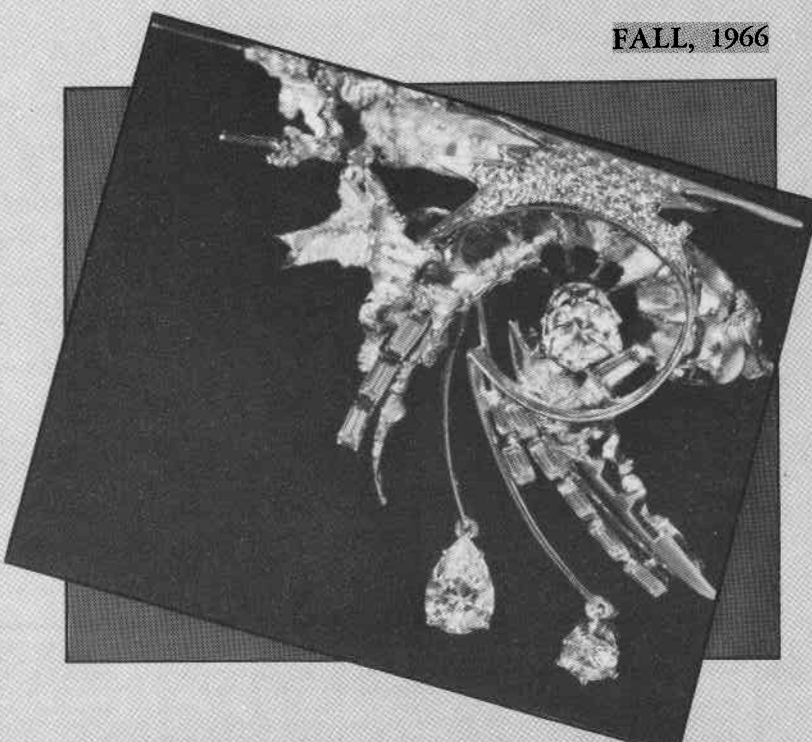
Gems and Gemology

FALL, 1966



Gems & Gemology

VOLUME XII | FALL, 1966 | NUMBER 3

IN THIS ISSUE

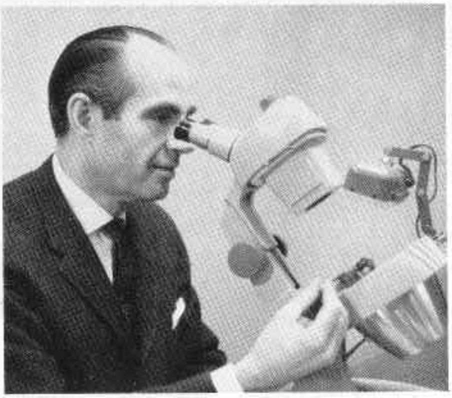
On the Cover

Whirls of diamonds and textured gold create a sense of motion in this award-winning design created by A. Teno for Georg Jensen of Copenhagen. It was one of the 26 designs that received awards at the Hotel Pierre of New York City, October, 1966.

Photo Courtesy
N. W. AYER & SON, INC.
New York City

GEMS & GEMOLOGY is the quarterly journal of the Gemological Institute of America, an educational institution originated by jewelers for jewelers. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the authors and not of the publishers. Subscription price $3.50 each four issues.

Developments and Highlights



at the

GEM TRADE LAB

in New York

by

Robert Crowningshield

Synthetic-Spinel Triplets

Although most texts on gems illustrate among the assembled stones a type made up of two pieces of colorless material, usually quartz, enclosing a slab of glass, we have never encountered such a stone until recently. Commercially available are triplets made to resemble peridot, in which the color comes from a relatively thick slab of glass between colorless synthetic-spinel crown and pavilion. *Figure 1* illustrates one of the stones immersed in methylene iodide; we have not yet determined whether they are cemented or fused. We appreciate a gift of these stones from GIA student, Joseph Garriti, New York lapidary.

Damaged Diamond

Figure 2 illustrates a damaged diamond that had cleaved at every exposed point between the prongs. We were able to determine that it was an example of the relatively rare "three-point" brilliant cut, in which the table approximately parallels the octahedral direction. As a result, the edges of the stone were vulnerable, because the cleavage direction was nearly at right angles to the table instead of roughly paralleling the back facets, as in a "four-point" stone, in which the table parallels the cube direction. Prior to the damage, it probably would not have been possible to determine the grain of the stone by observation alone.

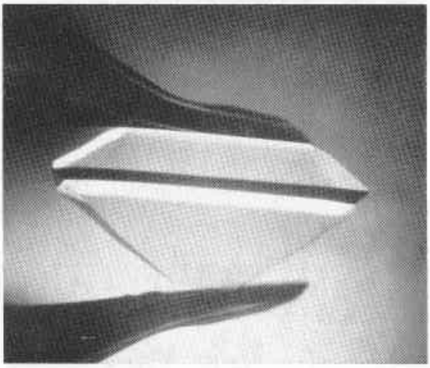


Figure 1

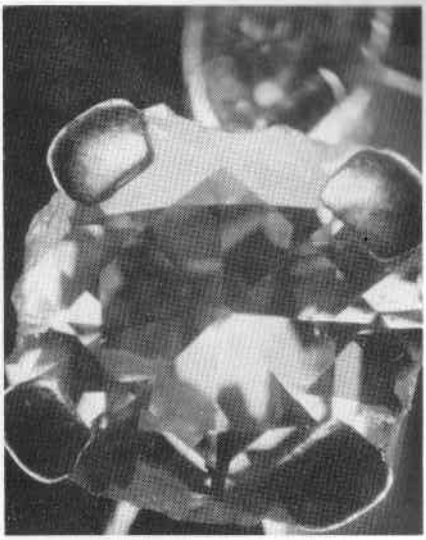


Figure 2

Repolishing Lechleitner Stones

A potentially troublesome feature of the Lechleitner synthetic-emerald overgrowth on beryl is repolishing a chipped stone. If the chip has occurred in an area in which the overgrowth contributes considerable color to the stone, a window may be made, spoiling the even color. We advised against having a chip polished out of the crown of the large stone illustrated in *Figure 3*. As it was, a definite white spot could readily be seen. The typical strain cracks in the synthetic-emerald overgrowth can be seen in the photograph.

Solution-Grown Synthetic Rubies

We have mentioned and illustrated solution-grown synthetic rubies in recent issues of GEMS & GEMOLOGY and we continue to see such stones. To date, the types seem to be limited to two, according to microscopic examination, although we do see stones with no imperfections, even under 120x. Without more rough and cut material to study, we are usually unable to determine whether the specimen being examined is an example of flux or hydrothermal growth.

The two types we associate with magnification are those in which wisps and clouds greatly resemble those in flux-grown synthetic emerald and those in which heavy fingerprints of flux inclusions can be seen. *Figure 4* illustrates a stone of the former type, and *Figure 5* is the same stone under immersion and dark-field illumination. *Figure 6* is the same stone under immersion but with light field. A central "seed" of natural corundum may be seen. As we have mentioned before, so far these solution-grown synthetic rubies are more transparent to short-wave ultraviolet light than natural rubies and similar in this respect to the common flame-fusion (Verneuil) synthetic rubies. *Figure 7* is

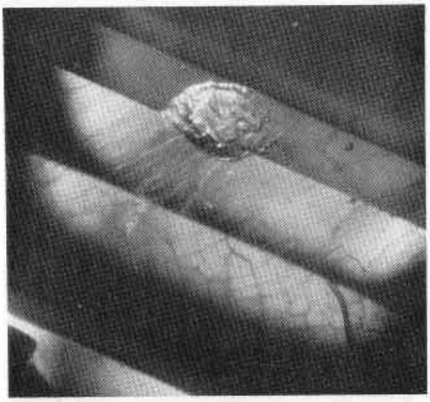


Figure 3

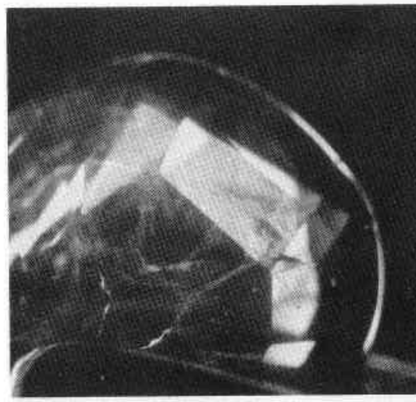


Figure 4

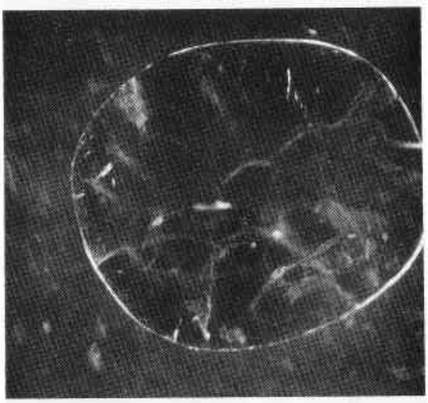


Figure 5

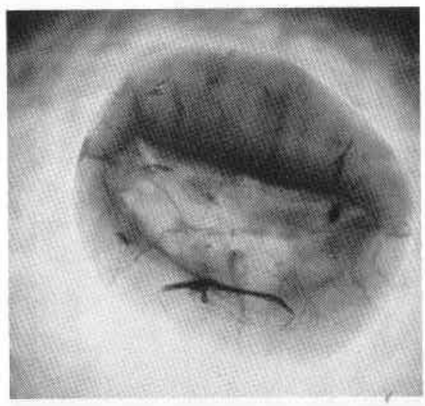


Figure 6

a photograph that has been enlarged to show the stone in *Figure 6,* in which the natural "seed" transmits less than the surrounding synthetic material. As we pointed out formerly, the incorporation of some or all of the seed is not an essential feature of these "wispy" synthetics. If the growth has been sufficient, the natural material need not be used. *Figure 8* illustrates the second type of

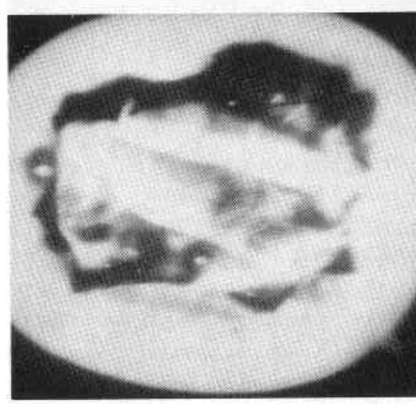


Figure 7

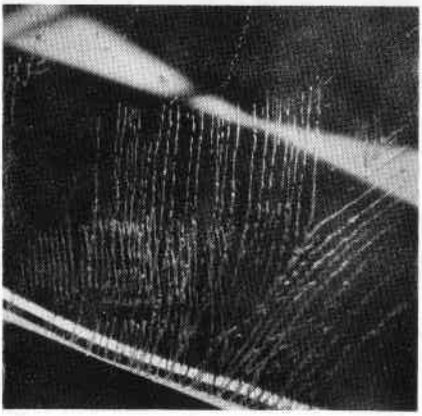


Figure 8

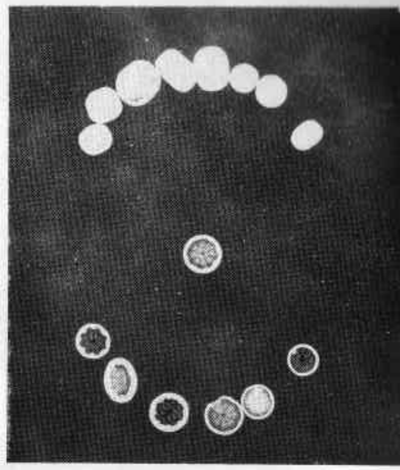


Figure 9

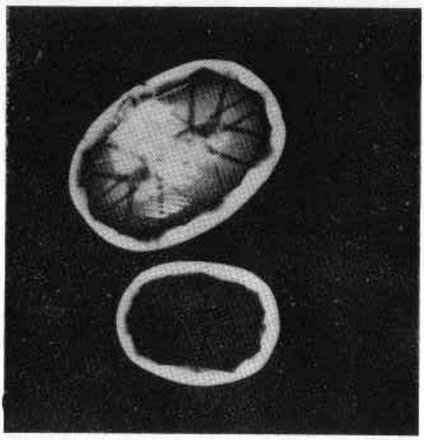


Figure 10

inclusion: coarse flux fingerprints. *Figure 9* is a short-wave, ultraviolet-transparency test using positive photographic paper. The light images are natural stones, the center stone is a flux-fusion synthetic ruby, and the six other dark images are flame-fusion synthetics. *Figure 10* is an enlargement of a short-wave ultraviolet-transparency test of a flux-grown synthetic ruby, in which the nontransparent flux inclusions are clearly visible as the light smudge in the center. Gas bubbles and curved striations may show up in a similar test done with ordinary Verneuil synthetic rubies *(Figure 11)*. *Figure 12* is a transparency test of four solution-grown synthetic rubies—whether flux or hydrothermal was not determined—with three natural rubies as control stones. One of the latter is mounted in a ring.

Maine Tourmaline

The beautiful tourmaline rough we illustrated in the last issue of *GEMS & GEMOLOGY* has been cut, producing some of the loveliest stones we have ever seen. *Figures 13* and *14* can hardly do justice to these extraordinary blue-green gems, in not one of which could we detect any flaws under 20x! The heart shape *(Figure 14)* weighs in excess of 50 carats. Again we are indebted

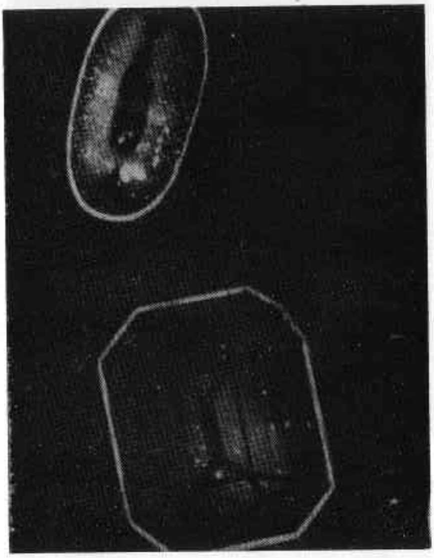


Figure 11

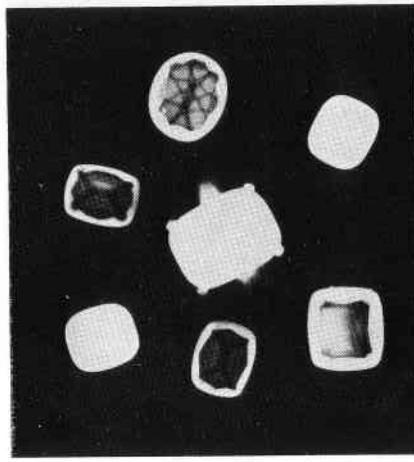


Figure 12

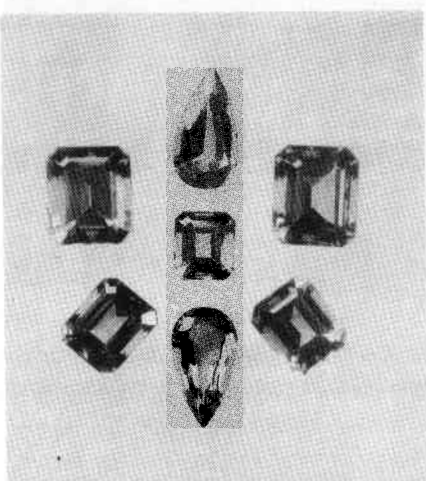


Figure 13

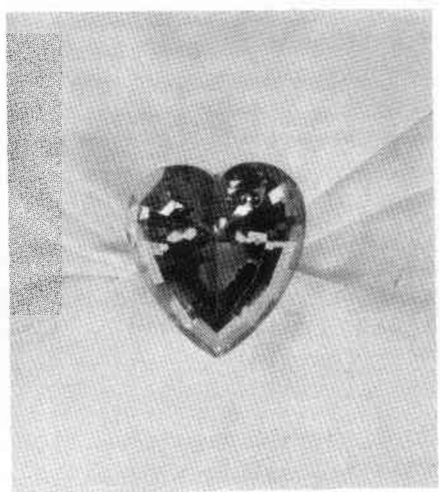


Figure 14

to Mr. Frank Perham of West Paris, Maine, for the opportunity to study these Maine tourmalines.

Unusual Tourmaline-Set Turtle

Figure 15 illustrates a phenomenal lapidary feat. The horny plates on the turtle's back are represented by 13 beautifully cut, fitted and polished green tourmalines set in 18-karat gold.

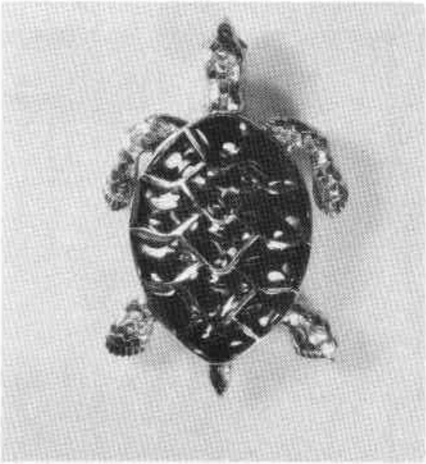


Figure 15

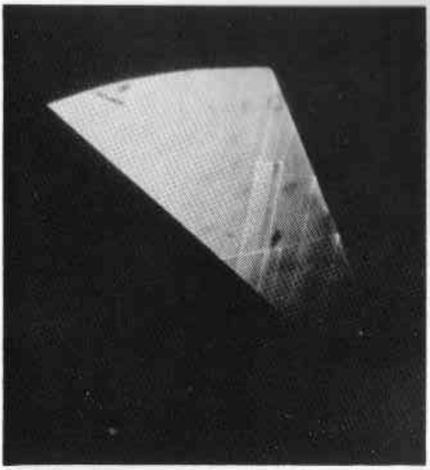


Figure 16

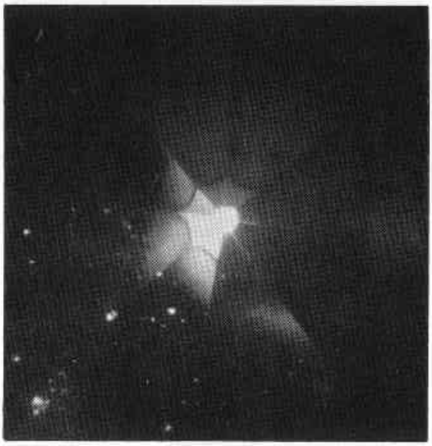


Figure 17

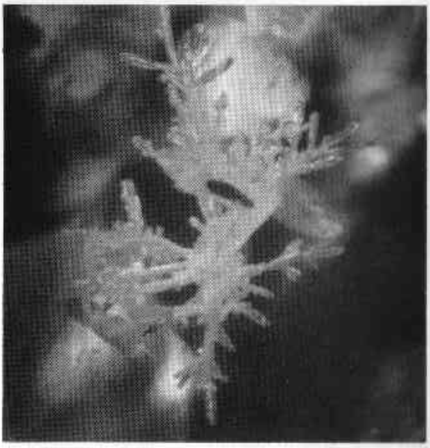


Figure 18

Drag Marks on Diamond

Polishing drag marks on diamond are frequently very difficult to photograph, as well as to discover. *Figure 16* shows them very clearly running from inherent fractures.

Cyclotron-Treated Diamond

Figure 17 shows the "umbrella" effect seen around the culet in a very large cyclotron-treated green diamond that had been represented to be not only natural color but the finest diamond of this color next to the *Dresden Green*. It was undoubtedly originally a decided, but not fancy, yellow stone.

Dendritic Inclusion in Diamond

We have encountered another weird

Figure 19

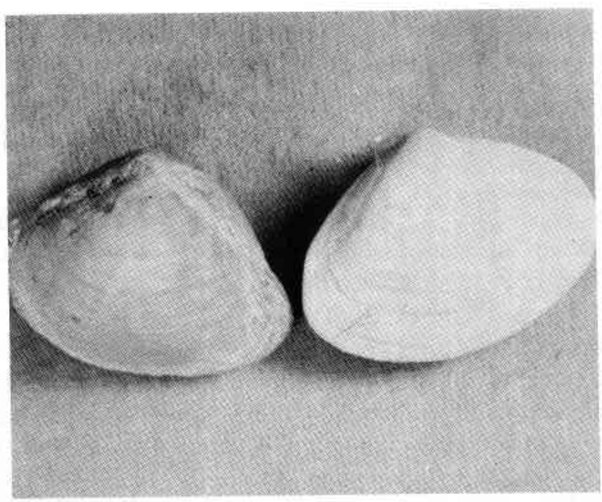


Figure 20

dendritic inclusion in a large, imperfect but very fine-color diamond. This inclusion is shown in *Figure 18.*

Unusual Textured Effect on Diamond

Figure 19 illustrates another unusual feature of a diamond: a textured effect on the surface of an emerald-cut stone that resembles human skin!

Unusual Items Encountered

Among the unusual items we have encountered since last issue is a fine-colored iolite mounted in a platinum-and-diamond ring and purchased originally as a sapphire.

A dark-blue natural sapphire, reportedly from Siam (Thailand), showed a very weak absorption spectrum and glowed with a greenish-white fluorescence under short-wave ultraviolet, illustrating again the necessity of using more than one test on both sapphires and rubies. In most cases, this type of fluorescence is confined to synthetic blue sapphire.

An unusual crystal examined recently proved to be a 2.12-carat uvarovite-garnet crystal. The stone was translucent and probably not cuttable, but it

(continued on page 95)

Hydrogrossular— A Hydrogarnet from the Transvaal

by

H. Lawrence McKague, Ph.D.

PART II

Stability of Hydroglossular and Idocrase

The physical conditions under which hydrogrossular is stable have been investigated by a number of workers (Flint, McMurdie and Wells, 1941; Yoder, 1950; Pistorius and Kennedy, 1960; and Christie, 1961). Yoder determined the upper stability limit of hydrogrossular to be 750° C. at atmospheric pressure and 850° C. at 2000 atmospheres of pressure. Pistorius and Kennedy (1960) determined the upper stability limit to be 780° C. and the composition (i.e., water content) dependent on temperature and independent of pressure.

In his study of the subsolidus breakdown of the members of the melilite group, Christie (1961) determined that in mixtures with less than 25 percent akermanite, hydrogrossular and idocrase are stable between 447 and 550° C. in the pressure range from 4,800 to 6,700 atmospheres. Although the mineralogy is different, the bulk compositions are not too dissimilar. Yoder (1950) showed that wollastonite, anorthite and gehlenite (a melilite-group mineral) formed when glass of grossular composition was heated above 850° C. at atmospheric pressure. The anorthites of the Bushveld Igneous Complex would contain Fe, Na, more Al, more Si, less Ca and less Mg than melilites. These differences in chemistry would undoubtedly affect the stability, but Christie's data are adequate for a first approximation of the conditions under which the Transvaal hydrogrossular formed.

Coes (1955) synthesized idocrase at 700° C. and 10,000 atmospheres. However, Rapp and Smith (1957) synthesized an Fe-Mg idocrase in the range 550-600° C. with pressures of from

1,666 to 3,000 atmospheres. Anorthite and grossularite (hydrogrossular?) were also present.

The laboratory data thus supports a hydrothermal metasomatic origin for this material, as proposed by Tilley (1957) and Frankel (1959), with the temperature probably below 600° C.

Conditions controlling the presence or absence of idocrase or hydrogrossular have been discussed by several authors. Deer, Howie and Zussman (1962) suggest the presence or absence of volatiles may be the controlling factor. Burnham (1959) suggests the development of the grossular zone as due to an increase in Si and a decrease in Al and Mg over that in the idocrase zone at Crestmore, California. Christie (1964) states that the development of hydrogarnet from idocrase ". . . may be the result of either an appropriate thermal history, a systematic variation in water activity, a variation in chemical constituents, or a delicate interplay of all of these factors." In the Transvaal material, where the idocrase occurs in random patches, it is suggested that its present distribution is a function of the original distribution of ferromagnesium minerals modified by late hydrothermal solutions. However, this suggestion needs to be substantiated by additional field and laboratory investigations, especially in view of the fact that Rapp and Smith (1958) produced Fe-Mg-free idocrase.

Conclusions

Several conclusions can be drawn regarding the samples studied:

1) The samples are predominantly hydrogrossular, with smaller amounts of idocrase and chromite.

2) They can be divided into two groups. The most obvious division is based on color, but there are distinct differences in refractive index, specific gravity and unit-cell size.

3) The consistent differences in refractive index, specific gravity and unit-cell size indicate the pink samples have a higher water content than the green samples. Based on Pistorius and Kennedy's work, this suggests a difference in temperature at some time in their history. It should be noted that refractive index, specific gravity and unit-cell size do not give uniform values for the H_2O content. For example, in sample number 7, the mole percent H_2O based on refractive index, specific gravity and unit-cell size are approximately 0.6, 0.8 and 0.2, respectively.

4) Because of similarity in physical properties, it is concluded that the best method of distinguishing between hydrogrossular and idocrase is by X-day diffraction. The method of X-ray fluorescence is still valid; however, hydrogrossular from other deposits should be checked.

Acknowledgements

The author wishes to thank Richard

T. Liddicoat, Jr., of the Gemological Institute of America, for critically reading this manuscript and Eric Dalhberg, of the Pennsylvania State University, for checking the calculations of the means and standard deviations presented in Table II.

Bibliography

Belyankin, D. S., and Petrov, V. P., *The Grossularoid Group (Hibschite and Plazolite).* Am. Min., 26, 450-453, 1941.

Burnham, C. W., *Contact Metamorphism of Magnesium Limestone at Crestmore, California.* Geol. Soc. Am., Bull. 70, 879-919, 1959.

Christie, O. H. J., *On the Subsolidus Relations of Silicates. I. The Lower Breakdown Temperature of the Akermanite-Gehlenite Mixed Crystal Series at Moderate Water Pressure.* Norsk. Geol. Tidsskr., 41, 255-269, 1961.

Coes, L., Jr., *High-Pressure Minerals.* Jour. Am. Ceram. Soc. 38, 298, 1955.

Crowningshield, G. R., *Developments and Highlights at the Gem Trade Lab in New York.* Gems & Gemology, XI, 359-367, 1966.

Deer, W. A., Howie, R. A. and Zussman, J., *Rock-Forming Minerals, Vol. I,* John Wiley & Sons, New York, 1962.

Donnay, G., and Allerhand, A., *Possible Application of Nuclear Magnetic Resonance to Order-Disorder Study in the Hydrogrossularite Series.* Ann. Rept. Direct. Geophysical Lab., 64, 210-212, 1965.

Flint, E. F., McMurdie, H. F., and Wells, L. S., *Hydrothermal and X-Ray Studies of the Garnet-Hydrogarnet Series and the Relationship of the Series to Hydration Products of Portland Cement.* Nat. Bur. Standards, Jour. Research, 26, 13-33, 1941.

Frankel, J. J., *Uvarovite Garnet and South African Jade (Hydrogrossular) from the Bushveld Complex, Transvaal.* Am. Min., 44, 565-591, 1959.

Hall, A. L., *Geology of the Haenertsberg Goldfields and the Adjoining Parts of the Secoecoeniland East of the Lulu Mountains.* Geol. Survey. Transvaal. Ann. Rept. (1907), 31-60, 1908.

.............................., *On "Jade" (Massive Garnet) from the Bushveld in the Western Transvaal.* Geol. Soc. South Africa Trans., (1924) 27, 39-55, 1925.

Hutton, C. O., *Hydrogrossular, a New Mineral of the Garnet-Hydrogarnet Series.* Roy. Soc. New Zealand Trans., 73, 174-180, 1943.

Kynaston, H., *The Geology of the Country North and Northwest of Potgietersrust.* Geol. Surv. Ann. Rept., (1908) 11-23, 1909.

McConnell, D., *Griphite, A Hydrophosphate Garnetoid.* Am. Min. 27, 460, 1942.

Pabst, A., *Re-examination of Hibschite.* Am. Min., 27, 783-792, 1942.

Peters, T., *A Water-Bearing Andradite from the Totalp Serpentine (Davos, Switzerland).* Am. Min., 50, 1482-1486, 1965.

Pistorius, C. W. F. T. and Kennedy, G. C., *Stability Relations of Grossularite and Hydrogrossularite at High Temperatures and Pressures.* Am. J. Sci., 258, 247-257, 1960.

Rapp, G. Jr., and Smith, J. V., *Synthesis of Idocrase.* Geol. Soc. Am. Bull., 69, 1741, 1958.

Skinner, B. J., *Physical Properties of End Members of the Garnet Group.* Am. Min., 41, 428-436, 1956.

Takańe, K., *X-Ray Analysis of Vesuvianite from Miho and an Ideal Formula of the Mineral.* Proc. Imp. Acad. Tokyo, 9, p.9, (from Deer, Howie and Zussman, 1962, 1933).

Tilley, C. E., *On the Replacement of Anorthosite by Hydrogrossular in the Transvaal.* Trans. Geol. Soc., South Africa, 60, 15-17, 1957.

Van der Lingen, J. S., *Garnets.* South African Jour. Sci., 25, 10-15, 1928.

(continued on page 95)

Six Centuries of Diamond Design

by

H. Tillander, CG, FGA

The first authentic description of the "modern" method of diamond polishing, given by Benvenuto Cellini around 1568, is aptly supplemented by the illustration of the coat-of-arms of the Nuremberg diamond-polishers' guild, showing clearly the dop and two faceted diamonds, Paul Grodzinski stated, in 1953: "There were diamond polishers in Paris and Nuremberg in the 13th century, but the usual secrecy and obscurity covers their methods, which were probably quite different from those used by the ancients."

Without evidence regarding the year of execution it is not possible to draw definite conclusions, but one is perhaps not much mistaken in saying that the shaping of the earliest table cuts in the Western World coincides with the time when women began to wear diamonds; in other words, well over 600 years ago.

S. Tolansky, in his *History and Use of Diamond*, states that grinding away the tip of an octahedron was the method used by the ancients to produce the table cut. This he believes was done at least around 1300. The earliest shaping of diamond may have been done in India some 2,000 years ago.

There are, however, two German authorities, Dr. Walter Fischer and Professor Dr. Siegfried Rösch, who both say that the earliest faceted diamonds appeared only during the second half of the 16th century, and that diamonds generally believed to have been polished before that were either natural crystals or cleaved fragments. Dr. Fischer illustrates his article with such jewelry from the period around 1500. In addition, he believes that the early table cuts were produced by sawing the rough crystal in two and not by grinding away the tip. The author has observed traces of sawing in a number of old diamonds and therefore suggests that both methods must have been used.

During mediaeval times, extensive trade with the orient, appreciation of minor arts, or at least a highly luxurious life must have existed in a city before

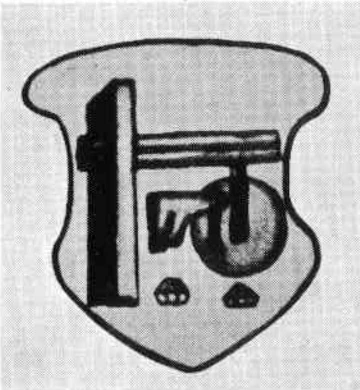


Figure 1. Coat-of-Arms of the Nuremberg Diamond Polishers' Guild (From *History of Diamond Polishing,* by P. Grodzinski)

it became a diamond center. It remains to be discovered when trading developed into purchase of rough for subsequent cleaving and polishing before sale.

Alexander the Great was responsible for first revealing the wealth of diamonds in India, but only some 1500 years after his death (in 323 B.C.) did regular trade develop between India and the West.

Early diamond centers were Alexandria, Venice, Bruges, Nuremberg and Paris. Places like Lisbon, Valencia, Barcelona, Madrid, Antwerp, Amsterdam and London became important much later.

The earliest price list for diamonds is given by the 12th-century Arab author, Teifashius. From 31 B.C., Alexandria was a very large trade center that gradually developed into an important transit place for Indian diamonds.

Quite early, around 900 A.D., Venice became a dominant center for industry and trade. It lost importance, together with other Eastern Mediterranian ports, after Vasco da Gama, in 1498, explored the sea route around the South African coast to the Far East. Venice and Florence produced famous diamond experts, such as Marco Polo, Nicolo Conti, Matteo del Nessaro, Benvenuto Cellini, Hortensio Borgius, Giulio Mazarini, Vincenzio Peruzzi and many others.

Bruges became another large and very important commercial town and diamond center during the 12th and 13th centuries, but lost importance to Antwerp at the end of the 15th century. After the Spanish Fury in 1585, the diamond cutters moved to Amsterdam.

Nuremberg, an inland town at the crossroads of travel and trade, developed early into a diamond center. Between the 14th and 17th centuries it was one of Europe's most important cities for trade, art and technical inventions (modern horology, famous artists, wealthy merchants, etc.). It may thus very well have contributed to the development of diamond cutting.

In France, the great passion among royalty and nobility for the minor arts dates as far back as the 7th century, when no less then three jewelers, Eloi, Alban de Fleury and Theau, were canonized. At that time, however, only monasteries had workshops and almost a monopoly of craftsmen. Clotaire II established, on an isle of Paris city, a workshop of goldsmith monks, free from all cares and wars, a life in silence devoted to sacred arts. The reign of Charlemagne (771-814) was one of magnificence, the goldsmith's art coming to the top during that period. In the 12th and 13th centuries, the zenith of the curve was reached, and France was the cultural center of the continent. Secular jewelers became strongly established. In 1319, the French Queen Clemence of Hungary (King Louis, the Quarreller's wife) is said to have worn a diamond-studded necklace, and Queen Jeanne d'Evreux (wife of Charles IV) possessed rich collections of personal jewelry.

In the following analyses, the universal principles for measuring diamond proportions are used – essentially the same as those that have, within recent years, also been adopted by American gemological organizations. But an effort has been made to introduce new signs and abbreviations that can be universally understood and are easy to type or write. They have been found most practical throughout the research work.

The original brilliant cut was the natural, perfectly developed octahedron. It had a girdle of 1%, a crown height of 70¾%, the same pavilion depth, a total height of 142.5%, and both crown and pavilion angles were equal to the octahedral angle of 54°44′8.3″, or almost 54¾°.

Eventually, the octahedron was slightly improved by primitive polishing. Together with several other regular forms of diamond crystals and cleaved fragments (the early baguettes), this

Figure 2. An early method of grinding away the tip of an octahedron (From Ars Memorative, 1480)

"diamond point" was used in jewelry for more than 1500 years.

It is not known when the first attempts were made to repair broken tips of otherwise perfect octahedra.

The early diamond cutter found, probably without fully appreciating the value of his discovery, the softest of all planes, the cubic. S. Tolansky believes that early workers often decided to grind away the tip until the width of the table face was 50%, involving a total loss of $1/16$th, or 6.25%. Other authors have quoted figures between $4/9$ and $5/9$. Experiments with synthetic spinels and comparisons with descriptions of fine table cuts, old designs and photographs of authentic mediaeval jewelry show clearly that not less then $5/9$ of the top pyramid had been ground or sawn off in perfect full-bodied table cuts.

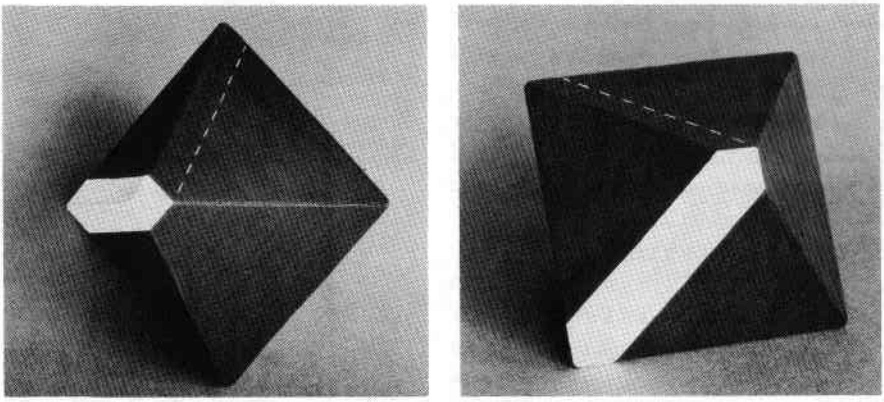


Figure 3. **How the earliest baguettes were cleaved from a diamond octahedron**

The ideal table cut has therefore been reproduced with $\frac{4}{9}$ of the top pyramid as a crown and $\frac{8}{9}$ as a pavilion, leaving a table of 56% and a culet of 11%. The magical total depth figure of 100% is not yet established. These proportions remained the best figures almost as long as the octahedral angles persisted.

Obviously, the table cut developed very gradually into this optimum and symmetrical shape, and few if any cutters adhered strictly to these rules, probably as few as today produce ideal brilliant-cut stones.

From the evidence of the numerous reproductions of known jewelry in museum and private collections, no doubt remains about the dominance of the primitive table cut up to the beginning of the 18th century, when it rapidly declined. The same applies to the "point cut," insofar that it persisted in sizes that today would be called melee, until it was gradually replaced by small table cuts and later by different types of single cuts.

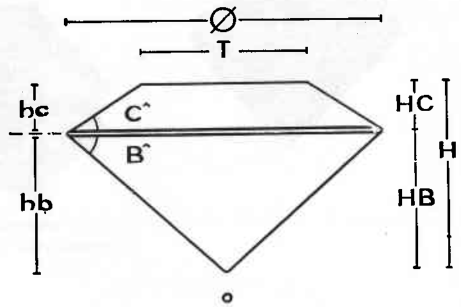
Further evolution was slow and haphazard. Inspired by the results achieved in shaping softer gems, and possibly due also to the various shapes of rough diamond, the first table cut with polished corners appeared; this may be termed an "octagonal table cut." This shape, however, never became popular or generally accepted, and it must be considered merely as a repaired table cut and a step towards the proper single cut with 8-fold symmetry in the girdle outline and in the shape of the table facet.

The perfect old single cut with 8 facets on the crown and 8 on the pavilion is thought by Professor W. Eppler, a well-known German mineralogist and gemologist, to date as far back as the 14th century. If he is right, it remained a rarity for well over 200 years.

Styles with more elaborate faceting cannot be dealt with in a strict chronological order. The reasons are that tech-

Figure 4. Abbreviations and signs used in proportion analyses:

- Ø Diameter of stone (usually the shortest)
- T Table size (in brilliant cuts between opposite corners, but in certain other shapes between opposite sides)
- o Culet size (measured as the table size)
- hc Height of crown x)
- - - - Average girdle thickness
- hb Height of base (= depth of pavilion)x)
- H Total height (from table to culet)
- C^ Crown angle
- B^ Base angle (= pavilion angle)
- x) Without girdle thickness



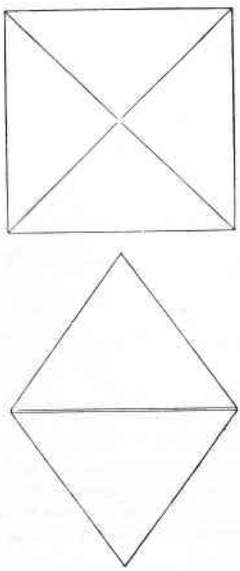


Figure 5. The perfect diamond point (4/4)
hc 70.75% C^ 54°44′8.3″
- - - 1.00%
hb 70.75% B^ 54°44′8.3″
H 142.50%
(With a girdle thickness of 1% the diamond point has a Ø of 99.6%, compared with the width of the perfect octahedron. For this reason, the depth figures differ from the measures of a crystal without girdle)

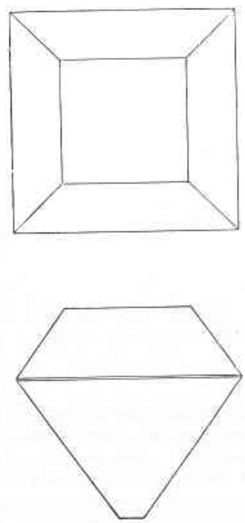


Figure 6. The optimum full-bodied square table cut (4/4)
T 56.0% (measured between opposite sides)
o 11.0% (square in shape)
hc 31.2% C^ 54°44′8.3″
- - - 1.0%
hb 62.8% B^ 54°44′8.3″
H 95.0%

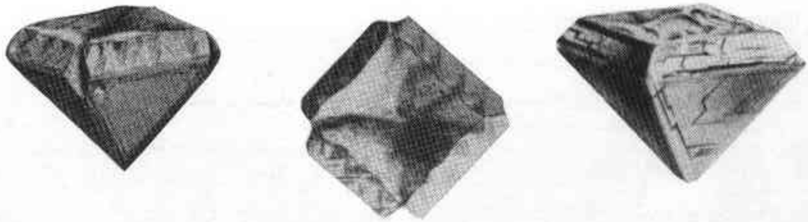


Figure 7. Natural diamond crystals resembling table cuts. (From *Der Diamant,* by Fersman und Goldschmidt)

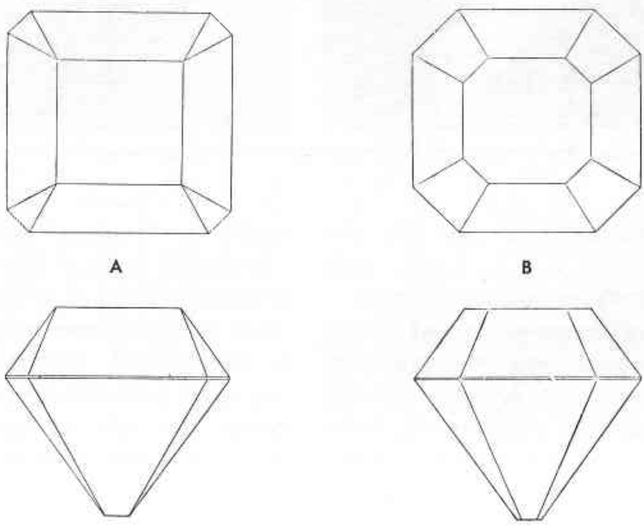


Figure 8. Optimum full-bodied octagonal table cuts (8/8)

A. The first step towards the proper single cut with a square culet and the table size measured between opposite sides. Length of outer edge of main facets is 80% of ∅

B. A shape, which persisted in melee sizes, with an octagonal culet and the table size measured between opposite sides. Length of outer edge of main facets is 60% of ∅. (The proportions are equal to those listed under *Figure 7)*

niques, once learned, imposed no limits on the number of facets that could be put on a diamond. The rose cut had been introduced in Europe very early in the 16th century and other richly faceted Indian diamonds, without too much geometrical symmetry, such as the *Sancy* and the *Florentine,* became well known in the West.

It remained only to invent the final shape of the full-cut brilliant. This was achieved during the 17th century, whereas somewhat less-complicated designs were created for the melee sizes.

The English star cut had 17 facets on the crown and 8 on the pavilion. The first stones of this style were no doubt cut with octahedron angles and the

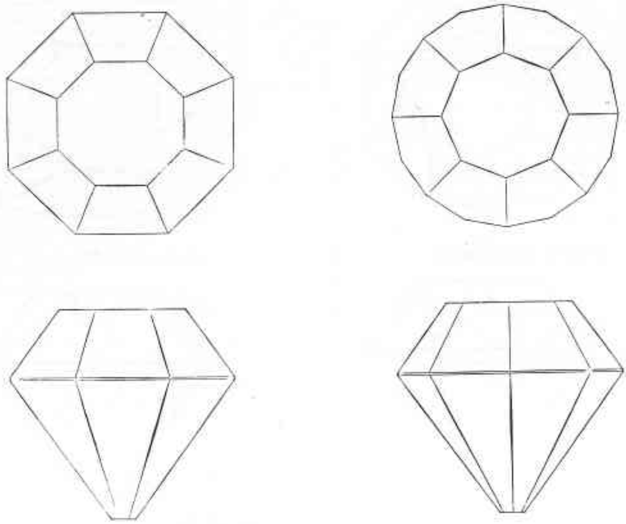


Figure 9. **Optimum octagonal and rounded full-bodied single cuts (8/8). Both have octagonal culets and proportions equal to those listed under *Figure 7*. T is measured between opposite sides on both A and B**

same optimum proportions as earlier diamonds.

The English square-cut brilliant had a different girdle outline, the same number of facets (16) on the crown, but 12 instead of 8 facets on the pavilion. Here, as in the following brilliant cut, the table size must again be measured between opposite facet edges.

Then the Mazarin-cut brilliant appeared; it was used in all sizes, including large stones. In all probability, it was older than the two previous shapes and was perhaps introduced about 1620, well before the era of Cardinal Mazarin.

The 17th century contributed to physics by discovering the laws of refraction and by introducing analytical geometry. There was rapid development in all fields of science. Diamonds with deliberately chosen angles and proportions no doubt appeared. Proportions considered ideal obviously changed. Only the table size remained 56%.

The following quotation in a letter by Marquise de Racan, a member of the French Academy, written in 1644 to Madame de Thermes, may be one reason for the wrong belief that Mazarin invented the 16/16 facet cut: "The Cardinal has demanded a cut with 16 facets above and 16 below the girdle; he makes a triumph of this double cut."

But this cut existed, as did the rose cut, well before 1644. 16/16 facet cuts

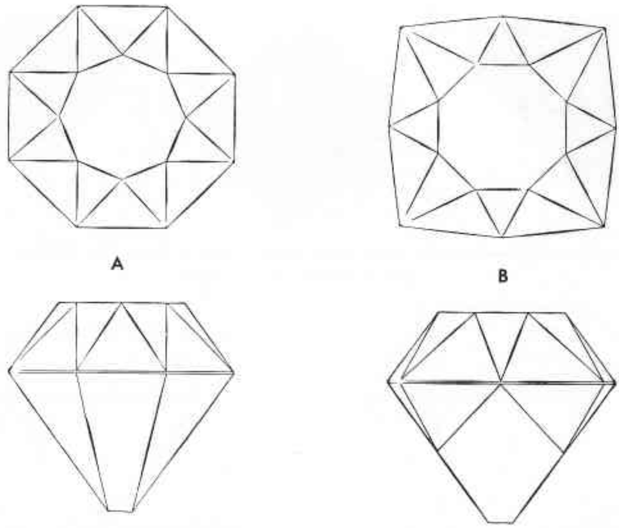


Figure 10. **The optimum full-bodied English star cut (16/8)**

A. The culet is square and the proportions equal to those listed under *Figure 7*

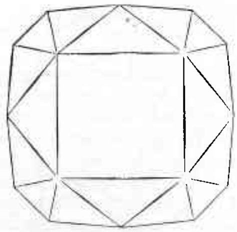
B. The optimum full-bodied English square cut (16/12). The culet is square and the proportions equal to those listed under *Figure 7*. The girdle facets on the crown and pavilion have the same height but a different shape. The distance between the corners is 90% of ∅

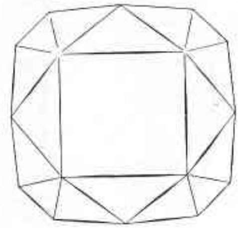
are mentioned in connection with Queen Henrietta Maria, who gave such diamonds in 1640 to the French Duke of Epernon as security against loans. These must have been acquired much earlier, since her husband, King Charles I, started to dispose of his valuables in 1625, the first year of his reign.

The truth about Mazarin is probably that he just became a fabulous collector of large and exquisite diamonds and thus learned more about them than others. He purchased diamonds from Tavernier and other merchants. He acquired the *Sancy*, the *Mirror of Portugal* and many other stones that had belonged to royalty in distress, such as Charles I, Henrietta Maria, Queen Christina of Sweden and others. Almost one-half of the large diamonds listed in his bequest to the French Crown were, strange as it may sound, table cut and only subsequently, after his death, recut into new shapes. As a collector of diamonds, Mazarin followed the example of earlier nobles, such as Seigneur de Sancy, Henry IV and his Queen Marie de Medici, Louis XIII and his Queen Anne, Cardinal Richelieu and many others.

A few years after the death of Mazarin large, full-cut brilliants appeared on the market, the earliest known to the author. One is a 19-carat brilliant-cut stone from the Green Vaults in Dresden, with a full-cut crown but a single-cut pavilion; the crown angle is 34°.

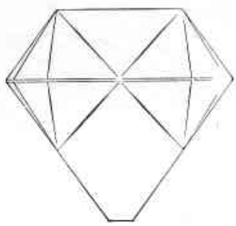
But much more fascinating is the





A Full bodied

B With 45° angles



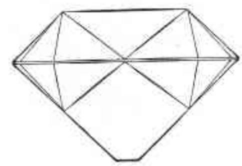
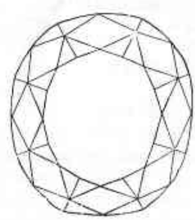


Figure 11. The optimum Mazarin cuts (16/16). The distance between the outer corners is 94% and between the inner corners, 64% of ∅. The culet is square and the girdle facets above and below the girdle are identical in size and shape

A. The proportions are equal to those listed under *Figure 7*

B. The lower Mazarin cut has the following proportions:

T 56.0%
o 10.0%
hc 22.4% C∡45°
--- 1.0%
hb 44.8% B∡45°
H 68.2%



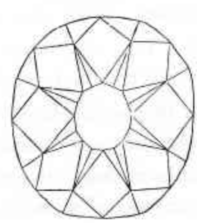


Figure 12. The *Wittelsbach Diamond* (40/40). (The pavilion is reproduced as if seen through the crown. The dimensions of the actual stone are 24.5 x 21.5 millimeters)

T 66.0%
o 31.0%
hc 12.5% B∡36°
--- 0.5%
hb 30.0% C∡42°
H 43.0%

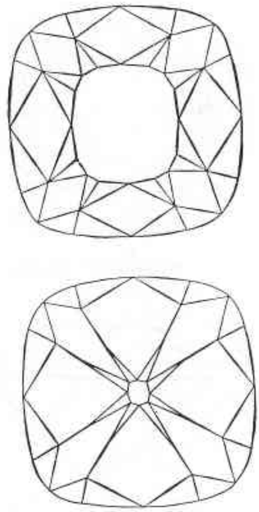


Figure 13

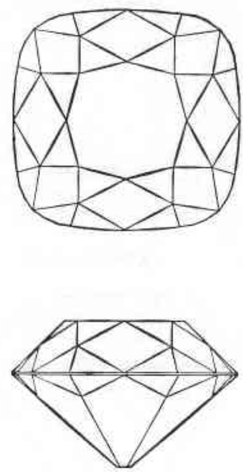


Figure 14

Figure 13. **The *Regent Diamond* (40/32). (The pavilion is reproduced as if seen through the crown. The dimensions of the actual stone are 30 x 29 millimeters)**

T 46.55% (16 sided)
o 10.35% (8 sided)
hc 25.90% C∧45°
--- 0.00%
hb 39.60% B∧41¾°
H 65.50%

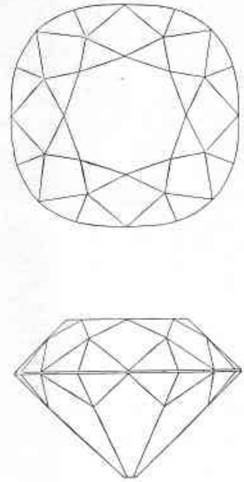
Figure 14. **The corrected Regent cut with 32/24 faceting. This may have been the best shape of the earliest brilliant-cut diamonds with four-fold symmetry in the table and 150° and 120° angles. The four larger main facets are symmetrical lozenges, but the girdle facets are of a different size and shape on the crown and pavilion; the proportion in height is about 12:10**

T 53.0%
o 6.0%
hc 23.5% C∧45°
--- 1.0%
hb 42.0% B∧41¾°
H 66.5%
The distance between the corners is 82% of ∅

lately rediscovered *Great Blue Diamond* of 35.50 carats, now also called the *Wittlesbach.* The appearance of this stone is particularly striking, because of its unusually fine polish and the absolute flatness of the facets. It is amazing that this stone has as high dispersion and can look so attractive, with a total depth of only 38.6%. It has recently been studied by the author and his team. The following proportions may be of interest: table, 65.8%; culet, 31.1%; height of crown, 12.4%; depth of pavilion, 25.2%. The crown and pavilion angles are both exactly the same, 36 degrees. The size in millimeters is 24.4 x 21.46, with a depth of 8.29. The number of facets is $^{40}/_{40}$.

Figure 15. The almost-round early brilliant cut (32/24). This shape is midway between *Figure 15* and the completely round brilliant cut, with a distance between the corners of 76% of Ø. The symmetry of the table is still four fold with angles of 127.5° and 142.5°. The main facets on the crown are all kite shaped and proportioned to please the eye only. The girdle facets on crown and pavilion all have a height of 15% but a slightly different shape. The proportion figures are different from the Regent cut, since the lower pavilion angle of about 41¾° was apparently never generally accepted

T 53.0%
o 6.0%
hc 23.5% C∠45°
--- 1.0%
hb 47.0% B∠45°
H 71.5%



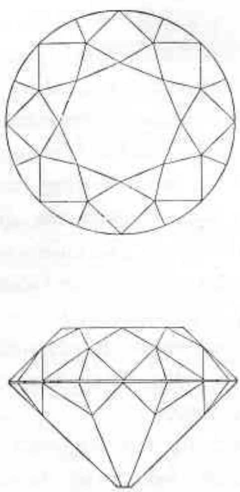


Figure 16A. The perfectly round early brilliant cut (32/24). The table has eight-fold symmetry with 135° angles. The meeting points of the main facets on the crown are found by drawing a circle midway between the corners of the table and the girdle. The girdle facets on crown and pavilion all have a height of 14½% and are identical also in their shape. The proportion figures are the same as listed under *Figure 15.*

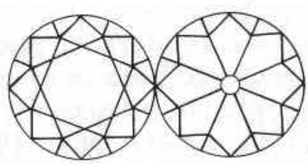


Figure 16B. The same early brilliant cut, as illustrated by David Jeffries in 1750, but with a larger table (58%) and culet (11). Judging from this diagram, the proportion figures may have been 41¾°

All that is known of the early history of the *Wittlesbach* is that in 1664 it was presented by the Spanish King Philip IV as part of the dowry for his daughter the Infanta Maria Teresa, who married Emperor Leopold in 1667, and that it

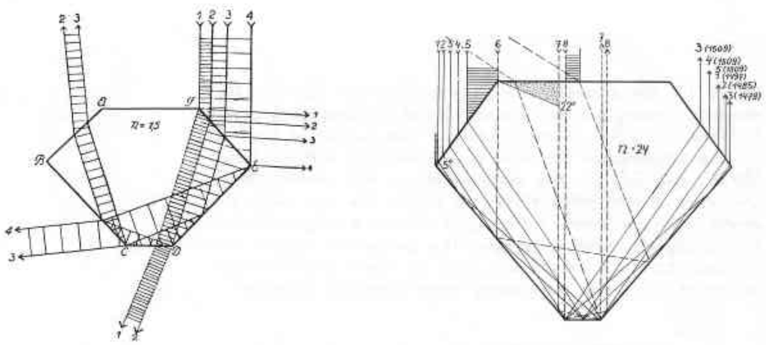


***Figure 17.* Leakage of light in brilliant-cut diamonds with a culet.**
A. With $54\frac{3}{4}°$ angles **B. With 45° angles**
(From *Brillanten und Perlen,* by W. Maier)

came from a new acquisition of precious stones from India and Portugal.

A very similar brilliant-cut stone, only without the extra facets on the crown, is a distinctly yellow diamond of 13.48 carats among the treasures of the Green Vaults. It has a table size of about 50%, a crown angle of 33°, and an equally modern pavilion angle of $41\frac{3}{4}°$, with a total depth of some 60%. The additional 8 facets on the pavilion were apparently applied because of the rather large size of the stone. The total number of facets is 32 on the crown and 32 on the pavilion.

The famous *Regent Diamond* is a $^{40}/_{32}$-faceted brilliant-cut stone of very similar type. It was cut between 1707 and 1717 with a distinctly rounded outline. The rough crystal was sawn in two, an operation that lasted almost a year. The instrument used was apparently a hand-operated saw, similar to the one described by De Boot in 1604 and to those used earlier for table-cut diamonds. There is an exceptionally even distribution of fire all over the crown. Not one of the main pavilion facets can be seen through the crown; this is due to a good pavilion angle of about $41\frac{3}{4}°$, discovered 200 years before Marcel Tolkowsky published his book on diamond design. The cutter, Harris by name, also found a crown angle, near 45°, that, in the flickering candlelight of those days, showed the diamond's fire to perfection. The culet is reflected in the center of the main facets, which Mawe in 1823 described as a criterion of ideal proportions. In practically every old miner, the culet reflects either higher or lower.

The size of the *Regent's* culet is 10.35%, the height of the crown is 25.9%, and the pavilion depth is 39.6%, with the knife-sharp girdle, giving a total depth of $65\frac{1}{2}$%. It was, maybe, only a happy chance that the *Regent* received these proportions, since David Jeffries, although he was full of admiration for this stone, in his publication of 1750, quotes 45° as ideal both for crown and pavilion. The same statements are repeated by practically every

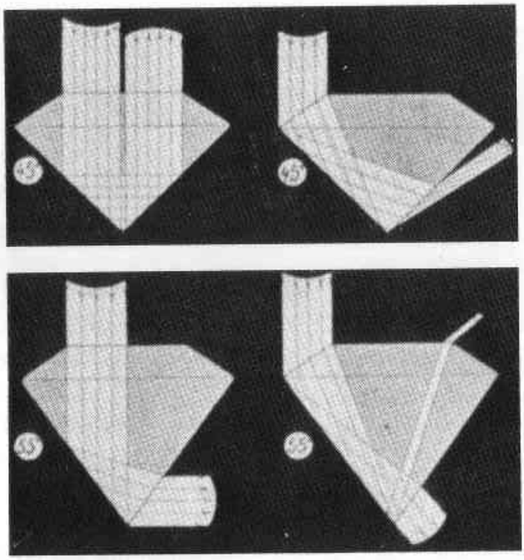


Figure 18. **Leakage of light in brilliant-cut diamonds without a culet. (From *Deutsche Goldschmiede-Zeitung,* Nr. 5-1926, page 48—Mitteilungen aus dem Laboratorium fur Diamantforschung, Düsseldorf-Oberkassel, Krumbhaar & Rösch)**

author until the introduction of the circular diamond saw.

The three diamonds described are stones of considerable size and received, for that reason alone, additional facets. Smaller diamonds were certainly simultaneously polished with the classical number of facets, 32 on the crown and 24 on the pavilion, as we are used to seeing them today. It has therefore been impossible to resist the temptation to reproduce a normal brilliant-cut stone with the same proportions as those of the *Regent.*

Contrary to the present-day taste, the culet was apparently much admired. In stones that were cut in brilliant style with the octahedron angles of 54¾°, the culet acted as a mirror for a considerable amount of light entering through the crown facets.

Other early brilliant-cut stones are worth mentioning, such as the *Tavernier A* and *Tavernier C,* 51 and 31 carats in size, and the *Little Sancy,* a stone of 34 carats. Unfortunately, they cannot be analyzed for design and proportions, since their present whereabouts are not known.

Le Grand Condé, a pink, pear-shaped, brilliant-cut diamond weighing 50 carats, said to have been bought in India in 1643, is on display in the Chateau de Chantilly, near Paris. It is probably even older than the *Wittlesbach,* and would therefore testify that full-cut brilliants existed when Mazarin still collected table cuts and admired rose and sixteen cuts. But definite conclusions cannot be made without further research.

Finally comes the story of Vincenzio Peruzzi, the 17th-century Venetian lapidary who is credited with first employing the brilliant form of cutting. This credit, which appears in practically every gemological publication, cannot possibly be correct.

Investigations and research covering a period of several months have not disclosed the secrets about this legendary person. If he ever existed is an open question. David Jeffries did not mention Peruzzi's name in his publication of 1750. So far his name seems to have been unknown or forgotten until 1833, when a French gemologist, A. Caire, in his book *La Science des Pierres Precieuses,* mentions Peruzzi as the inventor of the brilliant design. The Spanish author Miró repeats the statement in 1870, but such a famous author as Professor Max Bauer was not aware of his existence when, in 1896, he published the first edition of his *Edelsteinkunde.* In the second edition of 1909, however, he repeats Caire's and Miró's remarks, probably due to information given by Henri Polak, chairman of the Amsterdam Diamond Workers' Union, who, in several pamphlets published between 1890 and 1900, mentions Peruzzi, but again without giving any sources for his statements. Genealogical researches in several European libraries gave no positive answers, except that the Peruzzi family was not of Venetian but of Florentine origin. This is why inquiries in Venice have not led to any results. Further investigation may possibly reveal Vincenzio Peruzzi, if not in Florence, perhaps in quite another place. Perhaps he was one of the 75 diamond cutters then active in Paris or one of Amsterdam's 600 diamond workers. It is, however, quite possible that he lived in India, where so many Italian diamond cutters worked at different periods, and from where, during the second half of the 17th century, brilliant-cut, beautifully shaped and therefore not native-cut diamonds were thought to have been imported into Europe.

Commenting on the achievement attributed to Peruzzi, Dr. Wilhelm Maier is full of admiration for the perfect geometrical symmetry in his design *(Brillianten und Perlen,* Stuttgart, 1949). He describes the overall-size star design, the parallel facet edges throughout the stone, and the symmetrical facets. He believes Peruzzi to have known earlier brilliant-cut designs, such as previously described in this paper, since his creation is actually nothing but a definite improvement in beautiful symmetry; in fact, so perfect that nothing near to it has been achieved, earlier or later, in Maier's opinion. It therefore remained to find out if this statement was correct and if a shape with complete symmetry could be reconstructed.

A series of experiments with paper and pencil were carried out. Then several pounds of transparent rock crystal were consumed before it was possible to

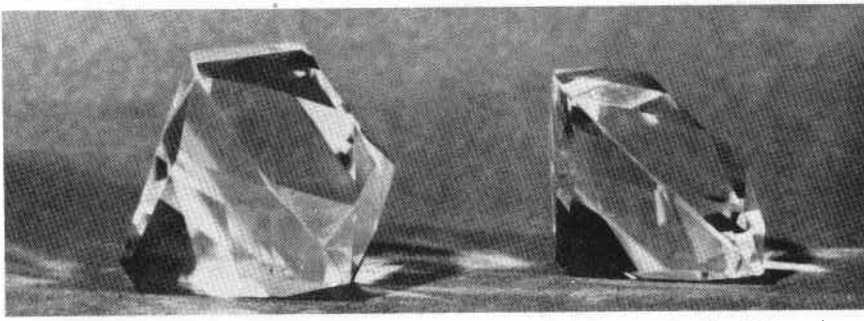


Figure 19. Side views of the Peruzzi design reproduced in rock crystal, with 54¾° and 45° angles

produce perfect symmetry paired with acceptable proportions.

It is not known if the Peruzzi design was executed for octahedral angles, which were at that period already practically abandoned for the then-modern and generally accepted angles of 45°. The proportion figures with 54¾° were: T=53%, o=7%, hc=33%, ---=1%, hb=66% and H=100%. The figures with the 45° angles were: T = 53%, 0 = 6%, hc = 23.5%, ---=1%, hb=47% and H=71.5%. Even these figures show a surprising exactness of symmetry. No deviations from these proportions are permissible. With 8-fold symmetry in the table, its size must have been 53%—again Tolkowsky's figure. The girdle outline is equally sized, with a distance between the corners of 94% and between the dividing edges of the girdle facets of 97%.

Now if this theory can be generally accepted as correct and the Peruzzi design thus established, it remains to find actual diamonds corresponding to these rules, examine them for fire and brilliancy, and make comparisons with other shapes and types. They should be preserved from recutting and treasured as precious examples of a truly artistic and unique creation from the end of the 17th century.

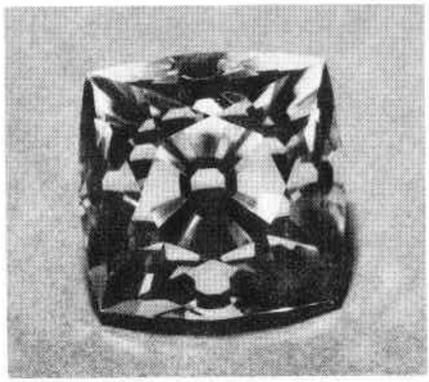


Figure 20. The Peruzzi design reproduced in rock crystal. The culet can be seen reflected in the center of the four main facets, according to Mawe a criterion of ideal proportions

The Peruzzi cut must be extremely rare, since, for instance, in the Dresden Green Vaults not one such diamond has been found. Although it is a very precise design and utmost accuracy is necessary to reproduce it, with the aid of a

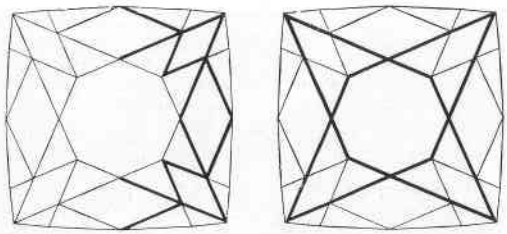


Figure 21. Diagrams of the Peruzzi design, with the heavier lines drawn to accentuate the elements of symmetry on the crown

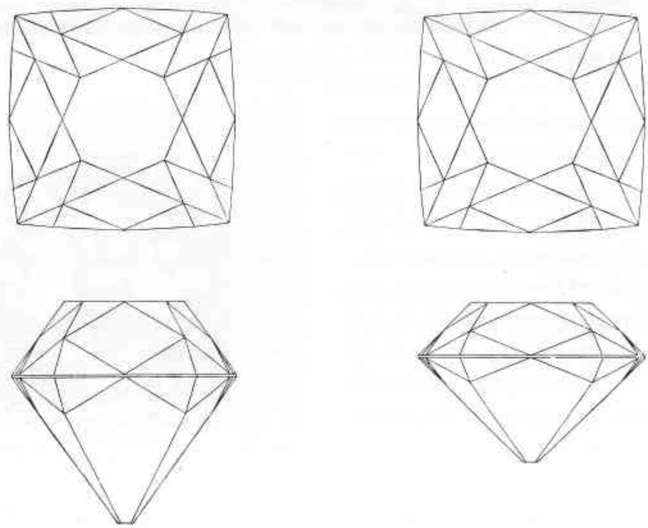


Figure 22. The Peruzzi designs (24/32)

A. T 53.0%
o 7.0%
hc 33.0% C∧54°44′8.3″
--- 1.0%
hb 66.0% B∧54°44′8.3″
H 100.00%

B. T 53.0%
o 6.0%
hc 23.5% C∧45°
--- 1.0%
hb 47.0% B∧45°
H 71.5%

simple metal gauge, the sides of which have only to be divided into four equal parts with a pair of ordinary compasses, any patient diamond cutter should be able to produce the perfect Peruzzi cut.

But, in reality, few cutters ever aimed to achieve perfect proportions (we recognize the situation today), and very inferior old-mine cuts, many of which did not even have a symmetrical girdle outline, dominated the market.

This is probably one of the reasons why the older type, the nearly circular-girdled brilliant-cut stone, remained in demand and finally outmoded the square-girdled stone. The further development of the rounded shape is outside the scope of this paper; therefore,

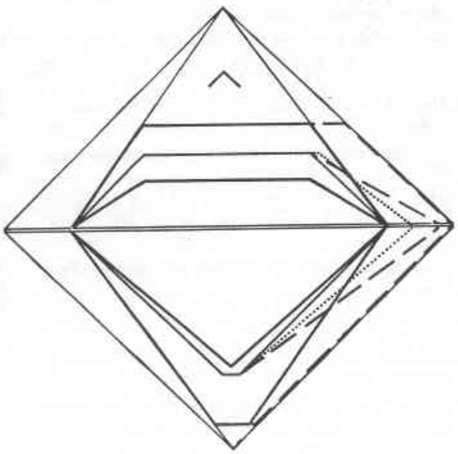


Figure 23. **Diagram showing the evolution from point cut to modern brilliant cut. (The octahedron, the table cut, the early brilliant cut, the Peruzzi cut and the modern ideal brilliant cut.) As a simplification one table size only, 53%, has been used.**

it is only suggested in a couple of diagrams.

With the invention and introduction of the bruting machine and rotary diamond saw about the end of last century, the brilliant cut became perfectly round and quickly developed into the now-accepted depth proportions.

Acknowledgements

I am indebted to my two collaborators. Ulf Pettersson, FGA, designer, photographer, gemsetter and workmaster, not only produced all the final illustrations but also sketched the innumerable suggestions necessary for the search for correct solutions. Tauno Paronen, FGA, able lapidary, but without experience in diamond cutting, found great pleasure in experimenting first with synthetic spinel and then with rock crystal, in order to find out if the proposed shapes could actually be executed in three dimensions. In several cases his skill and imagination helped to solve problems. The reconstruction of the Peruzzi design could never have been done without the assistance of these able members of my research team.

I am also greatly indebted to several scientists and friends: Professor W. F. Eppler, Dr. Walter Fischer, Mr. Manuel Massó, Professor R. Rösch, M. Pierre Verlet, Mr. Renatus Wilm and others for assistance freely given. My daughter, Ulla Tillander, has done valuable research work in museums and libraries in Amsterdam, Antwerp, Paris and London.

A special vote of thanks goes to Richard T. Liddicoat, Jr., who inspired this work by inviting me to lecture on diamonds at the American Gem Society's Conclave in Chicago, and to Gordon F. Andrews for a similar invitation to London.

Bibliography

Asscher, Louis, *The Rebirth of a Diamond City, Amsterdam,* Optima, March, 1959.

Bauer, Max, *Edelsteinkunde,* 1896, 1909 and 1932.

Bouihet, T. and Lanel, L., *L'Orfeure Contemporaine,* 1954.
Bouton, M. E., *Le Diamant,* 1886.
Bradford, E. *Four Centuries of European Jewellery,* 1953.
Caire, A., *La Science des Piérres Precieuses,* 1833.
Cavenago-Bignami, Speranza, *Gemmologia,* 1965.
Dake, H. C., *Development of the Brilliant Cut,* The Mineralogist, Vol. 20, 1952, pp. 373-376.
Dieulafait, Louis, *Diamants et Piérres Preciuses,* 1887.
Dragsted, A., *De Aedle Stene og Deres Mystik,* 1933.
Emanuel, Harry, *Diamonds and Precious Stones,* 1867.
Eppler, W. F., *Brilliant-Schliffe,* Diebeners Goldschmiede Jahrbuch, 1956, pp. 22- .
Eppler, W. F. *DerBrilliant,* Schweizer Goldschmied, Jan. 1949, pp. 12-18 and February, 1949, pp. 10-15.
Fersman und Goldschmidt, *Der Diamant,* 1911.
Fischer, Walter, *Zur Geschichte des Diamantschiffs,* Deutsche Goldschmiede-Zeitung, No. 6/1954, pp. 176-
Gemological Institute of America, *Diamonds,* 1965.
Gemological Institute of America, *The Diamond Dictionary,* 1960.
Grodzinski, P., *History of Diamond Polishing,* Industrial Diamond Review, Special supplement No. 1, 1953.
Huyge, René, *Larousse Encyclopedia of Renaissance and Baroque Art,* 1964.
Jannetaz, Fontenay, Vanderheym and Coutance, *Diamond et Pierres Precieuses,* 1881.
Jeffries, David, *A Treatise on Diamonds and Pearls,* 1771.
Klein-Rebour, F., A series of articles in the Revue Francaise des Bijoutiers Horlogers, Nr. 258, 263, 265, 1962 and 268, 274 of 1963.
Krumbhaar and Rösch, *Die Diamanten des Grunen Gewolbes in Dresden,* Deutsche Goldschmiede—Zeitung, Nr. 11, 1926.
Maier, W., *Brillanten und Perlen,* 1949.
Mawe, John, *A Treatise on Diamonds,* 1823.
Miró, J. I., *Estudio de las Piedras Preciosas,* 1870.
Polak, Henri, Various brochures, 1896-1900.
Rau, Wilhelm, *Edelsteinkunde,* 1923.
Rogers, F. and Beard, A., *5,000 Years of Gems and Jewellery,* 1947.
Saint-Simon, *Histoire du Regent,* 1874.
Schlossmacher, K., *Edelsteinkunde und Perlen,* 1965.
Selwyn, A., *The Retail Jeweller's Handbook,* 1948.
Smet, K. de, *The Great Blue Diamond,* 1963.
Smith, G. F. Herbert, rev. by Phillips, F. C., *Gemstones,* 1958.
Spencer, L. J., *A Key to Precious Stones,* 1946.
Steingraber, Erich, *Alter Schmuck,* 1956.
Sutton, J. R., *Diamond, A Descriptive Treatise,* 1928.
Tillander, H., *Jalokiwiopin Perusteet,* 1946.
Tolansky, S., *The History and Use of Diamonds,* 1962.
Tolkowsky, Marcel, *Diamond Design,* 1919.
Weinstein, Michael, *The World of Jewel Stones,* 1959.
Wilm, H. J., *Gold Treasures Untold,* 1954.

NEW YORK LAB NOTES

(continued from page 73)

was unique for its size and exquisite green color.

Acknowledgements

We are very much indebted to New York precious-stone dealer, **Allen Caplan,** for a selection of rough gem material ideal for use in the Gem Identification Course, and for a remarkable opalized clam. This is shown on the right in *Figure 20,* with a freshly dug clam on the left.

We express our thanks to Mr. **Burapa Chanpon,** gem dealer from Bangkok, Thailand, for two handsome blue-black star sapphires from that country.

We thank New York dealer, **Joe Dattoli,** for a specimen of a new type of dark greenish-blue imitation turquois in matrix.

And to student **Murray Darvick,** New York City, we are indebted for

specimens of black-coral branches and cabochons.

We acknowledge with thanks an especially important gift of various cut stones from New York precious-stone dealers, **Wm. V. Schmidt Co., Inc.**

From student **Bill Lott,** Engelhard Industries, we received a gift of various rare gem materials, as well as garnet and a new type of black-treated opal and glass doublets.

We are also indebted to GIA graduate **Ben Gordon** of New York and Houston for a selection of stones useful in the Gem Identification Course.

HYDROGROSSULAR

(continued from page 76)

Warren, B. E., and Modell, D. I., *The Structure of Vesuvianite* $Ca_{10}Al_4(Mg,Fe)_2Si_4O_{34}(OH)_4$. Zeit. Krist., 78, 422, 1931.

Webster, R., *Gems.* Butterworth and Co., Washington, (1962).

........................, *Massive Grossularite.* Gems & Gemology, XI, 35-37, 61, 1963.

Yoder, H. S., Jr., *Stability Relations of Grossularite.* J. Geol., 58, 221-253, 1950.

Zambinski, W., *On the Occurrence of a Dispersed Vesuvianite Phase in Some So-Called Hydrogrossulars.* Bull. Acad. Polonaise Sci., Ser. Geol. & Geogr., 12, 149-155, 1963, (Min. Abst. 17, 313).

Book Review

MINERALS, ROCKS AND GEMSTONES, by Rudolf Borner. (Translated by W. Mykura) Published by Oliver and Boyd, Edinburgh and London. 237 pages. Numerous black-and-white illustrations and 16 color plates.

Dr. Borner's book, *Welcher Stein Ist Das?,* has long been a favorite in Germany. The book was designed ". . . to provide an easy means of identifying stones without presupposing any detailed technical knowledge or requiring complicated apparatus." In translating and editing this book, Mykura emphasized British localities and terminology. In addition, he has expanded the glossary of rock and petrographic terms.

The book is divided into three sections. The first section, which contains two tables, is concerned with minerals. The first table is arranged so that identification is based on color and hardness. In addition to a listing of the commonly used physical properties, occurrence, localities, associated minerals, uses and crystal forms are listed. The more common crystal forms are shown with line drawings. The whole form is designed to facilitate field identification. In the second table, identification is based on hardness and color of streak.

The second section contains a discussion and description of the more common rocks, as well as a glossary of rock and petrographic terms.

Gemstones are covered in the third section. Following a brief description of some identification techniques, there is a breakdown of gemstones, according to transparency and color. An alphabetical listing of gemstones, with physical properties, localities, incorrect names, imitations and value, conclude this section.

Unfortunately, the book contains a number of inaccuracies and inconsistencies. In the gemstone section, under the table entitled *Translucent and Opaque Gemstones and Ornamental Stones,* there is no R.I. listed for opaque stones, suggesting either that they do not have one or that it cannot be measured in the same manner as transparent and translucent stones. The refractive index of smithsonite in Table XV is given as =1.618 and =1.818, whereas on pages 211, 213 and 215 it is given as 1.81-1.84.