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# THE JOURNAL OF GEMMOLOGY

*and*

## PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

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

Vol. VIII No. 5 JANUARY 1962

# FIRE MARKS ON GENUINE SAPPHIRE

*By W. F. EPPLER*

FIRE marks, sometimes also called " chatter marks ", are crack-like markings which are often to be seen on the polished surfaces of synthetic corundum (synthetic ruby and synthetic sapphire, Fig. 1). They are reported to be caused by local overheating during the polishing process.

The marks exhibit different forms of which Fig 1 only gives one example. In each case, a parallelism is remarkable which can be observed with the main directions and with corresponding parts of the cracks as well. Obviously, the designation as chatter marks is derived from similar markings on the surface of turned steel, or other metal, as shown in Fig. 2 and 3. Here, an overlapping of displaced metallic particles took place, the reasons for which are to be found in a possible vibration of the lathe, or in an overcharge of the chisel or the mandrel, or by an unsuitable turning speed, or by other technical reasons. The shifted metallic parts are typically outlined and closely resemble the markings on polished corundum.

In nearly every book of gemmology, these markings are suggested as an indication of the synthetic origin of corundum. E. J. Gübelin first pointed out the fact that these chatter marks can also be found in genuine corundum. In his book " Inclusions as a Means of Gemstone Identification " (Los Angeles 1953, p. 45) he mentions:

" These marks do not afford conclusive proof that the stone is synthetic for they also occur in natural corundum. They are

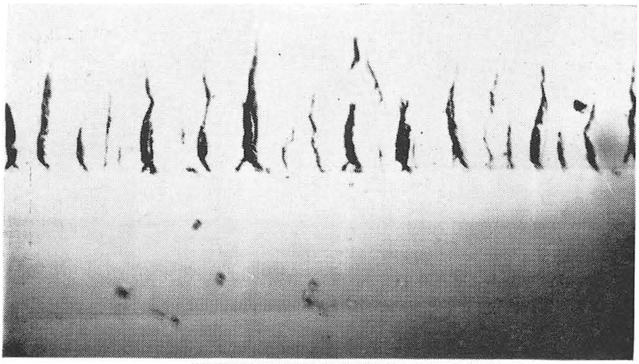

Fig. 1. *Synthetic sapphire showing "fire marks" on its surface. 65X*

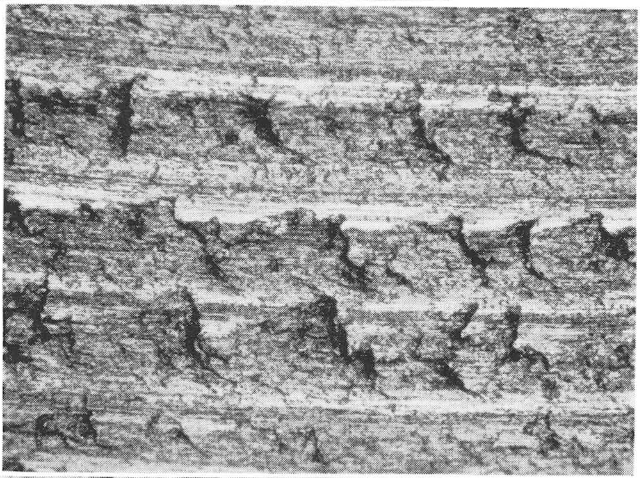

Fig. 2. *Chatter marks on turned steel. 120X*

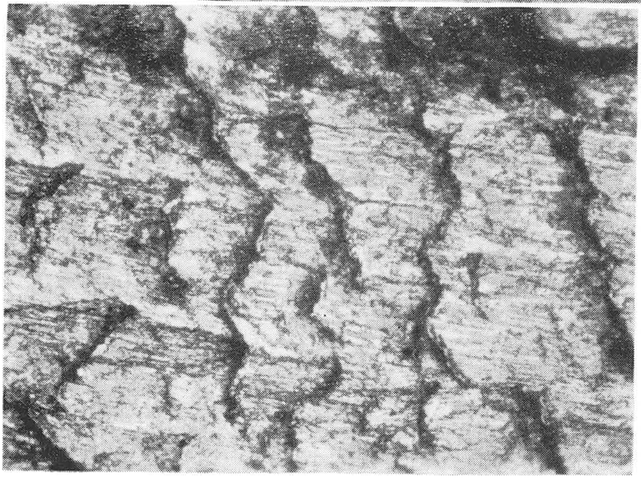

Fig. 3. *Chatter marks on turned steel. 200X*

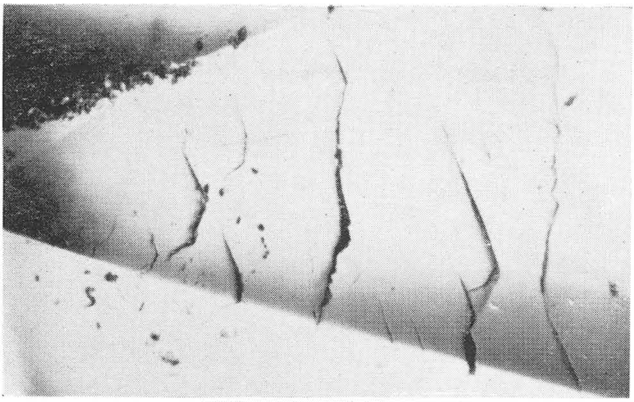

FIG. 4. *Fire marks on sapphire from Ceylon. 65X*

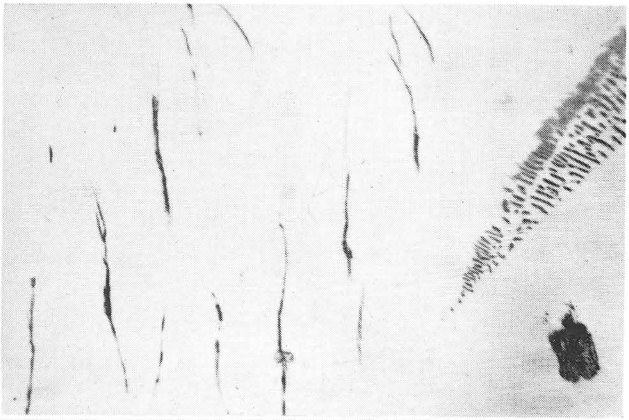

FIG. 5. *Rose-coloured sapphire from Ceylon exhibiting fire marks and a pointed healing fissure consisting of small liquid inclusions (right). The dark spot down right is a dust particle resting on the surface of the stone. 65X*

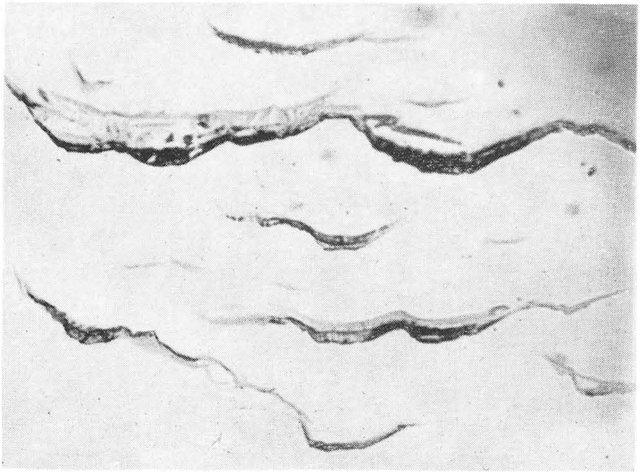

FIG. 6. *Greenish-blue sapphire from Australia with fire marks. 65X*

merely a feature of stones of the corundum species that have been polished too rapidly."

It seems to be regrettable that this observation has not yet entered much of the gemmological literature—and the mind of students likewise.

Fire marks on the facets of natural sapphire of different colours and localities are shown in Figs. 4–7. The marks exhibit some peculiarities from which their origin can be deduced. There is, firstly, the already mentioned parallelism; secondly, certain angles can be observed which, in Fig. 4 for instance, are not far from 90°, while in Fig. 6 and 7 the angles do not deviate much from 120°. Sometimes, the marks are broad and in other cases they are fine lines like small fissures (Fig. 5). An informative feature is revealed in Fig. 7. It represents a fire mark from which only the borderline with the polished surface of the stone is in focus. But it is obvious that the mark continues to deeper regions of the stone thus indicating that it is a wedge-like crack.

In accepting the idea that the cracks are caused by too rapid a polishing or by local overheating during the polishing process—an assumption which certainly is correct—it is most probable that the local overcharge of the surface causes a parting of the corundum along the planes of the primitive rhombohedron. Then it depends on the situation of the polished facet with respect to the planes of the rhombohedron in which direction the parting fissures occur, and also which forms and angles are generated. There exists, as indicated by the pictures, a multitude of possibilities.

Fire marks also occur on the surface of natural ruby, and for their origin the same explanation can be given.

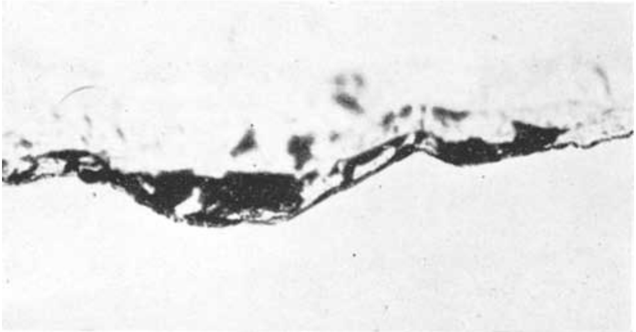

FIG. 7.
*Part of Fig. 6.
200X*

# THE GREAT TABLE DIAMOND OF TAVERNIER

*By S. TOLANSKY*

IT has often been repeated in successive books dealing with the history of diamond that Tavernier, when in India in Golconda in 1642, saw a remarkable table diamond weighing 242 carats and which has since vanished. More than one author has wondered what happened to this gem, which Tavernier says was " the largest he ever saw in a merchant's hands".

I am going to show here that previous historians have probably made a mistake. Tavernier's stone was probably *not* a diamond. It was almost certainly a ruby.

The description of this stone occurs in Chapter XIX of Part II of Tavernier's *Travels in India.* This very brief chapter is devoted solely to the description of one plate on page 148 (English translation, London, 1684) in which six different stones are illustrated, two of them twice.

The key to my conjecture lies in the chapter heading which is to Chapter XIX, " Observations upon the fairest and largest diamonds and rubies which the author has seen in Europe and Asia, represented according to the figures in the Plates; as also those which the author sold to the King upon his last return from the Indies, with the figure of a large topaz and the fairest pearls in the world ". This material is followed by five plates of illustrations which refer to this chapter and to Chapter XX, headed " The forms of twenty rubies which the author sold to the King".

We are concerned with the first Plate and Chapter XIX. The first plate is reproduced in Fig. 1.

The critical point is that Tavernier says he is making observations on the largest diamonds and RUBIES which he has seen. Let us look at his descriptions. For Fig. 1 he writes, " This DIAMOND belongs to the great Mogul . . . it weighs 279 9/16ths carats ". For Fig. 2 he writes, " The figure of a DIAMOND belonging to the Great Duke of Tuscany. It weighs 139 carats ". For Fig. 3 he writes, " *A STONE* that weighs 242 5/16th carats. It was the biggest that I ever saw in my life in a Merchant's hands. It was valued at 500,000 Rupees ". For Fig. 4 he writes, " A DIAMOND which I bought. It weighed 157¼ carats ". For Fig.

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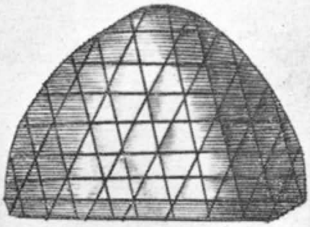

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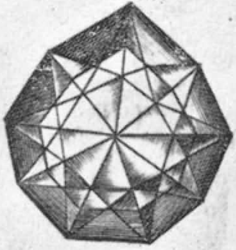

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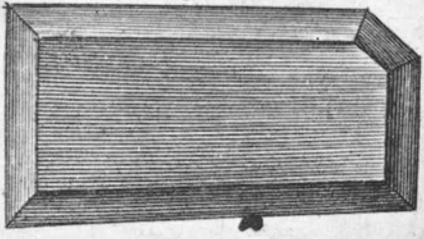

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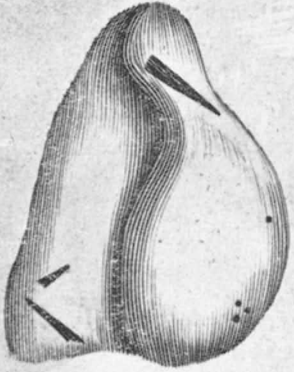

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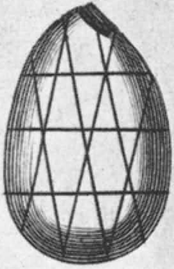

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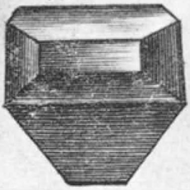

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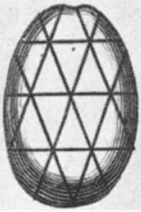

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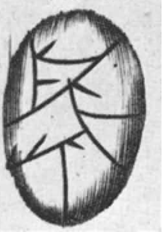


5, " The fore-mentioned diamond after it was cut ". For Fig. 6, " Another DIAMOND I bought. It weighs 63⅝ carats ".

For Figs. 7 and 8 he is more explicit and this is equally important, saying, " Two pieces of a *STONE* that was cut in two, which being entire weighed 104 carats. Though of good water it seemed foul in the middle. A Hollander bought it and cutting it in two found in the middle of it 8 carats of filth like a rotten weed. The small piece happened to be clean but for the other wherein there are so many cross flaws there was no way but to make seven or eight pieces of it ".

This completes the essential whole or written content of the chapter, apart from some minor insignificant wording I have left out. Now there are two important points. The first is Tavernier. gives a heading where he says he is describing both *diamonds* and *rubies*. Then he describes four gems which he specifically calls DIAMONDS and another two he definitely calls STONES. Clearly the STONES are the rubies. There are several points supporting this theory. To begin with his table stone, Fig. 3, is completely anomalous as a diamond. Nothing resembling it has appeared before or since. If indeed it were part of a huge octahedron worked to a table cut, why is the lower octahedron half not shown as it is in Fig. 6 which is recognizably a large octahedron polished down to table cut ?

However, far more striking are the notes about the STONE of Figs. 7 and 8. We are told the Hollander *cuts* this in half. How, if it is a diamond ? Was it sawn ? I do not believe it. True, Mawe in 1823 describes how small stones can be laboriously sawn by a wire charged with diamond dust. I have found also, in seeking the origin of diamond sawing, that Jeffries, writing in 1751 (*Treatise on Diamonds*) says that diamonds have been sawn to make them into rose-cuts but " this practice was attended with a great expense of workmanship ". Knowing the time taken to saw stones to-day with high-speed rotary saws, a charged wire would have taken months and months, over a year, to have sawn through a diamond weighing 104 carats, and surely Tavernier would have enlarged on this. Mawe mentions that a large stone takes 10 months to saw and large to him was certainly far less than 100 carats ! Then again after cutting, part was cut into seven or eight pieces. Again how ? All this is not early diamond practice at all. All this certainly does not sound like manual operation on a diamond in 1641, but is reasonable for a ruby.

Of course there is always the possibility that when Tavernier says the Hollander cut the stone he was implying a cleavage. This seems a remote possibility for three reasons. First it would be unusual to find the cleavage plane so convenient as to split the stone so really in half, second there is little evidence that such practices were ever carried out on large diamonds and thirdly, Tavernier goes on to say that the flawed part is cut into seven or eight pieces, and clearly, from the picture this could not be done by cleavage. Evidently the same method as is used to separate the small parts was being used to cut the whole crystal. Clearly then it had not been cleaved.

Now it cannot be too strongly emphasized that Tavernier at the head of his chapter says he is describing both diamonds and rubies. It seems perfectly clear that STONE in Figs. 7 and 8 refers to a RUBY and likewise I conjecture STONE in Fig. 3 also must refer to a RUBY. This being so, the mystery of the disappearance of Tavernier's so-called table-diamond is solved. It never was a diamond. Tavernier at any rate never said explicity that this was a diamond. He called it a stone, whilst using the word diamonds virtually in the same breath for other gems. It is in the following Chapter XX that he goes on to describe the 20 rubies he sold to the King of France and topaz and pearls. I therefore conclude that Tavernier has been simply misrepresented and that he has never stated he saw a huge table diamond. On the contrary with his usual great care, he describes only a great table STONE which he has seen.

# ULTRA-VIOLET LIGHT AS AN AID TO GEM TESTING

*By R. WEBSTER*

THE fascination of the glowing colours which are shown by many substances when they are irradiated by electromagnetic vibrations below those of the visible range has led to their use both in science and in the arts. Such phenomena may be used as an additional test in the identification of gem materials.

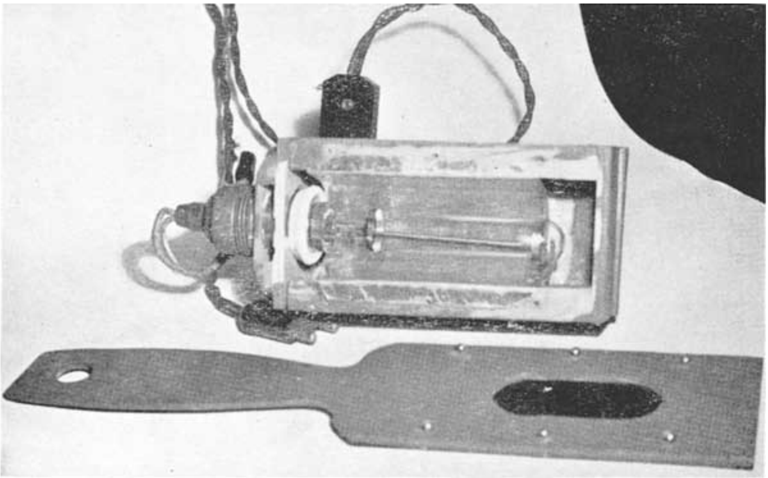
The history of luminescent phenomena is most interesting.

The first reference to a glow of light developed in a substance, that is apart from the so-called " phosphorescence of the sea ", decaying fish, and later on the oxidation of phosphorus, all of which are due to chemical causes rather than to stimulation by radiation, was probably as early as 1570, when a blue luminosity of the tincture of a certain wood when illuminated by sunlight was observed. The first recording of phosphorescence in a solid body was in 1602. At that time Vincenzo Cascariola, a cobbler and dabbler in alchemy who lived in the City of Bologna, calcined barytes, a barium sulphate mineral, which, probably owing to impurities present, produced a phosphorescent alkaline sulphide. This was called " Bologna stone ". The calcined barytes was often of porous appearance and led to the notion that the stone simply soaked up light like a sponge and released it in the dark. This idea was disproved in 1652 by Zecchi, who illuminated such a stone with different coloured lights and found that the colour of the phosphorescence was unchanged. Therefore it was not just a storing up of the incident light and re-emission in its original form.

Many scientists examined the problem of the luminescence produced in different substances when they are irradiated with sunlight. Of particular note is the postulation by David Brewster, who, in 1833, considered that the phenomenon when seen in liquids was internal dispersion. Brewster thought that the effect was due to diffusion or dispersion of the impinging radiation. Later, however, George G. Stokes in a classic paper " On the change of refrangibility of light " put forward the theory that the light was a new creation due to the absorption of rays of shorter wavelengths. Stokes proved his contention by an elegant experiment, that of using crossed filters. He used a source of white light and pairs of complementary filters between which was placed the fluorescent substance. In one of the experiments he used, as one of the pair of filters, a glass flask containing a deep blue solution of ammoniacal copper sulphate, through which the beam of white light was passed. The beam of blue light so produced was found to be quite invisible when viewed through certain yellow-coloured glasses.

The copper sulphate filter passes only blue and violet light and the yellow filter only the red, orange and yellow rays, so that if a suitably luminescent material was placed between the filters and the glow could be seen through the yellow filter the glow could not be part of the incident light. The incident light must therefore have been absorbed and re-emitted as visible light of a longer wavelength. Indeed, Stokes postulated that the exciting radiation causing the luminescence is of shorter wavelength than that of the resulting fluorescent light. B. W. Anderson has resurrected this " crossed filter " experiment of Stokes and has applied it to gem testing.

The change of refrangibility (wavelength) described above suggests that blue light, or perhaps those radiations below the visible violet and known as ultra-violet rays—or ultra-violet light—might provide the best exciting radiations to produce a glow in responsive materials, and this is certainly the case in many gem materials.



*A PHILIPS T.U.V.7 tube in a home made housing. The cover containing the CHANCE O.X.7 filter has been removed to show the lamp.*

Admittedly rays of still shorter wavelengths, such as X-rays and gamma rays, will produce luminescence in certain substances. X-rays, and less commonly cathode rays, which are fast moving electrons, have been used in experiments in gem testing, but apparatus for the production of these rays is not readily available.

Ultra-violet light as we understand it is made up of those radiations of shorter wavelengths than those of visible light; those wavelengths below, say, 4000Å. Ultra-violet rays are said to range from this wavelength down to below 150Å. Of this large range of wavelengths there are physical reasons why those below about 2000Å cannot be utilized. The useful range of ultra-violet light is therefore from 4000Å to 2000Å.

These wavelengths are conveniently divided into two sections; those between 4000Å and 3000Å, a section which is designated as " long-wave ultra-violet light ", and the range between 3000Å and 2000Å, which is known as " short-wave ultra-violet light". The importance of these divisions lies in the fact that luminescent responses of materials may differ considerably when different ranges of ultra-violet light are impinging on them. This differential effect may in certain cases assist in the determination of a specimen.

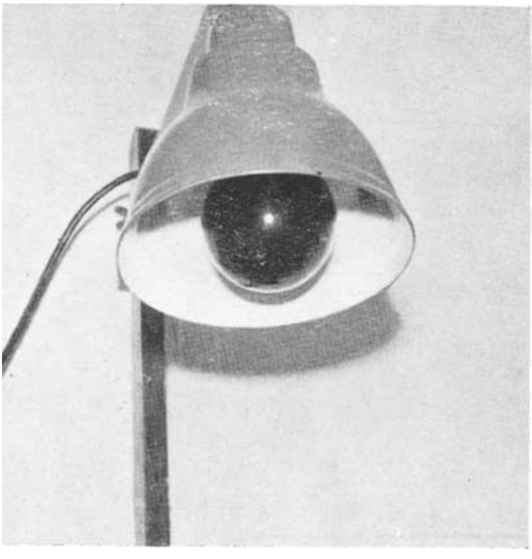
*Luminescence* is a term used for all the various manifestations producing a glow of visible light in a substance which is not in a state of incandescence. In fact luminescence is " cold light ". When the glow is caused by transformation of waves of shorter wavelength incident on the specimen, as outlined above, the effect is termed *photoluminescence*, and the term *fluorescence* is used for the glow of visible light which occurs while the exciting radiations are impinging on the substance. If the glow persists after the exciting rays are turned off the effect is known as *phosphorescence*. This " after-glow " can be of quite short or long duration. The observation of phosphorescence may also be of use in gem identification.

The physical causes of luminescence concerns the movement of planetary electrons which surround the nucleus of all atoms and any attempt at a full explanation would be out of place in this article.

Dissipation of the absorbed radiation by a solid will give rise to one or more of four distinct effects. The most common is that an increased thermal motion of the atoms occurs and this will account for some or all of the absorbed energy in nearly every case. A photochemical reaction resulting in a permanent change in the solid can occur, or the emission of photo-electrons producing a photo-electric effect. In this case transfer of energy from the incident light to the electrons in the substance irradiated may give rise to a photo-electric current when the system is included in a suitable circuit.

The effect which is of most interest in this article is that in certain cases the absorption of light energy causes the emission of photons (quanta of radiant energy). The substance is then said to luminesce, but this luminescence may or may not be in the visible range.

Solid substances which luminesce are called phosphors and these are divided into two classes, the first of which, the intrinsic phosphors, are those substances in the pure state which luminesce. There are few pure substances which show luminescence and these, except one, have little interest to the student of gemmology. The exception is diamond, the luminescence of which was at first thought to be due to an impurity, but it is now known to be due in many cases to an intrinsic property of the pure gem, the luminescent centres probably being carbon atoms near lattice imperfections in the crystal.

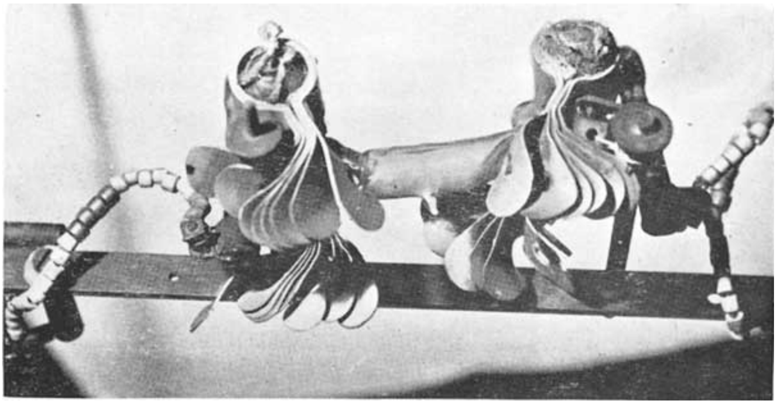


*A " Black bulb " long-wave ultra-violet lamp in reflector. This lamp has a small high-pressure mercury burner at the centre of an envelope made of Wood's glass.*

Most luminescing materials owe their glow to the presence of impurities and such phosphors are known as impurity-activated phosphors, the impurity being called the activator. The activator atoms (or ions) together with their neighbours in the phosphor form luminescence centres, or, as they are sometimes called, impurity centres.

Very briefly put, luminescence is the absorption of radiant energy by the substance. This raises an electron from a stable orbit (the so-called ground state) to a state of higher energy level, called the excited state, from which it immediately returns giving up its energy in the form of some type of light emission. This is fluorescence. If, however, as in some cases the excited electron does not immediately return to ground state but becomes trapped in a metastable level it cannot return to ground state. It is then necessary for the electron to receive further energy in order to bring it back to the excited state from which it can return to ground state with the emission of light. Thus there is a delay in return producing an " after-glow ", or, as it is called, phosphorescence.

The next question to consider is " How may ultra-violet light be produced " ? Sunlight is rich in ultra-violet rays and it is to these rays that sun-tanning of the skin is mostly due. The earth's atmosphere, however, absorbs practically all ultra-violet rays blow 2850Å, and even below about 3000Å in areas of industrial pollution. Despite the limitation of range of the ultra-violet rays reaching the earth from the sun, it was sunlight which was used by all the early experimenters in the field of luminescence.



*The burner of a Hewittic mercury vapour lamp on its rocking bar.*

A gas lamp burning carbon disulphide vapour in an atmosphere of oxygen or nitric oxide gives a rich source of ultra-violet rays and was used by some earlier workers despite its difficulty of operation. An electric spark discharge between metallic electrodes may also be used as a source of ultra-violet rays down to the shorter wavelengths. Here again the high-tension apparatus needed to initiate the spark is not easy to operate.

The electric arc, particularly if provided with special ultra-violet carbons or with certain metal electrodes, such as iron or tungsten, gives a powerful source of ultra-violet rays right down to below 2000Å. The disadvantage of the electric arc is that it is rather " messy " to use as it tends to give off noxious fumes and needs a lot of ventilation.

Photoflood lamps which use an over-run filament produce a source of ultra-violet light, and simple flashbulbs have been used when phosphorescence only is required to be observed. The expense of these bulbs seems to preclude their use to any extent, and, further, owing to the glass envelopes of either of these photographic lamps absorbing ultra-violet rays below 3000Å no experiments with short-wave ultra-violet light can be performed.

A small electric discharge lamp which has a glass bulb filled with argon gas has the attraction that it takes very little current

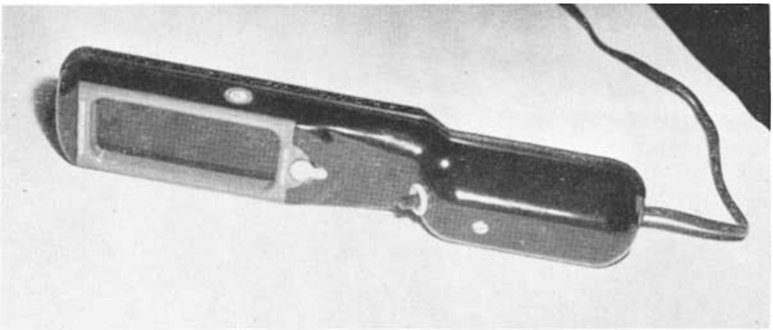
*The American BURTON lamp. A long-wave fluorescent tube lamp having twin filter glass tubes.*

and does not heat up. The disadvantage of this lamp is that its lower output is not much below 3900Å, so only in certain cases is it useful. Moreover these argon lamps, although fairly easily obtainable in the United States of America, are not commonly marketed in England.

A hydrogen discharge tube gives a spectrum continuous from the infra-red to the short-wave ultra-violet rays. This lamp, which operates by an electric discharge through hydrogen gas, has a quartz glass tube which passes the shorter radiations. Such a lamp needs special electric equipment to run it and in some lamps may need special cooling. It is mainly an expensive laboratory instrument.

The most convenient and efficient generator of ultra-violet light is an electric discharge through mercury vapour and all modern ultra-violet lamps use such a burner with the mercury, or mercury vapour, enclosed in a quartz-glass tube. Electric discharge lamps, including the aforementioned argon and hydrogen lamps and the electric arc using metal electrodes, have a spectral radiation consisting of sharply defined spectral lines. These are " bright " lines on a " black " background. The light from the sun and from tungsten lamps produce a " continuous spectrum ". With certain " bright line " emissions the lines are so numerous and so close together that they approximate to a continuous spectrum.

The earliest type of electric mercury-vapour lamp used for the fluorescence of gem materials was the Hewittic lamp, which was



*The American MINERALITE short-wave ultra-violet lamp.*

supplied to the trade in 1922 as a possible method for the detection of cultured pearls. The Hewittic lamp had a burner consisting of a quartz tube with a bulb at each end containing mercury. When the electric current (and direct current was needed for this lamp) was switched on—a resistance coil being incorporated in the circuit—the burner needed to be tipped in order for the mercury to join momentarily and complete the circuit. This vapourized the mercury and produced the arc—an electric discharge through mercury vapour which emitted, besides strong ultra-violet rays, an intense bluish-white visible light.

Modern quartz-tube mercury-vapour ultra-violet lamps operate on an alternating current (special models by direct current) and are much more convenient to operate. They may be small enough to be portable, or, as in some laboratory models, may be designed for table use or on floor stands.

There are two distinct types of mercury-vapour lamps. The first is the so-called " high-pressure " mercury arc, in which the mercury vapour is at a pressure of one to ten atmospheres. The spectral range of such lamps extends from about 14,000Å or higher in the infra-red to about 1800Å in the ultra-violet. Radiation in the visible part of the spectrum is concentrated mainly in a pair of yellow lines at 5791 and 5770Å and a green line at 5461Å. There are intense lines in the blue at 4358, 4347 and 4339Å as well as two in the violet at 4078 and 4047Å. The intense bluish visible light emitted by these burners is due to these emission lines.

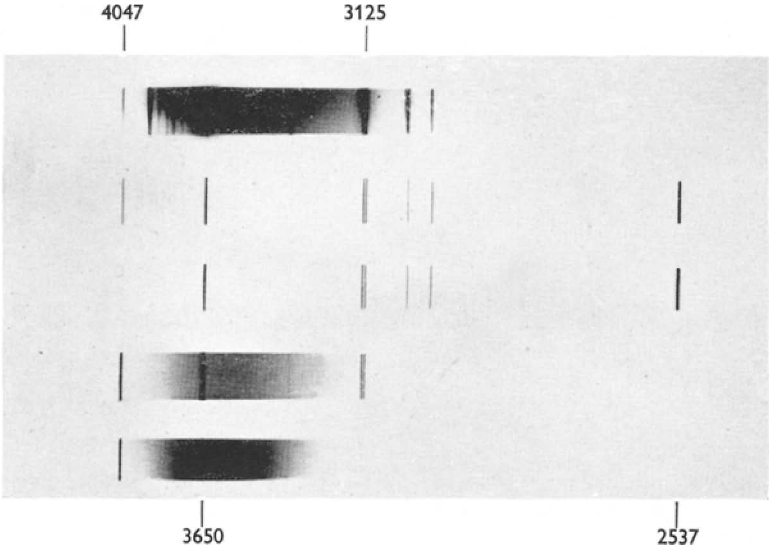
In the ultra-violet region the emission lines are centred at 3654 and 3650Å, and these lines produce the long-wave ultra-violet light used for many fluorescence experiments. The major emission lines below these are the powerful " resonance line " at 2537Å, and another at 1849Å. It is the 2537Å line which is used to produce short-wave ultra-violet light. The high-pressure burner is only suitable for long-wave fluorescence experiments.

The other mercury discharge lamp to be discussed is the low-pressure lamp where the mercury is at a pressure of only one or two millimetres—that is sub-atmospheric. In these low-pressure lamps the spectral strengths of the various mercury lines differ markedly from the high-pressure lamps. In the low-pressure lamp the visible emission is much less, the 3650Å band less strong, and the 2537Å line relatively more pronounced. The low-pressure lamp, a type of which is made commercially for germicidal purposes, needs an envelope of quartz-glass or a special glass in order to allow transmission down to about 1800Å.

There is a third type of ultra-violet lamp which has a value in gem testing. This may be said to be a " hybrid " lamp for it is a long-wave lamp but operates on the low-pressure system. In this lamp the inside of the glass envelope—made of a glass which does not transmit short-wave ultra-violet rays—is coated with a powder which " fluoresces " with long-wave ultra-violet light under the influence of the short-wave radiation given off by the electric discharge through the mercury vapour. In this lamp the long-wave ultra-violet rays, emitted from the powder lining the inside of the tube, produce a continuous spectrum and not a line spectrum.

These " fluorescent " lamps operate similarly to the fluorescent tube lamps so popular for lighting to-day except that the internal coating of the tube emits long-wave ultra-violet light instead of the bright visible light of the lighting tube. However, there is some bluish visible light given off by the ultra-violet tube.

The high-pressure lamps emit an intense bluish visible light and there is always some visible light produced by the short-wave



*Spectrograms of various ultra-violet lamps.*
*(Top) High-pressure lamp with Wood's glass filter.*
*(Next two) Two makes of short-wave low-pressure ultra-violet lamps.*
*(Bottom two) Two makes of long-wave fluorescent tube ultra-violet lamps.*

ultra-violet lamp. Such visible light precludes the observation of fluorescence effects which have to be seen in comparative darkness. The lamps, therefore, have to be fitted with some type of filter which will cut out as far as possible the visible components of the emission and the ultra-violet bands not needed.

For the high-pressure lamp a filter made of a cobalt-nickel glass is used. This glass, devised by R. W. Wood, and known as Wood's glass, cuts out most of the visible light and also the rays below 3000Å. It does transmit the important emission band at 3650Å.

For the separation of the short-wave emission at 2537Å a completely satisfactory filter—that is one which will cut out the visible light and the long-wave ultra-violet rays but pass the short-wave band—does not seem to be possible. The commercial " dark glasses " available are a compromise. Such filters do cut down the visible light from the lamp and also the long-wave ultra-violet rays but do not completely absorb them. They do pass a considerable amount of the 2537Å band.

A short-wave filter in front of a high-pressure lamp will not work. This is because far too much of the strong visible light from the lamp is passed by this filter, and also much of the 3650Å band. The latter mixes with the short-wave emission passed and confuses the results.

It is for this reason that the short-wave filter—and there are a number of short-wave filters of variable efficiency available—must be used in conjunction with a low-pressure burner for such a lamp emits a very much smaller amount of visible light and relatively less of the long-wave ultra-violet rays. These short-wave filters tend to lose their transmiscibility after some 200 hours use. They may be re-habilitated, however, by careful heating to 400°C and then slowly cooling to room temperature.

All ultra-violet lamps need a good housing in order to prevent visible light straying, and the ventilating louvres needed with the high-pressure lamps should be so designed with this in mind. Ultra-violet lamps should be fitted with aluminium reflectors as polished aluminium provides the best reflecting surface for ultra-violet rays. Some ultra-violet lamps are made with the necessary filter glass as an integral part of the lamp, but even with these lamps a suitable reflector is an advantage.

The " hybrid " fluorescence type of lamp, owing to the type of " black glass " filter used, emits further into the long-wave lengths of ultra-violet, and indeed into the violet and blue, than does the high-pressure long-wave ultra-violet lamp fitted with a Wood's glass filter.

The best results with any lamp are obtained when the stones are placed on a black background—such as a black velvet mat—and the room needs to be in comparative darkness or the specimens viewed in a dark cabinet which surrounds the lamp.

Observation of phosphorescence (after-glow) may in some cases be of diagnostic value. To do this it is necessary to shut off the ultra-violet rays from the specimen. It might be thought that switching off the lamp will do all that is necessary. Simple as this appears the method is not efficient for there may be a delay in the final extinction of the rays after switching off. This may tend to mask phosphorescence of short duration. Further, there are electrical characteristics of the high-pressure lamp which precludes it re-lighting again immediately after switching off. Some three to five minutes need to elapse for the burner to cool before it will re-light. Low-pressure lamps do not show this effect as they run cool and will switch on and off at will. A shutter arrangement might provide adequate and speedy shutting off of the ultra-violet rays, or the stone may be quickly removed from the beam.

The luminescent effects shown by the more important gemstones are given in succeeding paragraphs.

### DIAMOND

The first thing which strikes the observer when examining the fluorescence of diamonds is that they vary considerably in the intensity of their glow and in the colour of the light given off.

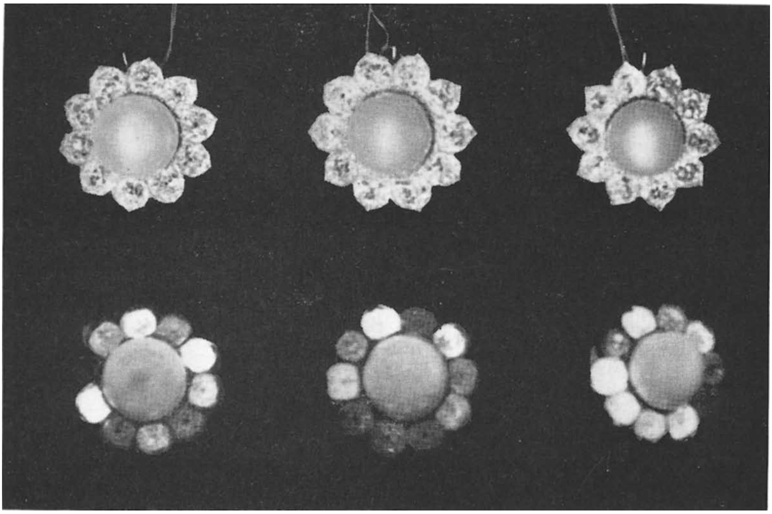
When irradiated with long-wave ultra-violet light the fluorescence colour most commonly seen in diamonds is a violet or blue and this can vary from a very weak dark violet to a brilliantly bright sky-blue. Some diamonds, however, glow with a green, orange or yellow light.

Colourless and yellowish diamonds, the so-called " Cape " diamonds, glow with a violet or blue light, while brown and greenish-yellow stones fluoresce green. Some colourless, bright yellow (Canary diamonds) and brownish-yellow stones give off a yellow glow. Pink diamonds appear to fall into two groups in that they may display a bluish fluorescence or exhibit a strong orange glow with a persistent orange phosphorescence. Natural blue diamonds are usually inert.

Under the short-wave lamp the effects seen are similar, but usually much weaker. Most diamonds when under either long- or short-wave ultra-violet rays show a yellow phosphorescence which is more pronounced the stronger the fluorescent glow exhibited by the stone.

In the case of diamonds artificially coloured by bombardment with atomic particles the ultra-violet lamp may aid in distinguishing them from diamonds of natural colour. Many of the treated stones show a green fluorescence. Therefore, as the stones usually treated are of the " Cape series ", stones which normally show a blue fluorescence and in the absorption spectrum the strong line at 4155Å, a green fluorescing stone which also shows this absorption line should be suspect.

It is fairly well authenticated that natural blue diamonds are Type IIb and are transparent to short-wave (2537Å) ultra-violet rays. The artificially coloured (electroned) blue diamonds do not pass rays below 3000Å. A test, therefore, which would show whether a stone was transparent to short-wave ultra-violet light would



*Three diamond and pearl brooches photographed in ordinary light (top picture) and by their fluorescent glows (lower picture). This shows the differential fluorescent intensities of diamonds.*

supply the answer as to whether the colour was natural or not. R. W. Ditchburn devised an apparatus using a short-wave ultra-violet lamp, a stone holder and a fluorescent screen in a suitable viewing box for this test to be carried out. The more recently proposed test—that for electro-conductivity which is based on the discovery that natural blue diamonds are electro-conductive—provides a much easier test in this case. No electroned blue diamonds so far tested have shown electro-conductivity.

It has been proposed to take advantage of the difference in intensity of the glows shown by diamonds for the preparation of identity documents concerning pieces of jewellery set with many diamonds. The piece of jewellery is photographed while the diamonds are fluorescing under a beam of ultra-violet light. An ordinary camera is suitable for this provided that an ultra-violet absorbing filter be placed over the camera lens. Such a picture will show the different intensities of fluorescence of the various stones. It is considered outside the bounds of probability that any facsimile piece of jewellery will have the stones glowing with the same intensities in the same places.

## CORUNDUM

Ruby exhibits a crimson glow under ultra-violet light which is caused by the trace of chrome oxide which has entered the crystal lattice. The glow emitted by ruby is always, red but the intensity can vary a great deal. Very chrome-rich rubies fluoresce less strongly than those of less saturated colour, or even than the paler red Ceylon rubies. Owing to the trace of iron in the make-up of Siam rubies they show a much duller glow. It has been suggested that this difference in intensity of glow might be used to distinguish between Burmese and Siamese rubies, but the method breaks down in those border-line cases in which it is most needed.

Synthetic rubies show a brilliant crimson red under the long-wave lamp, and when under a beam from such a lamp, it is sometimes possible to pick out the synthetic rubies, by their stronger glow, in a mixed parcel of rubies.

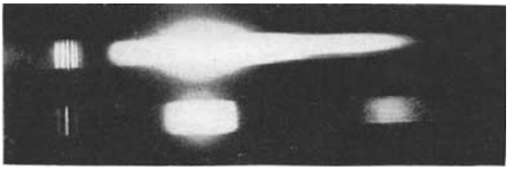
Under the short-wave ultra-violet lamp the red glow shown by rubies is less intense but is often more useful as a diagnostic aid in the detection of synthetic rubies. It is more helpful when dealing with parcels of rubies than it is for individual stones, even when comparison stones are used.

The red fluorescence shown by ruby may be induced by blue light. Therefore if a ruby be bathed in a strong blue light—by filtering a strong white light source by a flask containing a saturated solution of copper sulphate, which allows green, blue and violet light to pass but not red, orange or yellow light—and then viewed through a filter which only passes red light, the stone will be seen glowing red on a black background. Such a method, which is based on Stokes's original work, is useful in sparating rubies from red garnets, doublets and pastes, which do not exhibit a glow under such conditions.

Blue sapphires exhibit very little response under the long-wave ultra-violet lamp, an inertness probably due to the trace of iron always present in natural blue sapphires. An exception is in the case of some Ceylon sapphires which contain a trace of chromic oxide. These are the stones which appear a good blue in daylight and purplish in artificial light. Such sapphires show a weak red glow under the long-wave lamp. It is also true that synthetic blue sapphires do not respond when under this lamp.

Natural blue sapphires are also inert under the short-wave ultra-violet lamp, but the synthetic sapphires show a velvety green glow. Care is necessary in looking for this, as the visible light from the lamp tends to produce reflections of bluish light which tend to mask the fluorescence colour. It has been found best to turn the stone sideways, so that the ultra-violet beam strikes across the girdle. It is well to turn the stone and view it from different directions.

Colourless natural sapphires show an orange fluorescence under either range of ultra-violet light. Synthetic white sapphires are inert under the long-wave lamp but show a deep blue glow under short-wave ultra-violet rays, but occasionally a whitish glow may be seen in these stones which is similar to that shown by synthetic white spinels. Yellow sapphires from Ceylon show an apricot-coloured glow, but the iron-rich Siamese and Australian



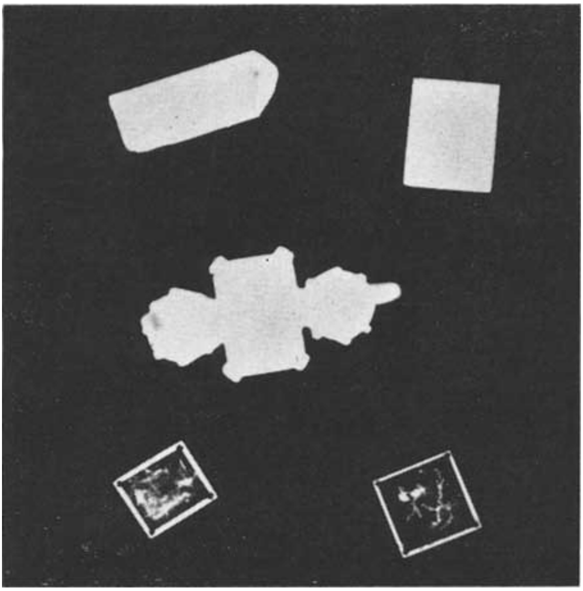
*Fluorescent spectra of (upper) natural red spinel and (lower) ruby.*

sapphires, and also all natural green sapphires, do not fluoresce. Most synthetic fancy-coloured sapphires show an orange or red glow when in the beam of either range of ultra-violet light.

BERYL

The luminescence of emerald can vary greatly. Under the long, or short-wave lamps many natural emeralds fluoresce with a weak green glow, but some stones may be found to show a reddish glow. Synthetic emeralds usually show a fairly strong red glow. The " hybrid " fluorescent type of lamp, which has its emission further into the visible violet, may be better than the ordinary long-wave lamp for this red glow to be seen. A red fluorescence seen in emerald should indicate that further tests are needed in order to confirm that the stone is synthetic and not a rare red-fluorescing natural emerald. The " crossed-filter " technique, using a copper sulphate filter and a red glass, will in this case perform a similar purpose.

The ultra-violet lamp is an effective tool in distinguishing the Lechleitner synthetic emerald-coated beryls, for under the lamp the thin coating of synthetic emerald glows and outlines the stone with a red rim.



*Transparency picture of natural emerald (3 at top) showing the lack of transparency to short-wave ultra-violet light, and the much more transparent synthetic emeralds (bottom two images).*

It is known that a natural emerald absorbs ultra-violet radiations below 3100Å, while the synthetic emerald is transparent to rays as far down as 2300Å—that is, the synthetic emerald will pass the 2537Å emission line of the short-wave lamp. Therefore this lamp may be used to ascertain the degree of transparency, for natural emeralds will not transmit these rays, while the synthetic emeralds will.

The technique necessary to do this is to place the suspected stone, with control stones of natural and synthetic emeralds, on a piece of slow photographic printing paper (preferably the old P.O.P.) which has been placed at the bottom of a water-filled dish. A short exposure from the short-wave lamp held about twelve inches above the dish is given, and the photographic paper removed and developed in the normal way. The synthetic emeralds will be distinguished by the greater darkening of the image.

Aquamarines and yellow beryls do not exhibit any diagnostic glows. The pink beryl may show a weak lilac coloured fluorescence.

### CHRYSOBERYL

The yellow and brown chrysoberyls, including the cat's-eyes, do not respond to ultra-violet radiations. Alexandrites show a dull crimson glow under both waves of ultra-violet light and thus may generally be distinguished from the synthetic fancy-coloured corundums which are made to imitate them, for these latter stones usually show an orange fluorescence.

### ZIRCON

A mustard-yellow glow is usually seen with zircons, but the glow can vary from a bright yellow to practically nothing. Care should be taken when testing the white and blue heat-treated zircons, for they tend to change colour (revert to their original brown shade) if kept for only a short time under the lamp.

### SPINEL

Red and pink spinels behave like rubies in that they show a crimson glow under ultra-violet rays. This can be observed by the " crossed-filter " technique. If the glow be examined by a spectroscope, the fluorescence spectrum will show a group of five or more bright lines, two of which are stronger than the others. This is unlike that of ruby, which shows one strong bright line with a diffuse red band on the side of shorter wavelength. This will clearly distinguish natural red spinel from ruby. The rarely met synthetic red spinels, however, show a single line somewhat reminiscent of the fluorescent spectrum of ruby.

Dark blue spinels are inert under ultra-violet light. The other colours of natural spinel are inert under the short-wave lamp, but the long-wave radiation produces various coloured glows. Pale mauve, pale blue and violet-blue spinels exhibit a green glow, while the deeper-coloured mauve and purple stones exhibit an orange or red fluorescence.

Colourless synthetic spinels do not luminesce with long-wave rays but usually show a bluish-white glow under the short-wave lamp. This strong white glow, usually masked by the body colour of the stone, is present in all colours of synthetic spinels. The exception is the pink synthetic spinels, which are inert, and the yellow and yellowish-green synthetic spinels, which fluoresce under all radiations a strong apple-green.

### OTHER STONES

Brown topaz shows an orange-yellow glow and kunzite a golden-pink or orange fluorescence. Peridots, tourmalines, garnets and quartz are usually inert under ultra-violet rays, and the rays have little diagnostic value in the case of opal, turquoise, lapis-lazuli and the jades.

The short-wave lamp is useful in the testing of moonstone, for the true moonstone shows a weak reddish-orange glow, while the " schillerized " synthetic spinel which is made to imitate it shows the typical bluish-white fluorescence. The " burnt amethyst " imitation is inert under this lamp.

Neither scheelite nor benitoite glow under the long-wave lamp, but both fluoresce with a blue colour under the short-wave lamp; thus benitoite can be readily distinguished from blue sapphires.

The whitish glow given off by pearls and cultured pearls under the ultra-violet lamps is insufficiently different for distinction to be made between them. By the " crossed-filter " technique natural black pearls can be distinguished by their reddish glow from black pearls which owe their colour to artificial staining, which do not glow.

Ordinary glass (paste) does not fluoresce under the long-wave lamp but may do so under short-wave rays. The glow then may be a misty pale green or a brightish blue. Here lies a danger, for this glow resembles that shown by the synthetic white spinels.

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*An English long-wave ultra-violet lamp, the ALLEN lamp, is a fluorescent tube lamp with twin tubes and has a separate filter attached to the removable cover.*

# LINES AND LINE SYSTEMS IN THE FLUORESCENCE SPECTRA OF DIAMOND

*By B. W. ANDERSON*

THE results of research on the already much-studied subject of diamond fluorescence continue to appear in the physical journals. Particularly valuable contributions have been the papers by Dyer and Matthews on " The Fluorescence of Diamond"; by Dean, Kennedy and Ralph on " Particle Excited Luminescence in Diamond " ; and by Ralph on " Radiation induced changes in the cathode luminescence spectra of natural diamonds ". These three papers(1,2,3) have brought to a conclusion a wide and fundamental survey of absorption and emission characteristics of natural and irradiated diamonds which has been carried out during the past five or six years by teams working at Reading University under Prof. R. W. Ditchburn, and at King's College, London, under the direction of Prof. F. C. Champion. Thanks to these and other workers we now know a great deal about diamond behaviour in these fields, but there is still much to learn.

The physicist, with the facilities of a large laboratory at his disposal, naturally works at low temperatures ( – 180°C) where the fluorescence spectra are both sharper and more intense than under ordinary conditions. He also employs spectrophotometer readings which are of course vastly more valuable for giving a true picture of events, not only in the visible but in the ultra-violet and infra-red regions, than the small hand spectroscopes used by gemmologists.

The purpose of the present article is to give a brief survey of the subject of luminescence phenomena, and particularly of line spectra, in diamond so far as these can be observed at room temperatures and with hand spectroscopes, and to record sharp line spectra in the yellow to red regions recently observed by the writer, which seem to warrant further investigation.

Early accounts of luminescence in diamond were nearly all purely descriptive and led to no fundamental conclusions. The wide variations in the colour and intensity of the fluorescent glow were put down to differing " impurities " in the stones or to their origination in different mines. In his researches on the phosphorescence of diamond and other minerals in 1859 E. Becquerel was ahead of his time(4). Credit also should be given to Sir William

Crookes who gives some interesting observations about the fluorescence (he calls it phosphorescence) of diamonds under cathode rays in his little book " Diamonds ". This was published in 1909; but the actual work was done over thirty years earlier. He mentions (pages 96 and 97) a green diamond with a strong greenish white fluorescence in which bright lines at 5370, 5130 and 5030Å could be seen. These wavelengths agree very closely with measurements made in more recent years. Crookes also writes of diamonds which phosphoresce red and " show the yellow sodium line on a continuous spectrum ", and of a Brazilian diamond with a bright reddish-yellow phosphorescence in which he " detected the citron line of yttrium ".

This statement, though fallacious, is highly interesting. Miss A. Mani(5) describes a strong emission line at 5895Å shown by one of the diamonds used in her work, and as this is virtually identical with the position of the famous sodium doublet, it was almost certainly this line which Crookes observed. As for the " citron line of yttrium ", it is on record that this was the name given by Crookes to a line actually due to dysprosium, at wavelength 5740Å. This is very close to the sharp line at 5750Å which will receive frequent mention later in this paper.

It was not until the early nineteen forties that certain basic patterns were recognized, which enabled some sort of law and order to be introduced into the apparently chaotic fluorescent behaviour of diamonds under the stimulus of ultra-violet light and other radiations.

In particular, the existence of two main emission systems, one in the blue, based on a line at 4155Å, and the other in the green, based on a line at 5040Å, was established. These important lines can appear either as absorption or emission (fluorescence) lines, and, as Miss Mani showed, they represent the heads of a series of bands spaced at nearly equal frequency or energy intervals—an absorption series lying on the short-wave side, and emission on the long-wave side, of the main " hinge " positions. There is in fact a remarkable " mirror image " symmetry between the emission and absorption peaks on either side of the key positions. The vast majority of Type I diamonds show both these systems in fluorescence though greatly differing in absolute and relative strength.

The presence of a yellow-green component even in diamonds which apparently display a pure blue fluorescence is revealed by the appearance of a yellowish after-glow when the stone is removed from the rays which excite the fluorescence. As Becquerel found, the blue component disappears almost instantly, but it remains " locked in " at room temperatures. It is released when the stone is heated as the so-called " thermo-phosphorescence ". A neat way of showing this is to pre-heat the specimen gently (conveniently in the flame of a small spirit lamp) before placing it under the rays. When removed from the rays while still sufficiently hot the stone will continue to glow with a *blue* colour. Experiments carried out by the writer showed that the temperature of boiling water (100°C) is insufficient to display this effect, but that it can be demonstrated clearly if the stone is heated to 200°C. That *all* blue fluorescing diamonds show a yellowish phosphorescence is one of the few invariable facts in a complex field of phenomena and a very practical aid in the identification of the mineral.

With many diamonds the green component is strong enough to impart a greenish tinge to the fluorescent colour, and in other cases patches of green may be seen against the blue background of the remaining parts of the stone. More rarely, the fluorescence appears to be entirely green or greenish-yellow in tint. Such stones include brown diamonds and also stones of a curious vaseline colour: an appearance which is due to the strong yellow-green fluorescence which is induced even by ordinary daylight. In green-fluorescing stones the key band at 5040 can usually be detected in a hand spectroscope, both in absorption, as a rather faint narrow line (often accompanied by another line at 4980), and as an emission line when the stone is fluorescing. Similarly in strongly blue fluorescent diamonds, the key band at 4155 can be seen, and less distinctly other bands on the long-wave side of this. Approximate measurements for these bands, made with a Beck " Wavelength " spectroscope, gave readings of 4285, 4390, 4520, and 4670Å. The latter two bands were hardly distinguishable from the general background of continuous emission in this region. There are also true " canary " yellow diamonds, which have a clear yellow fluorescence and no observable discrete lines either in emission or absorption, at least at room temperatures. Diamonds of this type which have been examined by the writer have shown the ultra-violet transmission of Type II diamonds.

In addition to the now well-established blue and green components, it has long been realized that other regions of fluorescence extending to the red end of the spectrum exist in certain diamonds, but no satisfactory scheme of mirror-image fluorescence and absorption bands hinged on a key wavelength has yet been observed or agreed upon for this region.

Stones emitting a notable red component can be picked out with ease from any sample of diamonds under long-wave (3650Å) ultra-violet light, or even under " copper sulphate " light, simply by viewing them through a good red filter, when the few stones showing the effect will seem to emit a red glow while the other stones will cease to show any visible fluorescence. Diamonds of this type have particularly interested the writer since his discovery of a type of pink diamonds showing an orange-yellow glow under ultra-violet and other rays—a fluorescence which could be analysed through a hand spectroscope into a well marked series of lines headed by a prominent member at 5750Å. The first stones of this type to be observed were a large (34·64 carats) diamond, almost certainly a Golconda stone, and a smaller (2·83 carats) specimen, both distinctly pink in colour. These were described in a previous article in this Journal(7). More recently a further gem diamond of over 20 carats has been examined, which showed a precisely similar fluorescence spectrum. This stone was also pink, though very pale in tint. The emission lines were not quite so pronounced as those previously reported in the 34 carat pink diamond, but were sufficiently clear to yield a reasonably good photograph, as can be seen from Fig. 1, where a mercury arc spectrum taken on the same plate serves as a

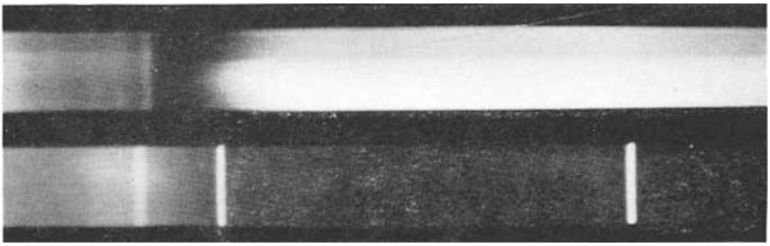

FIG. 1. (*a*) *Fluorescence spectrum of Type IIa pink diamond under light filtered through copper sulphate solution. Ilford H.P.3 plate, 40 minutes exposure.*

(*b*) *Mercury fluorescent tube spectrum for comparison.*

wavelength guide. This was taken with a small quartz spectrograph on an Ilford HP3 plate. The stone was bathed in blue light concentrated through a flask containing copper sulphate solution, the source being a 250 watt projection lamp, and the exposure time 50 minutes. A photograph taken under similar conditions with the 34 carat diamond but under 3650Å ultra-violet light, is also reproduced for comparison (Fig. 2).

A notable feature of all three of the pink diamonds mentioned was that the same orange-yellow fluorescence was produced under all available forms of radiation: visible blue light, long ultra-violet and short-wave ultra-violet rays, and even X-rays. Another notable feature was a persistent phosphorescence of the same colour. Tests showed these stones to be of the Type II category at least so far as ultra-violet transmission is concerned.

Pink diamonds of any kind, let alone of this particular type, are rarely seen in our Laboratory and not easily borrowed, but it was thought worth while to sort through parcels of " ordinary " diamonds, to see whether any could be found which showed at least the 5750 emission line in similar manner. A parcel of fair quality industrial stones from Sierra Leone, were kindly made available for this purpose by the West African Selection Trust. Of the 208 stones examined, 19 were picked out as having a strong blue fluorescence under ultra-violet light; 22 stones showed a rather weaker blue glow; 28 a dull blue; while there were 27 stones in which the fluorescence was green or yellow. The emission spectrum of those stones from the above categories which showed a

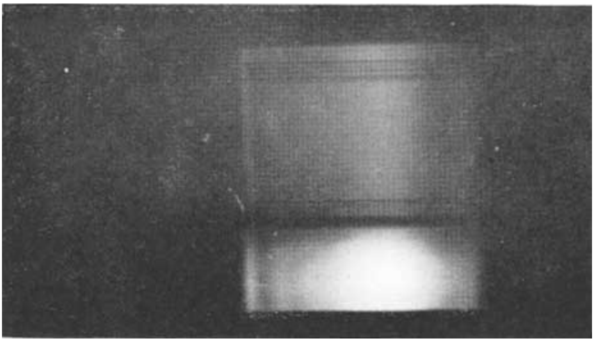

FIG. 2. *Fluorescence spectrum of large pink Type IIa diamond, under 3650Å light. Ilford H.P.3 plate, 50 minutes exposure.*

residual glow through a red filter was then closely examined through a direct vision prism spectroscope, both under " copper sulphate " visible light, and under a large Hanovia mercury lamp with Wood's glass filter.

The quest was surprisingly successful; no fewer than 8 stones showing the 5750 line feebly but very clearly. Four of these stones were from the strong blue fluorescers, two from the weaker blues, and two from the greens. In some cases, and unexpectedly, a bright line at 5370Å was seen in addition to the 5750 and this was equally sharp and clear. An absorption line at 5370Å had several times been observed in the past in brown diamonds, which also showed the 5040 and 4980 lines, but to see it as an emission line and in conjunction with the 5750 line, which is the head of a series extending into the orange, was indeed surprising.

A warning is necessary to anyone seeking these lines under a mercury source of ultra-violet light, or in a room illuminated by fluorescent lighting which emits a mercury spectrum. It so happens that the powerful yellow doublet at 5791 and 5770Å emitted by a mercury arc and the mercury green line at 5461 are very near to these emission lines in diamond, and any leakage of unfiltered mercury light can be reflected from the stone under examination and give any observer with a hand spectroscope a precisely similar effect. This points to one great advantage in using the less conventional and less powerful stimulus of visible tungsten filament light filtered through a flask of copper sulphate solution, since any bright lines seen with this as the only illuminant can, of course, come only from the feeble luminescent light emitted by the diamond.

A further parcel of industrial diamonds, in this case from Ghana, was later loaned for examination by the West African Selection Trust. The search for stones showing the 5750Å emission line was again successful, though in this instance only one example was found to show the effect, and this only under the stimulus of blue-violet " copper sulphate " light. The fluorescence of this stone under long-wave ultra-violet was blue. A third parcel, in this instance comprising well-formed crystals of " silver cape " quality from S.W. Africa, was kindly made available to the writer by Mr. Arpad Nagy, inventor of the revolutionary " Princess Cut " for diamond. Here again only one stone of those examined was found to show the yellow line. Further search with diamonds from other localities and of different qualities will be carried out as time and opportunity permit.

The writer's first experience of the 5750 line had been in 1957 with one of the stones from a parcel of small brown diamonds which owed their colour to bombardment and subsequent annealing. All these stones showed the tell-tale 5920 absorption line (which Dugdale(8) and later Crowningshield(9) found to be typical of treated diamonds) very clearly, but the specimen mentioned was exceptional in displaying an orange fluorescence under 3650Å ultra-violet rays, and under " copper sulphate " light. G. R. Crowningshield and Dr. Edward Gübelin, who are both skilled spectroscopists and vitally interested in diamond fluorescence, have independently observed an orange fluorescence and the presence of the 5750 line in certain bombarded diamonds—particularly in a few stones of pinkish tint which occasionally crop up as " freak " stones. One such stone was sent to the writer by Mr. Crowningshield and later kindly presented to me by Mr. Theodore Moed, an American supplier of treated diamonds. This stone showed a remarkable spectrum with a sharp absorption line at 6360Å, a weaker absorption doublet centred at 6170, and the 5920 line. Under " copper sulphate " light the 5750 emission line is clear, and 4 or 5 weaker lines of the series are visible.

In the paper by Dean, Kennedy and Ralph on " particle excited " luminescence in diamond, to which reference has already been made, the appearance of a yellow " system " having a principal line at 5755Å is described in detail. The other wavelengths given by these authors for lines in this series are 5870, 5980, and 6170Å. Undoubtedly this is the same system as that seen by the writer in the three pink diamonds mentioned above and photographed in Figs. 1 and 2. But it must be remarked that Dean and his co-workers were using not ultra-violet or blue-violet light, but cathode-ray excitation. In fact Ralph in his further paper states that the 5755 system has not been reported where ultra-violet or X-rays were employed. Further, the lines were recorded by these workers at the low temperature of - 180°C at which both the intensity and sharpness of fluorescence lines is known to be far greater than at normal temperatures. Thus the appearance of really sharp emission lines at 5750 and 5370Å under violet and ultra-violet light at room temperatures seems decidedly noteworthy.

The fluorescent behaviour of five of the Sierra Leone diamonds is summarized below in tabular form.

| *Stone* | *Carats* | *Under* $CuSO_4$ | *Under* 3650Å | *Under* 2537Å | *Trans.* |
|---|---|---|---|---|---|
| A | 1·57 | 5750<br>5370 sharp | Greenish<br>5750<br>5370 clear | Greenish | 2600Å |
| B | 2·03 | 5750 only | Dull bluish<br>5750 weak | Weak blue | 2400 |
| C | 1·25 | 5750 only | Strong blue<br>5750 only | Strong blue | 2400 |
| D | 1·52 | 5750 only | Mod. blue<br>5750<br>5370 clear | Mod. blue | 2400 |
| E | 1·36 | 5750 only | Dull blue<br>5750<br>5370 | Mod. blue | 2400 |

Table showing fluorescent behaviour under various radiations, and transparency to ultra-violet of five Sierra Leone industrial diamonds.

In their paper, Dyer and Matthews describe yet another series of narrow bands, in this case in the orange-red, which they found in the emission spectrum of certain Type I diamonds in addition to the far stronger blue and green emission systems. These emission " peaks " could only be recorded at liquid air temperatures. The four bands measured formed a true " system " based on wavelength 6195Å, with others at 6291, 6363, and 6494Å. Incidentally, Miss Mani recorded emission bands at 6177, 6265 and 6358Å which may refer to the first three just mentioned, but she did not envisage them as a separate series. She also referred to an emission band at 5758, giving it as part of the 5040 group. Dyer and Matthews also table a band at 5758Å as found, unassociated with any system, in some Type II diamonds.

There are records of lines still further into the red, e.g. bands at 7250 and 8000Å, found by Dean, Kennedy and Ralph in diamonds excited by cathode rays. The writer has seen undoubted " structure " effects in the deep red with certain fluorescing diamonds, but has been quite unable to measure these, as they occur in a region of very low visual acuity.

Another worker who has recently discovered sharp lines in the emission spectrum of an orange-fluorescing diamond, is A. Jayaraman of the Raman Research Institute in Bangalore. It was from this Institute that a rich flow of papers on diamond behaviour issued during the nineteen forties. Jayaraman describes(10) a series with its principal line at 5786·27Å (recorded at − 180°C). The decimal places imply great accuracy of measurement, but if, as seems almost certain, Jayaraman is referring to the same line as that we have recorded as 5750 and Dean *et alii* as 5755Å, so great a discrepancy in the estimate of wavelength is extremely puzzling. Even a glance at the spectra reproduced in Fig. 1 will show that the strongest luminescence line is on the shorter wavelength side of the mercury doublet at 5791 and 5770Å. Jayaraman was working with long-wave ultra-violet light and at liquid air temperatures. In addition to the 5786 series, he found other " new electronic emissions " at 4958 and 5106Å, and bands associated with these.

By rather a strange coincidence yet another reference to orange fluorescence in diamond has recently appeared in the literature. This is in a paper by a Czech scientist, J. Koursinsky, summarized in Mineralogical Abstracts, and describes a study of the fluorescence of 8949 diamonds from a Museum collection. Only one stone, Koursinsky states, showed an orange fluorescence, and this was a reputedly Bohemian diamond. He speculates whether the unusual fluorescence is a unique sign for a Bohemian stone. No spectral analysis of this orange glow was apparently attempted. It would be interesting to know if the stone was a 5750Å emitter.

Before concluding, the writer would like to record the curious luminescent behaviour of a pale steely-blue diamond, examined rather more than a year ago. This was mounted in a ring, and weighed about 3 carats. The stone proved to be semi-conductive, though to only a slight degree, and it transmitted ultra-violet light down to slightly below 2300Å. On this basis, and on account of its natural bluish colour, it could be claimed as one of Dr. Custers' Type IIb diamonds. The stone showed no noticeable fluorescence under either long or short wave ultra-violet light, but, in place of the usual blue phosphorescence usually shown by this type of diamond after exposure to short-wave light, this specimen showed a dull but persistent orange glow not only after this form of excitation, but after stimulation by long-wave ultra-violet and even by visible light.

Phosphorescence of any diamond, no matter of what category, after exposure to visible tungsten light is so unusual that experiments were carried out with light from a 500-watt projection lamp passed through a series of colour-filters, to ascertain which regions of the spectrum functioned as the most vigorous stimulus for the orange after-glow. The stone was exposed in turn to red, orange, yellow, blue, and 3650Å light for ten seconds, then, after a pause of twenty seconds, placed for 20 seconds in contact with an Ilford LRS plate. There was a long interval between each experiment to allow the phosphorescence to die down completely between each test. The plate was finally developed, and a print from this is reproduced as Fig. 3. It would appear from this that yellow light was the most productive of the phosphorescence, but the test is not very exact, since the yellow filter used transmits from the green onwards. As can be seen, the result under red light is very slight; nevertheless, to obtain any effect at all with light of such low energy (the filter cuts out at 6100Å) was sufficiently astonishing.

This grey-blue stone showed an orange fluorescence under X-rays, but this was not strong, and no line structure could be seen through the spectroscope.

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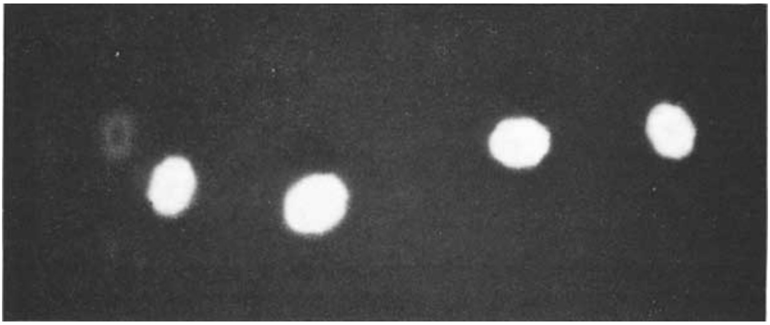


FIG. 3. *Autophotographs of orange-red phosphorescence of Type IIb grey-blue diamond on Ilford LRS plate, 20 secs contact after 10 secs. exposure to (reading from left) red, orange, yellow, blue, and 3650Å light.*

# Gemmological Notes

## TESTING WITHOUT INSTRUMENTS

A. E. Farn

During my six years' war service I was often sent on courses and lectures and returned to my unit aglow with enthusiasm and eager to dispense instructions. Nothing was more calculated to deflate one's buoyancy than the well-worn phrase so beloved of our Sergeant Instructor, " You can forget all that stuff they taught you on the course—you'll do it our way ".

Somewhat similar I think must be the feelings of the new F.G.A.'s as they emerge from their second year course. Their exams. behind them and the whole gemmological world at their feet, they enter the post-diploma course prepared for a leisurely approach to a much wider range of stones and to enjoy unalloyed wallowing amidst paraphernalia gemmological ad nauseam. How deflating then to find that one of the first lectures is entitled " Gem Testing Without Instruments "—almost as if to say to the budding F.G.A. " now forget all that practical work you have done, we'll show you just how unnecessary instruments really are". Though this is in fact true in part, it is only true because of the knowledge and practice gained at classes.

We do not discount those useful instruments, the microscope, refractometer and spectroscope; they are an essential to all round gem testing. The lecture usually takes one along the paths of logical conclusions based on knowledge and aided by observations with a lens. " An example of such testing is to examine a piece of lapis-lazuli with a lens—this is testing without instruments on a fairly easy basis ". Most people probably know their lapis-lazuli before they start classes. There are of course very many obvious examples which could be quoted of gems which can be identified by use of a lens without recourse to other instruments. However, this ability to test in such a manner rests solely upon a good technical training backed by sound theory.

I do not intend to reproduce here the substance of the third year lecture except to say that in it is a vast store of accumulated knowledge which would make a most useful adjunct to the rule of thumb knowledge and practice of jewellery dealers.

It is a very nice feeling to buy a garnet-set brooch at a garnet price knowing that the red stones happen to be Siam rubies. This I have experienced once or twice; it is a most rewarding feeling. This is gemmology with a plus !

Quite recently I was looking in a shop window fairly liberally dressed with interesting secondhand items of jewellery. Trying to assess their respective merits with a view to making a purchase, I was intrigued to see an obviously antique half-pearl cluster ring flanked by two small rubies with a square colourless centre stone. This centre stone looked wrong—it should have been a red stone of some kind. Peering through the window at the stone I was able to see by judiciously craning my neck the reflection of a lamp bulb used in the window illuminations. The table facet of this square stone was fairly small but had a polish which gave a perfect reflection of the word " OSRAM ". Re-focusing on a shelf bracket above I was able to bring this straight edge into my line of vision as a reflection on the table facet and slowly move my eye, causing the reflected edge to travel across the polished surface of the stone. This it did with razor sharpness and precision and not a trace of wobble anywhere. I knew that only diamond could give such plane-perfect reflection, so I went in and bought it, and subsequently sold it at a profit. This sort of thing gives a fillip to more mundane testing.

## RHODESIAN ALEXANDRITE

JOHN PROBUS

Well-formed crystals of alexandrite, though not of gem quality, have been found near Fort Victoria, Southern Rhodesia. The crystals are very dark in colour but a colour-change is apparent in many of them. The occurrence is in a grey mica schist.

## SYNTHETIC EMERALD

JOHN PROBUS

In the U.S.A. and Canada the recently produced synthetic emerald-coated beryl (a thin coating of synthetic emerald grown onto a faceted core of natural beryl) is being sold as Linde synthetic emerald. Thus the gemmological nomenclature tends to become more ambiguous.

## COVER IMMERSION OBSERVATION

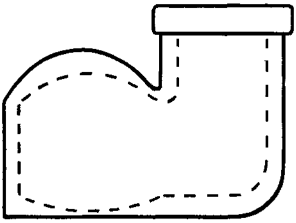
S. BUZALEWICZ.

Observation of the interior of a stone requires its immersion in a suitable fluid. During microscopical observation the immersion fluid usually remains in an open glass, which creates difficulties and inconvenience in the keeping of the fluid suitable for microscopical observation, and during the observation itself. The shape of usual immersion containers requires the immersion fluid to be kept in a closed bottle. Before microscopical observation the immersion glass must be cleaned, and during observation the surface of the fluid remains exposed and can become dirty by dust from the air. The surface of the fluid moves (especially by the turning during the microscopical observation for the optical birefringence of the stone), sometimes causing distortion of the image of the immersed stone. During manipulation of the microscope tube there arises a possibility of touching the liquid with the objective of the microscope, thus making it dirty by the oily immersion fluid. After observation the immersion fluid must be poured back into the bottle, and the glass, after cleaning, should be placed in a box. Such slow manipulation requires laboratory facilities and can scarcely be successfully applied in usual trade conditions.

Application of this important gemmological test in commercial practice could be made easier by cover immersion. This relies upon observation of a stone which has been immersed in a specially designed glass container. This container has on one side a long neck closed by an outside screw. This glass is always filled with an immersion fluid and kept in a dark shakesafe box, ready for immediate use. The upper wall of the immersion glass when not plain but curved acts as a lens. The base of the cell consists of a convex lens inside and is flat at the base. Use of the lens as the bottom of the immersion cell gives two advantages; the greatest transparency of the glass and the hollow for the stone in the centre of the field of view. Use of the lens in the upper part of the immersion cell gives also greatest transparency of the glass and forms the curvature of the fluid surface for the purpose of increasing the image of the viewed stone. By putting the stone in the cover immersion cell it falls into the hollow in the centre of the bottom and remains in this central position of the field of view during rotation of the cell. It is obvious that the turning around of the cell must be made so that the centre of the viewing part of the cover immersion cell remains always in the field of view of the microscope. The manipulation with the stone in the cover immersion cell can be done by means of curved stone tongs, by which the stone can be turned on the bottom, raised from the bottom and turned inside the cover immersion cell in the same manner as in the open immersion cell.

Cover immersion observation needs little preparation. The cover immersion observation can be carried out in closed glass (opened only a short time during the putting in and taking out of the stone and during change of the position of the stone in the immersion liquid), thus the liquid remains clean and safeguarded from the dust from the air. Any dust would rise to the surface of the immersion liquid in the neck of the glass and not in the field of view of an observed stone. The liquid surface does not move during the turning of the glass and the microscope objective is prevented from occasional touching of the liquid. The high neck of the glass makes a reservoir of fluid enabling observation of a great number of stones without the need of adding new fluid. It also makes unnecessary any portable reservoir bottle and of pouring in and out of the immersion fluid.

Cover immersion enables observation of the interior of a stone, pleochroism, birefringence and colour, with the application of optical filters, and light can be focused parallel, and be dispersed, from below, from the side or from above. It allows also the simultaneous approximate testing of specific gravity of the tested stone by means of a stone's behaviour in the neck of the glass fluid.



## NEW JEWELLERY CLEANER

A new cleaner, named " Jewellax ", has been developed primarily for the jewellery trade and provides an effective means of removing dirt and residual polishing composition from filigree work and gem settings.

" Jewellax " is supplied in small bottles of convenient size and is in the nature of a syrupy concentrate which is diluted in the proportion of one part to thirty parts of water before use.

The jewellery or other articles are immersed in the cleaning solution, which is maintained at a temperature of 180° to 200°F and may be contained in any suitable vessel such as a plain steel tank or vitreous enamelled utensil.

A few minutes soaking in the hot cleaner usually suffices to remove soil and impacted polishing composition without recourse to mechanical means. Gentle movement of the articles assists the operation and light brushing is only essential in the most stubborn cases.

Applications other than for jewellery include the cleaning of instruments parts and other small components with indentations, perforations or serrations, in which polishing residues tend to be retained. " Jewellax " is packed in 4 oz. bottles, price 7s. 6d. and is marketed by W. Canning & Co. Ltd., Birmingham.

## HILLS OF GOLD

G. A. White

This is the name sometimes given to the Harlech Dome which lies between the Mawddach estuary and the vale of Ffestiniog in North Wales. Geologically this consists of a dome of Cambrian strata, the top having been eroded away, and mineralization occurred on the margins of the dome in the Vale of Ffestiniog on the north, and the Dolgelley gold belt on the south side.

At various points in the region, notably Clogau St. Davids, Gwynfynydd, Prince Edward and Graigwen, gold has been mined for many centuries from the N.E.–S.W. lodes, some would even suggest since Roman times.

The presence of the " Roman steps " is possibly evidence of the gold traffic from the Trawsfynydd area to the former port at Harlech Castle. Evidence exists of the discovery of gold in 1843 and mining operations well established by 1850, operations proceeding in the hills north of the Mawddach estuary between Barmouth and Dolgelley.

The Clogan Gold Company reached a peak of production in 1872 with £30,000 of metal, but this was greatly reduced by 1900.

The Royal family have for many years had wedding rings made from the gold of this area.

Gold bearing quartz veins are still to be located in this district, particularly where Clogau shale bands are found embedded in the quartz reef. Spasmodic mining has been proceeding for the past thirty years as shown by production figures for Merioneth below:—

| | | |
|---|---|---|
| 1844 – 1865 | ... | 13,600 ozs. |
| 1866 – 1907 | ... | 104,600 ozs. |
| 1908 – 1957 | ... | 9,900 ozs. |

# BOOK REVIEW

PARSONS, CHARLES J., C.G., F.G.A., and SOUKUP, EDWARD J., G.G., F.G.A. *Handbook of Gems and Gemology.* 168 pp., illustrated, paperback. $3.00. Gembooks, Mentone, Calif., U.S.A., 1961.

A most useful book for the amateur rockhound, lapidary and gem collector. It is well written and contains sufficient detail for the hobbyist to gain a general idea about identifying gemstones and gem materials. Gem testing instruments are also described. It is pleasing to see that reference is made to incorrect descriptions which are given to some gemstones. The book is well illustrated with over 200 drawings and photographs.

H.W.

# ASSOCIATION NOTICES

## GIFTS TO THE ASSOCIATION

The Association is indebted to Mr. Stephan Barczinski, F.G.A., of Rio de Janeiro, for specimens of tourmaline, beryl and a synthetic emerald-coated beryl.

## REUNION OF MEMBERS AND PRESENTATION OF AWARDS

With four of the first Tully medallists present at this year's well attended annual reunion and with another Tully medallist presenting the awards the gathering at the Goldsmiths' Hall on 4th December was of a somewhat special nature. This was shown, moreover, by the fact that to be present at it, prize-winners had travelled from Glasgow and Guernsey, Paris and Taunton.

In the absence of the chairman owing to ill health, Mr. Norman Harper, Vice-Chairman, welcomed members to the newly decorated but 125 years old Hall. For many of them that evening represented the culmination of two years of hard study, but he stressed that gemmology was a continuing science. They would be able to learn more and, he hoped, contribute more in the years ahead.

They had 182 entrants in the Preliminary examination, the second highest figure in the history of the Association, and 123 passed. In the finals there were 105 entries with 65 passes. The Tully Medal, won by a Finnish student last year, was not awarded this year, but the Rayner prize had gone to a Canadian.

He was glad to be able to welcome Mr. Herbert Tillander, President of the Gemmological Society of Finland, who won the medal in 1935, who was visiting them again with his wife. Mr. Tillander had done much to encourage the study of gemmology in Finland and the Finnish Association had enriched the Association's collection of minerals by the gift he made at a gemmological conference held in Milan.

After presenting the awards to the successful candidates, Mr. Tillander said:

" I very much appreciate having been invited by the Gemmological Association, of which I am a overseas member—a hybrid, part jeweller—part devotee—part scientist, in other words a typical F.G.A.

" It is a great honour to be asked to present the awards, but all the credit is due to the affiliated group of gemmologists in Finland, which apparently is considered to have made a good start.

" I congratulate those who have gained awards and sympathize with those who have unfortunately for some reason not been successful, but have at least acquainted themselves well with the subject. Since the standard of the diploma examination is very high and since few students are able to devote more than their spare time for study, there is no question about it being a real achievement to qualify for a diploma. It could be said without much exaggeration that a normal student has less chance to pass than to fail. In some cases, also, factors outside the control of the student may have disturbed the normal rhythm of studies and practice in gemtesting. It really needs enthusiasm and sacrifice of time during two long years and a very good head for study to pass the examination with distinction.

" There is a tendency among some members of various gemmological associations to strive after recognition after a short time as gem experts by the public and even the courts of justice. A very dangerous ambition indeed, since theoretical knowledge must be coupled with long experience in the trade and constant handling of such gems that have to be competently tested and appraised. The only men who can distinguish the subtle differences between the various degrees of perfection in exceptionally fine gems, be it diamonds, pearls, rubies, sapphires, emeralds, alexandrites, or cat's-eyes are those who constantly are engaged in the business of buying and selling such treasures. It may often be difficult for the average gemmologist to find such a specialist and perhaps as difficult to get his honest opinion, since he may be interested to acquire such stones below their market value. It may therefore be necessary even for the very proficient gemmologist to deny himself the pleasure of a statement and recommend the appropriate colleague for the particular case, even though he may not yet be holder of a gemmological diploma.

" Most of you need constant practice with gems in order to know them better and this is now possible without the strain of an examination ahead of you. I am sure you will get very much pleasure and satisfaction from such a study.

" You will all have to keep well informed about new developments in the gemmological field in order to remain up to date. Many of you have, perhaps, the intention to build up a small laboratory of your own—in such case remember there are also other and perhaps for your needs more suitable instruments than those used during studies. You can find such described in earlier issues of gemmological periodicals, some may be of foreign make, some you may even be able to build yourself.

" The diploma alone does not make you an expert. In every profession, in every science and even in your hobby you are more or less a beginner when you have received your diploma, but you have all the qualifications to achieve the reputation of a real expert if you proceed. The jewellery trade in the world needs people with a scientific gemmological training and it must be noted with much satisfaction that through voluntary work the number of gemmologists is constantly growing. A great number of these gemmologists are associated with the trade and their theoretical knowledge and its application, particularly in the retail trade, must help a great deal to improve the reputation of the jeweller.

" Modern man wants to spend his surplus cash on things he is interested in and believes he understands. This is why intelligent presentation of gems have become more and more a necessity. And finally, since I am here to-night representing the Gemmological Society of Finland, you may expect to learn some details about the activities of this association. The first group of 12 diploma students sat for their examination in spring 1960. One of them only failed, seven qualified, three qualified with distinction and one gained the Tully medal. Everyone of the 11 who qualified applied for membership as an F.G.A. and as a research member of the Finnish association. This means an obligation to do research work on some particular subject and read a paper at one of the monthly gatherings of the group. We have now 17 research members who are all doing post-diploma work and prepare to read the results when their turn comes. The diploma holders are also engaged in the training of new students and fairly busy as lecturers at various public occasions as well as writers on gemmological subjects for newspapers and magazines. In a small country like Finland with only 4½ million inhabitants the gemmological influence on the trade has already been marked."

The Treasurer of the Association, Mr. F. E. Lawson Clarke, in thanking Mr. Tillander, said:

" I would like to express our warmest thanks to you for especially coming to London to present the Awards this evening, and we are delighted that Mrs. Tillander has come with you.

" To undertake the journey from Helsinki to London is some measure of Mr. Tillander's interest and enthusiasm, for gemmological affairs. So is the fact that it is Mr. Tillander and his colleague Mrs. Mikkola, who are responsible for a great deal of the enthusiasm that is shown for gemmology in Finland.

" Mr. Tillander is a leading Finnish Jeweller, and has successfully applied his knowledge of gemmology to his business. Retail gemmologists in this country could well take a leaf out of his book, and benefit their business by making more use of their specialized scientific knowledge of gem stones. They would find a great interest displayed by their customers in this aspect of the jewellery trade, and one worth cultivating.

" From my own experience in retail business I have found that many of my customers are quite ignorant about gem stones, but at the same time they are hungry for knowledge, and most grateful for any carefully chosen information that is given them. Retail gemmologists can serve their own interests, and the interests of the trade as a whole, very well, if they make it a part of their business philosophy to propagate their expert knowledge about gem stones.

" There is one thing that the retail gemmologist must guard against —he must never attempt to blind his customer with science. A very nice discretion must be exercised when imparting scientific knowledge to the buying public.

" But, it is quite a different question between gemmologists themselves— while there is simply no point in trying to blind each other with science, there is everything to be said for the exchange of ideas and the results of research, not only within the bounds of our own countries, but more important that we interchange these ideas, and these results, on an international basis.

" The overseas entries for the examinations are always strong. We have entries from all over the world, from Los Angeles to Hong Kong, and this year, for the first time, from behind the Iron Curtain. The standard set by the examiners is a very high one, and the results of the examination are excellent indeed. I would say that the candidates well deserved their awards—they certainly had to work hard for them, and those who did not win awards, deserve praise and mention for the same reason.

" Mr. Tillander I feel, is, a shining example of all the qualities to be looked for in a gemmologist. When he arrived in London, he called to see me at business, and before leaving, said in his droll way " The nicest visitors stay the shortest time". How true that is of him, his flying visit to London is so short, that by that standard he must be the nicest sort of visitor.

" On behalf of the Gemmological Association, I would, again like to thank him, for specially coming to present this year's Awards, and Mrs. Tillander, for gracing this occasion so charmingly."

## COUNCIL MEETING

A meeting of the Council of the Association was held at Saint Dunstan's House, London, E.C.2, on 4th December, 1961. Mr. N. A. Harper, Vice-Chairman, presided in the absence of the Chairman who was indisposed.

The following were elected.

### FELLOWSHIP

Aarne, Eino L., Helsinki, Finland
Agius, Frank J., Sliema, Malta
Ainsworth, Kenneth J., Blackburn
Allen, Michael H., Ilford
Axon-Ryder, Albert R., Bolton
Bacon, Frank H., Bedford
Badrutt, Reto, J. P., Geneva, Switzerland
Beasley, Barbara A., Windsor
Bills, Raymond F., Solihull
Butler, William C. F., Paisley
Francis, Roger, Birmingham
Greeph, Mayer, Manchester
Harrold, David J., Southend-on-Sea
Hayes, Denis, London
Heesom, Thomas H., Altrincham
Hill, Dennis A., Glasgow.
Hiscox, Sieglinde E., Solihull
Jean, Wilmer F., Dallas, Texas, U.S.A.
Joseph, Timothy R., Knowle
Kaksonen, Yrjo E., Helsinki, Finland
King, Archibald V., Edinburgh
Lusty, Kenneth C., London
Morris, Clive R., London
Musaeus, Hans B., Oslo, Norway
Price, Denis E., Smethwick
Rouvier, Andre E., London
Rowe, Alan D., East Molesey
Sanford, Peter, Hatfield
Siltanen, Ismo K., Jyvaskyla, Finland
Silva, Edward H. L. de, Negombo, Ceylon
Sloman, Peter, Southend-on-Sea
Snaddon, James, Sale
Stirton, Kenneth G., Ripon
Stout, Cornelis A., Rotterdam, Holland
Sundqvist, Arvo J., Helsinki, Finland
Synan, Martin T., Slough
Webb, Herbert H., London
Whitehead, Bernard, Sunderland
Wiik, Viggo H., Oslo, Norway

### ORDINARY MEMBERSHIP

Catulle, Marcel, Brussels, Belgium
Dambrink, K. W., Apeldoorn, Netherlands
Kan, Noah, Hong Kong
Milito, John T., Toronto, Canada
Pandurangiah, V., Madras, India
Sanz de Madrid, Miguel A., Barcelona, Spain
Nickolds, Ann M., London
Parsons, Joan, Harrow
Tomes, Simon C., High Wycombe
Scholl, Werner, Zollikerberg, Switzerland
Selvon, Dennis R., Woodford Green
Silverberg, Lily (Miss), Pretoria, S. Africa
Wyer, Philip G., Birmingham

### PROBATIONARY MEMBERSHIP

Blake, Robert, Tilbury
Blatter, Robert, Toronto, Ontario, Canada
Fowler, Barry Richard, Dundee
MacKenzie, Iain F., Manchester
Mayhew, Coral J., Salisbury, S. Rhodesia

The Council agreed the fees to be paid by instructors in the U.K. who wished to acquire the correspondence course papers and set up a committee to consider the improvement and development of gemmological instruments.

It was also agreed that the 1963 Herbert Smith Memorial Lecture should be held in Birmingham.

## TALKS BY MEMBERS

CAFFELL, E. W.: " Gemstones ", Wokingham Townswomen's Guild, 17th October, and Cobham Young Wives Group, 18th October, 1961.

BLYTHE, G. A.: " More about gems ", South East Essex Natural History Society, 19th October, 1961.

DONN, L.: " Gemstones", Prestwich and Whitefield Ladies' Circle, 18th September, 1961.

BETTS, G. N.: " Precious stones ", Bradford Tory Society, 4th September; " Gemstones ", Allerton Young Conservatives, Bradford, 22nd September; Haworth Road Methodist Guild, 11th October; R.N.L.I. Guild Luncheon Club, 12th October; Moor Allerton Luncheon Club, Leeds, 12th October; Bingley Parish Church Young Wives Club, 8th November; Elland Young Conservatives, 13th November; "Jewellery ", Carr Manor Townswomen's Guild, 6th December; " Gemstones ", Brighouse N.S.P.C.C. Ladies' Luncheon Club, 7th December; Cleckheaton Women's Luncheon Club, 12th December, 1961.

WELLER, G. T.: " Gemstones ", Hawkenbury Church Young Wives' Club, 18th October, 1961.

## 1961 EXAMINATIONS

In the October, 1961, issue of the journal the name of Mr. W. E. Cooper (Stockport) appeared incorrectly in the examination results as W. E. Conyers, and the name of Mr. B. Conyers (London) was inadvertently omitted from the list of those who qualified in the Diploma Examination.

## AWARD OF TULLY MEDAL

After the 1961 presentation of awards the examiners drew attention to what appeared to be a misunderstanding of their recommendations regarding the award of the Tully Medal. In confirming that, in fact, the medal should be given to Mr. Laurie Wallington, Scarborough, Ontario, Canada, they emphasised that the high standard required for this success had been attained. In view of the report to the contrary, that was made at the presentation, the Council is particularly gratified that the misunderstanding has been cleared up.

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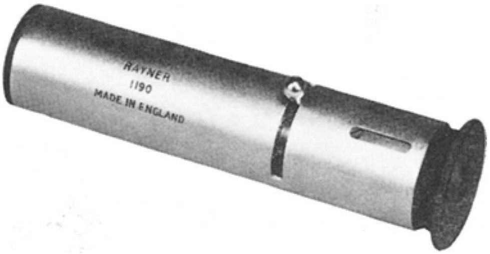

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# CONTENTS

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