Vol. VI No. 6 APRIL, 1958

THE JOURNAL OF GEMMOLOGY

and

PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN
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CULTURING PEARLS IN EARLS COURT

By FLORENCE M. VAUGHAN

A PASSION for miscellaneous and ill-regulated reading has its unexpected rewards, and one such recently presented itself to the writer from the unlikely pages of Lloyd Sanders's "Old Kew, Chiswick and Kensington" (1910). Writing of the transition of Earls Court during the eighteenth century from a small village in rural surroundings to a suburb of Kensington, the author notes that an early settler was John Hunter, the eminent surgeon, who in 1764 built a house there, in a sizeable piece of ground, where he kept a menagerie of an unusual and varied sort, including buffaloes and leopards. He had a pond in the grounds, ornamented with skulls (a nice 18th century Gothick—Castle of Otranto—touch, that !), and in it Sanders tells us that he experimented with the artificial formation of pearls in oysters.

Now, Lloyd Sanders's book is a vast *olla podrida* of anecdotal gossip about his three parishes, and its range is so extensive that one would expect it to be largely a surface gathering, so to speak, from readily accessible primary sources such as Lysons, Leigh Hunt and Faulkner. However, this does not seem to be the case with the statement about Hunter's work on pearls, since a reasonably thorough search through books about and by Hunter yielded only one reference to the subject, from the four-volume edition of Hunter's works, published by James F. Palmer in 1835. In volume I, page 105, the following tantalizingly short reference occurs :—

" Hunter, it would seem, was busied in trying to make pearls by introducing extraneous substances into oysters as nuclei for them to form. What success he had does not appear, and indeed the following letter of his to his friend Sir J. Bankes gives us all the information we possess regarding the inquiry.

Dear Sir Joseph, *1787*

I have these two days been draining the pond or rather fishing for pearls, the success of which you will see by the specimens. Those I had made the experiments on were dead but there is one recent. I have a few alive that I mean to put under experiment but I shall open the shell and put in the extraneous body. If any other method suggests itself to you be so good as to inform me. *J.H.*"

From this disappointingly vague letter, one is left in doubt as to Hunter's intentions in these experiments, whether to anticipate Mikimoto by culturing true pearls, or to rest content with the more modest objective of producing " japs." One would have thought that the chances would be nil of an oyster surviving sufficiently long in an Earls Court pond to cover an extraneous body, even if the pond water were laced with mineral salts to assist the process. Moreover, those were pre-Lister days, and one suspects that even Hunter's genius in the fields of surgery and anatomy could scarcely have compensated for an unawareness of the importance of asepsis.

NOTES ON ASTERISM
IN SPINEL AND CHATOYANCY IN CHRYSOBERYL, QUARTZ, TOURMALINE, ZIRCON AND SCAPOLITE

By W. F. EPPLER

In Vol. VI, No. 5 of the Journal, Professor Eppler discussed the causes of asterism and chatoyancy, and gave notes on asterism in corundum, rose quartz, almandine garnet and beryl.

THE nature of the star-producing inclusions within the spinel is not yet known in all cases. Probably needle-like crystals of rutile are responsible for this rare phenomenon, as in some spinels from Ceylon such crystals have been found (Fig. 1). They are strictly orientated and follow the edges of the octahedron. They are no doubt rutile, which has been crystallized by a process of exsolution.

Star-spinels are very rare. Anderson and Payne[1] described a grey-blue spinel with asterism from Burma in 1954 and a year later G. Switzer[2] reported an unusual black star-spinel from Ceylon. He found that the asterism was caused by needle-like inclusions which were parallel to the edges of the octahedron.

Another possible cause of asterism in spinel from Ceylon is the presence of doubly refractive crystal fibres. Sometimes they occur singly in the shape of a little rod, which may be either straight or bent, sometimes they are accumulated in very impressive bunches (Fig. 2). It is certain that these crystal fibres are not rutile, as the

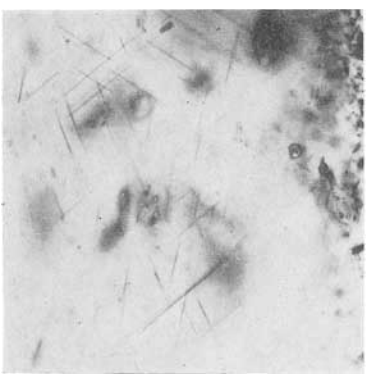


FIG. 1. *Inclusions of oriented rutile needles in a red spinel from Ceylon.* 120 ×.

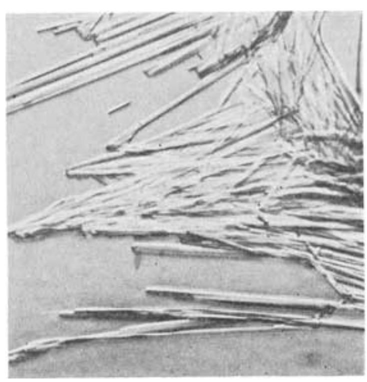


FIG. 2. *Doubly refractive crystal fibres in a red spinel from Ceylon.* 240 ×.

refractive index is lower than that of spinel. The material at my disposal has not been suitable enough to come to a definite decision as to their identity.

In E. J. Gübelin's paper, " A Contribution to the Genealogy of Inclusions "[3] it was pointed out that sphene crystals often cause asterism in spinel. Figs. 3, 4, 5 and 6 show some photomicrographs with sphene in a spinel from Ceylon. These crystals are too scarcely distributed to produce any kind of asterism. The sphenes are orientated parallel to the octahedral growing plane of the spinel. These sphenes are primary inclusions of xenogenetic origin. This can be seen in Fig. 4, where parts of the formerly complete crystals have been dissolved by the surrounding spinel. Also the arrangement of sphene crystals, as in Fig. 5, shows a characteristic group

FIG. 3. 90 ×

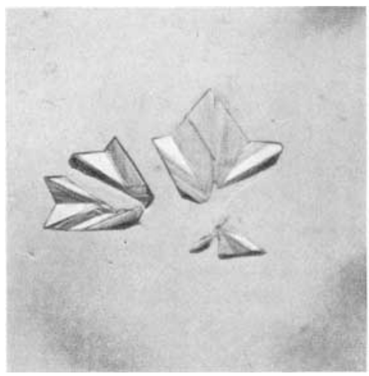


FIG. 4. 240 ×

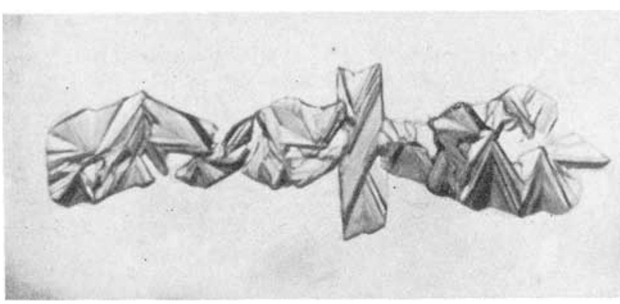


FIG. 5. 200 ×.

FIGS. 3–5. *Primary inclusions of orientated sphene crystals in a mauve-coloured spinel from Ceylon.*

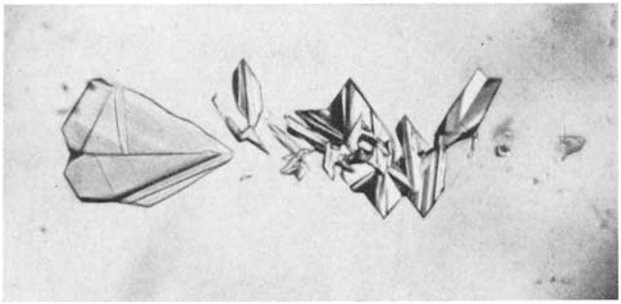


FIG. 6.
Sphene crystals in spinel from Ceylon.
220 ×.

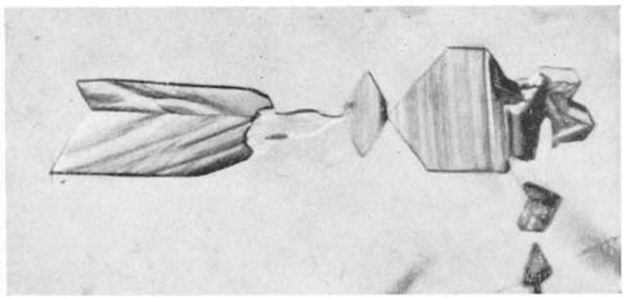


FIG. 7.
Sphene crystals in spinel from Ceylon.
240 ×.

of crystals, which formerly have been " freely " grown on the underlying octahedral plane of the spinel. Afterwards, this group has been " entrapped " by the further growing spinel crystal. These are not forms which indicate an exsolution (Fig. 6).

Another proof of the primary origin of the sphene is indicated in Fig. 7. Here, greater parts of the left-hand crystal have been dissolved by the surrounding spinel, which, owing to this newly " digested " material, shows in the places formerly occupied by the sphene a slightly higher refractive index. This is by no means in contradiction to the results of Gübelin. He also observed in spinel sphene crystals which have the form of minute needles and which have been caused by exsolution. It is obvious that the needle-like sphene crystals produce a better star in spinel than the larger crystals.

Spinels from Burma have inclusions (Fig. 8) which are very different from those in spinel from Ceylon. The large, nearly black, crystal inclusions are birefringent and have a hexagonal symmetry. They are not yet identified. The very fine, dust-like particles, which seem to have been concentrated near the larger

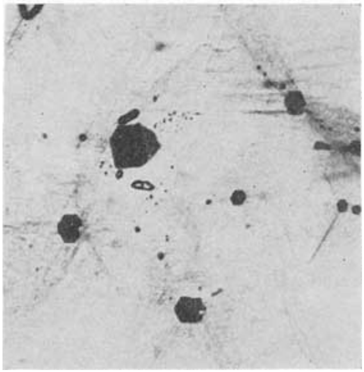


FIG. 8. 80 ×.

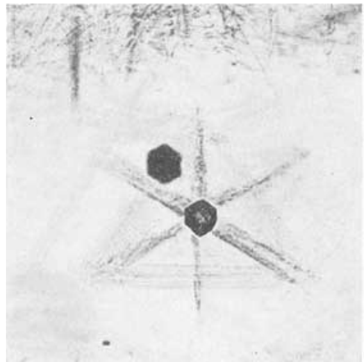


FIG. 9. 120 ×.

FIGS. 8 and 9. *Red spinel from Burma with inclusions of dark crystals of hexagonal shape, surrounded by tiny rutile crystals.*

crystals, are most probably rutile. Fig. 9 shows a strange pattern. It consists of a six-rayed star arrangement, which seems to superpose the triangular plane of an octahedron, and in the centre of the image is one of the large crystal inclusions. A possible explanation is that the large dark crystal is a primary inclusion. This crystal caused in one way or another a stress or a strain on its surroundings in the spinel crystal. Within this little zone of disturbance the exsolution of the rutile seeds started—so slowly that every newly formed crystal had time enough to take its pre-determined place within the possibilities of the spinel lattice. These small particles formed a pattern, which is in full coincidence with the symmetry of the spinel, from which they have been discharged. The pattern indicates further the main directions and places with a maximum amount of strain. Even at a higher magnification the dust-like particles remain so small that no further details can be recognized. The main indication why they are most probably rutile is the typical brownish colour, which is so characteristic for small rutile inclusions.

Even if they do not cause any kind of asterism, Burma spinels are of interest. Fig. 10 shows long and straight liquid inclusions, following crystallographic directions. Fig. 11 shows another part of these channel-like inclusions, which in some places are broadened to a band. Fig. 12 exhibits a part of such a band at very high magnification (1,500 : 1), revealing an accumulation of orientated and very small droplets.

Figs. 10 and 11. *Channel and band-like liquid inclusions in a red spinel of Burma.* 120 ×.

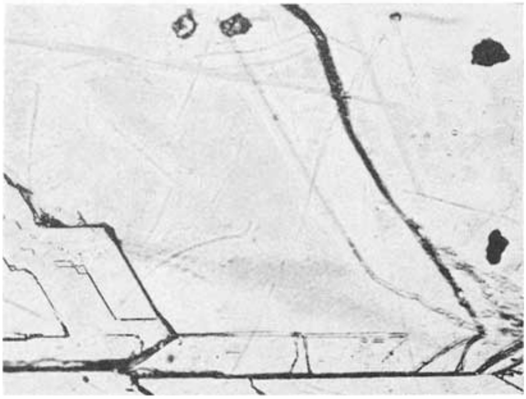


Fig. 10.

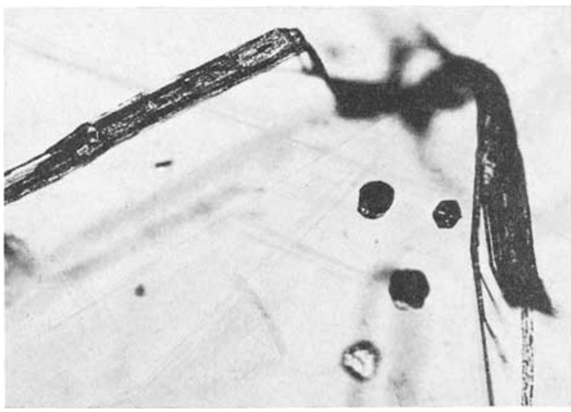


Fig. 11.

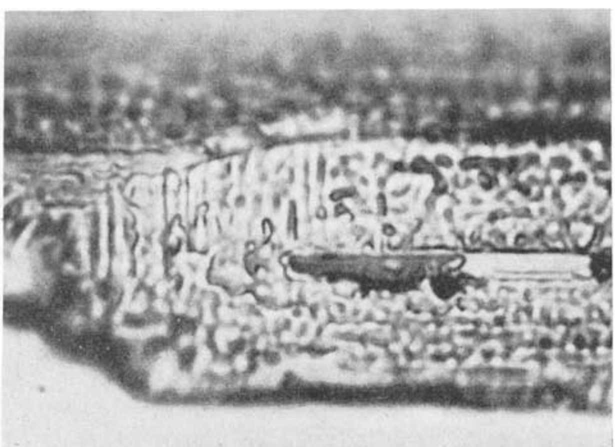


Fig. 12. *High magnification of broad channel from Fig.* 11. 1500 ×.

Some inclusions in a spinel from Burma are most puzzling (Fig. 13). They are singly refractive fibres with a refractive index near that of spinel ($< 1{\cdot}717$). They are not dirt particles on the surface or in a fissure—they are unknown things embedded as inclusions in a natural, untreated spinel from Burma.

Synthetic Spinel. Examination of the possibilities of manufacturing synthetic spinel star-stones brought no practical results. As long ago as 1928, F. Rinne[4] published his paper showing that an asterism could be caused by the exsolution of the excess of alumina in synthetic spinels. He found that heat-treated synthetic spinel of the usual composition separated a part of the excess alumina by exsolution. This alumina, he suggested, adopted the gamma form alumina, an interpretation which was revised recently by Jagodzinski. This author found an intermediate phase, consisting of a magnesium-aluminate ($Mg0.Al_{20}0_{39}$) of monoclinic symmetry. In any case flakes of an alumina composition are originated, which are parallel to the planes of the deltoid-icositetrahedron (311). These act as " asterites " ; but because of the unfavourable form of the flakes and the little difference of their refraction compared with the surrounding spinel, the asterism caused by them is very poor and of no commercial value.

Rinne found that exsolution in a commercial synthetic spinel starts in preferred zones of the boule. The zones are symmetrical

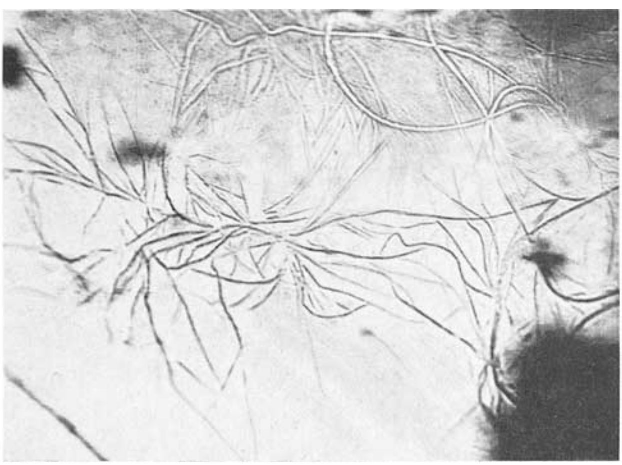


FIG. 13. *Unidentified inclusion in red spinel from Burma.* 120 ×.

to the geometric axis of the boule, and they indicate the areas of internal stress. The exsolution is caused by a heat-treatment, and the resulting separations (Fig. 14) are relatively coarse and somewhat irregularly distributed, but they follow the symmetry of the spinel crystal and, when properly cut, exhibit asterism. If, in a synthetic spinel, the excess of alumina is considerably increased, a particular kind of exsolution commences during the formation of the boule (Fig. 15), but the asterism caused by these flakes or little plates is very weak and not effective.

Synthetic spinel can be induced during its growth to develop long hoses of gas instead of round-shaped bubbles. The hoses include right angles, according to the cubic symmetry of the spinel. If a cabochon is cut from a boule containing these long gas hoses in a suitable manner, the hose-like inclusions act as " cylinders " and produce a four-rayed star. This experiment however has only academic interest.

Chrysoberyl cat's-eye. In literature, the chatoyancy of the chrysoberyl cat's-eye is always attributed to a multitude of microscopic channels, which are arranged parallel to the c-axis and which are said to be usually hollow. In opposition to this widely spread

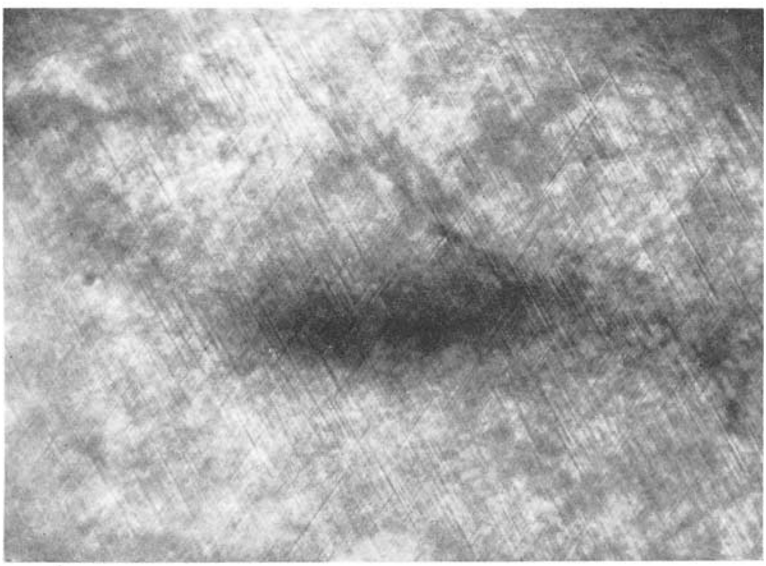


FIG. 14. *Orientated plates in a synthetic spinel.* 110 ×.

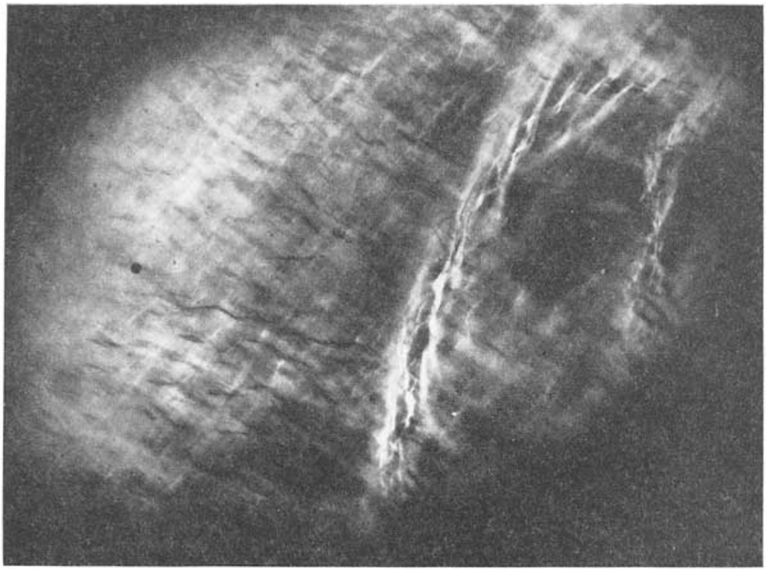


FIG. 15. *Orientated plates in a synthetic spinel with considerably increased excess of alumina.* 38 ×.

opinion, in a chrysoberyl from Ceylon with a fine and sharply developed cat's-eye effect (Fig. 16) a multitude of relatively short needles, all following the c-axis of the host crystal (Fig. 17) were observed. The needles had a higher refractive index than that of the chrysoberyl (mean value 1·748), and besides this, they were doubly refractive. These needles could not be recognized, nor could any evidence be found for their origin. Probably they may have been produced by a process of exsolution.

Quartz cat's-eye. This well known gem owes its chatoyancy to a multitude of fibres of the mineral asbestos or amianthus, which is a hornblende. The fibres are orientated parallel to the c-axis of the embedding quartz (Fig. 18). It is most probable that they are primary inclusions.

Tourmaline cat's-eye. As with chrysoberyl cat's-eye, the literature states also in the case of the tourmaline cat's-eye that its chatoyancy is caused by hollow channels, following the c-axis of the host crystal. Fig. 19 is from a good rose-coloured tourmaline with a strong line of reflection. The stone is supposed to come from California. The picture (E. Gübelin) was taken in reflected

Fig. 16.

Fig. 17.

Figs. 16 and 17. *Chrysoberyl cat's-eye with small needles (doubly refractive) parallel the c-axis.* 120 ×.

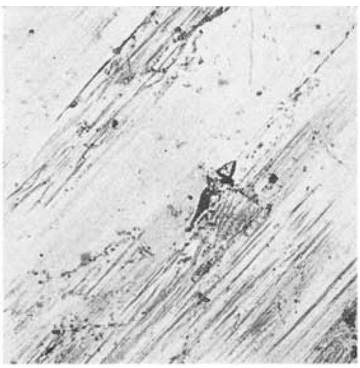
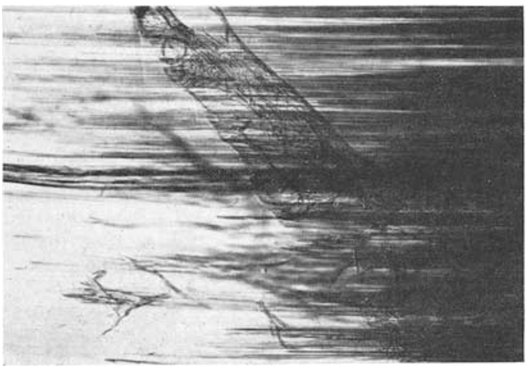


Fig. 18. *Quartz cat's-eye with orientated fibres of asbestos.* 120 ×.

Fig. 19. *Rose-coloured tourmaline cat's-eye with crystal fibres (Photo : E. Gübelin).* 80 ×.

light. Apparently it confirms the ruling opinion that these inclusions are hollow channels, particularly with regard to the curved and twisted ends of these " channels." Some further photomicrographs of my own taken from the same stone in transmitted light (Figs. 20 and 21) reveal that these fibres are crystals. They have a brown colouring and are doubly refractive. The refractive index is greater than that of tourmaline (1·63 as a mean value).

The form of the fibres gives the impression of extremely elongated crystal fibres. Similar to the explanation given for the origin of curved rutile needles in rose quartz by von Vultée, it can be assumed that in this case also the fibres and the tourmaline originated simultaneously. Consequently, the fibres are primary inclusions of syngenetic or xenogenetic origin.



Figs. 20 and 21. *Rose-coloured tourmaline cat's-eye with crystal fibres.*

Fig. 20. 120 ×.

Fig. 21. 420 ×.

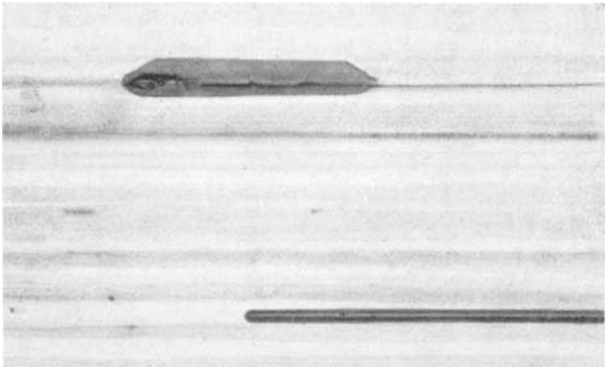


Fig. 22. *Scapolite with chatoyancy, Madagascar ; liquid-filled channels parallel c-axis and a patch of specular iron (on top).* 340 ×.

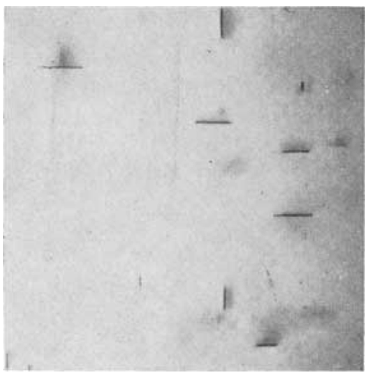


Fig. 23.
Scapolite with chatoyancy with newly-formed "blades," caused by exsolution
240 ×.

Zircon cat's-eye. Zircon sometimes shows chatoyancy. This was first described by R. Brauns.[5] He found in a green zircon from Ceylon a great number of inclusions, which proved to be minute crystals, situated parallel to the c-axis of the zircon. The nature of the inclusions was not determined.

Scapolite. Recently some fine crystals of scapolite came from Madagascar to Europe. Their colour ranges from a dark to a bright grey and is not so brilliant as Brazilian stones. Some of them have a very fine cat's-eye effect, the cause of which is hollow channels, liquid-filled channels (Fig. 22), and long needles of doubly refractive crystals, all following the main- or the c-axis of the scapolite. Sometimes, patches of specular iron can be observed, which also follow the general orientation.

The spacing of the channels and the needles observed on the basal plane reveal their minute size in diameter. Besides this, straight lines (Fig. 23) on the basal plane indicate that another kind of inclusion in the form of blades follows the channels and needles in orientation.

Fig. 24 shows the blades sideways, that is perpendicular to the c-axis. It is certain that, besides the channels and the needles, these blades likewise influence the chatoyancy of the stone. They represent a wonderful example of exsolution, for which the scapolite seems to be predestinated by virtue of its chemical composition. Scapolite is an isomorphous mixture of the minerals marialite and meionite. Both minerals have a complicated chemical composition and as marialite contains sodium and meionite calcium, it may be supposed that the molecule of meionite with its contents of calcium undergoes exsolution more easily than its partner (Fig. 25).

Marialite : $2\ NaCl . 3\ Na_20 . 3\ Al_20_3 . 18\ Si0_2$

Meionite : $CaC0_3 . 6\ Ca0 . 6\ Al_20_3 . 12\ Si0_2$ (sometimes with a certain content of $S0_4$)

	Marialite	*Meionite*
n_ω	1·539	1·596
n_ε	1·537	1·557
neg. D.R. ...	0·002	0·039

Tiger's-eye. Fig. 26 shows the reason for the chatoyancy of the tiger's-eye—long and slightly curved fibres of a hornblende asbestos. These are primary inclusions.

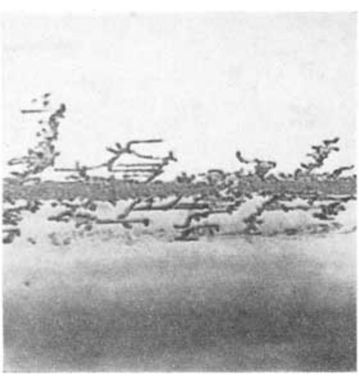


FIG. 24. *Blades in Fig.* 23 *shown perpendicularly to c-axis.*

FIG. 25. *Scapolite with chatoyancy with newly-formed "blades," caused by exsolution.* 120 ×.

FIG. 26. *Tiger's-eye ; long and slightly curved fibres of hornblende asbestos.* 70 ×.

REFERENCES

1. B. W. Anderson and C. J. Payne. *Three Gemstones from Burma.* Journal of Gemmology, Vol. IV, No. 8 ,October, 1954, p. 335.

2. G. Switzer. *Star-Spinel Showing Four Six-Rayed Stars.* Gems and Gemology, Summer 1955, **8**, 163-164.

3. E. J. Gübelin. *A Contribution to the Genealogy of Inclusions.* Journal of Gemmology, Vol. VI, No. 1, January, 1957, p. 44.

4. F. Rinne. *Morphologische und physikalisch-chemische Untersuchungen an synthetischen Spinellen usw.* Neues Jahrbuch für Mineralogie etc., BB LVIII, Abt. A, 43-108.

5. R. Brauns. *Lichtschein bei Granat, Zirkon und Saphir.* Neues Jahrbuch für Mineralogie, etc., 1907, Bd. 1, 13-20.

ACKNOWLEDGMENTS

The author is indebted to Dr. E. Gübelin, of Lucerne, for permission to publish the photograph of Fig. 19 in this issue of the Journal and Fig. 15 on p. 208 of Vol. VI, No. 5.

The two synthetic spinels illustrated on p. 200 of Vol. VI, No. 5, are the property of Dr. Gübelin, and it was he who produced the star-effect by scratching cylinder-like grooves on the back of the stones.

Gemmological Abstracts

Gübelin (E.). *Einschlusse in Diamanten.* Inclusions in diamonds. Gold und Silber, No. 11, pp. 27–30. 1957.

Inclusions generally recognized as diamond inclusions are carbon spots, feathers and cracks. The term " carbon spots " covers all inclusions of mineral in the diamond, and generally this could be graphite or haematite, magnetite or ilmenite or one of a number of colourless or coloured materials. Inclusions in diamonds, as in other stones, can be solid, liquid and gaseous. This article deals mainly with " carbon spots." Examinations have shown that many of the solid inclusions in diamonds were present as primary crystals in the magma. Apart from foreign minerals, diamond crystals are often found as inclusions in the diamond. Such an inclusion is usually of the rounded octahedral form, but twin crystals have also been found. The included diamonds vary in colour, but are usually darker than the mother crystal. Zircon must also be mentioned as an important inclusion of diamond. Diamonds which have solid inclusions have the tendency to break easily. This is especially so when zircon is the included material, as this has a higher heat expansion coefficient. When the diamond is warmed on the grinding wheel, this might cause the stone to break. South African diamonds often have garnet inclusions. Quartz is found in Brazilian, but never in South African, diamonds. The article ends with a short description of liquid and gaseous inclusions in diamonds, mentioning cracks and feathers.
7 illus. E.S.

Plate (W.). *Der Diamant und seine Syntheses.* The diamond and its synthesis. Gold und Silber, No. 12, pp. 26–28. 1958.

Survey of the development of diamond synthesis. The diamond lattice is described and compared with the lattice of graphite. Early attempts at synthesis, i.e. Moissan, Parsons, G. Friedel and von Berthelot are mentioned and synthesis by the G.E.C. described.

E.S.

BÖLSCHE (R.). *Neues von Smaragdvorkommen im Habachtal.* News of the emerald finds in Habach valley. Zeitschr. d. deutsch. Gesellsch. f. Edelsteinkunde, No. 22, pp. 19–22. 1957/58.

The Habach valley in Austria has been known as a source of emerald since the Middle Ages. This is a short review. Apparently some crystals have been found recently, the largest weighing 180 cts. and being 4½ cm. long; this stone should yield 8–10 emeralds of a total weight of 35cts.

E.S.

EPPLER. (W. F.). *Synthetischer Sternsaphir und synthetischer Sternrubin.* Synthetic star-sapphire and synthetic star-ruby. Zeitschr. d. deutsch. Gesellsch. f. Edelsteinkunde, No. 22, pp. 5–7. 1957/58.

In natural star-sapphires and rubies the star is formed by reflection of the light caused by very fine rutile needles, intersecting at 60°. When producing synthetic star-corundums, rutile needles have to be grown into the stone. The including of rutile needles is not very easy. Apart from the colouring materials, which are metallic oxides, TiO_2 is added to the boule. This forms a mixed crystal with the Al_2O_3 when heated, but later the rutile needles crystallize out again and are orientated in the same way as natural needles. This method was used separately in America (Linde Air Products) and in Germany, but various differences can be seen. In the American synthetic star-sapphire the needles are very long and thin, while the German rutile inclusions are shorter and thicker. Another difference is shown by the air bubbles, which are round in the American stone, and irregular, often triangular, in the German star-sapphire.

3 illus. E.S.

BAMBAUER (H. U.), BANK (H.). *Amblygonit und Brazilianit—Möglichkeiten ihrer Unterscheidung.* Amblygonite and brazilianite, possibilities of differentiation. Zeitschr. d. deutsch. Gesellsch. f. Edelsteinkunde, No. 22, pp. 8–10. 1957/58.

Refractive index seems to be similar for both stones (1·599-1·607, 1·619-1·632). The densities differ only very slightly (2·99 and 3·00). The authors suggest chemical analyses and radiography for differentiating between rough stones. In the case of cut stones the relation between refractive index, density and the optic axial angle have to be examined.

1 diagram. E.S.

RÖRIG (H.). *Lapis-lazuli und ultramarin.* Lapis-lazuli and ultramarine blue. Zeitschr. d. deutsch. Gesellsch. f. Edelsteinkunde, No. 22, pp. 10–16. 1957/58.

Historical survey of the use of the colour and of lapis-lazuli.

E.S.

DYER (H. B.) *Artificial coloration of diamond.* Gemmologist, Vol. XXVI, No. 316, pp. 193–199. November, 1957.

The assessment of colour by the eye and its limitations are discussed. The operation and function of a spectrophotometer are simply explained. Diamond is essentially colourless and any colour is due either to the presence of minute amounts of foreign atoms or to a local disarray of the carbon atoms. Artificial coloration is said to be due to the latter cause. Diamonds may be artificially coloured by bombarding them with suitable high-energy particles. The types of such particles, their characteristics and how they may be accelerated are discussed. The mechanism of colouring diamond by irradiation is explained by reference to the blueing of diamond by electron bombardment. A "blued" diamond shows a complicated system of absorption lines in the orange-red region of the visible spectrum. (Note—this is shown only by a photospectrometer and is not visible in an ordinary hand spectroscope.) A simple ultra-violet device is said to have been produced to enable distinction to be made between natural blue diamonds and those artificially coloured, but no details are given. A very full explanation of the irradiation process which alters the colour of diamonds is given. About one-tenth of the incident high-energy electrons make effective elastic collisions with carbon atoms transferring just sufficient energy to eject them from normal positions to interstitial positions leaving a vacant site behind. It is believed that the four atoms surrounding each vacant site give rise to the absorption. The effect of subsequent heating is explained, as are also the processes in the case of neutron bombarded diamonds. The cause of the colour in natural blue diamonds is discussed. A trace of manganese is said to be the cause of the colour of pink diamonds.

10 illus. R.W.

SINKANKAS (J.). *Recent gem mining at Pala, San Diego Co., California.* Gems and Gemology, Vol. IX, No. 3, pp. 80–87 and 95. Fall, 1957.

The history, geography and geology of the Pala district is given. A number of the mines are individually considered. In the Katerina mine much spodumene is found in association with pale straw-yellow quartz. Spodumene in the variety kunzite and crystals with a definitely bluish shade, as well as material of a peculiar greenish colour resembling aquamarine, are found in the Vanderberg mine. Kunzite from Pala fades on exposure to sunlight. The future prospects of the Pala group of mines are forecast.

4 illus. R.W.

SINKANKAS (J.). *" Green " amethyst from Four Peaks, Arizona.* Gems and Gemology, Vol. IX, No. 3, pp. 89–95. Fall, 1957.

Reports of a source of amethyst which, like the material from Montezuma, Brazil, turns to a green colour on heating. The " greening " of the amethyst from Four Peaks was an accidental discovery. A store of amethyst rough was burnt down and the crystals were then found to have assumed a green colour. Some notes on the geology and geography of the area are given. The amethyst deposits are crystal-lined geodes and the crystals have a habit similar to those found at Thunder Bay, Lake Superior. The distribution of colour and the twinning of the crystals are discussed. Heating experiments, by D. B. Stewart, are fully recorded.

2 illus. R.W.

GÜBELIN (E. J.). *The phase contrast method.* Gems and Gemology, Vol. IX, No. 3, pp. 67–79. Fall, 1957.

An article on phase contrast microscopy similar to that published in the Journ. Gemmology, Vol. VI, No. 4.

14 illus. R.W.

WEBSTER (R.). *The detection of cultured pearls.* Gemmologist, Vol. XXVI, Nos. 315 and 316, pp. 178–184 ; 200–207. October/November, 1957.

A comprehensive survey of the history and methods used in detecting cultured pearls. The use of density methods, the principles of the lucidoscope, pearl compass and the pearl microscope

are discussed and illustrated. The endoscope, its use and limitations are described, as are the spot diffraction X-ray method, direct method and fluorescence of pearls under X-rays.
16 illus. P.B.

Webster (R.). *Imitation pearls.* Gemmologist, Vol. XXVI, No. 317, pp. 213–217. December, 1957.

Imitation pearls were first produced by Jonquin of Paris, who noticed the lustrous nature of fish scales and used them in making a pearl essence. The preparation of the hollow glass bead type of imitation pearl is explained. The nature of the fish scales and the modern methods for their production are discussed. The solid glass bead type of imitation pearl is also explained. A special type of glass is usually used for making the beads, but plastics, mother-of-pearl and vegetable ivory have been used.
2 illus. P.B.

Webster (R.). *Coral, shell and operculum.* Gemmologist, Vol. XXVI, No. 318, pp. 7–15, January, 1958.

The coral polyp is described and the method of growth of the calcareous framework which supplies the precious coral explained. The locations of the fisheries, the methods of fishing and the varieties of coral are mentioned. The fishing and the use of mother-of-pearl from the pearl oyster and from the haliotidae are discussed. The Helmet shell and the Queen conch are used for cutting cameos. The thick columns of the Top Shells are used for beads and the dividing septa of the pearly nautilus provide a mother-of-pearl suitable for inlay, while the central whorl of the same shell gives the so-called *coque de perle.*
9 illus. P.B.

Barta (C.). *Why synthetic corundum boules split.* Gemmologist, Vol. XXVI, No. 317, pp. 219–224. December, 1957.

Natural corundum is the alpha modification of alumina produced by complex metamorphism of rock masses. The history of the early experiments in the synthesizing of ruby is told. The estimated production of synthetic corundum in 1952 is said to be about 550 million carats. The splitting of corundum boules, which is not connected with the parting of corundum, occurs with boules over 4 mm. in diameter. The causes of the splitting can be

influenced at certain stages, i.e. during production processes, following production (by removing internal stresses), and during mechanical machining. Discussions of these factors and the formation of rhombohedral cracking are given.
6 illus. R.W.

CORRECTION. In the abstract Coleman (R. G.). *Jadeite from San Benito Co., California.* (Journ. Gemmology, Vol. VI, No. 2, p. 92, 1957), the density should have been given as 3·43 and not 3·34 as printed.

BOOK REVIEW

PARSONS (C. J.) : SOUKUP (E. J.). *Gem Materials Data Book*, Gems and Minerals, Mentone, California, 1957. 36 pages.

This work endeavours to provide all the pertinent data needed by the gemmologist for the identification of gem materials.

The contents consist of an introduction and a master data-list of some 450 entries, followed by a number of gem identification talbes and a list of the false names applied to gems.

In their introduction the authors state that the data have been compiled from all reliable sources and from their own observations. It is further stated that these gem tables mark the first time an attempt has been made to compile all the pertinent information covering gem characteristics into one comprehensive body of data. This may be true for North America but it is certainly not so for Europe, for similarly designed tables, comprehensive at the time of their publication, have been known since 1937. Indeed the " pocket book " by Sir James Walton published in 1954 has also been translated and published in the German language.

Certain data have been omitted from the tables for one of the following reasons: (1) not available, and (2) of no interest to gemmology. In view of this it seems strange that there is only one reference to absorption spectra, but on the other hand measurements are given in a number of cases of the angular size of 2V, a constant which is difficult to measure, and which in the majority of cases is of far less value in gem distinction than absorption spectra.

The excellent main table, which by the use of a code of abbreviations, lists the colours, transparency, lustre, refractive index, birefringence, crystal system, optical characters and sign, dispersion, pleochroism, specific gravity, hardness, cleavage, fracture, characteristic inclusions, habit, and any special tests, is most complete. The purist may well question the right of some of the mineral species listed to be gemstones, but as some collectors cut anything, however unsuitable, as gems, the authors no doubt felt their inclusion justified.

The refractive index and density values appear to have been culled mostly from data published in mineralogical textbooks. Such values, while fairly satisfactory in most cases, are not wholly reliable when values for the *varieties* of gem materials are needed. This is exemplified in the case of the entry for beryl, where the values of refractive indices as given are not common to all varieties. Further, the higher values mentioned for aquamarine are much more commonly encountered in the pink and white beryls. Similarly, the green corundum often has higher indices of refraction than the other colour-varieties of sapphire.

The reference to synthetic corundum having an absorption spectrum with wider absorption bands than the natural stone is unhelpful for, apart from any consideration of the validity of the assertion, it is not stated what these absorption bands are or in what varieties they may be present. There are some minor inaccuracies.

The *Gem Materials Data Book* is a valuable contribution which has the advantage of carrying information on the more unusual types of gem materials. The book has a bright-yellow stiff paper cover and is rather large in size (12 by 9 inches). Opening like a reporter's note-book, it is more suitable for desk use and is not a pocket volume like the earlier English books of similar type.

R.W.

THE DESIGN AND CONSTRUCTION OF A GEMMOLOGICAL SPECTROSCOPE

By L. C. TRUMPER, B.Sc., F.G.A.

GENERAL AND INTRODUCTORY

The gemmologist's enthusiasm is continually being rekindled not only by the arrival of some new species or variety, but also by some hitherto unsuspected property or reaction. The study of the absorption spectra of gemstones—pioneered by Anderson and Payne in this country—is full of interest and excitement as well as being a valuable method of distinguishing various species, and the recognition of its importance in discriminative gemmology is now beginning to spread in the U.S.A. also. It has, however, appeared to me that the equipment available to meet the gemmologist's requirements in this field falls far short of what is needed and that suitable equipment ought to be specially designed to meet the growing demands of those engaged in this interesting branch of gemmology.

PRESENT PRACTICE

In his *Gem Testing*,[1] and more recently in *The Gemmologist*,[2] Anderson has rightly pointed out that an enormous amount can be done with the simplest of spectroscopes and the minimum of illumination. He has also shown how a more advanced instrument with more powerful illumination will bring still greater rewards.

Anderson has advocated the use of a 500 watt projection lamp (alternatively a 250 watt or 300 watt lamp) inside an asbestos-lined plywood box, with suitably arranged ventilation louvres permitting ample ventilation but arranged to trap the unwanted light. He has pointed out that projection lamps and suitable holders or adaptors can be obtained from any good photographic establishment—standard fittings with E.S. holders being available to fit or for the conversion of optical lanterns. He has explained in detail how the microscope may be used to collect the powerful beam of light on the substage mirror and thus direct it through the microscope condenser—the gemstone being held either in some form of tongs just above it or face down on a microscope slide. A low-power objective collects the resultant transmitted light after passing through the stone under observation, and, the microscope eye-piece having been removed, the spectroscope is held in the hand just above the tube thus flooded with light.

An alternative method has been described by D. J. Ewing.[3] He uses a car head-lamp in the base of a large cocoa tin, fitted with a diaphragm containing a condensing lens above the lamp ; the light is thus directed on to a small hole in the top of the lid of the tin, upon which is placed the gemstone to be examined. The spectroscope is again held in the hand with the slit about an inch above the stone.

An entirely different procedure, devised by R. Keith Mitchell,[4] makes use of reflected light. The spectroscope is placed in the cradle of a small stand at an angle of 45°, the slit directed at a small turntable with a matt black surface upon which the gemstone is placed table facet downwards. The turntable enables the stone to be rotated in the beam of light which is directed downwards through the stone on to the table facet and internally reflected up to the slit of the spectroscope. This method is useful with pale stones, as the path of the light through the stone is doubled, but it is a difficult technique to master in practice, and frankly I admit that I have had very little success with it.

In 1951, E. Gübelin[5] exhibited at the Gemmological Association's Exhibition in London the only spectroscope hitherto constructed solely for the gemmologist. A very compact instrument, it had built-in illumination, an illuminated wavelength-scale, tongs for holding the stone and other refinements. The cost at the time was understood to be in the region of £85 and this high cost has doubtless discouraged its commercial production.*

Some Improvements

Like many other gemmologists, I had hitherto followed Anderson's suggestions, using the lamp house and condenser of a " Russian Iron " Optical (or magic) Lantern fitted with a 250 watt projection lamp with Edison screw holder as the source of illumination and my Watson microscope to condense the light further on to the stage, racking up the microscope tube with the eye-piece removed and holding the spectroscope above it. I did, however, achieve two improvements. Firstly, the fitting of a mechanical stage greatly facilitates the movement to and fro and up

* In 1953 E. Gübelin improved his spectroscope by adding a polaroid filter and a diaphragm to exclude supplementary light. The instrument now has a prism system which enables an undisturbed spectrum from the light source to be compared with the spectrum under test. A monochromator aids measurement of position of absorption lines.—*Editor.*

and down of the stone under observation, and, secondly, I designed[6] a simple holder† for the spectroscope, which could be inserted into the top of the microscope tube and could thus not only hold the spectroscope steady, but also leave both hands free for adjustments.

In considering what improvements to gemmological spectroscopic equipment could be carried out I realized that one source of inconvenience was the continual " one-eyed " viewing. Having an admirable binocular prismatic microscope at a reasonable price, why not a binocular spectroscope ? I decided to put this latter problem to the test by borrowing an identical spectroscope and, by a system of iron stands and clamps, synchronizing both spectroscopes on to a gemstone. This proved my point, namely, that it was three times as restful to look with both eyes at rest at a spectrum, and that much easier to see a faint line, instead of half the time imagining one and probably seeing one in a different place each time one looked.

Obviously synchronizing a pair of spectroscopes was not a very practical way of setting about it, but as a result, I submitted to a firm of instrument makers the following suggested design, making use of a single wavelength spectroscope and a half silvered prism to divide the light between the two eyes. In this way there is no loss of light and comfort can be achieved. I argued that, given greater comfort, one could obviously get more accurate results and more pleasure out of spectroscopic examinations. It remains to be seen whether an adaptor is made to secure binocular viewing. I can see no reason why it should not and no reason why it could not be arranged as an extra to fit any type of spectroscope that may be designed.

Further Improvements Desired

The next point considered was the need for a direct-viewing prism spectroscope with a really accurate wavelength scale. The Beck instrument No. 2522, good as it is, has its limitations. My own experience is that it can be adjusted to be sufficiently accurate between say 4300Å and 6000Å, but above that the accuracy falls off rapidly. I can see no reason why with a little modification of the design the same type of instrument could not be made both more accurate and more reliable. I am quite sure that there is a large potential demand among gemmologists throughout the world for such an instrument.

† Now marketed by R. & J. Beck Ltd.

That there is a demand for a lighting unit suitable for spectroscopy appears to have been recognized and it is understood that work on the design of such a unit is proceeding. The desirability of incorporating a blue filter equivalent to that provided by a concentrated solution of copper sulphate needs little emphasis nor does the desirability of eliminating if possible the immense amount of heat produced by the powerful light-source.

In any design, the aim should be for the examination to be conducted sitting down comfortably at a bench or table, at normal table height, with the eyepiece of the instrument (or the optical centre of the instrument) inclined at an angle of approximately 60°.

To the above suggestions might be added provision for inserting a series of colour filters for the selection of different parts of the spectrum and provision for the illuminant to be transmitted through or on to the specimen.

One last suggestion considered was the desirability of drawing out the red end of the spectrum to try and emulate the even distribution of the grating spectroscope.

The Projected Design

My object was to build a table model with inclined viewing, complete as a unit and ready to switch on instantly, incorporating the source of illumination, wavelength spectroscope, illumination for the wavelength scale, interchangeable spectrum filters, provision for holding the stone and a heat resisting filter. Having had something of the sort in my mind for a long time, I had been gradually collecting the components together and with most of them to hand, made a start on the construction. The first essential was to plan and construct the body of the instrument to the minimum possible dimensions. To do this it was first of all necessary to know the focal lengths of the condensing lenses upon which the basic measurements throughout depended. Having by me an old lantern, I decided to make use of the condenser, the lenses of which were about 10 cm in diameter.

Using a small electric lamp as a source of light and a scale set alongside to make a crude " Optical Bench," I measured the focal lengths of the lenses separately and together using a ground glass screen (a piece of white card does just as well) to receive the image. One lens had a focal length of approximately 9·5 cm and the other of 13·5 cm.

Construction of the Gem Spectroscope

Upon this basis the box to form the body was constructed, but alas, although I had the 250 watt projector lamp by me, I had taken a chance on the height of the E.S. adaptor and when this arrived found that I had not allowed enough height. I felt, however, that I had by this time got too far with the rest, so decided to get over the problem by using an E.S. batten holder instead of the adaptor, which was adjustable for height, focus and laterally, to insert this " through " the base to gain head room (i.e. to lower the height of the filament) and to rely on accurate measurements to get the focus correct from the start, taking up any adjustment in the final positioning of the condenser. I did, however, make some slight provision for raising or lowering the filament and, most important in case of a replacement of the projector lamp, provision for rotating the holder so as to orientate correctly the filament and mirror which is integral with the lamp.

The Heat Absorbing Filter

The next item to consider was a heat-absorbing filter not only to prevent the uncomfortable heat, but also to avoid damage to the specimen and, equally important, damage to any filters being used. There is, however, the added point that the lower the temperature of the specimen the denser the absorption lines become. One filter tried had to be rejected as it failed to transmit the blue and violet part of the spectrum, but the ON20 filter made by Chance Brothers Limited proved satisfactory. Chance Brothers Limited claim[7] that it is the most efficient heat absorbing filter obtainable, the infra-red being almost completely absorbed, and the small percentage of heat transmitted coming entirely from the visible radiation.

ON20 is nearly colourless and, therefore, does not affect colour values. This point I have checked by examination with the spectroscope. No apparent absorption takes place beyond a very slight reduction in the intensity of the light. Chance Brothers point out that a theoretically perfect filter would still transmit 7 per cent of the heat energy falling on it. ON20 comes close to the ideal in that it transmits 9·5 per cent for a 3 mm thick filter and at this optimum thickness it transmits 84 per cent of the light. They point out that the best position for the filter is between the lamp and the condenser, it being important that a free flow of air can pass both surfaces.

As the filter absorbs the heat it naturally becomes very hot and for this reason the mount should be loose and even illumination of the whole area of the filter is important. Round filters are preferable to square ones, and large filters with very powerful sources should be cut into strips. The makers add that a 2″ disc can be mounted with reasonable safety within 3″ of the filament of a 1,000 watt lamp. Finally they issue a warning that the special glass used in its manufacture is sensitive to attack by moisture and should be kept in a dry place and preferably unwrapped.

Spectrum-Isolating Filters

I next turned my attention to the provision of a set of filters to isolate different parts of the spectrum and came to the conclusion that the position first selected, that is, between the condenser and the Abbé condenser, was undesirable in that it would be subjecting the filters to the almost unrestricted and concentrated output of the lamp as far as the light was concerned as well as the residual heat not absorbed by the ON20 filter. I, therefore, re-designed the unit, arranging for a disc consisting of eight filters and one blank to be rotated in the beam of light after passing through the specimen and the microscope objective and before it reached the slit of the spectroscope. Before adopting this procedure, I tested the result of inserting colour filters between the spectrum and the objective and between the eyepiece of the spectroscope and the eye. As had been anticipated the actual position made no difference to the results reaching the eye.

Ilford Limited of Ilford, Essex, manufacture two sets of spectrum filters for purposes just such as this and I decided to use the " Bright Spectrum Series," though for reasons which will become evident later it would be quite easy to have a second disc of the much deeper and narrower series.

The Spectrum Filter Disc

The disc of spectrum filters was constructed by cutting out three circles simultaneously, two of them in $\frac{1}{4}$″ plywood and one in $\frac{1}{16}$″ plywood. Holes $\frac{7}{8}$″ in diameter were then cut, accurately spaced, again simultaneously in all three circles ; the holes in the $\frac{1}{16}$″ circle, subsequently being enlarged to just over 1″ diameter. This circle acts as a spacer between the other two. The $\frac{1}{16}$″

thick circle was then carefully placed over one of the others and the spectrum filters, carefully cut to size, were then sealed between two microscope cover slips with Canada Balsam. When all had set, the top circle was screwed on, the whole painted matt black and the filter numbers then punched in, using a template to ensure accuracy. Finally, the edges of the filter disc were milled and each sector opposite a filter was painted with the corresponding filter colour for rapid identification.

THE PRE-FILTER SECTION

Gemmologists will be familiar with the advantages of filtering the light from the projector lamp with a blue filter so as to eliminate from the gemstone under examination all traces of orange and red light.

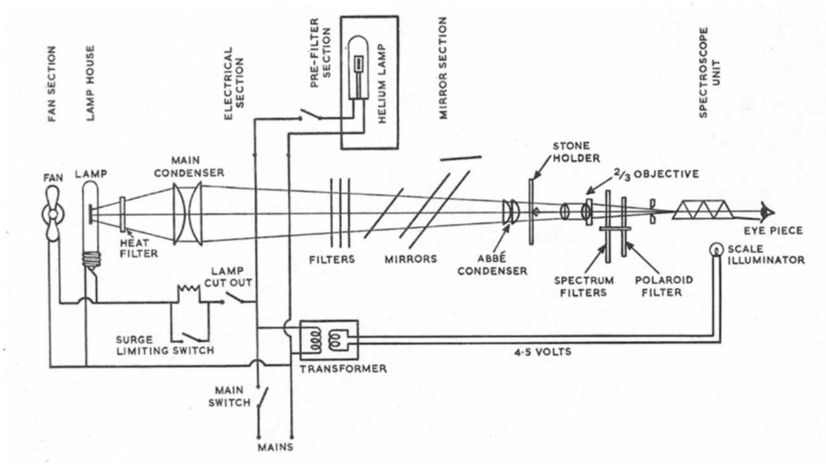
Under these conditions, the fluorescent lines in ruby, spinel[8] and certain other more rare examples stand out in brilliant red against an otherwise dark background in that portion of the spectrum. The fluorescence is induced by the blue light transmitted. The method usually adopted is to make up a chemical flask of copper sulphate solution, using this to filter and concentrate the light. Copper cuts out every trace of red and infra-red light.

It was clearly desirable to use a more permanent and compact method in the gem spectroscope. Unfortunately, the vast number of aniline dye filters all pass the infra-red and nearly all pass a proportion of light in the far red. I was, however, able to obtain a small quantity of a special celluloid filter, the transmission and absorption of which were equivalent to a two-inch thickness of copper sulphate solution.

The pre-filter section of the gem spectroscope is fitted with guides each side $2\frac{1}{4}''$ apart. The pre-filter unit is constructed as a self-contained piece of equipment which slides between these guides into the spectroscope, accurately locating the filters carried by it.

The unit consists of a container $2\frac{1}{8}'' \times 4\frac{1}{16}'' \times$ approximately $7''$ high. Internally it is divided by a set of guides into three sections. In each section a slide or filter carrier is arranged so that the pre-filters lie below the beam from the projector lamp and openings in the slide-carriers and container allow the beam to pass through unimpeded. The filters, each 5·8 cm wide and 4·2 cm high, can be brought into position, in the path of the beam

SPECTROSCOPE SYSTEM AND ELECTRICAL LAYOUT



of light, by lifting with the knob provided through a distance of 4·6 cm. In this position all extraneous light is masked by the filter carrier and container and only filtered light reaches the gemstone and spectroscope. The pre-filter unit is fitted with two blue filters, each the equivalent of 2″ of copper sulphate solution and cutting out all transmission above 5,600Å, and the third carrier has been fitted with a yellow filter which cuts out all transmission below 5,000Å. One, two or all three filters can be in use at a time. A blank is available to slide into the pre-filter section grooves when the pre-filters are not required, though the pre-filter unit can remain in position as it does not impede the beam of light.

A further means of distinguishing rapidly between ruby and pyrope garnet is provided by bringing all three filters into position and the spectrum filter 625, when light in the green between 5,200Å and 5,400Å only is transmitted. With pyrope there will be some transmission, with ruby practically none at all. Alternatively, with the pre-filters in operation only, with ruby the green transmission some 200Å in width is to the left of the transmitted band

and with pyrope to the right (this is with the violet end of the spectrum to the left as in the Beck instrument). If a known specimen is placed in the adjoining hole in the stone holder disc and the disc moved quickly from one stone to the other, the difference if any is at once apparent, as the narrow band of visible light jumps from left to right.

The Periscope Attachment

Having built in the prism spectroscope to receive light, either transmitted or indirect, from the projector lamp alone and from a point immediately over the Abbé condenser only, it became necessary to devise a means whereby light from an entirely outside source, whether Fraunhofer lines, mercury vapour, sodium light, etc., could be examined without dismantling or disturbing any part of the gem spectroscope.

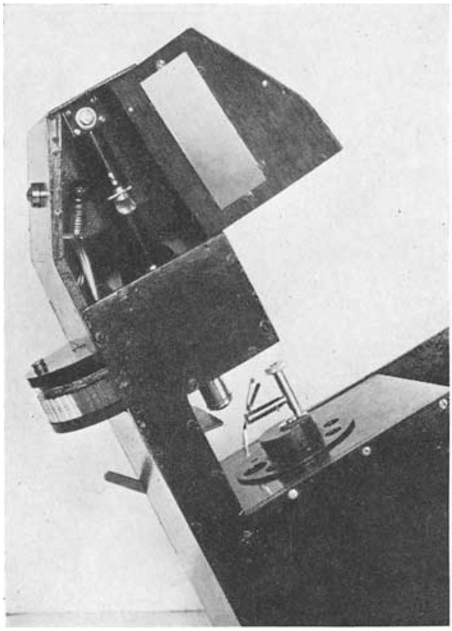
This was readily achieved by designing and constructing a simple periscope attachment, to the same general dimensions as the pre-filter unit and which could be inserted into the pre-filter section in its place. The mirrors are so placed that light grazing the top of the spectroscope is directed to the Abbé condenser by way of the deflexion mirror. A further mirror hinged to a base board which can be placed on the top of the spectroscope unit in front of the top periscope mirror can be arranged to collect light from any position and pass it to the periscope.

Examination in Polarized Light

It is well known that in many doubly refracting stones the spectrum of the ordinary ray differs substantially from that of the extraordinary ray, though for most practical purposes the combined spectrum of the two is sufficient. It was nevertheless decided to incorporate a polaroid filter in the unit, so that the light could be polarized before reaching the slit of the spectroscope.

This was done by sealing a 4″ disc of polaroid between two $\frac{1}{16}$″ thick circular discs of perspex, cementing them all together with Durofix. The disc is pivoted at the centre and placed immediately above the disc of spectrum filters.

So that the polaroid disc can be put out of action when not required a hole $\frac{7}{8}$″ diameter in line with the blank on the spectrum filter disc was cut out of it and a peg normally holds it stationary in this position. A small rectangular hole was also cut out to expose the spectrum filter numbers beneath. Irrespective of the



Head of spectroscope housing filter, polaroid discs, deflecting mirrors, $\frac{2}{3}''$ objective, stone-holder, disc of stops and spectroscope.

orientation of the gemstone under observation, rotation of the polaroid disc will bring first one ray and then the other into action when suitably rotated. The spectrum filters can be used simultaneously if so desired.

The Projector Lamp

In a leaflet accompanying their Osram Projector Lamps, the General Electric Co. Ltd.[9] point out that the filament, which is accurately located, operates at a very high temperature. The voltage applied to the lamp should not exceed that marked on the lamp, as for each 1 per cent rise in voltage the life of the lamp is reduced by 12 per cent. Most important of all, the lamp must be positioned as directed and for most lamps this position is vertical with the cap down. Cooling may be either forced or by convection, but an unobstructed flow of air past the lamp is essential. The equipment should be moved as little as possible particularly when the lamp is alight.

Surge-Limiting Resistor

A heavy surge takes place when a lamp is switched on and protection for the lamp against this heavy surge can be secured by a surge-limiting resistor connected in series with the lamp. The resistor can be short-circuited within a few seconds of switching on.

A resistor limiting the starting current to about three times the normal running current may be calculated from the formula

$$R = \frac{V^2}{3W}$$

where R = Resistance of the resistor in ohms
V = Voltage of lamp (i.e. of the supply)
W = The projector lamp voltage.

Thus for 230 volts and 250 watts a resistor of 70 ohms would be required and for 250 volts and 250 watts, of 82 ohms ; a 230 volt 500 watt lamp would need a surge limiting resistor of 35 ohms.

It was subsequently confirmed experimentally that a suitable surge limiting resistor for 230 volts, 250 watts was a 110 volts, 100 watt lamp.

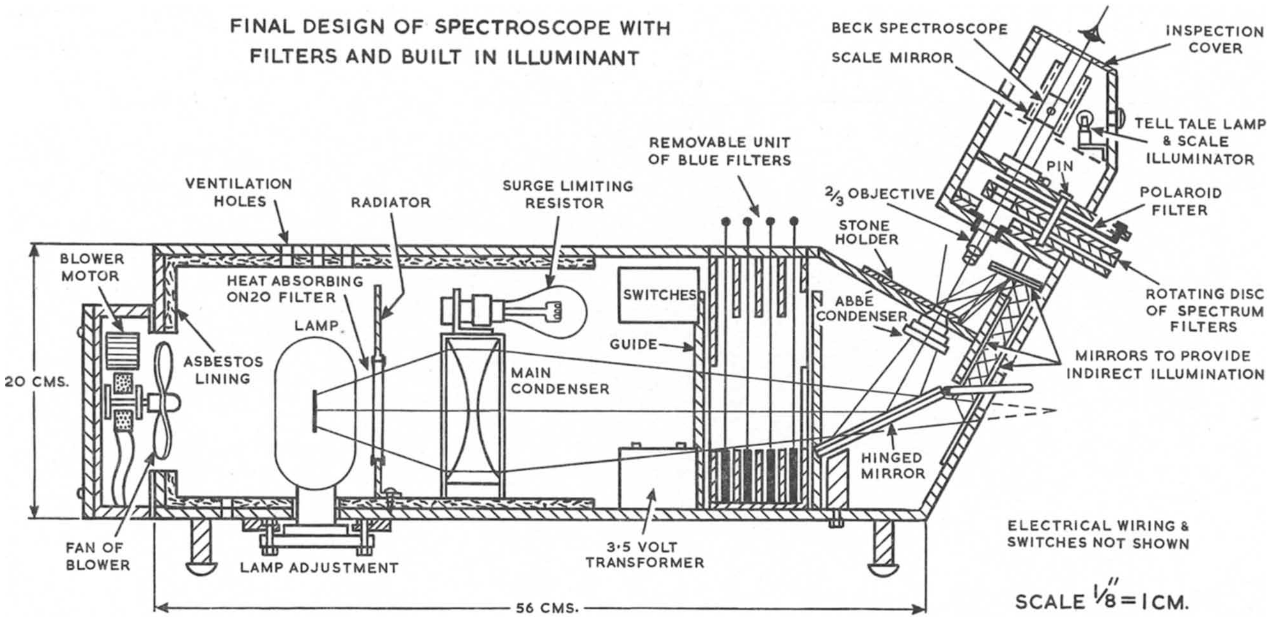
The Blower or Cooling Unit

The lamp-house had been very carefully lined inside with asbestos of appreciable thickness—about $\frac{3}{8}''$. The asbestos not only surrounded the projector lamp but also extended forward to cover the main $3\frac{1}{2}''$ condenser and also the surge limiting resistor. Asbestos may be fire-proof—being a mineral substance—but experience has shown that it is a poor insulator against heat and in spite of the provision of twelve half-inch holes in the base and nine above the lamp with complete freedom of air-circulation, it was found that the outer casing soon became very hot, scorching the polish.

The fitting of a blower was thus considered a necessity if the spectroscope was going to be run for more than a few minutes at a time, as well as a further insurance against the premature break-down of the projector lamp.

A blower was accordingly obtained from " The Educational Foundation for Visual Aids "[10] and the model suitable for up to 300 Watt projector bulbs was found to be ideal for the purpose. It would undoubtedly be quite suitable for 500 watt projector bulbs. It is supplied complete with a simple chassis, nuts and screws and a set of four small rubber buffers.

FINAL DESIGN OF SPECTROSCOPE WITH FILTERS AND BUILT IN ILLUMINANT



SECTION

A further piece of good fortune was that the blower was a perfect match in size for the unit as already constructed. Some consideration was given to the best place to fit it—the possible alternatives being at the end, on either side or even on the top. The best position would have been underneath, but this was ruled out as it would have entailed raising the whole unit by another $1\frac{1}{2}''$. The remaining logical position was as low down as possible at the front end, so that the air introduced could circulate around the base of the lamp and then upwards, as well as blowing at and through the radiator cooling the heat-absorbing filter. This was decided upon, the end of the unit removed without disturbing anything else and a 10 cm diameter hole was cut with a fretsaw through both $\frac{1}{4}''$ plywood and $\frac{3}{8}''$ asbestos sheet. It was then arranged that the blades of the fan of the blower unit should operate exactly within this hole to secure the maximum introduction of air into the unit.

To carry the blower, a framing was constructed around the hole, the sides of which were provided with louvres, the base being left open, but the top covered. An end cover was then constructed and the motor was attached to this cover on a frame so that it was accurately aligned with the hole in the end of the spectroscope unit. To mount the motor, the portions carrying special mounting slots in the chassis were cut off with a hacksaw, and these two metal plates were accurately screwed to the framing, taking care to see that there was clearance for the inside bearing of the fan between it and the end cover. The small rubber buffers were inserted in the slots and the screws on the motor then inserted through the holes and bolted finger tight. This provides the necessary resilience and freedom from noise and vibration.

The assembly completed, the wires of the motor were then connected in parallel with the projector lamp. This has the added advantage, that in addition to coming on and off with the projector lamp, which is of paramount importance to prevent too rapid cooling, it also runs at half speed when the resistor is in circuit and automatically runs at full speed when the projector lamp is fully on and the resistor cut out. The final result is admirable, there is a most excellent circulation of air, indeed air is blown out of every ventilating hole at considerable pressure and also finds its way throughout the unit, freely emerging out of the mirror opening above the stone holder and objective.

It is also quite quiet in operation, vibrationless, and does not distract from any observations being made.

PROVISION FOR INDIRECT ILLUMINATION

It will also be apparent from the design adopted, that by means of the system of mirrors built into the spectroscope section of the body, the light beam could be cut off from the Abbé condenser, by swinging the mirror upwards by pulling a short lever projecting through the back of the instrument, and thus allowing the converging beam of light to pass on to the back mirror and by repeated reflections to pass up the body, emerging through the aperture above the table by being reflected again down on to the table below the objective ; thus providing indirect lighting for the observation of opaque specimens, and for the observation of the fluorescent lines in ruby and red spinel. The correct angle for the top mirror is important ; luckily I got it right the first time, and on test was delighted to observe the strong rectangle of light on the table on pulling the lever.

Absolute accuracy of the position of the hinges of the mirror deflecting the convergent beam of light from the condenser to the Abbé condenser is essential so that the correct angle and position is taken up by the mirror when at rest. The underside of the Abbé condenser must be above the horizontal optical centre by an amount exceeding half the beam width at that point, plus the overall thickness of the mirror. The hinge must be accurately sited in the same plane as the mirror when at the correct angle of reflection, which is 30° for the comfortable viewing inclination of 60° from the horizontal. An adjustable stop was fitted in the base of the unit to ensure final accuracy of the angle of reflection.

Similarly correct alignment of Abbé condenser, objective, spectroscope and filter mount is vital. This gave some trouble to begin with, leading to a masking of part of the spectrum band. By trial and error, however, this was overcome and the use of a $\frac{2}{3}''$ objective was found to give the brightest spectrum. The distance of 4·3 cm between Abbé condenser and $\frac{2}{3}''$ objective and of 5·5 cm from objective mount (8·5 cm from objective lens) and slit of spectroscope have been shown experimentally to be sound and practical.

The use of a 4″ condenser close to the projector lamp increased by about thirteen times the illumination over normal procedure of using the sub-stage mirror of a microscope.

THE ELECTRICAL SECTION

A bell transformer giving an output of 4, 6 or 8 volts was wired to the switch, in parallel with the projector lamp and the output led by a twin wire up the body of the stand to illuminate the scale of the spectroscope and the tell-tale light at the rear of the unit.

The 4·5 volt miniature bulb being at the rear of the spectroscope and about half way down the body, a strip mirror was fitted to the inspection cover at the right hand side of the upper part of the body. A small mirror of tinfoil had already been attached to the short tube carrying the wavelength scale set at an angle of 45° and by trial and error this was soon positioned to pick up the reflected light from about the miniature bulb and at a total light distance of about 4″ the degree of illumination was found to be just about that required. Most of the wiring is carried out within the body of the instrument. Where it became necessary to go outside, this was done beneath the base and the exposed wires covered by a conduit screwed to the underside of the base for protection. An additional 2 amp. switch plug has been fitted inside the unit for the purpose of providing a 230 volt supply for subsidiary equipment, including a helium, neon or argon lamp for adjusting the wavelength scale of the spectroscope. A short length of flex ending in a bayonet holder emerges through a hole in the base. Construction of the base unit being completed, the whole was painted matt black and then French-polished. The completed unit stands on three short legs with rubber feet.

The best position for the gemstone under observation was found to be as close to the Abbé condenser as possible. The sloping table in this respect is a disadvantage, so it was decided to design and construct a small rotating disc containing a series of holes (or stops) of different diameters to accommodate different-sized stones up to the maximum aperture of the Abbé condenser. Further, it was decided to provide half-way round each hole at a distance of from 2 mm to 4 mm a low rim, or its equivalent, to keep the gemstone in place and prevent it from slipping down.

Provision of a stone holder of the small tweezer variety was also allowed for so that the gemstone might be orientated in any way required. This was fixed on to a circular pedestal capable of rotation, fitted over another $\frac{1}{16}$″ thick disc containing a similar series of eight different-sized stops, so that the appropriate size of stop could be selected. Correct orientation of the stone has to be achieved before inserting in the tweezers, as the Rayner type of mount[11] has no universal movements but only a limited amount of movement from side to side or to and fro or up and down.

Adjustment of the Wavelength Scale

Since the success of the spectroscope is greatly enhanced by the provision of a wavelength scale and since the scale on the Beck instrument is not accurate throughout, it is clearly important to take the greatest possible care in adjusting it to get the greatest degree of accuracy possible. To facilitate this, the instrument has been provided with a simple fitting, holding a neon or argon or helium glow-lamp immediately below the $\frac{2}{3}''$ objective, automatically centred by means of the spigot or pivot upon which the stone-holder disc rotates. The lamp is conveniently plugged into the 2 amp. switch plug referred to above, after first unscrewing the projector lamp or fitting a switch to cut it out of action. These lamps have a metal plate with a slit in it, arranged to concentrate the light in a small area.

Actually the 5 watt neon type of indicator or night-light lamp costing only a few shillings, does almost as well, but takes up rather more room. Helium is probably the most useful for calibration purposes as the lines are easy to see and are well separated through the spectrum. The sodium lamp used with the refractometer can easily be brought into use with a mirror, as can also the mercury lines from a fluorescent tube, should this form of lighting be available. Less easily, reference can also be made to the Fraunhofer lines of the solar spectrum.

Wavelength Reading Comparison Periscope

Notwithstanding having made the most careful setting of the wavelength scale, it is still difficult to obtain accurate readings due to a tendancy of the scale to float laterally as the eye, placed close to the eyepiece, is moved from side to side. The internal design of the No. 2522 spectroscope[12] requires that the rays forming the spectral image shall traverse the main dispersing prism which has an inclined exit face. The image-forming rays of the reference scale emanating from the side tube are brought coincident with the main tube by reflection off this inclined prism face.

Both sets of rays are, therefore, independent until superimposed in this way and are capable of being focused individually to suit each other and the observer's vision. This is accomplished by sliding either the slit assembly or the scale mount in the two tubes of the spectroscope body. If parallax exists between the spectrum and the scale, it can be eliminated by re-focusing either one or both of the two units. It may be possible that readings in the blue region require a different setting from those in the red region of the spectrum, but exact coincidence between the two images should be possible by careful adjustment of the focus. It was felt desirable to devise some means whereby the eye could take up a constant position when taking wavelength readings for record purposes, where a great degree of accuracy was desirable.

I decided to overcome the problem by making a further periscope attachment, in which the lower mirror occupied only half of the available space, the other half being open, front and back, so as to allow half of the beam from the projector lamp to pass through the Abbé condenser. Sodium light was then picked up, via any suitable mirror or direct from a sodium lamp, by the top periscope mirror, whilst the gemstone spectrum was examined in the usual way.

In this manner the bright yellow sodium emission doublet was superimposed upon the gemstone absorption spectrum ; the eye moved from side to side until the sodium line was synchronized accurately on the 5890/5896 mark on the scale and then, keeping the eye absolutely steady in this position, the desired wavelength reading was taken. This procedure was then repeated for each measurement required. In the same way, a standard line could easily be used from an alternative source, such as a mercury vapour lamp (fluorescent type) or a helium lamp.

Possible Modifications

It will be appreciated that this prototype although planned and designed as far as was foreseeable at the time, was frequently modified in the light of experience as construction and testing proceeded. In building further models, certain further modifications mostly of a minor character could be made in the light of the knowledge gained in the prototypes constructed and subsequent operation.

1. The external switches would be less obtrusive if they were of flush or panel mounting type.
2. So accurate is the construction of the modern projector lamp that the facilities for adjustment incorporated in the prototype could be dispensed with.
3. The housing around the eyepiece of the spectroscope, could be more drastically bevelled to the front and rear. It could indeed be bevelled on the side away from the scale attachment, which if on the left-hand side as in the prototype would slightly facilitate viewing with the right eye—but this would be at the expense of loss of symmetry and is not really necessary.
4. Some increase in the height of the projector lamp filament above the base—i.e. if the batten holder was fitted inside the base, instead of through it—could be obtained without increasing the overall height of the unit, by inclining or tilting downwards the whole optical train slightly, instead of having it truly horizontal as in the prototype.
5. It would probably be better, however, to gain the additional height inside the lamp house by (in effect) lowering the base and reducing the height of the legs or indeed dispensing with them entirely by not only mounting the batten holder inside, but also arranging the whole of the wiring inside also.

   In other words, the unit would remain exactly as the prototype except that the base would be lowered by some 4 cm and thus the overall height of the lamp house, etc., section would become 24 cm instead of 20 cm as shown in the drawing.
6. For comfortable viewing with the unit on a bench or table of normal 30″ height, the overall height of the eyepeice above the table or bench should not exceed 38 cm or 15 inches with the viewing section inclined at 30° from the vertical (60° from the horizontal).
7. It would be quite a simple matter to arrange for the adjustment of the width of the slit to be made from outside the unit. It is, however, a simple matter to remove the inspection cover to make this adjustment which rarely needs alteration once made.

8. As an alternative, the spectroscope could be fitted with a right-angled prism to swing over half of the slit, so that a further beam of light could be picked up to enable a comparison spectrum to be produced exactly adjacent to the main spectrum. To enable this to be done, a small window would be needed in the side of the unit, in line with the right-angle prism. An emission spectrum can readily be superimposed upon the absorption spectrum as already described.

Conclusion

The constructional details of the gem spectroscope have been given to encourage any gemmologist who is handy with a few simple tools, to build one for himself. Starting from scratch, it took five months of almost every available moment of spare time to build it. Nevertheless the instrument has more than fulfilled expectations and it has already been of the greatest help in making spectroscopic examinations quickly and at a moment's notice.

REFERENCES

1. B. W. Anderson. *Gem Testing*, 4th edn., 1947, 95-98.
2. B. W. Anderson and C. J. Payne. *The Spectroscope and its Applications to Gemmology*, Gemmologist, 1954, **23**, 87-88.
3. D. J. Ewing. *A Source of Light for Spectroscopy*, Journ. Gemmology, 1949, **2**, 151-2.
4. R. K. Mitchell. *A Useful Aid to Gem Spectroscopy*, Journ. Gemmology, 1948, **1** (5), 12-13.
5. G. Carr. *Gemmological Exhibition*, 1951, Journ. Gemmology, 1951, **3**, 138.
   E. Bruton. *Gemmological Exhibition*, Gemmologist, 1951, **20**, 209.
6. L. C. Trumper. *Spectroscopic Examination*, Gemmologist, 1951, **20**, 249-50.
7. Chance Brothers Limited. Leaflet No. O.S.5.
8. B. W. Anderson. *Crossed Filters for the Study of Fluorescence*, Gemmologist, 1953, **22**, 39-45.
   B. W. Anderson and C. J. Payne. *The Spectroscope and its Applications to Gemmology*, Gemmologist, 1954, **23**, 122.
9. General Electric Company Limited. Osram Projector Lamp operating instructions XL174A.
10. Educational Foundation for Visual Aids. Blower Unit suitable for 250 Watt Projector lamps.
11. Rayner & Keeler Limited. Spectroscopes and Gem-Testing Instruments.
12. R. & J. Beck Limited. Spectroscopes.

LIST OF COMPONENTS (APPROXIMATE COST £45)

About 10 sq. feet ¼″ plywood.
About 4 sq. feet ⅜″ asbestos sheet.
About 2 sq. feet $\frac{1}{16}$″ plywood.
About 1 sq. foot ⅛″ plywood.
Beck 2522 spectroscope.
Beck milled screw.
Ilford spectrum filters.
250 Watt Osram projector lamp.
110 Volt 100 Watt resistor lamp.
Brass holder with ½″ flange.
Bakelite lamp-holder.
Edison screw lamp-holder.
Three 5 amp switches.
One 2 amp switch plug.
Blower unit.
16 C.P. screws ½″ × 4.
140 Brass screws ⅛″ × 4.
20 Brass screws ⅜″ × 3.
Helium lamp.
Six handbag mirrors.
Four Bakelite knobs.
⅔″ objective.
3½″ Lantern condenser.
Abbé condenser.
ON20 Heat absorbing filter 2″.
G.E.C. bell transformer.
Miniature bulb.
Tell-tale fitting and holder.
Polaroid filter.
Rayner stone-holder.
Blue filters.
Rubber feet.
Paint, polish, saws and sandpaper, tin plate.
Objective rings.
20 ⅞″ microscope cover slips.
⅛″ perspex ½ sq. ft.

ASSOCIATION NOTICES

COUNCIL MEETING

A meeting of the Council was held at Saint Dunstan's House, Carey Lane, London, E.C.2, on Thursday, 6th February, 1958. Mr. Norman Harper, Vice-Chairman, presided.

The following were elected to membership :—

FELLOWSHIP

Vince, John O., Ipswich. D.1955
Weller, Christine J. (Mrs.), Croydon D.1957
Weller, Raymond J., Croydon D.1957

PROBATIONARY

Edwin, Wilfred, Sumatra, Indonesia
Pragnell, John W., Bournemouth
Robins, Alan P., London
Turner, Bernard A., Nelson
Yates, Roy F., Manchester

ORDINARY

Bennett, Bradley F., London
de Silva, L. J. C. F., Colombo, Ceylon
Dietz, Robert S., London
Fernando, K. S. L. T., Colombo, Ceylon
Gray, Eleonora (Miss), Paris, France
Hinton, Vera G. (Mrs.), Staines
Laarhoven, Andreas M. van, Nairobi, Kenya
Massey, Derek W., Wolverhampton
Medley, Harold, Kingsworthy, Hants.
Mendelsohn, Michael, Cape Town, S. Africa
Parson, Chhagan L., Bangkok, Thailand
Powell, Colin V., Cheltenham
Rawlinson, William, Rhos-on-Sea
Rowan, Cyril, Wellington, New Zealand

Examinations.—The Council received details of the arrangements that had been made to hold the 1958 examinations at Goldsmiths' Hall.

Provident Scheme.—Approval was given to a proposal for enabling members of the Association to join the scheme arranged between the National Association of Goldsmiths and the British United Provident Association whereby private patient facilities could be obtained in the cause of illness or accident rates available under group schemes.

MEMBERS' MEETINGS

Members who met at Goldsmiths' Hall, London, on 23rd January, 1958, heard talks and saw demonstrations by two Fellows of the Association : Mr. L. C. Trumper and Mr. T. G. Jones. The Secretary, Mr. G. F. Andrews, was in the Chair.

Mr. Trumper said that he was indebted to a great many people for help with the equipment he had produced. There were articles from the pens of Messrs. Anderson and Payne which had prompted him to take an interest in the subject and when Dr. Gübelin had produced a self-contained spectroscope the speaker and a friend had made some sketches of this equipment. He had also had some correspondence with Mr. Caudell, of Rayners, and, finally, had decided to build a spectroscope embodying the features he felt were required.

In the ordinary way the spectroscope required a powerful light-source and a " certain number of gadgets " to be set up in order to take a reading. He had come to the conclusion that " standing on a box and hovering above the instrument," trying to spot a line and then losing one's place when one stood up again was not very convenient. So he had decided to build an instrument with everything rigid. He had tried to incorporate other people's ideas and to put everything together.

Mr. Trumper's instrument is described on pp. 271-289.

In discussing the irradiation of gemstones Mr. Thorold Jones explained that nuclear scientists had been interested in the properties of diamonds for quite a number of reasons. The trade's interest was obviously that the irradiation of stones might make them more valuable.

A few stones had been irradiated, but with somewhat inconclusive results. The audience would know that these stones were not enhanced in appearance or value by irradiation. White stones subjected to irradiation sometimes gave attractive blue or blue-green results, but most had a green character. A certain amount of adjustment to the lattice took place through subsequent heat treatment. Some stones had as a result assumed quite pretty colours, mainly corn, gold and yellow. There was still much to learn about the mechanics of the colour-changes.

The speaker had had a small diamond put into the Bepo unit, where it was left for some weeks at a very high flux. This stone had turned black and has so far defied all efforts to restore its colour. Two other stones subjected to bombardment in the accelerator had come out respectively blue and, with the stone irradiated by neutrons, green. These experiments had not been carried out very accurately so the information was rather sketchy.

Irradiation could consist of X-rays, gamma rays, electrons, or neutrons, the latter being the source of big bangs and electrical power. The power acted upon things in the most extraordinary ways. The types of irradiation most commonly used were gamma rays, alpha particles, and neutrons.

Mr. Jones then explained the principle of the Bepo reactor and discussed its construction and use.

Both speakers interested members with demonstrations. Mr. Trumper showed what results could be obtained with his spectroscope and Mr. Jones displayed two cases of gemstones showing the effects of irradiation, together with instruments measuring their radioactivity.

Mr. B. W. Anderson proposed a vote of thanks to the two Fellows.

SYNTHETIC MOONSTONE-COLOURED SPINEL

The captions to the illustrations on p. 214 of Vol. VI, No. 5, were unfortunately transposed (*v.* Synthetic moonstone-coloured spinel by A. J. Breebaart, F.G.A., C.G.).

THE PRESIDENT SPEAKS ON GEMSTONES

The Director of the Davy Faraday Research Laboratory, Professor Sir Lawrence Bragg, O.B.E., M.C., M.A., D.Sc., F.R.S., who honours the Association by being its President, spoke on " Gemstones " at the 31st of January Friday Evening Discourse of the Royal Institution. The Friday Evening Discourses are only one of the many activities of the Royal Institution and are in fact social evenings arranged for the members and their ladies and friends ; the speaker, a notable person in the world of philosophy, discoursing on a subject of his particular interest. The talk, semi-popular in style, is given in the historic lecture hall of the Institution in Albemarle Street.

Sir Lawrence commenced his discourse by paying tribute to Dr. G. F. Claringbull, who had been so helpful in assisting in the preparation of the evening's lecture. Credits, too, were given to those who had arranged the exhibits shown in the library before (and after) the talk. In this connexion thanks were given to the Officers of the British Museum (Natural History), the Gemmological Association, the Diamond Trading Company, Messrs. Asprey Ltd., and the Director of the London Chamber of Commerce Laboratory (Mr. B. W. Anderson) and his assistant, Mr. R. Webster. Sir Lawrence also tendered thanks to Mr. Ginder for the loan of a large diamond which was to be used in the lecture demonstration.

Diamond, corundum, beryl, topaz, spinel, tourmaline, garnet, chrysoberyl, zircon and olivine, or, as it is known better in the jewellery trade, peridot, were discussed, and reference was also made to amethyst, citrine and rock crystal. All the major gemstones, except perhaps peridot, had a hardness greater than quartz and were thus able to resist the abrasive action of the quartz particles in the atmosphere. The superior hardness of diamond was explained by the close bonding of the atoms and was illustrated by the use of an atomic structure model.

The high index of refraction of diamond was the main cause of the superb brilliancy of a well-cut diamond, for in such a case the light rays entering the front were returned out again through the front of the stone. This total internal reflection of light was demonstrated by the use of a glass tank containing a fluorescent liquid, the beam of light projected through it being reflected internally at the critical angle for the liquid and air—this critical angle, in the case of diamond, being nearly a quarter of a right angle. The lecturer further illustrated the effect of this return of light in diamond, and the lack of it in a " glass imitation diamond," by an elegant experiment. A diamond and a glass imitation were placed table facet down on diaphrams.. The stones were illuminated from below and the effect projected on to the screen, no light coming through the diamond but a considerable amount through the " paste " stone. The " fire " of a diamond was also discussed and demonstrated by projected diagrams.

Sir Lawrence referred to the synthesis of diamonds by the General Electric Company of America and on the screen were shown (in colour) some of these diamonds and the apparatus used to make them. Some specimens of synthetic diamond were then placed under the epidiascope and by the comparison with the operator's hand their small size could be estimated.

By reference to atomic models the formation of gem crystals was explained as being due to the electronic attraction of positively charged oxygen atoms of relatively large size to small metallic ions with a strong negative charge.

A slide showing the various colours assumed by ruby and sapphire illustrated the coloration by trace-elements and reference to chromium as a colouring agent. Chromium normally gives a green colour but the speaker pointed out that in ruby the ions are in a state of strain, in fact they are " pinched so badly that they turn red." The effects of the selective absorption of light and colour induced by fluorescence were remarked upon. Two pairs of pink-coloured socks were used to demonstrate the effects of selective absorption and coloration by fluorescence, one of the pair of socks being fluorescent and glowing when placed in front of an ultra-violet lamp. Sir Lawrence remarked that fluorescent socks were a new idea, but ruby had the idea all through the ages.

The audience, which had been issued with pieces of cardboard, each framing a circle of polaroid split into two half circles mounted one above the other with their vibration directions at right angles to one another, was then told about the effects of the polarization of light and of dichroism. By the use of the polaroid gadgets polarization by reflection and the dichroism of gemstones were ably demonstrated, and included in these demonstrations was the effect of bad colour in a ruby cut in the wrong optical direction.

The cause of the star effect in star stones was shown to the assembly by an amusing experiment. A sheet of glass was lightly covered with vaseline and strokes with a whitewash brush were made in three directions at 60° to each other. When the sheet was held up with a light behind it, a six-pointed star was clearly seen.

The epidiascope was then used to throw on to the screen a number of boxes of cut stones of various species, species which the lecturer then dealt with in some detail. Referring to the misuse of the name topaz for the yellow quartz, Sir Lawrence mentioned an incident which occurred in Scotland. Seeing a lovely yellow quartz crystal he inquired about it and was categorically told that it was topaz. He queried this and was promptly informed that of course it was topaz and that the interfacial angles were correct for topaz, and further he was told that if he did not understand about the angles the vendor would be willing to lend him a book on the subject.

The difference in the density of topaz and yellow quartz was demonstrated and at the same time a crystal of brown topaz was placed on a retort stand over a lighted bunsen burner. At the end of the talk this crystal was removed and allowed to cool, when it was seen to have assumed a pinkish colour, thus illustrating the " pinking " of topaz. The use of a plate of tourmaline as a producer of polarized light and its early use for that purpose in the tourmaline tongs were also demonstrated.

Double refraction and its effect of doubling of the rear facet edges in the case of such stones as zircon and peridot were shown, but the most impressive demonstration of the doubling effect was produced when a notice was flashed on the screen telling the audience that there would be refreshments available after the discourse. Over this notice was placed a rhomb of iceland spar and the wording then appeared doubled. Finally a polaroid sheet was arranged over the rhomb of calcite and the writing became single again.

Sir Lawrence was applauded for the excellent discourse he had given and then the gathering, which must have numbered about five hundred, left the lecture hall for refreshments and to inspect the exhibits arranged in the imposing library of the Royal Institution.

These exhibits covered a wide field of gemmological endeavour. The Gemmological Association displayed a number of specimen gemstones from their collection. The Diamond Trading Company had on show a magnificent octahedral crystal of diamond weighing 167½ carats besides a suite of plastic models illustrating the stages of the cutting of a brilliant. The British Museum (Natural History) exhibited a number of specimen crystals of gem minerals, among which were a large aquamarine from Brazil, corundum crystals in matrix from Norway and emerald crystals in matrix from the famed Muzo mine in Colombia. Topazes from Russia and Brazil, spinels from Burma, opal from South Australia, kunzite from California, garnet from Italy, and sapphire from Ceylon, were some of the lovely minerals displayed.

One of the London Chamber of Commerce Laboratory displays, under the care of Mr. Anderson, comprised a very full suite of gem-testing equipment, to which could be added the show by Rayner and Keeler Ltd., who exhibited their new Asscher diamond microscope. Mr. Anderson had on display and demonstrated the immersion contact method of refractive index determination, the spectroscope set-up for observation of absorption spectra and the crossed-filter experiment. Mr. Webster at another table showed and demonstrated the use of ultra-violet light of both operable wavelengths, the two lamps for which were kindly loaned by Hanovia Ltd. This demonstration covered the use of the differential response of diamond as a means for the preparation of identity certificates. Coloured transparencies of gemstone inclusions set up in an illuminating frame, loaned by Kodak Ltd., and a case of tumbled stones flanked Mr. Anderson's exhibit.

The display which undoubtedly attracted most attention from the ladies present was a show of mounted jewellery by Asprey Ltd. In a well-lit showcase were suites of jewellery in diamonds and coloured stones of modern design, garnet-set jewellery of the Victorian era and many specimen coloured stones mounted in brooches and pendants. A rose-quartz dish and a seal with a red jasper handle showed beauty in another guise. In another showcase was a large piece of rock containing ruby crystals from the new source in Tanganyika, and alongside the wall an illuminated case contained a working model illustrating *Bragg's Law*, the law worked out by Sir Lawrence himself.

GIFTS TO THE ASSOCIATION

The Council of the Association is most grateful for the following gifts :—

Jade Miscellany by Una Pope-Hennesy, from P. J. Leese, F.G.A.

The Romance of the Jewel by Francis Stopford, from R. K. Mitchell, F.G.A.

Three models of famous diamonds, in case, from E. Burbage, F.G.A.

TALKS BY MEMBERS

R. J. N. Oliver. "Gemstones," Liverpool "41" Club, 6th December, 1957.

Kennedy, N. W. "Woman and Gemstones," 14th January, to Soroptimist Club, Wallasey.

Ewing, D. "Gemmology as applied to Police enquiries," Edinburgh C.I.D., 26th March, 1958.

Webster, R. "Pearls," Tunbridge Wells and Tonbridge Branch of the National Association of Goldsmiths, 25th February, 1958.

Warren, Mrs. K. G. "Gemstones," Business and Professional Women's Club of Bromley and Beckenham, 17th March, 1958.

Jarvis, C. A. "Gemstones," High Road Young Wives, Ilford, 25th March, 1958.

Duncan, J. "Gemstones," Townswomen's Guild, Netherlee, Glasgow, 11th March, 1958.

ANNUAL GENERAL MEETING

The 28th Annual General Meeting of the Association was held at Saint Dunstan's House, Carey Lane, London, E.C.2, on Thursday, 13th March, 1958, at 6.15 p.m. The Vice-Chairman, Mr. N. A. Harper, presided in the absence of the Chairman, who was indisposed.

The Treasurer, Mr. Lawson Clarke, presented the accounts and thanked the National Association of Goldsmiths for their assistance throughout the year. The Secretary read a message from the Chairman who wrote :

" The Association has had another active year and, in particular, it will be noted that our Midlands and West of Scotland branches have been going ahead with a steadily expanding programme. This, I think, you must regard with satisfaction.

" I would like particularly to thank those who have contributed to the success of the Association's year now under review. We are indebted to the examiners for their painstaking work and for maintaining the high standard in our examinations, which enjoy such a world-wide reputation. In addition I would like to thank Mr. Robert Webster for all that he has done in connexion with the practical examination arrangements in London. Our own *Journal of Gemmology* increased in circulation during the year, and we are grateful to those who contributed to its success. I would like to add a special word of thanks to Mr. J. R. Chisholm in this connexion. I am grateful to the members of the Council and to all those who have supported meetings in various parts of the country.

" 'The evil that men do lives after them—the good is oft interred with their bones.' Shakespeare's philosophy was rarely at fault, and here he qualifies with 'oft' the burying of his good deeds with the man. For it is not always so, and we, in the Gemmological Association, have two names we try to keep fresh in our minds . . . those of Dr. Herbert Smith and Sir James Walton. But we remember them for somewhat different reasons. Dr. Herbert Smith was the expert who, by his energies and research, advanced the study of gemmology. He left his own memorial in his book (which is still a standard work on the subject) and we remember him each year when the Herbert Smith Memorial Lecture is given. Sir James Walton was quite a different personality. In fairness he would not be called a brilliant gemmologist. His greatest assets were his sincerity and integrity, and it is these aspects of him that we remember most. For this purpose the National Association and our own organization created the Sir James Walton Memorial Library. The N.A.G. provided the major portion and the final section, a contribution from our own organization, was completed at the end of last year. The library will serve a valuable purpose and I hope that it will keep alive that extraordinary enthusiasm that Sir James brought to bear on the activities of the Association. Very few in the Association can hope to emulate Dr. Herbert Smith —though I am glad to say that we are fortunate in having some who will leave as deep an impression on the subject as he did ; but there is not one of us who cannot be quickened by the memory of Sir James and spurred into activity. There is always much to be done for the Association by the enthusiast."

The annual report and audited accounts for the year ended 31st December, 1957, were adopted.

The following officers were re-elected:—*President:* Sir Lawrence Bragg, F.R.S. ; *Chairman:* Mr. F. H. Knowles-Brown; *Vice-Chairman:* Mr. N. A. Harper; *Treasurer:* Mr. Lawson Clarke. The Vice-Chairman said that the Association was greatly honoured by Sir Lawrence continuing in office.

Miss Iris Hopkins was elected to the Council and Messrs. W. C. Buckingham, A. R. Popley and E. H. Rutland were re-elected. Messrs. Watson, Collin & Co. continued as auditors to the Association.

Professor Cavenago-Bignami, of Milan, sent a telegram conveying good wishes to members attending the meeting.

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C O N T E N T S