith

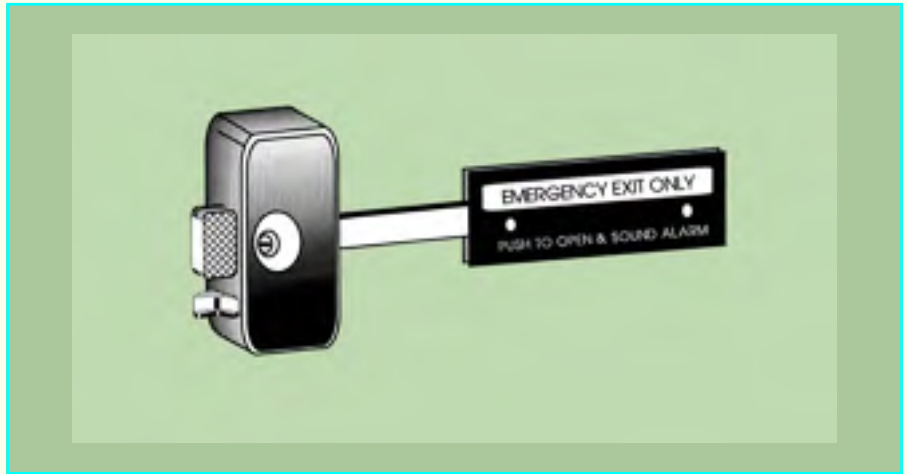
may custom-make a key by hand-filing a key blank. The locksmith doesn't perform this kind of work unless there's no alternative.

Installing locks. A locksmith may receive a call to install a lock on a front door, an inside door, a window, a toolbox, or just about anywhere else a customer requests. However, the largest portion of a locksmith's business comes from ordinary front door lock installations, replacements, or security upgrades (Figure 5).

FIGURE 5—Installing a Door Lock



Many locksmiths expand into installing commercial locks. Any facility or business that the public frequents has the potential of buying security merchandise from a locksmith. For example, the Life Safety Codes mandate the installation of *panic hardware* and *fire exit latches* in most public buildings, or special door locks that anyone can open in an emergency by leaning on or pushing a bar (Figure 6). Panic hardware differs from fire exit hardware, so be sure to purchase the correct one.

FIGURE 6—A Panic Bar

Stores install security systems to discourage pilferage and theft. Then, too, there are office security devices to install and service, like desk locks and filing cabinet locks. Finally, schools, hotels, and office buildings may contract a locksmith to install locks.

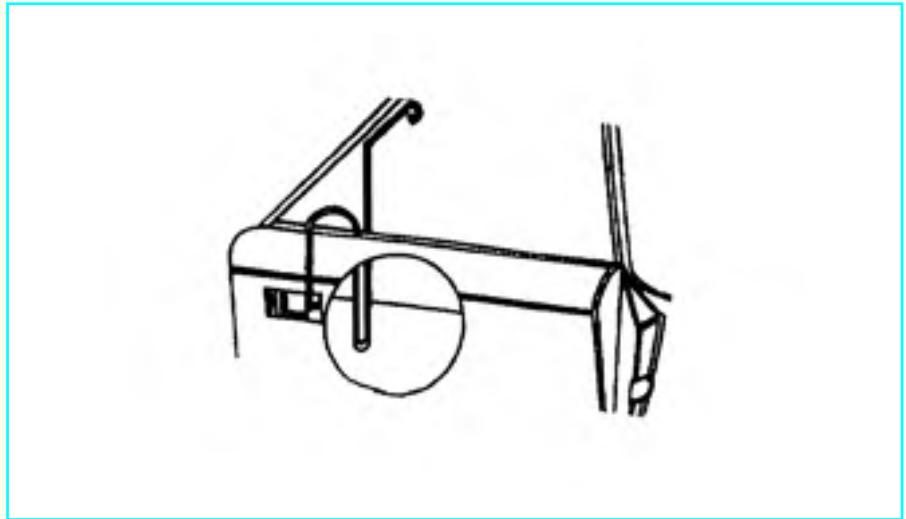
Repairing damaged locks. You wouldn't automatically replace all damaged locks with new ones. Any type of lock can need occasional repair, or a cleaning to remove dirt, oil, and rust from its delicate inner mechanism (Figure 7). A locksmith may replace a damaged part, lubricate a rusted lock, remove a broken key from a lock, or thaw out a frozen car lock in the winter-time. In addition, locks damaged by attempted forced entry will need repair.

FIGURE 7—Lubricating a Lock

Lock opening. Another important locksmithing skill is emergency lock opening, which involves the use of a number of specialized tools and techniques. For example, a locksmith can pick open a lock, but this technique is time-consuming. In emergency situations, a locksmith may have to force a lock open using a hammer, a wrench, an electric drill, or bolt cutters.

Auto work. It's normal duty for a locksmith to travel out to help locked-out drivers get back into their cars. It may be necessary to use specialized tools to unlock the door or trunk (Figure 8). It's even possible for the locksmith to make a new key at the scene, using the tools carried in the mobile workshop.

FIGURE 8—Opening a Locked Car

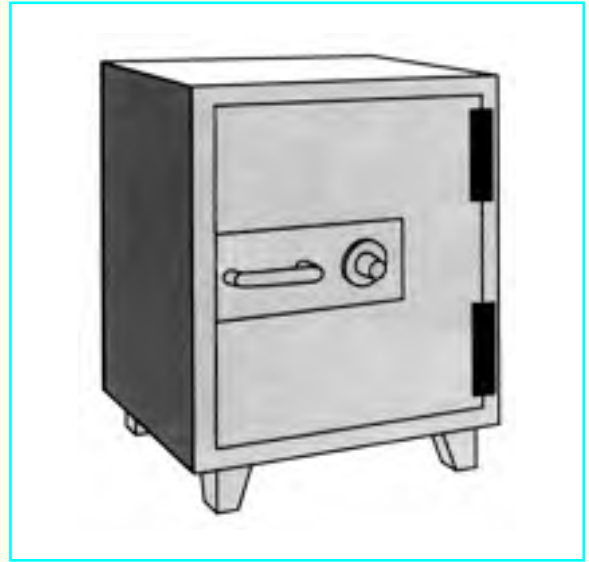


Evaluating home and business security. A locksmith employee who knows enough about security alarm systems might be asked to inspect a commercial establishment and give suggestions for putting in electronic devices to protect the business. The proposed security system can focus on areas of primary concern to the owner, such as employee pilferage, shoplifting, break-ins, or other risks.

Safe work. Servicing of safes involves repair, cleaning, changing combinations, and opening without a combination (Figure 9). One of the most common tasks is changing the combination, or *recombining*. Businesses often require this service when employees leave. The locksmith changes the combination to prevent anyone who knew the old combination from gaining access to the safe. Locksmiths either remove the safe mechanism to the shop or do the work on-site. Repair work may involve something as simple as replacing a broken handle. It's not uncommon for a locksmith to demonstrate how to properly dial a combination.

Also, banks call upon locksmiths to service and repair safe-deposit boxes.

FIGURE 9—A Floor Safe



Installing burglar alarms. The increasing demand for security products has made burglar alarm installation a growing area of specialization for many locksmiths. Burglar alarms, both residential and commercial, are an excellent source of specialized business.

We conclude our brief examination of what locksmiths do. We'll review all this information in detail later. For now, though, note that we intended this section as an introduction to locksmithing skills and terms. We'll discuss all of the professional skills in great detail in future study units. For now, however, you should keep an important fact in mind. Most locksmiths specialize in just one or two important locksmithing skills. This is because the locksmithing field varies widely, and it's virtually impossible for every locksmith to know how to do everything. For example, the field of safe opening is a specialized profession that not all locksmiths enter into. Installing electronic devices is another example of a specialized field.

There are hundreds of lock manufacturers and locking devices in existence, and manufacturers are constantly updating and improving their products. It's impossible to know everything about every kind of lock made in the world! Also, you would need a wide variety of expensive tools to offer every possible service for every lock made. Many locksmiths run very successful businesses offering only simple repairs, key cutting, and lock sales.

A beginning locksmith should concentrate on learning about the most modern and popular locks, and the most commonly used types of locks. *If you thoroughly understand the basics of how different types of locks work, you'll be able to work on just about any device a customer brings you.* Once you've mastered the basics of the field, you'll then be able to move on to specialize.

Tools a Locksmith Needs

A locksmith uses many ordinary tools found in any workshop, such as screwdrivers, hammers, pliers, small vises, and metal files (Figure 10). In addition, a locksmith needs specialized tools for work with different types of locks. Some examples of specialized locksmithing tools are lock picks, key gages, pick guns, and broken-key extractors (Figure 11).

FIGURE 10—Standard Tools Used by Locksmiths

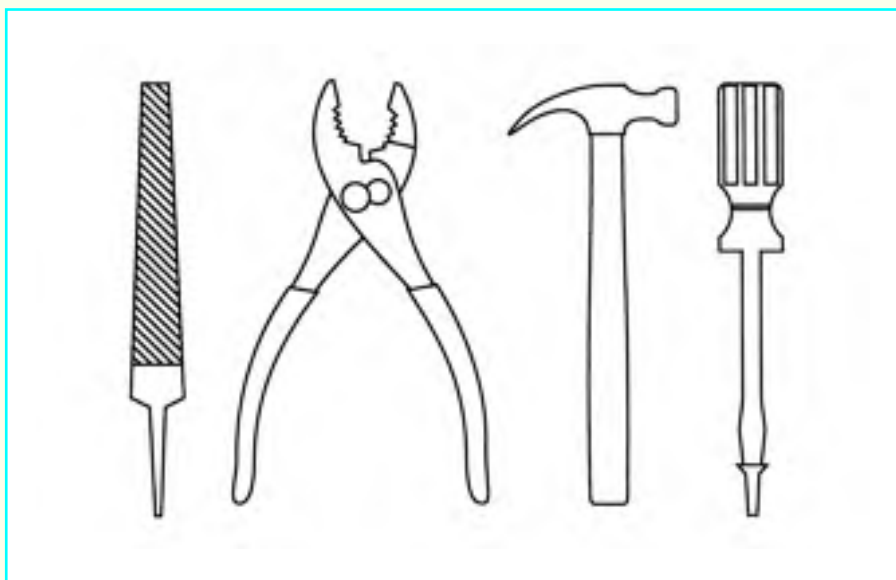
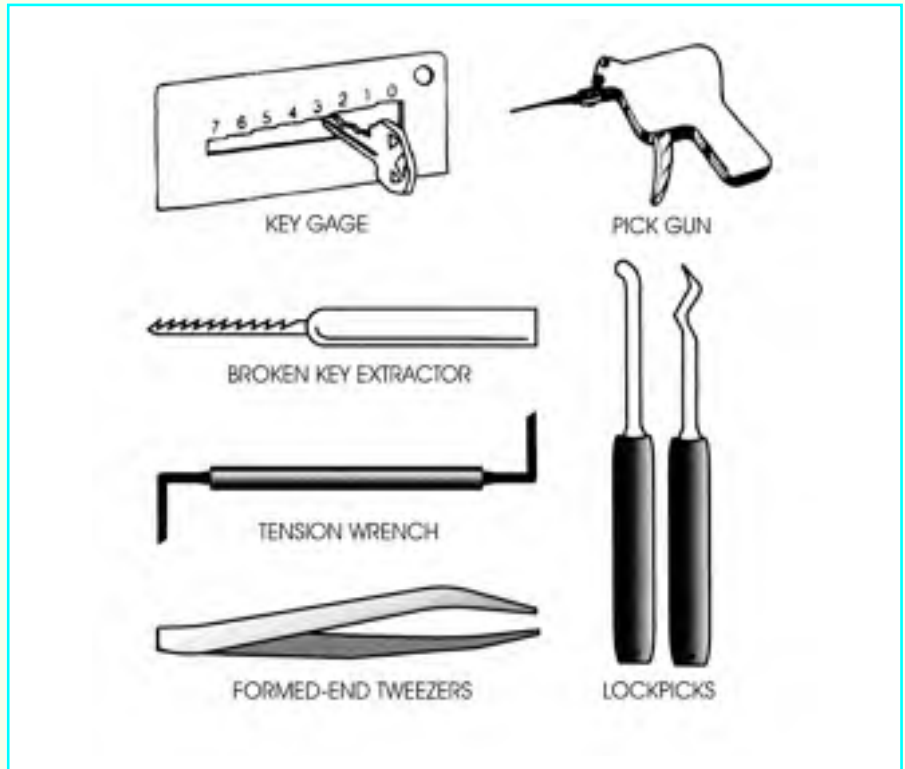


FIGURE 11—Specialized Locksmithing Tools



A locksmith also needs lock parts and supplies. A typical locksmithing shop will always keep a large assortment of key blanks on hand, plus a selection of commonly used lock parts, like pins and springs. In addition, most locksmiths sell locks and locking devices to customers in their shops.

Reference books and publications, like tools, are essential to the locksmith. Most locksmiths keep a variety of reference books on hand, and their collections keep growing all the time. One of the most important resources is a key blank directory. A *key blank directory* identifies the manufacturer's name and number on a given key blank. The locksmith needs to know this information before duplicating a key.

Another important source of locksmithing information are *key code books*. These reference books decode the numbers and define the cuts in a given key (particularly auto keys) so that the locksmith can generate a key. We'll discuss how to use locksmithing reference materials later in the program.

You can order all of the tools, supplies, and reference books we mentioned here from hardware and locksmithing supply catalogs. Later on in the program, we'll discuss locksmithing tools and supplies in more detail, and you'll have the opportunity to complete actual hands-on exercises using tools we supply

with the program. We'll also provide you with a supplier's listing and information on how to order your tools and supplies.

The next section of this text will introduce you to the growing security industry and explain how the locksmith fits into that picture. However, before you proceed, take a few moments to complete *Locking It Up! 1*.



Locking It Up! 1

At the end of each section in *Locksmithing: An Expanding Career Field*, you'll pause and check your understanding of what you've just read by completing a "Locking It Up!" quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

Indicate whether each of the following statements is True or False.

- _____ 1. Some examples of specialized locksmithing tools are screwdrivers, hammers, pliers, small vises, and metal files.
- _____ 2. Local hardware stores can duplicate keys for customers, so locksmiths seldom perform this service.
- _____ 3. Locks almost never need cleaning to remove dirt, oil, and rust from their inner mechanisms.
- _____ 4. Lockpicking is the fastest way to get a lock open in an emergency situation.
- _____ 5. The term *recombining* means to change the combination of a safe.
- _____ 6. If a person loses a car key, he or she can simply go to a hardware store and purchase a duplicate.
- _____ 7. An average car may have as many as eight locks on it.
- _____ 8. Occasionally, a locksmith may need to make a special key by hand for an old-fashioned or obsolete lock.

Check your answers with those on page 39.

THE SECURITY INDUSTRY

The Growing Crime Problem

There has never been a world more security-conscious than at the present time. New, tougher crime-fighting laws are constantly enacted, especially laws to fight violent and drug-related crimes. More laws haven't brought safety, or even a feeling of security, to the general public. The fear of crime is becoming a state of mind in many areas—urban and rural, affluent and poverty-stricken (Figure 12). For this reason, the average citizen is becoming increasingly aware of the need for home protection.

FIGURE 12—*The fear of crime is becoming a state of mind for many people.*



The FBI's *Uniform Crime Report* compiles statistics on reported crime in the United States annually. The crimes included in the report are divided into the categories of *violent crime* and *property crime*. Statistics from a recent year indicate that a total of 13.9 million criminal offenses were reported. Violent crimes accounted for 11 percent of this total; crimes against property accounted for the remaining 89 percent. This means that in the United States, one violent crime was committed approximately every 20 seconds, and one property crime was committed every 3 seconds.

The Canadian Center for Justice Studies publishes similar statistics in their annual *Canadian Crime Statistics* report. Statistics from a recent year indicate that 300,000 crimes were committed. Violent crimes accounted for 15 percent of this total, and crimes against property accounted for the remaining 85 percent. Thus, in Canada, one violent crime was committed every 2 minutes, and one property crime was committed every 18 seconds.

Preventing Crime

Statistics show that 70 percent of all burglars are amateurs who have no special training or familiarity with locks or security devices. Most are simply opportunists who take advantage of the first unlocked door or vulnerable target they find. Most retail shoplifters are also amateurs, and they tend to steal from stores where there are few or no preventative measures against shoplifting. In contrast, many car thieves are professionals. However, they'll also seek an easy target. The risk involved in stealing a car that has excellent security protection is too great. The thief simply won't have time to disarm the alarm system before being discovered.

Target hardening is one of the best techniques for fighting crime. The *target* is whatever the thief wants — cash, merchandise, or entry to a home. *Target hardening* means making the target harder to get to (Figure 13). An efficient burglar alarm or electronic security system is one of the best methods of target hardening, and more and more citizens and businesses are installing these devices. A vast new market for security products now exists. The security industry dedicated itself to developing and distributing new and better products to the public.

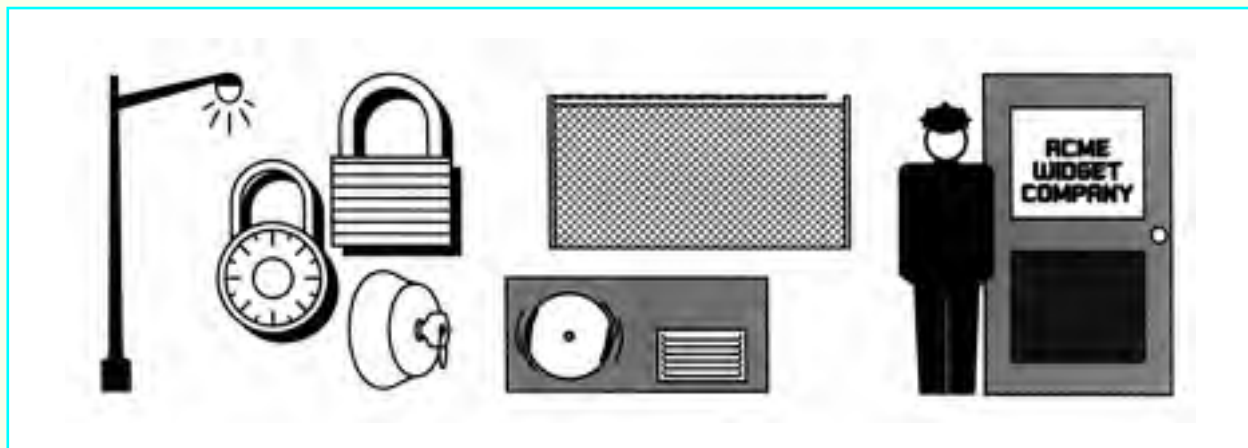


FIGURE 13—All of these devices improve security by making a target harder to invade.

The Security Industry Defined

The *security industry* is a broad-based market of products and services that protect life and property. The industry includes manufacturers, distributors, and sellers of security services and hardware, as well as all persons who work to prevent and control crime and maintain safety.

Security services are services that protect or secure persons or property, such as burglar and fire alarm monitoring (Figure 14) or patrols by uniformed officers. *Security hardware* is any equipment used to protect persons or property—locks, lighting devices, safes, and video cameras. *Security personnel* include employees such as gate guards, armored car drivers, and night-watch officers. A single business (an alarm company, for example) may privately employ security personnel or a government agency (such as the police force) may employ security personnel.

FIGURE 14—An Alarm Monitoring Service



Security manufacturers are all those companies that make security products. All tools, locks, hardware, locksmithing supplies, and key-making equipment are the end product of manufacturers. Some companies specialize in making electronic security devices, others make tools and equipment, and still others make high-security locks, automotive locks, safes, and so on.

The security industry manufactures many products that provide home and personal protection. Some products are designed for residential use (locks and alarm systems). Some products have commercial applications (panic bars, electromagnetic locks, high-security locks, and surveillance devices). Personal security items include stun guns and liquid pepper sprayers. Automotive security devices include antitheft alarms, ignition cutoffs, keypad door locks, and steering wheel “clubs.”

Security manufacturers and distributors have made a significant contribution toward public security by making available effective new devices and systems proven to deter crime. As you progress through this program, you’ll learn about many recognized manufacturers in the security industry.

Where the Locksmith Fits In

The crime statistics we’ve listed here are discouraging. However, they demonstrate that we need locksmiths to help fight crime. The locksmith is one of the most important members of the security industry. As a locksmith, every time you recommend, repair, or install a lock or security device, you’ll indirectly be preventing a crime from occurring.

The surging demand for improved home and business protection has created a vast new market for the locksmith’s skills. For this reason, locksmiths should keep up-to-date on crime trends, especially property crimes, and also on all new product developments in the security field. The best way to keep current is to subscribe to a popular trade journal. These publications offer up-to-the-minute information on products, as well as useful articles on lock servicing and installation. By keeping informed of news and trends in the security field, professional locksmiths can turn crime fighting into a lucrative business!

Now, in the next section of the text, we’ll look at some of the many employment opportunities available to locksmiths.

Employment Opportunities in the Security Industry

Where Locksmiths Work

As a locksmith, you'll have many opportunities for employment, each offering different advantages. You may choose to work in someone else's shop, your own shop, as a subcontractor, in a mobile van, in-house, for a manufacturer, as an installer, even as an instructor. Keep in mind that locksmithing tends to be "recession-proof," meaning that business tends to be good whether overall economic trends are good or bad. This paints an optimistic employment picture for the skilled locksmith!

No matter where you decide to seek employment, you'll draw on the many different skills you'll learn in this program. Later in the program, we'll provide you with valuable information on how to start your own business, how to apply for jobs, write resumes, and sell yourself in a job interview! For now, though, let's look at some of the different places locksmiths work.

Working for an Established Shop

As a beginning locksmith, you may choose to work in an established locksmithing business for a while to gain experience. Locksmith shops vary in size depending on the number of services they offer. You can find larger shops that have a dozen employees assigned to specialized tasks. Or, you may find small businesses operated by just one person. No matter what the size, however, many locksmithing shops can offer part-time or full-time employment.

As an entry-level locksmith working for someone else, your first assignments will probably be duplicating keys and answering the phone. Soon after, you may start doing service or repair work on locks in the shop. Later on, depending on your level of skill and experience, you install devices at customer's homes or perform mobile service calls on the road. After you've demonstrated your ability at the job for a while, you may decide to specialize in a particular task, such as auto opening or safe work.

Owning Your Own Shop

If you have business skills and a little more ambition than average, you may decide to open your own locksmithing shop. If you should decide to go into business for yourself, you may want to start out working in your own home. Many professional locksmiths start out this way, since it offers an opportunity to get started in the profession without the expensive investment of a shop.

Later on, you may consider setting up shop in a fixed location. You can develop a good business from a small two-room store. As your business grows, you might purchase a van for road service calls, hire employees, expand your advertising, hire subcontractors, and so on. Remember, later in the program, we'll be providing you with all the information you need to start your own business.

Subcontracting

Subcontracting is a form of self-employment in which you handle contracted jobs for another business. The other business hires you to complete jobs that it's unable to handle. The other business pays you, not the customer.

A variety of businesses may be interested in hiring a locksmith for subcontracting work. For example, an architectural firm that builds new homes may need someone to install all the locks in these buildings. Hotels or schools may hire you to replace or repair locks in their facilities. Or, another locksmithing business may hire you to perform jobs that it can't do, either because of a heavy workload or because you have specialized skills.

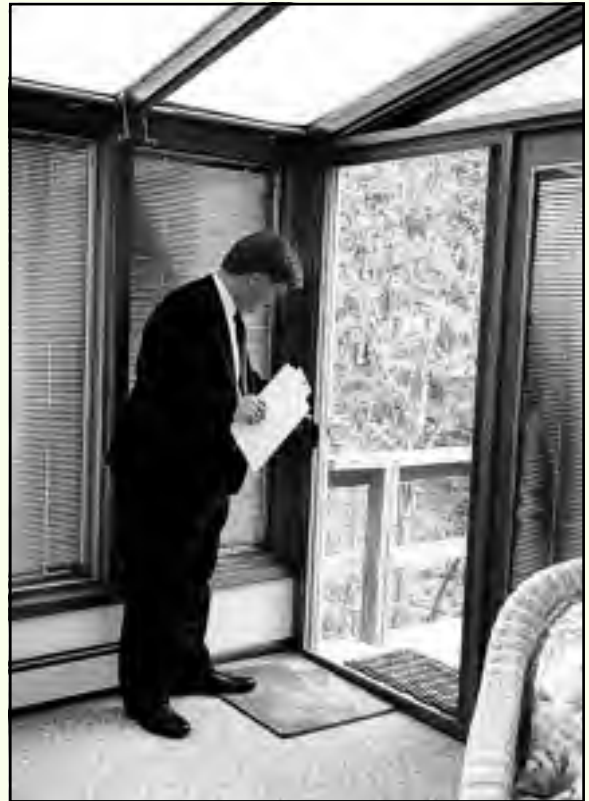
As a subcontractor, you'll be responsible for your own transportation, tools, materials, and record keeping. You may need to invest in a car or van to get you to and from jobs. However, you'll be able to take on many lucrative jobs without having the responsibility of running your own business.

Security Consulting

Many individuals and businesses turn to locksmiths for advice on how to prevent intrusion and protect property. For this reason, in addition to selling, installing, and repairing locks, a skilled professional locksmith who knows about crime prevention can find work in *security consulting*.

As a consultant, the locksmith first confers with customers to determine their security needs and fears. Then, the locksmith visits the customer's business or home to make an evaluation of the security of the property (Figure 15). Finally, the locksmith offers recommendations on products and techniques that can improve security. Security consulting can develop into a lucrative full-time job or a profitable sideline for some locksmiths.

FIGURE 15—A
*Locksmith Working
as a Security
Consultant*



Operating a Mobile Business

If you can't afford to open a shop at a permanent location, but you already own a van or pickup truck, an alternative may be to open a *mobile business*. In a mobile locksmithing business, you'll take service calls from customers and then travel to and from each job (Figure 16).

FIGURE 16—A Mobile Locksmithing Business



You'll have to outfit your van or truck with all the tools and materials you'll need to repair, replace, or install locks right on the scene. The tools include a workbench, key-cutting machine, and an inventory of parts.

A telephone is an important part of any mobile operation. Since there's no walk-in business, a mobile shop will be almost entirely dependent on telephone requests. You may use an answering service or take the calls yourself, depending on how busy you are.

A mobile business has the advantages of low operating costs (although there is an investment in tools and supplies) and the ability to help customers whenever and wherever needed. Since many locksmithing service calls are on the road where a customer is locked out of a car, you can see the profit potential of a mobile business.

Working as an In-house Locksmith

In-house locksmiths work in a variety of businesses, institutions, and government buildings. The in-house locksmith works right in the building and has an office or workroom there. The locksmith is on hand to provide services immediately. An in-house locksmith is generally in charge of all locksmithing duties, including door locks, security systems, company

vehicles, and locks on gates and outbuildings. These positions usually pay well in both salary and benefits. Experience is generally a requirement for in-house positions, but you can gain all the experience you need in a locksmith shop.

Working for Manufacturers and Distributors

Some manufacturers of locks and security devices employ locksmiths in their factories, warehouses, or offices to sell merchandise, stock their inventory, and serve customers. Some creative and talented locksmiths even work on developing new products for the industry. In addition, the company locksmith may be in charge of continuing education or training for other employees.

Teaching, Instructing, and Writing

Some experienced locksmiths find employment training others on a full-time basis. A vocational training school may hire you to conduct private seminars or lectures for a fee (Figure 17). In addition, many locksmithing publications accept articles and stories from professional contributors. In time, you may even want to publish a training manual or a book on a locksmithing specialty.

FIGURE 17—Some locksmiths demonstrate their skills in classrooms



Now, before you proceed to the next section of the text, take a few minutes to complete *Locking It Up! 2*.



Locking It Up! 2

Fill in the blanks in the following statements.

1. The _____ is the number of crimes reported annually per 100,000 inhabitants.
2. The crimes included in the FBI's Uniform Crime Report are divided into the categories of _____ and _____.
3. One of the best techniques for fighting crime is _____.
4. The _____ is a broad-based market of products and services that protect life and property.
5. _____ are all those companies that make security products.
6. _____ is a form of self-employment in which you handle contracted jobs for another business.
7. A skilled professional locksmith who knows about crime prevention can find work in _____.
8. If you can't afford to open a shop at a permanent location, but you already own a van or pickup truck, you could open a _____ business.

Check your answers with those on page 39.

LOCKSMITH QUALIFICATIONS

The Mission of a Locksmith

The mission of a business is its purpose for existing. For example, the mission of the legal profession is to protect the rights of clients; a doctor's mission is to save lives and to support the quality of life. In the same way, the mission of a locksmith is to promote security and peace of mind by supplying products that will defend customers, their families, and their property. The mission of the locksmith, therefore, carries with it a professional obligation toward customers, business associates, the security industry, and the public at large.

How can you fulfill this mission? Well, in this portion of the text, we'll look at some of the qualities, characteristics, and abilities that are desirable in a professional locksmith. Note that qualified locksmiths come from all walks of life and from a variety of age groups.

Education and Training

In locksmithing, the number of years of formal education isn't as important to success as is an *aptitude* (natural ability) for the work. Since you have enough interest in locksmithing to take this program, you probably already have natural ability. A high school or college education isn't necessary to be successful (although, of course, education is never a waste). If you have some natural mechanical ability, you probably have the creativity and intelligence that tends to go along with it.

Locksmithing places emphasis on the kind of brainpower associated with being alert, perceptive, patient, and attentive to details. One experienced locksmith indicates that we can sum up the mental tools needed for this work in a simple phrase, "common sense." Common sense, plus the skills you'll learn in this program, are the most important ingredients of a successful career in the industry. However, you should always improve your locksmithing skills, so even after you complete this program, continue reading trade journals or attend conventions and seminars to keep up with changes in the industry. Continuing your education is *very important*.

Personal Qualities

People Skills

Virtually anyone who's willing to work hard to learn the job can become a locksmith. However, learning to communicate with other people isn't easy. Developing "people skills" is as much a part of locksmithing as any other business. *People skills* are communication skills that strengthen understanding between persons (Figure 18).

FIGURE 18—"People skills" improve communications between persons.



High on the list of these skills is consideration, sincerity, courtesy, patience, and *empathy* (the ability to relate to and understand the problems of others). Any previous experience you've had in dealing with the public will be a definite asset to your locksmithing career. You'll use your communication skills every day when dealing with customers, manufacturer's representatives, employees, and phone callers. In fact, your communication skills are just as important as your technical skills as a locksmith!

Professional Image and Conduct

Did you know that a person will, upon meeting you, form an opinion of you within just a few minutes? Once a person forms an opinion, whether good or bad, it will be hard to change it. For this reason, it's vitally important that you always look

and act like a professional. This way, you'll always make an excellent first impression that creates confidence in your customers.

The pursuit of excellence sets a fine locksmith apart from an average one. Paying attention to detail is one important way to provide excellent service. You'll inspire confidence and loyalty in your customers when they perceive you to be honest and skilled in the way you conduct your business. One thing you should always avoid is "putting down" the work of other locksmiths in an attempt to gain business for yourself. Let your excellent work and professional manner speak for themselves, and you'll get all the business you can handle.

Remember, as an expert and a professional, you should always make an effort to look good, even when you're making a road call. No one is saying that you must look like a fashion model, but you should dress neatly, practice good grooming, speak pleasantly, and keep your vehicle and tools neat and clean (Figure 19). In addition, keep your shop and office well organized and attractive. An unkempt appearance detracts from your professional image and may even cause you to lose business.

FIGURE 19—A locksmith should dress neatly to maintain a professional image.



You may think that your appearance is unimportant if you're an excellent locksmith: "My customers care about my service, not the way I look." However, remember that the way you look is a reflection of who you are. If you arrive at a service

call looking shabby and with your toolbox a snarled mess, your customer may think you neglect your job as much as your appearance. No matter how good your work is, it will be difficult to change the customer's impression of you.

Think of it this way—suppose you're hiring an attorney to represent you in court. You can choose between two equally qualified professionals: one is clean, well organized, and tidy, and the other has a messy appearance and a disorganized office. Which person would you trust to take your case? Look at yourself every day in the mirror and ask yourself if you look like a person you would trust with the security of your home and family. This is the same question that your customers will be asking themselves!

Physical Requirements

There are no specific physical requirements for success in the locksmithing profession. You may be tall or short, plump or thin, young or old. You'll need sharp eyesight, but it's unimportant whether you use corrective lenses or not as long as you can see well enough to work with small parts.

Any professional career makes demands on your reserves of strength and energy (especially if you open your own shop). If you have any concerns about your health, consult your physician. There are many opportunities in the locksmithing field for all kinds of workers. If you feel you're not up to taking on a full-time job, consider working part-time or as a subcontractor.

Offering Outstanding Service

When you begin your career as a professional, remember this old saying: "Customers are not an interruption of our business; they're the reason for it." Therefore, the most important part of your job as a locksmith is to provide excellent service to your valuable customers. Let's look at a few ways that you can offer outstanding service.

Offer immediate service. Speedy and efficient service is essential in the locksmith trade. Probably no business or profession (with the possible exception of dentistry) has more incentive to get things done quickly than locksmithing. A broken lock or lost key can trigger great anxiety in the customer, who feels

vulnerable and exposed to danger (with some justification). If you're unavailable to do a job right away, recommend another locksmith who can. This kind of consideration for your customer will undoubtedly cause the person to come back to you the next time there's a problem.

Use quality products and materials. Build your reputation as an excellent locksmith by using reliable merchandise and parts. Good quality means durability and dependability. Even if you're the finest locksmith in town, if you use cheap or poorly made products, your jobs will come back to haunt you later. Always do a job right the first time.

Be knowledgeable about products. As a professional locksmith, your customers will often ask your advice. Therefore, you must be knowledgeable about the variety of products that are available. Take some time to study manufacturers' catalogs and familiarize yourself with their products. Visit a local hardware store or home improvement center to look at merchandise and judge its quality for yourself. This knowledge will be invaluable to you when you're recommending products to your customers. Discuss the differences in price and quality with your customers, and encourage them to purchase quality items that will last. In addition, remind them that the small investment in quality locks may help prevent a much larger loss to theft, or even help save their lives.

Set competitive prices. Your prices will depend on two factors — economic conditions where you conduct business, and what the competition charges. The public may be willing to pay a little more when you provide excellent services. However, make sure you always give your customers their money's worth.

Offer more services than your competitors. A knowledgeable locksmith who knows how to do a wide variety of jobs (and who has the tools needed to do them) is invaluable. Many professional locksmiths offer only a limited number of services. This is fine if, for example, you work in a large city where many locksmiths are available. Generally, there will be enough business for everyone to handle. However, in a smaller community, you may need to offer more than just basic services. Your customers may have no one else to turn to if you're not able to help them. Every time you have to turn down a job that you don't know how to do, you're losing a valuable customer. So, take the time and effort to learn more and improve your skills. The sweetest music a customer can hear is these words: "Yes, I can fix it for you. No problem!"

Locksmithing Laws and Ethics

Your locksmithing knowledge will carry a responsibility with it. Not only must the professional locksmith live by the rules of good business and professional conduct, but you must also uphold all laws applying to locksmiths. A locksmith holds a position of trust in the community, and you must not betray that trust by performing illegal services. In addition, you must fulfill any licensing or registration requirements your community has to prove that you deserve the trust of your customers.

Some cities require that a locksmith be registered by the police department or be issued a license before engaging in business. Some communities require you to show proof that you're a qualified locksmith. The purpose of laws isn't to annoy honest locksmiths. Rather, they prevent people from just calling themselves locksmiths and trying to set up businesses. If you want to know what legal qualifications apply in your area, consult local or national locksmiths' organizations. They're usually glad to supply information regarding laws and regulations governing the practice of locksmithing.

Remember, when you've satisfactorily completed your program in locksmithing, we'll award you a certificate indicating your proficiency, which you may present as evidence of your achievement. This certificate will become a permanent part of your credentials as a competent locksmith, and you'll be proud to display it in public view.

The following is a list of responsible practices by which you should abide.

1. Uphold all local laws and regulations applying to locksmiths.
2. Keep all required records.
3. Keep all your specialized locksmithing tools locked away when not in use.
4. Never divulge confidential information of the locksmithing trade to members of the public.
5. Keep all locksmithing manuals and books out of the view of the public.
6. Never discuss the confidential trade information in this program with anyone other than a qualified locksmith.

7. Be sure a customer shows proof of ownership before you make keys by code.
8. Never open a car or a house door for a customer without proof of ownership.
9. Never duplicate a key for a child (anyone under the age of 18) without written consent from a parent, unless you know the key is for his or her own property (a bicycle lock or book bag lock, for example).
10. Never duplicate keys for vending machines, telephones, safe deposit boxes, or post office boxes without proper authorization and identification from the owner or office in charge. [Figure 20](#) shows a sample authorization form.

<h2 style="text-align: center; margin: 0;">AUTHORIZATION</h2> <p style="text-align: center; margin: 0;">FOR SECURITY/EMERGENCY SERVICE</p> <p style="margin: 10px 0;">I hereby certify that I have the authority to order the lock, key, or security work designated on the reverse side. Furthermore, I agree to absolve the locksmith who bears this authorization from any and all claims arising from the performance of such work and/or not to hold him or her responsible for any reason whatsoever.</p> <p>NAME _____</p> <p>ADDRESS _____</p> <p>DATE _____ TIME _____</p>	<p style="text-align: center; margin: 0;">DESCRIPTION OF WORK COVERED BY AUTHORIZATION ON REVERSE SIDE</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;"> <input type="checkbox"/> MAIN ENTRANCE <input type="checkbox"/> FRONT DOOR <input type="checkbox"/> SIDE <input type="checkbox"/> REAR <input type="checkbox"/> HALL <input type="checkbox"/> INSIDE <input type="checkbox"/> WINDOW <input type="checkbox"/> CLOSET <input type="checkbox"/> SAFE <input type="checkbox"/> PATIO DOOR <input type="checkbox"/> OTHER </td> <td style="width: 50%; border: none; vertical-align: top;"> <input type="checkbox"/> OPEN LOCK(S) <input type="checkbox"/> SECURE PREMISES <input type="checkbox"/> FIT KEYS <input type="checkbox"/> INSTALL <input type="checkbox"/> REMOVE & REPLACE <input type="checkbox"/> MASTER KEY <input type="checkbox"/> RE-PIN <input type="checkbox"/> CHANGE COMB. <input type="checkbox"/> CLEAN/LUBR. <input type="checkbox"/> ADJUST <input type="checkbox"/> OTHERS </td> </tr> </table> <p style="margin: 10px 0;">IF AUTO</p> <table style="width: 100%; border-collapse: collapse; border: none;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 2px;">YEAR</td> <td style="width: 50%; border: 1px solid black; padding: 2px;">COLOR</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">MAKE</td> <td style="border: 1px solid black; padding: 2px;">LIC.</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">MODEL</td> <td style="border: 1px solid black; padding: 2px;"></td> </tr> </table> <p style="margin: 10px 0;">JOB ADDRESS (IF DIFFERENT FROM PERSON SIGNING THIS AUTHORIZATION)</p> <div style="border: 1px solid black; height: 40px; width: 100%;"></div>	<input type="checkbox"/> MAIN ENTRANCE <input type="checkbox"/> FRONT DOOR <input type="checkbox"/> SIDE <input type="checkbox"/> REAR <input type="checkbox"/> HALL <input type="checkbox"/> INSIDE <input type="checkbox"/> WINDOW <input type="checkbox"/> CLOSET <input type="checkbox"/> SAFE <input type="checkbox"/> PATIO DOOR <input type="checkbox"/> OTHER	<input type="checkbox"/> OPEN LOCK(S) <input type="checkbox"/> SECURE PREMISES <input type="checkbox"/> FIT KEYS <input type="checkbox"/> INSTALL <input type="checkbox"/> REMOVE & REPLACE <input type="checkbox"/> MASTER KEY <input type="checkbox"/> RE-PIN <input type="checkbox"/> CHANGE COMB. <input type="checkbox"/> CLEAN/LUBR. <input type="checkbox"/> ADJUST <input type="checkbox"/> OTHERS	YEAR	COLOR	MAKE	LIC.	MODEL	
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YEAR	COLOR								
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FIGURE 20—Authorization for Security/Emergency Service

Locksmithing Organizations

Many trade organizations exist within the locksmithing profession. Their main purpose is to uphold high standards in the business and fairness among their membership. Some well-known and respected organizations are the following.

[Associated Locksmiths of America, Inc.](#)

3003 Live Oak Street
Dallas, Texas 75204

[Institutional Locksmiths' Association](#)

P.O. Box 4097
Dedham, Massachusetts 02026

In addition, many state, provincial, and local organizations exist. Later in this program, you'll receive a full listing of locksmithing trade organizations that you may want to join.

Now, before you proceed to the conclusion of this study unit, take a few moments to complete *Locking It Up! 3*.



Locking It Up! 3

1. *True or False?* The mission of a business is its purpose for existing.
2. *True or False?* In locksmithing, having a formal education is far more important than having an aptitude for the work.
3. *True or False?* Empathy is the ability to relate to and understand the problems of others.
4. What are three ways to offer excellent service to your customers?

5. What are three responsible practices that locksmiths should always follow?

Check your answers with those on page 39.

CASE STUDIES

Case Study #1: Locksmithing and Business Growth



Ray Palacio is a 34-year-old automotive technician working in a busy auto repair shop. For a single man, his income is good—even in hard economic times, the shop has more work than it can handle. Although Ray likes his job and his boss respects his abilities, he's beginning to get tired of doing the same oil changes and tune-ups day after day. He would like to have more responsibility and a better variety of jobs to do.

He doesn't know what he can do to make his job more interesting—until locksmithing comes along.

The auto shop is in a city where people are very concerned about home and automotive security. Ray's boss has complained many times that none of his employees is truly an expert in auto security. For this reason, customers who request the installation of electronic security systems or security car door locks are referred to Dave Jackson, a local locksmith. Many potentially profitable jobs are "given away" this way every week.

One day, Ray is working on a car damaged by someone who attempted to steal it. The thief was caught before he could get into the car, but he left the door lock badly damaged. Ray goes to Dave's shop to pick up a new lock to complete the repair job.

In the locksmith shop, Ray is impressed with the amount and variety of business that Dave is doing. Two employees are already out on the road answering emergency calls, and a third worker is answering the phone almost nonstop. He's fascinated with the locks, keys, and other devices on display. But he's especially interested in the car alarm system advertised in a wall display. He also notices that two employees are working on customers' cars outside.

"Wow, it seems like you've got your hands full," Ray says.

"Yeah," says Dave, "I'm really backed up. Ever since we started offering car alarm installations, we can't seem to keep up. I'm thinking about hiring someone to do auto security work full-time, so my other guys will have more time to handle the regular work."

"But aren't these alarms really expensive?" Ray asks.

"The system you're looking at there costs me about \$150. I sell them for about \$400, including installation. That's not much when you consider the cost of losing your car, or even your car stereo! Everybody's finding out how well these systems protect their cars, plus insurance companies offer discounts for installing them."

"Are they hard to put in?" Ray asks.

"It depends on the car, but they're usually pretty easy to install. If I don't run into any special problems, it takes me about an hour to put one in."

Ray thinks, "I can do that, too!" He puts two and two together and realizes that the auto security business is growing fast. A lot of very profitable work is being lost every time his boss sends work out to Dave's shop.

Ray is quick to get the message. First, he contacts an automotive supplier to ask for all the available brochures and pamphlets on auto alarms and auto security. Ray spends several days studying the materials until he finds two systems that look easy to install and are affordable. Then, he orders one of each of the systems and practices installing them in his own car.

When Ray has learned the installation technique thoroughly, he approaches his boss with his idea to start offering security installations. He shows him the systems he installed in his own car and explains the cost and the time involved. His boss declares, "I'm impressed! I've been wanting to offer this service for a long time, but I didn't think anyone here could do it. Maybe you'd like to be in charge of all these installations from now on!"

This marks the end of Ray's job boredom. He now looks forward to work each day because he knows he has increased his value to his employer. Many exciting possibilities have opened to him, and he can hardly wait to cash in on them!

What's the moral? By being aware of new trends happening around you and improving your skills, you can increase your value as an employee and increase your amount of responsibility.

Case Study #2: Locksmithing and the Small Business



Chris McGrath is a graduate of Landmark Community College, where he studied business management. During his college years, Chris supported himself and paid his tuition by doing carpentry work, home repairs, and other odd jobs. When he graduated, Chris found a good job with a local building contractor. In his job, he gained wide experience in carpentry, electrical work, and a variety of other areas. He also rose within the business to become a construction supervisor. Chris enjoys working with his hands, but he also feels that his training in management has been valuable to his employer's business.

For several years, the construction business was up and down. However, at the present time, new construction is experiencing a serious downturn. The company Chris works for begins to experience financial difficulties. For the first time ever, his company may lay off several employees due to a lack of available work. Although Chris is loyal to his company, he can't help wondering if he should be looking for another job. Unless economic conditions change dramatically, he's not too optimistic about his chances of getting a job in another company in the same field.

In his spare time, Chris enjoys tinkering. He's always been talented at fixing things—small appliances, machines, all kinds of devices. One day, while reading a technical magazine, Chris finds an article about the growing field of locksmithing and home security. He likes the idea that locksmithing is a service that everyone needs, year-round, no matter what economic conditions are.

Chris decides to do a little research into this field. He looks into the possibility of taking a program to learn locksmithing in his spare time. Then, he feels, if he's laid off soon, he'll have the skills needed to get a different job. He also checks with local employment agencies, job placement services, and classified ads, and finds out that there is a shortage of trained locksmiths in his area.

Chris enrolls in a locksmithing program and spends some of his evenings and weekends studying. He quickly learns that he has a natural aptitude for the work; he enjoys the program so much that it hardly seems like work.

Since his original educational background was in business management, and since he learned that locksmiths are at a premium in his city, Chris wonders if he should think of starting his own locksmithing business. In the long run, this could offer him more security than working for someone else. He doesn't think he can afford to rent or buy a shop. However, he does already own a van. Could he open a "mobile business," that is, run a shop from his van?

Chris decides to take the plunge. He invests some of his savings in key blanks, tools, locksmithing supplies, business cards, and a small ad in the Yellow Pages. He makes a trip to the local county office to file his new business name, "Superior Locks and Keys". With energy and enthusiasm, Chris embarks on a campaign to let everyone know that he's open for business.

His business cards start appearing all over town, even in such places as supermarket bulletin boards and church vestibules. Soon, Chris's locksmithing van is a familiar sight to many local residents.

Chris is on his way to a better future! Although he's started out on a small, part-time scale, his business is growing quickly. Chris hopes that Superior Locks and Keys will expand into a full-time business that will provide him with a secure, long-term income.

What's the moral? Assessing your strongest skills and matching them with the things you enjoy doing as a basis for a career change is an excellent way to achieve success and personal satisfaction.

THE KEY TO SUCCESS

We protect our homes, our loved ones, and our property with locks. Locks give us a wonderful feeling of security — when they're working efficiently. But when they don't, we need the services of a professional locksmith.

No one should become a locksmith solely to make money. If you don't enjoy the work, you'll never become a good locksmith.

Locksmithing is an ancient and honorable occupation. In the past, a typical locksmith installed, repaired, and replaced locks and keys. However, as crime rates continue to rise annually, the need for electronic security increases. For this reason, locksmiths now install and service a variety of home and commercial security devices in addition to repairing mechanical locks.

The locksmith protects families and property from burglars and intruders. The locksmith protects millions of dollars' worth of cash, documents, equipment, and merchandise in banks, factories, offices, and retail stores from theft and vandalism.

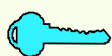
In a sense, therefore, locksmiths sell security and peace of mind to their customers. As guardians of security, locksmiths hold a position of trust in the community. A professional locksmith possesses highly specialized skills that few others have, and so is always in demand. Locksmiths command the respect of friends and business associates.

Since you began this study unit, you've accomplished a lot and absorbed much important information. You've learned important facts about the locksmithing trade, the security industry, and how locksmiths are a part of that growing industry. You examined some of the tasks locksmiths perform every day and some of the tools they use. Throughout the upcoming study units, we'll examine these locksmithing skills one by one. We've provided lots of detailed illustrations and specially designed hands-on exercises to help you learn. You'll also receive real locksmithing tools and sample locks as part of your program materials. These items are yours to keep.

When you complete the program, you'll have all the knowledge and skills you need to start working as a professional locksmith. We'll even show you how to go about setting up your own business or finding a job as a locksmith.

You can be proud of your achievement. Keep working toward your goal! Now, when you're ready, read through the following section of the text, *Key Points to Remember*. This is a review section designed to highlight all the most important facts you learned in this study unit. When you've reviewed the material and feel you know it well, proceed to the examination. Good luck!

KEY POINTS TO REMEMBER



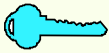
A typical locksmith installs, repairs, and replaces locks and keys, and installs and services a variety of electric and electronic security devices. Locksmiths sell security and peace of mind to their customers.



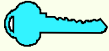
The average locksmith performs a variety of skilled jobs. One of the most common locksmithing tasks is *key duplication*. A locksmith makes a new copy of an old key using an uncut key blank that exactly matches the original key in shape and size. Occasionally, a locksmith will need to make a key by hand for an old-fashioned or obsolete lock.



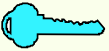
Another common locksmith task is *lock installation*. The most common are ordinary front door lock installations. Some locksmiths expand into installing *panic hardware* and *fire exit latches*. Burglar alarm installation is also a growing area of specialization for many locksmiths.



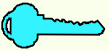
The servicing of safes involves repair, cleaning, changing combinations (*recombinating*), and opening without a combination. Banks may call upon locksmiths to service and repair safe-deposit boxes.



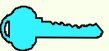
A locksmith uses many ordinary tools found in any workshop, such as screwdrivers, hammers, pliers, small vises, and metal files. In addition, a locksmith needs specialized tools for work with different types of locks, such as lock picks, car-opening tools, and key-cutting machines.



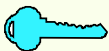
A typical locksmithing shop will always keep a large assortment of key blanks on hand, plus a selection of lock parts like pins and springs. A shop should also keep reference books and publications on hand. One of the most important resources is a *key blank directory*, which identifies the manufacturer's name and number on a given key blank. Another important source of locksmithing information is the *key code book*, which you use to decode the numbers on a given key.



The fear of crime is becoming a state of mind in many areas. For this reason, the average citizen is becoming increasingly aware of the need for home protection. Statistics in the FBI's *Uniform Crime Report* indicate that in 1988 in the United States, one violent crime was committed approximately every 20 seconds, and one property crime was committed every 3 seconds. In addition, the *crime rate* (the number of crimes reported per 100,000 inhabitants) has increased dramatically since 1984.



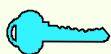
The *security industry* protects life and property. The security industry includes manufacturers, distributors, and sellers of security services and hardware, as well as all employees who work to prevent and control crime and maintain safety. The locksmith is one of the most important members of the security industry. Crimes are less likely to occur every time a locksmith recommends, repairs, or installs a lock or security device. Locksmiths should keep up-to-date on crime trends and on all new product developments in the security field.



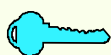
One of the best techniques for fighting crime is *target hardening*. The target is whatever the thief wants—cash, merchandise, or entry to a home. *Target hardening* means making the target harder to get to. An efficient burglar alarm or electronic security system is one of the best methods of target hardening.



As a locksmith, you'll have many opportunities for employment. You may choose to work in an established locksmithing business for a while to gain experience. Or, if you have business skills, you may decide to open your own locksmithing shop.



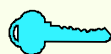
Subcontracting is a form of self-employment in which you handle contracted jobs for another business. The other business hires you to complete jobs that it's unable to handle. The other business pays you, not the customer.



Many individuals and businesses turn to locksmiths for advice on how to prevent intrusion and protect property. A skilled professional locksmith who knows about crime prevention can find work in *security consulting*. The locksmith first confers with customers to determine their security needs, then visits their home to make an evaluation, and finally offers recommendations on products and techniques that can improve security.



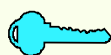
If you own a van or pickup truck, you may choose to open a *mobile business*. You'll take service calls from customers and then travel to and from each job. Your van or truck will have all the tools and materials you'll need to repair, replace, or install locks right on the scene.



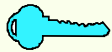
In-house locksmiths work in a variety of businesses, institutions, and government buildings. When anyone needs services, the locksmith is on hand to provide them immediately. An in-house locksmith is generally in charge of all locksmithing duties, including door locks, security systems, company vehicles, and locks on gates and outbuildings.



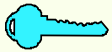
Some manufacturers of locks and security devices employ locksmiths in their factories, warehouses, or offices to sell merchandise, stock their inventory, and serve customers. Some creative and talented locksmiths even work on developing new products for the industry. In addition, the company locksmith may be in charge of continuing education or training for other employees.



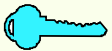
Some experienced locksmiths find work training others. You may work for a vocational training school or conduct private seminars or lectures for a fee. In addition, many locksmithing publications accept articles and stories from professional contributors. In time, you may even want to publish a training manual or a book on a locksmithing specialty.



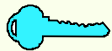
The mission of a business is the reason for its existence. The mission of a locksmith is to promote security and peace of mind by supplying products that will defend customers, their families, and their property. A professional locksmith will need several personal qualities to fulfill this mission.



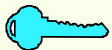
One such important quality is “people skills.” *People skills* are communication skills that strengthen understanding between persons. The skills include consideration, sincerity, courtesy, patience, and *empathy* (the ability to relate to and understand the problems of others).



A professional appearance is another important personal quality in the locksmith. You should always look and act like a professional so that you’ll always make an excellent first impression on your customers. Dress neatly, practice good grooming, speak pleasantly, and keep your vehicle and tools neat and clean. An unkempt appearance detracts from your professional image and may even cause you to lose business.



The most important part of your job as a locksmith will be to provide excellent service to your customers. Offer immediate service, use quality products and materials, set competitive prices, offer more services than your competitors, and be knowledgeable about products.



As a locksmith, you must uphold all laws applying to locksmiths and fulfill any licensing or registration requirements your community has. Many state, provincial, and local trade organizations exist within the locksmithing profession. Their main purpose is to uphold high standards in the business and fairness among their membership. You can join these organizations to enhance your standing in the professional community.

Locking It Up! Answers

1

1. False. Specialized locksmithing tools include a key gage, pick gun, broken key extractor, lock picks, tension wrench, and formed-end tweezers.
2. False. Key duplication is one of the most common locksmithing services.
3. False. Any lock can need an occasional cleaning.
4. False. In an emergency, you would force open a lock using a wrench, a hammer, an electric drill, or bolt cutters.
5. True
6. False. A duplicate key must be cut from a key blank.
7. True
8. True

2

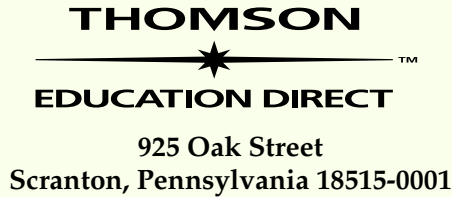
1. crime rate
2. violent crime, property crime
3. target hardening
4. security industry
5. Security manufacturers
6. Subcontracting

7. security consulting
8. mobile

3

1. True
2. False. An aptitude for the work is more important than a formal education.
3. True
4. Your answers should include any three of the following: offer immediate service, use quality products and materials, be knowledgeable about products, set competitive prices, offer more services than your competitors
5. Your answer should include any three of the following.
 - Abide by all local laws and regulations applying to locksmiths.
 - Keep all required records.
 - Keep all your specialized locksmithing tools locked away when not in use.
 - Never divulge confidential information of the locksmithing trade to members of the public.
 - Keep all locksmithing manuals and books out of the view of the public.

- Never discuss the confidential trade information in this program with anyone other than a qualified locksmith.
- Make no keys by code for a customer without proof of ownership.
- Never open a car or a house door for a customer without proof of ownership.
- Never duplicate a key for a child (anyone under the age of 18) without written consent from a parent, unless you know the key is for his or her own property (a bicycle lock or book bag lock, for example).
- Never duplicate keys for vending machines, telephones, safe-deposit boxes, or post office boxes without proper authorization and identification from the owner or office in charge.



Locksmithing: An Expanding Career Field

EXAMINATION NUMBER:

03100101

Whichever method you use in submitting your exam answers to the school, you must use the number above.

**For the quickest test results, go to
<http://www.takeexamsonline.com>**

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. The Life Safety Codes in most areas require the installation of
 - A. steel-reinforced doors.
 - B. panic hardware and fire exit hardware.
 - C. window locks.
 - D. burglar alarms.
2. Statistics show that most burglars are
 - A. amateurs with little familiarity with security devices.
 - B. juveniles who steal for fun.
 - C. professionals with much knowledge of locks and security devices.
 - D. kleptomaniacs who have a compulsion to steal.

3. A locksmith makes a duplicate key from an uncut key
- A. blank.
 - B. pattern.
 - C. copy.
 - D. original.
4. The term *target hardening* means
- A. charging more for your security services.
 - B. making it difficult for people to purchase burglar alarms.
 - C. hiring more employees at your shop.
 - D. making it difficult for a criminal to gain access to homes or property.
5. You use a key code book
- A. to find the name of a key's manufacturer.
 - B. to order keys from a supplier.
 - C. to decode the cuts on auto keys.
 - D. to decode the numbers printed on a key.
6. Of the lawbreakers listed below, who are most often professionals?
- A. Dishonest employees
 - B. Shoplifters
 - C. Car thieves
 - D. Burglars
7. The security industry is
- A. a group of locksmith societies and professional associations.
 - B. a broad-based market of products and services that protect life and property.
 - C. a group of locksmiths who write rules and regulations for the locksmithing profession.
 - D. a group of all the locksmith businesses in North America.
8. The main purpose of locksmithing organizations and professional associations is
- A. to license, certify, and bond locksmiths.
 - B. to assist local governments in creating locksmithing laws and regulations.
 - C. to uphold high standards in the business, to ensure fairness among their members, and to educate.
 - D. to provide loans to locksmiths who want to open shops.
9. All of the following statements are true except for which one?
- A. Common sense is one of the most important personal qualities in a locksmith.
 - B. Technical knowledge of locksmithing is more important than personal communication skills.
 - C. A college degree may be useful, but it's not necessary to become a professional locksmith.
 - D. Locksmiths are highly respected members of the community.

10. What is a subcontractor?

- A.** A self-employed professional who performs contracted jobs for another business
- B.** A locksmith who works only for architectural firms
- C.** A locksmith who repairs and replaces the locks in hotels or schools
- D.** Any employee of a locksmithing shop

11. You can gain a customer's confidence by

- A.** pointing out another locksmith's shoddy workmanship.
- B.** using expensive and elaborate tools.
- C.** paying attention to details and acting professional.
- D.** overcharging to make your services seem exclusive.

12. What is a security consultant?

- A.** A security professional who evaluates a property and recommends methods to improve security
- B.** Any locksmith who sells locks and security products in addition to providing services
- C.** A locksmith who works for a government agency
- D.** A locksmith who owns both a shop and a mobile business

13. The first task an entry-level locksmithing employee would probably be asked to do is

- A.** opening car doors for customers who lost their keys.
- B.** key duplicating.
- C.** installing locks at people's homes.
- D.** forcing safes open.

14. One of the most important personal qualities in a beginning locksmith is

- A.** at least two years of experience.
- B.** a college degree.
- C.** a high school diploma
- D.** common sense.

15. A mobile locksmithing business requires all of the following except which one?

- A.** A telephone
- B.** A van or pickup truck
- C.** A supply of key blanks
- D.** A permanent location

16. Where would an in-house locksmith work?

- A.** In residential homes
- B.** In a shop at a fixed location
- C.** For a school or large commercial complex
- D.** From a van

17. All of the following statements are true except for which one?

- A.** Formal education is not as important to a locksmith's success as is an aptitude for the work.
- B.** Some important "people skills" for a locksmith to develop are consideration, sincerity, courtesy, and patience.
- C.** Dress and personal appearance are unimportant as long as your work is excellent.
- D.** There are no specific physical requirements for success in the locksmithing profession.

18. What is the mission of the locksmith?

- A.** To sell goods and services
- B.** To acquire a business
- C.** To promote security and peace of mind
- D.** To gain self-respect

19. What is the meaning of the term *empathy*?

- A.** A close friendship with customers
- B.** The combination of excellent training and experience
- C.** The ability to relate to and understand the problems of others
- D.** Providing excellent service to your customers

20. How old is the locksmithing profession?

- A.** About 10 years old
- B.** About 50 years old
- C.** A few hundred years old
- D.** Several thousand years old

Study Unit 2

Introduction to Locks and Keys

Preview

This study unit will introduce you to the wide variety of locks, keys, and security devices that locksmiths see every day. We provide many illustrations and diagrams to make your learning easier and more enjoyable. At the end of this unit, you'll perform your first hands-on exercise with the cutaway padlock included in this package of materials.

When you complete this study unit, you'll be able to

- Describe the simple mechanics of how locks work
- List the three basic parts of a key-operated lock
- Identify the principal parts of a key
- Name the four main types of keys
- Define key blank
- Discuss the four main types of lock mechanisms
- List at least seven applications for key-operated locks
- Name the four factors that affect how well a lock works
- Describe several professional locksmithing skills and the situations when these skills are needed
- List the basic tools that a locksmith uses

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Introduction to Locks and Keys

HOW LOCKS WORK

The First Known Locks

A *lock* is simply a mechanical device for securing a door so that only a key or a combination can open it. This study unit will introduce you to a variety of common locking devices and the basics of how locks work. We'll also discuss some standard locksmithing tasks and the tools used to perform them. Let's begin our discussion of locks and keys with a brief look at the history of locks.

For thousands of years, people all over the world have been using locks to secure their homes and valuables. The oldest known lock in existence was found in the ruins of a 4,000-year-old palace near Egypt. Amazingly, this ancient wooden lock is of a very similar design to the pin tumbler locks we use today. Instead of a key, however, the Egyptian lock uses a wooden opener that looks something like a toothbrush with pegs. Figure 1 illustrates the operation of the Egyptian lock.

The Romans

In later years (about 2,000–3,000 years ago), the ancient Romans introduced the first metal locks (mostly iron locks with bronze keys). The locks had simple mechanisms and were easy to pick open. So, Roman designers attempted to improve security by concealing the keyholes beneath ornamentation. The Romans designed the first padlocks in their area of the world (the Chinese invented a padlock independently in the East at about the same time). The Romans were also the first to make small-sized keys—in fact, Romans sometimes wore keys on their hands as rings (Figure 2).

FIGURE 1—This 4,000-year-old Egyptian lock used a pin tumbler mechanism similar to a modern lock.

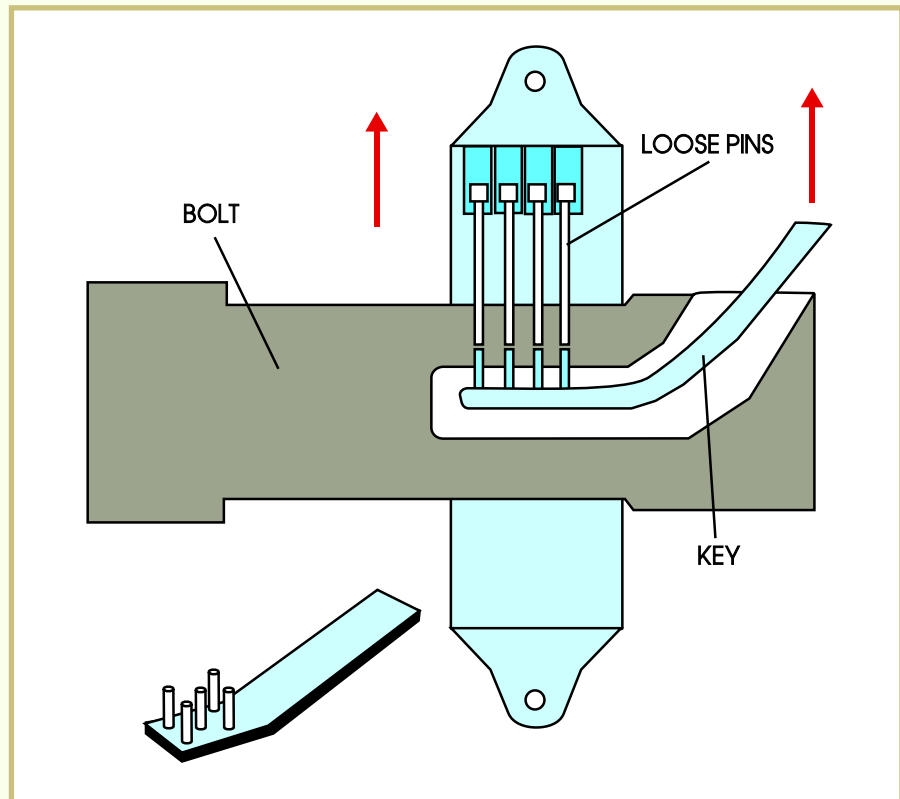


FIGURE 2—A Roman Ring Key



The Middle Ages

During the Middle Ages, as metalworkers gained new skills, the outward appearance of the average lock changed. Most locks were elaborate, beautifully decorated, and cleverly designed works of art. However, few real advances were made in improving lock security.

The people of the Middle Ages paid more attention to chest or box locks than to door locks. Many wealthy people kept money, jewelry, and other valuables locked in chests. One technique for securing a money box involved placing several locks on the box — perhaps as many as 20! Another technique introduces hidden keyholes, false keyholes, and other devices in an attempt to make locks harder to open. One locking device even included a spring-loaded knife that would pop out and injure a thief if tampered with!

The Nineteenth Century

Lock designers and metalworkers continued to develop their skills. By the time of the Industrial Revolution of the nineteenth century, the lock industry had expanded greatly. Many new lock designs were patented during this period, each offering improved security. The most important lock invention of the time was the patented device made in 1848 by the American inventor Linus Yale, the pin cylinder lock. The pin cylinder lock, also known as the Yale lock, was based on the same principle as the ancient Egyptian lock we discussed earlier. The special design of the lock allowed for an almost unlimited number of key variations, which made the lock very difficult to pick. While the original Yale-type lock has been improved upon over the years, its design is essentially the same as it was 150 years ago.

Modern Times

As you've seen, locks have been used since ancient times to protect homes and property from intrusion and theft. Today, we use locks to secure almost everything—doors, gates, windows, cars, drawers, cash boxes, vending machines, safes, and even bicycles! In addition, many new electric and electronic security devices have been developed. A modern locksmith may service many different types of locks in just one week of work. Therefore, locksmiths generally try to familiarize themselves with all kinds of security products, even though most specialize in one or two skills.

The Importance of Using Correct Terms

One of the best ways to gain locksmithing knowledge is to become familiar with locksmithing terms. As you learn the terms and phrases of the locksmithing industry, make them part of your everyday vocabulary. The better you understand the language of locksmiths, the better you'll understand what you read and hear about locks. In addition, by learning the locksmithing language, you'll be able to talk to other professionals, which is one of the most important ways to learn more about any field.

We included a glossary or dictionary of locksmithing terms in your first shipment of study materials. At any time during your reading, be sure to look up any unfamiliar words. This is the fastest way to learn new words and the best way to refresh your memory. We strongly encourage you to get into the "glossary habit."

Now, let's take a closer look at some locks you'll see every day as a professional locksmith. Have your glossary ready for reference! The first type of lock we'll discuss is the ordinary key-operated lock.

Key-Operated Locks

Basic Construction

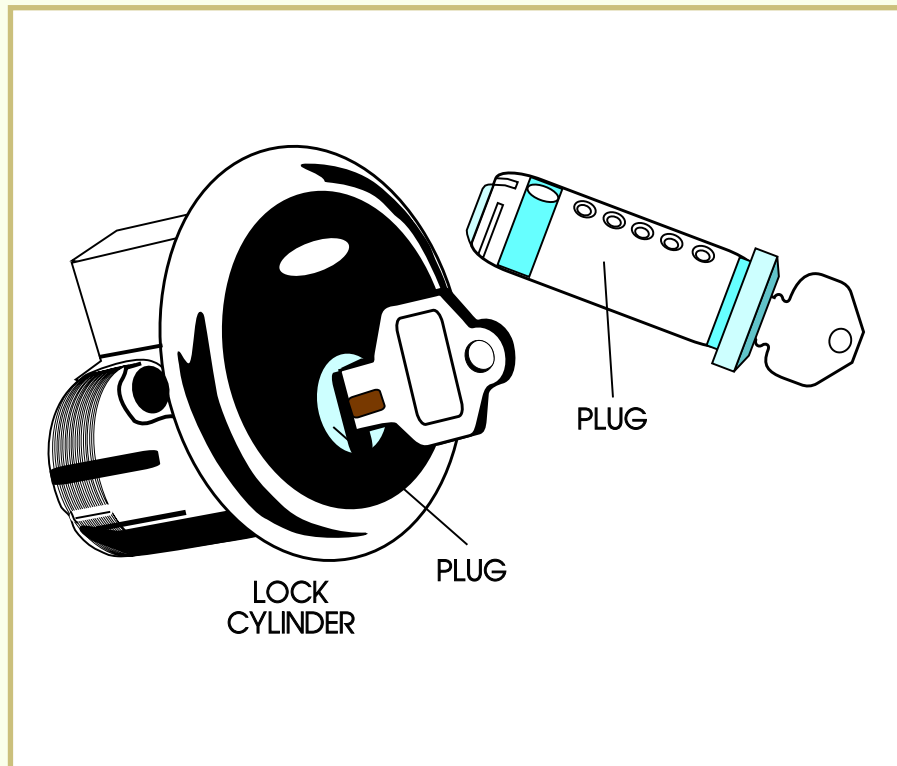
The term *key-operated lock* simply means any type of lock that a key opens. (Note: Not all locks are opened by keys—some are opened by a combination of numbers, and some by electrical switches. We'll discuss these types of locks shortly.) The most common use of key-operated locks is in residential doors.

A key-operated door lock has these three main parts: (1) a *plug* and the *cylinder* that surrounds it, (2) a *latch* or *bolt*, and (3) a *key*. Let's look at each of these parts separately.

Plugs

The *plug*, and the *cylinder* that surrounds it, is the central assembly of a key-operated lock (Figure 3). The plug is the tube, which contains the small parts that operate the bolt or latch. The cylinder is the tube assembly that surrounds and holds the plug. The cylinder holds the small parts firmly in the plug and prevents them from spilling out.

FIGURE 3—This illustration shows a lock cylinder that contains a plug, and a view of the plug when it's removed from the cylinder.



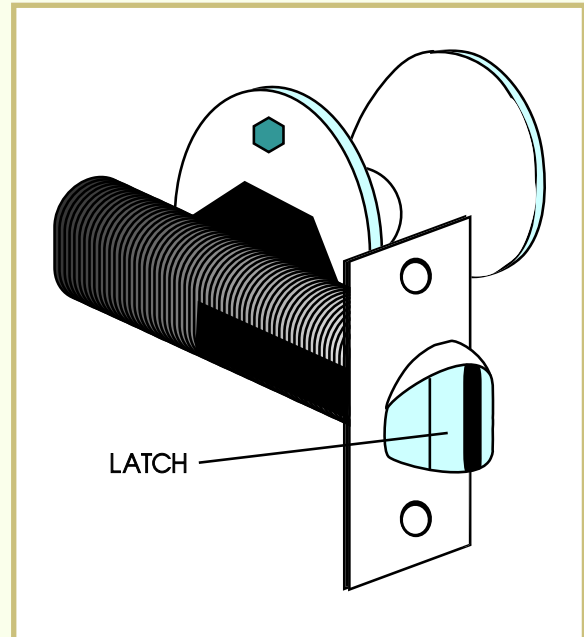
The *keyway* is the “tunnel” in the plug that a key slides into. The inside of a keyway isn’t completely smooth. Instead, the keyway is grooved and notched to allow only the correct blank to enter. When you insert the correct key into the keyway, the small parts inside the plug move in such a way that the plug is freed to turn. As you turn the key, you’ll turn the plug with it, locking (or unlocking) the door.

Some key-operated locks have more than one cylinder. For example, if you want to be able to lock a door on either side with a key, you can install a *double-cylinder lock*. You’ll often find double-cylinder locks on the doors of a business.

Latches and Bolts

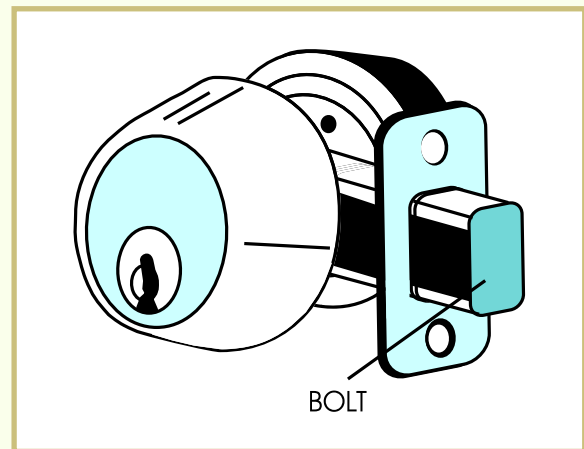
A key-operated door lock may have a latch, a bolt, or both. A *latch* is a piece of metal that protrudes out of the lock and fits into a recessed space in the door frame (Figure 4). This recessed space is a *strike*. The end of the latch is cut at an angle and is mounted in front of a spring. As the door closes, the latch contacts the strike, presses against its spring, and snaps into place in the strike. This leaves the door securely closed, but not locked. To open the door, you simply turn the doorknob.

FIGURE 4—A Typical Door Latch



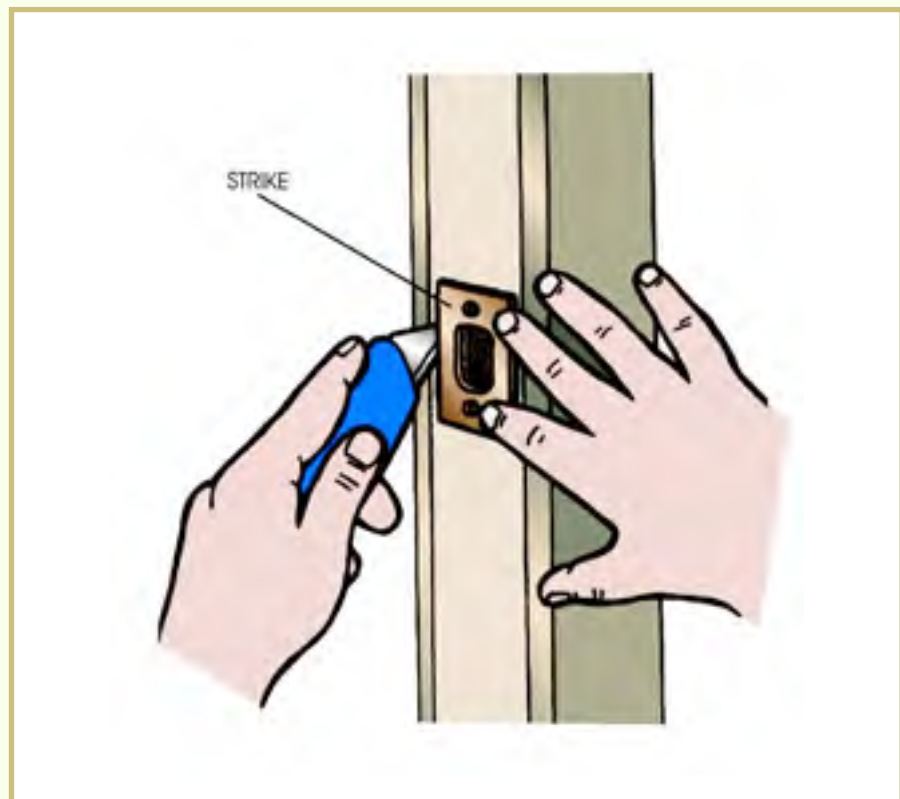
A *bolt* is also a strong piece of metal that protrudes from a lock to fit into a strike (Figure 5). However, a bolt has a squared-off end and is usually longer than a latch, so it fits more deeply and securely into a strike. Also, a bolt isn't mounted with a spring. Instead, a bolt is thrown into the strike either by turning a *thumbpiece* by hand, or by using the key. When a bolt is in place, a door is both securely closed *and* locked. The door can't be opened by just turning the doorknob; the bolt must be withdrawn from the strike first by using a key or turning the thumbpiece.

FIGURE 5—A bolt has a squared-off end to fit deeply and securely into a strike.



The strike is a vital part of the security of any door lock. A strike is a molded metal piece that's fitted into the door frame and secured by screws. However, a strike is only as strong as those screws; if the screws are weak, the lock can be defeated by simply kicking the door in. The most secure strikes are embedded deeply into the door frame, adding strength to the entire locking system (Figure 6).

FIGURE 6—This figure shows a typical strike mounted in a door frame.



Keys

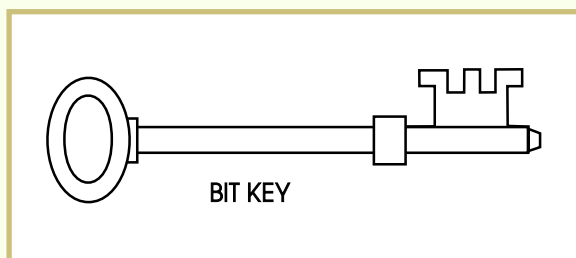
A *key* is simply the small, shaped piece of metal used to open a lock. There are five basic key types, and you're probably familiar with most of them. The four basic key types are

1. Bit keys
2. Barrel keys
3. Lever keys
4. Cylinder keys

Each of these key types goes with a certain type of lock. As you gain locksmithing knowledge, you'll quickly learn to identify locks by the types of keys used with them.

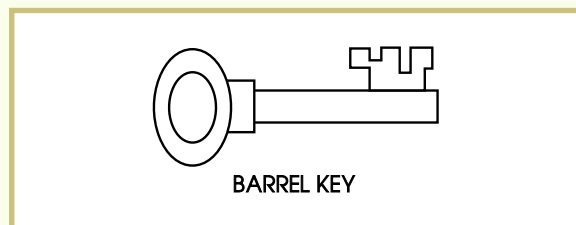
The *bit key* (Figure 7) is the oldest type of key and was once common for front doors. If you live in a very old home, you may still use a bit key for certain interior doors (closets, attic and basement doors, cabinets, etc.).

FIGURE 7—The oldest type of key still in use today. The bit key was also known as a skeleton key.



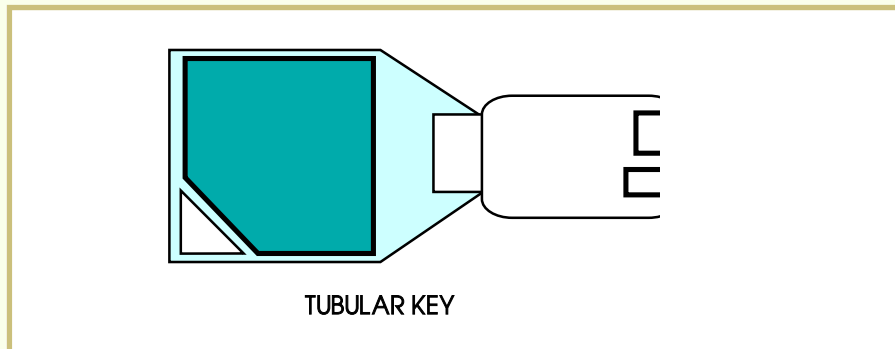
The *barrel key* is a variation of the bit key, and like the bit key, is old-fashioned and seldom used anymore. Barrel keys are round and hollowed out at the end (Figure 8). We use them to open china closets, interior doors, and some older padlocks.

FIGURE 8—Barrel keys are a hollow variation of the bit key.



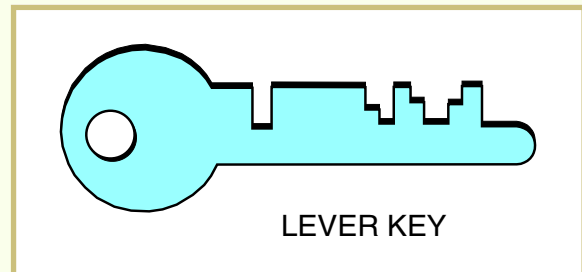
One modern version of the barrel key is the *tubular key* (Figure 9). Tubular keys are short, round, and hollowed out like the barrel key, but they function a bit differently. We use tubular keys in the locks on vending machines, coin-operated laundry machines, and computers.

FIGURE 9—We use tubular keys with vending machine locks and computer locks.



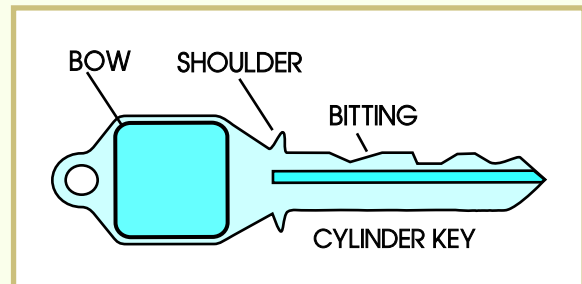
Lever keys are made from thin, flat pieces of steel (Figure 10). These flat keys have no grooves; they're completely smooth on both sides. We use lever keys for some small padlocks and also for safe-deposit box keys.

FIGURE 10—Lever keys have no grooves— they're completely smooth and flat.



The most common type of key used today is the *cylinder key* (Figure 11). If you look on your own key ring now, you'll probably find several cylinder keys. We use cylinder keys for most front door and car locks, as well as padlocks.

FIGURE 11—Cylinder keys are the most common type of key used today.



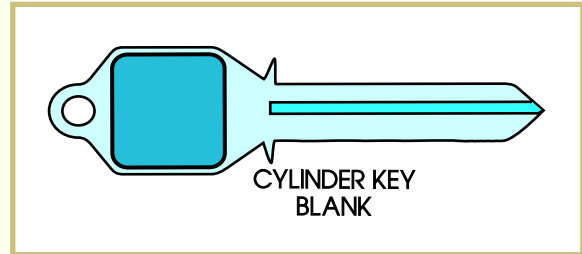
Three parts are common to most types of keys. These three parts are the bow, the shoulder, and the bitting (refer back to Figure 11). The *bow* is simply the handle of a key. Most lock manufacturers have their own distinct and recognizable bow shapes. All keys have a bow.

Just below the bow is the *shoulder* of the key. The shoulder of a key is slightly wider than the rest of the key's length. The shoulder prevents the key from being pushed too far into a lock.

The *bitting* is the pattern of notches cut into the edge of the key. The first notch is always cut just below the key's shoulder. The locksmith can make these notches with a key cutting machine, or by hand with metal files. Most keys have this type of bitting. One exception is the tubular key in which the bitting runs around the circular end of the key.

To make a new or duplicate key for a customer, a locksmith begins with a *key blank* (Figure 12). A key blank is simply an uncut key. All key blanks aren't alike. Each lock will accept only one type of key. A key blank must exactly match the length, width, thickness, shape, and groove pattern of the original key to fit the lock.

FIGURE 12—This figure shows a cylinder key blank.



Lock Mechanisms

Now that you understand the basics about keys, let's take a look at the locks that we use them with. A lock *mechanism* is simply the assembly of parts inside the lock that makes it work. There are only four common mechanisms used inside modern key-operated locks. They are

1. The *warded* mechanism
2. The *lever tumbler* mechanism
3. The *disk (or wafer) tumbler* mechanism
4. The *pin tumbler* mechanism

Let's take a closer look at these lock mechanisms now.

The Warded Mechanism

The *warded* lock mechanism is the oldest type of lock still in use today. The ancient Roman locks we talked about earlier contained *warded* mechanisms. A *warded* lock works on a very simple principle. The interior of the lock has protruding ridges called *wards* that prevent the wrong key from being inserted to throw the bolt. Figure 13 shows a lock mechanism with an edge ward. Note that we use bit keys with most *warded* locks. Figure 14 shows a slot milled on the edge of the key, which allows the key to pass a case ward.

FIGURE 13—A Warded Lock Mechanism Showing an Edge Ward

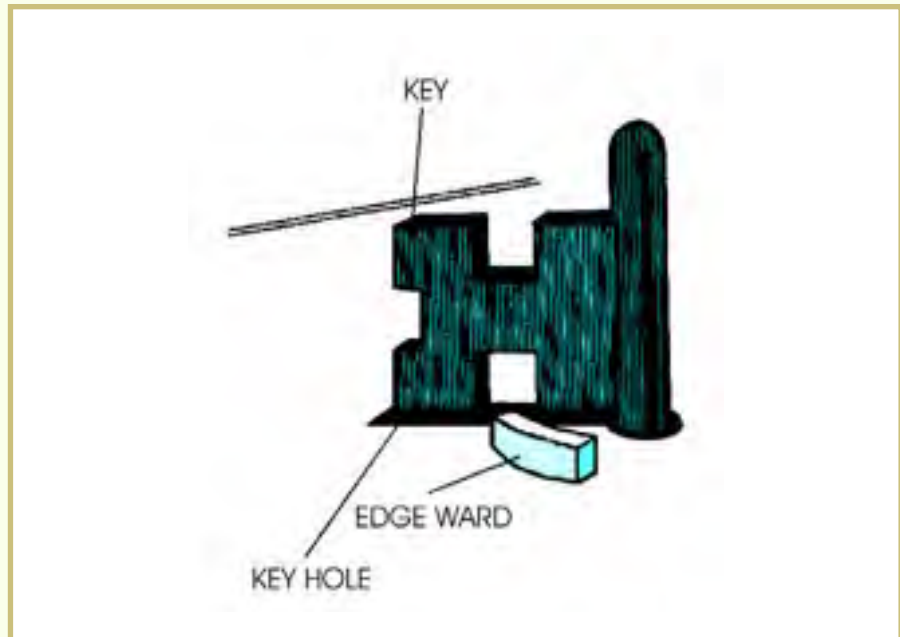
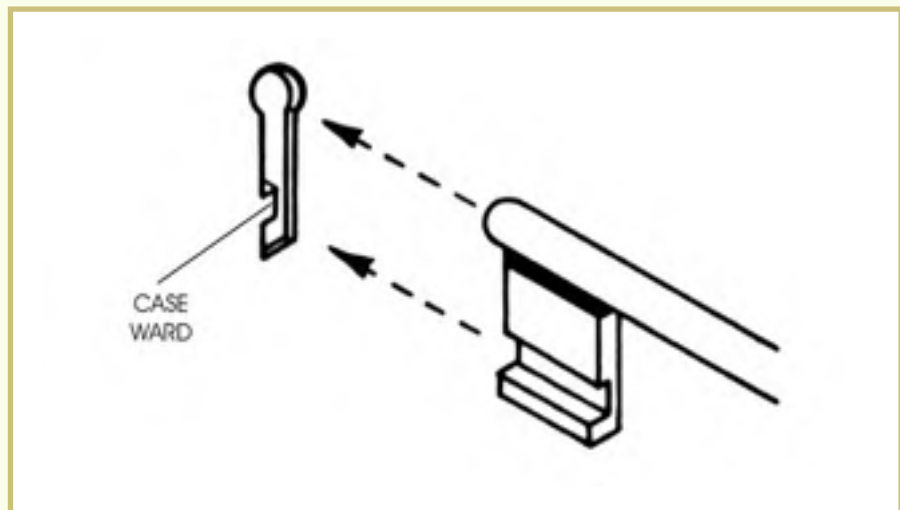


FIGURE 14—A Warded Lock Mechanism Showing a Case Ward



Warded locks were once commonly used as door locks. However, because they're very easy to pick, we seldom use them anymore. However, small warded padlocks are still common. The advantage of simple warded padlocks is that we can use them where sand, dirt, or ice may jam a more complex mechanism (on toolshed doors, toolboxes, in boats, etc.). Modern warded padlocks (Figure 15) don't use bit keys; they use lever keys.

Locksmiths still occasionally see some warded locks in very old homes. However, whenever you see these locks, you

should recommend replacement (or at least reinforcement) with a newer, more secure lock.

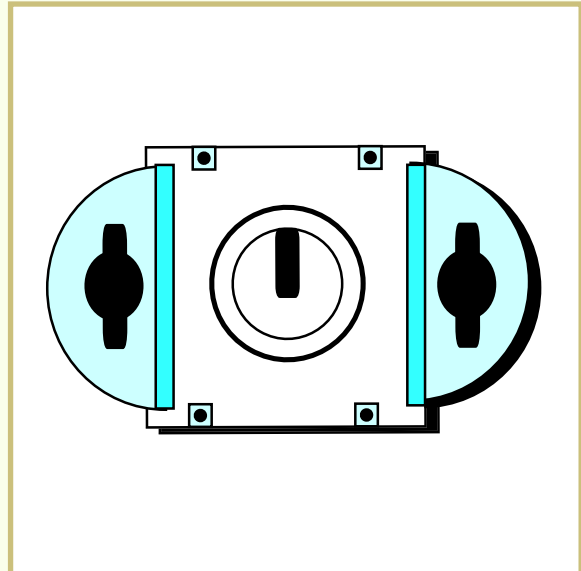
FIGURE 15—This *warded padlock* uses a *lever key*.



The Lever Tumbler Mechanism

Lever tumbler locks (Figure 16) have flat metal plates that must slide into place for the lock to operate. As the correct key is turned, it will move the plates just enough to allow the lock to work. The flat design of the lever lock makes it suitable for use on school lockers, mailboxes, luggage, cash boxes, and safe-deposit boxes. Lever locks are much more difficult to pick than warded locks.

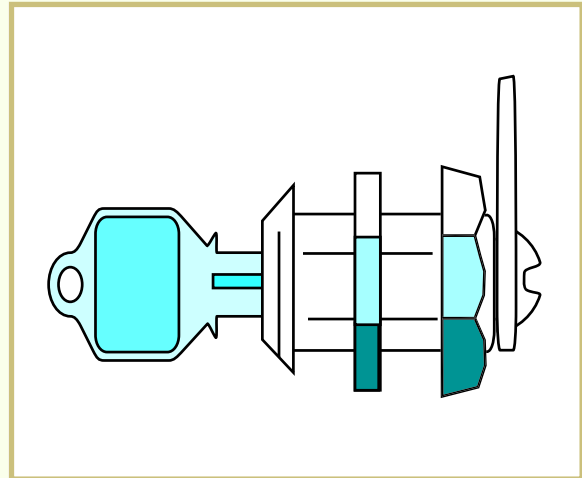
FIGURE 16—We use this type of *lever lock* on *gymnasium lockers and mailboxes*.



The Disk Tumbler Mechanism

The *disk tumbler* lock mechanism (Figure 17) is designed with a keyway surrounded by a cylinder. The cylinder contains rectangular metal disks that can move up and down. When you insert the correct key into the keyway, the disks are raised to the proper level, and the cylinder is freed to turn, opening the lock. Disk tumbler locks are most commonly used in automobile doors and as desk locks in offices.

FIGURE 17—We use this type of disk tumbler lock on desk drawers.



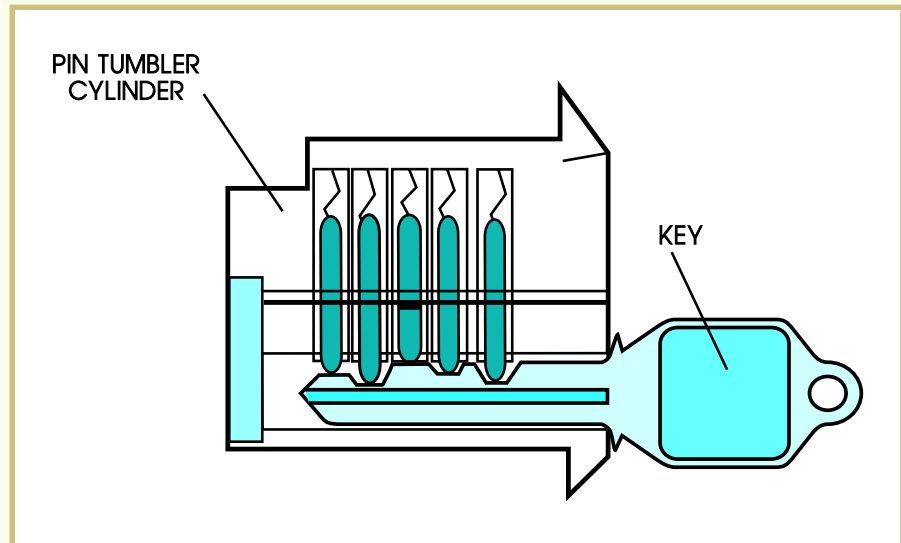
The Pin Tumbler Mechanism

The *pin tumbler* lock mechanism is the most secure in use today. You'll commonly find it in cars and residential doors. The pin tumbler lock, like the disk lock, has a keyway surrounded by a cylinder. Small metal pins align in a row along the length of the cylinder. The pins are of different heights, and can move up and down freely. When you insert the correct key into the keyway, the pins move to the correct height, the cylinder turns, and the lock opens (Figure 18).

Pin tumbler locks are very secure and are difficult to pick, though not impossible. For this reason, a special type of high-security pin tumbler lock is also available today. Such locks contain four rows of pins and require a special type of key (usually a dimple key) to open. High-security pin tumbler locks are virtually impossible to pick open.

As we mentioned before, keys aren't the only way to open locks. Let's now discuss combination locks.

FIGURE 18—This figure shows an interior view of a pin tumbler cylinder with the key inserted.



Combination Locks

Combination Lock Construction

A *combination lock* is a type of lock that you open by dialing a series of numbers instead of inserting a key. Combination locks have a numbered dial face with a knob. You turn the knob both clockwise and counterclockwise to certain numbers on the dial. Dialing the proper series of numbers releases the lock's internal mechanism, opening the lock's shackle. Figure 19 shows a typical combination padlock.

FIGURE 19—A Combination Padlock



The main parts of a combination padlock's inner mechanism are the *wheels* or *tumblers*. Most lock combinations contain three tumblers and a dial with its knob.

When you turn the knob on the dial face, you're actually turning only the first tumbler until it properly aligns with the second tumbler. Now, these two tumblers turn until they align with the third tumbler. Now, all three tumblers will turn as you rotate the dial knob. Once all three tumblers line up correctly, the lock will open. While some combination locks have more than three tumblers, they all operate on this same basic principle.

Combination locks provide greater security than keyed locks. A three-tumbler combination lock is practically impossible to defeat by trying random combinations. There are up to a million possibilities, and only one correct one. A combination lock with more than three tumblers will have even more possible combinations. That's why you find combination locks on safes and bank vaults.

Another advantage of combination locks is that you can change the combination easily (except in the most inexpensive padlocks). To maintain security, companies and stores frequently change the combinations on their safes when employees leave.

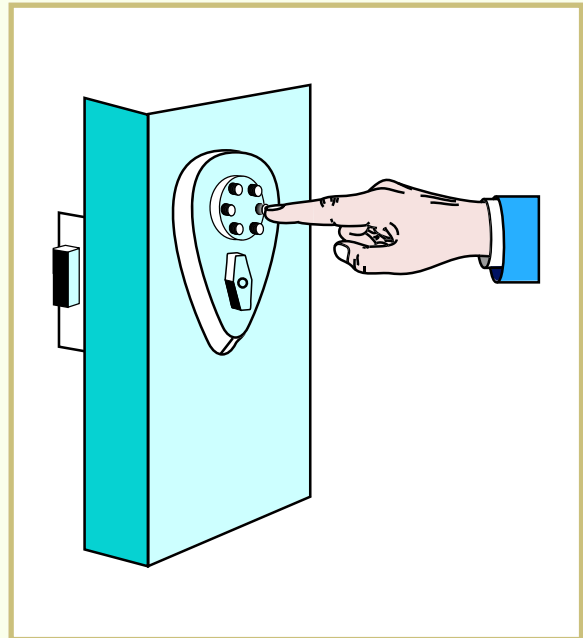
Types of Combination Locks

There are many types of padlocks, door entry systems, and safes that use a combination lock. Some combination locks, such as those on safes or rooms that contain classified information, are connected to automatic lock timers. The time clock is set for a particular time at which the lock opens or allows you to use a combination to open the safe. Such locks are *time locks*.

Time locks provide a double-lock security system. In banks, for example, the timers may be set to go on at 5:00 P.M. each day and off at 8:00 A.M. In businesses, time locks unlock all doors automatically at a certain time, eliminating the need to have a security officer open each door for employees.

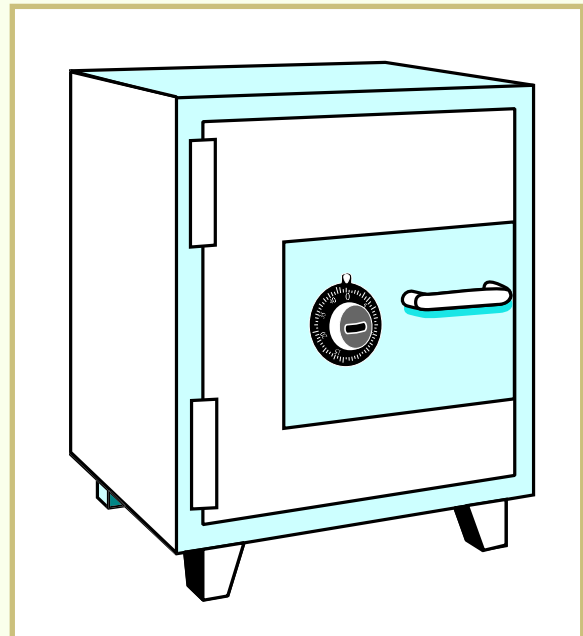
Push-button combination locks (Figure 20) require the user to press one or more buttons together or in a sequence. The correct pressing of the buttons opens the lock. These locks are mechanical—they don't use electricity to operate.

FIGURE 20—This illustration shows the operation of a push-button combination lock.



Most homes, businesses, and banks use a variety of safes of all sizes. Models are available that install in floors, walls, or under counters. In addition, specialty safes can store and protect rifles, pistols, and paper documents. Most safes are made of thick steel and are insulated with a fire wall (Figure 21). A business safe or vault that's fire-resistant as well as secure protects the contents from all kinds of destruction.

FIGURE 21—Homes and businesses commonly use this type of standing safe.



While safes will require occasional repairs, cleaning, and lubricating, the most common service calls for a locksmith are to change safe combinations.

Electric Locks and Electronic Security

Electric Locks

Electrically operated locks and release latches are commonly used on the doors of large office and industrial buildings. The locks typically open with a code number punched into a key pad or with a card key. *The card key lock* operates by inserting a coded plastic card into the door lock. The card has a magnetized strip that actuates the lock. You'll find the card key lock used in many hotels and motels.

Electric locks can provide extra security since they remain locked most of the day. Only authorized employees and security personnel are able to open the locks.

Electronic Security Devices

The rising crime rate and the fear of home burglary has made the installation of electronic security devices a lucrative locksmithing specialty. There are two basic types of alarm systems: local and central.

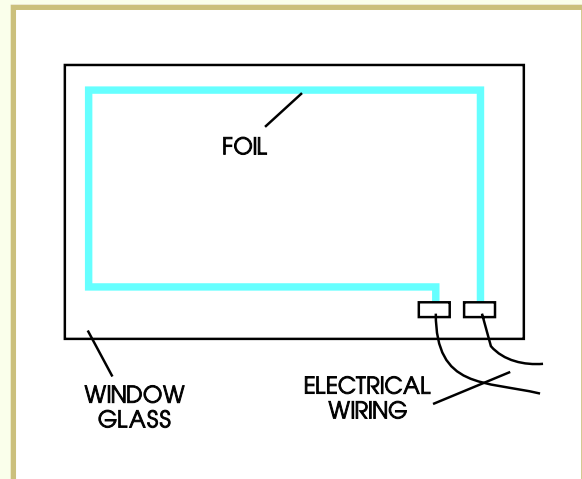
A *local alarm* sounds only at the building where it's installed. This type of alarm can alert neighbors and scare away would-be intruders. *Central alarms* connect to a monitor station owned and monitored by a private alarm company.

Some typical electronic security devices include the following.

Foil. Foil is a metallic ribbon that attaches to glass (Figure 22). When anyone breaks the window, the foil breaks and triggers an alarm.

Pressure mats. Pressure mats are alarm pads placed in doorways, hallways, stairways, and under carpets. The alarm mat contains a flat switch that sets off an alarm when it senses the pressure of footsteps.

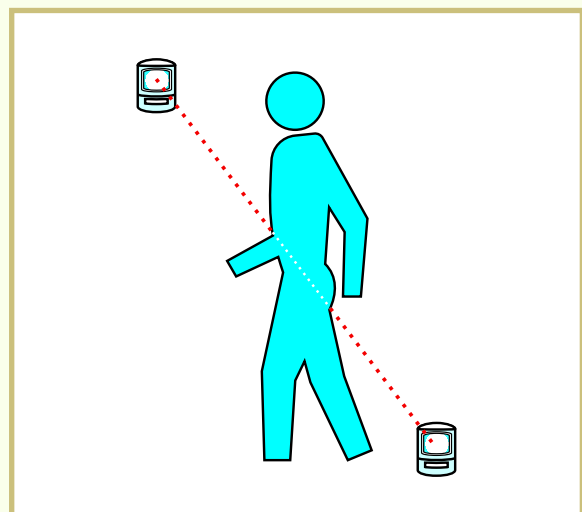
FIGURE 22—This illustration shows the installation of foil in a store window.



Vibration detectors. A vibration detector is a sensor device that feels the vibrations of an attacker on walls, floors, and ceilings. When the detector senses such vibration, the system triggers an alarm.

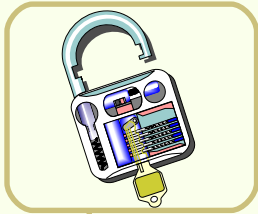
Photoelectric beams. A photoelectric beam device (also called a motion detector) looks like a standard wall outlet and sends beams of infrared light across hallways, rooms, and stairwells (Figure 23). The beams are invisible to the naked eye, but when an intruder walks through the beams, an alarm sounds.

FIGURE 23—If an intruder walks through a photoelectric beam, an alarm will sound.



Panic buttons. A panic button is a device that you would most often find below counters in retail stores. If a robber enters, the clerk or cashier can press the button to sound an alarm.

Now, before proceeding to the next section of the text, take a few moments to test your knowledge of what you've read by completing *Locking It Up! 1*.



Locking It Up! 1

At the end of each section in *Introduction to Locks and Keys*, you'll pause and check your understanding of what you've just read by completing a "Locking It Up!" quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

Fill in the blanks in the following statements.

1. A _____ lock is any type of lock that a key opens.
2. The _____ is the tube assembly that surrounds and holds the plug.
3. If you want to be able to lock a door on either side with a key, install a _____ lock.
4. The five basic key types are _____, _____, _____, _____, and _____.
5. The _____ is the handle of a key.
6. The _____ is the pattern of notches cut into the edge of the key.
7. A _____ has a squared-off end, while a latch has an angled end.
8. The four mechanisms used in modern locks are _____, _____, _____, and _____.
9. The _____ lock mechanism is the oldest type of lock still in use today.

Check your answers with those on page 57.

KEY-OPERATED LOCK APPLICATIONS

We use key-operated locks for a variety of purposes. Customers will often ask a locksmith to recommend locking devices for their particular needs. For this reason, you'll need to know more than just how to repair and replace locks. To be able to advise your customers well, you'll need to understand how to best use locks for everyday security.

Locks have six typical uses in everyday security.

1. To prevent entry (an exterior door lock)
2. To provide privacy (a bedroom or bathroom door lock)
3. To secure valuables (a deposit box or safe)
4. To prevent something from being removed from a location (a bike lock)
5. To prevent operation of a device (a car ignition lock or a gun lock)
6. To prevent access to information (a computer lock)

When a customer asks you to recommend a lock, the first thing you must do is determine why he or she needs the lock. If anyone uses a lock improperly (that is, for a purpose other than its intended purpose), the lock will have little or no deterrent value. A *deterrent* is something that prevents a thief or intruder from breaking into a house or stealing property. The *deterrent value* of a lock is simply how well it prevents crimes from occurring. How well a lock acts as a deterrent directly relates to the following four factors.

The type of lock. Most locks are designed for certain purposes. For example, a lock designed to secure a window sash would be worthless if installed on a wooden entry door. We wouldn't use a safe lock on a house door. Likewise, we wouldn't use a padlock to lock a car ignition. These are simple examples, but can you see how important it is that the right type of lock be used for a job? The type of lock used in a particular situation directly affects how well it will act as a deterrent.

The quality of the lock. Poorly designed locks of low quality offer relatively little security since they're easy to force open.

In contrast, *a high-quality lock that's precision-made and properly installed is difficult to force open.*

The quality of installation. You must install locks carefully and correctly according to the manufacturer's specifications to assure security. In addition, check the area on which you're installing the lock for proper strength. For example, it makes little sense to install an expensive, high-security lock on a "paper-thin" door. Thieves won't bother trying to pick the lock mechanism, they'll simply kick in the door! Thus, the way you install a lock (and where) directly affects how well it will prevent crime.

The skill of the potential intruder. All beginning locksmiths must learn that no lock is 100 percent guaranteed to stop a crime from occurring. If thieves are skilled enough and determined enough to get into a place or a thing, they will, and no lock will stop them. They may find some way to force open the lock itself, or they may simply find an alternate way to get in. However, a good lock can slow down a thief and make it more likely that the thief will be caught. Also, a burglar who judges that it's too much trouble to bother with a particular lock will simply move on to a less-protected house.

In summary, to create a proper deterrent to crime, a lock must be of good quality, installed securely, and used only for its intended purpose. Keep these factors in mind whenever you recommend a lock or security product.

Now, let's take a look at some common key-operated locks that are used every day. If you were to look in a lock supplier's catalog or in a hardware store, you'd find key-operated locks and locking devices divided into the following general categories.

1. Residential entry locks
2. Auxiliary door locks
3. Specialty locks
4. Office locks
5. Commercial Locks
6. Auto locks

Residential Entry Locks

A *residential entry lock* is a lock used on the exterior door of a home. One of the most common entry locks sold today is the *lockset*, which refers to any complete door opening set that includes a doorknob, a lock cylinder, a deadbolt, and all the hardware needed for installation.

Most modern locksets contain pin tumbler cylinders. You can install the cylinder directly into the surface of a door (a *mortise cylinder*) or in a doorknob (a *key-in-knob lock*). When a customer desires extra security, you can use both a mortise lock and a key-in-knob lock in the same door. Figure 24 shows a mortise cylinder; Figure 25 shows a key-in-knob lock.

FIGURE 24—Shown is a mortise cylinder, which you install into the surface of a door.

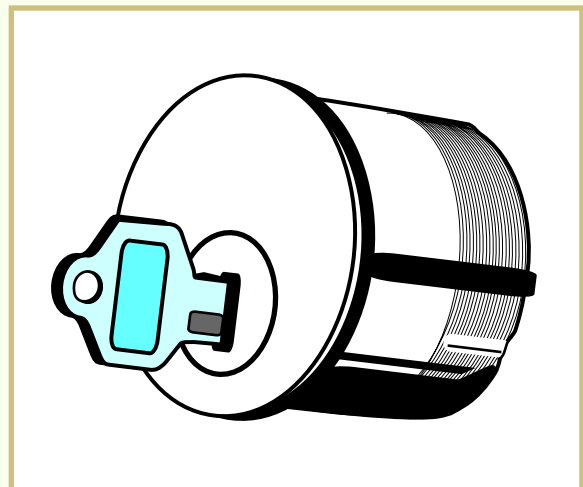
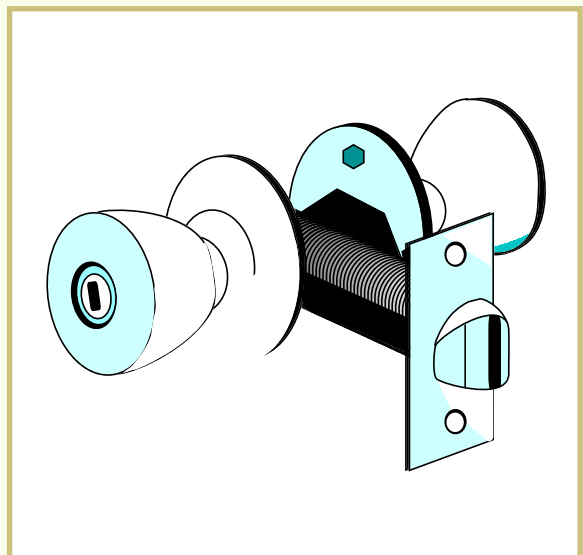


FIGURE 25—A Standard Key-in-Knob Lock.



A standard lockset uses a traditional round doorknob to open the door. However, other types of locksets are available. An *entrance handleset* (Figure 26) is a special type of lockset used for both homes and businesses. To open the door, you have to grasp the handle and the press down the thumbpiece. The *lever lock* (Figure 27) is another type of lockset frequently used in hospitals or on doors designed to allow access to the disabled. The shape of the lever handle makes it easier to grasp than a standard doorknob.

FIGURE 26—Entrance handlesets are a popular choice when home owners want a decorative alternative to the traditional lockset.

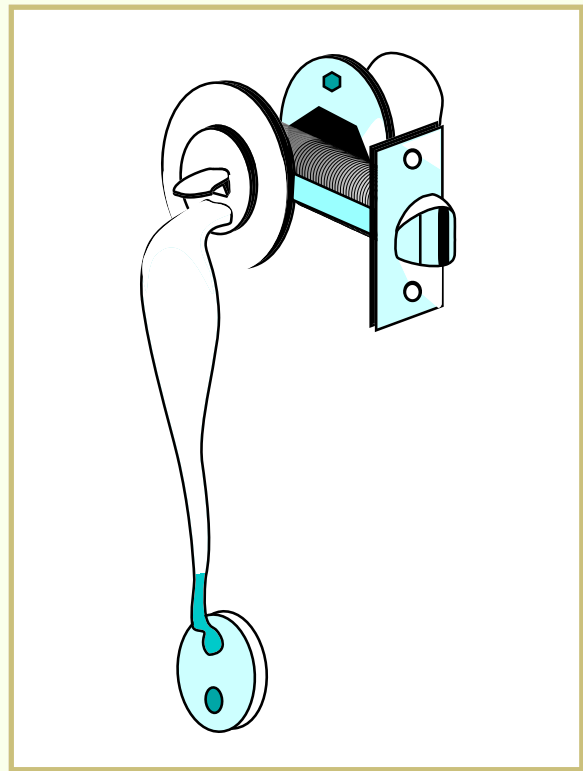
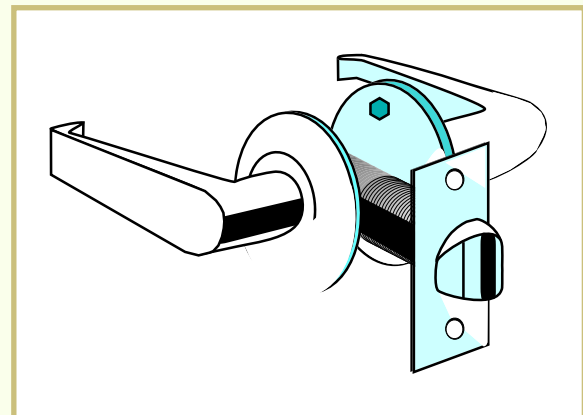


FIGURE 27—Because the lever handle is easier to grasp than a standard doorknob, lever locks are popularly used in hospitals and facilities for the handicapped.



Locksmiths occasionally describe door locks by the way they're installed. For example, some door locks fit into a recessed area cut into the door. The recess is termed a *mortise*, so a lock installed in this fashion is a *mortise lock*. In contrast, a *rim lock* is a type of door lock installed on the surface or rim of a door (Figure 28). A *cylindrical lock* is a lock shaped like a cylinder that fits into a tunnel cut into the door (Figure 29). Finally, a *narrow stile lock* is made especially for glass doors with a narrow frame. The term *stile* is the name given to the vertical wooden components of a door.

FIGURE 28—This figure shows how a mortise lock and a rim lock are installed in a door.

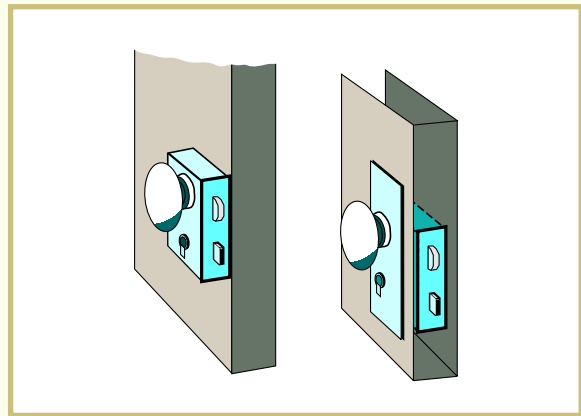
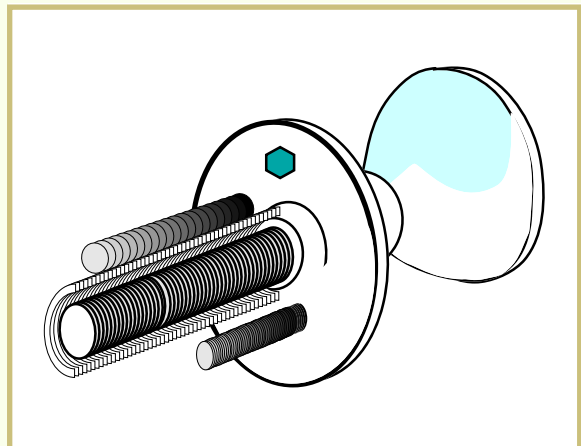


FIGURE 29—A Cylindrical Lock Installed in a Tube Cut Through a Door

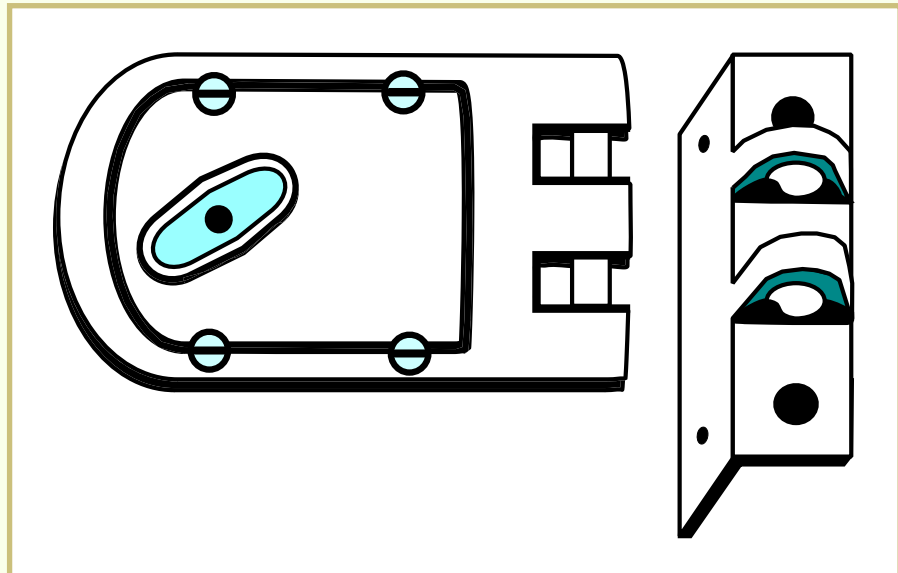


Auxiliary Locks

An *auxiliary lock* is simply an “extra” lock installed on a door to provide backup security. Two common key-operated auxiliary locks are the *tubular deadbolt* and the *turn knob rim lock*. You mount a tubular deadbolt into a horizontal “tube” cut into the edge of a door. Usually, a mortise cylinder is used with the tubular deadbolt. The bolt itself must be moved into position either with a key or by turning the thumb turn from the inside.

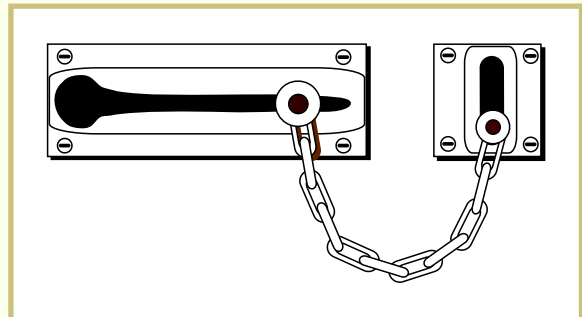
You mount a turn knob, vertical pin-rim deadlock on the surface of a door. You open the lock with a key or by turning the turnpiece (Figure 30). Rim locks are very secure and are resistant to jimmying, prying, and other types of forced entry.

FIGURE 30—A turn knob, vertical pin-rim deadlock is very resistant to attempts to jimmy or pick it open.



Another common auxiliary lock is the *safety chain* (Figure 31). Safety chains may or may not be operated by a key. The safety chain allows you to partially open a door to see out without granting entry to the person on the other side.

FIGURE 31—A Safety Chain

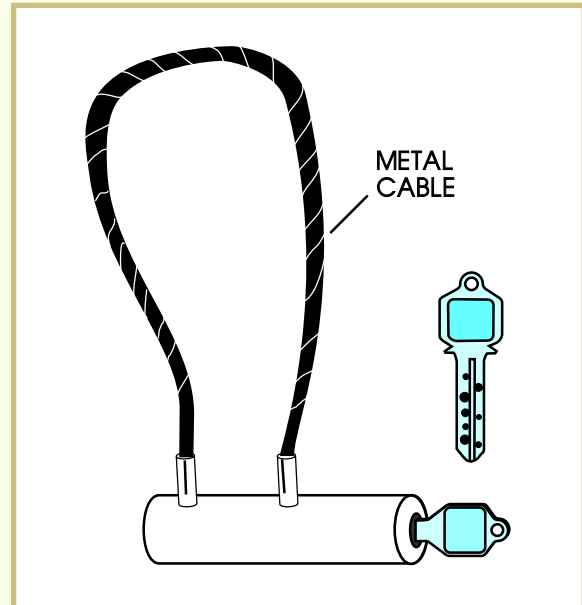


Specialty Locks

The term *specialty lock* applies to a variety of locking devices used for specific security purposes. The mechanisms are no different from any other type of lock, but the overall shape and function of the lock are adapted so that we can only use the lock for one purpose. Some common specialty locks are *padlocks*, *gun locks*, *luggage locks*, *bicycle locks*, *trailer locks* (used

to lock a trailer hookup on a vehicle), *cable locks* (Figure 32), *vending machine locks*, and *ski locks*. A tubular key operates the vending machine. Cylinder keys operate the other devices.

FIGURE 32—A High-security Cable Lock



Specialty locks help prevent the removal of property from a location or they prevent a device from being used. For example, a bicycle lock prevents someone from removing your bike from where you left it; a gun lock fits into the trigger assembly of a gun and prevents it from being fired.

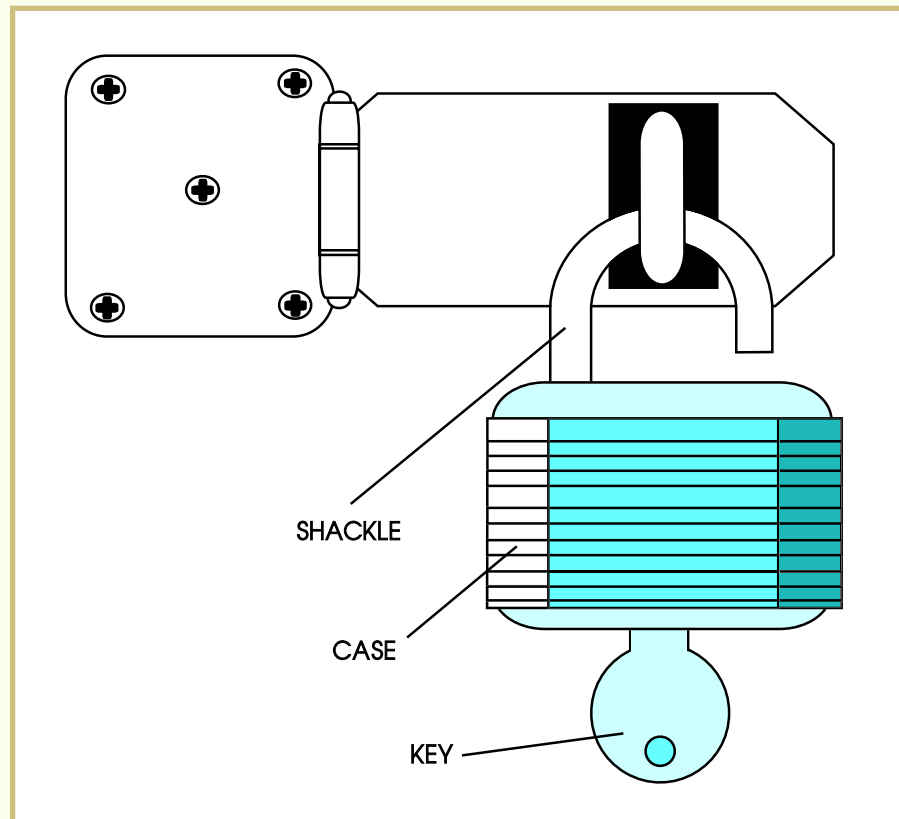
Padlocks are convenient, portable locks used to secure gates, doors on outbuildings, storage areas, and toolboxes. Padlocks come in many shapes and sizes, but they all have three basic parts: the *key*, the *casing*, and the *shackle*.

The casing is simply the outer shell of the padlock. The shackle is a U-shaped piece of hardened steel that extends out of the main body of the padlock. The padlock locks when the shackle is secured inside the lock. A padlock is most effective when it's connected to a solid surface. You can install a hinged metal strap called a *hasp* on a door to provide a place for the padlock to connect to. Figure 33 illustrates the parts.

Office Locks

Office locks include a variety of devices used to secure equipment and documents in office buildings. Because offices

FIGURE 33—This illustration shows the basic parts of a padlock.



contain valuable papers and information as well as property, offices need special locking devices to protect file cabinets, desks, and computer terminals.

The *cam lock* most often locks desk drawers and cabinets. The cam is a rotating piece of metal at the back of the lock plug. The plug itself may be a pin tumbler or disk tumbler mechanism. When in place, the cam forms a physical barrier that prevents a drawer from being pulled out or a cabinet door opened. When you insert the key and the plug turns, the cam at the back of the lock turns also, freeing the drawer or door to open.

A *file cabinet bar* is a common device used in high-security offices with valuable papers and documents (Figure 34). The bar locks in place over the fronts of the file drawers, preventing them from pulling out. When the bar is unlocked, it swings away from the file drawers, freeing them to open.

A *computer lock* is a device found on the front of a computer terminal (Figure 35). When locked with a tubular key, the lock prevents the computer's keyboard from operating. Without the keyboard available to type commands into the computer, an intruder can't gain access to the information stored inside.

FIGURE 34—A locking file cabinet bar physically prevents drawers from being pulled open.

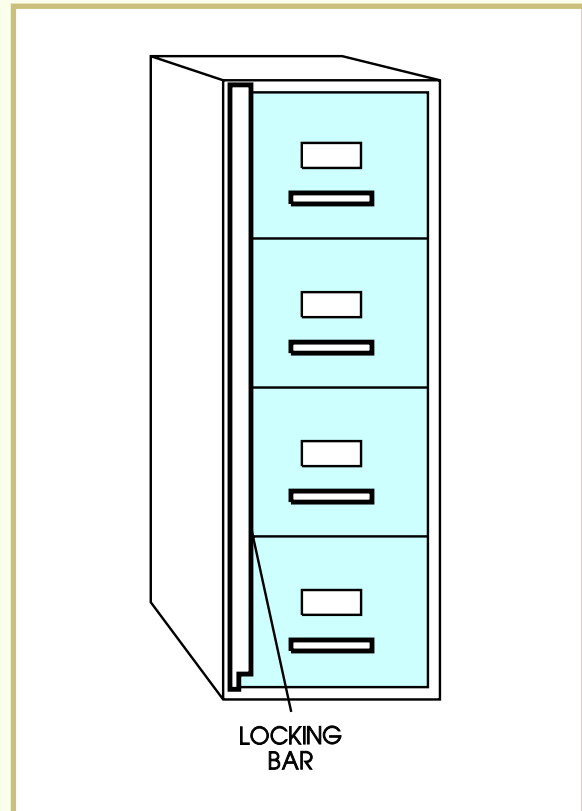
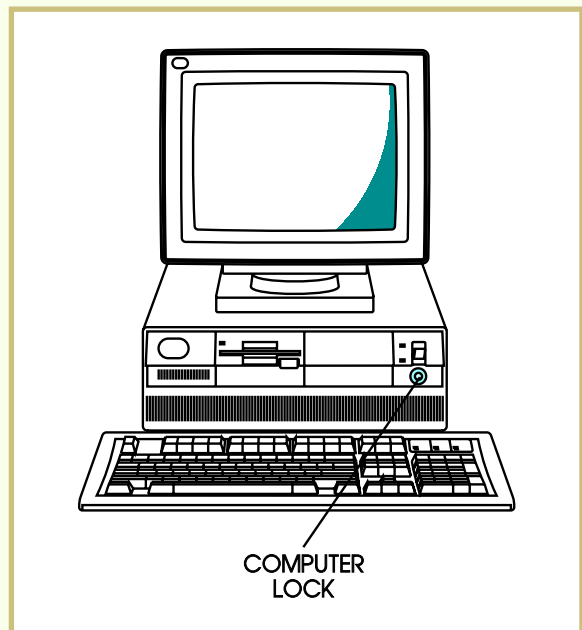


FIGURE 35—The lock on this computer terminal prevents the keyboard from being used.

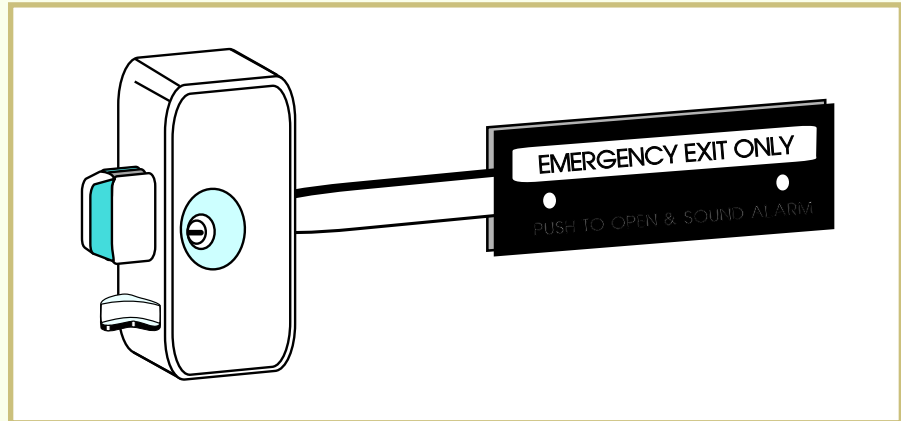


Commercial Locks

Commercial locks are locks used primarily for businesses and large buildings, rather than private homes. Building code

laws in most areas demand that commercial buildings install devices that make it very easy to get out of the building quickly in case of a fire or other emergency. For this reason, most commercial buildings install *panic hardware* on the insides of their doors (Figure 36). Even if a door is locked from the outside, anyone trapped inside only has to lean on the inside paddle or handle to release the door outward.

FIGURE 36—This illustration shows a typical panic bar device.

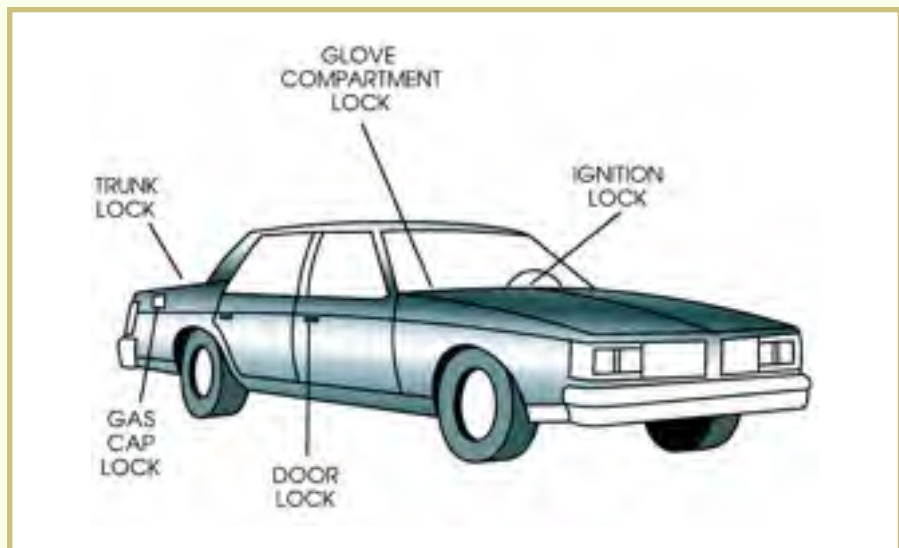


For security purposes, high-security pin tumbler cylinders are often used on commercial buildings. These locks make it very difficult to pick or force open a door.

Auto Locks

The average car may contain as many as five locks: ignition, door, trunk, glove compartment, and gas cap (Figure 37).

FIGURE 37—This illustration shows the location of standard auto locks.

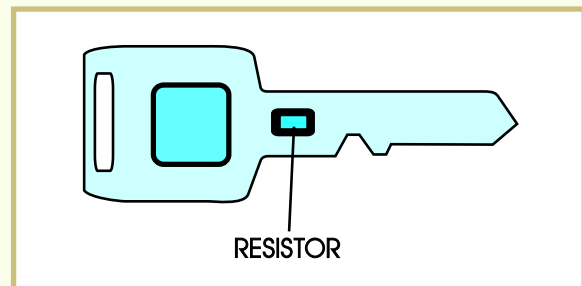


You'll find pin tumbler and disk tumbler cylinder locks most often in automobiles.

The market for vehicle security devices is growing fast to keep pace with rising crime rates. For this reason, many car manufacturers now include vehicle security devices in their cars in addition to locks. A wide variety of products is available for later installation as well.

One well-known security system is General Motor's *PASS*, which stands for *Personal Antitheft Security System*. In the *PASS* system, an electrical resistor chip is embedded in each car key (Figure 38). When you insert the right key into the car ignition, the *PASS* computer recognizes the chip and starts the car. However, when you insert the wrong key or attempt to bypass the system, the computer shuts off the starter and the fuel supply for several minutes.

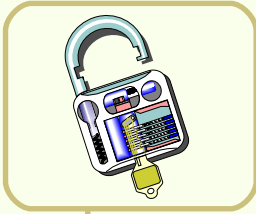
FIGURE 38—The General Motors *PASS* key has an electrical chip embedded in it. If the wrong key is inserted in the ignition, the car's computer disables.



Another common form of security is the car alarm. An electric, key-operated door lock is connected to a siren. When the owner locks the car door, the system turns on. If anyone else attempts to gain access to the car, the siren will go off. Some car alarms are so sensitive that they'll go off if someone bumps the car or taps a tool on a window, or if someone attempts to tamper with the hood of the car.

Remote control operates some newer-model car alarms. A receiver is simply mounted on the dashboard. To activate the alarm system, the owner closes the car door and presses the button on the remote control. Depending on the range of the remote control, the owner can turn the alarm on or off from a distance.

Before you proceed, please complete *Locking It Up! 2* on the following page.



Locking It Up! 2

Fill in the blanks in the following statements.

1. A _____ is a complete door opening set that includes a doorknob, a lock cylinder, a deadbolt, and all the hardware needed for installation.
2. A lock cylinder installed directly into the surface of a door is a _____.
3. A lock cylinder installed in a doorknob is a _____.
4. A _____ is a type of lockset used in hospitals or on doors designed to allow access to the disabled.
5. The three basic parts of a padlock are the _____, _____, and the _____.
6. The security system used on newer model General Motors vehicles is the _____.

Check your answers with those on page 57.

LOCKSMITHING SKILLS

Everyday Tasks

Professional locksmiths provide a variety of services for their customers. Let's take a look at some of these services now.

Duplicating Keys

Duplicating a key is to make one by copying another key that you use as a pattern. You duplicate most keys by machines that trace the original key to cut the same bitting in the new one. Duplicating produces a second key with the same shape.

Professional locksmiths also are able to duplicate a key manually, using a file.

Cutting Keys By Code

A way to duplicate keys when the original isn't available is to *cut them by code*. The code is a set of numbers (or letters) that helps the locksmith learn the correct combination for the key. There are books published for the locksmith industry and kept on hand for the locksmith that translate the code numbers. If the customer is able to supply the code number, the locksmith can make a new key almost as quickly as he or she could copy a key from the original.

Rekeying Locks

Rekeying is a procedure in which a locksmith changes the inside of a lock to fit a new key. This service is commonly requested when someone moves into a new home or when an employer dismisses a worker. Rekeying changes the lock so that the former owner or former employee can no longer use his or her key to gain entry.

Impressioning Keys

When a lock's key is lost, it's possible to make another key to fit by means of a procedure known as *impressioning*. In impressioning, you use the lock as a "mold" to make a new key. You impression a key by

- Inserting a blank key into the lock
- Turning the blank key against the interior of the lock
- Examining the marks made on the blank by the lock
- Using the marks as a guide to make cuts (the bitting)

Picking Locks

Lockpicking means opening a lock with the use of special tools rather than a key. A professional locksmith can pick a lock in three to five minutes on average, but it can take half an hour to open some locks. For some locks, the procedure requires two delicate instruments, one to put slight tension on the lock, and the other to manipulate tumblers. You can open simpler locks occasionally with a pair of stiff wires.

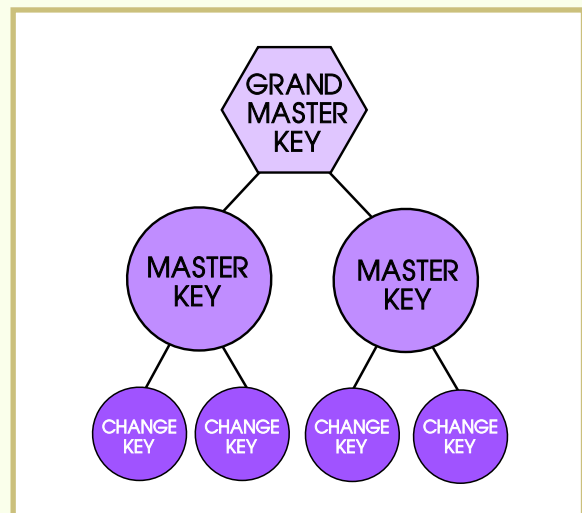
Reading Locks

Reading a lock is the art of visually examining the interior of a disk tumbler lock to see the placement of the tumblers. With the aid of a light, a locksmith peers into the key opening, or keyway, and notes the placement of the tumblers, “reading” them. The locksmith then cuts the key to fit that combination. This skill can be effective with locks having either disk tumblers or lever tumblers.

Master Keying

It often is desirable to set up a *master key system* in hotels, motels, large businesses, institutions—just about any place with a lot of doors. The locksmith can master key the locks for those who must have access to more than one room. For example, with a master key the custodian can enter and clean all the offices, while not permitting office employees to enter any other office than their own. Master key systems can be arranged in several levels, conforming to the levels of authority in an organization. The highest level of key will open all the locks in the system; the key of the lowest level will open only one (Figure 39). Locksmiths refer to the key that’s capable of opening only one lock as the *change key*. The levels each have a name, something like families: *change key*, *master key*, *grand master key*, *great grand master key*, and so on.

FIGURE 39—In a master key system, each change key will open only one lock. The master key will open all of them.



A Locksmith's Tools

Locksmiths use standard tools such as hammers, screwdrivers, and drills as well as specialized tools such as lock picks and key cutting machines.

As we mentioned, many of the tools found in a locksmith's shop are basic to many trades. If you're a "do-it-yourselfer," there's a good chance you already own many of them. The following list names some of the essential tools a locksmith always keeps handy.

- Assorted pliers
- Assorted screwdrivers
- Allen wrench set
- ½-inch electric drill
- Cordless electric drill
- Center punches
- Standard claw hammer
- Ball peen hammer
- Rubber mallet
- Ratchet wrench and sockets, both standard and metric
- Set of vise-grip pliers
- Bright flashlight
- Wood chisel (especially 1-inch size)
- C-clamps
- Pocket-size level
- Extension cord
- Electrical tape
- Miniflashlight or penlight

Specialized locksmithing tools include the following.

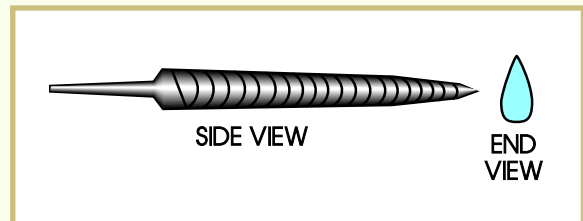
Bench vise. A bench vise (Figure 40) holds keys and cylinders firmly while you're working on them.

FIGURE 40—Bench Vise



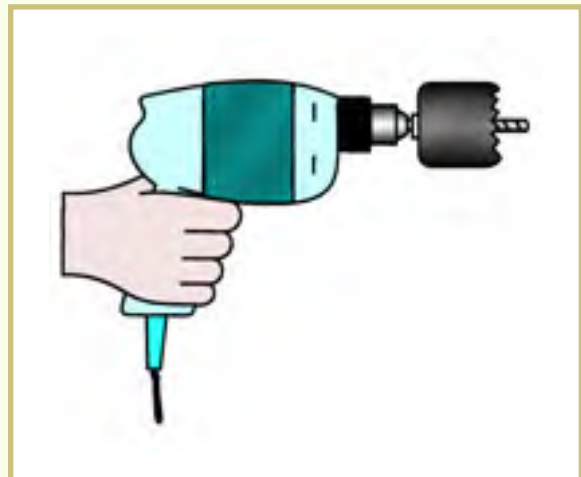
Assorted metal files. You use metal files in lock repair and for cutting keys by hand. Many locksmiths prefer and recommend the *pippin file* (Figure 41) for key duplication.

FIGURE 41—Pippin File



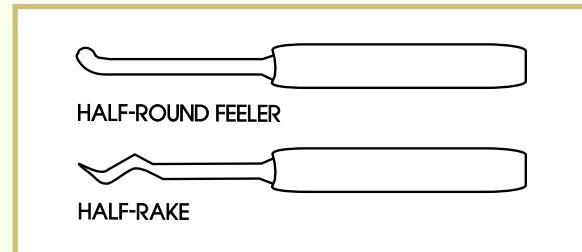
Hole saw kit. Locksmiths commonly use a hole saw kit for installing locksets in residential doors (Figure 42).

FIGURE 42—Use a drill, drill bits, and a hole saw for lock installations.



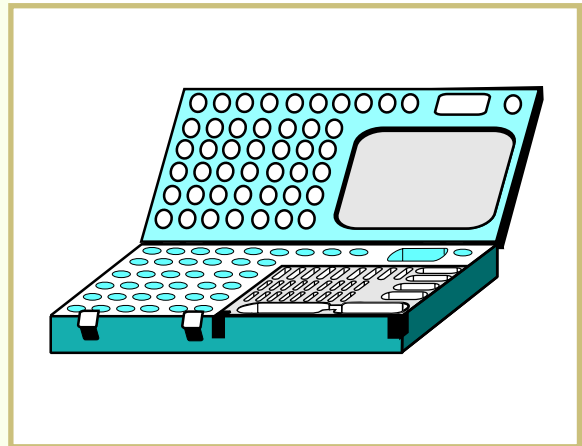
Lock pick. Lock picks of various shapes (Figure 43) open locks without a key.

FIGURE 43—Lock picks.



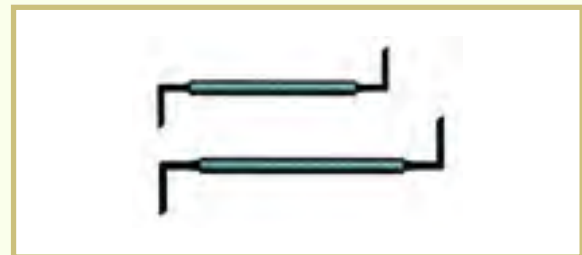
Pinning kit. You use pinning kits to rekey pin tumbler lock mechanisms. You may buy anything from a very small kit that's used with one lock type to a *universal pinning kit* (Figure 44) that's made to use with all locks.

FIGURE 44—Universal Pinning Kit



Tension wrench. You use a tension wrench (Figure 45) along with a lock pick when you pick a lock.

FIGURE 45—Tension Wrench



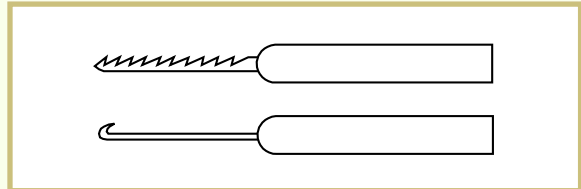
Formed-end tweezers. With formed-end tweezers (Figure 46), you can pick up small pins and springs when you're rekeying a lock.

FIGURE 46—Formed-end Tweezers



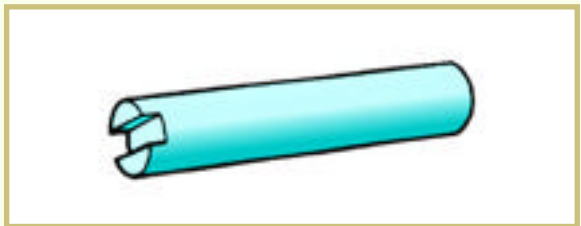
Broken key extractor. Using a broken key extractor, you can remove broken pieces of key from inside a lock (Figure 47).

FIGURE 47—Broken Key Extractor



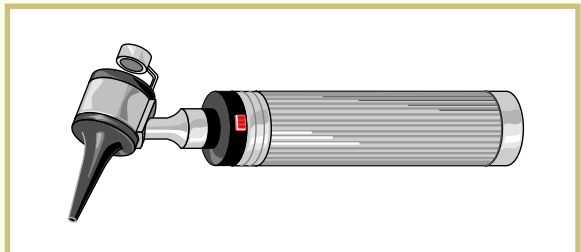
Plug follower. You use a plug follower when removing a plug from a lock cylinder. You insert the follower into the cylinder in place of the plug (Figure 48) to prevent the driver (top) pins and springs from falling out.

FIGURE 48—A Plug Follower



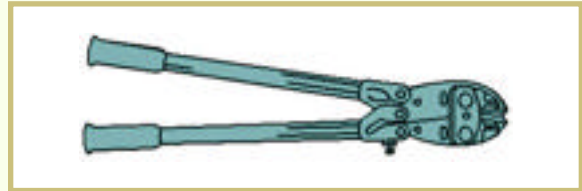
Otoscope. An otoscope is the instrument a doctor uses to shine light into people's ears and throats during an examination. A locksmith uses the same instrument to shine bright light into a small lock mechanism (Figure 49).

FIGURE 49—Otoscope



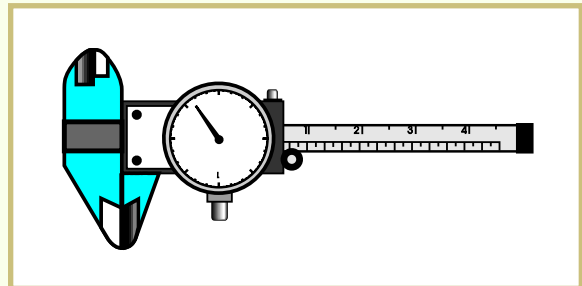
Bolt cutters. You can use a set of bolt cutters (Figure 50) to force open padlocks in an emergency.

FIGURE 50—Bolt Cutters



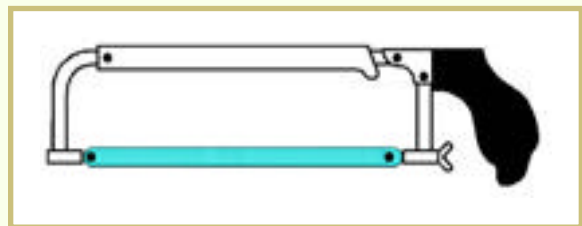
Dial caliper. A dial caliper (Figure 51) is useful for measuring pins, cuts in keys, and the dimensions of other lock parts.

FIGURE 51—Dial Caliper



Hacksaw. A hacksaw (Figure 52) can cut through bolts in an emergency.

FIGURE 52—Hacksaw



Cylinder removal tool. You would use a cylinder removal tool (Figure 53) to remove mortise cylinders from a door surface.

FIGURE 53—Cylinder Removal Tool



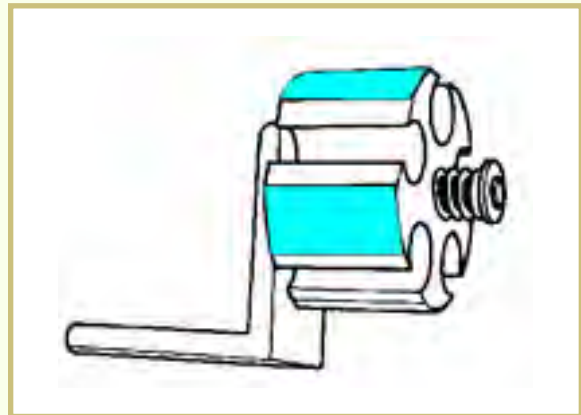
Picking gun. You can use a picking gun (Figure 54) to pick some kinds of locks quickly and easily.

FIGURE 54—Picking Gun



Plug holder. A plug holder (Figure 55) can be useful when rekeying or otherwise repairing lock cylinders and plugs.

FIGURE 55—Plug Holder



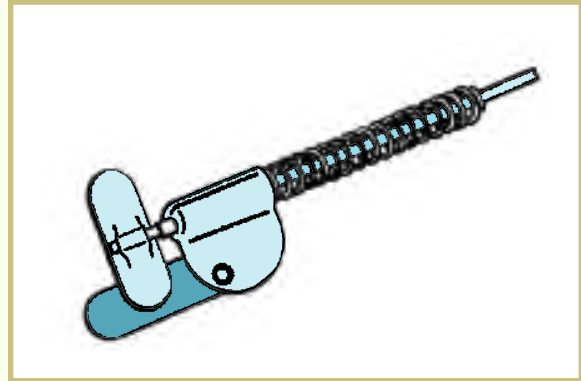
Double-D punch. A double-D punch (Figure 56) is useful for installing locks in metal cabinet doors and drawers.

FIGURE 56—Double-D Punch



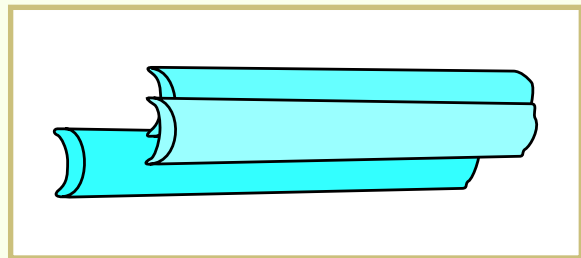
Plug spinner. Sometimes when a lock is being picked, the plug may accidentally turn in the wrong direction. A plug spinner (Figure 57) can rotate a plug in either direction to correct the situation.

FIGURE 57—Plug Spinner



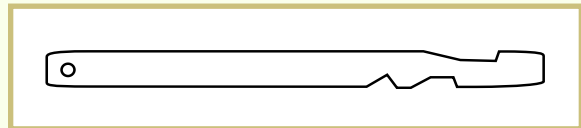
Shims. You may use thin metal shims (Figure 58) when taking pin tumbler cylinders apart.

FIGURE 58—Shims



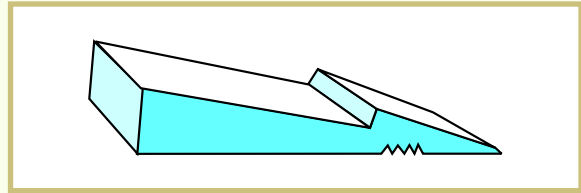
Car opening tools. You can use a wide variety of car opening tools to slide down into a car door mechanism and open a lock (Figure 59).

FIGURE 59—This figure shows the popular "Slim Jim" tool used to open car doors.



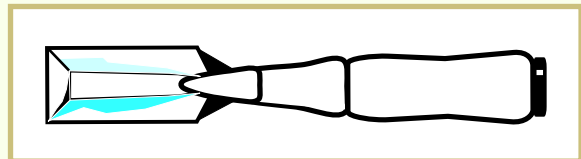
Car opening wedge. You can use a car opening wedge (Figure 60) in conjunction with car opening tools. When the fit of the car door's window is too tight to allow you to slip in the car opening tool, you use the wedge between door and window to create a space for insertion. Take great care when forcing in the wedge to prevent the car's window from shattering.

FIGURE 60—Car Opening Wedge



Wood chisel. When installing door locks in wooden doors, use a standard 1-inch-wide wood chisel (Figure 61).

FIGURE 61—Wood Chisel



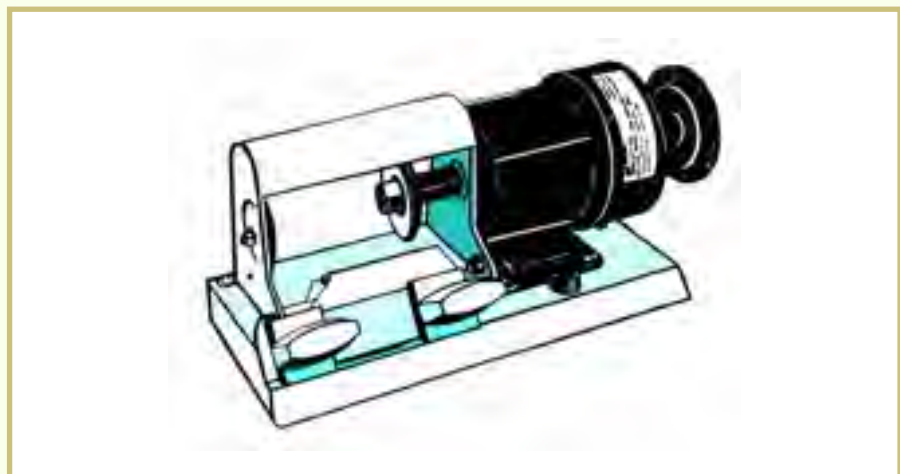
Key gage. A key gage (Figure 62) measures the depth of the cuts in a key.

FIGURE 62—Key Gage



Key duplicating machine. A key machine is standard equipment for the locksmith. A wide variety of machines is available to duplicate all kinds of keys (Figure 63).

FIGURE 63—This illustration shows a simple key machine used to duplicate cylinder keys.

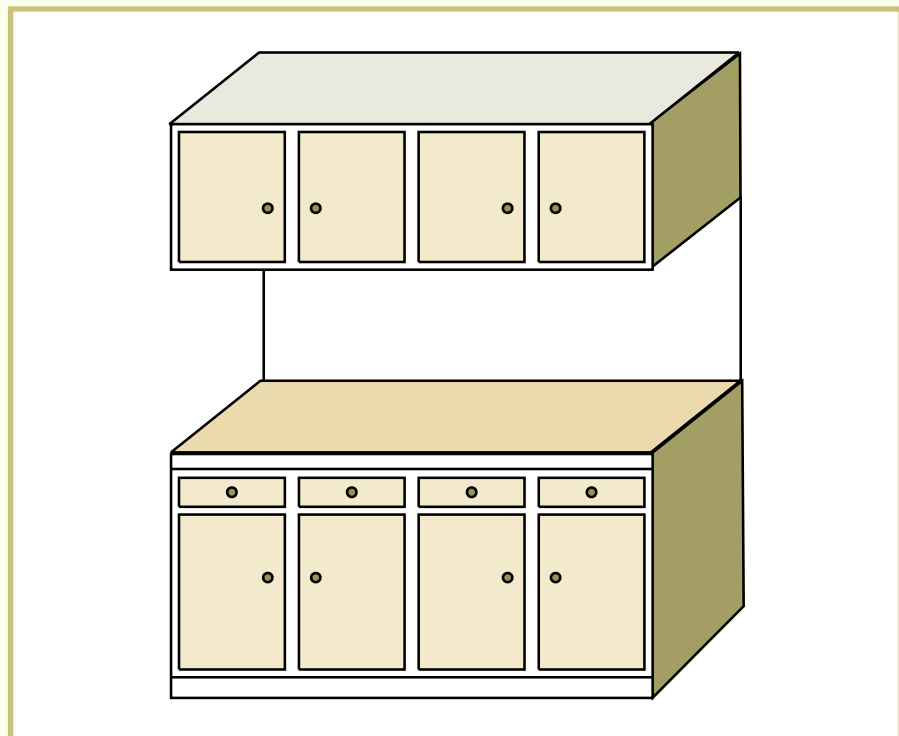


You can purchase many locksmithing tools individually or in sets. Sometimes, buying a complete set of tools is more practical and less expensive than buying tools one by one. However, a full set of tools can be a waste if you don't really need all the items in the set. Before you buy, try to determine what you really need and use most often.

However, all the tools that a professional locksmith uses should be well made and able to provide many years of service. Remember that a poor-quality tool can damage both you and the device you're working on. The small amount of money you save by buying an inferior tool you might pay out hundreds of times in botched jobs! Therefore, even though quality tools are sometimes more expensive, they're well worth the investment.

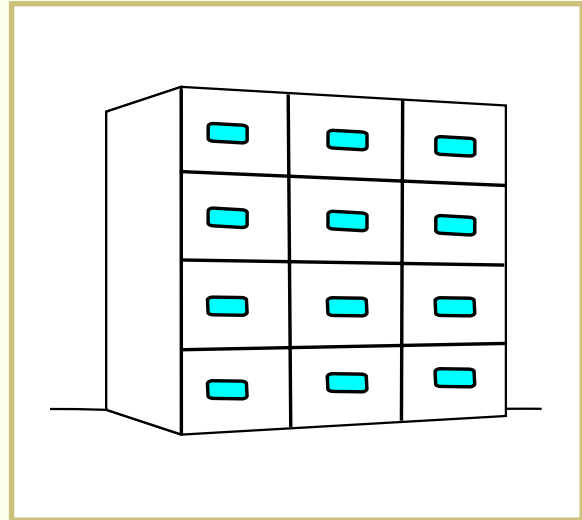
Professionals respect their tools and make sure they properly maintain and store them. Figure 64 shows a useful standing tool storage unit for locksmithing needs. When you purchase a tool storage unit, remember to allow room for future expansion. When your business grows, you may need more tools, and you'll already have the necessary space to store them.

FIGURE 64—A Standing Tool Storage Cabinet



You can also purchase smaller units or organizers for use on top of your worktable (Figure 65). Or, make some useful

FIGURE 65—Pictured here is a small organizer with drawers for the top of your worktable.



organizers for yourself out of discarded cigar boxes, egg cartons, or shoe boxes.

The next section of the text contains your first hands-on practice exercise. In this exercise, you'll examine the function of your cutaway padlock. You'll find the padlock in your first shipment of study materials.

Now, before you proceed to the practice exercise, take a few moments to complete *Locking It Up! 3*.



Locking It Up! 3

Indicate whether each of the following statements is True or False.

- ___ 1. In impressioning, you alter the interior mechanism of a lock to fit a new key.
- ___ 2. In rekeying, you use a key cutting machine to duplicate keys.
- ___ 3. Many locksmiths prefer the pippin file for filing keys by hand.
- ___ 4. You would use lock picks to rekey a pin tumbler lock.
- ___ 5. In a master key system, a master key would open all change key locks.

Check your answers with those on page 57.

PRACTICE EXERCISE

Introduction

This practice exercise covers the operation of a pin tumbler lock mechanism. As we mentioned earlier in this study unit, the pin tumbler lock mechanism has existed since Egyptian times. The early Egyptian lock used pins that, like today's locks, raised the pins. When the pins were raised, a sliding bolt released to open the door. The key used for these locks was a small wood device that looked like a toothbrush fitted with wooden pegs.

Today's pin tumbler locks work on the same basic principle of raising pins to open the lock. Refinements in the manufacturing process have made today's pin tumbler lock a precision device.

Your Cutaway Padlock

The cutaway padlock that comes with your course is a high-quality locking device containing a pin tumbler mechanism. Let's take a look at how your lock works.

Remove your lock from its box. The manufacturer prepared the shell of this lock to allow you to see the internal working parts of the lock. Look carefully at the lock and note that it has four major parts: the shell, the shackle, the locking mechanism, and the plug (Figure A).

The lock consists of two types of metal. The shackle is hardened steel. The remainder of the lock (except the springs) is a brass alloy, which prevents the lock from rusting if it's used outdoors.

The locking mechanism near the top of the lock holds the shackle in two locations. The two *tangs* at the top of the plug, when rotated, cause the locking mechanism to retract (Figure B). This action causes the shackle to rise under spring pressure. Place the key in the lock and turn it very slowly. Watch the tangs and how they place pressure on the lock mechanism.

FIGURE A—Shown here are the four main parts of the cutaway padlock.

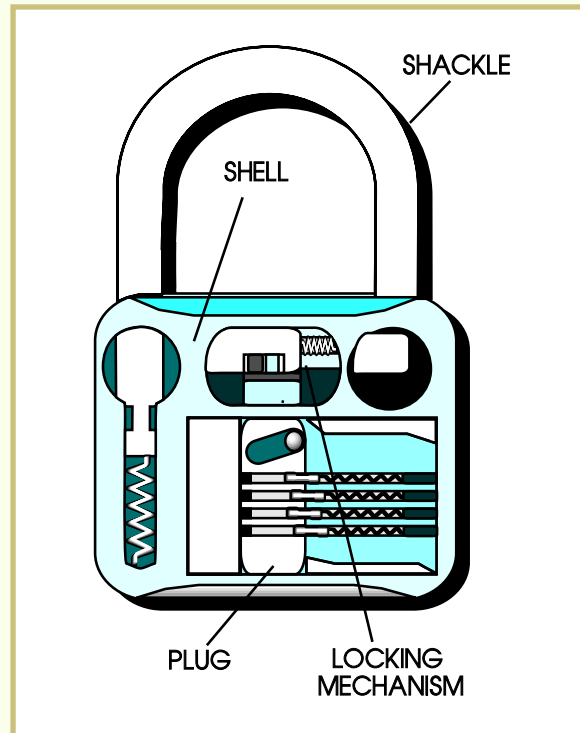
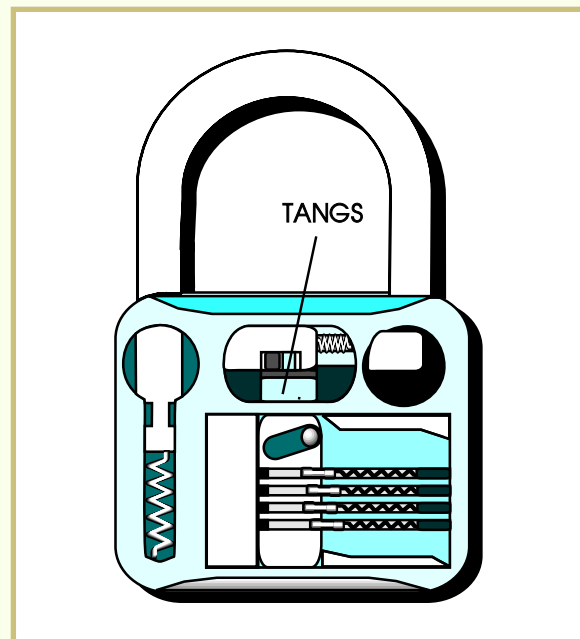


FIGURE B—When the lock plug rotates, the tangs place pressure on the locking mechanism and force it to retract.



The final components of the lock are the *plug* and the *pins* (Figure C). The plug contains the keyway (the slot the key is inserted into) and also holds the bottom pins.

The *top pins* are held in between the plug and the shell, preventing the plug from rotating. All of the pins are pushed downward into the plug by springs in the shell (Figure D).

FIGURE C—This illustration shows the parts of the lock's plug.

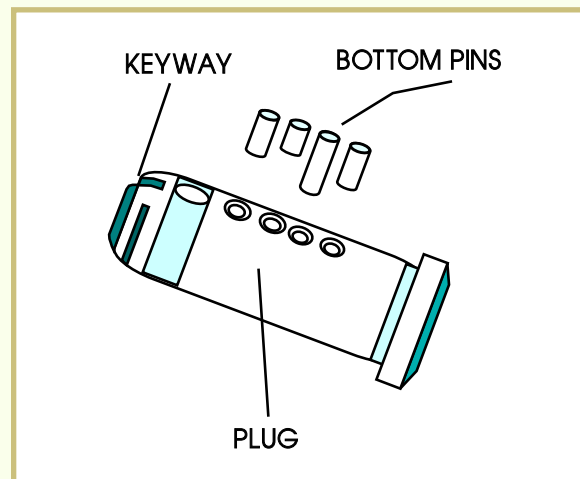
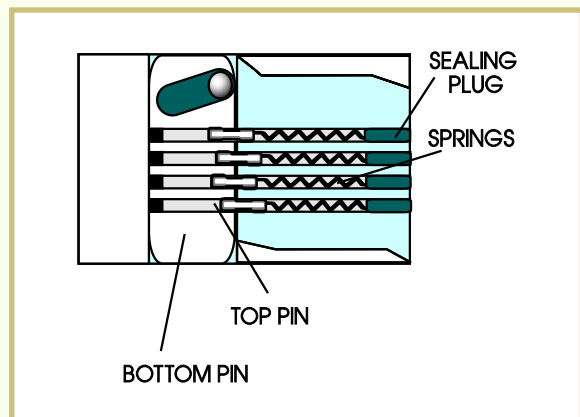
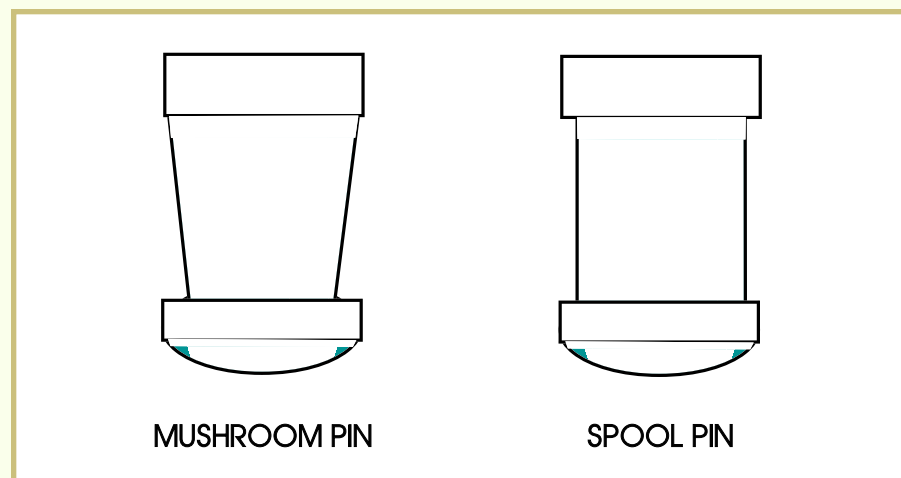


FIGURE D—This illustration shows a close-up of the pin assembly in your padlock.



Notice the shape of the top and bottom pins. The top pins are shaped like a spool or a mushroom (Figure E), and the bottom pins are shaped like a cylinder. The shape of the pins can prevent successful picking attempts, and so we call them *pick-resistant pins*.

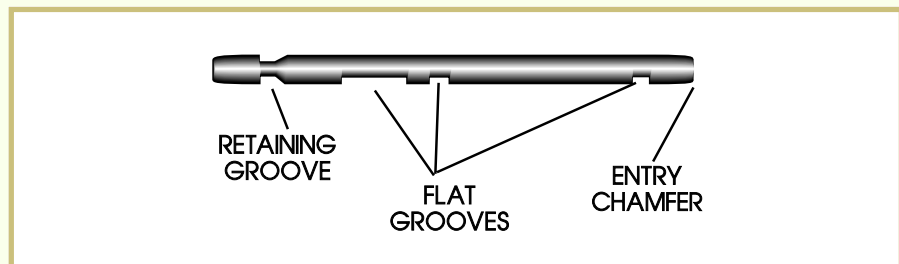
FIGURE E—Here are two types of pick-resistant top pins used in some types of pin tumbler locks.



How Your Lock Was Manufactured

Now, let's look at how this lock was made, starting with the shackle. The shackle begins as a piece of round steel stock. The steel stock is placed in a lathe where the *entry chamfer* and the *retaining groove* are cut. The stock is then cut to the proper length. Next, the shackle is placed in a milling machine where the flat grooves are cut. The shackle is then bent in a forming machine, hardened in an oven, and finally plated with high-gloss metal. Figure F shows the cuts made in the shackle before it's bent.

FIGURE F—Shown here is how the padlock shackle would appear after it's machined and before it's bent.



The lock's shell has a number of machining operations performed on it. The solid brass block is first shaped and squared on all four edges. Then, the two shackle holes are drilled in the block. Note that one hole is much deeper than the other hole. If you open your padlock and look at the bottom of each shackle hole, you can see where the end of the drill bit left cone-shaped depressions. The same drill bit then bores a hole through the side of the case for the locking mechanism.

A larger-diameter drill bit is used to drill the plug hole. Since the plug hole ends at the locking mechanism's hole, we can't see the cone-shaped depression at the top of the lock.

A very small drill bit is then used to drill the final holes. Four holes are drilled for the pin chambers through the side of the lock. Two additional holes are drilled for two brass retaining pins that will hold the plug and the shackle inside the lock.

Various other metalworking processes went into the manufacture of your lock. Holes were bored and slots cut away so that you would be able to see the inner workings of the lock. However, since these holes have nothing to do with how the lock works, we won't discuss them further here.

How Your Lock Was Assembled

The first step in assembling a padlock is the insertion of the shackle spring and shackle. Once these two components are installed, a brass pin is pressed into the shell to hold the shackle in the shell. The locking mechanism is then inserted through the hole in the side of the shell. With the shackle still open, the empty plug is inserted into the shell and the locking mechanism is aligned with the rear tangs of the plug.

Once the plug's tangs are aligned into the locking mechanism, a second brass pin is pressed into the shell to hold the plug in place. This pin is installed on the opposite side of the shell from the shackle retaining pin.

The bottom pins, top pins, and springs are then inserted into the pin chambers through the side of the lock. The lock's combination is determined before the process begins. In this way, the manufacturer can install the exact size pins necessary to create the proper combination.

Many lock manufacturers stamp a code number on the shell of the lock. The code number refers to the exact pin combination of the lock. The manufacturer then records the code number and the pin sizes it corresponds to in a code book. If a key is lost, a locksmith looking in the code book can cut a new key from these code numbers.

The final process in creating your pin tumbler lock is to plug the holes that lead to the locking mechanism and the four pin chambers. High pressure is used to push brass sealing plugs into each hole in the shell. All surfaces of the lock are then sanded smooth and finished. The surface sanding and polishing make it very difficult to see where the plugs were put in.

If you rotate your lock under a bright light, you can see the location of the sealing plugs on the outside of the shell. You'll find this same type of construction on many types of padlocks.

Besides the obvious holes and slots cut into your lock, your padlock differs in one major way from a standard padlock. In your lock, the plug is slotted or grooved to allow you to see the bottom pins. In a standard pin tumbler lock, the plug is drilled with holes and no slots are provided.

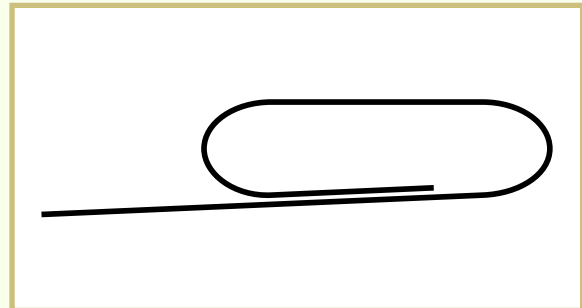
Exercise Instructions

Now, get ready to complete your first hands-on exercise with your cutaway padlock. In this exercise, you'll be using an ordinary paper clip or piece of stiff wire to lift the pins inside the lock. This will show you how the pins move inside the lock and how they must be aligned to free the locking mechanism.

Your lock is strong and should last a long time, even though it has had large amounts of metal cut away from the front. However, the lock is a delicate and precisely manufactured instrument. Be careful when working with the lock. Don't force it! If your lock binds, apply a little graphite powder or Tri-Flow to the locking mechanism, plug, and pins to free the lock. Also, *DO NOT* attempt to disassemble this lock. You'll need it for exercises in later study units.

Step 1: Take a small paper clip (or a piece of stiff wire) and bend it open as shown in Figure G. This will be our tool for exploring the inner workings of the lock.

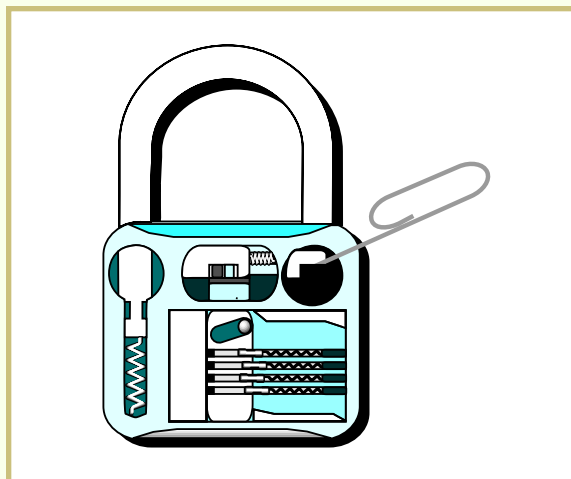
FIGURE G—Bend a paper clip as shown here to use in manipulating the internal components of the lock.



Step 2: Remove the key, if present, from the lock.

Step 3: Hold the lock sideways in your hand. Use the paper clip to push inward on the locking mechanism's catches or pawls as shown in Figure H. You may notice that when pushing in on one pawl, the shackle will move slightly upward, holding the pawl out of the shackle groove. Then, if you press inward on the second pawl, the shackle will open. Notice how hard it was to move the locking mechanism? The locking mechanism securely holds the shackle into the lock's shell until the plug is turned. It would be very difficult to open the lock by hitting it on each side with a hammer or other object.

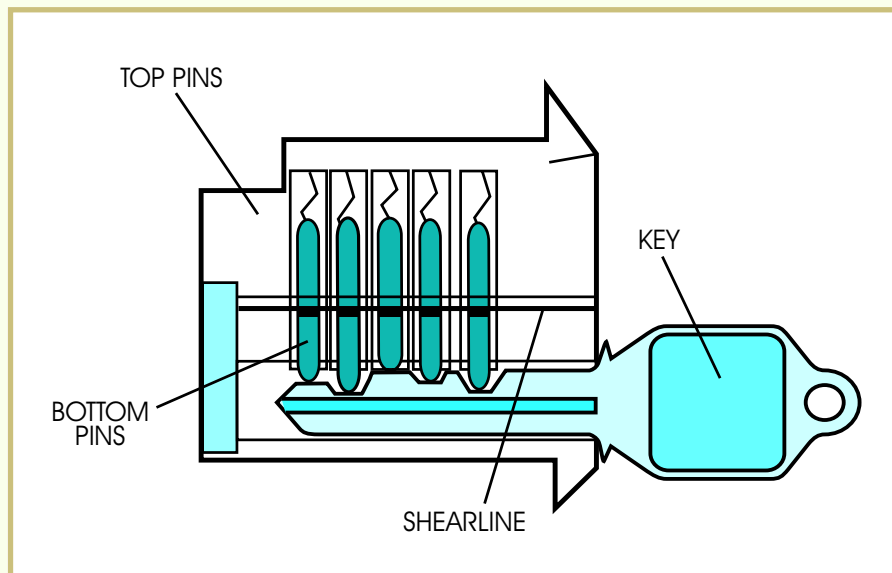
FIGURE H—You can force the locking mechanism backward to see how much force is placed on the shackle by this mechanism.



Step 4: Use the straight side of the paper clip to lift all of the pins inside the cylinder. Place the paper clip in the plug, just as you would the key. Move the paper clip upward to move the pins. Note how the top pins are all of the same height. The bottom pins, however, are of different heights. These are the pins that set the combination of the lock.

Step 5: Now, remove the paper clip and insert the key. Note how the tops of the bottom pins and the bottoms of the top pins all line up at the *shearline* of the plug as shown in Figure I.

FIGURE I—When the key is installed into your lock, the cuts in the key will raise the top pins above the shearline in all five pin chambers. The bottom pins will align themselves exactly at the shearline.



Conclusion

The following are some important facts to remember from the exercise.

- Your lock contains a double-sided locking mechanism that holds the shackle securely at both the heel and toe of the lock.
- Brass pins hold the shackle and plug in the lock.
- Small plugs hide the holes that are placed in the lock during manufacture.
- When the pins line up at the shearline of the plug, the plug of the pin tumbler lock can rotate.
- The key blade contains cuts that lift the bottom pins the exact amount needed to lift the top pins out of the plug and above the shearline.

Practice Exercise Questions

Now, let's see how well you know your pin tumbler lock. Check your understanding of this exercise by answering the following questions. Writing the answers to these questions will help you review what you've studied so far. *Do not* send the answers to this exercise back to the school for grading.

1. Why is the shell of your lock made of brass?

2. Which one of the springs is the largest spring on the lock?

3. If you take your paper clip and use the back end to try to turn the plug, why won't it turn?

4. What is the purpose of the spring in the locking mechanism?

5. What type of pick-resistant top pins are used on your lock?

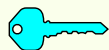
Check your answers with those on page 59.

THE KEY TO SUCCESS

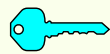
Well, you've come to the end of another information-packed study unit. Think about all you've learned so far! You now know about the major lock mechanisms and how they work, how we use locks for everyday security, and the different types of locks you'll likely see in your professional work. You've completed a valuable hands-on exercise with your cutaway padlock. You also learned about the typical jobs locksmiths do and the tools they use. Before you know it, you'll be using these same tools every day in your career as a locksmith!

Now, when you're ready, read through the following section of the text, *Key Points to Remember*. This is a review section designed to highlight all the most important facts you learned in this study unit. When you've reviewed the material and feel you know it well, proceed to the examination. Good luck!

KEY POINTS TO REMEMBER

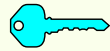


A modern locksmith may service many different types of locks. For this reason, locksmiths try to become familiar with all kinds of security products.

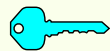


A key-operated lock is any type of lock that you open with a key. A key-operated door lock has three main parts.

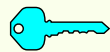
- A plug and the cylinder that surrounds it
- A latch or bolt
- A key



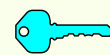
The plug is the tube containing the small parts that operate the bolt or latch. The cylinder is the tube assembly that surrounds and holds the plug. The key is the device that opens the lock.



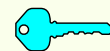
A key-operated door lock may have a latch, a bolt, or both. Both latches and bolts protrude out of the lock and fit into a recessed space in the door frame called a strike. The end of a latch is cut at an angle, while the bolt has a squared-off end. A bolt is thrown into the strike by turning a thumbpiece by hand or by using the key.



There are four common mechanisms used inside modern key-operated locks. The warded mechanism is the oldest type of lock still in use today. The interior of the lock has protruding ridges called wards that prevent the wrong key from being inserted to throw the bolt. Lever tumbler locks have flat metal plates that slide into place as the correct key is turned, allowing the lock to open. The disk tumbler lock mechanism contains rectangular metal disks that can move up and down. Pin tumbler locks contain small metal pins aligned in a row along the length of the cylinder.



Padlocks have three basic parts: the (1) key, the (2) casing, and the (3) shackle. The casing is simply the outer shell of the padlock. The shackle is a U-shaped piece of hardened steel that extends out of the main body of the padlock. The padlock locks when the shackle is secured inside the lock.

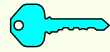


There are four basic key types. The bit key is used with warded locks. The barrel key is a variation of the bit key. The tubular key is a modern variation of the barrel key that's used with vending machines and computers. Lever keys are commonly used for lever locks. The cylinder key is used with disk and pin tumbler locks.

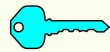


Three parts are common to most types of keys. The bow is the handle of a key. The shoulder is wider than the blade and

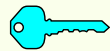
prevents the key from being pushed too far into a lock. The biting is the pattern of notches cut into the edge of the key.



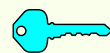
A lockset is any complete door opening set that includes a doorknob, a lock cylinder, a deadbolt, and all the hardware needed for installation. Most modern locksets contain pin tumbler cylinders. The cylinder may be installed directly into the surface of a door (a mortise cylinder), or in a doorknob (a key-in-knob lock). An entrance handleset is a special type of lockset in which you grasp the handle and press down the thumbpiece to open the door. You'll find the lever lock in hospitals or on doors designed to allow access to the disabled. The shape of the lever handle makes it easier to grasp than a standard doorknob.



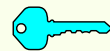
Locksmiths occasionally describe door locks by the way they're installed. For example, a door lock that fits into a recessed area cut into a door is a mortise lock. A rim lock is a type of door lock installed on the surface or rim of a door. A cylindrical lock is a lock that's shaped like a cylinder and fits into a tunnel cut into the door.



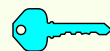
An auxiliary lock is simply an "extra" lock installed on a door to provide backup security. Common key-operated auxiliary locks are the tubular deadbolt and the turn knob rim lock.



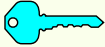
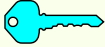
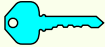
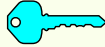
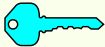
The term *specialty lock* applies to a variety of locking devices used for specific security purposes. Some common specialty locks are padlocks, gun locks, luggage locks, bicycle locks, trailer locks (used to lock a trailer hookup on a vehicle), cable locks, vending machine locks, and ski locks.



Office locks include a variety of devices used to secure equipment and documents in office buildings. You'll find the cam lock used most often used in desk drawers and cabinets. A file cabinet bar locks in place over the fronts of file drawers, preventing them from pulling out. A computer lock prevents the computer's keyboard from operating.



A combination lock is a lock that you open by dialing a series of numbers instead of inserting a key. Many padlocks and safes use combination locks. A time lock is used in conjunction with a combination lock to allow the door to open at a certain time of day. A push-button combination lock requires the user to press one or more buttons in a sequence to open the lock.

-  You'll find a variety of safes of all sizes in homes, businesses, and banks. Models are available that install in floors, walls, or under counters. In addition, specialty safes are designed to store and protect rifles, pistols, and paper documents.
-  You'll find electrically operated locks and release latches used on the doors of large office and industrial buildings. A code number punched into a key pad or a swipe with a card key opens the locks. The card key has a coded magnetic strip that actuates the lock. The card has a magnetized strip that actuates the lock.
-  There are two basic types of electronic alarm systems: (1) local and (2) central. A local alarm sounds only at the building where it's installed. Central alarms are connected to a monitor station owned and operated by a private alarm company.
-  In addition to electronic alarms, a number of security devices protect homes and businesses. Some of these include foil, pressure mats, vibration detectors, photoelectric beams, and panic buttons.
-  Professional locksmiths provide a variety of services for their customers, including key duplication, rekeying, impressioning, lockpicking, reading, and masterkeying. They use both standard tools (hammers, screwdrivers, and drills) and specialized locksmithing tools (lock picks and key cutting machines) to perform these tasks. All the tools that professional locksmiths use should be well-made and able to provide many years of service.

NOTES

Locking It Up! Answers

1

1. key-operated
2. cylinder
3. double-cylinder
4. bit keys, barrel keys, flat keys, cylinder keys, and dimple keys
5. bow
6. bitting
7. bolt
8. warded, disk tumbler, lever tumble, pin tumbler
9. warded

2

1. lockset
2. mortise cylinder
3. key-in-knob lock
4. lever handle lock
5. shackle, casing, key
6. PASS system (Personal Antitheft Security System)

3

1. False. In impressioning, the lock is used as a mold to make a new key.
2. False. Rekeying is when you change the inside of a lock to fit a new key.
3. True
4. False. You use lock picks to open locks without a key.
5. True

NOTES

Practice Exercise Answers

1. The shell is made of brass to prevent rusting in outdoor applications.
2. The spring beneath the long end of the shackle is the largest spring.
3. The plug won't turn because the top pins block the rotation of the plug.
4. The spring in the locking mechanism holds the locking pawls firmly in the grooves of the shackle.
5. Your lock uses pick-resistant, spool-shaped top pins.

NOTES

Introduction to Locks and Keys

EXAMINATION NUMBER:

03100202

Whichever method you use in submitting your exam answers to the school, you must use the number above.

**For the quickest test results, go to
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When you feel confident that you have mastered the material in Lesson 6, go to <http://www.takeexamonline.com> and submit your answers online. If you don't have access to the Internet, you can phone in or mail in your exam. Submit your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. All of the following are part of a padlock except which one?

- | | |
|------------------|-------------------|
| A. Casing | C. Key |
| B. Latch | D. Shackle |

2. Which of the following lock types are most frequently used in cars?

- | | |
|------------------------------------|--|
| A. Disk tumbler and warded | C. Pin tumbler and disk tumbler |
| B. Warded and lever tumbler | D. Lever tumbler and disk tumbler |

3. A double-cylinder lock is a good choice for when you want the ability to lock a door

- A.** without using a key.
- B.** with the same key used for the car's ignition.
- C.** from outside the building as well as from the inside.
- D.** in two different spots along the door's frame.

4. The process of changing the internal mechanism of a lock to fit a new key is called
- A. impressioning.
 - B. rekeying.
 - C. duplicating.
 - D. lockpicking.
5. Which of the following best describes a *strike*?
- A. A tool used to saw holes in a door
 - B. The motion used to cut notches in a key blank
 - C. The recessed space in a door frame that accepts the bolt or latch
 - D. The numbered dial on the front of a combination lock
6. The process of using a lock as a “mold” to make a new key is called
- A. rekeying.
 - B. lockpicking.
 - C. impressioning.
 - D. reading.
7. Which of the following keys is a type of bit key?
- A. Cylinder key
 - B. Barrel key
 - C. Lever key
 - D. Disk key
8. What are the main parts of a combination padlock’s inner mechanism?
- A. The wheels or tumblers
 - B. The shackles
 - C. The keys
 - D. The barrels
9. The oldest known lock in existence was discovered in Egypt. What basic type of mechanism does this ancient lock contain?
- A. Pin tumbler
 - B. Lever tumbler
 - C. Warded
 - D. Disk tumbler
10. Which of the following best describes the purpose of a *time lock*?
- A. It allows a safe to be opened at a certain time of the day.
 - B. It’s used to secure time clocks in the workplace.
 - C. It’s opened with a coded plastic card.
 - D. It’s fitted with a panic button in case of a sudden robbery.
11. What type of key is most commonly used in door locks and car ignitions today?
- A. Cylinder key
 - B. Bit key
 - C. Barrel key
 - D. Flat key
12. Any complete door opening set that includes a doorknob, a lock cylinder, a deadbolt, and all the hardware needed for installation is called a
- A. mortise cylinder.
 - B. rim cylinder.
 - C. door stile.
 - D. lockset.

13. Which of the following key parts is present in *all* types of keys?
- A. Bow
 - B. Shoulder
 - C. Barrel
 - D. Blade
14. The cylinder of a lock is the
- A. opening where the key fits through.
 - B. tunnel that a key slides into.
 - C. recess in the door frame that accepts the bolt.
 - D. tube surrounding the plug.
15. A lock cylinder that can be installed directly into the surface of a door is called a
- A. strike.
 - B. mortise cylinder.
 - C. padlock.
 - D. rim cylinder.
16. What shape does the end of a deadbolt have?
- A. Angled
 - B. Pointed
 - C. Squared
 - D. Rounded
17. What type of key is used with the locks most often found on vending machines and computers?
- A. Flat key
 - B. Bit key
 - C. Tubular key
 - D. Cylinder key
18. Hotels, motels, large businesses, and institutions frequently use what type of key system?
- A. A tubular key system
 - B. A precut key system
 - C. A blank key system
 - D. A master key system
19. The Yale lock is also known as the
- A. card key lock.
 - B. pin-rim deadlock.
 - C. computer lock.
 - D. pin cylinder lock.
20. Which of the following describes a key's *bow*?
- A. The overall shape of a key
 - B. The notches on the side of a key
 - C. The tip of a key
 - D. The handle of a key

Professional Locksmith

Study Unit 3

Identifying Keys

Preview

This study unit covers the all-important subject of key identification. Key duplication is one of the most needed and requested locksmithing skills. There are literally thousands of different keys out there, so when a customer comes into your shop to have a key duplicated, it's essential that you be able to do so quickly, efficiently, and profitably. It's sometimes said that the ability to identify an unknown key is the hallmark of the true professional locksmith. This ability will come to you with learning and experience, and by the end of this study unit, you'll be well on your way to mastering the skill!

When you complete this study unit, you'll be able to

- Explain the importance of key identification to the locksmithing trade
- Explain the difference between bit, barrel, tubular, flat, cylinder, and dimple keys
- Name the types of locks that these keys are used with
- Name the parts of a key or key blank
- Interpret the identifying markings on a key and use that information in key identification
- Identify the manufacturer of a key by looking at the shape of the key's bow
- Use a key blank catalog to identify unknown key blanks
- Use a cross-reference directory to match up key blanks made by different manufacturers
- Describe how key blanks are cut to make duplicate keys, both by hand and by machine
- Describe an efficient method of inventorying key blanks in a locksmith shop
- Identify a number of different old-fashioned or obsolete keys

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Identifying Keys

Do You Know. . .

What are the main parts of a cylinder key blank?

What is the E-Z numbering system?

What is a *cross-reference key directory*?

In these pages, you'll find the answers to these and many more questions dealing with the subject of key identification.

INTRODUCTION

The Importance of Key Identification

As a professional locksmith, you'll frequently be asked to duplicate a customer's key or keys. As a matter of fact, it's probably the most common reason why an individual seeks out the services of a locksmith. A duplicate key is made from a *key blank*, which is simply an uncut key. In order for the duplicate key to work in the customer's lock, the blade of the key blank you use must be *exactly the same* as the customer's original in shape and size. Obviously, then, being able to identify the customer's key and match it to the proper key blank is an extremely important locksmithing skill.

This study unit will teach you all you need to know to be able to quickly and easily identify any key and locate its match in your inventory. This is one of the most basic and vital skills of a professional locksmith.

Human beings have many different physical traits that make us different from one another. Dark hair, light hair, blue eyes, brown eyes, tallness, shortness, and so on—all of these are traits that make us look distinctly different from our neighbors. However,

people in the same family may have similar traits and resemble each other. And, identical twin brothers or sisters look exactly alike.

In the same way, keys have different characteristics that make them look different from each other. Keys made by the same

manufacturer will look similar, if not always identical (these keys are in the same “family”). However, every key made does have an “identical twin” somewhere (Figure 1). When you set out to make a duplicate key for a customer, your first task will be to locate the identical twin of the original key.

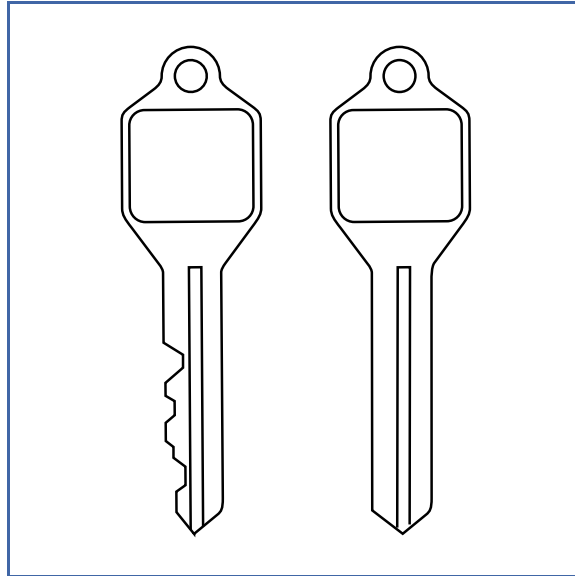


FIGURE 1—Every key made has an “identical twin” somewhere.

Every key manufacturer stamps identifying numbers on its key blanks (Figure 2). You can use these numbers to help you locate a matching blank for your customer’s key. And, whenever you call a manufacturer to order key blanks, you’ll use these numbers to place your exact order. A working locksmith keeps a fairly large inventory of different key blanks on hand. That way, any time a customer comes in, a key can be made immediately.

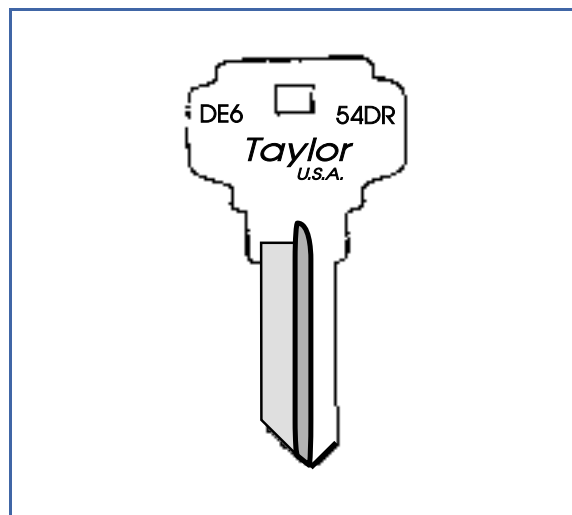


FIGURE 2—This key blank is manufactured by the Taylor Company.

The ease with which you can read the identifying information on a key depends to a large extent on the key’s condition. If the key is old and worn smooth, you won’t be able to easily read the numbers stamped on it. When this happens,

you'll need to identify using a visual comparison method (we'll discuss this method later in the study unit).

Now, before we get into the in-depth material on key identification, let's start out by taking a closer look at the basic parts of a key.

The Parts of a Key

A *key blank* is an uncut key—that is, a key without the distinguishing notches that will turn it into a working key. Take a minute now to look at the keys on your own key ring. Observe your house key or car key. Note the series of irregular cuts like a miniature mountain chain on the side of the key. A key blank lacks these cuts; consequently, it can't lock or unlock anything.

You might compare a key blank to an uncut piece of fabric before it has been tailored into a coat of precise size and proportions. You, the locksmith, will turn a key blank into a working key by “tailoring” it to exactly fit your customer's lock.

FIGURE 3—Parts of a Cylinder Key Blank

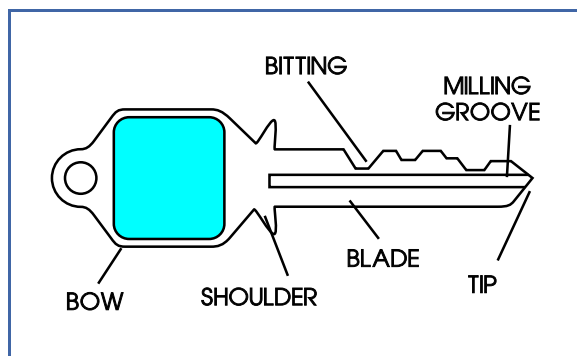
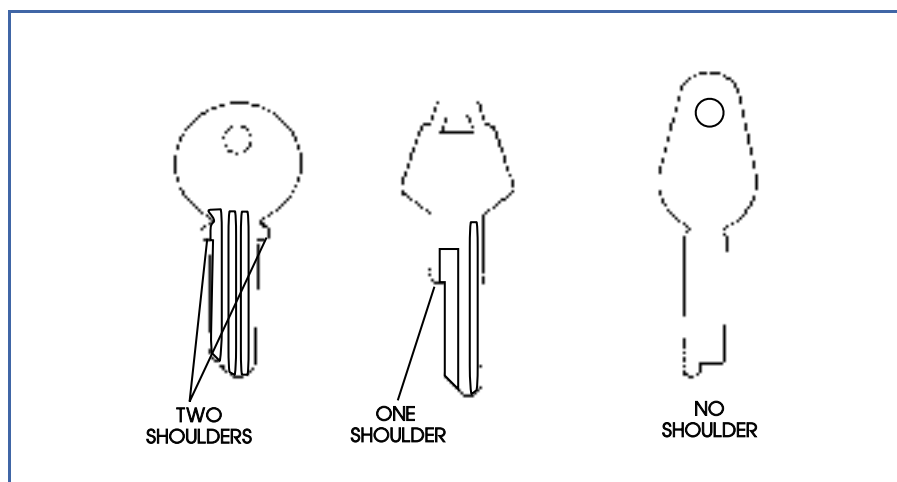


Figure 3 shows a typical cylinder key blank with its principal parts labeled (*bow, shoulder, blade, tip, bitting, and milling*). We'll take a closer look at each part in turn now.

Bow. The *bow* or handle of a key is the part that you grip with your fingers. The bow is the place to look for the important manufacturer's data that will aid you in key identification. The shape of the bow will vary depending on the manufacturer. We'll discuss bow shapes a little later in this study unit.

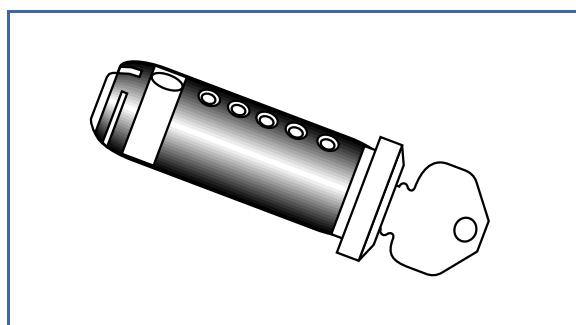
Shoulder. The *shoulder* of a key or key blank is the projection found between the bow and the blade. Most keys have two shoulders, but some keys have only one, and some have none (Figure 4).

FIGURE 4—This figure shows three key blanks—the first has two shoulders, the second has one, and the third has no shoulders.



The purpose of the key shoulder is to stop the key from penetrating too far into the lock mechanism (Figure 5). If you were

FIGURE 5—A key's shoulder prevents the key from penetrating a lock too deeply.



to force a key beyond its natural depth, it wouldn't work; it could also damage the lock. Thanks to the shoulder, you slip the key into perfect position every time.

Blade. The *blade* is the longest portion of a key where the locksmith cuts the distinctive pattern of notches that will turn a blank into a working key. You may sometimes find manufacturer's data on a key blade instead of the bow.

Tip. The *tip* of a key or key blank is simply the end of the blade.

Bitting. The cuts or notches made in the blade of a key are referred to as the *bitting*. The bitting must be cut precisely in order to allow the key to work in a lock.

Milling. On a key blank, the *milling* refers to the grooves engraved into the blade. Note that, typically, both sides of the blade are grooved (Figure 6).

Figure 7 shows several *end* views of keys. You can see a key's end view by holding it up and looking directly at the tip. The

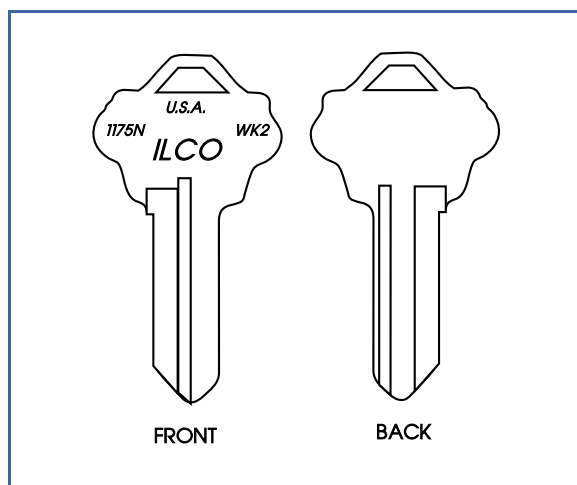


FIGURE 6—This illustration shows both sides of a key blank. Note that both milling grooves appear on both sides of the key.

end view clearly shows the shape of a key's milling grooves. The most common type of milling groove is the square cut. This cut is easy to manufacture and may be present in one or more areas of the blade on cylinder keys. Right- and left-angle grooves are also seen quite often on many key blanks. The final two kinds of milling grooves are the V-shaped groove and the half-round groove.

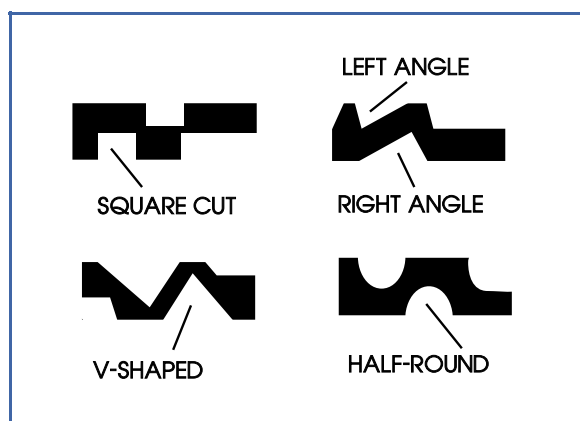


FIGURE 7—This figure shows four end views of the common milling groove shapes used in cylinder keys.

The Major Key Types

Now that you know the standard parts

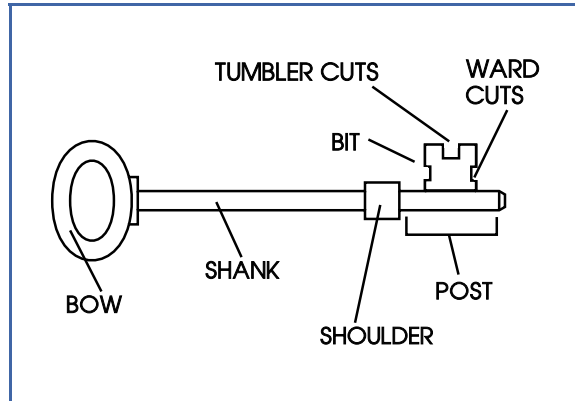
of a typical key, let's take a look at the various types of keys. The basic types of keys are the bit key, barrel key, tubular key, flat key, cylinder key, and dimple key. Each type of key is used with a particular locking mechanism.

Bit Keys

As you learned in Study Unit 2, bit keys are used to open *warded* locks. While these locks were once popular as front door locks, they're seldom seen today. However, in older homes, bit keys are still often used to open interior doors (closets, attics, etc.). Bit keys are also used with antique cabinets, cupboards, boxes, and desks. Owners of old homes or furniture may therefore occasionally need a locksmith to replace a lost bit

key. For this reason, you should be familiar with this type of key and how to duplicate one.

FIGURE 8—Parts of a Bit Key



A typical bit key is shown in Figure 8. Bit keys are made from a number of metals, but iron, brass, steel, and bronze are most common. The distinguishing feature of the bit key is the solid *bit* that operates the lock. The bit

is attached to the post on the end of the key. The *bit* is the blade of a bit key, and it's solid metal. Note that the shoulder of a bit key is positioned toward the end of the key.

Two types of cuts are used when making a duplicate bit key—*ward cuts* and *tumbler cuts*. The configuration of these cuts depends on the lock's mechanism. The tumbler cuts are made on the top edge of the bit, and the ward cuts are made on the sides of the bit.

A *skeleton key* is a common term you may hear applied to bit keys. A skeleton key is a bit key that has been specially filed down to bypass the wards in a warded lock. For this reason, one skeleton key can open several warded locks.

A *barrel key* is a variation of the bit key. However, while the bit key has a solid tip, the barrel key's tip is hollow. When a barrel

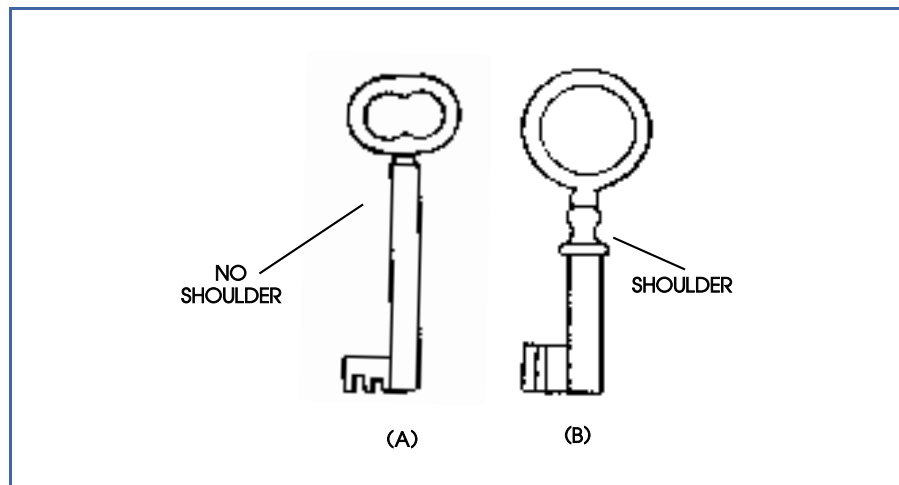
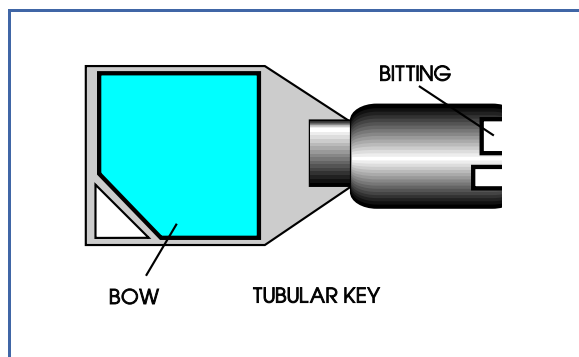


FIGURE 9—Figure 9A shows a barrel key without a shoulder; Figure 9B shows one with a shoulder.

key is inserted in a lock, the hollow tip fits over a pin in the lock keyway. So engaged, the key is held in the proper position for the bit to function inside the lock. A barrel key may or may not have a shoulder (Figure 9). Barrel keys are made from the same metals as bit keys.

FIGURE 10—Parts of a Tubular Key



A modern variation of the barrel key is the *tubular key* (Figure 10). Tubular keys are short, rounded, and hollowed out like barrel keys, but they function differently. Cuts are made on the round end of a

tubular key, as shown in Figure 10. Tubular keys are commonly used in the locks on vending machines, coin-operated laundry machines, and computers.

Flat Keys

Flat keys are made from thin, completely flat pieces of steel or nickel (Figure 11). Note the absence of milling grooves on the

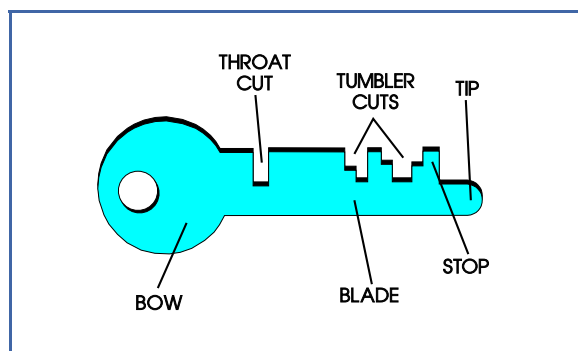


FIGURE 11—Parts of a Flat Key

blade. Flat keys are used with lever lock mechanisms and warded padlocks. Jewelry boxes, luggage, strongboxes, typewriters, store showcases, and safe-deposit boxes are typically opened by flat keys.

Look at Figure 12 to observe the cuts on a flat key. Note that all the cuts in a flat key must be *exactly square*. Now, note the position of the *throat cut*. The throat cut functions as a shoulder in a

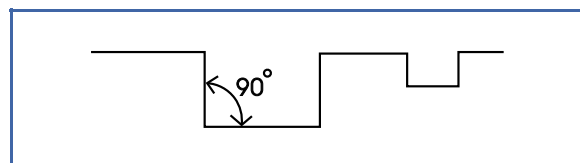


FIGURE 12—The cuts in a flat key must be exactly square.

flat key, keeping it from penetrating too deeply into the lock.

Cylinder Keys

The *cylinder key* is the most common type of key in use today. (The parts of a cylinder key were shown earlier in Figure 3.) You probably use a cylinder key to unlock and start your car or to open your front door. As a locksmith, you'll be dealing with this type of key most of the time. Cylinder keys are used to operate lock cylinders, which may contain pin tumbler or disk tumbler mechanisms.

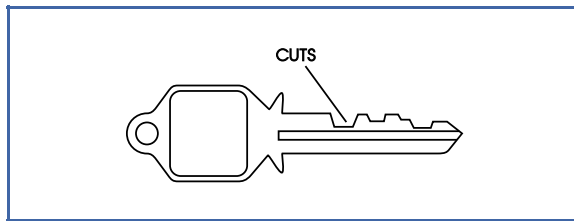


FIGURE 13—The cuts in a cylinder key are usually squared at the bottom.

Cylinder keys are made of brass, aluminum, nickel, and steel. The cuts made in a cylinder key are usually squared at the bottom, as shown in Figure 13.

If the key contains cuts on both sides of the blade, the key is most likely an auto key.

Dimple Keys

The *dimple key* is a variation of the cylinder key. Dimple keys are used with very high-security pin tumbler locks. Instead of

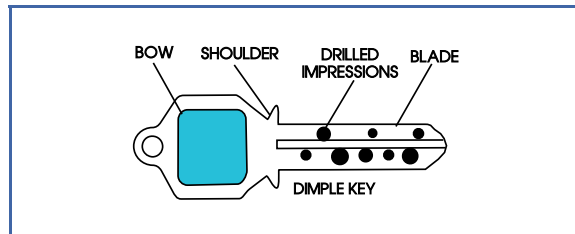


FIGURE 14—Parts of a Dimple Key

having the typical notched bitting on the blade, the dimple key has a pattern of impressions or “dimples” drilled onto its surface (Figure 14).

How Keys Are Cut

To make an original key or a duplicate from a key blank, the bitting must be cut into the key blank by machine or by hand. Machine duplication is preferred, since it is quick and inexpensive. Key machines are available to cut all types of keys. If you eventually decide to open your own shop, your purchase of one or more key machines will be your most important investment.

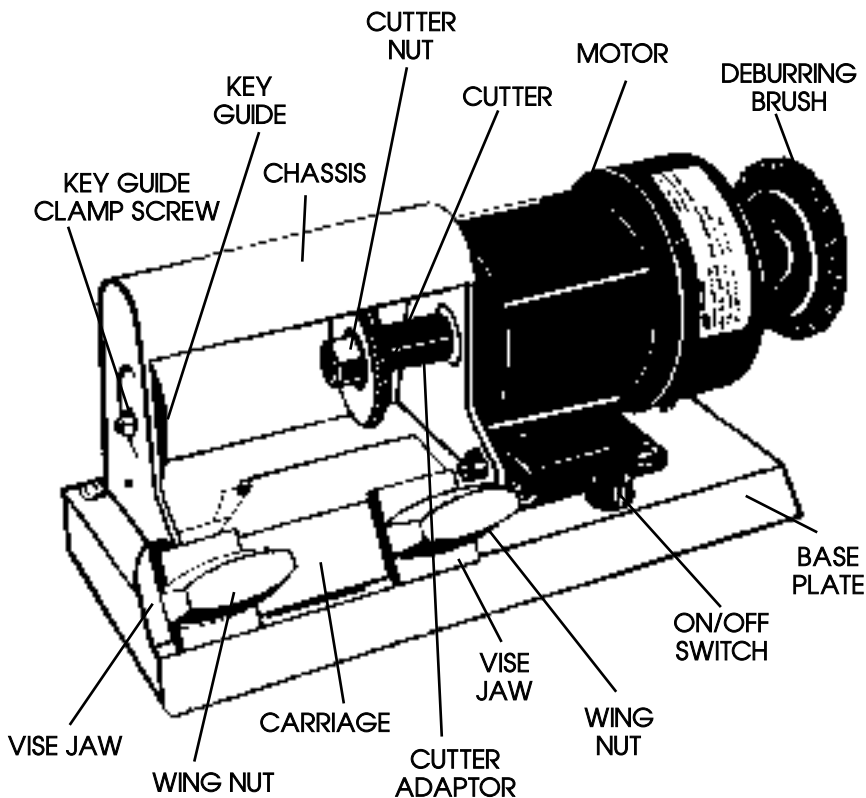


FIGURE 15—A Simple Key Duplicating Machine

A wide variety of key machines is available. A simple, moderately priced cylinder key machine is shown in Figure 15. As a professional locksmith, however, you may also wish to invest in a more expensive model that's also capable of duplicating flat keys. Regardless of the simplicity or complexity of the machine, all key-duplicating machines consist of the following basic parts:

- A *vise jaw* to hold the key being duplicated
- A second *vise jaw* to hold the key blank
- A *cutter wheel* that performs the actual cutting of the blank
- A *key guide* that moves over the bitting pattern of the original key, guiding the cutter wheel as it makes the same pattern on the key blank
- A *deburring brush* that removes rough spots from the finished duplicate

To duplicate a key, you simply clamp the original key and the key blank in place in the vise jaws, and then use the key guide to trace the profile of the key being duplicated. The cutter wheel will cut the key blank according to that profile.

Locksmiths can also cut a key duplicate by hand, which is a time-consuming and skilled procedure. However, hand duplication is sometimes necessary. (*Note:* We'll be covering key duplication and key machines in complete detail in a later study unit. You'll also get a chance to actually make some keys by hand using simple tools.)

Now, before you proceed to the next section of the text, please complete the quiz on the following page.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

Match the terms in Column A with their definitions in Column B.

Column A

- _____ 1. Throat cut
- _____ 2. Blank
- _____ 3. Shoulder
- _____ 4. Bow
- _____ 5. Tip
- _____ 6. Bitting
- _____ 7. Milling
- _____ 8. Blade

Column B

- a. The longest part of a key where the cuts are made
- b. An uncut key
- c. The cuts or notches made in a key blade
- d. The grooves engraved in a key blade
- e. The key handle
- f. The end of the blade
- g. The projection between bow and blade
- h. The "shoulder" in a flat key

Check your answers with those on page 51.

KEY IDENTIFICATION SYSTEMS

How Manufacturers Identify Their Keys

The manufacturers of locks and key blanks use a number of different methods to identify their products. Some lock manufacturers stamp only their names on the bows of their keys. Others stamp both their names and an identifying number on the bows. However, the most obvious way to identify the manufacturer of a particular key blank is by looking at the *bow shape*.

Bow Shapes

Each manufacturer uses a distinctive shape to make its key blanks look different from all others. In general, every key blank made by that manufacturer, no matter what lock it's made to fit, will have the same bow shape. Figure 16 shows the bow shapes used by a number of well-known manufacturers, including *Yale*, *Master*, *Russwin*, *Sargent*, *Kwikset*, *Ilco*, and *Weiser*. Figure 17 shows some popular automobile key bows. You may recognize some of these keys from your own key ring.

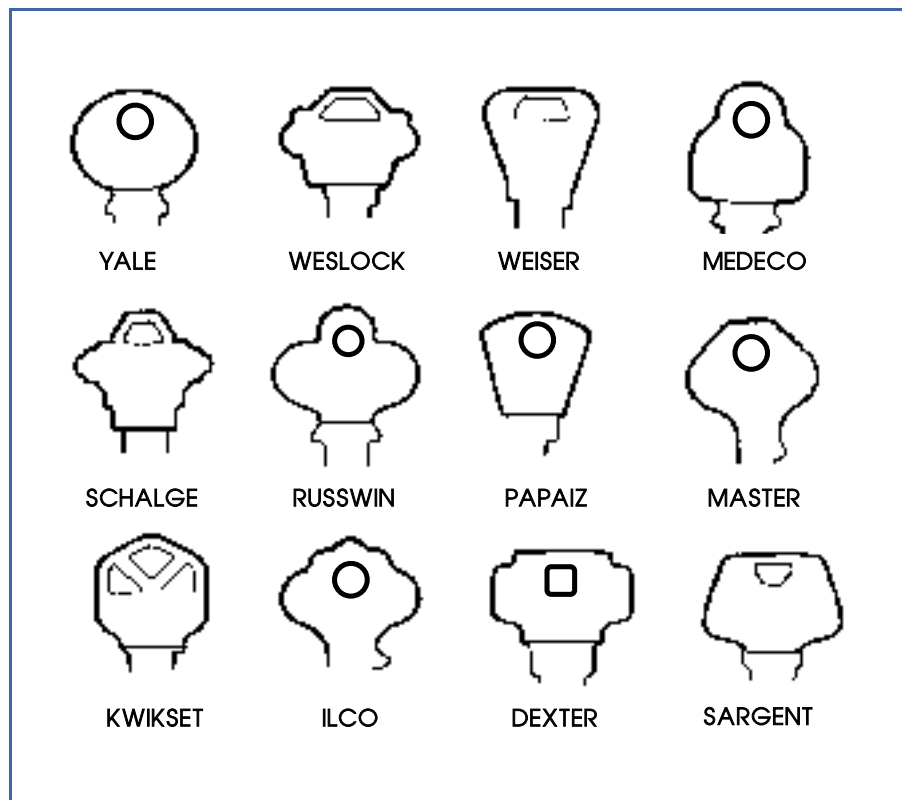
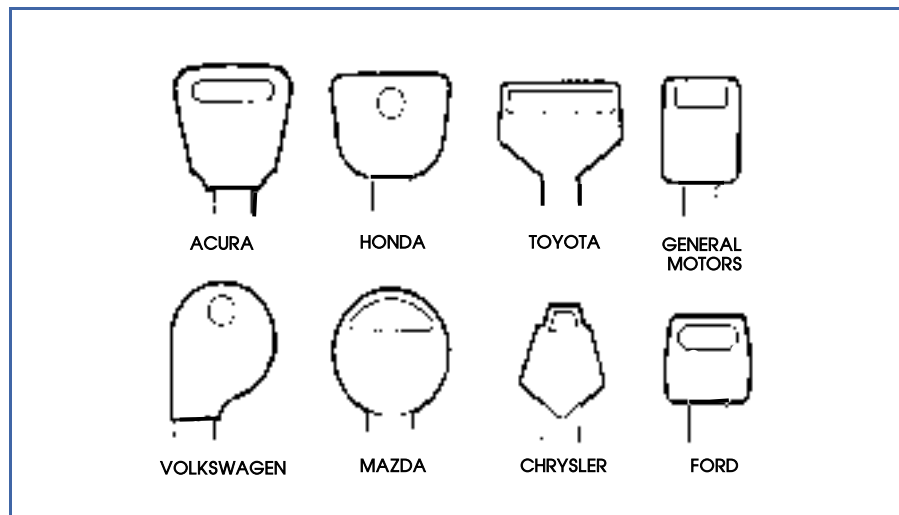


FIGURE 16—Key Bow Shapes of Well-Known Lock Manufacturers

FIGURE 17—Bow Shapes of Popular Auto Keys



As you can see, a key's bow design can greatly aid you in identifying its manufacturer.

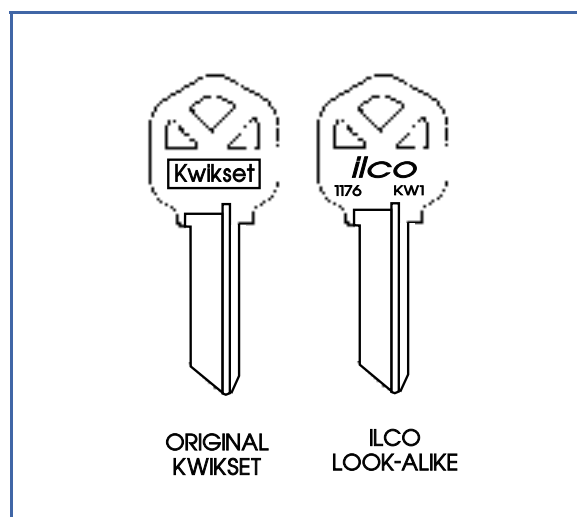
Identifying Numbers and Letters

Many companies manufacture locks and keys, and still other companies manufacture only key blanks. Some companies make key blanks to fit *only their own* locks; others make blanks to fit competitor's locks also. Thus, the identifying numbers and letters on a key blank may actually tell you two things: the manufacturer who made the key blank *and* the manufacturer of the locks that the key blank will fit. Confusing? Not really, with a little more explanation!

Let's look at a real-life example to make our discussion easier. The Schlage Company, the Kwikset company, the Yale company, and the Ilco company are all well-known manufacturers of door locks. They all make key blanks to fit their own locks. These are called *original keys* because they're made by the original lock manufacturer. However, the Ilco company also makes key blanks that fit the locks made by other manufacturers. These key blanks are called *look-alikes* because even though they're made by Ilco, they fit locks made by Kwikset, Yale, and others.

Thus, a key blank made by Ilco that's a "look-alike" for a Kwikset key will have the distinct Kwikset bow shape, even though Ilco's name is stamped on the key blank. The Ilco key "looks like" the original Kwikset key. Figure 18 shows an original Kwikset key blank and a look-alike made by Ilco.

FIGURE 18—This illustration shows an original Kwikset key blank and an Ilco look-alike blank. The two key blanks are absolutely identical in shape and size.



So, how can you tell who made a key blank? The name of the company will usually be stamped right on the key bow. How do you tell whose locks the key will fit? First, try to identify the bow shape. Then, look at the numbers and letters stamped on the key bow. As we mentioned ear-

lier, a key blank contains numbers and letters on its bow that identify its manufacturer. Every key blank that contains the same identifying number will be exactly the same size and shape. Each key manufacturer uses a different system of abbreviations to identify their keys. Let's take a look at some of the most popular systems now.

The Cole System

The Cole Company uses an abbreviation that usually contains one or two letters and one or two digits to identify keys. The letter or letters are the initials of the manufacturer. So, for example, *Y* stands for *Yale*, *SC* stands for *Schlage*, and *M* stands for *Master*. (Other abbreviations are shown in Figure 19.) By looking at these letters, you can instantly determine whose locks the key will fit. The digit corresponds to a particular model of lock made by that manufacturer. So, *M1* refers to a particular Master lock, *M2* refers to another, *M3* to still another, and so on.

The EZ System

Although manufacturers use many different systems for identifying keys, a Cole-type system is used by several. This is because the Cole system is easy to understand and use. The *EZ system* is a sort of “universal” key identification system that has been adopted by many manufacturers. The EZ system is based on the Cole system. An EZ identification number contains one or two letters and one or two digits. The use of the EZ identification system makes it easier for manufacturers to sell their keys.

Abbreviation	Manufacturer	Abbreviation	Manufacturer
AM	American	M	Master
AR	Arrow	NA	National
CG	Chicago	OL	Olympic
CO	Corbin	P	Penn
DE	Dexter	PZ	Papaiz
EA	Eagle	RU	Russwin
EL	Elgin	S	Sargent
FA	Falcon	SC	Schlage
FR	Fort	SE	Segal
HR	Harloc	T	Taylor
IN	Ilco	VR	Viro
KW	Kwikset	WR	Weiser
L	Lockwood	WK	Weslock
LO	Lori	Y	Yale

FIGURE 19—These are some of the abbreviations for manufacturer's names used in the Cole or EZ system.

As a working locksmith, you'll probably frequently hear references to *EZ numbers*. By laying in supplies of common EZ keys, you'll save the time that would be spent searching for them under other names and keep your key-blank inventory within manageable (and economical) limits.

The Ilco System

Since the Ilco Company was one of the first manufacturers to make key blanks for locks made by other manufacturers, their key identifying system is widely recognized. The Ilco system generally uses four numbers along with several letters as either prefixes or suffixes. So, for example, Ilco key blank #1176 fits a Kwikset lock; Ilco blank #1092B fits a Master lock; and Ilco blank #S1167FD fits a Ford automobile lock.

Note that with the Ilco system, unlike the EZ system, you can't tell who the manufacturer of the lock is at a glance. The letters used in the identifying numbers aren't necessarily the initials of the manufacturer. However, because Ilco manufactures "look-alike" keys, the bow of the key blank will often be the same shape as that of the original key. Thus, since Ilco's key blank #1176 is made to fit a Kwikset lock, it has the same bow shape as a Kwikset key, even though the blank is made by the Ilco Company. Are you starting to get the picture?

Generic Key Blanks

There are a number of companies that make keys to be used in other manufacturer's locks, as we've already discussed. Some of the best-known are Ilco, Star, Taylor, and Dominion. Look-alike keys manufactured by any of these companies will usually have the same bow shape as original keys. However, some companies that make blanks for other manufacturers' locks don't use the "look-alike" system. Some companies use their own bow shape no matter what locks the key blanks are made for. These keys are referred to as *generic key blanks*. An example of a generic key blank maker is the ESP Company. ESP makes key blanks for a number of different manufacturer's locks, but the bow shape of the ESP blank doesn't necessarily match that of the original manufacturers. Only the ESP name will appear on the blank, along with some identifying numbers. You'll need to use the numbers to identify each key.

Generic key blanks can be manufactured quickly and easily without the difficulty of imitating a variety of bow shapes. Thus, generic key blanks are usually quite inexpensive.

Neuter Key Blanks

There are many locksmith suppliers and ordinary hardware manufacturers that produce *neuter key blanks*. Neuter blanks are made to be used in *only one* retail store or locksmithing business. Neuter key blanks contain no manufacturers' information or identifying bow shape at all, only the name and/or phone

number of the retail store where they were sold (Figure 20). Thus, when a customer needs a new key, he or she must return to that particular store to get a duplicate made! This is a common selling tool used by many hardware stores and locksmiths.



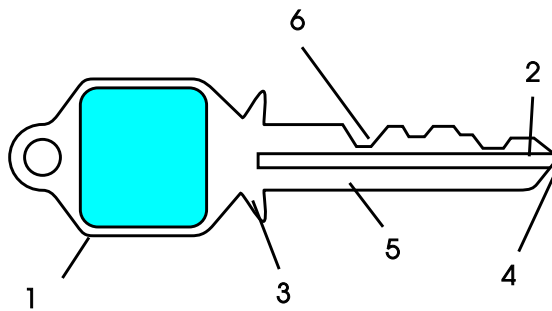
FIGURE 20—A neuter key contains no identifying information, only the name and phone number of the place where it was purchased.

In addition, the lack of identifying information on a neuter key makes its lock very secure. If the key was stolen, the thief wouldn't be able to guess what lock the key is for.



Locking It Up! 2

On the lines below, enter the names of the various key parts indicated by the numbers in this drawing.



1. _____

4. _____

2. _____

5. _____

3. _____

6. _____

7. The key illustrated above is an example of what type of key?

Check your answers with those on page 51.

FINDING A MATCHING BLANK FOR A CUSTOMER'S KEY

Where Do You Start?

When a customer comes into your shop and asks for a duplicate key to be made, there are a number of techniques you can use to determine what blank to use. However, the first step in this process is always to determine whether it's legal for you to duplicate the key.

It's important to be aware that some keys are deliberately stamped with the warning "DO NOT DUPLICATE" (or a similar warning) for a variety of security reasons. The warning will appear on the key's bow (Figure 21). For example, a hotel, motel, hospital, school, or business may issue a key to an employee so that he or she can have access to various rooms during working hours. However, the management would not want the key duplicated by the employee, since he or she could then have access at any time.

In addition, certain keys are actually illegal to duplicate. For example, post office box and safety deposit box keys can't be legally duplicated without proper authorization from the post office or bank.

A locksmith must not duplicate any of these keys at any time for anyone without proper authorization. If a customer presents you with a "DO NOT DUPLICATE" key and asks for a duplicate to be made, insist that the customer provide you with a *waiver of responsibility* form printed on the letterhead of the key's owner. (Figure 22 provides an example of this document.) If you copy a "DO NOT DUPLICATE" key without this authorization form, you could ultimately be liable for any damages or losses that occur as a result. Always protect yourself!

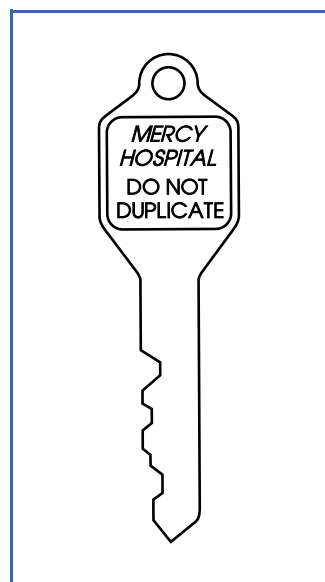


FIGURE 21—You should never make a duplicate for a key like the one illustrated here unless you're specially authorized to do so.

FIGURE 22—This waiver of responsibility should be signed by your customer before you copy a key stamped “DO NOT DUPLICATE.”

MERCY HOSPITAL
100 Main Street
Anytown, USA

Office of the Administrator

June 6, 19XX

To whom it may concern:

Please provide two (2) copies of the key presented by the bearer of this letter, even though the key is stamped “DO NOT DUPLICATE.” Duplicates are required for the normal functioning of Mercy Hospital.

Thank you for your assistance.

Sincerely,

Walter D. Wilson

Walter D. Wilson

Identifying the Manufacturer

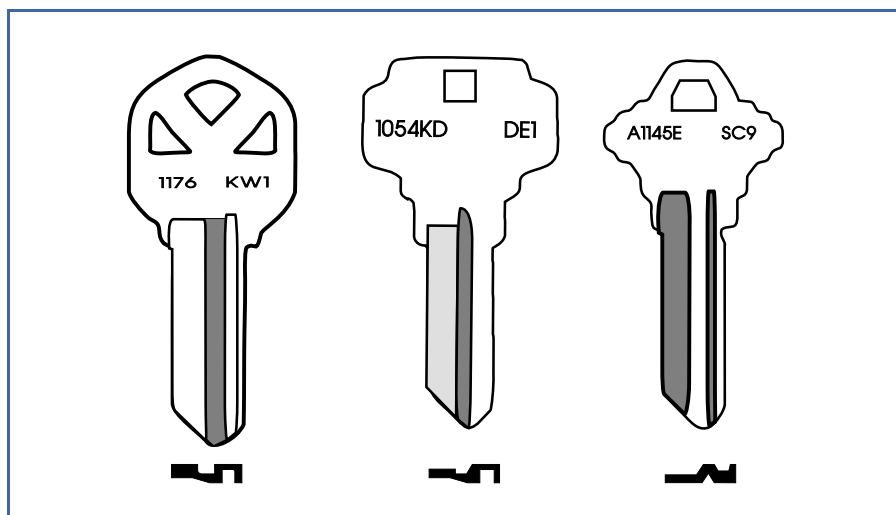
Once you’ve determined that it’s OK to duplicate the customer’s key, the next step is to identify the original manufacturer of the customer’s lock. You’ll always start by looking at the customer’s key for the manufacturer’s name on the key bow.

Once you know who made the key, there are two reference guides that most locksmiths use to identify the proper key blank to use. The first guide is the manufacturer’s catalog; the second is a cross reference directory. Let’s look at each of these useful resources now.

Key Blank Catalogs

Whenever a locksmith needs to purchase key blanks, he or she will order them through a manufacturer’s catalog. However, these catalogs are also very useful for identifying key blanks. Key catalogs typically contain *silhouettes* (outlines) of the keys made by that manufacturer. The silhouettes are exactly the size and shape of the real-life keys they represent (Figure 23). The

FIGURE 23—Silhouettes in a key blank catalog are exactly the size and shape of the real keys they represent.

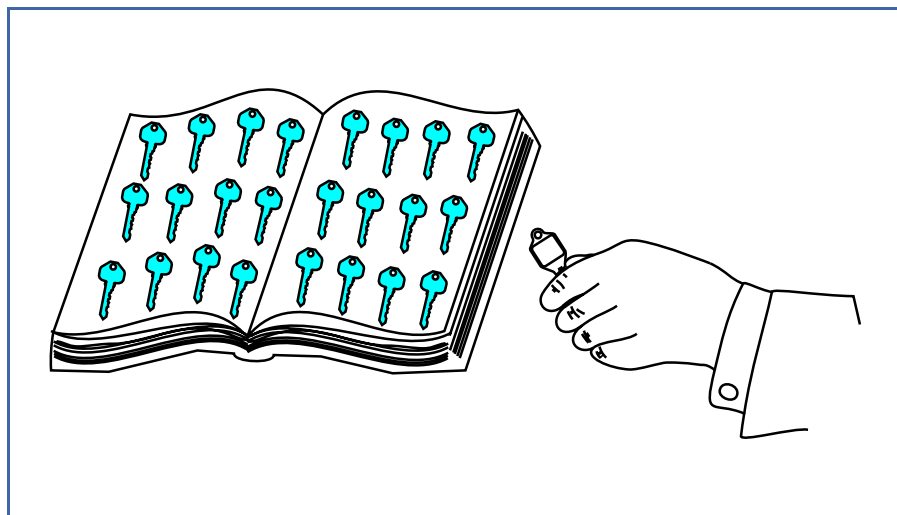


bow shapes, blade length, and the milling grooves for each key blank are clearly illustrated. Under each silhouette is listed the manufacturer's stock number for the key illustrated.

Under or next to each silhouette you'll also find an *end view* of the key blank. This is the way the key looks when you hold it up straight in front of your eyes and look directly at the end. Always check the end view in the catalog with your actual key blank to be sure that the milling grooves match. To do this, turn the key *face down* on the catalog page (that is, the side with the information on it should be facing down.) Now, lift the key up from the page and stand it on end. The end of the key should cover and match the end view in the catalog. Compare the real key's tip to the illustration in the catalog to be sure they match.

Now, suppose you need to identify a customer's key in order to make a duplicate. You've already determined the manufacturer, either from the name stamped on the key or from the shape of the bow. All you need to do now is consult that manufacturer's key catalog to find the blank you need. First, check the identifying number on the blank; then, look up that number in the index at the beginning of the catalog. (The index contains the numbers of all the key blanks in the catalog and a listing of the pages where they appear.) Find your number in the index and see what page that blank is pictured on. Then, go to that page and compare your real key to the silhouette. You can lay the key right on the page over the silhouette. It should match exactly! (Note: When you compare a key to the silhouettes in a catalog, you must hold the key with the printed side of the bow face-down. Thus, you compare the *back* or *reverse* side of the key to the pictures in the catalog.)

FIGURE 24—Lay the key you're trying to identify over the silhouettes in a key catalog until you find a match.



If you know the manufacturer, but the key contains no identifying number (or if the key is too worn to read) simply flip through the catalog pages and look for a picture that resembles your key. When you find a possible match, lay the key over the silhouette on the page to see if it matches in size and shape (Figure 24). Finally, note the manufacturer's number given under the matching silhouette. This is the number of the matching blank that you'll use to make your customer's duplicate.

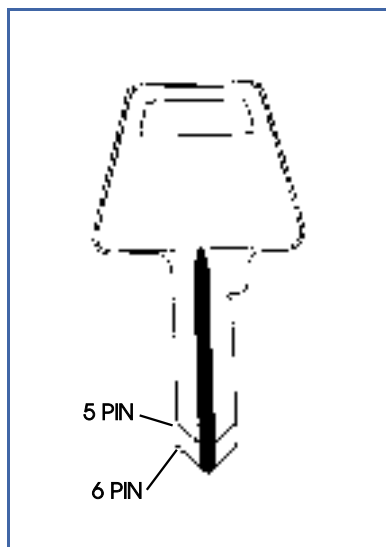


FIGURE 25—This silhouette represents two key blanks. The two blanks are exactly the same except for their lengths.

Some key silhouettes will contain more than one version of the same key. Look now at Figure 25. This figure shows a silhouette for a 5-pin key blank (for locks with five pins) and also a 6-pin blank (for locks with six pins). The two key blanks are exactly the same except for their length. Depending on the lock the customer has (that is, whether it has five or six pins) you'll choose either of those two key blanks.

Cross-Reference Directories

A *cross-reference directory* is a useful resource that can help you identify keys made by a variety of different manufacturers. A cross-reference directory lists the numbers of all the key blanks made by a given manufacturer; then, the directory lists the

corresponding numbers of key blanks made by several other manufacturers. For example, by looking up one Ilco key blank number, you can instantly find the corresponding Star, Dominion, Taylor, or Cole key blank numbers. A cross-reference directory is especially useful in a busy locksmithing shop when you run out of a particular key blank. By looking the blank number up in the directory, you can find an alternative key blank that will fit your customer's lock. A section of a typical cross-reference directory is shown in Figure 26.

A cross-reference directory is an essential tool in any locksmith's business. Ask your key-blank suppliers for any cross-reference literature they may have (they may even have free literature available). If no free information is available, consider investing in a universal cross-reference directory, which puts the whole world of key blanks at your fingertips in one volume. Among many other benefits, such a directory lets you manage your key blank inventory efficiently and economically.

Once you've determined the correct manufacturer and model number of the customer's key, you're ready to make a duplicate. Simply locate the correct blank in your shop inventory and cut the key.

ICS CROSS-REFERENCE DIRECTORY						
Ilco	Cole	Dominion	ESP	EZ	Star	Taylor
1001EB	CO3	01EB	CO3	CO3	5CO2	21EB
1001EN	CO7	01EN	CO7	CO7	5CO1	21EN
1001GH	CO67	01GH	CO97	CO97	5CO13	K22
1003M	CO106	03M	CO106	CO106	5AU1	22R14
1004KL	54KL	04KL	L37	—	71L2	54KL
1010N	S43	10N	S68	S68	5SA7	51S
1011	RU1	11	RU1	RU1	5RU1	55
1011D1	RU20	11D1	RU45	RU45	5RU7	57-1D

FIGURE 26—This illustration shows a sample section from a page in a key blank directory.

Working With an Unknown Key

We've already discussed how to handle a request for a duplicate key when the customer's key is readily identifiable. However, what do you do if the key brought to you for duplication is worn so smooth that no identifying information remains visible on it? Answering that question will be the business of this section of your text.

Identifying the Manufacturer

Let's assume now that a customer has brought you a key to be duplicated that contains no identifying marks at all. Since key identification procedure is essentially a process of elimination, the best place to start is with the key bow. In time, you'll be able to recognize the products of the larger key and key-blank manufacturers by bow shape. Until that time, however, you can use the bow information in this study unit to assist you.

Look at the bow shape to try to determine the key's manufacturer. If you're able to determine the manufacturer from the bow shape, you have two options available. You can flip through the pages of that manufacturer's catalog until you find a picture that matches your customer's key, or you can compare the key to real blanks in your shop.

If you can't figure out who made the key, then your only choice will be to try to match the customer's key to one in your key blank inventory. When you're actually working as a professional locksmith, your own work experience will help you choose a likely match. Until then, however, you'll probably have to use a trial and error method! Note, though, that this method will help you gain experience in recognizing important key characteristics.

The following information describes the techniques used to determine whether a key blank is an exact match for a customer's key.

Matching Key Characteristics

Once you've chosen a key blank from your inventory that you think may be a match for your customer's key, you're ready to start comparing *key characteristics*. These characteristics include

points of size and shape that can be used to match keys with great precision.

With a cylinder key or a flat key, the following general characteristics should be compared closely:

Blade Length. The length of a key's blade is measured from the bow to the tip. To check blade length, align the customer's key and your key blank, and check to be sure that the keys are

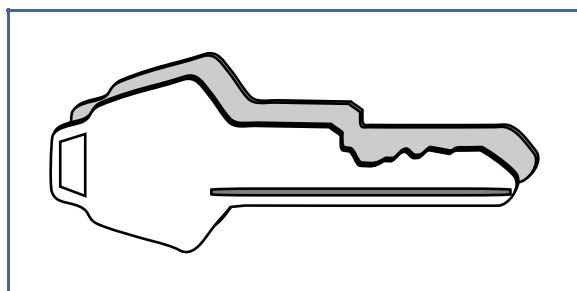


FIGURE 27—Compare the key blade length by aligning your customer's key with the blank.

identical in length (Figure 27). Be sure that the shoulders are exactly equal, also. Note, however, that the bows don't have to exactly match.

Note that it is possible to "trim" a too-

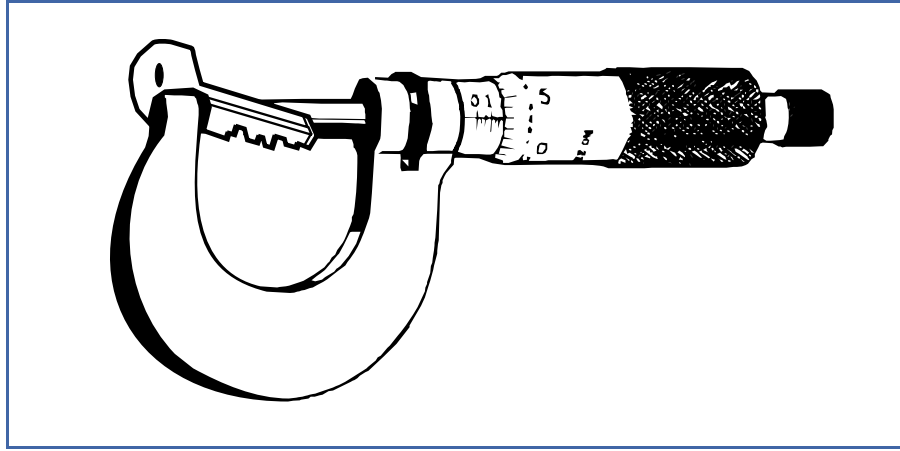
long key blank by filing the end (provided all other characteristics are identical). However, this technique isn't recommended unless absolutely necessary.

Blade Width. Key blade width is the distance across the blade. Check the width of the key blades at the same time you check the length. Note that the height of the key blades must also match exactly.

In an emergency, you can make a duplicate key from a blank that is *slightly* narrower than the key you're duplicating. Such a skinny duplicate won't fit snugly in the keyway, but it will probably still work. However, this practice isn't generally recommended. You should always attempt to make a duplicate key exactly match the original.

Key Thickness. When comparing a flat key to a blank, the thickness is an important characteristic that must be checked. Ideally, to check the thickness of a customer's flat key against the thickness of your blank, you should measure the two key blanks with a micrometer (Figure 28), which is capable of measuring objects to the nearest thousandth of an inch.

FIGURE 28—This illustration shows a key's thickness being measured with a micrometer.

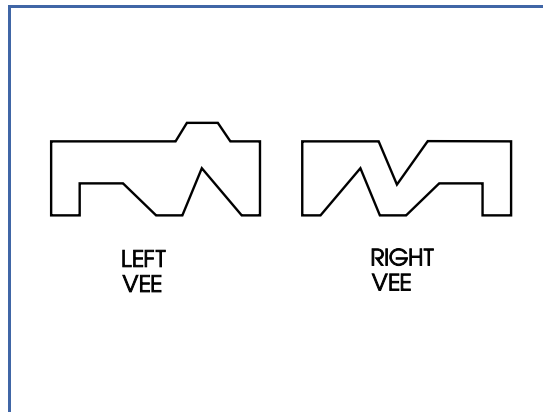


Tip Shape. With a cylinder key, check to make sure that the shape of the key tips is identical. Align the two keys and look directly at the ends. If they don't seem to match up, check to make sure that the keys are pointing in the same direction. If they still don't match, you've selected the wrong blank.

Groove Length and Shape. The milling, or grooves, on a cylinder key and key blank must match exactly. This means that

there must be the same number of grooves on each side of both key and key blank, and the grooves must be the same length and shape. The five standard groove shapes were shown earlier in Figure 7. Note that combinations of these standard shapes are

FIGURE 29—This figure shows two possible milling groove variations, the right vee and the left vee.

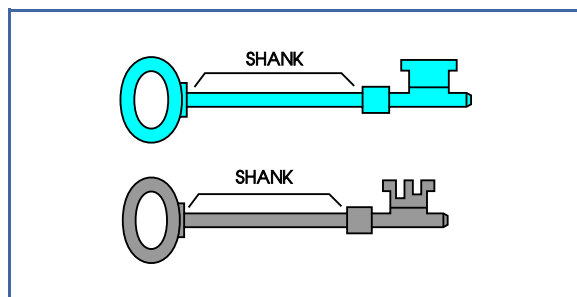


possible, providing such variations as the right vee and left vee in Figure 29.

If the key to be duplicated is a bit or barrel key, the dimensions of the key blank must match the customer's original key in the following four areas: shank, post, tip, and bit.

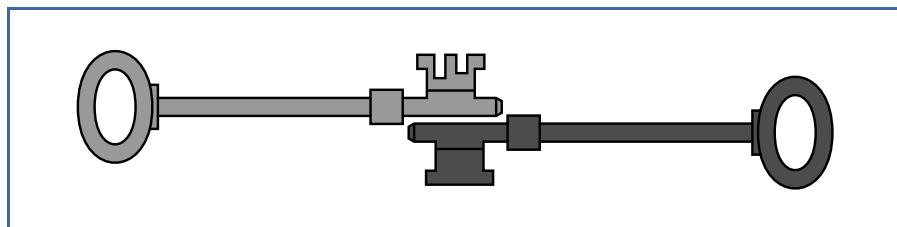
Shank. The shanks of the bit key and bit-key blank must be the same length (Figure 30). This is verified by laying the key to be duplicated on top of the blank.

FIGURE 30—Compare the shanks on a bit key and bit key blank to be sure their lengths are the same.



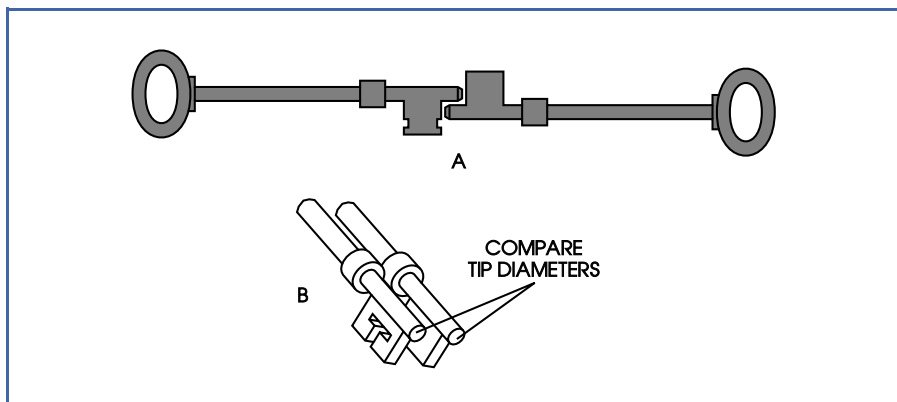
Post. Matching the dimensions of the post is critical to the smooth operation of the duplicate bit key. The post must be checked for proper length (Figure 31). Check by holding the key and blank together, tip to tip.

FIGURE 31—The posts should be the same length.



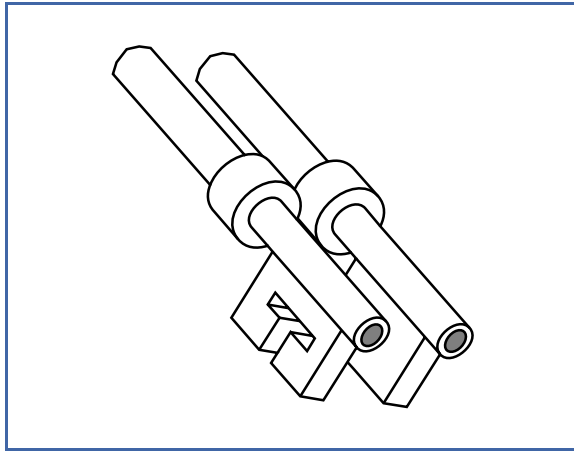
Tip. Check that the tips of the customer's key and the blank are the same length (Figure 32A) and that they have the same diameter when viewed from the end (Figure 32B).

FIGURE 32—Compare the tips of the bit key and bit key blank to be sure they're the same length as shown in 32A. Then, compare the tip diameter as shown in 32B.



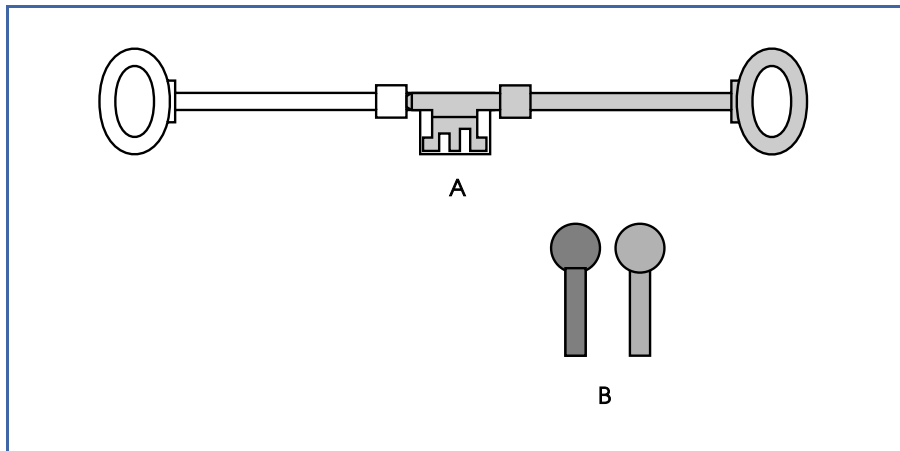
The hollow tip of a barrel key must be checked to be sure that the inside diameter matches that of the key blank. The easiest way to make this comparison is to hold the two keys so that the tips touch (Figure 33).

FIGURE 33—Compare the tip diameters of two barrel keys to check for a match.



Bit. Bit length, height, and thickness are critical dimensions in a bit key. Check the key to be duplicated against the blank for a match in all three areas (Figure 34).

FIGURE 34—Overlap the bit key and bit key blank as shown in Figure 34A to check the length and width of the bit. For bit thickness, compare key and blank head on, as shown in Figure 34B.



By using the key characteristics listed here, and with time and a little experience, you'll soon have no trouble matching a blank to any key!

Your Key Blank Inventory

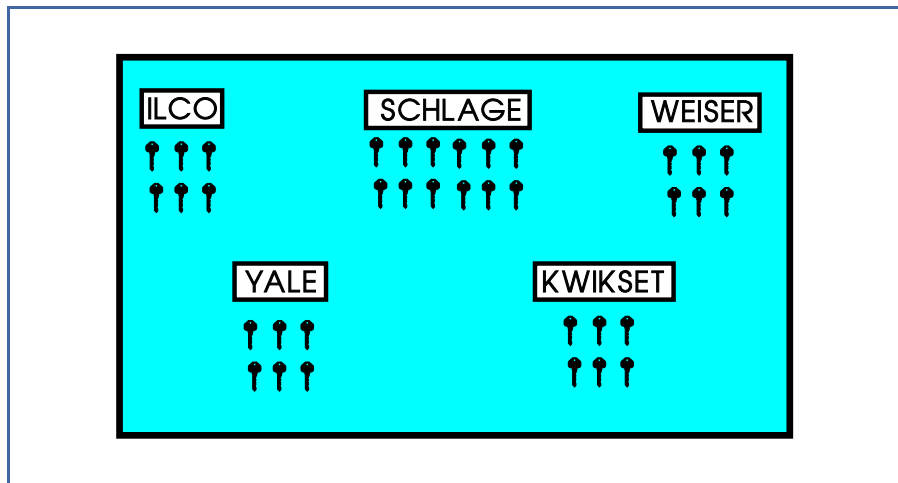
Your first purchase of key blanks is probably still a bit in the future, but it's important that you understand how to manage an inventory of key blanks in a busy shop.

As we mentioned in an earlier study unit, key duplication is the most commonly-requested service in a locksmith shop. Your supply of key blanks will constantly be in use as customers come in and out each day. For this reason, your stock of blanks must be organized and orderly. You should be able to

find the blanks you need quickly and easily, and you should have enough blanks on hand to make duplicates for all the most common keys.

Figure 35 shows a possible system for organizing key blanks in a shop. The blanks in this illustration are hung on an easy-to-see wall display, and are organized according to lock manufacturer (Schlage, Kwikset, Yale, etc.). The manufacturer's areas on the display are organized alphabetically. Note that generic keys are placed under lock manufacturers' names, not under the name of their own manufacturer. Thus, any time you need a Kwikset key, you just look under Kwikset. *All* keys that will fit a Kwikset lock are displayed there.

FIGURE 35—This illustration shows a system for displaying key blanks in a busy locksmithing shop.



Key blanks are arranged on a wall display under the names of each lock manufacturer. Note that all the keys are hanging in the same direction, with the “bitting side” facing to the right. This is the same way that keys are displayed in a key catalog. This method of display makes it easier to compare key blanks quickly by sight.

The keys are all hanging on long hooks. When the pile of key blanks begins to get “close to the wall,” they need to be refilled or reordered. This makes it easy to tell at a glance when blanks need to be ordered.

All automobile key blanks are placed separately, organized according to car model.

If a locksmithing shop owns a van, it will contain a supply of key blanks, too. This makes it easy to make duplicates instantly when on a road call. In a van, which is constantly moving and bumping over the highways, key blanks aren't hung on the walls. Instead, they're kept in carefully coded cases that can be opened when needed.

What Blanks Should You Buy?

Determining just what key blanks to stock in your inventory is a difficult choice. Since there are so many key blanks available, it's important to determine which ones are most often requested by customers. Otherwise, your investment in both cash and storage space will be wasted on a lot of blanks that don't sell! By giving a little thought to your key blank purchases, you can limit the size of your stock to a manageable number.

There are three good sources of information on what key blanks are best-sellers: locksmith suppliers, your competition, and your own experience. Let's look at each of these in turn.

Locksmith Suppliers. Locksmith suppliers can be an enormous help in deciding what merchandise to stock, especially to a beginner. These suppliers want you to succeed, because if you make money, so will they. Call a locksmith supplier and ask for assistance. They'll be happy to send you catalogs and other literature, as well as make recommendations on which blanks you should definitely inventory, and which ones you can get by without. Most suppliers are informed, experienced, and conscientious, and they will gladly draw on their own experience to help get you started.

Your Competition. Visit one or more of the other locksmith shops in your area and order a couple of duplicate keys. Note what brand of blank the locksmith uses. Which manufacturers does his key-blank display feature? This information may be very useful. Use your own judgment as to whether or not to reveal yourself as a new competitor. Surprisingly, though, you may find your potential competitors willing or even eager to talk about their businesses, including their preferences in blanks.

Your Own Experience. In your daily work as a locksmith, you'll begin to notice what blanks are used most often and which ones you reorder most frequently. Try to keep careful track of the blanks you sell, and periodically make notes on which ones sell the best. Then, when it's time to reorder, you'll know exactly what you need!



Locking It Up! 3

Indicate whether each of the following statements is True or False.

- _____ 1. The last step in key duplication is to determine whether you can legally make the duplicate.
- _____ 2. *Silhouettes* are exact-size outlines of keys in a manufacturer's catalog.
- _____ 3. An *end view* of a key blank is what you see when you hold it up straight and look directly at the bow.
- _____ 4. The length of a key's blade is measured from the bow to the shoulder.
- _____ 5. When making a duplicate key, the bows of the customer's key and the blank must match.
- _____ 6. Key blade width is the distance across the blade.
- _____ 7. The best way to compare the thicknesses of two flat keys is to use a micrometer.
- _____ 8. The five standard types of key blades are the square, half-round, vee, right-angle, and left-angle.

Check your answers with those on page 51.

IDENTIFYING UNUSUAL KEYS

The Mark of a True Professional

Hundreds of years ago, keys were finely crafted, highly detailed, and sometimes made from precious metals. For this reason, people prized these keys and saved them carefully. Many examples of very old keys exist today, and much has been written about them. However, in later years (about 100 years ago), keys began to be mass-produced. People of that time felt that their keys were ordinary tools, and threw them away when they were no longer needed. In addition, many keys were melted down over the years to use for scrap metal.

While many old keys were thrown away or scrapped, many still survive! You can never be sure when a customer is going to come into your shop and ask you to identify some strange-looking object. While you're obviously never going to see an ancient key outside of a museum, it's perfectly possible that a customer could come in with a 100-year-old key and ask you to identify it. This may happen quite often, as unidentified keys are always turning up in old homes. The key's owner may have no idea what the key is even used for—a door, a cabinet, a desk, or a clock.

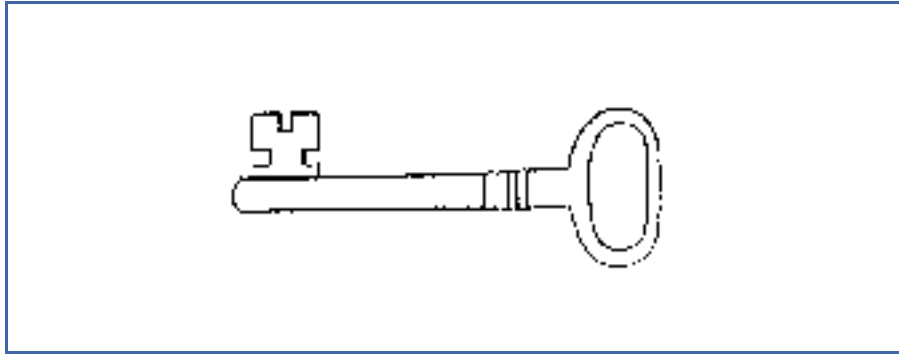
It certainly isn't expected that you be an expert in antique keys. However, there are a few common types of strange, old, or obsolete keys that you should be able to recognize. Being able to identify unusual keys will separate *you* from the average locksmith. Your knowledge will impress your customers and enhance your professional reputation!

Strange, Rare, and Obsolete Keys

Now, let's take a brief look at some unusual keys. Many of the keys described here are popular collectibles, and some (particularly railroad keys) are quite valuable.

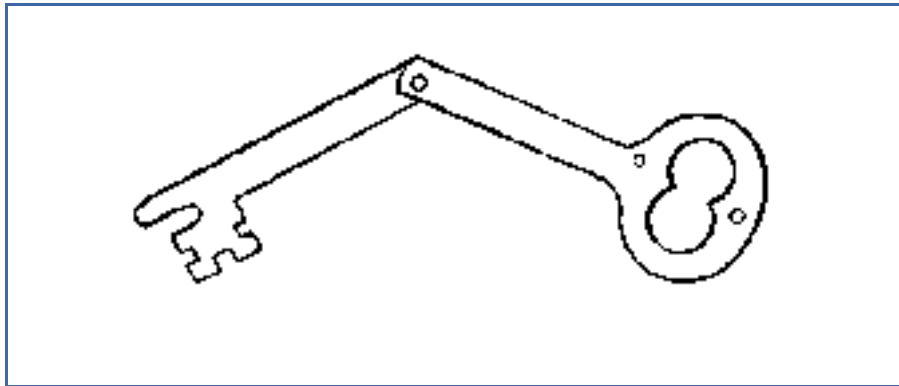
Gate Keys. The keys used in old gates were very large (between four and six inches long) and were usually made of iron (Figure 36).

FIGURE 36—Gate keys were often made of iron and were usually between four and six inches long.



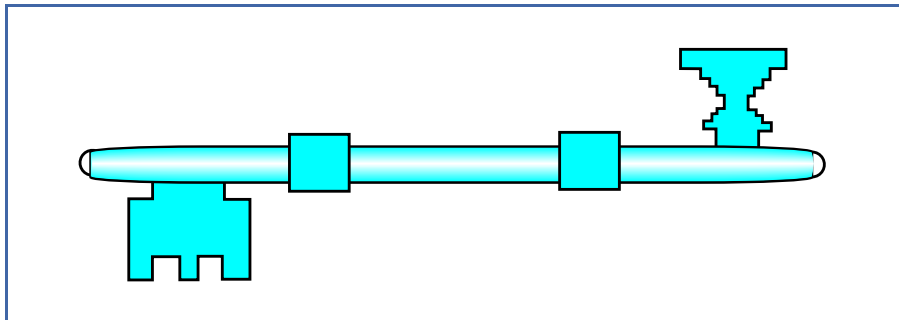
Folding Door Keys. One relatively unusual key you may see is a *folding* door key. Many old wooden doors were very thick, and in addition, the lock would often be mounted on the surface of the door. For this reason, long keys were necessary to reach the lock mechanism inside. Because it was inconvenient to carry such a long key in a pocket, the keys were jointed to fold in half (Figure 37).

FIGURE 37—This type of door key folded in half for convenient carrying.



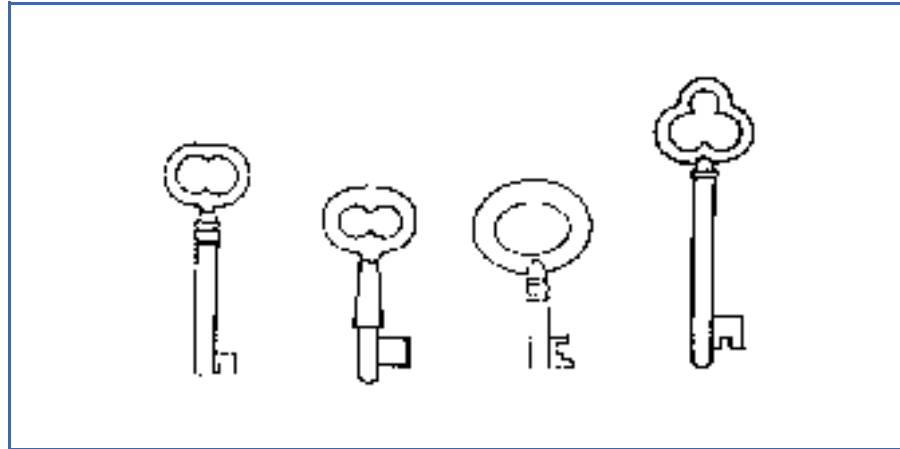
Double-Ended Keys. Genuine double-ended door keys are very rare and quite valuable. These keys contain two different keys, one at each end of the shank (Figure 38). Most double-ended keys were made in Europe, but some have been found in the United States.

FIGURE 38— Double-ended keys are quite rare.



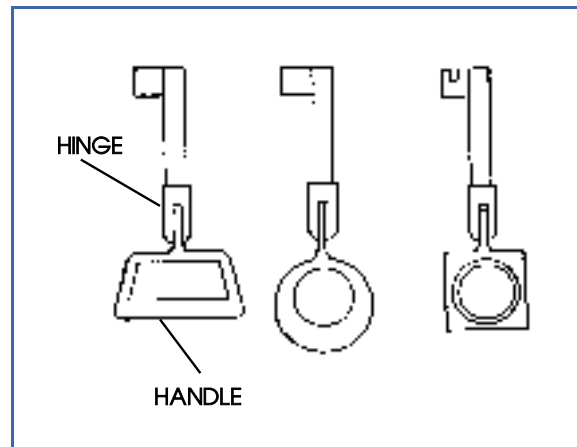
Cabinet Keys. Cabinet keys are bit or barrel keys that were used to open cupboards, cabinets, chests of drawers, and desks (Figure 39). Shorter versions of the cabinet key (also barrel keys) were used to unlock trunks, padlocks, luggage, and books or diaries. Just about every lock maker made cabinet keys at one time or another, so these keys are commonly seen.

FIGURE 39—Cabinet keys were used to open drawers, cupboards, and desks. Both bit and barrel types are shown here.



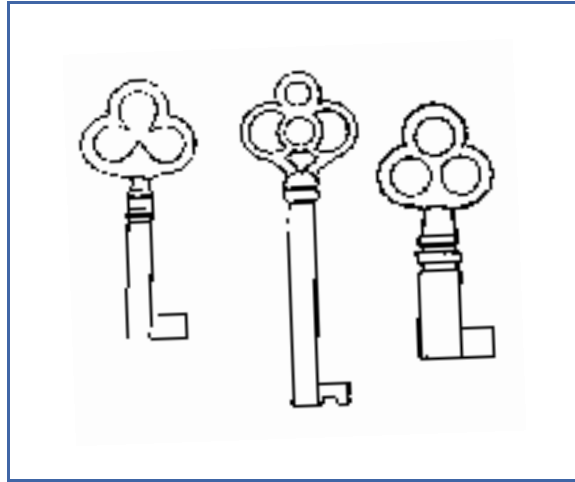
Years ago, some cupboards and chests of drawers were designed without handles or pulls on the doors or drawers. Instead, the keys made to open these cabinets had a built-in handle attached. After the key was inserted, the hinged bow folded down to create a handle to pull the door or drawer open (Figure 40).

FIGURE 40—After this type of cabinet key was inserted into the lock, the hinged bow folded down to provide a handle to pull the door or drawer open.



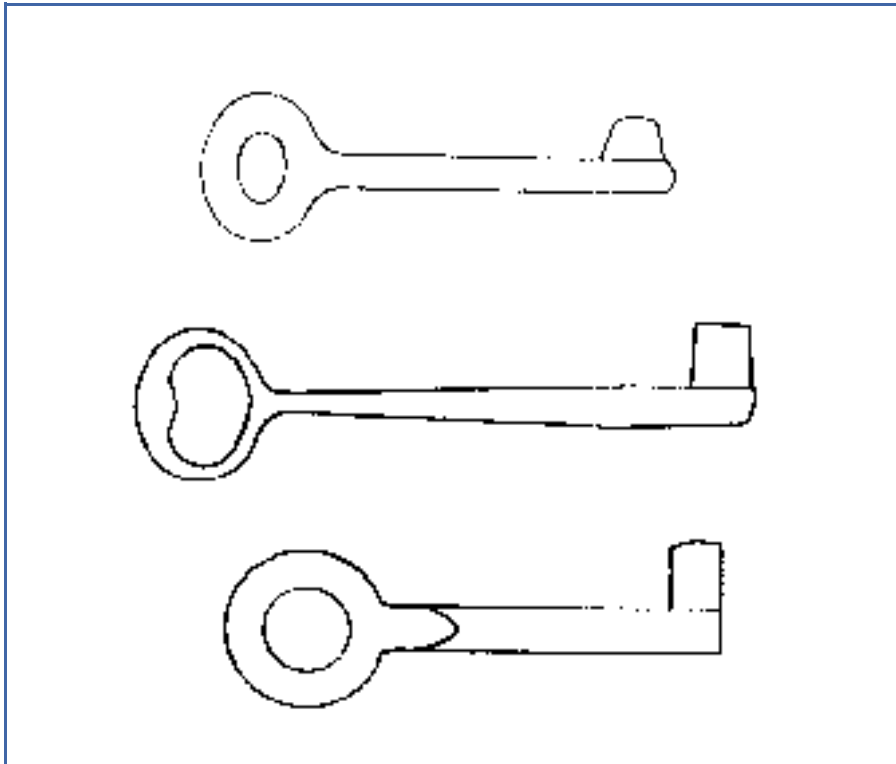
Another common type of cabinet key is the *cloverleaf key*. A cloverleaf key is simply a cabinet key with a bow in the shape of a three-leaf clover (Figure 41).

FIGURE 41—The cloverleaf cabinet key has this distinctive bow shape.



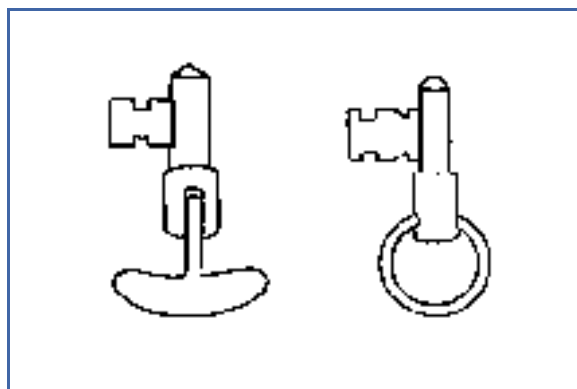
Chest Keys. Many years ago, before closets were standard in most houses, people kept clothing, extra blankets, and mementoes locked in large wooden boxes called *chests*. Most chests were handmade, and contained simple homemade locks. The locks were designed mainly to keep small children from getting into the chests. The keys used with these locks are generally very simple, and tend to resemble bit key blanks (Figure 42).

FIGURE 42—Many old chest keys look much like bit key blanks.



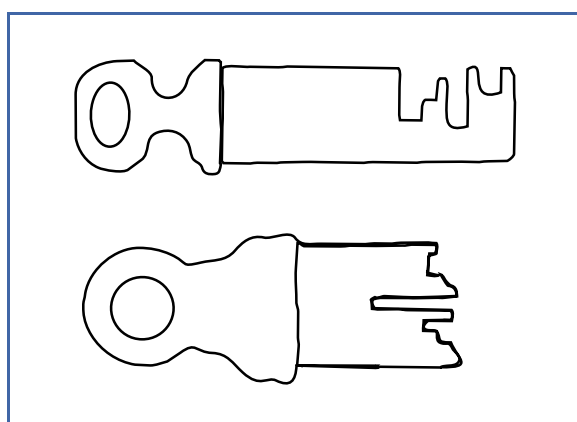
Pocket Door Keys. Sliding *pocket doors* are found in many old homes. These doors were usually located between a hall and a dining room, or between dining room and parlor. The doors slid back into the wall so that all that could be seen was the edge of the door. Pocket door keys are generally very short, and many folded in half (Figure 43). This was so that the key could be folded down and left in the door lock when it was slid into the wall.

FIGURE 43—Pocket door keys can be folded in half and left in the lock when the door is slid into a wall.



Safe Keys. Before the combination lock was perfected and readily available, many bank safes contained key-operated locks. Safe locks used the type of key shown in Figure 44.

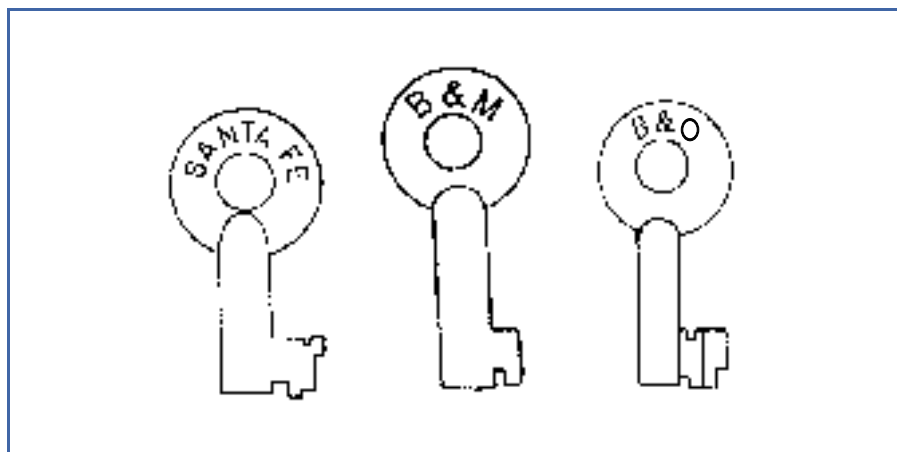
FIGURE 44—A safe key is shown here.



Railroad Keys. Railroads used a variety of keys for different purposes. The railroad key most prized by collectors today is the *switch key* (Figure 45). Switch keys are large barrel keys that were used by railroad switchmen to unlock gates and divert boxcars from one track to another.

Other railroad keys include keys to open boxcars, cabooses, Pullman sleeping cars, and padlocks. Most of these keys are standard-type bit keys. Many railroad keys are stamped with the identifying initials of the railroad system that used them, such as B & O (Baltimore and Ohio Railway), NYCS (New York Central System), Santa Fe (Atchison, Topeka, and Santa Fe Railway), and dozens of others. The collecting of railroad keys and locks is a popular hobby.

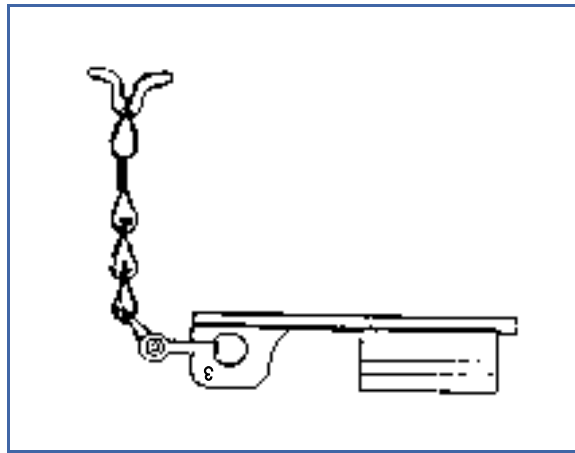
FIGURE 45—Several railroad switch keys are shown here.



Night Watchman's Keys. Years ago, night watchmen patrolled the streets of cities and towns, keeping an eye out for disturbances, crimes, and fires (much like our police do today). To make sure each watchman faithfully completed his rounds, several systems to check on the watchmen were devised. In one of these systems, check stations were located at various spots along the watchman's nightly route.

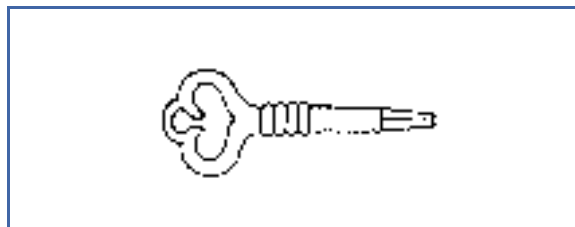
Each station included a metal box to which was attached a special key on a chain. The watchman carried a clock with him that contained a small piece of paper. As he reached each station, the watchman would take the key out of the station box, insert it into the clock, and turn it. The key's number would then be stamped on the paper inside the watchman's clock. In this way, the watchman's boss could determine if he made all the stops on his rounds. A typical night watchman's key is shown in Figure 46.

FIGURE 46—Each key on the night watchman's rounds was stamped with an identifying number.



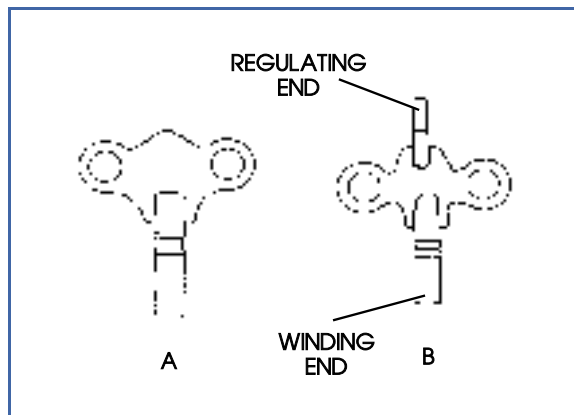
Sewing Machine Keys. A sewing machine key contained a triangular or square end (Figure 47) and was used in the locks found on sewing machines, pianos, and some other musical instruments.

FIGURE 47—This type of key was used to open sewing machines and pianos. Note the triangle-shaped end.



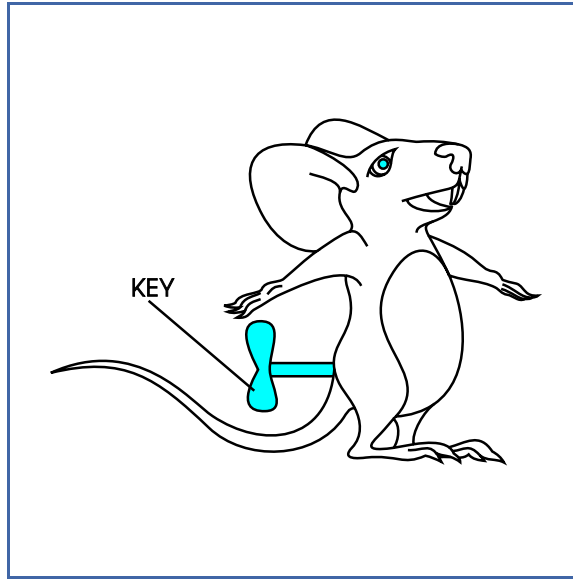
Clock Keys. Clock keys are used to wind the mainspring inside a wall clock (Figure 48). Clock key tips came in different diameters to fit various clock models. Some clock keys have two ends. In these keys, the larger end was used to wind the mainspring, while the smaller end was used to wind a *regulator* (a device that speeded up or slowed down the clock). These two-ended keys are called *regulating and winding keys*. Clock keys are still made today to fit reproduction antique clocks.

FIGURE 48—Figure 48A shows a typical clock key and Figure 48B shows a regulating and winding key.



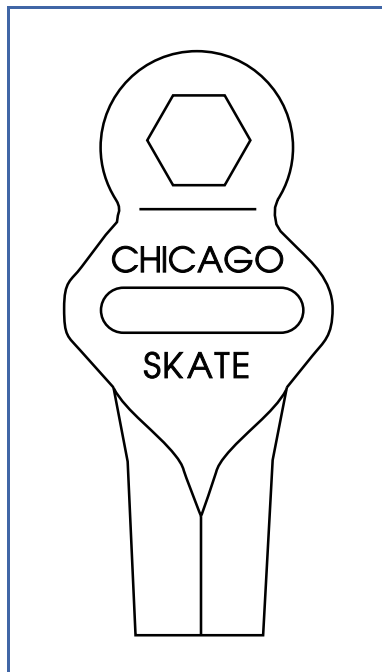
Toy Keys. Some old metal wind-up toys used keys that look very similar to clock keys (Figure 49).

FIGURE 49—Many wind-up toys use keys very similar to clock keys.



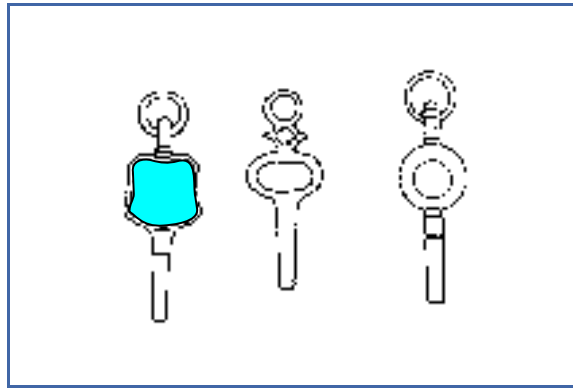
Skate Keys. Some of us are old enough to remember the old metal skates (both ice skates and roller skates) that clamped on and were tightened with a key (Figure 50). Because this type of skate is now obsolete, these keys are becoming popular collector's items!

FIGURE 50—This type of key was used to tighten roller skates.



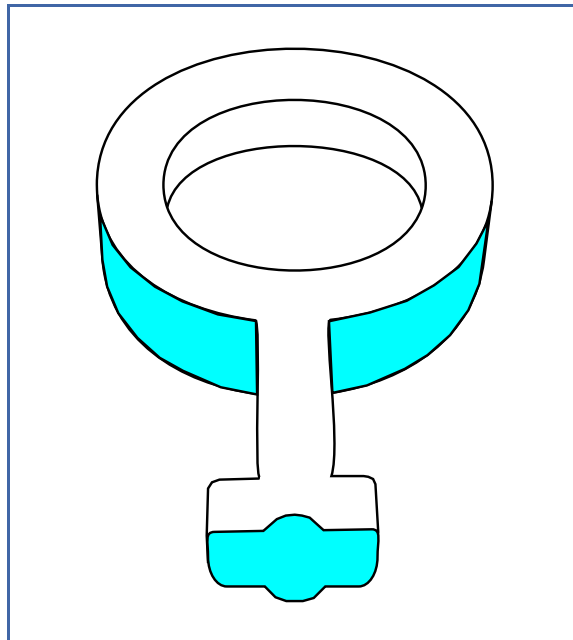
Watch Keys. Old-fashioned pocket watches were wound using a key (as opposed to later wristwatches that contain their own winding button). Most watch keys are very small, one inch in length or less (Figure 51). Pocket watches were made for both men and women, but either way, they were highly prized pieces of jewelry. For this reason, some watch keys were made in gold or silver, or were set with small jewels.

FIGURE 51—Watch keys are very small, often less than one inch in length.



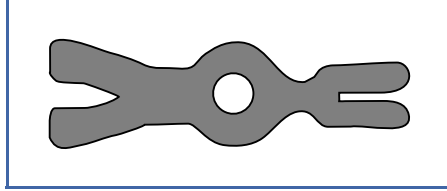
Water Keys. Water keys (Figure 52) were used to unlock water main covers and to release water valves. Water keys may more correctly be called wrenches than keys, since that's how they operate.

FIGURE 52—Shown here is a typical water key.



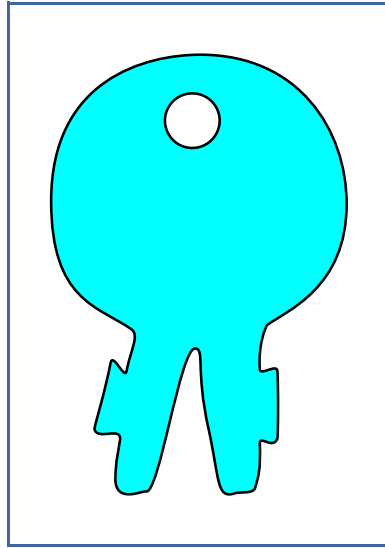
Electrical Switch Key. In some municipal buildings, if the power shuts off, a key is needed to access the main electrical panels to restore power. The type of key used to access an electrical switch is shown in Figure 53.

FIGURE 53—This type of key is used to access an electrical switch.



Lawnmower Key. Some power lawnmowers use the type of key shown in Figure 54.

FIGURE 54—This type of key is used in a power lawnmower.



If you should become interested in collecting keys, there are many good reference books available to help you learn about them. A good place to contact for more information about collectible keys and reference books is Key Collectors International, P.O. Box 9397, Phoenix, Arizona, 85806.



Locking It Up! 4

1. The _____ key was jointed in the middle so that it could be carried conveniently in a pocket.
2. _____ keys contain two different keys, one at each end of the shank.
3. A cloverleaf key is a type of _____ key with a bow in the shape of a three-leaf clover.
4. _____ keys are very short, and many fold in half so that the key could be left in the lock when the door was slid into the wall.
5. Large barrel keys that were used by railroad switchmen to unlock gates and divert boxcars from one track to another are called _____ keys.
6. The two-ended type of clock key that performs two functions is the _____ key.

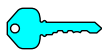
Check your answers with those on page 51.

THE KEY TO SUCCESS

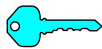
Well, you've made it to the end of another study unit! Think back on all the valuable information you learned in this text. You learned about key blanks, key duplication, and key identification. Remember that the ability to quickly and correctly identify keys is one of the most important locksmithing skills. You've already mastered the basics in this area. You should be proud of your continued efforts to reach your career goals.

Now, when you're ready, read through the *Key Points to Remember* that follow. When you've reviewed the material and feel you know it well, proceed to the examination for this study unit. Good Luck!

KEY POINTS TO REMEMBER



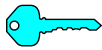
As a locksmith, one of your most common tasks will be key duplication. The key blank you use to make a duplicate must be *exactly the same* as the customer's original key in shape and size. For this reason, being able to identify a customer's key and properly match it to a key blank is an extremely important locksmithing capability.



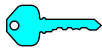
The main types of keys you should be familiar with are the bit key, barrel key, tubular key, flat key, cylinder key, and dimple key. Each of these key types is used with a specific type of lock. Bit and barrel keys are used with warded locks, tubular keys are used with vending machine and computer locks, flat keys are used with lever locks and warded padlocks, cylinder keys are used with disk tumbler or pin tumbler cylinders, and dimple keys are used with high-security lock cylinders.



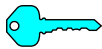
The main parts of a cylinder key blank are the *bow*, *shoulder*, *blade*, *tip*, *bitting*, and *milling*. The bow is the handle of the key. The shoulder is the projection between the bow and the blade that stops the key from penetrating too far into the lock. The blade is the longest portion of a key where the cuts are made. The tip is the end of the blade. The cuts or notches made in the blade are the bitting. The milling grooves are engraved into the blade.



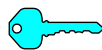
The manufacturers of locks and key blanks use a number of different methods to identify their products. Some lock manufacturers stamp their names on the key bows; others use both their names and an identifying number. However, the easiest way to identify the manufacturer of a key blank is by looking at the bow shape. Each manufacturer uses a distinctive shape to make its key blanks look different from all others.



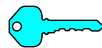
Some lock manufacturers only make keys to fit their own locks. These keys are called *original keys*. Some companies make keys to fit locks made by a number of other manufacturers. These keys are called *look-alikes*. Look-alikes are exactly the same as original keys in the size and shape of the blade and grooves, and will usually have the same bow shape as the original keys as well.



Some companies don't use the "look-alike" system; instead, they use their own bow shape no matter what locks the key blanks are made for. These keys are referred to as *generic key blanks*. You'll need to use the numbers to identify each key. Generic key blanks are usually inexpensive and are therefore popular with locksmiths.



The Cole or E-Z system is the most popular and recognized system for marking key blanks. The E-Z system uses one or two letters and one digit to identify key blanks. The letter or letters are the initials of the manufacturer. So, for example, *Y* stands for *Yale*, *SC* stands for *Schlage*, and *M* stands for *Master*. By looking at these letters, you can instantly determine whose locks the key will fit.



Many locksmith suppliers and ordinary hardware manufacturers produce *neuter key blanks*. Neuter blanks contain no manufacturers' information or identifying bow shape at all, only the name and/or phone number of the retail store where they were sold.

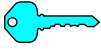


A manufacturer's catalog can be very useful for identifying key blanks. Key catalogs typically contain *silhouettes* (outlines) of the keys made by that manufacturer. The silhouettes are exactly the size and shape of the real-life keys they represent. Under or next to each silhouette you'll also find an *end view* of the key blank.

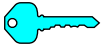


A *cross-reference directory* is a useful resource that lists the numbers of all the key blanks made by a given manufacturer; then,

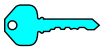
the directory lists the corresponding numbers of key blanks made by several other manufacturers. For example, by looking up one Ilco key blank number, you can instantly find the corresponding Star, Dominion, Taylor, or Cole key blank numbers.



When a customer comes into your shop and asks for a duplicate key to be made, there are a number of techniques you can use to determine what blank to use. However, the first step in this process is always to determine whether it's legal for you to duplicate the key. Remember that if a key is stamped "DO NOT DUPLICATE," the customer must provide you with a *waiver of responsibility* form printed on the letterhead of the key's owner before you can make a copy of the key.



The next step is to identify the original manufacturer of the customer's lock. Start by looking at the customer's key for the manufacturer's name, or look at the shape of the bow.

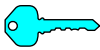


Then, consult that manufacturer's key catalog to find the blank you need. Check the identifying number on the blank; then, look up that number in the index at the beginning of the catalog. Find your number in the index and see what page that blank is pictured on. Then, go to that page and compare your real key to the silhouette. You can lay the key right on the page over the silhouette. It should match exactly!



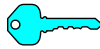
If you know the manufacturer, but the key contains no identifying number (or if the key is too worn to read) simply flip through the catalog pages and look for a picture that resembles your key. If a key contains no identifying marks at all, you'll have to compare the customer's key to blanks in your shop by hand. You'll need to compare *key characteristics* in order to make a match. For a cylinder key, these characteristics include the following:

- Blade length (The length of a the key's blade from the bow to the tip)
- Blade width (The distance across the blade from left to right)
- Key thickness
- Tip shape
- Groove length and shape



For a bit or barrel key, the identifying characteristics are these:

- Shank length
- Post length
- Tip length and diameter
- Bit length, height, and thickness



In addition to the standard, everyday keys that customers bring in to your shop, it's always possible that someone will ask you to identify an old-fashioned or obsolete key. While locksmiths aren't expected to be experts in antique keys, there are a few common types of old keys that you should be able to recognize. Being able to identify strange keys will mark you as a knowledgeable professional in the eyes of your customers! Some of these include the following:

- Gate keys (large iron keys used in old gates)
- Folding door keys (long door keys that fold in half in the middle)
- Double-ended keys (bit keys containing two different keys, one at each end of the shank)
- Cabinet keys (bit or barrel keys used to open cupboards, cabinets, chests of drawers, and desks)
- Cloverleaf keys (cabinet keys with cloverleaf-shaped bows)
- Chest keys (long, simple keys that resemble bit key blanks)
- Pocket door keys (short folding keys that remained in a pocket door when it was slid into the wall)
- Safe keys (used before combination locks were widely used)
- Railroad switch keys (large barrel keys used to unlock gates and divert boxcars from one track to another)
- Night watchman's keys (special keys attached to a watch station by chains)
- Sewing machine keys (small keys with a triangular or square end)

- Clock keys (keys used to wind the mainspring inside a wall clock)
- Skate keys (keys used to tighten metal roller skates)
- Watch keys (keys used to wind pocket watches)
- Water keys (keys used to unlock water main covers and release water valves)
- Electrical switch keys (keys used to access a building's electrical system)
- Lawnmower keys (keys used in the ignitions of power lawnmowers)

Do You Know Now. . .

Below are the answers to the questions asked at the beginning of this study unit.

What are the main parts of a cylinder key blank?

The main parts of a cylinder key blank are the *bow, shoulder, blade, tip, biting, and milling*.

What is the E-Z numbering system?

The Cole or E-Z numbering system is the most popular and recognized system for marking key blanks. The E-Z system uses one or two letters and one digit to identify key blanks. The letter or letters are the initials of the manufacturer. So, for example, *Y* stands for *Yale*, *SC* stands for *Schlage*, and *M* stands for *Master*. By looking at these letters, you can instantly determine whose locks the key will fit.

What is a *cross-reference key directory*?

A *cross-reference key directory* is a useful resource that lists the numbers of all the key blanks made by a given manufacturer; then, the directory lists the corresponding numbers of key blanks made by several other manufacturers. For example, by looking up one Ilco key blank number, you can instantly find the corresponding Star, Dominion, Taylor, or Cole key blank numbers.

NOTES

Locking It Up! Answers

1

1. h
2. b
3. g
4. e
5. f
6. c
7. d
8. a

2

1. Bow
2. Milling groove
3. Shoulder
4. Tip
5. Blade
6. Bitting
7. cylinder

3

1. False
2. True
3. False
4. False
5. False
6. True
7. True
8. False

4

1. folding
2. Double-ended
3. cabinet
4. Pocket door
5. switch
6. regulating and winding

NOTES

Appendix

ICS KEY BLANK CATALOG—INDEX

Note: The EZ number is developed by distributors to reduce the size of the part number. The EZ number is unique to each distributor.

EZ NUMBER	PAGE	EZ NUMBER	PAGE	EZ NUMBER	PAGE
AA2	1	DE4	4	KA14	27
AM1	1	DE8	4	KM9	27
AP1	1	EA1	4	KW1	1
AP2	1	EA13	4	KWI-PC	1
AR1	1	EA27	4	KW5	1
AR4	1	EL1	4	KW9	1
B1	22	EL2	4	L1	7
B2	22	EL3	4	L4	7
B3	22	ER1	4	L13	7
B44	22	ES9	4	LF7	28
B45	22	F91C	20	LO1	7
B51	22	F91C2	20	LUV1	29
B52	22	FA1	5	M1	8
B53	22	FA2	5	M2	8
BE2	2	FA3	5	M3	8
BL6	25	FC2	26	M4	8
BN1	2	FC7	26	M10	8
BO1	2	FT37	20	M12	8
CG1	2	FT38	20	M13	8
CG2	2	H5	25	MB15	28
CL1	2	H6	25	MB41	29
CO1	2	HD70	25	MG1	29
CO3	2	HD70U	26	MZ10	29
CO5	2	HD71	26	MZ17	29
CO102	3	HO1	26	MZ19	29
CO106	3	HO4	26	N1	9
DA20	25	HY2	26	N3	9
DA23	30	HY2-P	26	NA1	9
DA24	30	HY3	26	NA6	10
DA25	30	HY4	26	NE48	30
DC1	3	IL1	6	NH1	10
DC3	3	IN1	6	OL1	10
DC3-P	3	IN29	6	P1	10
DE1	3	JA2	27	P2	10
DE2	3	K1	6	PA5	10
DE3	3	K2	6	PA6	10

ICS KEY BLANK CATALOG INDEX—CONTINUED

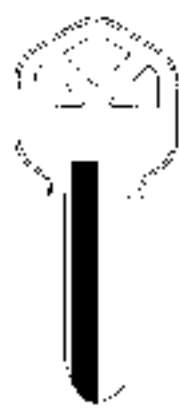
EZ NUMBER	PAGE	EZ NUMBER	PAGE	EZ NUMBER	PAGE
PA8	11	SC6	1	VO6	35
PG5	31	SC7	1	VO73	15
PO5	31	SC8	1	VR2	15
PO7	31	SC9	2	VR5	15
R3	11	SC10	2	VR7	15
RA1	11	SC22	13	VW77	35
RA2	11	SK1	13	W1	15
RA3	11	SL1	13	WE1	15
RE1	11	SL20	13	WK1	2
RO1	11	SUZ10	33	WK2	2
RO3	11	SUZ11	33	WR2	2
RU16	11	SUZ15	34	WR3	2
RU44	12	T1	14	WR4	2
RU45	12	T2	14	WR5	2
S1	12	T7	14	X95	32
S2	12	TR33	34	XL7	32
S1	12	TR37	34	Y1	16
S2	12	TR39	34	Y1-PC	16
S3	12	TR47	34	Y1E	16
S4	12	U61VW	34	Y2	16
S7BW-P	12	V27	34	Y3	16
S10	12	V32	34	Y4	17
S22	12	V35	14	Y5	17
S31	12	V37	15	Y101	17
SA1	12	VL6	35	Y152	37
SC1	12	VL8	35	YU2	37
SC4	1				

ICS KEY BLANK CATALOG

PAGE-1



CS*0



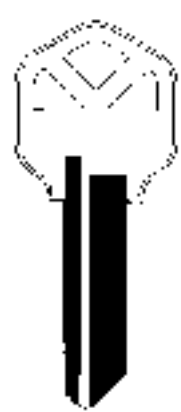
ICS*1



ICS12



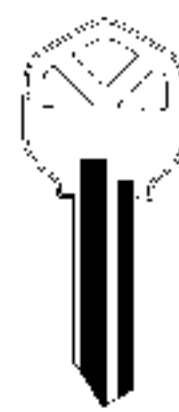
CS15



CS*4



CS*5



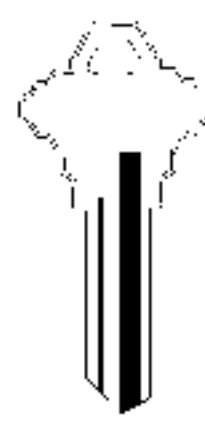
ICS16



CS17



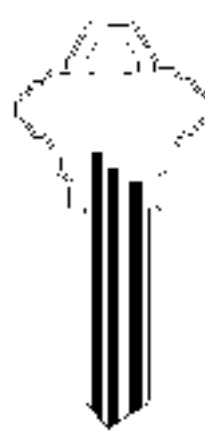
CSX1



CSX2



ICSX3



ICSX4

ICS KEY BLANK CATALOG

PAGE-2



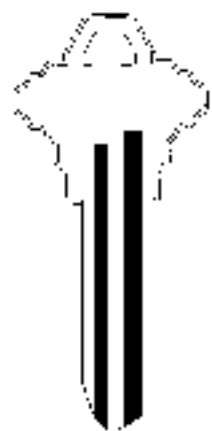
CSX5



IC3X6



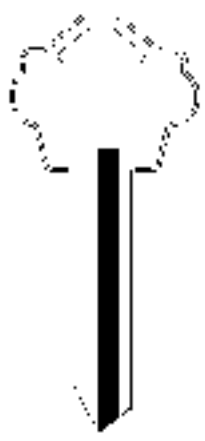
IC3X7



CSX8



CS0



CS02



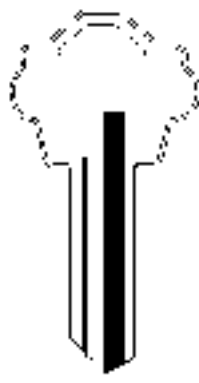
IC003



CS04



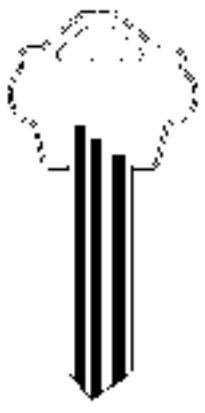
CS05



CS06



IC007



IC008

ICS CROSS-REFERENCE DIRECTORY

Ilco	Cole	Dominion	ESP	EZ	Star	Taylor
1001EB	CO3	01EB	CO3	CO3	5CO2	21EB
1001EN	CO7	01EN	CO7	CO7	5CO1	21EN
1001GH	CO67	01GH	CO97	CO97	5CO13	K22
1003M	CO106	03M	CO106	CO106	5AU1	22R14
1004KL	54KL	04KL	L37	—	71L2	54KL
1010N	S43	10N	S68	S68	5SA7	51S
1011	RU1	11	RU1	RU1	5RU1	55
1011D1	RU20	11D1	RU45	RU45	5RU7	57-1D
1011GH	CO67	11GH	—	RU44	5C013	57R
1011P	RU4	11P	RU4	RU4	5RU2	
1011PZ	RU1A	11KM	RU18	—	5RU5	57M
1014	EA1	14	EA1	EA1	5EA2	61
1014C	HR1	HR2	HR1	HR1	5HR1	S61FR
101AM	AP1	41AC	—	AP1	—	F41A
1022	SE1	22	SE1	SE1	5SE1	102
102AM	AP2	41AD	—	AP2	—	FR1B
103AM	—	41AB	—	AP3	—	FR1C
1041C	AM1	41C	AM1	AM1	JU1	41C
1041E	CG16	41T	CG22	CG22	CG5	41RB
1041G	CG1	41G	CG1	CG1	CG1	41G
1041GA	CG2	41GA	CG2	CG2	CG6	41GA
1041GR	CG4	41GR	CG3	—	CG2	41GR
1041T	CG15	41E	CG16	CG16	5CG7	41R
1041Y	CG14	41Y	KP1	CG17	5CG4	41Y
1046	AN4	41X	AM3	AM3	5JU2	J41
1046A	—	A41X	AM7	—	6JU2	J41A
1049D	—	49D	—	—	—	49D
1049E	SF7	49E	—	—	—	49S
1054HT	IN24	—	—	—	—	54HT
1054K	1N3	54K	1N3	—	5IL2	54K
1054KD	DE1	54KD	—	DE1	5DE1	54KD
1054WB	WR2	H54WA	WR3	WR3	5WR2	54WB

ICS CROSS-REFERENCE DIRECTORY—CONTINUED

Ilco	Cole	Dominion	ESP	EZ	Star	Taylor
1069	RO1	69	RO1	RO1	RO1	62
1069N	RO9	H69	—	RO3	RO6	174J
1079B	K2	79B	K2	K2	5KE1	79HK
1092V	M3	92V	M4	M4	5MA3	U92A
1096L	EL3	96L	EL3	EL3	5EL1	96L
1127DP	H27	127DP	H27	H27	HFD4	127DP
1145	SC1	145	SC1	SC1	5SH1	145
1154A	SC4	A145	SC4	SC4	6SH1	145A
1167FD	H33	167FD	H51	H51	H5D10	P27
1175	WK1	175	—	WK1	5WK1	175
1175N	WK1	H175	WK2	WK2	5WK1	175W
1176	KW1	H176	KW1	KW1	5KW1	54KS
1177N	NH1	22EZ	NH1	NH1	5NA1	N102
1179A	AR4	HL22W	AR4	AR4	6AR2	135A
1307A	SC6	707A	SC6	SC6	SH2	307A
1307W	SC22	707W	SC22	SC22	SH6	307W
1702K	Y152	702K	—	—	—	—
61VW	FO153	H62VN	—	61VW	—	V68D
62FS	EN2	62DR	UN18	62FS	UN3	S71B
999	Y1	9	Y1	Y1	5YA1	14
999A	Y2	9A	Y2	Y2	6YA1	14A
999B	Y145	X9B	Y220	Y220	4YA1	X14S
A1001ABM	CO89	01GM	CO89	CO89	6C012	A22GM
A1001EH	—	U00Z	CO66	CO88	6C011	A22Z2
A1114	ABE2	A114A	BE2	BE2	6BE1	—
A1145E	SC9	A145E	SC9	SC9	6SH4	145E
A1145EF	—	A145EF	—	—	—	145EF
A1145F	SC10	A145F	SC10	SC10	6SH5	145F
AA2	AA2	NE21	AA2	AA2	WN1	X51
B53	B53	—	B53	B53	SP1	X143

ICS CROSS-REFERENCE DIRECTORY—CONTINUED

Ilco	Cole	Dominion	ESP	EZ	Star	Taylor
B55	B55	—	B55	B55	TO3	X145
BMW1	—	HF28	BM3	BMW1	—	B80NR
C1096CN	EL10	EG1	EL10	EL10	5EL4	96CN
C1096LN	EL11	E96LN	EL11	EL11	5EL3	96LN
C999	Y3	C9	Y3	Y3	5YA2	14YM
DA23	DA23	DT21	DA23	DA23	DA6	X115
FC2	H7	KL6	FC2	FC2	CP1	X20
FT37	FO437	SF5	FT37	FT37	FT3	F79-1
FT6R	F77	DM9	WS2	FT6R	—	F81E
H1098LA	B10	H9BLA	B10	B10	HBR2	H98LA
H044	JA77	HD44	HD69	HO44	HON23R	HN4
K1122D	BN1	BG6	BN1	BN1	BN1	L54P
L1010N	S44	A10N	S69	—	6SA7	51SA
MZ10	JA72	MZ10	MZ10	MZ10	MZ2	X27
MZ9	JA65	MZ9	MZ9	MZ9	MZ1	X26
N1007RMA	S31	U07RN	S31	S31	6SA6	048KMR
P1098A	B48	P98A	B48	B48	HBR12A	P91A
P1098J	B46	P98J	B46	B46	HBR10J	X98J
P1770U	Y152	770U	—	Y152	—	P19A
P1771CR	Y106	771CH	—	—	—	X16
P1786P	—	—	—	P1786P	—	—
P1789	—	—	Y154	Y154	HPL89	—
PA5	GE26	WT6	PA5	PA5	—	A81R
PA6	GE34	WT7	PA6	PA6	AD1	A81S

NOTES

In this study unit, there are two examinations. The first examination, number 03100300, is a 20-question multiple choice examination. This examination will test your grasp of the information presented in the study unit.

The second examination, number 03180100, is a Practical Examination based on your accumulated knowledge of key identification and your ability to demonstrate your skills with real key blanks. Follow all instructions carefully. Both exams must be submitted to the school for grading. Good luck!

NOTES

THOMSON
—★—™
EDUCATION DIRECT
925 Oak Street
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EXAMINATION

03100300

Identifying Keys

Whichever testing option you choose for your answers, you must use this

EXAMINATION NUMBER:

03100300

When you feel confident that you've mastered the material in this study unit, complete the following examination. Then, *submit only your answers to school headquarters* for grading, using one of the answer options described in your first shipment. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. The manufacturer of the key bow shown below is



- A. Weiser.
- B. Schlage.

- C. Kwikset.
- D. Yale.

2. What is the maximum number of shoulders a key can have?

- A. 3
- B. 2**
- C. 1
- D. 0

3. Manufacturer's identifying numbers are most often found on a key's

- A. bow.**
- B. tip.
- C. blade.
- D. shoulder.

4. The cuts or notches in a key blade are called the

- A. milling.
- B. pins.
- C. bitting.**
- D. barrels.

5. What is a bit key's blade called?

- A. The barrel
- B. The shank
- C. The throat cut
- D. The bit**

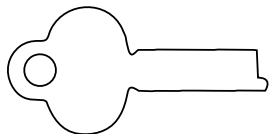
6. A flat key with cuts on only one side of the blade would be used with what type of lock?

- A. Disk tumbler lock
- B. Warded lock
- C. Pin tumbler lock
- D. Lever lock**

7. A key with the identifying number RU64 was made by which of the following manufacturers?

- A. Schlage
- B. Cole
- C. Yale
- D. Russwin**

8. What type of key is shown here?



- A. Flat key**
- B. Cylinder key
- C. Barrel key
- D. Bit key

9. A lock containing a disk tumbler or a pin tumbler mechanism would use what type of key?

- A. Bit key
- B. Flat key
- C. Cylinder key**
- D. Tubular key

10. Which of the following numbers is an EZ key blank number?

- A. 1029B
- B. 686C
- C. 14KR
- D. SC6**

11. Most cylinder keys that have cuts on both sides of the blade are used with
- A. warded padlocks.
 - B. key-in-knob door locks.
 - C. automobile locks.
 - D. suitcases and briefcases.
12. The projection found between a key's bow and its blade is called the
- A. tip.
 - B. biting.
 - C. milling.
 - D. shoulder.
13. The ideal way to measure the thickness of a key blade is with a
- A. micrometer.
 - B. ruler.
 - C. tape measure.
 - D. key gage.
14. A bit key is used with what type of lock?
- A. Lever lock
 - B. Pin tumbler lock
 - C. Warded lock
 - D. Automobile lock
15. A bit key's *bit* is attached to the key's
- A. shoulder.
 - B. milling.
 - C. post.
 - D. bow.
16. A throat cut may be found on what type of key?
- A. Cylinder
 - B. Tubular
 - C. Bit
 - D. Flat
17. A dimple key is used with what type of lock?
- A. A high security pin tumbler lock
 - B. A warded lock
 - C. A lever lock
 - D. A vending machine lock
18. When trying to identify a key, what part should you start with?
- A. Shoulder
 - B. Tip
 - C. Bow
 - D. Post
19. What type of key is the most common in use today?
- A. Cylinder key
 - B. Bit key
 - C. Flat key
 - D. Tubular key

20. The letters WR identify the key-blank manufacturer

A. Weiser.

B. Welch.

C. Weslock.

D. West Evanston.

Instructions For: PRACTICAL EXAMINATION

03180100

Introduction

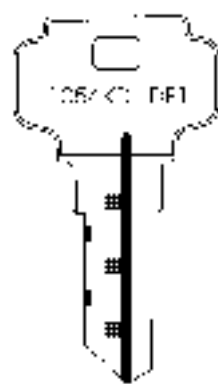
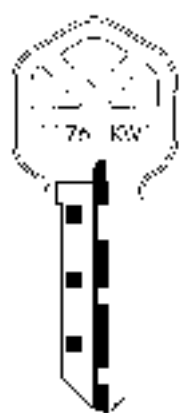
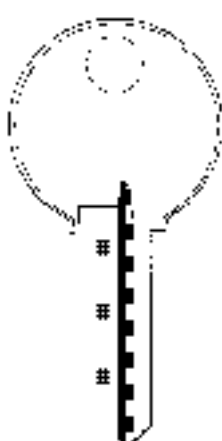
There are literally thousands of different keys being used today. One of the locksmith's most important skills is being able to identify and duplicate any key for a customer. In this study unit, we discussed some of the many professional techniques used in key identification. Now, we'll do some hands-on work with real keys. At the end of this exercise, you'll complete a Practical Examination based on what you learned.

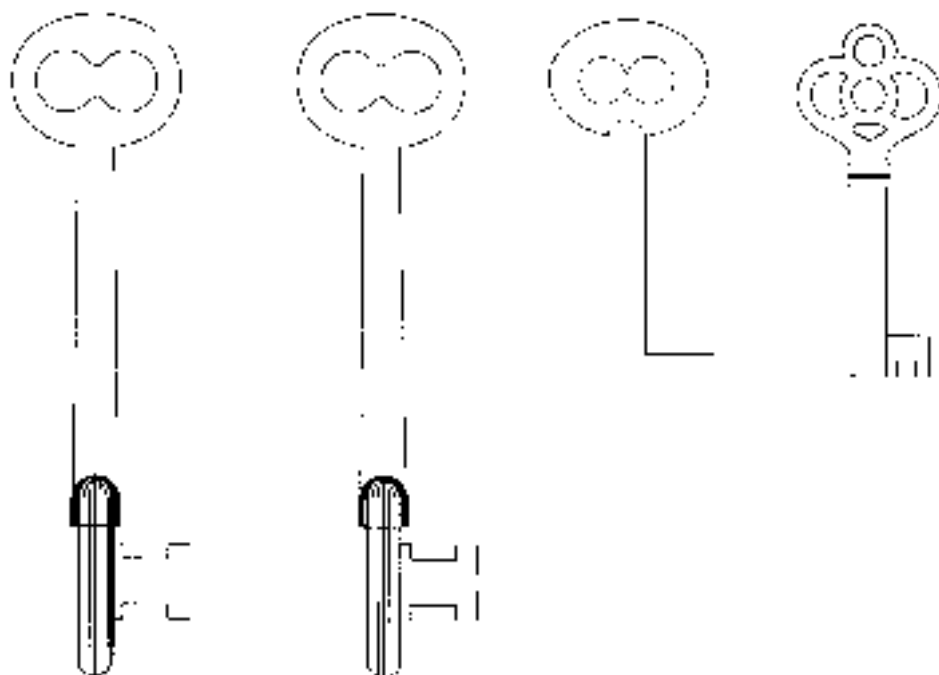
Locate the package of key blanks that was sent to you in this package of study materials. Open the package and lay the key blanks out neatly, face up, on a flat surface. (Be careful not to drop or lose any of the keys!) In counting the keys, you should have a total of 15 blanks altogether in front of you. While you may have your keys set out in a different order, your set should include all the keys pictured on the following pages.

Instructions

Now that you've laid out and examined your key blanks, you're ready to complete the five tasks that make up this hands-on practice exercise. In this exercise, you'll be doing all of the following:

1. Identifying Key Types
2. Identifying Bow Shapes
3. Identifying an Unknown Key





4. Using a Key Catalog
5. Using a Cross-Reference Directory

Part 1: Identifying Key Types

The first part of this exercise will require you to identify keys according to their type. Divide your keys into separate piles of bit keys, barrel keys, flat keys, and cylinder keys. Count the number of each type of key you have, and make a note of that information here:

BitKeys _____

FlatKeys _____

BarrelKeys _____

CylinderKeys _____

Part 2: Identifying Bow Shapes

Look at the cylinder keys you were sent. Remember that the most obvious way to identify the manufacturer of a particular key blank is by looking at the *bow or head shape*. Each manufacturer uses a distinctive shape to make its key blanks look different from all others.

All of the cylinder keys you were sent, with one exception, are “look-alike” cylinder key blanks. (The one exception is a “neuter-bow” cylinder key, which has no manufacturer’s information on it.) Look at the cylinder key blanks, and examine the shapes of their bows. See if you can determine the manufacturer of each lock the key is made for by the keys’ bow shape (you can refer back to Figure 16 on page 12 for assistance).

Part 3: Identifying an Unknown Key

Now, look at the neuter-bow key we just mentioned. You should easily be able to pick out this key because it’s the only cylinder key that has *no manufacturer’s information on it*. (Note that the shape of the neuter bow may vary.)

Now, notice that the blade and the milling cuts of this neuter key are an *exact match* for one of the other cylinder keys in your package. Which one? That’s for you to determine! Use the skills you learned in this study unit to help you compare the neuter key to the other cylinder keys. Compare the blade lengths, milling grooves, end views, and other features to help you find a match. You’ll be asked about the results of your comparison in the examination.

Part 4: Using a Key Catalog

Now, look at the Appendix in this study unit. This Appendix contains an example “key catalog” for you to use in completing this exercise. Note that the “catalog” has index pages, two pages of key blank silhouettes, and a cross-reference directory.

Try looking up one of your cylinder key blanks in the “catalog” now. Choose any one of the cylinder key blanks and examine it. Look at the identifying numbers on your key blank. On an Ilco blank, the number on the left-hand side of the blank is the Ilco number; the number on the right-hand side is the EZ number. On blanks of other manufacturers’ keys the EZ number may be on the left.

The first step in finding any key blank in a key catalog is to go to the catalog index. Find the EZ number on the key you’re examining. Then, find where that number is listed in the index. Next to each identifying number, you’ll find the number of the page where you can find that key blank in the catalog.

Go to the page number listed for your key. Look through the silhouettes illustrated on that page until you find an exact match for your key blank. Make a note of the manufacturer’s number printed under the matching silhouette. That’s all there is to it!

Part 5: Using a Cross-Reference Directory

Now, try looking up one of your cylinder key blanks in the *cross-reference directory* on pages 57–59 of the Appendix. (Remember that a cross-reference directory shows your key’s number, plus the corresponding numbers of other manufacturers.) Find the Ilco number on the key you’re examining. Look up the Ilco number in the column at the far left of the page. Then, look straight across the line to find the corresponding Cole, Dominion, Star, Taylor, and ESP numbers. Make a note of these numbers.

When you’ve completed all five of the tasks described here, you should have a much better “feel” for working with real key blanks. Proceed to completing the multiple choice questions that follow.

Whichever testing option you choose
for your answers, you must use this

EXAMINATION NUMBER:

03180100

When you feel confident that you have mastered the material in this practical exercise, complete the following examination. Then, *submit only your answers to school headquarters* for grading, using one of the answer options described in your first shipment. Use your package of key blanks, your knowledge of manufacturers' key bow shapes, the "key catalog" on pages 55 and 56, and the cross reference directory on pages 57–59 for assistance in answering these questions. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–15: Select the one best answer to each question.

1. How many barrel keys were included in your package?

- | | |
|------|------|
| A. 2 | C. 5 |
| B. 3 | D. 1 |

2. How many flat keys were included in your package?

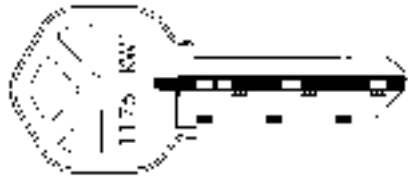
- | | |
|------|------|
| A. 4 | C. 1 |
| B. 2 | D. 5 |

3. Who is the manufacturer of the lock that this key is made to fit?



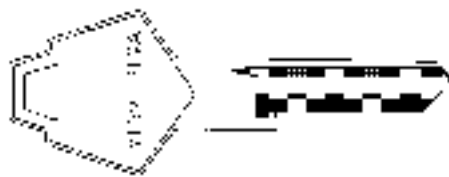
- | | |
|------------|------------|
| A. Kwikset | C. Weiser |
| B. Schlage | D. Weslock |

4. Who is the manufacturer of the lock that this key is made to fit?



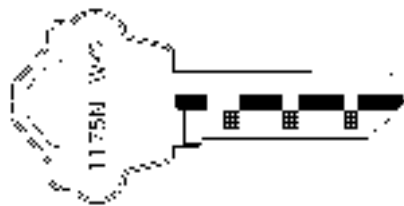
- A. Schlage
- B. Weslock
- C. Kwikset
- D. Dexter

5. Who is the manufacturer of the automobile key blank shown here?



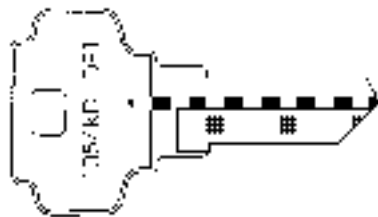
- A. Mazda
- B. Ford
- C. Honda
- D. Chrysler

6. What is the Iico number for the key shown here?



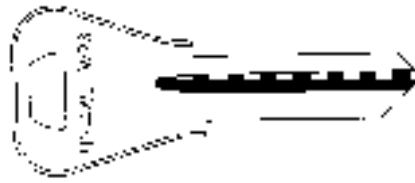
- A. 1175
- B. WK
- C. 1175N
- D. WK2

7. What is the EZ number for the key shown here?



- A. DE1
- B. 1054KD
- C. DE
- D. 1054

8. Look at the key blank illustrated here. On what page of our “key catalog” does this key blank appear?



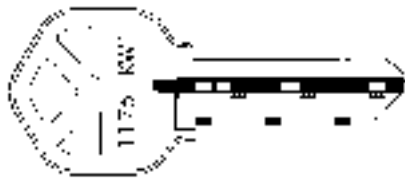
- A. 15
B. 2
C. 1
D. 22

9. For the key blank illustrated here, find the matching silhouette in the key catalog in the Appendix. What is the manufacturer’s number that appears below the silhouette?



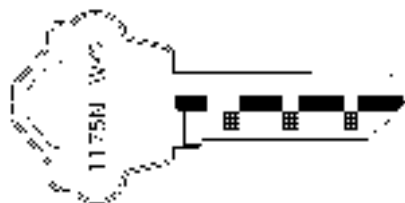
- A. ICSX8
B. ICSX5
C. ICSX2
D. ICSX3

10. For the key blank illustrated here, find the matching silhouette in the key catalog in the Appendix. What is the manufacturer’s number that appears below the silhouette?



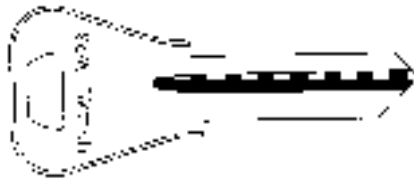
- A. ICS10
B. ICS14
C. ICS13
D. ICS17

11. For the key blank illustrated here, find the matching silhouette in the key catalog in the Appendix. What is the manufacturer’s number that appears below the silhouette?



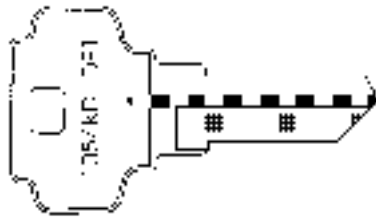
- A. ICS08
B. ICS06
C. ICS01
D. ICS03

12. What is the ESP number for the key shown here?



- A. WR3
- B. WR2
- C. 5WR2
- D. 54WB

13. What is the Dominion number for the key shown here?



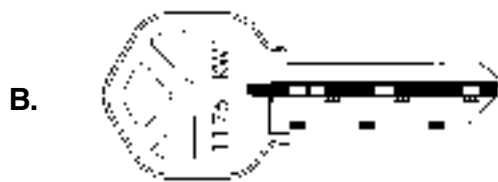
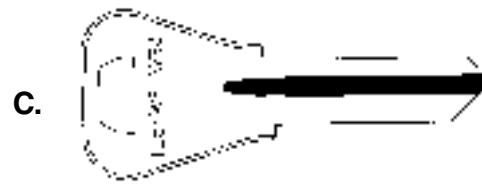
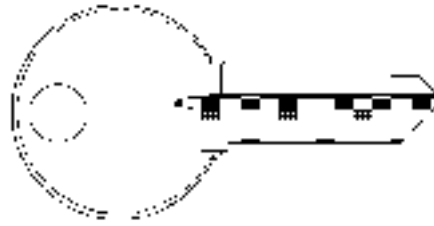
- A. DE1
- B. 5DE1
- C. 54KD
- D. H54WA

14. What is the Taylor number for the key shown here?



- A. BE2
- B. SC9
- C. 145EF
- D. 145E

15. Your neuter key blank (shown here) is a match for which of the other cylinder key blanks shown below?



COMING ATTRACTIONS

In your next study unit, we'll be examining lock mechanisms, the inner working parts of the locks we use every day. You'll learn about both key-operated locks and combination-type locks in detail. We'll discuss how these locks are constructed, how they work, and how to perform basic repairs on them. Good luck with your continuing studies!

Professional Locksmith

Study Unit 4

Lock Mechanisms

DRAFT

This sneak preview of your study material has been prepared in advance of the book's actual online release.

Preview

Welcome to Study Unit 4 of your Professional Locksmith course! In your last study unit, you learned all about keys and how to identify them. Now, in this study unit, you'll begin learning about lock mechanisms in depth. A *lock mechanism* is the internal assembly of a lock that makes it work.

You'll be learning about a variety of lock mechanisms including key-operated, combination, and electric types. With the assistance of plenty of detailed diagrams and drawings, you'll be able to look at the insides of locks. You'll discover how these locks are constructed and how they work.

Then, when you've gained a solid foundation of knowledge about lock mechanisms, you'll learn what types of problems these locks are likely to have and what services locksmiths will need to perform. We'll explain how to completely disassemble and reassemble various lock mechanisms. Finally, we'll tell you how to perform simple servicing, cleaning, and lubrication on lock mechanisms.

When you complete this study unit, you'll be able to

- Name the four basic key-operated lock mechanisms
- Identify the basic types of key-operated lock mechanisms by visual inspection
- Name the principal parts of each lock type
- Explain, in simple language, how different types of lock mechanisms work
- Clean, lubricate, and perform simple maintenance on locks
- Disassemble and reassemble each type of lock as needed for servicing
- List the strong and weak points of each type of mechanism
- Explain how high security locks function
- Explain how combination entry locks work

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Lock Mechanisms

Do You Know . . .

What is the most important component of a combination lock?

What are the major parts of a padlock?

What is a *ward*?

In these pages, you'll find the answers to these and many more questions about lock mechanisms.

INTRODUCTION

What is a Lock Mechanism?

A *lock mechanism* is the assembly of parts inside a lock that makes it work. In most common locks, the locking mechanism holds or moves a latch, bolt, or shackle into the locked or unlocked position. Due to the many types of lock designs, there are many different types of locking mechanisms.

For example, a door lock contains a mechanism to operate a latch or bolt. The latch or bolt is the part that extends into the

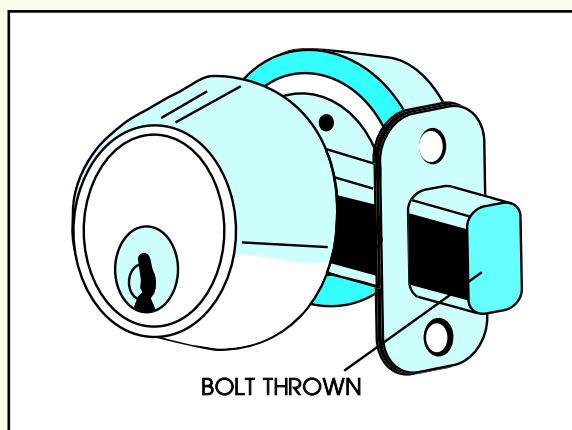
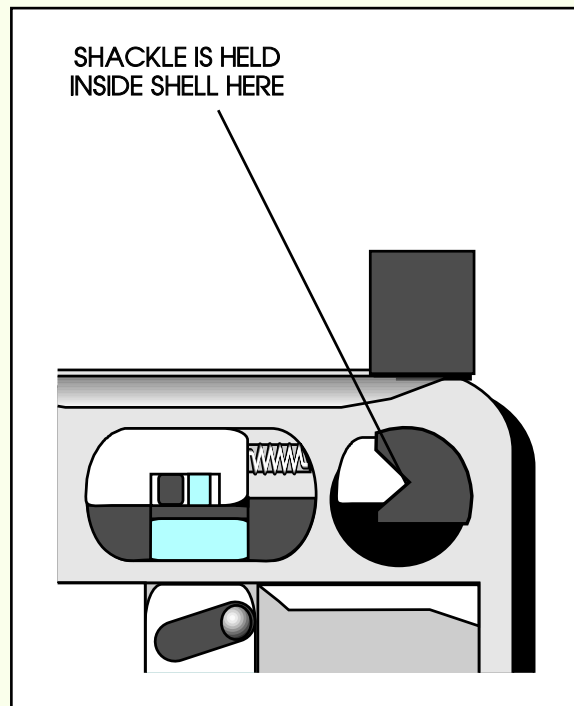


FIGURE 1—This figure shows a bolt in the “thrown” position.

strike, anchoring the door to the door frame. When the bolt is thrown, it moves into the strike and locks the door; when the bolt is retracted back out of the strike, the door is free to open (Figure 1).

FIGURE 2—A padlock mechanism holds the shackle inside the lock case or shell.



In contrast, a padlock contains a mechanism that holds the shackle in the case or shell of the lock, or that allows the shackle to release (Figure 2).

Locks vs. Lock Mechanisms

It's important for you to note the difference between a *lock* and a *lock mechanism*. The word *lock* is a general term that refers to any device installed or attached to improve security. A padlock, a door lock, a car ignition lock—all of these are *locks*. A *lock mechanism* is the inside structure of a lock. For example, a door lock could contain a warded mechanism, pin tumbler mechanism, or a disk tumbler mechanism, depending on how it was made.

For our study purposes, all lock mechanisms can be divided into three basic types: *key-operated lock mechanisms*, *combination lock mechanisms*, and *electric lock mechanisms*. In this study unit, we'll examine each of these different mechanisms in detail. We'll look at how they're constructed and how they operate; then we'll examine simple repair techniques for each type. Let's start by turning our attention to key-operated lock mechanisms.

KEY-OPERATED LOCK MECHANISMS

How Key-Operated Mechanisms Work

A *key-operated lock mechanism* is simply any type of lock that's opened and closed by inserting and turning a key. (Remember, as we discussed in Study Unit 2, not all locks are opened by a key. Some locks are opened by dialing a number combination, and some contain electrically-operated switches.) However, key-operated locks are the most common and familiar to us. Key-operated locks are found in residential doors, cars, and padlocks.

The four most common types of key-operated lock mechanisms are the *warded mechanism*, the *lever tumbler mechanism*, the *disk tumbler* or *wafer mechanism*, and the *pin tumbler mechanism*. We'll discuss each in turn now.

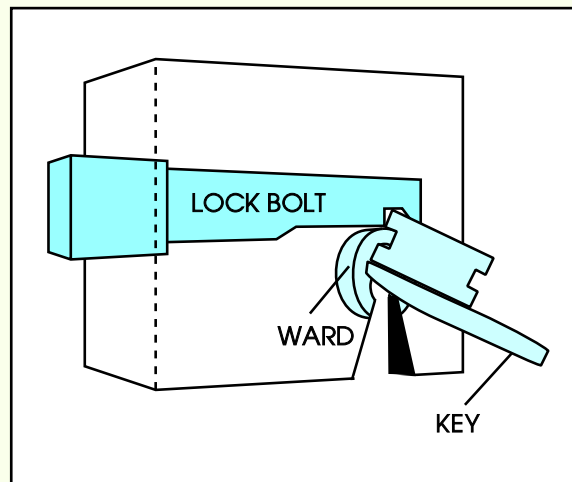
The Warded Mechanism

The word *ward* means *to guard* or *guard against*; thus, we may "ward off" a cold by taking vitamin C (or a bowl of chicken soup). Similarly, a *warden* is a prison guard. In locksmithing terms, a *ward* is a metal barrier inside a lock mechanism that prevents just any key from opening the lock. The ward ensures that only the proper key will engage the mechanism and open the lock. The "right" key contains cuts that exactly match the shape of the wards inside the lock.

The warded lock mechanism is the oldest type still in use today (it was first used by the Romans thousands of years ago). Bit keys and barrel keys are used to open warded door and cabinet locks; flat keys are used to operate warded padlocks.

The basic principle behind the warded lock is *barrier protection*. This means that the wards create a physical barrier that must be overcome before the lock can be opened. The security of the warded mechanism comes from the type and number of wards it contains. A ward is simply a metal ridge inside the lock that creates a barrier to the lock bolt. A properly-cut key will fit around the wards and be free to turn, opening the lock.

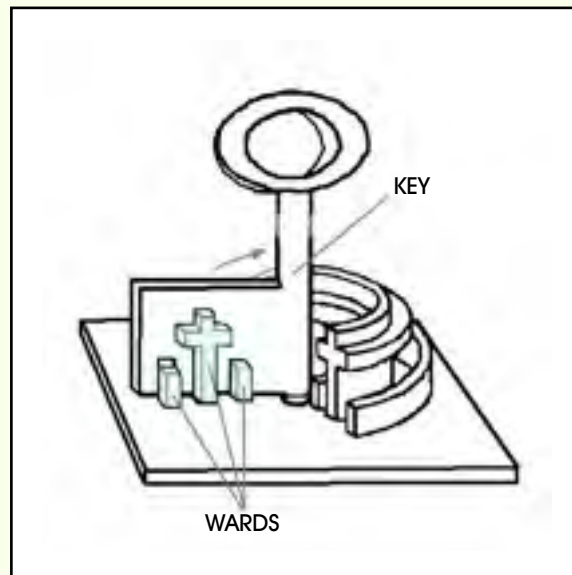
FIGURE 3—This warded mechanism contains two wards.



A warded lock can contain any number of wards. The simplest type contains only one ward and is called a *single-warded lock*. The interior of a simple warded lock is shown in Figure 3. Note that when the key is inserted, the cut corresponds exactly to the place-

ment of the wards. When the proper key enters the keyhole of the unlocked door, negotiates the wards, and is turned, it raises the deadbolt over the obstructions that detain it. The deadbolt enters the strike, and the door is now effectively locked.

FIGURE 4—This complex warded lock contains several wards arranged to provide extra security for the lock. Note the many cuts needed on the key to allow it to clear the wards.

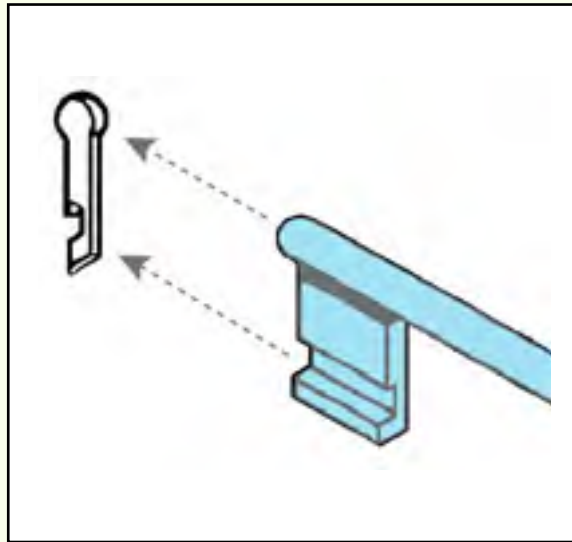


Now look at the lock interior shown in Figure 4. This lock contains several complex wards. The key for this lock was elaborately cut to “clear” the obstructions caused by the wards.

Some locks have wards on the exterior of their keyways. These wards are called

case wards. Case wards add a little security to a lock, since an additional cut must be made on a key just to allow it to slide into the keyway (Figure 5).

FIGURE 5—Case wards in the keyway of a warded lock add a little security.



A *skeleton key* is a key that has been ground down to make it very thin (Figure 6). The wards of a warded lock are easily bypassed using a skeleton key. For this reason, warded locks are not recommended in circumstances where a high degree of security is desired.

Warded Mortise Locks and Warded Rim Locks

The warded door lock in Figure 7B is called a warded *mortise lock*, because it is installed in a recess in a door called a *mortise*. By comparison, the warded *rim lock* in Figure 7A is surface-mounted *on* (rather than *in*) the door.

Figure 8 shows the interior mechanism of a typical warded rim lock. Note that the lock contains *two* bolts: a key-operated *deadbolt* and a latch bolt. The latch is operated by turning the door-knob. The latch fits securely into a strike, the metal plate recessed in the door jamb. When the latch is in place, the door will be held closed, but not locked, since no key is required to move it. When the inside latch

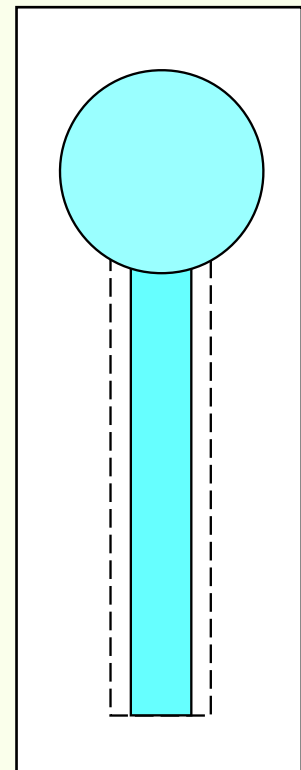
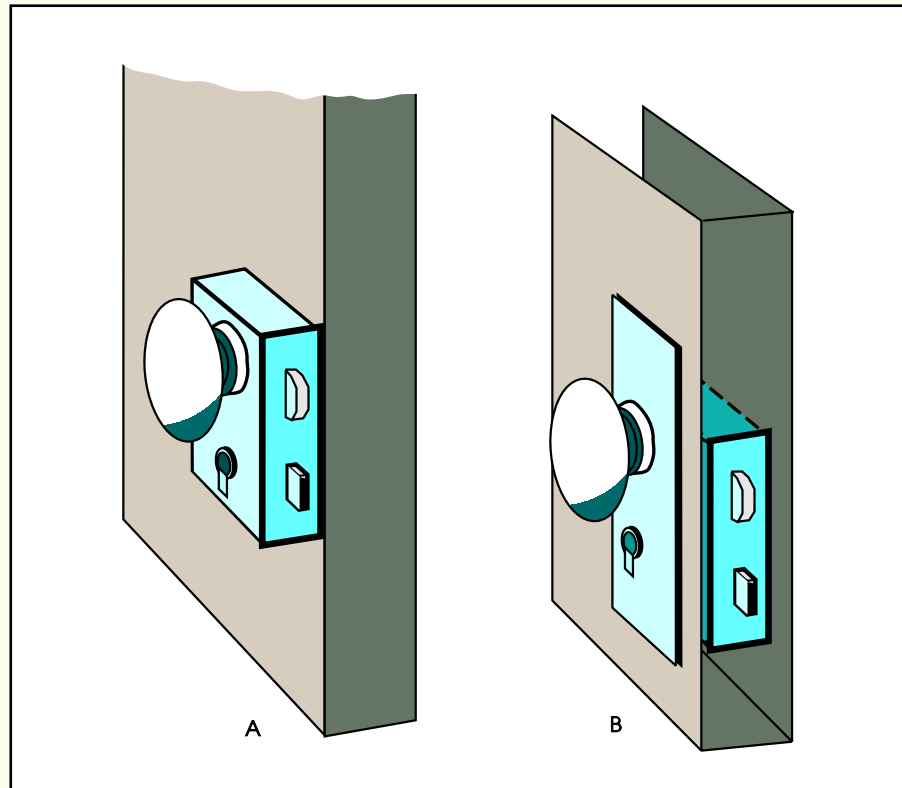


FIGURE 6—A skeleton key is designed to bypass the wards in a warded lock.

FIGURE 7—Part A of this illustration shows a warded rim lock; Part B shows a warded mortise lock.



button is pressed down, though, it does prevent the latch bolt from being released by anyone *outside* the door. The deadbolt is operated by a key or by turning a turnpiece inside the door. The door is truly locked when the deadbolt is thrown.

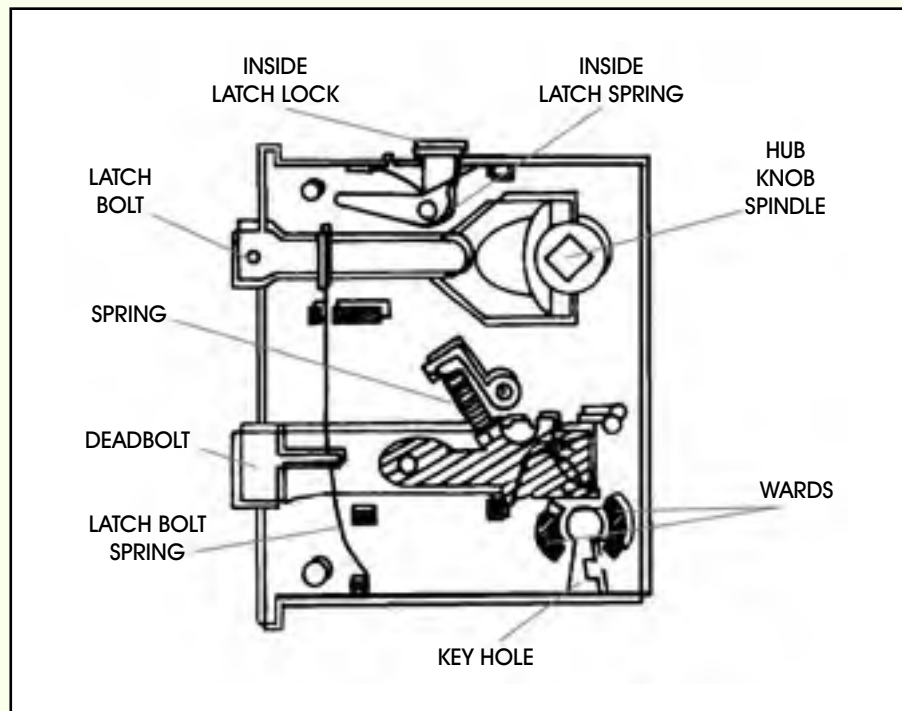


FIGURE 8—Interior of a Warded Rim Lock

Advantages and Disadvantages of the Warded Lock

Warded locks aren't generally used on today's exterior doors. They have been replaced by pin tumbler or disk tumbler locks in most cases. This is because warded locks aren't nearly as secure as pin tumbler locks (which we'll discuss shortly).

Why isn't the warded lock secure enough? Well, a lock's security depends on the following two things:

1. The complexity of its internal mechanism
2. The ease of looking into the lock to see the mechanism

In both of these cases, the warded lock offers little protection. Its mechanism is simple and the keyhole is large enough to view most of the inside of the lock. Because the keyway is so large, it's very simple to look inside the lock, bypass the wards with a pick, and release the locking mechanism to disengage the latch or bolt and open the door.

The simplest method of picking a warded lock is to use a *pick key*. Several pick keys for warded locks are illustrated in

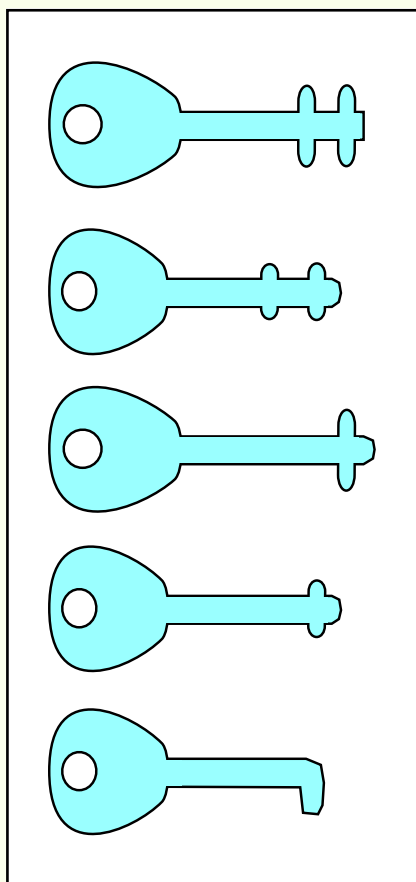


FIGURE 9—Key picks like the ones shown here are useful for opening warded locks.

Figure 9. A pick key is a specially ground and cut piece of flat steel that will fit into the keyway of a lock. A small curved projection is left near the tip of the key pick. The remainder of the key pick is quite narrow. A pick key will open all but a few warded lock types.

As you can see by the variety of ward cuts on these pick keys, it's a simple matter to select a pick key and turn it gently in the lock. If you feel an internal ward interfering with the pick key, you simply stop and try another pick key.

However, despite the relative lack of security in warded locks, note that there are circumstances when the simplicity of the warded lock is an

advantage. For example, warded padlocks are a good choice for use in wet, sandy, or dusty environments where a more complex lock would rust or jam easily.

Cleaning, Lubrication, and Repair of Warded Locks

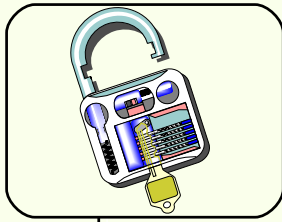
Often, a warded lock will stop working, or will work only with difficulty. Note that while it's usually easier and cheaper to replace a warded lock than repair it, a customer may want an old lock repaired anyway. This is especially true in very old homes where the owner may want to keep the warded lock for its "quaint" appearance.

You may also be called upon to repair small warded locks in antique furniture (chests, cabinets, clocks, trunks, and so on). One good suggestion is to keep any old lock parts and any old bit and barrel keys you can find (at junk shops, yard sales, and so on). Since these parts and keys aren't widely manufactured anymore, keep them on hand for repairs.

One of the most common causes of warded lock failure is the buildup of dust and debris inside the lock. Paint is one of the biggest offenders. Repeated painting of a door over the years can leave a warded lock clogged and can make it impossible to insert or turn the key.

In such a case, you'll need to open up the lock to clean it, lubricate it, or replace worn parts. The warded lock is the easiest to disassemble of all the lock types we'll look at. Simply remove the screws on the cover plate, and the "guts" are exposed. After removing the cover plate, replace any rusted or worn parts. Then, use a wire brush to clean dirt and old paint away from the affected lock parts. Unless absolutely necessary, stay away from commercial paint removers: they tend to attract lint after use.

Next, use a commercial lubricant such as WD-40 (*never* oil; we'll explain why later) to lubricate the lock. You can apply it using the spray assembly attached to the can.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

Fill in the blanks in the following statements.

1. _____ keys and _____ keys are used to open warded door and cabinet locks.
2. A _____ is the assembly of parts inside a lock that makes it work.
3. A _____ contains a mechanism that holds or releases a shackle in the case or shell of the lock.
4. A _____ is simply any type of lock that's opened and closed by inserting and turning a key.
5. The word _____ means *to guard* or *guard against*.
6. Wards on the exterior of the keyway of a lock are called _____.
7. A _____ is a key that has been ground down to bypass the wards in a warded lock.
8. A _____ lock is mounted on the surface of a door.

Check your answers with those on page 53.

The Lever Tumbler Mechanism

Figure 10 shows an exterior view of a typical *lever tumbler* lock. Lever tumbler locks are used on school lockers, cash boxes, suitcases, mailboxes, and safe-deposit boxes. The slim, flat design of the lever tumbler lock is more appropriate for these applications than a cylinder-type lock. Modern lever tumbler locks almost always use *flat keys*, although some European models are operated with bit or barrel keys. The average lever lock is only slightly more secure than the warded lock; however, the lever locks used on safe deposit boxes are very secure.

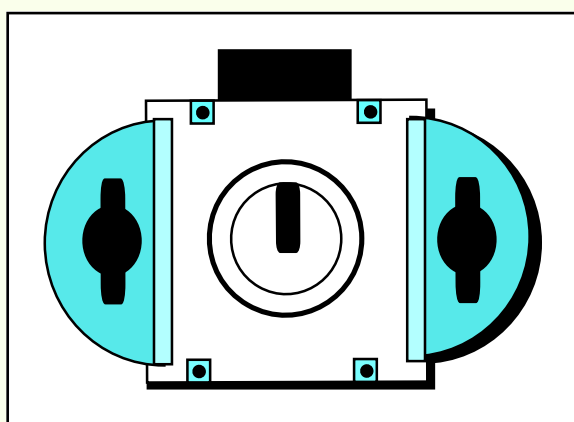


FIGURE 10—A Lever Tumbler Lock

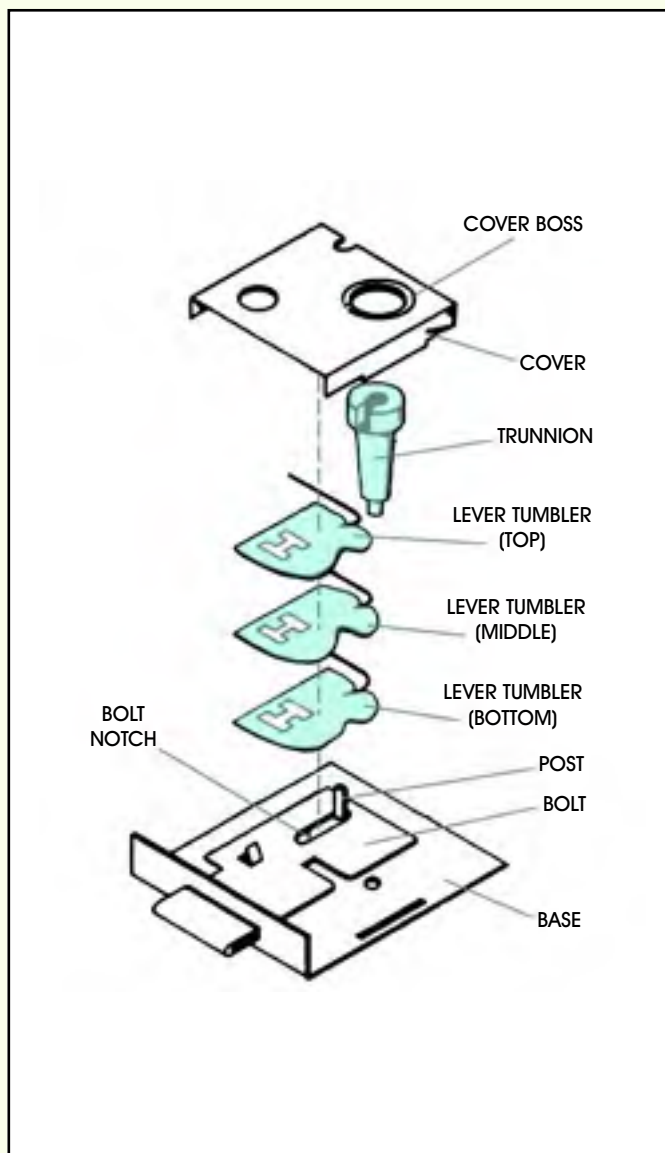
Lever tumbler locks are available in a wide range of security levels. Generally, the lever tumbler locks you will encounter will have between two and five lever tumblers within the lock. Some high-security lever tumbler locks can have

as many as sixteen lever tumblers. (The more tumblers, the more difficult it is to invade the lock.) High-security lever tumbler locks are used on some types of bank safe deposit boxes and on some types of public lockers. In this section on picking lever tumbler locks, we'll look at the medium security lever tumbler locks with two to five lever tumblers.

Now, let's look at the interior of a lever tumbler mechanism (Figure 11) to see how it operates. This lock mechanism contains three lever tumblers. Regardless of the number of tumblers, however, the operation is essentially the same in all lever tumbler locks.

Each lever tumbler is a flat metal plate held in place by spring pressure. Figure 12 shows the parts of one lever tumbler. Taking a close look at these parts will help you understand how the lever tumbler lock operates. The *lever* is the most important part of the lever lock mechanism, since its movement controls the movement of the bolt. Other important components of the lever tumbler lock are the *gate*, the *post*, and the *saddle*.

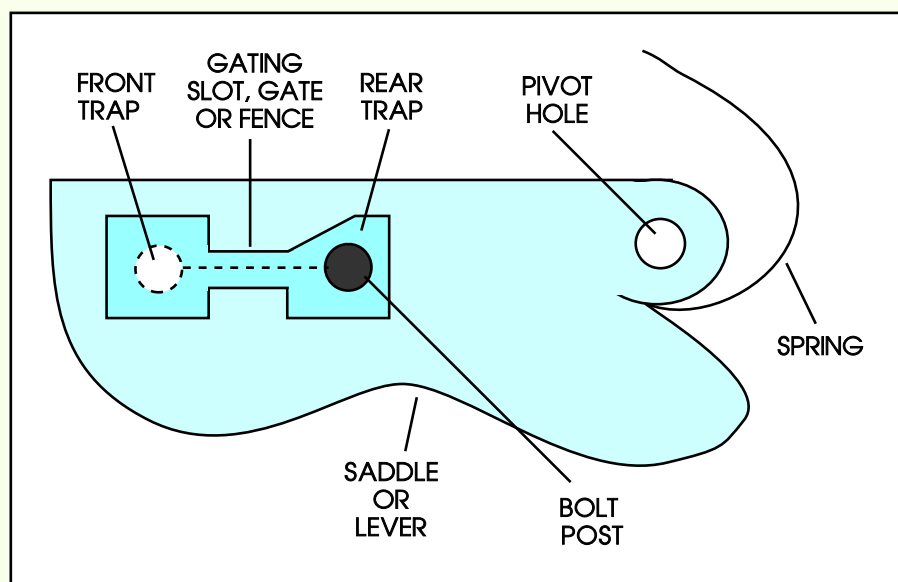
FIGURE 11—This figure shows the interior of a lever tumbler lock mechanism.



The key enters through the *cover boss* and *trunnion*. When the key is inserted, the key's cuts will engage the saddle of each lever tumbler. The saddle must be raised enough to allow the post that is attached to the bolt to slide into the rear trap. When this action occurs, the bolt will slide out of the jamb of the door, opening the door.

In some lever tumbler locks, you may see different colored levers. The color of the lever will identify the trap-to-saddle distance. Also, in some lever tumbler locks, the levers themselves will be of different thicknesses. Here the thicker the lever the greater the distance is between the bottom of the saddle and the center of the trap.

FIGURE 12—This illustration shows the parts of one lever tumbler.



Disassembly and Servicing

Lever tumbler locks that have been riveted or spot-welded are generally very inexpensive, and aren't worth the work required to disassemble and reassemble them. Instead, they should just be replaced. Other types of lever locks can be opened either by removing the cover screws or by prying the cover off, according to how the cover is attached. Carefully remove the trunnion, and then the lever tumblers *in order*. Reassemble by reversing the procedure.

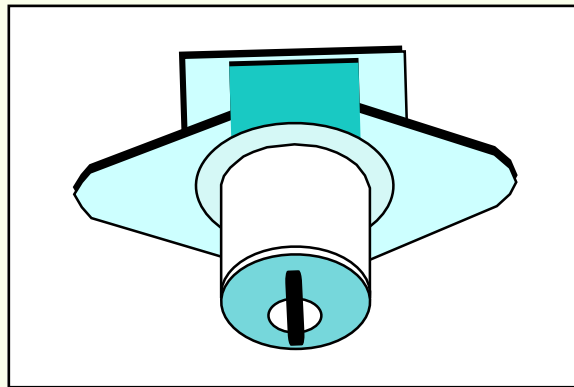
Once the lever tumblers have been removed, the exposed base and bolt can be checked for irregularities. If you find any foreign matter, remove it.

The most probable cause of trouble in a lever tumbler lock is a broken spring. To correct, remove the broken spring from the affected lever and replace it.

The Disk or Wafer Tumbler Mechanism

The disk tumbler mechanism (also called the wafer tumbler mechanism) is commonly used in automobile doors, desks and cabinets, and vending machines. Disk tumbler locks provide much better security than warded or lever tumbler locks. Note that while most disk locks are constructed the same way, their

FIGURE 13—This type of disk tumbler lock is commonly used on desks.

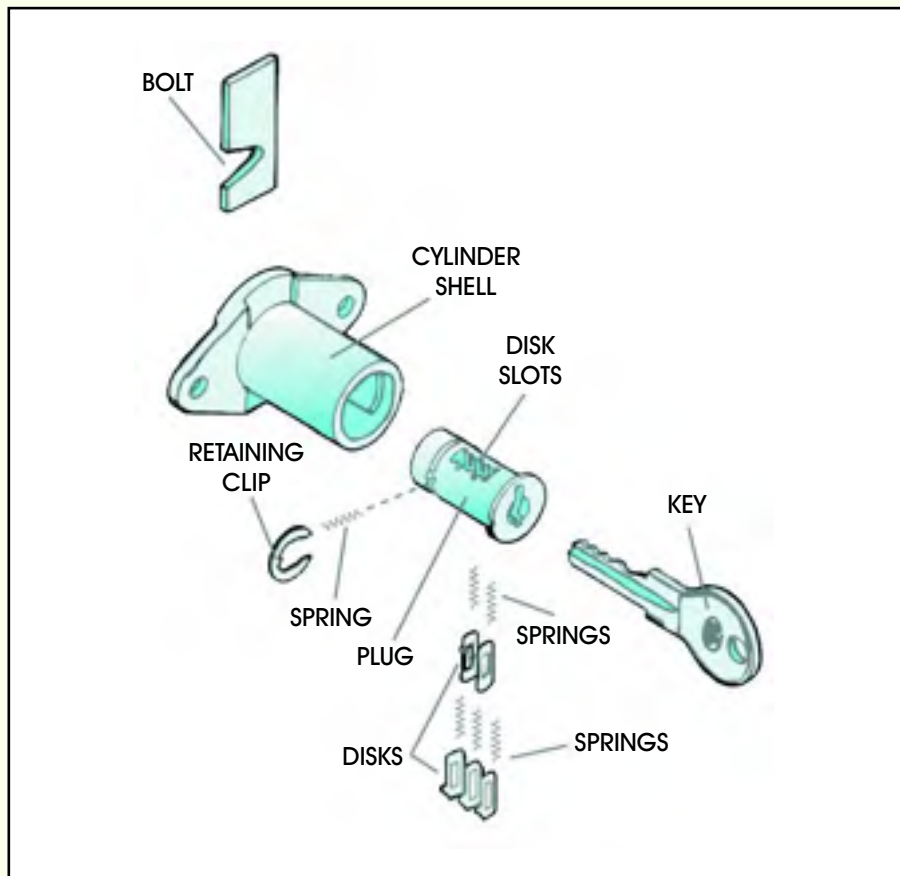


outward appearances may vary depending on what the lock is used for. Figure 13 shows a familiar example of a disk tumbler lock.

Figure 14 is an exploded drawing of the principal parts of a disk tumbler

lock. The main components of a disk tumbler lock are the *shell*, the *plug*, the *disks*, and the *springs*. Let's examine the disks first.

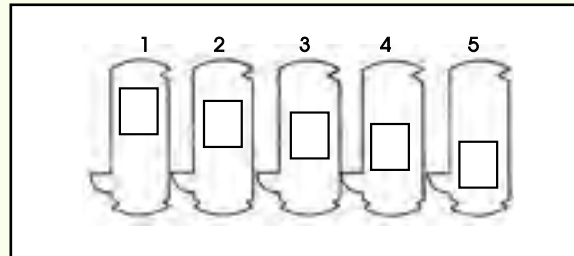
FIGURE 14—Exploded View of a Disk Tumbler Lock Mechanism



When you first think about a disk tumbler or wafer tumbler lock, you may think that the disks within the lock are circular. However, this is not the case. The disks or wafers inside these locks are small, flat, rectangular pieces of steel, each containing a slot or hole. The key will be inserted into these slots to operate the lock.

For most disk locks, the disks come in five different slot arrangements (Figure 15). The location of the slot in each disk will determine the key cut depth needed. In Figure 15, note that the position of the slot in each disk is a little different. The distance from the top of each disk varies. You may also notice that each disk has a number stamped on it. This number identifies the type of disk you're working with.

FIGURE 15—The five different sizes of discs in a disk tumbler lock are shown here.



A disk tumbler lock's *plug* will contain an arrangement of any of these five disks (any one of the disks may appear more than once, as well). While the

five disk tumblers inside the disk tumbler lock plug are the same height and width, the rectangular cuts in the disks vary in terms of their position on the disks. The key has five cuts that correspond exactly to these tumbler cuts. The arrangement of the disks forms each lock's individual combination.

The plug is held inside the shell. The shell contains an upper and a lower slot. The disks or wafers inside the plug "stick out" a little and fit into the lower slot in the shell. The disks or wafers are pressed into the slot by means of small springs. This keeps the plug from turning inside the shell when there's no key in the lock.

The disks are slotted for key entry. When the proper key is inserted into the lock, the disks are pulled away from the slot in

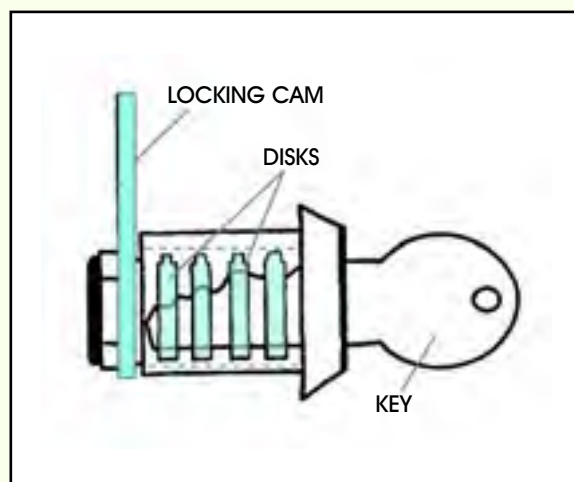


FIGURE 16—This cutaway side view shows a key inserted in a disk tumbler plug. The disks have been pulled into alignment by the key, freeing the plug to turn.

the shell and centered in the plug. This action frees the plug from the shell and allows the plug to turn with the key. Figure 16 shows a view of a key inserted in a disk lock.

If an improperly cut key is inserted into the plug, one or more of the disks

may not be lifted out of the slot in the shell. This action will prevent the plug from turning and the lock from opening.

The Side Bar Wafer Lock Mechanism

A *side bar wafer lock* is a variation of the disk tumbler lock. Side bar wafer locks provide a greater degree of security than simple disk tumbler locks because they're extremely difficult to pick. Side bar wafer locks will make up a large amount of your locksmithing work. This is because they're inexpensive, and also because they're widely used for ignition, door, and trunk or rear hatch locks for General Motors automobiles and light trucks.

The five types of wafers that you might find inside a side bar wafer lock are shown in Figure 17. The disks in a side bar wafer lock are much like those in a standard disk tumbler lock, but with one change: each disk (or wafer) has a V-shaped notch on one side. These wafers may be identified by a number (one through five) stamped on the wafer. These numbers refer to the heights of the position of the V-shaped notch.

You'll remember from our previous discussion that a regular disk lock opens when the disks disengage from a slot in the shell, allowing the plug to turn. In contrast, in a side bar wafer lock, the disks release a *side bar* that disengages from a slot in the shell.

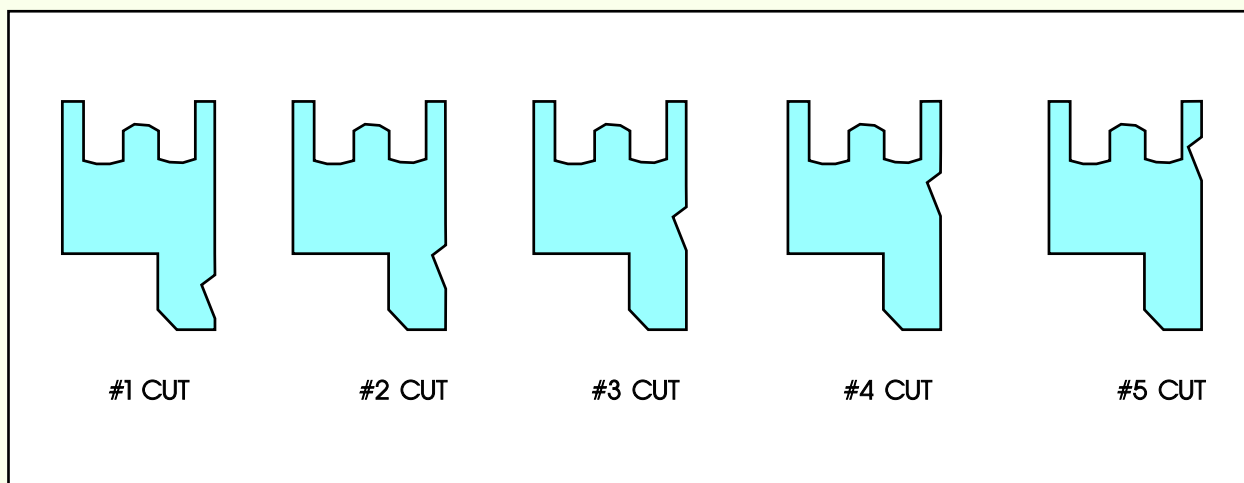
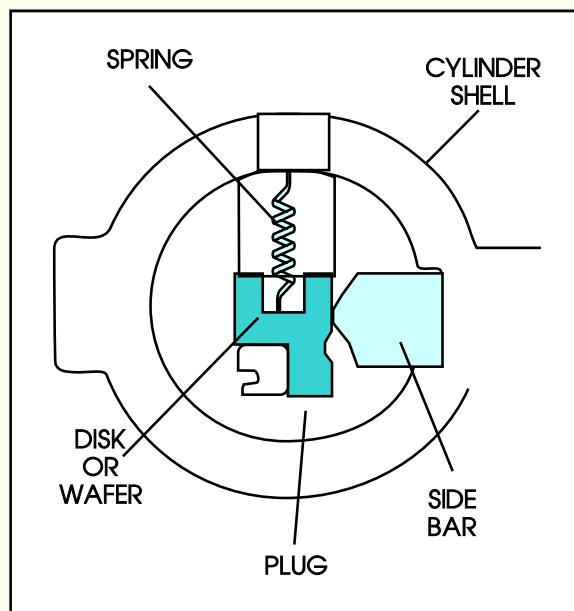


FIGURE 17—This figure shows the five types of wafers or disks you'll see inside a side bar wafer lock. Note the V-shaped notches in the sides of the wafers.

FIGURE 18—In this cutaway view of a side bar wafer lock, you can see how the disks must be aligned to allow the side bar to disengage from the shell.



When the side bar wafer mechanism is locked, the side bar extends into a special slot inside the shell; as a result, the plug is held securely in place. As the key enters the plug, the key pushes the disks upward, causing the side bar to fall into the group of V-shaped notches on the side of the disks. The side bar is now clear of the

slot, and the plug is free to turn with the key. The disks can only be aligned by the proper key. The operation of a typical side bar wafer arrangement is shown in Figure 18.

The Cam Lock Mechanism

One variation of the disk tumbler mechanism is the *cam lock* shown in Figure 19. Cam locks are used extensively on cabinet doors and desk drawers.

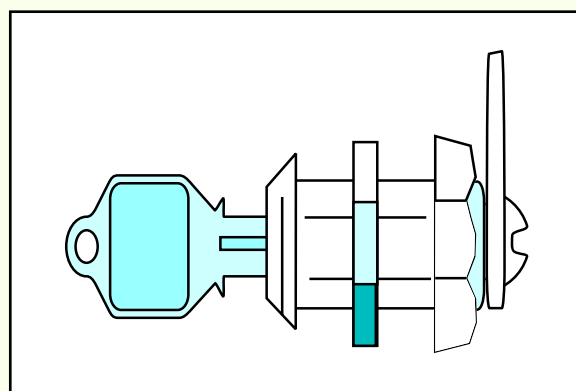


FIGURE 19—This illustration shows a typical cam lock.

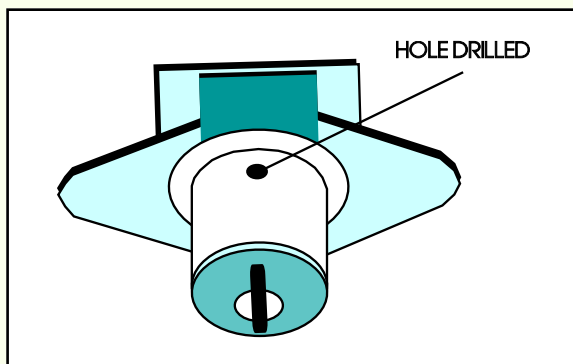
In this kind of lock, a moveable *cam* is attached to the rear of the lock. The cam is a flat piece of metal that rotates when the key is turned in the lock. The cam creates a physical barrier that prevents a door or drawer from being pulled open.

When the cam is turned into the “lock” position, the cam will hold the door or drawer in place. When the cam is turned to the “unlock” position, the door or drawer will be free to open.

Disassembly

Disk locks may need to be disassembled for cleaning, repair, or rekeying. Some disk tumbler locks are easy to take apart, others are not; it depends on the method used to hold the plug inside the shell. Some plugs are held with a screw-in retaining plate; others must be drilled to access the internal retaining clip.

FIGURE 20—A hole has been drilled in this disk tumbler lock to allow access to the retaining clip.



In the lock shown in Figure 20, a hole has been drilled in the shell to allow access to the retaining clip that holds the plug in place. On some disk tumbler locks, this hole may already be present.

To remove the plug from such a lock, insert a small tool such as a lock pick or thin awl into the drilled hole. By applying pressure, the retaining clip for the plug can be compressed. With the key located in the plug, turn the plug slowly while pulling outward. The plug should slide from the shell.

Once the plug is removed, you can begin removing the disks. The disks may lift right out, or they may need to be “pinched” to allow removal, depending on the type of lock. As each disk is removed from the lock, place it in order in a pin tray or other small container. To reassemble the lock, reload the disks into the plug. Then insert the plug into the shell, applying only as much pressure as is necessary for the end of the plug to engage the retainer clip.

Disassembling a Side Bar Wafer Lock. Since most side bar wafer locks are found in cars, you’ll need to remove it from the vehicle before you can disassemble the lock itself. In general, ignition and trunk locks are removed by driving out a retaining pin to release the lock shell. In a door lock, a special retaining clip may be used to hold the lock shell. (We’ll discuss the exact details on removing locks from automobiles in a later study unit. If you want more information now, you can consult any automotive service manual.)

To disassemble this type of lock, you will have to remove the spring and disk retainer cover. Pry upwards on the cover with

a small screwdriver and it will come free of the shell. (*Note:* Very often, this cover will be bent or distorted upon removal and require replacement after you have moved the discs. These covers are available through locksmith suppliers.)

With the cover removed, begin lifting the six internal springs from the lock with a pair of tweezers. Place these springs in your pin tray or other container.

If you were disassembling the lock for the purpose of rekeying, you would now lift the disks out of the plug and replace them as needed. Replace the springs and then insert a new spring retainer cover into the shell.

Disassembling a Cam Lock. To disassemble a cam lock, remove the nut, lock washer, and cam from the back of the lock. The core can now be pushed out with finger pressure, or eased out using the key.

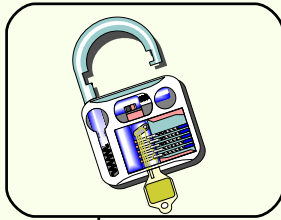
Cleaning and Lubricating

If a disk or spring has broken inside a disk tumbler lock, the lock is sometimes replaced. This is because it can be cheaper to replace a malfunctioning disk tumbler lock than to repair it. However, in many cases, a thorough cleaning and lubrication can quickly and easily correct many lock problems.

One of the first things to check when a disk tumbler lock fails is the key. When a key gets very worn, it may not lift the disks to the proper height, keeping the plug from turning. Often when a key is excessively worn, cutting a new key will correct the problem.

Many disk tumbler locks fail due to dirt or lack of lubrication (particularly car locks, which are constantly exposed to the elements). Disk tumbler plugs can be cleaned in a safe and non-flammable solvent. Spray solvents and other types of cleaning solutions are available from locksmith supply houses and hardware stores. If you wish, you can also use electrical spray cleaners such as those used on volume controls and other electronic components. A good cleaning solution should flush any dirt and dust from the lock.

It's a good idea to lightly lubricate the lock with a commercial lubricant after cleaning. Never use oil, grease, or any type of mineral- or paraffin-base lubricants. These types of lubricants will collect dust and dirt over time, and eventually turn into a paste inside the lock. This paste will cause the lock to malfunction.



Locking It Up! 2

Indicate whether each of the following statements is True or False.

- ___ 1. Modern lever tumbler locks almost always use bit keys.
- ___ 2. The disk tumbler mechanism is also called the wafer tumbler mechanism.
- ___ 3. A disk tumbler lock's springs typically contain an arrangement of five disks.
- ___ 4. Lever lock mechanisms are commonly used as ignition, door, and trunk or rear hatch locks for General Motors automobiles and light trucks.
- ___ 5. When the side bar wafer lock mechanism is locked, the side bar extends into a special slot inside the shell; as a result, the plug is held securely in place.
- ___ 6. Cam locks are used extensively on home entry doors and car ignitions.
- ___ 7. All disk tumbler locks are easy to take apart.
- ___ 8. It's generally cheaper to replace a malfunctioning disk tumbler lock than to repair it.
- ___ 9. In a disk tumbler lock, the rectangular cuts in the disks are always in the same position.
- ___ 10. Disk tumbler locks are seldom used today.

Check your answers with those on page 53.

The Pin Tumbler Mechanism

The *pin tumbler lock* is the most secure and widely used lock today. This type of lock is very popular in home entry locks, padlocks, and other types of locking devices.

A pin tumbler mechanism is contained within a device called a *cylinder*. Pin tumbler cylinders can be installed in a variety of products: in a door knob, in a door surface, or in a car ignition. While each of these locks functions differently from the outside, the pin tumbler cylinder itself always works the same way. Pin tumbler lock mechanisms are always operated with cylinder keys.

Construction

A pin tumbler cylinder contains the following parts: the plug, the keyway, the top pins, the bottom pins, and the springs. Let's start our discussion by examining these parts.

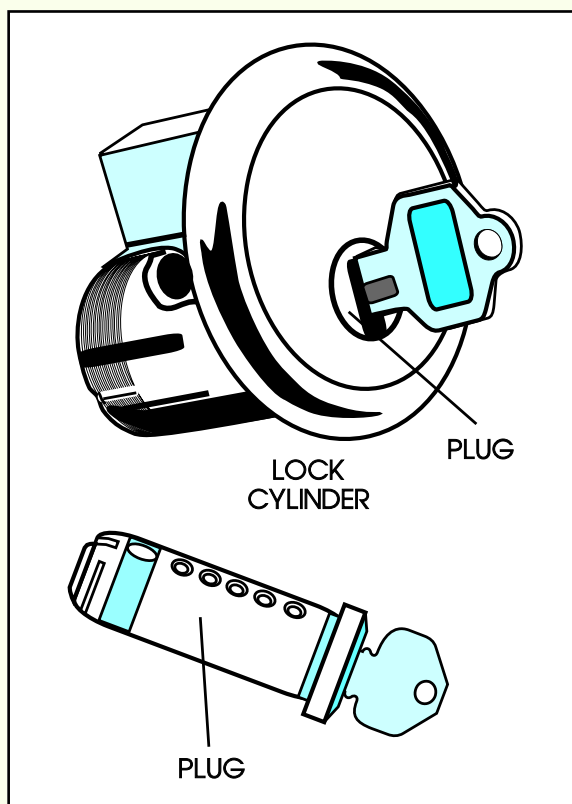
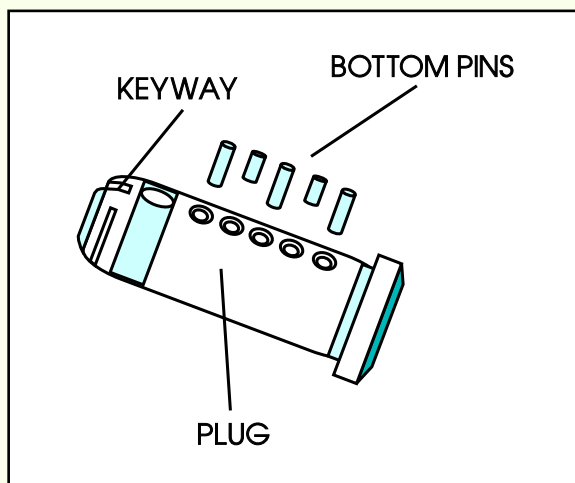


FIGURE 21—Exterior View of a Pin Tumbler Cylinder and Plug

Figure 21 shows an exterior view of a pin tumbler cylinder and a plug. The cylinder is the rounded shell that surrounds and holds the plug, which is the central assembly of the mechanism. The plug is a small “tube” that contains the *bottom pins* (Figure 22). Note the five holes that were drilled along the length of the plug, each containing a bottom pin. (Many pin tumbler mechanisms contain five pins, but

there are six- and even seven-pin arrangements.) The keyway is the opening in the plug that allows a key to be inserted.

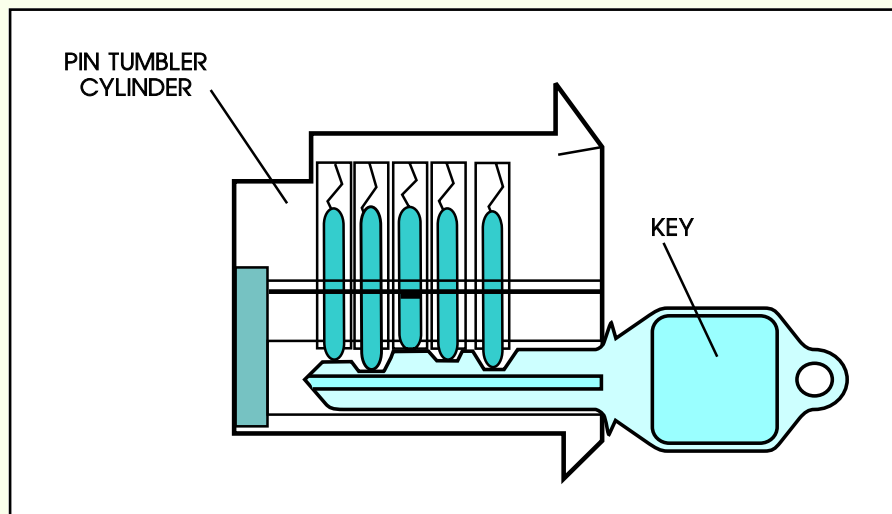
FIGURE 22—Plug and Bottom Pins



Now look at Figure 23, which shows an interior view of a pin tumbler cylinder. The visible components of the pin tumbler lock are the plug and the cylinder. This view also shows the internal components: the bottom pins, the top pins, and the springs.

Note the placement of the plug inside the cylinder. Inside the cylinder, directly above the five holes in the plug, are five more drilled holes, each containing a *top pin*. Above each top pin is a small metal spring. The *spring retainer* exerts pressure on the springs and the top pins to keep them inside the cylinder. The top pins in turn press down on the bottom pins.

FIGURE 23—Here is an interior view of a typical pin tumbler lock.



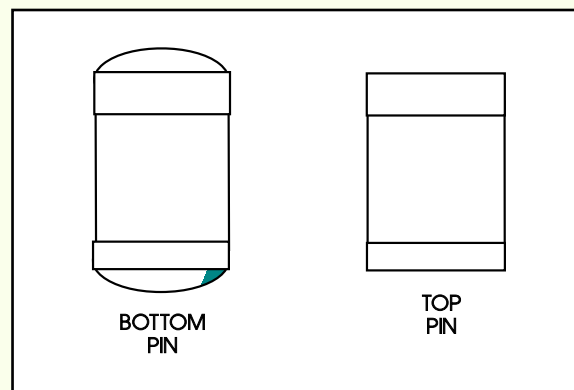
Notice that when there is no key in the plug, the top pins rest halfway between the plug and the cylinder, preventing the plug from rotating inside the cylinder. The plug is “locked” into place.

Pins and Key Cut Depths

To the average person, a *pin* may be a piece of jewelry or something to knock over in a bowling alley. To a locksmith, however, pins are very important lock components, since the movement of the pins controls the turning of the lock plug.

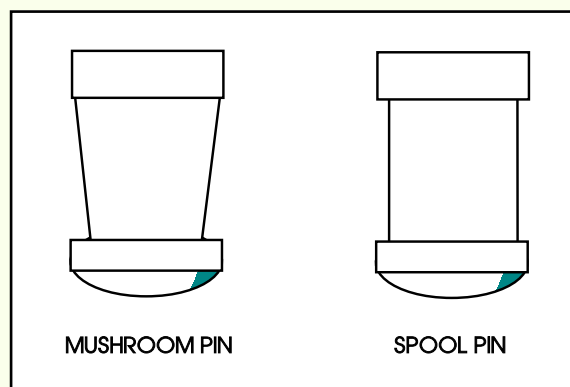
Figure 24 shows an enlarged view of a top pin and bottom pin. A top pin is flat on both ends. A bottom pin, however, is slightly “rounded” at the end to make the insertion of a key smoother.

FIGURE 24—Top Pin and Bottom Pin for a Pin Tumbler Lock



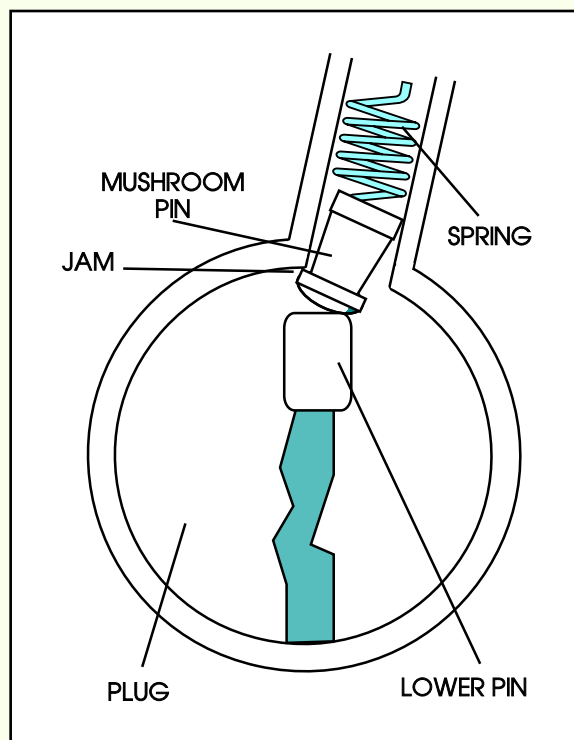
Some pin tumbler locks contain pins that make the lock harder to pick. *Anti-pick pins* are specially formed to jam inside the lock if someone tries to move them with a lockpicking tool. These pins are shaped like mushrooms or spools (Figure 25).

FIGURE 25—Anti-Pick Pins



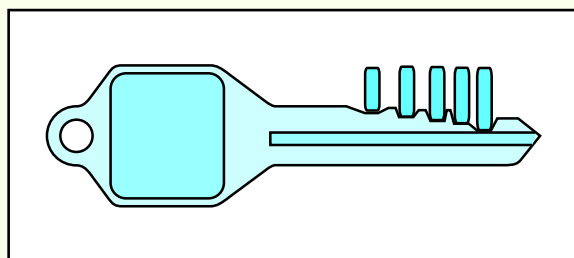
If you attempt to move anti-pick pins with a lockpick, they’ll jam between the plug and the cylinder (Figure 26).

FIGURE 26—If you attempt to lift an anti-pick pin with a lockpicking tool, the pin will jam between the plug and the cylinder.



In a pin tumbler mechanism, the length of the top pins is always the same, but the bottom pins vary in length. The length of the bottom pins must correspond exactly to the depth of the cuts in the key (Figure 27). The deeper the cut in the key, the longer the pin.

FIGURE 27—The bottom pins in a pin tumbler lock must correspond exactly to the cut depths in the key.



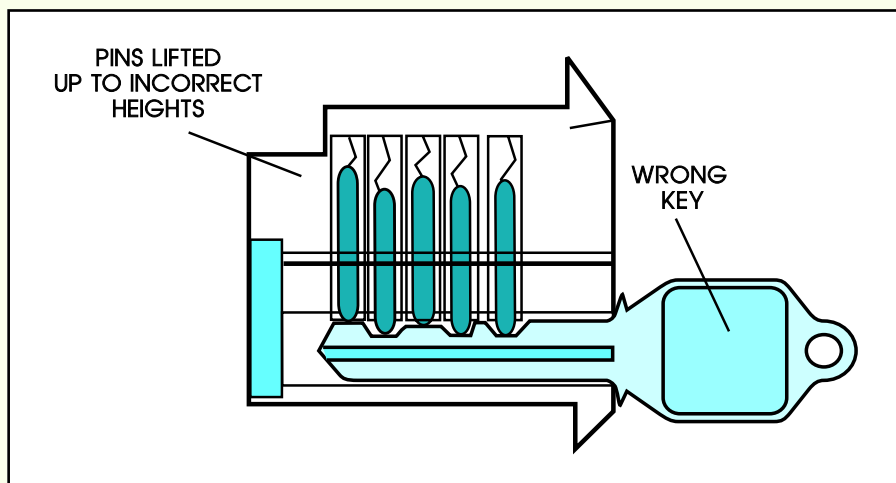
Operation

To open the pin tumbler mechanism, we need to move the bottom pins upward so that they align with the top pins. When the correct key is inserted into the plug, the bottom pins are lifted. The bottom pins press against the top pins, forcing them up into the cylinder. The bottom pins and the top pins will then line up exactly at the *shearline*. The shearline is the straight line formed between the top pins and bottom pins.

When the top and bottom pins have been aligned exactly at the shearline, the shearline is free of obstructions, and the key can be turned. When the key is turned, the plug will turn freely with it, allowing the lock to open. (Note that a very thin space exists between the plug and the cylinder. This is because if the plug were held too tightly in the cylinder, it couldn't turn to open the lock.) Refer back to Figure 23 for a visual aid to understanding this process.

Now, if the wrong key is inserted in this lock (Figure 28) the pins *would not* line up exactly at the shearline. Some of the top pins will be above the shearline, and some will be below it. This misplacement of the pins will keep the plug from turning inside the cylinder.

FIGURE 28—The wrong key was inserted in this lock, causing the pins to be misaligned at the shearline; the plug isn't free to turn.



Disassembly

Has it crossed your mind that you could make a “wrong key” fit in the lock simply by changing the heights of the bottom pins? Or, you could switch the locations of the bottom pins. If so, you’re starting to think like a locksmith! This is exactly what a locksmith does to *rekey* a lock. By changing the heights and placement of pins in the lock plug, the locksmith can make a different key operate the lock.

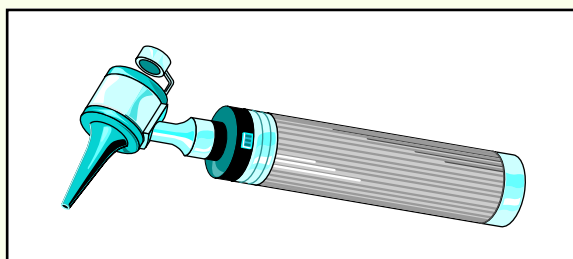
What kinds of repairs are made on a pin tumbler lock? All kinds! The pin tumbler mechanism is generally more expensive than other lock mechanisms, and it's also relatively easy to disassemble and repair. For these reasons, pin tumbler mechanisms are often repaired instead of replaced.

Typical problems with a pin tumbler lock include worn pins and worn or broken springs. Because the pin tumbler mechanism is more complex than the other mechanisms we've discussed, it's more vulnerable to dirt and grime. The small parts in a pin tumbler lock can easily "freeze up" from a buildup of dirt or a lack of lubrication. In addition, under the right weather conditions, a pin tumbler door lock can freeze from moisture intrusion or corrosion.

To perform repairs on a lock or to rekey it, you'll need to disassemble the lock. While there are many different types and sizes of pin tumbler locks, there are some general disassembly techniques that can be applied to most. (Consult the lock manufacturer's instructions for guidance whenever they're available.) Let's start by looking at a typical pin tumbler door lock.

Before you begin, note that a bright light is useful for viewing the inside of pin tumbler locks. Many locksmiths use lights called *otoscopes* to look into locks (Figure 29). (The otoscope is the same tool that a physician uses to look inside patients' ears and throats.) This light uses a halogen bulb and lens to concentrate an extremely bright beam of light into the keyway of the lock being picked.

FIGURE 29—Many locksmiths use an otoscope to view the insides of locks.



Some pin tumbler door locks are made with a *spring retainer*. The spring retainer is a small, rectangular metal cover that fits over the holes where the pins and springs are dropped into a lock plug. If the spring retainer is removed, you can gain access to the springs and the pins beneath them.

To disassemble such a lock, simply remove the spring retainer (you may need to use a pliers to "pinch" the retainer to remove it). Next, block all but one hole in the cylinder, and dump out the top and bottom pin from the one open hole. Continue this operation until all pins are removed from the lock. Set the pins in a pin tray for storage while you work on the lock. Keep the

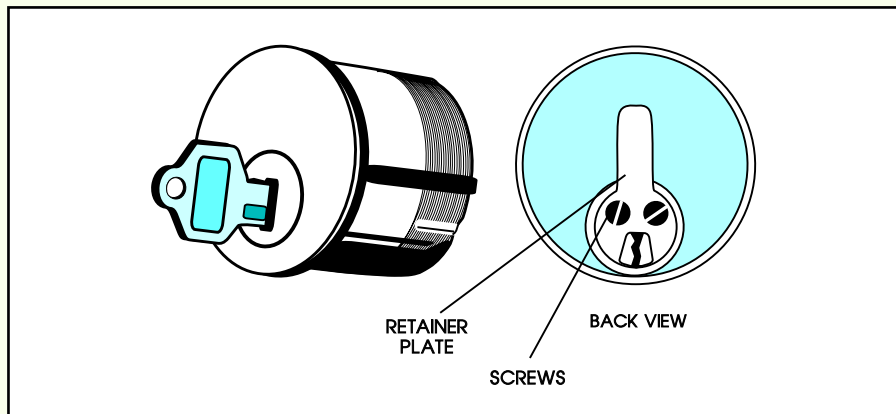
top pins together, and keep the bottom pins in the same order in which you took them out of the lock.

To reassemble the lock, replace the bottom pins in order into the plug holes. Then, replace the top pins, springs, and spring retainer. If the spring retainer was damaged during removal, replace it with a new one.

Now, let's look at a different method of disassembling a pin tumbler cylinder. Since most pin tumbler locks don't contain spring retainers, it will be necessary to use this second method in most cases.

Let's examine a pin tumbler *mortise cylinder* (Figure 30). (You may remember from an earlier study unit that a mortise cylinder is installed directly in the surface of a door.) This type of lock doesn't have a spring retainer. In order to gain access to the pins and springs inside the mechanism, it will be necessary to remove the plug from the cylinder. To remove the plug, the *retainer plate* must be removed first. The plug retainer plate is held by two small machine screws.

FIGURE 30—In this pin tumbler mortise cylinder, the plug can be removed after two screws are unscrewed from the shell, releasing the retainer plate.

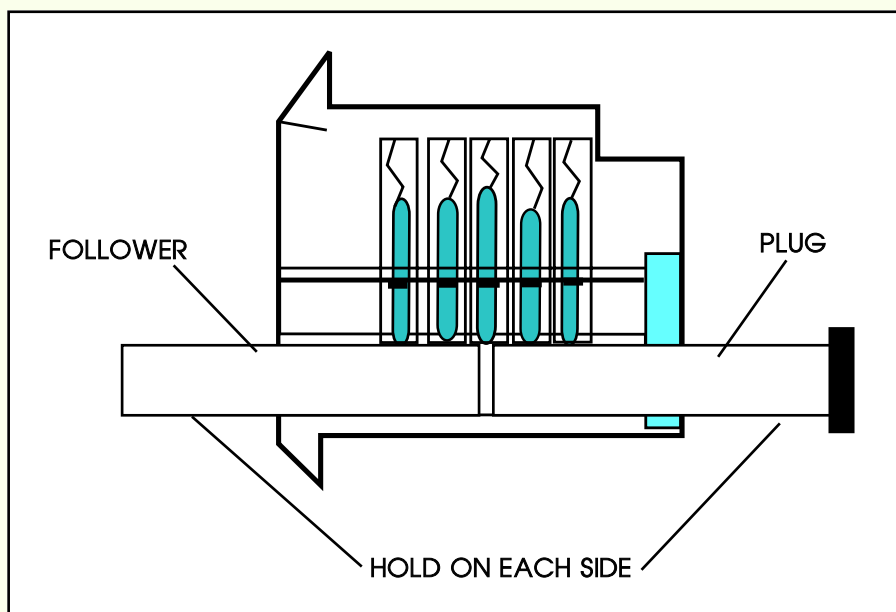


Remove the retainer plate using a small screwdriver. Now, once the retainer plate has been removed, you *could* simply insert the key, turn it one-quarter of a turn, and withdraw the plug from the lock cylinder. **BUT WAIT!** If you do that, all the top pins and springs will pop free of the lock! And, while these pins and springs *can* be replaced with a tweezers, it's not an easy job!

For this reason, the proper way to remove the plug is to use a *plug follower*. A plug follower is a wood, metal, or plastic dowel that holds the top pins and springs in place in the cylinder when you withdraw the plug. To use the follower,

simply insert the key to its full depth and turn it one-quarter of a turn. Now, place the end of the follower at the rear of the plug. Gently withdraw the plug, *and at the same time*, push in the follower. The follower will take the place of the plug while you're working on the bottom pins. The use of a plug follower is shown in Figure 31.

FIGURE 31—To properly remove a lock plug from a mortise cylinder, place a plug follower against the plug and push the plug from the shell.



With the plug out of the cylinder, the bottom pins can now be removed from the plug. Tip the plug slightly, and carefully remove the bottom pins *in order* with a tweezers. Deposit the pins in a pin tray *in order*. If you're only cleaning or lubricating the lock, you *must* return the bottom pins to their original positions in the plug; otherwise, the key won't open the lock when you put it back together! If the lock is being rekeyed, you can change the positions of the bottom pins, or replace them as necessary.

To reassemble the lock, your first task is to test the arrangement of the bottom pins in the plug. With the plug still out of the cylinder, insert the key into the plug. Check to make sure that the bottom pins are all lifted *exactly to the shearline*. If any pins fall below or stick out above the shearline, you've made an error somewhere. Rearrange the pins as necessary to get them back to their original order!

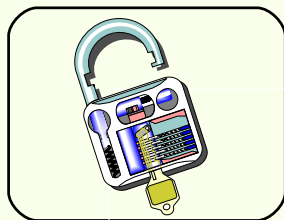
This is a very important step. If you *have* made a mistake in replacing the bottom pins, and you replace the plug in the cylinder without first checking the key, the plug could lock itself inside the cylinder. Once this happens, the original key will no longer work, and you won't be able to remove the plug again to

change the bottom pins! One option is to try to pick the lock to get it open again, which is extremely time consuming. Another option is to shim the cylinder open using a piece of shim stock. In most cases, this is faster. *Always remember to test the plug before you put it back in the cylinder!*

Once you've made sure that the key still works, you're ready to reassemble the lock cylinder. The plug is reinserted from the front of the cylinder. Place the end of the plug at the front of the cylinder so that it touches the plug follower. Then, gently press the plug into the cylinder, and *at the same time*, carefully withdraw the follower. The pins should be at a 45 degree angle to the top pins so the cylinder goes in more easily.

Servicing, Cleaning, and Repair

The disassembled parts of a pin tumbler lock may be cleaned with an application of WD-40 or a similar silicon-based solvent. In many cases, a spray cleaner (the kind used on electronic parts and components) can be used to remove dirt and grime. The parts may then be lightly lubricated with WD-40 and replaced in the lock. Never over-lubricate the parts before reassembly.



Locking It Up! 3

Indicate which of the following are True or False.

- ___ 1. A pin tumbler lock requires a special barrel key to open it.
- ___ 2. The top pins in a pin tumbler lock are all different sizes.
- ___ 3. The bottom pins in a pin tumbler lock are the same size.
- ___ 4. A plug follower is a tool used to clean a pin tumbler lock.
- ___ 5. Pin tumbler lock mechanisms can only be used in padlocks.
- ___ 6. The main parts of a pin tumbler lock are the cylinder, the plug, the top pins, the bottom pins, and the lever tumblers.
- ___ 7. The pin tumbler lock is rapidly being replaced by the warded lock.
- ___ 8. A pin tumbler lock can't be opened with a key until all the pins have been aligned along the shearline.

Check your answers with those on page 53.

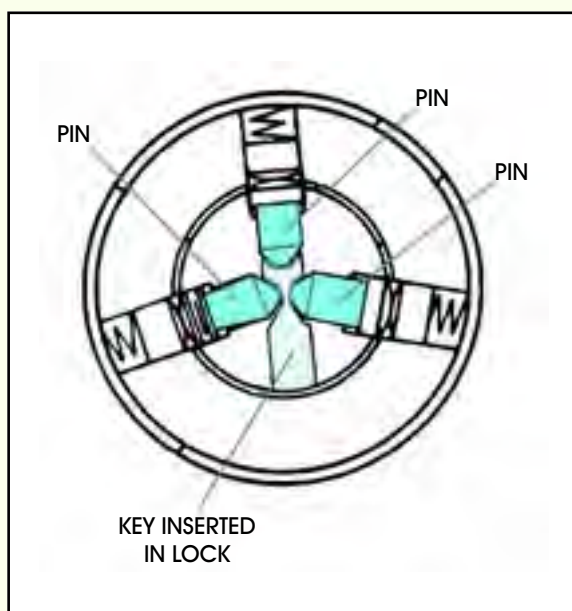
High-Security Lock Mechanisms

The term *high-security lock* can refer to any one of a variety of locking devices. High-security locks contain mechanisms that make them especially resistant to picking and forced entry. A number of lock manufacturers include a high-security line in their catalogs. Medeco Security Locks, Lori Corporation (Kaba), and Schlage Lock Company are among the best-known of the many manufacturers that do so.

Most of the high-security locks manufactured by these companies contain pin tumbler mechanisms. As such, they function basically in the same fashion as any pin tumbler lock; a key enters the plug and elevates pins of various heights to the shearline, after which the lock can be opened.

However, in a high-security lock, the pin tumbler mechanism is much more complex than in an ordinary lock. It usually

FIGURE 32—This high-security lock contains three sets of pins.



contains two or more sets of top and bottom pins. For example, in the Kaba Gemini brand high-security mechanism, the lock plug holds three sets of pins. The pins enter the lock cylinder at an angle, and the key must be specially cut to accept the pins at that angle. Figure 32 shows an end view of this type of mechanism.

Note the three sets of pins and the angled depressions needed in the key to make it fit in the lock. Figure 33 shows an exploded view of the lock plug. Note how the pins and springs are inserted into the plug.

Now, let's look at some other special features manufacturers put into their high-security locks.

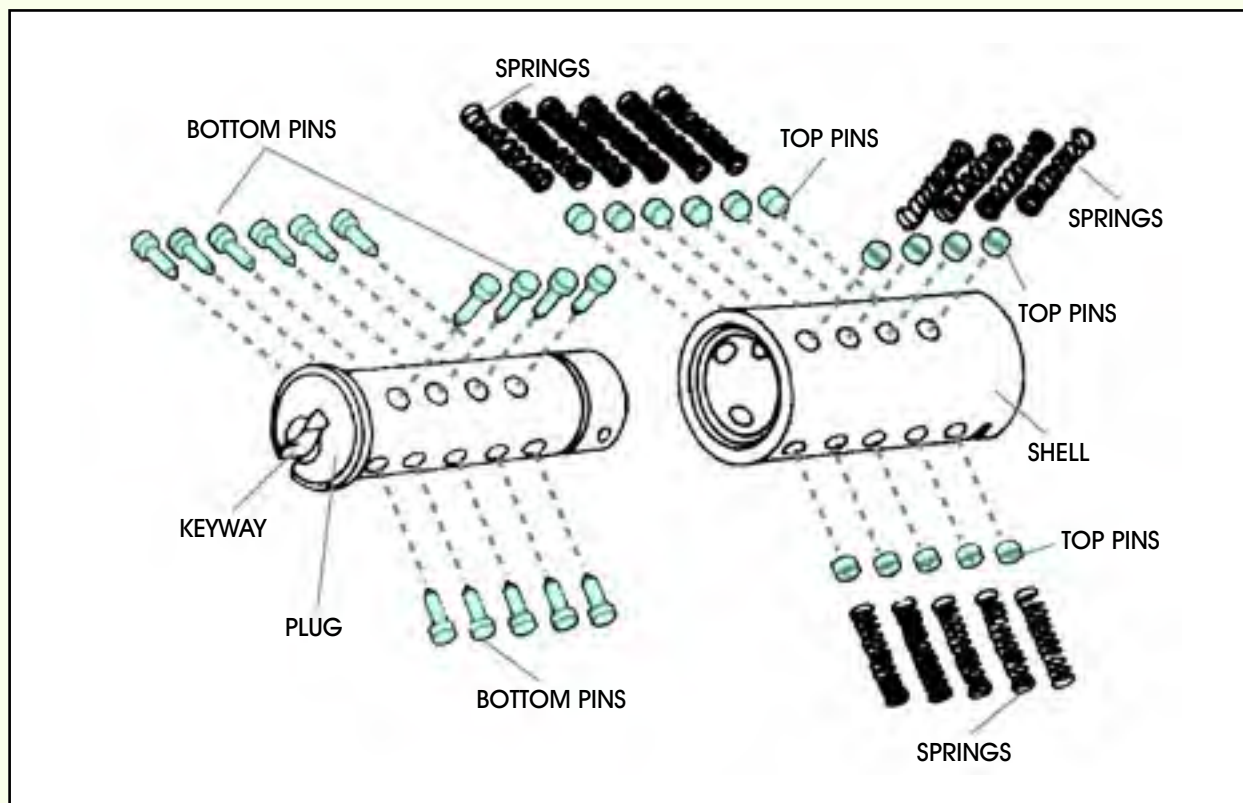
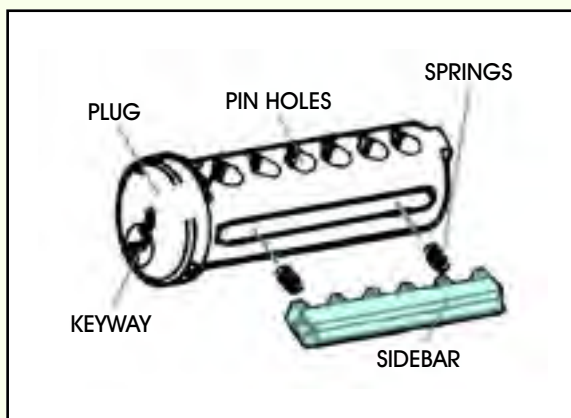


FIGURE 33—This illustration shows an exploded view of a high-security lock plug.

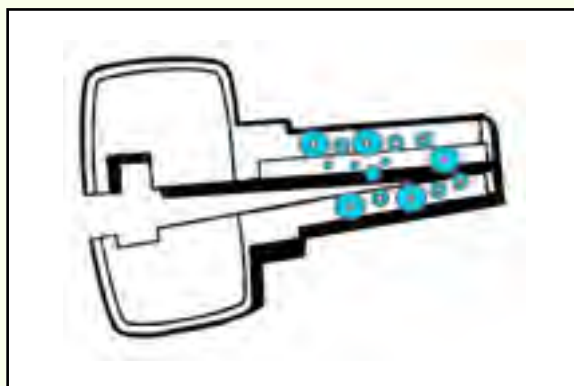
Sidebars. Medeco brand high-security locks incorporate a sidebar into the lock plug to increase security. As Figure 34 shows, the sidebar has five “legs” that correspond to five vertical slots on the facing bottom pins. When the proper key is inserted, the pins are raised to the shearline and also rotated so that the legs of the sidebar slide into the slots of the lower pins. This double action allows the plug to turn.

FIGURE 34—This type of mechanism uses a sidebar in the plug to add security.



Split Keys. Some manufacturers provide a security option with their locks known as the *split key* (Figure 35). Two people are required to open the lock—each is given half of the key. When two people are needed to open a lock, unwanted single-party access to the lock is effectively ruled out.

FIGURE 35—A split key requires two people to operate it.



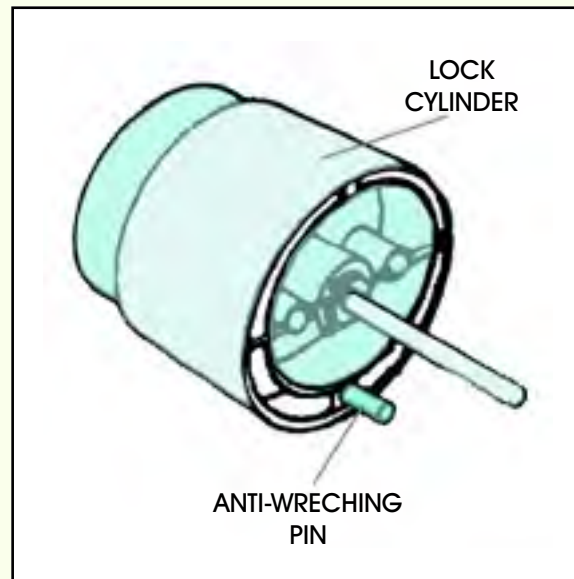
Multiple Locking Mechanisms. The Schlage company manufactures a high-security lock (the *Primus*) that contains two pin tumbler mechanisms inside. Both mechanisms are operated simultaneously by one key. However, the patented key is specially cut to operate both mechanisms. The key contains two rows of bitting (Figure 36).

FIGURE 36—This Schlage Primus key contains two rows of bitting to operate the two mechanisms inside the lock.



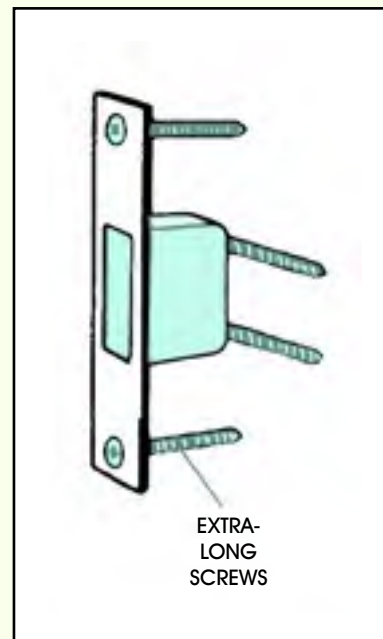
Anti-Wrenching Pins. Some lock manufacturers install *anti-wrenching pins* in their locksets (Figure 37). An anti-wrenching pin acts as an anchor embedded in the door, resisting attempts to wrench the cylinder loose.

FIGURE 37—An anti-wrenching pin anchors a lock cylinder to a door, preventing it from being wrenched or pried loose.



High-Security Strikes. One of the most popular methods of forcing entry to a home is kicking in the door. Unless the door is unusually thick or strong, the wood of the door will usually splinter around the lock and allow the burglar to get in. To prevent this, a high-security strike has extra-long screws that add strength to the door frame, making it very difficult to kick in a door.

FIGURE 38—A high-security strike has extra-long screws that add strength to the door frame.



Interchangeable Cores

Interchangeable or *removable cores* are specially-designed lock cylinders that can be removed from a door lockset without disassembling the lock or door knob. An interchangeable core is shown in Figure 39. They can easily be removed and rekeyed using a special key called a *control key*. To remove the core, the control key is inserted and turned, and the core is then withdrawn.

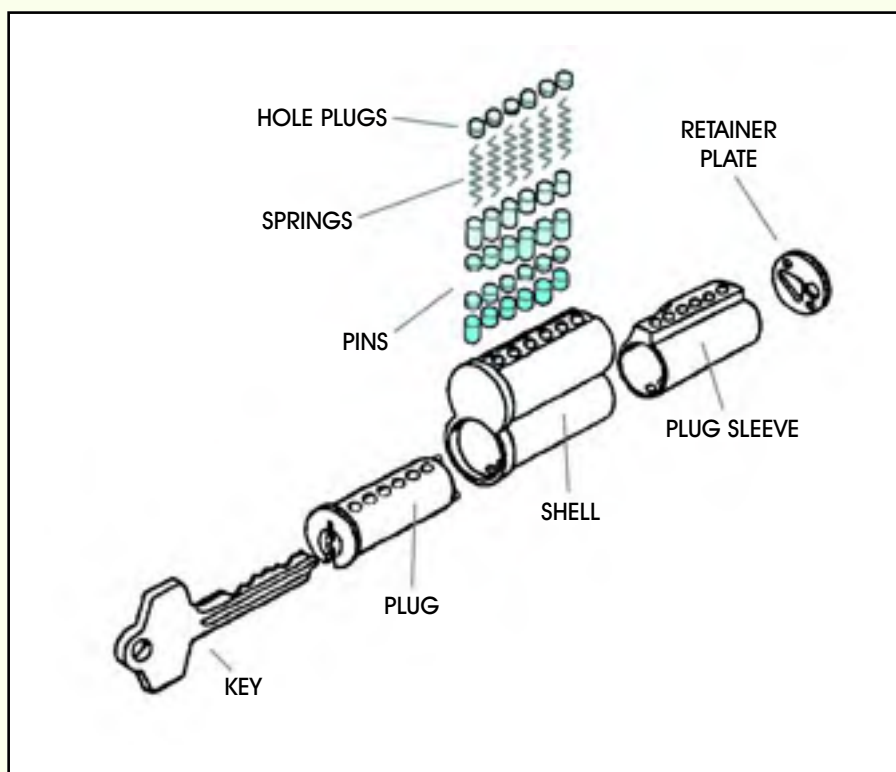


FIGURE 39—An Interchangeable Core

Most of these locks are used in commercial installations. The advantage of the interchangeable core is that if, for example, an employee loses a key to a store, the locksmith can simply remove the core, rekey it, and replace it. With another type of lock, the locksmith might have to remove the entire lock from the door to replace or rekey it, which is much more time-consuming and costly.

Key-Operated Padlocks

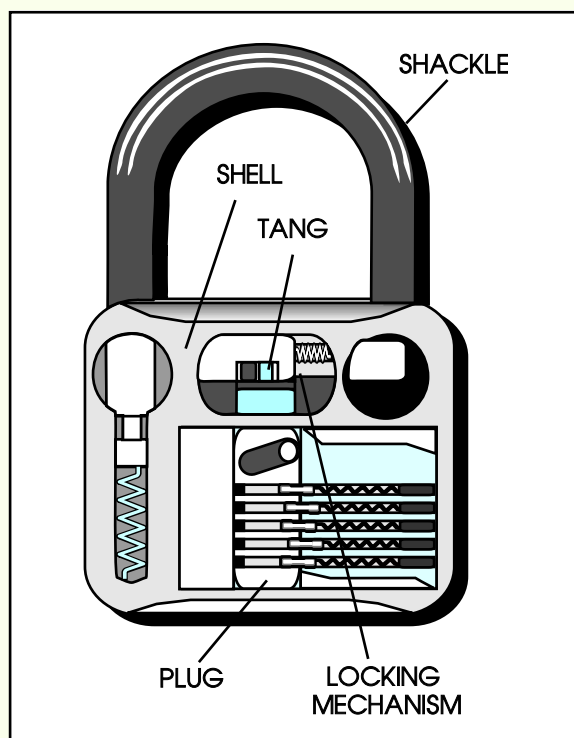
Padlocks are a familiar part of our daily lives. Many of us became familiar with padlocks as children, using them to secure

our school lockers and bicycles. Adults use padlocks to secure garages, outbuildings, toolboxes, trunks, storage units, and just about any other enclosure that offers a hasp to hang a padlock from.

There are a number of other padlock varieties. Some padlocks use a plug as a locking mechanism; the plug may hold pins, discs, or wafers. High-security padlocks are also available. These padlocks feature special laminations, as well as independent control of the two ends of the shackle.

We discussed the operation of a padlock in the Practice Exercise for Study Unit 2. Your Papaiz padlock is illustrated

FIGURE 40—Parts of a Padlock



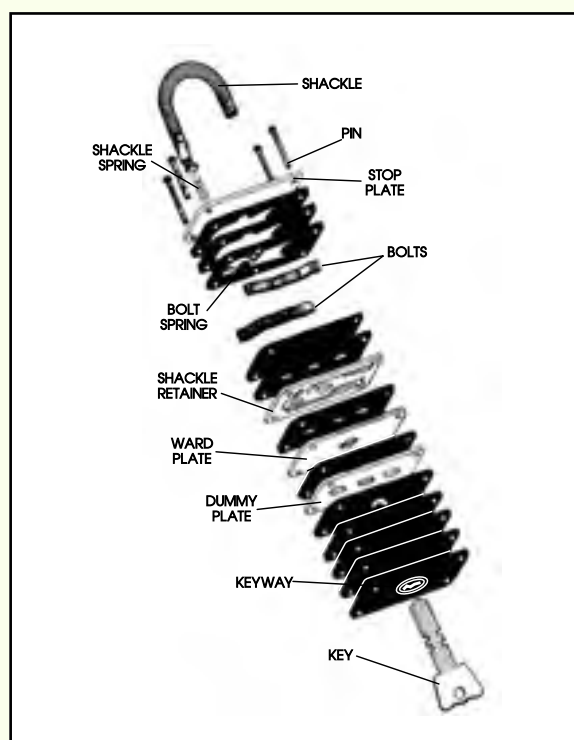
again for your reference in Figure 40. Remember that the main parts of a padlock are the shackle, the shell, and the tangs. The shackle is held in two locations by the locking mechanism near the top of the lock. The two *tangs* at the top of the plug, when rotated, cause the locking mechanism to retract. This action causes the shackle to raise under spring pressure.

No key is required to lock the padlock. Finger pressure is sufficient to return the shackle to the case, where the bolts catch the notch and secure it.

Warded Padlocks

Warded padlocks are constructed a little differently from the warded door lock, but the principle of operation is the same. A modern warded padlock is constructed from many flat layers of metal. The flat layers are then stacked up and laminated together to form the body of the lock. Small cuts are made in

FIGURE 41—Interior View of a Warded Padlock



some of the layers to create wards in the lock body. When all the layers are stacked up, the key will need to be cut to correspond to the lock's wards. An interior view of a warded padlock is shown in Figure 41.

When the correct key is inserted in a warded padlock, it passes through the *wards* and can be turned. As the key turns, it moves the bolts out of the notch and the

shackle is forced upward and out of the case by the now-relieved pressure of the shackle spring. Flat keys are used with warded padlocks.

Disassembly

Since most padlocks are inexpensive, they're more often replaced than repaired. In addition, many inexpensive padlocks (and all laminated warded padlocks) can't be disassembled at all.

Expensive heavy-duty, high-security padlocks, on the other hand, are well worth disassembly and servicing. The manufacturer's instructions will tell you how to disassemble a padlock; for example, some have special pins or rivets that must be removed to access the locking mechanism. In addition, some high-security padlocks contain interchangeable cores.

Choosing the Right Padlock

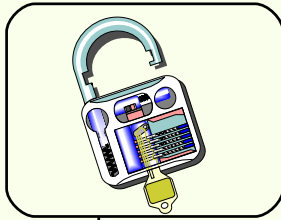
What's the best padlock to buy? As a locksmith, you'll hear that question repeatedly, and there's no easy answer. Nevertheless, since you'll be expected to come up with an answer, do so by

reviewing with the customer the following considerations: purpose, location, and frequency of use.

Purpose. What is the padlock going to be used to lock? A child's bicycle or school locker will obviously require much less security than the door to a garage or boathouse.

Location. Will the lock be used indoors or outdoors? An outdoor lock will naturally take more abuse from the weather than an indoor unit. A shed door that is covered in snow four or five months of the year presents a real problem for a cheap padlock. Urge the customer to consider any unusual circumstances due to location (moisture, sand, dust, extreme sunlight, and so on).

Frequency of Use. The price of a padlock is to a large extent dependent on its durability. If the lock is to be operated several times a day, consider a better model.



Locking It Up! 4

Fill in the blanks in each of the following statements.

1. A special key called a _____ key is used to remove an interchangeable core.
2. A _____ key requires two people to open a lock. Each person is given half of the key.
3. A special type of key that contains two rows of biting is used in the _____ lock.
4. A/an _____ acts as an anchor embedded in the door, resisting attempts to wrench the cylinder loose.
5. A high-security _____ has extra-long screws that add strength to a door frame, making it very difficult to kick in a door.
6. A/an _____ is a specially-designed lock cylinder that can be removed from a door lockset without disassembling the lock or door knob.

Check your answers with those on page 53.

COMBINATION LOCK MECHANISMS

Introduction

Let's stray away from key-operated locks for a short time and look at a lock that needs no key. This type of lock is called the *combination lock mechanism*. Combination lock mechanisms are used in many types of padlocks, door entry systems, safes, and vaults. Although combination locks differ in construction from one make and model to another, they all operate on the same basic principles.

Combination locks have a practically unlimited number of applications, from school lockers to trailer hitches to safes. They're particularly advantageous over key-operated locks in situations where several people—lab workers, industrial inspectors, high-school teachers—need access to the same equipment at random times. In a manufacturing plant, for example, six or eight workers may need to use tools or supplies that are too valuable to be left out in the open. Rather than provide each person with a key (which could be lost or stolen, requiring immediate rekeying or lock replacement), each can be given a simple three-digit combination.

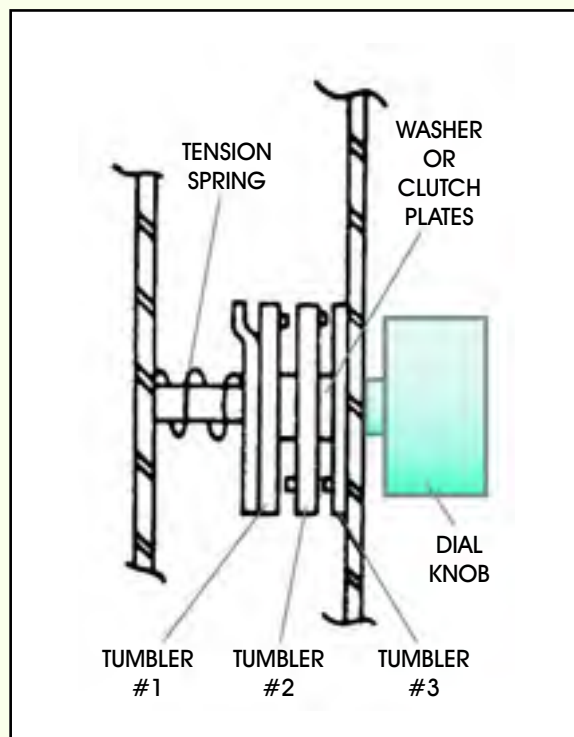
Operation

Now, let's examine the operation of the combination lock mechanism. First, the *combination* is a series of numbers (usually three numbers) that is dialed to open the lock. Typically, the combination is set at the factory. However, a locksmith can change a padlock combination at a customer's request.

Inside the lock, the main components are the *wheels* or *tumblers*. Outside, the lock has one or more *dials*. The internal components of a simple combination padlock are shown in Figure 42. This lock contains three wheels and a dial on its face.

The dial is a numbered knob on the outside of the lock which is used to dial the combination. It can be rotated to the left and

FIGURE 42—This combination lock mechanism contains three wheels and a numbered dial on its face.



right. The numbers on its face start at 0 and are read clockwise. Some locks read from 0 to 50; some read from 0 to 100. Locks with numbers up to 100 usually have a little more security than ones reading up to only 50.

When a combination lock is locked, the wheels are positioned in random relationship to each other. However, if the three wheels are moved in such a

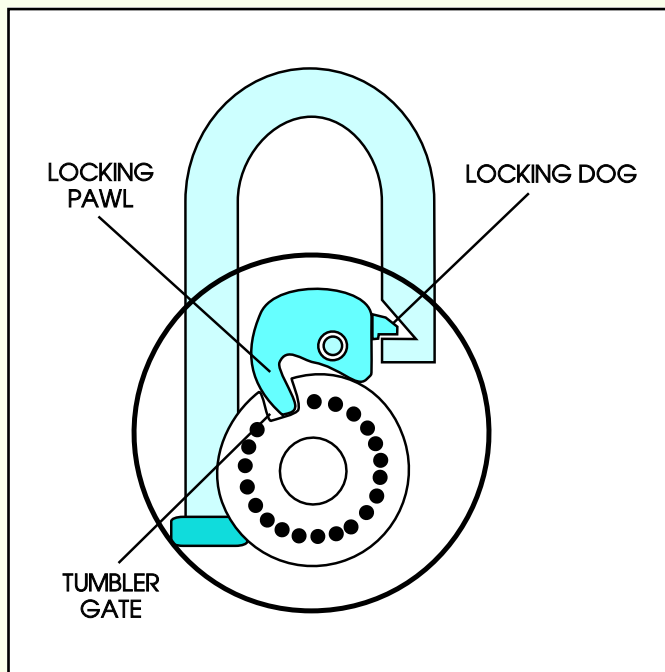
way that the wheels are caused to align, the lock mechanism will be released. To align the wheels, the dial is turned clockwise and counterclockwise to reach the numbers in the combination. As the dial is turned, the wheels inside are aligned. Each time a correct number from the combination is dialed, another wheel clicks into place. When all the numbers have been dialed, the wheels will be completely aligned, freeing the lock to open.

To see how this works in more detail, let's say we want to open a padlock with the combination 18-5-15. First, spin the dial a couple of times to clear it, and then align the zero under the arrow at the top of the dial. Next, we'd turn the dial *clockwise* two full turns, and continue to turn until number 18 is aligned under the arrow. The first wheel inside the mechanism is now set.

Next, move the dial *counterclockwise* one full turn, and stop at number 5. The first and second wheel are now aligned. Finally, turn the dial *clockwise* until number 15 is aligned under the arrow. All three wheels should now be aligned inside the mechanism, and the shackle should be free to open. In some models, the shackle will pop up out of the case, impelled by a spring; in others, you must pull down on the case to release the shackle.

If you look at a back view of the combination lock, you can see how the lock releases the shackle. Figure 43 displays this back view of the lock. Notice how the wheel has a *gate* cut into it. When the proper combination is dialed on the lock, each of the three wheels will line up with their gates open to the *locking pawl*. Since the locking pawl is free to pivot, it will enter the gates on the three tumblers and open the shackle of the lock.

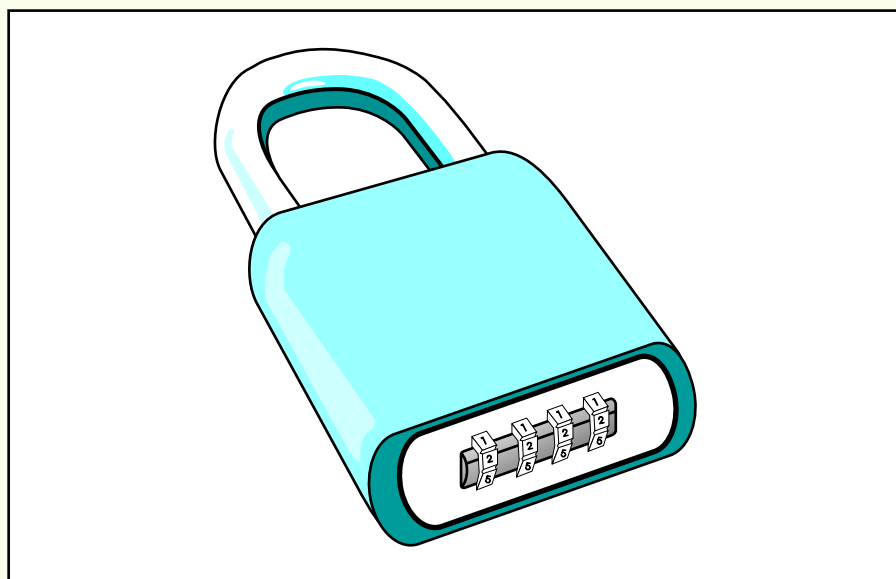
FIGURE 43—This figure shows how the gates on the wheels must align in order to free the locking mechanism.



Some combination locks carry code numbers stamped on their cases. A locksmith can discover the combination by looking up this number in one of the code books available only to professional locksmiths.

A slightly different model of combination padlock, the Sesame padlock, is shown in Figure 44. Note that this lock has four numbered dials on the bottom of the lock instead of the face. One of the most useful features of this lock is that the user can change the combination at will. To do so, a special key called a *change key* is inserted into the shackle hole, and a new four-digit combination rotated into place. *Note:* Don't confuse this combination change key with the change key of a master key system.

FIGURE 44—Sesamee Padlock



Disassembly

Most combination padlocks can't be disassembled without spending an enormous amount of time and effort to do so. If the lock is inexpensive, it's generally replaced rather than re-

paired. However, you can expect to meet customers who have lost the combination to a padlock. In such a situation, you may be able to remove the lock using bolt-cutters. Otherwise, it will be necessary to drill a small hole in the back of the lock to try to "see" the combination.

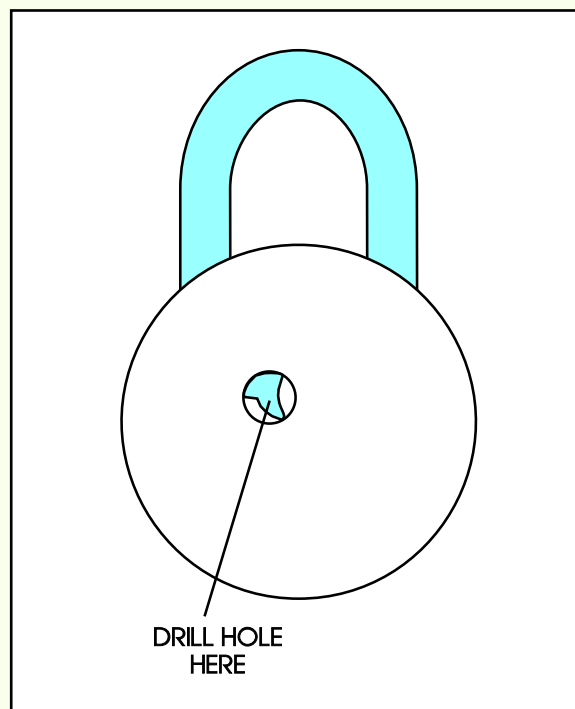


FIGURE 45—Drill a small hole as shown here to see the wheels inside a combination lock.

Drill a small ($\frac{1}{16}$ -inch) hole in the back of the padlock case. By looking inside the mecha-

nism, you can see the position at which all the wheels are aligned. Figure 45 shows where to drill the hole, which you can patch with liquid solder or liquid cement when

you're finished. The exact position of the hole might vary depending on the type and brand of lock.

Combination Entry Locks

The *pushbutton combination lock* in Figure 46 is a popular type of combination entry lock used in both home and commercial applications. These locks are especially common in hotels or other facilities where many strangers come and go at will. Instead of having to supply each person with a key, a three-number combination is supplied. The combination can be changed quickly and easily to maintain security. If desired, a security shield can be mounted around the lock face to screen it from curious eyes.

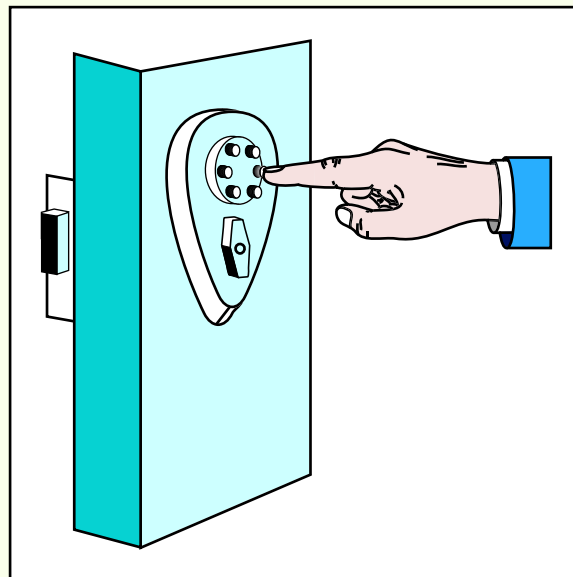


FIGURE 46—A
Pushbutton
Combination Lock

An additional advantage of the pushbutton combination entry lock is that it's easy to install. In a wooden door, two drilled holes are all that is required. For metal doors, a surface-mounted strike is provided, eliminating the need to mortise the jamb.

Now that you understand the basic operation

of the combination lock, let's take a look at another type of keyless lock, the electric lock mechanism. (*Note:* We'll be discussing the use of combination locks in much more detail later in your study unit on safes and vaults.)

ELECTRIC LOCK MECHANISMS

Applications

Electric locks are used widely by many types of businesses, hospitals, and industries. These keyless locks can be used on rear or side entries of a business to allow employees to enter and exit the building. Some homes and apartments have keyless entry systems to eliminate the need for keys.

Most modern hotels use electric locks for entry doors and/or keyless electric locks for the actual room doors. In addition, many of the hotel's interior doors may be held open using electric locks. Then, if a fire is sensed by the alarm system, these doors close to prevent the fire from spreading.

Operation

The simplest type of electric lock consists of a solenoid-type plunger that engages in a strike in the door or door jamb. When an electrical current is applied to the plunger, magnetic force pulls it out of the strike, opening the door. Another type of electric lock is operated by remote control. These are often mortised or key-in-knob locksets, and they're controlled remotely using push buttons or keyed switches. Keypad or card-reading keyless entry systems are another popular choice. Finally, the electromagnetic lock consists of a powerful electromagnet and a steel plate that can hold a door against 2,000 or more pounds of force.

In the simplest electric lock *circuit*, a single switch or pushbutton and an electric lock is used to protect one door. The power supply for this electric lock consists of a fuse and a transformer. One side of the transformer connects to the electric lock's coil, and the opposite side of the transformer connects to a pushbutton switch. When the pushbutton is pressed, the circuit is completed and the coil is energized. When the coil is energized, the coil attracts a plunger that allows the door to open.

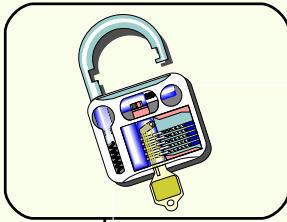
More than one electric lock can be linked to one circuit and controlled with a single switch. In such a system, both locks operate when the pushbutton is depressed. The current flow in this

circuit doubles, since two loads are connected across the power supply.

Two of the electric circuit devices we've been discussing—the transformer and the electric lock coil—use *electromagnetism* to operate. Electromagnetism is created by a magnetic field that surrounds a conductor when electric current flows through it.

The magnetic field that surrounds a wire is very small. If you could place a compass very close to the wire, you would see the needle of the compass deflect slightly. This small deflection serves no real purpose in pulling back an electric lock solenoid. However, if you loop the wire many times around a core, the magnetic fields would add together, increasing the overall field strength. The fields from the many turns of wire are concentrated in the core when the wire coil is energized. In fact, the coil has enough strength to pull the plunger out of the strike box on a typical electric door lock.

This introductory information to electric locks should be enough to familiarize you with their operation. However, note that we'll be discussing these locks (as well as *electronic security systems*) in much greater detail in a later study unit.



Locking It Up! 5

Indicate whether each of the following statements is True or False.

- 1. Only one electric lock can be connected to a circuit.
- 2. A special key called a change key is used to alter the combination of a Sesamee padlock.
- 3. The main components in a combination lock are the dials.
- 4. Once a lock's combination has been set at the factory, it can never be changed.
- 5. Pushbutton combination locks are very difficult to install and operate.
- 6. A padlock combination usually consists of three numbers.

Check your answers with those on page 54.

THE KEY TO SUCCESS

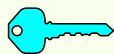
Since the beginning of this study unit, you've learned many of the important concepts and terms relating to lock mechanisms. You've learned how lock mechanisms work, in detail. You've also learned how to disassemble and service many lock mechanisms. Think about how important this valuable knowledge will be to your future career as a locksmith! You've already mastered many of the basic topics you'll need to become qualified as a professional locksmith. Be proud of your scholastic achievements, and continue to plan for your future!

Now, when you're ready, read through the *Key Points to Remember* that follow. When you've reviewed the material and feel you know it well, proceed to the examination for this study unit. Good Luck!

KEY POINTS TO REMEMBER



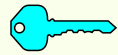
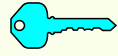
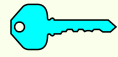
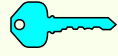
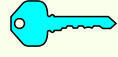
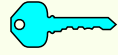

A *lock mechanism* is the assembly of parts inside a lock that makes it work. All lock mechanisms can be divided into three basic types: *key-operated lock mechanisms*, *combination lock mechanisms*, and *electric lock mechanisms*. A *key-operated lock mechanism* is simply any type of lock that's opened and closed by inserting and turning a key. Key-operated locks are found in residential doors, cars, and padlocks.


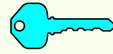


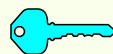
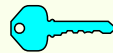


The *warded lock mechanism* is the oldest type still in use today. Bit keys and barrel keys are used to open warded door and cabinet locks. The word *ward* means *to guard* or *guard against*. In locksmithing terms, a *ward* is a metal barrier inside a lock mechanism that ensures that only the proper key will engage the mechanism and open the lock. The "right" key contains cuts that exactly match the shape of the wards inside the lock.

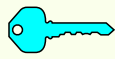


Warded locks aren't generally used on today's exterior doors. They have been replaced by pin tumbler or disk tumbler locks in most cases. This is because warded locks aren't nearly as secure as pin tumbler locks, since the warded lock has a simple mechanism and the keyhole is large enough to view most of the lock's inside.

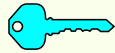
- 
- Lever tumbler lock mechanisms* are used on school lockers, cash boxes, suitcases, mailboxes, and safe-deposit boxes. The slim, flat design of the lever lock is more appropriate for these applications than a cylinder-type lock. Modern lever tumbler locks almost always use *flat keys*.
- 
- The lever tumbler mechanism may contain from one to sixteen lever tumblers, depending on the security of the lock. Each lever tumbler is a flat metal plate held in place by spring pressure. When the key is inserted, the lever tumblers are lifted and aligned inside the lock, allowing the lock to open.
- 
- The *disk tumbler mechanism* (also called the *wafer tumbler mechanism*) is commonly used in automobile doors, desks and cabinets, and vending machines. The main components of a disk tumbler lock are the *shell*, the *plug*, the *disks*, and the *springs*. The disks or wafers are small, flat, rectangular pieces of steel, each containing a slot or hole. For most disk locks, the disks come in five different slot arrangements. The location of the slot in each disk will determine the key cut depth needed.
- 
- A disk tumbler lock's *plug* will contain an arrangement of any of these five disks (any one of the disks may appear more than once, as well). The arrangement of the disks forms each lock's individual combination. The disks are slotted for key entry. When the proper key is inserted into the lock, the disks are pulled away from the lock shell and centered in the plug. This action frees the plug from the shell and allows the plug to turn with the key.
- 
- A *side bar wafer lock* is a variation of the disk tumbler lock that is widely used for ignition, door, and trunk or rear hatch locks for General Motors automobiles.
- 
- Another variation of the disk tumbler mechanism is the *cam lock*. Cam locks are used extensively on cabinet doors and desk drawers. In this kind of lock, a moveable *cam* is attached to the rear of the lock. The cam rotates when the key is turned in the lock, creating a physical barrier that prevents a door or drawer from being pulled open.
- 
- The *pin tumbler lock* is the most secure and widely used lock today. This type of lock is very popular in home entry locks, padlocks, and other types of locking devices. Pin tumbler lock mechanisms are always operated with cylinder keys. The pin tumbler mechanism is relatively easy to disassemble and repair.

- 
- A pin tumbler mechanism is contained within a device called a *cylinder*. A pin tumbler cylinder holds the plug, which is a small “tube” containing the *bottom pins*. The heights of the bottom pins correspond to the cut depths in the key. The top pins are all the same height, and rest halfway between the plug and the cylinder, preventing the plug from rotating inside the cylinder.
- 
- When the proper key is inserted in the lock, the pins are lifted to the height necessary to align them along the *shearline*, freeing the plug to turn. By changing the heights and placement of pins in the lock plug, the locksmith can make a different key to operate the lock. This process is called *rekeying*.
- 
- High-security locks* are locking devices that are especially resistant to picking and forced entry. Most high-security locks contain complex or modified pin tumbler mechanisms. For example, some high-security mechanisms hold more than one set of pins. The pins enter the lock cylinder at an angle, and the key must be specially cut to accept the pins at that angle. Some other features manufacturers add to their high-security mechanisms are sidebars, split keys, multiple locking mechanisms, anti-wrenching pins, and high-security strikes.
- 
- Interchangeable* or *removable cores* are specially-designed lock cylinders that can be removed from a door lockset without disassembling the lock or door knob. To remove the core, a special key called a *control key* is inserted and turned, and the core is then withdrawn. Most of these locks are used in commercial installations.
- 
- Padlocks are another common type of key-operated lock. Remember that the main parts of a padlock are the shackle, the shell, and the tangs. The shackle is held in two locations by the locking mechanism near the top of the lock. The two *tangs* at the top of the plug, when rotated, cause the locking mechanism to retract. This action causes the shackle to raise under spring pressure. No key is required to lock the padlock. Finger pressure is sufficient to return the shackle to the case, where the bolts catch the notch and secure it.
- 
- Another type of key-operated padlock is the *warded padlock*. A warded padlock is constructed from many flat layers of metal. The flat layers are then stacked up and laminated together to form the body of the lock. Small cuts are made in some of the layers to create wards in the lock body. When all the layers are

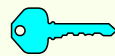
stacked up, the key will need to be cut to correspond to the lock's wards.



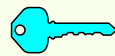
A commercial lubricant such as WD-40 (*never* oil) should be used to lubricate lock parts.



Combination lock mechanisms are used in many types of padlocks, door entry systems, safes, and vaults. The *combination* is a series of numbers that's dialed to open the lock. The dial is a numbered knob on the outside of the lock which is used to dial the combination. The dial is turned clockwise and counterclockwise to reach the numbers in the combination. As the dial is turned, the wheels inside are aligned. Each time a correct number from the combination is dialed, another wheel clicks into place. When all the numbers have been dialed, the wheels will be completely aligned, freeing the lock to open.



The *pushbutton combination lock* is a popular type of combination entry lock that is especially common in hotels or other facilities where many strangers come and go at will. Instead of having to supply each person with a key, a three-number combination is supplied. The combination can be changed quickly and easily to maintain security.



Electric locks are used by many types of businesses, hospitals, and industries. In the simplest electric lock *circuit*, a single switch or pushbutton and an electric lock is used to protect one door. The power supply for this electric lock consists of a fuse and a transformer. When a pushbutton is pressed, the circuit is completed and the coil is energized. When the coil is energized, the coil attracts a plunger that allows the door to open.

Do You Know Now . . .

Below are the answers to the questions asked at the beginning of this study unit.

What is the most important component of a combination lock?

The wheels or tumblers are the most important components of the combination lock mechanism.

What are the major parts of a padlock?

The major parts of a padlock are the shackle, the case or shell, and the tangs.

What is a *ward*?

A ward is a metal barrier inside a warded lock that obstructs any key but the proper one.

NOTES

Locking It Up! Answers

1

1. Bit, barrel
2. lock mechanism
3. padlock
4. key-operated lock mechanism
5. ward
6. case wards
7. skeleton key
8. rim

2

1. F
2. T
3. F
4. F
5. T
6. F
7. F
8. T
9. F
10. F

3

1. F
2. F
3. F
4. F
5. F
6. F
7. F
8. T

4

1. control
2. split
3. Schlage Primus
4. anti-wrenching pin
5. strike
6. interchangeable core

5

1. F
2. T
3. F
4. F
5. F
6. T



Lock Mechanisms

EXAMINATION NUMBER:

03100400

Whichever method you use in submitting your exam answers to the school, you must use the number above.

**For the quickest test results, go to
<http://www.takeexamonline.com>**

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then submit only your answers to the school for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. Do not wait until another examination is ready.

Questions 1–20: Select the one best answer to each question.

1. A *plug follower* is used in the disassembly of

- A. a combination padlock.
- B. all disk tumbler locks.
- C. all locks made in the United States.
- D. pin tumbler locks.

2. A lock mechanism containing more than two sets of top and bottom pins would be called a

- A. high-security mechanism.
- B. wafer tumbler mechanism.
- C. combination lock.
- D. lock plug.

3. Which of the following lock mechanisms is commonly used in General Motors automobiles?
- A. Warded lock
 - B. Lever tumbler lock
 - C. Padlock
 - D. Side bar wafer lock
4. What is a *case ward*?
- A. A warded padlock
 - B. A special cut in a bit key
 - C. A ward on a lock's keyway
 - D. A lock used on a suitcase or briefcase
5. A *cam lock* is a type of
- A. high-security pin tumbler lock.
 - B. disk tumbler lock.
 - C. lever tumbler door lock.
 - D. warded padlock.
6. Where is a rim lock installed?
- A. On a briefcase or suitcase
 - B. On a safety deposit box
 - C. On the surface of an automobile door
 - D. On the surface of an entry door
7. Wheels are essential to the operation of
- A. a combination lock.
 - B. a plug follower.
 - C. a disk tumbler lock.
 - D. a warded lock.
8. An *anti-wrenching pin* is a device that
- A. is found only in warded lock mechanisms.
 - B. prevents a lock cylinder from being pulled out of a door.
 - C. prevents a lock cylinder from being picked.
 - D. protects a lock cylinder from rust and corrosion.
9. A disk tumbler lock may also be called
- A. a wafer lock.
 - B. a lever lock.
 - C. a warded lock.
 - D. a high-security lock.
10. The wards of a warded lock may be bypassed using a
- A. change key.
 - B. skeleton key.
 - C. disk tumbler.
 - D. plug follower.
11. A typical combination on a combination lock consists of a series of _____ numbers.
- A. two
 - B. three
 - C. ten
 - D. no

12. Which of the following are components of a lever tumbler mechanism?

- A. The gate, the post, and the saddle
- B. The cover boss, the trunnion, and the ward
- C. The saddle, the top pins, and the lever
- D. The trunnion, the post, and the milling groove

13. Which of the following are components of a pin tumbler mechanism?

- A. The top pins, the trunnion, and the lever
- C. The plug, the case ward, and the bottom pins
- B. The springs, the top pins, and the wheels
- D. The top pins, the plug, and the bottom pins

14. The top pins in a pin tumbler lock mechanism

- A. are all the same size.
- B. are welded together.
- C. are all different sizes.
- D. correspond to the cuts in the key.

15. A warded door lock is usually opened with a

- A. cylinder key.
- B. flat key.
- C. bit or barrel key.
- D. tubular key.

16. If you attempt to move anti-pick pins with a lockpick, they'll

- A. lift up easily to the shearline.
- B. cause the top pins and springs to pop out of the cylinder.
- C. jam between the plug and the cylinder.
- D. cause the lockpick to become wedged inside the cylinder.

17. Which of the following lock types is generally the easiest to disassemble?

- A. Pin tumbler
- B. Lever tumbler
- C. Disk tumbler
- D. Warded

18. When an electric lock's pushbutton is pressed, what happens?

- A. The electrical circuit is completed, and an alarm bell sounds.
- B. The coil is energized, causing a powerful magnet to hold the door shut.
- C. The electrical circuit is completed, and the door opens.
- D. The coil attracts a plunger that locks the door.

19. Which of the following is used to service an interchangeable core?

- A. A change key
- B. A bit key
- C. A control key
- D. A flat key

20. A combination lock will open when

- A.** all of its wheels have been properly aligned.
- B.** the first number in the combination is dialed.
- C.** all of its wards have been bypassed by the key.
- D.** a small hole is drilled in the back of its case.

COMING ATTRACTIONS

Now that you've completed Study Unit 4, your next information-packed study unit is just around the corner. Study Unit 5 is entitled *Residential Locks*, and is designed to introduce you to the many door and window locks you'll see in your career as a locksmith. The most important career topics you'll learn about are the construction and operation of door locks and the practical installation of door locks. With the help of many illustrations and easy-to-follow, step-by-step instructions, you'll learn how to install a variety of locking devices—the same locks you'll be installing profitably every day in your professional career. Enjoy your continuing studies!

Professional Locksmith

Study Unit 5

Residential Locks

Preview

Congratulations on successfully completing another study unit! You're closer than ever now to your career goal. You've completed four study units that introduced you to a wide variety of important locksmithing topics. Now, in this study unit, you'll continue your studies by examining residential locks.

Residential locks are simply any locks that are used in homes (as opposed to commercial businesses). We'll focus our attention primarily on the standard door and window locks you'll see every day as a locksmith.

Residential locks make up a substantial portion of the average locksmith's daily work. You'll learn about the construction, operation, and installation of a variety of door locking systems.

When you complete this study unit, you'll be able to

- Define residential door construction, and the various types of residential doors
- Describe residential window construction, and the various types of residential windows
- Explain and demonstrate how a key-in-knob lock works
- Disassemble and reassemble a key-in-knob lock
- Explain the difference between interior and exterior locksets
- Describe how a variety of door and window locking devices are installed
- Explain what handlesets are, and how they operate
- Discuss auxiliary locks and latches
- Define what a deadlock is, how it works, and the names of its parts

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Residential Locks

Do You Know . . .

What is a *flush door*?

What is a *key-in-knob lockset*?

What is an *entrance handleset*?

In this study unit, you'll find the answers to these and many other questions about residential locks.

RESIDENTIAL DOORS

Introduction

As you've learned from earlier study units, people use locks to secure everything from their baggage to their bicycles. The most important use of locks, however, is to lock residential doors and, to a lesser degree, windows. This study unit will focus on how locks are used for home security. First, we'll examine the construction of doors and windows. While a locksmith isn't expected to have all the knowledge of a carpenter or home builder, you should have a general idea of how doors and windows are put together and how locks can be installed on them. Understanding the construction of doors and windows also helps you see where their weak points are. Finally, being familiar with the different popular styles of doors and windows will help you to determine what locks should be used in a particular situation. Now, let's look at the construction of a typical modern door.

Residential Door Construction

A residential door functions as the entry to a home, and also provides security for the home's occupants and their belongings. While the exterior appearance of residential doors has remained much the same over the past 100 years, the interior construction has changed greatly. Two factors have led to improvements in door construction: rising crime rates and the need to conserve energy. For this reason, door manufacturers have greatly improved the design of their products to keep intruders out and heat in.

Modern doors may contain a solid wood core (or an insulated rigid foam core), plastic or rubber thermal sheeting, and a fiberglass or metal shell. All of these features can add security and energy efficiency to the construction. If glass is used in the door at all, it's the insulated thermal type. Modern insulated doors don't require a storm door and are popular in all climates and regions.

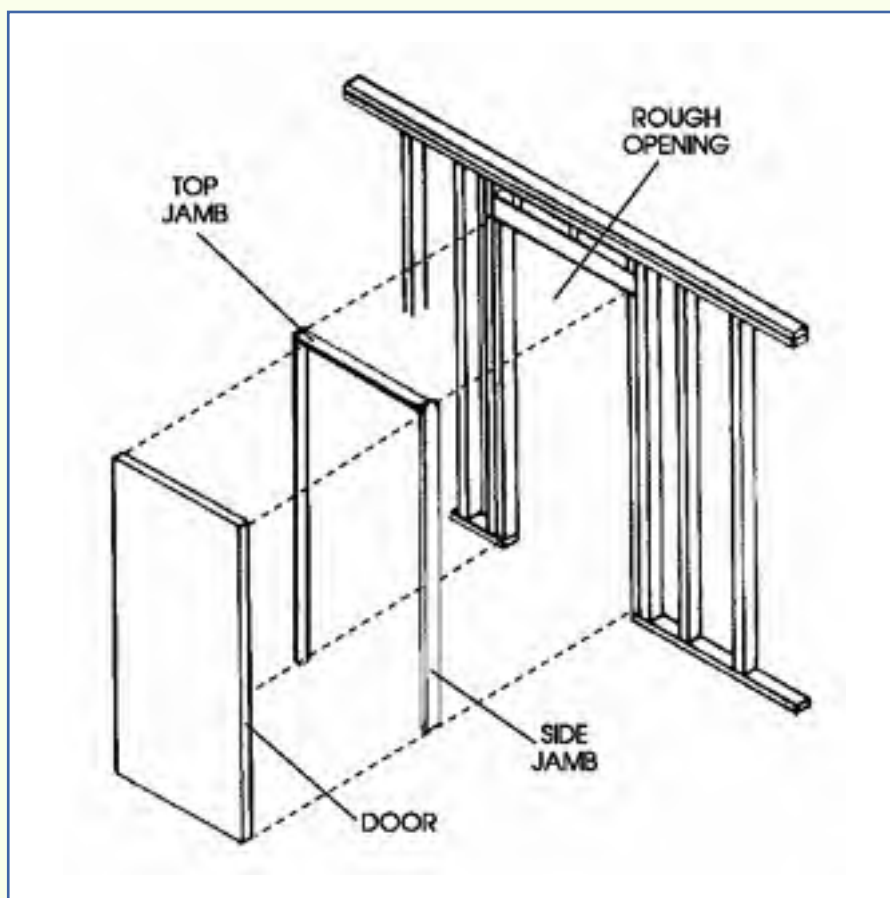
The individual parts used to construct a door vary according to the style of the door. We'll discuss different door styles in a moment. Now, however, let's take a look at how a door is installed in a home.

Door Installation

The installation of a door is relatively simple. If you were to look at a house as it was being built, you would see the *wall frame* as shown in Figure 1. An opening is left in the wall frame for the door to be installed in later. A door is typically installed in a *doorjamb*. A doorjamb is simply the wooden door frame that fits into the space in the wall. A doorjamb consists of two *side jambs* and a *head jamb* across the top. Also, most exterior doors contain a *sill* at the bottom to prevent leaks and drafts. A door *stop* is a thin vertical strip of metal or wood nailed or screwed to the jamb to prevent the door from swinging through the opening.

Today's contractor or home improver can purchase prefabricated *pre-hung doors* (doors already encased in their jambs). Pre-hung doors are ready to be installed. The door and jamb unit is simply placed into the wall cavity.

FIGURE 1—This illustration shows how a door is installed in a wall frame. Note all the parts of the door labeled in the figure.



Home security is an important concern in the installation of any door. The following are four important security factors to be considered when installing a door:

Door Construction. The first concern, door construction, refers to how strong the door is. The strength of a door's structure will relate directly to the amount of security the door can provide.

Hardware. The hardware used in installing a door (including hinges, knobs, latches, and so on) must be strong enough to withstand attack. Door hardware, like door construction, will directly affect the security of any door.

Locks. Locks must be strong enough in construction to withstand physical attacks, and their mechanisms must be complex enough to prevent unwanted entry.

Visibility. A door should provide proper visibility through the use of door viewers and /or sidelights so that occupants can view visitors before allowing them to enter the home.

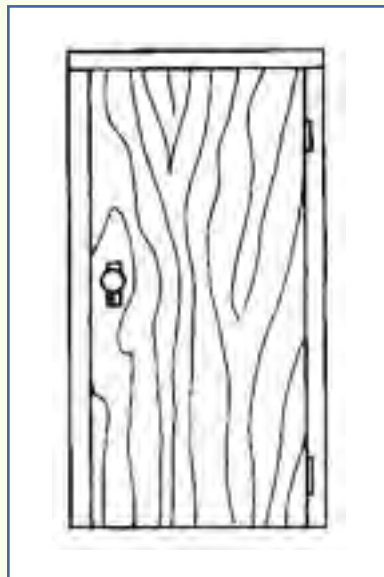
Door Types

Now, let's examine some of the most popular door styles. The following are descriptions of some of the most popular door types.

Flush Doors

A *flush door* (Figure 2) is a smooth wooden door that's usually composed of a hardwood veneer panel over either a solid or a hollow core. (A *veneer* is simply a very thin sheet of wood

FIGURE 2—Flush Door



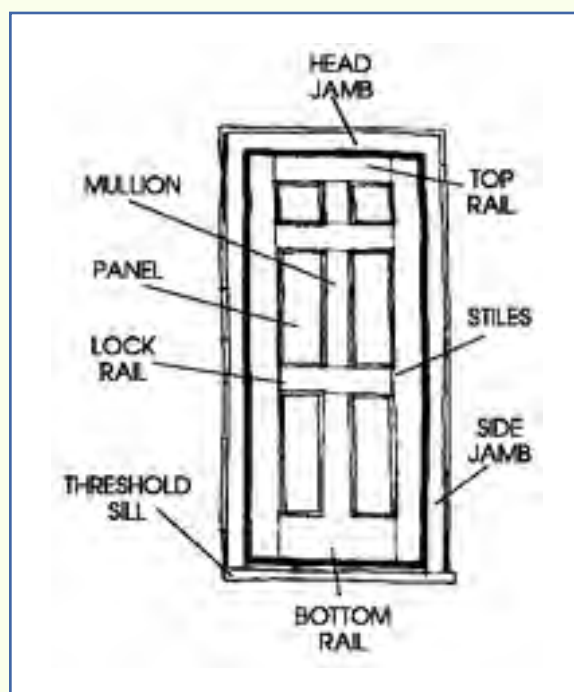
used as decoration on the outside of a door.) A *solid core* is usually constructed of wooden blocks or a rigid composition slab. A *hollow core* is made from wooden or cardboard strips laid on edge to form a sort of "honeycomb" inside the door. The outer veneer panels are glued securely over the core.

Some inexpensive flush doors have panels made of pine or other soft woods, or even textured hardboard. In contrast, flush doors containing embossed steel panels are considered to be high-quality installations. These

steel doors are often required in apartment buildings or other multifamily dwellings to meet fire code regulations. Steel doors are also preferred by many homeowners living in high-crime neighborhoods.

Note that solid-core doors are better for exterior use; hollow-core doors are more appropriate for use indoors. If a hollow-core door is used on an exterior opening, a waterproof adhesive must be attached to the veneer panels.

FIGURE 3—Panel Door



Panel Doors

Panel doors, also called *stile-and-rail doors*, are composed of four or more interlocking components positioned around one or more central panels (Figure 3). The vertical components are called the *stiles*, and the horizontal components are the *rails*. These doors are available in a wide range of woods and designs.

Since there are several joints in a panel door, its security and insulating properties aren't as good as those of a flush door. Panel doors are often used as exterior doors in homes when architectural beauty is of more concern than security.

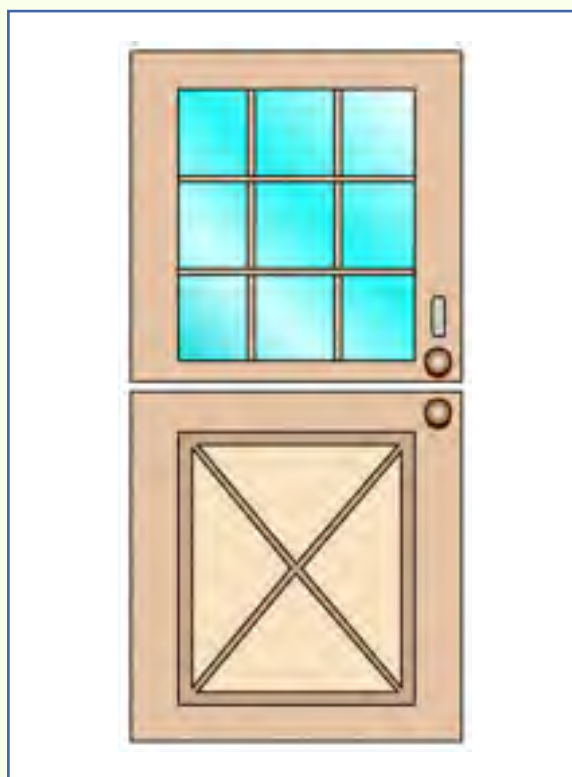


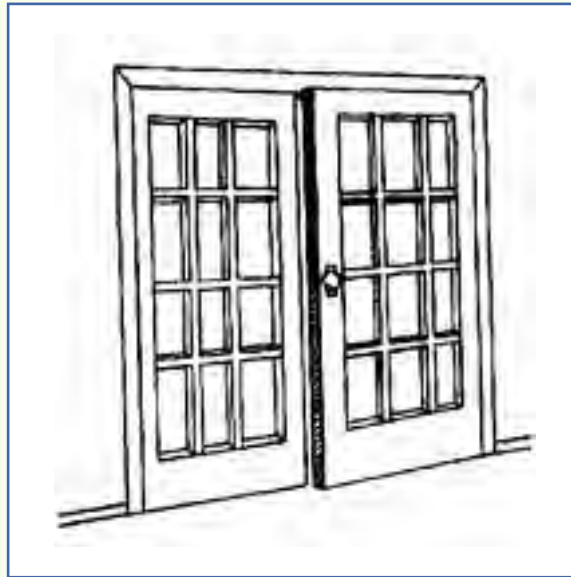
FIGURE 4—Dutch Door

A *Dutch door* (Figure 4) is a panel door that's been divided in half horizontally. The upper half can be opened for fresh air while the bottom half remains closed and locked. Each of the two halves must be properly hinged.

French Doors

The *French door* (Figure 5) is a variation of the panel door. A French door has

FIGURE 5—French Door

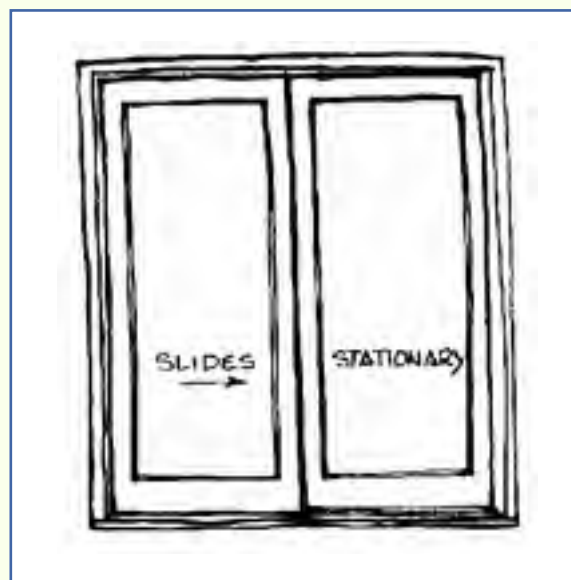


stile and rail components, but instead of flat wooden panels in between the stiles and rails, French doors contain panes of glass. For this reason, the French door is especially vulnerable to an intruder's attack. You'll often see French doors leading onto patios, porches, and balconies.

Old-fashioned French doors contained separate panes of glass. However, many modern French doors are now constructed to hold a large single sheet of insulated glass. The appearance of separate panes is then achieved by inserting snap-in grids over the glass.

Sliding Glass Doors

A *sliding glass door* (Figure 6) contains a large pane of glass inserted in a wooden or metal frame. The door opens and closes by sliding on tracks. Sliding doors usually contain



two panels. One panel slides in both directions, while the other panel remains fixed in place. The door handles are recessed into the door frame so they won't get in the way as the doors are sliding.

FIGURE 6—Sliding Glass Door

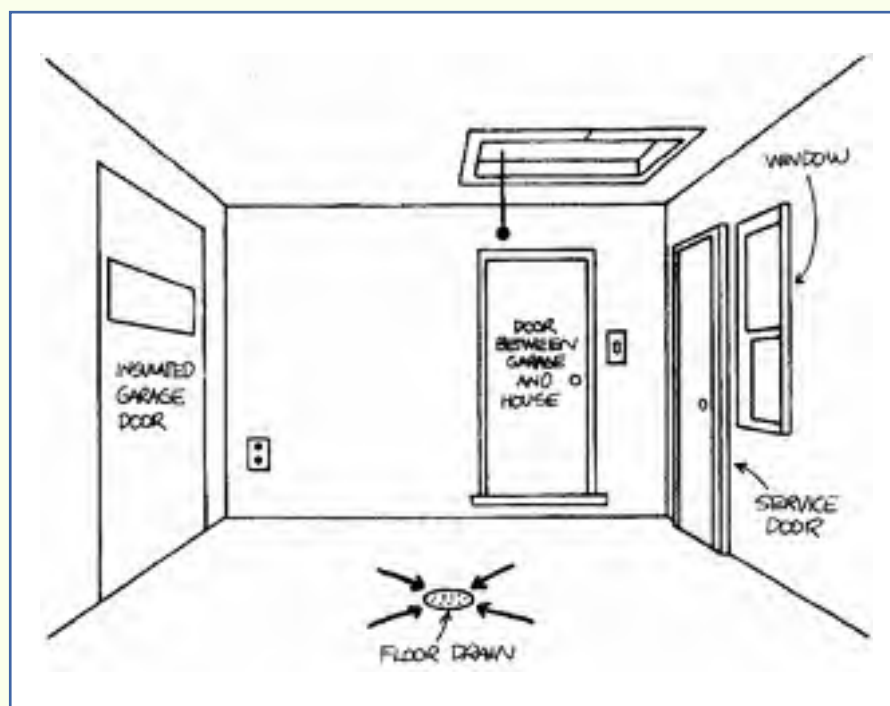
Sliding doors have been popular as patio and balcony doors in homes and apartments for decades. However, in years past, many people were injured by walking or running into sliding glass doors. For this reason, building codes today require the use of *tempered glass* in all sliding doors. Tempered glass is specially treated to increase its strength to prevent shattering.

In addition, sliding doors have lost favor in recent years because of their lack of security. A sliding door requires a locking bar for proper security; a simple lock isn't enough. Also, if a sliding glass door is located on the first floor or basement level, or if it's near sleeping quarters, an alarm system should be considered.

Garage Doors

An attached garage usually has at least two doors—the vehicle entry door and an interior door leading into the house. Some garages also contain a third door called a service door (Figure 7). The service door leads from the garage to another area: a laundry room, a workshop, or perhaps outdoors to a garden or patio. All of these doors will require proper locks to provide security to the house.

FIGURE 7—This interior view of a garage shows a service door and the entry door to the living quarters in the home.



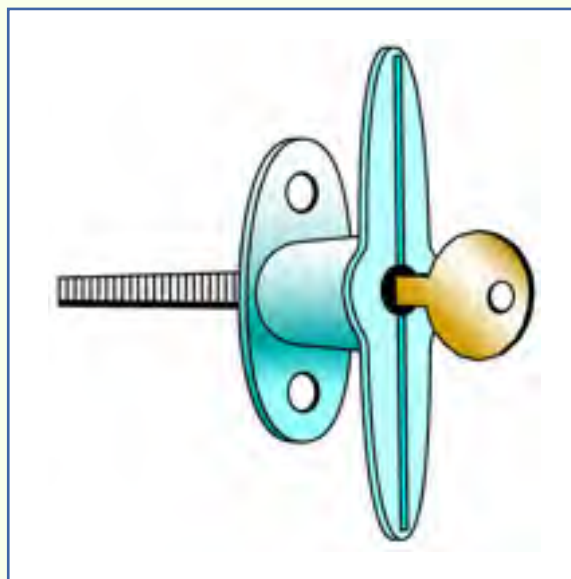
**FIGURE 8—Overhead
Garage Door**



The most common type of vehicle entry door is the *overhead door* (Figure 8). An overhead door can be fitted with an automatic opening device operated by a remote transmitter. The door may be constructed in several folding sections, or all in one piece that swings up. In addition, some garages contain

sliding doors, although these are rather rare. You may see these doors on a very old garage or on an old barn that's been converted to a garage.

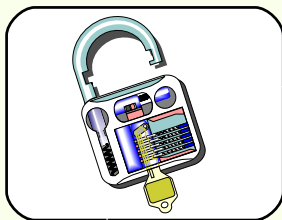
All garage doors should be fitted with suitable locking devices. A garage door lock is shown in Figure 9. In addition, it's a good



idea to connect any exterior doors that open into the garage (such as a service door) to an electronic alarm system. The interior door to the house should contain locking devices as well. That way, even if someone did gain access to the garage, they might not be able to get into the house itself.

**FIGURE 9—Garage
Door Lock**

Now that you understand a little more about door styles, we'll take a look at door hardware. First, however, take a few moments to test your knowledge of what you've read so far by completing *Locking It Up! 1* on the following page.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

Fill in the blanks in each of the following statements.

1. A/an _____ is the wooden door frame that fits into the space in a wall.
2. Most exterior doors contain a/an _____ at the bottom to prevent leaks and drafts.
3. A/an _____ is a smooth wooden door that's usually composed of a hardwood veneer panel over either a solid or a hollow core.
4. Panel doors are also called _____ doors.
5. In a panel door, the vertical components are the _____ and the horizontal components are the _____.
6. A _____ is a panel door that's been divided in half horizontally.
7. The _____ door is a variation of the panel door that has panes of glass between the stiles and rails instead of wooden panels.
8. A _____ door is a prefabricated door that's already encased in its jamb and is ready to be installed.

Check your answers with those on page 73.

Door Hardware

When it comes to doors, a locksmith is concerned only with the lock, right? Wrong! A knowledge of residential hardware is useful for locksmiths because the overall operation of doors and windows is greatly affected by hardware. For example, if a door won't lock properly, the problem may have nothing at all to do with the lock. Instead, poorly installed hinges may be causing the door to hang improperly and therefore fail to lock. The purpose of this section of the text is to give you a working knowledge of door hardware and how it affects the operation of doors and their locks.

Rough Vs. Finish Hardware

The hardware used in a building is of two general classes: rough hardware and finish hardware. *Rough hardware* includes nails, screws, bolts, and other items that are used during rough construction. *Finish hardware* refers to items that are a visible part of a building, such as locks, hinges, door closers, and other door trim.

Locksmiths are most concerned with finish hardware. This is the hardware that you'll most often need to examine, repair, and recommend to customers. Door locks and locksets themselves are considered to be finish hardware.

Finish hardware should be durable, have a pleasing appearance, and must be carefully selected according to how it will be used. Good hardware is essential for the efficient operation of residential doors and windows.

Hardware Construction

The metals most commonly used in builders' hardware are steel, aluminum, brass, and bronze. Steel is used mostly for rough hardware and for the moving parts in finish hardware. Some manufacturers also use plastics for moving parts. Brass, bronze, aluminum, stainless steel, and nickel silver are used on exposed surfaces and parts.

Solid brass, bronze, aluminum, stainless steel, or nickel silver hardware can be given dull or highly polished finishes. Unlike steel, these metals don't rust or corrode when exposed to moisture, and when tarnished they can be readily cleaned and polished.

Now, let's look at some of the specific items of hardware you should be familiar with.

Hinges

One of the most important pieces of door hardware is the hinge. A *hinge* is a metal joint on which a door swings open or closed. There are many types of hinges; most are named according to how they're installed on a door. A *butt hinge*, for instance, is applied to the *butt* (the edge) of a door. This is the type of hinge with which we're all most familiar.

The vertical cylindrical portion of a hinge is known as the *knuckle*. The flat parts containing the screw holes are called the *leaves*. Most butt hinges have five knuckles and two leaves as shown in Figure 10. The leaves rotate around a hardened steel pin. Today, most pins have a button-shaped tip. Some

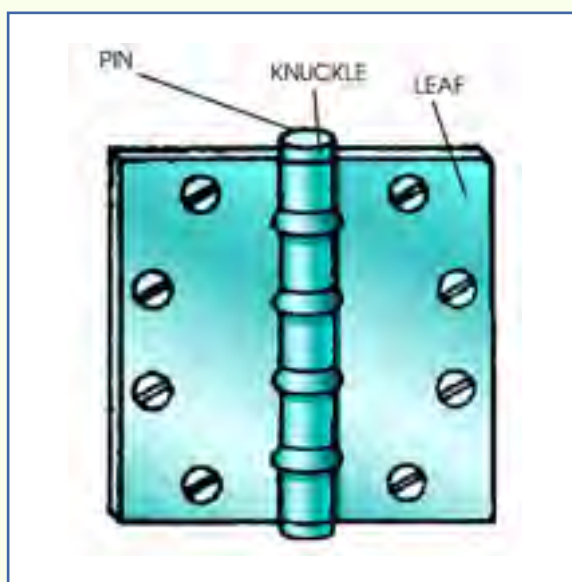


FIGURE 10—Parts of a Typical Hinge

pins can be taken out at the top of the hinge. However, *fixed pins* (those that can't be removed) are more desirable. A fixed pin provides extra security, since a burglar won't be able to easily remove the pins and open the door to gain access to a home.

With the continued use of a door, there's a tendency

for loose pins to work their way upward out of the hinge. To stop this problem, a *non-rising pin* can be used in the hinge. A non-rising pin has a projection that fits into a groove in one of the lower knuckles. This holds the pin in place and keeps it from rising.

A *full-surface hinge* has both leaves screwed to the surface of a door and frame. A hinge that has one leaf mortised into the door and the other leaf applied to the surface of the frame is termed a *half-mortise hinge*. A *full-mortise hinge* has one leaf mortised into the edge of the door and the other leaf mortised into the door frame. On any type of hinge, the hinge flaps are secured with screws. When the door is closed, most of the hinge is hidden from view.

For heavy entrance doors and for doors where silent operation is desired, hinges are available that contain stainless-steel ball bearings. The bearings cause the hinge to open and close silently and smoothly.

In selecting the proper type of hinge to install in a door, you should consider the requirements of use: whether the hinge will be installed on an exterior or interior door, the weight of the door, and the type of door and frame. In determining what metal to choose for hardware, local weather conditions must be considered. If the hinges will be used on an exterior door, they must be made from a metal that resists corrosion. Steel hinges can rust, so they're recommended for interior doors, and they're often painted to match the surrounding door trim. Bronze, stainless steel, or aluminum hinges can be used for exterior or interior doors.

Butt hinges support the entire weight of the door and are ordinarily in constant use, so they're subjected to great strain and considerable wear. Therefore, it's important to choose the proper size hinge for the purpose intended. The size of the hinge needed is determined by looking at the width and thickness of the door and the thickness of the door trim that must be cleared by the hinge. For example, the distance between the edge of the hinge and the edge of the door should be $\frac{1}{4}$ inch (on doors up to $2\frac{1}{4}$ inches thick) and $\frac{3}{8}$ inch (on doors over $2\frac{1}{4}$ inches thick).

Most butt hinges with two leaves are square. Thus, a standard hinge that is 4 inches high would also be 4 inches wide. The sizes of butt hinges that aren't square are given in two dimensions. The height of the hinge is given first, then the width. So, a 6-inch by 5-inch hinge is 6 inches high and 5 inches wide when open. Figure 11 gives recommended sizes of butt hinges for doors of various thicknesses.

FIGURE 11—This figure shows you how large a hinge should be in order to support a door of the given thickness.

Door Thickness (in inches)	Door Width (in inches)	Length of Hinge (inches)
$\frac{3}{4} - \frac{7}{8}$	Up to 24	$2\frac{1}{2}$
$\frac{7}{8} - 1\frac{1}{8}$	Up to 36	3
$1\frac{1}{4} - 1\frac{3}{8}$	Up to 32	$3\frac{1}{2}$
	Up to 37	4
$1\frac{3}{4}$	Up to 37	$4\frac{1}{2} - 5$
	37 - 43	5
	43 - 50	6
$2 - 2\frac{1}{2}$	Up to 43	5
	43 - 50	6

If a door is more than 5 feet high, it should be hung on three hinges. The bottom hinge is commonly placed 10 inches above the floor. The top hinge is placed at least 5 inches from the top of the door. On a panel door, the top of the hinge should be in line with the lower edge of the top rail. The third hinge is placed midway between the other two. The third hinge holds the butt edge of the door in alignment and help prevent the door from warping.

The weight of a door and how often it's used will determine whether standard-duty hinges or extra-heavy hinges are needed. Extra-heavy hinges should always be used on thick, heavy doors and on doors where frequent use is expected.

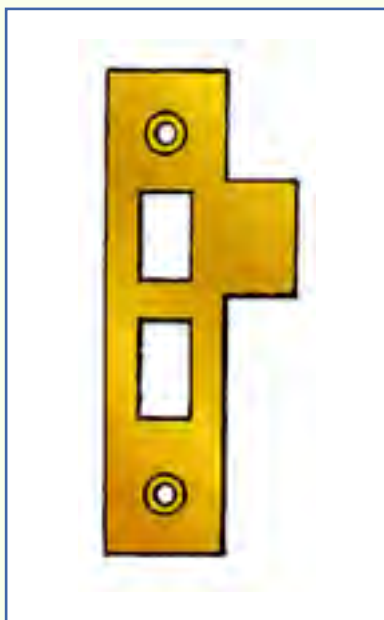
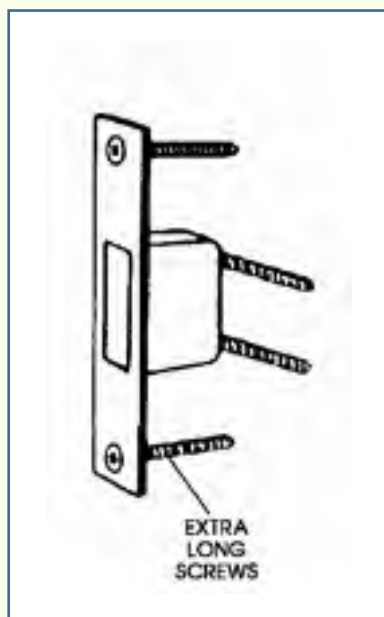


FIGURE 12—This figure shows a typical strike.

Strikes

The *strike* is the metal plate applied to the frame of a door to receive the projected bolts or latches of a lock. Figure 12 shows a typical strike. Note that the projecting lip of the strike should be long enough to protect the door jamb from being marred by bolts and latches, but it shouldn't be so long that it can catch on clothing.

FIGURE 13—Note the extra-long screws in this high-security strike.



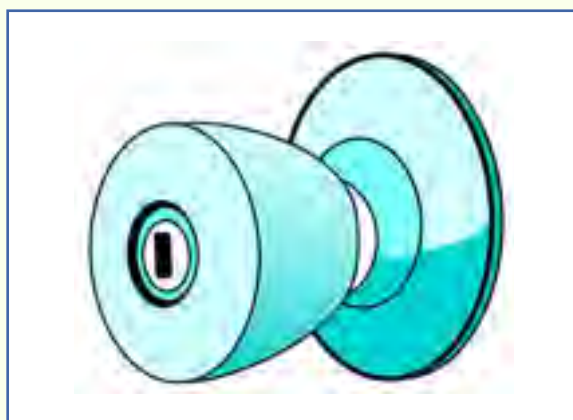
In the most common form of housebreaking, the intruder doesn't bother picking, drilling, or removing the lock: rather, he simply kicks the strike loose from the two simple wood screws that hold it in place. A *high-security strike* (Figure 13) can frustrate such break-ins. The four long screws anchor the strike to the doorjamb, greatly increasing the strength of the overall locking system.

Doorknobs

Knobs are made of many materials: steel, brass, bronze, aluminum, porcelain, and plastic. In any lockset, the knob, shank, and rose (the round plate behind the knob) are made of the same material. A standard residential doorknob is shown in Figure 14. Knobs are usually rounded or ball-shaped and between $2\frac{1}{4}$ inches and $2\frac{1}{2}$ inches in diameter. Plastic knobs are used for inexpensive installations. Brass or bronze knobs

are usually used in better-quality installations. The best knobs are cast in one piece. Others are assembled from several pieces, usually an interior steel shell over which a covering of brass is tightly drawn.

FIGURE 14—Standard Doorknob Shape



In most door installations, a lever handle (Figure 15) can be used in place of a standard knob. The shank and handle are made of one piece of metal, either steel or brass. The handle is usually from 2 inches to $3\frac{1}{2}$ inches long.

FIGURE 15—A lever handle such as this one can be used instead of a standard round doorknob. These handles are useful for anyone who has difficulty grasping a round knob.



Lever handles are very useful for people who can't grasp a standard round doorknob. Disabled persons, people with arthritis, or patients in a hospital may all benefit from the installation of lever handles. The Americans With

Disabilities Act has mandated the installation of lever handles in many buildings and facilities to provide equal access for disabled persons.

The thumbturns shown in Figure 16 can be used in simple dead bolt locks. A *thumbturn* replaces the doorknob on the inner side of a door.

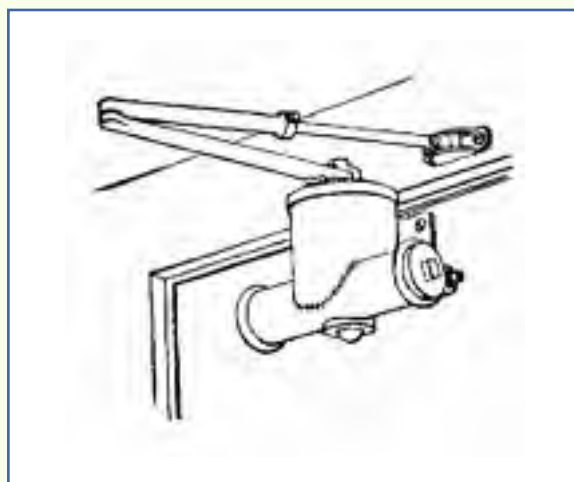
FIGURE 16—These thumbturns can be used with any dead bolt lock.



Door Closers, Holders, and Stops

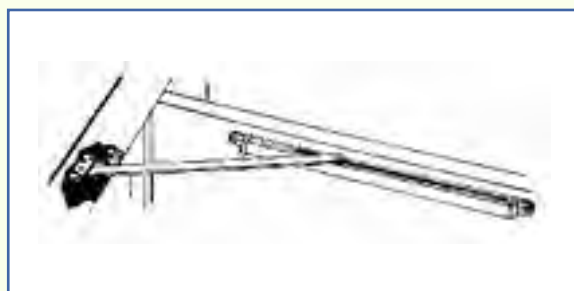
A *door closer* is a mechanism that closes a door and also controls the speed at which it closes to prevent it from slamming. A typical overhead door closer is shown in Figure 17. There are various sizes of door closers. For ordinary conditions, you should select the closer size recommended by the manufacturer for the width of the door. Heavy exterior doors and doors subject to strong drafts will require closers of larger size.

FIGURE 17—Door Closer



Overhead *door holders* are used to prevent doors from being opened too far and also to hold them in the open position when desired. They may be of the surface or concealed type. A door holder is shown in Figure 18.

FIGURE 18—Door Holder



A *doorstop* (Figure 19) is used to limit the opening swing of a door so that the door won't strike a wall or other objects. The doorstop may also be constructed to hold the door in an open position. It is

then known as a door holder. Any type of doorstop must be securely anchored to the floor.

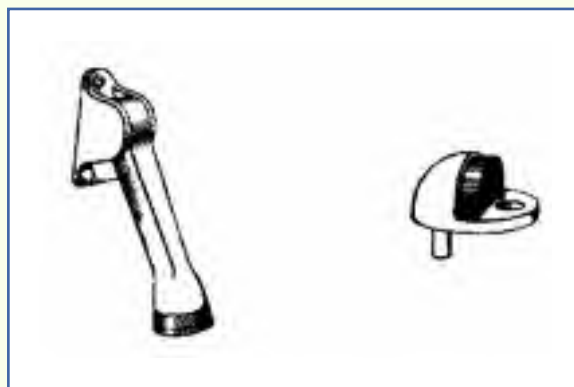
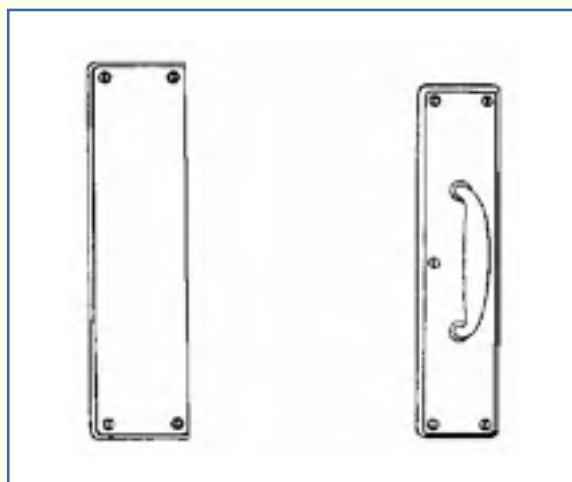


FIGURE 19—Doorstop

Push Plates, Door Pulls, and Kick Plates

Some doors require *push plates* and *pulls* instead of knobs. These devices are shown in Figure 20. The doors that open into the hall of a school building, for instance, are never locked and are held in a closed position by closers. These doors use push plates on one side and pulls on the other.

FIGURE 20—Push Plates and Door Pulls



A push plate is best located with its center about 4 feet 2 inches above the floor.

A *kick plate* (Figure 21) is a flat metal plate applied to the lower surface of a door to protect the finished surface from damage and wear. Kick plates

are used chiefly for doors in high-traffic areas. The plates are made of sheet brass, aluminum, or stainless steel, and are usually 8 inches to 10 inches high and the full width of the door.

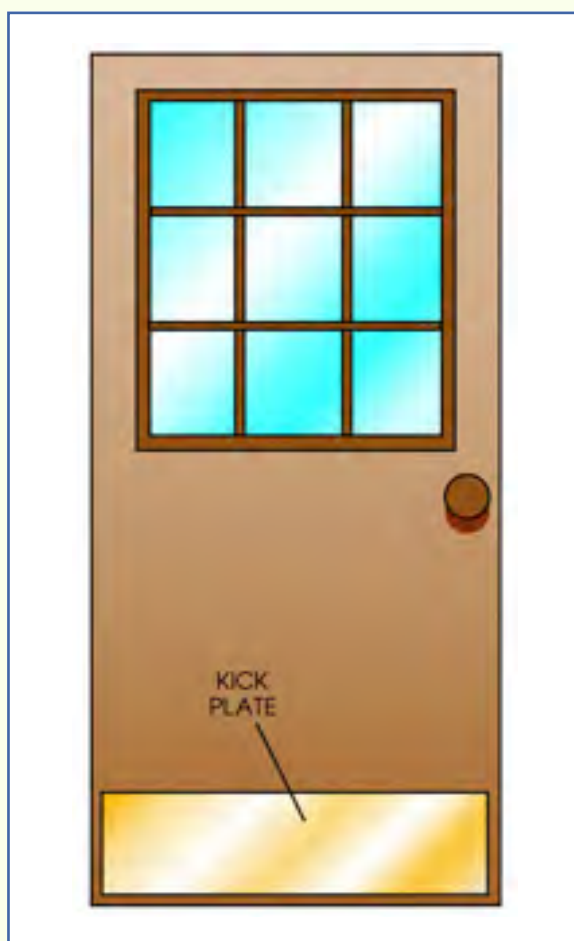
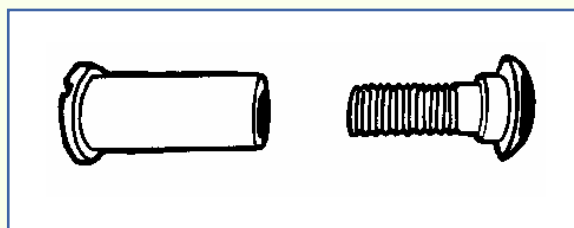


FIGURE 21—Kick Plate

Door Viewers

A *door viewer* (Figure 22) is a device installed in a door that lets the person inside see visitors before opening the door. A wide-angle lens is installed in the door viewer so that the person looking out can have a wider field of vision. The wide-angle lens has the opposite effect from the outside. If you try to look into a residence through a door viewer, you'll have only a pencil-thin field of vision!

FIGURE 22—Door Viewer



The Hand of a Door

In order to install a door lock, you must know the *hand* and *bevel* of the door. The *hand of a door* refers to the manner in which the door is hung in its frame. The hand is determined by looking at a door from the *outside*. (When looking at a door located between two interior rooms, you would look at the side on which the hinge knuckles *aren't* visible.)

When you stand outside a door, if the hinges are on the left-hand side, the door is a *left-hand door*. If the door swings *away* from you, the hand is *left-hand regular*. The usual abbreviation for a left-hand regular door is LH.

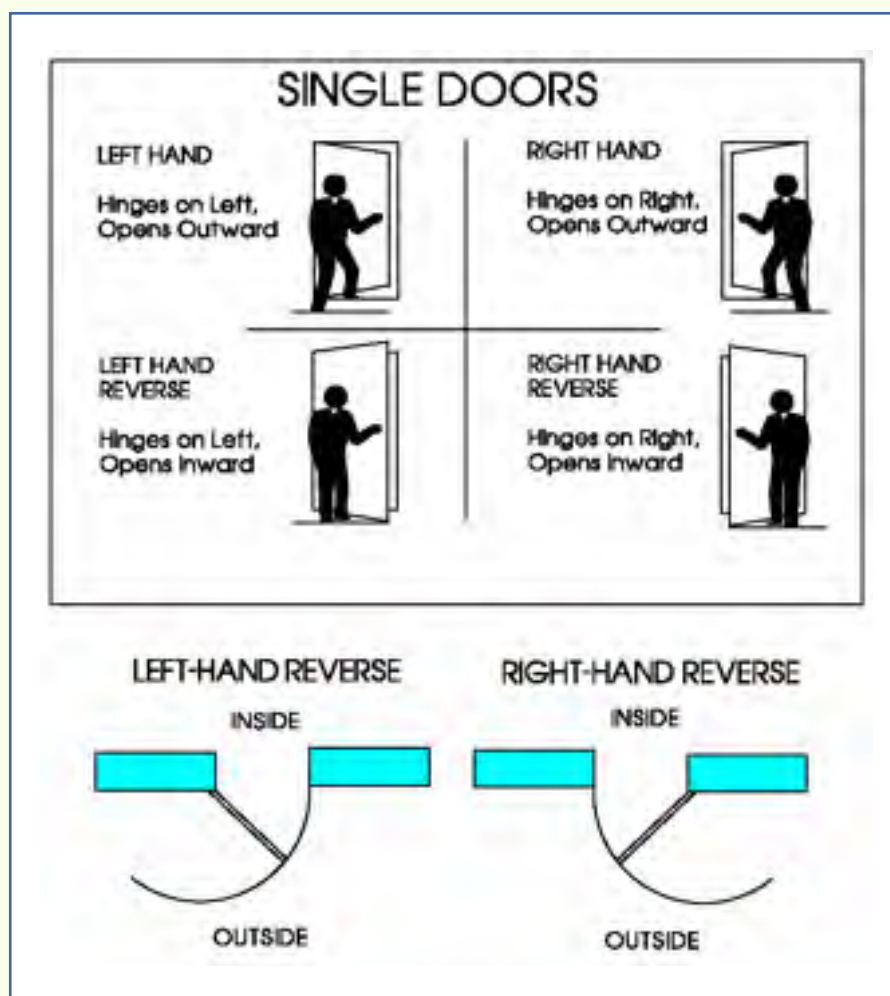
If the hinges are on the right-hand side, the door is a *right-hand door*. If the door swings away from you, the hand is *right-hand regular*. The usual abbreviation for a right-hand regular door is RH.

If the hinges are on the left and the door swings *toward* you, the hand is *left-hand reverse*. The usual abbreviation for such a door is LHRB. If the hinges are on the right and the door swings *toward* you, the hand is *right-hand reverse*. The usual abbreviation for such a door is RHRB.

Figure 23 shows you how to determine the hand of a door and where to place the lockset on each type of door.

The hand of a door will affect where a doorknob and lock must be installed. In order for a latch to work properly, the *beveled* edge of the latch (the slanted edge) must hit the strike plate and slide into the strike. The beveled side of the latch “gives,” whereas the other solid side doesn’t. Consequently, when installing a lockset, the locksmith must take care that the bevel of the latch faces the correct way.

FIGURE 23—The hand of a door will affect where you install the lockset.

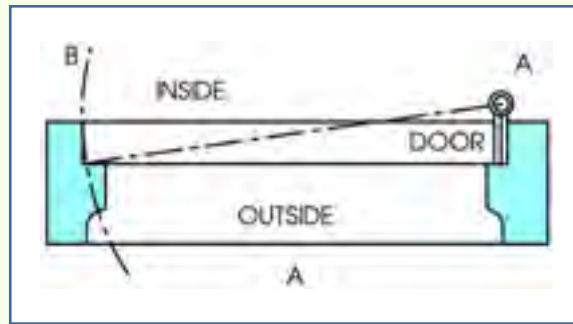


Some hardware pieces are made so that they can be used on either a right- or left- hand door. Others require that the hand of the door be given in the specifications. Most new door locks are equipped with reversible latches. This means that you can turn the latch over when installing it to make the beveled edge face in the correct direction.

Door Bevel

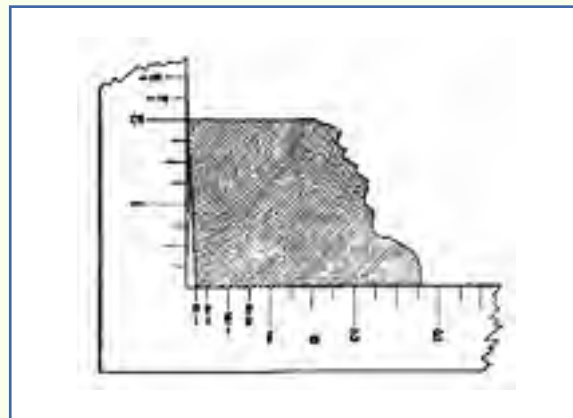
Figure 24 shows the path of a swinging door. Note that if this door had a perfectly squared edge, you wouldn't be able to swing the door freely and close it tightly. For this reason, if the door is to close tightly, the edge of the door must be *beveled* (trimmed slightly at an angle). The outside face of the door is made $\frac{1}{8}$ inch shorter than the inner face, as illustrated in Figure 25, which shows a steel square applied to the edge of a door.

FIGURE 24—Look at the path of this swinging door. Note that if the edge of the door was perfectly squared, you couldn't swing the door open or close it properly.

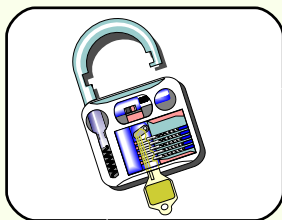


If the door isn't beveled, the door must be hung more loosely in the frame to provide a closing allowance. In most ordinary work, doors that are $1\frac{3}{4}$ inch or more in thickness should be beveled.

FIGURE 25—The measuring square applied to the edge of this door shows how a door is beveled.



Now, before proceeding to the next section of your text, take a few moments to complete *Locking It Up! 2* on the following page.



Locking It Up! 2

Fill in the blanks in each of the following statements.

1. _____ hardware refers to those items that are a visible part of a building, such as locks, hinges, door closers, and other door trim.
2. The flat parts of a hinge that contain the screw holes are called the _____.
3. A _____ has extra-long screws that anchor it to a doorjamb, greatly increasing the strength of the door locking system.
4. _____ are very useful for people who can't grasp a standard round doorknob.
5. A _____ is a mechanism that controls the speed at which a door closes to prevent it from slamming.
6. A _____ hinge has one leaf mortised into the edge of the door and the other leaf mortised into the door frame.
7. If a door is more than 5 feet high, it should be hung on _____ hinges.
8. A _____ is used to limit the opening swing of a door so that the door won't strike a wall or other objects.

Check your answers with those on page 73.

RESIDENTIAL LOCKS

Locksets

The term *lockset* refers to a complete door opening set including the knob, latch, bolt, strike, and lock cylinder. Locksets are offered by many different manufacturers and are the most popular residential door-opening devices today. For this reason, any locksmith should be very familiar with all types of locksets.

In this section of the text, we'll discuss several types of popular locksets including the key-in-knob lockset, entrance handleset, and deadlock. We'll look at how these locks are constructed, their principal parts, and how they're installed. Naturally, since there are so many different products on the market today, we can't cover the design of every manufacturer's products. However, we can provide you with general information that can be applied to just about any lockset. Let's start by examining the most popular lockset, the key-in-knob.

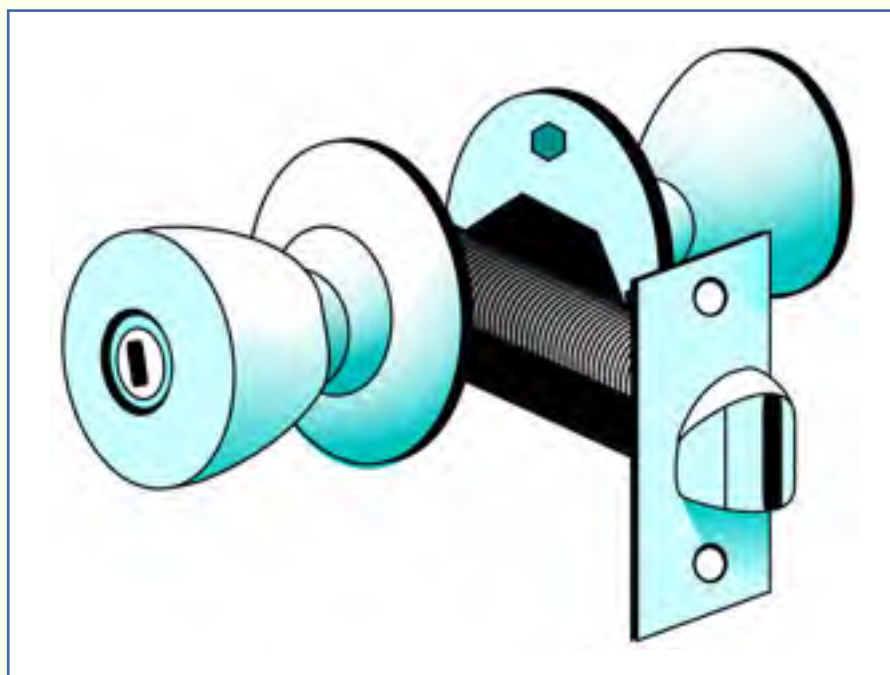
Key-in-Knob Locksets

As its name suggests, a *key-in-knob lockset* is a complete door opening set that contains a lock cylinder in the doorknob. The lock is opened by turning a key in the doorknob. The key-in-knob is the most popular residential lock on the market today, and is available from many manufacturers, including Kwikset, Schlage, Dexter, Weiser, and Corbin. The range of available styles, sizes, and security features is practically unlimited. The locksets made by these major manufacturers are all of high quality. In general, the inexpensive models you'll see for sale in local hardware stores are of medium quality; the name-brand, high-quality locksets are available only through locksmith suppliers.

Construction of a Key-in-Knob Lockset

Figure 26 shows an exterior view of a typical residential key-in-knob lockset, also called a *cylindrical lockset*. This name refers to the cylindrical shape of the main body of the lock and the cylindrical hole that must be drilled in a door to accept the lock.

FIGURE 26— Key-In-Knob Lockset



In a key-in-knob lockset, the outside doorknob is opened and locked using a key. The inside doorknob usually contains a turnpiece or a pushbutton to lock the door from the inside. Many key-in-knob locksets also contain *deadlocking pins*. Since the key-in-knob lockset has no dead bolt, the deadlocking pin is added to provide the protection and security of a dead bolt. A deadlocking pin makes the lockset virtually impossible to jimmy open with a credit card.

The length of the latch will also determine the security of a lockset. A longer latch that sits more deeply in a strike will be more difficult to force open than a short latch. The length of any latch or bolt should be at least $\frac{1}{2}$ inch; for highest security, a length of 1 inch or more is preferable.

An exploded view of the interior parts of a typical key-in-knob lockset is shown in Figure 27. Examine all the parts closely. Note that the drawing contains two sections. The body assembly is shown first—the body contains the majority of the important parts of the lock. The second section of the drawing contains the trim assembly. The fully-assembled body is shown at the center of the trim assembly drawing.

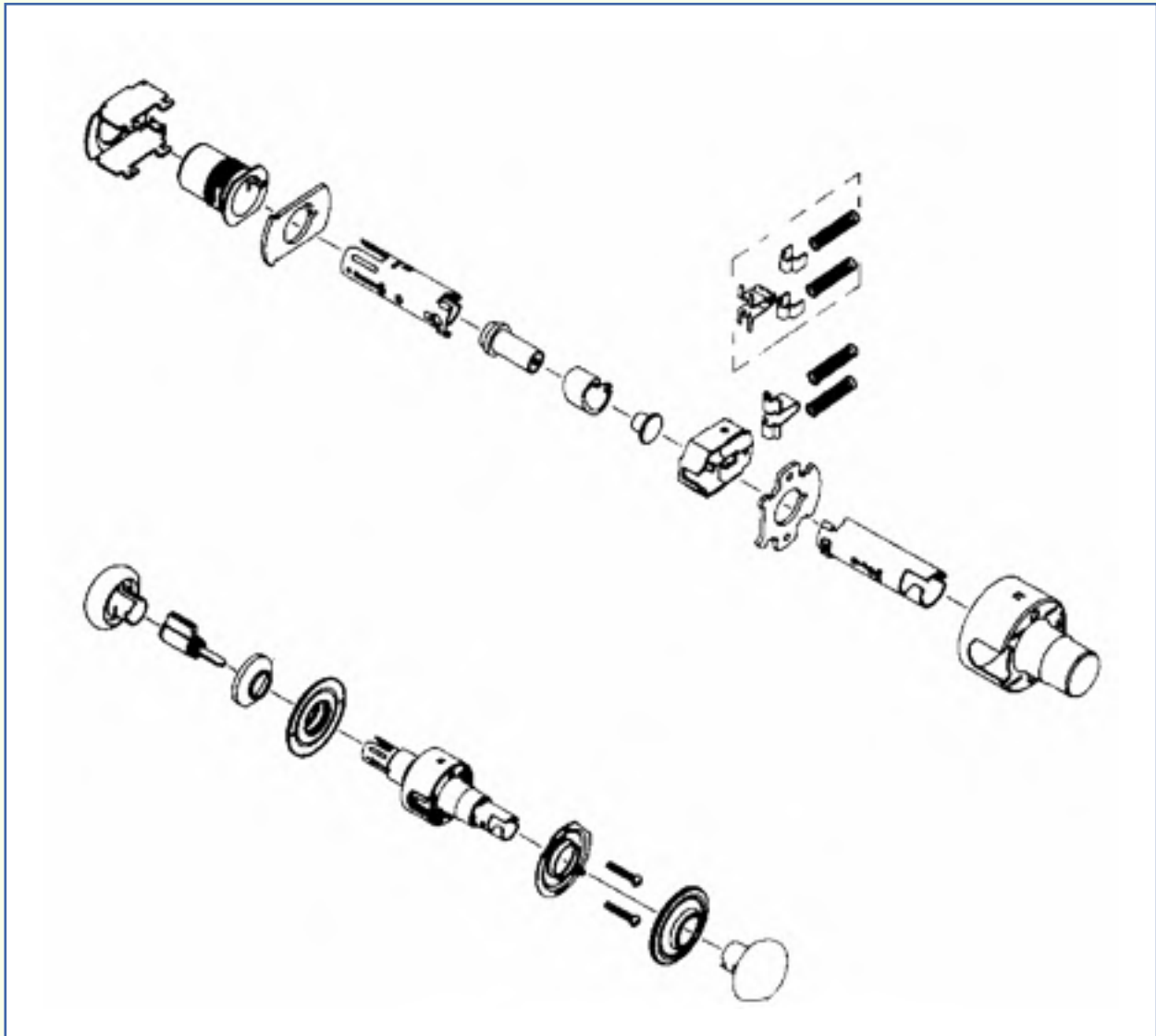


FIGURE 27—Exploded View of a Key-In-Knob Lockset

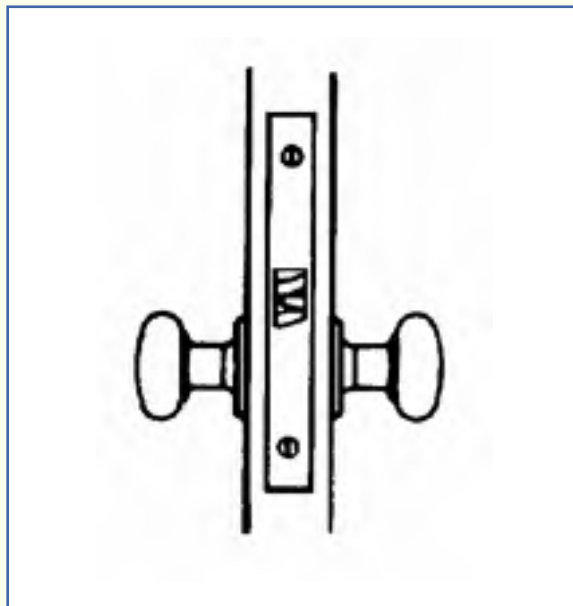
Look at the drawings and try to locate the most important parts of the lockset. Note the location of the doorknobs (both inside and outside) and the lock cylinder.

Lockset Applications

The American National Standards Institute (ANSI) tests, evaluates, and officially rates locksets according to strength and durability. Some locksets are classified as secure enough for exterior use; others are designed only for interior applications. Depending on the intentions of the building owner, locksets can be used in a variety of different ways to allow or prevent access to rooms. The following are a few possible lockset applications. Note that the placement of the doorknob

and lock cylinder(s) varies according to how the lockset is used. Keep these placements in mind when advising a customer on choosing a lockset.

FIGURE 28—This figure shows a closet door latch that is typically used in a storage closet.

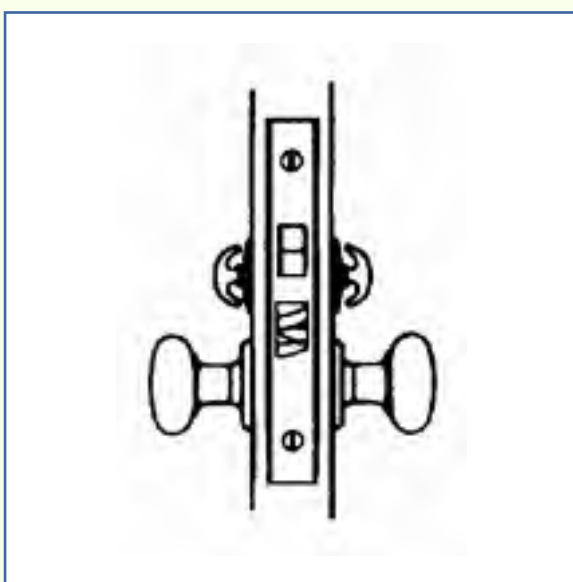


Closet Door Latch.

A closet door latch is a lockset that doesn't contain a lock cylinder (Figure 28). Therefore, no key is needed to open it; the door can't be locked—it can only be held closed by the latch. On the inside of the closet door, a second knob is provided to open the latch in case a child is accidentally trapped in the closet.

Usually, no security is needed on a closet door, but if a customer does want a locking closet, another type of key-in-knob lockset can easily be installed instead.

FIGURE 29—This figure illustrates a communicating door lock that is often used for doors that open between two hotel rooms.

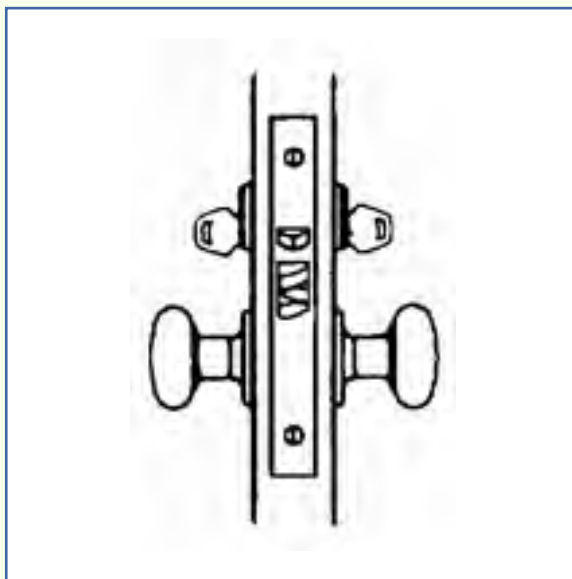


Communicating Door Lock.

A communicating door lockset contains two doorknobs and two turnpieces or push-buttons (Figure 29). The door can be locked from either side. To unlock the door, the locked knob must be turned to release the latch. A communicating door lock should only be

used on a door that opens between two rooms (such as connected rooms in a hotel) where each room also has *another* exit. A communicating door lock should never be used in a room that

FIGURE 30—Store Entry Lock



has no other exit, since someone could easily become accidentally locked and trapped in the room.

Store Entry Lock. This type of lockset is popular for use on entry doors in stores and other businesses. The lockset has two doorknobs and two lock cylinders (Figure 30). By inserting a key in

either cylinder, you lock or unlock the door *on both sides*. Thus, if you lock the door from the inside, the doorknob on the outside will be locked as well.

All-Purpose Lock. This type of lockset can be used for a variety of applications. The lockset contains two doorknobs. The inside knob is locked with a turnpiece or pushbutton and the outside knob is locked with a key (Figure 31).

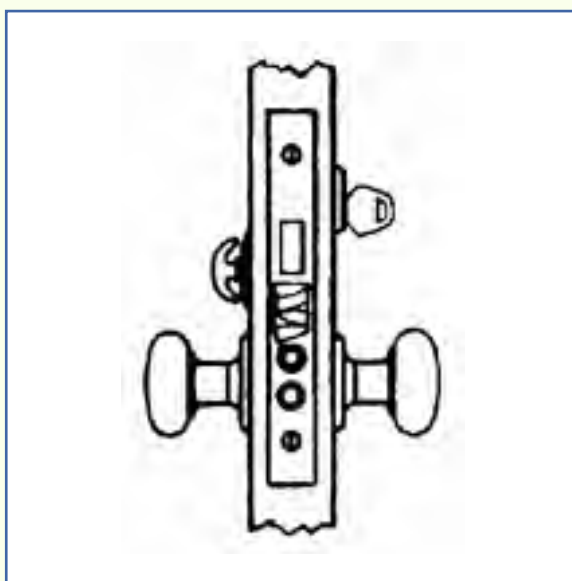


FIGURE 31—All-Purpose Lock

Note that these are only a few of the possible applications for a lockset. A wide variety of locksets with all possible features are available from locksmithing suppliers. Depending on the customer's needs, a locksmith should be able to provide and install any lockset. Figure 32 shows a list of some

useful questions to ask your customers. The answers to these questions will help you choose the proper lockset for your customer's needs.

FIGURE 32—When recommending a lockset to customers, always ask them these questions.

- Is the lockset for an exterior or interior door?
- Is the lockset for a new door, or is it replacing an existing lock?
- In the location where the lockset will be used, how important is security?
- Will the lockset be used with any auxiliary security devices (deadlatches, chains, etc.)?
- How much wear and tear will the lock be subjected to?
- Do you prefer a lockset that opens with a key only from the outside, or one that can be key-locked from both sides?
- Where are the hinges located, and does the door open inward or outward? (Determining the hand of the door)
- What (if any) cost limitations are there?
- Does the door have a metal core? (You'll need a special drill bit to drill through such a door.)

Entrance Handlesets

Entrance handlesets were briefly mentioned in an earlier study unit. A handleset is simply a lockset that has a long handle and a thumbpiece rather than a doorknob (Figure 33). The thumbpiece is pressed down to release the latch. Entrance handlesets are made of solid brass, or of another metal with

a brass, bronze, or chrome finish.

While the exterior appearance of the handleset is different from a key-in-knob lock, the two locks work in much the same way. The lock cylinder and the bolt are the same as on any other lockset. Some handlesets are made in one piece, with the deadlock incorporated in the unit. In other handlesets, the deadlock is a separate unit.



FIGURE 33—Entrance Handleset

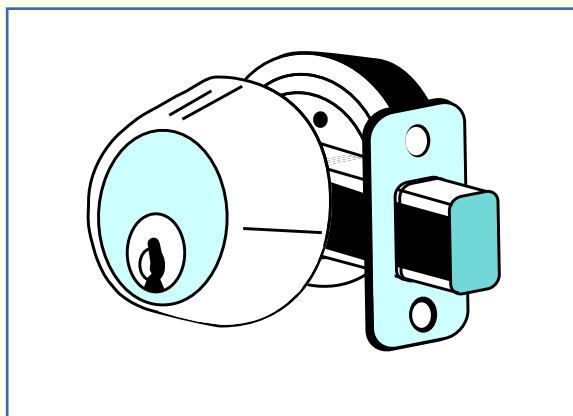
Auxiliary Door Locks and Latches

An *auxiliary lock* is a locking device that provides extra security on a door where a lockset is already in place. Auxiliary locks provide an extra obstacle to burglars: if they manage to get through one lock, they'll still need to break through another before they can get in. A wide variety of auxiliary locks are available for residential use, including sliding bolts, door chains, deadlocks and dead bolts, and rim latches. All of these locks are popular for different home uses; however, the deadlock and dead bolt are the most secure.

Dead bolts and Deadlocks

A *dead bolt* is a locking mechanism that works by throwing a square-ended metal barrier (the bolt) into a strike. A *deadlock* is simply a lockset that contains a dead bolt and a lock cylinder

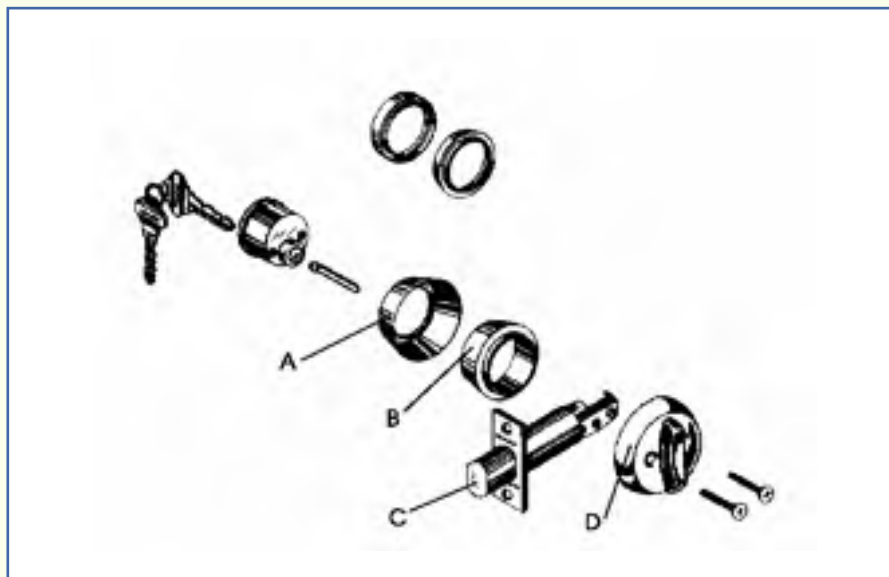
FIGURE 34—Deadlock



(Figure 34). The bolt can be thrown into place either by turning a key (on the outside of the door) or by turning a turnpiece (inside the door). The bolt is retracted in the same way.

Figure 35 shows an exploded diagram of a typical pin tumbler deadlock. As you look at Figure 35, note the location of the important parts of the deadlock. The lock cylinder holds the plug, just as it does in a key-in-knob lock. Part A in the diagram is the *security insert*. This sheath holds the lock cylinder tightly so that the cylinder can't be wrenched out of the door by force. Part B is the *trim ring*, which is simply the decorative outer case of the deadlock. Part C is the bolt itself. Part D is the *rose*, the plate that holds the turnpiece.

FIGURE 35—This figure shows an exploded diagram of a deadlock.



Deadlocks are classified according to strength and potential for intruder resistance. The three classifications are *standard-duty*, *high-security*, and *heavy-duty*. *Standard-duty* deadlocks are designed for use in ordinary residential situations.

A *high-security deadlock* is designed for both home and business applications. A high-security deadlock has hardened metal cylinders with anti-drill rods, ball bearings, and other devices to prevent forced entry. Often, even the rose (the decorative backplate) is made of hardened metal. The rose will simply spin on the cylinder if an attempt is made to force the lockset from the door.

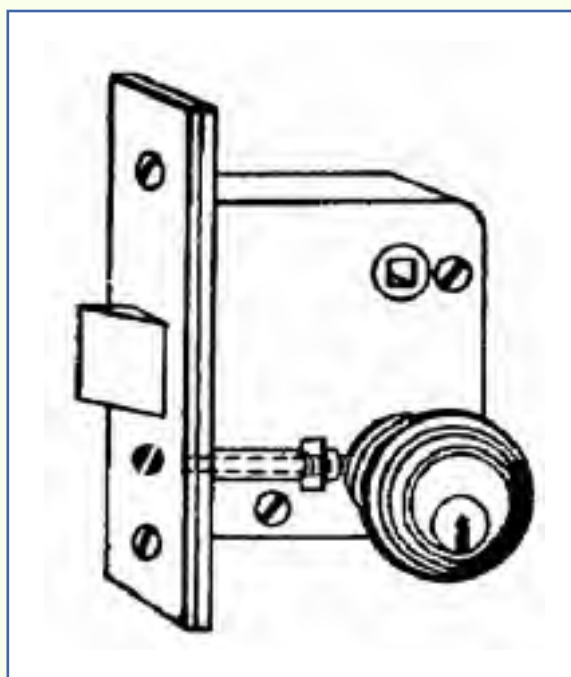


FIGURE 36—Mortise Cylinder Deadlock

A *heavy-duty deadlock*, on the other hand, is designed for years of use in high-traffic areas. The working mechanism inside a heavy-duty deadlock is much larger than that in a standard deadlock.

A *mortise cylinder deadlock* (Figure 36) is a type of deadlock that's installed in a cutout area in a door.

The lock contains a key-operated mortise cylinder that operates the bolt. Since a mortise deadlock is installed deeply in the door structure, it's very strong and provides excellent security.

In Figure 36, note how this deadlock has an *armored front* to provide extra security. The armored front is an "extra" faceplate that covers the *setscrew* and prevents it from being removed. The setscrew holds the cylinder firmly in place and prevents the cylinder from being tampered with.

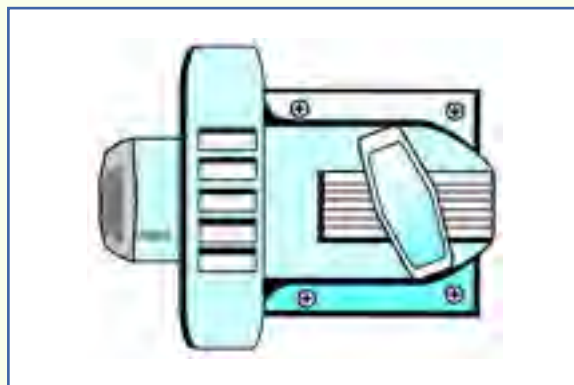
Rim Latches

The *rim latch* (Figure 37) is one of the most familiar auxiliary locks. This type of auxiliary lock is also called a *spring latch*

since the latch is kept in the extended (locked) position by the pressure of a strong spring. A rim latch is installed on the surface of a door and is used in combination with a lock cylinder. The cylinder is placed on the outer side of the door;

a key operates the latch from the outside. A small knob or turn-piece operates it from the inside.

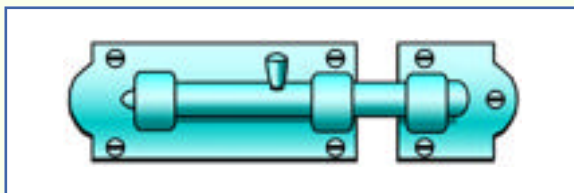
FIGURE 37—Rim Latch



Bolts and Safety Chains

The simplest kind of auxiliary locking device is the *sliding bolt* (Figure 38). These locks are often found on interior doors, closet doors, shed doors, and in other areas where less security is required.

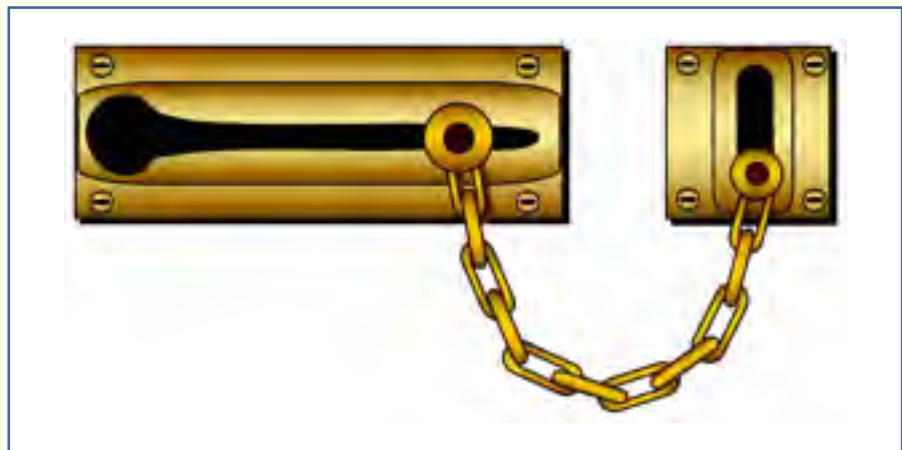
FIGURE 38—Sliding Bolt



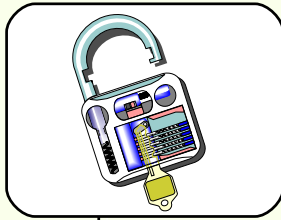
The *safety chain* (Figure 39) is another simple auxiliary lock. The chain is attached to the doorjamb and the *keeper* is fixed to the

door. With a safety chain in place, a person can open a door partway to look out at visitors while still maintaining

FIGURE 39—Safety Chain



some security. For at least as long as the screws hold out, the door can't be forced past that distance.



Locking It Up! 3

Indicate whether each of the following statements is True or False.

- ___ 1. A key-in-knob lockset is also called a *cylindrical lockset*.
- ___ 2. A sliding bolt is a lockset that contains a dead bolt and a lock cylinder.
- ___ 3. A store-entry lockset doesn't contain a lock cylinder.
- ___ 4. A communicating door lockset contains two doorknobs, each supplied with a pushbutton.
- ___ 5. A closet door lockset has two doorknobs, each with a lock cylinder.
- ___ 6. An entrance handleset is a lockset with a long handle and a thumbpiece rather than a doorknob.
- ___ 7. An *auxiliary lock* is a locking device that provides extra security on a door where a lockset is already in place.
- ___ 8. A rim latch is also called a *spring latch*.

Check your answers with those on page 73.

Disassembling a Key-in-Knob Lockset

If a key-in-knob lock is malfunctioning, you may need to disassemble it completely to perform repairs. The lock may need to be cleaned and lubricated, worn or broken parts may need to be replaced, or perhaps it just needs to be rekeyed. To perform services on the cylinder or plug of a lockset, the lockset will first need to be removed from the door and disassembled.

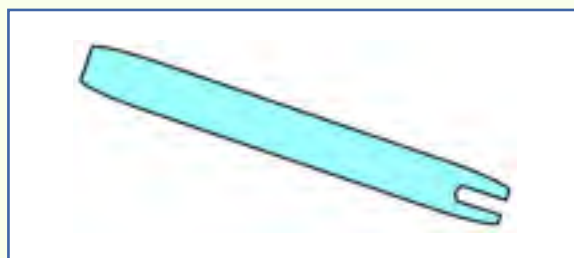
Although there are many different models of key-in-knob locks, most can be disassembled using the same basic steps.

To remove a lockset from a door, simply remove the screws from the *face plate*, the plate that holds the bolt in the edge of the door. Remove the screws from near the interior doorknob. Then, remove the doorknobs and the latch. Pick up the doorknob that has the lock cylinder in it (the one that's operated by a key) and prepare to disassemble it.

The following general steps can be used to disassemble most Kwikset pin tumbler key-in-knob locksets. The Kwikset brand of locks is very commonly found in homes and is therefore an excellent example for our study purposes here. (*Note:* Later in the course, you'll be performing a hands-on exercise in which you actually disassemble and rekey a Kwikset key-in-knob lockset. At that time, you'll follow these same steps.)

Step 1: The first step is to remove the spindle. This step requires the use of a tool called a *cylinder removing tool* (Figure 40). You can substitute a flat-blade screwdriver, if necessary. Insert the rounded end of the tool under the spring clip housing and press in firmly on the retainer clip (Figure 41). Turn the lockset upside down, and the spindle will fall out (Figure 42).

FIGURE 40—Cylinder Removing Tool



Step 2: Insert the forked end of the cylinder removing tool into the hole that the spindle just came out of (Figure 43). Press the tool in as far as it will go, and push hard (Figure 44). The cylinder should fall out into your hand (Figure 45).



FIGURE 41—Insert the rounded end of the tool under the clip housing as shown here, and press in on the retainer clip.



FIGURE 42—Turn the lockset over, and the spindle will fall out.



FIGURE 43—Insert the forked end of the cylinder removing tool into the lockset as shown.



FIGURE 44—Press the tool in as far as it will go, and push hard.

FIGURE 45—The cylinder should pop out into your hand.



Step 3: Once you've removed the lock cylinder from the door-knob, you'll be able to perform any necessary service on it. You'll need to remove the plug from the cylinder to perform services on it. To remove the plug, use the forked end of the cylinder removing tool to loosen the plug retainer clip (Figure 46).



FIGURE 46—Use the forked end of the cylinder removing tool to loosen the plug retainer clip.

Step 4: Once the plug retainer clip is removed, insert the key into the keyway, and turn the key one-half turn in either direction.

Step 5: You're now ready to withdraw the plug from the cylinder. *YOU MUST* use a plug follower to help slide the plug out of the cylinder. Place the plug follower against the back of the lock cylinder (Figure 47). Make sure the end of the follower is touching the back of the plug. Withdraw the plug by pulling gently on the key bow. As you withdraw the plug, push the follower all the way into the cylinder. The follower has now taken the place of the plug and is holding the top pins and springs in place (Figure 48).



FIGURE 47—Place the plug follower against the back of the cylinder, and make sure it's touching the back of the plug.



FIGURE 48—Withdraw the plug and replace it with the plug follower at the same time.

Step 6: Now that the plug is out of the cylinder, you can perform any needed services on it. Clean the plug, rekey it, or replace any worn-down pins. Then, clean and lubricate the lock cylinder if needed, following the instructions in Study Unit 2.

Step 7: To reassemble the lockset, carefully return the plug to the cylinder, withdrawing the plug follower as you do so.

Step 8: Hold the plug in the cylinder with your finger, and carefully withdraw the key.

Step 9: Reattach the plug retainer clip.

Step 10: Return the cylinder to the doorknob and snap it into place.

Step 11: Reinsert the spindle into the lockset.

Step 12: Complete your work with the lock by testing the lock and key thoroughly to be sure that it works properly.

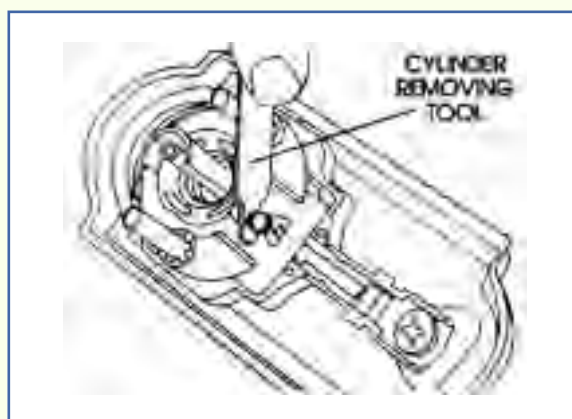
Disassembling a Handleset

The process of disassembling a handleset is very similar to that used for a key-in-knob lock. The following steps can be used to disassemble a Kwikset pin tumbler handleset:

Step 1: Use a cylinder removing tool (or a flat-blade screwdriver) to compress and remove the latch spring. The removal of this spring will reveal the location of the cylinder housing screw.

Step 2: Remove the *two* cylinder-housing screws with a screwdriver. These screws hold the lock cylinder housing to the handleset (Figure 49).

FIGURE 49—Remove these two screws to release the lock cylinder housing.



Step 3: Lift out the cylinder housing. Turn the housing over, and the lock cylinder will fall into your hand.

Step 4: You'll now need to remove the plug from the cylinder to service it. To remove the plug, use the forked end of the cylinder removing tool to loosen the plug retainer clip.

Step 5: Once the plug clip is removed, insert the key into the keyway, and turn the key one-half turn in either direction.

Step 6: Withdraw the plug from the cylinder. *YOU MUST* use a plug follower to help slide the plug out of the cylinder.

Step 7: Now that the plug is out of the cylinder, you can perform any needed services on it. Clean the plug, rekey it, or replace any worn-down pins. Then, clean and lubricate the latch mechanism and the body of the handleset if needed, following the instructions in Study Unit 2.

Step 8: To reassemble the lockset, carefully return the plug to the cylinder, withdrawing the plug follower as you do so.

Step 9: Hold the plug in place in the cylinder with your finger, and carefully withdraw the key.

Step 10: Reattach the plug retainer clip.

Step 11: Return the lock cylinder to its housing, place the housing back in the handleset, and reinstall the two screws and the latch spring.

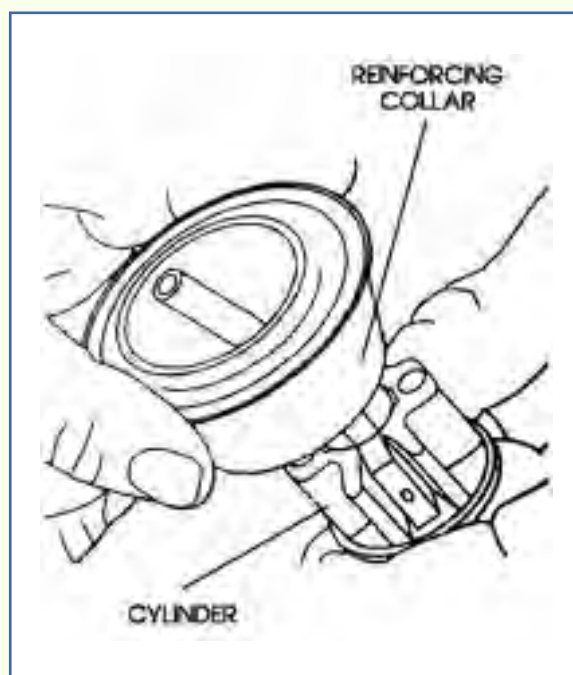
Step 12: Complete your work by testing the lock to be sure it operates properly.

Disassembling a Dead Bolt Lock

To perform services on a dead bolt lock, it may need to be removed from a door and disassembled completely. To remove a dead bolt lock from a door, simply remove the screws from near the inside turnpiece and from the face plate. Once the lock has been removed from the door, the procedure for disassembling the dead bolt lock is very similar to that used for a lockset. Follow these steps to disassemble a dead bolt lock:

Step 1: Turn the lock face down and remove the trim ring and the security insert from around the cylinder (Figure 50). The lock cylinder should fall out into your hand.

FIGURE 50—Remove the trim ring and the security insert from the deadlock, and the lock cylinder will fall into your hand.



Step 2: Once you've removed the lock cylinder from the door-knob, you'll be able to perform any necessary service on it. You'll need to remove the plug from the cylinder to perform services on it. To remove the plug, use the forked end of the cylinder removing tool to loosen the plug retainer clip.

Step 3: Remove the retainer clip.

Step 4: Instead of a spindle, the deadlock has a turning blade. Lift out the turning blade from the back of the lock cylinder.

Step 5: Insert the key into the keyway, and turn the key one-half turn in either direction.

Step 6: Withdraw the plug slowly from the cylinder. **YOU MUST** use a plug follower to help slide the plug out of the cylinder.

Step 7: Now that the plug is out of the cylinder, you can service it. Clean the plug, rekey it, or replace any worn-down pins. Then, clean and lubricate the lock cylinder if needed, following the instructions in Study Unit 2.

Step 8: To reassemble the lockset, carefully return the plug to the cylinder, withdrawing the plug follower as you do so.

Step 9: Hold the plug in place firmly with your finger, and carefully withdraw the key.

Step 10: Place the lock face down and reattach the turning blade to the back of the lock.

Step 11: Reattach the plug retainer clip.

Step 12: Reinsert the cylinder into the security insert and the trim ring.

Step 13: Complete your work with the lock by testing the lock and key thoroughly to be sure that it works properly.

Like other surface-mounted locks, deadlocks require periodic tightening of the screws. A sticking bolt can usually be corrected by cleaning the bolt or latch mechanism and lightly lubricating it.

Installing a Residential Lockset

The following general directions will instruct you in the steps needed to install a standard residential deadlock or key-in-knob lockset. Note, however, that these are only *general* instructions. Depending on the lock you purchase, the installation instructions may vary slightly. Always follow the *manufacturer's* installation instructions that are supplied with a lock.

If you're installing a lock in a new door, you'll need to cut holes in the door to accept the lock. In order to cut these holes

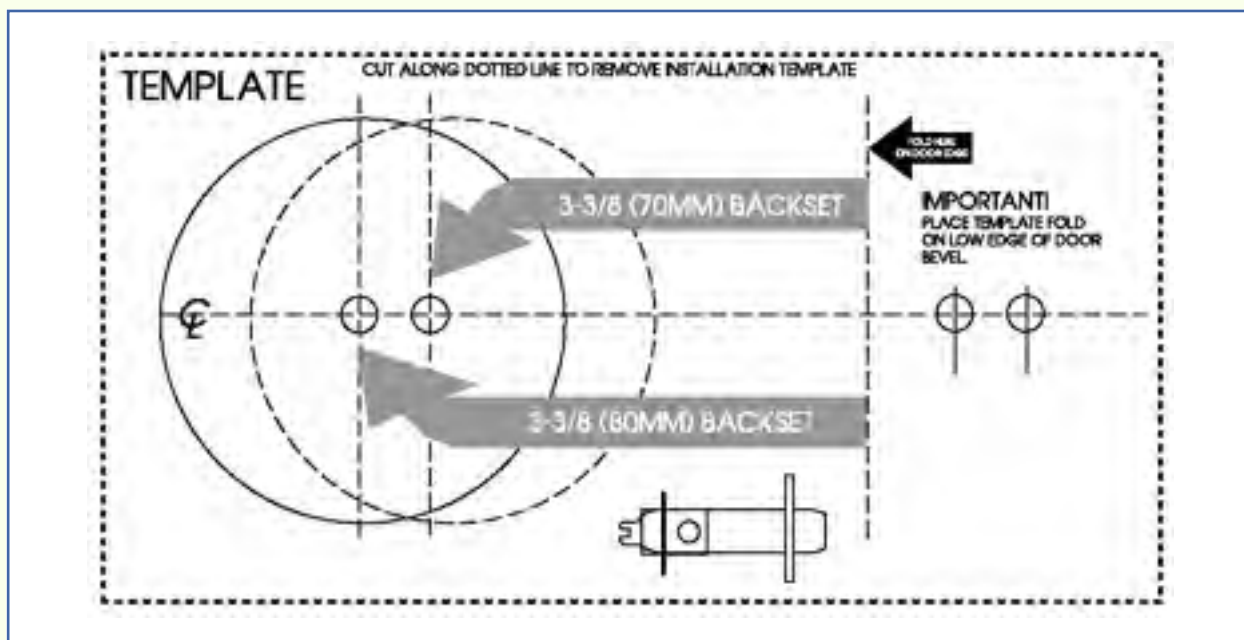


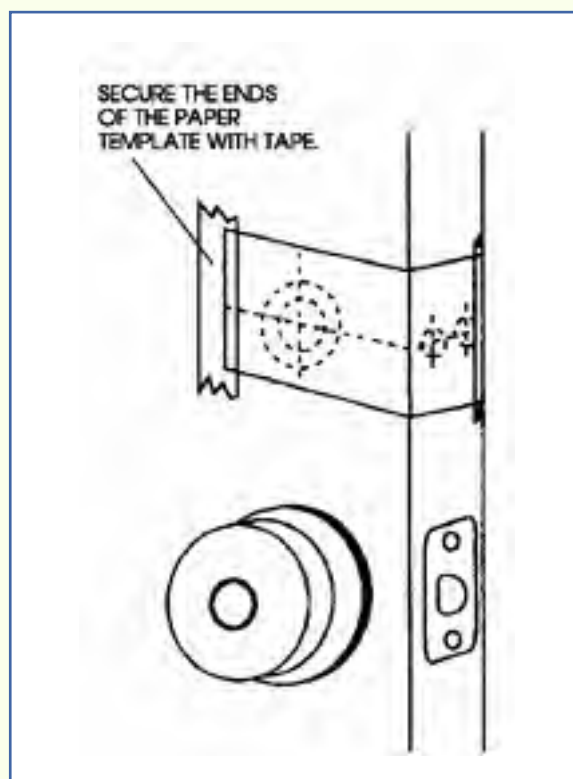
FIGURE 51—Lock Installation Template

with complete accuracy, you should *always* use the template supplied with the lock by the manufacturer.

A *template* is a printed paper guide that's included with the purchase of any door lock (Figure 51). The template will show you where you need to cut holes in a door to install the lock. The template is marked for different door thicknesses so that it can be used on any door. The template is folded and taped to the door to show you where to cut the holes.

Step 1: To use the template, first determine the thickness of the door you're working on. Then, look at the template and find the dotted lines that indicate the size of your door. Fold the template carefully on those lines. Fold the template around the edge of the door where the lock will go, and tape the template in place (Figure 52).

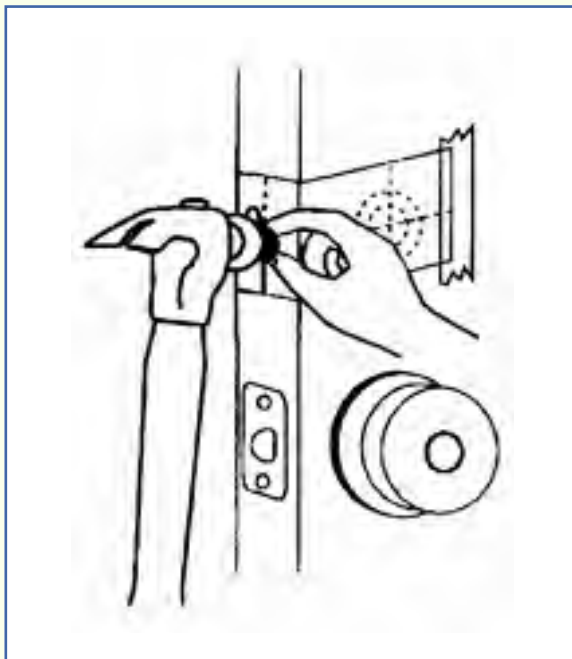
FIGURE 52—Fold the template around the edge of the door, and tape the template in place.



If you're installing a key-in-knob lockset, tape the template exactly where the doorknob will go. If you're installing a lockset, the template should be placed so that the centerline of the knob is about 36 inches (914 mm) from the floor. If you're installing a deadlock, tape the template about 6 inches above the existing doorknob.

Step 2: Now, using a hammer and nail or a center punch, mark the spots where the doorknobs and the latch or bolt will go (Figure 53). The template will be printed with the exact locations for the holes to be punched. Simply press the nail or the center punch through the paper template. Press hard enough to leave a visible mark on the wood of the door beneath the template. After your holes are marked, remove the template.

FIGURE 53—Mark the spots where the doorknob and the latch will be placed.



Step 3: The next step will be to drill the needed hole for the lockset. Close the door or use a doorstop to hold the door firmly in place. Use an electric drill and a hole saw attachment of the proper size recommended by the lock manufacturer. Before beginning to drill, note the following tips:

Always follow the drill manufacturer's operating instructions.

- Wear protective eye covering when drilling.
- Make sure the drill bit is sharp, securely attached to the drill, and the *correct size* for the job.
- Make pilot holes to guide the drill.
- Keep the door closed or otherwise secured while drilling.
- Drill slowly. Don't force the drill; let the bit take it through.
- When using a hole saw with a drill, stop frequently to clear sawdust and wood debris from the saw.

- To prevent the hole in the door from splintering, drill through the door only until the saw just breaks through to the other side. Then withdraw the drill, go to the other side, and complete cutting the hole from that side.

Now, you're ready to cut the hole that will hold the doorknob. When you're prepared to start, position the hole saw carefully in the spot you marked on the main surface of the door (Figure 54). Start to run the drill very slowly. Drill through the door until the hole saw emerges on the other side of the door, then stop the drill. Remove the drill, reposition the hole saw on the other side of the door, and start drilling again. By drilling from both sides in this way, you'll ensure that a smooth hole will be cut.

FIGURE 54—Cut the hole for the doorknob using a hole saw attachment on an electric drill.



Step 4: Next, you'll need to drill the hole that will hold the bolt or latch. A special bit called a *spade bit* will be used on the drill to make the hole (Figure 55). If possible, attach a drill guide to your drill to hold the bit straight while you cut. The latch hole must be exactly horizontal. Start the drill bit in the mark you made on the edge of the door, and cut the hole.

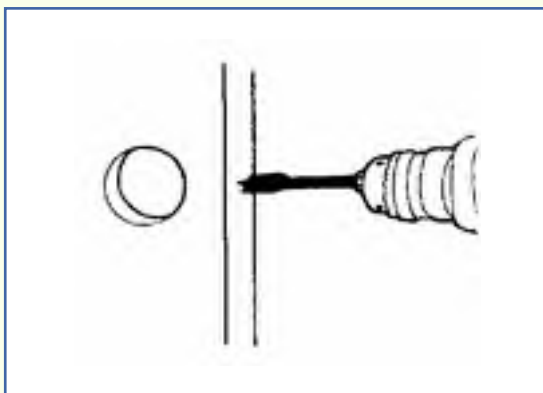
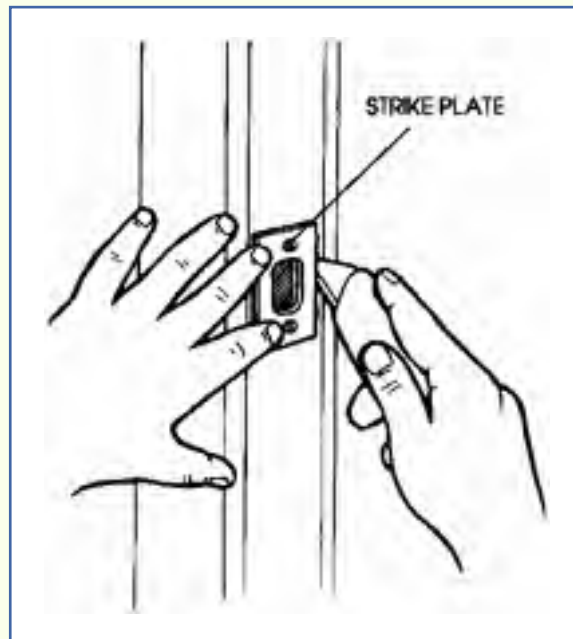


FIGURE 55—Drill the hole for the latch using a spade bit.

Step 5: The next step will be to cut a shallow depression (about $\frac{1}{8}$ inch deep) in the door to hold the face plate. You'll use a standard 1-inch wide wood chisel to do this. Before you cut, however, you'll need to mark the area to be cut.

Insert the latch or bolt into the hole you cut in Step 4. Hold the face plate in place over the bolt. With a sharp utility knife, a pencil, or a scribe, trace around the face plate to create a visible outline (Figure 56). Remove the face plate and bolt. You should be able to easily see the outline of the face plate.

FIGURE 56—Trace an outline around the face plate.



Step 6: Now, use your wood chisel and carefully cut out the shallow depression to hold the face plate (Figure 57). The depression you cut should only be deep enough to hold the face plate flush with the edge of the door. Be careful to stay within the outline as you cut, and don't dig too deeply with the chisel.

When you've completed the chiseling of the depression for the face plate, the door should look like the one shown in Figure 58.

FIGURE 57—Use a 1-inch chisel to cut a depression for the face plate.

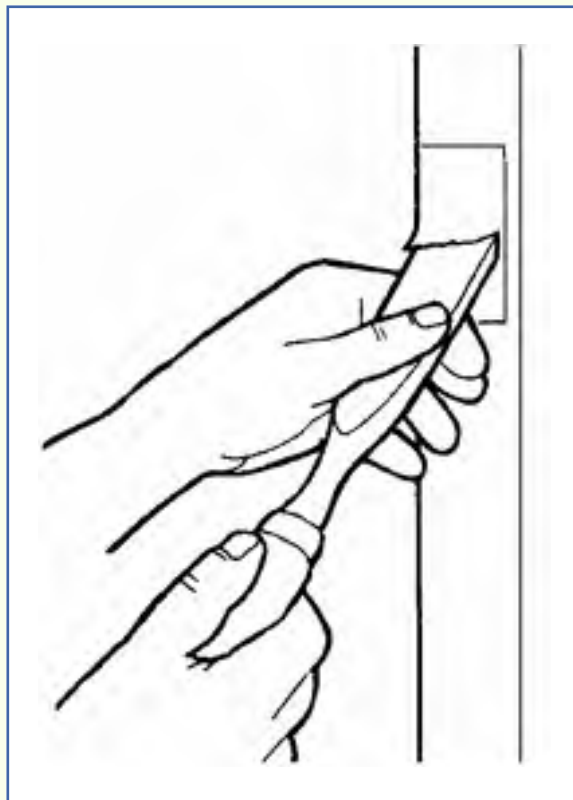
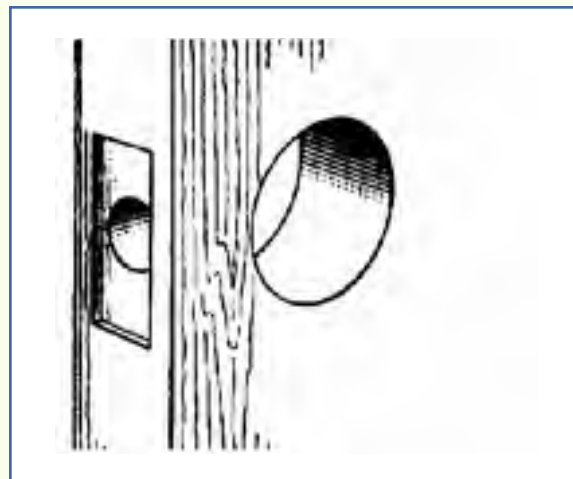
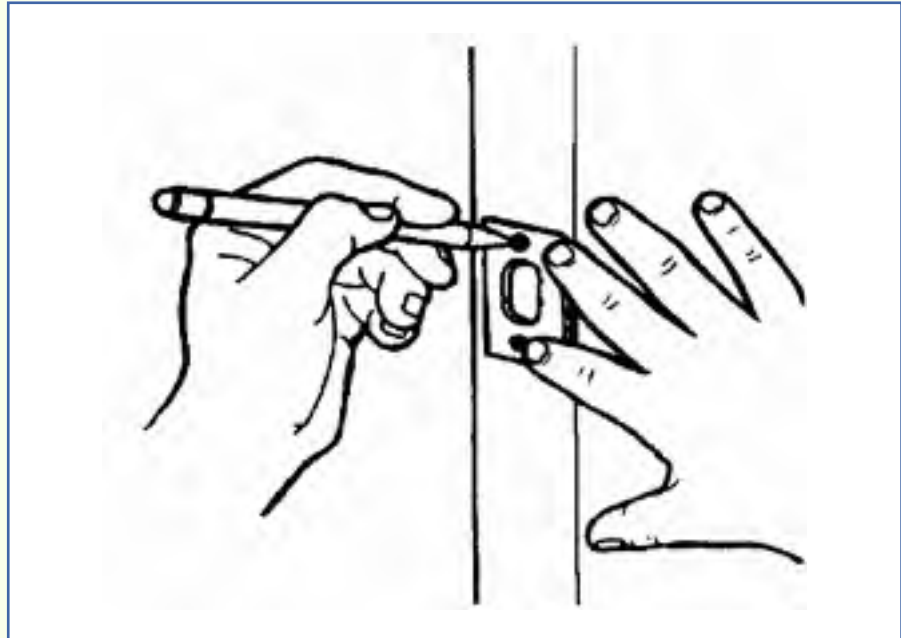


FIGURE 58—After chiseling out the depression for the face plate, the door should look like this.



Step 7: Insert the latch or bolt assembly into the hole again. Place the face plate over the bolt and hold it there. Using a sharp pencil, mark the location for the face plate screws (Figure 59). Use a hammer and nail, a center punch, or a small drill bit to start the screw holes.

FIGURE 59—Mark the location for the face plate screws.



Step 8: Then, install the latch and tighten the screws. Your installation of the bolt assembly is now complete.

Step 9: The next step will be to install the rest of the lock. Slide the lock into the hole you cut for it. The lock spindle must be inserted through the slot in the latch (Figure 60). Make sure you place the key-operated side of the lock on the exterior of the door.

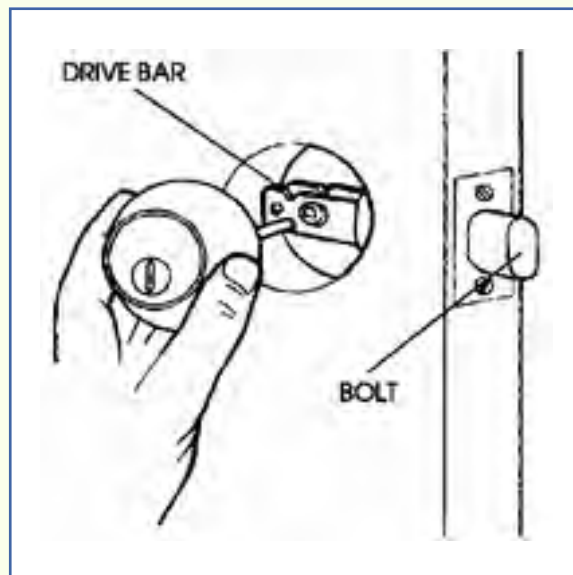
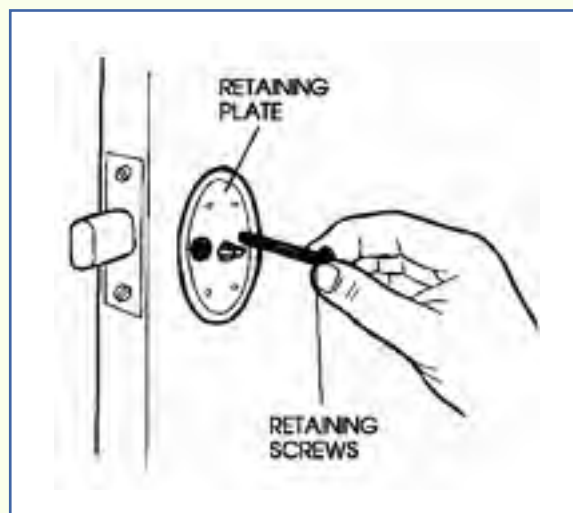


FIGURE 60—Install the main part of the lock.

Step 10: On the interior of the door, install the retaining plate and screw it into place (Figure 61).

FIGURE 61—Install the retaining plate and screw it into place.



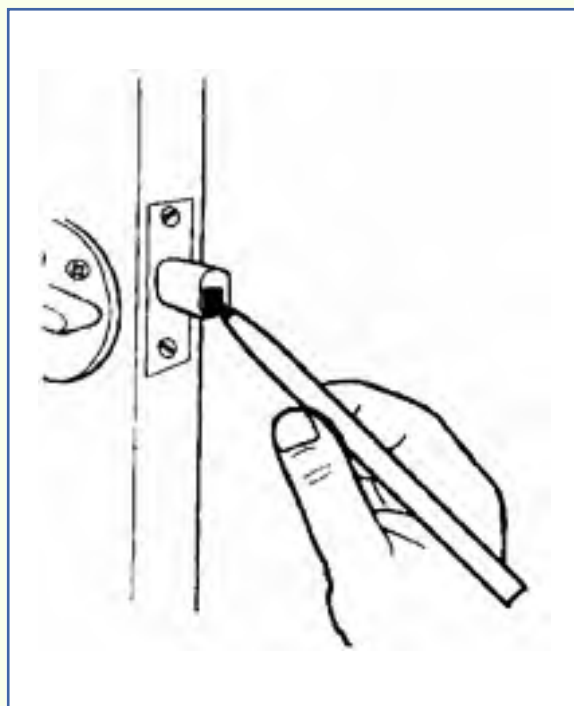
Step 11: Then, install the interior thumbturn or the interior knob, and screw it into place as well (Figure 62).

FIGURE 62—Install the interior thumbturn.



Step 12: The next step is to install the strike. Before you can do that, however, you'll need to mark exactly where it will be installed. To do this, use a grease pencil to color the end of the latch or bolt (Figure 63). Then, close the door. The movement of the latch against the door should leave a visible mark. This mark will show you exactly where to place the strike.

FIGURE 63—Use a grease pencil to color the end of the latch or bolt.



Step 13: Place the strike plate against the doorjamb and hold it there. Center the hole in the strike plate over the grease pencil mark. Now, just as you did when installing the face plate for the bolt, use a utility knife to cut an outline around the strike plate (Figure 64). Use a sharp pencil to mark the screw holes. Then, use the pencil to trace inside the opening in the strike.

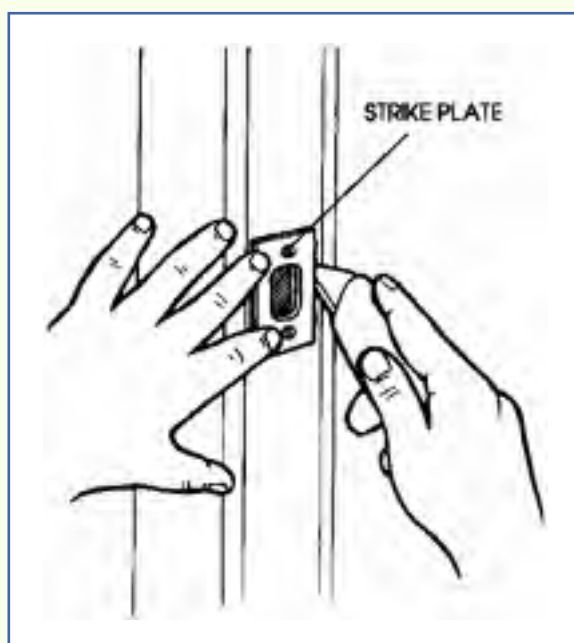
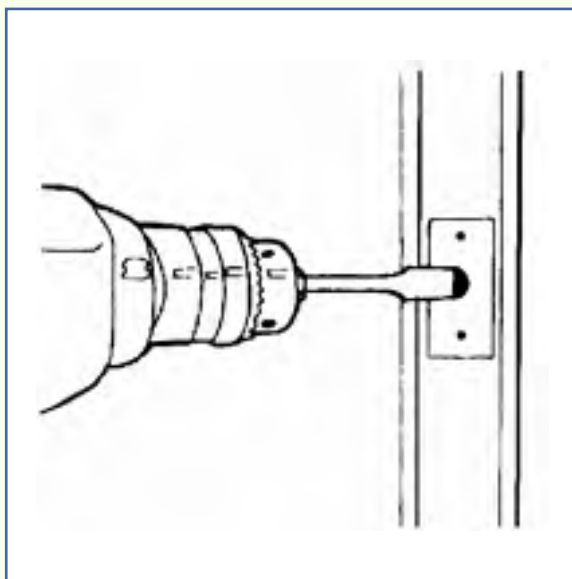


FIGURE 64—Outline the strike with a utility knife.

Step 14: Next, you'll need to use your drill to cut the hole that will receive the bolt. The hole should be only as deep as the bolt. Drill the hole inside the outline you traced for the strike plate opening (Figure 65).

FIGURE 65—Drill the hole that will accept the bolt.



Step 15: Use the wood chisel to cut a shallow depression to hold the strike plate (Figure 66). The depression should only be deep enough to hold the strike plate flush with the doorjamb.

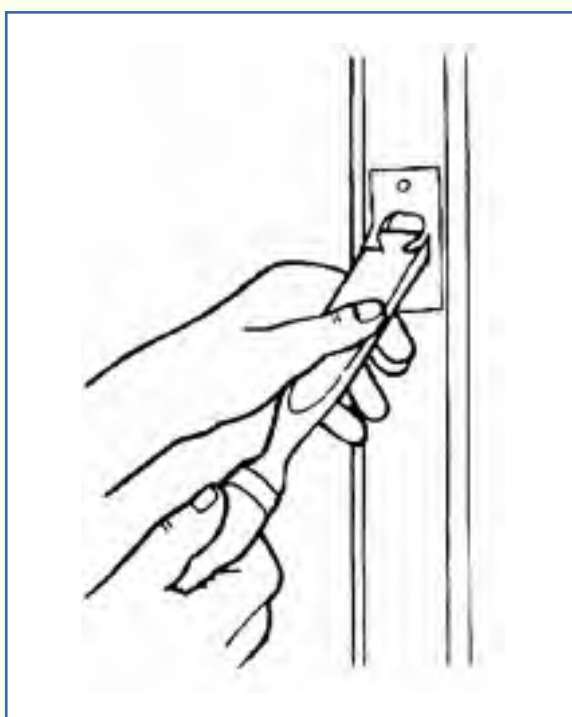


FIGURE 66—Chisel a depression to hold the strike plate.

Step 16: Install the strike plate and screw it in place.

Step 17: Check the door operation after completing the installation. You're now finished!

Just for review, we'll list the installation steps here:

Step 1: Tape the template to the door.

Step 2: Mark the holes for drilling.

Step 3: Drill hole for doorknob.

Step 4: Drill hole for latch.

Step 5: Trace outline of face plate.

Step 6: Cut depression for face plate.

Step 7: Mark the location of the face plate screws.

Step 8: Install the bolt and the face plate.

Step 9: Install the main part of the lock.

Step 10: Install the retaining plate.

Step 11: Install the interior thumbturn.

Step 12: Mark location for strike plate.

Step 13: Trace outline of strike plate.

Step 14: Drill hole for strike.

Step 15: Cut depression for strike plate.

Step 16: Install strike.

Step 17: Check door operation.

Now, let's look at how to replace a lockset that's already in a door.

Replacing One Lockset With Another

The procedure used to replace a lockset or deadlock isn't complicated. All you'll need to do is remove the old lockset, then replace it with a new one. Sometimes, depending on the size of the replacement lockset, you may need to slightly

enlarge the installation holes using your drill or a file. A new lockset, however, should never be *smaller* than the old lockset it's replacing. If a lockset is too small, it's almost impossible to get it to fit properly in the old installation holes. If necessary, purchase another lockset of the proper size for the job.

To remove an old lockset, you'll use one of two methods, depending on the construction of the lockset. Many locksets are removed by simply unscrewing the screws on the interior side of the door. These screws can be found near the doorknob. In the second method, you'll need to use an awl or a similar tool to press the button or the slot near the interior knob. The pressure will release the interior door handle. Remove the rose, then remove the screws holding the rest of the lock in place. Pull off the knob and rose from the exterior of the door. Unscrew the face plate and remove the latch. Remove the strike.

After you've removed the old lock, always measure the bolt and face cavities to make sure they're big enough to accommodate the new lock. If either hole is too small, carefully file or drill as necessary.

Servicing a Lockset

A lockset may stop functioning for a variety of reasons, and a professional locksmith will frequently be called for help. Most problems are straightforward and simple to fix. When a customer calls you to say that a lock isn't working properly, your first step in troubleshooting should be to ask the homeowner these questions:

Question 1: Is the door locked now?

Question 2: Are you sure that you're using the correct key?

Question 3: Do the hinges or the knob seem loose?

Question 4: Is the door warped or sagging?

As simple as it sounds, it's always possible that a customer is trying to use the wrong key to open a lock, or even that the lock is already open! Asking these two questions can save you a lot of time in wasted road calls.

Key-in-knob locks can work loose after long use. If the screws or knobs are loose, you'll need to tighten them. In many locksets, you can use a small wrench to tighten the area near the knob handle (Figure 67). If the lockset screws are loose, tighten them with a screwdriver. Sometimes the wood around screws may be deteriorating and failing to hold the screws tightly. In such a case, remove the screws, fill the holes with wood putty, let the putty dry, and replace the screws.

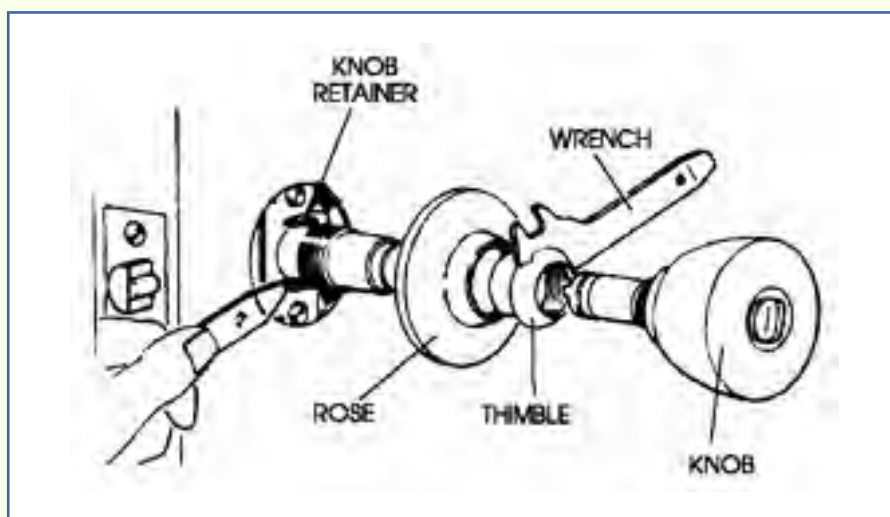


FIGURE 67—Use a small wrench to tighten a doorknob as shown here.

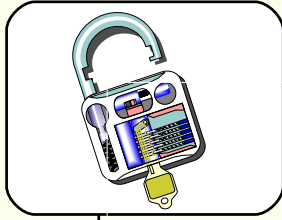
If the latch or bolt doesn't seem to contact the strike, the latch and strike are probably out of alignment. They may have been installed improperly, the strike hole may be too small, or the door frame and the door themselves may have become misaligned over time. Inspect the door first, and if it seems to be level and properly hung in the frame, you can simply move the strike to correct the problem. If the strike hole is too small to accept the bolt, enlarge the hole carefully with a wood file.

If the door seems to be warped, "sticking" in the frame, or hanging improperly in the frame, start by looking at the hinges. The hinges knuckles may be worn or the hinge screws loose. If the hinge knuckles are worn, replace the hinges entirely. If the door is sticking, consider the time of year and the environmental conditions in the home. Doors tend to expand in the summer (and in damp weather) and shrink in the winter (and in dry weather). Any of these conditions may be causing the door to stick and the lockset to work improperly. If the door has expanded greatly, it may need to be planed (cut down) at the edges to make it fit better.

If the weather doesn't seem to be the problem and the hinges are in good order, examine the door to determine if it's properly hung. If the door seems crooked or if the door frame is warped or sagging, the door may have to be planed and then rehung. In serious situations, the entire door frame may need replacing. If you possess the needed carpentry skills, you may correct the problem. However, *never attempt* carpentry-type repairs if you don't have the proper experience. Instead, simply charge your customer a standard fee for your locksmithing consulting service and then recommend that they contact a reputable carpenter.

Use WD-40 or a similar product to clean and lubricate a lockset mechanism. If the bolt tends to stick, clean it carefully with a spray cleaner. Then, wipe the bolt dry with a clean cloth. If the key begins to "work hard" in the lock, place a small quantity of powdered graphite on the key, insert it in the lock, and turn the key back and forth a few times. *Never use oil to lubricate a cylinder lock!*

This completes our discussion of residential door locks. In the next section of the text, we'll examine window construction and window locks. Before proceeding, however, please complete *Locking It Up! 4* on the following page.



Locking It Up! 4

Some of the main steps used to install a key-in-knob lockset are listed below, but they're out of order. Letter the steps in their proper order (*a* for the first step, *b* for the second step, and so on).

- ___ 1. Drill hole for doorknob
- ___ 2. Install bolt
- ___ 3. Cut depression for strike plate
- ___ 4. Tape the template to the door
- ___ 5. Drill hole for latch
- ___ 6. Mark location for strike
- ___ 7. Cut depression for face plate
- ___ 8. Install knob
- ___ 9. Drill hole for strike
- ___ 10. Check door operation
- ___ 11. Install strike

Check your answers with those on page 73.

WINDOWS

Major Window Styles

The last part of this text will focus on window construction and window locks. Windows are the weakest link in the home security chain; that is, windows provide burglars with the easiest access to a home. However, few people pay the attention they should to their windows. In this section, we'll look at the typical window installations you'll see in many homes. Then, we'll look at some of the locks and security devices that can be used to make windows more secure.

Now, let's look at the major window styles you'll be likely to see in most homes.

Double-Hung Windows

The basic parts of a traditional double-hung window are shown in Figure 68. *Double-hung* windows are usually made of wood, aluminum, steel, aluminum-clad wood, or vinyl-clad wood. Vinyl- and aluminum-clad windows require the least amount

of maintenance.

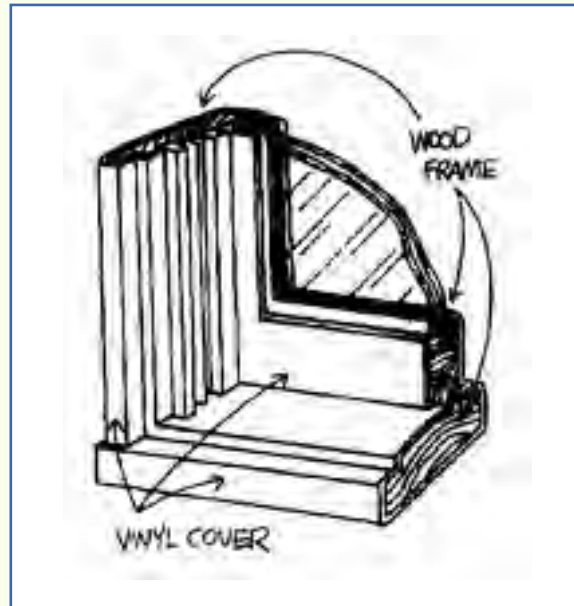
The two window sections seen in a double-hung window are called *sashes*. A sash may contain small, separate panes of glass divided by wooden strips, or a solid sheet of glass. Depending on its design, a double-hung window can slide open from the bottom or the top. In some windows, both sashes move.



FIGURE 68—The parts of a traditional double-hung window are shown here.

Modern windows are usually purchased as complete prefabricated units that include the frames, insulated glass, storm windows, and screens. Figure 69 shows a cutaway view of the construction of a modern window unit.

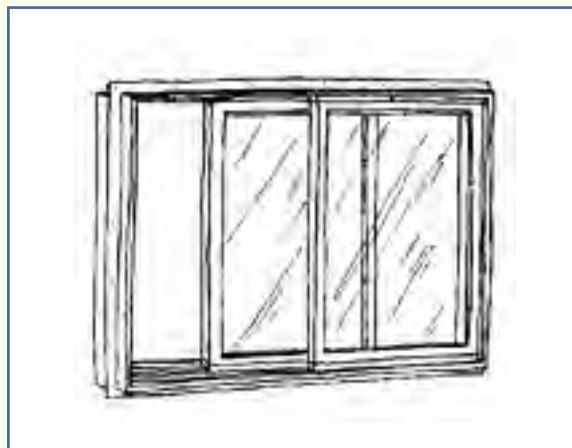
FIGURE 69—A cutaway view of a modern window unit is shown here.



Horizontal Sliding Windows

Most *horizontal sliding windows* have one moveable sash and one fixed sash set on separate tracks (Figure 70). Sometimes, however, both sashes can slide.

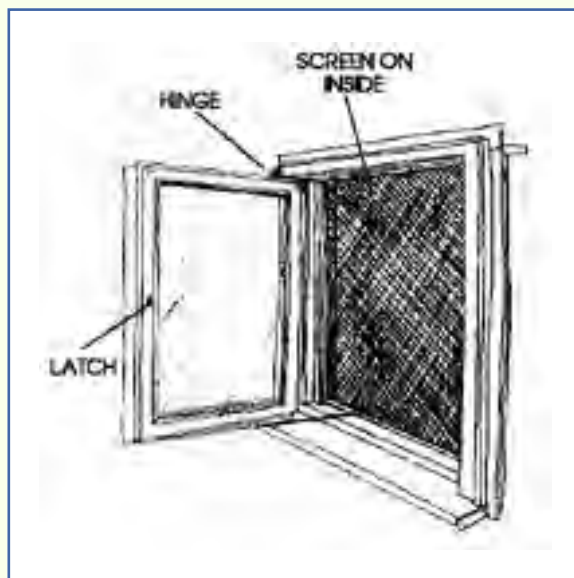
FIGURE 70—Horizontal Sliding Window



Casement Windows

The *casement window* (Figure 71) is hinged on one side so that it can swing outward. A hand-turned *crank* is used to open the window.

FIGURE 71—Casement Window



Awning Windows

Awning windows are often found in sun porches (Figure 72). They typically have one fixed pane with a hinge at the top. The opening mechanism is a push bar or a crank, and the window swings outward to open. These windows provide excellent ventilation.

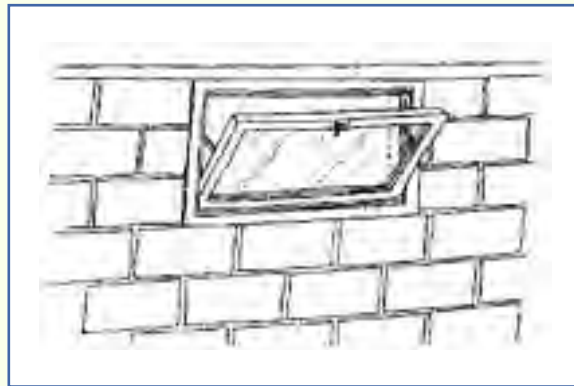


FIGURE 72—Awning Windows

Hopper Windows

Hopper windows are similar to awning windows, except that they are hinged at the bottom instead of the top (Figure 73). Hopper windows are crank-operated, open inward, and are often found in basements.

FIGURE 73—Hopper Window



Fixed-Pane Windows

Fixed-pane windows, as their name suggests, don't open and close. Fixed-pane windows have one or more panes of glass mounted in a frame, and are installed directly into a wall (Figure 74). These windows are relatively inexpensive and provide much better security than windows that can be opened. Special frosted or patterned glass can be installed in fixed-pane windows that prevents anyone from seeing into the home. Single-pane windows may contain decorative *snap-in muntins* (grids of crossed sticks) that fit into the window to create the illusion of multiple panes of glass.

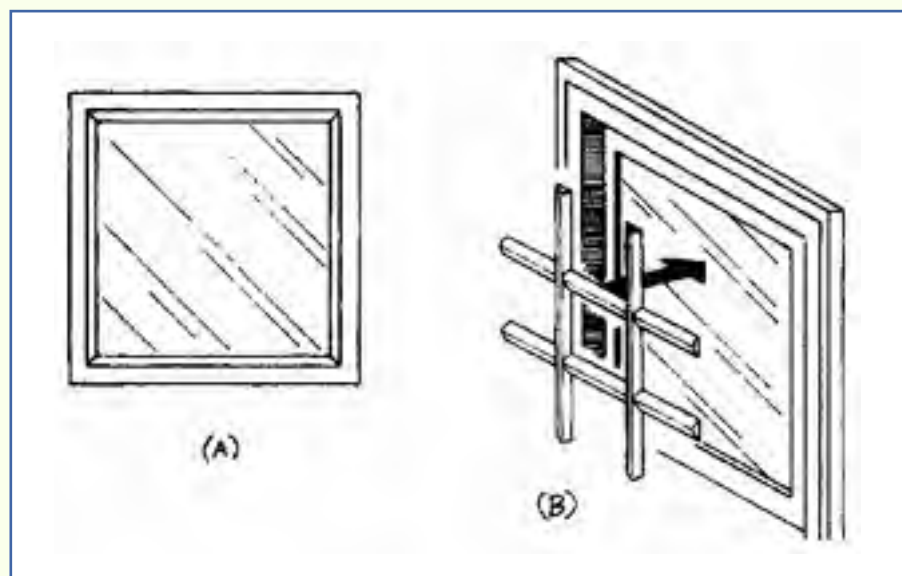


FIGURE 74—This figure shows a fixed-pane window in (A) and a snap-in muntin in (B).

Bay and Bow Windows

Bay windows are usually composed of three angled window sections (Figure 75). The center section is generally a large fixed-pane window, while the side sections may be casements or double-hung windows that can be opened. *Bow windows* are very similar to bay windows, but bow windows contain more window sections forming a curved front instead of an angled one (Figure 76).

Glazing

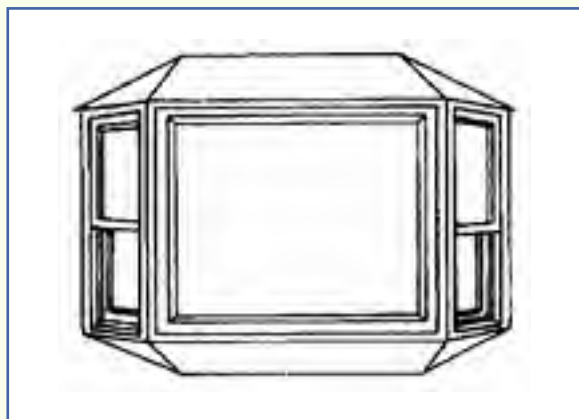


FIGURE 75—Bay Window

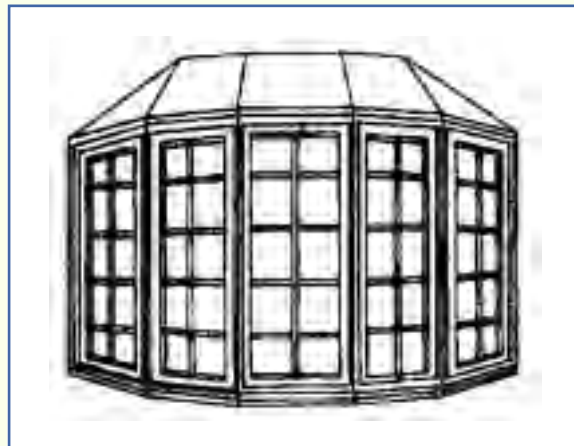
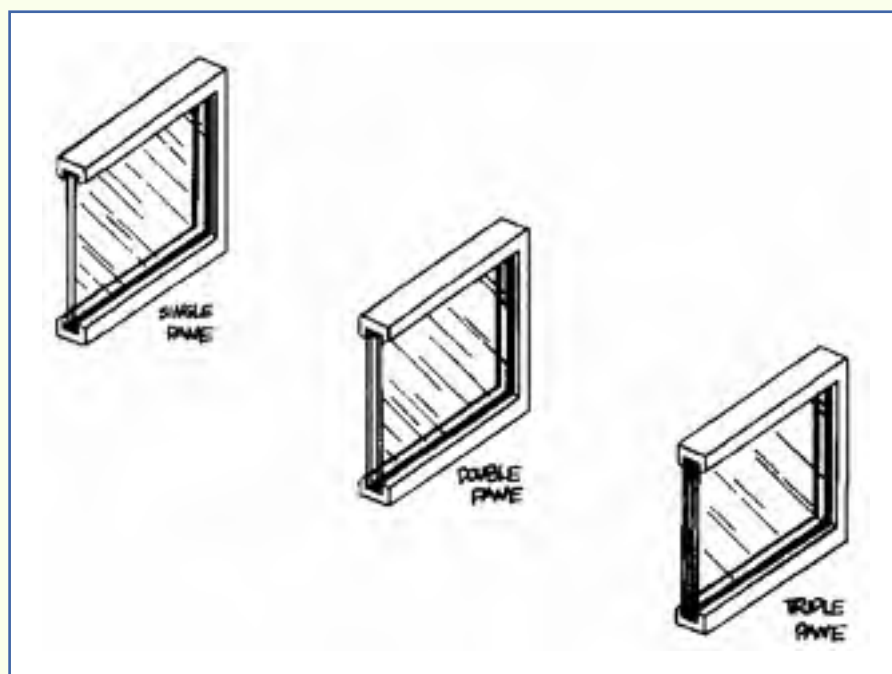


FIGURE 76—Bow Window

The term *glazing* refers to the glass or similar material used in a window frame to let light in. The type of glazing (glass, vinyl, acrylic) used in a window can make a big difference in how secure the window is. There are several different grades of window glass. These are often rated according to their energy efficiency.

Standard window glass is thin when compared to some of the more energy-efficient grades. *Sheet glass* is twice as thick as standard window glass, and *plate glass* is thicker still. Old-fashioned windows contained only one panel of glazing, but modern windows often contain two or three. A cutaway view of a modern window is shown in Figure 77. Note the *multipane glass* (multiple panels of layered glass). The thicker

FIGURE 77—This figure shows three types of window glazing—single pane, double pane, and triple pane.



the glazing, the more difficult the window will be to break and access. The air spaces between the panes are sometimes filled with a gas such as argon to prevent moisture from fogging.

Various acrylics and plastics are also used as window glazing, and are increasingly popular substitutes for glass in less-expensive residential applications. A $\frac{1}{2}$ -inch-thick sheet is virtually shatterproof, and offers far more security than glass.

Two of the newest types of window glazing are *low-E glass* and *solar glass*. Low-E glass is standard glass with a special coating applied to the interior of the glass window panel. During warm weather, this coating reflects heat from the sun back outside. In winter, the coating reflects heat from the house back into the rooms. *Solar glass* is used in window installations in warm climates. Solar glass contains a coating that is very effective at reflecting the sun's rays away from a home.

The quality of the putty or caulking installed around window panes is also important. If the caulking is dry, rotted, or cracked, an intruder may be able to chip it away and lift out a pane of glass to gain access to the home. Check caulking around any glazing you find in doors, as well.

Window Locks

Window locks are, for the most part, simple devices. The latch shown in Figure 78 has been used to lock double-hung windows for many years, and is usually very efficient. However, in

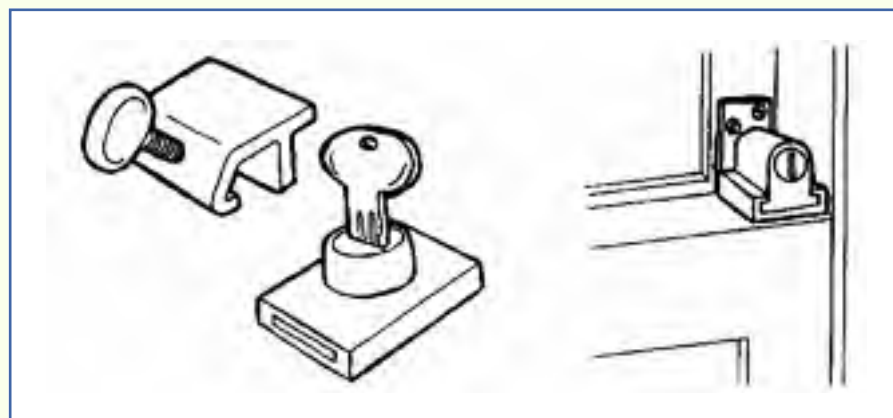
FIGURE 78—Standard Window Latch



order to provide the most security for a home, a *bolt lock* (Figure 79) should be installed on every double-hung window.

In Figure 79, the bolt lock is mounted on the lower sash, and the strike is installed on the upper sash. If desired, a second strike can be added higher up on the upper sash. Then, the homeowner can open the window a few inches for ventilation, but still be able to bolt the window for security.

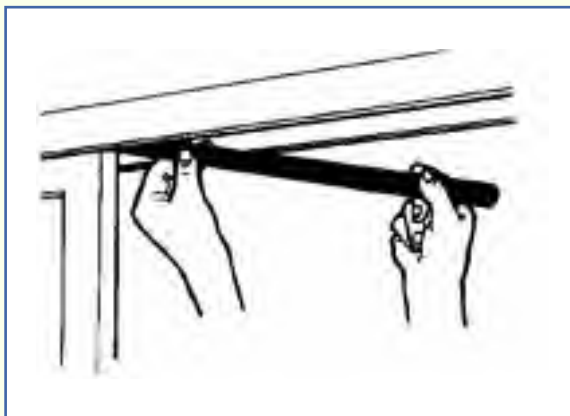
FIGURE 79—Window Bolt Lock



Protective bars and grates are also sometimes used instead of or in addition to window locks, especially on the ground-floor and basement-level windows in city buildings.

Sliding windows present a special security problem. Because of the way in which they're mounted in tracks, the windows can be lifted up and out from the outside of the house. To prevent this, the open space in the upper track above the window can be sealed by inserting a length of wooden dowel (Figure 80). The dowel makes the window fit snugly in the tracks and makes it impossible for a burglar to lift out the window.

FIGURE 80—The security of a sliding window can be improved by inserting a wooden dowel into the track above the window.



Installing a Window Bolt

The following instruction steps will explain how to install a bolt lock on a standard double-hung window. The only tools needed are a screwdriver and an electric drill.

Step 1: Close the window. Set the bolt lock on the top edge of the lower window sash as shown in Figure 81. The lock must be placed so that it doesn't interfere with the opening and closing of the window. The lock will be screwed into place in this location. Use a nail to mark the spots where the screws will go.

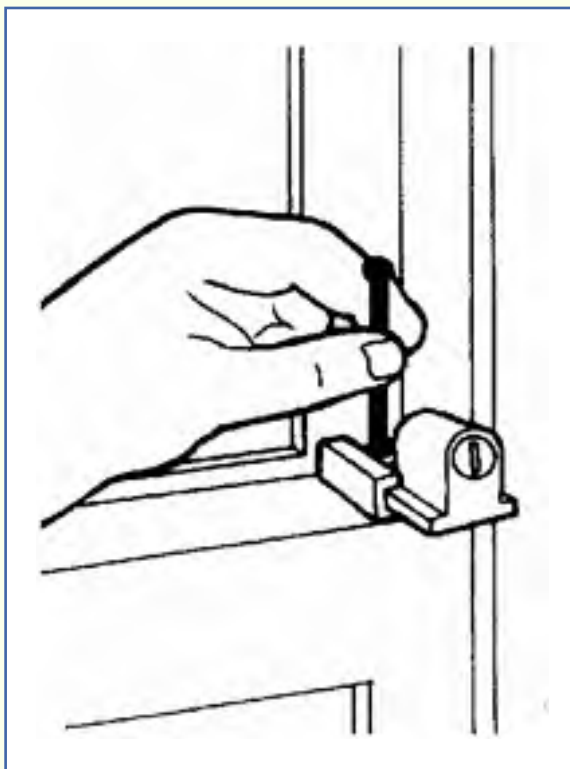
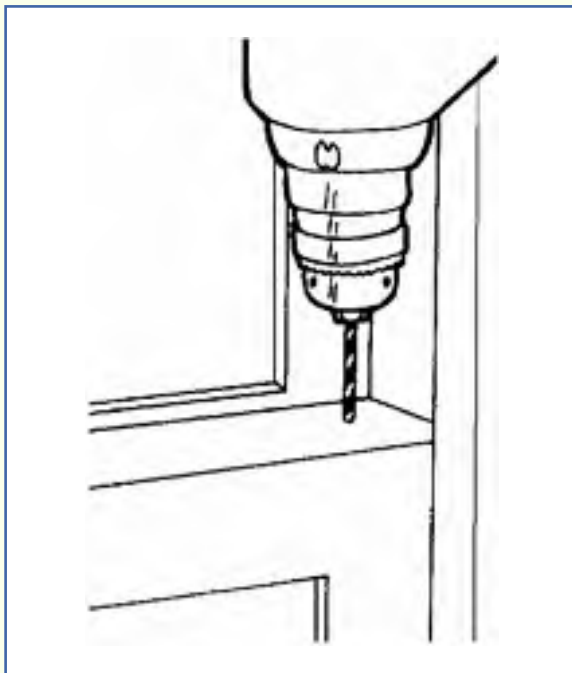


FIGURE 81—Mark the screw holes for the window bolt as shown here.

Step 2: Use an electric drill to carefully drill starter holes for the screws (Figure 82). Don't drill the holes too deep.

FIGURE 82—Use a drill to start holes for the screws.



Step 3: Coat the end of the bolt with a grease pencil. Then, set the lock in place again and operate the bolt a few times. The motion of the bolt will leave a mark on the upper sash (Figure 83). This is the location where the strike will be placed.

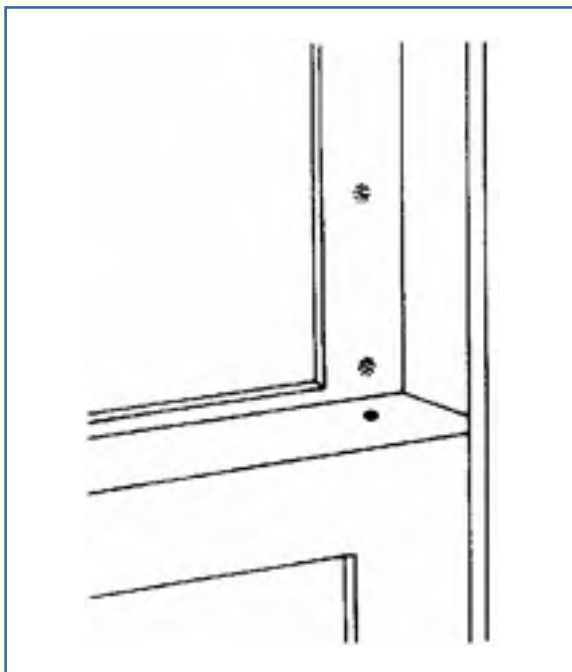
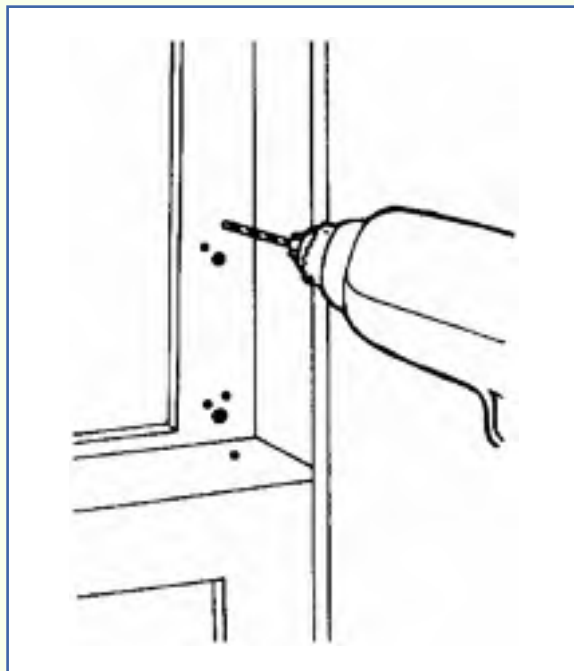


FIGURE 83—Mark the location for the strike.

Note: If a second “ventilation” strike is desired, open the window a few inches (*no more than 4 inches*) and mark the upper sash by operating the bolt in that location.

Step 4: Hold the strike in place over the mark you just made. Use a sharp pencil to mark the location of the screw holes and the bolt hole (Figure 84). If a second strike will be installed, mark its location as well.

FIGURE 84—Mark the location for the strike screws.



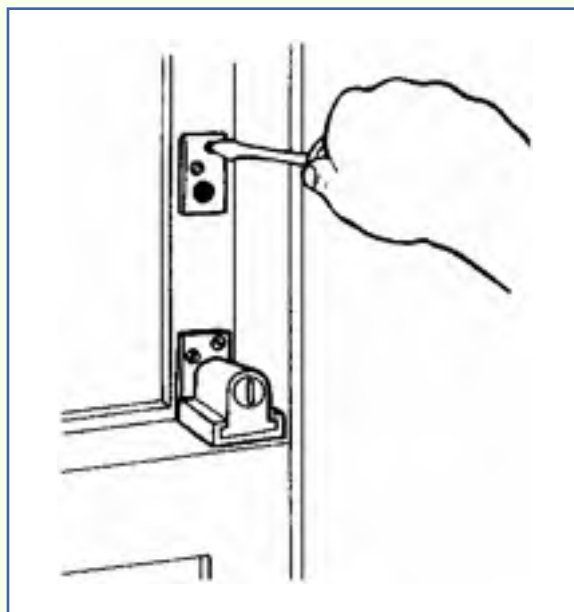
Step 5: Using a bit the same size as the bolt, drill out the bolt hole (Figure 85). Use a smaller bit to drill starter holes for the screws.



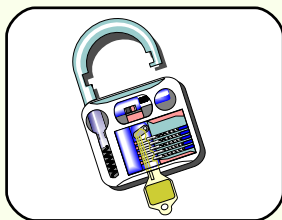
FIGURE 85—Drill the holes for the bolt and the strike screws.

Step 6: Screw the strike plate and the lock in place (Figure 86).

FIGURE 86—Install the strike and the lock.



Now, take a few moments to complete *Locking It Up! 5* on the following page.



Locking It Up! 5

Fill in the blanks in each of the following statements.

1. The two window sections seen in a double-hung window are called _____.
2. _____ windows don't open and close.
3. _____ windows are similar to awning windows, except that they're hinged at the bottom instead of the top.
4. _____ windows have one fixed pane with a hinge at the top and are often found in sun porches.
5. _____ windows are hinged on one side so that they can swing outward.
6. _____ windows are usually composed of three angled window sections. _____ windows are similar, but have a curved front instead of an angled one.
7. The term _____ refers to the glass or similar material used in a window frame to let light in.
8. _____ glass is twice as thick as standard window glass, and _____ glass is thicker still.

Check your answers with those on page 74.

THE KEY TO SUCCESS

At this point, you've now completed five study units in your course. You can be proud of the progress you've made toward your goals. Your hard work and dedication will soon pay off!

This study unit was the last of the five introductory units in the course. You've already learned all the important basics of the locksmithing field: the vital facts and skills you need at the start. You've completed the solid foundation that the rest of your course will be built on.

The rest of the study units in your course will cover in-depth, specialized locksmithing tasks and skills. In your upcoming studies, you'll learn about keymaking, rekeying locks, master-keying, working with safes and vaults, automotive locks, home security techniques, and electronic security devices. The knowledge and skills you gain from these topics will be your key to success. These are the special skills that will enable you to earn a solid living and establish a reputation as a professional locksmith. Keep working toward your goal!

Now, when you're ready, proceed to the examination for this study unit on page 75.

KEY POINTS TO REMEMBER










An understanding of door construction and a familiarity with popular door and window styles can help a locksmith determine what locks should be used in a particular situation.










A residential door is installed in a *doorjamb*, a wooden door frame that fits into a space in a wall frame. A doorjamb includes two *side jambs*, a *head jamb* across the top, a *sill* at the bottom to prevent leaks and drafts, and a *stop* (a thin strip of metal or wood nailed to the jamb) to prevent the door from swinging through the opening.



A *flush door* is a smooth wooden door that's composed of a hardwood veneer panel over either a solid or a hollow core. Solid-core doors are better for exterior use; hollow-core doors are more appropriate for use indoors.

- 
- A *panel door* or *stile-and-rail door* is composed of four or more interlocking components positioned around central panels. The vertical components are called the *stiles* and the horizontal components are the *rails*. A *Dutch door* is a panel door that's been divided in half horizontally. The *French door* is a panel door that has panes of glass instead of wooden panels between the stiles and rails.
- 
- A *sliding glass door* contains a large pane of glass inserted in a wooden or metal frame. The door opens and closes by sliding on tracks. A sliding door requires a locking bar for proper security.
- 
- Some attached garages have three doors: a vehicle entry door, an interior door leading into the house, and a service door that leads from the garage to another area (such as a laundry room, workshop, or patio). All of these doors should contain locks for the proper security of the house.
- 
- Rough hardware* includes nails, screws, bolts, and other items that are used during rough construction. *Finish hardware* refers to locks, hinges, door closers, and other door trim—items that are a visible part of the building. Locksmiths are most concerned with finish hardware.
- 
- A *hinge* is a metal joint on which a door swings open or closed. The vertical cylindrical portion of a hinge is the *knuckle*. The flat parts containing the screw holes are the *leaves*. Most hinges have five knuckles and two leaves. The leaves rotate around a hardened steel pin inserted in the knuckle. Some pins can be taken out at the top of the hinge. However, *fixed pins* (pins that can't be removed) provide extra security.
- 
- There are many types of hinges; most are named according to how they're installed on a door. A *butt hinge* is applied to the *butt* (edge) of a door. A *full-surface hinge* has both leaves screwed to the surface of a door and frame. A *half-mortise hinge* has one leaf mortised into the door and the other leaf applied to the surface of the frame. A *full-mortise hinge* has one leaf mortised into the edge of the door and the other leaf mortised into the door frame. If a door is more than 5 feet high, it should be hung on three hinges.
- 
- A *strike* is a metal plate applied to the frame of a door to receive a projected lock bolt or latch. A *door closer* is a mechanism that both closes a door and controls the speed at which it closes to prevent it from slamming. Overhead *door holders* are used to prevent doors from being opened too far. A *doorstop* is

used to limit the opening swing of a door so that the door won't strike a wall. A *kick plate* is a flat metal plate applied to the lower surface of a door to protect the finished surface from damage and wear. A *door viewer* is a device installed in a door that lets the person inside see visitors before opening the door.

-  In order to install a door lock, you must know the *hand* of the door. The *hand of a door* refers to the manner in which the door is hung in its frame. The hand is determined by looking at a door from the *outside*. Some hardware pieces are made so that they can be used on either a right- or left- hand door. Most new door locks are equipped with reversible latches.
-  The edge of a door must be slightly *beveled* (trimmed at an angle) to allow the door to close tightly. The outside face of the door is trimmed $\frac{1}{8}$ inch shorter than the inner face.
-  The term *lockset* refers to a complete door opening set including the knob, latch, bolt, strike, and lock cylinder. A *key-in-knob lockset* or *cylindrical lockset* is a door opening set that contains a lock cylinder in the doorknob. The key-in-knob lockset is the most popular residential lock on the market today. An *entrance handleset* is a lockset that has a long handle and a thumbpiece rather than a doorknob.
-  An *auxiliary lock* is any locking device that provides extra security on a door where a lockset is already in place. A *dead bolt* is a locking mechanism that works by throwing a square-ended metal barrier (the bolt) into a strike. A *deadlock* is simply a lockset that contains a dead bolt and a lock cylinder.
-  A *mortise cylinder deadlock* is a deadlock that's installed in a cut-out area in a door. The lock contains a key-operated mortise cylinder that operates the bolt. A *rim latch* or *spring latch* is installed on the surface of a door and is used in combination with a lock cylinder.
-  The simplest kind of auxiliary locking device is the *sliding bolt*. The *safety chain* is another simple auxiliary lock. The chain is attached to the doorjamb and the *keeper* is fixed to the door.
-  A malfunctioning key-in-knob lockset may need to be disassembled for repairs. Most locksets can be disassembled using the same basic steps, which are summarized as follows:

- Remove the spindle
- Remove the cylinder
- Remove the plug
- Perform needed services on the plug
- Reassemble the lockset



The steps needed to install a standard residential lockset may be summarized as follows:



- Tape the template to the door
- Drill the hole for the doorknob
- Drill the hole for the latch
- Cut a depression for the face plate
- Install the bolt and the face plate
- Install the main part of the lock
- Drill the hole for the strike
- Cut a depression for the strike plate
- Install the strike
- Check door operation



A locksmith should be familiar with popular window styles. *Double-hung windows* contain two window sections called *sashes*. A *horizontal sliding window* has one moveable sash and one fixed sash set on separate tracks. A *casement window* is hinged on one side so that it can swing outward. *Awning windows* have one fixed pane with a hinge at the top. The window swings outward to open. *Hopper windows* are hinged at the bottom instead of the top.



Fixed-pane windows, as their name suggests, don't open and close; a frame containing panes of glass is installed directly in a wall. *Bay windows* are composed of three angled window sections. The center section is a large fixed-pane window; the side sections may be casements or double-hung windows. *Bow windows* contain more window sections, forming a curved front instead of an angled one.

-  The term *glazing* refers to the glass or similar material used in a window frame to let light in. Most modern windows contain *multipane glass* (multiple panels of layered glass).
-  Most windows contain a simple latching mechanism. However, to provide the most security for a home, a *bolt lock* should be installed on every opening window. Protective bars and grates are also sometimes used instead of or in addition to window locks, especially on the ground-floor and basement-level windows in city buildings.

Do You Know Now . . .

Below are the answers to the questions asked at the beginning of this study unit.

What is a *flush door*?

A *flush door* is a smooth wooden door that's usually composed of a hardwood veneer panel over either a solid or a hollow core.

What is a *key-in-knob lockset*?

A *key-in-knob lockset* is a complete door opening set that contains a lock cylinder in the doorknob.

What is an *entrance handleset*?

An *entrance handleset* is simply a lockset that has a long handle and a thumbpiece rather than a doorknob.

Locking It Up! Answers

1

1. door jamb
2. sill
3. flush door
4. stile-and-rail
5. stiles, rails
6. Dutch door
7. French door
8. pre-hung

2

1. Finish
2. leaves
3. high-security strike
4. Lever handles
5. door closer
6. full-mortise
7. three
8. doorstep

3

1. True
2. False
3. False
4. True
5. False
6. True
7. True
8. True

4

1. b
2. e
3. i
4. a
5. c
6. g
7. d
8. f
9. h
10. k
11. j

5

1. sashes
2. Fixed pane
3. Hopper
4. Awning
5. Casement
6. Bay, bow
7. glazing
8. Sheet, plate

Residential Locks

EXAMINATION NUMBER:

03100500

Whichever method you use in submitting your exam answers to the school, you must use the number above.

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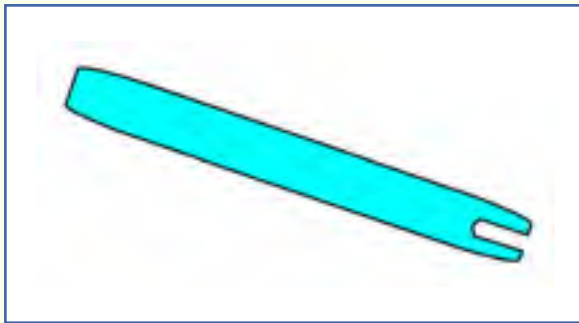
When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. Building codes today require the use of tempered glass in all
 - A. panel doors.
 - B. sliding glass doors.
 - C. casement windows.
 - D. Dutch doors.
2. When installing a residential door, the four security factors to be considered are
 - A. hardware, door construction, door style, knob shape.
 - B. locks, width of door frame, key type, visibility.
 - C. door construction, hardware, locks, visibility.
 - D. visibility, locks, glazing, door height.

3. Which of the following are the major parts of a door frame?
- A. Top jamb, bottom jamb, stop, knob jamb
 - B. Sill, closer, holder, head jamb
 - C. Stop, cylinder, side jamb, sill
 - D. Side jamb, head jamb, sill, stop
4. Key-in-knob locksets are also known as
- A. mortise locks.
 - B. rim locks.
 - C. cylindrical locks.
 - D. handlesets.
5. The simplest type of auxiliary lock is the
- A. rim latch.
 - B. safety chain.
 - C. sliding bolt.
 - D. deadlock.
6. The direction in which a door is hung in a door frame is called the
- A. hinge of the door.
 - B. dimension of the door.
 - C. hand of the door.
 - D. cylinder of the door.
7. The vertical components in a panel door are called the
- A. rails.
 - B. panels.
 - C. stiles.
 - D. sashes.
8. The proper name for a lockset that contains a deadbolt and a lock cylinder is
- A. handleset.
 - B. rim latch.
 - C. mortise cylinder.
 - D. deadlock.
9. A hinge that has one leaf mortised into the edge of the door and the other leaf mortised into the door frame is called a
- A. full-surface hinge.
 - B. full-mortise hinge.
 - C. half-mortise hinge.
 - D. fixed pin hinge.
10. If a door has hinges on its left side and the door swings away from you, the hand of the door is
- A. left-hand regular.
 - B. right-hand regular.
 - C. left-hand reverse.
 - D. right-hand reverse.
11. A door that is more than five feet high should
- A. be beveled.
 - B. have a window installed in it.
 - C. be hung on three hinges.
 - D. have a handleset instead of a doorknob.

12. The object illustrated below is a



- A. lockpick.
- B. doorjamb.
- C. lockset spindle.
- D. cylinder removal tool.

13. In the disassembly of a standard Kwikset lockset, which of these steps comes *first*?

- A. Remove the spindle.
- B. Remove the retaining clip.
- C. Remove the lock cylinder.
- D. Withdraw the plug.

14. Which of the following statements describes a *template*?

- A. A paper guide used to install a lockset
- B. A special drill attachment used to cut a hole in a door
- C. A type of key-in-knob lockset
- D. A device used to extract a plug from a lock cylinder

15. What type of door is divided in half horizontally, with both halves hinged so that they can be opened and closed independently?

- A. a French door.
- B. a sliding door.
- C. a garage door.
- D. a Dutch door.

16. Which of the following types of window glazing is the *thinnest*?

- A. Multipane glass
- B. Sheet glass
- C. Plate glass
- D. Standard glass

17. A deadlocking pin prevents a latch from being

- A. removed.
- B. jimmied.
- C. lubricated.
- D. unlocked.

18. A window that's hinged at the bottom and that opens inward is called a/an

- A. casement window.
- B. hopper window.
- C. awning window.
- D. bay window.

19. Which of the following is the *last* step in installing a residential lockset?

- A. Install bolt
- B. Check door operation
- C. Drill hole for strike
- D. Remove template

20. If a door has hinges on its right side and swings toward you, the hand of the door is

- A. left-hand reverse.
- B. right-hand regular.
- C. left-hand regular.
- D. right-hand reverse.

COMING ATTRACTIONS

Up to this point in your course, you've studied the basics of the locksmithing profession and learned about various types of locks and keys. In your next study unit, *Keymaking and Rekeying*, you'll begin your in-depth study of professional locksmithing tasks. We'll show you how to make keys by hand or with a key-cutting machine, and you'll learn exactly how to rekey disk tumbler and pin tumbler locks. You'll also learn the principles of masterkeying. Finally, you'll practice your new skills by completing several hands-on exercises with professional locksmithing tools.

Study Unit 6

Keymaking and Rekeying

Preview

Congratulations on moving successfully along in your course! You've completed five information-packed units and have added a considerable amount of knowledge to your locksmithing information base. Be proud of yourself! At this rate, you'll complete your course and move into the professional world of locksmithing in next to no time!

Up to this point, you've received important information on keys and key blanks, lock mechanisms, and door and window locks. Now, in this study unit, you'll learn how to make duplicate keys by hand using simple tools. You'll also learn how to cut a key with a key cutting machine, using the special codes available only to professional locksmiths.

Then, in the next section of this study unit, you'll explore the *rekeying* of a lock. (Rekeying is the locksmithing skill that changes the inside of a lock to fit a new key.) Finally, you'll learn about the keying system used in single and multiple levels of *master keying*.

After completing this study unit, you'll be able to

- Identify the tools needed to duplicate various types of keys
- Explain how to properly measure, clamp, and file a duplicate key
- Duplicate a flat key, cylinder key, and bit key by hand
- Describe how to use a key duplication machine
- List the steps to properly cut a key by using key codes
- Rekey a disk tumbler and a pin tumbler lock
- Describe how a master key system operates
- Develop a master key system for a customer's needs

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Keymaking and Rekeying

Do You Know. . .

What does the key code 2, 4, 1, 3, 5, 2 mean?

What is a *plug follower*?

What is a *great great grand master key*?

In these pages, you'll find the answers to these and many more questions dealing with the subject of keymaking and rekeying today's most common locks.

DUPLICATING KEYS

Definition

Let's begin our study of keymaking and rekeying by describing what's meant by *key duplication*. Key duplication is the process of creating a key that is equal to or better than a lock's original key. A new key is cut from a *key blank* (an uncut key) using either hand tools or a key cutting machine. If your customer's key is relatively new, your duplicate key should be *equal* in appearance and operation to the original. If the customer's key is old and worn, your duplicate should look and work as well as the original key.

Before we discuss specific key duplication methods, let's take a moment now to look at the tools you'll need to duplicate a key by hand.

Duplicating Tools

Bench Vises

A small *bench vise* is useful for many locksmithing tasks. A vise like the one shown in [Figure 1](#) can be clamped onto the

FIGURE 1—A quality vise will help you hold keys, plugs, and lock shells tightly while working on them.



edge of your workbench or table. The *jaws* of the vise can hold the original key and a blank key clamped together while you mark or file the duplicate.

Many locksmiths recommend using a four- to six-inch vise of high quality for key duplication. One way to judge the quality of a vise is to make sure that the jaws remain

parallel during opening and closing. The jaws should come together perfectly smoothly ([Figure 2](#)).

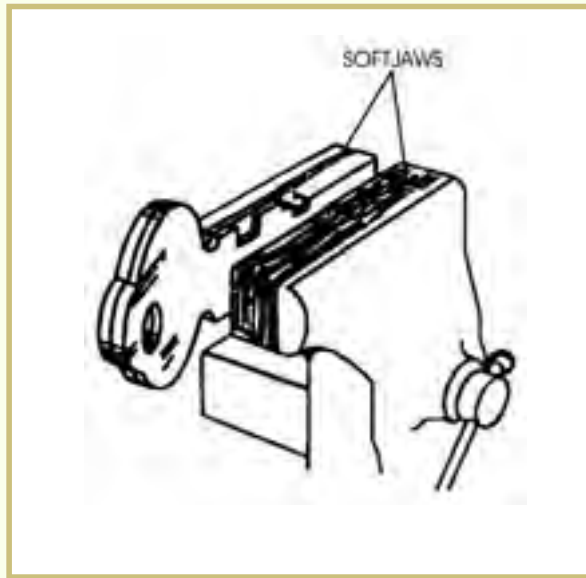
FIGURE 2—The jaws of a vise should come together perfectly smoothly.



A vise must be secured firmly to your workbench. If the vise is loosely mounted, it will move around when you file keys and throw off the accuracy of your key duplication.

Some locksmiths use devices called *softjaws*. Softjaws are shown in [Figure 3](#). Softjaws are purchased

FIGURE 3—Softjaws are pieces of aluminum angle iron that will help prevent damage to the items placed between the vise's steel jaws.



with the vise or can be made from small pieces of aluminum angle iron. The purpose of the softjaws is to prevent the rough-edged vise jaws from deforming or marking the keys or lock shell being held between the jaws.

Marking Pens and Scribes

Additional items you'll need for key duplication are a simple felt-tipped marking pen and a *scribe* (Figure 4). The marking pen is used to color in the blank key. Once the blank is colored, the scribe is used to draw lines where the file cuts are to take place. A common sewing needle can be used as a scribe; however, a needle will dull rapidly and require replacement. Therefore, a *carbide-tipped scribe* of the type used by machinists is a better tool. A carbide-tipped scribe will work for years before requiring replacement.

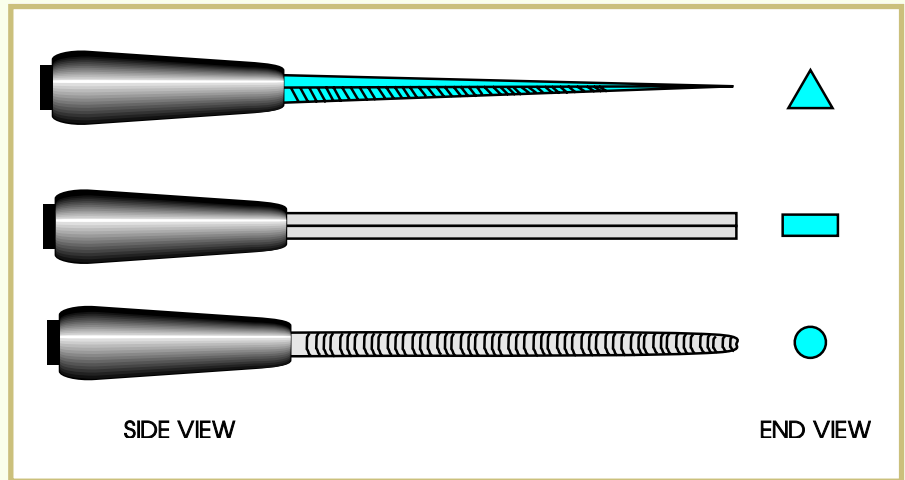
FIGURE 4—A carbide-tipped scribe is illustrated here.



Files

Metal *files* are used to cut notches in the metal of the key blank. These notches must exactly match the notches in the customer's original key. Three types of files commonly used by locksmiths are shown in Figure 5. These three files are the *three-corner* or *triangular* file, the *four-corner* or *rectangular* file, and the *round* file.

FIGURE 5—These types of files will be used to turn a blank key into a duplicate key.

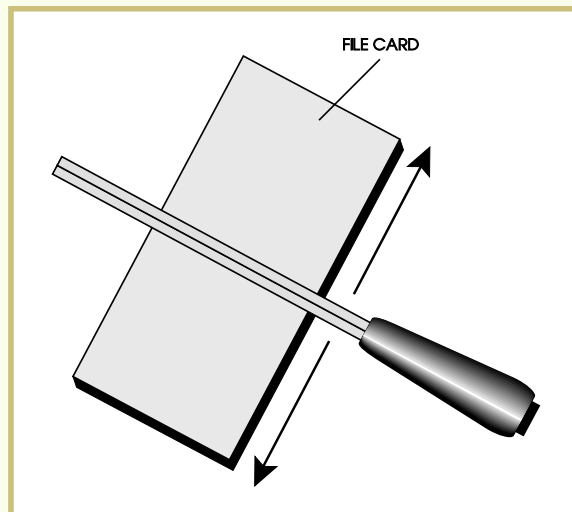


Files are available in various grades of quality and with a wide range of cutting surfaces, from extremely fine to very coarse. For most of your locksmith tasks, you'll use small, fine files. A fine file will remove only a small amount of metal from the key blank with each stroke, allowing for greater precision during key duplication.

Files periodically need to have their cutting surfaces cleaned. Since key blanks are made of softer metals such as brass or nickel, metal particles can build up between the file's cutting

edges. This buildup will cause a file to slide across, instead of cut into, a key blank. A special tool called a *file card* is used to clean built-up material from files. A file is stroked across a file card in the opposite direction from that used to cut metal. This process is shown in [Figure 6](#).

FIGURE 6—Files can be cleaned by moving them over a file card.



The following are two important safety tips to remember when using any type of metal file.

1. When using a full-size file, use the wooden or plastic handle designed to fit the file. The rear tang of the file can easily injure your hand (usually the palm) if the tang is left

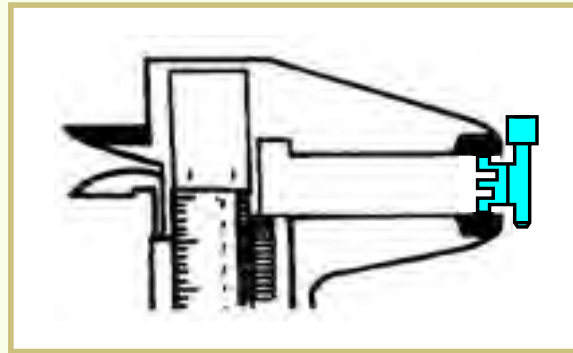
uncovered. A proper handle will not only prevent injury but will also make your cutting strokes more accurate.

2. Never use a file as a punch, wedge, prybar, or for any other purpose except that for which it was intended. Files are made of specially hardened tool steel, and like glass or other extremely hard materials, a file can shatter if used improperly.

Calipers

One measuring instrument you may find necessary is the *vernier caliper* (Figure 7). A standard caliper can measure objects placed between its jaws to an accuracy of one-thousandth of an inch (0.001 inch). Locksmiths pride themselves on

FIGURE 7—Vernier calipers are used in measuring key blanks, plugs, pins, and other such items.



accuracy, and, when duplicating a key, will attempt to make a duplicate that's an exact match of the original.

Calipers are read by placing the key blank between the jaws of the caliper.

As you can see, you'll most often be using the larger or outside dimension-measuring jaws. The second set of jaws is used to measure the inside dimension of a cylinder or other object.

The lines on the caliper are then read to give an accurate reading of the thickness of the key blank. The instruction booklet provided with the calipers will give you detailed information on reading dimensions displayed on the caliper. Some special calipers have a dial gage that can be read directly while still other expensive calipers use a battery-powered digital readout.

This short list of tools is by no means all of the tools required for key duplication. Tools such as small C-clamps and materials such as shim stock will also be used when duplicating certain types of keys.

Key Duplication Steps

Key duplication will require several steps. These steps are

1. Select the proper key blank.
2. Clamp the original key and the key blank together in a vise.
3. Match and mark the areas to be cut.
4. Cut the duplicate key.
5. Inspect the duplicate to be sure it matches the original.
6. *Debur* (smooth and polish) the duplicate key.

Let's look at each of these steps in detail now.

Selecting the Key Blank

The first step in duplicating a flat key is to select the proper blank key. The blank should have the same blade thickness and height. If the original key is identified with numbers and/or letters, it is an easy task to go to the key blank books and locate an exact blank to match the original. If the blank is not identified, then you will have to go to a key blank board and select a matching blank. Remember that the shape of the bow does not really matter since it serves no actual purpose in opening the lock.

Clamping

After the proper key blank has been selected, the first step in filing a key blank is to secure it in the vise. As mentioned earlier, use a set of softjaws on your vise whenever working with keys or locks in the vise. These softjaws will prevent the rough surfaces of the vise jaws from marking the keys or lock shells. Also, only tighten the vise handle enough to hold the parts securely between the jaws. Excessive pressure will only deform the parts.

When holding two keys in a vise for marking or cutting, make sure that all edges are even on the keys as shown in [Figure 8](#). The easiest method of making the key's edges even is to hold the bows of the keys together and place the blades of the keys in the vise. Now, lightly tighten the vise and check the surfaces of the keys. If the surfaces are exactly even,

FIGURE 8—Holding the duplicate and sample keys even in a vise is very important during key duplication.



then tighten the vise. If the surfaces are not even, lightly tap them together with a soft-faced mallet until even, and tighten the vise.

When you are placing a single key in the vise for cutting, the bow and the blade should be held almost entirely between the jaws of the vise.

The only area of the key that should be seen are the tip of the bow and the area of the blade that is to be cut. By holding the key in this manner, it will be secure and will not work loose from the vise jaws as you are cutting it.

Marking the Key

The type of marking system that you use depends on what is most comfortable for you. We'll examine two methods here – the smoking method and the marking pen method.

In the *smoking method* of marking a key (Figure 9), the locksmith places the blank behind the original key, then clamps the

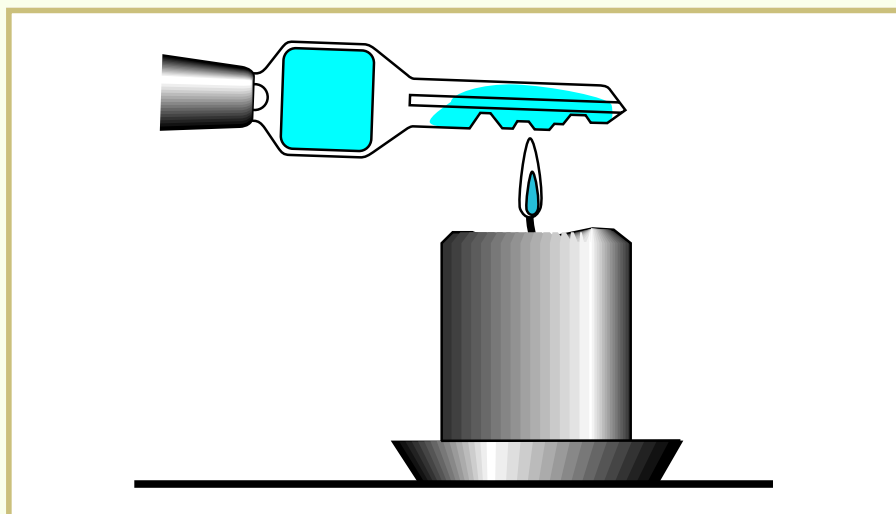
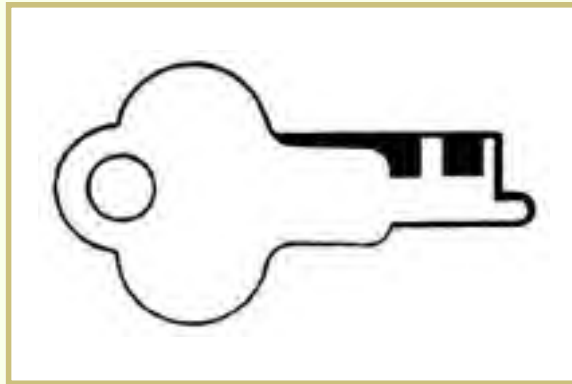


FIGURE 9—Here you can see how a duplicate blank key is “smoked” to place soot on the key where the cuts will be made with a file.

bows of the keys together in a C-clamp. Then, the keys are held about one-half inch above a candle flame for about 20 seconds. This is termed “smoking” the keys. (*Note:* Do not overheat the keys as they can tarnish.)

The soot from the candle flame marks the location of the cuts to be made on the blank key. When the keys are separated from each other, the cut pattern should appear as blackened areas, as shown in [Figure 10](#). These are the areas to be cut with the file.

FIGURE 10—After “smoking” a key, blackened areas will appear where the cuts are to be performed.



In the marking pen system, the blank key is colored using a marking pen. Then, the key blank is placed behind the original key, and the two keys are clamped together in a vise. A fine-pointed scribe or a sewing needle

is drawn across the cuts in the original key, leaving an “outline” on the key blank. Then the original key is removed, and the blank is positioned in the vise for cutting. The blank is filed until the cuts reach the scribe lines. The cut blank is removed from the vise periodically and compared to the original key using a caliper. If one or more of the cuts is not deep enough, the blank is returned to the vise for additional filing. [Figure 11](#) illustrates the marking-pen method for marking a key blank.

Some trained locksmiths do not mark the key blank at all. Instead, they will simply place a blank behind the original key in a vise and very carefully file the cuts in the blank. This method requires great skill and practice to avoid damaging the original key with the file while cutting the blank key. We don't recommend that you use this method when you're first learning to duplicate a key by hand.



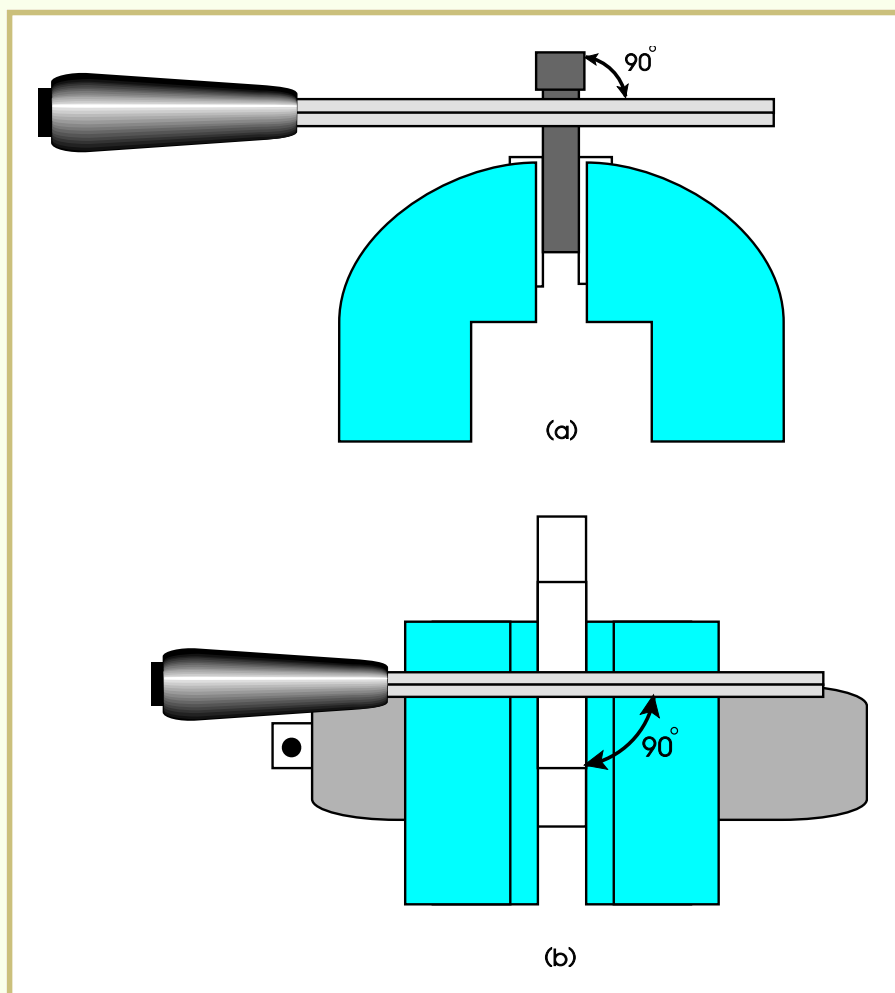
FIGURE 11—The marking-pen system for marking a key blank is illustrated here.

Filing

Before you can begin duplicating a key, you must select the appropriate file. For a flat, bit, or barrel key, the best file to use is the rectangular, box, or ward file. This file can produce the square edges necessary for this type of key. For a cylinder key, a small triangular-shaped file is used.

The natural tendency of a person when filing is to use a rocking motion. However, as shown in [Figure 12](#), a file must be used in a straight cutting fashion. In [Figure 12a](#), you can see a side view where the file is held horizontally 90 degrees from the blade at all times. In [Figure 12b](#), you see a top view where the file is also kept 90 degrees or perpendicular from the blade being cut.

FIGURE 12—Your filing motion must remain square to the key as shown here.



One way to keep your file straight and true is discussed here.

1. Stand in front of your vise and workbench with your left foot ahead of your right foot (right handed) or your left foot behind your right foot (left handed). This provides a stable platform for your upper body movements.
2. Hold the handle of the file in your right hand (right handed) with your index finger on top of the handle as shown in [Figure 13](#). Left-handed people will hold the handle with the left hand.
3. Place your free hand at the top of the file holding the tip between the index finger and thumb.

FIGURE 13—This is the proper way to hold a file to make clean, square cuts in the blank key.



When performing the filing, always make sure to cut only on the forward stroke. The cutting teeth on the file are designed like the teeth of a wood saw. They cut in one direction only. If you put pressure on the return stroke of the file, you can dull the cutting teeth and can load up the file with material.

Two hints from professional locksmiths are the following:

1. Always start at the bow or shoulder of the key to make the first cut
2. Always complete one cut before moving on to the next one.

Filing duplicate key blanks takes a certain amount of practice. It also requires a steady hand and patience. Your first hand-duplicated key may not look or perform as you desire.

However, after some practice, your hand-produced key may look and operate better than the original!

Inspecting the Duplicate

After completely cutting a duplicate, it should be measured and checked against the sample key. For a flat, bit, or barrel key, the dimensions of the cuts must be square to each other and identical in size to those of the sample. The calipers, mentioned earlier, can be used for this measurement task. For a cylinder key, the depth of each cut should be measured against the sample key.

Deburring

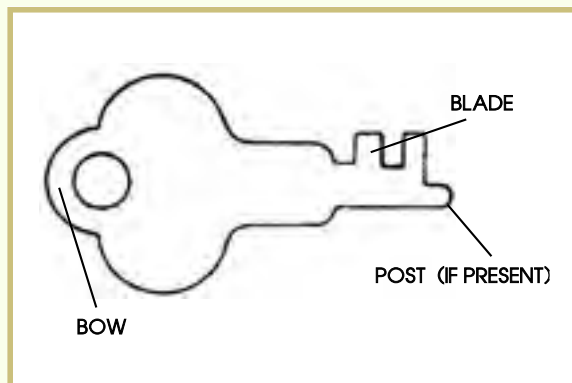
After you complete the cutting, remember to remove all burrs on the back side of the blade and check your cuts for square corners.

In the next section of the text, we'll show you how to duplicate three popular types of keys: flat keys, bit keys, and cylinder keys. We'll start with the flat key.

Duplicating a Flat Key

Flat keys fit many types of simple locks such as basic padlocks, drawer locks, and storage boxes. A typical flat key is shown in [Figure 14](#). The two major sections are the bow and the blade. This type of key or key blank is normally made of steel although some decorative locks may have a brass alloy flat key.

FIGURE 14—These are the names of the three major parts of a flat key.



Place the key blank in your vise with the sample key behind it. Align the two keys as precisely as possible. Grip as much of the bows and blades as possible exposing only the areas of the blades to be cut. Remember not to

touch the blank blade as the soot can be easily removed.

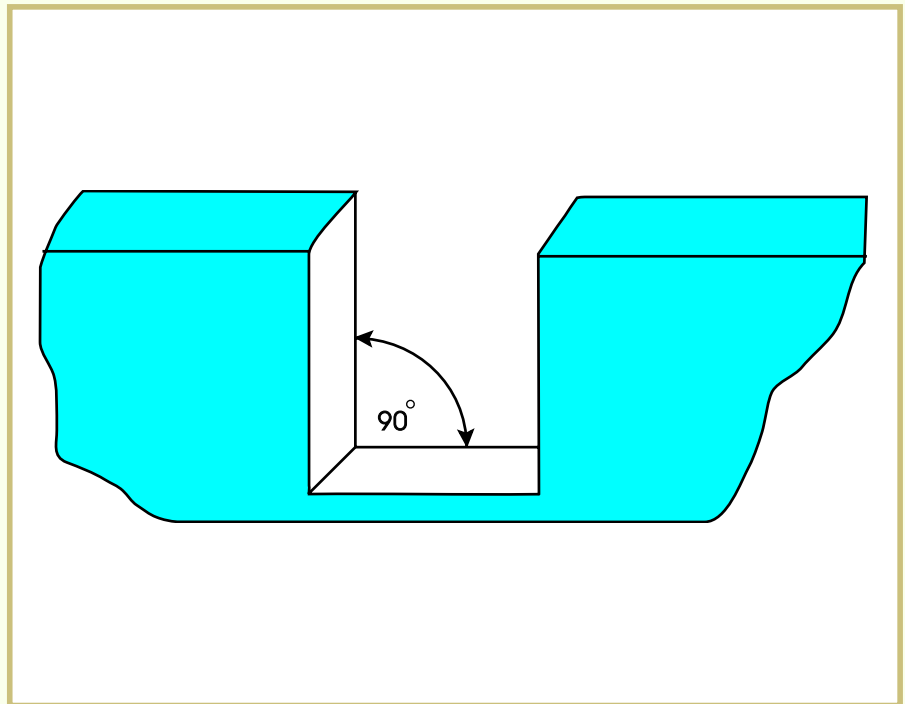
Now you are ready to begin cutting the blank. Once your body is in the proper position for filing, begin removing the

blackened areas of the blank using smooth straight strokes of the file. Start at the bow and proceed towards the tip of the key. Use patience and cut slowly. The idea is to create quality square cuts in the blank the same size as those in the sample without removing any material on the sample key.

After all of the blackened areas of the blank are removed, stop filing. Proceeding any further will cause you to cut into the sample key, ruining both keys. Take the keys from the vise and put the sample key away at this time.

Perform a visual inspection of the duplicate key, looking for square, or 90 degree, corners on your cuts. Your cuts should appear as shown in [Figure 15](#).

FIGURE 15—When you have completed filing a flat key, the corners of each cut should be square as shown here.



A final inspection can be performed using your calipers to check the depth of the cuts. If your duplicate key has not been cut deep enough, you can return it to the vise and gradually increase the depth of one or more cuts with your file.

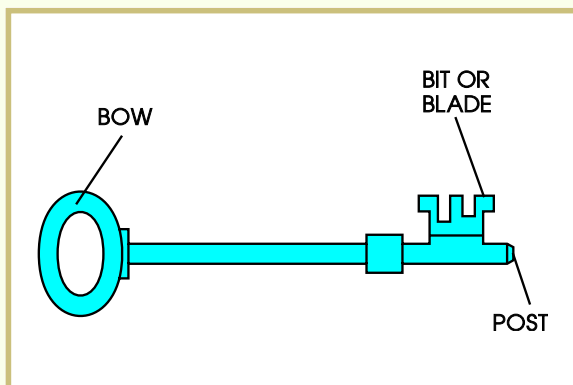
Finally, check the height and length of the blade of the duplicate key against the sample and file the duplicate as needed.

When you are satisfied that the duplicate key and sample key are an exact match, remove any burrs on the back of your key with fine sandpaper or your file.

Duplicating a Bit Key

A bit key and lock are one of the oldest and least secure of all locking systems. However, many of these systems are still in use today. Bit keys may also be called barrel keys by some locksmiths. A typical bit key is shown in [Figure 16](#).

FIGURE 16—These are the major parts of a typical bit key.

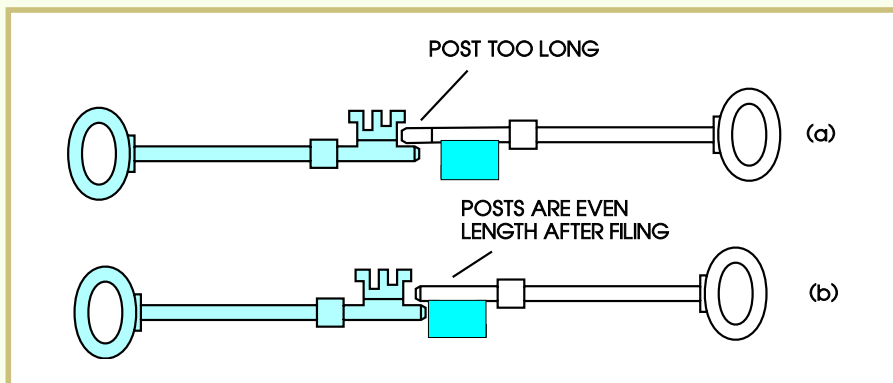


The major parts of a bit key are shown in this illustration. They are the bow, post, and the bit or blade. Where other types of keys are forged and machined in special metal-working machinery, a bit key is generally cast in a

mold. This method of manufacture causes the bit key to be of irregular dimensions due to the shrinkage of the metal in the mold.

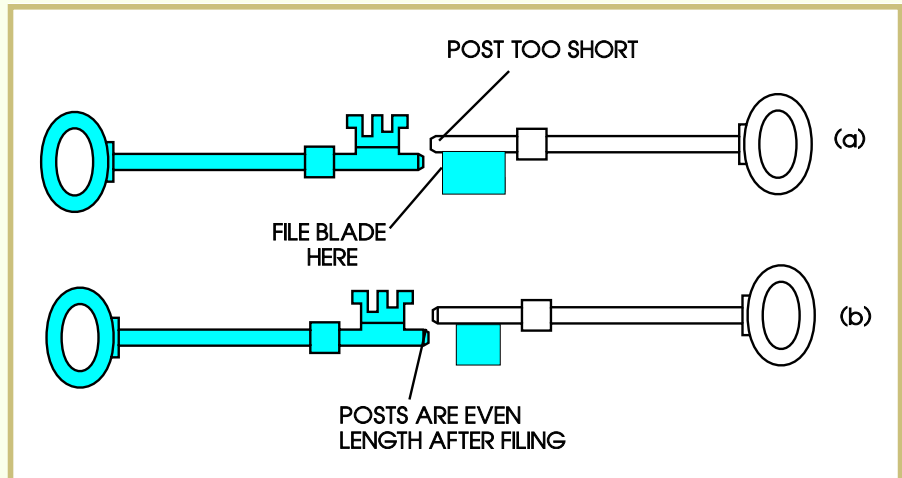
As with other keys, the first step to duplication is selecting the proper blank key. Because of the molding process used to make this key blank, there are certain problems to selecting a blank. [Figure 17](#) shows two keys held end to end. Notice how the post of the blank is much longer than the post of the original key in [Figure 17a](#). This extra length would cause the duplicate key not to work or to bind in the lock. If the bit is of the proper dimension, you can simply file the post of the blank until the gap is reduced as shown in [Figure 17b](#).

FIGURE 17—To properly size a bit key, you may need to file the post of the key.



The post of the bit key blank can also be too short, as shown in [Figure 18a](#). If this occurs, you can either select another blank or remove a portion of the blade, as shown in [Figure 18b](#). You must, however, make sure that reducing the size of the bit will not shrink it below the size of the bit on the sample key.

FIGURE 18—If the post is too short, you may be able to file the blade on the blank bit key.



There are several different methods of duplicating a bit key. These methods are:

Method 1. The measure and transfer method where each cut is measured with a caliper and transferred to the blank for cutting.

Method 2. The *shim stock method*, where a piece of thin sheet metal is cut on the sample and transferred to the blank.

Method 3. Purchasing a factory precut key.

In this section, we'll discuss using the second method, the shim stock transfer method. In using the shim stock transfer method, a small piece of metal stock is wrapped around the bit of the sample key, as shown in [Figure 19a](#). You then take a fine file

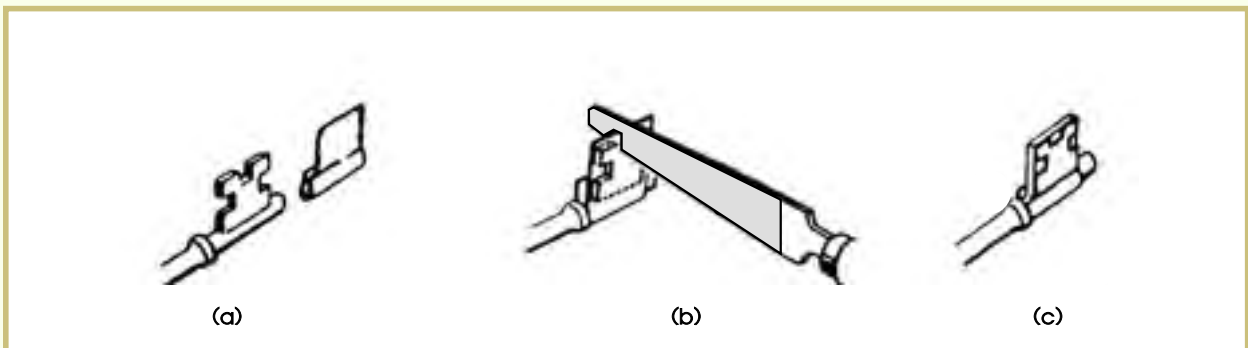


FIGURE 19—Shown here is the shim stock method of duplicating a bit key.

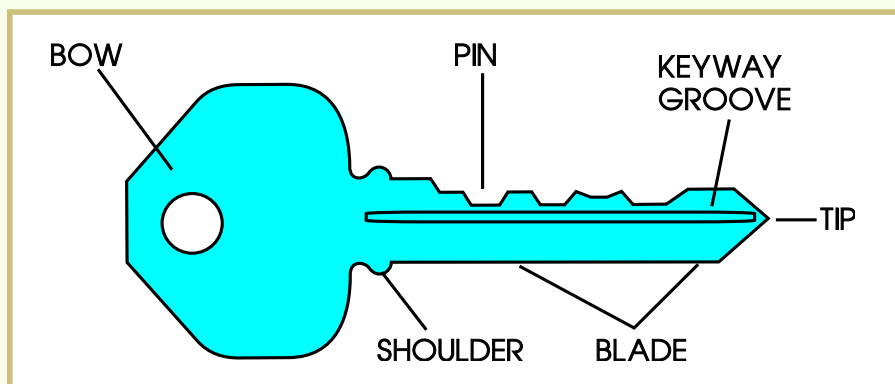
and remove the shim stock material, as shown in [Figure 19b](#). Be careful not to file on the surfaces of the sample key. Remove only the shim stock material. Finally, place the shim stock pattern on the blank and file the cuts on the blank as shown in [Figure 19c](#).

Duplicating a Cylinder Key

A cylinder key is one of the most popular keys in use today. A cylinder key and lock system offers a higher degree of security than either a flat or bit key.

The names for the major parts of a cylinder key are shown in [Figure 20](#). As you can see, they are the bow, shoulder, blade and tip. Within the blade are the keyway groove and the tumbler cuts.

FIGURE 20—These are the names for the major parts of a cylinder key.



In duplicating a cylinder key, it is especially important to match the blank and sample key. The distance from the shoulder to the tip, the type of blade, and the keyway groove of the blank must match the sample key. Even the most perfect cuts on an incorrect blank will not allow the duplicate key to open the lock.

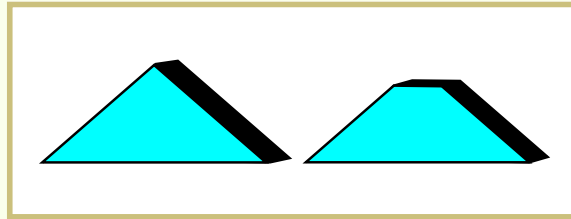
In this discussion of duplication, we will color the blank key with a black marking pen instead of “smoking” it under a candle flame. With the key blank colored on one side, place it behind the sample key in a vise. Once you have both the sample and the original keys properly aligned in your vise, it’s a good idea to C-clamp the bows together. This action will allow you to remove and reinsert the keys in the vise for inspection during your cutting.

To cut a cylinder key, you’ll use a small fine-tooth triangular file. Begin cutting the blank at the center of the first cut closest

to the shoulder of the key. Continue filing this cut until you almost reach the bottom of the cut in the original key. The black marker on the blank key will help you identify this point in the cut.

Continue cutting each cut in the key, proceeding from the shoulder to the tip. If you desire to inspect your progress, loosen the vise and remove the keys by holding the C-clamp. You can then reinsert the keys in the vise and complete your cuts.

FIGURE 21—Before you can call a cylinder key duplicate complete, you should remove all sharp points between deep cuts.



When you have completed cutting the key, remove it from the vise and remove the C-clamp to separate the keys. Remove all burrs

from the duplicate and remove all sharp points from the cuts. Sharp points will appear between two similar deep cuts as shown in [Figure 21](#).

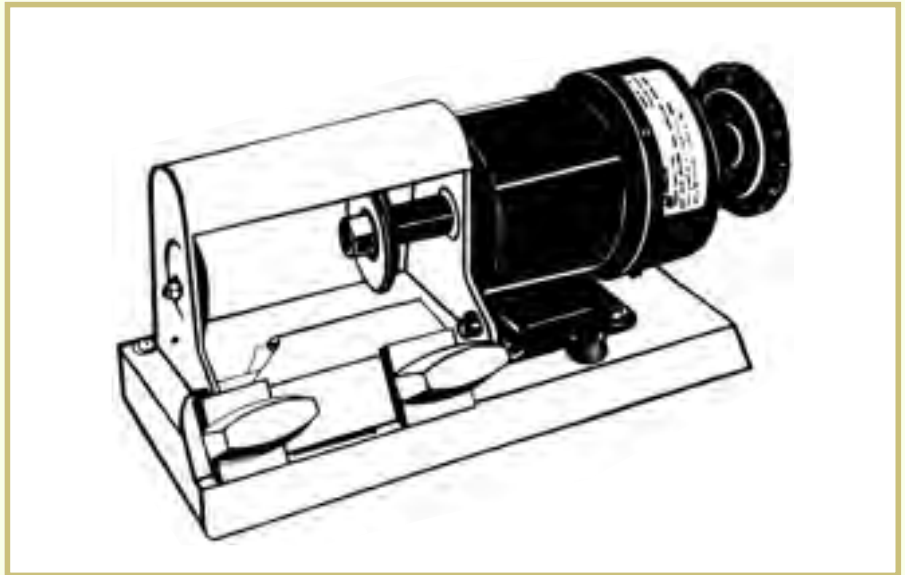
Operating a Key Machine

A key machine offers a quick and extremely accurate method of duplicating most types of keys. For example, flat keys and cylinder keys can be quickly duplicated on a basic key machine.

A key machine operates much like a basic tracing machine. As shown in [Figure 22](#), the sample key is placed in a vise at the left of the machine. A thumbscrew is tightened when the shoulder of the key is resting against the vise. The blank key is then placed in the right vise and aligned with its shoulder against the vise. The thumbscrew is then tightened. Before turning on the motor of the key machine, the alignment of the keys to the guide and cutting wheel is checked and adjusted as necessary. This action is performed by lifting the vises upwards. Both the sample key in the left vise and the blank key in the right vise should have their shoulders touch the guide and cutting wheel in exactly the same position. Adjust the blank key's position as necessary.

The vises are then lowered and the motor of the key machine is started. Now, slowly lift the left vise containing the sample key into the guide starting at the first cut to the right side of the

FIGURE 22—This illustration shows a typical bench-mounted key duplication machine.



shoulder. Now, slide the sample key slowly under the guide. The blank key in its vise will be following this motion of the sample key and will be cut by the specially-shaped cutter.

After one pass of the guide over the sample key, the vises are lowered and the motor stopped. The keys are removed from the machine and the duplicate key deburred. Some key machines have special deburring wheels mounted on the side of the machine for this purpose.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

1. When you're duplicating a key, with what type of key do the grooves in the blank have to match those in the sample key?
 - a. Flat
 - b. Bit
 - c. Barrel
 - d. Cylinder
2. When filing a duplicate key, what natural tendency should you try to avoid?

3. What measuring instrument can be used to measure the blade of a key during duplication?

Check your answers with those on page 69.

CUTTING KEYS BY CODE

Theory of Code Key Cutting

As a professional locksmith there will be many times when you will be asked to cut a key without ever seeing the original key or the lock it fits. For example, a customer may enter your shop with a padlock for which the keys have been lost. Somewhere on the plug or shell of this lock, a special identifier will have been stamped. This number or letter combination means nothing to most people. However, to a locksmith with the proper code books, this number identifies the code numbers needed to properly cut a key for this padlock.

Key codes are available for almost every lock made. One of the most common types of codes used by locksmiths are the codes for automobile keys. These codes not only will give you the key cutting code but will usually tell you what key blank to select.

Reading Codes

Let's begin this section by looking at typical key codes for a disk tumbler lock. A short section of a code book listing is shown in [Figure 23](#).

Let's look at the particular key code for a lock that has the number 4021 stamped on its shell. The key cut code for this lock would be 2, 4, 2, 5, 1. At first glance, this key code would seem

to be a random set of numbers. However, each number identifies a certain depth of cut for each cut on the key blank. These cut depths are identified in [Figure 24](#).

Notice that each depth differs by a dimension of 0.015 inches, or fifteen-thousandths of an inch. Also, notice that the numbers used

Lock Number	Key Code
4021	24251
4022	24242
4023	25242
4024	25342
4025	25241
4026	24142
4027	35314
4028	31352
4029	31425
4030	31424

FIGURE 23—Shown here is a short section of a listing in a code book.

FIGURE 24—A depth chart for a disk tumbler lock is shown here with the code number on the left and the dimension from the bottom of the blade to the bottom of the cut on the right.

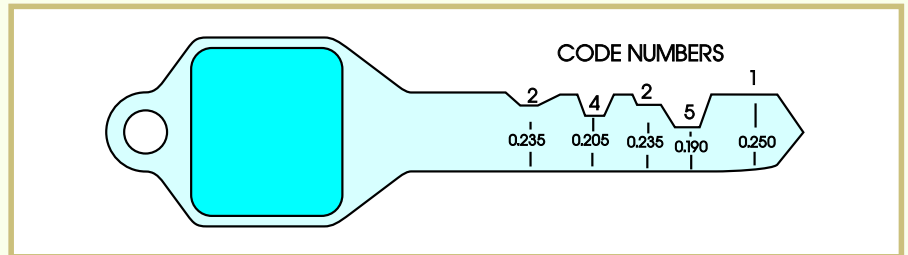
Code Number	Cut Depth
1	0.250
2	0.235
3	0.220
4	0.205
5	0.190

in the key code chart are always at least two cut numbers apart. Therefore, key code 24153 is a valid key code while code 12345 is not valid.

Now, let's get back to our sample key code of 2, 4, 2, 5, 1. This key with its cuts plainly marked is shown in [Figure 25](#).

By reading and using the key codes, you could precisely file each cut in the key blank if the spacing of the key cuts were known. Spacing will be based on a sample key, or more likely, a spacer, or guide key, as you will see in the next section.

FIGURE 25—Here is a visual display of how the key codes and the cut depths are related.



It should be noted that the cut depths given in the chart in [Figure 24](#) will only work for this type of disk tumbler lock key. In an automotive key, the difference in dimension for each cut number is 0.025 inch or twenty-five thousandths of an inch. A typical code book listing and the related cut depths are given in [Figure 26](#). Notice that the automotive lock table does not follow the same rules as the disk tumbler lock coding system. In an automotive key, two consecutive key cuts do not have to be separated by at least two digits. In fact, two or more adjacent key cuts can even be the same cut number!

Cutting Keys by Code

Although a key can be cut by hand once its codes are known, normally the keys are made using a machine called a code

FIGURE 26—A sample code book listing and cut code depths for the code numbers is given here.

CODE BOOK LISTING	
Lock Number	Code
8224	331424
8225	332343
8226	252344
8227	534443
8228	533554
8229	445421
8230	332355
8231	145422
8232	343523
Cut	Depth
1	0.250
2	0.225
3	0.200
4	0.175
5	0.150

cutting machine. This machine, which will be discussed very shortly, will use a micrometer feed device to set depth and special spacer, or guide, keys. A spacer key is used to set the spacing between the cuts on a blank. A few sample spacer keys are shown in [Figure 27](#).

Notice that the grooves on these keys are evenly spaced. If you were to transfer these grooves to a blank, you would get the spacing required for a functioning key. All that would be needed are the proper key codes for the lock to cut a key for a disk, pin tumbler, or other type of lock. Now, let's look at how to cut a key using key codes and a spacer key on a code cutting machine.

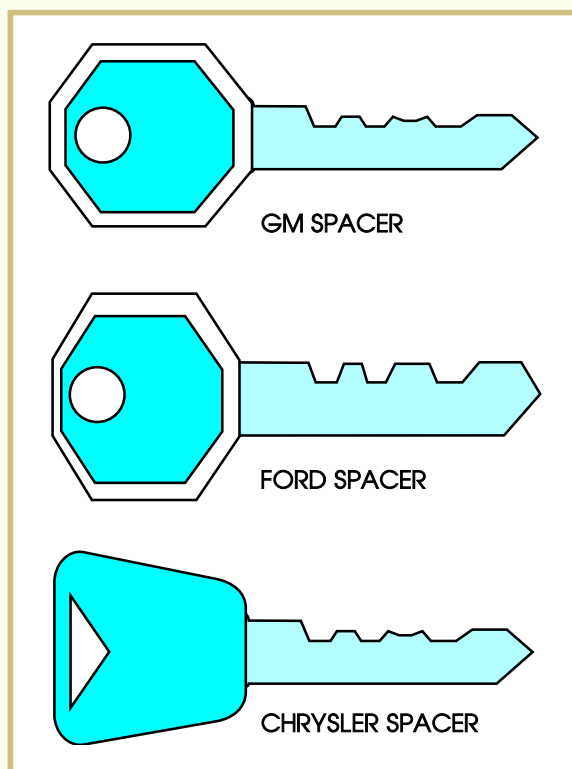


FIGURE 27—These are spacer, or guide, keys you would use on a code cutting machine to ensure proper spacing of the cuts.

Code Cutting Machines

You learned earlier how key duplicating machines operate. To review, the sample key is placed in the left vise and traced by a guide or stylus as it moves under the

stylus. The blank key is placed in the right hand vise which follows the motion of the left hand vise containing the sample key. The blank key is cut by a specially shaped wheel on the right hand side of the key duplicating machine.

A code key cutting machine will normally look like a backwards key duplication machine. The blank key is held in the left hand vise while the spacer, or guide key is in the right hand vise.

Many code key cutting machines also have a micrometer, which is basically an extremely precise screw and nut assembly. It operates in the same fashion as a bolt and nut. However, the micrometer's threads are so fine that one revolution of the barrel may move the center shaft only ten-thousandths (0.010) of an inch. A calibrated scale on the micrometer is used to set the depths of the cuts on the code machine. A V-shaped block at the end of the micrometer's screw is used to track the grooves in the spacer key. It should be noted that the distance between the blade bottom and the bottom of the groove on a spacer key is 0.025 inch. This, as you may remember, is the thickness of a blank key's blade and is equal to a number one cut on the keys you have seen previously.

Cutting Keys on a Code Cutting Machine

Cutting code keys by machine is actually very simple as long as you set up the machine properly. The steps to proper setup are

Step 1. Make sure a V-type cutting wheel is in place on the motor-driven arbor.

Step 2. Check the installation and tightness of the V-shaped guide on the end of the micrometer.

Step 3. Set the micrometer to zero by turning it in a clockwise direction. Never force the barrel when turning the micrometer – its fine threads could be damaged.

Step 4. Carefully mount your spacer key in the right-hand vise. It must be mounted square to the machine. If necessary, place a piece of shim behind the blade of the key to hold it square in the vise.

Step 5. Loosely mount the blank key in the left-hand vise.

Step 6. Lift up on the right-hand vise that holds your spacer key.

Step 7. Align the shoulder of your spacer key to the V-guide at the end of the micrometer.

Step 8. Align the shoulder of the blank key in the left-hand vise with the cutting wheel.

Step 9. Tighten the vise and recheck your alignment of both keys by lowering and raising the vises. Both shoulders of both keys should be centered on the V-guide and V-cutter at the same points on the shoulders of the keys.

Now let's see how to cut a key by codes on a key machine. As an example key, let's use an automotive key with the code 8229 stamped on the side shell of the lock. Going into our code book, we can see that the number 8229 would give us a key with cut codes of 4, 4, 5, 4, 2, 1.

Placing these numbers vertically from the shoulder cut at the top to the tip cut at the bottom gives us

4
4
5
4
2
1

Installing the cut dimensions next to the vertical column of cut numbers would give us

4 0.175
4 0.175
5 0.150
4 0.175
2 0.225
1 0.250

Let's add a third column to our key code chart. This column will be the difference in inches between the cut code value and the no cut or number one cut of 0.250. For example, cut number 5 has a dimension of 0.150. Therefore, subtracting this value from the number 1 or no cut value of 0.250 gives us 0.100 inches. Creating this third column will give you a chart that appears on the following page.

Code Number	Cut Depth	Difference from Cut 1
4	0.175	0.075
4	0.175	0.075
5	0.150	0.100
4	0.175	0.075
2	0.225	0.025
1	0.250	0.000

The difference column, the third column of our chart, shows the dimensions we will dial on the micrometer to perform the cuts. Before turning on the motor of the code key machine,

doublecheck that the cutting wheel is tight, the keys are firmly held in their vises and the micrometer V-guide is secure. Next, you can set the first value for code cut 4, or 0.075 inch. Do this by turning the knob of the micrometer counterclockwise until it has retracted the V-guide 0.075 inch. Your manual for your code key machine will give you detailed instruction on the reading of the micrometer's scales.

Now you can turn on the code key machine and slowly raise the right hand vise containing the spacer key upwards towards the V-guide. Our first cut will be performed on the notch on the spacer key nearest the shoulder of the key. Since this cut is rather deep, a large amount of material will be removed from the blank. Proceed slowly forward with the right-side vise until the guide on the micrometer is fully seated in the first notch or groove in the spacer key. Once the V-guide has bottomed in the groove, retract the vises.

Your next cut in the blank will also be a number four cut. It will be of the same dimension as your first cut. Therefore, it is a simple process of raising the right-hand vise until the second groove in the spacer key is fully seated in the V-guide of the micrometer.

The third cut is a number five cut with a dimension of 0.150 inch. The difference from cut number 1 is 0.100 inch. This means that you can increase the reading on the micrometer by turning the micrometer an additional 0.025 inch in the counterclockwise direction. If this seems confusing, you can simply re-zero the micrometer by turning it clockwise to zero and then turn it counterclockwise to 0.100 inches. When the micrometer is properly set, raise the right hand vise until the V-guide rests in the third groove of the spacer key.

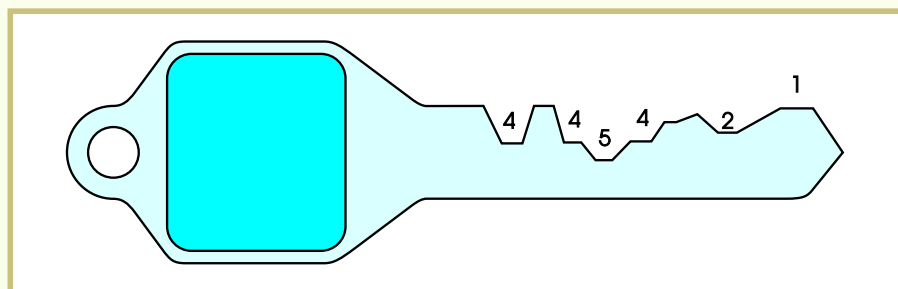
Your fourth cut is a number four cut that is similar to the first two cuts you performed. Reset the dial of the micrometer to

0.075 inches by either turning the micrometer clockwise 0.025 inches or return the micrometer to zero and back out 0.075 inches. Again raise the right-hand vise until the fourth groove in the spacer key is fully seated in the V-guide.

The fifth cut can then be performed in the blank. This fifth cut is a number two cut which at 0.025 inches is a rather shallow cut. Set this reading on the micrometer and raise the right-hand vise until the fifth groove of the spacer key is fully seated in the V-guide.

The sixth cut in your blank is really no cut at all. The dimension is 0.250 which is the actual dimension of the blade of the blank key. Therefore, its time to turn off the motor and wait for the cutter to stop turning. Now, remove the cut blank key, debur it, and inspect the cuts. The final key should appear as shown in [Figure 28](#).

FIGURE 28—This is how a sample code cut key would appear.



As you can see, if you have the lock number or key number in some cases, you can duplicate a key without looking at an original key or the actual lock. Using a spacer key and your micrometer V-guide adjustment, almost any type of key can be created.

Here are a few safety tips to use when working with a code cutting machine:

1. Always be sure to completely read the manual for your machine before using it.
2. Wear safety glasses with side shields. Small particles of brass, nickel, or bronze will be thrown from the machine when you are grinding the key blank. These particles are non-magnetic and very difficult to remove from your eye. Plus, the particles can be very sharp and cause significant eye damage.

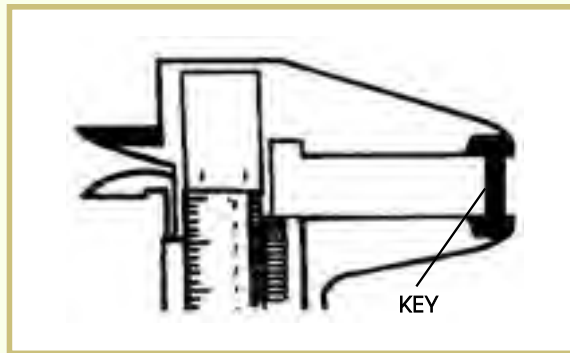
3. Avoid wearing loose fitting clothing, ties, and jewelry. These items can get caught in between the grinding wheel and the blank and pull you towards the machine.
4. Always keep the floor and workbench area around the key cutting machine clean and clear of obstructions.

Decoding Cut Keys

Decoding a previously cut key is actually a very simple task. The key will probably have a number or letter on it. Using this number, you may be able to go directly to your code book and get the key cut codes for that particular key. What could be easier? However, if these numbers are missing, you may still find a blank identifier number or letter somewhere on the key. Then you will have to measure the key to derive the key cut codes.

Measuring a key for cut codes is a simple matter of using your vernier calipers to measure each cut as shown in [Figure 29](#).

FIGURE 29—To decode a precut or sample key, measure each of the cuts in the key with a vernier caliper.



Let's say, for example, that a customer brings you a worn ignition key that will not always operate the automobile. Since the key is worn, you do not want to simply place it in a duplication machine.

To cut this key using codes, you will have to measure each cut and create the codes for yourself if no identifying numbers exist on the key.

Begin the process by clamping the bow of this key to the bow of your spacer key. You will, of course, have to select the proper spacer key to match the manufacturer's. Using a needle or scribe, mark the sample key at each point a groove occurs on the spacer key. A very fine mark is all that is needed. Separate the keys and, using your calipers, start at the point nearest the shoulder of the key and measure each cut in order.

Cut	Measurement
1	0.160
2	0.235
3	0.215
4	0.190
5	0.191
6	0.135

Shown here is a sample of the measurements you might make.

As you can see, none of these numbers matches the dimensions for a new code key since this key is worn. We will have to increase the measurement to

the next largest size to properly get the codes. You should never decrease the sizes since key wear has removed material from the key, reducing the cut sizes.

Shown here are the cut numbers, measured size, and increased size along with the key code number for that cut.

Cut	Measurement	Increased Value	Code Number
1	0.160	0.175	4
2	0.235	0.250	1
3	0.215	0.225	2
4	0.190	0.200	3
5	0.191	0.200	3
6	0.135	0.150	5

Thus, the proper key code for this key would be 4, 1, 2, 3, 3, 5. By using your spacer key and these numbers, you could quickly create a working key for your customer's vehicle. As previously mentioned, you'll find that a large amount of your key code cutting work will be in the area of automotive keys. As you will soon see, your other code cutting work will be made up of cutting keys for rekeyed locks and for master keying systems.



Locking It Up! 2

1. How many cuts does a typical automotive key have?

2. What is the purpose of a spacer, or guide, key?

3. If you are decoding the cuts on a worn automotive key and you read a dimension of 0.167, what would be the proper code number and dimension for the cut?

4. When cutting a key on a code machine, which cut should you begin at?

Check your answers with those on page 69.

REKEYING DISK/WAFER AND PIN TUMBLER LOCKS

Definition of Rekeying

If you are asked by a customer to rekey a lock, it means that you will disassemble the lock and either replace or realign the disks/wafers or pins. When you have completed this operation, the original key will not operate the lock. An entirely new key will need to be cut to open this lock.

Rekeying is often performed when your customer purchases a home, car, or other object for which the original owner may have retained a set of keys. This is especially true when the customer considers the rekeying of the locks as less expensive than the purchase of new locks. Also, your customer may consider that the locks presently in place are appealing and have no desire to change them.

Rekeying Procedures

Rekeying a lock will require you to perform the following general steps. (We'll give you more detailed instructions on rekeying disk/wafer and pin tumbler locks later in this section.)

Step 1. Remove the plug according to the manufacturer's instructions for the lock you're working on.

Step 2. Place the plug in your vise.

Step 3. Remove each disk or pin from the plug, and place them in a tray in the order in which you remove them.

Step 4. Change the order of the disks or pins and replace them in the plug.

Step 5. Cut a key to match the new arrangement of disks or pins.

Step 6. Reinsert the plug into the shell.

Step 7. Test the new key to make sure it works.

Tools

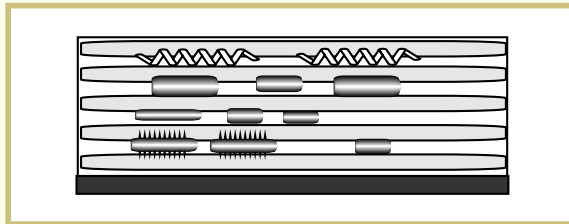
The tools you will need to rekey a lock are very similar to those used in cutting a key blank. You will need files, calipers, and a vise for holding the shell and plug. In addition, a few new tools may be necessary to help you rekey a lock efficiently.

An electric drill and small drill bits may be needed to drill into the shell or plug of the lock to remove the plug retainer.

A small, quality electric drill will suffice. The manufacturer's data sheets will show you exactly where to drill to spring or remove the plug retainer. A pair of fine tweezers will be helpful to remove the disks or pins when rekeying a lock. Some locksmiths, in fact, will have multiple pairs of tweezers, some with the ends bent at a 45 degree, or a 22 ½ degree angle.

A pin tray is also a useful aid when rekeying a lock. A pin tray has multiple dividers, as shown in [Figure 30](#). As you remove each disk, or lower pin, place it in its own special section of the pin tray. As the next disk or pin is removed, place it in the next separated compartment. This will keep the disks or pins in order as you work on the lock.

FIGURE 30—A pin tray will help you keep pins, disks, and springs in order as you remove them from the plug.



Some locksmiths will also mount a shallow drawer beneath their vise on their workbench. This drawer is opened when they are removing a

plug from a lock's shell. The drawer will then catch any loose springs, disks, or pins that may fall from the plug, eliminating the all-too-often futile search around the floor.

A special follower plug or dowel will be necessary to remove the plug of a pin tumbler lock. This follower plug or dowel is used to prevent the upper pins and springs from exiting the shell when the plug is removed. More will be seen on this item when we cover the removal of the plug later in this section.

A straight, pointed tool such as a lock pick or a thin carpenter's awl may be needed on some locks to release the retaining spring after a hole is drilled in the shell. Also, various types of screwdrivers, slotted and Phillips, may be necessary to

remove plug-retaining screws on some types of padlocks, and on mortise-type locks.

Rekeying a Basic Disk Tumbler Lock

In its most basic form, a disk tumbler lock is used for locking cabinets, trunks, and on some low security padlocks. More expensive disk tumbler locks can be found on higher-priced padlocks and on automobiles.

In review, a disk tumbler lock holds the plug in place with one or more disks that fit into a slot in the shell of the lock. The disks are spring loaded and held in the slot. When the proper key is inserted into the lock, the disks are centered in the plug away from the slot or slots in the shell, allowing the plug to turn. The disks within the plug are slotted for key entry. The slots are positioned in different places on the disks, thereby requiring a key with different cuts along its blade to open the lock. These different disks with their staggered slots allow us to change the keying system for the lock.

To begin rekeying a disk tumbler, the first step is to remove the plug from the shell. In the lock shown in [Figure 31](#), a hole has been drilled in the shell to allow access to the retaining clip that holds the plug in place. On some disk tumbler locks, this hole may be present.

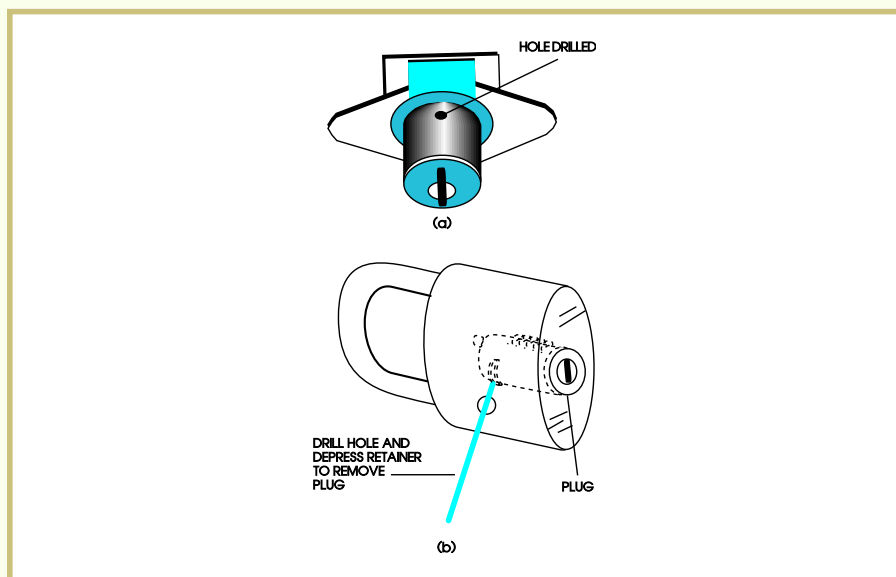


FIGURE 31—Here are two locations where a hole must be drilled to remove the plug of a disk tumbler lock.

In [Figure 31\(a\)](#), a small hole has been drilled in the shell near the top centerline of the plug. A typical padlock example is shown in [Figure 31\(b\)](#). Here, a hole has been drilled for access to the retainer. These holes can later be filled with an epoxy or other material and sanded, then polished to disguise their location.

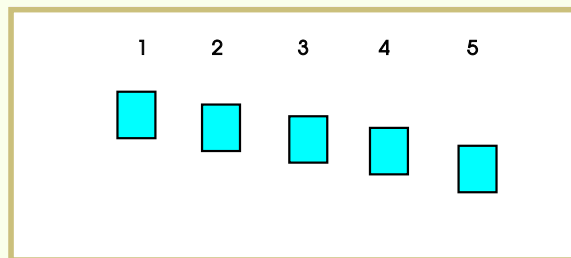
A small object such as a lock pick, thin awl, or other such object can then be placed into this drilled hole. By applying pressure, the retaining ring for the plug can be collapsed. With the key located in the plug, turn the plug slowly while pulling outward. The plug should slide from the shell.

Once the plug is removed, you can place the plug in your vise and begin removing the disks. As each disk is removed from the lock, place it in order in a pin tray or other small container. When all of the disks have been removed, set the pin tray aside and clean the plug.

The plug should be cleaned in a safe and non-flammable solvent. Do not use gasoline or kerosene. Spray solvents and other types of cleaning solutions are available from locksmith supply houses. If you desire, you can also use electrical spray cleaners such as those used on volume controls and other electronic components.

Now you can begin reloading the disks into the plug. Remember that you want to stagger the disks in the plug to rekey it. The disks that you have in the plug tray, or container, should look like those shown in [Figure 32](#).

FIGURE 32—The five different sizes of disks in a disk tumbler lock are shown here.



Note that there are five different sizes of disks shown. Not all five may appear in a disk tumbler lock that you open. Instead, one or more disks may be repeated within the

lock. You may notice that the disks can have a number stamped on them. This number identifies the type of disk you're working with.

You must switch at least two of the five disks in the lock to properly rekey it. Often three disks, such as the first, third, and fifth disks will be swapped in position in the tumbler to

properly rekey it. The disks, of course, must be of a different number or slot height. If the first and third disks are both number three disks, swapping them would provide no rekeying action.

Now with the disks swapped, it's time to rekey the lock. Locksmiths may use different methods to cut a key for this plug. Some of the methods that may be used are

Method 1. Code cutting the key. This is a relatively easy task since you know exactly what disk is in what position within the plug.

Method 2. Cut the areas of the key by hand where the disks have not been moved using the original key as a guide. Next cut the areas where the disks have been moved by measuring the original cuts in the key. Swap the location of these cuts on the blank and file these cuts in the new key.

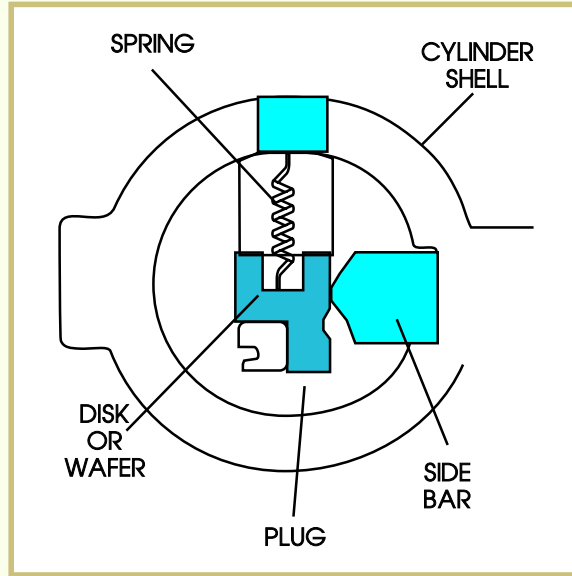
Method 3. A third method of cutting a key would be to use the original key to mark the spacing of the cuts. Once marked, the key is inserted into the plug and the heights of the disks are noted. The key is removed from the cylinder and cuts are continued where the disks extend from the plug. Here you should go slowly. Reinsert the key and recheck disk height many times. You can always remove more material from the blank but you can never add material. Never file the disk. When you are done filing, all of the disks should be even with the plug with the new key firmly seated in the plug.

Rekeying Side Bar Wafer Locks

A side bar wafer lock is constructed much like a disk tumbler lock seen previously. However, the lock does not depend upon the disks to disengage from a slot in the shell. A side bar wafer lock uses the wafers, which resemble disks, to release a side bar that disengages from a slot in the shell. Once the side bar is released, the plug can turn, opening the lock. The side bar is only released when all five or six wafers or disks are in the proper position as set by the cuts in the key. A typical wafer/side bar arrangement is shown in [Figure 33](#).

Side bar wafer locks provide a greater degree of security than simple disk tumbler locks. They are extremely difficult to pick and can be made inexpensively and in a compact

FIGURE 33—In this cutaway view of a side bar wafer lock, you can see how the disks or wafers must be aligned to have the side bar come free of the shell.



package. Side bar wafer locks will make up a large amount of your locksmith work. This is because they find use as ignition, door, and trunk or rear hatch locks for most General Motors automobiles and light trucks.

The five types of wafers that you might find inside a side bar wafer lock

are shown in [Figure 34](#). These wafers may be identified by a number, one through five, stamped on the wafer. However, on some wafers, you may see the letters C, N, B, or Y. These letters stand for copper, nickel, black and yellow, respectively. If the lock you disassemble has no letter marking on one wafer, it will be equal to a number five wafer.

The removal of the lock from the vehicle is the first step in rekeying this lock. Ignition and trunk locks are normally removed by driving out a retaining pin to release the shell of the lock. Door locks are removed after removing the locking linkage. Normally a specially shaped clip is used to hold the

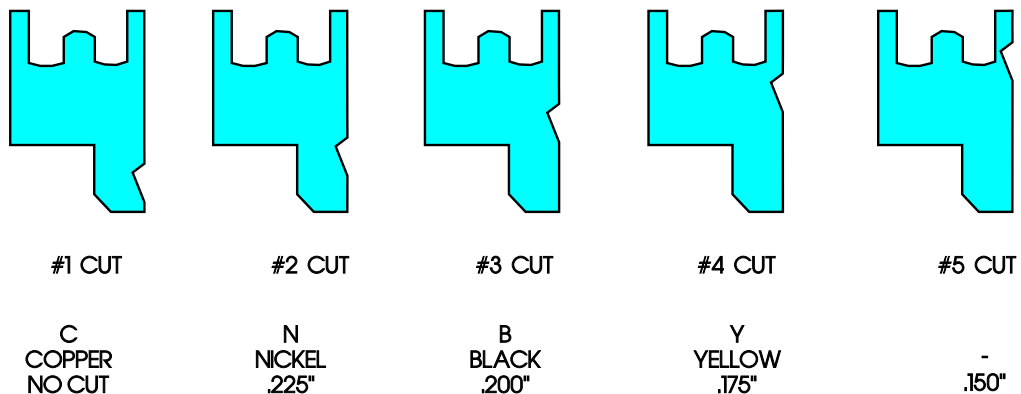


FIGURE 34—These are the five sizes and the size identifiers for a side bar wafer lock.

lock shell. Exact details on lock removal from automobiles are available in automotive service manuals.

To rekey this type of lock, you will have to remove the spring and disk retainer cover. Pry upwards on the cover with a small screwdriver and it will come free of the shell. Very often, this cover will be bent or distorted upon removal and require replacement after you have moved the disks. These covers are available at locksmith supply stores or by mail order.

With the cover removed, begin lifting the six internal springs from the lock with a pair of tweezers. Place these springs in your pin tray or other container.

The most important step in rekeying this lock comes next. You should decode the original key or study the wafers in the lock carefully to decide exactly which disks to move. If the original key code was, for example, 4, 4, 5, 3, 4, 1, then switching the first and second, or first, second, and fifth wafers would not rekey the lock. A better rekeying method would produce a new code key arrangement such as 4, 5, 4, 4, 1, 3. This arrangement would surely render the original key useless.

The actual rekeying will be performed by lifting the designated wafers out of the plug and replacing them in their new location. After this action has been performed, you can clean the lock thoroughly and begin replacing the springs. Once the springs are replaced, a new spring retainer cover can be inserted in the shell. Make sure this retainer is held in the shell tightly. If it is loose, bend the tangs of the retainer slightly outward to hold it in the shell. You can also lightly dent the tangs with a punch or other sharply pointed object to further improve the retaining force of the tangs.

Finally, you are ready to cut the key for the lock. The easiest method is to record what wafers are in position in the lock and code cut a key. The chart on the next page lists the code numbers, cut dimensions, and micrometer settings for your rekeyed side bar wafer lock.

Code Number	Cut Depth	Micrometer Setting
4	0.175	0.075
5	0.150	0.100
4	0.175	0.075
4	0.175	0.075
1	0.250	0.000
3	0.200	0.050

Now you can cut the new key for the lock using the micrometer settings listed in the chart above. Remember to debur this key and check its operation before giving the key to your customer. It is also a good idea to lightly lubricate the lock using WD-40. Never use oil, grease, or any type of mineral- or paraffin-base lubricants. These types of lubricants tend to collect dust and dirt over time. This dust and dirt will later become a thick paste. This paste will cause the lock to malfunction. WD-40 comes in a can with a small nozzle and cap. This nozzle can be inserted into the lock and the tube squeezed to place a small amount of WD-40 in the moving mechanisms of the lock.

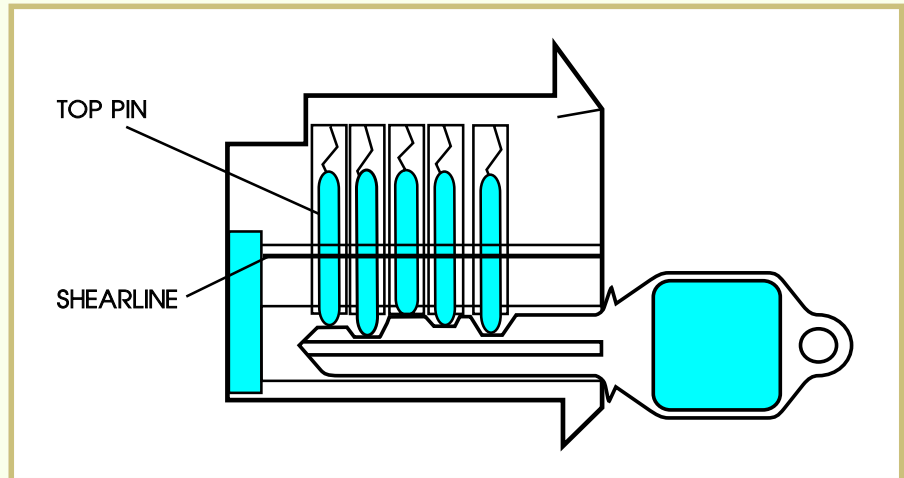
Rekeying Pin Tumbler Locks

Let's begin this section with a review of how a pin tumbler lock operates. This type of lock is one of the most popular in use today for home entry locks, padlocks, and other types of medium security locking devices.

The plug of this type of lock is held from rotating by the upper pins. The upper pins are all of the same height in most pin tumbler locks while the lower pins are of different heights.

To open this lock, the key pushes upward on the lower pins as shown in [Figure 35](#). When all pins are properly raised even with the top of the plug, the plug can be rotated releasing the locking mechanism. One term you will encounter often with pin tumbler locks is shearline. The shearline is the point at the top of the plug that the lower pins must reach in order to turn the plug. If an improper key is used, the lower pins may be raised too far above the shearline, inhibiting the turning of the plug. An improper key may also not raise the

FIGURE 35—When the proper key is inserted into the plug, the lower pins are raised to the shearline, allowing the plug to turn.



lower pins to the shearline. This action would allow the upper pins, under spring pressure, to remain below the shearline, also inhibiting the turning of the plug.

The object of rekeying a pin tumbler lock is to gain access to the lower pins and alter their position in the lock. This process will cause the original key to become inoperative.

Gaining Access to the Lower Pins

There are two basic methods of gaining access to the lower pins. These methods are

Method 1. Removal of the spring retainer on some types of locks.

Method 2. Removing the plug assembly on most pin tumbler locks.

Some door locks have a spring retainer similar to the one seen earlier on a side bar wafer lock. If this retainer is removed, the springs can be removed and placed in your pin tray. Next, you can block all but one hole in the shell and dump out the upper and lower pin, placing these pins in your tray. Continue this operation until all pins are removed from the lock. Now clean the lock using a safe spray solvent or by dipping the plug and shell into a cleaning tank. Once dry, reassemble the lock by placing the lower pins into the holes in a different order from which they were removed. It is a good idea to record on a piece of paper which lower pins were switched. Then, when you cut the key for this lock, you can measure the original key and switch cut depths on the blank key.

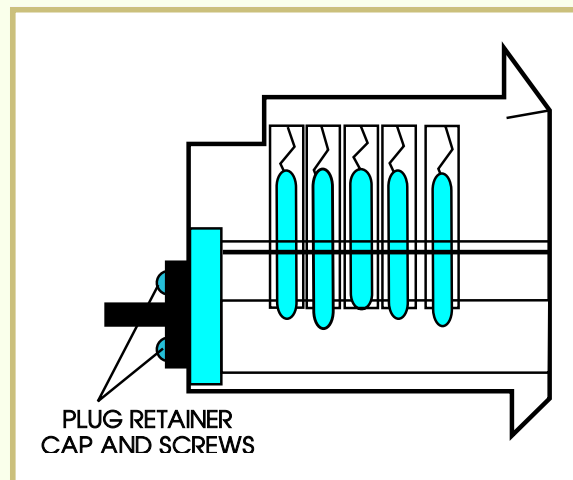
With the lower pins in the lock, simply replace the upper pins, springs, and spring retainer. If the spring retainer was damaged during removal, replace it with a new retainer.

To cut a key for this lock, duplicate the cuts in its original key where the pins were not swapped. Next, using your calipers, measure the cuts in the sample key where the pins were originally located and perform these cuts in the new key in the new pin locations. Go slowly and check your work by inserting and checking key operation after you think you are close to the final cut distance. Lubricate the lock with WD-40 and return the shell to its locking mechanism.

The second method of rekeying a pin tumbler lock is much more time-consuming and detailed. Unfortunately it is the more common method since many locks do not have spring returner plates or covers.

In this second method, you must remove the plug from the shell. Let's begin by looking at a lock where the plug is removed by removing a retainer plate. Such a lock is shown in [Figure 36](#). This type of plug retainer is held by two small machine screws on the retainer plate.

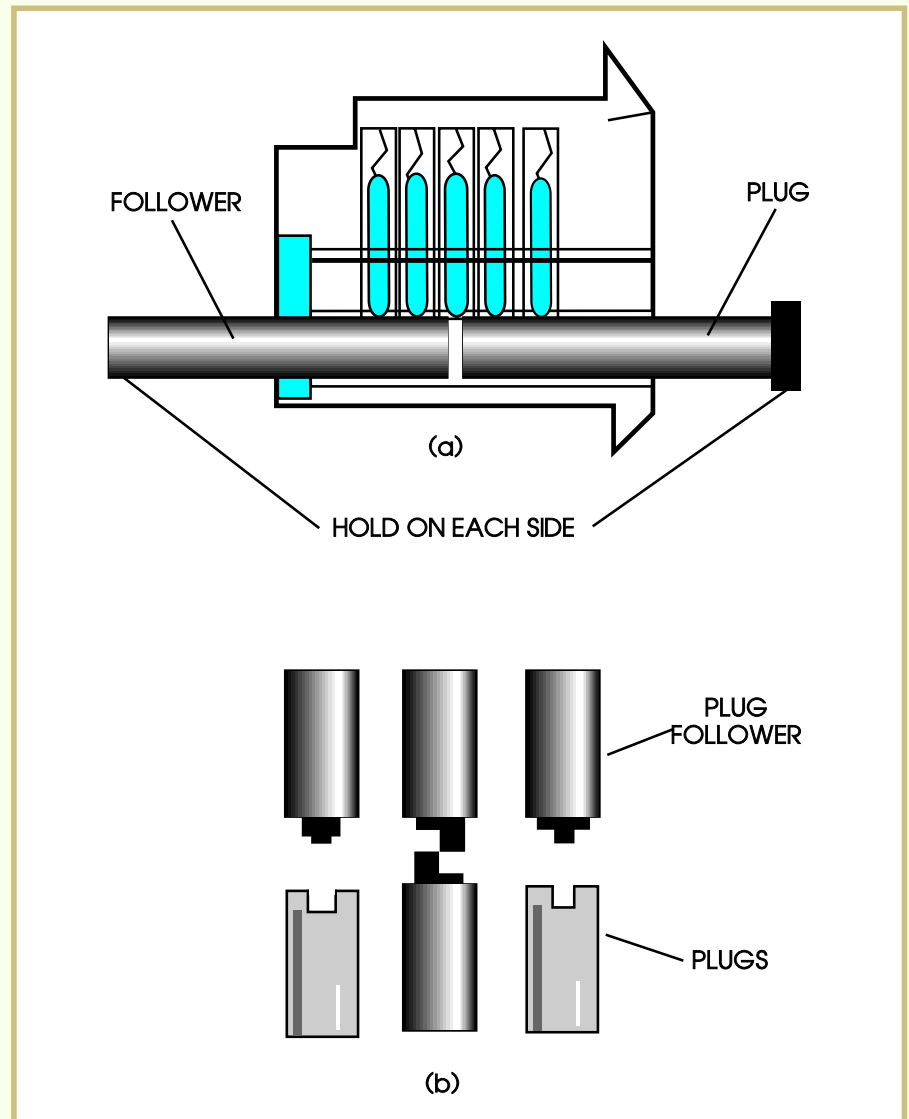
FIGURE 36—In this type of pin tumbler lock, the plug can be removed after two screws are unscrewed from the shell, releasing the retainer plate.



Once the retainer is removed, you could simply insert the key into the plug, turn the plug with the key, and pull the plug from the shell. However, all of the upper pins and springs would then pop free of the lock. Although these pins and springs can be easily replaced

with a tweezers, reinserting the plug would be difficult as the upper pins would try to block the insertion of the plug. For this reason, it is suggested that you use a plug follower. This follower will hold the upper pins and springs in the shell while you work on the lower pins and the plug. The use of the plug follower is shown in [Figure 37\(a\)](#) while some types of plug followers are shown in [Figure 37\(b\)](#). You may note

FIGURE 37—To properly remove the plug, place the correctly shaped plug follower against the plug and push the plug from the shell.



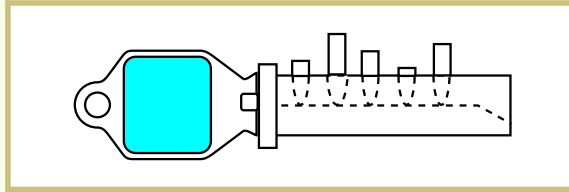
that the plug followers shown have different ends to match the type of plug you are working on.

To use a plug follower properly, you remove the plug retainer, insert the key into the plug, and turn the plug about 45 degrees. Next, insert the proper follower into the plug and gently push forward allowing the plug to exit the shell. With the plug follower in place, you can completely remove the plug while retaining the upper pins and springs in the shell.

With the plug out of the shell, the lower pins can now be removed from the plug and placed in the pin tray. To rekey this lock, you can then simply shift the positions of the lower pins in the plug. After the pin locations are shifted in the plug, you must make a new key to fit the new lower pin arrangement.

This key cutting process is best undertaken now, with the plug out of the shell of the lock.

FIGURE 38—With the blank in the plug, the difference in height of the lower pins can be clearly seen.



In cutting a new key, first insert the proper blank in the plug as shown in [Figure 38](#). As you can see, the lower pins are raised

different amounts above the shearline. The object of the key cutting will be to cut slots in the blank that will allow the lower pins to drop even with the shearline.

To mark the blank key, remove the lower pins, keeping them in proper order. Insert a pencil or carbide scribe in each hole of the plug and make a mark on the blank. Now, remove the blank, reinsert the lower pins in the lock and begin filing the blank key at the first cut mark nearest the shoulder of the key. Every so often, insert the blank into the plug and check the height of the first pin. If it is above the shearline, keep filing until this pin is even or just slightly above the shearline. Continue filing the blank until all pins are even or just above the shearline.

With the pins just above the shearline, you have two choices in completing the key. You can

1. Carefully continue filing on each cut of the blank key until the pins are even with the shearline.
2. File the lower pins until they are even with the shearline. This method of leveling the lower pins is suggested since it is more accurate and much easier than performing fine cuts in the blank.

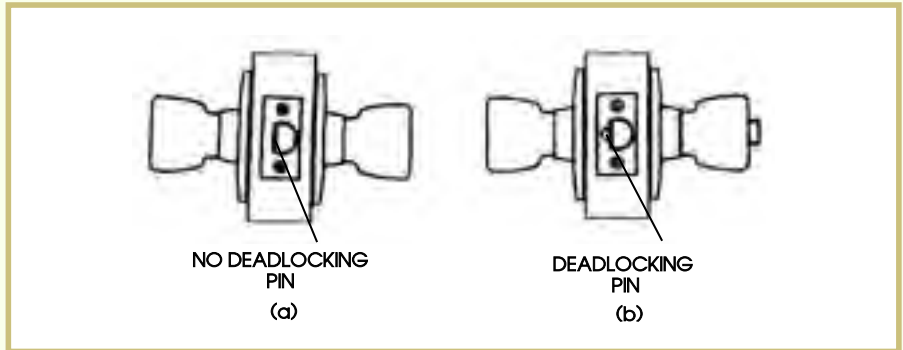
After the pins are filed to the shearline, the plug can be reinserted into the shell. You must first mate the plug to the follower dowel to eliminate a gap between the dowel and the plug. Any gap will allow the upper pins and springs to be released from the shell. Once mated, simply push the plug into the shell until it bottoms in the shell. Now, replace the retainer and its screws and then check the operation of the key. Clean the lock thoroughly and lubricate it. Finally return the shell to the locking mechanism and retry the key in the mechanism.

Rekeying Various Types of Locksets

In this section, we will look at how to rekey specific types of locking mechanisms. We will begin by looking at key-in-knob locksets followed by dead bolts and then rim and mortise cylinder pin tumbler locks.

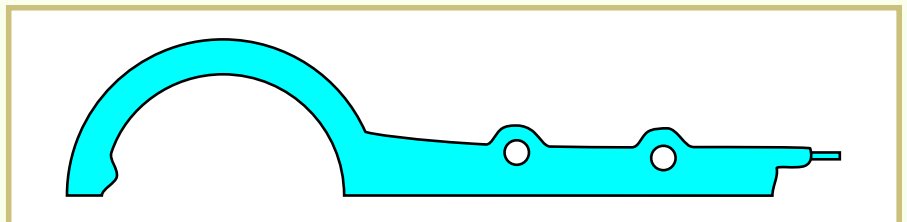
Two typical key-in-knob locksets are shown in [Figure 39](#). The lockset shown in (a) has no deadlocking pin and is, therefore, a minimum security lockset. The locked door can be opened rather easily – placing a credit card or other stiff piece of plastic between the doorjamb and the latch will open it. The lockset in (b) has a deadlocking pin that presses against the strike plate, preventing such a simple opening of the door.

FIGURE 39—Here are two types of latches on a typical key-in-knob lockset.



The first step in rekeying a key-in-knob lockset is to gain access to the shell and plug, or cylinder assembly. To gain access, you must remove the inner knob and rose. In order to remove these items, refer to the manufacturer's data sheets for the lock. Some locks have simple removal procedures for the inside knob. For example, all you need to do is to press inward on a retaining clip and wiggle the knob free. The rose can then be twisted and pulled to remove it. Other manufacturers use special tools to remove the knob. One such tool is specially designed with a spanner wrench on one side and a knob removal tool on the opposite side. Such a tool is shown in [Figure 40](#).

FIGURE 40—A spanner wrench, such as the one shown here, can be used to tighten retainers and remove interior knobs.



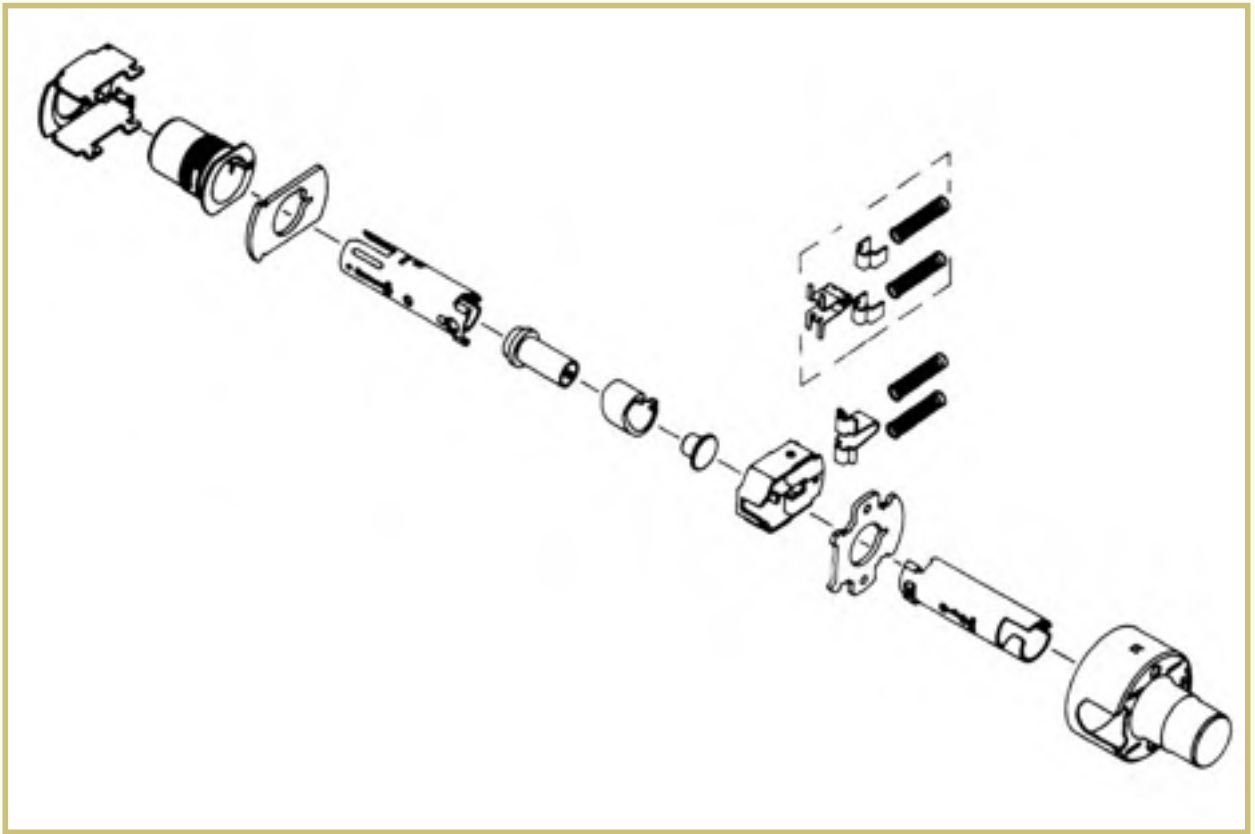


FIGURE 41—This is the internal assembly of a typical key-in-knob lockset.

Once the inside knob and rose trim piece are removed, two or more screws will be visible. These screws can then be removed to release the internal assembly of the lockset. This assembly is shown in [Figure 41](#).

The cylinder assembly can be clearly seen to the left side of this illustration. This cylinder assembly must be separated from the outside knob after it's pulled from the outside housing. In this model of lockset, a small steel pin is depressed at the rear of the cylinder. Then, a retaining ring is unscrewed and the cylinder freed of the exterior knob.

To remove the plug of this lock, you must use a specially formed plug follower. Insert the key into the lock and turn it about 45 degrees. Insert the follower into the back of the plug and push the plug gently forward. The follower will retain the upper pins and springs in the cylinder.

Most key-in-knob manufacturers make a special rekeying kit. This kit contains new lower pins and a precut key. The rekeying

of this lock is fairly simple. Place the precut key in the plug and insert the new lower pins in the plug. The proper combination of lower pins will leave all pins at the shearline of the plug. If any pins are slightly higher than the shearline, simply file them level with the plug.

Reassembly of this lock is basically the reverse process of disassembly. Place the plug against the plug follower and press forward until the plug is fully seated in the cylinder. Next, screw in the rear plug retainer and replace the steel pin, if present. Replace the cylinder in the outside knob and reassemble the internal assembly of the lockset into the door. Tighten the retaining screws next and replace the rose and inside knob. Most inside knobs will simply press in until they are retained by a keeper.

As mentioned, you should obtain the manufacturer's data sheets for the types of locks you will be working on. These data sheets will save you significant time in disassembly and rekeying. For example, some key-in-knob lockset manufacturers do not use a retainer to hold the cylinder in the outside knob. Instead, once the knob is removed from the lockset, all you need to do is hold the knob in your hand and rotate the key clockwise 180 degrees. Now pull back on the key to pull the cylinder out of the knob. Without the manufacturer's information, you could spend considerable time searching for the retainers and removing the inside knob assembly.

Two variations to the standard key-in-knob lockset are the deadlocking lockset and the dead bolt. As shown in the previous figure, the deadlocking spring latch mechanism is simply a variation of the simple spring latch mechanism. The upper latch unit is deadlocking while the lower unit is a simple spring latch assembly. Rekeying a deadlocking or a dead bolt assembly follows the same principles seen earlier.

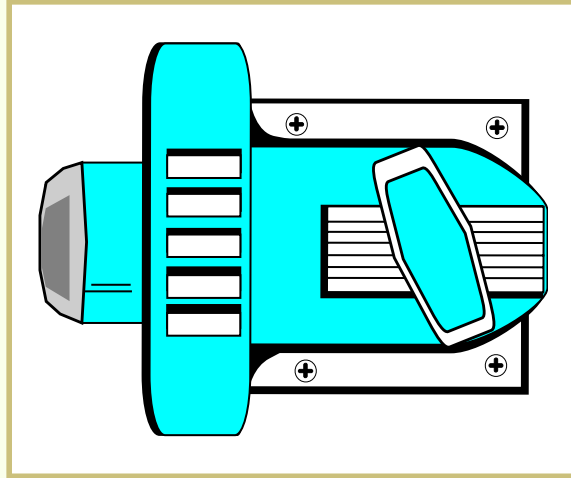
Rekeying a Rim Cylinder Lock

Rim cylinder locks are often used on entrance doors such as cellar and garage side-entrance doors. This type of locking mechanism is extremely easy to install and offers medium security.

A rim cylinder lock consists of three basic parts. These three parts are the rim cylinder, rim latch, and strike box. To install this type of lock, a circular hole is bored in the door using a

template. This hole accepts the rim cylinder. The cylinder has an outside circular-shaped security plate and an internal cylinder-holding plate. This internal plate is larger in diameter than the bored hole and securely holds the cylinder in

FIGURE 42—A rim latch locking system is easy to install and offers medium security.



place in the hole. The rim latch assembly is held to the door by three or more screws. The rim latch is placed over the drive bar that exits the rear of the cylinder and then securely screwed into the door. The strike box is then positioned on the jamb over the extended latch and also secured to

the doorjamb by means of screws. This assembly is shown in [Figure 42](#).

To rekey this type of lock, you must first remove the rim latch assembly from the door. Then, the cylinder retaining plate and screws will be visible. The next step is to remove the two cylinder retaining screws and press the cylinder and exterior security plate through the outside of the door. You now will have the cylinder assembly with the tailpiece exposed for rekeying.

Most rim cylinder locks can be rekeyed using one of the two previously mentioned methods. You can either remove the spring plate retainer and change pins or push the plug from the lock and change the location of the lower pins. In this section, we will discuss pushing the plug from the cylinder, since spring retainer plate removal can often damage the cylinder or shell.

To remove the plug of the lock, you must first remove the tailpiece. On most rim cylinder locks, the tailpiece is held to the plug by means of a hollow pin, or roll pin. This pin serves two purposes. First it holds the tailpiece to the plug, and second, it retains the plug in the cylinder. You can push the pin from the lock by using a small tool called a pin punch and a small hammer.

Whenever using a pin punch and hammer, be sure to wear safety glasses. In using a pin punch, simply hold it vertically on the pin and gently tap it with a small hammer. It is better to tap it several times rather than drive the pin free forcibly with a blow of the hammer. When the pin comes free of the plug, remove the tailpiece. Now, using pressure against the face side of the plug, place a follower against the plug and push the plug free of the cylinder.

The rest of the rekeying operation follows the procedures given earlier. Simply swap the locations of different-sized lower pins and cut a new key for the lock. Remember to check the new key in the plug and to clean the cylinder before reassembly.

Reassembly of the rim cylinder lock is basically the reverse of disassembly. Place the plug back into the cylinder and, using the pin punch, replace the pin through the plug and tailpiece. Insert the cylinder into the security ring and replace it in the hole in the door. Next, replace the cylinder retaining plate and its two screws that thread into the cylinder. Tighten these screws firmly, but not so firmly as to strip the threads in the brass-alloy cylinder. Finally, replace the rim latch assembly by meshing the tailpiece into the interior thumbturn and replace the three screws into the door. Lubricate the lock and check its operation to complete the rekeying.

Rekeying Mortise Locks

Mortise locks are available in many types and styles. Some small mortise locks are used for cabinet doors in mostly low security applications. Mortise door locks are available in a wide range of styles from low- to high-security levels.

This type of locking mechanism fits into a special pocket or mortise that is milled into metal doors or otherwise routed or cut into wooden doors. A strike plate mounted in the jamb or in a second mating door accepts the mortise lock bolt that is actuated by the keyed cylinder.

To remove the cylinder of a mortise lock, a set screw must be loosened. This cylinder-retaining set screw is hidden behind a hole in the face plate of the lock. A special tool called an Allen wrench is most commonly used to remove this set screw. An Allen wrench is a six-sided wrench that fits into the recess in the

head of the Allen screw. However, some mortise locks may have a slotted or Phillips head screw that can be loosened using a thin blade screwdriver.

Once the set screw is loosened or removed, the cylinder is simply unscrewed from the lock assembly. In some cases, you will have to press in on the latch assembly to free the drive cam at the rear of the cylinder. As with the previous locks mentioned, it is often a better idea to remove the plug of the cylinder to rekey this lock. The steps to plug removal are

Step 1. Remove the two-slotted or Phillips head screws at the rear of the plug to remove the drive cam and plug retainer plate.

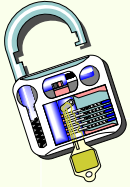
Step 2. Using a plug follower that matches the plug, press the plug from the cylinder.

Step 3. Change the location of the lower pins in the plug.

Step 4. Reassemble the plug in the cylinder and check your new key's operation.

Step 5. Reassemble the cylinder into the mortise lock, lubricate the lock and check its operation.

This section of this study unit described the rekeying of various types of disk/wafer and pin tumbler locks. It is assumed that your customer had the original keys for the lock and wanted the lock's "combination" changed. But what if the customer lost the keys to the lock? The next study unit will show you how to open locks without keys. Once you open the lock, you could then create a key by the various methods which you have seen here.



Locking It Up! 3

1. Why must you drill a hole in some types of locks before you can rekey them?

2. If a wafer in a side bar lock is stamped with the letter "C," what does this mean?

3. In rekeying a pin tumbler lock, should you file the upper pins?

4. How can you remove the cylinder from a mortise lock?

Check your answers with those on page 69.

MASTER KEY SYSTEMS

Definition

A master key system is a system where individual keys will open a certain lock and a special key will open all the locks within a system. Hotels, motels, apartment buildings, universities and other such large establishments often will use a master key system. This system allows individual access to certain rooms or areas using specific keys and total access to all areas by security personnel using master keys.

Let's begin looking at master key systems by studying some of the terms used in master keying.

Change Key. This is a key that will open only one specific lock within the master key system.

Bitting. Bitting is the name used to define the types of pins used in the master key system. For example, even bitting will use pins numbered zero, two, four, six, and eight. Odd bitting will use pins numbered one, three, five, seven, and nine.

Cross Keying. This term defines the ability of one change key to intentionally open more than one lock. This is sometimes abbreviated by an X.

Hardware Schedule. This is a paperwork procedure in which you list all locking hardware and the keying schedule for all locks in the system.

Master Key. The key that will open all locks within a master key system.

Grand Master Key. The key that will open all locks in two master key systems.

Great Grand Master Key. The key that will open all locks in a three master key system.

Great Great Grand Master Key. The key that will open all locks in a four or more master key system.

Sectional Master Keying. A system where the master key system is enlarged by using different key blade keyway grooves to

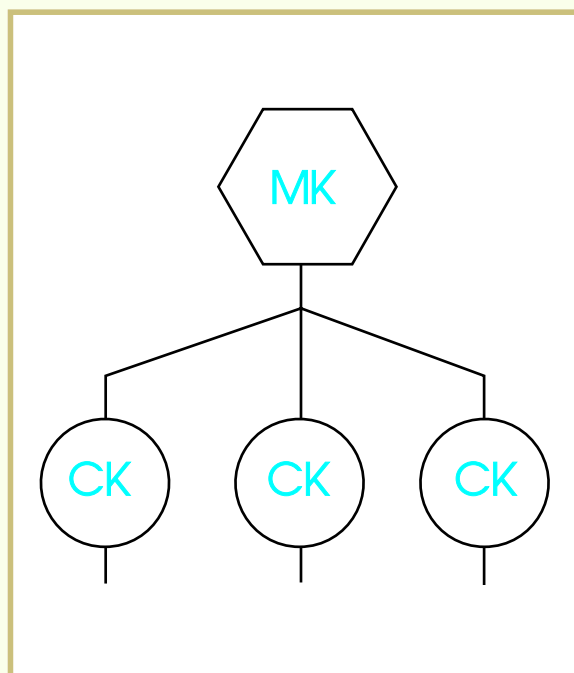
prevent access of similarly cut keys into cylinders that are pinned alike within the system.

Now that you know a few important terms in the world of master keying, let's begin looking at the types of master key systems available. These systems are categorized by level in the locksmith trade.

Let's begin with a level one system. Actually, a level one system requires no master keying at all. Each lock is assigned a key and only that key opens it. This is a typical system for most homes and small businesses.

A level two system is the first level to have a single master key. Any number of change keys may be available and each change key will open its own lock. One master key is present in the system that will open all locks. This type of system is shown in [Figure 43](#). A small apartment building might be one example of a level two master key system.

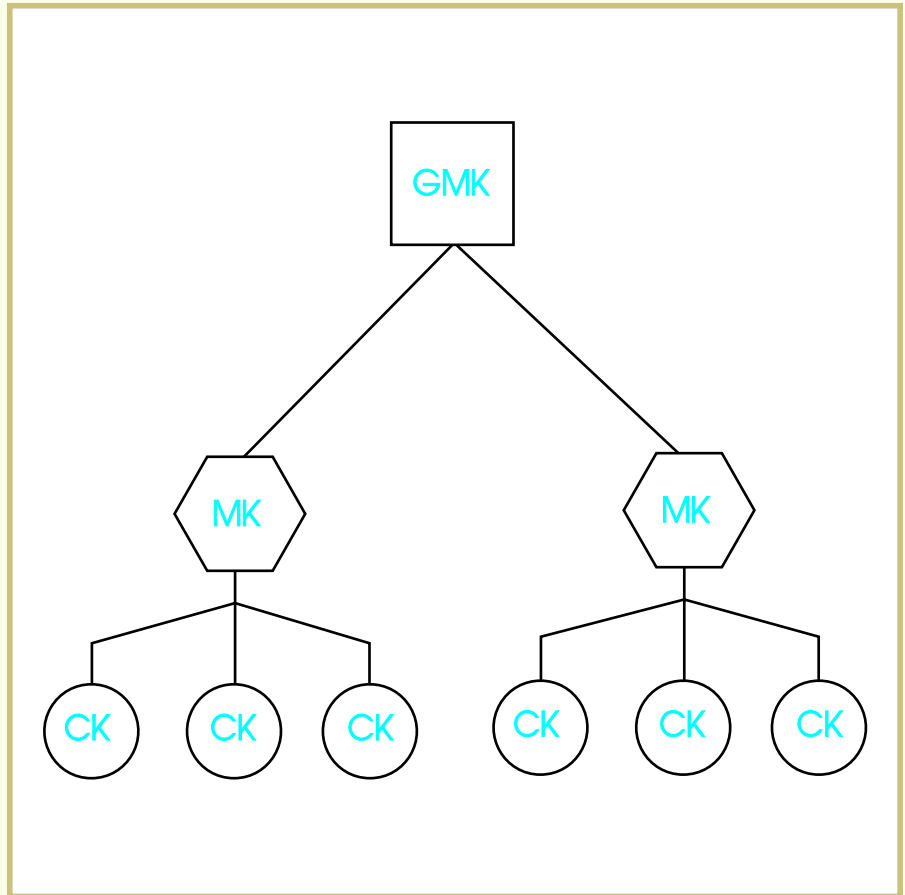
FIGURE 43—A level two master key system contains any number of change keys and a single master key.



A level three system makes use of two separate master key systems. Within the systems, each change key will only open the lock for which it is intended. Two master keys are provided in this system with each master key able to open only the locks designed for use with that specific master key. A grand master key in this system is designed to open all

locks within the system. A level three master key system is suited to small motels where a housekeeper may receive a master key for a certain group of rooms. A second housekeeper will receive the other master key for the other group of rooms. The front desk clerk, however, would have the grand master key to open any room in an emergency. Such a level three master key system is shown in [Figure 44](#).

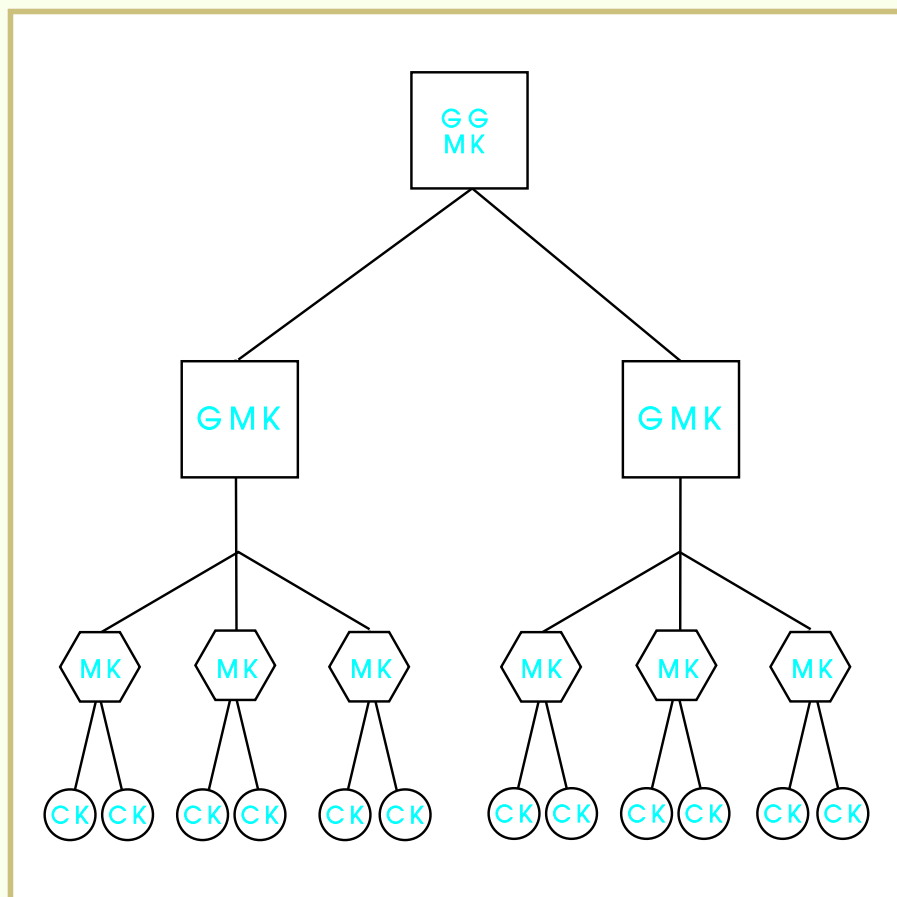
FIGURE 44—A level three system will have a large number of change keys, a few master keys and a grand master key.



A level four master key system will use four or more master keys, two grand master keys, and a great grand master key. In this system, the change, master, and grand master keys operate in a similar manner as seen in a level three system. The great grand master key will now be the key that will open all locks within the master key system. [Figure 45](#) displays the level four system. This type of system may be used in a hotel or school.

The final level we shall look at is the level five master key system. In a level five system, the level four system is duplicated and a great great grand master key has the ability to open any lock within the system. As you can see in [Figure 46](#), the level five system has at least four zones of change keys under its control. Universities, large hospitals, and large industries may use this system.

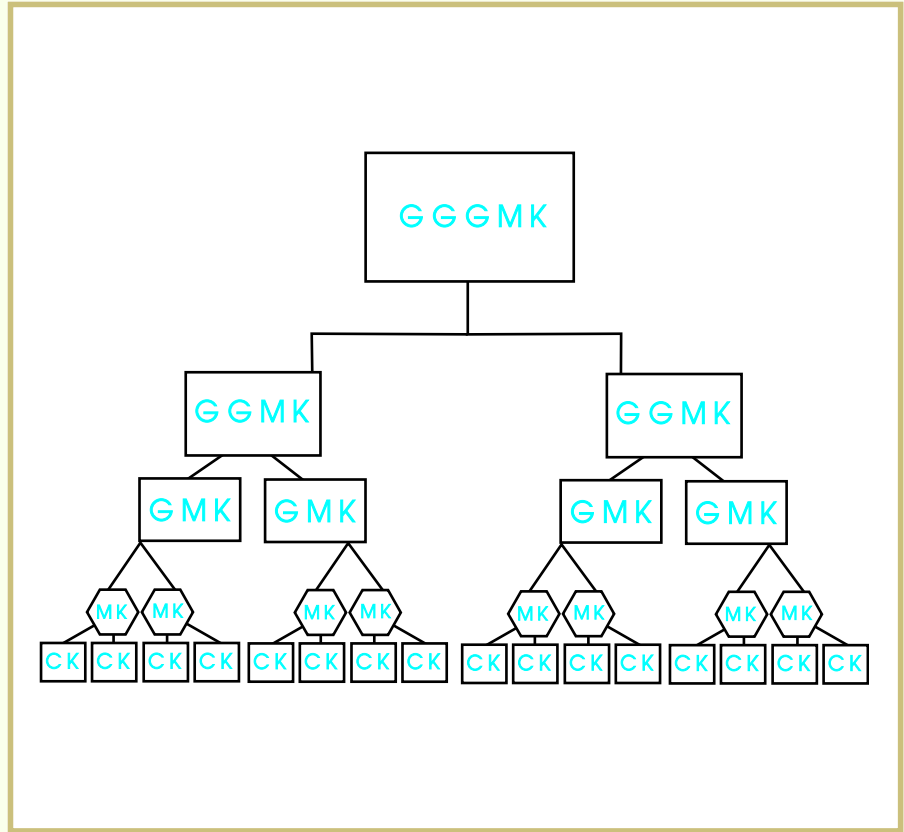
FIGURE 45—A level four master key system incorporates numerous change keys and master keys, two grand master keys, and a great grand master key.



Master Key System Security

Whenever any lock can be opened by two or more keys, the security of the lock is in jeopardy. This is especially true in extremely large systems where the number of keys becomes so large that the pins within the locks become very small. It may then be possible to “key pick” a lock. Key picking involves inserting a change key into a lock and then moving the key up and down within the plug while placing turning pressure on the key. If the pins in the plug are small and the change key is close in cut to the proper change key, the chances of opening a lock are quite good. Newer locks will be more difficult where older, worn locks are rather easy to “key pick.” For this reason, it is always best to keep a master key system to the smallest size possible while allowing for some future expansion.

FIGURE 46—A level five master key system performs like two level four systems side-by-side and has a great great grand master key.



How the System Works

Almost every master key system in use today uses the pin tumbler type lock as the basis for the system. By now, you are very familiar with how pin tumbler locks operate by raising the lower pin to the shearline. This action allows the plug to turn in the shell or cylinder opening the lock. A master key system will add more pins to the pin tumbler lock. These master pins will create a second point where a key can cause a pin to be level with the shearline, allowing the plug to turn.

The master pins are the heart of this keying system. Up to this point in this course, you have seen a maximum of six key cuts with five possible lower pin types. In a master key system, there are normally six or seven cuts in the change key or master key with an equal number of pin chambers in the tumbler and shell. Also, and most importantly, there can be up to nine different pin types allowing for a great number of change keys in the system.

In some master key systems, the difference in height between pins is 0.015 inches. In another system, the spacing is 0.023

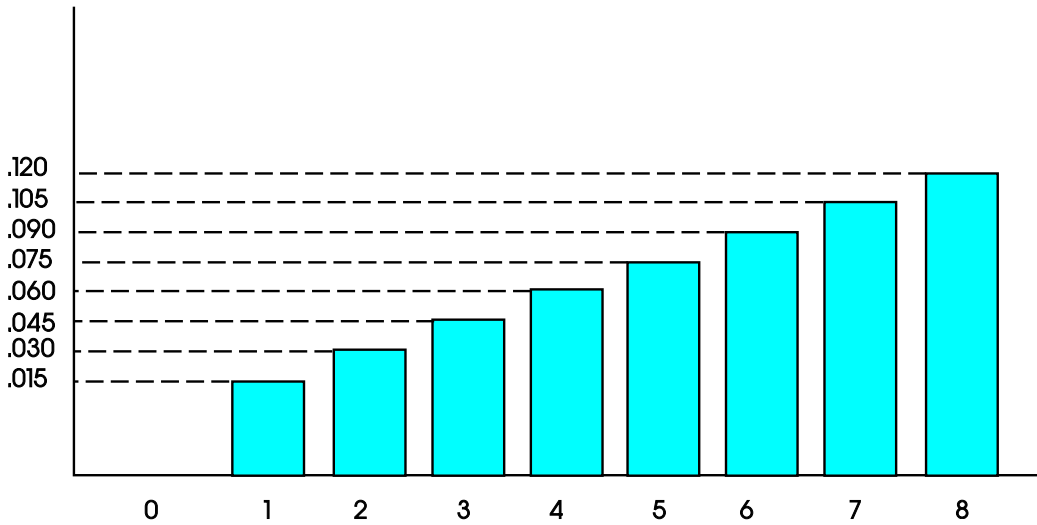
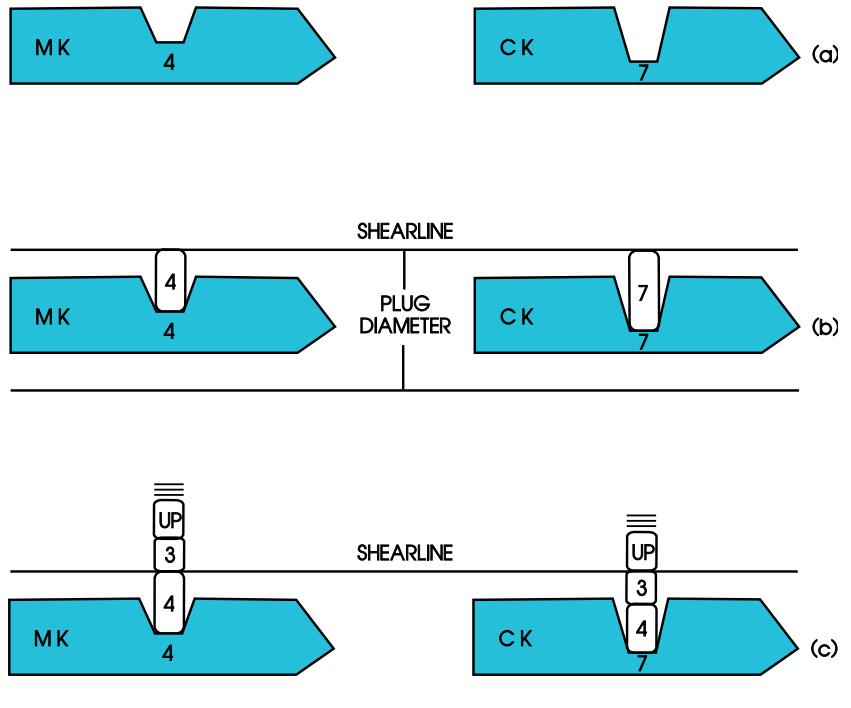


FIGURE 47—These are the master pins that are available in a 0.015 inch master key system.

FIGURE 48—Here are the keys and pins from a single-pin chamber lock we will master key.



inches. In the 0.015 system, there will be nine possible pin sizes while in the 0.023 system, there are six pin sizes. A 0.015 system is shown in [Figure 47](#).

Let's begin master keying a lock that has one pin chamber. Such a lock is shown in [Figure 48](#).

This lock will use 0.015 inch type pins. Let's give the master key, MK, a number four cut and say we want the change key to have a number 7 cut. These keys are shown in (a). Now let's set up the lock with shallower cut as shown in (b). Here we insert the master key and insert a number four pin. The pin reaches the shearline perfectly. Remove the master key and insert the change key and replace the four pin with a seven pin. Once again the lock works perfectly.

In (c), you now have removed all pins and reinserted the number four lower pin. On the left side of the figure, the master key, once again, will operate the lock. Now remove the master key and put the change key and add a number three master pin in

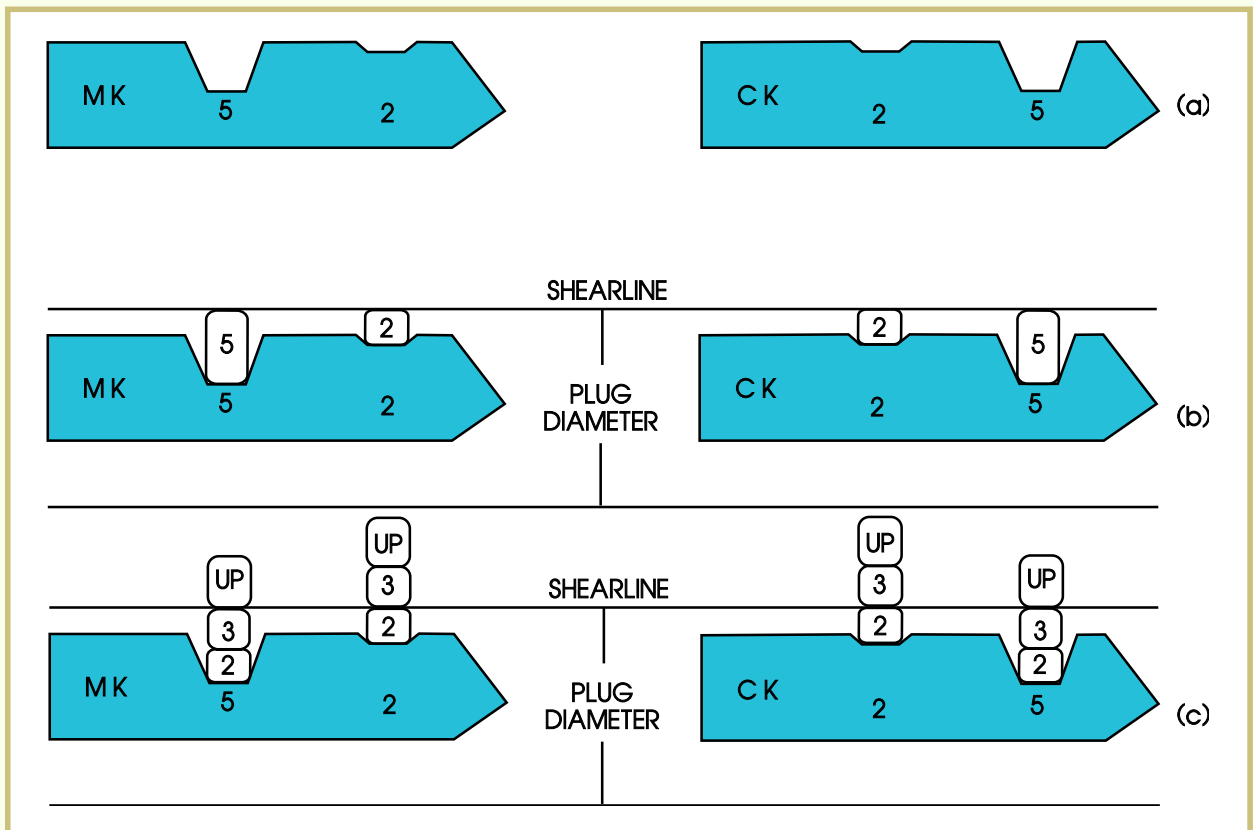


FIGURE 49—Here are the keys and pins from a two-pin chamber lock we will master key.

the pin chamber. Now the change key has its own shearline made by the addition of the number four lower pin to the number three master pin. Looking back to the left side diagram of [Figure 48\(c\)](#), notice how the number three master pin rides above the shearline when the master key is inserted into this lock. The upper pins, UP, and springs are also shown in (c). Now, either the change key cut to a number seven or a master key cut to a number four will open this lock.

Let's continue looking at master key systems by adding a second pin chamber to our lock. This type of system is shown in [Figure 49](#).

In this system, the master key will be cut as a five and two, as we will invert the change key to a two and five cut key as shown in (a). In (b), the lock is pinned using standard pins. Here, both keys will act as change keys, only opening the locks for which they are intended. In figure (c), the lower pins have been converted to a master pin system. With the master key inserted into the plug, the number two pin along with the number three master pin allow the plug to turn. Note how the number three master pin rides above the shearline of the second pin chamber when this key is inserted. On the right side of figure (c), the change key has been inserted into the lock. Now, since the change key is cut opposite to the master key, the number three master pin rides above the shearline at the first cut in the change key.

This system of master keying looks rather simple, doesn't it? All you are really doing is creating a lock with multiple pins that, in turn, create multiple shearlines within the lock. To make sure you understand this master keying process, let's look at one more example.

[Figure 50](#) gives us another example of a two-pin chamber master key system. In this system, we will dedicate the master key as having a two-eight cut while the change key will have a three-five cut in its blank.

In the (a) portion of the figures, you see the two pre-cut keys. In figure (b), we have added the plug and the proper pins that would make either key a change key for this lock. Remember that if the pin setup were a two-eight or a three-five setup, only one of the keys would work in the plug. In figure (c), we have placed a number two pin in the first chamber and a number one master pin above it. Now, either the master key or the

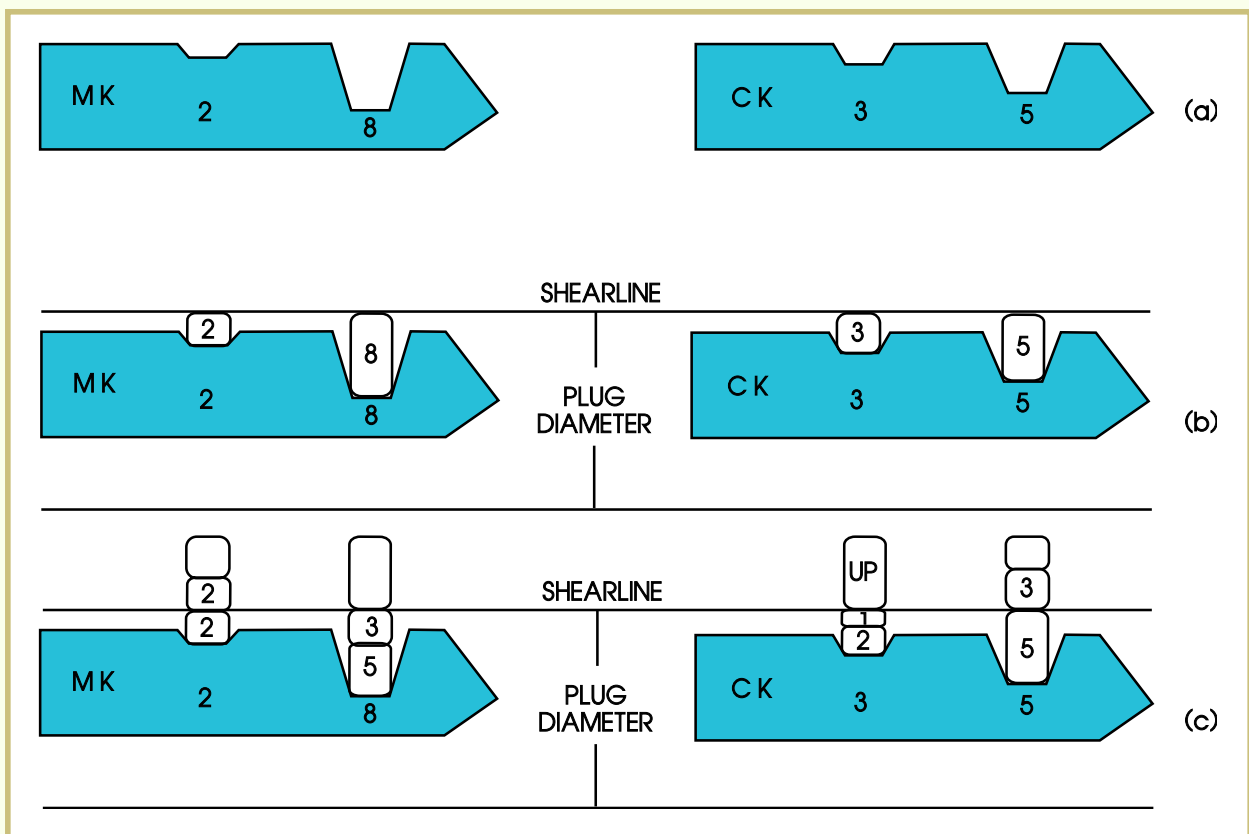


FIGURE 50—Another example of keys and pins from a two-pin chamber lock is given here.

change key would raise the lower pin combination to one of the two possible shearline points. In the second chamber, we have installed a number five pin and a number three master pin. Again, either the master key or the change key will now raise the pin combination to one of the two possible shearlines. It's that easy!

Of course, the locks you'll be master keying will not be two-chamber pin tumbler locks. Most master key systems will use a standard key system that has six pin chambers and a key with six spacings for the cuts.

A six-chamber pin tumbler master key system is not as difficult as it may seem. To keep it simple, let's look at an example using two locks to be opened by a master key and two separate change keys. In this system, we will again use the 0.015 inch pin system. Let's use a master key with a key code of 3, 4, 2, 4, 4, 2. The two change keys will have a code of 4, 5, 5, 6, 5, 4 and 2, 0, 1, 0, 2, 3. [Figure 51](#) shows this type of system.

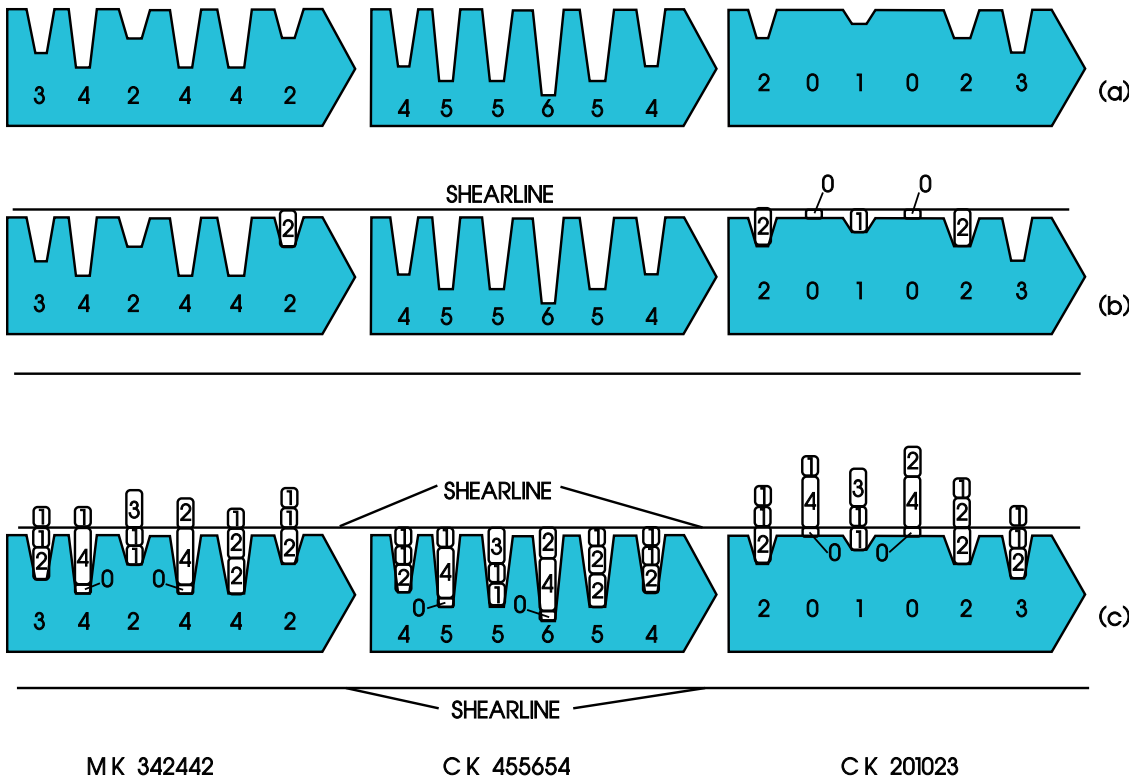


FIGURE 51—This illustration shows two change keys and a master key for a large six-pin chamber master key system.

In (a), you can see a visual display of what the three keys with these cuts would look like. We have selected the two change keys to be greatly different in cut depths so that you can see the extreme ends of a master key system without looking at all of the keys in the middle of the system.

In (b), we begin loading the pin chambers with the necessary bottom pin. You will note that the smallest cut in any key is the first position to receive a bottom pin. This is an important rule in master keying. The smallest biting, or pin, is always loaded into the plug or pin chamber first.

In (c), we have completed the loading of the pin chambers. Notice how the change key with the deepest cuts has all of the lower pins and master pins below the shearline. The second change key with the most shallow cuts has the most master pins above the shearline. Look also at the last cut in the master key and the same cut in the second change key. This is the only location where the number of master pins above the shearline of the master key is greater than those above the shearline of the second change key.

The actual planning of a master key system is much simpler than the process we have just gone through. In fact, a master key system can be ordered directly from the chosen lock manufacturer. All you must describe to the lock manufacturer is

- The types of locks to be used
- The number of locks and change keys
- The number of master keys, grand master keys, great grand master keys and so forth

The lock manufacturer will then supply you with the locks and precut keys for the system you are working on.

Developing a Master Key System for a Customer

In the event that you design and build a master key system for a customer, there are a few methods and rules to follow to make system planning easier and more efficient. First let's look at some of the rules.

Rule 1. In a very large system, no cut in any change key should match the cut in a master key in the position on the key. For example, the master and change keys we just worked with are listed here.

MK 342442
CK 455654
CK 201023

Note how the master key and the change keys do not have a similar cut in any one position. Now, let's look at another example. Let's say we have the following master and change key cuts.

MK (3)4244(4)
CK (3)5565(4)
CK 20102(4)

The numbers in parentheses are illegal numbers for change keys since they have the same number as a master key in the same position. Change keys may duplicate two or more numbers without a problem.

Rule 2. The depths between the successive cuts on a key should be no greater than seven for a 0.015-inch master pin system and five on a 0.023-inch system. This rule prevents a

very deep cut next to a shallow cut that can cause problems during keymaking. For example, a key with a code number 447019

would have an excessive depth change between the third and fourth cut and the fifth and sixth cut.

Rule 3. On a 0.015-inch system, there should be at least two cut sizes between successive cuts. (A 0.023-inch system is designed to allow single number changes.)

Rule 4. There should be no locks in the system set up with the same number pattern.

Of all the rules presented, Rule 3 may be the most confusing. In a system that uses master pins in steps of 0.015, it's very easy to key pick a lock with a change key that has similar cuts. If the system is set up with at least two pin size differences between change keys, the overall pin difference expands to 0.030—a difference that can prevent key picking. This double spacing of the key cuts is often termed *double step progression*.

Locks that use master pins of 0.023 inch difference in dimension can have keys with cut numbers just one value in difference. This method of keying a system is called *single step progression*.

In developing a master key chart for a customer, you will often use a pin chart to define the chamber pinning of the locks and the cutting of the master keys. Let's use a two-chamber lock to look at a simple example of a pinning chart.

Looking back at [Figure 49](#), the master key had a cut of five and two. We will use these numbers as the base numbers in the chart shown here.

	Chamber 1	Chamber 2
MK	2	5
	4	7
	6	9
	8	1
	0	3

In this chart, we have listed the even bittings on the left with the odd bittings on the right. Now we can begin to list the change keys that are possible in the two-chamber system.

Let's first take the four in the left-hand column and combine it with the seven in the right-hand column to give us a change key of 4, 7. Next, let's take the four of the first column and combine it with the nine of the second column giving us a change key with the cuts 4, 9. If we continue using this method, your change keys with a four first cut would give us

4, 7
4, 9
4, 1
4, 3

Now we can begin combining the six cut with the numbers in the second column to give us

6, 7
6, 9
6, 1
6, 3

Next, using the eight with the numbers in the right column we get

8, 7
8, 9
8, 1
8, 3

And finally, combining the zero with the numbers in the right column we get

0, 7
0, 9
0, 1
0, 3

Putting all these tables together gives us

4, 7	6, 7	8, 7	0, 7
4, 9	6, 9	8, 9	0, 9
4, 1	6, 1	8, 1	0, 1
4, 3	6, 3	8, 3	0, 3

But are all of these keys legal keys? According to our rules, especially Rule 2, there can be no more than seven cut depths between successive key cuts. Therefore, the key 0, 9 is an illegal key and should be eliminated from the system.

Now you can see how a simple two-chamber pin tumbler lock can give us 15 change keys and one master key. A six-chamber pin tumbler lock can give us many more combinations. In fact, using a six-chamber lock with a two-step system can give you 4096 possible change keys and a master key. A single-step system can yield 15,625 keys! Of course, inside these locks would be stacks of small master pins making the locks easier to pick than a standard level one lock. For this reason, one general rule locksmiths use on master key systems is to only place one master pin per chamber into each lock.

To show how one master pin per chamber would work, let's look at a lock coded 4, 5, 3, 1, 4, 2. By adding a number one master pin to the first chamber, we get a master key and change key codes 4, 5, 3, 1, 4, 2 and 5, 5, 3, 1, 4, 2. Now let's add a number two master pin to the second chamber of same lock. Our list of possible keys becomes

4, 5, 3, 1, 4, 2
 5, 5, 3, 1, 4, 2
 4, 7, 3, 1, 4, 2
 5, 7, 3, 1, 4, 2

Now let's add a third master pin to the third chamber. If it is a number three pin, you would get the following key combinations:

4, 5, 3, 1, 4, 2
 5, 5, 3, 1, 4, 2
 4, 7, 3, 1, 4, 2
 5, 7, 3, 1, 4, 2
 4, 5, 6, 1, 4, 2
 4, 7, 6, 1, 4, 2
 5, 5, 6, 1, 4, 2
 5, 7, 6, 1, 4, 2

This gives us eight possible combinations for three simple master pins. Note how the number of keys is doubling each time we add a new master pin. If we were to continue to the sixth chamber, we would have 64 keys and 63 different locks. However, our system with 63 locks and 64 keys has two problems. First, some of the change keys will have a cut the same as the master key in at least one position. Often, this becomes an unavoidable situation when using a single master pin in each chamber. Second, if a number one master pin is used, it becomes very possible to have change keys with cuts only one digit apart. The solution to this second problem, when dealing

with a 0.015-inch master pin system, is to not use a number one master pin in any chamber of a small master key system.

In order to reduce the chance of key picking, there is one “trick” locksmiths or lock manufacturers may use. For this example, let’s use a three story hotel with 60 rooms on each level.

Now, you can set up the 60 rooms on the first floor with 60 of the best pin combinations and key codes and a master key. You can then reuse these 60 pin combinations and key codes on the second and third floors. But wouldn’t this system allow a first floor key to open a second and third floor lock? It would unless you change the keying of the locks from floor to floor. If the keyway changes, then the keys will not enter the locks, rendering them useless except on the floor and for the room they are intended.

The master key for all rooms would need to enter all of these different keyway grooves. Special master blanks are available for this purpose. In fact, it can be possible to create a level three or four system using locks with different keyways. In these systems, a master key can be created to fit only the keyway on one floor. A series of grand master keys can then be created to open the locks on the first and second or second and third floors. A great grand master key can be made to open all locks in the entire hotel. All these keys can be made using the proper master blanks.

Selling a Master Key System

A master key system will basically sell itself to your customer. Your customer will need such a system and you will have the equipment to fill that need.

To create a master key system for a customer, the first step is to ask your customer a series of questions.

1. How many locks will be included in the system?
2. What type of lock is to be used?
3. Does the architect, owner, or builder have any preference to the manufacturer of the locking system?
4. How many change, master, grand master keys, and so forth will be required in the system?

5. Does the customer require duplicate change keys?

The answers to these questions will identify the exact size of the master key system to be put into place. It would now be a simple process to go into the manufacturer's master key system books and price sheets to develop a hardware schedule and estimated price for the job. If you have any problems in setting up the system, the manufacturer's sales engineers can be contacted for assistance.

In some master key systems, certain options may be desired by your customer. One popular option is the use of construction change keys. These keys are used during the construction of the building to open specific locks. Once construction is complete, a special key is used to render the construction keys useless. This feature is performed by adding pressed carbon or graphite master pins into one or more chambers of the lock. The special key crushes these pins, rendering the construction keys useless after the carbon or graphite pins are broken.



Locking It Up! 4

1. How many master keys are available in a level two master key system?

2. Why should there be at least two cut sizes between successive cuts on all change keys in a master key system?

3. What type of step progression system is used with a master key system using 0.023 inch master pins?

4. What type of pin can be used in a lock so that a construction change key can be rendered useless after construction is complete?

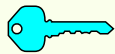
Check your answers with those on page 69.

THE KEY TO SUCCESS

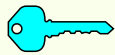
Well, you've finished another information-packed study unit and learned many new and valuable skills. Key duplication and rekeying are the most-often performed locksmithing services. Once you've mastered these skills, you'll be well on your way to your goal of becoming a professional locksmith!

Now, review the text material if you need to, and then proceed to the examination. Good luck!

KEY POINTS TO REMEMBER



Key duplication is the process of making a new key to match a customer's original. A new key is cut from a *key blank* (an uncut key) using either hand tools or a key cutting machine.

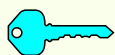


When duplicating a key by hand, a locksmith will find the following tools useful: a small bench vise, softjaws, a felt-tipped marking pen, a scribe, metal files, and a vernier caliper. Key duplication by hand requires several steps. These steps are

1. Select the proper key blank.
2. Clamp the original key and the key blank together in a vise.
3. Match and mark the areas to be cut.
4. Cut the duplicate key.
5. Inspect the duplicate to be sure it matches the original.
6. Debur the duplicate key.

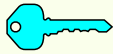


A key machine can also be used to quickly and accurately duplicate most types of keys. A key machine operates like a basic tracing machine. The sample key is placed in the machine's left-hand vise, and a blank key is placed in the right-hand vise. The motor is turned on, and the machine's guide moves along the original key, guiding the cutting wheel over the blank to create an exact duplicate.



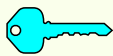
Key codes are code numbers that allow a locksmith to make a new key for a lock without having an original key to copy. The code numbers refer to the exact cut depths needed to create a

duplicate key. Although a key can be cut by hand once its codes are known, normally keys are made using a special type of key cutting machine called a code cutting machine.



The term *rekeying* means to change the inside of a lock to fit a new key. Rekeying is a common service provided by locksmiths every day. Rekeying is often performed when a customer purchases a home or a used car for which the original owner may have retained a set of keys. The rekeying of locks is less expensive than the purchase of new locks.

Rekeying a lock will require you to perform the following general steps.



Step 1. Remove the plug according to the manufacturer's instructions for the lock you're working on.

Step 2. Place the plug in your vise.

Step 3. Remove each disk or pin from the plug, and place them in a tray in the order in which you remove them.

Step 4. Change the order of the disks or pins and replace them in the plug.

Step 5. Cut a key to match the new arrangement of disks or pins.

Step 6. Reinsert the plug into the shell.

Step 7. Test the new key to make sure it works.

A *master key system* is a key system in which individual keys open certain locks and one master key opens *all* of those locks. Hotels, motels, apartment buildings, universities, and other such large establishments often will use a master key system. This system allows individual access to certain rooms or areas using specific keys and total access to all areas by security personnel using master keys.



Do You Know Now. . .

Below are the answers to the questions asked at the beginning of this study unit.

What does the key code 2, 4, 1, 3, 5, 2 mean?

These numbers can be used with a spacer or guide key to cut the proper depths in a key for a disk tumbler, side bar wafer, or pin tumbler lock.

What is a *plug follower*?

A plug follower is used to remove the plug from a lock while retaining the upper pins and springs in the shell or cylinder.

What is a *great great grand master key*?

A great great grand master key can open any lock in a level five master keying system.

Locking It Up! Answers

1

1. d
2. Filing with a rocking motion
3. A vernier caliper can measure a key blade.

2

1. Six
2. To provide proper cut spacing on the blank key
3. Code Number 4, dimension 0.175
4. Start at the cut nearest to the shoulder and continue cutting towards the tip of the key.

3

1. You drill a hole to gain access to a plug retainer.

2. It means copper and stands for a number one wafer.
3. No, you only file the lower pins on a pin tumbler lock.
4. You remove the cylinder by loosening a set screw and unscrewing the cylinder from the locking mechanism.

4

1. One master key is available.
2. To prevent "key picking" by a key cut somewhat similar to the actual key meant to open the lock
3. The single step progression system can be used.
4. A pressed carbon or graphite pin

NOTES

Important Instructions for Practical Exercises 03180200 and 03180300

In addition to your regular examination for Study Unit 6, there are two practical exercises with this unit. The first exercise (03180200) is Duplicating a Cylinder Key for the Papaiz Padlock. The second practical exercise (03180300) is Rekeying a Kwikset Lock.

These exercises will be sent to our locksmith consultants to be reviewed and graded. This takes extra time, so please be patient. To expedite the return of your graded exercises, please follow these directions carefully:

Specific instructions for each exercise begin on page 75 and continue through page 89. Read these instructions thoroughly before beginning the exercises.

Both exercise 03180200, Duplicating a Cylinder Key for the Papaiz Padlock, and exercise 03180300, Rekeying the Kwikset Lock, must be submitted together for grading.

After completing both practical exercises, remove the practical exercise answer sheets on [pages 73 and 74](#) from the binder and fill out the top portion. Answer the appropriate questions on the answer sheet and include it with your submission.

You must include all of these items:

Completed answer sheet for both exercises

Papaiz padlock

Original and duplicated Papaiz keys

Rekeyed Kwikset lockset

Original and miscut Kwikset keys

Do not include any other examinations with these exercises.

You must send these exercises in the special shipping box (PM0007) provided. Use of a different shipping container may cause additional delay in the grading and return of your exercises. Please contact our Customer Service Department if you did not receive this shipping container.

Tape your keys together and secure them inside the box to prevent damage or loss. Once the carton is sealed, it cannot be opened without tearing it. Do not seal it until you have placed all items in it. Address your lock projects to: Education Direct, 925 Oak St., Scranton, PA 18515. (In Canada: 610-245 Victoria Ave., Westmount, QC H3Z 2M6) You are responsible for paying the postage. Be sure to put your return address and student number on the box. Our locksmith consultants will evaluate your work and return your grades to you as soon as possible. Please be patient.

NOTES

Professional Locksmith

Practical Exercise Answer Sheet 03180200

Name: _____

Please Print Clearly

Grade 03180200: _____

For Office
Use Only

Address: _____

City: _____

State

Zip

Phone Number: _____

Student Number: _____

 Check here if new address

03180200

Practical Exercise: Duplicating a Cylinder Key for the Papaiz Padlock

This exercise is based on the Papaiz Padlock cylinder key duplication. For this exercise, your key will be evaluated in each of the areas listed below.

1. **Operation:** Proper operation of the key in the padlock. Smooth operation of the key. (This part is worth a maximum of 60 points.)
2. **Appearance:** Even file cuts and angles. Uniform file cuts. Free of burrs or excessively sharp edges. Cuts match the original key. Cuts that are smooth and clean. Appearance that would be satisfactory to your customer. (This part is worth a maximum of 40 points.)

Be sure to remove and complete both sides of this answer sheet and include them with both practical exercises of this unit.

Grade 03180300 _____
For Office
Use Only

03180300

Practical Exercise: Rekeying a Kwikset Lock

This exercise is based on the rekeying of the Kwikset lock cylinder. You'll be graded in these areas:

Operation: The lock must operate smoothly and reliably with the extra miscut key provided.

Appearance: There must not be any damage to the lock surface or mechanism.

(Operation and Appearance are worth a maximum of 70 points.)

Answer the following questions in the space provided on this answer sheet. (These are worth 10 points each.)

1. What was the original combination of your Kwikset lock? _____

2. What is the combination of the new key provided? _____

3. What three tools are present in a rekeying or repinning kit that makes lockset rekeying a simple task?

03180200 Practical Exercise: Duplicating a Cylinder Key for the Papaiz Padlock

Introduction

Key duplication makes up a large portion of a locksmith's business. People need keys for automotive, home, and business locks. Normally, the keys will be duplicated on a key cutting machine. However, in the event of machine failure, you should know how to cut a key by hand using the techniques given here.

In this exercise, you'll duplicate a key for your Papaiz cutaway padlock. The lock uses a PZ1 key blank. This blank is included in this package of materials. Locate the key blank now.

Your Tools

Except for the black magic marker, all the tools and supplies you need for this exercise are included in this instruction package. The tools you'll need for this exercise are

- Small bench vise
- Original key from the Papaiz padlock
- Key blank
- Metal files
- Black marker

Instruction Steps for Duplicating the Key

Key duplication will require several steps. These steps are

Step 1. Select the proper key blank.

Step 2. Blacken the key blank.

Step 3. Clamp the original key and the key blank together in a vise.

Step 4. Match and mark the areas to be cut.

Step 5. File the duplicate key.

Step 6. Inspect the duplicate to be sure it matches the original.

Step 7. *Debur* (smooth and polish) the duplicate key.

Step 8. Test the duplicate key in the lock to see if it works.

Since the key blank you need for this exercise is provided for you, Step 1 is already complete. You can go on to Step 2, blackening the original key. Remember that you can use either the smoking method or the marking pen method to blacken the key. When the key is completely blackened, move on to Step 3, clamping the keys in a vise.

Place the blackened original key in front of the key blank, align the keys exactly, then clamp them together in your vise. Tighten the vise handle just enough to hold the keys securely between the jaws. Excessive pressure will only deform the keys. Make sure that all edges are even on the keys.

Now, prepare to start filing the key blank. Use the triangular-shaped file from your file set. Starting at the cut nearest the bow, begin filing the key blank blade with slow forward motion cuts of your file. Remember to keep the file straight and level, and don't rock the file back and forth. When performing the filing, always make sure to cut only on the forward stroke.

Continue filing until you begin to get near the metal of the original key. File very carefully until the soot or ink is disturbed on the original key. Now stop! Cutting any deeper will damage the original key.

When you are satisfied that the first cut is complete, move to the next cut. Continue until you complete the last cut at the tip of the blade.

When you're finished, the duplicate key should have the same cut depths in the same locations as the sample key. After filing, the soot or ink should be barely disturbed at the sides and bottom of the key's cuts.

Now, before removing the duplicate and original key from the vise, check the areas between the cuts on your duplicate key. At this time, you should remove any sharp points between the cuts. Remove all burrs on the back side of the blade. Inspect the key by measuring its cuts against the cuts in the original key.

Next, clean the original key completely of all soot or ink. Black marker may be somewhat difficult to remove once it dries. You can dip the key in a solvent such as nail polish remover to completely clean the blade of marking ink. To clean soot from the original key, use a soft cloth or paper towel.

Checking the keys in the lock is a simple task. First, check the condition of the original or sample key. If you did not cut into the key cuts with the file during the duplication process, it should still operate the lock. Next, check your duplicate key in the lock. Don't force it. If there are problems with your duplicate key, check it against the sample key.

If additional metal must be removed from the duplicate key, resoot or remark the original and return both keys to the vise. When you are satisfied the cuts in both keys match, clean and debur them as previously mentioned and try each key again in the padlock.

Repeat the marking and filing steps until the duplicate operates the lock. If you make a mistake, replace the damaged blank with the second blank provided for you and try again!

NOTES

03180300 *Practical Exercise:* *Rekeying a Kwikset Lock*

Introduction

Just as with keymaking, rekeying can be a profitable aspect of your business. Many people buy used items, homes, automobiles, and many businesses require new keys made when employees leave their jobs. Take for example a restaurant. They may have many refrigerators and freezers stocked with expensive food products. If one of the managers leaves for other employment, the restaurant may want to rekey all of its locks to prevent theft in the event the keys were duplicated.

Your Tools

With the right tools and a knowledge of how a lock operates, rekeying is a simple task. All of the materials you'll need for this practical exercise are included in this instruction package.

These items include

- A Kwikset key-in-knob door lock, with two keys
- Another key that *does not* work in the Kwikset lock
- A professional pinning kit

Caution: If you open the pinning kit at this time, be careful not to spill all the small pins and parts inside!

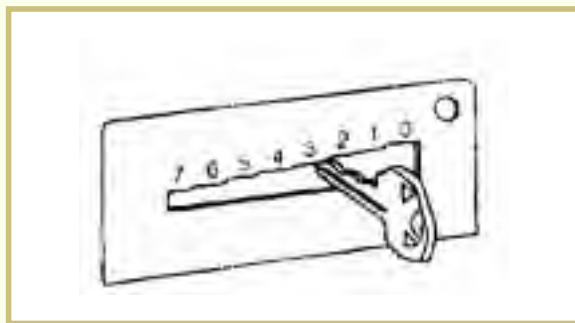
- Cylinder removal tool
- A supply of top pins
- A supply of the various sizes of bottom pins
- A supply of springs
- A plug follower that fits all Kwikset lock cylinders
- A key gage for determining key cut depths

Look now at the Kwikset key-in-knob door lock. In this exercise, you'll learn how to remove the lock cylinder from this doorknob and how to rekey the lock plug. You'll rekey the lock to fit the separate, single key found in this package.

Instruction Steps for Rekeying the Kwikset Lock

Your first task in this exercise is to determine the present combination of the lock. This can be done by measuring the key's cuts with the key gage provided in your pinning kit. Open the pinning kit and take out the key gage. Then, take the *original key* for the Kwikset lock out of the box (that is, the key that opens the lock *now*). Measure the key's cuts with the key gage as shown in [Figure A](#). *Start measuring at the cut nearest to the key's bow.* As you measure the key cuts, write down the depths in the space provided here. (There are five cuts altogether.)

FIGURE A



Your second task is to determine the combination of the new key (the combination that you'll rekey the lock to). Take the other key provided in this package (the key that *doesn't* work the lock) and measure its cut depths with the key gage. Write the depths in the space provided below.

This is the combination that you'll rekey the lock to. Now, let's begin the actual rekeying steps.

Looking at the doorknob, it may seem almost impossible to remove the cylinder! However, it's actually very simple using the cylinder removing tool found in your pinning kit.

Step 1: The first step in rekeying is to remove the round spindle bar from the lockset. Insert the rounded end of the cylinder removing tool and rotate the round spindle until the tab on the spindle lines up with the stem as shown in [Figure B](#).

FIGURE B



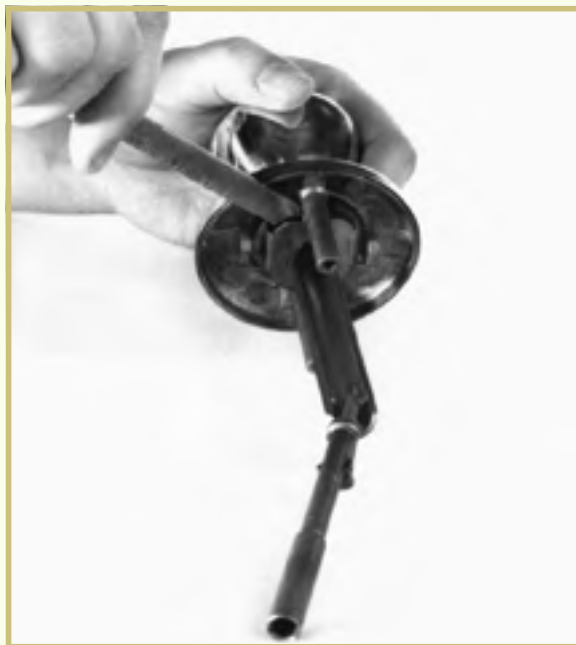
Once the tab is lined up with the threaded stem, insert the rounded side of the cylinder removing tool between the lower stem and the spring clip housing as shown in [Figure C](#). Note location of half round spindle.

FIGURE C



The rounded end of the tool should just come beneath the upper plate of the spring clip housing to strike the tab on the spring clip. If the rounded end of your tool is on the spring or below the spring, it will not free the spindle. With the clip properly pushed up with the tool, turn the lockset upside down and the spindle will drop out (Figure D). Set the spindle aside on your workbench.

FIGURE D



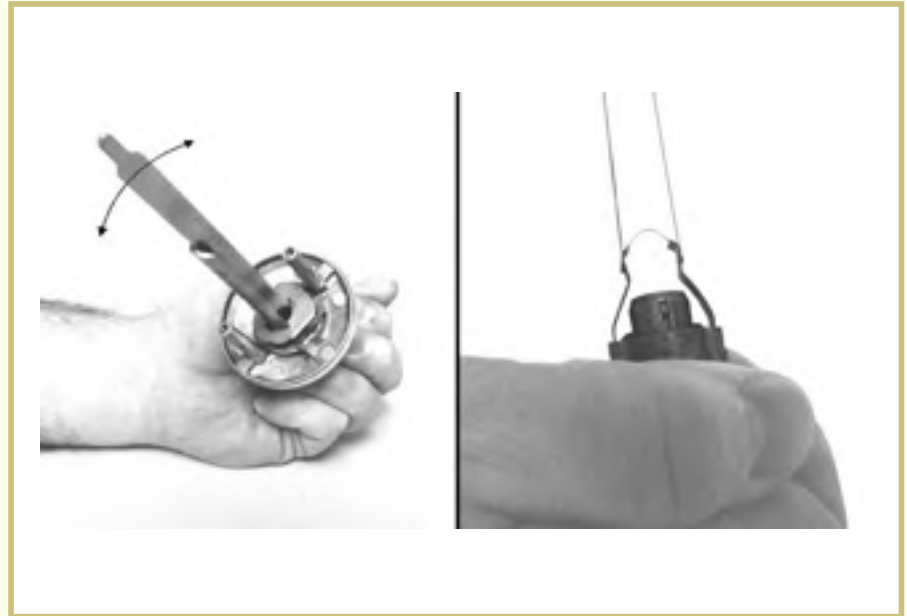
Step 2: The next step is to use the opposite end of the removing tool to release the cylinder. Insert the forked end of the cylinder removing tool as shown in Figure E. Align the tool with the two long screw stems on either side of the spindle hole. Move the rear end of the tool back and forth to release both cylinder retaining

FIGURE E



springs. Note the engagement of the forked end of the tool to the two cylinder retaining springs in [Figure F\(b\)](#). Push the cylinder out of the knob.

FIGURE F



Step 3: With the cylinder released, it is now time to extract the plug from the cylinder. A small retaining clip or C-clip is used to hold the plug in the cylinder of this lock. The forked end of the cylinder removing tool can be used to start to remove this ring as shown in [Figure G](#). Then, use the rounded end of the tool to pry the clip away from the plug ([Figure H](#)). However, be careful. Use your thumb to put inward pressure on the plug so that it does not come free, causing you to dump all of the pins and springs out of the plug and cylinder.

FIGURE G



FIGURE H



Step 4: To remove the plug, place the *original* key into the plug and turn it about 90 degrees to the right. Next, place the plug follower behind the plug (Figure I). Push lightly on the back of the plug follower, and extract the plug from the cylinder shown in Figure J. Be careful not to lose any of the pins contained in the plug.

FIGURE I



FIGURE J



Step 5: When you are done removing the plug, you can clearly see the bottom pins in the plug. Carefully dump these pins out of the plug into a tray or other receptacle ([Figure K](#)). Remove the key.

FIGURE K



Step 6: Prepare the new pins you'll need to rekey the lock plug. Remove the pins of the correct depths from your pinning kit and line them up in the correct order to be placed into the plug ([Figure L](#)).

FIGURE L



Step 7: Insert the *new* key into the plug ([Figure M](#)). Then, reload the pin chambers with the new bottom pins ([Figure N](#)). As you drop in each pin, you can see whether the pin is correct for the cut on the key. The pin should fall in and lie exactly at the level of the shearline. If a pin is above or below the shearline, remove it and install the correct lower pin. When you are done rekeying, your plug should appear as shown in [Figure O](#).

FIGURE M



FIGURE N



FIGURE O



Step 8: When you are confident that all of the bottom pins exactly match the cuts in the new key, reinsert the plug carefully into the cylinder. Place the edge of the plug carefully against the plug follower, and as you slowly insert the plug into the cylinder, withdraw the plug follower.

Step 9: Hold the plug in the cylinder with your finger, and carefully withdraw the key (Figure P).

FIGURE P



Step 10: When the plug is installed and it rotates properly within the cylinder, you can begin reassembly of the cylinder. Replace the plug retainer clip at the rear of the plug ([Figure Q](#)). This clip will push on with finger pressure.

FIGURE Q



Step 11: Return the cylinder to the doorknob and snap it into place ([Figure R](#)).

FIGURE R



Step 12: Reinsert the spindle into the lockset ([Figure S](#)).

FIGURE S



Step 13: Complete your work with the lock by testing the lock and key thoroughly to be sure that it works properly.

NOTES



Keymaking and Rekeying

EXAMINATION NUMBER:

03100600

Whichever method you use in submitting your exam answers to the school, you must use the number above.

For the quickest test results, go to
<http://www.takeexamsonline.com>

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. What is the name used for the aluminum angle iron pieces used over vise jaws to protect the shell or blank key from damage?
 - A. Face plates
 - B. Soft faces
 - C. Softjaws
 - D. Jaw pads

2. What is the proper cut depth for a disk tumbler lock with a cut code number of four?
 - A. 0.190
 - B. 0.205
 - C. 0.220
 - D. 0.235

3. What type of process is normally used by a bit key blank manufacturer to create a bit key blank?
- A. The blanks are cast in molds.
 - B. The blanks are drop forged.
 - C. The blanks are machined on metalworking machinery.
 - D. The blanks are formed in a press.
4. How do you remove the tailpiece from a rim cylinder lock?
- A. Remove the two screws from the retainer plate.
 - B. Turn the key completely around in the lock and pull out on the tailpiece.
 - C. Drive a roll pin from the rear of the plug.
 - D. Push in on the tailpiece as you turn the key until the tailpiece comes free of the plug.
5. Which of the following lubricants can be used on a lock?
- A. Oil
 - B. Grease
 - C. WD-40
 - D. Paraffin-based lubricant
6. How can you remove the cylinder of a mortise lock?
- A. Remove the face plate and spring latch assembly, then remove the retainer for the cylinder.
 - B. Remove an Allen or other type of retaining screw and unscrew the cylinder from the housing.
 - C. Remove the inner thumbturn and plate to gain access to the cylinder retaining plate.
 - D. Push in on the spring latch and unscrew the cylinder from the housing.
7. Which one of the following levels of master keying has a grand master key at the highest level in the system?
- A. Level one
 - B. Level two
 - C. Level three
 - D. Level four
8. You are working with a very large master key system. Your master key has a key code of 3, 6, 4, 2, 5, 7. Which one of the following keys is an acceptable change key for this system?
- A. 3, 4, 5, 4, 6, 2
 - B. 4, 5, 6, 2, 5, 3
 - C. 6, 6, 4, 3, 4, 5
 - D. 5, 2, 2, 4, 3, 4
9. What type of device is often used to clean a file of built-up material?
- A. Wire brush
 - B. Pen knife
 - C. File pick
 - D. File card

10. What type of instrument is used by locksmiths to measure key blades and key cuts?
- A. Vernier calipers
 - B. Micrometer
 - C. Steel rule
 - D. Machinist's rule
11. What type of file is most commonly used in duplicating a cylinder key?
- A. Circular
 - B. Half round
 - C. Box
 - D. Triangular
12. You're working with a 0.015 inch master key system. Which one of the following key cut codes is acceptable?
- A. 2, 4, 2, 6, 3, 5
 - B. 3, 3, 4, 2, 4, 2
 - C. 5, 5, 4, 3, 1, 1
 - D. 2, 8, 0, 4, 7, 1
13. What is the name used for the key that is placed in the right-hand vise of a code cutting machine and sets the spacing of the cuts on the blank key?
- A. Basic key
 - B. Guide key
 - C. Crown key
 - D. Stationary key
14. You have a change key with a key code 3, 5, 7, 4, 2, 6. If you add a number three master pin to the first chamber, what other key could open this lock?
- A. 0, 5, 7, 4, 2, 6
 - B. 6, 5, 7, 4, 2, 6
 - C. 3, 5, 7, 4, 2, 9
 - D. 3, 5, 7, 4, 2, 3
15. What type of tool is used to keep the upper pins and springs in position in the shell or cylinder when you are removing the plug from the lock for rekeying?
- A. Spanner wrench
 - B. Allen wrench
 - C. Plug follower
 - D. Sectional plug
16. You've begun code cutting a key for an automobile and have completed your first code cut which was a number two cut of 0.225 inches. Now you must make a number four cut of 0.175 inches. How far should you move the micrometer's reading from the first cut?
- A. 0.100
 - B. 0.075
 - C. 0.050
 - D. 0.025

17. You begin measuring an older automotive key and find the measurements to be:

Cut	Measurement
1	0.139
2	0.237
3	0.192
4	0.217
5	0.193
6	0.165

What key code should you cut the new key to?

A. 5, 1, 3, 2, 3, 4

B. 5, 1, 3, 3, 3, 4

C. 5, 2, 3, 3, 4, 4

D. 5, 1, 2, 3, 3, 5

18. A disk tumbler lock is brought to you for rekeying. Its original key was coded 4, 4, 3, 4, 5, 4. Which disks should you swap to rekey this lock?

A. First and second

B. First and fourth

C. First and fifth

D. First and last

19. What is the distance in inches between code numbers for automotive keys?

A. 0.015

B. 0.020

C. 0.023

D. 0.025

20. What is meant by “key picking” a lock?

A. Using a duplicate master key to open a lock.

B. Using a grand master key from one system to open a lock in a second system.

C. Using a master blank to create a universal master key.

D. Using a change key that is close to the proper change key to open a lock.

COMING ATTRACTIONS

In your next study unit, we'll be examining the different techniques used to open locks when no keys are available. These techniques include lockpicking, lock reading, key impressioning, shimming, and emergency lock forcing. This study unit will also include two more hands-on practical exercises that will help you develop more valuable locksmithing skills. Keep up the good work, and enjoy your next lessons!

Professional Locksmith

Study Unit 7

Opening Locks Without Keys

Preview

Welcome to Study Unit 7 of your Professional Locksmith course! After completing the previous six study units, you've learned a lot of new skills and added considerable knowledge to your locksmithing information base. Be proud of yourself! At this rate, you'll complete your course and move into the professional world of locksmithing in next to no time!

Study Unit 6 provided you with an in-depth look at two locksmithing skills you'll use on a regular basis. First, you learned how to duplicate keys by hand and by machine. Then, you learned how to rekey a lock—how to change the inside of a lock to fit a new key. Now, in this study unit, you'll learn how to open a variety of locks without using any key at all!

This information will be very helpful to you in your professional career. However, you should remember that a responsible professional locksmith uses these special skills with care and discretion. *Never* discuss the techniques of lock opening with anyone other than another professional locksmith!

After completing this study unit, you'll be able to

- Describe the various methods of picking locks
- Explain the type of lockpick to use on a specific lock
- List the steps for picking warded, lever tumbler, disk tumbler, pin tumbler, and cam locks
- Discuss how to make a key using the impressioning method
- Identify the proper tools to use in key impressioning
- List the steps for impressioning a key for a warded, lever tumbler, and pin tumbler lock
- Describe how to “read” a lock
- Explain how to cut a key after “reading” a lock
- Discuss how to force a lock and describe the tools needed to do so

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Opening Locks Without Keys

Do You Know...

What is a *tension wrench*?

How is a rake pick used?

What is a *pin impression*?

In these pages, you'll find the answers to these and many more questions about opening various types of locks without a key.

INTRODUCTION

Several times a week in the life of an average locksmith, a customer will come into your shop saying, "I lost my key and I'm locked out." What do you do? Where do you even begin? Well, the locksmith has several options when this happens. There are five basic ways to open a lock without a key. These methods are

1. Picking the lock open
2. Impressioning a new key for the lock
3. Reading the lock
4. Shimming the lock open
5. Forcing the lock open

The method you choose to open a lock in a given situation will depend on several factors. First, what type of lock is involved? Second, how much time does the customer have? Does he or she need to get into the house or car urgently, or is there more time available to work? Third, and perhaps most important to the customer, how much will it cost?

In this study unit, we'll teach you these four basic methods of opening a lock without a key. We'll also teach you how to select the method of lock opening that will be the most efficient and cost effective in a given situation. Let's start with an examination of lockpicking.

LOCKPICKING

Lockpicking Ethics

Before we begin our discussion of lockpicking techniques, we want to remind you of the important ethical considerations that a professional locksmith must always keep in mind. Being able to pick a lock open gives you, the locksmith, a great advantage over other people who can't pick locks. And, you may be surprised at how many people want this advantage!

We'd be willing to bet that the first time you told someone you were taking this course, they said, "Will you teach me to pick a lock?" Please don't! The ability to pick locks (and other sensitive locksmithing skills) should only be in the hands of serious, professional locksmiths. This is an important ethical matter. If a dishonest person were to learn how to pick locks, or any of the other trade secrets of the locksmith profession, no one's property would be safe! In addition, if everyone knew the locksmith's skills, the locksmith wouldn't be needed anymore! So remember, never discuss the special techniques of locksmithing with anyone but another professional locksmith.

In addition, it may sometimes be unwise to pick a lock for legal reasons. For example, suppose a customer calls you to his home after losing his only garage door key. Is it safe to pick the lock and make a new key for the door? Can you be absolutely sure that the home belongs to that person, or that he has the legal right to enter the home? Or, suppose a customer brings an expensive auto stereo to your shop. The stereo system is the type that pulls out of the dashboard, the wiring has been cut, and the system is locked in its case. Is it safe to pick the lock and make a new key for the system?

In situations like these, it's possible that the customers are legitimate. On the other hand, the persons described could be involved in some kind of criminal activities. If you're ever in doubt about any situation, ask the customer to provide proof of ownership of the property. If he or she can't provide such proof, it's better to refuse the customer service than to get yourself into trouble.

The Myths about Picking

As we've already mentioned, the subject of lockpicking holds a great fascination for many people. One popular myth that many people seem to believe is that a locksmith can open locks in a few seconds using a hairpin or some similar object. This is very far from the truth! Probably only the simplest, old-fashioned warded or lever lock could ever have been opened using a small piece of wire, and even then it would take longer than a few seconds. Modern locks are far too secure to be opened with any such methods. While it is true that many locks can be picked open, the time and effort involved in doing so is enormous, and as a result, there are often better methods for getting a lock open than picking. For example, why waste 20 minutes trying to pick a small, cheap padlock when a set of boltcutters would open it instantly?

It takes no great talent to pick a lock. To pick a lock, all you need is an understanding of how the lock works, the proper tools, patience, and time. The real talent is in knowing when to pick and when not to pick.

Sometimes it's inefficient to pick a lock when a more timely and inexpensive method is available. Even the most skilled locksmith may need twenty minutes or more to pick certain types of locks. Time wasted on such a project is time you could be spending on several other jobs. Or, a lock may be so inexpensive that it's not worth spending the time to pick it. In such a case, it might be more advantageous to open the lock some other way and replace it with a new one. To make the most of your time, therefore, know when to try another method to open a lock.

Now, before we get to actual lockpicking procedures, let's take a brief look at the tools you'll need.

Lockpicking Tools

A wide range of lockpicking tools is available to the professional locksmith. The first tool we'll describe is the actual lockpick. Lockpicks come in many different styles and shapes. The style you use for a particular job will depend on the type of lock being picked, and also your personal preference. Some locksmiths feel comfortable with one or two styles of picks, and use them for all kinds of jobs. Others prefer to use a different pick with each type of lock.

Two of the most popular lockpick styles are the feeler pick and the rake pick. Both of these styles are popular with beginning locksmiths. The name of the lockpick refers to the shape of the end of the pick. These two styles, and several others, are shown in [Figure 1](#).

If you wish, you can make your own lockpick by grinding a piece of 0.020-inch cold-rolled flat steel into the proper shape.

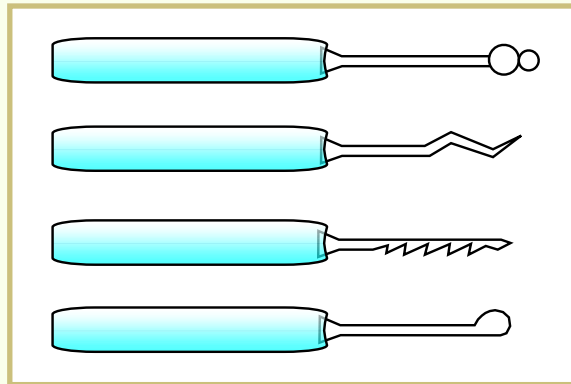


FIGURE 1—Various Styles of Lockpicks

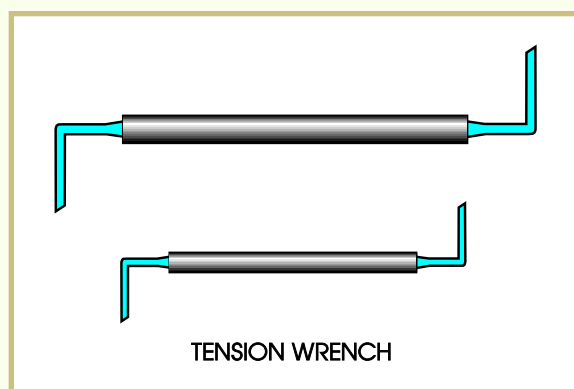
However, lockpicks are not expensive and can be purchased from any locksmith supply store or lock distributor.

To pick open a lock, a lockpick is first inserted into the lock's keyway. Then, the pick is slid along the

keyway, lifting individual pins or disks within the plug. When all the pins or disks are properly lifted to the shear line of the plug, the plug is freed to turn and open the lock.

The second tool you'll need to successfully pick a lock is the tension wrench or torque wrench ([Figure 2](#)). A tension wrench is inserted into the keyway of the lock at the same time as the lockpick and is used to apply turning pressure against the lock plug. You use the tension key to turn the plug in the same way you would turn a key.

FIGURE 2—Two Types of Tension Wrenches

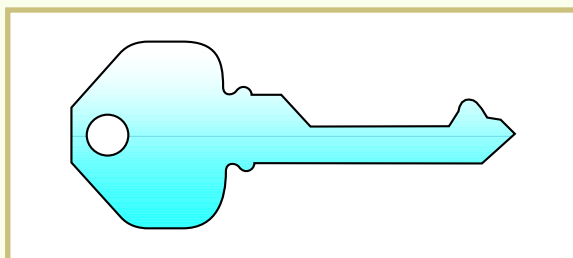


A tension wrench is made of spring steel, which allows for strength along with great flexibility. The blade of a tension wrench must be very thin (to fit in the keyway) yet be strong enough to apply the needed turning

pressure on a lock plug without breaking.

Another tool used to open locks is a key pick (Figure 3). A key pick is a specially ground and cut piece of flat steel that

FIGURE 3—A Key Pick

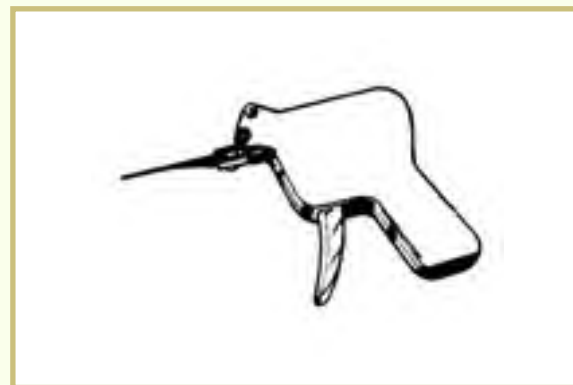


will fit into the keyway of a lock. A projection is left near the tip of the key pick, similar to the shape of a feeler pick. The remainder of the key pick is quite narrow. The

key pick is inserted into the keyway, and each pin or disk is lifted into place as the key pick is withdrawn from the plug.

A picking gun (Figure 4) is used by locksmiths for some types of lockpicking. The picking gun has a spring steel pick and a trigger assembly.

FIGURE 4—A Picking Gun



When the trigger is pulled, the pick is sprung upward within the plug, forcing the pins or disks upward. While the basic operation of a picking gun is simple, it takes practice to actually get one to open a lock!

Some locksmiths find it very simple to open a lock using shims. Typical shims are shown in Figure 5.

FIGURE 5—Typical shims are shown here.



A shim can be used to open a pin tumbler lock, and are usually used to open mortise and rim cylinder locks. To do so, the shim is placed at the rear of the plug and pushed forward until it strikes the rear most upper pin. Then, a feeler pick or a blank key is used to raise the pin until it reaches the shearline where the shim is advanced to hold the upper pin above the shearline. Once all pins are separated by the shim, the plug can be turned and the lock opened.

Now that you're familiar with the tools you'll need to pick a lock, let's examine some actual lockpicking methods.

Lockpicking Methods

In previous study units, you've learned how various types of locks operate. Lockpicking, in simplest terms, is simply substituting a lockpick and a tension wrench for a key. However, a key will lift all the pins or disks in the lock to the shearline at the same time. A lockpick, on the other hand, can lift only one or two pins or disks at a time to the shear line. This is where the skill comes in!

The method you use to pick a lock depends upon the following:

1. The type of lock you're working on
2. The system of picking that feels most comfortable to you and is the most practical and successful

Simple locks, such as warded, or a basic lever tumbler locks, are easily picked. Often, only a single tools is needed. Pin or

disk tumbler locks, especially those of medium- to high-security, require a much more complex process, additional tools, and practice.

Warded Locks

The security of any given lock depends upon many different physical factors. One of these is the complexity of the lock's internal lock mechanism. Another is the ease with which you can look into the lock to see the mechanism. Basically, the more complex the lock's internal mechanism and the more difficult it is to see inside the lock, the more secure the lock. In both of these cases, the warded lock offers little protection, as its mechanism is generally simple and the keyhole is large enough to see most of the lock's interior. Therefore, the basic warded lock is simple to pick. Three methods are commonly used to pick warded locks.

In the first method, you bend two wires so that they throw the bolt and lift the tumbler to the proper height when they're inserted into the keyhole. This method will be discussed in detail in the next section, Lever Tumbler Locks.

The second, and simpler, method for picking warded locks is to use one of the many available pick keys ([Figure 6](#)).

As you can see by the variety of ward cuts on these keys, selecting a pick key and twisting it gently in the lock is a simple matter. When you do this, if you feel an internal ward interfering with the pick key, stop and try a different key. If one

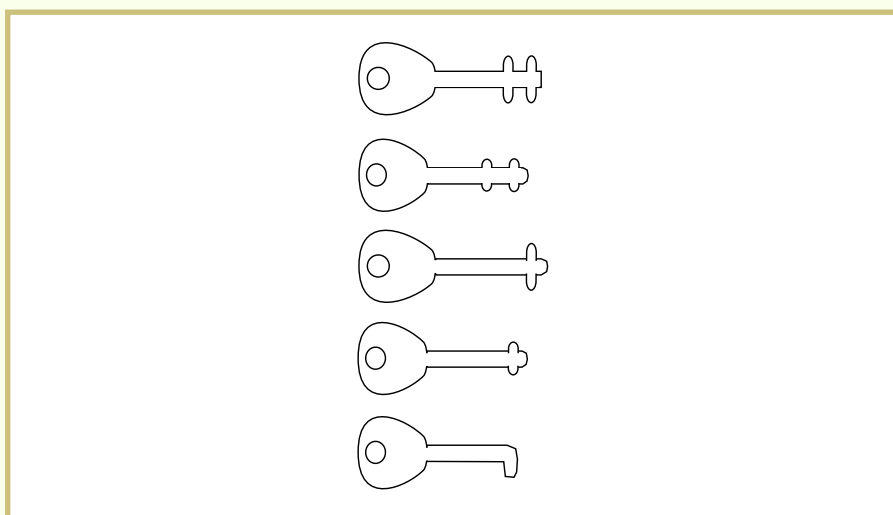


FIGURE 6—Various key picks used to pick warded padlocks are shown here.

of the two pick keys at the top of [Figure 6](#) doesn't work, the third or fourth should. Should all of these keys fail to work because of ward interference, you can make a final attempt with the key that appears at the bottom of [Figure 6](#). This key should be successful.

A third method for picking a warded lock is to actually make a key for the lock by impression. Impressioning is covered in the second section of this text, and is discussed in detail there.

Lever Tumbler Locks

Lever tumbler locks are available in a wide range of security levels. Some high-security lever tumbler locks can have as many as sixteen lever tumblers. These high-security locks are used on some types of bank safe deposit boxes and on some types of public lockers. For the most part, the lever tumbler locks you'll encounter will have between two and five lever tumblers within the lock. However, for this reason, we'll discuss medium-security lever tumbler locks with two to five lever tumblers.

To review the way a lever tumbler lock operates, look at [Figure 7](#). The most important components of the lever tumbler lock to consider when picking this lock are the gate and the post. The saddle must be raised enough to allow the post, which is attached to the bolt, to slide into the rear trap. When

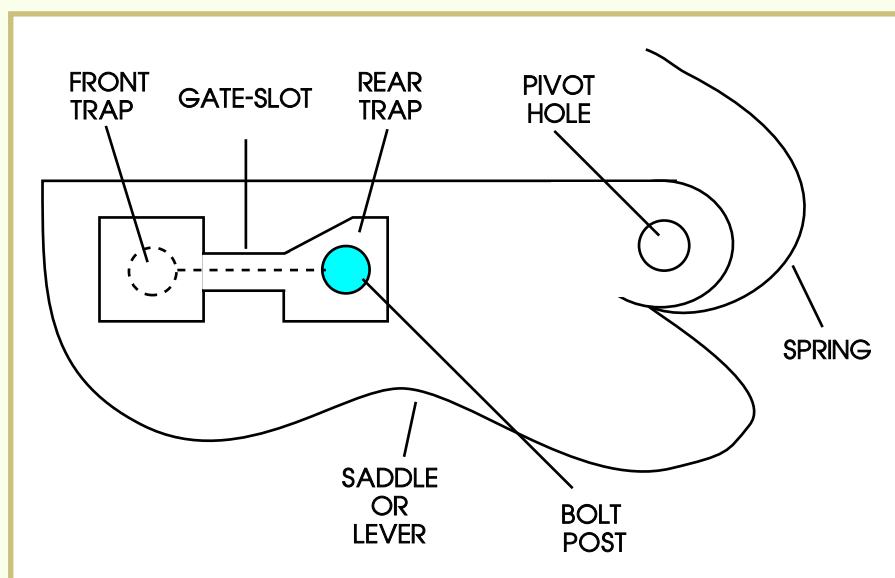


FIGURE 7—Parts of a Lever Lock

this action occurs, the bolt will slide out of the doorjamb, and the door will open.

To successfully pick a lever tumbler lock you must move two items within the lock — the lever tumbler and the bolt. For this reason, you'll need two different tools to pick this kind of lock. The first tool is a tension wrench. The second tool you'll need is a standard lockpick.

The two-step process for picking lever tumbler locks follows:

1. Insert a tension wrench into the lock to put force between the bolt's post and lever tumblers.
2. Lift the lever tumblers with a pick until the gating slots line up with the post, and the bolt opens.

To apply tension to the bolt and lever tumblers, insert the tension wrench into the keyway, small end in. Twist the tension wrench clockwise until you feel it stop. Now, using your pick, lift each tumbler until you feel the tension released from the tumbler. Continue lifting the remaining tumblers until the bolt snaps open.

To get a feel for picking this type of lock, it's a good idea to remove the lock's cover and all of the tumblers except one. Insert your tension wrench and the pick, and pick the lock open. Add a second tumbler and repick the lock. After you've successfully picked the lock with two tumblers, replace the cover and try it again. Continue doing this until you get a feel for how much tension you must apply to the tension wrench and how much tension you need to lift each tumbler. If the lock has additional tumblers, add these, one at a time, and continue picking the lock. One "trick" to picking a lever tumbler lock is to "feel" the tension on each tumbler with your pick and then release the tumbler with the greatest tension first.

Remember, practice makes for efficient locksmithing. In your free time, you should practice picking different types of locks. Practice is the only way to become a journeyman locksmith in lockpicking.

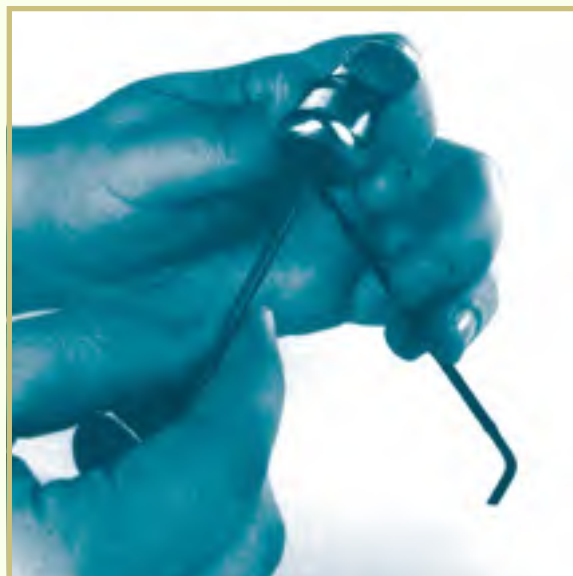
Disk Tumbler Locks

Picking disk tumbler locks is more challenging than picking basic warded or lever tumbler locks. This is because the keyway in warded and lever tumbler locks is relatively open, so you can easily insert your picking tools. In disk tumbler locks, however, the keyway is usually rather small.

To pick a disk tumbler lock, you will use a tension wrench and either a rake pick or a feeler pick. Our first-try system will involve the rake pick.

To begin, insert your tension wrench into the extreme bottom section of the keyway. Exert a small amount of pressure on the wrench. Exert this pressure in the same direction you would use to open the lock with its key. Normally, this direction is clockwise.

FIGURE 8—Hold the tension wrench and the pick as shown here when picking a lock.



With the tension wrench in place, insert the rake pick just above the tension wrench (Figure 8). The rake pick should enter the keyway without lifting any disks. If it interferes with the disks, remove both the pick and the tension wrench, then replace the tension wrench at the top of the keyway.

Hold the pick between your fingers the same way you would hold a pen. Use your little finger to steady your hand against the lock, and use your fingers to move the rake pick gently backwards within the lock. As the disks rise to the shearline, you'll feel a soft "click" in the pick and tension wrench. Don't expect the first pass of the rake pick to lift all of the disks to the point where the plug will turn. Many passes of the rake pick will be necessary, especially on newer locks where wear hasn't loosened the internal components.

If you aren't successful in opening the lock this way, slowly release your pressure on the tension wrench. Listen carefully

as you do this. You may be able to hear the clicks as the springs push the disks back into their slots. If it's a five-disk lock, you may hear three or four clicks. Try again. Remember, it requires practice to pick this type of lock.

A second method of picking a disk tumbler lock uses the feeler pick. In this method, you should place the tension wrench inside the keyway in the same way you did previously. Again, you can place the tension wrench at either the bottom or the top of the keyway, depending upon the position that's most comfortable for you.

With the tension wrench in place, begin lifting the first disk in the plug. Raise the disk just enough to lift it from the lower slot in the shell. If you raise it too much, the disk will enter the upper slot, and the plug won't be able to turn.

When the first disk is properly lifted, you'll feel it being released from the lower slot. At this point, stop lifting the disk. Continue applying a light pressure on the tension wrench while you begin lifting the second disk. When this disk is properly positioned, the plug's slight clockwise motion should hold it in place at the shearline along with the first disk. Continue lifting each of the internal disks until the plug turns and the lock opens.

If the lock doesn't open, you've either lifted one or more of the disks too far or too little. Gently release pressure on the tension wrench while listening for the clicking of the disks reentering the lower slot. Count the clicks to measure your performance. Don't be surprised to find that you only released one or two disks on your first try! It takes a great deal of practice to open a disk tumbler lock in less than five minutes.

The best way to learn how to pick a disk tumbler lock quickly is to remove the plug and take out all but one disk. Replace the plug and use your tension wrench and feeler pick to release the disk and turn the plug. After you've successfully completed this, remove the plug again and try picking the lock with two disks. Once you're confident that you can pick the lock with two disks, add an additional disk and pick it. After opening the lock with three disks and a feeler pick, return the plug to the locked position and try unlocking it with the rake pick. After opening the lock with both the feeler pick and rake pick with three disks, add another disk and try again with both picks. When done, add the final disk and try once more.

For additional practice, remove the plug and scramble the positions of the disks and try yet again. This practice will help you pick disk tumbler locks quickly and easily.

Another method for picking disk tumbler locks is the bounce method. This method is generally very successful, especially on worn locks. In this method, place the tension wrench in the plug and exert a light turning pressure. Next, insert the rake pick completely into the plug. Pull it quickly from the plug in a straight motion. This action “bounces” the disks upward, where they can get caught out of the slots, thus allowing the plug to turn. Try this method on a disk tumbler lock with two, three, four, and then five disks.

One of the hardest things to determine in lockpicking is the amount of tension you should apply to the tension wrench.

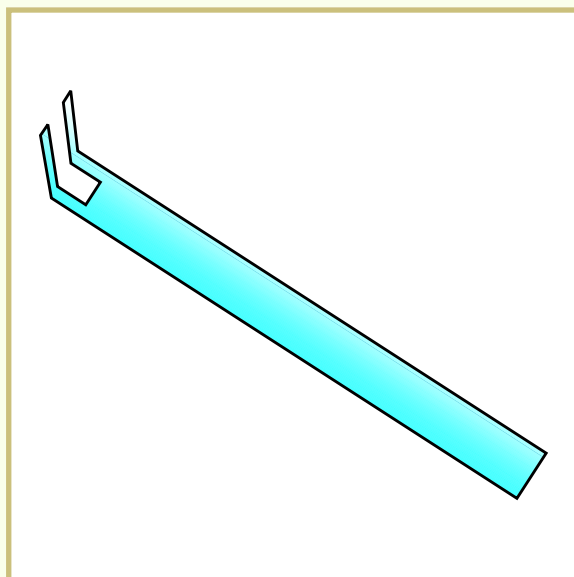
Beginners tend to apply so much tension that the disks bind in the lower slot. Then, the force needed to raise them in the plug is so great that the feeler or rake pick actually bends. This places too much pressure on both tools for them to work properly. If you’re having trouble picking a lock, try releasing some of the pressure on the tension wrench. Then try again. Apply just enough pressure so that the lifted disk stays in position as the plug turns, once the disk is free of the lower slot.

Double-Bitted Cam Locks

Double-bitted cam locks are more complex versions of disk tumbler locks. Like the disk tumbler lock, the double-bitted cam lock contains internal disks and slots in its cylinder. Unlike the disk tumbler lock, ten or more disks or wafers can be stacked within the double-bitted cam lock. These disks or wafers are placed between two end plates. The front plate contains a slot for the key, while the rear plate contains a keyway slot that matches the keyway grooves cut into the blank. This rear plate helps align the key within the stack of disks. The entire assembly within the lock is held together by a set of spring steel clamps shaped somewhat like the letter Z.

At first glance, this lock seems very difficult to pick. However, you’ll find that using a specially shaped tension wrench and a rake pick can make most double-bitted cam locks or padlocks open rather easily.

FIGURE 9—A
Double-Sided
Tension Wrench



To pick this kind of lock, you'll need a double-sided tension wrench like the one shown in [Figure 9](#). This wrench is made of spring steel and has two tangs that enter the upper and lower side of the keyway.

To open this kind of lock, follow these instructions. After seating the tension

wrench in the keyway and applying a gentle clockwise turning pressure, insert the rake pick towards the plug's rear. With the rake pick fully inserted, begin picking the lock by gently raking the top slots in the disks or wafers. After raking the upper slots several times, remove the rake pick and turn it upside down. Reinsert it into the keyway and begin raking the lower slots gently until the lock opens. If you have difficulty opening the lock, try it again, this time applying less pressure to the tension wrench.

One trick locksmiths often use in opening double-bitted locks is to use the bounce technique to rake the disks or wafers. In this case, install the tension wrench into the keyway and apply suitable pressure. Insert the rake pick entirely into the lock, then pull it straight out quickly. Invert the pick and perform the same action. Bouncing the discs or wafers this way tends to align them within the lock more quickly than strokes of the rake pick.

Pin Tumbler Locks

Of all the locks covered in this study unit, a pin tumbler lock is the most difficult to pick. This is because the keyway of the lock is relatively small, and the fit of the parts within the lock is somewhat close in tolerance.

As you remember, opening a pin tumbler lock is a matter of raising the upper pins above the plug's shearline. If the pins

aren't raised enough, they'll stay below the shearline. If they're raised too much, the lower pin will block the shearline.

For this reason, you must raise the pins to exactly the right height. Two conditions exist inside pin tumbler locks that help you to pick them. First, the lower pins don't fit tightly within the holes drilled inside the plug. Instead, the presence of a small clearance, roughly a few thousandths of an inch, allows the pins to wobble slightly in the plug's holes. This allows the plug to move slightly when a lower pin is raised to the shearline by your pick. Secondly, the plug's holes normally aren't drilled in a perfectly straight line. This lets you choose the order of the pins to pick.

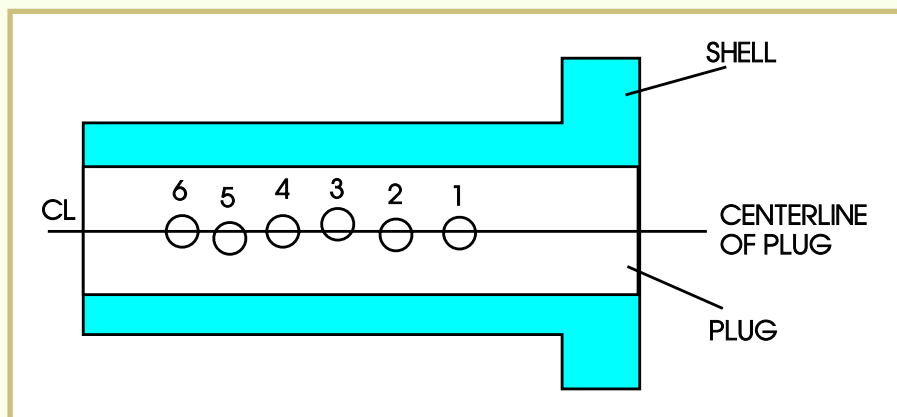
When picking this kind of lock, insert the tension wrench into the keyway. Once inserted and seated, apply a light pressure in the clockwise direction. Take your feeler pick and begin raising the first lower pin until you feel the tension release from the pin and a gentle turning motion of the plug. The first pin rises, taking the upper pin just above the shearline. Continue this process with each additional pin until the plug turns. If the plug doesn't turn on your first attempt, gently release your pressure on the tension wrench and listen for the number of clicks as the lower pins reseat in the plug.

Don't be surprised to hear only one or two clicks the first time you try to pick a pin tumbler lock. These locks are difficult and require plenty of practice and patience.

A few tricks can help you open these locks quickly when using the feeler pick method. First, use a bright light to look at the pins within the lock. Locksmiths often use a light called an otoscope. This light uses a halogen bulb and lens to concentrate an extremely bright beam of light into the keyway of the lock. Once you can see the heights of the pins, begin by picking the longest pins first, as the longer pins have the shortest space to "travel."

Once the longer pins are lifted, begin raising the shorter pins. Remember how the holes in the plug aren't drilled exactly in a perfect line? Keep this in mind as you lift each short pin gently. The short pin with the greatest tension should be the next pin to lift with your feeler pick. The reason for the extra tension on the pin is shown in [Figure 10](#).

FIGURE 10—Notice how the holes aren't perfectly lined up with the centerline of the plug. If you pick pin three first, you'll get the greatest rotation of the plug.



Since the holes aren't aligned, the short pin with the most clockwise offset will have the greatest force against it. Lifting this pin next will cause the plug to shift the greatest amount when the upper pin reaches the shearline. To continue picking the lock, try the remainder of the short pins; once again, lift the pin with the most tension. Continue this process until all the pins are lifted and the lock opens.

Pin tumbler locks are often opened on a first-try basis by using the rake pick. A common method to use with this pick is to insert the tension wrench and apply clockwise pressure. Then, insert the rake pick and gently rake the lower pins back and forth until the plug turns. On medium-security pin tumbler locks, this method is often successful because the internal fit of the pins is rather loose.

You can also use the bouncing technique by rapidly removing the rake pick on some pin tumbler locks.

Just as you do with disk tumbler locks, it's often best to begin picking pin tumbler locks with some of the pins removed. In the beginning, try picking the lock with only one pin, then two pins, and so on. Increase the number of pins until they're all present and you can pick the lock in under five minutes.

Want a real challenge? Try removing the plug and staggering the lower pins so that they alternate in a long pin, short pin, long pin, short pin fashion. With the pins staggered in such a manner, you'll develop a great talent for getting the "feel" of the pick. You'll be able to reach around the long pins to get at the short pins without even moving the long pins.

The pin tumbler lock is also a good lock to practice on when using a picking gun. The picking gun bounces pins much more violently than the rake pick.

When the picking gun's trigger is pressed, the spring steel pick end snaps violently upwards. It strikes the lower pins,

driving the upper pins rapidly up into the cylinder or shell. The action is similar to a hammer hitting a nail. When the hammer hits the nail, the hammer stops, but the nail moves forward. Likewise, when the picking gun's spring pick hits the lower pins, they transfer this energy to the upper

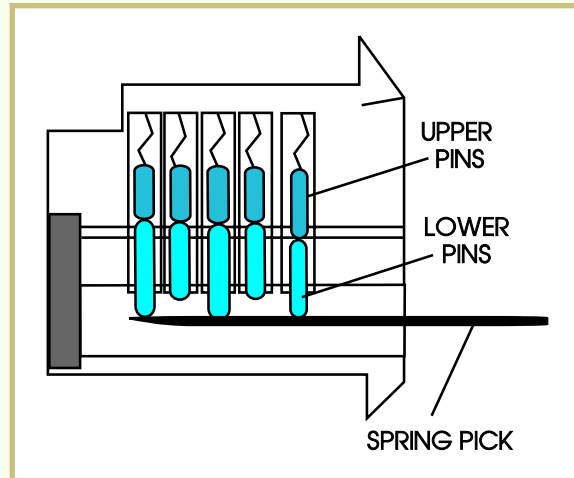


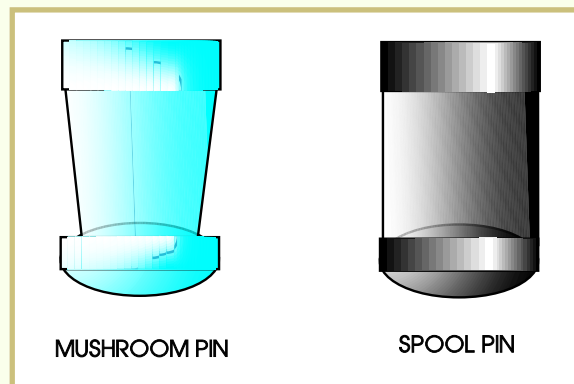
FIGURE 11—After the spring picking gun's trigger is pressed, the lower pins will strike the upper pins driving the upper pins up against their springs.

pins (Figure 11). The lower pins stop in place and the upper pins fly upwards against the spring pressure. If the proper tension is applied by the tension wrench, the upper pins leave the plug and the lower pins remain in the plug, allowing the plug to turn.

Some types of pin tumbler locks are constructed to

defeat attempts to pick the lock. These locks contain specially formed upper pins that normally jam when lifted by a rake or feeler pick. These pins are shaped like mushrooms or spools as shown in Figure 12.

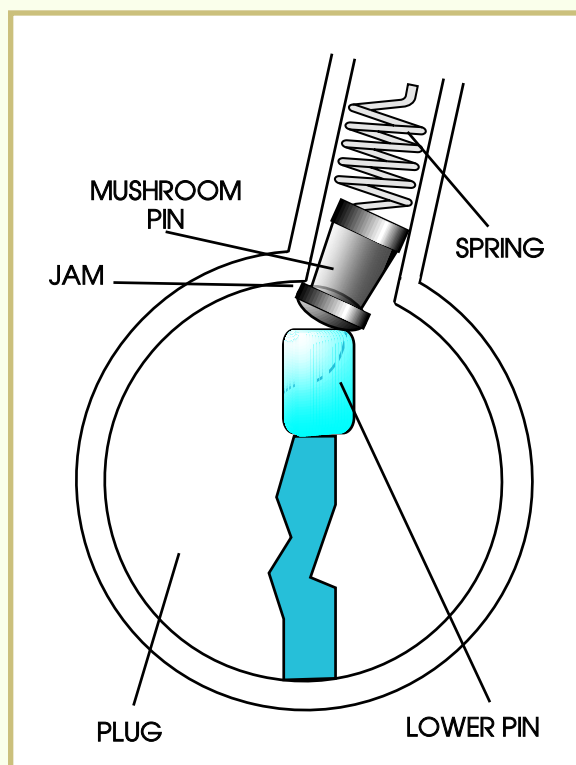
FIGURE 12—Spool Pins



When you begin lifting such pins with a rake or feeler pick, they jam between the plug and the shell as shown in Figure 13.

A picking gun is often the best tool to use in picking locks with mushroom or spool-shaped pins. Exert only a very light pressure on the tension wrench to keep the upper pins from binding. Increase pressure on the tension wrench just after pulling the picking gun's trigger.

FIGURE 13—If you attempt to pick a lock with mushroom or spool pins, the upper pins can jam as shown here.



Picking the lock takes a lot of practice and exceptional timing of the tension wrench's pressure, so it's a good idea to practice picking this type of lock.

In some cases, the picking of a pin tumbler lock can be very difficult when using a pick and a tension wrench. Another method, called shimming, can be used to open a pin tumbler lock. However, the lock, such as a rim cylinder or mortise cylinder lock, must be removed from the locking mechanism to perform the procedure.

In using the shimming method, a small thin metal shim is inserted between the plug and the cylinder or shell. When the shim is first inserted, it will strike the rear-most upper pin. Each pin is lifted in series from the rear of the lock toward the front, and the shim is advanced forward in the lock, separating the upper pin from the lower pin at the shearline of the plug and cylinder. Once all upper pins are lifted above the shim and the shearline, the plug can be turned and the lock opened.

The actual shim is a piece of thin metal that is about 0.0015 inches or one and one-half thousandths of an inch. It must be this thin to fit between the plug and the cylinder. The shim

FIGURE 14—Shim stock can be formed around a screwdriver handle.



must also be pre-formed with a bend that matches the plug. You can purchase these shims in lots of 100 or can purchase a sheet of shim stock from a hardware store or a machine shop supply house. You can then cut the shim stock with scissors. Once cut, the shim stock can be formed around a screwdriver as shown in [Figure 14](#).

In using the shim to open a mortise cylinder, rim cylinder, or other type of pin tumbler lock, the shim is placed in the rear of the cylinder as shown in [Figure 15](#). The edge of the shim is

FIGURE 15—The shim is placed in the rear of the cylinder.

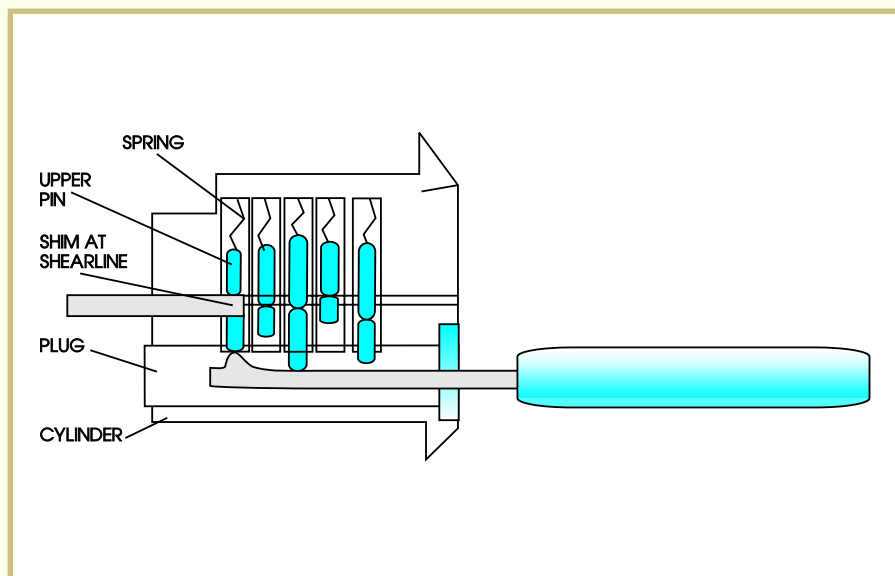


placed in the small gap between the plug and the cylinder. Once started, the shim is pressed into the cylinder until it strikes the first upper pin.

With the shim pressed gently inward toward the front of the plug, the feeler pick is used from either the front or the rear of the plug to lift

the lower pin at the rear of the plug. When the pin is lifted to the proper height, the shim will advance forward, separating the upper pin from the lower pin exactly at the shearline. This action is shown in [Figure 16](#).

FIGURE 16—When the pin is lifted to the proper height, the shim will advance forward, separating the upper pin from the lower pin at the shearline.



In this illustration, note how the shim holds the upper pin above the shearline of the plug. Also note that when you release the lower pin with your feeler pick, this pin will drop back down into the plug. The shim should have advanced into the cylinder until it strikes the next upper pin. Don't apply too much force on the shim to advance it. You don't want to bend the shim. If a shim is bent, it will require you to remove it from the lock and begin over with a new shim.

The shimming process continues with the lifting of the second lower pin from the rear of the plug. When this pin is raised the proper amount, the shim will slip into place between the upper pin and the plug at the shearline. This is shown in [Figure 17](#).

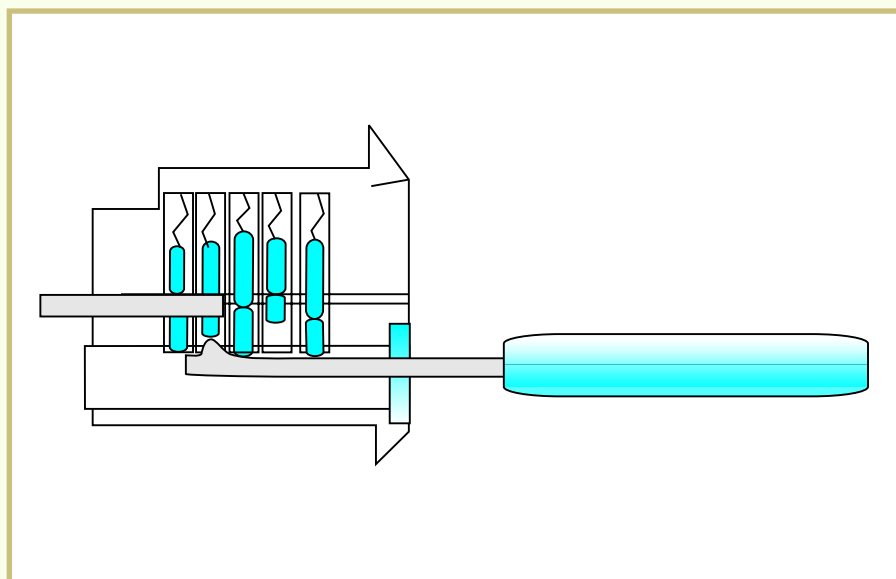
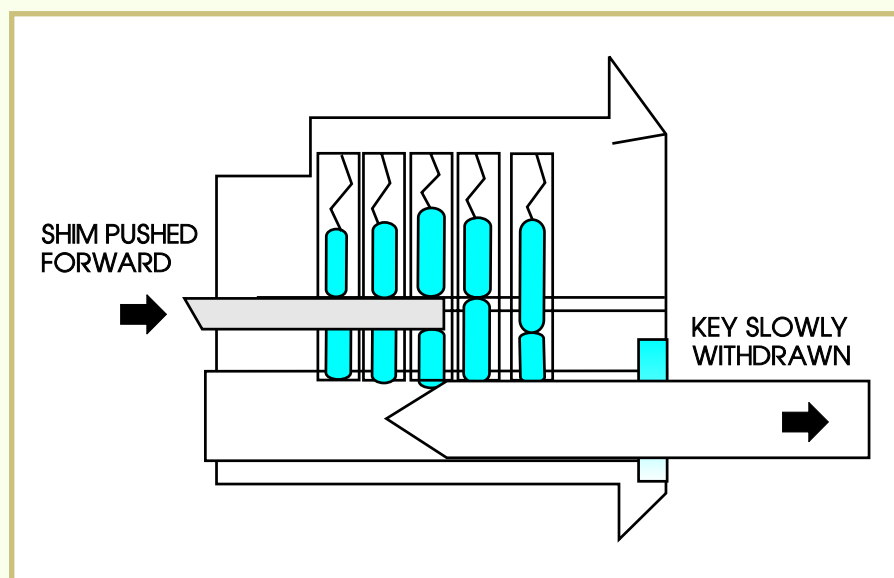


FIGURE 17—The shim will slip into place between the upper pin and the plug at the shearline.

This procedure for picking and advancing the shim continues from the rear to the front of the plug until all of the upper pins are separated from the lower pins and held above the shearline by the shim. The plug can now be easily turned using a tension wrench or a key. Once the plug is turned slightly, remove the shim and save it for your next shimming operation.

A second method of shimming a lock open is shown in [Figure 18](#). Here a blank key is used instead of a feeler pick to lift the tips of the lower pins to the shearline of the plug.

FIGURE 18—A blank key can be used to lift the tips of the lower pins to the shearline of the plug.



In practice, the shim is placed at the rear of the plug and the blank key is inserted into the front of the plug. This action will force most if not all of the lower pins into the shearline. As the key is slowly withdrawn, the lower pins will settle back into the plug. If the proper pressure is placed on the shim, it will separate the upper and lower pins as the lower pin rides down the angle of the front of the blank key's blade.

Combination Locks

Let's stray away from keyed locks for a short time and take a look at the lock that needs no key — the combination lock. Combination locks contain a numbered dial face and knob. The lock is opened by turning the knob both clockwise and counterclockwise until you reach certain numbers on the dial.

FIGURE 19—A typical combination-style padlock is shown here.



Once these numbers are “dialed,” an internal locking dog is released, opening the lock’s shackle. A typical combination padlock is shown in [Figure 19](#).

A combination lock can take many forms. Many types of padlocks, door entry systems, and safes use a combination lock. The internal components of a typical combination padlock are shown in [Figure 20](#). This particular lock contains three

tumblers, two washers that serve as clutch plates, a tension spring, and a dial with its knob.

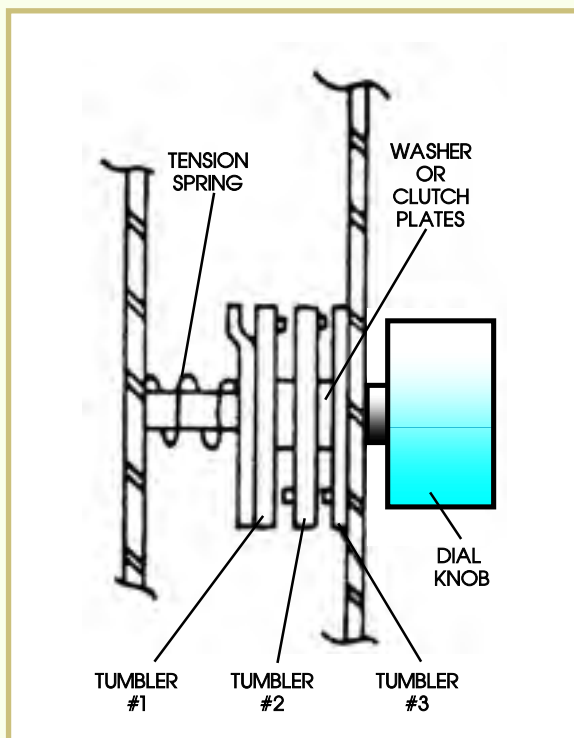


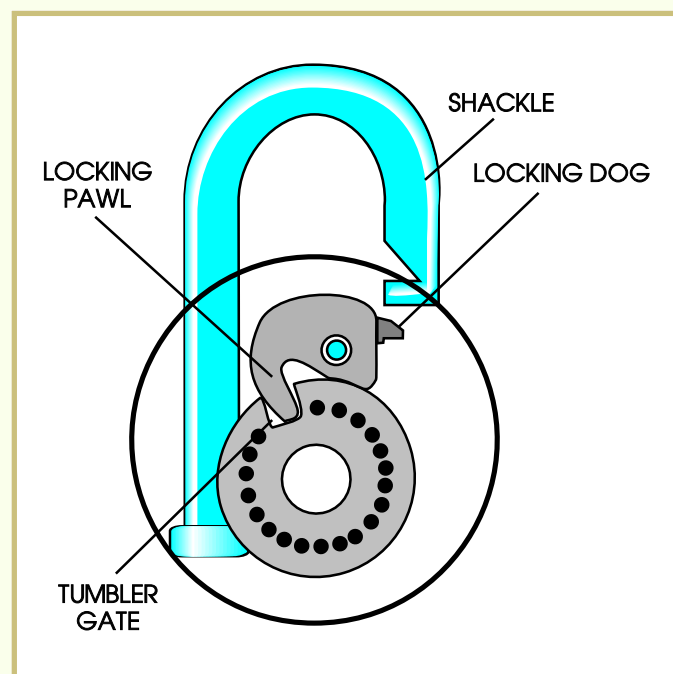
FIGURE 20—These are the internal components of a typical combination lock.

Note the tangs on the tumblers. When you turn the knob on the front of the lock, you turn only the first tumbler until its tang makes contact with the tang on the second tumbler. These two tumblers turn until the tang on the second tumbler makes contact with the tang on the third tumbler. All three tumblers turn as you rotate the dial knob. For this reason, you always begin picking this

lock by turning the knob at least three revolutions in either the clockwise or counterclockwise direction. This action lines up the tumblers inside the lock.

If you look at a back view of the combination lock, you can see how the lock releases the locking dog and the shackle (Figure 21). Notice how the tumbler has a gate cut into it. When the proper numbers are dialed on the lock, the three tumblers line up with their gates open to the pawl on the locking dog. Since the locking pawl is free to pivot, it enters the gates on the three tumblers and opens the lock's shackle.

FIGURE 21—When the tumbler gates are aligned, the locking pawl will be released.



You can pick this kind of lock using many different methods. Just as with keyed locks, a number may be present on the combination lock. By looking up the number in a code book, which you can purchase from a locksmith supply house, you may be able to find the combination. Then you just dial in these numbers and open the lock. The numbers would appear in the code book as shown here:

28R 6L 18R

The letters R and L signify the direction to turn the knob. R means right or clockwise, while L means left or counterclockwise.

Many locksmiths open this type of lock simply by listening to it. As each tumbler passes the locking pawl during knob rotation, you will hear a very faint click. This click will be somewhat amplified if you pull upwards on the shackle. These clicking sounds can be further amplified if you use a stethoscope or other amplifying aid.

In order to get the combination numbers, turn the lock at least three times in one direction. Lift up on the shackle and turn the knob very slowly. At some point during this rotation, you'll hear a faint click as the locking pawl touches a gate in a tumbler. The locking pawl has actually hit the back of the gate. The number at the front dial will be one digit off from the actual combination. Therefore, depending upon the direction of the front knob's rotation, add or subtract one number from the front dial's number. For example, if you're turning the knob clockwise and the numbers are increasing as you turn, subtract one number from the number that's on the dial when you hear the click. If the number on the dial is 26, the actual combination number will be 25.

Next, turn the dial at least two full turns past this first number, and begin turning the knob slowly until you hear another click. Again, look at the dial face and add or subtract one digit from this number, depending upon the direction of dial rotation.

You can find the final number by reversing the direction of rotation once again until you hear the third click. Add or subtract one digit and you'll have all three numbers of the combination. However, these numbers may not be in the correct order to open the lock.

If, for example, you have the numbers 25, 8, and 31, the possible combinations are

25, 8, 31

25, 31, 8

8, 31, 25

8, 25, 31

31, 8, 25

31, 25, 8

One of these six will open the lock.

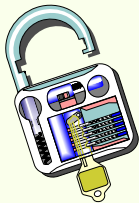
Some locksmiths open combination locks by drilling a hole into the lock's back. They then look inside and see exactly what numbers line up with the gates on the tumblers. This hole is then filled, sanded and polished.

Just as with keyed locks, "picking" combination padlocks takes practice and patience. It's often best for beginners to purchase a combination lock just for practice. Remove its back cover with a hacksaw or similar tool. Once the back is

removed, however, it can't be replaced, so remove the back cover from a lock you intend only to use for practice. With the mechanism in view, pick the lock open from the back side without looking at the dial. Reclose the lock and pick it using only the sounds of the pawl and the tumbler gates to guide you.

The information given in this section is applicable only to the more common low- and medium-security locks available today. The procedures and tools mentioned won't work on high-security locks. Obviously, manufacturers of high-security locks are very careful about who has information, spare parts, diagrams, and other such information about their locks. Normally, to get this information you must be a licensed, bonded locksmith invited to special training seminars. Even the keys for these locks are registered by the manufacturer and are often delivered to customers by courier or registered mail. High-security combination locks have internal cuts on the tumblers besides the gate cuts which give false clicks as you rotate them. You end up with a huge grouping of combination numbers (to make picking the lock an extremely difficult, time-consuming task).

Some high-security pin tumbler locks use keys with cuts at odd angles. These angular cuts rotate the lower pins into the proper position to lift the upper pins. One high-security pin tumbler lock even contains a side bar along with the lower and upper pins! Even more difficult high-security pin tumbler locks have as many as 30 pin sets spaced radially around the plug. The key for this lock is flat, with the proper holes drilled into the blade at the proper angle to open the lock. All of these "tricks" help keep the "wrong" lockpickers out.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

1. When making a key pick for a disk or pin tumbler lock, where should the shallowest cut on the key blade be?

2. Why is a warded lock easier to pick than a lever, disk, or pin tumbler lock?

3. What does the rear plate of a double-bitted cam lock look like?

Check your answers with those on page 65.

IMPRESSIONING

Making Keys with the Impression Method

In the last section, you learned how to pick various types of locks. Mastering this locksmithing activity takes many hours of practice and great patience. Trained locksmiths make the job look easy, though. The locksmith will study the lock a few moments, select the proper tools, and in a matter of seconds, the lock is open.

Key impressioning is also an art. Some locksmiths master lockpicking while others master key impressioning. Few locksmiths master both. Like lockpicking, key impressioning can open any keyed lock. And, when impressioning is complete, you'll have a working key for the lock you've just opened.

The process used for impressioning varies from lock to lock. The basic impressioning process is to place a key into a lock and twist it. The tumblers in the lock will leave faint marks or impressions on the key. You can then file these marks, thus creating a key for the lock.

Tools Needed

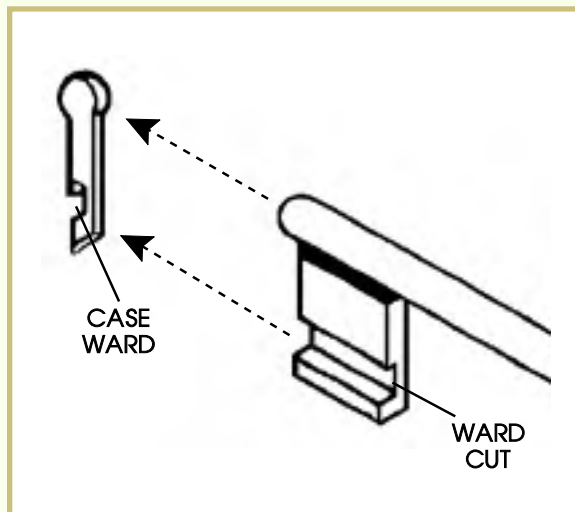
Key impressioning requires few new tools other than those already discussed. You'll need your vise, a selection of key blanks, a round file, a square file, a C-clamp, a candle or black magic marker, and a bright light.

Impressioning Keys for Warded Locks

Since warded locks are relatively simple, they provide a good introduction to key impressioning. The first step (in any impressioning procedure) is to select a blank of the proper size. The next step is to cut the blank so that it fits the keyhole.

Some warded locks have a ward in the lock's cover that prevents the blank from entering the lock. Such a lock is shown in [Figure 22](#). To begin impressioning this kind of lock, smoke

FIGURE 22—The first cut to make when impressing a key for a warded lock is the cover ward cut as shown here.



the blank's end with a candle. With a good layer of soot on the blank's end, press it against the cover ward and wiggle it slightly. Use a needle or scribe to draw two lines on the blank, one line just above and one line just below the case ward.

What you've just done is define the cut's depth and location on the key blank. The lines you've drawn indicate the area that must be filed across the blade face. The end of the blade will also have the soot removed where it came in contact with the case ward. These marks define the depth of the cut to be made. Now, take the blank to your vise and use a square or warding file to remove this area on the blank.

Now the blank should enter the lock. There may be one or more case wards that prevent the key from turning. To locate these case wards, blacken the blade of the key once again with a candle. (Some locksmiths use a black marking pen instead.) Place the key into the warded lock. Turn it hard against the case wards. Remove the key. You should see bright spots on the key where it came into contact with the case wards. Using your square or warding file, file these areas.

Be patient and don't file too deep. If the key still won't turn in the lock, remove it, and soot or mark it once again. Reinsert the key and twist it against the case wards. Remove the key and check for the bright spots where the wards came into contact with it. File these areas and try again. Re-soot or remark the key and file as necessary until the key turns in the lock.

Once you've done this, all you have left to do is clear the cuts of burrs using your file or emery paper. Some locksmiths smoke the key once more to check its contact points. If a bright spot appears on the key, lightly file and deburr it once more.

Impressioning Keys for Lever Tumbler Locks

Lever tumbler locks come in a wide variety of styles and security levels. Some lever tumbler locks can contain as many as sixteen lever tumblers. These locks are, of course, high-security locks such as those used on bank safe deposit boxes. In this section, we'll deal with medium-security locks with two to five internal tumblers.

The first step in creating an impressioned key for this type of lock is to select the proper key blank. Lever tumbler locks normally use a flat key, so you should look for a flat key of the proper length, height, and width. If the key blank is too long or too high, you can file the key blank as necessary. If the blank is too short or too wide, you must choose another blank.

After you've chosen the proper blank, make the first cut — the ward or throat cut near the key's shoulder. This cut lets the key turn within the lock. To make this key cut, insert the key into the lock until the tip is seated in the lock's rear. Now, draw a line on each side of the key where the key meets the lock's outer cover. Next, remove the key and place it in a vise. Make a thin cut with your square or warding file, starting at the lines and working towards the tip, as shown in [Figure 23](#).

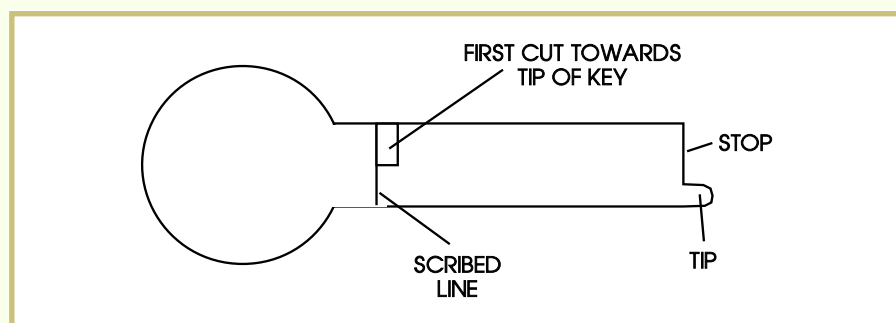


FIGURE 23—The first key cut to make on a flat key blank for a lever tumbler lock is the ward or throat cut.

Again, be patient. Make a short cut and try the key. If the cut is too small, you can always file away more material. If the cut is too deep, the blank is ruined, and you'll have to start over. Try the key and widen or deepen the ward or throat cut as necessary until the key turns within the lock.

Now the tricky part of key impressioning begins. First, smoke the key blank until it's completely covered with soot. Now, reinsert it into the lock and turn it clockwise. When the key is turned against the internal levers, the levers leave

shiny spots on the key where contact has been made. The idea here is to file **ONLY** the shiny areas of the key. Resmoke and reinsert the key as necessary.

You may find that it's often easier to pick lever tumbler locks. Once picked, you can remove the cover and positively identify the depths of the cuts to be made on the flat key blank.

Impressioning Keys for Pin Tumbler Locks

Though it's the most difficult method of opening a lock, many locksmiths open pin tumbler locks with key impressioning. This action not only opens the lock but provides a sample key for which a final key can be cut.

The first step in impressioning a pin tumbler lock is selecting the proper blank. The blank must be of the correct length and width, with the exact keyway cuts to match the lock's plug. Once you've selected the blank, remove all oil and dirt from it using a clean, lint-free rag or cloth. Next, insert its bow into a C-clamp or a vise grip; insert it into the plug. With the key fully inserted into the lock move the key up and down while twisting it clockwise and counterclockwise. Don't be gentle! The idea is to physically bind the lower pins and leave their marks in the key blade. This action is shown in [Figure 24](#).

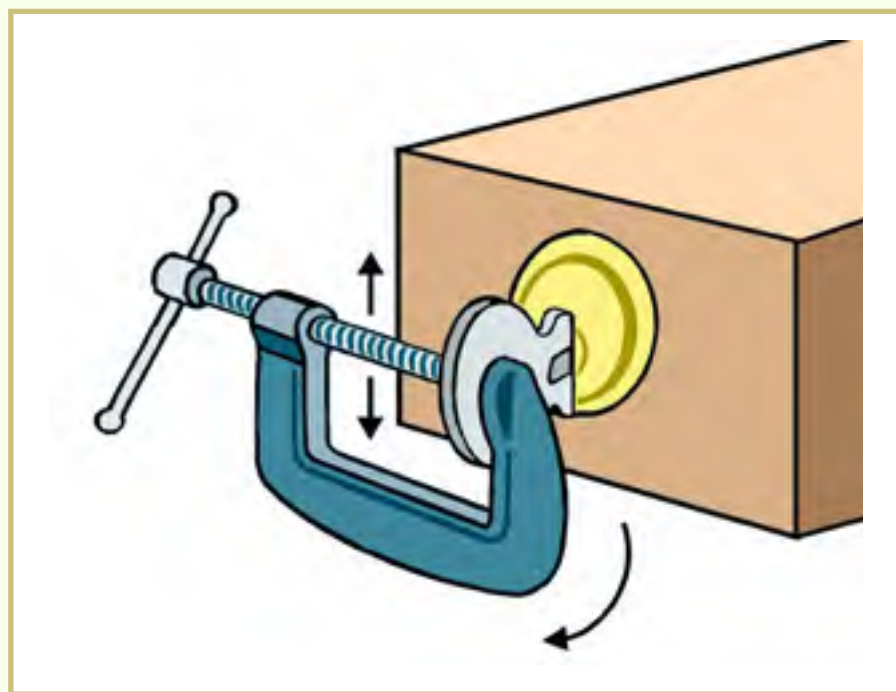
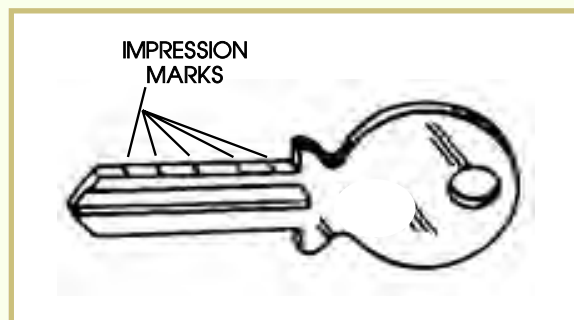


FIGURE 24—In order to create good impression marks in a blank, twist the key side-to-side while moving the key up and down in the plug.

The impressions on the key are very fine marks, which can best be seen by holding the key under a bright light and rotating it from side to side. Sample impression marks are shown in [Figure 25](#). These marks appear as very fine scratches on the blank's blade.

FIGURE 25—Impression marks will show up as small, shiny marks on the blank.



At this point, some locksmiths choose a small round file to file the impression marks. Others choose a small triangular-shaped file. However, your best choice is a number-four

round-swiss file, as this produces the best cuts in the blank.

Place the blank in a vise and begin filing it at each impression mark. But don't file too deeply. After one or two cuts with the file, it's time to impression the blank again.

Reinsert the blank into the plug and again wiggle it up and down while twisting it. Remove the blank and look for new impression marks in the cuts you just made. One method of forcing new impression marks is to place backwards pressure on the blank while turning it from side to side. To apply backwards pressure, place a screwdriver between the shoulder of the blank and the plug; apply force while twisting the blank.

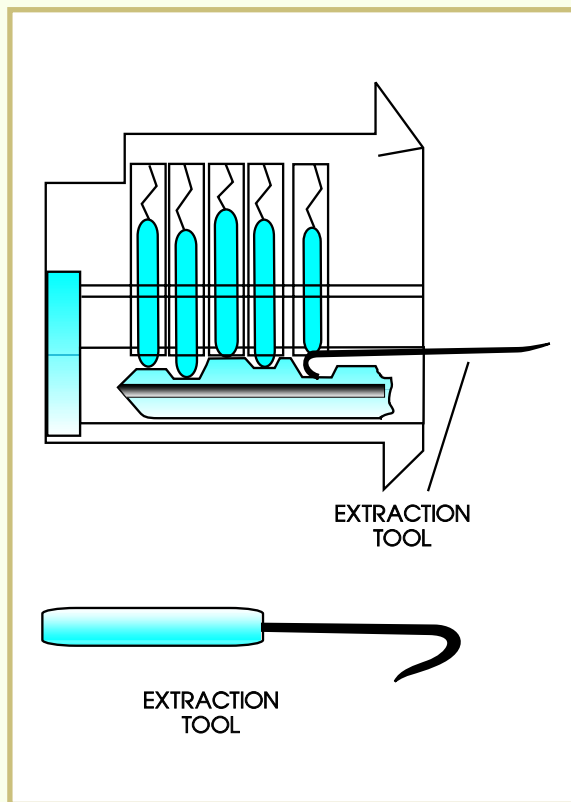
Now, remove the blank and examine it closely for new impression marks. File only those cuts where you see new marks; again, file only a few cuts at a time. Reinsert the blank after cutting. If it opens the lock, your task is complete, and you can deburr the key and create a duplicate. If the lock doesn't open, repeat the impressing process once more.

Experienced locksmiths employ a few tricks when impressing keys for pin tumbler locks, and you may find these helpful. One trick is to use impressing matte, which leaves a dull finish on the top of the blank. When the blank is inserted into the lock and impressed, the pins leave shiny marks that are easier to see.

Another trick is to file the blank key's blade to a knife edge. When this type of blade is inserted into the plug, the pins dull the knife edge at their locations. The blade is then cut at

the impression marks and a knife edge is again created at the cuts. Upon reinserting the key and forcing it, the lower pins again dull the knife's edge at each cut where they haven't reached the shearline.

FIGURE 26—If you break a key during impressing, you can remove the blade using an extraction tool as shown here.



One problem that often occurs during impressing is key breakage. Normally, the key breaks at the blade's shoulder or just before it. When this happens, a simple extraction tool, such as the one shown in [Figure 26](#), can be used to grab the blank and pull it from the plug.

One of the best methods for creating a key combines the impressing technique with reading a lock. Reading a lock gives you a good

idea of its cuts' depths. This topic is explored in detail in the next section.



Locking It Up! 2

1. List two methods of blackening a key for impressioning in a warded or lever tumbler lock.

2. When working with a lever tumbler lock, which cut is made on the key blank first?

3. How do the pins in a pin tumbler lock leave impression marks on the key blank during impressioning?

Check your answers with those on page 65.

“READING” LOCKS

Definition

Reading a lock is looking inside the keyway and determining the relative heights of the wafers, disks, or pins. Once you’ve determined these heights, you can cut a key on a code-cutting machine to open the lock.

Reading a lock accurately takes a lot of practice and patience. Don’t be surprised if the first few keys you make this way don’t open the locks. In fact, it’s a good idea to practice reading locks and cutting keys for them. If the key doesn’t open the lock, remove the plug and insert your key. You’ll get an ideal visual display of the disks or pins you misjudged during the reading process.

Steps in Reading a Lock

The process of reading a lock involves four major steps, as follows:

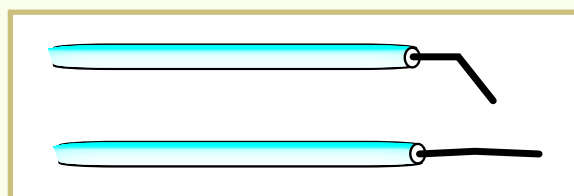
1. Read the lock using a reading tool.
2. Create a wafer, disk, or pin chart based on this information.
3. Create a key using a code cutting machine.
4. Deburr and test the key.

You’ve already studied the last two steps of this process in Study Unit 6. For this reason, only the first two steps are detailed in this section.

Reading Tools

Many different types of reading tools are available to locksmiths. The tool you select depends upon your personal preference. You might find one tool easier to use than another. Two common types of reading tools are shown in [Figure 27](#). Both are made of steel, and both are designed not to bend under the light pressure required during lock reading.

FIGURE 27—Two types of commonly used reading tools are shown here.



As you can see in [Figure 27](#), one type of reading tool has a straight pick end that's bent shortly below the handle.

The second has only a gentle bend to it.

Just as with a pick, the reading tool is held loosely in your hand like a pen. Support your hand's position by pressing your little finger against the lock. As a good first practice, insert the reading tool into the lock's keyway. Lift the reading tool so that all wafers, disks, and pins are raised to their maximum height. Now, slowly withdraw the reading tool, listening for the clicks as the tool is withdrawn from the plug. The number of clicks you hear should equal the number of wafers, disks, and pins that are in the plug of the lock.

In the actual reading of a lock, you'll be using the reading tool to lift the individual wafers, disks, and pins and judge their relationship to each other and to the typical depths of cuts used on the type of lock you're reading. The easiest method of performing these comparisons is to create a reading chart.

Creating a Reading Chart

Reading charts are great aids when you first begin reading lock codes. Two such charts are shown in [Figure 28](#). The top chart should be used with wafer or disk locks (0.015 inch), while the lower diagram is used with 0.025-inch pins or disks.

In a reading chart, a line is drawn from the cut number to the cut depth you determine. Let's look at a sample chart for a pin tumbler lock. The key code for this lock will be 3, 2, 4, 2, 1. [Figure 29](#) shows such a chart. Remember, these codes would be developed by using the reading tool.

To develop the codes for the pin tumbler lock, insert the reading tool into the plug and compress all but the last lower pin in the plug. This fifth lower pin has been judged to be a number 1 code, which will require a full width on the blank's blade to raise the upper pin to the shearline. Judging the lower pin's length comes from trial and error and practice, practice, practice.

FIGURE 28—These two charts can be used to decode the key code for locks during the reading process.

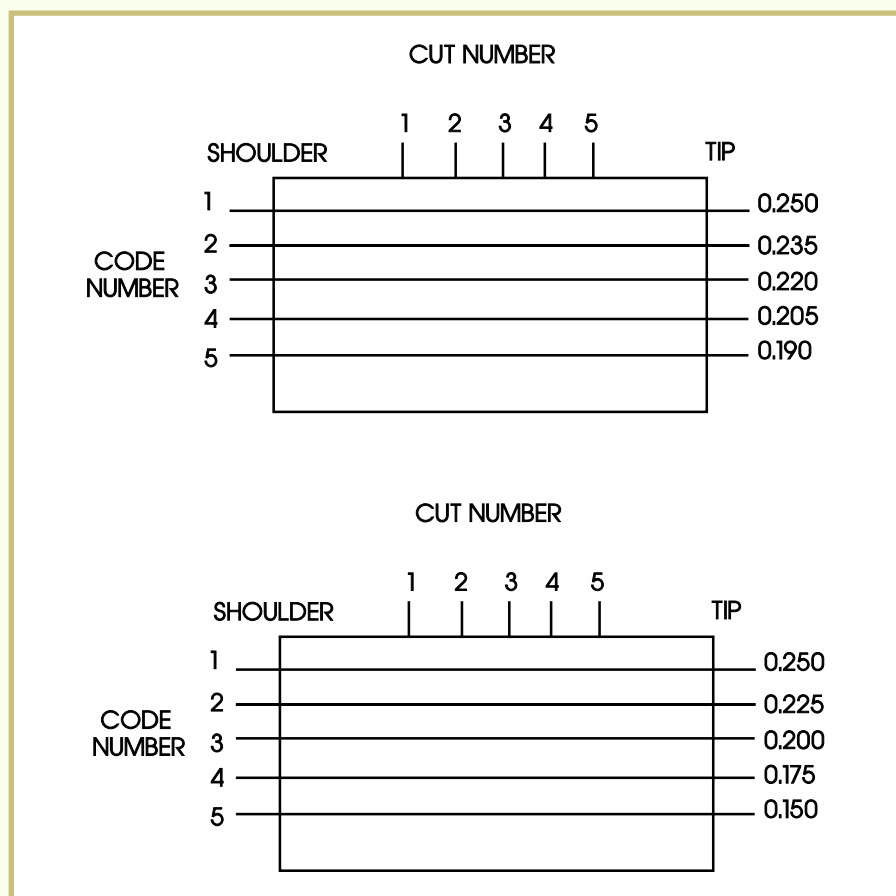
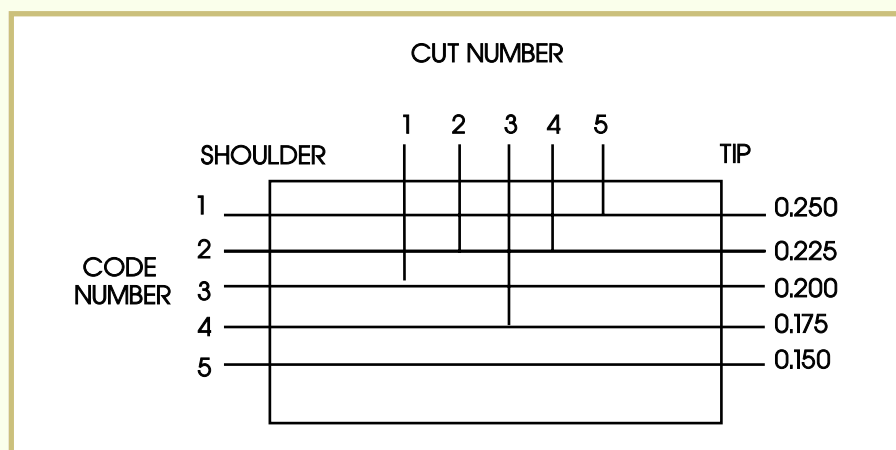


FIGURE 29—The reading chart shown here will display the cuts needed for a key for a lock coded 3, 2, 4, 2, 1.



When reading a lock, the length of the first pin or slot size in a wafer or disk is a critical judgment, because all of the other codes are compared to this first wafer, disk, or pin. If you're off even by one code number, the entire code sequence will be off, also. In our example key code of 3, 2, 4, 2, 1, if you're off by one number on the fifth cut, the code might advance by one number, resulting in a key code of 4, 3, 5, 3, 2. As you can

see, advancing the fifth pin by one number has a great influence on your final code.

Making Keys to Fit

After you've determined the lock's codes or cut depths, a key can be created in many different ways. You might impression the key in a pin tumbler lock to determine the spacing of the cuts. Then, you could use your codes to file and measure the cuts with a vernier caliper.

A second, more efficient method is to use a code key machine. However, you'll need the proper spacer or guide key to match the lock you're working on. Once you know the key codes, it's a simple matter to install the spacer or guide key in the machine and then dial in the proper cut depths.

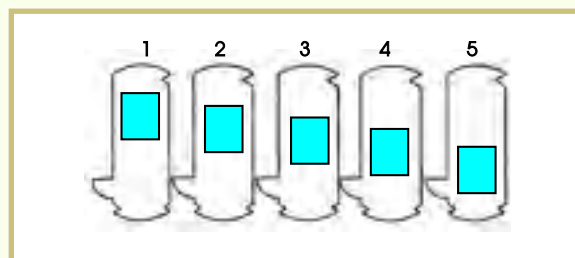
This operation can be performed either at your shop or in the field. Most modern key machines use dual-voltage motors that can run on either 120-VAC or 12-VDC power. The 120-VAC power can be supplied by a normal shop outlet, while the 12-VDC power can be supplied by an adapter that plugs into the cigarette lighter outlet of your car or van.

Now, let's look at how to read two types of locks, the disk and pin tumbler locks.

Reading Disk and Pin Tumbler Locks

As you'll recall, disk tumbler locks may contain up to five

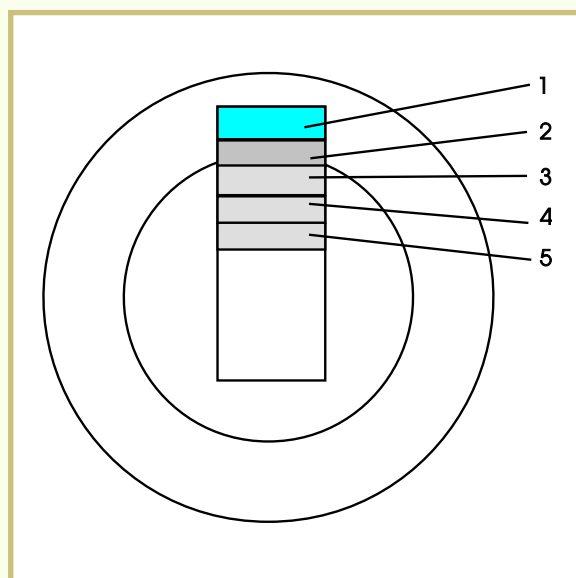
FIGURE 30—These are the five disk sizes used on typical disk tumbler locks.



types of disks in the plug. These five disks are shown in [Figure 30](#). Note that the shape of each disk is identical. Because the key slots are positioned in different places on the disk, a dif-

ferent cut depth is required to lift each individual disk to the shearline, thus allowing the plug to rotate.

FIGURE 31—If you were to look into the plug of a lock with a disk arrangement of 1, 2, 3, 4, 5, this is what you would see.



If the disks are placed in the plug in numerical order, the slot heights would appear as shown in [Figure 31](#). Since the dimension between the different code numbers is only 0.015 inch, only a slight amount of difference exists between the slot positions.

Let's look at the reading process for a typical disk tumbler lock. This type of lock is often used as a drawer or cabinet lock in homes and businesses.

The very first step in reading any form of lock is to illuminate the inside of the plug. As already mentioned, most locksmiths use an otoscope with a halogen bulb to provide a bright beam of light into the plug. An alternative to this is a small but very bright penlight.

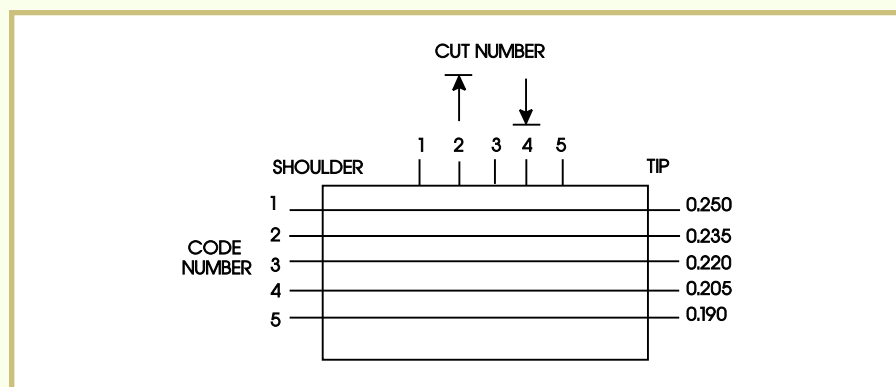
Next, position yourself so that your body is stable. Floor cabinets and desks can best be read using a kneeling position, while file cabinets require a standing position. Often, it's best to place your elbow against the desk or cabinet for support.

Slide the reading tool through the disk slots until it reaches the back of the plug. Once the reading tool is seated in the back of the plug, begin pulling it slowly from the lock. As each disk is released by the reading tool, make a mental note of the various heights of the slots. Slot height can be determined by visual inspection or by watching the distance the disks fall when released by the reading tool.

You can perform a first scan to find out which disk slot is the highest, a number one or two disk, and which disk slot is the lowest, a number four or five cut. This first scan will show you the relationship of the slots in the lock most efficiently.

At this time, you may want to mark the reading chart as shown in [Figure 32](#).

FIGURE 32—In this illustration, arrows have been added to display the highest and lowest disk slot.



Note the use of arrows on the reading chart. In the case of this disk tumbler lock, the second cut from the key's shoulder has the smallest code number (shallowest key cut), while the fourth cut from the shoulder has the largest code number (deepest key cut).

Reinsert the reading tool into the lock to judge the relationship of the other disk slots to the highest and lowest disk slots. Again, raise all of the disks with the reading tool. Now, release the fifth disk. Judge its depth compared to the fourth disk. Continue withdrawing the reading tool slowly until the third disk drops down in the plug. Finally, slowly remove the reading tool to view the slot relationship of the first disk in the lock.

In our sample lock, let's use a key code of 3, 1, 2, 4, 2. As we've seen in the first stage of reading, the second and fourth disks have the slots with the greatest difference in slot heights. We used large arrows on the top of the reading chart to identify these disks. Now, let's add smaller arrows to the chart to identify the relationship of the disks in positions one, three, and five.

While reading the lock, you should have determined that the third and fifth disk contained the same disk number, and therefore, the same slot height. This may have been difficult, since the number four disk separated these, blocking your vision. Often it takes more than one pass of the reading tool to judge slot height relationship when a larger-numbered disk separates two smaller-numbered disks.

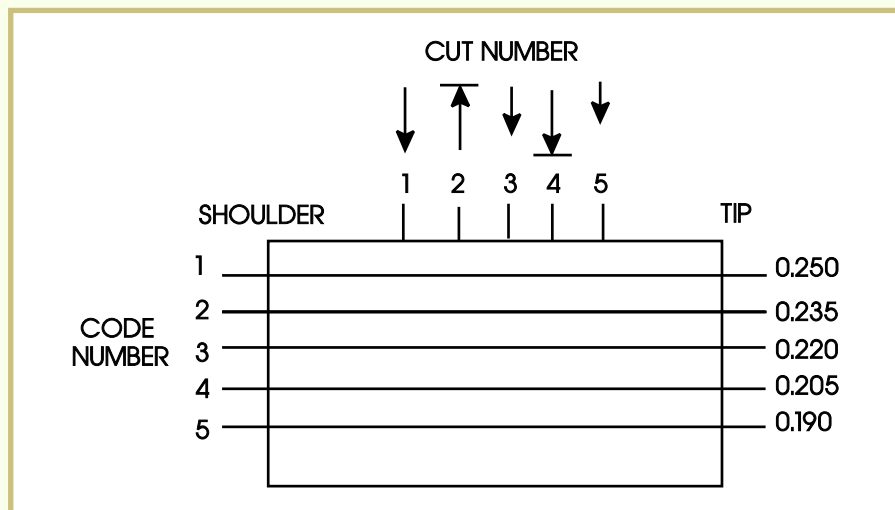
The first disk in the lock can then be judged to be just slightly deeper than the third disk in the plug. This is a fairly easy judgment, since you can look through the slot in the disk in the second position.

Adding shorter arrows to the top of the reading chart results in a chart as shown in [Figure 33](#). Note the relationship of the

arrows used on the chart. The deepest and shallowest slots contain the largest length arrows. The first cut nearest the shoulder has the second longest arrow (meaning the second deepest cut in the slot). The disks in positions three and five have equal length arrows which are slightly shorter than the arrows for the first disk.

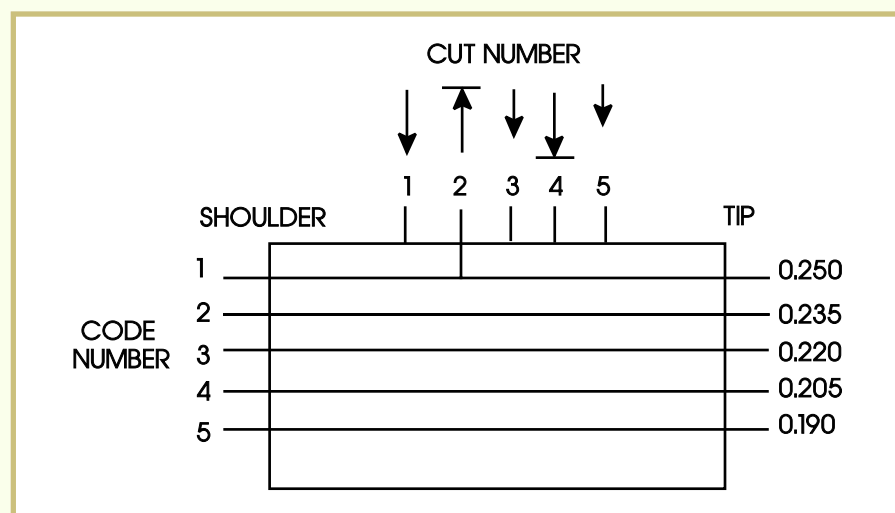
Now, all we need to do is identify one of the disks to complete our chart.

FIGURE 33—Adding the arrows for the rest of the pins would appear as shown here on the reading chart.



Remembering that a number one cut requires a full blade width of 0.250 or one-quarter inch, you can make a tool to read a number one disk. Simply bend a piece of wire at a right angle so that its small end is exactly one-quarter inch. Insert this wire into the plug of the lock. In our example, gage the height of the second disk. If the disk lifts, it will be a number two or three disk. In this case, the wire fits perfectly

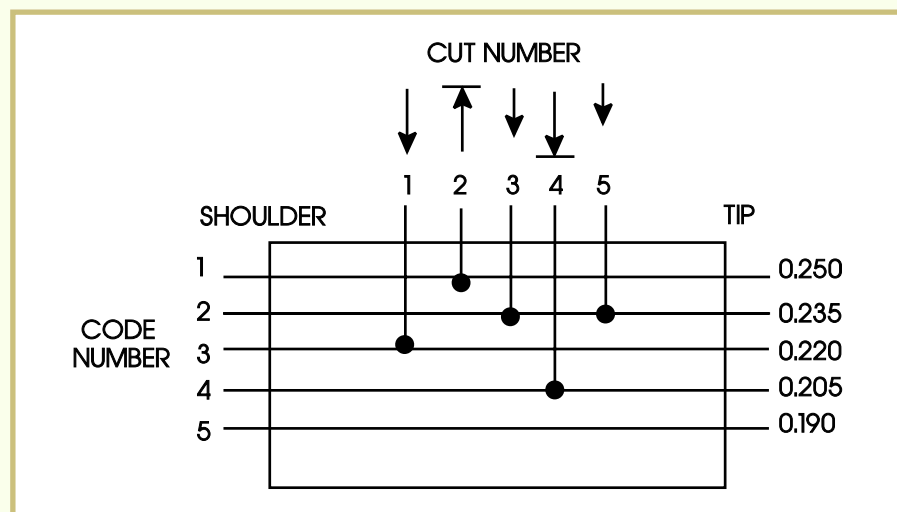
FIGURE 34—The reading chart can be added to by drawing a line for the number one disk as shown here.



in the slot, meaning that this slot is in a number one disk. Now, the relationship of the disks is known, and you have a starting point for completing your reading chart. This chart is shown in [Figure 34](#) with a line drawn to the number one cut depth on the chart.

At this point, you should be able to complete the chart using lines for actual cut depths, as shown in [Figure 35](#).

FIGURE 35—The completed reading chart would appear as shown here.



[Figure 36\(a\)](#) illustrates a profile view of the disks in our sample lock. The slots in each disk are highlighted as solid blank areas on each disk. [Figure 36\(b\)](#) shows how these disks align at the shearline when a properly code-cut key is inserted into the lock's plug.

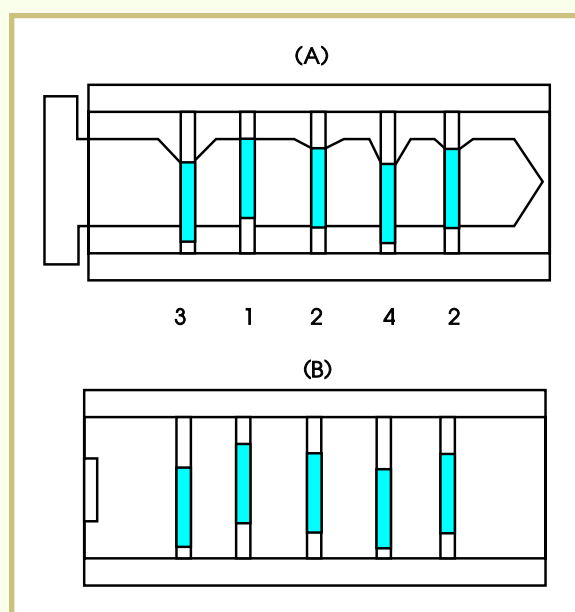


FIGURE 36—This diagram shows the profile views of our example lock with a key inserted as in (a), and with the key removed as in (b).

Would a locksmith perform this process in order to read a disk tumbler lock? No, because the locksmith would simply light the keyway and use a reading tool to scan-read the disks (he or she would have practiced, practiced, practiced!). One

final pass of the reading tool and the locksmith would be ready to cut the key. No chart would be created, as the locksmith would simply memorize the codes while withdrawing the reading tool the second time. The reading charts are simply an aid to use during your practice sessions. Once you can competently read a lock, stay on top of your skill by reading a lock several times each week.

Once you know the key codes, you can create a key for the lock. If you have a spacer or guide key and a code-cutting machine, this is a simple task. However, if you don't have this equipment, you can create a key using the impressioning method. Simply blacken the key with soot or a marker and insert the key into the plug. Twist and turn the darkened blank to pick up the disk locations. Cut the key using a file and a vernier caliper.

Pin tumbler locks can be read using the same methods shown for disk tumbler locks. Instead of reading slots, you lift all lower pins to their maximum upward travel using your reading tool. Now, as with a disk tumbler lock, determine the longest and shortest pins by the amount the pins drop when released. Finally, complete the reading chart by identifying the comparative heights of the remaining pins. Using a code chart for a pin tumbler lock, cut a key for the lock, deburr it, and open the lock.

Reading Lever Tumbler Locks

The reading of a lever tumbler lock requires great skill and again, practice. The difficulty in reading this type of lock lies in its narrow keyway which makes it very difficult to see inside the lock.

One advantage you may find is that some manufacturers use different width levers or saddles inside their locks. When using a reading tool, you can feel these different width saddles and identify them. In these locks, a thin saddle can be lifted by a key with a very shallow cut, while a thick saddle requires a deep cut to lift the trap and release the bolt.

Some lever tumbler locks contain saddles of the same width. These are the most difficult types of lever tumbler locks to read. To read these locks, lift each tumbler to its point of full

upward travel, which allows you to judge the minimum cut needed across the key.

From this point on, reading the lever tumbler lock is more like picking than reading. To begin, install a tension wrench to force the bolt of the lock inward. Use the reading pick tool to lift each lever. Begin reading the lever with the most tension on it. Judge how high you must lift it to release the tension as you “pick” this lever. Move on to the next-highest tension lever, and judge the height it must be raised to place the trap at the bolt’s post. Continue this process with each lever by raising the lever’s saddle with your reading tool. If need be, create a reading chart as you progress through the lock. Normal key-cut increments for lever tumbler locks are in the range of 0.015 to 0.025 inch.

Reading lever tumbler, disk or pin tumbler locks can be very frustrating at first. Often, it’s best to disassemble these locks, place only a few levers, disks, or pins in the lock, and then read only these. As you become more experienced, you’ll find it much simpler to perform a correct “read” of a lock on the first or second pass.



Locking It Up! 3

1. How is a reading tool different from a pick?

2. How can you tell if you've reached all five pins or disks in a five disk or pin tumbler lock?

3. What is the easiest method of cutting a key for a lock once the lock has been read?

Check your answers with those on page 65.

FORCING A LOCK AND FORCED ENTRY

The Last Resort

Locksmiths normally force a lock only in emergencies. Forcing a lock takes more skill than it seems at first glance. You must understand how the lock works, what its security level is, and where and how to force it. Brute force isn't always the proper method.

Picking, impressioning, or reading are usually the first attempts. In certain situations, however, it's quicker and easier to force a lock rather than to open it using one of the three previously mentioned methods. For example, a file cabinet can sometimes be forced in a matter of seconds. Forcing won't damage the lock, only drop the bolt behind the plug. In such a case, forcing is a quicker and more efficient way of opening the cabinet, especially if the owner has simply left the keys home and doesn't need to have a key cut for the lock.

Forcing a lock, like picking, impressioning, or reading, should only be used when you're sure that the true owner is present. Otherwise, forcing the lock is against the law.

Forcing Padlocks

Depending upon the type and security level of a padlock, you can force it open using many different methods. One commonly used method is called the rapping method. A tension wrench is inserted into the plug and a light force is placed in the plug's clockwise, or normal opening, direction. Then, a soft-faced hammer is used to strike the side of the padlock that contains the springs and upper pins. The striking force causes the upper pins to push back against their springs, raising them above the shearline. If the lower pins stay in the plug, the plug turns, and the lock opens. This method can also be used on wafer or disk tumbler locks. However, the rapping method isn't as successful with pin tumbler locks, because the disks or wafers move to the shearline only if the exact amount of tension wrench pressure is applied. Too little pressure lets the wafers or disks fall back into the lower slot, while too much pressure binds them in the lower slot.

Inexpensive padlocks and combination locks can also be opened by applying force to the locking mechanism. The force necessary depends upon the lock's security level.

The shackle locking mechanism of inexpensive padlocks is a simple spring-loaded locking dog that mates with a notch cut out of the shackle. If enough force is applied upward on the shackle or downward on the shell, the locking dog moves backwards enough to free the shackle. This force is normally provided by a brass bar and a hammer. The object is to place the brass bar against the lock near the shackle and strike the bar once, violently, with the hammer. The brass bar tends to spread the blow evenly over the shackle. [Figure 37](#) shows the internal locking mechanism and the point on the lock where you should strike it.

FIGURE 37—A padlock can often be opened by hitting the padlock in the location shown here.



One brute force method often used by the nonprofessional is to use a long pointed bar or crowbar to slam the lock. Although this method is often successful on inexpensive padlocks and combination locks, it can damage the lock's shell, shackle, or locking mechanism.

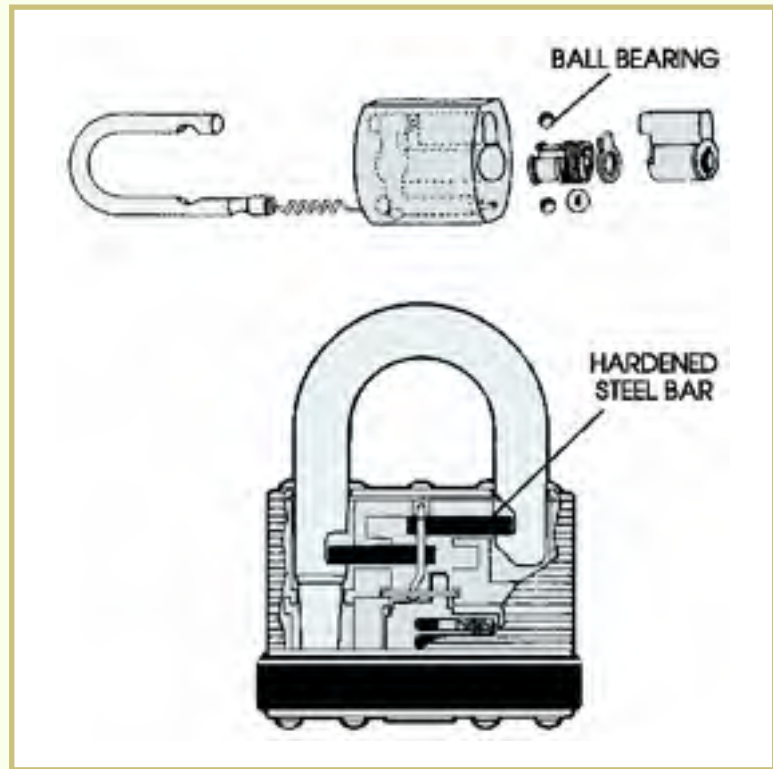
Most high-security padlocks have been internally designed to defeat rapping, hitting, or slamming. In these locks, both sides of the shackle

are held by the locking mechanism, instead of just one side.

Two of the most common methods for providing double locking of the shackle are

1. Using two hardened steel bars on a pivot plate in the lock

FIGURE 38—High-security padlocks can use either a set of hardened steel bars or ball bearings to hold the shackle.



2. Using hardened steel ball bearings

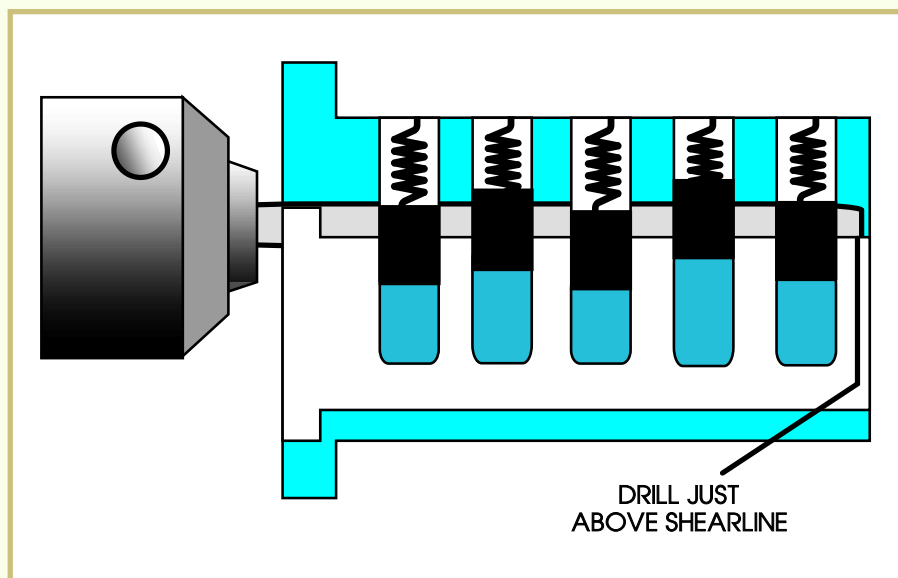
These methods are shown in [Figure 38](#).

High-security locks can withstand force in excess of 5000 pounds (2 ½ tons) before opening. This amount is well beyond the capabilities of your brass bar and hammer or the nonprofessional's crowbar.

Although the shackles of high-security locks are hardened steel, you can often defeat them by using a tool called a bolt cutter. This tool has extremely hard steel cutting blades and long handles to let you amplify the cutting pressure. This tool isn't simply squeezed to cut the shackle. Instead, you position the cutting jaws on the shackle and violently pull the handles together to snap the shackle. Hardened steel shackles break after repeated attempts are made with a bolt cutter. Sawing these shackles with a common hacksaw blade can take upwards of one hour. If you must cut the shackle, it's best to use a small grinder and a steel cutting wheel.

Another option for opening a padlock is to drill out its plug. This is shown in [Figure 39](#). Normally, the lock is drilled slightly above the shearline. This action damages the upper pins as the drill goes through them. After you've drilled into

FIGURE 39—A lock can be drilled just above the plug to force it open.

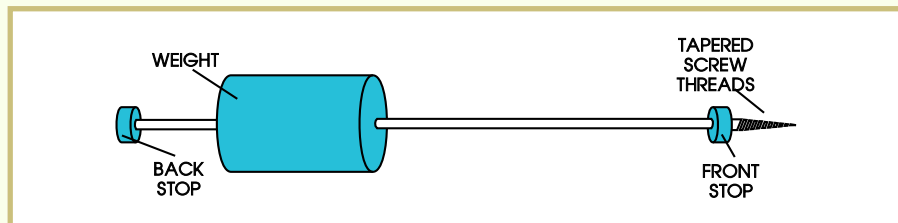


the lock as far as the key would enter, turn the plug with a tension wrench or screwdriver.

Some locks contain hardened steel areas to protect the plug and locking mechanism. These areas can sometimes be drilled with tungsten-carbide drill bits. In some cases, hardened steel ball bearings are used inside the locks to protect against drilling.

The lock's plug can also be pulled from a lock to open it. On padlocks and even automobile locks, the center of the plug at the keyway can be drilled. Then, a device called a slide hammer with a screw tip can be inserted into the drilled hole in the plug. The slide hammer's weight is inserted slowly forward and then violently backward against a stop collar. The force exerted when the weight hits the collar can be great enough to pull the plug from its retainer, thus removing it from the cylinder or shell. The locking mechanism can then be tripped, opening the lock. The lock is destroyed in this process. [Figure 40](#) displays such a slide hammer.

FIGURE 40—A slide hammer uses a weight striking a collar to apply backward force on the plug.



Opening Desks and File Cabinets

Desk and file cabinet locks generally feature a wafer, disk, or pin tumbler lock. The locking mechanism is normally a bolt that rises from the lock's rear when the plug is turned to the locked position.

You can use one of two basic methods to open desks and file cabinets without destroying their locks or using the picking, impressioning, or reading methods. These methods are

1. Lowering the bolt with a specially shaped pick
2. Drilling a small hole into the desk or file cabinet to release the bolt

Due to the construction of most desk or file cabinet locks, a specially shaped pick can often be inserted through the keyway to lower the bolt. This action can take place without turning the plug. [Figure 41](#) shows this tool lowering the bolt.

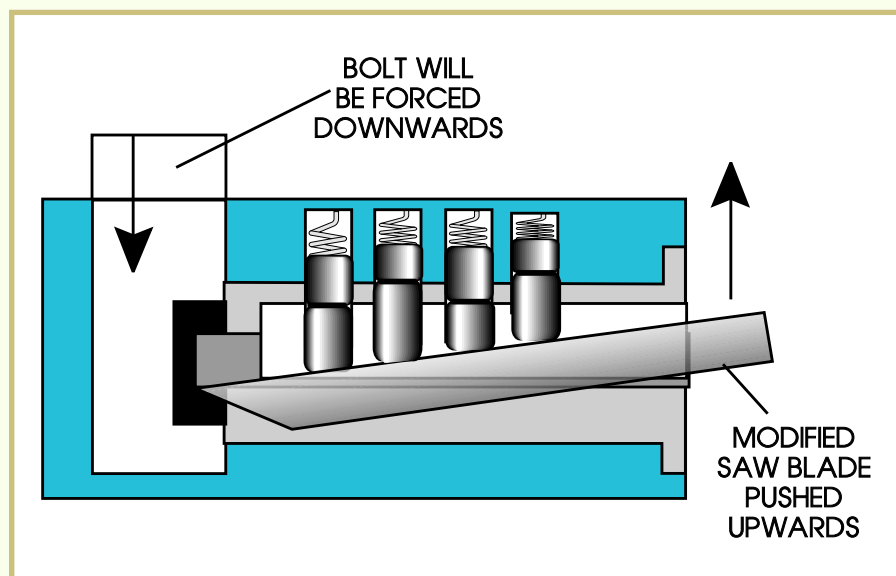
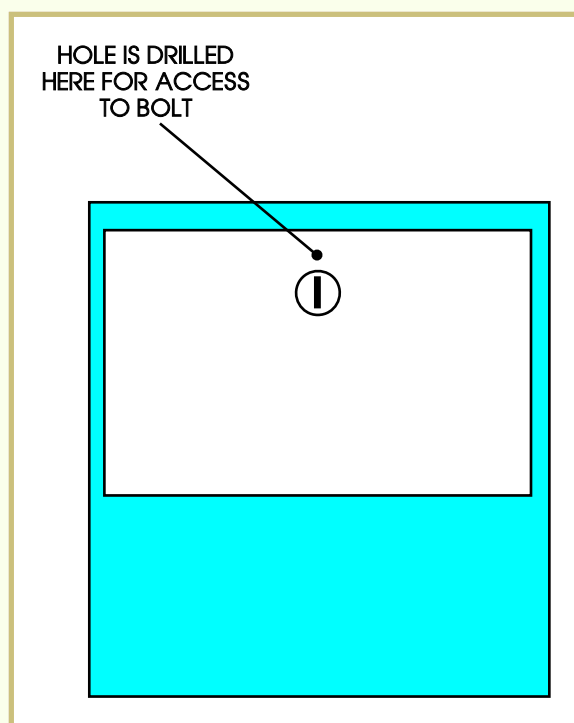


FIGURE 41—A desk lock can be forced open by lowering the bolt as shown here.

The picking tool can be made from a saber or jigsaw blade. Select a blade that's longer than a standard blade and one that is made for cutting thin metal. The blade can then be ground to the shape needed to drop the bolt.

The second method of opening a desk or file cabinet lock requires that you drill a hole just above the lock. The hole should be as small as possible, around one-eighth of an inch in diameter. Normally, a small battery-powered drill can

FIGURE 42—If the bolt can't be lifted through the plug, the bolt may be accessed through a hole drilled as shown here.



quickly and easily drill a hole of this diameter through wood or steel drawers without the need to run extension cords. Once the hole is drilled, you can insert a small, straight-pointed spring steel pick inside the hole. Push down on this pick while pulling gently outward on the drawer. The pick lowers the bolt, releasing the drawer. The hole can then be filled in

with color-matching wood putty, epoxy, with a bolt and nut, or a decorative screw. The location to drill the hole is shown in [Figure 42](#).

Forced Entry

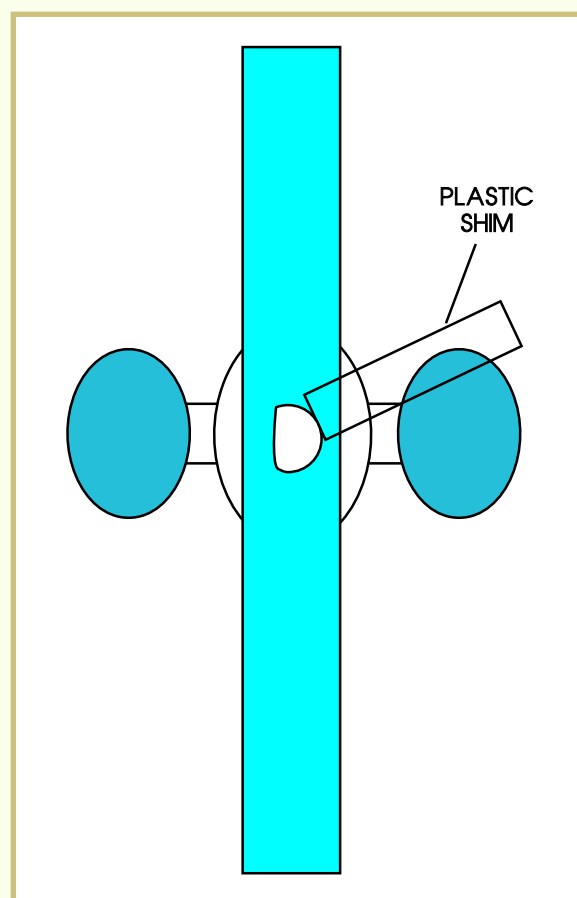
The forced entry of an automobile, locker, home, or business is always a last resort. It's much better to pick, impression, read, or use "try" keys to open a lock rather than force your way into it. "Try" keys are produced by lock manufacturers; they feature the most common key cuts and open many locks. Lockpicking with "try" keys should also be attempted.

In many cases, forced entry results in some form of damage to the lock or its surroundings (e.g., the desk in which the lock resides). And remember, forced entry without the owner's approval is illegal. It's called breaking and entering by law enforcement personnel.

Forced Entry of Homes and Businesses

Any area of a home large enough for a person to enter is a potential location for forced entry. Cellar windows, doors,

FIGURE 43—A plastic shim can be used to open simple key-in-knob locksets without a deadlocking pin.



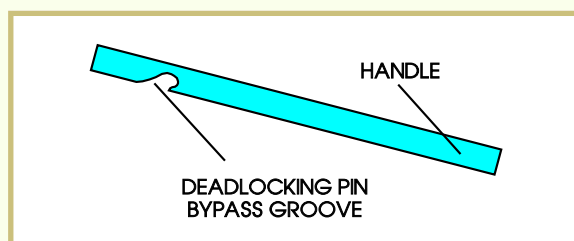
house windows, attic vents, and so on, offer viable opportunities for forced entry. Most locksmiths prefer to use a door or first-floor window as a point of entry.

A wide range of tools is available to force doors open. One simple tool is a plastic shim shaped like a credit card. If you place this shim between the doorjamb and the latch of a key-in-knob lockset, you can usually spring the latch. This system is shown in [Figure 43](#).

When using the plastic shim, place it between the door and the jamb at knob level. Insert the shim until it makes contact with the latch. Wiggle the shim up and down while pressing it forward against the latch. If the lockset doesn't contain a deadlocking pin, the latch is pushed backward into the lock, opening the door.

For locksets with deadlocking latches, you can purchase a tool to force the latch. This type of tool, made of spring steel, is approximately one-half inch wide and about ten inches long ([Figure 44](#)). The bar is placed between the door and the jamb until it contacts the deadlocking pin. The lower jaw on the bar fits around the deadlocking pin. By wiggling the bar properly, you can move the latch behind the deadlocking pin and free the strike on the jamb.

FIGURE 44—A jimmy bar can be used to open many types of lockset protected doors.



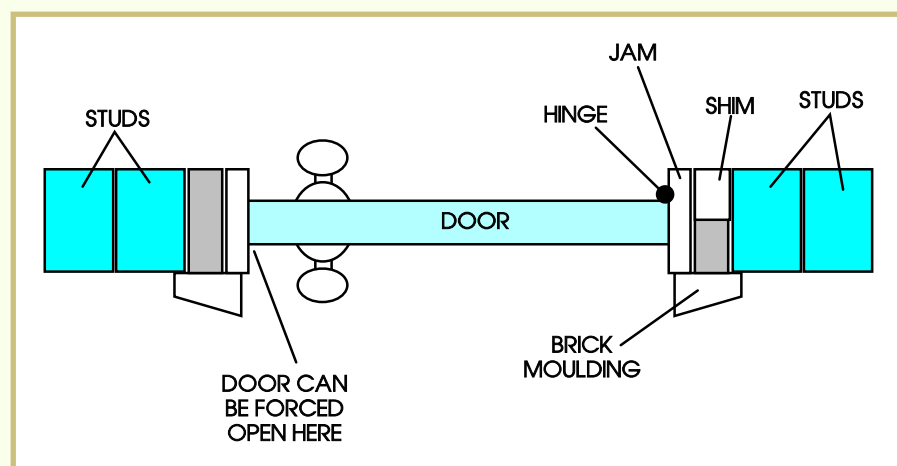
By wiggling the bar properly, you can move the latch behind the deadlocking pin and free the strike on the jamb.

You can also use many brute force methods to open doors. The outside knob assembly can be dealt a severe blow, causing it to separate from the rest of the lock. Then, you can simply insert a screwdriver and turn the latch out of the strike. Of course, the lock is destroyed when you do this.

Another brute force method is to drill the plug's center and use a slide hammer to remove the locking cylinder. Then, with the cylinder removed, insert a pair of thin-nosed, or needle-nosed, pliers into the cylinder cavity to turn the connecting bar and open the latch.

In extreme emergencies, the door can be forced open with a crowbar. Push the crowbar in between the door and the jamb, and wedge the door open. Normally, the jamb moves and the door flexes enough to open it. The movement comes from the method of mounting most doors. [Figure 45](#) shows a top view of a typical door-mounting system.

FIGURE 45—This is a top view of how a typical entry door is mounted between the studs of a house.



When a home is first studded for a door entry, a larger-than-necessary gap is left between the studs on each side of the door. This gap around the door allows the installer to insert the door into the opening and shim it until it's square and level. Normally, the door's strongest side is the hinge side, since long screws are used through the hinge and shims, finally seating in the studs. The strike side is simply shimmed and screwed into the opposite stud on the knob side of the opening. An external molding called a brick molding is often used to cover the external gap. On the inside, the gap is filled with loose insulation; an interior molding is then used to cover the gap. Since the knob side of the door and its jamb

are the weakest links, a crowbar should bend the jamb and the door enough to release it.

Again, you should use a crowbar to open a door only in extreme emergencies where damage is unimportant.

Forcing Dead Bolt Locks

Many modern doors contain a decorative latch and a dead bolt. The dead bolt is securely mounted above the latch and has a long bolt that passes into a strike box in the jamb. Forcing these doors with a crowbar won't usually allow entry, since the dead bolt protrudes well into the strike box on the jamb.

The center of the dead bolt mechanism is normally a pin tumbler cylinder. The first try on this lock should normally be to pick, impression, or read the lock. However, in an emergency, the entire cylinder can often be removed from the door, allowing you to open the bolt with a pliers or screwdriver.

A special tool is used by locksmiths to grab the cylinder. The cylinder itself is mounted through a plate on the outside door. This plate can sometimes be pried off with a screwdriver to allow better access to the cylinder. This arrangement is shown in [Figure 46](#).

In use, the tool has two hardened steel jaws used to grab the outside of the lock. These jaws are sharpened and contoured to grab the lock's outer diameter. Once the jaws are tightened, the tool is

pivoted against the door to remove the cylinder. A padded end in some tools protects the door from damage. Otherwise, use a piece of wood to protect the door from damage.

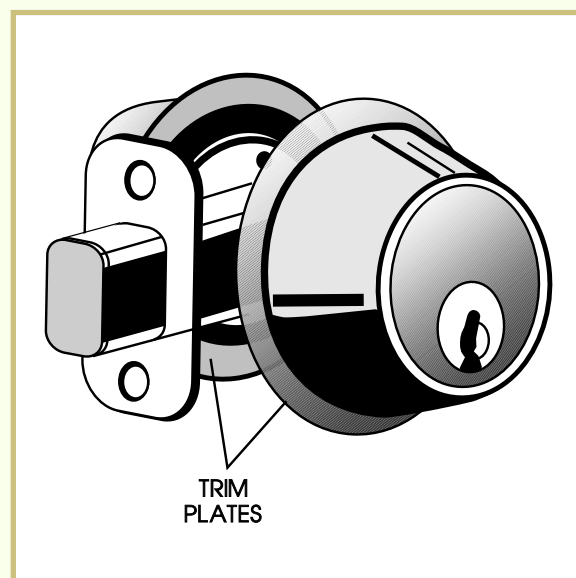


FIGURE 46—A dead bolt assembly is protected by trim plates as shown here.

Some dead bolt door locks use a hardened steel security plate behind

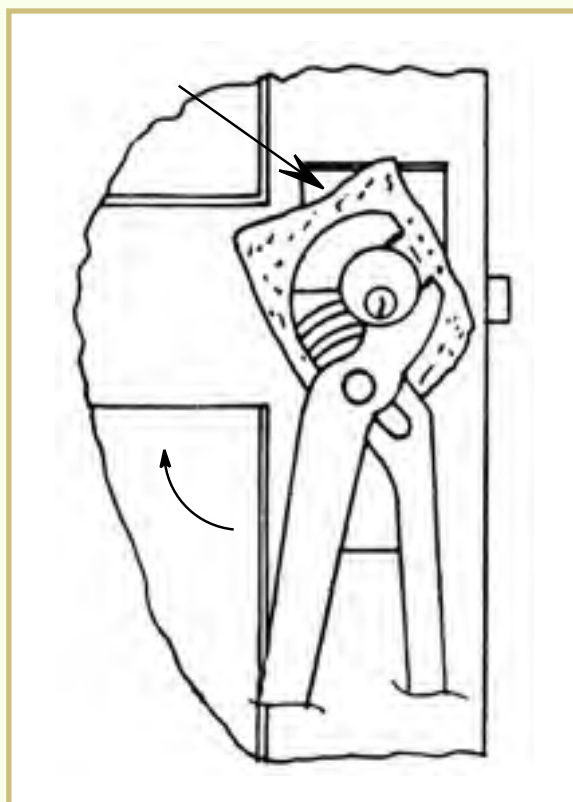
the cylinder on the outside of the door. Also, the cylinder is somewhat recessed behind the plate, rendering the tool useless. In this case, it's best to drill the lock with a tungsten-carbide drill bit and remove the plug with a slide hammer.

Forcing Rim Cylinder and Mortise Locks

Rim cylinder locks have a cylinder that's held from the inside of the door by two screws and a retaining plate. Because of this construction, a rim cylinder lock can be opened using the cylinder-gripping tool just mentioned. Simply grab the cylinder and pry it from the locking assembly.

If a cylinder-pulling tool isn't available, you can always use a pair of pliers, as shown in [Figure 47](#). Use the pliers to grab the lock and twist it until the bolt pulls back or the retaining screws break.

FIGURE 47—Pliers such as the long handled type shown here can be used to twist the lock from the door.



A soft cloth or a circle of plastic material can be cut to protect the door from damage.

This method can also be used to force mortise cylinder locks. Remember that a mortise cylinder lock is screwed into the locking mechanism and is held by a set screw. If sufficient pressure is applied, the set screw releases, allowing you to unscrew the cylinder from the lock. Of course, the cylinder

is destroyed in the process. Once the cylinder is removed, the lock can be easily opened with a screwdriver or a pair of needle-nose pliers.

A professional locksmith carries various types of locks to replace those damaged during forcing. By replacing the damaged lock, you provide two services to your customers.

1. You force open the door, allowing access to the property.
2. You replace the broken lock, providing security to the customer against unlawful entry.

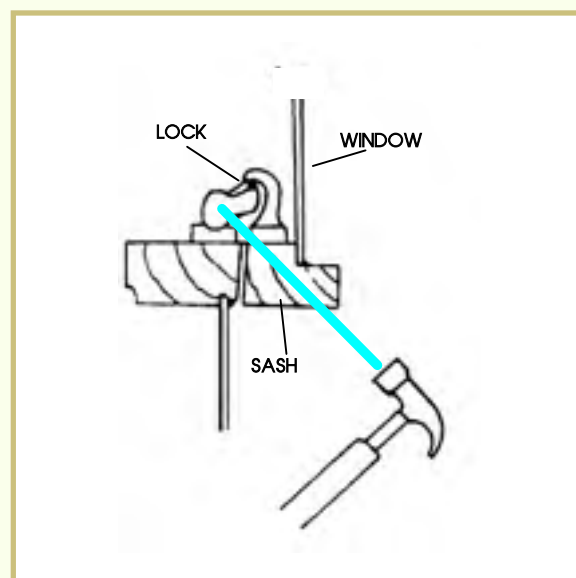
In providing this service, you help the customer and provide a greater income for your business.

Window Entry

Windows offer another opportunity for forced entry. The method of entry depends upon the style and age of the window. Older windows tend to shrink over time, which results in a loose-fitting window with a gap between its moving parts. This gap allows you to insert a stainless steel bar such as the one shown earlier (Figure 39) into the gap and trip the latch.

On newer windows, you might have to drill an access hole to reach the latch as shown in Figure 48.

FIGURE 48—An access hole can be drilled through the sash of a window to operate the latch as shown here.

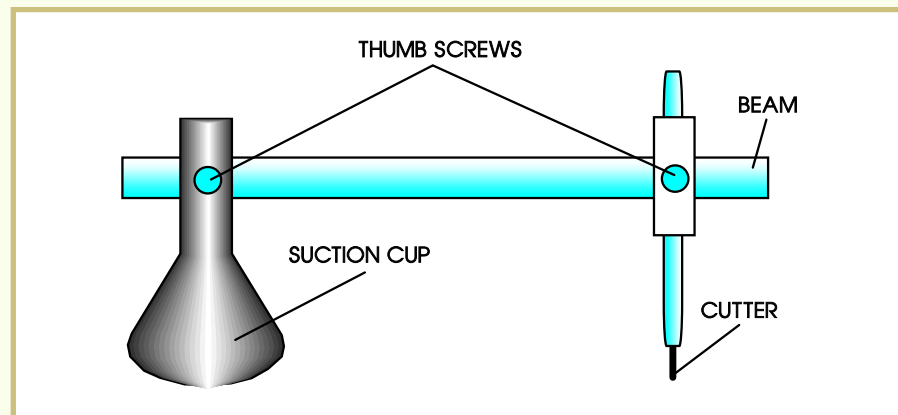


When drilling the hole, use a one-eighth inch drill bit. Place the hole in line with the latch handle. Once the hole is drilled, slip a piece of stiff wire or drill rod into the hole, until it contacts the latch handle. Then, tap the wire or rod with light blows of your hammer to open the latch.

One other method of opening a window or a door is to cut the glass pane. You can purchase a special cutter that cuts perfect circles in glass. Once this circle of glass is removed, you can stick your arm through to open the window or door.

A typical glass cutter is shown in [Figure 49](#). Use a suction cup to secure the cutter to the glass pane. The radius of the cutter is adjusted by means of the two thumbscrews. Hold the top of the cutter between your fingers as you rotate the cutter around the suction cup, using a light force against the cutter. It's a good idea to lubricate the cutting wheel with a light oil or kerosene. Once you've completed one pass of the cutter, stop. A single complete pass is all that is needed.

FIGURE 49—A glass cutter uses a suction cup and a cutter to remove a circle from glass panes.



After this pass is complete, hold the suction cup on the glass and use a small pointed object to tap on the glass in a circular pattern where the glass has been scribed by the cutter. Normally, when you've tapped around the entire scribed circle, the glass circle can be lifted out with the suction cup.

Always be careful when you're cutting glass. Use leather gloves and safety glasses to avoid injuries.

When you're cutting glass for forced entry, look for the easiest windows to cut. Obviously a single pane window is easiest, since you have to cut only one glass pane. Double- and triple-pane windows are much more difficult. If you must cut through a double- or triple-pane window, start with a fairly large diameter hole in the pane, working toward smaller holes in the inner panes.

In this section, you've seen how to force locks and how to use certain forced-entry procedures to enter a home or business. There are also many specialized tools and equipment that can be purchased for forced entry on specific locks and systems. These are available through locksmith supply houses and are listed in their catalogs.

Please keep the information in this study unit confidential. Picking, reading, impressioning, and forcing are talents only a locksmith should know and use. This knowledge should never be abused for personal advantage or profit.



Locking It Up! 4

1. When should locksmiths force a lock instead of picking, impressioning, or reading the lock?

2. Why does hitting the side of a pin tumbler lock while applying tension to the plug open some types of locks?

3. What type of tool can be used to unscrew a mortise cylinder lock from its locking mechanism?

Check your answers with those on page 65.

NOTES

Practice Exercise: Picking a Lock

Introduction

In this exercise, you'll be picking open your Papaiz padlock, a pin tumbler lock. As you've seen in this study unit, picking a lock open requires that you raise the lower pins or disks to the shearline of the lock. This action can be performed by

1. Using a feeler pick to raise each individual pin or disk to the shearline while applying a slight turning force on the plug with a tension wrench
2. Using a rake pick to lift multiple pins or disks to the shearline while using the tension wrench to apply pressure
3. Using the "bounce" method of pulling a rake pick quickly from the plug
4. Using a pick gun

In this exercise, you'll open your Papaiz lock using a feeler pick and a tension wrench.

Picking Pin Tumbler Locks

The picking of a pin tumbler lock is somewhat more difficult than a disk tumbler lock. The keyway is rather small and after the tension wrench is placed into the keyway, it's often difficult to feed the pick into the lock. It's also rather difficult to find the feel of how far up to raise each lower pin.

In general, in the picking of a pin tumbler lock, apply a slight pressure with your tension wrench. Then lift each pin gently. Find the pin with the most tension against it and pick this pin first. Continue on to the next pin with the greatest tension and pick that pin next. After each pin is picked, you can feel a gentle nudge on the tension wrench. Also, the plug will shift ever so slightly in the clockwise direction.

Picking the Papaiz Padlock

The Papaiz lock that comes with your course is an ideal training guide for picking. It's difficult because of the spool-shaped pick-resistant upper pins. Yet it's simple since you can see the action of the pins through the cutaway.

Step 1: To begin picking the Papaiz lock, place the tension wrench in the lower side of the keyway as shown in [Figure A](#). Make sure the tension wrench's end lies flat in the keyway so as not to obstruct your feeler pick.

FIGURE A—Place the tension wrench into the keyway as shown here.



Step 2: Next, holding your feeler pick between your fingers like an ink pen, place it into the keyway. Feel the tension on each pin and begin picking the pin with the greatest tension on it. This procedure is shown in [Figure B](#).

FIGURE B—To begin picking the pin tumbler lock, arrange the tools as shown here and lift the lower pins.



Step 3: Continue picking the cutaway lock until you get all of the tips of the lower pins at the shearline. Then, the tension wrench should open this lock.

Step 4: Repeat the exercise several times until you can open the lock in under one minute. Then, cover the cutaway with tape and again pick the lock without your eyes as a guide. The spool pins will make this difficult but not impossible. If you gained a good feel of the pins in the lock previously, this action should also take about one minute.

Practice Exercise Questions

Now, let's see how well you've learned the basics of picking a pin tumbler lock. Check your understanding of this exercise by answering the following questions. Writing the answers to these questions will help you review what you've studied so far. **DO NOT** send the answers to the school for grading.

1. What makes picking a lock with pick resistant pins so difficult?

2. When lifting the pins or disks within the plug of a lock with a feeler pick, which pin or disk should you select first?

3. Why should a feeler pick be held like an ink pen?

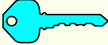
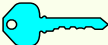
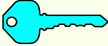



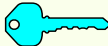
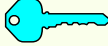
Check your answers with those on page 67.

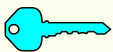
THE KEY TO SUCCESS

Well, you've come to the end of another information-packed study unit. Think about all you've learned so far! You now know how to open a variety of locks without using any key at all. And you've completed a valuable hands-on exercise with your Papaiz padlock. With a little more practice, you'll be ready to open locks without keys on all types of locks.

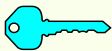
Now, when you're ready, read through the following section of the text, Key Points to Remember. This is a review section designed to highlight all the most important facts you learned in this study unit. When you've reviewed the material and feel you know it well, move on to the practical exercises and your examination. Good Luck!

KEY POINTS TO REMEMBER

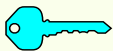
-  A wide selection of picks are available for your use.
-  The half-round and round feeler picks are used to lift individual wafers, disks, or pins. Rake picks can be used to rake the internal components of plugs. Rake picks can also be used in "bounce" procedures for picking disk, pin tumbler, and double-bitted locks.
-  Tension wrenches are used to apply light turning pressure on plugs. Special tension wrenches can be purchased or made for double-bitted and lever tumbler locks.
-  When picking a lock, hold the pick in your hand like a pen.
-  Combination locks can be opened by listening to the clicks created as the locking pawl hits the gates on the tumbler.
-  Impressioning is a practice of producing impression marks on a key blank where cuts should be made.
-  When impressioning a warded lock, you'll need to start with the cover ward cut and then impression the internal case ward cuts.
-  When impressioning lever tumbler locks, the first cut is the throat cut; then you continue with the saddle cuts.



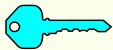
When impressing a pin tumbler lock, look for the small impression marks left in the key after it's twisted and raised and lowered in the plug.



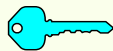
Reading a lock ultimately gives you the key codes that can be used to cut a key for that lock.



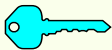
A reading tool is used to lift all wafers, disks, or pins to judge their required cuts on a key blank.



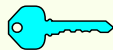
Reading charts are a great aid when you begin reading locks.



Forcing a lock, window, or door is normally a last resort for most locksmiths.



Some padlocks can be forced with a blow to the shell or shackle.



A home or business can be entered through a door, window, vent, or other open area.

Do You Know Now . . .

Below are the answers to the questions asked at the beginning of this study unit.

What is a *tension wrench*?

A tension wrench is a spring steel tool used to place light tension on the plug.

How is a rake pick used?

A rake pick is used by inserting it into the lock and lifting the wafers, disks, and pins. A rake pick can also be used to bounce the internal components of the plug.

What is a *pin impression*?

A pin impression is a fine line or mark left on a blank key by the lower pins of a pin tumbler lock.

Locking It Up! Answers

1

1. At the tip of the key
2. Because the internal locking mechanism is simple, and you can easily see into the keyway
3. It's shaped like the wafers, but has a key slot cut into the plate.

2

1. Smoke it over a candle or use a blank marking pen.
2. The case ward or throat cut
3. The pins leave impression marks, since you twist the key in the plug while lifting it up and down.

3

1. A reading tool doesn't have a shaped end for lifting disks, levers, or pins. Instead, its end is straight or slightly bent.
2. The reading tool is fully inserted into the lock. As it's withdrawn, you listen for the clicks of the disks or pins reseating in the plug.
3. To cut the key using key codes on a code-cutting machine

4

1. Most locksmiths force a lock only in an emergency.
2. Hitting the lock while pressure is applied to the plug can cause the upper pins to leave the plug, allowing the plug to turn.
3. A large pair of pliers

NOTES

Practice Exercise Answers

1. The pick resistant pins tend to bind at the shearline, making the tension provided by the tension wrench very critical.
2. You should always try picking the pin or disk with the most tension against it. This will deliver a greater feel and the most motion of the plug after the pin or disk has been picked.
3. By holding the feeler pick like an ink pen, you get the greatest feel and the most accuracy in lifting the pins or disks.

NOTES

Important Instructions for Practical Exercises 03180401 and 03180501

In addition to your regular examination for Study Unit 7, there are two Practical Exercises with this unit. The first exercise (03180401) is *Shimming Open and Rekeying the Mortise Cylinder*. The second practical exercise (03180501) is *Impressioning a Key for a Mortise Cylinder*.

As with your previous exercises, these will be sent to one of our locksmithing consultants for evaluation and grading. This expert evaluation may take several weeks. Please be patient. To expedite the grading and return of your exercises, *please follow the directions carefully*.

Specific instructions for each exercise begin on page 73 and continue through page 82. Read these instructions carefully before beginning the exercises. After completing both practical exercises, remove the practical exercise **answer sheets** on pages 71 and 72 from your binder and fill out the top portion. Answer the appropriate questions on the answer sheet and include it with your submission.

Be sure to include *all* of the following:

- Mortise cylinder re-pinned to the proper key code
- Impressioned key to fit and operate the mortise cylinder
- Properly completed answer sheets for both exercises

Do *not* include any other examinations with your exercises.

Submit *both* of your completed exercises together.

Failure to follow instructions may affect your grade for these projects. You must send these exercises in the special shipping box (PM0008) provided. Secure your key and lock in the shipping container. Once the carton is sealed, it cannot be opened without tearing it. Do not seal it until you have placed all items in it. We recommend that you put your *name and return address* on the carton. Our locksmithing consultants will evaluate your work and return your grades as soon as possible. Again, please be patient.

NOTES

Professional Locksmith

Practical Exercise Answer Sheet 03180401

Name: Duwane Higginbotham

Grade 03180401: _____

Please Print
Address: 17060 89th rd

City: McAlpin | FL | 32062
State Zip

Phone Number: 386-364-8001

Student Number: 20516951

Check here if new address

Exercise Number

03180401

Practical Exercise: Shimming Open and Rekeying the Mortise Cylinder

This exercise is based on shimming open and rekeying the Mortise cylinder. You'll be graded in the following areas:

Part I: Operation: The lock must operate smoothly.

Appearance: There must not be any damage to the lock surface or mechanism.
(Operation and appearance are worth a maximum of 75 points.)

Part II: Answer the following questions in the space provided on this answer sheet.
(These are worth up to five points each.)

1. Why must the plug be turned slightly before removing it from the cylinder?
2. What type of lock can be opened using the shimming method?
3. Which pin must be picked first when using the shimming method?
4. Which end of the plug follower should be used to push the plug out of the cylinder?
5. When properly shimmed, what does the shim separate in the lock?

1 so the top pins do not fall into bottom while removing.

2 a pin tumbler lock 4 the slotted end

3 the rearmost pin first

5 the top and bottom pins

Exercise Number

03180501

Practical Exercise: Impressioning a Key for a Mortise Cylinder

This exercise is based on the *impressioning* of a key for a mortise cylinder. Please note that this exercise consists of two parts—the impressioning of the key to fit the mortise cylinder and the questions asked below on this answer sheet.

Grade 03180501:

You will be graded in these areas:

Part I: Operation: Your mortise cylinder must operate smoothly and reliably with your impressioned key.

Appearance: Your key must be free of burrs and rough areas.
(Operation and appearance are worth a maximum of 80 points.)

Part II: Answer the following questions in the space provided on this answer sheet.
(These are worth up to five points each.)

1. How do you first prepare a key for impressioning? buff the blade and use a marker
2. What will happen if you do not bind the pins in place by twisting the key and plug while impressioning? you will not get marks to go by
3. What are two “tricks of the trade” that you can employ to better see the impressioning marks? buff the blade and use a magic marker
4. How deep should you file the key on each impressioning session? just a few strokes

Practical Exercise: Shimmiing Open and Rekeying the Mortise Cylinder

Introduction

As you've seen, there are many methods of opening a lock without a key. This exercise will cover the use of a piece of shim stock to open a lock.

The shimmiing method will work only for pin tumbler locks. In using the shimmiing method, a piece of shim stock is inserted between the plug and the cylinder or shell. A gentle forward force is placed on the shim stock toward the front of the plug. Then a pick is inserted into the keyway and the rear most lower pin is raised to the shearline. Once raised the proper amount, the shim stock will fit in between the lower and upper pins and separate them at the shearline. The shim stock will advance forward in the plug until it reaches the next upper pin.

Each pin is then lifted in sequential order from the rear of the plug to the front of the plug until the shim stock reaches the front of the plug. Once the shim stock has reached the front of the plug, you can use a tension wrench or a blank key to spin the plug.

Your Tools

The tools that you'll need to work on a mortise lock will fall into two categories. The first category will include a screwdriver, an Allen wrench, and a pair of pliers. These tools will be used to remove the mortise cylinder from the locking mechanism.

The second category of tools consists of shims, a pick, and a key blank or other key that won't operate the mortise lock. The final items you'll need are a pinning kit to repin the plug of the lock once the plug is shimmied and removed from the shell or cylinder.

The mortise cylinder that you will use for this exercise has a Schlage keyway. However, you will still use the pins from

your LAB brand pinning kit for Kwik-Set locks and you can also use your Kwik-Set key gauge to measure your progress.

For this exercise, you've received a typical mortise cylinder, a key, and a set of shims. These shims are 0.0015 inch in thickness and are preformed to match the shape of the plug.

[Figure F](#) shows a few preformed shims.

FIGURE F—Preformed shims are shown here.



Instructions

Step 1: Begin this exercise by trying your key in the mortise cylinder. You'll notice that this key does not operate the lock. Two or more of the lower pin combinations must be the wrong combination for the key in your possession.

Step 2: Next, remove the retainer plate at the rear of the lock. This action is shown in [Figure G](#).

FIGURE G—Remove the retainer plate as shown here.



Two small screws are used to hold the retainer plate to the plug. Select a proper fitting screwdriver, remove these screws, and place them and the retaining plate in a tray or other container.

Step 3: With the retainer plate removed, try to push forward on the plug. Notice that it won't move forward or turn since the upper pins are pushed down into the plug below the shearline. To open this lock, you must raise the upper pins above the shearline.

Step 4: To continue with the shimming procedure, select a single shim. Place the shim in the small gap between the top of the plug and the cylinder. Don't force it! Start with one edge of the shim as shown in [Figure H](#). Work this edge into the gap between the plug and the cylinder, and then press gently forward to seat the shim against the rear upper pin.

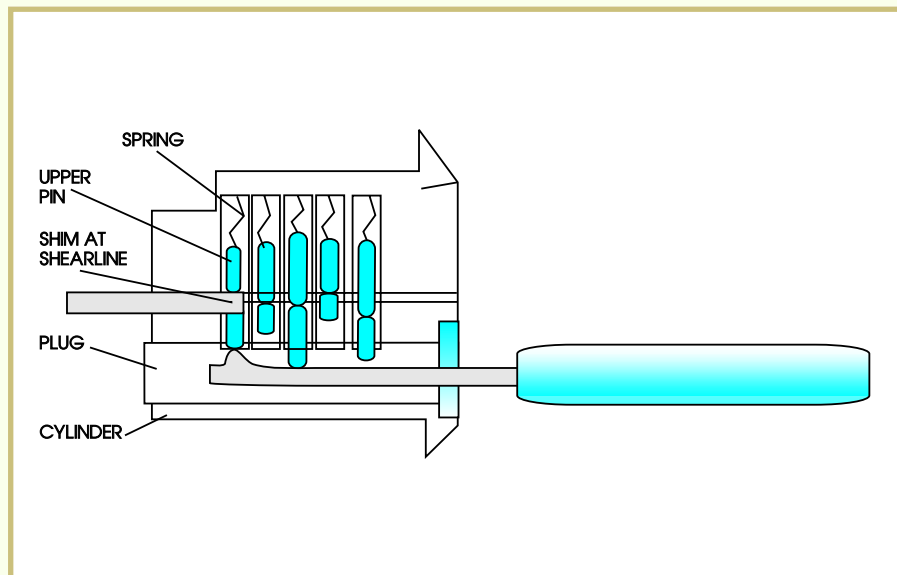
FIGURE H—Begin shimming as shown here.



Step 5: With the shim in place, insert the feeler pick into the keyway of the mortise lock. Use the feeler pick just as if you were attempting to pick the lock with the feeler pick and tension wrench. However, go all the way back to the rear of the plug and lift the last lower pin.

Step 6: As you're lifting this lower pin, apply a gentle forward pressure against the shim stock. Once the lower pin is raised so that the top of the lower pin is at the shearline, you should feel the shim slide forward and strike the next upper pin on the plug. You'll have shimmed your first pin. This action is shown in [Figure I](#).

FIGURE I—*Shimming a pin*



Step 7: With the shim seated against the second upper pin from the rear of the plug, pull back gently on the feeler pick until it strikes the lower pin. Now, carefully raise this pin with your pick until the shim slides gently forward. Don't apply too much force on the shim stock and bend it. Once bent, the shim stock will need to be removed from the lock and replaced.

Step 8: Once the second upper pin is separated with the shim stock, continue raising the lower pins and inserting the shim stock until all of the pins have been picked.

Step 9: At this time, the *plug should be turned* slightly with the tip of a key blank or a tension wrench. Remember to maintain pressure on the front of the plug to keep it from falling from the cylinder. After turning the plug, gently pull on the shim material and remove it from the lock.

Step 10: The next step is to remove the plug from the lock. Here you'll use the plug follower to push the plug out of the cylinder. This is shown in [Figure J](#). The slotted end of the plug follower must be used against the plug. Remember the plug and follower must be turned slightly to prevent the top pins and springs from dropping down and becoming wedged in the gap between the rear of the plug and the follower.

FIGURE J—Use a plug follower to push the plug out of the cylinder.



Step 11: Empty the lower pins from the plug. You are now ready to re-pin your lock. The pin combination that you must use is 31512. Select the proper pins from your *pinning kit* and place them in your plug in the proper order. You may want to measure the pins to be sure you are using the correct size. The proper length of each is marked in your kit. You can use a caliper, micrometer, or simply sort the six different sizes in your kit.

Step 12: When you're sure that you have the correct pins in the proper order, reinsert the plug into the cylinder. The plug must be properly aligned with the groove in the plug follower and the plug must be turned slightly or the pins and springs may jam the lock. If this occurs *you must completely disassemble the lock and rebuild it.*

Step 13: Now you can reattach the retainer plate to the back of the plug with the two small screws. Remember that the plug can still fall out until the retainer plate is securely reattached.

Remember, the shimming method of opening a lock will only work with pin tumbler locks. Disk, wafer, or lever tumbler locks can't be opened by shimming.

Now that your lock is reassembled, make sure that the answer sheet on [page 71](#) is complete. Now you can continue to the next exercise: *Impressioning a Key for a Mortise Cylinder.*

NOTES

Practical Exercise: Impressioning a Key for a Mortise Cylinder

Introduction

This exercise will be the most difficult of all of the exercises you'll perform. Impressioning a key is no easy task. It takes great patience, vision, and a slow, steady file to make an impressioned key for a lock.

Impressioning can be performed using many methods. All of these methods deal with how the blank key is prepared. For example, some locksmiths that are experts at impressioning won't prepare the blank at all. Their great practice has resulted in a trained eye for impression marks and a skilled hand for cutting these marks.

Another method is to use a black marker to color the top edge of the blank's blade. When this blade is placed into the plug and twisted, the lower pins will leave clear marks in the blank. This is the method we'll use in this exercise. Using a black marker, however, has one major drawback. When impressioning with black marker, the marker will leave a deposit inside of the plug on the lower pins. This deposit can cause the lock to malfunction if it's not properly cleaned out of the lock after impressioning is complete.

Selecting the Blank

If a number appears on the lock, it's a simple matter to select a blank for a lock. Look in the code book or blank catalog for an exact blank for the lock you want to impression. If no number appears on the lock, you'll have to select a matching blank from your key board or inventory.

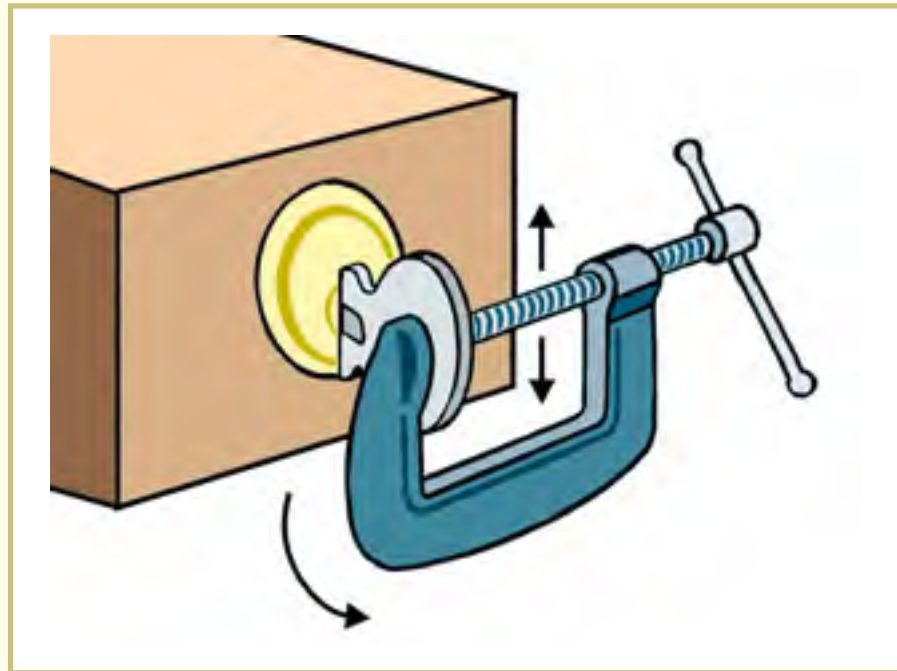
In this exercise, you will be using an SC1 blank to fit the Schlage style of keyway.

Instructions

Step 1: Once you have selected the correct blank, clean it to remove all dirt and oil. If the edge of the blade is very rough, you may want to polish it with *very fine* emery paper to better see the impressed marks.

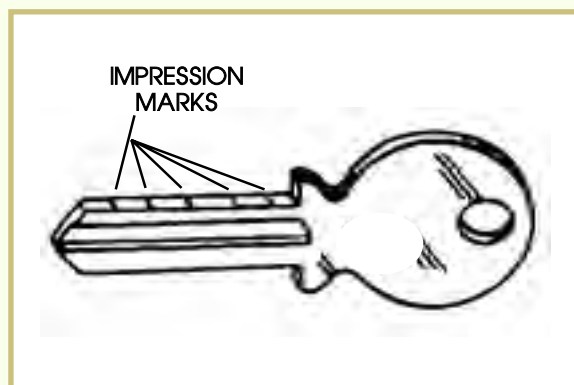
Step 2: Secure your lock in a vise. Attach a C-clamp or hold on to your key blank with vise grip type pliers. Insert your key blank into the lock. Twist the blank and plug to one side or the other. This is very important! This will *bind* the bottom pins between the plug and the cylinder. Now, move the blank in a vigorous up and down motion against the pins to make the indentations or impressions.

FIGURE C—With the lock in your vise, twist the key and move it up and down to create impression marks.



Step 3: Remove the key and examine the edge of the blade under a bright light. Rotate the key at an angle to help you see the impressions better. Seeing the impressions is often said to be the most difficult part of impressioning a key blank, so look very carefully. If you prepared the edge properly and moved the key correctly, you will see five slight impressions on the edge of the blade. If you didn't make impressions, re-read the instructions and try again.

FIGURE D—The impression marks will appear as small scratch marks on the blank.



Step 4: Use your round file to make a shallow cut at each impression mark. Make sure that the bottom of your cut is very smooth or you may not be able to see your next impression marks. You may want to polish the cut with very fine emery paper.

FIGURE E—Using a small round file, begin cutting at the impression marks as shown here.



Step 5: Re-insert the blank in the lock and re-impression your key. Some locksmiths work on only one cut at a time. They repeat the impressioning process and deepening one cut until the pin no longer makes an impression at that location.

Step 6: Repeat this process with each of the pins until they no longer make impressions on the edge of the blade. Note that if you make your file cuts straight down into the blade, the pins will not be able to ride over the cut as you attempt to insert or withdraw the key. This will lock the key in place. So, be sure to file an angle at each cut so that the key will not become jammed in the lock. You have a selection of files to use.

Step 7: Inspect your blank for burrs and rough edges. Make the appropriate corrections, if necessary. Your key should now be capable of operating the lock smoothly and reliably.

Your impressioned key should now fit and smoothly operate your mortise cylinder that you have re-pinned to 31512. If your key does work smoothly and reliably—Congratulations! You're on your way to mastering one of the most difficult locksmithing skills. You can be justifiably proud of your accomplishment.

If your key doesn't work, don't be discouraged. This skill often takes a lot of practice and patience to develop. Review the study unit and the exercise instructions on impressioning. Figure out where you went wrong and use your other blank to complete this exercise.

After you've completed the Impressioning exercise and the appropriate [answer sheet](#), refer to [page 69](#) for instructions for submitting them for grading.

THOMSON
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Opening Locks Without Keys

EXAMINATION NUMBER:

03100700

Whichever method you use in submitting your exam answers to the school, you must use the number above.

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When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1-20: Select the one best answer to each question.

1. Which one of the following picks or tools moves the pins of a pin tumbler lock most violently when picking?

A. Rake pick

B. Picking gun

C. Diamond pick

D. Circular pick

2. What type of file produces the best results with a blank key being impressioned for a pin tumbler lock?

A. Flat

B. Round

C. Square

D. Triangular

3. Which of the following locksmith activities usually requires the most practice to learn?
- A. Picking a lever tumbler lock
 - B. Impressioning a pin tumbler lock**
 - C. Knowing when to pick a lock
 - D. Forcing a door open without damage
4. How can you pull the plug from a lock after it has been drilled?
- A. Use a tension wrench to spin the plug and then remove it.
 - B. Use a slide hammer to forcibly pull the plug from the shell.**
 - C. Grab the plug with needle-nosed pliers.
 - D. Pry the plug from the lock with a screwdriver.
5. Before impressioning a pin tumbler lock, which one of the following actions should be performed?
- A. Clean the blank with a lint-free cloth.**
 - B. Form shim stock around a screwdriver.
 - C. Twist the key violently in the plug.
 - D. Prepare a reading chart.
6. What type of pick or tool would you most often use to raise an individual pin to the shearline of a plug?
- A. Picking gun
 - B. Reading tool
 - C. Rake pick
 - D. Feeler pick**
7. What type of pick should be used as a first-try pick on a disk tumbler lock?
- A. Half-round feeler
 - B. Round feeler
 - C. Half-rake
 - D. Rake**
8. What's the primary reason a brass bar is used while you're applying a blow to the shackle or shell when forcing open the shackle?
- A. Brass tends to spread the blow evenly over the shackle.**
 - B. Brass won't leave residue on the shell or shackle.
 - C. Brass prevents the shackle from being broken.
 - D. Brass causes the blow to be intensified at the point of contact.
9. What tool should be used to turn the plug after the disks or pins have been picked?
- A. Tension wrench**
 - B. Rake pick
 - C. Reading tool
 - D. Extraction tool

10. One method of opening desks and file cabinets without destroying their locks is
- A. using pliers to twist the lock.
 - B. using a cylinder-pulling tool.
 - C. using a jimmy bar.
 - D. lowering the bolt with a specially shaped pick.
11. What holds the end plates and the wafers together inside the plug of a double-bitted cam lock?
- A. Z-shaped spring steel clamps
 - B. Grooves in the plug
 - C. A special shell cavity
 - D. Spring steel pins
12. How can you increase the sound made by a combination lock as the locking pawl passes over the gates of the tumblers?
- A. Use a locksmith's otoscope.
 - B. Tap on the lock's dial.
 - C. Apply upward pressure on the shackle.
 - D. Turn the dial quickly clockwise, then counterclockwise.
13. What feature of some lever tumbler lock's construction makes these types of locks easy to read?
- A. The large keyway allows you to see all of the tumblers.
 - B. The levers are always color coded for easy reading.
 - C. The tumblers have saddles of different width.
 - D. The tumblers have tapered gates that allow the lever to be easily pushed into place.
14. Rapidly pulling a rake pick from a plug of a lock while applying light turning pressure with the tension wrench is termed as what kind of picking method?
- A. Scrape
 - B. Bounce
 - C. Dance
 - D. Comb
15. What's the easiest method of opening a warded padlock?
- A. Use a bent wire to offset the ward.
 - B. Use a pick key to open the lock.
 - C. Use a round feeler around the ward.
 - D. Use two tension wrenches to pressure the bolt and lift the lever.
16. The rapping method of opening a padlock involves
- A. hitting the shackle of the lock with a hammer.
 - B. tapping on the bottom side of the plug to loosen the disks or pins.
 - C. using a soft-faced hammer to strike the side of the padlock that contains the springs and upper pins.
 - D. using a thick tension wrench and a hammer to force the plug, breaking the pins or disks.

17. What type of pins can be used in a pin tumbler lock to help defeat picking attempts?

- A. Oval
- B. Radial
- C. Convex
- D. Spool

18. A reading tool is used for a disk tumbler lock involving which one of the following methods?

- A. A reading tool is inserted after the tension wrench to see how far the disks must rise to reach the shearline.
- B. A reading tool raises the disks. You judge their size by the amount the disks drop when released.
- C. A reading tool has a calibrated end width of 0.015 inches to be used in comparing disk slots.
- D. The reading tool is used to even out the disks in the lock for comparative height judgement.

19. When picking a pin tumbler lock with a feeler pick, what pin or pins should you begin picking first?

- A. The center pin
- B. The last pin and work towards the front
- C. The longest pins
- D. The shortest pins

20. What type of file should be used to make cuts in a flat key for a lever tumbler lock?

- A. Triangular
- B. Square
- C. Round
- D. Half-round

COMING ATTRACTIONS

Well, you've completed your study of how to open locks without keys. You should now be familiar with the various methods of picking locks and forcing locks open. Remember, though, to discuss these procedures only with other trained locksmiths. Study Unit 8 covers home, business, and retail security and how they are related to the locksmithing profession. You'll learn about crimes against property and how you can help your customers prevent their property from being targeted by criminals. See you there!

Professional Locksmith

Study Unit 8

Home and Business Security

Preview

This study unit is designed to give you an overview of the entire security field of which you're a part. As you'll see in this unit, locksmithing involves more than locks. As a locksmith you must be familiar with who commits crimes, how crimes are committed, and how to prevent them. This study unit will teach you the basics of home and business security. You'll learn of the many threats to both the workplace and the home. You'll also learn the costs of such crimes to us all. Working with other security professionals, you'll recognize security weaknesses and what to do about making both home and business more secure.

When you complete this unit, you'll be able to

- Define the different types of crime
- Interpret crime statistics
- Discuss home security and some of the devices and techniques used to provide it
- Discuss retail security and some of the devices and techniques used to provide it
- Discuss industrial security and some of the devices and techniques used to provide it
- Define the term *target hardening*
- Name the six most frequent groups of shoplifters
- Define the term *retail shrinkage*
- Name four common precautions against burglary
- Define the term *access control*
- Explain how to achieve access control

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Home and Business Security

Do You Know. . .

What is *target hardening*?

What is *access control*?

What is *risk analysis*?

In these pages you'll find the answers to these and many more questions about home and business security.

THE GROWING CRIME PROBLEM

Basic Crime Definitions

The profession of locksmithing has a long tradition. For over 4,000 years, people have been making and using locks for protection and security against criminals and thieves. As a locksmith, you'll be part of the fight against those who still try to break the law today.

You may remember the old saying, "Know your enemy." Because you'll be working to prevent crime, it's important to know more about it. In this lesson you'll learn some of the basics of security in the home and in the business world. Let's start by looking at a definition of crime.

A *crime* is an action or an omission that's forbidden by law and punishable by the government (local, state, or national). A *criminal omission* is something that wasn't done that should have been. Not cleaning up hazardous wastes is an example of criminal omission. Not conforming to fire codes is another criminal omission (especially if a building catches fire and employees are hurt or killed because of the fire) (Figure 1).

FIGURE 1—Because the bakery owner violated fire codes, he is guilty of criminal omission.



These actions or crimes are generally grouped into three categories—felonies, misdemeanors, and infractions. Felonies are the most serious of the three. A *felony* is normally defined as a criminal act that may be pun-

ishable by imprisonment for more than one year, or, in some states, by the death penalty. Murder and forgery are two examples of felonies. *Misdemeanors* are somewhat less serious crimes which are usually punishable by fines and/or short-term jail sentences, normally for a period of one year or less.

An *infraction* of the law is simply a violation of a city or county ordinance. Although the action is illegal, it isn't necessarily criminal. For example, simple speeding is an infraction of the law. Parking violations are infractions. Hunting out of season or fishing without a license are also infractions. These offenses are usually punishable by fines.

The FBI Uniform Crime Report

Each year, the U. S. Department of Justice produces the *FBI Uniform Crime Report*, a series of reports and statistics about crime. To understand how important your job as a locksmith is, you should be aware of this report. It gives an overview of crime across the nation based on statistics contributed by state and local law enforcement agencies. Since it's a yearly report, you can see the changes that occur in the national and international crime picture. Statistics concerning crime in Canada and other industrialized nations are similarly tracked by the appropriate agencies. Exploring and anticipating trends in crime can make you a better-informed locksmith and businessperson.

National Crime Index Statistics

Another reference for an informed locksmith is the *National Crime Index*, which records statistics on crimes of violence and crimes against property. The statistics are staggering. In

1988, one *Crime Index* offense was committed every two seconds. One violent crime was committed every 20 seconds, and one property crime was committed every three seconds (Figure 2).

In this same year, a total of 13.9 million *Crime Index* offenses were reported. Violent crimes (murder and non-negligent manslaughter, rape, robbery, and aggravated assault) accounted for 11 percent of this total. Crimes against property (burglary, larceny-theft, motor vehicle theft, and arson) ac-

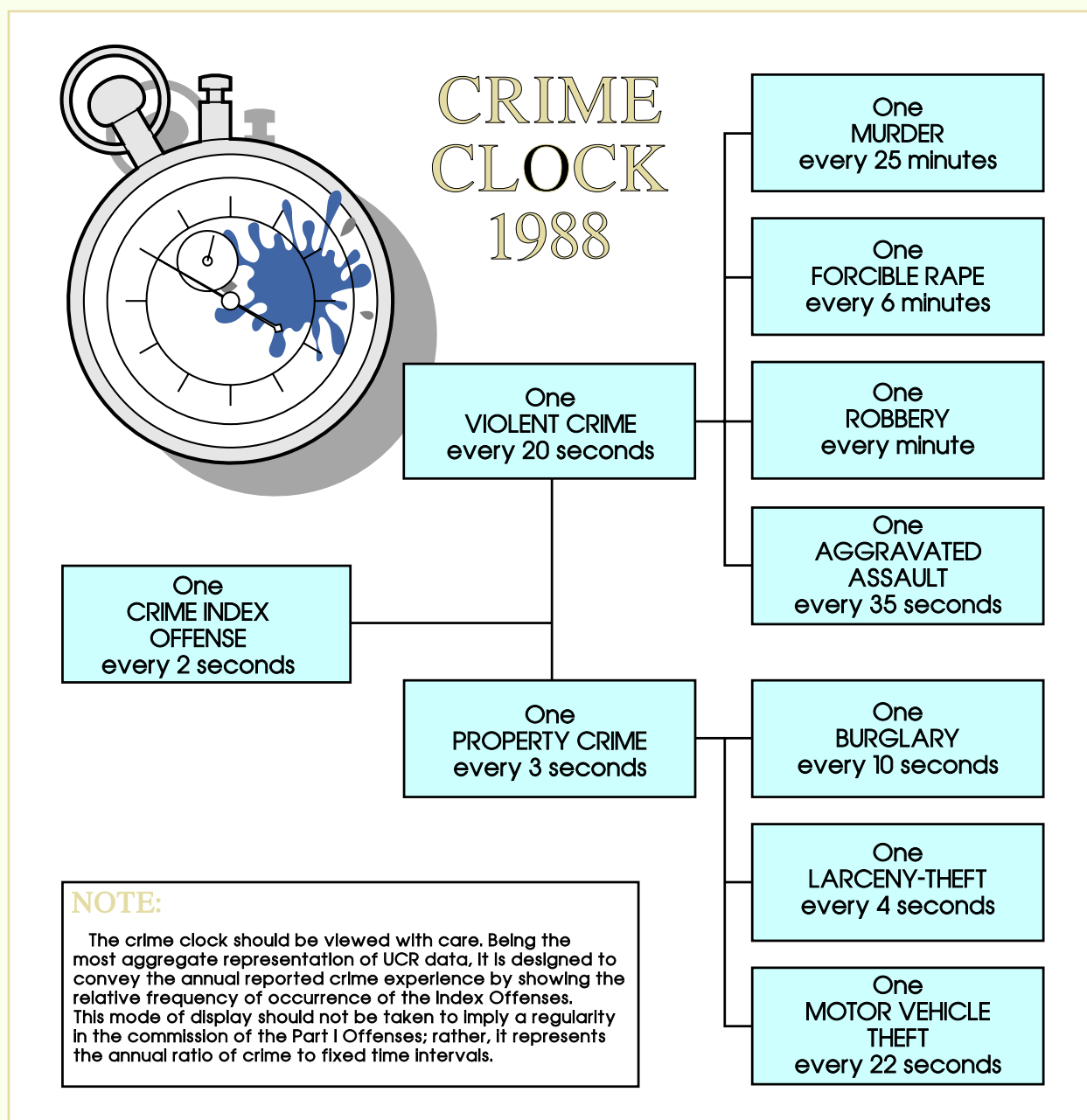


FIGURE 2—The Crime Clock in 1988

counted for the remaining 89 percent. Your job will be to help in the fight against property crimes.

A review of the *Uniform Crime Report* shows that the reports of violent and property crimes have increased every year. In addition, the crime rate (the number of crimes reported per 100,000 inhabitants) has also increased dramatically. From 1984 to 1988, the crime rate increased 12.6 percent. During that period, the crime rate for violent crimes rose 18.2 percent and the rate for crimes against property rose 11.9 percent. These statistics may seem discouraging. But they also demonstrate that there's plenty of work for a skilled locksmith who can offer the right services and advice.

What these statistics also point out is that many criminals are not arrested; many crimes—especially those dealing with property—are not solved in the same year they are committed (and may never be solved). Such a realization can be very discouraging. But it means that you can offer help where help is needed most. By installing devices to cut down this rate of theft, you can be secure in knowing that you're doing your part in the war against crime.

RECENT TRENDS AND CHARACTERISTICS OF CRIMES AGAINST PROPERTY

As we just mentioned, crimes against property constitute the greatest number of crimes recorded in the *Crime Index*. Since, as a locksmith, you'll be working to prevent crimes against property, it's important to understand the nature of such crimes. Let's begin with a common danger: burglary.

Burglary

Burglary is the unlawful entry of a structure in order to commit a felony or theft. The felony or theft does not actually have to be completed in order for someone to be arrested for burglary. Likewise, the use of force to gain entry isn't a necessary requirement for the crime to be classified as a burglary.

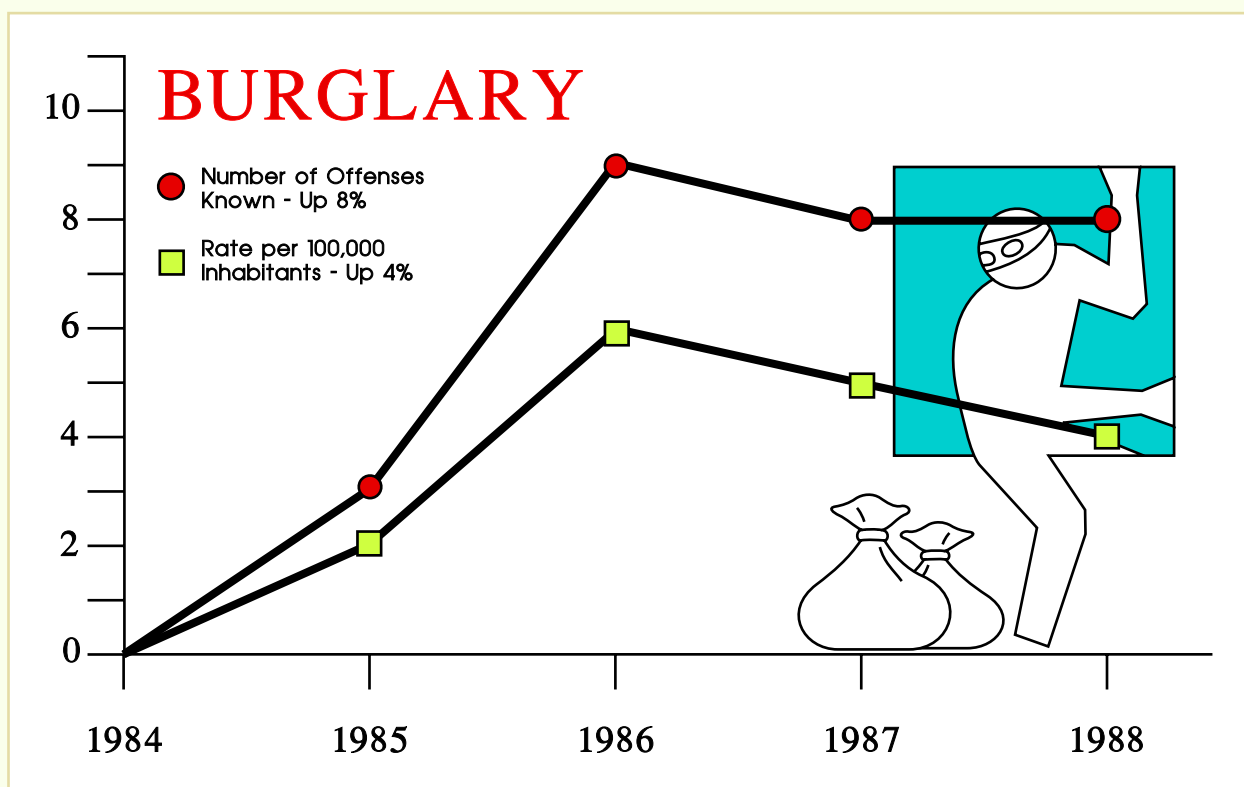


FIGURE 3—A Comparison of the Number and Rate of Burglaries from 1984 to 1988

The *Crime Index* lists three types of burglaries under this category: (1) forcible-entry, (2) unlawful entry where no force is used, and (3) attempted forcible entry.

During 1988, there were over three million reported burglaries. This total represents 23 percent of all *Crime Index* crimes and 26 percent of all property crimes. Between 1984 and 1988 there was a marked increase in the number and rate of burglaries (Figure 3).

There are recent trends in residential burglaries (both those at night and during the day) and non-residential burglaries. Residential burglaries occurring at night were up one percent since 1985, while day rates show no change since 1984. Non-residential burglaries occurring during the day were up 25 percent since 1984, while those at night were down 2 percent.

The statistics also show that burglary victims lost an estimated \$3.3 billion throughout the year. The average loss for residential burglaries (which accounted for two out of every three burglaries) was \$1,037. The average loss for non-residential burglaries was \$967. Seventy percent of the reported burglaries involved forcible entry.

Forty-two percent of all burglaries occurred in the South. The least number (16 percent) occurred in the Northeast. As expected, the crime rate for burglaries was higher in cities than in suburbs or in rural areas.

Typical Burglars

Who is a typical burglar? We know that “he” (92 percent are male) is usually young (67 percent are between 15 and 19). He may range in age from preteen to middle age, but will probably be between 18 and 30. Youngsters tend to steal because of peer pressure and to take small amounts of money for games, alcohol, or soft drugs. Chances are they’ll limit their thefts to familiar neighborhoods. They steal small objects that are then easily sold.

Teens and young adults generally have more nerve. They’ll drive to neighborhoods where they aren’t known and “cruise,” looking for easy targets. They too tend to steal to support a drug habit (usually hard drugs). They’re hit-and-run artists, and are still considered amateurs.

Adults in their 20s and 30s are often more skilled and cautious in burglary. They have turned it into a profession of sorts. They work in pairs; they carefully look over the target and they study the family’s schedule. More experienced burglars have a cover, or excuse, if someone questions their presence in the neighborhood. These thieves will take almost anything of value.

The older burglar tends to be a professional thief, the “cat burglar” or “second story man” we read about, who limits his activities to expensive homes in upscale neighborhoods. Older burglars steal only the most valuable items; one burglary is usually very profitable.

As a rule, burglars don’t intend violence against the occupants of a building or home when they break in. They may use force to get in, but they want one thing: valuables. However, your clients shouldn’t be lulled into peace of mind. A trapped burglar can be dangerous. Sixty-seven percent of burglars arrested are in the 15–19 age group. Ninety-two percent are male; 67 percent are white; and 31 percent are black.

The most frequent month for burglaries is August; the least frequent month is April. It's clear from all these statistics that there's a great need for locksmiths and all other security professionals to work together to make both the home and business less vulnerable to burglary.

Larceny-Theft

Larceny-theft is the unlawful and nonviolent taking, carrying, leading, or riding away of property. It is a crime against property, rather than against a person. It includes crimes such as shoplifting, pickpocketing, purse-snatching, thefts from motor vehicles, thefts of motor vehicle parts and accessories, bicycle thefts, and so on; however, no use of force, violence, or fraud occurs. This category does not include embezzlement, con games, forgery, or the writing of worthless checks. The *Uniform Crime Report* listed over seven million acts of larceny-theft in 1988, with both the number and rate of offenses significantly higher than just four years earlier (Figure 4). That number represents 55 percent of the *Crime Index* total.

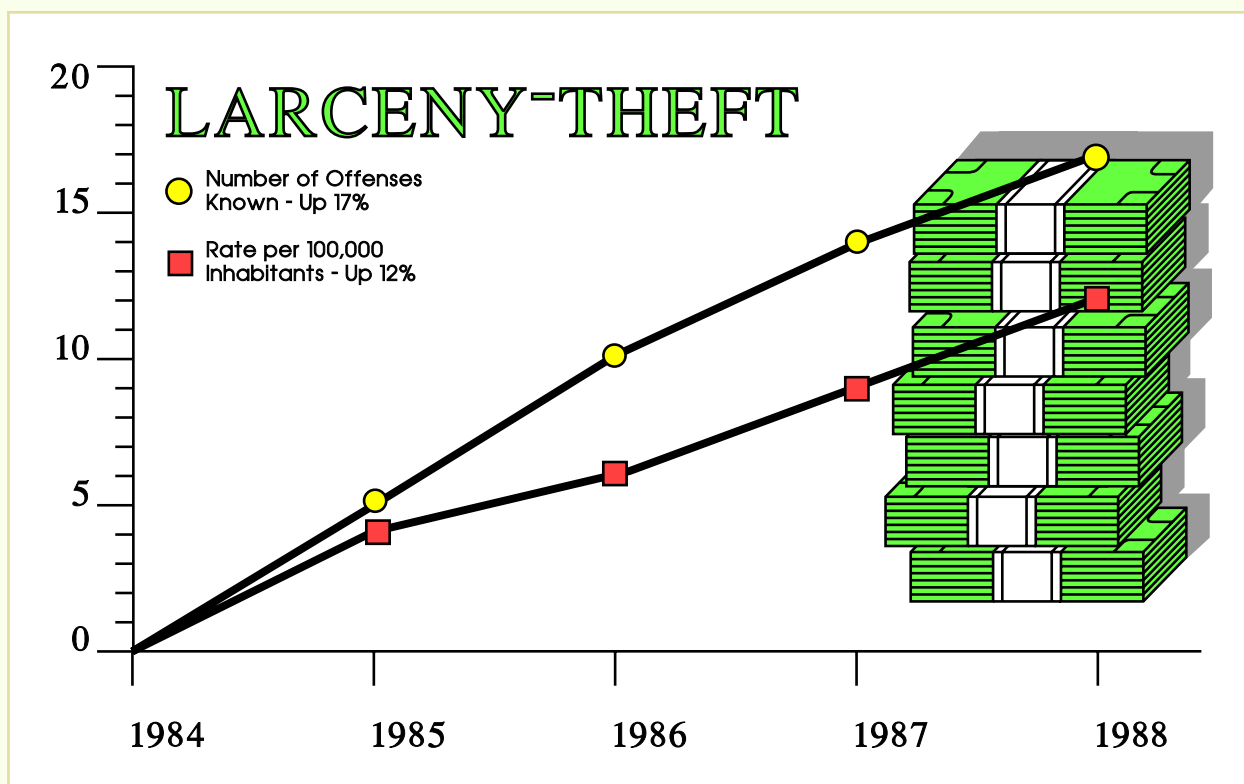


FIGURE 4—A Comparison of the Number and Rate of Larceny-Thefts from 1984 to 1988

According to the statistics, nationwide losses due to larceny-theft amounted to \$3.3 billion. Average losses per theft were broken down into the following categories: shoplifting (\$104); thefts from buildings (\$673); thefts from motor vehicles (\$461); thefts from coin-operated machines (\$144); thefts of motor vehicle accessories (\$297); thefts of bicycles (\$188). The percent distribution by type of theft is shown in Figure 5. With your knowledge of locks and safety systems you can offer direct assistance in reducing crime in these areas.

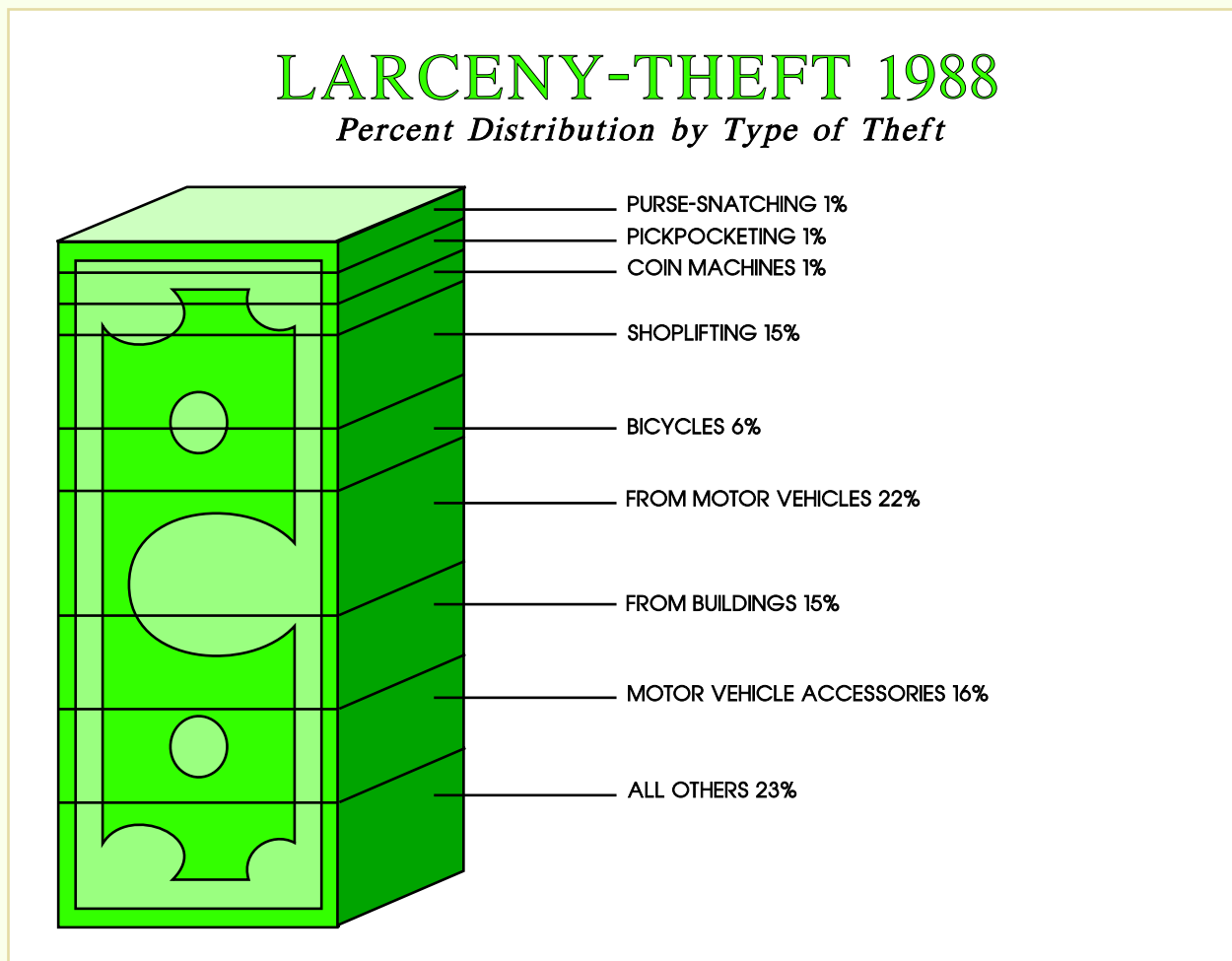


FIGURE 5—Larceny Distribution by Type of Theft in 1988

Motor Vehicle Theft

The Uniform Crime Report defines motor vehicle theft as the theft or attempted theft of a motor vehicle (including cars, trucks, buses, motorcycles, motorscooters, snowmobiles, and so forth). The definition excludes the taking of a motor

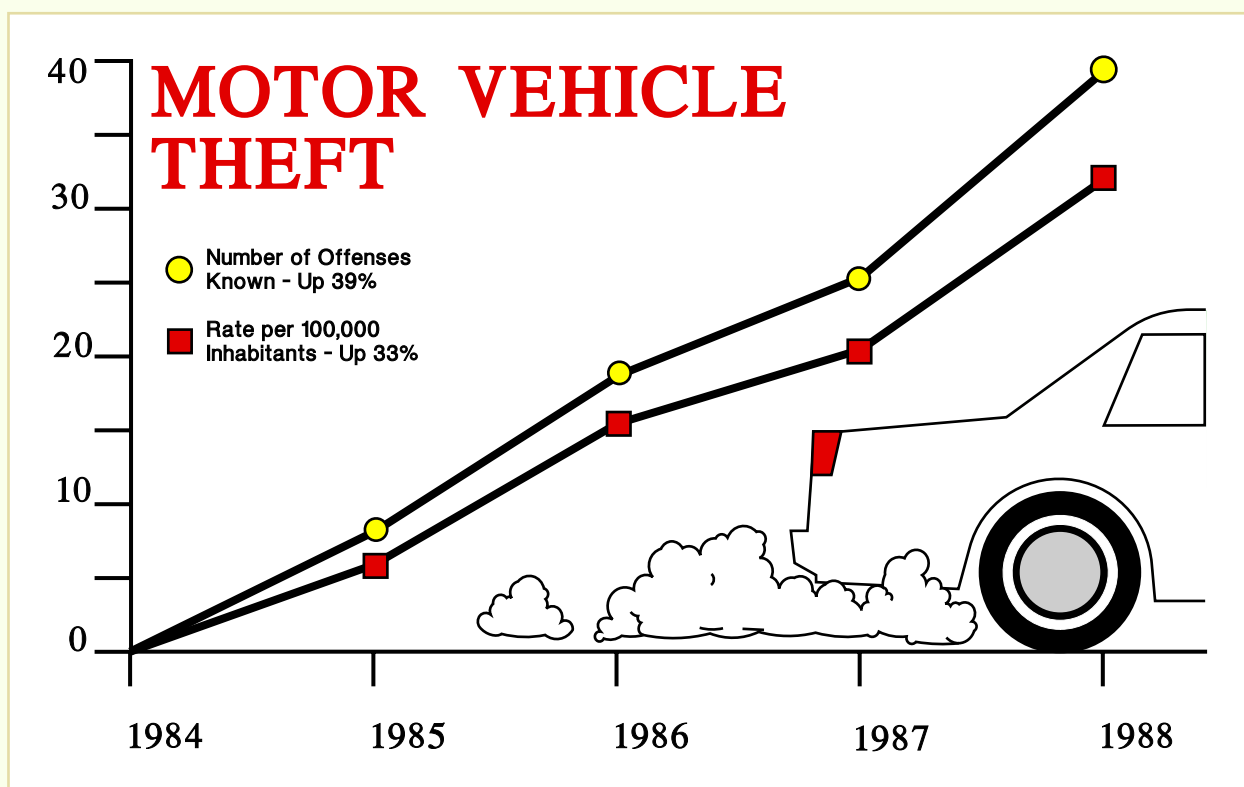


FIGURE 6—A Comparison of the Number and Rate of Motor Vehicle Thefts from 1984 to 1988

vehicle for temporary use by those persons having lawful access. According to the *Uniform Crime Report*, people nationwide lost \$7 billion to motor vehicle theft in 1988, with the number and rate of offenses up from 1984 (Figure 6). There were 1,432,900 reported cases of such thefts; they accounted for 12 percent of all property crimes. Seventy-seven percent of the vehicles stolen were automobiles; 15 percent were trucks or buses. The region with the most frequent vehicle theft was the South (31 percent); the region with the least vehicle theft was the Midwest (19 percent).

Preventing Property Crime

As a professional locksmith you can show your client that you can do more than install or repair locks. You can offer advice on how the client can decrease the likelihood of burglary. Here are four of the most common precautions.

1. **Target hardening.** The term *target* refers to the property, person, or information that is the goal of a criminal's attack. Target hardening ensures that all entry points to

property and buildings are safely guarded by visible means of security. The strategy is to use lights, locks, fencing, alarms, and a security officer near entrances, making illegal entry very difficult, and hence hardening the security.

2. Routine patrols and checking of equipment. This measure ensures that all security equipment is operating as intended. This may mean replacing light bulbs when they burn out; changing the batteries in a walkie-talkie, flashlight, or alarm, and checking fences for any breakage, holes, or vulnerable spots. The strategy here is to make burglarizing the building more time consuming. The longer it takes for a burglar to break in, the greater the likelihood that he will be noticed and stopped.
3. Remote alarm system. This security device is installed, maintained, and monitored by a professional security firm. The alarm can signal the firm that a break-in is in progress, and the firm can respond immediately.
4. Tagging target merchandise. Many stores, businesses, libraries, and supermarkets are now using electronic tags, stickers, or sensors that will trigger an alarm if they are not removed from the merchandise. Other identifying features, such as engraved and registered identification numbers on automobile engines, VCRs, and expensive audiovisual equipment, make it easier for law enforcement agencies to trace merchandise once it has been stolen.

By advising your clients to take the steps listed above, you can show them how to make it difficult—and in many cases, too difficult—for the amateur burglar to succeed.

HOME SECURITY

Home Security Concerns

It is a sad comment on our society that we need home security. We can never completely stop residential burglars, but as a professional locksmith you can understand more about them and take steps that stop or at least slow them down.

Wherever there's an opening in a house there's a potential security problem. Burglars can enter through doors and windows on the ground floor. But basement windows and doors are also potential areas of entry. A second floor window by a tree can become an entryway for a determined crook. A porch roof can become a step to an upstairs window. Attached garages can be penetrated, leading to the house proper. You'll learn more later about the six points of penetration. Thieves are so devious and daring that they've been known to try any opening, even climbing down chimneys. Installing lights and protective devices on doors and windows are basic to protecting a home. The following are the essential techniques you'll need to make a client's home secure.

Protecting Your Client's Home Against Burglary

There are several security measures you can advise your clients to take to help them protect their homes from burglary. Let's take a look at some of them now.

Lighting

Lighting is critical in home security. Floodlights, automatic lights (light sensitive or timed), motion lights (that go on when movement is sensed), and low voltage lights can be installed by anyone who is handy around the house. It can be merely a matter of plugging in the lights and placing the connecting wiring in shallow, underground trenches, as with low voltage lights. Or sometimes it's just buying something as uncomplicated as photocell lights that store energy from the sun and turn on automatically at night.

Darkness hides the thief. Take away the darkness and you make it more difficult for the thief to operate. Lights should be placed strategically throughout the homeowner's property, especially if street lighting is limited. Three common types of outdoor lighting are:

1. Floodlights, which can be placed at corners of homes, facing dark approaches.
2. Porch or door lights—automatic or switch-operated—which illuminate the main entrances in the front or back.

Remember more entries are made through doors than through any other entry way.

3. Low voltage lights, which may be distributed throughout the property as long as there are adequate outlets/power sources.

Windows

Window bars can be attached as a security measure. They're great for basement windows. They can be permanently installed on the inside or the outside. There are also portable bars that can be locked. The keys should be kept handy in case of an emergency.

Window locks may be as simple as a sliding window lock or window screw which fits over a vertical or horizontal track and is secured with the flip of a lever or the turn of a screw. Some track stops are key-operated (Figure 7). Other window locks require some installation. Double hung windows may be secured by drilling a hole through both sashes and installing a rod lock. A nonlocking variation of this is the locking pin, which fits into the same kind of hole and is secured to the frame with a chain. A third variation is a lag screw which can be removed with a nut driver.

Double hung and sash windows can be secured with a "Charley" bar —steel bar that is mounted and can be swung into place for use. A piece of scrap wood cut to fit the window frame will also do the job. (Some of these techniques will also work for sliding doors.)

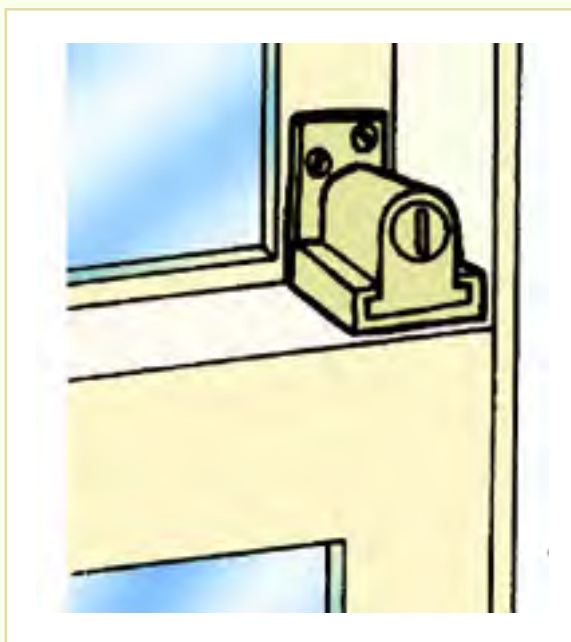


FIGURE 7—Some window track locks are key-operated.

Locks may be easily attached to the sashes of double hung windows. The first step is removing the clam shell latch and replacing it with a lockable one. Casement

windows may be secured simply by removing the crank, which is kept nearby for emergency use. A key latch may be installed along the sash rail.

Doors

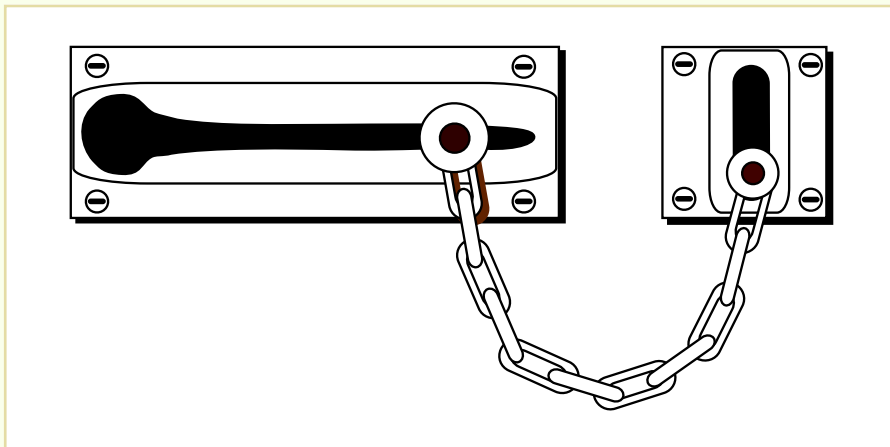
In addition to locks, doors can be secured by other devices. Sometimes the best protection is knowing who is at the door before we open it. A door viewer or peephole will allow the homeowner to see anyone who comes to the door. Installation usually involves cutting a hole in the door and screwing both sides of the viewer together (Figure 8).

FIGURE 8—A Door Viewer



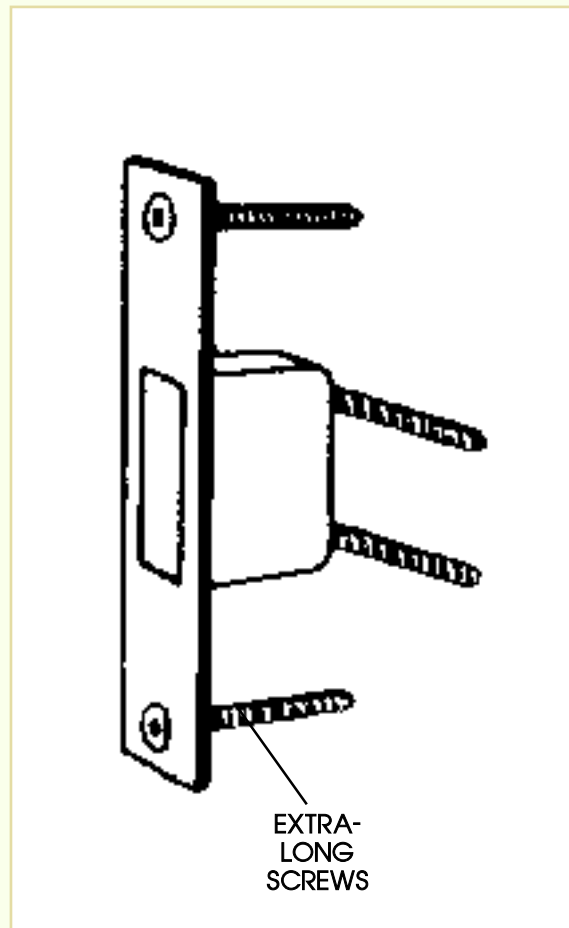
Door chains and guards permit a person to open the door without admitting the visitor (Figure 9). Installation is simple, usually involving six to eight screws.

FIGURE 9—A Door Chain



Doors may be further secured by using a variety of devices in addition to the strongest locks. Door clubs are steel bars designed to be wedged against steel slots mounted on the door and the floor. Heavy duty strikes may replace old or worn strikes. Sinking long screws adds extra strength (Figure 10). Also consider a cylinder guard which covers all of the lock except for the keyhole. It is installed with nuts from the inside.

FIGURE 10—Note the extra-long screws in this high-security strike.



Burglars have been known to remove hinges from doors. This can be prevented by installing commercial steel hinge pins, or by using a heavy nail and cutting off the head.

Landscaping

We all love shrubs, trees, and bushes, but placed unwisely they can be nesting places for crooks. Here are four steps you can recommend that homeowners take to ensure that their landscaping doesn't encourage burglars.

1. Trim trees that overhang roofs or are near windows.
2. Trim shrubs or hedges near walkways or that might shield the actions of thieves.
3. Consider planting thorny shrubs as a deterrent.
4. If worried about an area of the property, be sure that you have a clear line of sight to it from the security of the home.

Home Security Checklist

Here are a few dos and don'ts of home security about which you should be ready to advise your residential clients.

- DON'T leave your doors unlocked. Why help a thief?

- DON'T buy cheap security materials. Use solid hardwood doors for outside entrances. Use good, strong locks. Scrimping on your safety is foolish.
- DON'T assume that it'll never happen to you.
- DON'T leave valuables near windows where they can be spotted by strangers.
- DON'T live in constant fear. Take positive steps to become more security minded.
- DO lock doors. More entry in homes and automobiles is through unlocked doors than we care to admit.
- DO examine property from the point of view of a crook. (If you had to break into your client's home, how would you do it?)
- DO put good, strong, appropriate locks on doors and windows.
- DO use safety glass where a window is easily reached. Or use bars or grates if necessary.
- DO leave lights on when no one is home.
- DO use timers, especially variable timers that change the on/off cycle by a few minutes each time they activate.
- DO cancel deliveries when on vacation. Newspapers on the doorstep are an invitation to crime.
- DO consider installing burglar alarms.
- DO work with neighbors to develop a neighborhood crime watch.
- DO be careful with strangers. That's what we tell kids, and it's good advice for adults. Con men use a variety of tricks to get into a house. Two favorites are (1) posing as legitimate representatives of charitable organizations (ask for identification) and (2) distracting the homeowner at one door while an accomplice enters another.
- DO have some common sense about security.

RETAIL SECURITY

Retail Security Concerns

The FBI Uniform Crime Report for 1988 reveals that half of the thefts occurring that year took place in retail settings. The great majority of these thefts—99 percent, in fact—were shoplifting and petty theft. *Shoplifting* is familiar to all of us. A person enters a retail store, conceals an item of merchandise, and exits the store without paying for the item (Figure 11). *Petty theft* by employees includes both theft of merchandise and cash.

FIGURE 11—A shoplifter removes merchandise from a store without paying for the item(s).



It is estimated that only one-third of all *detected* shoplifting incidents are reported to the police. In 1988, approximately one million shoplifting offenses were reported to the police. We can only speculate about the number of offenses that were never discovered or, if discovered, were not reported.

According to some retail industry estimates, the average case of shoplifting and petty theft in 1988 resulted in a

loss of \$100. Multiply \$100 by three million estimated offenses and you begin to realize the size of the shoplifting problem: \$300 million in stolen merchandise. That amount of theft cannot be called *petty* by anyone's standards. And those were only the *known* incidents of shoplifting and petty theft. Retail industry estimates of the scope of the shoplifting problem indicate that only one shoplifter in 100 is detected.

There is no exact way to determine what percentages of retail shrinkage are the result of *internal* (employee) theft or *external* (customer) theft. Once again, we have to rely on the educated guesses of professionals in the retail security industry. Some experts believe that employee theft accounts for as much as 75 percent of all retail theft. And most of this theft goes completely undetected.

How much does retail theft cost consumers in increased merchandise prices, as retailers try to recoup their losses? Estimates of the price consumers pay to cover the undetected crimes of others go as high as 25 percent. On a \$10 purchase, for example, you may be paying \$1.50–\$2.50 to cover the store's security problems.

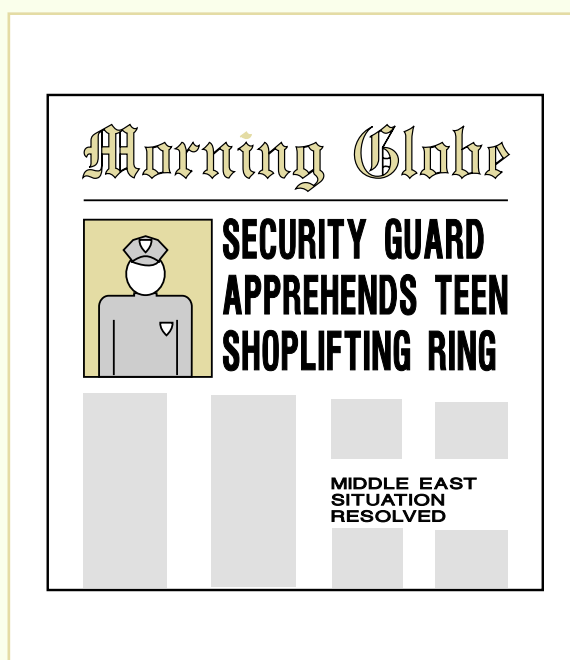
Clearly, retail shrinkage must be addressed by retailers and the professionals like you that they hire to assist them with security. Equally clearly, the problem is not one to which law enforcement can devote much energy. Local police departments simply do not have the manpower to deal with retail store shoplifters and petty thieves in any volume.

Retail Theft and Customer Relations

Most retailers prefer to suffer shoplifting rather than run the risk of losing business as a result of negative publicity (Figure 12). Retailers do not like to see articles in the newspaper about shoplifters being arrested in their stores. Retail-

ers are terrified of making a mistake and detaining an innocent person who will sue the store and everyone involved in the incident. Many retailers feel that aggressive anti-shoplifting measures are not worth the potential loss of customers and the risk of lawsuits.

FIGURE 12—Retailers don't like to see articles in the newspaper or other media publicity about shoplifters being arrested in their stores.



Assessing Retail Vulnerability

National or regional statistics will not help in determining the risk of loss at any individual retail establishment. Just how likely a particular retail store is to suffer a greater or lesser amount of loss seems to depend on two key factors, (1) the type of store and (2) the nature of its clientele.

Type of store. Some types of retail stores are especially vulnerable. Supermarkets, large variety stores, drug stores, and neighborhood convenience stores, for example, are much more vulnerable to shoplifting and petty theft than a jewelry store in a shopping mall. These stores usually stock a large amount of small, easily concealable items, such as cosmetics, costume jewelry, candies, foods, cigarettes, and household items. In contrast, a men's clothing store may experience a much smaller loss. Obviously, it is harder to steal a leather jacket off a rack and get it out of the store than it is to steal a tube of lipstick or a pack of chewing gum.

Clientele. A major supermarket in an upscale suburban neighborhood will not experience the same degree, or percentage, of loss as a store in the same supermarket chain located in a low-income, high-unemployment neighborhood. Does this mean that well-to-do people have higher moral standards than poor people? Not necessarily. Financial hardship and lack of economic opportunity are often factors that lead people to commit acts of shoplifting and petty theft. Those whose financial lives are more stable are not as prone to steal groceries and other consumable items.

Types of Shoplifters

One of the problems that makes retail theft difficult to monitor is that there is *no typical offender*. However, certain groups or types are more likely to engage in shoplifting than others. The profile varies depending on the type of store, but here are six categories of people who steal: (1) juveniles, (2) adult female homemakers, (3) professional shoplifters, (4) kleptomaniacs, (5) (so-called) privileged shoppers, and (6) employees. Does this mean that adult males do not steal from retail stores? Of course not. Statistically, however, they do not steal as often as the groups we have outlined.

Juveniles. One statistic has emerged as reliable over the years: *shoplifting is primarily a crime of the young*. An estimated

78 percent of all retail thieves are under 30. More than half of those offenders are between the ages of 12 and 17. Almost all juvenile thieves are amateurs who steal for the excitement of it, or for status, or because they want some personal item they cannot afford. The average incident nets the thief about five dollars worth of goods. Teenage shoplifters usually operate in small groups and prefer to steal from large variety stores and discount stores.

Adult female homemaker. Next to juveniles, the adult married woman with a family is the most frequent shoplifter. Typically, this shoplifter is an amateur without a criminal background. She often justifies her actions by citing unreasonably high prices of food, clothing, and other items. She rationalizes shoplifting as a way of getting even with the retailer.

Professional shoplifter. The third largest group of shoplifters consists of both males and females who are likely to have criminal backgrounds and arrest records for theft and other related crimes. Most security professionals agree that this type of shoplifter prefers to steal from large department stores and from discount stores.

The professionals' motive for stealing is simple: money. They hope to sell the items they steal for cash. Thus they are interested in expensive items such as leather coats, watches, and jewelry. They try to convert the goods quickly to cash by selling them on the streets; often they unload the merchandise for a huge discount to a *fence*, who will resell it at a profit. Professionals are very good at what they do. As a result, they rarely get caught.

Kleptomaniacs. *Kleptomania* is a mental illness characterized by the psychological compulsion to steal (Figure 13). True kleptomaniacs are extremely rare.

Privileged shoppers. Privileged shoppers are neither employees nor customers. They are vendors, sales representatives, visiting buyers, former employees, and others who can move around a store without arousing suspicion. They often have access to back rooms and storerooms that are not open to the general shopping public. They usually are familiar with the layout of the store and its electronic surveillance equipment. They are on friendly terms with store sales personnel and security guards and usually know who is working what shifts on a given day.

FIGURE 13—True kleptomania is an illness characterized by a persistent compulsion to steal.



Employees. Most security professionals believe that 70–80 percent of all employees steal from their employers. About 30 percent of employees who steal from their employers will do so no matter what security measures are in place. The rest will steal only on an occasional basis. The good news is that 20–30 percent of all employees will not steal under any circumstances. A few employees are virtually professional thieves.

They steal sizable

amounts of money and/or property on a regular basis. Usually these cases involve accomplices who may be fellow employees or outsiders. Some analysts claim that retail prices are inflated three to five percent because of employee theft alone.

Now, let's take a look at some of the ways that retail shrinkage can be combatted.

Combating Internal Theft

As a locksmith, you would be advising the store about measures to prevent, rather than to detect, shoplifting and petty theft by employees because prevention is the key to solving retail theft.

Theft of Cash

One suggestion you can make to your retail clients is to use a cash register to deter theft of cash (Figure 14). Businesses

FIGURE 14—The cash register can provide protection against employee theft.



have cash registers to hold cash and checks and to make cashiers accountable for payments made on sales. Whenever a sale is rung up, it is recorded on a paper tape within the register or on a master computer in the business office. Computerized point-of-sale (POS)

registers now do more than track sales. Registers are often linked to a master database that keeps track of inventories and may even trigger restocking orders from the warehouse when supplies reach a certain level.

Ideally, the record on tape or computer corresponds with the amount of cash in the drawer. When this happens, everyone is happy. Reconciliation problems occur when cash is put into the drawer and no sale is rung up (causing an *overage*), or when a sale is rung up but no cash is put in the drawer (causing a *shortage*).

Unfortunately the cash register system is not theft-proof. Some of the methods by which employees cheat are the following:

- Ringing up a *No Sale* transaction and pocketing cash handed over by a customer
- Holding out cash from one sale until the next sale is made and the cash drawer opened
- Ringing up a *cash* sale for less than the correct amount and keeping the difference
- Failing to give the customer a receipt

You've probably shopped in stores that have signs at the checkout stand offering to give you a small bonus gift if the clerk fails to give you a receipt. The store is not making this offer for your benefit; it has its own interests in mind. Such offers allow the store to monitor the cash-handling practices of

employees. The store is encouraging you to look at your receipt to make sure the amount on the receipt reflects what you actually spent.

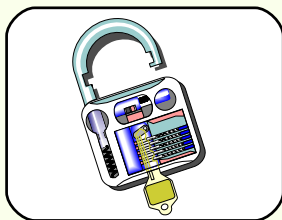
Theft of Merchandise

It is more common for employees to take merchandise rather than cash. Usually they conceal the property on their person like a shoplifter. Employees have this advantage over the customer-shoplifter; they have unrestricted access to merchandise stocks. Be alert for employees who conceal stolen items in a package containing merchandise which they have legitimately purchased.

Sometimes, employees will give away or “discount” merchandise for friends and relatives. Here are a couple of examples showing how this works.

1. An employee with access to the pricing machine has a friend come in to purchase a \$100 item. The employee tags the item at \$50. This type of cheating may be done simply as a favor to someone, with no financial gain on the part of the employee. It is possible, however, for an employee and an accomplice to run a profitable business this way. The accomplice sells the “discounted” merchandise and splits the profit with the employee.
2. Another scheme is one in which the cashier rings up a lesser amount for friends’ merchandise. Optical laser beam and bar code scanners at checkout counters have made this type of cheating more difficult. But there is no easy way to spot a quick-handed checker in a supermarket who bypasses the scanner with every fifth or sixth item as a way of reducing a friend or relative’s final total.
3. Advise your client to watch that employees are not concealing merchandise in trash containers inside the store and later retrieving the goods from outside bins.

The unfortunate truth about employee theft is that there is almost always a way for smart, dishonest employees to beat even the most sophisticated security or control systems, at least for a while.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

1. What is the *FBI Uniform Crime Report*?

2. *True or False?* Residential burglaries account for two out of every three burglaries.

3. What two crimes represent the greatest majority of retail thefts?

4. Who steals more, employees or customers?

5. List two ways to prevent property crime.

6. What group is the second-largest group of shoplifters?

Check your answers with those on page 83.

INDUSTRIAL SECURITY

The Essential Role of Security

Modern industrial security has rapidly progressed toward a twenty-first century approach to protection of life and property. This new approach is needed to match the new threats to industrial sites from criminals armed with modern weapons and the latest tools of the electronic age. Meeting this modern threat requires the ability to use the same sophisticated, high-tech tools in the prevention of crime and industrial loss.

In today's industrial settings, security is essential. Large losses take place annually in industrial settings. The losses in raw materials alone due to employee theft and theft from outside sources are staggering. To cope with such threats, every company today needs some kind of security protection, even if it consists of something as simple as an alarm system that runs during off hours or an extra lock or two on access doors.

Let us consider the problems of providing a high level of industrial security for some of the *general classes* of industry.

Heavy industry. Manufacturers of equipment and other heavy industries have multiple security needs. These companies have the basic gate/entrance guards who monitor people coming in and going out. They also need security to monitor in-plant inventories and thus reduce the opportunity for employee theft or loss from external sources. The manufacturer also needs to protect vital research and development projects. And you will help by providing locks and locking devices.

Security in industrial parks. Throughout the United States and Canada, suburban industrial parks house a wide variety of light industries. Many tenants share a single complex. Most of these businesses have their own alarm systems, but do not have their own private security personnel. Usually the owners of the complex contract with a private security company to provide protection services for the entire facility.

Computer and electronics industry. Computer-related companies have a special security problem. One of the greatest dangers to high-tech companies is that unauthorized persons can

gain access to their research files via an outside computer link-up (Figure 15). In a sense, the computer industry has created the very instruments which plague it. Today, the computer industry and all those who use its products must protect themselves against those who use computers for illegal purposes.

FIGURE 15—One of the greatest dangers to high-tech companies is that unauthorized persons can gain access to research files via an outside computer linkup.



Protecting Materials and Information

Vast amounts of data can be stored on computer disks and tapes. Even paper-originated documents can be *read* into a company's master computer by using *optical scanning devices* (Figure 16). A *flatbed*, or *full-page scanner*, is one of the quickest and easiest ways to get data into a computer for processing or storage.

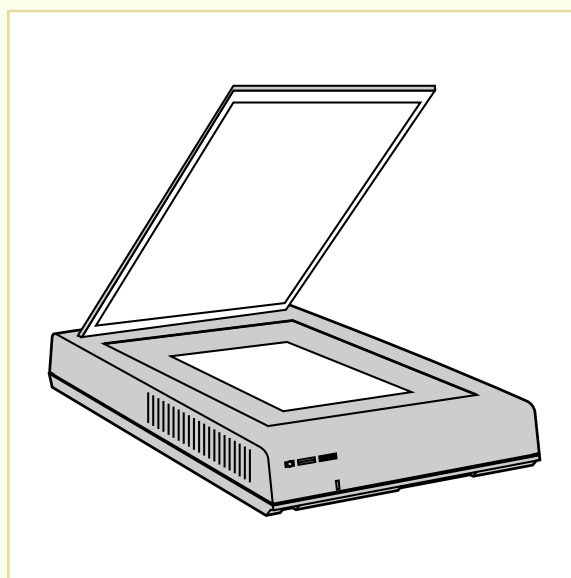


FIGURE 16—A company's documents can be read by a scanning device.

It allows the user to enter text into a computer without having to key the data in manually. Scanners can input graphic images as well as text.

If the company puts documents on microfilm, security is concerned about where and how microfilming is

done, and where and how the microfilm is stored. What if someone within the company wants to view or borrow a document that is on microfilm? There have to be definite procedures for releasing documents, with assurances that only properly identified and authorized parties can gain access to them.

Suppose a company engineer from another department walks into the research and development department and says, "I need to look at the plans for computer chip X-156. I've been asked to work on part of it, and I need to get up to speed on the project." Does the filing clerk in R&D just hand over the plans to the top-secret project? Absolutely not. There have to be controls to do each of the following:

- Check the *identification* of that employee
- Check the employee's *authorization* to look at those plans
- Determine *where* the employee can look at the plans
- Determine *when* and *how long* the employee can have access to the plans

Every stored document must have at least one backup copy, preferably several. To minimize the risk of a total loss due to fire, earthquake, or another natural or man-made disaster, at least one set of backups must be stored in an off-site location. Storing document backups off-site presents another set of security risks and problems. The backup location must be tightly protected against the same dangers as the original site.

Companies not only have a problem archiving documents in a safe and orderly manner, but they also have a problem getting rid of documents. After a company has put paper-originated documents on computer disks or microfilm, they may need to keep one or only a few additional copies on paper. But dozens of copies may exist. Although these documents may contain valuable and even classified information, they may also take up critical space within the facility.

When management decides it no longer needs all these paper copies, it will call upon security to dispose of the unwanted materials. What does security do with them? Obviously, you wouldn't just take them out to the trash bins and throw them in. Nor is burning documents always thorough enough, because some pages may not be totally consumed by the

flames. The preferred means of document disposal today is shredding, because it makes the contents of the document absolutely unreadable.

Fire Protection

FIGURE 17—Fire protection is a major security concern in industry.



In many industrial settings, fire protection comes under the responsibility of security (Figure 17). A large facility may even

have its own fire-fighting personnel and equipment. The security professional must be aware of sound fire protection procedures. He or she must make sure that the proper fire protection equipment (extinguishers, hoses, sprinklers, alarms, and so on) is available and functioning properly at all times. Security must also see that fire protection equipment is strategically located and readily accessible.

In addition to inspecting and maintaining fire protection

equipment, a major responsibility of security personnel within an industrial setting is to be aware of fire hazards. Safe storage of combustible items and flammable liquids, such as solvents and gasoline, should receive high priority. Security must regularly inspect all areas within the plant, with an eye for spotting and correcting unsafe conditions. Plant inspections should examine the effectiveness of ventilation in areas where combustible items and flammable liquids are used. The use, storage, and disposal of acids and other toxic materials must also be carefully monitored.

In rural or suburban areas, weed abatement in dry seasons is critical. Dry grass and weeds growing close to buildings present a major fire hazard, but one that is easily correctable by a planned program of spring rototilling. Such a task is simple to perform and can save the company from disaster.

When a fire occurs at an industrial plant, security is normally the first to be notified and the first to respond. When security does respond to a fire alarm, officers must evaluate the situation quickly and make the right decisions instantaneously.

Important: Regardless of the size of a fire, the correct procedure is always to call the fire department, even if you think you can put the fire out or control it yourself. A small fire can become a big fire in seconds. Rather than risk further damage, you should always call in the fire-fighting professionals. Then, either contain the fire in the best way you can with the equipment at hand, or help evacuate people from the premises. It's better to have the fire department arrive to find an extinguished fire than to call them too late to save property and lives.

Disaster Plans

An efficient industrial security department will create a *written* set of guidelines for use in the event of a large-scale emergency (Figure 18). These written guidelines are often called a *disaster plan*. Since security's response to a fire in the plant must necessarily be different from its response to a flood or an earthquake, a written disaster plan will outline both general procedures and procedures for particular risks and hazards.

Among the items to be included in a written plan, or manual, are the following:

- A statement of policy
- A description of the types of hazards that are possible, with an evaluation of the degree of risk involved
- A detailed physical description of the facility, including building plans, utility lines, and so on
- A detailed description of the actual use of the building, including the number of occupants during each shift, hours of operation, and so on

FIGURE 18—*In an emergency, workers must have a set of written guidelines and an evacuation plan.*



center, the most effective evacuation routes, the assembly points, and the locations of alarms and communications systems

- An outline of the emergency organization, including the chain of command and responsibilities
- The location of emergency equipment and supplies on hand, including, medical, first aid, fire fighting equipment, and food and water supplies
- The availability of emergency facilities, the location of the command center, the most effective evacuation routes, the assembly points, and the locations of alarms and communications systems
- A list of mutual aid agreements with outside agencies, including their emergency phone numbers
- The shutdown procedures for water, chemicals, oil, gasoline, electricity, natural gas, and so on
- A list of physical security procedures
- A list of evacuation procedures
- Any other items unique to the specific organization

This written document should be the basis for periodic inspections and emergency-procedure testing. But such a document is of no value in itself. Its value is determined by how effectively it can keep the entire facility in a constant state of readiness to meet whatever emergencies may arise.

Internal Threat to Industrial Settings

We have said many times that employee theft and larceny by outsiders are the two major problems at all levels of commerce today. Theft by those directly associated with the company from whom property is stolen is called *internal threat*. Theft by those not directly associated with the company from whom property is stolen is called *external threat*.

Shrinkage

The term used in business for the kind of losses created by employee theft and external theft is *shrinkage*. Shrinkage includes loss of merchandise, cash, jewels, tools, equipment, or any property not belonging to the one who takes it. Shrinkage, in a broader sense, also includes misplaced products and inventory and bookkeeping errors.

Employee Theft

The biggest cause of internal shrinkage in industrial settings is employee theft (Figure 19). We may never have a true estimate of such losses because the raw-material and product-inventory methods of some companies are so inexact that shrinkage from employee theft can take place without ever being discovered and reported.

While theft by employees is a crime punishable by law, many employees in industrial and other commercial settings feel no



FIGURE 19—The employee lunch box is a common vehicle for minor company theft.

qualms about taking things from their place of employment. They consider company property as something which exists for their own personal use. They think that taking it is somehow different from shoplifting or theft from a place where they are not employed.

Who reimburses, or makes restitution to, employers for these losses? Is it the same employees who steal cash and goods? Well, yes, but only indirectly—as consumers. To recoup their losses, businesses add \$100 billion to the cost of their goods and services, a penny here, a few cents there, on each item sold. The consumers make restitution for the crimes committed by employees against their employers.

Combatting Internal Threat

Industrial security departments must prevent or deal with theft by company employees. What do you do when confronted with a situation in which shrinkage of cash, raw materials, or products is occurring from within the plant?

When shrinkage is discovered within some department of the company, someone has to investigate and determine how the loss is occurring and who might be responsible. How could the cash or material have been removed from the premises? If an employee seems to be responsible, what was the method of operation (in Latin, the *modus operandi*, or M.O.)? Did the employee act alone, or did the crime require the cooperation of more than one person within the plant?

The best way to deal with internal threat, of course, is prevention. Diligent work on the part of security in helping the company set up efficient anti-theft controls in every department reduces the opportunities for employee theft.

Realistically, however, employee theft is not likely to be eliminated. This form of industrial shrinkage cannot be completely stopped without taking away some of the basic human rights we as free people value as much as life itself. None of us wants to solve the problem of employee theft by creating a prison-camp atmosphere where all who enter the workplace leave behind their rights and dignity as free human beings in a free society.

External Threat to Industrial Settings

Burglary

Large industrial facilities are vulnerable to theft from outside sources. Even with modern electronic methods of theft-prevention (roving robots in warehouses, for example), security cannot

FIGURE 20—Large industrial facilities use electronic surveillance equipment to check areas vulnerable to burglary.



monitor every corner of a plant with equal intensity at all times (Figure 20). Professional burglars are the greatest external threat to industry. They know exactly what they are looking for when they set their sights on a particular facility. They case a site thoroughly, and

they have the skill, hardware, and weaponry to enter the targeted industrial site. They can break gate locks, cut through chain-link fences, or use deception of various types to gain entrance to the area where the goods or raw materials they want are stored.

Knowing the vulnerable areas enables security professionals to increase mechanical measures and guard assignments in those areas. This kind of company commitment to plugging security gaps is a major force in preventing break-ins. It also reduces the possibility that outside persons intent on stealing from the company can simply drive or walk in, take what they want, and exit the premises undetected.

Sabotage

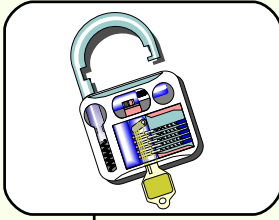
Sabotage is any intentional and malicious damage to machinery, tools, property, personnel, or production procedures. The basic aim of an act of sabotage is to disrupt a company's ability to function normally and produce its goods or provide its services to its customers.

Espionage

Companies spend many millions of dollars over several years to develop products for market. Take a major automobile manufacturer, for example. Years, and a huge capital investment, are required to bring an innovative line of cars to market. The success of the venture depends on keeping competitors from obtaining the secrets to new technology and designs. In other words, the first company to get to market with a new product

has a tremendous competitive advantage. Only then will the millions of investment dollars have a chance of paying dividends.

As the financial stakes get higher, unscrupulous competitors are tempted to take the shortcut of buying trade secrets from employees or stealing these secrets outright. It is not unusual for trade secrets worth millions or even billions of dollars to be printed on a few sheets of paper. Loss of proprietary information, especially by the research and development department of a modern corporation, can cause untold damage and the loss of thousands of jobs. The general term for this kind of illegal activity is *industrial espionage*.



Locking It Up! 2

1. *True or False?* The biggest cause of internal shrinkage in industrial settings is employee theft.
2. *True or False?* Data stored in computer files is usually safe from unauthorized access.
3. What is shrinkage?

4. What is sabotage?

Check your answers with those on page 83.

ACCESS CONTROL

What is Access Control?

Burglaries and thefts, like most crimes, are a result of opportunity. Unlocked doors and open windows offer easy *access* for criminals into a building, to restricted information, or to a certain person. This explains the importance of access control. As a locksmith, you will be an integral part of the process to control access. When you control access, you limit the opportunity to commit crime.

For our purposes, *access control* will be defined as any hardware, techniques, and personnel that limit one's ability to get into a building, to restricted information, or to a certain person. Such access may be either lawful or unlawful. Parking lots that allow employees to enter by electronic card keys are controlled but lawfully accessible. Breaking and entering is unlawful access.

Three Types of Security

Access control deals with all types of security, including physical, information, and personnel security.

Physical security. This term refers to protecting property—a building, a store, an airport. Access control of physical property involves security measures such as gate guards, patrol guards, alarms, locks, fences, and lighting. Access control of property includes control of every possible way in and out of that property: doors, windows, crawl spaces, roofs, fire escapes, fences, gates, or anything else.

Information security. Preventing the destruction of information and records by such forces as fire, shredding, and flood and preventing breaches of confidentiality through theft, espionage, and sabotage are considered information security. The type of information that needs securing will vary with the business or facility.

FIGURE 21—Employee security may involve the use of laminated identification badges.



Personnel security.

Personnel security deals with the protection of individuals —employees, visitors, students, customers, airport travelers, business executives, sports figures, and movie stars, just to name a few. Access control may include issuing employee identification badges and parking permits, checking in and escorting visitors,

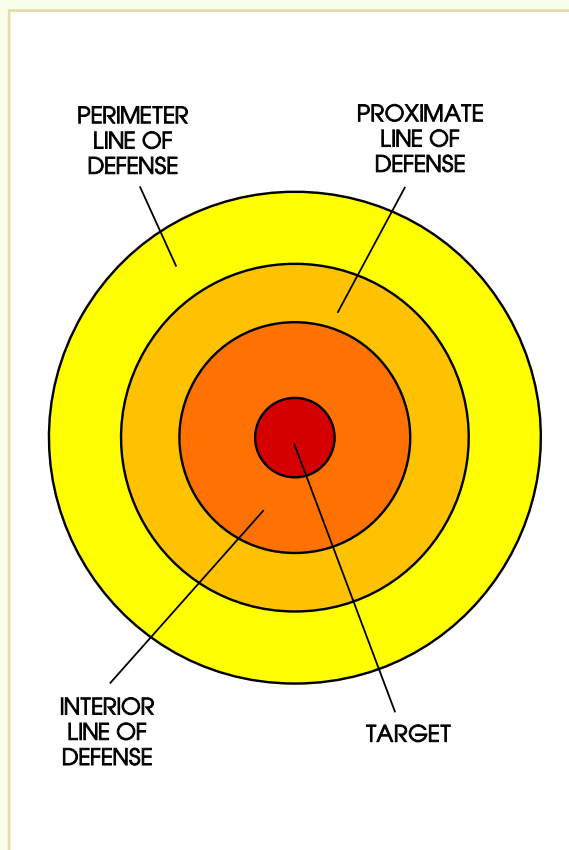
enforcing visiting hours, locking public rooms in office buildings, and installing locks in hotel rooms (Figure 21).

Understanding the Terms

To understand access control you should know some of the terms associated with it. To repeat what we have learned earlier in this unit, the term *target* refers to the property, person, or information that is the goal of criminal's attack. In most cases the person, property, and information are located in the same place.

To provide access control, the target is surrounded by defenses. The three basic lines of defense are the (1) exterior, or perimeter, (2) the proximate, and (3) the interior lines (Figure 22). The first obstacle that the intruder encounters is the perimeter defense—the wall, fence, or gate surrounding the facility. The second, or proximate, line of defense may be the architecture of the building or the landscape immediately surrounding the building. The proximate line of defense may include such things as outdoor lighting, clear-cut land, and a security guard. The third line of defense is interior security: locked elevators, doors and safes, silent alarms, and patrols. In the case of corporate sabotage or employee theft, the criminal will face the same obstacles but in reverse order.

FIGURE 22—Lines of Defense in Access Control



Defensible space is an area that can be reasonably protected. If the target is a person, then it would refer to the space needed to allow the person to defend himself or herself from attack. If the target is a building, then it would refer to the space needed to defend the building.

Natural surveillance refers to the area that can be seen with the naked eye. Statistics prove that visibility is important to crime prevention. If the

entrance to a building is brightly illuminated, there is less chance that someone will break in. Likewise, if a security officer has a clear line of vision from the building entrance to its perimeter, there is less chance that someone will sneak up to the building.

Encouraging Management Commitment

As a locksmith, you may be asked to assess and increase your client's commitment, in procedures, manpower, and money, to security measures. If the client has inadequate policies or staffing and/or is unwilling to spend what is necessary to secure the home or business, you should try to persuade him that these measures are both necessary and cost effective. You should be familiar with some basic security measures, so that you can offer effective advice.

Policy Manual

A *policy manual* is a written collection of practices and procedures regarding the way tasks are to be performed. In

access control, a policy manual ideally answers every WHO, WHAT, WHEN, WHERE, and WHY of security. A security professional knows the company's position on who gets into an operation. If there is no policy manual, it is the responsibility of the security professional to work with management to develop one, even if it is only a loose-leaf binder with handwritten memos. Security begins when everyone knows the rules.

Staffing

The staffing policy of any facility should be determined by security needs; it should also be economically reasonable. If two guards are needed to ensure security, then one guard doing the same job will be ineffective. Although money might be saved, once security is breached and property has been lost or damaged, the overall expense may be much more costly.

Fiscal Support

Management has to understand the concept of access control and agree to its importance and implementation. It is useless to say that security is necessary and then not provide any funding to support it. Security professionals should work to explain the problems and the reasonable solutions available. Access control is teamwork.

Environmental Design

When a new office complex is on an architect's drawing board, security consultants, including locksmiths, must have input about how the facility will be built. Basically, environmental design focuses on three kinds of security needs: (1) the architecture of the building itself, (2) the location of the building or structure, and the (3) surrounding environment (both proximate lines of defense and perimeter lines of defense). Crime prevention through environmental design starts with a basic first question, What type of building or facility is being designed? The answer to this question will determine the amount and type of security needed.

Building Design

It's important to determine what the possible ways a building or facility can be entered or breached are. In other words, how might a criminal gain access to the interior? Actually, the answer to this question is the same for all buildings. Every building can be entered from six directions: the roof, the flooring, and the four sides (doors, windows, and miscellaneous entrances such as fire escapes, vents, delivery or trash doors, and storm sewers) (Figure 23). A locksmith's responsibility is to help secure all openings into the building.

Roofs. Most office complexes, hospitals, shopping malls, apartment buildings, and commercial facilities have flat roofs. While flat roofs are less expensive to maintain, they are also greater security risks. It is difficult to see someone hiding on a flat roof. Roofs made of wood, tar, and shingles are easily broken into; roofs made of pitch, on the other hand, are more difficult to breach. Roof attachments—fire escapes, stairwells, skylights—increase the security risk and should be

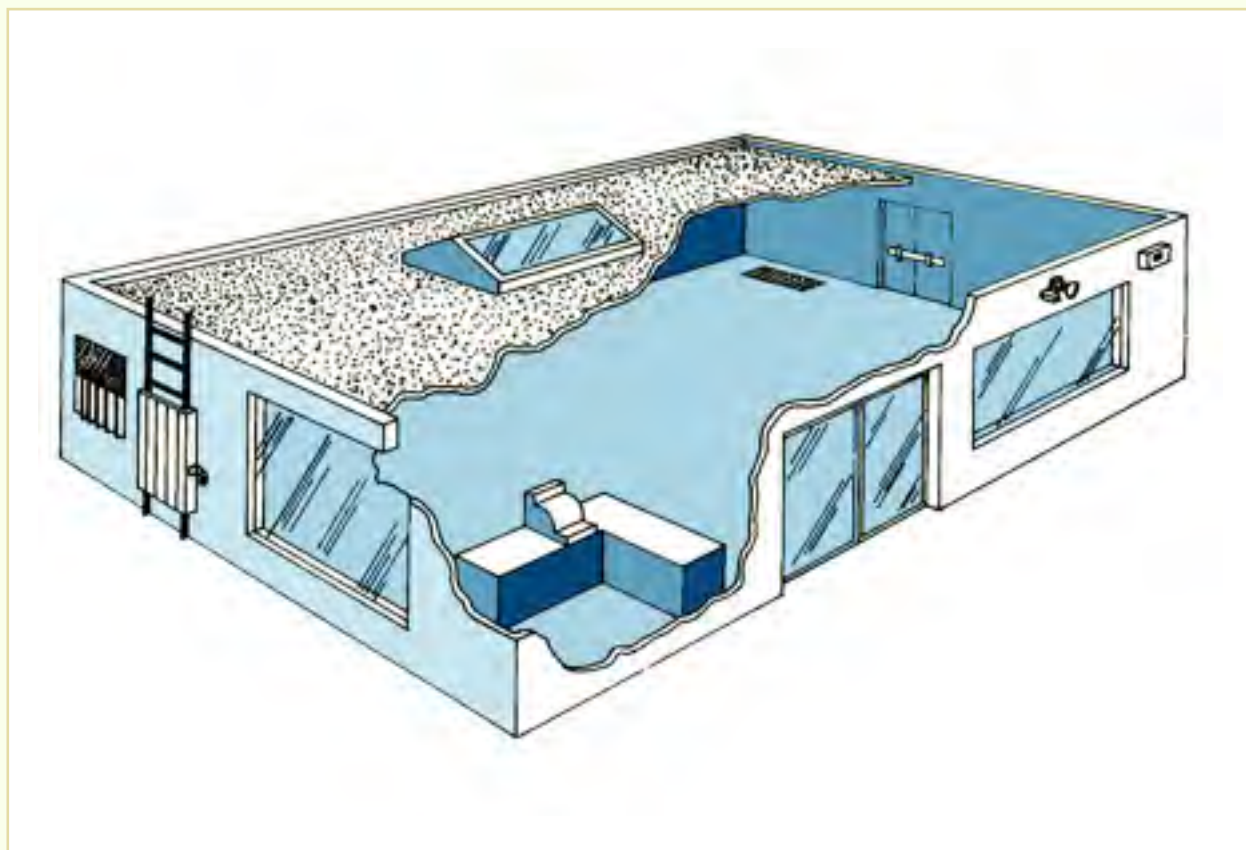


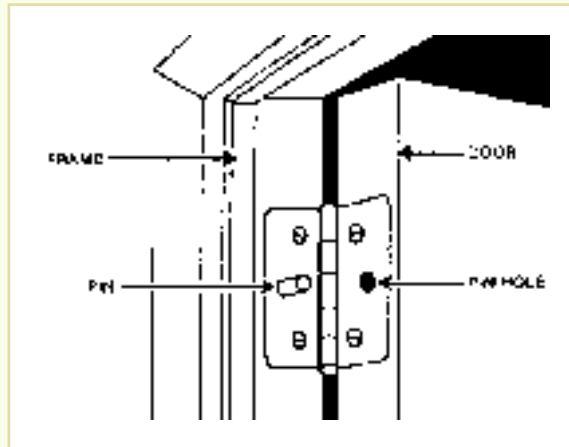
FIGURE 23—A building can be accessed from six directions: the roof, the flooring, and the four sides.

reduced or locked. Buildings close to other buildings are also more breachable.

Flooring. Criminals have been known to enter buildings by digging tunnels underneath the foundations and breaking through the floor. Crawl spaces, vents, storm sewers, and trash doors are other ways of gaining access through the flooring.

Doors. Statistics have shown that in 50 percent of all illegal entries, criminals have gained access to a building through one of the doors. Thus, a high-priority concern of environmental design is the placement and construction of doors. Here again is an area where a locksmith can have a direct impact on crime prevention. Main doors that are hidden by

FIGURE 24—Pinning a Door to Prevent Its Removal



ornamental shrubbery may be attractive, but are an invitation to a thief who can use the shrubs for cover. Wooden doors or doors unprotected by good locks or alarm systems also attract thieves. Wooden exterior doors should have a sheet metal cover

on the inside to deter someone from kicking them open or cutting through them. The best exterior doors are made of metal, with well-lit entry ways. The door should be secured with a deadbolt, a horizontal retaining bar, and an alarm system. Door frames and hinges also deserve attention. To prevent a criminal from removing the doors from their hinges, each exterior door should be pinned (Figure 24).

Windows. Next to doors, windows are the second most frequent point of illegal entry. The popular sliding glass is easy to break into. In high crime areas all windows should be eliminated on the ground level, if possible. Otherwise, all windows should be secured with bars, heavy screens, chain links, and alarm systems. Even bars and grates, however, can be pried off the face of the building if they are not installed properly.

Miscellaneous entrances. All miscellaneous entrances, no matter how small, need to be checked and secured. Criminals

have been known to have children crawl through a small opening and then open a door or window.

Proximate Lines of Defense

Proximate lines of defense are another major concern of environmental design. Where the building sits on the lot can determine its defensibility or its vulnerability. For example, a building that sits immediately next to a perimeter wall or has walls in common with another building presents a substantial security risk. Criminals can gain access by knocking a hole in the wall. In securing such a building, pay attention to the adjacent structure as well, especially on weekends when criminals have more time to work unnoticed.

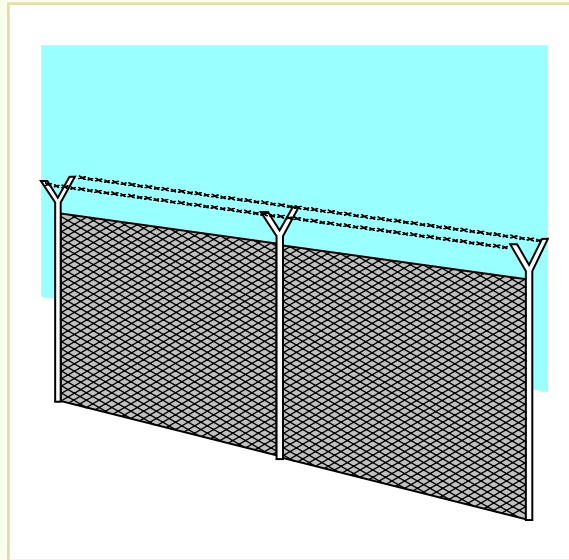
The best place to situate a building, from a security standpoint, is in the middle of a lot. This ensures a clear view of all four sides of the building. For maximum security, all entrances need to be visible from adjacent thoroughfares—places where there is likely to be heavy pedestrian and vehicular traffic. Remember, the more an entrance is hidden from public view, the easier it is to break into.

Perimeter Barriers

The last area of environmental design involves the use, placement, and choice of barriers. Physical barriers may be of two types: human-made barriers such as fences, walls, grills, or bars; and natural barriers, such as bodies of water, mountains, cliffs, deserts, canyons, or swamps.

Perimeter barriers include metal detectors, electronic sensors, walls, and fences. To be effective, barriers must be properly constructed and maintained. Locked gates that are easy to push open, for example, are ineffective in preventing vehicles from entering. As perimeter barriers, walls of cement, wood, or stone are preferable to fences because they are stronger and more resistant to intrusion. The disadvantage of walls is that security personnel can't see through them. Fences are usually used as perimeter barriers around large areas. The three main types of fences used in access control are the chain link fence, the barbed wire fence, and the concertina wire fence. Chain link is generally used to secure permanent sites (Figure 25). Barbed wire is for less permanent sites. Concertina wire is for emergency or short-term situations.

FIGURE 25—A Chain Link Fence with a V-Shaped Topguard of Barbed Wire



Locks

Locks are the most widely used access control hardware. Basically, a lock is a delaying device. It prolongs the time it will take an intruder to gain entry. Locks are used on almost everything: doors, gates, windows, drawers, strongboxes, vending machines,

vehicles, lockers, safes, and vaults. The amount of delay depends on the quality of the lock, the type of lock, the quality of installation, and the skills of the intruder.

Lighting

Statistics show that in the majority of burglaries, the point of entry was not illuminated. To make lighting effective in crime prevention you must consider size, brightness, contrast, and space.

Size. Where you put lights and how many lights are used will depend on the size of the object being protected. Large objects need less light than smaller objects.

Brightness. Brightness is the reflective quality of an object or building. White objects reflect more light than black, and thus need less light. Coarse objects diffuse light, and thus need more light than smooth-surfaced objects.

Contrast. Contrast refers to the shape and color of objects in relation to the shape and color of the background. The greater the contrast, the less light is needed.

Space. Crowded areas need more light than wide, flat spaces.

Types of Lighting

The type of lighting is also important. The most common type of protective lighting is *continuous*, or *stationary*. Such lighting consists of a series of fixed lights that flood an area with overlapping cones of light. *Standby lighting*, the second most common type, consists of lights that are not continuously lit but are manually or automatically turned on when necessary. A third type, *movable lighting*, is used to supplement other types of lighting. Last is *emergency lighting*, which is used only when regular lighting is inoperable. Emergency lighting systems must include their own source of power.

Two methods of deploying continuous lighting are glare lighting and controlled lighting. Glare lighting is aimed directly at potential intruders (Figure 26). It is useful in illuminating a perimeter barrier. It is also useful in lighting entrances, checkpoints, and gates. Because it is set up behind security, they can see more than the intruder. Its disadvantage is that it cannot be used near major streets or highways because it could blind on-coming traffic. Controlled lighting is mounted on poles, buildings, or fences and is directed downward, reducing the amount of glare (Figure 27). One problem it creates is that it lights both target and proximate lines of defense.

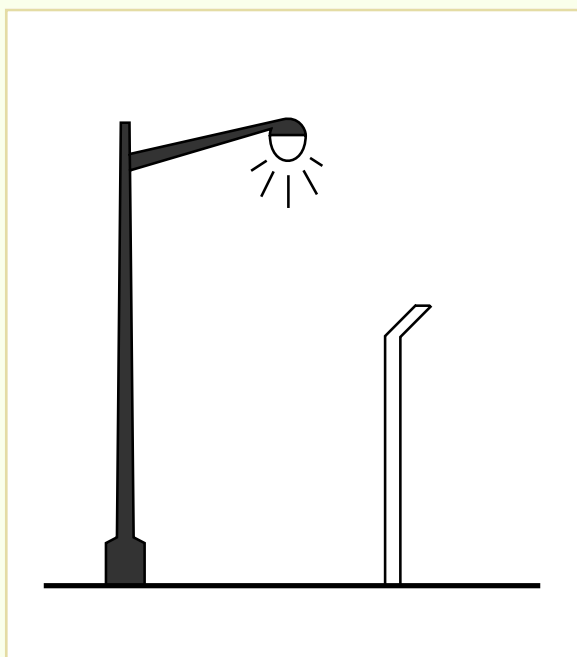


FIGURE 26—Glare Lighting

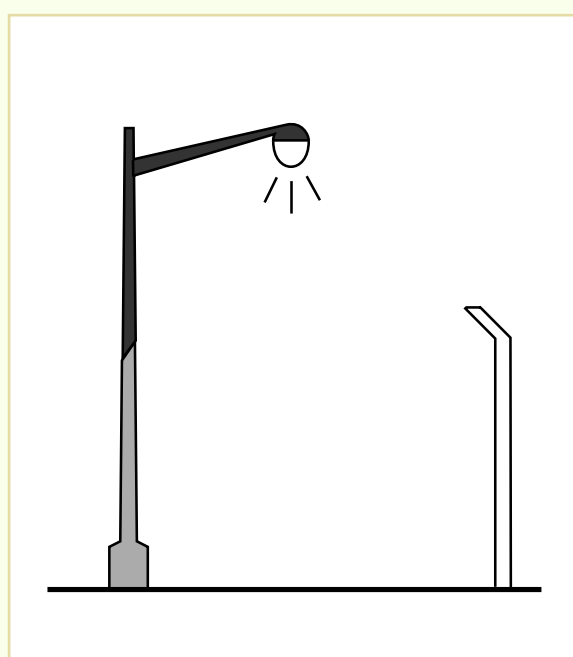


FIGURE 27—Controlled Lighting

A light's source is also important. Incandescent or filament lamps using the standard light bulb are used in homes and workplaces, but they have limited use in security because they burn out so quickly. For security purposes gaseous discharge lamps are preferable to standard light bulbs. They include: mercury vapor lamps, which emit a blue-green light, and are used to effectively light both interior and exterior work areas; metal halide lamps, which emit a harsh yellow light, and are used for security but not work areas; and fluorescent lamps, good for work areas but not for security. The best lamps for security purposes are sodium vapor lamps, the most efficient lamps in use today. They emit a harsh yellow light which is not appropriate for office use, but they provide excellent security lighting, especially for perimeter areas. Their only drawback is that they may take up to four minutes to become fully lit.

Lighting equipment must also be considered. The facility and its security needs will determine the type used. *Floodlights* project light in a concentrated beam. They are used primarily in glare-projection lighting to illuminate boundaries, buildings, or fences. *Streetlights* produce diffused light rather than a directional beam and its glare. They are best for parking lots, thoroughfares, entrances and boundary perimeters where glare is not helpful. *Fresnel units* emit a fan-shaped beam of light. These are most useful when glare lighting is desired, for example, between buildings. *Searchlights* produce a highly focused beam of light. They are used to complement existing lighting systems.

Alarms

Since its invention in 1906, the burglar alarm has been one of the most popular ways to prevent burglaries. Today, alarm systems are used to detect fire, to detect intrusion, to notify appropriate authorities regarding fire, intrusion, or emergency, and to monitor equipment and facility conditions such as temperature, humidity, and even the presence of radioactivity.

There are three major types of alarms systems. A *local* alarm system sounds locally but not anywhere else; it is best used to control access when a building is located in a populated area. *Central* alarm systems are connected to a central police station; the police call to determine false alarms, but respond immediately to real emergencies. *Central proprietary systems* are

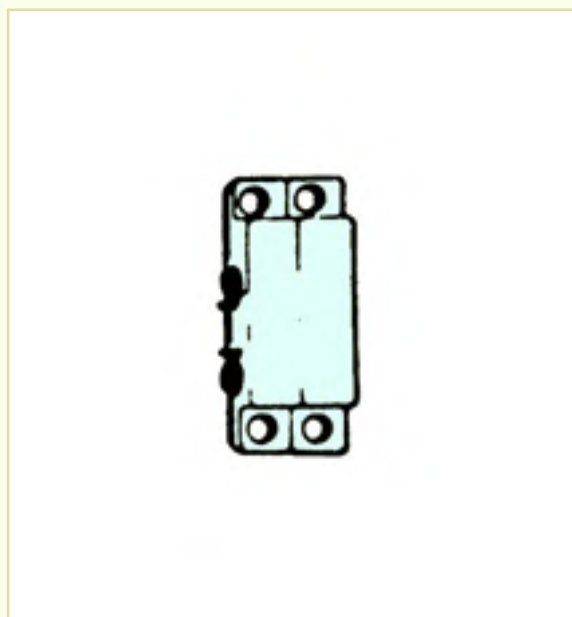
owned and operated by individual business and monitored by a security officer who checks the problem and calls police if necessary.

In addition, *auxiliary* alarms—like tape dialers, digital dialers, and dry line direct-connect systems—are also used in access control. A tape dialer dials a programmed telephone number when an alarm is activated and repeats a message concerning the type and location of the alarm to the police or proprietary office who answers. Instead of sending a programmed message, a digital dialer sends a coded message indicating the location and type of alarm to a special receiver in a police station, fire department, or security office. A direct-connect system uses a telephone transmission circuit called a *dry line*, an exclusive circuit connecting the alarm system to a specific location.

Perimeter Alarms

Alarms can also be classified by where they are placed to protect the property. *Perimeter alarms* are installed on the perimeter of a facility or on the outside of a building. Although many perimeter alarms exist, we'll look at five kinds: (1) magnetic contacts, (2) plunger contacts, (3) foiling, (4) vibration detectors, and (5) screens.

Magnetic contacts are the most widely used perimeter alarm systems (Figure 28). They use electromagnetic devices comprised of a simple switching system. The switch is on when the two magnets touch each other. Magnetic contacts are at-



tached to windows, doors, transoms, and other openings. If the door is opened while the alarm system is on, contact is broken and the alarm sounds. These alarms cannot control access through the roof or the walls, nor will they detect people who stay behind after hours until they try to leave the building.

FIGURE 28—Magnetic Contacts

Plunger contacts are concealed and recessed in a door, cabinet, or desk. When the door is closed, the plunger recesses and the circuit is closed. When the door is opened, the plunger comes out and activates the circuit. This method is the same one used for the hidden light switch on automobile and refrigerator doors.

Foiling makes use of a metallic ribbon that attaches to such surfaces as glass, door panels, and walls (Figure 29). When someone tries to break in, the foil breaks and activates an alarm.

FIGURE 29—Foiling



Vibration detectors are special sensing devices that react to vibrations. This system is used on walls, doors, and windows. Sometimes, however, they are too sensitive and can be set off by heavy footsteps or vehicles driving by the building.

Specially designed *screens* contain built-in alarm wires. If the screen is removed or cut

when the system is on, the alarm will go off.

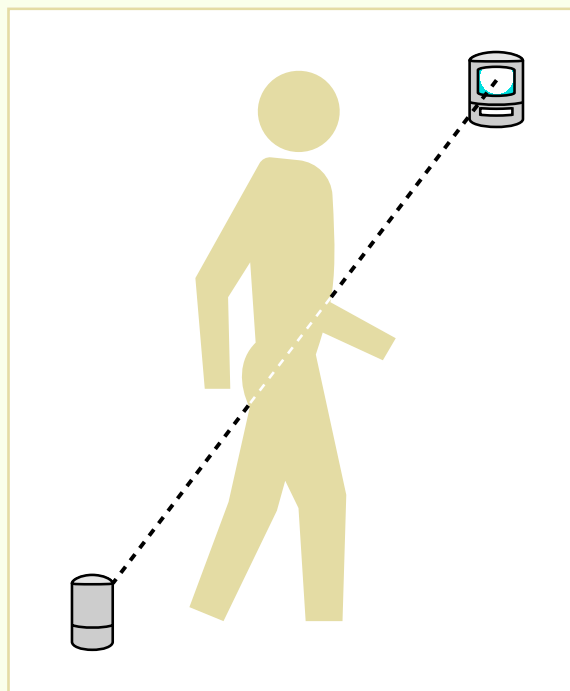
Interior Alarms

Alarm systems installed on the inside of a building to form an interior line of defense are known as *interior alarms*. We'll look at six types.

Pressure mats are alarm pads placed in doorways, hallways, and stairways, or under mats and carpets. A flat switch inside activates the alarm when pressure is applied. These are used to isolate a particular area in a house or office, and one drawback is that they can be set off easily and accidentally.

The *photoelectric beams*, designed primarily for residential use, send out small beams of infrared light from a wall unit (Figure 30). When someone walks through the invisible beam, the circuit is broken and the alarm sounds. They should be used in contained areas so

FIGURE 30—A
Photoelectric Beam



that an intruder can't crawl under or step over the beams, and they should not be used in areas that have large amounts of smoke or dust which might show the light. They require frequent inspection.

Passive infrared systems measure the infrared heat generated in a certain area; that is, they detect body heat. Such alarms are extremely sensi-

tive and can be set off by small animals like mice.

Motion detectors are either ultrasonic waves or microwaves. They fill an area with a preset pattern of sounds or waves. When the pattern is disrupted, the alarm goes off. These systems are not practical for areas where there are pets or small children.

Proximity devices protect safes, file cabinets, and works of art. If a person gets within a certain distance of the object, an alarm is triggered.

Panic buttons can be placed anywhere. Pushing a button activates a silent or regular alarm. These systems are used near cash registers and at bank tellers' windows.

You now have an overview of the vast field of access control. You know that the design and placement of doors and windows are crucial security considerations. You know how landscaping and the location of a parking lot can help or hinder access control. You have studied the major types of perimeter borders and lighting used in security. And you have also explored the challenging world of locks and alarm systems.



Locking It Up! 3

1. What is access control?

2. What line of defense is a silent alarm?

3. From a security standpoint, where is the best place to situate a building?

4. What is natural surveillance?

Check your answers with those on page 83.

SECURITY SURVEYS

An Objective Tool

Security is the *prevention* of damage and loss of any kind, thus assuring the safety of all personnel and property. The security survey and risk analysis, which we will cover in more detail in the next section, are the basic loss-prevention tools to assess potential problems related to personal and physical security. Whatever the size of the organization needing protection, providing security begins with an assessment of the potential for loss. This is the security survey, the chief investigative tool used by security professionals in gathering the information they need.

The security survey is an *objective* instrument. It looks at all the relevant variables at a particular moment, without making judgments about good or bad, right or wrong, safe or unsafe. The survey tries to find the weaknesses in the security setup.

Security Survey versus Insurance Survey

An insurance survey done for property, casualty, and liability insurance purposes is concerned with many of the same things as a security survey. Both look for fire hazards and other potential danger spots that might cause bodily injury. The insurance survey is also concerned about reducing potential loss from theft, but mostly as a cost saving method for itself. A security survey, on the other hand, focuses much more directly on crime-prevention.

Survey Objectives

Surveys are usually customized to meet the needs of the organization and facility being studied, its specific goals, and the unique physical and personnel structure.

A security survey addresses most or all of the following objectives.

- To determine the current risk of injury, death, damage, or destruction by *natural causes* such as a hurricane, a flood, or an earthquake
- To determine the current risk of loss of assets due to criminal activity from *outside* the organization
- To determine the current risk of loss of assets due to criminal activity from *within* the organization
- To assess the current status of physical security relative to property
- To measure how effective current protection policies and standards are
- To measure how well employees follow established security policies
- To audit how effective the organization is at detecting policy violations, fraud, theft, and other violations of procedure
- To study the problems of inventory shortages, cash or property losses, vandalism, or other unexplained crime within the organization

Looking at Everything

A security survey must look at *everything*: it must examine every inch of the physical plant, inside and outside, top to bottom, and it must consider the people who occupy the location for any amount of time, no matter how infrequent or incidental their presence might be. For example, all of the following people would need to be considered.

- Full-time and part-time employees
- Vendors and outside delivery people
- Visitors

- Service providers, such as telephone company technicians and maintenance personnel
- Off-site persons who may have access to the premises via computerized telecommunications

FIGURE 31—Outside delivery personnel and service vehicles should be added to a list of approved access.



A good rule of thumb is the following: if someone enters the building, add him/her to the list of approved access (Figure 31). Security surveys also study all policies and procedures currently in effect in every department.

There is nothing magical about a security survey. In fact, it really consists of common-sense principles.

Creating a Security Survey

Before any security system can be effective, a company must know where the *danger points* are in every aspect of its operation. Such points include any physical, human, or procedural weakness



FIGURE 32—A security survey must include any risky or careless breaches, such as leaving a cash drawer open and unattended.

that make the possibility of damage or loss *in any degree* likely to occur (Figure 32). Effective security systems must also form an accurate estimate of the employer's overall security requirements.

The responsibility for conducting a security survey may be given to the *in-house security force*, *outside security consultants*, or an individual *private security officer* employed

by the company performing the survey, depending upon the type of job.

A Typical Security Survey Form

To help organize the data collected during a security survey, managers often use some kind of standard or customized form; we will illustrate the various sections of a typical survey form. Keep in mind, however, that the actual form used to conduct a survey of a particular organization and its facilities will usually be customized. The first section usually contains general information (Figure 33). The second section deals with the type of private security unit in force at the location (Figure 34).

SECURITY SURVEY			
Facility _____	Survey Date _____		
Address _____			
Facility Manager _____			
Telephone Number _____			
Survey Conducted By _____			
Evaluation Done By _____			
GENERAL INFORMATION			
Operating Hours:	Weekdays	Saturday	Sunday
	Opens _____	Opens _____	Opens _____
	Closes _____	Closes _____	Closes _____
Address & Phone of Police Jurisdiction: _____			

FIGURE 33—Security Survey Form: General Information

SECURITY CONTROLS	
1.	Is a guard service employed to protect this facility? If Yes, Name _____ No. of Guard _____ No. of posts _____
2.	Are after-hours security checks conducted to assure proper storage of classified reports, key controls, monies, checks, etc.? (Yes / No)
3.	Is a property pass system utilized? (Yes / No)
4.	Are items of company property clearly identified with a distinguishing mark that cannot be removed? (Yes / No)
5.	Are yard areas and perimeters included in guard coverage? (Yes / No)
6.	Are all guard tours recorded? (Yes / No)
7.	Are package controls exercised when packages are brought onto or removed from the premises? (Yes / No)
8.	Do the guards have written instructions outlining all security-related policies and procedures? (Yes / No)
9.	What type of training do guards receive?
10.	Are personnel last leaving building charged with checking doors, windows, cabinets, etc.? (Yes / No)
11.	Are adequate security procedures followed during lunch hours? (Yes / No)
Comments: _____	

FIGURE 34—Security Survey Form: Guards/Security Controls

Basic Elements of a Security Survey

A security survey is normally divided into several parts. Let's go over each of them now.

Buildings. Either for a single building, such as a hospital, or for several buildings, as is commonly the case in an industrial or college campus setting.

Outside perimeter. This includes parking lots, walkways, and storage areas.

Traffic. All vehicles that enter the property (*ingress*) and leave the property (*egress*) anytime in a 24-hour period, every day of the week.

Individual departments within the security complex. In a college or university, departments with a wide variety of equipment and materials require safe storage and protection from unlawful use or theft. In an industrial setting, administrative, assembly, and warehousing areas must be secured. An office building usually has many tenants representing a variety of separately owned businesses. In a hospital, there are administrative areas, surgery and emergency rooms, and a variety of other highly specialized units. Each of these presents a separate security risk and has a special security need.

Assessing Loss Potential

The extent of a security survey in each department of a company depends on the potential for damage or loss in that department or area. The greater the potential for loss, the greater the need for tight security. Security professionals assess the potential security problems. For example, many companies, schools, businesses, and organizations deal with large amounts of cash. Even with regular trips to the bank, there may be thousands of dollars on hand at any given time. A hospital unit in which narcotics are kept presents a high degree of risk and a corresponding need for a high degree of protection. Research and development (R&D) departments in an industrial or high-tech facility are also a high security risk,

PROPRIETARY INFORMATION
1. What type of proprietary information is possessed at this facility?
2. How is proprietary information protected?
3. Is some type of "Restricted" marking used? (Yes / No)
4. Are safeguards followed for paper waste, for its collection, and destruction? (Yes / No)
5. Are desk and cabinet tops cleared at the end of the day? (Yes / No)
6. Is management aware of the need for proprietary information? (Yes / No)
Comments: _____

FIGURE 35—Security Survey Form: Proprietary Information

for they often contain what is called *proprietary information* (Figure 35). Such information is owned or patented by an individual or the organization. Many manufacturing processes require the use of high-cost materials, chemicals, or precious metals. Similarly, colleges and universities use valuable computers and other high-tech equipment. In these and other situations you will be required to determine security needs.

You have seen that a security survey must cover these four main areas: (1) buildings, (2) outside perimeter areas, (3) traffic, and (4) individual departments. Let's take a more detailed look at each one of these areas.

Buildings

Most people spend one-third or more of their waking hours at their jobs. You might think that the employees of a company, school, or hospital would be familiar with every inch of the facility in which they spend so much of their time. Security experts know, however, that just the opposite is generally true.

Except for their own area, most employees know little of the physical layout of the rest of the facility or what goes on in the other parts of the company. It is the job of the security professionals to know all about a facility because a thief, especially the professional thief, knows that same building in detail, from roof to basement, inside and out. A thief knows all the security weaknesses at the targeted location. The security professional must know as much as the thief who's trying to break in. A risk analysis will either confirm that the present security is efficient and sufficient or will lead to new and tighter security measures (Figure 36).

When surveying entrance and exit points and procedures, a security consultant must always consider the following elements.

Rooftops

Rooftops are common entry points for thieves and vandals. Skylights and air-conditioning vents are potential openings into the interior of the building. The best way to protect skylights from burglars is to install metal bars, grills, or steel

BUILDING & PERIMETER	
1.	Type of construction? _____
2.	Door construction (hinges, hinge pins, solid core, etc.)? _____
3.	Total number of perimeter entrances? _____
4.	Are all exits and entrances supervised? (Yes / No)
	If not, how are they controlled? _____
5.	Are there perimeter fences? (Yes / No)
	Type? _____
	Height? _____
	Distance from building? _____
	Cleared areas? _____
	Barbed wire top? _____
	Roof or wall areas close to fence? _____
6.	Are there any overpasses or underground passageways? (Yes / No)
7.	Height of windows from the ground? _____
	Are windows adequately protected? (Yes / No)
8.	Are there any roof openings or entry points? (Yes / No)
9.	Are there any floor grates or ventilation openings? (Yes / No)
10.	Are any materials stored outside the building? (Yes / No)
	How are they controlled? _____
11.	Is there adjacent occupancy? (Yes / No)
	Comments: _____

FIGURE 36—Security Survey Form: Building and Perimeter

wire mesh. When mesh is used, it should be firmly secured by machine or roundhead bolts that cannot be removed from the outside. Special burglary-resistant glass should be used in skylights.

Air ducts, vents, and transoms that measure more than eight inches by 12-inches on roofs should have round or flat iron or steel bars secured by non-removable bolts.

It is easy for people to conceal themselves on buildings with flat roofs. Because of this, roof access deserves special attention. If buildings are close to each other, thieves can use the roof of one building as a platform from which to break into the building next door. This requires a thorough security check of adjoining buildings. When such buildings are under separate ownership, only a joint effort by both owners can ensure full security.

Windows

All of a building's windows, no matter how small, are critical to the security of that building. The windows in many older buildings were constructed at a height that makes them too easily accessible from the ground (Figure 37). A relatively

FIGURE 37—The windows in many older buildings were constructed at a height that makes them too easily accessible from the ground.



new feature in commercial and industrial architecture is to have security experts review plans for new construction or remodeling jobs. Among the items that receive a great deal of attention in these security reviews are the location, construction, and locking mechanisms of windows.

Display windows should be made of burglary-resistant material and should be labeled

as such. Some retailers don't like unbreakable or bullet-proof glass because it tends to distort or magnify the items on display. The final decision is usually based on the potential for loss. If the risk is great, the distortion may be worth it.

Another security measure is to paint over side and rear windows that are not needed for vision or display. This keeps outsiders from viewing what is going on inside, and what equipment is present within a facility.

When physical barriers are needed to protect windows, security contractors should use either $\frac{1}{2}$ -inch round steel bars that are five inches apart or one-inch by $\frac{1}{4}$ -inch flat steel bars five inches apart. All bars should be secured in three inches of masonry. Steel wire mesh is also effective when it is at least $\frac{1}{8}$ -inch thick with openings no larger than two inches bolted to the building over the windows. Windows not used for ventilation should be constructed of unbreakable glass panes or of translucent glass bricks.

No window is ever secure if it can be lifted out of its frame. For retail or industrial purposes, windows and glass doors need to be secured with adequate locking mechanisms. The two types of windows that are most vulnerable and should never be used in non-residential settings are louvered windows and crank handle windows. Both are easily broken into by thieves. Even when lever-type locks are installed, just a slight settling of the building is sometimes sufficient to loosen locks or render them inoperable.

Sliding windows and glass doors need attached bars that swing down at a 90-degree angle to brace the unit against the frame or, even better, fit into a slot in the window or door frame.

Metal shutters are one of the best solutions to protecting glass fronts. Shutters can be made either of solid metal or see-through mesh grills, and can be raised or lowered electronically or by hand.

Shipping and Receiving: Product Controls

You've read news stories about thefts that have taken place in broad daylight simply by backing up a truck to the loading dock and hauling merchandise away. Frequently, these cases involve the cooperation of company employees. A security survey must look at all shipping and receiving procedures in force at a site. Can unauthorized persons in fact drive up to the company's loading dock and get away with valuable products and merchandise? Are there sufficient identification and authorization checks to stop such an occurrence? These and other questions must be asked in a thorough security survey (Figure 38).

PRODUCT CONTROLS

1. Are all thefts, shortages, or other possible problems (anonymous letters, crank calls, etc.) reported immediately? (Yes / No)
2. Conduct an inspection of the shipping area and review control policies and procedures.
3. Conduct an inspection of the receiving area and review control policies and procedures.
4. Is there a supervisor in attendance at all times? (Yes / No)
5. Are truck drivers allowed to wander about the area? (Yes / No)
6. Is there a waiting area segregated from the product area? (Yes / No)
 Are there toilet facilities nearby? (Yes / No)
 Is there a water cooler nearby? (Yes / No)
 Is there a pay telephone available? (Yes / No)
7. How are loaded trucks protected? _____
8. Are all trailers secured by seals? (Yes / No)
9. Are seal numbers checked against shipping papers for correctness, both "IN" and "OUT"?
10. What kind of locks are utilized on trailers? _____
11. Is a separate storage location utilized for overages, shortages, damages? (Yes / No)
12. Is parking (employee and visitor vehicles) prohibited from areas adjacent to loading docks or emergency exit doors? (Yes / No)
13. Is any material stored outside a building? (Yes / No)
 If so, how is the material protected? _____
14. Are trailers or shipments received after closing hours? (Yes / No)
 If so, how are these shipments protected? _____
15. Are all loaded trucks or trailers parked within a fenced area? (Yes / No)
16. What product inventory controls are in place? _____

	Loss	Breakage	Returns
Average	_____	_____	_____
Monthly	_____	_____	_____

17. What controls over breakage are in place? _____

FIGURE 38—Security Survey Form: Product Controls

Gates

When the location to be secured is one that is shared by multiple tenants, as in an industrial park setting, there should be some kind of electronic gate control. This is especially true when the nature of the tenants' businesses concerns high-technology research and/or production.

Main Entrances

Obviously, people need to get in and out of a building to do their jobs and conduct business. Visitors and guests are often in a building. A security survey looks at the procedures for controlling access to the building by logging in individuals who enter and accounting for them when they leave the building (Figure 39). Does the building have a properly supervised sign-in log around the clock?

Elevators

Elevators present a special security problem. The survey looks at the kinds of controls that are in place to keep people from using the elevators to gain access to restricted parts of

EMPLOYEE & VISITOR CONTROLS	
1.	Is a daily visitors register maintained? (Yes / No)
2.	Is there a control to prevent visitors from wandering into restricted areas? (Yes / No)
3.	Do employees use identification badges? (Yes / No)
4.	Are visitors issued identification passes? (Yes / No)
5.	What type of visitors are on the premises during off-hours and on weekends?
6.	Do any other company's employees have access to the facility? (Yes / No)
	List of Company Names _____
	Type of Service Performed _____
7.	Are controls over temporary help adequate? (Yes / No)
Comments: _____	

FIGURE 39—Security Survey Form: Employee and Visitor Controls

the building. Procedures for using freight elevators deserve special attention in a security survey.

Interior and Emergency Lighting

A prime enemy of thieves is *light*. Adequate lighting is one of the major deterrents to crime. This is true both outdoors in walkways and parking lots, and inside a building. Interior hallways and work areas require lighting that is adequate to prevent people from easily concealing themselves in the building. A potential danger exists in buildings with no sources of natural light. In the event of a power failure, the entire interior of a large building can go black. If the building is heavily occupied, the sudden darkness can cause panic among those trapped inside. A good security survey will examine the building's provision for automatic emergency lighting—even if the building has backup generators to take over in the event of a power failure (Figure 40).

LIGHTING	
1.	Is perimeter lighting provided? (Yes / No) Is it adequate? (Yes / No)
2.	Is there an emergency lighting system? (Yes / No)
3.	Are all doorways sufficiently lighted? (Yes / No)
4.	Is lighting in use during all night hours? (Yes / No)
5.	Is lighting directed outward toward the perimeter? (Yes / No)
6.	Is lighting adequate for the parking area? (Yes / No)
7.	How is lighting checked? _____
8.	Is interior night lighting adequate for surveillance by night guards (or by municipal law enforcement agents)? (Yes / No)
9.	Are guard posts properly illuminated? (Yes / No)
Comments: _____	

FIGURE 40—Security Survey Form: Lighting

Keys

Every organization must take great care in issuing and tracking keys, especially *master keys*, keys that operate two or more locks in a series. As a general rule, as few master keys as possible should be issued. A security survey will look carefully into existing policies for issuing and accounting for keys (Figure 41).

LOCKING CONTROLS	
1.	Does the facility have adequate control of all keys and a record of all persons who have keys? (Yes / No)
2.	Is a master key system in use? (Yes / No)
3.	How many master keys have been issued? _____
4.	Are all extra keys secured in a locked container? (Yes / No)
5.	Total number of safes? _____
6.	When was the last time combinations were changed on the safes? Date: _____
7.	If the combinations are recorded, where are they stored? Location(s) _____
8.	What is the total number of employees possessing combinations? _____ Names & Titles: _____
9.	What policies and procedures are in place for securing sensitive items, such as monies, precious metals, high dollar value items, narcotics, etc.? _____ _____
10.	Who performs the locksmithing function for the facility? Name _____ Address _____ Phone _____
11.	When was the last key inventory taken? Date: _____
12.	What procedure is followed when keys are lost? _____
	Comments: _____

FIGURE 41—Security Survey Form: Locking Controls

ALARMS	
1. Does this facility utilize any alarm devices? (Yes / No)	
Total number of alarms?	_____
Type	_____
Location	_____
Manufacturer	_____
Remarks	_____
2. Are alarms of central station type connected to police department or outside guard service? (Yes / No)	
3. Is the list of personnel authorized to "open & close" alarmed premises up to date? (Yes / No)	
4. Are local alarms used on exit doors? (Yes / No)	
5. What are the procedures when an alarm is received?	_____ _____
6. Is closed-circuit TV utilized? (Yes / No)	
Comments:	_____

FIGURE 42—Security Survey Form: Alarms

Alarms

Emergency doors should be equipped with alarms so that departure from the building through an unmonitored door alerts security. In addition, a security survey will ask if a system of personal or local alarms is in place (Figure 42). For example, industrial and educational chemistry labs usually have their own alarms to warn everyone in the building of a chemical spill. Cashiers and bank tellers are able to trigger an alarm in the event of a robbery.

Equipment

A major emphasis of every security survey is the manner in which portable equipment is protected. Such equipment includes computers, typewriters, copy machines, fax machines, and video equipment. Is this valuable equipment physically secured in some way? Is expensive equipment located close to outside doors, so that someone can steal it and get away

from the site quickly? These are questions a security survey must address.

After-hours Restrictions

Most buildings are less crowded in the off-hours, usually evening to early morning. This is a time when many areas of the building are particularly vulnerable to unlawful admission, theft, and damage. Here are only a few of the items a thorough security survey will examine.

- Who is *legitimately* allowed to be in the building at night or on weekends?
- Is access to elevators restricted in the off hours?
- Are there late-night and early-morning deliveries to the building? Who receives these deliveries?
- Who collects the trash? When is it removed from the building?
- Does the building have exterior fire escapes and closed fire stairs? Can a floor of the building be reentered from a closed fire door? Outside doors should be set to trigger alarms when used during off hours.
- Are the restrooms open to the public? For security purposes, it may be wiser to arrange a restroom key system for the building personnel.

Open Areas

By *open area* we refer to the area surrounding a building; such areas are part of the complex, but exclude roads. Open areas include parking lots, gardens, patios, outdoor recreation areas, playing fields, and so on. Security measures taken to protect open areas will vary depending on a number of variables; however, the security survey will examine all of the following:

Fences

Are fences necessary? Is the fence properly maintained and effective in keeping people out? Are the locks adequate?

Outside Lighting

One of the best burglary-prevention steps is the provision of adequate lighting. Thieves do not like to be seen. They tend to stay away from areas that are well lighted. An outside area needs to be well lit, particularly around entrances, entrance gates, parking lots, or walkways.

Parking Lots

Parking lots present one of the greatest security challenges. Here you are dealing with both theft of property and personal security. Most hospital and school parking lots allow easy and open access. Unless restricted by permits, the lots are largely unsecured. Even when security officers patrol regularly, plenty of opportunity for wrongdoing remains. Parking permits may have to be issued for good security.

A security survey examines all parking areas to see how well lit they are (Figure 43). Clear pavement markings and well-placed exit signs are also important so that people can easily find their way into and out of the lots. Telephones should be readily available to allow someone to call the security office for help.

VEHICULAR MOVEMENT

1. Is employee parking within the perimeter fence? (Yes / No)
2. Are cars parked abutting interior fences? (Yes / No)
3. Are cars parked adjacent to loading docks, building entrances, etc.? (Yes / No)
4. Do employees have access to cars during work hours? (Yes / No)
5. Are vehicle passes or decals required? (Yes / No)
6. Are guards involved in traffic control? (Yes / No)

Comments: _____

FIGURE 43—Security Survey Form: Vehicular Movement

Traffic in and around the Complex

A security survey will monitor traffic patterns into and out of a complex or installation. Data obtained from such monitoring is essential to setting up an effective security system, to control and channel the volume of traffic.

Traffic must be considered from two angles: *external traffic* and *internal traffic*. Examples of external traffic include customers, sales representatives, vendors, service persons, delivery persons, or visitors of any sort. Internal traffic means the pattern of foot and motorized movement within the boundaries of a complex. The term also includes the flow or movement of personnel, vehicles, products, cash, mail/messages, and information in any form within a facility. A security survey also studies internal traffic patterns, asking questions such as these:

- Where are departments with the heaviest motor and foot traffic located?
- Who is authorized to open and close the gates and doors of the complex?
- Who delivers the mail around the complex, and when?
- Do vendors, caterers, or other salespersons actually come into a building to sell their goods?
- If deliveries are made, who is doing the delivering? How are they identified?
- If outside organizations are allowed to solicit contributions, is there a way of checking out who are these people are?
- Who cleans the building—internal custodial employees or an outside maintenance contractor? Are they given keys? If maintenance is done by company employees, are any security checks done to find out if new employees have a past record of criminal activity? If outside contractors are used, are they bonded?
- Does anyone monitor the credentials of the variety of other people who occasionally enter the premises: coffee service people, tradespeople, telephone company employees, or

others? Are these people allowed unlimited access to the buildings?

- How are outside messenger services monitored? Are messengers allowed to go directly into the interior of the complex unescorted to deliver the message to the addressed party?
- What policies and procedures are in force for handling visitors?
- Are all employees of the company allowed unrestricted access to all parts of the facility by way of the stairs and elevators?
- If outsiders are allowed to use facilities, as in a hospital or college cafeteria, is there any monitoring of this use by security?

Landscaping

A security survey will also look at the way a complex is landscaped. The aim is to see if there are places behind trees and bushes where a would-be thief or rapist might hide. Are trees kept far enough away from buildings to prevent someone from gaining access to windows or the roof of the building by climbing a tree? Is there high grass near buildings that can present a fire hazard in dry seasons?

Outside Storage Areas

Raw materials and finished products stored outdoors are concerns of those conducting a security survey. If the products or materials are at all portable, are they governed by special security measures? Are they kept near a fence? Are they so close to a building that they can be used as a ladder to gain access to windows or the rooftop?

Surveying Potential Loss within a Department

A security survey must assess the potential for loss within an individual department. It must focus especially on the department's vulnerability to theft and malicious damage. The survey looks at each of the following:

- The *equipment* stored in or used by the department

- The possibility that employees' *personal equipment or other property* may be at risk
- The potential for *embezzlement* of company or institutional funds
- *Cash funds* or *negotiable securities*, such as stocks and bonds
- The manner in which *confidential records* are maintained
- The handling of computer equipment and data that is backed up and stored on computer disks and magnetic tapes
- The manner in which prescription-only drugs are stored and dispensed

Specialized Departments and Their Security

Certain departments within a business or institution have individual needs. We certainly cannot cover all of them here. A look at a few typical departments, however, will give you an idea of the kinds of details that a security survey must look for within any individual department.

Security survey of a personnel department. A personnel department contains confidential information about the people who have worked for that organization and about those who currently work there. This information may be on paper and stored in filing cabinets, or it may be stored on a computerized database. Often there are both computer records and duplicate hard-copy (paper) records. A security survey notes how personnel records are kept, where they are kept, and whether it is possible for the wrong people to gain access to them (Figure 44).

Security survey of an accounting department. An accounting department has full supervision of a company's or institution's money. That is a major responsibility. It also presents serious temptations to the unscrupulous. All accounting departments have some kind of security system. A security survey examines these procedures to see if they are being followed and if they are effective in preventing loss (Figure 45).

PERSONNEL QUESTIONS

1. Are background investigations conducted on all employees? (Yes / No)
2. Are background investigations conducted on employees who:
 handle products? (Yes / No)
 are engaged in other sensitive duties? (Yes / No)
 are in supervisory positions? (Yes / No)
3. Who conducts background investigations? _____
4. Do newly hired employees execute a corporate briefing form for inclusion in their personnel files? (Yes / No)
5. Are exit interviews conducted when employees are terminating? (Yes / No)
6. Is a program followed to ensure return of keys, credit cards, I.D. cards, manuals, and other company property? (Yes / No)

Comments: _____

FIGURE 44—Security Survey Form: Personnel Security

Here are some examples of the questions a survey may ask.

- How accessible is the cashier's window to hallways, elevators, and stairs? Would it be relatively easy for a thief to take money and run?
- What procedures are in place to prevent the cashier from forging vouchers and pocketing the cash?
- How are incoming funds handled so that an employee cannot cash checks made out to the company or organization?
- Is the billing procedure monitored?
- What rules are in effect for the withdrawal of company funds from bank accounts?
- How often are accounts audited and by whom?

Security survey of a data-processing department. Data processing is a critically important part of the modern company

MONEY CONTROLS	
1.	How much cash is maintained on the premises? _____
2.	What are the locations and types of cash repositories? _____
3.	Review all cashier functions and procedures. _____
4.	What protective measures are taken for money deliveries to the facility? _____ To the bank? _____
5.	If an armored car service is utilized, list name and address: _____ _____
6.	Does the facility have a procedure to control the cashing of personal checks? (Yes / No)
7.	Are checks immediately stamped with a restricted endorsement? (Yes / No)
8.	Are employee payroll checks properly accounted for and stored in a locked container (including lunch hours), until distributed to the employee or the em- ployee's supervisor? (Yes / No)
Comments: _____	

FIGURE 45—Security Survey Form: Money Controls

or institution. A great deal of the financial stability of the organization depends on the accuracy of the computer programs that have been set in place to handle all facets of the operation. A security survey of the data-processing department focuses on how easy it would be for an unauthorized person to gain access to the computer operations center and to various computer programs.

Security survey of a purchasing department. The policies and procedures of the purchasing operation will vary from organization to organization. Purchasing agents, like controllers, have a great deal of responsibility. They also face many temptations, especially in large companies and institutions. Outside vendors and suppliers are eager to gain an advantage over their competitors. To gain that advantage, they may offer improper cash, gifts, or other incentives to purchasing agents. Some kind of monitoring or supervision of the purchasing function should take place to reduce the temptation to favor certain suppliers.

Security survey and miscellaneous items. No one who designs a security survey can know in advance all the details

that will need to be checked. Inevitably some miscellaneous areas will prove important. These areas might include the following:

- Unauthorized use of postage meters, a common form of theft and loss to businesses and organizations
- Personal use of telephones
- Pilfering of office supplies, tools, and other materials, such as toilet paper, napkins, cleaning materials, and so on
- Regulations governing the borrowing and returning of equipment such as computers, VCRs, and dictating machines

Security Survey Contents Summary

Most companies lose more money from employee theft than from theft by outsiders. A thorough security survey examines all parts of an operation. In many cases, the recommendations of a security survey are matters of common sense. If, in the surveyor's best judgment, a particular policy or procedure does not seem wise or proper, a closer look at that operation is in order.

Organizations should conduct annual surveys of their security status. Between surveys, the security staff must keep accurate and detailed records of everything that relates to the security of the site. You never know how a seemingly small and insignificant bit of information may turn out to be the key piece that makes a large investigative puzzle fit together.

You've examined briefly the concepts of security surveys. You now have a better understanding of why security surveys are conducted and the issues they need to address. They are thorough because the people who try to breach security are often highly professional themselves. To prevent problems, the security staff must be even more thorough and professional.

RISK ANALYSIS

A Subjective Tool

We have been examining all the areas that must be included in a security survey. Once the data from the security survey have been collected, three more steps remain in the total process, and these steps make up the *risk analysis*. Unlike a security survey, which is an objective tool, a risk analysis is a subjective tool. An expert analyst takes the information gathered during the survey, studies it in detail, and makes recommendations based on what the survey reveals. Analysis involves judgments about what is good and not so good, what is safe and unsafe, and what are the right and wrong ways to conduct business. Specifically, the surveyors must:

1. *Analyze* the data.
2. *Recommend* changes, if necessary.
3. *Implement* new security measures and procedures.

These three steps together form the second major part of the security survey/risk analysis process. Let's look at each of these three steps individually.

Analysis

You've seen that before an effective security program can be set in place, top management must thoroughly investigate the risks that exist at every level of the operation. These risks may be from natural or man-made forces. They may be the result of criminal activity, accidental causes, or acts of nature.

Taking all of the information collected in the course of the security survey, those charged with analyzing the data usually set up a system of priorities. Areas most critical for the survival of the business or institution are given top priority for protection (Figure 46). Non-critical areas are assigned a lesser priority.

Sometimes the level of priority can shift in the course of a single 24-hour period. Take the example of a major department store. During hours when the store is open for business, the

STATE UNIVERSITY				
	Very High Priority	High Priority	Some Priority	Low Priority
CAMPUS LOCATIONS				
Main Gate			X	
Cafeteria			X	
Library			X	
Research Labs	X			
Chemistry Labs		X		
Computer Labs		X		
Playing Fields				X
Administration Building		X		
Classrooms			X	
Dormitories	X			
Bookstore & Other Stores		X		
Athletic Dept.			X	
Auditoriums			X	
Surrounding Grounds (after dark)			X	

FIGURE 46—Sample Priority Assignments

security staff may give highest priority to the jewelry and camera departments. When the store closes, top priority shifts to the office where the day's receipts are stored in a locked safe. All these variables make up the risk analysis, which is the basis for a security report and recommendations.

An element of the security survey we have not yet mentioned is the collection of *past records*. Security surveyors also need to know how much loss the organization has experienced in all areas since the last survey was conducted. They should then compare these figures with the loss history over the past three to five years.

Recommendations: The Security Survey Report

Surveyors and analysts always compile a complete report of their findings upon conclusion of a security survey. The report may take one of the following forms.

- A one- or two-page cover letter attached to the filled-in security survey form itself
- A description of problem areas discovered, along with recommendations for changes and improvements in the security measures currently in force
- A complete and detailed description of *all* findings, along with the results of the risk analysis, and recommendations, as needed, for improvements, changes, further study

Unless the organization requests otherwise, the more detail the final report provides, the better. The annual security survey is both a *practical* and a *historical*, or *archival*, document. It is practical in the sense that it has here-and-now value as a security assessment instrument. It is historical in the sense that it will be kept on file and compared with future surveys. These annual comparisons of past and present studies let surveyors observe security-related trends. Are problems increasing over time, or is there a measurable improvement? In other words, are the security measures that have been taken effective?

Implementation

Writing up a great report is only part of the battle. Security consultants must also work to bring about the appropriate changes. Whether or not to make such changes, however, will depend on a careful comparison of the cost of implementing new measures versus the potential for loss if the measures are not implemented. This comparison and decision-making process is one of the main objectives of risk analysis.

A factor that has to be weighed in the decision to implement recommended security measures is the cost against the expected benefit. This is accomplished with a cost-benefit analysis. Every business and organization keeps a close eye on the financial *bottom line*. Not everything desirable is affordable. This applies to security as well as everything else.

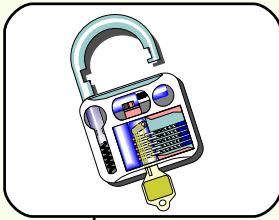
The current level of security technology makes it possible to reduce greatly the possibility of loss. But, modern technology has a high initial price tag. One decision every organization has to make is: *can we afford the security we want and need?*

The answer to this question depends on three things:

1. The likelihood of future loss
2. The potential cost of the loss
3. The estimated cost of solving the problem

If you were Chief Financial Officer of a company, you would need to know each of these factors to make a decision.

All of the above-mentioned items and areas of concern are central to a security survey and risk analysis. The answers to the survey's questions become the basis of future security planning. As you can see, a security survey of a building has the potential to save a company or institution many thousands of dollars that would have otherwise been lost, stolen, or spent to repair damage.



Locking It Up! 4

1. *True or False?* A security survey doesn't usually evaluate visitor access to a building.

2. What is the prime enemy of thieves?

3. What is an open area?

4. *True or False?* A vendor is an example of internal traffic.


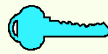
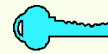
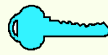

5. What are the four steps in a security survey?

Check your answers with those on page 84.

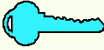

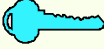

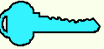


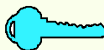
THE KEY TO SUCCESS

Now you have a detailed overview of the security field in which you play an important part. You've learned about threats to a business and a home, and how to create access control. In this complicated environment it's necessary to take many of these factors into consideration when making security decisions.









KEY POINTS TO REMEMBER

-  Locksmithing is an ancient tradition. It is more vital than ever with the increase in crime against both home and industry.
-  Crime is an action or an omission forbidden by law and punishable by the government. A criminal omission occurs when something necessary for the safety and welfare of people or environment was not done.
-  Criminal actions are grouped into three categories: felonies, misdemeanors and infractions. Felonies are criminal acts punishable by imprisonment of more than one year, or even the death penalty. Misdemeanors are less serious crimes punishable by fines and/or short term jail sentences. An infraction is a violation of the law. It is an illegal action, not necessarily a criminal one.
-  There are many types of crimes. Each year, the Department of Justice compiles statistics about eight major kinds of crime in its *Uniform Crime Report*. This report is a valuable tool for both law enforcement officers as well as others working the field of security and interested in discovering: the number of crimes committed; the crime rate for each type of offense; the arrest rate by region; the arrest rate by sex; the arrest rate by age; and the arrest rate by race. These statistics can help identify the factors which contribute to crime. Knowing these factors can help you as a locksmith anticipate and try to prevent crime in a wide variety of environments.
-  Burglary is the unlawful entry of a structure with the intent to commit a felony or theft. Between 1984 and 1988 there was a 32.8 percent increase in the number of reported burglaries. The typical burglar is male (92%), young (67% are between 15

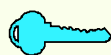
and 19). Teens and young adults look for easy targets; they are hit-and-run artists and are still considered amateurs.

-  The target is the property, person, or information to be protected.
-  Adults in their 20s and 30s are more skilled and cautious burglars. They usually work in pairs, take time to study their target, and know a family's schedule. They also have a "cover" or excuse to account for their presence in a neighborhood.
-  Professional thieves limit their activities to expensive homes in upscale neighborhoods. They steal only the most valuable items. One burglary is very profitable.
-  Four of the most common precautions against burglary are: (1) Target hardening, using lights, locks, fences, alarms and security personnel to make illegal entry difficult. (2) Routine patrols and the checking of security equipment to keep it in good working order. (3) A remote alarm system which is monitored by a security company and signals a break-in. (4) Tagging merchandise with electronic tags, stickers or sensors that will trigger an alarm if not properly removed.
-  For retail stores, shoplifting is a primary concern. In 1988 approximately one million offenses were reported to police. It's estimated that only one-third of all detected shoplifting is reported to police. In 1988 the average shoplifting incident resulted in the loss of \$100. This represents \$300 million in stolen merchandise annually.
-  Shoplifting, also called retail shrinkage, is the result of both internal (employee) and external (customer) theft. As much as 25 percent may be added to the purchase price of goods to cover a store's shoplifting losses. Since police do not have the manpower to devote to this problem, it is clearly an area where security can have an impact.
-  Retailers fear that aggressive anti-shoplifting measures will result in negative publicity. Nor do they want to make a mistake and detain an innocent person. Thus the emphasis is on the prevention of shoplifting.
-  Supermarkets, large variety stores, drug stores and neighborhood convenience stores are more vulnerable to shoplifting and petty theft than a jewelry store in a shopping mall. These stores have a large inventory of small, easily concealable items which makes them vulnerable.

-  Profiles vary, but there are six categories of people who shoplift: (1) juveniles; (2) adult female homemakers; (3) professional thieves; (4) kleptomaniacs; (5) privileged shoppers and; (6) employees.
-  All modern industry has a variety of security needs. People must be monitored going in and out. Inventory and raw materials must be protected from theft. Opportunity for employee theft must be reduced. Research and development projects need to be guarded.
-  The computer and electronic industries face great security challenges. Access to computer research files must be protected from outside computer links by unauthorized persons. Companies must guard against industrial espionage, which threatens their secret product development projects. This type of information is called proprietary. A company that gets a new product to market first has a huge competitive advantage, and thus needs dependable security.
-  Access control involves three types of security. (1) Physical security protects a property by use of gate guards, patrol alarms, locks, fences and lighting. (2) Access control of property guards every way in and out of that property. (3) Information security protects information and records from fire, shredding and flood. It also prevents theft and protects confidential information from theft, espionage and sabotage.
-  The third type of access control is personnel security. Employees, visitors, students, customers, airport travellers, business executives, sports figures, movie stars all require protection in a variety of situations. Security will involve identification badges, parking permits, visitor escorts, and internal building security.
-  In access control, the target is surrounded by two lines of defense: the exterior or proximate line of defense and the interior lines of defense. The exterior line of defense includes the walls, fences or gates surrounding a facility. The interior lines of defense will include locked elevators, doors and safes, silent alarms and patrols within a building.
-  Natural surveillance refers to the area that can be seen by the naked eye. This is critical for crime prevention. An area that is clearly visible and well lit will be a deterrent to a criminal.

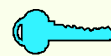
-  A policy manual is developed by the security professional to cover every question of security for a company. It must have management support, both in recognizing the importance of access control and in funding.
-  Building design is critical to access control. Any building can be entered from six directions: the roof, the flooring and through the four sides (doors, windows, fire escapes, vents, delivery or trash portals, and storm sewers).
-  Building placement, the proximate line of defense, is also critical for building security. The middle of a lot, with a clear well-lit view on all four sides is ideal. Physical barriers, such as man-made fences, walls, grills or bars and natural barriers such as water, mountains, etc., are all part of environmental design considerations.
-  Locks and lighting are further aspects of environmental design that contribute to building security. There are many types of lighting, including stationary lights that flood an area with light and are operated either manually or automatically. A second lighting type is movable, as a supplement and for emergency lighting when other systems shut down. For security purposes sodium vapor lamps are the best.
-  Alarms are also key to enhanced security. There are three main types: local, which sounds within the facility only; central, which are connected to the local police station; and central proprietary alarms, owned and operated by an individual business and monitored by security officers.
-  There are five types of perimeter alarms: *magnetic contacts*, *plunger contacts*, *foiling alarms*, *screen alarms*, and *vibration detectors*.
-  There are six types of interior alarms: *pressure mats*, *photoelectric beam systems*, *passive infrared systems*, *motion detectors*, *proximity devices*, and *panic buttons*.
-  Many of the same precautions used in business security apply in the home. Darkness hides the thief, so lights are of crucial importance. Floodlights, lights on timers, and motion lights can help make a home more “burglar proof.” Locks on doors and windows and landscaping details are also part of home security.

Fire is also a threat to home security. A few guidelines will help make a home more secure. Smoke alarms, fire extinguishers,

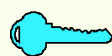


cleaning flues and chimneys, checking electrical outlets, emergency numbers near the phone, care taken with space heaters, care with flammable material, and teaching children fire safety all contribute to a secure home environment.

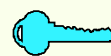
Window bars can make a home more secure, although the keys to open them should be kept handy in case of an emergency.



In addition to locks, doors can be made secure with a door viewer or peephole that allow a homeowner to see who is at the door before opening it. Door chains and guards permit opening a door without admitting the visitor. Doors may also be secured by steel bars.

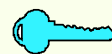


The *security survey* and *risk analysis* are the basic loss-prevention tools to assess potential problems relating to



personal and physical security. A security survey looks at a business and assesses its potential for loss. It makes no judgments; it is objective. Its sole purpose is to look at weaknesses in security.

Risk analysis is a subjective document. A security expert examines the security survey and makes recommendations based on that survey.



Do You Know Now. . .

Below are the answers to the questions asked at the beginning of this study unit.

What is target hardening?

A *target* is the property, person, or information that is the goal of a criminal's attack. *Target hardening* refers to the process where all entry points are guarded by visible means of security. Some of these means include lights, locks, fencing, alarms, and security officers. All these security measures make entry difficult, thus hardening the target against attack.

What is access control?

Criminals take advantage of weaknesses in security to commit crimes. *Access control* involves measures taken which restrict access to a target. Any hardware, techniques and personnel that limit the access to a building, to restricted information or to a certain person are part of access control. This control covers a wide variety of security measures, including physical, information, and personnel security.

What is risk analysis?

A *risk analysis* is a subjective overview of a security survey. A security survey looks at all the objective precautions taken by an organization. A risk analysis looks at the survey, analyzes the information, and makes security recommendations based on the security survey. The risk analysis also includes the weighing of benefits versus cost.

Locking It Up! Answers

1

1. The FBI Uniform Crime Report is a series of reports and statistics about crime published annually by the U.S. Department of Justice.
2. True
3. shoplifting and petty theft
4. employees
5. Any two of the following are acceptable:
 - Target hardening
 - Routine patrols and checking of equipment
 - Remote alarm systems
 - Tagging target merchandise
6. The second largest group of shoplifters is adult married women with children.

2

1. True
2. False
3. Shrinkage is the term used in business for the kind of losses created by employee and external theft.

Shrinkage includes loss of merchandise, cash, jewels, tools, equipment, or any property not belonging to the person who takes it.

4. Sabotage is any malicious and intentional damage to machinery, tools, property, personnel, or production procedures. The basic aim of sabotage is to disrupt a company's ability to function normally and produce its goods or provide its services to its customers.

3

1. Access control is any hardware, techniques, and personnel that limit one's ability to get into a building, to restricted information, or to a certain person.
2. third, or interior, line of defense
3. The best place to situate a building from a security standpoint is in the middle of a lot.
4. Natural surveillance refers to the area that can be seen by the naked eye.

4

1. False
2. light
3. An open area is the area surrounding a building. It includes parking lots, gardens, patios, outdoor recreation areas, playing fields, etc.
4. False
5. data collection
analysis
recommendation
implementation

Home and Business Security

EXAMINATION NUMBER:

03100801

Whichever method you use in submitting your exam answers to the school, you must use the number above.

For the quickest test results, go to
<http://www.takeexamonline.com>

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school for grading*, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1-20: Select the one best answer to each question.

1. *Shoplifting* refers to

- A. an employee stealing cash from a cash register.
- B. the removal of merchandise from a store by mistake.
- C. passing a bad check to pay for merchandise in a retail store.
- D. concealing merchandise on one's person and leaving a store without paying for it.

2. What percentage of illegal entries is made through doors?

- A. 25 %
- B. 50%
- C. 65%
- D. 75%

3. The last step in a security survey is
- A. analysis.
 - B. follow-up.
 - C. data collection.
 - D. implementation.
4. Security surveys should be done
- A. every month.
 - B. every six months.
 - C. every year.
 - D. every two years.
5. A gate is an example of
- A. physical security.
 - B. information security.
 - C. personnel security.
 - D. communications security.
6. What percentage of employees will never steal?
- A. 10–20%
 - B. 30–40%
 - C. 20–30%
 - D. 40–50%
7. Which if the following is the most commonly used perimeter alarm?
- A. Magnetic contacts
 - B. Foiling
 - C. Vibration detector
 - D. Pressure mat
8. Retail vulnerability to shoplifting depends on which two key factors?
- A. The location of the store and its electronic security system
 - B. The type of store and the nature of its clientele
 - C. The number of cash registers and surveillance cameras
 - D. The store's exterior and interior lighting
9. What is the most frequent month for burglaries?
- A. February
 - B. June
 - C. August
 - D. December
10. The largest percentage of retail thieves are between the ages of
- A. 65–80.
 - B. 30–45.
 - C. 50–65.
 - D. 12–25.
11. How many ways are there to penetrate a building?
- A. Two
 - B. Four
 - C. Six
 - D. Eight

12. The decision to implement a recommended security measure is usually based on
- A. the cost of equipment and labor.
 - B. a cost-benefit analysis.**
 - C. the need for the recommended equipment.
 - D. security department priorities.
13. Which of the following is a basic loss-prevention tool used in assessing potential problem areas?
- A. Insurance analysis
 - B. Security survey**
 - C. Proprietary information
 - D. Crime prevention statistics
14. Stealing trade secrets comes under the general heading of
- A. shrinkage.
 - B. sabotage.
 - C. external theft.
 - D. industrial espionage.**
15. The term used in business for the kind of losses created by employee theft and external theft is
- A. larceny.
 - B. burglary.
 - C. grand theft.
 - D. shrinkage.**
16. The key to solving the retail shrinkage problem is
- A. prevention.**
 - B. parental discipline.
 - C. prosecution.
 - D. restricting teenage access to stores.
17. What is the first line of defense against intrusion from external sources?
- A. Target
 - B. Interior lines of defense
 - C. Perimeter lines of defense**
 - D. Proximate lines of defense
18. How do criminals most often gain access to a building?
- A. Roof
 - B. Window
 - C. Floor crawlspace
 - D. Door**
19. Walls, lights, locks, and alarms are examples of
- A. access control hardware.**
 - B. access control techniques.
 - C. personnel security.
 - D. information security.

20. A data-processing department survey is mainly concerned with the potential loss of

- A. vital computer programs and sensitive data stored in the computers.**
- B. computer supplies, such as diskettes, paper, and so on.
- C. personal use of computer time and equipment by department employees.
- D. keeping former employees from revealing trade secrets.

COMING ATTRACTIONS

Now that you have a firm understanding of the importance of security in home and business environments, it's time to move on to your next study unit. In Study Unit 9 you'll learn all about automotive locks, their construction and operation, and how to install and repair them. You'll also review the coding system used to cut automotive keys and learn about emergency car opening. See you there!

Professional Locksmith

Study Unit 9

Automotive Locks

Preview

Welcome to the study unit on auto locks! The repair and replacement of auto locks is a lucrative specialty service pursued by many locksmiths. Even if you don't wish to become an expert in this area of locksmithing, you should understand the operation of auto lock cylinders and be able to perform simple repairs for your customers.

This study unit is designed to teach you about the construction and operation of lock cylinders found in most car models. While car models vary widely among manufacturers and model years, the basic lock mechanisms used on cars have been the same for many years. So, we'll begin with a discussion of these various lock mechanisms. You'll be happy to learn that the same disk tumbler and pin tumbler mechanisms you're already familiar with are the most common types used in cars!

Next, we'll learn about the construction of car doors, trunks, and steering columns. This basic information is necessary in order for you to understand how to work with auto locks. Then, we'll cover a general procedure for the removal and replacement of auto lock cylinders. We'll discuss why cylinders may need to be replaced, where to find them in the car, and how to gain access for their removal.

Next, we'll review the key coding system used to cut automotive keys. We'll discuss the types of key blanks used by different auto manufacturers, where to find the key codes on some popular car models, and how to interpret key codes using popular reference books such as the Reed Code Book. Finally, we'll cover the use of key code cutting machines.

In the next segment of the text, we'll discuss emergency car opening. Occasionally, when keys are lost or locked inside a vehicle, it may be necessary to use special techniques to open the car door. We'll cover these car-opening methods (and the tools needed to do them!) for a variety of car models.

Then, we'll cover the important automobile security issues facing today's car owners. Rising crime rates have led the manufacturers of both cars and security devices to invent an ever-expanding variety of anti-theft items. We'll discuss GM's VATS system, physical locking devices, and electronic alarms. We'll also offer some common-sense recommendations on how to prevent car thefts, even if you don't have an expensive electronic protection system!

When you complete this study unit, you'll be able to

- Identify the various types of locks used in an automobile
- Describe the operation of the locking mechanism for a typical car door, trunk, and ignition assembly
- Explain the general procedure for replacing a typical automobile door, trunk, and ignition lock
- Discuss the various methods used to open a locked vehicle in an emergency situation
- Explain how replacement keys are made for automobiles
- Discuss the coding system used for automobile keys
- Explain the operation of the GM VATS system
- Discuss the most common types of automobile security systems

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Automotive Locks

Do You Know . . .

What is a *primary key*?

What is a *krypton light*?

What does *VATS* stand for?

In this study unit, you'll find the answers to these and many other questions about automotive locks.

INTRODUCTION

A Growing Specialty Field

Automobiles are found in vast numbers in every area of the world, and more and more are being produced each year. Most average families own more than one vehicle, and a typical automobile contains several locks. When we hear the phrase "automotive locks," most of us automatically think of door and ignition locks. However, an automobile can also have a trunk or rear hatch lock, a glove compartment lock, a gas cap lock, and possibly an anti-theft alarm system.

So, when you consider that a typical automobile can contain as many as seven locks (as well as an electronic alarm system), you can see that a very lucrative market exists for a qualified locksmith in auto lock servicing! Even the smallest town provides many opportunities for auto lock repair and maintenance.

The Unique Problems of Auto Locks

Automotive lock mechanisms are much the same as the lock mechanisms in residential doors, padlocks, and so on. However, the servicing needs of the auto lock are unique in

the field of locksmithing. For example, in the average car, the driver's side door lock and the ignition lock are used every day (every time the owner enters the car or starts the engine). Since these locks are used so often, they tend to wear excessively. Typical problems include pin wear (which causes the key to work poorly or not at all), broken parts, "freezing" due to lack of lubrication, and even broken keys.

In contrast, there are other locks on a vehicle that are rarely used. These locks include passenger door locks and the glove compartment lock. Try to remember the last time you used a key to open a glove compartment or the passenger side door! Because these locks aren't used often, severe corrosion, frozen components, or excessive dirt buildup are typical. All of these situations will prevent the lock from working and will require servicing by a qualified professional locksmith.

A Golden Opportunity for Locksmiths

As a locksmith, you'll frequently be called on to service and replace automobile locks. Auto lock service is one of the fastest growing and most profitable areas of the locksmithing field. Again, think about how many cars are already on the road. Now, consider the rate at which new cars are being sold each year. Multiply all those cars by the number of locks found on a single car. Consider the growing crime rate and the increasing popularity of auto alarm systems. When you calculate the number of different locks, you can see that a tremendous volume of work exists for locksmiths specializing in auto work. Let's take a look at some of the typical services a locksmith will be asked to perform on a vehicle.

Typical Vehicle Services

The most common reason a locksmith is called to assist with an automobile is the *lockout*. Almost everyone has had the experience of locking their keys inside the car at one time or another. Since you're normally in and out of your vehicle several times in a single day, it's very easy to do this. For most customers, this is a minor inconvenience. However, in some cases it may be an emergency. For example, a small child may be locked inside the car. In such a case, it's vitally

important for the locksmith to be able to get into the car quickly and efficiently.

The second most common occurrence is *lost car keys*. If you're like most people, you've probably often misplaced your car keys only to find them after a few minutes of searching. However, sometimes keys are lost permanently or even stolen. If the customer doesn't have a duplicate set of keys, he or she will need the services of the locksmith. In most cases, the locksmith can travel directly to the scene, bringing along all the necessary tools to create a new key for the customer.

Another typical service locksmiths perform is *rekeying*. Some customers may decide that they would like to have just one key to operate all the locks in their car (some cars are designed this way at the factory, but others aren't). Or, a customer may want to have locks rekeyed after purchasing a used car. This will ensure that the new owner has the *only* set of keys that will operate the vehicle.

Locksmiths are often called upon to install security systems in vehicles. This is especially true if a customer has had a past experience with vehicle crime (a theft or attempted break-in). For many higher-end car models, an alarm system is installed at the factory. However, for most cars an alarm system is only an option. The customer may decide to have a system installed long after purchase. The installation of auto alarms has been made much easier over the past few years by the creation of new, simpler technology. Alarm installation is one of the fastest-growing and most profitable specialty areas for locksmiths.

Finally, a locksmith may be needed to repair or replace a defective or inoperative lock. Like all mechanical devices, locks are subject to wear and component failure. As we discussed earlier, vehicle locks are often the victims of poor maintenance, road dirt, and harsh weather conditions. A locksmith may be needed to clean or lubricate a lock, replace worn or broken parts, remove a foreign object or a broken key from a lock, "defrost" a lock in very cold weather, or totally replace a lock that has ceased to operate. Sometimes, a key may be so worn that it no longer operates the lock, in which case the locksmith will simply cut a new one.

What Will You Need to Know?

Looking at all the situations previously discussed, you may be thinking, “How am I going to learn to do all of that?” The answer is, you *already know how* to do most of it! The lock mechanisms used in vehicles are basically the same as those you’ve already studied. All of the basic locksmithing techniques—lockpicking, key duplicating, key impressioning, rekeying, and so on, are exactly the same when used with a vehicle. The only new information you need is *how to apply your locksmithing skills* to a car. Let’s take a look at some of the things a locksmith will have to know in order to work on a vehicle.

First of all, if you would like to someday specialize in auto lock work, it naturally will be helpful to be familiar with the most common names and manufacturers of automobiles. While you don’t have to be an expert in the field of automobiles, when a customer calls you with a problem, you should recognize the name of their car, be familiar with its appearance, know where the locks are located on it, and know what types of locks are installed by the car’s manufacturer. In fact, this is basic information every locksmith should know, even if you don’t do much auto work at all.

Due to the changing needs of their customers, auto manufacturers frequently change the design of their products. To become an expert in the auto locksmithing field, you must keep up with the constant changes made to auto locks and locking systems every year. (Most of the changes are made to increase vehicle security and reduce thefts.) However, there are so many different vehicles on the road today (both domestic and foreign) that it’s virtually impossible for a locksmith to memorize servicing details about every vehicle.

For this reason, most professional locksmiths rely on *reference manuals* to supplement their locksmithing knowledge. Remember, most car locks operate on the same basic principles. If you understand these basic principles, you can look up the other details you may need to know in a reference manual. There’s absolutely no “shame” in using these manuals to help you in your work! The only shame would be attempting to work on a vehicle without having enough information to complete the job properly.

One useful manual is the original manufacturer's service manual. Every car manufacturer publishes repair manuals for their vehicles. A repair manual will have detailed information on the repair of all the systems in that automobile. Similar repair manuals are also published by several independent companies. These manuals can be purchased through auto dealers, at an auto parts store, or from a bookstore. Auto service manuals are especially useful for obtaining the proper replacement procedures for locks. They can also provide excellent illustrations of the inside locking mechanisms present in a car's door. However, they don't provide much information on how to open a locked car or on how to service the lock mechanism itself.

For information on how to open a locked car, many locksmithing suppliers publish manuals of their own that contain the exact procedures for opening locked vehicles and repairing lock mechanisms. These manuals are extremely useful, but they're also expensive and must be updated annually to include new car models. However, if you intend to do a lot of automotive lock work, they may be well worth the investment.

Experienced locksmiths may be able to make many common repairs without the aid of a service manual. However, even the most experienced locksmith likes to keep reference materials available for unusual circumstances. Over the course of your locksmithing career, you may even compile "tips" and "tricks" of your own in a personal service manual!

The purpose of this study unit will be to teach you the basic information you'll need to enter the lucrative field of automobile lock servicing. You'll learn about the construction and operation of car locking mechanisms. You'll learn to disassemble a standard-style car door, how to find the locking mechanism inside the door, and how to replace lock cylinders in a vehicle. You'll learn about the various types of automobile locks and how they operate. You'll also look at the various ways that a locked vehicle can be opened without keys.

As stated earlier, because there are hundreds of different model cars on the road today, it isn't practical for us to show you how to work on each and every one of them, especially since most vehicle models change slightly in design from year to year.

For this reason, the procedures in this study unit are *general* procedures for working on automobiles. These general procedures can be applied to many vehicles. If you find you need

more specific information to work on a particular car model, you can easily find the information you need in the service manual or owner's manual for the car.

Now that you have a general idea of how locksmiths work with vehicles and the types of opportunities that are available, let's take a look at how automotive locks operate on a typical vehicle.

OVERVIEW OF AUTOMOTIVE LOCKS

Automotive Lock Location

A typical automobile has locks to secure the car doors, trunk, glove compartment, and, of course, the ignition switch. Each of these systems will contain a lock cylinder as well as a latching mechanism. To get a better idea of exactly where the locks are located, let's take a quick look at the design of a typical auto-mobile (Figure 1).

Doors

The doors of an automobile allow us to enter and exit the vehicle. Most automobiles have either two or four doors. Every door has a latching mechanism to hold it closed (just like a

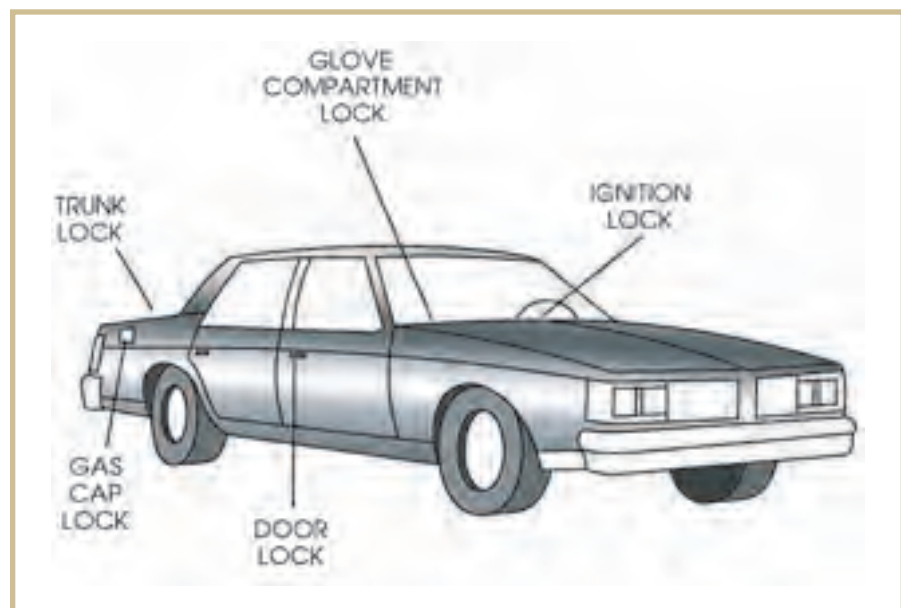


FIGURE 1—This figure shows the placement of locks in a typical automobile.

residential door lock). However, in most cases, only the two front doors (driver's side and passenger) will contain a *lock cylinder* into which a key is inserted. Thus, in most cars, only the two front doors can be unlocked with a key from outside the vehicle. If the vehicle is a four-door, the two rear doors will lock only from the inside.

Trunks and Hatches

An automobile *trunk* is the storage compartment at the rear of a vehicle. A *hatch* is the rear access to the passenger compartment and storage area in a station wagon or minivan. On most vehicles the trunk consists of a hinged panel that can be lifted up to expose a storage compartment beneath. The hinged trunk panel contains a latching mechanism and a lock cylinder that prevents unwanted access to the trunk compartment. A hatch uses a similar locking mechanism and lock cylinder, even though it may open a little differently from a trunk.

Glove Compartments

In most automobiles you'll find a small storage compartment inside the vehicle, usually located in the dashboard at the passenger side of the vehicle. In years past, this compartment was usually used to store gloves, hence the name *glove compartment*. Today, few people keep gloves here, but the compartment is commonly used to store items such as a car registration, insurance card, owner's manual, and any number of small personal objects. The glove compartment has a hinged door that's secured by a lock assembly to prevent unwanted entry.

Ignition Switches

Finally, we come to the most important lock on an automobile, the *ignition lock*. The ignition lock is typically located in the steering column. When the proper key is inserted and turned, the engine will start. The ignition lock doesn't contain a latching mechanism, since there's no door or panel to be held shut. Instead, the ignition lock cylinder simply prevents a person from starting the car's engine unless he or she has the proper key, thus providing security from theft. The ignition lock also locks the steering wheel of the car, preventing it from being turned until the proper key is inserted. In some older car models, you may find the ignition cylinder located in the dashboard or some other location within easy reach of

the driver. However, the most common location is to the right-hand side of the steering wheel.

In most cases, the basic operation of automobile locks is the same regardless of where they're used. This operation will become much clearer when we look at the individual locking mechanisms later in this study unit. However, before we look at auto lock mechanisms, let's take a moment to review the types of lock cylinders used in automobiles.

Automotive Lock Cylinders

Automobiles use basically the same type of lock cylinders as do residential door locks, padlocks, and so on. In most vehicles produced today, there are only three types of cylinders used. These are

1. The disk tumbler lock
2. The side bar wafer lock (a variation of the disk tumbler lock)
3. The pin tumbler lock

You're probably already very comfortable with the operation of these cylinders from your previous studies, but let's just take a moment to quickly review.

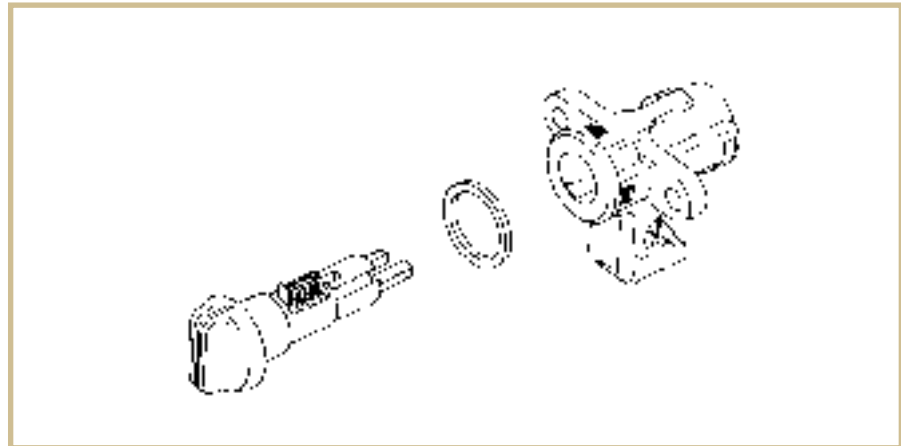
Disk Tumbler Locks

The disk tumbler lock mechanism is designed with a keyway surrounded by a cylinder. The cylinder contains rectangular metal disks that are spring-loaded and that can move up and down. These disks are fitted into slots in the lock plug, and the plug fits into the lock cylinder. The disks protrude out of the plug and fit into a slot inside the cylinder. When the key is removed from the lock, the disks are pushed into the slot in the cylinder, preventing the cylinder from turning. When the proper key is inserted into the keyway, the disks are withdrawn from the slots in the cylinder into the plug. Once this occurs, the cylinder is free to turn, and the lock can open (Figure 2).

Side Bar Wafer Locks

The *side bar wafer lock* is a variation of the disk tumbler lock that's widely used in today's automobiles, including almost

FIGURE 2—This figure shows a diagram of a disk tumbler lock.



all vehicles produced by the General Motors Corporation. Side bar cylinders are used for all types of lock mechanisms, including the ignition, doors, and trunk or rear hatch. Side bar wafer locks provide a greater degree of security than simple disk tumbler locks. They're extremely difficult to pick and can be made inexpensively and in a compact package.

The design of the side bar cylinder has remained virtually the same since 1935, when it was originally manufactured by the Briggs and Stratton Company. Today, Briggs and Stratton and many other companies continue to produce them. Since so many of these cylinders are in use today, you must know how to service them!

The side bar wafer lock is constructed much like the disk lock we examined already. A side bar cylinder has four main parts: the plug, the shell, the disks or wafers, and the side bar cover (Figure 3). Pay special attention to the two small

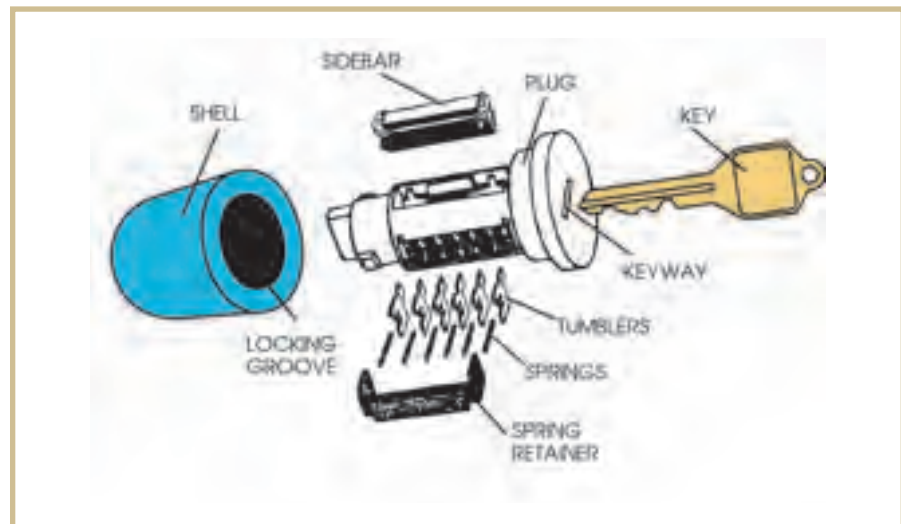


FIGURE 3—This illustration shows an exploded view of a side bar wafer lock.

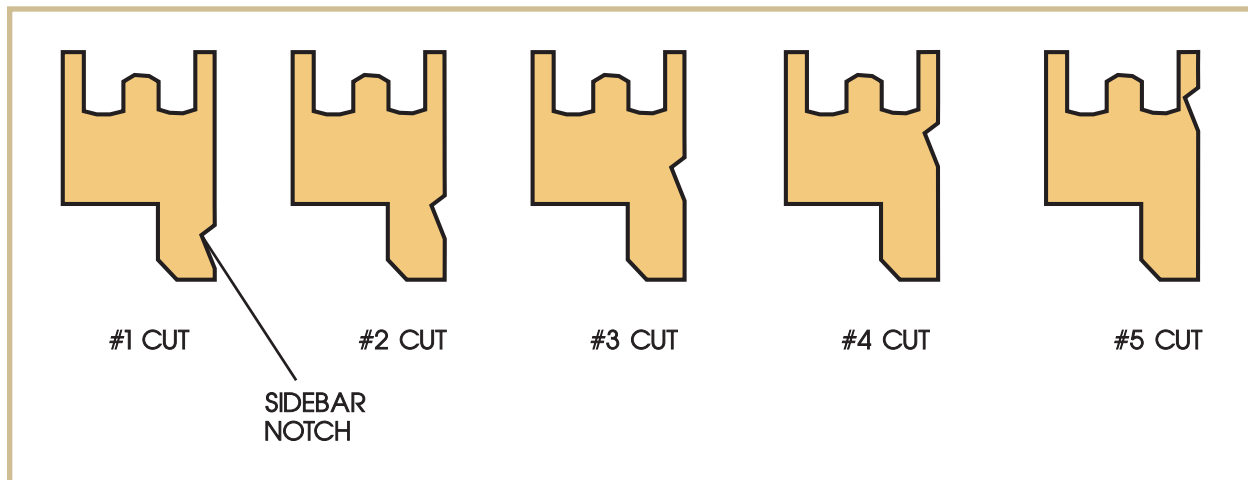


FIGURE 4—This figure shows the five types of wafers or disks you'll see inside a side bar wafer lock. Note the V-shaped notches in the sides of the wafers.

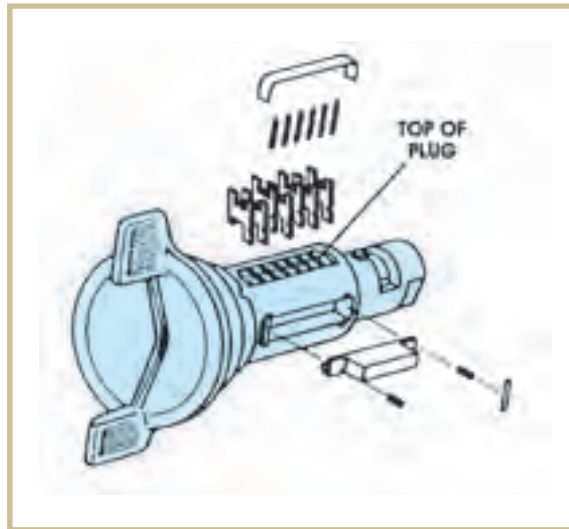
springs, one on each end of the sidebar, that hold the side bar in place against the disks within the lock.

The disks or wafers in a side bar wafer lock are much like those in a standard disk tumbler lock, but with one change: each disk (or wafer) has a V-shaped notch on one side. There are a total of five different disks available for use in a side bar lock. These wafers may be identified by a number (one through five) stamped on the wafer. The depth of the notch is the same for each wafer. The position of the notch varies (Figure 4).

Let's look now at what happens inside the side bar cylinder when a key is inserted (Figure 5). You'll remember that in a regular disk lock, when the disks are aligned by the key, the disks disengage from a slot in the shell, which allows the plug to turn. When the side bar wafer mechanism is locked, the side bar mechanism extends into a special slot inside the shell; as a result, the plug is held securely in place. When the disks are aligned by the key, the disks release the side bar mechanism from a slot in the shell. Once the side bar is released, the plug can turn, opening the lock. The side bar is only released when all five or six wafers or disks are in the proper position as set by the cuts in the key.

When you purchase a new side bar wafer lock from a manufacturer, the lock cylinder will sometimes need to be assembled before you can install it. Also, if you need to rekey a side bar wafer lock, you'll need to disassemble it and reassemble it to the new combination. We'll describe the procedure for

FIGURE 5—In this view of a side bar wafer lock, you can see how the disks or wafers must be aligned in order to allow the side bar to come free of the shell.



disassembling a side bar lock now. Note that you'll use this same procedure whether you're assembling a lock for the first time or whether you're rekeying it. One important note: to remove the plug from the cylinder on a General Motors vehicle the face cap must be

pried off. When you finish, the face cap must be replaced with a new one. This is true for both door and trunk locks.

Follow these steps to disassemble a side bar wafer lock:

Step 1: Remove the plug from the cylinder.

Step 2: Remove the spring retainer.

Step 3: Tip the cylinder to release the springs.

Step 4: Some of the disks may fall out as well. If any disks remain wedged in the cylinder, gently pry them out using a stiff piece of wire.

To reassemble or rekey a side bar cylinder, follow these steps:

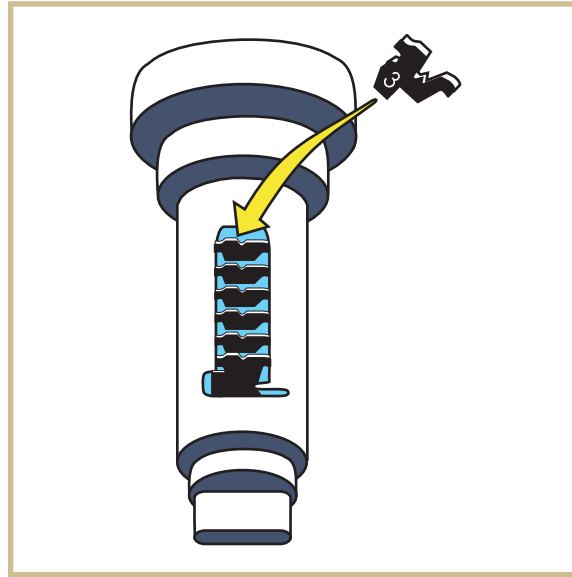
Step 1: Determine the combination you want to set the lock to. For this example, let's say that the combination you chose is 331223.

Step 2: Look through the supply of disks that came with the keying kit. These disk tumbler kits are available at a locksmith supply company. Choose the six disks you need. The number of each disk will be stamped on it.

Step 3: Lay out your disks in order in front of you: 3, 3, 1, 2, 2, 3.

Step 4: Pick up the first disk (the 3). Hold the plug as shown in Figure 6, and insert the disk in the first slot as shown. Make sure that the notched side of the disk is facing to the left.

FIGURE 6—Insert the disks into the side bar plug as shown here.



Step 5: Pick up the second disk (the 3) and insert it in the second slot. Continue this process until all the disks are installed in their proper order.

Step 6: Look through the parts that came with the lock to find the springs. Take out six springs.

Step 7: Insert one spring into each of the small holes above the disks (Figure 7). As you insert each spring, you may need to cover the holes with your finger to hold the springs in.

Step 8: When all the springs have been inserted, carefully insert the spring retainer to hold the springs in. The retainer should be staked in to make sure it will not come out.

Pin Tumbler Locks

The *pin tumbler* lock is another type of lock that's commonly used on automobiles. The pin tumbler lock, like the disk lock, is designed with a keyway surrounded by a cylinder. Small

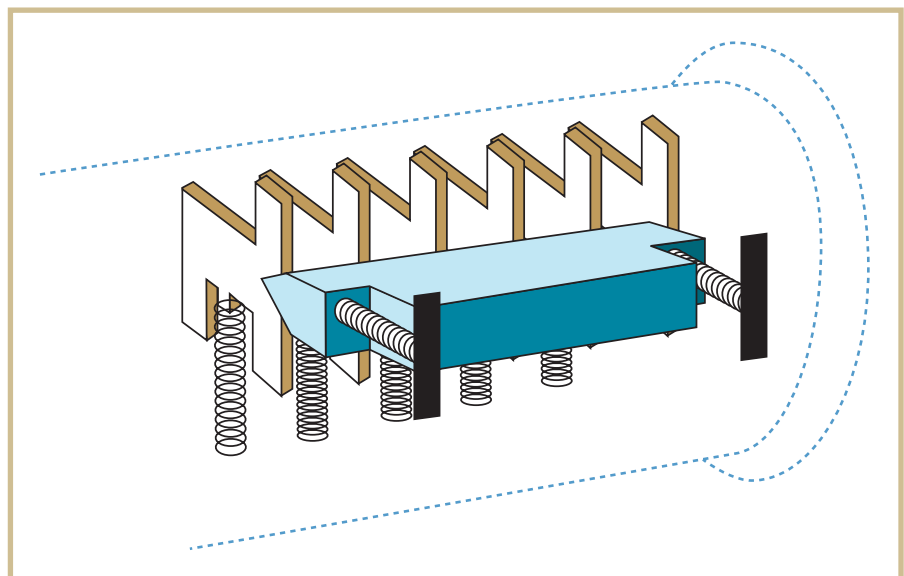
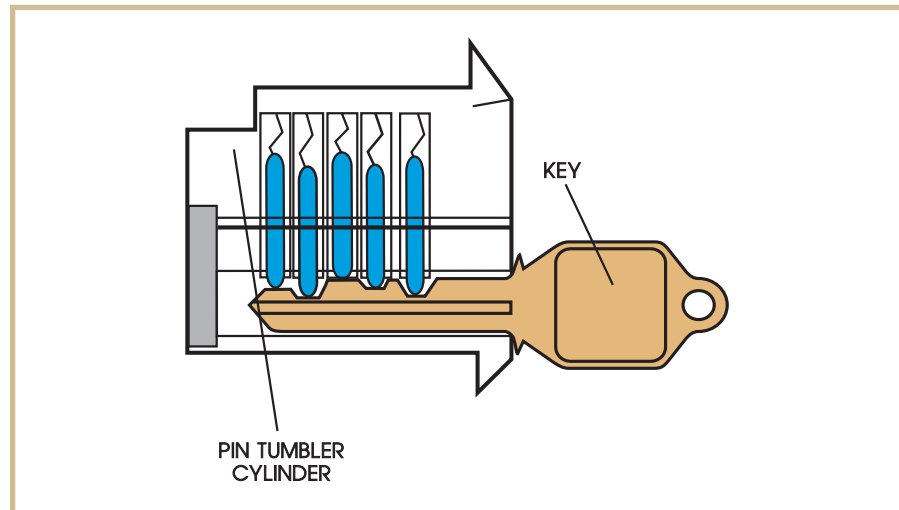


FIGURE 7—Insert the springs into the side bar wafer lock as shown here.

FIGURE 8—This figure shows an interior view of a pin tumbler cylinder with the key inserted.



metal pins are aligned in a row along the length of the cylinder. The pins are of different lengths, and can move up and down freely. When the correct key is inserted into the keyway, the pins are moved to the correct height, the cylinder turns, and the lock opens (Figure 8).

Pin tumbler locks are used in many car models. The basic structure and interior design of these cylinders is exactly the same as the door lock cylinders you've already studied. The only thing that's different about auto cylinders is the way in which they're installed (in a car door or ignition, for example). You'll learn how to remove lock cylinders from an automobile a little later in this study unit. Once you have the lock cylinder out of the car and in your hand, the rekeying, impressioning, and lockpicking procedures are exactly the same as for door locks. Refer back to your earlier study units if you wish to review these topics at any time.

Identifying Lock Cylinders

At a quick glance, most auto locks look the same. However, as you've learned, the internal mechanisms of these locks are very different from one another. As with any locksmithing task, to properly repair a lock cylinder, you must first determine what type it is. The type of lock cylinder installed in a car will depend on these factors:

- Purpose of the lock (door, ignition, trunk, etc.)
- Manufacturer of the auto

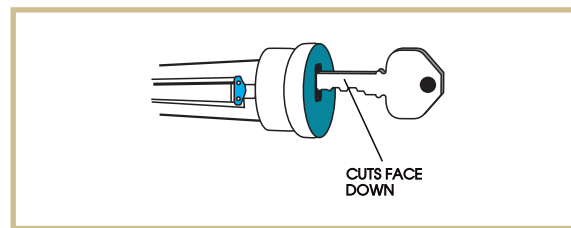
- Make and model year of the car

Determining the type of lock cylinder that's installed in a car can be difficult (without actually removing it from the car). However, there are ways to identify lock cylinders.

For example, the side bar wafer lock has several distinguishing features. First of all, they're used extensively on General Motors vehicles. If you're working on a GM vehicle, chances are good that the lock is a side bar wafer cylinder. Second, these locks can be easily distinguished by looking at the key slot, which is slightly off-center.

Another interesting observation you'll make with the side bar wafer lock is the position of the key when it's inserted into the lock. Most side bar locks are designed so that the flat side of the key is up as the key is inserted (Figure 9). This is exactly

FIGURE 9—In a side bar wafer lock, the key is inserted with the flat side up, exactly the opposite of most other locks.



opposite to most other type of locks. The reason this lock is different is in the way it's designed, keeping the bottom side of

the lock open to prevent moisture and debris from building up inside the lock.

As you can see, the side bar lock is easy to identify visually. As for the other types, the lock can either be identified once it's removed from the vehicle, or you can simply refer to a service manual. Most automotive locksmithing service manuals will list the type of lock cylinder used on each make and model of vehicle.

Now that you have a general idea of the types of lock cylinders used on a vehicle, let's take a closer look at the keys used with automobile locks. First, however, take a few moments to complete *Locking It Up! 1* on the following page.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

Indicate whether each of the following statements is True or False.

- _____ 1. In a side bar wafer lock, the key is inserted with the biting side up.
- _____ 2. In a typical automobile, only the two front doors will contain lock cylinders.
- _____ 3. A *hatch* is the small storage compartment located in the dashboard of a vehicle.
- _____ 4. The three types of lock mechanisms used in a vehicle are the disk tumbler lock, the side bar wafer lock, and the lever tumbler lock.
- _____ 5. The side bar wafer lock is a variation of the pin tumbler lock.
- _____ 6. The keyway in a side bar wafer lock is located slightly off-center in the plug.
- _____ 7. In a side bar wafer lock, the disks contain V-shaped notches on one side.

Check your answers with those on page 101.

AUTOMOTIVE KEYS

Keying Systems

In some cases, two keys are used to operate the locks in a vehicle. The *primary key* operates the ignition and doors, and the *secondary key* operates the trunk and glove compartment. This two-key system allows the vehicle's owner to have someone (such as a parking lot attendant) drive the car without being able to open the trunk and glove compartment. This provides the owner with a little bit of security when someone else must drive the vehicle, such as in a parking lot or when it's left at a garage for servicing.

While the use of a two-key system does provide more security, it may also cause some inconvenience for the car owner. With a two-key system, you must always carry two separate keys with you and you must remember which key is for which lock. This may seem easy enough, since most companies use a different blank for the two keys. However, any car owner who has tried unlocking a car door at night or with a handful of packages will tell you that it isn't that easy. For this reason, there are still several vehicle manufacturers that use a single-key system. Although a single-key system isn't quite as secure, it's much more convenient. As you can see, there are advantages and disadvantages to each type. Because of this, you'll probably come across both systems often.

Some manufacturers use a single-key system (one in which all the cylinders are keyed alike). Other manufacturers prefer the two-key system. Since manufacturers change their keying systems with every model year, however, as a locksmith you'll need to be familiar with all these changes.

Still another system used in automobiles is the *master-key system*. This system uses the same principle as the master-keying of residential or commercial locks. With a master and valet key system, you have one key that will only operate *one* lock, and a key which will operate *all* locks in the system. In an automotive master and valet key system, the owner has one valet key that will operate only the door and ignition, and a master key that operates all of the vehicle's locks.

The use of a master-key system on an automobile will give you the best of both worlds. It allows you to conveniently carry and use one key, but still gives you the option of additional security when someone else is operating the vehicle. Some of the automobile companies that use this type of master-key system are BMW, Mercedes, Toyota, Subaru, Honda, and Chrysler.

Key Blanks

Like any other lock that uses a lock cylinder, automobile locks use a *cylinder key*. These keys can easily be duplicated using a key duplication machine. To duplicate an automotive key, you must start with a proper key blank. Let's take a look at the variety of key blank types used in automobiles.

With any type of lock, you must use the exact key blank the manufacturer designed the lock to accept. No other blank will operate the lock correctly. Automotive locks are no exception. Each automobile manufacturer uses its own key blanks, designed to fit only their locks.

Like other lock manufacturers, many automakers use a distinctive bow shape to identify their blanks. In addition, the name of the automaker will usually be stamped on the key's bow. In most cases, a locksmith can determine what type of vehicle a key is for simply by looking at the shape of the key's bow. Some of the most common automobile key blank shapes are shown in Figure 10. Notice the distinguishing shape of each bow.



FIGURE 10—These are some of the most common key bow shapes used by automobile manufacturers.

Automotive key blanks for all types of vehicles are easily available from almost any locksmithing supplier. The majority of key blanks for automobiles are relatively inexpensive (less than \$1.00). However, there are some, such as a blank for a Rolls Royce, that can cost as much as \$10.00! As you become experienced in the auto lock field, you'll quickly learn which blanks are the ones that are used most often and which ones aren't. This information is very useful when it comes to deciding how many and what type of key blanks you should keep in your shop's inventory.

Key Duplication

The duplication of original keys is one of the most common jobs performed by a locksmith. Once you have a key blank that matches the original key, you can begin to make a duplicate key. As stated earlier, key duplication is done by an electric key duplication machine. The procedures for duplicating an automotive key are no different from those of duplicating any other cylinder key.

To duplicate a key using a key machine, always follow the procedure outlined in the manufacturer's reference manual that comes with the particular machine you're using. In general, a key machine will have two viselike clamps to hold the keys. These clamps are mounted on a pivoted bracket so that they can move in and out or left and right. In line with the clamps will be two wheels. One is a cutting wheel, used to cut the new key blank, and the other is a tracer post, used to trace the pattern of the original key.

To duplicate a key, place the original key in the clamp by the tracer wheel. Then place a new key blank in the clamp by the cutting wheel. The machine is then turned on and the operator will "trace" the pattern of the original key by moving the original key across the tracer wheel. As the original key is moved across the tracer wheel, the new key blank is being cut to the same shape by the cutting wheel. Once the cutting of the duplicate key is complete, the key is removed from the clamp. Finally, the edges of the duplicate key are cleaned up and polished using the deburring wheel on the machine. Once you've completed this process, you have a duplicate key that should function exactly like the original key. (Refer to your previous study units for more information on using a key machine.)

Cutting an Automotive Key by Code

As you can see, the process of key duplication is relatively easy. However, what happens when you don't have the original key to copy from? As you can imagine, the process becomes a little more difficult.

We mentioned earlier that one of the most common locksmithing problems is that of lost keys. If the original key isn't available for duplication, the most common method used to make a new key is to *cut the key by code*, using the coding system established by the automobile manufacturers. Using a key cutting machine capable of cutting by code and a proper automotive code reference book, most automobile keys can be duplicated without having the original key or disassembling the lock.

Let's take a moment now to review the concept of keymaking by code. In this process, a locksmith makes a new key using a code number only. The code number is usually a number that reflects a set number of cuts for the lock. An original key isn't necessary to copy from, and the lock doesn't have to be disassembled.

Years ago, before security was such a major concern, key code numbers for car locks were commonly stamped right on the door and ignition cylinders. All the locksmith had to do was read the code and make a key for the lock. While many of today's automobiles still use a coding system, the codes aren't often marked in an easily visible place on the lock cylinder anymore. This removal of codes from lock cylinders has helped deter some vehicle crimes, but it has also made it a little more difficult for a locksmith to make a new key for a car lock. The locksmith now has to exert a little extra effort to find key code information for a vehicle, but this task is far from impossible.

For example, some cars still carry key code numbers on their cylinders. Others have the code stamped in a hidden location in or on the car. If the codes aren't marked on a vehicle at all, the code number can be found in the files of the car dealer who originally sold the vehicle.

Car key codes must be translated before they can be used. Several special code books are available for locksmiths. These code books translate an auto key code into the actual key cut depths and spacing and will also tell you what key blank to select.

FIGURE 11—Shown here is a short section of a listing in a code book.

NOTES		
BRIGGS & STRATTON 00J0-99J9		
1973 & 1981 General Motors		
See instructions on page 01-02-245		
15J0		20J0
15J0 113331	20J0 431354	25J0 454245
1 335311	1 123453	1 312444
2 224532	2 533434	2 444323
3 242332	3 135355	3 322421
4 534343	4 223331	4 313212
5 324353	5 132235	5 543224
6 134321	6 331234	6 113322
7 544221	7 431224	7 134534
8 422422	8 231235	8 342232
9 454423	9 211321	9 555454
16J0 131223	21J0 332435	26J0 212335

Reading Codes

As you know, key codes are listed in code books, which are available from locksmith supply companies (Figure 11).

Let's take as an example the particular key code for a General Motors lock that has the number 58A7 stamped on its shell. The key cut code for this lock would be 1, 1, 3, 2, 3, 4. At first glance, this key code would seem to be a random set of numbers. However, each number identifies a certain depth of cut for each cut on the key blank. For a GM key code the numbers must add up to an even number, with a maximum of two cuts between them.

In an automotive key, the difference in dimension for each cut number is 0.025 inch or twenty-five thousandths of an inch. Each manufacturer has different methods of key coding their automotive keys. A well-informed locksmith will need to be familiar with the different standards for each manufacturer. You can find this information with the technical data that comes with each machine.

Now, let's get back to our sample key code of 1, 1, 3, 2, 3, 4. This key with its cuts plainly marked is shown in Figure 12.

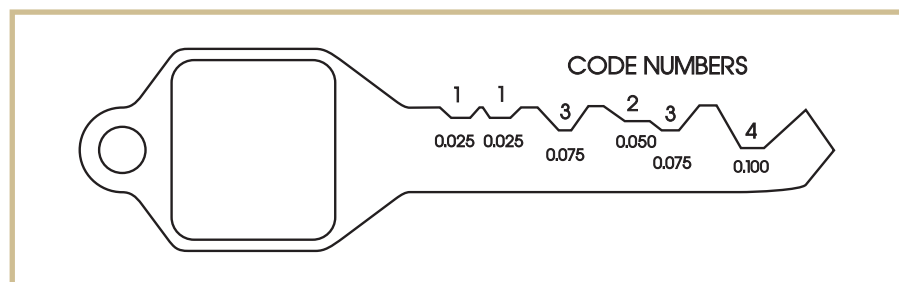
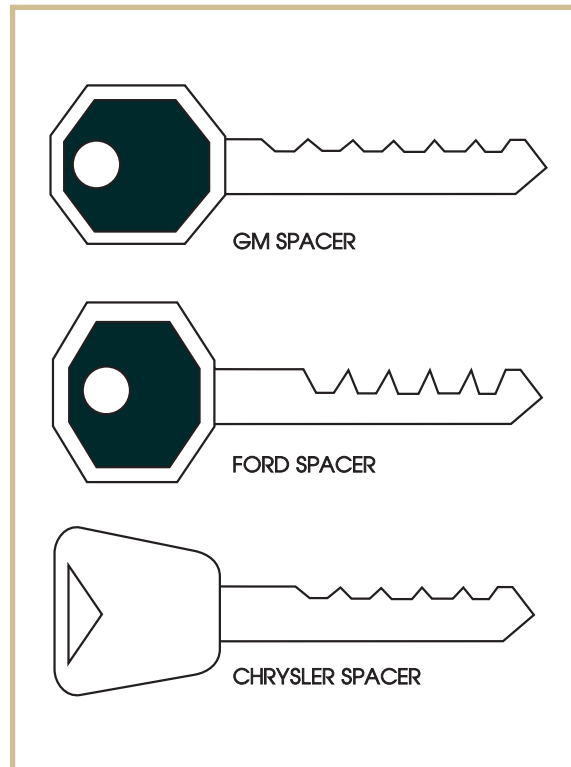


FIGURE 12—Here's a visual display of how the key codes and the cut depths are related.

FIGURE 13—These are spacer or guide keys you would use on a code-cutting machine to ensure proper spacing of the cuts.



Although a key can be cut by hand once its codes are known, keys are usually made using a code-cutting machine. This machine uses a micrometer feed device to set depth and special *spacer* or *guide* keys. A spacer or guide key is used to set the spacing between the cuts on a blank. A spacer key is shown in Figure 13. You can purchase spacer keys from any locksmith supply company.

Notice that the grooves on these keys are evenly spaced. If you were to transfer these grooves to a blank, you would get the spacing required for a functioning key. All that would be needed are the proper key codes for the lock to cut a key for a disk tumbler or pin tumbler lock. By using your spacer, or guide key and the code numbers, you could quickly create a working key for your customer's vehicle.

Finding Key Code Information

Suppose a customer has lost his vehicle keys and comes into your shop to have duplicates made. How would you get the key code information you need to make a new key?

You can obtain key code information for a vehicle from a number of possible sources. These sources include the following:

- The car dealer
- The car owner
- The car itself

- The lock cylinder
- The owner's manual

Note that these are possible sources of key code information. Not all of these sources will provide information for every vehicle. For example, not all lock cylinders or owner's manuals contain code information. The easiest and most reliable place to look is the original sales invoice supplied with the vehicle by the manufacturer. Most car dealers keep this information on file for many years after a vehicle is sold.

The dealership may also have provided the original car owner with a printed card containing the key code information. Always start by asking the customer if he or she has this information available. If not, you can try calling the car dealership that sold them the vehicle to obtain the information.

However, it's not always this easy. If you're called out late in the evening or if you're in an isolated location, it may not be possible to call for the information. In such a situation, there are other alternatives available. Oftentimes, vehicle manufacturers stamp the key code information right on the vehicle itself. The key code may be found on the ignition cylinder, a door cylinder, in the glove box, and sometimes in the owner's manual for the vehicle. If you can find this information, your job is almost done!

However, you should be aware of two possible pitfalls. One is that many of today's car manufacturers don't stamp the key codes anywhere on the vehicle. Although this will make the vehicle more secure, it also makes the job of a locksmith more difficult. The other pitfall concerns possible work on the lock at a previous time. If the car was previously owned, or if the present owner has lost keys before, the key code information on the vehicle may no longer match the actual lock cylinder! That is, some other locksmith may already have changed the locks in the car so that they no longer match the manufacturer's original information. Ask your customer if the locks have ever been changed before you waste valuable time cutting the wrong key!

The following table lists the locations where key codes may be found on various popular vehicles. While this information may not apply to every model made by the listed manufacturer, in general, it will give you a good idea of where to start. Note that some of the cars have no key code information

located anywhere on them. In such a case, your only choice would be to contact the car dealership for the information, or to use some other method of making a new key (such as impressioning).

Once you've obtained the code for the lock, a new key can be made. As explained earlier, to make a key, you first need to look up the code in an automotive key code reference

Vehicle Manufacturer	Code Location
Acura	Passenger door lock, ignition cylinder
AMC/Eagle	Ignition cylinder
Audi	Passenger door handle
BMW	Ignition cylinder
Buick	Ignition cylinder (ignition key only)
Cadillac	Ignition cylinder (ignition key only)
Chevrolet	Ignition cylinder (ignition key only)
Chrysler	NONE—see dealer
Dodge	Some models—passenger door lock
Ford	Some models—passenger door lock cam Some models—ignition cylinder
Honda	Passenger door lock; ignition cylinder and other places
Hyundai	NONE—see dealer
Isuzu	Passenger door cylinder
Lincoln	NONE—see dealer
Mazda	Passenger door pawl and stamped on lock
Mercury	Some models—passenger door lock cam
Mercedes	NONE—see dealer
Nissan	Glove box; passenger door cylinder
Oldsmobile	Ignition cylinder (ignition key only)
Plymouth	Some models—passenger door lock
Pontiac	Ignition cylinder (ignition key only)
Subaru	Passenger door cylinder and on sticker in glove box
Toyota	Passenger door cylinder
Volvo	NONE—but may be in owner's manual
Volkswagen	Door handles

manual. The code manual will convert the key code to the proper key cut depths that are required. The code manual will also specify which key blank should be used.

Once the key cut depths are determined, the key is cut using a key machine that's capable of cutting by code. The specifications obtained from the code book are set on the machine, a proper key blank is inserted, and a new key is produced.

As you can see, cutting a key by code is the easiest method of making a key for an automotive lock when the original isn't available. It requires no disassembly of the locks in the vehicle and a key can be made very easily on a machine capable of cutting by code.

Now that you understand more about automotive keys and how they're duplicated, let's take a closer look at how automotive locks work. In the following section of the text, we'll look at the construction and operation of door locks, trunk locks, glove compartment locks, and, finally, ignition locks in detail. First, however, take a few moments to complete *Locking It Up! 2* on the following page.



Locking It Up! 2

Fill in the blanks in each of the following statements.

1. In some cars a _____ key operates the ignition and doors.
2. The most common method used to duplicate an automotive key when the key is missing is _____.
3. The master-key system includes a _____ and a _____.
4. In a two-key system, a car's _____ key operates the trunk and glove compartment.
5. When cutting an auto key by code, a _____ is used to set the spacing between the cuts in the key blank.
6. The five possible sources of key code information are _____, _____, _____, _____, and _____.

Check your answers with those on page 101.

CONSTRUCTION AND OPERATION OF AUTOMOTIVE LOCKS

Door Locks

The most-used and therefore most-serviced lock on an automobile is the door lock. Just think of how many times in a typical week you lock or unlock the door of your car.

Before we look at the replacement procedure, let's look at the operation of a typical car door.

Parts of an Automotive Door Lock

The principal parts of a car door locking system are the following:

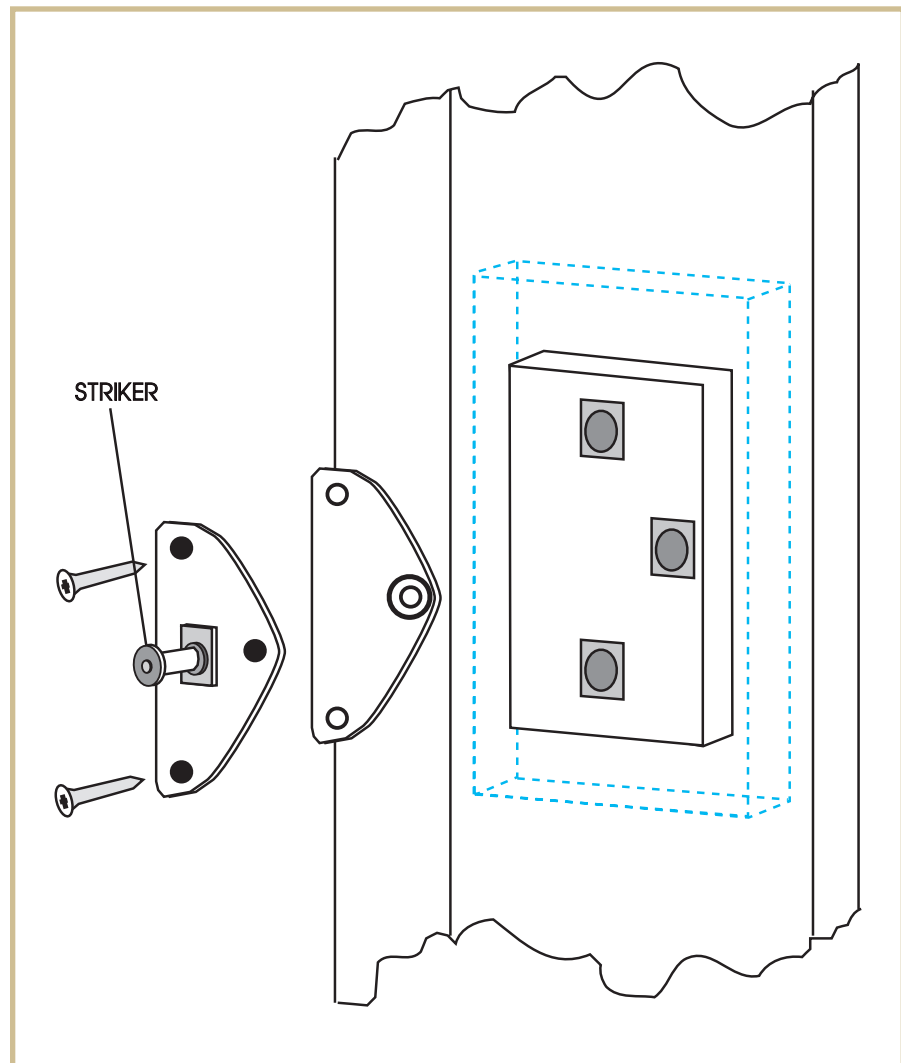
1. The door latch
2. The striker
3. The lock cylinder
4. The cylinder cam (also called a *pawl*)
5. Lock rods or connecting rods
6. The lock button
7. The inside door handle
8. The outside door handle

Let's begin by looking at the door latch. The *latch* is the device on a vehicle that holds the door closed tightly. In most cases, the latch is separate from the lock cylinder.

An automotive door latch consists of two parts. The first part is the latching mechanism itself, which is mounted in the door. The second part is a bracket that's mounted to the body of the car in the area where the door closes. This bracket is commonly called the *striker* (Figure 14).

When the latch strikes the bracket, the latch will hook onto the bracket and secure the door. In order for the door to open again properly, the latch mechanism must have a release

FIGURE 14—This illustration shows a typical striker used on Ford, GM, and Chrysler automobiles.



mechanism that will allow the latch to be opened. Otherwise, once the door is closed and latched, you wouldn't be able to get it open again.

Automotive doors have inner and outer handles that you can use to open them. Connecting rods attach the latch's release mechanism to the handles. Therefore, when the door handle is moved, the connecting rods will release the latch and allow the door to be opened. Each vehicle is slightly different, but, for the most part, all door latches operate in a similar manner.

In most cases, the latch mechanism itself isn't serviced by a locksmith. Repair work on the door's latching mechanism is usually performed by an automobile mechanic. However, you should have clear understanding of how the latch works so that you can understand the operation of the door's locking system. Then you'll be able to service the locking system.

Let's examine the part of the locking mechanism that's the main concern of the locksmith—the lock cylinder. The lock cylinder is a small locking device that's attached to the door's latch mechanism. Thus, once the door is shut and the latch is closed, you'll be able to lock the door in place using a key. The ability to lock the latch is important. It prevents any unwanted entry into the car, while at the same time adding a safety feature that will keep the door from opening if a passenger in the car accidentally moves the inner door handle while the vehicle is moving.

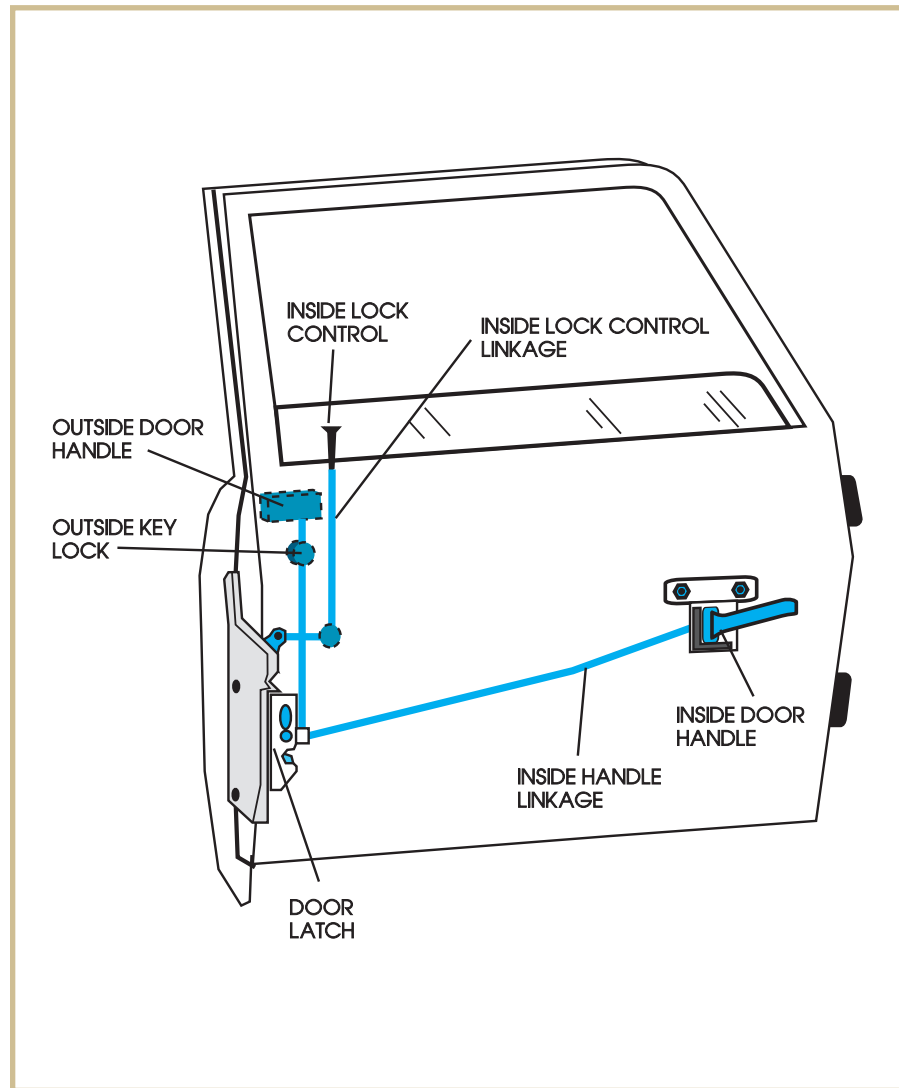
Now, let's take a closer look at how a door's locking system works. As mentioned, the lock cylinder is usually separate from the latch mechanism. The lock cylinder is mounted in the door in a location that allows easy access from outside the vehicle. The location must be convenient so that a key can easily be inserted into the lock. You may find some lock cylinders as part of the door handle itself, but for the most part, the lock cylinder will be mounted separately in the door.

A car door lock typically has a *cam* or *pawl* connected to the rear of the lock cylinder. The system will also contain two separate small-diameter metal rods that connect the lock cylinder and lock button to the door latch. The end of one rod is attached to the cam on the rear of the lock cylinder. The opposite end of that rod is connected to the door latch. This rod is commonly known as the *connecting rod*.

On most car doors, there's also another rod that's attached between the door latch and the lock button. This rod is commonly known as the *locking rod*. The *lock button* (the button the driver actually uses to lock and unlock the door) is found on the inside of the car door, and either moves up and down or slides side to side to unlock the door. The entire locking assembly described here is contained within the walls of the vehicle door (Figure 15).

In most vehicles, to unlock the car door from outside the vehicle, the proper key must first be inserted into the lock. The key is then turned in the door lock. When the lock cylinder turns, it rotates the cam with it, pulling the connecting rod up and thus unlocking the latch. As the latch is unlocked, the latch will move the locking rod, which, in turn, moves the lock button to the unlock position.

FIGURE 15—The locking assembly for a car door is entirely contained within the wall of the door.



In most cases, the key can also be used to lock the door from the outside. To lock the door, the key is turned in the opposite direction, which will push *down* on the connecting rod and *lock* the door latch. At the same time, the lock rod will move the lock button to the lock position.

Keep in mind that this is the operation of *most* vehicles. You may find some vehicles that push *down* on the connecting rod to *unlock* the latch or pull *up* on the rod to *lock* the latch. In any case, the operation is much the same. The door lock assembly will still contain a cylinder cam that's rotated when the key is inserted and turned. When the cylinder cam rotates, it moves the connecting rod, which will then lock or unlock the latch. At the same time the latch moves the lock rod, which moves the lock button to the proper position.

Usually when any one of the parts in a door lock assembly is moved to the “unlock” position, all the other parts are moved to the unlock position also. In other words, if you unlock the door from the inside using the lock knob, the door can be opened from either the inside or the outside. To open a vehicle, you simply need to move any one of those parts to an unlocked position. This is an important fact to remember later when we’re discussing how to make emergency entries to a vehicle. If a car key is lost, the cylinder can’t be operated. But it will only be necessary to move one of the other door lock parts to the “unlock” position in order to open the car. Therefore, by using special tools you can unlock the door by moving the lock knob inside the vehicle.

Installation of the Lock Cylinder

Most automobiles contain either a disk tumbler or pin tumbler lock cylinder. During construction, the lock cylinder will usually be inserted from the outside through a hole in the door of the car. The lock contains a *flange* that’s larger in diameter than the hole in the door. This flange limits how far the lock can be inserted into the door. Once the lock is inserted into the door, it’s retained by a special *retainer clip* that’s clipped onto the lock from inside the door. The retainer clip is often U-shaped and made of thin, flat steel. The retainer clip holds the lock in the door and prevents it from being pulled out of the hole. Figure 16 shows the installation of a lock cylinder in a car door.

Most problems with a car door lock involve the interior door lock mechanism, not the lock cylinder. Some of these problems include broken springs, rust on working parts, and missing retainer clips. However, if a problem does occur with a lock

cylinder, it will be necessary to remove the lock to service it. Many modern car door locks are removed from inside the door. Note that if the lock cylinder is damaged, modern practice is to replace it rather than attempt repairs.

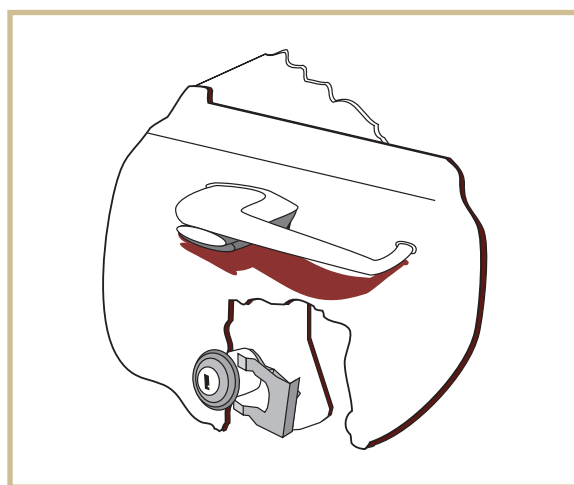


FIGURE 16—This illustration shows how a lock cylinder is installed in a car door. Note the position of the retainer clip.

Trunk Locks

In addition to door locks, automotive locksmiths are often called upon to repair the locks used to secure the trunk of the vehicle. As we explained earlier, the trunk of the vehicle is the storage compartment at the rear of a typical automobile. Most trunks use the same type of lock cylinder as used in the door. However, the locking mechanism is somewhat simpler since the trunk doesn't have to be opened or locked from the inside. Access to the trunk will most often be from the outside of the vehicle, although some cars have an inside release for the trunk.

The mechanism for a typical trunk lock is similar to that of a door. The latch mechanism is contained in the trunk lid itself, and a strike plate is mounted to the body of the car. When the trunk lid is closed, the latch hits the strike plate. Once it hits the strike, the latch hooks around the strike and the trunk lid is secured. Trunk locks are very simple mechanisms, which make them easy to perform repairs on.

One major difference between a door lock and a trunk lock is that, in a trunk lock, the lock cylinder is located very close to the latch mechanism. This means that only a short connecting bar is needed to attach the lock cylinder directly to the latch (Figure 17). In contrast, in a door, a long connecting rod is needed to attach the lock cylinder to the latch.

When the proper key is inserted and turned, the lock cylinder and the attached connecting bar rotate. As stated earlier, the other end of the connecting bar is attached to the latch mechanism. When the connecting bar rotates, the trunk latch is released, allowing the trunk lid to be opened.

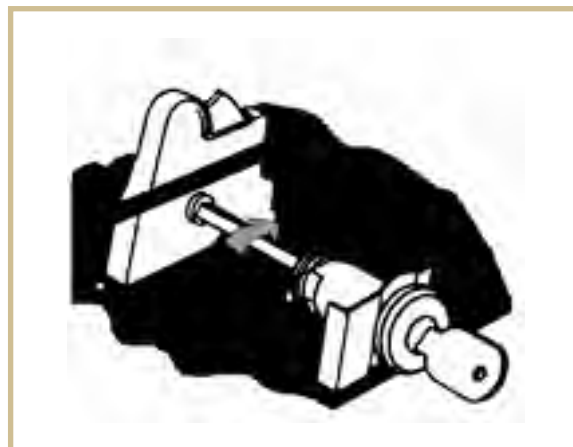


FIGURE 17—This figure shows the parts of a trunk locking mechanism.

Since the trunk is usually only accessed from the outside, an inner release handle isn't often needed. In addition, most trunks are in the lock position at all times, thereby eliminating the need for an outside

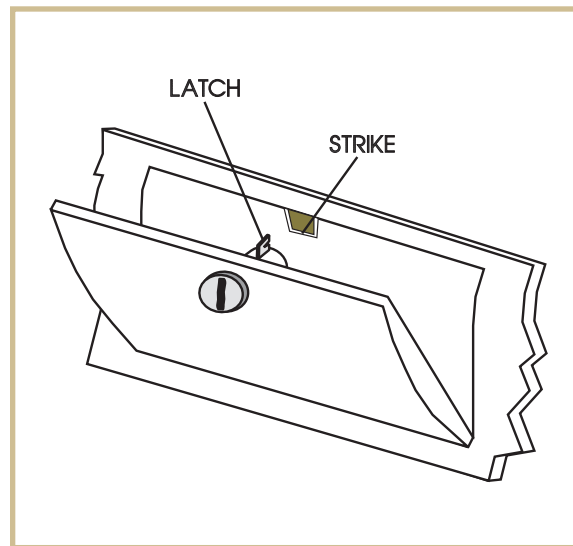
release handle or button. Therefore, the only requirement for the lock system is for the latch to be released when the key is turned. For this reason, there are no other connecting rods connected to the latch. This makes a trunk locking mechanism much simpler than a door locking system.

Glove Compartment Locks

Another common lock on a vehicle is the glove compartment lock. This lock is normally quite small, and its only purpose is to secure the cover of the glove compartment. One unique feature of the glove compartment lock is that the lock and the latch system are usually all one piece and are replaced as a unit.

Like the trunk lock just described, the glove compartment

FIGURE 18—This illustration shows a glove compartment lock.



doesn't need an inside release handle or inside lock button. However, most glove compartments have an outside release handle or button (Figure 18). This allows you to open the compartment without having the key.

The operation of the lock is similar

to the trunk. The lock mechanism is attached to the glove compartment cover, and a strike plate is attached to the dashboard. When the cover is closed, the latch hooks itself around the strike plate, securing the cover. When the release handle is turned, the latch is released. The lock cylinder in a glove compartment lock prevents the handle from being turned, or, in the case of a push-button release, prevents the button from operating.

Glove compartment locks seldom need repairs, primarily because few people lock the glove compartment. Therefore, the lock experiences very little wear. In addition, the lock cylinder is located inside the vehicle where it's protected from adverse weather conditions.

Ignition Locks

In most car models today, the ignition lock is mounted on the steering column. The steering column is the thick post that holds the steering wheel. The ignition lock will usually be found to the right of the steering wheel. The ignition is connected to the ignition switch which operates the car's starter. A connecting rod is normally used to attach the ignition lock cylinder to the ignition switch, which is mounted nearby.

Besides operating the starter switch, the ignition lock also serves some additional purposes. When the key is out of the ignition, the ignition lock cylinder will lock the steering wheel and gearshift lever in place. This function serves two purposes. One is that it will prevent the vehicle from being put into gear unless the key is in the lock. This could prevent someone (especially a small child) from accidentally taking the car out of "park" without the car running, which could result in a serious accident. The second purpose is to prevent vehicle theft. With the steering wheel locked, the vehicle can't be driven, even if the thief manages to get the engine running.

With the insertion of the proper key, the car's starter can be activated, and the steering wheel and gearshift lever will be free to operate (Figure 19).

Ignition locks are often in need of adjustments or repairs, since they're in constant use. In order to repair, rekey, or replace an ignition lock, it's necessary to remove the lock

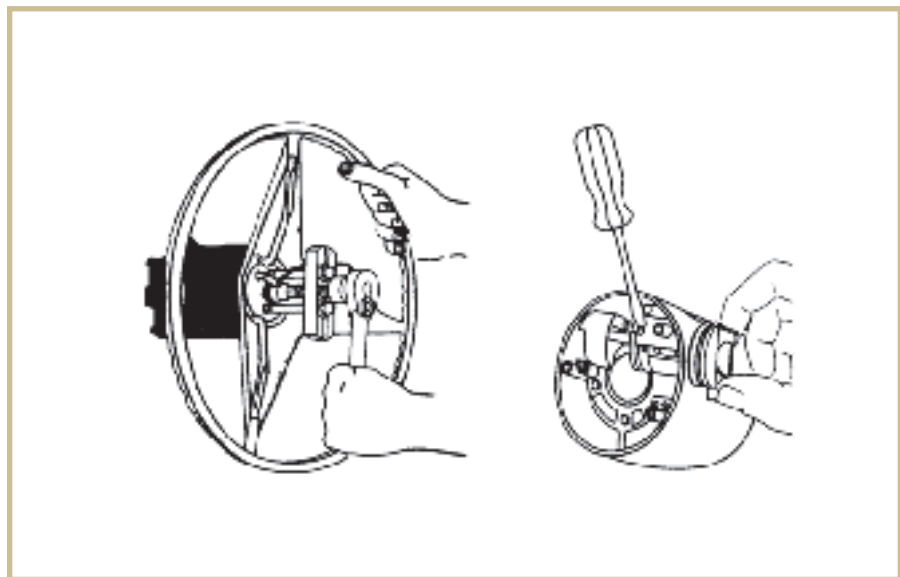


FIGURE 19—The basic parts of a steering wheel and ignition are shown here.

cylinder. And, in order to remove the lock cylinder, you'll often need to disassemble the steering wheel assembly. This is usually no problem if the vehicle is older. However, if your customer's vehicle is newer and is still under warranty, *YOU MUST ALWAYS DISASSEMBLE THE STEERING WHEEL ACCORDING TO THE MANUFACTURER'S DIRECTIONS.* You can get these instructions from a reference manual published by the manufacturer of the vehicle. If you don't follow these instructions and a later problem occurs with the ignition, the customer's warranty may be invalidated, and you, the locksmith, will be in big trouble! Just remember to always be careful when dealing with a customer's vehicle, and be sure to always follow the manufacturer's warranty regulations! (*Note:* We'll examine how to remove a lock cylinder from a vehicle shortly.)

In the next section, we'll cover automotive lock maintenance. First, however, take a few moments to complete *Locking It Up!* 3 on the following page.



Locking It Up! 3

Fill in the blanks in each of the following statements.

1. If a car door's lock button moves up and down, the door contains a _____ lock rod.
2. The _____ is connected to the rear of the lock cylinder.
3. The _____ is connected between the cam and the lock button.
4. If a car door's lock button slides from left to right, the door contains a _____ lock rod.
5. If a lock cylinder is damaged, modern practice is to _____ it rather than _____ it.
6. A _____ lock seldom needs repairs because few people use the lock and because the lock is protected from outside weather conditions.

Check your answers with those on page 101.

AUTOMOTIVE LOCK MAINTENANCE

Maintenance Services You Can Perform

Automotive lock servicing is a very profitable locksmithing specialty. Locksmiths can provide many useful maintenance services for automotive locks. These services include cleaning and lubricating locks, removing broken keys or foreign objects from lock cylinders, and defrosting frozen locks. Maintenance services can be performed without having to remove the lock cylinder from the vehicle. Let's take a look at some of these services now.

Troubleshooting Tips for Car Doors

Door locks are frequent trouble spots in a vehicle, mostly because these locks are constantly exposed to the elements. Let's take a look at some troubleshooting tips for fixing an inoperative car door. Sometimes, a lock may need only cleaning or lubrication to get it working again. It's always a good idea to try these methods first before taking action to replace a lock cylinder.

If a vehicle door can be opened from the outside but not from the inside, follow these steps to locate the trouble:

Step 1: Check the door latch to see if it works.

Step 2: If the latch works, check the strike to be sure it's aligned properly.

Step 3: If the latch *doesn't* work, try lubricating it.

Step 4: If lubrication doesn't help, you may need to repair the connecting rod inside the door.

Step 5: If all else fails, you'll need to replace the door latch entirely.

If the door can't be opened from either the inside or the outside, follow these steps to locate the trouble:

Step 1: Test the key in the door cylinder.

Step 2: If the key turns but the door doesn't open, any of the following situations may be true:

- The connecting rod may be disconnected
- The cylinder may need lubrication
- The cylinder may need replacement
- The latch may need replacement

Check each of these possibilities in order until you locate the source of the problem.

If the key doesn't turn in the cylinder when you test it, take the following steps:

Step 1: Lubricate the cylinder.

Step 2: Check the key for excessive wear, and cut a new one if necessary.

Step 3: Replace the cylinder.

If a key is stuck in a door lock (but not broken off), the key can be removed by following these simple steps:

Step 1: Turn the key to the upright position in the lock.

Step 2: Clamp a vise grip pliers onto the bow of the key.

Step 3: Pull firmly to withdraw the key from the lock.

If a key is broken off in the lock, you can remove the broken piece in the same way you would remove it from a residential door lock. You'll need a broken key extractor tool (Figure 20). Insert the tool into the keyway, and hook the end of the tool onto the piece of broken key (Figure 21). Carefully manipulate the tool to withdraw the broken piece from the cylinder.

If it's difficult to turn the key in the cylinder, the problem may be a bent connecting rod. A bent rod is sometimes caused by the improper use of auto opening tools (we'll be discussing these tools

later). To correct this problem, you'll need to disassemble the car door to straighten the

FIGURE 20—These broken key extractor tools can be used to pull broken pieces of keys from any lock cylinder.

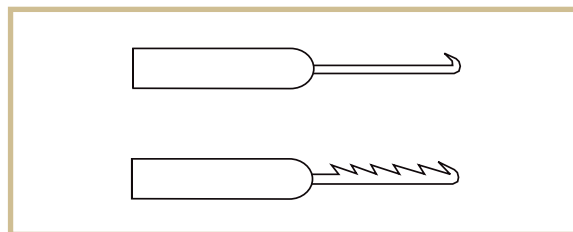
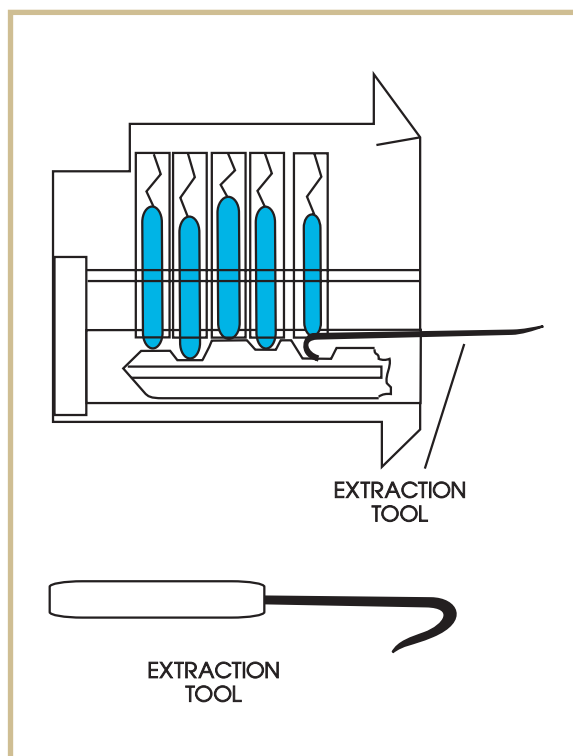


FIGURE 21—Insert the broken key extractor into the keyway, and hook the end onto the broken piece of key.



connecting rod. We'll cover the disassembly of a car door later in the study unit.

Now that we've covered basic auto lock servicing, let's proceed to the information on removing and replacing the lock cylinders.

REMOVING AND REPLACING AUTOMOTIVE LOCK CYLINDERS

Why Do Lock Cylinders Need Removal or Replacement?

In the previous sections, you've learned how to duplicate keys for all types of automotive locks, even if the original key isn't available. But what happens if there's a problem with the lock cylinder itself or the lock needs to be rekeyed? In almost all cases, the lock cylinder has to be removed from the vehicle to be repaired, rekeyed, or replaced. The following sections will explain how lock cylinders typically are removed from the vehicle. But first, let's look at some possible reasons for removing and/or replacing an automotive lock cylinder.

If you decide to offer auto lock services to your customers, you can expect to be called on frequently to replace damaged or inoperative lock cylinders. As stated above, if a problem occurs with an auto lock, it will be necessary to remove the lock to service it.

Auto lock cylinders can be damaged in a variety of ways. One of the most common causes of damage is excessive wear. One typical wear problem area is the door lock on a vehicle, which is often used many times in a single day. Each time we enter a vehicle that's locked we'll be using the door lock. This continual use can lead to problems with the lock assembly. And since most people always enter the car from the driver's side, that door lock is the one that receives the most wear.

Now, you may be thinking that since the passenger side lock is rarely used, it may never need servicing. But this isn't quite true. Unlike the ignition key and glove box locks that are inside the vehicle and not exposed to the elements, the door locks are constantly exposed to all types of weather conditions. This can cause corrosion of the door locks which may, in turn, cause a lock to stop working properly. The less the lock is used, the more buildup of dirt and corrosion can occur. So, as you can see, each door lock has its own unique problems. A simple lack of proper maintenance and lubrication is one of the most common reasons that a lock seizes up and fails to turn.

Some other common lock cylinder problems are broken keys or other foreign objects stuck in the lock. An attempted car theft may also leave a car with a badly damaged or smashed lock cylinder. Some thieves use hammers and screwdrivers to try to force locks open (especially trunk locks) in search of items to steal. These locks will often be damaged beyond repair and will need replacement.

Should the Cylinder Be Repaired or Replaced?

It's important to note that modern practice is to *replace* lock cylinders in cars rather than attempt to repair them. This is because the cylinders themselves are relatively inexpensive and it takes less time to replace a cylinder than remove it, repair it, and reinstall it. Also, an old lock cylinder that's been repaired is likely to fail again soon, and when it does, your customers may think that *you*, rather than the defective lock, are at fault! If a customer requests that you repair an old cylinder rather than replace it, you should tactfully explain that this will take much more time and cost them far more than a simple replacement.

Replacing a Door Lock Cylinder

When replacing automobile cylinders or working on the lock mechanisms, you should keep in mind that each make and model of automobile is different. Hundreds of different model cars are manufactured; vehicle models change slightly in design from year to year; and you'll even find some variations in vehicles from the same model year. The location of lock cylinders and the removal procedures will vary from vehicle to vehicle. For this reason, it isn't practical for us to show you how to work with *every* make and model of car. However, we can provide you with a general procedure that can be applied to most vehicles.

For the average locksmith, this general procedure is all the information you'll need to provide excellent service to your customers. However, if you wish to eventually pursue auto lock repair as a specialty service, you can easily learn more about common car models by studying the reference manuals published by various car manufacturers. There are also many excellent locksmithing service manuals published, and current trade journals carry articles about auto lock repair regularly. With a little extra effort and a bit of experience, you can become an expert in the repair and replacement of auto locks!

Now, let's take a closer look at the general lock removal procedure you'll be learning.

The lock cylinder in many cars is held in position in the door panel by a large diameter flange on the lock cylinder and a U-shaped clip that straddles two slots on the outer cylinder shell. The U-shaped clip is made of thin metal and is inserted onto the cylinder from the inner side of the door panel. This arrangement places the door panel between the cylinder flange and the clip, thus holding it tightly in the door panel. The metal U-shaped clip that holds the cylinder in place must be removed from inside the door by removing the inner door trim panel. The exception to this rule is vehicles produced by Ford Motor Company. With most Ford vehicles, the lock cylinder clip and the lock cylinder can be removed *without disturbing the interior trim and door panel*.

Now, for the moment, let's imagine that you're working on a car that requires you to remove the door panel and trim to gain access to the lock cylinder. In *simple terms*, the procedure to replace a door lock cylinder is as follows:

Step 1: Remove each piece of the door trim

Step 2: Remove the trim panel and the watershield

Step 3: Remove the U-shaped retaining clip with a flat-blade screwdriver

Step 4: Pull the lock cylinder from its mounting

Step 5: Reverse the procedure to install a new cylinder

The following section of the text provides a detailed explanation of how to disassemble a car door to gain access to the lock mechanism.

Disassembling the Car Door

As stated above, in some car models, you'll need to remove the interior door trim and panel to reach the lock. The following procedure is a *general* one. Keep in mind that each vehicle is a little different. Therefore, *be observant* of all trim items that must be removed. If you're unsure of what items need to be removed to gain access to the lock retaining clip, you can always consult a service manual for the vehicle you're working on.

To remove a lock cylinder from a typical car door you must first remove the inner door trim panel to gain access to the cylinder retaining clip. The inner door trim panel is the decorative panel that makes up the inside of the door. Most trim panels are made of a heavy cardboard, metal, or plastic and are often covered with upholstery. Mounted on the door trim panel will be a variety of items, such as the armrest, inner door handle, window handle, etc., all of which must be removed before the door panel can be taken off the door.

In addition, you'll also find a thin sheet of plastic or foam between the trim panel and the door. This sheet of plastic is called the *watershield*. The watershield serves an important function by preventing moisture and condensation from damaging the trim panel. Because of this, you should always be sure that the watershield is reinstalled when you assemble the door.

Before you begin disassembling the car door, here are some tips that will make the job a little easier.

Tip 1: Be sure that your tools and clothing are free of any grease and dirt. Since you'll be working on the interior of the

vehicle, dirt and grease can easily get onto the upholstery and carpeting of the vehicle, making the customer very unhappy. To help prevent dirt from getting on the upholstery, it's a good idea to use plastic to cover the seats of the vehicle while you're working on it.

Tip 2: Have a small container available to store parts. The removal procedure will require you to remove several small screws and retainer clips. A container to store these items will prevent them from getting misplaced or lost.

Tip 3: Keep a notebook or piece of paper and a pencil available to take notes on the location of the various components so that you can refer to your notes if necessary during reassembly.

Tip 4: Don't apply force to remove a component. If a component seems to require force to remove it, stop and look for an additional screw or other objects retaining it. Most items have screws that are placed out of sight, and thus, easy to overlook.

Now, to remove the trim from the interior of the door, follow these steps.

Step 1: Before beginning the removal of the door trim panel, remove the negative battery terminal lead from the battery (Figure 22). The reason for removing the negative, and not the positive, lead is because touching one end of the wrench

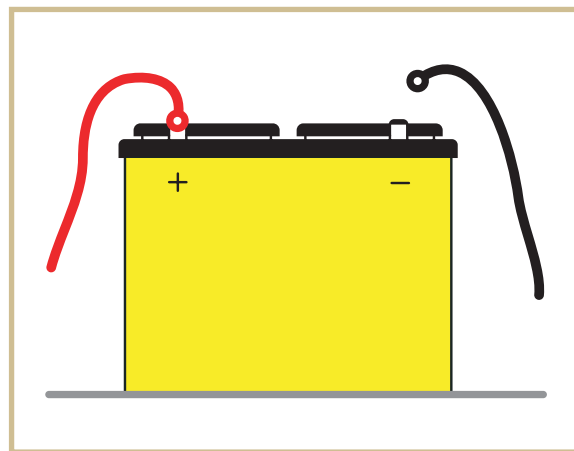


FIGURE 22—Before starting to disassemble a car door, disconnect the negative lead from the car's battery.

to the *positive* terminal and hitting any part of the frame with the wrench handle will weld the wrench. This will not happen when you touch the negative lead. The battery of a typical car will be located under the hood, near the front of the

vehicle. The removal of the battery connection will cut off all electrical power to the vehicle. When working on a car door you may have to work around electric accessories, such as power mirrors and power windows. Disconnecting the battery will prevent a short circuit if you accidentally touch a power lead in the door.

Step 2: Carefully observe the inner door trim panel and try to familiarize yourself with all items and screws that are holding the panel on.

Step 3: Raise the car window. Once the trim panel is removed, you'll need to have access to the lock cylinder. If the window is down, it will block your access. Therefore, it's a good idea to have the window up before beginning, since in most cases the window handle will have to be removed to remove the door trim panel. Since car windows are very expensive to replace, be very careful not to scratch, crack, or break the glass while you're working on the door lock.

(*Note:* If it's necessary for you to have the window *down* for any reason during removal of the trim panel, you can always reinstall the window handle to raise the window.)

Step 4: Remove the interior lock button. On many vehicles, the lock button is removed by simply unscrewing it (Figure 23).

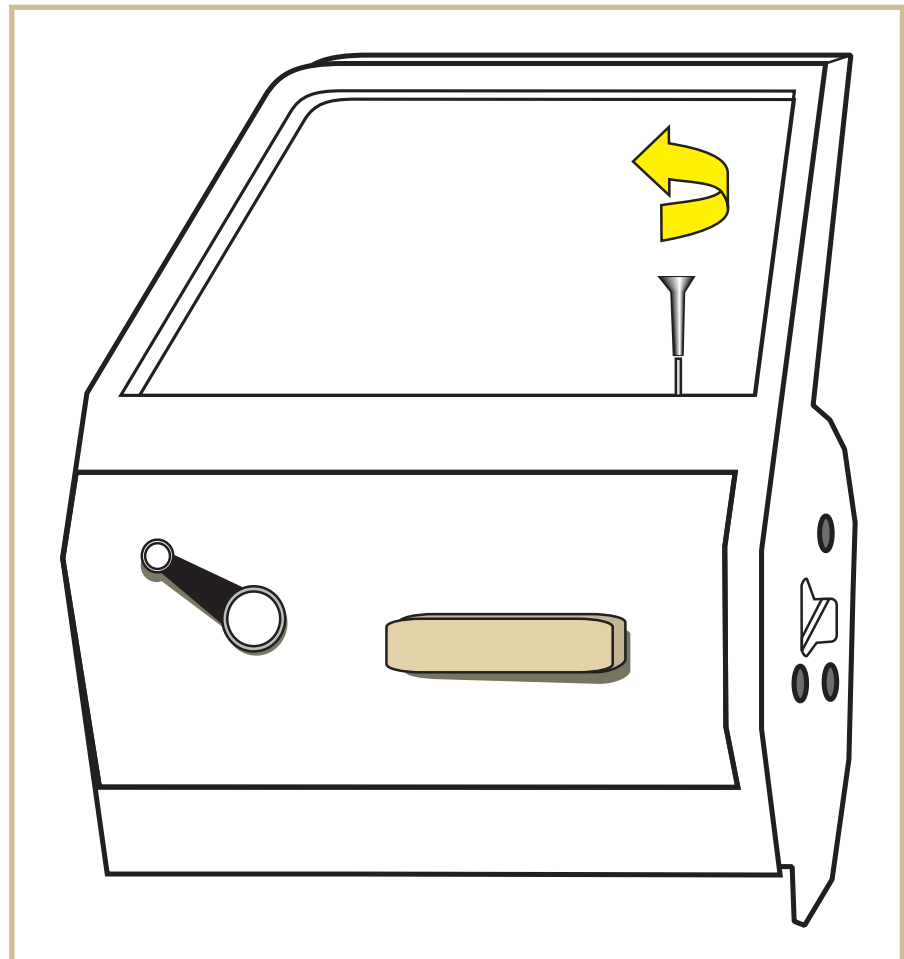


FIGURE 23—On many vehicles, the lock button is removed by unscrewing it.

The lock button is threaded onto a rod, called a lock rod, that attaches to the door latch assembly.

If the lock button is the horizontal sliding type, the button won't have to be removed; instead, it will remain attached to the door. However, the plastic trim around the sliding lock button will have to be removed. The trim will be held on by one or two screws.

Step 5: Remove the armrest. Most armrests are held in place by two or three screws that are inserted from the side or up from the bottom (Figure 24). To remove the screws you'll need to use either a Phillips screwdriver, a hex socket, or a

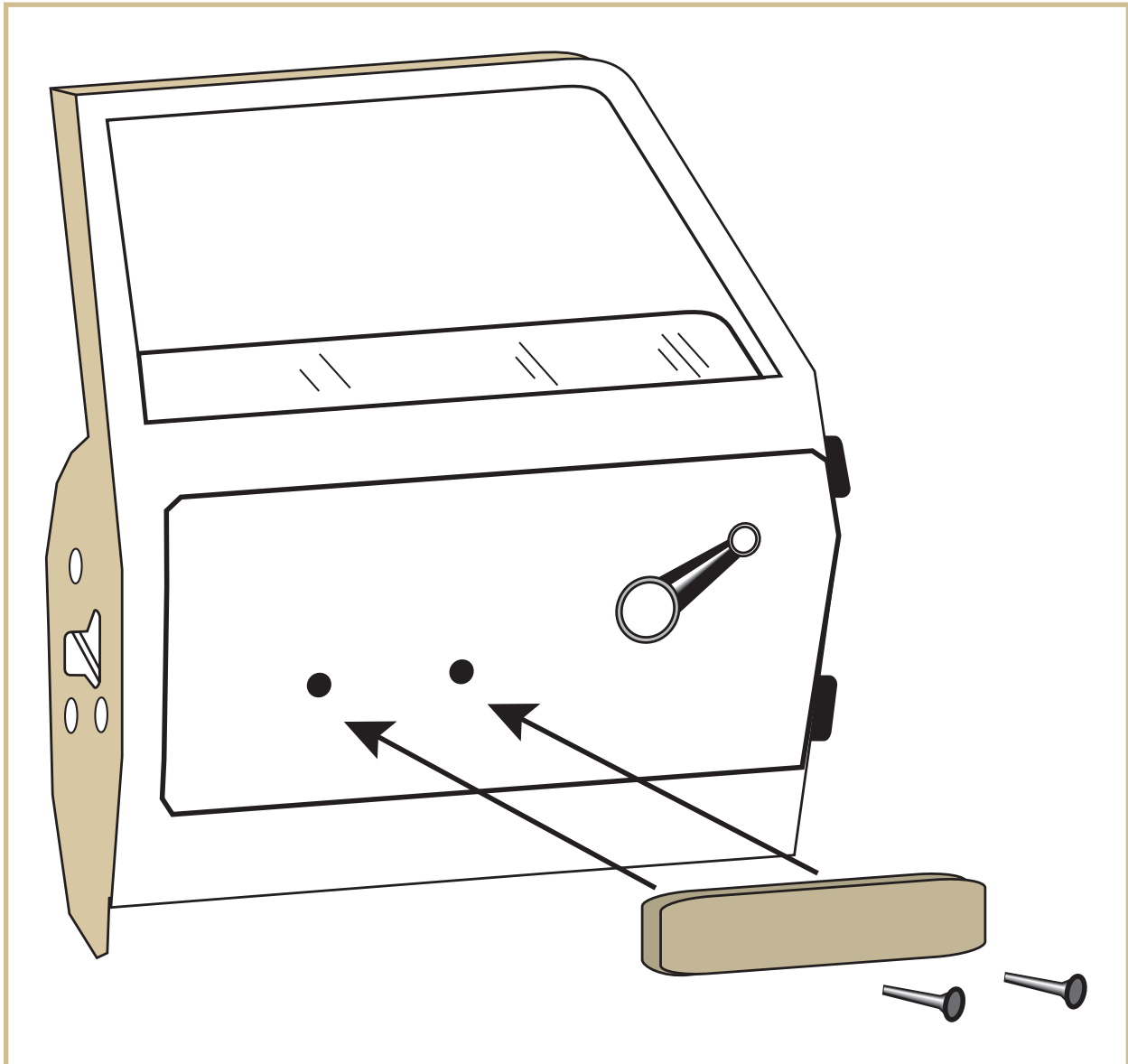
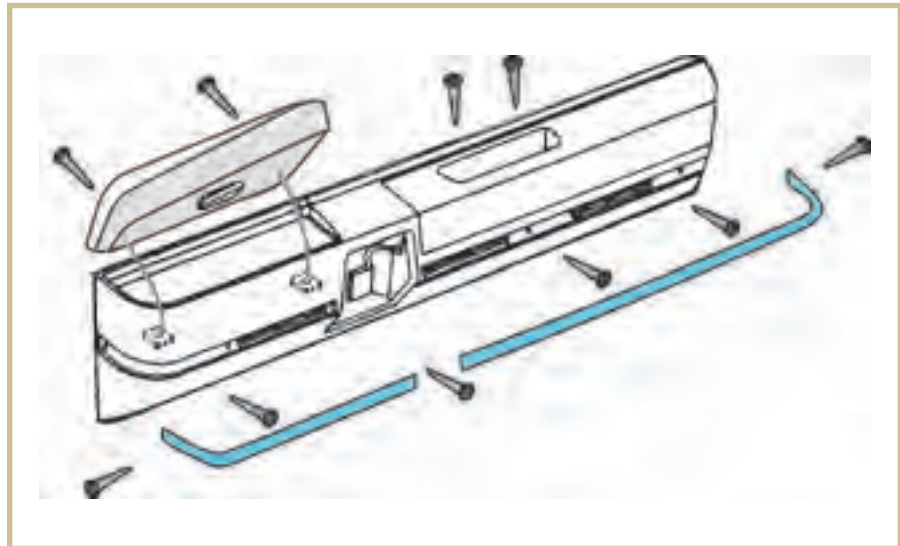


FIGURE 24—Remove the armrest by unscrewing the screws that hold it to the door panel.

Torx screwdriver. A Torx-head screw is similar to a Phillips-head screw, with the difference that the head of a Torx screw will have a six-sided star-shaped slot in it. Torx screwdrivers can be purchased at most auto tool suppliers or hardware stores. Once the screws are removed, the armrest can be removed from the door trim panel.

You may find that some vehicles have the armrest and trim panel as all one piece. These are called *integral armrests* and are found most often on more expensive cars with power windows. On these models the screws are removed as described above, but the armrest will be removed when the trim panel is removed. These screws aren't always easily visible; they're sometimes concealed behind metal trim or under power window switch plates. When working on a car with an integral armrest, be sure to carefully check for any hidden screws that might hold the armrest to the door panel (Figure 25).

FIGURE 25—The screws that hold an integral armrest to the door panel may be hidden.



Step 6: Remove the window handle. There are two common types of window handles. One type is held in place by a screw through the handle, while the other is held in place by a wire clip. The screw-on type handle is commonly seen in Ford and Chrysler vehicles. For the type held by a screw, the handle is removed by first removing the screw in the center of the handle (Figure 26). Most handles will have either a Phillips-head or Allen-head screw, which can be removed by the appropriate tool. Once the screw is removed, the handle can be removed. *Note:* You may find some window handles that have a cover over the screw head. For this type, you must puncture or remove the cover to access the screw head beneath.

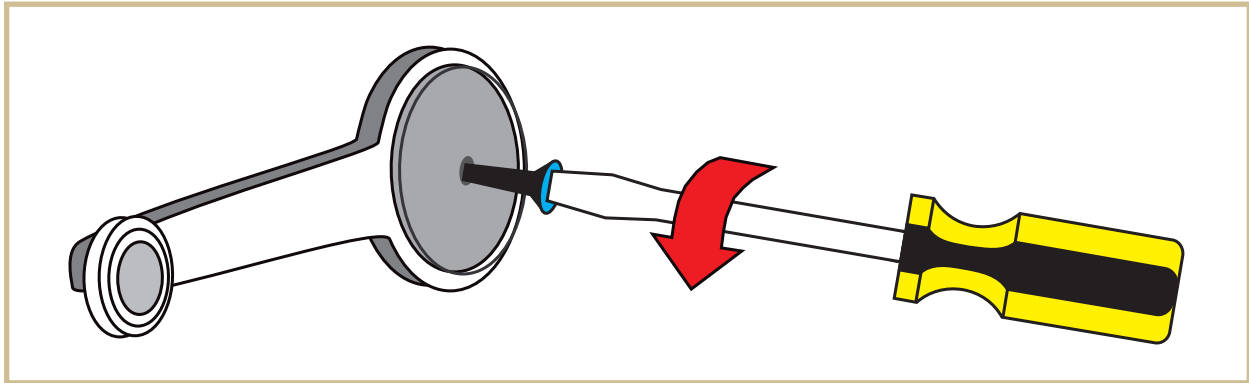
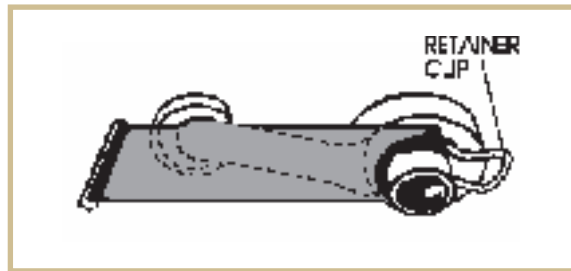


FIGURE 26—Loosen the screw in the center of the window handle to remove the handle from the door.

Another type of window handle uses a retaining clip to hold it on the retainer shaft (Figure 27). This type of window handle is commonly used on General Motors vehicles. It has a wire horseshoe-shaped retainer clip that fits into slots in the

FIGURE 27—This type of window handle is held on by a retainer clip instead of a screw.



handle, thereby holding it onto the window shaft. In most vehicles with this type of handle, there's also a spring behind the trim panel that holds it

against the handle, thus improving its appearance. A thin plastic plate between the handle and the trim panel acts like a bearing plate. This plastic bearing plate prevents damage to the upholstery when the window handle is turned.

To remove this type of handle, follow these steps:

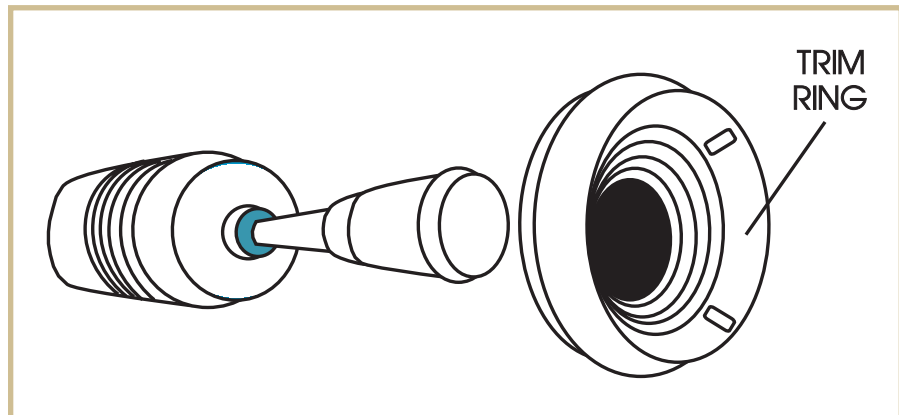
- Press in the trim panel around the handle so that the retainer clip and plastic bearing plate are exposed.
- Remove the wire retaining clip. To remove the clip you should use a special tool designed for this purpose. This tool can be purchased relatively inexpensively at most locksmith or automotive supply stores. It's a flat metal-type tool with a specially designed end to grab the retainer ring. To use the tool, simply insert it between the handle and the trim panel, so that the open end of the retainer clip is facing the tool. Push inward on the tool to release the clip. Be sure to keep a close watch on the clip so that it doesn't drop and get lost. The clip is relatively small and therefore easy to misplace.

- Once the clip is removed, the handle may be removed by pulling it off of the shaft.

Step 7: If the car has power windows, remove the trim from the control panel. This trim panel is held in place by one or more screws. On most vehicles, the power window and lock control buttons are mounted on the door itself and thus aren't removed with the door panel. In these cases, only the trim panel will have to be removed. *Note:* There are some vehicles which have the control button mounted on the trim panel. For these vehicles, the power wires to these switches will have to be unhooked before the panel can be completely removed.

Step 8: If the vehicle is equipped with remote control mirrors, the trim ring around the window control handle will have to be removed (Figure 28). This trim ring is sometimes held by a threaded nut and can be removed by simply turning the nut counterclockwise. Sometimes the threaded nut is part of the trim ring.

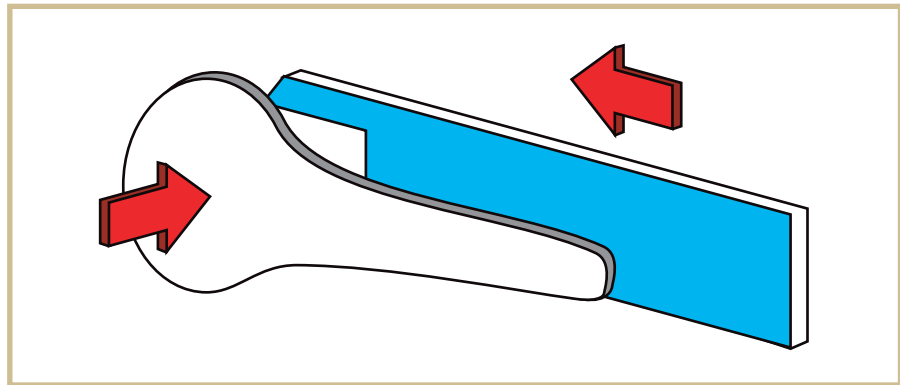
FIGURE 28—Remove the trim ring from a mirror remote control.



Step 9: Remove the inner door handle. On most vehicles, the inner door handle is held in place by one or more screws. These screws are normally inserted from the front or from the bottom of the handle. To gain access to the screws, you'll often have to pull the handle out and hold it while you remove the screws. Once the screws are removed, the handle can be taken off and set aside (Figure 29).

Step 10: Once all the items have been removed from the door panel, the panel is ready to be removed. At this time, it's usually a good idea to double-check to be sure that all trim items have been removed.

FIGURE 29—Remove the inner door handle as shown here.



Step 11: The interior door trim panel on most cars is simply an upholstered piece of cardboard. On most vehicles, the trim panel is hooked over the top of the door and held tightly to the door using plastic push-in fasteners. These fasteners are located along the outer edges of the panel. The fasteners simply push in through the panel and then through holes in the door itself. To remove the panel, the fasteners must be pried out of the holes.

A flat-blade screwdriver can be inserted between the door and the panel to force out the fasteners. However, the preferred method is to use a special tool designed for this purpose (Figure 30). The tool is inserted between the trim panel and the door and used to pry the fasteners out of the holes. To get the fasteners out, simply twist the tool once it's inserted between the panels. The fasteners are pried free one at a time, until all of the fasteners holding the panel are out. If one of the plastic fasteners happens to break off, don't worry. This is a common occurrence. Replacement clips can be purchased at any auto parts store. (*Note:* Some door panels may be held in place by screws. For this type panel, simply remove all screws holding the panel in place.)

Step 12: Once the trim panel is loose from the door, pull the panel out slightly and then lift it upward, unhooking it from the door (Figure 31). Once the panel is unhooked, it can be removed and put in a safe, clean place.

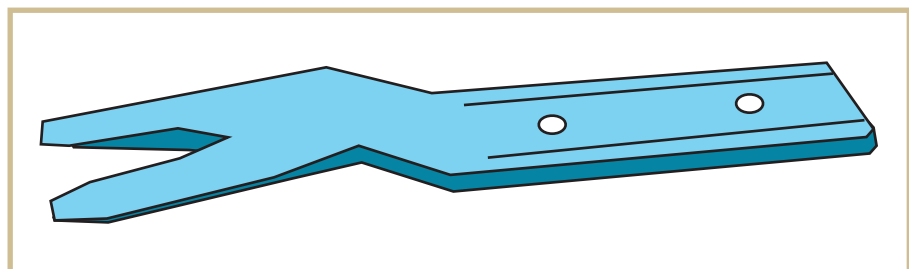


FIGURE 30—This tool is used to pry trim fasteners out of a car door.

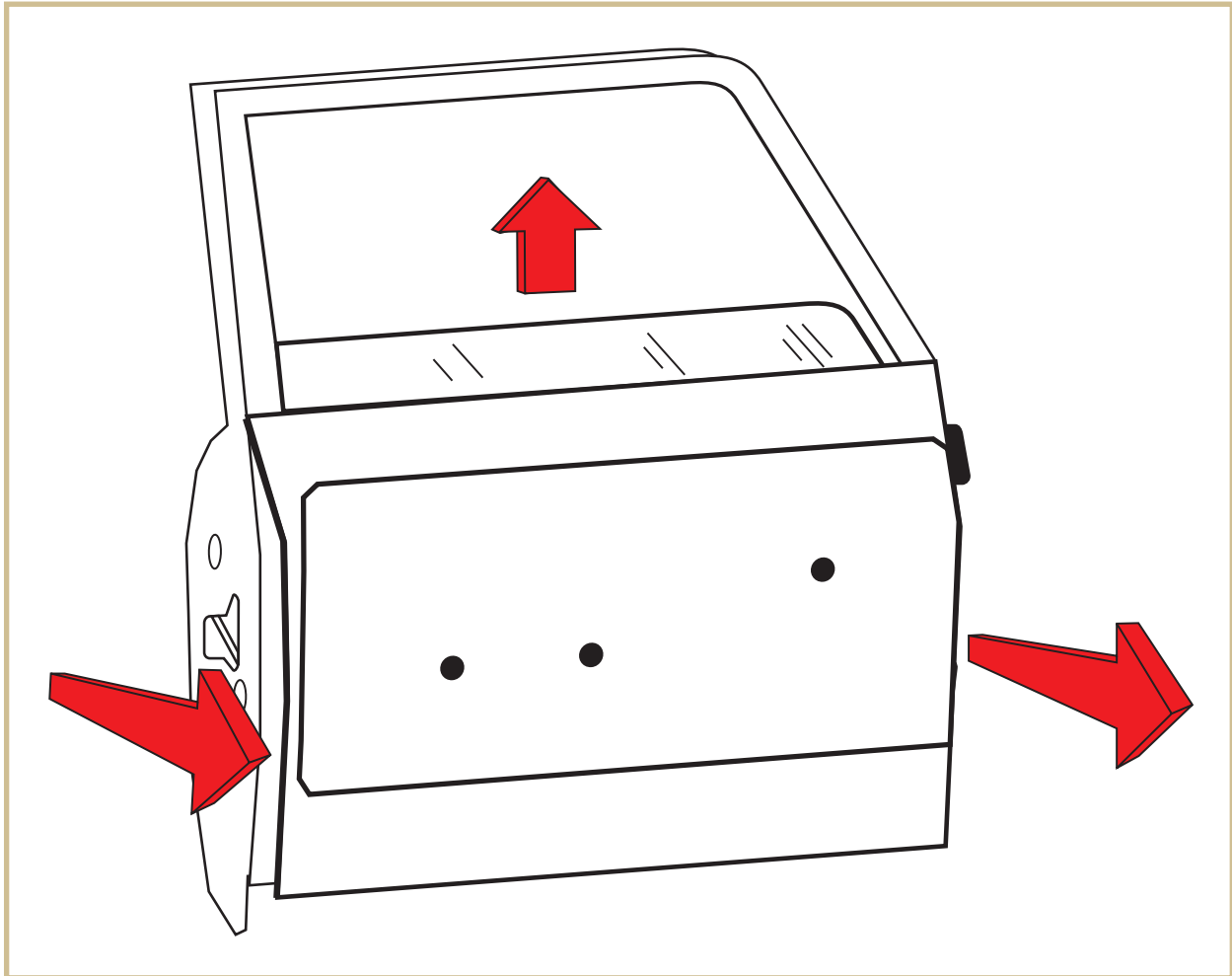


FIGURE 31—Lift the trim panel off, as shown here.

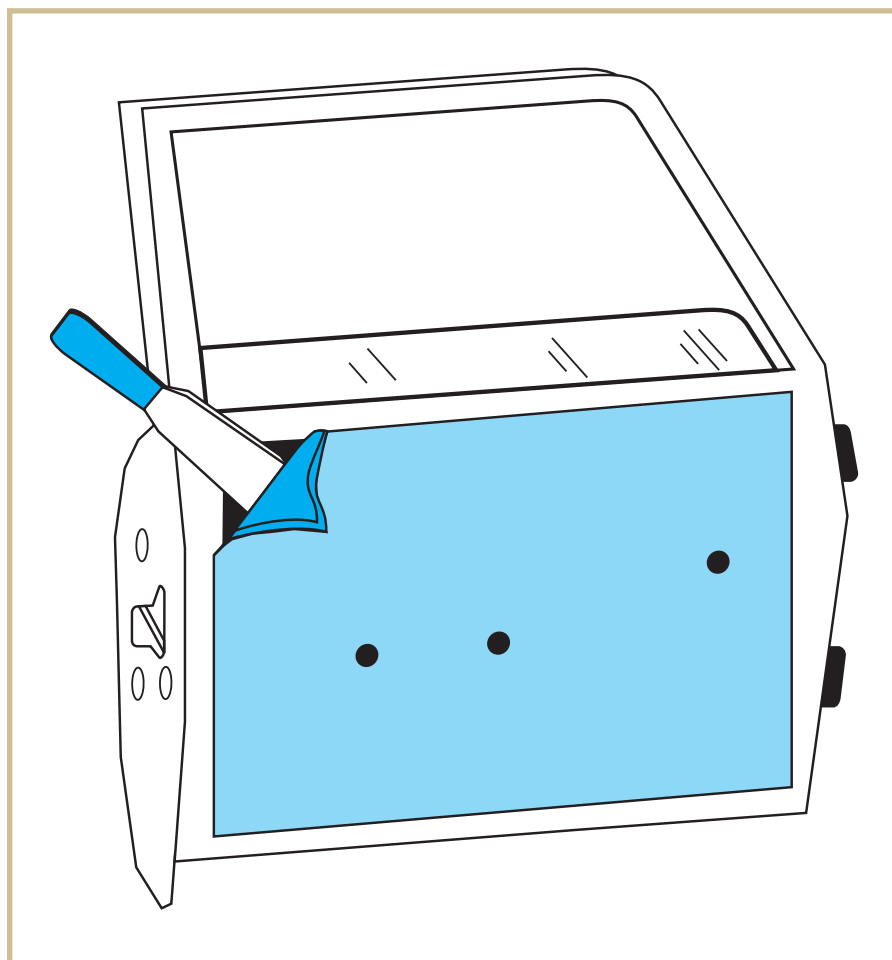
Step 13: After the trim panel is removed, remove the watershield. The watershield is taped or glued in place and can be easily pulled free from the door. If necessary, insert a putty knife or paint scraper behind the shield and slide the tool back and forth to loosen the seal. You can now peel the watershield away (Figure 32).

At this point, the car door is disassembled as far as necessary to begin lock cylinder removal.

Removing the Lock Cylinder

After all the trim has been removed from the interior of the door, and the door panel and the watershield have been removed, you'll see cutout sections in the door panel (Figure 33). They provide access to the locking components inside the

FIGURE 32—Peel the watershield away, as shown here.



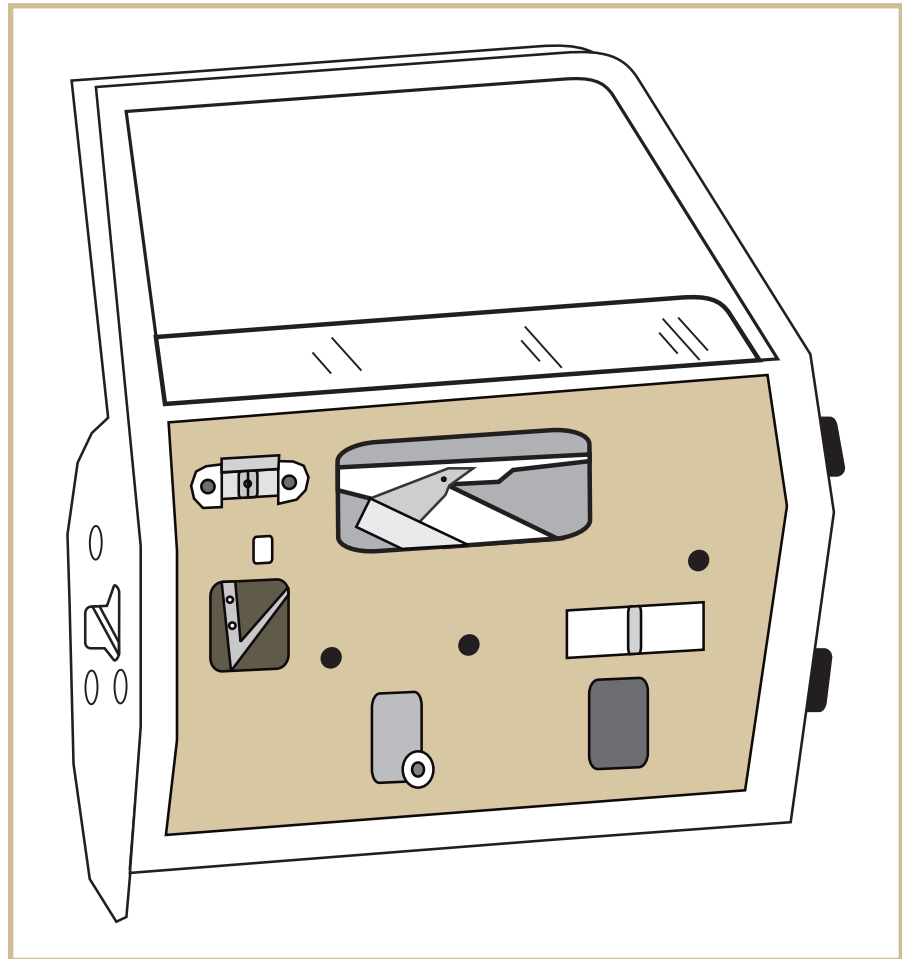
door. You should be able to easily see the lock cylinder inside the door. If not, look at the location of the lock on the *outside* of the car door for a clue as to its placement in the door.

Once you've located the lock cylinder, follow these steps for its removal:

Step 1: Disconnect the connecting rod that attaches the cylinder to the door latch. The connecting rod will have a metal or plastic clip that holds the rod to the cylinder pawl. The design of the metal or plastic clips will vary from vehicle to vehicle. However, the following are the three most common types.

One type of clip has a lifting tab built in to assist in its removal. This type is commonly used in vehicles manufactured by Ford (Figure 34). To remove this type of clip, a flat-blade screwdriver is inserted under the lifting tab on the clip. Once in place, the screwdriver is twisted, unhooking the clip from the lock rod. Once unhooked, the clip can be rotated out of the way, allowing the rod to be pulled out of the lock pawl.

FIGURE 33—After the trim panel and the watershield have been removed, you'll see these cutout sections in the car door.



Another type of clip is very similar to the one explained above, except it doesn't have a lifting tab. The removal is very similar. A flat-blade screwdriver is used to pry the clip loose, but you must place the screwdriver blade against the edge of the clip and apply pressure (Figure 35). If the clip doesn't come free with pressure applied to it, you can usually tap the end of the screwdriver with the palm of your hand to knock the clip loose. Once the clip is loose, the rod can be removed. This type of clip is commonly used on vehicles produced by the Chrysler Corporation.

The third type of clip is a sliding type that slides on the lock pawl and locks into a retaining groove on the lock rod (Figure 36). This type is commonly used on General Motors vehicles. To remove this type, use a flat-blade screwdriver to pry the clip sideways so that the clip is free from the grooves on the lock rod. Once the clip is free of the grooves, the rod can be removed.

FIGURE 34—The rod clip in a Ford vehicle will have a small tab to help you lift it.

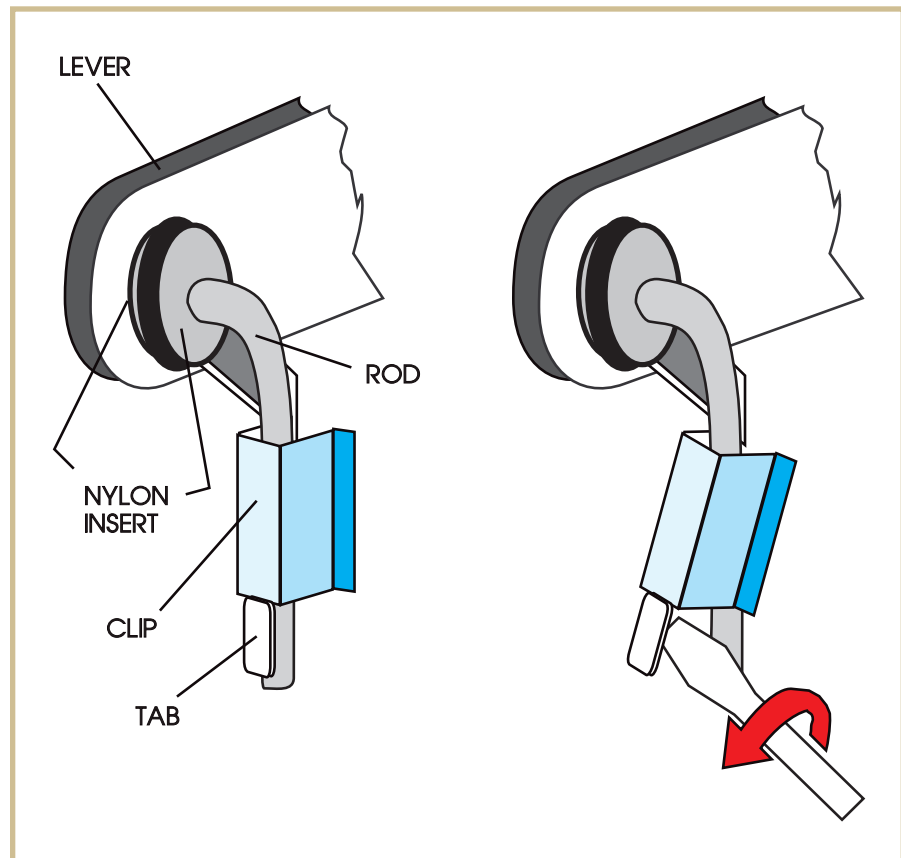


FIGURE 35—To remove the rod clip in a Chrysler vehicle, exert pressure on the clip with a screwdriver, as shown here.

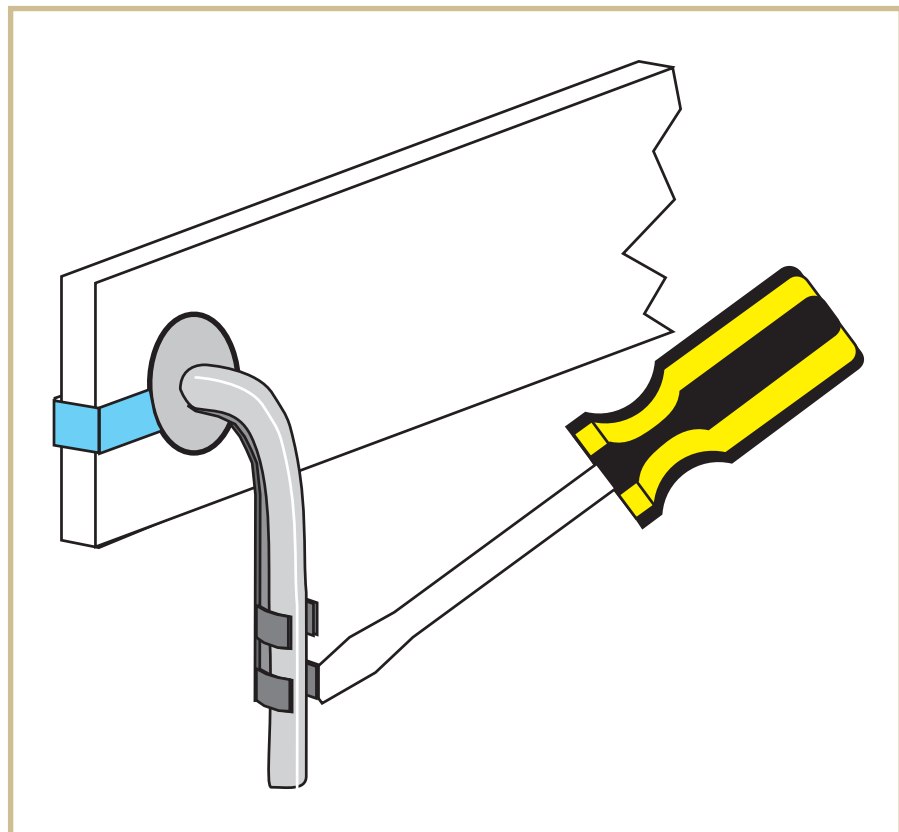
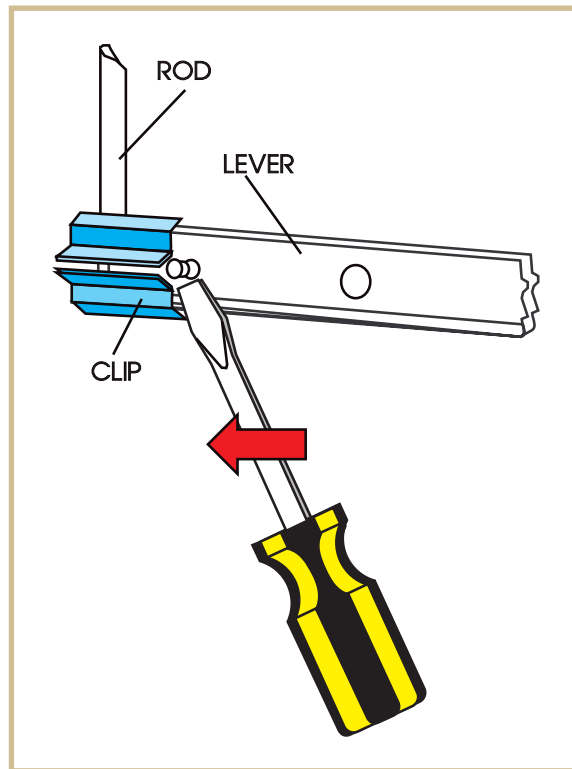


FIGURE 36—This type of rod clip is used in a General Motors vehicle.



As stated earlier, the design of the rod clip will vary slightly from vehicle to vehicle, but the removal procedure for most vehicles will almost always be one of the three methods described.

Step 2: Once the connecting rod is free, it's time to remove the lock cylinder. As you've already learned, most locks are held in place by a U-shaped retainer clip

(Figure 37). To remove this clip, simply insert a flat-blade screwdriver between the clip and the lock cylinder and pry the clip loose. Once the clip is free, remove it from the cylinder and put it in your parts container.

Step 3: Now the lock cylinder can be removed by gently pulling it out of the door. When removing the cylinder, note its

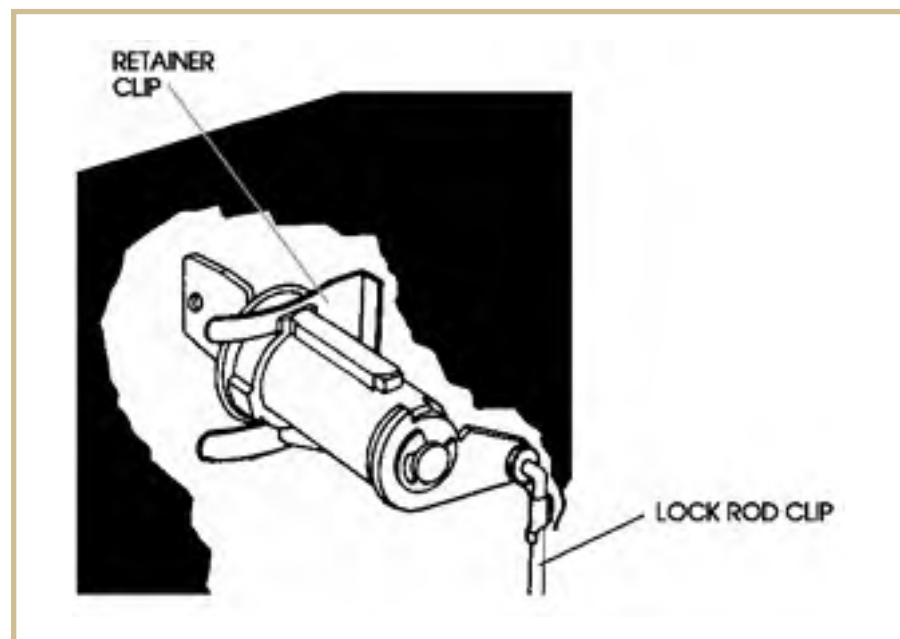


FIGURE 37—Most lock cylinders are held in place by U-shaped retainer clips.

position and the position of the key. This will assist you when you install the replacement cylinder.

Installing a New Lock Cylinder

At this point, you've completely disassembled the car door and removed the lock cylinder. Now, you're ready to do your actual work on the lock cylinder. You can rekey the lock, repair it, clean and lubricate it, "read" it to determine the key code, or perform any other service necessary. All of these procedures were described earlier in this and other study units.

However, for the purposes of our discussion here, let's assume that the lock cylinder you just removed is no longer serviceable, and that you need to install a new one. Follow these steps to install a new lock cylinder:

Step 1: Insert the new lock cylinder into the hole in the exterior side of the door. Be sure that the lock is inserted all the way and make sure that the lock is inserted correctly and isn't upside down.

Step 2: Install the U-shaped retaining clip into the slots on the lock cylinder (Figure 37). Use a flat-blade screwdriver or the special tool designed for this job to pry the clip into place.

Step 3: Connect the connecting rod to the new cylinder and snap the lock rod clip in place to hold it securely.

Step 4: Test the door lock to be sure it turns and operates the locking mechanism properly. This step is important and can save you a lot of time. (Just think of the time wasted if you reassembled the entire door only to find that the lock didn't operate properly and the door would have to be taken apart again!)

Reassembling the Car Door

Once you've performed your service work on the lock cylinder itself, and once you've tested the lock cylinder to make sure it works properly, you're ready to reassemble the door. Follow these steps to put the car door back together:

Step 1: Reinstall the plastic sheet watershield. This moisture barrier is important in preventing damage to the trim panel. If the sheet doesn't want to stay in place, you can use some tape to hold it to the door.

Step 2: Install the trim panel. To install the panel, first be sure all of the retaining clips are in place and none of them are broken. Then, hook the panel over the top of the door. Once the panel is hooked at the top, line up the clips with the holes in the door and tap them into place using the palm of your hand.

(*Note:* If the panel uses a spring behind the window handle, be sure that it's in place before installing the panel.)

Step 3: Install the armrest, inner door handle, and all other trim items that were removed.

Step 4: Install the window handle. Place the plastic bearing shield on the handle shaft. For handles using the wire clip, insert the clip into the handle and then push the handle onto the shaft; the clip will snap into place when the handle is pressed on. If the handle uses a screw to hold it in place, put the handle on the shaft and install the screw.

Step 5: Finally, install the lock knob and/or lock knob trim plate.

Removing and Replacing a Lock Cylinder in a Ford Vehicle

Compared to most other vehicles, the lock cylinders on vehicles produced by the Ford Motor Company are relatively easy to install and replace because *you won't need to remove all the trim from the door*. On most Ford vehicles, there's easy access to the U-shaped cylinder retainer clip without having to remove any of the door trim or the trim panel itself. To replace a lock cylinder on this type of vehicle, follow these steps:

Step 1: Open the door and locate the lock cylinder and the U-shaped retainer clip. The clip can be seen by looking at the edge of the door near the lock cylinder.

Step 2: Remove the U-shaped retaining clip at the edge of the door by prying it loose with a flat-blade screwdriver. Once the clip is loose, pull it out and place it in a container.

Step 3: From the exterior side of the door, gently pull out the lock cylinder.

Step 4: Have the replacement lock assembly ready to be installed and within easy reach at this time.

Step 5: Disconnect the connecting rod that holds the cylinder to the latch. To remove the clip, follow the instructions given in the previous section. *WARNING: HOLD ONTO THE LOCK LINKAGE CAREFULLY.* Secure the linkage with masking tape to prevent its slipping back into the door. If you let go of it, it will slip back into the door and you'll have to take the door apart to retrieve it!

Step 6: Reconnect the new lock cylinder to the connecting rod and snap the clip into place.

Step 7: Gently, push the lock cylinder into the hole in the door.

Step 8: From the edge of the door, install the U-shaped retaining clip onto the lock cylinder.

Step 9: Once the retaining clip is in place, check to see that the lock is operating properly.

Replacing a Trunk Lock Cylinder

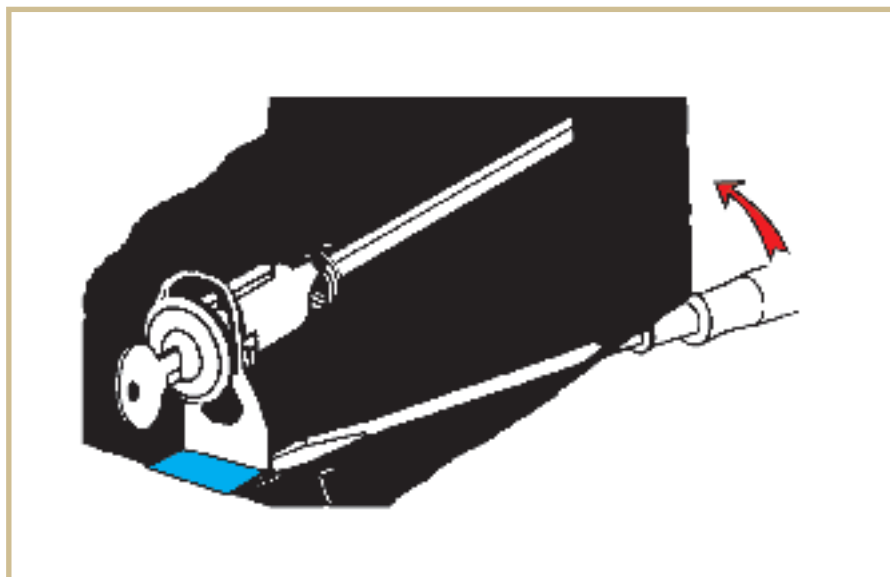
Since the same type of lock cylinder is used, trunk lock cylinders are installed in a similar fashion to the procedure for doors. In most car models they're quite easy to remove or replace with the aid of a few tools, such as a screwdriver, pop rivet tool, or an electric drill.

As with car doors, the trunk lock cylinder is held in place with a retaining clip. Unlike most doors, this retaining clip is screwed or riveted in place. This prevents the clip from accidentally coming loose when the trunk lid is slammed shut.

You'll find that on most vehicles the screws or rivets can easily be reached with the trunk lid open, without removing any additional components (Figure 38). On some other vehicles, the retainer clip screws or rivets may be accessed from outside the trunk lid.

For example, some vehicles produced by Chrysler require you to turn the trunk emblem out of the way to insert the trunk key. When you turn the trunk emblem, you'll also notice that the rivets for the retainer clip are also located behind the emblem. For this type, the rivets can be drilled out from this side. Still another type requires you to unbolt and

FIGURE 38—In some vehicles, the retainer clip that holds the trunk cylinder in place can be reached with the trunk open.



remove the latch assembly to gain access to the retaining clip. This method is common on vehicles with hatchbacks.

As stated earlier, each vehicle is slightly different. The following is a general procedure that will work for most vehicles. Keep in mind that a service manual for the vehicle will give you the exact procedure for that vehicle.

Follow these general steps to replace a trunk lock:

Step 1: Open the trunk and locate the underside of the trunk lock. The lock mechanism is found on the edge of the trunk lid, directly in the center. Look for the retaining clip. Keep in mind that, on some vehicles, you may have to unbolt the latch assembly first.

Step 2: Determine what type of system is used to hold the retaining clip in place. In most cases, small rivets are used.

Step 3: Drill out the rivets that hold the retaining clip in place, using an electric hand drill and a drill bit the same diameter as the rivet. In the case of clips held by screws, remove the screws holding it in place. If the clip is only a press fit, go on to Step 4.

Step 4: Remove the retaining clip from the lock cylinder. In some cases, you may have to use a flat-blade screwdriver to pry it free.

Step 5: Remove the lock cylinder. Remove any connecting bars or links that are attached to the lock. *Note:* Some locks may not have any attaching components.

Step 6: Install the new cylinder.

Step 7: Replace the retaining clip, and install a new rivet or a screw.

Step 8: *DON'T CLOSE THE TRUNK YET.* First, insert the key and test the new lock to be sure it turns and works properly. If you close the trunk lid and the lock doesn't work, you've got a major problem.

Step 9: Close the trunk lid and try the lock again. If the lock works smoothly, your job is finished. If the lock seems to bind, open the trunk and check for proper installation and lubrication.

Replacing a Glove Compartment Lock Cylinder

Glove compartment lock cylinders are normally easy to remove, because in most cases the lock cylinder and the latch assembly are one unit. In most cases, to remove this type of cylinder you only have to unbolt the latch assembly from the inside of the glove compartment and replace it with a new one.

Some glove compartment locks will require removal of the lock knob before the lock cylinder can be removed. This is common on many vehicles, including many made by Ford. To remove the lock knob on these vehicles, a special tool is used. This tool is made of a piece of small wire, such as a straightened paper clip. The wire is straight except for a $\frac{1}{4}$ -inch, L-shaped hook on the end. The hook is inserted into the keyway of the glove compartment knob (Figure 39). The wire is then turned and pulled, thereby releasing the spring clip that holds the knob in place.

The following is a general procedure for replacing a glove compartment lock assembly:

Step 1: Open the glove compartment door.

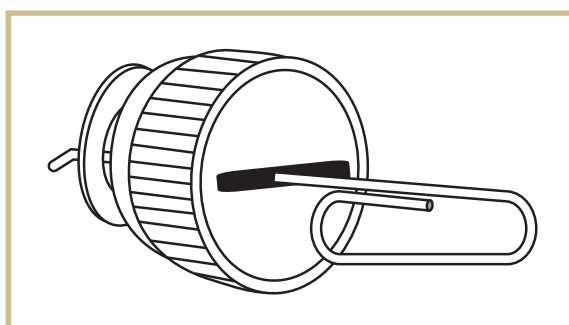


FIGURE 39—This special tool is inserted into the keyway of a glove compartment to release the spring.

Step 2: Remove the lock knob, using the special wire tool described above if necessary.

Step 3: Remove the latch assembly by

removing the two or more screws holding it to the glove compartment.

Step 4: Install the new lock assembly.

Step 5: Test the lock operation.

Step 6: Close the glove compartment door and test the lock again. Keep in mind that when you replace the glove compartment lock, the new lock won't use the same key as the old lock and therefore won't match the other locks in the car. So, in most cases, the new lock cylinder is rekeyed to match the other car locks, or the other locks are replaced at the same time.

Replacing an Ignition Lock Cylinder

In most cases, the removal of a lock cylinder can be accomplished with a few tools and some basic knowledge of how the locks are installed. One area that isn't quite as easy is the replacement of the ignition lock. To deter vehicle theft, most car manufacturers deliberately make it difficult to access the ignition lock. Making the lock difficult to access does help reduce vehicle theft, but it also makes the locksmith's job much more difficult. However, there's no need to panic. The replacement of the ignition lock, although more difficult than a door lock, isn't impossible. With some specialized tools and the aid of a vehicle service manual, the lock can be replaced.

Experienced locksmiths will be able to make most replacements without the aid of detailed reference materials, such as a vehicle service manual. However, novice locksmiths will often refer to a reference manual for the exact procedure for lock replacement. Vehicle service manuals are manuals that contain detailed information and repair procedures for most systems on the vehicle. These manuals normally can be purchased from a dealer for the automobile, an auto parts store, or a local book store. These manuals cover the repair of all the automobile's systems. Therefore, information on lock replacement is contained in the service manual. However, if you're only interested in the replacement of the locks, the majority of information in the manuals will be of no use to you. A preferred option may be to purchase an automotive guidebook specifically designed to cover automotive lock replacement. These guidebooks are normally available from a locksmith tool supplier.

Replacing an auto lock cylinder isn't difficult if you have the proper tools and you know what you're doing. The replacement of trunk locks and door locks is a lucrative service area for many locksmiths. In most cases, the removal of the lock can be accomplished with a few tools and some basic knowledge of how the locks are installed. This is true for most car lock types, such as the door, glove box, and trunk locks.

However, ignition locks are a different matter. While it is possible for a locksmith to do ignition work, the problem you'll run into is the wide variety of car models and their ever-changing features (tilting wheels, telescoping wheels, and so on). In addition, most new car models now contain air bag mechanisms in the steering column. Another concern is that unless you perform the disassembly procedure very carefully and according to the manufacturer's instructions, you may compromise the manufacturer's warranty protection. Therefore, unless you possess excellent skills, knowledge, and experience working with cars, you may want to leave the disassembly of steering columns and ignitions to a certified auto technician.

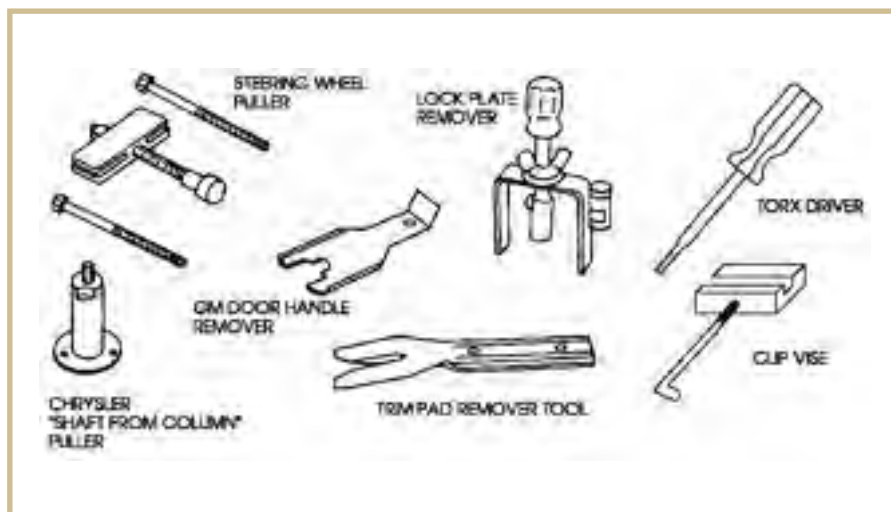
This doesn't mean, however, that you can't still perform rekeying and other services on auto locks. If you have a large volume of auto work, you could work in collaboration with an auto technician or car dealership. You can allow the technician to disassemble the steering column, then do the lock work yourself. The technician can then reassemble the steering column to complete the job.

In this section of the text, we'll describe the procedure of replacing ignition lock cylinders. *NOTE: WE DON'T RECOMMEND THAT YOU ATTEMPT TO DISASSEMBLE AN AUTO STEERING COLUMN AND REPLACE AN IGNITION LOCK WITHOUT EXPERIENCE AND THE PROPER PROFESSIONAL TOOLS.* Also, remember that if your customer's car is still under the manufacturer's warranty, *you must disassemble the steering wheel according to the manufacturer's instructions.* Otherwise, the warranty may be invalidated. We'll discuss the general steps involved in replacing an ignition lock so that you can see what's involved in the procedure.

Disassembling a General Motors Steering Wheel

In some car models, before you can remove the ignition lock, you'll need to remove the steering wheel. Most General

FIGURE 40—These tools will be needed to disassemble a steering wheel.



Motors vehicles work this way. Even though an ignition lock is found in plain view on the steering column, it's held in place by screws or retaining clips from the inside of the column. In order to remove the lock, you'll need to disassemble the steering column to gain access to those clips and screws.

You'll need the following tools for this procedure: a wheel puller, socket wrench, screwdrivers, and a Torx driver (Figure 40). The following procedure can be used with any standard General Motors steering wheel. Figure 41A shows the parts of the steering wheel that we'll be referring to in the following discussion. Follow these steps to disassemble the steering wheel:

Step 1: Always start by removing the negative lead from the car battery as a safety precaution.

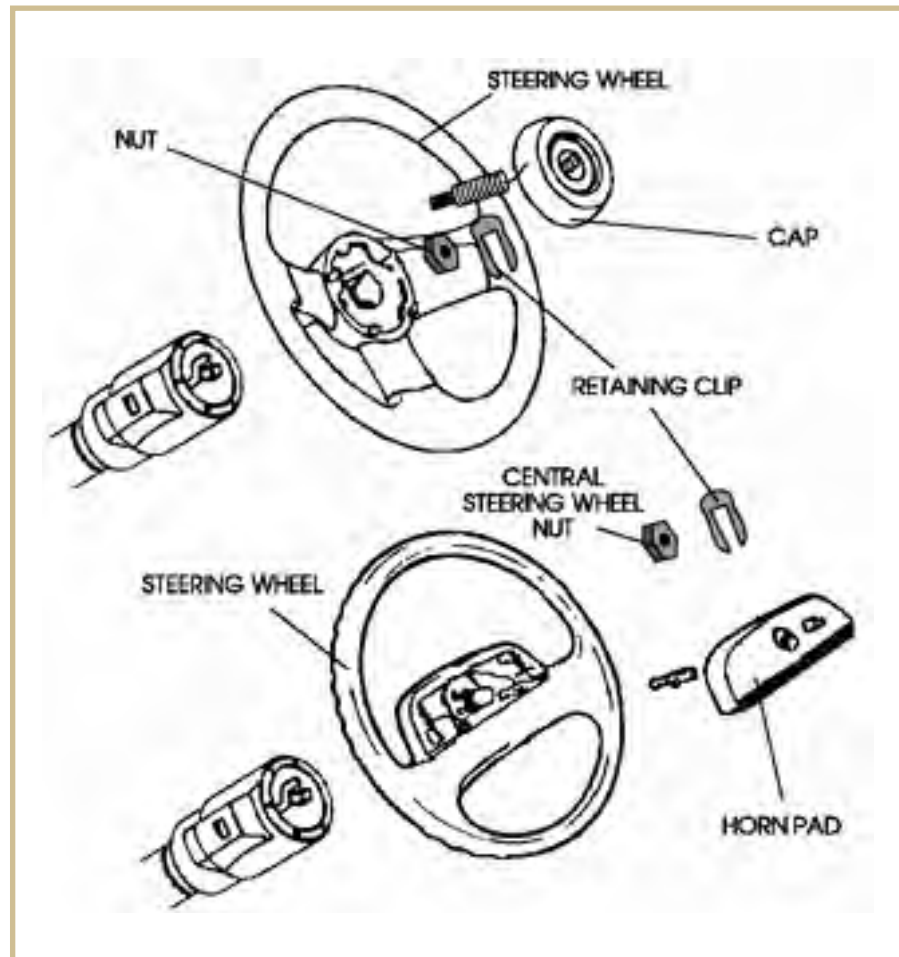
Step 2: Remove the horn pad and/or wheel trim (Figure 41A). These are usually fastened by screws at the back of the wheel.

Step 3: Remove the retaining clip on the main steering wheel nut (Figure 41A). However, don't remove the steering wheel yet.

Step 4: Some steering wheels fit on with a spline. Others may have small alignment arrows drawn on the nut and the wheel. Note the location of these arrows now, as you'll need to line them up during your reassembly of the wheel.

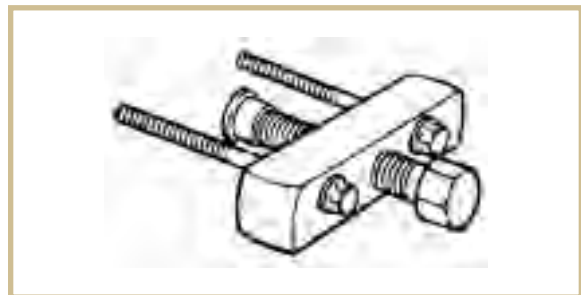
Step 5: Remove the central steering wheel nut (Figure 41A).

FIGURE 41A—Parts of a Steering Wheel



Step 6: Screw on a proper wheel puller for the model of the car. Turn the center screw on the tool carefully to remove the wheel. A typical one is shown in Figure 41B.

FIGURE 41B



Step 7: Once you remove the steering wheel, you'll have exposed the lock plate cover. Remove it now (Figure 41D).

Step 8: Now the lock plate is exposed. This is held in place by a retaining ring. You'll need to use a compression tool to remove the ring (Figure 41C). Thread the compression tool

FIGURE 41C

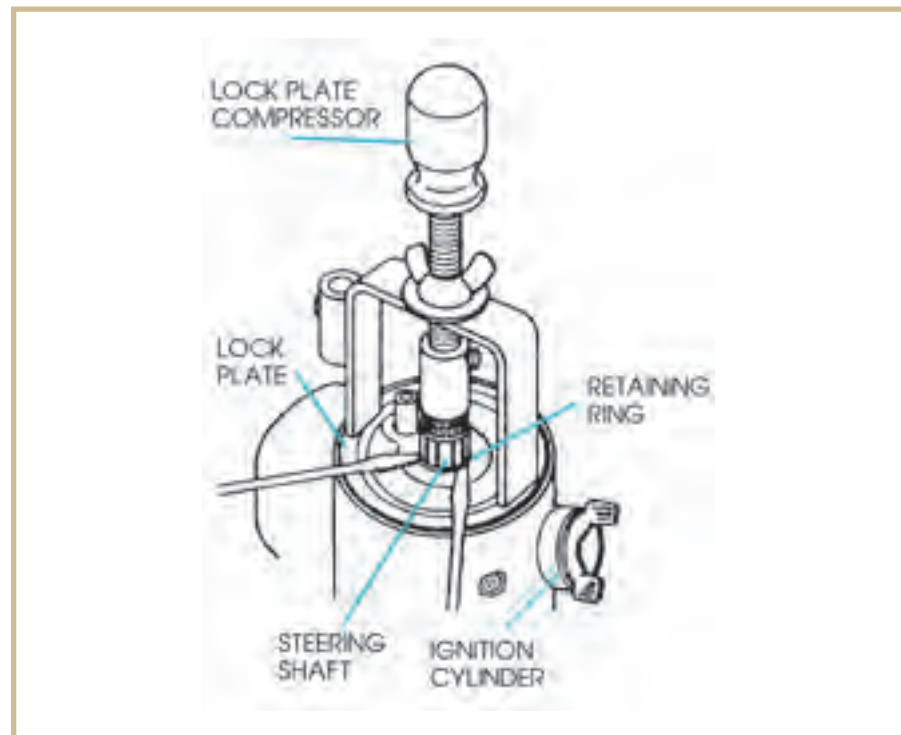
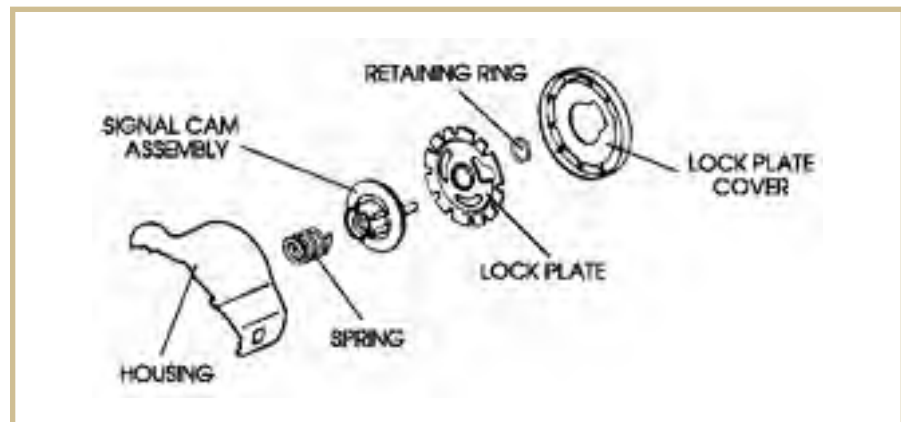


FIGURE 41D



onto the wheel shaft and tighten the wing nut on the tool. This will compress the lock plate. Remove the retaining ring.

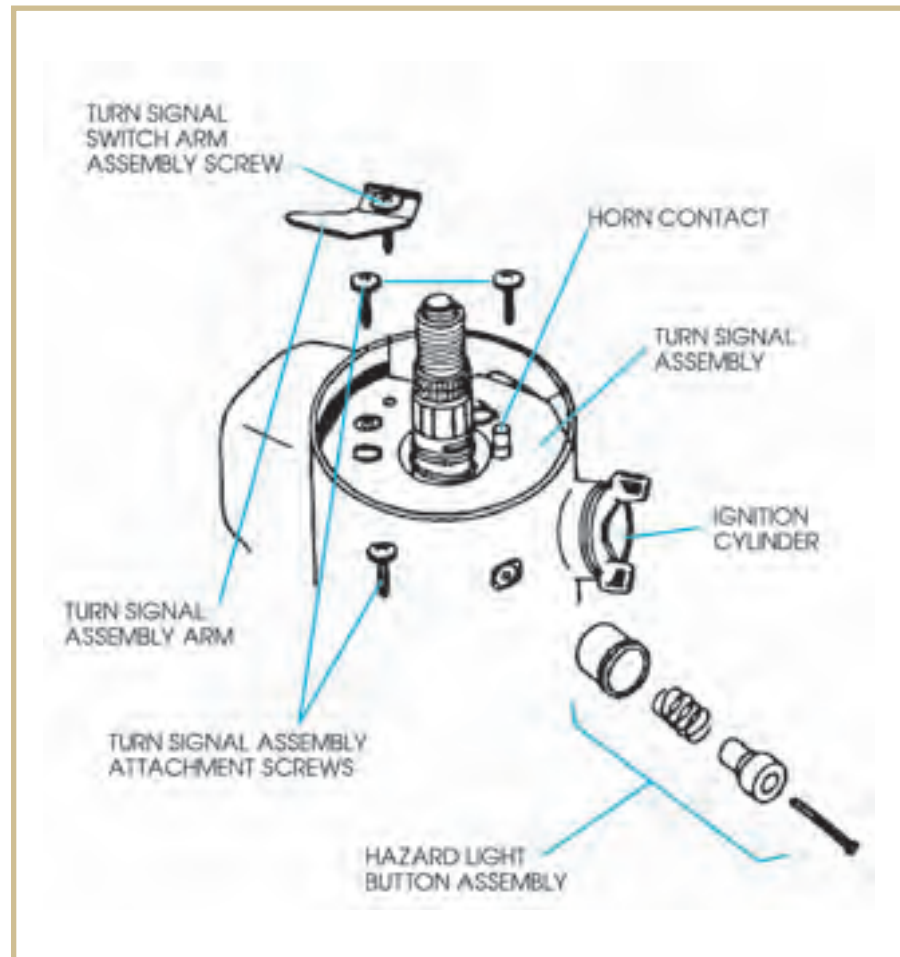
Step 9: Lift off the lock plate (Figure 41D).

Step 10: Slide off the signal cam assembly (Figure 41D).

Step 11: Lift off the large coil spring found behind the cam (Figure 41D).

Step 12: Depending on the model, you may have to remove the signal switch arm. If so, remove the screw holding the signal switch arm (Figure 41E).

FIGURE 41E



Step 13: Lift out the signal switch arm (Figure 41E).

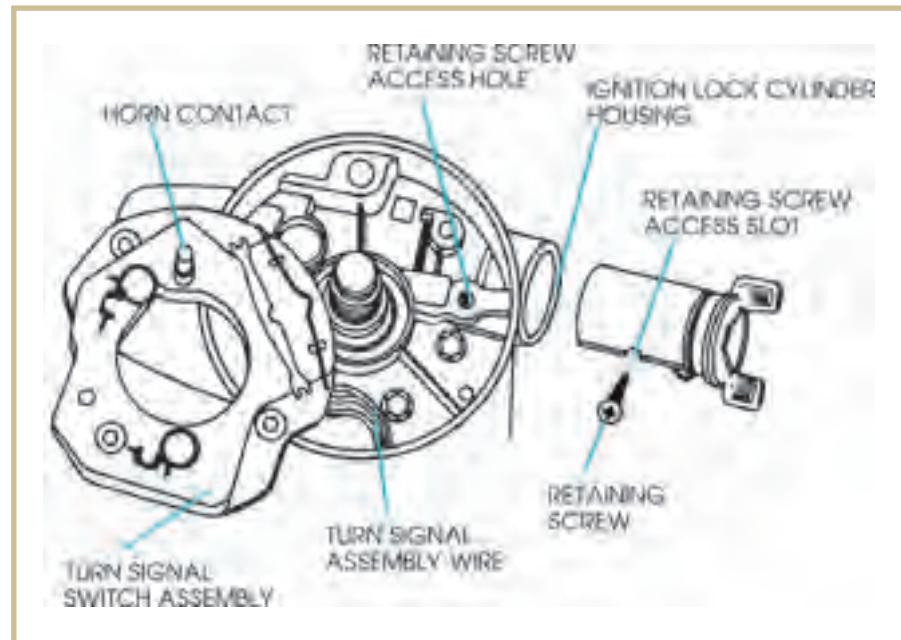
Step 14: Unscrew and remove the hazard light button (Figure 41E).

Step 15: Remove the three screws holding the turn signal switch (Figure 41E).

Step 16: *VERY CAREFULLY* lift up the turn signal assembly, but be careful not to break any wiring connections (Figure 41F). Gently pull the signal switch out far enough so you can gain access behind it, but don't remove it all the way. Behind the turn signal switch, you'll see either a lock-retaining screw or a lock-retaining tab (depending on the car model).

Step 17: You'll now have access to the lock cylinder (Figure 41F). Make sure the key is out of the lock. This is very important; if the key is left in and you attempt to remove the lock cylinder, you'll damage the lock. Remove the retaining

FIGURE 41F



screw or depress the retaining tab, depending on the model. Lift out the lock cylinder.

Step 18: Remove the key from the new lock cylinder, and slide the new cylinder into place. If the model has a retaining tab, you'll hear it click. Otherwise, replace the retaining screw.

Step 19: Reverse the steps we've described here to reassemble the steering wheel. Don't forget to reconnect the battery and test the horn at the end.

Note: For tilting, telescoping, or square column steering columns, the procedure is very similar. You can consult the car's manual for further details on disassembling any special steering wheels.

Disassembling a Ford Steering Wheel

To replace an ignition lock in a typical Ford automobile, follow these steps:

Step 1: Disconnect the negative lead from the battery.

Step 2: Remove the steering wheel as described in Steps 2 through 7 above under *Disassembling a General Motors Steering Wheel*.

Step 3: Put the key in the ignition and turn it to the *RUN* position.

Step 4: Use a small pointed tool to depress the lock release pin.

Step 5: Pull out the old cylinder.

Step 6: Put the key in the new cylinder and turn it to the *RUN* position.

Step 7: Depress the release pin and slide the new cylinder in.

Step 8: Replace the steering wheel.

This marks the end of our discussion of lock cylinder removal. The next section of your text will deal with how to open automobile locks without keys. Before you proceed to the next section, however, take a few moments to complete *Locking It Up! 4* on the following page.



Locking It Up! 4

Indicate whether each of the following statements is True or False.

- ___ 1. With most Ford vehicles, the door must be disassembled to remove the lock cylinder clip and the lock cylinder.
- ___ 2. The thin sheet of plastic or foam between the trim panel and the door is called the *retainer clip*.
- ___ 3. Before beginning the removal of any door trim panel, remove the negative battery terminal lead from the battery.
- ___ 4. Before disassembling a car door, lower the car window.
- ___ 5. An *integral armrest* is an armrest and trim panel made all in one piece.
- ___ 6. Anyone can easily disassemble a car steering wheel and ignition without experience.

Check your answers with those on page 101.

OPENING AUTOMOTIVE LOCKS WITHOUT KEYS

The Three Basic Methods

In this section of your text we'll be looking at the various methods of opening a locked car door without keys. Most automobile locks can be opened without keys using the same basic methods as with regular locks. Three methods you can use to open a car lock without keys are the following:

1. Using special tools
2. Picking
3. Impressioning

In most cases, more than one of these methods can be used to gain access to a locked vehicle. Which method is the *best* to use will depend on the vehicle and the particular situation. By being knowledgeable about the various methods, you can easily determine which is the best method for the circumstances.

If a car owner loses keys or locks the keys in the car, the locksmith will probably be called to help. Since the owner can't gain access to the car, he or she can't bring the vehicle to your shop. Thus, you'll need to make a service call to open the vehicle. Since you'll be some distance away from the shop, you must be sure that your vehicle is equipped with all the tools and key blanks you may need to service the vehicle. Having the needed tools for the job will eliminate unnecessary trips back and forth to the shop. (*Note:* Preparing a vehicle for a mobile locksmithing service will be covered in another unit of your course.)

In addition to having the proper tools on hand, a good auto-opening manual is also very important. An auto-opening manual will contain detailed information on the easiest methods to use to open locked doors on many makes and models of cars. An experienced locksmith will become so familiar with many vehicles that he or she will only need to refer to a manual for unusual model cars. In fact, many locksmiths are so familiar with the opening of car doors that they may develop special tools and methods of their own. However, as a novice, you'll probably find yourself referring to a manual quite often and

using standard tools that can be purchased from most locksmith supply companies.

As you might have guessed by now, having the proper tools and the proper knowledge is essential in opening a locked car. The objective of the locksmith is to open the car in a reasonable amount of time without causing damage to the car. This is an important point. Most locksmiths will agree that *at no time* should you damage the vehicle you're working on. Although there will be times when "throwing a brick through the window" would seem like a good idea, you would be liable for the damage. If the owner of the vehicle decides that breaking into the vehicle by breaking a window or damaging the vehicle in any way would be more cost-effective than the method you recommend, it's best to let the owner break in. This will release you, the locksmith, from any liability for the damage.

Using Special Tools

In most situations, locksmiths will open a vehicle using a variety of special tools. Picking or impressioning takes too much time and effort compared to using opening tools. The most common method of getting into a car is, therefore, by using specially designed opening tools.

Since the window is the most vulnerable area of many cars, most locksmiths will attempt to gain entry there. There's a small amount of space alongside the window so that it's free to move up and down. This small space is big enough to allow a tool to slide alongside the window and into the door. Most auto opening tools are inserted between the window glass and the surrounding weatherstripping. Once inside, the tool is manipulated to open the door-locking mechanism from the inside.

A door with a vertical lock rod can usually be opened by using a tool to hook the lock rod and pull it up. Doors with horizontal lock rods can be opened by using a tool to hook the rod and pull it forward.

In older vehicles, this method is quite simple to use. However, with the rise in auto-related crimes, manufacturers have designed their vehicles so that it's much more difficult to open a door in this manner. On older vehicles the window gaps were much wider and there was clear access to the door lock knob.

Also, the lock button had a wide head that could easily be hooked and lifted with a piece of twisted wire coat hanger. The end with the hook was slipped between the door and the window. Once inside the car, the hook could be slipped around the lock knob and the knob pulled up, thus unlocking the door.

However, manufacturers today have designed their vehicles so that this type of access isn't possible. Most vehicles today have much tighter window gaps and lock knobs placed farther away from the window gaps. Newer model cars have lock buttons that are tapered or sit flush with the door when the door is locked. These buttons are virtually impossible to hook with a piece of wire. For these reasons, the opening of a locked door isn't as easy as it used to be. For today's vehicles, specially designed tools and the knowledge of a trained locksmith are required to successfully open the door.

Now, let's look at some of the more common car-opening tools in a little more detail. There are many specialized car-opening tools available from locksmithing suppliers; in fact, there are about as many different tools as there are vehicles. These tools are designed for use with the many different car models a locksmith will commonly see. However, while there are many tools available, most locksmiths have found that just a few of them can be used to successfully open most cars. The most commonly used tools are the following:

- A rubber wedge
- A krypton light
- A Slim Jim
- The MCOT (multiple car opening tool)
- The Spring-L
- The Slide Lock

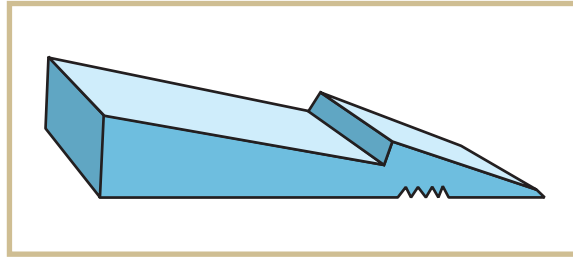
Let's look at each of these tools separately now.

The Rubber Wedge

Before you can slide a car-opening tool between a car window and the surrounding weatherstripping, it will usually be necessary to create a space for the tool to fit. As stated earlier, today's vehicles have very little space between the window

and the door. To increase the space, a wedge made of rubber is forced into the small space that does exist. This wedge will widen the space between the window and door enough so that a tool can be inserted. Since the wedge is made of rubber, it won't scratch the door or the window and it's soft enough so that it won't break the window once it's inserted (Figure 42).

FIGURE 42—A Rubber Wedge



The use of a wedge is fairly simple. The wedge is inserted with the thin edge first between the window and the car door. On some vehicles you'll find

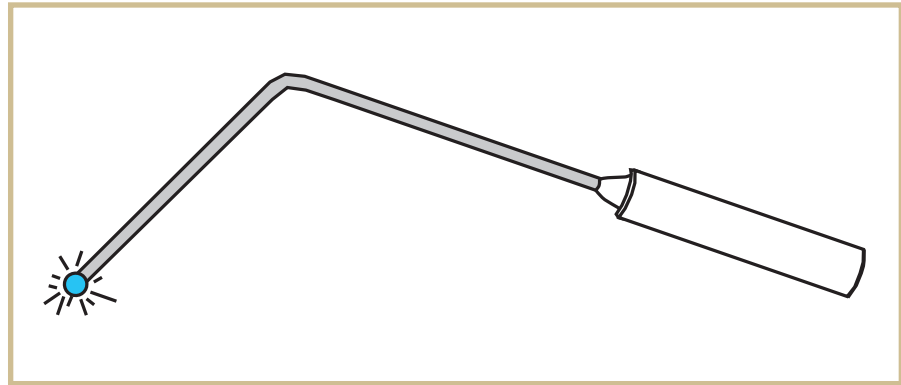
a flexible rubber seal between the window and the door. The seal is commonly known as the weather strip. If the weather stripping is in the way, you can slide a paint scraper or a similar tool between the glass and the weather stripping, and *gently* pry the weather strip out of the way.

Once the weather strip is out of the way, you can insert the rubber wedge, thin edge first, between the window glass and the weather stripping. Press the wedge into place. As you push the wedge in, the wedge should force the glass and the weather stripping apart slightly, leaving you room in which to insert a light and an opening tool. The farther the wedge is pressed in, the wider the gap will be. Now that you have a way to widen the gap enough for tools to be inserted, let's look at some of the tools that can be inserted into the door.

The Krypton Light

One very useful tool in car opening is the *krypton light* (Figure 43). The krypton light has a handle containing a battery, a flexible shaft that's small enough to be inserted into a car door, and a tiny light bulb at the end of the shaft. To use the light, simply turn it on and insert it into the car door. The light will illuminate the inside of the door, allowing you to clearly see the locking mechanism inside, and making your work easier. While a krypton light is very useful anytime, it's essential for night-time service calls. By being able to see the mechanism, you can more easily decide which tool and procedure will work best. Now that we can see what we're doing, let's look at one of the most common tools, the Slim Jim.

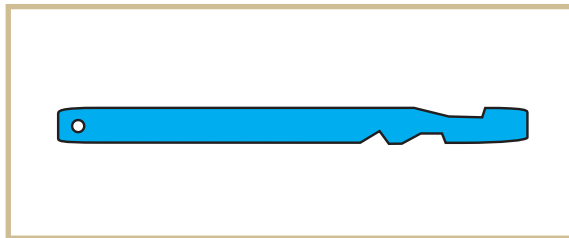
FIGURE 43—Krypton Light



The Slim Jim

The *Slim Jim* is a simple but very useful car opening tool. The tool is a long, thin strip of metal with a notch, or “hook,” cut into the end (Figure 44). While the Slim Jim has been around for many years, it’s still used to open many of today’s car models. Since the Slim Jim works on a variety of different vehicles, it’s one of the most versatile tools for opening doors.

FIGURE 44—The Slim Jim



In most cases, the Slim Jim is used to pull up on the lock rod, thus unlocking the door. To use the Slim Jim, follow these steps:

Step 1: Insert a rubber wedge between the window glass and the car door as described earlier. As you face the door, insert the wedge about four or five inches to the right of the locking button. Automotive car entry books will tell you where to wedge for each particular car. These are available from locksmithing supply houses.

Step 2: If needed, insert a Krypton light into the door to help you see what you’re doing inside.

Step 3: Bend the Slim Jim slightly.

Step 4: Insert the Slim Jim into the space created by the wedge. (The tool should be inserted between the wedge and the locking button.) The curved end of the tool should be facing the interior of the car.

Step 5: After inserting the tool, lower it about 12 inches into the door.

Step 6: Slide the tool to the left until you feel the end of the tool make contact with the vertical locking rod. (The locking button will move slightly when contact is made.)

Step 7: Pull back on the tool and lift it upwards at the same time. Lift the tool slowly, keeping it in contact with the locking rod.

Step 8: Keep lifting the tool until you feel it contact the locking button. Then, simply lift the locking button to unlock the door.

The MCOT Tool

An *MCOT tool* (Figure 45) is a special type of car-opening tool that's designed for certain models of cars. The tool is inserted into the car door in the same way as a Slim Jim, but instead of operating the locking mechanism inside the door, the MCOT tool is bent around the window glass and hooked onto the

locking button inside the car. This tool is used with a number of modern car models.

To use the MCOT tool, follow these steps:

Step 1: Insert a rubber wedge between the window glass and the weather stripping.

Step 2: Insert the MCOT tool into the space created by the wedge.

Step 3: Remove the wedge to relieve the pressure on the glass.

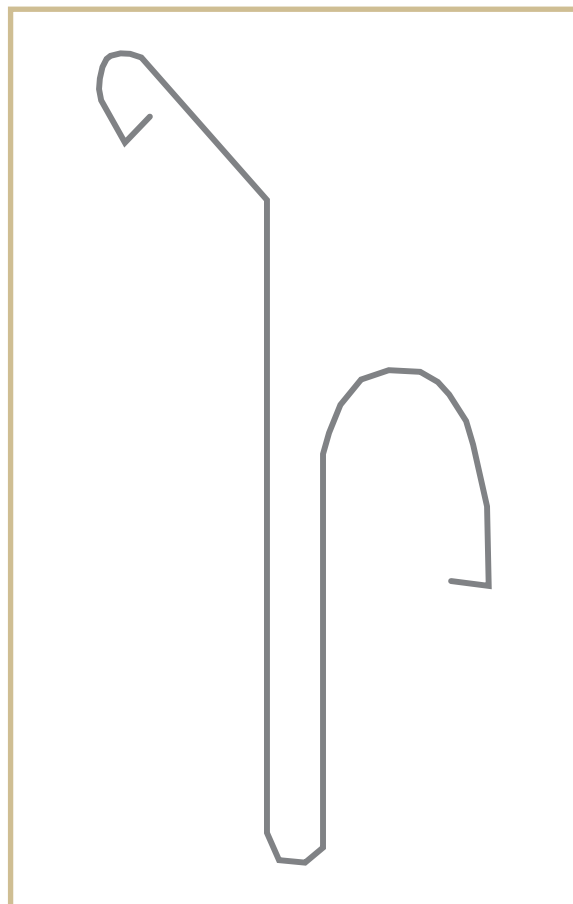


FIGURE 45—The MCOT Tool

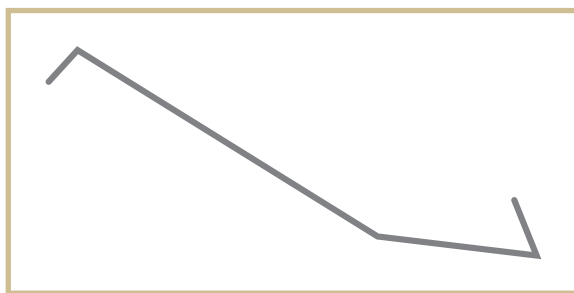
Step 4: Rotate the MCOT tool, turning it around inside the car door so that it bends under the window glass.

Step 5: Lift the tool up on the *inside* of the car door between the glass and the weather stripping. Lift the tool until the end clears the weather stripping on the inside of the car.

Step 6: Use the end of the tool (now inside the car) to hook onto the locking button, and lift to unlock the door.

The Spring-L Tool

FIGURE 46—The Spring-L Tool



The *Spring-L tool* is a simple but useful tool that resembles the old-fashioned bent coat hanger (Figure 46). To use the Spring-L tool, follow these steps:

Step 1: On the passenger door, insert a rubber wedge about four or five inches to the right of the door lock.

Step 2: Insert a Krypton light to look for the locking pawl.

Step 3: When you've identified the locking pawl, insert the Spring-L tool into the door between the window glass and the weather stripping.

Step 4: Manipulate the tool until the end of the tool is hooked under the locking pawl.

Step 5: Lift the locking pawl to unlock the door.

The Slide Lock Tool

FIGURE 47—A Slide Lock Tool



The *Slide Lock tool* (Figure 47) is another simple tool that's very useful for opening certain car models. Follow these steps to open a car using the Slide Lock tool:

Step 1: On the passenger door, insert a rubber wedge about four or five inches to the right of the lock between the window glass and the weather stripping.

Step 2: Insert the Slide Lock tool into the space created by the wedge.

Step 3: Lower the tool until the end passes beneath the window glass.

Step 4: Rotate the tool slightly and manipulate the tool until the end of the tool hooks under the door locking button.

Step 5: Lift the tool up to unlock the door.

Car Opening Information

The tools we've just described can be used to open most car models on the road today. Since manufacturers change their vehicles all the time, it's difficult for us to give you a definitive list of what tools to use with which car models. However, the

A = Slide Lock
B = Slim Jim
C = MCOT
D = Spring-L

Vehicle Manufacturer	Opening Tools	Vehicle Manufacturer	Opening Tools
AMC/Eagle	A	Isuzu	A
Audi	B	Lincoln	A
BMW	D	Mazda	B
Buick	C	Mercury	B, D
Cadillac	B, C	Nissan	D
Chevrolet	A, B, C	Oldsmobile	C
Chrysler	D	Plymouth	A, B, D
Dodge	A	Pontiac	A, C
Ford	B	Subaru	A
GMC	C	Toyota	D
Honda	A, B	Volvo	A, B
Hyundai	A	Volkswagen	A, D

table on the previous page lists some popular car models and the tools that will most often open them successfully when no keys are available.

Lockpicking and Impressioning

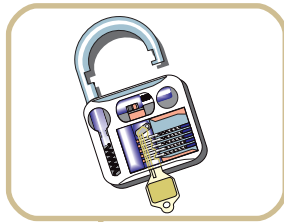
Lockpicking and key impressioning are two other techniques used to gain access to a locked car. In general, since these two methods take a lot more time than opening the vehicle with a special tool, they aren't used as often as opening tools.

However, in some situations and with certain vehicles it may not be possible to get into the vehicle using an opening tool. In these situations, lockpicking may be the next best choice. A skilled professional locksmith can pick a car door lock fairly quickly, especially when using a pick gun.

If for some reason lockpicking doesn't work, the locksmith can attempt to impression a key for the car door. This is the most time-consuming process of all the methods we've discussed, and, for that reason, impressioning is only used when all other attempts have failed.

The techniques used to pick a car lock or impression a car key are exactly the same as those used with any other type of lock. Refer to Study Unit 7, *Opening Locks Without Keys*, if you wish to review these techniques at this time.

This concludes our discussion of auto opening. The next section of the text will cover auto security systems. First, however, take a few moments to complete *Locking It Up! 5* on the following page.



Locking It Up! 5

Match each of the car opening tools in Column I with its proper name in Column II.

Column I

Column II

1.



2.



3.



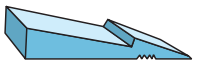
4.



5.



6.



a. Rubber wedge

b. Slim Jim tool

c. MCOT tool

d. Krypton light

e. Spring-L tool

f. Slide Lock tool

Check your answers with those on page 102.

AUTOMOBILES AND CRIME

Some Grim Statistics

In North America today, a vehicle is stolen every few seconds. In a recent year, according to the FBI's *Uniform Crime Report*, \$7 billion was lost nationwide to motor vehicle theft. Motor vehicle thefts account for 12 percent of all property crimes, and the incidence of these thefts is increasing every year (Figure 48). Seventy-seven percent of the vehicles stolen were automobiles, and 15 percent were trucks. The average value per stolen vehicle was estimated at \$5,117. Only a small percentage of these thefts are cleared by an arrest. Even fewer cases result in the return of the stolen vehicle.

These grim statistics show that motor vehicle theft is a big business for the criminal population. Because of this, locks and security systems are becoming more and more important on

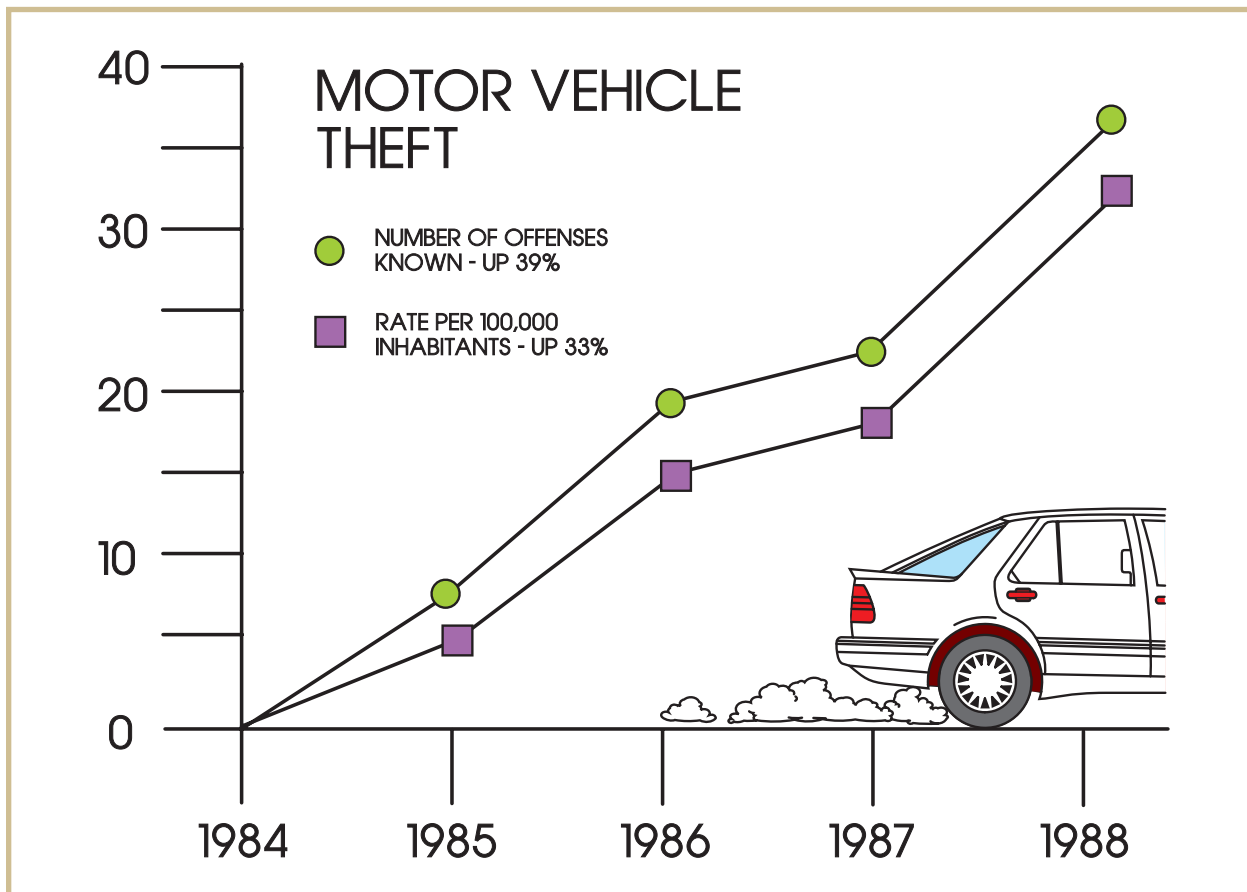


FIGURE 48—The incidence of motor vehicle theft is on the rise.

automobiles. Only a few short years ago many people didn't feel a need to lock their vehicles, but today it's very important. With the continual increase in the number of vehicle thefts, car-jackings, etc., locking your car has become necessary.

How the Locksmith Can Help

Many of today's manufacturers are developing high-tech systems that make it difficult for a criminal to gain access to a vehicle. A wide variety of security devices is available on the market today. Many of these systems are very effective and relatively inexpensive, when compared to the cost of replacing a stolen vehicle!

Some of these systems are installed at the factory by the manufacturer. Other security systems are sold by locksmith suppliers, stereo stores, and electronics shops (these systems are much more common). However, one well-known security system installed by a vehicle manufacturer is the General Motors Vehicle Anti-Theft System (the GM VATS system). The GM VATS system uses specially designed key blanks. Only one type of key blank can be used in the lock. If the incorrect key blank is inserted into the lock, the vehicle won't start and the engine will be automatically disabled for a period of time. You'll learn about the VATS system a little later in this section of the text.

The security efforts of these manufacturers have helped slow down vehicle theft. But, as overall crime rates continue to climb, manufacturers will have to continue to develop better and better systems to deter thefts and vandalism.

The continual development of various systems by vehicle manufacturers means that your knowledge of these systems will need continual updating. With most professions today, the rapid change in technology requires each individual to keep current with the latest procedures. The efforts to reduce the amount of vehicle crime have served their purpose, but it hasn't made the job of a locksmith any easier. Although the basic operating concept of locks hasn't changed much over the years, there are many different variations in the exact procedures used for various vehicles, such as those equipped with the VATS system. As more and more manufacturers develop anti-theft systems on vehicles, the need to stay current will become even greater.

This rise in vehicle crimes has also helped create a new market for companies selling automotive anti-theft devices. These devices range from clamp-on steel bars to prevent the steering wheel from being turned to sophisticated anti-theft systems equipped with motion detectors.

Most car manufacturers don't include an alarm system in their vehicles. Those that do have such a system offer it only as an option. This provides two lucrative sales possibilities for the locksmith: installing systems for new car dealers or installing systems in older cars. A car dealer who subcontracts alarm installations will probably make a larger profit than if he purchases the system from the car manufacturer. In addition, the owners of recreational vehicles, boats, and other vehicles may be interested in a security system. The car alarm system will work just as well in any of these vehicles. In addition, insurance companies offer sizable premium discounts to their customers who purchase an alarm system. For these reasons, many locksmiths have found that selling and installing auto security devices is very profitable, and have therefore added it to the list of services they perform.

Now, let's take a closer look at some popular types of auto security systems.

Automotive Security Systems

Car thieves are often professionals. They're well aware of the risks of being caught and how to recognize those risks. The thief's chief enemy is *time*. The more time a thief spends trying to break into a car, the greater the chance he'll be caught, so he'll always go for the car that's the easiest to steal. For this reason, a vehicle protected by an alarm system is far less likely to be stolen than one that's not protected.

Auto security systems include both electronic and mechanical devices. The security systems help deter the theft or vandalism of a vehicle and its contents. They do this by making it very difficult for a thief to get into the car without being detected. Note that auto security systems can't be said to *prevent* crime. If a thief is determined enough, he *will* steal your car. Also, auto alarms generally only work if there's someone around to hear the alarm and summon the police. Thus, if the right circumstances are in place, no alarm is 100 percent foolproof.

Older alarm systems were difficult to install and, in many cases, required hard-wiring, which means that it has permanent electrical connections. This has kept some locksmiths out of the alarm business. However, this is no longer the case. Modern alarm systems are so advanced and so easy to install that the locksmith would be foolish not to take advantage of the opportunities presented by alarm installation.

How Car Alarms Work

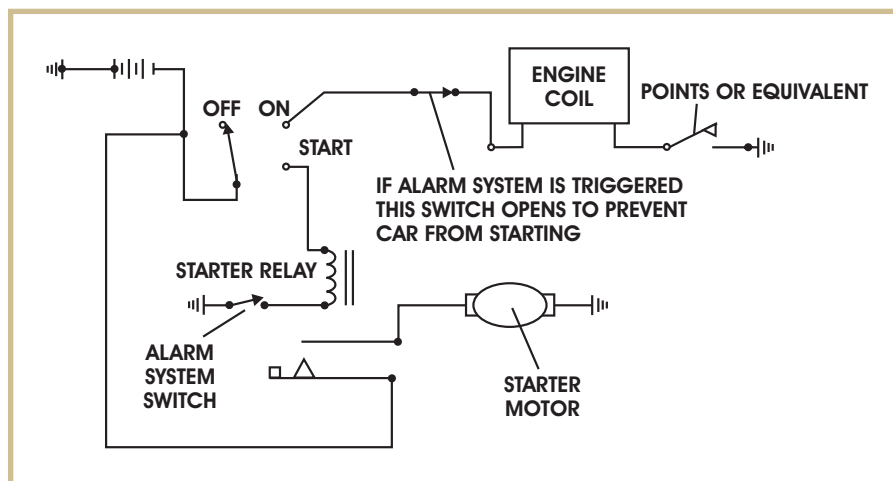
There are many different car alarms designed to perform a variety of functions. However, for the most part, these systems operate on a simple *relay* principle. (*Note: We'll be discussing home electronic security devices in detail in a later study unit. So, when we're talking about electronic auto security devices in this study unit, we'll concentrate on basic terms and general operation.*) A relay, in simple terms, is an electric switch that changes the direction of electrical flow. An alarm circuit consists of simple wiring connecting the various parts of the car to the alarm bell. These parts include the ignition, the starter, the hood, the windows, or any other location where the security of the car can be compromised. Under normal circumstances, the alarm remains quiet. However, when any part of the alarm circuit is disturbed (glass broken, engine turned on without turning off the alarm system first, etc.) the alarm system's "brain" realizes that someone is tampering with the vehicle, and the alarm bell sounds.

Now, look at the simple auto circuit with alarm shown in Figure 49. Under normal circumstances, power from the ignition flows down to the starter relay and the starter relay switches heavy current from the battery to the starter motor, starting the engine. A second wire supplies current to the engine coil. If an intruder cuts an alarm wire the alarm control will disable the start and run circuits.

An alarm system can use any one of three basic methods to alert the car owner to trouble at the vehicle. The following are three basic types of alarm systems:

Noisemaker alarm. This type of system relies on a horn, bell, or siren to make noise and draw attention to the vehicle.

FIGURE 49—A Simple Alarm Circuit



Silent alarm. A silent alarm system alerts only one person (the owner) at a given location that there has been a break-in. This system relies on the element of surprise to catch the thief.

Visual alarm. In a visual alarm system, a flashing light draws attention to the vehicle. These systems are useful in, for example, indoor parking garages where a source of sound can be difficult to locate due to echoes.

Now, let's take a closer look at some specific alarm devices. The following devices can be used in any customized combination to provide maximum security benefits for your customer.

Manually Operated Alarms

The following auto security systems are all turned on *manually* (by hand).

Hidden-Switch Alarms

A manually operated alarm contains a simple switch that's thrown by hand to turn the system on. Once the alarm system is on, it must be turned off again before you can start the engine, or else the alarm will sound. The switch to the system is hidden in the car so that only the owner will know where it is, and therefore, only the owner will know how to disable the system.

Keypad Alarms

A keypad alarm is a type of manually operated alarm. In this system, the car's owner has to enter a code number into a key pad in order to turn the alarm system on or off. Since only the owner knows the code, only the owner can get into and start the car.

Passive Alarms

A passive alarm is connected directly to the car's ignition switch. The system is called *passive* because the car owner doesn't have to do anything special to turn the alarm on or off. When the owner inserts the key into the ignition, the alarm system turns itself off. When the engine is turned off and the key removed, the alarm turns itself on. The biggest advantage of this system is that you can never forget to turn it on! If your customer is interested in getting a sizeable auto insurance discount, this is the type of system to install.

Key-Operated Alarm Switches

Another type of manually operated alarm system is the key-operated switch. The switch is installed in the driver's side door of the car. The owner inserts and turns a special key to turn on the alarm system. The advantage of this model is that the owner doesn't have to be inside the vehicle to turn the system on. Also, if someone were to tamper with the doors, the alarm would instantly sound. With the ignition-connected models previously described, the alarm will not sound until the vandal has already gained admission to the car.

Remote-Controlled Alarm Systems

Because of the disadvantages of the manually operated systems we just described, the remote control alarm system is gaining in popularity. In these systems, the alarm system is installed in the car in much the same way we've already described. However, to activate the system, a radio signal is generated by a small transmitter device. The receiver device in this type of system is an *LED (light-emitting diode)*. The LED is a small box-type device mounted on the car's dashboard. The LED has a small button that flashes when the system is armed, warning any would-be intruders that the system is

on. To turn on the alarm system, the owner simply closes the car door, points the transmitter at the car, and presses a button. The LED receives the signal and turns itself on (or off, depending on whether the owner is leaving or entering the car).

These systems can be passively connected to the car's ignition, so the customer can get all the insurance advantages from this model. One additional feature of this type of alarm is that if you see someone suspicious near your car, or if you're accosted in a parking area near your car, you can use the remote-control device to sound an alarm and summon help. The car's alarm can be triggered from anywhere within the transmitter's range, which is usually between 20 and 150 feet.

The remote transmitter can be programmed to perform a variety of functions in the car. For example, it can start your car automatically to allow it to warm up on cold mornings. The transmitter can also be programmed to operate your garage door opener.

The main disadvantage of this type of system is that the transmitter device is small and can be lost or misplaced. In such a situation, the owner has to "break in" to his or her own car (setting off the alarm in the process) and find a hidden switch to manually deactivate the alarm system.

Other Alarm System Options

Dome Light Connections

Most security systems are designed to sound an alarm when any one of the car doors is opened. The easiest way to do this is to run a wire from the alarm system to the dome light of the car. The *dome light* is the light on the ceiling of the car that goes on when any door is opened. Any time a door is opened, the dome light goes on, and unless the alarm has been disarmed, the alarm will sound. Even if the dome light is blown out, the alarm system will continue to function.

Motion Detectors

Motion detectors are alarm components that are designed to sense movement in any part of the vehicle. If an intruder attempts to do anything to the car—break the window glass, open the door, open the hood—the alarm system will detect

the motion and set off the alarm. Most motion detector devices operate with *mercury switches*. A mercury switch contains a small glass tube of mercury with wiring connected to the end of the tube. Since mercury is a liquid metal, it's free to move around inside the glass tube (just like in a thermometer). Any motion in the vehicle will cause the glass tube to tilt. When the tube tilts, the mercury inside will roll to the end of the tube and make a connection with the electrical wiring. When this contact is made, the wiring will signal the alarm to sound. A disadvantage of motion detectors is that they're prone to false alarms (for example, a strong wind could disturb a parked car and cause the alarm to sound). However, detectors are very inexpensive components to install, and are therefore quite popular.

Glass-Break Detectors

A *glass-break detector* is a "listening" device that's designed to listen for the sound of breaking glass. The device is tuned to listen for the exact sound frequency that occurs when glass breaks. When an intruder attempts to enter a vehicle by breaking a window, the alarm will instantly sound.

Sirens

The *siren* is the most familiar alarm-sounding device. Sirens are designed to be very loud, and sound at a frequency that is very annoying to human ears at close range. This is a deliberate feature; if the sound is loud enough and disturbing enough, it will chase the intruder away from the vehicle.

Pagers

A *pager* is an electronic device that sends a signal to the car's owner when someone breaks into the vehicle. When the device is activated, it raises the car's antenna and transmits a signal through the antenna. This feature is designed to give the owner time to alert the police.

A Sample System in Action

Let's take a look at a sample alarm system in action. Imagine for a moment that a thief has approached an armed car. If a

thief decides to pay no attention to the flashing LED on the car's dashboard, he may decide to smash the driver's side window to gain access to the car. When the glass breaks, the glass-break detector hears the sound of the glass breaking or the touch of the tool on the glass, causing the alarm to go off. The thief continues to try to get into the car, when all of a sudden he notices that the car's antenna is going up. The alarm system has a paging device that automatically raises the car's antenna and sends a signal to the owner. The thief tries to start the car, but the starter has already been disabled. If the thief is determined enough to continue, he may open the hood and attempt to cut the battery cable. However, the alarm will continue to sound and the signal keeps broadcasting to the owner, because the system's back-up power supply has fed the alarm to keep it going. With nothing left to do and running out of time, the thief will have no choice but to abandon the vehicle.

The example you've just read describes an efficient auto security device. The combination of security devices used in this example provides maximum protection for the vehicle.

How Vehicle Alarm Systems Are Installed

Since there are so many security products on the market and because they're constantly being updated, we can't describe how to install every type of system. In addition, any product you buy will come with its own manufacturer's installation instructions, which you should always follow carefully. The following procedure is used to install the most common and popular type of remote alarm system. This example will help you to understand how such a system is installed.

Follow these steps to install the system:

Step 1: The first step in installing any alarm system is to inspect the customer's vehicle. Thoroughly inspect the car to determine where devices may best be installed. Consult the owner's manual, if needed, to find out where important vehicle components are located.

Step 2: Find a suitable location for the receiver on the dashboard to the left of the steering wheel. The receiver must be mounted in an area where the signal can be transmitted and received freely.

Step 3: Mount the current sensor to the positive battery cable.

Step 4: Mount the siren.

Step 5: To test the operation, aim the handheld transmitter at the dashboard receiver, and press the button.

Selling an Auto Security System to a Customer

When you're selling a system to a customer, start by asking them for a price range on how much they want to spend. No matter what they expect the system to do for them, it won't matter if they're unwilling to make at least a small investment in the proper equipment. If your customer wants to spend only a small amount of money, show him or her the systems in that range, and keep in mind that some systems are designed to permit upgrades at a later date. Or, if the customer is interested in a particular feature (such as a remote-controlled system) they may be willing to pay a little extra for the features they want. Remind the customer of their enormous investment in a vehicle, and try to help them choose an alarm system that's within their budget yet provides all the protection they need. When a person pays a large sum for a car, he or she should be willing to pay a small amount to protect it. In general, the more expensive the system, the more difficult it is to defeat.

If you're interested in specializing in auto alarm sales and installations, your first step should be to contact a distributor of alarm products in your area. Familiarize yourself with the popular name-brand products on the market. Get sales information on these systems from your supplier. Find out all you can about the products; inquire about any special offers the distributor may have (such as special promotions, discounts on volume purchases, or assistance with advertising); and ask if the distributor can supply demonstrator models. A working demonstrator system in your shop is an excellent sales tool and a useful visual aid when you're telling a customer how a system works.

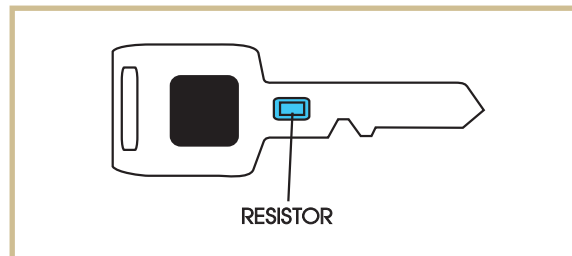
The VATS System

Let's take a look now at a different type of auto security system, the VATS system. The General Motors *Vehicle Anti-Theft*

System, or VATS for short, was designed to reduce thefts of popular GM car models. Some of the cars using this system include Corvette, Camaro, Firebird, Allante, and Cadillac. Since the installation of VATS in these vehicles in the mid-1980s, their theft rate has been reduced by about 70 percent. This has also resulted in a lowering of insurance rates for these vehicles. We'll look at the VATS system separately, because, at the present time, it's the only security system routinely installed in vehicles at the factory.

The VATS system intimidates many mechanics and locksmiths. You may even have heard people complaining about trying to service the system! However, you should be aware that if you know what you're doing, the VATS system isn't difficult to work with. In addition, since the system is installed on expensive cars and it takes a little more time than usual to make duplicate and replacement keys, you can charge a nice fee for your services!

FIGURE 50—A VATS Key



The VATS system works on a simple principle. Each VATS key has an electrical resistor pellet embedded in it (Figure 50). When a VATS key with

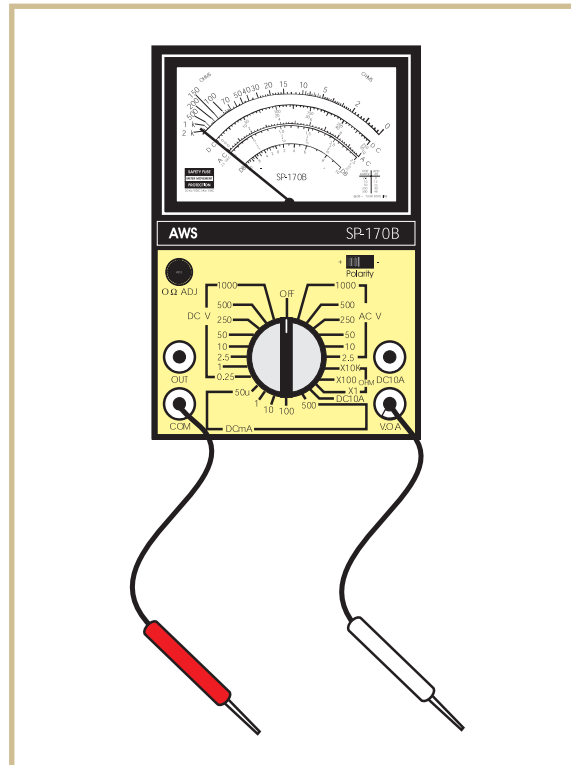
the correct pellet is inserted in the ignition, the car will start. If a key with the wrong pellet is inserted, the vehicle's computer shuts off the fuel pump, starter, and powertrain for approximately four minutes.

There are 15 different VATS key blanks used with the system, and they're expensive (about nine dollars each!). A locksmith will need to stock all of them, however, in order to be able to make replacements for customers. Each of the 15 blanks has a pellet with a different electrical resistance.

You can determine what resistance a key has by testing it with a *digital multimeter* or an *ohmmeter* (Figure 51). A digital multimeter can actually be set to function as an ohmmeter. Either of these tools can be purchased through a locksmith or electrician's supply catalog.

So, when you're making a duplicate for a customer, you'll need to first select the proper key blank. To do this, test the

FIGURE 51—A digital multimeter or an ohmmeter can be used to test the electrical resistance of a VATS key.



customer's key with your ohmmeter or multimeter. If the customer's key has a resistance of 681 ohms, for example, you'll know the correct blank is the #3 by checking against the VATS values found in any automotive servicing manual for locksmiths. Once you have the correct key blank, you'll cut it to fit just as you would any other key.

(Note: Whenever you purchase or use VATS key blanks, always test each one before cutting it to double-check that it's the right blank. Because the blanks all look alike, it's easy to make a costly mistake!)

Now, here's the more frustrating part! What if your customer has lost the key? It's a little more time-consuming to make a new replacement VATS key, but it's not complicated. You could take any VATS blank, cut it to fit, and insert it to see if it works. However, each time you choose and cut the wrong blank, the car will be shut off for four minutes, and the expensive blank will be wasted! The easier and faster way to find the right blank is as follows:

Step 1: Have an extra VATS cylinder, a code key cutting machine, a *standard* (not VATS) GM key blank, and the 15 VATS key blanks ready.

Step 2: Disassemble the steering wheel to get to the lock, using the procedures we described earlier. Remove the lock just far enough to read the code on it.

Step 3: Cut the standard GM key blank (not the VATS blank!) to match the code stamped on the lock. Set this key aside for a moment.

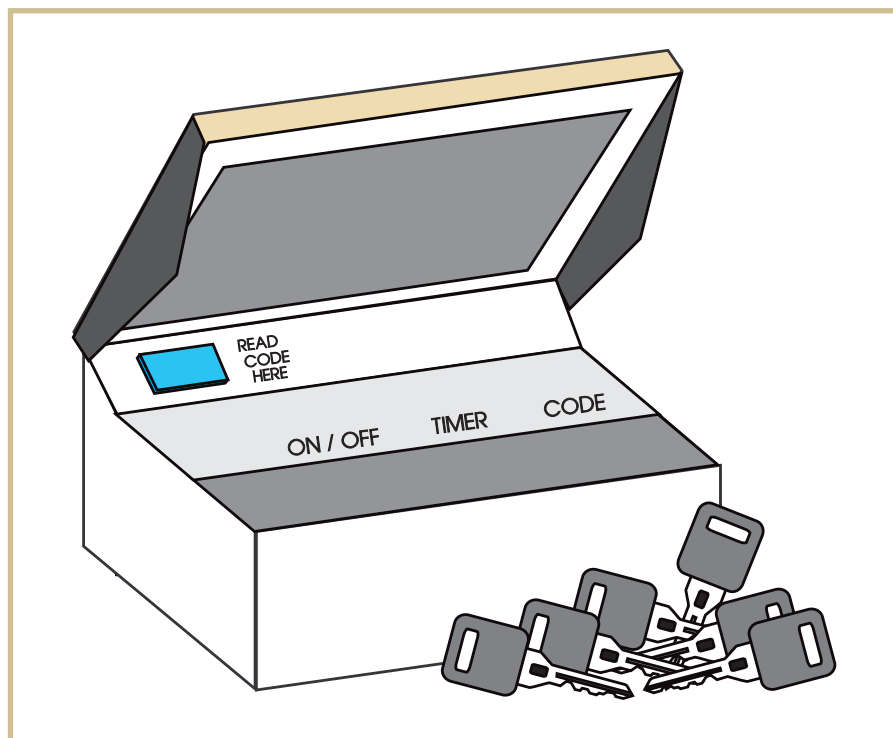


FIGURE 52—A VATS decoder is a useful tool that can perform several different functions.

Step 4: Behind the steering column, a two-pin connector joins the VATS ignition switch to the VATS control module. Carefully grasp the connector and disconnect it.

Step 5: Connect that wire to the extra VATS cylinder.

Step 6: Insert the first VATS blank into the extra cylinder.

Step 7: Insert the standard key that you cut to fit into the car's ignition and turn it to see if the car starts.

Step 8: If the car starts, you're done! However, if it doesn't work, the car will shut down for four minutes. Wait four minutes, and repeat the test procedure with the second VATS blank.

Step 9: When you finally find the correct blank and the car starts, transfer the cuts from the standard GM key onto the VATS key. Remove the wire connection from the extra lock cylinder, reconnect the wire to the VATS module, and reassemble the steering wheel. Now you're done!

Using a VATS Decoder

A VATS decoder (Figure 52) is a device that can be purchased from a locksmith supply company. A decoder can be useful for any of the following jobs:

Selecting a VATS blank to make a duplicate. To choose a blank to make a duplicate, all you have to do is insert the customer's key into the decoding slot.

Decoding the correct blank from a vehicle. When no key is available to duplicate, follow the procedure we outlined previously. Disassemble the steering wheel, read the code on the lock cylinder, and cut a *standard* GM blank to fit the lock. Then, connect the VATS decoder to the VATS module connectors. Turn the decoder's switch to #1, and try to start the car with the standard key. If the car doesn't start, press the four-minute timer on the VATS decoder. When the timing light goes off, try again by turning the decoder's switch to #2, and so on. When you find the right key blank number, cut the new VATS key as before.

Checking for electrical problems. A VATS decoder can also be used to check for electrical problems in the steering column or for problems in the VATS computer. The manual that comes with the decoder will explain these functions in detail.



Locking It Up! 6

Indicate whether each of the following statements is True or False.




- _____ 1. All modern car alarm systems require hard-wiring within the vehicle.
- _____ 2. A mercury switch is designed to measure the temperature inside a vehicle.
- _____ 3. Alarm systems are standard equipment in most vehicles, and are routinely installed at the factory.
- _____ 4. A glass-break detector “listens” for the sound of breaking glass and sounds an alarm when it detects glass breakage.
- _____ 5. A digital multimeter or an ohmmeter can be used to test the resistance of a VATS key.


Check your answers with those on page 102.

THE KEY TO SUCCESS


Well, you've completed another study unit! Congratulations on your successful progress through the course! You can be proud of your accomplishments and you can soon look forward to the beginning of your career as a professional locksmith. You've already learned all the basic information that locksmiths must know. This study unit introduced you to a specialty locksmithing field—auto locks. Now, in your upcoming study units, you'll be learning more about specialty locksmithing services, including safes and vaults, panic hardware, electric locks, and electronic security systems. Enjoy your continuing studies, and remember that you're learning valuable skills every step of the way!


KEY POINTS TO REMEMBER


-  Automotive lock mechanisms are much the same as other lock mechanisms. However, the servicing needs of the auto lock are unique. For example, in the average car, the driver's side door lock and the ignition lock are used every day. Since these locks are used so often, they tend to wear excessively. Typical problems include pin wear (which causes the key to work poorly or not at all), broken parts, "freezing" due to lack of lubrication, and even broken keys.
-  The most common reason a locksmith is called to assist with an automobile is the *lockout*. The second most common occurrence is *lost car keys*. Another typical service locksmiths perform is *rekeying*. Locksmiths are often called upon to install security systems in vehicles. Finally, a locksmith may be needed to repair or replace a defective or inoperative lock.
-  Because there are so many different car models available today, it's impossible for the locksmith to know everything about every type of vehicle. For this reason, most professional locksmiths rely on *reference manuals* to supplement their locksmithing knowledge. Most car locks operate on the same basic principles. If you understand these basic principles, you can look up the other details you may need to know in a reference manual.


 A typical automobile has locks to secure the car doors, trunk, glove compartment, and of course, the ignition switch. Each of these systems will contain a lock cylinder as well as a latching mechanism. Automobiles use basically the same type of lock cylinders as do residential door locks, padlocks, and so on. In most vehicles produced today, only three types of lock cylinders are used. These are


1. The disk tumbler lock
2. The side bar wafer lock (a variation of the disk tumbler lock)
3. The pin tumbler lock

 The *side bar wafer lock* is a variation of the disk tumbler lock that's widely used by General Motors Corporation. Side bar wafer locks provide a greater degree of security than simple disk tumbler locks since they're extremely difficult to pick.

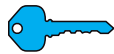
 A side bar cylinder has four main parts: the plug, the shell, the wafers, and the side bar cover. The disks in a side bar wafer lock are much like those in a standard disk tumbler lock, but with one change: each disk (or wafer) has a V-shaped notch on one side. When the side bar wafer mechanism is locked, the side bar mechanism extends into a special slot inside the shell; as a result, the plug is held securely in place. When the disks are aligned by the key, the disks release the side bar mechanism from a slot in the shell. Once the side bar is released, the plug can turn, opening the lock.

 The side bar wafer lock can be easily distinguished by looking at the key slot, which is slightly off-center. Also, the key is inserted into a side bar wafer lock with the flat side up. This is exactly the opposite of most other types of locks.

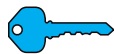
 In most vehicle keying systems, two keys are used to operate the vehicle's locks. The *primary key* operates the ignition and doors, and the *secondary key* operates the trunk and glove compartment. Still another system used in automobiles is the *master key system*. In an automotive master key system, the owner has one key that will operate only the door and ignition, and a master key that operates all of the vehicle's locks.

 If the original key isn't available for duplication, the most common method used to make a new key is to *cut the key by code*. Using a key-cutting machine capable of cutting by code and a proper automotive code reference book, most

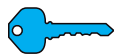
automobile keys can be duplicated without having the original key or disassembling the lock.



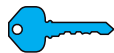
The key code number corresponds to the cuts of the key for a particular lock. It reflects a set number of cuts for the lock. You can obtain key code information for a vehicle from a number of sources, including the car dealer, the car owner, the car itself, the lock cylinder, or in the owner's manual for the vehicle. The easiest and most reliable place to look is the original sales invoice supplied with the vehicle by the manufacturer.



During construction, a lock cylinder is usually inserted from the outside through a hole in the car door. Once the lock is inserted into the door, it's retained by a special *retainer clip* that's clipped onto the lock from inside the door. This retainer clip holds the lock in the door and prevents it from being pulled out of the hole.



If a problem occurs with an auto lock, it will be necessary to remove the lock to service it. It's important to note that modern practice is to *replace* lock cylinders in cars rather than attempt to repair them. This is because the cylinders themselves are relatively inexpensive and it takes less time to replace a cylinder than remove it, repair it, and reinstall it.



Most automobile locks can be opened without keys, using the same basic methods as with regular locks. Three possible methods you can use to open a car lock without keys are the following:

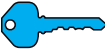


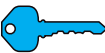

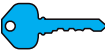

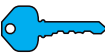
1. Using special tools
2. Picking
3. Impressioning



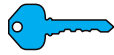
In most situations, the locksmith will use an opening tool to gain access to a locked car. Since the window is the most vulnerable area of many cars, most locksmiths will attempt to gain entry there. Most auto-opening tools are inserted between the window glass and the surrounding weather stripping. Once inside, the tool is manipulated to open the door-locking mechanism from the inside.



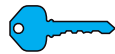
The most commonly used opening tools are the rubber wedge, the krypton light, the Slim Jim, the MCOT tool, the Spring-L tool, and the Slide Lock tool.

-  In a recent year, according to the FBI's *Uniform Crime Report*, \$7 billion was lost nationwide to motor vehicle theft. The average value per stolen vehicle was estimated at \$5,117. Only a small percentage of these thefts are cleared by an arrest. Even fewer cases result in the return of the stolen vehicle.
-  These grim statistics show that motor vehicle theft is a big business for the criminal population. Because of this, locks and security systems are becoming more and more important on automobiles.
-  This rise in vehicle crimes has also helped create a new market for companies selling automotive anti-theft devices. These devices range anywhere from clamp-on steel bars to prevent the steering wheel from being turned to sophisticated anti-theft systems equipped with motion detectors.
-  Many of today's manufacturers are developing high-technology systems that are more resistant to criminals. One such system is the General Motors Vehicle Anti-Theft System (VATS). The GM VATS system uses specially designed key blanks. If the incorrect key blank is inserted into the lock, the vehicle won't start and the engine will be automatically disabled for a period of time.
-  *Auto security systems* help deter the theft or vandalism of a vehicle and its contents. The systems do this by making it very difficult for a thief to get into the car without being detected.
-  Older alarm systems were difficult to install and required hard-wiring in many cases. This kept some locksmiths out of the alarm business. However, modern alarm systems are very advanced and easy to install.
-  Many different car alarms are available that can perform a variety of functions. However, most of these systems operate on a simple *relay* principle. A relay is an electric switch that changes the direction of electrical flow. An alarm circuit consists of simple wiring connecting the various parts of the car to the alarm bell. Under normal circumstances, the alarm remains quiet. However, when any part of the alarm circuit is disturbed (glass broken, engine turned on without turning off the alarm system first, etc.) the alarm system's "brain" realizes that someone is tampering with the vehicle, and the alarm bell sounds.
-  A *hidden switch alarm* contains a simple switch that's thrown by hand to turn the system on. Once the alarm system is on,

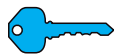
it must be turned off again before you can start the engine, or else the alarm will sound. The switch to the system is hidden in the car so that only the owner will know where it is.



With a *key pad alarm*, the car's owner has to enter a code number into a key pad in order to turn the alarm system on or off. A *passive alarm* is connected directly to the car's ignition switch. When the owner inserts the key into the ignition, the alarm system turns itself off. When the engine is turned off and the key removed, the alarm turns itself on.



The key-operated switch is installed in the driver's side door of a car. The owner inserts and turns a special key to turn on the alarm system. The advantage of this model is that the owner doesn't have to be inside the vehicle to turn the system on.



In a remote-control alarm system, the alarm system is installed in the car in much the same way we've already described. A radio signal generated by a small transmitter device is used to activate the system. The receiver device in this type of system is a small box mounted on the car's dashboard that's called an *LED (light emitting diode)*. The LED has a small button that flashes when the system is armed, warning any would-be intruders that the system is on. To turn on the alarm system, the owner simply closes the car door, points the transmitter at the car, and presses a button.



These systems can be passively connected to the car's ignition, so the customer can get all insurance advantages from this model. One additional feature of this type of alarm is that if you see someone suspicious near your car or if you're accosted in a parking area near your car, you can use the remote-control device to sound an alarm and summon help. The car's alarm can be triggered from anywhere within the transmitter's range, which is usually between 20 and 150 feet.


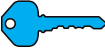


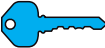


The remote transmitter can be programmed to perform a variety of functions in the car. For example, it can start your car automatically to allow it to warm up on cold mornings. The transmitter can also be programmed to operate your garage door opener.



The main disadvantage of this type of system is that the transmitter device is small and can be lost or misplaced. In such a situation, the owner has to "break in" to his or her

own car (setting off the alarm in the process) and find a hidden switch to manually deactivate the alarm system.

-  Most security systems are designed to sound an alarm when any one of the car doors is opened. The easiest way to do this is to run a wire from the alarm system to the dome light of the car. The *dome light* is the light on the ceiling of the car that goes on when any door is opened. Any time a door is opened, the dome light goes on, and unless the alarm has been disarmed, the alarm will sound.
-  *Motion detectors* are alarm components that are designed to sense movement in any part of the vehicle. If an intruder attempts to do anything to the car—break the window glass, open the door, open the hood—the alarm system will detect the motion and set off the alarm.
-  A *glass-break detector* is a “listening” device that’s designed to listen for the sound of breaking glass. The device is tuned to listen for the exact sound frequency that occurs when glass breaks. When an intruder attempts to enter a vehicle by breaking a window, the alarm will instantly sound.
-  The *siren* is the most familiar alarm-sounding device. Sirens are designed to be very loud, and sound at a frequency that’s very annoying to human ears at close range. This is a deliberate feature; if the sound is loud enough and disturbing enough, it will chase the intruder away from the vehicle.
-  A *pager* is an electronic device that sends a signal to the car’s owner when someone breaks into the vehicle. When the device is activated, it raises the car’s antenna and transmits a signal through the antenna. This feature is designed to give the owner time to alert the police.

Do You Know Now . . .

Below are the answers to the questions asked at the beginning of this study unit.

What is a *primary key*?

In most cases, two keys are used to operate the locks in a vehicle. The primary key operates the ignition and doors. The secondary key operates the trunk and glove compartment.

What is a *krypton light*?

A krypton light is a tool used in car opening. It has a handle containing a battery, a flexible shaft that's small enough to be inserted into a car door, and a tiny light bulb at the end of the shaft.

What does *VATS* stand for?

VATS stands for Vehicle Anti-Theft System.

NOTES

Locking It Up! Answers

1

1. False
2. True
3. False
4. False
5. False
6. True
7. True

3

1. vertical
2. cam or pawl
3. lock rod
4. horizontal
5. replace, repair
6. glove compartment

2

1. primary
2. cutting by code
3. master key and valet key
4. secondary
5. spacer or guide key
6. a car dealer, the car owner, the car itself, the lock cylinder, the owner's manual

4

1. False
2. False
3. True
4. False
5. True
6. False

5

1. c
2. d
3. f
4. e
5. b
6. a

6

1. False
2. False
3. False
4. True
5. True

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Automotive Locks

EXAMINATION NUMBER:

03100900

Whichever method you use in submitting your exam answers to the school, you must use the number above.

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When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. What is the name of the auto opening tool shown here?



- A. Slide Lock tool
- B. MCOT tool**

- C. Slim Jim
- D. Spring-L tool

2. In a car door, the thin sheet of plastic or foam located between the trim panel and the door is called the

- A. retainer clip.
- B. window glass.
- C. integral armrest.
- D. watershield.

3. When is an automotive spacer key used?

- A. When disassembling a side bar wafer lock
- B. When removing a door lock cylinder
- C. When cutting an auto key by code
- D. When installing a vehicle alarm system

4. Which of the following statements about automotive security systems is correct?

- A. Auto security systems are routinely installed at the factory by many manufacturers.
- B. No auto security system is 100 percent foolproof.
- C. Only remote transmitter alarms are approved by insurance companies.
- D. Only an automotive mechanic can properly install a vehicle security system.

5. An automotive master key will operate

- A. only the door and ignition locks.
- B. only the ignition lock.
- C. all the locks in the vehicle.
- D. all the door locks, but not the ignition.

6. What type of lock cylinder is used in the doors, trunks, and ignitions of almost all General Motors vehicles?

- A. The pin tumbler lock
- B. The side bar wafer lock
- C. The warded lock
- D. The standard disk lock

7. Imagine that you're servicing a faulty door lock cylinder. The key won't turn in the cylinder to operate the door. What remedy would you try first?

- A. Replace the lock
- B. Disassemble the lock
- C. Cut a new key
- D. Lubricate the lock

8. What is the name of the auto opening device shown here?



- A. MCOT tool
- B. Slide-Lock tool
- C. Slim Jim
- D. Krypton light

9. How many disks does a typical side bar wafer lock contain?
- A. 7
B. 5
C. 3
D. 1
10. Which of the following statements about motor vehicle crime is correct?
- A. Motor vehicle theft accounts for only one percent of property crime.
B. Most stolen cars are never returned to their owners.
C. The incidence of motor vehicle thefts has decreased over the past few years.
D. Most of the motor vehicles stolen annually are trucks and vans.
11. In a two-key system, the *primary key* is used to operate
- A. only the trunk.
B. the ignition and the doors.
C. only the doors.
D. the glove compartment and trunk.
12. How is a passive auto alarm system turned on?
- A. By turning a switch in the door lock with a key
B. By removing the key from the ignition switch
C. By turning on a hidden switch within the vehicle
D. By aiming a transmitter device at the car and pressing a button
13. Which of the following statements concerning automotive lock service is *incorrect*?
- A. Only an automotive technician can replace an ignition lock.
B. Modern practice is to replace faulty cylinders rather than repair them.
C. If a key doesn't turn in a lock, you should first try to lubricate the cylinder.
D. Auto lock cylinders often need replacement due to excessive wear.
14. Which of the following vehicle security systems is most often factory-installed by the manufacturer?
- A. Remote-control transmitter devices
B. Hidden-switch alarms
C. VATS
D. Glass-break detectors
15. What is the most common reason why a locksmith is called to assist with a vehicle?
- A. A small child is locked in the car.
B. A key has broken off in the door lock.
C. The owner has lost the keys to the car.
D. The owner has locked the keys in the car.
16. How many different VATS key blanks are there?
- A. 10
B. 15
C. 5
D. 1

17. When opening a vehicle without a key, how is a rubber wedge used?
- A. To hook the locking pawl inside the door
 - B. To remove the window glass from the car door
 - C. To remove lock cylinder retainer clips
 - D. To create a space between the window glass and the weather stripping
18. In terms of security, what is the most vulnerable area of a vehicle?
- A. The passenger door
 - B. The ignition
 - C. The hood
 - D. The window
19. What is the function of an automotive key code manual?
- A. To describe the assembly of various automotive locks
 - B. To provide instructions on how to open automotive locks without keys
 - C. To convert key codes to the key cut depths required to make a proper key
 - D. To explain the VATS system in detail
20. What is the first step in the disassembly of a car door?
- A. Roll down the window
 - B. Remove the armrest
 - C. Remove the negative lead from the battery
 - D. Remove the watershield

COMING ATTRACTIONS

Your next study unit will examine the specialty locksmithing field of safe and vault service. We'll look at how safes are constructed, how combination locks operate, and the types of services that locksmiths perform on safes. These services include combination changing, cleaning, lubricating, and repairs.

Professional Locksmith

Study Unit 10

Safes and Vaults

Preview

The specialized knowledge required to become an expert safe technician would fill many books. This study unit isn't intended to make you an expert on safes, but it will introduce you to the ways in which locksmiths regularly work with safes. Despite the complexity of safes, many locksmiths have made safe work a profitable part of their business. In this chapter, you'll learn basic safe terminology, the types of safes and how they're used, major manufacturers, and how combination locks work.

When you complete this study unit, you'll be able to

- Avoid the one most costly and time-consuming error a locksmith can make on a safe or vault
- Clean, lubricate, and repair combination locks on residential and commercial safes
- Change the combination on several different types of safes
- Troubleshoot an improperly functioning safe
- Replace a malfunctioning safe lock
- Recognize if explosives may have been tried on a burglarized safe, and what safety precautions to take
- Explain what causes most safe lockouts
- Describe the techniques used to open a locked safe
- Service, and to open when necessary, safe deposit boxes in banks

The material in this study unit is confidential. Keep this study unit in a safe place. Only professional locksmiths should have access to this confidential material.

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Safes and Vaults

Do You Know . . .

What is the locksmith's "golden rule" for working with safes?

What two services do locksmiths perform most often on safes?

How are burglar-resistant and fire-resistant safes different?

In these pages, you'll find the answers to these and many more questions dealing with the subject of safes and vaults.

INTRODUCTION

Safe Technicians and Locksmiths

The study of safes and vaults is actually a specialty within the field of locksmithing. Locksmiths who specialize in safe work may spend a decade or more perfecting their craft, and often do no other kind of locksmithing work. These professionals usually prefer to be called *safe technicians* instead of *locksmiths*. Safe technicians even have their own association—the Safe and Vault Technicians Association, headquartered in Dallas, Texas.

There are two main reasons why safe work is its own specialty: the complexity of safe and vault locking mechanisms, especially the combination lock characteristic to both; and the vast array of safe makes and models still in use.

Even though safe work is a specialty field, many professional locksmiths offer some safe services, including simple repairs, cleaning, and combination changes. To perform these services, a locksmith must have a working knowledge of safe construction, operation, and combination lock theory. This study unit will cover these topics thoroughly. We'll also discuss some of the common techniques used to open locked safes. Even though you may never choose to do safe work,

you should at least be familiar with these techniques and the terminology associated with safe work.

Banks and other related institutions sometimes contract with independent locksmiths to service, repair, and rekey *safe deposit boxes*, and to open locked safe deposit boxes when necessary. Safe deposit box work also will be covered in this study unit.

Your “Golden Rule” for Safe Work

Before we go any further in this course on safe work, there’s one important rule you must know. As you start to work hands-on with combination locks and safe doors, on practice models or on actual job sites, remember: *always* test your work *with the door open*. Never shut a safe or vault door and *then* see if you can unlock it! The most costly and time-consuming error a locksmith can make on a safe is a total lock-out. It’s not uncommon for a safe technician to be called in, usually at the locksmith’s expense, to open a safe that the locksmith unintentionally locked shut. Safe technicians recommend locking and unlocking the door a minimum of five times *while the door is open*, to make sure the combination lock and all other parts are working correctly. Have the customer run the combination three times, after you’re finished and before closing the door. You’ll see why this is the locksmith’s No. 1 rule for working with safes as we continue through this study unit.

WORKING WITH SAFES

Where Are Safes Used?

Safes are found in many homes and in nearly all commercial businesses from the smallest corner grocery store or gas stations to the largest department store chain. People protect their homes and businesses with locks and security systems, but they generally place their most valuable property inside safes. A coin collection in a home safe, the day’s receipts in a restaurant drop safe, documents and stocks in a safe deposit box—whatever the safe contains, you can be sure it’s treasured by the owner. That’s why a malfunctioning safe is a disaster to its owner, and why most safe calls are emergency calls!

Modern Safes and Vaults

Many years ago, before the invention of the combination lock, a safe or vault was simply an extra-strong metal box fitted with a special type of key-operated lock. Today, however, the safes and vaults you'll see in common use in homes and businesses are incredibly secure. Typically made of iron, steel, or both, the modern safe is a mini-fortress built to resist all sorts of forced entry. In addition, many safes are designed to survive fires, water damage, structural abuse, and even explosions.

Modern safes are fitted with complex combination locks, which help make them even more secure. Combination locks are keyless locks that, for all practical purposes, are pick-proof. It's nearly impossible for someone to open a combination lock without knowing the *combination*. A combination is a set of letters or numbers unique to each lock. When dialed in sequence, this set of letters or numbers allows the bolt of the safe or vault door to be withdrawn and the door to open. (The basic parts and operation of the combination lock will be explored a little later in this study unit.)

Safes and vaults are very similar devices. The main difference is their size and what they're used for (Figure 1). A *vault* is basically a room-size, walk-in safe built right into the structure of a bank or other building, secured with a heavy door that uses a combination lock. Vaults are used for long-term storage of cash, documents, and property. In contrast, a safe is much smaller. Safes are often used for the temporary storage of cash or documents awaiting transfer to a bank vault.

While many of the principles you'll learn in this study unit can be applied when working with vaults, most locksmiths work only with safes. This is because banks, which are the primary users of vaults, usually contract with a vault manufacturer for repairs rather than an independent locksmith.

Most safes are the free-standing type, with wheels or skids underneath so that they can be moved when necessary. A *floor safe* is set directly into a floor, with the safe door lying flush against the floor's surface. Many businesses use floor safes that are permanently set into a concrete floor. These safes are often bombarded with dirt and mop water, and as a result, may need more frequent cleaning and servicing than standing models. A *wall safe* is installed in a wall, and like a floor safe, it's often a permanent fixture. A wall safe is often

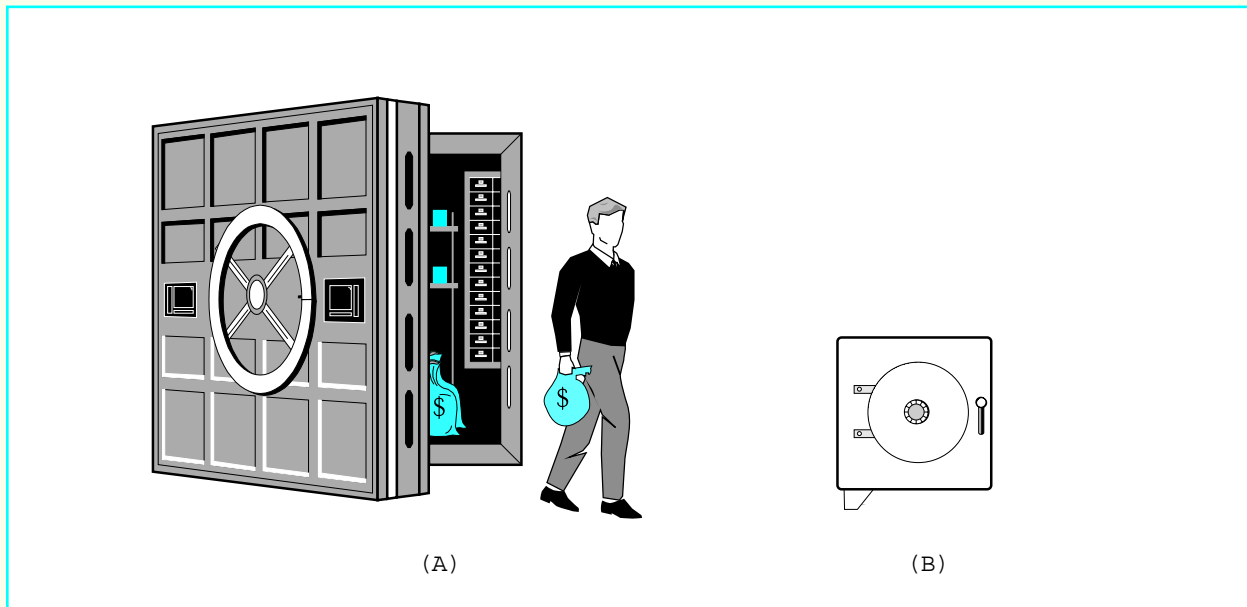


FIGURE 1—Vaults and safes are both used to store cash, documents, and property. However, a vault (a) is a room-size, walk-in storage structure. In contrast, a safe (b) is smaller, usually free-standing or built into a wall.

set in concrete to anchor it into the wall. A common type of wall safe is the *round-door money chest*.

Manufacturers were, and still are, constantly redesigning safes in order to keep the inner workings secret, and to minimize problems such as unintentional lockouts. Thus, just like automobile manufacturers, safe manufacturers over the years have produced many different makes and models of safes. And, because safes are built to last a long time, a vast array of safe makes and models is in use today. It's not unusual, for example, to be called to examine a safe that's more than 50 years old. Such a safe may have been made by any one of a hundred different manufacturers. Not all safes are easily identified, however, and one of the safe technician's challenges is to figure out the make, model, and year of the safe, and the make and model of the combination lock that operates it.

Safe Services

Safe work is a small part of most locksmiths' trade, but it can be very profitable. Safe work often accounts for about 10 to 20 percent of a locksmith's business. Locksmiths perform the following two services most often:

1. Changing the combination on the combination lock
2. Troubleshooting, cleaning, and repairing the combination lock and safe door

Locksmiths say that about 90 percent of the calls they receive concerning safes are requests to change the combination on the combination lock. Businesses often request a combination change after an employee leaves or is fired, to keep the safe's combination from becoming known to outsiders. Some residential and commercial safe owners will call just to have a safe cleaned and serviced, but often these requests aren't made until the safe is working poorly, or not at all.

Calls on lockouts are rare. When locksmiths do receive a call concerning a lockout, they ask one question first: Is the combination known? If the combination is known but the customer still can't get the safe door open, the locksmith may try to open the safe using troubleshooting techniques (we'll review these techniques later). If the combination is unknown, the situation is much more complicated. Many locksmiths will immediately refer these cases to a safe and vault technician, rather than attempt it themselves.

Note: In keeping with the locksmith's code of ethics, you should be careful to keep the information in this study unit out of the hands of those who aren't in the locksmithing trade. The locksmith's code of ethics requires that a locksmith not reveal the inner workings of locks to people outside the trade. Safeguard your work and your reputation!

SAFE CONSTRUCTION

The Lock, the Door, and the Body

Before you can successfully clean, repair, or open a safe, you need to understand the basic operating principles of safes. First, we'll look at the workings of the most vital part: the combination lock. Then, we'll look at the construction of a safe body to understand how the combination lock works with all other parts of the safe.

Although all safes work on certain basic principles, different makes and models of safes will differ in many details. To service them properly, you'll need to know how to identify them and how they differ from one another. We'll finish up this section by comparing several of the most popular brand-name safe manufacturers and their products.

The Combination Lock

Over the years, locksmiths and safe technicians adopted various names for the different parts of combination locks. This caused confusion when they tried to order parts from a manufacturer, because the factory couldn't always tell which part or parts they wanted. Standardization of the names of parts was sorely needed. Finally, Sargent & Greenleaf Inc., one of the foremost makers of combination locks, published a combination lock glossary that pictured and named combination lock parts. The names used in this reference work are now considered industry standards, and are used in this text.

Figure 2 shows an exploded view of a typical combination lock. We'll examine each major part and its function, starting with the first part of the lock you normally see on the outside of the safe door.

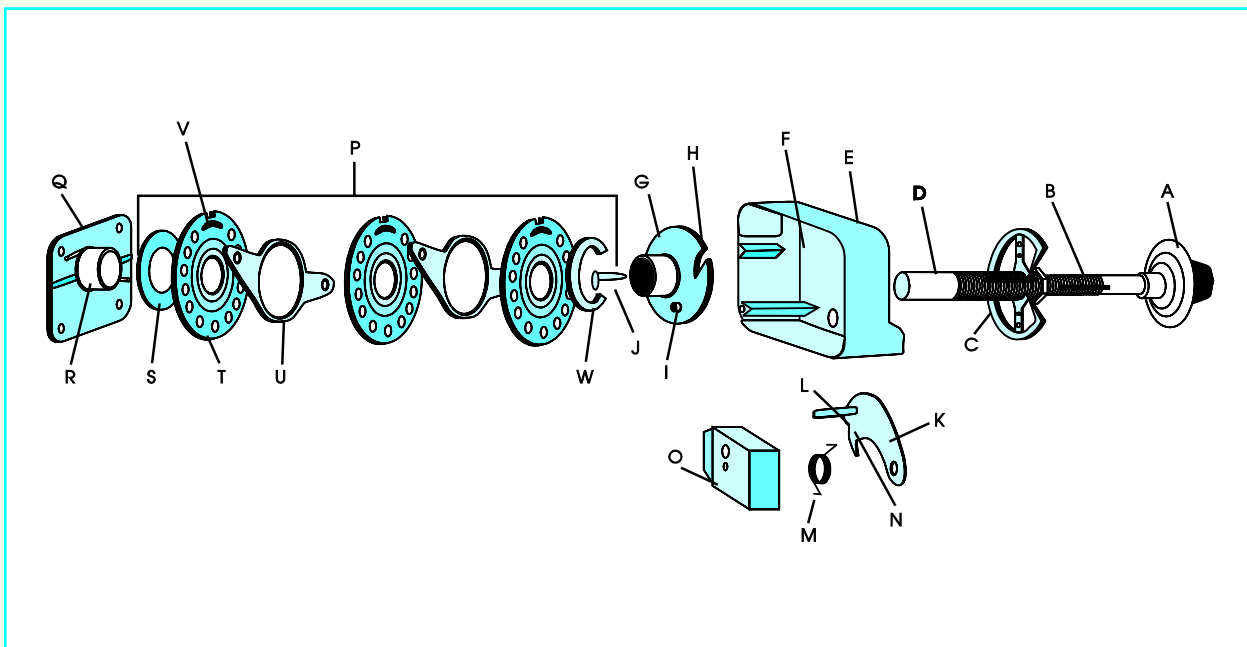


FIGURE 2—This exploded view shows the many parts of a three-wheel combination lock.

Dial

The *dial* (Figure 2A) is a numbered wheel on the outside of the safe door which is used to dial the combination. It can be rotated to the left and right, and the numbers on its face read clockwise as you face the dial. The numbering starts with 0. Some locks read from 0 to 50, while some read from 0 to 100. The higher the final number, the closer the spaces are between the numbers. Locks with numbers up to 100 usually have a little more security than ones reading up to only 50. A few locks use letters instead of numbers on the dial, but this is seldom seen today. (At one time, locks with letters on the dial were opened by turning the dial to spell out a word or name, instead of a set of numbers!)

Spindle

The *spindle* (Figure 2B) is attached to the dial, and rotates with the dial as the dial is turned. How long the spindle is depends upon the thickness of the safe door.

Dial Ring

The *dial ring* (Figure 2C) is permanently fastened to the outside of the door, or to the *tube* (Figure 2D). The dial ring has a mark on it at top center called the *opening index*. The numbers on the dial are turned to this mark, in the order specified by the combination. Some dial rings have a mark to the right or left of the opening index. We'll explain the purpose of these other marks later in this study unit.

Tube

The *tube* (Figure 2D) can be part of the lock or part of the safe door, depending on the particular lock and the safe it's installed in. Some locks don't have a tube. The purpose of the tube is to protect the spindle and other lock parts when they're mounted in double-wall doors. Some safe doors are solid metal, but all fire-resistant doors are double-wall: they have two walls, with layers of insulation in between. The tube encloses the spindle to keep small particles of insulation from working their way into the lock. The tube fits against the dial and extends all the way through the door, with the spindle rotating inside it. The length of the tube depends upon the thickness of the door.

Lock Case

The *lock case* (Figure 2E) bolts onto the inside of the safe door. It houses the *wheel pack* (Figure 2P) and all other elements of the combination lock. The *tube horn* (Figure 2F) is a round sleeve extending from the case, to which the tube is attached.

Drive Cam

The *drive cam* (Figure 2G) is threaded and screws directly onto the spindle. When the dial is turned, the drive cam turns the same amount, in the same direction. The *drive pin* (Figure 2I) drives the wheels in the wheel pack (Figure 2P) when the dial is turned.

Gate

The slot in the drive cam shown at Figure 2H is called the *gate*. The purpose of this very important part is to retract the bolt, which allows the door to be opened.

Spline Key

The *spline key* (Figure 2J) connects the drive cam to the spindle. Because the drive cam is threaded and screws onto the spindle, it could screw loose from the spindle unless the spline key is used to connect the two. Some locks don't use this connection. Their spindles have square ends which fit into square holes in the drive cam. A lock with a threaded cam, however, will use the spline key.

Lever

The purpose of the *lever* (Figure 2K) is to move the bolt when the proper combination is dialed. Figure 2L is called the *nose* of the lever. This nose rides around the outside edge of the drive cam. When the gate (Figure 2H) contacts the nose of the lever, the nose will drop into the gate and allow the cam to move the lever, except for one obstruction: the *fence* (Figure 2N). The *lever spring* (Figure 2M) keeps constant pressure on the lever, forcing it against the wheels and drive cam.

Fence

The *fence* (Figure 2N) is a small rod, usually rectangular, connected to the lever and extending out from it at a 90 degree angle. The fence extends into the *wheel pack* (Figure 2P) riding on the outside edges of the wheels as they rotate inside the wheel pack. It won't let the nose of the lever drop into the gate until all the wheels are properly aligned (the wheels are aligned properly when the correct combination is dialed). Many old texts call the fence by different names, such as *dog*, *drop-pawl*, and *lock drop*. In this text, however, we'll consistently refer to this part as the fence.

Bolt

The *bolt* (Figure 2O) is the actual locking part of the lock. The bolt extends out the edge of the door and into the frame of the cabinet when the safe is locked. When the safe is unlocked, the bolt is drawn back into the lock case. The bolt is worked back and forth by the lever. If there were no other parts to this lock, you could lock and unlock the safe just by turning the dial back and forth. The dial turns the cam, which moves the lever back and forth, which moves the bolt in and out. All the other parts of the lock are made to prevent the bolt from being moved unless the combination has been dialed correctly.

Wheel Pack

The *wheel pack* (Figure 2P) controls the changeable part of the combination. We'll be working with these parts when we set a lock to a new combination. Remember, this figure shows a three-wheel combination lock, which is very common. Some combination locks have only two wheels, and some have more than three. If this diagram showed a six-wheel combination lock, there would be *twice as many* parts shown at Figure 2P.

Cover

The *cover* (Figure 2Q) is the plate that covers the back of the lock case. Two screws hold it onto the lock case. Figure 2R is the wheel post. The entire wheel pack is assembled onto this post in the order shown in the wheel pack diagram, and rotates around this post. On some locks, the post is located on the lock case, and on some it's located on the back cover as

shown. When it's located on the back of the cover, the assembly is called the *curb*.

Tension Washer

The *tension washer* (Figure 2S) is the first part of the wheel pack assembled onto the wheel post. By exerting tension against the other parts of the wheel pack, the tension washer provides the correct friction on each wheel, so that they won't turn by themselves.

Wheel

The *wheel* (Figure 2T) is the heart of the combination lock. Wheels are also often referred to as *tumblers*. After the tension washer, the wheel is the next part to go onto the wheel post. Wheels are made to be adjustable, so that the combination of the lock can be changed. We'll take up the various styles of wheels and how to adjust them later in this study unit. Each wheel has a *gate* (Figure 2V). The correct combination turns the wheels until all of their gates line up in a row, allowing the fence to drop into the gates. The bolt can be drawn back and the safe door can then be opened.

Spacing Washer

There is a *spacing washer* (Figure 2U) between each pair of wheels. Their purpose is to reduce friction between the wheels. In a three-wheel combination lock, as shown here, there is a spacing washer on each side of the center wheel.

Retaining Washer

When all of the other parts of the wheel pack are assembled on the wheel post, in the order shown, the *retaining washer* (Figure 2W) holds them in place. There are several different styles of retainers, but all of them perform the same function.

Variations

The parts we've just covered are the basic parts used in most combination locks. Different makes and models of locks will have slight variations or special features built into them, but all of them work on the same principles. You may wish to

keep Figure 2 handy as we go through the rest of this study unit, because we'll be referring to these parts frequently.

Now that we've identified the basic parts of the combination lock, we'll look at the the following:

- What the door and body of the safe are made of
- What the UL rating of a safe is and what it reveals
- How to find the make and model number of a safe
- How to determine the "hand" of the lock

This section will also introduce two special security features that we'll explore more fully later: the *relocking mechanism* or *relocker* and the *hardplate*.

The Door and Body

The door and body jambs of very old safes usually are made of cast iron, with solid iron or steel forming the safe's top, bottom and sides.

In the 1920s, *Underwriters' Laboratories (UL)* began testing safes and rating them for insurance purposes. In response, manufacturers began to extensively redesign their safes. The "iron age" of safe-manufacturing waned, and the modern pressed-steel type of manufacture began. Most safes today are made of steel. (Manganese steel was used in bank-quality safes called *cannon balls*.) The steel is also often *case-hardened*, meaning that the exterior surfaces of the steel have a hardened outer skin that resists drilling.

Burglar Resistance and Fire Resistance

The materials and construction of a safe's door and body will depend on whether the safe is meant to be *fire-resistant* or *burglar-resistant*. If the safe has a UL label, the label will tell you which kind of safe it is.

Why these two categories? Because people buy safes to protect their property against two different kinds of danger: thieves and fire. A convenience store manager, for example, is more likely to lose cash receipts in a holdup or through employee pilfering than by fire. This manager will want a

safe that's mainly burglar-resistant. On the other hand, a data-processing manager may need a secure place to store computer disks and tapes, or paper records such as spreadsheets, ledgers, etc. These items wouldn't be of much value to a thief, but they could be destroyed in a fire. The data-processing manager will want a safe that's fire-resistant.

Burglar-resistant safes are often made of solid steel, or of a concrete-like compound sandwiched between thick sheets of steel. They have special security features, such as recessed doors and heavy-duty hinges that resist prying and hammering. As you may guess, a lockout on a burglar-resistant safe causes much grief because, when locked, these safes are made to remain locked. They aren't very good at protecting their contents from fire, however. This is because steel is an excellent heat conductor. If the outside of the safe heats up in a fire, the heat can quickly radiate to the interior, damaging or destroying any paper records or cash in it.

The compact security safe shown in Figure 3 is mainly burglar-resistant. It's constructed of solid steel, but doesn't have insulation, and therefore wouldn't protect its contents for long in an intense fire. However, it would provide excellent protection of its contents from burglary, and therefore would have a UL rating of *B* (burglary). We'll explain this rating and other UL ratings in a moment.

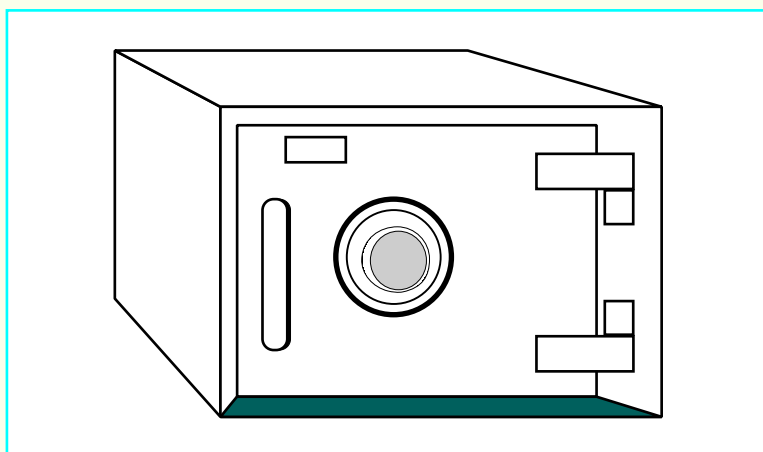
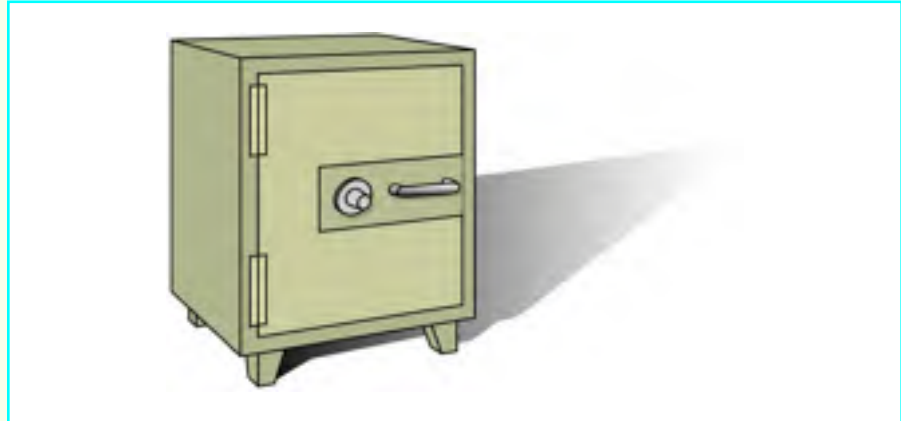


FIGURE 3—This safe is designed to protect its contents from burglary.

Fire-resistant safes have doors and bodies made mostly of a fireproof compound encased in sheet steel (Figure 4). The fireproof material shields the interior from heat, protecting the contents of the safe. The steel skin is thinner than that of a burglary-resistive safe, however, making fire-resistant safes more vulnerable to break-ins.

In an advertisement for such a safe, the safe's fire-resistance rating would be mentioned first, and the insulation would also be mentioned in the description. There would be no burglary rating; most fire-resistant safes don't meet the requirements of burglary ratings. However, a manufacturer would point out that these safes do have relockers, hardplates, and deadbolts to beef up their security against break-ins.

FIGURE 4—This safe is designed to protect its contents from fire.



Many manufacturers combine elements of both kinds of construction in different models of safes, to give customers many options and price ranges to choose from. Just one example is the “safe within a safe” shown in Figure 5. This particular model features a burglary-resistive safe welded within a fire-resistive safe, giving the owner good protection against both hazards.

As a professional locksmith, you should be familiar with the basics of safe insurance ratings. One of the most important



FIGURE 5—Some safes are meant to resist both fire and burglary.

ratings is the *mercantile safe classification*. This rating indicates a safe that is suitable for commercial applications (stores and businesses). The mercantile rating is often indicated by the letters *B* or *C*. A safe rated *C* has a 1-inch thick steel door and (at least) a $\frac{1}{2}$ -inch thick steel body. A safe rated *B* has a steel door less than 1 inch thick, and a steel body less than $\frac{1}{2}$ inch thick. In this class, *B* and *C* are the most common ratings.

Underwriters' Laboratories (UL) ratings are commonly used to indicate the level of a safe's fire resistance. You'll find a UL label on most safes manufactured during and after the 1920s. The UL label typically shows a *temperature and time classification*, as seen in Figure 6. The Underwriters' Laboratories test safe models to determine these ratings. The UL rating *350-2 HR* means that after two hours of exposure to intense heat, the safe's interior heated to no more than 350 degrees Fahrenheit. This is a common rating on safes made for home use. A UL rating of *125-2 HR* indicates a very fire-resistant safe; *125-4 HR* is even better. In addition to their fire ratings, the UL has ratings for safe locks, and also for *drop tests* (to see how well a safe holds together when dropped).

The UL also has its own separate tests for burglary resistance. For example, one typical UL listing for a tested safe is *TL-15*. The *TL* means that the safe was tested with a *tool attack*; the *15* indicates that the safe withstood the attack for 15 minutes. A rating of *TL-30* means that the safe withstood a tool attack for



FIGURE 6—A UL label usually shows the temperature and time classification of the safe.

30 minutes. A *TRTL-30* listing means that a tested safe withstood a *blowtorch (TR)* and tool attack for 30 minutes. Again, these are only a few of the UL ratings you might find on a safe. (You can obtain a complete UL listing for safes from a variety of reference sources.)

Relockers and Hardplates

Safe doors may contain two other items the locksmith should be aware of: relockers and hardplates.

A *relocker* is a secondary locking device that's set off by tampering. The relocking device may be within the lock itself, within the safe door, or both. As its name implies, it independently relocks the door, so that even if the combination lock is defeated, the door won't open. We'll examine different kinds of relockers in the next section of this study unit.

The *hardplate* is a piece of drill-resistant steel mounted within the safe door to protect the lock from drill attacks. Hardplates come in different sizes, shapes, and thicknesses. Some hardplates are made big enough to protect both the lock and the whole bolt mechanism in the door from drilling. We'll look at hardplates more closely when we cover drilling in a later section in this study unit.

All of the above is important to the locksmith for two main reasons. First, if you have to replace a lock on a safe door or drill through the door, you should know what kind of material(s) you may be dealing with. Second, if you're servicing or replacing a lock on a safe door, you should know if there's a relocker and how to disarm it.

The Make and Model Number

How can you recognize a particular make and model of safe? Most locksmiths have no trouble identifying new safes. The manufacturer's name and model number are usually marked prominently on the safe. By checking the number in a reference manual or a manufacturer's catalog, you can easily find out what you need to know: what the safe is made of, what make of lock it takes, how the door functions, and so on. Some of the best-known safe manufacturers in use today are the following:

- Mosler
- Diebold

- Herring-Hall-Marvin (H.H.M.)
- Meilink
- Reliable
- Cary (discontinued, but still many in use)
- Syracuse
- Baum
- Remington Rand
- Gardall
- Sentry
- American Security Products Company (AMSEC), maker of the popular Star and Major floor safes

Some major combination lock manufacturers are the following:

- Sargent & Greenleaf (S&G)
- Yale
- LaGuard
- ILCO

One of these lock brands could be seen on a variety of safe models. For example, 90 percent of Meilink safes are equipped with Yale locks. Several of Gardall's models come with S&G locks. However, one of the largest manufacturers of safes, Mosler, makes some of its own locks.

Now, what if a safe was made 30 or more years ago? These are the safes that are harder to identify. A safe that old may well have been repainted, repaired, or survived a fire, any of which could have obliterated its make and model number. Some safes have the manufacturer's name stamped on the face of the door in raised letters, which can be felt or seen by looking sideways across the door surface.

Sometimes a name can be found on the combination dial hub, but be warned: this is often the name of the lock manufacturer, not the safe manufacturer. Although there have been a hundred or more safe manufacturers over the years, there are

only a handful of major manufacturers of combination locks, and these locks will be found on many different makes and models of safes. It's a common mistake of locksmiths to identify a safe as a Sargent or a Yale, when actually there's no such make.

There's another way to determine the make of a safe, and that's to become familiar with the peculiar identifying characteristics of different manufacturers. The different shapes and styles of dials, handles, body and door corners, wheels and casters all give a clue as to who the manufacturer is. As you can guess, identifying a safe this way is an art, like identifying antique cars by the shape of their tailfins and headlights.

For all practical purposes, locksmiths rarely have to identify a safe this old or obscure, as long as it's *open*. If the safe is open,

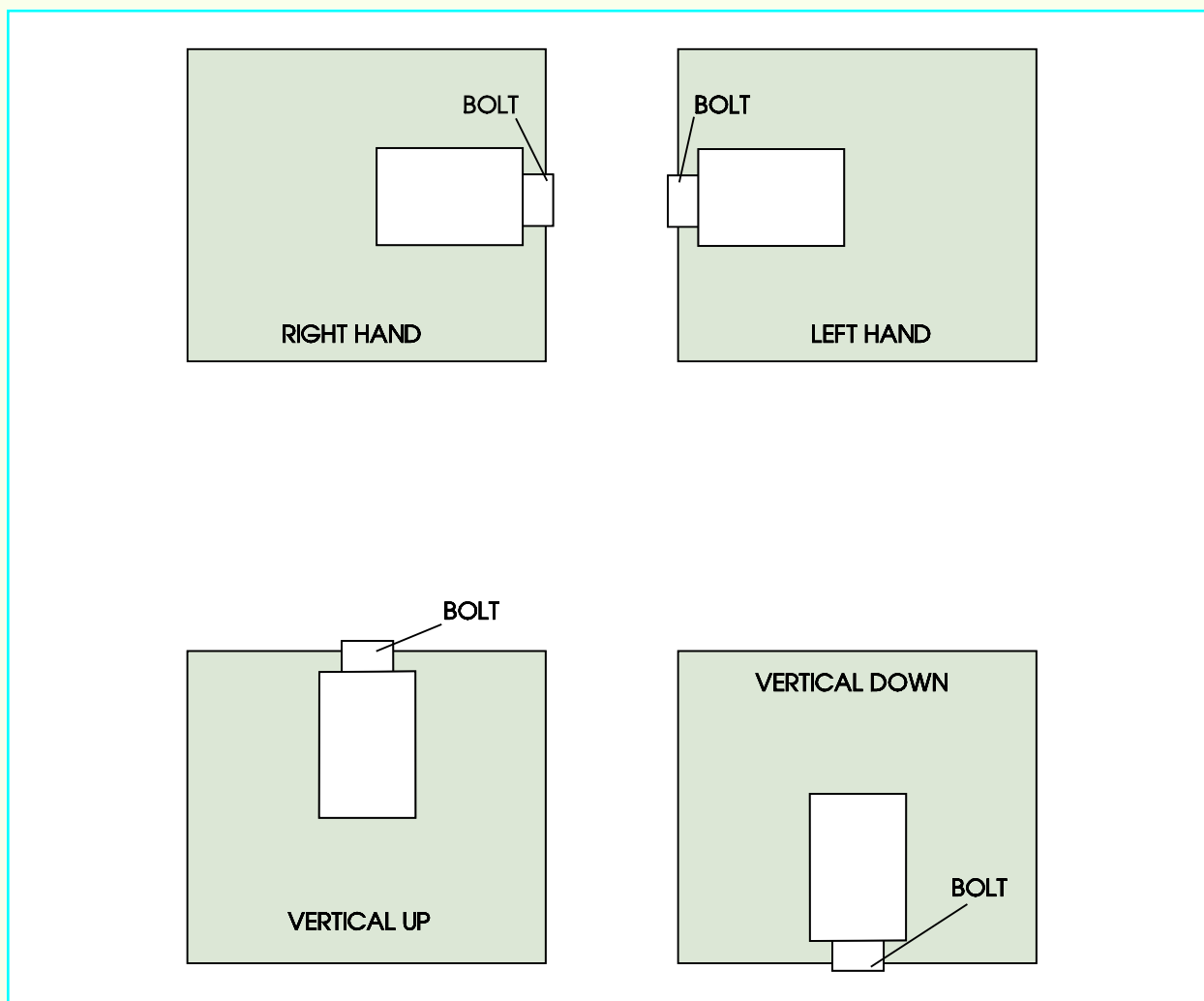


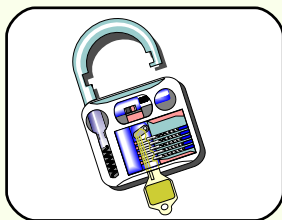
FIGURE 7—The hand of the lock is determined by viewing the bolt from the rear of the door when the door is open. Note that the hinges don't determine the hand of the lock.

a well-trained locksmith will be able to service or replace the combination lock, and with good mechanical aptitude, will be able to service the working parts of the door to give them many more years of service.

Determining the “Hand” of the Lock

Sometimes you need to order a replacement lock for a safe, one of the first things you’ll need to know is the *hand* of the lock.

Safe locks are mounted in four different positions: *right-hand*, *left-hand*, *vertical up*, and *vertical down* (Figure 7). Remember, these are the positions as you’re facing the rear of an open door.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

1. What is the difference between a locksmith and a safe and vault technician?

2. What is the most expensive mistake a locksmith can make while working on a safe?

3. What are the two most common tasks locksmiths perform on safes?

4. If a customer calls and says a safe is locked up and won't open, the locksmith will usually ask if the _____ is known. This indicates how much time and effort it will probably take to get the safe open.

5. *True or False?* It's rare to find a safe that's more than 50 years old, because they wear out and are replaced often.

Check your answers with those on page 91.

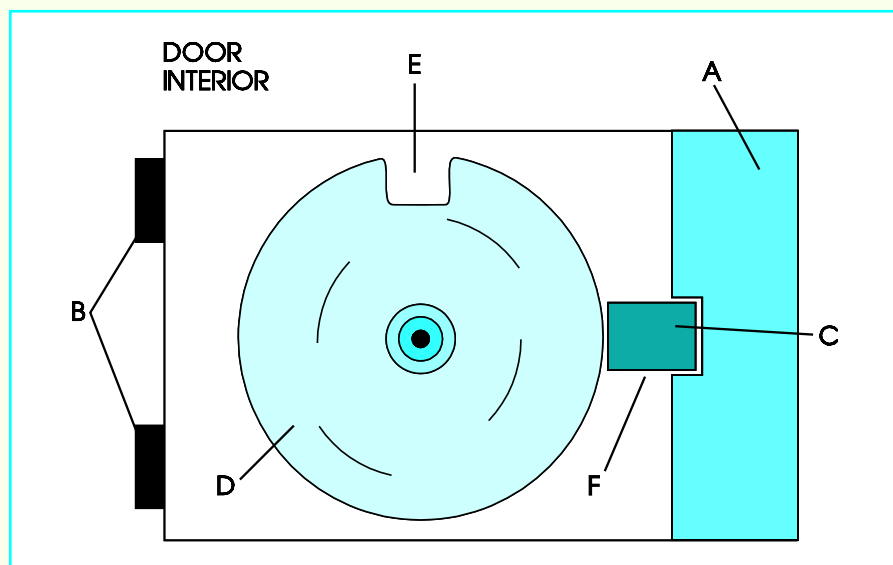
THE COMBINATION LOCK

Combination Lock Construction

Although combination locks differ from one make and model of safe to another, they operate on the same basic principles. The dial is turned to a preset series of numbers that line up the gates with the fence, allowing the door to open.

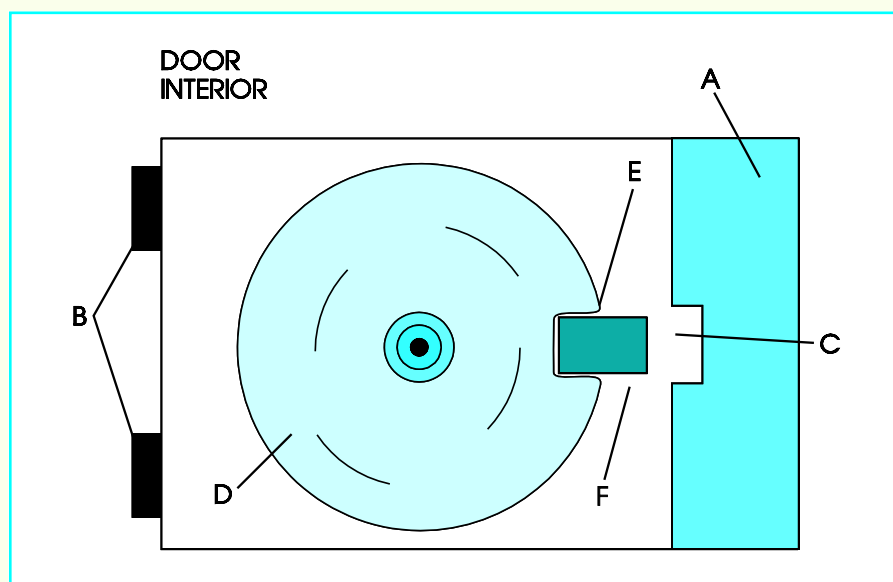
Imagine for a moment that you were small enough to fit inside a safe with a very simple combination lock. This combination lock has what's known as a *direct-in fence*. (Up to this point we've been discussing a lever fence.) Figure 8 shows what you would see from the inside of the safe if the cover were removed from the lock. Figure 8A is the doorjamb; 8B shows the hinges; 8C is the hole in the jamb into which the bolt fits when the safe is locked; 8D is the wheel; 8E is the gate in the wheel; and 8F represents the bolt and the direct-in fence. You can see that right now, as you look at this lock, you're locked inside this safe!

FIGURE 8—The wheel of this combination lock is in locked position.



Now suppose a friend on the other side of the door starts turning the dial, hoping to let you out of the safe. The person knows the single number combination, so when the dial stops turning, the gate in the wheel is opposite the bolt and the direct-in fence combined (Figure 9). The person turns a handle on the outside of the door, drawing the bolt from the doorjamb and the fence into the gate. The door swings open. You're free!

FIGURE 9—When the correct number is dialed, the gate of the wheel now allows the bolt to be pulled, unlocking the safe.



This is a very simple exercise. If combination locks had only one wheel, you could see how easy they would be to open. As more wheels are added, however, it becomes more difficult for the person on the outside of the safe, who can't see the wheels turning inside, to line up all the gates so that the bolt may be retracted from the doorjamb. Let's see just how this is accomplished.

When the dial is turned, the rotating parts are the first to go into action, so we'll look at them first. Remembering the example in Figure 8, what do you think the hand of this lock is? If you said left-hand, look at Figure 8 again. In this figure remember, you're looking at the lock from the inside of the safe. If you face the door from the inside, the bolt will be on the right. This is a right-handed lock.

We start by turning the dial to the left, which is counterclockwise as you face the dial. The handing of the lock doesn't define the direction of rotation. A given lock will turn the same direction regardless of the mounting position—vertical up, vertical down, left hand, right hand.

The direction of rotation is determined by

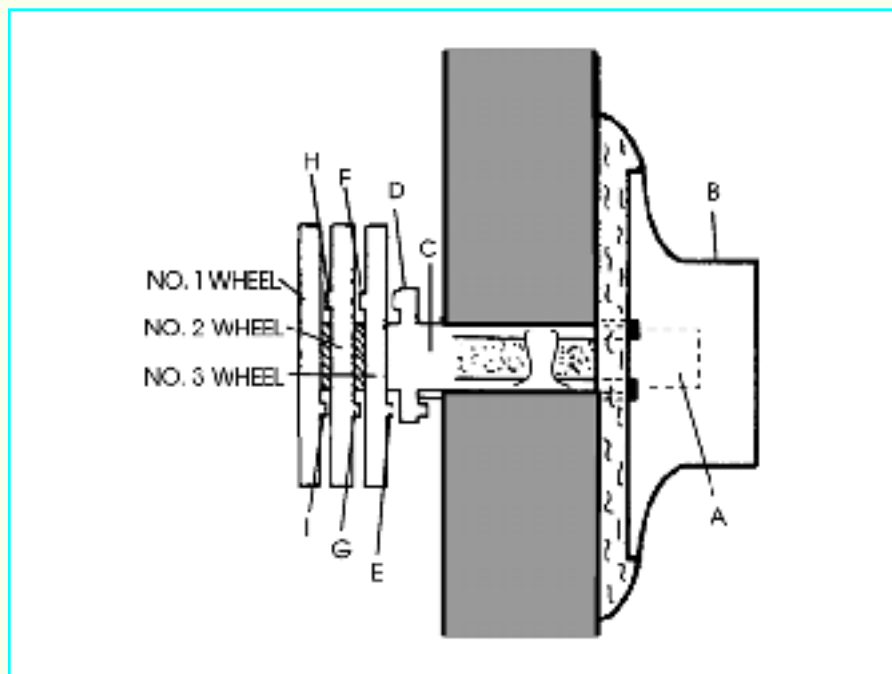
1. Number of wheels
2. Type of lever
3. Position of lever

Some locks can be opened by either rotation.

Now, look at Figure 10. The spindle (Figure 10A) is connected to the dial (10B) and the drive cam (10C). As we turn the dial, the drive pin on the drive cam (Figure 10D) will contact the drive pin on the wheel (10E). This wheel is known as the No. 3 wheel, or the “last wheel” of the combination. If this were a four-wheel lock it would be known as the No. 4 wheel, and would be the “last wheel” of the combination.

We continue turning the dial to the left. When the No. 3 wheel has made one complete revolution, its drive pin (Figure 10F) will contact the fly (10G) on the No. 2 wheel. This sets the No. 2 wheel in motion. Another complete revolution, and the drive pin (Figure 10H) will contact the fly (10I) on the No. 1 wheel, setting it in motion. Now all the wheels in the wheel pack are rotating.

FIGURE 10—A cutaway profile of a three-wheel combination lock assembly shows the drive pins on the drive cam and the three wheels.



The order of the wheels is important to remember, because

- The No. 1 wheel is the first number of the combination
- The No. 2 wheel is the second number of the combination
- The No. 3 wheel is the third number of the combination (in a three-wheel lock, it's also the last number of the combination)

Most wheels have their numbers stamped on them.

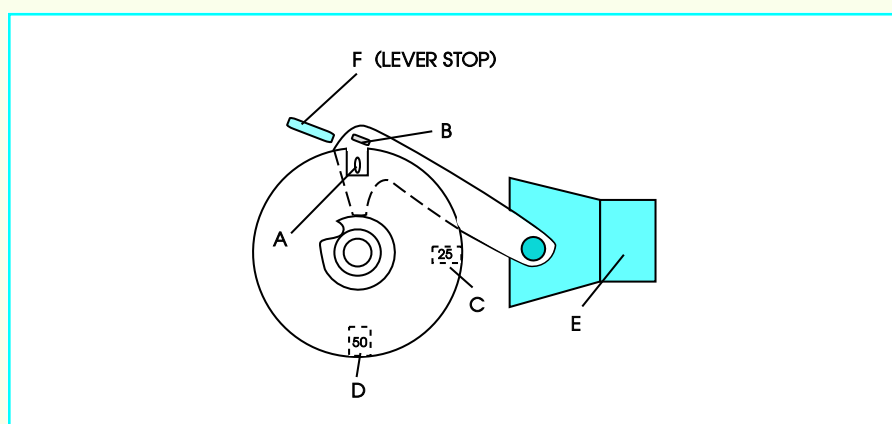
Remember that the No. 1 wheel, the first number of the combination, is the one farthest away from the drive cam. The wheel next to the drive cam is the last wheel, and the last number of the combination. Don't confuse them! Inexperienced locksmiths have set a desired combination backwards because they didn't understand this sequence.

On a three-wheel lock, you must turn the dial four complete revolutions to make the No. 1 wheel turn one complete revolution. Why four turns? Because the drive cam, with its own drive pin, actually acts as a fourth wheel in this three-wheel lock. It takes four complete turns to get the No. 1 wheel turning.

A note on turning the dial: never spin the dial hard, snapping the drive pins together, because prolonged abuse can wear or break them. Also, be careful to dial your numbers up to the opening index, not past it. Spinning the dial will also cause the wheels to turn too far. If you dial past the mark, you can't bring the wheel backwards by turning the dial backwards; you just have to start again.

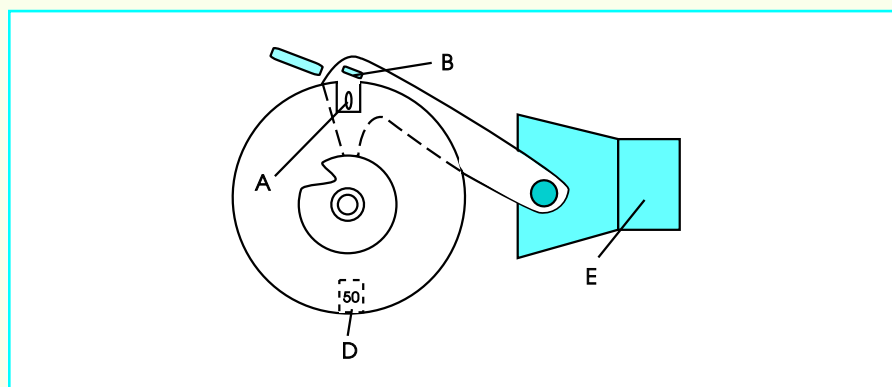
Let's say our lock's combination is 0-25-50 and the dial reads from 0 to 100. Because our lock is a three-wheel lock, we first turn the dial at least four complete revolutions to the left usually (counterclockwise) and stop at 0. Look at Figure 11. The gate of the No. 1 wheel is now in position (Figure 11A). But the fence, connected to the lever (Figure 11B), can't drop in because it's resting on the outer edges of wheels No. 2 and 3. If these wheels were made of clear plastic, we could see that the gate in the No. 2 wheel, which is combination number 25, is positioned at point C in Figure 11. The gate in the No. 3 wheel is positioned at point D. The bolt (point E) is in the locked position. Our next task is to move the No. 2 wheel until its gate is also at point A in Figure 11.

FIGURE 11—Four revolutions counterclockwise ending with the first number of the combination moves the gate of the No. 1 wheel to point A where the fence rests on the three wheels.



We moved the No. 1 wheel to its combination by turning the dial four times to the left and stopping on 0. Now, to move the No. 2 wheel to its combination, we turn the dial three times to the right, stopping at 25, the second number of the combination. Turn the dial from 0 to 25, then to 25 again and stop on 25 the third time the dial comes around to the opening index. The gates for wheels No. 1 and 2 are now lined up at Figure 12A. The fence still can't drop, however, because it's resting on the outside edge of the No. 3 wheel. The gate in the No. 3 wheel is still at 12D.

FIGURE 12—Three clock-wise revolutions, ending on the second number of the combination, bring the gate of wheel No. 2 to position 12A, lined up with the gate of wheel No. 1.



To move the No. 3 wheel to its combination, turn the dial to the left, counterclockwise. Turn left to 50, then stop the next time 50 reaches the opening index. Now the gates of all three wheels are lined up at point A in Figure 13. However, the fence still won't drop into the gates. That's because the nose of the lever, shown at point B, is resting on the edge of the drive cam. Notice the lever stop shown at point G. This stop is part of the lock case and the lever can't move to the left, retracting the bolt, unless it can drop down and miss the stop.

Now turn the dial to the right, slowly. This will turn the drive cam in the direction of the arrows shown at point H in Figure 13.

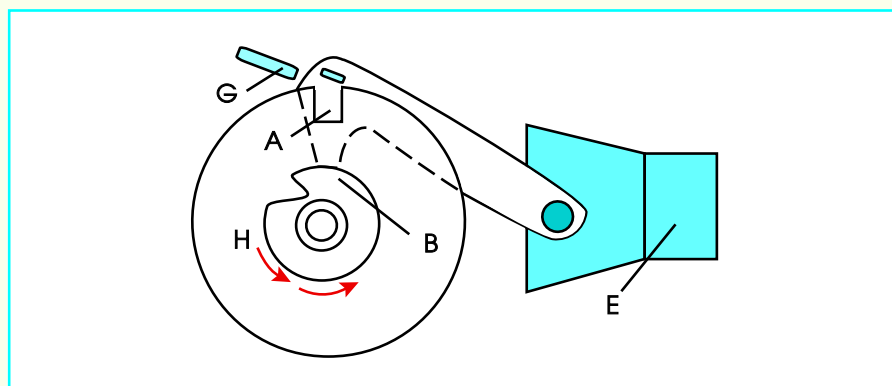
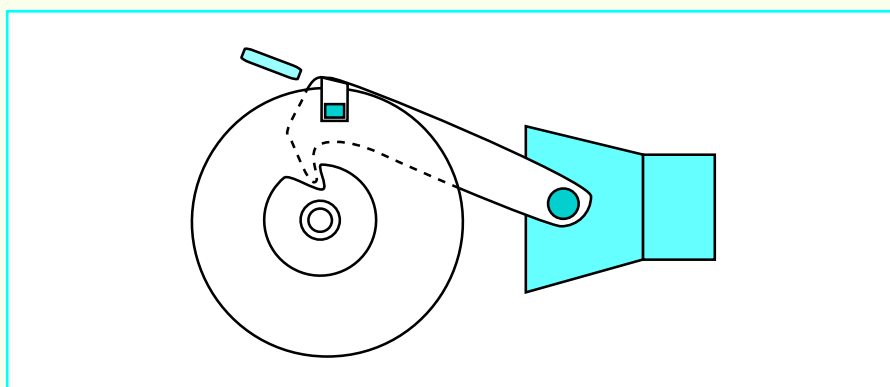


FIGURE 13—The gate of the third wheel is lined up with the others after the last number is dialed.

Figure 14 shows what happens next. The gate in the drive cam will come around, allowing the nose of the lever to drop in. When it drops in, the fence will simultaneously drop into the gates of the wheels. As you continue turning the dial to the right *slowly*, the drive cam will continue to turn in a direction counterclockwise, pulling the lever over to the left. Since the lever has dropped, you can see that it can now move past the stop. The lever is attached to the bolt assembly, as shown in Figure 14. As the lever moves to the left it will retract the bolt, and the safe door will open.

FIGURE 14—The final slow turn clockwise allows the lever's nose to drop into the gate on the drive cam. As the cam turns, it pulls the bolt, opening the door.



We advise that you make this last turn of the drive cam slowly for a reason. The gate in the drive cam and the nose of the lever strike each other every time the lock is opened, and like all mechanical parts, they can break. These two parts have the added stress of retracting the bolt assembly. Sometimes the lever is made of plastic and it can break, causing a lockout (Figure 15). Also on most safes, holding pressure on the door handle will bind the bolt and make it difficult to retract. Safes with no handle will have the door bolt linkage directly

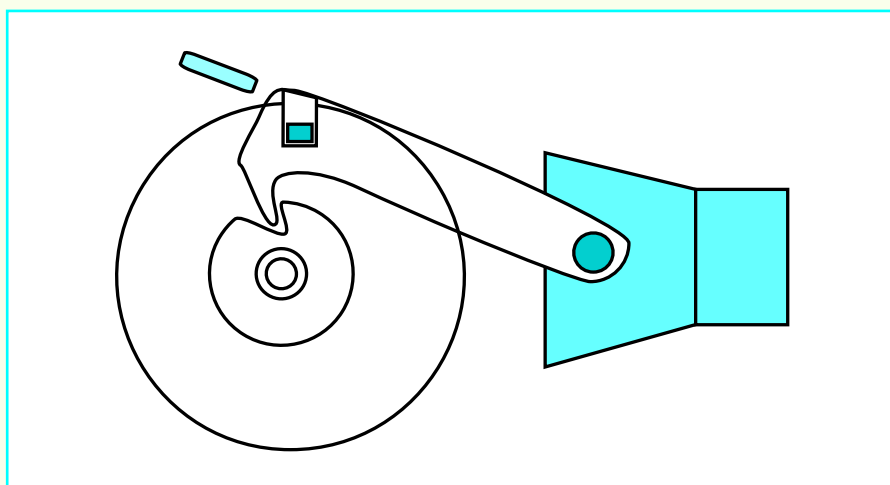


FIGURE 15—If the lever of a safe is made of plastic, it can break and cause a lockout.

attached to the lock bolt, which puts extra strain on the bolt, lever, drive cam, spindle, and dial when retracting the bolt.

Most people don't realize how destructive spinning or snapping the combination dial can be, on all the parts of the lock, especially the drive pins and the flies. Always turn the dial with care, and teach your customers to do the same.

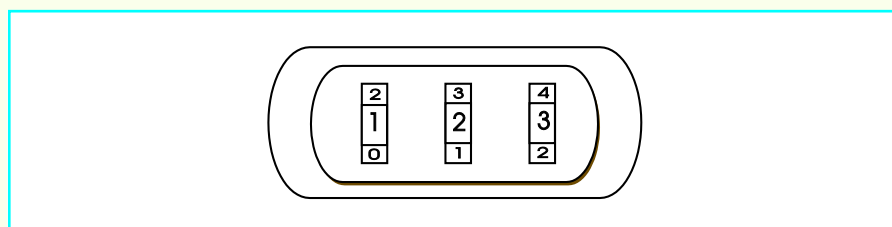
Combination Lock Theory

Now that we've seen how a typical combination lock works, we'll take a closer look at the combination itself, and how the parts and construction of each lock, such as its drop-in point, affect the combination.

How many combinations are possible on a combination lock? The average lock in use today has from 1,000 to 100 million possible combinations. You can find the number of possible combinations by using a simple mathematical formula: you multiply the possible combinations of each wheel by each other.

For example, consider the three-wheel combination padlock shown in Figure 16. Each wheel in this lock is numbered from 1 to 10 (or from 0 to 9) meaning each of the wheels could be set at 10 different positions. To determine how many possible combinations could be set on this lock, we multiply 10 by itself *three times* (because there are *three* wheels): $10 \times 10 \times 10 = 1,000$.

FIGURE 16—A three-wheel combination padlock with 10 positions in each wheel has 1,000 possible combinations.



Now consider the three-wheel safe lock we studied earlier. If the dial is numbered from 0 to 100, will the lock have one million combinations? After all, $100 \times 100 \times 100 = 1,000,000$.

The answer is: not necessarily. It doesn't make any difference if the dial is numbered 0 to 50 or 0 to 100. What controls the number of possible combinations is

1. The number of wheels in the lock
2. The number of change positions available on each wheel

Not every wheel can make use of every point on the dial. Look at Figure 17. These wheels are from a hole-change lock; the combination is changed by sticking the drive pin of each wheel's drive pin washer (shown at point A in Figure 17) into a different hole on the wheel. (We'll learn how to change the combination on this type of wheel in the next section of this study unit.) Notice the wheels at point B and point C each have 22 holes. The wheel shown at point D has only 16 holes. Using our formula, we learn that this three-wheel lock has 7,744 possible combinations ($22 \times 22 \times 16 = 7,744$).

FIGURE 17—Multiply the number of change positions on each wheel ($22 \times 22 \times 16$) to discover the number of possible combinations for this hole-change lock.

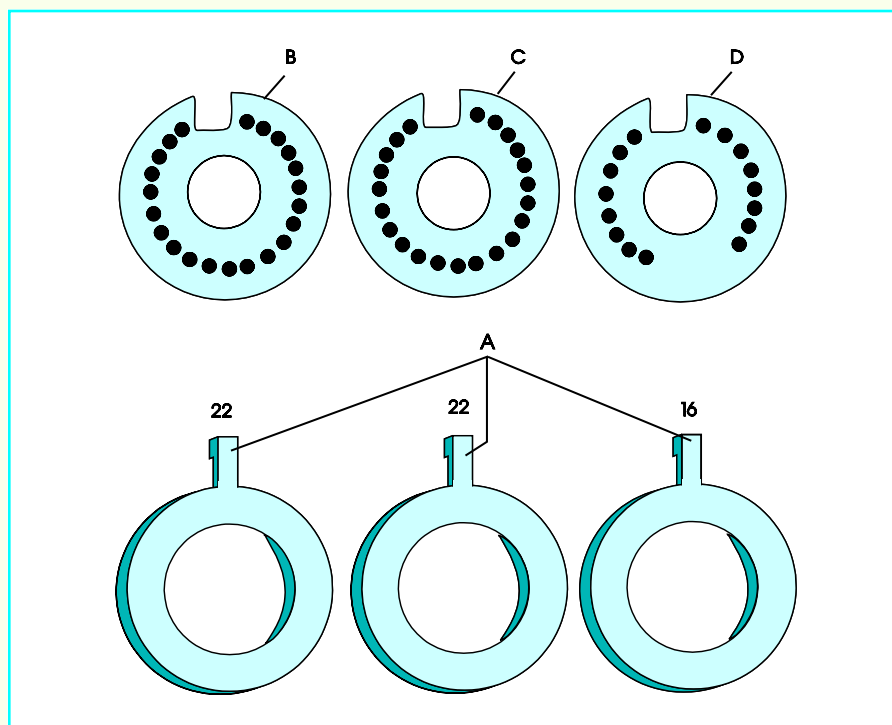
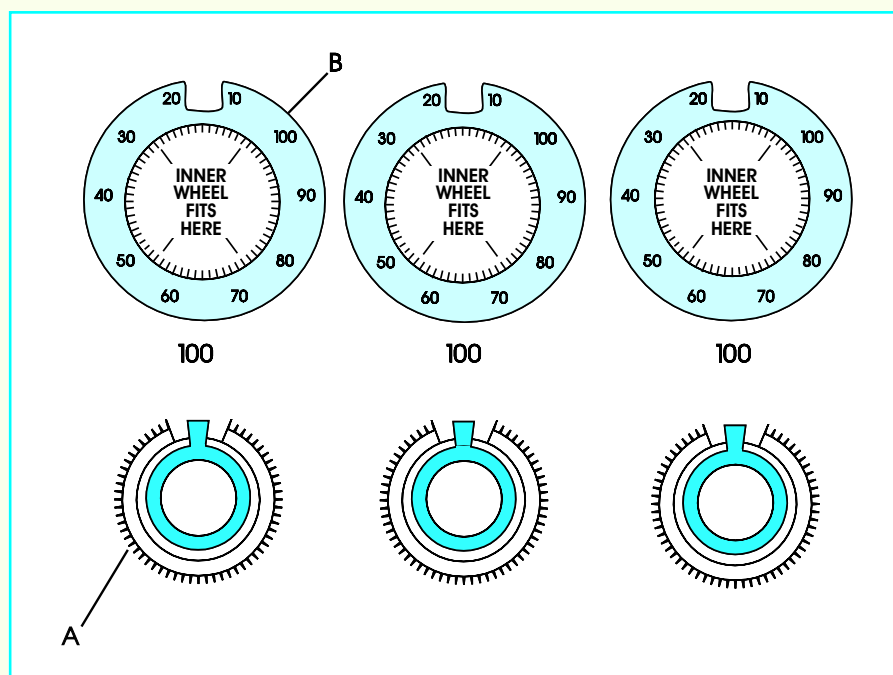


Figure 18 shows wheels from a mesh-change lock. In this type of lock, the inner wheel (Figure 18A) can be removed and replaced in the center of the outer wheel (18B). (We'll also learn more about this type of combination change in the next section.) The inner wheel can be positioned in any one of 100 different locations. Since there are three wheels, this lock has one million possible combinations ($100 \times 100 \times 100 = 1,000,000$). If it were a four-wheel lock, it would have 100 million combinations ($100 \times 100 \times 100 \times 100 = 100,000,000$). This is the theoretical number of combinations. The actual number must consider the forbidden zone. The *forbidden zone* is approximately 10 numbers either side of "drop-in." This will vary with each model lock. For a three-wheel lock the combination would be $100 \times 100 \times 80 = 800,000$.

FIGURE 18—The possible combinations for this mesh-change lock number one million.



In theory, you could figure out the combination of a lock by working through all of its possible combinations until you found the one that would open it, but you can see how time-consuming this would be. If a locksmith worked one combination every three minutes, it would take 230 days, working 24 hours a day, to try every combination possible on a lock with 1 million possible combinations.

The Drop-in Point

The *drop-in point* is the position showing on the dial at which the fence drops into the lined-up gates of the wheels. Figure 19 shows the dial in relation to the fence and wheels. Figure 19A represents the fence, attached at a 90-degree angle to the lever and extending out over the wheel pack. Figure 19B shows the gates of the wheels lined up together. In this diagram, the fence is in position to drop into the gates. Notice the numbers on the dial. In this example, 0 is the drop-in point.

If this lock were constructed as shown in Figure 20, the fence would drop into the gates in a different position. In this diagram, the fence drops into the gates opposite the number 25 on the dial. The drop-in point is 25.

FIGURE 19—In this lock the drop-in point is at 0 on the combination dial.



FIGURE 20—In this case, the drop-in point is 25.



Different locks have drop-in points all over the dial, including 50, 75, and many others. The drop-in point is primarily used as a reference point when drilling safes, which we'll be covering in a later section.

References to the drop-in point always assume that there are 100 points on the dial. If you're working with a 50-point dial, each point from 0 to 50 would be considered two numbers. For example, if the drop-in point of a lock is said to be 10, on a 50-point dial it will be at 5.

Combination Numbers You *Shouldn't* Use

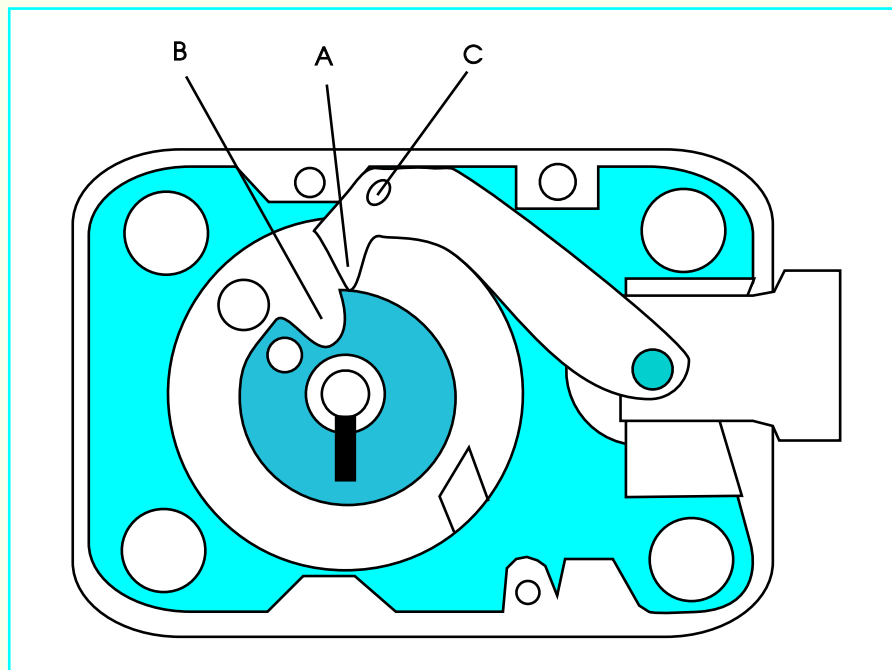
There are certain numbers and series of numbers that shouldn't be used in setting a combination. In determining which numbers to use, you must consider two factors: *function* and *security*.

Numbers That Affect Function

To ensure a smoothly functioning lock, the last number of the combination shouldn't be too close to the lock's drop-in point. As we've mentioned, this is known as the forbidden zone.

Figure 21 shows a right-hand lock with the dial set at 0. The nose of the lever (Figure 21A) is near the gate of the drive cam (21B). If the last number of the combination were set in this area, the fence (connected to the lever at point C), would drop into the gate of the last wheel at almost the same time the nose drops into the gate of the drive cam. This could cause a malfunction of the lock. The lock won't lock.

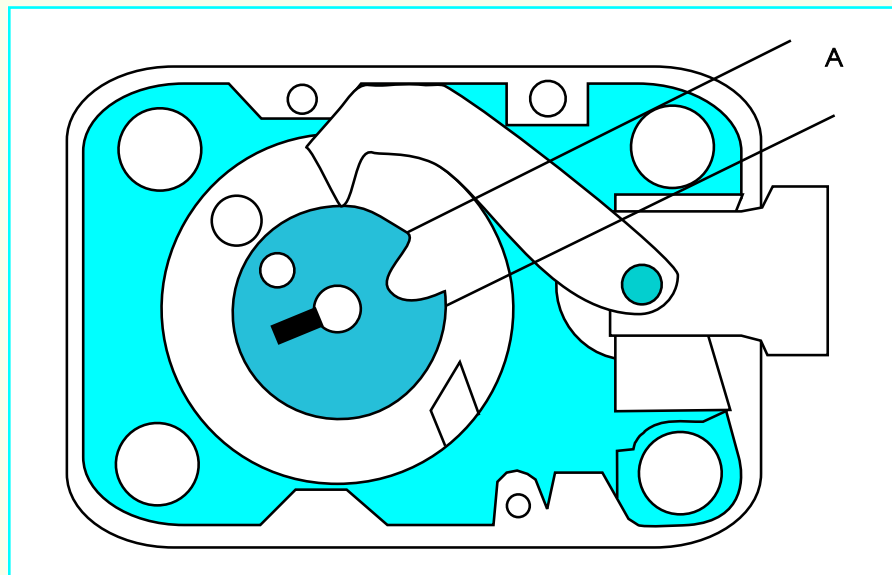
FIGURE 21—The final combination number should be set so that the lever's nose doesn't fall into the drive cam gate too close to the lock's drop-in point.



To guard against malfunction, about 20 points on the dial covering this area should be set aside and not used as the last combination number—10 numbers on either side of the drop-in. Figure 22 shows the same lock with the dial set on 20. Notice where the nose of the lever rests on the drive cam. The part of the dial that corresponds to this section of the drive cam (Figure 22A) shouldn't be used in the last number of the combination. Different locks have different drop-in points, so this 20-point section will vary from lock to lock. Safes with direct-in fences don't have this problem.

There are other numbers that may cause malfunction in different locks. Usually, if a number or series of numbers might cause a particular lock to malfunction, this will be explained in the instructions that come with the lock.

FIGURE 22—The 20-point section marked at Figure 22A shouldn't be used for the final combination number because it's too close to the point where the lever nose will enter the drive cam's gate.



Numbers That Affect Security

To get the maximum security from a combination, avoid setting number series that an unauthorized person might easily figure out. Such numbers can be the owner's birthday, favorite lottery numbers, telephone number, street address, and other numbers that can be associated with the owner, business, or building. Consecutive numbers up or down, such as 10-20-30 or 25-50-75, aren't considered good numbers because one number suggests what the next number might be. It's best to spread the numbers well over the dial, and set them so that they rise and fall, such as 25-7-31 or 31-7-25.

If not given a desired combination by the owner, some locksmiths will simply set the combination to that day's date. Even this may not be a secure combination, however. If employees are aware that the locksmith is in the building on a particular day, they may guess the combination and gain access to the safe. However, for many safe owners, top security isn't as important as convenience. Many of them need only minor security and require frequent access to the safe. What's important to them is a number they can remember. If the owner asks that the combination be set on a birthdate or other common number, advise that this might compromise the security of the lock, and let the decision be the owner's. Don't set a combination on less than its maximum security unless the owner requests it.

The owner may request that you set the combination to a single number. To do this on a three-wheel lock, set all the

wheels to the same number. To open the lock, turn the dial four times in the same direction and stop on the combination number. Turn in the opposite direction slowly until the bolt retracts. If it's a right-hand lock, you'll turn the dial four times to the left and stop on the combination number, then turn right slowly until the bolt retracts.

To set the combination of a three-wheel lock to open on two numbers, set the No. 1 and No. 2 wheels to the same number and the No. 3 wheel to the second number. Remember that the No. 3 wheel is always the wheel next to the drive cam. Work the combination by turning the dial four times in the same direction and stop on the first combination number. Then turn in the opposite direction until the second number reaches the opening index, the second time it comes around. Then, turn the dial back in the opposite direction slowly until the fence drops into the gates and the bolt retracts.

Drive Cam Gating and Location

The wheels in a combination lock may be driven from the front or from the back. Figure 23 shows the drive cam located at the front of the wheel assembly. Figure 23A is the drive cam and 23B is the spindle. The wheel on the right, next to the drive cam, is the No. 3 wheel, the last number in this lock's combination. In front-drive locks like this one, the wheel assembly will be attached to the cover of the lock case.

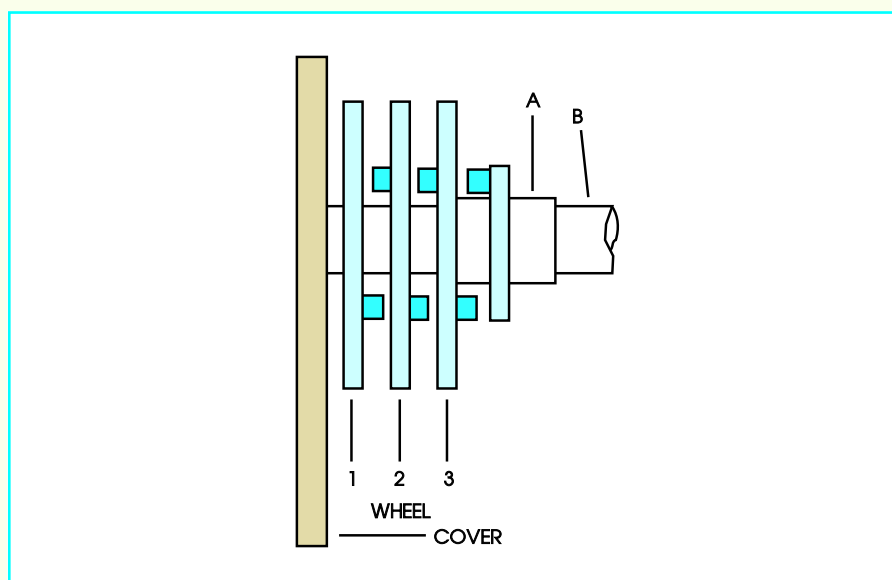
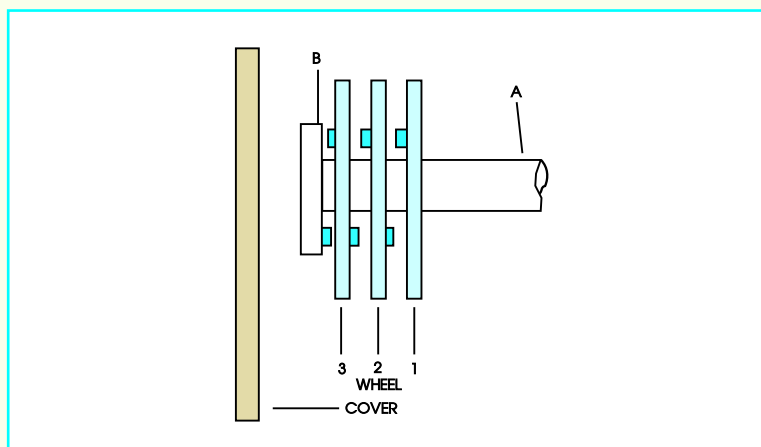


FIGURE 23—In a front-drive lock, the drive cam (22A) is located at the front of the wheel assembly.

Figure 24 shows a rear-drive lock. Figure 24A is the spindle, inserted through all three wheels, connecting to the drive cam (Figure 24B) in the back of the lock case. In this lock the wheel on the left, next to the drive cam, is the No. 3 wheel, the last number in this lock's combination.

FIGURE 24—In a rear-drive lock, the drive cam (24B) is located in the back of the lock case.

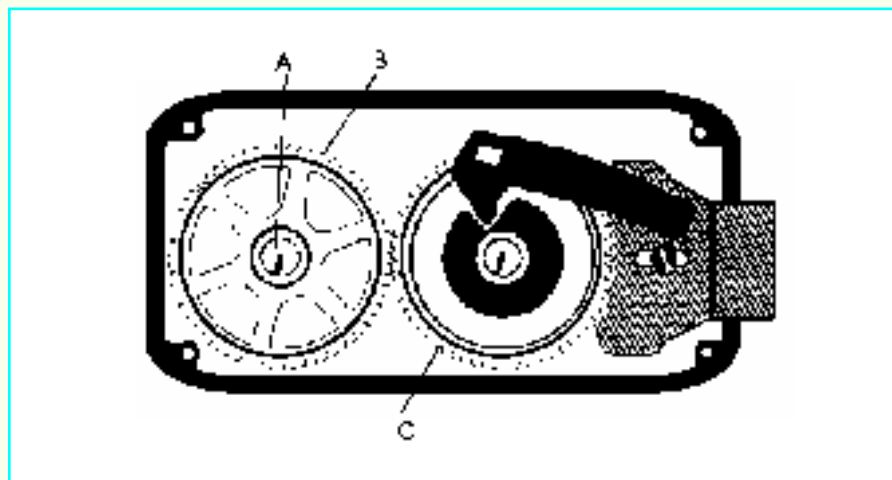


Before you change a combination, you need to know where the drive cam is, so that you don't get the wheels mixed up. The first and last numbers of the combination are determined by this.

Gear-Driven Locks

Some lock manufacturers use a gear drive to make their locks extra resistant to tampering. It's more difficult to know where to drill to line up with the drop-in point in a gear-driven lock. Also, punching the spindle will miss the wheel pack. Figure 25 shows a typical gear-driven lock. The spindle (Figure 25A) attaches to the first gear (25B). When the dial is turned, the first gear rotates. This gear meshes with the second gear (25C) and sets it in motion. The drive cam is attached to the second gear, instead of directly to the spindle as in most locks. It's the second gear that turns the drive cam and wheels.

FIGURE 25—In a gear-driven lock, the dial and spindle turn a gear that meshes with a second gear to which the drive cam and wheels are attached.



Relockers

Many of the more expensive locks are equipped with a burglar-resistant feature known as a *relocker*. This is a spring-loaded mechanism within the lock case that keeps the bolt locked, in case the lock itself is forced or damaged.

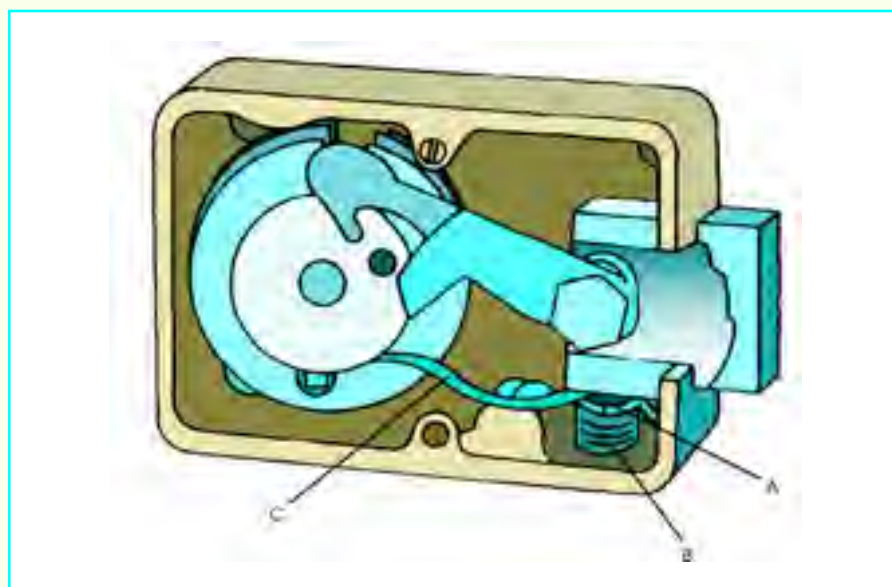
Most burglars are *bunglers*! Rather than try to work the combination lock, they may knock off the dial and drive a punch through the lock, trying to tear off the wheel pack and cover inside. Then they try to access the lever or the bolt through the hole in the door, and work the door open.

That kind of attack won't work on the lock shown in Figure 26. Figure 26A shows the relocking pin under the bolt. At 26B is the spring that would force the relocking pin up into an opening in the bottom of the bolt, except the relocking lever (26C) won't let it enter the bolt. If the cover on the back of this lock case were removed, by force or otherwise, the relocking lever would spring out because it's also under spring tension. This would release the pin and allow its spring to push it into the bolt. If this happens, the bolt will stay locked until the relocking device is disengaged.

This is a typical relocking device. Different locks have different kinds of relockers, and high-security locks may have more than one.

If you remove the cover from a lock with a relocker inside, it will be necessary to reset the relocking pin. To do this, use a

FIGURE 26—A typical relocking device uses a relocking lever activated if the case cover is removed: the lever activates a spring that pushes the relocking pin into the bolt.



small screwdriver to depress the spring, and push in on the relocking lever.

Besides a relocker within the lock, some burglary-resistive safes will have a separate relocker within the door. Some of these consist of bolts suspended on a heat-sensitive wire. If heat from a grinder or blowtorch is applied to the safe, the wire melts and the bolts drop or spring into the doorjamb, keeping it locked even if the lock or hinges are burned off.

Figure 27 shows a relocking pin within the door of one model of Meilink safe. A heavy spring (Figure 27B) activates the relocking pin, shown at point A, when the cover of the lock

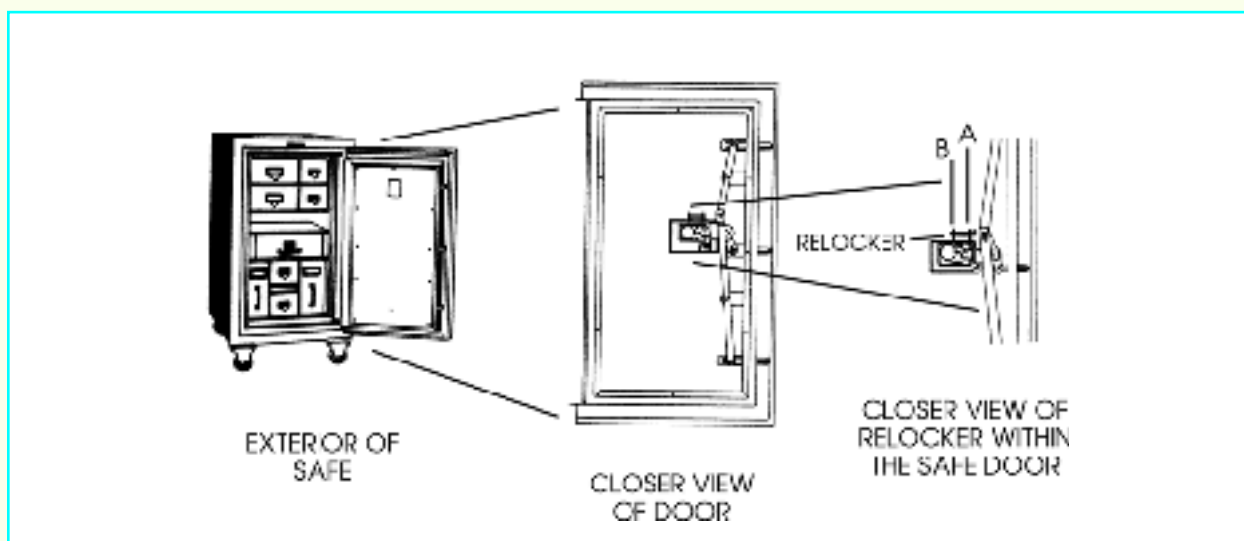
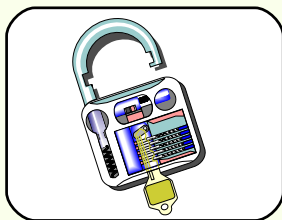


FIGURE 27—A relocking pin is shown here.

case is moved or knocked out. You can see that in Figure 27, the cover is missing and the relocking pin has been activated. Notice how the locking mechanism of the door strikes this pin, thus preventing the bolts from being retracted. This is so that even if the combination lock and its internal relocking pin are defeated, the external relocker in the door will keep the door locked.



Locking It Up! 2

1. What is the purpose of the spline key? Do all locks have one?

2. What do fire-resistive safes have within them that burglary-resistive safes usually don't have?

3. How do you determine the "hand" of the lock?

4. Is the wheel next to the drive cam referred to as the last wheel or the first wheel? Does it correspond to the last number or the first number of the combination?

5. What two things tell you how many combinations are possible on any given lock?

Check your answers with those on page 91.

CHANGING A SAFE COMBINATION

The Most Often Requested Service

The most common request a locksmith gets from a safe owner is to change the combination of the lock. At the same time that the combination is changed, the locksmith generally services the lock, making sure its working parts move freely, replacing worn or broken parts, and cleaning out dirt and debris that may jam the lock. This section of your text will cover the basics of changing a combination. The next section will deal with servicing the lock.

When it comes to combination changing, locks fall into two main categories: *hand-changing* and *key-changing*. Hand-changing locks are changed manually. There are three major kinds of hand-changing locks: *hole-type*, *screw-type*, and *mesh-type*. As their name suggests, key-changing locks are changed only with a special key. We'll look at the different types of hand-changing locks first.

A reminder: As you begin to change combinations on locks and service them, always test your work at least five times *with the safe door open*. Never assume that you've followed every step, lock the door, and *then* see if you've done it correctly! Even if you make the combination change correctly, there may be a mechanical malfunction that keeps it from working, which you won't be able to see unless you test the lock before closing the door. After you've tested the lock, have your customer test it too, *while the door is still open*. That way, if it should lock up when the customer next uses it, the customer will know it was working properly when the locksmith was done with it. The second reason for the customer operating the lock at least three times with the door open is that it's a good check on the locksmith's work.

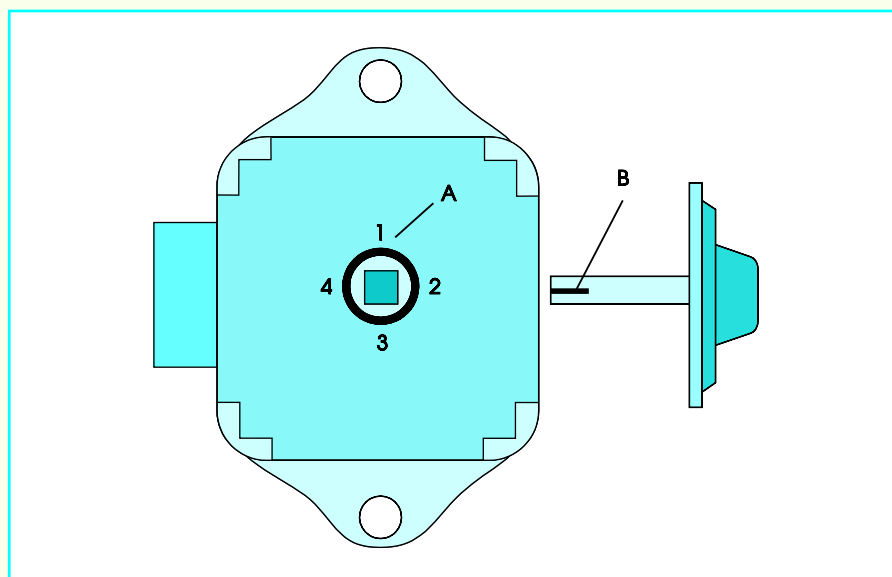
Hole-Type Locks

Hole-type wheels are typical of many inexpensive locks. They're often found on chests, locker boxes, and some of the smaller inexpensive safes. Looking at Figure 28, you'll notice

that this lock doesn't have a tube. These locks aren't generally installed in fire-resistive doors, so the tube isn't necessary.

The spindle is different from spindles found in other locks. It isn't threaded, and doesn't have a spline key. The drive cam extends right through the case. Notice the square hole in the center of the drive cam (Figure 28A). The four sides of this square hole are usually numbered 1 through 4. There's a mark on the spindle (Figure 28B). This mark helps change the combination and will be explained later.

FIGURE 28—A Typical Hole-type Lock



Open the lock case by taking off the cover, remove the wheel pack assembly and set it upright on a clean surface. Remove the retaining washer with a small screwdriver.

The next step will be to remove the drive pin washers, wheels, and spacing washers. Be careful to take them off and set them aside on a clean surface or mat *in the order in which they came off the wheel post*. This is very important, because you'll have to replace them in the *exact same order* that you removed them. Figure 29 shows the parts lined up in order.

Each wheel has its own drive pin washer, as shown at Figure 30A. The drive pin on the washer, shown at 30A, fits into one of the holes drilled along the outer edge of the wheel. You change the combination of each wheel by setting the drive pin into a different hole in the wheel.

To change the combination on one of these locks, start with the No. 1 wheel (Figure 30). For example, take the drive pin

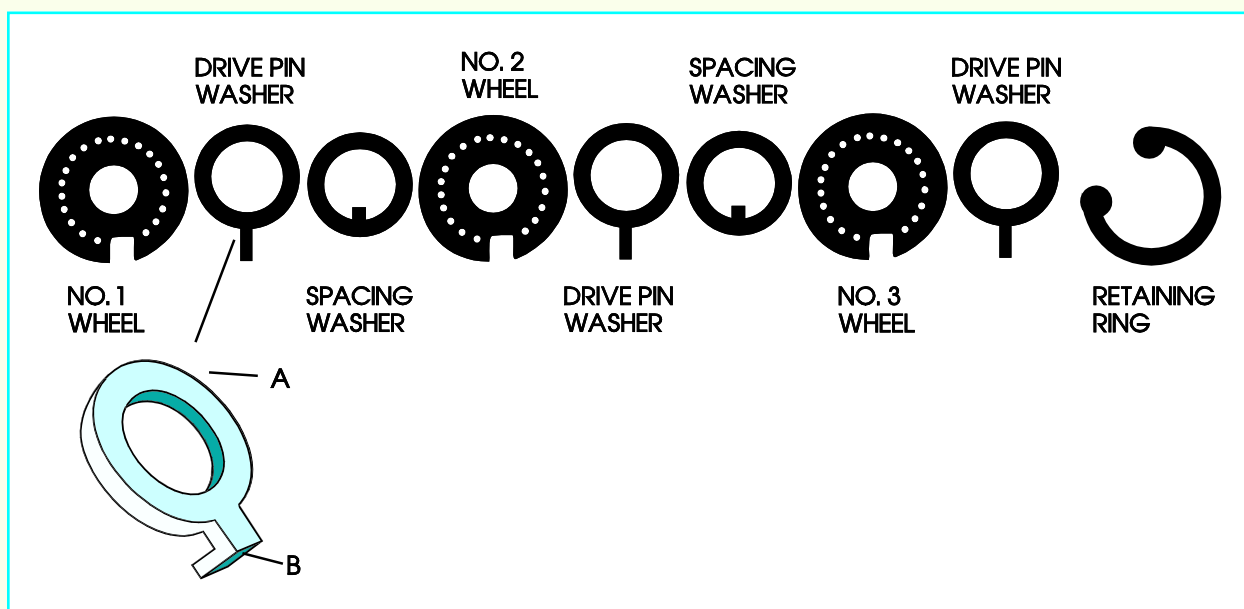


FIGURE 29—This illustration shows the parts of a hole-type lock lined up in order.

washer from the No. 1 wheel and set it in the seventh hole to the right, as shown at Figure 30A. Set the wheel and drive pin washer back on the wheel post, followed by the spacing washers (Figure 30B). Again, just as an example, set the drive pin washer of the No. 2 wheel into the ninth hole to the left (Figure 30C). Place it back on the wheel post, followed by its spacing washers (Figure 30D). Then set the drive pin washer of the last wheel into the sixth hole to the right (Figure 30E) and install it onto the wheel post. Slip on the retaining ring.

At this point, the combination is changed, but we don't know what it is! We'll have to install the wheel pack back into the lock case and then determine the combination, unless the

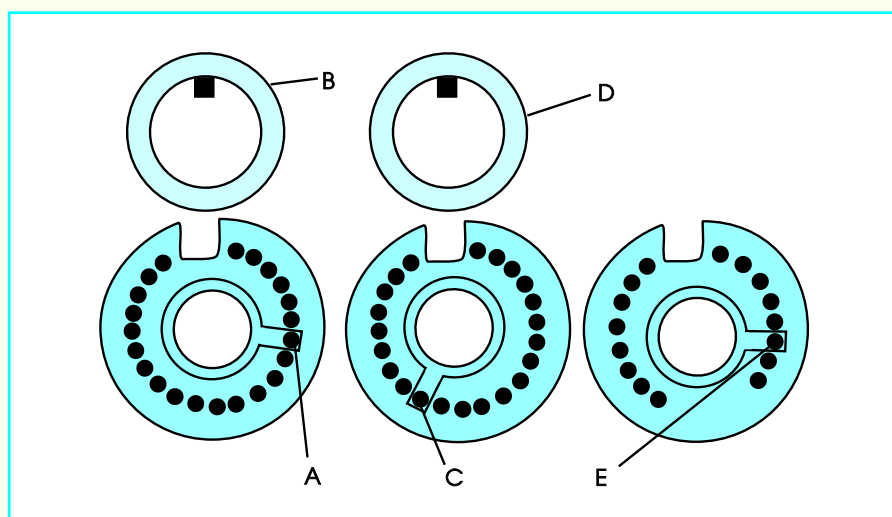
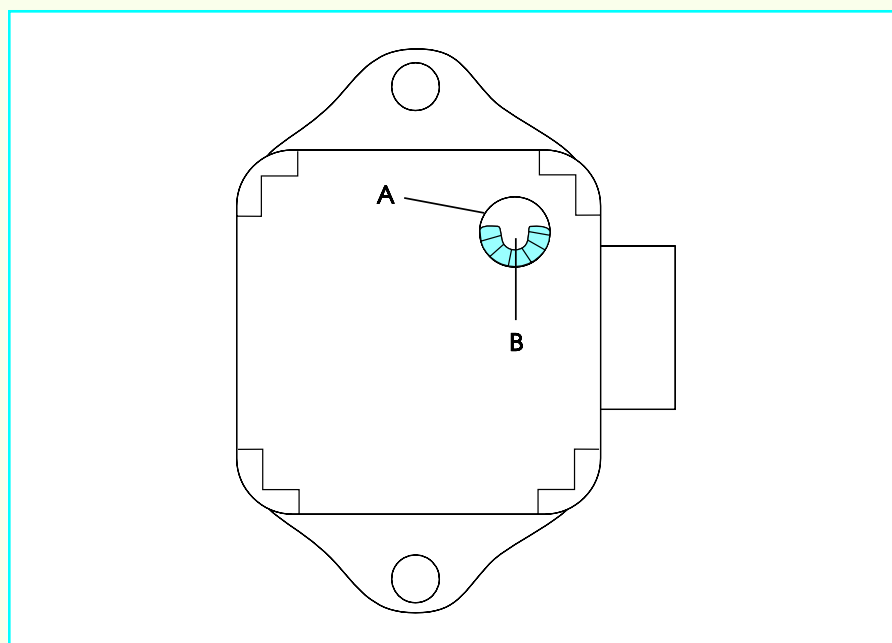


FIGURE 30—Move each drive pin to a new hole in each wheel as you reassemble the hole-type lock in the proper order.

holes in the wheels have numbers on them. If they do, you already know the combination numbers. If they aren't numbered, you must determine the combination as follows.

Notice the hole in the cover, shown at Figure 31A. If you turn the dial four or five times to the left and look into this cover hole, you'll see the No. 1 wheel rotating as the dial is turned. Turn the dial to the left until the gate in the No. 1 wheel (the one nearest the cover) lines up with the hole in the cover. Figure 31B shows the No. 1 wheel's gate in proper position. When you have it lined up, take a reading on the dial. The number at the opening index is the first number of the combination. Write it down.

FIGURE 31—The gates of the wheels can be lined up by watching for each in succession through the hole in the cover of the lock.



Next, turn the dial to the right (clockwise) until you see the gate of the No. 2 wheel line up at Figure 31B, in line with the gate of the No. 1 wheel. Take a reading on the dial, and write the number just below the first number. This is the second number of your combination.

Then turn the dial to the left until the gate of the No. 3 wheel lines up with the other two. Take this reading on the dial, and write it down. You can now turn the dial slowly to the right and watch the fence drop into the gates of the three wheels. By continuing to turn to the right, the bolt should retract. If the fence doesn't drop into the gates, check to make sure the three gates are lining up properly, or that the small spring on

the lever hasn't come loose. This spring forces the lever against the wheels at all times.

You should now be able to work the combination from the front, without looking into the cover hole. Test it from the front with the door *open*. Remember the procedure for opening a three-wheel, right-hand lock:

Step 1: Turn the dial *left* four times, stopping at the first number.

Step 2: Turn the dial *right* three times, stopping at the second number the third time it reaches the opening index.

Step 3: Turn the dial *left* two times, stopping on the third number the second time it reaches the opening index.

Step 4: Turn the dial *right* slowly until the lock opens.

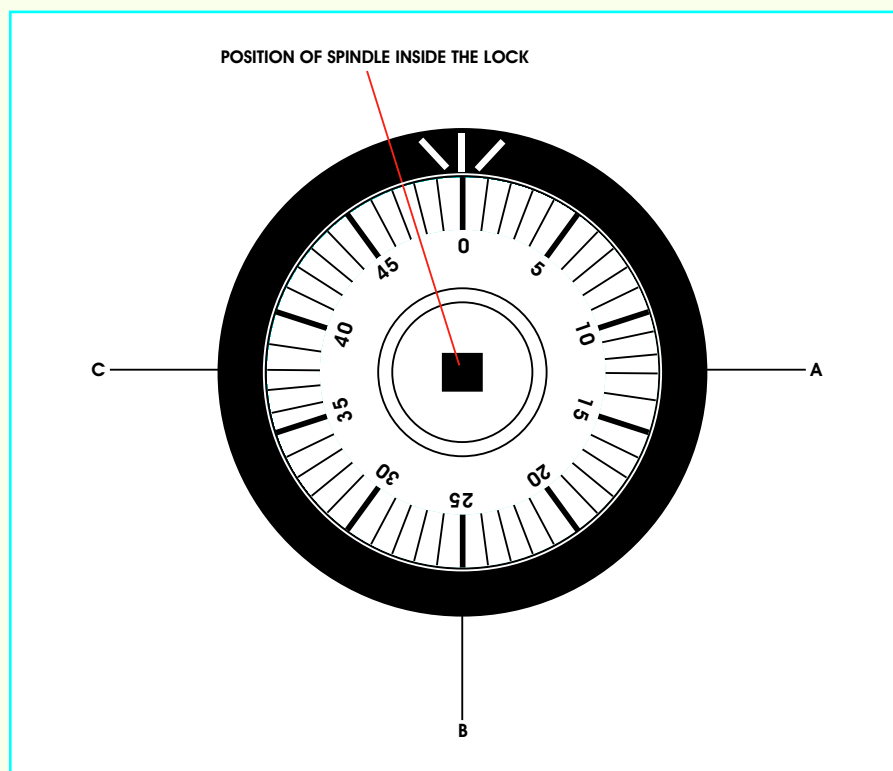
Always work the combination at least five times to be sure the wheels turn freely, without binding on each other. Try working the combination one-half number more or less of each correct number; this tests the proper reading of the combination.

There's a shortcut to changing the combination on this type of lock. It only works if the spindle is the square-hole type (this method won't work with the round spindle seen in previous examples). With the shortcut, you can set one of four different combinations without making any changes in the wheels themselves.

First, loosen the two nuts holding the lock to the dial assembly. Then rotate the dial one quarter turn so the mark on the spindle is in the hole in the drive cam on the side marked "2." You can now read this new combination through the cover hole, as in the previous example, or you can figure it out mathematically.

Once you know one combination, you can figure out in advance the other three, and invite your customer to choose one. Figure 32 shows what happens when you turn the dial one quarter turn. Because the spindle is square, you can divide the dial into four equal sections. The dial in Figure 32 has 50 numbers, and we'll assume for this example that your first setting was with the spindle mark at 0. If you rotate the dial and spindle one quarter turn to the right, you'll change your setting by 12.5 numbers, as shown at point A in Figure 32. You would subtract 12.5 from each of the numbers of your original combination to determine what your new combination is.

FIGURE 32—The square spindle of some hole-type locks allows you to take a shortcut to changing to one of four possible combinations.



Say your original combination was 34-47-26. Subtracting 12.5 from each, your new combination would be 21.5-34.5-13.5.

If you rotate the dial and spindle an additional one quarter turn, the mark on the spindle will be at 32B, which would change your original setting by 25 numbers. You would then subtract 25 from each number of your original combination to determine your new combination. If the original setting was 34-47-26, your new combination would be 9-22-1.

What about a dial with 100 points? Simple—just double the formula used for the 50-point dial. One quarter turn of a 100-point dial will change the original combination by 25, instead of 12.5. So you would subtract 25 from each number in the original combination. If you turned the 100-point dial and spindle to 32B, you would subtract 50 from each of the numbers in the original combination.

What if a number in the original combination is lower than 50? How would you subtract 50 from it? Of course, there are no negative numbers on the dial. Here's how: If it's a 100-point dial, add 100 to the original number, then subtract 50 from that number. This will give you the new number of the combination. If it's a 50-point dial, add 50 to the original

number, then subtract 25 to find the new number of the combination. To demonstrate this, look again at Figure 32.

Say you want to turn this 50-point dial and spindle to point 32B, and your original combination is 34-47-20. You already know that you must subtract 25 from 34 and from 47 to find the first two numbers of the new combination: 9 and 22. But you can't subtract 25 from 20. Therefore, you add 50 (the number of points on the dial) to the original number (20), then subtract 25.

$$\begin{aligned}50 + 20 &= 70 \\70 - 25 &= 45\end{aligned}$$

The new combination will be 9-22-45.

Figure 32C shows the fourth possible combination point, three quarter turns from the original setting at 0. With a little practice you'll easily figure out all four possible combinations. But as always, test the new combination at least five times *with the door open*. Make sure your new combination will actually open the lock, and that the lock is functioning smoothly, before you put it back in your customer's hands.

Screw-Type Locks

The screw-change wheel is very similar to the hole-change wheel. Instead of a drive pin on a movable washer, however, there's a tiny screw on each wheel that acts as a drive pin (Figure 33). Each hole around the edge of a screw-change wheel is threaded, and the drive pin can be screwed into any one of the holes on the wheel, changing the combination number for that wheel.

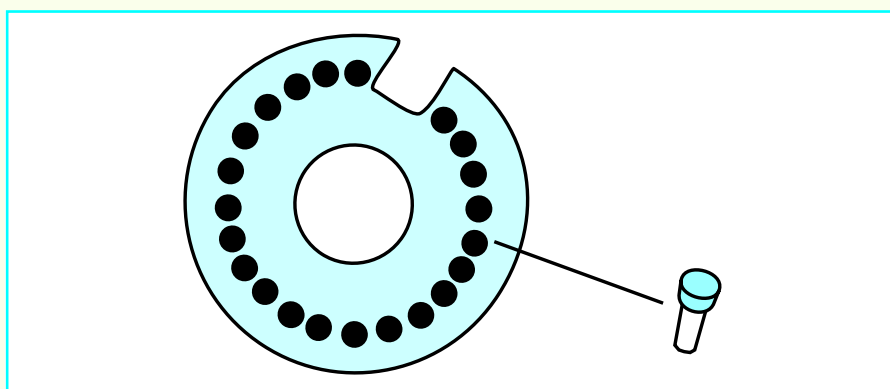


FIGURE 33—A screw-type lock has a screw that acts as a drive pin.

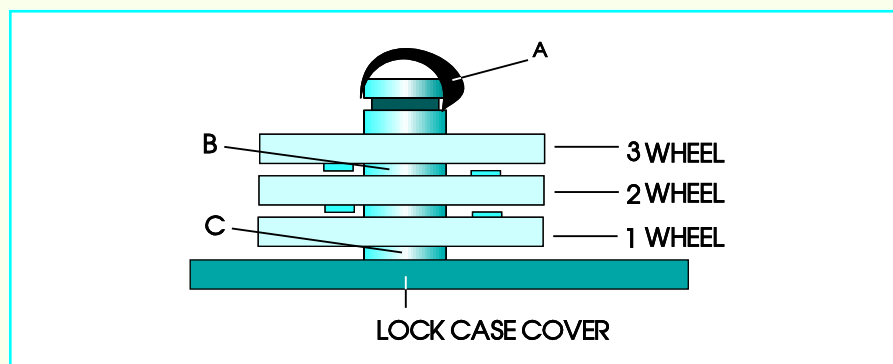
Mesh-Type Locks

We saw in a previous example that the mesh-type wheel is made of two parts, an inner wheel and an outer wheel, both of which have teeth that mesh to hold them together.

To change the combination on this type of lock, take the cover off the lock case and set the wheel pack assembly upright on a clean surface, with the wheels horizontal, as in Figure 34.

Remove the small spring, shown at Figure 34A, which holds the wheels to the wheel post. This spring may be a spiral, horseshoe or round spring, but each type can be removed fairly easily with a small screwdriver.

FIGURE 34—To dismantle a mesh-type lock, begin by setting the wheel pack upright with the wheels horizontal.



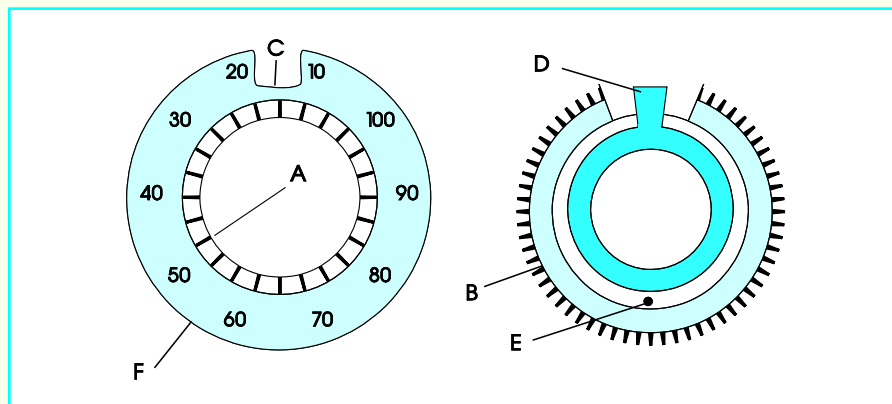
The next step will be to remove the wheels and spacing washers and set them aside, in the order in which they come off the wheel post. Keep them in order because you'll have to replace them in the *exact same order* after the combination numbers are changed.

Remove the top wheel, which is the No. 3 wheel, and set it aside. Remove the spacing washer, shown at Figure 34B, and set it next to the No. 3 wheel. Then remove the center or No. 2 wheel and the spacing washer underneath it. Keep this wheel and washer together. Then remove the remaining wheel. This last wheel is the No. 1 wheel, and will be the first number of the combination. The tension washer is shown at Figure 34C; there's no need to remove it from the wheel post.

Now, let's look at the No. 1 wheel up close. Figure 35 shows the two parts of this wheel separated. The inner wheel snaps into the center of the larger piece. The teeth on each piece, shown at points A and B of Figure 35, mesh to hold them together. You'll notice that the numbers on all the wheels, including this No. 1 wheel, read counterclockwise. The gate of

the No. 1 wheel (Figure 35C) is between the numbers 10 and 20. The part in the inner wheel (Figure 35D) is called the *fly*.

FIGURE 35—In a mesh-type lock, each wheel has two parts: an inner wheel that snaps into the center of a larger wheel.



On the No. 2 or center wheel, the gate is between the numbers 60 and 70, and there's a drive pin on the back side of the inner wheel. The No. 3 wheel's gate is between the numbers 10 and 20, like the No. 1 wheel. Its inner wheel also has a drive pin on the back side, as does the No. 2 wheel. From this you can see that the outer wheels of both No. 1 and No. 3 are the same, but their inner wheels are different. The inner wheel on the No. 1 wheel doesn't have a drive pin but the one on the No. 3 wheel does. The inner wheels of No. 2 and No. 3 have a drive pin, but the gates of the outside wheels are in different positions.

Why are the gates in the wheels opposite each other? So that you won't disturb the No. 1 wheel as you're dialing the No. 2 wheel, or the No. 2 wheel as you're dialing the No. 3 wheel. In a three-wheel lock, the center wheel will have the gate opposite the No. 1 and No. 3 wheels. On a four-wheel lock, the No. 1 and No. 3 wheels will be alike, and the No. 2 and No. 4 wheels will be alike.

Notice the mark on the inner wheel, shown at Figure 35E. You set the combination number of the wheel by lining up this mark with the desired number on the outer wheel. Remember that the numbers on the outer wheel read counterclockwise. If the first number of the combination is 45, be sure to set the mark at 33, and not between 40 and 30. This is an easy mistake to make, because for many people it's natural to read clockwise.

To reset the combination of this lock, take the No. 1 wheel (the last wheel removed from the post), push out its inner wheel, and align the mark on the inner wheel with the first

number of the combination on the outer wheel. Push the inner wheel back into the outer wheel. Make sure they fit flush, and there's no burr sticking up that may interfere with the rotation of the wheel. Put this wheel back on the wheel post, then slip on the spacing washer.

Next, change the middle or No. 2 wheel to the second number of the combination, and place it and its spacing washer back on the wheel post. Then change the No. 3 wheel to the last number of the combination, and put it back on the post. Replace the retaining washer, and the combination change is complete.

Reassemble the wheel pack and put the cover back on with its screws. Test the combination with the safe door open, and if the combination doesn't allow the bolt to retract, run through each step again to recheck.

Key-Changing Locks

Much like mesh-type wheels, each wheel in a key-changing lock has an outer ring and an inner ring with teeth that mesh. In our previous exercise, you separated the rings of each mesh-type wheel, turned them, then meshed them again to make a new combination. What was done manually in the hand-changing lock is done automatically in the key-changing lock with the use of the proper key. No disassembly is required—this lock is designed so that you can change the combination without taking the cover off the lock case.

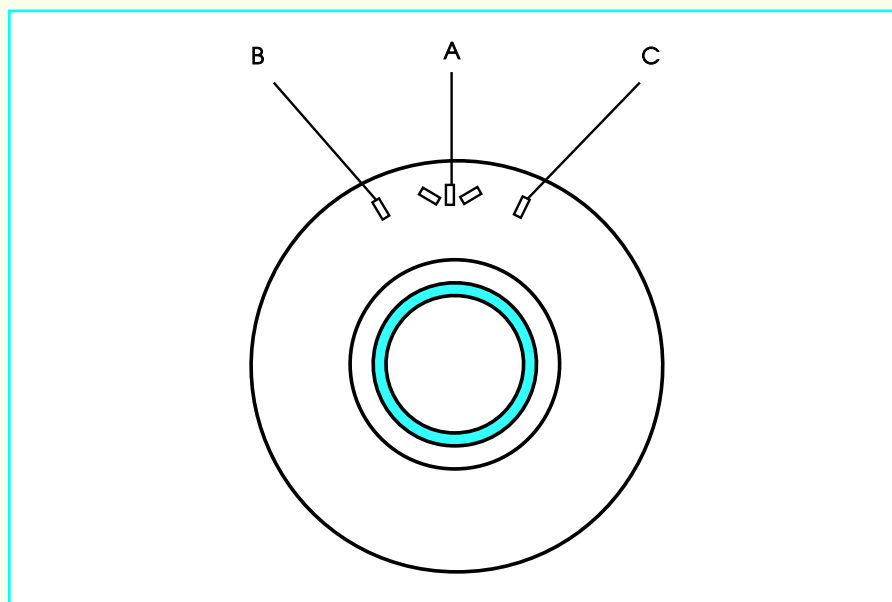
The key-changing lock is generally more expensive than simpler kinds of locks, and has a wide variety of combinations. It has closer tolerances than many other locks, so there's very little room for error when using it. Dial carefully on this lock, because there will be very little "play" between numbers.

The Changing Index

First, let's look at the dial in Figure 36. Notice that there are three marks on the dial ring. As you know, point A in Figure 36 is the opening index, sometimes called the "crow's foot." This is the mark to which you dial the numbers to open the lock. Figure 36B is the changing index for right-hand locks of the key-change type. Figure 36C is the changing index for left-hand locks of the key-change type. There will be only one changing index on a given dial ring.

The changing index (points B or C in Figure 36) is to be used only for setting a new combination. The proper combination dialed to either of these two marks won't open the lock. Dial rings will have only one changing index, depending on whether the lock is right-hand or left-hand, not two as the dial ring in Figure 36 does. If there's no changing index on the dial ring of a key change lock, the opening index and the changing index are the same.

FIGURE 36—*The changing index for key-change locks will be marked on the dial: to the left or to the right of the opening index.*



The Key-Change Wheel

To understand how the key permits the changing of the combination, it's necessary to understand how the wheels are constructed. Figure 37 shows the wheel and the eight basic parts that make it work.

Figure 37A shows the side plates. There are two of them, riveted together like a sandwich, which hold the other parts in position. They're permanently assembled and aren't designed to be repaired. (In other words, if a malfunction in a key-change wheel occurs, you'll be replacing the entire wheel, not just a part of the wheel.)

Figure 37B shows the inner wheel, with small teeth all the way around it. Notice the fly, at 37C, which performs the same function as the fly on the mesh-type wheel. When released by the key, the inner wheel can be turned 360 degrees inside the two outer plates. It can be positioned at any point in the circle, the same as the inner wheel on the mesh-type lock.

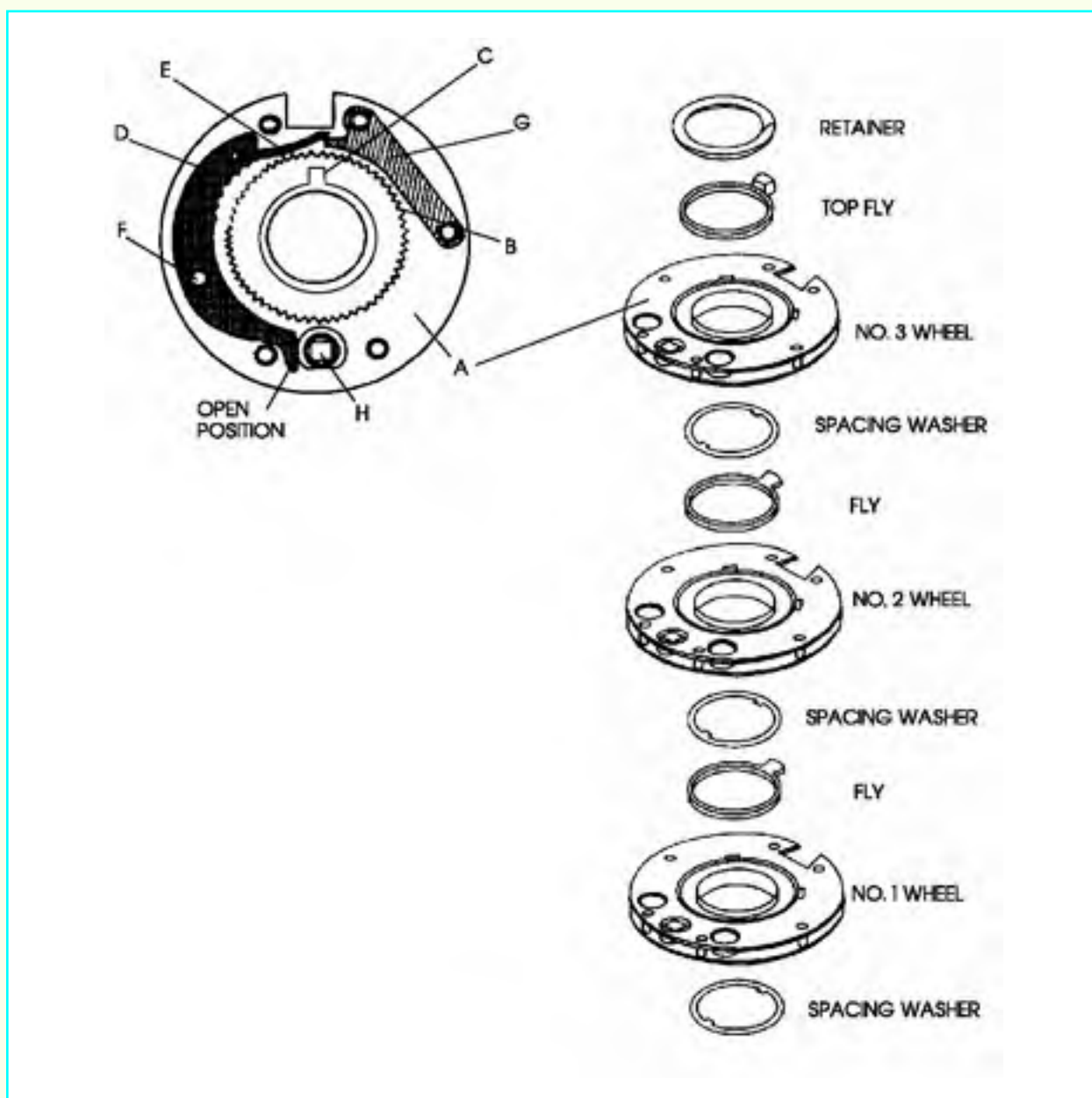


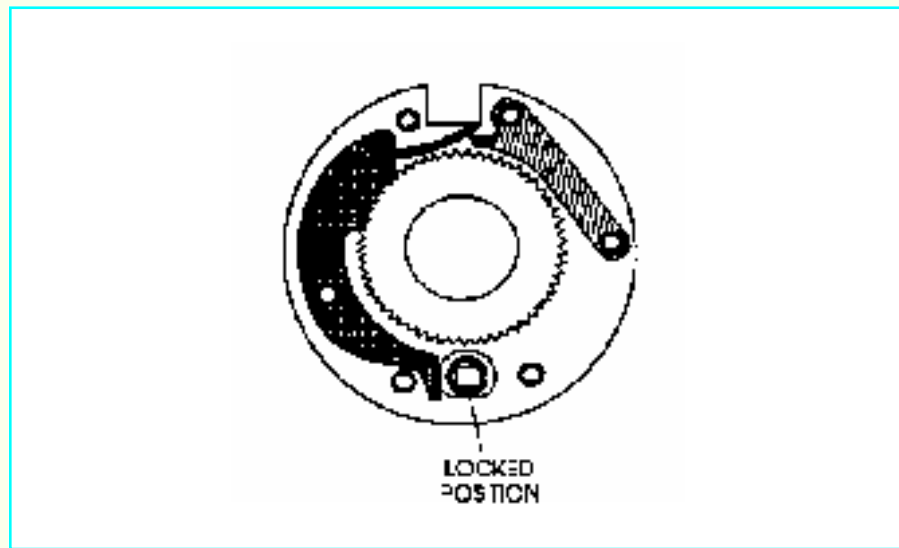
FIGURE 37—The wheel pack of a key-change lock is dismantled here to show its eight basic parts.

Figure 37D shows the arm. Notice the teeth on the arm, made to mesh with the teeth on the inner wheel and lock it in place. In Figure 37, the arm is released, and the inner wheel can turn freely. Figure 37E is the spring that exerts constant pressure against the arm, pushing it away from the inner wheel. There's a pivot point, shown at Figure 37F. Figure 37G is the stop.

The part shown at Figure 37H is the locking cam. Notice how the heel of the arm is against the flat side of the locking cam, allowing the inner wheel to rotate freely.

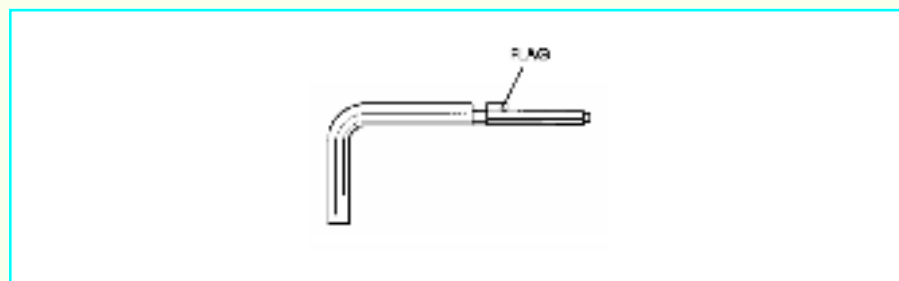
Figure 38 shows the wheel in its locked position. Notice that the locking cam has been rotated one quarter turn to the left. The heel of the arm is now on the round side of the cam. This causes the arm to pivot and engage the teeth of the inner wheel. When this happens, the inner wheel is locked and can't rotate.

FIGURE 38—The round side of the locking cam contacts the heel of the arm when the wheel is in the locked position.



The hole in the center of the locking cam is made to accept a special key used to turn it (Figure 39). There are approximately 50 different kinds of change keys. The key is inserted right through the cover of the lock case to change the combination.

FIGURE 39—A special key is used to turn the locking cam in a key-change lock.



Working the Key-Change Lock

To change the combination on a key-change lock, you must know its current combination, or the safe door must be open so that you can manually line up the change key holes. For this example, we'll use a right-hand, three-wheel lock with a combination of 50-75-25.

First, open the safe door by dialing the combination to the opening index, shown at Figure 36A. Remember the dialing sequence for a lock with three wheels:

1. Left four times, stopping at 50
2. Right three times, stopping at 75
3. Left two times, stopping at 25
4. Right slowly to open

With the safe door open, you'll next need to dial the same combination, 50-75-25, to the changing index shown at Figure 36B. Follow the first three steps above, then stop—*do not* complete the fourth step. After you dial left two times stopping on 25, leave the dial in this position.

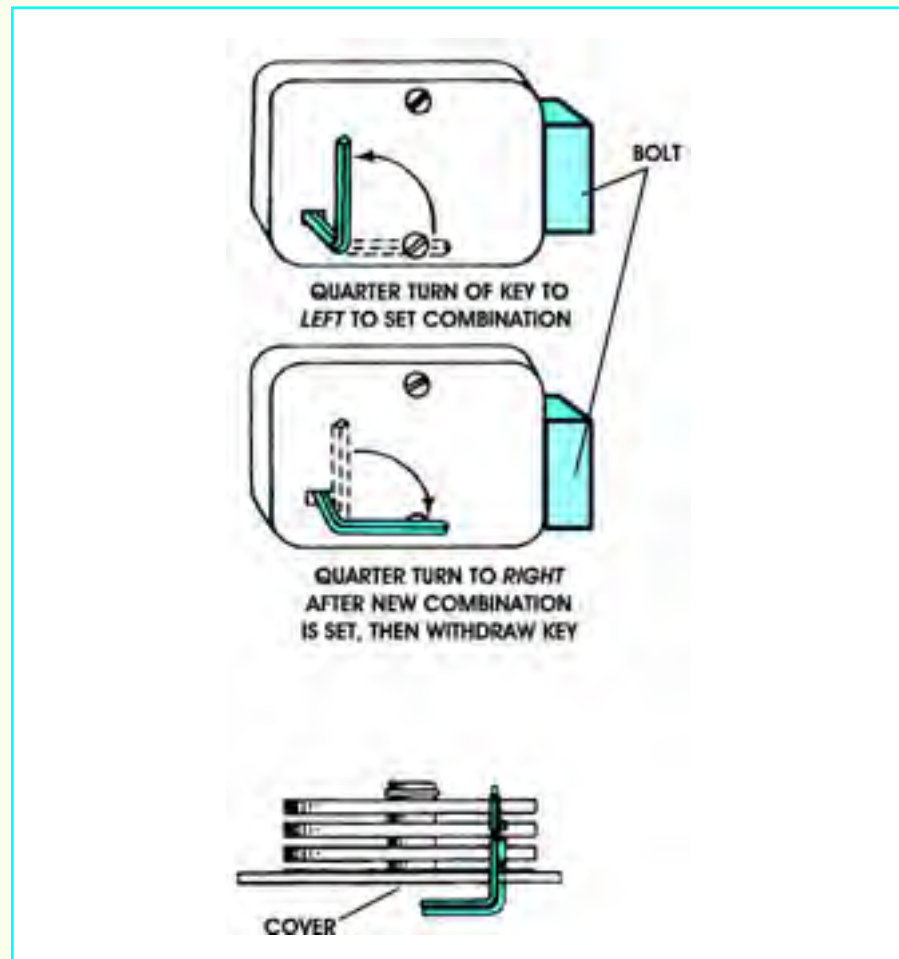
What this does is line up the holes in the center of the locking cams on each wheel with the keyhole in the cover. You can now insert the key into the hole in the cover, and it should go right through the locking cams of all the wheels. *Don't use force when inserting the key.* If it doesn't pass *completely* through the lock, as in Figure 40, the holes aren't in line. You may have slightly over-dialed or under-dialed the combination, or bumped the dial off of 50. If the key can't be inserted, dial the 50-75-25 combination again to the changing index.

Most change keys are designed with flags and the lock case with flag stops so that the change key will be inserted correctly and turned correctly. It's easy to put too much pressure on a change key and break or distort a flag or a stop. This will likely result in an unlocked wheel and a lockout, so never force a change key.

Once the key can be inserted, push it into the keyhole as far as it will go. Notice the position of the key in Figure 40 in relation to the bolt. Now turn the key one quarter turn to the left. The inner wheels are now able to rotate freely.

We'll make the new combination 25-95-55. We're changing the combination, so we're still working with the changing index on the dial ring, not the opening index at top center. First, turn the dial left until the first number, 25, comes up to the changing index mark for the fourth time. Next, turn the dial right until the second number, 95, comes up to the changing index for the third time. Then turn the dial left until

FIGURE 40—Once the holes are aligned, you can gently pass the key through the locking cams of all the wheels.



55 lines up with the opening index for the second time. Stop on this number.

We're now ready to lock the inner wheels into position, making the combination change complete. Turn the key back to its original position when you inserted it, one quarter turn to the right. Remove the key from the lock.

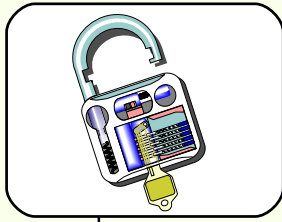
The next step is to test the lock to make sure it will open on the new combination. It's easy to have set the new combination one or two numbers off the ones you meant to set. As always, test the combination *with the safe door open*. You test the new combination by dialing it several times to the opening index, and making sure that the bolt will retract each time you dial it. (Remember, if you dial it now to the changing index, the bolt won't retract. The changing index is for changing the combination only, it won't open the lock.)

If the combination you intended to set won't open the lock, then it has unintentionally been set to a different combination,

and you'll have to determine what it now is. You can do this by taking the cover off, turning the dial and watching the gates in the wheels line up under the fence. As each one lines up, take a reading of the dial, and write down the number beneath the opening index. This will be the true combination of the lock. You can simply use this combination to open the lock. If you want to try again to set the combination you originally intended to set, put the cover back on and repeat the entire process. *Never insert the key when the cover isn't in place.*

If you take the cover off, you may trigger a relocking device within the lock case. You'll have to reset it before the lock will work properly again. To determine what might be lurking behind the cover of any lock, determine the make and model of the lock and then consult reference manuals or the manufacturer's catalog concerning it.

Another important note: Be sure the key you're using is the proper key for the lock on which you're working! All keys aren't made alike, although they look alike. If the key is too short, it won't disengage all of the inner wheels. To ascertain which key is correct, check the lock make and model against a change key reference manual. The reference manual will give a tool number. Most change keys have the tool number engraved on them. (Remember, there are approximately 50 different change keys.) Once the key has been turned in the lock, it can't be withdrawn until it has been turned again. There's a wing tip on the key which holds it in the lock case, just as a bit key is held while it's being turned in a lock.



Locking It Up! 3

1. What are the three types of hand-changing locks?

2. If you disassemble a lock, then put the wheels back on the wheel post in different order, will the lock malfunction?

3. When can you insert the key into a key-changing lock without the cover in place?

4. What tells you if you have the correct key for a key-changing lock?

5. Once the combination is changed on a key-change lock, the safe door should open when the new combination is dialed to the changing index, correct?

Check your answers with those on page 91.

SERVICING SAFES

Servicing the Combination Lock

When you're called to change the combination on a safe lock, always plan to do one other thing as well: service the lock and safe door. To do a good job for a customer and to protect your professional reputation, it's a must. There could be worn parts, lack of proper lubrication, screws loose or any number of other problems that could cause a lockout. It may have nothing to do with the combination you set, or even the lock itself; but if a lockout occurs you may be blamed because you worked on the safe last. While you have the door open and the lock apart, examine the whole mechanism carefully and suggest to your customer whatever repair work or replacement parts you feel may be needed. If the customer refuses to have the safe serviced, be sure to note on the invoice that it needed service and state what it needed.

The main concern in servicing the combination lock is to make sure that the wheels turn without binding or dragging one another out of position. Once a wheel is turned to its proper position by the dial, it must rest there until the other wheels are brought into proper position—this is at the heart of how the combination lock works. Wheels that drag each other out of position are the main cause of lockouts.

When you have all the wheels and spacing washers spread out in order on a clean surface, spray and wipe each part. *Never use oil to lubricate a combination lock.* Oil tends to collect dust and become gummy. Use what the manufacturer recommends. Sometimes it's nothing, sometimes it's a space-age lubricant like "Tri-Flow." All the lock manufacturers have customer service numbers, and they're happy to assist locksmiths. Proper maintenance and lubrication is the best way to prevent lockouts. As you clean them, feel the parts for burrs or rough edges that may catch on other parts and cause drag. Once you've made the combination change on mesh-type wheels, make sure the inner and outer wheels fit flush. If they don't, the *canted* part may catch on other parts and cause drag. On screw-type wheels, the screws that act as the drive pins may become rough-edged or loose. When changing the combination, be sure to move the screws to holes in the wheels that are not worn and will hold them tightly in place.

On a key-changing lock, pay special attention to the inner rings of the wheels, because they often come loose. Once you remove the cover from the lock case, but before you take the wheel pack out, try this: insert a screwdriver into the gate of each wheel, and by applying pressure to the dial in both directions you can see if the inner wheel is slipping. If it is, you'll want to replace that wheel. (You may want to repeat this test once you've changed the combination, to make sure the key has tightened each one properly.) As you remove the wheels, clean and lubricate them. Rough handling often shows on the flies, so inspect them. A bright or worn spot on top of a fly indicates that a drive pin may be riding over it, and this also calls for replacement of the wheel.

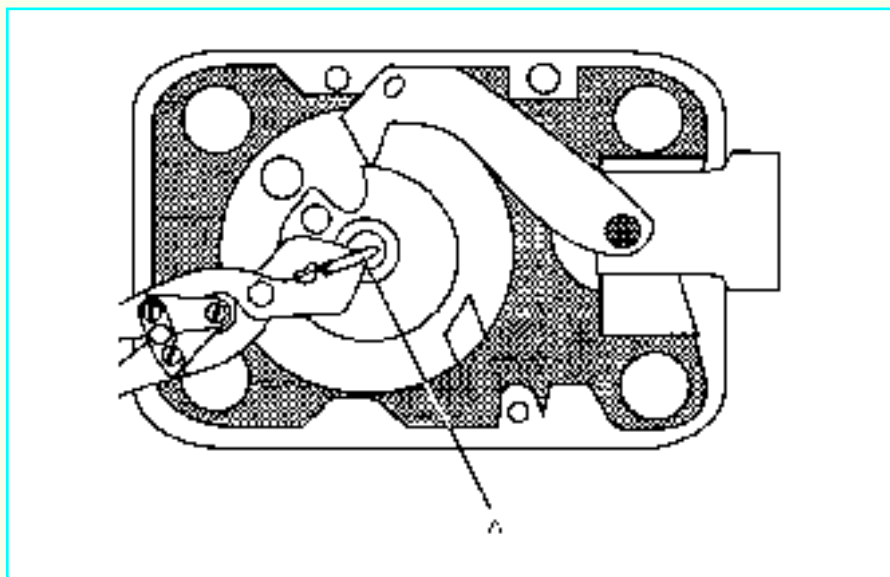
When you've lubricated all the parts and reassembled them on the wheel post, hold it upright in one hand and with the other hand, work the outer wheel in reverse directions to get all the gates in line. If the wheels do not stay in place—that is, after one is in position, it moves a little while the next one is being worked—this indicates that a spacing washer is worn and should be replaced.

This is why we've been recommending that you test a lock at least *five times* with the door open before you close and lock the safe. This probably seemed over-cautious to you at first. However, if one of the wheels is dragging, it can move *slightly* out of position the first time the combination is worked; *slightly more* out of position the second time it is worked; and increasing more out of position the third, fourth, and fifth time the combination is worked until it causes a lockout. If the combination is still working the fifth time you try it, you can be reasonably sure the wheels are turning freely, and your customer will be able to get the safe open once you're gone.

Before you replace the cover, inspect the spline key, which connects the drive cam to the spindle. If it is loose or worn, *carefully* pull it out and replace it. Get a firm grip on the head of the spline with wide grip pliers, as shown in Figure 41, and pull it straight out. Do not use a screwdriver to pry it up, as it's quite likely to break off at point A in Figure 41.

If the spline head is broken off, the best way to remove it is to drive it out the other side. If necessary, smooth off the broken edge of the spline with a file so it's flush with the drive cam. Using a small piece of spring wire slightly smaller than the spline,

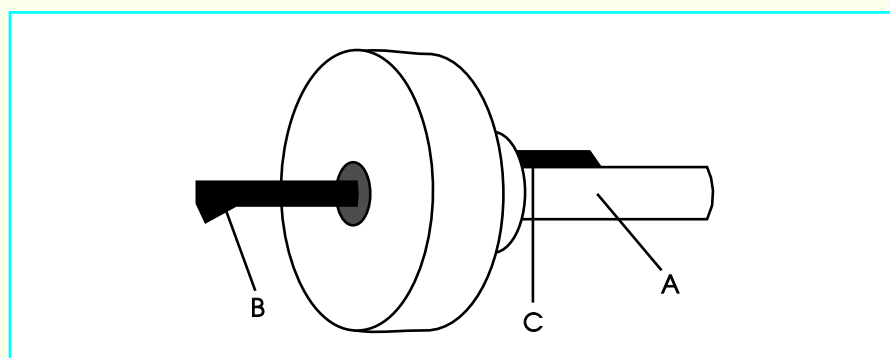
FIGURE 41—To remove a spline key, always use wide grip pliers to pull it straight out.



you can drive it out through the drive cam, as shown in Figure 42. In this figure, point A is the spline, and point B is the piece of wire approximately $\frac{1}{8}$ " long. Tap the end of the wire to drive the spline key out of the drive cam, as shown at point C.

Never try to drill out a broken spline, as this will damage the drive cam and the spindle.

FIGURE 42—If the spline is broken off, file it down flush with the drive cam and then use a short piece of spring wire to drive it out, through the drive cam.



Servicing the Door: Hinges, Handle, Bolt Mechanism

If the lock seems to work smoothly but the safe door is difficult to open or close, the problem very likely is lack of lubrication of the bolt mechanism. Both hinges and bolts should be lubricated lightly. Test all screws to be sure they're tight.

If you're called to a "safe job" and find a broken handle, that's an indication that the bolt mechanism is not operating

as it should. To get at the source of the trouble, test it like this: If the bolt mechanism is hard to work when the safe door is open, then you know the problem is an obstruction or, most likely, a lack of lubrication. If, however, the bolt mechanism operates freely while the door is open but only with difficulty when the door is closed, then the place to look is in the doorjamb, the frame or the hinges. One of these areas may be causing the bolts to lose their alignment with the corresponding bolt holes in the doorjamb. For example, worn hinges will cause the entire door to sag and fit poorly in the frame. If the incorrect alignment is not too severe, grinding out the bolt holes and lubricating the works will again permit the bolts to pass freely and smoothly. If it's severe, don't risk a lockout—unless you've had safe building experience, it may be best to refer this case to a safe technician, or to the manufacturer.

See that the door handle works freely, but isn't loose. If it's loose, the nut on the inside end of the handle is coming loose, and in a short time may drop off and jam the bolt works. It may be no trouble to tighten it; or it may be the kind of door where you have to take out some of the fireproof insulation to reach it (in this case, an extra labor charge may be in order).

Some round-door money chests have a problem with rust slowing or even jamming the door. You may find that even on chests that are opened daily, the surfaces are reddish with rust (Figure 43). These round-door chests employ "screw wedge" revolving action with only 10-thousandths of an inch tolerance, so it doesn't take much rust to make the door unworkable. When servicing these doors, sand the contact surfaces of the door and doorjamb with a fine grit emery cloth until they're shiny clean.

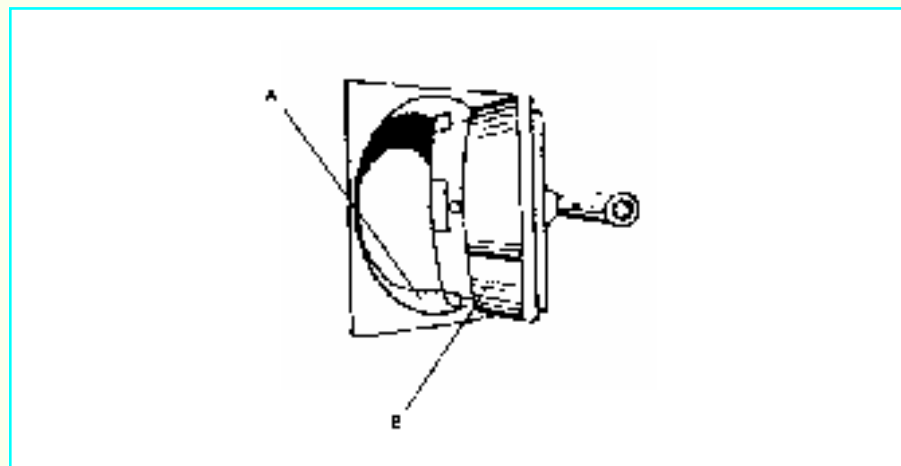


FIGURE 43—Even the thinnest layer of rust can make the door of a round-door money chest unworkable.

Replacing a Lock

Safe bodies may last forever, but locks don't. Eventually you'll need to order a new lock for a safe, especially if the safe has been drilled or burglarized (because a burglary attempt usually causes a lockout, servicing burglarized safes will be covered in the next section). Here's the proper procedure for ordering a new lock:

Step 1: Determine what make and model of new lock will be needed. Try to use the same make and model of lock that is already on the safe, unless the customer requests otherwise. Usually the lock manufacturer's name will be on the dial, or the make and model number will be on the lock case. Most customers will prefer to have a lock replaced with an identical one. Of course, if the safe is very old this may not be possible, so choose a new lock that fits the requirements of the safe. Detailed installation instructions will be included with each new lock.

Step 2: Specify the thickness of the door. The length of the tube and spindle of a combination lock will depend upon the thickness of the door. Figure 44 shows the door thickness at point A; measure from the lock mounting surface on the inside of the door to the dial mounting surface on the outside of the door. With this information, your lock supplier can provide you with a tube and spindle that's long enough. (If they're too long, you can always cut them off to the proper length.)

All safes don't use a tube, and some fire-resistant safes have a tube already built into the door. If a tube isn't needed, specify no tube.

Step 3: Specify the dial and type of dial ring needed. Many locks come with a dial and dial ring. If you need to order the dial and dial ring separately, let your supplier know what make and model of lock they'll be used on. Figure 45 shows a few of the different styles of dials and dial rings you may see.

Choose a dial from the manufacturer's catalog that most nearly resembles the original, unless your customer wants something different. The dial ring should match the dial in diameter and finish. All dial rings will have the opening index mark (the "crow's foot") at top center; dial rings for key-change locks will also have a chanting index on them, depending on the hand of the lock.

FIGURE 44—Measure the thickness of the door from the lock-mounting surface on the inside to the dial-mounting surface on the outside.

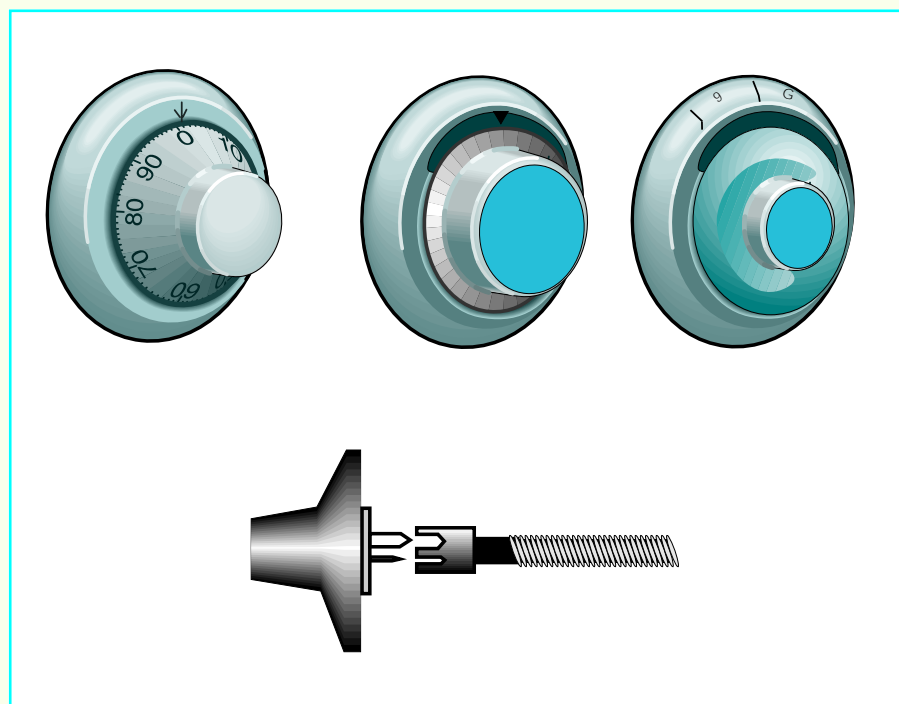
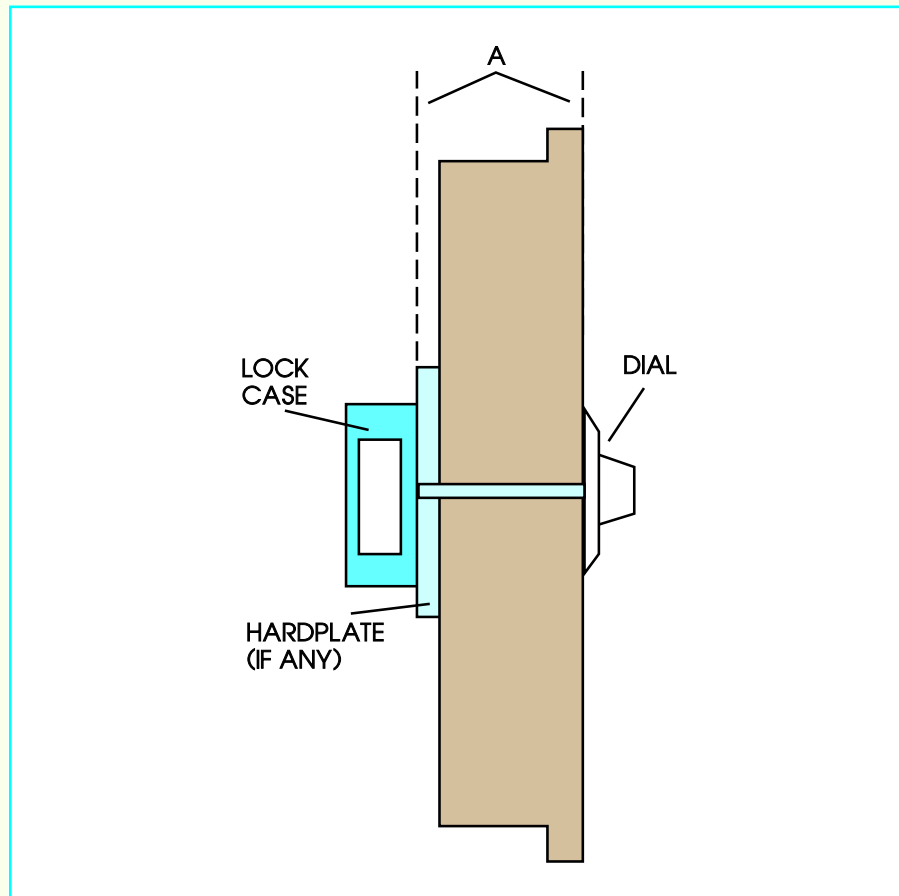


FIGURE 45—This illustration shows a few of the different dials and dial rings available from safe manufacturers.

Step 4: Once all the correct materials are received, remove the old lock and install the new lock according to the instructions that come with it. Always remember your presentation to the customer: be professional, organized, and neat as you work. Clean up your work area when you're finished installing the lock. *Don't shut the safe door yet.*

Step 5: Test the lock; then change the combination. Locks coming from the same factory are often set to the same combination. The instructions with each lock will give you these "factory numbers." Make sure the new lock is functioning properly by dialing it to these numbers and retracting the bolt, *while the safe door is open*. If it's working properly, change the combination as you learned in the last section. Then test the new combination at least five times with the door *open* to make sure the new combination works smoothly. While the door is *still open*, ask your customer to work the new combination. That way the customer is personally assured that the lock is working, and that you've done the job you were called to do.

Step 6: Let your customer replace valuables in the safe, shut and lock the door. Do this step *only* after Steps 1 through 5 are completed! You or your customer will want to work the combination once more, just to show your customer that the door will open.

Servicing a Burglarized Safe

While the average locksmith performs only basic services on safes, it's perfectly possible that a customer may call you to ask for guidance or advice, especially if a safe has been burglarized. The customer may have no idea of how to go about getting the safe repaired or replaced.

If you get a call on a safe that's been burglarized, the first thing to ask the customer is: have the police finished their investigation of it? *Never* touch a safe in such a situation until the police give their OK.

Burglars can leave a safe in a very dangerous condition. They usually cause a lockout, but before you attempt to open the safe or make repairs, make sure you and anyone else nearby won't be injured.

Explosives are rarely used today. Even so, always look for signs of an unexploded charge of nitroglycerin or other liquid which might be inside the safe. The presence of soap or some kind of waterproof putty around the door indicates the presence of a liquid explosive like nitro (soap acts as a sealant to keep the explosive in place). If you suspect the safe has been prepared for blowing, use every precaution! Alert the authorities and the owner, and keep people out of the area until the explosive is neutralized.

Another dangerous condition is severed hinge pins. Always examine the hinge pins on a burglarized safe, even if the hinge caps are still in place. The pins may be sawed in two right where the two halves of the hinges come together—leaving the door hanging precariously, although it doesn't look it. Safe doors are very heavy, especially on the larger safes. Make sure the door cannot fall on you or anyone else, injuring hands or feet, before you begin to work on it.

Burglars seem to love to knock off the dials and handles of safes, as if this will make them easier to open! Occasionally you will find a dial knocked off but the spindle still free and movable. If so, you might try attaching a dial and dial ring to the spindle, and working the combination the owner gives you. Since it's probable that you won't attach the two parts perfectly, work the dial from two to five numbers over or under the correct combination numbers. If this doesn't work, drilling the lock is probably the only answer.

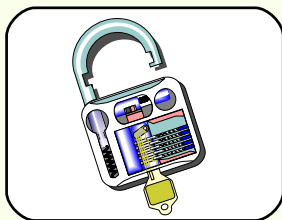
Your goal is to get the safe open with as little further damage to it as possible. If your first drill hole misses its mark, fan another hole up or down, left or right, from the *same drill hole* in the door, instead of making a second drill hole beside the first.

Once the lock is open, the next step is to retract the bolt. But if the handle controlling the bolt works was also knocked off, it won't be easy. If the safe is small, you may be able to turn it over on its side once the lock is open, and vibrate the door with a mallet or hammer to get the bolts to drop back by gravity. If this is impractical, you'll have to drill for the bolt mechanism. Again, it helps greatly to know the make and model of the safe you're working on, so that you can determine the kind of bolt mechanism in it and where it is within the safe door. In most safes, if you drill a hole directly above the hole of the handle, you'll contact some part of the bolt

mechanism. If you can work it with a punch, wire, or other tool, you may be able to retract the bolt.

If after all this the door still won't open, then the burglary (or your repair attempts) probably set off a relocking device and yes, you'll have to drill for that too. At this point, it's important to know the make and model of the safe you're working on and the make and model of the lock that's on it, in order to determine where the relockers are. Without this information, you may pepper the outside of the safe with drill holes and still not get it open! If this information isn't readily available, it may be better to refer the case to a safe technician.

Once the safe is open, you'll need to test all working parts and, with the owner's OK, replace broken, bent or damaged parts. In almost all cases you'll need to order a new lock and install it, as explained in the last section.



Locking It Up! 4

1. Why is it important to service the safe door as well as the lock? After all, it's the lock that controls the bolt mechanism.

2. What is one of the most common causes of lockouts, and how do you prevent it?

3. To order a new lock, you need to know two things about the safe. What are they?

4. *True or False?* If the bolt mechanism locks and unlocks easily while the door is open but only with difficulty when the door is shut, you should take the lock apart to find the problem.

5. What is the one common lubricant you should never use on a combination lock?

6. *True or false?* If you get a call on a burglarized safe, you should get to work on it right away, so that any unexploded charge in it will not go off and harm those nearby.

Check your answers with those on page 91.

SAFE LOCKOUTS

What a Locksmith Should Know

Safe opening has a long and colorful past. Gangster movies especially romanticized the “safecracker.” He was usually a shady little character who could put his ear to the door and, with a well-trained sense of touch, turn the dial and spring it open like magic.

Actually, magic doesn’t get a locked safe open—training does. This study unit isn’t designed to provide the highly detailed training it would take to make you an expert safecracker. You’re ready, however, to apply the skills you’ve learned in previous sections to the challenging work of getting a locked safe open. In this section of the text, we’ll discuss the following topics:

- What questions to ask the customer to help you diagnose the cause of the lockout
- Troubleshooting techniques that save time and expense for you and your customer
- The most common causes of lockouts, and how to handle them
- How to determine if a lockout is likely to be permanent or merely temporary, and what your next step should be
- How locked safes are opened: the basic techniques explained

Now, let’s start our discussion with the theory of safe manipulation.

Theory of Safe Manipulation

Manipulation is the process of opening a locked safe without knowing the combination of the lock and without the use of force or explosives. The safecracker in the gangster movies, by turning the dial slowly and listening to the parts moving inside the door, was using manipulation to get the safe open.

If you've been working hands-on with combination locks, you probably have a sense of how manipulation works. As you turn the dial slowly, you can feel rough and smooth spots. Have you noticed the friction increasing slightly as each wheel is picked up by the drive cam? You might hear the click of the drive pins as they strike one another, setting the wheels in motion, or the click of the fence dropping into the gates. These sensations wouldn't have made sense to you before, but your training in previous sections now tells you what's happening inside the lock. In theory, these sensations could be translated into numbers that might open the safe.

Manipulation was more practical in "Bugsy's" time than today, however. Because lock parts were machined with less precision years ago, there was more error in all the parts, which made them easier to hear, feel and manipulate. Today's locks, however, are made with very close tolerances on precision machinery. It's much more difficult to try to determine the combination by the sound or feel of the wheels turning in the lock.

Manipulation is a controversial topic in the locksmithing industry. Most highly skilled safe technicians will attempt manipulation first on most lockouts, depending on the type of safe, type of lock, and type of lockout.

Modern safecrackers have gone to faster methods of opening, such as drilling. Safes can be drilled and repaired quickly, with little evidence of damage. Drilling isn't necessary in every case, however. The next section will describe how to figure out what kind of lockout you're faced with, and this will tell you how best to approach it.

All Lockouts Are Not Alike

Lockouts can be permanent or temporary. Temporary lockouts usually don't require drilling, but permanent lockouts usually do.

You learned earlier that one of the first questions to ask when you get a "safe call" is: Is the combination known? A lockout is more likely to be permanent if the combination is known because the problem is probably due to mechanical failure. A second key question is: Has the safe locked up suddenly, or has it been difficult to open for some time? If the safe has been difficult to open for some time, it's probably a temporary lockout.

If the safe has locked up suddenly, it has probably suffered a breakdown of one of the mechanical functions and will have to be drilled. You can generally tell by the feel of the dial if any parts are not functioning properly. The dial may be extremely hard to turn; or it may spin too freely and easily. Both conditions indicate that it has lost control of the wheels, which means you have little chance of working the lock without drilling it.

Troubleshooting

First, talk to the owner of the safe and learn as much as you can about the safe and its use. If the safe is used frequently, there's a chance the problem is caused by excessive wear. This is usually a temporary lockout.

Temporary lockouts are often caused by dirt in the lock, or worn parts. Where the lock may be gummed up by dirt, try dialing the numbers slowly, stopping on each number, and tapping the face of the door just above the dial with a dead-blow hammer. (A dead-blow hammer is a hammer with a shot-filled head; it won't mar the surface you're working on and won't rebound.) The vibration can help a sticking part fall into the correct position.

Lockouts quite often are caused by one wheel dragging another out of position. Sometimes the drag will move the wheel only a number or two to the left or right. This may be just enough to keep the gates from lining up properly, so the fence won't drop in and allow the lock to open. Try dialing the combination one or two numbers to either side of the known combination. For example, if the combination is 36-7-50, try 35-6-49, 34-5-48, 37-8-51, or 38-9-52. Rapping on the face of the safe door as each number is dialed will often help in this case too.

If your customer is exasperated (and they usually are), don't discount the possibility that they've got the combination, or the direction of turns, or the number of turns between numbers wrong. The combination they give you may be the right numbers, but in reverse order; also, they may be too upset to turn the dial the right number of times, or as carefully as they should. After dialing the combination carefully, turn the dial *slowly* to its open position, and rap on the door with the wooden mallet. Your customer may be turning the dial so quickly that the nose of the lever doesn't fully engage the gate in the drive cam, allowing the bolt to be retracted.

If the safe is used infrequently, the owner may simply have forgotten the combination. By questioning the owner about birthdate, age, car license plate number, address, date safe was purchased or serviced, etc., you or the customer may come up with the right numbers. Even though these aren't good numbers to use, many people still use them, especially on safes in their homes. Also be aware that one number might suggest the next number; combinations like 20-40-60, or multiples of 5, are not uncommon.

The owner may also have gotten the order of the numbers mixed up or reversed. They may insist they're right, and you should always be diplomatic, but try the numbers on the lock in different order, or in reverse order.

Always inspect the area around the safe. By some quirk of human nature, you'll very often find the combination written, usually in reverse order, on walls or furniture within arm's length. Doorjamb and window sills seem to be universal favorite places to record combination numbers. You might find the combination written on the safe itself, in some inconspicuous spot.

Another common cause of a safe failing to open is turning the dial in the wrong direction. Try the combination in both directions, and be sure you make the proper number of turns between each number. The customer will often get this wrong if the safe is not used frequently. Many people, with a three-digit combination like 50-50-50, will start out by dialing the number three times to the opening index, instead of correctly dialing it four times.

Drilling

If all of the above fails to open the safe, the lockout is probably permanent and drilling is called for. Drilling is a fast and fairly accurate way to get a safe open, but should be handled with care. One of the marks of a professional is knowing when to turn a job over to the person most qualified to do it. Safe technicians specialize in drilling safes.

How Drilling Works

Remember the function of the hole in the cover of hole-type locks? It allowed you to see into the back of the lock case and

watch the gates of the wheels lining up under the fence as you turned the dial. One goal of drilling is basically to do the same thing from the front of the lock. A second goal of drilling is to disable the boltwork. If the correct combination is dialed correctly, probably the boltwork linkage will need to be disabled. You drill a hole about the size of a pencil into the safe door, look through it with a bore scope (which is like a surgeon's light or otoscope), line the gates up manually, and open the safe. Then the hole is threaded, a steel plug is screwed in tightly, and the plug is cut off and filed flush with the surface of the door. A little enamel paint of the correct color is applied, and the safe is as good as new.

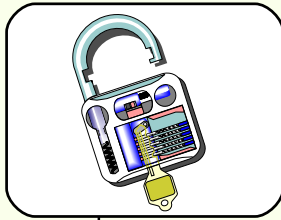
The difficulty is knowing where to drill. To do it correctly, you need to know the make and model of the safe, and the make and model of the lock that's on it. This will determine where and at what angle you drill to dodge hardplates and relockers, for example. It will also keep you from drilling into bolt works or gears inside the door, which if damaged can make the safe even harder to open.

Does It Damage the Safe?

Your customer may object that drilling a hole in the safe will damage it. The customer may have seen "Bugsy" open a safe in the movies like magic, and thinks you should be able to do it too. Of course, you should give the methods above a good chance to work before drilling the safe. But if they don't work, drilling is the only thing left to do.

To answer your customer's concern: when done correctly, drilling does not make the safe any more easily attacked by a burglar, nor does it decrease the insurance rating or the commercial value of the safe. The door is put together at the factory with many rivets, and this simply adds another rivet to the strength of the door.

Locksmiths who wish to learn safe drilling may want to purchase a technical manual from a locksmith supply house. The information in these manuals is restricted to professional locksmiths.



Locking It Up! 5

1. What is the “manipulation” method?

2. *True or False?* If the dial spins freely like a top, you probably won't need to drill the safe.

3. Dialing the combination _____, and _____ on the door, will sometimes vibrate sticking parts into place and allow the safe door to be opened.

4. When confronted by an angry or upset safe owner, it's very important for the locksmith to be _____.

Check your answers with those on page 92.

SAFE DEPOSIT BOXES

What Is a Safe Deposit Box?

Safe deposit boxes are like small personal safes within a bank. They offer maximum security against theft and fire for almost anything the renter wants to put in them—not only cash but valuables like jewelry, wills, and other important papers. The renter has complete privacy and ready access to the cash and other items. At the same time, the renter has all the security that a bank offers.

To gain entry to the safe deposit box, both the renter and a bank employee must be present, with their keys. Each safe deposit box is operated by a *dual-custody lock*—a lock which can be opened only by the use of two different keys.

The bank's key is called the *guard key*. It opens only part of the lock. The other key is the *renter's key*. The renter can't open the safe deposit box without a bank employee present with the guard key, and the bank employee cannot open the box without the renter present with the renter's key.

What does this mean to a locksmith? Steady, well-paying repeat business! These locks need to be serviced just as other locks do. Much like the door locks of hotels and apartment houses, the renter's lock also needs to be changed each time there's a new renter. Renters often misplace their keys and need to have a duplicate made. This chapter will give you the information you need to make these dual-custody locks a profitable part of your business.

Who Can Open a Safe Deposit Box?

The contents of a safe deposit box are not available to anyone, other than the renter, without a court order. The question of who can open a safe deposit box involves many legal details, but usually locksmiths don't get involved in these questions. All the locksmith really needs is the bank's authorization to service or open a safe deposit box.

Security in the safe deposit box section of a bank is very strict. Usually each person entering the safe deposit box section is

required to show identification and sign a register. There's one thing you should insist on with the bank: have a bank employee present whenever you're working on a safe deposit box. Don't be alone in the safe deposit section of a bank! In most banks this is standard procedure, but in small towns where the banker and the locksmith know each other well, they may become lax about this rule. Having a witness guards your professional reputation.

Because banks are responsible for the contents of their safe deposit boxes, they want control over the duplication of keys. Renters are given two keys. If one of them is lost, the renter is supposed to contact the bank, and the bank will send the renter to the locksmith to get a duplicate made. Again, as long as you have authorization from the bank to make the duplicate, you'll be safe in doing so.

Where Does the Locksmith Fit In?

Banks usually call upon a locksmith to do two things with their safe deposit boxes: make and/or duplicate renters' keys; and open a locked box if the renter's key is lost. Some banks also ask locksmiths to change the locks on the boxes regularly, to ensure the security of the boxes.

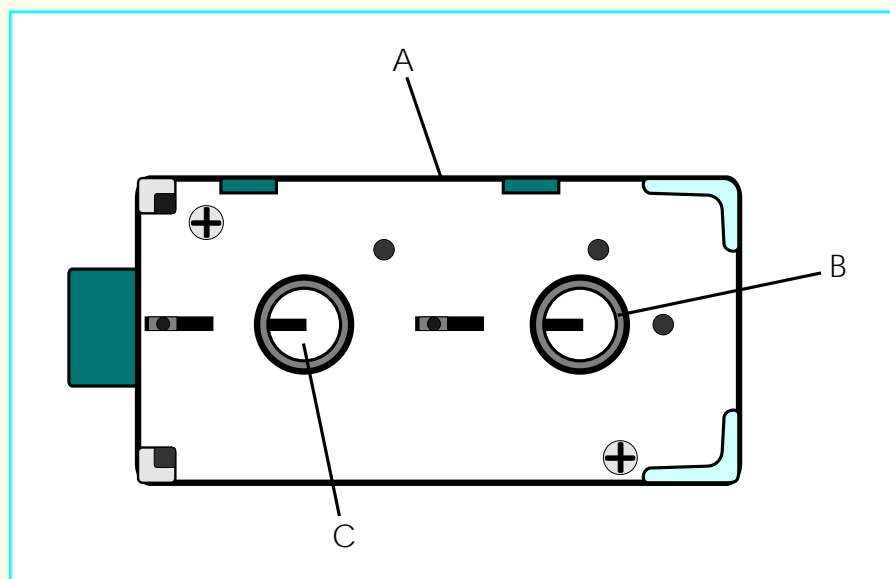
We'll begin by taking a close look at the typical dual-custody lever lock found on most safe deposit boxes.

The Dual-Custody Lever Lock

Lever locks are made by several different companies, including Bates, Diebold, Eagle, Herring-Hall-Marvin, Miller, Mosler, Victor, Western, Yale, York, Remington-Sermen, and Sargent & Greenleaf. Some of these manufacturers make more than one style of lock and door, but they're all very similar in design.

A *dual-custody lever lock* (Figure 46) actually contains two locks. Two keys are required to operate the lock; this adds extra security to the container. The case (46A) is usually made of bronze or some similar metal, although older cases are made of steel. The keyway shown at point B is for the guard key, the key which is retained by the bank. This same guard key may fit all of the

FIGURE 46—The lock case of a typical dual-custody lock houses two locks: one for the guard key (46B) and one for the renter's key (46C).



safe deposit boxes in the bank, or the bank may have several guard keys that fit several “nests” or groups of boxes.

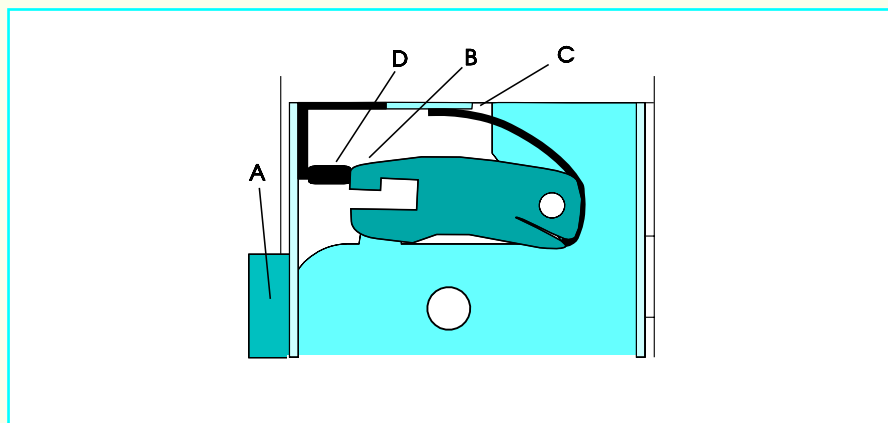
The keyway shown at point C is for the renter’s key. This key will fit only one box in the bank. It will not open the safe deposit box, however, until the guard key is first turned in the plug at point B.

In very old institutions, you might find a single-custody lock; however, it works on the same principle as the dual-dustody lock. To open a single-custody lock, you first insert the guard key into the plug and turn it; then you remove the guard key and insert the renter’s key into the plug and turn it. The guard key opens a section of the lock, and the renter’s key moves the bolt.

Lever locks aren’t well understood by all locksmiths, and for this reason, not all locksmiths can get profitable work with safe deposit boxes. If you wish to work with safe deposit boxes, learn all you can about the function of the lever lock!

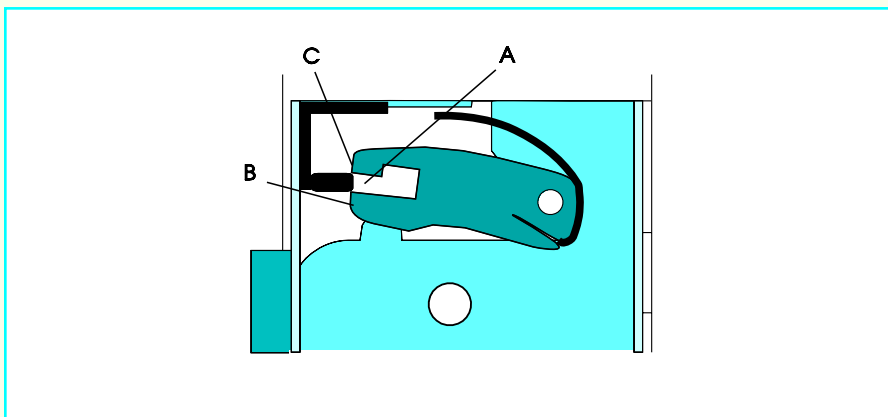
Let’s look first inside a simplified lock with only one lever (Figure 47). Figure 47A is the bolt. When it’s extended, as shown, the box door is locked. Figure 47B is the lever and 47C is the lever spring, which exerts constant tension against the lever, pushing it down. The bolt can’t be moved to the right because the fence (47D) is against the lever. The fence is a built-in part of the bolt (actually, the bolt has two fences built into it, one for the renter’s side of the lock, and the other for the bank’s side of the lock).

FIGURE 47—In this simplified view of one lever, it's easy to see how the lever spring (47C) presses the lever (47B) down, keeping the fence (47D) in place so that the bolt (47A) cannot be moved.



In Figure 48, the lever's gate (Figure 48A) has been raised by the renter's key to the correct height to accept the fence. If the cut in the key is not deep enough, it will raise the lever too high and the fence will strike it at point B. If the cut in the key is too deep, it will not raise the lever high enough, and the fence will strike it at point C.

FIGURE 48—The fence is ready to enter the gate (48A).



Now let's add one more lever to this simple lock. Look at Figure 49. Figure 49A shows our first lever. Notice where its gate (49B) is in relation to the fence (49C). The second lever is noted at point D. As you can see, if it were raised just a little, it would be in proper position to accept the fence. This would require a deep cut in the key, deeper than the cut needed to get lever A in the proper position. The location of the gates in the levers determines the depth of cuts in the key.

To better illustrate this, Figure 50 shows an end view of the levers previously shown in Figure 49. The levers are resting on the key blank (Figure 50E). Notice that the gate in lever D is higher than the gate in lever A.

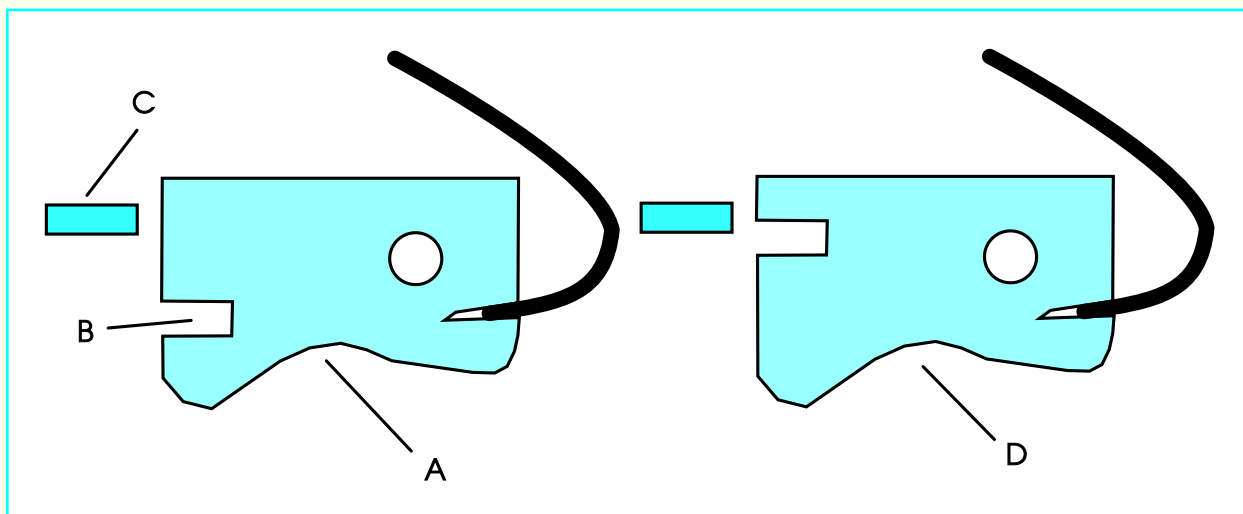
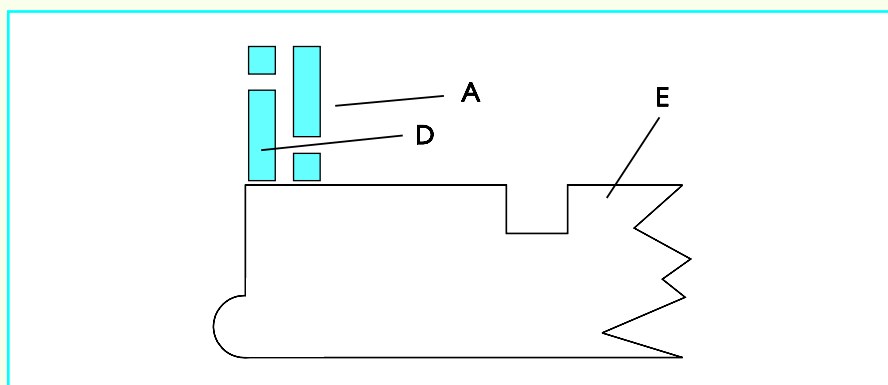


FIGURE 49—This illustration shows two different levers requiring different key cut depths to line up the fence (49C) and the gate (49B).

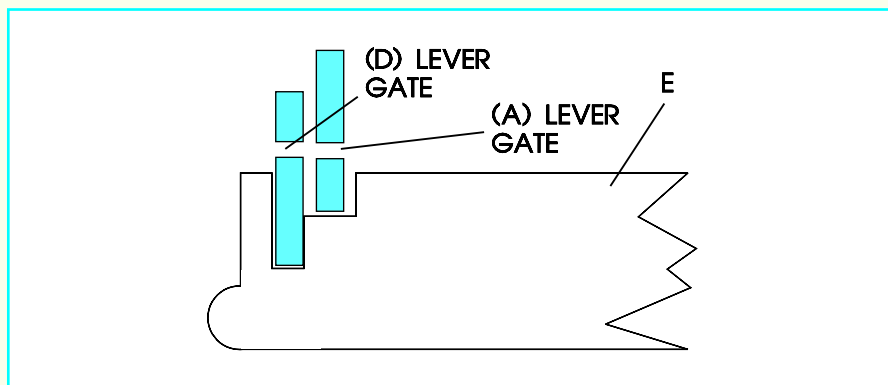
FIGURE 50—This figure shows an end view of levers resting on a key blank.



Therefore, it will require a deeper cut in the key blank. Figure 51 shows the key with the proper cuts to bring these gates in line, so that they both can accept the fence.

Of course, lever locks have more than two levers. Two or three guard levers and six to eight reenter levers within one

FIGURE 51—The proper cuts in the key bring the gates of levers A and D into line.

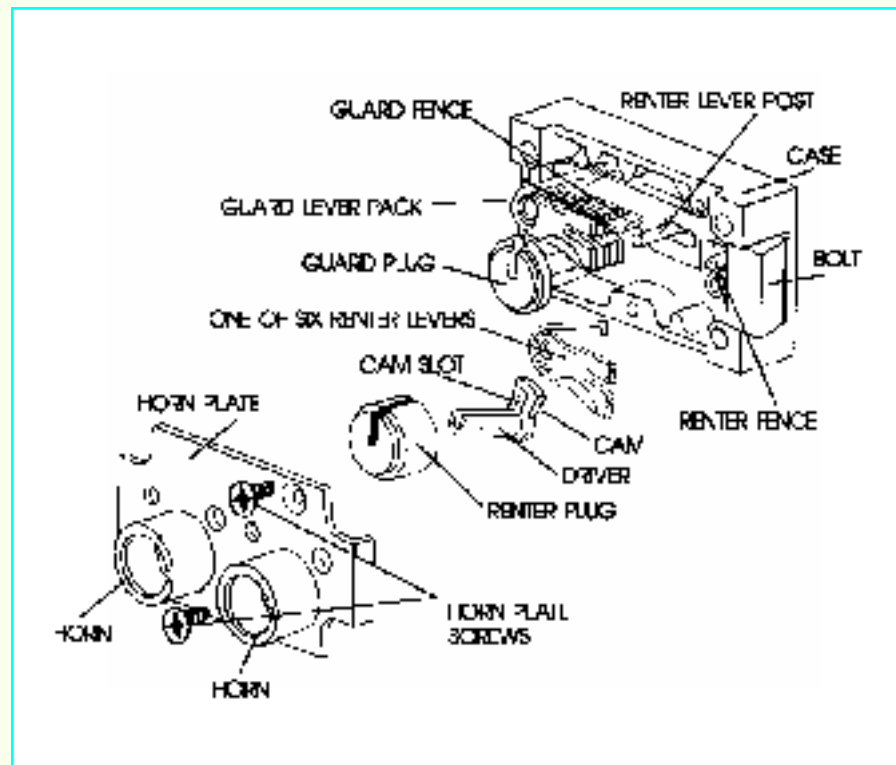


lock are common. You may find up to eight different positions of gates in the levers, meaning there will be eight different depths to cut in the key. Many locks have a fewer number of depths, however, and very often these depths will have the same distance between each other.

For example, on one Yale lock, the full width of the blank is .350", the first cut is .325", and each cut gets .025" deeper. If you can measure a couple of keys, you can figure out what multiples, such as .025", the levers are cut on, and this makes it much easier to cut the key on a key machine. Often, the levers are marked with a number that indicates the depth of the cut. We'll study this a little later.

Now that we know basically how the lever lock works, we'll continue on with the safe deposit box lock, which is simply two lever locks within one case. Figure 52 shows the parts of a safe deposit lock.

FIGURE 52—Parts of a Safe Deposit Box Lock



The *case* houses all lock parts except the keys. The *horn plate* is the cover of the lock. The two *horns* are part of the horn plate, and each one houses one *plug*. The *bolt* is the sliding assembly which fits into the doorjamb, holding the door closed when locked; it's controlled by the *drive cam*.

The two *fences* are part of the bolt. The *renter fence* is the projection on the bolt with which the renter levers' gates must align before the bolt can be retracted. The *guard fence* is the projection on the bolt with which the guard levers' gates must align before the bolt can be retracted.

The *cam* is the component attached to the driver on the renter's side which controls bolt movement. The *cam slot* is the opening in the cam that accepts the tip of the key. The *driver* is a spindle connecting the plug and the cam. It's slotted along its length to guide the key.

Each plug is a cylindrical fitting containing the keyway. The *renter plug* is the plug closest to the opening edge of the safe deposit box door, and it accepts the renter's key. The *guard plug* is the plug closest to the hinge side of the door, and it accepts the guard key.

The lock contains two *lever posts*, upon which the levers pivot. The *lever* is a flat, spring-loaded tumbler that contains a gate which must be aligned with a fence to allow movement of the bolt. The *lever spring* is either attached to or manufactured as part of the lever. This spring holds the lever in locked position.

Opening a Locked Safe Deposit Box

In this section we'll assume that the guard key is available, so the only part of the lock you'll need to open is the renter's side. It would be most unusual if the guard key wasn't available. However, if for some reason you did have a lockout on both sides of the lock, you would use the same procedure to open the guard side as you would for the renter's side, because each operates in the same way.

There are two general rules to follow when opening these locks:

Rule 1: Always use the opening method preferred by the bank

Rule 2: Do the job in the most efficient way possible, with the least amount of damage to the lock and the door.

The first thing to do is to familiarize yourself with the boxes, to see what type of doors and locks are used. Generally, you'll find all of one kind used for all of the bank's boxes, but if the bank built an addition to its original group of boxes,

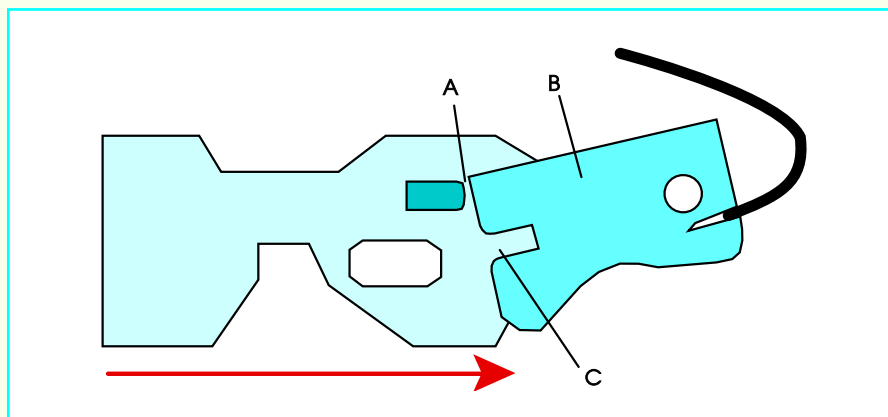
you may find a different kind of lock or door on the new boxes.

If you're called on a lockout, examine one of the vacant boxes in the same "nest" and determine the best way to get it open. We'll start with some methods that seem like good ideas, and work our way up to the best all-around method.

Assuming that the guard side of the lock is open, can't we just pick the renter's side? This would do the least damage to the lock and door. However, lever locks probably have the highest degree of security against picking of any lock made, and you will seldom be successful. Figures 53 and 54 show why.

To pick this lock, you would first exert pressure on the bolt in the direction of the arrow. This would push the fence (Figure 53A) against the lever (53B). With a curved pick, you would raise the gate (53C) to line up with the fence. Constant pressure of the fence against the gate might hold it in position, and so on. If the fence and the edge of the levers were rounded, as they are in Figure 53, picking might be possible.

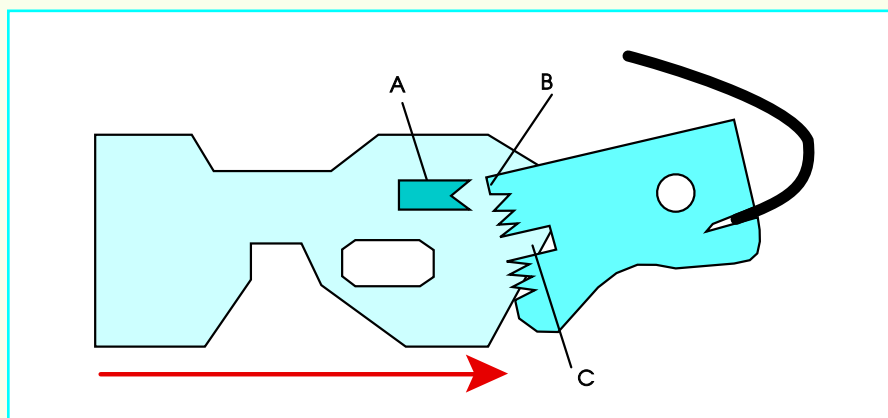
FIGURE 53—Lever and fence with rounded edges might allow this lever lock to be opened using a curved pick.



However, nearly all levers in use today have a saw-tooth edge, as shown in Figure 54. Often the edge of the fence is also toothed to fit the saw-tooth edge of the lever. Obviously, these edges are not going to slide past each other! They make picking nearly impossible.

Another method is to drill out the screws holding the lock to the door, or to drill the hinge screws holding the door. This should *only* be done if all other attempts at opening the box have failed, however. The bank is likely to object, because drilling will damage the face of the door.

FIGURE 54—The saw-tooth edge of most modern levers makes picking nearly impossible.



If you must drill out the screws holding the lock to the door, open a vacant box in the same nest, look at the back of the lock, and determine where the screws are. The lock is probably held on by two or three screws. If you measure carefully, you can transpose their location to the front of the locked-up box, and drill them out.

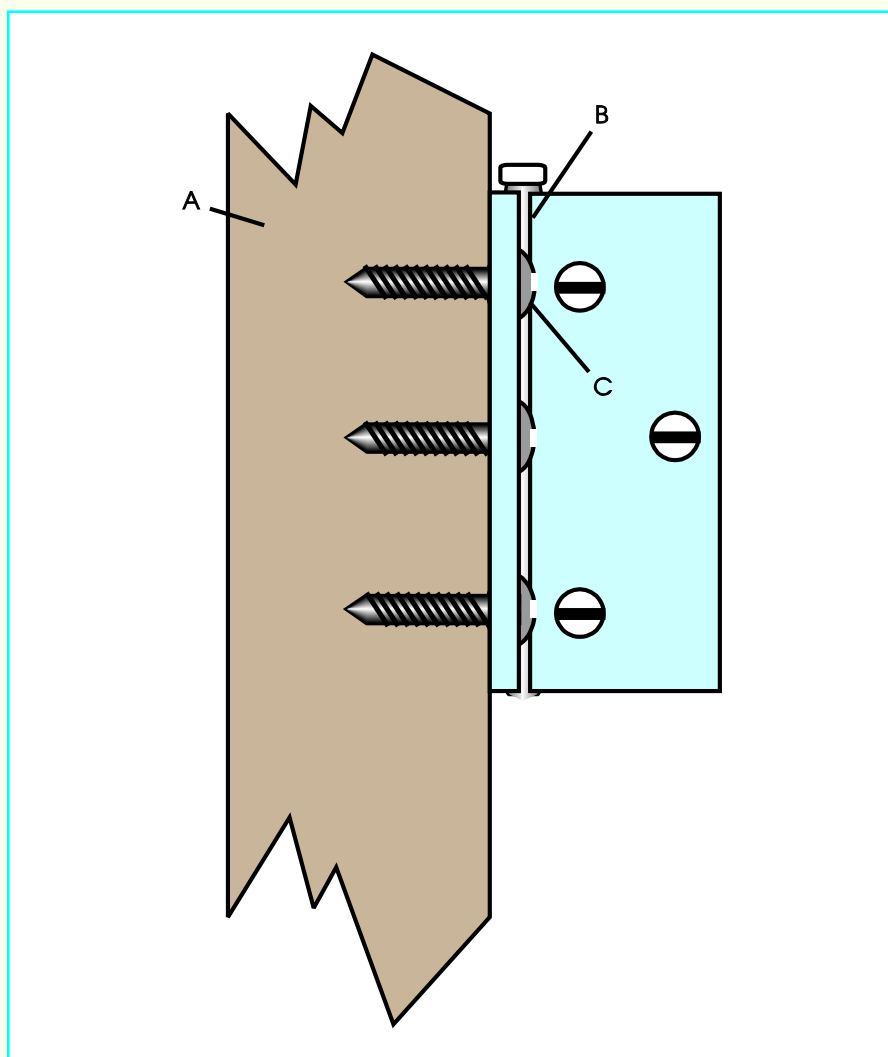
To drill out the hinge screws, you would also look first in a vacant box in the same nest and determine where they are, then measure carefully and transpose their location to the front of the locked-up box. Center-punch each location and drill. Figure 55A is the door, 55B is the hinge, and 55C is the hinge screw. Once the screws are drilled, you may be able to pry the door open from the hinge side. Again, this causes a lot of damage and should only be done if other methods fail.

Filling a drilled hole so that it's unnoticeable is difficult to do. Some locksmiths tap the hole for a bolt and then grind the head of the bolt flush with the face of the door. A better method is to drive a taper pin into the hole; this makes an almost invisible filling. You don't have to tap the hole, since the taper pin isn't threaded. You cut the taper pin to the correct length, drive it into the hole, and grind off the top so that it's flush with the face of the door.

The Best Method: Pulling the Plug

The most popular method by far is pulling out the plug on the renter side of the lock. This method does not damage the door and leaves no indication of entry since you'll replace the plug, or the whole lock. Once the plug is pulled, you can generally work the levers in the renter side easily, after the guard key has opened the other side.

FIGURE 55—Measure the location of the screws very carefully before drilling.

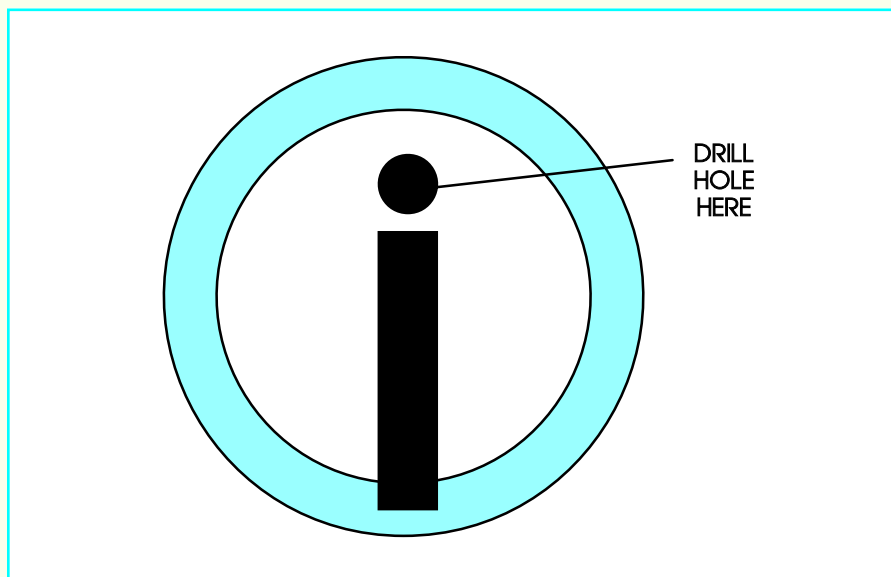


Specially-made tools are available from locksmith suppliers for pulling either the plug or the door of safe deposit boxes. However, the tools needed are simple and many locksmiths use their own. We'll give instructions for using items you're sure to have in your shop: a drill, a tap, a large nut or small block of wood, a washer, a screw, and a wing nut.

To pull the plug, drill a hole in it as shown in Figure 56. Use a #25 drill and a #10-24 tap, and make the hole about $\frac{3}{8}$ " deep. The goal of the next step is to pull the plug straight out so you won't damage the face of the door. The commercial puller sets do this well, or you can do it as well by creating a tool using the readily-available hardware shown in Figure 57.

The plug on the guard side of the lock is shown at Figure 57A. We're assuming that you've set this side of the lock with the guard key, so you won't be touching it. Figure 57B is the plug

FIGURE 56—To begin pulling a plug, drill a hole in it.



on the renter's side of the lock, the one you'll be pulling. Once you've drilled and tapped the plug, place a large nut (Figure 57C) or a small block of wood with a hole in its center, over the plug and against the door surface. The hole in the nut or in the block of wood must be larger than the plug; the plug will enter this space as it's pulled. If you use the nut, be sure to pad it with felt or something to keep it from scratching the face of the door.

Place the washer as shown at point D in Figure 57, and screw a 10-24 screw into the drilled hole, as shown at point E. Place the wing nut (57F) on the end of the screw and tighten it. This will pull the plug straight out of the lock.

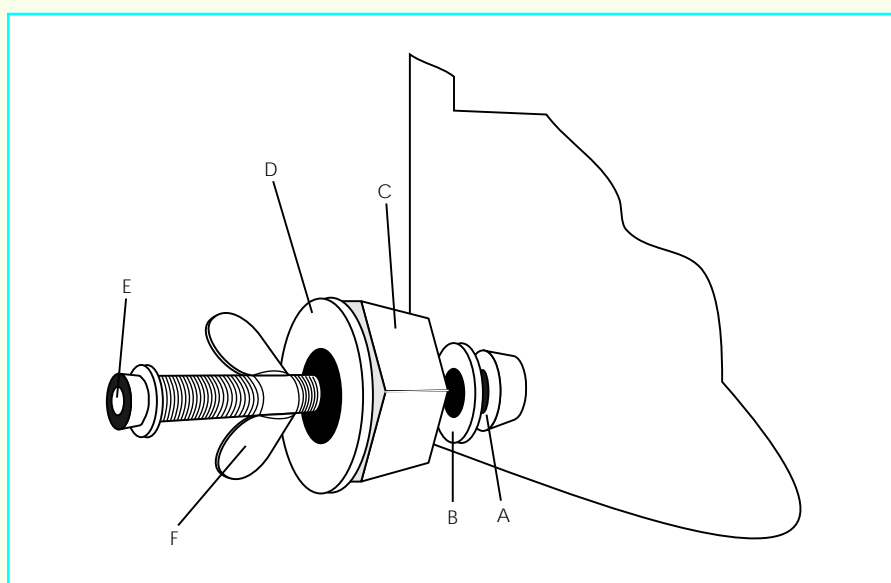
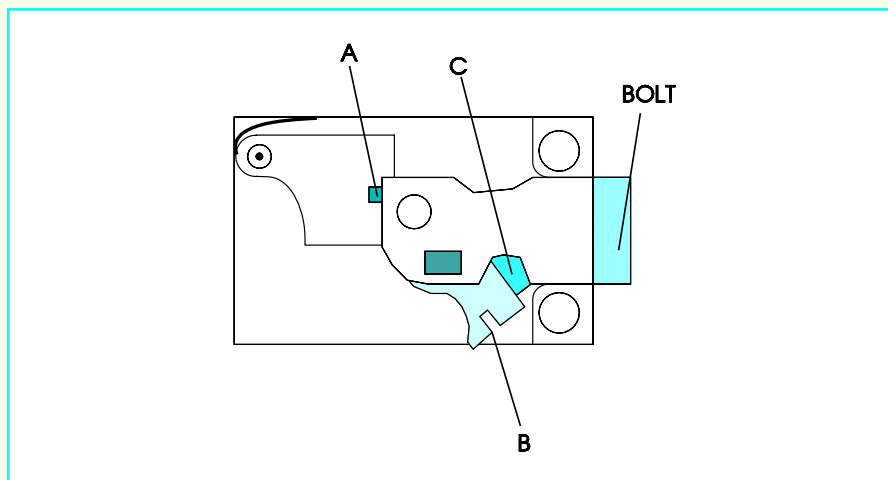


FIGURE 57—Readily available hardware can be used to create a tool to pull a plug.

Figure 58 shows what happens once the plug is pulled. This figure shows the back of the lock, on the interior side of the door. The guard key has been set and the gates of the levers (Figure 58A) are in line to receive the guard fence on the bolt. The renter-side levers (58B) have fallen, so they won't stop the renter fence on the bolt. To open the door, contact the bolt at Figure 58C and move it to the left.

FIGURE 58—The bolt can be moved from 58C after the renter's side levers (58B) have fallen because the renter's plug was pulled.

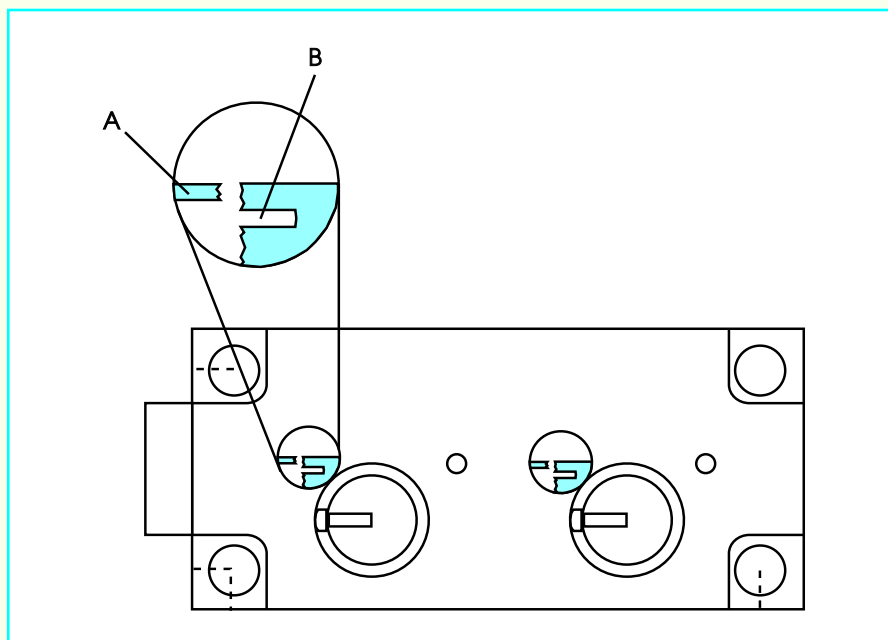


In order for the lock to work again, you'll have to replace the old plug with a new one. Depending on how much damage the pull did, you might have to replace the entire lock. As with any door, test the lock with the door *open* to make sure both sides of the lock will work properly.

Some safe deposit box locks are manufactured with a gate and fence window in the horn plate. This window is located right in front of the point where the gates and fence meet. By locating the window and drilling a hole to reach it through the front of the door, you can look into the lock and line up the gates with a pick. Figure 59 shows an enlarged view through the window; 59A is the fence and 59B is the gate in the lever which must be raised up to accept it. But again, this method should be used only if other methods fail.

But why? you might ask. This method shouldn't damage the lock at all; all you would have to do is plug the drilled hole. However, the bank has hired you, and the bank will likely object to *any* drilled hole or *any* picking. A drilled door might look "repaired" and decrease a renter's confidence in its security; likewise, if the lock is picked in front of a renter, the renter may quickly lose confidence in the security of the bank's boxes. Use whatever method the bank prefers.

FIGURE 59—This figure shows an enlargement of a gate and fence window in the horn plate of a lever lock.



Making a “First Key” for a Safe Deposit Box

To make a key for a lever lock, first select a blank that will fit the keyway properly. If the blank, shown in Figure 60A, is a little too wide, it can be filed down along the edge shown at 60B (don't file edge 60C). The blank must be long enough to bottom against the back of the lock case. If the tip shown at D is a little too large to allow this, file it down.

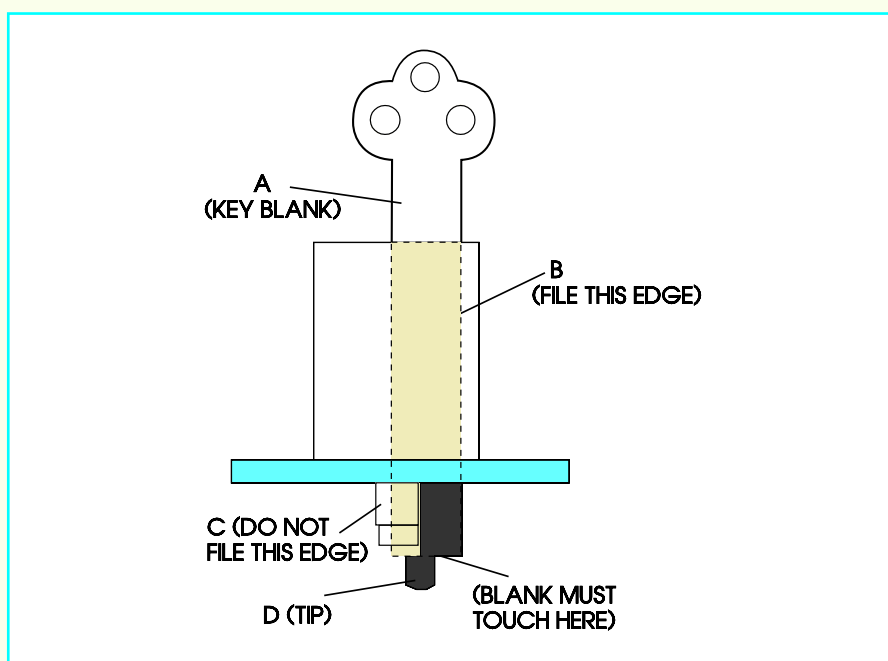
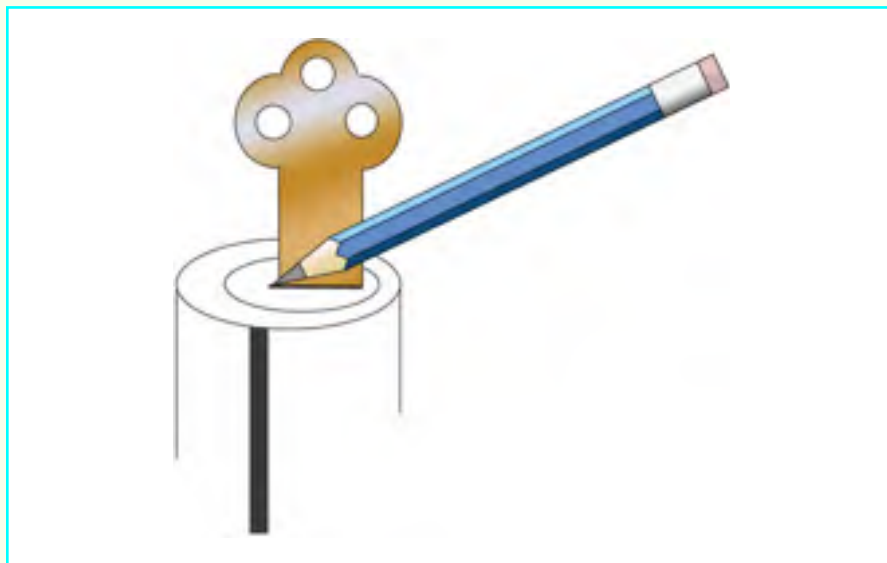


FIGURE 60—Select a blank that will fit, or can be made to fit, the keyway properly.

With the blank all the way into the keyway, make a mark as in Figure 61 to make a ward cut. (Some blanks are cut at the factory and won't require a ward cut.) Cut it on your key machine about $\frac{1}{16}$ " deep. If it tends to hang up when you try to turn it in the keyway, widen the cut slightly. Turn the blank to the right (clockwise), and watch the movement of the levers; the uncut blank will probably raise the gates in the levers past the fence.

The blank will have to be cut so that the gate in each lever will line up with the fence. If a lever lines up perfectly on the blank, this indicates a no-cut space. If two or more levers line up perfectly with each other, they'll probably take the same size cut in the key to line up with the fence. Then, as the key is turned further to the right, it will retract the bolt, unlocking the door.

FIGURE 61—Marking for the Ward Cut

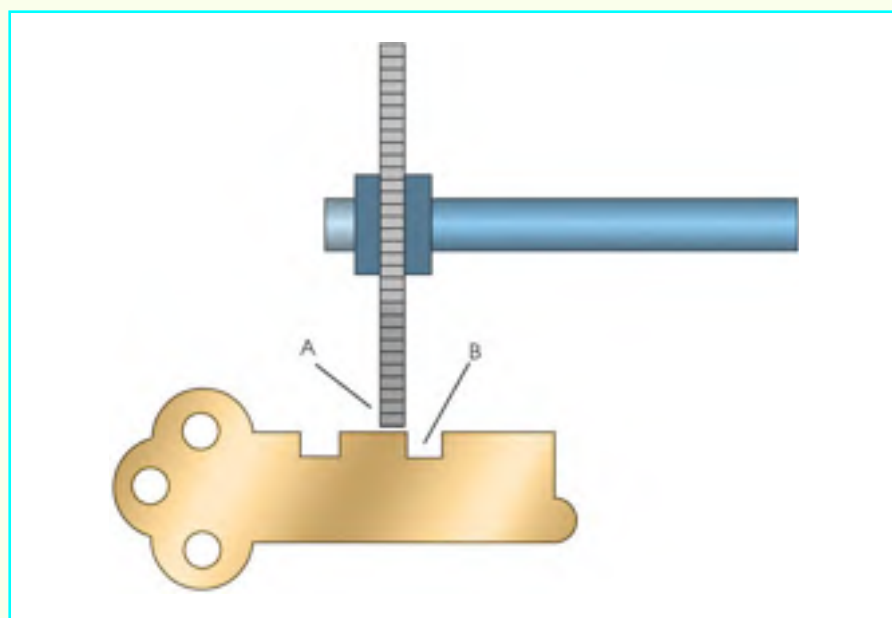


Make the first cut for the top lever, the one nearest the window. Find the mark made by it on the blank, make a slight cut with the key machine, and test it in the keyway. If the gate is still raised past the fence, make another slight cut, until the gate lines up with the fence. Do this for each of the levers, until the key raises all the gates into correct position.

One of the most difficult things to do correctly is to *space each cut* on the blank. Make sure the blank's length is correct, since this can throw off the spacing of all the cuts. Most levers, at the point the key contacts them, are from $.040$ " to $.055$ ". If you use a flat steel key cutter that's $.055$ " wide, you'll make the cut slightly wider than the lever contact point, so it will work freely.

To make the next cut, position the key in your key machine and line up the cutter as shown in Figure 62. The side of the cutter (62A) should come down the side of the cut (62B). Make a very light cut and test the blank in the keyway. If it's not deep enough, continue to cut lightly until the gate lines up with the fence. Test the key after every cut to make sure you're spacing them correctly. Any time you make a cut but the gate in the lever doesn't change position, you'll know there's a problem in the spacing, which you'll have to correct before you go on to the next lever.

FIGURE 62—*Lining Up the Key and Cutter*



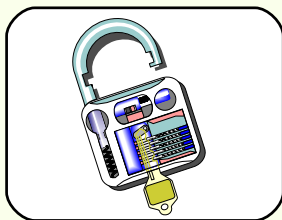
When all the gates are lining up with the fence, open the guard side of the lock and test the new key. The new key should open the renter side of the lock and retract the bolt.

If the levers are numbered, you can fit a key to the lock much faster and more easily, somewhat like cutting a key by code. That's because the number indicates the depth of the cut needed in the key. If you measure the distance shown at Figure 63A,



FIGURE 63—*Measuring the Depth of a Cut*

with a micrometer on several different depths on keys you've made, you may uncover a pattern. A lever marked with a 1 may have a depth of .350", a lever marked 2 may be .375", and a lever marked 3 may be .400"—all have a .025" difference between cuts. If you can crack the levers' number code, you can save a lot of time by cutting "by number" on your key machine. This data can usually be found in code books and key machine instruction manuals.



Locking It Up! 6

1. A safe deposit box lock is actually two _____ locks within one lock case.
2. *True or False?* It doesn't matter which of the keys in a dual-custody lock is turned first.
3. *True or False?* If you know how to pick or drill a safe deposit box lock without damaging it, then you should always do it that way, because you're actually doing the bank a favor.
4. *True or False?* There are a lot of legal rules covering who can open a safe deposit box, and a locksmith must get court permission to open a locked box.



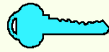
Check your answers with those on page 92.

THE KEY TO SUCCESS

Well, you've completed another important study unit and you're one step closer to your career goal. You now know a great deal about safes, vaults, and safe deposit boxes: their construction, operation, and repair. You also learned about the techniques used to open locked safes. These skills should serve you well in your professional career, even if you decide not to specialize in safe work. Locksmiths should always seek to expand their professional skills, since this will enable them to better serve their customers (and advance themselves as well).

Now, read through the following *Key Points to Remember*. This review of the important facts and concepts in the study unit will help you retain what you've learned. When you feel you know the material well, proceed to the examination. Good luck!

KEY POINTS TO REMEMBER

-  Safes can be found almost everywhere, in commercial and residential settings, and they're used in many ways: to guard cash, important papers, firearms, and many other valuables. Locksmiths aren't safe and vault technicians, but the changing of safe combinations and the servicing of locks and safes are very much a part of a locksmith's business.
-  A safe's fire-resistance or burglary-resistance determines what materials you'll find inside it. We covered the function of relockers and hardplates, how to determine the make and model number of a safe, and what the "hand" of the lock is. We also looked at how the combination lock works in fact and in theory — how many possible combinations there are on any given lock, and so forth — which makes it the ingeniously secure device that it is.
-  Changing the combination is one of the most common services a locksmith performs on a "safe call." Although it's common, it should never become "routine"! Combination changing is a very delicate job which requires much skill. A mistake on even a very simple lock can cause a lockout. In this study unit, we examined the two main types of locks: hand-changing, and key-changing. Of the hand-changing locks, we examined the hole-type, screw-type, and mesh-type

wheels and how to change their combinations neatly and proficiently. We looked at how the key-changing lock works, and the correct procedure for changing its combination by key. Last but not least, we learned what combination numbers are best *not* to use, and why.



When setting or changing a combination, don't concentrate on just the lock alone. Of course, it's very important to have a smoothly functioning lock. In this study unit, you learned how to properly clean and service the combination lock. You learned what to look for, like dirt, burrs, or worn parts that can cause the lock to malfunction, and how to correct them. You may have the lock working perfectly, however, and the safe may still lock up if the rest of the door isn't serviced. It's difficult to convince a customer with a locked safe that the lock itself is working properly! Safeguard your professional reputation by lubricating the boltworks, making sure screws are tight, and following the other service points outlined in this text.



Movies have made safe opening look easy, but in reality it's not. A major factor in getting a locked safe open is the answer to this question: Is the combination known? By using the troubleshooting techniques outlined here, you may pop open the safe to the owner's amazement. If the safe has been burglarized, you now know what conditions to look for, including evidence of an unexploded charge, before you begin working on the safe. If the combination is unknown, drilling the safe may be the only choice. You know basically how drilling works in getting a locked safe open, and how to repair the safe door so that it's as good as new. Drilling is a specialized skill that brings the locksmith into safe and vault technicians' territory. For more information on becoming a technician, you may wish to contact the Safe and Vault Technicians Association (SAVTA) at 3003 Live Oak Street, Dallas, TX 75204-6186.



Many locksmiths would add safe deposit box work to their business, if they understood the concept of the lever lock better. Safe deposit box locks are dual-custody locks that combine two lever locks within one lock case. In this study unit, you learned the correct terminology for these locks, and how they work. You learned how banks and renters use safe deposit boxes, and why it requires a key from each to open the lock. You learned how to deal with the bank in changing the locks and duplicating keys.

Do You Know Now . . .

What is the locksmith's "golden rule" for working with safes?

The locksmith's "golden rule" for working with safes is: Always test your work with the door open. Never shut a safe or vault door and *then* see if you can unlock it!

What two services do locksmiths perform most often on safes?

The two services that locksmiths perform most often on safes are (1) changing the combination on the combination lock, and (2) troubleshooting, cleaning, and repairing the combination lock and safe door.

How are burglar-resistant and fire-resistant safes different?

The materials and construction of a safe's door and body will depend on whether the safe is meant to be *fire-resistant* or *burglar-resistant*. Burglar-resistant safes are often made of solid steel, or of a concrete-like compound sandwiched between thick sheets of steel. They have special security features, such as recessed doors and heavy-duty hinges that resist prying and hammering. Fire-resistant safes have doors and bodies made mostly of a fireproof compound encased in sheet steel. The fireproof material shields the interior from heat, protecting the contents of the safe.

Locking It Up! Answers

1

1. Safe and vault technicians are locksmiths with highly specialized skills related exclusively to safe and vault doors and combination locks.
2. Cause a lockout
3. Servicing the lock and door and changing the combination
4. combination
5. False

2

1. It connects the drive cam to the spindle. Not all locks have a spline key, but if the spindle and drive cam are threaded, the lock will have a spline key.
2. Fireproof insulation
3. With the door opened, face the back. The lock hand is determined by the bolt position.
4. It's the last wheel, the last number of the combination.
5. How many wheels are in the lock and how many change positions are available on each wheel

3

1. Hole-type, screw-type, mesh-type
2. Yes
3. Never!
4. If you can see or feel the tip of the key projecting through the front of the lock case
5. No—it will only open when the combination is dialed to the opening index.

4

1. The lock works with all other parts of the safe door — the bolt works, handle, hinges, etc. — to make the safe the little fortress that it is. It's important to service the other parts of the safe door, because these other parts can cause a lockout, even when the lock is working perfectly.
2. Wheels binding or dragging each other out of position. The cure is proper repair and lubrication of the wheels.
3. The model of the lock and the thickness of the door
4. False
5. Oil
6. False

5

1. The “manipulation” method is the process of opening a locked safe without knowing the combination of the lock and without the use of force or explosives. In this method, you turn the dial slowly and listen to the parts moving inside the door in order to determine the combination.
2. False
3. slowly; rapping
4. diplomatic

6

1. lever
2. False
3. False
4. False

Safes and Vaults

EXAMINATION NUMBER:

03101000

Whichever method you use in submitting your exam answers to the school, you must use the number above.

**For the quickest test results, go to
<http://www.takeexamsonline.com>**

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then submit *only your answers to the school for grading*, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. What is the main cause of most lockouts?

- A. A breakdown in one of the parts in the lock or safe door
- B. Wheels binding or dragging each other out of position**
- C. Losing or forgetting the combination number
- D. A mistake in changing the combination

2. What is the best way to prevent the most common type of safe lockout?

- A. Proper maintenance and lubrication**
- B. Better manufacturing techniques
- C. Careful training and practice
- D. Not abusing the lock

3. Most people purchase safes to protect against which of the following?
- A. Fire and burglary**
 - B. Fire and natural disasters
 - C. Explosives and burglary tools
 - D. Water and smoke damage
4. Imagine that you're called to a lockout. The safe owner tells you that the first number of the combination is 13, but that he is unsure of the other two numbers. You check the area around the safe, but can't find the combination written anywhere. You learn that the owner's birthday is April 13, 1961, and his address is 1339 First Avenue. The safe was purchased last December but has never been serviced. What group of numbers would you try first on the lock to see if it will open?
- A. 13-13-13 and 4-4-4
 - B. 4-19-61 and 12-12-12
 - C. 1-1-1 and the current date
 - D. 13-4-61 and 13-39-1**
5. A fire-resistant safe will have a door and body made mainly of
- A. solid steel.
 - B. solid iron.
 - C. fireproof insulation encased in sheet steel.**
 - D. fireproof insulation only.
6. A safe with a high burglar-resistant rating will probably have
- A. a removable dial.
 - B. a solid steel door, a relocking device, and a hardplate.**
 - C. fireproof insulation in the door.
 - D. a medium-security lock with no relocker.
7. The purpose of a hardplate in a safe door is to
- A. guard the lock and bolt mechanism from drill attacks.**
 - B. make the safe door more fireproof.
 - C. make the safe door stronger.
 - D. make the safe more watertight.
8. In any combination lock (whether two-wheel, three-wheel, etc.) the wheel next to the drive cam is
- A. the first wheel, and the first number of the combination.
 - B. the last wheel, and the last number of the combination.**
 - C. the drive wheel.
 - D. the fly wheel.

Questions 9 and 10 are based on the following scenario.

A safe owner is having trouble with a right-hand, three-wheel lock. You're told that the combination is 25-50-75. The owner first turns the dial three complete revolutions to the left (counterclockwise), stopping at 0, then dials the proper numbers. Although each number is dialed to the changing index slowly and carefully, the door still won't open.

9. What is the *first thing* the safe owner did wrong?

- A. The owner needs to make four complete revolutions to the left, not three.**
- B. The owner needs to make three complete revolutions to the right, not to the left.
- C. The owner should dial the combination to the opening index, not to the changing index.
- D. The owner must have gotten the combination numbers reversed.

10. What is the *second thing* the safe owner did wrong?

- A. The owner needs to make four complete revolutions to the left, not three.
- B. The owner needs to make three complete revolutions to the right, not to the left.
- C. The owner should dial the combination to the opening index, not to the changing index.**
- D. The owner must have gotten the combination numbers reversed.

11. You have a three-wheel, hole-change lock whose dial reads from 0 to 100. Two of the wheels have 10 holes in which the drive pins can be placed; the third wheel has only 5 holes. How many combinations are possible?

- A. 50
- B. 500**
- C. 1,000
- D. 1,000,000

12. What is the *drop-in point*?

- A. The number on the dial corresponding to where the fence drops into the gates of all of the wheels**
- B. The number on the dial at which a lock might malfunction
- C. The point at which both locks in a dual-custody lock can open
- D. The point at which nitroglycerine is poured in to blow a safe

13. When changing a combination, what numbers and series of numbers should you *not* use?

- A. Numbers too easily guessed, like the owner's birthdate or street address**
- B. Numbers that rise and fall
- C. Numbers that mean nothing to the owner of the safe
- D. Numbers that are far apart on the dial

14. Watch out! There might be an unexploded charge in a burglarized safe if
- A. the hinges are sawed in half.
 - B. the dial and/or handle are missing.
 - C. there is soap or some kind of waterproof putty in or around the safe.
 - D. the safe is on its side.
15. Before you begin to work on a burglarized safe, the first thing to find out is:
- A. Are the police finished with their investigation of the scene?
 - B. Did the police find any fingerprints?
 - C. Is the combination known?
 - D. Is the safe door open?
16. A locked safe should be drilled
- A. only if the lockout is temporary.
 - B. only if other methods fail.
 - C. at the first sign of trouble.
 - D. only if the owner doesn't care if the safe's security and value is decreased.
17. What feature of modern safe deposit box locks makes picking nearly impossible?
- A. The number of levers in both the guard and renter's sides of the lock
 - B. The number of possible combinations
 - C. The number of keys needed
 - D. Saw-tooth edges of levers and fences
18. Which of the following are the two rules to follow in opening locked safe deposit boxes?
- A. (1) Use the opening method preferred by the bank, and (2) do not damage or deface the door.
 - B. (1) Use the opening method you know will work best, and (2) do not damage or deface the door.
 - C. (1) Use the opening method you know will work best, and (2) do not damage the lock.
 - D. (1) Pick the lock, and (2) do this without the renter present.
19. What is the preferred method for getting a locked safe deposit box open?
- A. Pull the plugs out of the renter's and the guard sides of the lock.
 - B. Drill for the gate-and-fence window built into the lock.
 - C. Pull the plug out of the renter's side of the lock.
 - D. Drill out the hinge screws.

20. In making a key for a lever lock, one of the most difficult things to do is to

- A.** space the cuts correctly along the blank.
- B.** cut the blank to the right length.
- C.** cut the ward.
- D.** make the renter key different from the guard key.

NOTES

COMING ATTRACTIONS

In your next study unit, you'll be introduced to electric locks and panic hardware. These important security devices are widely used in commercial businesses and public institutions where the safety of large groups of people is a major concern. You'll start by learning about basic electrical concepts; then you'll move on to the construction and installation of electric locks and panic devices. Good luck with your continuing studies!

Professional Locksmith

Study Unit 11

Panic Hardware and Electric Locks

Preview

Congratulations once more on successfully moving along in your course! You've completed 10 information-packed units on locksmithing and are well on your way to completing your training in this exciting field.

You've completed all of the study units concerning the mechanical actions of locks and security. Now it's time to begin looking at electric locks.

In the past, many locksmiths stayed away from this lucrative part of the security business. This was partially due to the locksmith's traditional lack of training in electricity and electric circuits. In addition, most architects and contractors generally used to call in electricians as soon as a system required wires. Times have changed, however, and many of today's locksmiths are trained to install and troubleshoot electric locks and equipment. Most locksmiths can also install and troubleshoot the most modern electronic burglar and fire alarm systems. When you complete this study unit, you'll also be able to boast of such skills.

When you complete this study unit, you'll be able to

- Explain why electric locks are chosen over other types of locks
- Discuss common building and fire codes and how they relate to electric locks and panic hardware
- Identify common types of panic hardware and discuss typical panic hardware installation practices
- Describe how electric circuits operate and how to test common electric lock circuits
- Identify common types of electric locks, including strikes, solenoid locks, and keyless locks
- Discuss how electromagnetic locking systems operate and how to install and troubleshoot these systems

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Panic Hardware and Electric Locks

Do You Know . . .

What is an *armature*?

What is the difference between an intermittent-duty coil and a continuous-duty coil?

What is an *ohm*?

In these pages, you'll find the answers to these and many other questions about panic hardware and electric locks.

INTRODUCTION

The Need for Panic Hardware and Electric Locks

The need for security systems has existed for a long time. In fact, the first electrically powered security system was patented in the mid-1800s, long before the telegraph, radio, and other modern inventions.

Panic hardware features a locking mechanism with a solid metal bar across the door to release the lock. This hardware is called *panic hardware* because the door is designed to be easy to open in the event of a “panic” event, such as a fire or other emergency.

Panic Hardware Uses

Let's begin by looking at a few possible uses of panic hardware. Figure 1 shows a floor plan for a restaurant, which is a typical environment for panic hardware. The entry doors may or may not require panic hardware, depending upon local building and fire codes. A set of doors exists at the one end of the dining room. These doors are normally a set of double doors, each containing panic hardware. A second set of double doors with panic hardware should be located in the

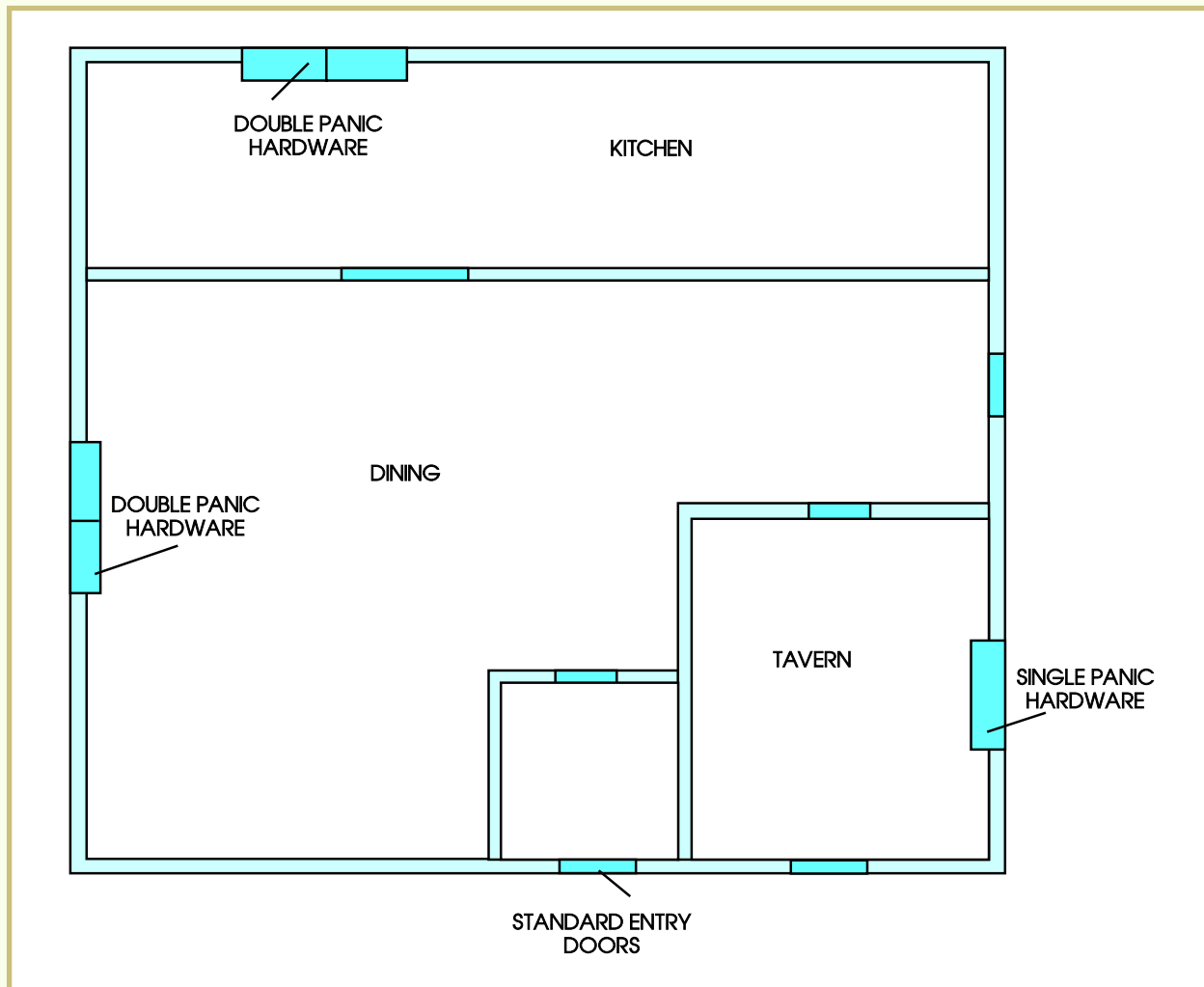


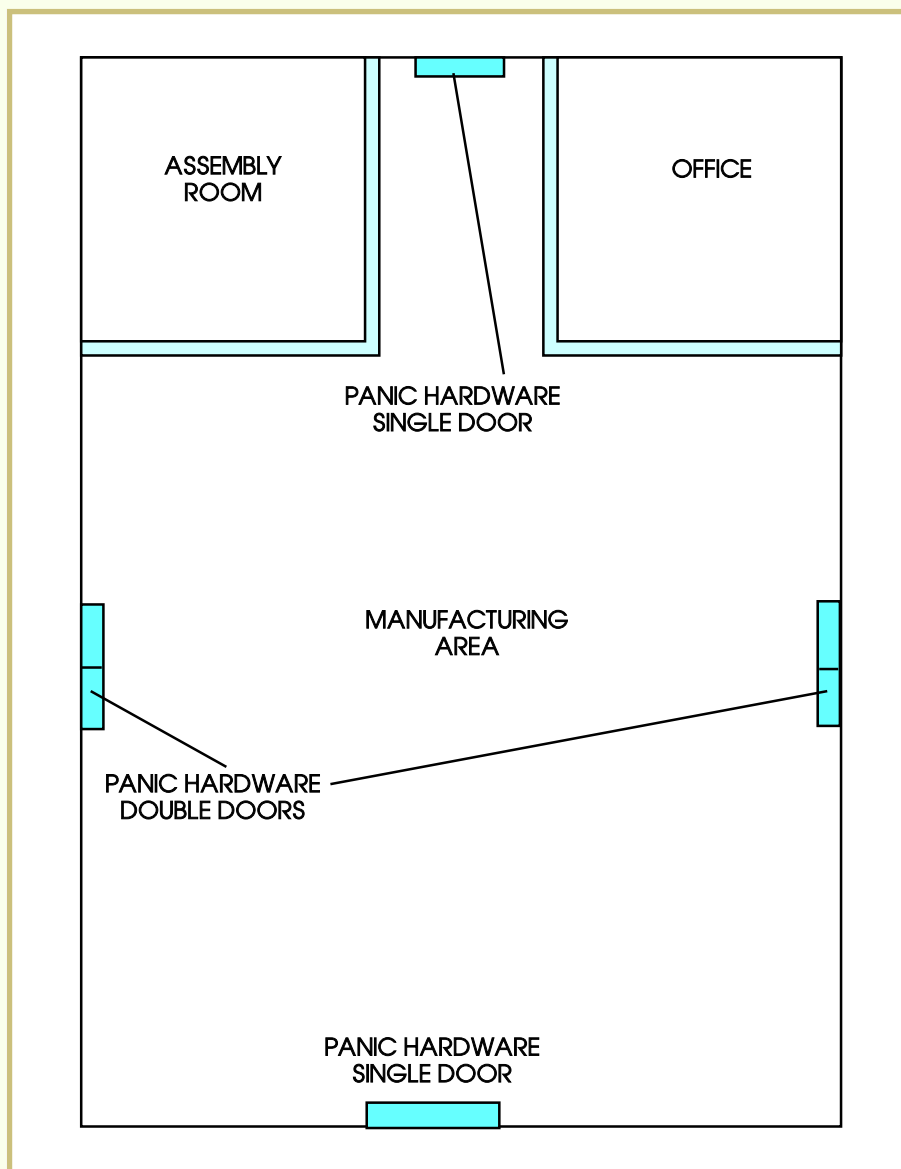
FIGURE 1—Panic hardware will be used in this situation to provide emergency exits.

kitchen area. If the tavern area of this restaurant is closed off from the dining room, a single door with panic hardware is generally located on an outside wall. In the event of a fire or other emergency, these doors can be opened easily to allow a quick exit from the building. Normally, these doors are illuminated by battery-powered emergency lighting which automatically turns on when the main electric service is lost.

Panic hardware is also installed on all doors in industrial plants. If this kind of building contains closed rooms for assembly, painting, or other operations, each room normally features panic hardware on all doors. A small, sample manufacturing plant is illustrated in Figure 2.

Entry doors on banks, stores, gas stations, and so on normally use one of the many types of panic hardware available. Elec-

FIGURE 2—Many industries use panic hardware in their doors.



tric locks provide security for homes or businesses in different ways. One major way—as with keyed locks—is to control access to certain areas of a building. With keyed locks, access is provided through the use of keys. With electric locks, access is provided by remote control. The person would push a button or throw a switch to either allow or prevent access.

Remember, however, that controlling access or exit within a building shouldn't be overdone. In the event of fire or other dangerous conditions, people must be able to exit the building.

Electric locks are used widely by many types of businesses, hospitals, and industries. The simplest electric lock consists of a solenoid-type plunger that engages into a pocket in the

door or doorjamb. More complex locks appear as mortise or key-in-knob locksets, devices that can be controlled remotely using push buttons or keyed switches. In addition, electronic keyless entry lock systems which use keypads or card readers to allow or prevent access to protected areas are also available. Still another type of electric lock is the electromagnetic lock, which consists of a powerful electromagnet and a steel plate that can hold a door against 2000 or more pounds of force.

A simple electric lock application is shown in the sample gas station illustrated in Figure 3. Gas stations generally have two electric strike-type locks on the restroom doors. If a customer wants to use a restroom, the gas station attendant can simply press a button to unlock the door, without having to give out a key. The electric lock system can, therefore, prevent key theft or key duplication in this and other types of public installations.

Electric keyless locks are widely used in businesses, industries, and in some residential applications. These keyless locks can be used on rear or side entries of a business to allow employees to enter and exit the building. Some homes have keyless entry systems to eliminate the need for keys.

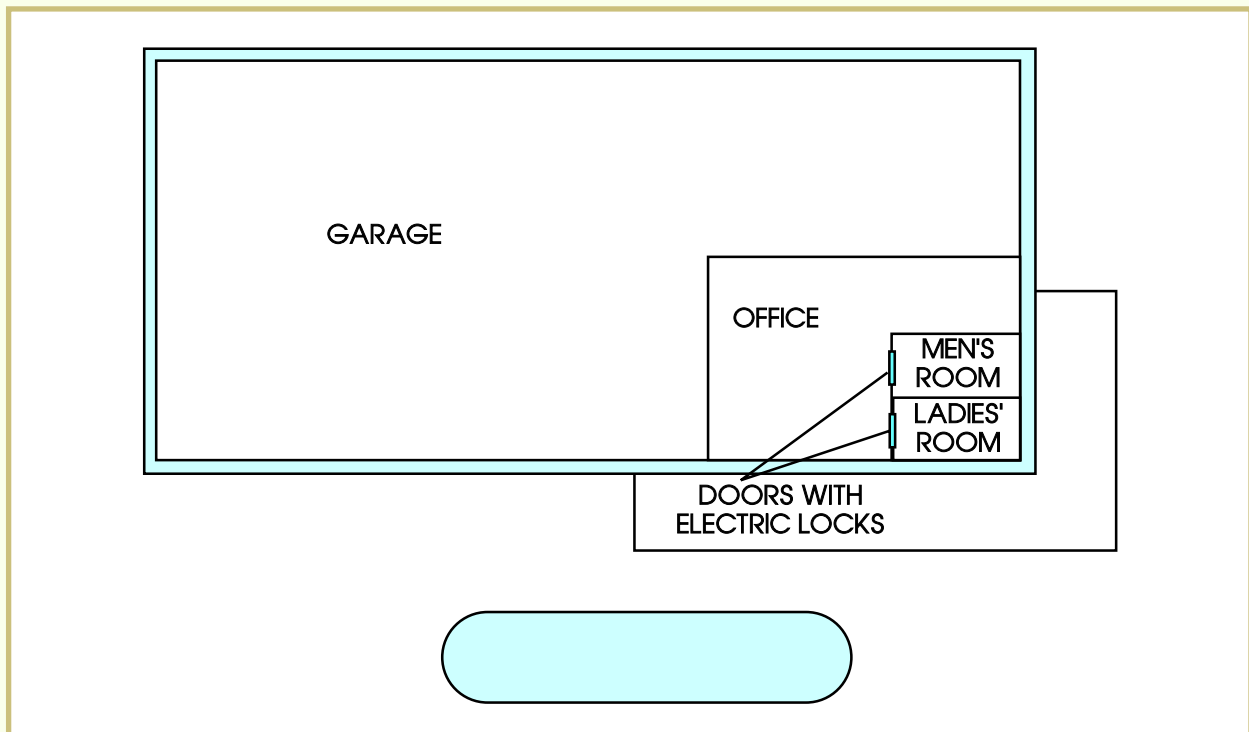


FIGURE 3—Some gas stations use electric locks instead of keyed locks for their restrooms.

Most modern hotels use electric locks for entry doors and/or keyless electric locks for the actual room doors. In addition, many of the hotel's interior doors may be held open using electric latch backs. Then, if a fire is sensed by the alarm system, these doors close to prevent the fire from spreading.

These are but a few of the many applications for panic hardware and electric locks. As you travel around your town or city, take note of the many other applications of these systems.

Building and Fire Codes

Almost every county or municipality in North America has building and fire codes that you must take into account when installing any locks. These codes protect the owner, customer, and any fire/rescue personnel that must enter or exit the protected building.

Some building and fire codes restrict the use of a lock known as a *fail secure* electric lock. This type of lock prevents passage through a door if the electricity supplied to the lock's coil is disrupted. Obviously, this type of lock can cause many problems should fire personnel need to cut power to a building during a fire.

You can review the building codes for your area at your local library. You can also obtain a copy of your area's fire codes from the National Fire Protection Agency (NFPA) or from any local consultant who specializes in fire prevention.

Building codes apply to the materials and techniques involved in the construction of buildings. Fire codes, although somewhat pertinent to residential construction, are geared toward business, industrial, and hotel/motel construction, as such public areas must be protected by fire alarm systems and sprinklers. Doors that separate different areas in buildings are normally held open with electric hold back latches which can be freed to close off in the event that a fire is sensed by the alarm system.

Before installing panic hardware or electric locks in any business or industrial location, be sure to check the building and fire codes for your area. The codes aren't always easy to locate. To find these codes you must contact the Authority Having Jurisdiction (AHJ) in your area. (The "AHJ" is a gen-

eral term for the authorities; it isn't one specific group or organization.) The AHJ in any given area can vary widely. The AHJ might be the local fire department, the local code authority, the township supervisors, etc.

There are two types of listings for exit hardware, panic or fire. UL (or another testing lab) tests and lists for one or the other. If you're installing new hardware, check the hardware schedule (a document prepared by the architect) for the specified type. Don't make a mistake here; this hardware is extremely expensive.

The number one reference manual is the *Life Safety Code Handbook*, which is published by the National Fire Protection Agency and contains a detailed rationale for each code. All panic hardware is approved by the Authority Having Jurisdiction. The AHJ generally goes with the *Life Safety Code*, but it doesn't have to. The AHJ has the final word.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

1. Is panic hardware normally installed in residential areas?

2. What is used on a keyless electric lock to open the door?

Check your answers with those on page 77.

PANIC HARDWARE

Different Types of Panic Hardware

As you've seen, panic hardware is used as a security device to protect businesses or industrial buildings. Three basic types of panic hardware are available. Let's take a look at these.

The first type is the simple bar and latch/bolt system. When the bar is pressed, the latch or bolt is released from the strike, allowing the door to be opened (Figure 4). Some models of this type of panic hardware also have an external keyed cylinder to allow for entry from outside the building. This model is said to have *active trim*. A model without the exterior cylinder is termed *inactive trim*.

The second type of panic hardware is the vertical locking system. In this system, the bar is depressed, causing the two vertical bars to retract from their strikes. These strikes are mounted at the top (in the frame) and the bottom (in the sill or floor) of the door. This type of locking mechanism provides additional security against the door being forced open. As with the bar/latch system, this type of hardware may also

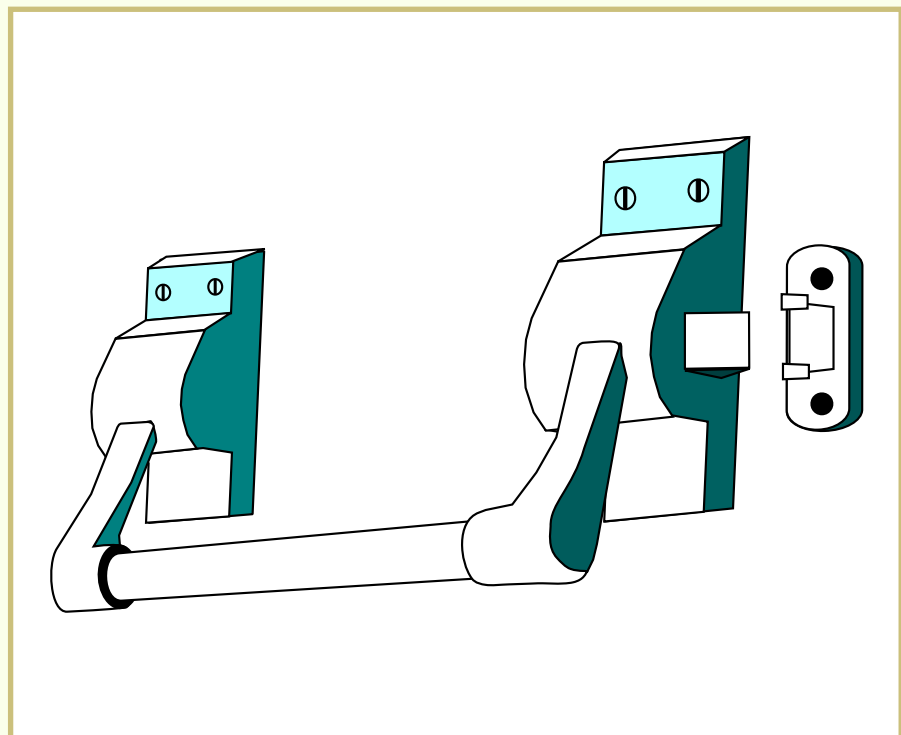


FIGURE 4—The basic form of bar-actuated panic hardware is shown here.

FIGURE 5—A vertical bar-type panic hardware adds additional security to an exit door.

contain an outside keyed cylinder. A typical vertical panic hardware system is shown in Figure 5.

The third type of panic hardware system features a simple paddle to throw the latch or bolt. This system features a battery-powered alarm circuit that sounds a loud buzzer when actuated. In some models, a light on top of the housing also illuminates when the paddle is actuated.

Let's look at different systems that are based on these three basic models.

One type of panic hardware system that finds wide use in businesses is the *Exitguard*, shown in Figure 6. The Exitguard uses a bar on the inside to operate the spring latch and a thumbturn or key on the outside trim to operate the springlatch. Some Exitguard panic locks have a latch holdback device which is important

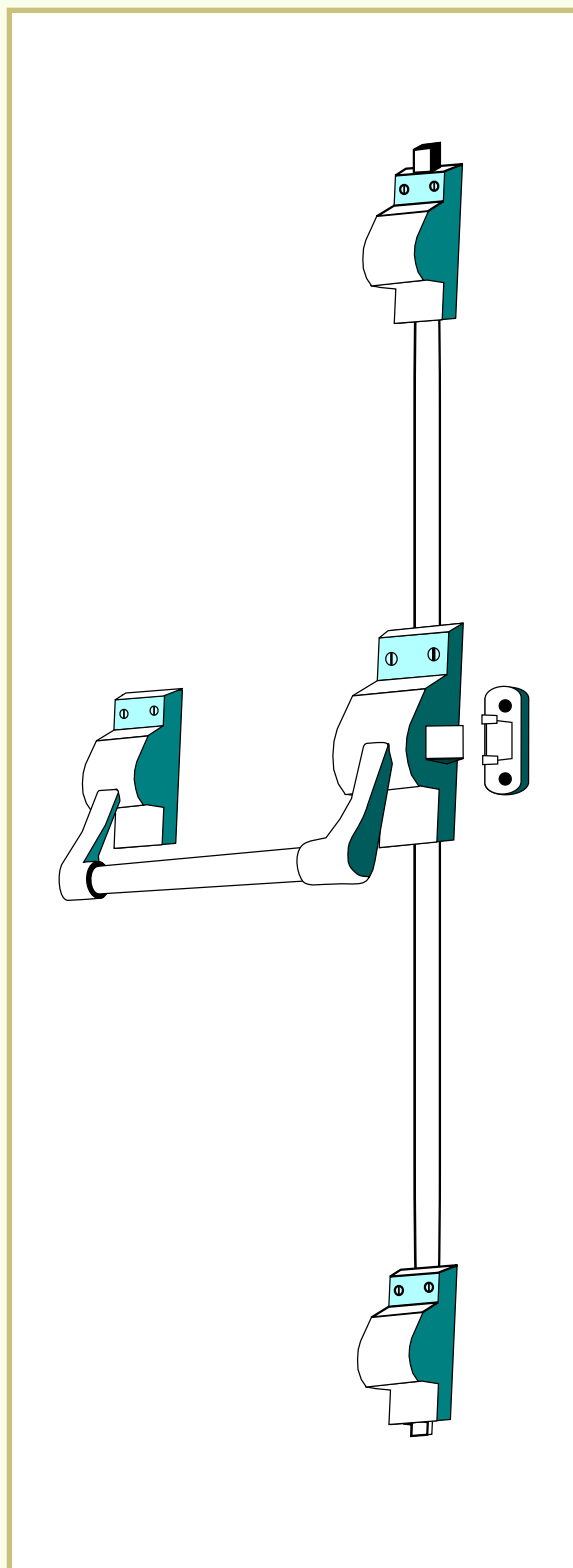
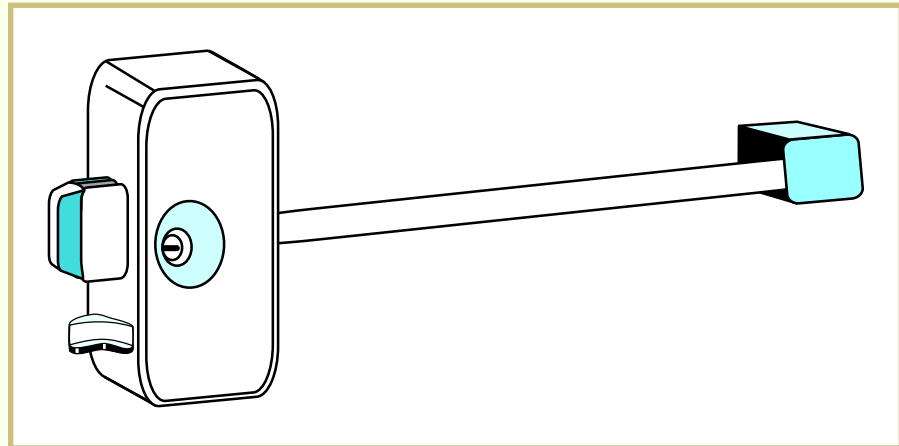


FIGURE 6—A bar-actuated system, such as the one shown here, may have an internal switch for connection to an alarm system.



when your customer wants the door to remain unlocked for periods of time, for example, when deliveries are being made. Another option with the Exitguard system is its *remote sensing capability*. This means that the system actuates an internal switch when the bar is pressed. The switch's contacts can be used in a burglar alarm circuit. The Exitguard system has no audible alarm.

Two other types of panic hardware use paddles or bars. These devices are the *Sentryguard* and the *Theftguard*, as shown in Figure 7.

The Sentryguard and the Theftguard are both dead bolt-based systems. When the paddle or bar is depressed in either of these systems, the dead bolt is withdrawn and either one or two alarm horns sounds to indicate that the door has been opened. The alarm can only be turned off with a key.

The Exitguard, Sentryguard, and Theftguard systems are manufactured by the Alarm Lock Corporation.

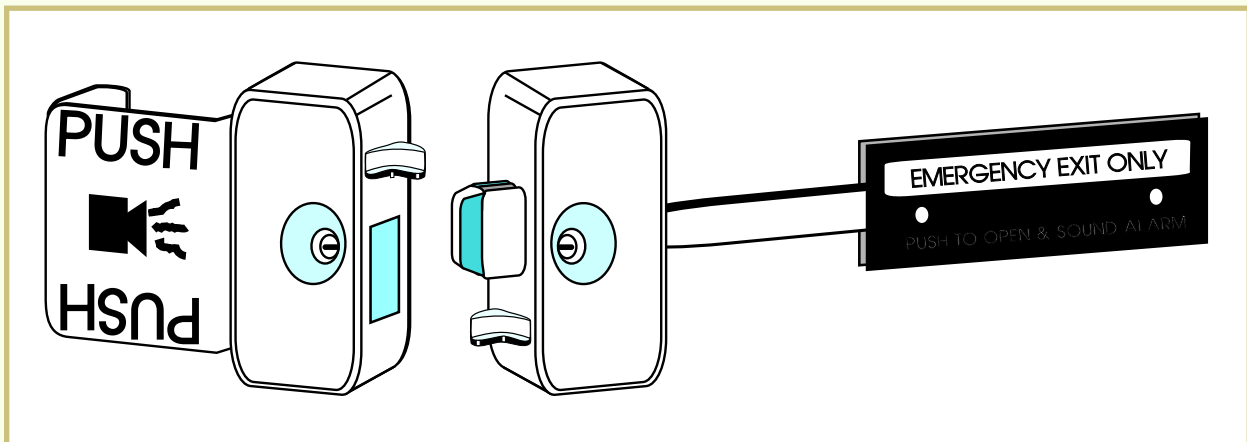


FIGURE 7—These two systems sound loud alarms when their paddles or bars are actuated.

Panic hardware that contains an audible or silent remote alarm circuit is often used in restaurants, retail stores, and in industries where the law requires emergency exits. Naturally, these systems are only installed in doors that aren't normally used.

Installation of Panic Hardware

Panic hardware can be installed on almost any type of door. Models are available in right-handed, left-handed, or double door configurations. In addition, doors up to 48 inches in width can be protected by this type of hardware.

The actual installation relies heavily on the use of templates. For metal doors, mortise-type locks are normally used in place of dead bolts or other latches. Although you can cut the mortise with a jigsaw, doors usually have a cavity that's machined at the factory.

Once the mortise lock is installed, place the template on the door. Drill a series of holes, then use the fasteners provided by the manufacturer to hold the panic hardware in place on the door. The screw locations for this type of installation are shown in Figure 8.

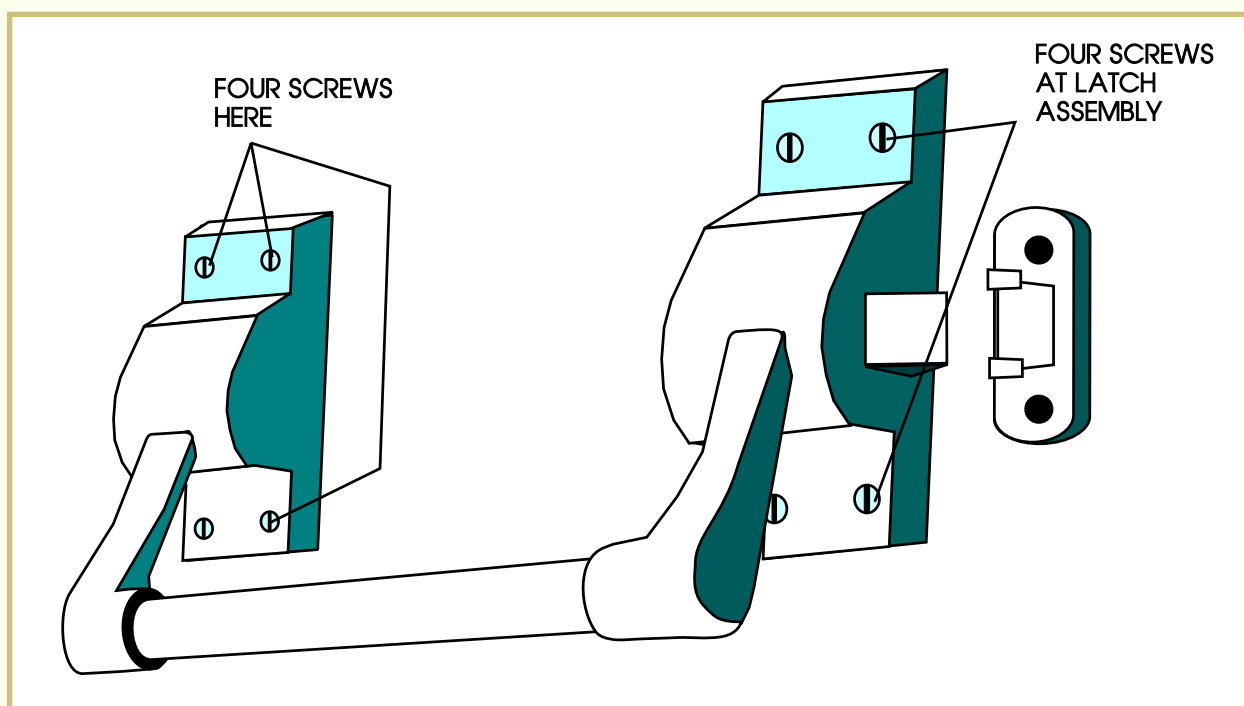


FIGURE 8—This panic bar assembly is held to the door by eight screws.

Once you've installed the hardware, locate and mount the strike.

Vertical panic hardware is slightly more difficult to install. You can locate the bar mounting hardware on the door by measuring up from the door's bottom. Once measured, scribe a line and install the templates. Drill the holes for the bar support and locking assembly, and drill the holes for the vertical bar supports and latching mechanism. Install the mounting screws and depress the bar, pulling inward on the vertical bars. Open the door, and use the templates or the strikes to mark and drill the locations of the strikes' mounting screws. Install the mounting screws and check the door's operation.

The paddle-type or bar-type alarm panic hardware is also fairly easy to install. As with the previous panic hardware discussed, install the dead bolt-style mortise locking mechanism first. Then use a template to drill the holes for the mounting hardware. Next, install the screws through this hardware to mount the interior case assembly.

Some modern panic hardware assemblies don't even use a swing bar across the door. Instead, they have a push bar that's part of the horizontal assembly used to open the door's latch. This type of panic hardware is shown in Figure 9.

This type of system is mounted in a manner similar to standard panic hardware.

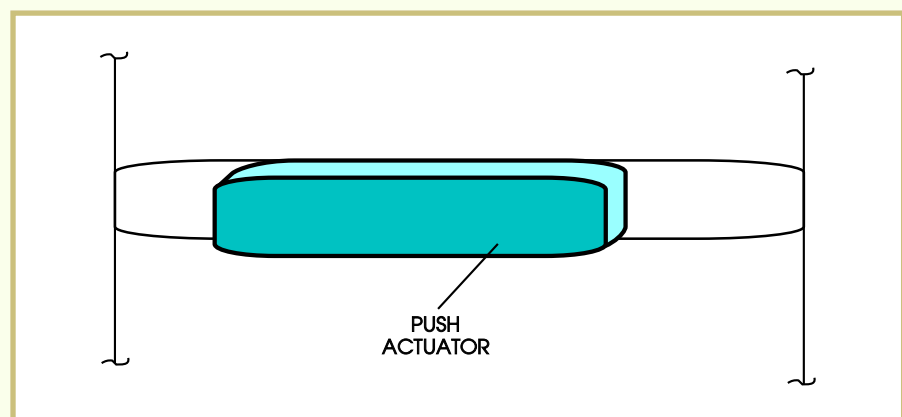
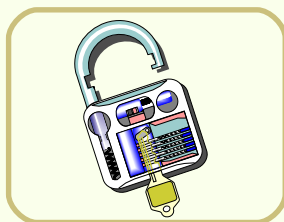


FIGURE 9—Some modern panic hardware use a padded bumper to actuate the lock as shown here.



Locking It Up! 2

1. What is used to aid you in the installation of panic hardware?

2. What is meant by a push bar?

3. What is meant by active trim?

Check your answers with those on page 77.

BASIC ELECTRICITY FOR LOCKSMITHS

Introduction

The study of electricity and electric circuits can be very simple or very detailed. In this course, we'll keep the study of electricity simple, while going into more detail in our discussion of circuits.

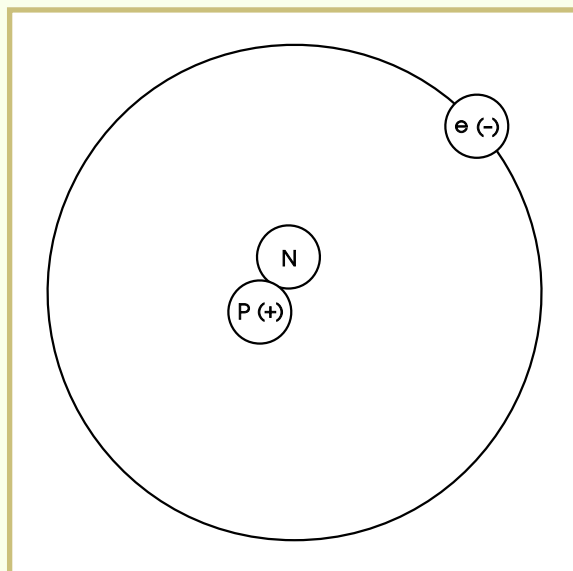
Electricity is a very abstract quantity. You can't see it until it heats up a filament in a light bulb. Even then, you aren't really looking at electricity, only its by-product flowing through a filament, heating the filament until it produces light. You can't smell electricity until something is wrong with the electric circuit, resulting in a burned wire or device. You can't hear electricity unless you use it to energize an alarm or buzzer. And you surely wouldn't want to taste or feel electricity since it can give you a nasty—or fatal—shock. Therefore, you can't see, hear, or otherwise use electricity, unless you use it in a circuit and convert it to some useful purpose, such as heat, light, sound, and so on. This is why we'll keep the study of electricity brief, and then take the time to review electric circuits and their troubleshooting in much greater detail.

What Is Electricity?

Electricity is the flow of charged atomic particles from a location of excess charge to a location with a lack of charge. The atomic particles responsible for electricity are *electrons*. Electrons surround the outer area of substances, as shown in Figure 10.

In nature, most substances present a *neutral* charge. Each atom contains three atomic particles—the *neutron*, the *proton*, and the *electron*. The neutron holds a neutral charge and is ignored in this text. The charged particles are the proton, which is positively charged, and the electron, which is negatively charged. The atom is naturally in balance, as it contains a positive charge (the proton) and a negative charge (the electron). Even billions of atoms in this state produce no electrical charge, because their structure is in balance.

FIGURE 10—This atom contains one particle with a positive charge, one with a neutral charge, and another with a negative charge.



To use electricity, an imbalance must occur in the charges.

In nature, the greatest display of electricity is lightning, which is caused by the friction of clouds against the earth. When the clouds become charged beyond the point where the air stops acting as an insula-

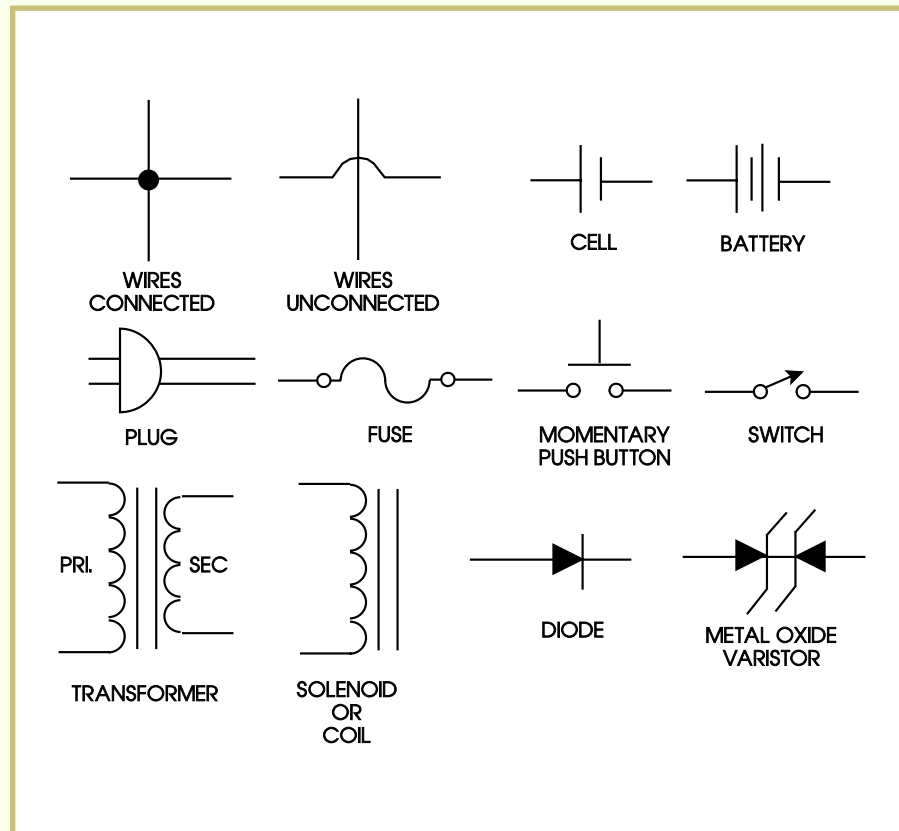
tor, a bolt (or bolts) of lightning results. The same type of charge occurs when you walk over certain types of carpets. Your body becomes charged, and then discharges shocks when you touch a grounded object. Both of these examples deal with a form of electricity known as *static electricity*. Static electricity is caused by friction and can reach very destructive levels.

Because we want electricity to be useful and productive, not damaging, our electrical power sources are closely regulated.

The electricity we use daily is rated in *voltage* or volts (V or E) and *amperes* or amp (A). You've probably heard the term 120 volts in discussions that involve, say, plugging a radio or other small appliance into a standard home or business electric outlet. You've probably also changed a 1.5 volt battery in a portable radio or flashlight. You've also probably changed a fuse or reset a circuit breaker with a 15 amp or 20 amp rating. By controlling the voltage and current of electric energy, we can make it perform useful work.

Voltage is often related to the force or pressure of electric energy. *Current*, on the other hand, defines the quantity of electricity flowing in a circuit. If we were to relate electric energy to water flow, a greater water pressure (voltage), pushes more water (electrons), through a hose than a lower pressure. If the hose is increased in diameter and the pressure remains the same, a greater quantity of water (current) would pass through the hose.

FIGURE 11—These are the symbols used in this text.



Electric Circuit Symbols

A special set of symbols has been developed to display an electric circuit visually. These symbols are standardized so that all manufacturers use them. The group of symbols used in this text are shown in Figure 11.

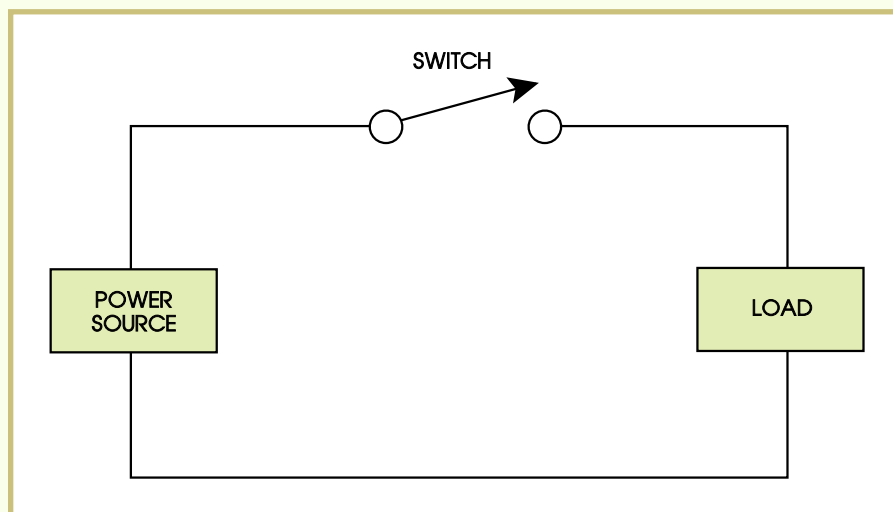
Electric Circuits

As mentioned, we must control and contain electricity so that it can perform useful work. In all of our modern systems, we contain and control electricity in *circuits*.

An electric circuit is a closed path of a power source, switch, and working device or load, as shown in Figure 12.

The power source can be either an *alternating current* (an AC source) such as an outlet, or a *direct current* (a DC source) such as a battery supply. The load can be any device such as a buzzer, bell, light bulb, and so on, that changes electric energy to some useful product. This simple circuit could be

FIGURE 12—An electric circuit contains a power source, switch, and a load.



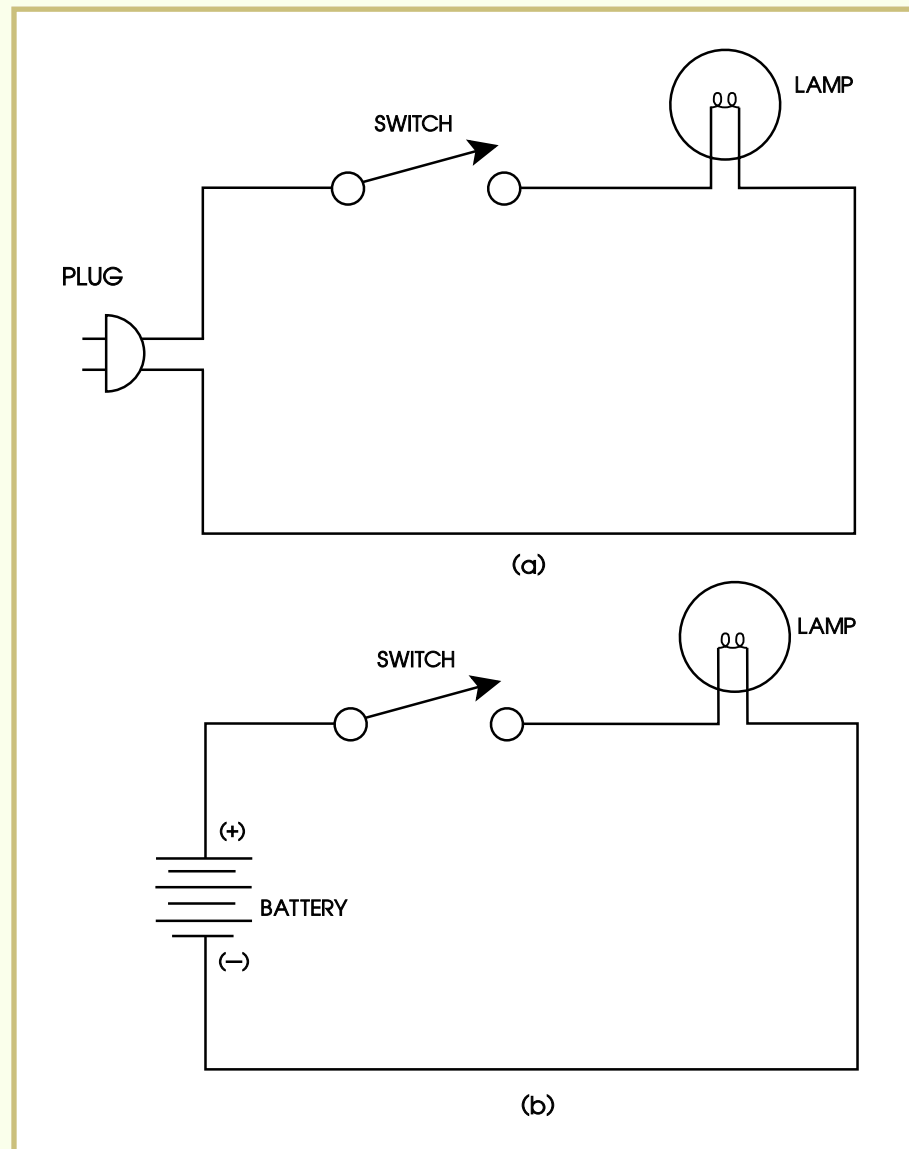
used to display the circuit for a table lamp or a flashlight. It contains the power source, conductors, a switch, and a light bulb load. Figure 13 shows the circuit diagrams for a table lamp in (a) and a flashlight in (b).

In both of these diagrams, the switch is open and the light bulb is off. This is the number one rule of electric circuits: In order for an electric circuit to operate, there must be a closed path for electron flow. Figure 14 displays both of the previous circuits with the switches closed, which allows electrons, better termed *electric current*, to flow. This current flows from the power source through the load and switches, and back to the power source, which completes the circuit and illuminates the light.

The third quantity of any electric circuit is called *resistance*. Resistance opposes the flow of current in any circuit and is measured in *ohms*. A lamp, alarm, buzzer, heating element, and other such working devices or loads have a certain amount of resistance to current flow. If resistance isn't present in a circuit and the circuit is closed, it's called a short circuit. This short circuit presents no opposition to current flow. In a home electrical circuit, a short circuit draws enough current so that the fuse or circuit breaker opens the circuit before the wires heat up enough to cause a fire. In a battery-powered electrical circuit, a short circuit causes the battery to quickly discharge.

As a locksmith, the most common form of resistance you'll add to a circuit is an electric lock. Inside the lock is a coil of fine copper wire wound many times around a metallic core. Copper has slight resistance to the flow of electricity. This resis-

FIGURE 13—This diagram shows an AC- and a DC-powered circuit.



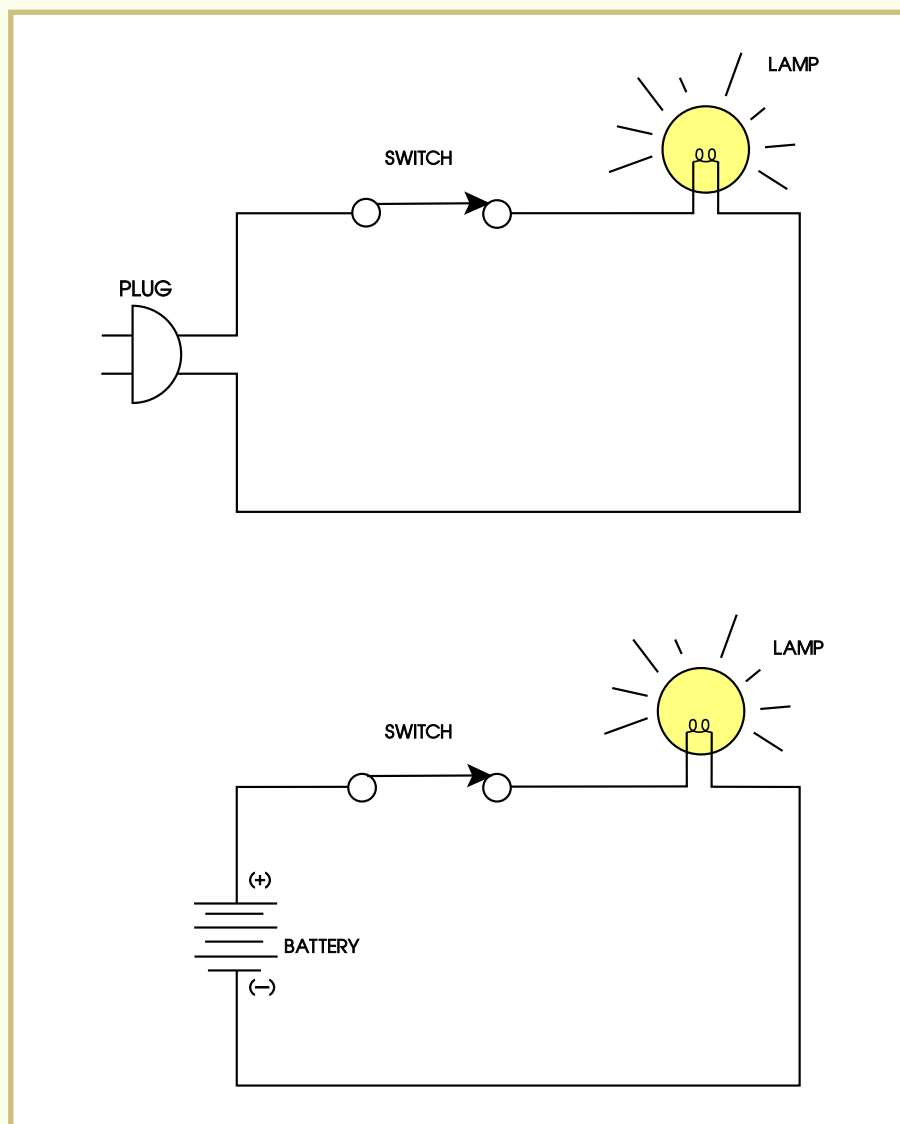
tance is normally measured in ohms per foot or per 1000 feet. In a typical lock coil, there's enough wire wound around the coil to produce a resistance from 20 to 60 ohms. In electrical notation, the ohm is denoted as the Greek symbol omega (Ω).

Ohm's Law

Voltage, current, and resistance are all related in electric circuits. The relation of these three quantities can best be shown in the formula known as *Ohm's law*:

$$\text{Current} = \text{Voltage} \div \text{Resistance} \text{ or } I = E \div R$$

FIGURE 14—If the switches of our previous circuit were closed, current would flow to the lamps causing them to illuminate.



What this formula states is that the current flowing in a circuit is equal to the voltage in the circuit divided by circuit resistance. If we looked at the circuit of a typical two-cell flashlight, the circuit would look like this:

$$I = E \div R$$

$$I = 3 \div 15$$

$$I = 0.2A$$

Here, the applied voltage—3 volts—is divided by the resistance, 15 ohms, to produce a current of 0.2 amp. As you can see, if the voltage in this circuit is increased, the current would also increase. If the resistance is increased, the current decreased.

Understanding Ohm's law will eliminate a great deal of confusion on the operation of electric circuits. Ohm's law can be

modified to find either the current or the voltage if the other two quantities are known. For example, if you know the voltage and the current, you can convert the formula to find resistance as shown here:

$$R = E \div I$$

In our previous flashlight example, if the current is 0.2 A and the voltage is 3 V, the circuit resistance would be

$$\begin{aligned} R &= 3 \div 0.2 \\ R &= 15 \text{ ohms} \end{aligned}$$

If you know the resistance and current, you can again change Ohm's law to read

$$E = I \times R$$

Using our original example numbers, therefore, we have

$$\begin{aligned} E &= (0.2) \times (15) \\ E &= 3.0 \text{ Volts} \end{aligned}$$

VOMs (Volt-Ohm-Milliamp meters) are designed to measure all three of these quantities. By using test meters, you can quickly and easily determine if there's a problem in an electric lock circuit and where this problem is located.

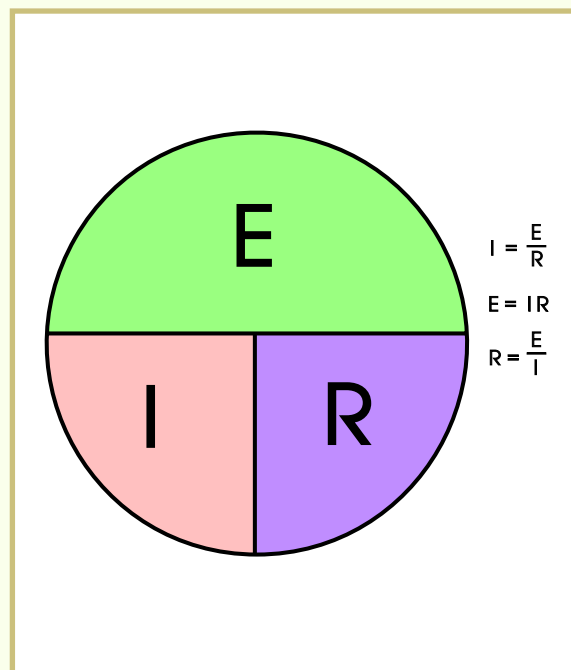


FIGURE 15—By placing your thumb over the desired circuit quantity, you can determine how to find that quantity.

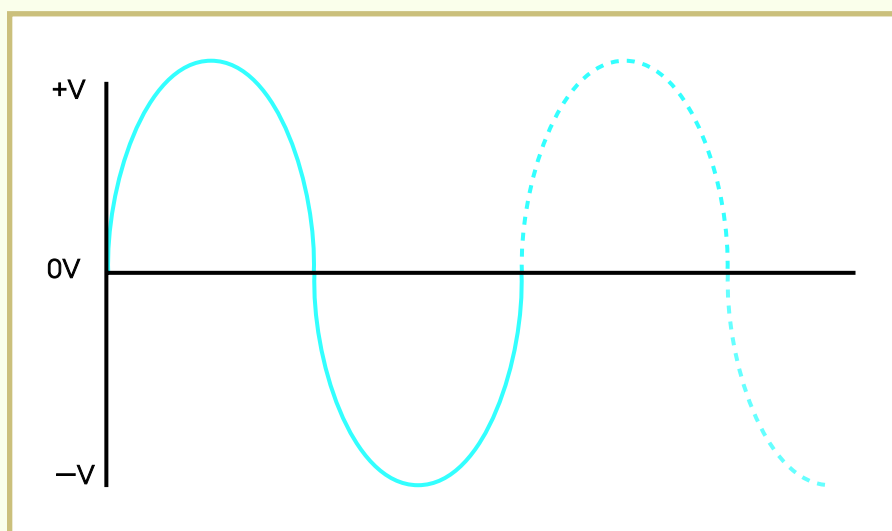
A handy aid to remembering Ohm's law is shown in Figure 15. To use this chart, simply place your finger over the quantity you want to determine. If the two uncovered quantities are above and below the horizontal line, divide the upper quantity by the lower quantity. If the two quantities are separated by the vertical line, multiply them.

Alternating and Direct Current

Electric locks are designed to operate on two forms of electrical energy—alternating current (AC) and direct current (DC).

Alternating current is the electric energy delivered by your local electric utility. AC electricity is delivered to your home or business as a sine wave as shown in Figure 16.

FIGURE 16—Alternating current changes from a positive half cycle to a negative half cycle 60 times a second.

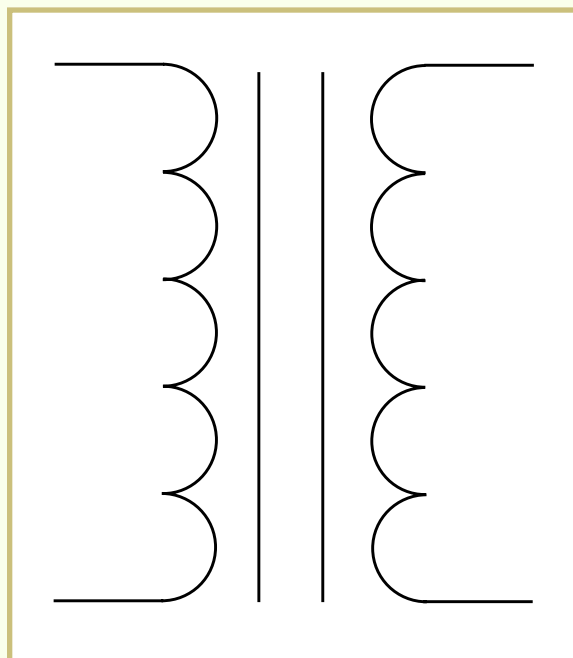


AC electric energy oscillates from a maximum to a minimum value in what's known as a *cycle*. These cycles occur very quickly, at the rate of 60 times per second. This is often called 60 hertz and can be abbreviated 60 Hz. AC electric energy is used by utilities since it's easily transmitted at a very high voltage and then “stepped down” for residential and business use. The component that steps the voltage down is known as a *transformer*. The symbol for a transformer is shown in Figure 17.

The symbol for a transformer shows a primary winding, PRI, that has many turns of wire. This side is normally connected to the high-voltage side of the incoming AC electric energy. Electric utilities use pole- or pad-mounted transformers to step down the 7200 volts or more used in transmission lines to the 120, 240, or 480 volts used by homes and businesses. The primary side would connect to this high-voltage side of the line voltage.

The secondary side, SEC, carries the reduced voltage. In the utility transformer example, the lower voltage is then sent to a home as a 120/240 volt line, or to a business as a 120, 240, or greater voltage.

FIGURE 17—The electric circuit symbol for a transformer is shown here.



Most of the electric lock circuits you work with use a transformer to step down 120 VAC (Volts Alternating Current) to 6, 12, 24, or 48 VAC. Most electric locks use this lower value of AC voltage to eliminate the possibility of shock hazards.

Direct current, or DC, is a steady state, electric-

energy source as shown in Figure 18. It doesn't cycle as AC electric energy does. Direct current can be provided by batteries, as in our flashlight example given earlier. In this case, each cell produces about 1.5 VDC (Volts Direct Current). If the cells are stacked together (+) to (-), or end to end, you add the cell values together. A good example is a 12 VDC car battery that contains six cells stacked together.

Some electric locks that you work with have direct current, or DC coils. These coils are rated for 6, 12, 24, or 48 VDC. However, these locks normally aren't powered from batteries. Their coil resistance is somewhat low, and therefore, their current draw is rather high. (Remember Ohm's law?) A special device is used with AC transformers to create a DC voltage from the

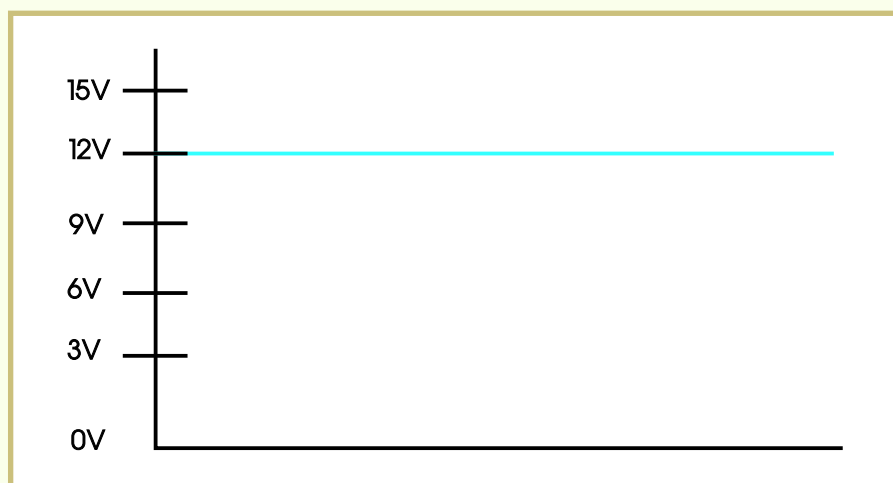
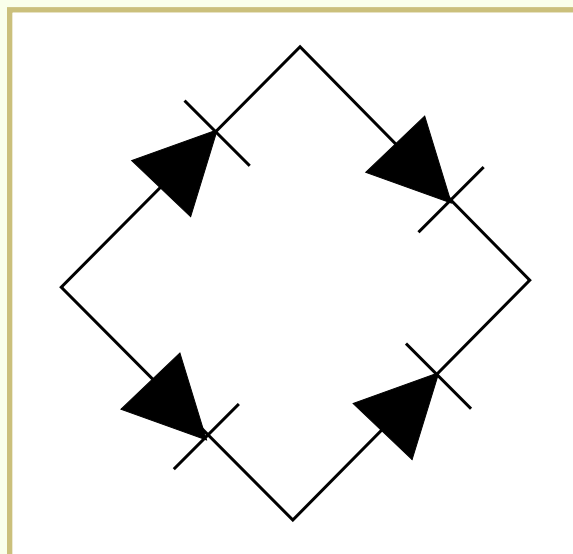


FIGURE 18—DC or direct current holds a steady voltage at all times.

FIGURE 19—The symbol for a bridge rectifier is shown here.

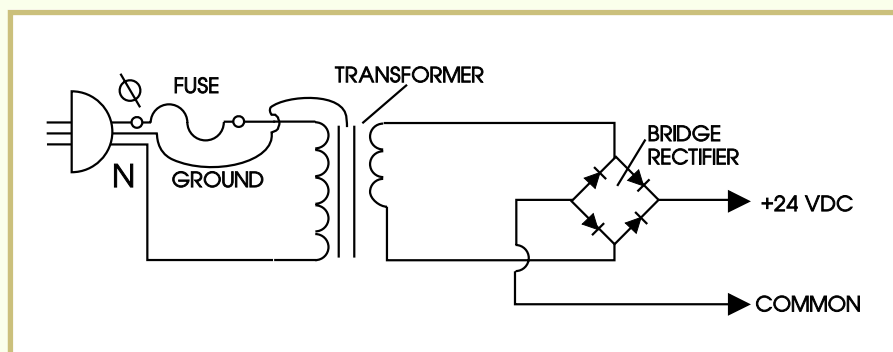


stepped-down AC voltage of a transformer.

The special device used to change AC to DC is called a *rectifier*. The type of rectifier used on electric lock circuits is the *full-wave bridge rectifier*. The symbol for a bridge rectifier is shown in Figure 19.

The basic circuit for AC to DC conversion is shown in Figure 20. Let's start at the left and discuss this circuit.

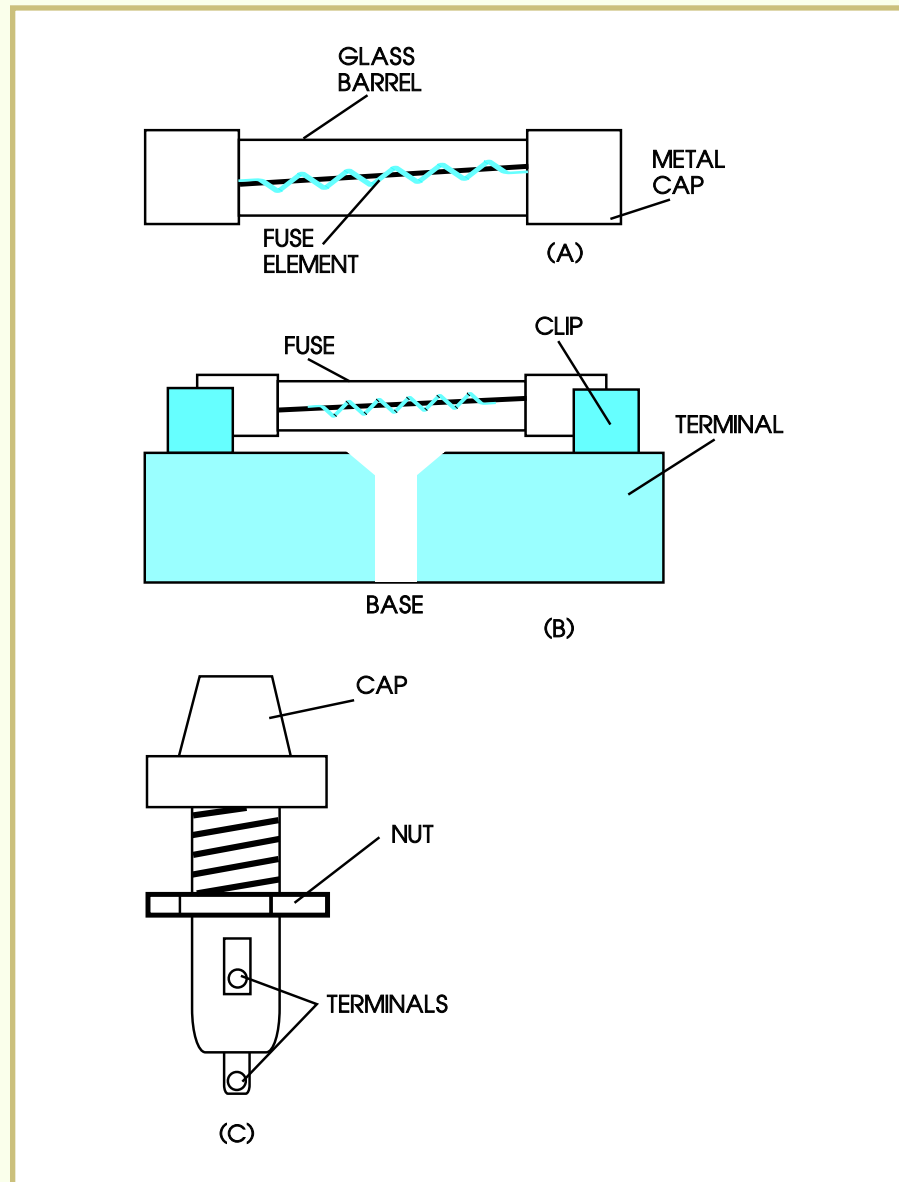
FIGURE 20—This is the basic configuration for a DC-powered electric lock's circuit power supply.



At the extreme left is the power cord. A plug is shown; however, in some installations, the transformer is mounted to a junction box and is directly connected to an AC power source. The symbol to the right of the power cord is a fuse. Following the fuse is the transformer and the full-wave bridge rectifier.

The fuse is a protection device for the circuit. If the transformer, rectifier, switch, or lock coil fail, causing excess current draw, the fuse would open the circuit. This action would prevent additional circuit damage or a fire. A typical fuse is rated in amps or in fractions of an amp, depending upon the current draw of the circuit. Typically, the fuse has a glass barrel with an internal conductor and two metal ends. If the fuse senses excess current, the internal conductor melts and separates, opening the circuit. A typical glass fuse and two

FIGURE 21—Shown here is a fuse in (a), and two types of fuseholders in (b) and (c).

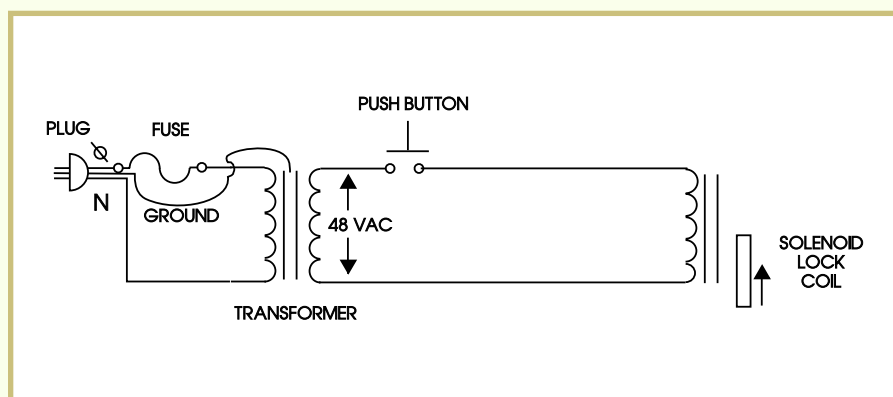


types of fuseholders are shown in Figure 21. The transformer and the rectifier complete this circuit. The transformer takes the 120 VAC service and converts it to a lower voltage. The rectifier changes this low AC voltage to a DC voltage. Fuses are one method of providing overcurrent protection. Another common way is "impedance protected." If this way is used, it will say so on the transformer.

The Electric Lock Circuit

Now that the power source for an electric lock circuit has been covered, let's look at the electric lock circuit. In the

FIGURE 22—A complete circuit for a 48 VAC electric lock is shown here.



simplest electric lock circuit, a single switch or push button and an electric lock is used to protect one door. The circuit for this simple electric locking system is shown in Figure 22.

The power supply circuit for this electric lock consists of a fuse and a transformer. The output of this transformer is 48 VAC. One side of the transformer connects to the electric lock's coil and the opposite side of the transformer connects to a push button switch. The coil remains de-energized until the push button is pressed, which completes the circuit and energizes the coil. When the coil is energized, the coil attracts a plunger that allows the door to open. This type of circuit is called a *series circuit*. One end of each component is connected to one end of another component. The electrical current flow through each component is equal.

Next, let's look at a parallel circuit, made by adding a second switch to the circuit. Figure 23 shows such a circuit. The power supply section of this figure is similar to the circuits shown earlier. The only modification is the addition of a switch that's connected across, or parallel to, the push button. Now, if either the push button is depressed or the switch is turned to the ON position, the electric lock's coil energizes, allowing the door to be opened.

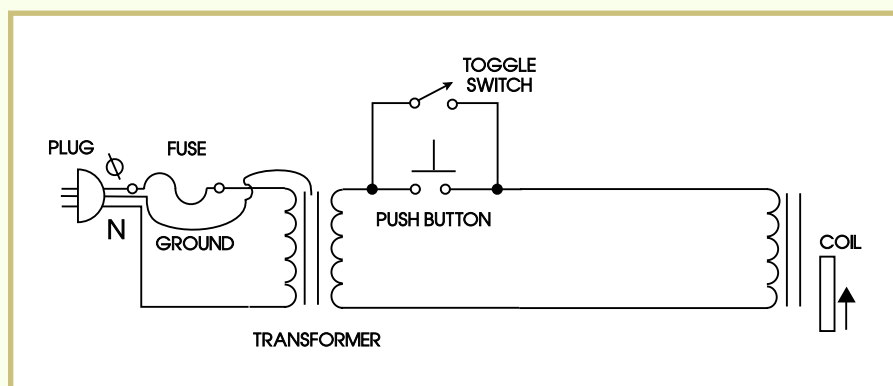
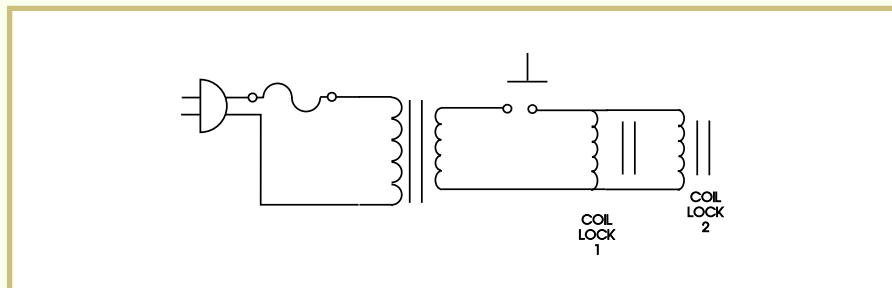


FIGURE 23—In this circuit, either the toggle switch or the push button switch energizes the electric lock's coil.

FIGURE 24—This circuit shows how two electric lock coils can be connected in parallel.



Electric loads or working devices can also be connected in parallel. This is normally the case when two or more doors with electric locks are controlled by one switch. This type of system is shown in circuit schematic format in Figure 24. In this system, both locks operate when the push button is depressed. The current flow in this circuit doubles, since two loads are connected across the power supply.

Electromagnetism

Two of the electric circuit devices we've been discussing—the transformer and the electric lock coil—use *electromagnetism* to operate.

Electromagnetism is created by a magnetic field that surrounds a conductor when electric current flows through it. This field is shown in Figure 25.

The magnetic field that surrounds the wire is very small. If you could place a compass very close to the wire, you would see the needle of the compass deflect slightly. This small deflection serves no real purpose in pulling back an electric lock solenoid. However, if you loop the wire, as shown in Figure 26, the magnetic fields would add together, increasing the overall field strength.

In an electric lock's coil, hundreds of turns of wire can be wound around a core. The fields from the many turns of wire are concentrated in the core when the wire coil is energized. In fact, the coil has enough strength to pull the plunger out of the strike box on a typical electric door lock.

Transformers also work on electromagnetism. In a transformer, the primary and secondary windings are wound on the center part of a laminated steel core. This construction is shown in Figure 27. When the primary winding receives a source of AC electricity, a magnetic field is built up in the core. This field alternates in one direction and then in the

FIGURE 25—A single wire that has current flowing through it produces a magnetic field that can align a set of compasses. The clock in the figure shows that the field is in a clockwise direction.

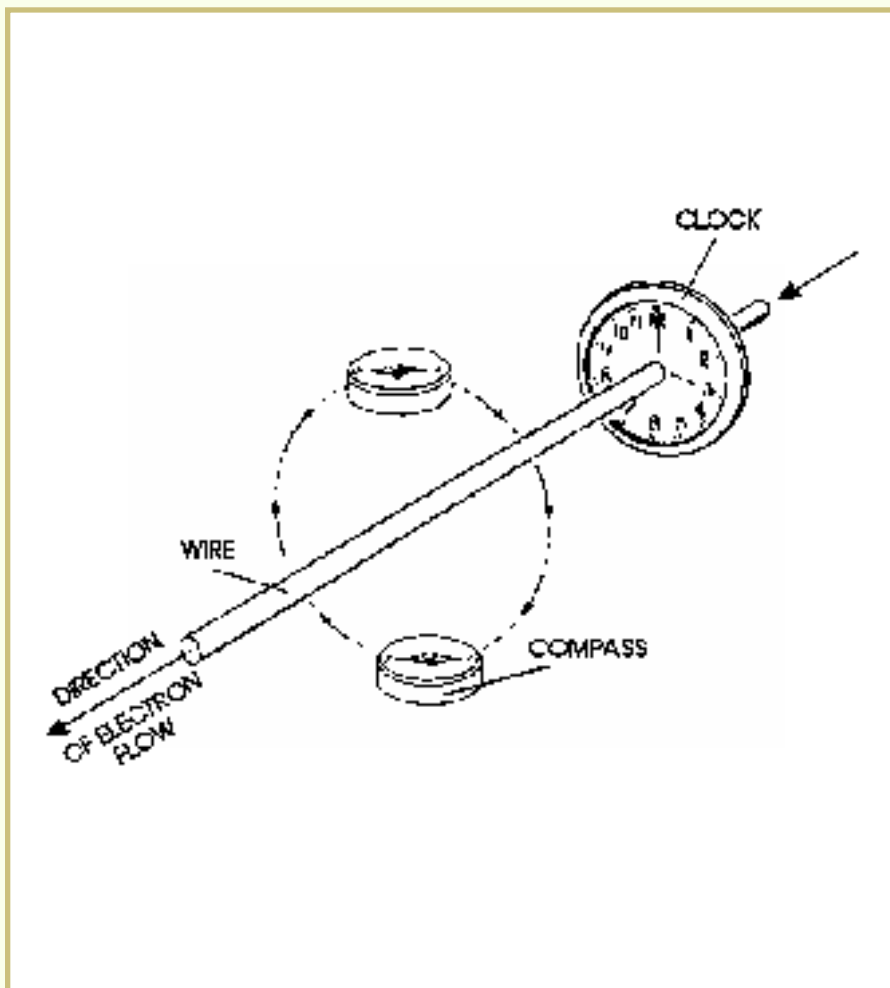
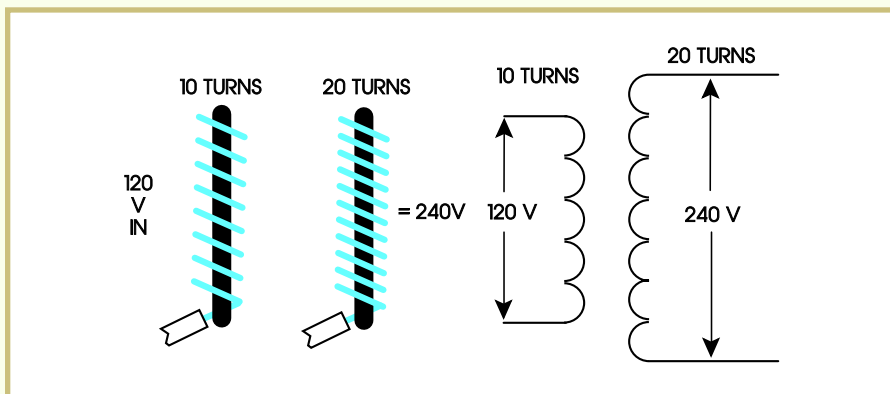


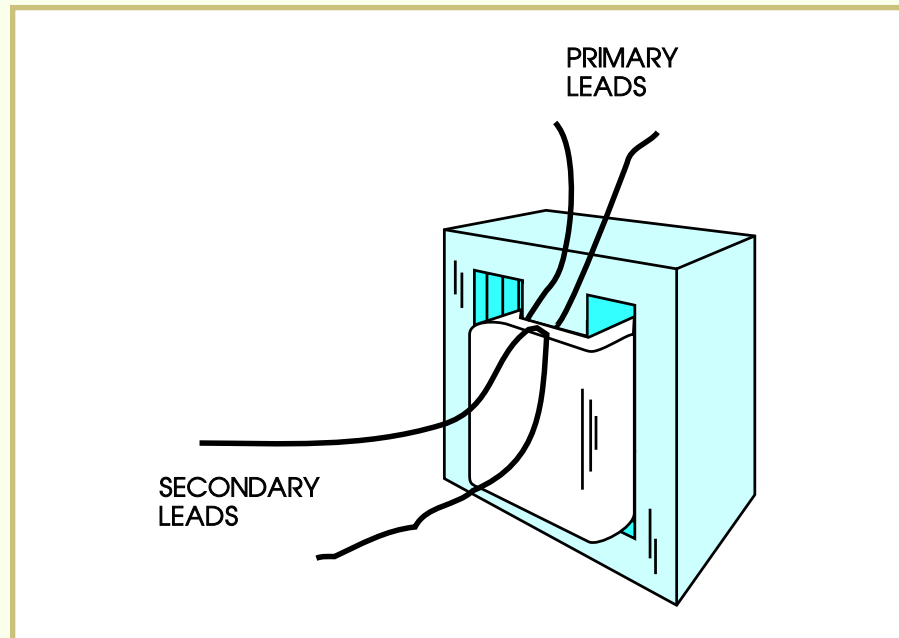
FIGURE 26—When the wire is looped as shown here, the magnetic fields add together to produce a stronger field.



other direction as it follows the AC cycle. This field is induced into the secondary windings that supply AC voltage to the circuit and its load.

The actual output voltage of the transformer is normally stamped on the transformer. Along with this information is the current transformer’s carrying capabilities.

FIGURE 27—Since both coils in a transformer are wound on a single core, the magnetic field in the primary winding is induced on the secondary winding.



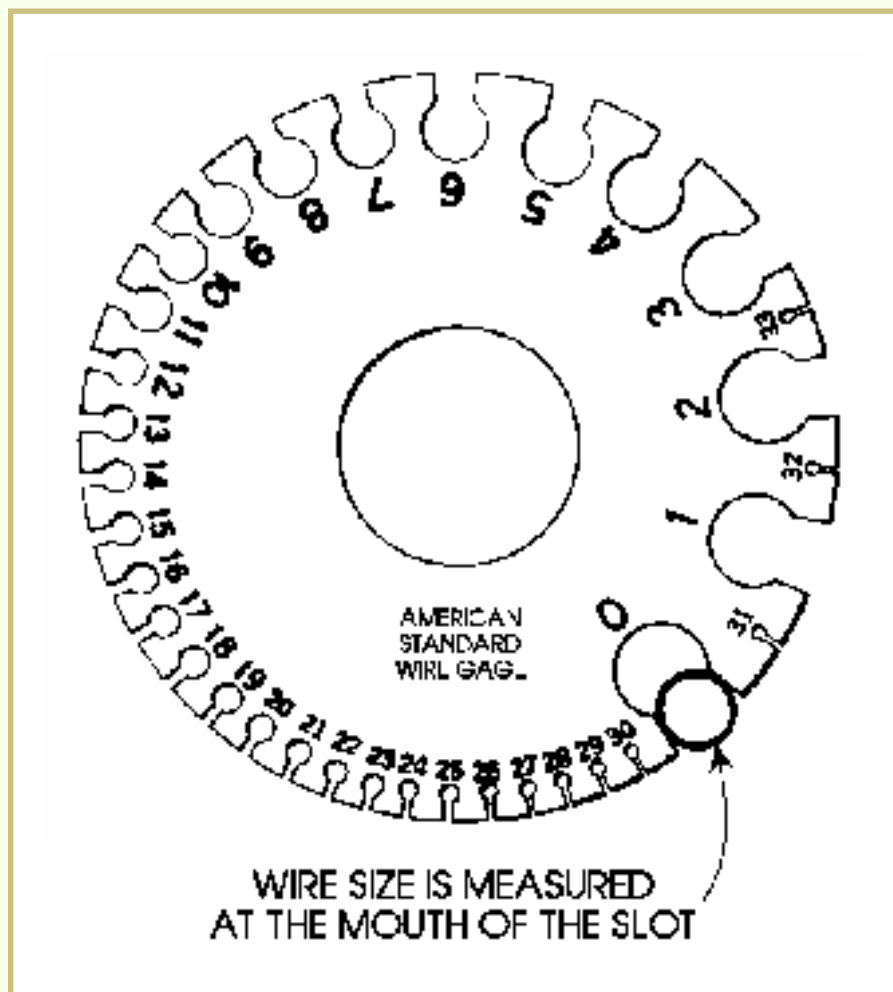
The transformers you work with are step-down transformers. These contain a greater number of turns in the primary, rather than the secondary, winding. Be careful to connect this transformer to the AC line properly. If you reverse the connection, you will have created a *step-up* transformer producing a potentially lethal voltage. This is because a transformer works on a turns ratio. For example, a transformer that changes 120 VAC to 240 VAC has a turns ratio of 1:2, meaning that for every one turn in the primary, there's two turns in the secondary. If you hook this transformer up backwards, it has a 2:1 ratio. Now the 120 VAC input voltage on the secondary will present 240 VAC on the primary windings. As mentioned, this voltage can present a lethal shock hazard and will destroy rectifiers, switches, and door lock coils. Be careful! If you ever have any doubts about which way to connect a transformer, ask an electrician! Don't assume! Most transformers for electric locks have wire leads for the primary and screw terminals for the secondary. Transformers may also be stamped with the letters PRI and SEC on the coil's sides where the leads exit the windings.

Additional Electric Locking Circuit Devices

All electric lock circuits use some form of wire as a conductor. Wire is normally made of a copper core surrounded by a plastic or rubber insulator. The thickness of the copper core determines the amount of current the wire can carry without

becoming hot. The thicker the conductor, the greater the amount of current the wire can carry. Wire size is rated by a number system, the *American Wire Gage system*, or AWG. Figure 28 displays the common AWG sizes.

FIGURE 28—The AWG wire gage system of rating a conductor is shown here.



One unusual aspect of the AWG system is the larger the number used to identify the wire, the smaller the wire's current-carrying capability. With most electric lock circuits, you'll be using AWG 18 or 16 gage wire. The coils of electric locks draw less than one amp, allowing you to use the higher number wire that has a lower current-carrying capability.

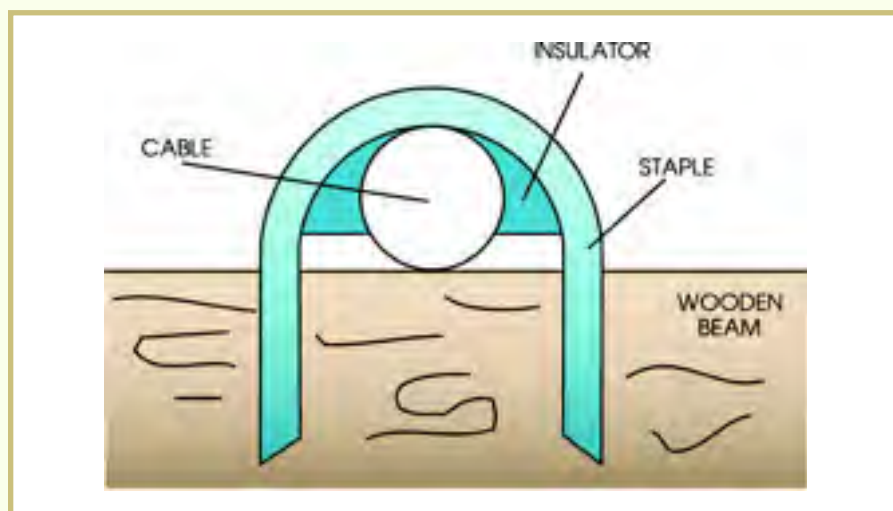
The insulation that surrounds the copper conductor is normally made of plastic or rubber. Special coatings can also be made of silicon rubber, teflon, and other synthetic compounds. As mentioned, the type of insulation and the spacing between the wire and metallic surfaces determine the maximum voltage that the wire can safely carry without the wire arcing to a

grounded object. Typically, in electric lock circuits, you'll be using thermoplastic single- or two-conductor cable. Thermoplastic cable carries the markings TFFN for *thermoplastic teflon*. Electric lock manufacturers have cable available in spools of various lengths for use with their systems.

The individual wires or cables used must be properly stapled or otherwise held in place at various points in the installation. Typically, the wires run from the power supply to a remote switch or push button, and then to the locking device.

If you use staples, make sure to use insulated staples as shown in Figure 29. These staples can be hammered into wooden beams to hold the wires or cables securely to the beams. The staples shouldn't be hammered too far into the beam, pinching the wire. Instead, hammer them in just enough so that the wire is held loosely in the staple's insulator.

FIGURE 29—An insulated staple can be used to hold cables or wires to wooden beams.

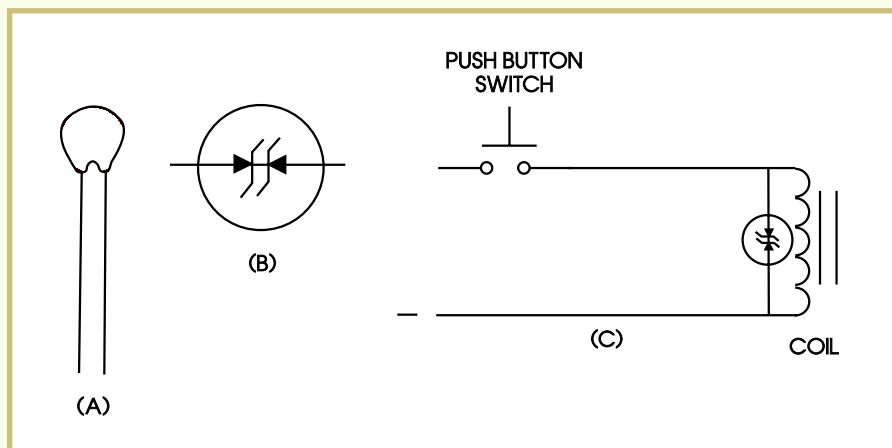


Some installations require the use of conduit. Here, you have two choices—plastic or metal conduit. Plastic conduit is very simple to cut, glue, and install. Metal conduit requires many additional tools, such as cutters and benders and should be avoided.

Some AC electrified lock manufacturers use an electrical spike suppressor across the coil of the lock. This device is called a *metal-oxide varistor*, or MOV. This is the same type of device that's used on power strips for computers and other home entertainment equipment. In operation, a MOV doesn't conduct and is invisible to the electric lock circuit. However, when the coil of the lock is de-energized, the magnetic field around the coil acts as a form of generator. A large voltage

spike, up to four times the voltage rating of the coil, can be developed for an extremely short period of time. This spike can damage switch contacts and be passed back into the power lines influencing computers, television sets, or whatever. When placed across the coil of the electric lock, the MOV dampens this spike, preventing damage to the electric system and equipment. Figure 30 displays a typical MOV, its electric circuit symbol, and how you should connect it across an electric lock coil.

FIGURE 30—A typical MOV is shown in (a) with its circuit symbol in (b). In (c), you can see how the MOV is connected across the coil's leads.



If the electric lock coil is powered by a DC power supply, the same type of spike can occur as the magnetic field around the coil collapses. A MOV can be used across the coil to dampen this spike. However, a semiconductor device known as a *diode* is normally used. A diode is a form of rectifier device that allows the flow of current in one direction while preventing the flow in the opposite direction. A typical diode, its symbol, and a circuit diagram are shown in Figure 31.

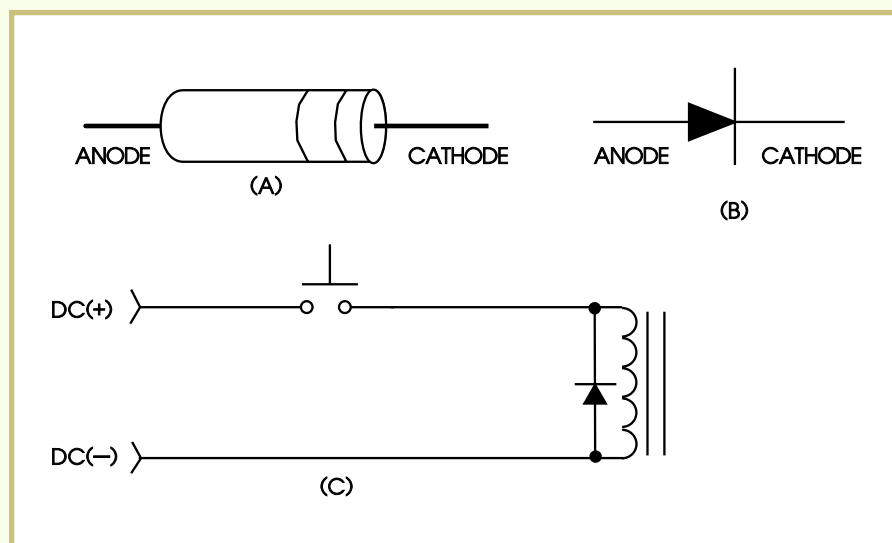


FIGURE 31—A diode can be used in a DC circuit to prevent circuit damage. A diode is shown in (a) with its circuit symbol in (b) and connection in (c).

A diode looks like a small barrel with two leads exiting from each end. These leads attach to the diode's anode and cathode. The cathode is always on the band end of the diode. The trick to installing a diode across the coil is to place it with the anode on the negative lead of the coil and the cathode on the positive lead of the coil. This configuration prevents the diode from conducting when the button is depressed, energizing the coil. The diode conducts only when the button is released, absorbing the spike. The easiest method of properly placing the diode is to use color-coded wires for connection to the coil. If, for example, you use red wire for the positive supply and white wire for the negative supply, you can easily attach the anode to the white wire and the cathode to the red wire. If the diode is installed incorrectly, it will provide a short circuit which would cause the fuse to blow in the transformer's primary circuit.

A current limiter finds wide use in mortise or cylindrical electrified locksets that are energized for long periods of time. By limiting current to the lock's coil, the coil's temperature is greatly reduced, prolonging the coil's lifespan. Sometimes current limiters are built into full-wave rectifier modules.

The final components we'll look at in this section are the actual switches used to energize or de-energize the coils. These switches come in a wide variety of styles, from simple toggle switches to keyed-style switches. Normally, the switches have a single set of contacts to be used in the circuit. However, in special applications, the switches may be ganged together to provide multiple contact arrangements. Figure 32 displays two types of switches.

Troubleshooting Electric Lock Circuits

Troubleshooting electric lock circuits isn't difficult. With the proper equipment and knowledge, you can easily identify an electric lock circuit's reason for failure.

The ideal test instrument for circuit troubleshooting is the *Volt-Ohm-Milliamp meter*, or VOM. A VOM can measure AC and DC voltage, resistance, and circuit current. Two types of VOMs are shown in Figure 33.

FIGURE 32—Shown here are two of the many different types of switches used in lock circuits.

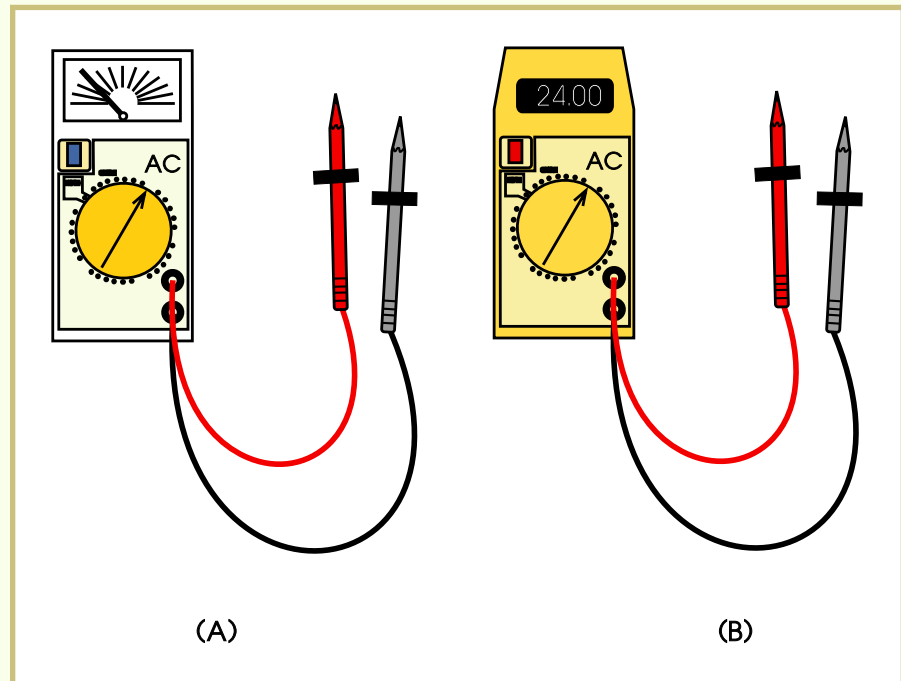
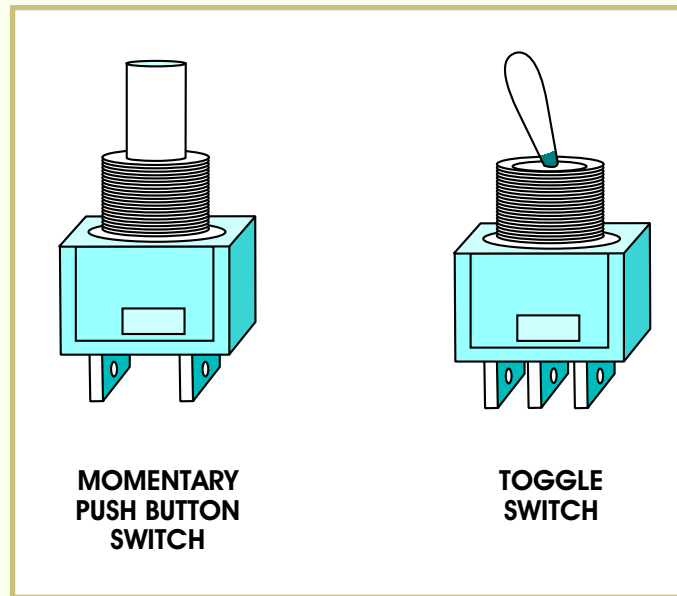


FIGURE 33—Shown here is a typical analog VOM in (a), and a digital VOM in (b).

The VOM on the left is a typical analog VOM. (An analog display has a needle, and you have to read the value off a scale from where the needle is pointing.)

The measurement is always an approximate measurement.) It features a meter on which the values of voltage resistance and current can be read. The VOM on the right is a digital VOM. It features a digital display for measuring these circuit quantities. (A digital display is a direct numerical readout. The measurement is an exact measurement.)

Either type of VOM has insulated test leads that plug into the front or side of the case. One test lead is black in color and is normally plugged into the COM, or common terminal, of the VOM. The other test lead is usually red and is plugged into the jack marked (+), volts, or ohms.

An analog VOM normally has a selector switch on its case which is used to set the meter to the circuit quantity and range you desire to measure in the circuit. For example, if you want to measure an AC voltage of 120 VAC, you would select the AC range and 200 V. Always select a value of voltage much higher than you expect to actually measure in the circuit. This action prevents “pegging” the meter’s needle and possibly causing internal meter component damage. This care should also be exercised when measuring current with an analog meter. If you don’t select a meter range above the amount of current in the circuit, the meter may possibly be damaged. When measuring resistance, it doesn’t matter what range you select on the resistance scales. This is because the meter provides its own circuit voltage by means of an internal battery. However, don’t try to measure resistance in an energized circuit. The circuit’s power source must be removed before resistance tests are made.

Circuit measurements with most digital VOMs are much simpler than with analog VOMs. The digital VOM normally can’t be damaged by using the wrong scale. If the meter senses that the circuit voltage or current is too high, it displays an OL, which means “overload in the digital display.” You can, therefore, increase the range and get a true reading of the circuit quantity.

A digital VOM may have a selector switch like the analog VOM. Other types have a series of push buttons on the side of the case, which are used to select the resistance, voltage, and current scales.

A VOM makes electric circuit troubleshooting quick and efficient. However, it’s a good idea to completely read and understand the manual that comes with your VOM before you attempt to perform any type of circuit measurements.

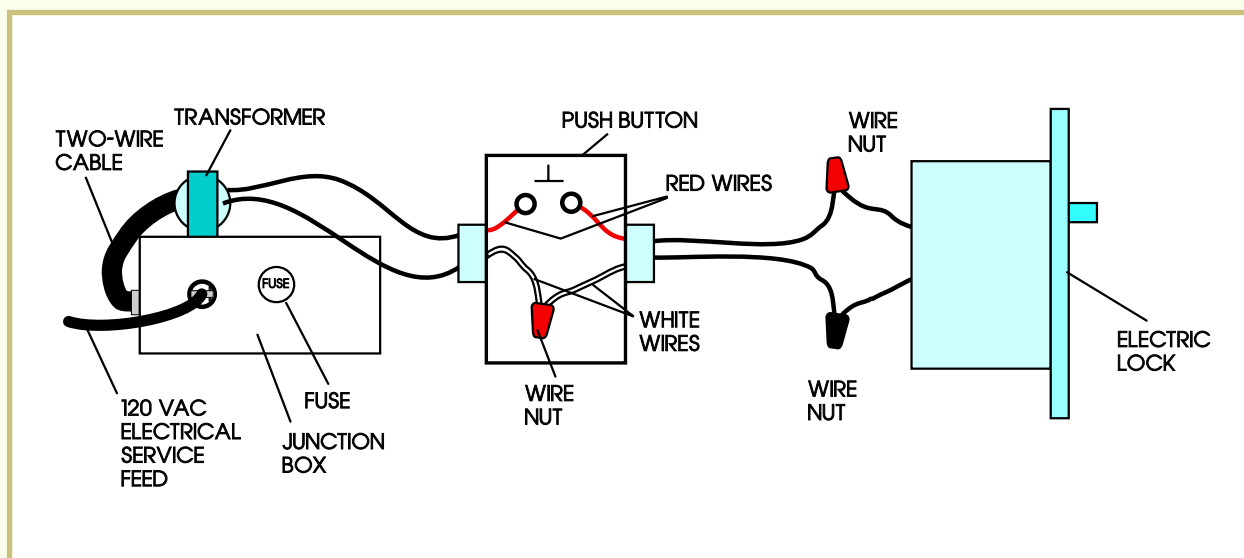


FIGURE 34—This pictorial diagram is used in our troubleshooting examples.

Testing AC Circuits

A typical single electric lock circuit is shown in pictorial form in Figure 34. On the diagram's left is a junction box with the transformer mounted to its lid. The home or business power circuit connects to the transformer's primary leads in this box. A fuse, if present, is placed on this box. The cable to the push button switch connects to two screw terminals on the secondary of the transformer. The voltage at this point is 24 VAC. The cable runs from the transformer to a switch box. In the switch box, the red wire in the cable is connected to the switch. The white wire is connected to the white wire that goes to the electric lock. The red wire in the second cable attaches to the opposite side of the switch. This second cable exits the switch box and is connected to the electric lock's coil.

Let's assume that this circuit was installed and in working order until yesterday. Now, the customer calls to tell you that the system isn't working and the door is locked shut. You arrive at your customer's site to discover that pressing the unlock push button has no effect whatsoever on the electric lock. Where should you start checking the circuit?

You could begin checking at any point in the circuit and continue testing until the problem is found. However, this method wastes a great deal of time. Instead, it's better to divide the circuit into two parts and test at the midpoint of the circuit. This method allows you to test more components in a shorter period of time.

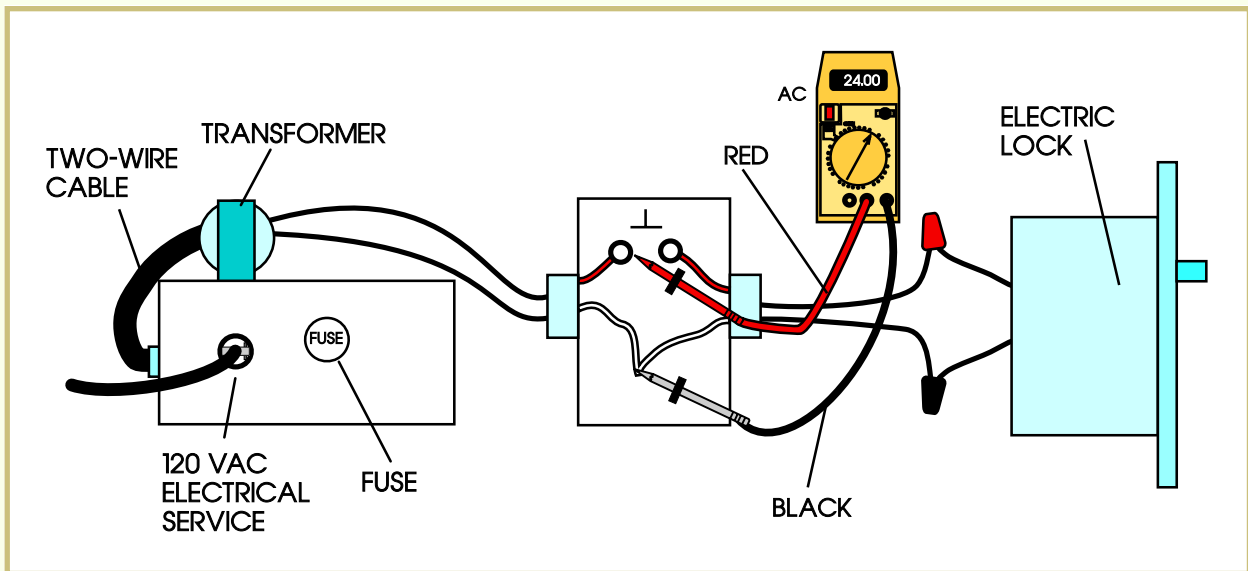


FIGURE 35—Since the digital meter is measuring 24.00 VAC, the circuit up to the push button is in proper working order.

In our example, we'll check the circuit at the push button with a VOM, as shown in Figure 35. If voltage is found at this test point, the problem is located at the wire to the coil or the coil itself. If no voltage is found at this test point, the problem is located in the 120 VAC service, fuse, transformer, or cable to the push button box.

In looking at this figure, the meter displays 24 VAC. Therefore, the power supply components are in working order. The problem must be at or ahead of the push button switch.

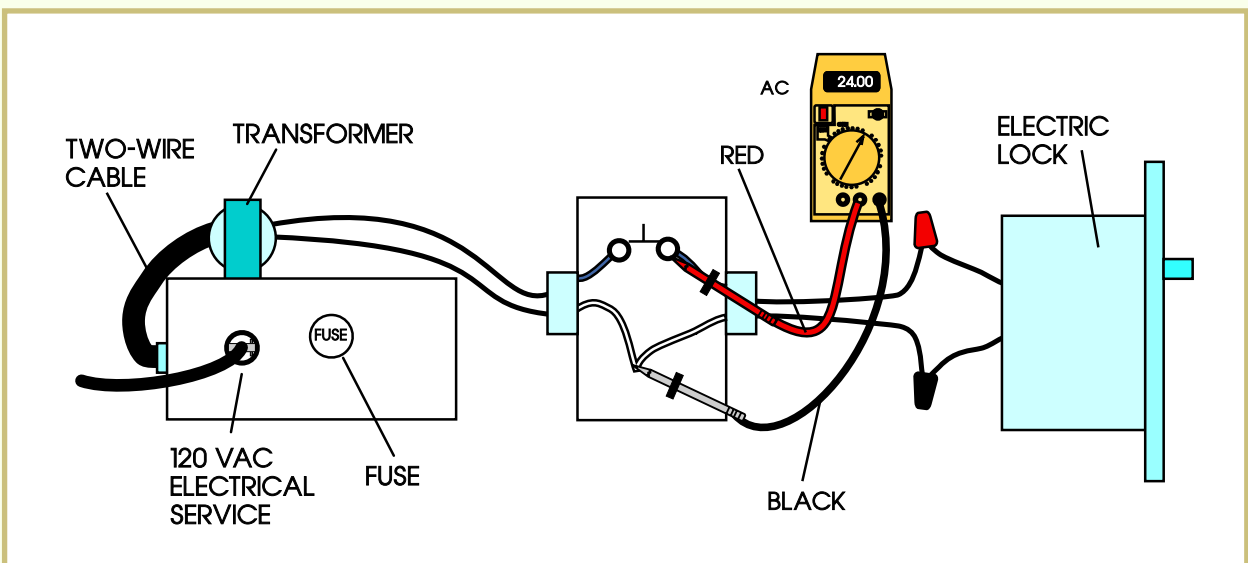


FIGURE 36—After depressing the push button, check the load side of the push button, as shown here, to check its operation.

To check the push button, move the red wire test lead to the opposite side of the push button, as shown in Figure 36. Now, press the push button. As you can see on the meter, the proper voltage, 24 VAC, is shown on the meter's display.

The problem, therefore, must be in the wiring to the coil or the electric lock's coil. These tests are best performed by making resistance readings on the remainder of the circuit. Remember: to perform resistance tests, you must remove power to the circuit. You can disconnect the electric service to the lock by turning off the circuit breaker or removing the fuse at the service panel for this circuit. If you can't find the fuse or circuit breaker, you can remove the two wires at the transformer's secondary.

With power removed from the circuit, perform a resistance test on the coil as shown in Figure 37. The meter shows an OL in the display, meaning that there's no resistance or continuity in the coil.

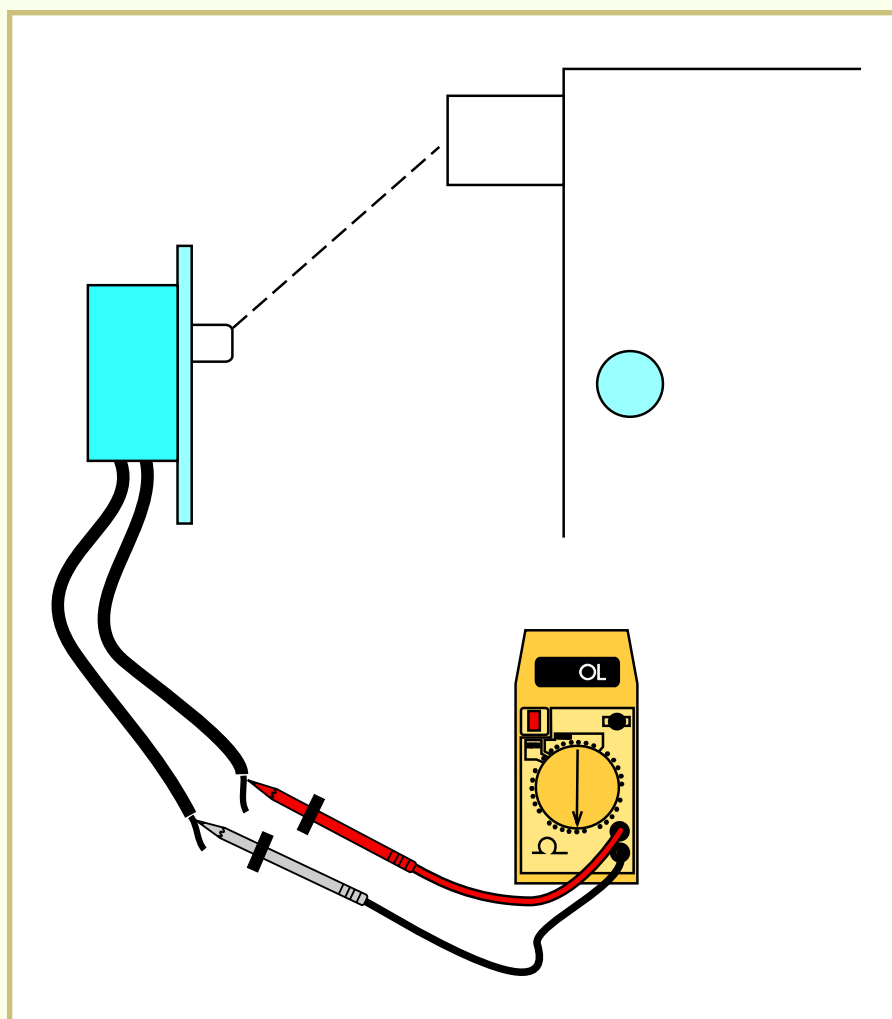


FIGURE 37—Checking the coil of this solenoid type electric strike shows that the coil has broken and there's no resistance between its leads. The measured value should be 60 ohms.

The coil is marked 0.4 A. Its proper resistance from Ohm's law would be

$$R = E \div I$$

$$R = 24 \div 0.4$$

$$R = 60 \text{ ohms}$$

Since the meter reads an open circuit, the wire has broken somewhere inside the coil. Replacing the electric lock coil would repair this system.

Breaking the circuit in half and testing at the midpoint saved you many troubleshooting steps. Since the voltage was present at the push button and the push button was in good working order, you eliminated all of the components except the cable to the electric lock and the lock's coil. By testing at the coil, you quickly found the problem.

Testing DC Circuits

Let's look at another circuit. This time, let's look at one for a DC electric lock (Figure 38). This circuit is quite similar to the earlier circuit. However, a bridge rectifier has been added at the transformer's secondary.

If the same problem of no operation is evident, where would you check first? Just as with the AC system, the best first check is for DC voltage at the push button. This first test tells you if the problem is at the power supply or the electric lock assembly. This first test saves you a great deal of time in troubleshooting.

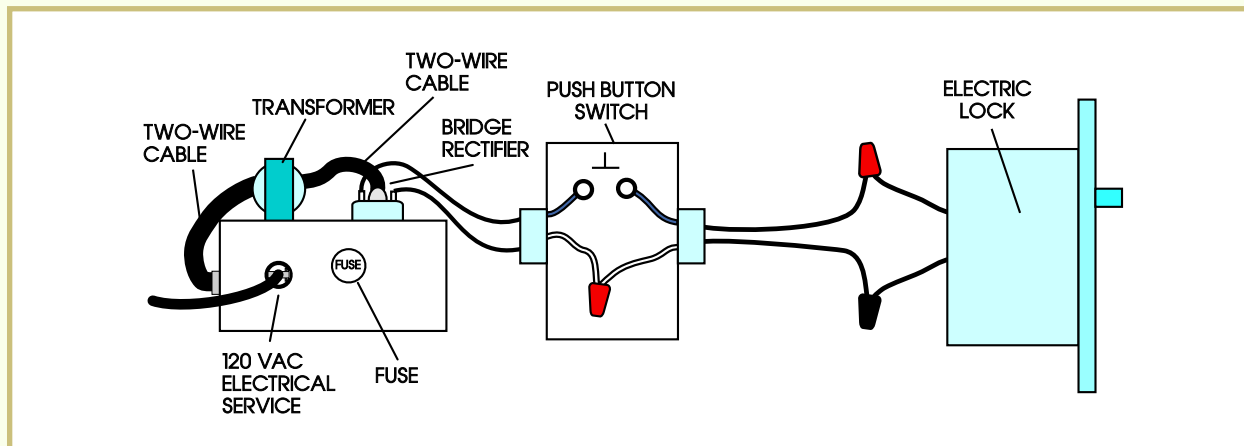


FIGURE 38—The DC-powered lock circuit is very similar to the AC-powered circuit, except this circuit contains a bridge rectifier.

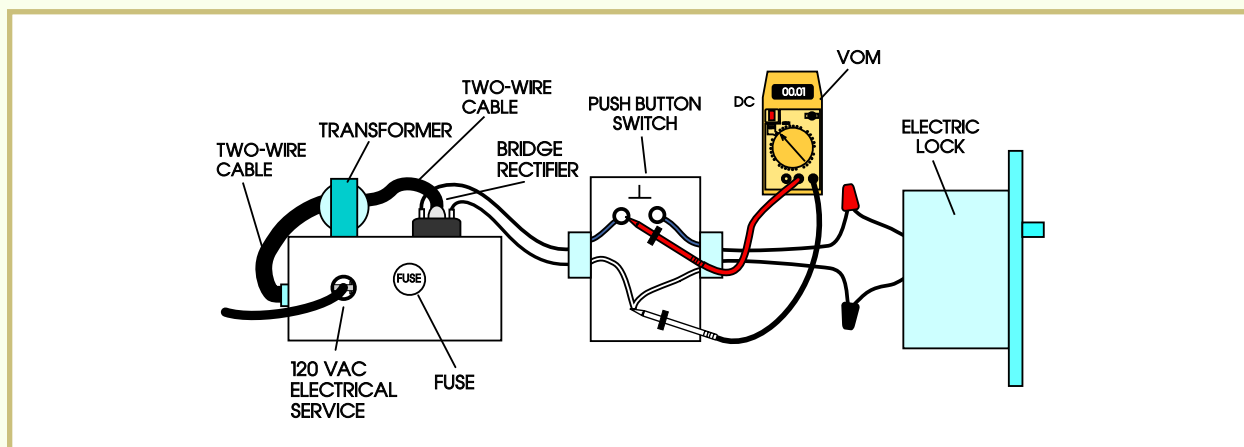


FIGURE 39—As shown here, the voltage from the power supply is zero volts. This indicates that the problem is in either the power supply or the cable from the power supply.

The test for 24 VDC at the push button is shown in Figure 39. Here the meter is set to measure DC and the test reveals that there is no voltage present at this location. What should the next test involve?

The next best test point is at the transformer's secondary. (The secondary is the winding that delivers the desired transformed voltage.) Again, the circuit is divided in half. The test on the transformer's secondary is shown in Figure 40. This test can be taken at either of two locations. You could test for the presence of 24 VAC at the two screw terminals at the transformer as shown in this figure. Or you could test at the AC input terminals of the bridge rectifier. However, the placement of the test leads is somewhat more difficult on the crowded rectifier module.

This test reveals the presence of 24 VAC on the transformer's secondary. Now, let's remove the test leads, switch the meter to DC voltage, and place the test leads on the DC output terminals of the rectifier, as shown in Figure 41. The red lead should be placed on the (+), or positive terminal of the rectifier, and the black meter lead should be placed on the (-), or negative terminal. The meter display shows only 00.09 VDC coming from the rectifier meaning that this component has failed and should be replaced to make the system functional.

As you can see, by dividing the circuit in half and testing in a logical process, problems in an electric lock circuit can be quickly found and repaired.

In the first problem, we found a failed electric lock coil that could be easily replaced. The rectifier assembly could also

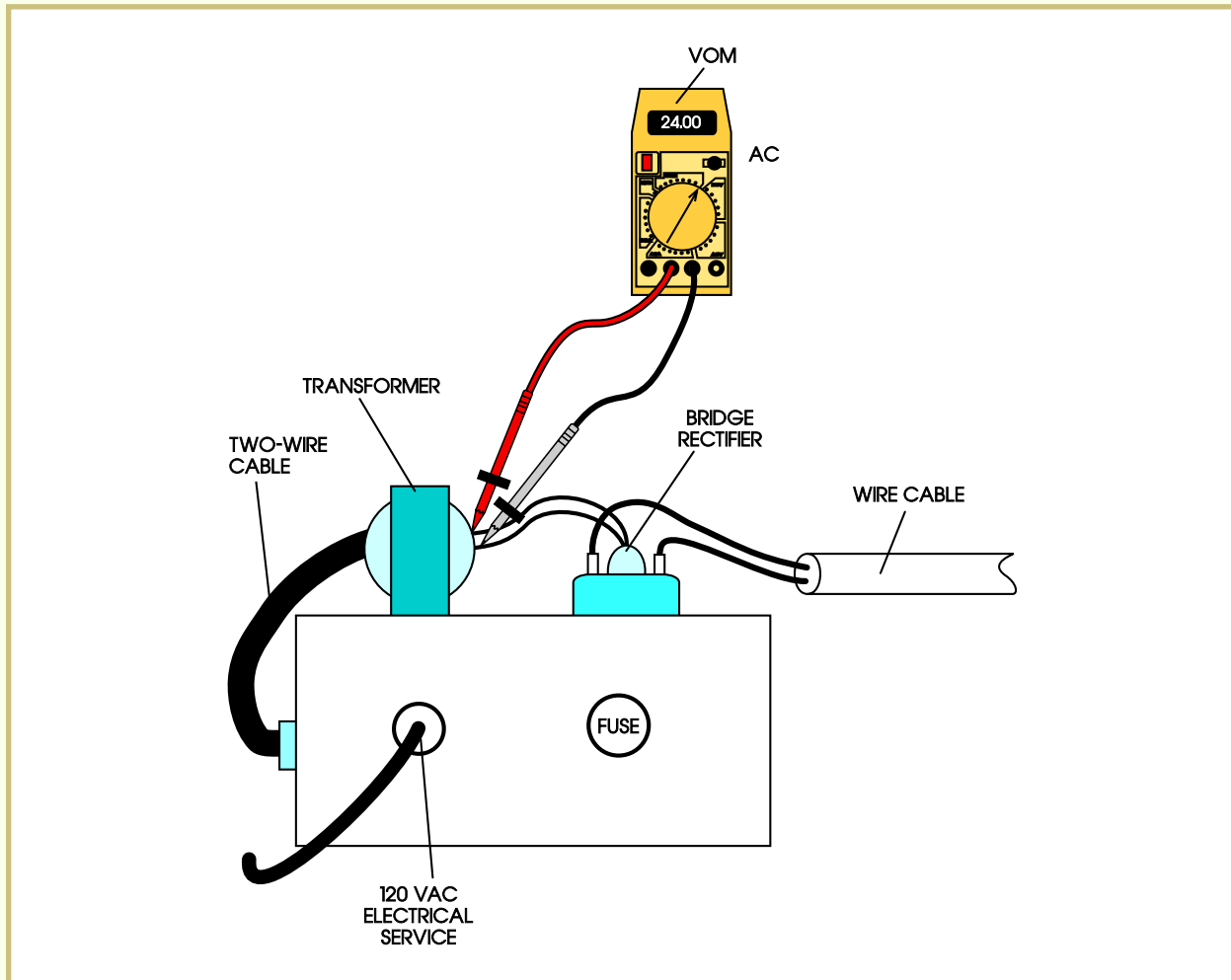


FIGURE 40—A test on the transformer's secondary shows that the electric service and the transformer are working properly.

easily be replaced by removing the wires from the terminals and loosening one screw in the center of the bridge rectifier assembly. Then just screw in the new rectifier and replace the wires, and you're done.

Note: Always make sure to remove the main electric service to the transformer at the service panel *before* replacing any electric lock circuit components.

Testing for Short Circuits

Although short circuits aren't common in lock circuits, they may occur. For example, the transformer's winding can short circuit if the transformer overheats; a bridge rectifier can short; or a cable that's pinched too tightly by a staple can short.

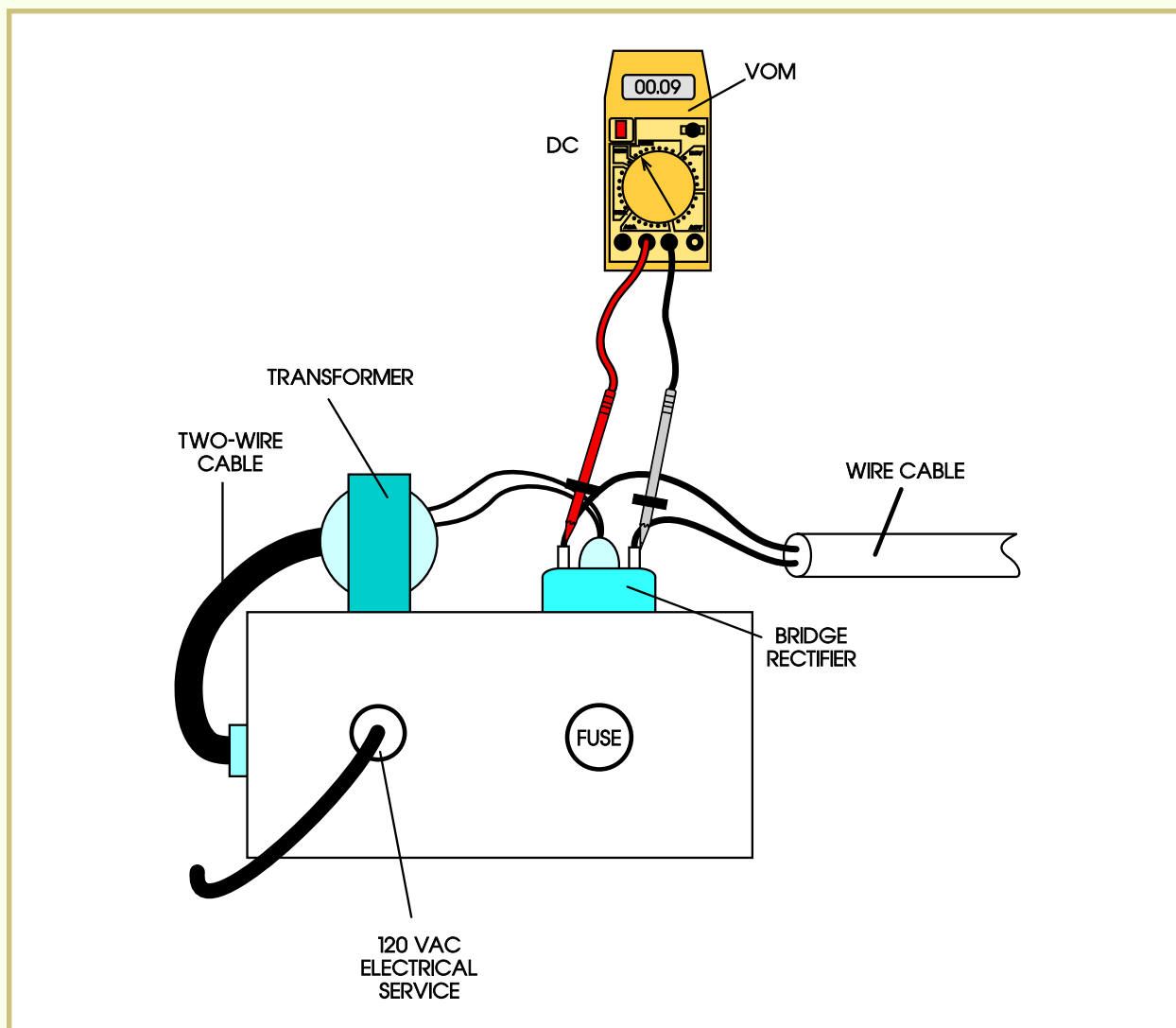


FIGURE 41—In this test of the bridge rectifier assembly, the meter displays a very low voltage, revealing a failed rectifier.

Short circuits are tested with all power removed from the circuit. The resistance scales of the VOM are used. Transformers normally display a very low resistance. Primary windings typically range from 3 to 10 ohms. Bridge rectifiers normally display a very high resistance in the thousands of ohms (kilohms or Kohms). Terminal-to-terminal resistances can even be in the millions of ohms (megohms or Mohms). As you've already seen, the resistance of a lock's coil can be in the range of 2 to 60 ohms, depending upon the coil voltage and the coil's operating current.

When taking resistance measurements, the best place to start is normally at the electric lock's coil. This test was already shown in Figure 37.

Measuring Circuit Current

Circuit current tests aren't as common as voltage and resistance tests in electric lock circuits. Circuit current checks, however, are used when one component in a circuit is overheating. A typical circuit current test is shown in Figure 42.

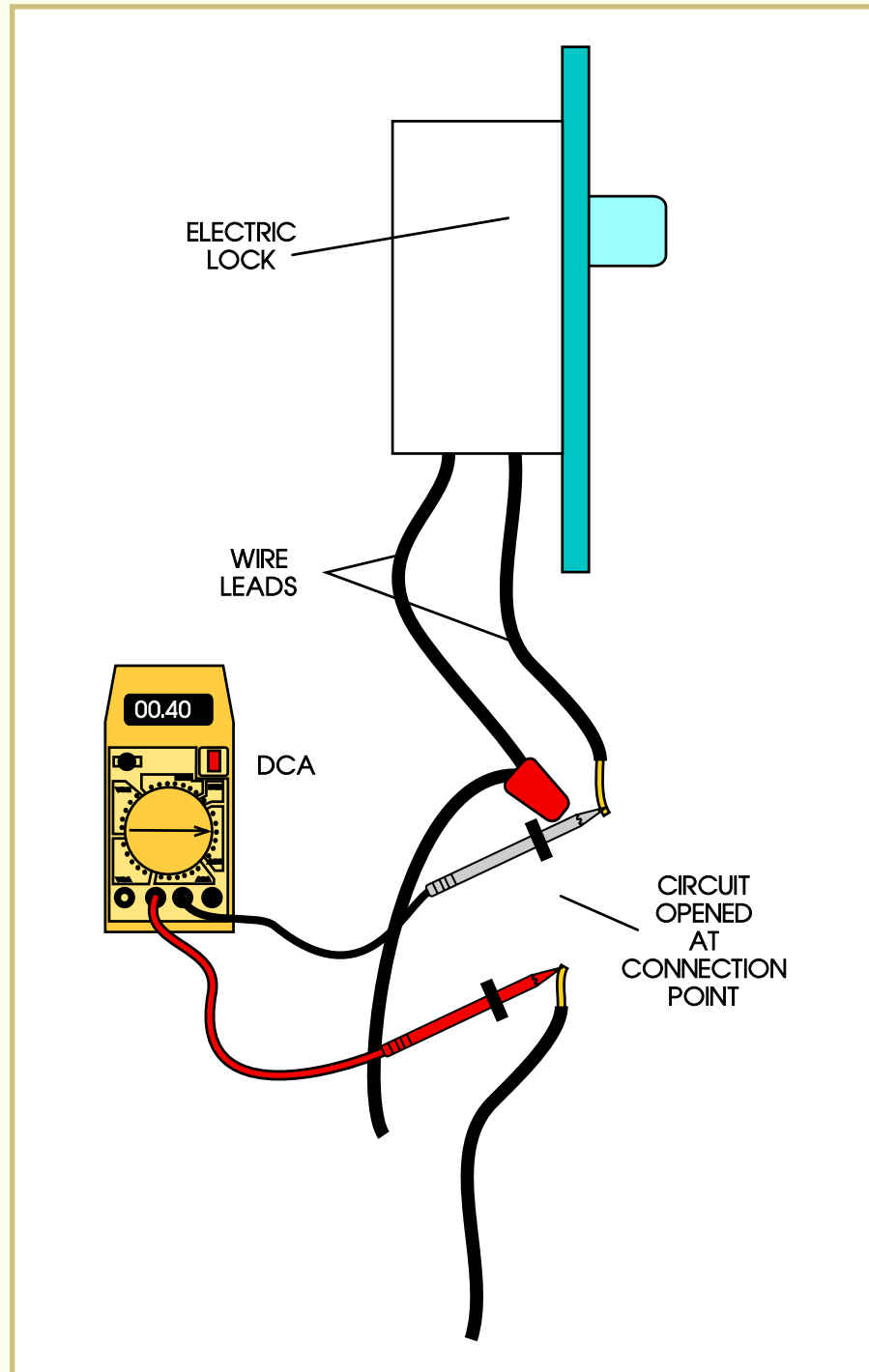


FIGURE 42—When measuring current, you must open the circuit and install the meter leads to complete the circuit.

Here, the circuit must be broken and the meter’s leads inserted as shown. If the reading is normal, it tells you that the power supply and electric lock circuit are operating properly. The overheating of the lock’s coil could then be caused by the mechanical binding of the latch or bolt assembly. If the circuit current is too high, the problem is most likely in a faulty lock coil. Or the problem could be a defective diode or MOV.

The following troubleshooting chart will aid you in making electric lock circuit repairs.

Problem	Cause	Remedy
Coil doesn't operate	No electric service	Check service and reset circuit breaker or replace fuse
	Blown fuse	Replace fuse in power supply
	Faulty transformer	Replace transformer
	Faulty rectifier	Replace rectifier
	Faulty temperature limiter	Replace temperature limiter
	Open wire	Test wires and repair as necessary
	Open switch or push button	Test and replace as necessary
	Open lock coil	Test and replace as necessary
Transformer overheats	Stuck locking mechanism	Free mechanism or replace
	Short circuit	Check circuit and repair as necessary
	Wrong coil	Check coil ratings—voltage-current duty type
	Shorted rectifier	Replace rectifier
	Shorted diode or MOV	Replace as necessary

Electric Safety

The secondary voltages in our example circuits has been 24 or 48 V. This voltage is below the human threshold needed to feel the electricity in the form of a shock. The primary voltage, however, is 120 VAC. This voltage is felt as a nasty shock and can be fatal in certain conditions. Also, some older electric lock circuits contain 120 VAC coils, with the entire circuit at this voltage. To prevent electrical shock, follow these guidelines:

1. Make sure you understand the circuit before you work on it.
2. Identify any circuit point above 48 V, AC or DC. This is the threshold voltage where you can receive shocks.
3. Use insulated tools, such as screwdrivers, pliers, and so forth. *Never* use tools with metal handles when working on electric circuits.
4. Check your tools and meter leads for breaks in the insulation; repair or replace these items as necessary.
5. Never touch grounded objects such as electrical boxes, water pipes, heating pipes, and so on while working on electric circuits. If you must hang on to one of these items when testing or replacing a component, something is wrong. Instead, use an insulated ladder—wooden or fiberglass—to provide a stable work area.
6. Always measure twice before touching any electrical component. For example, if you must change a transformer, the primary side is at 120 VAC. Shut off power to the transformer and measure the service wires for the presence of voltage. Now, check an outlet that's energized to make sure your meter is working properly.
7. Work with only one hand whenever possible.

A fatal electric shock occurs when electric current passes through the body and heart. Even a very slight current through the heart causes palpitations or irregular heartbeats (fibrillation). A large current through the heart can cause the heart to stop pumping blood. A nominal amount of electricity, for example, 65 MA for eight seconds, will cause fibrillation. To put this in perspective, note that a 100 watt lightbulb pulls 830 MA.

To prevent electrical shock, always work with one hand on a circuit and don't allow the other hand, arm, or shoulder to become grounded. Always remove your watch and rings.

When to Call an Electrician

With a little experience on electric lock circuits, you can quickly and easily install, troubleshoot, and repair these circuits. However, the installation of the electrical service to the

transformer (and other electrical service installations) should be performed by a licensed electrician. An electrician knows what size wires to install and understands how to connect these wires in a circuit breaker or fuse box. Most areas have building codes and require, by law, that electricians install service wiring.

You should also call an electrician if you can't disconnect the primary side of the transformer from the building's electrical service. For example, you may have turned off many breakers or removed fuses and the transformer remains under power. At this time, call an electrician to investigate the circuit before you attempt to work on an energized circuit.



Locking It Up! 3

1. List two types of volt-ohm-milliamp meters, or VOMs.

2. Why should you use insulated tools when working on a circuit?

3. What atomic particle is responsible for current flow?

Check your answers with those on page 77.

ELECTRIC STRIKES, LOCKS, AND KEYLESS LOCKS

Introduction

Now that you've seen how electric circuits for locks are constructed, let's begin looking at the electric lock itself.

As you remember, an electric lock operates by means of a wire coil. When the coil is energized by electricity, it creates a magnetic field. This magnetic field can be used to attract a plunger or other locking device.

Many different kinds of electric lock coils exist. As you've seen, there are AC and DC coils used on electric locks. Locks with AC coils are often termed *audible locks*, since a buzzing sound can be heard when the coil is energized. This buzzing occurs as the rising and dropping AC cycle causes the magnetic field to increase and decrease. An audible strike or door lock is very advantageous in certain situations. For example, if an entry door is protected with an electric lock, a telephone, and a video camera, once the operator decides to allow passage, the person entering the building will know the door is open by a coil's buzzing sound.

AC electric locks normally have coils rated at 12, 16, 24, and 48 VAC. Coil resistance for these coils is in the range of 7 to 15 ohms.

DC electric lock coils are also very popular. Since DC locks don't buzz, they're called *silent locks*. The only thing you'll hear with this kind of lock is a slight click when the coil is energized.

DC coils are available in voltages of 6, 12, 24, and 48 VDC. The normal coil resistance ranges from 1 ohm to over 60 ohms.

Electric strikes and locks can also be categorized by the period of time the coil can be energized. The two categories are *intermittent* and *continuous duty*.

Most electric strikes normally remain de-energized for long periods of time. As a matter of fact, the only time most electric strikes are energized is when the door needs to be released for entry. Often, the coils remain energized only for a few seconds. This is called *intermittent duty*. If this type of coil is energized for a long period of time, the coil would overheat and be destroyed.

On some doors with electric strikes or locks, the coil must remain energized for long periods of time. The coils used for these locks are *continuous-duty* coils. These coils generally have a much higher resistance than intermittent duty coils and have wires with a better grade of insulation to handle the heat. In some systems, a temperature limiter is used to reduce the coil's voltage, and therefore, the current, a few seconds after the coil is energized.

Electric Strikes

Electric strikes are a popular form of electric lock for protecting remote doors or for limiting access within a building. A typical electric solenoid-type lock is shown in Figure 43.

This type of lock is the simplest form of electric lock. Normally, the spring inside the coil's center keeps the plunger extended into a hole or slot bored into the door. The door remains locked until the plunger is retracted by energizing the coil. This is the most common configuration of the simple electric lock. However, other units that allow the door to be in an unlocked state until the coil is energized are also available.

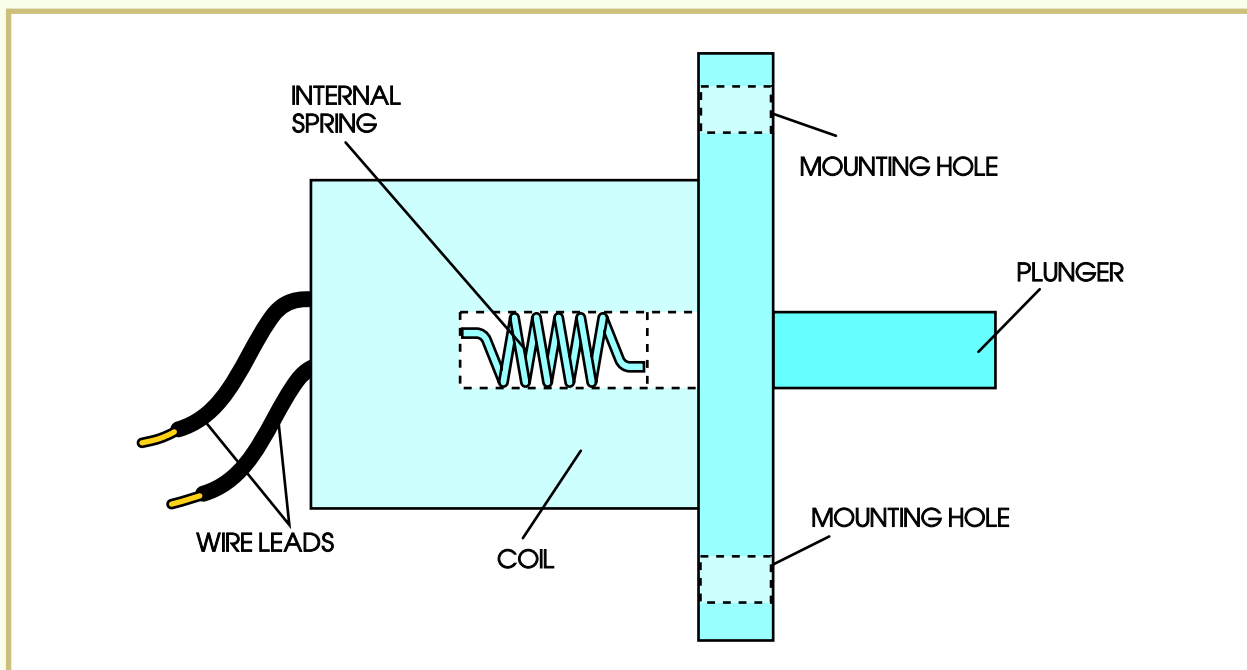
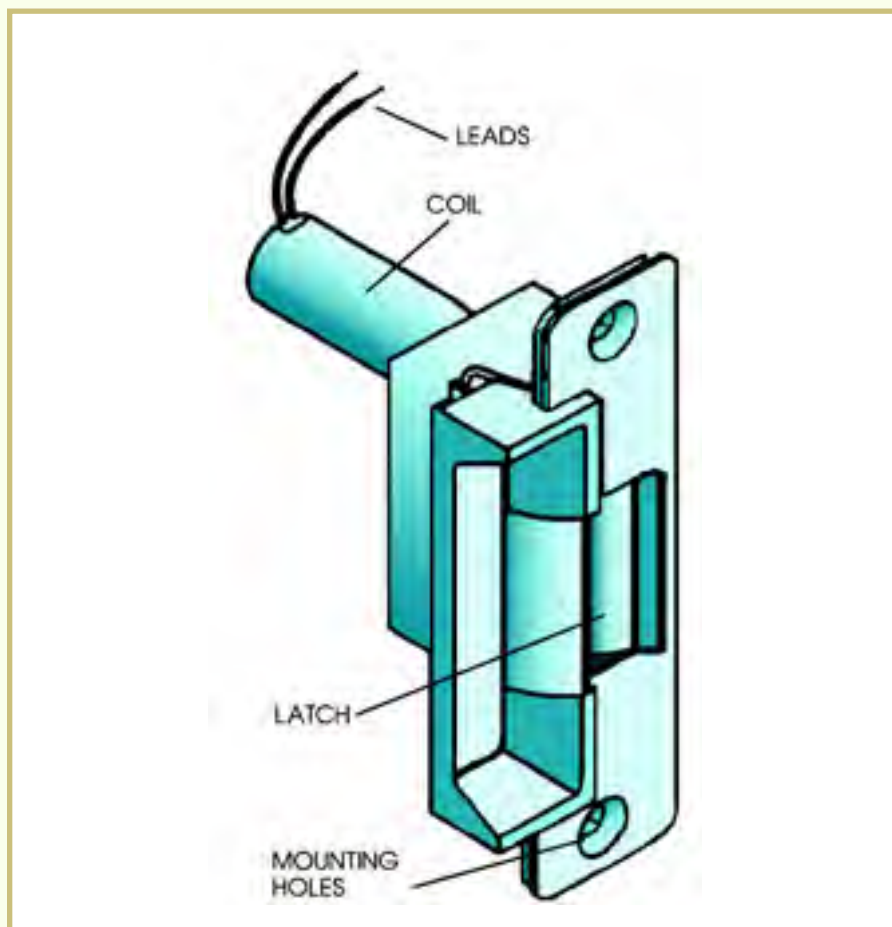


FIGURE 43—In a plunger-type electric lock, when the coil is energized, the magnetic field pulls back on the plunger, opening the lock.

FIGURE 44—A more complex electric strike has a specially shaped latch that mates with the strike.



A more complex electric strike is shown in Figure 44. This type of electric strike has a specially shaped latch that mates with a strike plate fastened to the door. The electric strike itself is installed in the doorjamb.

In most installations, this more complex electric strike is used. When continuous-duty coils are used to hold the strike in the locked position, the system is called a *fail safe* system. Here, the coil remains energized to keep the door locked. But in the case of power failure, the coil is de-energized, releasing the latch and opening the door. A circuit for a DC-powered, fail safe electric strike is shown in Figure 45. The main difference between this circuit and the circuit you already examined is the use of a normally closed switch to supply power to the lock's coil. In this case, when the push button is pressed, the coil is de-energized, and the door is opened.

A more complex electric strike lock can also be used similarly to the basic solenoid-type lock. In this case, the lock remains de-energized and holds the door locked. When the normally

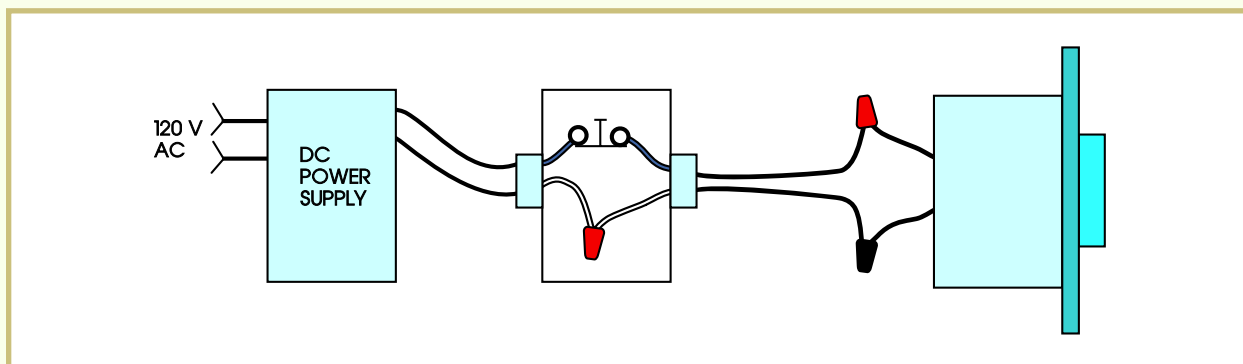


FIGURE 45—A continuous-duty electric strike uses a normally closed push button or keyed switch to turn off the coil.

open push button is pressed, the armature pulls back on the latch allowing the door to be opened. In the event of power failure, the bolt holds the door in the locked condition. This is often called a *fail secure* system.

Electric strikes are also called *electric door openers* by some manufacturers. These units are similar in construction and operation as the electric strike models you've studied here.

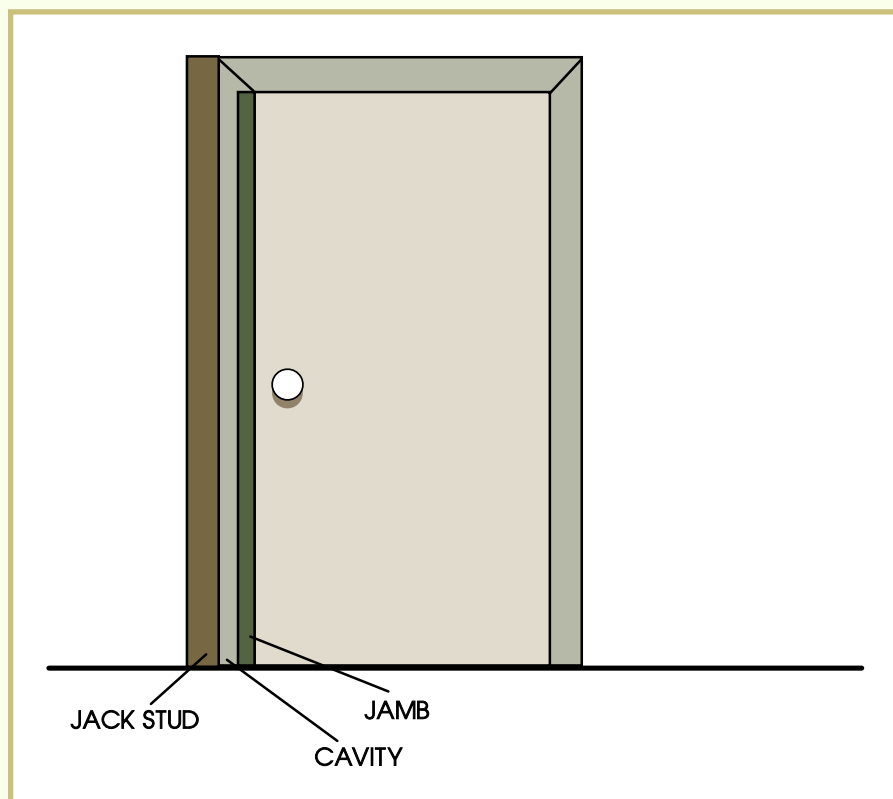
Installing Electric Strikes (Door Openers)

The installation of an electric strike or door opener can normally be performed in four or five hours, depending on the construction of the door and the construction of the building. Wooden doors with a shallow electric strike provide the easiest installation. Aluminum doors or deep electric strikes create more difficult installations.

Let's begin by looking at the installation of an electric strike on a wooden interior door (Figure 46). The first step in installation is to remove the trim molding around the door's knob side. Usually, it's easiest to use a nail set punch to punch the nails inward until they no longer grip the molding. Once the nails are recessed, the molding can easily be removed from the door-jamb or frame.

With the molding removed, you should see a slight cavity between the jamb and the wood or steel studs that surround the door. You'll run the wires or cable into this cavity to power the electric strike's coil.

FIGURE 46—Once the molding is removed, you should see a gap between the jamb and the support stud.



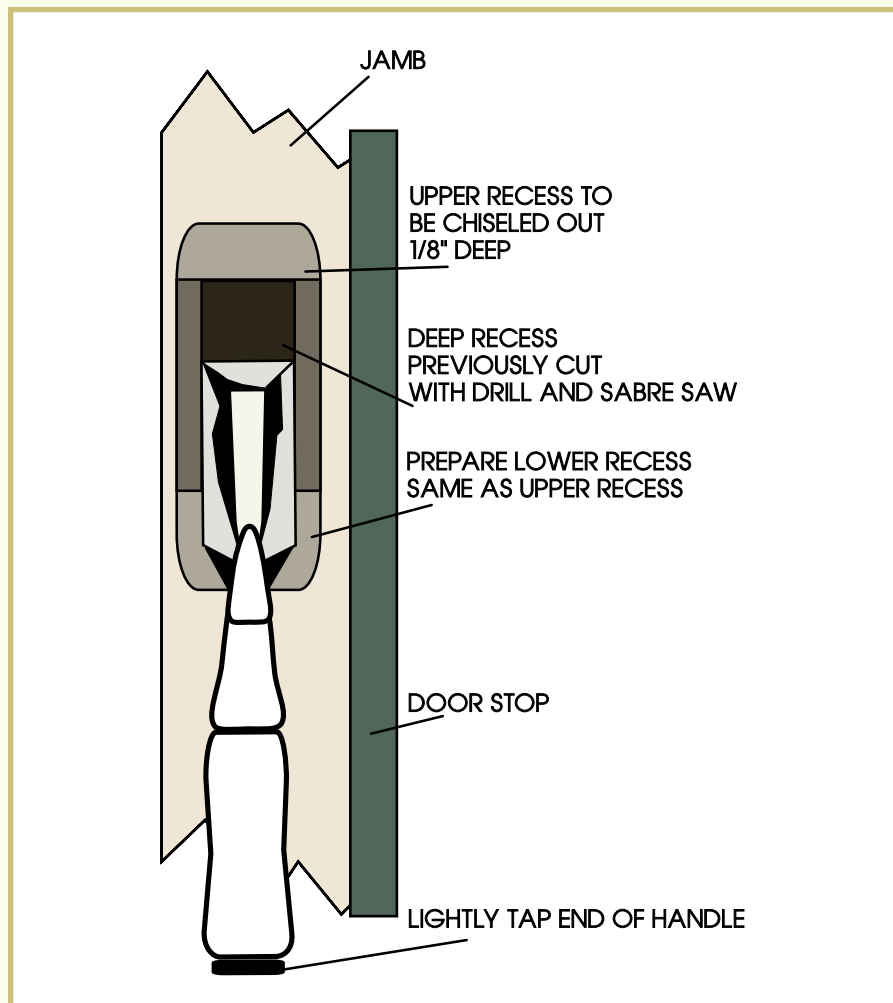
The next step in installation is to cut an opening through the jamb for the electric strike or door opener. A template is usually provided with the electric strike to help you locate the opening's height and width properly. The hole's depth should also be listed on the template, or can be measured from the lock face to the rear of the assembly or coil.

The opening for the electric strike can be cut in many ways. The best method is to use a *router*, which is a high-speed wood or (soft) metal cutting tool that uses drum-shaped bits. If you don't have a router, the next best cutting tools are a saber or jigsaw and a drill. First, drill a hole at each corner of the opening. Next, take the jigsaw and cut from one hole outward around the opening to the next hole. Continue cutting until all four holes have been connected. Finally, use a wood chisel and hammer to remove the wood material left in the opening's center.

A slight recess must also be cut into the jamb for the faceplate of the electric strike. As before, a router is the best tool to cut this recess. Set the router to cut the proper depth; move it around the recessed areas to remove only the desired depth of jamb material.

A wood chisel can also be used to cut this recess. Once the dimensions are marked on the jamb, simply chisel around the jamb on the outside lines of the recess. Once this is done, use the chisel as a plane and remove the jamb material to the proper depth from the deep hole toward the outside of the recess area. Use light hammer taps to prevent digging too deep in the jamb. This is shown in Figure 47.

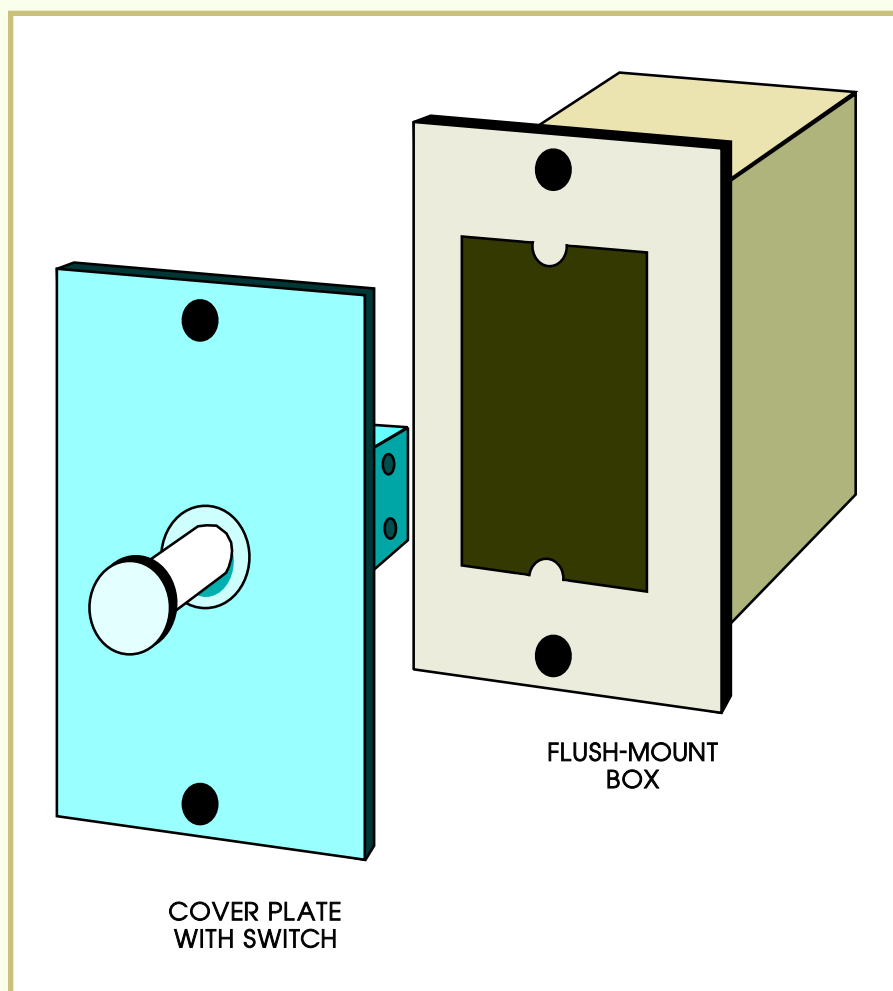
FIGURE 47—Use a wood chisel to remove about one-eighth inch of material above and below the cutout.



A mating hole and recess will also have to be cut into the door for the latch and the strike plate. The hole can normally be drilled using a round drill bit of the proper diameter. The recess can also be cut with a router or a chisel. Take extreme care that the hole and recess line up with the opening you've cut in the jamb.

The next item to work on is the push button or key switch that is used to energize or de-energize the lock's coil. A typical box and push button is shown in Figure 48.

FIGURE 48—A typical flush mount box with a push button switch is shown here.



The flush mount box shown can be used for mounting within an inside or an outside wall. Surface mounted boxes are also available. To install a flush mounted box, you must cut a hole into a wall the size of the box. A saber or jigsaw is the easiest tool to use. Mark the wall with the size of the opening required and drill the holes at two diagonally opposite corners. Use the jigsaw to remove the wallboard material between the holes.

The next assembly to mount is the power supply. This assembly is normally mounted in the basement, in a convenient location near an electric service junction box. Many poor installations feature a transformer mounted to a wooden basement beam by means of wood screws. A better installation involves mounting the transformer to the cover of a standard electrical junction box, as shown in Figure 49. If a fuse, rectifier, or temperature controller are part of the power supply, you can add it to the assembly. Preassembled power supplies are also available.

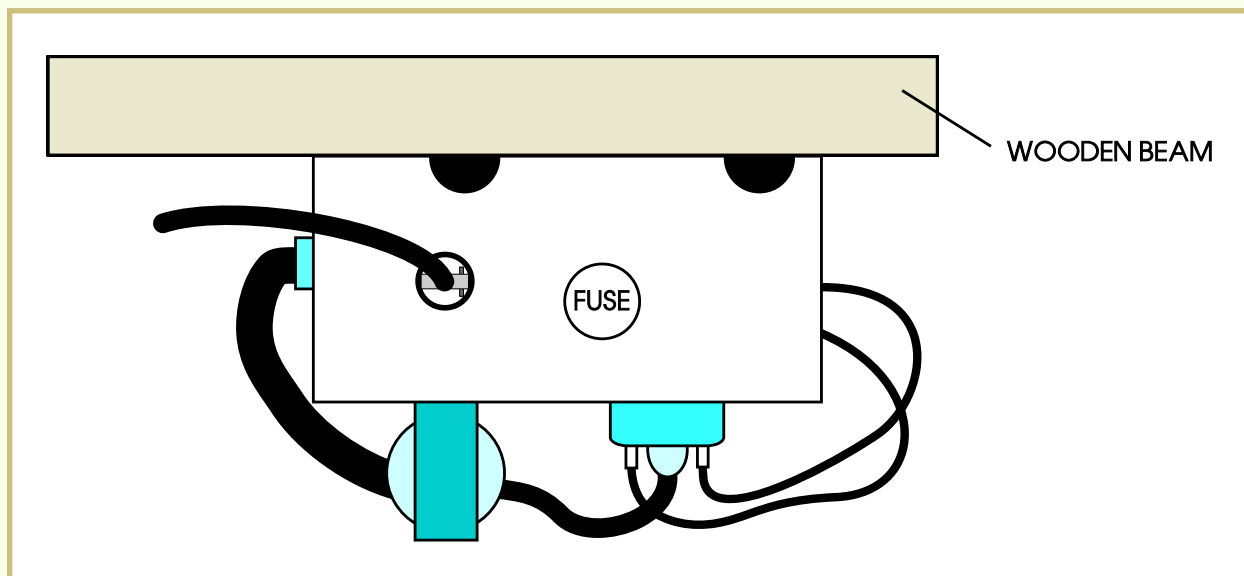


FIGURE 49—The power supply can be mounted either to a wooden beam or to a piece of wood between the beams, as shown here.

Now it's time to run the wires. Normally, a two-wire cable is used to run electricity from the power supply to the switch box and then to the coil. As a general rule, you can use 18 AWG gauge wire to connect these items in the system. However, if the installation requires wires over 200 feet long, you should install 16 AWG wire. This larger diameter wire prevents a voltage drop along the wire that could influence coil operation.

To perform the physical installation, you'll have to drill holes and run the wire. Drill a hole from the basement through the interior stud, just below the switch or push button box. Drill a second hole between the doorjamb and the supporting stud directly below the electric lock's desired location.

To pull the cable through these holes, you can use a piece of stiff wire or an electrician's fish tape. A fish tape is actually a thin spring steel band that's released from a roll as you pull it. Figure 50 illustrates the use of a fish tape.

When pushing the fish tape or wire through the switch box hole, it's rather tricky getting it to go through the hole you drilled in the plate stud. If possible, have a colleague in the basement catch the end of the fish tape or wire with a hooked piece of wire or coat hanger.

The next step in the installation is to mark one of the cables. Wire markers are available at electrical supply stores. These

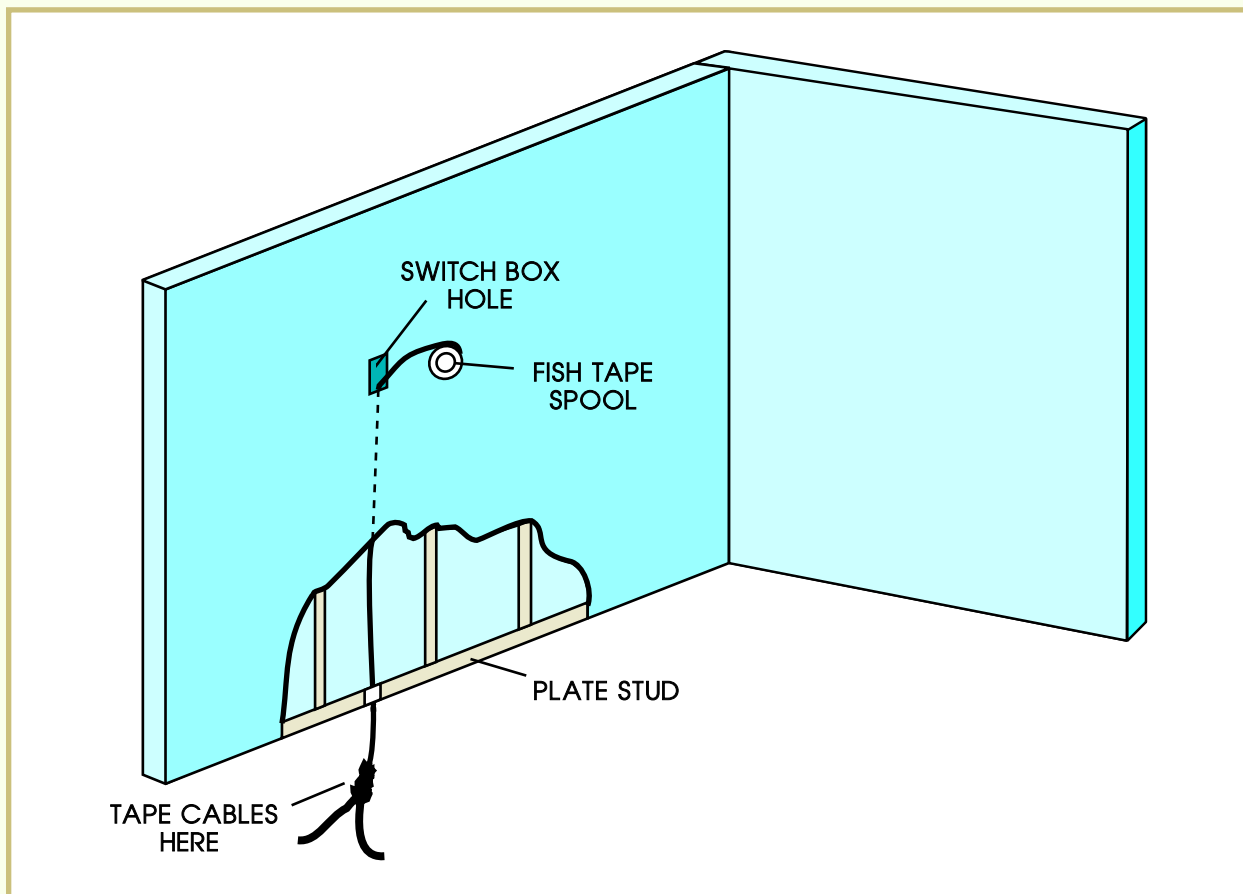


FIGURE 50—Cables can be easily pulled through a wall by using a fish tape or stiff wire, as shown here.

wire markers come in number and/or letter varieties and peel off from a card. You can wrap the number or letter strip around one of the two cables to identify it. You could also simply mark one cable with colored tape.

Once the wires are marked, tape them to the fish tape or wire and pull them up through the wall into the switch box, leaving at least six inches of wire for you to make your connections.

With the wires in the switch box, take the cable that you identified with the marker or tape and run it over to the power supply. This cable can simply be stapled to the bottom of the beams using insulated staples. However, a more professional installation results from running the wire through holes drilled in the beams. Next, run the cable to the coil, passing it up through the hole drilled between the jamb and the support stud. Now all of the wiring is in place.

When connecting this system, start at the electric lock and work backward through the system. The power supply will

be the last item to be connected. Start at the electric lock's coil. Strip the cable jacket from the wires as shown in Figure 51. The cable's jacket should be stripped back about three inches and each wire should have about one-half inch of insulation removed. Use a pocket knife or electrical wire stripping tool (which is quicker and easier) for the wire stripping.

FIGURE 51—Strip the cable jacket and wires as shown here. Take care not to damage the insulation on the wires.

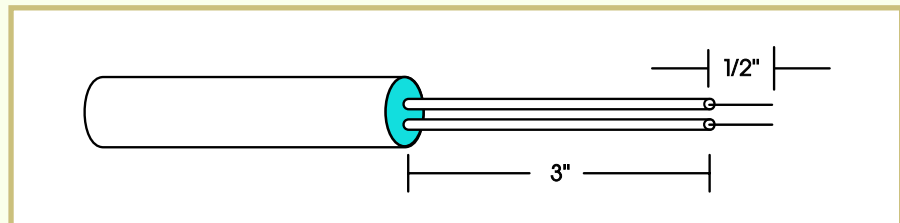
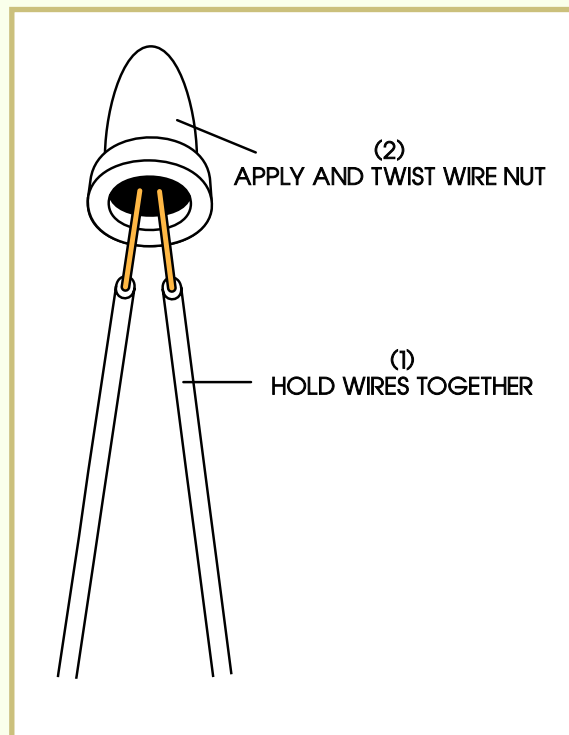


FIGURE 52—When using wire nuts, strip the wire back one-half inch, hold the wires together, and then twist the wire nut onto the wire ends. Tape the joint when you're done.



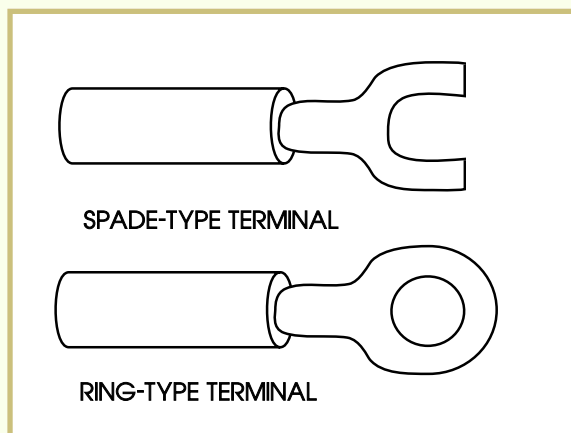
The wires in the cable are normally connected to the coil's leads with wire nuts. When selecting wire nuts, use a nut that's rated for the number of wires and the gage of wire you're using.

Most wire nuts are also color-coded. (You'll normally be using a wire nut of an orange color.) Now, place the two wires together as shown in Figure 52. Don't twist them together. Simply place the wire nut over the two wires and turn it until it's tightened. Use electrical tape to cover the wire nut and the wires just below the wire nut. Repeat this process for the second wire group.

With the wires connected and taped, mount the electric strike in its cavity in the jamb and install the retaining screws. Leave the molding off the door, in case you experience problems while powering up the system.

The next place to make circuit connections is at the switch box. As before, strip the jacket from the cable and strip each wire. Take two of these wires of the same color and install a

FIGURE 53—Solderless terminals simplify wiring to push button switches and key switches.



wire nut; tape as you did earlier. The remaining two wires are attached to the switch. Normally, a solderless terminal is used for these connections. These terminals are shown in Figure 53. These terminals are used

with a crimping tool to make a secure connection on the wire. The wire end is stripped back about three-eighths to one half of an inch and placed inside the barrel of the connector. The crimping tool is then placed over the barrel and squeezed to crush the barrel onto the wire.

Solderless terminals are easy to connect to the push button or keyed switch's terminals. Simply loosen the screw for the forked terminal or remove the screw for a ring terminal, install the connector, and tighten the screw. With solderless terminals, you won't be fighting with those few strands of wire that always seem to fail to be captured by the screw. When the switch box is wired, attach the cover to the box with the screws provided.

On some installations, a pilot light may also be part of the switch box. This pilot light is wired to the circuit as shown in Figure 54. One lead of the pilot light is placed inside the wire nut where you joined the common leads. The second lead receives a solderless terminal and is placed on the side of the switch that connects to the lock's coil. With this system of wiring, the light is on until the button is depressed. In a fail secure system, the light comes on only when the button is depressed.

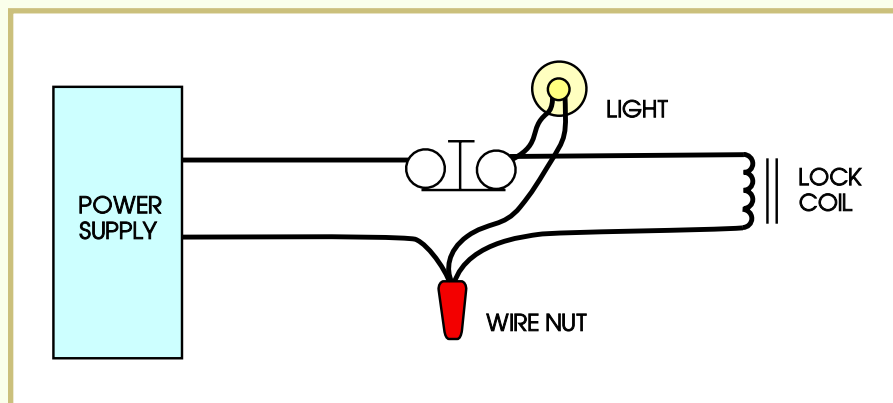


FIGURE 54—If a pilot light is connected to the circuit, it's usually connected at the push button as shown here.

The final wire connections are made at the power supply. If the coil is an AC coil, place the two leads from the cable directly to the screw terminals in the transformer. If a bridge rectifier or temperature limiter is present in the system, connect the cable to these devices and then connect these devices to the transformer's secondary. Now, make sure that the AC power is disconnected and attach the transformer's primary to the fuse, if present, and to the AC line.

Testing and Troubleshooting the System

After you've completed the installation, apply power and test the system. Reapply power by turning on the circuit breaker or reinserting the fuse in the electrical service to the transformer. Now, look for signs of overheating at the power supply. If everything looks like it's in proper working order, take your meter and measure the transformer's secondary voltage.

Next, take a voltage reading of the DC rectifier and temperature limiter, if present. The rectifier module's DC output should also be within 10 percent of its rated value. A temperature limiter, however, displays the proper voltage for about three seconds after the circuit is energized. Then, after the three-second interval, the voltage drops by about one-third.

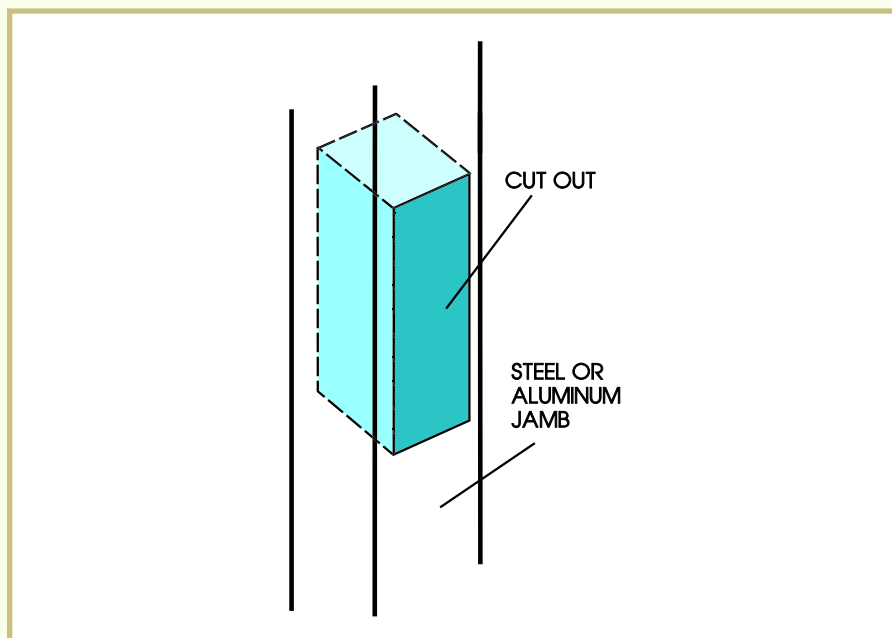
After checking the power supply, test the lock's operation. Have someone press the push button or turn the key switch to energize or de-energize the coil. Check to make sure the plunger or latch moves through its full range of motion and that it isn't sticking.

The final two steps in installation are to (1) replace the molding and (2) install the door's strike plate. The molding is installed with small finishing nails. The strike plate should be installed loosely on the door and then checked for proper alignment. Once alignment is complete, tighten the retaining screws on the strike plate.

Electric Strike Installation on Metal Doors

The only real difference in installing an electric strike on a metal door is the cutting of the metal jamb and the running of the wire to the lock's coil. A typical cutout for an electric strike in a metal frame is shown in Figure 55. This cutout can

FIGURE 55—A typical cutout for an electric strike in a metal jamb is shown here.



be performed with a jigsaw equipped with a metal cutting blade. Be careful when cutting, and be sure to wear safety glasses.

To run the wire to the electric strike's coil, drill a hole from the basement up behind the jamb. Locating this hole from the basement can be difficult; if possible, drill a very small hole where the door meets the jamb. Then, place a small wire down through the hole. In the basement, you can find this wire and then drill an inch or so towards the jamb side of the hole. Once the hole is drilled, use fish tape or pull wire to pull the cable from the basement.

Electric Mortise Locks

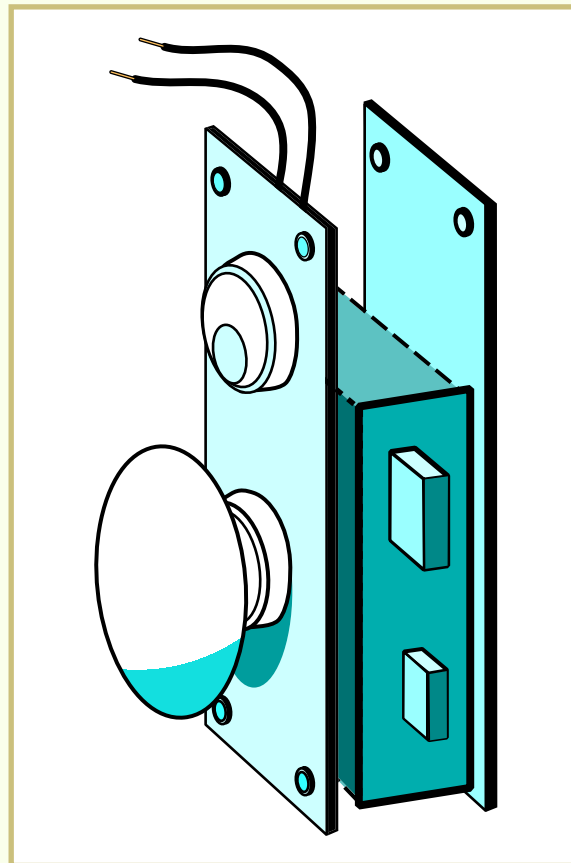
Electrified mortise locks can be used in place of electric strikes or electric door openers in most applications. A typical electrically operated mortise lock is shown in Figure 56.

Three basic styles of electric mortise locks are available in both the fail safe and fail secure categories.

In the fail safe category, mortise locks are available as follows:

1. The latch is operated by an inside knob that's independent of the coil's energized or de-energized state. The outside knob is unlocked until it's electrically locked. An outside key cylinder can open the lock at any time.

FIGURE 56—A typical electric mortise lock is shown here.



2. The latch is operated by the inside knob at all times. The outside knob is unlocked until the coil is energized. There's no outside keyed cylinder.
3. Both knobs are unlocked until the coil is energized. Then both knobs are in their locked state. When the lock is in its locked state, a keyed cylinder on each side of the door operates the latch.

In the fail secure category, mortise locks are available as follows:

1. The inside knob operates the latch. The outside knob is locked until electrically released or bypassed with the keyed cylinder.
2. Both knobs are locked and won't be released until they're electrically released by energizing the coil. The latch can be operated by a key on either side of the door.
3. The inside knob operates the latch at all times. The outside knob is locked until electrically released. No outside keyed cylinder is provided.

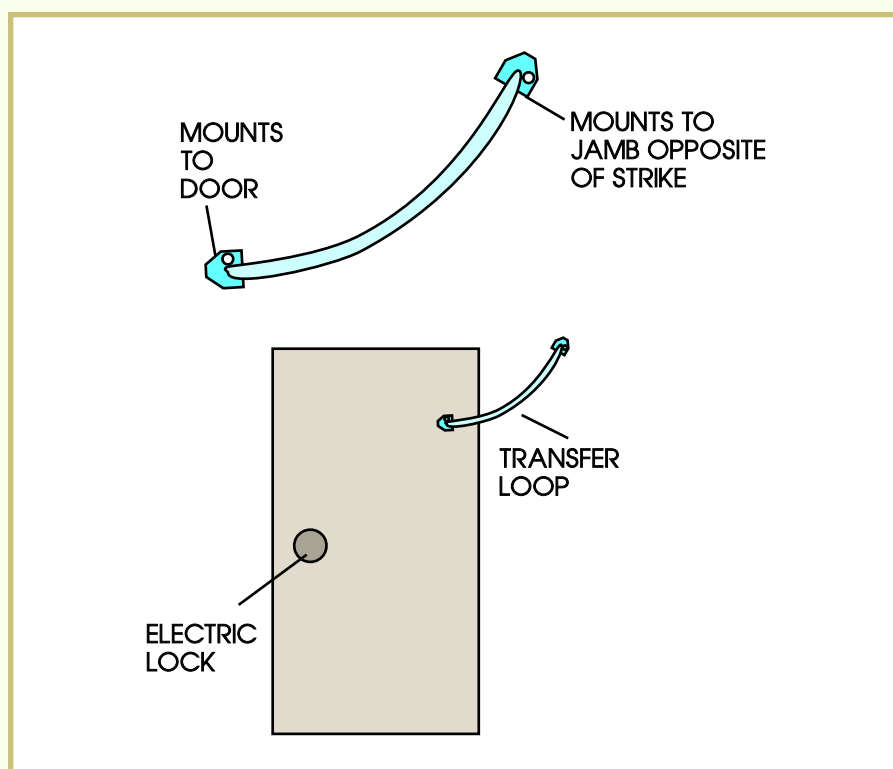
The electric coils within the electric mortise locks are quite similar to those used in electric strikes and door openers. AC- and DC-powered models are available with 12, 24, and 48 volt ratings.

The installation of an electrically operated mortise lock is similar to the procedures used for strikes and openers. The power supply and switch box installation and wiring procedures remain the same. However, you must cut a mortise

cavity in the door rather than at the jamb. A template is provided with each mortise lock to help you in the layout of the cuts.

Power for an electric mortise lock must be provided through the door, since the coil is inside the mortise lock and moves with the door. The electric cable must, therefore, be connected through a device called a *door transfer loop*. One of these is illustrated in Figure 57.

FIGURE 57—A door transfer loop is a shielded metal cable that protects the wires that run through the loop.



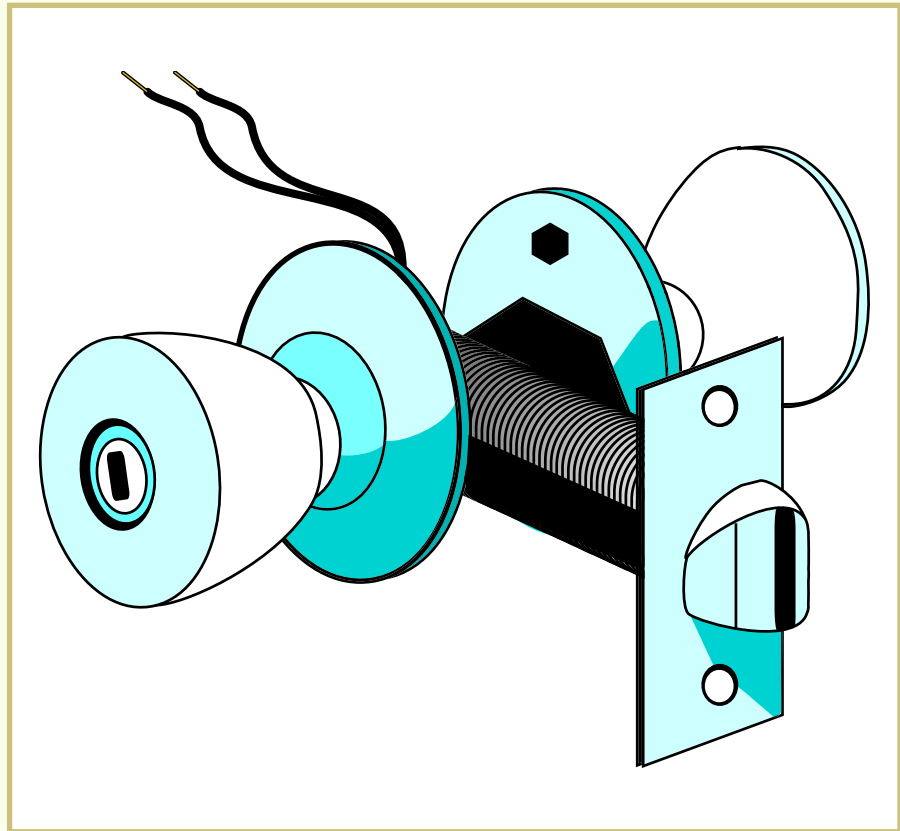
The loop itself is made of flexible conduit with two hollow mounting pads. The cable is fed through the inside diameter of the conduit and the pads are then screwed into the door and the trim. The conduit protects the cable from physical abuse.

Electrified Key-in-Knob Locksets

An electrified lockset operates similarly to the electrified mortise lock. Electrified locksets come in both fail safe and fail secure models and can use either AC or DC coils.

In an electrified lockset, the inside knob normally remains unlocked. The outside knob is locked (fail secure) or un-

FIGURE 58—A typical electrified lockset is shown here.



locked (fail safe) until the coil is energized. A key in the cylinder of the outside knob opens the latch in either case. A typical electric key-in-knob lockset is shown in Figure 58.

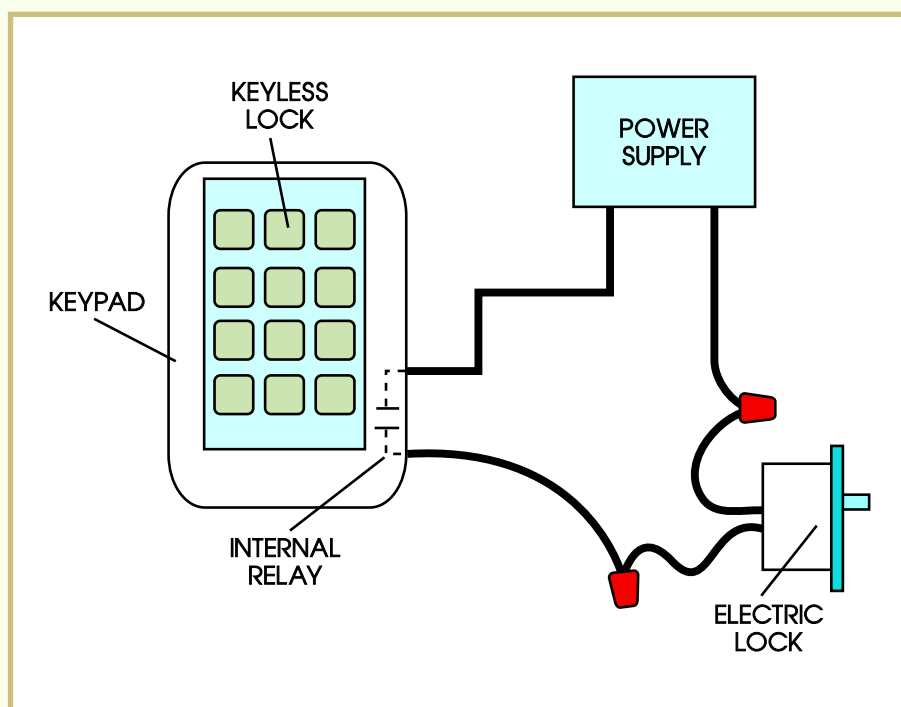
As with the electric mortise lock, the coil for the lock is inside the door. Therefore, the door transfer loop must be provided at the upper side of the door.

Electric Keyless Locks

Electric keyless locks find wide use in some residential and many business applications. An electric keyless lock is shown in Figure 59.

An electric keyless lock has a set of push buttons on its front panel. A number sequence, or a group of number sequences, is programmed into the lock's memory. When the proper number is entered into the keypad, an internal relay in the lock energizes. The relay's contacts can be used in place of a push button or keyed switch to energize or de-energize the electric lock's coil, thus opening the door.

FIGURE 59—An electric keyless lock circuit is shown here.



If the wrong code is entered into the keypad, most keyless electric locks can be set with an alarm. This alarm could be a flashing light, a bell, a buzzer, or any combination of these.

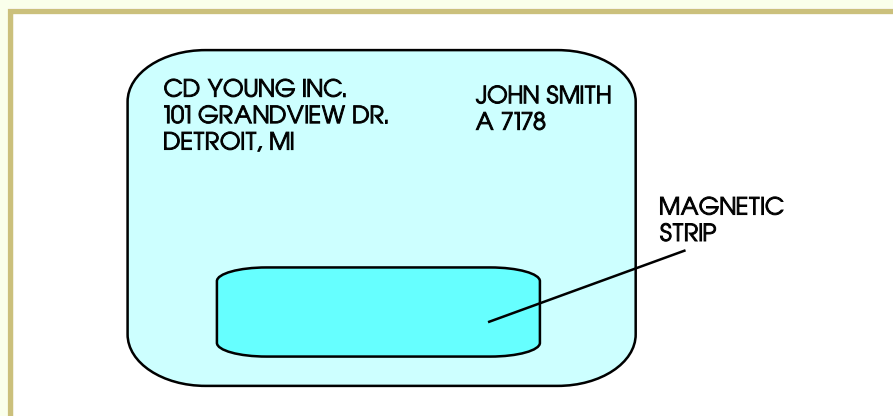
Still another option on some electric keyless locks is the inclusion of a card reader. In this kind of system, a business's employees are provided with magnetically coded cards. The card is inserted into the reader before the code is entered on the keypad. When the code and the card information are correct, the relay contacts are enabled, opening the door.

Some of the most modern keyless electric locks don't use a keypad at all. Instead, they use a magnetically coded, or bar-code, card. A small strip of magnetic tape is fastened to one side of the card as shown in Figure 60.

This magnetic strip is passed through the reader as the employee enters the building. If the employee's card contains the proper numbers (usually the employee's number), the lock opens, allowing access to the building. In some cases, the card or card reader is connected to a computer in the payroll department, which lets the payroll department automatically account for employee time of entry and exit.

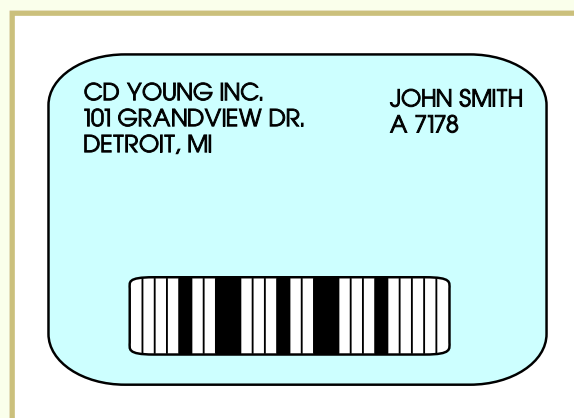
Many modern hotels also use magnetic card readers for their customers. The card is placed into a special device when the customer checks in at the hotel. This device programs the

FIGURE 60—Some businesses use employee cards that can be programmed with the employee's number.



magnetic strip with a coded number that matches the room number. When the card is placed in the reader attached to the customer's room, the door opens.

FIGURE 61—A barcode card for a card reader is shown here without the polarized filter.



Magnetic card readers have one small problem. If the customer is working at an industrial plant, hospital, or other location that contains magnetic fields, the card can be reprogrammed by these fields.

When the customer returns to his or her room, the card won't operate the lock and will have to be reprogrammed. For this reason, many businesses are turning to barcode encrypted cards. Such a card is shown in Figure 61.

The barcode on these cards is somewhat hidden from view behind a polarized filter. Any attempt to photocopy the barcode to retain its information would be defeated by this filter. The reader, however, defeats this filter by using a special light source. The barcode itself uses a proprietary coding system that's quite different from the coding system used for consumer purchases.

A block diagram for an electric keyless lock system is shown in Figure 62. This diagram shows how the keyless lock is installed in place of the push button or keyed switch to open the electric strike, mortise, or lockset. A bypass switch may also be included in the circuit. This bypass switch can be used to

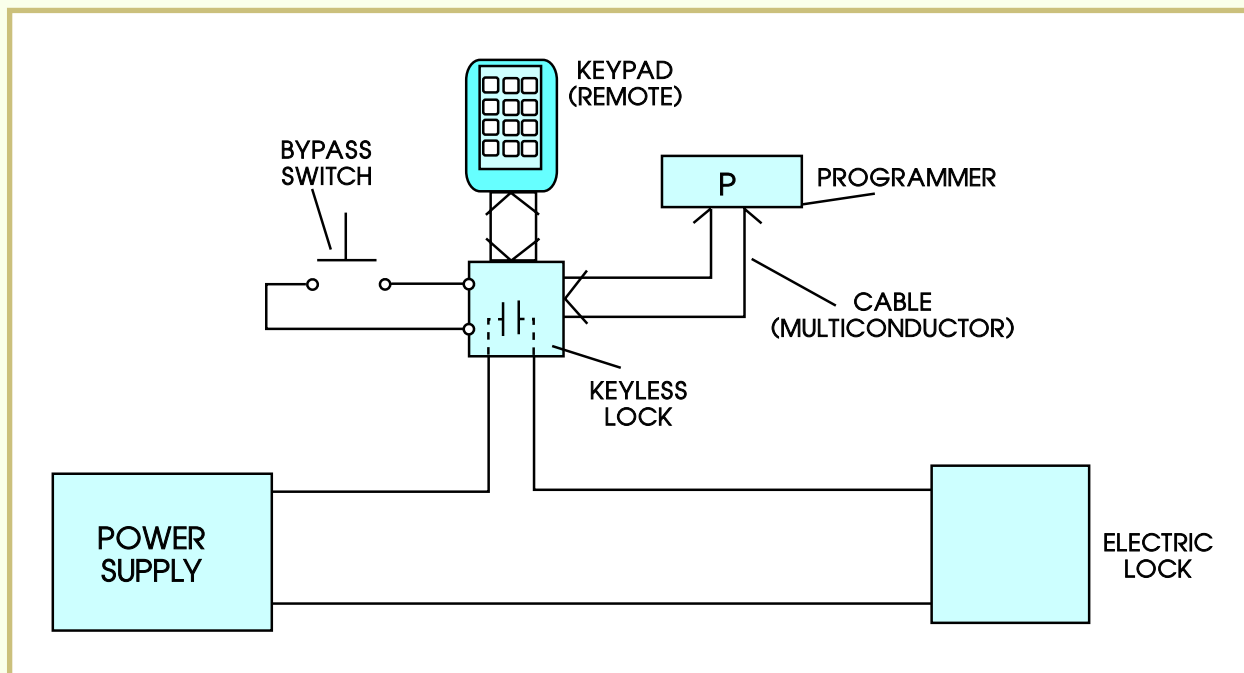


FIGURE 62—A complete keyless lock circuit is shown in block diagram format in this illustration.

let people leave the building or area by pressing the push button. A built-in time delay normally leaves the door unlocked for 3 to 30 seconds before automatically relocking the door.

In normal operation, a keypad-style, keyless electric lock has a three-, four-, or five-digit code. The complete code must be entered within a programmed time span after the first digit is entered. If the code is entered incorrectly, a preprogrammed time delay is initiated. The time delay can be up to thirty seconds. This feature prevents the “running” of numbers by someone not allowed access to the system. “Running” numbers basically means that someone continues to press keys until, by process of elimination or blind luck, the person enters a code that opens the lock.

In addition, some models of keyless electric locks have a preprogrammed function that energizes an alarm after a certain number of improper attempts to enter the code sequence have occurred. This provides an extra measure of security for businesses.



Locking It Up! 4

1. What is an intermittent-duty lock coil?

2. How long does it take to install an electric strike or door opener?

3. What type of connectors are normally used to connect the wires to the push button or keyed switch?

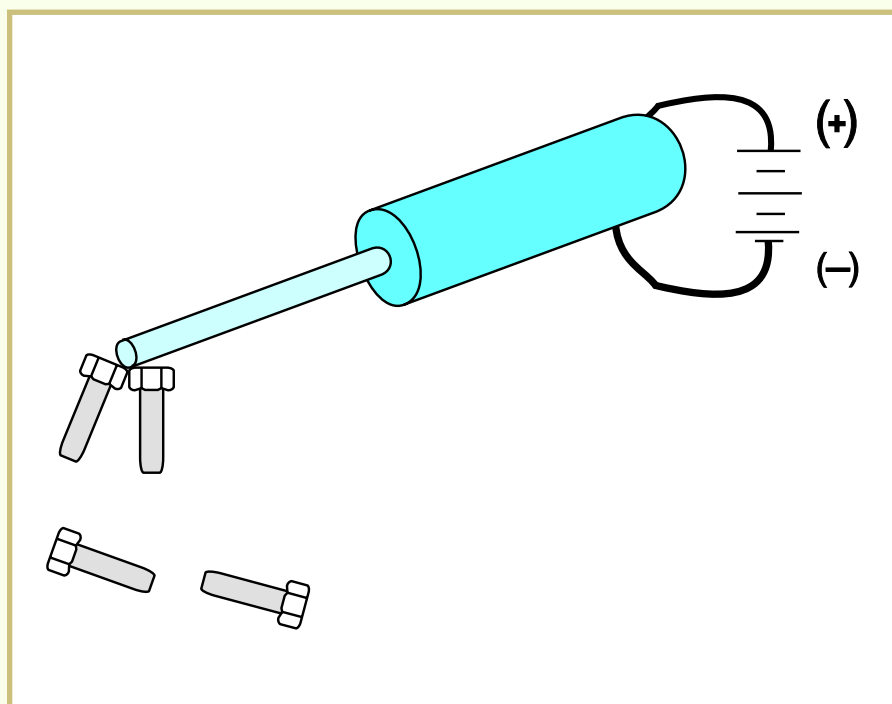
Check your answers with those on page 77.

MAGNETIC LOCKING SYSTEMS

Introduction

In the previous section, you learned how energizing a coil of wire creates a magnetic field. This field can be used to move a plunger, engage a latch, release a knob, and so forth. This magnetic field is concentrated at one point in the coil's center. The field is strong enough to lift several bolts or nuts when a metal rod is placed inside the coil, as shown in Figure 63. This is considered a rather weak electromagnetic field.

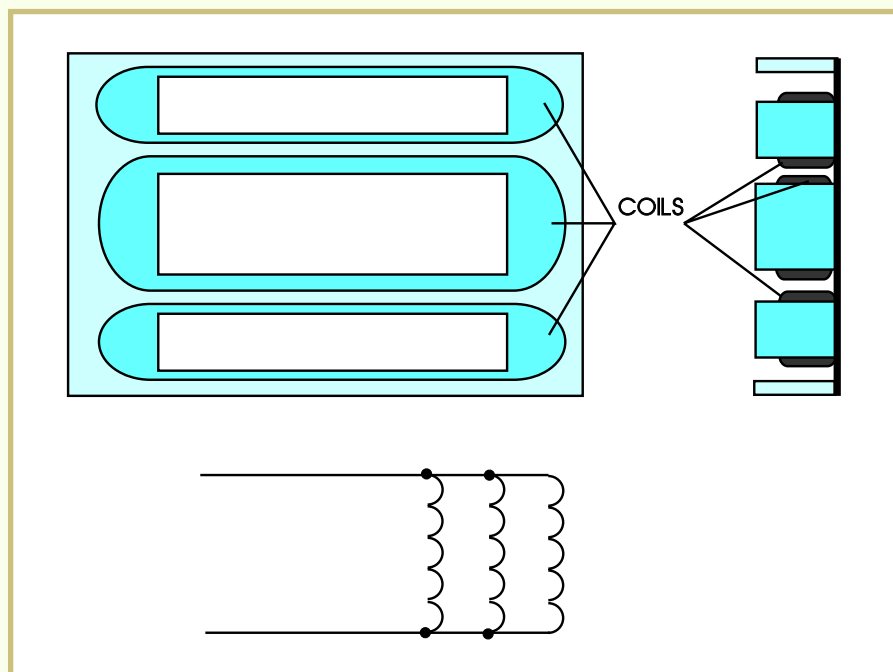
FIGURE 63—The coil of an electric strike produces a somewhat weak magnetic field as shown here.



If many more turns of wire are placed in the coil, the magnetic field increases. This is the principle behind the electromagnetic lock. A typical electromagnetic lock has two components—an *electromagnet* and an *armature*. The electromagnet is actually made up of three or more parallel connected coils in one assembly. The armature is a steel plate attached to the door. A typical electromagnetic lock is shown in Figure 64.

In our example electromagnetic lock, three coils are connected in parallel. These coils are made of many turns of very fine wire. When the power of all three is summed together, the attracting force on steel is very great.

FIGURE 64—The large electromagnetic field of this type of lock is created by multiple coils.



Once installed, an electromagnet lock can provide enough holding power that the protected door can't be forced open without damaging the door.

Typically, the coils in the electromagnet are rated for either 12 VDC or 24 VDC. Typical coil resistance is in the range of 50 ohms, resulting in a current of about $\frac{1}{2}$ amp. Thermal or temperature limiters shouldn't be used, since this device limits the electric power to the coils, weakening their magnetic fields. A properly sized diode or MOV should always be used with an electromagnet lock. The large magnetic field, upon collapse, can generate a large voltage in the coils. This large voltage can quickly destroy push button or keyed switch contacts if the diode or MOV isn't used.

In highly repetitive situations where the door is locked and unlocked many times each day, a solid-state switch is often used to energize the coils. The solid-state device is placed between the power supply and the lock in place of the push button or keyed switch. Figure 65 displays a solid-state switch circuit.

In this circuit, power is tapped off the power supply and runs through a push button to the control terminals of the solid-state switch. When the switch is closed, the solid-state contacts allow power flow to the lock's coil. Solid-state switches are also available in a normally closed configuration. When the push button or key switch is closed, the solid-state switch opens the circuit to the coil. This circuit is shown in Figure 66.

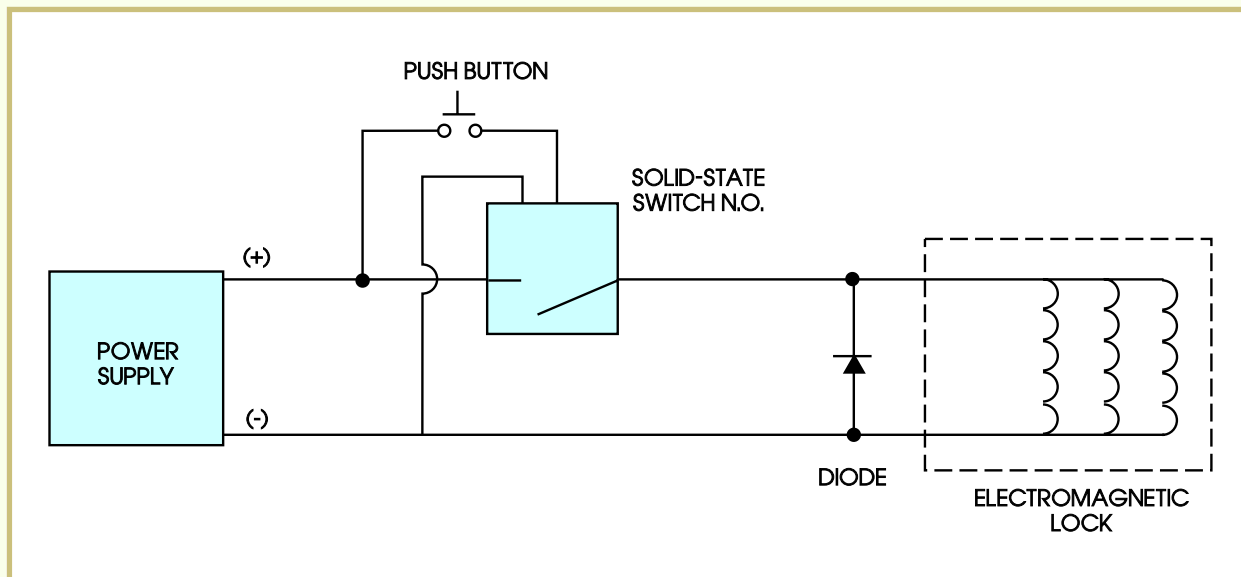


FIGURE 65—A solid-state switch can energize a coil without the use of mechanical contacts that can fail.

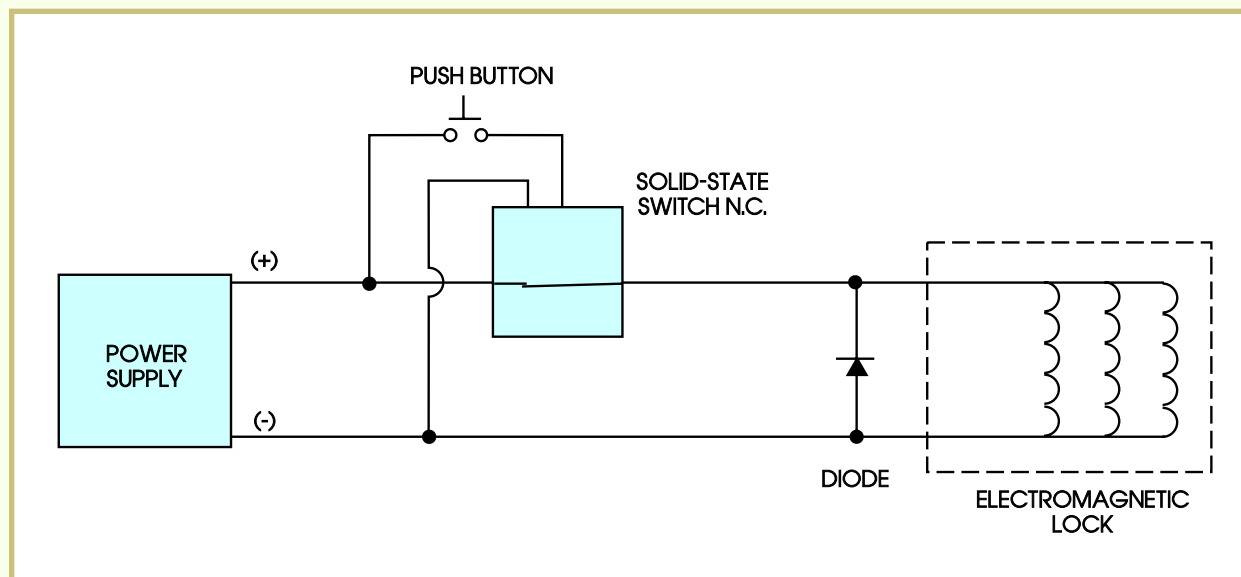


FIGURE 66—Solid-state switches can also be normally closed for fail safe systems.

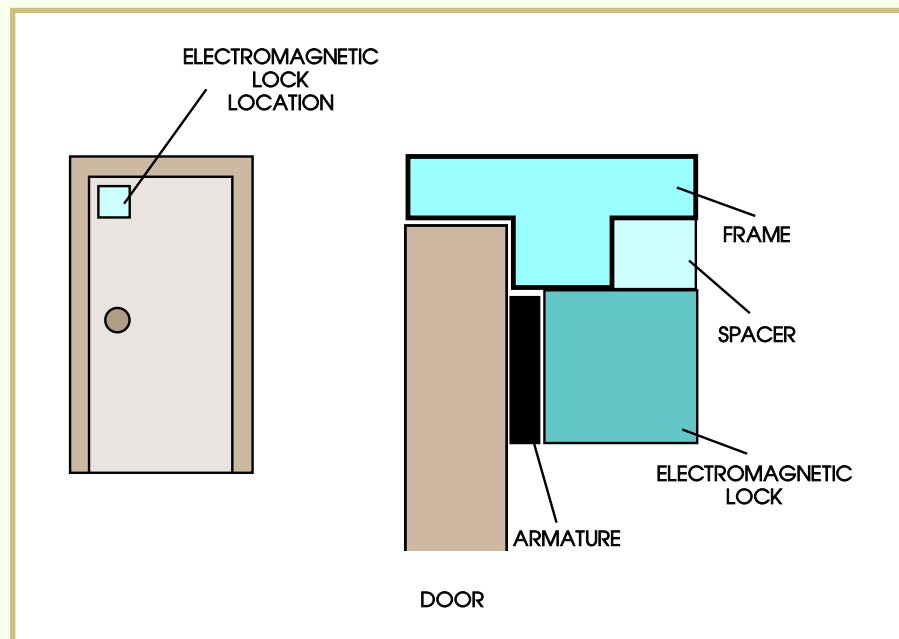
Electromagnetic Lock Installation

The installation of the power supply switch box, switch, and cables is similar to the procedures given earlier for electric strikes and door openers. However, like the mortise and key-in-knob lockset, the power cable to the coil must be located towards the top of the door.

An electromagnetic lock is normally mounted on the top of the door on the knob side. The lock assembly is bolted to the door frame with the armature bolted to the moving door. Since the electrified section remains stationary, there's no need for a door transfer loop or other flexible conduit.

A typical installation is shown in Figure 67. The lock is mounted in the upper-left corner of the door. Since the frame has an indentation, the lock requires that a spacer be placed between the lock body and the frame. Other types of frames may require the use of an angle bracket, or the lock may be directly mounted to the frame if it's flat. The armature, which is a flat steel plate, is bolted directly to the door.

FIGURE 67—An electromagnetic lock is mounted as shown in this illustration.



The use of the supplied template for lock and armature mounting is suggested. Using the template, you can mark and drill the exact locations for the mounting bolts or screws. Once the holes are drilled, attach the lock to the frame with the supplied fasteners. Next attach the armature plate to the door. There should be little-to-no gap between the lock's face and the armature. If a gap exists, the armature can be shimmed away from the door and closer to the lock by using spacers or washers.

The gap must be very small, because magnetism follows a physical principle called the *inverse square law*. What this basically means is that each time you double the lock's distance from the armature, you divide the attraction force of the magnet to the armature by a factor of four.

The lock's face and armature must be kept clean and free of damage. A protective coating of film is placed on most models of locks. Don't remove this protective film, because it serves two purposes. First, it sets the gap distance between the lock's face and armature. Second, it protects these items from rust and other forms of damage.

Troubleshooting Electromagnet Lock Circuits

Electromagnet lock circuits are simple to troubleshoot and repair. As with electric strikes, begin your tests at the circuit's centerpoint. Take a voltage test here to determine if the power supply and cables are in working order. If this point checks out, check the operation of the push button or keyed switch or solid-state switch. A voltage should be present at this location when the lock is to be energized. The final test can be taken at the lock's coils. As mentioned, the typical resistance of the coil should be about 50 ohms.

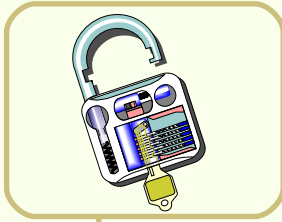
Poor lock performance is normally caused by too large an air gap between the lock's face and armature. If this is the case, shim the armature away from the door, closer to the face of the lock. Also, check the armature surface and lock-face surface for damage. It's also possible that the supplied voltage is too low because of a faulty rectifier, push button, keyed, or solid-state switch. You can test the voltage at the coil by loosening the wire nuts and performing a voltage measurement. It's also possible that one or more of the coils in the lock has broken, becoming an open circuit. If one or more coils opens, the resistance of the assembly becomes much higher. Test the resistance and check the value reading against the value published in the manufacturer's literature.

The electric locks described in this text reflect the basic models of locks and systems available. Many other types are available with options such as system indicator lights and multiple lock capabilities controlled from one or many switch locations. A special switch that's triggered by the door is also available.

The equipment described in this text can also be used together in certain situations. For example, a keyless electronic lock can be used with panic hardware to provide a complete entry/exit system for a business.

To view all of the locking systems available, contact the various electric lock manufacturers. Try to get on their mailing lists and collect their equipment catalogs. A handy source for addresses is the *Locksmith Ledger International* directory.

One other feature of electric locks is their use in an electronic fire and burglar alarm system. Information on these systems will be presented in your next study unit.



Locking It Up! 5

1. Why must the armature of an electric lock be very close to the electromagnetic lock assembly?

2. Should a temperature limiter be used in an electromagnetic lock circuit?

3. How are electromagnetic lock circuits tested?

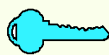
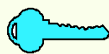
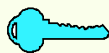
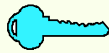
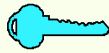
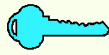
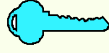
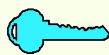
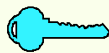

Check your answers with those on page 77.

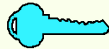
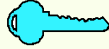








THE KEY TO SUCCESS

Congratulations on completing another study unit! This study unit has introduced you to the basics of panic hardware installation, electricity, electrical circuits, and electric lock installation. You'll be able to use this valuable information often in your work as a locksmith, whenever you're called upon to install and service business and commercial locks. In addition, if you eventually decide to specialize in the installation of electric locks and/or electronic security devices, you'll find your studies especially helpful.

Now, review any material you feel you need to. Read through the *Key Points to Remember*. Then, when you're ready, complete the examination at the end of this study unit. Good luck!

KEY POINTS TO REMEMBER

-  Panic hardware or electric locks can be used to protect the entry/exit doors to a building.
-  Panic or fire exit hardware must be used on exit doors for public places to comply with building and fire codes.
-  Electric locks can replace keyed locks if there's a chance the key can be stolen or duplicated.
-  Some panic hardware contains an internal alarm system that will close its contacts or sound an alarm when the door is opened.
-  A circuit contains a power source, controlling device, and load.
-  In a circuit, there's voltage, current, and resistance.
-  Ohm's law can be used to determine one circuit quantity, such as current, if the voltage and resistance are known.
-  AC-powered lock coils will be rated at 6, 12, 24, or 48 VAC.
-  DC-powered lock coils will be rated at 6, 12, 24, or 48 VDC.
-  Below 48 volts AC or DC, there's no shock hazard.

-  Lock coils can also be rated by their energized state, such as intermittent-duty coils that are briefly energized or continuous-duty coils that are held energized.
-  In testing an electric lock circuit, begin testing at the midpoint of the circuit and work towards the cause of failure.
-  A MOV or diode can be used to prevent a voltage spike from being formed as the lock's coil de-energizes and the magnetic field collapses.
-  A dangerous shock occurs when current passes through the heart.
-  Electric strikes or door openers mount in the jamb of a door.
-  Electric mortise and key-in-knob locksets have their coils inside of the locking mechanism that's inside of the door.
-  Electric keyless locks will use a keypad to enter numbers. If the numbers are correct, an internal relay will be energized to open the door.
-  Some electric keyless locks will use a card or badge reader to open a door.
-  Electromagnetic locks use multiple coils to create a large magnetic field. The field attracts an armature that's placed on the door.
-  Some electromagnetic lock circuits will use a solid-state switch to energize the coils.

Do You Know Now . . .

Below are the answers to the questions asked at the beginning of this study unit.

What is an *armature*?

An armature is a flat steel plate that's bolted securely to a door. An electromagnet lock attached to the door's frame attracts the armature, using magnetism to hold the door closed.

What is the difference between an intermittent-duty coil and continuous-duty coil?

An intermittent-duty coil is energized for short periods of time. A continuous-duty coil remains energized for long periods of time.

What is an *ohm*?

An ohm is a measure of circuit resistance. One ohm allows a current of one amp to flow through a circuit that's powered by one volt.

Locking It Up! Answers

1

1. Panic hardware isn't normally installed in residential areas. Instead, it's installed in businesses and industries.
2. Keyless locks operate by numbers entered into a keypad or by means of a card reader or push buttons.

2

1. Templates help you drill holes for hardware mounting.
2. A push bar replaces the horizontal bar on some types of panic hardware.
3. Active trim is located on the outside of a door protected by panic hardware; it contains a keyed cylinder.

3

1. Analog and digital VOMs
2. To prevent electric shock
3. The electron is responsible for current flow.

4

1. An intermittent coil is one that receives electric current only for short periods of time.
2. The installation of an electric strike or door opener can normally be performed in four or five hours, depending on the construction of the door and the construction of the building.
3. Special connectors called *solderless* or *crimp-on* connectors

5

1. The magnetic field becomes less effective the farther it's located from the armature.
2. No, because the reduced voltage limits the lock's holding power
3. In the same way standard electric lock circuits are tested—start at the midpoint in the circuit and move towards the failure's location.

NOTES

Panic Hardware and Electric Locks

EXAMINATION NUMBER:

03101100

Whichever method you use in submitting your exam answers to the school, you must use the number above.

For the quickest test results, go to
<http://www.takeexamsonline.com>

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then submit only your answers to the school for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. Do not wait until another examination is ready.

Questions 1–20: Select the one best answer to each question.

1. What form of resistance will you be adding to an electric lock circuit when you perform an installation?

- A. Diode
- B. MOV
- C. Electric lock coil
- D. Bridge rectifier

2. You’re performing an electric lock installation. The power supply is located about 300 feet from the lock’s coil. What AWG gage wire should you use?

- A. 16
- B. 18
- C. 22
- D. 28

3. How wide should the air gap be between the face of an electromagnetic lock and the armature?

- A. At a minimum
- B. $\frac{1}{8}$ inch
- C. $\frac{1}{4}$ inch
- D. $\frac{1}{2}$ inch

4. Which one of the following statements is correct in referring to vertical panic hardware?
Vertical panic hardware

- A. is easier to install than horizontal panic hardware.
- B. always triggers a silent or audible alarm when the bar is pressed.
- C. protects doors against forcing more effectively than standard panic hardware.
- D. uses a single dead bolt to hold the door closed.

5. What device in an electric lock circuit changes AC voltage to DC voltage?

- A. Transformer
- B. Rectifier
- C. Fuse
- D. MOV

6. What device in an electric circuit protects the circuit from shorts or an overcurrent condition?

- A. Transformer
- B. Rectifier
- C. Fuse
- D. MOV

7. Which one of the following statements is correct in referring to making resistance measurements with a VOM?

- A. Start all resistance measurements with a resistance measurement of the incoming electric service lines.
- B. Be sure the circuit is a DC circuit before you take a measurement. AC circuits will damage the VOM.
- C. Make sure the circuit is de-energized before making any resistance measurements.
- D. Use a battery to power the circuit whenever taking resistance measurements.

8. Which one of the following letters is used to denote circuit current?

- A. V
- B. E
- C. R
- D. I

9. Your customer desires an electric lock on an interior door to a storeroom. The lock will be energized for a short period of time by a key switch with only the purchasing agent and the owner having a key. When power fails, the door should remain locked. What type of locking system should you use?

- A. Intermittent duty, fail safe
- B. Intermittent duty, fail secure
- C. Continuous duty, fail safe
- D. Continuous duty, fail secure

10. What would be the coil resistance of an electric lock's coil if the voltage of the current is 12 V and the current in the circuit is one-half amp?
- A. 24 ohms**
 - B. 18 ohms
 - C. 12 ohms
 - D. 6 ohms
11. What type of electrician's tool or device can be used to pull wires or cables through a building?
- A. Hanger bar
 - B. Transfer loop
 - C. Wire reel
 - D. Fish tape**
12. What type of electric lock circuit device protects the circuit from spikes caused by the collapsing magnetic field of a DC coil?
- A. Fuse**
 - B. Diode
 - C. Current limiter
 - D. Solid-state switch
13. Which one of the following coil types is normally used for an audible locking system?
- A. DC intermittent-duty coil
 - B. DC continuous-duty coil
 - C. AC intermittent-duty coil**
 - D. AC continuous-duty coil
14. You're working on a failed electric lock circuit. A measurement at the push button switch reveals 24.07 VDC on both sides of the push button switch. What could be wrong in this circuit?
- A. The electric service to the circuit is missing.
 - B. The transformer or the cable from the transformer is faulty.
 - C. The transformer or the bridge rectifier is faulty.
 - D. Either the lock's coil or the cable from the switch to the coil is open.**
15. How much current should flow in a circuit that has an applied voltage from the power supply of 24 VDC and the coil resistance is 48 ohms?
- A. 2 amps
 - B. 1 amp
 - C. $\frac{3}{4}$ amp
 - D. $\frac{1}{2}$ amp**
16. Which one of the following statements is correct concerning AC voltage?
- A. The voltage remains at a constant level with the current rising and dropping through a cycle.
 - B. Both the voltage and current rise and drop through a cycle, 60 times a second.
 - C. The current remains constant, while the voltage rises and falls 120 times a second.
 - D. The current and voltage remain constant through each cycle.**

17. What is the most likely problem when a transformer overheats?

- A. A short circuit or the wrong coil is being used in the circuit
- B. Open switch or push button
- C. Open lock coil
- D. Stuck locking mechanism

18. Two locksmiths are working on a DC-powered continuous-duty lockset-type lock. The customer has been complaining that the lock goes out of operation intermittently. Locksmith A says that the transformer or rectifier is bad. Locksmith B says that the problem is a loose connection or a bad switch contact. Who is correct?

- A. Both locksmiths A and B are correct.
- B. Locksmith A is correct.
- C. Locksmith B is correct.
- D. Neither locksmith is correct.

19. What is the typical resistance of an electromagnetic lock's parallel connected coils?

- A. 10 ohms
- B. 12 ohms
- C. 25 ohms
- D. 50 ohms

20. What is the maximum width for a door that can be protected by standard panic hardware?

- A. 48 inches
- B. 42 inches
- C. 36 inches
- D. 30 inches

COMING ATTRACTIONS

Your next study unit will cover the topic of electronic security devices. This study unit has already given you the basic knowledge of electricity and electrical circuits you'll need to understand electronic alarm installation. The field of electronic security is a growing and very profitable field for many locksmiths. We hope you enjoy your continuing lessons!

Professional Locksmith

Study Unit 12

Electronic Security Systems

Preview

Well, you've now completed 11 information-packed study units on locksmithing and are well on your way to completing your training in this exciting field. In this study unit, you'll be learning about electronic alarm systems, one of the fastest-growing areas of the locksmithing business. Electronic security systems have evolved from a simple wire-loop and relay system to today's modern electronic systems. At first, it may seem that the design and installation of a burglar or fire alarm system would be very difficult. However, people just like you are installing these systems every day. Today's modern electronic advances in burglar and fire alarms will actually make these installations fairly simple.

When you complete this study unit, you'll be able to

- Describe the need for electronic security systems

- Discuss the difference between a local alarm system and a central reporting system

- Describe the difference between a hard-wired and a wireless system

- Identify common alarm system components and explain their purpose in a modern alarm system

- Discuss typical alarm system functions such as fire protection, panic circuits, 24-hour zone protection, duress codes, and other such functions

- List the steps to the installation of an electronic security system

- Explain the programming of a typical alarm system and how the program influences alarm system operation

- Discuss additional security measures that can be taken beyond an alarm system

- Describe how to enter the alarm installation business

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Electronic Security Systems

Do You Know . . .

What is an *EOLR*?

What is a *dual-technology sensor*?

What is a *panic circuit*?

In the following pages, you'll find the answers to these and many other questions about modern electronic security systems.

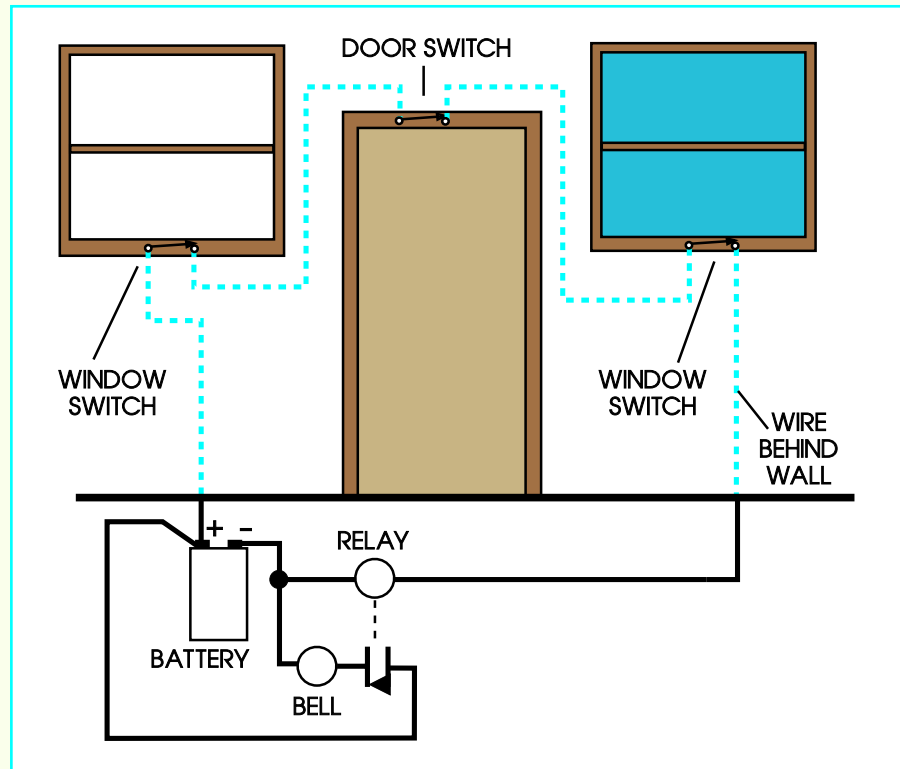
INTRODUCTION

The History of Alarm Systems

The first working alarm system was developed in 1853. It consisted of a battery supply, a loop of wire, contact strips, and a bell. If the strips made contact, the bell would sound alerting the owner of the property to the presence of an intruder. Later systems were actually not developed much farther than the simple system of 1853. Figure 1 displays a simple loop system for an early alarm system.

This system is a normally-closed system. Power from the battery supply goes from the battery (+) terminal through a set of three normally-closed switches mounted on the windows and door of the example room. The negative supply then is connected to a relay coil. The opposite side of the relay's coil connects to the switch circuit. This closed circuit energized the relay's coil in the same manner as the electric lock's coil was energized in the last study unit. The relay's coil creates a magnetic field that pulls on an armature. Connected to the armature is a set of contacts that can change their state. (Normally-open contacts close and normally-closed contacts open.)

FIGURE 1—This is a diagram for a simple loop circuit.



A bell is connected through the normally-closed contacts of the relay to the battery power supply. Since the relay is energized by the closed security circuit, the normally-closed contacts have opened. Therefore, the bell won't be energized and will remain quiet. If one of the switches on the windows or the door were to open, the relay would become de-energized. This would cause the contacts to close, energizing the bell.

The reason for the normally-closed circuit is to prevent tampering. If a burglar were to snip one of the wires of a normally-open circuit, the circuit wouldn't trigger an alarm. In a normally-closed circuit, however, snipping a wire would de-energize the relay, causing the alarm bell to sound.

This type of normally-closed loop circuit with relay control was used for many years. The next improvement came with electric power distribution and the use of a power supply to replace the battery that required recharging and replacement at short intervals.

Modern burglar and fire alarm systems have advanced far beyond the loop and relay circuit. Modern burglar and fire alarm systems use microprocessors and integrated circuits in

a manner similar to a personal computer. Modern sensors use microwaves, ultraviolet light, piezoelectric crystals, and other such space-age technology to create a total system that can be easily customized for a wide range of residential and commercial applications.

The Need for Electronic Security

By this point in this course, you can see how easy it is for a burglar to enter a building when it's unoccupied: the burglar may pick a lock or force a window, vent, or door. A burglar has many ways to find out whether a home is occupied. The burglar may simply call to see if the resident is home. Also, mail delivery can be checked or the property "cased" to find out when the occupants normally leave for work and school. Most businesses have an obvious pattern for when they're occupied and when they're vacant. Electronic security systems can protect these homes and businesses from entry in a safe and invisible manner 24 hours a day, seven days a week.

Another advantage of an electronic security system is peace of mind. A family may have valuables that they need to protect. Also, consider people who must travel a great deal and be away from their families or dwellings for long periods of time. Electronic security systems can protect their residences against intrusion during their absence.

How Alarms Deter Crime

Each year alarm systems have helped to catch over 30,000 burglars in the act. When the alarm system is connected to a central reporting office or police station, the criminal can normally be caught during the burglary rather than after the crime has taken place. Therefore, knowledgeable burglars won't touch a home that contains a modern burglar alarm system. Instead, they'll move on to a location that doesn't have this type of system.

TYPES OF ALARM SYSTEMS

Local Alarms and Central Reporting Systems

Note: Before we begin our discussion of alarm systems, we would like to remind you to keep your course glossary handy during your studies. The subject of electronic security contains a lot of new terms, and you may want to periodically refer to the glossary until they're all familiar to you. Use your glossary to prevent mix-ups and to make your studies easier!

Just as with any other consumer product, there are a wide variety of burglar and fire alarm systems available on the market. Simple systems are available that will protect a limited number of zones within a typical residence. Large systems are also available that protect a large number of zones within a business.

Alarm systems can be categorized by the type of alarm that's generated by an intrusion or fire. These two categories are the *local alarm* and the *central reporting system*.

A local alarm system is the simpler of the systems available. This type of system is normally used in residential or in small business applications. In a local alarm system, the control will energize a sounding device when it senses an intruder or a fire. A sounding device could be a buzzer, bell, or specially equipped speaker system that produces a loud alarm sound outside the home. This event is in no way reported to the police or other agency over phone lines. Most systems depend on the sounding device to create panic in the intruder or concern in a neighbor. The intruder will normally leave the property or a neighbor will call the police or fire department to report the disturbance.

Just because the alarm system doesn't call an agency or the police doesn't mean that it isn't a high-tech system. Many local alarm systems include sensors and control systems that use the latest technology. Use of a local alarm system rather than a central reporting one may simply mean that the property owner thinks that central reporting won't be necessary.

A central reporting system is a system that uses regular phone lines to call a central 24-hour monitoring station. This system is called a *digital communicator*, and it transmits digitized data. If an entry or fire were to take place, the system

would call the central station. The central station would send someone to check on the situation or call the necessary authorities. The customer pays a monthly or yearly fee to the monitoring company. An audible local alarm may or may not be part of the system, depending on the customer's preferences.

A second type of reporting system uses leased telephone lines to the local county communications center. This system is usually a point-closure type of system.

A third type of reporting alarm system is the digital communication. An automatic dialer system will call a preset telephone number or numbers in the event of an intruder or a fire. An automatic dialer can be used to contact the customer at work, a reporting agency if previously arranged, and in some cases, a police or fire department. Unfortunately, many early burglar and fire alarm systems were prone to false trips causing police and fire departments to make unneeded visits to the protected site. Therefore, many localities won't allow an automatic dialer system to directly contact police or fire dispatchers.

Burglar and fire alarm systems can be further divided into the categories of hard-wired, wireless, or combination systems.

Hard-Wired Systems

A hard-wired system will have wire loops used to connect the sensors that are included in the system. Although these wire loop systems may seem similar in construction to the early burglar alarm systems, they are, in reality, quite different. A typical series connected loop is shown in Figure 2.

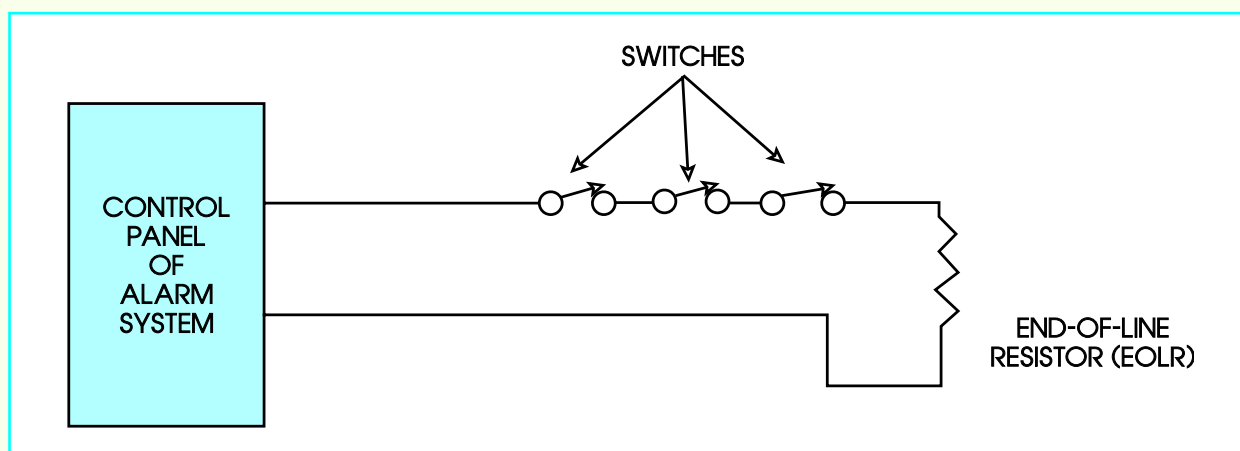


FIGURE 2—This is one type of series loop connection that uses an end-of-line resistor or EOLR.

In this circuit, three switches are shown in the circuit. Actually the circuit can contain any number of switches as needed to protect a zone in a home or business. The special feature of this circuit is the end-of-line resistor, or EOLR.

As you may remember from the last study unit, resistance opposes the flow of current in a circuit. This same action occurs intentionally in a hard-wired burglar alarm loop for a protected zone. The burglar alarm controller constantly monitors the resistance, or current flow, in each hard-wired zone. Any change in current above or below the preset value set by the EOLR will trigger the alarm for that zone.

Current monitoring of a zone provides additional security for the system and owner. As in earlier systems, if a switch is opened or a wire is cut, the resistance of the circuit will rise toward infinity. Since the resistance is infinity, the current flow in the loop will decrease to zero. The alarm system will sense this condition and trigger the alarm. The alarm will also trigger if a burglar attempts to short out the loop with a piece of wire. Now, the loop resistance will fall to zero and the current will reach the maximum level the control system will allow. Therefore, opening or shorting the circuit will disrupt current flow in the circuit. This is shown visually in Figure 3. The typical loop current is about 0.005 A or 5 milliamp (5 mA) of current. If the loop current would vary

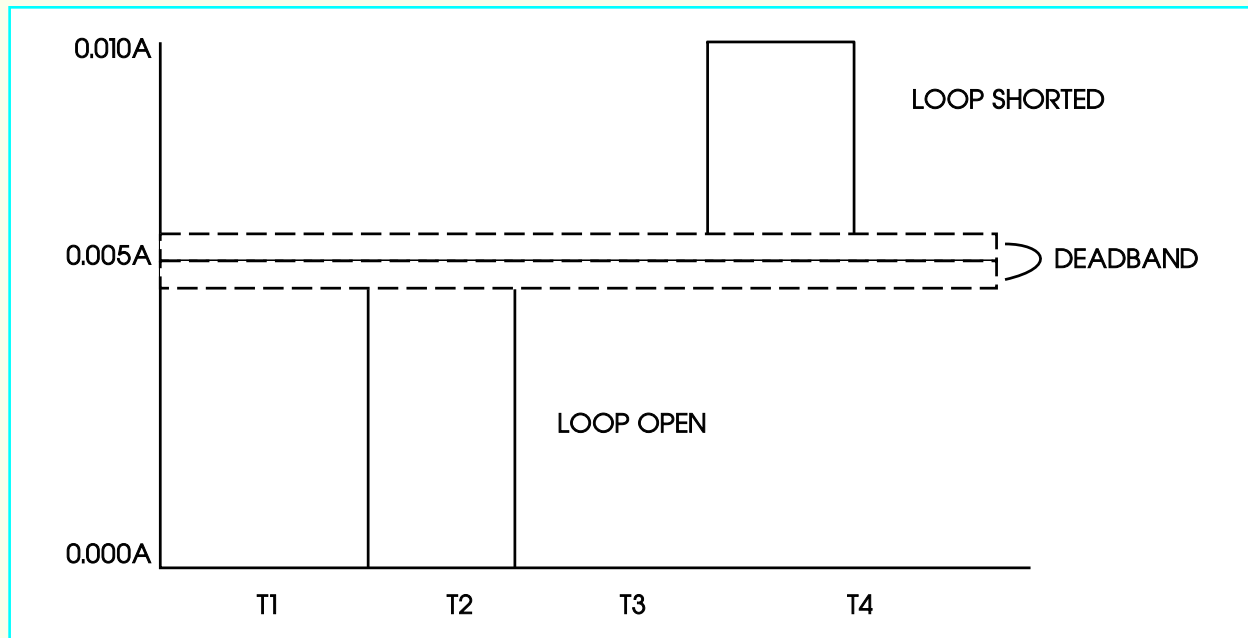
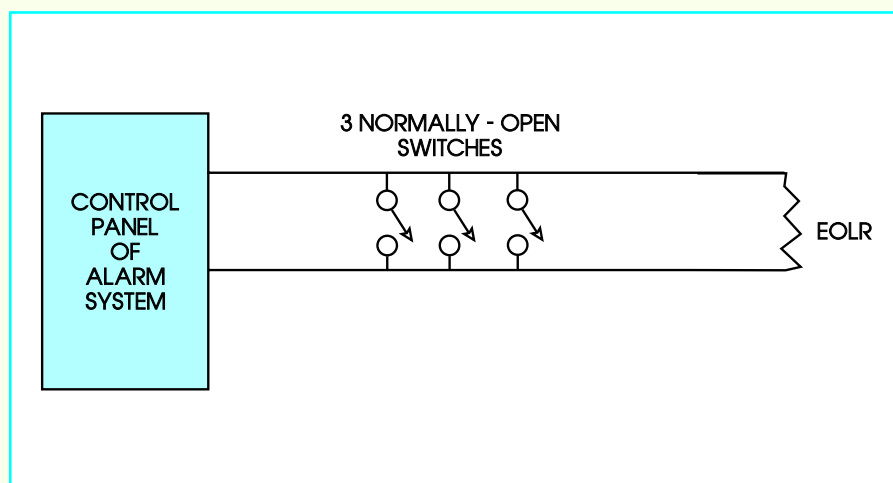


FIGURE 3—This is the typical operation of a current-monitored loop, or a supervised loop with an EOLR.

slightly, yet remain in the deadband area, the alarm wouldn't trigger. However, if the loop opens, shown by the dropping current of T2, the alarm would trigger since the current fell below the deadband. At T4, the loop was shorted causing the current to increase above the deadband triggering the alarm.

The ability to monitor current in a loop offers many other loop wiring and sensor configurations. A loop for a zone that uses all normally-open switches is shown in Figure 4.

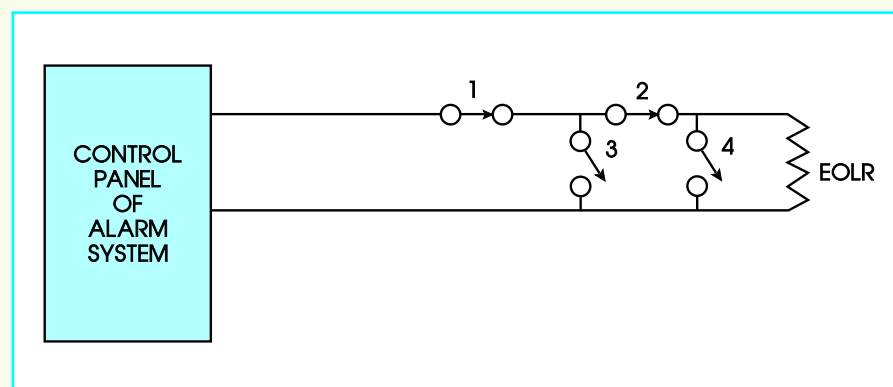
FIGURE 4—Normally-open switches can also be used with a supervised loop like the one shown here.



When none of the switches are actuated, the loop current flows through the EOLR. If a switch is actuated, it will act as a short circuit and raise loop current to its maximum value triggering the alarm. Also, if an attempt is made to open the circuit by cutting a wire to a switch, the loop current will drop to zero triggering the alarm.

Another advantage of loop-current monitoring in a hard-wired circuit is the ability to mix normally-open and normally-closed switches in a loop. This type of circuit is shown in Figure 5.

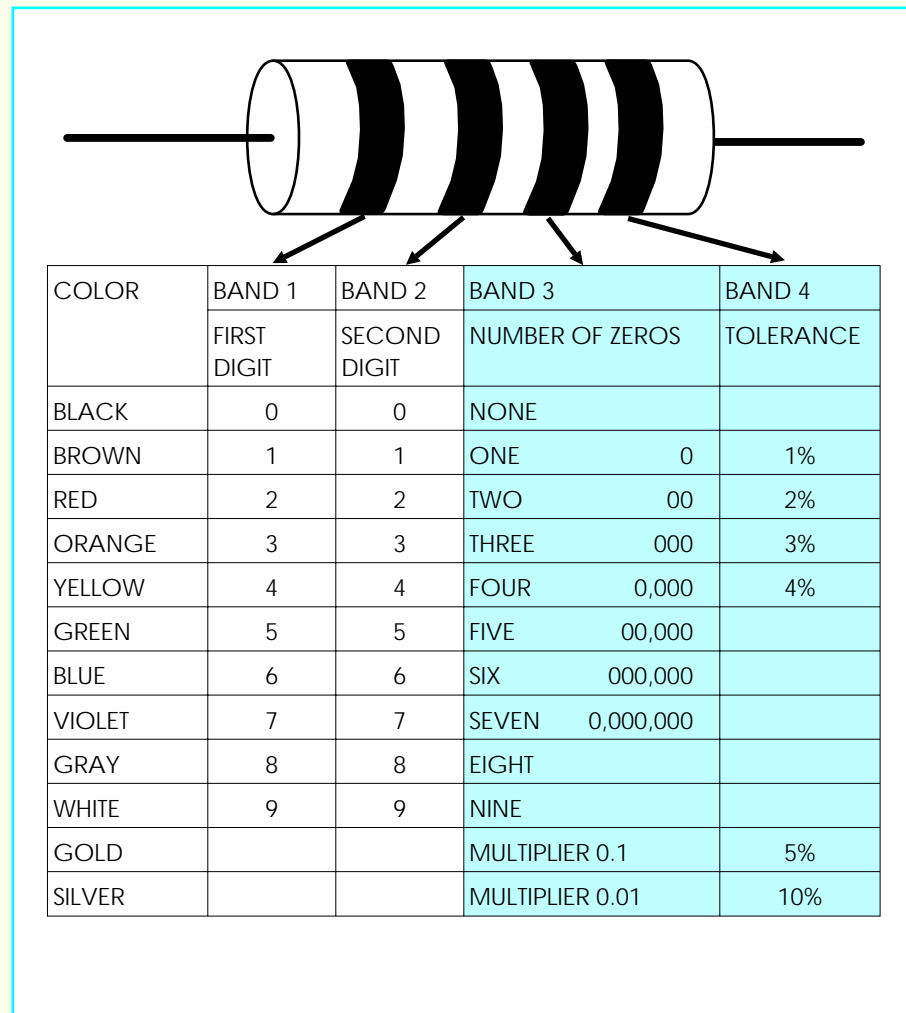
FIGURE 5—In this circuit, the loop contains both normally-open and normally-closed switches. Actuating any switch will trip the alarm.



Now if you open switch 1 or 2, or close switch 3 or 4, or try to open or short the loop in any way, the alarm will trigger since loop current will change from its 5 mA value.

The end-of-line resistor, EOLR, is a small electronic circuit component. This component is shown in Figure 6.

FIGURE 6—This is a resistor and a chart that decodes the color bands.

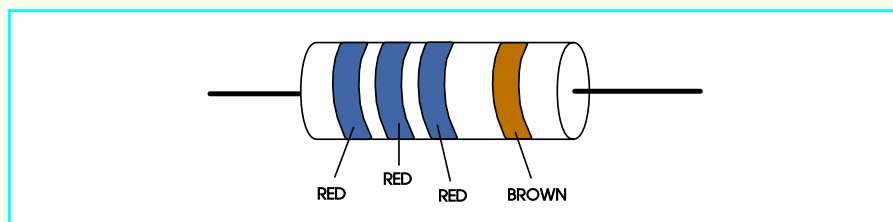


Notice that there are many bands that encircle the resistor. These bands are color coded and identify the value of resistance the resistor will present to the circuit. In resistor color coding, a different color has been assigned to each number from 0 to 9: black for 0, brown for 1, red for 2, and so on. In our example circuits shown previously, the resistor was a 2,200 ohm or 2.2 kohm resistor operating in a circuit with an applied voltage of 12 volts. The color code for this resistor would be

2 = Red
2 = Red
00 = Red

The bands would, therefore, be as shown in Figure 7.

FIGURE 7—These are the color bands for a 2.2 kohm resistor.



The final band denotes the tolerance of the resistor. This resistor is a one percent tolerance resistor. This means the resistor, if measured on an accurate VOM, would read from 2178 to 2222 ohms. A higher tolerance value resistor can also be used in alarm loop circuits. However, due to other variations in circuit resistance caused by long wire runs, switch contact resistance, and so forth, the use of one percent tolerance resistance is suggested. Their additional cost over a wider tolerance resistor is inexpensive compared to the trouble of false trips of the alarm circuit.

Resistor values can also be measured with a VOM. Simply place the resistor between the leads of the VOM and place the selector switch in the proper resistance range. The value can then be read off the analog scale or digital display.

The resistance value used as an EOLR will vary from manufacturer to manufacturer. Consult the wiring diagrams for the alarm circuit you're working on or installing for the proper values.

Large Hard-Wired Systems

Imagine the difficulty in hard-wiring a large factory's windows, doors, and other points of entry along with installing fire alarm devices, sounding horns, and other alarm circuit devices in such a large area. If each individual loop had to be hard-wired and there were 30 zones to be protected, it would mean 60 wires would be needed to enter the control panel just for the basic protection loops alone! To reduce the number of wires, some alarm systems use a two-wire

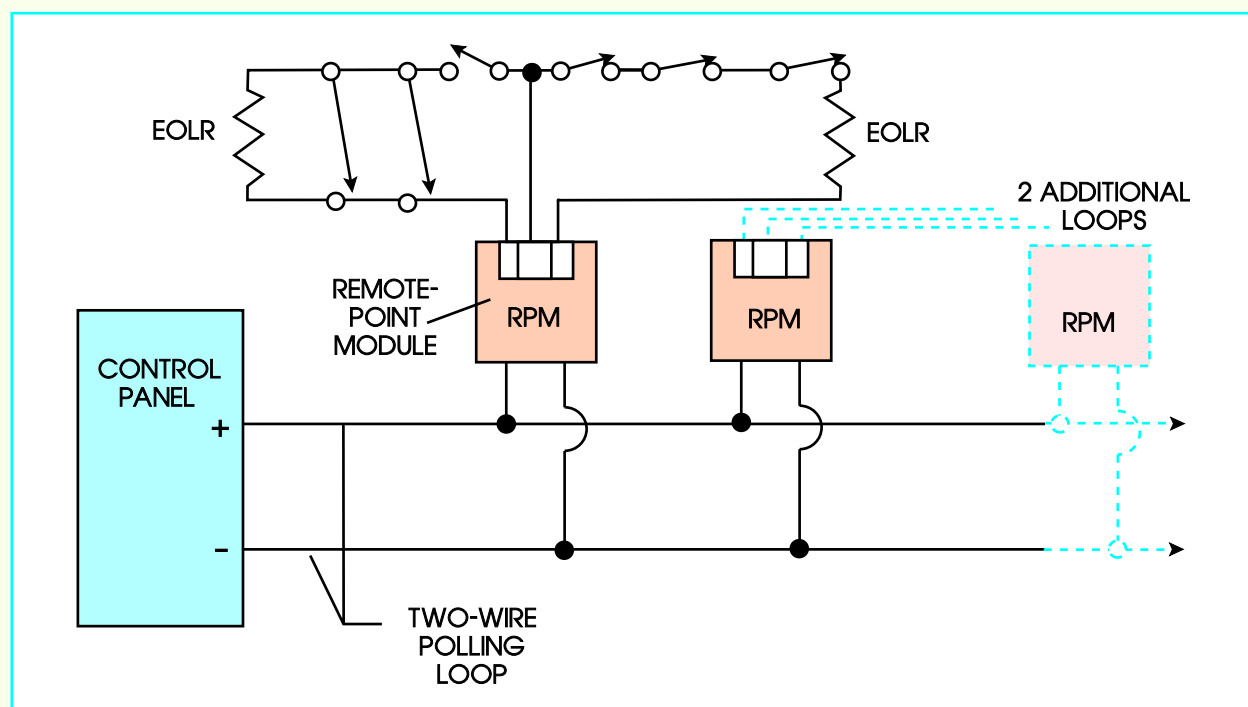


FIGURE 8—Multiple remote-point modules, or RPMs can be used on a two-wire polling loop to expand an alarm system.

multiplexed system often called a *polling loop*. A typical polling loop shown in block diagram form is shown in Figure 8.

A multiple polling system uses a special alarm controller. This controller connects to many *remote-point modules*, or RPMs, at the locations to be protected. The zones are then wired with protective loops that connect to the RPMs. An EOLR will be used in a similar manner as seen previously for each loop.

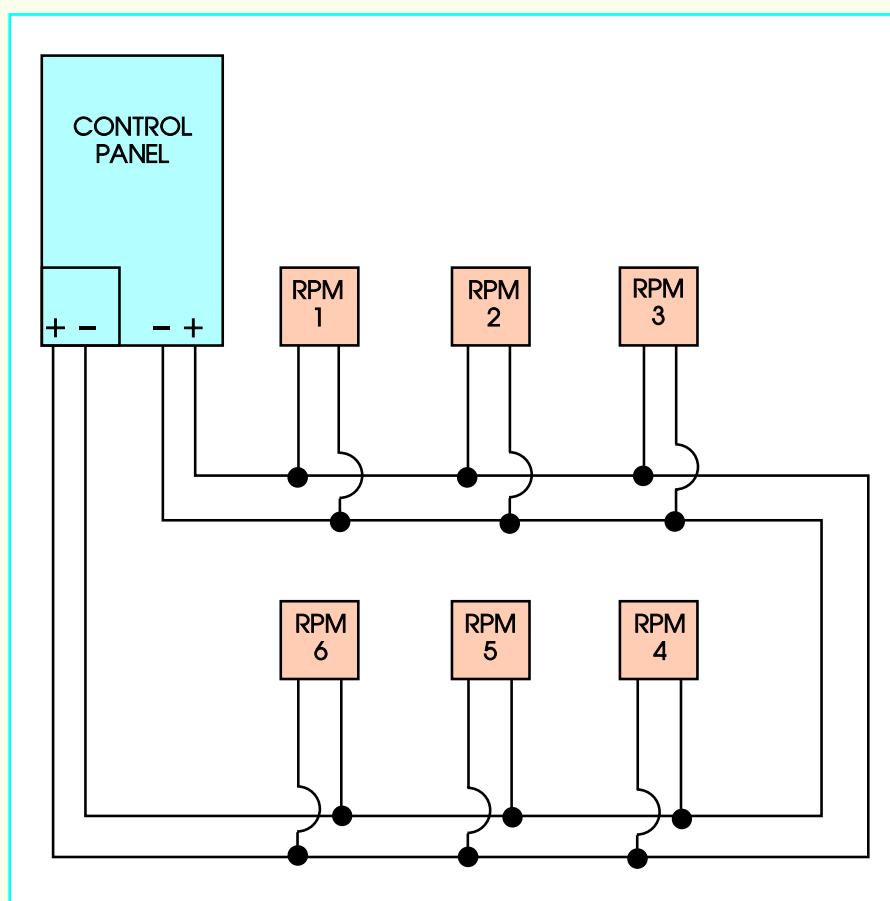
The two-wire polling system operates much like a telephone system. In operation, the main controller calls up a specific RPM. The RPM that has its own unique system number, responds to the call by answering with its ID number and loop-status information. The main controller will then call up the next RPM and have it answer with its ID number and loop-status information. This operation continues until the last RPM has been called and has answered the main controller.

Each RPM has its own ID number set by means of small switches on the RPM's circuit board. Each RPM is also powered by the two-wire polling loop, and the sensors or switches within the system are powered by the polling loop. If a sensor or switch opens or closes a loop at an RPM, the RPM, when called (polled) by the main controller, will report

that one of its loops has been intruded upon. The main controller will know which loop has been intruded upon and will sound an alarm, call a reporting agency, police or fire department, or simply ignore a bypassed zone, depending on how the main controller is programmed.

Some polling loops operate in a special closed-loop mode often termed a Class A polling loop. Such a system is shown in Figure 9. A closed loop or Class A polling system will continue to operate even if damage occurs to the wires in the polling loop.

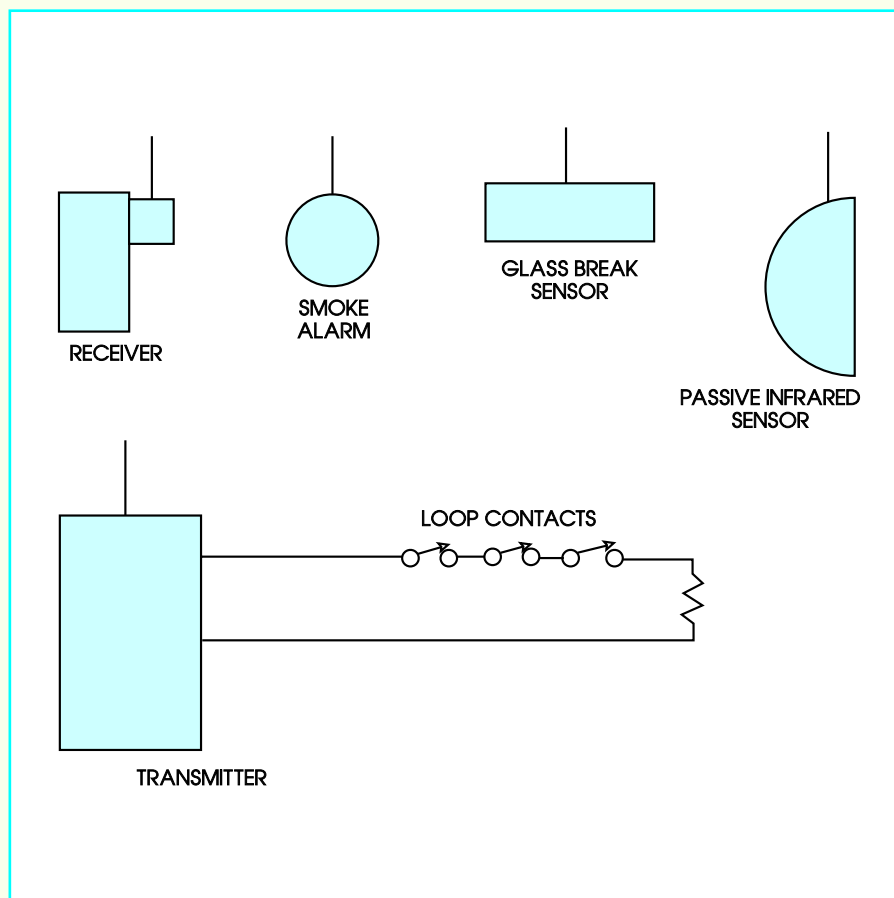
FIGURE 9—This is a typical diagram of a closed-loop or Class A polling loop.



Wireless Systems

The newest advance in alarm systems is the development of wireless sensors and devices. A typical wireless system in block diagram format is shown in Figure 10. In a wireless system, an ultra-high frequency (UHF) signal is used to transmit information from transmitters located around the building to a receiver located at the main control panel of the alarm system. Like a polling system, each transmitter has a

FIGURE 10—Shown here are a few of the many devices in a wireless system. All of the transmitters and devices will communicate with the receiver at the control panel.



unique call-in code. And, each transmitter, like an RPM, can be used to check the status of one or more protective loops that are terminated with an EOLR. Transmitters may also be used for single purpose sensors such as infrared or microwave interior detectors.

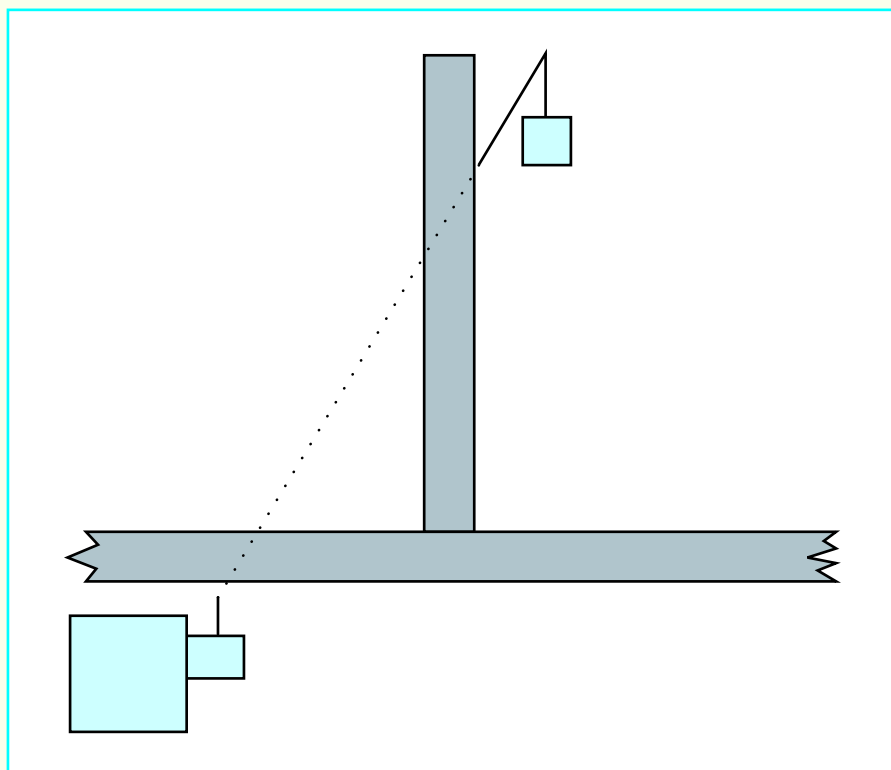
In a typical wireless system, the main control panel and its receiver are preprogrammed with the ID numbers of each of the transmitters. Each transmitter must report in at specific times by transmitting its ID number and the status of its protected loops or sensor conditions. If a loop is intruded upon, the transmitter will return its ID number and report that a specified loop is shorted or open. The alarm system can then act upon this information according to its program.

The transmitter will be powered by either a three- or nine-volt internal battery. The transmitter can either power the loop or operate with self-powered smoke, fire, ultrasonic, infrared, or other type of sensor. Most of the newest transmitters are powered by long-life lithium batteries that can last up to 15 years under normal operating conditions. This long life

is created by a “sleeper” mode for transmitter powered sensors. In the sleeper mode, the sensor will draw negligible power from the transmitter’s battery supply. In the active mode when the sensor triggers, the current draw remains low through the use of solid-state devices. As mentioned, most of the newest sensors are available with their own internal batteries, eliminating the need to use the transmitter’s battery to power the sensors. In the event that a transmitter’s or sensor’s battery becomes low, the alarm system will normally send a series of beeps at a remote keypad. This allows your customer to change the battery or to call you for a service call.

Wireless systems offer two advantages: they’re easy to install and they’re less likely to have wiring problems such as pinched cables or loose connections. However, wireless systems can have some drawbacks. The transmitted signal can often be absorbed by concrete, brick or metal as shown in Figure 11. Some control systems that are used in large buildings will have multiple receivers hooked to the main controller with a two-wire multiplexed polling loop as previously seen.

FIGURE 11—The transmitted signal can often be absorbed or reflected by concrete or metal-covered walls.



Another possible problem with a wireless system is that radio-frequency sources can interfere with the alarm system's transmission and reception. If a wireless system is used in a hospital or industrial plant or other location that produces radio-frequency interference, the alarm system can be fooled into thinking a sensor has tripped or a zone has been intruded upon. Some of the more expensive receivers use special circuitry to eliminate most of the transmission interference problems of wireless systems.

Combination Systems

An alarm system doesn't necessarily have to be a strictly wired or strictly wireless system. Most burglar and fire alarm systems are extremely adaptable. If the installation requires hard-wired, wireless, and remote-point modules, all three of these systems can be accommodated by most alarm systems.

Building Codes, Fire Codes, and the Americans with Disabilities Act

As you've seen in the previous study unit, building and fire codes are written to protect the public, the homeowner, and fire and rescue personnel. Therefore, you should follow them carefully in planning and installing alarm systems. Building codes for your area are available for your inspection or for photocopying at your local library. Fire codes are normally available from the fire marshall or fire chief at your local fire and rescue company. Some areas have codes, that, for example, dictate how many smoke or heat sensors must be installed in a building. Also, the codes may describe the location for the placement of these sensors. Be sure to check with the authority having jurisdiction for final approval.

The Americans with Disabilities Act (ADA) has greatly influenced the construction of new buildings in providing access for handicapped people. The ADA act has also changed the way fire alarms are installed. Also, the ADA is very specific about commercial alarm installations in hotels/motels, museums, theaters, schools, restaurants, and other public places (except churches). The ADA gives many specific guidelines that you will need to follow in your work with alarm systems; for example, the ADA states

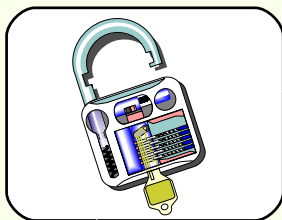
1. An audible alarm system shall produce a sound level of at least 15 dBa over the natural or common sound level of the surrounding area. This level of sound should be maintained for at least 60 seconds. The maximum level of the alarm should not exceed 120 dBa. (*Note: dBa is a sound measurement value that's rated in units called decibels. A dBa is a value of decibels audio power versus a dB rating for radio frequency energy. As an example, traffic noise near a highway is about 50 to 60 dBa. A jet taking off from an airport is in the range of 80 to 90 dBa.*)
2. Visible alarm devices, also called visible signal appliances, shall produce a minimum of 75 candela. They shall be clear or white and use a very powerful light such as a Xenon strobe. The light shall have a minimum flash rate of once per second and a maximum flash rate of three times per second. (A candela is a measure of light intensity. The visible signal appliance will have the candela rating listed on the appliance.)
3. Visible signal appliances shall be located in sleeping rooms in hotels/motels, restrooms, hallways, lobbies, and other areas of public usage.
4. Manual fire pull boxes (fire alarm boxes) should be mounted no higher than 48 inches above a floor level. If a wheelchair is capable of parallel approach to the pull box, the box may be mounted no higher than 54 inches above the floor.

What the ADA means to the alarm installer is evident in the placement of audible and visual signal appliances. Also since the law increases the loudness and brightness of the appliances in current use, the new appliance will draw much more current. This creates two problems for an alarm system that's already in place.

These problems are

1. A greater current will be drawn from the output section of the alarm control panel. Newer large systems can provide this greater current. Older systems will have a limited current capability. These systems can be upgraded by placing a device known as a power booster between the output of the older alarm system and the new audible and visible alarm signal appliances.

2. A larger gauge of wire will be needed between the alarm's control panel, or the retrofit power booster and the signal appliance. This larger gauge wire is needed to carry the increased current these devices consume and to prevent a voltage drop on the wires leading to these devices. If a voltage loss were to occur, it would greatly reduce the audible level or visible output of the alarm signal appliances. For example, if AWG 16 or 18 wire was used previously, you'll need to use AWG 12 or 14 wire in new installations.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

1. What is the purpose of the EOLR in an alarm circuit?

2. Where is an RPM used?

3. Can a protective loop in a zone contain both normally-open and normally-closed switches or sensors?

Check your answers with those on page 91.

ALARM SYSTEM COMPONENTS

An Overview of the System

Before we begin to look at the wide array of components, switches, and sensors available in a typical alarm system, let's look at an overview of the entire system. A block diagram of such a system is shown in Figure 12. Looking at this figure, you can see that the main control panel is the center of any burglar and fire alarm system. This section of the system contains the power supply, microprocessor-based circuit board, termed strips for input and output device connections and other main system components.

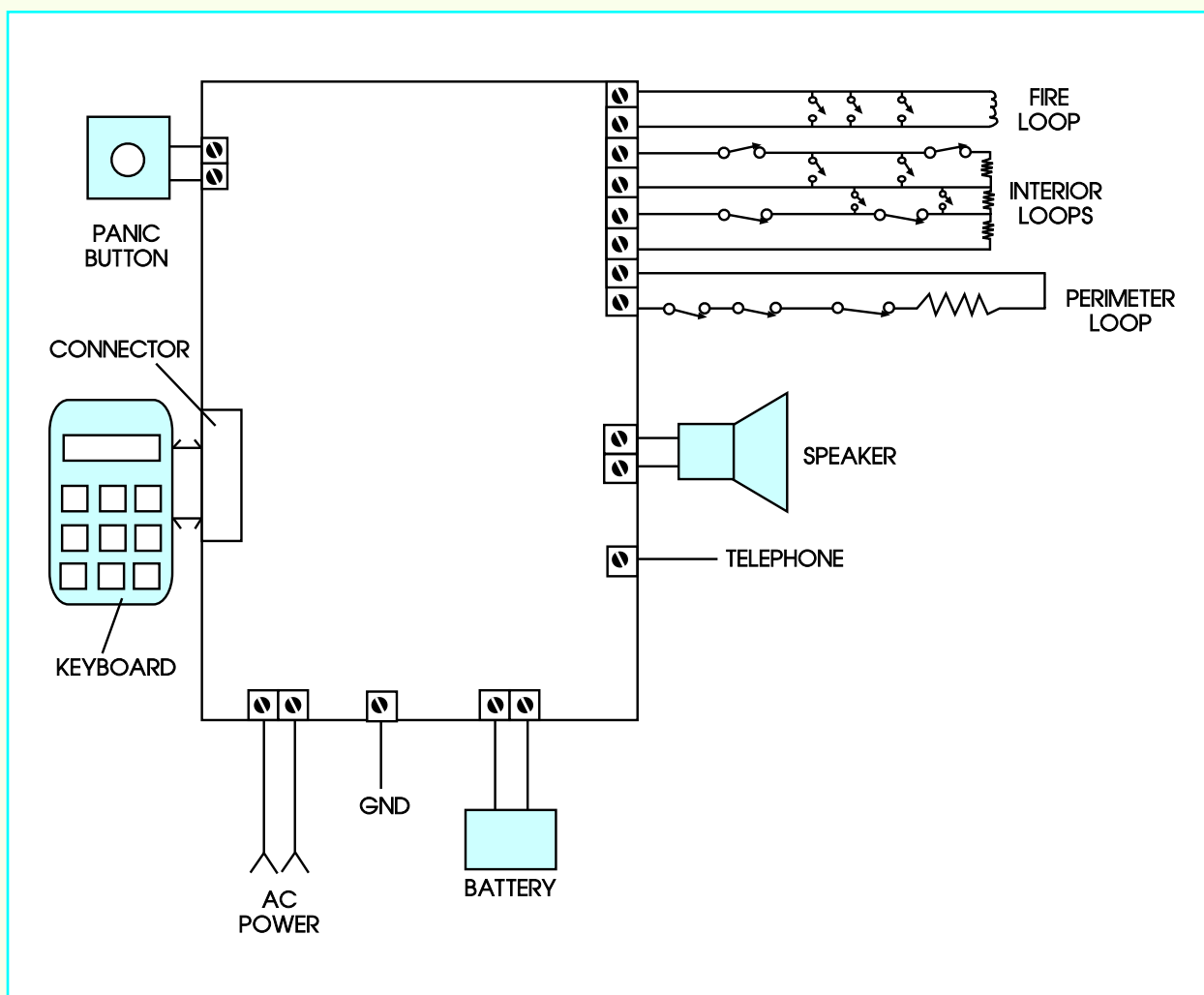


FIGURE 12—This is a basic drawing of a typical control system.

At the bottom of the main control panel is the power supply for the system. The burglar and fire alarm's main control panel will normally operate off the AC power line. However, if power is interrupted, either naturally or intentionally, the battery supply will take over.

The input devices to the control system are

- The panic button

- The perimeter loop switches and sensors

- The interior loop switches and sensors

- The fire alarm detectors

- The keyboard (remote or local)

The output devices from the main control panel are

- An audible speaker, buzzer, or siren (light also available)

- An automatic telephone dialer

Control Zones

In this text, we've been using the terms *zones* and *loops*. Let's take the time to define these terms. A zone is a protected area of a building. A zone could be a hallway, a room, a series of rooms that are connected by a large open space, a basement, garage or other such area. The entire perimeter of a building can also be considered a zone.

A loop is a run of wire within a zone. For example, a zone such as a series of offices can be protected by an alarm system. In the control system, the office area is programmed to be protected from 6:00 P.M. to 6:00 A.M. The sensors within this office space will trigger an alarm if they're actuated. The sensors may be connected by multiple loops of wiring. However, each loop is identified at the control panel as being part of one zone that will be protected for the 12-hour period.

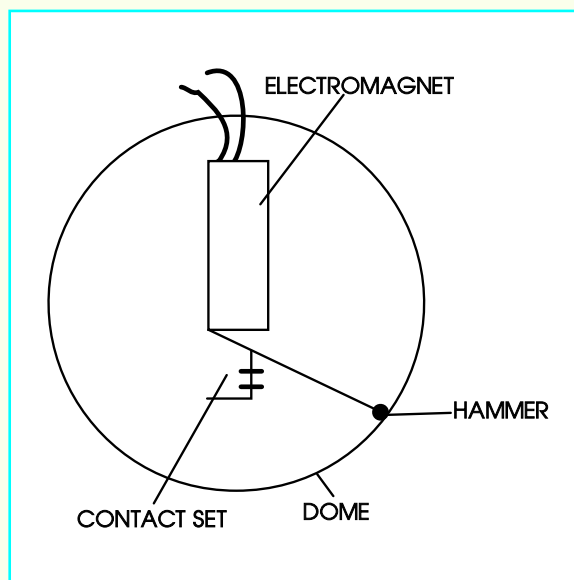
The same building may have a separate area that may need to be entered or exited during this 12-hour period. This will be called an entry/exit zone. The control system will sense that someone has entered this area and allow a certain

programmable time period for the person to enter a code on a keypad or to enable a keyswitch before the alarm system will trigger an output. This entry/exit zone may also be protected by any number of loops. One loop may contain glass break sensors that will trigger an alarm instantly, since this would be a forced entry. A second loop of wire and sensors can be infrared or microwave-based and allow a timed interval after sensing entry before the alarm system triggers.

Output Devices

Output devices, also termed audible or visible signal appliances, are used by the alarm system to announce the presence of an intruder or a fire. A bell was one of the first types of devices used by alarm systems. A bell for an alarm system is available in many forms. The simplest form is shown in Figure 13. Here the dome of the bell is made from formed steel. Inside the bell is an electromagnet and a set of contacts. When the coil is energized by the output voltage from the alarm system's control panel, the electromagnet will pull the striking hammer

FIGURE 13—These are the major internal components of an alarm bell.



until it strikes the dome. At this point, the internal set of contacts will open the circuit to the coil causing the hammer to drop away from the dome. Once the hammer has fallen away, the contacts will reclose, re-energizing the coil and pulling the hammer once again towards the

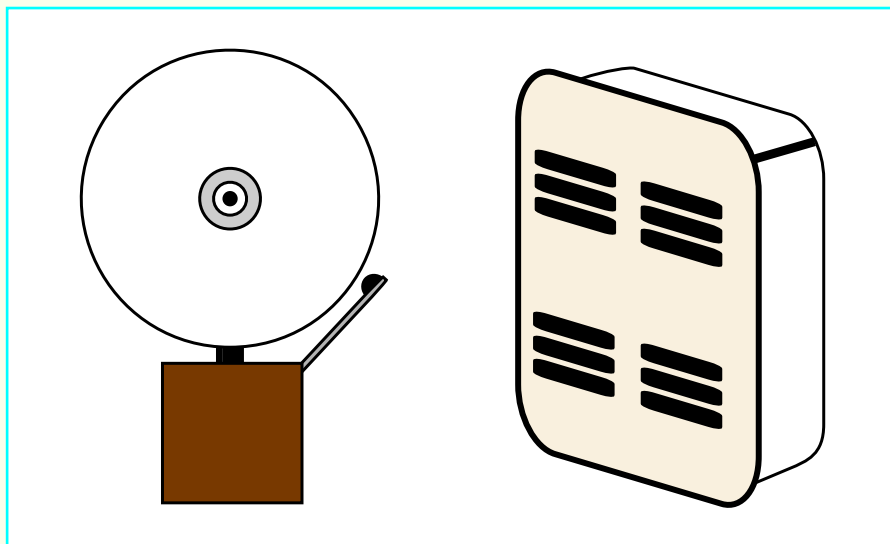
bell's dome. This action is repeated until the power source, at the alarm system's control panel, drops the alarm output.

A second type of bell is also available that uses a low current motor to cause the hammer to strike the dome. When the motor turns, it rotates a small plate with the hammer attached to the plate. The hammer is held to the plate by a

spring-steel arm. As the hammer rotates, it hits a strike that compresses the spring- steel arm. As rotation continues, the arm passes the strike. The spring-steel arm then decompresses, allowing the hammer to hit the dome.

Some bell systems will also have a strobe light mounted on the unit. Even others will be mounted in a steel box that's normally installed on the outside of the building. The box will help protect the bell from the weather and from tampering. Some boxes will even contain tamper-proof switches in the event a burglar attempts to open the box and disconnect the bell. A typical bell and a bell in a tamper-resistant box are shown in Figure 14.

FIGURE 14—Shown here are a typical alarm bell and a bell in a tamper-resistant box.



Alarm horns and sirens are also available. Alarm horns and sirens are normally slightly louder than bells when operating in the 12 to 24 VDC range. For example, a typical horn will produce about 90 to 105 dBa while a bell will produce about 80 to 90 dBa. A horn can be motor driven in a manner similar to a bell. However, the horn-shaped outlet makes the sound contained and highly directional.

Sirens use an internal electronic circuit to generate the sound. The typical sounds generated can be a constant 100 dBa sound, or a similar, level, pulsating sound called a warble. Many sirens will have a multiple-input terminal strip on their circuit board. If one input is energized, signifying a fire condition, the siren will produce a warble sound. If the alarm system produces a second output connected to another terminal of

the siren's circuit board, a steady tone is produced, signifying an intruder.

One of the most common output devices used on modern alarm systems is the speaker. A speaker is the same device used in your stereo or television set to produce sound. Most modern alarm control panels will have an output that directly connects to the speaker's terminals. The control panel's electronic control board will automatically produce a sound depending upon the condition it senses. Example sounds may be a bell for burglary, warble for fire, a chirp for entry/exit or armed state, and a chime for daytime entry.

Older control systems will have one or two outputs for a fire bell and speaker. The outputs are rated for the amount of current they can produce. For example, an output can be rated for 750 mA, 0.750 A of current. If a fire alarm bell or horn draws 120 mA, you would be able to connect six of these bells or horns for a total load of 720 mA, to this circuit. The speaker output of an older system will need to be connected to a speaker device or sound board if one isn't present on the main control board.

Automatic Dialers

Automatic dialers, often termed digital communicators, have become a common option found on residential and business alarm systems. When the alarm system is tripped, the controller will normally wait a preset amount of time before any action occurs. This action allows the owner to enter a code into the keypad or activate an alarm bypass switch to prevent an alarm from being sounded or dialed.

Once the delay has "timed out," that is, once the preset time has elapsed, the alarm system may perform one of many functions. A sounding device may be energized to alert the intruder that his or her presence is known. The alarm system may not trigger this sounding device but instead use the digital communicator to dial a number of a central reporting station. On all central reporting station systems, the information passed on to the station is of a digital nature, system ID number, problem type, etc. The alarm system may also both produce an audible or visual alarm.

Digital communicators will have many standard features. For example, a communicator will automatically take hold of the

telephone lines by disconnecting any incoming or outgoing calls. This is called a line seizure feature. Also, the communicator will eliminate call waiting on most systems. Most of the modern systems will also be capable of calling more than one phone number in the event that no one at the first phone number answers. The digital communicator must be properly connected to the phone lines.

Input Devices

Input devices are used for two purposes. The first obvious purpose is to alert the system that a trouble condition exists, that fire or heat is sensed by smoke detectors, or that entry has occurred, by perimeter and interior sensors. The second purpose of an input device is to input information. A keypad is used to enter programming information, arm/disarm codes, and other such information into the control system.

Keypads

Keypads are a common addition to all modern alarm systems. Keypads can be connected as a remote device through a multiple-conductor cable or can be mounted directly to the alarm system's main controller. The remote installation is much more common with the remote keypad located near an entry/exit door.

A typical keypad is shown in Figure 15. This keypad has a keyboard that's very similar to the one used on a telephone.

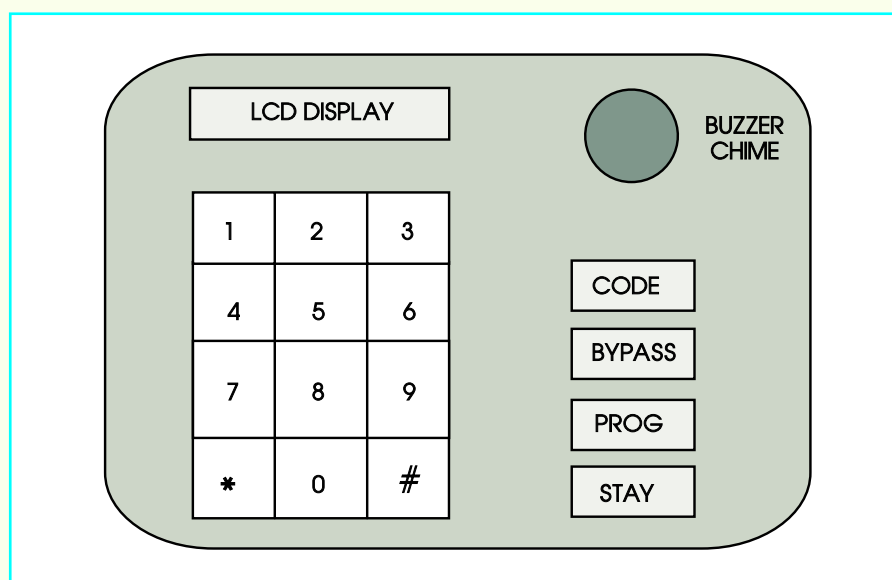


FIGURE 15—This is a sample keypad for remote installation in an alarm system.

An LED or LCD screen is also a part of the remote keypad. This screen is used to view programmed information, see entered codes, and check system status.

A series of large buttons will be located to the right of this simple keypad. These buttons are used to enter data and to arm/disarm the system. A small buzzer is also included. This buzzer will generate different tones to notify the owner of system status.

Remote keypads can be mounted in flush-mount boxes near entry/exit doors, or can be surface mounted to walls. Normally, a multiconductor cable with four or six wires will connect the keypad to the main control panel.

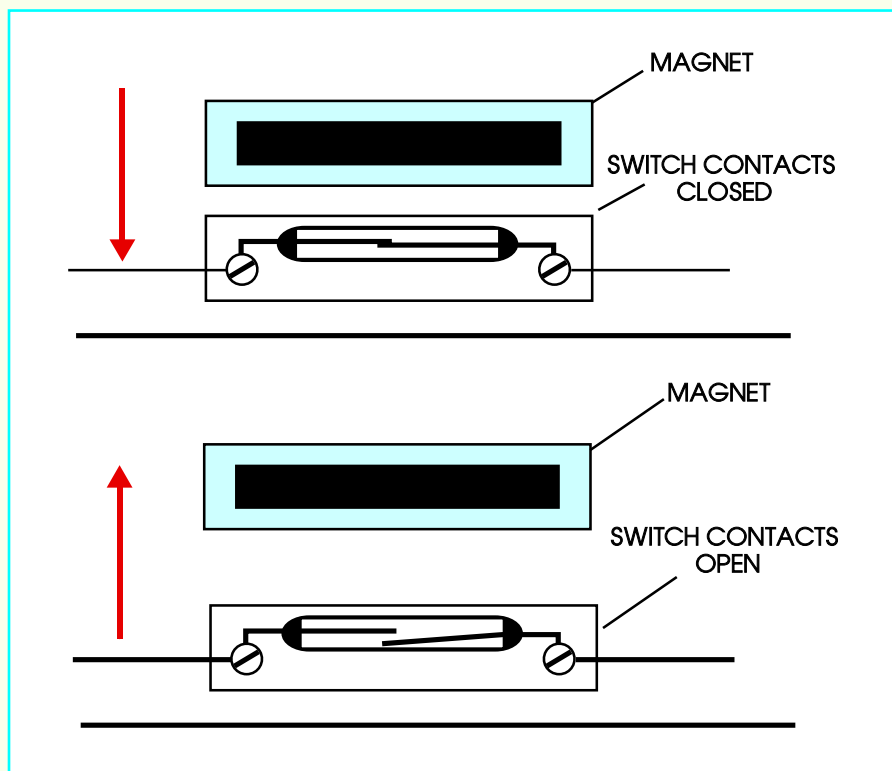
Perimeter Detectors

Perimeter detectors are the first line of defense for any type of residential or business system. This group of sensors checks all of the building's doors, windows, and other entry points for open doors or windows, broken glass, and other such signs of entry before the entry actually occurs.

One of the most common types of perimeter sensors is the magnetic contact assembly. Magnetic contacts are used to monitor the opening and closing of doors and windows in a building. A magnetic contact may also be called a reed switch. This term is caused by the use of internal contacts called reeds as shown in Figure 16. Two contacts are sealed in a glass envelope. When the magnet is placed near the contacts, the contacts will close, completing the loop for the zone. When the magnet is moved away from the contact set, the contacts will open, signaling the burglar alarm system. The most basic magnetic contact will have normally-open contacts. However, normally-closed contact devices are also available.

Magnetic contacts are also available in a wide range of security levels and in a wide range of packages. The standard security level and package format is shown in the previous figure. High-security models of magnetic contacts are also available. These are said to be biased magnetic contacts. The trouble with standard contacts is that a burglar with a magnet can often bypass these contacts by placing a magnet near the contact assembly and opening the door or window. In a biased magnetic contact, the magnet must have its poles

FIGURE 16—This is the operation of a magnetic contact. When the magnet is close to the reed switch, the normally-open contacts will close. As the magnet moves away, the contacts open.



aligned in a certain direction and at a certain strength or the internal contacts will trip, signaling the alarm system. Some very high security models can be triple biased with three sets of internal contacts that are both magnetic-pole and magnetic-strength sensitive.

Another version of magnetic contacts is the concealed series. A typical concealed-magnetic contact is shown in Figure 17.

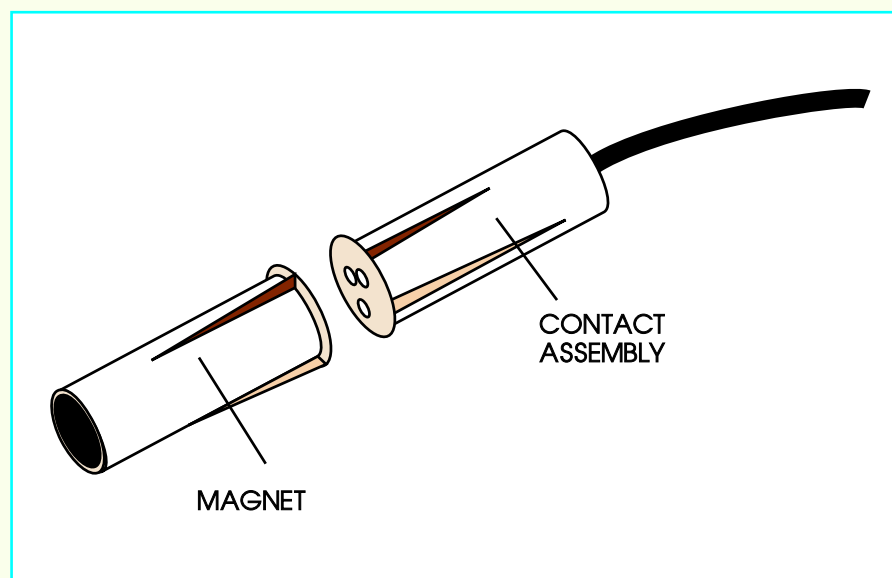


FIGURE 17—These components are typical of concealed-magnet contacts. The magnet is on the left with the contact assembly on the right.

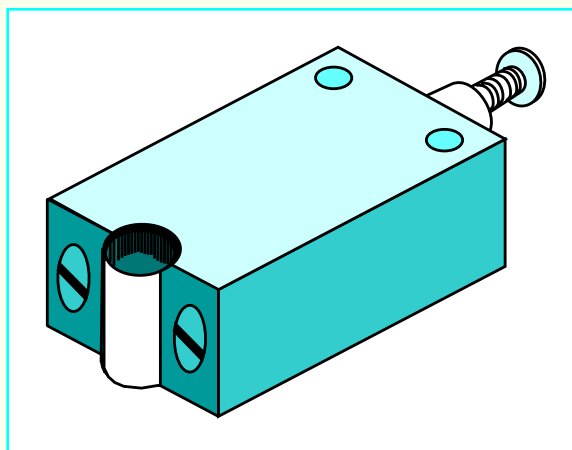
Once installed in a door or window, concealed contacts are extremely hard to identify or bypass.

Special-purpose magnetic contacts are also available for garage overhead doors, freezers, industrial environments, and other such applications. Other versions of inexpensive low-security magnetic contacts are surface contacts. These are either flange mounted or have a peel-and-stick glued surface that can be attached to doors, windows, and the trim that surrounds these items. Some manufacturers will also include a specified EOLR inside the switch for a small additional fee.

Plungers and Roller Contacts

Plunger switches and roller switches can be used either as perimeter or interior detectors. In a perimeter mode, the plunger or roller switches can be used to protect certain kinds of doors or windows. In interior protection, plunger and roller switches are used for protecting gun cabinets, drawers, safes, and other such areas where valuables are stored. A plunger switch is shown in Figure 18. The main components are the body, terminal strip, and plunger.

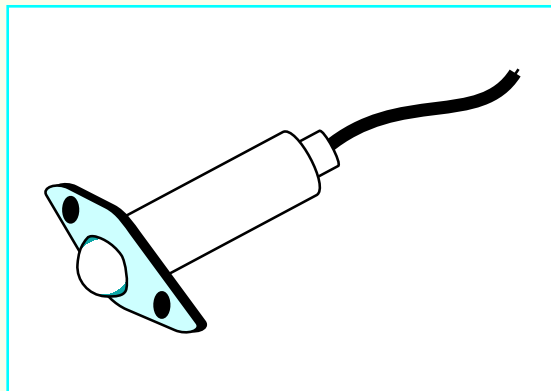
FIGURE 18—A
plunger-type switch can be used on a door or window for perimeter protection or on a cabinet for interior protection.



Plunger switches are available in both normally-open and normally-closed configuration. They're installed in a recess that's milled into the door or window frame or behind the door of a gun cabinet or drawer.

One advantage to the use of plunger switches like the one shown in the figure is that the plunger may be pulled out to close the switch for testing purposes, without the need for switch jumpering with a wire. Some plunger-type switches use a roller at the end of the

FIGURE 19—A roller switch can also be used for perimeter or interior protection.



plunger for use where a door or window will be opened at regular intervals.

A roller switch is shown in Figure 19. Inside the roller switch may be reed contacts operated by a magnet or a sensitive microswitch. A

plunger is acted on by the external ball. This plunger will move the magnet or activate the switch to transfer the switch's contacts.

Vibration Sensors

Vibration sensors are another type of sensing device that can be used for perimeter or interior protection. In perimeter detection, the vibration sensor can be mounted to a window, door, or wall. If forcible entry is attempted, the sensor's contacts will change states open-to-closed or closed-to-open to signal the alarm system. In interior protection, a vibration sensor can be attached to a safe, cabinet, interior wall, or other such surface to protect

against access to the protected item by forcing.

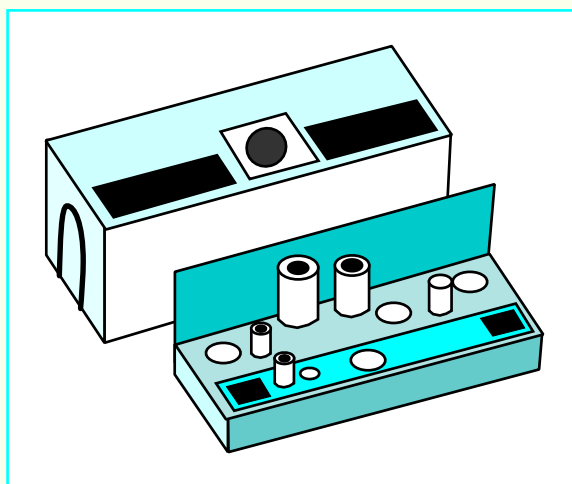


FIGURE 20—A vibration sensor unit is shown here. Note that the cover is removed.

A typical vibration sensor is shown in Figure 20. Inside the sensor are two contacts or a sensitive electronic circuit. In the contact sensor, vibration will cause a weighted contact to move against a stationary contact to

trigger the alarm. In the electronic vibration sensor, a special circuit is used to sense a change in the device that measures vibration. If the circuit and sensor are vibrated beyond a

threshold value, the output contacts are closed. The electronic-circuit type vibration sensor is adjustable, making it more versatile through a wide range of applications.

Glass Sensors

For many years, a fine strip of foil was used to protect door and window glass from breakage. The foil is about three-eighths of an inch wide. It's applied with or without an adhesive backing and is covered with a fine coating of varnish or polyurethane to protect the film from damage. The foil is connected to the alarm system by means of take-off blocks that contact the film and end in screw terminals to which the wires of the alarm system are connected. If the glass were to break, the thin lead-based foil would be sheared, creating an open circuit. This open circuit in a closed- or series-circuit loop would trigger the alarm.

Foil installation has many problems. First, it takes a great deal of time and patience to install foil on a window. Then there are contact problems and possible damage to the exposed foil. Foil usage has dropped considerably due to the development of glass-mounted shock sensors and acoustical glass-break sensors.

Glass-Mounted Shock Sensors

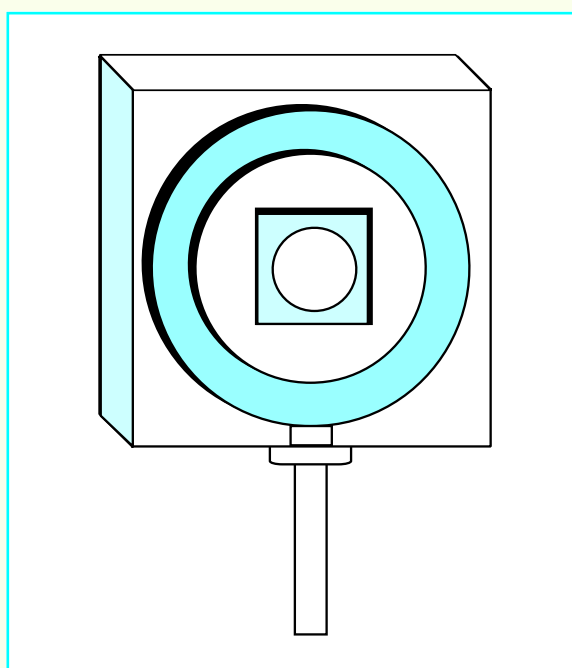


FIGURE 21—A glass shock sensor, like the one shown here, can be used to protect a large glass area.

Shock sensors can eliminate foil coverage for windows, skylights, and solariums. A standard glass shock sensor can sense breaking glass in a radius five to twenty feet from where the sensor is placed on the glass. A typical shock sensor is shown in Figure 21.

Most glass shock sensors use a miniature piezoelectric microphone that will be tuned to the vibration that occurs when glass breaks. A piezoelectric element will produce its own electric current when the vibration of the breaking glass reaches a certain level. Therefore, no power is required to energize this type of sensor. Most shock sensors will have a sensitivity adjustment and an LED that will light when the sensor trips.

Another feature of modern glass shock sensors is the use of solid-state outputs. The output solid-state device changes from a resistance of 20 ohms to a resistance of over a million ohms; this change in resistance simulates a mechanical contact opening.

Four-wire glass shock sensors are also available. These sensors are powered from the loop wiring of the alarm system, or from an internal battery. These sensors will, once triggered, maintain the LED in the ON state until the sensor is reset. This feature helps in troubleshooting alarm loop problems.

Acoustical glass-break detectors are sensors that constantly monitor an area for the sound frequency of breaking glass.

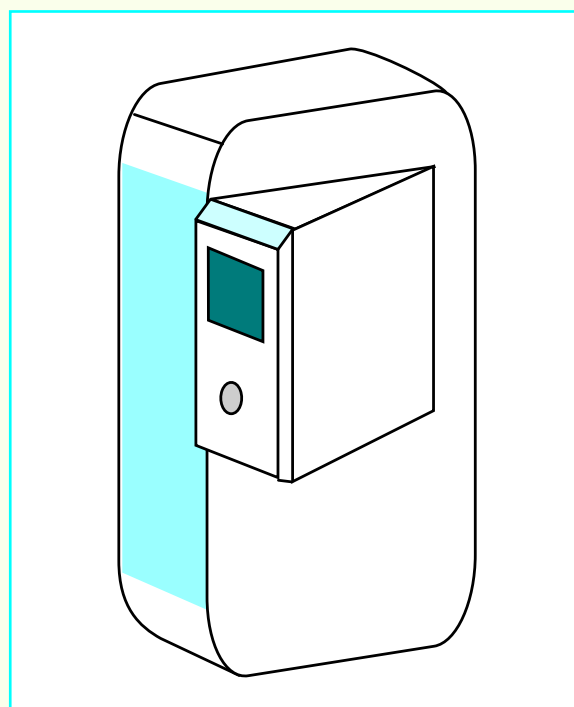


FIGURE 22—This is an acoustical glass-break sensor that's tuned to the frequency of breaking glass. When that frequency is detected by the sensor, it will trigger an alarm.

All other sounds are rejected by the sensors sensitive electronic circuit. Glass-break sensors may be placed in contact with the glass. More common, however, is a ceiling-mount or wall-mount detector. A wall mount detector is shown in Figure 22.

An acoustical glass-break detector will require power from the loop wiring, an internal battery, or

will draw power from the transmitter in a wireless system. An LED will remain on if this sensor is tripped to aid you in troubleshooting an alarm circuit. Most modern sensors won't have a sensitivity adjustment. All adjustments are made at the factory for optimum performance.

Alarm Screens

Alarm screens are used to protect the windows that are open for ventilation. Within the screen are small wires that, when disturbed, will make contact. The screen is connected to the alarm loop circuit as a typical normally-open contact.

Interior Detectors

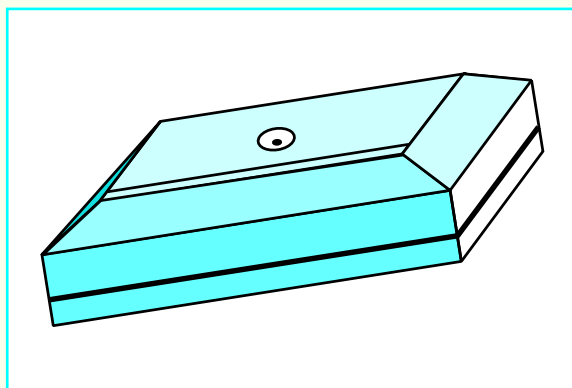
Just as with perimeter detectors, there are a wide range of simple to high-tech interior detectors available to the alarm system designer and installer. These switches and sensors are the burglar alarm's second line of defense in the event that the perimeter sensors have been bypassed or compromised. Some of the interior sensors we'll be looking at are the ultrasonic, microwave, photoelectric, passive infrared, and the dual-technology sensors.

Ultrasonic Sensors

Ultrasonic sensors use sound waves above the human range of hearing to sense the presence of an intruder. Normal human hearing capabilities range from 20 to 20,000 cycles per second (20 Hz–20 kHz). A typical ultrasonic sensor will produce sound waves

at approximately 45 kHz, well above human's and even animal's ranges of hearing. An ultrasonic sensor has a built-in sound transmitter and receiver. A typical ultrasonic sensor is shown in Figure 23.

FIGURE 23—An ultrasonic sensor produces a signal at a frequency above human hearing that's reflected and detected if an object moves.



Ultrasonic sensors work on the principles of phase shift, much like police radar. The transmitter produces the sound waves that are sent into the protected room. The receiver picks up these sound waves as they bounce off adjacent walls, furniture, and other objects in the protected area. Once

it's been adjusted properly, the sensor will reject the out-of-phase signals that are produced by these objects. However, if a person were to walk through the protected area, a sudden change in the returned sound waves would occur, triggering the sensor's contacts.

Early ultrasonic sensors suffered from a few problems that would cause many false alarms. One problem was false alarms due to swinging curtains. Another problem was crosstalk between two or more sensors triggering one of the sensors. (Crosstalk occurs when both receivers are picking up one transmitter; for example, the receiver from unit A is picking up the transmitter from unit B.) A third problem was often caused by changes in air temperature, humidity, or air turbulence caused by an open window or by a forced hot air, or air-conditioning system. The problem of false alarms from ultrasonic sensors has been greatly eliminated by the use of modern electric circuits that reject false alarms.

Typical range for an ultrasonic sensor is about three to 25 feet, adjustable at the sensor. An LED is used on most models for set-up purposes. Once the sensor trips, this LED will remain on to aid you in troubleshooting the alarm circuit.

Microwave Sensors

Microwave sensors operate on the same principles as ultrasonic sensors. The sensor contains a transmitter and a sensitive receiver. The major difference between a microwave sensor and an ultrasonic sensor is the frequency used by the sensor. A typical microwave detector will emit and receive a 10.5-GHz (gigahertz) signal. This is 105 with eight zeros or 10,500,000,000 Hz. (A gigahertz equals one billion hertz.) Microwave energy isn't as readily absorbed as ultrasonic energy, allowing this type of sensor to have a range of about 100 feet in a pattern similar to that of an ultrasonic sensor.

Microwave sensors may require their own power source, especially for the long-range versions. This power can be supplied from a separate transformer for those microwave sensors that use an AC input voltage. Other types of microwave sensors use a special solid-state transistor that emits microwave energy. These sensors may be powered by batteries, off the

alarm loop, or may be powered from the transmitter supply in some wireless systems.

Microwave and ultrasonic systems can also be used outside the home to automatically turn on lights when someone approaches a building. These systems will turn on the lights only and won't signal the alarm system's main control panel.

Photoelectric Sensors

Photoelectric sensors find wide use in both interior and perimeter detecting of intruders. In fact, photoelectric sensors find wide use in outdoor detection of areas such as parking lots, warehouse areas, storage areas, and so forth. Photoelectric sensors have the greatest range of all the sensors mentioned previously. Photoelectric sensors are capable of ranges up to about 500 feet outdoors and 1000 feet indoors. Typical residential photoelectric sensors will have a range of 150 feet or less.

A standard photoelectric sensor will use pulsed infrared light, usually at a pulse rate of 10 kHz, 10,000 cycles per second. By using infrared light, the beam produced by the transmitter can't be seen by an intruder without special beam detection equipment. This eliminates the problem of the older photoelectric sensors that could have the beam "smoked" with a cigarette or other smoke source to locate the beam. Once located, the beam could easily be bypassed. The beam is also pulsed with the receiver looking only for infrared energy at that pulse rate. This feature eliminates false trips from direct or reflected sunlight, spotlights and other such wide-spectrum light sources.

There are two basic types of photoelectric systems. One system uses a separate transmitter-receiver pair as shown in Figure 24. The transmitter is mounted on one wall and the receiver is mounted on an opposite wall or surface. When the light beam from the transmitter to the receiver is broken, the receiver's internal contacts or solid-state output will change state, issuing an alarm.

The second type of photoelectric system is the retroreflective system. In a retroreflective system, the transmitter and receiver are mounted in the same enclosure. A reflector is used to bounce the transmitted light beam back to the receiver section of the photoelectric sensor. This type of system is shown in Figure 25.

FIGURE 24—In one type of photoelectric system, the transmitter and receiver are separate units.

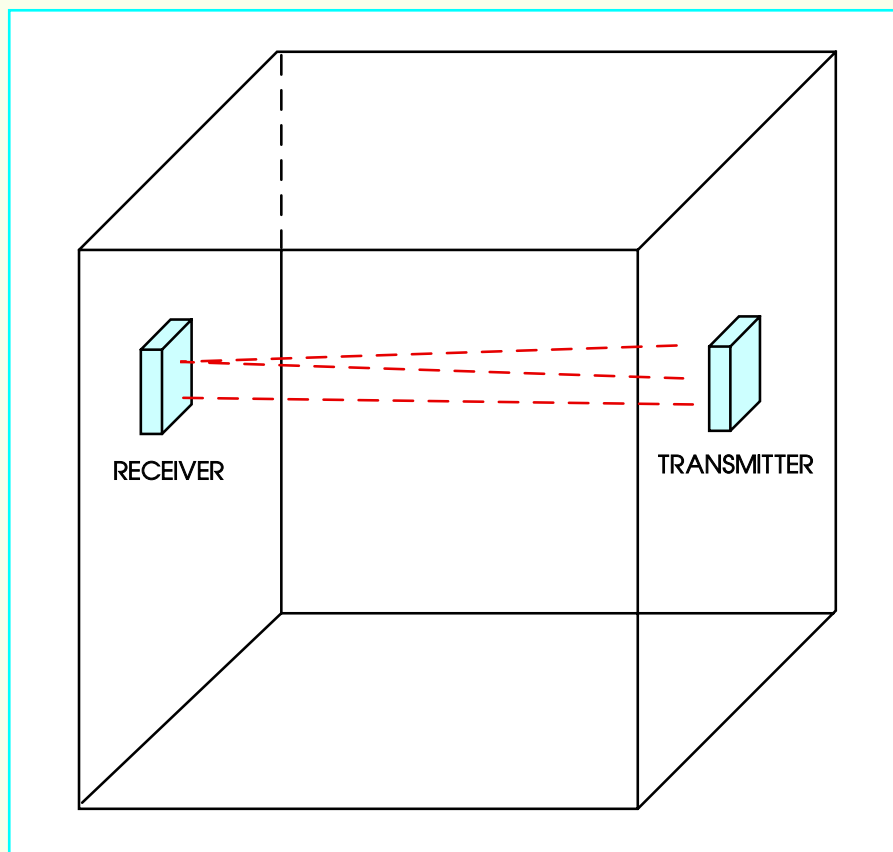


FIGURE 25—This type of photoelectric sensor has the transmitter and receiver housed in one unit.

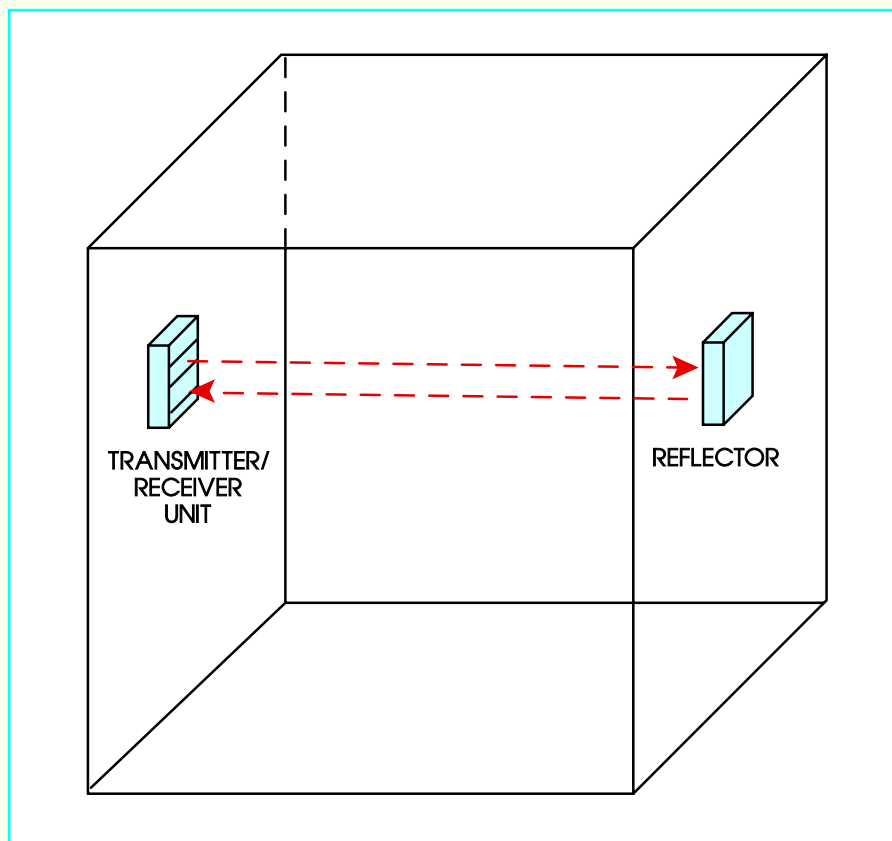
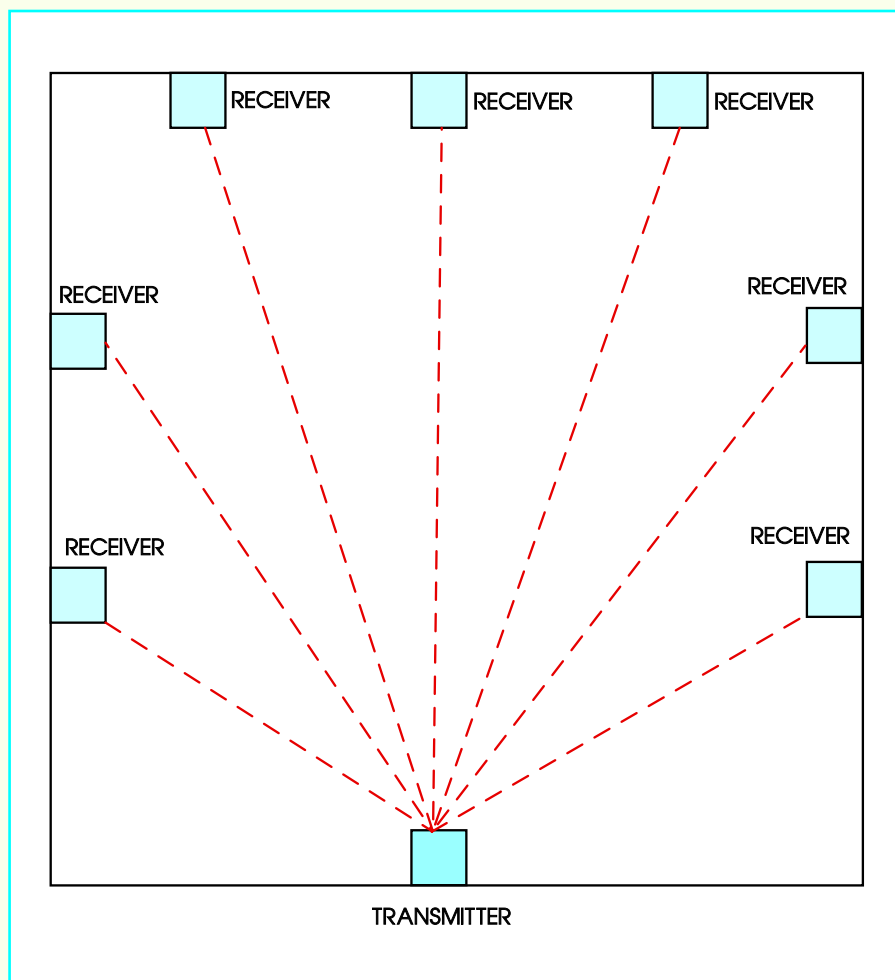


FIGURE 26—In some photoelectric systems, there can be multiple receivers placed in the area to receive the beams.

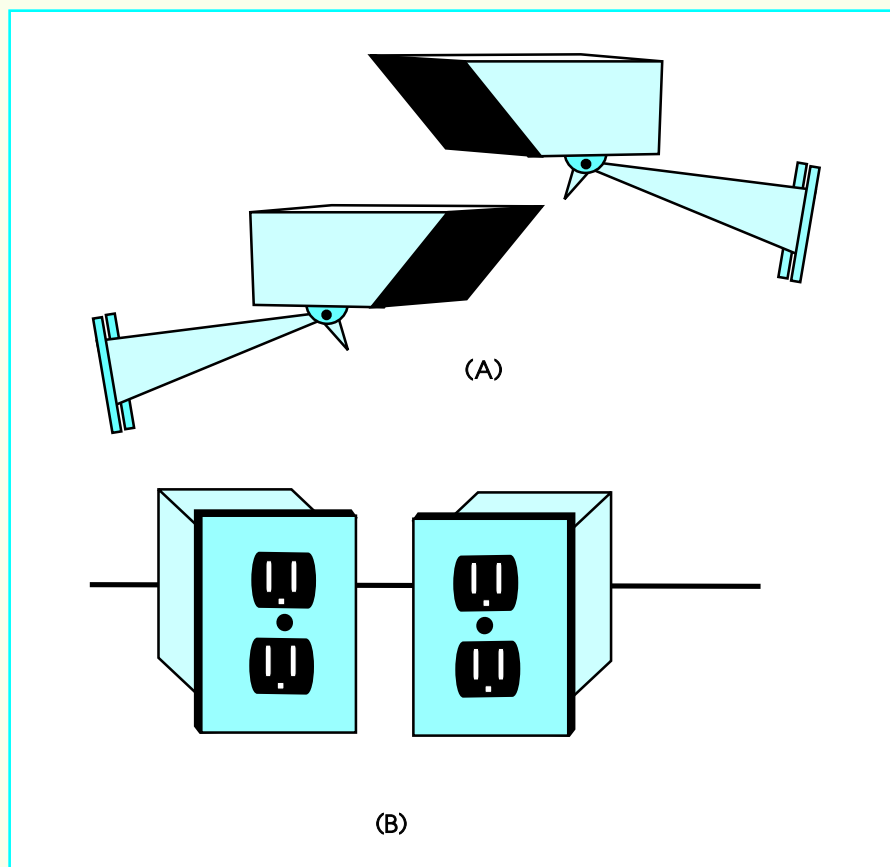


Long-range outdoor systems are also available. These systems can use a single transmitter and multiple receivers. This feature is available in a wide-angle system such as the one shown in Figure 26. The single transmitter sends a beam that's of significant strength and that's spread outward to cover a flat wide area by means of a special lens. Multiple receivers are placed at various locations to receive the wide beam. Each can signal whether the part of the beam that it receives is broken. This type of system can be used for large open areas such as theaters, gymnasiums, parking lots, and so forth.

Outdoor units are extremely susceptible to weather conditions. Rain, snow, blowing dust, and so on, will all limit the range of the system and can cause false trips. Some manufacturers have a special circuit within the system that monitors these conditions and will bypass the zone if these weather conditions exist rather than produce a false alarm.

A typical outdoor photoelectric system is shown in Figure 27, along with a disguised indoor system. Note how the indoor

FIGURE 27—Outdoor photoelectric systems use devices shaped like cameras (a). These devices will often contain heaters and special circuits that monitor weather conditions. A disguised indoor system is shown in (b).



system is disguised as a set of outlets, making its detection unlikely without a special infrared beam finder. The outdoor unit looks much like a security camera. An internal heater is often a part of an outdoor system to eliminate frosting of the lenses.

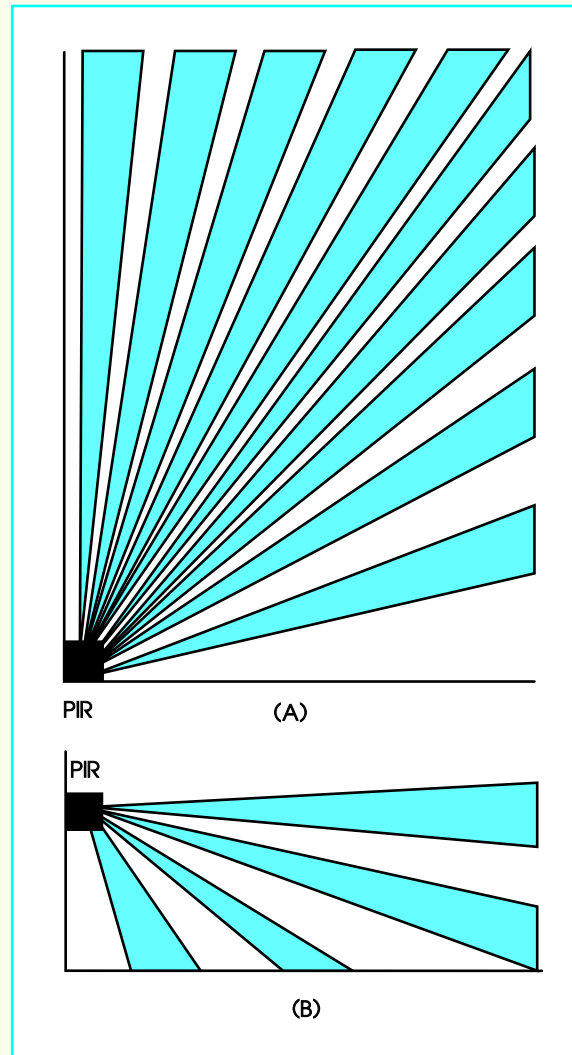
Passive Infrared Detectors

All of the interior sensors that you've seen so far are called active sensors. These sensors produce a signal in sound, microwaves, or light, and act on how the signal is returned to the sensor.

Infrared detectors take a passive approach to the detection of an intruder. They produce no signal that can be detected. Instead, they scan the area around the sensor for a change of heat.

Modern passive infrared sensors have come a long way from the early versions of this type of sensor. Early *passive infrared sensors*, also called PIRs, had many false trips due to changes in temperature, pets or animals, moving curtains, and other such incidents. Today's PIRs use extremely complex electronic

FIGURE 28—The top view of the detector pattern for a PIR is shown in (a) with a side view given in (b).



circuits and special lenses to prevent false triggering. First, let's look at the detection pattern of a modern PIR. Such a pattern is shown in Figure 28.

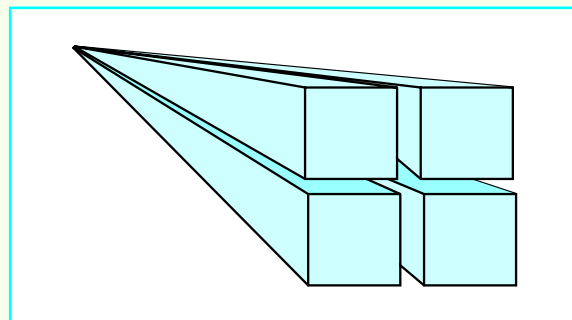
When looking at the figure, remember that these are not beams projected from the sensor. Rather, these areas are detection areas. Some sensors will also have double-detection areas as shown in Figure 29.

Modern PIRs will require that more than one sensing area "sees" the body heat of an intruder within a preprogrammed

period of time before an alarm is triggered. Normally, the sensor will require that an upper-detection area and a lower-detection area are sensed together to be sure an intruder is really present.

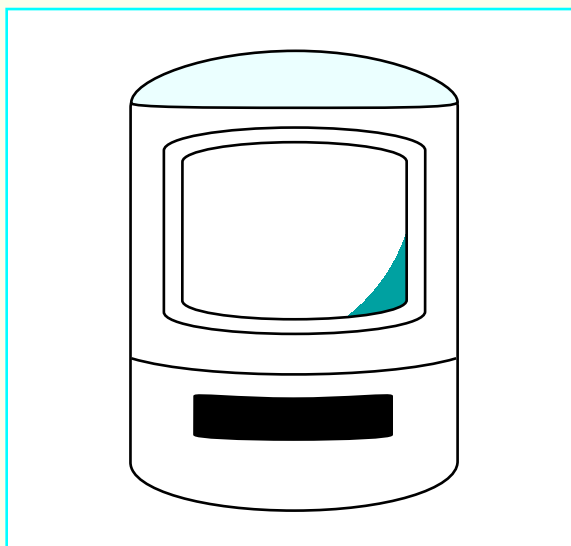
A process known as masking is also performed to eliminate heat registers or radiators from influencing the performance of a PIR. A mask is placed in the lens to eliminate false trigger points.

FIGURE 29—Some PIRs will use a double-detection area as shown here. These beams must be triggered together to trip the alarm.



With proper masking and the use of sensors that require two detection areas to be sensed, PIRs have become a standard form of

FIGURE 30—This is a typical corner-mounted PIR.



intruder sensor used in home and business applications. When choosing a PIR, use one for which the manufacturer supplies masking material and has pulse count technology (dual-detection circuitry) as standard features. A typical PIR is shown in Figure 30.

Some PIRs can be installed that won't look at an area from the floor level to four feet above floor level. These are called "pet alley" sensors that allow the homeowners to keep pets without the pet tripping the PIR sensor.

Dual-Technology Sensors

Dual-technology sensors will use a passive infrared detector along with an ultrasonic or microwave sensor. A typical

dual-technology sensor is shown in Figure 31.

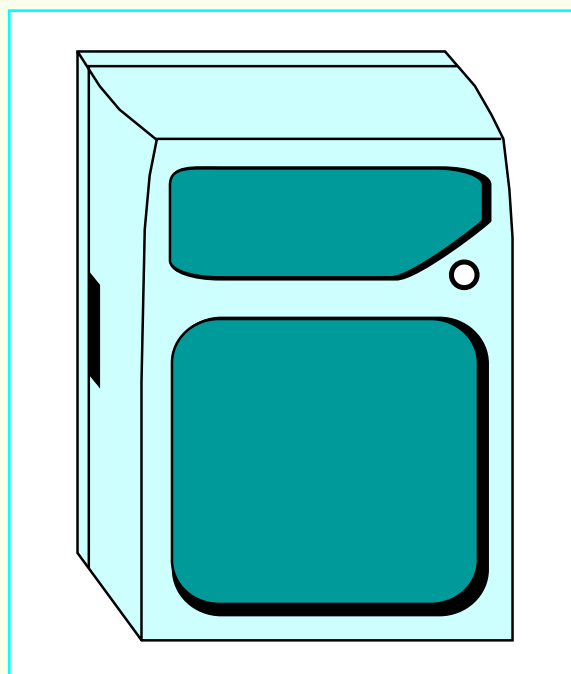
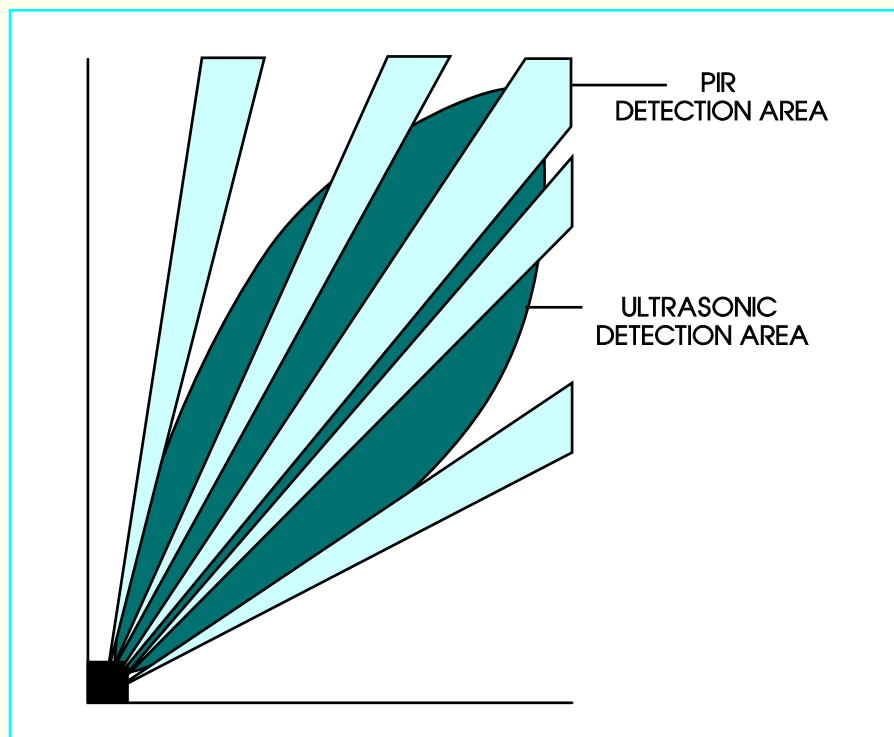


FIGURE 31—A dual-technology sensor is shown here. This sensor uses both PIR and ultrasonic technology.

The use of dual-technology sensors has grown in both residential and business application. These sensors are used in typical problem areas for standard ultrasonic, microwave, or passive infrared. The dual-technology sensor incorporates two different types of sensors in

one package. Both sensors must be tripped to produce an alarm output from the dual-technology sensor. The typical detection pattern for a dual-technology sensor is shown in Figure 32.

FIGURE 32—The area of detection for a dual-technology sensor is shown here.



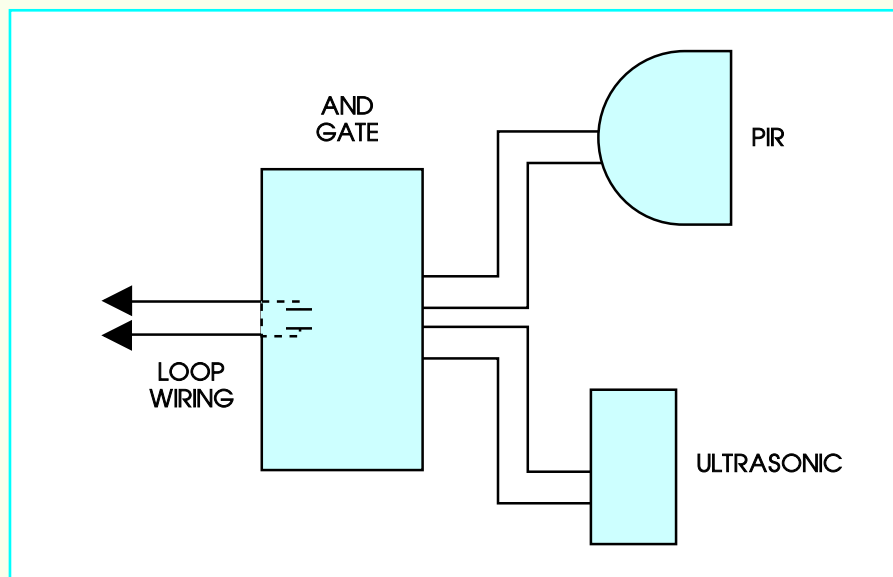
The beam-shaped forms are the detection areas of the passive infrared sensor and the dome- or circular-shaped area is for the ultrasonic sensor's detection pattern.

The AND Gate

A fairly new device to alarm installers is the AND gate. An AND gate will produce an alarm output to the control system only if both sensors attached to the AND gate are tripped at one time. AND gates are used to combine two sensors together to make a dual-technology sensor out of two stand-alone sensors. For example, you may have a customer that has a PIR mounted in one corner of a large room. Unfortunately, the heating system has been causing false trips. You can add an ultrasonic or microwave sensor to this system by using an AND gate as shown in Figure 33.

With the AND gate, you can program the time delay before an alarm circuit is tripped. Also, both the PIR and the ultrasonic

FIGURE 33—An AND gate can be used to combine two sensors into a single output that will be tripped only if both the PIR and ultrasonic sensor trip together.



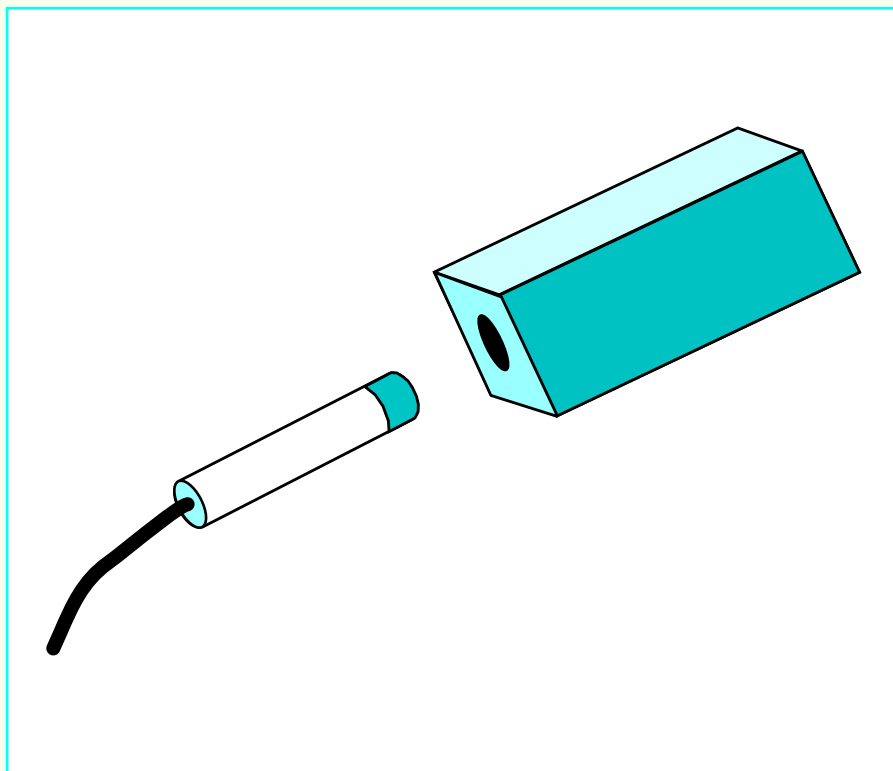
or microwave sensors must be tripped before an output from the AND gate can occur. You can also buy off-the-shelf dual-technology sensors with the AND built in.

Simple Interior Protection Devices

Two simple interior protection devices are the floor mat and the pull-apart switch. A floor mat, once a common security device, is losing popularity due to the comparative ease of installation and repair of the electronic sensor. A floor mat is normally placed underneath a carpet. If an intruder steps on the area of the floor mat, the contacts in the mat are closed. A second type of floor mat is fluid filled. When the mat is stepped on, the fluid becomes pressurized, acting on a bellows-type switch. Due to the difficult installation and even more difficult repair procedures, floor mats are becoming less widely used.

Pull-apart switches, or cords are often used to protect computers, stereo equipment, file cabinets, and so forth. A typical pull-apart cord is shown in Figure 34. In operation, the magnet section of the switch is attached to the device to be protected. The switch is held in the barrel of the magnet by magnetic attraction. If someone attempts to remove the protected object, the switch will be pulled from the magnet, triggering the switch. Pull-apart cords are also available to protect boats and trailers.

FIGURE 34—This is a typical pull-apart cord type switch.



In some instances, you can use a mercury tilt switch to protect a device. As long as the switch stays level, the contacts of the switch will remain open. If someone tilts the object, the mercury moves in the internal glass tube, closing the contacts.

One of the newest equipment-protection systems is the fiber-optic system. In a fiber-optic system, a loop of fiber-optic cable is run from one piece of equipment to the other. A transmitter/receiver is used for the light source to feed the fiber-optic cable. A sensitive receiver checks the cable's integrity by receiving the returning pulsed light beam sent by the transmitter. Any attempt to bend, distort, or disconnect this cable will cause the alarm in the transmitter/receiver to trigger. Loop lengths of fiber-optic cable can be up to 300 feet.

Fire and Smoke Sensors

Fire detectors, also called heat detectors, find wide use in hotels, restaurants, and other areas where the heat from a fire, rather than the smoke, will be detected. A typical heat detector will be made like the thermostat you use to control the heat in your home. A heat detector's contacts will close or open (depending upon the type of heat detector) at 135 degrees. Special heat

detectors are also available for higher-temperature sensing in areas such as a boiler room.

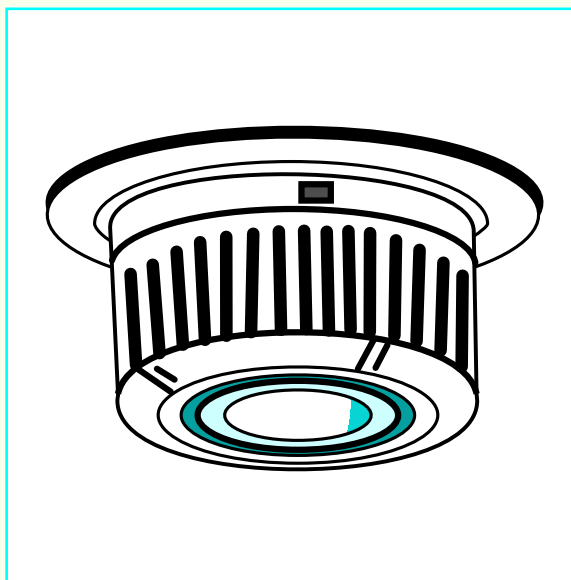
Some special heat detectors use a rate of temperature rise to detect a fire. In this type of heat detection, if the temperature rises 15 degrees a minute, the alarm system will be triggered.

Smoke sensors detect products of combustion (the earliest possible detection) and would be used in sleeping areas. Heat detectors and rate of temperature rise detectors would be used in restaurant kitchens, where cooking would cause the detector to go off in error.

Flame Detectors

Another type of fire detector is called a flame detector. Flame detectors are often used in garages, boiler rooms, and other

FIGURE 35—This is a typical ionization-type smoke alarm.



areas where smoke and temperature variations are a common event that can cause false triggering. There are two types of flame detectors: ultraviolet (UV), and infrared (IR). Both of these sensors will sense the flame produced by a fire. Some types even look for the flicker of the flame to eliminate false trips from weld-

ing, lightning, and other sources of light in these spectrums. Some flame-detector units will use both UV and IR sensing.

Smoke alarms are available in many styles. For example, there are

- Ionization smoke alarms

- Photoelectric self-contained smoke alarms

- Photoelectric pair smoke alarms

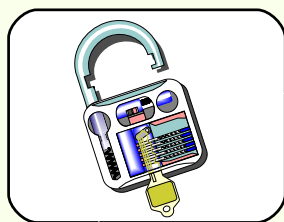
Ionization-type smoke alarms are the type you normally see in homes. A typical ionization smoke alarm is shown in Figure 35. There are single chamber and dual chamber ionization smoke alarms. A dual-chamber alarm is the more sensitive type of smoke detector. Inside the chamber is a small radioactive source. This source of radiation causes the air in the chamber or chambers to become electrically charged or ionized. When smoke enters the chambers, it will unbalance the electrical charge. A sensitive electronic circuit monitors this activity and trips the alarm. All smoke detectors should be installed where there's air movement. Installing in dead air (a corner, for instance) will delay sensing the fire.

A self-contained photoelectric sensor will look much like the ionization sensor seen earlier. The dome of the sensor will normally be slightly larger. A photoelectric sensor uses a light beam to detect smoke within the dome. Under normal conditions, the light beam is unrestricted in its passage from the transmitter to the receiver. However, when smoke enters the dome, it blocks the light beam enough to trigger the alarm. This is called the light-obstruction style of operation.

Some photoelectric smoke detectors will operate on the light-scattering principle. In this system, the photo transmitter and receiver aren't lined up so that the receiver doesn't see the light beam under normal conditions. However, when smoke enters the sensor, the smoke will scatter the light, allowing some of it to strike the receiver, and trigger the alarm.

Long-range photoelectric transmitter-receiver pairs are available for long-range smoke detection in large areas. For example, a transmitter may be placed on one end of an airport hangar and the receiver placed on the opposite end. The sensitivity of the receiver can be adjusted so that normal conditions won't trigger the alarm. However, the smoke of a fire will be of sufficient quantity, especially at the peak of the hangar's roof, to quickly block the beam and trigger the alarm.

Smoke detectors may also be dual-technology devices. For example, a dual-chamber ionization smoke detector may have a heat detector alongside it within one housing.



Locking It Up! 2

1. What is the difference between an alarm bell, horn, and speaker?

2. What will an automatic dialer do if an alarm condition occurs and the burglar has tied up the phone line to your house?

3. Name two problems with the use of foil as a glass-break detector.

4. How does an ionization-type smoke alarm operate?

Check your answers with those on page 91.

ALARM SYSTEM FUNCTIONS

System Flexibility

Due to the use of microprocessor-based control systems, today's fire and burglar alarm systems are extremely secure and flexible.

The security is created through the use of end-of-line resistors, EOLRs, that protect the alarm's sensor loop wiring from being bypassed through cutting or shorting of the loop's wiring. This, in modern terminology, is called a supervised loop. The flexibility of today's alarm system comes from the programming functions that are available. These functions allow the alarm installer to purchase and inventory a few models of alarm systems and, through programming, tailor these systems to the end-user's needs.

Now, let's look at some of the functions that are available on all modern fire and burglar alarm systems. In general, these functions can be divided into two categories—fire-protection functions and security functions.

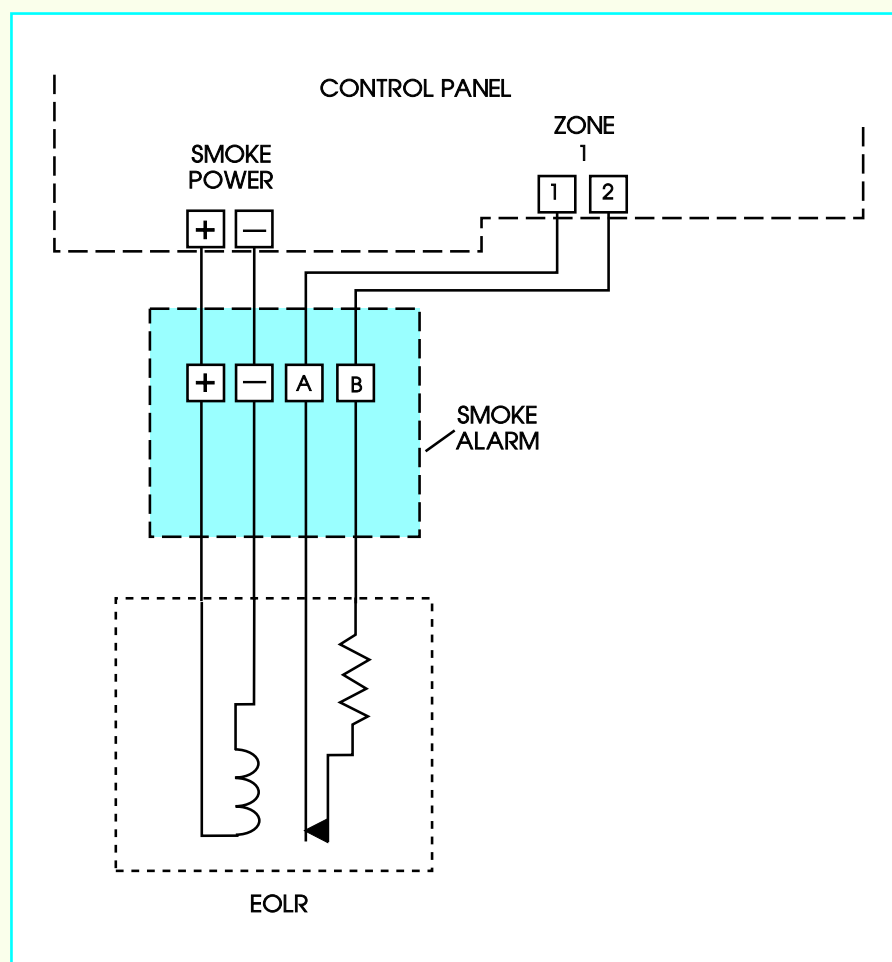
Fire Protection

The fire-protection loop of an alarm system is a 24-hour priority circuit. This loop can't be bypassed by the user through programming. Most fire-alarm loops originate at the control system as a two-wire power supply system. This power supply is then fed to the smoke, heat, or other type of detector through a relay as shown in Figure 36. Two additional wires from the sensors are the loop wiring. The fire and smoke detectors are normally-open and will latch into the closed-contact mode once triggered. If the trigger was false due to cooking smoke or other nonalarm conditions, the alarms must be reset by pushing the reset at the remote keyboard.

Panic/Holdup Circuit

A security function that can't be bypassed by programming is the second loop circuit, called the panic or holdup circuit.

FIGURE 36—As shown here, the end-of-line relay is located at the end of the smoke-detector circuit.



In a residential alarm system, the panic circuit is normally wired to a normally-closed push button switch in the master bedroom. In some systems, a bathroom can also have normally-closed push button switches. Burglars frequently enter through the bathroom, so a good place to bug internally is the bathroom door. If an intruder enters a home, the homeowner can press the push button, tripping the alarm.

In commercial applications, the panic circuit becomes a holdup alarm circuit. A hidden push button under a desk or counter, or a floor switch, may be used to open or short this loop. Using modern wireless technology, many businesses are using concealed holdup switches that are carried by the employees of the business while on duty. In fact, some types of wireless holdup switches can be triggered by body movement alone so that the employee can trigger the panic/holdup circuit without the knowledge of the intruder.

The Duress Function

Duress is the situation where the owner of the system is being forced to disarm the system at the keypad by an intruder. This type of situation can occur as a homeowner is entering or leaving home, or as a business owner opens or closes each day.

When the duress situation occurs, the system owner will enter a preset code number into the keypad before entering the disarm code. The control system can then produce a silent alarm to a central reporting station, call the police, or set off an audible alarm after a preset delay.

The Interior Function

The interior function will allow the perimeter sensors to remain active while eliminating the interior sensor loops from the arming of the system. Therefore, people could walk around in a building without setting off an alarm, but the doors and windows protected by perimeter sensors would still be active.

The 24-Hour Zone

Any one or more of the zones connected to the alarm system can be dedicated as 24-hour zones. These zones will always be armed. For example, a homeowner may have a group of basement windows, a set of skylights, and ventilation hardware that's never opened. You can wire all of these areas in one loop and call it a 24-hour zone. This zone (or any zone) can be bypassed if a switch or sensor has opened or closed so that the zone can't be reset.

The Day Zone

Any zone can be programmed as a day zone, sometimes called a chime mode. A day zone will cause a chime tone, buzzer at the keypad, or actual alarm to be energized if the supervised loop isn't in working order. A day zone will therefore report a loop problem before you attempt to arm it.

Entry/Exit Delay

An entry/exit delay is a programming feature of almost all control systems. The entry/exit delay allows you to arm the system and walk through one or more sensors and open and close a protected door before the system will arm. On entry, the system will allow you enough time to open the door, close it, and pass through the sensors. You must then enter a disarm code before the entry-delay time has expired, or the alarm system will trip.

Entry delay can be programmed separately from exit delay. Typical times for entry are 45 seconds, and for exit the time is 60 seconds. This is user selectable and can range up to 300 seconds. The delays can be bypassed to allow instantaneous triggering. This would be used on the delay entry/exit zones when the home owner goes to bed.

Manual Bypass

Bypass will cause a zone or zones to be eliminated from the protection network. Normally, the user of the system will press a bypass key, enter a code number, and then enter the number of the zone to be bypassed.

One example of a bypass zone may be where a person has a guest house separate from his or her home. Normally, this guest house will be protected by both perimeter and interior sensors. If someone comes to stay at the guest house, the two zones that protect it can be bypassed manually to prevent an alarm condition when the guests arrive.

Automatic Bypass

When the system is being armed, auto bypass will allow the zones selected as auto bypass zones to be eliminated from the protection network if one or more sensors are tripped or are open.

Automatic Unbypass

When this mode has been selected, all zones that have been bypassed will automatically return to the protection network.

Manual Unbypass

Using this mode, the system will allow you to rearm the system with previously selected zones unbypassed. The user simply programs which zones to unbypass before arming.

Bell Time-Out

The bell time-out function defines the amount of time a fire or burglar alarm trip will keep the warning bell, horn, speaker, or siren active. Most communities will have a law that specifies the maximum amount of time an audible signal appliance can operate. This prevents a nuisance to neighbors if the alarm trips while you are away. Typical times are between five and fifteen minutes.

Automatic Reset

Most systems will go into an automatic reset shortly after the bell time-out function has completed. Normally, all zones will remain protected except the zone that triggered the alarm.

Automatic Arm/Disarm

Some fire and burglar alarm systems, especially those used by businesses, will have a time-of-day and date clock. Using this internal information, the system can automatically arm or disarm itself. This feature can be bypassed if a key is pressed on the keypad when a pre-arming chime is generated by the system.

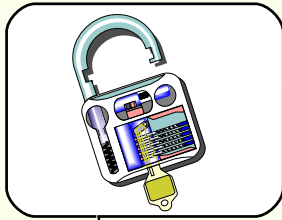
Easy Arm

Some alarm systems can be quickly armed by pressing a pre-programmed single-key digit into the keypad. This saves having to enter a complete four- to six-digit code.

User Codes

Most residential systems will have a number of codes that can be used to arm or disarm the system. For example, the master user can have one code while the family members can have their own code. If a guest is to need a code number, it can be easily programmed into the system and removed once the guest leaves.

These are some of the more typical features provided by modern fire and burglar alarm systems. Other features are being added with each new model. Check the user and programming manual for the system you'll be working on to completely understand the features and functions of that system.



Locking It Up! 3

1. What is meant by a panic circuit?

2. Name one type of 24-hour protected circuit.

3. What is a duress code?

Check your answers with those on page 91.

INSTALLING AN ALARM SYSTEM

Tailoring a System for a Customer

The first step in installing any system is to design the system and tailor it to the customer's needs. Since you're just starting out in the locksmithing and alarm business, your first installations should be simple residential installations. And, the first step in designing any system is to collect manufacturer's catalogs and price lists. Through these catalogs and price lists you can identify what types of sensors or contacts to use, what size control system is needed, and other such information. Once the size, the quantity, and type of sensors are known, you can perform a layout diagram and create a price quote for your customer.

Remember, start small. A small residence, preferably of new construction or under construction, is your best bet. Also, you may want to look at system expanding as a good start to your business. If a customer is enlarging his or her home, the addition may require that the present burglar- or fire-alarm system be expanded in size to accommodate the new room or addition. If you happen to get a large installation, consider using a subcontractor to aid you or to actually perform the installation.

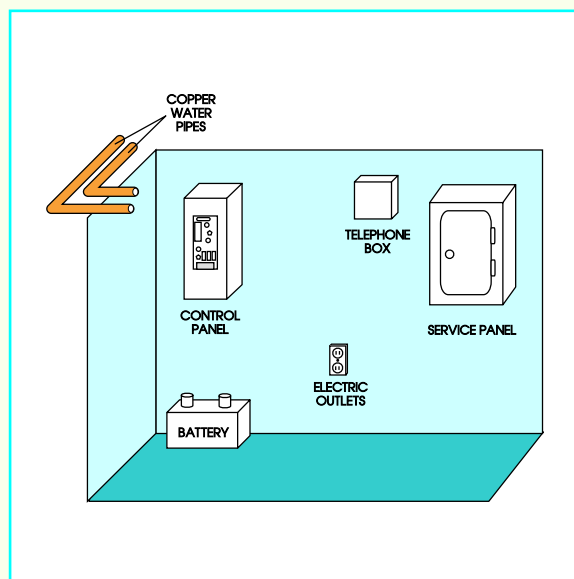
Installing the Control Panel

The main control panel should be installed in a convenient location. Normally this will be in the basement of the home. In a business situation, the main control is located in the basement or in a first floor closet. The best place in a basement is near a source of electric power, telephone service, and a copper cold water pipe. A basement is shown in Figure 37.

By having the control panel mounted close to these three services, the wire that runs from the control panel to these services is short and rather simple. If the three services aren't close together, select a location close to the electric and water service. A phone line is simple to run, and distance isn't normally a problem for phone lines.

To mount the control panel, remove the electronic control board and mark the location of the metal enclosure's mounting holes

FIGURE 37—The best location for an alarm system control panel is near the telephone, water, and electric services.



on the wall. Once the holes are marked, drill them into the cinder-block or finished walls. On cinder-block walls, you'll have to use anchors and screws, while on a finished wall, you may only need wood screws.

Once the panel is mounted, carefully replace the electronic circuit board

if it was removed for marking purposes. Next run a 14 AWG green wire from the ground terminal of the circuit board to a copper cold water pipe or to the service entrance ground in the load center for the home or business. The connection at the cold water pipe should be made as shown in Figure 38.

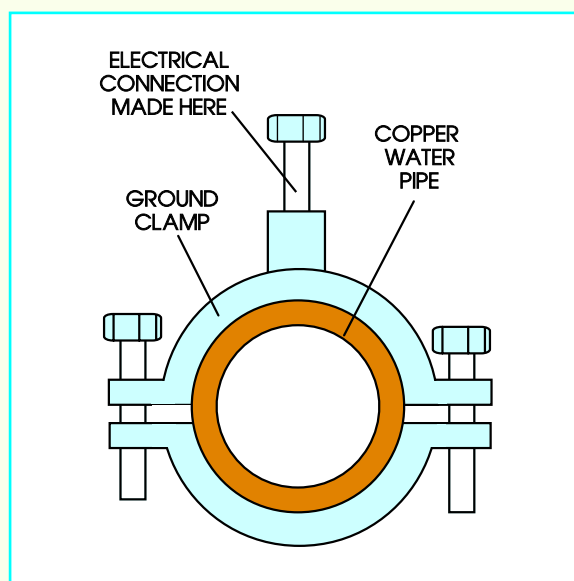


FIGURE 38—A wire can be connected to the service entrance ground rod by using a ground clamp as shown here.

The NEC (National Electrical Code) and the laws of physics require one and only one ground grid in any structure. The basic reason for this is to protect electrical/electronic equipment against lightning damage. Well over 90 percent of lightning enters a building through the service entrance (electric wires coming in from the

transformer on the pole or pad). We can't prevent that shot from coming in, but we can control it by tying all metallic surfaces and systems together.

Running Wire

In new construction, it's very simple to run the wires for all of the system's switches and sensors. Simply drill the studs as necessary and pull the alarm-system wires through the studs to their proper location. Don't run the alarm wires through the same holes as the electric wires. The alarm control should have a dedicated branch circuit. This will eliminate noise and reduce the exposure of a tripped circuit breaker disabling the alarm.

When you're working on a finished home, the wire-running process is much more difficult. Normally it will involve the removal of moldings, drilling precise holes near the moldings, and other such difficult tasks. In most cases, wireless sensors are used when finished walls are too difficult to run wires through.

Installing Protective Devices

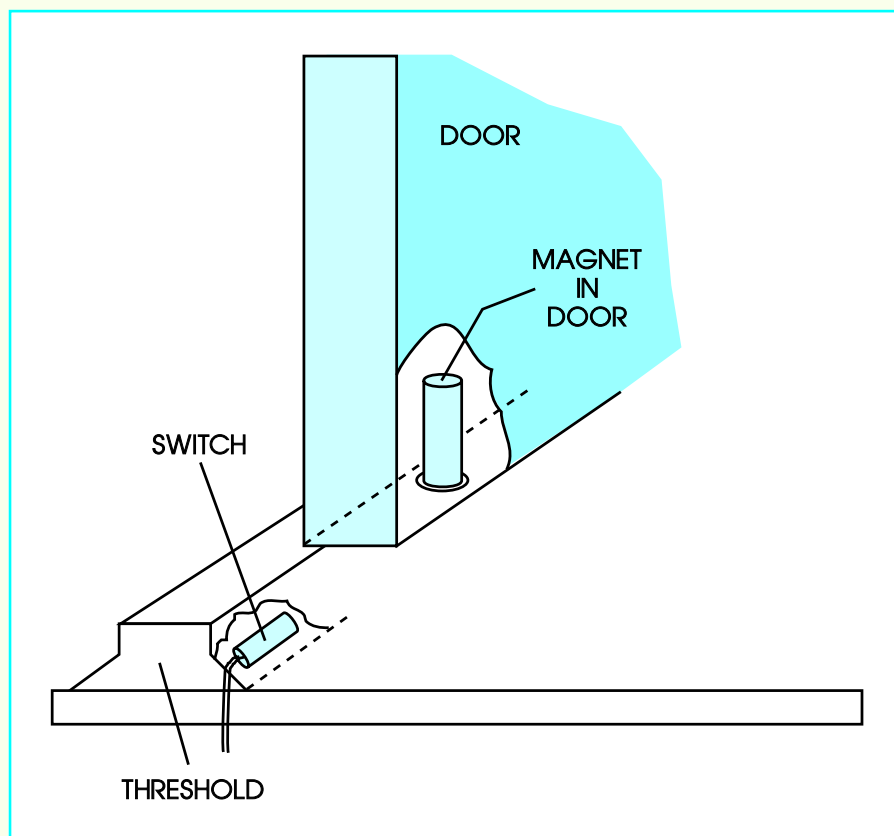
The installation of the protective switches and sensors will consume a large amount of your installation time. In fact, the installation of protective devices will normally take as much time as running wires through an unfinished home.

Sensors and switches must be properly installed for the alarm system to work properly. A chain is only as strong as its weakest link; the same can be said about an alarm system. Each loop is only as good as its poorest sensor or switch installation.

Installing Magnetic Contacts

Magnetic contacts find wide use as perimeter switches. These switches will be mounted on doors, windows, garage doors, and other such points of entry. Let's begin by looking at how to mount a magnetic contact switch in a typical entry door. As shown in Figure 39, the switch itself is mounted under the threshold of the door. The wires from the switch can be

FIGURE 39—This is one method of concealing magnetic contacts in an entry/exit door.

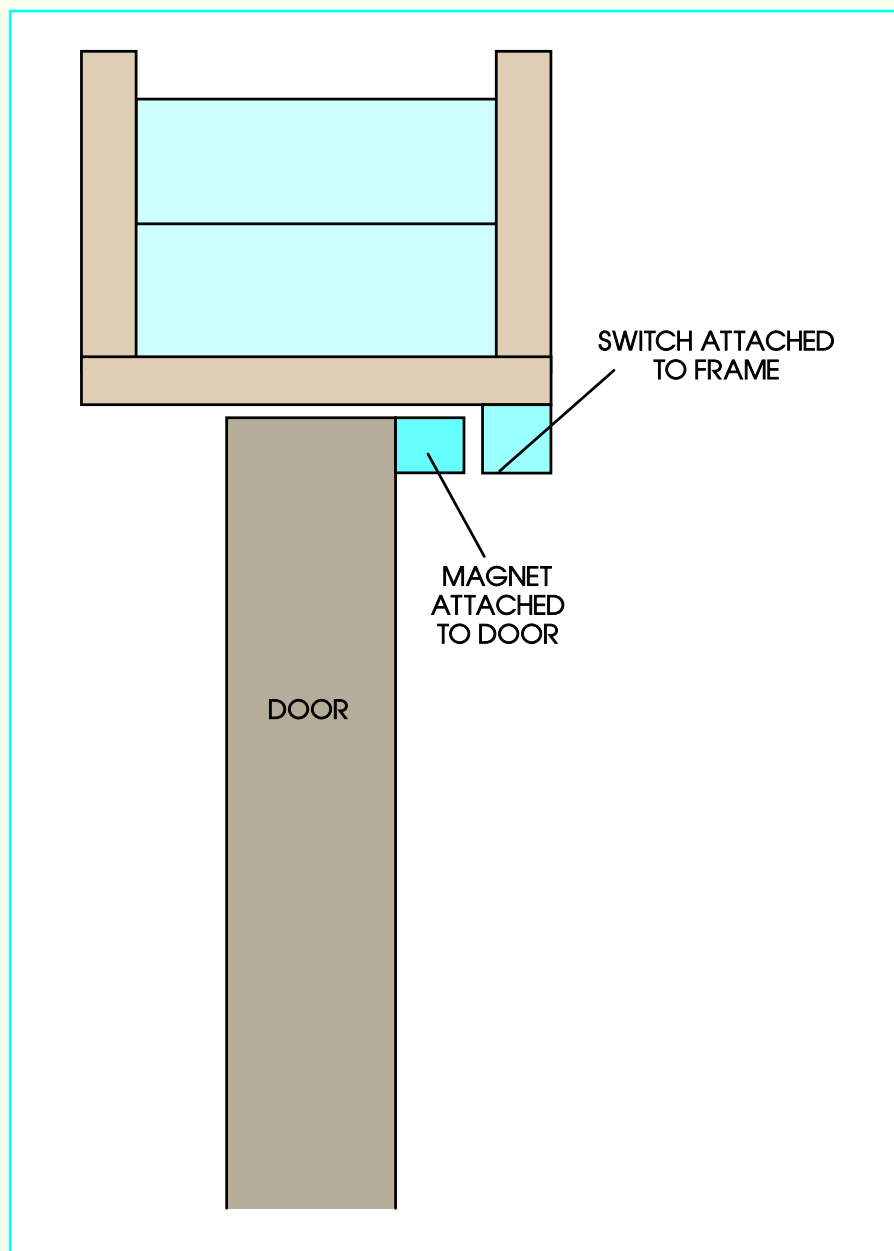


passed through a hole beneath the threshold into the basement. The magnet that keeps the switch's contacts closed is located directly above the switch in the door. When the door is opened, the magnetic field will be pulled away from the switch causing the switch's contacts to open. This type of installation uses concealed switches and magnets. Notice how the switch is held closed by a magnet placed at a right angle to the switch. This type of switch is widely available from a number of manufacturers.

A simpler but much-less-concealed form of protecting a door is shown in Figure 40. The surface-mount magnet is applied to the top surface of the door. A magnetic-contact switch is then mounted to the frame above the door and its wires are fed down along the inside of the molding. When the door swings away from the magnet, the switch's contacts will open, triggering an alarm if the protective loop is active.

Garage doors are also easily protected with magnetic switches. A typical installation is shown in Figure 41. Here the magnet is placed at one of the bottom corners of the garage door. The switch can either be a shielded type mounted to the floor or simply buried in the concrete floor beneath the

FIGURE 40—Surface-mount magnets and switches may also be used to protect a door or window.



magnet. Various brackets can be purchased or made to place the magnet near a stationary sensor at the top or near a side rail of a garage door.

Protecting Windows

Like doors, windows can be protected by using either concealed- or surface-mount switches and magnets. On crank-out or casement windows, surface-mount magnetic contacts can be used as shown in Figure 42. The magnets are mounted to the moveable window panels and the switches

FIGURE 41—A garage door can be protected as shown here.

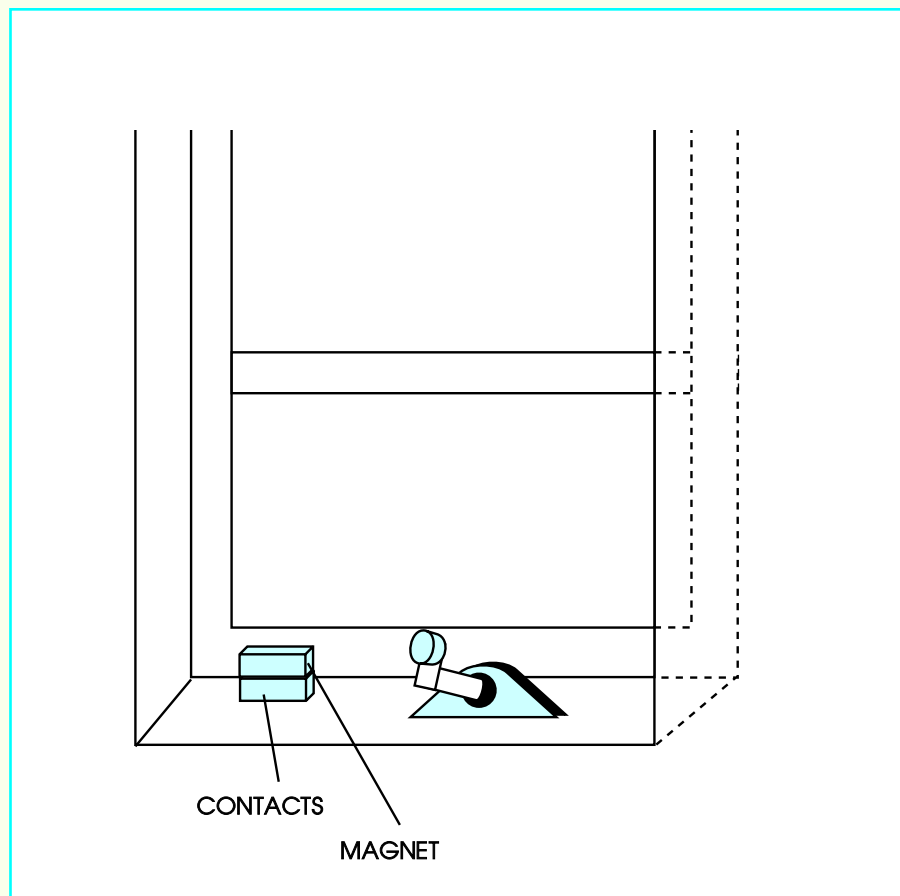
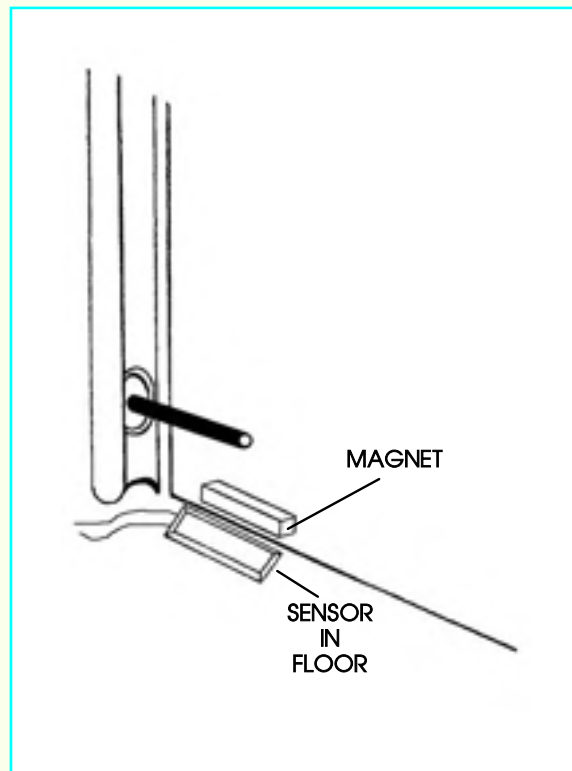
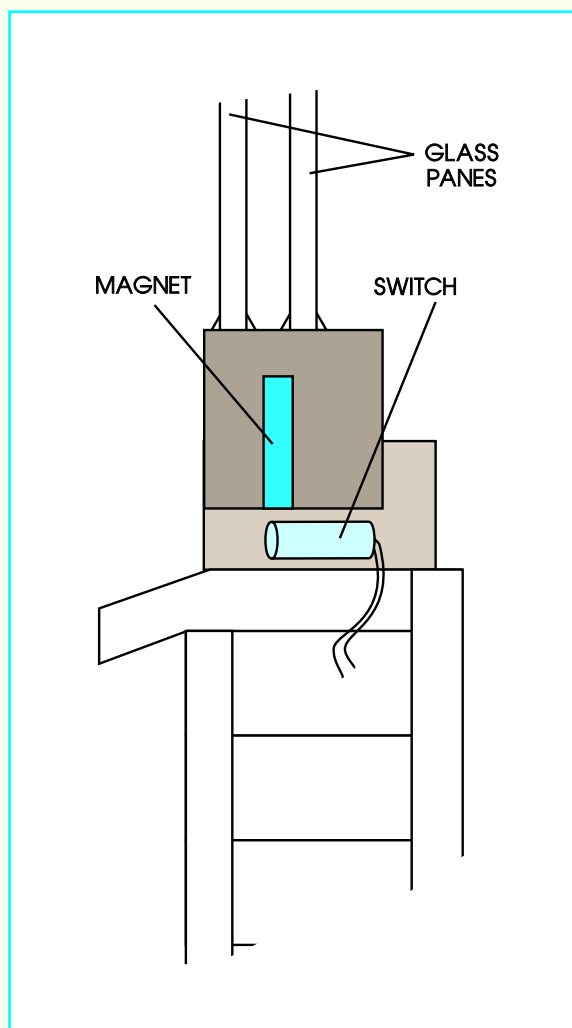


FIGURE 42—A crank-out or casement window can be protected with surface-mount magnets and contacts.

FIGURE 43—In a concealed installation, the magnet is placed in the moveable pane and the switch is located under the sill.



are secured to the window's frame. When the windows are closed, the magnet holds the contacts closed. When the window is opened, the contacts will open since the magnetic field has been removed.

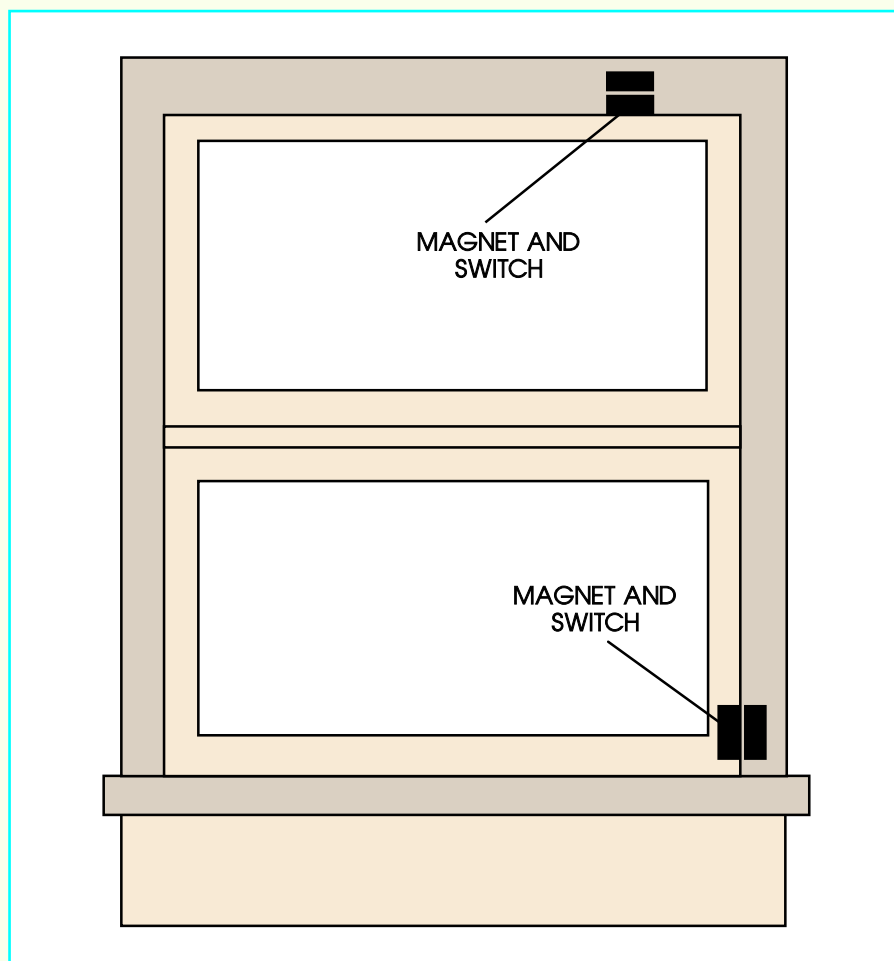
Concealed magnetic contacts can also be used on crank-out windows as shown in Figure 43. Here the magnet is installed into the window's moveable section. The concealed switch is mounted into the frame.

Figure 44 shows you how to mount surface-mount

magnetic contacts on a typical double-hung window. As before, the magnet attaches to the moveable window while the contact assembly remains stationary.

Concealed contacts will offer better protection for a double-hung window. Concealed contacts also won't restrict window movement. Concealed magnetic contacts are difficult to detect and defeat. Such an installation of concealed contacts is shown in Figure 45. Notice the use of one perpendicular switch at the bottom of the window and one in-line switch at the top of the window.

FIGURE 44—A typical double-hung window can be protected with two sets of magnetic contacts and magnets as shown here.

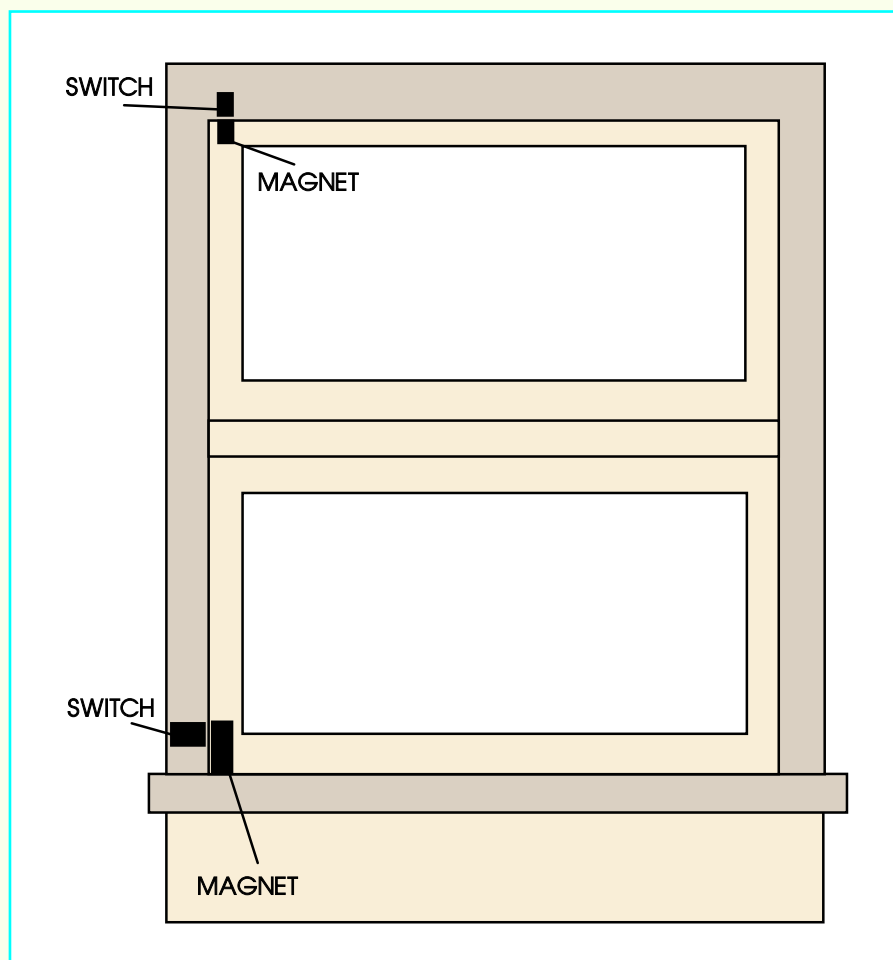


If it's desired that the window be able to be opened for ventilation, a second magnet can be installed as shown in Figure 46. Now when the homeowner raises the window to a preset point, the second magnet in the window's frame will keep the magnetic switch's contacts closed. Normally, an alignment mark is made in both the window and the frame to help the user place the window in the proper position to close the switch.

Protecting Sliding Glass Doors and Windows

At first it may seem that a sliding glass door or window would provide a real challenge to the installation of magnetic contacts. However, as shown in Figure 47, surface contacts are easily installed. The magnet is simply attached to the moving member with the contact assembly mounted to the frame. Spacers may be needed to properly align the magnet and contact assembly.

FIGURE 45—This is how to protect a window with concealed magnetic contacts.



Concealed installations are more difficult to perform. To install the concealed switches in the upper channel of the door or window, remove the doors or windows. Drill upwards through the frame and mount the switches using silicon adhesive. Mount the magnets in the top channel of the door or window as shown in Figure 48.

There are a wide range of surface- and concealed-mount magnetic contacts for you to choose from when performing an installation. Standard contacts are normally placed side-by-side or in-line as shown in Figure 49.

The space between the magnet and the contact assembly is called the gap. Standard gaps range from one-quarter inch to one inch. Wide-gap magnetic contacts and magnets are available with a range of up to $1\frac{5}{8}$ inches. If a wider gap is needed in special applications, two magnets may be placed near the contact assembly. Some forms of magnetic contacts will allow you to place the magnet perpendicular, in line, alongside of, or at an angle to the magnetic contact assembly.

FIGURE 46—When you want to protect a window, yet allow for ventilation, place two magnets in the window. When the window is raised, the second, lower magnet will keep the contacts closed.

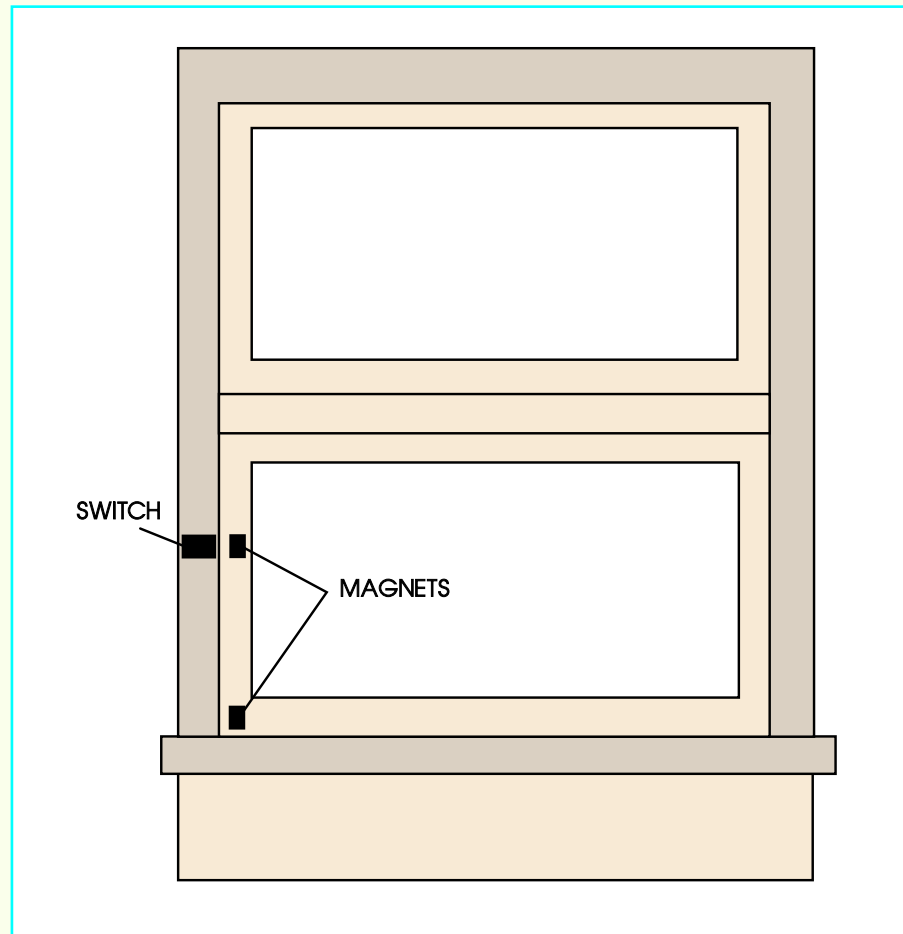


FIGURE 47—A sliding glass door can be protected with surface-mount contacts as shown here.

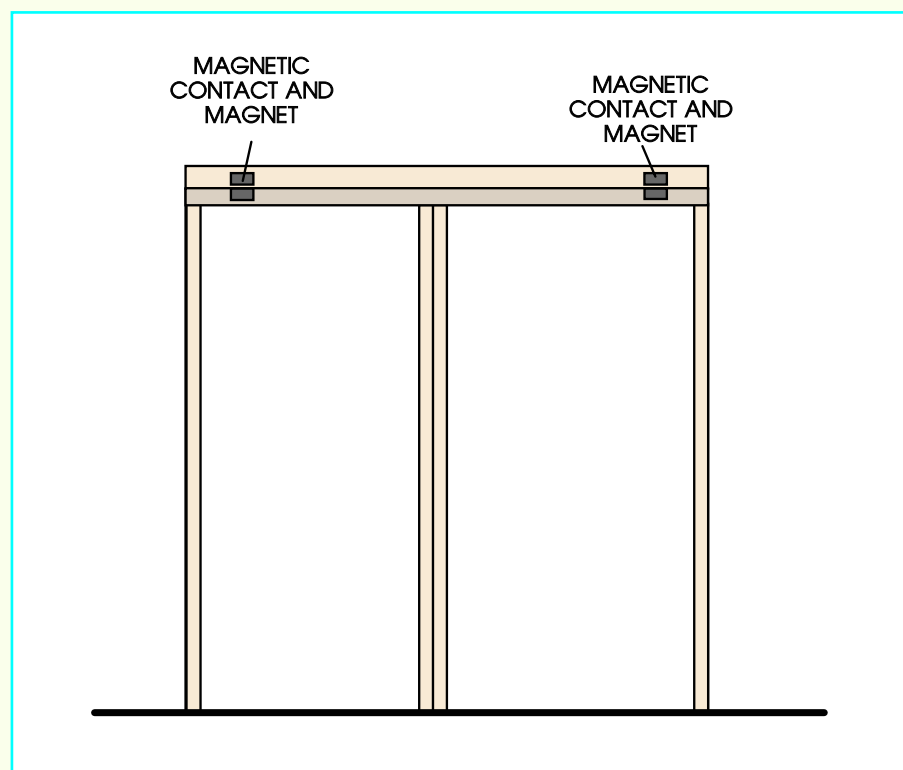


FIGURE 48—A sliding glass door can be protected with concealed contacts as shown here.

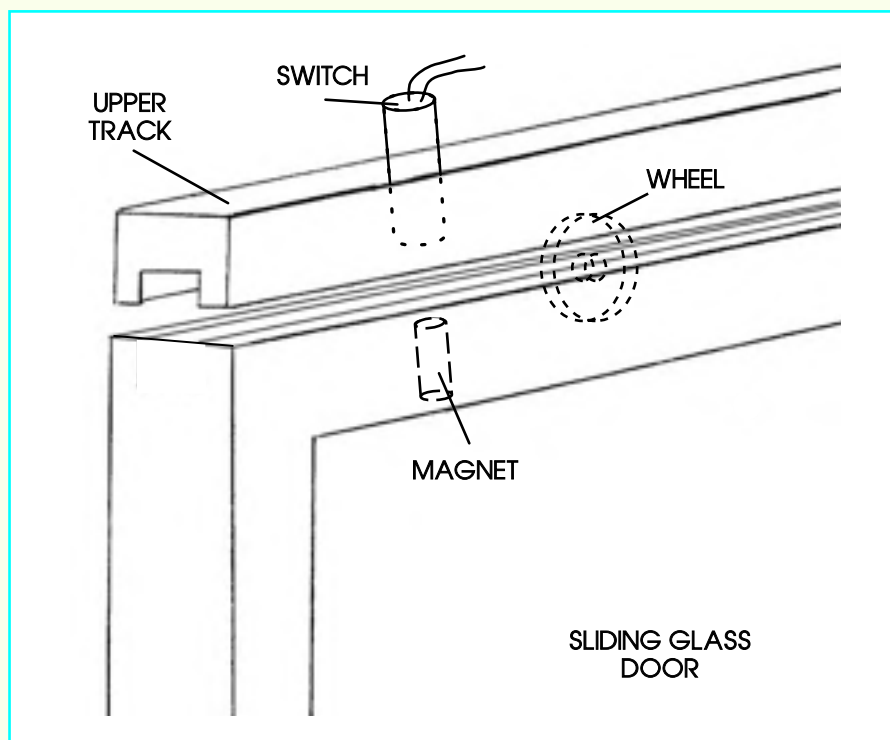
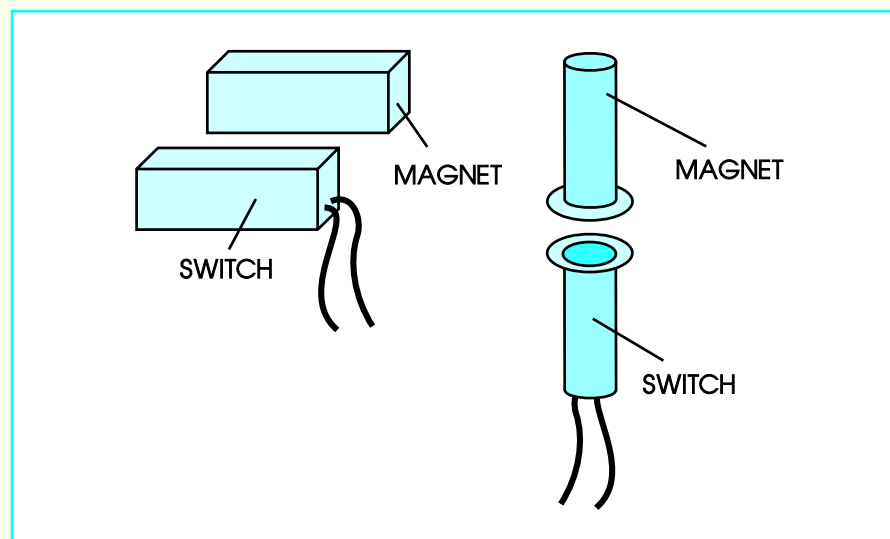


FIGURE 49—This is the normal side-by-side or in-line mounting of magnetic contacts and magnets.



Installing Foil

Foil isn't as widely used as it once was for protecting the glass area of windows and doors. Today, installations normally use vibration, shock, or glass-break sensors for glass protection. However, if the glass is sealed in a large rubber gasket or a large thick curtain covers the glass, or other such sound and vibration dampening items are located on or near the glass, foil installation may be your only choice. Also,

many older systems used foil and you may receive a call to repair a foil-protected window.

To begin the installation, a window must be clean and dry. Clean the window using a glass cleaner and a number of paper towels or cloths. Dry the window using a heat gun or hair dryer. Moisture on the glass will cause great difficulty during the installation of the foil.

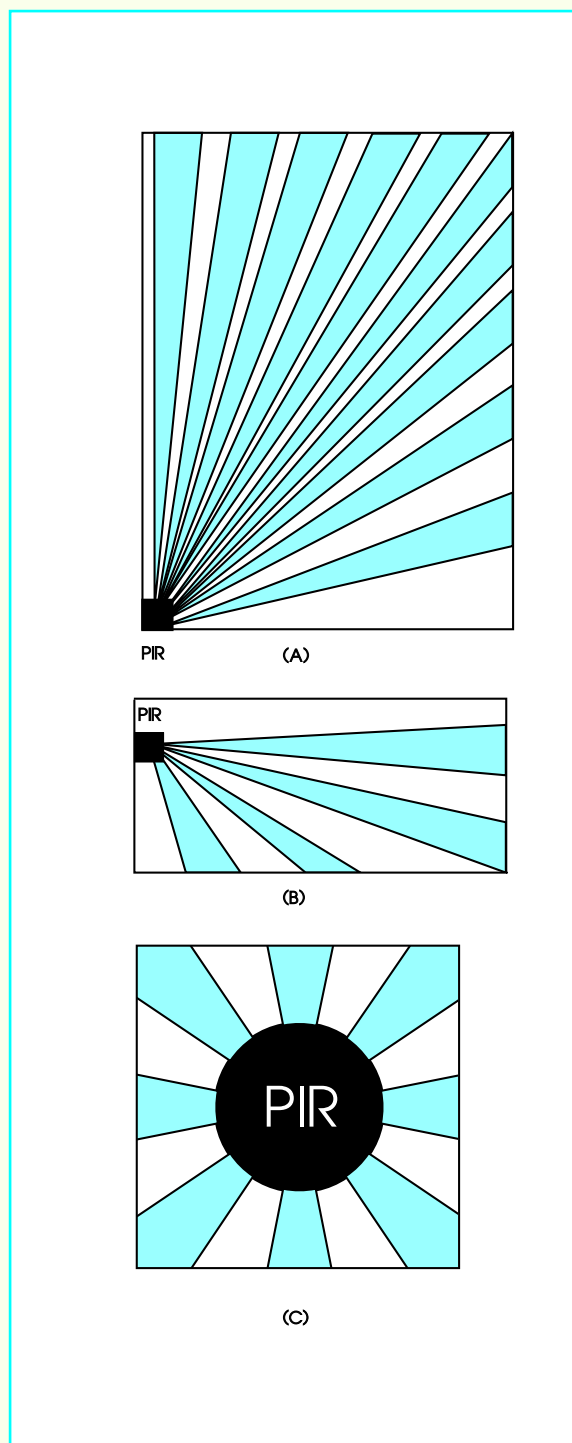
Once the window is clean and dry, locate the position of the take-off block. This block will simply stick on the window with self-adhesive tape. Next, using a straightedge and a marking pen, place a line around the window where the foil will be located.

Leaving a little excess foil at the contact block, begin to run the foil out from the contact block. Apply about eight inches of foil at a time to the window and smooth it on with a small dowel roller or other round object such as a small glass bottle. Follow the line you marked until you reach your first corner. Now, double back on the foil run and turn a 90 degree angle across the window. Continue installing the foil until you return to the contacts or take-off block. Contact of the foil to the contact or take-off blocks is made by running the foil up the ramps inside the block. A screw that will hold the wire on the block will also hold the foil to the block.

Installing Interior Sensors

Microwave, ultrasonic, and passive-infrared detectors are all mounted in basically one of three methods. These three methods are the wall-mount, corner-mount, and ceiling-mount methods. The mounting method used largely depends upon the case design of the sensor and the protection pattern needed for the sensor. The most common sensor design used today for PIRs and dual-technology sensors is the corner-mount design. A special corner-mount bracket is used to hold the PIR (passive infrared sensor) or the corner-mount sensor in place. This type of mounting provides a protection pattern for a room as shown in Figure 50. When mounting the PIR, follow the manufacturer's instructions for height above the floor, wiring, and masking.

FIGURE 50—This is the typical protection pattern for a corner-mount PIR. The top view is in (a), while a side view is in (b), and the ceiling-mount method is shown in (c).



In general, you should follow these mounting rules:

Rule 1: Avoid pointing the PIR at locations that produce a sudden change in temperature. These locations include heat registers, stoves, radiators, and other heat-producing sources.

Rule 2: Avoid PIR or other sensor positions where the sensor's beams or range will be blocked by walls, curtains, or other obstacles.

Rule 3: Mount the sensor at least seven feet above the floor.

Rule 4: Keep the sensor out of direct sunlight.

If you're installing a self-powered sensor, you'll need to run two wires to the sensor. If the sensor is to be

powered from the alarm system's control board, you'll need to run a four-wire cable. Self-powered, wireless PIRs or other sensors will require no wiring. A two-wire system is easy to connect to a battery-powered PIR. Simply connect the two wires for the loop to the terminals of the sensor.

A four-wire installation is shown in Figure 51. As shown, there are two PIRs, ultrasonic, microwave, or dual-technology sensors hooked to this loop. The positive and negative terminals are connected as a parallel arrangement from the auxiliary power output terminals of the control board to the two sensor's power-input terminals. A red and a black wire are used for this 12 VDC power feed. The loop wiring for this zone is using the yellow and green wires. Since the sensors are using normally-closed contacts, the sensors are wired in series.

Additional switches, magnetic contacts and other devices can also be connected to the loop with an end-of-line resistor, or EOLR, at the end of the loop. *Note:* In some sensors the cover is also protected by a tamper switch. This switch will open the circuit if the cover of the sensor is removed.

Once the sensor is mounted and the wires are connected, it's time to adjust the sensor. Some sensors have range or sensitivity adjustments that can be made by viewing the LED while the adjustments are being made. One new approach to

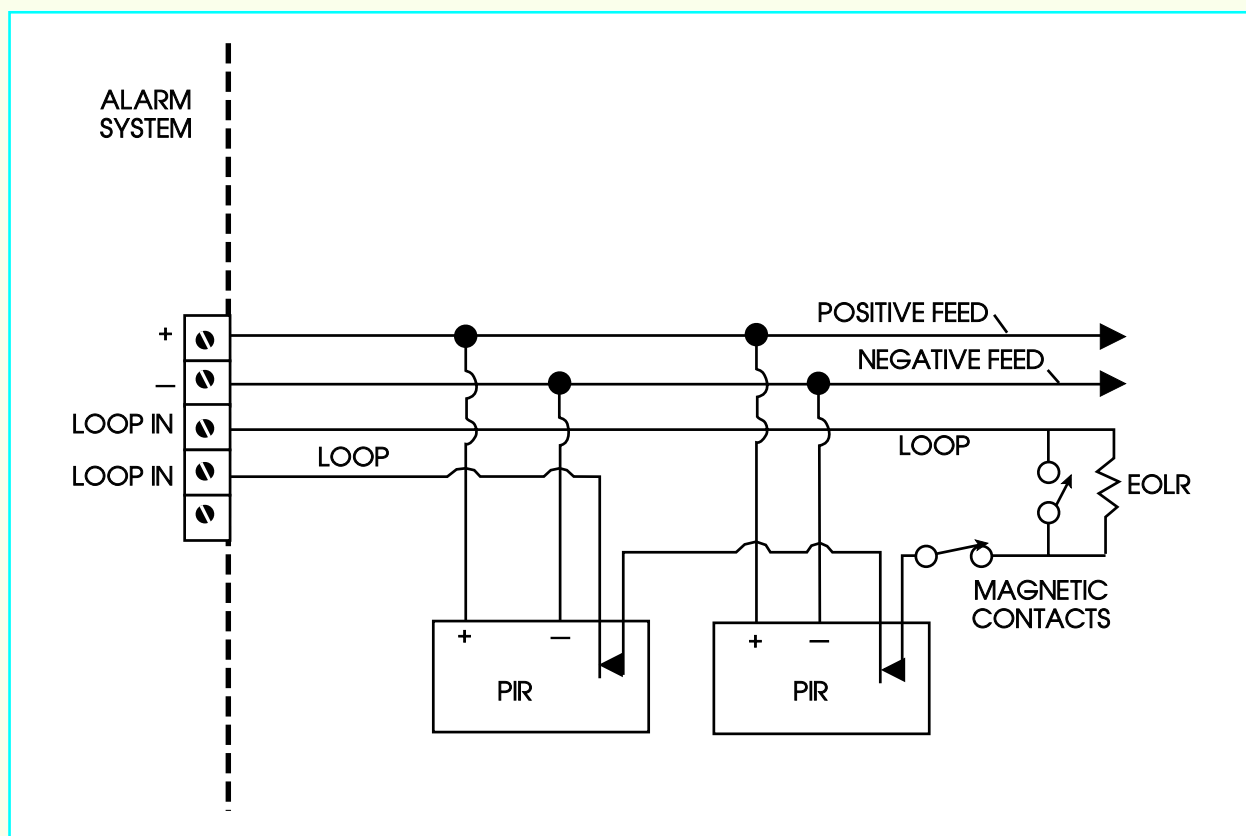
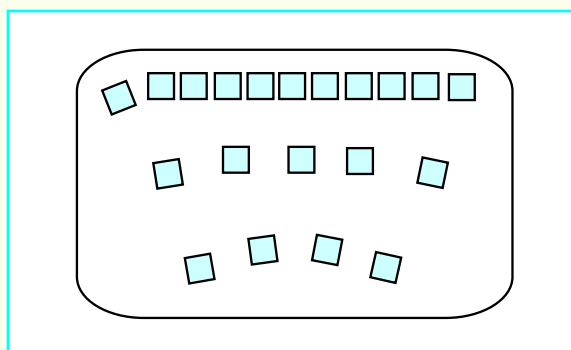


FIGURE 51—This is the four-wire system of wiring a system-powered PIR in series with magnetic contacts and in parallel with a normally-open magnetic contact.

FIGURE 52—By installing a mirror such as the one shown here in place of the PIR lens, you can see the area of detection clearly and perform alignment or masking more easily than by standard methods.



PIR adjustment is the use of a specially-designed mirror as shown in Figure 52. The mirror is used in place of the front panel lens of the PIR. By looking into the mirror, you can see the room's reflec-

tion in the mirror. The boxed areas of the mirror represent the areas of detection of the PIR. If you need to adjust the position of the PIR, loosen the mounting bracket screws, adjust the position, and retighten the screws. If you need to mask any areas of the lens, you can see the exact area of the lens in the setup mirror.

A PIR or other sensor can be tilted up for long-range sensing or tilted down to sweep the area below the sensor. Multiple PIRs or other sensors can be used back-to-back, in each corner, or in many other configurations to sense intruders in large areas.

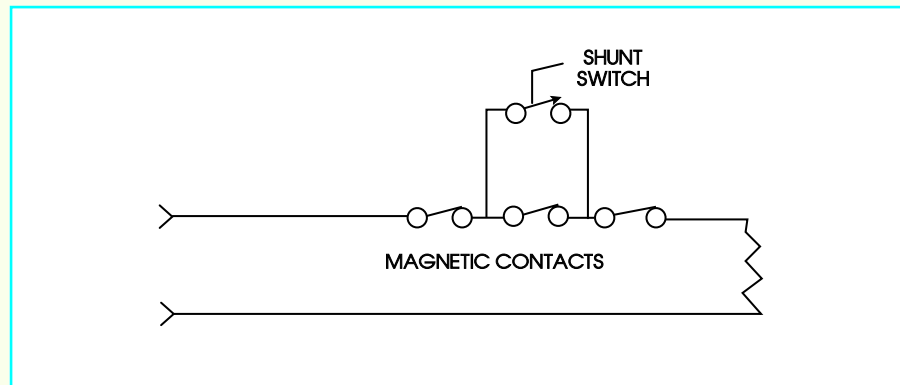
Some microwave and ultrasonic sensors use a flat case that can be directly mounted to a wall. This type of installation is often used in rectangular-shaped rooms and in hallways. The wiring, mounting, and adjusting are basically the same as with a PIR except no alignment mirror is available for the adjustment of these sensors.

Installing a Shunt Switch

A shunt switch, normally a keyed or key-operated switch, is often used to short or remove a sensor from an armed system. Normally, the switch will be mounted in a flush or surface mounted box much like the switches you've seen that energize electric locks in the previous study unit. The switch will be used to maintain a closed circuit or open circuit around a magnetic contact, switch or sensor. Figure 53 displays a typical normally-open shunt switch wired across or shunting a normally-closed magnetic contact.

In this circuit, the normally-open contacts of the shunt switch parallel the closed contacts of the magnetic contacts. However, suppose your customer desires that the door protected

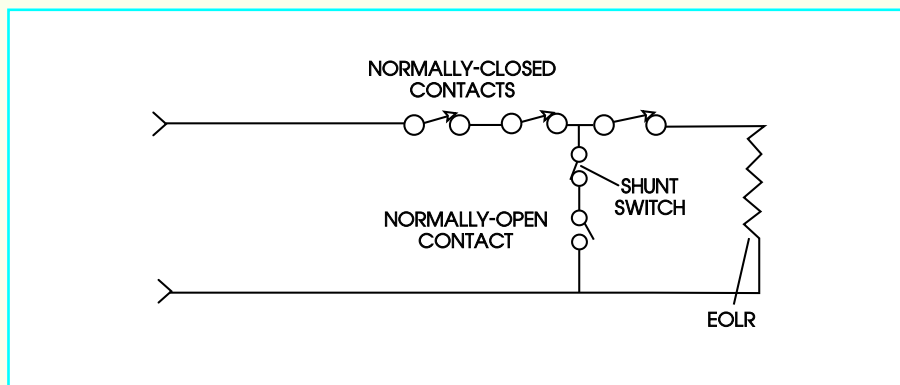
FIGURE 53—This diagram shows how to install a normally-open shunt switch across a closed magnetic contact.



by the second magnetic contact be allowed to open and close, yet the system remain armed. In this condition, the shunt switch can be closed to bypass the second magnetic contact that's located on the door. The door can be opened and closed at will without tripping an alarm.

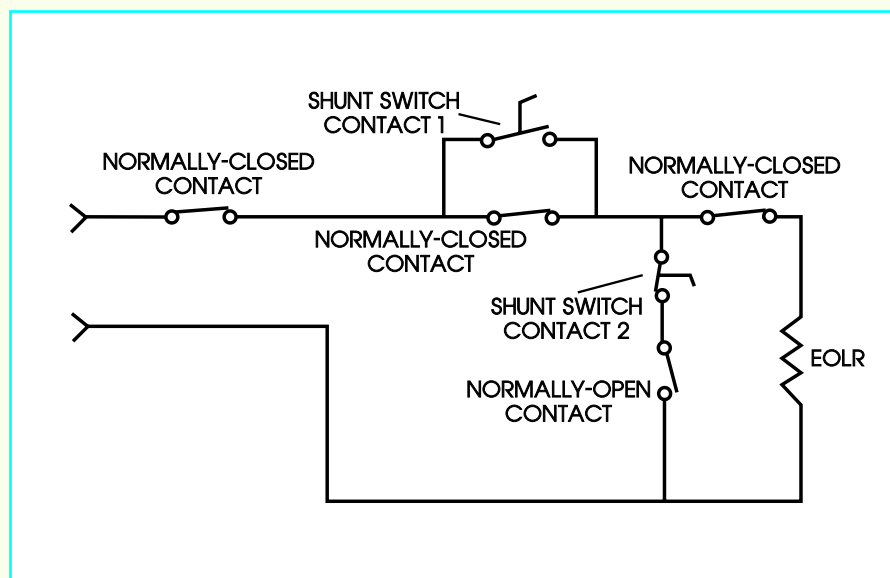
A normally-open sensor can also be bypassed by a shunt switch. This type of installation is shown in Figure 54. In this case, a normally-closed shunt switch is used. When the shunt switch is transferred to the open state, it disconnects the sensor from the circuit.

FIGURE 54—A shunt switch can also be used to bypass a normally-open switch contact.



Sometimes more than one switch or sensor must be bypassed. Such a condition may occur in a storeroom where the main entry door and a sensor are to be disconnected from the loop during normal working hours. However, the windows in this area are to remain protected. In this case, the shunt switch should have two sets of contacts and be connected as shown in Figure 55. This would be a DPST (Double Pull Single Throw) switch with one NC (Normally-Closed) and one NO (Normally-Open) set of contacts. Shunt switch contact 1 will be used to bypass the normally-closed contacts below the shunt switch's contact set. Shunt switch contact 2 will be used to maintain an open circuit when the normally-open sensor contacts close.

FIGURE 55—Here's how two contacts can be bypassed with one switch that has two contacts.



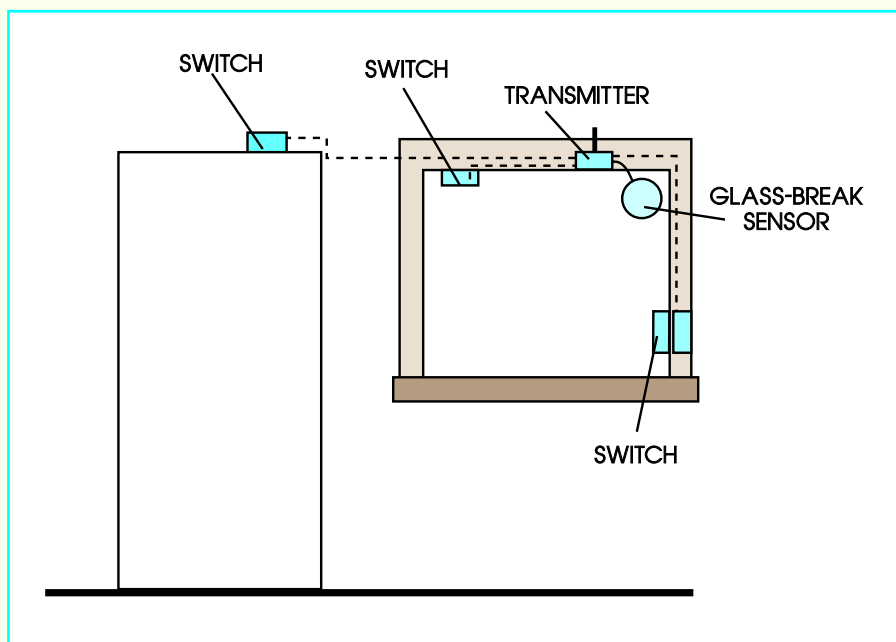
Installing a Wireless System

Wireless systems are very easy to install since the major work, running wires, is eliminated. Wireless systems are finding wide use in homes and businesses where fishing wires through finished walls presents a difficult or nearly impossible task. In a wireless system, you proceed much like the wiring of a hard wired system. First, mount the control panel and hook it up to the service entrance ground. Next, bring over the phone and electric service but don't connect these services to the control system at this time.

Next, begin mounting the glass sensors, magnetic contacts, PIRs and other sensors in their proper locations. In many systems, the magnetic contacts, glass-break sensors and other devices will be tied to the individual transmitter in a typical loop with an end-of-line resistor. Each zone will normally have at least one transmitter. A typical door/window installation is shown in Figure 56. Here magnetic contact switches are wired for the door and window. These devices are loop wired with an EOLR and connected to the transmitter input contacts. The wire between the door and the window is hidden behind the wall. The window uses concealed magnetic contacts and the transmitter is hidden behind the curtains to complete the concealment of the system.

There are a wide range of transmitters available for a wireless system. Some PIRs, glass-break sensors, smoke alarms, and dual-technology sensors will have their own transmitters for

FIGURE 56—Here are a door and window protected by three magnetic contacts and a glass-break sensor. The transmitter will be hidden behind the curtains.



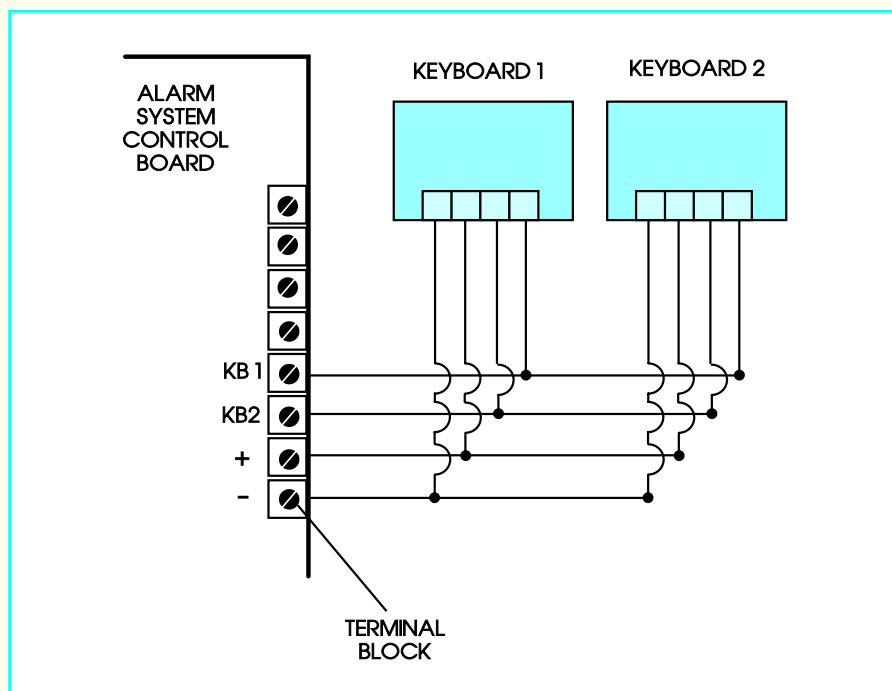
ease of installation. Some transmitters even have their own internal reed contacts for ease of installation near a window or door.

Once all of the perimeter and interior sensors are installed, the next step is to install the remote keypad. The keypad, also called a keyboard, is normally installed in a flush-mount box near an entry-exit door. (A flush-mount box mounts inside a wall cavity cutout. A flange around the box covers the cut out area.) A four-wire cable will connect the keypad to the control panel. In most systems, you can parallel wire up to four remote keypads. Two keypads for the front and back door are shown connected in parallel in Figure 57.

Now that the keyboards, sensor switches, and transmitters are connected, you can plug in the transformer unit to the electric service, program, and test the system. The programming of the system will be covered in the next section. The testing of the system involves tripping each sensor or contact and making sure that the sensor and contacts operate properly.

One of the most difficult sensors to check is the glass-break sensor. Fortunately, the manufacturers of glass-break sensors have developed a test device that emits a sound at the frequency the sensor uses to trip its contacts. When using this test device, point it at the glass and not directly at the sensor.

FIGURE 57—Two or more keyboards may be connected in parallel as shown here.



When your system is complete, the last connections to make are at the battery and the phone lines. A battery backup is a common component of modern alarm systems. This battery will supply the electric energy needed to power the circuit board, sensors, and alarms in the event of electric service power failure.

The phone lines are connected last in the system. Typical phone line connections involve a four-wire system as shown in Table 1.

The diagram shows an RJ-31X terminal block with eight terminals numbered 1 through 8. On the left, four wires are labeled: GRAY, BROWN, RED, and GREEN. A 'DIRECT CONNECT CORD' is connected to terminals 1 and 2. A 'PROTECTOR' is connected to terminals 3 and 4. 'PREMISES PHONES' are connected to terminals 5 and 6. Terminals 7 and 8 are also shown.

Table 1	
Green	Telephone Company Tip (Conductor 1)
Red	Telephone Company Ring (Conductor 2)
Brown	Home Tip (Conductor 1)
Gray	Home Ring (Conductor 2)

The final point of any installation is instructing your customer as to how the system works. Time spent on instruction is well spent. This instruction time will prevent calls back to the installation at the residence or business.

Installing Smoke and Fire Detectors

The first place you should go to understand the placement of smoke and fire detectors is to your local fire code. This code will describe coverage areas and detector placement. Smoke detectors are typically four-wire normally-open devices. They're wired in parallel along with an end-of-line device, normally a relay. This wiring method is shown in Figure 58.

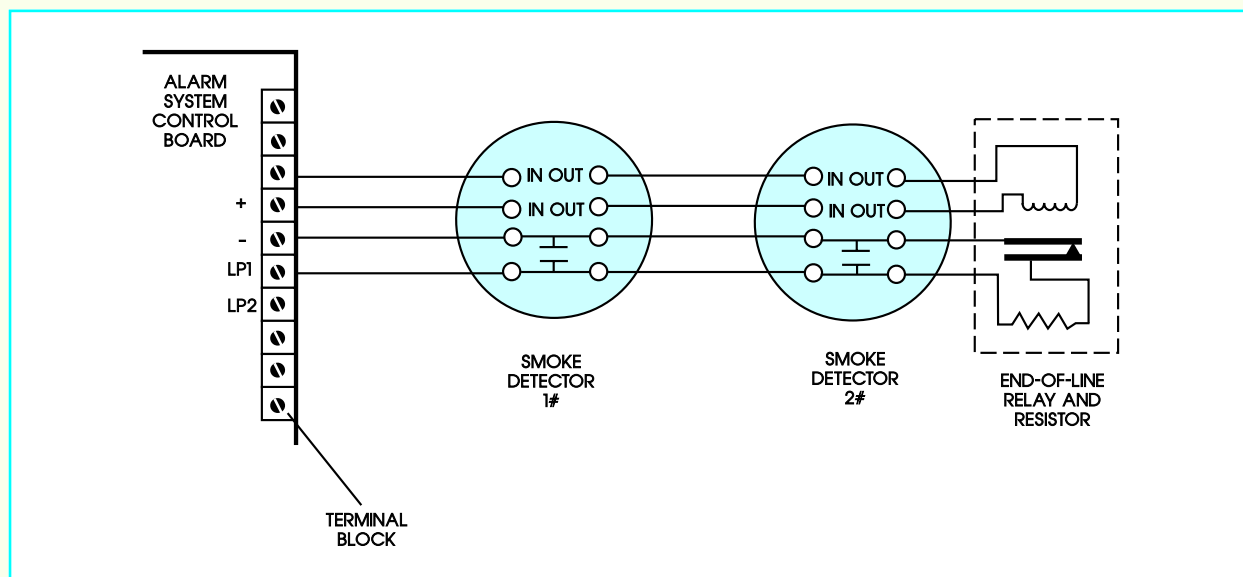
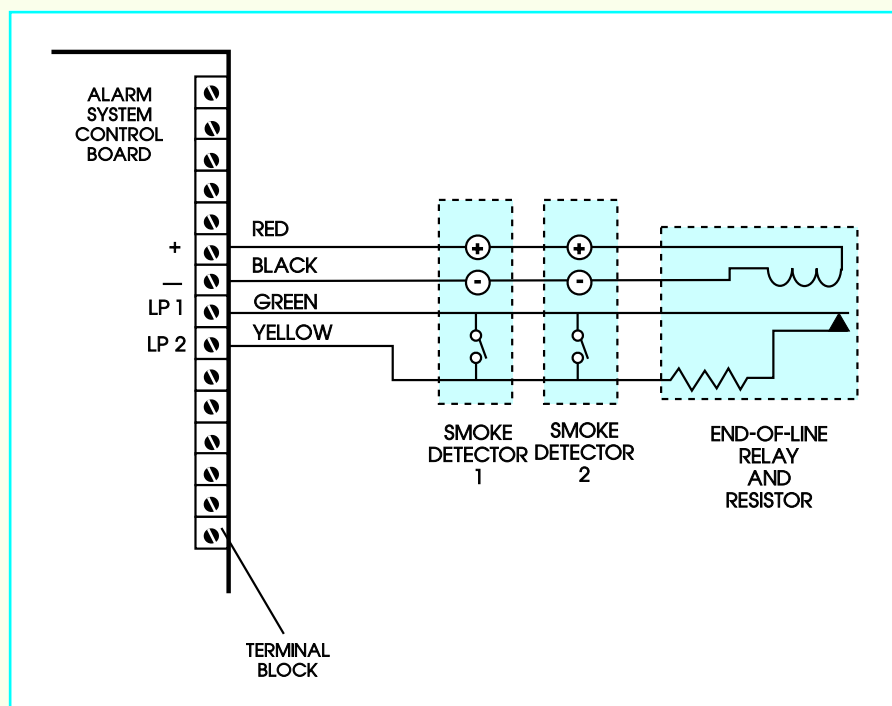


FIGURE 58—This is a typical loop wiring for a smoke alarm.

A schematic representation of this same circuit is shown in Figure 59. Here you can see the contact arrangement of the normally-open contacts and the end-of-line relay with an end-of-line resistor.

In operation, the smoke and heat detectors will be wired in a parallel arrangement. If one of these devices senses smoke or excess heat, it will close its contacts and hold them closed (latch closed). This action will short the loop causing the fire alarm to trip and the alarm horn and/or dialer to operate. The system can be reset from any of the remote keypads by entering a code number.

FIGURE 59—Here's a second form of a smoke detector circuit shown in circuit-schematic format.



The end-of-line relay with the internal end-of-line resistor is used to monitor the power supply to the alarm. In normal operation, the end-of-line relay's coil will be energized holding its normally-closed contacts open. If power were to be disrupted to the smoke- and heat-detector circuit, the relay's coil would be de-energized. This would cause the contacts to close, shorting the EOLR producing a fire alarm condition. By using an end-of-line relay at the end of the smoke- and heat-detector loop, the condition of the power supply to each of the devices can be checked constantly. Remember that the end-of-line relay must be mounted at the end of the loop. Placing it ahead of the last detector won't allow the relay to sense the condition of the power supply to that sensor.

Smoke detectors are normally mounted to the ceiling of the protected area. When smoke from cooking, welding, or other such situation is possible, the use of heat detectors or IR or UV flame detectors will be necessary.

To pull it all together, Figure 60 shows how a typical control panel is connected to the system. The terminal blocks on the system are used for all connections. Normally, solderless connectors are used to terminate the wires.

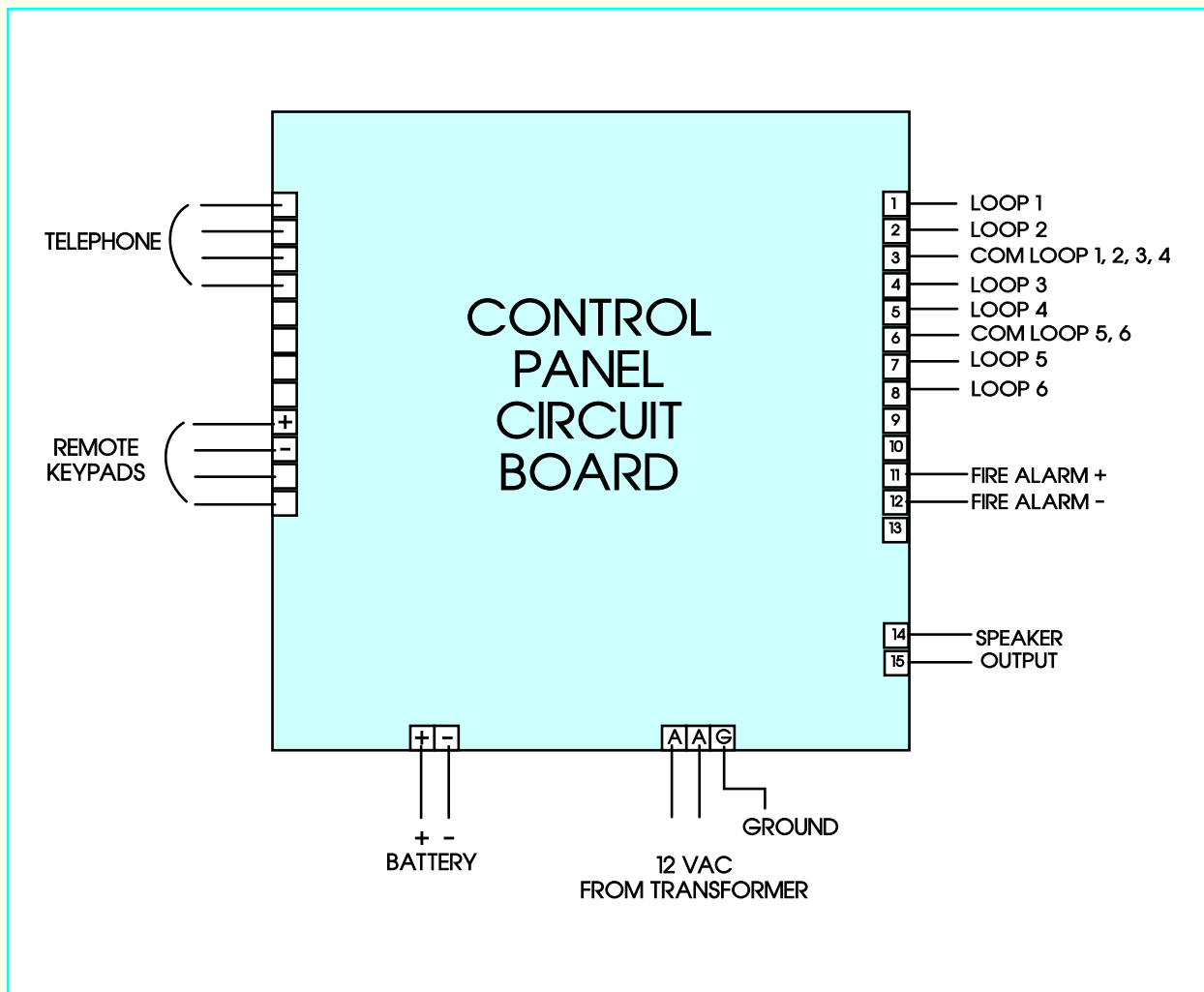
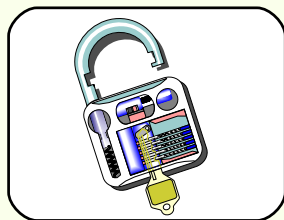


FIGURE 60—These are the typical connections to an alarm system's main circuit board.



Locking It Up! 4

1. Is a fire-protection loop a 24-hour protected loop?

2. What is meant by the instant function of an alarm system?

3. What three services will an alarm system require?

Check your answers with those on page 91.

PROGRAMMING AN ALARM SYSTEM

Programming Techniques

The word “programming” often scares people away from a computer-based system. However, the programming of an alarm system is a rather simple task. All you need to know are what information you’ll need to program and where that information is to be placed in the memory of the system. One aid to the programming of an alarm system is the use of a programming sheet. This programming sheet will display the information that will be needed by the control panel to operate the system properly.

On most small systems, you’ll be doing the programming on the remote keypad. On larger systems, the alarm system’s memory may be programmed by a system known as downloading. Here a central computer is used to enter the information and the computer is then downloaded over telephone lines to the memory of your customer’s alarm system.

Some older systems used a programming method called programmable read-only memory (PROM) programming. A PROM is a miniature electronic circuit or integrated circuit. This PROM is placed in a programming device and programmed with the system information. The PROM is then pushed into a socket in the alarm’s circuit board to let the electronic circuit know what type of system is beyond the circuit board.

PROM programming has been greatly replaced by keyboard- or downloading-type programming. This fact is largely due to the difficulty in making changes in a PROM-based system. Every change requires that the PROM be erased by UV light and reprogrammed to reflect the changes. With keyboard or download programming, the changes can be immediately entered and made in the system. Let’s begin looking at programming by viewing a typical programming sheet. Such a sheet is shown in Figure 61.

Parameters

Parameters are typical values that are first entered into the programming worksheet; these same values are then entered into the control box to activate the system. The first four parameters are the master and secondary codes. After the system is programmed, these codes will be used to

FIGURE 61—This is a sample programming worksheet for an alarm system.

1	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	MASTER CODE NUMBER					
2	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	CODE NUMBER 2					
3	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	CODE NUMBER 3					
4	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	CODE NUMBER 4					
5	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	PRIMARY TELEPHONE NUMBER					
6	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	SECONDARY TELEPHONE NUMBER					
7	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	ACCOUNT NUMBER					
8	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	ACCOUNT NUMBER					
9	<input type="text"/>	<input type="text"/>	ZONE 1 TYPE	12	<input type="text"/>	<input type="text"/>	ZONE 4 TYPE			
10	<input type="text"/>	<input type="text"/>	ZONE 2 TYPE	13	<input type="text"/>	<input type="text"/>	ZONE 5 TYPE			
11	<input type="text"/>	<input type="text"/>	ZONE 3 TYPE	14	<input type="text"/>	<input type="text"/>	ZONE 6 TYPE			
15	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	DURESS CODE					
16	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	ENTRY DELAY	18	<input type="text"/>	<input type="text"/>	<input type="text"/>	BELL TIMEOUT
17	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	EXIT DELAY					

Arm or disarm

Change with new parameters

Reset from an alarm state

Bypass at one or more zones

The master codes are derived by the homeowner. When the system is first powered up, a number such as 1, 2, 3, 4 will normally be the preprogrammed master code. This preprogrammed number is called a default number. To change this value to the system user's number, you enter this number into the first parameter boxes. Later, it will be programmed into the control system's memory. The remaining codes for additional users can be entered on the programming sheet as with the first code.

The next two parameter numbers are for the telephone number the automatic dialer will call when the system is in an alarm state. The control system will dial the number in parameter five first. If there's no response, the number in parameter six will be dialed next.

Parameter seven and eight will contain the account number for the system. When the alarm is tripped and the automatic dialer makes contact with a central reporting station, these numbers will be sent over the phone lines in a digital format. The central reporting station will then identify the customer through these numbers sent from parameter seven and eight in order to inform the fire department or police.

The next parameters, numbers nine through fourteen, specify the type of zone coverage. Table 2 lists the numbers used to represent the types of zones.

NUMBER	ZONE TYPE
01	Perimeter
02	Perimeter, day
03	Perimeter, chime
04	Perimeter, dial delay
05	Perimeter, chime, dial delay
06	Interior, chime
07	Interior, dial delay
08	Interior, chime, dial delay
09	Alarm, audible
10	Alarm, silent
11	Panic
12	Fire

Table 3 shows an example of a system set up with six zones and the corresponding parameter numbers for those zones.

Zone Number	Zone Type	Zone Code Number	Worksheet Parameter Number
Zone 1	Perimeter, dial delay	04	9
Zone 2	Perimeter, chime, dial delay	05	10
Zone 3	Interior, dial delay	07	11
Zone 4	Interior, chime, dial delay	08	12
Zone 5	Panic	11	13
Zone 6	Fire	12	14

The third column (Zone Code Number) in Table 3 lists the numbers to be entered into the parameter worksheet; these numbers identify the type of zone to the alarm system. The fourth column (Worksheet Parameter Number) lists the parameter numbers.

The next parameter, number 15, identifies a special ambush code number. If the home or business owner is being forced to disarm the system, this number would be used. Once entered, it will produce a silent alarm, such as through the automatic dialer.

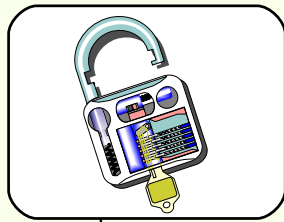
The final three parameters deal with system timeout numbers. These parameters will be listed in seconds except for parameter 18 that is in minutes. For example, parameter 16 may be for the entry delay with parameter 17 for exit delay. If you want a 45-second entry delay and a 60-second exit delay, the programming sheet should have these numbers entered in the boxes. The final parameter, number 18, deals with the amount of time the audible and/or visual signal appliance will operate. Most communities have a code for how long an audible alarm may be on. Typical times range from five to fifteen minutes. You would enter this value in parameter 18.

To enter these parameters into the memory, you'll have to use a series of key combinations. For example, the manual that comes with the alarm may say to press the code button, the enter button, and then a four-digit number. Refer to the manual for your system to find the key sequence that will allow you to enter parameters. Also refer to the manual to see how to step through the parameters as you're entering them.

There are a wide range of methods of entering parameters into alarm systems from different manufacturers. The material given in this section is typical of many systems. Other systems may be different. For example, the system may program in the octal or hexadecimal system.

When the alarm is tripped, the digital communicator will seize the telephone line, call the 24-hour monitor station, and transmit the data which has been preprogrammed into the controller. This data will include the customer's I.D., the installer's I.D., and the type of alarm.

The programming varies from system to system. Refer to the manufacturer's programming manual. If you experience difficulty, most manufacturers have a technical support line (with 800 numbers) to assist professional alarm installers from 8:00 A.M. to 5:00 P.M.



Locking It Up! 5

1. What is a default value?

2. What is a PROM?

Check your answers with those on page 92.

AUXILIARY SECURITY EQUIPMENT

When an Alarm Isn't Enough

In many commercial, and in some residential applications, an alarm system isn't enough. Retail outlets may suffer great losses due to shoplifting. Homes may be the repeated victims of vandalism that sets off their alarm systems. In these and many other cases, auxiliary security equipment may be the answer.

Closed-Circuit Television

With the development of the CCD (charged coupled device) camera tube, security cameras have become an inexpensive aid to security. If a retail outlet or a home installs these devices, the shoplifting and vandalism will normally be greatly reduced if not eliminated. A CCD camera will connect to a monitor or a VCR (video cassette recorder) as shown in Figure 62. It's normally a four-wire installation. Two wires power the camera while the other two wires are actually a single shielded cable. Some camera mounts are motorized to create a sweeping view of the area. A two-movement mount is also available that will sweep side-to-side and up-and-down.

With the proper type of VCR, the system can be set up for loop-type recording. In this system, the VCR records about 20 minutes of video from the camera. After the 20-minute

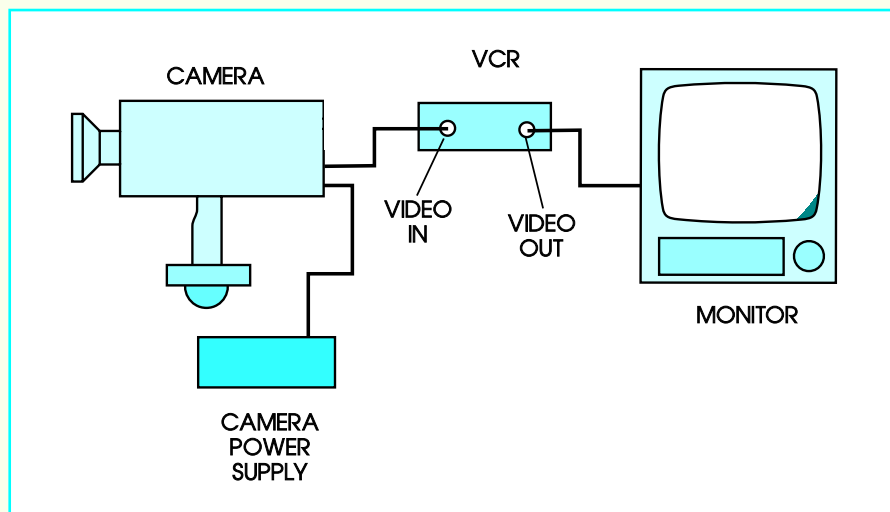


FIGURE 62—This is a typical closed-circuit television (CCTV) camera circuit.

period, the tape will be recorded over. This action occurs as one continuous loop with the capability to stop and view any period within the last 20 minutes on tape.

Dummy cameras are also available with standard or motorized mounts. Normally, a small red light will also be a part of the front of the camera. The camera looks exactly like its working counterpart. However, there's no internal camera tube or electronics, and therefore, no video. The sole purpose of the dummy camera is to prevent theft or vandalism by making the potential criminal believe that he or she is being viewed.

One of the newest developments in closed-circuit television cameras is the "camera on the chip." This miniature camera is becoming a common addition to PIR sensors and other types of sensors used by security agencies. Now, when a detector senses an intrusion or fire and the alarm system calls the central reporting station, the station can actually view the area that has tripped the alarm. Normally, with this system, a video frame is sent to the central reporting station every three or four seconds. The central reporting stations personnel can then determine exactly how to respond to the alarm. Although too expensive for most residential applications, this system is being used more and more for commercial and retail applications.

Lighting

Exterior and interior lighting can play a large role in the security of a building. No intruder wants to go near a well-lighted area. For business, the lighting circuits should be divided into two circuits per area, especially those areas that are behind windows or doors. One circuit can be the main circuit for daytime use. The second circuit can be the night circuit to provide interior illumination. The outside of the building should be well lit at all points of entry. Areas such as entry/exit doors, loading docks, and so forth, should have spotlights aimed from the top of the building at the doors.

Residential lighting should include both interior and exterior lighting. The interior lights can be placed on timers to simulate a "lived-in" condition when the occupants are away. Outside spotlights, low-voltage lighting, and especially motion-detector lighting can aid in reducing theft and

vandalism. As with a commercial building, try to mount spotlights well above the reach of a person. The lighting won't work well if the intruder can simply reach up and unscrew the bulb.

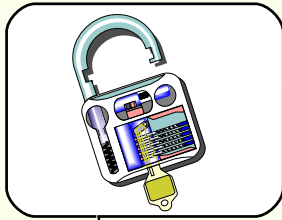
Labels and Stickers

Labels and stickers are often applied to a home or business after an alarm system is installed. These labels and stickers will normally say: "Warning, these premises protected by a security system." Labels and stickers can act as a deterrent to unlawful entry or vandalism. If an intruder knows the area is protected, he or she will be less likely to attempt entry or do damage.

Labels and stickers are normally placed on all entry/exit doors, large window areas, and other locations that are visible to the general public. Security system labels and stickers can also be applied to the windows and doors of a nonprotected residence or business to provide the same deterrent to crime.

Two-Way Mirrors

Many retail stores are using two-way mirrors to halt shoplifting. A two-way mirror appears as a standard mirror from the outside. However, from the back side, it appears as a slightly discolored pane of glass. For added security, a camera can be placed behind the two-way mirror. Then, if someone is caught in the act of shoplifting, the act will be recorded on tape. This recorded tape aids greatly in the prosecution of the shoplifter.



Locking It Up! 6

1. What is meant by a dummy camera?

2. Where should security labels and stickers be applied?

Check your answers with those on page 92.

GETTING INTO THE ALARM BUSINESS

Selling Products and Services

The best way to start off in the alarm sales and installation business is to start small. Begin with a small home or business or expand a present system.

Hands-on training can be provided by purchasing a small alarm system. Also, purchase a few of the many types of sensors. You'll be using this equipment later in your career so it won't be a waste of money. You can even install a burglar and fire alarm system in your own home and experiment with it. Check to see the range of the sensors, gaps for magnetic contacts, and so forth.

Obtaining Equipment

Fire and burglar alarm equipment is available from many sources. You can purchase it directly from various manufacturers. Some businesses specialize in supplying equipment made by many different manufacturers. One of the best methods of purchasing alarm equipment is to purchase it through a company name. That is, you should purchase the equipment using the name of your company—Security Systems, Inc., for example—rather than your own personal name. Most alarm system manufacturers would rather sell equipment to a company than to an individual user.

Many areas of the country have trade associations affiliated with alarm installation. If possible, become a member of these associations, attend their meetings, and collect their literature. Through your trade affiliations you'll find out what type of equipment is being used in your area, what equipment is causing problems and should be avoided, and so forth.

How to Sell Systems

Normally, once you start a locksmithing business and advertise your business, the selling of an alarm system will be the result of the customer calling you. Usually, this will occur

after your customer has experienced a loss due to burglary. However, often this customer contact results from a series of burglaries in one neighborhood. When you're contacted by a potential customer, you'll go to the residence or business and perform an on-site survey.

Performing an On-site Security Survey

The on-site security survey is the most important step in alarm system sales, design, and installation. The site survey will tell you what kind of system to use, how many sensors or switches, how long and how difficult the wire runs will be, and so forth.

A good survey will check

1. The number of windows and doors
2. Type and number of outbuildings (garages, sheds, barns, etc.)
3. Number of interior rooms
4. Other points of access into the home, vents, crawl spaces, etc.

This first step in the survey will let you know the size and number of devices the system will require.

A second form of site survey can then be performed to

1. Check for potential hiding places
2. Locate the electrical, telephone, and water services
3. Locate the visual and sounding devices
4. Sketch a diagram of the home, outbuildings, and the home's basement and attic areas

With all of this information in hand, you can then go back to your shop and design a system for this particular residence or business. With the system designed, you can then come up with a price quote for the alarm system and its installation.

Liability

Liability is a difficult subject to understand. Liability means legal responsibility. An alarm installer may be held responsible for the protection of the residence or business during, and often more importantly, even after the installation. A court of law may find the installer liable for losses that have occurred at a site where he or she installed an alarm system that didn't keep the site secure.

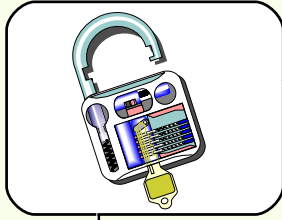
To cover liability, every alarm installer needs insurance. This insurance protects you, the installer, from liability for losses and damages caused during the installation and after the installation is complete and the system armed.

The best place to find out about insurance in your area is through your state or provincial alarm installer's trade association. This group will know which companies provide the best coverage at the best rates. There are many other sources of insurance information. In addition to your local insurance company, you could consult your accountant, tax attorney, local Chamber of Commerce, or the Small Business Association.

Insurance is necessary. Why? Because no alarm installation is perfectly secure. Here are many of the methods used to bypass an alarm system.

1. Phone lines may be cut, so they won't be able to report to the central station.
2. A sophisticated burglar may have enough knowledge of the system to bypass it.
3. The signals for wireless transmitters can be blocked or jammed.
4. An intruder may break into an unprotected area.
5. Electronic circuits may fail.

In many localities, the alarm installer can be held liable for these types of losses. Insurance is your only protection from financial problems in the event the system you install fails or is defeated.



Locking It Up! 7

1. How can you get first-hand experience on an alarm system?

2. How will most of your alarm systems be sold?

Check your answers with those on page 92.

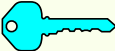
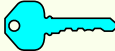
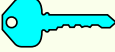
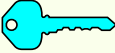
THE KEY TO SUCCESS

You've made your way to the end of our material on electronic security systems, and you should be proud of your achievement! Success is almost always the result of hard work, and by completing this study unit, you've proved that you can work hard. You've taken another important step toward your career goal of becoming a professional locksmith.

In this study unit, you learned about many important electronic security systems, including local alarm systems, central reporting systems, hard-wired systems, and wireless systems. You examined alarm system components and alarm functions. Finally, you learned the steps for installing and programming an alarm system. This knowledge will be invaluable to you in your professional career.

Now, take a few moments to read through the following *Key Points to Remember*. This review of the most important facts and concepts of the study unit will help you retain what you learned. When you feel that you know the material well, proceed to the examination. Good luck!

KEY POINTS TO REMEMBER

-  Early alarm systems used a normally-closed loop and a battery and bell. The two types of alarm systems available now are the local alarm and the reporting alarm system. A hard-wired system will use wires to connect the various switches or sensors in the system. A wireless system will use a series of transmitters and a receiver to eliminate the need for wiring. A combination system will use both wired and wireless switches and sensors.
-  An end-of-line resistor, EOLR, is used to set a certain loop current. If this current rises or drops, the alarm system will trigger. A resistor's value can be determined by measuring it with a VOM or by decoding the resistor's color bands. A system can be expanded by using a polling loop and remote-point modules.
-  Wireless systems use UHF transmitters and a receiver.
-  The Americans with Disabilities Act (ADA) specifies the placement of pull boxes and output levels of visible and audible signal appliances in an alarm system. Local codes,

particularly fire codes, may also require specific types of installations.



A complete alarm system is made up of a main control panel, input devices wired to loops or to transmitters, a power supply, and output devices. Bells, horns, sirens, and speakers are used as output or signaling devices. Another output device—the digital communicator—can be used to contact a central reporting agency, police, or fire department, if the alarm system is tripped. Perimeter detectors are used to protect the windows and doors of a building. Perimeter detectors include magnetic contacts, foil, plunger and roller switches, vibration switches, and glass-break sensors. Interior detectors can include ultrasonic, microwave, photoelectric, passive infrared or PIR, and dual-technology sensors. A key-pad is used for data input, code number input, and to view system conditions on an LED or LCD screen.



Modern alarm systems have many functions and features that are easily used to simplify arming and disarming or to bypass certain zones. An alarm system's main control panel is normally mounted in the basement of a residence or in the basement or first floor closet of a business. An alarm system will connect to an electric outlet, to the service entrance ground rod, and to the telephone service. Doors and windows can be protected by surface-mount or concealed magnetic contacts. PIRs can be mounted in a corner of a room using a standard mounting bracket. Some ultrasonic and microwave sensors have a flat case that can be mounted to a wall.



The programming of a system is made easier through the use of a worksheet. The worksheet helps you and the customer choose all the codes, phone numbers, and other numbers needed to program the system.



Auxiliary security equipment includes closed-circuit cameras, lighting, labels and stickers, two-way mirrors, and dummy cameras. These may be necessary to prevent or detect shoplifting or vandalism. Obviously visible equipment, whether functioning or dummy models, deter burglary, vandalism, and shoplifting just by being on display.



Customers will normally contact you due to a recent break-in or a series of burglaries in a neighborhood. Making a careful survey of the home or business is the first step to designing a system for a customer. Besides testing equipment in your own home, attending trade association meetings will be an excellent way to learn about all the types of equipment available.

Do You Know Now . . .

What is an *EOLR*?

An EOLR is an end-of-line resistor used in a supervised loop of a fire or burglar alarm system.

What is a *dual-technology sensor*?

A dual-technology sensor will use a PIR in combination with an ultrasonic or microwave detector. In this case, both sensors must be triggered to produce an alarm output.

What is a *panic circuit*?

A panic circuit for a home normally uses a push button to sound the alarm in the event of an emergency. This push button is mounted in a bedroom or bath. In a business, the panic circuit may be used as a holdup circuit, calling police by means of a hidden switch or sensor.

NOTES

Locking It Up! Answers

1

1. The EOLR is used to set the loop current that's sensed by the alarm control panel.
2. An RPM is used in large systems to limit the wire runs from the main control panel.
3. Yes, a protective loop can contain both normally-open and normally-closed switches and sensors.

2

1. An alarm bell uses a dome and a hammer. It will produce about 80 dBa. An alarm horn can produce more than one tone in a directional pattern. A horn will produce a sound at about 100 dBa. A speaker can produce many tones generated by an internal or external speaker driver circuit.
2. The automatic dialer or communicator will disconnect the call and make its own call. (This is called line seizure.)
3. Foil is difficult to install and is subject to damage.

4. An ionization-type smoke alarm has an ionization chamber in which a small amount of radioactive material ionizes air. If smoke enters, it unbalances the electric charge on the ionized air, triggering the alarm on the sensitive electronic monitoring circuit.

3

1. A panic circuit contains a push-button switch that's normally installed in a master bedroom to trigger an alarm if the switch is pressed.
2. A fire alarm circuit is always armed and is a 24-hour circuit.
3. A duress code is entered into the alarm system if someone is forcing the owner to disarm the system. This code will normally trigger a silent alarm to the automatic dialer.

4

1. Yes. All fire-protection loops on all alarm systems provide 24-hour protection.

2. The instant function allows for instant arming of the entire system after a preset exit delay has timed out.
3. An alarm system will require an electric service, phone service, and service entrance ground.

5

1. A default value is a value placed in memory by the manufacturer.
2. A PROM is a form of integrated-circuit memory device that can be preprogrammed with the system information.

6

1. A dummy camera doesn't have an internal camera tube or electronic circuit board. However, it appears to be a real camera.
2. Labels and stickers should be applied to the entry/exit doors, large areas of glass, and other areas where the public can see them.

7

1. By purchasing a few of the components and testing them at home
2. Through customer contacts as a result of your advertisements

Electronic Security Systems

EXAMINATION NUMBER:

03101200

Whichever method you use in submitting your exam answers to the school, you must use the number above.

**For the quickest test results, go to
<http://www.takeexamsonline.com>**

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. Which one of the following interior sensors is a passive sensor?

- A. Microwave
- B. Ultrasonic
- C. Photoelectric
- D. Infrared

2. What function of an alarm system maintains the perimeter loops as armed but eliminates all interior loops?

- A. Manual bypass
- B. Interior
- C. Day zone
- D. Instant

3. Approximately how many burglars are caught in the act each year due to burglar and fire alarms?
- A. 20,000
B. 25,000
C. 30,000
D. 10,000
4. A glass-shock sensor doesn't require power to operate. It will generate its own power when the glass is broken due to the use of
- A. a charging strip and capacitor.
B. a weighted contact and battery.
C. internal static charged elements.
D. a piezoelectric element.
5. How is a remote-point module connected to a typical alarm system?
- A. A two-wire polling loop
B. A four-wire polling loop
C. A UHF transmitter
D. A microwave transmitter
6. Which of the following statements about the Americans with Disabilities Act (ADA) is correct?
- A. The ADA has no effect on the way alarm installers do their jobs.
B. The ADA requires the use of brighter and louder alarm system components in buildings.
C. The ADA applies only to home alarm systems, not the systems in public buildings.
D. The ADA provides no specific guidelines for the installation of alarm systems.
7. What type of perimeter switch or sensor can be used at the top of a double-hung window?
- A. In-line magnetic contact
B. Ultrasonic sensor
C. Microwave sensor
D. PIR
8. A number that's present in the system parameters when the system is first powered up is a
- A. starting number.
B. default number.
C. zone number.
D. original number.
9. What is the typical frequency of an ultrasonic sensor?
- A. 20,000 Hz
B. 25,000 Hz
C. 30,000 Hz
D. 45,000 Hz

10. What is the typical pulse rate of an infrared photoelectric beam?
- A. 5,000 Hz
 - B. 10,000 Hz**
 - C. 20,000 Hz
 - D. 30,000 Hz
11. How is the air in an ionization-type smoke detector charged?
- A. By a high-voltage source
 - B. By a battery supply source
 - C. By an AC supply source
 - D. By a radioactive source**
12. What is the purpose of the end-of-line relay in a smoke- and heat-detector circuit?
- A. To properly power the smoke detector independent of the heat detector
 - B. To monitor the loop for an open circuit
 - C. To monitor the power circuit for an open or shorted circuit**
 - D. To act as a test device during installation
13. What is the red wire in a telephone hookup to an alarm system used for?
- A. Telephone company ring**
 - B. Telephone company tip
 - C. Home ring
 - D. Home tip
14. At least how many dBa over the natural sound level should an alarm be?
- A. 50 dBa
 - B. 80 dBa
 - C. 10 dBa
 - D. 15 dBa**
15. What is the typical minimum height above the floor to mount a PIR?
- A. 5 feet
 - B. 6 feet
 - C. 7 feet**
 - D. 8 feet
16. What type of switch or sensor is normally used to protect computers, stereos, television sets, boats, and trailers?
- A. Plunger switch
 - B. Roller switch
 - C. Pull-apart cord**
 - D. PIR
17. Which one of the following loops or zones can't be bypassed through user programming?
- A. Fire**
 - B. Perimeter, dial delay
 - C. Interior, chime
 - D. Interior, dial delay
18. Which one of the following alarm system functions can be used if the alarm system has its own time-of-day clock?
- A. Auto bypass
 - B. Auto arm/disarm**
 - C. Auto unbypass
 - D. Auto reset

19. What type of device can be used to perfectly mount, align, and mark a PIR sensor?

- A. Sonic transmitter
- B. Dual-purpose LED
- C. Alignment mask
- D. Alignment mirror

20. What is the most important reason to have insurance as an alarm installer?

- A. To protect against damage during alarm installation
- B. To protect against damage by vandals or burglars in the home you are working on
- C. To protect against the liability that results from a lawsuit if the system you installed doesn't keep a home or business from being burglarized
- D. To protect against a lawsuit caused by damage from the alarm system

COMING ATTRACTIONS

This study unit contains the last of the technical locksmithing information we'll be covering in the course. Now that you've learned so many of the important skills a locksmith must know, it's time to discuss the business side of the profession. The next study unit, *Starting a Small Business*, contains a wealth of useful information about starting a locksmithing business. You'll learn how to finance a new business, how to find a good location, how to determine what business equipment and supplies you'll need to get started, and how to hire employees. In addition, we'll discuss the importance of creating a business plan, establishing a business identity, and keeping business records. Good luck with your continuing studies—you've almost reached the end of the course!

Professional Locksmith

Study Unit 13

Starting a Small Business

Preview

Welcome to Study Unit 13 of your Professional Locksmith course! You've now completed all the study units that deal with the actual techniques and skills of locksmithing. You should have all the technical skills you need to feel qualified to pursue your chosen career as a locksmith.

The next step to starting your career is determining where you want to work. To help you make this choice, Study Units 13 and 14 will provide you with a wealth of information on career possibilities. First, this study unit will show you how to go about starting your own small locksmithing business. Then, Study Unit 14 will continue with information on finding locksmithing jobs and on working in the professional locksmithing field.

When you complete this study unit, you'll be able to

- List several reasons why small businesses fail and how to avoid them
- Name several sources of information and training available for new business owners
- Prepare a written business plan for your locksmithing business
- List several possible sources of financing for your business
- Explain the importance of accessibility for a business location
- Describe the procedures you can use to assess your competition
- List several ways to establish a business identity
- Name the essential equipment you'll need when first opening your shop
- Explain the steps to take in hiring employees
- List and explain the various types of business records and financial statements

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Starting a Small Business

Do You Know . . .

What government agency can help you in starting a small business?

What is a *business plan*?

What are *start-up capital* and *working capital*?

In this study unit, you'll find the answers to these and many more questions about starting your own business.

INTRODUCTION

The First Steps

At some point in every locksmith's career, the question "Should I start my own business?" inevitably arises. Many locksmiths decide that they derive sufficient career satisfaction working for someone else. They have no desire to take on the risk of business ownership, with its added administrative demands and financial concerns. The status and independence that come from operating one's own business just aren't tempting enough to pull them in that direction.

However, there are many locksmiths who like the idea of banking the profits from a business instead of receiving a fixed hourly wage. If you're one of these professionals, read on! The information you need to open your own business is now at your fingertips. Even if you're not interested in opening your own business, the following information can help you further your career in someone else's shop.

The first thing you should know about opening your own business is that you don't necessarily have to open a commercial space to be successful. You can operate a business on a

part-time or full-time basis right from your own home. If you choose to make your debut in business this way, your first clients may be friends, relatives, and neighbors. If you provide good service, your business will grow through word-of-mouth referrals. You may even choose to advertise by passing out flyers at your local churches, schools, and businesses (always obtain permission from the proper authorities beforehand) or by placing ads in the classified section of your local newspaper. As your number of clients grows, you can expand as you desire.

Of course, you might wish to start out in a commercial space. Many people have successfully done so. However, there are some serious issues you must explore before actually taking this plunge. This study unit is here to help you examine some of the key issues involved in opening and operating a locksmithing business.

Are You Ready for Your Own Business?

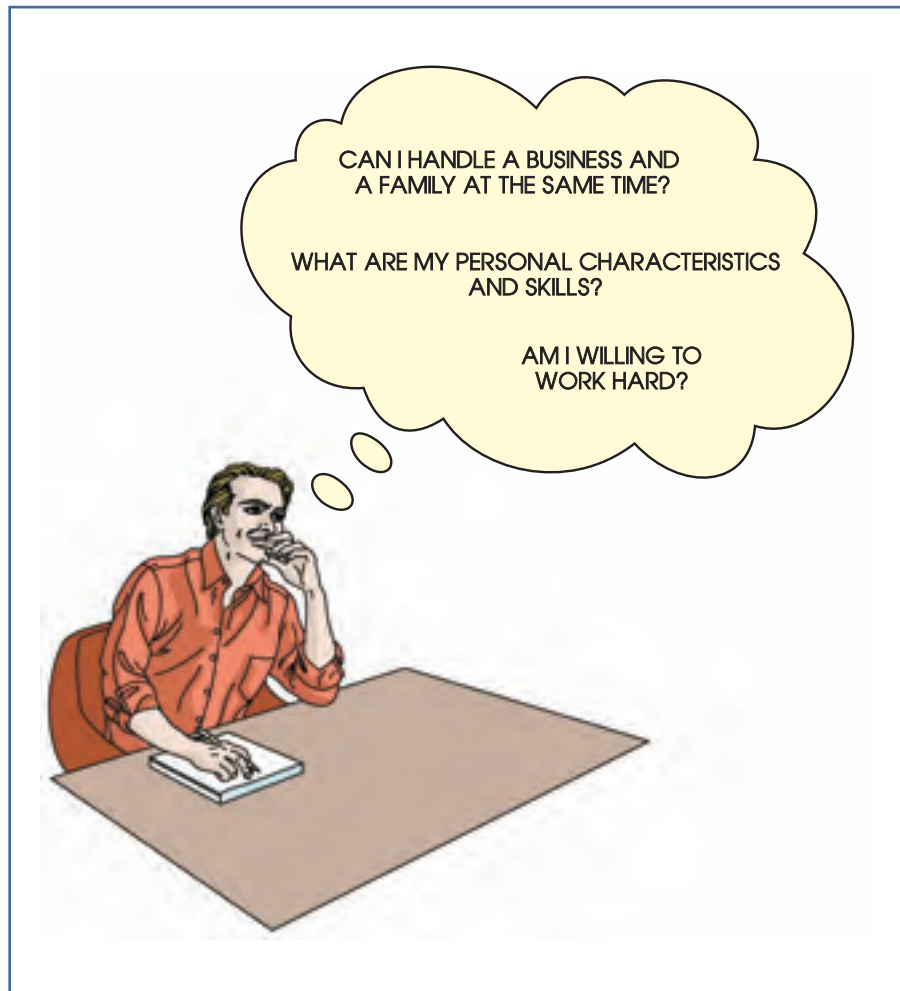
Starting your own business will make tremendous demands on you as an individual. From the outset, you should be aware that many small businesses fail within the first three years of operation. You must be committed to work hard to be a success.

If you have a family and all the responsibilities that go along with a family, are you ready to take on the added responsibilities of a new business as well? To help you make this decision, begin by asking yourself the following questions (Figure 1):

- Am I willing to work hard?
- If I operate the business alone, do I have the physical stamina and emotional strength to give sufficient time to both my family and the business?
- Can I temporarily lower my standard of living until my business is firmly established?
- Is my family prepared to withstand the emotional and financial strains of getting the business started?
- Am I (and my family) prepared to risk my savings?

Did you answer “yes” to these questions? Good! That’s the first step. There are many other issues you must take into

FIGURE 1—Are you ready to start your own business?



account, however. Let's start by looking at some kinds of business training you may be interested in.

Getting Training

Expertise and *experience* are two of the most important elements of a successful business formula. If you don't have experience in running a business, there are several ways that you can get training, help, and advice.

First of all, even though this course provides your initial training in locksmithing, you might want to consider spending some time working with an experienced locksmith before striking out on your own. Doing so will help you obtain practical experience in the everyday workings of a locksmith shop. You may have already acquired experience by working for someone else.

FIGURE 2—A small business management course can be helpful to those just starting out in the business world.



If you've ever taken a business course, you already have some idea of what is involved in record keeping, inventory management, and accounting procedures. If you don't have a business

background, you might consider taking a small business management course or seminar offered at a local community college (Figure 2).

The *Small Business Administration (SBA)* offers business courses through its *Small Business Institute* and *Small Business Development Centers*, often in conjunction with local community colleges. These courses are available in most areas, not just in large cities. The SBA also provides more than 100 publications—at nominal prices—for small business owners. To obtain a free copy of "Management Assistance Publications" (SBA 115-A), which lists the available SBA publications, contact your nearest SBA office. Look in the telephone book under U.S. Government or write to

SBA Publications
P.O. Box 30
Denver, CO 80201-0030

Another way to get help in starting a business is to use the services of a business advisor, such as a financial consultant or accountant. Again the SBA can help in this area. It sponsors the *Service Corps of Retired Executives (SCORE)*, a group of former business executives who can answer specific questions about starting your business. Each SCORE client is matched with a business retiree who has expertise or knowledge in specific areas. Your district SBA office can give you the address and telephone number of the nearest SCORE office. All services provided by SCORE are free of charge. All SCORE advisors are volunteers and receive no pay for their services.

Finally, you may prefer to team up with a businessperson who has the training you lack and open your business as a partnership. The choice is up to you!

Getting Off to a Great Start

The locksmithing business can be lucrative, but success will depend on you. It isn't enough to be a great locksmith; you must also have business sense and wise spending practices. Success also depends on how you promote your business through marketing and advertising and how well you manage the daily operations of the business.

Good management makes things happen. It controls and directs people and events. Good managers have common sense and the ability to make (and stick with) decisions. They're willing to work hard.

If all goes well, you can expect to see your initial investment come back in about five years. Your own expertise and creative skills will play a part in the eventual success of your business. There's no getting away from the fact that some businesses fail. However, if you're aware of why some businesses succeed and others fail, you'll be more likely to succeed yourself. The following is a list of reasons why some small businesses fail:

- Lack of business plan and goals
- Insufficient financing and cash reserves
- Inadequate skills and training of management and employees
- Inadequate public relations and marketing efforts
- Inadequate record keeping
- Lack of creativity
- Insufficient attention to quality control

In spite of all that's been said about the possibility of failure, a locksmithing business has more chance of success than many other types of business. Start-up and overhead costs can be kept as minimal as you like. Also, locksmithing is more recession-proof than other businesses. Your service is a part of daily life, not a luxury. Customers will always need your skills.

If you know your job, price your services fairly, and operate your business in an honest, responsible, and legal manner, there's virtually no reason why you can't succeed and make good money while doing it.

MANAGEMENT CHECKLIST FOR A SMALL BUSINESS OWNER		
Yes	No	
___	___	Does your service supply an unfilled need or serve an existing market in which demand exceeds supply?
___	___	Is your service competitive in relation to quality, price, special services offered, promptness of service, and area served?
___	___	Do you understand your customer's needs and desires?
___	___	Are your advertising and promotional programs effective?
___	___	Are you aware of federal, state, provincial, and local laws and regulations that relate to your business, and do you obey them?
___	___	Do you have adequate insurance coverage and/or bonding for your needs?
___	___	Do you maintain complete and accurate records of fees, subcontractors' services and payments, accounts and taxes payable, and expenses?
___	___	Do you submit employees' tax withholdings and your own employee taxes (FICA, FUTA) on a timely basis?
___	___	Do you have sufficient capital for operating expenses and expansion needs?
___	___	Do you prepare budgets, cash flow projections, and profit and loss projections?
___	___	Has your business maintained a good credit rating so that expansion funds will be readily available when needed?
___	___	Do you update your business plan and goals on a regular basis?
___	___	Do you review your operations on a regular basis to ensure quality service, to evaluate the performance of employees and subcontractors, to reduce excessive expenses, and to change outmoded or wasteful business practices?
___	___	Do you utilize your accountant, attorney, and other business professionals when they're needed in order to avoid future problems?
___	___	Have you established hiring and firing practices that will ensure fairness to all applicants and employees?
___	___	Do you provide ample opportunity for employee growth and promotion?
___	___	Do you spend too much time and money on hiring and training new employees without seeing any benefits from your efforts?

FIGURE 3—Business Management Checklist

Figure 3 contains a management checklist that has been tailored for a locksmithing business. If you do decide to open your own business, you should regularly fill out such a checklist to be sure that your business goals are being reached.

Now, let's take a moment to look at your goals and how to achieve them. One of the best ways to examine your business goals is by developing a formal *business plan*.

DEVELOPING A BUSINESS PLAN

Planning and Setting Goals

Planning is the most important stage of any project. Before you get started in business, therefore, it's important to have a "game plan" that describes your ambitions and goals for your business. This game plan should be flexible so that it can change as conditions change. By adopting and sticking to a plan, you can control (as much as possible) the destiny of your business. In other words, you'll run the business; it won't run you.

Your *goals* are your expectations of what your business will do for you. Your goals should be realistic, and you should establish both long-term and short-term goals for yourself. For example, your long-term goal may be to get the business up and running. To accomplish this, you may need to establish a number of short-term goals, such as finding a location, getting a loan, and hiring employees.

Contents of a Business Plan

If you're seriously thinking about starting a commercial business, you should start by drawing up a business plan to clearly identify your business goals. A *business plan* is a written document that describes all areas of your small business. In your business plan, you'll identify what you're selling, where you're selling, and who you're selling to. A good business plan is a blueprint for success. It shows where you intend to go with your business and how much money it will take to get you off to a successful start.

In this next section of the text, we'll briefly consider the contents of a business plan. The major topics in a business plan include the following:

1. The mission of your business
2. The structure of your business
3. A marketing analysis, including any information you have about your competition

4. A description of the daily operation and management of the business
5. Your financial projections for the business

Mission of Your Business

Your business plan should begin with the *mission* (the purpose) of your business as you envision it. Why will your business be needed? What services will you offer and why are they important to the public? What will be the scope of the business (local, county, state, national)? Are you starting a new business or are you taking over an existing one? If you're taking over an existing business, describe its present strengths, your plans to improve the business, and any problems you must overcome.

Next, give some information about yourself that will help others understand you better. Explain why you want to start your own business and what you feel you can offer the public. Include any education or experience you've had that's applicable to the business. Also, include any innovative ideas you have to make your service unique or desirable.

Structure of Your Business



FIGURE 4—In a sole proprietorship, the business is owned and operated by one person.

In the second section of the business plan, define the way in which your business will be structured. There are three major business structures:

Sole proprietorship. The sole proprietorship is the most common form of business ownership. A sole proprietorship is a business that's owned and operated by only one person (Figure 4). The owner receives

all the business's income and maintains sole control of the business. The virtue of a sole proprietorship lies in its simplicity. In a sole proprietorship, you're literally your own boss. However, the main disadvantage of a sole proprietorship is that the owner is responsible for all the business's debts, including all financial and legal claims made against the business. Another disadvantage of a sole proprietorship is that it's more difficult for one person alone to raise funds for business expansion.

FIGURE 5—In a partnership, two or more people share the responsibility of running a business.



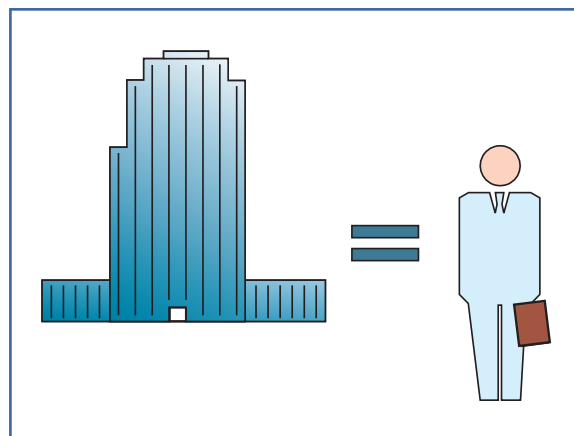
Partnership. In a partnership, two or more people co-own and operate a business (Figure 5). The partners combine their capital, labor, skills, and experience in conducting the business. The partners share both the

income and debts of the business, and are equally responsible for any legal claims against the business. Thus, all the partners are responsible for the mistakes of one. If you choose to form a partnership, choose your partners carefully and make sure a lawyer draws up a detailed partnership agreement defining the rights and obligations of each partner.

Corporation. A corporation is a complex business structure that may have one or many owners. To make a business into a corporation, the owner or owners must file Articles of Incorporation with state authorities. Under the law, a corporation is considered to be a “person” (Figure 6). As such, a corporation can

make contracts, pay taxes, and sell stock to the public. Creditors can only be paid with the corporation's money (not with the personal money of the owners). The principal advantage of a corporation is limited

FIGURE 6—A corporation is a business structure that's considered to be a “person” under the law.



liability. That is, the corporation only, and not the owners or stockholders, is responsible for debts or claims against the business.

Marketing Analysis

Once you've described your purpose and business structure, the next topic you should address is the way you intend to market your business. A *marketing analysis* is an explanation of how you'll go about the actual selling of your goods and services. Describe the geographical area you'll do business in, your potential customers, the types of services you'll offer, and your fees.

In addition, any information that you may have about your competitors should be included here. What do your competitors offer? How do you intend to deal with your competition? How will you advertise? How will you draw yourself to the attention of potential customers? Include a description of your advertising plans, public relations efforts, and any plans to participate in trade shows or fairs.

Daily Operations and Management

In this section of your business plan, include a detailed description of your operating and management plans for the business. Include the following information:

- Number of employees you plan to hire, if any
- A detailed list of job descriptions that includes employee duties and responsibilities
- Procedures for using, hiring, and paying subcontractors
- Your methods for dealing with clients
- Accounting procedures, including an indication of whether you plan to employ an outside accountant
- Maintenance procedures for financial and personnel records
- Procedures for paying taxes
- How you'll maintain quality services
- How complaints will be handled

Financial Projections

In this section of your business plan, include realistic estimates of your projected income and expenses for the next three to five years. You should include estimates of your start-up capital needs, projected profit and loss, cash flow, and return on investment. Let's look at each of these estimates in more detail.

Start-up capital. Start-up capital is the amount of money you'll need to get your business's doors open.

Projected profit or loss. To project your profit (or loss) for the first year of your new business, subtract your total expenses (the money needed to operate your business daily) from your estimated total income.

Calculate your total expenses by adding your *fixed expenses* and your *variable expenses*. Fixed expenses are those expenses that don't change from month to month, such as rent, mortgage payments, loan payments, property taxes, and insurance. Variable expenses change each month according to the volume of business you do. Variable expenses include materials, labor, and advertising.

To calculate your total income, estimate the amount of money you expect to earn each month, based on the fees you intend to charge.

Once you've calculated your total income and your total expenses, simply subtract expenses from income; the result is your total profit or loss. If you earned more money than you spent, the amount is your profit. If you spent more than you earned, the amount is your loss. Figure 7 contains a worksheet for calculating your projected business profit or loss for a three-month period.

Cash flow projection. A cash flow projection is an estimate of how much cash will be available during a particular period. If your bills become greater than the amount of cash coming in, you'll need to rethink your capital needs or your anticipated market approach, or both. Figure 8 contains a worksheet for calculating your projected cash flow for a three-month period.

Return on investment. Your return on investment, or ROI, is the amount of profit you'll make from your initial investment. Calculating your ROI for a given time period isn't difficult. Simply divide your net profits (profits before taxes) by

PROJECTED PROFIT AND LOSS STATEMENT (For Three Months)				
	Month 1	Month 2	Month 3	Total
1. ESTIMATED TOTAL INCOME	\$ _____	\$ _____	\$ _____	\$ _____
2. FIXED EXPENSES				
a. Depreciation	\$ _____	\$ _____	\$ _____	\$ _____
b. Mortgage or rent	_____	_____	_____	_____
c. Insurance	_____	_____	_____	_____
d. Taxes and permits	_____	_____	_____	_____
e. Loan payments	_____	_____	_____	_____
3. TOTAL FIXED EXPENSES (add lines 2a–e)	\$ _____	\$ _____	\$ _____	\$ _____
4. VARIABLE EXPENSES				
a. Salaries	\$ _____	\$ _____	\$ _____	\$ _____
b. Payroll taxes	_____	_____	_____	_____
c. Utilities	_____	_____	_____	_____
d. Maintenance	_____	_____	_____	_____
e. Travel expenses	_____	_____	_____	_____
f. Professional fees	_____	_____	_____	_____
g. Equipment and supplies	_____	_____	_____	_____
h. Advertising	_____	_____	_____	_____
i. Miscellaneous	_____	_____	_____	_____
j. Subcontractors' fees, if applicable	_____	_____	_____	_____
5. TOTAL VARIABLE EXPENSES (add lines 4a–j)	\$ _____	\$ _____	\$ _____	\$ _____
6. TOTAL EXPENSES (add lines 3 and 5)	\$ _____	\$ _____	\$ _____	\$ _____
7. NET PROFIT OR LOSS (before taxes) (subtract line 6 from line 1)	\$ _____	\$ _____	\$ _____	\$ _____

FIGURE 7—Worksheet for Calculating Profit and Loss

your net worth at the end of the given period. ROI is expressed as a percent.

For example, if your net profit before taxes is \$10,000 and your net worth is \$40,000, calculate ROI as follows:

$$\frac{\text{Net profit}}{\text{Net worth}} = \frac{\$10,000}{\$40,000} = .25 = 25\%$$

PROJECTED CASH FLOW (For Three Months)				
	At Start-Up	Month 1	Month 2	Month 3
1. CASH (beginning of month)				
a. Cash on hand	\$ _____	\$ _____	\$ _____	\$ _____
b. Cash in bank	_____	_____	_____	_____
c. Investments	_____	_____	_____	_____
2. TOTAL CASH (add lines 1a–c)	\$ _____	\$ _____	\$ _____	\$ _____
3. INCOME (during month)				
a. Fees	\$ _____	\$ _____	\$ _____	\$ _____
b. Credit card payments	_____	_____	_____	_____
c. Investment income	_____	_____	_____	_____
d. Other cash income	_____	_____	_____	_____
4. TOTAL INCOME (add lines 3a–d)	\$ _____	\$ _____	\$ _____	\$ _____
5. TOTAL CASH AND INCOME (add lines 2 and 4)	\$ _____	\$ _____	\$ _____	\$ _____
6. EXPENSES (during month)				
a. Salary for owner(s)	\$ _____	\$ _____	\$ _____	\$ _____
b. Wages for employee(s)	_____	_____	_____	_____
c. Subcontractors' fees	_____	_____	_____	_____
d. Taxes	_____	_____	_____	_____
e. Travel expenses	_____	_____	_____	_____
f. Utilities and maintenance	_____	_____	_____	_____
g. Advertising	_____	_____	_____	_____
h. Loan repayment	_____	_____	_____	_____
i. Other cash expenses	_____	_____	_____	_____
7. TOTAL EXPENSES (add lines 6a–i)	\$ _____	\$ _____	\$ _____	\$ _____
8. CASH FLOW EXCESS (DEFICIT) (subtract line 7 from line 5)	\$ _____	\$ _____	\$ _____	\$ _____
9. CASH FLOW CUMULATIVE (monthly)	\$ _____	\$ _____	\$ _____	\$ _____

FIGURE 8—Worksheet for Calculating Projected Cash Flow

Thus, in this example, you've earned a 25 percent return on your investment for the period. Always ask yourself: Are my profits from this business greater than the profit I could make through some other type of investment (stocks, bonds, or certificates of deposit)? If you could be making a lot more

money elsewhere, you may want to reconsider your business goals.

Writing Your Business Plan

A good way to begin getting your business plan down on paper is to make a rough draft first. Divide a notebook into sections, and label each one according to the categories we've listed above. Then, start jotting down your ideas as they come to mind in each of the categories. Later, you can go back over the plan, making changes and refinements until the plan is in a final form. You may want to have the plan professionally prepared by a typing service into a formal document. Then later, when you go to a bank to apply for a loan, you can present the loan officer with your formal business plan, which will no

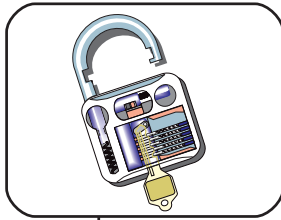
FIGURE 9—You can present your formal, written business plan to a loan officer when applying for a bank loan.



doubt make an excellent impression (Figure 9).

Well, this completes our discussion of business plans. As you can see, creating a good business plan requires time, thought, and research, but it will be worth your time in the long run.

Now, in the next section of the text, we'll discuss getting financing for your business.



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

Indicate whether each of the following statements is True or False.

- _____ 1. Expertise and training are unimportant in starting a business if you have enough start-up capital.
- _____ 2. The Service Corps of Retired Executives is a group of accountants who provide free tax preparation services to small business owners.
- _____ 3. Many small businesses fail within the first three years of operation.
- _____ 4. In a sole proprietorship, two or more people co-own and operate a business.
- _____ 5. Start-up capital is the amount of money you'll need to get your business's doors open.
- _____ 6. Variable expenses are business expenses that don't change from month to month.
- _____ 7. A cash-flow projection is an estimate of how much cash will be available to you during a particular period.
- _____ 8. Rent, mortgage payments, loan payments, and insurance are examples of fixed expenses.

Check your answers with those on page 71.

FINANCING YOUR BUSINESS

Determining How Much You'll Need

Different types of businesses require varying amounts of capital (money) to get started. A new business needs capital to buy or rent facilities and equipment, purchase inventory, and run the business until its income grows enough to support its operations. Some new business owners save until they have enough money to open their business venture themselves. However, most new retail businesses need more capital than the owner has available. When this is the case, capital can be obtained through loans.

The first step in obtaining a loan is determining how much money you need. To do this, ask yourself the following questions:

1. How much money do I need to open the business?
2. How much money do I need to stay in business until I earn a profit?
3. How much money do I have?

Figure 10 contains a worksheet that you can fill out to determine how much money you'll need to get your business going.

Start-Up Capital and Working Capital

To start your own business, you need two types of funds: *start-up capital* and *working capital*. We mentioned start-up capital earlier in the text. This is the money that gets your business's doors open, including the money for major equipment (key machines, delivery vans, computers, phone systems, and so on) and supplies. Start-up capital is also used to pay insurance premiums, license fees, and any business-related legal fees you have at the start. The money needed to operate your business every day is called working capital, or *overhead*. This includes money for monthly rent, utilities, employee salaries, and so on.

As a business owner, keep in mind that unless you have some other source of income besides the business, you'll need capital for your living expenses until the business becomes profitable enough for you to draw a salary. Once your shop is

FIGURE 10—Worksheet for Calculating Start-up Capital for a Locksmithing Business

START-UP COSTS	
Worksheet for a Locksmithing Business	
Shop space (down payment for purchase or lease deposit, plus initial rent payment)	\$ _____
Fixture installations, remodeling, redecorating	_____
Utilities (heat, water, electricity, telephone), including deposits and installation fees	_____
Professional services (attorney, accountant, consultant)	_____
Equipment and supplies	_____
Field equipment, including truck or van	_____
Insurance premiums	_____
Business permits and state license, if needed	_____
Local and state taxes, if required	_____
Travel expenses	_____
Advertising and promotional materials	_____
Miscellaneous	_____
Total start-up funds	_____
(Less) Cash reserve	_____
TOTAL START-UP FUNDS TO BORROW	\$ _____

completely operational, your business should have enough money to

- Cover the business's expenses
- Meet your personal living expenses
- Maintain a reserve fund (for unforeseen emergencies)

One mistake new business owners often make is underestimating the amount of working capital they'll need to keep their business in operation. One way to avoid this mistake is to include a *contingency fund* in your estimate. An extra 10–20 percent of your total loan request is considered reasonable.

For a new service business, you should plan to borrow enough money to cover the business operation for at least three months. If you practice sound management, you can probably expect to reach the *breakeven point* within these three months. The breakeven point is the point at which business income equals business expenses.

Extra Expenses

It's no secret that starting a business requires a major financial investment. As with any business, you're bound to run across some hidden costs. Be realistic when apportioning money for expenses, since wise planning and ample capital will give you a far better chance for success. Costs that a new business owner sometimes overlooks include

- Printing costs for such necessities as business cards, invoices, and flyers (Figure 11)



FIGURE 11—New business owners frequently overlook the costs of printing and advertising.

- Advertising costs, whether you advertise in newspapers, the yellow pages, on radio, on television, or through direct mail pieces
- Professional fees (accountants, lawyers, etc.)
- Utilities, garbage disposal, and other similar costs

Getting Your Loan

Getting a loan is an art. And, as with other arts, getting a loan requires a considerable amount of discipline and preparation. Knowing what your bank or other lending institution requires for a loan makes the process easier. Before granting you a loan for start-up expenses, your lender will require you to provide a detailed business plan to demonstrate that you're prepared to spend the money wisely. Loan requests are always denied when a business owner fails to provide a reasonable plan for success—and for paying back the loan. If you want to borrow money, you must know exactly how much you need, why you need it, and how you plan to pay it back. You also must prove that you're a good credit risk (Figure 12).

Before you actually apply for a loan, consider the following important tips:

1. Begin your preparation for financing before you actually need the money. Lenders will need time to study your loan application and approve the loan. It often takes quite a while for money to actually be handed over to you.

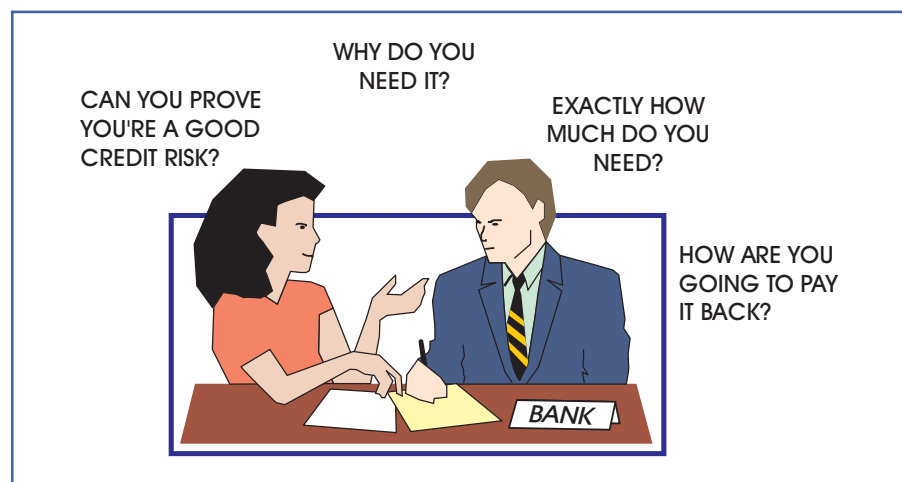


FIGURE 12—When you approach a bank for a loan, you must be prepared to answer numerous questions.

2. Whenever possible, establish and maintain cordial relations with loan officers from local lending institutions. This should be done long before you ever ask for a loan. The better the loan officer knows you and understands your proposed business, the greater the possibility you'll have of obtaining favorable loan terms. (Keep in mind, however, that although a personal relationship with a loan officer is helpful, you should always shop around to see if other lenders are offering better terms.)

The SBA recommends that a loan proposal contain the following key elements:

- General information—business name and address; names, Social Security numbers, and addresses of principals; purpose and amount of loan request; amount and percent of ownership equity available
- Business description—history, nature, structure, assets, number of employees
- Management profile—short statement of background, education, experience, skills, and accomplishments of each principal
- Market information—complete definition of your service and market, analysis of your competition and your niche in the market, and description of your clients and how your business meets (or will meet) their needs
- Financial information—for a new business: projected balance sheet and projected profit and loss statement; for an established business: balance sheet and income statement for past three years; for both new and established businesses: personal financial statement for each principal with 20 percent or more ownership in the business and a list of all collateral to be pledged as security for the loan

In addition to these key elements, a number of documents must also be submitted with your loan proposal. They are

- A complete business plan that includes an explanation of how the loan proceeds will be used
- A resume of the applicant's education and work experience, with emphasis on particular experience in the relevant field

(required for each general partner and corporate officer, as applicable)

- A personal financial statement for each applicant that shows net worth, plus income tax statements for at least the preceding two years. Your personal financial statement indicates your total net worth. Make separate lists of all your personal assets and liabilities. Personal assets include everything you own that has a monetary value, such as a home, other real estate, cars, life insurance, bank accounts, stocks and bonds, and jewelry, art, or other valuable possessions. Figure 13 contains a worksheet to help

PERSONAL FINANCIAL STATEMENT	
as of ____ (date) ____	
ASSETS	
Cash (including checking accounts)	\$ _____
Savings accounts and certificates of deposit	_____
Stocks, bonds, and other securities	_____
Accounts and notes receivable	_____
Life insurance (cash value)	_____
Motor vehicles (current value)	_____
Real estate	_____
Vested pension plans and retirement accounts	_____
Jewelry, art, or other valuables	_____
TOTAL ASSETS	\$ _____
LIABILITIES	
Accounts payable	\$ _____
Notes payable	_____
Mortgages and equity loans payable	_____
Contracts payable	_____
Taxes payable	_____
Other liabilities	_____
TOTAL LIABILITIES	\$ _____
NET WORTH (total assets less total liabilities)	\$ _____

Source: Adapted from Small Business Administration "Checklist for Going into Business," 1988

FIGURE 13—Worksheet for Calculating a Personal Financial Statement

you compile a personal financial statement. *Liabilities* include outstanding medical bills, bank loans, mortgages, taxes owed, outstanding contract payments, and all other moneys owed to individuals, organizations, or government agencies. To determine net worth, subtract the total liabilities from the total assets.

- Start-up expenses and an equipment list
- Copies of the lease agreement and insurance policies
- Credit references for each applicant
- Personal budgets for the first three months of business (if requested)

Where to Get Loans

Loans can come from many sources (Figure 14). Here are some you might consider for your business:

- Banks and credit unions (the most common sources of funds for small businesses)
- Personal savings
- Assets (possessions) that you can easily convert into cash
- Friends and relatives, some of whom may be willing to lend you money at no interest or at less interest than you would pay at a bank
- Private investors, persons other than family members who are willing to loan capital at a lower interest rate than a bank, or who may accept a share of the business instead of a payback
- Partners, persons who contribute funds and participate in the business's daily operation
- Financial institutions including savings and loan associations, commercial loan companies, consumer finance companies, and life insurance companies (*Note:* Some of these institutions will have higher interest rates than banks or credit unions.)

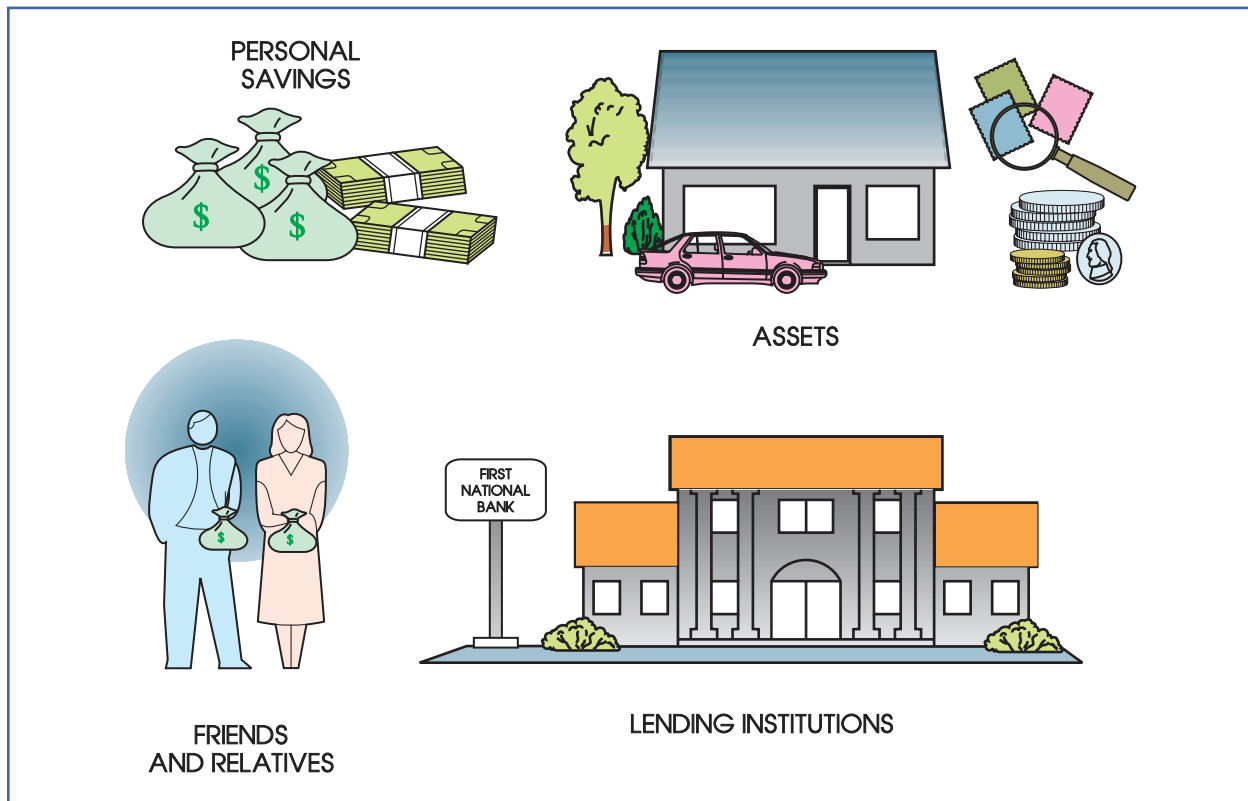


FIGURE 14—Any of these sources may provide you with the funds you need to start a business.

- Venture capital firms, which provide start-up and operating funds for companies in exchange for equity or part ownership
- Regional and local business development corporations
- The Small Business Administration, either by a direct loan or by guaranteeing a bank loan (within specified limits). The SBA will consider your business for a direct loan only after you've been turned down by one or two commercial lenders. You must also satisfy certain other requirements, including good character and demonstrated business ability.

If you do borrow money, be sure to make your loan payments on time. If you can, occasionally make an extra payment on your loan. This will help you establish a good credit rating and cement your relationship with your bank. If for some reason you can't make a loan payment on time or you run into other financial trouble, your banker should be the first to know. Make an appointment with the banker to discuss the problem. Bankers are usually willing to work

with established customers to solve their problems or help with a tough situation.

At the beginning of the loan process, it would be a good idea to seek the advice of an accountant or an attorney. These professionals can provide you with guidance throughout the process of getting your loan. In the next section of the text, we'll discuss how to hire the services of professionals such as attorneys, accountants, and insurance agents. The advice of these professionals will be invaluable to you in the day-to-day running of your shop.

PROFESSIONAL SERVICES

Getting Professional Advice



FIGURE 15—Seek professional advice before making any major business moves.

The old adage “an ounce of prevention is worth a pound of cure” applies very well to the hiring of professionals at the start of your business. For example, a small amount spent up front to hire an attorney or a professional accountant could save you thousands of dollars

later on. Always get professional advice and assistance before you make any serious moves or changes in your business (Figure 15).

Here are some general guidelines for securing the services of any professional:

1. Make contact with the professional several months before your business start-up date. In this way, you can obtain

any information you need to write your business plan and organize your business operation ahead of time.

2. Don't just hire any attorney or other professional. Shop around until you find one that's familiar with the locksmithing industry.
3. Be sure the professional is someone you can work with and trust.
4. If you don't know anyone in a profession that you need, ask your friends or business acquaintances for leads, or check with referral services or local chapters of professional associations such as the American Bar Association or the Association of Certified Public Accountants.
5. Be sure to agree upon a fee before your first chargeable visit with any professional.

Accountant

No matter what your business size or structure, an accountant can help you set up a bookkeeping system for you to follow daily, to control cash flow, and to establish a secure system for handling funds. An accountant's services can be invaluable not only in establishing your business, but also on an ongoing basis.

For example, every business that shows a profit must pay federal income taxes, in addition to state, provincial, or local income taxes. Employers are responsible for submitting withholding taxes collected from the employees and the employer's share of Social Security (FICA) taxes. It must also pay federal unemployment taxes (FUTA) on a certain percent of each employee's wages. In addition, in most jurisdictions you'll be required to obtain authorization to collect taxes before you open your doors for business. In some places, this authorization is called a *seller's permit*.

As you may know from filing your own personal federal income tax forms, the federal income tax laws are complex and constantly changing. If you begin your own business, you'll be responsible for paying all applicable taxes in an appropriate and timely manner. If you don't, you may be held liable for

CALENDAR OF FEDERAL TAX FORMS		
Date Due	Form	Sent To
January 31	W-2 (Annual Wage and Tax Statement)	IRS
January 31	940 (Employer's Annual Federal Unemployment Tax Return)	IRS
February 28	W-3 (Income and Tax Statement)	Social Security Administration
March 15	1120 (Corporation Income Tax Return)	IRS
March 15	1120S (Small Business Corporation Income Tax Return)	IRS
April 15	1040 (Individual Income Tax Return)	IRS
April 15	1040SE (Computation of Social Security Self-Employment Tax)	IRS
April 15	1065 (Partnership Income Tax Return)	IRS
At time of employment	W-4 (Employee's Withholding Allowance Certificate)	Company file
End of month after close of any quarter	8109 (Coupon booklet for quarterly deposit)	Company's bank account
End of month after close of any quarter	941 (Employer's Quarterly Federal Tax Return)	IRS
15th day of months 4, 6, 9, and 1	1040ES (Estimate Income Tax for Individuals)	IRS

FIGURE 16—Schedule of Dates for Submitting Necessary Federal Income Tax Forms

penalties and interest. For this reason alone, it's to your advantage to employ the services of an accountant.

Figure 16 contains a calendar listing the dates for submitting important tax documents to the federal government.

Insurance Agent or Broker

In a perfect world, insurance wouldn't be necessary. However, our world is hardly perfect and unfortunate incidents do occur. People injure themselves, fires destroy merchandise and buildings, vandals break windows and destroy property, thieves steal merchandise and money, and natural disasters topple buildings to the ground. Business owners must have

some means of protecting themselves from loss, and insurance provides this protection. Although many people are reluctant to pay insurance premiums, when a loss occurs, they realize the true value of insurance coverage.

For this reason, the insurance agent is an important professional that you should consult. Your insurance agent will be invaluable in analyzing your business to determine what type and amount of insurance you'll need. It's a good idea to establish a professional relationship with an insurance agent or broker who is competent and knowledgeable about the insurance needs of the locksmithing industry. This individual should be aware of adequate coverage for your type of service business and the availability of coverage at the best premium prices. Once you've chosen your insurance professional, be sure to keep him or her fully informed about any changes in your operation that could affect your insurance coverage.

Business insurance policies replace merchandise that's damaged or missing (either from natural disasters or as a result of theft or vandalism). Included in an insurance package should be *liability coverage*, which pays for damages if you're sued by a customer or employee who is injured on your premises. If you're uninsured, such losses can put you out of business. As an added benefit, standard business policies also compensate owners for business that's lost if their shops must be temporarily closed following an insured occurrence.

The following is a specific list of the types of insurance a business owner may wish to consider and discuss with an insurance agent:

- *Fire and theft coverage* for the office and equipment
- *Automobile coverage* for all vehicles, including liability, comprehensive, and collision in adequate amounts that reflect today's medical and property costs
- *General liability insurance* for any damage or injuries resulting from your actions or the actions of your employees during the course of operating your business
- *Errors and omissions (E & O) insurance* to protect your business if you or one of your employees errs during a lock installation or other service call

- *Crime insurance* to protect the company from losses from robbery, burglary, employee dishonesty, and vandalism
- *Fidelity bonds* to protect the company against financial loss from embezzlement by employees who have access to cash receipts and other company funds
- *Business interruption insurance* to compensate your business for lost revenue during a temporary halt in business caused by fire, theft, or illness of the owner or manager
- *Key person insurance* to compensate your business when any partners or persons essential to managing the operation become disabled or die
- *Product liability insurance* to protect your company against claims for defective merchandise

Finally, if you're operating your business on a full-time basis, you'll need appropriate life and health insurance coverage for yourself, your family, and your employees. As with all other types of insurance, your insurance agent can explain the options and costs associated with providing such coverage.

You'll discover that the liability rates for an alarm installer/locksmith are three times the rates for a locksmith who doesn't install alarms. This is primarily due to the substantial losses a customer can have if the alarm system fails.

Attorney

There's no doubt that at some future time you'll require the services of an attorney. Finding the right attorney up front can help you avoid serious problems in the future. Some states and provinces require you to hire an attorney if you plan to organize your business as either a corporation or a partnership. A sample partnership agreement is shown in Figure 17. In any case, the advice of an attorney can be helpful in many areas of your business, including the following:

- Choosing the best structure for your business
- Interpreting contracts and leases
- Helping you understand your legal rights and obligations

PARTNERSHIP AGREEMENT

AGREEMENT made _____, 19____, among _____, of _____, and _____, of _____.

WHEREAS the parties (hereinafter called the "Partners"), desire to carry on a retail locksmith business in _____; and

WHEREAS the Partners desire to define certain rights among themselves, and to make certain provisions as to their business;

NOW, THEREFORE, in consideration of the mutual agreements herein contained, the Partners agree as follows:

1. Name and Place of Business. The partnership and its business will be conducted under the trade name of _____. The principal place of such business of the partnership will be at _____, or at such other location as the Partners may agree.
2. Business Activities. The Partnership's general business shall be the operation of a retail locksmith business and such other activities as are necessary or incidental thereto.
3. Term. The Partnership will continue until terminated under this Agreement.
4. Books. The Partnership books and records will be maintained at the principal office of the Partnership, and the Partners will have access thereto at all times. The books will be closed and balanced at the end of each year.
5. Capital. The Partners having resolved to make equal contributions to the capital accounts of the Partnership, the partners agree that the capital accounts will continue to be equal, except as hereinafter provided, and in such amounts as the Partners will determine from time to time. If, at any time or times hereafter, further capital will be required for carrying on the business, such capital will be advanced by the Partners in the same percentages as their capital accounts. No interest will be paid on any contributions of capital to the Partnership.
6. Profit and Loss. The net profits and losses of the Partnership will be divided and borne equally among the Partners.
7. Salaries and Drawings. The Partners will receive equal salary for services rendered to the Partnership and the Partners will also have equal drawing and expense accounts, provided that, as to each Partner, the Partner continues to comply with his obligations under Paragraph 8 hereof.
8. Management and Duties. The Partners will have equal rights in the management of the Partnership business, and both Partners will be required to devote substantially all of their time to the conduct of the business. Each Partner will, however, be allowed, to also engage in any other business without the consent of the other Partner so long as such activities do not interfere with the Partners' duties contained herein.
9. Restrictions. No Partner will, without the consent of the other Partner, endorse any note, or act as an accommodation party, or otherwise become surety for any person on behalf of the Partnership. Without the consent of the other Partner, no Partner will, on behalf of the Partnership, borrow or lend money, or make, deliver, or accept any commercial paper, or execute any mortgage, security agreement, bond, or lease, or purchase, or sell any property for or of the Partnership.

(Continued)

FIGURE 17—An attorney can provide you with advice on how to fill out this partnership agreement.

10. Prohibition Against Assignment. No Partner will, except with the consent of the other Partner, assign, mortgage, grant a security interest in, or sell his or her share in the Partnership, or do any act detrimental to the best interests of the Partnership of which would make it impossible to carry on the ordinary business of the Partnership.
11. Bank Account. All funds of the Partnership will be deposited in its name with such banking institution or institutions as the Partners will from time to time determine. All withdrawals therefrom are to be made upon checks signed by either Partner.
12. Death and Disability. (a) Upon the death of either Partner, the Partnership will be terminated as of the date of death of the deceased Partner. Thereafter, the personal representatives of such deceased Partner, or the person or persons to whom such deceased Partner will have bequeathed his interest in the Partnership (all collectively referred to hereafter as the "Estate"), and the surviving Partner will have the following rights, duties and obligations:
- (i) The surviving Partner will be required to purchase the deceased Partner's interest in the Partnership at the price and under the terms determined pursuant to Paragraph 15 of this Agreement, and the Estate of the deceased Partner will be required to sell such interest to the surviving Partner. The surviving Partner must purchase the deceased Partner's interest in the Partnership by giving written notice to the Estate of the deceased Partner within ninety (90) days of receiving actual notice of the death of the deceased Partner, that he or she will purchase such deceased Partner's interest in the Partnership.
 - (ii) The term "Estate" for purposes of this Agreement shall be deemed a word of collective reference only. Insofar as it includes any personal representatives and any person or persons to whom any deceased Partner will have bequeathed any interest in the Partnership, its use will not be deemed to bind any such persons to any collective action, and they will each have all of the rights and privileges accorded to the "Estate" of a deceased Partner.
- (b) Upon the disability (as defined in Section 105(d)(4) of the Internal Revenue Code of 1986, as amended) of either Partner, the other Partner will have the option to purchase the disabled Partner's interest in the Partnership at the price and under the terms determined pursuant to Paragraph 15 of this Agreement, and the disabled Partner will be required to sell such interest to the other Partner. This option to purchase the disabled Partner's interest can be exercised at any time after such Partner has become disabled within the meaning of this Paragraph 12 and shall be exercisable by the purchasing Partner giving written notice to the disabled Partner that he desires to exercise such option.
13. Voluntary Withdrawal of Partner. Either Partner will have the right to voluntarily withdraw from the Partnership by giving ninety (90) days written notice to the remaining Partner of his or her intention to withdraw. In such an event, the remaining Partner will have, for ninety (90) days from the receipt of such notice, the option to purchase the interest of the withdrawing Partner at the price and under the terms determined pursuant to Paragraph 15. The remaining Partner's option to purchase the withdrawing Partner's interest will be exercisable by giving written notice to the withdrawing Partner of his or her intention to purchase the withdrawing Partner's interest, within the said ninety (90) day period commencing with the date of the withdrawing Partner's notice of withdrawal from the Partnership. In the event that the remaining Partner does not elect to purchase the withdrawing Partner's interest in the Partnership, the Partners will proceed with reasonable promptness to consummate the liquidation and sale of the business and assets of the Partnership. Any profits or losses which the Partnership realizes during the period of liquidation will be divided and borne equally among the Partners. The proceeds of sale will be divided and borne equally among the Partners.

(Continued)

14. Legal Disabilities. Upon the insolvency, bankruptcy, or adjudication of incompetency of a Partner or if a lien, attachment or garnishment is entered against a Partner's interest in the Partnership or its assets or his interest in the Partnership or its assets become subject to equitable distribution in any divorce proceeding (collectively "Legal Disabilities"), the Partnership shall be terminated as of the date of such an event. Thereafter the other Partner shall have all the rights, obligations, and duties hereinabove prescribed in Subparagraph 12(a) for the surviving Partner in the case of death of one of the Partners, and the Partner under such Legal Disabilities and his receiver, trustee, committee, guardian, conservator, or other parties claimant of such Partner shall have all of the rights, obligations and duties prescribed for the Estate of a deceased Partner in such Subparagraph 12(a).
15. Purchase Price and Terms. The purchase price and terms of the purchase of a Partner's interest in the Partnership in the case of death, disability, voluntary withdrawal or Legal Disabilities of a Partner shall be determined respectively as follows:
- (a) In the case of the death or disability of a Partner, the purchase price shall be one-half (1/2) of Monthly Net Profits (as hereinafter defined) for _____ months from the Date of Closing (as hereinafter defined), payable in consecutive equal monthly installments.
 - (b) In the case of the voluntary withdrawal or Other Legal Disabilities of a Partner, the purchase price shall be one-half (1/2) of Monthly Gross Commissions (as hereinafter defined) for _____ months from the Date of Closing, payable in consecutive equal monthly installments.
 - (c) The term "Monthly Net Profits" means monthly net profits, exclusive of federal, state or local income taxes, determined on a cash basis, received by the Partnership for the month preceding the date on which such monthly installment of the purchase price is due. In no event, however, shall any monthly installment of the purchase price under this Paragraph 15 exceed one-half (1/2) of the highest monthly net profits earned by the Partnership during the twelve (12) month period immediately preceding the Date of Closing.
 - (d) In the event of the death, disability, voluntary withdrawal or Legal Disabilities of a Partner, closing shall take place thirty (30) days after the sending of written notice by a Partner that he or she will purchase the other Partner's Partnership interest as provided herein ("Date of Closing").
16. Compulsory Buy-Out. At any time (other than a time when Paragraph 12, 13 or 14 hereof is operative), either Partner (the "Offering Partner") may send a written notice to the other requiring a compulsory buy-out. The notice shall specify a price for the other Partner's interest in the Partnership and state that the Offering Partner will purchase the other Partner's Partnership interest at that price or sell his or her own Partnership interest to the other Partner at that price. The other Partner must, within six (6) months after such offer, either (i) purchase the Offering Partner's Partnership interest at such price by giving written notice of such to the Offering Partner before the expiration of said six (6) month period or (ii) tender his or her own Partnership interest for purchase at such price. Closing on the sale of a Partner's Partnership interest under this Paragraph shall take place thirty (30) days after the earlier of (i) the sending of written notice to the Offering Partner by the other Partner that the other Partner shall purchase the Offering Partner's Partnership interest or (ii) the expiration of the six (6) month period.
17. Covenant Not To Compete. In the event that either Partner purchases the Partnership interest of the other Partner, the Partner whose Partnership interest is being purchased agrees that, following the date of such purchase, he or she will not, directly or indirectly: (i) hold or acquire an

(Continued)

ownership interest in any run business or engage in any other phase of the retail gun business anywhere within a fifteen (15) mile radius of _____, for a period of five (5) years from the Closing of the purchase of such Partner's Partnership interest; or (ii) use or permit the use of any trade secrets relating to the Partnership (including, without limitation, customer lists, marketing methods, cost, price, and other financial data) and will not, either directly or indirectly, communicate or divulge such trade secrets to any person, firm or corporation whatever.

18. Notices. Notices under this Agreement must be in writing and sent by registered or certified mail, return receipt requested, postage paid, to the Partners at their last address as shown on the records of the Partnership or at such other address with respect to any party hereto as such party may notify the other in writing.
19. Severability. The various provisions of this Agreement are severable from each other and from the rest of the Agreement, and in the event that any part of this Agreement is held to be invalid or unenforceable by a court of competent jurisdiction, the remainder of this Agreement will be fully effective, operative and enforceable.
20. Binding Effect. This Agreement is binding upon and will enure to the benefit of the parties hereto and their respective heirs, executors, administrators, donees, successors and assigns.
21. Governing Law. This Agreement is to be construed and interpreted in accordance with the laws of the State of _____.
22. Entire Agreement. This instrument contains the entire agreement of the parties and cannot be changed orally but only by an agreement in writing signed by the Partners.

IN WITNESS WHEREOF, the parties have signed this Agreement on the day and year above written.

WITNESS:

 _____, Partner

WITNESS:

 _____, Partner

FIGURE 17—(Continued)

- Arbitrating disputes within your business or with other businesses or subcontractors
- Filing necessary paperwork for licenses, permits, and so on
- Preparing partnership agreements (Figure 17)
- Handling the legal requirements for corporations

As with other professionals, deal with a reputable attorney with whom you feel comfortable. While all attorneys must meet certain requirements to be licensed, some are undoubt-

edly better than others. Your local county bar association can provide you with names of attorneys in your area and their specialties.

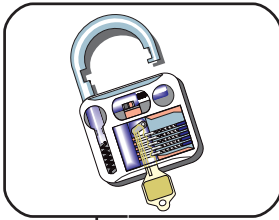
Banker

Whether or not you need to borrow money, you should establish a good working relationship with a bank. In addition to lending money, bankers can help you to choose the best type of checking and savings accounts for your business and provide financial guidance. Select a bank that can offer you the services you need as your business expands.

Marketing or Management Consultant

A *marketing consultant* may offer marketing services only or a combination of both marketing and management services. A consultant who offers both services can advise you on every aspect of operating your business. Your decision to work with a consultant will depend on your own knowledge, expertise, time available, and your desire to delegate business responsibilities to a professional consultant.

A good consultant can advise you in the areas of business start-up, advertising and public relations, security measures, employee hiring, fee setting, record keeping, and many other details. A consultant can also recommend attorneys, accountants, advertising agencies, and other information sources. A management or marketing consultant usually charges on an hourly, daily, or weekly basis, but you may be able to hire a consultant only when needed for a short period by paying a monthly retainer fee.



Locking It Up! 2

Fill in the blanks in each of the following statements.

1. A _____ is a reserve of money for emergencies.
2. A _____ is the most common source of funding for small businesses.
3. The _____ will consider a small business for a direct loan only after it has been turned down by one or two commercial lenders.
4. A _____ is an authorization to collect sales tax that businesses in most jurisdictions are required to have.
5. _____ is insurance that pays for damages if you are sued by a customer or employee who is injured on your premises.
6. The money you need to operate your business every day is called _____.
7. Your personal _____ is a document indicating your total net worth.
8. A _____ can help you choose the best type of checking and savings accounts for your business.

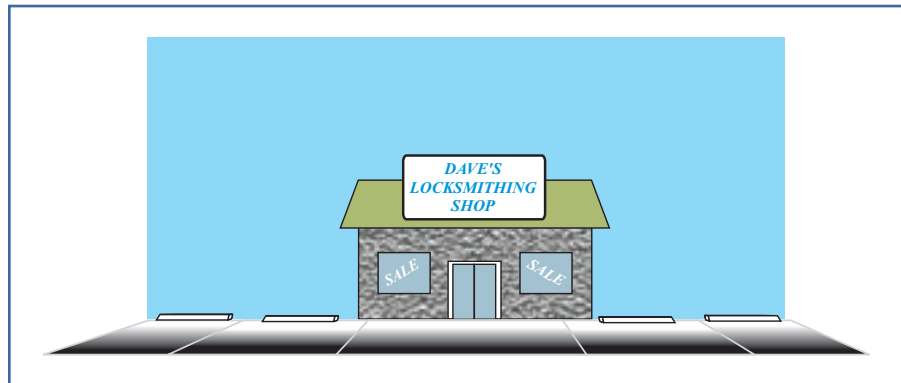
Check your answers with those on page 71.

FINDING THE BEST LOCATION

Accessibility

If you were to ask any business owner the single most important factor in starting a business, you'd hear: location, location, location! Why? Well, the purpose of a retail shop is to provide a product or service to people who live or work within a specific geographical area. This means that the shop must be easily accessible to customers (Figure 18). How can you judge how accessible a particular location is? Try answering the following questions.

FIGURE 18—An accessible location offers ample parking spaces and unobstructed visibility from the street.



Does the location offer

- Unobstructed visibility from the street?
- A parking lot that can be easily entered and exited?
- Ample parking spaces?
- An entryway that's usable by persons with physical handicaps?
- Nearby businesses that help attract customers?

If you can answer “yes” to these questions, you can consider your chosen location to be extremely accessible to the public.

Traffic Flow

When you're researching the merits of a possible business location, check with your local chamber of commerce, banks,

and real estate companies to get an idea of the average income and annual retail sales figures in the area. Doing so will give you an indication of the health of the area's economy. Another resource you can use is County Business Patterns, which is published by the United States Department of Commerce and contains vital statistics about the county in which you intend to locate your business. Naturally, it's always a good idea to start a new business in an area where customers have money to spend on goods and services.

In order to succeed, a retail business should be located in a high-traffic area—one that draws large numbers of people in cars and on foot. Many city, county, and state transportation departments will provide traffic flow information for major roads. Traffic flow measures the amount of traffic passing through an area. If the traffic flow is high, it usually means a brisk business is possible.

This discussion may be leading you to the conclusion that one of the best places to open a shop is in a major shopping mall, but this isn't usually true. Although the volume of potential customers in a large mall is high, the cost of overhead in many malls is too high for a business to be profitable. However, a small "strip" shopping center, where six to ten stores open onto a shared outdoor parking lot, is sometimes a viable option.

Good news is that, unlike some businesses, a locksmithing business can be successful even in a less-affluent area or a low-traffic area, simply because locksmithing skills are so much in demand. Just about everyone, regardless of their income, needs strong locks on their homes and cars. In fact, the need for security is often greater in neighborhoods that have a crime problem. Also, locksmiths may conduct much business on the road or at people's homes, which makes a large, elaborate shop unnecessary.

One possibility is to simply establish your business in your own home. You could operate out of your kitchen, your basement, a spare room, or your garage. The principal advantage of a home business is the low cost of overhead. This is the way many people start out when opening their own business; you can always move to a professional location later on.

The location of your shop is something only you can decide. But choose it with extreme care and thought. Remember to consider your future needs as well as your present needs

when evaluating any location for your business. There's one exception for locksmiths. Some locksmiths have a mobile only (van) business, and no retail store. For these locksmiths, of course, the shop location isn't very important.

The Appearance of Your Shop

Appearance is important for any business that's visited by its customers. Customers and potential customers alike make their initial judgment about a business from its appearance, so first impressions are important! The building that houses your business and the surrounding area must be attractive and compatible with the quality of your services. Display windows are nice to have, but not as essential for a locksmith as for a retail shop. However, look closely at the windows in any building you consider as a location for your shop.

Assessing Your Competition

One critical area that must be checked out before committing to a location is the strength of your competition. How can you find the competition? First, you can personally scout the area. Then, check the yellow pages of your telephone book. Look under such relevant categories as locksmiths, home security, hardware, building supplies, and so on. Any one of these, even those listed as wholesalers, represents a possible competitor.

One way to analyze competition is to mark off an area on a piece of graph paper to represent a one-mile radius around your proposed site. Sketch in the major streets in the area, and mark the location of all competing businesses within that mile. How many locksmith-related competitors are located within that radius? How many competitors are located within two or three city blocks of your proposed site? If your research shows that there are no serious competitors within one mile of your prospective site, you may have struck gold.

Note that the presence of competition in your target area doesn't necessarily mean that you shouldn't start a business there. In fact, competition in any industry should be welcomed because it challenges competing businesses to provide better service and higher quality for their consumers. For example, if a new locksmith shop opens up just across the

street from a well-established shop, both owners will work harder to keep up with trends and satisfy their customers. (Remember, however, that if you take on a competitor directly, you must be absolutely sure that your product and service are superior!)

Once you know who your competitors are and where they're located, take the time to become acquainted with their operations. Visit the shops and check out their inventory and displays. Do certain shops seem to have more walk-in business than others? If so, compare their window displays with those of the other, less busy shops. This will help you see what draws customers in off the street. Also, be aware of the shops' days and hours of business and the presence or lack of "road" services.

Browse through local newspapers and telephone books for competitors' advertisements. Are the ads large? Do they seem effective? Do your competitors provide the kind of service or quality that they advertise? The answers to these questions will enable you to properly evaluate the strength of your competition.

Leasing vs. Buying

Once you've chosen your location, your next question may be: Should I lease or buy the shop? Leasing may be less expensive in the short term; however, you may find that purchasing a space is less expensive in the long term. Rent money, once paid, is gone, but mortgage payments result in equity buildup.

If you do rent a property, be sure to have an appropriate written agreement. This means a well-written lease which clearly spells out the respective parties' rights, duties, and obligations. Have your attorney review a lease before you sign it. Your attorney can explain any provisions in the lease.

Every lease is set for a defined period of time. Building owners generally want long-term leases. They usually ask for three-, five-, or ten-year commitments. As a new business owner, you should be wary of long-term agreements.

If you are intent on buying your own business, a written purchase agreement should be drawn up which spells out the rights, duties, and obligations of each party in the transaction. The agreement should indicate whether a deposit is being made, and, if so, whether it's refundable if the deal falls through. It should also provide a deadline for closing the deal.

ESTABLISHING A BUSINESS IDENTITY

Name Recognition

One of the most important factors in the success of any business is name recognition—how well the public knows the name of your business. Ideally, when someone in your area needs a locksmith, they should think of you first. Name recognition doesn't happen overnight. It's the result of a planned marketing effort on your part. Your retail store must lock its name into your customers' minds every time they come near the business. Location alone doesn't do this. After all, can you recall the name of every store in your local mall? The stores that you can't remember are failing to draw enough attention to themselves.

Developing a business identity begins with the name of your business. The best name is one that's memorable and not easily confused with any other business. Your business name should always reflect what you do. For example, if your name is Dave Smith and your partner is Jerry Johnson, you could call your business Dave and Jerry's. However, this name doesn't tell anyone what you do. Dave and Jerry's could be a restaurant, a garage, or a clothing store as well as a locksmith shop. By the time customers figure out what you do, it may be too late to get their business. They may have already given their business to a company whose name more easily identifies it. Don't make it hard for potential clients to find you. Make the name of your business as unique and unmistakable as possible. In the situation we described here, a good name for the shop would be Dave and Jerry's Locksmithing.

Using your own name in the business's name is recommended because it sends the public a message of individuality and shows pride in ownership. For example, Smith's Locksmith Service is better than the generic name Locksmith Service by itself. Another good idea is to include the name of your city or town. For example, Springfield Locksmith is appealing since it identifies the business with the city of Springfield. Using the name of the town also gives the business name a sense of permanence and stability.

If you plan on purchasing a locksmith shop that has already been successfully operating for some time, don't change the business's name. The established name has a recognition

value in the local area that could take years to recreate under a new name. Also, customer's tend to be wary of change. Customers of an established business are more likely to continue coming to the shop if new ownership is introduced gradually. If you intend to change an established shop's name, your best bet is to phase the new name in gradually over a period of time. For example, in an advertisement, you could say "Smith's Locksmithing Shop, formerly The Lock and Key Shop, is proud to announce their grand opening this Friday."

Another consideration when choosing a name is the positioning of the shop's listing in the yellow pages. Names that begin with A are at the top of the alphabetical list, and customers using the yellow pages tend to call the first shop they see in the listing. Also, the largest ads (no matter where they fall alphabetically) are positioned at the beginning of the yellow page listing. You can be assured of getting top billing if you can afford to purchase a large-size ad. If you plan to give 24-hour service, be sure to include that in your ad.

Almost as important as your business's name is its telephone number. A great percentage of a locksmith's business comes from emergency service calls. For this reason, negotiate with your telephone company for a number that's easy to remember. Focus on the final four numbers—for example, a number such as 555-1234 is much easier to remember than 555-6982. Or, you could try to get a catchy word into the number, like 555-LOCK or 555-KEYS. With a clear identity and an easy-to-remember phone number, you'll stand out in a customer's mind when he or she needs to call a locksmith.

Designing a Logo

After you've decided on a name for your business, you should direct your attention to designing a logo. A logo is a graphic symbol that helps the public identify your business at a glance. A well-done logo has the power to draw the public's eye and stimulate interest in your business. Although it isn't absolutely necessary, it's a good idea to incorporate your business's name into the logo. For example, if your logo is an illustration of a padlock and keys, you can put the store's initials on the front of the padlock (Figure 19). If you belong to a professional locksmithing organization, such as ALOA or SAVTA, you should also include that information on your

FIGURE 19—An effective logo will identify your business at a glance.



logo. Customers will eventually begin associating that logo with your shop.

Your logo is very important, so if you can afford it, hire a professional artist or graphic designer to develop it. Not all graphic designers are equally talented at creating logos. The best way to find a good logo

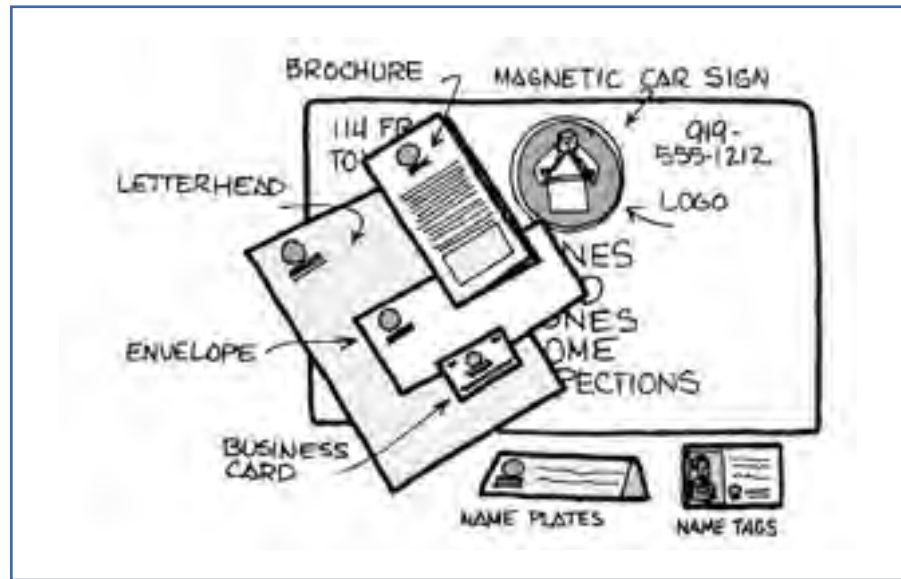
designer is to look at other people's business cards and ads. When you see a logo that you think is particularly effective, call the owner of that business and ask for the name of the graphic artist who did the design. You can also ask several designers to show you samples of their work so you can make an informed choice among them.

Designing an effective logo necessitates teamwork between the business owner and the artist. It's important to work with someone that you can communicate with. The artist must have a good understanding of your business and what sets you apart from your competition. The better you can communicate your own business and philosophy, the easier it will be for a graphic artist to capture that in a symbolic design.

Finally, be sure that both you and the designer are perfectly clear about the cost of this work. Agree in advance on what the charges will be if you decide not to use any of the designs recommended by the artist.

Once your logo has been designed, you must use it! Use your logo on signs, in newspaper and magazine advertisements, in the yellow pages, on the sides of delivery vehicles, and on your business cards, stationery, bills, work clothes, brochures, and so on (Figure 20). Any material that's seen by the public should include your logo. Once your business has been established for a while, people will begin to associate your logo with your business.

FIGURE 20—Once you have a business logo, use it everywhere!



Participating in Community Activities

Another excellent way to establish your business identity is to participate in local community activities. One of the best ways to do this is to join your local chamber of commerce, business groups, or charitable organizations. Volunteer your time or donate products or services for a worthy local cause. Sponsor a local sports team or children's club. The more active

you are, the more familiar your business will become within your community.



FIGURE 21—One way to attract favorable attention to your business is to sponsor a local sports club.

Becoming involved with community, civic, and professional groups helps not only your community but your business as well. Find a civic group or organization that shares a common interest with you (Figure 21). Attend a few meetings and if the group offers what you're looking

for, and you feel you have something to contribute, join. The fellowship you'll experience by participating in these groups is enjoyable, and some of the friends made through attending meetings and functions will become your customers.

Yes, joining community organizations can help your business, but be careful that you don't join more groups than your schedule will permit. When you become overcommitted, you won't fulfill any of your responsibilities well. In this case, your business reputation may be hurt instead of helped.

Purchasing a Sign

Most businesses need a clearly visible, lighted sign to identify it and tell potential customers what products or services are offered inside (Figure 22). Your sign is your outdoor advertising, so choose its design, materials, and placement with care. Remember, your sign will be seen by your customers for a long time to come; it should be attractive and eye-catching, and visible from a distance for anyone walking or driving by.

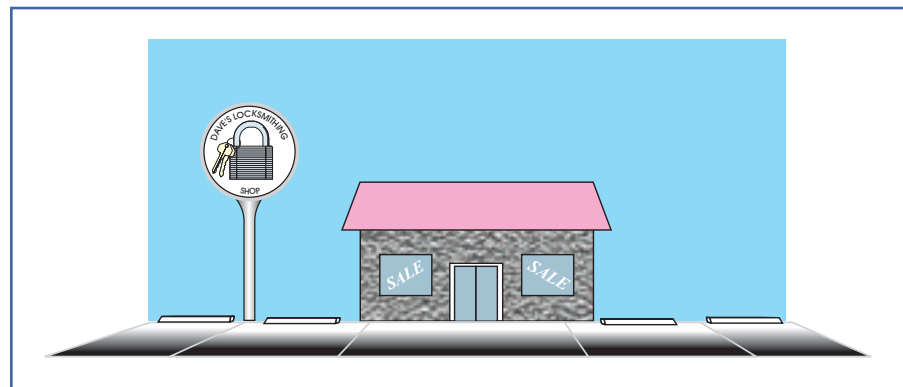


FIGURE 22—A clearly visible, lighted sign will identify your business to potential customers.

Most communities require a permit and an annual fee for any type of sign that's lighted, suspended, or attached to a building's exterior. In addition, many malls, neighborhood shopping centers, business blocks, and historic districts have their own committees that advise a business on the types of signs that are permitted and those that aren't. If your sign conforms to accepted guidelines, your permit is usually issued by the city, township, or zoning office the same day that you apply. You can see that, before signing a lease, it's important to research

any ordinances that may affect your business. Before purchasing any signs, you should submit the exact specifications to the zoning office for approval. You certainly don't want to purchase a sign that you won't be allowed to use! Again, if a locksmith has a mobile only business, the only sign the locksmith will need will be on the van. Some locksmiths use detachable magnetic signs, because an unattended locksmith van attracts thieves.

Advertising

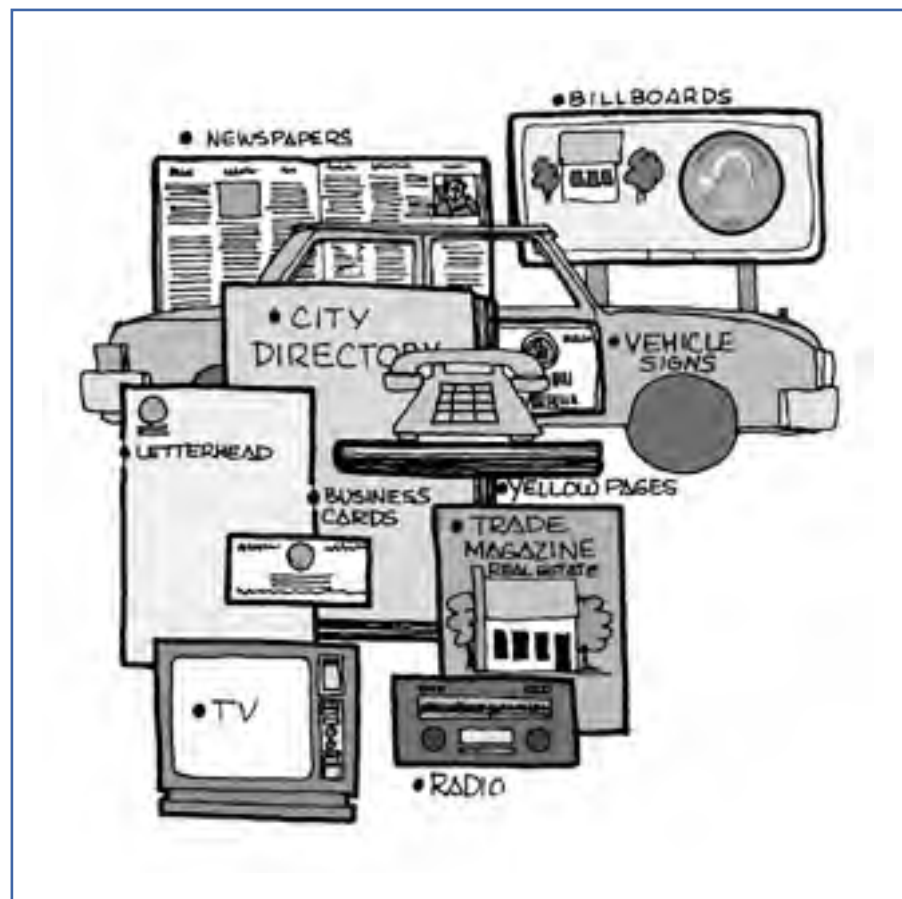
Customer goodwill and a good business reputation take years to develop. For this reason, the best way for a new business to bring in new customers is to *advertise*. The key to advertising is getting your message to your desired audience. That means advertising yourself, your services, your merchandise, and your prices.

The means of getting your message out through advertising are fairly straightforward. They consist of television, radio, and the print medium (i.e., newspapers, magazines, or direct mailing) (Figure 23). While television advertising gets at a large audience, it's also very expensive, usually beyond the reach of most individuals. The cost of even a 30-second television spot could swallow up a week's pay and then some, and that doesn't include charges for peak-hour advertising with its corresponding higher rates.

Radio is a far less expensive means than television for getting your message to the public. If you decide to use radio, make sure you choose a station and commercial times that will be heard by those needing locksmithing services. For example, it doesn't make sense to advertise your services during a children's program, even if you get a bargain price for the time slot. Make sure you choose both the station and your market segment carefully! Depending on the station, you can usually run several 30-second advertising spots each day for a week for about what it would cost to take your family out for dinner.

For a new business, the print medium is probably the most effective method at the most reasonable price. Newspapers, local magazines, classified ads, the Yellow Pages, and direct mail campaigns are all effective, and are far less expensive than television and radio. The Yellow Pages are the best place to advertise.

FIGURE 23—These are just some of the advertising possibilities available to new business owners.



You can also pool your advertising resources with others, and this can be a useful means of bringing in new business. These kinds of group ads are most successful when you advertise with others not in direct competition with you in your community, but who still have a common interest with you in the type of products being advertised. For example, you could pool your resources with a local homebuilder, car dealer, hardware store, private security company, or anyone else who has a business related to locksmithing.

In addition, some manufacturers and suppliers offer *co-op advertising programs*. In these plans, the manufacturer or supplier pays for all or part of your business ad, and you advertise that you use their products. If you're interested in these kinds of ads, you should contact the manufacturer or supplier.

EQUIPMENT AND SUPPLIES

Determining What You Need

The office equipment that you buy at start-up will depend on your business operation and your circumstances. The two most important decisions to make are (1) how much you can afford to spend and (2) what you expect the equipment to do for your business operation. A good idea is to make two lists—one for the absolute necessities and the other for things you would like to have. Let's start by looking at some of the "must-have" equipment. The items we'll discuss here are general office equipment only. We'll discuss specialized locksmithing tools and supplies in the next study unit.

Cash Register or Cash Box

A cash register or box of some kind is necessary in any business. You'll need a secure locking area to keep your change and incoming cash. If your business is very small, you may be able to use a locking cash box (and a calculator) at the start. Or, a simple cash register may be adequate (Figure 24).

If your shop is larger or if you expect your business to grow quickly, an electronic or a computerized point-of-sale (POS) cash register (like those commonly used in supermarkets) may be the right choice for you. A point-of-sale cash register is programmed to help you keep track of your inventory. Your inventory list is programmed into the computer. Then, each time

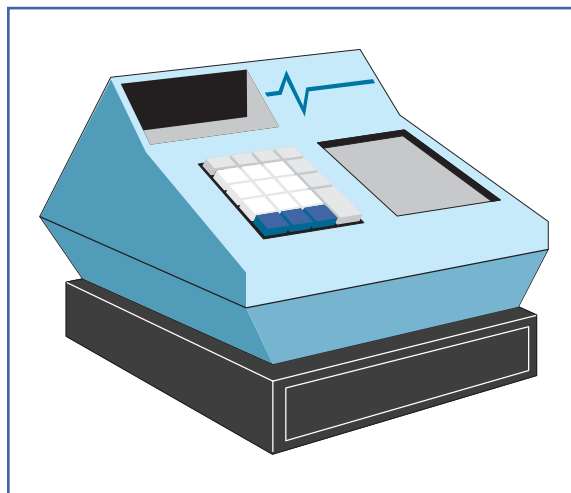


FIGURE 24—This simple cash register may be adequate for your business at the start.

you ring up a sale, the item is automatically deducted from your total inventory. The computer records what is sold and what remains in stock.

While you can purchase a new cash register from a business supplier,

remember to check out your local classified ads to see if any used equipment is available. You may be able to get an excellent bargain on equipment from a shop that's going out of business.

Telephone

Between 50 and 80 percent of your business will be transacted over the telephone once your shop becomes established. Obviously, then, an efficient telephone system is a top priority. The telecommunications industry is highly competitive these days, so shop around to find the most suitable, reliable, and affordable telephone system you can.

The system you select should have enough incoming lines to handle the calls from customers, vendors, and on-the-road employees. Make sure the system you choose is expandable, so it can grow with your business. Remember, many of your customers will be calling for emergency service, so if they get a busy signal, they'll call another locksmith. If you're frequently on the road doing service calls or are otherwise out of your shop, consider using a professional answering service.

No matter how efficient your phone service is, there will be times that you'll have to put callers on hold. Your system should provide either music or information about your business to waiting callers. This lets customers know they haven't been disconnected and keeps them from hanging up.



FIGURE 25—The person answering your business phone should always be courteous and helpful.

Finally, make sure that the person answering your phone has a clear and pleasant speaking voice and enough knowledge of your business to answer customer questions. In addition, the person answering the phone should be polite and helpful at all times (Figure 25).

Remember, the telephone call will be the first impression most customers have with your business!

Cellular Phones

A *cellular phone* is a type of telephone that can be used in a car or van. The phone system uses available radio channels to transmit calls. The term *cellular* refers to the way that the local geographical area that the phone serves is divided into small sections, or *cells*. Cellular phones have a limited range but are very useful for receiving service calls while you're on the road.

Paging Systems

Another phone option you may want to consider is the *paging system*. In a paging system, you wear or carry a small electronic receiver device (the *pager*). When a person wants to reach you, they dial your phone number. Their call is answered by a computer system. Depending on the type of system, the person may leave a vocal message or simply type in their phone number.

The computer system will then "call" you on your electronic pager by sending an electronic signal. The signal makes a beeping noise on your pager. Then, depending on the type of system, you may need to call the number of the service to get your message, or the caller's phone number may appear in a small window on the paging device, in which case you can call them directly. Some locksmiths call forward from their regular phones to their cellular phones.

Office Furniture and Supplies

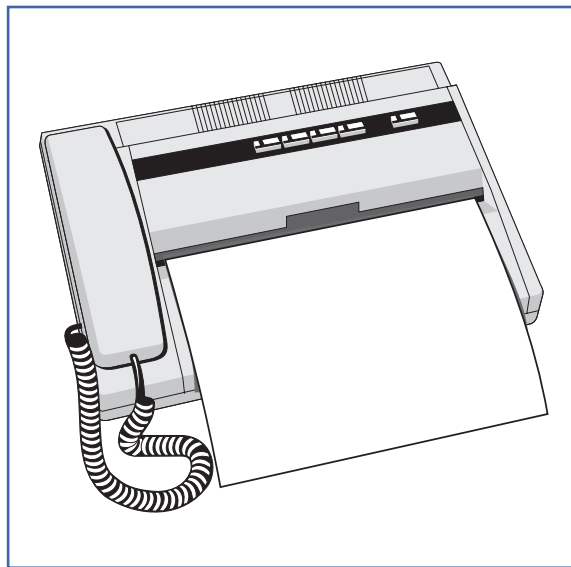
No matter how small your shop and office, you'll need some furniture and fixtures. A desk, chair, desk lamp, bookcase, chairs for waiting customers, and a secure metal file cabinet are essential. Your file cabinet should be fireproof and have a strong lock on it to protect the security of your documents. The lock that comes on a file isn't very strong. The file can be made much more secure by adding a locking bar or a caterpillar hasp and a padlock.

Some standard office supplies you'll need include staplers, paper clips, pens, pencils, sales slips or booklets, memo pads, scissors, tape, price stickers, and an appointment calendar.

Your "Wish List"

Now, let's look at some non-essential items you may wish to purchase for your shop. These items may be included in your "wish list" of items to be purchased in the future.

FIGURE 26—A fax machine is used to send documents instantly from place to place.



A *fax machine* (Figure 26) is a useful device used to send documents instantly from place to place. The machine is attached to telephone lines. A fax machine allows you to send in orders for supplies, receive letters and documents from customers or manufacturers, and so on.

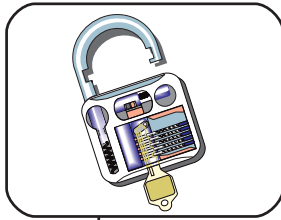
A *photocopier* will be useful for making copies of documents for record keeping purposes.

A personal *computer* has many uses in a small business. Many software packages with practical business applications are now available. You can use your computer to keep records, do your taxes, and even balance your checkbook. However, a personal computer may be impractical unless you or your employees know how to use it. You can find a wide variety of computer books and teaching aids in any computer store. Be sure to shop around and consider your needs carefully before you purchase a computer system.

A personal computer is almost a necessity for locksmiths to keep track of their key blanks. There are eight or nine common key blank manufacturers, and all use different reference letters/numbers. The hard copy cross-indexes refer to two or three manufacturers. To do a hard copy crossover is sometimes almost impossible. However, with a computer, you can

type in any manufacturer's number and come up with the other numbers and where the blank is used. There are at least two software suppliers that provide this service.

All of the devices we've mentioned here are fairly expensive and not generally essential to a business that's just starting out. However, later on when your business expands, you may find these machines to be valuable timesavers that can increase your profits.



Locking It Up! 3

Indicate whether each of the following statements is True or False.

- _____ 1. Traffic flow is the number of new businesses opening annually in a city or town.
- _____ 2. It's always better to buy a business location than to lease it.
- _____ 3. It's unimportant for a business's name to identify the type of business it is.
- _____ 4. One excellent way to establish your business identity is to participate in local community activities.
- _____ 5. You can expect to transact only about 10 percent of your business over the telephone.
- _____ 6. A fax machine is an essential piece of equipment when you're first opening up a shop.
- _____ 7. If you purchase an established locksmith business, you should always change the name of the shop before opening.

Check your answers with those on page 71.

STAFFING YOUR SHOP

Deciding Whether to Hire

Loyal and efficient employees can be your company's most valuable asset. They can create more goodwill than the most extensive public relations program you could ever afford. It isn't easy to find good workers, but in this section of the text, we'll give you some tips on how to go about hiring and managing employees.

The number of employees you hire at start-up, if you hire any at all, is a personal decision based on your needs. The size of your operation, how you plan to run your business, and the availability of subcontractors are all factors to be considered when hiring workers. You can hire full-time, part-time, or temporary workers depending on your needs and the size of your business. No matter what type of worker you select, however, remember that you should only hire employees if the amount of business you do justifies the need for more help.

Hiring an employee is an economic decision. As an employer, you'll be responsible for paying the employee's salary and benefits, as well as workers' compensation insurance, and half of the employee's social security taxes. Because of all this extra expense, any employee you hire must produce extra income for your business. This income can be earned in two ways: through higher production or greater sales.

To make hiring worthwhile, an employee should generate an increase in business earnings at a rate *three times* the employee's salary. For example, if you hire an assistant at a salary of \$15,000 per year, your gross sales should increase by \$45,000 (3 x \$15,000). A very good employee can increase your earnings by an even greater amount.

Before hiring an employee, you must obtain a federal employer identification number. In most states and provinces, you must also register with the employment department.

Job Descriptions and Personnel Policy

Before you hire an employee for a position, you should prepare a job description and a personnel policy. A *job description* is a written plan of an employee's duties, responsibilities, and authority. Include in the description anything that applies specifically to the job's requirements and conditions. When you approach employment agencies or place ads in the paper, you'll be able to describe exactly what kind of person you're looking for based on the duties and responsibilities in the job description.

Writing a job description is sometimes a bit tricky for a first-time business owner. To get yourself started, divide a sheet of paper into four columns with the following headings:

1. What the employee has to know to handle the job
2. What duties the employee must perform from the outset
3. What extra duties you want the employee to perform once he or she is accustomed to the job
4. What you expect the employee to learn from performing the job

A *personnel policy* is a contract between you and your employees which outlines standards of conduct and procedures for your business. When an employee is hired, you and the new employee will sign the contract, indicating that you've reviewed it and agreed to it.

Some items you should include in your personnel policy are the following:

- How employees are expected to report to work (punching a time clock, signing in)
- Pay periods and paydays
- What employees should do if they're unable to come to work
- What benefits the employees will receive (medical/dental insurance, vacation days, sick leave, paid holidays)
- Employee restrictions (restrictions on the use of drugs, alcohol, and tobacco; locations where food and drink can

be consumed; use of telephone for personal calls; office dress codes)

- Whether weekend work and overtime are required
- In-house training programs and other educational opportunities (including payment of tuition or scholarships for outside seminars, correspondence courses, or college or university courses)
- Schedule of employee evaluations
- Procedure for reporting a job-related injury or illness
- Termination procedures

Your personnel policy should also include incentives to get your employees to work harder. Such incentives include

- Sales commissions
- Promotions based on merit
- Regular raises based on performance
- Employee discounts on products sold in-house

Your state or provincial labor department can provide you with excellent material on the rights of both employers and employees. Use this information to help develop your personnel policy.

Employment Applications

Once you've developed written job descriptions and a personnel policy, you're ready to begin the search for employees. Some possible sources for employees are

- State or province employment agency (services are free)
- Private employment agencies (fees are charged to either applicant or employer)
- Help wanted ads placed in local newspapers
- Job applicant pools at local schools and colleges

Any persons who wish to work for you will first submit a written job application to you. A job application is a printed form that asks for a variety of important personal and professional information about the prospective employee. You can purchase a preprinted job application form from an office

supply store, or you can design your own application. However, in designing your own application, you should use a preprinted form as a guide. A sample job application is provided for you in Figure 27.

One of the best ways to evaluate the skill level of a job applicant is to check his or her PRP (Professional Registration Program) level. The PRP is a program started by ALOA (Associated Locksmiths of America) about 10 years ago. Its primary goals were to show the public the skill level of the locksmith they were hiring, to show the locksmith where he or she needed to study more, and to prepare for licensing of locksmiths.

The levels are CRL (Certified Registered Locksmith), CPL (Certified Professional Locksmith, and CML (Certified Master Locksmith). Each level requires taking and passing an exam with 9–12 sections. Each section must be passed to achieve a specific level.

The original program resulted in permanent ratings. The program has been revised to require annual educational activity on the locksmith's part to maintain each level.

Many customers now require at least a CRL to do their lock work.

Job Interviews

Once you've reviewed the job applications submitted by prospective employees, you'll need to decide who you want to talk to in person. This is called the job interview. When you conduct a job interview, your intention is to get as much information as you can about the applicant, in his or her own words. Before the interview, make a list of questions you want to ask of the applicants. The list will help you keep on track during the interview and also prevent you from forgetting important questions.

Ask specific questions: What did you do on your last job? What was your reason for leaving? What type of experience do you have? Then evaluate the applicant's answers to determine if he or she really has the skills and experience claimed on the application. Look for sincerity, honesty, and integrity in the applicant's answers.

APPLICATION FOR EMPLOYMENT

AN EQUAL OPPORTUNITY EMPLOYER

PLEASE NOTE: The fact that you have been asked to complete this detailed application indicates our interest in your qualifications. You can aid in making a fair appraisal of those qualifications by answering each question as accurately as possible. Please examine the form before completing it.

TODAY'S DATE

POSITION DESIRED

MIDDLE

FIRST

LAST

NAME

PERSONAL				
NAME (LAST)	(FIRST)	(MI)	SOCIAL SECURITY NO.	
ADDRESS (number & street)	(CITY)	(STATE)	(ZIP)	TELEPHONE
List other name(s) under which you attended school or were employed				
How, or by whom, were you referred to this company?				
Are you over the age of 18? <input type="checkbox"/> YES <input type="checkbox"/> NO Except for those records which have been ordered sealed or erased by the court, have you ever been convicted of a felony? (Conviction of a felony will not necessarily disqualify you from employment.) <input type="checkbox"/> YES <input type="checkbox"/> NO If "Yes" explain and give date of conviction, reason, and current disposition of the case: Explain:				
Do you have any friends or relatives working for this company, its affiliates, parent companies, subsidiaries or divisions? <input type="checkbox"/> YES <input type="checkbox"/> NO If yes, who?				
Have you ever worked for this company before? <input type="checkbox"/> YES <input type="checkbox"/> NO If yes, when?				

EDUCATION AND TRAINING					
Type of School	Name	City, State	Graduated? or Last Grade Completed	Degree Granted	Kind of Course, Major Subjects, Honors Received Outline as completely as possible
High School					
College					
Graduate School					
Other Training					
List other qualifications and skills (e.g., languages, typing, office machines, etc.)					

MILITARY (UNITED STATES)
Have you served in the Armed Services of the United States? <input type="checkbox"/> YES <input type="checkbox"/> NO
If yes, did you acquire any job-related skills during your military service?

PROFESSIONAL REFERENCES					
Please provide a minimum of three (3) professional references.					
1.	NAME	OCCUPATION	HOW LONG KNOWN?	ADDRESS	PHONE #
2.					
3.					
4.					
5.					

75-010 (REV. 5/91) Complete form by continuing on back

FIGURE 27—A Sample Job Application (Partial)

Keep your questions focused on the applicant's work experience, education, and qualifications for the job. It's illegal to ask any questions about an applicant's age, religion, national origin or race, marital status, and other personal matters. This is considered to be discrimination, and a job applicant could sue you if you even appear to be discriminating against them for any reason.

Dismissing Employees

If you hire someone who doesn't perform as you expected, you may have to dismiss that employee. Firing an employee isn't always a simple matter; most jurisdictions have laws that protect employees from unfair dismissal. You should fully inform yourself on the federal and local labor laws that apply to your business. This way, if you must dismiss an employee, you'll know what the law requires and what procedures you must follow. The consequences of not following the established procedures can be heavy: the employee can sue for lost earnings, reinstatement, and punitive damages.

Even if the laws in your jurisdiction don't require it, always document each employee's work history in writing. This information is needed to protect yourself in case you have to dismiss an employee. Document tardiness, absenteeism without advance notification, poor job performance, and insubordination.

Annual performance reviews should also be performed for each employee. A performance review is a meeting between you and the employee where the employee's job performance is discussed. Problem areas in need of improvement should be brought up at these meetings, and exceptionally good performance should also be noted. The review document should be signed by both the employer and the employee. Such documentation will help back you up if an employee challenges your decision to dismiss him or her, and files a grievance with the labor board.

Subcontractors

A *subcontractor* is an individual or a business contracted to complete all or part of another person's contract. A locksmithing business may use subcontractors to answer telephones and schedule work assignments, type, keep accounting records, operate a computer, or clean the shop. In addition, a locksmith may hire another locksmith to perform specialized services (such as safe opening, auto work, and so on).

Before a subcontractor performs any services, he or she should sign an agreement with you. A subcontractor agreement should specify, in precise terms, every aspect of the relationship between you and the subcontractor. Seek the assistance and advice of an attorney in the preparation of a subcontractor agreement. Once a subcontractor has signed an agreement with you, give him or her a copy of the agreement and keep the original in your permanent file.

A subcontractor is responsible for paying his or her own income tax and Social Security tax. Subcontractors' agreements must clearly indicate that subcontractors will handle all of their own tax responsibilities and carry proper and adequate insurance. Subcontractors who don't actually represent your company to the public, however, may not be required to carry liability insurance. (Check with your insurance broker or attorney about your insurance obligations relating to specific types of subcontractors.) Thus, you can see that hiring subcontractors simplifies accounting record keeping for you, and involves less responsibility and liability than for full-time employees.

Apprenticeship Programs

Since most fully qualified professional locksmiths wish to open and run their own businesses, it's sometimes difficult to find good assistants for your shop. For this reason, many locksmiths provide apprenticeship programs to interested employees. Under an apprenticeship program, an employee can serve as an apprentice to a professional locksmith until he or she has the skills needed to be qualified as a professional. (While no formal apprenticeship requirements are generally necessary, you may wish to speak with and meet other professional locksmiths to determine what type of arrangements are typical in your area.) Providing apprenticeships is an excellent

way to obtain skilled workers without the expense of paying subcontractors.

BUSINESS RECORDS

The Importance of Good Records

Good record-keeping is a must for every successful business. Without them, you don't know where you've been or where you're going. If something hasn't worked in the past, it's not likely to work in the future. Complete and accurate records can keep you from making the same mistake twice.

A locksmithing business usually maintains the following records (at the minimum):

- Personnel records
- Client records
- Financial Records



FIGURE 28—An efficient record-keeping system will allow you to find any needed information quickly and easily.

An accountant can help you set up a record-keeping system (Figure 28). After the system is established, your accountant may keep all records, or you may decide to maintain all the books until you turn them over to your accountant at tax time. Whatever you decide, in order to satisfy IRS requirements, you

must keep accurate, consistent, and permanent records of all income, expenses, and allowable deductions for the business.

Now, let's take a look at each one of these types of records.

Personnel Records

As a business owner, you should keep a separate file for each employee and subcontractor. Keep all personnel files in a secure place—in a locked cabinet with a key or combination, or in a separate computer file with special access. Never allow any employee to see another employee's personnel record, and don't give out any information in an employee's personnel file to anyone, inside or outside the company, without the express written consent of the employee.

Each personnel record should contain the following information:

- Personal information (name, address, telephone number, Social Security number, emergency number)
- Pre-employment papers (application, resume, references)
- Job information (title, job description, wage rate or salary, and benefits)
- Payroll information (for example, hours worked each pay period; leave accumulated and used per pay period; reimbursable expenses paid; total gross earnings per pay period less total deductions; date, check number, and net amount of each payroll check)
- Performance (evaluations, merit raises, promotions, awards, and so on)
- Education (record of all education and training completed during employment)
- Leave without pay
- Termination (date, type, reason, rehire status, copies of company's reference letters to future employers)

You should also maintain a separate file for each subcontractor who performs services for you. Each file should contain the following three documents:

1. The original agreement signed by you and the subcontractor
2. Personal information sheet (the subcontractor's name and/or business name, address, and telephone number; names of all persons employed by the business; home

telephone number of the person responsible for the operation of a subcontractor company; employer identification number or Social Security number, as applicable; types and numbers of licenses, if applicable; and any other desired information, such as previous experience, number of years in the business, and names and addresses of references)

3. Assignment sheet that lists, by column, the location of each assignment, dates started and completed, amount and date of payment, and any other information you require. (You may also wish to note any exceptional events, such as injuries or damages that occurred during a job, customers' comments, or your own notes.)

In each file you may also choose to include a copy of any correspondence sent to or received from the subcontractor, and any other information or document relative to the individual or company.

Financial Records

The following financial records should be maintained by every business.

Checkbook. All funds that pass in and out of your business should go through a separate checking account set up for the business.

General journal. All receipts of incoming funds and all funds paid out should be entered daily in a cash journal. Separate journals, one for receipts and one for disbursements, may be used if desired.

Balance sheet. A balance sheet is a formal statement of the financial condition of a business. It shows an itemized list of the total assets, liabilities, and owner's equity at a given date. (The owner's equity is equal to the total business assets minus total liabilities.) Potential lenders and investors are particularly interested in a company's balance sheets. Figure 29 shows a sample balance sheet for a fictitious locksmithing company.

Records of fixed assets and depreciation. Any asset that's depreciated should be included in this record. Examples are vehicles, office equipment, and any special equipment you use for inspections.

FIGURE 29—Balance Sheet for Dave’s Locksmithing Shop

DAVE’S LOCKSMITHING		
Balance Sheet		
December 31, 19XX		
ASSETS		
Cash		\$ 23,450.00
Prepaid insurance		675.60
Equipment assets:		
Office equipment	\$25,010.00	
Less accumulated depreciation	<u>4,733.50</u>	20,276.50
Field equipment	18,254.00	
Less accumulated depreciation	<u>7,323.50</u>	<u>10,930.50</u>
Total assets		<u>\$ 55,332.60</u>
LIABILITIES		
Accounts payable		\$ 17,969.45
Notes payable		6,347.75
Subcontractor fees payable		450.00
Employees’ withholding tax payable		615.48
FICA tax payable		317.80
Insurance payable		450.60
Accrued bank credit card expense		<u>75.20</u>
Total liabilities		\$26,226.28
OWNER’S EQUITY		
Dave’s Locksmithing, capital:		
Capital, January 1, 19XX		\$21,349.57
Net income for year	\$36,056.75	
Less cash withdrawals	<u>28,300.00</u>	<u>7,756.75</u>
Capital, December 31, 19XX		<u>\$29,106.32</u>
Total liabilities and owner’s equity		<u>\$55,332.60</u>

Payroll records. These records must include the amount and the date of all wages or salaries paid to employees, which are subject to withholding taxes.

Corporation records. Additional records are required for corporations, including the salaries and benefits paid to its officers and dividends paid to stockholders.

Profit and loss statements (actual and projected). Your business tax is based on the bottom line (profit or loss) of the actual profit and loss statement. Projected statements are also necessary and should be prepared at least quarterly to help you make sound estimates of quarterly taxes and help you plan steps for minimizing your total taxes.

Authorization Records

One of the most important records for a locksmith to keep is the opening authorization form. It's imperative that locksmiths get an authorization filled out and signed whenever opening a car, home, safe, or anything that's locked, especially when the customer isn't known to the locksmith.

There are various authorization forms available to the industry or you can make your own or incorporate the authorization into your invoice forms. A sample form is shown in Figure 30.

AUTHORIZATION FORM

Date: _____

Last Name: _____ First Name: _____

Address: _____

Home Phone: _____ Work Phone: _____

Photo ID#: _____ Issued by: _____

I hereby certify that the information on this form is correct, that I have the authority to open the locked property described, and that I shall indemnify and hold harmless the locksmith providing me with lockout services.

Signature: _____

VEHICLES Make _____ Model _____

Owner: _____ Year _____ Color _____

_____ License/Tag No. _____ State: ____

DWELLINGS Address: _____

Owner: _____

COMMENTS: _____

FIGURE 30—Locksmiths must keep careful records of all authorization forms.

If you're opening a safe for an estate, have *all* the executors sign as well as the attorney who's handling the estate.

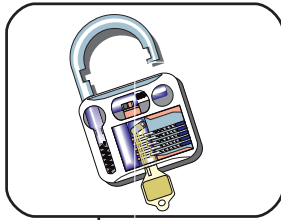
Don't just rely on the signed form. Assure yourself that the customer has legal access to the car, home, safe, etc. This can be done for a car opening by checking the registration and a picture operator's license.

Computers in Record Keeping

A personal computer can be a tremendous asset to record keeping. Many easy-to-use commercial software programs are now available at local stores that can simplify all types of financial and business record keeping. However, a computer won't be cost-effective unless you or one of your employees knows how to use it. If you have a one-person operation, instead of buying your own computer, you may find it less expensive to turn over your records to an accountant or bookkeeper for processing. On the other hand, if you employ a clerk or office assistant, you can save money on accounting fees if one of those employees can use a computer in-house. For many businesses, computers can directly result in increased profits. Your time can be better spent doing locksmithing work than in sitting at your desk with a pile of papers and a calculator in front of you.

Before you purchase a computer system for your business, seek the advice of a professional computer consultant. He or she can help you choose the best system for your reporting and accounting needs. In addition, consider the future capability of a computer when making your choice. You don't want to spend thousands of dollars on a system that will be obsolete in several years.

Finally, before purchasing a computer system for your company, check around with owners of other service businesses and interview as many computer sales representatives as possible. Keep abreast of current and projected developments in the computer field through articles in computer magazines. All of these efforts will contribute to your making the best choice of a computer system for your business.



Locking It Up! 4

Write a brief definition for each of the following terms.

1. Job description

2. Personnel policy

3. Performance review

4. Employment application

5. Job interview

6. Subcontractor

Check your answers with those on page 71.


THE KEY TO SUCCESS


The decision of whether or not to open your own business may still be down the road for you, but this study unit has shown you some of the considerations involved in starting a business. Remember that while owning a business is challenging, it's also very rewarding!

You've learned that the first and most important step in starting a business is to develop a business plan. That way, you'll be able to organize your thoughts and examine your goals. You'll also have a professional-looking document that you can show to loan officers when you begin searching for business financing.

We discussed the importance of choosing the proper location for your business and how to establish your business identity in your community. You learned what equipment is essential to opening a business. We covered some of the issues involved in hiring employees. Finally, you learned about the importance of keeping good records for your business.

KEY POINTS TO REMEMBER

 Two important elements to running a successful business are expertise and experience. In addition to this course, you could gain training through working with a veteran locksmith, taking a course at a local college, or attending subject-related seminars. To help you with the business aspect, the Small Business Administration (SBA) offers courses, publications, and advice through the Service Corporation of Retired Executives (SCORE).

 A successful business is the result of a thorough business plan. This plan includes short- and long-term goals, a definition of the purpose of your business, operating and management plans, income and expense estimates, and how you intend to structure your business.

 The three major business structures are

1. Sole proprietorship, which is a business owned and operated by one person

2. Partnership, in which two or more people combine their resources to run the business
3. Corporation, which is a more complicated business structure. A corporation makes contracts, pays taxes, and sells stock to the public.



To establish your business you need money. Start-up capital is the money needed to launch your business and working capital is the money used to keep your business running.



Capital can be acquired through loans. The many sources of loans are

- Banks and credit unions
- Personal savings
- Assets
- Friends and relatives
- Private investors
- Partners
- Corporations
- The Small Business Administration



Atop the list of priorities for starting your career as a locksmith is finding the best location for your business. A good location should offer ample parking, visibility, neighboring businesses to attract customers, and heavy traffic flow. Also, be wary of locating too close to your competition.



Just as important as choosing a good location is to the success of your business, so is choosing a name for your business. Your customers need to be able to identify your business. A keen logo will also help your business's identity.



Once your business is established and is prospering, you may find it necessary to hire employees. Before you do, develop a personnel policy to include your employee's benefits, salary, procedures, restrictions, etc., and write a job description to include your employee's responsibilities and duties.



Accurate and thorough business records will keep your business running smoothly. You'll need to maintain financial, client, and personnel records.

Do You Know Now . . .

Below are the answers to the questions asked at the beginning of this study unit.

What government agency can help you in starting a small business?

The *Small Business Administration (SBA)* can help anyone interested in starting a small business. The SBA provides information, seminars, and other business services for a nominal charge, and can also provide loans for qualified applicants.

What is a *business plan*?

A *business plan* is a written document that describes all areas of your small business. In your business plan, you'll identify what you're selling, where you're selling, and who you're selling to. A good business plan is a blueprint for success. It shows where you intend to go with your business and how much money it will take to get you off to a successful start.

What are *start-up capital* and *working capital*?

Start-up capital is the money that gets your business's doors open, including the money for major equipment (key machines, delivery vans, computers, phone systems, and so on) and supplies. Start-up capital is also used to pay insurance premiums, license fees, and any business-related legal fees you have at the start. The money needed to operate your business every day is called *working capital* (or *overhead*). This includes money for monthly rent, utilities, employees, and so on.

NOTES

Locking It Up! Answers

1

1. False
2. False
3. True
4. False
5. True
6. False
7. True
8. True

2

1. contingency fund
2. bank or credit union
3. Small Business Administration
4. seller's permit
5. Liability insurance
6. working capital
7. financial statement
8. Banker

3

1. False

2. False
3. False
4. True
5. False
6. False
7. False

4

1. A job description is a written plan of an employee's duties, responsibilities, and authority.
2. Your personnel policy is a contract between you and your employees that outlines standards of conduct and business procedures.
3. A performance review is a meeting between you and your employee to discuss the employee's job performance.
4. An employment application is a printed form that asks a prospective employee for personal and professional information.
5. A job interview is a personal interview with a job applicant.
6. A subcontractor is an individual or a business contracted to complete all or part of another person's contract.

NOTES

Starting a Small Business

EXAMINATION NUMBER:

03101300

Whichever method you use in submitting your exam answers to the school, you must use the number above.

**For the quickest test results, go to
<http://www.takeexamsonline.com>**

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1–20: Select the one best answer to each question.

1. The *breakeven point* is the point at which
 - A. variable expenses become fixed expenses.
 - B. your start-up loan is completely paid back.
 - C. your working capital equals your start-up capital.
 - D. business income equals business expenses.
2. Which government agency offers information, advice, and seminars to new business owners?
 - A. Small Business Administration
 - B. Small Business Development Center
 - C. Small Business Institute
 - D. Internal Revenue Service

3. A formal written business plan should start with a statement of
- A. your profit intentions.
 - B. your financial needs.
 - C. the mission of your business.
 - D. your personnel policy.
4. What is the first step in starting a business?
- A. Finding a location
 - B. Writing a formal business plan
 - C. Hiring employees
 - D. Purchasing business insurance
5. The purpose of a personnel policy is to
- A. inform employees of rules, regulations, and expected job performance.
 - B. improve accounting procedures.
 - C. keep salary costs down.
 - D. let the public know what you expect from your staff.
6. Which business structure has only one owner who is responsible for the business and all its debts?
- A. Capitalism
 - B. Sole proprietorship
 - C. Corporation
 - D. Partnership
7. Which of the following statements about a business telephone system is true?
- A. Most callers don't mind being put on hold for several minutes if they really want your services.
 - B. A business telephone system should have enough incoming lines so that callers rarely encounter a busy signal.
 - C. The manner in which your employees answer the phone has no bearing on your business.
 - D. A single telephone line is usually sufficient for a large locksmithing shop.
8. Working capital is money that is used for
- A. day-to-day operating expenses.
 - B. covering the business owner's personal expenses.
 - C. the first month's rent or lease on a business site.
 - D. business expansion.
9. A *business logo* is
- A. a special type of business card designed for locksmiths.
 - B. used only to identify large corporations.
 - C. an advertisement in the local Yellow Pages.
 - D. a symbol or picture that represents your business.

10. What is a *performance review*?

- A. A policy that states the minimum standards each employee must meet
- B. A notice that says the employee is about to be dismissed
- C. An outline of the duties and responsibilities of each employee
- D. A meeting between employer and employee to discuss the employee's job performance

11. A written statement describing the duties and responsibilities of an employee is called a

- A. job application.
- B. personnel policy.
- C. job description.
- D. resume.

12. The Small Business Administration will consider you for a business loan if

- A. you've been turned down by one or two commercial lenders.
- B. a bank or other lending institution guarantees the loan.
- C. you have no other sources of capital.
- D. your collateral is insufficient for a bank loan.

13. What is your *return on investment*?

- A. An estimate of how much cash you have available during a particular period.
- B. The amount of profit you make from your initial investment.
- C. The amount of money you take in during your first month in business.
- D. The total of your fixed expenses and variable expenses.

14. Unfortunately, many small businesses fail within the first

- A. year.
- B. five years.
- C. two years.
- D. three years.

15. What is the greatest disadvantage of a shopping mall location?

- A. Not enough customers
- B. Store spaces too small
- C. Not enough parking
- D. High cost of overhead

16. An employee's address, telephone number, Social Security number, and original job application will be kept in your

- A. client records.
- B. personnel records.
- C. balance sheet.
- D. profit and loss statement.

17. Your company's logo should

- A. be as large as possible.
- B. include at least six colors.
- C. be designed even before you write a business plan.
- D. be eye-catching and memorable.

18. Your company's name should always reflect

- A. what your business does.**
- B. how much money you earn.
- C. your customer's needs.
- D. your own name.

19. If you hire an employee at a salary of \$18,000 per year, how much should your gross sales increase?

- A. \$18,000
- C. \$54,000**
- B. \$36,000
- D. \$25,000

20. Which of the following professionals would be best to consult about your taxes?

- A. Insurance agent
- C. Accountant**
- B. Attorney
- D. Banker

COMING ATTRACTIONS

You may have noticed that there are a number of important business issues that we didn't discuss, such as advertising, setting prices for your services, locksmithing laws, finding a job, and buying tools and supplies. The good news is that all of these topics are covered in detail in the next study unit! By the time you finish that study unit, you'll have all the knowledge you need to start working as a professional locksmith. You've almost reached your goal, so keep up the good work! Good luck with your continuing studies!

Professional Locksmith

Study Unit 14

Working as a Professional Locksmith

Preview

At this point you've learned a great deal about all kinds of locks and keys, and how to make, repair, and service them. This course has given you an excellent overall view of the locksmithing field, and you're ready to put your skills and know-how to work. You can be the best locksmith in the world, however, and still lose money at it if you don't know how to manage yourself and your work. You're ready to make some very important decisions about your future, and this study unit will serve as your guide.

Will you go into business for yourself? Then you'll need to know what services to offer, how much to charge for them, how to advertise, how to handle customer credit and billing, and other details every business owner handles. Will you work for someone else? This unit will help you identify prospective employers and how to approach them, and give you tips on resumes and job interviews.

Of course, a malfunctioning lock doesn't pick up the phone and call a locksmith—a customer does. We'll cover good customer relations in this unit, and how to maintain a good professional image. We'll also cover important legal and ethical considerations in locksmithing.

When you complete this study unit, you'll be able to

- Recognize the services available to a locksmith
- Define the concept of specialization
- Identify sources for specialty equipment and supplies
- Implement mobile, or off-premise, services to customers
- Be aware of the wide range of laws pertaining to locksmiths
- Consider the steps in developing a code of ethics of your own
- Distinguish between certification and licensing, and understand the value of both
- Recognize some of the national associations for locksmiths and understand the value of joining
- Explore methods for acquiring tools and supplies
- Develop an effective resume, contact prospective employers in person and in writing, and conduct yourself well during a job interview
- Identify the characteristics important to maintaining a professional image

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Working as a Professional Locksmith

Do You Know . . .

What is a noncompeting agreement?

Where do you find information on locksmithing law for your area?

What is the Locksmith's Code of Ethics?

In this study unit, you'll find the answers to these and many other questions about working as a professional locksmith.

LOCKSMITH SERVICES

Government reports suggest that there are an estimated 50,000 to 60,000 locksmiths working full and part-time in the United States. They're employed in large and small businesses and shops and in organizations such as hospitals, schools, and hotels. Projections for the next decade suggest that skilled professionals have many opportunities for work in locksmithing and in security services.

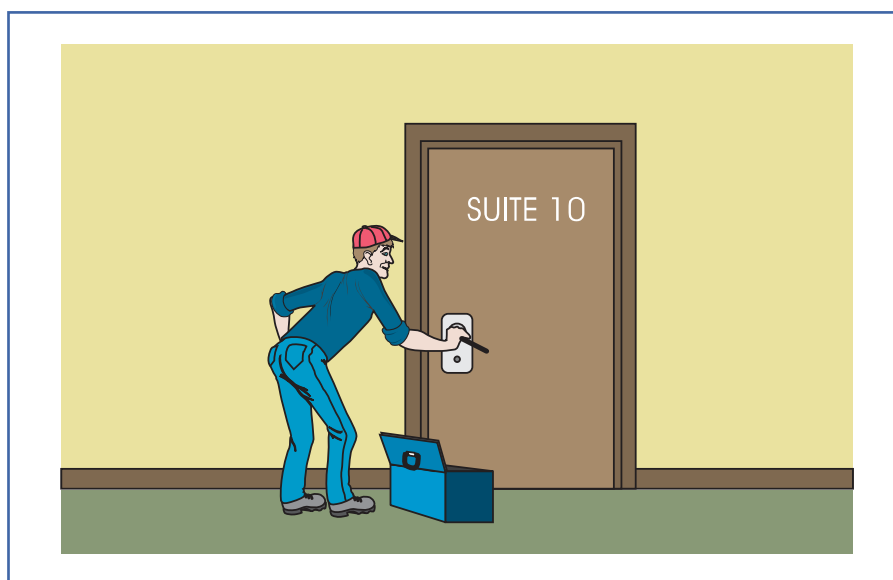


FIGURE 1— Hotels often employ locksmiths to change locks on doors. Locksmiths also find work with schools, hospitals, and factories.

Experienced locksmiths may earn on the average of \$45,000 to \$50,000 annually, depending on the areas in which they live, their skill levels, and the sophistication of the specialties they can offer. Entry-level locksmiths, on the other hand, often begin at the respectable rate of \$10 to \$12 per hour in larger cities.

If you work for someone in a shop or for an institution, you may expect to put in the standard 40-hour week. Perhaps you might be expected to do some extra or emergency work, in which case you might be paid overtime or get compensatory time. If you run your own shop, your time is your own. But realize that most small business owners work 50, 60, or even 70 hours per week when you consider all aspects of the job.

Working for Someone Else

One option for you is to seek employment in an established shop. Working in a shop has a number of advantages. First, you have the security of stability, working for an employer who has been around for a number of years and will assume the responsibility of running the business. Second, you can learn on the job from more experienced colleagues who can teach you about locksmithing as well as how to run a business. And third, you have the opportunity to meet new people and learn how to interact with them. (You'll hear about these ideas again.)

There are some minor disadvantages too. You'll be working for someone else, and you'll have to do what they want you to do. You'll be working to make someone else successful and prosperous. As the new person on the job, you may be expected to do some of the less pleasant work around the shop, or to work less favorable hours. And your fortune may be tied to someone else's.

All of these things must be considered.

Working for Yourself

Your goal, however, is probably to work for yourself. You may start out small and work part-time from your basement or garage. You may decide to invest in opening a shop full-time,

so you can offer a full range of services: key cutting, lock repair and installation, sales of locks and security devices.

Another option might be to open a *mobile shop only*, a locksmith shop on wheels in a van or panel truck (Figure 2). This is less expensive than also opening a store because rent and utilities would be eliminated. The advertising approach here would be to say, “We bring our service to you.” This approach would focus on home or industrial sales and service. Or you and your mobile shop could offer the “extra” service of late-night emergency repair, in which case you might have to purchase a mobile phone system. All locksmiths have a van (or some vehicle) because you can’t operate at a fixed location only, unless you’re an industrial locksmith.

FIGURE 2— Many locksmiths offer 24-hour emergency service with mobile equipment to handle any situation.



Specializing

There are some who say, “Learn one job and learn it well.” This is *specializing*. Perhaps there are many locksmiths in your area. To compete with them you may have to consider offering specialized services that few have. If, for example, you plan to market high-tech electronic security installation and repair, know that you’ll have to go through extensive training and possibly *certification* before you can go into business. But the reward might be that you’re now a valuable asset in the

work community and a potential subcontractor for other locksmiths. If you plan to specialize in home installation and repair, you must be certain that you're experienced in carpentry skills. If you plan to work in industrial settings, you should have a good knowledge of current (as well as old-fashioned) security systems; and this specialty could help you get work as a security consultant.

You may wish to focus your efforts on automobile door and ignition locks. You can specialize even further by concentrating on foreign cars. Or perhaps you feel that your town needs an alarm specialist or a safe specialist. But you should not direct your energies into specializing until you've done extensive research on the local need for such work. Being the best Rolls Royce lock specialist is useless if there are no Rolls Royces within 200 miles.

Preparing to Specialize

Once you decide to specialize, and you know that there's a need for the specialty, you *must* get training. There are many options available to you.

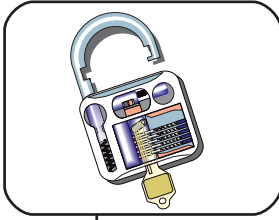
1. *Company training.* If you want to work with Rolls Royces, you may have to contact the nearest Rolls distributor to find out if there's a training center accessible to you. Or you may want to apprentice yourself to a local dealership to learn more. But often companies who train you will require that you sign a *noncompeting agreement*, which you'll learn about.
2. *Postgraduate training.* There are many training programs offered by distributors and manufacturers. You should also consider taking college business courses.
3. *Research/reference.* Throughout this unit you'll read about one of the most valuable community assets: the public library. You should get to know your local librarians for they can help you get much information. Some of the reference materials may be in the library already. Other materials may be obtained from other libraries. Your librarians can help you research the latest developments.
4. Some information is readily available in book form. *Books in Print*, a multivolume reference set, can help you find information by author, title, subject, and publisher.

FIGURE 3— Use your local library to obtain available references and information.



These books may be found in your local library or in bookstores in your area.

5. Catalogs and repair manuals may be obtained directly from some manufacturers, distributors, or supply houses. Again, your librarian can help you start locating them. One starting point might be the *Thomas Register of American Manufacturers*.
6. *Kits, parts, machines.* As you become more expert in your specialty you may need to purchase specialty equipment. You may want to buy kits that will help train you. Machines that you may wish to purchase will come with written instructions or service manuals, perhaps even videos. And you may collect used or broken equipment and practice on that. Your imagination should be unlimited. Once more the *Thomas Register* may be of help.
7. You can also turn to professionals in your area of specialty and ask for advice or help. This is a form of *net-working*, and you'll hear more about it later in this unit.
8. The best source of education, second only to working with another locksmith, taking a course, or going to school, is subscribing to all of the monthly locksmithing trade magazines. They are *Keynotes*, published by the Associated Locksmiths of America (ALOA), the *Locksmith Ledger International*, *The National Locksmith*, *Reed's Security Reporter*, and *Safe and Vault Technology*. (You'll find the addresses of these trade magazines later in this study unit.)



Locking It Up! 1

At the end of each section in your *Professional Locksmith* texts, you'll be asked to pause and check your understanding of what you've just read by completing a *Locking It Up!* quiz. Writing the answers to these questions will help you review what you've studied so far. Please complete *Locking It Up! 1* now.

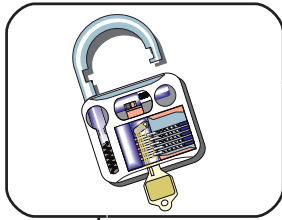
1. What are some of the areas in which locksmiths specialize?

2. What are some of the advantages of working for another locksmith?

3. What are some of the disadvantages?

4. List five ways you can get specialized training.

(Continued)



Locking It Up! 1

5. Name two institutions that regularly hire locksmiths.

6. What is a mobile shop?

Check your answers with those on page 69.

ON THE ROAD

Whether you offer “road service” as a specialty or as a part of your regular service, you should be aware of some of its benefits and potential drawbacks.

Emergency Calls

Some locksmiths offer 24-hour *emergency service*, emergency being defined as a situation which is sudden, serious, unexpected, and demanding immediate action. Emergency service is an attractive feature which can bring in additional, and profitable, business. But because of its very nature, you must be well prepared in advance to handle it. First, you need equipment which is ready when you need it. Ideally, you should have a mobile shop, or at least portable equipment that’s always ready to go. If you can’t afford to equip yourself properly, don’t offer the service. Second, you must be prepared emotionally. Emergency service is filled with stress, the customer’s and yours. Are you willing, and do you have the temperament, to deal with stressful situations? If so, you may be well suited to offer emergency service.

You’ll need to establish an *emergency hotline* which will be answered 24 hours a day. If there’s any question about not having someone to work a shift, you might consider an answering service which can answer and screen calls for you. You would have to instruct the service thoroughly so that they know your policies. And you should have *policies*, written and very specific. These would include types of services available, minimum service charges for each service, and the minimum information necessary for service. (If you get a call to open a bank safe at 3 A.M., you had better be certain that the call is legitimate, or that you can confirm who’s calling.) If the call seems suspicious, you may want to have a partner go with you. If you have a good rapport with your local police department, you may want to inform them. (Locksmiths who offer emergency service *should* notify their local police; they’re a source of business. Many people call the police when they lock their keys in their cars because they want to get them opened for free. However, the police usually refer such calls to a locksmith, since car openings are getting much more complicated and there’s liability if the car is damaged.)

Be prepared for some degree of potentially suspicious calls and be prepared as to how you plan to answer them. Also be prepared for “crank” calls, the party-goers who call to ask for help in “cracking open” another bottle of champagne, etc. You’ll probably need a portable phone system—a cellular phone or business radio—for your van or car, as well as a police scanner for the shop to keep alert to emergencies that might affect you. All of these items can add expense to your business.

Road Calls

Everything that applies to emergency calls can also apply to *road calls*, except for the intensity of the emergency and the possibility of a life-or-death situation. However, every customer feels that every situation is a rush. Again, to do the job right you need the right equipment and the right attitude.

FIGURE 4— Locksmiths are often contacted for “road calls” to retrieve keys locked inside cars or to repair frozen door locks.



Road calls might include calls about keys locked in cars at shopping malls, frozen locks, lost keys, calls from store owners or large businesses like hotels or manufacturers who need on-site service such as duplicating keys that can't leave the

facility (Figure 4). You may wish to hire an answering service to take calls when you're out. At the very least, consider getting an answering machine to record nonurgent business. Be sure to get an authorization form signed before opening anything.

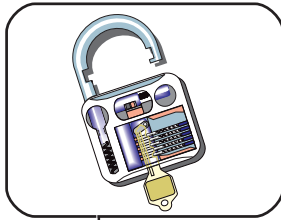
House Calls

House calls are usually planned in advance. Perhaps your first visit to the home was an inspection visit to determine the scope of the job to be done. You should have provided a *written estimate* to the customer, and gotten a signature

confirming the agreement. When the agreement is reached, you assemble the necessary materials and establish a mutually convenient time to do the work. House calls might include opening locks when the keys have been lost; repairing broken locks; replacing old locks with new; or repairing, replacing, or installing security systems. Some of the work requires skills in addition to locksmithing skills. The true professional will be something of a carpenter, an electrician, and a mason as well.

Later in this unit you'll learn more about protecting your customer and yourself. Road service can be tricky. Once a job is done it can't be undone without legal ramifications. Before you go out on the job, it's wise to remember that you and the customer should be aware of all costs, limitations, liabilities, and stipulations. Remember, always get an authorization form signed.

Road service can be a profitable part of your business if you maximize its advantages.



Locking It Up! 2

Indicate whether each of the following statements is True or False.

- 1. Twenty-four-hour emergency service is a regular part of every locksmith's business.
- 2. Locksmiths who plan to offer emergency service should always notify the police of what they're planning.
- 3. Locksmiths have no need to learn basic carpentry skills.
- 4. There are potential disadvantages to offering road services.
- 5. Answering services aren't helpful to locksmiths who offer road service.
- 6. An answering machine can be an asset to your business.

Check your answers with those on page 69.

LOCKSMITHING LAWS AND ETHICS

Learning the Law

A lock is a security device, a way to protect people and valuable property. You, as a locksmith—the word *smith* means one who makes or fixes—are a part of the protection and security profession. And like any other professional who serves and protects, you should know and observe the laws of your community, your state, and your country.

The Laws in Your Community

You'll discover as you progress in your profession that laws regarding locksmithing will vary greatly depending on the area in which you plan to work. Some states and provinces are tightly regulated (California is one); some communities may have no specific laws at all. Your first task, then, is to contact local agencies to find out as much as you can about the laws in your town. An excellent first step is to visit your local police department to introduce yourself. First, it will show that you respect the law and want to cooperate with law enforcement officials. Second, and on a more practical level, it may provide you with a source of job leads. If the police are in need of a locksmith and they've met you, they may call you! The police may be able to inform you of legal requirements or direct you to a legal aide or attorney who could explain municipal statutes.

A second source of information about the law is other locksmiths. While some shop owners may see you as a competitor and be a bit reluctant to give you much information, you can work to convince them that you're sincere in wanting to do the best job you can. Others may be eager to share information with you.

A third source of information is local, state, or national locksmithing organizations. You'll learn more about how to join them later in this unit. Working with professional / fraternal associations is invaluable for finding out the latest on locksmithing. Most organizations offer magazines, seminars, annual conventions, and books on all aspects of locksmithing.

For example, the Locksmith Publishing Company, which also publishes the *Locksmith Ledger International*, produces a series of books entitled *Locksmith Law*. These are practical and handy booklets focusing on legal advice, court cases and judgements involving security, and legislative reports. Starting a library of legal reference material may save you money and worry in the future.

Who Is Protected by Law?

Laws not only protect the customer, they also protect you. What is your liability in cases where you install a lock? When can you legally duplicate “official” looking keys? This kind of information is invaluable. For instance, post office keys can’t be duplicated without postmaster authorization.

Here, briefly, are seven points of legal advice that every locksmith should commit to memory:

1. Always put everything in writing. This means everything: orders, receipts, agreements. This can be done in specific, uncomplicated terms. However, if you’re committing to a large and expensive project, get an attorney to draw up a contract to protect you and your client. All locksmiths should have preprinted *authorization-for-service forms* that can be filled out quickly and easily filed for future reference (Figure 5).
2. Once you install a door lock on a building, you can’t remove it without the permission of the owner, even if he or she has refused to pay you for your services. You would have to consult an attorney to find out what steps you would need to take next. (If you have a *written and signed* authorization-for-service agreement, it will help your case.)
3. Insist on payment in full before returning to a customer duplicated keys, repaired locks or equipment. This will reduce the possibility of your being “stuck” for work done.
4. When you work on security equipment at a customer’s home or business premises, it’s relatively safe to assume that the equipment belongs to the customer. However, if a customer brings equipment into your shop for repairs,

<p style="text-align: center;">AUTHORIZATION FOR LOCKSMITH SERVICE</p> <p>I hereby certify that I have the authority to order the lock, key, or security work designated on the reverse side. Further, I agree to absolve the locksmith who bears this authorization from any and all claims arising from the performance of such work and/or not to hold him or her responsible for any reason whatsoever.</p> <p>Name _____ Phone _____</p> <p>Address _____</p> <p>City _____ Zip/Postal Code _____</p> <p>Employed by _____</p> <p>Address _____</p> <p>City _____ Zip/Postal Code _____</p> <p>Phone _____ Date _____ Time _____</p> <p>I am the person who called the locksmith to perform the work described on the reverse side of this authorization.</p> <p>Signature _____</p>	<p style="text-align: center;">DESCRIPTION OF WORK COVERED BY AUTHORIZATION ON REVERSE SIDE</p> <table style="width: 100%; border: none;"> <tr> <td><input type="checkbox"/> Main Entrance</td> <td><input type="checkbox"/> Open Lock(s)</td> </tr> <tr> <td><input type="checkbox"/> Front Door</td> <td><input type="checkbox"/> Secure Premises</td> </tr> <tr> <td><input type="checkbox"/> Side</td> <td><input type="checkbox"/> Fit Keys</td> </tr> <tr> <td><input type="checkbox"/> Rear</td> <td><input type="checkbox"/> Install</td> </tr> <tr> <td><input type="checkbox"/> Hall</td> <td><input type="checkbox"/> Remove and Replace</td> </tr> <tr> <td><input type="checkbox"/> Inside</td> <td><input type="checkbox"/> Master Key</td> </tr> <tr> <td><input type="checkbox"/> Window</td> <td><input type="checkbox"/> Re-pin</td> </tr> <tr> <td><input type="checkbox"/> Closet</td> <td><input type="checkbox"/> Change Comb</td> </tr> <tr> <td><input type="checkbox"/> Safe</td> <td><input type="checkbox"/> Clean/Lubricate</td> </tr> <tr> <td><input type="checkbox"/> Patio Door</td> <td><input type="checkbox"/> Adjust</td> </tr> <tr> <td><input type="checkbox"/> Other</td> <td><input type="checkbox"/> Other</td> </tr> </table> <p>If Auto</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">YEAR</td> <td style="width: 50%;">COLOR</td> </tr> <tr> <td>MAKE</td> <td>LIC</td> </tr> <tr> <td>MODEL</td> <td></td> </tr> </table> <p>Job Address (if different from person signing this authorization)</p> <div style="border: 1px solid black; height: 20px; width: 100%;"></div>	<input type="checkbox"/> Main Entrance	<input type="checkbox"/> Open Lock(s)	<input type="checkbox"/> Front Door	<input type="checkbox"/> Secure Premises	<input type="checkbox"/> Side	<input type="checkbox"/> Fit Keys	<input type="checkbox"/> Rear	<input type="checkbox"/> Install	<input type="checkbox"/> Hall	<input type="checkbox"/> Remove and Replace	<input type="checkbox"/> Inside	<input type="checkbox"/> Master Key	<input type="checkbox"/> Window	<input type="checkbox"/> Re-pin	<input type="checkbox"/> Closet	<input type="checkbox"/> Change Comb	<input type="checkbox"/> Safe	<input type="checkbox"/> Clean/Lubricate	<input type="checkbox"/> Patio Door	<input type="checkbox"/> Adjust	<input type="checkbox"/> Other	<input type="checkbox"/> Other	YEAR	COLOR	MAKE	LIC	MODEL	
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<input type="checkbox"/> Side	<input type="checkbox"/> Fit Keys																												
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FIGURE 5— Authorization contracts for service protect you and your client from possible liability.

you can't be sure whether the customer really owns the equipment. In addition, whenever you do work on-site—especially on emergency calls, late at night, in an unlikely area, or with an expensive automobile—there's always the chance that the customer has criminal intentions. Always ask for proper ID and have the client sign a *Declaration of Ownership form* (Figure 6).

5. Add to your library the fire codes of the state/province, county, and cities where you plan to offer your services. This is a way to quickly check on possible code violations when you're installing locks. You should also have the life safety code handbook and the Americans with Disabilities Act (ADA) requirements.
6. You can't be forced to do locksmithing work you don't want to do, even if you're asked to do so by a law enforcement officer. But, for peace of mind, always check with your attorney to assure your rights.

FIGURE 6— A signed Declaration of Ownership form protects you from possible criminal liability.

DECLARATION OF OWNERSHIP	
I, _____	(Name)
_____	(Address)
do hereby certify that I am the owner of the	
Automobile _____	License No. _____
	Make
House or Apartment _____	Address _____
	Number
Commercial establishment _____	Address _____
	Address
Safe _____	Make and Location _____
	Make and Location
Box, Chest or Cabinet _____	Description _____
	Description
I authorize (your name) to open on the premises or articles above described and to fit keys or make repairs to same.	
I hereby agree to absolve said locksmith from any and all claims or to hold the locksmith responsible for any cause whatsoever by reason of the performance of his or her work.	
Owner _____	_____
Title _____	_____
Date _____	_____

7. If you're hired as an apprentice or as a locksmith by an established locksmithing shop, you may be asked to sign a *noncompeting or restrictive covenant*. This means that you're promising not to take the skills you learn on that job and directly compete by opening up a rival shop. If you hire an apprentice or a locksmith, you have the right to ask him or her to sign a similar agreement.

The law is a complex and ever-changing subject that you'll have to keep up with throughout your professional life. You'll find that sometimes reading will be as much a part of your life as repairing locks.

Written Records

You'll notice that the first and most important word of legal advice to locksmiths was "get it in writing." This process can be streamlined, as you've seen, by the use of preprinted forms. In addition to information relating to the up-front aspects of the job—client's name, task to be performed, etc.—you can add follow-up information: amount of payment, method of payment and any other relevant data. A good filing system will also help you with your tax records as

well as providing you with some backup should the law require it.

The information you include on your *client records* can also help you plan future marketing efforts. Accurate client records provide an overall picture of your referral sources; the percent of location service calls by geographic location and types of buildings (private or business); special needs of your clients; and other factors useful in expansion, specialization, and public relations decisions.

A client record should include at least the following information:

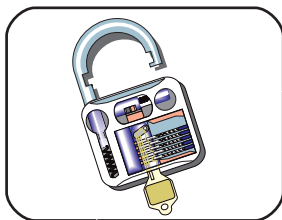
1. Name, address, and telephone number (home and business) of client
2. Referral source (name, company, address, and telephone number)
3. Date and time of service call
4. Location and type of property
5. Type of service (locks, security; repair, entry)
6. Special situations or instructions (rush job, contact person other than client or referral source, particular problems at location)
7. Name of the locksmith who performed services (indicate if owner, employee, or subcontractor)
8. Date and time billing statement was sent to client (Note whether it was mailed, faxed, or hand delivered.)
9. Any unusual circumstances, hazards, or problems in completing the job
10. Amount of the fee charged
11. Date the fee was paid
12. Method of payment (cash, check, or credit card)
13. Name and address of bank, account number, check number, or credit card information (if applicable)

Ethics

You obey the law because you have to, but as a professional you follow good business *ethics* because you want to. *Ethics* are codes of operation, morals, scruples, that businesspeople follow to show that they're responsible citizens and reliable members of the business community. You'll develop your own code of ethics as you mature in your work, but here are some examples of ethical attitudes for locksmiths.

Locksmith's Code of Ethics

1. Always obey the laws of your community, your state or province, and your country.
2. Never help others break the law.
3. If a job is too much for you to handle, say so. Recommend a locksmith who can do the job.
4. Keep thorough written records: of buildings you've been asked to work on or in; of the person who hired you to do the job; of any automobiles you've been asked to unlock, including model, year, and license number.
5. Always charge a fair fee for a job well done.
6. Never share or discuss techniques of lockpicking, lock opening, or bypassing electronic security with anyone but a professional locksmith.
7. Cooperate with all officials and officers of the law.
8. Seek constantly to improve your skills.
9. Join with your fellow locksmiths on the local, state/province, and national level to make locksmithing an even more professional and respected occupation.



Locking It Up! 3

The questions in this self-test are based on real-life situations. How would you answer them?

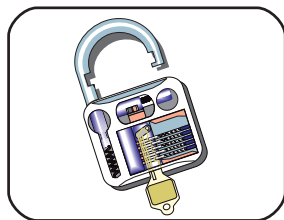
1. Locksmith Lou installs a lock on the shop door of Shopkeeper Sam, with the understanding that he'll be paid upon completion of the job. Lou does the installation, but Sam doesn't pay. Can Lou remove the lock?

2. Sally calls your shop because she's locked out of her home. You tell her you'll be there in 10 minutes. When you arrive, she has found the key and is now inside. Does she owe you anything?

3. Sally's husband Stanley calls you, this time at midnight and on your emergency phone number. He's been locked out again by his wife. He asks you to come and open the door. Can you help him? Would you help him?

4. When you get to Sally and Stan's, she has forgiven him and he is inside. Does he owe you anything?

(Continued)



Locking It Up! 3

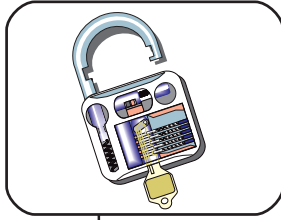
5. A customer comes into your shop for a duplicate key. You tell him to come back in 10 minutes. When he returns, you've completed the job and have the keys. But he refuses to pay because he says there's a shop down the street that's 50 cents cheaper. He wants his key back. Do you have to return his original key?

6. Imagine the same situation. You refused to give the customer the key until he pays for the job. He gets a police officer who insists that you return the key. Do you have to return the key now?

7. With large numbers of military, industrial, and educational locks and lockers being sold for surplus, is it okay for you to fit keys for these types of equipment?

8. A restaurant owner who's a good friend of yours complains that food is being stolen from the restaurant, probably through the back fire door. Your friend wants you to install a deadbolt lock to prevent such thefts. Would you do it?

(Continued)



Locking It Up! 3

9. John Smith hires Security Sellers to install solid steel grilles over the first floor windows of his downtown shop. One morning, six months later, he opens his shop to discover that he has been robbed. The thief ripped the grille from a window and came in. Is Security Sellers liable?

Check your answers with those on page 69.

LOCKSMITHING CREDENTIALS

Today's public demands the best from the people who provide the services they need. The more important the service is to people, the more important professional credentials become. Potential customers want to know that the person they're entrusting their security to—the locksmith—is honest and competent. Thus, it's not surprising to see locksmiths advertising that they're "certified," or "licensed," or "bonded," or combinations of the three. But what do these terms mean?

Certification

According to *Black's Law Dictionary*, *certification* is "the formal assertion in writing of some fact. The act of certifying or state of being certified." *Black's* defines *certificate* as "a written assurance, or official representation, that some act has or hasn't been done, or some event has occurred, or some legal formality has been complied with."

The emphasis in certification is one of competence. Certification confirms that an individual has completed specified tasks or gained a certain level of skill in doing those tasks. Normally, certification comes from a school or professional organization; in a few cases it may come from a governmental body. You've heard of a CPA, a certified public accountant; CPAs are certified by the state. You've probably heard of a board-certified surgeon; surgeons are certified by a committee of expert surgeons, perhaps from a hospital or a medical school or the AMA.

When you complete your program you'll receive a certificate of completion (a diploma). If you take a seminar from a local locksmith you might receive a certificate of attendance. Some colleges or vocational schools offer courses of study and award a certificate on completion. The value of the certification depends on the organization awarding it. A certificate from Education Direct, an accredited home-study school operating for over 100 years, is respected because of the industrywide regard the school has earned.

Even though some members of the locksmithing profession feel that certification is an intrusion into private business, most members feel it's a valuable asset. One state association,

the California Locksmith Association, summarized the significance of certification as follows:

1. It sets a minimum standard that all members of the association should meet.
2. It sets a minimum standard that all customers can expect from an association member.
3. The profession itself would already have standards in place if a state government should decide to require licensing for locksmiths, as more and more states are doing.
4. It's a way to assure that locksmiths continue their education.

After the program completion, the next levels of certification are

- CRL—Certified Registered Locksmith
- CPL—Certified Professional Locksmith
- CML—Certified Master Locksmith

These are the Professional Registration Program (PRP) ratings implemented by the Associated Locksmiths of America (ALOA). You must take comprehensive examinations to earn these ratings.

Licensing

Black's gives two broad definitions of “license.” The first definition—“The permission by competent authority to do an act which, without such permission, would be illegal, a trespass, or a tort”—refers to business operations. You may have seen words similar to the following on your favorite beverage can or bottle: “licensed for bottling by XXX Corporation.”

The second definition applies to you as a locksmith: “A permit, granted by an appropriate governmental body, generally for a consideration, to a person, firm, or corporation to pursue some occupation or to carry on some business subject to regulation under the police power.”

Two parts of this definition make *licensing* very different from certification. “Appropriate governmental body” clearly tells you that licensing can only come from official governmental bodies—local, state, or federal; “business subject to regulation under the police power” tells you that you can be arrested if you try to operate without the correct license. We’ve stressed the importance of cooperation with law enforcement officials. This definition serves to emphasize how important cooperation can be.

Be certain that you know the law on licensing requirements for your area before you start offering your services. You know that you must follow standard business practice and get any appropriate licenses needed. Certain states have also passed licensing laws for specific professions, so check carefully with authorities or associations for more information about requirements. Although several states are addressing licensing, California is the only state that requires locksmiths to be licensed. Many cities, such as New York, license locksmiths.

Bonding

This term is often associated with businesses that deal with the handling of large sums of money or with valuable personal property. *Bonding* is a type of insurance that protects the company or owner in the event that an employee steals or does something dishonest on the job. This type of bond is called a *conditional bond*, because its payment is linked to the *condition* of something happening or not happening. It’s distinguished from an *unconditional bond* which is a kind of *investment security*.

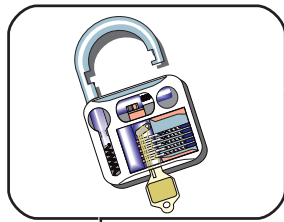
There are many types of conditional bonds. You’ve certainly heard of a *bail bond*: it guarantees that a defendant in a court case will show up for trial or sentencing, or the money (bond) will go to the court. Locksmiths would most likely be interested in *fidelity bonds*. These are bonds that insure employees, so that their actions are covered by insurance and you’re protected. You get paid if they do some criminal act in their capacity as your employee. How much you get depends on the size of the bond you’ve purchased. Remember, a client who suffers as a result of your dishonest employee gets none of the bond; that money goes to you. But also remember that the customer has the right to sue you for any losses or damages.

If you look in the Yellow Pages of your telephone book, you'll see local agents or companies who issue bonds. If you have any doubts about the need for bonding, contact an attorney or your nearest locksmith association. Most of the trade magazines offer very low-cost bonding for locksmiths. ALOA also offers bonding.

Certification is something that every professional locksmith will want to look into. As we've said before, certification sets standards that benefit everyone. Licensing, on the other hand, is something that's generally mandated; if you don't get the license, you don't practice. In both cases, look upon these as legitimate parts of your job. You'll be a better locksmith and businessperson for it (Figure 7).

FIGURE 7—
Certifications, licenses, or bonds may be needed when offering your services. Contact your state government for the proper licensing requirements.





Locking It Up! 4

1. What, according to the California Locksmith Association, are the reasons for certification?

2. Why is licensing more particular than certification?

3. What is bonding?

Check your answers with those on page 70.

LOCKSMITHING ASSOCIATIONS AND PUBLICATIONS

By now you know what happens to a lock that's unused or never lubricated. It rusts and freezes up. It jams and isn't useful any more. Your skills as a locksmith can suffer a similar fate. "But," you'll say, "when I'm working I'll keep my skills sharp." "But," we reply, "the field of locksmithing, like any other technological field today, has the potential to change weekly." Twenty years ago few businesspeople thought it would be possible to use plastic cards as keys. Today, electronic locking systems have replaced the standard lock and key in many operations. And how many expensive automobiles now use touch pads with combinations as locks? Or even miniature, remote-control electronic door openers? The locksmith who doesn't know how to work with new technologies will lose customers.

There are many ways to keep abreast of new technology. The first is to become a member of a local, state, or national *professional association*.

Professional Associations

As a new business owner, you may wish to join one or more professional associations. If you decide to do so, be sure to include any necessary membership fees in your estimation of start-up costs. Although each association has its own membership requirements and benefits, here are some of the more common benefits you might expect to receive from such a membership:

- Seminars and conferences
- Group insurance
- Technical and business publications
- A measure by which you can determine if your business is keeping up with current trends and innovations
- Association with other locksmiths
- Certification

Local/State Associations

The easiest way to find out about local or state associations is to look in the Yellow Pages of your telephone book. First, you'll find the names of local locksmiths. Calling them can provide you with information on whether or not there are local groups which meet formally or informally. Meeting other locksmiths can help you develop fellowship and information-sharing—sometimes called “networking.” Be sure to impress on anyone you call that you're not trying to “pick their brains” as a competitor.

A second step might be to contact your local library to see if they can help you locate information about state or local groups. Most public libraries have, or have access to, a directory entitled *The Encyclopedia of Associations*, which comes in several editions. There's a five-volume edition covering five geographical sections of the country which is devoted to regional, state, and local organizations. If your public library can't help you, the libraries of local colleges or universities should be able to help.

National Associations

The Encyclopedia of Associations is also available in a national/international edition, three volumes listing over 23,000 organizations. Again, most public libraries have it, or have access to it.

For example, later we'll mention two associations that may be of service to you: Associated Locksmiths of America (ALOA) and the Locksmith Security Association (LSA). ALOA is listed in the “hardware” section of the *Encyclopedia*. If you plan to work primarily with householders or builders it might be helpful to examine other related associations which might be beneficial. The Builders' Hardware Manufacturers Association (BHMA), for instance, may have information on the latest in locks, door hardware, latches, and other supplies that you could use in your business. LSA, on the other hand, is listed in the “security” section of the *Encyclopedia*. If you plan to specialize in security work, you'll find information about such groups as the National Alarm Association of America and the National Burglar and Fire Alarm Association. If working with combination locks on safes and

vaults is your calling, you may be interested in the Safe and Vault Technicians Association. Due to the sensitive nature of their work, all SAVTA members must be fingerprinted. A little interest and ambition on your part can provide you with a wealth of results.

Associated Locksmiths of America (ALOA)

The ALOA is a large (10,000-member) national organization of owners of retail locksmith shops. Manufacturers and distributors of locks and other security devices may join as associate members. Through its membership journal, *Keynotes*, and through yearly technical training classes, ALOA seeks to educate and inform individuals in the physical security industry. ALOA publishes an annual *Who's Who Among Professional Locksmiths*, another valuable resource tool. In addition, members have access to insurance and bonding programs. For more information contact

Associated Locksmiths of America
3003 Live Oak Street
Dallas, TX 75204
Phone: (214) 827-1701

Locksmith Security Association (LSA)

LSA is a smaller organization since its focus is primarily on the security aspect of locksmithing. It too seeks to provide its members with education in practical and physical security. In addition to offering a number of educational seminars a year, LSA has a speakers' bureau on topics of importance to security professionals. LSA publishes *LSA Times*. Contact

Locksmith Security Association
4732 Rochester Rd.
Royal Oak, MI 48073
Phone: (313) 589-0318

Lock Museum of America (LMA)

Finally, for locksmiths interested in the historical aspect of the business, the Lock Museum of America may be valuable. Located in Connecticut, the museum is dedicated to the colonial craft of locksmithing. The museum publishes a *Newsletter and Historical Research Series*, a quarterly for

members. Locksmiths who work with antiques, antique dealers, or restorers could find this a helpful source for resource information.

Contact

Lock Museum of America
130 Main Street
P.O. Box 104
Terryville, CT 06786-0104
Phone: (203) 589-6359

Another association that can be of help to you when you start to establish your own business is the National Locksmith Suppliers Association, 1900 Arch Street, Philadelphia, PA 19103. They should be able to provide you with dealers and suppliers in your home area.

Books and Periodicals

The second way to keep informed about the state of locksmithing is to read current books and periodicals (magazines). Again, your local library is the best place to start looking.

A publication entitled *Books in Print* can tell you what books on any subject are currently available, their costs, their publishers, and the year of publication. If the book seems important, try to find out more about it before you buy it. Go to your library again. If they don't have the book, they may be able to get it for you through interlibrary loan. That is, they'll borrow it from a library that has it, and you can check it out. If it's particularly good, you may want to buy your own copy of it and add it to your library.

There are a number of periodicals dedicated to locksmithing:

Keynotes

Associated Locksmiths of America
3003 Live Oak Street
Dallas, TX 75204-6189
Phone: (214) 827-1701

The National Locksmith

1533 Burgundy Parkway
Streamwood, IL 60107
Phone: (708) 837-2044

Reed's Security Reporter
4141 Blue Lake Circle, #130
Dallas, TX 75244-5105
Phone: (214) 980-9393

Keyways
(Master Locksmiths Association)
Paramount Publishing Ltd.
17-21 Shenley Rd.
Borehamwood Herts WD6 1RT
England

Locksmith Gazette: The Magazine of Professional Locksmithing
Box 14321
Columbus, OH 43214

Locksmith Ledger International
Locksmith Publishing Company
850 Busse Highway
Park Ridge, IL 60068-5980
Phone: (708) 692-5940

Master Lock News Today
Master Lock Company
2600 N. 32nd Street
Milwaukee, WI 53210
Phone: (414) 444-2800

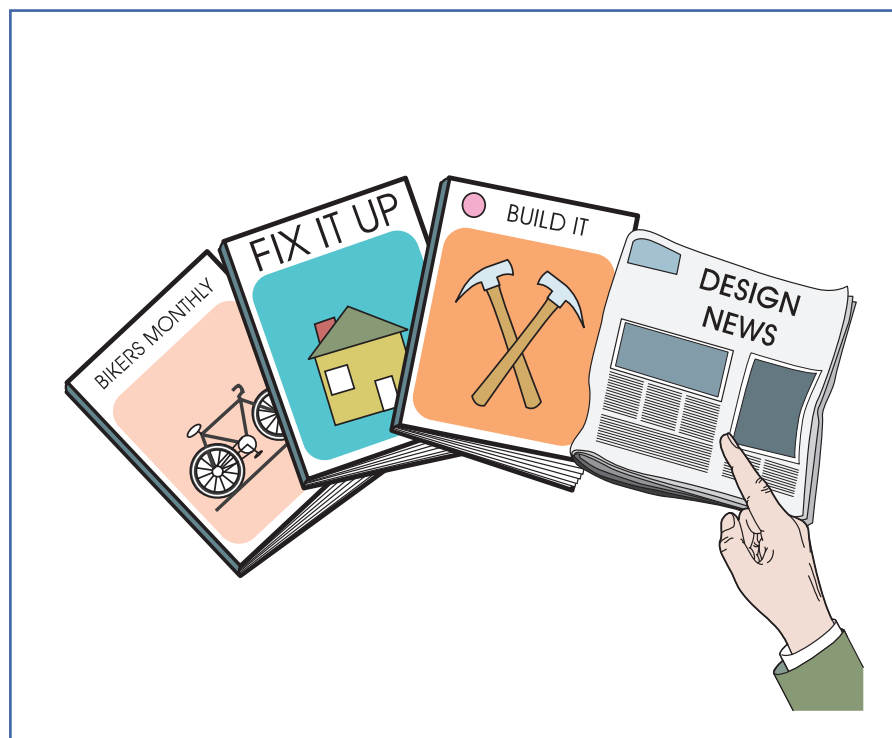
Safe and Vault Technology
3003 Live Oak Street
Dallas, TX 75204-6189

The phone numbers are current, but may change without notice, so please check. Subscription rates will vary. Subscriptions may be deductible as a business expense, but check with an accountant, Small Business Administration office, or your local IRS office for clarification. If you don't want to invest the money, you may be able to convince your local librarian to order the magazine for the library. Or if you have a number of friends or colleagues interested in the magazine, you might take out a joint subscription and share it.

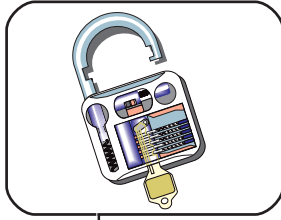
Specialized journals aren't the only place for information, however. A recent computer search of articles published within a six-month span revealed that the following magazines and newspapers printed articles on the latest information on

locks: *Cycle World*, *Bicycling*, *Home Mechanix*, *Design News*, *American Journal of Public Health*, and the *Wall Street Journal*. (Your librarian can help you do research in the annual *Periodicals Directory*, a source for all types of magazines [Figure 8].)

FIGURE 8—
Professional journals aren't your only source of news and information about locksmithing. All of these publications have featured articles of interest to locksmiths.



As you can see, there is a wealth of information available for the resourceful locksmith. And resourcefulness is one of the hallmarks of a successful businessperson. To be effective you have to know what is happening now. With some initiative on your part—checking your local library, doing some extra reading—you can become knowledgeable and successful.



Locking It Up! 5

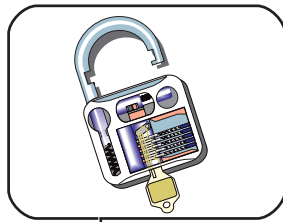
1. List five benefits of joining a local or national locksmith association.

2. Which national locksmith association is for locksmiths who work in the security profession?

3. Where can you find information on what locksmithing books are currently in print?

4. Where is the easiest place to start looking for information about a local locksmith association?

(Continued)



Locking It Up! 5

5. A client who deals in antiques thinks she has a lock that belonged to Paul Revere. Where would you go to find out what kind of locks might have been used during the Revolutionary War?

6. *True or False?* Only magazines that focus on locksmithing have any information in them about new developments in the field.

Check your answers with those on page 71.

TOOLS, PARTS, AND SUPPLIES

What you'll need in terms of support/service materials will obviously depend on the scope of your business plans. If you work for someone else, you may need nothing but your knowledge and skills, and perhaps your own set of tools. If you plan to offer your services part-time or on a limited scale as part of another business (carpentry, perhaps), you'll need tools, a certain amount of replacement parts (assuming that you figure out where your service might be most in demand), and perhaps a small amount of supplies like locks.

On the other hand, if you decide to open your own business—on-site or mobile—you'll need to invest in start-up materials and establish an adequate *inventory*.

Start-Up

You know that you'll need all the basic start-up materials that every businessperson needs: phones, furniture, business supplies, insurance, licensing and permits where appropriate, an accounting system, and an advertising plan and budget. In short, you need a complete business plan.

You'll have your tools from your ICS Professional Locksmith Course. You know that you can gather some parts from used, broken, or discarded locks and security systems. (Your friends and relatives can help you assemble a good supply of replacement parts.) And by now you know that if you plan to cut keys, you'll need a key cutting machine—stationary or portable—and a variety of blanks, perhaps on a display stand or rack. If you plan to sell locks and other security devices—alarm systems, smoke detectors, lighting—you'll have to do some research to discover what “sells.” This means contacting local suppliers and distributors and major manufacturers and asking them to help you track security demands for the past 10 years or so (about the life span of some devices). Contact salespersons for the items you wish to offer. They're always willing to help a potential customer and they can provide you with a lot of marketing information. You'll have to determine how much inventory your business plan and budget will allow you to purchase.

Inventory

Every business needs some kind of material in order to operate successfully. This is especially true of retail businesses, which need inventory to sell to customers. And while locksmithing is in many respects primarily a *service industry*—that is, you’re selling your abilities and knowledge—you’ll also make money operating as a retail business, selling locks, keys, alarms, and all the other items you’ve learned about.

Managing and regulating your inventory is important because inventory controls the cash flow in your business. How does this happen? Well, buying too much inventory ties up your cash; and if the inventory is slow-moving merchandise, the cash you bought it with is unavailable until that merchandise is sold. Additionally, the space these items are taking up in your shop is unavailable for other purposes. (Hence, the importance of up-front research.)

On the other hand, if you purchase too little inventory, you won’t have the merchandise your customers want—they’ll learn to turn to your competitors for those items and you’ll lose their business (Figure 9).

Tracking inventory in a small shop is just as important as tracking inventory in a large shop. As a matter of fact, it’s

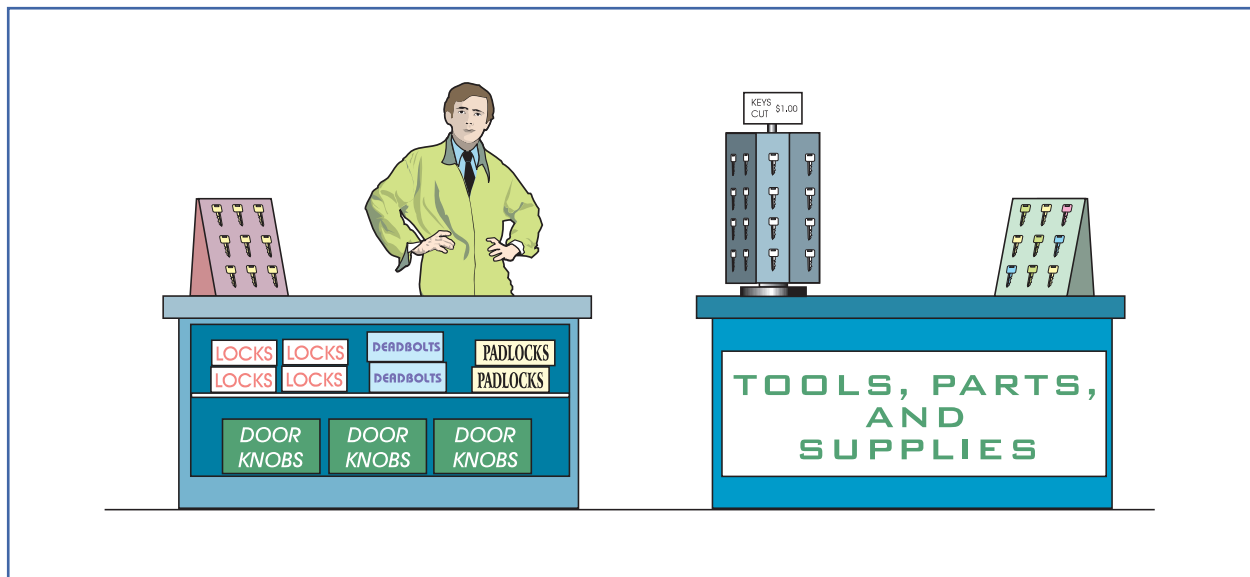


FIGURE 9— It’s beneficial to have a well-stocked inventory of items frequently used. Tools and parts can be ordered from supply catalogs or distributors.

probably more difficult, since a small shop has less space for large amounts of inventory.

You should keep a constant eye on your inventory. If something doesn't turn over quickly enough, consider marking the price down to the extent necessary and get rid of it.

Investing your money in something that doesn't sell is foolish. Get what you can from it and reinvest your dollars in something that's readily saleable and profitable.

Obviously, if you have extremely limited financial resources, you won't be able to offer a vast inventory on your shelves. In such a case, spend your limited resources on the items that are most popular, but make sure you let the customer know that you can order something if he or she doesn't see it in your shop. If you can, offer products in different price ranges to maximize customer coverage.

Even if a particular product is in demand and readily available, before you take the plunge to go out and buy it, first determine whether or not you can sell it profitably and quickly.

Having your money tied up for long periods of time in slow moving merchandise, or letting your customers pay for their goods on drawn-out time arrangements, can have serious consequences on your cash flow. One procedure that can help you avoid rocky spots in the cash stream is to keep collected money, such as sales tax or withheld income tax, in a separate bank account to avoid spending it accidentally. Not being able to pay this money at the required time will get you into trouble with the law fast.

As far as purchasing goes, many distributors offer quantity discounts for high-volume purchases. Usually these quantity discounts "kick in" at anywhere from five to ten items for major purchases, with higher ceilings applicable for smaller items. For items which can turn a quick profit, volume purchases are desirable, provided that you have the necessary financial resources available.

Most often, distributors aren't located in your geographic area. As a result, your order will be shipped to you, usually through UPS or, in the case of shipments which exceed UPS's weight limits, by drop shipment from an appropriate freight line. Some distributors or individuals base freight charges on the dollar amount of your order, or they'll even pay the entire

freight cost to your door. In other cases, you'll be responsible for actual freight costs once the goods are delivered to you.

Also, when you order goods from a distributor who isn't in your local area, the method of payment becomes a very important consideration. Many distributors or individuals will accept your order Cash On Delivery (C.O.D.) for a slight additional charge. This is an extremely safe method of payment, as you pay for the goods only if they're actually delivered to you. Thus, you aren't at the mercy of the seller concerning whether the goods are actually in stock at the time you order them, or, in the case of con artists, whether the goods ever even existed.

The next best method of payment is a money order or certified or cashier's check. These are readily accepted by sellers, unlike personal checks, because they know the funds are guaranteed available. However, payment by such methods doesn't provide the protection that C.O.D. payments do. For example, if you were to pay by a post office money order for goods, and the goods were never delivered, your only hope is that the post office or law enforcement officials can track down the person who cheated you. If they can't, you'll most likely never recover your money.

While most dealers buy from several distributors, they usually concentrate on one or two for a good percentage of their purchases. Choosing a distributor is usually based on several factors, including geographic location, price, inventory availability, and service. All of these factors should be considered.

For example, if you choose a distributor solely on the basis of price, but that distributor rarely has the inventory on hand to satisfy your needs, you might be better off with a distributor who charges more, but who always has the goods on hand. In addition, if all other things are equal, a distributor who provides you with prompt, courteous service is obviously more desirable than one with a carefree attitude who's slow to respond. As is the case when choosing an accountant, an attorney, a banker, or an insurance salesperson, select a distributor with whom you can become familiar and comfortable.

There's no substitute for a good personal relationship with someone with whom you do business. This can pay off in many ways as time goes by. For example, if your distributor gets in an item which is in short supply, having a personal

relationship with a sales representative may enable you to get these hard-to-get goods when others can't.

In dealing with a distributor, first verify whether the price listed for the item you want is indeed the most current one. Often, distributors change prices and even offer short-term "super specials" in order to increase sales. Some of these deals come from the manufacturer, some come from the distributor. Nevertheless, it always pays to ask if there are any specials available on the products in which you're interested or on a similar product which you may have overlooked due to its higher advertised price.

Any time you order a product from a distributor, make sure that the goods are indeed ready and available for shipment. All too often a distributor advertises a product with a supply on hand insufficient to meet expected demand. As a result, you may be placing an order for what you believe to be a really great deal, but you don't receive the product until several weeks or months later. That lost time is better spent stocking and selling goods on which you can make a quick profit.

Finally, any time you place an order with a distributor you should try to determine how quickly your order will be processed and the goods shipped to you. Some distributors offer "same day" service while others may take several weeks to process an order. Know what you're getting into at the time you place the order. Doing so avoids needless uncertainty and worry.

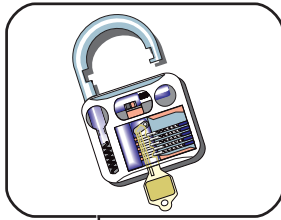
Finding Suppliers

You can find many suppliers and distributors in the Yellow Pages. Your local locksmith network (associations, dealers) can also provide you with some information. (For example, you've already learned about the National Locksmith Suppliers Association.) Other sources are the Chamber of Commerce and the Small Business Office in your area. And don't forget your local librarian, who can help you work with the *Thomas Register of American Manufacturers*. It's a very comprehensive directory. It can provide you with information by product and even by state. This is probably the most

comprehensive source for a small businessperson to discover more about suppliers of all types of security devices.

Once you have a list of manufacturers and suppliers, you begin to call or write for more information, perhaps asking to have a salesperson contact you. Then you assemble as much data as possible, compare all the prices, the advantages and disadvantages of all your options, and make a decision.

Again, as you've read many times, document all your transactions and keep copies of all correspondence.



Locking It Up! 6

1. List five sources for information about suppliers.

2. What is inventory?

3. What does it mean when we say locksmithing is a service industry?

4. What happens if you have too much inventory in stock? If you have too little?

5. What is the second best method of payment for inventory?

Check your answers with those on page 71.

FINDING WORK AS A LOCKSMITH

Now that you've taken the first steps toward acquiring the practical skills of a locksmith, your next step is to put those skills to use: getting a job as a locksmith.

Some Jobs for Locksmiths

The most obvious job for a locksmith is in his or her own shop. This means that you can take the steps necessary to open your own business as a full-time occupation. Many people don't feel ready for this step until they've gained a few years of experience. A second option is to work at locksmithing as a part-time job. This can permit you to gain experience and earn some money at the same time. It assumes that you have another job that supplies your main income.

As a first-time locksmith you have other options, however. First, you may seek work with another locksmith. This is an excellent option, if there are large shops in your area. Getting a job with an established shop provides you with some security, helps you develop your skills by working with professionals, and provides a sense of belonging to a group. Some concerns might be that you would have to do entry-level work for a while, you would have to prove yourself on the job, and you would be working for someone else when you could be working for yourself.

Second, you may seek a job with a large institution: college or university, school system, manufacturing company, hotel, or municipal government. These "in-house" locksmithing positions are often difficult to get and in today's economy are usually only part of the job a worker might be expected to do. In-house jobs require experience.

Third, you may seek work in security. Some security companies need locksmiths to install or repair security systems. Some companies specialize in making and/or selling security devices. An apprentice locksmith might be assigned to work in either of these areas.

Finally, when you have a number of years of experience behind you, you may consider work as a teacher of locksmithing, or even as a consultant. Some local community colleges offer

programs that could use the instructional services of a skilled craftsperson. Some larger locksmithing/security firms offer seminars to the public. Consulting is a rewarding and profitable job, some might say the highest rank a locksmith can attain. But it's the most difficult level to reach. It's something you might want to set your sights on for the future.

How to Find a Job

There's more to finding a job than just reading the want ads, although that's a good place to start. Getting a good job, a job that makes you feel productive, fulfilled, and happy with yourself, is one of the most important steps you can take in life. And, because it's so important, you have to work just as hard at looking for a job as you will later on at the job itself. Job hunting is a full-time job in itself. You'll be doing interviews, filling out employment applications, and waiting in between. This way, you'll cover more potential employers in a shorter time, and you'll almost certainly find a job faster. And it won't just be any job, but a job that best fits your needs and goals.

Where to Look for a Job

Now that you're ready to look for a job, where do you begin? If you limit your search to the classified ads in your local newspapers you may not find the job for you. Many companies never advertise because they have a file of applications from other job seekers. There's nothing wrong with looking in the newspapers, but that should not be the only source for your search. Your job until you get a paying job is to find as many job leads as possible. A job lead is any type of contact that can lead you to a job opening. It's important to realize that job leads are *everywhere* and can come from anyone. The classified ads in all the trade magazines have job listings.

The Yellow Pages

Use the Yellow Pages to make a list of such jobs leads as locksmith shops, private security companies, security sales and manufacturing firms, and private locksmiths. Call the personnel office for the larger companies and tell them you're interested in

full-time employment and would like the name of the person you should send a resume to. Smaller companies may not have a personnel department so you can probably get the information from the person on the phone.

If you get the names of local locksmiths, you can call them to introduce yourself, ask about the job market, and ask if you could come to their shop to speak to them in person about the job availability in the area.

Networking

Don't underestimate your friends and relatives when you're looking for work. Make a special effort to tell everyone you know that you're looking for work as a locksmith, especially anyone who works for large firms or institutions. Ask your friends and relatives to be on the lookout for leads. You never know when an acquaintance might have a job lead. But you won't ever know if you don't get the word out that you're looking for work.

Being a member of local, state, or national locksmithing associations can provide you with an in-place network that you can turn to.

Employment Agencies

Another source of jobs is employment agencies. There are two types: public and private. The services of public employment agencies are available, free, to any citizen. Whether state or federally sponsored, there are listings with job descriptions of the jobs currently being offered. To find the location of such public employment agencies, look in the phone book under "Government Offices—State" and "Government Offices—Federal." They're normally listed in the front of the directory, before the regular "white page" listings. At state employment agencies, often called Bureaus of Employment Security, you can register with the agency; this will provide you with access to some jobs that aren't offered anywhere else.

If you prefer that someone else do your job searching for you, try a private employment agency. Understand that there will be a fee involved, which either you or the employer will have to

pay. You may be asked to sign a contract that sets the fee as payable at the start of the job search, in the form of a commission based on your salary when you find a job or in some other terms. Do not sign a contract unless you're completely sure what you're getting and what you're pledging yourself to give. A good company will usually be willing to pay the fee, although sometimes it splits it with the new employee. As a general rule, however, it's best to avoid those agencies that charge the job seeker a fee. Use them only if all else fails.

The Resume

A resume is a written summary of an individual's education and work history. It's usually submitted with a letter of application, but may also be attached to an employer's standard application form. A resume allows a prospective employer to evaluate your qualifications at a glance and compare you to other applicants. Thus, it's very important to make sure that your resume is well written, concise, and neatly typed, and that you've presented your qualifications in the most effective form and organization.

The resume reflects you as an applicant. Since each person is unique, with individual strengths and backgrounds, it's impossible to provide a fill-in-the-blank sort of resume that can represent all job seekers. However, your resume should include information about you, any previous work experience you have, your job skills, and education.

There are two general types of resumes that can be adapted to suit most needs: chronological and functional. With each of these resume styles, you can use any arrangement you think is most effective. Experiment with headings, the order of information presented, and writing style until your resume looks good and represents you well.

The Chronological Resume

The chronological resume lists your personal and work information in order from your most recent experiences to the most distant (Figure 10). It may hold several categories of information, including the following:

FIGURE 10—A chronological resume makes effective use of headings, margins, underlining, and indentations to call attention to your accomplishments.

	DAVE LACH 123 Oak Street Mainville, CA 68765 (635) 555-1837																								
PROFESSIONAL OBJECTIVE	To join the operating staff of a respected, efficient security/locksmith company or corporate security division.																								
EDUCATION	Professional Locksmith Diploma, August 20— Education Direct, Scranton, PA Centerville Union High School, Graduated May 20— Honors: Certificate for highest class average in electronics lab. Captain of the wrestling team. Served as master-at-arms in ROTC.																								
WORK EXPERIENCE																									
May 19— to present	R-K Locksmith Service, Great Waves, CA Senior Apprentice <ul style="list-style-type: none"> • Assisted master locksmith with design of building security units • Safe maintenance and repair • Maintained shop tools and equipment • Ordered supply and tracked inventory 																								
September 19— to May 19—	Pro-Security, Ventura, CA Security Guard <ul style="list-style-type: none"> • Monitored building security for corporate office building • Executive of master keys • Responsible for daily lock maintenance and repair 																								
INTERESTS/ ACTIVITIES	Hunting, fishing, jujitsu, and aikido																								
REFERENCES	<table> <tbody> <tr> <td>William Kelvin</td> <td>J. P. Gables</td> </tr> <tr> <td>Master Locksmith</td> <td>Pro-Security</td> </tr> <tr> <td>R-K Locksmith Service</td> <td>7357 Masonic St.</td> </tr> <tr> <td>128 Ladder Ave.</td> <td>Ventura, CA 98424</td> </tr> <tr> <td>Great Waves, CA 98468</td> <td>(635) 555-9268</td> </tr> <tr> <td>(635) 555-8357</td> <td></td> </tr> <tr> <td colspan="2">Randy Evans</td> </tr> <tr> <td colspan="2">Manager</td> </tr> <tr> <td colspan="2">Randy's Hardware Store</td> </tr> <tr> <td colspan="2">44 Essex Highway</td> </tr> <tr> <td colspan="2">Ventura, CA 98424</td> </tr> <tr> <td colspan="2">(635) 555-6485</td> </tr> </tbody> </table>	William Kelvin	J. P. Gables	Master Locksmith	Pro-Security	R-K Locksmith Service	7357 Masonic St.	128 Ladder Ave.	Ventura, CA 98424	Great Waves, CA 98468	(635) 555-9268	(635) 555-8357		Randy Evans		Manager		Randy's Hardware Store		44 Essex Highway		Ventura, CA 98424		(635) 555-6485	
William Kelvin	J. P. Gables																								
Master Locksmith	Pro-Security																								
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(635) 555-8357																									
Randy Evans																									
Manager																									
Randy's Hardware Store																									
44 Essex Highway																									
Ventura, CA 98424																									
(635) 555-6485																									

1. Your name and address—centered at the top of the page, followed by your telephone number
2. Professional objective—a statement of the kind of work you're applying for. This can be omitted if you're using the same resume to apply for several different kinds of jobs. You may wish to prepare several different resumes tailored to the specific jobs you're applying for.

3. Education—names of schools you attended, including Education Direct, and any seminars, especially those that awarded certificates. You may also draw attention to good grades, specialized course study, extracurricular activities, and any honors or awards that you think will strengthen your chances of getting the job.
4. Experience—a complete listing of all the jobs you've held, including the employers' names and addresses, followed by your major duties, responsibilities, and accomplishments. If your experience section is more impressive or important than your education, put it before the education section.
5. Personal information—a reference to your interests, background, and leisure activities gives the reader an idea of you as a person. This category is usually very short and is often omitted unless the information is important or specifically related to the job you're applying for.
6. References—a listing of three to five individuals who know your qualifications and have agreed to describe them to employers. References can come from former employers, co-workers, or your clergyperson. People who have worked with you can explain your job qualifications; others may provide a personal reference—an account of your honesty and good character. Many resumes simply state, "References available upon request."

The Functional Resume

Perhaps you don't have a great deal of working experience, but do possess the skills needed in a locksmith job. Perhaps you've had experience when you were in the service. In this case, a functional resume might work best for you (Figure 11).

The functional resume starts out the same way as a chronological resume—with your name, address and phone number. You may follow that with your professional objective, then a brief list of your educational and work experiences. The chronological resume describes in detail the duties held in your past jobs, whereas the functional resume doesn't. Rather, it offers another section, often called *Skills*, which highlights functions you have performed in other jobs, in school, or elsewhere. As with a chronological resume, you may end with personal interests and a list of references.

FIGURE 11—Here’s an example of a functional resume. Notice that the information is similar to that included in a chronological resume, but with a very different appearance and effect.

<p>DAVE LACH 123 Oak Street Mainville, CA 68765 (635) 555-1837</p>					
PROFESSIONAL OBJECTIVE	To join the operating staff of a respected, efficient security/locksmith company or corporate security division.				
EDUCATION	Education Direct, Scranton, PA Professional Locksmith Diploma awarded 20— Centerville Union High School Graduated May 20—				
WORK EXPERIENCE	Senior Apprentice, R-K Locksmith Service, 128 Ladder Avenue, Great Waves, CA May 20— to present Security Guard, Pro-Security, 7357 Masonic Street, Ventura, CA September 20— to May 20—				
SKILLS	Locksmithing: Experience with corporate building door security locks and safes. Experience with design and maintenance of building security units. Expert key cutter. Can effectively troubleshoot problem to ensure accurate repair to lock.				
PERSONAL INTERESTS	Hunting, fishing, jujitsu, and aikido				
REFERENCES	<table border="0"> <tr> <td style="vertical-align: top;"> <p>William Kelvin Master Locksmith R-K Locksmith Service 128 Ladder Ave. Great Waves, CA 98468 (635) 555-8357</p> </td> <td style="vertical-align: top; padding-left: 20px;"> <p>J. P. Gables Pro-Security 7357 Masonic St. Ventura, CA 98424 (635) 555-9268</p> </td> </tr> <tr> <td colspan="2" style="padding-top: 20px;"> <p>Randy Evans Manager Randy’s Hardware Store 44 Essex Highway Ventura, CA 98424 (635) 555-6485</p> </td> </tr> </table>	<p>William Kelvin Master Locksmith R-K Locksmith Service 128 Ladder Ave. Great Waves, CA 98468 (635) 555-8357</p>	<p>J. P. Gables Pro-Security 7357 Masonic St. Ventura, CA 98424 (635) 555-9268</p>	<p>Randy Evans Manager Randy’s Hardware Store 44 Essex Highway Ventura, CA 98424 (635) 555-6485</p>	
<p>William Kelvin Master Locksmith R-K Locksmith Service 128 Ladder Ave. Great Waves, CA 98468 (635) 555-8357</p>	<p>J. P. Gables Pro-Security 7357 Masonic St. Ventura, CA 98424 (635) 555-9268</p>				
<p>Randy Evans Manager Randy’s Hardware Store 44 Essex Highway Ventura, CA 98424 (635) 555-6485</p>					

Information NOT to Include

Some resume no-no’s are obvious. First, remember that you should never misrepresent yourself or your job qualifications. In your attempt to present your qualifications in their best light, don’t deliberately mislead your prospective employer. If you’re hired, you’ll certainly be found out later to your embarrassment. And it might even destroy your future in locksmith/ security.

Who would hire a dishonest person to do sensitive security work?

Never list someone as a reference without their permission. It's unnecessary to include such personal statistics as height, weight, marital status, or eye color. In fact, it's illegal for an employer to use personal considerations as a basis for hiring. By law you can't be eliminated from consideration for a job because of sex, age, race, religion, or national origin.

If an item of information won't help you get a job, don't include it in your resume.

Letters of Application

Letters of application, sometimes called cover letters, are sent along with your resume when you apply for a job (Figure 12). They tell an employer why you're the best person for the job. Whatever the source of the job lead, the letter will be the source of the employer's first impression of you, so it should be the best possible impression. It should be neat, clear, and grammatically correct; that is, all the words should be spelled properly and punctuation should be perfect. If you're not sure on any point, have someone help you with it. Keep the letter short and to the point, and follow any instructions in the want ad exactly.

The letter is a first step. It should make the prospective employer want to meet you and interview you—the second step. The first paragraph of the letter should explain how you came to learn about the job. Be direct. Don't make the reader guess where you found out about the job. Say that you wish to apply for the job, or, if you're applying for a position that you understand will be available in the future, say that. Next, identify yourself in some way that shows your ability to do the job. For example, "I recently finished the Education Direct Professional Locksmith program, and have worked for Joe's Locks for three years." End the first paragraph in such a way that the employer will want to read on to find out more about you as a person and a potential employee. You might mention that your resume will show how qualified you are to be a locksmith. If your resume is thin, you could say that you want to gain experience by working with a fine company. The first paragraph should be short, no more than three sentences.

In the middle of the letter, devote two or three paragraphs to developing your qualifications for the job. Be sure to draw attention to the appropriate parts of your resume. Develop further any items that you think may influence the employer favorably. Most importantly, stress the skills, background, and/or experience you have that the employer needs. With every sentence, use the YOU attitude. That means, concentrate on what the reader really wants to know (rather than on what

September 1, 20—
123 Oak Street
Mainville, CA 68765

Mr. Brian T. Egan
Chief of Security
SGA World Headquarters
156 Island Boulevard
Jayne, CA 94567

Dear Mr. Egan:

I'm writing in response to the locksmithing position advertised in The Chronicle on August 31, 20—. I have enclosed a resume for your review.

I enjoy security work and would like to use my locksmithing skills in a corporate setting. I have recently completed a correspondence course in locksmithing with Education Direct. I can offer professional locksmithing services such as lock maintenance and repair. I also have experience in maintaining proper building security. I enjoy working with the public and am experienced with on-call and emergency locksmith procedures. My work has given me the opportunity to become familiar with closed-circuit television, electronic locks, and computer security.

I will look forward to the opportunity to combine my locksmith and security skills with the needs of a major international corporation. An interview can be scheduled at your convenience. I can be reached at my home telephone (635) 555-1837.

Cordially,

Dave Lach

Dave Lach

FIGURE 12—The appearance of your cover letter is almost as important as what it says. Always type your letter and use one inch margins on top, bottom, and sides. Double-check all grammar and spelling. This letter serves as a good example of a cover letter.

you want to tell him or her.) Don't forget, the employer probably has a stack of letters to go through; you have only a minute or two of his or her time in which to sell yourself. Don't repeat yourself. Don't brag. Don't include anything that doesn't bear on the job you're seeking. Keep the letter short, hard-hitting, and factual. Try to get the impression across that you're efficient, loyal, dependable and versatile, since these are the qualities an employer looks for in a potential employee.

If you're answering an ad, be sure to address every point raised in the ad. Try to avoid the issue of salary; however, if the ad requests that you state a figure, handle it with a statement such as: "I would prefer to discuss salary during a personal interview."

End the letter on a positive note by politely suggesting an appropriate action. But don't get pushy and try to tell the employer what he or she has to do.

Application Forms

Many employers will ask you to fill out an application form (Figure 13), in addition to your letter of application. Most forms ask you to provide information regarding your education, work experience, salary expected, and certain health considerations. It's possible that, by accident, you may receive an out-of-date form that asks for more personal information, such as the number of people you support, your marital status, and the existence of any distinguishing physical characteristics or defects. Provide such information only if you want to; no employer has a right to ask such questions. Don't be afraid that the employer will think you're trying to hide something. Every personnel office knows and, if wise, abides by the federal antidiscrimination laws that make such an interrogation illegal. If questioned, simply say that you realized that the form was out-of-date, and that those questions are no longer appropriate.

You should fill in all other spaces on the application form as completely and honestly as possible. Be factual. Don't try to be funny. List your goals and abilities as straightforwardly as possible. Describe any special talents you have that may be relevant to the job. Some detail that you think hardly worth mentioning may incline the employer to conclude that you're exactly what he or she is looking for.

APPLICATION FOR EMPLOYMENT

AN EQUAL OPPORTUNITY EMPLOYER

PLEASE NOTE: This job has been advertised to comply with federal employment laws. We reserve the right to discontinue this position at any time without notice. You can aid in making a job application for these positions by answering each question as accurately as possible. Please examine the time before completing it.

PERSONAL

NAME (LAST) (FIRST) (M) SOCIAL SECURITY NO.

ADDRESS (number & street) (CITY) (STATE) (ZIP) TELEPHONE

List other names used when you attended school or were employed:

Name of us whom were you referred to the company?

Are you over the age of 18? YES NO
 Except for those records which have been ordered sealed or sealed by the court, have you ever been convicted of a felony? Convicted of a felony will not necessarily disqualify you from employment.
 YES NO If "YES" explain and give date of conviction, reason, and court's sentence of the case.
 Explain:

Do you have any friends or relatives working for the company, its affiliates, parent companies, subsidiaries or divisions? YES NO If yes, who?

Have you ever worked for this company before? YES NO If yes, when?

EDUCATION AND TRAINING

Type of School	Name	City, State	Graduated in Last Grade Completed	Diploma Graded	Type of Course, Major Subjects, Hours Required (Date of completion if possible)
High School					
College					
Graduate School					
Other Training					

List other qualifications and skills (e.g., licenses, ratings, office machines, etc.):

MILITARY (UNITED STATES)

Have you served in the Armed Services of the United States? YES NO

If yes, did you assume any job-related skills during your military service?

PROFESSIONAL REFERENCES

Please provide a minimum of three (3) professional references.

NAME	OCCUPATION	HOW LONG KNOWN	ADDRESS	PHONE #
1.				
2.				
3.				
4.				
5.				

75198 (REV. 5/81) Continued form by continuing on back

FIGURE 13—Application forms have space for you to provide information about your education, work experience, and other criteria which employers use to evaluate prospective employees.

EMPLOYMENT RECORD		
<p>Please complete this section for each of the past seven years, starting with present employer. Account for all time, including periods of unemployment or self-employment. A separate employment record form is available from the employer if necessary. Feel free to attach resume, but please complete this page whether or not you attach a resume.</p>		
EMPLOYER	MONTHS EMPLOYED FROM TO	YOUR POSITION/TITLE
ADDRESS		YOUR RESPONSIBILITIES
CITY/STATE/ZIP	LAST BASE SALARY	
NAME OF SUPERVISOR	PHONE #	
REASON FOR LEAVING	OTHER COMPENSATION	
NAME OF CONTACT - YES NO		
EMPLOYER	MONTHS EMPLOYED FROM TO	YOUR POSITION/TITLE
ADDRESS		YOUR RESPONSIBILITIES
CITY/STATE/ZIP	LAST BASE SALARY	
NAME OF SUPERVISOR	PHONE #	
REASON FOR LEAVING	OTHER COMPENSATION	
NAME OF CONTACT - YES NO		
EMPLOYER	MONTHS EMPLOYED FROM TO	YOUR POSITION/TITLE
ADDRESS		YOUR RESPONSIBILITIES
CITY/STATE/ZIP	LAST BASE SALARY	
NAME OF SUPERVISOR	PHONE #	
REASON FOR LEAVING	OTHER COMPENSATION	
NAME OF CONTACT - YES NO		

READ CAREFULLY BEFORE SIGNING

I certify that all of the information and documents submitted by me in connection with this application (collectively, "Application") are true and accurate to the best of my knowledge. I understand that any misrepresentation of such information in any false statements made by me in this Application may result in denial of employment or discharge. I further understand that any offer of employment and continued employment is contingent upon my ability to provide documentation evidencing citizenship or right-to-work status.

I grant National Education Corporation and its subsidiaries (the "Company") permission to check the information submitted by me in connection with this Application and to make a thorough investigation of my past employment, education and activities, including the employer and references listed in the Application, unless otherwise indicated above, to give the Company any and all information concerning my previous employment and other pertinent information they may have, personal or otherwise. I release the Company and all persons or entities supplying such information to the Company from any liability for any damage which may result from furnishing information to the Company.

Additionally, I understand and agree that nothing contained in this Application or in the granting of an interview is intended to create an employment contract between the Company and me and no promise regarding employment have been made to me.

If an employment relationship is established between me and the Company, I understand and agree as follows: (1) I will be employed on an at-will basis and my employment can be terminated by either the Company or me at any time, with or without cause, and with or without prior notice; (2) the Company's written and unwritten policies, practices, procedures and employee handbooks shall not in any way constitute an express or implied contract of employment; and shall not in any way modify the at-will status of my employment; and (3) the at-will status of my employment can only be modified by a written agreement signed by a corporate officer of the Company.

I acknowledge that I have read, understood and voluntarily agreed to the terms listed above.

DATE: _____ APPLICANT'S SIGNATURE: _____

FIGURE 14—Application forms may ask you to give detailed information regarding past employers.

Use a pen to fill out an application form. Take at least two pens with you, in case you're asked to fill out the form on the premises. Be sure to print, so that what you answer is legible. Spell correctly. Know your Social Security number. Know the names and addresses of past employers, references, and the schools you've attended (Figure 14). If you can't remember, bring your resume with you so that the information will be readily available. The application is an important part of the first impression you'll make on your prospective employer. Making sure it's both readable and correct is the least you can do.

Successful Interviewing

Each year thousands of jobs go to applicants who are less qualified than other job seekers who are turned away. The reason for this, generally, is that the people who got the jobs knew how to sell themselves. Those who didn't know how, didn't get the jobs.

First, you must learn to sell yourself on paper, techniques you just looked at. Next, you must learn to sell yourself in person. The personal interview may be the most important single thing that determines whether or not you get the job. It shows the employer how well you think on your feet. More importantly, the interview shows your skills in dealing with other people. If you handle yourself well in an interview, you demonstrate that you probably also know how to handle yourself on the job. Thus you increase your chance of being the employer's first choice.

Preparing for the Interview

When you appear for the interview, you have no way of knowing if it will take an hour or five minutes. But be prepared for an in-depth interview. This means that you should be thoroughly familiar with the qualifications for and the requirements of the job you're seeking, so you can answer specific questions related to the performance of your duties. If you've had this type of job before, you should have little difficulty with this; however, if it's your first job in this area, you should do some research. Look over your Locksmithing program materials; network; consult materials in your personal library or in the public library. Try to find out something about the prospective employer. It will be to your advantage if you can show that you did your homework.

Appearance and Attitude

Even locksmiths need to “dress for success.” Does this mean that you have to wear a suit for a job interview as a locksmith? No. But it means that you shouldn’t look like a scarecrow either. Clothes should be clean and wrinkle free. Common sense can tell you that if you’re applying for a job with a large corporation you may want to wear that suit, or at least a blazer or sports jacket.

How you act is another crucial aspect of the interview. Self-confidence is important, but cockiness is a negative. Know your good qualities and present them carefully and well. Be optimistic, cheerful, and positive; don’t be pessimistic or glum. If you’re inexperienced, don’t apologize; emphasize your good qualities and your desire to learn rapidly and perform your duties well. Think of your past successes as proof that you can do well again. If you think you can do it, you will. Your attitude will come across in a positive and winning manner.

The Interview

Showing up for the interview well prepared, looking good, and having a positive attitude is important; but once there, you must know how to act. First of all, be on time. In fact, be early. Being late to an interview sends the employer a clear and immediate message—and one he or she won’t like.

Enter the room confidently. Don’t be too stiff or too relaxed. Greet the interviewer with a smile, introducing yourself and offering to shake hands. If more than one person is present, shake hands with and introduce yourself to everyone in turn. The next step is up to the person giving the interview. (Remain standing until asked to sit.) Answer the interviewer’s questions candidly. Be complete. Don’t wander off the subject.

Try to maintain the YOU attitude. Think about what the interviewer wants to know at this point, not about what you want him or her to know. Remember, the interviewer’s main purpose is to get to know you. He or she wants to evaluate your education, experience, and ability—to see if you will fit in and make a positive contribution to the business.

Expect some tough questions that may catch you off guard. (This is usually no more than an attempt to see how well you handle tough situations.) Don’t get angry or hostile, or lose your confidence. Take a moment to think about the question,

including why it might have been asked. Then answer as pleasantly and as completely as you can. “Keeping your cool” is an essential for someone who works in the security profession. The interviewer may be testing you to see how you react under pressure, how you might act with an irate person locked out of his or her car.

When the interviewer has finished questioning you, he or she will usually ask if you have any questions. You should ask questions about job requirements, working hours, working conditions, salary, and benefits. These types of questions are the only reason to prolong the interview. Otherwise, once the interview is over, thank the interviewer and leave. Figure 15 offers some handy do’s and don’ts for interviewing.

FIGURE 15— *The Do’s and Don’ts of Interviewing*

THE DO’S AND DON’TS OF INTERVIEWING

- **Do** try to look relaxed, even if your knees are knocking together with nervousness.
- **Don’t** sit on the edge of your chair. It makes you look nervous.
- **Do** look pleasant. Smile and thank the interviewer for taking the time to talk to you.
- **Don’t** avoid eye contact with the interviewer.
- **Do** answer questions directly, clearly, honestly, and specifically. When possible, support your statements. For example, “One of my best qualities is that I’m very organized. A job review once stated that I’m efficient, neat, and always on top of things.”
- **Don’t** pretend you’re strong in areas where you aren’t.
- **Do** listen carefully. Make sure to answer the question asked. Don’t ask questions the interviewer has already answered.
- **Don’t** mumble. Don’t try to use big words to impress the interviewer.
- **Do** discuss your ideas and ambitions for the future. Relate them to the employer and what the company does.

The Follow-Up

The job interview isn’t the end of the job hunt. To impress the employer that you’re serious, it’s a good idea to send a follow-up letter. As a matter of fact, even if you conclude for some reason that the job isn’t for you, it’s a good idea to write such a letter to thank the employer for the courtesy of the interview. (This is another aspect of networking, for who knows whether or not you may need to contact the company again?) If

you're interested in the job, the follow-up letter can help a lot. Be sure to write it immediately, so that the employer will get it before a determination has been made as to who gets the job.

The follow-up letter should be short (Figure 16). In the first paragraph, remind the employer who you are and thank him or her for the interview. In the next paragraph, repeat your desire to work for the company. Give specific reasons, if possible.

September 1, 20—

123 Oak Street
Mainville, CA 68765

Mr. Brian T. Egan
Chief of Security
SGA World Headquarters
156 Island Boulevard
Jayne, CA 94567

Dear Mr. Egan:

Thank you for the opportunity to interview with you and SGA. I enjoyed meeting with you and touring your world headquarters.

After seeing your corporation's security system and your need for professional locksmithing services, I am all the more interested in the prospect of working for you. However, if there is another candidate better suited to the position's needs, you can still be assured of my continued interest in your corporation.

Again, thank you for meeting with me. If you have any further questions, please don't hesitate to call (635) 555-1837. I will look forward to hearing from you.

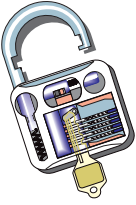
Cordially,

Dave Lach

Dave Lach

FIGURE 16— It's a good idea to send a short, positive "thank you" letter after each interview.

If you overlooked anything during the interview that might bear favorably on your selection, include it now. Take this opportunity to enlarge upon answers that were perhaps not sufficiently addressed during the interview. In the last paragraph, finally, repeat your thanks for the interview. State how pleased and satisfied you were with it. Sign off with a final reference to your hopes for the future, and the company's large role in them.

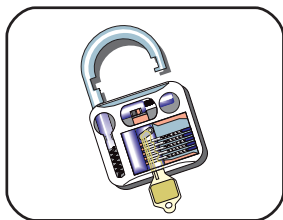


Locking It Up! 7

1-9: Indicate whether each of the following statements is True or False.

- 1. The job interview is the last step in the hunt for a job.
- 2. Job leads can come from only one source: newspaper ads.
- 3. You should never ask questions during a job interview because you might irritate the interviewer.
- 4. Job hunting is itself a full-time job.
- 5. Your Education Direct program would be listed in a functional resume.
- 6. It's not necessary to ask a person to be a reference before using his or her name on your resume.
- 7. It's necessary to tell an employer about your marital status.
- 8. It's not wise to smile during an interview.
- 9. Letters of application and cover letters are the same thing in job hunting.

(Continued)



Locking It Up! 7

10-12: Write your answers to the following questions in the spaces provided.

10. List at least five general sources for employment as a locksmith.

11. Give three good reasons for getting a job with an established locksmith shop.

12. How many kinds of resumes are there? Name them.

Check your answers with those on page 71.

YOUR PROFESSIONAL IMAGE

All the advice you've received—technical information on locksmithing, business information, job-hunting skills—is only as useful as you make it. You may be the master locksmith of all time, but if you don't interact well with potential customers, you may find yourself without business. Here are a few final words of advice to set you off on your new career.

How to Look Professional

Do you have to wear a suit to work? Do men have to wear a tie? Do you need a company uniform? Of course not! But you have to show your customers or employers that you care enough about yourself to dress in clean clothes, and to keep your physical appearance neat.

If you work for someone else, find out what style of clothing is expected on the job. Some employers purchase uniforms for their employees. The uniform may have the emblem or logo of the shop and perhaps the name of the employee over the breast pocket. Smaller shops may permit the employee to wear jeans and sports shirts. But whatever the choice of the shop owner, keep your clothes clean. When they get dirty, don't let them stay dirty. Nothing will hurt customer relations more than to be seen as a slob. The same applies to your personal appearance. Keep yourself neat and clean. Men with beards should keep them neatly trimmed; beardless men should shave daily. Rock stars can get away with looking scruffy, you can't. Make certain your personal hygiene is acceptable. Men and women should wash and comb their hair, bathe regularly, brush their teeth, use mouthwash, and use deodorant.

If you work for yourself, all of the above suggestions are even more important for you. This means that your business, therefore your very livelihood, depends on how you present yourself. You don't need a suit or a uniform or any fancy clothes, but you do need to look presentable. How would you react if you went into a store and the person waiting on you looked and smelled awful? A careless employee can be terminated. Can you fire yourself? Yes; it's called losing your business.

How to Act Like a Professional

How do you act professionally? We've mentioned some of the characteristics throughout this unit. In short, you act the same way you would like to be treated if you were a customer. You'll be courteous, patient, honest in your responses and in your actions toward the customer. You'll show the customer that you know your job, and that you appreciate his or her business. You should remember the YOU attitude. You're in business to serve. Let the customer tell you what the problem is, then *help* find the answer by suggesting options. Preaching may turn the customer away.

THE KEY TO SUCCESS

Being a successful businessperson is most often a matter of common sense. Think of every bad business experience you've ever had, then avoid doing the same things. Don't use swear words; don't mumble or grumble; don't be rude or vulgar. Keep your temper; keep your cool. Keep informed; keep growing.

KEY POINTS TO REMEMBER



As a locksmith your goal is probably to work for yourself. However, when you're getting started in the business, there are some advantages in working for someone else. You have the security of stability, working for an employer who has been around for a number of years and will assume the responsibility of running the business. Second, you can learn on the job from more experienced colleagues. And finally, you have the opportunity to meet new people and learn how to interact with them.



But there are some minor disadvantages, too. You'll be working for someone else, and will have to do what they want you to do. You'll be working to make someone else successful and prosperous. As the new person on the job, you may be expected to do some of the less pleasant work around the shop, or to work less favorable hours. And your fortune may

be tied to someone else's. All these things must be considered as you make your decisions.



As a locksmith you can specialize if you find a specific need in your area. There are many areas that you can pursue, but you **MUST** get training. There are many options open to you. You may choose to work for a business in your field of interest. There are also many fine programs offered through community colleges, business colleges or vocational/technical schools. Another important resource is the public library. Get to know your local librarians, for they can help you find information. Some of the reference materials may be in the library already. Your librarians can help you research the latest developments.



Some information is readily available in book form. *Books in Print*, a multivolume reference set, can help you find information by author, title, subject, and publisher. Catalogs/repair manuals may be obtained directly from manufacturers, distributors, or supply catalogs. One starting point might be the *Thomas Register of American Manufacturers*.



As you become an expert in your specialty you may need to purchase specialty equipment. You may want to buy kits to help you train. Machines you may wish to purchase will come with written instructions or service manuals, perhaps even videos. There are many other ways, including working on used equipment and networking with professionals in your area of specialty, that can help you learn the skills you need.

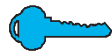


One specialty service is "road service." Some locksmiths offer 24-hour emergency service. Ideally, you should have a mobile shop, or at least portable equipment that's always ready to go. If you can't afford to equip yourself properly, don't offer the service. Second, you must be emotionally prepared. Emergency service is filled with stress, both yours and the customer's. Are you willing, and do you have the temperament, to deal with stressful situations? You'll need an emergency hot line which will be answered 24-hours a day. You'll also need to establish specific policies and charges for your types of service.



Another aspect of road service is road calls. These might include calls about keys locked in cars at shopping malls, frozen locks, lost keys, and calls from store owners or large businesses who need on-site key duplicating services. The same stresses and rules apply to road calls, although these

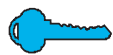
don't usually mean emergency life and death situations, but are matters of urgency to your customers.



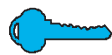
House calls are usually planned in advance. Your first visit is to determine the scope of the job. You should provide a written estimate to your customers, and get a signature confirming the agreement. When the agreement is reached, you'll assemble the necessary materials and establish a mutually convenient time to do the work.



A lock is a security device, a way to protect people and valuable property. You, as a locksmith—the word “smith” means one who makes or fixes—are part of the protection and security profession. And like any other professional who serves and protects, you should know and observe the laws of your community, your state, and your country.



The Locksmith Publishing Company produces a series of books called Locksmith Law which can be important references for legal advice, court cases, judgments involving security, and legislative reports.



Laws not only protect the customer, they protect you. There are seven points of legal advice that every locksmith should commit to memory:

1. Always put everything in writing.
2. Once you install a door lock on a building, you can't remove it without the permission of the owner, even if the owner has refused to pay for your services. You'll need an attorney, but if you have a written and signed authorization for service, you'll help your case.
3. Insist on full payment before returning items to a customer. That way you won't get “stuck.”
4. Always ask for proper identification and have a client sign a Declaration of Ownership form for any equipment brought into your shop. Use the same procedure on jobs that are emergencies, late at night, in an unlikely area, or involve an expensive automobile. You must protect yourself from criminals.
5. Know the life safety codes for the state, county and cities where you work. This is a way to quickly check on possible code violations when you're installing locks.

6. You can't be forced to do a job you don't want to do, even if asked by a law enforcement officer. Check with an attorney to assure your rights.
7. If you work for someone else, you may have to sign a non-competing or restrictive covenant. This means that you can't take the skills you learn and open a competing shop.



You obey the law because you have to, but as a professional you follow good business ethics because you want to. Ethics are codes of operation, morals, and scruples that business people follow to show that they're responsible citizens and reliable members of the business community. You'll develop your own code of ethics as you mature in your work. There are some basic rules that apply to all called the Locksmith's Code of Ethics.



Today's public demands the best from the people who provide the services they need. The more important the service, the more important professional credentials become. Potential customers want to know that the person they're entrusting their security to—the locksmith—is honest and competent. Locksmiths can be certified, licensed, or bonded.



As a locksmith, you must keep abreast of new technology. The locksmith who doesn't know how to work with new technologies will lose customers. Joining a local, state or national professional association is one way to keep up with new developments in your field. There are many to which you can belong, with a variety of benefits to their members.



Books and periodicals are also excellent sources of information for the resourceful locksmith. Check *Books in Print* at your local library for relevant books. Take time to read and update your skills, it will pay off in increased business.



To start your own business, you'll need all the basic start-up materials that every businessperson needs: phones, furniture, office supplies, insurance, licensing and permits where appropriate, an accounting system, and an advertising plan and budget. In short, you need a complete business plan.



Every business needs some kind of material in order to operate successfully. This is especially true of retail businesses, which need inventory to sell to customers. And while locksmithing is in many respects primarily a service industry—that is, you're selling your abilities and knowledge—you'll also make money operating as a retail business, selling locks, keys,

alarms, and all the other items you've learned about. Managing and regulating your inventory is important because inventory controls the cash flow in your business.



There are a variety of options available to locksmiths. They may own their own shop, work part-time to gain experience, work for another locksmith, work as an "in-house" locksmith for a company, work in security, or work as a teacher or consultant.



Getting a good job, a job that makes you feel productive, fulfilled, and happy with yourself, is one of the most important steps you can take in life. And because it's so important, you have to work just as hard looking for a job, as you'll later work doing the job itself. Job hunting is a full-time job in itself. You'll be interviewing, filling out employment applications, and waiting in between. By concentrating your efforts, you'll cover more potential employers in a shorter time, and you'll almost certainly find a job faster. And it won't just be any job, but a job that best fits your needs and goals.



Where do you begin to look for a job? A job lead is any type of contact that can lead you to a job opening. It's important to realize that job leads are everywhere and can come from anyone.



A resume is a written summary of an individual's education and work history. It's usually submitted with a letter of application or cover letter, but may also be attached to an employer's standard application form. It's important that your resume is well written, concise, neatly typed, and presented in the most effective form.



The letter of application is the first step. It should make the prospective employer want to meet and interview you, the important second step in getting a good job. Make your letter short, factual, and hard-hitting. With every sentence, use the YOU attitude. That means, concentrate on what the reader really wants to know. Try to give the impression that you're efficient, loyal, dependable, and versatile, since these are qualities an employer looks for in a potential employee.



The personal interview may be the most important single step that determines whether or not you get the job. It shows the employer how well you think on your feet. More importantly, the interview shows your skills in dealing with other people. If you handle yourself well in an interview, you demonstrate that you probably also know how to handle yourself

on the job. Thus you increase your chance of being the employer's first choice.



Arriving for the interview well prepared, professionally dressed, and having a positive attitude is important; but once you're there, you must know how to act. First of all, be on time. In fact, be early. Enter the room confidently. Don't be too stiff or too relaxed. Greet the interviewer with a smile, introduce yourself, and offer to shake hands. Answer the interviewer's questions candidly. Be complete. Don't wander off the subject. Expect tough questions; they may want to see how you'll react to a tough situation. Keep your cool.



A follow-up thank you letter should be sent immediately after your interview. It should be short, remind the employer who you are, and thank the person for the interview. Repeat your desire to work for the company, and take the opportunity to enlarge upon answers that were perhaps not sufficiently addressed in the interview. Repeat your thanks and sign off with a final reference to your hopes for the future with this company.

Do You Know Now . . .

Below are the answers to the questions asked at the beginning of this study unit.

What is a noncompeting agreement?

A noncompeting agreement or restrictive covenant is a legal agreement between an employer and employee that the employee won't take the skills learned from his or her employer and open up a competing business.

Where do you find information on locksmithing law for your area?

To find out about locksmithing law in your area, contact local agencies. An excellent first step is to visit your local police department to introduce yourself. This shows you want to cooperate with law enforcement officials. Other locksmiths can also be a source of information about local laws. A third source are the local, state/provincial, or national locksmithing organizations.

What is the Locksmith's Code of Ethics?

The Locksmith's Code of Ethics are codes of operation, morals, and scruples that locksmith's follow to show that they're responsible citizens and responsible members of the business community.

NOTES

Locking It Up! Answers

1

1. Electronic security systems; home installation and repair; automobile door and ignition locks; safes and vaults; and many other areas
2. It offers security, the opportunity to learn from professionals on the job, and the chance for meeting and working with new people.
3. You'll be working for someone else; you'll be low in seniority and have to do some less welcome jobs, and your job will depend on somebody else.
4. Company training; postgraduate training; research/reference; books; catalogs/repair manuals; practice kits, parts from old locks or devices, machine manuals; networking
5. Hospitals, schools, and hotels often employ locksmiths.
6. Basically, it's a locksmith shop in a van or panel truck. It allows you to take necessary tools and supplies to the job site.

2

1. False
2. True

3. False
4. True
5. False
6. True

3

1. Once a lock is attached it becomes part of realty and you can be arrested if you try to remove it. A written agreement would help because you could threaten legal action.
2. If you told her there was a minimum service charge for the visit, she owes you. If you said nothing, she may refuse to pay you. However, if she has any sense of fairness she should offer to pay. **BUT YOU AS A PROFESSIONAL SHOULD NEVER GET ANGRY IN A CASE LIKE THIS.** Show her that you're a pro.
3. Assuming that he's the owner or co-owner of the home, he can hire you to open the door. As long as the couple is still married, and he's still legally a resident of the house, you can open the door for him. Would you do it? That's a question that you must answer for yourself. If you decide to open the door, make certain that he understands the service charge for an emer-

- gency visit at midnight. Make him give you a firm commitment and when you get there ask him to sign a form stating that he knows—before you open the lock. Note: If the couple is arguing when you arrive, don't get drawn into their fight by choosing sides. Don't open the lock; call police.
4. If you made an agreement with him on the phone, in conscience and in law he owes you. If you didn't get an agreement, you're not paying attention to this study unit.
 5. You don't have to return the key because he made an agreement with you. BUT are you going to lose the goodwill of the customer for the cost of a blank? You might wish to explain that you're extending a courtesy to him and that under the law you don't have to return his key until he pays.
 6. You don't have to return the key, even at the request of the police officer. But remember common sense. It may be better to return the key than risk getting a reputation as difficult.
 7. Because military equipment is sold as surplus so frequently, you could generally assume that most items are what the client says they are; but if you were near a military base, you should find out more about the items. Be very careful about the other items; schools and companies don't sell surplus items that often and they usually provide a receipt. Insist on one. Always make sure the client actually owns the item you're opening.
 8. If deadbolts or any kind of locks are installed on fire doors or panic doors, they must be released by one action (the push of the bar). These regulations are contained in the Life Safety Code Handbook.
 9. If the bars were installed properly, that is, if they were bolted into studs surrounding the window and not merely drilled in plaster, then Security Sellers isn't liable.
- 4**
1.
 - a. It sets a minimum standard that all members of the association should meet.
 - b. It sets a minimum standard that all customers can expect from an association member.
 - c. The profession itself would already have standards in place if a state government should decide to require licensing for locksmiths, as more and more states are doing.
 - d. It's a way to assure that locksmiths continue their education.
 2. For two reasons: a license is granted by an appropriate government body, and it's for a business that can come under police regulation.
 3. Bonding is a type of insurance that protects the company or owner in the event that an employee steals or does something dishonest on the job.

5

1. Seminars and conferences; group insurance; technical and business publications; finding out about business trends; networking; certification
2. Locksmith Security Association
3. Books in Print
4. Look in the Yellow Pages of your telephone book.
5. The Lock Museum of America
6. False

6

1. Yellow Pages, Chamber of Commerce, networking, library, Small Business Office
2. Inventory is the collection of materials that a business has for sale. It refers to goods, not services.
3. Locksmithing is a service industry because what it offers for sale is primarily the locksmith's knowledge and ability.
4. Buying too much inventory ties up your cash; and if the inventory is slow-moving merchandise, the cash you bought it with is unavailable until that merchandise is sold. On the other hand, if you purchase too little inventory, you won't have the merchandise your customers want—they'll learn to turn to your competitors for those items and you'll lose their business.

5. Money order, or certified or cashier's check

7

1. False
2. False
3. False
4. True
5. True
6. False
7. False
8. False
9. True
10. a. Owning your own shop
b. Working in another locksmith's shop
c. Working for large institutions
d. Working in security
e. Teaching
f. Consulting
11. a. Security of having a steady job
b. The opportunity to develop skills on the job from professionals
c. The opportunity to belong to a group, to network
12. There are two types of resumes: chronological and functional.

NOTES

Working as a Professional Locksmith

EXAMINATION NUMBER:

03101400

Whichever method you use in submitting your exam answers to the school, you must use the number above.

**For the quickest test results, go to
<http://www.takeexamsonline.com>**

When you feel confident that you have mastered the material in this study unit, complete the following examination. Then *submit only your answers to the school* for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. *Do not wait until another examination is ready.*

Questions 1-20: Select the one best answer to each question.

1. What is the most important piece of legal advice given to locksmiths?

- A. Get it in writing.**
- B. Keep inventory low.**
- C. Don't give credit.**
- D. Never trust anyone.**

2. Which association publishes a “Who's Who Among Professional Locksmiths”?

- A. Associated Locksmiths of America**
- B. International Master Locksmiths Association**
- C. Locksmith Security Association**
- D. Security Enforcers Association**

3. What factors should you consider when choosing a distributor for parts and supplies for your locksmithing business?
- A. Price, prompt delivery, and friendly sales representatives
 - B. Service, inventory availability, price, and location**
 - C. Price and service only
 - D. Cheapest supplies, quick delivery, and best service
4. A chronological resume is different from a functional resume in that it doesn't focus on
- A. references.
 - B. education.
 - C. previous jobs.
 - D. skills.**
5. One of the most important attitudes to remember in both letters of application and interviews is the
- A. "aggressive" attitude.
 - B. "YOU" attitude.**
 - C. "educated" attitude.
 - D. "I" attitude.
6. Which of the following statements regarding professional locksmithing ethics is correct?
- A. State or provincial laws are of no concern to the locksmith with a small business; only local laws need to be obeyed.
 - B. Information about locksmithing and security techniques should be freely shared with any person who wishes to learn from you.
 - C. Keep thorough written records of the work you performed for your various customers.**
 - D. Even if you have no idea how to fix a particular lock or security device, you should never recommend that your customer consult another professional locksmith.
7. It's illegal for an employer to ask you one of these questions, and you don't have to answer it. Which one is it?
- A. What is your name and address?
 - B. What was your hourly rate at your last place of employment?
 - C. Can you provide a list of references?
 - D. Do you have a disability?**
8. What additional skill is necessary if you're planning to specialize in home lock installations and repairs?
- A. Plumbing
 - B. Electronics
 - C. Carpentry**
 - D. Landscaping

9. You're thinking about specializing in safe and vault work, so you do some research in your local area to see if this specialty would be profitable for you. Which of the following indicates that it would be a good specialty in your area?
- A. A lot of other locksmiths are already doing it.
 - B. There's a definite need for it, but no other locksmiths are doing it.**
 - C. There's no need for it, so there would be no competition.
 - D. You just like doing it.
10. To find out more about locksmith suppliers you would most likely turn to
- A. Books in Print.
 - B. Thomas Register.**
 - C. Locksmith Law.
 - D. Encyclopedia of Associations.
11. You're called out at night to open a locked, expensive automobile. What should you do to be reasonably sure that the person who called is the owner of the car?
- A. Ask the person for proper ID, and have the person sign a declaration of ownership form.**
 - B. Insist that the person produce the title to the car.
 - C. Note if the person is wearing expensive clothes that would match the expensive car.
 - D. Note if the person seems honest.
12. What is the safest method of payment for inventory that has yet to be shipped?
- A. Money order
 - C. C.O.D.**
 - B. Company check
 - D. Cash
13. Your employee would most likely be bonded with a/an
- A. fidelity bond.**
 - C. unconditional bond.
 - B. bail bond.
 - D. security bond.
14. When you're job hunting, your most important task is to
- A. keep as calm as you can.
 - C. find as many job leads as you can.**
 - B. read as many want ads as you can.
 - D. visit as many companies as you can.
15. The portion of the resume that specifies the type of job that you're looking for is the
- A. skills section.
 - B. professional objective section.**
 - C. personal information section.
 - D. education section.
16. What is the second step in the process of contacting a potential employer?
- A. The letter of application
 - C. The interview**
 - B. The job application
 - D. The thank you letter

17. Certification is usually obtained through
- A. other locksmiths.
 - B. a school, professional association, or organization.**
 - C. local police.
 - D. a government agency only.
18. Clean clothes, a neat appearance, a “YOU” attitude, and a courteous manner are all part of
- A. the laws of locksmithing.
 - B. the locksmith code.
 - C. portraying an educated demeanor.
 - D. your professional image.**
19. A form listing the agreed-to tasks to be performed by the locksmith and signed by the customer is known as a/an
- A. restrictive covenant.
 - B. declaration of ownership.
 - C. authorization for service.**
 - D. right to work agreement.
20. If you can't afford an answering service to help you with your road call business, the next best thing is to
- A. hire a relative.
 - B. use an answering machine.**
 - C. drop the emergency business.
 - D. get a business radio.

COMING ATTRACTIONS

Now you can look forward to a successful career as a locksmith—thanks to your own hard work and careful study. Remember that your career will flourish only if you continually work to improve your skill and professionalism. Keep learning and looking for new challenges in your field. Your success will make the future brighter for you and your family.