GRANITE QUARRIES.

QUARRYING is unquestionably one of the very early steps in the development of human culture, and the stone age, the earliest recognized stage in the progress of civilization, is that period when man first began to supplement the implements afforded him by nature by fashioning crude, artificial weapons and utensils. Beyond doubt there existed prior to the stone age a period when man employed exclusively more perishable material, such as wood, but we are absolutely without knowledge of it, for while these ages are defined by the prevailing material of the relics, rather than by the actual implements then in common use, we can but conjecture the state of cultural development during that vague period between the indefinite beginning of the age of stone and the time of primitive man's emergence from the anthropoid ape. In the beginning of the stone age man certainly contented himself with the use of bits of stone such as adaptably shaped, water-worn rocks; but it is not a far cry from gathering loose stones to loosening others from the greater masses, and to this we may ascribe the beginnings of the quarry. The science of quarrying advanced rapidly, especially after the introduction of the metals, and that, in fact, it outdistanced the metallurgical arts, is evidenced by the historic ruins still existent and containing those vast monolithic blocks, columns, and ornaments, unparalleled even to-day, which were carved out of the living rock by the hands of men whose civilization arose, flourished, and passed away scores of centuries before the Christian era.

The beginning of quarrying in America was to all intents and purposes coincidental with the settling of the country, and it is probable that many, even of the very early pioneers, cut and roughly shaped hearthstones and door-sills of stone for their cabins. It was not till much later, however, that the industry began to assume anything like the importance which it now holds. Granite quarrying, the subject of the accompanying illustration, was begun on a large scale in the United States at Quincy, Mass., in 1820, and since that time New England has been the principal granite-producing section of the country, Maine leading the individual States. The industry developed gradually but steadily, owing to the low freight rates by water, and to-day the value of the stone of all kinds produced annually for structural and ornamental purposes is nearly seventy million dollars. In the old days the labor of quarrying was all done by hand, but at the present time steam or compressed air gadding-drills largely take the place of wedge and sledge hammer, and the steam derrick, electric hoist, and crane have generally supplanted the old horse-sweep for lifting the blocks from the quarry. Improved pneumatic shaping and pointing machinery and polishing apparatus have also long been in use. Paradoxical as it may seem, the introduction of modern machinery has not altered the underlying fundamental methods used in quarrying and preparing the material; and so, for instance, while the artisan formerly "finished" a stone by rubbing it painstakingly with some polishing substance, to-day this is performed by a machine which practically does nothing more than substitute an arm of iron for the human member, and which executes practically the same motions in the same manner as the other.

The photograph illustrates the method of removing a large block from the parent mass. The stratification of the granite is used to advantage in obviating undercutting of the stone. A stratum of proper thickness for the required block is chosen, and then the section is loosened by making vertical cuts extending from one horizontal seam to the next below. Sometimes the cuts do not extend entirely through the stratum, and in this case the block is riven from the ledge by means of wedges and hammers. The cuts are made by drilling a series of circular holes, about two inches in diameter, close together, and then joining these with a connecting cut. The drills are of the usual steam type, but in order to avoid the necessity of setting up the machine for each hole, it is suitably mounted on a long steel rod, along which it can easily be moved from point to point as required. Very little blasting is made use of, as this operation is extremely liable to injure the granite.

After the block is loosened it is removed to the side of the quarry and roughly split into the shape desired. Lines are marked upon the surface of the stone, and a series of holes drilled into it along this marking. Two flat, thin strips of iron are inserted into each hole, and the protruding ends bent outwardly to prevent the strips from entering too far. An ordinary iron wedge of suitable shape is inserted between each pair of the strips, which are used to prevent the edges of the hole from chipping as the wedges are driven in. The tightening of the latter is executed as uniformly as possible, and if properly done the granite will split smoothly unless it contains faults. If flat slabs, too narrow to be obtained by the wedging process, are desired, a sawing operation is resorted to. The saw is not of the usual type, but consists of a flat bar of soft iron, which is notched by a series of drill-holes just intersecting the lower edge. The saw is fed downward, and as the cut progresses water and coarse emery are introduced from above through a sort of clay funnel plastered onto the stone. For certain varieties of softer stone, circular steel saws or diamond saws are employed, but the hardness of granite makes the use of these impracticable here.

The next operation after the block has been approximately split or sawn into shape is called pointing. The operation consists in smoothing down the surfaces to the exact shape and dimensions outlined,

by means of pneumatic tools of various sorts and shapes, depending on the character of the surface desired. These grinding tools are so mounted upon a movable arm that they can be easily shifted in all directions by the workmen engaged in the operation. The machine is not unlike, in certain respects, the ordinary dentist's drill.

When the final shaping is completed, the stone is polished according to the purpose for which it is intended. For flat surfaces a machine is used in which a revolving iron plate or grating is attached to the lower end of a vertical shaft. The shaft is so arranged that it can be moved about freely, the workmen guiding the polishing plate to various parts of the surface. The latter is inclosed in a framework or rim of wood made water-tight by means of plaster of Paris, so that the water and abrading material which is constantly fed onto the surface may not escape. In the first polishing, a flat plate is used, with water and emery or corundum powder. In the second operation the plate is replaced by a series of flat concentric rings held in their relative positions by radial ribs, and the water and abrading substance, finer than in the first polishing, are fed in between the rings. In the final operation a felt-covered plate is used with pumice stone and polishing putty or oxide of tin. Small blocks are often ground, first with wet sand and then with finer material upon a revolving iron bed-plate. Pendulum machines are used for polishing simple moldings, which are first cut as smoothly as possible with the chisel. A plate of cast iron, fitted as accurately as possible, is made, by means of a long arm, to travel back and forth along the molding with water and an abrasive. Where it is not possible to use a machine, granite is polished by hand with water, polishing material, and a small piece of similar stone presenting a finished surface.

The turning of a column in a lathe is a method entirely analogous, with the exception of the form of cutting tools, to the one used in metal work. The cutter consists of a steel disk 6 to 8 inches in diameter, mounted rotatably on a shaft and presenting a sharp beveled edge. The shaft of the disk lies in the same plane as the center line of the object turned, but at a sharp angle with it. The disk revolves with the stone against the shoulder of the cut, which is small and is made at a slow rate of speed. The edge wears off very rapidly, and the disks must be frequently replaced. To-day, pneumatic tools are used almost exclusively in cutting ornamental stonework, though chisels and hammers are still essential for certain portions of the work.

PRECIOUS STONES IN 1904.*

By GEORGE F. KUNZ.

THE important facts in the history of precious stones in 1904 are in the main as follows:

The output of diamonds was less in quantity than in 1903, and the year was marked by several advances of 5 per cent in the price of the rough-diamond material, which was imported into the United States to the value of \$9,675,742, from which it would appear that diamonds and pearls to a greater value are now cut annually in the United States than were imported, cut or uncut, into the country for the years 1867 to 1871, inclusive, or for any one year until 1887. The value of the total import of precious stones for the year was \$26,086,813.

The cutting strikes in Amsterdam, which were of long duration and threatened to be so disastrous to the diamond trade, are apparently settled for a period of at least three or four years to come.

The greatest diamond known in history (prior to 1905), the "Excelsior" of Jagersfontein, has been cut up and divided into ten stones, weighing from 13 7/8 to 68 carats each, and furnishing a total of 340 17-32 carats of the whitest material of any of the large diamonds, with a total value of about \$400,000.

No great diamond discoveries abroad were chronicled during 1904, but the development of the mines in the Transvaal has been remarkable, the new Premier having produced diamonds to a total of 749,653 carats, valued at \$4,201,000, during the year, and promising to become a still greater factor in production. In the case of this mine, 60 per cent of the output is controlled by the Transvaal government.

No discoveries of diamonds were recorded in the United States during the year 1904.

In Brazil a number of attempts were made to form new diamond mining companies, but the output has been very small.

In British Guiana the interest is still maintained, and the production was about the same as in the preceding year.

It is a fact of especial interest that in the cutting of gems other than the diamond many foreign lapidaries have entirely discarded emery (corundum) and are substituting for it the artificial carbon silicide, carborundum, which has a hardness of 9.5, between corundum (9) and diamond (10), and is the best-known abrasive next to the diamond. The year 1904 also witnessed the first discovery of this substance as a natural mineral in the Canyon Diablo meteorite by Prof. Henri Moissan, of Paris, France, and the naming of it after him, *moissanite*, as a true mineral, by the writer.

Australian sapphires, from the Anakie district of New South Wales, which are frequently too dark for high-grade stones, were cut in quantities in both faceted and unfaceted forms and *en cabochon* and used for the medium quality of jewelry.

In the United States one gem discovery after an-

other has been made in southern California, notably in San Diego County, where there have been found magnificent blue and white topazes, near Ramona, which as crystals quite equal those from Siberia, a single one weighing more than a pound; beryls from 3 to 6 inches in length and 1 or more inches in diameter, pale to dark sea green in color; crystals of rose-colored beryl, until recently one of the rarest varieties of this mineral, at Mesa Grande and Pala (and also at Hemet, in Riverside County); axinite, a gem mineral not previously known in good crystals in this country, though formerly in Switzerland and France, in beautiful crystals, near Bonsall; colored tourmalines, red and green, have been extensively mined at Mesa Grande, Pala, and other localities in the same county; and epidote in crystals only 1 inch in length and one-eighth of an inch in diameter, but transparent, has been found near Hemet, in Riverside County. The old locality at Mount Mica, Paris, Me., has produced fine tourmaline crystals and some good gems; a new locality, also interesting for its crystals of tourmaline, which are large and beautiful, although of little gem value, has been opened near Rumford Falls, Me., and some very fine crystals have been found at the mine at Haddam Neck, Conn. Kunzite, the new gem spodumene, has been mined, but not so extensively. As to sapphires, the entire output and also all previous outputs of those found at Yogo Gulch, Mont., have been disposed of abroad up to the present time by the companies which operate these mines from London. Turquoise has been mined with some success at a number of localities in New Mexico, Arizona, Nevada, and California. The new locality for peridot, olivine, or chrysolite, as it is variously known, at Talkai, Gila County, Ariz., has yielded great quantities of this mineral, immediately associated with or inclosed in the volcanic rocks; thousands of beautiful gems of from 1 to 5 carats have been cut from this material and extensively sold throughout the United States.

Great development has taken place in gem production in Brazil. Continued exploration in the State of Minas Geraes has led to great discoveries of tourmaline, which have furnished magnificent red (rubellites), as well as blue-green, and green gems; and large quantities were found, cut and sold during 1904. Further discoveries of gem beryls in the same state have furnished magnificent blue and green aquamarines, which have been cut and have reached the gem markets of the world.

In regard to the Brazilian amethyst, a large quantity of gems have come from the great geode, the bulk of which was shown at the Düsseldorf Exposition in 1902. Many of these which were obtained from the points of the myriads of crystals that lined the great grotto were, on account of their rich, dark color, sold as Siberian amethyst.

There has been an extensive demand for many of the semi-precious stones, such as the peridot, of which quantities have been cut from Egyptian material, and the yellow smoky quartz called topaz from Spain and Brazil. The Queensland opal matrix has also been much in favor, both the variety with rich patches of opal, either white or bluish, often of great brilliancy, and the variety that is dark brown, with the entire mass permeated with very thin irregular streaks or veins of highly colored opal, making a perfectly iridescent play of color on a brown field, like the lumachelle marble.

Semi-precious stone beads of every variety of material, in short and long necklaces and of all sizes, either round, India cut, or faceted, made of amethyst, Spanish topaz, rock crystal, rose quartz, aventurine, blue chalcedony, amazon stone, New Zealand jade (nephrite), Burmese (so-called Chinese) jadeite, moonstone, garnet, and other minerals of every kind, have been sold in great profusion.

Coral has been greatly in vogue, especially in the form of beads, often of great size. The market has demanded the richest Mediterranean coral, either deep red or delicate pink; Japanese coral, pink, yellow pink, and red; as well as white coral, either pure white or with a single speck of red or pink on each bead, the beads in the center of a string being often 3/4 of an inch to 1 inch in diameter. The demand and the high price for the pale-pink coral has led to some imitations, consisting, first, of a decoloration of the darker coral by heating; second, of marble of about the same weight as coral and stained with aniline or other dyes; third, of white coral stained in the same manner; and, fourth, of glass paste imitations imported from the East. Another imitation is made from the mineral substance so much used by the Chinese for their stone carvings and imitations of jade, agal-matolite or Chinese figure stone, which is very cleverly stained to be palmed off as red or deep-pink coral.

THE COAL RESOURCES OF JAPAN.

THE coal industry in Japan has become important. At present Japan is exporting annually more than 7,000,000 tons, instead of 4,000,000 ten years ago. In this respect, the other countries of the extreme Orient are tributary to the empire of the Rising Sun. It must be acknowledged, however, that the Japanese coal is not of superior quality. It is quite bituminous, producing much smoke and ashes and clogging grates; it is also easily converted into coke, but it has the advantage of being found in a vast region where English and American coal cannot penetrate without long and costly transportation. The great basin of its production is in the island Kiou-Siou. But it is affirmed, after geological investigation, that Yezo contains 600,000,000 tons of the precious combustible, nearly as much as the rest of the country. Of these 600,000,000 tons, some

* From a monograph issued by the United States Geological Survey.