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SOME INCLUSIONS IN MOONSTONE

by R. Webster, F.G.A.

THE appearance of the moonstone variety of feldspar is so characteristic and inimitable that the testing of such stones, and therefore the observation of the inclusions, is rarely necessary. Indeed, except for a short reference to the inclusions given by Dr. E. Gübelin,[1] very little is written on the subject in gemmological literature.

Most moonstones used in jewellery emanate from Ceylon and show a type of inclusion which is typical for the variety. These inclusions have been adequately described by Edmondson Spencer[2] who made a study of the moonstone from Ceylon and other areas. Spencer writes : " The large isolated inclusions appear as thin lath-shaped lamellae or cavities. Their length is 10 mm. or less and the breadth 1 mm. or less. A section cut parallel to the plane of these inclusions (100), shows them as narrow laths parallel to the vertical axis (c) with numerous branching lines or cracks which extend a short distance (0.2 mm.) on each side of the inclusion in the direction of the b axis after which they taper off in an oblique direction. In addition to these lath-shaped lamellae numerous shorter cigar-shaped inclusions are visible. These vary in length

Fig. 1 (*below*). "*The centipede.*" *A rather large, but typical stress fissure in a moonstone.* 27 ×.

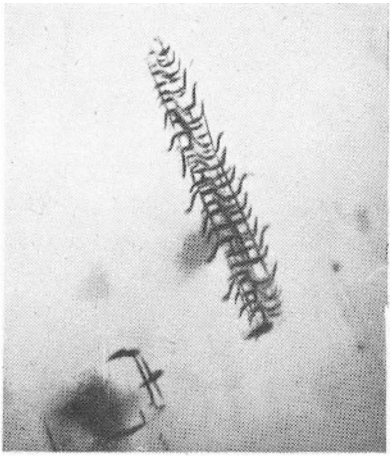

Fig. 2 (*above*). "*Chinese aeroplanes.*" *Typical stress fissures in a moonstone.* 22 ×.

Fig. 3 (*below*). *A group of fissures seen in a moonstone.* 15 ×.

Fig. 4 (*above*). *This stress fissure seems to have turned broadside on.* 15 ×.

from a few millimetres downwards, and are usually clear and devoid of branching cracks. Many of these inclusions are, in reality, very thin cavities as can be demonstrated by taking fragments cleaved across the direction of the cavity and boiling them in strong dye solutions, when the dye penetrates for some distance along the cavity."

Gübelin (loc. cit., p. 292) states that these " fractures " are stress fissures developed along twin planes of poly-synthetic twin lamellae and may suggest insipient albitization.

Some of these inclusions are large enough to be visible to the naked eye, and under the magnification normally used in gemmological practice may appear to resemble centipedes, or, in the case of the shorter cracks, to show a resemblance to the older type of bi-planed aircraft.

The accompanying photomicrographs illustrate some of the patterns which these crack-like stress fissures assume. Figures 1 and 2 show the more usual types of pattern seen in moonstones while figure 3 shows an interesting group of such fissures. Study of the central inclusion in figure 4 will show that this fissure has " lost its direction " and is at right angles to the direction taken by the other stress fissures in the stone. Although they may possibly be of a similar nature to the stress fissures so far illustrated, a slightly

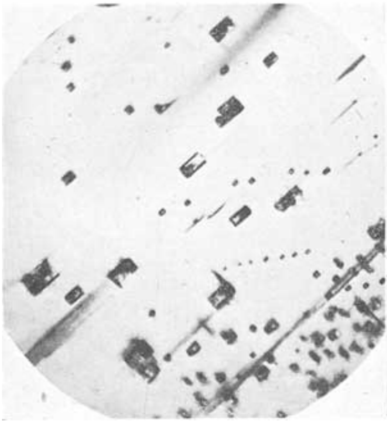

Fig. 5. *In this moonstone the inclusions appear to be similar to negative crystals.* 22 ×.

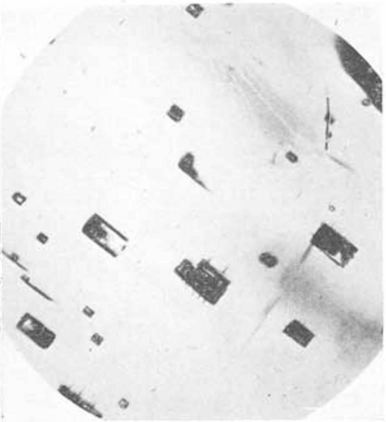

Fig. 6. *The same set of inclusions as shown in the preceding picture but taken at a higher magnification.* 55 ×

different formation may be seen in some moonstones. Figures 5 and 6 illustrate these inclusions in which the main " body " of the crack seems to adopt the form of a cavity or negative crystal.

As far as is known the specimens photographed are of Ceylon origin. No opportunity has been given to examine moonstones known to have come from Madagascar or Tanganyika Territory. The Burmese moonstones do, however, seem to adopt a different type of inclusion altogether. These are short needles running in one, but generally two or even more, definite directions, and are somewhat reminiscent of the needle inclusions seen in many garnets. Figure 7 shows this type of inclusion.

The beautiful blue shimmering light of moonstone obscures the hidden glory within the stone—fascinating beauty which the microscope alone can bring to view. May these few pictures throw a new light on a Cinderella among gemstones.

In conclusion, thanks are tendered to Mr. B. W. Anderson and Mr. L. W. Pooley for the selection and loan of the specimens used in taking the photomicrographs.

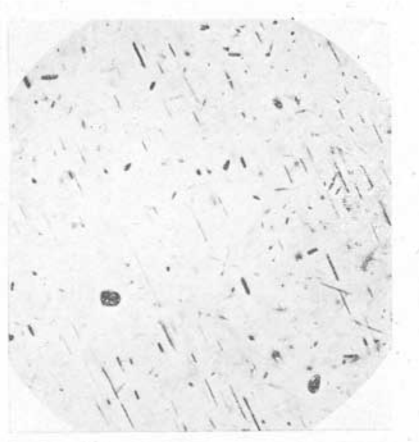

Fig. 7. The typical needle inclusions seen in a Burmese moonstone. 15 × .

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LIVE-BOX TECHNIQUES

by

J. R. H. Chisholm, M.A., F.G.A.

As a gemmological tiro I experienced some difficulty in mounting cut gem-stones satisfactorily for examination under the microscope. While no doubt immersion in a liquid of similar refractive index gives the best results,[1] it is liable to be messy unless time and care are spent ensuring cleanliness and it also necessitates the microscope being used in a vertical position, which does not make for comfort. For most purposes it is sufficient to examine a stone without immersion, provided it can be fixed on the stage with the table uppermost and approximately at right angles to the optical axis of the microscope : sufficient light to illumine a considerable part of the stone then enters via the culet. Similarly it may be examined through any other facet, if it can be satisfactorily held with that facet uppermost and parallel to the stage, provided there is an approximately parallel facet at the under side of the stone through which sufficient light is admitted.

Apart from holding the stone in one's fingers[2]—only practicable with stones of a certain size and with low magnifications—my gemmological reading suggested only Anderson's plasticene technique[3] and I naturally began with that. It still appears to be the best general purpose method, but it has certain drawbacks, especially for small stones. It needs no little skill and patience to prop up a really small stone on its culet with a blob of plasticene without at the same time either blocking out some of the light or covering the stone (and the slide) with plasticene. Moreover, if the microscope is at all close to a strong illuminant giving off appreciable heat, the plasticene becomes semi-liquid — πάντα ῥεῖ, to quote Heraclitus—and the result is a mess.

Searching round therefore for some other method of holding a stone with its uppermost facet parallel to the stage, as simple as the plasticene technique but without its disadvantages, I found that for all but very large stones the biologist's " live-box " or " live-cell "[4] provided a satisfactory answer. For this purpose a rather narrow but deep live-box as shown in Figure 1 is required.

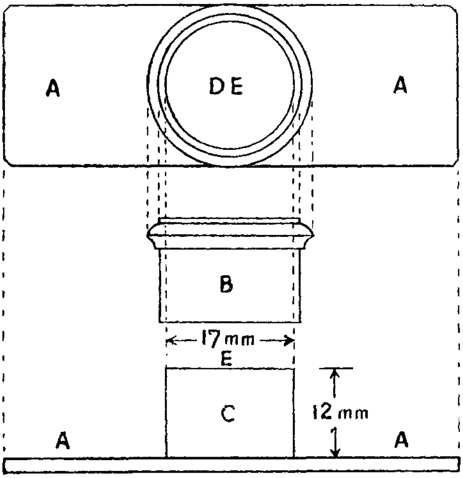

FIG. 1.

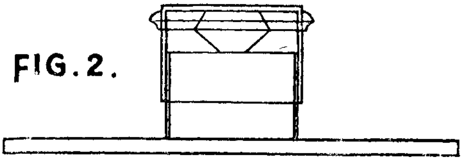

FIG. 2.

The depth of the live-box governs the depth of the stone it can accommodate, so for this purpose the more usual wide but shallow cell is useless, although it can help the gemmologist in another way mentioned later.

The method of use is to place the stone table-down inside and at the centre of the inverted top of the live-cell, insert the lower part of the cell into the top until the stone is firmly held as in a vice between the glass top and bottom of the cell—taking care, of course, not to break the glass—and then turn the whole cell the right way up and place it on the stage (see Figure 2). It is usually possible to clamp the stone in position with other facets uppermost if desired. As the stone is held at a considerable distance above the stage—depending on the height of the cell—it is advisable for the focus of the substage condenser to be raised appropriately, which may involve the removal of the top lens of a two-lens condenser, but even without adjusting the condenser the stone can be examined without difficulty under low-power magnification.

Mounting a stone in this way also facilitates the determination of its refractive index by the Duc de Chaulnes' method.[5] The apparent depth is measured by the travel of the fine adjustment while the tube is raised from focus on the culet to focus on the table, and the real depth is similarly measured from the top surface of the bottom-glass of the cell to the under-surface of the top-glass. It is, of course, desirable to keep the glass of the cell clean, but just a little dirt may facilitate accurate focusing of these surfaces.

If the stone is well centred in the cell and has a reasonably pointed and central culet, then if the top of the cell is carefully rotated with the fingers the stone will rotate with it, pivoting on its culet, while the lower part of the live-box is held motionless by the stage-clips. With suitable stones, therefore, the live-box thus serves as a rotating stage and can be successfully used to show whether the stone is isotropic or not between crossed polaroids or nicols. This is, however, liable to scratch the lower glass of the cell and stones with eccentric culets or with culets shaped rather as a line than as a point are difficult to revolve satisfactorily.

A reasonable substitute for a revolving stage for any size or shape of stone—and for any size or shape of microscope—is provided by a wide and shallow live-box—say, 7 mm. depth and 35 mm. diameter. With its base firmly clipped to the stage this may easily be rotated by the fingers without disturbing the stone, which may be mounted by the plasticene method on the top (outside) or immersed in a glass cell either placed on or (preferably) cemented to the top of the live-box. Accompanied by two discs of polaroid this type of live-box may therefore be a most useful adjunct to a portable microscope or at any time when a microscope with a revolving stage is not available : while for quick examinations I have found the deep live-cell a most useful accessory.

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GEMSTONE RECORDS for the COLLECTOR

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

A COLLECTION of gemstones can provide a great deal of interest whether neatly mounted, or filed away in pockets, with little more than the species of the stone marked on the label or pocket. How much more interesting it becomes however, if reference can be made to the gems inner and hidden story.

A certificate of identification is of course something quite different and not to be confused with gemstone records in any way. For this purpose it is only necessary to state the stones correct name and the barest evidence supporting its identification such as refractive indices, specific gravity and other data.

A collector's record on the other hand will tell a great deal about the stone, quite apart from its standard properties. Such records may be relatively simple in character or extremely elaborate depending to a large extent upon the equipment at the collector's disposal and the time he is prepared to devote to any one stone.

A very good illustration of the simple type of record form is that used by Mr. G. G. Waite of Toronto who is particularly interested in the cutting of his own stones from rough material. Here is the form he uses :—

Variety	No.
Cut	Source
Color	Dealer
Weight or size	Price of Rough
Remarks	

GEM STONES

Nº 400

Stone Collection No.
Type of cut Purchase Price £
Weight grams carats Date of Purchase
Locality
Occurrence
Lustre Degree of Lustre

COLOUR.

Hue Shade Tone Intensity

TINTOMETER READING

COLOUR	RED	YELLOW	BLUE	NEUTRAL TINT
UNITS				

Equivalent to :

COLOUR	NEUTRAL TINT	RED	ORANGE	YELLOW	GREEN	BLUE	VIOLET
UNITS							

Colour through Chelsea Filter in Ultra Violet Light
Refractive Indices Double Refraction
Dispersion Optical Properties and sign
Pleochroism Colours
Crystallographic System Form
Cleavage Fracture
Hardness Structure Habit
Electrical Properties Heat Conduction
Chemical Composition Formula

SPECIFIC GRAVITY.

Weight of Stone in air grams Weight of Stone + Suspension in Water grams
Weight of Stone in Water grams Weight of Suspension in Water grams
Loss in Weight in Water grams Weight of Stone in Water grams

$$\text{Specific Gravity} = \frac{\text{Weight of Stone in Air}}{\text{Loss in Weight in Water}} = \underline{\qquad\qquad} =$$

INTERNAL APPEARANCE OF STONE UNDER THE MICROSCOPE.

Flaws Inclusions
Cavities Air Bubbles
Doubling of back facets
Examination in Polarised light
Spectroscopic Examination

At the other end of the scale is the type of form that I use, which I have deliberately made as comprehensive as possible, though even this is by no means the possible limit.

I have explained my methods many times to my friends. Gemstones, after all, are rather expensive, so the great thing is to get as much interest out of them as possible. What better way than to systematically work through such a record form as that set out below ?

The filling up of such a form ensures that stage by stage every physical property will be worked through after examination by instrument after instrument, and when all has been done that can be done, any remaining gaps will be filled in by reference to text books and works of reference.

In this way, several hours can be enthusiastically employed on a single gem, every minute of the time being full of interest.

The actual form illustrated is of foolscap size and can be suitably punched with holes for inserting in a binder.

When all this has been done, or as much as can be done, and only then, does the stone go into its alloted place in the trays already described in this Journal.* The records themselves are kept in binders and it is surprising how useful these are. Frequently in an article there is a reference to a certain stone and perhaps for example some reference to unusually high specific gravity. I can at once refer to my records to see whether any of my specimens show the same abnormality.

Similarly, when checking a stone, it is interesting to see how it compares with others already investigated and recorded.

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* Journ. Gemmology, Vol. 2, No. 8, 1950, pp. 229 - 235.

NEW SYNTHETICS

Reports have been received of a new synthetic strontium-titanite, which is said to be no harder than rutile but very much like diamond in appearance. This development of synthetic rutile no doubt arises from the somewhat yellowish appearance of most of these stones, though this, too, has been the subject of experiment and is now being produced in a tint that is not quite colourless but almost so.

NOTAE — UT INFRA

by D. S. M. Field, A.G.A.

THE *Illustrated London News* for April 5, 1952, contains a supplementary set of two remarkably fine colour plates of gemstones in the collections of the Geological Museum in London.

Much wisdom has been shown in the choice of specimens : the ubiquitous plate gems, ruby, diamond, emerald and sapphire were omitted in favour of stones less familiar to the general public.

Remarkably good examples of diopside, phenakite, brazilianite, scapolite, apatite, danburite and orthoclase are shown ; and the various colour varieties of fancy corundum, tourmaline, topaz, garnet, zircon and other gems are well represented.

Each of the two 9 x 11 in. plates shows twenty-five specimens, well balanced and in actual size, with only one or two minor duplications. The set is, therefore, unique, and of interest and value to all lovers of precious stones. Since the apparent demise of the splendidly illustrated 4to books on gems, which were so popular during the latter half of the 19th century, large plates of gems in colour have become collectors' items ; and not a single plate of this calibre has been available during the past fifty years. Fine colour-photo prints do occasionally occur in magazines ; but they are generally spoiled for framing by intrusive hands or so-called " leg-art."

* * *

Gemmologists who frequently utilize monobromonaphthalene for gem testing might do well to bear in mind its toxic properties. Since 1950, at least a half-dozen American children have died from severe haemolytic anaemia that resulted from the eating of naphthalene moth-balls. Poisoning can also occur though the substance is not taken into the mouth. According to Dr. Edward T. Wilkes, an American medical specialist, a six-day-old infant developed acute anaemia which was traced to the use of diapers, that even though they had been rinsed, still possessed a *strong odour* of the moth-balls in which they had been stored.

The symptoms of naphthalene poisoning are sudden vomiting, abdominal pain, diarrhoea, pallor, and dark wine-coloured urine.

A simple clear polaroid cap, slipped over the eye-piece of the spectroscope, will permit anyone interested in the finer points of gemmology to examine the differential absorption spectra of the various gems to which this property appertains. The eye-cap, when rotated through a 90-degree angle, separates the rays quite effectively. Emerald and alexandrite, among the uniaxials and biaxials, respectively, show the most striking change when examined in this manner. (Vide : SMITH, " Gemstones "—11th Edition, pp. 107-108).

* * *

There is a growing number of persons in Canada and the United States who are not gemmologists but unqualified characters posing as such.

Even small-town watch repairers (" jewellers ") with no testing equipment other than a file and 3x eye loupe, and who do not know the difference between a synthetic and an imitation, and who probably believe that " specific gravity " is the force that causes the rise and fall of tide in the Pacific Ocean, have been known to class themselves " gemmologists " and insert this title into their advertising. Such characters very often operate within the very trade itself, and the jewellery industry publications that are more concerned with advertising revenue than with the welfare of the industry take no action to prevent such impersonation—though thousands of dollars may be involved in a single transaction.

For instance, a year or two ago, the sum of 6000 dollars was paid for four rings set with emerald-cut synthetic white spinels, after they had been passed by a Connecticut " jeweller " as genuine diamonds. The fraud was uncovered only when the rings were submitted to the G.I.A.'s Gem Trade Laboratory in New York.

Similarly, in Alberta, a dozen or more synthetic rutiles were mistaken and bought and sold for diamonds by self-styled jeweller " experts," until qualified persons brought the matter to their attention—and to the attention of the police.

The public quite reasonably expects its jewellers to be thoroughly familiar with gemstones, and to be able to identify and correctly evaluate any gems or jewellery submitted to them. Consequently, the existence of pseudo-experts in the jewellery trade undermines the reputations of qualified jewellers and gemmologists alike—and seriously endangers public confidence in the industry as a whole.

In Canada, at present, all that is required to become a " jeweller " (an " expert in gems ") is the necessary capital to purchase stock, pay the rent, and buy a licence. It is high time that aspiring jewellers be required to show proof of their qualifications to identify the gems they buy and sell, before licences are issued to them. Failing that, they could always obtain the services of an accredited gemmologist . . .

* * *

Anyone who has experienced the difficulty involved in examining gemstones with a lens of short working-distance under poor lighting conditions will appreciate the self-illuminating magnifiers *Lumag* and *Luminex*. These loupes are manufactured by Messrs. R. & J. Beck Limited, and distributed by both Beck and Messrs. Rayner & Keeler.

The Lumag loupe has a field of view of 1.25 inches (31 mm.), and, with a magnification of 5x, will be found quite suitable for the casual inspection of gemstones.

The Luminex is available in magnifications of 10, 15, and 20 diameters.

Two models of the 10x loupe are available, one having a fixed focus and the other adjustable. The 15x and 20x instruments are always fitted with a focusing adjustment to the lens. All models give an undistorted image to the very edge of the field of view.

Since a 10x loupe has been more or less universally adopted as the standard for precious stones, the 10x Luminex magnifier will be of particular interest to the gemmologist.

One model is equipped with a focusing adjustment and ancillary 10 mm. numbered scale divided into 100 parts. Hence, it is possible to measure accurately to 0.1 mm. the size of gemstones and their inclusions, and to record such information for reference and identification purposes. When the measuring unit is unscrewed from the loupe, the field of view is increased from approximately 10 mm. to 25 mm.—which is ample for gems of normal size.

The magnifying unit consists of two non-achromatic lenses, which provide a clear, flat field but show a small amount of colour. The writer therefore intends to replace the present 10x unit with a compound lens of the same power—but corrected for both spherical and chromatic aberrations, thus increasing the usefulness of the instrument and bringing it up to the approved standard for diamonds.

One of the most interesting features of the Luminex loupe is the focusing adjustment to the lens. When the measuring-scale unit is removed and the lens raised to its full extent, the magnifier is focused on the gem when the latter is well within the instrument and illuminated from the side. This condition results in a dark-ground lighting effect not greatly inferior to that produced by much more elaborate and costly apparatus.

The light is contained within the handle of the instrument and controlled by a switch. Gems held in tweezers or three-prong spring stone holder are consequently always observed under ideal lighting conditions, every detail being visible.

The illuminating unit is powered by two standard dry-cells, one-half inch in diameter and two inches long. The lamp is a standard 2.5 volt flashlight bulb.

For prolonged use in the laboratory, a mains-type unit (comprising a small transformer which plugs into an electrical outlet and has a lead attached to the handle of the magnifier) can be supplied at somewhat higher cost.

With the lens unit removed, Luminex can also be used in conjunction with the microscope for the examination of opaque gemstones and pearls under much higher magnification than is normally required.

* * *

> " Our (Canadian) universities are now loaded down with such trade school curriculae as gemology, real estate, forestry, physical culture, journalism, commerce and countless other subjects having the same intrinsic value as the square root of nothing, as far as ' education ' is concerned . . ."

The above somewhat startling statement appeared in an article entitled, "*Don't* Send Them to College," by Hugh Garner, a writer for *New Liberty Magazine* (Toronto).

Subsequent investigation carried out by the present writer has shown that an alleged course in gem(m)ology offered by a university in the Maritime Provinces is actually a very elementary course in the lapidary arts—misnamed " gemology " by the university. It would be interesting to learn whether students who complete the course will consider themselves to be gemmologists duly certified or diplomated by the university in question ?

MEASUREMENT OF COLOUR

by

M. D. S. Lewis, B.Sc., F.G.A.

IT is estimated that about ten million different colours can be distinguished by the average human eye. In gemmology the number normally occurring probably runs in thousands, yet until quite recently there has existed no precise method of measurement or even specification. It is true we speak of " pigeon-blood " rubies, " sherry-coloured " topazes, etc., but in doing so we are only making a mental comparison with some object we may previously have seen ; we are attempting to describe colour in terms of our own private personal experiences. Through this lack of objectivity each observer has probably a different standard and although we can specify unambiguously the weight, density, refractive index and other properties of a gemstone, we have been at a loss accurately to describe what is often the most important feature—colour.

The advantages of a universally adopted system of colour specification and measurement are obvious. From the theoretical point of view there are many unknown fields to be explored. What is the exact difference between a " blue white " and other diamond ? How can the fading of a stone be measured ? What are the relationships between Burma, Ceylon and Montana blues ? Is there some unique difference between the yellow of topaz and that of citrine ?

In practical gemmology colour measurement might well yield valuable results. Some jewellers and dealers with a highly developed optical sensitivity can distinguish between many stones through colour alone. If asked to define the difference in colour between a good synthetic and a natural stone they could probably not do so. It is too subtle—it defies definition but is nevertheless present. A stone might conceivably be distinguished from another through a numerical evaluation of colour alone.

Probably the greatest benefits from colour specification and measurement would accrue in the commercial field. It would be very advantageous for an auctioneer to be able to specify in his catalogue the colour co-ordinates of a valuable stone (in addition to weight and certificate of genuineness) so that a prospective-purchaser in another country could form a good idea of its appearance. The colour grading of diamonds can only be successfully achieved through a scientific method of colour measurement.

By 1931 the need in industry for a universal language of colour had become so strong that an international convention met at Cambridge and formulated the C.I.E. system (Commission Internationale de l'Éclairage). In America it is referred to as the I.C.I. system (International Commission on Illumination). Rarely can any international conference have produced such unanimity and prescience of future requirements and there is no doubt that the conventions adopted will remain unchanged for many years The C.I.E. system is rapidly pervading all fields in which colour is of importance and it is only a matter of time before it impinges on gemmology. We may, in the not distant future, hear of a customer warning his jeweller that the " chromaticity " of the ruby he is seeking for an engagement ring must lie within a certain area on the C.I.E. chromaticity chart. The purpose of this article is to describe briefly the C.I.E. system and to discuss its possible application to gemmology. Although the mathematics involved is simple the subject as a whole is not exactly easy to grasp at first because of new and strange concepts. Whilst much has been known of colour for three centuries the technique of colour measurement is less than thirty years old. Before proceeding further it may be as well to ask what is required of such a system.

It will be assumed that the reader is familiar with the article in the previous issue* on " Colour Perception." The observance of colour is a mental sensation influenced by three attributes :—

(a) HUE, by which we distinguish red from blue, green from yellow, etc.

(b) SATURATION. Concentration of hue, intensity, purity, or freedom from white.

(c) BRIGHTNESS (the most difficult attribute), depending on the total amount of light entering the eye. If we have two

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* Journ. Gemmology, Vol. 3, No. 6, 1952.

identical red surfaces and add black to one, the colour sensation moves towards brown. Hue and Saturation have remained constant but less light is reflected from the blackened surface causing the eye to register a different sensation.

Whatever arithmetical results a system yields they must be such that some correlation with these three attributes is possible, for it is only through them that a colour is appreciated. They should also be capable of graphical representation to show the relationship of one colour to another and, furthermore, the system must be sufficiently simple for manipulation by comparatively unskilled operators. The C.I.E. system fulfils all these requirements and remains the master pattern to which any other subsidiary system should be capable of reference if it is to remain valid.

The difficulty of the subject is best appreciated by considering the sequence of events which must precede the observance of colour. First there must be some illumination—without light there can be no colour. When this illumination passes through a gemstone it becomes modified to an extent depending on the absorption properties of the stone. The " colour " of a gem is mainly the " colour " of the illuminating light after it has been modified by passage through the stone. So far everything that has happened can be defined in physical terms. The coloured light travelling from stone to eye can be analysed by spectrophotometers, etc., and its spectral composition and relative energy measured. This, however, is the last word which physics can say because it cannot forecast what effect will be produced on the eye. The relative energy of the various rays gives no more than the crudest idea since the sensitivity or response of the eye is not the same for all wavelengths. Radiation of energy so great as to cause actual burning, may yet totally fail to stimulate the colour mechanism of the eye. We must therefore now leave our comfortable world of straightforward measurement in grams, centimetres, degrees, etc., and move to another sphere in which human sensations are involved. The bridge between the purely physical and what the Americans call the " psycho-physical " is the " International Equal-Energy " Luminosity Curve (Fig. 1) which records the inverse of energy required at each wavelength to produce a visual sensation of constant magnitude.

Suppose the light travelling from gemstone to eye has been analysed and that Fig. 2 records the result given by spectrophotometers. The light is obviously very rich in " blue " energy but that does not mean to say that it will appear blue since these rays have low luminosity. If we multiply curves I and II we obtain another curve (Fig. 3) which gives the actual visual response to the coloured light. It will be observed that energy has dropped out of the picture and has been replaced by visual sensation. In spite of the physical instruments having recorded a preponderance of " blue " energy the eye experiences a yellow green sensation, practically devoid of blue.

How then is this visual sensation to be specified and measured ? It may be said that skilled colour physicists can do so by manipulation of graphs of this type and express the result in C.I.E. terms. This " analytical " method, however, is lengthy, requiring a thorough knowledge of the subject, very high technical skill, costly apparatus and laborious calculation. For those less experienced, a simpler method is called for, but before embarking on details it may be helpful to consider an analogous though fanciful situation.

Suppose we are in a café and have in front of us a cup of tea, the sweetness of which we are asked to measure. Our first instinct may well be that it is impossible—sweetness is a sensation of the palate, a private experience—and whereas we can roughly compare sweetnesses, we can no more say that one cup of tea is twice as sweet as another, than we can proclaim that we are twice as happy or half as miserable as someone else. On reflection, however, we may realize that sweetness is due to sugar and if we can find the quantity of sugar in the cup of tea we can say that the sweetness is that of, say, a teaspoon of sugar. By this specification we can stimulate an equivalent sweetness sensation whenever required. To find the amount of sugar we could apply the " analytical " process, but this would require the services of a skilled chemist and his procedure would be unsuitable for use in a café. A much simpler method presents itself for less skilled operators. We can call for a second cup of tea, identical with the first, except that it must be unsweetened. We then add sugar in carefully controlled amounts until both cups of tea taste equally sweet to us. We can then say that the sweetness of the first cup is also that stimulated by say, a teaspoon of sugar. At this stage a supercilious waitress who

FIG.1.

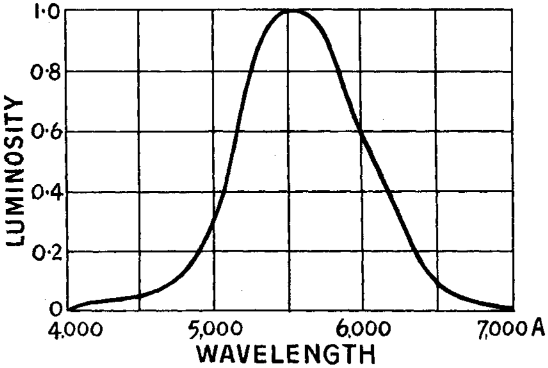

Fig. 1. *International "Equal-Energy Luminosity" curve showing the relative response of the average eye to the different wavelengths of the spectrum.*

FIG.2.

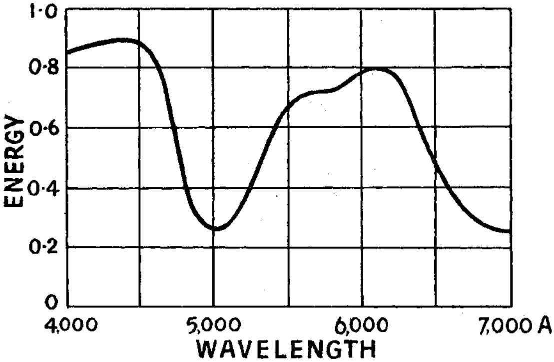

Fig. 2. *"Relative Energy—Wavelength" curve of light from a coloured gemstone.*

Figs. 2 & 3 adapted by permission of the author and publishers from "The Measurement of Colour," by W. D. Wright (Hilger, London).

FIG.3.

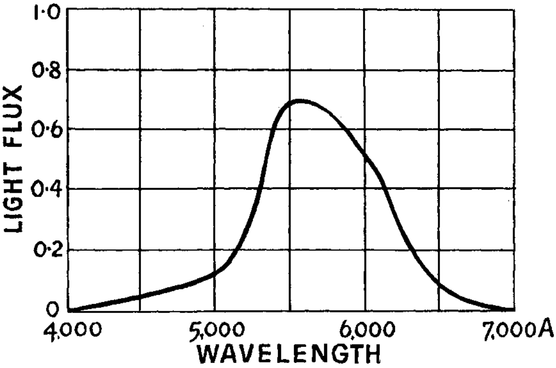

Fig. 3. *The product of curves in Figs.* 1 *and* 2 *giving the actual response of the average eye to the coloured light represented by Fig.* 2. *"Light Flux" is a measure of luminosity.*

has been observing the whole affair may intervene to point out that our premises are entirely wrong. Owing to sugar shortage there was none at all in our first cup—she had substituted a saccharine tablet. This would be immaterial so long as some skilled observers before us had, through repeated tests, ascertained the relative amounts of sugar and saccharine necessary to produce on the average person the same sensation of sweetness. This could then be expressed either in sugar units or saccharine units by a simple arithmetical transformation or, if economy in the use of sugar were desirable, it could be expressed as so many sugar units plus so many saccharine units.

The analogy with colour is quite close if not pushed too far. The problem colour is thrown on a screen and another colour patch is built up adjacent to it by mixing lights of known physical properties until a complete match is obtained. When this occurs the line of demarcation vanishes. The eye, like the palate, cannot analyse its sensations but is very sensitive to *differences* of colour and quickly recognises when two patches of colour are identical in all respects. When this has been done we " measure " the colour by stating that it is the sensation produced on an average observer under the stimulus of certain lights of known physical properties. This technique of " synthesis " is known as " colorimetry " and the instrument which synthethises an equivalent stimulus is called a colorimeter.

The C.I.E. system and the whole subject of colorimetry rest on the remarkable fact that most colours can be matched by the mixture in suitable proportions of three primary colours. Usually a red, green and blue are chosen, but no special combination is essential ; there are an infinite number of triplets which can be used. Only two conditions are attached to this statement. Firstly, the three primaries, if mixed in certain proportions, must produce white and secondly, no one primary may be matched by any mixture of the other two. As a matter of fact, even monochromatic lights are not essential and some colorimeters employ composite colours, obtained by passing white light through filters.

In order not to break the continuity of what follows certain axioms may be stated beforehand. They are either self-evident or can be proved by theory or experiment. For the present it must

FIG.4.

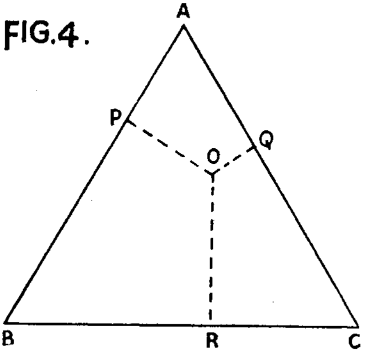

Fig. 4. Equilateral Triangle. Wherever " O " may be OP + QR + OR = the distance of A from BC. The distances OP, OQ, OR are called co-ordinates of the point " O ".

FIG.5.

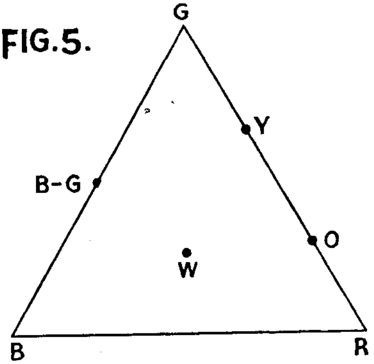

Fig. 5. Equilateral Triangle showing colours of spectrum (Red, orange, yellow, green and blue) arranged round sides. At the centre is the white point " W ".

also be assumed we are dealing with coloured lights (not surfaces or objects).

(a) The hues appearing in the spectrum are the purest normally obtainable and no greater saturation is possible under ordinary circumstances.

(b) If two primary colours are mixed to produce an intermediate colour—say red and green to produce yellow—the addition of a third primary (blue) does not necessarily produce a different hue but rather at first tends to desaturate the mixture. Thus the addition of blue to green and red tends to give a desaturated yellow. This might be argued from first principles. The first small amount of blue added combines with small amounts of red and green to give white which automatically desaturates the yellow mixture.

(c) If the height of an equilateral triangle is unity the sum of the perpendiculars from any point within to the three sides is also unity. Thus if the height of triangle ABC (Fig. 4) is unity then $OP + OQ + OR = 1$. The position of the point " O " is fixed if any two of these distances (co-ordinates) are known, and the value of the third co-ordinate can always be found by subtraction from unity.

The fact that most colours can be matched by the mixture of three primaries immediately suggests the use of Maxwell's Triangle as a frame of reference. In Fig. 5 imagine spectrally pure red, green and blue lights to shine inwards from the corners of an equilateral triangle. By definition these three primary colours are the purest, most saturated obtainable. If one travels along the perimeter from R to G the various colours resulting from the mixture of red and green are met with—first orange and then yellow. At G there is pure unadulterated spectral green and proceeding thence towards B the intermediate colour of " Blue-Green " is found, whilst further along at B there is pure spectral blue. In other words, all the hues of the spectrum are met with along the two sides RG and GB. Between B and R lie the purples and magentas, which are not spectral colours but which result from the mixture of blue and red. Immediately one leaves the perimeter for the interior the third primary begins to exert influence and therefore some desaturation will occur (axiom b), whilst at the centre of the triangle is the white point " W " where equal quantities of the three primaries—red, green and blue—co-exist.

Is then this simple triangle a suitable frame of reference within which any colour may be plotted ? The position of a point relative to the perimeter would seem to indicate the hue and its distance from the white point " W," a measure of saturation. Unfortunately further investigation shows that a triangle of this nature cannot contain all possible colours.

FIG.6.

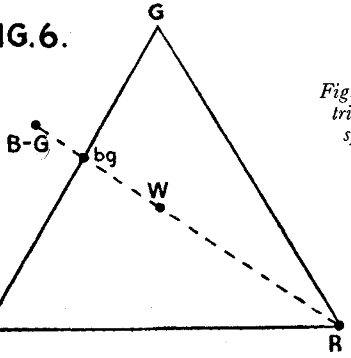

Fig. 6. In this equilateral triangle " R " represents pure spectral red, " W " white, " bg " the blue-green obtained by mixing blue and green. Spectral " blue-green " can only be obtained outside the triangle at BG.

In Fig. 6, consider the colours met with along the line RWbg. At " R " there will be pure spectral red, the saturation of which may be called unity. At the white point " W " the red is only one-third as strong and here the saturation may be called one-third. At " bg " it will be zero but experiment shows that no mixture of blue and green lights can give the saturation of spectral blue-green. It appears that to obtain this we should have to move further away from the white point to a point " BG " outside the triangle. As the amount of red has decreased from unity at R to zero at " bg " it follows that at BG it must have become a negative amount. Physically this means to say that a match can be made between spectral " blue-green " on the one hand and any mixture of blue and green lights on the other, only if the *spectral* colour is desaturated by the addition of red light. (Subtracting a quantity from one side of an equation is equivalent to adding it on the other side). Similarly all the pure saturated colours must be outside the triangle except at the points RGB. Fig. 7 shows them joined by a curve which is known as the Spectral Locus.

Whilst an experienced colour physicist would have no more difficulty in handling negative colours than a mathematician has in dealing with negative numbers, it was felt that for a system to be used generally all positive colours were preferable. Obviously, the only way to get all colours within our frame of reference is to enlarge our triangle and this has been done in Fig. 8, RGB having to be discarded for three new entities XYZ. If RGB represented

FIG. 7.

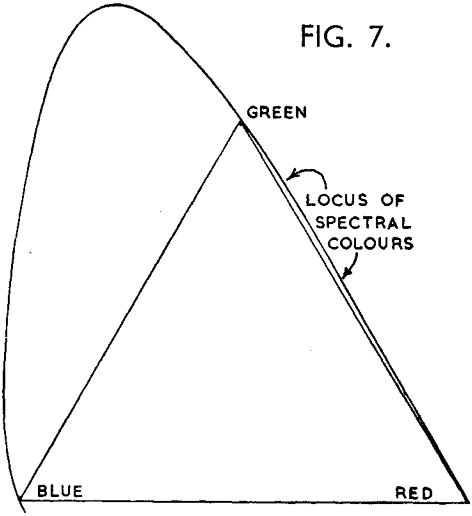

Fig. 7. *The position of all pure spectral colours relative to the equilateral triangle of Fig.* 6 *have now been plotted and joined by a curve known as the " spectral " locus.*

Reproduced from "The C.I.E. International Colour System Explained," by G. J. Chamberlin, by permission of the publishers, The Tintometer Ltd., Salisbury.

primary colours of spectral purity what can XYZ represent ? They can only be imaginary colours of super saturation not capable of being realised in practice and since they are hypothetical they are no longer referred to as colours but as " stimuli."

We now seem to have jumped from the frying pan of negative colours into the fire of imaginary colours, but this need not worry us for the mathematicians have arranged matters so that any real colour can be expressed in terms of XYZ (and vice versa) by a simple arithmetical transformation. Thus, if in a colorimeter a colour is matched by a mixture of red, green and blue lights in certain quantities the corresponding proportions of X, Y, Z can usually be obtained from tables. The expression of tangible quantities in unreal units is not so far-fetched as it might at first seem. The engineer often expresses " power " in terms of horses which do not exist and the whole structure of classical physics rested mainly on the existence of an imaginary aether. The exact specification of these XYZ stimuli was a problem in mathematics and physics but need not concern us here ; their great virtue is that they are the alphabet of a universally accepted language of colour. Thus in one laboratory a colour may be matched by a mixture of deep red, yellow and blue lights whilst in another those worked

FIG. 8.

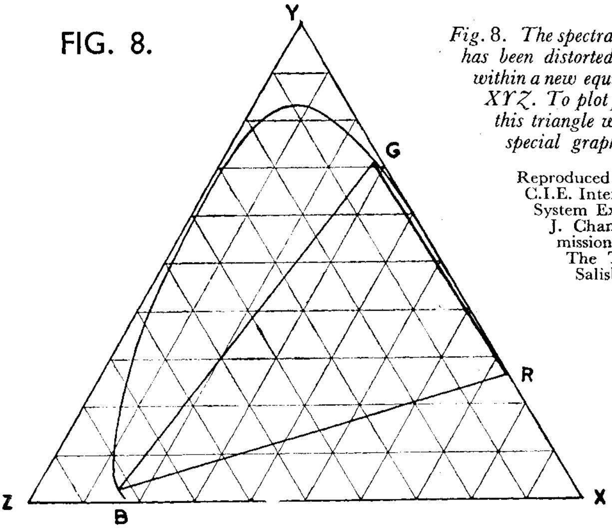

Fig. 8. *The spectral locus of Fig.* 7 *has been distorted to fit wholly within a new equilateral triangle XYZ. To plot positions within this triangle would necessitate special graph paper.*

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with might be medium red, green and blue. When, however, the necessary arithmetical transformations had been made they would both give the same XYZ specification.

The quantities of XYZ stimuli in any colour are known as the tristimulus values and are usually written in the form of an equation known as the tristimulus equation. Thus the C.I.E. specification of the colour of a piece of turquoise might perhaps be given as follows :—

$$\text{C (Colour)} = 15.51\text{X} + 21.33\text{Y} + 38.64\text{Z}$$

which is a statement of fact that the colour of the light from this stone would be matched by 15.51 units of X stimulus, plus 21.33 units of Y stimulus, plus 38.64 units of Z stimulus. Although XYZ are imaginary stimuli the actual match would have been made with real colours and the result transformed to the above by easy calculation or through the use of tables. The tristimulus equation in its final form specifies both quantity and quality of a colour for a given illumination. It should be noted that the value of Y is of particular interest, for reasons which will be explained later.

Having now succeeded in labelling a colour—for no other can have these particular tristimulus values—the whole subject for some purposes might perhaps be left here. To do so, however, would leave much of value unsolved. Except to an operator very experienced in colour physics the mere statement of tristimulus values would not convey more than a crude idea of colour and no connection of the three essential attributes—hue, saturation and brightness is yet obvious. Suppose the turquoise were " treated " in some way and re-measured for colour, the new tristimulus values being $25.85\text{X} + 35.55\text{Y} + 64.00\text{Z}$. In which way has the colour changed ?

The answer to these questions lies in graphical representation but the equilateral triangle of Fig. 8 is not an easy frame of reference to deal with, requiring triangulated graph paper and considerable mathematical knowledge. If, however, the three variables XYZ could be reduced to two, the usual rectangular co-ordinates of ordinary graphs would be employed. To do this we can divide the three tristimulus values by their sum, which converts them from actual amounts into proportions, adding up to unity. Thus if a certain colour were specified in C.I.E. terms as $\text{uX} + \text{vY} + \text{wZ}$ we should divide throughout by $\text{u} + \text{v} + \text{w}$ and an equation written

FIG. 9A.

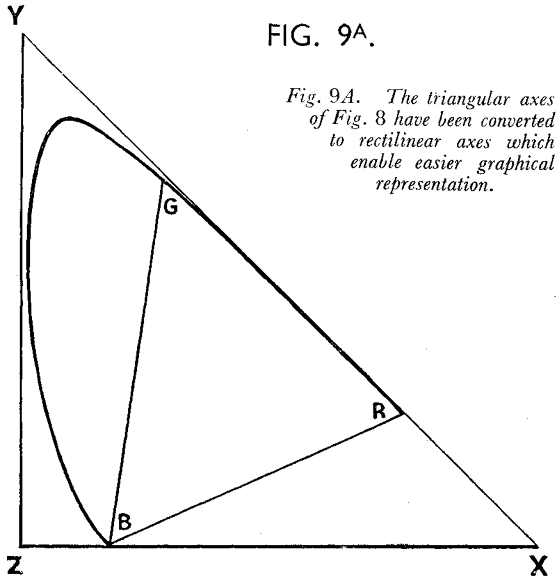

Fig. 9A. The triangular axes of Fig. 8 have been converted to rectilinear axes which enable easier graphical representation.

FIG. 9B.

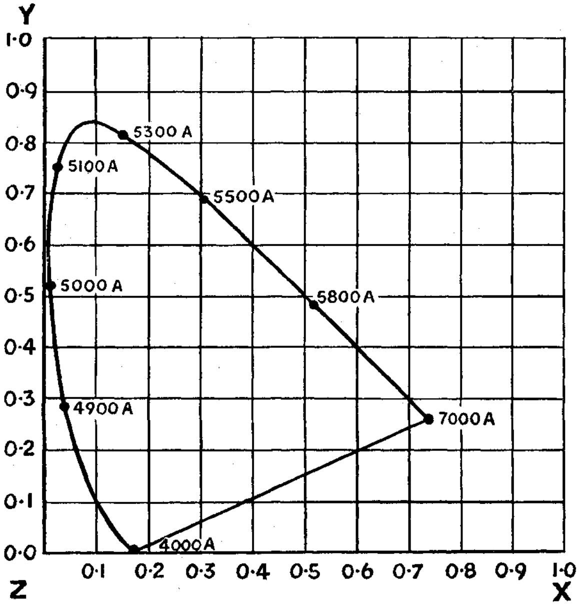

Fig. 9B. All traces of the original triangle have now been obliterated and the axes calibrated. Wavelengths have been marked on the spectral locus which has been adjusted to the new rectilinear axes. This is the standard C.I.E. Chromaticity Chart.

$$c = \frac{u}{u+v+w}X + \frac{v}{u+v+w}Y + \frac{w}{u+v+w}Z$$

Where " c " is one unit of the colour

$$\text{Let } x = \frac{u}{u+v+w};\ y = \frac{v}{u+v+w};\ z = \frac{w}{u+v+w}$$

$$\text{Then } c = xX + yY + zZ.$$

$$\text{Where } x + y + z = 1.$$

This equation is called the unit trichromatic equation and the coefficients x, y, z are called the trichromatic co-ordinates. It will be noted they represent not the amounts of X, Y, Z present but their proportions and always add up to unity. If, therefore, two of them are known the third can always be found by subtraction from one. Since the sum of the co-ordinates in the equilateral triangle of Fig. 8 can also be assumed unity, it is mathematically justifiable to convert the curve of Fig. 8 to rectangular co-ordinates and the result is shown in Fig. 9A. In Fig. 9B the last triangular traces have been obliterated and scales provided to both rectangular axes to give the most important diagram of all—the " C.I.E. Chromaticity Chart " in which we can plot every possible hue by using the trichromatic co-ordinates of the unit equation. Any two of the coefficients could be used—though x and y are invariably chosen.

In Fig. 10 the writer has crudely indicated the positions which might be occupied by some of the typical gemstones. The dependence of colour on illumination has been repeatedly stressed and in accurate colour measurement the precise illuminant used is of paramount importance. In the C.I.E. system three standard sources are used corresponding to tungsten electric light, sunlight and north sky light—consistency being achieved by use of standardised lamps and filters. The trichromatic co-ordinates of these standard illuminants are, of course, accurately known and their position fixed on the C.I.E. chromaticity chart.

In Fig. 11 the chromaticity chart is reproduced with one of these illuminants indicated by the point S. Suppose the unit

FIG. 10.

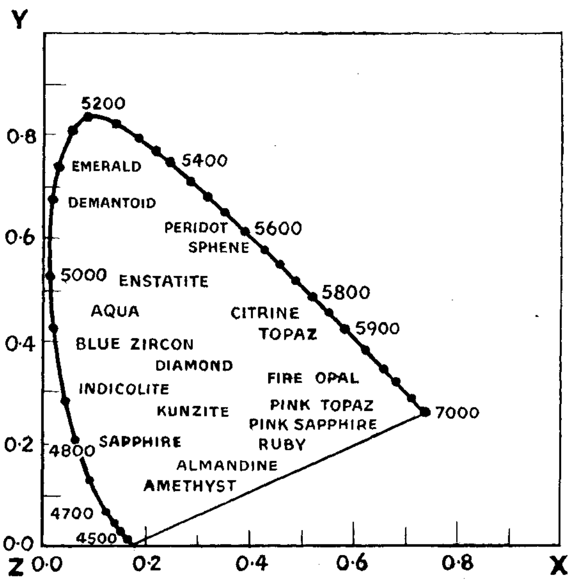

Fig. 10. *The average position of some typical gems has been very roughly indicated on a C.I.E. Chromaticity Chart. The exact position of any particular stone would be found by reference to the X and Y axes.*

trichromatic equation of a colour has been found by experiment to be ;—

$$c = .50\,x + .35y + .15z$$

The coefficients of x and y which are .50 and .35 respectively become the co-ordinates on the C.I.E. chromaticity chart and are plotted at the point " C." These two points S and C are now joined by a straight line which is produced to meet the spectral locus at D. This immediately gives the dominant wavelength, approximately 6,000A—that is to say, the monochromatic light which when suitably mixed with white light, or rather the illuminant, will match the colour under observation. Those with no knowledge of the subject would probably refer to it as "the" colour. Expressing it another way, one could say that the hue of the monochromatic light represented by point D on the spectral locus is the hue of the colour which is being examined. The ratio SC/SD is called the " Excitation Purity" which corresponds with saturation. The combination of Hue and Saturation of a colour is referred to as its "quality" or "chromaticity" and whilst they themselves (Hue and Saturation) remain mental sensations which cannot be measured as such, they are very closely correlated with dominant Wavelength and Excitation Purity which can be expressed numerically.

FIG. 11.

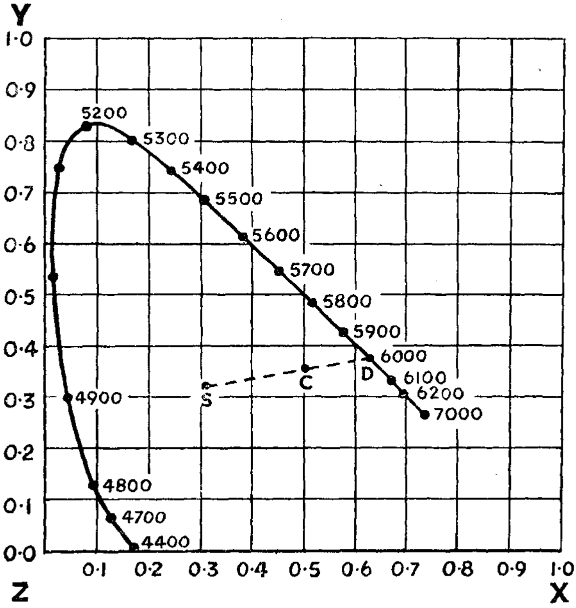

Fig. 11. *A C.I.E. Chromaticity Chart showing the position of an illuminant " S ". The trichromatic coefficients of a colour have been found to be* $x = .50$, $y = .35$ *and the position plotted at " C ". The line SC produced to D meets the spectral locus roughly at* 6000*A, which is the dominant hue of the colour. The ratio SC : SD corresponds to the saturation on a scale in which zero would represent colourlessness (or rather the colour of the illuminant) and unity would represent spectral purity.*

Thus emerges one of the outstanding advantages of the C.I.E. system. Suppose it were desired accurately to describe the colour of a gemstone to someone in another country. Without such a method one could only photograph the absorption spectrum or take a large number of measurements of relative energy in the transmitted rays, recording them on a graph. Neither of these methods —though perhaps physically accurate—could possibly convey more than the vaguest conception of actual colour. Under the C.I.E. system the dominant wavelength could be quickly found and isolated in the spectrum whilst the " depth " or " paleness " of hue could be assessed from the Excitation Purity.

The all important aspect of brightness does not yet seem to have been catered for in this C.I.E. specification and it will be seen that a difficulty will arise if the line SC produced meets the straight line at the base of the diagram as no spectral colours are located here. These matters will be discussed in the next article on the subject. In the meantime, however, it may be helpful to summarise very briefly the fundamental steps in the simplest method of colorimetric evaluation.

(i) Coloured lights of known physical properties are mixed in controlled amounts until they match exactly the unknown colour.

(ii) The amounts of these real coloured lights are transformed into units of the imaginary stimuli XYZ giving a tristimulus equation of the form

$$C = uX + vY + wZ$$

(iii) To plot the colour on the C.I.E. chromaticity chart, divide the three coefficients u, v, w by their sum " $u + v + w$ " which will give the unit trichromatic equation of the form

$$c = xX + yY + zZ$$

This merely specifies the quality or chromaticity of the colour, not the amount or brightness, but by finding the point on the C.I.E. chromaticity chart with the co-ordinates x, y, the colour is accurately charted in relation to other colours.

(iv) By joining the illuminant point to the colour point and producing the line to the spectral locus, the " dominant wavelength " and " excitation purity " are quickly found. These two quantities are closely correlated with Hue and Saturation.

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(*The second part of this article will appear in Vol.* 3, *No.* 8, 1952, *of the Journal.*)

Some More
UNUSUAL GEMS

by R. K. Mitchell, F.G.A.

IT might almost be said that, within the framework of the natural laws, nothing is impossible in the mineral kingdom. In my own experience it seems necessary only to be dogmatic over the colour or crystal habit of a mineral for the exception to turn up and confound one's most forthright pronouncements. Minerals have established habits but their behaviour in formation is subject to a myriad outside influences so that, while complying with certain rigid laws, very considerable variation may be found.

The island of Ceylon is no exception in this matter of producing the unusual, and a recent parcel of 10 cabochon cut stones yielded no fewer than three exceptional specimens.

The first of these flatly contradicted a statement I had made quite recently to my friend in Ceylon. I said that gem enstatite occurred only in an intense green. The present stone was a glassy grey and, although it was sent to me as an enstatite, I was inclined to doubt it and at first thought it might be the closely similar mineral diopside, which, incidentally, should also be green.

I was able to get a rather hazy refractometer reading from a partly polished flat on the back of the stone and, finding that the absorption spectrum showed a distinct line at 5060A (a line seen in both these minerals) and another fainter one at 5510A, I still plumped for diopside. It remained for Mr. B. W. Anderson, guide, mentor and friend to so many bewildered gemmologists, to point out that the 5060A line in this instance was in fact a single line (characteristic of enstatite) while that for diopside should be a doublet. A specific gravity test served to confirm this finding.

Now enstatite, according to Dana Ford, does occur in glassy grey forms, but it seems that these have not, until now, been cut as gems. The reason the present specimen has been so treated is almost certainly the presence of a faint but definite chatoyant streak. This, of course, is yet another unusual feature of the stone.

Considering the absorption spectrum we have another significant fact. The line at 5060A has, until now, been considered to be due to the presence of iron, which imparted the normal green colour to both enstatite (enhanced by chromium) and diopside. In this instance we have the absorption spectrum and no vestige of the green colouring. The next specimen throws further light on this discrepancy.

This stone proved to be an unusually fine specimen of chatoyant tourmaline, a pale honey yellow in colour with a vivid streak rivalling and even surpassing that of a fine cymophane cats-eye. The specific gravity of 3.10 was quite normal, but the birefringence of 0.015, obtained from a polished flat on the back of the stone, was distinctly low for this species.

Tourmaline is not as a rule a very profitable source of absorption spectra, but this specimen yielded two faint but definite lines which, when measured, proved to be at the same wavelengths as those in the enstatite described above. This is a matter for some comment.

It is known that the elements responsible for the intrinsic colour in minerals belong to a group known as gap elements. That is to say their outer structure, consisting of a series of electron " shells," has one of the inner shells incomplete. The absorption spectra produced by these elements when present in a mineral, consist characteristically of rather broad dark bands (chromium is an exception, producing, apart from the broad absorption in the yellow-green, fine clear-cut lines). The position of these bands is also variable from mineral to mineral, suggesting that the colouring element is itself radically influenced by the structure of the host mineral.

Two other groups of elements also have gap structures ; the heavy radio-active elements and the rare-earth group. Both have interesting effects on absorption spectra, although it is uncertain whether they greatly influence colour.

The first of these groups contributes uranium to our list of absorption spectrum producers. Its effect is seen in the highly developed and very characteristic spectra of the various types of zircon ; the spectrum being generally clear cut and apparently quite fixed in position.

The second group comprises those elements generally referred to as rare-earths. These provide absorption spectra in which the lines are again fairly narrow and are stable in position to within the limits of the small spectroscope.

It now seems likely that the lines seen in these two gems (one of them occurring also in diopside) must be due to the presence of one of these rare-earth elements. Some comparison may perhaps be made with the yttrium line at 5505A seen, in conjunction with others in the same region, in Brazilian andalusite ; while neodymium shows a line near the 5060A position. Both these elements normally show much richer absorption spectra than are seen in these minerals, but it must be born in mind that data on their typical spectra are usually obtained from solutions of their salts, generally a more prolific source of absorption lines.

Regretfully, I have had to return this parcel of gems to Ceylon and the two specimens are not available for further work. The fact remains that there are now three minerals which have shown very similar, if not absolutely identical absorption lines. An occurrence sufficiently unusual to justify comment.

My third specimen was less startling in appearance but was sufficiently out of the ordinary to warrant discussion. It was simply a deep brown chrysoberyl cats-eye in which a second and rather fainter streak crossed the first at right angles, making, in fact, a four-ray star stone. It is the first I have seen, but I suppose there is really no reason why the " silk " should not be parallel to one of the lateral axes as well as to the vertical axis.

The mineral is, of course, orthorhombic in symmetry. The axes are unequal and the atom sequence is therefore different in each axial direction. The fact that one of the chatoyant streaks is much fainter than the other is undoubtedly due to this variation in lattice pattern. The fibrous inclusions producing the reflected streak are probably denser parallel to the C axis.

The presence of fibres parallel to two *unequal* axes is unusual. Normally such inclusions are parallel to axes or directions which are equal, as in corundum or garnet, or parallel to a unique direction (the C axis) as in quartz cats-eye and normal chrysoberyl cats-eye and others. Another instance of this occurrence of two separate and different groups in one specimen was seen in the strongly asterated quartz which I have described elsewhere (Gemmologist, Feb., 1951). In that instance a strong six-rayed star due to submicroscopic fibres parallel to the normal lateral axes, was supplemented by a series of much fainter four-rayed stars caused by sparce but coarser inclusions, possibly related to one or other of the rhombohedra.

In conclusion I must own my usual indebtedness to Mr. F. L. D. Ekanayaka (who identified them all correctly) for the sight of these and other most interesting gems ; and to Mr. B. W. Anderson for his advice in the matter of the enstatite.

LETTER TO EDITOR

Dear Sir,

With reference to the article by Mr. L. C. Trumper under the heading of " Photomicrographs " in Volume 3, No. 6, of the Journal of Gemmology, April, 1952, I venture to suggest that the difficulty of focusing referred to in the fourth paragraph of the article can be very simply got over by the insertion of a thin cover glass at an angle of 45 degrees at the appropriate position behind the back glass of the objective, coupled with the addition of a tube to hold a second ocular to act as a watching and focusing eyepiece. This will enable focusing to be carried out with the camera in its normal position at the normal ocular end.

In case facilities are not available, any of the microscope manufacturers will make the alteration very cheaply. The main expense is in the use of the second ocular which should be twice the power of the normal ocular.

I should add that the loss of light for photographic purposes is only about 10% of that available.

Yours faithfully,

E. MACKIE.

23, Mount Park Crescent,
Ealing, W.5.

May 6*th,* 1952.

Gemmological Abstracts

BENSON (L. B.). *Gem Trade laboratory instals new testing equipment.* Gems and Gemology. Vol. VII, No. 4, pp. 107-112. Winter, 1951-2.

Intended primarily as a report on the new X-ray equipment for pearl testing at the New York laboratory the article gives a summary of the requirements of microradiography and X-ray luminescence of pearls. The methods discussed are confined to the direct radiographic process and X-ray fluorescence. It is suggested that better radiographic results may be obtained by completely immersing the pearls in carbon tetrachloride and employing very soft X-rays (25 kV) with longer exposure times and using fine grain film. A full description of the apparatus used ; the methods of operation and the safety precautions taken are given. It has been found that by using this technique the layers of the mother-of-pearl bead in cultured pearls may show up on the shadowgraph when oriented correctly with relation to the X-ray beam. An ingenious plastic dish with nylon net is used to keep loose pearls in position when being radiographed. The microradiographic (and magnification) technique could with advantage be better explained. A trenchant revue of the current American practice in pearl identification by X-rays. R.W.

DAY (N. H.). *Finding refractive index by direct measurement.* Gemmologist, Vol. XXI, No. 249, pp. 57-58. April, 1952.

A description of the direct measurement method of refractive index determination when employing a microscope which has no calibrated fine adjustment or vernier scale. A small square of celluloid is rested on its edge on the top of the limb of the microscope. With a sharp point the celluloid square is marked at the positions taken up by the top of the rack on the body tube when the microscope is focused on the three positions necessary, the distances of these three points are then measured by placing the celluloid square on the stage with a suitable stage micrometer. Simple calculation of the ratios gives the refractive index. F. A.

LENTZ (M.). *Emeralds of Chivor.* Gemmologist, Vol. XXI, Nos. 248/249, pp. 49-51 ; 58-60. March/April, 1952. (*Reprinted from The Lapidary Journal, U.S.A.*).

The writer tells of his visit to the emerald hoard at the bank at Bogota, and his journey to the mines of Chivor, which, known some 250 years ago had been lost and not rediscovered until 1905. No machinery is used at Chivor, the emeralds being searched for along narrow terraces—a form of open-pit mining—and by making low untimbered tunnels into the rock. The water necessary for the mining operations is brought along a wooden aquaduct from 16 miles away just as it was so brought during the earlier mining during the 16th and 17th centuries. The emeralds are found in veins varying from several inches to a few feet in thickness. The emerald pockets are indicated by the presence of *moralla* an uncrystallized (massive ?) form of green beryl. Many of the emerald crystals are encrusted with iron oxide which completely obscures the green colour. The article concludes with a general survey of the recent history of the mines—that is from 1905—and some notes of the mineralogy of beryl. R. W.

GAINES (R. V.). *The Sapphire Mines of Kashmir.* Rocks and Minerals, Peekshill, N.Y., Vol. 26, pp. 464-472, 1951.

Sapphire occurs in metamorphosed rocks and associated minerals include kyanite, tourmaline and andalusite. The article describes mines which are near Kudi. F. A.

REIS (E.). *Description of third largest diamond discovered in Brazil.* Gems and Gemology, Vol. 7, pp. 26-27, 1951.

The diamond weighed 407.6 carats when found in 1949 in the Douradinho river, Coromandel, Minas Gerais. Named the " Presidente Enrico Gaspar Durta " it has since been cut into 36 stones ranging from .55-9.60 cts., with a total weight of 136 cts. F. A.

ANDERSON (B. W.). *Stokes on Fluorescence.* Gemmologist, Vol. XXI, No. 250, pp. 77-80. May, 1952.

A centenary tribute to George Gabriel Stokes the 19th century English physicist who carried out so much of the earlier work on the understanding of fluorescence. A colourful resumé of the work of this great scientist. R. W.

BARLOW (C. H.). *Ancient Pharaonic turquoise mines of Sinai.* Rocks and Minerals, Peekshill, N.Y., Vol. 26, pp. 348-353, 1951.

The turquoise occurs in Nubian sandstone and the article gives a description and a brief history of the mines. F. A.

COGGIN BROWN (J.). *More about Golconda.* Gemmologist, Vol. XXI, No. 249, pp. 72-75. April, 1952.

The history of the ancient State or Kingdom of Golconda and of the capital city of the same name, the latter of which was only the mart for the diamonds found in the southern parts of the state—and elsewhere in India. Some notes on the diamondiferous areas and the localities of the mines are given, and something is told of the famous Indian diamonds. R. W.

CHUDOBA (K. F.). *Neue Schmuck-und Edelsteinmineralien.* New gem materials. Gold und Silber, Vol. 5, 1952, (3), p. 16.

Short survey of new gem materials discovered during the last 50 years, mentioning kunzite, benitoite, brazilianite, and taaffeite. Not yet mentioned is sinhalite. E. S.

H. C. D. *Benitoite Mines Open.* Mineralogist, March, 1952.

A note on the re-opening of the benitoite mines of San Benito, California. Gem specimens are available in limited quantities.

A. G.

P. G. *The Diamond Tool Industry in* 1951. Pamphlet, 12 pp. Published by Industrial Diamond Information Bureau, London.

A survey of the chief scientific and industrial developments that took place during 1951, as reported in various periodicals and publications, as well as in patent literature.

SCHLOSSMACHER (K.). *Unterscheidung von echten Perlen und Zuchtperlen durch Röntgenschattenbilder.* Differentiation of genuine and cultured pearls through radiography. Gold und Silber, 5, 1952, (No. 4), p. 10.

The X-ray radiogram technique developed in America and in this country has been tried out by Siemens Reiniger-Werke, A. G., Erlangen. After further tests in Mr. Saller's laboratory in Munich, the Idar-Oberstein Institute is now ready to introduce this efficient method. E. S.

ASSOCIATION NOTICES

COUNCIL MEETING

A meeting of the Council was held at 19/25 Gutter Lane, London, E.C.2, on May 19th, 1952, at 4.30 p.m. Mr. F. H. Knowles-Brown presided.

The following were elected to membership :—

Fellows

Farn, A. E., London. D.1947 (re-election).
Schunk, J. E., Sheridan, U.S.A. D.1950.
Small, J. G., Los Angeles. D.1951.

Probationary

Boudreau, A. G., Harrow.
Branford, E. V., Beccles.
Cummins, W. G., Blackburn.
Foreman, V. L., Stockton-on-Tees.
Forman, E. M. (Mrs.), Buckingham.
Freedman, L., London.
Furness, G. V. (Mrs.), Reading.
Gerling, C. W., Gloversville, U.S.A.
Keay, G. E., London.
Lachowich, V. A., Astoria, U.S.A.
Leese, P. F., Northwood.
Marshall, A., Hull.
Porter, L., Preston.
Ross, R., Edinburgh.
Rudell, J. J., Birmingham.
Sacks, Dr. L., London.
Sandlan, J., Nairobi, Kenya.
Shackman, J., London.
Smith, S. N., Amesbury.
Spray, W. F., Norwich.
Strömdahl, Ake, Stockholm, Sweden.
Thomson, D. M., Dumfries
Towells, M. B. (Miss), Bristol.
Wardall, C. H., Chester.
Watson, P. J., London.
Wood, B. M. (Miss), London.

Ordinary

Brown, J. E., Dewsbury.
Carrington & Co., London.
Dunstall, S. G., London.
Hamilton, J. J., Edinburgh.
Hill, F., Chesterfield.
Hyde, T. H., Sleaford.
Harkness, L.
Hyman Bros., Ltd., Blackpool.
Illingworth, R., Halifax.
Mitchell, B., Harrogate.
Pressley, H. J., Worthing.
Ruffell, E., Tunbridge Wells.
Sanders, G., London.
Sargent, G. T. (Mrs.), Launceston.
Sawyer, F. (Mrs.), South Shields.
Scott, W. S. & A. M., Lincoln.
Sims, B. W., Southend-on-Sea.
Slingsby, J. T., Bradford.

The Council felt that it was desirable to include a member from Scotland on the Council and it was decided to invite Mr. D. J. Ewing (Edinburgh) to serve as a co-opted member. The Council also agreed that where it was felt to be necessary local branches of the Association should be established. The proceedings of the twenty-second annual general meeting held at Goldsmith's Hall on April 2nd, 1952, were approved.

EXAMINATIONS IN GEMMOLOGY

The 1952 examinations of the Association were held as follows :—
Preliminary (Great Britain and overseas), Wednesday, June 4th ; Diploma (Theoretical) (Great Britain and overseas), Thursday, June 5th ; Diploma (Practical) (London and overseas), Friday, June 6th ; Monday, May 12th—Plymouth ; Friday, May 16th—Birmingham ; Monday, May 26th—Edinburgh ; Tuesday, May 27th—Glasgow.

The results of the examinations will be notified to all candidates on 27th August.

Applications for the 1952/53 Course should be made no later than as follows :

Overseas—1st August, 1952.
Great Britain—15th August, 1952.

The Course commences for overseas students on 8th September and for home students on the 22nd September.

GEMOLOGICAL INSTITUTE OF AMERICA

Dr. Edward H. Kraus of the University of Michigan has been re-appointed as President of the Gemological Institute of America for the seventh consecutive year.

At the same time Charles Peacock III, C. D. Peacock, Inc., Chicago, was elected to the office of Vice-President which has been vacant for several years. Fred J. Cannon, Slaudt-Cannon Agency Company, Los Angeles, was retained as Secretary-Treasurer.

John S. Kennard, Kennard & Company, Inc., Boston, was chosen to succeed H. Paul Juergens who retired as Chairman after having held that position on the G.I.A. Board for the past four years. Carleton G. Broer, Broer-Freeman Company, Toledo, will serve as Vice-Chairman to the Board, replacing J. Lovell Baker of Henry Birks & Son, Ltd., Montreal.

The retirement of Robert M. Shipley as Director of the Gemological Institute of America was announced on March 31st. In his retirement he can look back with pride and satisfaction upon the important organisation which he was largely responsible for bringing into being and to the status it has to-day. It was during the years of his operation of a large retail jewellery shop that he became conscious of a lack of centralised source to obtain all the information and background that he needed. After visits to factories, shops and museums in various European countries he studied the courses of the Gemmological Association of Great Britain which were, at the time, the only ones available on the subject.

On his return to America and series of lectures to groups of interested jewellers and eventually the Gemological Institute of America became a reality in 1931. No project of this magnitude could have come about through the effort of one man (in 21 years over 10,000 students have been enrolled) but Robert Shipley's leadership and imagination played a dominant part in the building up of a responsible gemmological organization.

Richard T. Liddicoat, Jr., has been appointed to succeed Mr. Shipley as Director of the Institute. He joined the Institute in 1940 and has had wide experience of its many activities. He is author of a " Handbook of Gem Identification " and is well equipped to direct the future activities of the Institute.

GERMAN GEMMOLOGICAL SOCIETY

A German Gemmological Society (Die Deutsche Gesellschaft fur Edelsteinkunde) has recently been established with Headquarters in Idar-Oberstein. The Society aims at furthering the study of gemmology and its objects are very similar to those of the British organization.

PROF. SCHLOSSMACHER

Prof. Dr. Karl Schlossmacher, the well-known German gemmologist, will celebrate his 65th birthday on July 10th, 1952. Until 1945 he was Professor of Mineralogy and Petrography in the University of Königsburg ; since 1948 he has been Director of the State-controlled Institute for Precious Stone Research in Idar-Oberstein. His chief publications have been the third edition (1932) of Max Bauer's great text-book " Edelsteinkunde " ; " Die Plaxis der Eedlsteinbistiminung" (1935) ; and " Lietfaden der exacten Edelsteinbistiminung" (1951). Prof. Schlossmacher has been an Honorary Fellow of the Gemmological Association of Great Britain since 1939. He was recently elected an Honorary Fellow of the Gemological Institute of America. In Germany he is Honorary Fellow of the Central Union of Jewellers, Goldsmiths and Silversmiths.

TALKS BY FELLOWS

G. Blythe : " Gemstones." Crowstone Social Society, Westcliff-on-Sea, March 12th ; " Historical Diamonds." Southend Baptist Senior Fellowship, March 18th.

Joyce Ferrand-Thomas : " Gemstones and Jewellery." Married Families Wives Club, R.A.F. Station, Honnington, Suffolk ; *ibid,* Bury St. Edmunds Townswomen's Guild, March 10th.

G. N. Sprague : " Identification of Gemstones." Quekett Microscopical Club, Royal Society's Lecture Hall, April 8th.

J. M. Duncan : " Gemstones." Rover Scouts of St. James's Church, Paisley, April 11th.

G. M. Parry (Mrs.) : " Gemstones." Royal College of Nursing (Cardiff Branch), April 30th.

D. J. Ewing : " Gemmology—Its application to Police Inquiries." Edinburgh, Newcastle, South Shields and Sunderland C.I.D. and members of Northern Section of the National Association of Goldsmiths (North of England Jewellers' Association), Heriot Watt College, Edinburgh, April 23rd.

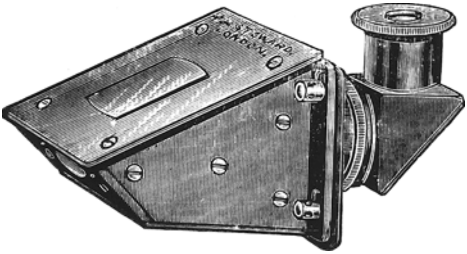
F. Warren : " Science of Jewellery." Young Conservatives Assn., Bristol Bishopsworth Branch, April 23rd.

G. Parry (Mrs.) : " Gemstones." South Wales and Monmouth Branch of British Horological Institute, May 29th.

S. T. Solomon : " Gemstones." Buckland Monochorum Women's Institute, July 2nd.

DIAMOND TOOL INDUSTRY IN 1951

The Industrial Diamond Information Bureau has issued a small brochure summarising articles and patents that have been published during 1951, and that have a special bearing on the development of industrial diamonds. Copies of the brochure are available, free of charge, from the Industrial Diamond Information Bureau, 32-34 Holborn Viaduct, London, E.C.1.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