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THE JOURNAL OF GEMMOLOGY

and

PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN
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UNUSUAL EMERALDS

By CHARLES A. SCHIFFMAN, F.G.A., G.G.

RECENTLY, there has appeared on the market, in cut form, a type of emerald whose unusual characteristics cannot be likened to those of any of the "classical" occurences.

Since 1966, more and more parcels of these stones have appeared, but as their appearance is still not well known, buyers have occasionally mistaken them for synthetic emeralds. In the interest of the trade, and in order to avoid serious mistakes, the author describes below the recent examination of a parcel of 16 stones, of which the average weight per stone was 1¾ ct.

To the eye and with the help of a lens, the following clues to this unusual type of emerald are quite obvious:

— a strong grass-green colour
— a general clouded appearance, the emeralds being transparent to semi-transparent, this being due more to their structure than to the presence of a large number of inclusions.
— internally, on the inside face of the facets, the light appears diffused and not as lively as the reflections of a properly cut stone carved from a clear crystal.

The good size of the emeralds under examination allowed for a precise determination of the specific gravity, using the hydrostatic method with dibromoethane. A good reading of the refractive index was also obtained.

Specific Gravity

5 emeralds with very few flaws: 2·7250; 2·7133; 2·7109; 2·7052; 2·7021.

10 emeralds with a few more inclusions: 2·69 (average).

1 emerald with flaws (pockets of air) 2·68 (average).

The mean result for material having few inclusions is 2·70-2·72.

Refractive Index

For the 16 specimens, there is a variation in values between:

minimum:	ω 1·581	—	ε 1·576	d.r. ·005
maximum:	ω 1·587	—	ε 1·581	d.r. ·006
the mean values being	ω 1·586	—	ε 1·581	d.r. ·005

The high values of specific gravity and refractive index immediately attract attention because they are higher than the normal values for synthetic emeralds, being the same as those of Colombian emeralds, and lower than those of Siberian emeralds, or emeralds from Habachtal, India and South Africa, as these appear in progressive order in the following list (taken from B. W. Anderson's Gem Testing[1]:—

Usual Characteristics of Emeralds

Occurrence:	*R.I. ordinary ray*	*Birefringence*	*S.G.*
Synthetic (Chatham)	1·564	·003	2·65
Brazil	1·571	·005	2·69
Colombia, Chivor	1·577	·006	2·69
Colombia, Muzo	1·584	·006	2·71
Siberia	1·588	·007	2·74
Habachtal	1·591	·007	2·74
India	1·593	·007	2·74
South Africa	1·593	·007	2·75

Dichroism

As indicated earlier, the colour is a fairly strong grass-green, well saturated and well distributed within the stone. The dichroism is distinct green and yellow-green.

Absorption Spectrum

This, observed visually in transmitted light on a Gübelin spectroscope, shows the normal lines of beryl coloured by chromic oxide:

6835 Å	marked
6806 Å	marked
6620 Å	weak
6460 Å	weak
6370 Å	marked
6200 – 6000 Å	distinct

FLUORESCENCE

With the ultra-violet lamp, under the two wave-lengths 3650 Å and 2537 Å, the stones are inert. In natural light and crossed filters ($CuSO_4$ plus red filter) they show a distinct red hue. Colour under the Chelsea filter is a pale to distinct red hue.

TRANSPARENCY TO ULTRA-VIOLET

It is generally admitted that the synthetic stones have a border of transparency to ultra-violet lower than the genuine stones. The test under the radiation of 2537 Å allows one to observe this phenomenon easily, according to the method described by Norman Day(2);. A word of precaution, however, is necessary because the reaction is not always infallible, at any rate with emeralds. (The author recently tested a Gilson synthetic emerald of about 4 cts., showing the same ultra-violet opacity as a natural emerald that was tested at the same time. Of course, identification could not be made on that test only, and checking of other characteristics allowed for an easy classification of the synthetic).

However, the method is usable and can be applied in the following way.

The transparency is determined by a short exposure under 2537 Å radiation. In darkness the stones are placed directly onto a piece of photographic paper, this being immersed in water. The lamp rests above it, at a distance of about 30 cm. Some proofs, of known transparency, allow the degree of transparency to be ascertained by the stronger or softer darkening of the paper after development (Fig. 1). In the illustration the paper has darkened under the octagonal quartz, which is transparent to ultra-violet. By comparison the sensitive surface stays unaffected under the natural opaque round beryl, this being due to the presence of iron in its composition. The 16 emeralds tested have the same reaction as the natural beryl.

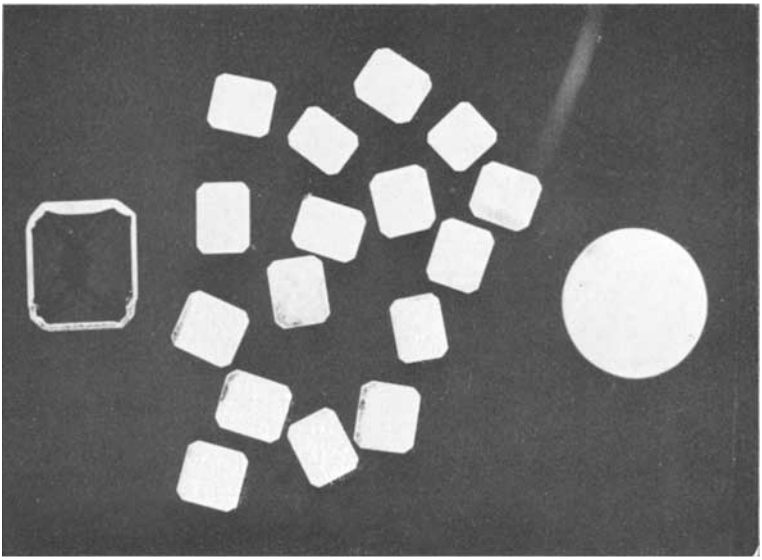

Fig. 1. *Test of transparence to ultra-violet radiation* 2537 Å *with comparison proofs. On the left, the photographic paper has darkened under a natural octagonal quartz, showing its transparence.*

On the right, the photographic paper is clear under a natural beryl, showing also its opacity due to the presence of iron in the chemical composition.

In the centre, under the 16 *emeralds tested, the paper has the same reaction as under the natural beryl, suggesting also the presence of iron.*

Enlargement paper Agfa Brovira, exposure 2 *seconds at* 30 *cm.*

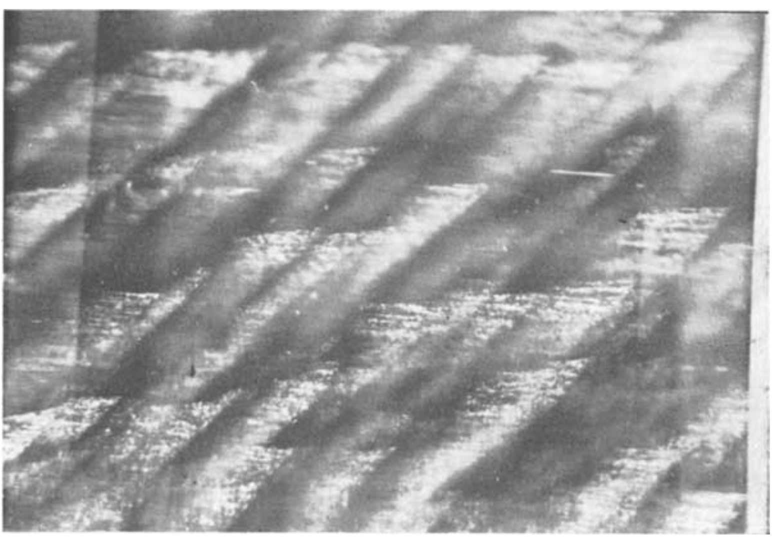

Fig. 2. *Natural emerald: fine channels in parallel bands, the same orientated in successive planes, whose parallel arrangement is impressive. The bands are cut by the table plane at an acute angle of about* 50°, *magnification* 25 ×. *Orange filter.*

Examination under the Microscope

The most interesting characteristics are visible under the microscope. The stones are transparent to distinctly cloudy. This seems to be due not to a great number of inclusions, but more to their own structure. In some way, the appearance of the stones resembles that of a chrysoprase. The most curious of the inclusions are the orientated channels running in parallel bands (Fig. 2). At first sight their general distribution resembles that of synthetic emeralds (see B. W. Anderson: Gem Testing. 7th edn. Fig. 42), which could just as easily cause an error. The difference is, however, seen under stronger magnification. In the synthetics, these inclusions appear like a network of channels spreading without order in all directions.

In the present instance, the bands are arranged in the same direction, all collected together in adjacent planes, and this characteristic is unmistakable. The majority of the stones had been cut in such a way that the plane of the table facet cuts that of the bands at an angle of about 50°.

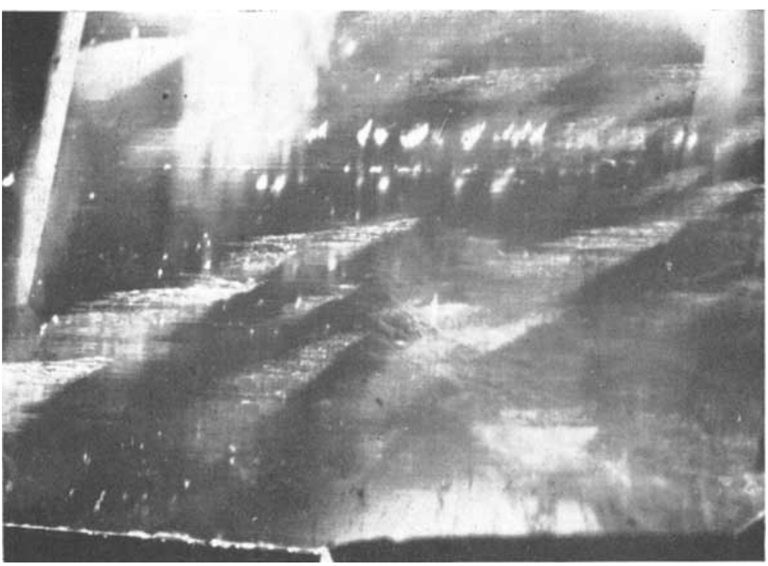

Fig. 3. *Natural emerald: similar bands to those in Fig.* 2 *and small inclusions (fissures) perpendicular to the longitudinal axis of the crystal. Magnification* 25 ×. *Orange filter.*

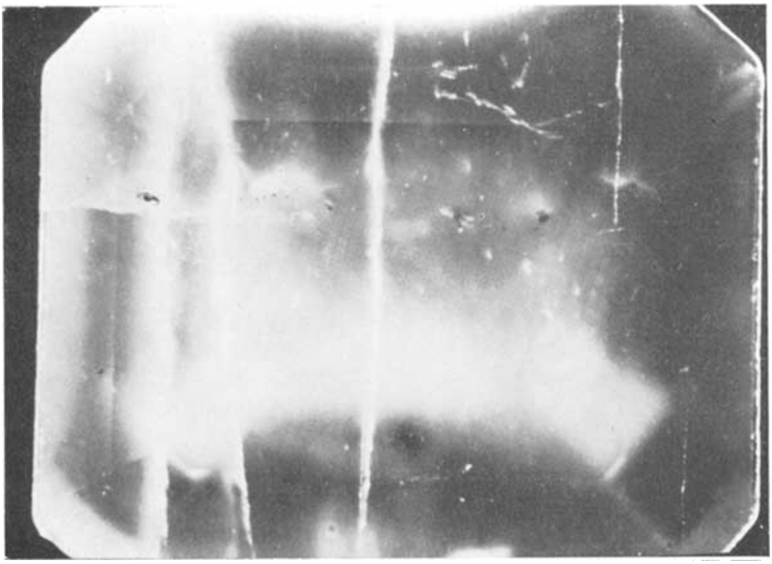

FIG. 4. *Natural emerald: examination under polarising microscope, abnormal extinction between crossed nicols, the stone appearing marbled by diffused zones. Inclusions: thin fissures crossing the whole stone. The general cloudy appearance is well visible. Magnification* 15 ×.

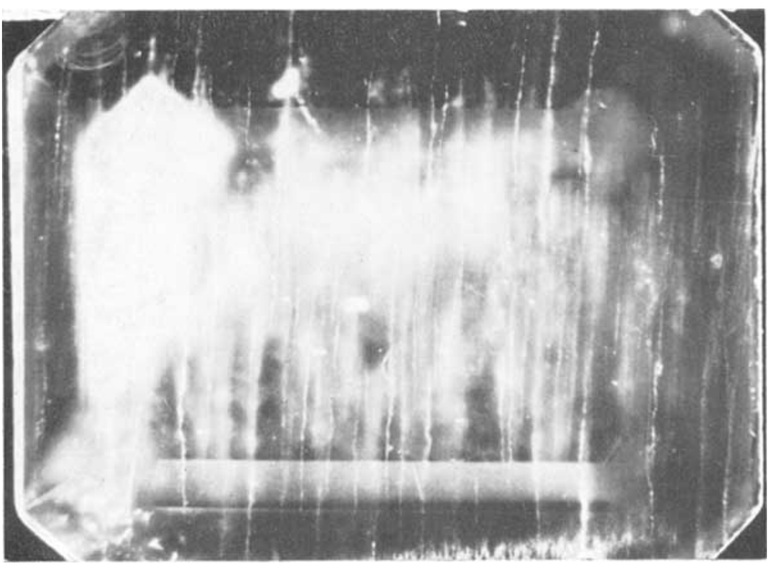

FIG. 5. *Natural emerald: Examination under polarising microscope, abnormal extinction between crossed nicols, typical general cloudy appearance. The marbled distribution, partly recalling the bees nest structure, was more obvious in reality than in this photograph. Inclusions: thin fissures more or less parallel acrosss the stone. Magnification* 15 ×.

Like other inclusions, small clouds of blackish and brownish particles distributed like seeds, as well as brownish films perpendicular to the C axis of the original crystal, have been observed. Moreover, some black granules like those seen in trapiche emeralds can be considered as an indication of natural origin (Fig. 3). Particularly interesting images have been observed while using crossed nicols in a polarizing microscope. On rotation, the extinction is abnormal, i.e. not very striking (Fig. 4). In a favourable position, angular marbled zones feebly resembling the hexagonal structure of a bees' nest, and unevenly coloured, are visible (Fig. 5). Interference colours in parallel belts also appear, recalling polysynthetic twinning patterns.

The various features described, which have not yet been observed together in emeralds of known localities, suggest the possibility of a new source. In the interest of research, it is hoped that complementary observations will soon permit a list of properties of these unknown stones to be established.

Following this line of thought, two recent cases can be recalled.

In 1966, a parcel of six emeralds was examined—the individual weights varying between 0·30 cts. and 1·30 cts.—and the values obtained are as follows:

Refractive index	*Birefringence*	*Specific gravity*
ω 1·586 — ε 1·580	0·006	2·71 to 2·72

The structural characteristics and inclusions were similar to those of the stones mentioned at the beginning of this article.

E. Gübelin, to whom the parcel had been submitted, had not found any clues in the sparse literature existing on this subject. He was then led to consider them to be trapiche emeralds, as a possible source of origin, due—among other things—to the unique character of the black granular inclusions. In order to obtain a reasonable amount of support for his hypothesis, he deemed it necessary to investigate the typical inclusions seen in trapiche emeralds. At his request, an analysis carried out by the Institute of Crystallography and Petrology at the Federal Polytechnic School in Zürich, using the A.R.L. microprobe, has furnished unedited information printed for the first time here.

Three main types of inclusions have been found in the trapiche emeralds examined. Their natures are as follows:

Type 1	Black matter, powdery	
	Chemical element present: C	
	Mineral: carbonic substance (possibly graphite)	
Type 2	Other matter	
	Chemical element present: Si	
	Mineral: quartz	
Type 3	Other matter	
	Chemical elements present: Na, Al, Si	
	Mineral: albite	

There is a similarity with the inclusions of Colombian emeralds, of which the physical and optical properties have been known for a very long time. The analogous properties shown by trapiche emeralds could also well have their source in a parent chemical composition.

The second case is mentioned by F. Duyk, of Brussels, who has recently examined two similar emeralds. The results were as follows:

Refractive index	*Birefringence*	*Specific gravity*
ω 1·592 — ε 1·588	0·004	2·7379

It is interesting to compare these values, somewhat higher than those of the 16 stones mentioned at the beginning of this article, with those of the B. W. Anderson table(1). As for the inclusions found by F. Duyk, they are of the same character. In an attempt to ascertain the natural origin, he increased the microscope examinations up to X300 and even X1200, and in the reflected light could at last discover 3-phase inclusions (Fig. 6). The smallness of the inclusions reproduced should be noted. The side of the cubic crystal in the centre of the image has the true size of five microns. This beautiful photography represents a technical feat accomplished at the Laboratory of Geochemistry of the University of Brussels by Professor J. Jedwap, who demonstrates the possible presence of three-phase inclusions, until now typical of Colombian emeralds.

Fig. 7 shows a crystal section of trapiche emerald, magnified 15 ×. The photograph (transmitted light) shows the starshaped hexagonal outline developed at the time of growth by the inclusion of opaque granules of blackish material. How, from such a rough crystal, does one obtain cut stones without the blackish zones disturbing the colour? The following hypothesis can be given. If one observes the crystal in elevation, it appears that each of the

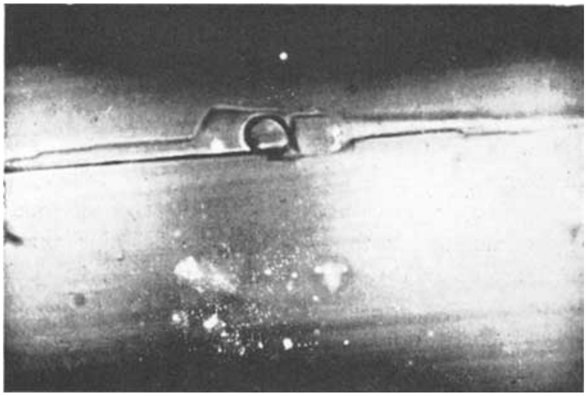

FIG. 6. *Trapiche emeralds: 3-phase inclusions observed in reflected light. The side of the cubic crystal, 5 mm on the photograph, measures 5 microns in reality. Magnification* 1200 ×.

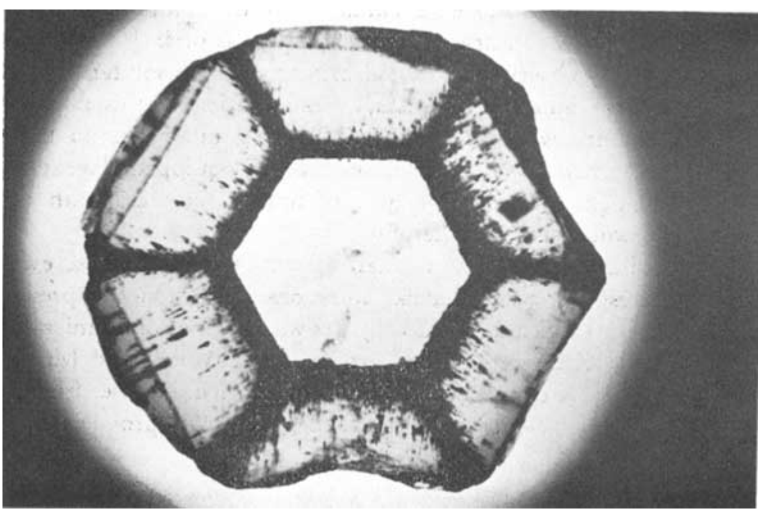

FIG. 7. *Trapiche emerald: Photograph of a section perpendicular to the longitudinal axis of the original crystal. Photographed in natural light. Magnification* 15 ×.

six clear outer zones forms itself into a trapezoidal prism, and the six prisms could be removed individually by sawing across the crystal in the plane of three axes of the star, at 120°. The rough shapes obtained, of a more even colour after the extraction of the blackish parts, which fall away on sawing, could permit the cutting of step-cut stones.

One immediately sees that the arrangement described requires a rough specimen of respectable dimensions. For example, the 16 stones described in this article had dimensions of about 8 × 7·5 × 4·5 mm.

The following question also arises. In what maximum size have trapiche crystals with zonal colour been found until now, of the kind shown in Fig. 7? Statistical information on this subject would be welcomed and would help to solve the problem.

Another question arises. Could another type of trapiche exist, with similar optical and physical properties but, however, without the very marked zonal character of Fig. 7, and which would permit a better use of the material, without having to saw to remove the black bands?

Without doubt the answer to these questions will be given in the near future, because the peculiarities of the stones studied are sufficiently typical to attract attention, and it is desirable that any complementary observation should bring a definite solution to the origin of these unusual emeralds. Classification of this gemmological problem, which actually could bring difficulties to those who do not have on hand the facilities of a well-equipped laboratory, and who might confuse this type of natural emerald with the synthetics, would be most helpful.

The author would like to thank Dr. E. Gübelin, whose ever-lively interest in gemmological questions permitted the present work; Mr. F. Duyk and Professor J. Jedwap for the communication of the results of their research; Professor M. Weibel and Mr. R. Gubser of the Federal Polytechnic of Zürich, whose friendly interest and competence have made the ARL microprobe examination possible.

Source of illustrations: Fig. No. 6—Laboratory of Geochemistry at the University of Brussels (Professor J. Jedwap).
Figs. Nos. 1, 2, 3, 4, 5 and 7—by the author.

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GEMSTONES AT THE I.C.C.G.

By D. ELWELL and J. M. ROBERTSON

THE second international conference on crystal growth (I.C.C.G.) was held in Birmingham in July of this year and formed an important milestone in the development of crystal growth as a scientific discipline. From the earliest attempts by Fremy and others to grow synthetic rubies, crystal growth has been closely linked with gemmology and it is hardly surprising that the ruby is one of the most widely used crystals in scientific devices such as the maser and laser.

In this article an account is given of some of the papers presented at the conference which we felt would be of interest to gemmologists. These examples will indicate some of the recent technical developments which are being applied to the growth of synthetic gemstones.

The methods which have been used to grow synthetic gemstones may be divided into growth from solution and growth from the pure melt. The former category includes hydrothermal growth, in which water at a high temperature and pressure is used as the solvent, and fluxed-melt growth, in which the solvent is a molten salt such as lead fluoride. Growth from the melt is often carried out in the Verneuil oxyhydrogen furnace or by the Czochralski method which involves pulling crystals out of the melt.

Diamonds

Perhaps the most interesting paper from a gemmological viewpoint was that by Angus, Will and Stanko of Case Western Reserve University, Cleveland, U.S.A., who claimed to have deposited diamond onto diamond seed crystals by the decomposition of methane at 1200°C at pressures below atmospheric. The methane gas was passed with helium into a heated zone containing diamonds and the decomposition product was claimed, after careful investigation, to be diamond rather than graphite. However, the proof of diamond formation offered was not wholly conclusive and further study is clearly required.

Work by Dickinson of the U.S. Air Force Cambridge Research Laboratories was carried out to improve the quality of diamonds grown under high pressure from solutions of carbon in metals. The metal solvents studied were nickel, cobalt, manganese and iron. The best crystals grown using a 600 ton tetrahedral anvil press were normally obtained at temperatures in the region of 1800° to 2000°C. Cobalt and manganese gave the best quality diamonds, the cobalt giving very clear diamonds with less colour than the other solvents. Manganese gave finer quality, almost white diamonds free from inclusions. The size of diamonds was in the submillimetre range and is limited since the operation is carried out in a closed system of rather small volume. Mixed metal solvents are now being studied.

Developments in Heat Sources

Several papers were presented on the growth of rubies using novel types of heat source designed to produce less strained crystals than those grown in a conventional Verneuil furnace.

Adamski and his co-workers at the Air Force Cambridge Laboratories have carried out improvements to a Verneuil burner which have resulted in very good optical quality ruby boules. A three-tube burner was employed to give a larger flame and heat shields were used to prevent radial heat loss and hence to reduce the radial temperature gradient. Particular attention was paid to the alignment of the furnace and the resulting boules were of hexagonal rather than circular cross-section. A slab rather than a cylindrical seed crystal was used and the quality of crystals grown was studied for different orientations of the seed crystal. It was found that the hexagonal boules grown perpendicular to the basal plane of the alumina crystal had the highest degree of perfection.

Field and Wagner, also of the Air Force Cambridge Laboratories, used two 5,000 watt Xenon lamps as heat sources. The radiation was focused onto a ruby rod by the use of a novel mirror arrangement which produced a highly concentrated beam. An additional heater was used to control the shape of the boundary between the molten region and the growing crystal. The growth rate was two centimetres per hour and the chromium distribution very uniform. The quality was better than Verneuil grown material but the diameter was limited to $\frac{5}{16}$ in. so that even more powerful energy sources would be required to produce rods of a size suitable for cutting as gemstones.

Ainger and Bickley of the Plessey Company also described an arc image furnace which produced good quality ruby rods but of small diameter. Thermal strains were reduced in materal grown in this furnace by the use of two lamps. One provided the main energy flux which was sharply focused by parabolic mirrors to produce intense local heating of the alumina rod. The second was of lower power and was focused to give a much larger image in order to reduce temperature gradients across the growing crystal. The resulting crystals were almost strain free but this type of furnace is a long way from becoming a practical rival to the Verneuil furnace for economic production of gem ruby.

The most unusual heat source described was that developed by Class of the Materials Research Corporation (U.S.A.). It involves the production of a discharge in oxygen at low pressure by applying a potential of 1,500 to 2,000 volts. Shaped electrodes focus the discharge onto the central zone in which a polycrystalline rod is located and the ruby crystal is grown by passing the rod slowly through the hot zone as in the arc image furnaces. This furnace aroused considerable interest but is still at an early stage of development.

Growth from Solution

Of a number of papers presented by crystal growers from the Soviet Union, the only one of any gemmological interest was that by Kuznetzov of the Moscow Institute of Crystallography. He reported on the hydrothermal growth of rutile at 800 to 2,000 atmospheres pressure and 500 to 700°C. The crystals were only ½ to 1 mm in size after a six day growth period, which illustrates the very slow growth rates normally encountered with this technique.

Wood and White of Imperial College, London, discussed their method of growing spinel crystals from solution in lead fluoride. The fluoride is evaporated off from a 500 c.c. platinum crucible for 6-7 days at 1200°C and crystals of up to 1 inch in diameter may be produced. The crystals have been doped with nickel, cobalt, manganese, chromium and copper to give turquoise blue, deep blue, yellow, red and pale green crystals respectively, all of pleasing appearance.

Wang and McFarlane of the R.C.A. Laboratories, U.S.A., also used this method and made a detailed investigation of the quality of the spinel crystals. The lattice parameter varied from 8·079 to 8·085 Angstrom units (10^{-8} cm), compared with 8·085 for Verneuil- and Czochralski-grown crystals, and the mean value was close to the accepted value of 8·080 Angstrom units.

Flux-grown crystals contain small inclusions of the solvent not visible to the unaided eye and most closely resemble natural gemstones under microscopic examination.

The papers presented at the conference will be published in a special issue of the *Journal of Crystal Growth.*

A ROTATING STONE TABLE FOR THE BENCH POLARISCOPE

By B. F. MARTIN, M.D., B.Sc., F.G.A.

AS an aid in the identification of gemstones the bench polariscope finds considerable use, and it can often be of service when stones are mounted in jewellery. The instrument is of relatively simple construction and can be made by the handyman.

Essentially, the instrument consists of a box, which serves as the base, and to this is attached a vertical arm which is bent over the upper surface of the box. A disc of polaroid is let into the bent arm and lies directly above a second disc of polaroid, let into the upper surface of the box. The discs are fixed in the "crossed" (or "extinction") position. The box houses a small 15 watt lamp, operated by a switch. The base of the box is attached by screws so that there is access to the lamp, and in one side there is an air vent to prevent overheating.

Although commercially-made models are constructed of metal throughout, the home-produced model is more easily constructed from a wooden box with a metal arm screwed on. The polaroid discs can be glued into metal rings, such as those which are used for lens attachments to cameras. The rings may be fixed with contact adhesive into accurately cut holes in the box and its arm, making sure that the polaroid discs are in the "crossed" position.

In testing a stone, to determine whether it is singly or doubly refracting, or shows anomalous double refraction, the light is switched on and the stone rotated between the polaroid discs. Although rotation of the stone is the active operation, most commercially-made instruments have not been fitted with any mechanical device to rotate the stone, presumably because the instruments were originally designed for purposes other than gem-testing, such as testing polaroid lenses. The stone therefore is usually placed on the protecting glass overlying the lower polaroid and manipulated with the fingers, or placed on a small glass plate, such as a microscope slide, which is then rotated. Small stones are difficult to rotate steadily with the fingers and a glass plate is rather awkward to manoeuvre through a full rotation.

When constructing a polariscope for personal use, the author found that the addition of a rotating stone table was a considerable improvement. It consisted of a shallow plastic cap, closed at its upper end with a thin glass plate which served as a table for the stones, whilst the open lower end simply fitted over the ring containing the lower polaroid disc. Two small metal brackets were screwed to the box, on either side of the cap, and their extremities bent over the rim of the cap to hold it in position, but allowing for freedom of rotation

The convenience of a rotating stone table was conveyed to the firm of Rayner & Keeler, Ltd., who now equip their bench polariscopes with such a device. (see advertisement XVII).

ANOTHER LECHLEITNER-MADE SYNTHETIC EMERALD

By W. F. EPPLER

FOR some years Mr. J. Lechleitner, of Innsbruck, Austria, has worked to produce synthetic emerald by the hydrothermal method. His first success, from the commerical point of view, was the "covered beryl", a synthetic emerald with a large core of natural beryl covered with a thin layer of synthetic emerald. This was in 1960(1). At first, this synthetic emerald was called "Emerita" and eventually the product was named "Symerald". The core of natural beryl was cut before it was covered and after covering the thin overlay of synthetic emerald had to be polished. During this process it could happen that one or more of the facets of the stone lost the covered part and also the green colour. To avoid such a fault, in the early period of production the stones were covered a second time not with synthetic emerald but with synthetic colourless beryl. In Fig. 1, the core of natural beryl (below) bears a relatively thin but very dark green layer of synthetic emerald, followed by another layer of colourless beryl (above), to protect the green one. The second run to produce the additional colourless layer seems to be worthwhile for two reasons. Firstly, the protection of the green layer against a damage by the polishing process is guaranteed and secondly, the colour-free synthetic beryl has a growing rate greater by far than the chrome-coloured green material. Therefore it is easy to obtain a thick-layered stone with more weight.

Some years later, in 1964(2), the ingenious Mr. Lechleitner surprised the market with the so-called "sandwiched" synthetic emerald, as shown in Fig. 2. This hydrothermally-grown material started from a thin seed-plate of natural (or synthetic) colourless beryl, which in the first run was "plated" with synthetic emerald. Afterwards it was "enlarged" by synthetic colourless beryl. Cut stones of this type exhibit the sandwich-structure only when they are examined from the side, preferably immersed in a liquid of suitable refractive index.

During his work Mr. Lechleitner tried to accomplish a "complete" synthetic emerald. The first results were small pieces of a dark green colour with many imperfections of growth and therefore they were not very attractive. But he improved his

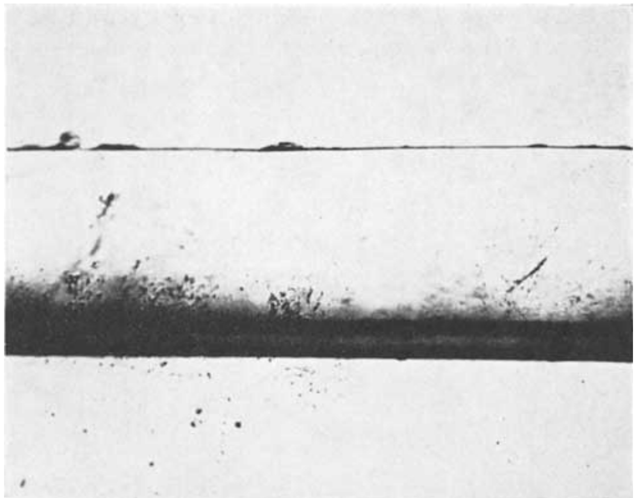


FIG. 1. *Synthetic emerald, so-called "covered beryl". Thickness of the green layer of synthetic emerald is approximateley* 42 *microns, of the colourless coating approximately* 190 *microns.* 120

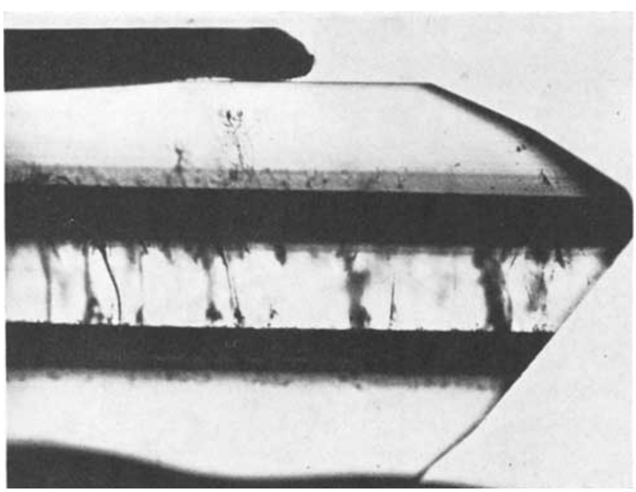


FIG. 2. *So-called "sandwiched" synthetic emerald. The coating of the seed plate has a thickness of about* 300 *microns on each side.* 22 ×

technique until he succeeded in synthesizing an emerald without a core (or a seed) of natural beryl. This happened two or three years ago, but the author obtained samples of it only very recently. The cut stones exhibit a good emerald-green and are fairly transparent. Under long- and short-wave ultra-violet light they produce a weak, dark-red fluorescence.

Using the microscope, it can be observed that this synthetic emerald is grown from a seed-plate of synthetic emerald (Fig. 3), which obviously has previously been grown on a suitable piece of natural beryl. It was sawn off after it had reached the necessary thickness of approximately 0·5 millimetres.

It is evident that the seed-plate of synthetic emerald was placed several times in the autoclave because it was necessary to maintain the supersaturation of the nutrient. But, at the same time, it may be possible that the composition of the nutrient differed a little from that of the foregoing run. This causes an extraordinary striation, as seen in Fig. 3, which is unknown in any other synthetic emeralds.

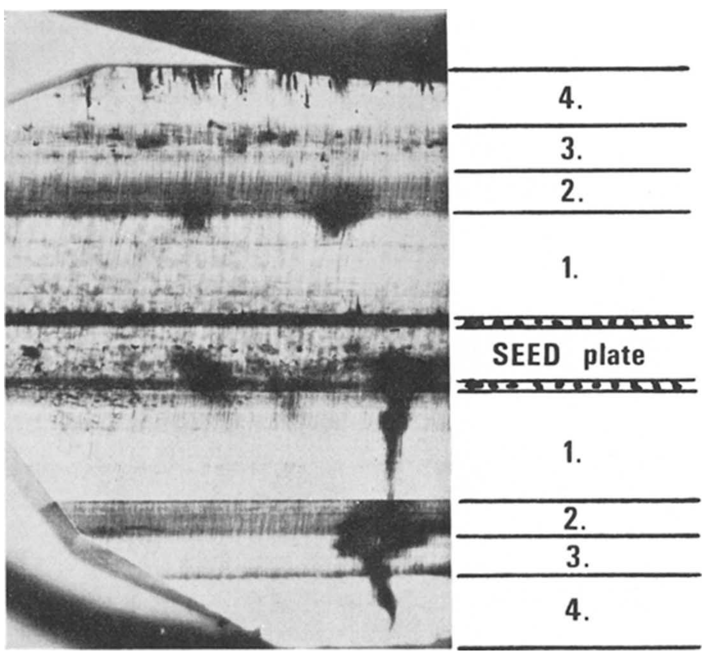


FIG. 3. *The new full-synthetic emerald from Lechleitner. Above and below the seed plate, four grooves of growth can be observed.* 22 ×

In particular, some further irregularities must be mentioned which are not easy to describe. Fig. 4 indicates in some way the "wavy extinction" exhibited by synthetic spinel in polarized light. With a lower magnification, the irregularities resemble cracks or fissures (Fig. 5). In reality, these features, including the darker background of Fig. 5, represent differences in the refractive indices of certain parts of the stone, causing optical boundaries. These phenomena indicate that the growth of the stone was rather difficult.

Another peculiarity of the new synthetic emerald is the very tiny inclusions of rounded material of a brass-like colour. In Fig. 6, some of them can be seen as single spots or in little clusters. In each case, they are the origin of a cuneiformed tube of growth. The presence of this material can only be declared by the supposition that a crystallizer has been used to stimulate the crystallization of the synthetic emerald or its rate of growth respectively.

The physical properties of the synthetic emeralds made by Lechleitner are the following:

					Colour under UV. light	
	nω	nε	nε–nω	S.G.	2540 Å	3650 Å
Synthetic-emerald overgrown on beryl	1·581	1·575	–0·006	2·695	greenish	greenish
Synthetic sand-wiched emerald	1·570	1·566	–0·004	2·678	—	—
Full-synthetic emerald	1·574	1·569	–0·005	2·70	dark red, weak	dark red, weak

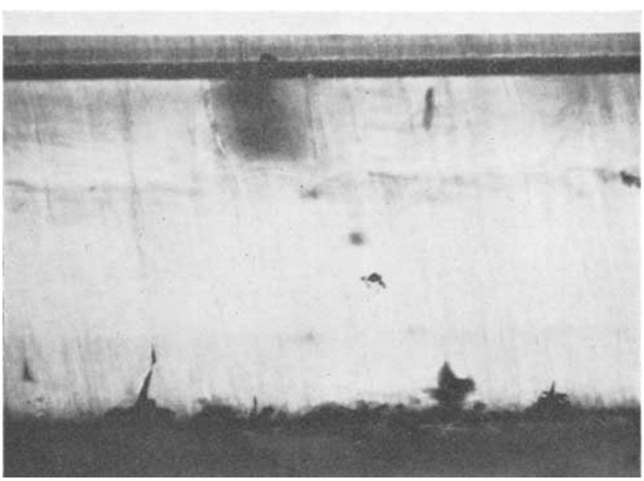


FIG. 4. *Irregular growth of the full-synthetic emerald from Lechleitner.* 65 ×

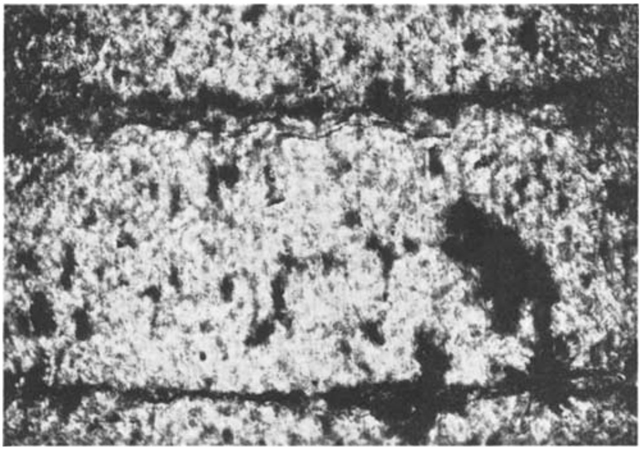


FIG. 5. *Full-synthetic emerald from Lechleitner showing irregular growth.* 22 ×

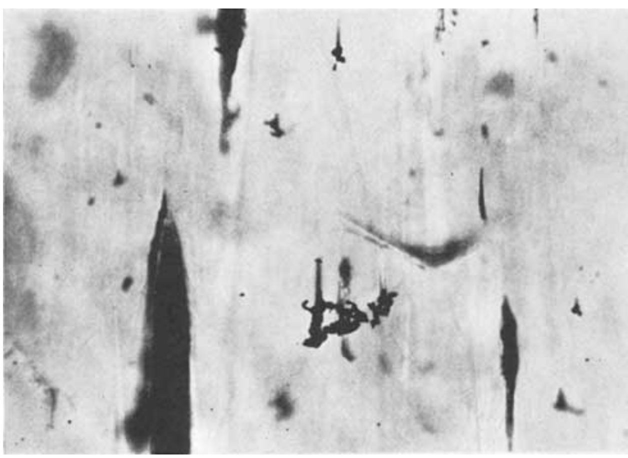


FIG. 6. *Full-synthetic emerald from Lechleitner showing tiny inclusions of brass-like colour, which are the origin of cuneiformed tubes of growth.* 120 ×

ACKNOWLEDGEMENT

The author is indebted to Mr. R. Biehler of Messrs. Ernst Färber, Munich, West Germany, for having placed at his disposal the new material described in this article.

LITERATURE

1. R. J. Holmes and G. R. Crowningshield. *Gems & Gemmology*, Spring 1960, 11–22.
2. R. T. Liddicoat, Jr. *Gems & Gemmology*, Spring 1964, 131–138.

AN INDIAN ULTRA-FLAT BRILLIANT-CUT DIAMOND

By H. TILLANDER

THE standard brilliant-cut has an eight-fold symmetry with 32 facets in the crown and 24 in the pavilion, a fairly large table and in most cases a tiny culet. Further it is fashioned with a deep pavilion, a comparatively low crown and a rather thin girdle. The outline is mostly round or nearly round.

This is the normal definition of the shape into which practically all diamonds have been fashioned since the beginning of the 18th century.

Small and very small diamonds have been cut similarly, but with fewer facets. The modern versions of such decorational stones are the "swiss-" and "single-cuts". Very large diamonds usually received additional faceting.

The brilliant-cut is today essentially equal to those cut one, two or three hundred years ago, with the exception only of experimental shapes which have been created at aiming for an improvement of the traditional design. There are also examples of "fancy" brilliant-cuts where the particular rough diamond has not permitted a normal solution.

One such example is analysed here, a "portrait-diamond" designed like a brilliant-cut above and a single-cut below a very thick girdle.

The outline of this stone is clearly triangular. It is a flat hexagonal plate, apparently cleaved from the face of a large octahedron.

The proportions are listed below and compared with a correctly shaped modern brilliant-cut diamond:

Diameter	12 mm	100 %	100,0 %
Table size		54 %	57,2 %
Culet size		6 %	—
Crown height		3 %	14,0 %
Girdle thickness		4 %	1,5 %
Pavilion depth		1 %	42,1 %
Total height		8 %	57,6 %
Weight		1,41 cts	6,00 cts
Crown angle		9,55°	33,1°
Pavilion angle		1,25°	40,1°

The author believes to have found another example of the early diamond cutters' skill and imagination, a further contribution to the descriptions of historical and curious diamonds. Since this diamond was originally in an authentic old Indian pendant (Fig. 4) it has probably been polished in India.

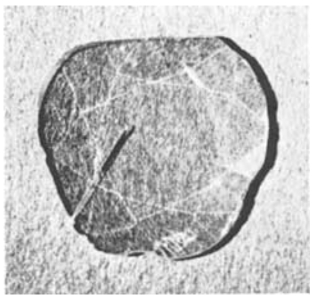


FIG. 1

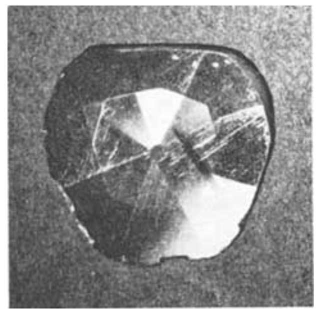


FIG. 2

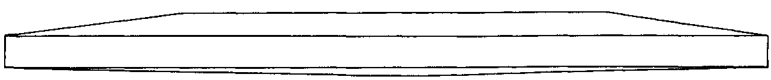


FIG. 3. *A side-view of the diamond showing the extremely thick girdle, the low crown and the hardly distinguishable pavilion.*

FIG. 4

FIG. 1. *Top view of the diamond with the faceting clearly visible.*

FIG. 2. *The diamond viewed from below, the culet in focus and the eight rather badly scratched pavilion facets. The table can be seen through the stone.*

FIG. 4. *A photograph of the Indian enamelled gold pendant with the analysed diamond in the centre. The stone immediately below is a cross-cut rose, the small ones are three-face roses and the hanging drop a briolette.*

THE PETTERSSON PROPORTION-SLIDE

A WELL proportioned diamond is easily recognized by the fine brilliancy of the stone. It is no less difficult to recognize a pronounced "fishy" or an extremely lumpy diamond. The practice in the trade has been to give an approximate description of the "make" of diamond, stating divergencies from generally acceptable proportions, such as the crown is too low or too high, the pavilion too shallow or too deep, the crown angles too steep, the table too large or exceptionally small.

Modern man is however, not always satisfied with such summary descriptions. He may still trust his jeweller and purchase his engagement diamond without asking "pertinent questions". However, in order to meet the ever growing competition from outsiders the jeweller should start proper grading of his diamonds and be prepared to discuss the merits and details of stones he has in stock, as well as those accepted for valuation.

Diamond-grading of the jeweller's level has been done in several countries for many years and the methods have been improved and instruments developed.

For colour-grading, "master-diamonds" scientifically pre-graded can be obtained and neutral light and surroundings is all that is needed in addition to some efficient training.

Clarity-grading also calls for training. One of the newest tools available to the jeweller is the extensive chart published by the Scandinavian Diamond-nomenclature Committee, with nearly 100 diagrams showing combinations of inclusions.

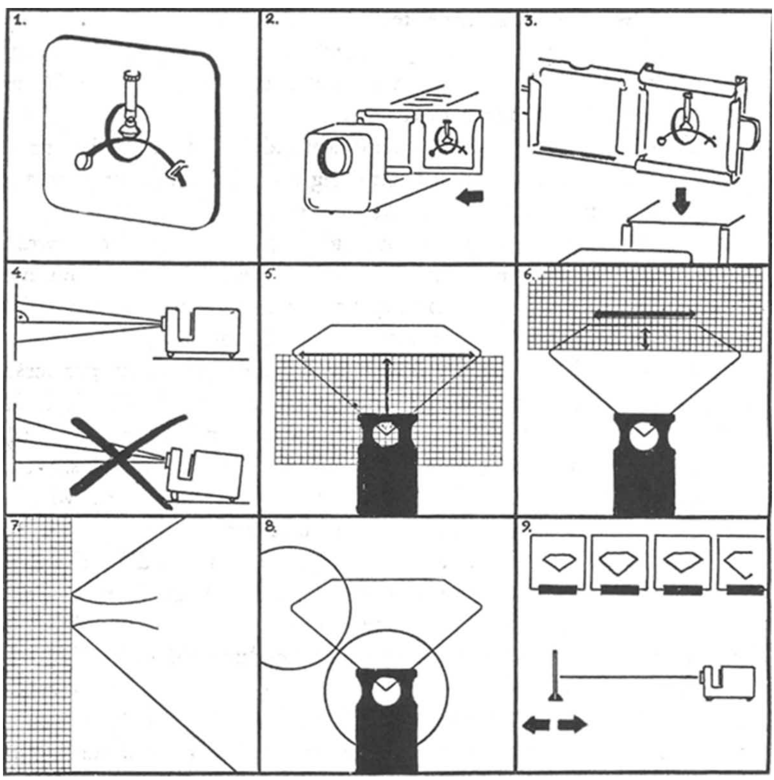
The "make" has hitherto been the problem to many graders. There is an instrument on the market since early in 1967; it is excellent in every respect, but unfortunately calls for a rather expensive investment. U-J Pettersson, F.G.A. has recently designed a simple slide, which fits into any inexpensive projector and which can be used for exact measuring of diamond proportions.

Fig. 1. The slide with a spring holds the diamond firmly in a rotating stoneholder. When the diamond has been inserted the slide is slipped into the sides of the projector as shown on Fig. 2. If the diamond is over one carat the procedure shown on Fig. 3 should be followed. Fig. 4 exemplifies how to use the projector. It should always be kept strictly horizontal. The Figs. 5, 6 and 7 describe how to take the various measurements. Concentrate

first on the girdle and measure the diameter and the depth of the pavilion. This can be done either using millimeterpaper or a slideruler. Fig. 6 shows how to calculate the crown-height and table size, Fig. 7 the width of the girdle. All results should one way or another be translated into percentage figures. Fig. 8 shows how the angles can be measured by applying an angle-ruler against the shadowedges and Fig. 9 a suggestion to use screens with known proportions—for instance the tolerances for very good, good, medium and poor proportions. If space permits these can be placed so that the size corresponds with the shadow of the diamonds in the slide.

No more detailed rules are given, since the PP-slide can be used in many different ways. It seems advisable for every grader to develop the method he finds most convenient to his specific needs.

The PP-slide is available from: The Gemmological Society of Finland, c/o Tillander, Alexanderstreet 48A, Helsinki.



Gemmological Abstracts

HARDER (Hermann). *Zur Farbe der natürlichen Korunde.* Naturwiss., Vol. 54, No. 21, p. 562, 1967.

The relationship between the trace elements content and the colour of natural corundum was investigated by X-ray fluorescence analysis and the electron microprobe. The valence of an iron content ranging from 0·005 to 0·8 per cent was found definitive in determining the colour. Yellow sapphire is characterized by ferric iron. Blue sapphire is characterized by ferrous iron. Sapphire from Khau Ploi Waeng (Thailand) has a uniform total iron content, but is deep yellow on one side and deep blue on the other.

R.A.H.

NASSAU (K.). *On the cause of asterism in star-corundum.* Amer. Mineralog., 1968, vol. 53, 300-305.

Examination by electron microprobe of the fine needles included in pale blue star-sapphire from Ceylon suggests that these needles are Al_2Ti0_5. The needles in Linde synthetic star-ruby were too small for a definite conclusion to be drawn as to their composition; from theoretical considerations they could be either $Ti0_2$ or Al_2Ti0_5.

R.A.H.

ROLFF (A.). *Topaz in Brazil.* Gems & Minerals, 1968, 371, p. 44.

Clear blue and white topaz has been found in the Federal Territory of Rhondonia, near the Bolivian border. Worn pebbles and well developed crystals are found as a by-product of tin mining in the area.

S.P.

BOOK REVIEWS

BOARDMAN (J.). *Archaic Greek Gems.* 1968. Thames and Hudson, London. £6 6s.

This volume has followed quickly after the author's study of the Ionides collection of engraved gems. Schools and the work of artists in the sixth and early fifth centuries B.C. are considered in detail. It is the first account of Greek engraved gems of the period.

The gem material mostly used was cornelian. Agate was not quite so popular. Lapis-lazuli is referred to once, and amethyst twice. Clear rock crystal was used mainly for scaraboids, as was pale chalcedony.

The great skill of the artists of the time resulted in a perfection of gem engraving in ancient Greece. Mr. Boardman's painstaking research has resulted in an authoritative companion volume to his earlier work. The text is excellently supported by 15 colour and 372 black and white illustrations.

S.P.

SINKANKAS (J.). *Van Nostrand's Standard Catalog of Gems.* D. Van Nostrand Company, Inc., Princeton, 1968. 276 pages, illustrated. 75s. or 56s. (paper-back).

This is a very important book: much more so than the title might suggest. The author has attempted the seemingly impossible task of placing a range of values on every conceivable type of gem material, and as a useful preliminary has given us a very clear and reasonable analysis of the factors upon which these values and their wide variations are based. Thus he may be said to have extended to some degree the systematic methods of evaluation which in recent years have been increasingly applied to gem diamonds (in which colour, clarity, perfection of cutting, and weight are recognized as the chief operative factors) to the far more complex and varied field of gemstones in general, and even to pearls and cultured pearls.

Anyone who deals in precious stones needs experience and flair, and a knowledge of the particular markets open to him, if he is to be successful in the business: but even the experienced will find such a book as this helpful when some gemstone outside his usual field is offered or asked for; and it will certainly help the beginner from making gross mistakes.

The author, Capt. John Sinkankas, is exceptionally well-equipped for such a monumental undertaking. The earth sciences have interested him since boyhood, and lapidary work and prospecting for gems and minerals been an absorbing hobby—but his skills in these pursuits are of professional rather than amateur standard. Although he has been writing full-time only since 1961, when he retired after 25 years of distinguished service with the air arm of the U.S. Navy, he has already written a number of books including "Gem Cutting," "Gemstones of North America", and "Mineralogy for Amateurs" which are written with rare originality and accuracy. He quite obviously enjoys writing the kind of book that entails a great deal of hard work.

The "Catalog" opens with a short introductory chapter in which the qualities most desired in a gemstone are enumerated and described. The second chapter, on supply and marketing, contains much useful information not obtainable from other books. Included here are tables of a few weights and measures, which could usefully be extended to cover, for instance, such weights as the Japanese momme and the Indian tola used by pearl dealers in these countries. In this table the grain is given as equal to $\frac{1}{5}$ carat—obviously a misprint for $\frac{1}{4}$ carat, which is the pearl grain. There is apt to be confusion here with the troy and avoirdupois grain which is distinctly heavier (0·324 carat), and should be defined in the table. There is also a very full table for converting the currencies of a large number of countries into terms of the dollar.

The third chapter deals with rough gemstones, and is a massive one of some 80 pages. It opens by discussing the significance to the lapidary of colour, colour-distribution, dichroism, flaws, cleavage, double refraction, etc., and gives practical hints for the critical appraisal of rough material. This part could well have been accorded a chapter to itself. The second part consists of the "Catalog of Rough Gems", in which a very full list of gem materials, including synthetics, is given in alphabetical order, with a range of values in dollars for each according to quality and size. Some of the mineral names included here will be strange to the average gemmologist. At least a score of them are totally unfitted for use in jewellery, as indicated by the author's phrase "collectors' stone only". These only gain inclusion because enthusiastic amateur lapidaries have seen in their fashioning fresh problems to overcome, and because there are collectors avidly seeking for something in the gem world that the other fellow hasn't got. This scraping of the mineral barrel poses quite a problem for authors of books on gemstones who wish to give complete coverage to all minerals used as such, and find it inreasingly hard to draw the line. Water-soluble substances seem so far to have escaped the lapidaries' attentions, so that such things as salt, sugar, and copper sulphate are at the moment safe.

Taaffeite (here spelt with one "f") which is included in the list, is described as "an excessively rare mineral found in pebbles in the gem gravels of Ceylon". Actually this may be regarded as an informed hope for the future, since all four of the known taaffeites have been encountered as already faceted stones. It was quite a relief to find that ekanite and painite are not amongst those present in the "Catalog".

Chapter 4 moves on, logically enough, to consider faceted and cabochon stones, and again consists of two parts which might well be separated. The first 40 pages describe and illustrate the main styles of cutting—and many fancy cuts also, with their appropriate names: the second consists of a price-list for polished stones parallel with that given for rough material. It should be explained that these are much more than mere *lists.* Under each of the more important headings there is a compact description of the stone in question, indications of the sizes available, what constitutes the optimum in colour shades, the main sources, degree of rarity, and so on. Varieties of one species are logically dealt with, as a group. Thus, under corundum, ruby is followed by sapphire; under beryl, aquamarine is followed by emerald, and so on. Under diamond, the grading system worked out for the American Gem Society according to colour, clarity, and cut, is shown in tabular form with their effect on the value of a 1-carat stone. A useful inclusion under diamond is an indication of the value given to irradiated stones. Similarly, under opal one is glad to see values placed upon black opal doublets, and upon treated "black" opal.

The two following chapters deal respectively with engraved gems and with carvings and miscellaneous objects. Each section is again introduced by much general information and advice, including suitability of the various materials for the work in hand. Descriptions, with values attached, of carvings of typical subjects in jade and other hardstones are given as a means of obtaining a rough estimate for a piece which is on offer. Sinkankas is at pains to distinguish between modern mass-produced "commercial" quality carvings, with their lack of detail, crude shaping, and brilliant, glass-like polish, and older carvings of truer merit, the purchase of which he regards as a far wiser investment.

The seventh and last chapter deals with pearls: natural pearls, including saltwater, abalone, conch and freshwater types, but not the shiny black "clam" pearls—and cultured pearls, including saltwater, freshwater (Biwa) and "Mabe" or blister pearls. The section dealing with the traditional oriental pearl, which for hundreds of years has been ranked with ruby, sapphire, emerald and diamond as one of the supremely precious gems, is perfunctory in the extreme, and in considering their value the author does not bother to explain the "base" system as it is still practised amongst those few merchants who understand and deal in genuine pearls.

Cultured pearls, which now of course dominate the commercial pearl market, provide John Sinkankas with an easy ride home to the end of the book, since there are few more organized and regimented products in the whole of jewellery. Diameter (given in millimetres), colour, and quality are the factors considered, 17 inches being taken as the length of a standard graduated necklace. The rise in price with size is even more marked in the case of cultured pearls than with other gems—the small size of *Pinctada martensi* making large pearls extremely rare. Thus the variation in price for a top-grade rosé graduated cultured pearl necklace is given as rising from 75 dollars for a 2 to 5 millimeter strand to over 5,000 dollars for an equivalent 8 to 12 mm. diameter strand.

The "Catalog" concludes with a list of selected recent books on gems and an excellent index. It is hoped that enough has been said to indicate the great interest and value this new book should have, not only for those who deal commercially in gemstones, but for anyone whose concern for the subject is more than skin-deep.

B.W.A.

FISHER (P. J.). *The Science of Gems.* Charles Scribner's Sons, New York, 1966. (London; Transatlantic Book Service Ltd.) 189 pp., 4 colour plates and 89 illustrations in black and white.

The Science of Gems is essentially an American edition of Mr. Fisher's book *Jewels,* which was published in this country by Batsford in 1965, and was reviewed in the *Journal* for April of that year. Although it bears the imprint 1966 it has only recently arrived in England. The book has been considerably revised for this new issue and additions made both to the text and to the illustrations, and the employment of larger type has also helped the publishers to produce a very handsome quarto volume. The new title also is an improvement, since the term "jewels" normally applies to ornaments set with stones rather than to the stones themselves.

As before, the first chapter, on "Gems through History" treats with the earliest use of gemstones, not only for adornment but because of their supposed magical and medicinal properties, and proceeds to describe the development of the craft of cutting and jewellery making from ancient times to the present day.

The second chapter, on "The Nature of Gems" was probably the most difficult for the author to write and is the least satisfactory in the book. It is notoriously a difficult matter to introduce the necessary elements of science to the general reader. One has to be at great pains to be accurate as well as simple, and to avoid as far as possible an "instructional" manner. The author, unfortunately, has difficulty in forgetting his training from course notes, the bones of which can be seen protruding here and there with unhappy effect, particularly in his treatment of atoms, molecules, and crystals.

The next chapter belongs to diamond, which lends itself admirably to striking descriptions and illustrations. Chapter four contains brief descriptions of the score or so gemstones most used in jewellery, together with spodumene, fluorspar, and sphene. Also included are descriptions of the manufacture of synthetic corundum and synthetic emerald. A picture of Carroll F. Chatham (here given as Carroll S. Chatham) at work, looking young and handsome, is reproduced as Fig. 44 and is a welcome innovation. A photograph of Verneuil products is unfortunately printed upside down, making the boules appear as stalactites instead of the stalagmites they really are. An interesting addition is a description of the functioning of synthetic ruby as a laser material. Synthetic spinel and strontium titanate are briefly mentioned in this chapter, but neither here nor elsewhere is any helpful information offered which might enable them to be recognized. Synthetic spinel, both in its popular "aquamarine" colour and as a substitute for diamond in cluster rings and the like, is so extensively on the market that it merits more attention in the text.

Following a chapter on organic gems, treating with pearl, cultured pearl, amber and coral, comes one on diamond cutting, with a few words on the lapidary's craft at the end. In the diagram (Fig. 70) of dispersion in diamond, white light is shown entering the side facets of the crown and emerging as separated colours from the table. In practice it is light travelling in the reverse direction which is effectively dispersed, and emerges as coloured rays from the side facets of the crown.

In the last chapter, simple methods of gem testing are described, by specific gravity, refractive index, absorption spectra and inclusions under the microscope. The simplest and most generally useful of all testing instruments, a good 10 × lens, is not mentioned; nor are two other pocket-sized aids to identification—the dichroscope and the Chelsea filter.

The book concludes with three appendices, a glossary, a short bibliography, and a good index. Appendix I consists of the now conventional table of the stones described in the text, with their varieties, physical properties, and occurrence; but the two pages occupied by the other appendices might be more usefully employed. One is a conversion table between grams and carats, which presupposes an inability in the reader to divide or multiply by five. The other gives the numbers of diamond workers in eight main centres: information which could easily have been incorporated in the main text.

Most of the above criticisms and others unuttered are individually of minor importance, but they should be attended to if this is to become not merely a popular, but a *good* popular book on gemstones.

B.W.A.

ASSOCIATION NOTICES

HISTORY OF OPAL MINING IN DUBNIK

The Director of the Technical Museum in Kosice, Czechoslovakia, is compiling a history of opal mining in Dubnik and would be interested to hear from readers of the *Journal* who might be able to assist with information.

In 1901 a Mr. G. A. With, London, and in 1908 Mr. J. Carew Martin, also from London, showed a great interest in the opal mining in Dubnik, and in 1905 Mr. W. H. Shrubsole visited the mines and lectured about them on his return to London. Any information concerning these persons or the early history of the opal mines near Červenica (or in Hungarian known as Vörösvágás, now in Czechoslovakia but formerly Hungary) should be sent to the Secretary of the Association.

GEM DIAMOND EXAMINATION 1968

In the 1968 Gem Diamond Examination held by the Association there were 17 entries and the following is an alphabetical list of the successful candidates:—

Qualified with Distinction

Nash, Geoffrey Edwin, Great Wyrley
Taylor, Andrew William, London

Qualified

Bodenham, John Edward, Halesowen
Brown, Judith Audrey (Miss), Altrincham
Buckler, Albert Norman, Kidbrooke, London
Bytheway, Keith Leonard, Walsall
Cuss, Christopher Jude, London
D'Arcy, Michael Stephen, Peterborough
Gay, Alan Leslie, Bartley Green, Birmingham
Goodman, Brian John, Walsall
Hayes, Lillian Eveline (Mrs.), Aylesbury
O'Shea, John Patrick, Worthing
Popper, Madeleine Charlotte (Miss), London
Sanford, Peter, Hatfield
Sloman, Peter, Southend-on-Sea
Talbot, Peter Ernest, Westcliff-on-Sea
Wade, Michael Balfour, Edgware

MEMBERS MEETING

Mr. Alan Henn, Chairman of the National Association of Goldsmiths, will present the awards to successful candidates in the 1968 examinations at Goldsmiths Hall, London, on the 23rd October, 1968 at 7.15 p.m.

GEM CRYSTAL TRANSPARENCIES

The first series of colour transparencies of crystals of the twelve principal gem minerals was compiled by R. Keith Mitchell, F.G.A. with the idea of bridging the difficulties experienced by some students in recognising crystal habits. In spite of the high cost of colour duplicates the series proved very successful and has been a considerable help in the field for which it was intended.

Since three printings have now been sold, a second edition has now been substituted for the original version. The total number of specimens illustrated has been increased from about 160 to 210. Less than one third of these were used in the first series. The first printing of this new edition consists entirely of direct photographs, produced by using Pentax single reflex equipment. Subsequent printings will be copied with the same apparatus. Thus a greatly improved standard of definition has been obtained when compared with the commercial copies used in the first edition.

With this equipment it was possible to pay particular attention to image size and to fill each frame to give larger and more detailed pictures of most crystals. The directional nature of electronic-flash lighting is also well used and only in one instance has it failed to produce the precise effect desired. In most specimens sharp detail is recorded even to a fortuitous thumb print on a tourmaline crystal which the eye had missed.

In spite of rising costs these improvements have been achieved with only a small increase in cost and gem crystal transparencies are available from the Gemmological Association at £2 15s. 0d. complete, plus postage.

GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to Mr. D. L. Ackworth of Las Vegas, Nevada, for microfilms of volumes 1 and 2 of the *Journal of Gemmology*.

Mr. J. G. Roach of Johannesburg, South Africa, has kindly donated mineral specimens from Swaziland and North Transvaal for the Association's collection.

WARNING RE. SCHEELITE

It has come to the notice of the Association that some specimens of scheelite which have been offered to collectors have proved to be synthetic. Intending purchasers are advised to obtain laboratory reports in cases where doubt might exist.

OBITUARY

Mr. Vete G. Black, age 54, of San Diego, U.S.A., 14th July.(D. 1958).

MIDLANDS BRANCH MEETING

The annual general meeting of the Midlands Branch was held on the 2nd May, 1968, at the Auctioneers' Institute, Birmingham. The following Officers were elected:—

Chairman:	Mr. D. N. King, F.G.A.
Deputy Chairman:	Mr. N. A. Harper, F.G.A.
Vice-Chairman:	Mr. P. Stacey, F.G.A.
Secretary:	Mrs. S. E. Hiscox

A meeting was held on the 6th September, 1968, in Birmingham, at which Mr. Lionel Burke spoke on Mining and Distribution of Rough Gem Diamonds.

SCOTTISH BRANCH

The Annual Summer Outing of the Scottish Branch of the Association took place on Sunday, 9th June, to Usan, by Montrose in Fife.

More than 40 members from Aberdeen, Edinburgh, St. Andrews and the Glasgow area spent the day on the foreshore.

Agates were found on the beach and also in the rocks above the beach. Agates were found *in situ* in the rocks by the beach and also good samples of calcite, quartz and garnet were located.

Below high water mark agates could be picked up from the beach and should prove most interesting.

GEM-DEALING BUSINESS

Englishman 32, interested in small partnership in gem-dealing business. Would appreciate hearing from an established dealer. Replies treated in confidence. GA/68/2, Gemmological Association.

ASSOCIATION TIES

Ties bearing the crest of the Association, in all-over pattern in yellow, are available in terylene or crimplene, price 22s. 0d. including postage.

ADVERTISEMENT

Mr. M. Davis regrets that the colour charts advertised in the July 1968 issue of the Journal (p.ii) will not be available until December.

COUNCIL MEETING

At a meeting of the Council of the Association held on the 10th September, 1968, it was decided to terminate probationary membership. Consequently no new probationary members will be accepted. The membership of those who already fall into this category will continue until the 31st December, 1969.

The Council further agreed that Bye-Law 10 be amended by substituting the words "Arms or emblem of the Association" for the word "seal". This Bye-Law prohibits the exploitation of the emblem of the Association or any colourable imitation thereof without the consent of the Council.

The Council considered that the Association might be consulted from time to time by Weights and Measures Inspectors in connection with the Trade Descriptions Act, 1968, which would come into force on the 30th November (U.K. only). It was agreed to include in the Association's recommended nomenclature a definition for compact limestone and stalagmitic calcites.

The following were elected to membership:

FELLOWSHIP

Buckingham, Robert George, Witney, Oxon. D. 1968.
Mitchell, Frank Richard, Frampton on Severn, Glos. D. 1968.

TRANSFERS FROM ORDINARY AND PROBATIONARY MEMBERSHIP TO FELLOWSHIP

Alabaster, A. Paul, Birmingham
Arends, Henri, Aerdenhout, Holland
Bartolo, Cynthia Milvaine, Salisbury, Rhodesia
Beechey-Newman, Hansel J. A., Falmouth
Berlin, Ronald, London
Blackburne, James William, Warrington
Bond, Ian Norman, Whangarei, New Zealand
Butler, Terence, Bologna, Italy
Carr, Malcolm, Addington
Coleman, Walter D., Arvada, U.S.A.
Covent, Richard J., Toronto, Canada
Crawford, Leslie Raymond, Pforzheim, West Germany
Dickenson, Henny, Salisbury, Rhodesia
Engstrom, Barbara, Watford Green
Gosling, James Granville, Coulsdon
Grimminger, Alfred, Frankfurt/Main, Germany
Halls, Norman Edward, London
Holmes, Graham John, Bexhill on Sea
Hughes, Anthony, Bradford
Jamieson, Sara Blackburne, Coleraine, N. Ireland
Ledbetter, Susan, Dublin, Ireland
Mitchell, Roger, London
O'Donoghue, Michael John, London
Poultney, Sidney Augustus, Salisbury, Rhodesia
Sadler, David Alex, Ayr
Schupp, Heinz, Pforzheim, West Germany
Staatsen, Albertus Claudius, Utrecht, Holland
Summerhayes, Edward, Gravesend
Swithinbank, Pamela Adele, Lowton, Lancs.
Taylor, John, Bridgend
Turner, George Maurice, Airdrie
Van Den Berge, Anton, Hoofddorp, Holland
Van Starrex, Gertrud, Colombo, Ceylon
Waldegrave, John Geoffrey, Taumarunui, New Zealand

ORDINARY MEMBERSHIP

Alyea, Robert, Ontario, Canada
Armstrong, Richard David, Illinois, U.S.A.
Ashelford, Enid (Mrs.), N.S.W., Australia
Badour, Bernard, Manila, Philippines
Bailey, Helen Moyle (Mrs.), Ohio, U.S.A.
Belenke, Burton, Florida, U.S.A.
Blair, Stella (Mrs.), Longtown, Cumb.
Bourgois, Pieter, Ootende, Belgium
Clowry, Raymond Vincent, London, S.W.18
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Brereton, Diarmuid Joseph, London, E.8
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EXAMINATIONS IN GEMMOLOGY 1968

In the 1968 examinations in gemmology organized by the Gemmological Association of Great Britain, 380 candidates sat for the preliminary examination and 244 for the diploma. Centres were again established in many parts of the world and the number of entries for both examinations was the highest in the history of the Association.

Upon recommendation of the examiners the Tully Memorial Medal and Rayner Prize have been awarded to Mr. Stephen Jones of Newcastle upon Tyne.

The Rayner Prize in the preliminary examination has been awarded to Mrs. Jutta Elisabeth Manser of Southampton.

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

Diploma Examination

Tully Medal and Rayner Prize

JONES, Stephen Richard, Newcastle upon Tyne.

Qualified with Distinction

Bartolo, Cynthia Milvaine, Salisbury, Rhodesia
Butler, Terence, Bologna, Italy
Crawford, Leslie Raymond, Pforzheim, West Germany
Dickenson, Henny, Salisbury, Rhodesia
Domenech Bisbe, Juan, Barcelona, Spain
Gastager, Max, Bad Reichenhall, W. Germany
Gosling, James Granville, Coulsdon
Grimminger, Alfred, Frankfurt/Main, Germany
Holmes, Graham John, Bexhill-on-Sea
Jones, Stephen Richard, Newcastle-upon-Tyne
Mercer, Ian Frederick, London
Nwe, Yin Yin, Rangoon, Burma
Pairman, Gordon Sinclair, Leven, Fife
Solans Huguet, Joaquin, Barcelona, Spain
Traveria Cros, Adolfo, Barcelona, Spain
Turner, George Maurice, Airdrie
Win, Soe, Rangoon, Burma

Qualified

Alabaster, A. Paul, Birmingham
Arends, Henri, Aerdenhout, Holland
Arla Felisart, Ramon, Barcelona, Spain
Ash, Stephen Leslie, Exeter
Aye, Tun Tin, Rangoon, Burma
Baguena Ruiz, Carlos, Barcelona, Spain
Ball, Norman Douglas, Exeter
Barlow, Seaton, Totnes
Barrenger, Jonathan, Weybridge
Beechey-Newman, Hansel J. A., Falmouth
Berlin, Ronald, London
Blackburne, James William, Warrington
Blockley, Doreen Sandra, Cheadle
Bond, Ian Norman, Whangarei, New Zealand
Bos, Elisabeth Greet Gerrie, Amsterdam, Holland
Broughton, Timothy John, Knutsford
Bruquetas Dot, Eduardo, Barcelona, Spain
Buckingham, Robert George, Witney

Butler, Barry, Sheffield
Carr, Malcolm, Addington
Coleman, Walter D., Arvada, U.S.A.
Collin, Alan Arthur, Chester
Connard, John Martin, Southport
Covent, Richard J., Toronto, Canada
Dalewski, Orest, London
Derges, Leonard Frederick, Paignton
de Souza, Victor Joao, Kobe, Japan
de Vroomen, Leonardus Johannes Maria, London
Dey, Bimal P., Rangoon, Burma
Engstrom, Barbara, Woodford Green
Fieldhouse, John Ernest, Sutton Coldfield
Gibson, Paul Walter, London
Glen, Susan Elizabeth, Coventry
Goodson, David Lloyd, Tettenhall
Halls, Norman Edward, London
Hayes, Brian, Sheffield
Holden, Terence, Southport
Holroyd, Philip, Frodsham
Htein, Win, Rangoon, Burma
Hughes, Anthony, Bradford
Hulme, Elizabeth, London
Jamieson, Sara Blackburne, Coleraine, N. Ireland
Kaye, David, Leicester
Kjendlie, Karl M., Larvik, Norway
Ko, Ko, Rangoon, Burma
Ledbetter, Susan, Dublin, Ireland
Lewis, David Trevor Keyes, Nottingham
McAleese, David Albert, Toronto, Canada
Millington, Grenville Arthur, Warley (Worcs.)
Mitchell, Frank Richard, Frampton-on-Severn (Glos.)
Mitchell, Roger, London
Moreno del Rio, Carlos, Barcelona, Spain
Morgan, Deryck, Treforest
Morrow, Roger Anthony, Lymm (Cheshire)
Mu, Khin Saw, Rangoon, Burma
O'Donoghue, Michael John, London
Pardoe, Paul Roger, Worthing
Pass, John, Crewe
Pitt, Robert William, Sutton Coldfield
Pladellorens Lluch, Jose, Barcelona, Spain
Poultney, Sidney Augustus, Salisbury, Rhodesia
Pragnell, Jeremy, Stratford-upon-Avon
Purchon, Eric, Bradford
Pye, George Anthony, Kingswinford (Staffs.)
Sadler, David Alex, Ayr
Samuels, Stephen Jeffery, London
Satterthwaite, Frank Clement, Wraysbury
Schupp, Heinz, Pforzheim, W. Germany
Scott, Colonel Conroy, Salisbury, Rhodesia
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Thein, Hla, Rangoon, Burma
Thin, Nyan, Rangoon, Burma
Thompson, Michael William, Knebworth
Torrents Domenech, Thomas, Barcelona, Spain
Van Den Berge, Anton, Hoofddorp, Holland
Van Starrex, Gertrud, Colombo, Ceylon
Waldegrave, John Geoffrey, Taumarunui, New Zealand
Williams, Christopher John, West Wickham

Winterson, Martin Richard, Bristol
Wohlwend, Hans Ruedi, Rothenburg, Switzerland
Zara, Louise Vida, Leicester
Zaw, Khin, Rangoon, Burma

Preliminary Examination

Rayner Prize

MANSER, Jutta Elisabeth, Southampton.

Qualified

Abbott, Arthur Colin, Ripon
Alabaster, Wendy Jane, Stratford-upon-Avon
Ali, Nasim, Sutton
Allen, Rendall James, Darwen (Lancs.)
Almenar, Ibanez Vicente, Barcelona, Spain
Alvarez, Fernandel Laurentino, Barcelona, Spain
Alvarez, Fernandez Manuel, Barcelona, Spain
Ma Amigo, Descarrega Jose, Barcelona, Spain
Andrade, Malde Julio, Barcelona, Spain
Andrews, Robert Eric, Cheadle Hulme
Apter, Alexander, London
Arbunies, Andreu Manuel, Barcelona, Spain
Asami, Yukiko, Tokyo, Japan
Aye, Tun Tin, Rangoon, Burma
Babot, Vizcaino Enrique, Barcelona, Spain
Bartlett, Stewart Michael, Northwich
Bates, William Ernest, London
Beaver, Francis Bertram, London
Beck, Russell Joseph, Invercargill, New Zealand
Bedingfield, Roger, London
Benet, Tejedo Jose Antonio, Barcelona, Spain
Bennett, Augustus, Sheffield
Bloomberg, Maurice, Ilford
Bosch, Senao Ma Pilar, Barcelona, Spain
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Bradley, John Raymond, Cardiff
Bradshaw, Stephen, London
Brennan, John Douglas, Birmingham
Brooking, Grassy Alberto, Barcelona, Spain
Broomhall, Alan Richard, West Bromwich
Brown, Kenneth John, Sydney, Australia
Brumpton, Jean Frances, London
Burke, Winifred Mary, Bromley
Cader, M. Fazli, Colombo, Ceylon
Calvert, Leonard Silverwood, Brough (E. Yorks)
Camerer, Carin Elizabeth, Stellenbosch, S. Africa
Campbell, Ian Colin Cecil, Bulawayo, Rhodesia
Campbell, Lucie, London
Carballal, Cirici Montserrat, Barcelona, Spain
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Castellano, Munoz Carlos, Barcelona, Spain
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Taipei, China
Christophersen, Elsa, Croydon
Citoler, Tormo Ignacio,
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Stellenbosch, S. Africa
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Canada
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W. Malaysia
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