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IN THIS ISSUE

The Tears of Heliades

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Lucerne, Switzerland

Phaethon, the son of Helios, the Sun-God, was probably a somewhat impetuous young man – so the myth tells us. One day his father allowed him to drive the sun chariot, but he drifted off his course and skidded so close to the Earth, that he kindled a disastrous fire. Zeus, undertandably very angry over this carelessness, killed the imprudent driver hurling him by means of a destroying flash of lightning into the remote northern river Eridanos. The father of the gods was so furious that he did not even tolerate the grief of Phaethon's surviving sisters. Their tears flew him into such a mad rage, that he turned the poor girls, the Heliades, into black poplars. Yet, also this spell was of no avail; even in the shapes of trees the distressed sisters continued to mourn and their tears solidified into smooth, lustry drops of – *amber.* The sadness of the Heliades must have been so overwhelming that they shed such an abundance of tears that even in this present day they can be heaved from the sand by means of excavators.

There are a good number of sources in Europe, e.g., in Denmark, England, Holland, Rumania, Sicily, Sweden and even in the Ukraine (Map 1). The most important deposit, however, is situated in the Samland, the East Prussian peninsula between the Frische and the Kurisch Haff (Haff = lagoon). This source was already known in ancient times, and amber has always been a highly desired object of exchange and trade. For centuries amber has played a significant role in the civilization and culture of the peoples in Europe in the form of ornamental objects and a material easily workable for artistic articles such as chalices, jugs, vases, snuff boxes, amulets, ritual adornments, etc. Amber was collected along the beaches, hauled with nets and picked out of the earthy layers of the steep coast of the Samland rising, in places, to more than 200 ft. above sea level. Even today it is no rare event to discover golden yellow, glittering pieces of amber after stormy days on the beach onto which the churned-up sea has thrown them.

In accordance with the amber's high commercial value, the amber deposits are being industrially worked by strip mining. Huge excavators remove the thick layers of clay which cover the striking zones. These placers, called "Blue Earth," are being exploited, washed and screened.

Since the days of Aristotle and Pliny the Elder we already know that amber is no mineral but an arboreous resin. The massive concentration on a large scale along the Baltic Sea suggested the conjecture that enormous forests had once grown on the very same spot. However, this surmise proved to be wrong, for today we know that the place of discovery is not the place of origin.

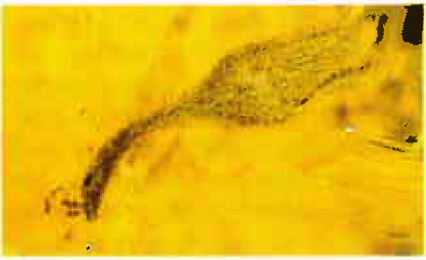
At a depth of about 75 to 120 ft. amber is being found embedded within two strata of a marine sediment of the Tertiary (higher and lower Tertiary), which is colored by green glauconite and hence called "Blue Earth." Since in these strata the fossil remnants of a marine fauna of medium depth are found, the movements of the earth's crust causing elevations and depressions of the sea bed must have been considerable and recurred several times over long periods. This assumption may be derived from the 19 different sediments above the "Blue Earth." The fact that all the deposits along the shores of the Baltic Sea are of secondary origin leads to the question about the primary origin of amber and how it got into the placers where it has been found ever since.

A landmass – comprising large parts of present day Scandinavia and the Baltic Sea – must once have been covered with vast forests, in which the

Map 1. Map of the Samland. The richest deposits of amber are situated along the coast and are marked here in black color.

Subtropical flower with stamen and ovaries.

Withered flower of a holly (Ilex aquifolium).



Fruit capsule on its broken-off stem.

Well preserved working ant (Formica). Master sample for investigation.

Black soldier ant (Formica nigra). Note the clearly visible multifaceted eye.

Female ant (Formica Lasii). Note distinct details of the body.

Mosquito (Dipterus) trying hard to walk off.

Mosquito (Dipterus Nematocerus) ready to take off.

Mosquito (Dipterus) holding a bubble between its forelegs.

A graceful little ballerina performing a pirouette.

Close-up portrait of this same ballerina flashing beautifully large eyes at the beholder.

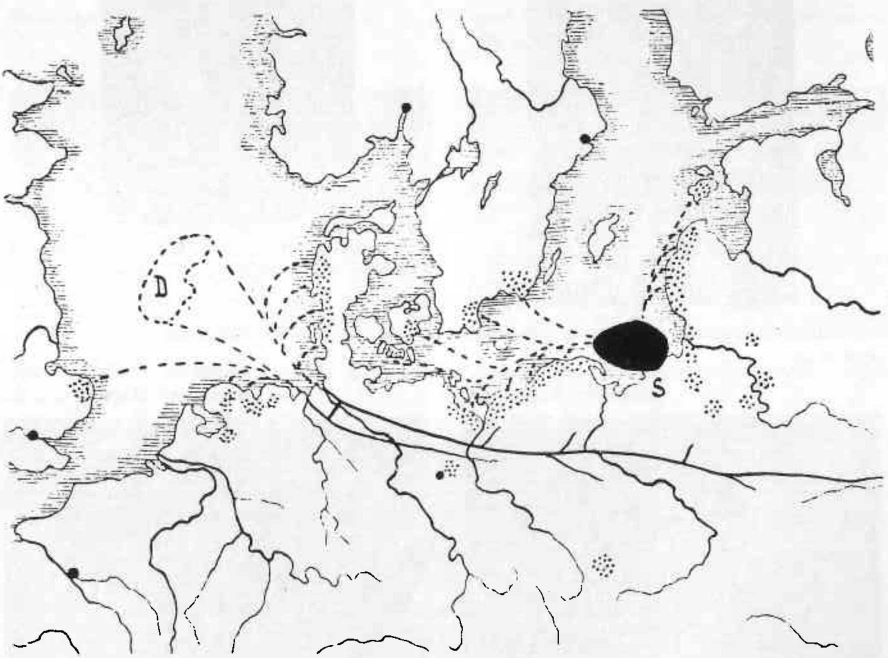
Fly (Dipterus brachycerus), which appears to have been trapped while trying to land.

Head with large multifaceted eyes of this same fly (Dipterus brachycerus).

amber pines grew. All the trees secreting amber resin belong to the order of the *conifers* and within this to the genus (=category) of the *pinites.* Of the latter, six varieties have become known to produce amber resin. Three among them – the *pinites Mengeanus, pinites radiosus* and *pinites anomalus* – are rarely represented by the pine needle inclusions found in amber. Somewhat more frequent are the relics of wooden fragments and needles of the *pinites succinifera* which greatly resembles our *pinus abies* as we know it today. The highest-yielding producer of amber resin was *pinites stroboides,* which is extremely difficult to distinguish from *pinus strobus.* Its productivity was enormous, and by far the largest quantity of amber being found was produced by *pinus stroboides.*

One of the mysteries concerning amber and which keeps us guessing and will most probably remain unsolved, is the fact that special types of trees, which are near relations to living species of pines, secreted a resin of the particular chemical composition of amber ($C_{10}H_{16}O$) only during that period, and that next to those a substantial number of other conifers existed yielding resin – yet completely devoid of the essential amber acid.

However, the secretion of amber resin need not necessarily have been extraordinarily abundant, for inclusions

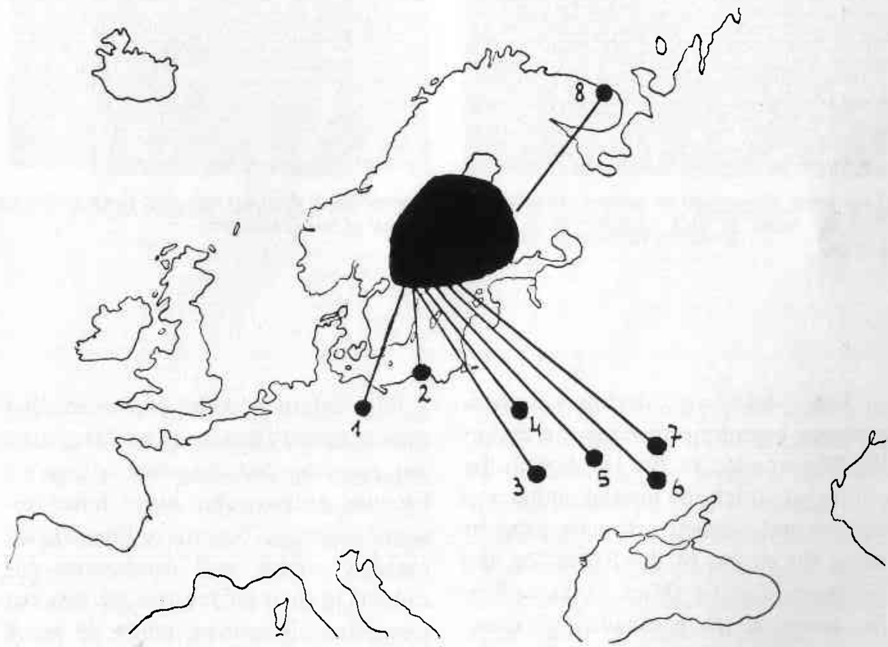


Map 2. Later transport of the amber from its secondary deposits in Samland by the currents of the sea and the rivers into its present deposits (dotted). (after Bachofen, 1949)

in amber reveal that periods of relative sterility interchanged with such of medium or intensive productiveness. Consequently we may assume that under equal climatic conditions the forests covered vast areas of Fenoscandia for an – even geologically seen – long era. Possibly these forests outlasted the hardly conceivable space of time of more than 15 million years, i.e. from the Lower Eocene to the Upper Oligocene.

The inundation of lower regions, caused by a tectonical depression of the Fenoscandian mainland during the Old Tertiary, allowed enormous masses of the resin that had – from time immemorial – accumulated and solidified in the forest soil to get into the sea. Strong currents carried part of the resin into the tranquil bays of the Samland, where, covered by strata of sand and sediments, it was embedded in the "Blue Earth."

Only portions of these tremendous quantities of amber remained there till now. Frequently, further displacements occurred by way of river transport, by marine currents, wash-ups of the ocean or shore slides.



1) Eberswalde
2) Samland
3) Shitomir
4) Brest-Litovsk
5) Kiev
6) Jekaterinoslav
7) Charkov
8) Svatoi Noss

Map 3. The occurrences of amber in northern and eastern Europe which were deposited by tertiary transport from its place of origin in the amber forests in Fenoscandia and its secondary placers in Samland. (after Bachofen, 1949)

Hymnopterus braconidis; the outstretched antenna seems to forebode the forthcoming catastrophe while the other has already been caught by the disaster.

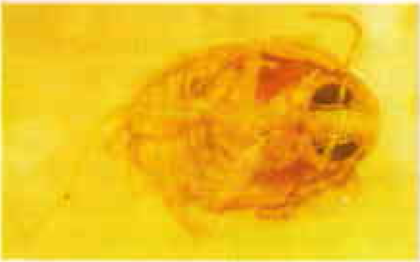
Long-horn beetle (Colepterus).

Two bees (Hymnopteri apides melliferae). One of them is still clinging to a white pollen.

Spider (ord. Aranea) realizing the paralyzing shock of being trapped.

The period of decline in temperature beginning towards the end of the Pliocene led to the Ice Age, in the course of which the host of amber was carried and washed into new deposits along the shores of the Baltic Sea and Northern Europe (Map 2), as well as far down on the mainland of Eastern Europe as the Ukraine (Map 3) by the repeated advance and retreat of the mighty glaciers as well as by colossal streams of melting water. The majority of amber collected and mined till now originated from the Baltic Sea and those remote placers.

The internal world of the coveted amber must already have fascinated our ancestors just as exuberantly as we become enthusiastic over these fossilized, yet eloquent witnesses of vanished times and landscapes enshrined in their golden and transparent sarcophagi. Numerous pieces of wood and bark, parts of cones, twigs and roots, fragments of coral and shells, uncountable numbers of insects, such as mosquitoes, flies, butterflies, bees and others as well as spiders and their cobwebs, water fleas and mites, but also worms, caterpillars, centipedes,



Bug (Heteropterus cimex), upside down displaying its large eyes, the folded legs and the segmental abdomen.

Termite (ord. Isoptera) with drooping wings and antennae.

Gnat (Fungivorida Mycetophilida).

Midge (Fungivorida Mycetophilida). Note its hornlike, segmental antennae.

larvae and even lizards were trapped by the viscous and sticky resin and preserved for posterity in unaltered condition. While to our forebearers all these inclusions may only have been objects of myth and awe, to modern science they are the revealing testimony of conditions and events which prevailed more than 40 million years ago, and with incomparable lucidity they enrich our knowledge about those geological eons.

Many aspects indicate that the landscapes of the amber country were characterized by more or less dense stands of pinites succinifera similar to those forming the pine savannes in North America (e.g. in higher altitudes of Florida) as well as in East Asia.

We learn from blossoms and fruit, leaves and fragments of wood which could be determined that deciduous trees, such as alder, beech, birch, chestnut, cypress, elm, maple, oak, poplar and willow were no rarity, and that camphor trees and even date and fan palms grew in those forests. Of the cinnamon tree, blossoms and leaves have been identified, while the magnolia is represented by one known leaf only. This curious mixture of trees still growing in our domestic forests with relatives of sub-tropical and tropical species was towered over by mammoth trees similar to the sequoias in California. Many kinds of mushrooms and mosses were also present.

However, as informative as the uncountable inclusions of parts of plants proved to be they are not capable of procuring a complete picture of the flora of the "amber country." Only those particles which happened to occur in the immediate neighborhood of the amber-producing pines could be embedded. Parts of plants which were outside the forests rarely ever got into the resin. In most cases these were withered blossoms, flowers and leaves or shreds thereof, blown off and scattered by the winds which settled upon the still glutinous amber.

However, the world of small animals handed down in the amber illustrates much more expressively the multitude of forms and conditions of life in the amber forests. Yet, it must be considered that the concentration of certain animals, as it manifests itself in the inclusions, does not correspond with the true circumstances of the amber forests and their environment. The mode of behavior and biotape of certain categories and geni may have determined the frequency of a particular inclusion (e.g. insect).

The most abundant inclusions are dipterous insects (ord. diptera), i.e. mosquitoes and flies, which were trapped as they settled on the still liquid and soft resin – and held by the gummy fluid were afterwards entombed by the subsequent drops. Specimens of amber were found containing more than a hundred of them. But also beetles, ants and other insects – if belonging to those species which preferred to sojourn on trees or their vicinities – are among the captive guests of the amber. Occasionally small butterflies are encountered, whilst samples with large butterflies are valued as rare treasures. Only a few dragonflies are known, and the order of the dayflies (ord. Ephemeridae) is represented by hardly more than a dozen species. From other indices we may derive knowledge about landscape and topography vanished long ago. Thus, investigations of the insect species of the quiverflies (trichoptera), for instance, allow us to speculate that certain areas of the amber landscapes were mountainous, with numerous brooks and streams. Approximately half of all known species are to be attributed to families whose present-day representatives can only pass their larval stage in rapidly flowing water. Furthermore, the stone- and bank-flies, which have been transmitted in a small number of species and whose larvae also depend on flowing water indicate the existence of brooks and rivers. Certain other species of the quiver-fly, on the other hand, suggest tranquil, stagnant waters which must have contributed towards the appearance of the landscape.

Apart from the numerous silvan insects preserved in amber we also observe those whose habitat was the open countryside and which surely must have come into contact with the fatal resin by unfortunate accident.

It is, therefore, likely that the vast

forests were interspersed by smaller and larger glades and possibly also by large open fields. Of many of the examined insects we may assume that they belonged to species visiting and pollinating blossoms and flowers. Especially the bees, represented by numerous geni, indicate that meadows were resplendent with a variegated abundance of flowers.

Those captive insects whose relatives populate rather different climate zones nowadays have always met with increased interest. Apart from those which live in temperate regions, there are others which exist only in areas with a subtropical or even tropical climate. An illustrative example are the descendents of the termites enclosed in amber.

Countless animals appear to have paused suddenly in the middle of a movement. Mosquitoes, flies and bees seem to be caught while flying, butterflies and their caterpillars peregrinate with their housesack, ants seem to be on the point to relax quietly or drag a wasp, while beetles may resume roaming about. Even enclosed feathers betray a catastrophic event in the life of their former bearers. The impression of a hardly-extinguished life is amplified by the completely preserved colors, which we admire on the gossamer wings of many insects. The entrancing amazement, which fauna and flora of the amber evoke by the lifelike pantomime of their bodies, is further enhanced by the unique preservation of subtle and minute details. The observation of the daintiest sensory organs such as mouth parts, and the possibility of counting the individual cells of a fly's multifaceted eye, is eclipsed when we recognize the tiny hairs on the antennae, or the nectar-collecting legs of a bee, or behold the threads of a cobweb and may, by the architecture of the construction, determine the family to which the spider belonged. In cross-sections, even the inner organs can easily be discerned and identified! The wealth of interesting and stupendous observations is legion and may still be multiplied. Even the host of those animals, which were surprised by death while resting, is far more intriguing than the systematic arrangement or exhibition of any modern collection of insects.

We do not know whether the amber continent (the eastern Scandinavian shield) has distinctive climate zones which favored a simultaneous existence of species and groups adapted to definite conditions of temperature, or whether in the course of long-dated changes of climate these orders and geni lived at greatly different times. Systematic research of those host ambers which coincidentally housed various insects could shed light onto such questions. Such specimens of amber are found quite often, and we know with certainty that the insects embalmed in them definitely lived at the same time at the same place. The yields of relics from vertebrae have been rather poor, yet they have disclosed some early types of birds never observed elsewhere, as well as the oldest finds of hair which have delivered fresh corroboration for the very high age of bats. Just the same as so many other inclusions in amber, these finds of vertebrae form clear evidence of their existence and afford a profound insight into the life of animals. They also display much more important features than the discovery of a skeleton, which only serves to identify a species not known before.

Thus, the wonderful world of inclusions in amber, which have been passed on by the thousands and in abundant diversities is – by comparing them with present-day fauna and vegetable specimens and their dependence upon their area and climate – granting us in a unique manner welcome and reliable conclusions as to climatic, geological and topographical conditions of the amber country prevailing at the time when the amber was formed and captured all these manifold contemporaries of its surroundings. They also enable us to investigate the situation, as well as the regularity of phylogenetic evolution of life on earth, through a great animal category.

Amber, the Tears of the Heliades, the Gold from the Baltic Sea is a fascinating material which has accompanied mankind from very early times just the same as admiration, curiosity, respect and superstition have accompanied this lovely gem of which we now know to be the solidified resinous sap of ancient pines, and one of the very few of earth's treasures divulging its geological and biological past.

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Photos by Gübelin

Laser Reflection Patterns in Diamond and Diamond Substitutes

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Introduction

During the last half century, man has been experimenting with light reflections and exploring new methods of "fingerprinting" diamonds to serve as permanent records for future identification and recognition of the same stone. It was the late Robert Webster, with his involvement in Forensic Science in Great Britain, who stimulated me to explore methods of identifying a particular gemstone through its "fingerprints."

Robert Webster referred in the *Criminologist* publication of May, 1968, to detection techniques through "light reflections." One of the earliest recorded methods of "fingerprinting" was by Professor Johnson of Berlin, Germany. He devised the "Brilliantscope" to observe the reflection of cut stones on a ground glass hemisphere. While recently in the office of Reginald Miller, a New York lapidary, we observed differences in the reflection patterns of diamond vs. synthetic cubic zirconia as they were projected on a very thick rectangular piece of glass used for display. This difference will also be shown with laser beam reflection patterns.

Later, Bohman from Holland adapted the idea of the "Brilliantscope" to a camera with which he could photograph spots of reflected light from a diamond. In 1948, Dr. Bruce D. Eytinge of New York produced a cylindrical-shaped camera with a simple lens system in which light passes through a hole in the center of a back-reflecting x-ray film. (The hole also served to center the table of the stone.) The light reflection pattern of the stone was then recorded on the film.

In the 1960's to 1970's, the "Laser Beam" had become accepted in medicine and numerous industrial usages, as well as for removing undesirable black inclusions from diamond. It was inevitable that someone would think of the laser and apply its light energy to reflection patterns in "fingerprinting" diamonds and diamond substitutes.

In 1975, Charles Bar Isaac introduced laser technology in gemology in his presentation to the Scientific Council of the Weizman Institute of Science in Rehovot, Israel. Here he introduced *Gemprint,* a recording camera and low-powered laser light source, with an application of the "laser fingerprinting" for diamond and diamond substitutes.

Operation of the Gemprint Camera

The *Gemprint* laser-lighted recording camera is just under three feet long, about one foot wide, and slightly over a foot high. Its size allows it to be set on a table at a comfortable operating height. The camera is equipped with a helium neon gas laser light source, considered weak and safe to the user. It also has a simple shutter and double lens system. With the shutter open, the laser beam passes through the first lens, which focuses the beam to a pin hole opening in the center of the Polaroid film (Polaroid-Land 4x5 film, black and white Type 52 Pola Pan, which produces a "fine grain positive print with excellent gradation and tonal range"), which is held firmly in a film holder. The laser light passes through the centered pin hole, continues through a second lens, becoming more divergent, and passes into the diamond. The laser light striking the table of the diamond positioned at 90° to the laser beam is thus reflected directly back to the film and recorded as the strongest reflection point in the pattern. Laser light internally reflected from back facets of the diamond is recorded as weaker points in the pattern on the film. The dominant reflection pattern must coincide with the center hole in the film to produce a true laser reflection of the particular stone being recorded. A unique pattern is recorded for each stone depending upon the symmetry of the cut and the nature of the material. The stone must be held securely in a specially designed stone holder which allows the stone to be accurately positioned, with the center of its table at precisely a right angle to the laser beam.

Diamond and Diamond Substitutes – A Comparison

Initially, a selection of 10 transparent colorless round brilliant cut gemstones, varying in weight from 0.67 carat to 1.50 carats, were examined. We photographed the laser reflection pattern of diamond and the following nine diamond substitutes with *Gemprint:*

Natural Gemstones
- Diamond
- Zircon

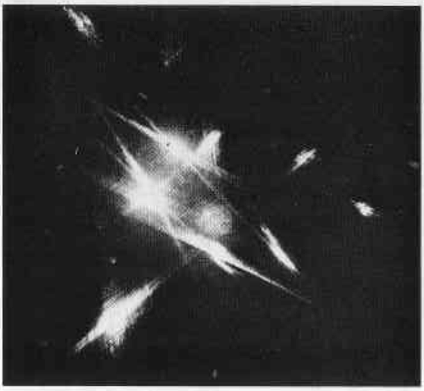
Assembled Stone, Doublet
- Strontium Titanate and Synthetic Spinel

Synthetic/Man-made Gemstones – Diamond Substitutes
- Synthetic Sapphire
- Synthetic Spinel
- Synthetic Rutile
- Strontium Titanate
- YAG – Yttrium Aluminum Oxide
- GGG – Gadolinium Gallium Oxide
- Synthetic Cubic Zirconia

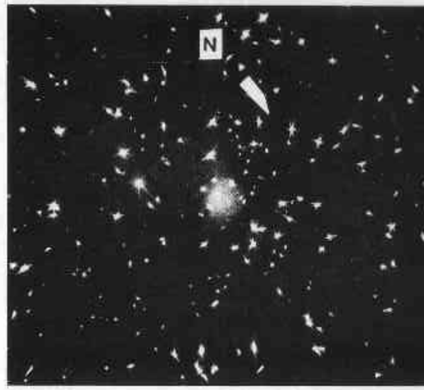
Then another 10 gemstones of comparable identity were photographed to match their similar reflection patterns with the initial set.

Curiosity led me to take the reflection pattern of a 1.30-carat blocked diamond *(Photo 1).* As was expected, this pattern did not resemble that of a finished stone. This diamond was then

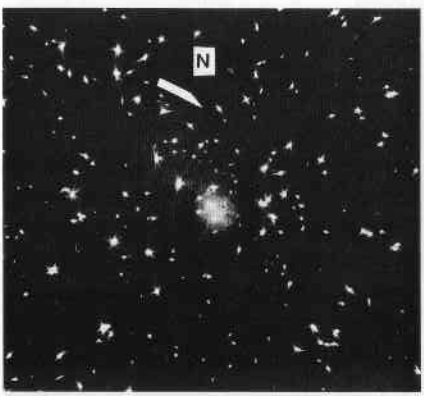
GEMPRINT Laser light reflection patterns of diamond



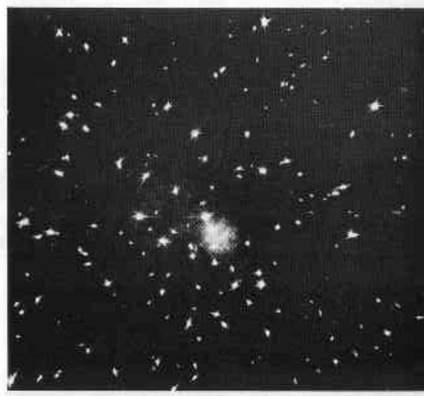
Photograph 1. Blocked diamond. 1.30 ct.



Photograph 2. Diamond. 1.05 ct.



Photograph 3. Diamond. 1.05 ct.



Photograph 4. Diamond (recut to 1.04 ct.)

finished to a 1.05-carat round brilliant cut stone. We photographed it in two different positions, *Photo 2* and *Photo 3*. If *Photo 3* is rotated approximately 12° NE, its pattern matches *Photo 2*. This proves it is the same stone. This same diamond was then recut to a 1.04-carat round brilliant cut stone, in *Photo 4*. It exhibits a new pattern and must now be considered a new stone, based on reflection patterns only.

The reflection patterns in diamond and nine most common diamond substitutes have definitive characteristics. A few of the substitutes' patterns are fairly similar to one another. However, all of the diamond substitutes' reflection patterns are very different from those shown by diamond.

Reflection patterns were photographed of other colorless gemstones – i.e., rock crystal, glass, topaz and

TABLE OF CHARACTERISTICS

Material	Pattern	Image(s)
Diamond	random pattern	sharp star-like image
Zircon	random pattern (most closely resembles diamond)	small "double" pulled-out modified star-like image
Synthetic Sapphire	bold semi-concentric brushed-like center pattern	fish vertebrae-like image
Synthetic Spinel	semi-concentric pattern	fuzzy finger-print and stringer images
Synthetic Rutile	random pattern	"double" slightly fuzzy, less distinct and larger image than Zircon
Strontium Titanate	modified cut corner ribbon, or cube-like pattern	random horse-tail images
YAG — Yttrium Aluminum Oxide	random pattern	pulled-out stars and triangles with connecting stringers
GGG — Gadolinium Gallium Oxide	double concentric pattern	triangles and larger patchy images
Synthetic Cubic Zirconia	random pattern	fuzzy fingerprint-like comet-like tail images
Strontium Titanate/ Synthetic Spinel Doublet	spoked wheel, with outer concentric ring pattern	random knife-like slash images

colorless beryl (goshenite). Their reflection patterns neither resemble diamond or the nine diamond substitutes.

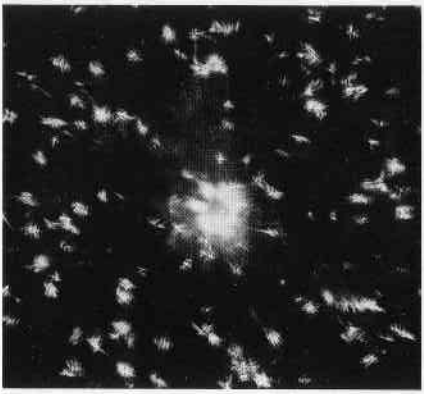
Since synthetic cubic zirconia has become of great concern to the gemologist/jeweler, a reflection pattern of a 1.49-carat oval brilliant cut is included, *Photo 5.*

This same stone was recut to 1.20 carats, now showing a new pattern *(Photo 6).* It is readily seen that upon recutting the pattern of reflection has been drastically altered. However, on closer examination, the fuzzy sweeping image characteristic of cubic zirconia is still present.

In the 1960's, the GIA was deeply involved in researching a method of detecting artificially-coated diamond. Therefore, I felt it would be of interest to observe and photograph the laser beam reflection of a coated diamond. A 1.25-carat round brilliant was used and the pattern is shown in *Photo 7.* As can be seen from the photograph, this stone showed only the normal random reflection pattern and characteristic star-like image that is normally associated with uncoated diamonds.

However, you can "fingerprint" a coated diamond by photographing the

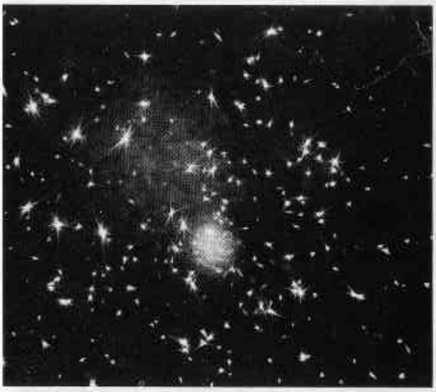
GEMPRINT Laser light reflection patterns of diamond and its substitutes.



Synthetic Cubic Zirconia. Round Brilliant. 0.91 ct.

Photograph 5. Synthetic Cubic Zirconia. Oval

Photograph 6. Synthetic Cubic Zirconia. Oval



Photograph 7. Artificially coated diamond. 1.25 ct.

stone through the Gemolite. Focus through the stone to the back facets and observe in reflected and diffused transmitted light sources together. You can then record crater-like areas, broken bubbles in the coating, or concentration of coating paralleling a facet junction, or an all-over bluish-gray coating. (See *Gems & Gemology,* Winter '62-'63, Summer '64.)

Conclusion

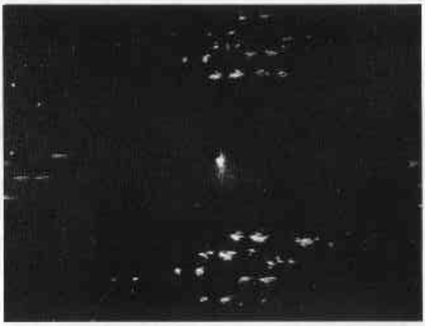
A jeweler/gemologist can use *Gemprint* to:

1. record laser reflection patterns of his stock.
2. supplement a laboratory report for insurance purposes.
3. stimulate customer confidence.
4. help to separate diamond from diamond substitutes for a deci-

GEMPRINT Laser light reflection patterns of diamond substitutes.

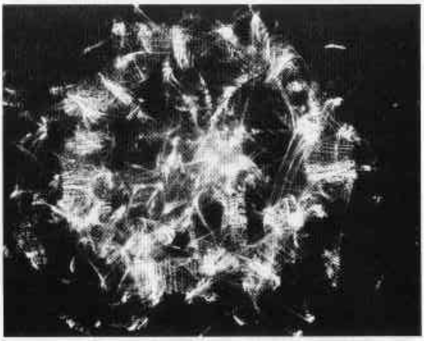
Quartz (Rock Crystal).

Glass.

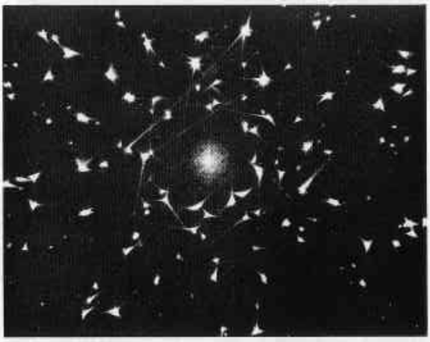


Topaz.

Beryl (Goshenite).

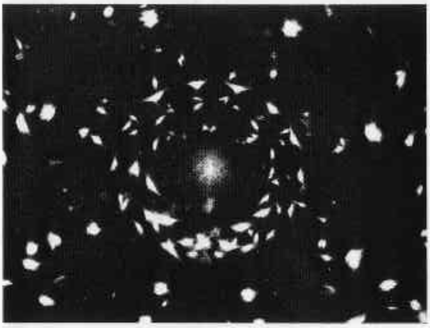


Synthetic Spinel. Semi-concentric pattern; fuzzy finger-print and stringer images.

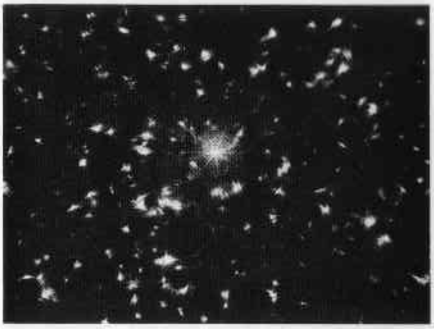


YAG — Yttrium Aluminum Oxide. Random pattern; pulled-out stars; triangles with connecting stringers.

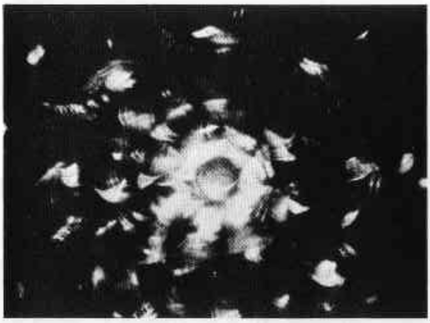
GEMPRINT Laser light reflection patterns of diamond substitutes.



GGG — Gadolinium Gallium Oxide. Double concentric pattern; triangles and larger patchy images.

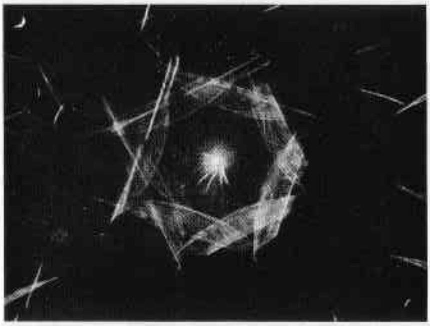


Synthetic Rutile. Random pattern, double slightly fuzzy, less distinct and larger images than Zircon.

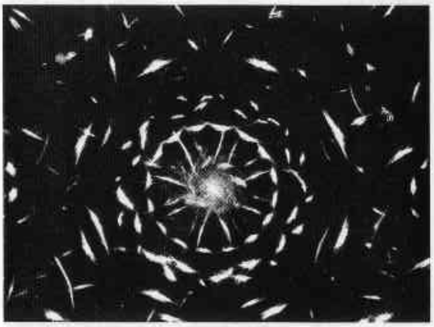


Synthetic Sapphire. Bold semi-concentric brushed-like center pattern; fish vertebrae-like image.

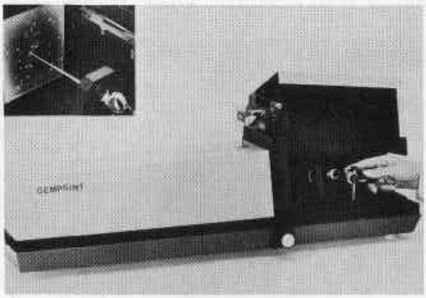
Zircon. Random pattern (most closely resembles diamond); small double pulled-out modified star-like image.



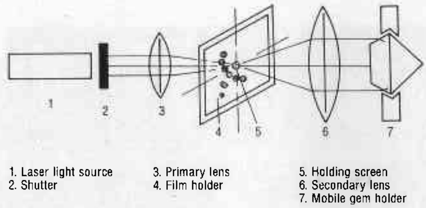
Strontium Titanate. Modified cut corner; cube-like pattern, random ribbon and horse-tail images.



Strontium Titanate/Synthetic Spinel Doublet. Spoked wheel, with outer concentric ring pattern; random knife-like slash images.



The GEMPRINT recording camera.



Schematic drawing of the GEMPRINT camera.

sion on a loan or as collateral against another diamond.

5. verify whether a mounted stone is the same stone a customer bought loose.

Gemprint provides another recording system for future identification and recognition of a diamond, under the following conditions: if the stone has been formerly "fingerprinted," the records of it are on file, and the stone has not been recut.

Other proven means of identifying a diamond are laboratory reports such as those prepared by the Gem Trade Laboratories. Those may include a photomicrograph of the internal characteristics and structure of a stone.

Future research holds promise for other uses for *Gemprint,* e.g.,

a. to study whether a stone has been "recut" by comparing its side reflection patterns with those on record. A circular film in a cylindrical film holder, in a camera with a circular rotating exposure aperture, is used for making the photographic record. This would be comparable to film used for recording a picture of the entire human jaw including the back of the head as done by a dental technician.
b. pattern reflection symmetry, to study the "make" of a diamond, e.g., shallow, near ideal, too deep.
c. pattern reflection of "fancy cuts" of diamond and diamond substitutes as recorded by *Gemprint.*

Acknowledgements

Gemprint Ltd.
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Santa Monica Headquarters

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New York Offices

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Some "New" Angles on Faceting

By EDWARD A. DANBOM
Colombo, Sri Lanka

Much has been written about angles for faceting colored stones and the results of scientific analyses have been reported in *Gems & Gemology*. However, when the cutter works on a stone, he is confronted by the many problems that each stone presents. Since most jewelers prefer stones with low crowns, the favored crown main angles of 32 to 37 degrees and table sizes of 50 to 60% of stone diameter are used. Fortunately, crown angles can be changed to suit the desires of the customer without seriously changing the color and brilliance of the stone, although the dispersion may be slightly affected.

The cutter's greatest opportunity to enhance the beauty of a stone is in designing the pavilion. Color will be enhanced by the addition of pavilion step facets. Considerable freedom is allowed in pavilion design, as long as certain rules are followed. Usually, facets cut at angles less than the critical angle allow light to leak through the facets adjacent to the culet area. Facets cut at angles much greater than the critical angle will allow light to leak out the side of the stone. Note that the angles greater than the critical angle, which allow leakage of light, depend upon the critical angle of the individual stone. If

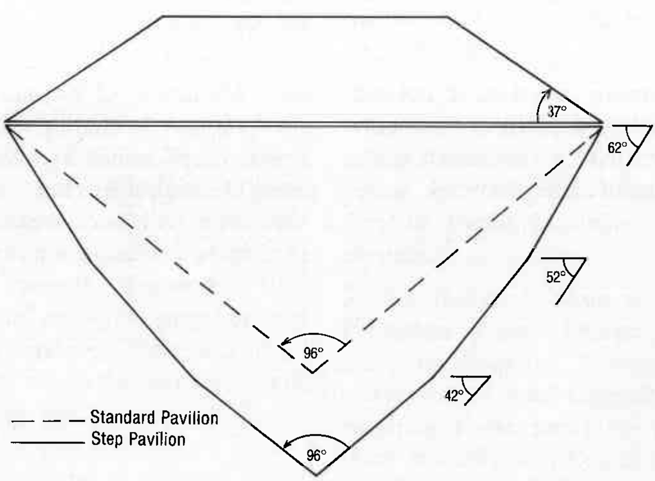


Figure 1.

Figure 3. Table view. Standard brilliant is on the left.

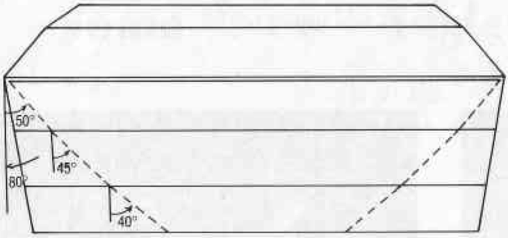
Figure 4. Pavilion view. Standard brilliant is on the left.

Figure 5. Table view. Standard oval is on the left.

Figure 6. Pavilion view. Standard oval is on the left.

Figure 7. Table view. Standard marquise is on the left.

Figure 8. Pavilion view. Standard marquise is on the left.



--- Standard Emerald Cut at 5° Steps
——— Dark Tourmaline Pavilion at 80°

Figure 2.

the facets which are cut at these steep angles, which allow light leakage from the side of the stone, are kept near the girdle and not allowed to project under the table, the effect of that light leakage will not be apparent. There is some "tunneling" or "see through" effect, but the enhancement of color more than makes up for this loss. Therefore, the cutter should select a culet angle at least two degrees above the critical angle and cut step facets into the pavilion. For example, for pavilion step facets in sapphire, one would choose angles of 62 degrees, 52 degrees, and 42 degrees to obtain the best color, if the stone is relatively pale. (See *Figure 1.)*

There are exceptions to the above: colorless stones must be cut with most pavilion facets at, or near, the best angle for maximum reflection. Therefore, no additional steps should be used in the pavilion design. Very dark material must be cut shallow to allow sufficient light to penetrate the stone. Some brilliance is sacrificed for the beauty of color, since the dark stone deliberately cut shallow allows light leakage. Dichroic stones with very dark color along one axis, as in some tourmalines, present special problems. In designing the pavilion of dark tourmaline, one must prevent refracting light through the dark axis. The cutter must cut the end facets steep enough so that any light that touches those end facets will be allowed to leak out, thereby lightening the stone. *Figure 2* shows the side view of a dark tourmaline where the steps are eliminated and the end facet is cut to 80° to lighten the stone.

To illustrate the effect of enhancing the color of weakly colored stones by cutting step pavilions, I experimented with stones cut from the same boule of synthetic spinel. A standard brilliant cut, compared to one cut with ten degree steps in the pavilion, is seen in *Figures 3* and *4.* The steps were staggered to create "diamond-shaped" facets, although it can also be accomplished by using parallel steps. The stepped stone appears richer in color and is more brilliant in appearance. *Figures 5* and *6* show the same treatment of oval cut stones. In this comparison, the effect is further improved because leakage through the end pavilion facets is reduced, since no facet is cut at less than the critical angle. The same type of color and brilliance enhancement occurs in the marquise cut, which is seen in *Figures 7* and *8*.

No pavilion facet is cut at an angle less than the critical angle; therefore the light is reflected back into the stone and out the crown. In all of the aforementioned stones, the crowns were cut identically. The total improvement of appearance can be attributed to the change in pavilion design by the addition of step facets.

Dispersion: Considerations in Faceting

Dispersion, the separation of white light into the colors of the visible spectrum, should be considered in planning gem cuts. This "fire" improves the appearance of pale or colorless materials. Some stones exhibit more of this property than others, but effort should be made to bring out the best in each potential gem.

Maximum dispersion occurs where light emerges from a facet at angles near the critical, and decreases as angles approach the perpendicular.

Most cutting diagrams require that crown facets be aligned precisely over pavilion facets, and crown angles be increased for material with wider critical angles, to improve dispersion. These materials will then have higher crowns than are desired by some buyers. The alternative to higher crowns is a change of design that will cause light to be reflected from the pavilion at different angles of rotation.

Some improvement may be accomplished by extending the break facets of the pavilion further toward the culet, since break facets reflect light at different angles of rotation from those of the mains.

More improvement may be obtained by offsetting the crown so its main facets fall between the pavilion mains, or by coupling a vertically split pavilion to a standard crown. These plans, also, produce "busier" appearing pavilions, which may be desirable, especially for larger stones.

The New Gem Diamond Pen

By RICK SHAW, G.G.
Gemological Institute of America
Santa Monica, California

As the name suggests, the purpose of the Diamond Pen is to separate diamond from its substitutes and imitations. This separation is accomplished strictly by visual means, made possible by the unique atomic properties of diamond which do not characterize any of the imitations. Although theoretically complex, the principle on which the pen is based has been utilized for many years. It has been said that an experienced diamond man with a tooth pick and a glass of water can tell a diamond from any other gem material. This simple test is founded on the principle that the surface tension of diamond is unique for its optical density.

For a technical explanation of the contact angle and the principle of surface tension, please refer to the article by Dr. Kurt Nassau and Dr. H. Shornhorn in *Gems and Gemology* dated Winter 1977-1978. As Dr. Nassau's article has done so already, this article is not an attempt to elaborate on technical subjects. It is rather my intention to describe the use of the pen and offer some hints regarding its application.

Our objective was to create a liquid which would spread only on diamond and bead on all of the diamond imitations or substitutes. The pen itself is really of no consequence. It is manufactured by a company which makes drafting pens. The tip number 2.5 enables the somewhat viscous liquid to flow evenly; each time the pen is drawn across the stone's surface, a metered amount of liquid is deposited. The liquid, a non-drying fluid, consists of inert chemicals which cause no problem when in contact with the skin; the dyes, however, may stain clothing. The pen contains a plunger which is gravity activated and will keep the tip free-flowing at all times. There is enough liquid supplied with the kit to test several thousand stones, probably more liquid than one might use in a lifetime.

During the initial laboratory testing, we found that it was sufficient to clean the gemstone surface with alcohol. It has since come to our attention that due to the notoriety of the contact angle of water on gemstones and the availability of other pens which will more or less produce an effect similar to, but not as conclusive as, that of the Diamond Pen's, stones have been coated to give a diamond-like reaction. We decided, therefore, that it would be much more practical to polish the surface to be tested with a polishing compound rather than simply attempting to clean it. The polishing would remove any coating, even a very tenacious one such as magnesium fluoride.

In the kit (see photograph) is included a hard piece of felt and some polishing compound suitable for use on all diamonds and diamond imitations. In the case of diamond, this compound is not hard enough to polish the surface of the diamond; it can, however, polish the surface of diamond imitations so care must be taken not to round the edges or damage the imitation in any way.

GEM Diamond Pen Kit

To insure a clean and well-polished surface, usually a table or other large facet, place a very small amount of polishing agent – just enough to be visible – on the felt pad included in the kit. Use the locking tweezers to hold loose stones; for larger stones, use the jaws of the tweezers to grasp the girdle. Make sure the jaws of the tweezers do not cover the surface to be tested. For small stones, place the stone table down on the polishing felt. The small hole in the base of the tweezers is placed over the culet to hold the stone for polishing. For mounted stones, hold the mounting in the fingers and polish the exposed table or other facet. Rub the facet or table to be cleaned back and forth briskly on the polishing agent. After the surface has been thoroughly cleaned, wipe the stone with a clean cloth or facial tissue. The next step is the test itself.

The Gem Diamond Pen test should be observed under magnification of 2x to 10x to aid in separating the reactions. To perform the test, hold the pen in a vertical position above the clean facet, press down on the pen gently and draw a straight line of liquid across the surface of the facet. You should get immediate and accurate results. If the stone is a diamond, the application should appear as a straight line, possibly even spreading *(Figure 1)*. If the stone is a diamond substitute, the application will not be a continuous line but a series of individual beads along the path of the pen's movement *(Figure 2)*.

The enclosed list of gemstones *(Table 1)*, taken directly from Dr.

Nassau's article, indicates the relationship between the reliability of the Diamond Pen test and the surface contact angle shown. It will be noted that the contact angle of diamond is closest to that of the imitations synthetic rutile and zircon. If difficulty is to be encountered when using the pen, these two stones, especially those with poorly polished surfaces, will present the most trouble. Separation should be confirmed by their obvious physical and optical properties.

The only other anomalous results with the pen have occurred on stones with indices well below 1.80, the upper limit of the conventional refractometer. As a practical limitation, we have stipulated that the pen works on stones with a refractive index over 1.80, where in reality, it will work on spinel, sapphire and transparent materials with an R.I. as low as topaz (1.619 – 1.627). The only two diamond substitutes and imitations which could possibly cause confusion are quartz and low property glass which can give a diamond-like reaction; all of the other transparent and man-made transparent materials have a surface tension which will cause the pen's

TABLE 1
CONTACT ANGLES (WATER)
In descending order of the average angle in degrees.

Zincite	94-90
Corundum	94-86
YAG	92-86
Strontium Titanate	90-80
Lanthanum Aluminate	91-85
Alexandrite	90-84
Elbaite	88-80
Grossularite	84-76
Cubic Zirconia	90-70
GGG	84-74
Beryl	89-83
Topaz	80-69
Lithium Niobate	77-71
Spinel	84-64
Wulfenite	73-69
Yttralox	71-65
Rutile	72-62
Zircon	67-60
Spessartite	67-60
Powellite	64-60
Moissanite	66-58
Iolite	62-56
Scheelite	60-50
Diamond	55-47
Oligoclase	41-35
Quartz	0
Glass	0

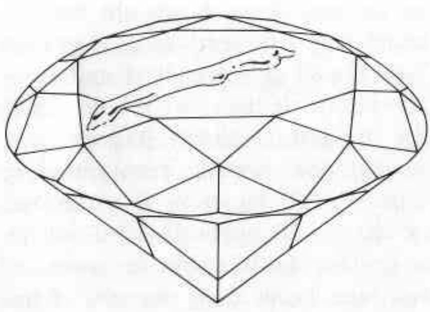


Figure 1. The pen draws a smooth unbroken liquid line on diamond.

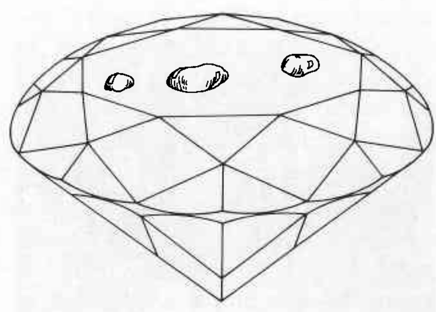


Figure 2. The liquid beads up on any of the major diamond substitutes.

liquid to bead. Beading will never be visible on a diamond with a clean surface. The true problem separations in the trade, CZ and GGG, have high contact angles or a surface tension which allows for a very rapid beading of the pen's liquid. If the pen's directions are followed exactly, no problems should arise.

While conclusive results can be achieved by gemologists and non-gemologists alike, it is advisable to have an example of diamond on hand for comparison purposes until you and your staff are familiar enough with the reaction to make calls confidently.

We feel that this pen alone is sufficient to enable the average jeweler to avoid common costly mistakes resulting from the marketing of new gem substitutes such as CZ and GGG. The reaction of gem materials produced in the future is almost certainly to be similar to these substitutes. It is extremely unlikely that any optically dense diamond substitute produced in the future would not give a reaction characteristic of all the existing imitations. In the event that such a substitute is manufactured, however, a complete article on it will appear in *Gems and Gemology*.

GIA Mourns the Passing of James Donavan

The Gemological Institute of America and the jewelry industry of America have lost one of their pillars in the passing of James G. Donavan, Jr., long-time Chairman of the Board of Governors of the Gemological Institute of America.

For a period of over 50 years, Jim Donavan served the jewelry industry, the consuming public and, for the last 40 particularly, the Gemological Institute of America. He was an exceptionally effective jeweler. In addition, he was selfless in his devotion to the standards he felt a school devoted to training jewelers should maintain. He felt that every jeweler should serve the public with integrity and knowledge and that it was the function of GIA to provide jewelers and the public with accurate information. He felt that jewelers should be professionals and he devoted a lifetime to furthering that goal.

During the many years that he served the GIA and also the American Gem Society, he gave thousands of hours of his time without recompense and without expecting even a pat on the back for his efforts. He was truly a selfless idealist to whom all GIA's students and graduates owe an enormous debt of gratitude.

Mr. Donavan was an exceptionally objective person with an incisive mind that enabled him to cut to the heart of a problem quickly. Particularly in his early years of guidance and wise counsel to the American Gem Society, as its President, and later, as the long-term Chairman of the Board of the Gemological Institute of America, did he demonstrate his incisive thinking.

Jim Donavan was a man of very strong convictions. He always felt that the Gemological Institute of America should be housed very close to one of the major universities in Southern California and that its ultimate aim should be to offer a degree in gemology.

Even after he retired from his chairmanship of the Board of GIA, he retained his vital interest in its activities.

As a small token of appreciation of the Board and the staff of GIA, the James G. Donavan annual grant was established to fund research in the gemological field. The most important grant to date has been the establishment of the GIA Research Laboratory funded initially by over $125,000, to purchase the essential equipment to establish what is probably the most advanced gemological laboratory.

Each year since that laboratory was first established, major new additions of equipment have been made under the James G. Donavan grant. To memorialize his contributions, a new grant has just been authorized to purchase a new energy dispersive unit for the laboratory at a cost of over $17,000.

As long as there is a GIA, people on the staff, students and the jewelry industry will be indebted to the enormous contributions made by James G. Donavan, Jr. He will be sorely missed.