Marble in New England

Newcomen Address by Redfield Proctor

President Vermont Marble Company

The Newcomen Society of England – American Branch
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President
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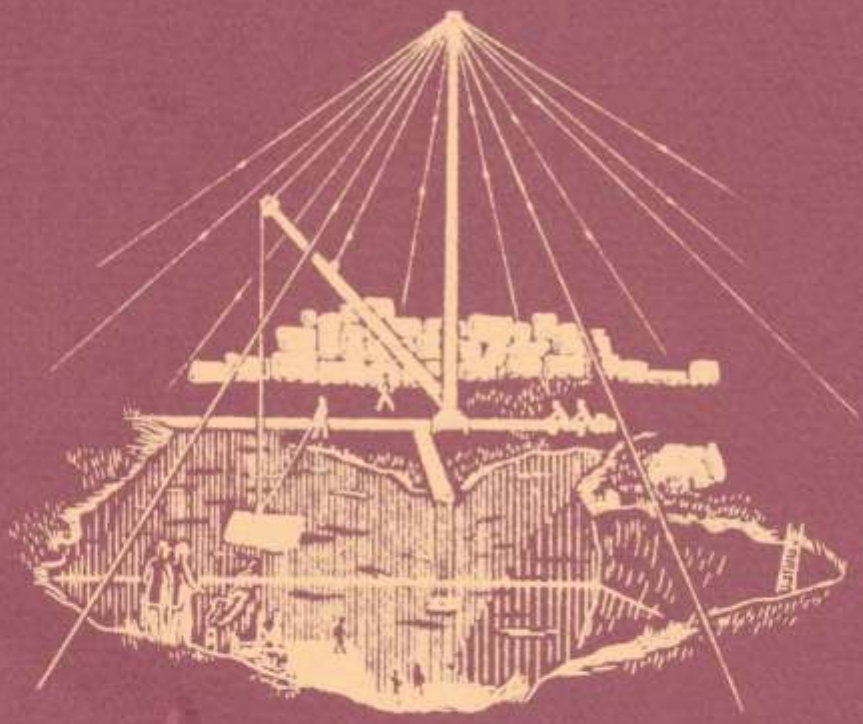

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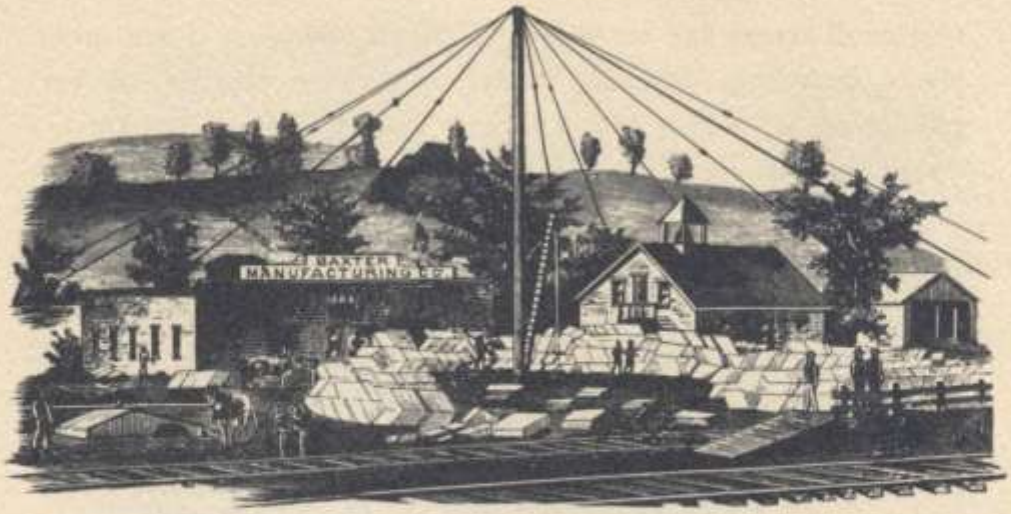

Mr. Chairman, Fellow-Members of the Newcomen Society of England, and Guests:

THE WAR has brought us many new scientific discoveries and developments, some of which are almost cataclysmic, and some may have far-reaching industrial application. We will get new materials which will change our ways of doing many things, and may actually change our way of living and even the way we carry on some of the essentials of living.

My subject to-night is a product of such ancient origin that we do not know when it was first used by man, but it was so long ago, and has been used so continuously since, that there seems good reason to believe it will have a modern application with new uses, and in possibly some new forms.

Marble of what we may term "commercial value" is found in widely scattered sections of the world, but the deposits are not numerous, and many are very limited in extent. In the United States there are deposits in Vermont, Tennessee and Georgia, known to be of considerable size. Smaller deposits occur in Alabama, Missouri and Colorado, and marble has been found and quarried

to a small extent and for short periods in perhaps a dozen other places, including, of course, Massachusetts—but practically every good thing is found in Massachusetts, even if in limited quantity. These presumably small deposits in Massachusetts are not now actively operated.

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The earlier settlers of Vermont were a peculiar people; peculiar because of the condition of things there. For many years the whole territory was a theatre of Indian wars, and residence in Vermont was long regarded as dangerous and indeed impracticable. The uncertain political condition of the territory stood in the way of its being rapidly populated. But these very facts made the country more attractive to certain classes of men—the rough, the bold, the adventurous, who could find just the kind of happiness which their natures craved.

Two of my direct ancestors, who at the time had presumably never heard of each other, migrated from Massachusetts to Vermont in the early 1780's. One of them built the first house in the present town of Cavendish, which my sister and I have the pleasure of still owning. The country then was not far from an unbroken forest, but in 1784 there is reason to believe that one Isaac Underhill opened the first commercial marble quarry in North America. This was in the town of Dorset, just a short distance over the mountain from Cavendish. Vermont, you remember, was then operating as an independent republic, and although it joined the United States in 1791, it has at times since shown a tendency to preserve its independence to a marked degree. I have, within the last decade, heard the question raised, "Is Vermont still a part of the United States?"

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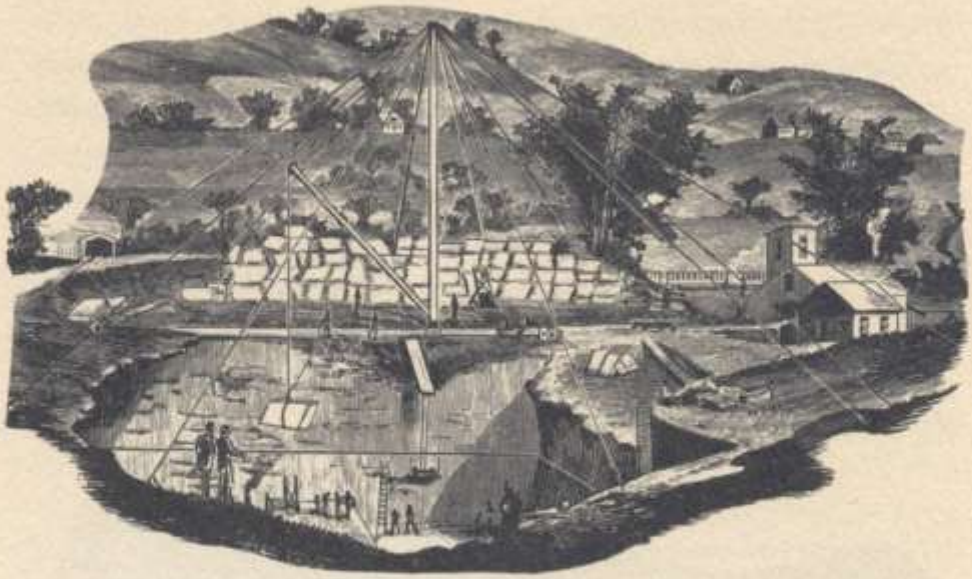
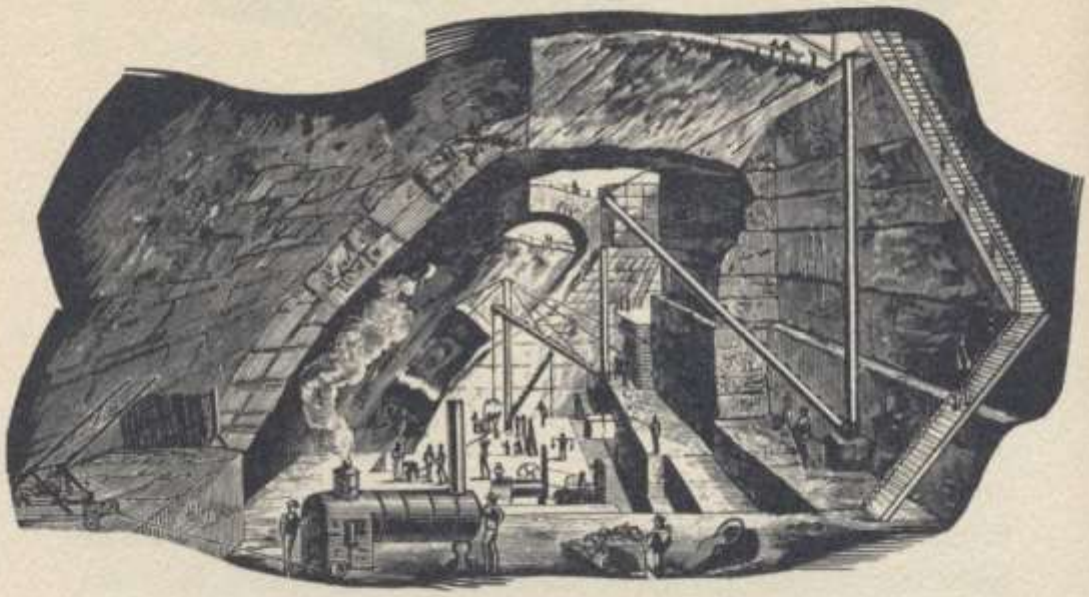
To a casual traveller observing the northwestern section of New England from the railroad or the main auto highways, its uplands look rather uniformly green. Seldom does one see any extensive area of bare rock. But the tramper on these hills finds the woods, the



pastures, and frequently even the "mowings" of the higher farming areas dotted with outcropping ledges. These have been weathered for hundreds of thousands of years, and are largely covered with moss or other rock growth and little ferns. When the surface is disturbed the rocks in certain sections may show the crystalline appearance characteristic of granite. In others there are parallel lines and evidences of probable easy cleavage suggesting slate; in still other regions the rock, after the weathered and discolored surface is removed, is white in appearance, or possibly green. The white suggests marble and the green serpentine, which either indicates nearby talc or is itself the polishable green serpentine so highly regarded among the colored marbles.

Many of these outcroppings of ledge show evidence that sometime they have been visited by a man with a prospector's hammer, or even touched with a sharp-pointed drill. Still others show unquestionable evidence of the removal of a chunk of rock. We frequently find ledges where an area a few feet square has been drilled or blasted away to an approximately level floor. Next beyond such evidences of investigation on somebody's part we find holes frequently filled with water in size from that of the cellar of a small

house to ten times the size of this room. Perhaps the depth is discernible and perhaps not. These are old abandoned quarries, indicating that effort and money had been spent by someone who ultimately experienced disappointment. I know of one such place with an area of about fifty feet square. There was an ancient steam boiler there, left exactly as it had been used. Two very old-type machines stood on the quarry floor, as any workman might have left them any night. Against the rock walls were standing numerous drills and bars and near the boiler was a pile of wood now decayed so as to be



little more than recognizable. The metal was rusty. The boiler stack had fallen down. Vegetation had crept into the quarry. A tree the size of one's arm grew out of a crack that showed practically no evidence of anything to support vegetation.

Even the experienced and successful producers have had many trials that turned out to be errors, and the production of marble to-day, like the production of almost any natural-source material, is fraught with many uncertainties.

Experience and intelligent prospecting give a great deal of helpful and to a degree reliable, but by no means conclusive or infallible, information. Not infrequently a good quarry suddenly and quite contrary to expectation gives evidence of trouble ahead.

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Mr. Underhill's quarry in Dorset, to which I referred as the first commercial quarry in Vermont, was not the earliest known source of marble in New England. There is reason to believe that a small quantity of dark marble had been taken from an island in Lake Champlain and used by the French during their occupancy of that region in the 17th Century. Vermont white marble was used prior to the Revolutionary War. In some old hill cemeteries there are still many headstones of white marble which have dates earlier than 1800. These first grave or headstones were split off from the sides of outcropping ledges—certainly not quarried in the sense in which that word is used to-day. The work was all done by hand; only the face of the stone and possibly the top were given any finish, the other sides showing evidence of age-long exposure, including ancient glacial markings. The designs of these stones are often quaint, some of them painfully original and the workmanship crude, but these old craftsmen selected with good judgment for many of the stones are so sound that the carvings and lettering are as sharp and legible to-day as when they were first set in place to mark the graves on the newly-cleared hillsides.

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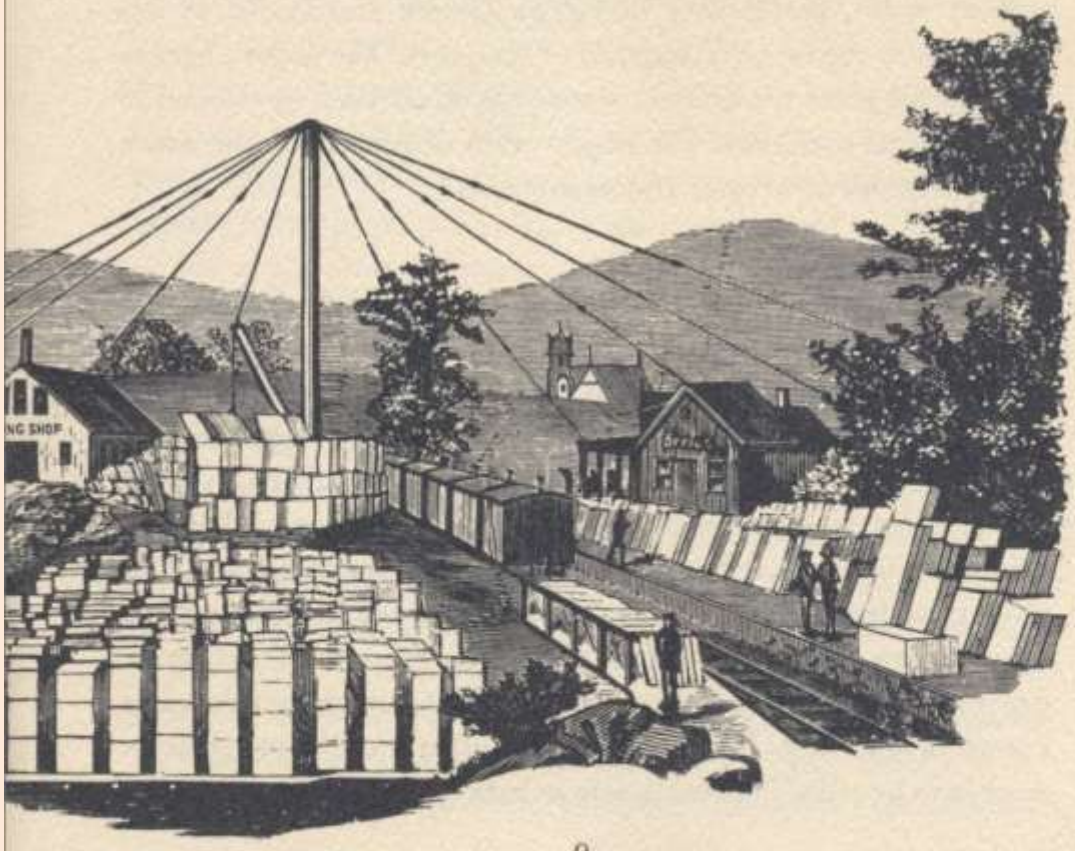
The stones from Underhill's quarry were used in the pioneers' new homes, around open fireplaces, as chimney backs, hearths, lintels, doorsteps, etc. Thus the marble business in this country in its three major divisions—cemetery memorials, structurally in buildings, and for decorative purposes in buildings—originated in the hills of Vermont before the end of the 18th Century, or about as early as that part of the country got organized and started operations as, may I say, "a going institution."

Geologists tell us that marble is a very old formation of rock and, if their present theories are correct, probably the earliest of the rocks which owe their existence to life on the earth. Thousands and thousands of years ago the area from the St. Lawrence to the mouth of the Hudson was a deep sea, with the peaks of the Adirondacks and the Green Mountains submerged. This water was populated by lime-producing animals, which through a long period—millions of their generations—built up vast beds, as coral beds are built to-day.

Thus marble, a compact rock in its pure form, is composed almost entirely of carbonate of lime, that is, limestone, which has been crystallized by metamorphic action. Through millions of years volcanic heat and pressure bent and twisted the forming layers of stone to produce the veins of marble that we quarry to-day. The name "marble" comes from a Greek word meaning "to sparkle"—for the tiny crystal facets flash in the light.

Vermont probably contains the greatest variety of marble, and perhaps the greatest quantity of marble and rock classed as such, of any equal area in the United States—almost a hundred commercial varieties. Within the area of our small state there is a large

quantity of white and near-white marble—three different "deposits" as the trade calls them, differing slightly in appearance in the rough. When fabricated, two of them appear to the uninitiated like mass deposits, while the third is very sharply veined, with surprising differences in color, including mixtures of blue and green on white backgrounds and in two layers a distinct suggestion of pink. Elsewhere really deep gray and definitely blue-gray marbles are found. A very nearly black variety is obtainable in one part of the state, and other deposits produce large quantities of the serpentine—deep and brilliantly polishable green. There is a bright red, and a red with a mixture of blue-gray, and another with white, and one quarry produces most attractive slabs of sea-green, a quite accurate reproduction of ocean waves. One quarry, or even one block, may produce more than one "commercial" variety. Sawn with the grain the slabs may have stripes of color. Sawn across the grain a clouded surface



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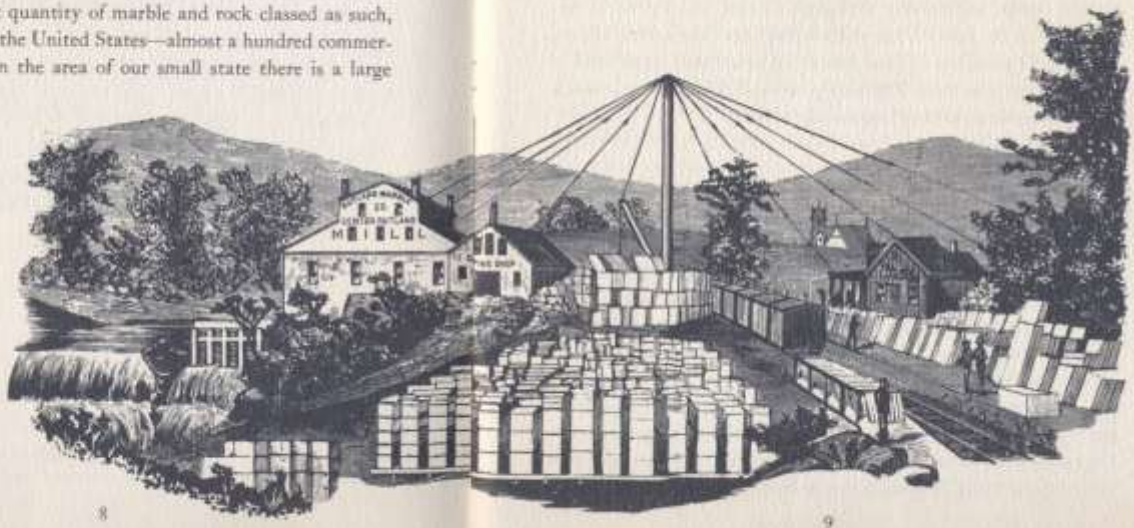

of very different appearance may be the result. Unfortunately no buff or flesh colors, which are so popular with architects, have as yet been discovered in the United States.

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Pure calcium carbonate is white. The colors, the veinings, the clouds, the mottlings and the shadings of marble are caused by the presence of extraneous substances. Iron oxides make the pinks, yellows and reds. Some of the blue-grays and grays come from magnesium combined with the calcium. Black is from bituminous substances changing to graphite, and the greens are caused by mica, silicates, talc and iron pyrite. There are other colored stones that are sold commercially as marbles—the serpentine rocks.

For many centuries marble has been considered the most *beautiful* material for use in the construction of buildings. It has been extensively used in the religious, memorial and cultural structures of the ancient world, particularly in Egypt, Greece and Rome. It has always been the favorite material of sculptors. The superb beauty that marble gives the finished statue has never been duplicated in other natural materials. The huge Forum of Ancient Rome was a mass of marble structures and monuments.

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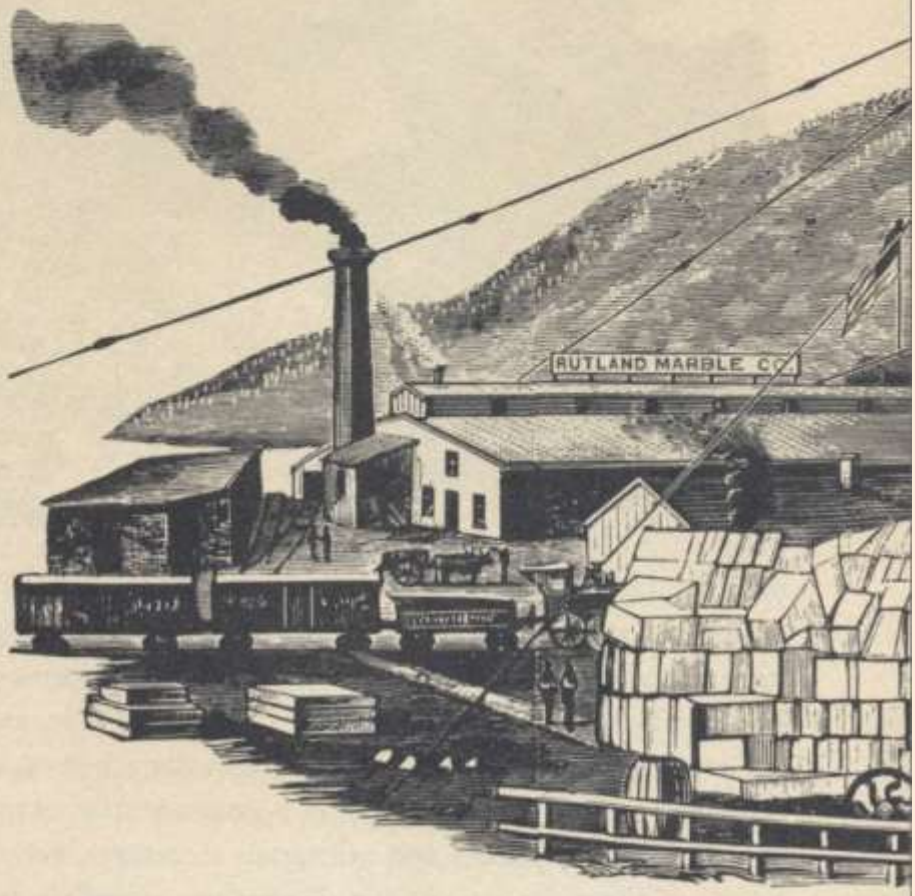
Perhaps to speak of a structural stone as "precious" is using a word that should be reserved for smaller and more delicate things, but what natural building material has a more romantic or sacred heritage than marble? Through the centuries it has been used to decorate the halls of the world's greatest public buildings, the interiors of our most beautiful cathedrals and the rooms of the most luxurious mansions. It has also served in many humbler capacities in very modest homes, most sentimentally as the hearthstone and the doorstep. In modern times it has had rather more utilitarian uses—for example, the floors of the vestibules in those structures known as apartment houses (which by no flight of the imagination deserve to be called "homes"), also as both a useful and a decorative

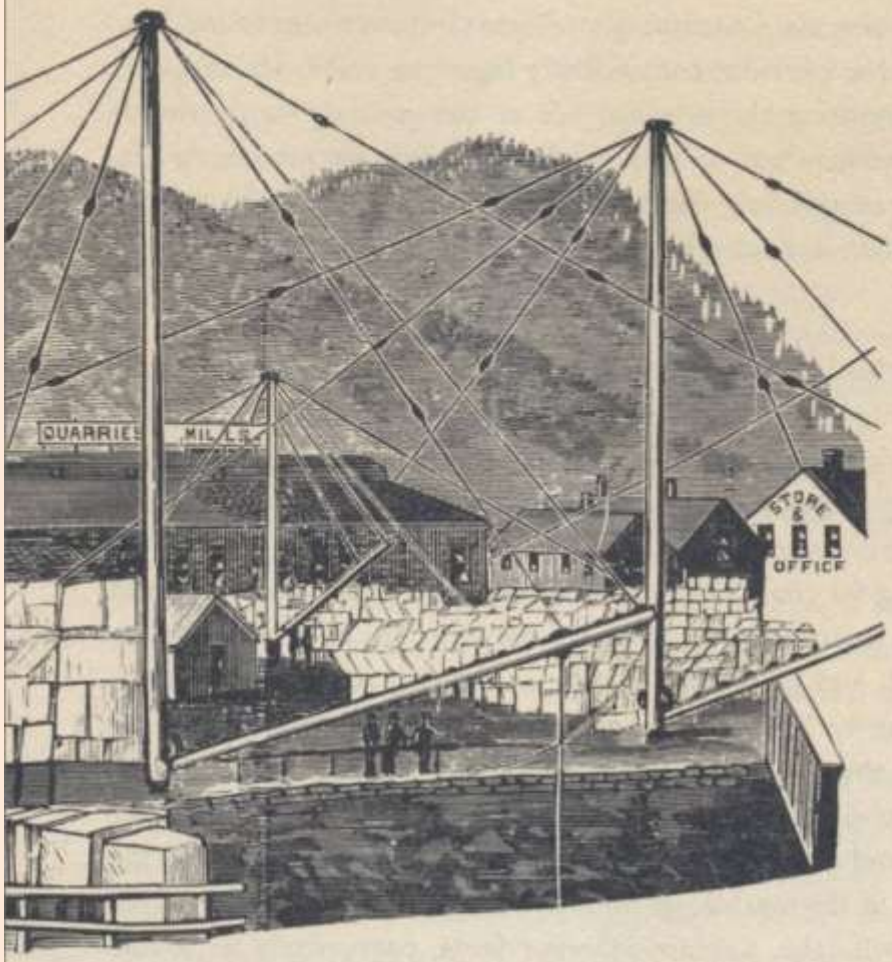
material in bathrooms, in the entrance lobbies in many business buildings, and as the lining of up-to-date swimming pools. The variety and the beauty of the colors, the different forms of veining, the translucency and varied effects of light and shade, are all inherent parts of its beauty. The harmonious color schemes, its adaptability and statuary and architectural ornamentation or other simple dignified lines of plainer and utilitarian structures, acclaim marble as one of the most artistic and decorative, as well as truly usable natural materials.

Marble has certain properties that make it an ideal building material structurally. Its crushing strength runs from six thousand to seventeen thousand pounds per square inch. It could stand at the base of a monument well over one mile high before failure from compression would result. Its expansion is less than that of steel or concrete, and absorption of moisture is very low. One hundred pounds of marble suitable for exterior use will absorb only about one-tenth of a pound of water—in other words, one-tenth of one percent by weight. It has a peculiar and surprising resistance to heat, far greater than that of granite, limestone, sandstone or slate. This is shown practically by the experience in several disastrous conflagrations.

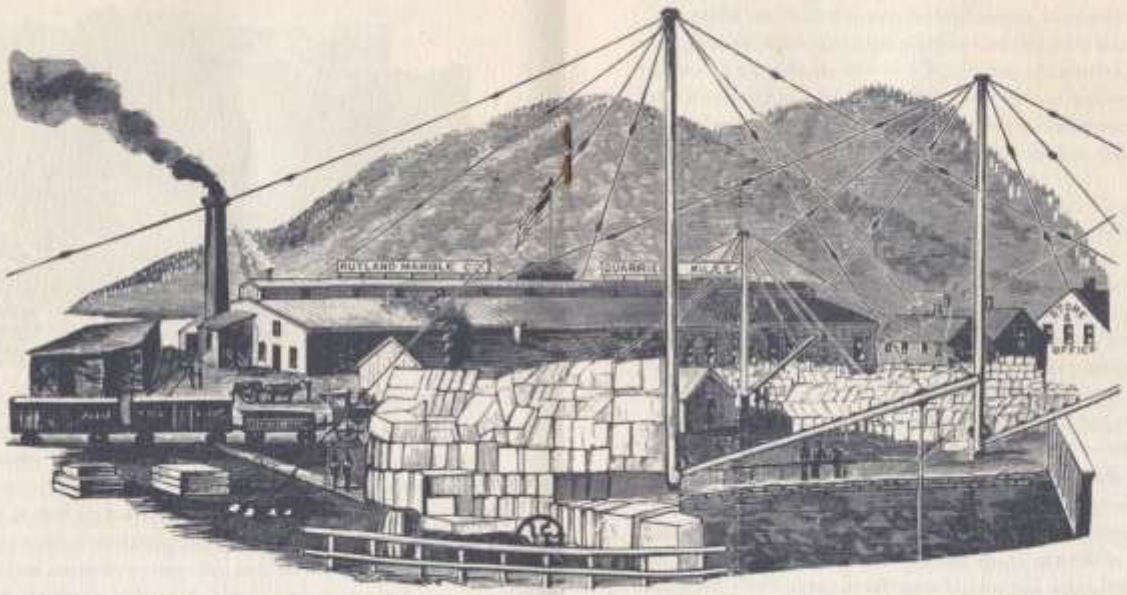


Marble shows evidence of having a convenient resistance to the disturbing effects of earthquakes. How well it will resist the Atomic Bomb is still unknown.

The history of the industry is that most of the developments have been started in a small way as single units, some continuing to confine themselves to production from a quarry, many others ultimately building small fabricating plants including only the first process—that of sawing the marble into chunks or slabs—or perhaps including all the fabricating processes. Most of these isolated small units have been consolidated.



In the early days, say when I was a boy, there was little machinery used to pick up or convey pieces of marble, other than a simple form of power derrick. The pieces were largely moved about by hand, hand-pushed trucks, horse-drawn "stone-boats," so-called, which were nothing more than two or three planks nailed together and dragged along the ground by from one to six horses, and a simple kind of low-hung, low-wheeled stone wagon. The marble, after being freed, was moved out from the ledge and in the various stages of fabrication moved into the exact place desired by means of the primeval crowbar and the exercise of a lot of elbow grease or shoulder-shove, and hence a great deal of manual labor. Now it is exceptional to move any piece of marble by hand if it weighs more



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than a few pounds. Continuing intelligent improvement of mechanical means has provided conveniently ingenious and fairly adequate means for getting the material out of the ground, for moving it almost anywhere and in any condition during its processing life, and for accomplishing the work required to produce the various finishes—that is, final appearances desired.

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The marble industry to-day, in step with more scientific ideas in all industries, seeks to obtain more factual information about a supposed deposit before undertaking expensive efforts to open a new quarry. The area or location is investigated by means of a core drill with a diamond-edged barrel-head, a bit similar to that used in prospecting for coal. This machine cuts out a cylindrical core, and such cores are usually taken at several locations on the area being prospected, and preferably at different angles, so that as much as possible can be learned as to the thickness of the good part of the mass and the variations in color therein. These cores, approximately two inches in diameter, are then rubbed smooth to give one flat side, and polished. This gives a fairly good impression of the soundness of the marble, its different colors, and the quality of the polish it will take. Certain inherent facts, particularly as to the soundness and the structure of the material are thus learned. If it is judged that the prospects indicate that profitable production may be expected, two general methods of developing a quarry are in use. It must be remembered that these cores, even though good, are by no means complete assurance that a profitable quarry has been found.

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There are two kinds of quarries. First are those open in their full extent on the surface and at least for a time developed straight downward. These quarries are approximately rectangular holes. Eventually the floor area may considerably exceed the area of the original opening.

The second type of quarry is a tunnel, in some respects resembling a mine, where layers of worthless rock must be passed through before the marble is reached. The opening or tunnel may be horizontal or sloping downward into the side of the hill. When the usable grades of marble are reached the opening is widened by tunnels perhaps both to the left and right, and then the whole floor area within the hill is quarried out deeper and deeper.

Some quarry developments are to a degree a combination of the two methods—the vertical rectangular hole, after going down a distance, may have tunnels driven in any direction, for the vein or mass of good marble, or possibly the colors which we are interested to produce, must be followed. Obviously, unless the rock structure is very sound, tunnels are not practical, for the roof of this heavy mass of stone cannot be supported as in many types of mining operations. The tunnel type of quarry, though more complicated to operate, prevails in Vermont, where the good material often lies far below the surface.

The open type of quarry is fairly simple to operate. Work can be carried on with the ordinary channeling machine and blocks lifted out with the aid of strong derricks. Generally speaking, much useless material must be removed before the profitably merchantable marble can be taken out. All the work on the usable marble must be done by cutting rather than by blasting, in fact blasting is entirely out of the question in connection with marble production unless the nearby good material is first protected by an open machine-made cut.

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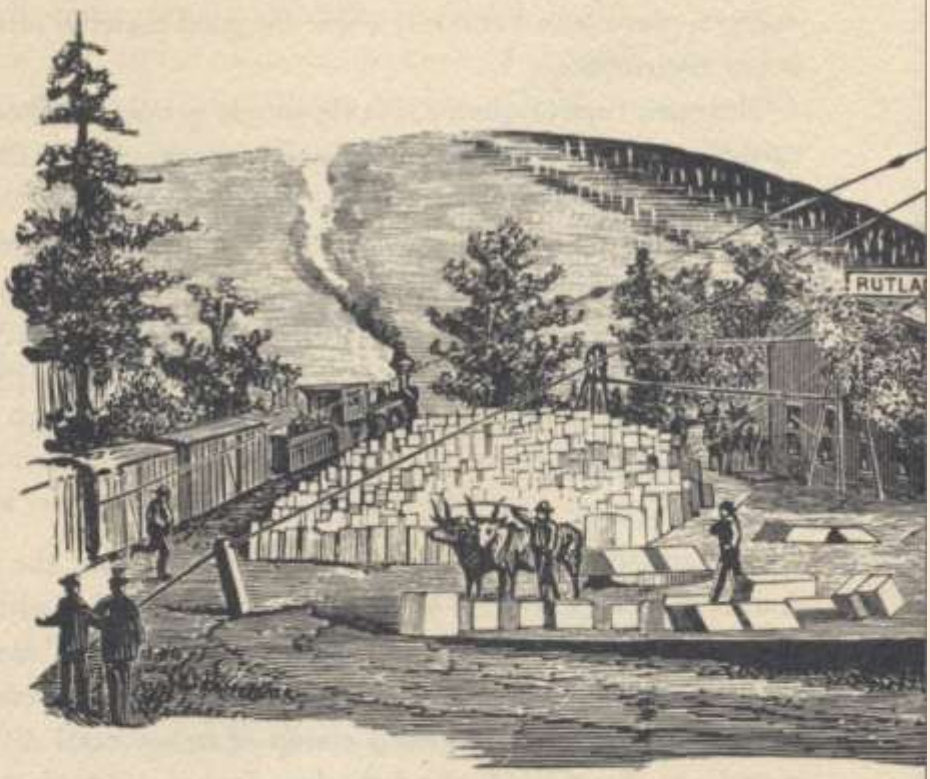
The present day "channeler," used in cutting out the blocks of marble in the quarry, is a small, flat car, equipped with flanged wheels to run along a short piece of track. This "car" is equipped with an electric motor driving an air compressor. The compressed air in turn raises and lowers a clamp of heavy steel drills which pound into the stone. As the drills drive into the rock, the channeler itself moves back and forth along its track, thus producing a long

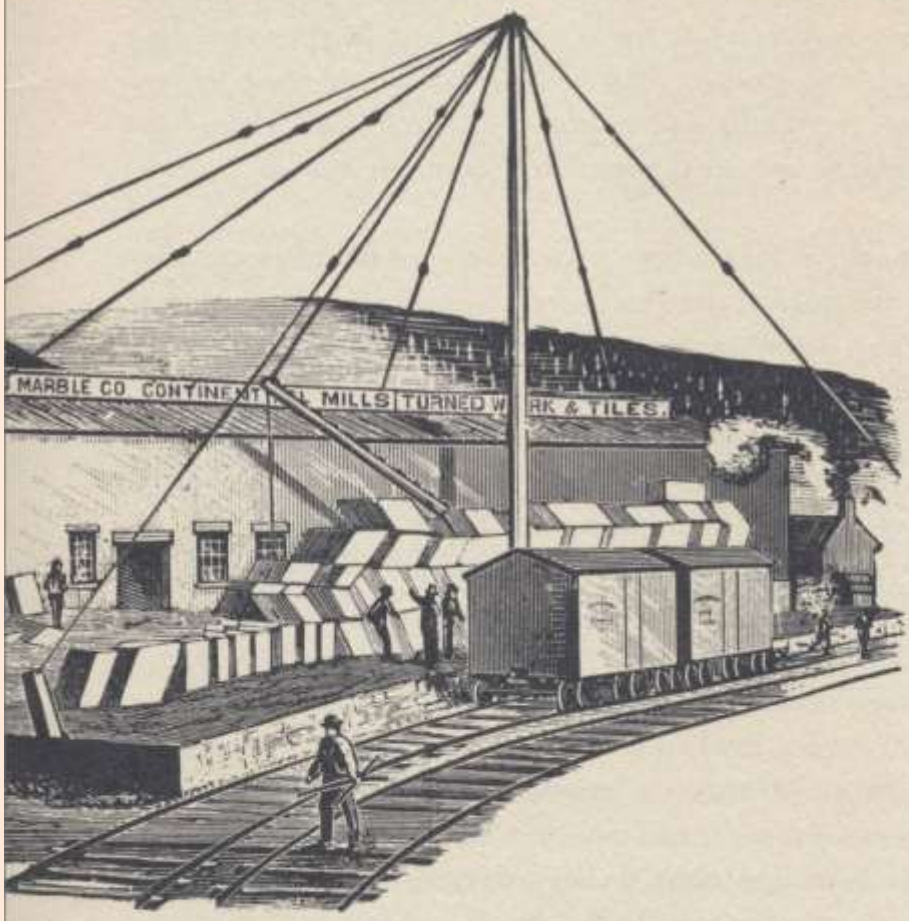
narrow slot that eventually becomes one side of a series of marble blocks.

Channel cuts are run on all four sides of the area to be removed and two or three extra channel cuts are made directly across the floor. The long strips produced by three of these channel slots are then cut cross ways into rectangular blocks of different sizes, the first one of which is removed by a derrick either as a single piece or broken, according to what is possible. The next cubic piece is then broken from what will be the next quarry floor; this is accomplished by drilling holes at intervals of six to eight inches in which wedges, that is, slim elongated half-rounds of steel and "feathers" or half-wedges, are driven and the blocks thus split off. Like many still-used processes of the marble business, this wedge method was employed in a more simple form by both the Egyptians and the Greeks. Their



wedges were probably of wood, which by expansion from constant soaking in water produced the rift in the rock.

Some of the Vermont quarries are deep, one for example, extending more than three hundred and fifty feet straight down. The present end of another tunnel is nearly five hundred feet below the surface of the ground directly above it, under village streets and people's homes. Others have been driven horizontally half a mile into the hill. From the Danby quarry, which has produced the marble for some of the largest marble buildings in the United States, more than 10,000,000 cubic feet of stone have been excavated.



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Single blocks have been taken from this quarry weighing over eighty-five tons.

Transporting the blocks from the quarries to the fabricating plants or to a railroad often presents bothersome problems. The blocks are heavy and quarries seem to have been located by the Lord without special reference to their industrial development. Many times the blocks must be hauled on heavy trucks, sometimes by means of a cable railroad, and in one instance by a cable suspended in mid-air between two hills.

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One quarry may produce many varieties of marble. The variety desired is rarely the easiest to obtain and frequently many blocks of varieties not in demand at the time must first be removed. As a consequence huge storage areas with heavy cranes must be provided, where the blocks may be stored for future use. There have been as many as sixteen thousand blocks in our storage yards at one time.

The first step in fabrication is the cutting of the blocks as they come from the quarry, and this is done basically by a very ancient method. Pliny described it in his history of the period before the Christian era. The block is placed beneath a rectangular swinging-frame. In this frame are smooth, steel bands from one-eighth to one-fourth inch in thickness and from three to five inches in width. The edges of these bands are smooth, without teeth, and the edges of the steel blades, set vertically in the frame and drawn very tight, rub an abrasive against the marble and thus wear it slowly away, actually cutting thin grooves down through the block. The abrasive is usually sand or fine steel shot—sometimes garnets, water-borne.

This rather crude method does not do credit to the mechanical engineers connected with the marble industry. Numerous other methods have been tried, and a lot of time has been spent by perfectly good mechanical talent, trying to devise a better method. Two other methods are used to a limited extent and for certain types of

sawing only. One is a long wire, also with a loose, water-carried abrasive. This, of course, makes only one cut at a time through a piece of marble, while by the "gang" method first described, as many as ninety saws may be operating simultaneously in one frame. In the third method a rapidly revolving circular saw, a type of buzz saw, is used, but the depth of the cut or the thickness of the piece that may be thus sawed is limited by the practical diameter of the saw. Here again a simple steel blade, in this case with notches in the circumference, may be used with sand and water. If black diamonds are wedged into the notches in the circumference of the wheel the work is done faster, but these are expensive. Carborundum wheels may be used, but as these are thicker the amount of waste resulting from each cut is increased. Recently, a narrow band of metal on the circumference of the circular saw, somewhat like a tire, saturated with diamond dust, has been used successfully, but these blades for practical reasons of construction must be thin, and their thinness unavoidably reduces their diameter and hence the possible depth of the cut.

Marbles that we are accustomed to see in the interiors of buildings, and to a degree their purpose is ornamental, are usually polished. This may be done by hand, but is mostly done by machines with a rapidly revolving head covered with heavy felt, with water

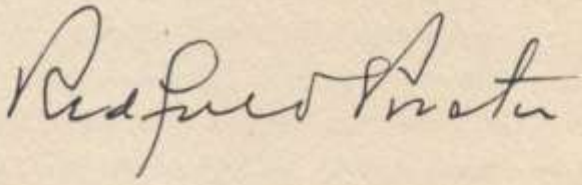
and a fine abrasive, often putty powder. This gives a high polish. Mouldings and cornices are cut by specially shaped carborundum wheels in heavy machines with movable tables, like metal planers.

Notwithstanding the fact that this is a machine age, there is a good deal of hand work in the business. Some polishing is done by hand, some lettering and all of the finer carving, although compressed air tools many times take the place of the old wooden mallet and chisel. Compressed air is used in sand-blast operations, where letters and decorations are cut into the marble by the use of a stencil or mask of a heavy flexible material. But the steady hand and artistic eye of the marble craftsman are still an important element in producing the highly artistic statuary and carvings.

The by-products of marble quarries also enter into other industrial fields. Chemically, marble is valuable in many modern manufacturing processes. Marble unsuitable for fabrication has been used for many years in acid towers in the sulphite process for manufacturing paper pulp and as a flux in refining iron ore by the open-hearth method. More recently, through newly developed machinery, it has been possible to crush marble to a very great degree of fineness. This ground product finds an extensive use in paints, coat-

ing for cloth and paper, as a filler for rubber tires, in tooth powder, linoleum, phonograph records and many other products.

In these days all sorts of synthetic materials are being developed either to resemble closely or equally as well to serve the purpose of a natural material. While some of these do not with time prove to have all of the qualifications that are claimed for them, many of them prove very satisfactory. However, it seems likely that there will continue to be interest for some purposes in the use of a real or natural material where the object is something other than purely utilitarian, or where there is sentimental interest in a natural material—something created by God, not man. Some members of the architectural profession, on which the business of producing and fabricating marble is so dependent, tell us that they believe there is to-day a swing back from the synthetic to the real and therefore those of us who are in the marble industry take hope that a business which is known to have existed for generations before the time of Christ and has continued in all civilized parts of the world ever since, still may have a few years of life left.



THE NEWCOMEN SOCIETY OF ENGLAND
IN NORTH AMERICA

BROADLY, *this British Society has as its purposes: to increase an appreciation of American-British traditions and ideals in the Arts and Sciences, especially in that bond of sympathy for the cultural and spiritual forces which are common to the two countries; and, secondly, to serve as another link in the intimately friendly relations existing between Great Britain and the United States of America.*

The Newcomen Society centers its work in the history of Material Civilization, the history of: Industry, Invention, Engineering, Transportation, the Utilities, Communication, Mining, Agriculture, Finance, Banking, Economics, Education, and the Law—these and correlated historical fields. In short, the background of those factors which have contributed or are contributing to the progress of Mankind.

The best of British traditions, British scholarship, and British ideals stand back of this honorary society, whose headquarters are at London. Its name perpetuates the life and work of Thomas Newcomen (1663-1729), the British pioneer, whose valuable contributions in improvements to the newly invented Steam Engine brought him lasting fame in the field of the Mechanic Arts. The Newcomen Engines, whose period of use was from 1712 to 1775, paved a way for the industrial Revolution. Newcomen's inventive genius preceded by more than 50 years the brilliant work in Steam by the world-famous James Watt.

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