THE JOURNAL OF GEMMOLOGY
AND PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

Vol. IV No. 4 OCTOBER 1953

FORENSIC GEMMOLOGY

by ROBERT WEBSTER, F.G.A.

ARISING from a discussion with a detective officer of the Metropolitan Police Headquarters, New Scotland Yard, it has been the writer's privilege to publish in a semi-official journal circulating among Police Forces throughout the British Empire[1], an article giving elementary information on gemstones and jewellery for the guidance of Police Officers. That this compilation was well received is evident by its re-publication in the *International Criminal Police Review*—the Official Journal of the International Criminal Police Commission (INTERPOL), whose headquarters are in Paris, this Journal being circulated to the Chiefs of Police in almost every country in the world.

The concluding paragraphs of this article were set out to show where any police officer could obtain advice on jewellery and gemstones. It is the intention now to suggest how any gemmologist called upon to assist the police, and who is willing to do so—as one should be if circumstances permit—may best perform the required services. To this end some idea will be given of the usual requirements of an investigating officer; the necessary testing required for given cases—both hypothetical and actual—and some details of Court procedure should the gemmologist agree to attend as an " expert witness."

Cases involving fraud are those most likely to come the way of the gemmologist. Such cases mostly comprise the simulation of diamond by white zircon, synthetic white spinel, or similarly made corundum, and other colourless stones—even pastes. The question " synthetic *versus* natural " seems to be a subject rarely investigated in the criminal courts—more often such a problem is dealt with before the civil court. However, the procedures in either court are fundamentally similar.

Questions involving jewellery in charges of theft may sometimes occur in which the gemmologist may be able to assist. Such matters may well involve considerable gemmological skill. Even the most serious charge in the criminal calendar may require the service of a technical gemmologist. This was manifest in the report of one such case which will be briefly referred to in this article. It is these last two types of cases which produce the most interesting work; sometimes even needing experiment.

For the purposes of description let a relatively simple case of fraud be taken; say a zircon ring fraudulently sold as a diamond ring. Such a description may well be divided into three main sections: the initial visit and discussion with the police officer in charge of the case; the testing and reporting and lastly the actual giving of evidence before the court.

A police officer having charged a person—in this case possibly with a charge of " stealing by means of a trick," or " obtaining a sum of money by false pretences," then has to prepare his case. He, or she, for there may well be a woman detective on the case, must not only produce his witness or witnesses to prove the actual commission of the crime, and give evidence of arrest; but must also find a suitable " expert witness " to testify to the stone, or stones; the nature of the mount; the value of the ring as it is and also its probable value should it have been set with real diamonds.

Finding a suitable and willing expert to give such evidence is one of the headaches of the detective officer, for his only hope is to approach any local jewellers for assistance. In doing this he may spend much valuable time finding someone who is suitable and willing to attend the court hearing. In this connection it is much more satisfactory to the officer if his witness has " status," and that is where a Fellow of the Gemmological Association is more acceptable than an ordinary jeweller. To this end the Gemmological

Association may give on request the names and addresses of all qualified gemmologists in a given area to any police officer needing such services.

It will be wise to mention at this stage the *snag* which causes most annoyance to a witness. That is the time wasted hanging about the court before being called to give evidence. This is in no way the fault of the detective dealing with the case, for he is answerable to the court and must produce his witnesses when called upon to do so. It is not always possible to state with any accuracy the time a witness will be required, hence, witnesses are required to attend in good time. Further, the defence may ask for further time to prepare the case, and this the magistrate usually gives, even if all the prosecution witnesses have been assembled. A remand for another day thus makes an abortive attendance for those witnesses. These are matters over which the police have no control. In recent years, however, the judge usually dismisses from the case all expert witnesses as soon as they have finished their evidence. This is a favourable and understanding turn from the old times when witnesses were not allowed to leave until the close of the case. The writer has purposely placed emphasis on these snags because it is better to be warned than to *moan* afterwards. With the modern judicial efficiency it is rare for an expert witness to be at the court for more than one day—only half a day is more usual. It is wise to remember that any attendance at court is not wasted, for the crook fraternity are detrimental to your own business. It is for your ultimate benefit, and for your colleagues in the jewellery trade, that you should assist the forces of law and order whatever be the slight inconvenience involved.

The first point to consider if asked to assist the police is whether the time can be afforded. If you cannot do the job then tell the officer directly, but do, if possible, advise him where next to try. If you are prepared to assist, then get a clear idea of the officer's need and further, get from him the full facts of the case as far as it is known. The writer states this advisedly, for you with your general and technical knowledge may be able to suggest points which have not been realized by the officer, who may well be unversed in gemstones and jewellery.

Having in mind the full picture, the necessary testing is next carried out. The gemstones will usually present no difficulty, but

the metal of the mount is more of a problem because to obtain an accurate determination of the metal and its quality would need an assay, which is outside the scope of a jeweller/gemmologist. It is a good plan, therefore, that the officer be informed that your decision is based on tests by acids, and, thus, can only be approximate.

It is suggested that on completion of the testing a full personal report be written out. This report should be signed by you and given to the detective. The report, of which you should keep a copy, should contain: a good description of the piece or pieces of jewellery; the nature of the stones and the metal of the mount, with, on your own copy, notes of the tests performed in all cases; your estimate of the value of the jewellery—each individual piece separate—and your estimate of the probable value if the stones had been real diamonds.

It is at this stage, *i.e.*, before the " signed statement " is made, that some consideration be given to the presentation of your evidence. In a simple straightforward case, where oral statements in the witness box are all that would be required, nothing further need be done than that which has been outlined. Depending on the nature and seriousness of the case, it may be felt that pictorial illustrations may be of assistance to the court in emphasizing the points you need to bring out. Should you decide to put in pictorial evidence, then prepare these ready for the first hearing (at the lower court), where they will be put in as exhibits.

Should pictorial illustrations *not* be prepared for the lower court and the case goes to the Assizes or Sessions (higher court), then, if it is considered better to supply pictures and this is done, such exhibits will need to be put in as additional evidence. Such an arrangement is not favoured by either the court or by the police authorities. It is for this reason that it has been stressed that the full facts—the strengths and weaknesses of the case—are obtained from the police officer in the first place. The employment of photography or drawings as an aid to presentation will be discussed later.

For completeness a few notes on court precedure could with advantage be given—mainly for those readers who have not had the necessity of attending a court hearing. Firstly, it should be noted that a witness attending court must remain out of the court

during the hearing of his case until called upon to give his own evidence, after which he remains in court until the end of the case; unless, as pointed out earlier, the judge allows the witness to leave. On being called into the court to the witness box, the usher, or sometimes the Clerk of the Court, will instruct you to read the oath, the wording of which may not be quite the same in all courts. Following the taking of the oath the Clerk will state your name, address and other particulars and ask you whether they are correct. The examination will then be taken over by the prosecuting solicitor (or barrister if in a higher court) who will ask you such questions which should bring forth answers from you which are the means of proving his case against the accused. In the hypothetical case of the zircon ring the questions may well be quite simple, such as: What are the stones in the ring? What is the metal used in the mount? What is your estimate of the value of the ring? What would be the value of the ring if the stones were genuine diamonds? Quite often, and sometimes by the judge himself, you may be asked to explain what a zircon is and how it compares with a real diamond. In cases heard before a jury the judge often puts such questions in order that the " twelve good men and true " should be in full possession of all the facts. Such questions should present no difficulty to a trained gemmologist. Indeed, it is for this very reason that the police authorities prefer a qualified gemmologist to a non-technical jeweller, who, maybe, knows the value of jewellery well, but is often hazy over the nature of the stones used as" fakes." To report, as one so-called expert did recently (if the press report be true) that the stones in a ring were " white spinels " known as " jargoons," lays a witness wide open to discredit from a knowledgeable defending lawyer. It is he who cross-examines after the prosecuting lawyer and his questions aim at bringing out any point which will favour the accused.

All the evidence given at the first hearing, *i.e.*, at the lower court, is taken down in writing by the Clerk of the Court. If the case is sent for trial—to the Assizes or Sessions—then the witness signs this written copy of his evidence, and he is then " bound over " in a sum of money to attend the hearing at the higher court. This is one of the " snags " in acting as an expert witness, for no exact information is forthcoming as to when the higher court will hear the case, and, moreover, the higher court may be held at a place

some distance away, which again wastes time in travel. Unfortunately these difficulties cannot be wholly avoided, but at the present time everything possible is done by the authorities to minimise time wastage.

Suggestions for the initial preparation of the evidence may be best demonstrated by assuming definite types of cases and discussing various methods which may well assist in driving home the points it is desired to bring out. By discussing a number of different cases it should be possible to apply these as a " framework " for any given problem.

Let the simple zircon ring case be the one to start with. The initial testing, from a gemmological point of view, would be to prove the stones to be zircons, by, it is suggested, the double refraction and the absorption spectrum. What can be done by way of identifying the metal of the mount and making the necessary valuations will complete the data required. In the matter of the presentation of the evidence, anything which will implement the spoken word would be an advantage, and in this respect photography can be an invaluable silent witness.

A photomicrograph of the doubling of the back facets seen in the actual stones in the jewellery—even the effect seen in one stone of the piece—will do much to assist the court, with, of course, verbal explanation that the doubling effect cannot be seen in diamond.

The question of the best type of photograph for this presentation may conveniently be discussed. The usual type of photomicrograph showing the doubling of the back edges of a stone due to double refraction illustrated in text books, may not be the best. Such a picture is shown in Figure 1. Although such a picture could be used, if it is possible to employ a sufficiently low power so as to show the full outline of the stone the impression will be clearer to the court and especially to a jury. Figure 2 illustrates this point. While contact prints might be acceptable (if the size of the negative be suitable), it is manifestly far better to have enlargements made —postcard size or 6 ins. by 4 ins. would be suitable. Initially three copies are needed, one for the prosecution and one for the defence, and a copy for you to hold as a control. If the case goes for trial before a jury a further six copies would probably be required—it is usual to have one copy between each two jurymen. Another copy to hand to the judge might well be desirable, or you

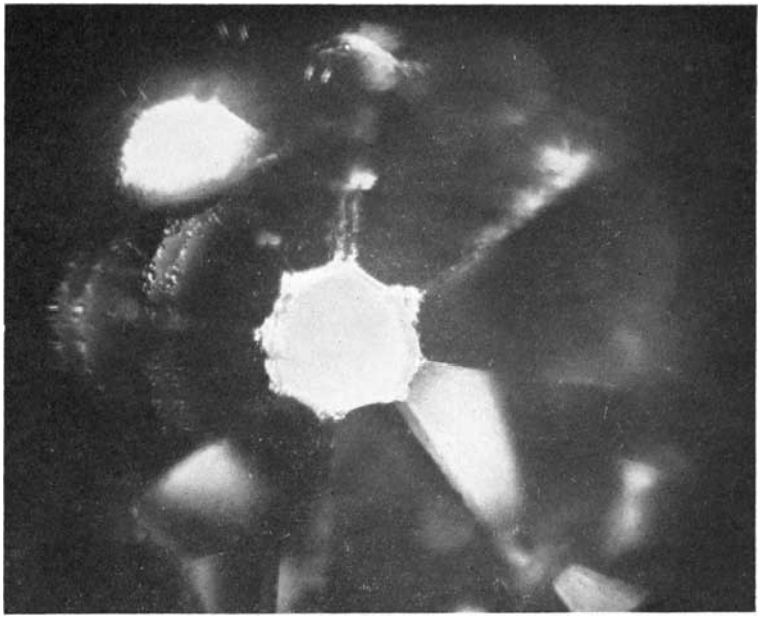


Fig. 1. *The usual type of text-book illustration of the doubling of the back facets of a zircon showing "paper worn" edges.*

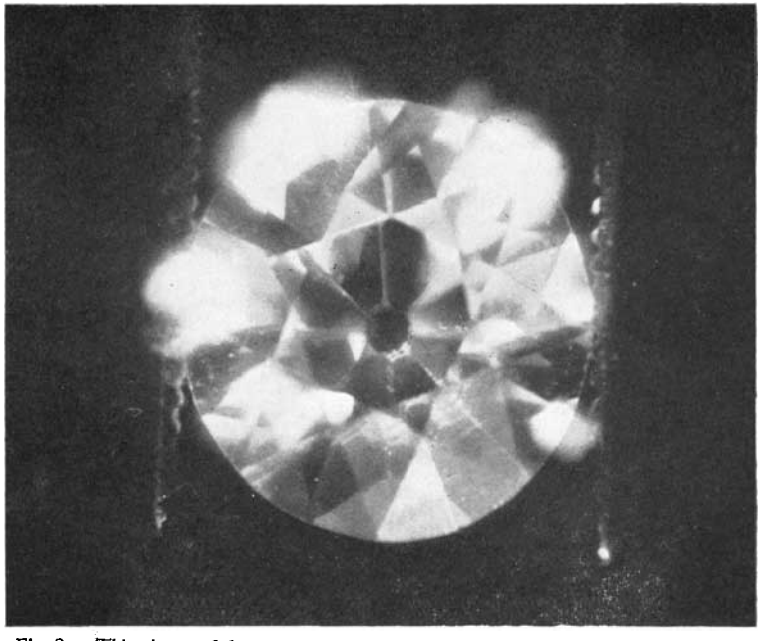


Fig. 2. *This picture of the same zircon as pictured in Fig.* 1, *has the advantage of showing the full outline of the stone. Such a picture is better understood by a lay person.*

could hand him your own " control " copy. Anyway, the cost of all photography is a charge on the expense sheet. It is not suggested that it is necessary to go to the extent of photography in every simple case. The detective officer will tell you how strong or weak in evidence his case is.

An elegant variation of the pictorial exhibit was used by Anderson nearly twenty years ago (Rex *v.* Rice). In this the marked difference between the degree of transparency to X-rays of diamond and white zircon was employed. Figure 3, which are prints of the actual radiographs taken at the time, show the effect. The lower picture was the one used in evidence in order to show that there was indeed a diamond in the single stone ring, for should the top picture have been used alone there would have been no reply to the defending lawyer's assertion that there was never a diamond in the ring. The contention that X-radiography is completely outside the scope of the average gemmologist has been proved false by Vincent[2], who obtained the services of a dentist in possession of an X-ray machine. Quite a number of dentists have such apparatus and would be willing to take the necessary X-ray picture. Or, in serious cases, the police would doubtless contact a hospital and obtain their assistance in taking a radiograph.

If the subject of the fraud is either a synthetic white sapphire or a synthetic white spinel, a " relief " picture comparing the degree of relief of the synthetics with that of diamond when immersed in a highly refractive liquid may be prepared. Such a picture is shown in Figure 4. The same effect may be shown with pastes.

A short discussion on the murder case referred to earlier (Rex *v.* Heath) will illustrate several points. In this case a solid glass imitation pearl bead was found in the jacket pocket of the accused, and the problem was to prove, as far as proof was possible, that the pearl could have come from a necklet, the broken remains of which were found near the body of the second victim. This pearl was sent to the Laboratory of the London Chamber of Commerce, with several of the pearls found by the body, for the experts there to see what comparison could be made.

The problem was not easy, for there was little in the way of published data on imitation pearls to go on. After an accurate weighing of the pearl found in the accused's pocket—for control purposes —an accurate density was taken by suspension in a bromoform

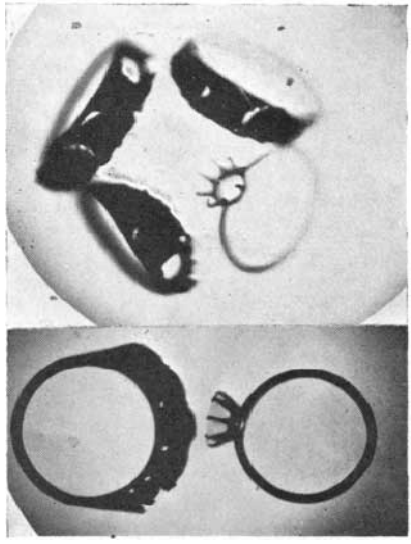


Fig. 3. *X-ray comparison photograph of zircon rings (in 3 cases with one stone deficient) showing the opacity of the zircons and the transparency of diamond to the rays. The lower picture was taken with a shorter exposure in order to prove that there was a stone in the diamond ring.*

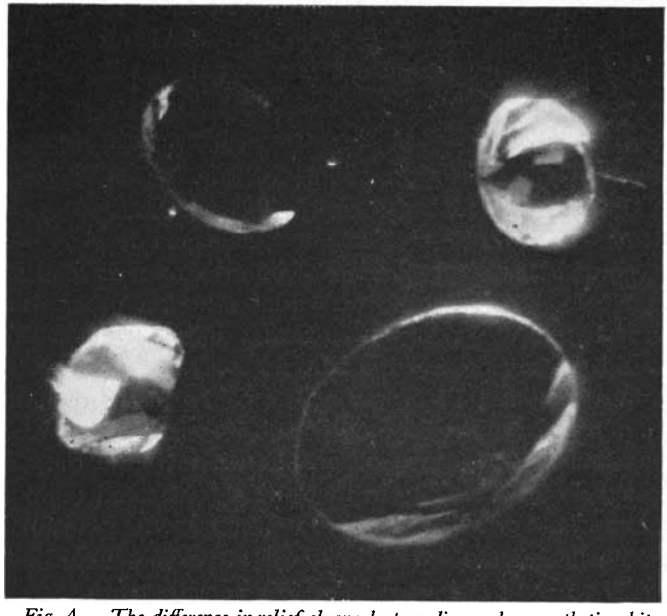


Fig. 4. *The difference in relief shown by two diamonds, a synthetic white sapphire (smaller stone) and a synthetic white sapphire (larger stone) when immersed in lighter petrol. Petrol was used instead of monobromonaphthalene as in the latter liquid the stones could scarcely be seen in a photograph.*

mixture and compared with the density of pearls from the broken necklace. The densities were not only found to be exactly similar, but were significantly lower in density than the values found for imitation pearls of that type by the writer some time earlier[3]. This, and the fact that the pearls were new, judged by the fact that the pearl essence coating near the string canal was not worn to any extent, suggested that the usual type of glass employed to make beads for imitation pearls was not used. This, it was considered, may be due to the fact that the manufacture of the " alabaster glass " normally used had not then been restarted after cessation during the war. Enquiries proved this premise to be correct, and to verify how common these low density pearls were a great number of pearls were examined for their density—the result of this minor research was published for record[4]. Comparison of the size of the string hole and the colour and texture of the " pearl essence " skin was made. The several chemical spot tests for the nature of the bonding of the guanine crystals in the essence forming the skin, reported in this journal[5], were not available at the time and were not used. One of the peculiarities of this case was that the one pearl found in the pocket of Heath could not in anyway be destroyed because it was essential that it be produced in evidence as an exhibit.

Another police investigation involving solid glass bead imitation pearls was mentioned to the writer by Mr. Lewis Nickolls, the present Director of the Metropolitan Police Forensic Laboratory at New Scotland Yard. In this case, the accused, charged with larceny, contended that the string of imitation pearls found in his possession belonged to his daughter and were not proceeds of the larceny. Mr. Nickolls was able to take a different line in this case as he could destroy part of the exhibit. His method was to take spectrograms of the glass of one of the pearls in the necklet, and the glass of a pearl taken from necklets in the stock from where the theft was presumed to have occurred. In this case the spectrograms showed dissimilarities, in that one glass showed the presence of arsenic and the other did not. The accused was acquitted. This instance illustrates the impartiality of an expert witness—he is there solely to assist the court in arriving at the truth.

Pearls are not as a rule suitable for pictorial representation, but cultured pearls may radiograph well enough to show with sufficient

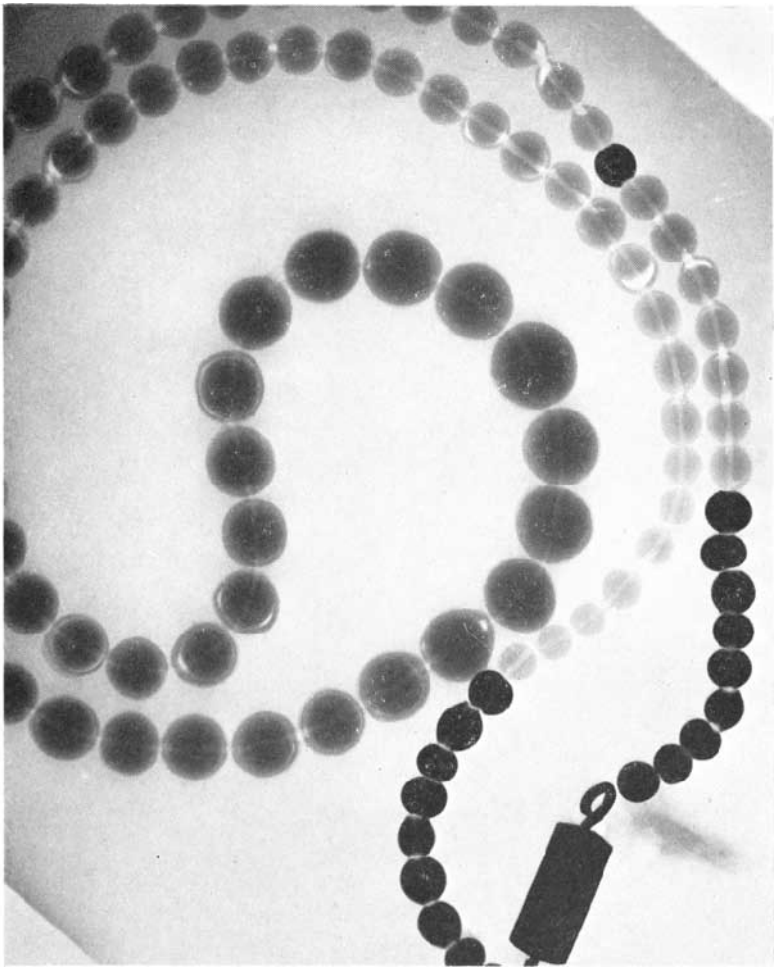


Fig. 5. *Imitation beads in a cultured pearl necklet are shown up by their great opacity to X-rays. There are nine imitations at each end of the necklet and a stranger in the body of the necklet.*

detail the bead nucleus to be of value as cogent evidence. The inclusion of imitation pearls in a necklet also show by their opacity to the rays, in comparison to the other pearls, that they are "foreign" to the necklet (Fig. 5). Synthetic stones and garnet topped doublets may also be suitable subjects for photographic presentation of evidence. It may be as well to remind the reader

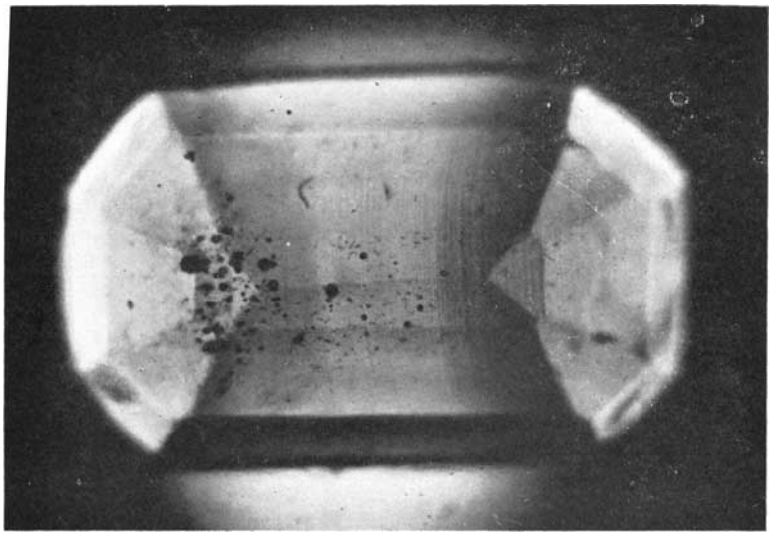


Fig. 6. *Enlarged photomicrograph showing the curved lines and gas bubbles in a synthetic ruby. Note that the full outline of the stone is pictured.*

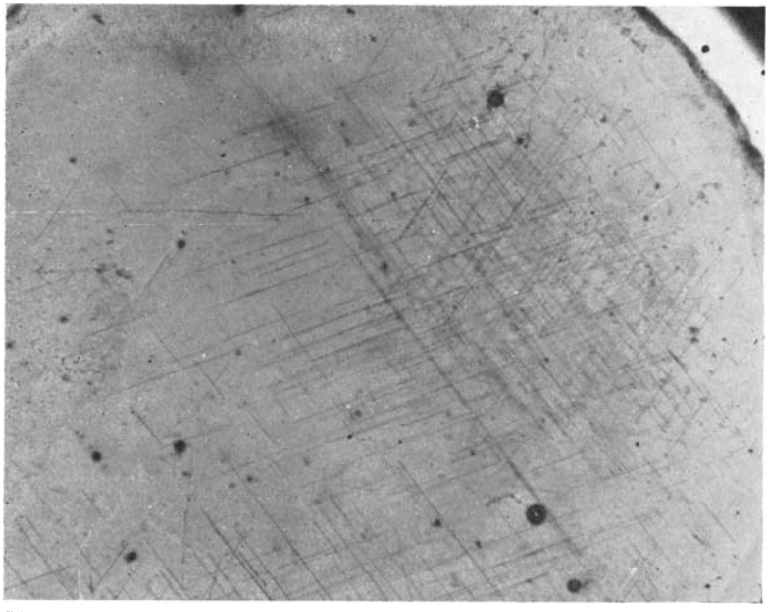


Fig. 7. *Enlarged photomicrograph of a garnet-topped doublet. In this case the full outline of the stone is not shown, but there is sufficient to enable the layman to understand the description given by the witness.*

that such pictures are to be shown to lay persons, and if the full outline of the stone can be got on to the picture it will be much more readily understood (Figures 6 and 7).

In a comparatively recent trial (Regina *v.* Hewett), the accused being charged with burglary and/or receiving stolen property, the prosecution sought to prove, as part of their case, that some small diamonds found in Hewett's possession had been forced out of a brooch which was part of the property stolen. In order to make clear to the jury the reasons for assuming that the stones had indeed been forced out of jewellery, the writer, who gave expert evidence in the case, prepared a photomicrograph showing the broken edges of two of the stones. The photograph was taken by reflected light, the stones resting on a piece of black paper—initial magnification being 10.5x and then enlarged 1.5 times giving a final magnification of approx. 16x. This was quite easy as only the broken girdle of the stones needed to be in focus (Fig. 8).

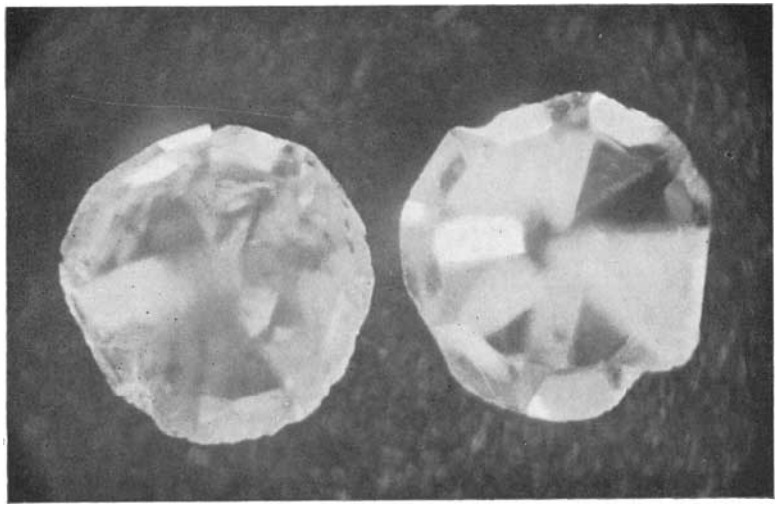


Fig. 8. *This photomicrograph showing two small diamonds (there were* 23 *diamonds weighing together* 0.53 *carat involved in the case) was taken in order to demonstrate the submission that the stones had been clumsily forced out of their setting.*

The photography so far discussed has been that used in conjunction with a microscope. Such type of work is best carried out by a gemmologist who understands the techniques of examining the internal features of gemstones. If it should be necessary to

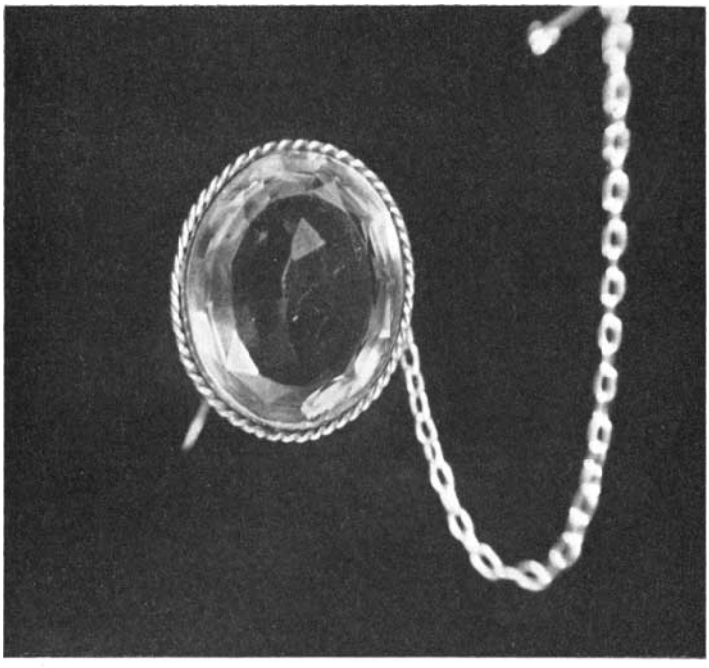


Fig. 9. An experimental picture of a single stone citrine brooch. This was taken with a small reflex camera, over the ordinary lens of which was held a short focus lens. This supplementary lens was an ordinary convex lens and failed to give sharp definition at the edge of the field, as is shown by the imperfect focus of the safety chain.

photograph pieces of jewellery in order to show the positions of stones or damage to the setting, the problem is rather one for a professional photographer, who should be told what prominent features to bring out. There is of course no reason why a keen amateur photographer should not be successful in producing what is necessary. Figure 9 shows what can be done by an amateur. Radley[5] recommends that in the photography of gemstones it is best to paint the stones thinly with a white water-paint, the solid edges and angles having the paint removed from them—this is to eliminate interference by reflections. It is suggested that the stone be placed on black velvet and photographed from above using low magnification, up to five diameters if the stone be small. A camera with double extension bellows in conjunction with a short focus lens is most convenient. To avoid the multiple reflections from

the stones in a piece of jewellery an indirect method of lighting has been evolved. The jewellery is placed on black velvet and completely surrounded with a cylinder of white paper. A concentric ring of lights around the paper gives an even diffuse glow over the whole piece which is then photographed from above.

Photography has been stressed advisedly for it is probably the best means of illustration. This does not imply, however, that practical demonstrations may not be of as great a value providing that they are not too elaborate—over elaboration would probably confuse the issue. A density test might conceivably be shown in court, or an experiment on painting the back facets of diamonds in order to improve their colour. At least two cases of experimental painting of diamonds has been carried out for the court, but whether actually in the courtroom or not is not clear. According to Press reports, in one such case the " expert " was reported to have stated that the stone had been painted with " luminous paint." It is rather difficult to reconcile that with colour correction.

In more serious cases it may be well to remember that when first examining jewellery, especially rings, that evidence may be concealed within the recesses of the setting. Obviously any investigation along these lines must be the work of the professional forensic scientist. Do, however, enquire about this factor before cleaning the filth from such settings in order to complete your own work. Failure to do so may destroy what may have been vital evidence.

At various times much has been made of the idea of " finger-printing " gems and jewellery. In certain countries, particularly France and the U.S.A., certificates have been issued giving details of size and shape, weight, surface and internal imperfections, etc., with the view of future identification in mind. Although this problem is essentially bound up with forensic gemmology, the subject is too broad to include in this article without making it unduly long. It is hoped that a fuller discussion of this particular aspect may be given in a future issue of this Journal.

The writer has endeavoured to describe, within the limits of an article, the essentials, as far as gemmology is concerned, of police investigation and court procedure. Before closing it may be wise, if loose stones are the subject, to take into court a suitable pair

of stone tweezers—or better, spring tongs, in order to hold the stone safely. A lens should, of course, always be to hand. Finally, it must be stressed that your evidence is impartial, and your evidence can only be true evidence if it is your own work. Do every test and weighing yourself.

Acknowledgement is made to Detective-Inspector R. E. Phillips of the Criminal Investigation Department of the Metropolitan Police, New Scotland Yard, for his helpful suggestions.

REFERENCES

1. Webster (R.). *Gemstones and Jewellery.* Police Journal, Vol. XXVI. Nos. 1 and 2, pp. 69-80 and 150-156. Jan. and April, 1953.
2. Vincent (J.). *X-Rays and the Jeweller.* Journ. Gemmology, Vol. 1, No. 5., pp. 14-15, Jan., 1948.
3. Webster (R.). *The Density of Imitation Pearls.* Gemmologist. Vol. XV. No. 176, pp. 43-44, March, 1946.
4. Webster (R.). *The "Murder" Pearl.* Gemmologist. Vol. XV, No. 184, pp. 91-92, Nov., 1946.
5. Webster (R.). *Some Tests for Plastic Imitations.* Journ. Gemmology, Vol. II. No. 3, pp. 87-102, July, 1949.
6. Radley (J. A.). *Photography in Crime Detection,* p. 52, London, 1948.

EXPERIMENTS with a POCKET MAGNET

by B. W. ANDERSON, B.Sc., F.G.A.

IN manuals of petrographic methods, such as the well-known books by Johannsen and by Milner, the magnetic properties of minerals are treated as a matter of considerable importance, and practical instructions are given for the separation of mineral grains into different categories by means of an electro-magnet. A much briefer treatment of magnetic methods is given in works on mineralogy, while in gemmological text-books, though some attention is usually given to the electrical properties of stones, the subject of magnetism is completely ignored.

In recounting the results of some very elementary experiments on gemstones with a small pocket magnet I make no claim to have added a testing method of any real importance to the ever-increasing list. But I do hope to show that magnetic tests on gemstones are quite easy to carry out ; that quite a large number of gemstones show some response to even a small magnet ; and that magnetic tests may in some circumstances yield information about the composition of an incompletely determined stone which cannot be gained by any other means of comparable simplicity.

A large electro-magnet, consisting of cores of soft iron surrounded by wire coils carrying an electric current, is capable of exciting a tremendous magnetic pull, influencing even substances not commonly classed as magnetic. Compared with this, the power of a pocket " permanent " magnet of the usual horseshoe type is very small. In fact until recently little magnets of this kind were thought only suitable for such puny and menial tasks as recovering pins, needles, small nuts or bolts from inaccessible places.

For the last ten years or more, however, the power of permanent magnets has been enormously increased thanks to the development of new alloys containing aluminium, nickel and cobalt, capable of acquiring and retaining a much higher degree of magnetism

than the tungsten steel formerly employed. It was with a small horseshoe " Eclipse " magnet of this improved type that most of the experiments described below were carried out. This was bought during the war for a shilling. To-day its price has risen to 2s. 3d. but is still not unreasonable considering its powers. Though it is little more than an inch in length and weighs only one ounce it is capable of lifting an iron weight of 2 lbs.

Some months ago, when using a George & Becker aperiodic balance for a hydrostatic density determination, it struck me how easy it should be on such an instrument to assess the magnetic " pull " exerted on a specimen simply by noting its loss in weight when attracted by a magnet held closely above it. The aperiodic type of balance is ideal for the purpose in hand since the degree of magnetic attraction exerted on a stone can be followed as it takes place, and the maximum measured in less than a minute. A similar assessment could probably be obtained on a standard balance but would take more time and patience. If any object weighing less than 300 mg. (= 1½ carat) is placed on the pan the balance, owing to an air-damping device, assumes a steady position of tilt, and the weight can be read off directly on a scale which is a projection of a transparent graticule attached to the pointer of the balance. For ranges of 300 mg., then, no weights need be added. There are, in addition, metal ring weights of 300, 600 and 900 mg. which can be dropped into position at the turn of a knob. Thus, only beyond 1,200 mg. (= 6 cts.) need the balance case be opened and external weights added. In no case do weights below 1 gram have to be handled, as the final fractional weights are always provided for by the rings and the graticule scale.

The metal of the balance pan was found to exert a slight magnetic pull, and to avoid any effect due to this a large cork of known weight was placed on the pan and the stone to be tested placed on this as a pedestal. Having weighed the cork and stone in the usual manner these were left on poise and the magnet held immediately above the stone and lowered slowly and steadily. When the poles have approached to within ¼-inch or so of the upper surface of the specimen, if the latter has any magnetic susceptibility the scale will begin to record a marked loss in weight. *The minimum weight which could be " held " by the magnet was taken as the required reading* and the difference between this and the true

weight recorded. If (as often happens) the magnet actually touches the stone the reaction on the scale is of course immediately noticeable as a sudden move *away* from the required minimum. The only way a lower minimum than the true one can be obtained is by reading the end of the swing when the balance beam is moving rapidly ; hence the insistence that the weight should be " held " by the magnet, if only for a few seconds. The most powerful pull was found to be exerted when the magnet straddled the stone as it rested on its table facet. The mean of at least three readings was always taken, and, considering the rough and ready nature of the process, results were remarkably consistent for any one specimen. The variation was usually not more than ± 5%. Each measurement takes less than a minute but the intense concentration needed to maintain the magnet steadily in the optimum position and at the same time read the scale almost inevitably entails holding one's breath. In any case, to avoid the effects of gusty breathing on the balance during a weighing it was found wise to close the glass front of the balance and thrust the left hand holding the magnet through the side door of the case. To ensure steadiness the arm can be supported by leaning the elbow on the table or shelf on which the balance rests. Enough has now been said about the technique employed. Other investigators are almost certain to modify it to suit their own particular needs and their particular type of balance.

Turning now to the results so far obtained. It is natural to expect that compounds containing a considerable quantity of iron, which is the magnetic element *par excellence*, would be the most likely to yield positive results. Broadly speaking this is true, but the mere percentage of iron present in a mineral does not necessarily give a clue as to its magnetic susceptibility : the nature of the other elements present and the structure of the crystal play an important part. Iron pyrites, for instance, with formula FeS_2, contains 46.6% of iron, and yet it is hardly magnetic at all—nor is marcasite, of similar composition. Almandine and even peridot, containing far less iron, are perceptibly attracted by the magnet. What surprised me most, however, were the strong magnetic effects shown by the gem minerals containing manganese. This element seemed to produce an effect quite as vigorous as iron, though nothing I have so far seen in the literature suggests that this is the case.

Here, for instance, is a list compiled by Doelter, who was one of the early workers on the subject ; the minerals being given in order of decreasing magnetism :

Native iron	Tourmaline
Magnetite	Bronzite
Pyrrhotite	Idocrase
Ilmenite	Staurolite
Haematite	Actinolite
Chromite	Olivine
Siderite	Pyrite
Almandine	Biotite
Limonite	Chlorite
Iron Augite	Rutile
Iron spinel	Diopside
Hornblende	Dolomite
Epidote	Feldspars

Apart from the omission of the distinctly magnetic andradite garnet and the absence of manganese minerals, my own results agree fairly well with Doelter's order. Magnetite, famous of old as " lodestone," the material for the first crude compasses, is unique among minerals in being not merely passively but actively magnetic; that is, its molecular constitution enables it to retain the magnetism derived by induction from the earth's own magnetic field. Readers may have seen a Museum exhibit in which a large lump of this iron-grey mineral is festooned with nails held in place by its magnetic power.

Of the gem minerals, haematite (100% Fe_2O_3), the two iron garnets, almandine (43% FeO) and andradite (31% Fe_2O_3), the manganese garnet, spessartite (43% MnO) and the manganese carbonate and silicate rhodochrosite (62% MnO) and rhodonite (54% MnO), are those which show the strongest magnetic susceptibility. The figures just given for the percentage of the magnetic oxide present in each are of course only to be taken as a rough guide, particularly in the garnets, where isomorphous replacement is so common that each variety shows some admixture with the others.

Having measured the magnetic loss in milligrams for each stone tested, it seemed reasonable to reduce these figures to a common basis by expressing the magnetic susceptibility in terms of " loss in milligrams per 1,000 " or in other words loss in milligrams

per gram. Obviously a small stone showing, say, 50 mg. magnetic loss was far more magnetic than another stone ten times its size which showed the same loss under the magnet. In the course of scores of measurements made, however, it soon became very apparent that the size (and to some extent the shape) of the specimen in relation to the magnet played a very important role in the results obtained. Using the small 1 oz. " Eclipse " magnet, stones of any one species gave the largest figures in milligrams per thousand if they were of small size. Such a stone would presumably be " saturated " with the magnetic lines of force, while with a big stone much of the material would be outside the strongest field of attraction. When weights of stones are plotted graphically against magnetic loss per gram the result for any one species is a shallow curve. Since in practice one cannot expect to work with stones which are all of the same size and shape, I sought for some way of expressing the experimental results which would give more or less consistent figures for each species, regardless of their dimensions. Having to resort to such an expedient is of course one of the penalties involved in not dealing in fundamental units but only in phenomena having a rough dependence on such units. As an analogy one might compare it with trying to assess the dispersion of different gemstones by measuring the length of the spectrum thrown on the wall when the stone was held in sunlight rather than by the fundamental method of measuring the difference between the refractive indices for two definite wavelengths.

Be that as it may, the entirely empirical formula

$$\frac{\text{Magnetic loss} \times 100}{\sqrt{\text{weight in mg.}}}$$

was found to " iron out " irregularities due to size to a considerable extent, and the figures obtained from this formula are therefore to some degree useful as a rough indication of the relative magnetic susceptibility of the different minerals tested. Some figures obtained with peridots of different sizes will illustrate this point. All the stones were of similar colour and provenance and could be presumed to contain almost identical amounts of iron (about 10% of ferrous oxide). The variation found in the values for magnetic loss in milligrams per thousand can thus be assumed to be not intrinsic but a function of the size of the stones.

Weight	Mag. Loss	Loss per 1,000	Loss × 100/$\sqrt{\text{weight}}$
328	11	33	59
669	17	25½	63
898	22	24½	73
1945	33	17	75
2702	34	12½	65
3569	41	11½	68

The gradual diminution in values of " loss per 1,000 mg." in inverse ratio to the weight of the specimen is obvious from the above table, whereas the figures in the last column, though by no means constant, do at least achieve a certain consistency. Square roots are admittedly tedious things to calculate, but are very quickly obtained by halving the logarithm of the number concerned or more quickly still with the aid of a slide rule. I must confess to having used a 10″ slide rule myself for all calculations connected with this paper : the errors inherent in the method are in any case so large that careful calculations would be a waste of time.

Much more experiment needs to be done, and indeed will be done as time permits ; but as the result of the tests so far carried out the following categories for gem materials showing appreciable magnetism can be suggested. The figures obtained by the empirical formula given above are appended in each case. It must be emphasized that the actual figures are only valid for a magnet of the size and strength used for these experiments : but the *relative* values should be similar whatever magnet was employed.

Strongly magnetic ...	Almandine*	290 — 410
	Spessartite	250 — 360
	Rhodochrosite ...	270 ±
	Rhodonite	280 — 370
	Haematite	220 — 310
Moderately magnetic	Demantoid	120 — 200
	Epidote	100 ±
	Pleonaste	80 — 130
	Peridot	50 — 75
	Pyrope*	40 — 75
	Dark green tourmaline	50 — 70
	Hessonite	40 ±
	Indicolite	40 ±

Weakly magnetic ...	Brown sinhalite	...	15 ±
	Green tourmaline	...	10 — 20

* The term "alamandine" in the above table is confined to stones with refractive index 1·79 and over, while by "pyrope" is meant those with index below 1·75. Intermediate members of the series (pyrandines) give intermediate magnetic values.

As remarked at the beginning of this article, no claim is made that magnetic measurements on gemstones will prove to have any great importance, but the following distinctions, at least, are some of those which could be made by a careful worker with no apparatus beyond a good balance and a small " Eclipse " magnet. In each case the more magnetic material is mentioned first.

Demantoid	from	Green zircon, sphene or diamond.
Pyrope	,,	Ruby or spinel.
Haematite	,,	Black pearl or black diamond.
Spessartite	,,	Hessonite or zircon.
Rhodonite or Rhodochrosite	,,	Thulite.
Brown peridot	,,	Sinhalite.
Stainless steel	,,	Marcasite (pyrites).

Some experiments have been carried out with larger magnets made by the " Eclipse " firm in Sheffield, but it was thought better to confine my remarks to the small magnet as this is the only one readily obtainable at most hardware stores, is cheap, easily carried in the pocket, and does its work very well. Even on an ordinary balance, provided the pans are non-magnetic, a marked diminution in weight can be easily noted when the magnet is caused to approach a magnetic stone closely when the balance is in poise, while if no balance is available a magnetic stone suspended on a thread will move perceptibly out of the plumb position at the near approach of a strong magnet.

I have to thank those of my colleagues and friends who have taken an interest in this work, and who have made several ingenious suggestions for better methods of magnetic measurement than the one I have described. These will, I hope, be given a trial in due course.

Gemmological Abstracts

SCHLOSSMACHER (K.). *Smaragd und Rubin—warum so selten?* Emerald and ruby—why so rare ? Zeitschr.d.Deutsch.Gesell.f.Edelsteinkunde, Summer 1953, No. 4, pp. 9-14.

The colouring in emerald as well as ruby is chromium, which occurs only once in the evolution of the rock and mineral forming processes and then only as chromite ($FeO.Cr_2O_3$). Chromite deposits are connected with the gabbros, *i.e.*, rocks which contain little silica, and which constitute about five per cent. of the earth's crust. The gabbros (and the chromium) originate in the " Sima " (silicon-magnesium magma). The corundums and beryls on the other hand belong to the " Sial " (silicon aluminium magma) which forms 95 per cent. of the earth's crust. Ruby and emerald are formations of the pneumatolitic phase of Sial magma solidification, emerald especially belonging to the pegmatitic and hydrothermal phase. Only where the rising sial magmas and solutions broke through chromite deposits in sima rocks could the chromium be dissolved and carried away to become the pigments of emeralds and rubies in rare instances and few localities. E.S.

CHUDOBA (K. F.). *Zur Farbe und Farbänderung von Diamant.* On the colour and (artificial) colour change of diamond. Zeitschr.d.Deutsch.Gesell.f.Edelsteinkunde. Summer 1953. No. 4, pp. 3-7.

X-Rays do not effect colourless diamonds, but yellow diamonds may acquire a purer yellow colour, green Brazilian stones may become bluish green or pure green, and brown diamonds may acquire a violet hue. Cathode rays hardly affect diamonds, only some colourless stones become slightly bluish. Remarkable is the influence of radium rays, especially alpha rays, which cause a deep (yellowish) green colour. Beta and gamma rays alone do not have this effect. Treated stones are radioactive. The green colour becomes paler or disappears when heat is applied. Lindt and Bardwell's tests (1923) are mentioned but not the earlier investigations of Sir William Crookes (*Diamonds*, Harper, London, 1909).

Deuteron bombardment by means of the cyclotron causes an olive green or turbid grey-green colour within three to eight minutes. Long and intensive bombardment causes a deep brown colour. After treatment the stones remain radioactive for less than an hour only. Heat application does not affect the green colour of bombarded (or natural) stones. Deuteron bombarded stones display a sharp demarcation between the green surface layer and the rest of the stone, creating the impression of well-made doublets. H. Berman's (1950) and F. H. Pough's (1951) investigations are mentioned. E.S.

SCHLOSSMACHER (K.). *Die Bonner Diamantsynthese.* The Bonn Diamond Synthesis. Zeitchr.d.Deutsch.Gesell.f.Edelsteinkunde, Summer 1953, No. 4, pp. 7-8. (Journ. Gemmology, Vol. IV, No. 3).

In the Bonn trial the " diamond maker " H. Meincke was sentenced to three years in prison, his wife to fifteen months, his brother to seven months, and his niece to three months. Meincke admitted having smuggled natural boart into the raw material. Investors lost half a million D-Mark. E.S.

ANON. *Die Quartzlampe in der Edelsteinbestimmung.* The Mercury Vapour Lamp in Gem Determination. Zeitschr.d.Deutsch. Gesell.f.Edelsteinkunde, Summer 1953, No. 4, pp. 16-20.

Description of new lamp model PL 342 by Quarzlampemgesellschaft m.b.H. Hanau. The price is about £9 in Germany. Transformer (from 220 v. A.C.) and lamp itself are housed in a tube of about 14 ins. length and 2 ins. diameter. A wooden handle and stand allow easy manipulation. The glass filter (about $2\frac{3}{4}$ ins. x $1\frac{3}{4}$ ins.) passes mainly wave lengths between 3,500 and 4,000Å. Also mentioned is the lamp described by H. Lee in the June 1953, *Gemmologist* for the shorter wave range around 2,500Å. The theory of luminescence and phosphorescence is shortly discussed. E.S.

GOEBELER (H.). *Lupenreinheit und Farbbestimmung bei Brillianten.* Purity and Colour Determination of Brilliants. Zeitschr.d. Deutsch.Gesell.f.Edelsteinkunde, Summer 1953, No. 4, pp. 20-22.

The purity is determined with an eye-glass (loupe) of 10x

magnification. The colour is graded according to the following scale:

Jager	finest blue white
River	blue white
Top Wesselton ...	fine white
Wesselton	white
Top crystal ...	very, very light yellowish
Crystal	very light yellowish
Top Cape	light yellowish
Cape	yellowish
Yellow	yellow

The " Colorimeter " and " Diamolite " of the Gemological Institute of America, and Dr. Gübelin's Coloriscope are mentioned. E.S.

WELLS (R. A.). " *Three-phase* " *inclusion in Synthetic Emerald.* Gemmologist, Vol. XXII, No. 263, p. 107, June 1953. Also described in Gems and Gemology, Vol. VII, No. 9, p. 283, Spring 1953.

A trapezoidal formation in an inclusion which also contains a bubble is remarked upon as either being a " three-phase " inclusion, or could be mistaken for one. One illustration. R.W.

ANDERSON (B. W.). *A New Test for Synthetic Emerald.* Gemmologist, Vol. XXII, No. 264, pp. 115-117, July 1953.

Synthetic emeralds were found by the author to be more transparent to ultra-violet light than stones of natural origin. Natural stones were found to absorb in the ultra-violet at about 3,000Å, while the synthetic stones are transparent down to 2,300Å. Experiments were carried out by the employment of a copper arc and a quartz spectrograph. It was further established that the effect could be observed directly by the use of a Philips TUV 7 watt lamp in conjunction with a Beck direct vision ultra-violet spectroscope. One illustration. R.W.

TRUMPER, (L. C.). *Viewing Boxes for Ultra-Violet Light or Chelsea Filter.* Gemmologist, Vol. XXII, No. 264, pp. 127-8, July 1953.

Descriptions of suitable viewing boxes for the easy observation of fluorescence (and colour filter effects). The ultra-violet viewing boxes are designed for use with the Hanovia " Detectolite " and the other for the Philips TUV 7 watt tube—both, therefore, for short wave ultra-violet. Two illustrations. R.W.

CHUDOBA (K. F.). *Zur Kennzeichnung der Synthetischen Smaragde.* The Determination of Synthetic Emeralds. Zeitschr.d. Deutsch.Gesell.f.Edelsteinkunde, No. 3, pp. 8-11, Spring 1953.

Survey of differences between synthetic and natural emeralds. Bibl. of seven items. E.S.

WILD (K. E.). *Das Achatschleifereigewerbe an der oberen Nahe.* The Agate Cutting Trade on the Upper River Nahe. Zeitschr.d. Deutsch.Gesell.f.Edelsteinkunde, No. 3, pp. 18-21, Spring 1953.

Historical review on the development of the German agate cutting industry. E.S.

STEIN (R.). *Drehapparat zur Untersuchung von Edelsteinen mit dem Vertikalen Mikroskop.* Adjustable Gem Holder for Investigation with the Vertical Microscope. Zeitschr.d.Deutsch.Gesell. f.Edelsteinkunde, No. 3, pp. 22-23, Spring 1953.

Description of a holder allowing sensitive adjustment of the object in an immersion cell. E.S.

WEBSTER (R.). *Gemstone Luminescence.* Gemmologist, Vol. XXII, Nos. 262-3-4, pp. 77-80; 98-103; 123-126, May/June/July 1953.

A series of articles (to be continued) on the luminescence of gemstones under long and short wave ultra-violet light, and under X-Rays. The first two instalments deal with the types of luminescence; the theory of photoluminescence; some historical notes, and the types of apparatus used in the production of ultra-violet light and X-Rays. The third instalment commences the record of the luminescent glows observed in gem materials by the author, and this is alphabetically arranged. Six illustrations. P.B.

ANDERSON (B. W.); Payne (C. J.). *The Density of Pearls and Cultured Pearls.* Gemmologist, Vol. XXII, No. 262, pp. 81-86, May 1953.

A reprint of an article published exactly fourteen years ago. It is the record of a vast amount of work on a considerable number of pearls. It was the outcome of some similar work carried out by Kerr in the United States. The densities were ascertained by employing suitably diluted bromoform solutions, and the experiments confirmed Kerr's original announcement that most cultured pearls sank in a solution made up to freely suspend a small rhomb of calcite (which has a density of 2.72). The statistical results of

the research are shown by two graphs and a table. A further table records the densities found for individual pearls. P.B.

LEE (H.). *A Pocket Lamp for Short Wave Ultra-Violet.* Gemmologist, Vol. XXII, No. 263, pp. 104-106, June 1953.

Describes the construction of a suitable aluminium lamp housing for the Philips TUV 7 watt germicidal lamp in conjunction with a Chance OX7 filter. The lamp described is portable and may be used either as a microscope lamp, to illuminate specimens on a table, or simply as a portable hand lamp. Full constructional details are given. One illustration. R.W.

GRODZINSKI (P.). *The History of Diamond Polishing.* Indust. Diamond Review, 1953, Special Suppl. No. 1, pp. 1-13. 22 figs.

Notes on early history with picture reproductions. Earliest account of methods used appears to have been made by Benvenuto Cellini. The claim that L. van Berquem of Bruges invented diamond cutting in 1476 is not substantiated. (A. SELWYN, *Retail Jewellers' Handbook*, 1945, p. 210, also held that the claim was invalid, citing the investigations of Henri Polak). The development of diamond cutting in the Netherlands and in England is commented upon. S.P.

JARMAN (R.). *They Spot Fake Jewels.* Saturday Evening Post. Commencing on page 28, June 27th, 1953.

A colourful popular article on gemstones and jewellers with particular emphasis on the formation and work of the Gemological Institute of America. Abundantly leavened with anecdotes, an article has been produced which is most readable. Journalistic enthusiasm had led the author to imply that the American jeweller was unable to value his merchandise correctly before the formation of the Gemological Institute of America. For the enlightenment of our American friends the value of the Black Prince's " ruby " lies in its history; exception, too, can be taken at the passage which states " recent scientific tests, however, showed that it was not a ruby at all, but a spinel of comparatively little value." The stone has been known to be a spinel from quite early times, certainly it was so known in the year 1653, for it was in the list of the regalia ordered by Cromwell to be destroyed or sold, and was correctly described as "1 Ballas ruby." An entertaining article which is useful propanganda for the gemmologist. Five coloured plates. R.W.

EPPLER (W. F.). *Further Observations on Synthetic Red Spinel.* Gems and Gemology, Vol. VII, No. 10, p. 306, Summer 1953.

Discusses the theory of growth striae in synthetic stones grown by the flame fusion method with respect to the facility of their crystallization. Dr. E. J. Gübelin, in an earlier article on synthetic red spinel, inferred that the strong striae seen in the stones he examined was due to difficult crystallization. This, Dr. Eppler does not accept and gives his reasons for not doing so. An appended table compares the succession of synthetic corundums and spinels according to the increasing facility of crystallization as suggested by Dr. Gübelin and by the author. R.W.

RUZ LHUILLIER (A.) *Gems of Ancient Mexico.* Gems and Gemology, Vol. VII, No. 10, pp. 291-302, Summer 1953.

Tells of the archæological finds of carved stones and jewellery in Mexico. Particular mentioned is made of the objects from Monte Alban; the find in Cerro de la Mesas on the coast of Vera Cruz; and the extensive finds at Palenque. The jade of Mexican archæological finds is jadeite, but is less transparent and more mottled than the Chinese jade (Burmese?). It is not known with certainty where the jadeite originated; there are no known deposits in Mexico. The use of gold, silver and copper appeared in Mexico only some three centuries before the Spanish Conquest. Much information on the materials used by the Ancient Mexicans. Seventeen illustrations. R.W.

WARWICK (J. E.). *The Thrill of Finding Opal.* Gemmologist, Vol. XXII, No. 263, pp. 110-112, June 1953. (Extracted from the Lapidary Journal).

The story of a visit made by the author to the Australian opal fields. Much anecdote but a good description of the country rock and the methods used in the mining of the gem. R.W.

CHUDOBA (K. F.). *Zur Formveredlung von Diamant.* On Improving the Diamond Shape. Gold Und Silber, Vol. 6, No. 4, pp. 12-14, April/May 1953.

Short historical review of the development of diamond polishing from the old " table cut " via " single cut," " double cut " (Mazarin) and " triple cut " (Peruzzi) to the modern American cut brilliant. E.S.

ANON. *Steinschneidekunst.* The Art of Gem Engraving. Gold Und Silver, Vol. 6, No. 4, p. 15, April/May 1953.

Zeitschr.d.deutsch.Gesell.f.Edelsteinkunde, No. 3, pp. 6-8, Spring 1953.

Report of the exhibition of cameos and intaglios by the (German) Association of Goldsmiths at Beckum in March 1953.

E.S.

BOOK REVIEW

BRADFORD (ERNLE). *Four centuries of European Jewellery.* Country Life, Ltd. London, 226 pp., 48 illus. Two guineas.

Antique jewellery has been largely neglected by writers on antiques—fortunately, perhaps, for there are many pitfalls for the unwary, and all too often the expert himself has to shrug and say that such a piece is " evidently South German, possibly 16th century . . ." Compared with silver or porcelain or furniture, little jewellery has survived the great melting pots of four centuries of European upheaval, and the few relics are scattered far and wide in the museums and art galleries and libraries of the Continent. In his recently published book Ernle Bradford has skilfully traced the history of jewellery styles from the Renaissance to the present day, weaving into his pattern a picture of jewellery against a background of social customs and changing fashions. To his credit he has done what few writers on the antique ever do—he has remembered that the student of antique jewellery wants to know how a piece is made, and he has been at pains to explain techniques—of setting, casting, ornamenting, and so on.

The book falls into two distinct sections—the history of jewellery and the materials of jewellery, and one is tempted to suggest that it might have made a little lighter reading if the methods and materials had been worked into the historical section—with perhaps some illustrations of contemporary craftsmen at work. But, despite this, for it is a book to be dipped into and digested slowly, Mr. Bradford has achieved a useful and comprehensive textbook. He has sorted out and illustrated the changes in jewellery fashions during four hundred years, and has not forgotten that to-day craftsmanship and techniques still play an important part in jewellery design. This is, indeed, the first book on the history of jewellery that treats of anything after the end of the last century. It is good to feel that the achievements of to-day, are recorded.

J.B.

TRANSPARENCY of GEMSTONES
to SHORT WAVE
ULTRA-VIOLET LIGHT

by NORMAN H. DAY, F.G.A.

I HAVE used a Trumper Viewing Cabinet for some months—the model[1] which, besides the half watt lamp for use with the Chelsea filters or crossed filters, incorporates a Philips TUV 7 watt short wave tube with an OX7 filter. This lamp, which gives a strong emmission at 2537 Å, has been fully described by P. M. Caudell and R. Webster[2].

With a suitable holder it is possible to use a microscope objective and eyepiece, to obtain an enlarged view of the fluorescing materials. I suggested to Mr. L. Trumper that the fluorescence of inclusions within gemstones might be of some diagnostic value. This raised the problem as to which stones were transparent to the rays of this lamp so that the inclusions could be excited. Search through the published literature failed to reveal any tables relative to gem materials, not even for long wave ultra-violet light of the wavelengths between 3000 Å and 4000 Å. The only tables relative to invisible light, are those of X-rays in the *Gemmologists' Compendium.* Since the beginning of this quest, Mr. B. W. Anderson has published[3] the results of his investigations with the quartz spectrograph of the transparency of natural and synthetic emerald and other beryls to the shorter waves of the ultra-violet light.

I have been using Mr. Anderson's shadowgraph immersion method[4] to record the size and cut of gemstones; and because photographic emulsions are in general very actinic to ultra-violet light, it seems feasible to adopt this method to obtain the information required provided that cells and suitable liquids transparent to the short ultra-violet light could be obtained. It appeared essential to cut out internal reflections because the collection of specimens which it was proposed to use are mostly of a small size.

L. Trumper has since overcome this difficulty by constructing a supplementary device incorporating a fluorescent screen and mirrors (see second paper).

It proved fortunate that the thin-bottomed cell obtained some months ago especially for normal immersion work should be made of Pyrex glass. This cell has a diameter of 40 m/m., is 15 m/m. high and has a base 2 m/m. thick. The makers, Messrs. Tintometer Ltd., explained that it is only practical to use this type of material when making a fused cell with a thin base. To test the transparency of the cell to short ultra-violet light, it was placed on a small piece of Ilford Contact Hard No. 3 printing paper and placed in the drawer of the cabinet, the room was reasonably darkened out and an olive safelight was in use. The ultra-violet lamp was switched on for five seconds and subsequent development of the paper in Ilford P.F.P. developer and fixing in an acid hypo bath, gave a negative that proved the cell to be practically transparent to this light.

Referring to literature on the use of ultra-violet light with the microscope, Johnson and Martin[5] suggest a mixture of glycerine (R.I. I.49), cane sugar (R.I. I.45) and water (R.I. I.33) to obtain a suitable mounting fluid. Kodak[6] have a table which shows that cedarwood oil (R.I. I.51), sandalwood oil (R.I. I.51) and balsam (R.I. I.52) are semi-transparent to the long ultra-violet wavelengths but are opaque to short ultra-violet.

Test negatives were made; filling the cell half full with series of liquids; the method already described was used, with the same exposure of five seconds.

Water	transparent	Clove Oil	opaque
Glycerine ...	nearly transparent	Methylene Iodide	opaque
Bromoform...	semi-transparent	Monobromonaphthalene...	opaque
Toluol... ...	nearly opaque		

A five seconds exposure of a 1.5 m/m. thick glass microscope slide showed it to be opaque, while a fourfold exposure of twenty seconds showed that quite sufficient light to make it appear transparent passed through ; therefore, in using this photographic method, due consideration of the exposure time and the thickness of the subject must be made. The human eye, in observing a fluorescent screen, judges the amount of brightness momentarily visible, whereas the photographic emulsion adds together the actinic value of the light for the whole period of the exposure.

Furthermore, the prolonged exposure allows residual light which passes through the OX7 filter to have its effect upon the emulsion.

This residual light arises from the other less powerful isolated spectral emission lines of the mercury vapour which the filter allows to pass. Some of this is visible as violet light when the direct light of the lamp is observed through the filter. (It is important to use some form of protection to the eyes in doing this for any length of time.

For the first trial with stones a green fluor and a white opal which is yellow to transmitted light were immersed in water. A five second exposure was made. The negative showed the opal to be opaque while the fluor proved to be transparent, with an interesting cut " pattern " and a Becke line edging. Changing to glycerine (same exposure) the fluor gave a negative which showed some fuzziness due to the fluorescence of the fluor and showed shadows of some cleavage inclusions.

Using a group of quartz in glycerine with an exposure of five seconds, a negative (Fig. 1A) and the subsequent print (Fig. 1B) were made; the stone at the top of this picture is rock crystal, the centre chalcedony, to the left a pale amethyst, to the right a cairngorm and at the bottom a dark amethyst. It is apparent that, whereas the rock crystal and the chalcedony are transparent, the cairngorm is opaque, and the amethysts become more opaque with the increase in the depth of colour. It is interesting to note that the rock crystal is more transparent than the glycerine.

Prints made from paper negatives are not so sharp as those made from plates or films. These prints were made on Ilford Bromide normal paper. Using bromoform, a series of the natural corundums were used, because of the semi-transparent nature of this liquid —the longer exposure of twenty seconds was given. This negative (Fig. 2A) and print (Fig. 2B). The print shows (left to right) top row, pink sapphire followed by three rubies; centre row, white sapphire, violet sapphire, green sapphire, yellow (pale) sapphire and star ruby; bottom row, pale blue sapphire, light blue sapphire, dark blue sapphire and dark blue sapphire colour mostly in the culet.

At a later date some Reflex Contact document paper was obtained. A small piece was placed in the cabinet and several stones placed on it table facet downwards, and an exposure of ten seconds made. This paper is much slower, more contrasty and its paper base much thinner than the paper used previously, though the development and subsequent processing is similar.

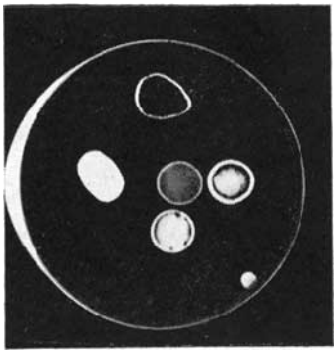


Fig. Ia.
NEGATIVE. Series of Quartz, in Glycerine.

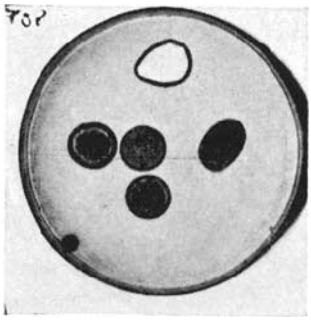


Fig. Ib. POSITIVE.
Top.—Rock Crystal. Centre.—Chalcedony. Right.—Cairngorm. Left.—Light amethyst. Bottom. —Dark amethyst.

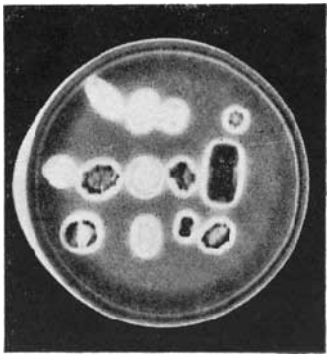


Fig. IIa.
NEGATIVE. Series of natural corundums in bromoform.

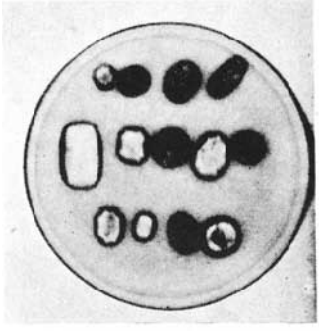


Fig. IIb. POSITIVE. (Left to right)
Top row.—Pink sapphire, three rubies. Centre row.—White sapphire, violet sapphire, green sapphire, yellow sapphire and star ruby. Bottom row.—Pale blue sapphire, medium blue sapphire, dark blue sapphire and dark blue, colour in culet sapphire.

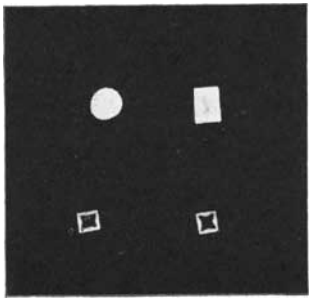


Fig. III.
NEGATIVE. Two top stones natural emeralds, the lower two stones synthetic Chatham emeralds.

So long as judgment is made on that part of the paper covered by the table facet only, it is quite easy to see which are transparent, (black on the negative) and those which are opaque (white on the negative). Figs. 3 to 4 inclusive show a series of negatives made by this method.

Using this shadow method, mass tests were quickly made; the immersion method being used in doubtful cases. With so many results it was necessary to record them on some form of chart; primarily a list of species with some grouping as to colour, Mr. Anderson[3] having shown that amongst the beryls transparency to short ultra-violet light varies with colour, and the prints (Fig. 1B and Fig. 2B) shows that this also occurs with the quartz and natural corundum species.

On this chart white stones are considered as colourless unless to transmitted light they show a body colour as do most white opals, which may show orange, yellow or green.

Reviewing this series of tests, the following conclusions can be made:

all colourless and pink stones are transparent, even water opal;

all colours of topaz are transparent;

all colours of synthetic spinel and corundum are transparent;

peridots and all varieties of the garnet species are opaque;

all green stones are opaque, synthetic emerald being the exception;

all yellow stones are opaque, the exceptions being topaz, natural sapphires and some chrysoberyls;

deep coloured natural blue and green sapphires and rubies are opaque.

Results for alexandrites are so far inconclusive; of the two specimens so far tried, one is transparent and the other semi-transparent; also, of the eleven andalusites tried, one appears semi-transparent.

Glass pastes require much more investigation and cannot be said to be in general opaque; one series of pink pastes are semi-transparent, while a pale blue paste with a cobalt absorption spectrum and which fluoresces a light blue appears extremely transparent. It is interesting that while the half pearls tested were quite opaque, a aragonite crystal is transparent. Iceland spar is transparent—this may prove useful for later experiments in the study of the directional transparency of crystals to short ultra-violet light.

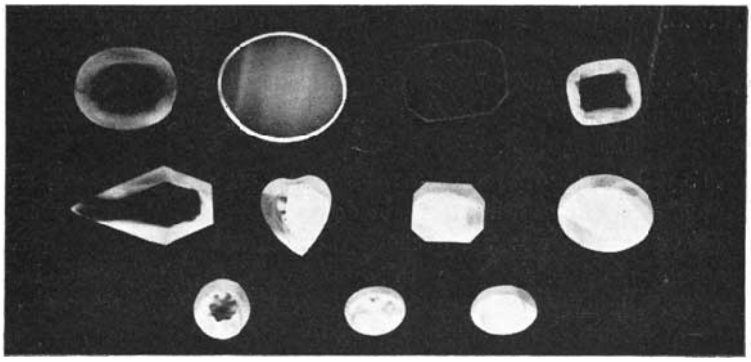


Fig. IV. NEGATIVE. Quartz Species. (Left to Right).
Top row.—Rock Crystal, Chalcedony, Rose Quartz, Lt. Smoky Quartz.
Centre row.—Pale Citrine, Citrine, Lt. Cairngorm, Cairngorm.
Bottom row.—Lt. Amethyst, medium Amethyst and dark Amethyst.

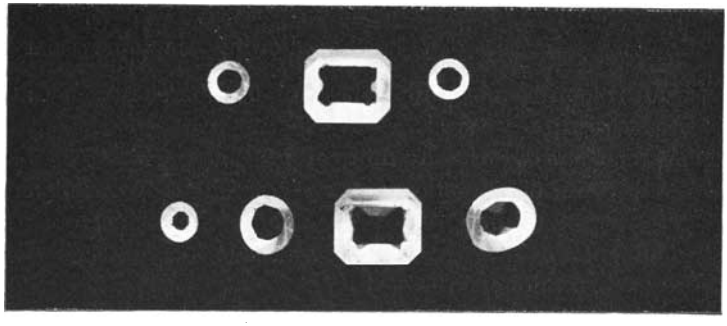


Fig. V. NEGATIVE. (Left to Right).
Top row.—White, Lt. blue and dk. blue, synthetic spinel.
Bottom row.—White, red, dk. blue and alexandrite-type synthetic sapphire.

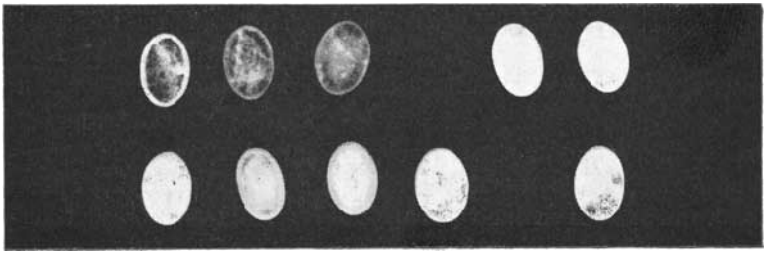


Fig. VI. NEGATIVE. Jadeites.
Top row.—Translucent white, translucent grey, translucent pink, orange and red brown.
Lower row.—Four shades of green and one black.

Fig. 3 shows a negative showing the important difference between the natural (top) and Chatham synthetic (bottom) emeralds.

Though some gemmologists may possess a TUV 7 watt short wave tube with an OX7 filter, they may not have a dark room and " wet " photographic facilities. Therefore, I have tried out some P.O.P. printing out paper. With this the negative image is visible without development, though it is not permanent. This paper was over twenty-five years old and is not now manufactured.

Bromide paper can be used in a like manner if sufficient exposure is given.

The emeralds to be tested are placed table facet downwards on a piece of bromide paper in a light-tight cabinet, so that the paper is within one inch of the filter. After an exposure of fifty minutes it will be found that the paper has turned a medium grey except under the table facets of the natural stones; the synthetics will show a light outline of the table facet due to internal reflection preventing the light reaching the edge, but the centre of the table facet will be dark, due to the rays passing through the stone. These negatives cannot be processed but they will not fade quickly unless they are exposed to a strong light or sunlight. Bromide paper used in this way can be handled in subdued natural light or ordinary artificial light. It should be noted that once paper is exposed to light other than a safelight, it cannot be used at a later date for normal photographic work.

I am indebted to Mr. P. Hoskins for the loan of several specimens which made it possible to study the effect of colour differences in several species.

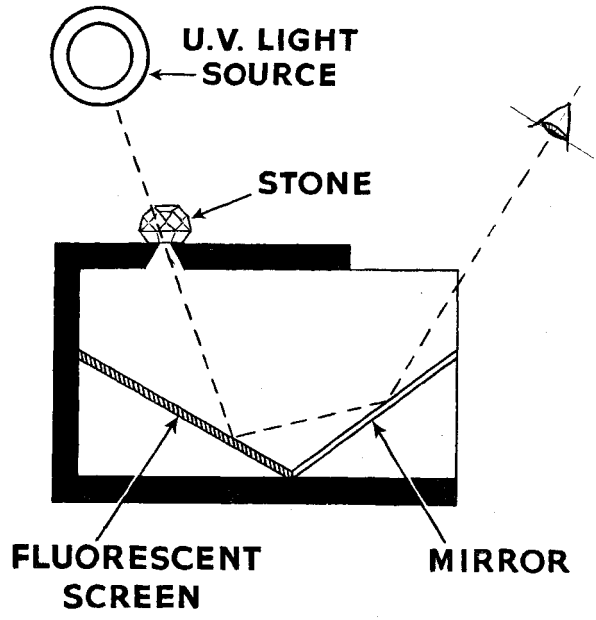
TRANSPARENCY to ULTRA-VIOLET LIGHT

by L. C. Trumper, B.Sc., F.G.A.

THE inexpensive short wave ultra-violet lamp, Mr. Robert Webster's interesting notes in the Gemmologist on Gemstone Luminescence and Mr. B. W. Anderson's article "A New Test for Synthetic Emerald " in the same journal for July, open up new fields of enquiry.

Few can have spectrographic equipment at their disposal, so it is to be hoped that Mr. Anderson and others will provide us from time to time with spectrograms of the other gemstones showing their transparency to ultra-violet light. Meantime, Mr. Norman

Day, F.G.A., of Salisbury, and I thought that some method of assessing transparency to ultra-violet light, open to the gemmologist with more modest equipment, would be very useful and might moreover provide interesting results. Day has thought out a very interesting procedure which seems to give excellent results (see first paper). I had simultaneously, the same week-end, thought out another method which may give useful and rapid visual results and as this seems to provide a very simple way of providing approximate results, the method involved is set out here.



Gemmologists will be familiar already with the light-tight viewing boxes lined with black velveteen, which I consider to be a virtual necessity for the satisfactory study of luminescence. Anyone handy with a fretsaw and a few simple tools can make a viewing box for a few shillings. Anyone not so handy, I do strongly advise to have one or more built by the local carpenter or handyman. A point worth noting is that there is a great advantage in having the drawer and more especially the front of the drawer deep enough. Not only to take large specimens, but also to take the stage described below and which has to go in and out when the drawer is opened

and shut without fouling the upper portion of the front of the viewing box. It should be at least 3½ ins. deep and perhaps 4 ins. would be better. It will be seen from the diagram that the device consists of a small stage 2½ ins. x 4 ins. in which a very small hole ⅛ins. diameter and a larger hole, say, ¼ ins. diameter has been drilled and bevelled with a countersink bit from underneath. This stage rests on three sides 2¼ ins. high and within is a fluorescent screen set at an angle of 30 degrees and a mirror set at an angle of 45 degrees. When this is inserted in the drawer of the viewing box, the angle of incidence of the ultra-violet light from the lamp is such that the spot (in actual fact with the short wave lamp, a horizontal bar of light) is seen in the mirror on the fluorescent screen suitably in the centre from the viewing position. At the same time, the fluorescent screen cannot be illuminated by any direct light from the lamp. The device is inserted in the drawer of the short wave ultra-violet light viewing box, the stone under examination is placed over the hole and with the drawer closed, the lamp is then switched on. If the stone is opaque to the radiation, no fluorescence is seen; if transparent, however, then a bar of light is seen on the fluorescent screen. If semi-transparent then the glow on the screen is blurred or slight, and so on.

So far time has permitted only a small number of observations to be made, but colourless quartz, as was to be expected, showed full transparency and a bright fluorescence on the screen. Amethyst, on the other hand, and citrine were opaque. Colourless topaz was transparent; a piece of ordinary slip glass was almost opaque. A synthetic alexandrite was opaque; on the other hand a natural pale pink spinel was moderately transparent and glowed with a reddish fluorescence at the same time.

It would appear, therefore, that the test could be useful in many cases and would, for example, quickly differentiate between diamond and paste. It is fully effective with transparent colourless stones, but with coloured stones it may be necessary to concentrate the rays with a quartz lens which at the moment I do not possess.

A word or two about the fluorescent screen. This can quite readily be made in one or two ways. Any fluorescent material that is sensitive to both long and short ultra-violet wave will do, but clearly it must be a material with the brightest possible fluorescence. Barium platino cyanide is the best, but is expensive. A good second

is potassium uranium sulphate which fluoresces the typical bright uranium green. A screen is prepared by gluing a small piece of white card on the base of the screen. Covering the exposed surface with gum or Durofix and carefully shaking the powder over it as evenly as possible from a pepper pot, afterwards tapping the surplus off. It is a good idea to have a practice run once or twice before putting the gum on, collecting the powder carefully on a large piece of white paper. To prevent reflections the stage and box should be painted dead black.

REFERENCES

1. Trumper (L. C.). *Viewing Boxes for Ultra-Violet or Chelsea Filter.* Gemmologist, July, 1953.
2. Caudell (P. M.) and Webster (R.). *An Inexpensive Short-Wave Ultra-Violet Fluorescent Lamp.* Gemmologist, April, 1953.
3. Anderson (B. W.). *A New Test for Synthetic Emerald.* Gemmologist, July, 1953.
4. Anderson (B. W.). *Immersion Contact Photography.* Journ. Gemmology, April, 1952.
5. Martin (L. C.) and Johnson (B. K.). *Practical Microscopy.* Blackie & Son, 1946.
6. *Photomicrography.* Eastman Kodak Company, New York, 1944.

See also

Wild (G. O.) and Biegel (H.). *Absorption of Sapphire in the Ultra-Violet Region.* Gemmologist, Oct., 1947.

Anderson (B. W.) and Payne (C. J.) *Absorption of Visible and Ultra-Violet Light in Natural and Artificial Corundum.* ibid. Oct., 1948.

SYNTHETIC EMERALDS

There has recently been exhibited in the United States, at the Smithsonian Institute, a synthetic emerald crystal weighing 1,014 carats. It was made specially for the Institute, and must be regarded as exceptional, as it is of good quality. A larger crystal, of inferior quality has been shown at the Harvard Museum. This weighed 1,275 carats. The production of synthetic emeralds of fine quality and size suitable for mounting in jewellery is increasing.

PEARL FISHING CONTROL

The Commonwealth Government of Australia has broken off the negotiations with Japan which have been proceeding since April in an effort to find agreement on conditions under which the Japanese may fish for pearl shell in waters off the north coast of Australia. Australia is now to proclaim sovereignty over the whole continental shelf, reaching in places beyond 200 miles off the coast instead of the internationally recognized three-mile limit.

Having assumed in this area powers not recognized under international law but claimed also by the United States, the Government will enforce licensing and control measures over all pearlers of whatever nationality.

ASSOCIATION NOTICES

COUNCIL MEETING

A meeting of the Council was held at 19-25 Gutter Lane, London, on Tuesday, 25th August, 1953, at 4.30 p.m. Mr. F. H. Knowles-Brown presided

The following were elected to membership:

FELLOWS

Mary Adene Harrison, Lichfield D.1951
Albert Edward Shipton, Birmingham D.1932

PROBATIONARY

Michael Anthony Bates, Colombo, Ceylon
Peter Benton, Brighton.
Arthur Edmund Charles, London.
Neville Deane, Wednesbury.
Reginald George Golby, Birmingham.
Bapusaheb Shamrao Mahajan, Fort Bombay, India.
George Morton, Edinburgh.
Bernhard Muscat, Johannesburg, S. Africa.
Roger Arthur Pyatt, Orpington.
Philip Seager, Glasgow.
Mrs. G. Spiro-Haccou, Djakarta, Indonesia.

ORDINARY

Harold Charles Abbott, Auckland, New Zealand.
Doris Disby, Birmingham.
Isidore Abraham Drapkin, Birmingham
Frederick A. Ferraro, London.
S. Lorne Fear, Toronto, Canada.
Richard Homer, Birmingham.
Leonard Nathan, Birmingham.
Major Cyril Albert Reynolds, Wembley.
Commander Gerald Scott, Birmingham.
Harold G. Tandy, Birmingham.
Frederick William Thorn, Coventry.
John Harland Waller-Davies, Seaford.

It was decided to hold the presentation of awards gained in this year's examination at Goldsmiths' Hall, London, on 7th October, at 7.15 p.m., and that prior to this there should be held a Reunion of Members.

The Council with deep gratitude, heard of the various bequests to the Association made by the late President, Dr. G. F. Herbert Smith.

A report on the recent and highly successful gemmological exhibition held in Glasgow during June was received, and the Council placed on record its appreciation of the great efforts made by members of the West of Scotland Branch of the Association in contributing to the success of the Exhibition. The Council also recorded its appreciation of the part played by the Glasgow Art Gallery and Museum.

The results of the 1953 examinations, which were considered by the Council, are recorded separately in these notices.

RESEARCH DIPLOMA

The Council of the Association has awarded a Research Diploma to George Frank Leechman (Diploma 1938) for his thesis on the origin of the colours in precious opal. The topic selected was a very difficult one and Mr. Leechman's paper presented a very creditable performance.

This is the third occasion a Research Diploma has been awarded, the others being 1945 Mr. M. D. S. Lewis, and 1946 Mr. R. Webster.

OBITUARIES

David Lawrence Meek. We regret to announce the death of one of Edinburgh's jewellers, Mr. David L. Meek. He was the first Chairman of the recently formed Edinburgh and East of Scotland Branch of the Association and a past President of the Edinburgh and East of Scotland Goldsmiths', Silversmiths' and Watchmakers' Association. He represented the third generation of his firm, Messrs. J. and D. Meek of Bank Street.

Rose Rachael Meisl, of London. The death has occurred, after a serious illness, of Mrs. R. Meisl. She gained her Fellowship in 1947. The Vice-Chairman represented the Association at the funeral service.

SWISS GEMMOLOGICAL ASSOCIATION

In May, the Swiss Gemmological Association held a General Meeting in Germany. Three days were devoted to visiting the Idar Oberstein exhibition of precious stones, the Gemmological Institute, plants for polishing coloured stones, agate cutting shops, stores of imported agate, a local agate quarry, and an engraver's shop. Relevant historical, scientific and economic papers were read. The first contact between the members of the Swiss and German Gemmological Associations seems quite promising. It is intended to arrange exhibitions of Idar-Oberstein products (cut and rough) at the three or four biggest Swiss towns whose jewellers will take advantage of this by decorating their windows accordingly. Similar exhibitions are planned, with the help of the Swiss Association, for France, Holland and Belgium.

TALKS BY MEMBERS

Anderson, B. W. : "The use of the refractometer." Netherlands Gemmological Association, Amsterdam, 8th October, 1953.

Mrs. K. G. Warren : "Gemstones." Christ Church Young Peoples' Fellowship, Bromley, 16th October ; *ibid.*, Town's Women's Guild, Bromley, 4th November.

LETTER TO THE EDITOR

DEAR SIR,

May I, through the courtesy of your columns, express the gratitude of the Executive Committee and Members of the West of Scotland Branch of the Gemmological Association to all the following persons, companies and organisations for the assistance and advice afforded the Branch in the staging of its first Gem Exhibition in Glasgow during the month of June.

The Director, Royal Scottish Museum, Edinburgh, The Director, Birmingham Museum, The Director, Kilmarnock Museum, Messrs. Norman H. Day, A. Herriot, Kenneth Parkinson, A. R. Popley, R. Webster, K. A. Webster,

the Agent General for Queensland, Agent General for South Australia, British Museum (Natural History), East of Scotland Branch of the Gemmological Association, Dr. Norman Holgate, Midlands Branch of the Gemmological Association, Messrs. Rayner & Keeler Ltd., Muir & Sons, Diamond Trading Company Ltd., J. H. Steward Ltd., Impregnated Diamond Products Ltd., A. Bernard (Gems) Ltd., Gregory Bottley & Co., George Tarratt Ltd., Salford Electrical Instruments Ltd., Geo. Lindley & Co. (London) Ltd.

We are especially indebted to Messrs. J. & C. Ginder Ltd., for their part in arranging the diamond polishing demonstration and for the handsome donation towards the expense involved.

Finally, we would like to acknowledge the assistance and guidance afforded us by the Secretary of the parent body.

Yours faithfully,

S. D. WOOD, Exhibition Convenor.

1953 EXAMINATION RESULTS

In the 1953 examinations of the Gemmological Association the high number of candidates, which has been characteristic of post-war years, was maintained. For the Diploma examination eighty-six candidates sat in Great Britain and sixteen at overseas centres, while in the Preliminary examination the home and overseas entries were one hundred and five and twenty-eight respectively.

The Tully Medal has been awarded to Mr. J. B. Kemp, of Bristol, and the Rayner Prizeman is Mr. N. Deane, of Wednesbury.

The following is a list of successful candidates, arranged alphabetically :

DIPLOMA

Qualified with Distinction

John Brian Kemp, Bristol (Tully Medal)
Trevor Martin Brook, Lincoln
Robert Cecil Fox, Seven Kings.
Ronald Albert Hall, Lingfield.
Anthony Lionel Wickenden Kemp, Bristol.
Bertram Krashes, Levittown.
Jeanne Gladys Marie Martin, San Diego.
Raphael Isaac Roth, London.
Colin Sidney Wickens, London.

Qualified

Samuel Bache, Old Hill.
John Thomas Baker, Bristol.
Hermann Bank, Idar-Oberstein.
Walter Bowen, Birmingham.
Alfred John Brack, London.
Helen Mary Lufkin Charles, London.
Rodney Frederick Collyer, Birmingham.
Anthony Warren Davis, Potters Bar.
John Norman Forsey, Sutton Coldfield.
John Galloway, Edinburgh.
Adrienne Mary Grahame-Ballin, St. Albans.
David John LeGrew Harrison, Amersham.
John Francis Hodges, Chester.
Roger Ward Jones, Cirencester.
Vincent George Jones, Sutton.
Graham Edward Keay, London.
Michael John Kutner, Wembley.
Norman Alfred Lambert, London.
Marjorie Betty Leak, Bristol.
Peter Francis Leese, Northwood.
David Gemmell Lennie, West Kilbride.
Brenda Elizabeth Lewis, Bristol.
Eric Lewis, Woking.
Leonard George Noye, Rushmere.
Richard James Neville Oliver, Eastleigh.
Dermot Stephen Rogers, Belmont.
William Sena, Singapore.

Anthony I. Stanton, London.
Winefride Jane Summerfield, London.
Gunnar Sunde, Oslo.
Roger Ian Thomson, London.
Ronald Frank Tugwell, Thornton Heath.
Leslie Phillip Waites, Birmingham.
Derek Walden, Enfield.
Peter Jervaise Watson, London.
Leslie Nield Wells, Chadderton.
Helge Richard Westgaard, Oslo.
Harold John Wheelock, Solihull.
Beatrice Mary Wood, London.

PRELIMINARY

Qualified

Bohitige Amaradasa, Ceylon.
Hermann Bank, Idar-Oberstein.
Keith Michael Batt, Torquay.
Albert Louie Baumann, Southall.
Claus Bender, Hamburg.
Peter Benton, Brighton.
Ivan Berger, London.
Carlos Bock, Badhoevedorp.
Werner Bolli, Lucerne.
Leslie Thomas Boxall, Richmond.
Sheila Anne Betty Bradshaw, Petts Wood.
Walter Robert Burley, London.
June Rose Mary Chalmers, London.
Antony Beresford Chinn, London.
Gordon Ralph Cleaver, Parkstone.
Eric Colman, Leamington Spa.
Dorothy Grace Cross, Birmingham.
George Davis, Aden.
Hatharasinghe Vidanage Daya, Colombo.
Neville Deane, Wednesbury. (Rayner Prize).
Warwick Sydney Eady, Auckland.
Alan Martyn Gard, London.
David Walley Gardner, Tiverton.
Sydney Norman Gaythorpe, Amesbury.
John Stanley Harper, Birmingham.
Scott Carswell Henderson, Dundee.
Alan Wesley Henn, Bridgnorth.
Richard John William Hogg, Edinburgh.
Ann Holmes, Edinburgh.
Alan Cecil Jackson, Greenford.
Doris Marjorie Janes, London.
Wilmer F. Jean, New York.
Bjarne Anfin Jensen, Bergen.
Fridthjof Jorgensen, Oslo.
Alison Margaret Kennedy, Bebington.
Rodger Sutton Boyack Lyon, Dundee.
Emil Lystskjold, Bergen.
Daniel McAllister, Glasgow.
Jeanne Gladys Marie Martin, San Diego.
Cyril Thomas Mason, Lahore.
Harold Medley, Kingsworthy.
George Morton, Edinburgh.
Sigurd Gerhard Olsen, Bergen.
Loti Raman, New York.
Henri Roulet, Geneva.
Roderick Ross, Edinburgh.
Moira Enid Samson, Glasgow.
Philip Seager, Glasgow.
Jack Shearman, Barnehurst.
John Terence Sidaway, Torquay.
John Stamnaess, Oslo.
Noel Jame Sutton, London.
Alan Walker, New York.
Arthur Hugh Walker, Bournemouth.
Harry Walle, Oslo.
John Warrender, Sutton.
Malcolm Henry Webb, Maidstone.
Frederick Albert Welch, Bebington.
Helge Richard Westgaard, Oslo.
Alan John Whiteson, London.
Elizabeth Doreen Wines, London.
David Wright, Weston-super-Mare.

COURSES IN GEMMOLOGY, 1953/54

Applications for the Association's courses in gemmology exceeded expectations and it is regretted that further entrants cannot be accepted for the present session. A waiting list is being prepared for entry into the 1954/55 preliminary and diploma courses.