THE BOOK OF DIAMONDS

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Key to Stones Shown in Colored Plate with Weight of Each

	Carats
1. Diamond, Crystal, white	5.94
2. Diamond, white, Brilliant Cutting	2.07
3. Diamond, pink	1.85
4. Diamond, green	1.45
5. Diamond, black	3.50
6. Sapphire, blue, Fergus County, Montana.	3.27
7. Sapphire, blue, Burma	5.94
8. Ruby, Burma	1.16
9. Sapphire, green, Siam	4.40
10. Sapphire, yellow, Ceylon, Briolette	12.75
11. Star Sapphire, Ceylon	27.33
12. Chrysoberyl, Brazil.	5.91
13. Catseye, Ceylon	7.93
14. Alexandrite, Ceylon.	8.05
15. Spinel, Burma	4.12
16. Emerald, Colombia.	2.08
17. Aquamarine, Brazil.	12.05
18. Golden beryl, Connecticut	10.65
19. Morganite (pink beryl), Madagascar	14.89
20. Zircon, green, Ceylon	7.74
21. Zircon, blue, Ceylon.	12.63
22. Topaz, yellow, Brazil	9.75
23. Topaz, pink, Brazil.	10.74
24. Topaz, white, Briolette, Brazil	20.83
25. Tourmaline, green, Paris, Maine	9.35
26. Rubellite (var. Tourmaline), Mesa Grande, Cal.	11.43
27. Tourmaline, bicolored, Mesa Grande, Cal.	22.17
28. Zircon, brown, Ceylon	18.00
29. Kunzite (var. Spodumene), Pala, Cal.	10.90
30. Hiddenite (var. Spodumene) North Carolina	9.29
31. Peridot, Egypt	10.92
32. Garnet, precious, East Africa	8.96
33. Carbuncle (var. Garnet), India	14.63
34. Hessonite (cinnamon garnet), Ceylon	10.72
35. Lapis Lazuli, Persia.	
36. Amazonite, Virginia.	4.42
37. Amethyst, Uruguay.	10.55
38. Spanish Topaz (var. Quartz), Spain	7.60
39. Precious jade (Jadeite), Burma	6.57
40. Chalcedony, scaraboid, Persia	
41. Sard, scaraboid, Greece	
42. Sardonyx, India	7.13
43. Bloodstone, India	5.29
44. Chrysoprase, Silesia.	5.19
45. Carnelian, India	6.37
46. Turquoise, New Mexico	5.79
47. Flame Opal, Mexico.	17.40
48. Black Opal, New So. Wales, Australia	7.69
49. Fire Opal, Queretaro, Mexico	6.24
50. Moonstone, blue, Ceylon	11.99
51. Rose quartz, Madagascar	13.34
52. Malachite, Russia	8.47

THE BOOK OF DIAMONDS

THEIR CURIOUS LORE, PROPERTIES, TESTS AND SYNTHETIC MANUFACTURE

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19  40

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DEDICATED TO ALL MY STUDENTS
WHO HAVE HAD ANY PART
IN HELPING TO MAKE SYNTHETIC
DIAMONDS UNDER MY INSTRUCTIONS.

TABLE OF CONTENTS

FOREWORD

THIS BOOK IS PRESENTED for the general reading public, as well as high school or college students, who have a desire for the non-technical aspects of science. An attempt has been made to interest the reader without sacrificing accuracy. The book should be found a pleasant pastime for all classes of people. Every young man is interested in diamonds sometime in his life and every young woman is looking forward to receiving a diamond from her sweetheart.

For the last ten years the author has received hundreds of letters of inquiry about natural and synthetic diamonds. This is what prompted him in part to write the book. He has lectured on this subject before many different clubs, high schools, colleges, universities and scientific groups. It is his hope that this book will answer many questions that were raised in his lectures and those which could not possibly be answered in an hour's lecture.

The author has endeavored to cover the subject of diamonds and some of the precious gems in a very brief, popular way, from their very earliest history to the present. The last chapter gives the history of synthetic diamonds and how they have been made at McPherson College for the last fifteen years. Meanwhile the experiments are contin-

ued here with the desire to add further information to the interesting chemistry of diamonds and the aim of making larger synthetic diamonds.

It is the hope that you will enjoy reading it as much as the author has enjoyed writing it. If you do, he will be more than satisfied.

Much of the information has been obtained from many sources by reading books and journals over a period of years, especially from the libraries of Boston, Harvard and the University of Chicago. The list is too long to be written here. The principal references are given in the footnotes.

The author is particularly indebted to Dr. Claude R. Flory who has read the manuscript and much of the proof. Valued assistance has been rendered also by Mrs. J. Willard Hershey both in the preparation of the manuscript and in the proof-reading.

J. Willard Hershey

CHAPTER ONE

THE EARLY HISTORY OF DIAMONDS

From the earliest times the diamond has fascinated mankind. The diamond is the best known and most admired ornament which Nature has provided for man, "a thing of beauty and a joy forever." Of many of her beauties, Nature gives us glimpses only. The diamond sparkles and flashes whenever and wherever the light finds it, while the generations which successively enjoy its beauty fade and are forgotten.

Among all the stones that our world's fancy holds precious, the diamond stands preeminent. The diamonds that gleamed with such strange fire in an idol's eye before the rising of the Star of Bethlehem may be sparkling today with more dazzling radiance in the crown of an emperor.

By the traffic of Rome from the East the diamond was gradually carried Westward, but owing to the inability to cut and polish it until the fifteenth century, it was not classed as the equal of rubies and emeralds. Even in the middle of the sixteenth century, it was ranked by Benvenuto Cellini as third among precious stones, placing the value

of it (diamond) as one-fourth that of the emerald, and the emerald at half that of the ruby. It may interest some who know a little of the value of these colored precious stones to learn that Cellini estimated a perfect ruby weighing one carat at the equivalent of eight hundred dollars.

In a lecture "On Diamonds" seventy-five years ago Professor Maskelyne said, "The diamond is a substance which transcends all others in certain properties to which it is indebted for its usefulness in the arts and its beauty as an ornament. Thus, on the one hand, it is the hardest substance found in nature or fashioned by art. Its reflecting power and refraction energy, on the one hand, exceed those of all other colorless bodies, while it yields to none in the perfection of its pellucidity." He was constrained to add, "the formation of the diamond is an unsolved problem."

The glory of Solomon, the grandeur of the Caesars and the gorgeous pomps of the Dukes of Burgundy have had their celebrated periods in history. Now, Americans are setting a new record of luxury more dazzling, at least in one respect, than any of the past—they have more and better diamonds.

Diamond in the English, and Diamant in the French, are both synonymous with Adamant, which comes directly from the Greek word, ἀδάμας, meaning literally invincible, the unconquerable; and from the Latin word, adamare, to love, and also the Latin word adamas, meaning hard.

Combined with the qualities that withstand the destruction of time, diamonds possess other qualities which prevent the weariness of monotony growing usually out of

changeless existence. These make them as captivating to the senses when the eye dims with age as when they attracted it in eager youth. To the sun, "soul of surrounding worlds," year after year and age after age, they respond like stars. The appreciation of precious stones marks the rise of the individual from grubbing to a broader outlook; of a nation from the hard struggle for existence to the plane of acquirement.

India has always been regarded as the natural home of the diamond, for there it was first found. It appears certain that diamonds were known and appreciated in India at least five thousand years ago. It is thought that they were first brought to Europe about 290 B.C. How long they have been known and used as jewels is uncertain. Nor do we know when they were first distinguished with certainty from similar transparent white stones. Hindu legend in the Mahabharata tells of a diamond worn by one of the heroes 5,000 years ago. It is possible, of course, that the stone was a rock crystal or a colorless zircon, or white sapphire or topaz, for all of these have at one time or another passed for diamonds.

The opening of the twentieth century sees this gem (diamond) in much more beautiful form than ever the monarchs of old saw it—scattered through every village and hamlet in the United States upon the hands and necks of daughters of the plain people sparkle and flash gems more royal than the royalties of the world for thousands of years ever knew.

Of the present day forms of jewelry the necklace is with-

out doubt the most ancient. With higher development in culture such as is found among the Egyptian jewelry of about 2000 B.C., the gem stone beads were better rounded and polished. From the necklace composed of strung beads it is but a step to one in which the roughly shaped stones were encased in a metal setting.

It would be interesting if we could trace the history of every diamond. Some of them may have been named only last year, but others may be centuries old. Rarely if ever is a diamond that has once been cut destroyed. It never wears out. If not buried with its owner or lost in some way, it must pass on to decorate milady of the next generation. Gold and silver objects may ultimately be melted up and shaped into something else, but a diamond never loses its distinct character. The diamonds that graced ancient queens are probably in existence somewhere in the world today.

The Hindus believe to this day that lightning transforms rock crystal to diamond. This is a poetical fancy but it may have some foundation in fact, for the power of electricity over the elements is great and it is possible that under certain conditions it could crystallize carbon as it can separate the component of gases of water. Some have thought that diamonds grow. There are men today, not ignorant or imaginative, who think it possible that diamonds grow by the slow precipitation of infinitesimal particles to a nucleus.

It is recorded in Sprat's *History of the Royal Society* (1667) that among the questions sent out by order of the Society to Sir Philiberto Vernatti, Resident in Batavia, was

one inquiring whether diamonds grow again after three or four years in the same places where they have been dug out. The answer sent back was, "Never, or at least as the memory of man can remember."

The most generally accepted theory is that diamonds are a form of carbon produced by heat and pressure, but how Nature obtained the carbon, held it inert from its affinities, and subjected it to the necessary forces, still keeps scientists guessing. The fact that some diamonds taken from the African mines burst as artificial ones do is accepted as evidence that they were formed under great pressure. Diamonds in different mines have different forms of crystals, and properties, therefore, must have been formed under different conditions.

Liebig, Dana and others concluded that diamond is the product of the gradual decay of organic matter under influences at present unknown. The theory advanced by Professor Carvill Lewis, that the carbon was derived from carbonaceous shales decomposed by the action of an igneous magma forced through them by volcanic action, is considered disproved by the fact that there are no carbonaceous shales in the pipes near Pretoria though they contain many diamonds. Such shales do overlay the lower strata surrounding most diamond pipes and, as the volcanic filling of the Pretoria pipes may have come from foreign sources, the theory is tenable.

Some have thought that diamonds may have been formed from anthracite coal, possibly without passing from a solid state. Several eminent men advocated the theory that pure

carbon was separated by electricity from carbonic acid surrounded by reducing agents. Other chemists have thought that diamonds may have been formed by the gradual decomposition of gaseous hydrocarbons, whereby the hydrogen, escaping through fissures, was converted into water by oxidation, part of the carbon was converted into carbonic acid and the remaining carbon was left crystallized in a free state. It is said black diamond was obtained by Rousseau by subjecting acetylene to electric furnace heat.

It is reported that Dr. Burton of Cambridge has succeeded in crystallizing carbon by means which do not include very high temperature and great pressure. His method is founded on the idea that diamonds are simply a denser form of charcoal. He used an alloy of lead and metallic calcium to hold charcoal in solution. To separate the calcium he introduced steam into the fused mass, whereby part of the carbon crystallized. It is said that if the alloy is in a state of ignition when the steam is introduced, graphite crystals are formed; but at a lower temperature, diamond crystals. The crystals obtained by Dr. Burton are said to possess an unusually high power of refraction. These experiments have strengthened the belief of some that Nature used some solvent for carbon, as yet unknown, which by evaporation left part of the carbon in the crystallized form, as the crystals of other minerals are.

"It has been said that the sharp edges of the diamond crystals found in the Kimberlite would be impossible had they been formed in a molten mass but as Moissan produced such diamond crystals, though small, from charcoal

confined in fused iron, and diamond will not burn without a free supply of oxygen, the argument appears invalid." [1]

It is noticeable that all diamond fields of importance are within 30° north or south of the equator. They are situated, therefore, where vegetation is or has been extremely luxurious.

It seems evident that the chimneys of the South African diamond fields were not vents of sudden, local, igneous volcanic eruption. The crater formation seems to be absent, and there seems to be no overflow of scattered ashes and lava about the mouth of any one of them. The plateau has apparently been raised to, or a little above, the surface of the surrounding land by a series of uplifts. From the nature of these conditions of the surrounding reef it would seem that dykes were not made by a volcanic eruption.

What is the natural origin, no one can say with any positive assurance; apparently diamonds were fused in the earth from iron or from silicon rocks under great heat and pressure, but that happened so long ago that no trace remains of the process by which they were formed.

"A natural solvent for carbon with sufficient heat to cause the necessary chemical reaction, and pressure, is probably Nature's method of crystallizing carbon." [2]

Diamonds are most often found in alluvial soil; sand and gravel along the beds of streams or on the dried shores of old seas where they were deposited after rains washed them out of the hills, in which they first appeared.

It is a well known fact that in all of the South African

[1] Cartell, W. R., *The Diamond*, p. 383.
[2] Cartell, W. R., *Ibid.*, p. 389.

diamond mines there is a gradual decrease in the yield of diamonds as the mines become deeper. There is no exception to this rule, and it can only be accounted for by the carbon supply in the original magma giving out, or by the conditions in the magma under which the carbon could crystallize into diamond becoming such that crystallization does not take place. The yield per load of sixteen cubic feet of blue ground from the surface workings of Kimberley mine was 1.33 carats, while that of the blue ground on the 3,520 foot level was .30 of a carat. What is true of the Kimberley mine is true of all other mines.

For years there has been a feeling among river diggers and expert diamond sorters that there is a difference between diamonds produced from mines and diamonds recovered from the alluvial diggers. With the exception of the worn surface of some alluvial diamonds Alpheus F. Williams has never been able to see this difference.

The geological studies made on the different rocks in which crystalline carbon is found establish indisputably that the diamond is not a vein mineral. No crystal has been found on a rock which serves as its support. Sometimes diamonds are found in alluvial sands, sometimes in soft conglomerates or in a serpentine breccia.

Lewis and Randall[1] assume that if diamonds were formed in nature under conditions in which they represent the stable form of carbon they must have been produced at least fifteen miles below the surface of the earth.

The theory that the diamonds must have crystallized in

[1] Lewis and Randall, *Therm. Dyn.*, p. 571.

a matrix of iron or "blue ground" is not a new one. That diamonds have been produced in this way there is no doubt, especially since small diamonds have been found in meteorites. However, Gardner F. Williams, who spent twenty years as a scientist in the South African diamond mines and was general manager of the De Beers Consolidate Mines, says, "I am positive that the iron found with the diamonds is not the original matrix of the diamond. My assurance rests upon the fact that no diamonds, however small, have been found in the combination, although these concentrates have passed daily under the eyes of hundreds of keen-eyed sorters for more than thirty years, and thousands upon thousands of the tons have been looked over, not once but at least four times. We must, therefore, look to other sources for the genesis of the diamond. I have been of the opinion that diamonds crystallized in very much the same way as quartz or other minerals, but under peculiar circumstances possibly of pressure and heat."

My belief is that in some unknown manner carbon, which existed very deep in the internal regions of the earth, was changed from its black appearance to the most beautiful gem ever seen by man; this was no doubt due to high temperature and pressure.

As a gem mineral the diamond is in so many ways an unusual substance that we are fully justified in considering it as standing alone among the gems, in a class apart. Diamond is composed of a single element, carbon. Thus it is chemically the simplest of all gems.

CHAPTER TWO

SUPERSTITIONS AND RELIGIOUS USES OF THE PRECIOUS STONES

From the earliest times in the history of man gems and precious stones have been held in great esteem. They have been found in the monuments of prehistoric peoples —the Pharaohs, the Incas and the Montezumas put into these brilliant things from Nature's jewel casket a significance beyond mere suggestion of their intrinsic properties.

The people of East India called the rock-crystal an unripe diamond, and the real jewel a ripe diamond. Their notion evidently was that it was a vegetable. In parts of Europe, during the Middle Ages, it was classed as an animal.

Early sages were firm believers in the immunizing influence of gems; they thought that the evil in the world could be kept from contaminating a child if he were properly protected by wearing the appropriate gems. Indeed, folklorists are wont to wonder whether the custom of wearing gems in jewelry did not originate in the talismanic idea instead of in the idea of mere additional adornment.

In a poem addressed to Marguerite de Valois by Jean de la Taille de Bondaroy[1] we read of a diamond which came from gold and from the sun. But we are told that not only are precious stones endowed with life, they are also subjected to disease, old age, and death; "they even take offense if an injury be done to them, and become rough and pale." The sickness of the pearl has been a theme for centuries, and in many cases is only fancied. It is but a subterfuge or deception for a lady to remark that her pearls have sickened; by referring to this sickness, her friends are naturally led to believe that one time they were fine, perfect pearls, when in reality they may never have been so. It is supposed in the East that a living spirit dwells within these stones, a spirit potent for good.

Like all the precious stones, the diamond was accredited with many marvelous virtues; among which were the powers of averting insanity and rendering poison harmless; and in the Middle Ages it was known as the peacemaker between husband and wife.

Of the birthstones, the diamond is awarded to April and is said to typify purity and to preserve peace. Undoubtedly it has preserved peace under many threatening conditions as motives are to be found hiding somewhere behind every superstition.

Time was when owners of jewels rejoiced not only in their beauty and their value, but likewise in their influence upon the physical and moral nature of man. The diamond protected young ladies from the visits of those extremely

[1] Jean de La Taille de Bondaroy, "*Le blason de la Marguerite*", Paris, 1754.

malicious nocturnal visitors called incubes so the ladies adopted the fashion of always removing the rings before retiring to rest. Men derived courage from wearing diamonds. Rubies were deemed a specific remedy against the plague. Amethyst enabled a man to drink his fill without getting drunk. An emerald, if exposed to the view of a false witness, would fill him with confusion and check the flow of his perjury. A sapphire was invaluable to persons who desired to win the favor of princes. So on throughout the list. Each stone had its specific virtue.

According to Garcias ab Orta (1563), the diamond was not used for medicinal purposes in India of his time, except when injected into the bladder to break up vesical calculi. He notes, however, the belief that diamonds or diamond dust, when taken internally, worked as a poison. As a proof of the falsity of this belief, Garcias adduces the fact that the slaves who worked in the diamond mines often swallowed diamonds to conceal them and never experienced any ill effects, the stones being recovered in a natural way. The same author notes the case of a man who suffered from chronic dysentery and whose wife had for a long time administered to him doses of diamond dust. While this did not help him, neither did it injure him; finally, by the advice of doctors, this strange treatment was abandoned. The man eventually died of his disease, but not until many days after the doses of diamond dust had been discontinued.[1]

The idea that diamonds or diamond dust had deadly

[1] Kunz, G. F., *The Curious Lore of Precious Stones*, p. 153.

effects when swallowed has very little, if any, confirmation, since many miners in the South African fields have, without ill effects, swallowed diamonds with the hope of escaping with them. A Mohammedan legend represents the different heavens as composed of precious stones of different types, and in the Middle Ages the religious ideas became interwoven with a host of astrological, alchemistic and medical superstition.

Of the many medicinal virtues attributed to the diamond, one of the most noteworthy is that of an antidote for poisons. The diamond was also believed to afford protection from plague or pestilence, and a proof of its powers in this direction was found in the fact that the plague first attacked the poorer classes, sparing the rich who could afford to adorn themselves with diamonds; in other words, it was thought that diamonds would be a protection to keep the plagues away.

During the Middle Ages and even down to the seventeenth century, the virtues of the precious stones were believed in by high and low, by princes and peasants, by the learned as well as by the ignorant.

A Persian legend of the origin of diamonds and precious stones shows that in the East these beautiful objects were looked upon as the source of much sin and sorrow. We are told that when God created the world he made no useless things such as gold, silver, diamonds and other precious stones; but Satan, who is always eager to bring evil among men, kept a close watch to spy out the appetites and passions of the human mind. To his great satisfaction he noted

that Eve passionately loved the many colored flowers that decked the Garden of Eden; he therefore undertook to imitate their brightness and color out of earth, and in this way produced colored precious stones and diamonds. These in after time so strongly appealed to the greed and covetness of mankind that they have been the cause of much crime and wretchedness.[1]

In olden days there was widespread belief in the significance of the color of precious stones; the yellow stones were especially effective in the case of jaundice; the red stones were endowed with the power of checking the flow of blood, the so-called bloodstone was especially prescribed for this use, and was supposed by its mere touch to stop the most violent hemorrhage; and green was regarded the most beneficial color for the sight. Diamond with its superior qualities was looked upon as the gem of the sun.

The poor natives of India believe to this day in the efficacy of sapphires and ruby in purifying the blood, strengthening the body, quenching thirst, dispelling melancholy, averting danger and assuring honor and fortune.

The influence exerted by precious stones was assumed in medieval times without question, but when the spirit of investigation was aroused in the Renaissance period, an effort was made to find a reason of some sort for the traditional beliefs.

The mystery which surrounds the diamond is emphasized even in the etymology of the word itself already explained in the first chapter. Although the word is found in

[1] Kunz, G. F., *Ibid.*, p. 25.

the Greek records, the substance itself was unknown in Europe until comparatively recent times. Mention is not made of it by the Greeks until about 300 B.C., though Hindu legends disclose a knowledge of it centuries earlier. When dealers advertise today they appeal chiefly to the commercial instinct. In the old days appeals were made to superstition.

The use of stones for the decoration of images of the gods and in religious ceremonies, more especially in those connected with the burial of the dead, can be traced back to a remote antiquity. While this employment of mineral substances for religious purposes is practically universal, the earliest recorded instances come from Egypt. Precious stones have been used everywhere as especially appropriate offerings at the shrine of a divinity, for the worshipper naturally thought that what was most valuable and beautiful in his eyes must also be most pleasing to the divinity he worshiped.

According to Charles William King the first undoubted application of the name to the diamond is found in Manilius, A.D. 16; and Pliny, A.D. 100, speaks of the rarity of the stone—"The most valuable of gems, known only to Kings." The "diamond" in the breastplate of the high priest, Exodus XXXIX, 11, was probably some other stone, for it bore the name of a tribe, and methods of engraving the true diamond cannot have been known so early. The stone can hardly have become familiar to the Romans until introduced from India, where it was probably found at a very early period.

Later Roman authors mentioned various rivers in India as yielding the Adamas among the sands. The name Adamas became corrupted into the forms adamant, diamant, and diamond. The same word was also applied to lodestone.

The Bible makes few references to diamonds. The third stone of the second row in the Jewish High Priest's breastplate, according to Biblical translation, was a diamond, and in common with the others had the name of a tribe of Israel engraved upon it. Some Hebrew schools think the name of this stone was a diamond and others think it stood for agate. It is possible that the diamond was intended though the one used may have been another, but similar stone, as the ancients undoubtedly confused different colorless transparent stones with the diamond. The supposed diamond might have been white zircon, topaz or rock crystal. If the stone was really diamond, the art of engraving diamonds must be one of those ancient arts which were later lost, for conclusive evidence does not exist of engraved diamonds earlier than the sixteenth century.

We find the most important enumeration of the precious stones known to the ancient Hebrews in Exodus XXVIII, 17-20. This catalog is repeated in the book, Chapter XXXIX, 10-13. The same list is found, with the exception of three precious stones, the gems worn by the high priest on his breastplate, in the citation of royal ornaments worn by the King of Tyre, Ezekiel XXVIII, 13.

The diamond mentioned in Exodus is also mentioned by prophets, Jeremiah and Ezekiel. Many scholars, however,

are not satisfied with the translation, and say that the words rendered diamond really signify a stone hard to break, or a stone used in breaking others. It is considered very doubtful if the diamond was really known in the time of Moses.

If the poet exclaims: "The woods were God's first temples," how truly may we also say, "The stones were man's first tablets!" If the geologist tells us of "Sermons in stones", we think that these sparkling jewels have "sermons" also. This is especially true of the lost stones. There we touch upon the tenderest point in the feelings of the student of history. That which is lost always seems to us of far more priceless value than that which we have retained. The lost Iliad, the lost "Fairie Queen," how tenderly does the bibliophile picture to himself what might have been their golden contents! How gladly would we have seen that fair ruby, "great like a rocketball," which Queen Elizabeth showed in her cabinet to the Ambassador of Mary Stuart when the latter with some assurance "Desired she would either send it to my queen, or the Earl of Leicester's Picture." She replied: "If Queen Mary would follow her counsel she would get them both in time, and all she had, but she would send her a diamond as a token by me".

The names of the precious stones and semi-precious stones are frequently used as adjectives and when so employed convey something more to the mind than to the corresponding adjectives of color. We may suggest the following expressions:—the "Emerald Isle" and "emerald

meadows"; "sapphire seas" and "sapphire eyes"; "ruby wine" and "ruby lips" and "coral ears"; "pearly teeth" and "pearly skin"; amethystine locks" and, in Roman times, "amber hair".

The "enormous pearls" which encircle the throat of Mary of Orange in one of her portraits have long since faded from mortal sight with others of her jewels, save for the page or canvas which still preserves to our view. The unfortunate James the Second and his queen carried with them in their flight from England a number of valuable belongings to the royal collection. One of these, a historic ring of great interest, was pathetically restored to King George of England by James's grandson, Cardinal York, sometimes known as Henry Ninth, from Rome; where the exiled Stuarts found their last resting place. One even feels a painful thrill by reading that the magnificent crown prepared for the coronation of Queen Victoria was enrided from older crowns, so great is one's fear lest some priceless footstep of the past may have been lost in the transfer. The care with which the really ancient regalia of England have been preserved, however, and their almost sacred value, rebuke the doubt.

"Here stand these great historic gems, however, preserved through all the ages, for, if we count their geological birth, they are indeed immemorial, and linking the grandmother past to the infant future with clasp of undying brilliancy. It seems to me that their intrinsic value forms the least part of their real worth, as in the case of coins, medals, etc. And if we speak of their age, shall we not call

these treasures immemorial, as we ponder upon the eons of repose which they enjoyed in their prehistoric cradle, the bosom of old mother earth, rocked by her convulsions and lulled by her deluges, with earthquakes for a lullaby and eternity for a lifetime? To speak of more trifling matters, even the early laces, china, etc., which it is now the fashion to rescue from oblivion and somewhat ostentatiously display, have their value as historical records and indications. Believing as I do, that the background of history forms a most important part of all present truth, I handle these portraits of the great originals with the deepest invicissitudes with a student's reverence."[1]

The preciousness of diamonds has long made their theft one of the most frequent motifs in mystery or "detective" fiction; almost any one can cite examples. But probably one of the most striking of all stories of the general type is *The Diamond Lens* by Fitz-O'Brien (1858). After a history of theft and murder a beautiful one hundred forty carat diamond, the Eye of Morning, is submitted to an "electromagnetic current" for a long time in order that its atoms may be indefinably rearranged. It is then by drilling and cutting made into the lens of a wonderful microscope so powerful that its pseudo-scientist owner discovers a whole new world in a drop of water and falls in love with a marvelously beautiful woman who lives in that world.

A glance at any book of literary quotations—Bartlett's, for example—will disclose that the diamond, and other precious stones are used frequently and effectively in liter-

[1] Anagnos, J. R., A brief account of the most celebrated diamonds, p. 7.

ary figures of speech. There is poetry for all the stages of man's life—childhood, maturity, decline—and the diamond is in them all. Probably the first poetry in your own childhood, as in mine, was:

"Twinkle, twinkle, little star
How I wonder what you are,
Up above the world so high
Like a diamond in the sky."
(Taylor)

Spencer, in his search of heaven and earth for something with which to compare the eyes of chaste beauty, passes the diamond thus, "Nor to the diamond; for they are more tender." But Moore, when he sings of charms so ensnaring that even knowledge of the charmer's faithlessness could not prevail against their potency, enumerates among them:

"Those eyes of hers, that floating, shine
Like diamonds in some eastern river."

Lowell "Strewed moss and grass with diamonds bright," and one of Moore's angels, telling in his story of a maiden of Earth, says:

"While playfully around her breaking
The waters that like diamonds shone,
She moved in light of her own making."

Shelley, too, saw:

"Many a fountain, rivulet and pond,
As clear as elemental diamond."

Moore illustrates the wisdom of pleasure in a line thus: "The diamond sleeps within the mine." And of the complaint of grief an old writer says:

"Such were the accents as might wound,
And tear a diamond rock in twaine."

The ambitious student and the aspiring business man will do well to remember that

"Sense is the diamond, weighty, solid, sound;
When cut by unit, it casts a brighter beam;
Yet, wit apart, it is a diamond still."
(Young)

As man's journey through life brings him closer and closer to his long home, he looks out and sees

"Twilight's curtain gathering far
Pinned with a single diamond star."
(Clark)

CHAPTER THREE

INDIAN DIAMONDS

As far as we know diamonds were first found in Central India. It is not known when diamonds were first mined in India. There is no evidence that Arabia ever produced any diamonds. Topaz occurred there, and white topaz was probably thought by the ancients to be a kind of diamond. It is quite possible that the Phoenicians in their day tricked the world as the Portuguese did later with the diamonds from Brazil.

India, the land of gems, gave us the first diamonds known to commerce. They were found in various parts of Hindustan, Africa and in some of the Indian Islands, above all, in the territory of the Nizam, sometimes called Golconda, after a powerful fortress. A Sultan of this country died, in the time of the Crusades, bequeathing 400 pounds weight of diamonds to his successor. This little legacy, assuming all the stones to have been small, and if, as is probable, many of the gems exceeded one and two carats in weight, would have been worth approximately $42,000,000.

Over two centuries ago diamonds were found in Brazil;

and for nearly a century almost all the new diamonds have come from there. Most of the Indian diamond mines, as well as those of Egypt and Borneo, long ago ceased their yield. In Golconda diamonds were found by treading the earth—a soft carboniferous loam—with the naked feet.

Tradition tells that the diamond was worn as a jewel in India 5,000 years ago. The Bible establishes its existence as a graver nearly 3,000 years back. The poets and historians of Greece and Rome over 2,000 years ago informed us that India was the source of it. The diamond mining industry in India is therefore certainly 3,000 years old, and one may reasonably think that it is twice that old. The diamond was a local jewel. The reports of early European travelers do not indicate that diamonds were preeminent among the jewels of India. The diamond, before it was polished and cut, was not considered very much. It was mounted as a natural crystal, and when mounted, though a wonder stone, it was a clumsy crystal.

Diamond mines of India were simply diggings here and there in a gravel deposit which, to the initiated, had the earmarks of diamonds. Sometimes it lay on the surface, sometimes in the beds of streams, and at others, under a valueless covering of some other kind of earth anywhere from two to twenty feet thick. Most of the so-called Indian diamond mines have been abandoned entirely.

Previous to the discovery of the Brazilian mines in 1725 diamonds were found chiefly in India and Borneo. The early diamond-mining industry gave employment to a large number of people, but, owing to the gradual exhaustion of

the deposits and the crude methods of working, it has steadily declined. The diamond mines of Borneo, which supply about 3,000 carats annually, are located in the western part of the island.

Peninsular India was the early known source of diamonds for about twelve hundred years. About 600 A.D. diamonds were discovered in Borneo.

"A diamond[1] of 367 carats, celebrated for the superior quality of its stone, was found at Laudak (Borneo) and is said to be still in the hands of the chief of Pontiana. This stone is shaped like an egg with an indented hollow in the smaller end, and should be worth at least 3,500,000 dollars. One is glad to think of at least one of the great eastern diamonds being preserved by a native chief, since so many of their brilliant treasures have gone to grace the aliens."

Diamond is many times more rare than gold. If gold occurs one part in 250,000, it can scarcely be worked with profit, while the diamond can be worked to advantage when found only one part in 10,000,000.

In 1905 India reported 3,095 carats, valued at 5,160 pounds sterling. Only a hundred carats a year now come from the Indian mines, which contributed twelve million carats to the world during its twenty centuries of life.

Diamonds of large size have always been extremely rare even in India itself. Travinier asserts as late as 1550 that the largest diamond ever found weighed only from ten to twelve carats. This last statement as to size seems to be questioned.

[1] Anagnos, J. R., *A Brief Account of the Most Celebrated Diamonds*, p. 25.

Most of the Indian mines, at that time, were located in the Kingdom of Golconda, which has ceased to exist. Rough diamonds were sent to the capital city of Golconda (now in ruins) to be cut.

In India, where diamonds were first found and where more diamonds are bought at retail today than in any other nation except the United States, the art of polishing the diamonds' natural faces by rubbing them together was practiced as early as the sixteenth century, at Golconda, the market place for the mining country. Spreading into Europe in the wake of the medieval jewel trade, this simple art grew more and more complicated as the taste of Europe's kings (who bought most of the diamonds) grew more and more artificial. Because Holland was free of the religious oppressions that stifled most European commerce, the trade of cutting diamonds settled in Amsterdam around 1600 and flourished there for the next three centuries.

The mines of Golconda and Kurnoor (India) were described as early as 1677 in the twelfth volume of Philosophical Transactions of the Royal Society.

The Panna fields are supposed to be among the oldest of the Indian diamond mines. As far as is known, the district has never yielded as fine stones as the others but it has been prolific, and operations have been carried on with more or less vigor constantly to the early part of the twentieth century. The entire output of India today is insignificant. The production of India for the year 1905 was 172.4 carats and for 1906, 305.9 carats, the increase being chiefly from the Panna mines.

In recent years, India, the land of gems, which for centuries has glistened in the imagination of the world, has a bit of the earth where the rocks are studded with jewels and the sands become starred with diamonds as the miner turns them to the tropical sun, imports more diamonds in a year and of greater value than all the gems of every kind which she produces.

Until Mohammedan invasions about the first part of the eleventh century the native princes of India held all the best of the yield of the diamond mines, but from that time they were periodically plundered by foreign powers and a large part of the store of centuries was carried off, until the invaders established dynasties within the country, when they began to accumulate precious stones for themselves as their despoiled predecessors had done before them. Mohammed founded the Mohammedan rule there, and it is said, had accumulated about 400 pounds of diamonds by the time he was assassinated in 1206.

The mines of India in modern times have been made by excavations of shallow pits and sluicing, sifting and sorting by hand labor, the only machinery used being chain pumps made of earthern bowls to remove the water from the deeper pits. India was no doubt the source of all the large stones of antiquity; a stone of 210½ carats was found in 1809, and one of 67⅜ carats in 1881.

At present few diamonds are found in India except where the rivers wash them from their places of concealment and carry them to light and the eye of man. Nor is it strange, for the diamondiferous strata are thin deposits and scat-

tered. A few inches to a few feet thick at the most; sometimes near the surface, sometimes twenty or thirty feet under it; nothing to betray them except where they themselves appear on the surface, thousands might look long and far and not find them. As the ancient mines became exhausted, India as the land of diamonds was eclipsed by Brazil and now fades to a memory before the rising sun of Africa.

CHAPTER FOUR

BRAZILIAN DIAMONDS

Diamonds were discovered in Brazil in 1725. The Brazilian diamonds like those of India occurred in gravels and conglomerates, and much of the later mining operations to recover them have taken the form of dredging the river beds and washing down the gravel deposits by water under pressure (hydraulic mining).

In Brazil the earth, which is gravelly, is washed in troughs, much after the method of the early California gold hunters; and the diamonds, if any, are found among other pebbles at the bottom of the trough. Such a system is very severe upon the sight of the workers; children are always the best washers, and a worker's eyes cannot usually be trusted for this fine work after he has reached the age of twenty-five years. If magnifying glasses were used to find the diamonds in the sand much time would be saved and there would be less loss.

It is during the process of sifting that most robberies are effected. Few workers swallow the diamond, not because it is considered poisonous, as by the Hindu, but because of the difficulty of doing so unobserved. The civilized thief

pretends to be short-sighted, and picks up the plunder with his tongue-tip. (In India, before the mines had become exhausted, the miner jerked the stone into his mouth or stuck it into the corner of his eye; twelve to fifteen overseers were required per gang of fifty light-fingered men.)

Diamonds were first discovered in Brazil by natives while washing sand for gold. The government's first move was to order the entire gold mining population to move out of the area, and mining rights were placed in the hands of a few favored planters who used slave labor. This lasted about ten years, during which time it is said that many a diamond was taken from the region, unknown to the government, by ex-gold miners who resented their high-handed treatment. In 1740 a new system of mining was started, whereby a contractor, employing about six hundred slaves, was allowed the sole mining rights for a period of three to five years. He paid the government so much per slave and sold most of his diamonds to the crown. This must have been a paying proposition, for we hear tales of the contractors building magnificent estates and maintaining large staffs of personal slaves and concubines.

Brazilian diamonds were not well received in Europe at first. Owners of Indian stones, fearful that their value would suffer, spread stories that the Brazilian product was soft and of inferior grade. This the Portuguese traders cleverly eluded by sending the stones first to Goa, reshipping them to Europe as Indian diamonds, and breaking the news gradually to European buyers. Brazilian gem diamonds are today highly prized among jewelers for their

excellence of crystallization and for their purity of color.

Later, when diamonds were found in Brazil they were carefully packed in cases and shipped to Paris or Amsterdam. At the time they were discovered here, Brazil was a rough, undeveloped Portuguese province. The Portuguese crown took immediate steps to assume control of the fields.

The discovery was made in the neighborhood of Tejuco, a town about three miles north of Rio de Janeiro and about two hundred and fifty miles west of the Atlantic Ocean.

The contract system was abandoned in 1772, and for more than fifty years the government itself operated the mines very ineffectively and at high cost. The diamonds were sent in to Diamantina once a month, thence to Rio de Janeiro once a year. The latter shipments were always sent under military escort in a box with three locks, the keys for which were sent by three separate messengers.

The work was mostly done by negro slaves who occupied long sheds with troughs on each side. Upon elevated seats sat overseers who watched the men and received the diamonds when found. When a slave found a diamond he raised his right hand and shouted; the overseer approached him, received the diamond and rewarded him. If the diamond was over 17 carats in weight the lucky finder received his freedom, was crowned with flowers and was allowed to look for diamonds thereafter for his own benefit. For gems of lesser weight lesser rewards were given.

Innumerable precautions were taken to prevent thefts by the workmen. The men were stripped before they left the shed and left their working-clothes in the hands of the

overseers. On the least suspicion attached to a man he was vigorously purged. His mouth was examined, and his whole naked body underwent a survey by men skilled in detecting strange hiding places for diamonds. Similar precautions were adapted in India with regard to visitors who went to see the diamond mines. They were such that no female was likely to visit them twice. For all this it was believed that fine diamonds were constantly stolen by the Brazilian slaves, and no doubt their Indian brethren were equally dexterous in stealing.

Meanwhile, the Portuguese crown jewels had grown to be a fabulously rich collection. No accurate estimate could be placed on its tremendous value, for the secret was jealously guarded. But this was not to last. In 1822, among the wave of revolutions sweeping South America, Brazil was reborn an independent empire, and a republic was established in 1889. Now mining is done by any one who can afford to pay the taxes set by the republican government.

In 1850 the Brazilian mines were at their height. Slavery was still in vogue; men and women alike, black and white, worked under their master's lash. It is interesting to note that rewards were occasionally given out to these wretched people for finding a large diamond and surrendering it promptly to the landowner. For a stone eight to ten carats, the prize consisted of a new suit of clothes, a hat and a knife. The fortunate slave no longer clapped his hands in the old style of signal. He might receive his freedom after finding a stone weighing more than an oitava and a half;

not by law, however, but in order to encourage the other laborers.

In the year 1733 rough diamonds were not worth twenty shillings per carat. In the year 1735 they were not worth thirty shillings; the year 1742 not more than thirty shillings. All of which may clearly be made to appear from public sales in the above mentioned years. The above cheapness may have been due to the fact that the Portugal King was deeply in debt to other European countries and the Brazilian diamonds were sold at public sale to pay off part of this debt.

An American author, writing of the Brazilian fields in 1856, said that the unhealthful climate had taken toll of a hundred thousand lives since the discovery of the mines. Food and supplies were brought inland by traders and sold at a profit of 500 to 800 per cent over the prices prevailing in Rio de Janeiro. "Racketeering", it seems, is by no means a modern idea.

Diamonds of large size are seldom found in Brazil. Few have been found worthy of mention when compared with the numerous large crystals of Africa. The largest on record weighed 254 carats or about one-twelfth of the weight of the Cullinan and a little over one-fourth the size of Excelsior. Most of the diamonds run from ¼ to ½ carat.

It is said that in 1838 the diamond was used by the Indians as playthings for their children. As Brazil borrowed her gold mining through Portugal from the Romans, so she has taken her system of diamond washing from Hindustan.

It was related by Dr. Beke, in a paper read at a meeting of the British Association, that a Brazilian slave, seeking for diamonds in the river, broke with his iron bar through a crust of silicious material, cemented together by oxide of iron, in which he discovered a bed of diamonds which were afterwards sold for 1,500,000 dollars. This immense quantity, being carried to England, so overstocked the market that few of the English houses were able to stand up against it.

In the latter half of the eighteenth century new discoveries extended the Brazilian fields gradually from Diamantina (this place was formerly called Tejuco) northward into the province of Bahai, westward into Goyaz and finally into the jungle province of Matto Grasso, almost to the Bolivian frontier. The district is an exceedingly rough plateau at an elevation of about 4,000 feet above sea level, cut up by gorges and deep valleys, enclosed by abrupt mountain walls. In all these fields the diamonds, as in India, are found in the beds of present streams or in solid rocks formed by the compression of very ancient river-sands. Here again, geologists have had little success in tracing the stones to their source.

Here the season is in January when the rains have ceased, and the rivers run clear. The diamantine earth is carried into an enclosure surrounded by a wall from a foot to two feet high, with little drains at the foot. The washing here begins with the rains about November. The material is washed in troughs with water from a shovel. The contents are then stirred with the fingers of the washer to relieve the

mass of the worthless earth, dust and clay, until the water runs clear, and this washing may be repeated. In this way a pocket full of diamonds may sometimes but very rarely be found.

The miners use diving machines, probably movable caissons, in which a man can work for several hours on the river bottom. Under cover of one of these, two men work alternately, it is said, in three-hour shifts, gathering the cascalho into sacks lowered to them from the surface. Others dive for the cascalho much the same as the pearl divers dive on the pearl banks, gathering as much of the gravel as they can during the submergence. In the shallows, others drag the gravel into the mouths of sacks with their feet. The diamantiferous material is found not only in the beds of the streams and rivers, but also in fissures and gullies in the rocks which band the valleys of the watercourses, as in the other Brazilian fields. The sands and gravels are gathered from the beds of the streams in dry seasons, and from fissures and beds in the rocks during the wet seasons. The richest finds are made usually in pot-holes in the river beds.

The tools and methods used in the mining are crude, and some think that with capital and machinery better results could be obtained, but it is doubtful if it would be as profitable on the average. Undoubtedly there are great deposits of diamantiferous material yet unworked, and there are doubtless rich gravels in the sections already worked which cannot be reached with the appliances now in use, as for instance the lower parts of the deposits in

gullies and fissures in the rocks, river bottoms which have been covered by debris from washings on the streams above, and the like; but with deposits of uncertain richness, which may be here or may be there over square miles of very rough country, the odds seem to be largely against adequate returns for an expensive equipment.

The general character of the Brazilian diamond field indicates a wide upheaval of the basic granite rock leaving a very rough and broken surface full of huge gullies and fissures. In these fissures, and in the basins or depressions in the granite, are deposits of disintegrated material forming substances and conglomerates of varying hardness in which diamonds occur. The indications are that during a period of disruption the material was exuded from the interior of the earth.

What is commonly called the first water in diamonds means the greatest purity and perfection and must be a drop of the clearest rock water. When one speaks of a diamond falling short, more or less of that perfection, it is expressed by saying it is of the second or third water, etc., until a stone may properly be called a colored one.

Authorities conflict regarding the output of the Brazilian mines in the early years after their discovery. Up to 1740 estimates of the yearly production varied from 20,000 to 144,000 carats. From 1740 to 1772 the official reports gave an average production of about 52,000 carats per year. In round figures, the production from 1740 to 1772, 1,700,000 carats; and from 1772 to 1818, 1,300,000 carats. In all up to 1818, 3,240,000 carats; and up to 1850

a little over 10,000,000 carats. Since the discovery of diamonds in Africa, from 1870 to the present, it is doubtful if the entire Brazilian diamond and carbon output much exceeded a yearly average of 100,000 carats.

Today, after producing sixteen million carats, the Brazilian mines have declined, being eclipsed by the great African fields and by natural exhaustion. The production is about 20,000 carats per year. Nearly all of these are carbonado, or black diamonds, most of which come from Bahia. This state is the only spot in the world where black diamonds are found.

The most valuable diamond, "Southern Star", found in 1854, weighed 254 carats in the rough and 124 carats after it was cut. The "Southern Star" had impressions upon its faces when it was found which appeared to have been made by other diamonds so that the whole was probably a group of diamond crystals. Massive diamonds have been found in Brazil in the form of pebbles.

India and Brazil are interesting only as historical fields. The capital of the diamond empire is on the "dark continent". In the last sixty-five years, the Union of South Africa has produced a hundred and eighty-five million carats—three-quarters of all the diamonds owned by the human race.

CHAPTER FIVE

SOUTH AFRICAN DIAMONDS

THE MOST IMPORTANT places for diamonds have been: (1), in India where they were mined from the earliest times till the close of the nineteenth century; (2), South America, where they have been mined since the middle of the eighteenth century; (3), South Africa, to which almost the whole of the diamond mining industry has been transferred since 1870.

North Africa is a desert, Central Africa is a jungle and South Africa is one great mine. In a good year, such as 1929, South Africa can export some 440,000,000 dollars worth of goods. Of that, around 240,000,000 dollars come from gold and other minerals, 50,000,000 dollars from a single hard, white glistening gem—the diamond. Gold is a familiar metal found in many places. It has stood so long for money, a medium of exchange, that it belongs rather to the world than to any nation. But diamonds are the purest of all luxuries.

The first discovery of diamonds in South Africa was made in 1867 by Dr. W. G. Atherstone who identified as a diamond a pebble found by a child on a farm on the

southern banks of the Orange River. What led to this discovery by this child? One of the children of a Boer farmer named Daniel Jacobs, while playing outside of her home one day with her dolls, found a shining pebble. She unconsciously brought to the notice of the world the fact that such inexhaustible riches were to be had in Africa. To her childish mind this pebble (diamond) could become the kerosene lamp for doll's house, owing to its bearing some resemblance to the lamp in the sitting room, which her mother used only on special occasions.

This pebble, which was of a striking beauty, was proudly displayed in the home to visitors. Chalk Van Nierkerk, from a neighboring farm, was visiting this home some time later. The doll's lamp was shown him and it interested him very much. He wanted it and offered to buy it. Mrs. Jacobs would not think of selling it but a deal was made whereby he gave, in exchange for the pebble, a tiny lamp carved out of wood. Thus the pebble changed hands and by doing this simple act of generosity Mrs. Jacobs changed the whole course of South Africa.

Van Nierkerk laid it away in the cupboard for several weeks and later threw it out in some trash, but later recovered it in order to show it to a traveling trader named O'Reilly who later sent it to a mineralogist, Dr. Guiban Atherstone, who found it to be a genuine diamond weighing over 21 carats. It was immediately purchased for $2,500 by the governor of Cape Colony after which Van Nierkerk paid over to the little girl who first found it one-half of the

proceeds. This diamond was displayed in the Paris Exhibition of that year.

After Van Nierkerk sold the diamond first found by the little girl he was on the lookout for strange pebbles. Within a short time, 1869, a shepherd showed him a stone weighing 83½ carats that was found near the Orange River. He promptly bought it from the shepherd boy for the sum of 500 sheep, 10 oxen, and one horse. This stone was sold for the enormous sum of eleven thousand two hundred pounds sterling in Hopetown, and later the Earl of Dudley bought it for twenty-five thousand pounds sterling and it became famous as the "Star of South Africa". The news of this great find caused a rush of prospectors, and discoveries were made over an extensive area.

The finding of this diamond drew many to this place where numerous smaller ones were found in the alluvial gravel on the banks of the Vaal. Alluvial deposits form the surface ground on both sides of the river, stretching inward for several miles. In some places the turns of the stream are frequent and abrupt, and there are many dry water courses which are probably old river channels. The flooding and winding of the river partly accounts for the wide spreading of the deposits, but there has been a great abrasion of the surface of the land, for the water worn gravel sometimes covers even the tops of the ridges along the course of the river.

The valuable diggings lie within a limited circuit of three and one-half miles diameter. The Kimberley and DeBeer

mines are one mile apart and the Bultfontein and DuToit's Pan less than a quarter of a mile apart.

This second find, "Star of South Africa", created such a sensation that it drew the attention of the world to South Africa and soon fortune hunters were flocking there from all quarters of the globe. In the midst of the quiet Boer farms there sprang up small ragged mining villages along the banks of the Orange and Vaal Rivers that resulted in considerable discoveries so that in 1870 there was a mining camp of no less than 10,000 persons on the "River Diggings".

In the River Diggings the mining was carried on in the coarse river gravels. A committee who controlled the digging limited the size of claims to 30 feet square, with free access to the river bank. But towards the close of 1870 stones were found far from the Vaal River and this led to a second great rush in 1871 to what is now known as the Kimberley mine. The diamonds are found in both river diggings and dry diggings. River diggings occur along the Vaal River from Potchefstroom down to the junction with the Orange and up the latter river as far as Hopetown.

Diamond mining is conducted in a similar manner to gold washing, the operations usually being on a limited scale. The dry diggings are on the borders of the Orange River Colony, about 640 miles northeast of Cape Town. They contain a number of small areas of circular or oval form, ranging in diameter up to one-fourth of a mile. They are at present worked by a single company, the DeBeers Consolidated Mines Limited. The mines are opened on a

large scale and yield enormous profits. It is stated that the output from 1867 to 1897 was over 33,000,000 carats, or about 7½ tons, valued after cutting at $450,000,000. Quite recently another diamond field has been opened in Transvaal. The largest mine is the Premier. At this time the South African diamond fields yield about 98 per cent of the total output of the world.

In 1883, as the first shafts began to burrow down into the mines at Kimberley, the diamond trade was expanding so swiftly that the mines could barely keep up with it. Wealth was diffusing downward to improve the lot of the common man, and diamonds for the engagement rings, once the prerogative of kings, were now available to any laborer who could save his money. Brazil's peak of production had never passed 600,000 carats a year; about 100,000 was its average. But South Africa was soon able to mine a million carats annually, and more and more.

The "River Diggings" at first was supposed to be alluvial in its origin like the river gravels; but it was soon discovered that below the red surface soil diamonds also were found in a layer of yellowish clay about fifty feet thick known as "yellow ground". Below this again was a hard bluish-green rock which has become famous under the name "blue ground". The yellow ground is merely decomposed blue ground.

It was soon found that each mine was in reality a huge vertical crater descending to an unknown depth. At first each claim was an independent pit thirty-one feet square sunk into the blue ground.

It is a mistake to speak of "river washings". The diamantiferous deposits are not special to the old or recent river beds, but appear to be alluvial deposits spread over a large tract of country by the agency of water, which at some period of time subsequent to the filling up of the volcanic pipes planed off and projected from the surface of the country. Thus the debris was scattered broadcast over the land. The larger diamonds and other heavy minerals would naturally seek the lowest places, corresponding with the river bed, past and present.

At Klipdorn near Kimberley the diamantiferous earth is remarkably like river gravel, is of a strong red color—quite different from the Kimberley blue ground—and forms a layer from one to eight feet thick.

The surface of the country round Kimberley is covered with a ferruginous (iron like) red, adhesive, sandy soil which makes horse traffic very heavy. Below the red soil is a basalt, much decomposed and highly ferruginous, from twenty to ninety feet thick, and lower still from two hundred to two hundred and fifty feet of black slaty shale containing carbon and iron pyrites. These are known as Kimberley shales; they are very combustible, and in a part of DeBeer's Mine where they were accidentally fired they smouldered for over eighteen months.

By 1889 mining below the bottom of the pits by means of shafts and underground tunnels had been commenced. Modern methods date from this time when Cecil Rhodes and Alfred Beit secured control of the DeBeer company.

The scene of native mining was now transferred from

the open pit to underground tunnels; the vast network of wire ropes with their ascending and descending buckets disappeared, and with it the cosmopolitan crowd of busy miners working like ants at the bottom of the pit. In 1905 the main shaft had been sunk to a depth of 2,600 feet at the Kimberley mine.

How the great pipes were formed originally is hard to say. They were certainly not burst through in the ordinary manner of volcanic eruption, since the surrounding and enclosing walls show no signs of igneous action and are not shattered or broken up even when touching the "blue ground". It is pretty certain that these pipes were filled from below after they were pierced and the diamonds were formed at some previous times and mixed with mud volcano, together with all kinds of debris eroded from the rocks through which it erupted. The direction of flow is seen in the upturned edges of some of the strata of shale in the walls.

The scene below ground in the labyrinth of galleries is bewildering in its complexity and very unlike the popular notion of a diamond mine. All below is dirt, mud, grime; half-naked men, dark as mahogany, dripping with perspiration, are seen in every direction, hammering, picking, shoveling, wheeling the trucks to and fro, keeping up a weird chant which rises in force and rhythm when a greater task calls for excessive muscular strain. The whole scene is more suggestive of a coal mine than a diamond mine, and all this mighty organization, this strenuous expenditure of energy, this costly machinery, this ceaseless toil of skilled

and black labor, goes on day and night, just to win a few stones wherewith to deck my lady's finger! All to gratify the vanity of woman! "And" a lady who overheard this, remarked, "for the depravity of man".

The process of mining diamonds is interesting and yet simple. The "blue ground," as the diamond-bearing ground is called, is a shale-like material. It contains approximately one grain of diamond per ton of ground, or one part in fourteen millions, and the recovery of this small content is the problem which has to be faced. Subsequent recovery depends upon the fact that the diamond is of a higher specific gravity than the ground with which it is associated.

The blue ground is blasted out in the same manner as coal or any other mineral. This ground from the mine varies in size from lumps which measure eighteen inches across down to dust. When it is brought to the surface it is sent to the crushers. These are run very slowly, for, although the diamond is the hardest substance known—so hard, in fact, that under sufficient pressure it can be pressed into a solid steel-like structure—a blow will fracture it into small pieces. Naturally, then, the breaking up of the diamantiferous ground must be attended with great care. On being broken up, the blue ground is passed through a series of especially constructed pans where a copious supply of water washes off the more readily soluble material, leaving the concentrates (insoluble) behind with a percentage of smaller undissolved lumps of blue ground. The small stones and other material are then passed through a second set of

crushers, set very finely, and then through the second and final set of rotary pans where the operation is completed.

In many cases, instead of using crushers, the blue ground is spread out on "weather floors" which cover from four to five thousand acres and is left exposed to sun and rain until it crumbles and disintegrates, the process being hastened by harrowing with steam ploughs; this may require a period of six months or a year. The disintegrated ground is then brought back in the trucks and fed through perforated cylinders into the washing pans. The heavy minerals are then passed over sloping tables smeared with grease to which practically all the diamonds adhere. The diamonds are won by scraping off the grease and melting it. The other minerals are washed away and shaken to and fro under a stream of water which effects a second concentration of the heaviest material.

The average yield per wagon load of 1,600 pounds of blue ground containing 16 cubic feet averages about one-eighth carat of diamonds or one and one-half grains per ton, which may or may not be of good color.

In twenty-five years the diamond did more to build a new empire than the pioneers of the most vigorous and tenacious races the earth has ever known had succeeded in doing in over three hundred years.

SOUTH AFRICAN DIAMONDS
(*Continued*)

"THE LURE OF THE DIAMOND in Africa has raised a new generation of wealthy men, begun a new empire, ground together a number of antagonistic individuals into a coherent nucleus for a new people; it has encouraged scientific research; stimulated engineering skill, developed great natural resources and uncovered others. By its magic, hitherto almost inaccessible stretches of the earth have been added to the habitable world, and thousands of savages are brought to a better understanding of life."[1]

The annual output of diamonds from the DeBeer's mines is valued at nearly 5,000,000 pounds. The South African fields have yielded 38,000,000 carats in the last sixteen years. This is a fairly good record when we consider that during two hundred years the Brazilian mines produced only 3,000,000 carats. The old Kimberley mine is the largest excavation ever made by human hands in any part of the world. It is as long as five good-sized city blocks and 1,400 feet deep, which is higher than the Empire State Building.

[1] Cattell, W. R., *The Diamond*, 1911, p. 32.

The average output from each mine today is over 5,000 sixteen cubic foot truck loads during an eight hour shift, which is equal to 4,000 tons. The ground is loaded into trucks, mechanically transported to the main rock shaft and loaded into the hoisting skips. At one time electric locomotives were used for haulage purposes, but these have been discarded and an endless rope engaging with jockeys on the top of the trucks is now in use. The rope is driven by electric motors through suitable gearing. Each skip in the main shaft holds ten of these trucks, and to prevent confusion at the shaft the full trucks are attached to the haulage rope in spans of five. The full trucks as they run past the loading box are automatically tipped, ten truck loads being fed alternately into each half of the box. When a hoisting skip, after its trip to the surface, arrives at the bottom of the shaft, it comes to rest upon a strong carrying beam so placed that the upper lip of the skip is just below the door of the loading box. The door is opened by means of a machine operated by compressed air, and the ten loads which have, during the time occupied by the trip, been tipped into the box slide into the skip at once. The box door is closed and the signal is given to the engine driver at the surface for him to commence his wind. The time occupied in filling the skip is about five seconds.

At first diamonds were found only on the surface. It was soon learned that diamonds were found twenty feet below the surface. After this was learned, mining started in earnest. Two farms were sold for a few thousand dollars

which today are worth millions of dollars. These farms make up the important part of the DeBeer's Consolidated Mines which controls ninety-five per cent of the diamond output of the world.

These mines on this land have been worked so thoroughly today that some of them are 3,000 feet down in the ground and are kept from caving in only by the greatest engineering knowledge.

The five diamond mines or craters (of Kimberley) are all contained in a circle three and one-half miles in diameter. They are irregularly shaped round or oval pipes, extending vertically towards to an unknown depth, retaining about the same diameter throughout. They are said to be volcanic necks filled from below with a heterogeneous mixture of fragments of the surrounding rocks, and of older rocks such as granite, mingled and cemented with bluish-colored, hard clayey mass, in which famous blue clay the imbedded diamonds are hidden.

The diamond fields at Kimberley funnel their way up from a great depth in the foundations of the earth crust, widening as they approach the surface. There they vary from about 60 feet to a half-mile across. There is a series of tunnels forty feet below each other in one of these spans. At the top is that rotted yellow rock which hardens as you go deeper until it passes into a hard, igneous rock called the blue ground, or Kimberlite. After careful observations Dr. Stelzner and others have reached the conclusion that the blue ground is of volcanic origin and was forced up from below. There are no beds of sand and gravel into

which the stones have accidentally been washed by millenniums of rain. In this blue ground are no less than eighty different minerals pushed up together from within the earth by the heaving force of actions under the crust. Presumably all diamonds once arose through such pipes in India, Brazil and Africa. This is yet a theory and an unsolved problem.

The "blue ground" of the South African pipes is a basic igneous rock; it contains no quartz whatever. Igneous rocks, in general, are classified according to the amount of quartz they contain. Quartz is one of the commonest of minerals; each grain of sand on the seashore is made of it. If an igneous rock contains lots of quartz, it is said to be "acid"; if it contains little or none, it is "basic". This, it seems, is one of the many conditions to be satisfied before a diamond can be formed. The blue ground was composed, originally, of large amounts of the glassy, grass-green mineral olivine, with smaller amounts of scores of others; notably garnet, bronze-colored mica and dark, heavy iron minerals. While this mass was cooling, the olivine was attacked by chemical solutions, and most of it turned into serpentine—a dark greenish-blue, rather soft mineral. Hence the color, and hence the name, "blue ground".

The chief use of most diamonds is for adornment. Today they come from one continent, Africa, except in quantities so small as to be negligible. Two-thirds of the diamonds in Africa are mined on British territory, a few in Portuguese Angola, the rest in the Belgian Congo. Almost all the diamonds taken out of Africa are sold by

London's Diamond Trading Company, Ltd., whose members own the British mines and hold contracts with the rest.

Until a few years ago, the mining of diamonds in South Africa was entirely in the hands of a very limited number of mining companies, but at that time new alluvial fields were suddenly discovered near the Orange River which brought in a rush of prospectors similar to the first rush over fifty years ago. The region was thrown open to the public on a fixed day and hour when thousands of miners, including women, lined up ready for the rush. At the signal to start, they swarmed over the field in automobiles, on horseback and afoot in feverish haste to stake their claim, but this time there was no shooting as before. Mushroom towns sprang up in the space of a few days, in spite of the fact that all construction material had to be brought from a great distance. The land in this section is without trees or vegetation of any kind. Instead of wood the shacks had to be built of corrugated iron, hauled many miles from the railroad terminus. Another serious problem was the lack of water supply. All of the water had to be brought in tanks over land for a distance of twenty miles. These fields, as well as all of the large diamond mining properties in South Africa, are affiliated in one way or another with the London Diamond Syndicate which fixes the price of rough diamonds and controls their marketing in London. The mines ship only according to the Syndicate's order, so that there is never the slightest chance of over production.

Before very long the diamond industry may find itself

prosperous again. In fact, that prosperity is already on its way. Production of diamonds had dropped from its peak of 7,500,000 carats in 1927 to about 3,775,000 carats in 1933; to have been curtailed less than 50 per cent was a good record for any business in these seven years. Diamond prices have not been reduced more than one third. For this measure of stability, miners and cutters alike thank the Diamond Syndicate.

Most of the diamonds coming out of Africa today, with DeBeer's pipe mines all closed down because they were overwhelmed by reckless competition and by depression, are alluvial diamonds. No one can say just to how many productive years the mines may look forward, not even DeBeer's own engineers. But certain it is that the pipes have many years of production before them.

The DeBeers directly controls every important source of diamonds in South Africa, including both pipe mines and alluvial fields.

The stones vary enormously in grade of purity and color, but they must come within a certain standard in order to be selected for jewelry purposes. Fine white diamonds, free from flaws, are extremely rare. Even rarer are flawless blue diamonds, so much like sapphires that only their hardness and specific gravity distinguishes them.

When the workmen are hired they sign a contract for three months, during which it is agreed that they shall remain perpetually within the mine. Besides food and lodging they are supplied with a radio and other forms of entertainment to make the evenings as cheerful as possible.

When a man's contract is about to expire he is sent to a hospital one week before his departure and thoroughly examined and X-rayed to be sure that no diamonds are concealed somewhere in his anatomy. This precaution had to be introduced as a part of the general routine because so many valuable diamonds disappeared in the past underneath human skins. A man would steal a diamond about the size of a nut, cut a slice in his leg and insert the stone, and then bandage the wound; when he left the mine he would never have to work again. Others carried them out in their mouths and ears, and X-ray examinations seemed to suggest that some swallowed theirs. If a man is caught with a diamond outside the mines he is required to break stone on the roads for seven years without pay.

One boy, many years ago, went to his "boas" complaining of a stomach-ache, and an operation brought forth six diamonds weighing, in all, over thirty carats.

The principal diamond mines of South Africa are as follows: The Dutoitspan, 45 acres; the Bultfontein, 35 acres; the DeBeer, 22 acres; the Kimberley, 33 acres; the Jagersfontein, 24 acres; the Premier, 1,723 acres, the greatest diamond mine in the world; and the Robert's Victor mine, 500 acres.

The DeBeer's consolidated has gradually absorbed most of the smaller companies of the diamond fields in South Africa; and the London Financiers have organized a marketing agency, the Diamond Corporation, through which most of the world's diamonds flow to the channels of

trade. In 1931 the Diamond Corporation and the De-Beer's Company united. These two combined firms are recognized to be the masters of the diamond world.

L. R. Lenox gives the analysis of the quartzite found in the diamond fields of Brazil as follows:

SiO_2	97.94 per cent
Fe_2O_3 and Al_2O_3	1.98 per cent
Lime	none
Magnesia	trace
Total	99.92 per cent

Professor Williams gives the analysis of the "Blue Ground" of the South African diamond fields furnished him by Professor James Bull as follows:

Carbonate of lime	34.77 per cent
Carbonate of magnesia	2.73 per cent
Serpentine	62.50 per cent
Total	100.00 per cent

The composition of serpentine was given as follows:

SiO_2	40.67 per cent
Al_2O_3	5.13 per cent
FeO	8.12 per cent
MgO	32.61 per cent
H_2O	12.77 per cent
Total	99.30 per cent

The consolidation of mines was a result of the force of circumstances. This was done in a smaller way in the Kimberley by Barney Barnato, simply as a money-making af-

fair, and on a large scale by Cecil J. Rhodes when he forced an amalgamation of all the Kimberley mines.

Some idea of the extent and power of the DeBeer's Consolidated Mines Company may be had from the statement of Mr. Gardner F. Williams, the former manager, that it occupies 200,000 acres; employed in 1906 nearly 24,000 natives, but owing to the 1907 panic in the United States the number of employees had been reduced by the end of 1908 to 12,000; consumed monthly 250,000 pounds of mutton, 200,000 pounds of beef; used 6,000 tons of coal a day; had 2,000 horses and mules, and kept 12 stallions of the best breeds and 200 brood mares—this in a country that a little over thirty years ago was over four hundred miles from the nearest railroad and port and was obliged to transport most of the necessities through an undeveloped country by ox or mule wagons. At that time coal cost eighty dollars per ton; wood, one dollar and seventy-five cents per one hundred pounds; eggs were seventy-five cents a dozen. The first machinery used cost fabulous prices. A hundred horse-power engine cost forty thousand dollars delivered in Kimberley. Transportation from Port Elizabeth or Cape Town ranged from two dollars and fifty cents to seven dollars and fifty cents per hundred pounds. Wagons were also very high. White men in the mines got from twenty to forty dollars per week; natives five to eight dollars. After the railroads from Cape Town and Port Elizabeth were brought into Kimberley in 1885, prices fell.

Foremost in the development of the diamond empire

stands the name of Cecil John Rhodes. He was born in 1853, the son of an Oxford clergyman, and went to South Africa as a young man. He was a fine figure of a man, tall and well-built, with blue eyes and curly blond hair, possessing a fearlessness, a knack of leadership and an intense patriotism which were to make him an idol among his countrymen. He went to work as a digger in the fields, sharing the hardships and pleasures of that rough, motley crew—but always with an eye toward buying out his neighbors' claims and building toward greater financial strength.

Another man was doing the same thing at the same time. This was Barnett Isaac who styled himself "Barney Barnato". Grandson of a Jewish rabbi, he was the opposite of Rhodes in background and training, and he possessed the shrewdness and foresight for which his race is famous. It was inevitable that these two men should come to grips; and their rivalry was the talk of the fields for some time. Finally, one memorable July night in 1889, Rhodes' company (the DeBeer Consolidated) bought out the Kimberley Central (Barnato's) for the staggering sum of twenty-five million dollars, paid with a single check, and Rhodes was master of the diamond region.

Rhodes had early employed many American engineers to develop the system of mining. For this he received sharp criticism from many of his countrymen. But he was convinced that "Yankee" ingenuity could help to conquer the difficult engineering problems which arose in mining out the great pipes. His right hand man was Gardner F.

Williams from California who had had world-wide mining experience. He was like Rhodes—a strapping big man physically, and together they made an unbeatable pair—Rhodes with his financial wizardry and political craftiness, Williams with his keen mastery of mining technique and efficiency in operation.

Rhodes died in 1902, Williams in 1906. Under their leadership, the DeBeer Company had grown to be a giant in the world of diamonds, and since their time their successors have carried it to even greater heights. The financial reins have been held by Rhodes' London backers, foremost among whom was the great House of Rothschild. Williams' work as a general manager was carried on for many years by his son, Mr. Alpheus F. Williams, who recently retired, bearing the reputation of one of the world's leading authorities on diamond geology and mining.

CHAPTER SEVEN

DIAMONDS FOUND IN OTHER PARTS OF THE WORLD

In many other parts of the world diamonds have been found to a small extent. Other countries where diamonds are known to occur are the United States, British Guiana, Russia, China, Sumatra and Australia. In the United States there are no deposits of sufficient value to warrant mining operations except in Arkansas—for the stones are found elsewhere only occasionally in alluvial materials and drift.

Diamonds are said to have been found in many parts of the United States. A theory is entertained in some quarters that wherever gold is found diamonds may be looked for. There used to be a theory maintained that diamonds abounded in California but had been neglected by the miners through ignorance of their value. There was a famous stone picked up at Manchester, opposite Richmond in Virginia in 1855. It weighed 24 carats when found, and 12 after cutting. But it was not clear, and so much doubt was entertained as to its genuineness that it could not be sold for over $2,000, whereas a fine Brazilian of 12 carats would have commanded over $10,000. The occurrence of

deposits is generally confined to the regions of the Southern Appalachians, the Great Lakes and the Coast and Sierra Nevada ranges of California and Oregon.

Diamond mining in the United States is so unimportant that it hardly deserves any mention. As a matter of fact there is not a single diamond mine operating in this country at present. Arkansas is the only state where diamonds have been mined. At Murfreesboro, Pike County, Arkansas, in 1906, small diamonds were found in a ground somewhat resembling the blue ground of Kimberley, South Africa. In 1925 diamonds were mined at this place. It is estimated that the output of the Arkansas diamond field from the time of its discovery in 1906 to 1912 was approximately 1,400 stones weighing 550 carats and valued at about $12,000. Some diamonds that are found in Arkansas are so small that 50 of them would be required to weigh one carat. The largest diamond found in Arkansas, in 1924, weighed 40.23 carats. The American diamond industries—the mines of Arkansas—were closed in 1929 which fixed an index of returns within the economic activities of the United States, that is, these Arkansas mines could not compete with the South African mines. They have not reopened up to the present.

A diamond was found while miners were searching for gold in the interior of British Guiana. The average size of diamonds found in this place was 6.1 stones per carat. Quite a large number were found here. Diamonds have been found also in the central part of Dutch Guiana. All of these are alluvial deposits, apparently very shallow and sim-

ilar to those distributed among the streams of Bahia, India.

Diamonds were discovered in the southeastern part of Australia in 1850, which has been a small producer ever since. Australian diamonds have a reputation among cutters for being the hardest in the world. It is said that they can be successfully cut only with their own dust. Australia now produces less than a thousand carats a year, most of which is obtained as a by-product of the alluvial tin mines. The crystals seldom weigh over one-fourth carat. They resemble the diamonds of Borneo in hardness, in being of average size, and in tendency, when colored, to great depth of color.

The occurrence of diamonds in New South Wales was recorded by Stutchburg on the Turon River and by Hargraves at Reedy Creek as early as 1851. In 1859 the Rev. W. B. Clark reported their occurrence at Burrendong and at Pyramul Creek. Since then, diamonds, in single specimens, have been recorded in many widely separated portions of New South Wales. In 1867 they were found to occur at the Cudgegong River. In 1872–73 a somewhat extensive rush took place at Bingera where a large number of mineral leases were applied for, and it was anticipated that diamond-washing would become a permanent and payable industry. Unfortunately, however, the stones being small and the Sydney jewelers declining to buy, there was no outlet and the work was suddenly abandoned.

The diamonds of New South Wales in their physical characteristics are more nearly allied to those of Brazil than any other country. They have been largely sold in London

as such. As regards to their color they differ very little from those of other fields. In brilliancy and refractive power the New South Wales gems surpass the African, and one of those cut in London was stated to have been as fine a brilliant as it was possible to obtain in any part of the world.

Professor David came to the conclusion that the Cape Creek diamonds were probably derived from the tourmaline granite. It is, however, now believed that their source will ultimately be traced to volcanic "pipes" analogous to those found in the celebrated Kimberley Field of South Africa. Whether or not this solution will prove correct, time alone can determine—certainly up to the present time there is no evidence of any such "pipe" having yet been found.

The diamonds found in this colony generally average from 5 to 6 to the carat, although gems of 2-2½ carats are occasionally found, and one of 5⅝ carats has been found. The number obtained per load varies very greatly; the Round Mount Company in 1886 washed 722 loads for 2,685 carats—from 6 loads obtaining the exceptional yield of 1,080 diamonds, weighing 296 carats, which probably establishes a record so far as our fields are concerned.

Very great difficulty is experienced in procuring accurate and reliable information as to the quantity and value of the gems which, up to the present, have been won, especially as regards the earlier years of the industry. It is a significant fact that, in spite of the severe drought with its attendant drawbacks, the output for 1898—16,493 carats—is in quan-

tity, though not in value, the largest recorded since the opening of the industry.

The next diamond field of importance is situated about six miles from Bingera. This field has been practically idle during the year owing to the water difficulty, the only work being done by Captain Rogers in the "Monte Christo" Mine, from which 1,573 carats were won. As soon as rain falls, work will be started by several large companies, and it is expected to prove highly successful.

The crystals partake more of the dodecahedral with its numerous modifications, than of the octahedral habit, which is so marked a feature in those from the Cape. In this respect the New South Wales stones bear a remarkable resemblance to those from Brazil, and also differ from the Indian gems. Another peculiarity of the Cape diamond is the large proportion of cleaved stones, or "cleavage", which appear to be entirely absent in the parcel submitted to us from the Crown Jewel Mine.

The black specks so frequently met with, not only in the Cape, but also in Brazilian diamonds, appear in those from Inverell to be more or less confined to the surface planes, not extending to any depth within the crystals, and would doubtless be eliminated in the cutting without detracting to any great extent from the value of the stones as gems. These stones are mostly either colorless or yellow. Some of the colorless diamonds are very beautiful stones, and the quality quite justifies the manner in which parcels have been brought into the London market.

It is stated by Messrs. Ford and Wright that the New South Wales diamonds are much harder than those from South Africa judging by the time necessary for the preparation of the facets. The average specific gravity of the New South Wales diamonds is 3.42. New South Wales has no large diamonds compared with those of South Africa. The smallness of size is compensated, however, by the fact, as we are informed by an excellent trade authority, that medium sized diamonds are now more in request than large ones, for mounting in conjunction with other gems, such as rubies and sapphires.

The following conclusions are emphasized for the New South Wales diamonds:—

1. The diamonds of New South Wales in their physical characters are more nearly allied to those of Brazil than any other country.
2. They have been very largely sold in London as such.
3. As regards to color, they differ practically but little from those of other fields.
4. The general absence of "cleavage" and "macles" is a point much in their favor.
5. Stones of the rarer colors assumed by the diamond should be particularly sought for.
6. The greater hardness of the New South Wales gems will probably raise the cost of cutting, but this will be compensated for by their extra "brilliancy".
7. "Bort" should be eagerly sought for.
8. The matrix of the diamond in New South Wales bears no resemblance to those of South Africa.

The diamonds that are found in Borneo are accompanied by pebbles of a siliceous nature and also by a form of bluish-

gray corundum which is regarded by the natives as a sure indication of the presence of diamonds.

Very little is known regarding the diamond regions of Borneo. Those of Landak mines where the Maton was found in 1787 are amongst the oldest and most productive and have been worked, though not very systematically, ever since establishment of Malay settlement on the coast. Here diamonds are found not only in the river beds when dry, but also in their original sites at the foot of the mountains. The diggings are usually carried to a depth of from ten to thirty feet, and constant experience has shown that the deeper they are dug the gems are both more plentiful, and of larger size and finer quality.

As far back as 1738 the Dutch annually exported from this district diamonds to the value from 200,000 to 300,000 dollars. The mines in this part of the island have been worked for over a century chiefly by the Chinese. But in 1842 the "Celestials" were set upon, and either massacred or driven out of the country by the Dyaks, as the aborigines. The cause of this outbreak was the intolerable tyranny of the Chinese, who appear to have treated the Dyak laborers employed by them with the most atrocious cruelty and oppression. It was one of these Dyaks who found the Maton diamond.

The Malays of Landak are firmly persuaded that the water in which the Maton has been dipped is a specific for all disorders; and, no doubt, this very belief has occasionally produced good results, especially in cases of nervous complaints.

The Maton is uncut, and weighs 376 carats, so that if cut and polished it would be reduced to at least 180 carats. So far as it is known the diamond remains in possession of the governor of Batavia.

Fifty small diamonds have been obtained in the Ural district. Humboldt, one of the greatest of naturalists, who has contributed more than any man of modern times to the progress of physical science was born in Berlin in 1769. He traveled extensively. In 1829 he, with Rose and others, was sent out by the Emperor Nicholas to explore the Ural mountains and the Caspian Sea. Its principal results were the scientific examination of the beds which produce gold and platinum and the discovery of diamonds in an extra-tropical region. These were the first European diamonds to be found.

Diamonds have been found in Shantung, China. About four miles east of the market town of Li Chia Chuang, is a low, sandy ridge, extending south and parallel with Ching Pu, the main road south, after it crosses the I Sui River about eighteen miles southeast of Cheefoo. The diamonds are found along this ridge for a distance of fully eight miles. The natives will only look for them after rains, because they believe the rains bring them, quite oblivious of the fact that the washings of the sands by the following rain discovers them. They cannot be persuaded to dig and wash the sand.

The stones are nearly all quite small. Occasionally, one as large as a pea or a hazel nut is picked up. The usual method

of the farmers is to walk back and forth over the water-washed sands with sabots of rye-straw, which pick up the sharp-pointed crystals. The sabots are then burned and the ashes sieved for the diamonds. The larger ones are picked up from the ground when seen during the tramp. Many of them are broken or splintered crystals, and as they are used chiefly for drill points, most of the unbroken crystals are broken up later for the purpose. A few are sold for gem purposes. Some of them are white, but a large majority are yellow or brownish-yellow.

The finders obtain a good price for the stones, as buyers visit the place regularly at certain seasons of the year and usually carry away the entire output. The quantity obtained is unknown, but the output of stones suitable for cutting to jewels is inconsiderable.

Very small diamonds have been found in meteorites from Australia, Russia, and Arizona. The meteorite that fell in Russia, September 22, 1886, contained one per cent of diamantoid carbon in the form of carbonado in small grayish grains. In the famous Canyon Diablo (Arizona) meteoric masses containing small black diamonds were found and in one piece there was discovered a tiny white diamond one fiftieth of an inch in diameter.

In finding diamonds in meteorites which are fused masses of iron principally has done much to establish the conviction that carbon in some form was crystallized into diamonds in the earth by heat and pressure.

The most striking confirmation of the meteoric theory

comes from Arizona where ten tons of this iron have been collected, and specimens of the Canyon Diablo meteorites are in most collectors' cabinets.

An ardent mineralogist—Dr. Foote—cutting a section of this meteorite, found the tools were injured by something vastly harder than metallic iron. He examined the specimen chemically, and soon found the Canyon Diablo meteorite to contain black and transparent diamonds. This discovery was afterwards verified by Professors Moissan and Friedel.

But it is also certain from the evidence offered by the Arizona and other meteorites, that similar conditions have existed among many bodies in space, and that on more than one occasion a meteorite freighted with jewels has fallen as a star from the sky.

Meteorites were used at McPherson College as a solvent for sugar carbon to make synthetic diamonds. Some microscopic diamonds were made this way, but never any as large as with natural wrought iron. I have found some spinels in meteorites. Spinels are found in meteorites more frequently than diamonds.

In the earth and air; in things animate and things inanimate; in the vegetation of the earth and the bodies of the animals; in the charcoal pit and the breath we constantly exhale, is that of which diamond is only a form known as carbon; for example, substances like sugar and starch contain carbon which is the same element as a pure diamond.

CHAPTER EIGHT

PROPERTIES AND TESTS FOR DIAMONDS

THE DIAMOND IS A FORM of carbon and differs from pure charcoal or pure soot merely in the arrangements of the atoms of carbon in the molecules. A diamond is pure carbon. Let us consider carbon for a moment. Of the ninety-two elements which compose the earth's crust, carbon is one of the commonest and the most familiar to us. It is everywhere present in nature. It occurs in all living matter. The human body is one-eighth carbon. Wood is about half carbon. The food we eat, the clothes we wear, the houses we live in—the very air we breathe—all contain carbon. When the carbon crystallizes into geometrical shapes—octahedrons (with eight triangular faces), cubes, rhombic dodecahedrons (with twelve rhombic faces), and related structures—it is what we call diamonds. The faces and edges of the crystals frequently are curved. It has a very perfect cleavage by which the primary form of the octahedron may be derived.

All diamonds have a definite cleavage or grain, much like a piece of wood. These planes of weakness are not vis-

ible in fine gem diamonds, except under the microscope; but they pass through the stone parallel to the crystal faces; all along these planes the diamond can be split. If cleavage is too well developed, the planes may appear as flaws. Other types of flaws are often seen in rough diamonds, such as "knots" inclusions of other minerals, tiny spots of black carbon, or bubbles of gas or liquids.

The cubic diamonds are sometimes found in Brazil but are very rare among the South African stones; and the dodecahedron is perhaps more common in Brazil than elsewhere.

Diamonds, frequently found in association with various minerals are universally recognized as chief among precious stones. The majority of minerals are found most commonly in masses which can with difficulty be recognized as aggregates of crystalline grains, and occur comparatively seldom as distinct crystals; but the diamond is almost always found in single crystals; which show no signs of previous attachment to other stones. The stones were, until the discovery of the South African mines, almost entirely derived from sands or gravels, but owing to the hardness of the mineral it is rarely, if ever, waterworn, and the crystals are often very perfect. Small diamonds have been found in larger crystals. The fact, and the statement, that the bursting of crystals is due to inclusions of compressed gas, led Mr. Gardner F. Williams to question the igneous theory of the slow growth of large crystals by accretion instead of sudden solidification in a fused mass. One large diamond of 228 carats found several years ago, was formed around a small

red diamond crystal. In an another case the smaller enclosed crystal was surrounded with another mineral (apophylite).

Some dealers embed large diamonds in raw potatoes to prevent explosion when transported from the mines to England.

One of the main characteristics of diamond is its hardness. It is the hardest of all natural things. Some years ago a German mineralogist named Moh arranged a scale giving the relative hardness of various minerals, from talc, the softest, to diamond the hardest. He made the division as follows:

1. Talc, common foliated variety.
2. Gypsum, or rock salt.
3. Calcite, transparent variety.
4. Fluorspar, crystallized variety.
5. Apatite, transparent crystal.
6. Feldspar, cleavage variety.
7. Quartz, transparent variety.
8. Topaz, transparent crystal.
9. Sapphire, cleavage crystal.
10. Diamonds—.

These minerals were selected because they are constant in the quality of hardness and reach in steps, from the softest to the hardest; but the difference of degree between does not correspond with the ratio of the numbers. The scale therefore does not represent exact and absolute degrees of hardness, but is an arrangement of minerals of different degrees in that quality, numbered from convenient reference.

Nor is the diamond always of the same degree of hard-

ness. Stones from wet diggings are usually harder than those from dry diggings. African diamonds are softer than Brazilians; Indian are harder, and those of Borneo and Australia are said to be the hardest of all. The skin of a crystal, or outside, is harder than the inside, and frequently there are knots in the grain, so much harder that it is difficult to cut them. The wheel makes very little impression when cutting against the grain of the diamond. It must be cut across the grain.

The only rival of the diamond in hardness is the metal tantalum, of which it is said that in the effort to bore a hole through a plate of it, a diamond drill driven at the rate of 5,000 revolutions per minute for three days and nights, made a depression one-fourth millimeter deep.

Graphite and diamond pass insensibly into one another. Hard graphite and soft diamond are near the same specific gravity. The difference appears to be one of pressure at the time of formation. Graphite may be attacked by fuming nitric acid and potassium chlorate.

Diamond is the hardest, the most imperishable, and also the most brilliant of minerals. Nothing will cut diamond except diamond. Nothing will cut so well; nothing drills porcelain so neatly; and the dentist will tell you that when he uses a whirling instrument of torture for hollowing out a cavity, he is using a diamond on your tooth.

Charles Kingsley once said: "We may consider the coal upon the fire as a middle term of a series of which the first is live wood and the last diamond."

Diamonds may be tested by the aid of sapphire. The true diamond will scratch the sapphire.

The diamond is found in all colors—white, yellow, orange, red, pink, brown, green, blue, black, and opalescent. There is a slight difference between the specific gravity of the Indian, or oriental diamond, and the Brazilian, and also between the white and colored. Absolutely colorless stones are not so common as cloudy and faintly colored specimens. The usual tints are gray, brown, yellow or white; and as rarities, red, green, blue, and black stones have been found. Diamonds may be the most perfect reflector of light. It may be as purely transparent and colorless as a dewdrop, or it may display all the primary colors. It is highly phosphorescent. Even the blackest of diamonds are transparent to the X-rays. Neither acid nor alkali will mar it; no solvent will dissolve it; but if heated to a high temperature in the presence of oxygen it burns to carbon dioxide. It is oxidized on heating with potassium dichromate and sulfuric acid. Its brilliant luster and display of prismatic colors are due to the property of reflecting and dispersing the light rays, a property possessed in the highest degree by colorless stones. The specific gravity ranges from 3.47 to 3.56; generally it is about 3.51.

The specific gravity or relative density of a mineral is the ratio of its density to water at 4°C. (39.2°F). The specific gravity of the diamond as given by different writers varies considerably, which may be accounted for by the different conditions under which the experiments were made, espe-

cially temperatures, and also by the quality of the diamond examined. Undoubtedly the chemical impurities and the foreign inclusions contained in the diamond affect the specific gravity.

Specific Gravity Table

Hard graphite	2.5
Quartzite and granite	2.6
Beryl	2.7
Mica	2.8
Hornblende	3.0
Methylene iodide	3.3
Thalium lead acetate	3.6
Garnet	3.7
Corundum	3.9
Zircon	4.4
Barytes	4.5
Chrome and tantic iron ore	4.7
Magnetite	5.0

The above table shows that if this whole mixture of minerals was thrown into methylene iodide, the hornblende and all above that mineral would rise to the surface, while the diamond and all minerals below would sink to the bottom. If the heavy minerals were thrown into thalium lead acetate, they would all sink to the bottom, except the diamond which floats, and could be skimmed off.

The diamond is considered a non-conductor of electricity, but it will become positively electrified. It retains the charge for a very short time only; never more than half an hour. The coefficient of expansion increases very rapidly above 750°, and diminishes very rapidly at low temperatures, the maximum density is attained about −42°C. The

very high index of refraction for diamond, 2.42, gives its extraordinary brilliancy.

Index of Refraction Table

Diamond	2.42
Zircon	1.95
Sapphire	1.77
Ruby	1.77
Spinel	1.71
Emerald	1.59
Flint glass	1.58
Quartz	1.55
Ice	1.31

The rose and brilliant are standard shapes of diamonds. The reflected light is refracted into a wonderful play of "lightning flashes", and "sparkling scintillations" as it passes into the air.

The somewhat general idea that the quality of shining in the dark is common to all diamonds is an error founded on the statement by careless educators, of the truth that some do. Experiments show that very few diamonds, either by exposure to sunlight or rubbing, will show any light in a dark room.

Color is one of the most important qualities of diamond. Generally, "fine color" means the absence of color, or pure, clean, colorless, transparency. Tints of pink and blue are considered extra fine. So also fine color sometimes means a rich or rare color as the term is usually applied, as pink, blue, and yellow.

Almost all gems conceal their true beauties in a natural

state. The diamond in the rough is most unattractive, and would be thrown away by a casual observer as a worthless pebble; its perfections are hidden under a hard crust, which can be removed by its own dust. The deep velvety blue of the sapphire, the glowing brilliant red of the ruby, the soft clear green of the emerald, and the delicate strata of the onyx, alike only display themselves in their true character after the lapidary has exhausted his skill in cutting them into facets and polishing them.

Most precious stones are infusible or fusible with great difficulty by means of fluxes such as borax or sodium carbonate. The ruby, sapphire and all corundums, emerald and spinel are fusible but with great difficulty. Spinel and corundum are not affected by any acid.

Various tests can be made for diamonds. One of these is their hardness. No chemicals will react with diamonds. The density of diamonds can be determined with methylene iodide and thalium lead acetate. In the former it will sink and in the latter float. An index of refraction and the burning of diamonds in the presence of oxygen with a temperature of 800°C. are also very good tests for diamonds.

Various attempts have been made to measure the intensity of the iridescence of diamonds by photographic means, but solar light has always proved too diffused for accurate results. M. Malaval, of Paris, a chemist, has invented a method to test the quality of diamonds. He has obtained perfect results with ultraviolet light rays passed through a screen. The purest white stones give the clearest picture, yellow stones showing darker, while imitation diamonds

show quite black. It is claimed that this method will make it impossible to substitute stones of lesser value for real diamonds. All the possessor of the diamond needs to do is to get an ultraviolet ray picture made of them before temporarily giving up the stones and then have a second picture made when they are returned. This method will make it possible to decide the exact quality of any diamond with almost mathematical accuracy.

There are two kinds of imperfections or flaws: those which are inherent and others arising from imperfect cutting.

Of the former, black, or carbon spots are the most discernible. They range from specks so small that it is difficult sometimes to discover them with a magnifying glass, to spots and broken, ragged clusters, quite plain to the naked eye. They are formed often of uncrystallized carbon or portions of the original element which did not crystallize with the rest but took one of the other forms of carbon, that is, graphite or carbonado, probably the latter, and were included in that which did crystallize. Others are inclusions of foreign matter, iron, etc. They are considered bad imperfections because they are so easily detected by the naked eye. It is worthy of observation, however, that the blackest and most abrupt carbon spots are usually found in the whitest and finest diamonds. They remind one of human nature, in which the flaws of great talent are more than ordinarily bad. Not only do black spots look blacker when set in material of peerless color and splendor, but they are blacker. Where carbon appears in the lower grade dia-

monds of Africa, it is often not only somewhat scattered, but cloudy and less distinct. In the pure white brilliant stones of India, it is decidedly black, and abruptly distinct in formation. Why the carbon inclusions failed to crystallize with the surrounding diamond, has not been satisfactorily explained. As they must have been subjected to the same heat and pressure as the remainder of the crystal, some other agency whose power was not equally distributed during the process of crystallization probably failed; again it may be necessary for the crystallization of carbon that it should be in a certain specific condition when the heat and pressure assumed to be requisite are applied. Rapid chemical action whereby carbon in solution is thrown down in transparent crystals, might surround particles which had escaped the solvent; on the other hand, the same result might be attained by the slow accretion of crystallized carbon atoms from a surrounding composite, to a nucleus of the element.

According to Dr. C. Everett Field, director of the Radium Institute in New York City, it is possible to change yellow diamonds, which are comparatively cheap and plentiful into valuable blue-white diamonds by means of radium treatment. The process consists in placing enough radium near the diamond to draw off the impurities in the stone which cause the yellow color. If more radium is used, the change will occur more rapidly. The quantity is also governed by the relative hardness of the jewel. It was found that 100 milligrams of radium, worth about eight thousand dollars will change one diamond in four days. The experi-

ments extended over four years, and in that time no stone which had been changed to blue-white reverted to its original hue.

Diamonds are measured by a tiny unit of weight called a carat. There are 2,268 metric carats in a pound, or about 142 carats to the ounce. Specifically, the metric carat is equal to .2 grams; this is about the size of an average pea. Most of the stones passing through the office of the Diamond Corporation in London are less than one carat, some of them are as small as 200 to the carat. A good one carat stone in any jeweler's shop will cost three hundred and seventy-five dollars or more; but you can buy a carat of small diamonds for as little as seventy-five dollars. The word, carat, is said to be derived from the name of a seed which was once used in the East as a weight.

Wedding rings usually have the diamond in a gold ring. The ring which contains 22/24 of pure gold, is called 22 carats fine, or 22 carat gold. The lower standard used for watch cases which contain 18/24 of pure gold is called 18 carats. The carat used in this sense has therefore no absolute weight; it merely denotes a ratio. This, however, is not the case with the carat used for weighing diamonds and other precious stones, which has a fixed weight.

CUTTING DIAMONDS

In the rough a diamond is a very homely object. You would scarcely bother to pick it up if you saw one lying in your back yard. It looks much like a piece of broken glass. It is not surprising to learn that the ancients who knew nothing of cutting except that one diamond could be used to cut another, regarded the diamond as something difficult to adopt in the way of an ornament. They could cut much easier the pearl, the ruby, and the emerald which were of a softer material. The unyielding hardness and indestructibility of the diamond they admired even then, but that it had any other virtue was entirely unsuspected.

Just about the time that diamond cutting was penetrating into Europe from India, 1456, there lived a lapidary in the city of Bruges; Louis Van Berquen, a Belgian. It is generally supposed that he was the first to discover the art of cutting and polishing diamonds by their powder; but this must be somewhat inaccurate, as already in 1373 the Emperor Charles had the clasps of his cloak ornamented with diamonds.[1]

[1] Emanuel, Harry, *Diamonds and Precious Stones*, p. 64.

Into Louis Van Berquen's head one day came the fantastic idea of grinding off the upper and lower points of an octahedral diamond (having eight triangular faces) to produce a symmetrical gem of a new and artificial design. Where the points had been, would now lie two artificial facets. To make it possible Berquen conceived a new technique of cutting. He took the fine sharp dust of a crushed diamond and sprinkled it on a wheel. Then coating the wheel with oil, he held the corner of another diamond against it while it turned. Berquen's primitive cut, admired and imitated everywhere, was fashionable in Europe for a hundred years. His dust-sprinkled wheel is the basic tool of the cutting industry today.

In Amsterdam competent mechanics lay the stone bare by removing the outer crust, and then a jury of diamond-cutters set upon it to decide how it should be cut. Diamonds are cut in four shapes—the brilliant, the rose, the table, and the brilliolette. It is hardly necessary to describe the latter two, as they have gone out of fashion and are now rarely seen. The rose diamond is flat on the under surface, and cut into innumerable facets on the upper. This form of diamond is rarely seen in this country. It is, however, the best form in which to cut diamonds of small depth, and has been adopted for some large gems, such as the Orloff and the Florentine, with fine effect.

The table cut was not abandoned until another lapidary invented the rose cut a century later. This was a diamond shaped like a hemisphere, with a flat base from which arose twelve triangular facets, ending in a point at the top. The

rose cut was elaborated later until it contained as many as thirty-two facets; this cut prevailed another hundred years. Then a Venetian, Vincengo Peruzzi, in 1660, improved the plan of the table and rose cuts until he attained the brilliant appearance of the diamond as it is cut today fifty-eight facets, the cut which gives a stone fifty-eight facets brings out its full light and beauty. Such diamonds assumed their rightful place in the front ranks of precious stones and were widely employed in the jewelry of the late seventeenth and early eighteenth centuries.

The standard cut diamond of fifty-eight facets is cut properly proportioned, the diamond shows an equal distribution of light and brilliancy at all distances from the eye. The center under the table is as full of light as the edge facets, because the back facets are holding the light which has entered from the front. If the stone were cut too deep or too shallow, part of the light would pass through the back facets and leave a dark center, called a "well" in a deep stone, or a "fish eye" in a shallow stone.

Diamonds may be cut in many other ways, according to the taste of the times. Diamonds have been cut in the form of squares, triangles, lozenges, kites, keystones, hexagons, etc. To make full use of its refractive power, and so exhibit all its splendor, a diamond must have many facets. But jewelers agree that no other design brings out the same prismatic play of colors as Peruzzi's brilliant cut. On this one design, the diamond industry of Amsterdam and Antwerp is founded. Other guilds (an association of persons for a common purpose) were soon founded in Amster-

dam and Antwerp, and later in New York City. At present the roughest and smaller ones are cut in the former place and the finest quality stones in New York City which is a big diamond cutting center.

It took two years of steady work to cut the Pitt diamond. But art is long, and diamond-cutters are patient. Sometimes two rough diamonds are made to cut each other; as fast as one facet is completed the solder is melted out of the stick, and the diamond replaced by a different position.

Some stones are naturally more brilliant than others, but many diamonds would be more brilliant if cut better. As very many crystals are quite irregular in shape, absolutely correct cutting would often entail too much cost. Very many more persons recognize the beauty of a perfectly cut stone when they see it, than the number of those who are willing to pay the extra cost in time and material necessary to secure it. For that reason, though the average cutting today is very good, and conforms generally to the proportions of excellence, a large number are not mathematically exact, and when they are so the price appears to many unreasonably high.

Cutting is the most important stage in the diamond career. In diamond cutting the apparatus is simple but its manipulation requires both skill and experience. The American invention of the diamond saw enables one workman to do the work of twenty or more and turn out a more perfect product. This marvelous little tool measures but one-thousandth of an inch in thickness and is turned at a speed of 2,000 to 3,000 revolutions per minute. Even with

this amazing device but a single carat diamond can be cut in a day. Formerly a diamond could be cut only by splitting it along its line of cleavage; now the saw cuts its way through the stone at any angle. What a diamond gains in brilliancy through being cut and polished, it loses in size for about sixty per cent of the stone is cut and polished away before it is ready for market.

The apparatus consists of a small disk of spongy cast iron, turning on a vertical spindle. The stone is imbedded in the apex of a metallic cone and held by a clamp against the surface of the disk which is smeared from time to time with a mixture of olive oil and diamond dust. This apparatus requires constant attention as the stone may be permanently damaged by over heating. The mistake of a single stroke in cleaving the stone, may shatter it to pieces. Any diamond in the rough is full of imperfections, with only certain parts clear and the skill comes in saving as much of the stone as possible in providing it with some fifty-eight faces. With a diamond-edged tool little slits are made in the stone where the cutting is to take place, and just one of these slits, misplaced, is likely to bring on a total ruin. Cutting diamonds is an art so delicate and so precise that few outsiders ever learn it.

As Europe did more to advance the art of cutting diamonds in a few centuries than the Orient did in several thousand of years, so the United States has done more in the last ten years than Europe did in the centuries. Precious stones have been long sawed by the Chinese, with a string charged with oil and emery, spun over a bow. It is said that

sawing was done on the Regent with lead strips charged with diamond dust, a process possible only where time and labor counted practically nothing. When the United States took hold of the industry, machines were soon perfected to rip a diamond in any direction at a minimum expense of both time and labor. Today there are numerous patents for sawing, convenient dops and devices for sawing and splitting the crystal, whereby time, labor, and costly material are saved.

The supply of large and splendid stones has not increased materially, but the widening market has been chiefly for small diamonds. On these the modern jeweler's trade is for the most part founded. London has become the primary market.

The depression in the diamond market began in 1927, and went on dropping until 1933 when the bottom was reached at 180,000 carats.

CHAPTER TEN

REMARKABLE DIAMONDS AND GEMS

Jewelry is older than dressmaking, and its radiant variety has expressed the individuality of women since the dawn of time. There always has been and there always will be an element of mystery in the appeal of the bits of bright and colored stones that we call gems. This appeal is not solely to the sense of beauty although beauty has very much to do with it. Nor is it entirely a question of value although again the sentiment of value is very closely linked to the lure of gems. In many things, but especially in the buying and wearing of gems, we desire most that which is rare, that which other people cannot afford to have, that which proclaims our opulence.

It is undoubtedly this element of barbaric heritage that impels the man or woman of today to pay many times the value of a synthetic sapphire or ruby for a natural stone of the same kind. And this in spite of the fact that in all essential characteristics the gems are identical, and no eye but that of a trained gemmologist can discern the difference between Nature's product and that which is made of the same substance by man.

Back of all these considerations there lies a subconscious appeal, something psychic and primitive that moves one frequently to lie, murder, and steal for the sake of some sparkling shred of mother earth. We have every reason to believe that this appeal swayed men and women since the beginning of history. The subtle charm that renders a modern woman spellbound before a jeweler's show case is the same that urged her earliest forebears to hang bright colored stones about themselves before it occurred to them to adopt any other means of adornment.

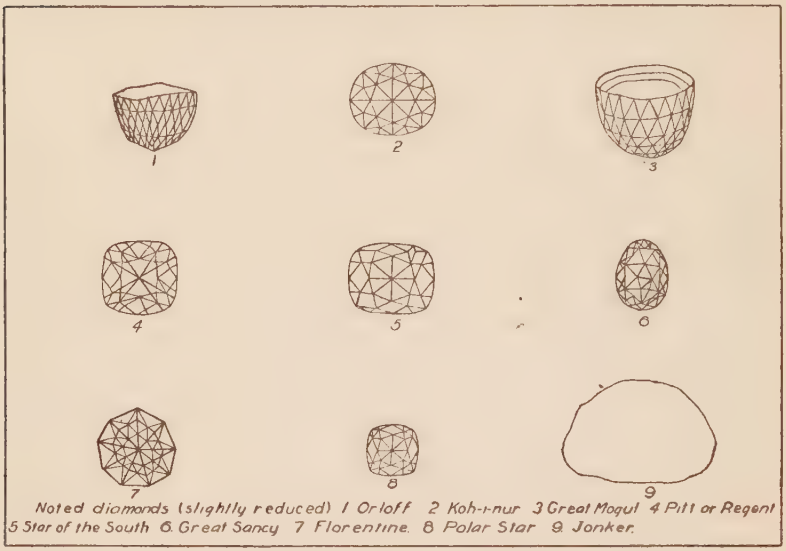
The most valuable gems are generally owned by royal families or are treasured by governments as state jewels. A striking hindrance to an adequate appreciation of the diamond as a jewel was its lack of color. The ruby, emerald, and other stones, attracted the Oriental eye by their color, but the glory of the diamond is its brilliancy and that was partly hidden. For that reason, the ruby and inferior stones were preferred to those of diamonds.

ORLOFF

The great diamonds of the world are as famous as the great mountains and river. Who has not read of the Orloff or Orlow also called the Amsterdam Diamond, so named because purchased by Prince or Count Orloff for Empress Catharine II, is the most renowned of the crown jewels of Russia. Bauer says it is the finest water, greatest luster and perfectly clean.

Orloff, one of the largest, was owned by the Czar of Russia. It weighs 195 carats and is cut in rose form. Its

origin is uncertain; according to one account, it was stolen from a Brahman temple of India, while another indicates that it was owned by Nadir, Shah of Persia, and after his death came into the hands of an Armenian merchant. In 1772 it was purchased by the Empress Catharine II of Russia at a price said to have been 450,000 rubles, besides



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an annuity of 4,000 rubles and a Russian title. It is among the Russian crown jewels. In every respect the Orloff is the most remarkable of the great Russian Diamonds. It forms the chief ornament in the Imperial scepter. From this circumstance it is sometimes called the "Scepter" diamond. In size it ranks first among the European gems; in beauty it yields only to the "Regent" while for romantic interest it

rivals the Koh-i-nur itself. This stone was carefully examined by Professor Nevil Maskelyne, an English astronomer, who became convinced that it was an Indian cut stone. It is about the size of a pigeon egg.

It is said, according to tradition, to have formed one of the eyes of an idol of a Brahman temple at Seringham, India. After the assassination of Shah Nadir, who had adorned his throne with it, it was stolen by a French grenadier who had taken service there. A ship captain bought the stone for 2,000 pounds sterling and sold it to a Jew, who let an Armenian merchant named Shafrass have it. The latter sold it to Empress Catharine Second of Russia and the negotiator Lazaref was raised to the rank of nobility.

KOH-I-NUR

The Koh-i-nur, the "Mountain of Light", is preeminently the "Great Diamond of history and romance." According to an Indian legend it was found long before the Christian era. The Koh-i-nur had been stolen from sovereign by sovereign for nearly a thousand years. It first belonged to the god Krishna. From him, a poor helpless god, it was stolen by a wild Delhi chief, who wore it in his cap; from him by Ala-eddin; from him, in 1526, by Baber of the Moguls.

Although this diamond had been famous from the beginning, Baber gave it no particular name, and it did not take its present name till it passed into the hands of Nadir Shah. The first authentic records carried the Koh-i-nur

back to the year 1304, beyond which date it had a tradition giving it an antiquity of some fifty centuries. Streeter does claim emphatically the Koh-i-nur and Great Mogul are not the same diamonds, although at least one authority has shown reasons to believe they were the same diamond.

This is probably, at least among English-speaking peoples, the best known of all diamonds. For centuries it has served as a symbol for supreme beauty and worth. Several diamonds surpass the Koh-i-nur in size, brilliancy, and transparency. None, however, equal it in the length and eventfulness of its history. The story of the Koh-i-nur, begins far back in the dim past. According to tradition, it was found in the Godavery River, South India, four or five thousand years ago.

The Koh-i-nur, by all means the most celebrated of diamonds, owes its European reputation to its first appearance at the London Exposition of 1851, when it already had a history in its own country—a history which has its legendary roots in the dimmest antiquity. The first historical accounts of the Koh-i-nur are from the 14th century when it came through Ala-eddin into the treasury of Delhi (1304). When Sultan Baber made himself Master of the Hindustan in 1526, the diamond as well as other treasures was voluntarily presented to him by its possessors of that period as a testimonial of gratitude for its not having been taken by plunder.

It occurred to Aurunzebe that the Koh-i-nur, like other diamonds, would be better for some polishing and cutting. Unfortunately the diamond cutter who received it in charge,

Hortensio Borgio of Venice, was not skilled enough to carry out such a task. From 793 carats the blockhead cut it down to 186. For this he was punished with the loss of his entire fortune.

Nadir Shah stole it when his turn came. His descendants were tricked into losing it to Achmed Shah, whose son was forced to give it up to Runjeet Singh. Through the people of that potentate it reached British troops. Their Queen, to whom they had loyally presented it in June 1850, had it displayed in the Great Exhibition of 1851.

She was not satisfied with the brilliance of the stone and had it cut again—this time by the great Costar of Amsterdam. He reduced it to 106 carats.

Costar and his men came over from Amsterdam for the purpose, and installed the equipment at the Queen's jeweler's shop. A steam engine was erected to do the work. It was the Duke of Wellington himself who set the machinery in motion, and made the first cut. All England was a breathless spectator of the thrilling scene. A single slip of the cutter's hand might have done a mischief not to be measured save by hundreds of thousands of pounds. A moment's inattention might have cost a million. Happily the operators' nerves were steady, and their thoughts concentrated on their work, so that no accident occurred. The Koh-i-nur is now a perfect brilliant, with duly proportioned table, facets, and culet.

Nadir Shah got the stone from the Mogul dynasty by cunning means in 1739. The unhappy Mohammed Shah, to whom Nadir Shah restored the throne of India used to

hide the jewel in his head covering, which he never took off. At the farewell ceremony, however, when the two rulers exchanged once more the assurance of external friendship and faith, Nadir Shah took his sheepskin cap, trimmed with the costliest pearls, off his head, as if to strengthen his asseveration by an outward sign, and placed it upon the head of Mohammed Shah, but at the same time cocked his friend's turban upon his own head. In the turban, however, lay the Koh-i-nur, and Mohammed could not, according to the strict etiquette of his country, even make a wry face at his loss. The empire-changing times which dawned in India, and often revolved around the jewel made its destiny a wonderful one. Through Achmed Shah the Koh-i-nur came to Peshawer, where the English ambassador first saw it on the breast of Shah Shurja. The unhappy king saved the diamond in Kashmir, but was at last obliged to deliver it up to his conqueror, Runjeet-Singh, who adorned himself with it on all public occasions. The stone remained henceforth in Lahore, where, at the suppression of the famous revolt of the Sikh troop, the Koh-i-nur became the booty of the East India Company who reserved it for the English Crown and as previously stated it was presented to Queen Victoria. At this time it was valued at $700,000. The cutting by Costar required thirty-eight days of twelve hours each and is said to have cost $40,000 to cut it. In the process the diamond lost eighty-four carats.

The Star of the South, a much larger stone, required three months by the same man. The Pitt or Regent during

the eighteenth century—cut by a much slower process—required two years.

The Koh-i-nur is now preserved in Windsor Castle. A model of the gem is kept in the jewel room of the Tower of London.

GREAT MOGUL

The Great Mogul has been referred to as the diamond of "a stormy birth and a tragic end". At the time of its discovery Roundheads and Cavaliers were fighting for supremacy in England. The Great Mogul challenged the wonder and admiration of the world from 1650 until the last days of the Indian Mutiny.

We learn from Jean Baptiste Tavernier that this diamond had been found by persons unknown, about 1650 A.D. in the Kullur mine on the River Kistna in India. He states that he saw it in 1665 in the possession of Great Mogul of India. The stone was so named after the Mogul dynasty in India. The year that the first European saw this diamond was 1665.

In the rough the Great Mogul weighed 900 carats. It was as large as a hen's egg. After it was cut it weighed 280 carats.

Mirginola, who betrayed his king, Golconda, presented this stone to Shah Jehan, when it was in the rough state and weighed 900 carats. Shah Jehan virtually ceased to reign from about 1657 till his death in 1666. But his successor, Aurung-Zeb, allowed him to retain possession of the

greater part of his jewelry throughout his imprisonment in Agra.

The subsequent history of the Great Mogul from the time it was seen by Tavernier in 1665, remains a blank. Henceforth no distinct reference anywhere occurs to it, although we may presume that it continued in the possession of Aurung-Zeb's successors down to the sack of Delhi by Nadir Shah.

THE GREAT DIAMOND TABLE

Another large stone mentioned by Tavernier which has been lost to general knowledge, is recorded as "The Great Diamond Table". Tavernier saw it in Golconda in 1642, and said it was the largest he had seen in private hands while in India. It was offered for sale to him for 500,000 rupees or 750,000 livres. He took a casting of it, and sent that to two friends at Surat, who commissioned him to offer 400,000 rupees for it if the stone was clean and of fine water. The offer was refused, and nothing further is known of it. The weight as given by Tavernier was 242 3/16 carats.

BRAGANZA

The Braganza is said to be the largest diamond ever found in India. But its very size—it weighs 1,680 carats in the rough—has caused its quality to be questioned. Mawe claims that the stone is a white topaz. It must be remembered that topaz is a fluo-silicate mixed with silicate of aluminum which is often very apt to be mistaken for a diamond by the unpracticed eye.

As a rule the larger the stone the more it loses, proportionately in the process of cutting for the full development of its beauty. The loss is usually considered about one half for moderately large gems. But for one of such large dimensions as the Braganza it could not safely be estimated at perhaps less than two-thirds. This would reduce the finished jewel to about 560 carats; but even so it would still remain twice as large as the next largest (The Great Mogul) on record.

Murray tells us that the Braganza remained uncut. Don John VI had a hole drilled through it, and it was suspended from his neck on gala days.

The date of its discovery is questioned by some but the most reliable date seems to be about the year 1798.

NIZAM

The Nizam diamond was at one time considered one of the largest stones in the world. However, little or nothing reliable is known about it except its size, estimated value, and its fortunate owner. Barbot says that "the King of Golconda, the magnificent stone in the rough state known by the name of the Nizam, weighs 340 carats and is valued at 5,000,000 francs". The title "King of Golconda", once belonged to a fabulously rich Indian prince. It has long been obsolete, but it still flourishes in French literature as a symbol for magnificence.

Undoubtedly the Great Mogul and Nizam diamonds were found in the same locality. They are thought to have been originally parts of one huge stone. It is quite possible

that the breakage of this stone, accidental or otherwise, was regarded as an omen of trouble, and may have had its influence on historical events, for not only uncivilized and Oriental potentates, but Christian kings and learned men have attributed wonderful powers to precious stones. In mediaeval days carbuncles were credited with an influence on poisons; jasper was believed to cure fevers; agate ministered to defective eye-sight. Juvenal records of a ring, belonging to Cicero, was believed that it endowed him with eloquence; and Edward the Confessor had a ring which was believed to cure epilepsy. (See Chapter Two on Superstition.)

STAR OF THE SOUTH

The Star of the South was found by a negress in July, 1853, in the Province of Minas Geraes, and is the largest of the known Brazilian stones. It is a stone of singular beauty, with a lovely tint. It had 24 natural facets. It weighed 254 carats before it was cut and 125 carats after it was cut.

The stone ultimately reached a Paris syndicate, by which it was shown in the Dutch department of the London Exhibition of 1862, and in that of Paris in 1867. On both occasions it attracted great attention, and its fame reached the remotest corners of the globe. It was soon afterwards forwarded to India. During the exhibition of the gem in India glowing accounts of its rare size and beauty had reached the late ex-Gaikwar of Baroda, one of the greatest diamond fanciers of modern times. This prince commis-

sioned Mr. E. Dresden of London and Paris to buy the "Star of the South" for 80,000 pounds sterling. Mr. Dresden applied through Mr. Halphen to the syndicate and later paid Mr. Halphen the 80,000 pounds sterling for the diamond.

HOPE DIAMOND

The Hope diamond is interesting, as it is the largest blue diamond known. It is called the "Hope" because it once belonged to a famous London banker by that name. Mr. Henry Hope purchased it in 1830 for 18,000 pounds. Hope's grandson who was given possession of the diamond at his grandfather's death became bankrupt and the diamond disappeared. Later it was pawned, and the trustees of the Hope estate purchased it. It was sold at public auction in Paris, June 24, 1909, and bought by an American syndicate for 80,000 dollars. February 2, 1912, Evalyn Walsh McLean (an American woman who at present lives in Washington, D. C.) purchased it for 154,000 dollars. The present weight of the Hope diamond is 45.42 carats —formerly it weighed 67.125 carats. It has a shape something like that of a pear.

PITT OR REGENT

The "Pitt" or "Regent" diamond was found by a negro slave in 1701 in the Partneal mines on the Kistna River, India. This slave cut his leg deeply to pouch the stone in his flesh. At the first chance he ran away to the sea coast where he met an English skipper whom he trusted with his

secret. It is said that he offered to give the diamond to the mariner, in return for his liberty. The English skipper, professing to accept the slave's proposal, took him on board his ship and, having obtained possession of the jewel, flung the slave into the sea. The English sea captain sold it for one thousand pounds sterling, not to Governor Pitt, but in all probability to Jamchund, at that time the leading diamond merchant in the East. Jamchund sold it to Mr. Thomas Pitt, Governor of Fort St. George, Madras, East Coast of India for twenty thousand four hundred pounds sterling. The Governor was the grandfather of William Pitt, first Earl of Chatham. While it remained in possession of Thomas Pitt he never slept two nights running under the same roof. At last he was relieved of further anxiety by the negotiations, in consequence of which the "Pitt" became the "Regent", passing from the English owner into the hands of the Duke of Orleans, Regent of France, in 1717 for 135,000 pounds.

The first name was given it because it was owned for some years by Governor Pitt; the latter because it was bought by the Duke of Orleans while he was Regent of France during the minority of Louis XV.

It was sent to England and cut into a brilliant. In the process it was reduced from 410 to 136¾ carats. The cutting required two years. It cost 27,000 thalers, and 10,000 thalers worth of diamond dust were used in the operation. The pieces ground off were worth 48,000 thalers. During the reign of terror of 1792 it disappeared with the rest of the crown diamonds, but was found again later. Under

the republic it was once pawned at Berlin. Napoleon the Great wore it on his sword-hilt.

In 1792 the value of the Pitt was estimated at 12,000,000 francs or 2,200,000 dollars.

A personal letter was received by the writer from the American Consul, Robert D. Murphy of France, on January 18, 1938, stating that the "Regent" diamond was in the jewelry collection at the Louvre Museum in Paris.

STAR OF SOUTH AFRICA

In 1869 came a confirmation of the existence of diamonds in the locality where the first one was found by the Jacobs family in 1867, a confirmation which created much excitement. A diamond weighing over 80 carats was picked up by a native. It has since been named the "Star of South Africa". As soon as this find was noised abroad, adventurers flocked to the Vaal and Orange Rivers.

CHAPTER ELEVEN

REMARKABLE DIAMONDS AND GEMS (*Continued*)

CULLINAN

THE LARGEST GEMS of the Orient that have long ranked among the world's wonders are fast becoming insignificant when compared with the numerous larger ones furnished by South Africa.

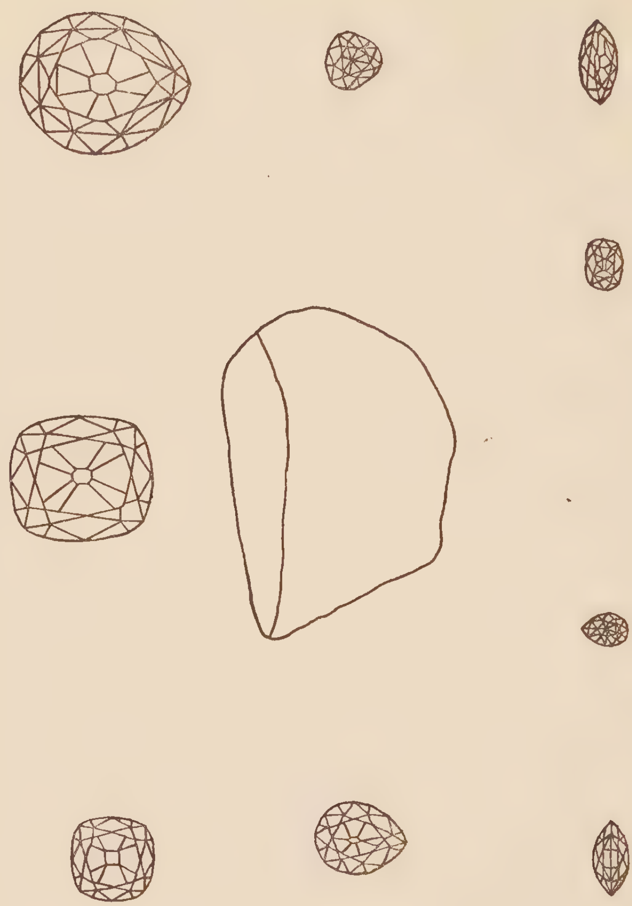
The largest and in many respects the most remarkable diamond of which there is any record was found on January 26, 1905, in the Premier Diamond Mine, near Pretoria, Transvaal. The Premier Diamond Mine is the largest in the world at this time—size 1,723 acres. The farm on which it is located was bought by T. M. Cullinan for 50,000 francs. On this farm the Cullinan diamond was found. This stone is nearly twice the weight of the fabled Great Mogul diamond. Its dimensions were 4 by 2½ by 1½ inches. The finder was mine captain Frederick Wells.

He observed, while making his morning rounds, something shining in the wall of the mine and on further investigation a wonderful gem was disclosed, which, it is said, took all day to free from its rock matrix. The dis-

covery of this stone, while the source of the greatest elation, is said to have been accompanied by some fear on the part of the mine owners that a purchaser could never be found for so large a jewel. The stone weighed 3024 carats or about one and a half pounds, the size of a man's fist. It showed five cleavage planes, indicating that it was only a portion of a large crystal. The stone in the rough resembled a lady's fist in size and shape and its transparency made it appear like a piece of ice. It was named the Cullinan diamond for Mr. T. M. Cullinan, President of the Premier Diamond Mining Company. As before stated the diamond's planes and markings indicated that it was only a part of a crystal. The whole was probably a huge octahedron, from which the Cullinan diamond had been separated by natural cleavage. The color is reputed to be the purest of any of the largest stones. This diamond is four times as large as the largest of those of ancient India, and more than three times the size of Excelsior, one of the wonders of the modern world.

The question of the disposal of the stone was finally solved on November 9, 1907, nearly three years after the diamond was found by its purchase, at the suggestion of Premier Botha of the Transvaal Colony, by the Assembly of that Province for the sum of a million dollars as a birthday present to King Edward VII of Great Britain in recognition of his grant of a constitution to the Colony.

King Edward sent it to Amsterdam. There in 1908 it was ceremoniously cleft by Joseph Asscher of the firm of I. J. Asscher, with doctors and nurses attending him lest a



The Cullinan Diamond and the nine pieces into which it was cut.

By permission of Walter S. Hiatt

slip of his hand should bring on heart failure. From it came nine large diamonds and 96 others of miscellaneous sizes. Cullinan I which weighs 530 carats is the world's largest polished diamond. It reposes in the Royal scepter of King George VI. In the Imperial State Crown rests Cullinan II. It is the second largest diamond weighing 309 carats. The others are scattered among Britain's crown jewels.

JONKER

The Jonker Diamond was found only a few years ago by Johannes Mokane on the land of Jacobus Jonker only three miles from where the Cullinan diamond was found in 1905. Consider the case of Jacobus Jonker, sixty odd years of age, who had been working in the river-beds all his life for small returns. In January of 1934, not far from Premier Mine there was uncovered on his property a 726 carat flawless, blue-white diamond as large as a small egg, the largest in recent years which brought him over 300,000 dollars. A "bright pebble" indeed to bring sunshine into his later years. The Jonker diamond became at once one of the world's largest diamonds.

The discoverer of this famous diamond was given but fifty dollars for finding it. In 1934 the Jonker diamond was bought by Sir Ernest Oppenheimer for 312,000 dollars and in 1936 it was sold to Mr. Harry Winston, a diamond merchant of New York, for the sum of 725,000 dollars.

THE GREAT SANCY

This diamond has a great history. Even if it weighs but 53½ carats and is worth hardly a million dollars, it is entitled to a high place among the noted gems. It was an heirloom in the family of the Duke of Burgundy. In one of the many fierce battles in which the dukes engaged in the stormy Middle Ages, the Burgundian chief was cut down, and on his body some human vulture found and carried off the diamond. He sold it to the King of Portugal. Ten years later the King, sorely pressed for money, sold it to the Baron de Sancy, who sent it to the King of France as a present. Unhappily, news of the present went before, and a band of robbers attacked the messenger and slew him. The faithful man, in his last agony, determined to balk his assassins. He swallowed the diamond. The baron was dismayed when he heard the news; but the practical monarch speedily had the corpse of the dead messenger cut open, and the jewel was found undigested in his stomach. From the King of France the Sancy passed to James the Second of England as the price of one of those acts of subserviency which eventually cost James his throne. In his exile and poverty poor James sold it back to the French for 125,000 dollars and it remained among the French crown jewels till the Revolution.

This diamond, Sancy, was at the Paris World's Exposition of 1867, having previously changed owners many times. It was later sent again to Bombay and from a jeweler there was purchased in 1875 by the Maharaja of

Patiala. It is set in platinum and forms part of a necklace. Dr. Kunz stated later that this diamond is now in the possession of Lady Astor.

FLORENTINE

This gem is also known as the Austrian Yellow and Grand Duke of Tuscany. It is an Indian diamond of odd shape and unusual cutting—a beautiful double rose-cut. It has 126 facets and has the form of a star with nine rays. The Florentine is one of the largest of famous diamonds. It weighs 139.5 carats, and is worth 700,000 thalers. The first recorded mention of this diamond was made by the French traveler, Tavernier, in 1657 who saw it in the collection of the Grand Duke of Tuscany. It bears the name of his capital city, Florence. Later it was sent to Austria and, after a barter of land and wealth, became part of the Austrian Crown jewels. Its history is not so exciting as its radiant beauty.

The Florentine is the same stone which Charles the Bold lost in the battle of Granson together with other valuables. A Swiss who found it sold it to a clergyman for a florin; the priest sold it for three francs to the citizen of Berne. The next possessor who gave 5,000 florins for the jewel, besides a present to May, the magistrate, sold it to a Genoese, from whom Lodovico Moro Sporza of Milan obtained it for about 10,000 florins. Pope Julius Second, however, gave 20,000 ducats for the gem when the Milanese treasure was sold.

THE AUSTRIAN DIAMOND

The Austrian Diamond is a beautiful lemon yellow color and cut in a rose. Its weight is 139 carats. It was purchased for a bit of rock crystal in a stall in the market place of Florence at the cost of a few pence. It belonged first to the Grand Duke of Tuscany, and is now in the possession of Austria.

DRESDEN GREEN DIAMOND

There is a very fine green diamond among the jewels of the celebrated "green vaults" collected by one of the Kings of Saxony at Dresden, Germany. This gem is the largest in the "Green Vaults" of Dresden and, owing to its peculiar green tint, one of the rarest diamonds in the world. This rare stone weighs 48½ carats. It is probably of Indian origin, but nothing seems to be known of its antecedents. It is valued, according to Kluge at 30,000 pounds sterling, a very large sum for a stone of such a small size, but accounted for by its unique character. It was the Saxon monarch's weakness to collect the most valuable jewels and the oddly shaped pearls and other curiosities of the vaults. They must, however, have been exceedingly interesting. Mr. Streeter had at one time a small red diamond, altogether unique of its kind, for which he asked one thousand pounds sterling although it weighed only three-quarters of a carat.

The Dresden Green was purchased in 1743 by King August the Strong of Saxony for the Royal Treasury. He is

said have paid 60,000 dollars for it. It was valued by Kluge, a German authority, in 1860 at 150,000 dollars. It is apple-green in color and is perfectly transparent and flawless.

Another green diamond in this collection (August the Strong) is a brilliant weighing 40 carats which, it is said, the King was accustomed to wear in his hat.

ENGLISH DRESDEN

The English Dresden, so called to distinguish it from the Green Dresden, is one of the few large diamonds that have been obtained from Brazilian mines. It weighed in the rough 119½ carats. The rough stone was found about 1857 in the Bagagem district, Brazil, the locality in which nearly all the large Brazilian stones have been found. The same year it came into the possession of Mr. E. Dresden of London, England, who after cutting it, offered it for sale to various crown princes of Europe without success. He finally sold it for 200,000 dollars to an English merchant in Bombay, India. This merchant was a large dealer in cotton and was able to purchase the diamond through profits made possible by the great increase in the price of this commodity during the American Civil War. Shortly after his purchase of the stone, however, the war ended, the price of cotton fell to such a low point that, lacking capital which he had invested in the gem, the merchant failed. The shock of failure soon brought on his sickness and death. The stone was then sold by his executors to the Gaikwar of Baroda, in whose possession, it still remains so far as is known.

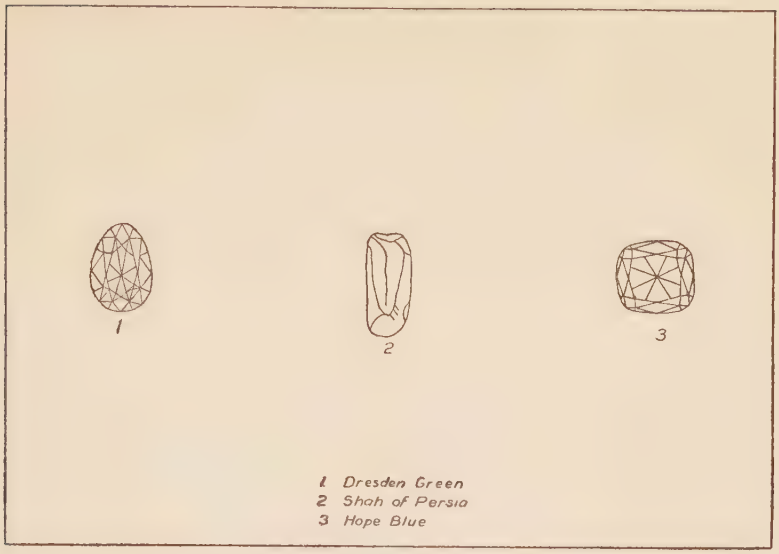
THE POLAR STAR

Next to the "Orloff", "Moon of Mountains", and "Shah", the largest and finest diamond which belonged to the Russian Crown, is the "Polar Star". It was purchased by England for the Imperial Regalia, and is remarkable for its purity and luster. It is brilliant cut, and weighs 40 carats.

THE MOON OF MOUNTAINS

After unravelling the intricate history of the "Orloff", so often interwoven with that of the "Moon of Mountains", the tragic story of the latter gem flows smoothly enough. That this diamond originally belonged to the Mogul emperors, and passed from them together with a vast quantity of other treasures, to Nadir Shah, is highly probable. It seems to have been in the Persian conqueror's possession for many years. It was most probably found in Delhi the place, of all those visited by his destroying hosts, by far the most likely to have harbored a rare stone, such as this. It was said to have been one of the two large diamonds which ornamented Nadir's throne, and which were respectively known as the "Sun of the Sea", and the "Moon of Mountains".

Shafrass, an Armenian, became the possessor of it by murdering the owner of the diamond. Through negotiations Prince Orloff bought it from Shafrass for Catherine of Russia, 1766, for 90,000 pounds sterling and a patent of nobility. The Armenian had no connection with the "Orloff" as some claim.



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SHAH OF PERSIA

As has more than once been true of famous diamonds, this one represents the price of a man's life. On January 30, 1829, A. Griboiedov, the Russian Ambassador to Persia and a famous author, was murdered in Teheran, Persia. Feeling in Russia against the Persian Government ran high and war was threatened until, to conciliate Russia, this diamond was sent to the Czar at St. Petersburg by a special Persian envoy as a gift. By this acknowledgment of fault and offering of indemnity on the part of Persia, Russia was appeased and war was averted. The diamond was kept in the Diamond Room of the Winter Palace at St. Petersburg up to 1914. In that year, however, it was removed from St. Petersburg to Moscow and in 1922 was

added to the "Russian Diamond Treasure" of the Union of Soviet Republics.

Previous to its acquisition by Russia, the diamond had had a long and checkered career and, fortunately for history, important dates in that career are marked on the diamond itself. It is one of the few known engraved diamonds.

The diamond has been little altered from its natural form by its various possessors, this form being an elongated octahedron. Some of the natural facets have been polished and the others have been left in the natural state. The stone is not of the finest water, since it has a yellowish tinge. It is, however, of perfect transparency. Its weight is 86.5 metric carats. The models that have been made of the stone represent it but imperfectly.

STAR OF ESTE

This is comparatively a small diamond, weighing only 26 carats. It appears larger, however, because of its well-designed proportions. In purity and brilliancy it is said to be of the highest quality. It has been valued at 25,000 dollars. It derives its name from having been owned for many years, before his death, by the Archduke Franz Ferdinand of Austria-Este, heir to the throne of Austria-Hungary. It will be recalled that the assassination of this prince, in Sarajevo, June 28, 1914, was the immediate cause of the World War. What subsequent disposition has been made of this diamond after the death of the Prince is unknown.

BORT OR BOART

Some diamonds are dark gray, and even black. They exhibit a more or less imperfectly crystalline structure, and are known as black diamonds, bort (boart), or carbonado. Boart is an imperfectly crystallized, translucent, dark-colored diamond which has various colors, but no clear portions, and is therefore useless as a gem. Boart is used in drilling of rocks and in cutting and polishing other stones. Boart and carbonado are usually regarded as forms intermediate between diamonds and graphite.

When we think of a white stone we instinctively visualize a diamond, because this gem alone among the galaxy of brilliant colored stones is notably without color. However, we should not attempt to analyze the appeal of the diamond in terms of its white color because it is the brilliance of its reflection that constitutes its appeal and not the color of purity and innocence which white suggests. The appeal of the diamond is one of ostentation, of glamour, and of display. In the Occidental world at least the wearing of diamonds belongs to a culture already well advanced. There are no European myths that link the diamond with romances of early centuries. It is far too sophisticated, too hardly brilliant in its glitter to measure emotions in primitive terms.

CHAPTER TWELVE

OTHER PRECIOUS STONES

At one time when you said "jewels" to a lady of fashion in New York, you meant diamonds—nothing less. There are, however, other stones which are not to be despised. The emerald has come into fashion, and pure flawless emeralds of one to two carats are worth nearly as much as diamonds.

Precious stones other than diamonds are emerald, ruby, and sapphire. Semi-precious stones are topaz, spinel, garnet, zircon, and peridot. The softest of all gems are pearls, which are not stones at all, but a kind of cancerous growth in oysters. Rubies, sapphires, and emeralds will also stick to the tables as the diamonds, but all other minerals flow down over them and are washed away. The greased tables save DeBeers more than 400,000 dollars a year in time and labor.

Perfect emeralds of a bright green, well proportioned, are as rare as diamonds. The emerald possesses a history older than that of the diamond. There was a fine emerald in the breastplate of the Jewish high priest. It is certain that Nero, who had weak eyes, used spectacles made of

emeralds, and watched the fights of gladiators through them. Pliny mentions a statue of a lion with emerald eyes which was set over the grave of Hermione on the shore of Cyprus. Many large emeralds are owned by monarchs in Europe and Asia, but as the value of the emerald does not increase as the square of its weight like the diamond, they are not as famous as the large diamonds.

The green color embodied in the emerald invariably calls to mind the verdure of spring; the budding of life; victory over the cold of winter; faith in the fruition of plenty which comes with summer.

Emeralds were the favorite gems of Cleopatra. They were the embodiment of royalty for what was probably the most gem-bedecked queen of all time. Many of the green stones such as chrysoprase were often called, "victory stones" by the old writers. Such a gem is reputed to have been worn by Alexander the Great in his girdle.

The ruby, when it is fine and large and of the right color, is one of the most valuable of all stones, nearly as valuable as diamonds. To be first-class a ruby must be of the color of blood—bright, sharp red. More than half of the rubies of commerce are inferior semi-precious stones called spinels.

According to a Hindu folk-tale that recounts the birth legend of the ruby, this fiery stone was once a diamond. Its color was changed to red by the lifeblood of a Maharanee slain in anger, disappointment and envy. The stone was subsequently placed as the red glowing eye in the image of Siva, the destroyer.

The sapphire has the same composition, hardness, electrical and other properties as the ruby. It differs in name from the ruby on account of its color, which varies from white to the deepest blue and black. To the sapphire has been ascribed the following magical properties: it prevents evil and impure thoughts; it is such an enemy of poison, that if put into a glass with a spider or venomous reptile, the creature would die.

Blue stones call to mind truth and constancy. There is something of divinity, something of heaven, in the deep blue of the sapphire or the opaque ultra marine of lapis lazuli. In the Vedic tale of the churning of the ocean, the sapphire was born from the last concentrated drop of Amrita, the drink of the Gods "whose shadow is immortality". Because this legend originated in India where Kashmirian or Singhalese sapphires must have been known in very early times, we have every reason to assume that the writer of the Rig Veda referred to the blue sapphire. The sapphire mentioned many times in the older books of the Bible, on the other hand, was in reality lapis lazuli. This latter is the blue stone referred to in the Talmudic legend as being the material upon which the Ten Commandments were engraved.

Many and various are the legends involving blue stones, but always their symbolism points to immortality, to divinity, to heaven. It is significant that the human-headed falcon that in Old Egypt represented the soul had its feathers beautifully inlaid with slabs of turquoise and lapis lazuli.

Sapphires are found to be much larger in size than rubies.

Several weighing over 100 carats, are exhibited from time to time at the courts of Europe.

Topaz, zircon, emerald, garnet, quartz, amethyst, onyx, agate, opal, and pearls found in the shells of oysters are made up of the composition of silica, carbonates and organic matter.

The topaz affords a striking illustration of the vicissitudes of fashion. A century ago this brilliant yellow gem, which is identical with the ruby and sapphire in everything but color, was nearly as valuable as they. Now it has no value worth mentioning as a jewel, and is chiefly used for optical purposes and by clock-makers.

The bluish-violet mineral hyacinth has been known for many years as an inferior gem-stone. The name hyacinth is not altogether a good one, although it has been applied by jewelers to all of the zircon gems. Zirconium does not occur free in nature. As a mineral, zircon is found chiefly in India and Ceylon. Zircon is essentially an Oriental gem. It is found in the sand as grains.

Zircon is much oftener met with in the bazaars of Ceylon than in the jewelry shops of Fifth Avenue and the Rue de la Paix. The sixth of the seven Moslem heavens is said to be composed of yellow jacinth, which is one of the names for the gem zircon.

In hardness zircon is 7.5, rather harder than quartz but not as hard as topaz. It is therefore not altogether suitable as a ring stone, but with a range of color that is highly attractive and an index of refraction that enables them, when cut, to rival the diamond in brilliancy. With all the strik-

ing and attracting colors characteristic of the zircon gem, it seems indeed strange that the only variety of this gem mineral that is at all popular at present, should be an artificially produced color. This is a steely blue zircon gem of great brilliancy and dispersion when cut.

Recently the amethyst, a much finer crystal of quartz, has become quite popular. It is not a precious stone; but its violet color and, if properly cut, its play of light, are pleasing, and often fascinate purchasers of jewelry.

The turquoise has been a favorite gem for centuries. Shylock wept over his lost turquoise, and Mohammed's followers slaughtered Christians with scimitars adorned on the hilts with turquoises engraved with the sacred name of Allah.

The only precious stone which defies imitation is the opal. This brilliant gem, whose play of color is unequaled elsewhere in nature, is found in Hungary and Honduras. It is a form of quartz with an admixture of water and air in infinitesimal crevices. When moved about in the sunlight it exhibits all the prismatic colors in such a variety, and with such sudden and inexplicable whim, that it seems to possess a life within itself. Large opals are rare, and have always been valued at very high prices. There is an opal in the museum at Vienna valued at 250,000 dollars. Marc Antony is said to have sent a Roman Senator into exile because he would not sell his opal ring which Antony desired. Unlike the emerald and the sapphire or ruby, the opal looks best alone either in ring or breastpin. Like the diamond it is its own best companion.

The garnet was the favorite gem of Mary Stuart, that tragic queen whose life was swayed by passion, and whose blood in the end stained the headsman's axe.

In marked contrast to the cold glitter of the diamond is the warm serene glow of a pearl of fine luster. There is something of life, something vitally individualistic about the pearl. It is as if the one who wore them wore part of herself suspended from her neck. The fabulous and much discussed draught of pearls of Cleopatra was not a meaningless gesture. She seemed to drink something that pulsated with her own vivid vitality.

Its purity and delicacy of tint, its inimitable perfection of form, its exquisite effect when laid upon the smooth white neck or the braided hair of a fair girl, have rendered it a deserved favorite with the sex. When a love-struck swain wishes to condense into one word all his admiration for his lady love, he calls her his "pearl". No lover in his senses ever addressed his lady friend as his sapphire or his turquoise. Pearls, as every one knows, are found in oysters and mussels. Large pearls were owned by the Romans. A cart was required to carry off the pearls which Pompey took from Mithridates.

In our day pearls are found in the Red Sea, off Ceylon, and some other Indian islands, in the Gulf of Panama in the Pacific, and in many streams and rivers in all the continents.

Pearls are measured by the grain, not the carat. False pearls are common. Stage pearls can be bought by the pound at a small expense. An experienced eye detects them

at a glance. Generally artificial pearls are more brittle than the real gems.

Substances used in jewelry not properly precious stones are: moonstones, malachite, jet, jade, amber, coral, etc. Spinel is a mineral of magnesia and alumina coming from impurities in the iron.

The name corundum itself is of Indian origin and is applied only to the opaque massive varieties of hard mineral next to those of diamonds, generally of a dull color. Its composition is alumina, 98.5 per cent; oxide of iron, 1 per cent; and lime, .05 per cent.

CHAPTER THIRTEEN

THE BUYING AND USES OF DIAMONDS

In order to buy diamonds one should have a good knowledge of the stones and their values, or good judgement in selecting a dealer, and confidence in him. It is owing to the lack of these in transactions in which the general public takes part that so many poor stones are sold at unreasonably high prices.

In examining diamonds there are a great many things which befog the judgement of inexperienced buyers. It is impossible to see a diamond at its best in some stores. One must know the light and surroundings to judge the stone properly. In other stores, the light is so strong that the brilliant reflections hide faults. Often the strong sunlight will make a false color stone appear so blue that one could hardly believe it to be the same stone when seen under another light.

The diamond is probably one of the most lasting investments that can be made today. It does not wear out like the sealskin coat, nor go out of fashion as all clothes

do. In still another sense, it is an investment, for it is productive of larger returns of pleasure than most things. It will continue to pay interest in that way after a hundred fashions have come and gone.

Americans spend many millions of dollars for diamonds every year. They buy three-fourths of all the finest stones taken annually from the great South African mines. Each year they purchase from 75,000,000 to 100,000,000 dollars worth of diamonds, over a quarter of a million each day. They have bought so many that they have grown difficult to please and will not buy anything but the best. The average American stenographer wears a finer diamond in her engagement ring than any possessed by the bejeweled royal ladies of Henry VIII's court. This is not because the rough diamonds recovered from South Africa mines today are so much better in quality than those found centuries ago in India and not so long ago in Brazil, but because the method of cutting them has improved enormously.

In Europe great diamonds are a badge of caste. When a man puts them on his wife he means to say we intend to belong to the aristocracy. Sometimes he succeeds; sometimes he does not. It is generally a question of money. If he has money enough, aristocracy scrutinizes his balance sheet and admits him.

Before 1848 but few diamonds were imported into the United States. With the increase of wealth caused by the discovery of gold in California a taste for rich jewels developed, and a demand for diamonds arose which has been increasing ever since. In the ten years succeeding 1849 the

value of gems duly entered at the custom-house of the United States rose from an annual average of 100,000 dollars to about one million. Most of the stones imported belong to the class of stones weighing less than half a carat. When pure and without blemish they sell here at the rate of fifty to sixty dollars per carat. Diamonds and all precious stones cost more in the United States, relatively speaking, than those sold in Europe.

In New York in 1866 a pure diamond weighing one carat was worth from ninety-five to one hundred and twenty-five dollars according to its brilliancy and the merit of the cutting.

Bright blue, green, or rose-colored diamonds, if perfect otherwise, are worth as much as white diamonds, but green ones are rare in this country. Over one carat, the price advances as the square of the weight.

The value of diamonds cannot be determined by absolute standards. Weight, cut, brilliancy, color, history, and perfection of the stones are factors that must be considered in estimating their value. It is, moreover, subject to fluctuation. Colorless diamonds bring higher prices than off-colored stones, but if decided tints of red, blue, or green are present they may increase the value abnormally.

Had you bought a fine one-carat stone in 1929 (the peak year for prices), you would have paid 750 dollars for it—and thereafter its value fell off to 500 dollars (depression low) in 1930. Yet during the year 1934 that same stone would have been worth 650 dollars. In other words, diamonds suffered a decline of not more than thirty-three and

one-third per cent during the beginning of depression, and today they have regained all but ten per cent of their high prices.

A London diamond syndicate controls the price and marketing of diamonds. Having reached London from South Africa in the rough, our diamonds are only half way through their journey to a glass case in some American jewelry shop.

Probably the first objects chosen for personal adornment were those most easily strung together, for example certain shells and brilliant seeds. The harder gems were hoarded as pretty toys long before they could be adjusted for use as ornaments.

Fifty per cent of all diamonds are used industrially, and two-fifths of these are all applied to the grinding wheels. To shape the hard surface of emery, of carborundum, and of tungsten carbide, only the diamond can be economically used.

One of the principal uses of diamonds is in the manufacture of jewelry. Today a woman reaches the peak of happiness when her lover places a beautifully-cut diamond set in a gold ring upon the third finger of her left hand. Her beloved uses the diamond as a token of his love and it becomes a covenant between them that they belong to each other. It has been said, "The diamond is to the pearl as the sun is to the moon".

The use of the diamond for other purposes than jewelry depends upon its extreme hardness. It has always been

the only material used for cutting or engraving the diamond itself.

Diamonds are now employed not only for faceting precious stones, but also for cutting and drilling glass and porcelain; for fine engraving such as the marking of scales; in dentistry for drilling; as twining tools for electric-light carbons; for finishing accurate turning work such as the axle of a transit instrument. For these tools the stone is actually shaped to the best form. It is now electroplated before being set in its metal mount in order to secure firm fastening. It is also used for bearings in watches and electric meters.

To turn machine parts of all kinds is another of the diamond duties. The Ford Motor Company, for instance, uses many diamonds for this purpose.

Another important use for diamonds is in drawing wire. Here the metal is drawn through a round hole drilled in a diamond die. A series of such dies, with different sized holes, will reduce the wire to the desired diameter. So hard is the diamond that 300 to 400 tons of copper can be drawn through such a die before any enlargement of the hole takes place. That makes a wire, of the diameter used in radio sets, long enough to go around the world twenty times. Gold, silver, platinum, iron, and tungsten are also made into wire by this means.

Diamonds with holes in them are also fitted into oil nozzles to be used in the furnaces of our homes and factories. This is a rapidly growing use. By passing the oil

through a diamond, a constant, correctly shaped spray of oil is delivered and the efficiency of the nozzle is not impaired by the action of grit or acid in the oil, or by the great heat.

Boring the hole in a diamond for a die or a nozzle is an interesting process. A needle, impregnated with diamond dust, hammers away on the stone for about a week before the hole is bored. This drilling operation costs seven times as much as the diamond itself.

About forty-five per cent of the product of African diamond mines consist of bort, an opaque dark colored variety of diamond, called also black diamond. Such crystals weighing from one-half to one carat each are used extensively as teeth in stone-saws for sawing marble and stone for building purposes.

CHAPTER FOURTEEN

HOW TO MAKE SYNTHETIC DIAMONDS

Carbon is one of the most interesting of all the ninety-two elements, because of the many forms in which the pure element is found and the infinite number of compounds of which it is a component part. One of the most interesting forms of carbon is the diamond, not only because of its high value but also because of the amount of work which has been done to obtain it by means of synthesis. A great deal of work still remains to be done before synthetic diamonds can be produced on a commercial basis.

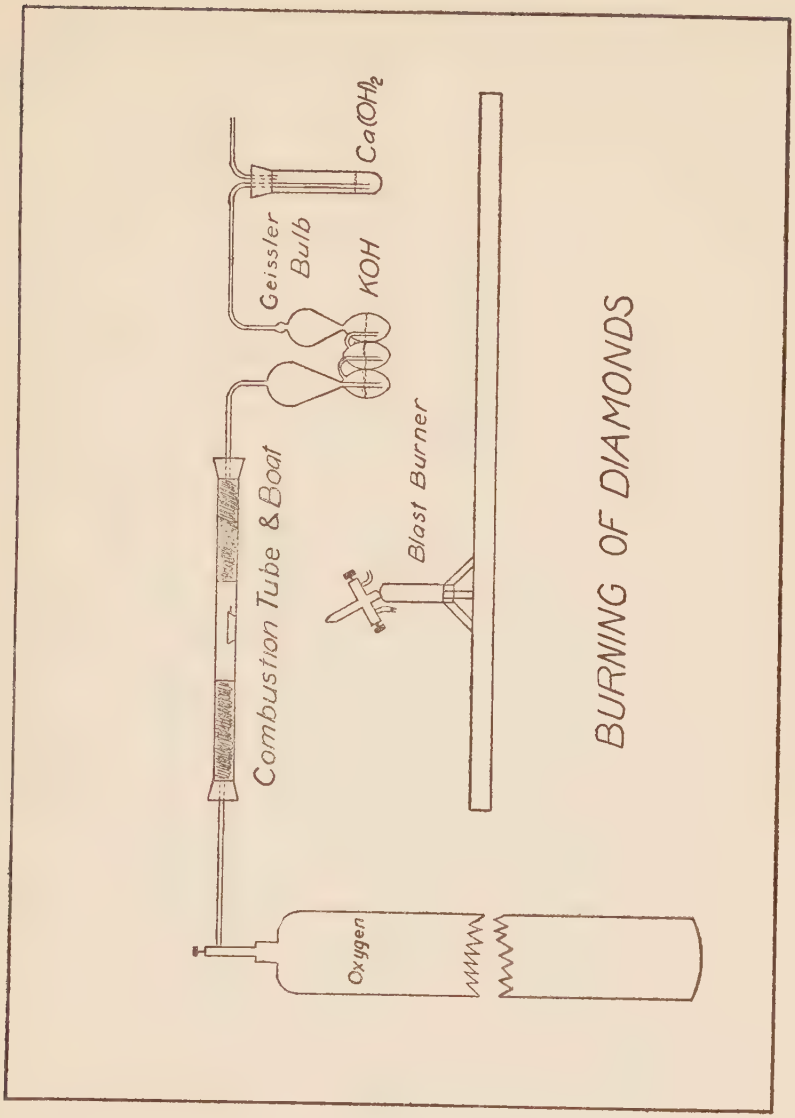
Soon after Lavoisier demonstrated in his remarkable work that diamond was crystalline carbon, attempts at its artificial preparation were made. Many attempts have been made to manufacture synthetic diamonds, that is, to enhance the commercial value of carbon by transforming it from its ordinary opaque black condition to limpid crystals of diamond. The attempts made in this direction have been numerous, but little has been done in a methodical and systematic manner. If we except some important works on the subject, we see from the historical side of the question, how much contradictory or doubtful matter has been published. However, while the number of experiments has been

large, the publications have not been as extended as one would at first expect. It appears, without doubt, that many of the workers have considered more the synthetic preparation of carbon for the diamond than the study of the different allotropic forms of carbon.

Among the first attempts to make synthetic diamonds may be mentioned that of J. B. Hannay of Glasgow, who commenced his experiments in 1879. After many trials, some of which resulted in violent explosions, he is said to have succeeded. The method adopted by Mr. Hannay is described as follows:

> A tube twenty inches long by four inches in diameter was bored so as to have an internal diameter of half an inch. In the tube was placed a mixture of ninety per cent of rectified bone oil, and ten per cent of paraffin spirit, together with four grams of the metal lithium. The open end of the tube was welded air-tight, and the whole mass was heated to redness for fourteen hours; on opening it a great volume of gas rushed from the tube, and within was a hard, smooth mass adhering to the sides of the tube. It was quite black, and appeared to be composed of iron and lithium, but on closer inspection small transparent pieces were found imbedded in it. The mass was dissolved, and the small transparent pieces proved to be 'crystalline carbon', exactly like diamonds but almost microscopic.
>
> Out of eighty complex and extensive experiments only three succeeded. Violent explosions were frequent, steel tubes burst, scattering their fragments around, and furnaces were blown up. 'The continued strain on the nerves', writes Mr. Hannay, 'watching the temperature of the furnace, and in a state of tension in case of an explosion, induces a nervous state which is extremely weakening, and when the explosion occurs it sometimes shakes one so severely that sickness supervenes'.[1]

[1] Williams, Gardner F., *The Diamond Mines of South Africa*, B. F. Buck and Co., N. Y., 1906, Vol. II, p. 138.


Ca(OH)2
Geissler Bulb
KOH
Blast Burner
Combustion Tube & Boat
Oxygen
BURNING OF DIAMONDS

Sir William Crookes attributes the possibility of making artificial diamonds to the facilities afforded by the enormously high temperatures which have been obtainable only in recent years by the use of electricity. While electricity has, no doubt, played an important part in the scientific researches during the last decades of the nineteenth century, Mr. Hannay's experiments would indicate that it is not absolutely essential to have extremely high temperatures or pressures in order to produce artificial diamonds. Still Sir William Crookes shows that by means of these high temperatures substances such as carbon obey the common laws which govern other substances, and can be made volatile and fusible under certain conditions. He has demonstrated that the temperature necessary to volatilize pure carbon is about 3,600° C., and that it passes into the gaseous state without liquefying. He infers that, if, however, sufficient pressure were applied with the high temperature, liquid carbon would be produced which upon cooling would crystallize in diamonds. In making this product the absence of oxygen is absolutely necessary since carbon at high temperatures is chemically most energetic, and if it can possibly get at oxygen from the atmosphere or from any compound containing oxygen it will combine with it and fly off in the form of carbon dioxide. Heat and pressure, therefore, are of no value unless the carbon can be kept inert.

Sir William Crookes went through the process of producing diamonds before the eyes of his audience, but was able to show them the result of his experiment only by pro-

ducing a lantern slide of microscopic diamonds which he had made in the same way previously, for it takes a fortnight to separate them from the iron and other substances in which they are imbedded.

The scientific principle upon which this experiment rests, according to Sir William Crookes, is that iron dissolves carbon, and it increases in volume as it passes from the liquid to the solid state. Authorities differ somewhat as to the exact moment when molten iron expands in cooling, but it is the generally accepted theory that expansion takes place at the moment of solidification. It is also a well-known fact that shrinkage or contraction takes place as the solidified metal cools. It is therefore possible to obtain enormous pressure in the molten center of a casting by the contraction of the outer shell which has been rapidly cooled and the expansion of the inner mass just as it begins to solidify. This process supplies the two factors necessary for the crystallization of the diamond—heat and pressure.

Of the early attempts to make synthetic diamonds the most successful was that of Henri Moissan, a Frenchman, who, after patient and careful experimenting succeeded in 1896 in obtaining minute particles of diamonds. He very carefully investigated the scheme that Nature employed in making her diamonds and he found that she did so by heating carbon to a very high temperature and cooling it suddenly under enormous pressure. Swedish iron was melted in the presence of sugar carbon in an electric furnace at a temperature which seldom exceeded two thousand degrees Centigrade. When the iron was saturated with

the carbon at the temperature of the electric furnace the crucible containing the fused metal was removed from the furnace and plunged into ice cold water. The pressure produced by the quick chilling of the outer crust with an internal expansion changed the black sugar carbon to crystal diamonds. The iron of the solidified mass was dissolved in strong acids. From this residue Moissan obtained tiny crystals which had the properties of diamonds. His largest synthetic diamonds were three-fourths of a millimeter in diameter.

In a paper to the Royal Society in 1888 Hon. Sir Charles Parsons described experiments in which a carbon rod heated by a current of electricity was immersed in liquids at pressures up to 2,200 atmospheres, and in which the liquids—benzene, paraffin, and bisulfide of carbon—were found to yield deposits of amorphous carbon.

In another paper to the Royal Society in 1934 he gave the following method. A deep iron dish was packed tightly with graphite, and above the graphite was filled in loosely to a depth of half an inch covering the ingot of iron. An arc was struck by a carbon on to the ingot submerged in the loose graphite. When the iron was well boiled the ingot remained in the bed until it had quite set, hard enough to handle with the iron spoon, and then cooled in water and mercury. It gave a fair diamond residue. About one to three per cent of other elements such as manganese, cobalt, and silicon added to iron appeared to give the best results.

It has been long known that iron, when melted, dis-

J. WILLARD HERSHEY

The author in his testing laboratory at McPherson College.

Getting ready to make diamonds—Charles Wagner (assistant) and J. Willard Hershey at the furnace.

solves carbon, and on cooling, liberates it in the form of graphite. Moissan discovered that several other metals, especially silver, have similar properties. The quantity of carbon entering into solution increases with the temperature.

For the manufacturing of artificial diamonds the first necessity is to select pure iron free from sulphur, silicon, phosphorus, etc., and to pack it in a carbon crucible with the pure charcoal of some organic substance such as sugar and starch. Moissan used such a mixture in a furnace with 700 amperes and 40 volts. Beside graphite and diamonds there may be formed black opaque carbon particles of a density from 3.0 to 3.5 and the hardness of diamonds. These are black diamonds or carbonado. In fact comparatively few diamonds are transparent and colorless and show crystalline structure. Besides these may be carbide of silicon and corundum, arising from impurities in the material employed. Graphite dissolves in hydrofluoric acid. Graphitic oxide may be left.

Crookes says Sir James Dewar placed a few small diamonds in a carbon tube, and, maintaining a current of hydrogen to prevent oxidation, raised the temperature of the tube in an electric furnace to that of the arc. In a few minutes the diamond was transformed into graphite.

To remove graphite after it is well washed allow it to soak in strong hydrofluoric acid in the cold for two days, then in boiling acid. After this treatment, hot sulfuric acid is again applied to remove the fluorides. The residue is well washed and again treated with nitric acid and potassium

chlorate—kept warm but not above 60° C. to prevent explosion. By repeating this process six or eight times all of the graphite will disappear.

An article that appeared in Nature (London), May 19, 1928, treats the problem of the making of artificial diamonds. The author, who is known as C. H. D., refers to the experiments and results of various experimenters, among whom are Crookes, Parsons, and others. His general conclusion, drawn from the experiments of these men, is that no artificial diamonds have been produced in the laboratory as yet.

In the Philosophical Magazine, March, 1929, in an article written by Sesta, the thesis that no synthetic diamonds were ever made in the laboratory is discussed. Dr. Sesta argues that the work of Professor La Rosa has undoubtedly escaped the attention of the above mentioned author. Dr. Sesta claims that these objections raised against the method of Moissan and his followers are groundless so far as the case has been examined. He further states that the results of the experiments and the accuracy of method are sure proofs which lead him to withdraw from the ultimate conclusion arrived at by C. H. D.

In 1923 an article appeared in a McPherson, Kansas, newspaper to the effect that diamonds had never been manufactured and, in the opinion of its writer, a noted scientist, never would be. We read the article with interest because, secretly, for years, it had been our belief that some day science would succeed in what then seemed to the best trained minds in the field an impossible task. It was deter-

mined to conduct experiments along the lines already thought out. In our opinion views of Moissan that diamonds are made by the compression of carbon are correct, but his method of making them may be improved upon.

A plan of the procedure was outlined and the assignment given to senior students working in the chemistry department. The first step in the plan was to secure an electric arc furnace capable of producing a temperature of 3,000 to 4,000 degrees Centigrade—about twice the temperature obtained by Moissan.

It was soon learned that no such furnace could be obtained from laboratory equipment companies in either the United States or Europe. The use of an oxygen-hydrogen blowtorch was next suggested, and the necessary equipment was transferred to a local welding shop for an experiment. However, it was found that the oxygen from the torch burned away all the carbon from the mixture of carbon and iron before the desired temperature could be obtained.

Next firebrick was secured from a steel foundry and attempts were made to build our own electric arc furnace. A neat furnace was constructed, but its first trial proved that its current consumption was too great for the ordinary power lines leading to the college. The equipment was transferred to the municipal lighting plant, where sufficient current could be obtained. Here the furnace was reduced to a glazed mass of molten rock by its own heat. The outlook was very discouraging.

The next five years were spent in gathering equipment and information. At last, a man was found in Chicago who

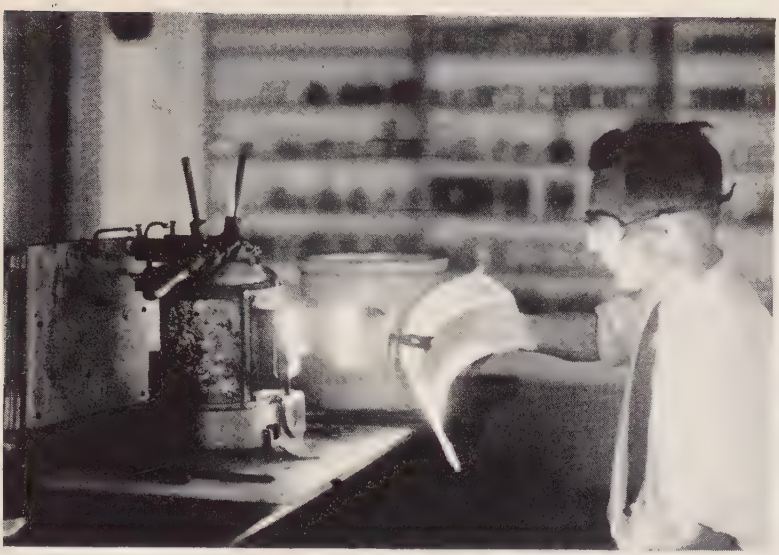
was confident that he could build a furnace of the required type. Special steels were generously contributed by steel companies and after a great deal of work and research, the furnace was completed—a simple affair no larger than a two-gallon pail, but capable of producing temperatures exceeding 4,000 degrees, Centigrade.

Crucibles and electrodes of chemically pure synthetic graphite were made by the Acheson Graphite Company at Niagara Falls for use in the furnace. It was necessary to install a special transformer and a heavy power line, since the power consumption of the electric furnace was extremely high.

On June 7, 1929, a mixture of two parts of chemically pure iron filings and one part of pure sugar carbon, parts taken by volume, was placed in a graphite crucible, which in turn was placed in the furnace and heated continuously for one hour and seven minutes, after which the crucible was removed and plunged into freezing mixture.

As the white hot molten iron cooled to a red solid, it expanded. As it cooled from a red solid to room temperature, it contracted. Thus the outside surface of the iron, which cools more rapidly than the inside of the mass, contracted while the inside still expanded. The carbon which dissolved in the iron was thus subjected to a pressure estimated at 180,000 pounds, or ninety tons, per square inch.

The hardened mass of carbon and iron was removed from the freezing mixture and treated with hot aqua regia for 300 hours to dissolve the iron. The residue, mostly amorphous carbon and graphite, was digested as much as



The furnace in operation by one of the author's assistants.

Mr. Lloyd, another of the author's assistants, with carbon arc furnace.

possible in various acid solutions. The search for diamonds was then begun in the black carbon dust.

After two days of searching with microscopes by the assistants and students interested in this work we were rewarded for our labors. Two stones were found, which, after being tested were found to be pure transparent diamonds of the finest quality. These diamonds, although quite small, were the largest synthetic diamonds on record.

Since that time, McPherson College chemistry students have continued the experiments using different forms of carbon, different metals and alloys as solvents for the carbon, and different methods of procedure.

Some of the solvents recently used besides pure iron, are meteorite iron, copper, silver, lead, nickel-steel, manganese-steel, tungsten, aluminum, and blue ground from the South African diamond mines. None of these proved to be so suitable as pure iron filings. Carbon did not dissolve in copper at all, and not very readily in molten silver. Tungsten was heated in the furnace for about two hours because of its high melting point and by that time most of the carbon was burned away into carbon dioxide. The tungsten on cooling was found to be changed largely into an oxide, tinted somewhat yellow. No diamonds were formed when lead was used. The lead seemed to form carbide of lead. When aluminum was used as a solvent for carbon, some hard crystals having the appearance of diamonds were formed, but these would not withstand the tests to which they were subjected. Probably they were carbide of aluminum or spinel.

In the mines of South Africa, diamonds are found in a hard blue ground which may have had some part in forming diamonds in nature. With this fact in mind, some blue ground was obtained from South Africa and used in an experiment as a solvent for carbon. This blue ground worked in much the same way as iron until it was treated with acid in an attempt to dissolve it. The mass then became as hard as concrete and nothing more could be done with it.

Recently, other substances have been substituted for sugar carbon, especially pure gum arabic—a form of starch —since this has a larger number of carbon atoms per molecule. Coal, wood-charcoal, coke, petroleum carbon, and other forms of carbon were used, but the most successful has been gum arabic.

In most cases the atmosphere of the furnace during the heating was one atmosphere of the ordinary air. In a number of cases hydrogen was used as atmosphere during the experiment. A steady flow of hydrogen was passed into the furnace before the electric current was turned on and continued until the mass was completely fused. The hydrogen was generated a long distance from the furnace and dried by passing through calcium chloride before passing into the furnace. Some diamonds are formed in such an atmosphere but none larger than with ordinary atmosphere.

In several experiments a small natural diamond was used with the hope that it might serve as a nucleus for a larger diamond. In only one case, however, did we obtain a small diamond. But on that occasion we had not weighed the

nucleus diamond at the beginning. It could not be certain, therefore, whether the gem we took out was newly formed or the one that we had put in. More likely it was newly formed since the experiment was repeated a number of times afterwards and in none were any diamonds found. Probably the diamond that was put in at the beginning of each experiment was burned into carbon dioxide by the high temperature of the furnace.

An ice-brine solution has been used in most of the experiments to cool the hot molten mass taken from the furnace, but various other methods of cooling have been tried. In several experiments, all of which failed, the fused mass was allowed to cool slowly to room temperature. It appears that rapid cooling is necessary in order to form diamonds. In an attempt to secure more rapid cooling, liquid nitrogen and solid carbon dioxide were used. Neither was satisfactory. The instant hot molten iron was dropped into liquid nitrogen, the nitrogen changed to a gas, immediately forming an insulating atmosphere around the iron which prevented rapid cooling. When solid carbon dioxide was used, it was impossible to secure a surface contact which would cool the iron effectively.

When the white hot fused mass is thrown into the cold water (ice brine solution), some of the water burns and sometimes explodes since part of the water decomposes into hydrogen and oxygen. The stone jars that were first used for holding the cold water were usually broken when the hot fused mass was thrown into them. Recently large graphite crucibles have been used.

Several attempts were tried to use mercury for cooling. In one case the mercury was thrown on the red hot fused liquid. There was a violent explosion. Small hot metallic shots formed and flew all over the room. In another instance the fused mass was poured on top of the mercury. In this case very little explosion occurred. Diamonds were not formed in either case. Many other methods of cooling have been tried, but none has been as effective as the ice-brine solution.

It appears that it is not the extremely low temperature of the cooling agent, but the rate of change of the temperature of the molten iron that determines the pressure and the inner contraction of the iron and carbon mixture and forms diamonds.

In all of the above experiments alternating current was used. The heating was conducted as follows:— A mixture of chemically pure iron filings and starch carbon was heated in the furnace for one hour and fifteen minutes. The current used was 70 volts and 150 amperes.

On April 21, 1937, a direct current was supplied from the electric welder at the Churchill Boiler Works of McPherson. It was used in an experiment made in June, 1937. The procedure for this experiment was much like that for the one above excepting that in this case 100 volts and 250 amperes were used. An arc was struck between a carbon electrode in the welding holder and the surface of the mixture in the crucible. In the first case no diamonds were apparently made and in the second case very small crystals

scarcely large enough to be seen were formed. There is some doubt as to whether these were diamonds.

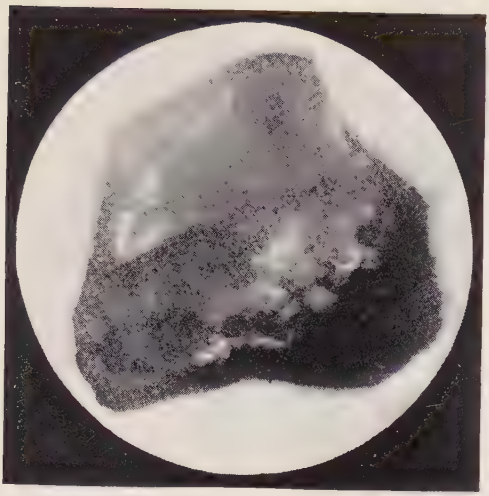
In the years since the first diamonds were made under the author's direction, a great deal has been accomplished. The procedure has been greatly improved and shortened. At present the iron from the furnace after being cooled is dissolved in hot aqua regia. The residue is digested first in hot concentrated sulfuric acid and dissolved potassium nitrate. The remaining residue is washed with water for several days and then searched for diamonds.

Recently a student (Jonathan Hamersley) proposed a new plan which may save a great deal of work. He suggested that after the residue is washed with water it be fused with potassium bisulfate, which has a specific gravity between that of graphite and diamonds. This would allow the diamonds and a few particles of carbon to sink to the bottom, while the graphite would float on top. After the mass would harden, the diamonds, if any, could be removed from the bottom of the solidified mass.

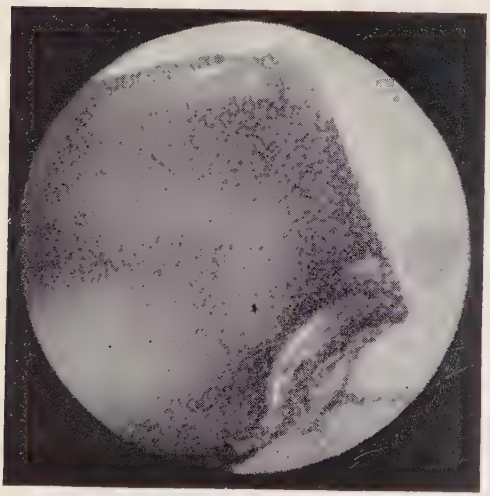
"When the hot, melted metals containing carbon are poured into the cooling bath, there is some tendency for the metal to form globules the size of a pea to much smaller globules. However, the sputter of the water is insufficient to make all the metal into globules the size of a pea. About three-fourths of the metal is in globules or chunks the size of a half dollar. If it is assumed that diamonds are most likely formed in globules the size of a pea, then these half dollar pieces are a great waste. A method

devised by the above mentioned student makes use of a sieve to produce globules of the desired size. The name given to this method is the "Drop Shot". The first piece of equipment necessary is a sieve that will stand molten metal. Fifteen holes were drilled in the bottom of a graphite crucible, exactly like the one used in the furnace. Against the bottom is directed the hottest possible flame of a compressed air-natural gas blast lamp. This is to prevent too rapid cooling of the fused metal which will not solidify in the sieve before running through and producing drop shot.

Fifty-seven pounds of iron were melted by the Hutchinson Foundry and at the same time it was poured, a pint of sugar carbon was mixed with the melted iron to see whether any of the sugar carbon would crystallize into diamonds. The purpose of trying this method instead of the usual one was to see whether we might get larger stones by using larger quantities of iron. After the iron had solidified it was dissolved in hydrochloric acid. It required over a year to complete the solution. The residue was then washed and searched for diamonds. Several dozen transparent crystals the size of an average pin head were found. Treating these with pure hydrofluoric acid failed to dissolve them in twenty-four hours, but after thirty-six hours they began to become somewhat soft. This proved that they could not be diamonds. They could not be the ordinary quartz since they remained in hydrofluoric acid for over a day without dissolving. They are probably minerals as spinels or corundum.



Largest synthetic diamond on record magnified 40 diameters.



A synthetic diamond magnified 30 diameters.

The identification tests used on the diamonds are the following: insolubility in hydrofluoric acid, hardness, specific gravity, index of refraction, and burning in an atmosphere of oxygen. The power of a transparent medium to refract a ray of light is expressed by a certain number called index of refraction. The phenomenon of dispersion shows that this number is different for rays of colors, or wave lengths. It is generally greater in proportion to the density of the medium.

A diamond is insoluble in hydrofluoric acid, although this dissolves most other substances. The hardness of a diamond is tested by scratching on carborundum. The specific gravity of the diamond is usually tested in methylene iodide which has a specific gravity of 3.33 at 15° C. and very close to that of the diamond which is 3.51. Diamonds burn in oxygen at 800 degrees, Centigrade.

In the burning test, the specimen is placed in a platinum boat, which in turn is placed inside a silicon tube and heated to 800 degrees, Centigrade, while oxygen is passed into one end of the tube and out of the other and through a Geissler tube containing potassium hydroxide. If the specimen is a diamond it will burn, forming carbon dioxide which is absorbed in the Geissler tube. A pure diamond leaves no ash in the platinum boat, hence any ash remaining in the boat is positive proof of impurities in the diamond. These impurities are generally metallic oxides. They can also be detected by the color of the diamond—a pure diamond is transparent, while impure diamonds are tinted various colors. A number of the smaller synthetic diamonds

have been burned and most of them left no trace of ash. A number of natural diamonds have also been burned for comparison.

Since we first began our experiments in their manufacture more than 50 diamonds have been made synthetically at McPherson College, ranging in size from the smallest, one millimeter (about 1/25 inch) in diameter, to the largest, which is two millimeters by one and one half millimeters by one millimeter, weighing 1/30 carat. This is still the largest synthetic diamond on record. Six smaller diamonds were made in the same experiment, in which gum arabic carbon was added to molten iron and the mass cooled in an ice-brine solution.

Thus the story of the diamond will always remain the romance of science—the romance of adventure—the romance of the ages. While it is true that the diamond is everlastingly King of Gems, and that time cannot mar the magnificence of Nature's handiwork, it, too, is beginning to feel the effects of this highly synthetic age. In the words of Ted Brooks of the *Wichita Beacon*, "Coronado, dauntless Spanish explorer, who blazed through Kansas in search of Indian gold, was four hundred years too early. A modern Coronado now displaces him, not with the sword but with science as the ally, and the object of his search is not gold, but diamonds."

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