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A SPECIFIC GRAVITY BALANCE

By Sir James Walton, K.C.V.O., F R.C.S., B.Sc., F.G.A.

THE determination of the specific gravity has tended to be neglected by gemmologists, for the hydrostatic method is rather prolonged and tedious and the use of heavy fluids requires constant control of the accuracy of the fluids.

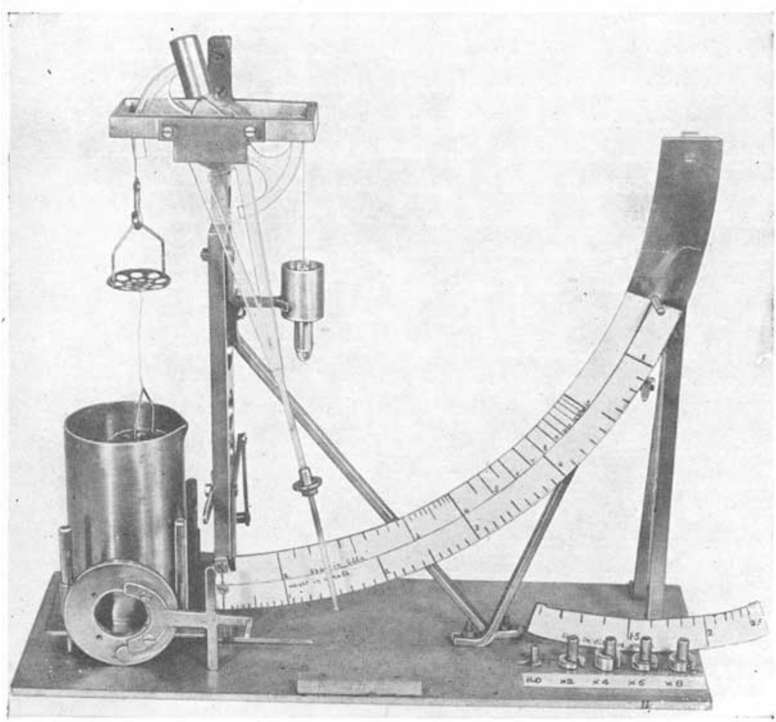
For some time I have been experimenting to produce a balance which in a few minutes would give a direct specific gravity reading sufficiently accurate for diagnostic purposes. The following is a description of a model which has been able to meet these requirements. It differs from an ordinary balance in that the arms, instead of moving only for a few degrees, have to traverse an arc of 90° and the position of the centre of gravity has to be altered.

Two arms (B) extending for 32 mm. from the centre of a pinion (A) terminate in grooved quarter circles (C). In the grooves lie silk threads which on the left support two scale pans united by thin tantalum wire and on the right a counter weight (E). Hence the horizontal distance of the points of suspension from the centre of the pinion does not alter as each arm moves through 90°. A long pendulum with a screw thread cut on its lower part is also attached to the pinion ; at its lower end a weight (F) can be moved up and down the threaded portion, and a counter-weight (G) is attached to the upper end of the pendulum bar. The whole of this unit must be of the lightest weight possible commensurate with rigidity or a high modulus of elasticity. After many experiments perspex was found to be the most satisfactory material. The pinion is supported by a strip of razor blade or a narrow agate wedge (H) which passes through it at an angle of 45° with the horizontal. It rests on either side in two short lengths of glass or pyrex tubing, so that it rotates around its edge with hardly any friction.

Below the lower scale pan is a beaker resting on a stage which is capable of being raised or lowered by an eccentric wheel. When lowered the fluid in it is below the lower pan ; when raised this pan is entirely submerged. The counter-weight (E) consists of a hollow duralumin tube with a screw top. It contains lead filings of an amount necessary to give an accurate balance. The scale has two series of gradations, the lower giving the weight and the upper the specific gravity.

The principle of the balance is that the point of suspension is above the centre of gravity and is in such a position that if L is the length of the balance arm, 6 carats the weight to be placed in the pan, W the weight of the pans, balance arms and counter-weight, and X the height of the point of suspension above the centre of gravity, then $WX=6L$, and since W and L can be measured X is easily estimated. When on such a position, and a weight of 6C is placed in the upper pan, the balance will swing round until the centre of gravity lies in the same horizontal line as the point of suspension. In this position the balance is unstable, therefore only 5/6ths of the arc is used ; that is, the scale is graduated up to 5C and a stop placed above this. The distance between the point of suspension and the centre of gravity will be inversely proportional to the weight of the perspex unit and its appendages. These, therefore, must be made of the lightest possible materials in order to give a working distance. Even with the extremely light materials used in this model it was only 2.25 mm.

The pendulum weight (F), made of brass, is screwed up to a convenient position on the pendulum ; a counter-weight (G), also



A new type of specific gravity balance. The upper scale gives sp. gr. 2-15, using carbon tetrachloride. The lower scale gives weights 1-5 carats. The smaller supplementary scale gives sp. gr. 1-2.5, using water.

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of brass, is made of such a size that when screwed home on the upper end of the pendulum and the latter placed on a knife edge running through the point of suspension, an accurate balance is obtained. The pans and their counter-weight are weighed against one another, with the lower pan suspended in carbon tetrachloride, on an ordinary hydrostatic balance, lead filings being added to the counter-weight until they balance accurately. The pendulum is then permanently fixed to the pinion with perspex solution in such a position that when hanging vertically the balance arms form an angle of 45° with the horizontal (Fig. 4).

With the lower pan in the fluid (carbon tetrachloride) the pendulum will hang vertically and will thus be the zero point on the scale ; when a 5-carat weight is placed in the upper scale pan the pendulum will swing round for 5/6ths of the quarter circle, i.e. 75° from the vertical, if not, a slight adjustment of the pendulum weight (F) is made. The stop (S) is screwed up to it and fixed with perspex cement ; the rest of the scale is then graduated.

In use the beaker is raised so that the lower pan is submerged, the specimen placed in the upper pan, the pendulum released and will swing along the scale to give the correct weight. The pendulum weight (F) is slowly screwed up and so gradually raises the position of the centre of gravity. As a result the pendulum slowly rises, the adjustment being made so that it comes to rest exactly opposite the figure 5 on the lower scale. The pendulum is then placed back at the zero point and fixed. The beaker is lowered, the specimen placed in the lower pan, the beaker again raised, and when the pendulum is freed it will register the correct specific gravity on the upper scale.

The principle is that whatever the weight (up to 5 carats), the raising of the pendulum weight makes it register 5 unknown units ; then, since the weight of fluid displaced is always a fixed proportion of the weight in air, the correct specific gravity will be given on the upper scale, e.g. corundum of specific gravity 4 will lose a quarter of its weight in water, whatever its weight may be ; hence, if it is made to register 5 unknown units, it will, when weighed in water, lose a quarter of its 5 units, so that the mark 4 on the upper scale will be opposite the 3.75 on the weight scale. The specific gravity scale can therefore be estimated, but it is controlled by the use of minerals of known specific gravity.

The upper limit of the scale is 5 carats, but four extra weights are made which slip over the pendulum weight (Fig. 6). They are very carefully graduated so that when in use the scale has to be multiplied by 2, 4, 6 and 8 respectively, and hence the range of the instrument is extended to 40 carats. The lower limit is about 1 carat, for below this the viscosity and surface tension of the fluid, even when carbon tetrachloride is used, makes the movement of the pendulum so sluggish that the specific gravity readings are uncertain.

Certain substances of very low specific gravity, such as amber, jet, ivory and the plastic imitations, will float in carbon tetrachloride and hence distilled water will have to be used. Different readings

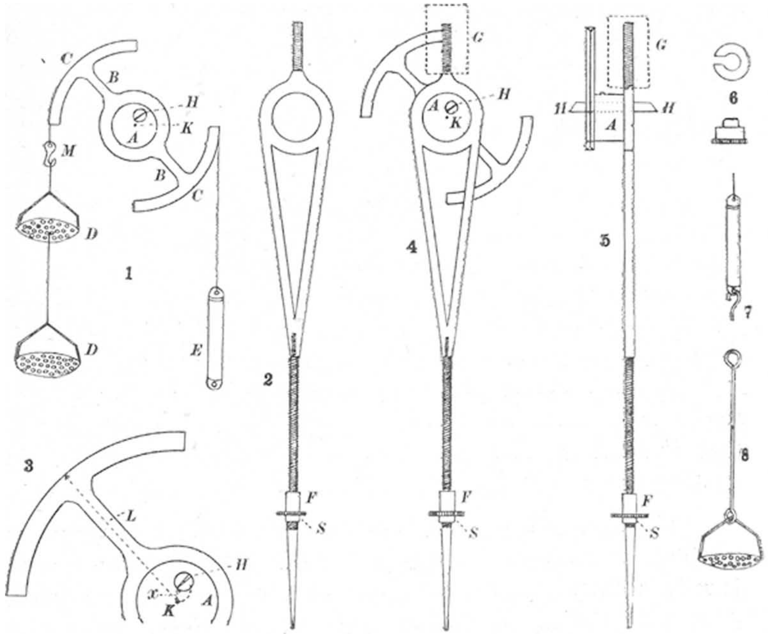

FIG. 2.—Parts of the specific gravity balance. (1) Arms, pans and counter-weight ; (2) pendulum ; (3) razor edge pivot of arms and pendulum ; (4) front view of assembled perspex unit ; (5) side view of unit ; (6-8) accessories.

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of the specific gravity will then be given, therefore a small accessory scale is provided reading up to 2.5 which slips over the fixed scale, and since the specimen weighs more in water than in CCL4, an extra weight in the form of a small hook (Fig. 7) is hung on to the counter-weight.

The instrument may also be used as a delicate simple balance. The beaker is removed and the double scale pan replaced by a single one (Fig. 8), which in air correctly balances the counter-weight (E). The pendulum will then swing over and give the correct weight of a specimen in the pan and thus avoid trial with several weights as in an ordinary balance.

The instrument is being manufactured for me by Messrs. Rayner and Keeler, of 100 New Bond Street, W.1.

THE MOST EFFECTIVE DISPLAY OF GEMSTONES

By Nigel W. Kennedy, F.G.A.

MODERN writers seem to disfavour the use of quotations, probably because, like the writer, they find some difficulty in remembering them, yet there is no doubt that a quotation sometimes contains a lot of common-sense. One old adage states that " What is worth doing at all is worth doing well," and another warns us " not to spoil the ship for a ha'p'orth o' tar."

Both sayings apply very strongly to the *display* of gemstones, whether in the form of a private or public collection, or in a jeweller's shop window, and this does not refer to the general scheme of the lay-out which may vary with the precise object in view. For example, three different schemes might have as their purposes (a) A comparison of colour varieties; (b) Examples of cut and uncut gems in their species; (c) Uses to which gem materials may be applied.

In *all* cases the main object of the display is almost certainly to attract attention and interest in the gems.

Now the writer is a mineralogist (of sorts) and used to be considered as the possessor of a very sound knowledge of crystallography, but after having tried to wade intelligently through Phillips' " Crystallography," and to absorb some of its fascinating data, has regretfully come to the conclusion that his own knowledge of the subject must be very elementary. However, the conviction is still retained that some of the most perfect examples of crystals whether produced in nature's marvellous laboratory, or that of the humble chemist, will compare with any faceted gem, and even transcend some gems in beauty of form, proportion, and colour.

It is conceded with little reserve that when a mineral is cut, polished, and faceted it acquires a new status, and any inherent features of beauty are enhanced, particularly if cut correctly, polished with care and viewed under the best conditions.

Clearly such ideal conditions are not attained in complete darkness or even a dim light, and it is not necessary to be colour-blind to be unable to tell the difference between an emerald and a ruby under such conditions.

The beauty of form of a mineral can be appreciated even by a blind man through the sense of touch, but in the case of a gem each feature of beauty is purely visual, and therefore the effect of light. Now, what are the several features upon which the beauty of a gemstone depends? These have been formulated as colour, lustre, and transparency, and each of these in kind, and from a maximum to a minimum intensity, are further modified by the specific optical properties of refractive index, single and double refraction, dichröism and dispersion.

In order that the full effect of these properties should be produced it is necessary that certain laws should be followed in the method of cutting and faceting most stones.

The various popular cuts are not accidental but have been selected to give optimum optical effect, cabochon for opaque gems and translucent stones, asterias, chatoyants et cetera; deep trap cut for transparent coloured stones, and a much shallower mixed and brilliant cut for lighter or achroic gems. The lapidary knows that the best results are only obtained by cutting a stone in relation to its crystallographic and optic axes, and in special cases, by the exact angles of the facets above and below the girdle, so as to obtain a maximum reflection and refraction of light rays entering through the top facets, thus producing the maximum scattering of the emergent analysed rays, producing the desired " fire."

The beneficial effect that more careful consideration of the correct cut has had upon the improvement of gems is most marked when one compares the old-fashioned rose and double-rose cuts of 200 years ago with the brilliant cut, especially as now developed on mathematical lines, and a more recent and equally remarkable example was the dull and waxy appearance of the early synthetic rutiles compared with those now faceted more correctly, and dazzling with brilliance.

Since the skill of the lapidary is only concerned in producing the best results from a given mineral, subject to the gem being given an opportunity to display its charms under the best conditions, the entire effect may be marred by lack of attention to the essential detail of correct lighting.

As not merely light, but the best form of illumination that can be adapted to bring out the characteristic optical properties of each type of gem, is so obviously of paramount importance, it will no doubt be an advantage to discuss in greater detail some of these properties.

THREE MAIN PROPERTIES

The first is of course *colour* covering the whole range of the visible spectrum, and including achroic stones, as well as those of white, greyish, brown, purplish and black tones. That is, stones with definitely selective absorption; those which transmit light of all wave-lengths with equal facility and little or no absorption; those which reflect a complicated colour combination which we speak of as " white "; and finally those which reflect certain mixtures of light or absorb all colours.

It is clear that the source, intensity and direction of light used for highly refractive achroic gems is not of necessity the best for denser coloured stones.

Then *lustre*, which is actually a common property enough but one of which little appears to be understood; this is a feature which again varies very considerably, and is definitely related to the nature of internal inclusions and their orientation, dimensions and number, and their distance from each other and from the surface. This fascinating subject has already been very excellently dealt with by Mr. M. D. S. Lewis in his article " Speculations on Lustre," " Journal of Gemmology," Vol. I, No. 8, Oct., 1948, which is well worth re-reading.

He raises an interesting point, with which the writer does not agree, that lustre may be due to a stereoscopic effect. Now this effect is only observable, surely, when two (usually different) images are superimposed on each other, and seen by a *pair* of eyes. Therefore, if lustre is a stereoscopic effect it should not be apparent when the object is seen with one eye, which is not the case, particularly in metallic lustre. But possibly the writer has misread or misinterpreted Mr. Lewis's hypothesis.

For the purpose under discussion lustre may be divided into three convenient categories, metallic and sub-metallic, adamantine and vitreous; and resinous, waxy, oily, greasy, pearly, silky and opalescent.

The third main feature, *transparency*, may be considered under two heads; transparent and sub-transparent, translucent and sub-translucent in one, and opaque and semi-opaque in the other.

Now as to the specific optical properties which modify the effect of the above three features, refractive index is common to all ; single and double refraction are best seen in achröic or pale stones, and not at all in opaque minerals: dichroism is limited to coloured stones, and dispersion is at its best when the maximum proportion of the incident light is reflected and refracted through the facets on the upper side of the stone, while "fire" is a scintillating effect only to be observed when either the gem or the eye of the observer is subjected to a sudden lateral displacement across the path of the incident ray, and line of sight. A stationary stone may exhibit dispersion but cannot show "fire" or scintillation which is an effect of movement. It is next necessary to consider the method of illumination, the intensity and kind of light to be selected, and its location with reference to the mineral and the observer.

The writer should add at this point that if anyone should feel that this seems to be wasting a lot of time over a simple matter, he should try some simple experiments on the proper illumination of gem stones, and even if it does not carry him far, he will begin to understand why some jewellers' window displays, often of fine gems, appear to be of very indifferent glass or plastic. As will be seen later, this problem is quite a complicated one.

The writer possesses a very modest collection of gems, which are simply representative of their various species and colour variants, types, et cetera, and as there is no very great likelihood of adding really expensive specimens, he decided to concentrate upon effective display rather than perfection of exhibits, and it seemed very obvious that correct lighting for each type of mineral was essential. In order to discover what improvements could be made in this direction the schemes of lighting of several celebrated collections were examined.

IMPORTANCE OF LIGHTING

Any apparent criticism of the lighting or general scheme of display of such well known gemmological collections as those of the Geological Survey Museum, or the Natural History Museum at South Kensington, may seem presumptuous, but any inferred criticism is made constructively and is in no sense derogatory. The fact is that having set up certain standards as ideals in this connection, the writer has discovered that no collection so far examined has achieved them.

In the first of the above collections the general conception of the display, and the illumination on an average basis, is excellent, and the idea of covering the cabinets with modern " invisible " glass was a happy inspiration and adds much to the pleasure of inspection. Yet the fact remains that the fixed top lighting, and the diffused illumination, is too soft and allows too little for the best effects of reflection and refraction in the case of faceted gemstones. In addition, coloured stones are rarely so placed that their depth of tint is fully developed as it should be, by transmitted light, and in many cases no attempt has been made to select a suitable background. A soft, diffused light is quite the worst for many stones, and asterias in particular require a special " spot " light, and for optimum effect, may even have to be shrouded to prevent cross-lighting, and it is no exaggeration to state that with the diffused system of illumination adopted it is practically impossible to see the star effect in what are probably magnificent specimens of asterism.

This is reminiscent of an experience of a married friend who served in India during the recent War, and on returning brought with him a number of gemstones which he had " picked up " while there. As usual, some 75% were synthetics of one kind or another, but he had one quite nice pale translucent Star Sapphire, which was soon mounted in a ring for his wife, who very much admired it. Quite a long time afterwards they were in their garden one very bright afternoon when his wife suddenly let out a little squeal of surprise and delight—" Oh, do look! " she exclaimed, " There's the most wonderful star in my ring." She had only examined it previously by artificial light and never near a single bright light, but under ideal conditions with the sun as a spot light she saw the perfect six-rayed star for the first time! Readers may remember the beautiful star sapphire and star ruby each of about 15 carat, exhibited at our first Exhibition by Pittar, Leverson, which were displayed to full advantage by the use of individual spot lights invisible to the observer, but focussed on to the centre of each gem, thus producing magnificent stars—probably the finest ever seen in this country.

Let us turn now to the remarkable collection of coloured gemstones, most of them of incredible size, and representing very unusual mineral species, which have been on view for some time at the British Museum's (Natural History) Mineral Gallery, and which have been carefully arranged and fitted into spaces in a curved sheet of transparent " Perspex " so as to allow full colour development by transmitted light, the effect aimed at being that of stones suspended in mid air. In actual fact, lack of attention to what may have been considered as a minor detail, has resulted in the effect being merely that of some beautiful stones resting on a sheet of curved plastic, because no attempt has been made to conceal the margins of the sheet, and the view extends over and beyond the limits of the sheet. The background is neutral and has been sympathetically selected, and if it had been continued right round the collection, to the top of the case, the sheet being gripped tightly between shaped panels, the desired effect would easily have been attained, and the illusion of suspension in space would, in the writer's opinion, be an aesthetic improvement.

The reader may be excused for asking, and in fact, is quite entitled to ask, if the writer has arrived at any definite conclusions as to the optimum conditions for effective display of gemstones, and of the best methods of obtaining such desirable results.

The reply is, certainly, as it seems obvious that particular attention must be paid to the correct kind of illumination to be adopted, and this is qualified by several essential conditions, namely, the type of stone displayed, which automatically controls the nature of the background, the other important points being the source, type and position of the illumination in relation to the exhibits.

In the case of achroic gems such as diamond, zircon, synthetic rutile, possessing high R.I's and abnormal dispersion, a fairly intense source of white light is necessary and this should be so placed that the maximum effect is obtainable from the top facets, and the highest degrees of refraction and maximum reflection by the back facets, so that entering rays are analysed in traversing the stone and emerge with maximum dispersion.

Since such stones are cut so as to reflect as near 100% light as possible it is theoretically impossible to see through the back of such stones, or for light from the back to enter them; therefore, no purpose is served by having any light behind them, particularly as it is not essential to develop body tints, which are absent. For the same reasons a sharp contrast is required as a background and in the writer's opinion, this is provided by the almost matte yet " warm " surface of a deep blue or black velvet.

Soft, diffused light is useless for the effective display of faceted jewels, particularly achroic stones, and it is a grave and extraordinary error that fashion in adopting modern diffusion lighting should have overlooked this important psychological fact. Far too many restaurants and popular rooms used for dinners and evening entertainments are illuminated by some form of diffused light, the worst examples of course being the concealed cornice and wainscoting lights, under which a woman is lucky if her most precious jewels look like anything but indifferent paste or plastic

Another essential feature which is taken for granted by most people, is that " fire " or scintillation are inherent properties of a stone, but it actually results from movement in the path of a ray of fairly bright light. Now, it is women who wear most gems, and on whom they look their best, but much of their beauty (that is, of course, the beauty of the gems!) is due to the fact that when thrilled or excited—as most women are when conscious of being well and expensively dressed, and of wearing beautiful jewellery—they are never still, and therefore, ear-rings, pendants, tiaras, chokers, bracelets and rings, are in a constant state of movement, intercepting countless rays of light, if they are provided, and disintegrating and dispersing it in all directions and producing the maximum dispersion and " fire."

This is clearly demonstrated when one stands before the average jeweller's window, particularly one that is badly lighted, when it will be noted that in spite of the fact that the gemstones on view may be the best of their kind, there is no display of " fire " so long as one remains stationary, and scintillation is only apparent when one makes a quick movement to either side across the line of sight. This clearly indicates that, in order that this very important feature be developed, it is essential that a lateral displacement of this nature must take place. Obviously the observer cannot be requested to bob his head about, as in a crowd this might cause complications, so that either the exhibits or the lights must move. In some rare instances this problem has apparently been appreciated and solved by the provision of small turntables in the showcase on which a number of selected stones revolve so that dispersion and "fire" may be viewed from all points.

In the case of coloured transparent faceted gems a similar system of top lighting should be employed, although it is probable that a somewhat softer illumination will be more effective, but where possible, the gems should be mounted so that soft light from below may be transmitted through them, thus giving prominence to their body colour.

Cabochon stones probably look their best in a moderately soft light, particularly if opaque, but this does not apply to asterias, chatoyants, and moonstones, which require very particular care for their effective display. When a star is visible by reflected light a spot-light of suitable intensity should be provided in the best position in front of the stone (or stones, if there are several, as one such light will serve for a number of stones if properly arranged), and screened from the observer, and the stone should stand out against a suitable background, such as black velvet. In the case of minerals like star mica, a plate of rose quartz, or some almandine garnets which may only show asterism by transmitted light, the observer should be able to view the source of light (a spot light) through the specimen which should preferably be mounted in a holder, which may be rotated on the axis of the light.

Generally speaking a neutral, or cream, or flesh-tinted velvet background will give excellent results with coloured stones.

Although lighting is of paramount importance in the effective display of gemstones it seems doubtful if any collection so far exists in which full attention has been devoted to this factor, and it is obvious that in the course of time much improvement will be achieved in this direction. The results of such carefully planned illumination will certainly be fully appreciated by all genuine gemmologists, and in fact, by anyone having a cultivated sense of beauty.

If the reader had been interested enough to read so far, it is likely that another question has arisen in his mind, namely, whether or not the author has been able to evolve any positive scheme of effective display of gemstones on the lines advocated above, and if it is sufficiently practicable to be utilised?

Yes. The origin of this investigation, as has previously been explained, was a desire to discover a method by which a rather indifferent collection could be displayed to the greatest advantage. This laudable ambition was preceded by some considerable amount of soul-searching mental queries: "What am I collecting?" "What is the aim of my collection?" Probably few people collect gemstones methodically and it was essential to have some definite objective in view before deciding upon effective display, but once this constructive decision was made, it formed a basis upon which the whole fabric of the collection will rest.

The specimens were to be arranged first as a general collection in species of gemstones, and sub-divided as occasion arose, so that ultimately, each species may have its own separate section, with special sections for particular kinds of stones. This obviously meant that, unless due care was taken in anticipation of it, such a collection might be in a perpetual state of flux "under re-arrangement" which is a perfectly hopeless state of affairs.

One of the first schemes was to use a sheet of transparent "perspex" with counter-sunk apertures for each stone (long before this idea was first seen in the British Museum (Natural History)), but this presented several disadvantages for an impermanent, mobile collection. That is to say, one in which the specimens were liable to be exchanged for others, and which had to be mobile for use at lectures and demonstrations.

If it was requisite to substitute one stone for another, it would usually be necessary to alter the shape of the aperture, which would mean dismantling the collection temporarily; in addition, stones merely resting in such setting could not be safely moved for any distance, and it was impracticable to cement them in position. This scheme was therefore scrapped in favour of an improvement on it. In the meantime the idea of supporting each stone in 3-prong flexible holders was considered, but the cost of these gadgets seemed rather prohibitive, although, no doubt, one of our Fellows who has a genius for intricate metal work would have solved this problem simply and neatly.

After further brain-searching which spread over a period of years, a scheme was eventually evolved which seemed to allow for easy accessibility of individual gems for dismantling or replacement, combined with extreme portability, and (it is profoundly hoped) an exceptionally efficient system of illumination and display. Of course most of these provisions refer to cut and faceted, polished stones, rather than to crystals and uncut minerals.

The general scheme as finally adopted was to start with a small mixed collection of cut and faceted stones, arranged in a series of vertical rows, in their several species, and disposed horizontally according to their colour. This should allow of an easy comparison between the colour and " fire " of stones of similar appearance. The top row consists of achroic stones, which are sharply displayed against a background of soft dark-blue velvet. The remaining rows are respectively, red, orange and yellow, green, blue, violet, with odd stones on the last row. The background is cream velvet as a foil for the transparent coloured gems above it.

The system of illumination has been the cause of much more trouble and perplexity than anyone who has not tackled the same problem would have thought possible, and it is still in the experimental stage. It is a top-lighting at present consisting of several small electric lamps mounted on a pivoted bar in such a way that it can oscillate horizontally across the specimens from end to end, so as to provide the essential scintillation from the faceted stones.

Transmitted light is provided by a small opaque (opal) strip light lying below and at the back of the coloured stones, giving a soft illumination through them, but screened from the " white " stones.

The method of mounting the stones is quite simple, and, to the best of the writer's knowledge, is unique, each stone being lightly yet firmly gripped in a suitable ring of transparent colourless " Perspex " split at one side, and slotted to grip the bezel, and reinforced by plastic where necessary. Rings of several diameters are used, and of varying wall thickness. The tension, or " spring " of each ring is sufficient to ensure that there is little likelihood of a stone slipping out of its setting, but at the same time, any stone can be withdrawn quickly.

The rings are cemented, six in a row, to curved strips of the same material. The cement is quite strong, yet if it is necessary to remove a ring, it can be snapped off at once, and another substituted, with a drop of cement.

The strips are 9 in. long with a curve of about 20 in. radius so that it has a " focus " at a point in front and above the cabinet at which one's eyes are normally likely to be. These curved strips are cemented to several straight horizontal strips 12 in. long, and the whole inclined towards the front at an angle of about 45°.

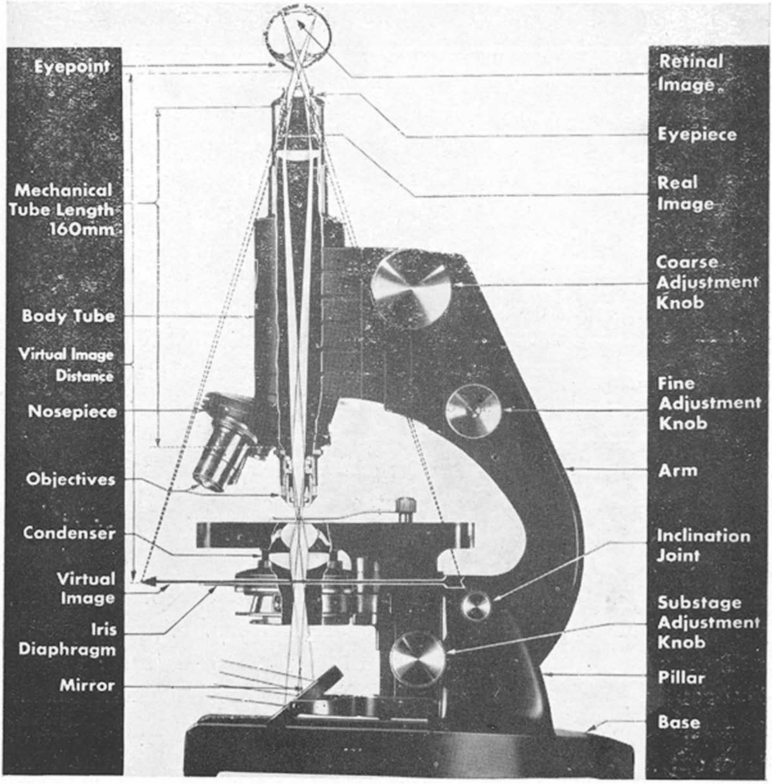
The display is protected in front by an " invisible window " of the same product and in the front of the cabinet an aperture 12 in. x 6 in. had been cut, forming a protective flap, which can be let down in front. The inside of this flap will be covered with cream velvet, on which the names of the specimens will be given, in position, engraved on black ivorine in white letters.

This first section requires particular care in order to produce the desired effect, but as the collection grows, other similar cabinets will be provided. In addition to these there will of course be special displays for opaque cabochon stones and flat ornamental stones, with suitable illumination.

Star Stones and moonstones, chatoyants and others, will be provided for in the way already outlined for these specimens, and the collection will include such things as a rotatable rhomb of Calcite to demonstrate the effect of polarized light.

The striking double refraction of zircon, compared with the single refraction of spinel will be demonstrated in an illuminated cabinet with a screen and spotlight, and further improvements which will add to the pleasure of examining the exhibits, will be added in due course.

In this way it is hoped that even a most modest and unassuming collection of gems can be so displayed as to enhance its inherent beauty and to provide a definite cultural entertainment to an average interested small audience, as well as a considerable amount of pleasure to the owner.



Courtesy of American Optical Co.

FIG. 1.—A moderately priced Modern Microscope with parts named.

OLD vs NEW MICROSCOPES

By D. S. M. FIELD

A MODERN MICROSCOPE DEFINED

For all practical purposes, the name "Modern Microscope" may be given to all short tube instruments manufactured during the first half of the present century; and, in the case of the petrological type with long tube, those of somewhat older vintage may be so qualified. These include (1) microscopes which, while old in years, are functionally the equals of those of recent manufacture, and (2) the very latest post-war types.

It might be said at once that age alone does not determine the value of an instrument. Quite a number of petrological microscopes (e.g. those manufactured by Swift & Son) have been in continuous daily laboratory use for more than sixty years and still render satisfactory service. Indeed, a well made old stand —constructed piece by piece with infinite care and pride of workmanship—is often found to be superior in mechanical performance to some of the later products of the machine age.

Determining the Age of a Stand

The serial number definitely establishes the age of a microscope stand; but if this cannot be traced, there are several other means whereby the gemmologist can determine the age with reasonable accuracy. For instance, several makers, such as Crouch, are no longer in business, having retired from the field around the turn of the century.

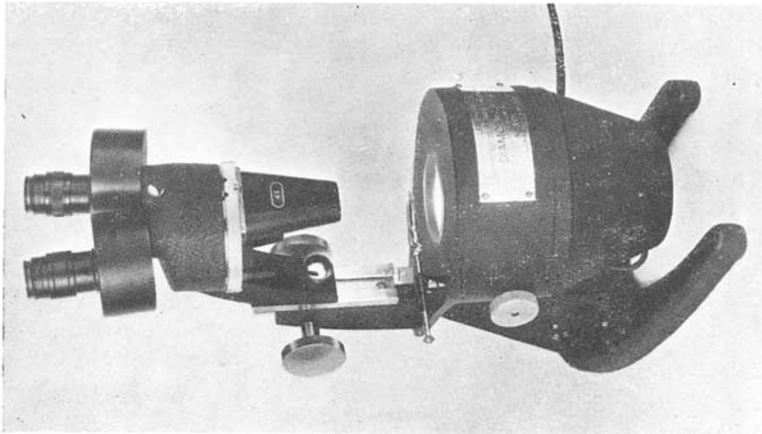
We know, then, that the very latest Crouch models are more than fifty years old, and many others are considerably older.

The Finish

The type of finish is also a clue to the age of the stand; providing, of course, that it is the original one. Instruments of the nineteenth century were universally constructed of solid brass or of brass plated metal, with a highly polished or matt finish, coated with clear lacquer to prevent tarnishing. Later, microscopes with black japanned cast-iron bases began to make their appearance; and when it was found that this was a more durable and effective finish, black japan was gradually adopted as the finish of all parts of the instrument excepting the adjustment screws and trim—which remained lacquered polished brass.

In the late twenties and early thirties, black and brass were superseded by black and chromium or rhodium plate. Occasionally, a light grey and brass or chromium finish is met with—the latter, especially, in some of the newer models. Undoubtedly the grey *shows* less dust than the conventional black enamel ; but whether or not this may be considered a virtue is questionable

In recent years, too, a wrinkle finish is much in evidence. This does not require so much care in the machining of the metal surfaces prior to the application of the enamel; consequently, it is generally to be found on the lower priced "students'" instruments.



FIGS. 2 and 3.—Greenough - type stereoscopic microscopes with special lighting features developed for the testing and grading of coloured stones and diamonds.

Courtesy of The Gemological Institute of America.

Noteworthy exceptions are the gem-testing microscopes produced by the Gemological Institute of America, and shown in Figs 2 and 3. These beautifully designed instruments feature a matching shade of dark grey or black fine-grained wrinkle finish in combination with non-reflecting smooth enamel. The two finishes provide a pleasing contrast; but in the writer's experience, the ordinary coarse-grained wrinkle finish is liable to become shabby looking in the course of time. It is also somewhat difficult to clean thoroughly, unless one uses a fairly stiff brush; while simply wiping with a soft cloth or chamois will at once remove most of the dust and grime from the regular smooth surface.

The Fine Adjustment

Another feature indicative of the age of a microscope is the position of the fine adjustment. Older instruments were generally equipped with fine adjustment actuated by a horizontally operated milled head located on top of the limb; while in the case of practically all microscopes manufactured since World War I, the fine adjustment is controlled by a milled head on either side of the limb, with the same direction of motion as the coarse adjustment.

The older form, when well made, is very smooth in operation, and in the better class instruments is capable of giving accurate reading to 0·0025 m/m. of movement; hence, while the side fine adjustment has now become almost universal in application, there is actually little difference, if any, between the two types insofar as the quality of performance is concerned. Indeed, there are many experienced microscopists who would rather welcome the return of the earlier form, with its large, easily read dial.

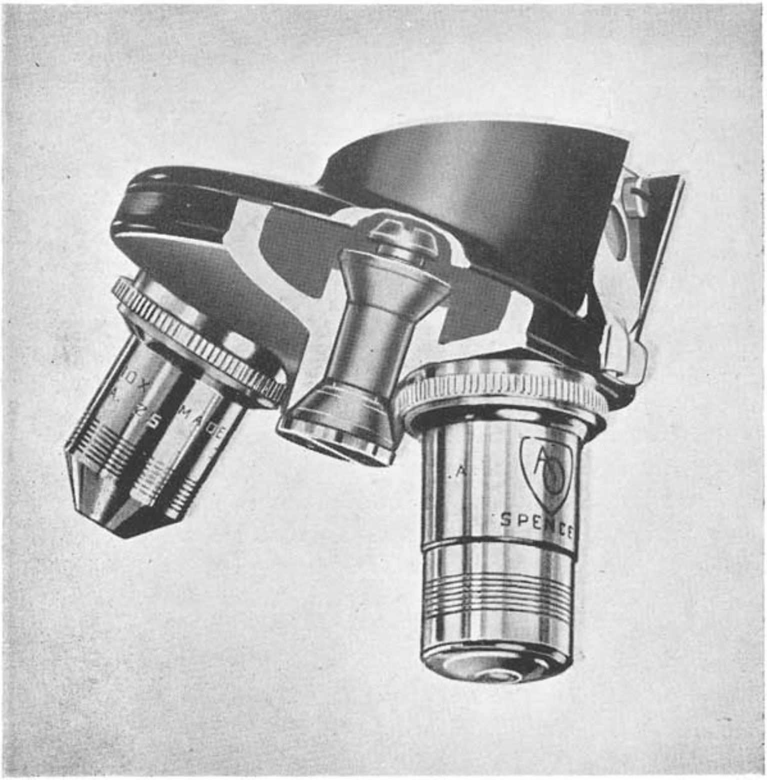
The Base or Foot

The high tripod base sometimes encountered on instruments still in use, and designed to provide greater stability than the early horseshoes forms, seems also to have lost favour, and bases of modified horeshoe shape have largely replaced it. Some manufacturers now concentrate the weight in the front toes to ensure maximum stability in all positions from the vertical to the horizontal.

As in the case of the fine adjustments mentioned above, there is little to choose between the two, and the final choice would seem to depend solely upon the personal taste or preference of the purchaser. Generally speaking, a lower table is required for a microscope with tripod base.

The Nose-Piece

The multiple nose-piece or revolving objective changer is still



Courtesy of The American Optical Co.

FIG. 4.—The Spencer "Dual-cone" nosepiece with rounded top and automatic centring device.

another part of the microscope that has undergone a radical change in design—in this case, unquestionably for the better.

In the older models—that is, in models produced before the first World War—the dust guard covered the extra object glasses only when they rested in the stationary position. Thus the back of the objectives were exposed to floating dust particles when changing from one power to another. With the advent of the circular guard, this fault was entirely eliminated.

Since that time, the circular revolving nose-piece has undergone numerous modifications with respect to design and accurate centring, but the basic principle remains the same. The accompanying photograph—Fig. 4—shows a multiple nose-piece that is undoubtedly the last word in beauty of design and functional excellence. This nose-piece is manufactured by the American Optical Company, Buffalo, New York, and is standard with the new line of Spencer microscopes. Having a rounded top, it is particularly easy to keep free of dust particles and lint, and its streamlined appearance constitutes a decided advance over the conventional form with concave top. Unfortunately, however, the new model cannot be used on other than the latest Spencer microscopes which were specially designed to accommodate it.

THE BODY TUBE

The length of the body tube of all standard modern microscopes, excepting the so-called petrological instruments still employing nicol prisms, is about 140 m/m; but when the instrument lacks a draw-tube and is provided with a revolving object changer, the distance from the top of the objective to the eyepiece rest (the mechanical tube length) is fixed at 160 m/m.

On the more advanced instruments, an inner sliding drawtube for varying the mechanical tube length is commonly provided. This allows the separation between objective and eyepiece to be changed at will, and has several distinct advantages over the tube of invariable length, which in recent years, has regrettably been adopted as a standard, by several makers.

The inside diameter of the modern eyepiece tube is 23·3 m/m. —as laid down by Royal Microscopical Society Standard. This will receive all regular sized eyepieces of recent manufacture (23 m/m. diam.*) as a sliding fit.

The lower end of the body tube is fitted with the standard R.M.S. screw thread, which will accommodate modern objectives of British, Continental or American manufacture, as well as the objective changers described above.

When purchasing second-hand instruments and accessories, care should be taken to see that the threading of both tube and objective glasses conform to this standard, the specifications of which are as follows:

THE SOCIETY THREAD

Diameter: 0·800 in. (20·3198 m/m.)

Pitch: 36 threads to the inch (14·7 to the centimetre)

* Wide diameter eye-pieces are still often encountered in petrological microscopes of recent make.

Form: Whitworth screw—a V-shaped thread having the sides inclined at a 55 degree angle to each other, with one-sixth of the V rounded off at both the top and bottom of the thread.

Length of Objective Thread: 0·125 inch (3·1750 m/m.)

Length of Plain Fitting Above Thread: 0·1 in. (2·5400 m/m.)

Diameter of Plain Fitting Above Thread: not more than 0·759 in. (19·2784 m/m.)

Length of Screw in Tube or Nosepiece: Not less than 0·125 in. (3·1750 m/m.)

OBJECT GLASSES

When Abbe, in 1886, designed the first of the apochromatic objectives, near perfection in the correction of the object glass was achieved. Since that time, only very slight improvements have been made in either the achromatic or apochromatic series; consequently, many of the older objectives compared very favourably with those manufactured in the present day, providing that they are used with the tube length for which they were computed,* and are in good condition.

Since only the lower powers are required for gem testing, the achromatic rather than the expensive apochromatic series should be chosen by the gemmologist.

In recent times, the trend in object glass design has been toward a plain cylindrical barrel, with individual sleeves for each lens, none of which can be unscrewed from the outside. This form is attractive and easily kept clean; moreover, it obviates the danger of damage or improper assembly of the indivdual components by persons who like to "take things apart," but who lack the technical knowledge and skill to put them properly together again.

However, in view of the high quality and ready availability of many of the older types, the writer is preparing a separate paper covering their choice for gemmological work, and outlining methods for determining the total magnification of a microscope equipped with either the old or new forms.

THE CONDENSER

Although much has been written about the optical deficiencies

* Although not of so much importance in gemmology, where only comparatively low powers are utilized, old objectives optically corrected for a ten-inch tube length should not be used with a modern short-tube microscope unless the draw-tube is fully extended.

of the well-known two-lens Abbe condenser, this unit is unquestionably capable of supplying with complete efficiency the ordinary requirements of microscopy, and no expensive achromatic model need ever be purchased by the gemmologist.

A sub-stage rack and pinion focussing adjustment is more commonly to be found on old stands than on new ones; for, in recent years, many manufacturers have sought to cut down manufacturing costs by omitting refinements that were formerly standard to all but the simplest models. Furthermore, it has been clearly shown by Mr. Robert Webster, in his recent microscope series for the " Gemmologist " that a focussing arrangement to the condenser is a very desirable feature, where the microscope is intended for gem testing.

BINOCULAR VISION INSTRUMENTS

Binocular microscopes are undoubtedly more comfortable and less fatiguing to use than the monocular types—and in the case of the binocular Greenough models, stereoscopic vision combined with an erect image greatly enhance their value to the practical gemmologist and student.

Figures 2 and 3 illustrate two microscopes of this type designed by the Gemological Institute of America especially for use in the testing of gemstones without immersion; and the special lighting features their construction thus incorporates set them apart from most Greenough instruments designed primarily for biological or industrial application.

Alternately, it is possible for the student to purchase microscopes equipped with binocular bodies (or binocular eyepiece attachments for almost any type of monocular microscope of standard make manufactured during the past fifty years); but, with gems, it is hardly possible to achieve the same degree of stereoscopic relief when using the attachments so far developed by the various makers.

Years ago, the Wenham type binocular microscope described by Mr. Webster* was a very popular instrument—although, by modern standards, somewhat odd in appearance. However, the writer has been assured by good authority that the Wenham, equipped with a set of low-power achromats, is a very effective

* Webster, R.—" Gemmologist," Nov., 1950, pp. 246-49

instrument for the testing of gems. Furthermore, many of these instruments are equipped with circular, revolving stage and polarizing equipment.

Since, owing to the nature of their construction, Wenham-type binocular microscopes cannot function with the high power object glasses now demanded for biological and medical research, their manufacture has long since been discontinued, and those formerly in use have been replaced by high power instruments. This condition is greatly to the advantage of the gemmologist, who, not requiring high initial magnifications, can acquire second-hand Wenhams at comparatively low cost.

Wenham orthoscopic microscopes of very fine quality and heavy construction are readily available from many London dealers in good used optical equipment (such as, Chards (Reg.), at prices ranging from about twenty-five to forty pounds sterling. These prices include suitable objectives and several sets of eyepieces ; as well as a great variety of ancillary apparatus—though mostly of a biological nature. A few have retractible prisms or separate monocular body tubes.

As always, the inexperienced student would be well advised to consult a competent established dealer when purchasing a microscope of this type, in order that the instrument selected will be guaranteed in good condition throughout, and be suitably equipped for gemmological work.

Personal Comfort

When using any type of microscope, the gemmologist should take care to avoid unnecessary fatigue resulting from adverse working conditions. Consideration should first be given to the height of the instrument or the chair upon which he is to sit. A cramped, awkward position is neither conducive to enjoyment of the task at hand nor to an accurate interpretation of the inclusions or structure present in a given gemstone under test.

Since inclusions are best observed when gems are immersed in a liquid of similar R.I., the stage must of necessity be in a horizontal position. Under this condition, an inclined eye-piece tube (not at all a costly accessory) or built-in binocular body, or separate binocular eyepiece attachment, will add considerably to the personal comfort of the worker.

Since all inclined attachments are set at a fixed angle to the body tube, the relative heights of the worker's chair and the table on which the microscope rests are quite critical; hence, when such attachments are employed, even more attention should be given to the height factors. The ideal combination can only be found by trial and error, and will depend entirely upon the height and idiosyncrasies of the individual worker.

Many authorities have recommended that the user of a monocular instrument keep both eyes open in order to prevent undue fatigue to the muscles of the inactive eye. However, most of them have failed to point out that good work is impossible when the inactive eye is allowed to perceive light in a passive manner.

This condition has been alleviated by using one of the eye shields specially designed for use with the monocular microscope. Such shields are usually available from manufacturers of optical instruments, or one may be constructed at home from black zylonite, hard rubber, or other suitable material. A very attractive and effective shield manufactured by Bausch & Lomb was described in an earlier paper.* This shield is now in use not only on the writer's microscope, but also on his spectroscopes, dichroscope, and refractometer.

Contrary to the popular notion, but in obedience to the natural law of use and disuse, the proper use of the microscope is beneficial rather than harmful to the eyesight. It has now been conclusively established that, after a time, the eye used for microscope work develops markedly better vision than the inactive one. It is imperative, however, that no stronger light be employed than is absolutely necessary for clarity of detail. This rule obtains particularly where ultra-violet light is being emitted by the light source, as when using arc or quartz mercury vapour lamps, or strong daylight. Needless to say, transmitted direct sunlight must *never* be employed as a light source, unless a suitably dense filter is inserted below the condenser, both as a means of filtering out the harmful ultra-violet rays, and to lessen the intensity of the visible light.

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* Field, D. S. M.—" Journal of Gemmology," Vol. II, No. 6.

A TALK ON JADE

By S. Howard Hansford

THE fascinating story of Chinese jade from its earliest manifestations was told by Mr. S. Howard Hansford, Lecturer in Chinese Art and Archaeology at the Courtauld Institute of Art, University of London, when he spoke to members of the Gemmological Association at the British Council on January 31st.

He said that among the many expressions of the Chinese artistic genius with which we were now familiar in the West there was one in which the Chinese occupied a position of unique and unchallengeable superiority, the carving of gems and ornaments from semi-precious stones. The fashioning of stones, harder than any known metals, into tools and ornaments had been practised in many parts of the world, but nowhere with such success and in such a continuous tradition as by the Chinese. Jade, the most precious stone known to them, had been their speciality. Throughout the formative period of Chinese civilisation jade had furnished the material for insignia and ceremonial objects and shared with bronze the function of providing the material for ritual symbols.

In China, as elsewhere, the stone-age man found that jade made excellent tools. A slide showed some of the neolithic tools found in China by Dr. J. G. Andersson, of Sweden. Whilst, however, in other lands jade went out of use, as stone tools were superseded by those of metal, in China it acquired the status of a precious stone, and the jade carver a position analogous to that of the goldsmith in Europe.

Mr. Hansford showed an early example of a pi, a disc of jade with a circular hole in the centre, which represented the deity "Heaven." The central hole probably portrayed the sun shining in the vault of heaven. It appeared to have been carved without metal tools, he said, the orifice being drilled out from opposite sides with a length of bamboo and quartz sand. The piece was probably not much less than 3,000 years old.

The true jade prized by the ancient Chinese so highly was nephrite, a mineral harder than steel and made up of minute crystalline fibres, which accounted for its toughness and durability. It came from the region of Khotan in central Asia which appears to have been the source from the earliest times It was a long way from the ancient centres of population in China, something like 2,000 miles by caravan, the hazardous journey being alone sufficient to account for the high price. At first it was obtained only in the form of pebbles and boulders from the beds of rivers. An illustration from an old Chinese book showed one of the rivers being searched for jade.

Because jade was believed to be a product of Heaven, it was thought to be highly charged with creative force. Supernatural powers of healing the body and conferring immortality were attributed to it and jade amulets were buried with the dead to preserve the corpse. Women were said to have been used to search rivers for jade because it represented the male force in nature. The Chinese, explained Mr. Hansford, believed that everything in nature was male or female. Heaven, for example, was regarded as male, and Earth as female. Therefore women were supposed to exercise special attraction upon jade and, so likely to be specially successful in the search for it.

From the 18th century onwards the other jade mineral jadite, had been entering China from Burma. He showed micro-photographs of thin sections of nephrite and jadeite which showed the fibrous structure of the former and the granular crystals of jadeite. The mere possession of jade and its contemplation was supposed to impart fine qualities of character, especially the white jade with its typification of morality and all the virtues. The lecturer told how Confucius was asked why jade was esteemed more highly than marble. His reply was a little homily in which he compared the natural qualities of jade, one by one, with the most admirable human virtues, concluding with the remark, " Like the Way of Truth and Duty, jade is reverenced by all."

Certainly a beautiful object in white jade might well inspire such words. Nephrite was in fact being carved in China long before the time of Confucius. Pictures of objects were shown, some of which were made in the second millennium B.C. The holes in some were probably bored with pencils of bamboo used with an abrasive such as sand. The work must have been very laborious. Jade was not known to exist in the natural state within the eighteen provinces of China proper and appeared never to have done so. Mr. Hansford mentioned that he had marshalled the guidance for and against native jade in his recent book on Chinese Jade Carving, and had reached the conclusion that in the light of our present knowledge there was no reason to suppose that jade had ever been found in China.

From about 1400 B.C. onwards it was much used as ornaments for clothing and for fittings of utensils. Bronze tools were used to make most of these. From about the 4th century B.C. when the craft was reaching its maturity, it was applied to new purposes, sword furniture, accoutrements and vessels.

An illustration of an excavated tomb showed a first century A.D. jade scabbard fitting found attached to the weapon in Korea, which was then a colonial settlement of the Chinese. Later hollow vessels were carved in jade, though he did not think these were made much before the 3rd to 4th Century B.C., or well into the iron age.

Mr. Hansford went on to deal with the craft and its methods, saying that as jade was harder than metal, it had to be cut and ground by an abrasive. The first to be used was probably quartz sand, later superseded by powdered garnets and corundum. Fortunately nature had given the Chinese a perfect drill in the form of the bamboo. He had recently drilled holes in nephrite using the old Chinese method. Gradually metal tools were introduced and iron rotary tools operated by treadles were in general use as today. Illustrations showed the modern jade carver at work, the abrasive now-a-days being powdered carborundum known as " black sand " imported from the United States. It would take a week or more to cut a fair sized piece of jade in two. The fact that the Chinese craftsmen practised intense specialization gave them their supremacy. After the jade had been roughly

Continued on page 76

Stress Figures in AMBER

by Robert Webster, F.G.A.

SEVERAL pieces of clear amber fashioned as pendants or as beads for necklaces have been seen to contain large " inclusions," often coloured green or red, which are reminiscent of nasturtium leaves (Figure 1). Such pieces are often described as being " Sicilian amber," and the second illustration in the coloured frontispiece to Dr. Williamson's book on amber, which seems to be of this type, is stated to be Latvian in origin, While such ascriptions may in some cases be correct, the presence of these leaf-like structures cannot be taken as proof that the amber comes from any one locality since they can be artificially induced, as will be described.

Recently, whilst examining a ring set with a cabochon-cut amber stone mounted in a closed-back setting, it was noticed that small uncoloured " nasturtium-leaf " inclusions were present near the base of the stone, and also a number of bubbles on the base The history was that these inclusions were not present before the ring had been to the repairers in order that the shank be enlarged. It was considered possible that the heat employed in the re-sizing had been the cause of the blemishes now present in the stone, and to prove this point a number of experiments were carried out.

Preliminary tests by heating a piece of amber on a copper plate held over a Meker burner gave clear evidence of the production of the leaf-like figures. These are undoubtedly caused by stresses set up in the amber by heating, or maybe in some way by a change or release of stress, for as Herbert Smith mentions (1), " but it (amber) is always in a state of strain sufficient to show bright interference colours in polarised light."

The likeness of these " induced " inclusions to those seen in the fashioned pieces just mentioned, suggested further experiments on the lines of controlled heating. A number of pieces of block amber were prepared, so that at least one side had a crudely polished face, and various methods of heating were tried out. As was quite expected, heating in boiling water (100°

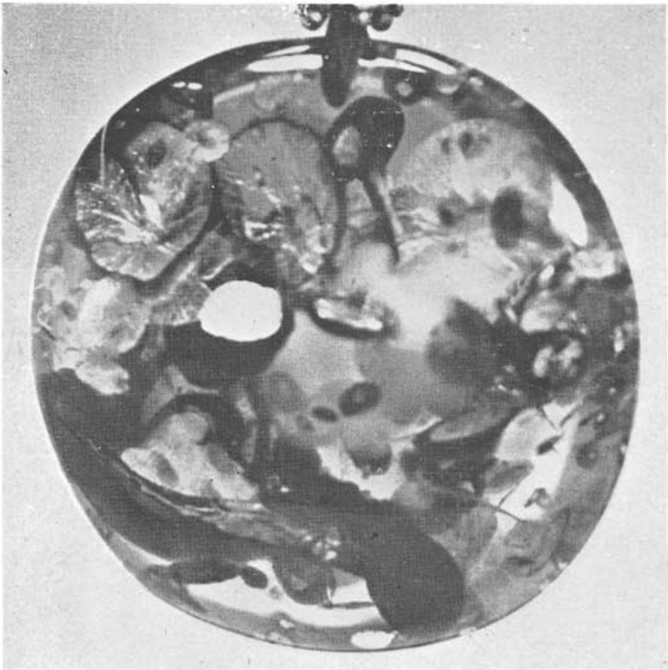

FIG. 1.—A very fine example of amber containing green coloured stress figures.

From the collection af B. W. Anderson.
Photo by G. A. Plastow, Wimbledon Photographic Society

C) for thirty minutes produced no effect and the amber was not altered in any way. Neither was any change in structure observed when the amber was packed in powdered blackboard chalk in a porcelain crucible and heated for a short time at about 200° C, but in a subsequent experiment on similar lines with longer and stronger heating, the stress figures appeared.

Repeating the earliest experiment; first by heating the amber in a lidded porcelain crucible, and secondly by heating on a wire gauze, until the amber tended to decompose, i.e. started to give off smoke (about 270° C), again produced the stress patterns. These patterns, however, were nowhere near so large as seen in the commercial material. Similar heating followed by rapid cooling in coloured inks (red and green) showed that the stress figures took up the dye and appeared similar to the coloured figures in the marketed pieces. However, as was expected, much cracking occurred by this method—much more than when the amber was heated after being packed in powdered chalk.

Max Bauer (2), referring to the process used in clarifying cloudy amber by employing controlled heating in rape seed oil (oil expressed from the seeds of the rape—*Brassica napus*), states the following:—" Unless the greatest care be taken the operation of clarifying amber results in the development of peculiar cracks which in some respects resemble fishes scales. They are at first so small as to be scarcely visible, but gradually become more and more conspicuous and begin to show iridescent colours until towards the end of the operation they become quite obvious as shining golden cracks. These are known to the amber workers as ' sun spangles,' and their presence often serves to distinguish a clarified from a naturally transparent specimen of amber."

FIG. 2.—Leaf-like stress figures artificially induced in amber.

In view of this note of Bauer's, a series of experiments was carried out using rape seed oil. Pieces of amber were placed in the oil contained in a porcelain crucible which was heated until the oil was near decomposing point—evident by the strong smelling fumes which were evolved. During the heating the amber specimen was occasionally turned to ensure that different sides were at the bottom of the crucible where heating was strongest. In these experiments the amber was not removed and rapidly cooled, but was allowed to cool slowly in the oil. On removing the specimen a large number of stress figures were noticed. These were somewhat larger than those induced in the earlier experiments, and, moreover, were oriented at all angles just like those seen in the commercial article. Figure 2 shows a group of these heat-induced stress figures.

Experimental colouration was attempted by various methods, such as by inducing stress figures by heating in rape seed oil and then dropping into cold water, coloured by red or green ink. The figures were found to take up the colour, more effectively with the green solution that with the red, but much cracking occurred due to the rapid cooling. The use of a hot solution (near the boiling point of water) did not lessen this tendency to cracking.

An attempt to use alcoholic solutions of fuchsine and methyl green to dye the rape seed oil directly showed that the two liquids (alcoholic dye and rape seed oil) were not readily miscible. However, the green dye acted quite well but tended to colour the whole of the amber when heated in the coloured oil as well as the stress figures produced by the heating. The red dye became decolourized during the heating and little staining occurred. The very slightly coloured piece of amber was then dropped into a cold alcoholic solution of rhodamine, which, like the coloured ink experiments, dyed the stress figures but caused much cracking. On inspection it was seen that some of the stress figures were stained with the red fuchsine dye and rather more with the rhodamine which has a different shade of red.

The sum total of the experiments, although not producing the magnificent effects seen in the commercial articles, does show that some method of controlled heating and staining can produce the nasturtium-leaf effect. It is most probable, therefore, that the pieces offered for sale are "treated," although no proof can be given that the effect cannot be produced by nature.

Parallel experiments on pieces of bakelite "B" and "C" did not give the typical stress figures shown by amber. A recent copal resin (probably from Zanzibar) softened when heated on a gauze and when so treated in rape seed oil and no stress figures were induced. Finally, small leaf-like figures were seen after pieces of pressed amber (Ambroid) were similarly treated.

In conclusion; a visit to the collections at the British Museum (Natural History), and the Geological Survey Museum, showed that no specimens of amber having these leaf-like stress figures were exhibited. In the case of the British Museum (Natural History) no amber is as yet shown in the Mineral Gallery, and the only exhibit of amber is a fairly comprehensive one in the the Fossil Gallery, but which does not show a specimen of Sicilian amber. The Geological Survey Museum shows several specimens of fluorescent amber from Sicily, but as far as could be observed through the glass case, no stress figures were present. Enquiry from trading merchants gave the general impression that the marketed material had definitely been "treated," but how and where was not known. Perhaps someone more knowledgable may be able to throw more light on this mystery.

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(1) Herbert Smith (G.F.), "Gemstones," 1949, p. 488. Methuen. London.
(2) Bauer (M.), Trans. Spencer (L.J.), "Precious Stones," 1904, p. 539. London.

JADE (*continued from page 71*)

shaped by the revolving disc worked by a treadle, the edges would be ground down by a large grinding wheel. Much ingenuity was used to make the design fit the natural peculiarities of the stone.

The tools for the treadle lathe are made in a great variety of shapes, but they may all be separated into the three categories of grinders, gouges and drills. Mr. Hansford showed slides made from photographs which he had taken in the Peking jade workshops and which illustrated many of the processes. His audience was thus able to realize how, after months of patient cutting, grinding and drilling, a superb vessel emerges from this apparently intractable material polished to the semblance of the softest wax, with delicately undercut carving and loose ring-handles of faultlessly regular shape. He concluded his lecture by showing slides, some in colour, of a number of outstanding masterpieces in jade, executed within the last two centuries by such simple tools and skilful methods as he had described.

A New Gemstone

By C. J. Payne, B.Sc., F.G.A.
Diamond, Pearl and Precious Stone Laboratory of the London Chamber of Commerce.

On Saturday, 17th March, 1951, a letter appeared in "Nature" from Dr. G. F. Claringbull, B. W. Anderson and the writer, describing a new gemstone. Several newspaper enquiries have been made since and it seems appropriate to describe the circumstances of the discovery in greater detail.

The honour of discovering this new stone is due to Count Taaffe, of Dublin, a keen amateur gemmologist, collector and connoisseur. In 1945 he was examining a parcel of spinels in his collection under the microscope, and to his eternal credit he noticed that one of them, a pale lilac stone, showed a very slight doubling of the back facets. At that time he did not possess a refractometer and so had no means of measuring either the refractive index or confirming the birefringence. So he sent the stone to the Laboratory, where it was soon established that it had the following properties:—

Refractive indices $n_{D\omega}$ 1.723, $n_{D\varepsilon}$ 1.719, n_{ω}—n_{ε} .004.
Specific gravity, 3.62. Hardness, 8. Uniaxial negative.

A search through the literature failed to reveal any mineral with similar properties and the stone was submitted, with Count Taaffe's permission, to the British Museum experts. Dr. Claringbull declared that he could not identify it and so we had to ask the owner if he would allow us to saw a piece off for identification and analysis. He very kindly gave permission and Dr. Claringbull was able to declare that X-ray analysis had shown that it was a new mineral. We were surprised and so was he. Nowadays new minerals are very rare and then generally only small incrustations, so a solid hard crystal actually cut as a gemstone was a very remarkable discovery.

The stone was a pale lilac colour and its hardness was the same as spinel, and refractive index and density were also very near to it. The student of gemmology may pause a moment and consider. It has the hardness and general appearance of spinel, and the birefringence is so small—.004—that it would be unnoticed unless sodium light was used, and being small, only 1.41 carats, no density could be relied on unless elaborate technique was used, though anyone possessing a sample of Clerici's Solution could have seen that the density was very near to that of spinel. The stone showed a perfectly good uniaxial negative interference figure.

Dr. Claringbull set to work on the sawn off piece and established that the mineral was hexagonal. In fact, he discovered that it belonged to a very rare class of the hexagonal system, the hexagonal trapezohedral or hexagonal holoaxial class. The symmetry of this class consists of all the axes (holoaxial implies this), i.e. the vertical hexagonal axis and the six digonal axes but no plane of symmetry at all. The word "trapezohedral" refers to the general form of this class, the hexagonal trapezohedron. However, in the few crystals belonging to this class this face or form has never been seen. Until recently no mineral had been known belonging to this class, but in 1942 Dr. Bannister described a mineral from Kenya called Kalsilite which belonged to it, and now this new mineral has come to make it two. Curiously, they both belong to the same space group. A minor point is that among the few artificial crystals barium aluminate has been found to belong to it. Since this new mineral has been found by spectrum analysis to be a magnesium beryllium aluminate, it seems that there might be a connection between the two.

Some idea of the price Count Taaffe had to pay in the cause of science is shown by the fact that his stone originally weighed 1.419 carats and after sawing and recutting 0.55 cart. His only consolation is that Mr. Bull-Diamond, of Charles Mathews (Lapidaries), Ltd., has made, as usual, a very good job of it and the stone now looks much brighter and more attractive.

As far as composition is concerned, we know that it contains magnesium, beryllium and aluminium and very little else. The amount reserved for chemical analysis is so small that we have to wait patiently for that brilliant mineral microanalyst, Dr. M. H. Hey, of the British Museum staff. It was thought at first that the stone contained boron, which is very troublesome in a microanalysis, but a further examination showed this to be absent.

It might be added that the writer tried very hard to establish the refractive index of the ordinary ray by means of the minimum deviation method and found it to be $1.7230 \pm .0001$ for sodium light.

In October, 1949, the writer was testing a case of stones which consisted mainly of green sapphires and pale spinels. One of the green sapphires turned out to be a very nice Ceylon kornerupine, and finally, when nearly all the stones had been tested, one pale lilac spinel was found to have a rather higher refractive index than the others. It was in no way different from them in colour or general appearance, but these pale spinels had as usual a refractive index of 1.715, whereas this stone was 1.720 or 1.721. The refractometer was in very bad condition and our other one on show at the Gemmological Association's Exhibition, so it was not possible to see birefringence ; but it was possible to obtain the interference figure and to the writer's surprise and great delight it showed a uniaxial figure which proved to be negative. A few days later better refractometers were available and the birefringence was established definitely. The purchase of this stone was negotiated not without difficulty.

Dr. Claringbull took an X-ray rotation photograph and pronounced it to indicate a stone similar to Count Taaffe's. In the meantime we had acquired a Zeiss Abbé Pulfrich refractometer and a new X-ray set with a more powerful tube. We had the table facet enlarged and better polished and obtained the following data: $n_{D\omega}$ 1.7208, ε 1.7167, $\omega - \varepsilon$ .00412. The stone before re-cutting weighed .87 carat and after .860 carat, so it had not lost much.

This stone was paler than Count Taaffe's and this accounts for the slightly lower indices, due probably to less iron in the composition. The density was taken in Clerici's Solution by the refractive index method. It was found to be 3.61, again a little lower than the first. We submitted this stone to Dr. W. Stern for indentation hardness tests, and he found that it was slightly harder than natural spinel and slightly softer than synthetic spinel. In Mohs's scale it was 8. This is, of course, unusually hard for a mineral ; only chrysoberyl ($8\frac{1}{2}$), corundum and bromellite (9), moissanite (" meteoric carborundum ") ($9\frac{1}{2}$) and diamond (10) are harder.

Our hopes were raised when we found that the stone had a green fluorescence in X-rays though it showed nothing under ultraviolet light. Unfortunately, the spinels in the case in which it was found also showed a green fluorescence, particularly those most resembling it in colour.

This stone was too pale to show any real absorption spectrum, but Count Taaffe's stone showed a vague band in the blue very near and exactly like the band shown by blue spinel, a band due to ferrous iron at 4,580 Å.

It is unfortunate that the locality of this mineral is unknown. Count Taaffe's specimen was obviously cut in the East ; in fact, one might almost certainly say Ceylon. The second stone, together with the other stones in the case, was cut somewhere in Europe, possibly Idar-Oberstein. It was certainly associated with many Ceylon stones, but obviously not all. We cannot say for certain where this new mineral comes from though we suspect the gem gravels of Ceylon.

As the only two specimens have been cut as gemstones we do not know the habit. They are too pale to show dichroism.

Summary of properties:—

Crystal System—Hexagonal. Class 62. Hexagonal trapezohedral.

Cell structure—Space group $C6_32$. Unit cell a, 5.72; c, 18.38 A.

Habit—Unknown.

Chemical Composition—Contains Mg., Be., Al. and Fe (trace).

Absorption Spectrum—Vague band at 4,580 A.

Fluorescence—Green in X-rays, inert U.V.L.

Dichroism.—None apparent.

	H	ε	ω	$\omega-\varepsilon$	D
Count Taaffe's stone ...	8	1.719	—1.723	.004	3.62
B. W. Anderson's stone	8	1.7167	—1.7208	.0041	3.61

It only remains to express thanks to Mr. Bull-Diamond (Charles Mathews (Lapidaries), Ltd.) for his kindness and trouble in re-cutting and re-polishing both stones ; to Dr. W. Stern for the indentation hardness tests ; and finally to Mr. I. E. Pressman for his co-operation in obtaining the second specimen.

Gemmological Abstracts

GÜBELIN (E. J.). ***Ein neues Verfahren zur Erhohung der optischen Wirkung der Edelsteine.*** (A new method of increasing the optical effect of gems.) Uhren, Schmuck und Edles Gerät, 1950, *10*, 294-295 (cont. Journ. Gemm., 1951, *3* (1), 29).

Anti-reflection films can enhance the appearance of a good spinel so that it looks like a fine ruby. The possibility of fraud cannot be excluded but the film can sometimes be detected with the unaided eye, and it can be dissolved in acids. The fluor in the film can also be detected by micro-chemical methods for inst. zirconium-alizarin reaction or the " etch test." The detection of barium and magnesium is also described.

E. S.

SCHLOSSMACHER (K.). ***Nieuwe problemen van de synthetische edelstenen.*** (New problems relating to synthetic gemstones.) Edelmetaal, 1950 (10), 221-223.

Article in Dutch mentioning (apart from synthetic corundum) synthetic emeralds (I.G. Farben, C. T. Chatham) and synthetic rutile. The latter are already encountered in the trade, covered with a thin film of corundum to improve the surface hardness.

E. S.

MCLINTOCK (W. F. P.). ***A Guide to the collection of gemstones in the Geological Museum.*** Revised by P. A. Sabine.

A third edition of this inexpensive (price three shillings) yet very valuable publication follows much the same lines as the original. It has been brought up to date and has benefited by Mr. Sabine's revision and Dr. Phemister's editorship. As it deals with the properties and cutting of gemstones and the imitation, treatment and artificial formation of them, and gives, in addition, a series of identification tables, the booklet is a text-book as well as a guide to the gems in the museum. Gemmological students of the 1915-1935 period remember the first edition with affection.

CROWNINGSHIELD (G. R.). ***Reports on Brazilian heated green quartz.*** Gems and Gemology, Vol. VI, No. 11, p. 346.

In a vein of quartz, mined near Montezuma in the District of Rio Pardo, Minas Gerais, is found, with sparse amethyst, a partially opaque quartz having a yellowish cast, which on proper heat treatment (process not given) various shades of green are induced. Colours resemble green beryl, green tourmaline and a dark peridot green. It is suggested that the possibility of producing green quartz was discovered accidentally through the prevalence in Brazil of applying heat treatment to all types of stones. The colour is said to be permanent and stones up to twenty carats have been cut in Rio de Janeiro, where the gem is called " Prasiolita."

R. W.

KOHN (J. A.). ***Observations of the Slijper diamond.*** Gems and Gemology, Vol. VI, No. 11, p. 347.

A discussion on the orientation of the included diamond in a diamond crystal of 7.25 carats in relation to twinning. No convincing results obtained. This diamond was reported upon by R. T. Liddicoat in " Gems and Gemology," Vol V, No. 12, 1947, pp. 492-493.

It is interesting to recall that E. Trillwood, in 1934 (" The Gemmologist," Vol. 3, No. 30, January, 1934, pp. 186-189), reported on a diamond crystal with a similar large inclusion of diamond. This diamond, then said to weigh 7½ carats, may have been the same stone.

P. B.

MITCHELL (R. K.). ***Two rarities from Ceylon.*** Gemmologist, Vol. XX, No. 235, February, 1951, pp. 28-30.

A report on an unusual chatoyant aquamarine of silky blue colour and on a slaty-blue star stone (flesh pink by transmitted light) which was identified as a remarkable asteriated quartz.

R. W.

ALEXANDER (A. E.). ***Restoring moisture to pearls.*** Gemmologist, Vol. XX, No. 234, January, 1951, p. 1.

Discusses the loss of water by pearls over a period of time with detriment to the pearls. Experiment showed that by placing the pearl in a dessicator containing water in its base the pearl took up moisture and rejuvenation is suggested by using the method.

R. W.

ASSOCIATION NOTICES

MEMBERS' MEETINGS

January: At a members' meeting held at the British Council Cinema on January 31st, 1951, Mr. S. Howard Hansford, Lecturer in Chinese Art and Archæology at the Courtauld Institute of Art, University of London, gave an illustrated talk upon the occurrence and working of jade.

February: On February 20th, Dr. G. F. Claringbull, Vice-Chairman, described a unique colour film dealing with the formation of the Mexican volcano Paricutin. This film was first shown to members in 1948 and caused so much interest that an opportunity of showing it again was welcomed.

The Council of the Association is grateful to Dr. G. H. Pough, of the American Museum of Natural History, for making this possible.

March: On March 15th, at Goldsmiths' Hall, Mr. Nigel Kennedy gave an extremely interesting talk to members on the subject of " Gold in Britain, and illustrated it with slides that he had prepared himself. The talk will be reported in the next issue of the Journal.

PUBLICATIONS

Fifty-two pages have been added to the new edition of the " Handbook of Gem Identification," by R. T. Liddicoat, first published by the Gemological Institute of America in 1947. This increase in size is largely due to the addition of a comprehensive chapter which gives detailed descriptions and property ranges of all the important gemstones, as well as many of the minor ones.

In the elaborated new edition, recently developed testing instruments are described and their purposes and importance outlined; the " spot method " of refractive index determination is more fully discussed than in previous editions; and explanation is given of the radiographic and fluorescence methods of pearl examination. Additional gemstones have also been added to the tables and flow charts, plus a Cleavage and Parting Table in the Appendix. Tables already included in previous editions are Specific Gravity, Refractive Index, Hardness, Optic Character, Pleochroism, Birefringence, Colour, Dispersion, and Property.

There are 117 illustrations in the book, including an abundance of photomicrographs showing characteristic inclusions useful in the identification of gemstones.

TALKS BY FELLOWS

Gordon A. Blythe: " Gemstones." Townswomen's Guild, Southend-on-Sea, Thursday, January 11th, 1951; Townswomen's Guild, Prittlewell, Tuesday, March 13th, 1951.

Mrs. G. I. Parry: Nursing Staff of Llandudno Hospital, Cardiff, Wednesday, February 28th, 1951.

Dr. G. F. Claringbull: B.B.C. Home Service—Science Survey. Thursday, April 5th, 1951.

THE LATE PROF. W. T. GORDON

The sudden death of W. T. Gordon, emeritus professor of Geology in the University of London, has already been briefly recorded in the last issue of this Journal.

He was in his earlier years chiefly noted as a palæo-botanist, but in his long period of work at King's College, first as lecturer and later as professor, he developed so many interests that he was widely known as an expert in many fields, including the study of diamonds, synthetic corundum, and gemstones generally.

Both B. W. Anderson and C. J. Payne were students of his in the early twenties, and in a personal note Mr. Anderson writes:—

" My own memories of Prof. Gordon date back for more than 25 years, when I was a chemistry student at King's College. Drs. A. W. Wells, S. W. Wooldridge, and L. D. Stamp were my lecturers in Geology and Mineralogy, which I took as a subsidiary subject for my degree: Prof. Gordon lectured to me only in palæontology, and even his enthusiasm and skill as a lecturer failed to make this branch of geology very interesting to me.

" It was outside the lecture hours, browsing through his splendid mineral collection and on other informal occasions that I learnt most from Gordon and came to know him well. It was he who recommended me for the job of starting the Precious Stone Laboratory of the London Chamber of Commerce, and it was at his hands that I had my first lessons in distinguishing natural from synthetic corundums, and in the use of the refractometer. I well remember Mr. S. A. Phillips (an enthusiastic and knowledgeable F.G.A.) and I foregathering late in the evening at King's and poring through petrological microscopes at synthetic corundums immersed in methylene iodide, with Prof. Gordon similarly engaged at our side. Thus early was the smell of methylene iodide associated with gemmology in my mind.

" Prof. Gordon allowed himself no respite and no recreation. He gave generously of time and trouble in helping past and present students 'out of hours.'

" His own work suffered in consequence, but lives on in that of many of his former students, who will always remember him with admiration and affection."

GIFTS TO THE ASSOCIATION

The Council of the Association acknowledges with gratitude the following gifts:

Large pink tourmaline crystal, A. Sandhurst, Esq.; parti-coloured cabochon tourmaline, Miss M. J. Biggs.

ANNUAL MEETING

Annual Meeting, 1951. The twenty-first (fifth since incorporation) Annual General Meeting of the Association was held at Goldsmiths' Hall, Foster Lane, London, E.C.2, at 7 p.m. on Wednesday, April 4th, 1951. Mr. F. H. Knowles-Brown, the Chairman, presided.

The audited accounts for the year ended 31st December, 1951, were presented and commented upon by the Treasurer, Mr. F. E. Lawson Clarke. Mr. Knowles Brown, in submitting the annual report, thanked the Officers, Council and Committees for their work throughout the year end expressed appreciation of the work carried out by many Fellows. It was moved from the Chair—" That the Report of the Council and the audited Accounts for the year ended December 31st, 1950, be hereby approved and adopted." Mr. N. Kennedy seconded the resolution, which was unanimously approved.

Mr. R. Webster and T. G. Jones were re-elected to serve on the Council and Miss E. Ruff elected to serve in the place of Mr. J. H. Stanley.

Messrs. Watson Collin & Co., Chartered Accountants, were re-appointed as Auditors to the Association.

After the election of these Fellows, Dr. G. F. Herbert Smith, President, asked Mr. Stanley to accept from the Council a case of two briar pipes as a token of the Council's appreciation of his long and useful service to the Association. Mr. Stanley acknowledged the gift with gratitude.

Dr. Herbert Smith also presented to Col. G. M. Sprague a refractometer that he had won as co-Tully medallist in the 1947 examinations. A special welcome was extended to Mr. Siu Man Cheuk, a Fellow of the Association from Hong Kong.

After the meeting members took light refreshments in the Livery Hall where members had an opportunity for informal discussion.

COUNCIL MEETING

At a meeting of the Council of the Association held on January 31st, 1951, the following were elected to membership:—

FELLOWS:

Coote, James W., Pasadena, U.S.A (D.1950)
J. L. Hyde, Hounslow (D.1950)
Jennings, John D., Windsor, Canada (D.1950)
Rillstone, R., West Leederville, Australia (D.1950)
Shapshak, Leon, Johannesburg, S. Africa (D.1950)
Shaw, J. R., Great Bridge (D.1950)
Shipster, T. R., Abadan, Iran (D.1950)
Wainwright, F., Hutton (D.1950)

ORDINARY MEMBERS:

Rait, R. L., Winsford

PROBATIONARY MEMBERS:

Lawrence, J. F., St. Albans
Wheelock, H. J., Birmingham
Randall, J. A., Bath
Shepherd, G. T., Birmingham

GEMMOLOGICAL EXHIBITION IN EDINBURGH

An Exhibition is to be held at the Heriot-Watt College, Edinburgh, on April 25th, 26th and 27th, from 6 to 9 p.m. each evening. Aarrangements are in the hands of Professor W. H. J. Childs, D.Sc., F.Inst.P., of the Physics Department at the College, and Mr. D. J. Ewing, F.G.A., the Instructor of the Gemmology Classes.

There will be a display of minerals, cut gemstones and books, but the principal theme will be actual gem testing methods and it is intended to demonstrate the various instruments to the public

GEMMOLOGICAL ASSOCIATION OF AUSTRALIA
1950 DIPLOMA EXAMINATION RESULTS

The following are the members who have qualified in the 1950 Diploma Examination for Fellowship. The first three positions in Australia were filled by:-

K. N. S. Hall (N.S.W. Branch)
G. A. Tombs (N.S.W. Branch)
B. J. Skinner (South Australia)

The best students in each State were:—

NEW SOUTH WALES: K. N S. Hall. QUEENSLAND: Miss H. Mole
VICTORIA: B. McMaster SOUTH AUSTRALIA: B. J. Skinner

The Australian Prize has been presented to Mr. K. N. S. Hall and the Stevenson Award to Mr. J. B. Campbell.

The complete results are as follows:—

N.S.W. BRANCH

Armitage, C. C.	Engel, Miss C.	Redman, Miss J
Barnett, Miss Nella	Farley-Thew, R.	Russell, R. F
Becker, J. B.	Gerrard, W. A.	Symons, N.
Bellwood, E. J.	Gumbley, C.	Tombs, G. A.
Blair, J.	Hall, K. N. S.	Vernon, E.
Brandman, H.	Humphries, Mrs. R.	Whiteman, R.
Cliff, R. H.	Leadbeater, Miss E.	Wilkinson, D. E.
Castle, L. F.	Lowe, E. E.	
Durst, T.	Massa, C.	

VICTORIA

Brook, B.	Durkin, J.	McMaster, B.
Brown, R.	Ezard, H.	Turvey, G.
Caulfield, R.	Feore, N.	Wynde, L.
Cramp, J.	Hall, N.	
Davey, L.	Hood, D.	

QUEENSLAND

Gardner, J. W.	Mole, H. (Miss)	Staines, E. H.
Herdsman, L. P.	Quain, M. (Miss)	Virgo, R. A.
Isaacs, K.	Squires, S. J.	

SOUTH AUSTRALIA

Campbell, J. M.	Howeler, D. C.	Skinner, B. J.
Congdon, W. R.	Moss, J. A.	Stapledon, D. H.
Foskett, C. W. K.	Noble, G. E.	Wilson, J. G.
Hale, J. E.	Richardson, W. M.	