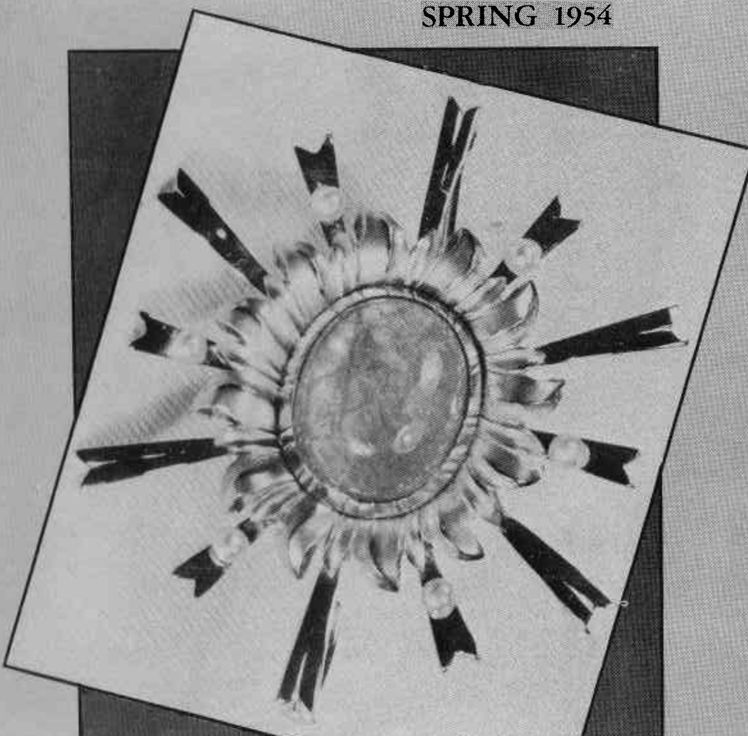
Gems and Gemology

SPRING 1954



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On the Cover

Yellow gold brooch fashioned of emeralds containing six oriental pearls. Actual size.

Photo courtesy American Swedish News Exchange, New York City, New York.

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Watch Jewels of the Past

by

ALVIN A. KLEEB

The pride of possessing a fine watch is often based more upon the number of jewels it contains than on its time-keeping qualities or the workmanship evidenced in its construction. The kind of jewels or the purpose they serve makes little difference to most people, provided there are at least seventeen of them.

My watch repairing experience of over 25 years, both as a vocation and as an avocation, in addition to a keen interest in antique watches, long ago taught me that the exact number of jewels is relatively unimportant. A more recent interest in the field of gemology, however, roused my curiosity regarding the materials used for watch jewels. The stock answer of "rubies, sapphires and garnets" may have been true for the era immediately preceding the acceptance of synthetic corundum for such purposes, but what was used before that?

A fairly complete set of gem testing instruments and several cigar boxes full of antique watches and movements made unnecessary an exhaustive search for literature on the subject. Such literature as I eventually found usually consisted of one or two sentences in a book or article if it were mentioned at all. Putting all of these sentences together resulted in a very incomplete story particularly with regard to the materials used.

The invention of watch jeweling is usually attributed to Nicolas Facio in the year 1703. Early literature on the subject is very scarce, however.

G. H. Baillie, the noted British authority on antique timepieces, in his book *Clocks and Watches: An Historical Bibliography* (N.A.G. Press Ltd., London, 1951) attempted to catalog all known literature on mechanical timepieces written before 1800. The items are listed by date with a brief resume of their contents. As usual, very little is to be found concerning jewels. Following is a quotation of part of page 132:

"1704. FACIO DI DUILLIER, PETER AND JACOB DEBAUFRE.

"Petition to Parliament for the extension of their Patent for jewels in pivots in watches.

"MS. of one sheet in Library of the Clockmakers' Company, Guildhall.

"A Bill was brought into Parliament and read a second time, and was then opposed by the Clockmakers' Company on the ground that jewels had been used before the date of the Patent. As evidence of prior use, a watch was produced, made by Ignatius Huggeford, who died before 1698. In this watch a large ruby was fixed in the blued steel cock and, on this evidence, the petition was dismissed. The watch is now in the collection of the Clockmakers' Company at the Guildhall, and the ruby has been found to be ornamental only, covering an ordinary brass blind pivot hole.

"1704. FACIO DI DUILLIER, NICOLAS.

"Reasons for an Act Intituled, An Act for the further Encouragement of the New Art, or Invention, of Working and Applying of Precious and more common Stones for the greater Perfection of Watches, Clocks and other Engines.[1]

"Among the reasons is 'The incredible Tediousness and Difficulty of Working, in Rubies and other Precious Stones, some Holes almost as small as a Hair and of Figuring and Polishing them . . . will require that the hands of very many Subjects be imployed.' "

"Reasons of the English Watch and Clockmakers against the Bill to confirm the Pretended New Invention of using Precious and Common Stones about Watches, Clocks and other Engines.[2]

"This begins: One Nicolas Facio Gent and Peter and Jacob Debaufre Watchmakers, have under pretence of a New Invention, obtained Letters Patent, dated the 1st of May, 1704, for Fourteen Years, to have the sole use of working Precious and more common Stones . . . to be imployed in Clockwork and Watchwork . . . not for ornament only, but as an internal and useful Part of the Work or Engine itself: And now, before One Year of the time spent, apply for an Act of Parliament to confirm the same, and to enlarge their Term.

"The reasons are based on want of subject matter for invention, and no mention is made of Huggeford's watch."

The following quotation from Baillie's preface will serve well as a brief background for the subject under consideration:

"Some unknown person, at an unknown date (probably the end of the thirteenth century), invented the verge escapement and made a mechanical clock possible. This escapement remained in common use, without a material change, for five and a half centuries. For three and a half centuries, it was the essential part of every clock and watch. But its immediate effect was the start of a revolution in time-reckoning, a change throughout Europe from the canonical hours of the Church to the equal hours of our present system. The change was radical, because the period between two canonical hours was from two to four hours, varying with the season; it was gradual, following the erection of public clocks, over a period, roughly, from 1350 to 1450.

"An inventor responsible for so much deserves a name.

"Another unknown person at an unknown date (probably late fifteenth century), devised a spiral spring to drive

1. "4pp. 12-½ x 6½ inches. British Museum.

2. "4pp. 12½ x 6½ inches. British Museum.

> a clock, combined with a device to secure a constant force from the spring. He made portable clocks and, eventually, watches possible.
>
> "Then came a revolution in time-keeping. Galileo discovered that the pendulum was a time-keeper in itself and, in 1658, the great Dutch physicist Huygens showed how to combine a pendulum with a clock. A little later, in 1675, he discovered a time-keeper suitable for a watch—a balance with a spiral spring. Before these discoveries, the whole of the clock or watch took part in the time-keeping. After them, the office of the previous mechanism was reduced merely to keeping the pendulum or balance swinging and to counting its swings."

Of particular significance is this quotation from Baillie's resume of Christaan Huygens book *The Pendulum Clock, or Geometrical Demonstration of the Motion of Pendulums applied to Clocks,* written in 1673.

> "Huygens says that experience has shown that the best way of avoiding friction in the rotation of the vertical arbor is to make the lower end of hardened steel and let it rest on a flat diamond. As far as I know this is the first mention of an endstone."

It is evident, therefore, that the credit for discovering the use of gemstones as friction free bearing surfaces should actually go to Christaan Huygens the man who made possible clocks and watches as we now know them. Nicolas Facio apparently made the first hole jewels and may have been first to apply them to a watch.

So far my search for literature on watch jewels written since 1800 has been nearly as limited as that which Baillie found for the preceding 150 years. It is evident, therefore, that I have discovered a relatively unexplored field and have the equipment with which to make the exploration.

In my collection are several dozen watches with large colorless plate jewels. They represent early Walthams and Howards, English watches from 1800 to 1875, and also French and Swiss watches of the same period. I had always assumed the jewels to be colorless sapphire. Since I wanted to preserve my watches, I started by making only a few random tests. To my surprise the first jewels I tested on the refractometer all seemed to have a refractive index of 1.75 instead of 1.77. I had never heard of absolutely colorless chrysoberyl, nor had I heard of chrysoberyl being used for watch jewels. So I removed several of the jewels from a badly damaged watch plate and took them to the Gemological Institute's Los Angeles laboratory to confirm my findings.

I found some members of the GIA staff rather skeptical, although Dick Liddicoat did express the opinion that chrysoberyl seemed a perfectly logical stone for such a purpose. Their findings confirmed mine, however, and to cinch the argument the jewels just floated in clerici solution which had a specific gravity of 3.75.

A more careful examination of a few more watches revealed that some of the chrysoberyl jewels had a slight olive color. Some had a girasol effect, wherein a pale blue light seemed to float inside the stone. My first reaction was to suspect orthoclase moonstone, although the idea did not seem to make sense, considering its hardness and cleavage tendencies. The girasol stones tested 1.75 on the refractometer like the others, however, indicating that they were a colorless varity of cymophane.

Watch jewels, of course, represent relatively thin sections, so it is possible that even the stones which appeared absolutely colorless would have showed some color in the original crystal.

Having discovered the chrysoberyl jewels, I made no further tests for several months, but I did search for confirming literature on the subject with little or no success. Eventually I tested some more colorless jewels from an English watch, and this time I found that I was dealing with quartz. Just plain rock crystal. Further tests revealed more watches with quartz jewels. This made it apparent that the old English jewel makers were not particular what they used. Perhaps they used any stone they were able to procure. If so, all the stones harder than quartz were possibilities, and perhaps even some of the softer stones could have been used.

My project began to take on the aspects of an interesting search. My next goal was to find a watch with beryl jewels. I started testing jewels in more watches of my own and mentioned the project to some of my brother members in the National Association of Watch and Clock Collectors. They lent me several plates and movements.

One of the first I checked had the beryl jewels I was looking for. I lost no time in purchasing it. It is an English watch marked John Hornby, Parr Street, Liverpool, No. 26116. (See Figure 10.) I would estimate that it was made between 1815 and 1825. The upper plate jewels, as in most English watches of that period, are in individual brass settings held in the plate by two or three screws. I removed a couple of them and ground down the bezel of the setting around the edges of the stone, so the flat side of the jewel was flush with the brass. This way the stone made good contact with the refractometer, and there was still sufficient lip on the bezel to hold the stone firmly in the setting. These tested 1.58 on the refractometer and showed a birefringence of approximately .006. The other two jewels contained the characteristic straight hairlike needles, so there was no question that they were beryl.

Some of the jewels on the lower plate were set into a strip of brass which was screwed to the plate under the dial. Since the watch was not complete anyway, I eventually decided to remove the lower jewels from the brass strip and test them also. These had a refractive index of 1.75 and a specific gravity slightly greater than 3.50, indicating chrysoberyl again. All five jewels on the lower plate proved to be chrysoberyl. The upper balance hole jewel was also chrysoberyl. The upper balance cap jewel was diamond.

I had now found beryl plate jewels in a watch, but this watch contained chrysoberyl also. It immediately became evident that if I was to be thorough in this search I must start at the beginning again. I had made complete tests covering all the stones in only a few watches and had assumed that if one plate jewel was quartz, beryl, or chrysoberyl all the others were the same. I was aware that the balance jewels were often different from the plate jewels. In fact, in English lever watches the upper balance cap jewel is usually diamond and the hole jewels often ruby or sapphire.

My next step was to start a more systematic search by testing all the stones in some top plates. I soon found several plates containing both beryl and chrysoberyl. Also quartz and beryl. It was now quite evident that if I was to discover all the kinds of stones used, I must check all the jewels in every watch I inspected. I had been avoiding this approach because of the time and difficulties involved, which included completely disassembling the watches. In many of the watches I had found it possible to remove one or two of the top plate jewel settings without any further disassembly. Since I wished to keep my watch collection intact, I eventually adopted a modified approach which eliminated positive identification of certain jewels if it meant damaging the watch or if too much time would be involved.

It is of course possible to make positive identification of some stones without using a refractometer, particularly if the stones are red. Many ruby and garnet stones can be identified with a dichroscope, polariscope, and microscope. If the stone is ruby — as are many balance hole jewels, and pallet stones — the identification can often be made with a dichroscope and microscope. Sometimes it is necessary to tilt the stone at several different angles before the dichroism will show up, particularly if it is a small, light-colored stone.

Considerable evidence of a visual nature can be gained by a binocular microscope. Needle-like inclusions can often be seen in both ruby and garnet jewels, as well as other characteristic inclusions. The polish and surface luster will usually give some evidence of the stone's possible identity. Also the amount of wear can be noted, which will help to identify the softer stones.

Very few of the garnets used as watch jewels will light up completely in the polariscope. Most of them seem to remain completely dark.

Balance hole jewels cannot often be conveniently tested on a refractometer, but I have made spot tests on the curved portion of some hole jewels and obtained fairly distinct readings. Good refractive index readings can nearly always be obtained from a balance cap jewel, however, and since both stones must withstand similar stresses, I have assumed that any stone used for balance hole jewel material would also find its way into cap jewels.

The fact must also be considered that any stone used in the escapement is more subject to breakage if the watch is dropped. Therefore, it might have been replaced during the lifetime of the watch, which may have included the lifetimes of several owners.

With these things in mind I have rarely used specific gravity tests in my watch jewel identification, and use of the refractometer has been confined principally to plate and cap jewels. I eventually found it was not always necessary to grind a plate jewel setting down flush with the stone to obtain the refractive index, particularly if the bezel holding the jewel was a shallow one. A jewel in a deep bezel or in a bezel high on one side may read low on a refractometer, if a reading is obtained at all, so it takes a little experience and judgment to safely eliminate this step. The refractive index liquid will make sufficient contact for a good reading on a large proportion of the jewels in settings and also on those set directly in the upper plate or in bridges. The liquid, being a mixture of methylene iodide and sulphur is corrosive to watch plates, and will leave a dark tarnish stain if not completely removed. When I test the jewels of a watch in running condition, I usually overhaul the watch at the same time. The plates must be cleaned, and it is not much more trouble to clean all the parts before reassembly.

Now let us determine what the early American watchmakers did and said with regard to watch jeweling.

The oldest American watch I have was given to me when I was a high school student and a neophyte watchmaker. I used it as one of my early practice pieces and later disassembled it to use as repair parts. Fortunately I had no call for parts to fit an 18 size key-wind Waltham. It eventually occurred to me that such a watch was a rarity and would be much more valuable in running condition, so I made the necessary repairs and reassembled the parts. As a result I still have Waltham No. 1525 (See Figure 1) as a part of my collection. The top plate is engraved "Dennison, Howard & Davis," the names of the founders of the company. It was one of the first watches produced after the factory was moved to Waltham, Massachusetts, in 1854.

The plate jewels are colorless and those in the top plate are one-eighth inch in diameter. Some have long fine needles and other inclusions characteristic of beryl. Those I was able to test have a refractive index of 1.58. They all appear to be original. Most of the jewels in the escapement are probably replacements, so testing them would not give us the desired information.

Another Dennison, Howard & Davis watch, serial No. 4702, also has colorless beryl plate jewels. These come the closest to having a faint blue body color of any beryl I have seen in watches to date. The lower balance cap jewel, which also appears to be original, is chrysoberyl.

Beryl is also used in the top plate of a Waltham, engraved Wm. Ellery, made probably in the 1860's. However, another Waltham top plate, marked Appleton, Tracy & Co., No. 150962, made about 1864, contains nearly colorless chrysoberyl jewels. A top plate of the same style but much later date, marked Waltham Watch Co., has garnet jewels of a reddish purple color. These stones remained dark in the polariscope, and the refractive index was apparently above the range of the refractometer. Needles in one of the jewels were characteristic of almandite.

Concerning jeweling at the Waltham factory during these early years, I have patched together the following information from several sources. Aaron Dennison brought a jewel maker named Sibley back with him from England in 1850 when he made his trip to purchase material, tools and supplies to start the new watch factory. Sibley made a few aquamarine jewels for the earliest watches, but these were abandoned in 1852. Jewels were then imported from England until after the factory was moved to Waltham late in 1854.

About this time Napoleon Bonaparte Sherwood went to work for the company and was eventually placed in charge of the jeweling department. He proceeded to revolutionize the whole system as far as jeweling was concerned, including the invention of tools and machinery for the improved processes. N. B. Sherwood gives a fairly complete description of the method used in handturning and opening watch jewels in his book *Watch and Chronometer Jeweling,* published by George H. Hazlitt Co., Chicago, 1869. My paper bound third edition, purchased about 1930, contains no copyright date. Perhaps the publishers felt that the date would not encourage sales, even though little had been written on the subject. On page 20 Sherwood says, "For watch and chronometer purposes the only really useful stones are sapphire, ruby, chrysolite and aquamarine . . . In our estimation chrysolite is the most valuable of all stones for jeweling."

As evidence that chrysolite meant to him what chrysoberyl does to us, he made the following statement when comparing chrysolite and aquamarine. "These two gems are the only ones in which the rare metal glucinium has been detected."

Glucinium, by the way, is now commonly known as beryllium.

The E. Howard & Co., Boston, descriptive catalog for this period reads on page 5 as follows:

"This watch is furnished either plain or jewelled in aquamarine, chrysolite or ruby, with plain or chronometer balance."

E. Howard & Co. watch, serial No. 4249, from my collection, was probably made before 1860. (Mr. Howard left Waltham in 1857 and started his own watch factory in Boston shortly thereafter.) The stones that I have tested so far in this watch indicate that it contains ruby, sapphire and chrysoberyl. The balance hole jewels and pallet stones appear to be sapphire, but it is difficult to distinguish sapphire from chrysoberyl in spot tests. To date, however, I have never been able to make a positive identification of anything other than ruby, sapphire and garnet used as pallet stones in any watch.

The Kerney and Swartchild jeweler's supply catalog for 1882 lists chrysolite, aquamarine and ruby plate jewels among the United States Watch Company materials. Material catalogs of the 1920's, however, list only four kinds of jewels — ruby, sapphire, garnet and diamond.

Diamond cap jewels were listed only for Elgin and Waltham watches; whereas ruby, sapphire and garnet were used for plate jewels. Garnet roller jewels and pallet stones were listed by nearly all of the American companies, including Hamilton, even though garnet was used nowhere else in many watches and in the best grades not at all.

From a gemological point of view the important thing to consider is that the early American watchmakers did know what stones they were using for watch jewels. All the stones I have found in American watches to date have been mentioned in the meager literature on the subject. The aquamarine they speak of is so light in color that it could more properly be called goshenite. Chrysoberyl was referred to as chrysolite at that time, and many of their rubies I would call pink sapphire. These are mere technicalities, however. The garnet used was principally almandite, but pyrope was used by some companies. Beryl and chrysoberyl was limited to a few of the earlier companies, and diamond was seldom used. Very few American watches contained more than three varieties of jewels.

Concerning European watch jewels the story is a little more involved, particularly with regard to watches of English manufacture. A watch made by Joseph Johnson, Liverpool, serial No. 13468, contains beryl, chrysoberyl, sapphire, garnet and diamond. Johnson was a prolific maker who catered to the American trade about 125 years ago. I have also found his watches with quartz plate jewels.

White sapphire is often found in the plates and bridges of Swiss and French watches, but was seldom used by the English. I did test one English top plate, however, which contained three white sapphire jewels and one nearly colorless spinel with a slight bluish cast. It was the first colorless stone I had found which remained dark in the polariscope. A refractive index of 1.72 and a string of included octohedral chrystals left no doubt that spinel should also be included among the stones used for watch bearings.

I have not found quartz or spinel mentioned in any literature on the subject. Rock crystal was sometimes used to make watch cases, and I have heard of transparent top plates being made of it. Carnelian was used extensively by the French for clock pallet stones. Sherwood says that they also used agate, but it was inferior to the carnelian because of its stratification which prevented forming a uniform surface. While on the subject of clocks, I might mention that I once repaired a wooden clock with ivory bearings.

Red glass was often used to fool some unsuspecting buyer who thought he was getting a bargain in a fine 21 jewel watch. Usually these were glass caps which did not even touch the pivots, and a red celluloid washer was placed over the upper center bearing.

The L. H. Keller Company, New York, jeweler's supply catalog for 1900 lists polished ruby, polished garnet, unpolished garnet and common glass hole jewels, so it is quite probable that some glass found its way into good watches as replacements.

I have run fairly complete tests on nearly fifty watches so far, including several made between 1750 and 1790 which had garnet and diamond balance cap jewels. I have also tested a great many unset jewels from various sources. I still have several dozen watches with jewels large enough for testing, so I plan to write a future article after I have been able to conduct and compile the results of a more thorough search.

In the meantime I would be interested in knowing whether any of you gem enthusiasts have found this phase of gemology of sufficient interest to conduct a few tests of your own. If you should happen to find any stone not mentioned or a watch with yellow, orange, blue or green jewels in it, I would be pleased to have you write to me in care of the Los Angeles headquarters of G.I.A. I may never find those grossularite, tourmaline, topaz or zircon watch jewels, but I am still looking.

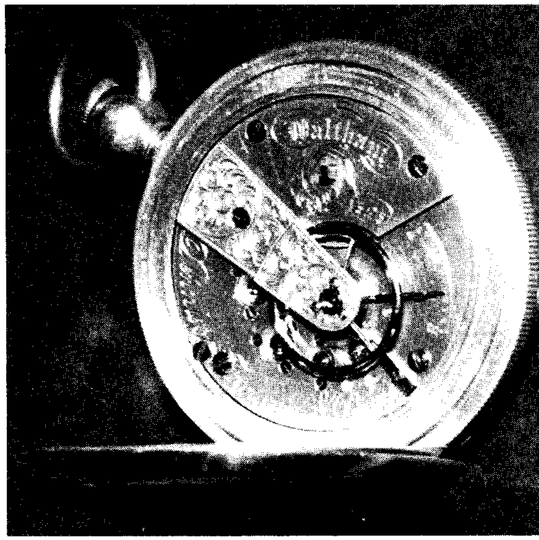


Figure 1

• Waltham #1525. Made about 1855. Plate jewels are colorless beryl.

Figure 2

• Elgin #371. This model sold for $117. in 1867. Plate jewels are garnet. Escapement contained ruby and sapphire.

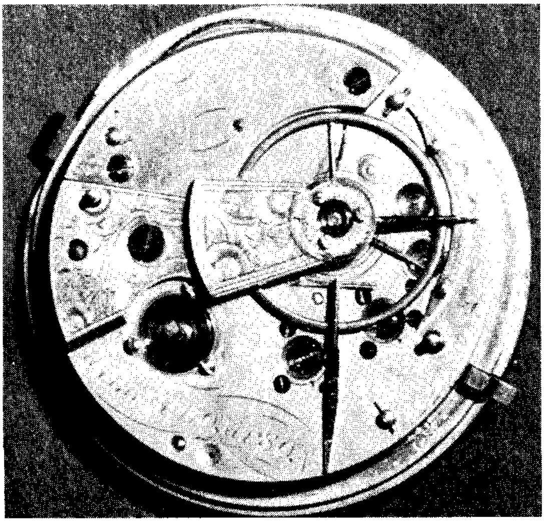
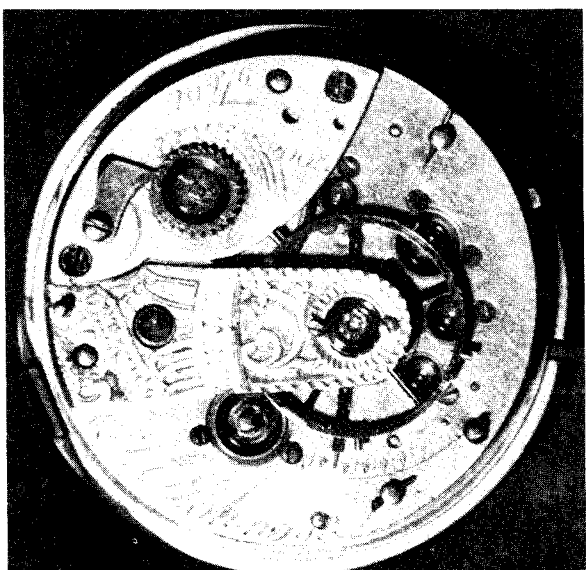


Figure 3

• English watch with large garnet plate jewels and diamond cap. Note drive chain wrapped around mainspring barrel.

Figure 4

• Watch by Joseph Johnson, Liverpool. Plate jewels are chrysoberyl. The upper fourth jewel is colorless cymophane. Note 2 mm. rose cut diamond cap jewel.



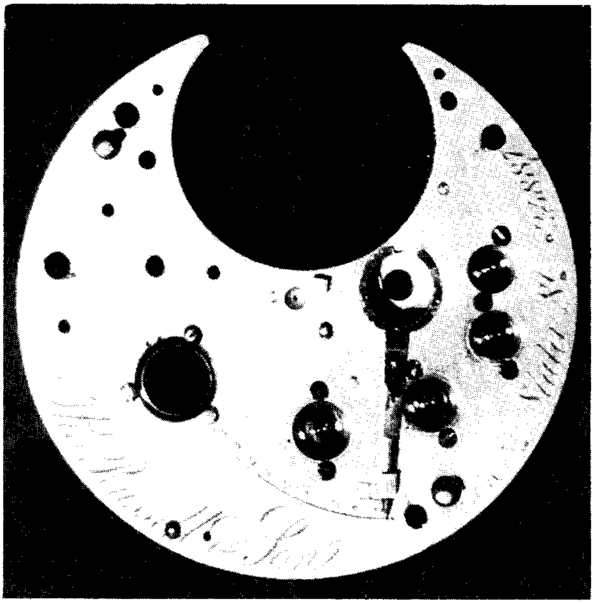


Figure 5

• This English top plate contains three colorless sapphire jewels and one nearly colorless spinel.

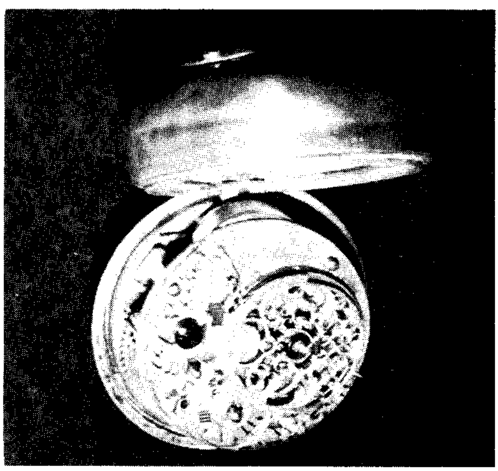


Figure 6

• Verge watch made about 1750 has diamond cap jewel only.

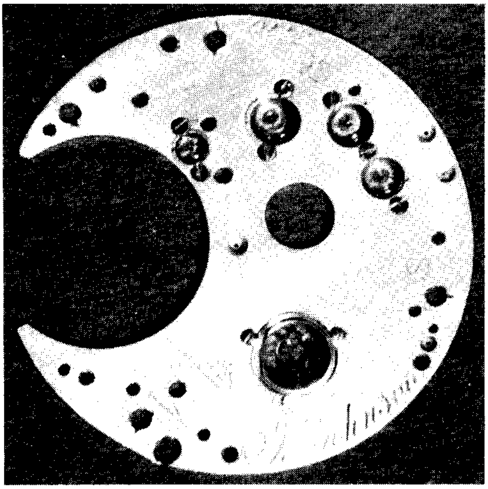


Figure 7

• Top plate of watch by Joseph Johnson, Liverpool. Jewels are rock crystal.

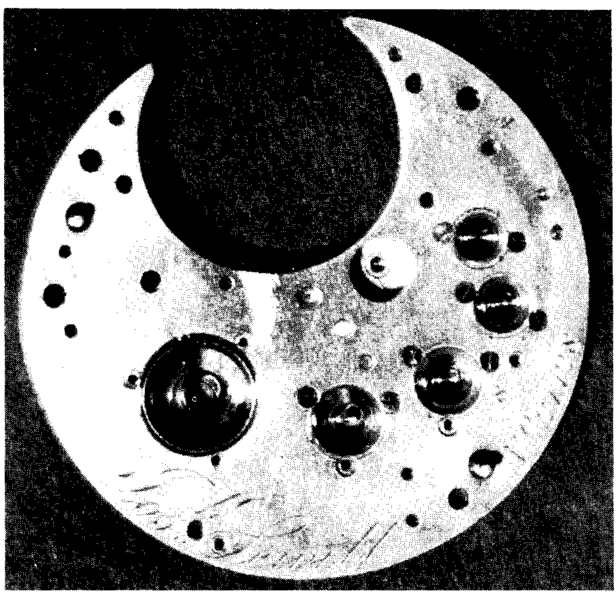


Figure 8

• The two smaller jewels in this plate are chrysoberyl, the others beryl. The large jewel is 9/16 inch in diameter.

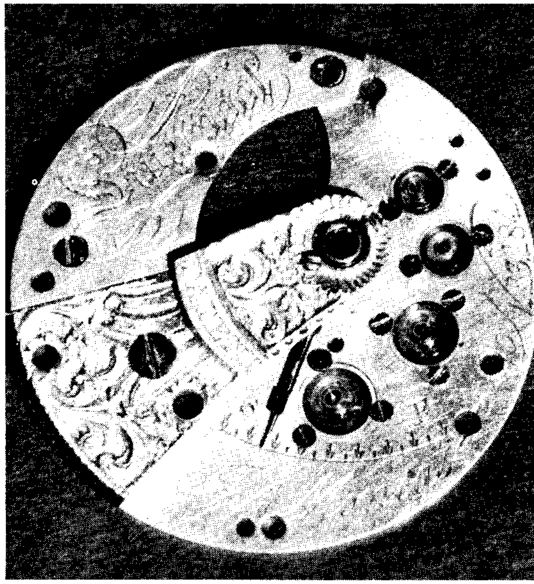


Figure 9

• All jewels in this top plate are chrysoberyl. The two larger ones are colorless cymophane.

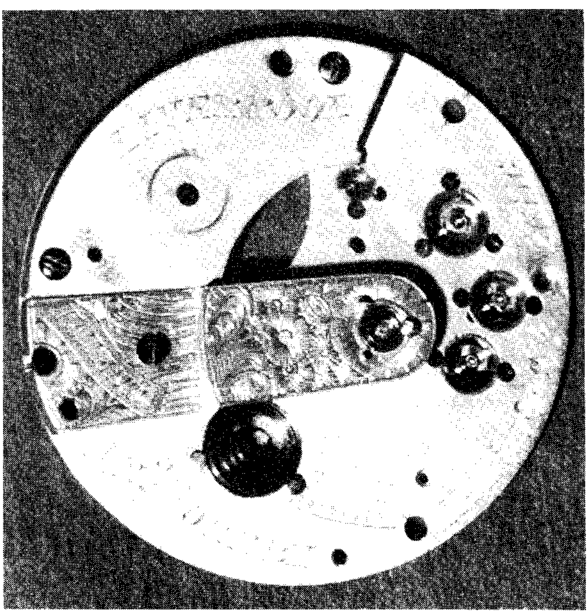


Figure 10

• Top plate of English watch containing beryl jewels. All jewels in bottom plate of same watch were chrysoberyl.

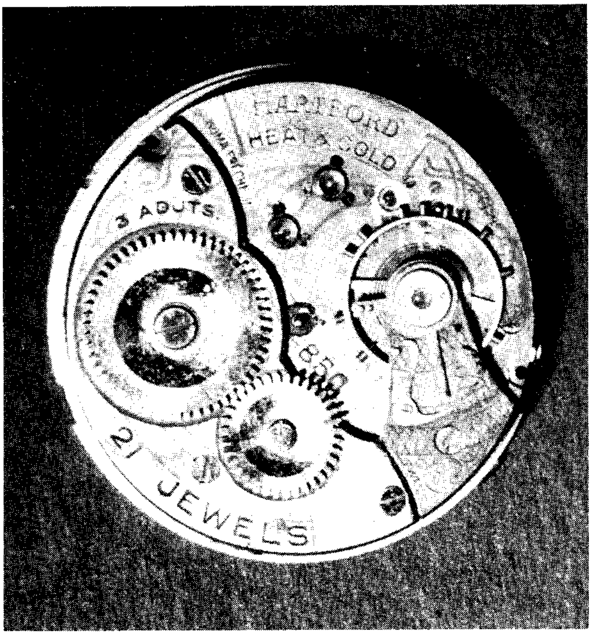


Figure 11

• This fake railroad watch actually has 21 jewels. Many so marked did not. Two of the six useless cap jewels are glass, two are pyrope. All other jewels are almandite. Red celluloid washer covers center bearing.

Pages FROM A Jeweler's Notebook of Memories Part V

by

By George H. Marcher

The next morning following our arrival I joined Dodge and we proceeded with the merchandise to O'Connors Department Store. A large area had been cleared to provide sufficient room for the dancers as well as space for the merchandise and the spectators.

In the afternoon the Navajo entertainers arrived in full regalia. Dodge then took his place in the middle of the floor and gave a brief talk about how the Indians made their jewelry and wove the rugs. He explained briefly the significance of the various dances, and the program began.

The music started and the thump, thump, thump of the Indian braves brought everyone to attention. At unexpected intervals, the dancers would let out an uninhibited war whoop that brought in more spectators. When the din stopped between numbers the clerks displayed the merchandise and made sales.

To stimulate interest in Navajo jewelry during such sales we had found it helpful to have an Indian jeweler prominently placed in the salesroom to demonstrate the crude methods employed. One of the dancers, Homer Vance, had spent several years in that manner in Hollywood. Homer, who was also a Navajo priest, was well versed in Indian lore. To decorate his jewelry, he had a large variety of punches, or stencils, made of steel with which to impress various decorations and emblems into the metal with a hammer before bending the piece into a ring or bracelet.

After the shows agreed on had been completed, we checked the remaining stock and packed the bulky part into Dodge's trailer while I took charge of the jewelry.

Now that we were ready to return home, I visited the San Francisco "man at the desk" and was assigned a "berth" in a fine Packard. This was driven by a man whose conversation sounded much like that of the villains seen on the screen of those days punctuated with a few fancy words which would have been censored.

Soon after we had started he decided that he should have another passenger whose name had been given him by the desk man. Promptly he veered off the course and crossed over to Oakland on the San Mateo Bridge, which cost him $1.50 and 20 miles of travel, only to find the man had tired of waiting and left by some other means of transportation. On returning to our original route and reaching Salinas we forked off on the wrong road and about 1:00 a.m. found we were in Monterey. Back we went again to continue down through the night toward Los Angeles. One of the three men passengers was sitting with the driver. In the course of their conversation the driver took out a revolver and tilted the cylinder out to prove it was not loaded, while he discussed small fire arms and their respective merits. One interesting tidbit in his revealing conversation was something as follows:

"I bought this car in Denver. It's not all paid for yet. Of course I am not supposed to have it out of Colorado 'til it is all paid for but I got around that all right; as soon as I left the state I sent in another payment which they accepted. Now they can't do nuthin' about it. Of course I ain't got no pink slip, but I know what to do about that too. Just got to go to the Department of Motor Vehicles and tell 'em I lost it, etc., etc., I can get a new one."

As we drove along he, in a rather stern voice, suggested that we should recompense him for some of the extra travel on the detours. Most of us did for it seemed like a good policy at the time.

My gripful of silver jewelry was tied on the trunk rack behind the car and I had expressed concern several times that it might loosen and fall off. On passing through Hollywood on our way into Los Angeles I asked to be dropped off near my home so I could freshen up before going on into town. "You come along with me," he sternly replied and kept right on driving.

He was planning to demand more money for the trip when he reached the "desk" and he thought he might want all of us for witnesses. As we reached our destination I decided it would be safe to tell him where I was going and about my cheap jewelry on the rack.

"I thought you had something in there of special value," he said. "You seemed to be watching it so much." When he learned that I would not be far away in case he needed me he let me unload near the store—and so goodbye!

Before finally closing this series of articles I should like to discuss certain matters connected with the zircon. Again turning back the leaves of my experiences, my first knowledge of this strange gemstone was derived from a small parcel of them in my brother's original stock. It consisted of an admixture of the usual Ceylon colors, such as dull leaf greens, browns and whites. But among them were a few that we called "red zircons" that were different from anv that I have seen in the market in recent years. By "red" I do not mean to suggest a color approaching that of a ruby or a garnet. Neither do I refer to the reddish type that so closely resembles the "Spanish topaz," nor quartz. These stones that I am attempting to describe after so many years were of a dull brick-red color that seemed to emerge from a subdued green. Puzzling, isn't it? When they were offered to us by Eastern dealers we were informed that such stones were considered very choice in Ceylon, and we had to pay substantially more for them. In looking back into the pre-gemological days I wonder whether these "desirable zircons" might not have been identified as some other gem. Could they have been chrysoberyl? Perhaps of a quality that would now be classed as alexandrite? Frankly I do not know. According to the reputation of the Ceylonese of that period they were habitually lax in regard to the identity of the gems they sold.

Continuing the vicissitudes of the other varieties of zircon, about 1906 I extended my "road selling" into the East going only to the larger cities. Among several kinds of stones that we had recut to improve their brilliancy, such as amethysts, citrinites and our "white topaz" (quartz), were two papers of white and brown zircons. Practically the only store lighting used in those early days was the clear-glass incandescent light. This was excellent to bring out the rainbow colors of dispersion and caused the zircons to resemble diamonds quite closely whether they were white or brown. Even with my limited experience I could discern a superiority in them as compared to our equally well cut "white topaz." However, I found great difficulty in getting jewelers to buy even two or three white zircons along with the watery white quartz. After my best efforts had been expended, I had to return home with a substantial part of both parcels. Still ringing in my ears after more than 40 years was their usual reply. "No. At $2.00 to $3.00 per carat for white zircons? I'd rather handle 'white topaz' at only $1.00 to $2.00 each. Nobody will notice the difference."

Who today would buy white quartz to sell instead of a zircon?

As soon as World War I was over around the world travel began. All such steamers stopped at Colombo, Ceylon, where zircons were prominently displayed to attract the tourists. They bought them freely. After they had taken them home and showed them to friends and relatives, the demand for zircons of various colors increased. Gradually their diamond-like density of brilliance and dispersive rainbow colors gained recognition, and white topaz brilliants became obsolete.

At the end of the second decade a discovery in the Far East occurred that gave the zircon trade an impulse of international importance. It was learned that certain varieties mined in Indo-China could be altered in color from an uninteresting brown to a beautiful sky blue. Immediately much speculation started concerning the method employed by the cutters in Siam to produce this radical color change. The stone soon became an object of mystery. What accounted for this color change? Some of the blue ones were found to revert to brown again, and the bleached white ones sometimes did likewise. Was the blue color induced by heating in the presence of certain reported chemicals? No one in this country succeeded in making that experiment work. Some brown ones would obstinately refuse to turn white when heated. Heating caused some of them not only to change their color, but also caused them to increase drastically in specific gravity. Before long a Danish scientist discovered the new metallic element, hafnium, in the zircon, which is present in variable amounts. The Siamese cutters remained very close mouthed about the secret color manipulation. Now, the most satisfactory explanation is that zircons differ in their composition and some of them will respond to heat by turning blue while others react differently due to this variable composition.

During the early part of 1920, an unexpected parcel of these blue stones came to me from Bangkok, Siam. They were the first I had ever seen. Insofar as I have been able to learn, this parcel was one of the first shipments of blue zircons to this country. I was very pleased to get such new and beautiful stones before anyone else seemingly knew about them. At that time there was no jeweler in town who came close to making a specialty of colored stones and with considerable satisfaction and pride I took the parcel of zircons to him. Reluctantly he picked out about $45.00 worth of these blue beauties to be paid for within 30 days. About the time that the bill came due he called on me to ask me to take back the stones as he could not sell them.

Before white zircons became well known among dealers we were occasionally approached in our store by a couple of innocent looking young men of about the same age to inquire about white zircons.

"We want to see your best," the spokesman would declare. "Nothing flawed, but a good white color and well cut."

On showing them the stones, preferably three quarters of a carat or a little larger, they both would carefully examine them under their pocket magnifier and would reject any not up to their standard. Even the girdles were required to be unpolished as if they were diamonds. When they had found a few that met with their approval, they would buy without quibbling over price provided it was not excessive.

Now what do you suppose they were up to? Feeling quite secure, they were in some cases quite willing to talk about what they planned to do, which was to borrow money on the zircons by palming them off as diamonds on unsuspecting pawnbrokers.

Their method usually was to mount the stone in a simple Tiffany ring, like an engagement ring, admonishing the setter to avoid any nicks in the top of the zircon that might be made by the setter's file. They would then pick out a certain pawnbroker they believed vulnerable and take the ring into his place between daylight and darkness. From here on the touching words might be something like this:

"I just landed in town and expected to find a job waiting for me, but I won't be able to go to work for another week. I need some money, and I would like to know how much you can lend me on this ring?"

Glancing at it casually and observing good brilliancy the broker looks the ring over under his eye loupe and seeing no flaws says, "Forty dollars."

With sadness in his manner the young man hesitates a few moments then accepts, regretfully explaining that he was hopeful of getting a little more than that. But he has made a $29.00 profit and the pawnbroker has just bought a ring, even if he does not know it.

Occasionally the pawnbroker would be wise and retort, "I can't lend you anything on that ring. It isn't even a diamond."

In which case, the youth would reply, "That can't be so. I bought it for a diamond and always believed it to be one."

According to my experiences, these boys usually worked in pairs, but why I have never learned. Perhaps one was a lookout of some sort.

Another zircon "operator" traveled all over the United States working the same racket from Florida to California. When I met him he was no longer interested in buying zircons, but wished to have a book written about his experiences. For at least an hour he recounted his adventures naming brokers in Los Angeles, Long Beach and many other cities. In a town in South Dakota, the duped pawnbroker through some local technicality had him worried enough to leave town just ahead of the police.

To digress for a moment I would like to relate a couple of his more interesting experiences. He got into the "zircon racket" quite by accident when he was approached by a stranger in a bar who wished to sell him a ring. The man showed him a beautiful brilliant stone about 2½ carats in size which he would sell him for $50.00. He explained that he had just bought it and was afraid that it was "hot" and needed the money. The sale was made and our friend now had the ring. The following morning he became suspicious and decided to take the ring to a jeweler friend who identified it as a zircon worth about $20.00. Our friend had noticed, however, that his jeweler friend had to study the ring quite carefully and lengthily before he had made his decision. He began to wonder what a pawnbroker would offer him for the ring and suited the action to the word by heading immediately for such a broker. When he arrived he boldly declared, "I need to borrow a hundred dollars on my ring. Can I get it?"

Looking the ring and the stone over, the pawnbroker agreed to give him a hundred dollar loan on it and the transaction was completed.

As he left the shop he couldn't believe how easy it had been. A fifty dollar profit just like that! Back to his jeweler friend where he bought two or three rings with good looking zircons and he was on his way.

Another incident occurred in Long Beach.

He approached a pawnbroker with several fine looking pieces that the broker agreed would be satisfactory security for around $350.00. This happened to be more cash than was available in the office and the two of them walked a block or so to the broker's bank. On the way to the bank the "operator" said the broker kept the stones very carefully in his own possession lest there might be a change of mind regarding such an excellently secured loan from the broker's viewpoint. At the bank the deal was made and they parted company, each secure in his mind that they had gotten the best of the other.

If these pawnbrokers had taken an interest in learning about some of the gemstones they came in contact with, they would have recognized these as zircons quite easily by observing the doubling of the back facet edges while viewing them through the top. However, they had to learn the hard way, caring nothing about knowledge of any gemstone but the diamond.

At this point I should like to examine other aspects of this "gemstone of mystery." Gradually this startlingly new variety of this old, but little known gem with twinkling glints of the rainbow through its sky-blue body color acted as a spearhead to open wide the market for all zircons. It soon became evident, though, that the public — the buyers — decreed that only the blue and the white zircons were to dominate. The leaf-green stones were too dull in appearance to command interest; the golden and brown colors failed to present the dispersive glints with enough emphasis to gain popular approval. Some of the public were greatly fascinated with these new blue stones, others were attracted to the white ones because they so well imitated diamonds. On the other hand some dealers obstinately refused to deal in zircons of any kind because of their brittleness. For too long a time these dealers had let their customers believe that if a gemstone was natural "it would never lose its luster through wear." How could they now reverse their attitude and sell zircons when they had to tell their customers "you can't wash dishes wearing these stones without ruining their beauty." Nevertheless the public still wanted zircons, and if certain dealers declined to sell them, they bought them elsewhere. In the midst of these plus and minus influences the sale of zircon grew immensely. However, some of the other influences which affected the market may prove of interest.

In the course of my selling to the trade on the Pacific Coast I discovered many new selling methods utilized by retailers in selling zircons, not all of which were completely ethical. Some of the smaller stores featured attractive eye-catching displays of zircons of both blue and white varieties. Some of the dealers would secure plates of clean white quartz crystal groups into which were placed a lot of fine zircons, while around the plates they would display the mounted pieces — rings, brooches, etc. The rest of the large window then was filled with white glass-stone jewelry with no line of demarcation. The entire display was then brilliantly illuminated. On the awning for everyone to read was a sign — *A ONE CARAT ZIRCON RING FOR $1.00.* According to what I have been told, when prospective customers went in to see the $1.00 ring they were shown a small silver ring with a poor zircon that scarcely anyone would want. Once in the store the prospect got a fast sales talk in an effort to interest him in a larger, better quality zircon at, of course, a much higher price. What was the result of this? The buying public who saw these various misleading signs decided that zircons had become cheap since they evidently were selling at $1.00 a carat. People who would see the dazzling display in the various windows began to think since zircons were so plentiful they couldn't have any value. This combination

(Continued on page 27)

The Structure and Optical Behavior of Iridescent Opal

by

SIR C. V. RAMAN
and
A. JAYARAMAN

EDITOR'S NOTE: This article has been reprinted through the courtesy of the Indian Academy of Sciences Publication, Volume XXXVIII, Section A, Number 5. Of necessity the article has been somewhat condensed from its original length.

The remarkable and very beautiful effects exhibited by iridescent opal have long been known and have made it one of the most admired of gems. In the finest specimens, the play of colour takes the form of localized internal reflections exhibiting hues of extraordinary brilliance and saturation which vary from place to place over the area of the gem and change in a surprising manner with the angle of incidence of the light. Not the least part of the beauty of a fine opal is the orange-red colour of the transmitted light which may be seen reflected back by the rear surface of the gem and then appears all the more vivid by reason of its contrast with the greens and blues so frequently seen in the iridescence. Spectroscopic examination reveals that the internal reflections and the corresponding extinctions in the transmitted light are highly monochromatic. From this, it is evident that they are consequent on the presence within the material of regularly stratified layers in great number. Indeed, the existence of such stratifications is not just a hypothesis. When a gem-opal is examined through a microscope which has arrangements for illuminating the object from above the stage and viewing it by the internally reflected light, the lamellar structure of the material becomes immediately evident. In not a few cases, geometric patterns of a very striking character are observed (see Figures 1 to 4).

A reasonable hypothesis which would fit the observed character of the stratifications as well as the optical effects to which they give rise is that iridescent opal consists of alternate layers of two crystalline modification of silica of slightly different refractive index. In a recent paper[1], we presented evidence which supports this hypothesis derived from a study of the X-ray diffraction patterns of hyalite which is a material having a composition similar to that of gem-opal and exhibiting optical phenomena of a similar nature. Further studies have since been carried out by us in which X-ray cameras of higher resolving powers were used and the resulting photographs were precisely measured. They have enabled us to reach the definite conclusion that the *two modifications of silica present in hyalite are respectively low-tridymite and high cristobalite.* X-ray studies have also been made by us with common opal which occurs in massive form with a waxy lustre. These have led to a similar conclusion regarding the nature of the latter material.

The X-ray patterns of gem-opal are diffuse, thereby making it less easy than in the case of the crypto-crystalline materials hyalite and common opal to identify the nature of the atomic groupings which appear in the alternating layers of the lamellar structure. Nevertheless, a careful examination of the patterns leaves little room for doubt that, as in the case of the iridescent hyalite, we are concerned with two modifications of silica present side by side in it, one of them having a structure resembling that of low-tridymite and the other that of high-cristobalite. Comparative studies of the optical behaviour of hyalite and of gem-opal made by us confirm this finding and establish this as the origin of the iridescence exhibited by these materials.

As is well known, agate and chalcedony are massive forms of silica which X-ray studies show to consist of crystallites of quartz. The latter are frequently grouped together in specific orientations, thereby giving rise to the characteristic banding of the material, as has been shown by us in a recent paper[2]. *Prima-facie*, one may expect that two other crypto-crystalline forms of silica should also be forthcoming in nature consisting respectively of low-tridymite and low-cristobalite. The latter expectation, at least, is found to be fully justified. Some years ago, a white and compact porcelain-like material was collected by one of us on the open terrain not far from Indore in Central India. It was usually found associated with agate, but occasionally also appeared as separate masses. The density of the material has been determined and lies between 2.32 and 2.35, thus excluding the possibility of its being chalcedony. The density approximates closely to the known value of low-cristobalite, and examination by X-ray diffraction methods confirms this identification. On heating the substance to about 300° C., it transforms completely to high-cristobalite, and on cooling reverts again to low-cristobalite.

It is clear from the X-ray patterns that the cristobalite is present in the material in random orientations and in a highly divided form, the particle size indicated being about 1 μ in diameter. This is confirmed by optical observations. A slice about half a millimeter thick cut from the material and polished on both sides regularly transmits light of a deep red colour which is unpolarized. From these observations again, one infers that the crystallites are of small dimensions and are randomly orientated. The most significant result that emerges is that high-cristobalite is unstable at ordinary temperature even when in a fine state of subdivision and reverts immediately to low-cristobalite.

Another material examined by us in detail is common opal with a waxy lustre, two large lumps of which were purchased from a mineral dealer in New York. The material is translucent in thick layers, but in smaller thicknesses of the order of a millimeter transmits light freely. The density of the material is 2.02 and its refractive index 1.440. On heating to about 800° C., it becomes opaque and white and also loses about 10% of its weight, presumably due to the loss of absorbed water.

The density of gem-opal ranges between 2.1 and 2.2, and its refractive index between 1.45 and 1.46. The density and the refractive index of hyalite are respectively 2.0 and 1.44 respectively, these lower values being related to those for gem-opal at least approximately in the manner demanded by the Gladstone-Dale formula. The principal difference between gem-opal and hyalite is that while the latter, as we have seen, gives a well-defined X-ray diffraction pattern, the pattern of the former is diffuse and resembles that of vitreous silica, though there are recognizable differences.

The X-ray data point clearly to the conclusion that the structure of gem-opal is essentially the same as that of hyalite, except that the crystallites are now much smaller, thereby tending to make the material simulate a vitreous solid.

The essential similarity between hyalite and gem-opal indicated by the X-ray data is supported by other facts of observation. One of the most striking features observed with gem-opal is the appearance of visible stratifications in it. These are very conveniently observed with the aid of an "Ultropak" microscope. In this arrangement, a conical beam of light is directed from above the stage on to the surface of the specimen and the latter is viewed by the light reflected from its interior and returned to the objective of the microscope. A great variety of geometric patterns are observed, a few particularly striking examples of which are reproduced as Figures 1, 2, 3 and 4. Figures 1 and 4 refer to exactly the same portion of a particular specimen but under slightly different conditions of illumination. Figure 2 refers to another area on the same opal. Figure 3 is a particular area on the finest gem-opal in the collection of the Indian Institute. It will be seen from these pictures that the stratifications run in several directions simultaneously and in fact the entire material is honeycombed by them. The material is divided up into layers parallel to one, two or even three sets of parallel planes crossing each other. It is to be noted that hyalite also shows visible evidence of internal stratifications.

In examining the optical behaviour of regularly stratified media, the use of monochromatic light is very helpful. We shall proceed to recount some observations made with opals, respectively in the light of a sodium vapour lamp and of a mercury arc.

The finest opal in the collection of the Indian Institute is a square tablet which in diffuse daylight exhibits bright green, blue or violet flashes of internal reflection. In the light of a sodium vapour lamp, however, this brilliance disappears and the gem is seen transformed to an insignificant and unsatisfactory object exhibiting numerous defects, including especially a cloudiness over part of its area on one face in which no iridescence is visible even in diffuse daylight. Every one of the opals in the collection of the Institute which exhibits a green or blue iridescence resembles in the light of a sodium lamp a piece of common but rather turbid glass. Such disappearance of the iridescence is intelligible in the light of optical theory, for a regularly stratified medium ceases to reflect at any incidence if the wave-length λ of the light is greater than 2 μt, where μ is the mean index and t is the spacing of the stratifications.

The opals which show up so badly in the light of the sodium lamp present a very different appearance in the light of a mercury arc. The difference between the mercury arc and diffuse daylight is however conspicuous in the colour exhibited by the internal reflections, as also in the colour of the transmitted light. The former shows less variety than in daylight, while, on the other hand, the transmitted colours are more lively, being less diluted by the light of longer wavelengths present in daylight.

It is clear from the facts that the optical effects exhibited by transparent hyalite and by iridescent opal form a continuous sequence in which there are three stages. In the first stage, the stratifications are too widely spaced to result in internal reflections, but give rise to diffraction haloes or diffraction spectra in forward directions. In the second stage, the stratifications are too closely spaced to give diffraction effects in forward directions, but result in reflections backwards towards the source. Finally, we have a third stage when the stratifications are too closely spaced to give any effects at all, unless the wave-length of the light is sufficiently small. In the crypto-crystalline hyalites, we would naturally expect the first stage to be commonest, and the second stage less common. In the gem-opals, on the other hand, where the material is approaching the vitreous condition, the stratifications may be expected to be much finer and the third stage therefore attained, unless the wave-length of the light is chosen sufficiently small. We do indeed have opals which exhibit a bright yellow or red iridescence. But those with a green, blue or violet iridescence are commoner, indicating that the more closely-spaced stratifications are favoured.

In studying the optical behaviour of opal rather more closely, we may adopt one of two different methods. In the first method, we view the opal directly or through a microscope, illuminating it from one direction and viewing it in another, and vary those directions. The second method is the same as described in our earlier paper. We illuminate the opal by an intense narrow pencil and the light reflected backwards is received on a white screen held not too far away from the specimen, a small aperture in the screen permitting the illuminating pencil to pass through and fall on the opal. The complete pattern of reflected, diffracted or scattered light returned by the opal is then visible on the screen.

Observations made in the manner described disclose a great variety of effects in different cases. With some specimens, we observe a bright spot or a group of bright spots constituting a reflection-pattern properly so-called. There are also cases in which no pattern appears but only a diffuse area of light on the observing screen, its colour being the same as that of the observed opalescence of the specimen. Opals giving brilliant localized reflections give, in general, complex patterns composed of bright spots, bright coloured streaks of light and brilliant diffraction spectra crossing each other in different directions, the whole pattern altering rapidly as the opal is moved with respect to the illuminating pencil of light. Even those opals which are not of much value as gems, exhibiting colour only in tiny specks or spots on a non-iridescent background, give interesting patterns of various kinds.

It would take us too far from the main purpose of the paper to describe or discuss the reflection patterns of opal in greater detail. We may, however, make a brief reference to the behaviour of a particularly interesting specimen in our collection. This is a so-called "black opal" in other words, a layer of opal on a background of opaque ferruginous material. When it is illuminated by a narrow pencil of sublight, the pattern seen on the viewing screen is a single bright streak of light covering a wide range of angles and exhibiting the usual sequence of colours seen in a diffraction spectrum. The distribution of intensity in the spectrum is however anomalous, a concentration of intensity appearing at one place and a dark gap elsewhere, the position of the former altering with the inclination of the reflecting surface to the incident pencil of light. Examination of the specimen under the microscope reveals the presence of parallel striations over its area. These presumably represent the stratifications of the opal meeting the surface of the specimen obliquely. That in these circumstances a diffraction spectrum appears and not a simple reflection is scarcely surprising.

The X-ray investigation of the structure of the crypto-crystalline hyalites reported in an earlier paper has now been revised using cameras of higher resolving power. Precise measurements of the resulting photographs reveal that low-tridymite and high-cristobalite are present associated with each other in this material. Investigation of the structure of common opal exhibiting a waxy lustre leads to similar results. From a detailed examination of the diffuse X-ray patterns given by gem-opals as well as a comparative study of the iridescent hyalites and opals, it is concluded that in both of these materials, the presence of alternating layers of high-cristobalite and low-tridymite is **responsible for** the iridescence.

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2. ....Ibid, 1953, 38A, 199.
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- Lamellar structures in precious opal.

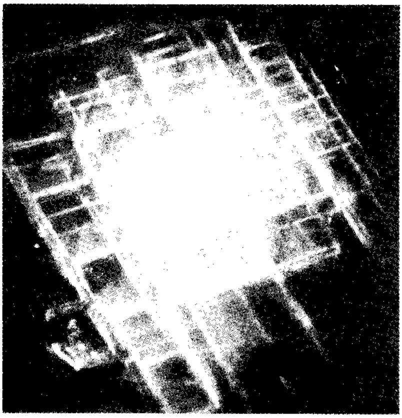

Figure 1

Figure 2

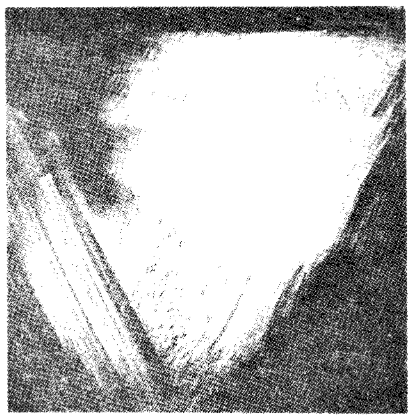

Figure 3

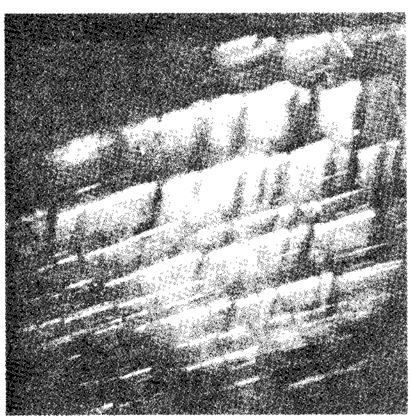

Figure 4

Jeweler's Notebook of Memories

(Continued from page 20)

of circumstances began to affect sales and frequently when I would offer zircons to other retailers they would turn me down. What could I say? Not much, but I had a very sour taste in my mouth. I regretted this "killing of the goose that laid the golden egg."

Now please look at another aspect of merchandising the zircon, which a jewelry firm in Portland utilized to make money with this beautiful stone. About 1926 they began to specialize in fine blue zircons. They bought the best and mounted them boldly into the best mountings. Every piece made for the stone was creditably designed. Some were merely beautiful artistic designs without diamonds and others were elaborately made with diamonds. The zircon business was thereby dramatized and placed into the jewelry class in a manner that was worthy of the attention and interest of the wealthier buying public. Zell Brothers, who had introduced this manner of merchandising zircons, gained a national reputation in the trade. They profited by this policy while their competitors shared the benefits. Long after the zircon business died in some areas, it continued good in the Northwest.

Concerning zircons today, as the old saying goes "what goes up must come down." Beginning as unknown gemstones they were appreciated by the public until a certain saturation point had been reached and then their sale started to slow down. About this time, a new stone came into the limelight and took the interest away from zircon insofar as the buying public was concerned. This then new stone is none other than synthetic rutile, or titania. Its marvelous display of prismatic colors eclipsed the dispersion of the zircon to such a degree that the zircon market has been substantially depressed.

In bidding you a temporary goodbye, I wish to sum up my articles by pointing out that gemology to me represents not only my business and my hobby, but also a source of pleasure. If in reading these articles you have shared that feeling with me, then I shall feel a definite sense of accomplishment. All of us have had experiences with gemstones that are more than mere business experiences. In the future, I plan to try to bring to you other episodes concerning gemstones new and old, in the hope that you will approve and also continue to share my feeling in regard to gemology.

Book Reviews

FUNDAMENTALS OF PHYSICAL SCIENCE by Dr. Konrad Bates Krauskopf. New 3rd edition published by McGraw-Hill Book Company, New York; $6.00. Reviewed by E. S.

Dr. Krauskopf, professor of geochemistry at Stanford University, has enlarged and revised to date his excellent work on the physical sciences in this new third edition. The *Fundamentals of Physical Science* was first published in 1941 and the second edition came off the press in 1948. The chief value of Professor Krauskopf's book is the excellent manner in which he has correlated the fundamental funds of knowledge accumulated in the fields of astronomy, chemistry, geology and physics. Today's scientific researcher finds his efforts combine so fully the important aspects of what he once considered separate scientific fields that such a correlation is invaluable. The reader is taken through the early theories developed in each of the fields and the effects upon these theories of later observation. Revisions of the original theories to fit today's fund

Book Reviews

of facts are indicated clearly. As Professor Krauskopf stated in the preface to his first edition: "It should likewise fill the need of the general reader, college trained or not, who seeks information about the methods of science and the place of science in our modern world. For either college student or general reader the book requires nothing in the way of preparation beyond a lively curiosity and a willingness to make some effort to train his mind in unaccustomed ways of thinking."

FIELD GUIDE TO ROCKS AND MINERALS by Dr. Frederick H. Pough. 288 illustrations; 333 pages; published by Houghton Mifflin Company, Boston; $3.75.

The growth of mineral collecting as a hobby has been almost too rapid for the development of suitable texts. The heavy early sale reported on this book is both a measure of the demand in this field and the excellence of Dr. Pough's answer to the problem. This book serves well both as an elementary laboratory manual and as a field guide. It is clear that Dr. Pough considered carefully the amateur collector's problems before undertaking the unusual approach that distinguishes this from texts for training professionals and which makes this book particularly useful to the amateur collector. A real effort has been made to emphasize common characteristics chemically or structurally in a manner which permits a general chemical classification on the basis of physical properties. In his effort to simplify testing procedures Dr. Pough has placed heavy emphasis on the use of ultra-violet in testing to what seems an advantageous degree. In addition he has given some good advice for the private collector not only as to collection methods but to collecting propriety and care of the specimens.

"Ask permission before visiting private property if you can, and go easy on the ore piles you may find at a mine or quarry. Even a few pounds of some minerals, like beryl, are valuable and the quarry owner is not likely to be pleased to find his hoard stripped on a Monday morning after leaving it unguarded over a weekend. When you have the owner's permission do not abuse the collecting privileges granted you, for one bad experience will put the whole mineral collecting fraternity in a bad light. Do not clean out a locality or batter up crystals you cannot take out yourself; there will be other collectors after you. Encourage others to join in the hobby; from today's collectors come tomorrow's professional mineralogists. Join local mineral societies and work to improve their meetings. *Study some phase of mineralogy and make yourself a master of it;* you will get as much out of your hobby as you put into it. Visit the museums and see what they have from your localities. Take a pride in them and give to them, because the museums cannot exist without your support. Their only funds for the purchase of specimens are those you contribute."

Of the 333 pages, 235 pages are devoted to descriptions of the approximately 200 minerals considered by Dr. Pough as best suited to the text. Undoubtedly no two mineralogists would agree as to which of the estimated 2000 minerals should be described in a text of this sort. However we could find few about which we would be inclined to argue. The book contains 254 photographs, mostly of mineral specimens from the American Museum of Natural History collection, and of these some 72 are in color. For the most part the color plates appear to be of high quality.

Gemological Digests

PERCY K. LOUD

GEMOLOGICAL DIGEST
LOUD RETIRES AS PRESIDENT
OF WRIGHT, KAY & COMPANY

The board of directors of Wright, Kay & Company, leading jewelers of Detroit, Michigan, announced recently the retirement of its president, Percy K. Loud, who will continue to actively pursue his other interests.

Percy K. Loud first joined the firm at the age of 12, serving as a holiday employee. Upon Robert Kay's retirement his progress and rapid development in executive roles soon led to a road of steady advancement. He was appointed secretary, followed by his promotion to the office of treasurer in 1919. He retained both positions until his elevation to president treasurer in 1944. He resigned the responsibilities of treasurer in 1949. During the 43 years he was associated with the firm, Mr. Loud was active in many organizations and activities designed to raise the standards of the jewelery industry.

He has given many years of service to the advancement of the science of gemology without recompense. Mr. Loud and Walter Jaccard of Kansas City organized the National Jewelers Research Group, Loud becoming the first secretary-treasurer and member of the Board of Directors. On the retirement of Jaccard, Loud became chairman. He also was active in the organization of the American Gem Society and became the first chairman of their International Committee. For many years Mr. Loud has contributed much to the growth of the Gemological Institute of America and was one of the members of the first Board of Governors, also serving as treasurer of the Institute from 1942 until 1948. He is currently chairman of the Board of Governors of the Gemological Institute of America and a member of the Board of Trustees of the Endowment Fund. Mr. Loud also serves as Michigan representative of the Jewelers Vigilance Committee.

BLUE DIAMONDS FROM ATOMS?

An item appeared recently in the Wall Street Journal as follows:

> WANT A GREEN DIAMOND?
> ATOM RAYS MAKE THEM
>
> NEW YORK—Green or yellow diamonds may become a jewelry fashion rage of the future.
>
> Scientists at the British atomic plant at Harwell, England, have been experimenting with making such colored stones by bombarding regular water-white diamonds with atomic particles inside a nuclear reactor. The bombardment changes the structure of the diamond crystal, which in turn changes its color.
>
> Blue diamonds are occasionally found in nature and are worth much more than white ones. Dr. J. F. H. Custers, acting director of Diamond Research Labs, an

industry-supported group, recently broke the story of the British scientists shenanigans in warning jewelers how to spot artificially made blue diamonds from natural ones.

Evidently this was picked up from an article, ARTIFICIAL COLORATION OF DIAMONDS published in the Review OPTIMA in December 1953. When we noticed this statement, we wrote to Dr. J. F. H. Custers, director of research of the Diamond Research Laboratories in Johannesburg. In his reply, Dr. Custers stated that diamonds were colored blue artificially for the first time at the Harwell Atomic Energy Research Establishment. He said that the coloration is performed by making use of a beam of electrons as generated in a Van de Graaff machine. The Van de Graaff machine provides a means by which a very high voltage may be obtained. In his letter Dr. Custers informed us that the Diamond Research Laboratory is at the moment engaged in an extensive program embracing various methods for the discrimination of artificial blue diamonds and natural blue diamonds. To quote Dr. Custers:

"These methods are still in the Laboratory stage, but progress made so far has shown that it will be possible to establish without any doubt whether a diamond has been coloured artificially. We feel that these methods can be simplified to such a stage where they will be suitable to be applied by a layman. Apart from this, this artificial colouration of diamonds is being patented so that we will be in a position to protect the diamond interests.

We do not think that diamonds can be made blue by making use of a cyclotron, but it might be possible under very special conditions, to introduce a blue colouration by means of neutrons. For this, however, a nuclear reactor would be required. Under ordinary conditions, diamonds will turn green when bombarded by neutrons."

GEMOLOGICAL DIGESTS AWARD ANNOUNCED FOR YOUNG JAPANESE SCIENTISTS

Elmer W. Ellsworth, Ph.D., of Tulsa, Oklahoma, importer of Horiguchi cultured pearls and Business Manager of the American Association of Petroleum Geologists, in 1952 established a Best Paper Award for research in pearl culture. This award is offered annually as a measure of encouragement to young Japanese scientists engaged in cultured pearl research. Each year a selection is made of the best original paper published in Japanese by Japanese scientists under 35 years of age, by the following committee: Chairman, Prof. Keeichi Omori, of the Institute of Mineralogy, Petrology and Economic Geology, of Tohoku University; Dr. Shinjiro Kobayashi, Prof. of Biology, Hokkaido University; Dr. Takeo Imai, Prof. of Biology, College of Agriculture, Tohoku University; Dr. Isam Motomura, Prof. of Biology, Tohoku University; Mr. Kiyohiko Otsuka, Yamato Chemical Ind. Co., Ltd. (Tokyo); Dr. Jun-ichi Takahashi, President of Shinshu University; Dr. Manjiro Watanabe, Dean of Faculty of Science, Tohoku University; Mr. Hiroshi Yokose, President of Fuji Pearl Co., Ltd., (Tokyo).

Two young scientists were selected to share the 1952 award, each receiving $25.00. These two papers are "Daily Rhythmic Activities of Byssus Secretion in Pearl Oysters, *Pinctada Martensii*" by Ryogo Yuki; "On the Abnormal Lamellae of Cultured Pearls and the Environmental Conditions under which These Lamellae are Formed" by Norimitsu Watabe.

Similar awards are made in this country in various branches of science particularly by the societies and associations in the fields. Such Best Paper Awards have given national recognition to brilliant young scientists in these fields and serve the industry well in stimulating fundamental research. It is Dr. Ellsworth's hope that capable young scientists in Japan can be similarly encouraged in contributing to the scientific aspects of the cultured pearl industry.

The following is a translation of a published Japanese report on the 1952 award announced in May of 1953.

"Professor Omori states: The annual award of $25.00 is not a large amount, but its significance lies in the favor and interest shown by a foreign scholar to our pearl industry. Heretofore, many foreigners have been very much interested in cultured pearls, but this interest has been confined to just the production and business aspects of the industry. This award is the first interest directed to the fundamental research on the cultured pearl. As a qualification of his scholarship, Dr. Ellsworth confined the age of a candidate to 35 years or younger, a fact which reveals his interest in the future of the cultured pearl industry.

"At the present time, our country is leading all other countries in research on cultured pearls. This award will encourage more research and help young scientists recognize the importance of their work, which in turn will keep up our country's prominent standing. Appreciating the significance of this matter, our committee made its selections with extreme seriousness."

We feel that Dr. Ellsworth is to be congratulated on his action in this case. Such encouragement is certain to be helpful to the young scientists.

SIMPLE MEANS TO DISTINGUISH YELLOW CHRYSOBERYL AND YELLOW SAPPHIRE

by Robert Crowningshield, Gem Trade Laboratory.

It has occurred to the writer that a simple means of distinguishing between yellow chrysoberyl and yellow sapphire is possible when a refractometer is available but not monochromatic light nor a spectroscope. Particularly do students have difficulty in making this separation as white light readings are indistinct. A simple test is to use a drop of pure methylene iodide (R.I. 1.74) instead of the normal contact liquid. If a portion of the spectrum is seen in the blue-violet, we are dealing with chrysoberyl. The green and yellow components will be beyond the index of the liquid. A sapphire tested under the same conditions will not show any spectral colors, only the liquid reading will appear.

This test has been satisfactory for a large number of stones tested including those with flat surfaces and cabochon shaped stones, though with less success with the latter.

Of course, where monochromatic light or a spectroscope are available, this test would be pointless. However, most gemologists who have a refractometer will have access to pure methylene iodide.

Other lower index liquids such as mixtures of bromoform and Xylene which have a reading of 1.56 should help in the same manner to distinguish between natural and synthetic emerald. Unfortuately the mixtures available to the writer at the time of experimentation are not successful as they produce a spectrum themselves when in contact with a stone. Some experimenter may hit upon a liquid which will work in this instance.