The Book of Vermont Marble

A Reference for Architects and Builders

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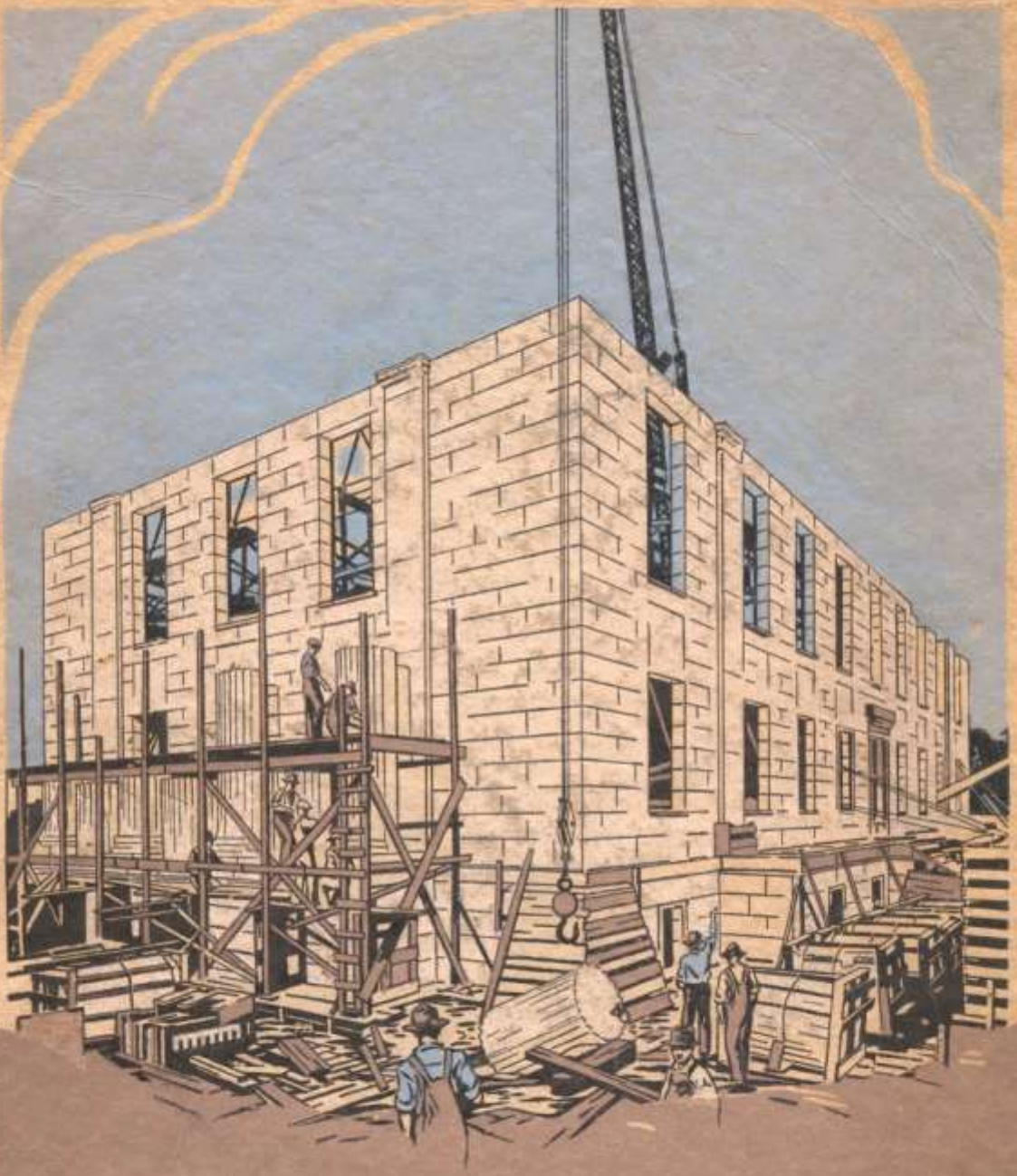

THE BOOK OF VERMONT MARBLE

OLD *Vermont chimney after the house of wood has fallen away. These pioneer fireplaces were cased with marble slabs.*

One of the first Vermont Marble buildings—the U. S. Bank, Erie, Pa., later used as a Custom House. In 1836, when it was built, the marble had to travel by team, canal and lake boat.

THE BOOK OF

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A Reference for Architects and Builders

THIRD EDITION

Published by the

VERMONT MARBLE COMPANY

PROCTOR, VERMONT

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This recent photograph of the old Custom House, Erie, Pa., shows the excellent condition of the marble after nearly a hundred years of exposure. Edward Summers, Architect.

When New England Was Under Water

(From "The Marble Border of Western New England," issued by the Middlebury Historical Society.)

"A BRIEF summary of the present theory of geologists in regard to the origin and history of the marble region will help perhaps to a better understanding of the Vermont deposit.

"It is believed that once in the remote past the Green Mountain area, from the lower St. Lawrence to the present site of New York City, was a gulf or arm of the ocean. At first the tides or currents of the sea were such as to cause extensive deposits of sand over the greater part of this gulf.

"Afterward, from some oscillation in the earth's crust and some change in the direction or character of the ocean currents, the waters became more clear and the conditions were more favorable for the growth of lime-producing animals. The sea swarmed with various species of molluscs, crinoids and trilobites, and especially with organisms allied to the corals that are still building continents in the South Seas. The calcareous remains of these animals formed beds over the entire region of western New England, varying in thickness from 1000 to 2000 feet. This may appear incredible, but it should be remembered that the time was indefinitely long.

"This second period was brought to a close and the third initiated by the waters of the sea becoming for some reason turbid. The ocean currents may have flowed across a gradually sinking barrier-reef which existed to the east of the Green Mountain area. The waters deposited their fine silt or mud over the immense beds of shells, and the animals that produced them became extinct. The deposition of fine sand and clay continued for a vast period.

Slab of Vermont Marble in which shell formation is plainly marked.

"Then came the era of mountain-building. The earth's crust is but a comparatively thin shell (perhaps 30 to 50 miles thick) over a white-hot, if not molten interior. The natural results of the accumulation of sediment several thousand feet deep along a region where the earth's crust is at the same time sinking in the form of a trough 300 miles long by 50 wide is that the interior heat will melt off or soften

the under side of the sinking trough until it becomes a comparatively weak line in the earth's crust.

"At the same time there is a lateral push from the east. For, as the earth is continually becoming smaller from cooling, the external shell must contract or wrinkle to fit it. By a powerful shove from the direction of the ocean, the horizontal sedimentary beds are tilted up at a steep angle, crumpled together, folded over one another, and thrust high up above the level of the sea. These movements of the rocks under this enormous strain are a source of heat. So it is proved by exact calculation and experiment that the crushing and shoving of a rocky stratum may raise its temperature to a red-heat. But a less temperature combined with enormous pressure and the agency of super-heated steam would suffice to convert the sediment into the existing rocks.

"The process of crystallization, moreover, may be compared to the analogous process of tempering steel. In both cases, by a certain increase of temperature and subsequent cooling, the molecules are grouped in regular crystals, which can be seen with the microscope and often in the case of marble with the unaided eye."

* * *

Such, if we may believe the geologist, were the earth-throes by which the Green Mountains were brought forth, and the marble beds formed.

Since then, the mighty forces of rain and frost, the erosion of rivers and the grinding of glaciers, have been wearing away the mountains. Finally, in Revolutionary days, the Vermont pioneers discovered the outcropping ledges of marble and began splitting them up into slabs. Thus was a new industry born.

The product was first used for facings and hearthstones in the fireplaces of the early settlers, then for headstones in the bleak churchyards and family burying grounds. Its career as a building stone started about a century ago.

Outcropping ledge of Vermont Marble where glacier marks made 10,000 years ago are still intact.

* * *

"A comparatively small portion of the lime-rock has been converted into valuable marble. It is not possible to draw the line sharply between a limestone and a marble. Webster's definition of marble is 'a fine limestone, fitted, either when polished or otherwise, for ornamental uses.' The best marble results only from a happy concurrence of many circumstances."

Marble Quarrying Methods

Most Vermont marble deposits occur in beds or layers, each one of which has its own individuality in color and other characteristics, including decorative pattern. Because of these differences, individual beds are in most cases quarried separately.

At the surface the layers usually outcrop in an almost vertical position. The Danby deposit, where the layers outcrop on the side of a steep hill, in a nearly horizontal position, is a notable exception. At West Rutland, at a depth of about 225 feet, the deposit becomes thinner, the layers turn and proceed under the hill at an angle of about 30 degrees with the horizontal.

Before quarrying operations at any point are started, prospecting is done by means of diamond-core drills and by cleaning and examining the surface outcrop. In spite of these precautions, the opening of a quarry is attended with considerable financial risk.

In quarrying marble, blasting cannot be resorted to on account of the danger of shattering the blocks. The electric channeling machine, running on movable tracks on the floor of the quarry, first makes a series of vertical cuts or channels to the required depth. The first strips of blocks, known as key blocks, must be cut on all four sides. After these are wedged out and removed the remaining strips are channeled on two parallel sides only. A drill, placed in the keyway, drills horizontal holes between the layers and at the bottom of the cut. The blocks are then broken off by wedges. All quarrying machinery is operated by electricity, and the tunnels are lighted by powerful electric lights.

At West Rutland, where the vein has been

Two views in the underground quarries at West Rutland.
(Left) *Looking down into tunnels.* (Right) *At the foot of the inclined cable way.*

followed under the hill, electric railways carry the blocks to a point where they can be reached by the surface derricks or by cable track.

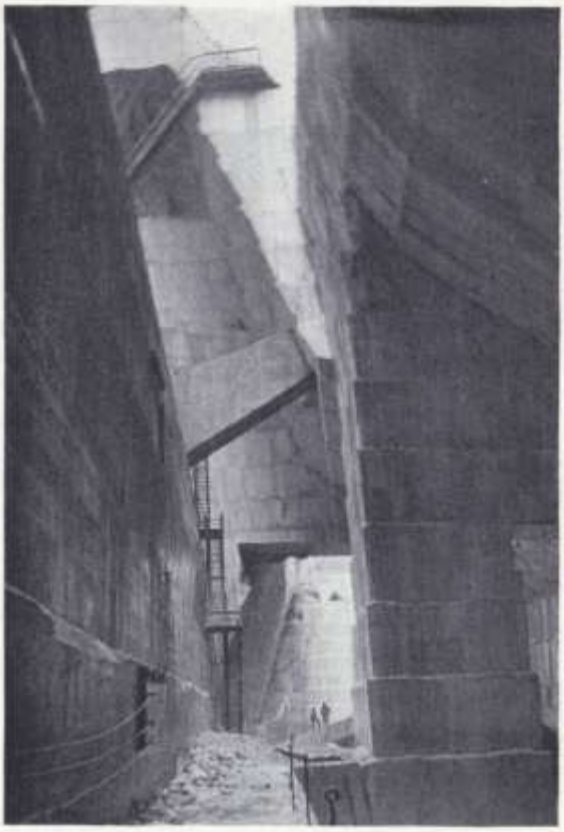
Operations are carried on through the entire year and there is a practically constant supply of blocks.

America's Most Famous Marble Deposit

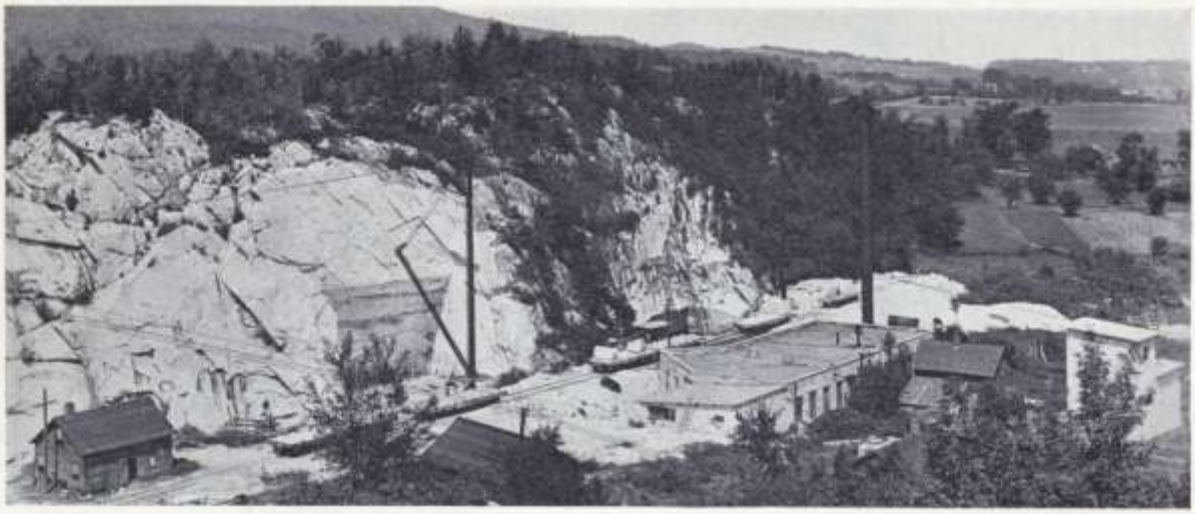
QUARRYING on the West Rutland deposit began about the year 1844.

In recent years, from 400,000 to 600,000 cubic feet of marble have been removed each year, and there still appears to be an unlimited quantity available.

Not counting the various grades of blue marble which lie to the west of the white deposit at West Rutland, this remarkable vein produces fifteen different grades of marble for monumental and building purposes. These range from the almost pure white of Extra White Rutland to the dark greens such as Verdoso and Olivo.



Looking up from lower floor of Pittsford Valley Quarry, over 300 feet below surface.



Outside the Pittsford Valley Quarries, where the openings appear insignificant.

Electric channeling machines at work in Verde Antique Quarry at Roxbury, Vt.

Overcoming Nature

FOLLOWING a comparatively narrow vein of marble to a depth of over 300 feet, the tremendous lateral pressure held in check by immense reinforced concrete struts, the Pittsford Valley quarries present to the architect and engineer one of the most interesting developments of the Vermont region.

The Pittsford Valley quarries produce large quantities of stock for cemetery memorials and several varieties of interior and exterior marble. The quarries are notable for the large sizes which are obtainable. Blocks for monolithic columns measuring 32 feet long and over four feet square have been readily secured. A 63-ton block about 14 feet square and three feet thick was quarried here for the Scott Memorial Fountain, Detroit, Mich.

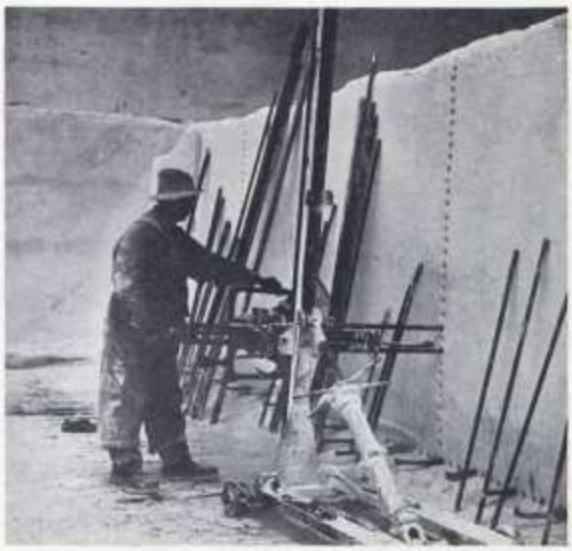
For the Bridgeport Savings Bank, Bridgeport, Conn., these quarries furnished two huge monoliths, one weighing 55 tons and the other 52 tons. From these quarries also came the fourteen monolithic columns for the Curtis Publishing Company Building, Philadelphia, ranging in weight from 45 to 50 tons each.

The Pittsford Valley deposit has been in active operation since 1870.

Vermont Verde Antique

THIS product, which has come to be the standard dark green marble of America, was first put upon the market about 1850. The original quarry, located at Roxbury, Vermont, practically the geographical center of the state, was operated in only a limited way until 1893. The earlier methods were crude in the extreme and the quantity of marble produced was very small in comparison to the present demand. That Vermont Verde Antique has continued to grow in favor is evidenced by the fact that the quarry production today is over twelve times that of 1901. During the last ten years several new quarries, all in central Vermont, have been developed.

Vermont Verde Antique occurs in isolated masses which, roughly, are of the shape



Drilling and wedging apart the blocks of marble in the quarry.

Distant view of the quarries at Danby. The cable road, which extends from quarries to railway 900 feet below, is nearly a mile long.

of a double-convex lens standing on edge. The marble is of such extreme hardness that the quarrying presents a difficult problem. The machinery is the same as that in use in other quarries but specially tempered cutting steel must be provided.

The finishing of Vermont Verde Antique also presents an unusual problem. The bulk of this work is done in an especially designed and equipped plant at Swanton, Vermont. There, at the lower falls of the Missisquoi River, are twenty-four saw gangs and a large finishing plant.

The Pioneer Marble

THE most exacting as well as the most convincing test that can be applied to any building stone is the test of time. The early settlers in the vicinity of Danby Mountain discovered its deposits of marble and from the outcroppings in the valley split off pieces for memorials to their dead. Headstones bearing dates as early as 1765 are still standing, their crude lettering sharply defined in spite of the passing of the years. In 1836 the marble was provided for the United States Bank of Pennsylvania at Erie, Pa. The building was purchased later by the Government and used as a custom house. It is still well preserved.

As the demand for marble increased, quarries farther up on the mountain side were developed, the blocks at first being drawn down by teams. This crude and dangerous method of handling finally gave way to an inclined railway, operated by immense cables. The steam cutting machines which were first used

Opening a new floor in one of the quarry tunnels.

were replaced by modern electric channelers, and there was finally evolved the remarkable quarry development pictured in this book.

Tunnels have pierced the mountain to a distance of 400 feet, and lateral branch tunnels have been added until upwards of an acre of quarry floor is now producing blocks. The quantity production of marble whose quality has been proven by over a century of use is now possible.

Marble from Many Openings

OTHER Vermont quarries, each producing its own distinctive types of marble, are being operated by the Company at Proctor, Florence, Brandon, Swanton and Isle La Motte. These products are listed elsewhere in the book.

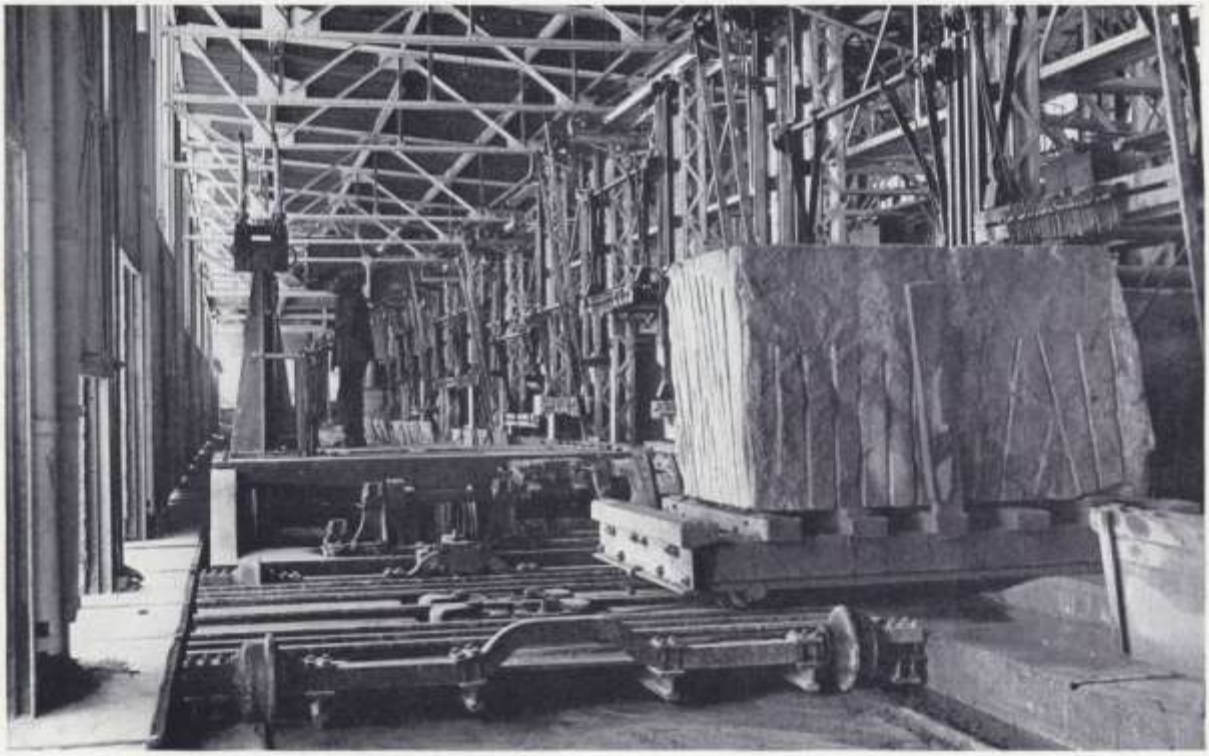
In addition to its operations in its home state and the quarries at Bluff Point, N. Y., the Vermont Marble Company has extensive holdings in Colorado and Alaska.

The Alaska quarries are in the vicinity of Prince of Wales Island, off the coast of British Columbia. Work there was started in 1908 and a considerable quantity of marble was put on the market the following year. The quarrying season lasts from February until December. Additional property in Alaska was acquired in 1920 so that patent is now held on upwards of 2,800 acres of marble claims.

Blocks are shipped by boat to the Vermont Marble Company's plants at Tacoma and San Francisco where sawing and finishing are done. A storage of blocks is maintained at Tacoma and blocks for the eastern trade are shipped from that point.

The Alaska quarries produce marbles

One of the storage yards where about 12,000 marble blocks are piled.



Interior of Marble Mill, at West Rutland, showing electric locomotive for handling blocks.

that are very hard and take a splendid polish. They have been extensively used for interior work.

The Company has recently bought an interest in the quarries at Marble, Colorado, known as the Yule Colorado properties, and is now in charge of their operation as well as of all sales of the product.

Sawing Marble

THE process of sawing marble with sand and water goes back at least twenty-one hundred years. Yet the mill of today with its improved mechanical equipment and its labor-saving devices, is far removed from the old form.

The modern mills of Vermont are operated entirely by electricity. Each gang consists of a steel frame suspended from above with an arm reaching back to machinery in the rear which gives it a swinging motion. The frame is arranged so that saw blades, which are plain bands of rather soft steel, can be tightly stretched from front to rear. A mixture of sand and water flowing on the block from above furnishes teeth for the saws. A suitable apparatus feeds the gang of blades as the sawing progresses.

There is a car under each gang to carry the block or slab which is being sawed. As soon as the block is sawed down, it is pulled out by power and another car, carrying a new block, is rolled under the gang. The sawed slabs go direct to the finishing shops, or, if there are no orders for the particular grade, to storage yards. Many blocks produce marble of several different grades.

From the Mills to the Finishing Shops

Bringing in the Sand

IN the sawing of marble and in the earlier stages of finishing, little can be done without water and sand. Both of these great aids are literally on the threshold of the Vermont marble deposit. The water has only to be drawn from the river as it runs by, while the sand needs simply a string of conveyers to transport it over the mountain.

Years ago, when the quarries were young, a big sand hill stood beside the mills. Little by little that was carted down to take its turn with the grinding steel. Later a short aerial tramway was stretched across the river to another sand deposit. Finally, when that was cleared away, the tramway was extended for more than two miles over the mountain to a supply which by comparison has made all others small. For more than twenty years the steel buckets in endless chain have been eating into the heart of that gigantic sand bank. They arrive in Proctor, each with its load of 500 pounds, at the rate of one every 28 seconds. Millions of tons have been moved down into the valley, and the end is not yet in sight. Not only does this one opening furnish sand for all the shops and mills in Proctor, but

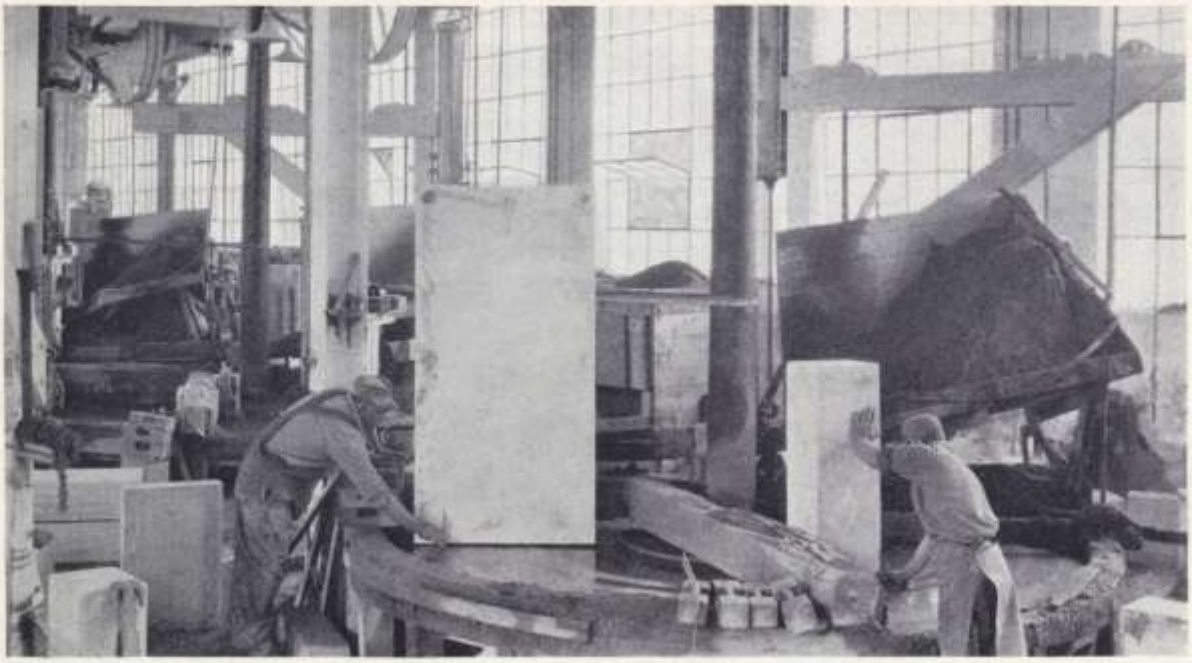
(ABOVE) *Marble block which has been sawed into slabs.*

(RIGHT) *Sand tramway terminal, Proctor, with falls and power station below.*

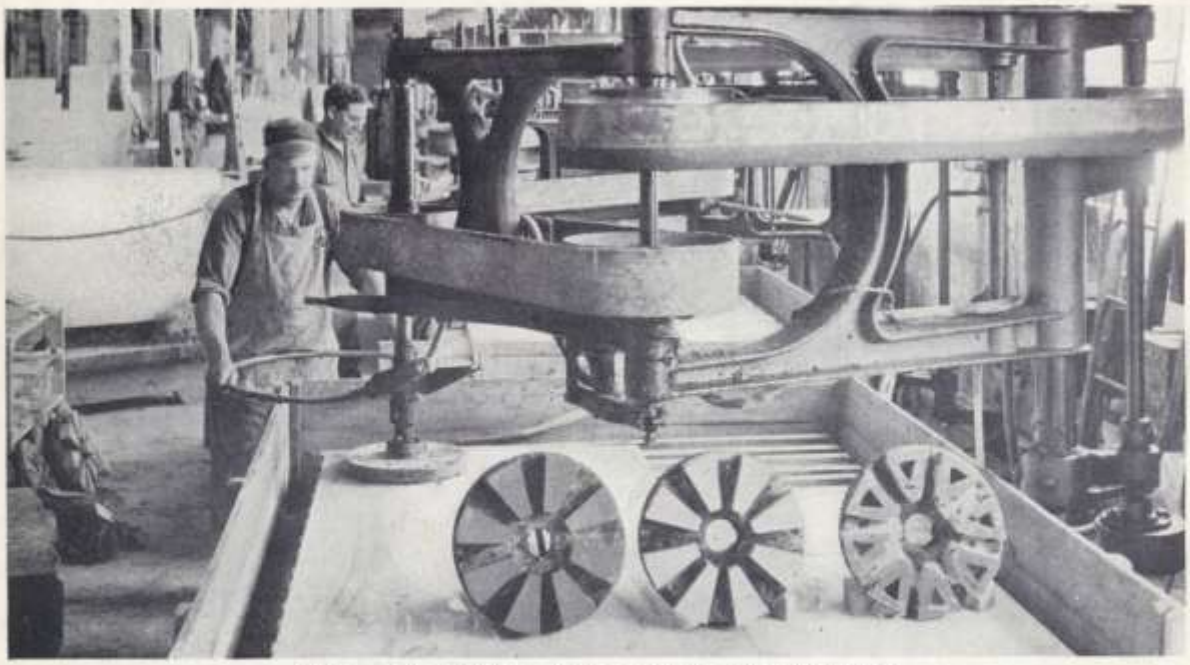
© Underwood & Underwood

(BELOW) *Top of mountain, looking down tramway toward sand deposit.*

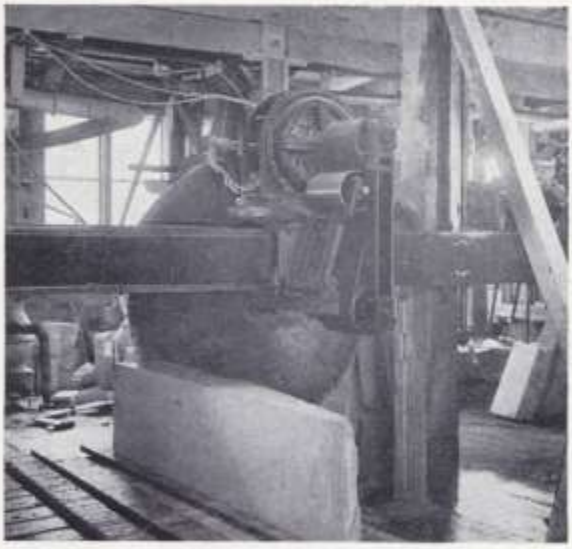
© Underwood & Underwood



Marble Rubbing Beds in the Proctor Shops.



A Battery of Marble Polishing Machines with Adjustable Abrasive Heads.



This marble saw has 125 diamonds in its rim and makes 600 revolutions a minute.

it is shipped away by train to many of the outside plants.

Finishing Exterior Marble

EXTERIOR marble may go to the shop in slabs to be split or sawed with the diamond saw, or it may be sawed down nearly to size in the mill. It then goes either to the rubbing bed or planer where it is reduced to correct size and form. Plain ashlar after it leaves the bed or planer needs only to have its exposed faces finished and be drilled for pins or Lewis irons and crated.

The exterior finishes in common use are: sand, tooled and axed. Sand finish is wrought by rubbing wet sand on the marble by hand with a block of metal. Both the tooled and axed finishes are applied by the stone cutter, the one with a wide flat tool and the other with a set of fine chisels held together in a clamp.

Moldings are cut largely by the planer. The carborundum machine may be used but the planer is better adapted to the character of exterior marble. Before going to the planer the marble is usually "set in" by the cutter, which means that the mold is cut by hand for about an inch at each end of the piece.

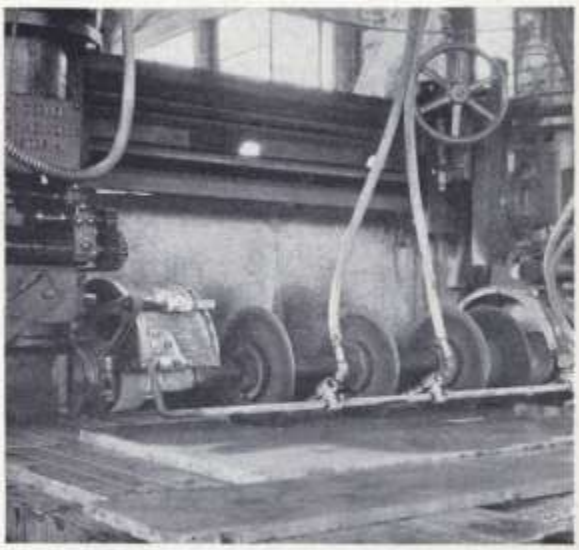
Shop lists or diagrams of each stone are provided by the drafting department so that the cutter may know the dimensions and finish. In the case of molded sections it is the prevailing custom to furnish metal templates or patterns for the guidance of the shops.

Turned work is brought to form in a lathe in much the same way that wood or metal is fashioned. If a column is to be fluted, the work is done on a planer or carborundum machine after it has been turned.

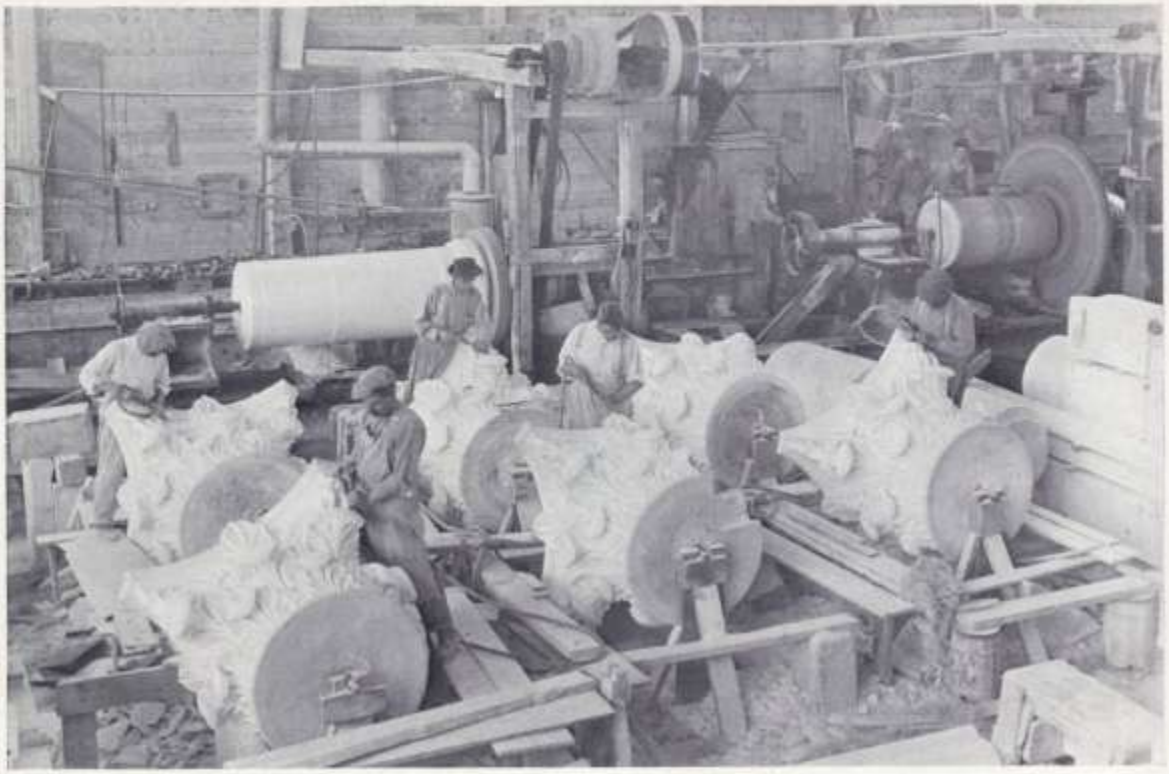
Intricate portions of the exterior such as feature pieces, carved groups and entrances are fitted together whenever possible before they leave the shops.

Finishing Interior Marble

WHAT is known as "thin stock" may range in thickness from 7/8" to 2", depending on the way it is used in the building.



The carborundum machine has taken the place of much hand-cutting.

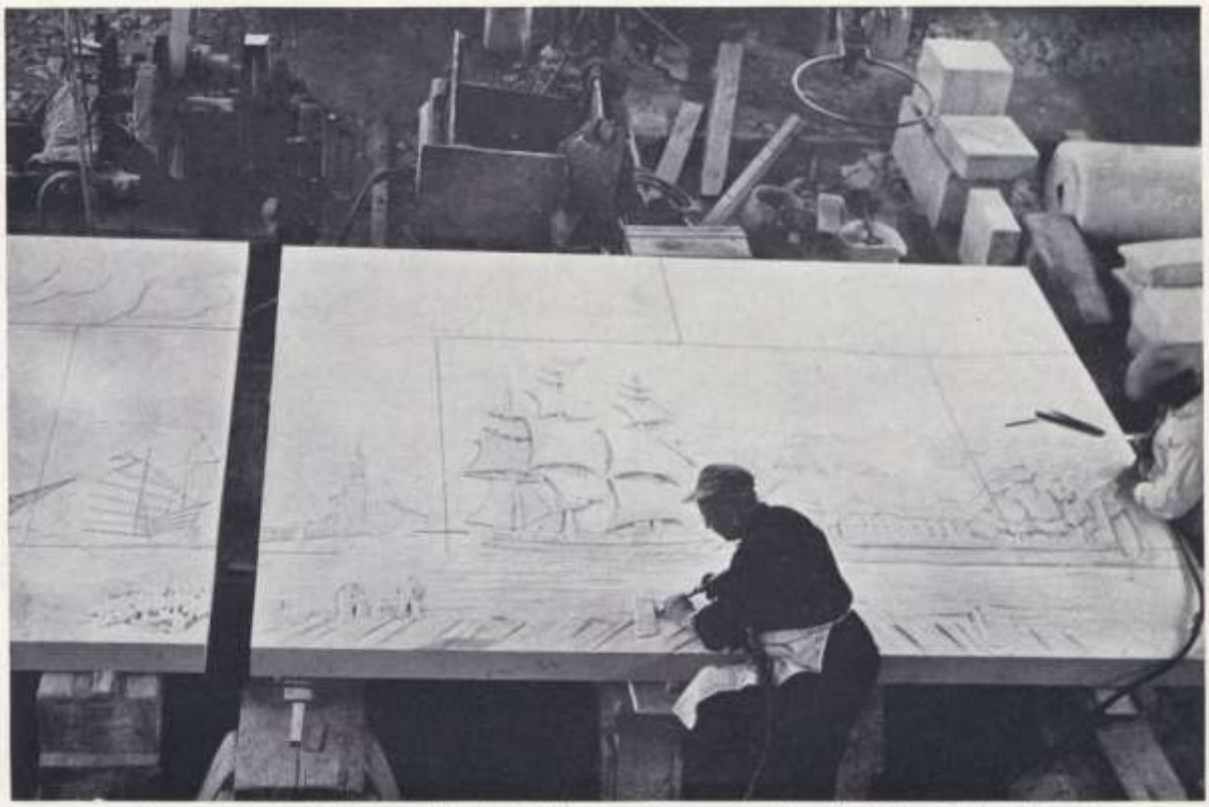


Carving the column-caps for the Arlington Amphitheatre as designed by Carrere & Hastings.

Turning large marble column in specially constructed lathe.

The stock comes to the shop in the form of full-size slabs. They are first coped, either by hand or carborundum machines. The more fragile marbles, particularly the foreign varieties, are difficult to cope by hand.

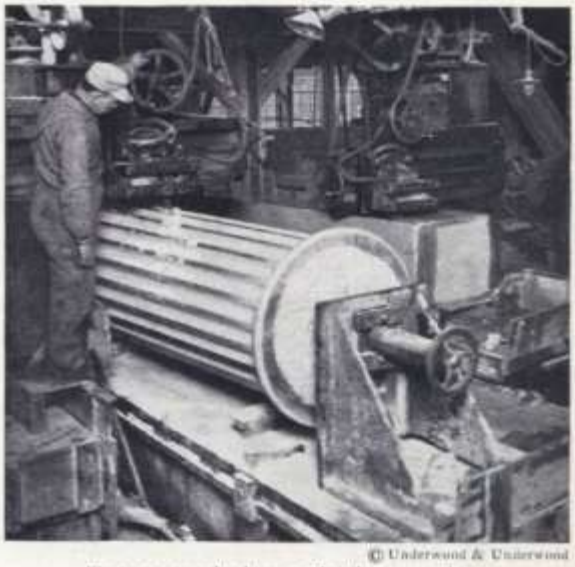
The pieces thus obtained then go to the rubbing beds where they are squared and worked down to exact size and where all scratches and scars are removed. The rubbing bed is a large horizontal iron plate which is propelled like a top at the rate of about 40 revolutions a minute. Water charged with sand flows out from the center over the flat upper surface, and as the pieces of marble are held thereon in a fixed position, the abrasive action wears them away. Ordinarily, each piece is rubbed separately but if there are



At work on one of the Symbolic Sculptured Panels for the Institute of Savings, Providence, R. I. Howe & Church, Architects.

several of the same size they may be clamped together and the combined edges rubbed at the same time.

Leaving the beds the marble goes to the polishers. The polishing machine consists of a movable arm, at the end of which is a rapidly revolving horizontal disk. The marble is placed on a banker under this disk which is coated with abrasive material. Various disks are used in the process, ranging from a medium carborundum to a fine hone. The final polish comes from applying a felt buffer with polishing powder. Most of these operations require a constant flow of water. The polishing machine is used almost exclusively for the faces of slabs, but although there are machines designed for polishing the edges, they are still done largely by hand. The



Fluting a turned column in the planing machine.

process is the same whether the work is done by machine or hand.

The finish of interior marble varies according to use. Sand finish is best adapted to floors and stair treads. Hone finish or polish applies to wall work.

At Sutherland Falls, Proctor, the Otter Creek drops 120 feet.

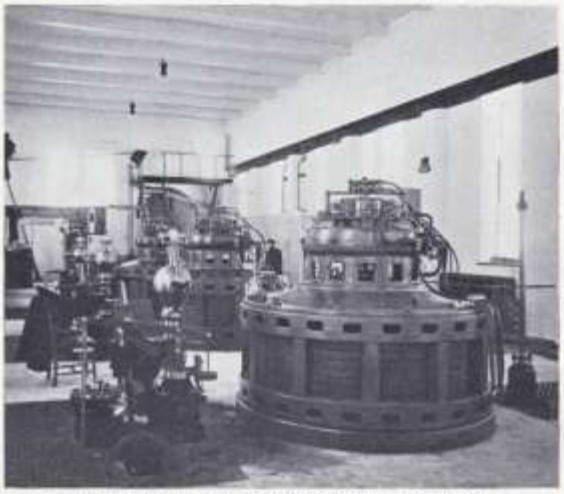
Much of the molded work is done on the carborundum machine. To be used economically however there must be considerable stock to be removed or a number of pieces of the same pattern. If there is only a little cutting to be done it can be executed more profitably with pneumatic tools.

In most cases, pneumatic tools are applied also to carved work. For the finest of detail it is sometimes necessary to resort to the older method of hammer and chisel.

All interior marble which is more than two inches thick is known as "cubic." Usually it is sawed to approximate size in the mills although there are times when it is worked up from the slab by diamond saw or carborundum machine. In any case it goes from the saw to the rubbing bed as in the case of interior thin stock.

Whenever possible interior cubic is cut on either the carborundum machine or the planer. The difference between these two machines is that in the former the marble moves on a platform under revolving abrasive wheels of different shapes while in the latter it moves under stationary chisels.

In polishing cubic as well as thin stock, the machine is used whenever possible. Frequently as a guaranty of even lines and superior matching, involved sections are fitted together in the shop and polished in that form. Turned work is polished in the lathe while the marble is in motion.



Hydro-Electric Power Station, Proctor, a part of the 13,000 H.P. circuit.

* * *

The Otter Creek provides power for by far the larger part of the machinery in the shops, mills and quarries of the Vermont Marble Company. Power houses at several of the falls of the river feed into a general circuit, with a combined force of about 13,000 H.P. This is entirely adequate for all the needs of the industry.

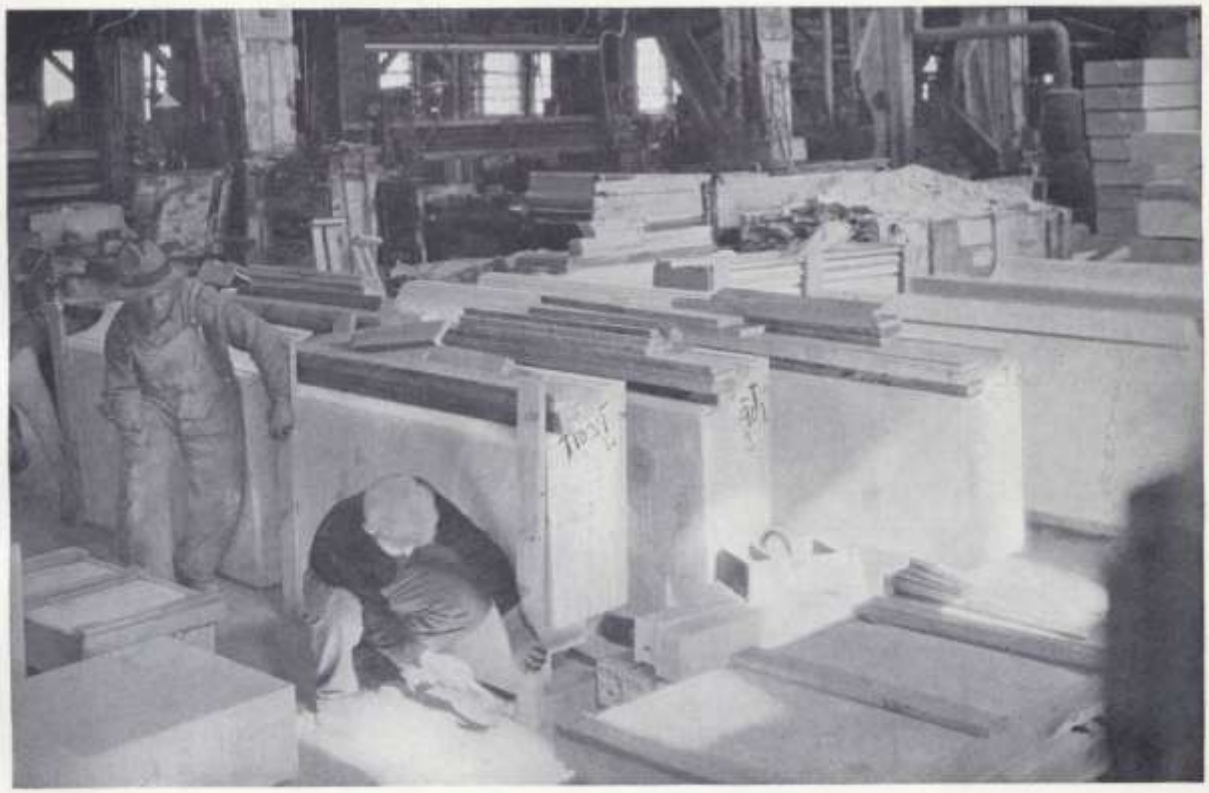
Finished Marble in Transit

MARBLE should come into the boxing room thoroughly clean, properly marked and numbered.

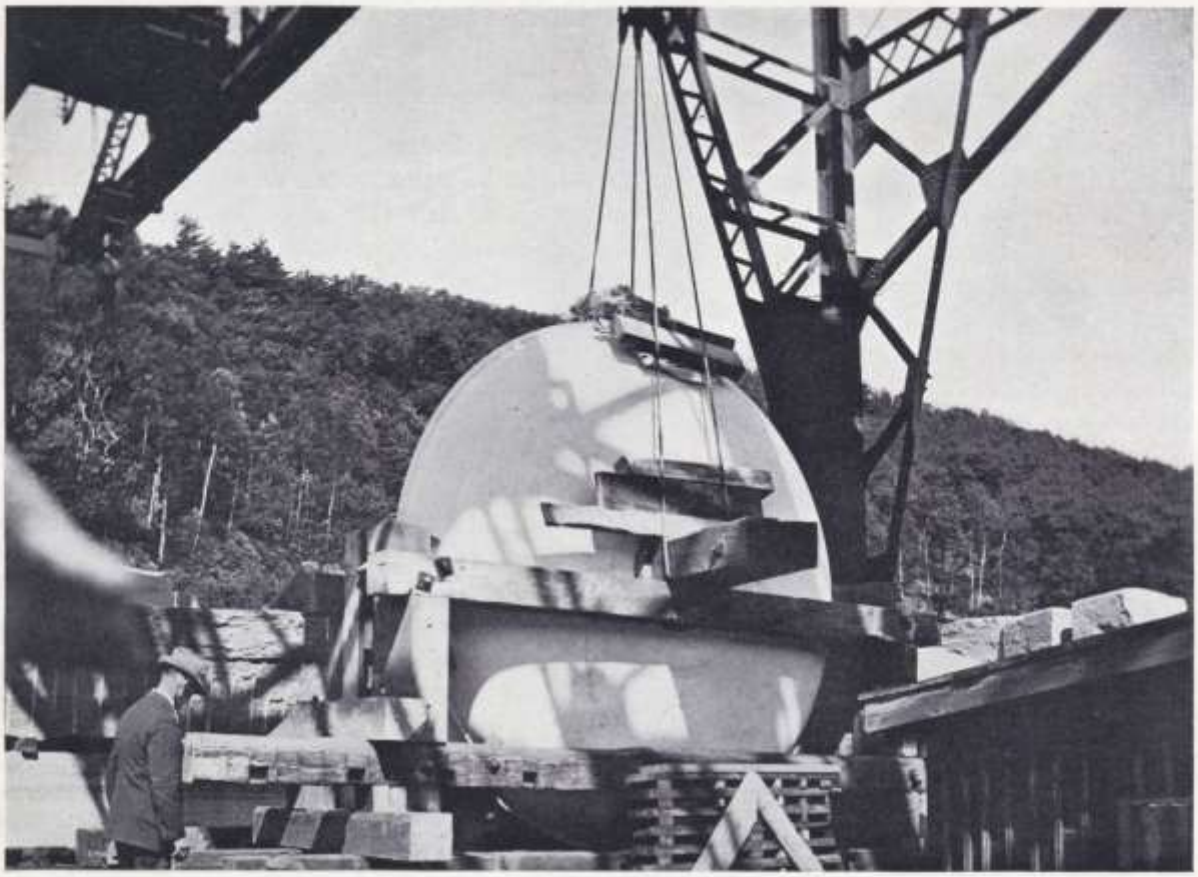
The term "boxing" covers both ordinary crating and solid boxing where there are no spaces between the boards. Sand-finished marble, which is most often specified for exterior construction, can be sufficiently protected by crating.

Large cornice members, carved caps, columns, and other similar pieces offer special problems in crating.

When marble is polished, and that is the finish commonly applied to interior work, it must be boxed more carefully than exterior marble. As a rule all of the smaller polished pieces are boxed tight. Thin strips may be boxed together up to a combined weight of 500 pounds. In most cases polished balusters are packed four in a box and held apart at the ends with wood cleats. All single pieces that exceed the maximum weight must be boxed separately. When two or more slabs or strips go in the same box the polished surfaces should be brought together, separated only by sheets of wrapping paper. All space between



Finished marble in the shops ready for boxing.



Loading huge marble bowl for Scott Memorial Fountain, Detroit, Mich. Cass Gilbert, Architect.

marble and box is filled with excelsior. Polished surfaces must be given special padding lest they come in contact with the boards.

Loading and Shipping

BUILDING marble in general is shipped in regular box cars. Large columns or other huge sections may require special cars of the flat or gondola type.

Pieces drilled for the Lewis iron, a metal ring attachment which fits into a hole in the marble, offer the crane men a special means of loading. If that method is barred, the marble must be raised with grab hooks or slings.

Columns of moderate size are frequently worked into box cars by placing one end on rollers or trucks and manipulating the other end with a derrick. However the marble may be loaded, it must be suitably blocked in the car. Otherwise it will be displaced by the motion of the train.

The greater part of all interior marble is loaded with hand trucks. All crates containing thin stock should be placed on edge and wedged or braced to hold them in an upright position. The safer method is to attach the braces to the car. When legs are placed on the crates they may be knocked off in transit, resulting frequently in the breakage of the marble.

One of the columns for the Bridgeport Savings Bank, Bridgeport, Conn. Cass Gilbert, Architect.

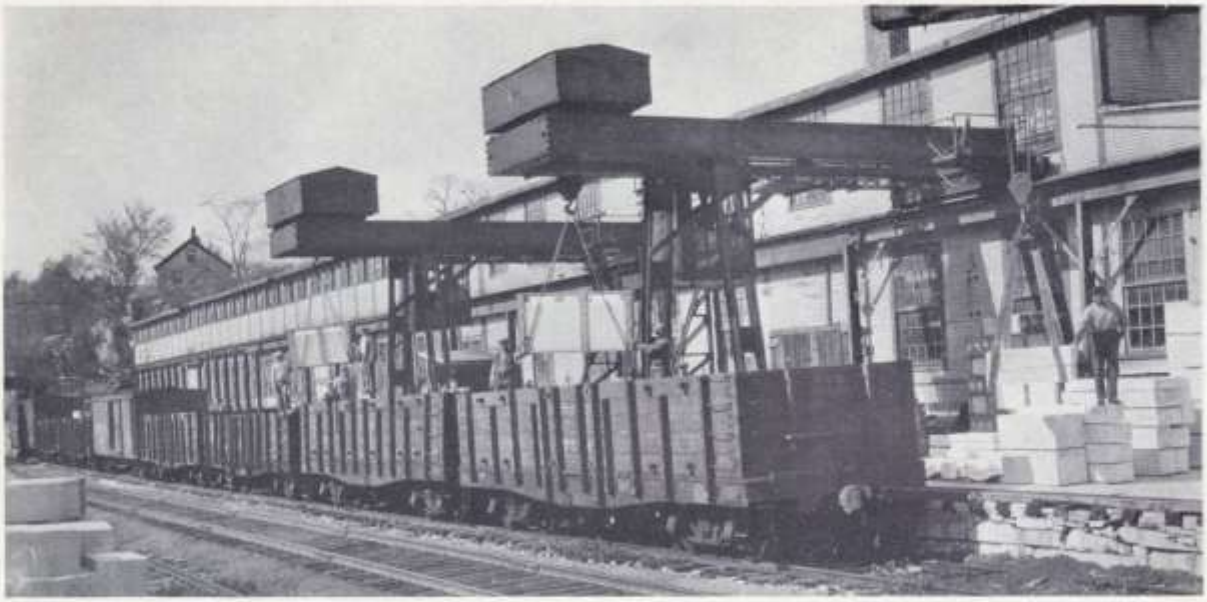
Protection at Destination

MARBLE intended for different sections should be piled according to number and in the proper order so that the pieces which must be set first will be on top. Finished surfaces or edges cannot be knocked together or walked on without injury, nor is it safe to rest any marble on the finished sides or edges.

When slings or special tackle are used instead of Lewis irons for setting, the marble should be padded with strips of canvas or other similar material. New rope, or at least rope which is free from grease and dirt, is the only suitable kind for the slings.

In setting exterior marble the masons extend sheets of canvas from the wall out over the staging. This keeps the mortar away from the stone which has already been set. In certain cases a solid board frame is built up over the face of the wall as the courses rise. It is customary to keep columns and other projecting sections well boxed in until the work of construction is complete. In combining marble as a trim with brick or local stone the sills, belt courses, etc., are boarded over with spruce or white pine. Zinc strips may be built into the wall as a means of keeping the boards in position. If acid is used to remove

Marble columns for the Curtis Publishing Company Building, loaded on cars at Vermont Quarries. E. V. Seeler, Architect.



Sectional View of Exterior Building Shops, Proctor.

surplus mortar from the brick work, it should never be permitted to touch the marble.

The rules already prescribed apply equally well to interior marble. In all sections where many people are likely to pass, the marble is guarded by boxing as soon as it is set. Exposed marble which must be handled by the workmen can be painted with a non-staining preparation which is easily removable. If plastering and decorating are done after the marble is set, it is imperative that all marble be covered meanwhile with heavy paper or canvas. Marble floors are covered with paper, or when travel demands it, with temporary board floors.

Care and Cleaning of Marble

MARBLE is entitled at all times to the treatment which is given to any other fine product. It should be kept free from dirt and sources of stain, not alone while the building is in progress, but throughout its long and serviceable life. Marble needs no redecorating or refinishing but it does need occasional cleaning, and that work should be intelligently done. A little book issued by the Vermont Marble Company, called "The Care and Cleaning of Building Marble," contains all the necessary instructions. This book will be sent to anyone who will take the trouble to write for it.

Loading marble on cars with electric crane.

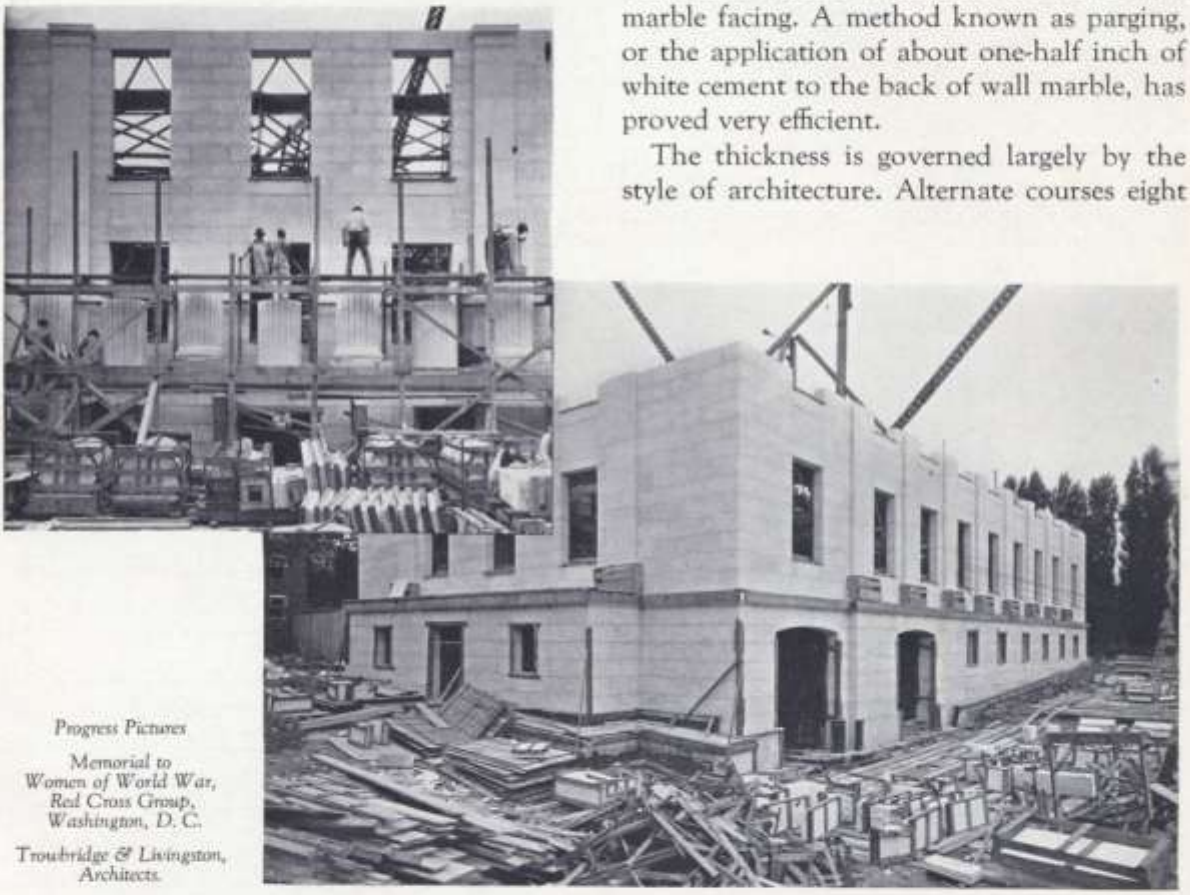
The Work of the Marble Setter

Exterior Setting

ANY marble specified for the outside of a building is known to the trade as exterior. It may be used in what is called a wall-type, the setting is frequently delayed until at least a large part of the steel is in place.

Exterior marble, except in unusual cases, requires no waterproofing. It is understood that structural steel or reinforcing rods should be painted wherever they are in contact with marble facing. A method known as parging, or the application of about one-half inch of white cement to the back of wall marble, has proved very efficient.

The thickness is governed largely by the style of architecture. Alternate courses eight



Progress Pictures

Memorial to Women of World War, Red Cross Group, Washington, D. C.

Trowbridge & Livingston, Architects.

bearing structure, which means that the weight of the floors is borne largely by the outside walls, or in a structure where a steel frame supports the weight. In buildings of the first class the marble setting may start as soon as the foundations are complete. In the latter

inches and four inches should be about the minimum. The thicker courses are intended to provide a bond, it being the common practice to back up marble walls with brick. The marble is attached to the brick work with anchors of suitable material. If dowel holes

Setting Monolithic Columns of Vermont Marble, Curtis Publishing Company Building, Philadelphia, Pa. E. V. Seeler, Architect.

are required as in the case of balustrades, they should be a little larger than the dowels to allow for the expansion of the metal.

The approved thickness for joints is $\frac{3}{16}$ of an inch. The mixture for the setting is made up of sand and stainless cement, with the proper amount of hydrated lime. The sand should be of superior quality. White sea sand is recommended. In the process of setting, the joints are raked out about an inch back from the surface, to be pointed later with a different mixture.

It is imperative that moisture be kept out of the joints and this applies particularly to the vertical joints of the cornices. The safest way is to fill them with liquid grout and give them occasional inspections. Elastic cements are now available for the waterproofing of joints which are exposed to the weather.

Marble should be set in a full bed of mortar, although sills are bedded on their ends only. It is backed up as the setting progresses. The placing of derricks for the setting varies with the construction. If it is a wall-bearing structure they may be raised outside. If it has a steel frame they may be attached to that. The marble is lifted either by rope sling or by a Lewis iron. Special tongs are sometimes

needed for setting of cornice or other sections where the Lewis iron alone is inefficient. Scaffolds may have to be constructed outside the building to accommodate the setters.

The boxing for the projecting courses should be kept in place until the marble work has been pointed and cleaned, or until the building, both exterior and interior, is practically finished. See that clear water and white sand are provided for cleaning the outside walls.

Interior Setting

After the outside of the building is finished then begins the installation of interior marble. This starts as soon as the rough floors are in, the window and door frames set and the plaster adjoining the marble in place. If for any reason the plastering cannot be done first, the marble should be adequately covered while the other work is in progress. Walls of heavy marble ashlar should be backed with brick or hollow tile. Interior columns which

(Left) *Raising Section of Cap into position at Public Ledger Building, Philadelphia. Horace Trumbauer, Architect.*

(Below) *Marble Workers in action on Exterior of Institute of Arts, Detroit, Mich. Paul P. Cret and Zantzinger, Borie & Medary, Architects.*

The William H. Porter Mausoleum, Woodlawn Cemetery, New York, as it looked in the early stages of construction. Trowbridge & Livingston, Architects.

serve as supports ought to be installed before the overhead work, and protected against damage from that source. The general contractor is supposed to provide water, heat, light, hoisting facilities and runways. The owner of the building generally arranges for the fire insurance.

In the actual work of installation much depends on the skill and ingenuity of the marble setter. He must see that all sections are properly fitted and securely anchored to the wall. He has a helper to mix the mortar and lend a hand in putting up such scaffolding as may be needed, but he alone is responsible for results. In short, marble setting is a work which demands the resourceful hand of a trained craftsman.

The best construction allows for an airspace back of the marble. It is both unnecessary and injurious to back up the slabs with solid plaster of Paris or cement. In mausoleums, especially where there is a lack of ventilation back of the side walls or above the ceiling, changing climatic conditions are likely to cause condensation of moisture on the face of the marble. Underground halls should be waterproofed to keep out the moisture. All structural steel or reinforcing rods which come

in contact with marble should be coated with damp-proof paint as a precaution against stains.

The marble contractor must expect to do certain cutting for the accommodation of other trades such as openings for pipes, electrical outlets and similar adjustments. This is contingent always on the assumption that the other work has been properly done.

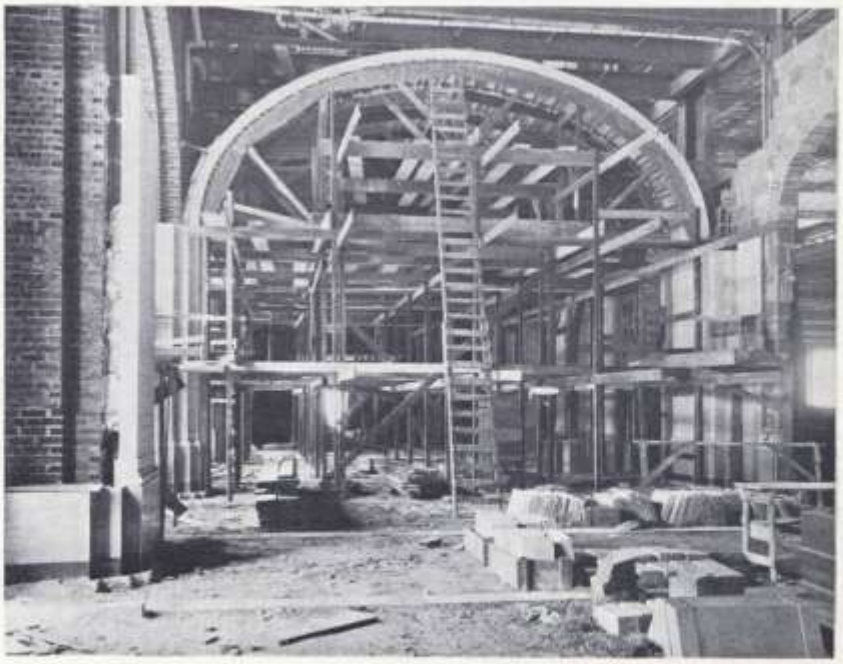
After the marble has once been set and cleaned, granting that it is cleaned at the approved time, the contractor cannot be brought to account for damage wrought by other trades. If the plaster is decorated after the marble is set the decorator must arrange in some way to give the stone suitable protection. On the other hand the marble contractor should be ready to furnish a year's guaranty, proving thereby that the work has not been undermined by inefficient workmanship or unreliable material.

Floor Marble

THE generally accepted thickness for floor tile and border is $\frac{7}{8}$". In a majority of cases the floor extends under the wall base. The setting space from the finished floor line to the rough slab should be about $2\frac{1}{2}$". Prior to setting the tile the concrete floor should be swept and sprinkled. The standard mortar for the setting consists of one part Portland cement and three parts sand. With the aid of a wooden mallet, the tile are sunk to the required depth in the soft mortar. Then they are raised so that dry cement can be sprinkled under them, to make them stick to the mortar. Twenty-four hours later, the joints are grouted or filled with a mixture of neat cement and water. For white floors, white Portland cement is recommended for grouting, although standard Portland may be employed for the setting. The sand must be clean and sharp and free from substances which are likely to produce stains. After the cement is thoroughly set, the floors are rubbed down to proper form with a marble surfacing machine.

Stair Treads

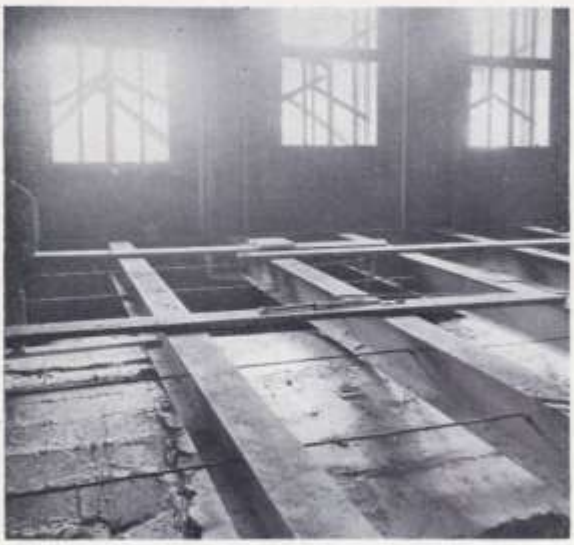
TREADS and platforms are seldom less than $1\frac{1}{4}$" in thickness. If the plan calls for marble strings they should be set first. Either



Constructing Interior Arch, Hamilton County Courthouse, Cincinnati, Ohio.

Marbles from Vermont, Texas and foreign quarries were used for this interior.

Rankin, Kellogg & Crane, Architects.



Cement Work and Anchoring over Marble Ceiling, Hamilton County Courthouse.

cement or plaster of Paris will answer for bedding.

Anchors are not required for treads but marble risers should be anchored like any other standing marble.

Toilets

TOILET marble may be held in place by metal supports or it may be self supporting. Under the latter method a slot is cut in the backs or in the wall and the mullions are grooved to fit the partitions. The customary thickness for wall wainscot is $\frac{7}{8}$", for partitions $1\frac{1}{4}$", and for stiles $1\frac{1}{4}$" or $1\frac{1}{2}$".

Since the marble in toilets is installed before the fixtures are in place, the marble contractor must do such cutting as may be required to accommodate pipes, latches and door hinges. If the floors are marble the plumber should avoid the use of putty and substitute grafting wax or some other non-staining preparation. When a marble shower bath comes over a plastered ceiling, a lead pan which drains into the outlet should be placed under the marble. A waterproofing mixture consisting of glycerine and litharge gives best results in pointing the joints in marble shower baths.

Other Forms of Standing Marble

GENERALLY in setting all standing marble, (where no liner is required), the finished face is brought out $1\frac{1}{2}$" from the rough wall. It is held there with brass, copper or aluminum anchors, which are attached to the supporting wall with plaster of Paris.

Nearly all interior marble can be raised without the aid of a hoist. Sometimes a chain hoist is needed for the lifting of columns. Marble columns are set on cushions of brass or aluminum to guard the joint at the bottom. If marble staves are placed around structural columns, the columns should first be fireproofed, then the staves can be anchored to the fireproofing and cramped together on the top bed.

Forms are required for the setting of heavy arches and domes. If there is working space over the vault or dome, the marble may be set prior to the backing. Then, after the arch stones have been properly anchored, the marble is waterproofed and the concrete applied to the upper surface.

The thickness of the marble in flat ceilings is governed by the amount of unsupported space. If this space exceeds five feet in length the slabs should have additional thickness as a safeguard against sagging. Ceiling slabs in mausoleums may be supported by hangers with bronze rosettes at the ends.

In the case of marble bank screens, the supports, whether of hollow tile or metal, are provided by the general contractor, unless the specifications declare otherwise.

For marble shop fronts, it is safe to use the minimum thickness of $\frac{7}{8}$", the only requirement being that the grade specified is one which is adapted to outside work.

Specifications and Finishes

To Avoid Mistakes and Disputes

UNUSUAL features of design or construction should be thoroughly covered by the specifications. It is well to provide for the special dowels which go in finials and balusters, also the dowels in coping. Both the specifications and the drawings should be explicit as to the position of raglets. If placed too near the edges of the stone the lead used in calking is likely to split them.

The thickness of material in general should be specified and the height should be either specified or clearly shown. In toilet work state whether the stiles run to the floor or are supported on metal legs, whether there is to be marble capping or metal rail. If cove base is desired, the size should be given, and if it is to run under the stiles and partitions that point should be covered.

The specifications and the drawings as well should designate the kind of joints. Butt joints conform to ordinary construction and if quirk-miter joints are wanted their position should be defined.

When plaster occurs in connection with marble work the plasterer should be required to finish the whitecoating before the marble work is started. Wet plaster is likely to deaden the glow of marble. This, with the damage from scaffolding, far outweighs the slight disadvantage of plaster patching. The marble contractor should be given at least one inch bed for tile.

On contracts of any size, the general contractor should be required to agree with the marble contractor to certain finished sizes in advance, thus enabling the work of the latter to proceed. The work of other sub-contractors should of course be constructed in accordance with these finished sizes. This procedure will insure the delivery of the marble as soon as the building is ready to receive it.

(LEFT) *Public Library, New York. Dorset Marble. Carrere & Hastings, Architects.*

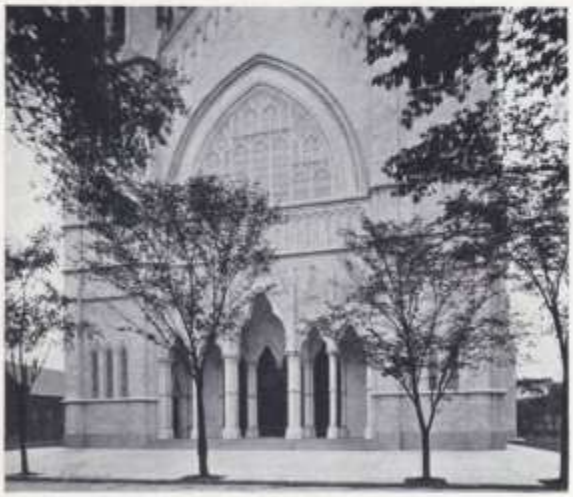
(BELOW) *Colony Club, New York. Imperial Danby Marble and Brick. Delano & Aldrich, Architects.*

Specifications for Exterior Marble

Material. All cut stone work shall be (insert name of grade) from the quarries of the Vermont Marble Company.

Work Covered. (Explain here in detail what portions of the building are to be of marble.)

Quality. All marble entering into the construction of the work shall be selected for uniform color. It must be free from cracks,



St. Joseph's Cathedral, Buffalo, N. Y.
Exterior: Eureka Marble. Aristides Leonori, Architect.

chips, stains, or other defects upon exposed surfaces.

Samples. Before proceeding with the work the contractor shall submit a sample 4 by 8 by 2 inches of the marble he proposes to use. One face of this sample shall have (specify what finish is desired).

Joints. All marble shall be cut for $\frac{3}{16}$ inch joints.

Finish. All exposed surfaces of marble work shall have (specify desired finish).

Drawings. Detailed drawings will be furnished by the architect for all work requiring them. The contractor shall make, and submit for the architect's approval, shop drawings showing in plan and elevation the dimensions of all stones, position of joints and the spacing of dentils or other repeated ornament.

Cutting. All cutting must be done in a workmanlike manner and in accordance with the shop drawings. All faces shall be free from winds so as to present a true and even surface. Joints shall be at right angles to the face. Intersecting profiles shall be accurately cut. Re-entering angles of moldings shall be cut from the solid, unless otherwise shown by the drawings. The contractor shall, where called for by the architect's drawings, cut the marble work to accommodate steel, flashings, leaders or other structural materials.

Delivery. All marble shall be crated or otherwise protected so as to be delivered at site in good condition.

Storage. All marble stored at the site shall be on cleats, off the ground, and protected where necessary from any stains from above.

Setting. Marble shall be set with a derrick and on a full bed of mortar. The mortar bed

St. Joseph's Cathedral, Buffalo, N. Y.
Interior: Light Vein Rutland. Aristides Leonori, Architect.

shall be kept back at least one inch from the face of the stones. Sills shall be bedded at the ends only. Backs shall be parged with mortar similar to that used in setting.

Mortar. The mortar for setting marble shall be composed of one part white non-staining Portland cement, three parts clean, sharp sand, and a quantity of hydrated lime equal to 10% of the volume of cement.

Finishes of Exterior Marble

Sand Finish. This finish is the one most commonly specified. It brings out to the greatest degree the natural veining of the marble. It is put on by rubbing the stone by hand, using coarse sea sand.

Tooled Finish. Where a rougher finish is desired, tooling is often specified. The work is done by hand or by a special tool used in the planer. In either case the effect is that of a slightly corrugated surface. The lines are continuous and are regularly spaced.

All plain surfaces are tooled vertically. Moldings are tooled lengthwise of the molding. Very small moldings, as well as all top surfaces and washes, are sand rubbed instead of tooled.

Axed Finish. This is also known as hammered finish. It is the usual granite finish. It is distinguished from tooled finish by the fact that the lines are finer, nearer together and somewhat irregular.

Chisel Finish. This is a special finish put on with the pneumatic tool. Designed as it is for monumental work, it is not adapted to large structures. It is recommended, however, for mausoleums or other memorial work.

Rock Face. This, as the name implies, is a very rough finish. After the pieces are sawed, the faces are split off by hand, leaving the stone with its natural surface. The work is done in such a way as to leave the stone somewhat thicker at the center than at the beds and joints.

Staircase
Horn & Hardart Building, Philadelphia, Pa.

Brocadillo, French Gray and foreign marbles.

Ralph B. Bencker, Architect.

Specifications for Interior Marble

Material. All interior marble shall be as follows: all toilet marble, Vermont Florence; all corridor marble, Vermont Light Cloud. (Always insert the name of the desired grade, avoiding the too general term, "Vermont marble.")

Public Ledger Building, Philadelphia, Pa.

Imperial Danby Marble and Brick.

Horace Trumbauer, Architect.

Work Covered. (Explain here in detail what portions of the building are to be of marble.)

Quality. All interior marble shall be of good quality, free from stains. Patching will be permitted only where the natural imperfections of a particular stone are subject to correction by the established usage of the industry.

Samples. Before proceeding with the work the contractor shall submit to the architect samples of all the marbles specified above, one foot square and 7/8 inch thick.

Finish. All floors and stair treads shall have a fine sand finish. All standing marble shall be highly polished.

Drawings. Detailed drawings will be

Red Cross Memorial, Washington, D.C. Exterior: Mountain White Marble. Interior: Best Light Cloud Rutland with Royal Antique Columns. Troubridge & Livingston, Architects.

furnished by the architect for all work requiring them. The contractor shall make and submit for the architect's approval shop drawings showing proposed jointing.

Measurements. Before proceeding to finish the interior work the contractor shall verify all measurements at the building, or shall work to agreed measurements.

Cutting. The marble contractor shall do such necessary cutting and fitting to accommodate his work to other trades as is sanctioned by common usage in the trade.

Setting. All floor marble shall be set in a cement mortar of one part cement and three parts sand, adding a quantity of hydrated lime, not exceeding 10 per cent of the volume of cement. The concrete fill must be swept and thoroughly sprinkled before setting is started. All stair treads and all standing marble shall be set in plaster of Paris. All wall marble shall be securely anchored with brass, copper or aluminum wire.

When work is completed all marble shall be cleaned and left in good condition.

Finishes of Interior Marble

Polished. This is the standard finish for interior work, not exposed to wear. The marble has a mirror-like surface.

Hone Finish. As described under finishing processes, marble that is honed presents a perfectly smooth surface but is not glossed.

Fine Sand Finish. This is the standard finish for floors and stair treads. It is put on by the rubbing bed.

Sectional Views of Memorial Amphitheatre, Arlington, Va. Mountain White Marble. Carrere & Hastings, Architects.

The In's and Out's of Detailing

THE marble work in a building may be a necessary part of its actual structure or it may be merely a decorative feature. Many buildings are solidly constructed of marble. Cemetery mausoleums are of this type. Gothic churches frequently come within the same classification. But in the more common forms of modern construction, while stone still forms an integral part of exterior and interior construction, solid walls have given way in large measure to the steel frame. In the building of today, except in the case of arches or lintels, the vertical bearing strength of any tested stone should be sufficient as a support for the work above it.

Duke University Buildings, Durham, N. C. Veined Rutland Marble and Brick. Horace Trumbauer, Architect.

Exterior Details

WHEN the ashlar is intended to form a part of the structure it is laid in alternate courses of 4″ and 8″ or 8″ and 12″, and is anchored to the backing walls with strap anchors. Projecting courses should have a bed which is at least equal to projection of the marble beyond the wall. When this is impossible, large courses particularly should be anchored into the walls by long vertical rods placed at the joint and extending three feet or

Balustrade, Harvard Medical College, Cambridge, Mass. Imperial and Highland Marble.

Coolidge, Shepley, Bulfinch & Abbott, Architects.

Vermont Marble Fountain, Jennings Estate, Fairfield, Conn. Stephenson & Wheeler, Architects.

more down into the marble. When four-inch ashlar is used throughout it must be even more securely anchored to the backing walls.

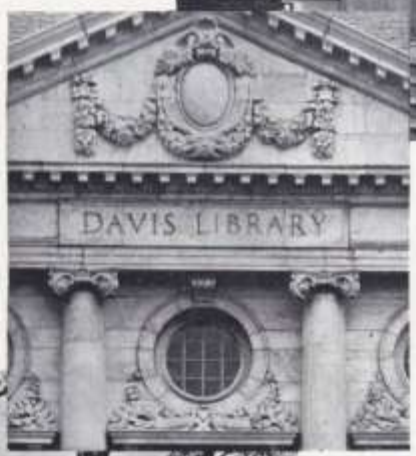
Ashlar less than four inches in thickness is not recommended for exterior work. Top courses such as coping and chimney caps are secured by dowels in the bottom of the stone.

The jointing should be on the side of economy as well as good construction and should be governed somewhat by the capacity of the quarry. Modillions and fillers may be cut in separate pieces if it means a saving of stock. In detailing roofs, as in the case of mausoleums, the stones should be as large as possible and when joints are necessary they should be rabbeted so that they will overlap. Flashings of copper may be objectionable architecturally, but copper splines are often inserted in the rabbets to insure protection.

(Above) *England Residence, Pittsfield, Mass.*
Danby Marble and Brick.
Albro & Lindeburg, Architects.

(Left) *Entrance to Hornblower Residence, Boston, Mass.*
Mountain White Marble.
W. W. Dinsmoor, Architect.

(Right) *Davis Library, Exeter, N. H.*
Mountain White Marble and Brick.
Cram, Goodhue & Ferguson, Architects.



(Below) *Municipal Building, Waterbury, Conn.*
Imperial Marble and Brick.
Cass Gilbert, Architect.

(Left)
Public Library, Detroit, Mich.

Imperial Marble from Danby Quarries.

Cass Gilbert, Architect.

construction—by omitting all indicated iron or concrete work which is not needed for the strength of the structure.

The frame can be so detailed as to avoid the expensive checking of marble string. Where circular risers occur at the foot of the stairs, the regular stair construction should be omitted and the marble supported on masonry. This does away with finishing the back of the marble to adjust it to the curved steel.

The stair treads and risers in many instances may be built up from the floor when

(Left) *Institute of Arts, Detroit, Mich.*

Danby Imperial Marble.

Paul P. Cret and Zantzinger, Borie & Medary, Architects.

(Right) *Scott Memorial Fountain, Detroit, Mich.*

Vermont Imperial Marble.

Cass Gilbert, Architect.

Interior Details

The uses of interior marbles are varied and, to secure the best results, the detailing should be carefully done.

One essential is to leave an air space back of the marble.

Avoid cutting the back of the piece whenever possible. Such cutting not only adds to the expense but offsets the advantage of solid construction. It may be avoided on almost any kind of circular work—especially in stair

(Right)
Branch Bank of Detroit.

Imperial Danby Marble.

Louis Kamper, Architect.

Stairway of Alaska and Verde Antique Marble in Public Auditorium, Cleveland. J. H. MacDowell, Architect.

the marble is set. In the string of the stairs the fitting together of twisted members is an expensive process and, if the structural features will permit, it is frequently better economy to cut the pieces from the solid. Elimination of the joints in this way not only improves the appearance but adds to the strength of the marble as well. These points should be taken up when the stairs are designed so that the details may be worked out to the best advantage of both the structure and the finished marble.

Bank screens may be supported by a wall of hollow tile, or by angle irons bolted to floor beams, or the soffit of the ledge may be plastered. Other plans call for solid marble cornice. Check desks can be either free-standing or supported by wall work.

Toilet work ordinarily is seven feet from the floor to the top of the partitions, the dividing partition being one foot from the floor, with those on the ends extending to the floor. The stiles may run to the floor or be supported on metal legs. The tendency at present is to omit metal rail and legs in toilet enclosures. No shower bath should be installed without a lead pan unless it is placed where a possible leak would do no harm.

An approved method for detailing vaulted ceilings shows the marble supported by forms. Anchors are placed in the joints and allowed to project several inches above the upper surface. The surface is then plastered with cement and waterproofed, after which structural concrete is poured in around the anchors.

Fountain Theatre, Cincinnati, O.

Exterior: Imperial, Metawee and Verde Antique Marble.

Interior: Second Statuary, American Pavonazzo, Verde Antique with Danby Tile.

Thos. W. Lamb, Architect.

A series of plates, illustrating methods of detailing for various forms of marble construction, may be obtained by writing to the Vermont Marble Company, Proctor, Vt.

The Problems of Estimating

Exterior

THE price on exterior work depends on the grade of the marble, the character of the construction, and the amount of cutting or carving.

If the decorative treatment is unusually elaborate, the price is correspondingly higher. Variation of color also, as between the darkest and lightest grades, may make a difference. To keep the price down, the work must be comparatively plain. Columns or molding, and cornices of intricate pattern, all add to the expense. Particularly is this true where the cornice includes modillions. A contract for trim without ashlar means a higher unit price, for the trim usually calls for machine and hand work, while the ashlar, being reasonably plain, offsets in part the extra labor on the other section.

In line with the adaptability of marble to carved work the tendency is to introduce many ornamental features. There is no denying that by this means the building gains individuality, but there must necessarily be a proportionate advance in the expense. Under this classification come carved caps of the various orders, sculptured panels, cartouches, and the various ornamental courses.

For all unusual work of this kind the architect should if possible provide satisfactory models. Otherwise the marble contractor will have to procure them, an arrangement which

(ABOVE) *First Trust & Savings Bank, Chicago, Ill.*
Vermont White and Verde Antique Marble.
H. Hanselman, Architect.

(LEFT) *Seaport National Bank, Houston, Tex.*
Imperial and Champlain Black Marble.
Sanguinett, Staats & Hedrick, Architects.

(BELOW)
Mantel in Northern Hotel, Billings, Mont.
Royal Antique Marble.
Link & Haire, Architects.

(Above) *State Capitol, Olympia, Wash. Alaska Marble. Wilder & White, Architects. Bebb & Gould, Associates.*

separate pieces and not a part of the work above or below.

Interior

On the inside of the building, the features are so varied and the range of marbles so broad that the price question becomes still more elusive. Even a plain wall has almost as many different prices as there are kinds of marble, and as further complications there may be elaborate pieces of ramp or twisted stair work, or other sections equally complicated, all of which have a decisive effect on costs.

(Left) *Staircase in King County Courthouse, Seattle, Wash. Alaska Marble. A. Warren Gould, Architect.*

(Below) *Temple of Justice, Olympia, Wash. Alaska Marble. Wilder & White, Architects.*

may lead to misunderstanding and complications. It is out of the question to give any range of price on carved work. Each case is affected by its own peculiar conditions.

Columns up to fifteen feet in length can be procured almost as cheaply in monolithic form as in drums. Beyond that length monoliths can be quarried and finished only at increased expense. If the price is to be kept to a minimum, columns more than twenty feet long should be made up in drums.

If the design calls for modillions, the most economical construction is to make them in

In marble floor tile, irregularities of pattern, although they add to the beauty, are sure to increase the cost. The expense of curved wainscot is two or three times that of plain work.

As already stated, there are many things which go into the making of the prices, but the two great variants are the character of the work and the variety of marble. Each estimate, therefore, is a law unto itself, and must be figured on its own basis.

(Above)
City Hall, San Francisco, Cal. Yule Colorado Marble. Bakewell & Brown, Architects.

(Right)
Southern Pacific Railway Station, Los Angeles, Cal. Alaska Marble. Parkinson & Bergstrom, Architects.

(Left)
Title Insurance Bldg., Los Angeles, Cal. Alaska Marble. Parkinson & Bergstrom, Architects.

Varieties of Exterior Marble

VERMONT marble for exterior building is classified under the following names: Mountain White, Imperial, Highland, Corona, Eureka, Florence, Plateau, Gray Vermont. These rank according to veining and in the order given from clear white to bluish gray.

Varieties of Interior Marble

THE Vermont Marble Company produces from its own quarries some forty-five different grades of marble for interior work. In color they range from pure white, through variegated shades of brown, gray, green and red,

into black. Some naturally are better adapted than others for special uses. As a preparatory step in the providing of the marble, it is customary to submit samples to the architect. These represent the average color and veining of the stock to be used. At best they can only indicate what may be expected, for marble is a product of nature and no two pieces are exactly alike. The classification on this page is intended as a guide in selecting the proper grade for a particular purpose. (See key below.)

It is manifestly impossible to give complete lists of the buildings where these various marbles are installed. Representative examples of any type of construction will be gladly furnished on request. As an introduction to some of the standard varieties of Vermont marble, we have prepared a set of color plates which will be mailed without charge to any architect. A card addressed to the Vermont Marble Company will bring them to your office.

American Pavonazzo, E
Avenatto, A-E
Best Light Cloud, D-E
Brocadillo, D-E
Champlain Black, C
Extra White Rutland, E
Florence, A-B-C
French Gray, C
Grand Isle Fleuri, C-E
Gravina, C-E
Imperial, A-B
Jasper, C-E
Light Cloud, B-D
Light Vein, B-D
Listavena, E-F-G
Lyonaise, C-E
Metawee, A-B
Neshobe Gray, A-B
Northern Ivory, D-E
Northern Pearl, A-B
Olive, C-E
Olivo, B-E
Oriental, C-E
Pink Lepanto, C-G
Pittsford Italian, A-B
Royal Antique, E-F-G
Royal Red, E
Second Statuary, D-E

Masonic Temple, San Francisco.
Alaska Marble. Bliss & Faville, Architects.

Standard White, A-B
Striped Brocadillo, E-F-G
Tokeen, A-B-D
Venoso, A-B-D-F
Verdoso, C
Verde Antique, C-D-E
Westland Cippolino, C-E-F-G
Westland Cream, D-E
Westland Cream Vein, D-E
Westland Green Cream Vein, E-F-G
Westland Verde Verde, C-E
Yule Colorado Marble, B-E

—Key—

A Toilets
B General Utility
C Base and Trim
D Ashlar Wainscoting
E Decorative
F Matched Panels
G Columns and Pilasters

Tests and Analyses

Composition

MARBLE is less complex than almost any other stone. It is almost pure carbonate of lime in the form of mineral calcite. Most Vermont marbles contain 98% or over of calcium carbonate, mainly in calcite ($CaCO_3$) but also up to two per cent in dolomite ($CaCO_3, MgCO_3$), a mineral having physical properties almost identical with calcite.

A typical white calcite Vermont marble slightly mottled with gray, according to Geological Survey Bulletin 521, gives the following analysis:

Carbonates	99.174
Manganese and Aluminum Oxide	.005
Insolubles	.63
Organic Matter	.08
	99.889

Swimming Pools on Grounds of Phoebe A. Hearst Memorial, at University of California, Berkeley, Cal.

Brocadillo and Verde Antique Marble.
Julia Morgan, Architect.

The "insolubles" are the constituents which expand and contract differently from the carbonates. If these are low and the porosity is low in the same marble, it ought to be a good exterior stone.

It is difficult to determine precisely the

causes of the more delicate tints of marble such as the bluish, ivory, and smoky colors. The causes of the other tints are more apparent.

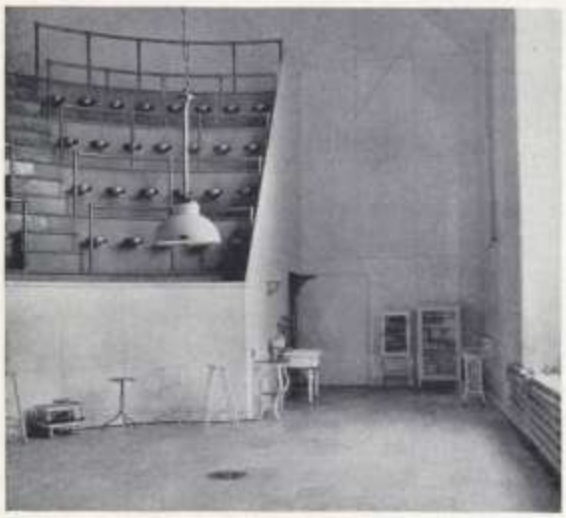
King Edward Hotel, Toronto, Ontario. Alaska Marble. Esenwein & Johnson, Associated with Watt & Blackwell, Architects.

The black and grayish marbles owe their shade to the presence of carbon, usually in the form of graphite in infinitesimal scales and powdery particles disseminated throughout the plates of calcite.

The reddish, pinkish and reddish-brown marbles contain minute particles of a compound with manganese oxide, or hematite, or both.

The brownish, yellowish and cream-colored marbles owe their color to limonite in varying amounts.

The greenish markings are the result of fibrous muscovite (sericite) with which in the brighter marbles chlorite and epidote are associated. (Note—Comments on colors are based on U. S. Geol. Survey Bulletin No. 521.)



Operating Room in Royal Victoria Hospital, Montreal, Canada. All wall work is Rutland Second Statuary. Even the doors are slabs of marble. Henry Saxon Snell and Stevens & Lee, Architects.

Internal Structure

All Vermont marbles are made of tightly interlocked crystals. Some are interlocked more tightly than others. No other related group of marble deposits in the world yields a greater range in size of crystals than those of Western Vermont.

Compressive Strength

The importance of crushing strength is greatly over-estimated. There are few

stones on the market that will not support ten times as much weight as is ever required of them.

Some rocks which test unusually high in compressive strength and hardness are far less durable than others of lower test.

It means little to the average person to say that a stone will stand so many thousand pounds to the square inch. It is much simpler to say that the marbles we recommend for exterior building work could be used in the base of a tower 2½ to 3 miles high before failure from compression would result.

Museum of Arts, Montreal, P. Q. Dorset Marble. Edward Maxwell, W. S. Maxwell, Architects.

Marble is unusually flexible. Blocks of stone used in a building are often subjected to a bending strain due to improper setting. The movement necessary to relieve the strain may be imperceptible but it is enough to crack the average stone. Most marbles are flexible enough to allow readjustments to take place instead of fracture. The weight of marble is approximately 170 pounds to a cubic foot.

Hardness

THE rock in which diamonds (the hardest known substance) occur is made of two minerals—one having a hardness of 6 to 7 Moh's Scale and the other a hardness of 5. The surrounding rock is made up largely of a mineral having a hardness of 2½. The diamond-bearing rock is much harder—yet it weathers and disintegrates so much more rapidly than the soft surrounding rock that circular depressions mark the place where it is found.

Hardness in a stone simply means that it will resist abrasion, not that it will resist exposure to the weather.

Absorption

THE freezing of moisture, completely filling open spaces in a rock, is the most severe test to which that rock can be subjected. No stone has yet been found that will stand this test unaffected. It follows, therefore, that the best stone is one which will exclude moisture most completely. Water expands when it freezes and forces the containing walls farther apart. Fracturing due to this cause increases greatly with the increase in absorption.

Other things being equal the stones which absorb the most water will be least likely to endure. The following statement was made by Dr. Hiram A. Cutting, the eminent geologist:

Bishop Bank, Honolulu, T. H. Vermont and Tennessee Marble.

John Mason Young, Architect.

"I have no doubt that the capacity of a stone to absorb moisture is against its durability even in the warm climates, and vastly more so in a changeable and wintry climate where it is often frozen before any considerable part of the moisture from autumn rains can be evaporated."

In addition to the exceptionally low absorption of Vermont marble, all the pore space is not filled upon immersion. The air that is locked in the micro-crevices is compressed under freezing conditions and acts as a cushion, saving the stone from the rupturing action of freezing.

Absorption Tests

Taken from bulletins issued by the United States Government:

100 Pounds of	*Absorbs*
Carrara Marble	0.490 lbs. of water
Bethel White Granite	0.470 lbs. of water
Milford (N. H.) Granite	0.420 lbs. of water
Hallowell Granite	0.405 lbs. of water
Concord Granite	0.371 lbs. of water
Westerly Granite	0.340 lbs. of water
Milford (Mass.) Granite	0.340 lbs. of water
Barre Granite	0.294 lbs. of water
Troy White Granite	0.269 lbs. of water
Silver Gray Georgia Marble	0.131 lbs. of water
Gray Vermont Marble	0.122 lbs. of water
Brandon Marble	0.116 lbs. of water
Pittsford Italian Marble	0.108 lbs. of water
Pittsford Valley Marble	0.106 lbs. of water
Riverside Marble	0.103 lbs. of water
Danby Marble	0.102 lbs. of water

In the flood of 1913 the Vermont marble interior of the City National Bank, Dayton, Ohio, was subjected to an unusual water test. Although it was submerged for three days, all that was needed to restore it to its original condition was a little cleaning.

Weathering

MARBLE is the result of a sedimentary formation that has been metamorphosed by heat and pressure to a crystalline product. In this process any unstable constituents have been reduced to their ultimate condition and cannot decay further from atmospheric agencies alone.

The CO_2 fumes in the atmosphere of the modern city, when combined with rain water, have a solvent effect on natural building stones. The effect is in proportion to the

freedom with which the acid may move through a rock. Marble is so impervious to moisture that the action is limited to the exposed surfaces of the stone.

In the process of weathering there is formed a protective coating which is nature's own best preservative. That is one reason why we do not recommend the sand blast for cleaning.

Fire Resistance

VERMONT marble will stand a heat of 1200° F. without injury.

The Security Savings Bank, San Francisco, a Vermont marble structure, was in the path of the great fire. Adjoining buildings of brick and stone were ruined by the intense heat, but the Security Bank remained intact. Several other cases of this kind might be cited.

Uses of Marble

ASIDE from the more general forms of exterior and interior building, cemetery memorials and mausoleums, Vermont marble is in demand for a wide range of smaller work. For example, contracts are listed under each of the following headings:

Church Work
Wall Tablets
Bank Fixtures
Store Fronts
Vestibules
Mantels
Toilet Rooms
Thresholds
Tile Floors
Lamp Bases
Ink Stands
Switchboards
Table, Scale and Radiator Tops
Refrigerators
Regalia Work
Sign Plates
Waste (Paper Mills and Foundries)
Theatre Entrances
Garden Furniture
Treads and Risers
Carpet Strips
Bootblack Stands
Drinking and Soda Fountains
Imposing Stones
Fireplace Stands
Cash Register Work
Plumbing Slabs
Show Case Base
X-Ray Machine Equipment
Water Filter Tables
Terrazzo Chips
Dust for Hard Finish
Surveyors' Lot Markers

Chung Foo Bank, Chung Foo (Near Shanghai), China.
Column Facings of Red Swanton Marble. Base of Verde Antique and Floors of Alaska.

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