THROVGH THE AGES

FEBRUARY, 1925

And the cold marble leapt
to life, a god.

—MILMAN

THROVGH THE AGES

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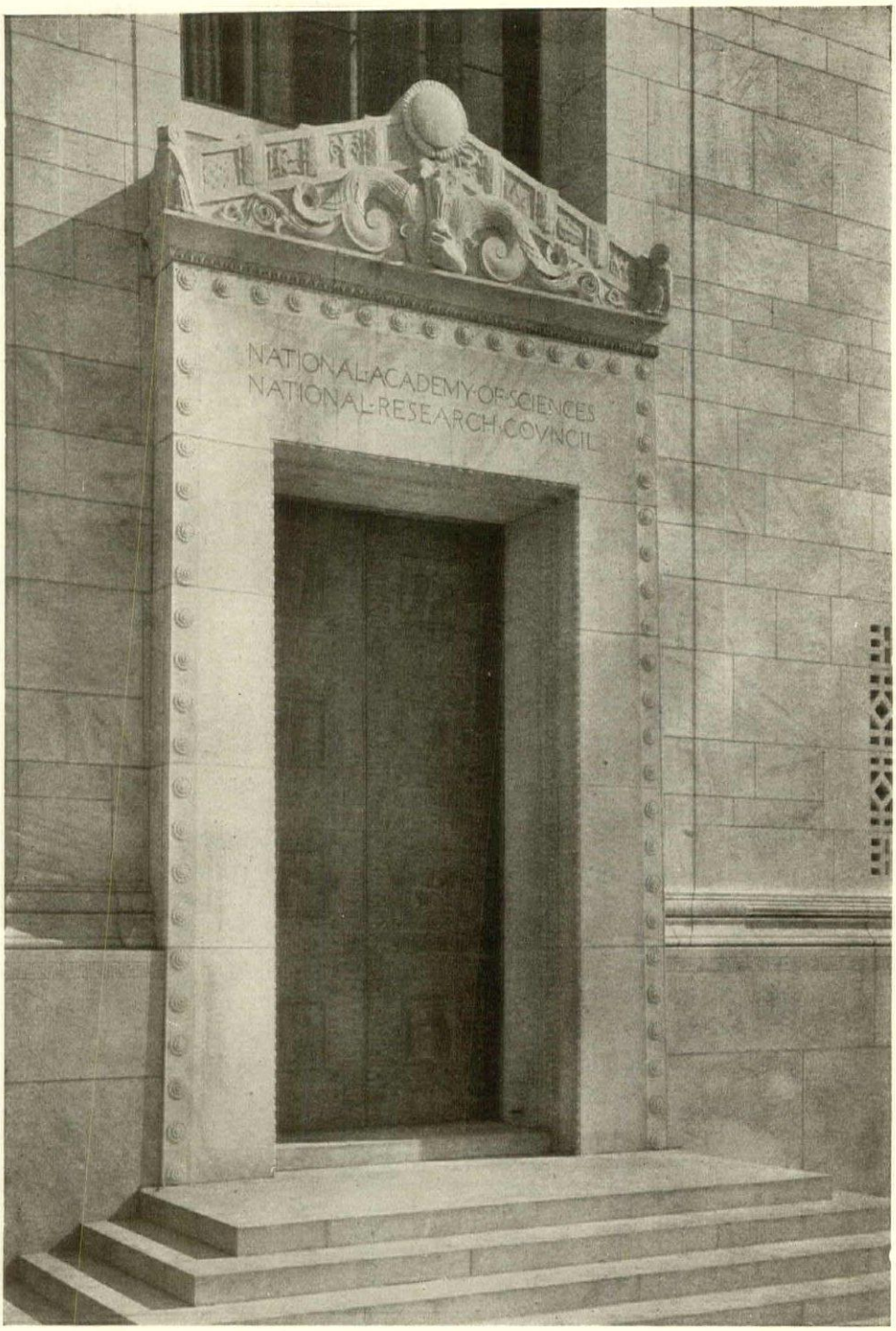


Main entrance door of the National Academy of Sciences and National Research Council, Washington, D.C. The architect was the late Bertram Grosvenor Goodhue, and this was his last completed work.

THROVGH THE AGES

A Monthly Magazine devoted to the uses of Marble - its universal adaptability, beauty, permanency and economy.

VOL. 2 FEBRUARY, 1925 NO. 10

THE NATIONAL ACADEMY OF SCIENCES

A Classic Treatment that Harmonizes Perfectly with the "Washington Theme"

DURING the year that has just passed, there was opened in Washington almost unnoticed by the people of the nation at large, even by the residents of the Capital itself, a beautiful building of white marble that is eminent in the exemplification of classic architecture. Its dedication was attended by but little pomp; the gathering that assembled was composed chiefly of scientists from all parts of the country, a band of men prominent in achievement but obscure to public notoriety; and yet the building itself is intended to "serve as a means of keeping the public in touch with the progress of science and to demonstrate the importance of research." (Dr. George Ellery Hale.)

This building is the $1,450,000 temple of the National Academy of Sciences at Twenty-first and B Streets, Northwest. The Academy grounds occupy the entire block between Twenty-first and Twenty-second Streets, a location that lies within a thousand feet or so of the Lincoln Memorial. The site was determined upon after considerable discussion between Dr. Hale, chairman of the National Research Council, and the late Bertram G. Goodhue, the architect of the building. Mr. Goodhue had been known previously for his Gothic and Spanish Colonial buildings; it was therefore natural that he should be at first opposed to a location in close proximity to the boundaries of the architectural system that included the Capitol, the Washington Monument, the White House and the Lincoln Memorial, since he felt that the structure must needs be much duller and formal in character than if located beyond the influence of these important monuments.

Mr. Goodhue, however, gave ample evidence of his great ability by complying with the conditions imposed by the site. The æsthetic problem was met by a design that is classical in its simplicity, yet one richly embellished with appropriate sculptural and mural decorations. The structural problem caused by the softness of the ground, which was "made" when the old tidal flats were filled in years before, was solved by

NOTE—Illustrations courtesy *Architecture*.

South or B Street Façade, showing formal gardens.

the sinking of seventy-four large concrete piers to bed-rock, as supports for the girders bearing the walls. The terrace that surrounds the building was built upon thirty-three huge tubes of steel, filled with concrete after being driven to bed-rock.

Allowance has been made in the design of the building for the expansion that is expected to come with the future. As finished at present there is, first, a central pavilion which contains the main auditorium, surrounded by seven chambers given over to various exhibitions; and, second, the four-story portion fronting B Street, containing the library, reading and lecture rooms, and various offices and workrooms. It is intended that the building when fully completed shall be in the form of a square, with two light courts, one on either side of the central pavilion.

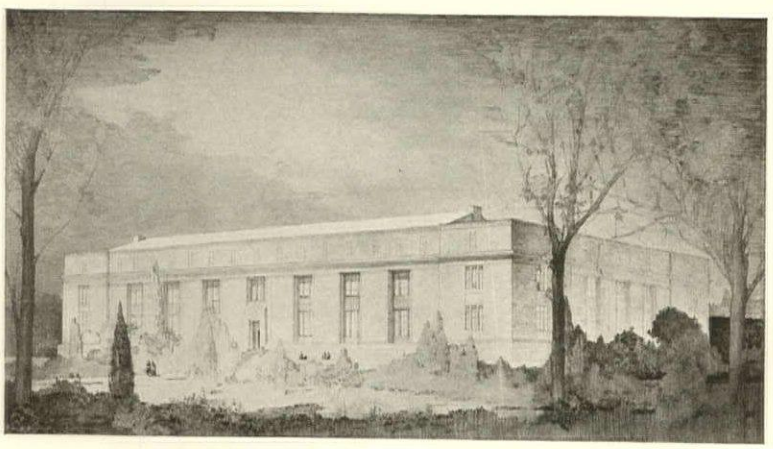
Formal gardens provide a colorful setting, in accord with the architect's purpose of placing the structure in a small park, abundantly wooded. Three pools at different levels, not unlike the basins of the nearby Lincoln Memorial, divide the central approach to the entrance. These pools, as well as the steps to the successive levels and the main steps leading to the podium level, are of the same white New York State marble that was used for the building itself.

From the street, the observer is disconcerted by the severity of the structure's outlines. Closer approach reveals a warm and pleasing façade of marble and bronze; and the austerity is softened further by the ornamentation in the frieze, in the spaces between windows and elsewhere. The marble carving is particularly fine and delicate, beside being unusually profuse. From the cornice, a line of bronze owls and lynxes, ancient symbols of erudition, peer down. In a series of six large panels filling the spaces between the upper and lower windows on the chief façade, Lee Lawrie, "whose hands wrought marble, bronze and copper with such historical insight and compelling genius," has represented the outstanding Founders of Science from Greek to recent times. The marble pseudo-pediment above the doorway portrays the same sculptor's conception of the elements in which science deals—earth and clouds, through the various forms of the animal and vegetable kingdoms, to man, surmounted by the sun, the source of warmth and light. The massive entrance doors depict eight episodes in the history of science, from Aristotle to Pasteur. Other sculptural work by the same artist includes elaborate grilled screens of bronze and glass at either end of the entrance halls, figures of Night and Morning in the central hall, a portrayal of the art of writing, from cave man to mediæval scribes, on the chimney piece of the library, and other beautiful details throughout the building.

Lamp either side of approach steps.

The simplicity of the general design made it necessary to give especial attention to the material for the exterior. Since the general character of the building was to be Grecian, but of no pronounced period; and, further, since the structure would conform to the "Washington theme," as it is called by Doctor Charles Moore, it was decided to use a white marble of sufficient surface variation in the individual blocks to give life to the walls. There are several native white marbles that would have met the requirements; a choice was finally made of White Dover from New York State, which was laid in irregular courses.

At the top of the steps leading from the street level to the base upon which the building rests is, on either side, a green marble pedestal of Italian Verde Antique, topped by a woman's bust that in turn supports an electric globe. The entrance way, previously described, opens upon an ornate entrance hall from which doors lead to the central hall and corridors of the east and west wings. Two light wells on each side of the hall contain seismograph and



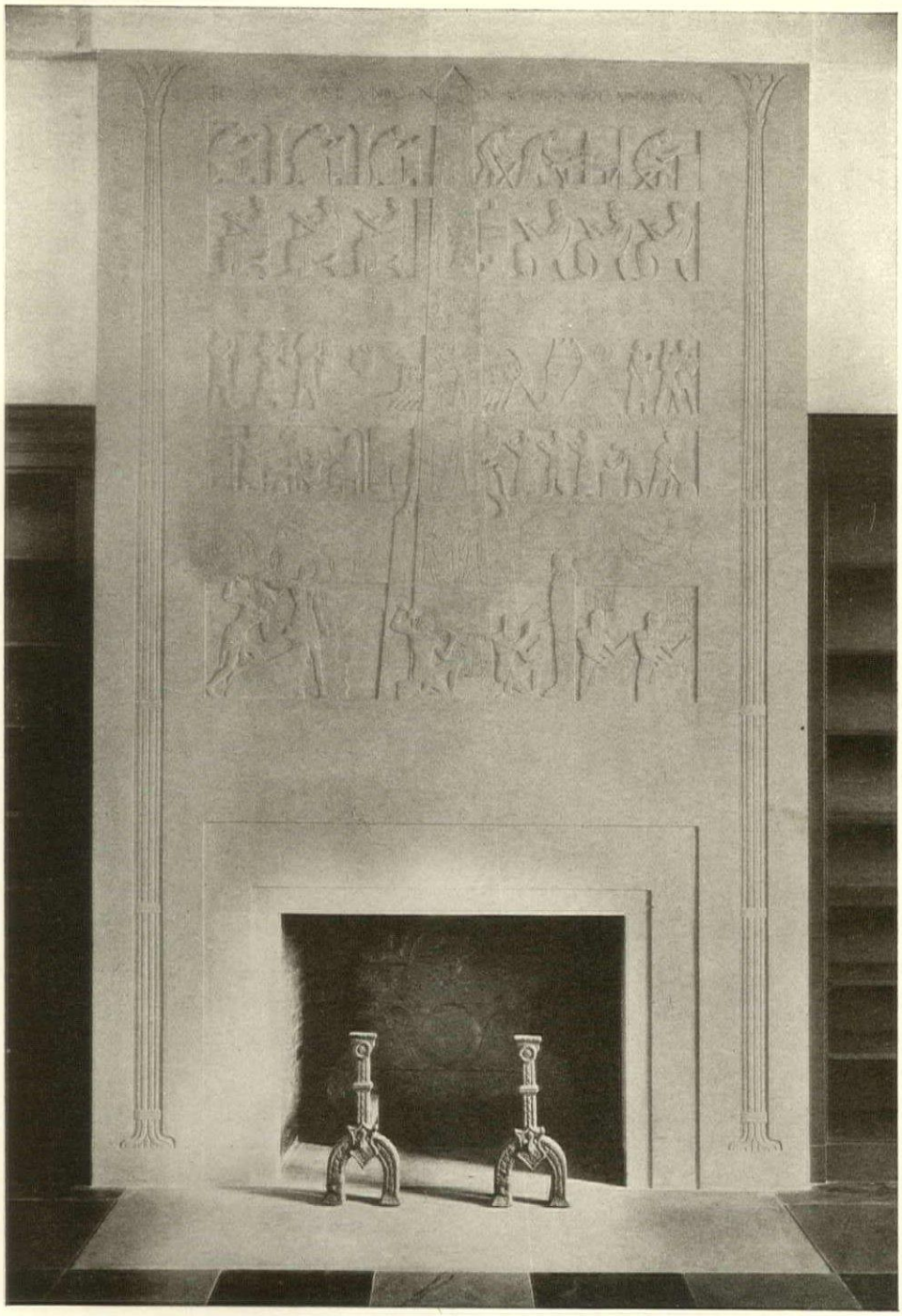
Study for National Academy of Sciences by Bertram Grosvenor Goodhue.

Central Hall, looking toward Entrance Hall.

electrograph instruments. The Vestibule is given touches of color by the use of strips of yellow Siena marble in the floor and Verde Antique over the large radiators.

The floor of the entrance hall has a similar treatment, in addition to four stately pedestals of Verde Antique at intervals around the walls, supporting light urns. Drinking fountains of Siena marble are placed at each side.

As the inmost shrine of Science, the central hall is adorned with the best of the arts.



Here the architect departed from the Greek theme. The four arms of the cruciform chamber are vaulted to support a pendentive dome. The walls to the center of the arches are of Gustavina acoustic tile, and the dome is of the same material, elaborately decorated with emblems and figures symbolic of the sciences, the whole richly colored and gilt by Miss Hildreth Meiere. The figures in the pendentive represent the elements of the Greeks—Earth, Air, Fire and Water—while the soffit arches bear

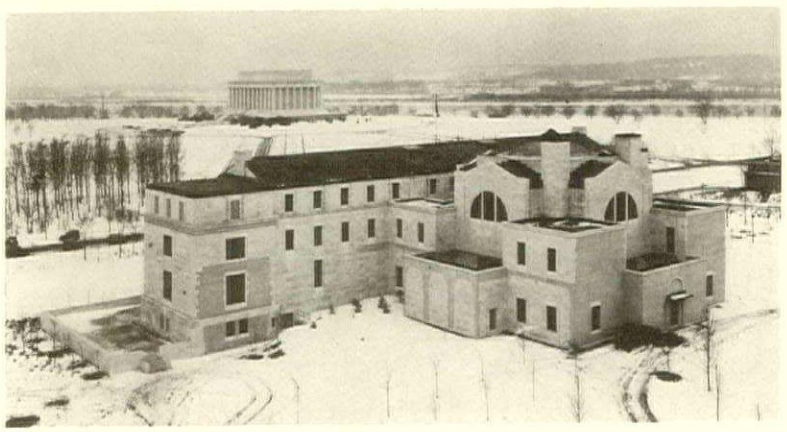
the insignia of Alexandria, the great Academy of antiquity, and one of the three historic National Academies of Europe: The Accademia dei Lincei of Rome, the Academie des Sciences of Paris and the Royal Society of London. The inscriptions encircling the dome are: "Ages and Cycles of Nature in Ceaseless Sequence Moving," near the apex and the following characterization of the various aspects of science in the zone at its base: "To Science, Pilot of Industry, Conqueror of Disease, Multiplier of the Harvest, Explorer of the Universe, Revealer of Nature's Laws, Eternal Guide to Truth." The balance of the walls of this fine auditorium is of Caen stone. On each of three sides of the room are small galleries at the second floor level, each supported by two large and colorful columns of Verde Antique marble.

A striking decorative feature of the central auditorium is a mural painting by Albert Herter, of Prometheus lighting his torch at the chariot of the sun, thus bringing fire (typifying knowledge) to earth for the benefit of mankind, inscribed below with a quotation from the "Prometheus Bound" by Æschylus.

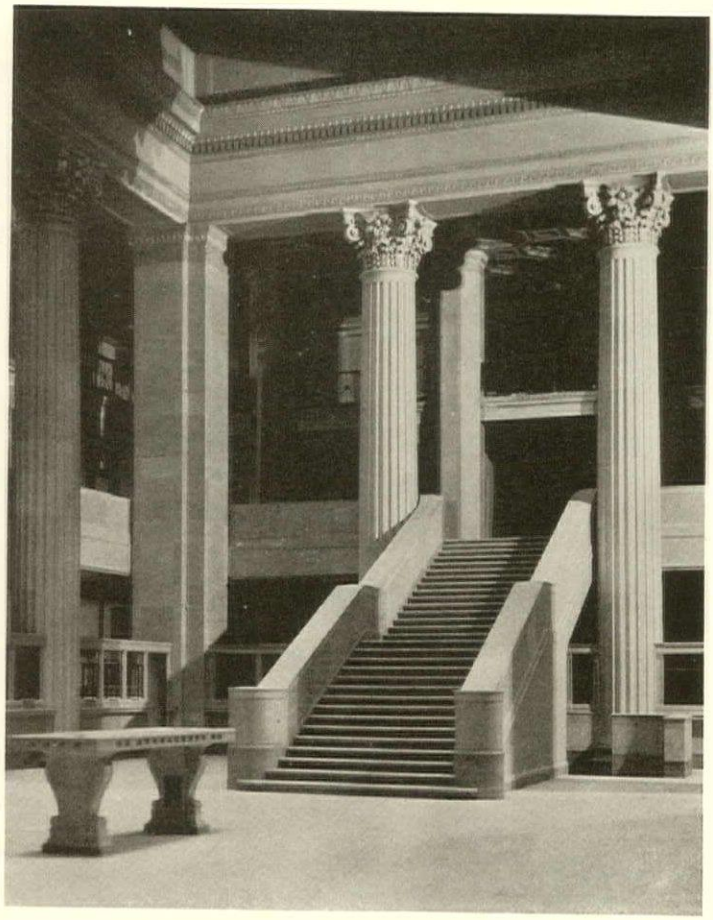
Through a central opening at the very apex of the dome, the rays of the sun through a coelostat telescope form an image on a bronze drum. The spectrum of the sun may thus be seen through an eyepiece, as well as the sun spots that vary daily. A Foucault pendulum, suspended from the dome, demonstrates the rotation of the earth.

The small exhibition rooms, seven in number, surrounding the central hall, contain mechanical contrivances that demonstrate the progress of scientific research or illustrate current or fundamental phenomena of nature. Some of these are permanently installed, such as those that show the variations in the earth's magnetic fields, and the records of earthquakes. Others can be operated by the visitor, such as those that reveal the exquisite structure and gorgeous colors attending the formation of crystals in polarized light, the effects of electric discharges in rarified gas, the thermal emission of negative electrons, and many others.

All of the stairways throughout the building are of Tennessee marble. In the east wing, on the first floor, there is a fireplace of green Italian marble of massive proportions; a similarly placed fireplace in the west wing, or Library section, is equally large but is constructed entirely of the same yellow Italian Siena marble used elsewhere in the building.



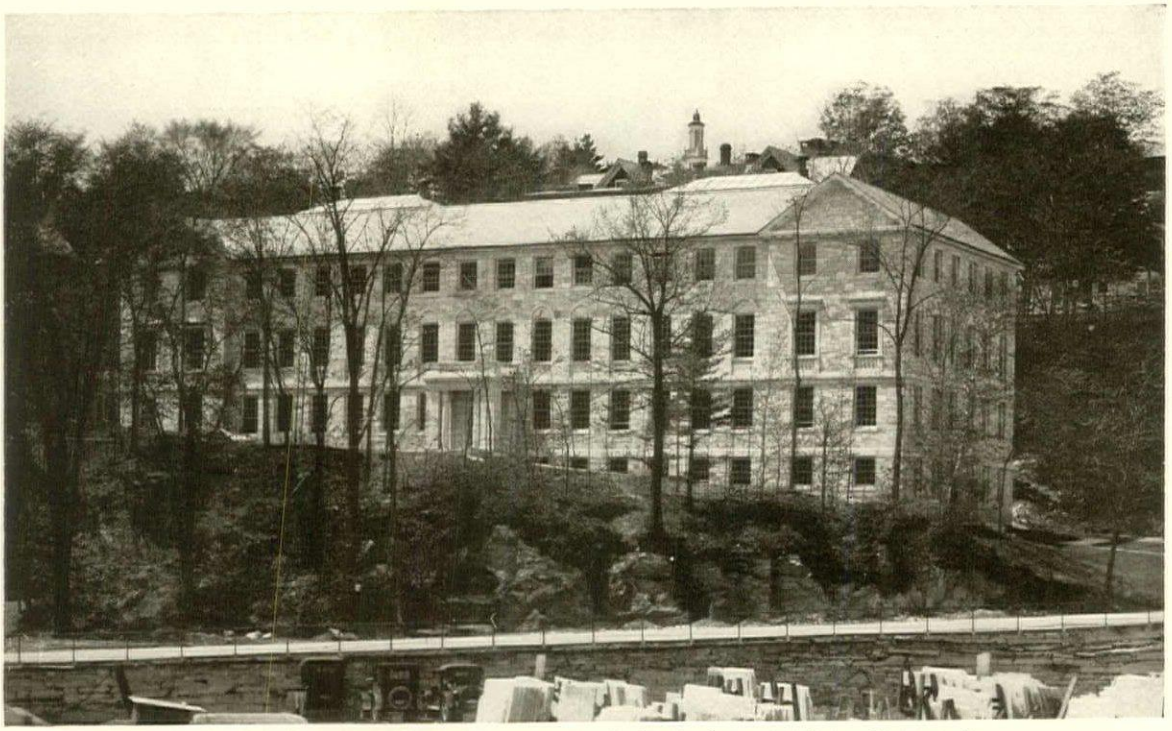
The Academy, looking toward the Lincoln Memorial.



STRENGTH

"I would have you call to mind," wrote Rabelais, "the strength of the ancient giants that undertook to lay the high mountain Pelion on the top of Ossa, and set among these the shady Olympus."

Such strength as this is not only inherent in marble, but is suggested by its very use. No one can escape the impression of beauty, combined with strength, conveyed by mighty columns, stately steps and broad expanses of marble.



The building as it looked when completed. In the foreground may be seen the retaining wall, also built of by-products.

THE USE OF MARBLE AS RANDOM ASHLAR

The Office Building of a New England Marble Company, Built of the By-Products from Their Plant

The Office of R. CLIPSTON STURGIS, Architect,
described by S. WINTHROP ST. CLAIR, A.I.A.

"The stone which the builder rejected
is become the head of the corner."

ARCHITECTS are gradually developing, in the public, an appreciation of "texture" in wall surfaces. There was a time when perfect uniformity in color and tone were considered a requisite for good ashlar. Now, however, variety of texture is the requirement most sought.

This tendency to drift from the artificially perfect surfaces, to the more natural variation has been going on for over twenty-five years.

McKim, in the Harvard College gates and elsewhere, was among the first to seal the doom of the pressed brick era and bring into delightful use the long discredited and neglected bench brick, with their splendid range of color and texture.

Indiana limestone is passing through the same sort of change in use. Until very recently limestone specifications customarily called for very careful selection so that every stone would match the approved sample, either warm buff, cool gray or some intermediate shade according to the desire

NOTE.—This story appeared in a somewhat different form in *The American Architect*. Mr. St. Clair has rewritten it for this magazine. The illustrations are through the courtesy of *The American Architect*.

of the architect. The result of this was huge piles of material in every stone yard discarded because of some combination of the different colors found in every quarry at certain levels. Another result of course was a definite item in the cost of the selected stones to cover the cost of quarrying and handling the discarded stones, sound but variegated in color.

Recent years have seen many important buildings built of this variegated stone at a very considerable saving in cost, and in the opinion of their designers with a definite gain in appearance due to the pleasant random variations in color.

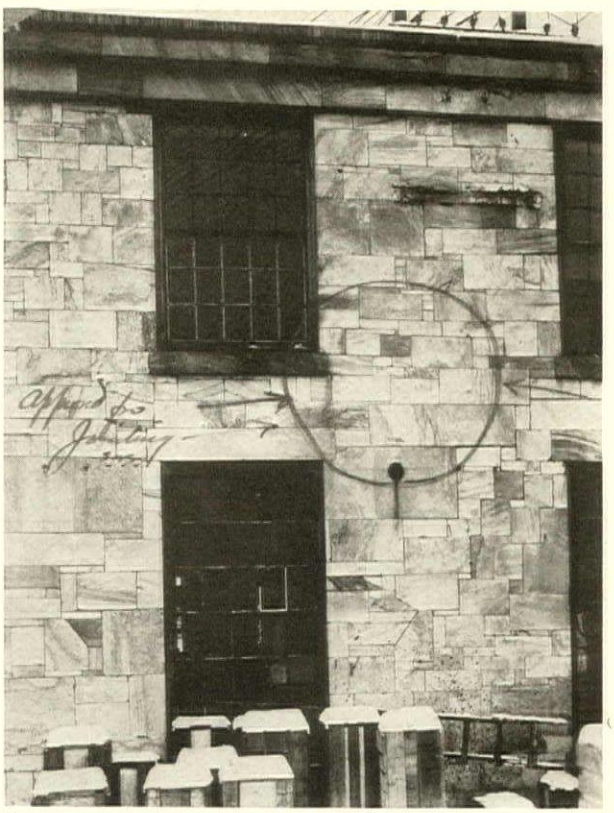
The construction of the new office building at Proctor, Vermont, for the Vermont Marble Company, has brought this same policy into play with the use of marble, perhaps for the first time in this country in a building of any size and importance.

The old shop buildings at Proctor have been built, from time to time, during the last sixty years, and always of such local material as was thought to be the least valuable. Blocks of fine marble, which developed some flaw of color or marking, were thrown in the pile of rejected stone. Whenever the company needed new buildings for its own use, it built from this pile, which had grown to sizable proportions.

As has often occurred, under similar conditions, the old builders who erected these walls, with no other object than the best use of material at hand, developed a texture of marble ashlar which gave a wonderful combination of economy and beauty.

When the problem of the new administration building was presented to Mr. Sturgis, the use of this local material naturally suggested itself. Sections of the ashlar in the old shops, where the old-time workmen had been most happy in their selection of stones, were photographed and the photographs bound into the specifications as "approved examples" of jointing and arrangement. Samples of marble were selected for range of color, from pure white to clouded and gray. Any stone taken from the quarries producing these colors was accepted at random for the ashlar. Markings, chipped corners or other imperfections which made the marble undesirable for monumental work only added a pleasing texture to the mass of the exterior walls.

This marble is usually sold by the ton for various commercial uses. By taking advantage of this low cost of material a wall of great interest was built of marble at only a little above the usual cost of good brickwork. The cornice, belt course and ornamental members were selected cut marble, but the plain ashlar was entirely made of the random blocks, with their surfaces as they came from the saws, built into the wall by

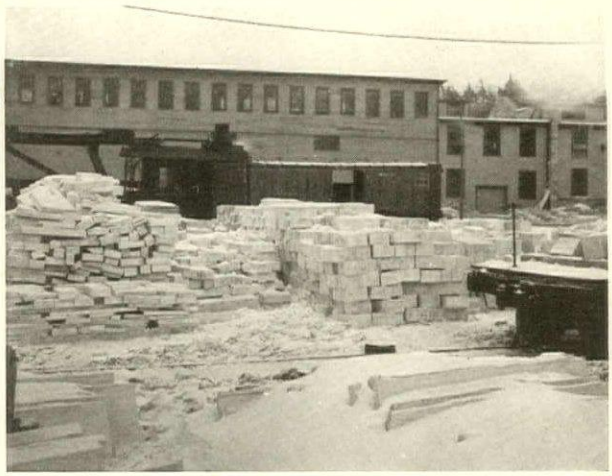


Section of an old marble wall marked as an approved sample of jointing.

The Entrance Porch.

stone masons who laid this material just as they would have laid an ordinary random stone ashlar. It was a straightforward stone job, only in this case the stone was marble.

It would seem that here is a valuable building material for many uses. The large amount of monumental work customarily done in marble and demanding generally careful selection for uniformity of color, will continue to create a large amount of this by-product of variegated marble of random size, shape and color. The cost of quarrying this material is to a considerable extent a part of the cost of the selected material and it can be sold for use in building work as described above at a price not usually associated with a marble wall facing. The use of this material is an opportunity that ought not to be overlooked by the building industry. It doubtless will not be overlooked by thoughtful designers.



The pile of random blocks that was used for the marble ashlar.

The South Front shows the marble ashlar, the cost of which is only a little more than good brickwork.

Loggia del Capitanio and Basilica, Vicenza, by Palladio.

PALLADIO'S ART

The Decline of the Renaissance in Italy

IT seems to be the common fate of revivals in art and architecture that, having their inception in bold and original work inspired by the prototype, but mixed with a great deal of what was currently accepted, they should tend more and more to a likeness of that prototype until something like literal reproduction is produced, and the revival eventually robbed of its vitality. The Renaissance was no exception to this usual tendency. Beginning with the work of Brunelleschi, original and skillful, it rapidly became formal when relieved from the authority of his immediate school.

Sansovino's Library, Vignola's works and Palladio's Basilica are all much closer to antique Roman than anything to be found in the earlier phases of the Renaissance movement; and the Porta Santa of Sanmicheli, the Massimi of Peruzzi and the latest Vicenza palaces of Palladio show a far closer approximation to Greek art than the early work of the Lombardi or other Northern masters.

Illustrations courtesy Thomas Machen, architect, Baltimore, Maryland.

There is another tendency which, if not characteristic of revivals generally, certainly can be distinctly seen in the course of the Italian Renaissance, and that is, the inclination to seize first upon the later developments of the prototype, and gradually work backwards to the earlier treatments as the revival becomes more pronounced. The fifteenth century Italian structures were mostly inspired by the third century Roman works of the type of the Baths of Caracalla. Augustan Roman was the model for the early sixteenth century Renaissance; while the later architects, ending with Palladio, incorporated into their designs a combination of features that were almost late Grecian.

Such a backward tendency did not necessarily imply that the style was deteriorating. Its elements certainly did not lack life, for we shall see in subsequent articles that France and England made excellent use of them. We are confronted, however, with the fact that the revival, after a hundred years of experiment, reached a high point in the works of Peruzzi and Sanmicheli, and then collapsed with almost startling suddenness.

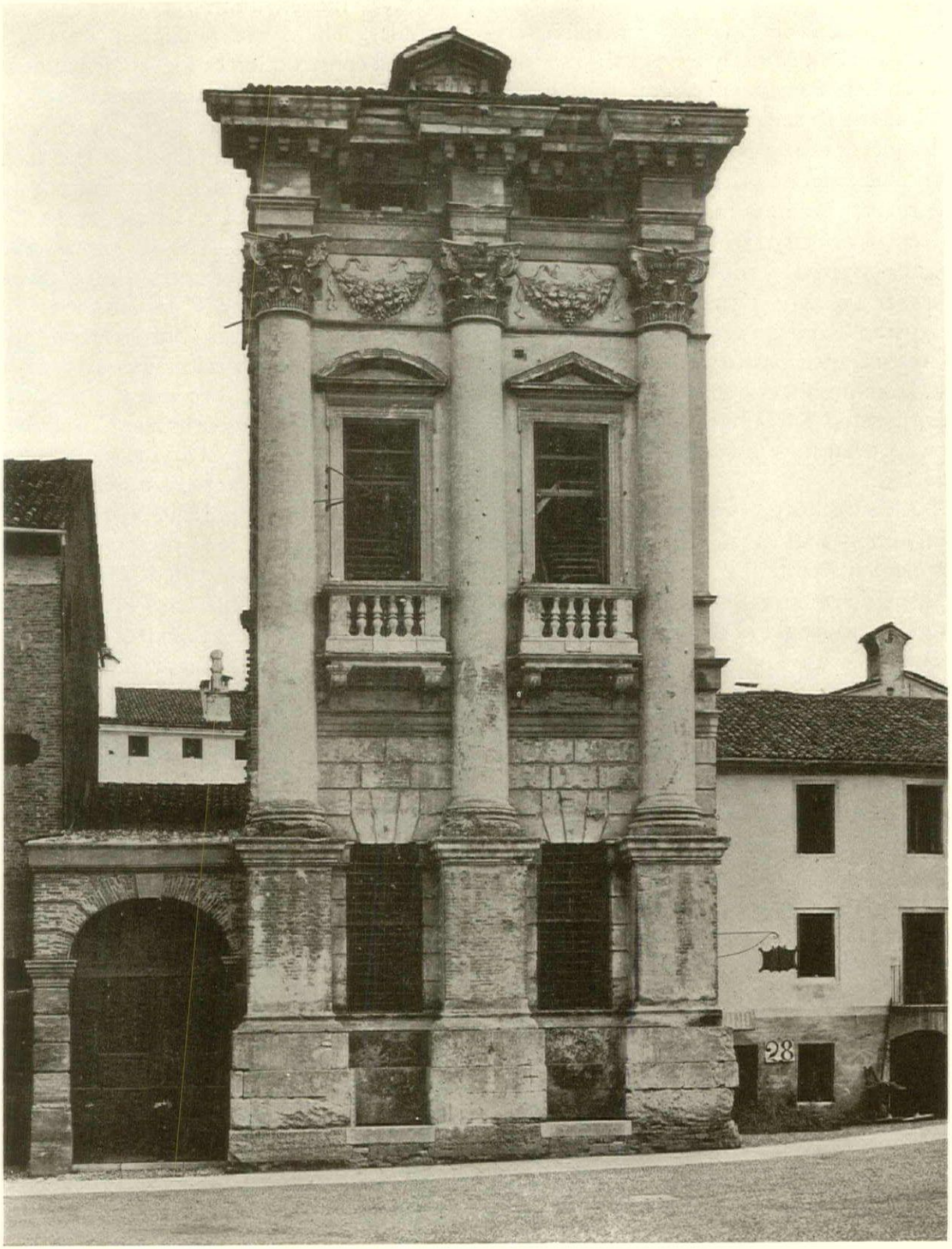
Chief among the causes which brought this about are: the decline of prosperity and liberty; the ascendency of Michelangelo and his weak style; and, finally, the reduction of classic architecture to a system of rules and regulations. Of the first of these causes, it is not necessary to speak; we are more concerned with a consideration of the two latter.

The architecture of Michelangelo was both insincere and of an exaggerated scale, both of them qualities that had a deep influence in bringing about the dark and devious ways of the Barocca corruption. He employed architectural features as mere scenery, introducing false or unnecessary windows, niches, panels, consoles and balustrades. There was a painful absence of truthful construction or logical articulation, partly explained by his apparent dread of unbroken wall surface. His craving for largeness is well exemplified in the treatment of the pilasters in the Palazzo dei Conservatori as well as those in the exterior of St. Peter's. Since his deserved reputation as a painter and sculptor gave to his architectural works an authority not self-contained, it was but natural that every impropriety, weakness and vulgarity should immediately become the architectural mode, wherever his influence was felt.

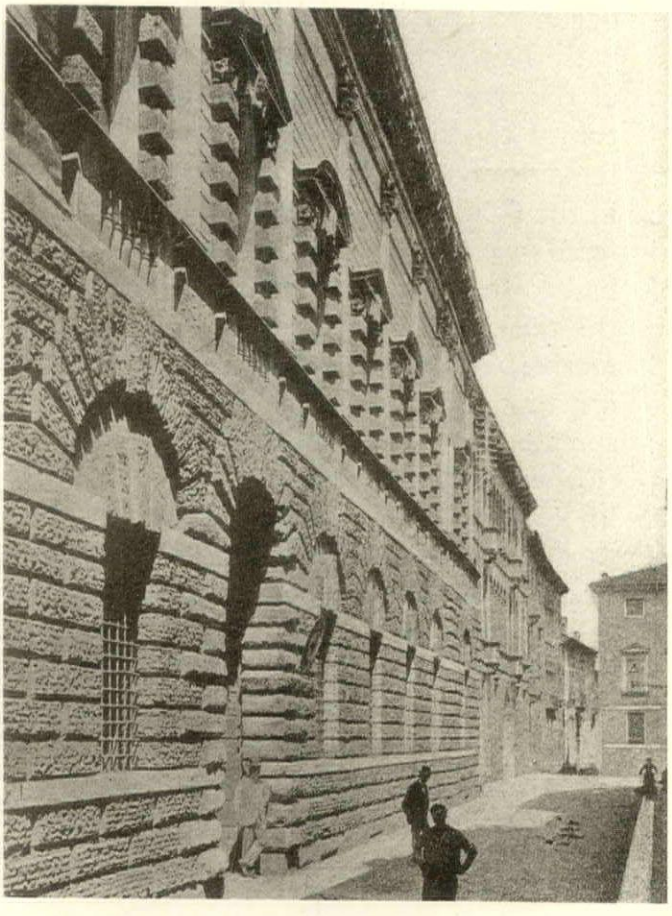
The apotheosis of Vitruvius had reached its full height and the most absurd homage was paid to the only architect of antiquity whose writings had been preserved. Vitruvius himself has been called "that worst of architects"; and yet his rules were set up as the only infallible standard of excellence. Even this condition might have in time given way to a better, had the generation of architects not been so engrossed with conforming to the Vitruvian formulæ that they completely lost track of true constructive principles. Instead, they were careful about the proportions of a column and careless as to its use; they discussed its proper entasis, and depth of base and capital, and were indifferent as to whether it did its constructive work or merely carried a bust or filled a recess.

Of the Later Renaissance, before it degenerated into the extravagances of Baroco, the two great masters were Vignola and Palladio. They were more than architects, for each of them contributed many writings on the subject of their art, and their books have been received as textbooks of the neoclassic school.

Andrea Palladio was born in 1518, in Vicenza, and he passed almost the whole of



Façade of the Porto Palace, or Casa del Diavolo, designed by Palladio. Notice how the roof is superimposed without intermediary on the mouldings of the Composite cornice.



Tiene Palace, by Palladio. An over-rustication mars an otherwise fine façade.

his life in his native town, hardly ever leaving it except for short absences necessitated by his studies and work. He was one of the first to publish in book form the measured drawings which he himself executed from the antique; later on he added to these the plans of his own many compositions, and this collection, completed after his death by his pupil, Scamozzi, soon gained an enormous reputation. The "Four Books on Architecture," published first in Venice in 1570, subsequently ran into many editions. It gives us geometrical designs of most of the master's creations, and constitutes for the architect of today a wealth of precious documents.

The importance given to the study of the antique by Palladio, as shown by his book, is not surprising; what does astonish us is the variety of *parti* which distinguishes the edifices of Palladio himself. It is truly a treatise on architecture by examples. One after the other, he points out the motives which it is possible to utilize, showing us in each case the effect they produce on a finished monument. Sometimes the orders are superimposed, sometimes a single row of first floor columns rests upon a rusticated base; often the order extends the height of two floors, and this disposition would be characterized as the Palladian manner if he had not just as often adopted other schemes.

His treatment of the upper portion of his buildings shows even as extensive variation. We distinguish those cases in which he crowns the order with an attic and in which the roof rests simply on the last moulding of the entablature, though other treatments are equally Palladian. It would appear that he did not show any great passion for one particular treatment, "and yet," as Gromort remarks, "it has sufficed for him merely to have employed them *once* for them to bear forever his powerful stamp and make them 'Palladian'."

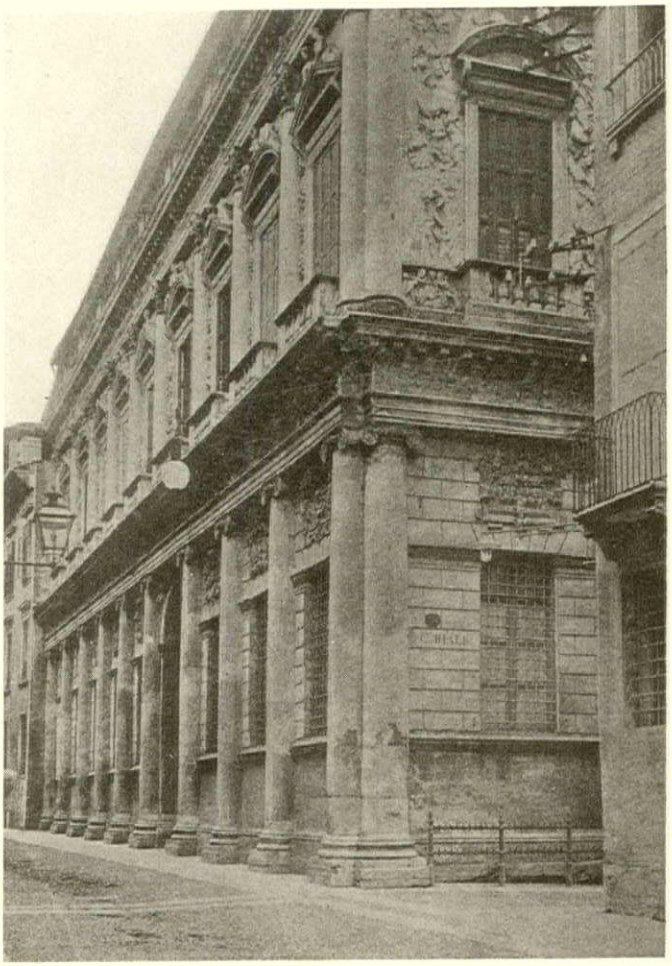
We know very little of the life of the man, but his remaining works show him to have been a man of fine perceptions and no little originality. His appearance came at a time that was, for him, unfortunate, and his opportunities were far less than fell to the lot of inferior men. That he made the most of them is fully evident by the eminence which has been attained by Vicenza merely because of his works in that palace.

However, his genius was stifled in an inferior kind of cement; you do not find the use of marble or precious stones, and he

seems to have rejected all idea of color effect. It has been said of him that he "knew how to make a building grand without great dimensions and rich without expense"; this is giving him more than his due, for at best he only showed what could be done on a small scale and with simple and cheap materials. Gromort, in speaking of this phase of his work, says: "Except for the construction of the Basilica, never indeed had Palladio at his disposal, at Vicenza, anything but bricks and coats of stucco; columns, ornaments, mouldings, everything is treated with stucco, even when the rustication of the base imitates, very cleverly, rough-hewn blocks of stone. *Need we add that the majority of his decorations, in the relatively cold climate of Vicenza, have, after three centuries and a half, deteriorated in the most regrettable fashion?*

It is this, aided by the lack of color, which makes Vicenza today one of the dullest and most depressing towns in Italy, in spite of the Palladian genius; it is this which brought forth the criticism that "the cold hand of that friend of virtuous poverty in architecture lies heavy in many places." However, it is only doing justice to Palladio to add that it was his influence that gave to the late Venetian work its superiority over that of Rome and Genoa at that time, when the tide of corruption in architectural fashions was sweeping over Italy.

The Basilica, mentioned above, was built by Palladio at the age of thirty-one, in the year 1549. It was his first work, and the one which assured his reputation. The Gothic arches which had encircled the Town Hall (or Palazzo della Ragione) had begun to crumble and Palladio, entrusted with the reconstruction, saw in the erection of the huge two-storied portico an opportunity to duplicate the old basilicas, the remains of which he had undoubtedly seen in the Roman Forum. The old building offered axes irregularly spaced, and which had to be considered. The architect solved the difficulty by ingeniously adopting the motive we know, by keeping the arch of constant dimensions in each bay, and spreading the intercolumninations at each side under the architraves of the small order in varying degrees according to the distance between the axes. By this method the irregularities of the façade are hidden to the casual observer. The large central arch was



Palazzo Porto, Vicenza, by Palladio.

The Teatro Olimpico, by Palladio, showing an amusing immovable, scenic background of three streets executed in perspective.

sprung from the entablature of the columns with lesser lintelled spaces and the spandrils pierced by a simple circular opening. The thickness of the wall and the consequent double range of columns carrying the arches of both tiers greatly increased the richness of the whole.

The composition did not depart in its fundamentals from the practice of the Central Period, and belongs properly, in time and character, to that epoch. The judgment shown by the architect in breaking the entablature around the columns was justified by the elimination of any sense of clumsiness in the proportion. The bays, otherwise, would have looked too low; and the returning of the cornice and mouldings around the columns carried the eye up to the figures which completed it. That Palladio was not bashful about giving himself his due is shown in his book, in which he says of arcades: "I don't question but that this fabric may be compared to the ancient edifices, and be looked upon as one of the most noble and beautiful buildings erected since the time of the ancients, as well on account of its largeness and decoration as of its matter, which is all hewn stone, hard to the last degree, and joined and bound together with the utmost care."

It is interesting to note his comments about the use of hewn stone and its truthful construction as compared with his later practice with less worthy materials such as common brick, wood and stucco, out of which, as we have already noted, nearly all the Vicentine palaces were built.

The favor which his Basilica brought him from his fellow-citizens immediately secured for him other work and the number of palaces, large and small, that they requested him to erect was sufficient to give to Vicenza a character of unity. The most important of his designs were the Palazzi Chiericati, Tiene and the del Consiglio, sometimes called the Municipio or Prefettizio. This last was a small building opposite the Basilica, and belonged to a period

The Palazzo Valmarano, Vicenza, by Palladio. The order here is crowned by an attic and the entablature breaks out over each pilaster.

twenty years later than his chief work. The Valmarana Palace (1556) was built at the same time as the Tiene, and the Barbarano in 1570; the Teatro Olimpico was completed in 1584, after his death; the Casa Diavolo was completed after Scamozzi, but the beautiful façade is published in the various editions of Palladio. In addition to these just mentioned there were others not so well known, including the Loggia del Bernardo (1571); the Villa Capri, known also as the Rotonda; the churches of Redentore and San Francesco della Vigna, these latter in Venice.

San Giorgio Maggiore (1560), on the island opposite the Library and Ducal Palace in Venice, was similar to the Redentore and their façades showed a free use of the colossal order, but their interiors were their most striking features, since an impressive result was secured with the aid of simple means, a rare enough achievement in the Renaissance style. The Redentore, in particular, with its calm nobility, was more nearly like the idea we hold today of what the character of a religious edifice should be.

Palladio's palaces and villas are columnar. This is readily accounted for through the influence of the Vitruvian school. Finding in Vitruvius copious instructions for the erection of temples and buildings, and scant information concerning domestic architecture, Palladio and his followers were forced to insert the essentially columnar treatment of the former into domestic designs. In Book I of his works, he says: "Having thus treated of plain walls, we shall next consider their ornaments, among which none are more considerable than columns, when they are properly placed, and in a just proportion to the whole edifice."

The fact that the column, for domestic styles, is suitable only for constructional purposes, was never apprehended by Palladio. That he succeeded as well as he did in adapting it to his purpose speaks volumes for his ability.

The Palazzo Chiericati, now the Museum, has a two-story front of colonnaded loggias with horizontal entablatures instead of arches. The whole length of the ground floor has a Doric portico of unbroken cornices while the central part of the first story carries a wall pierced by windows which rest on the architraves of the order below, the same motive found in the façade of the Théâtre Français in Paris, by Victor Louis.

The Barbarano palace also has superimposed orders, with very simple lines. Its uninterrupted cornices and ground floor windows topped by a rectangular bas-relief was the forerunner by two hundred years of the French Louis XVI style.

It was most successful in solving the difficulty of the return of the Greek Ionic shaft. The columns were not set on pedestals and the upper tier rose between the balconies from a simple block on the cornice. It was in many respects superior to Sansovino's Library, and deserved to be carried out in marble instead of brick and stucco.

The Valmarana Palace had the order only in pilaster form, and consequently much less rich, though better suited to the stucco material out of which the front was formed above the pedestals in imitation of stone. A figure at each end terminated the façade and happily relieved the monotony, arising from the pilaster repetition.

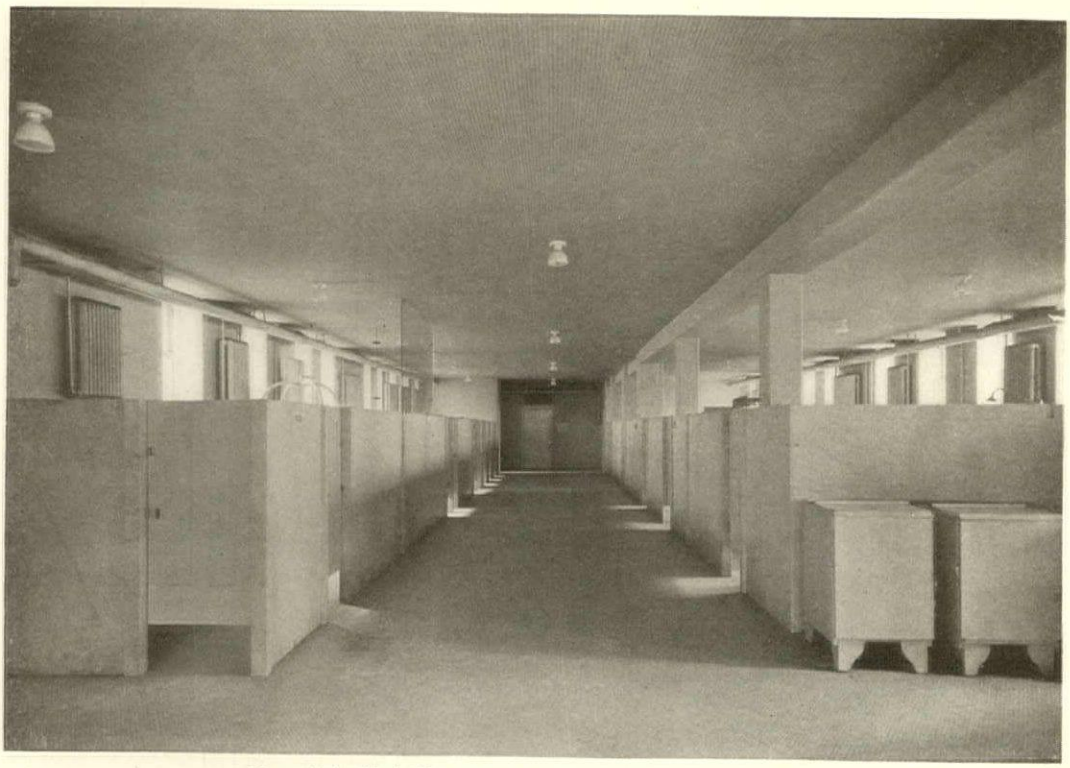
In the Palazzo Tiene the order was restricted to the first story, which had plain windows under arches of rusticated work. The upper floor had square windows crowned with pediments, one flanked by Ionic half-columns tied into the wall, course by course, by rustications arranged in squares. This

same motive appeared later in the Pitti Palace on the façade overlooking the gardens.

The Casa de Diavolo is more generally known as the Antica Pasta. It was never completed, but had it been it probably would have ranked as one of the finest of Palladio's palaces. It was of immense scale, but beautifully proportioned and delicately modelled. The composite capitals were linked together by graceful festoons, and the flat arch of Sanmicheli was used; the pediments were alternately segments and triangles, and the frieze showed the low windows as first adopted by Peruzzi.

Palladian architecture is often taken to mean the combination of two stories in one order, but that is somewhat misleading. He often has not superimposed his orders or restricted them to the height of one story. Furthermore, he gives in his book elaborate directions for their disposition, declaring "the Doric must always be placed under the Ionic, the Ionic under the Corinthian, and the Corinthian under the Composite," although he adds that the Doric may be just below the Corinthian provided the more solid is beneath. But even granting that Palladio did frequently combine two stories in one order, he was not the first Italian architect to adopt such a treatment. Both Bramante and Peruzzi did it after a fashion, and Sanmicheli did it most successfully in the lower part of the Grimani Palace.

Interior of the Church of S. Giorgio Maggiore, at Venice.
Built in 1560 from plans by Palladio.



Part of the Bath Department of Sacred Heart Sanitarium, Milwaukee, Wisconsin.

MARBLE AS AN INTERIOR FINISH

JOHN STEPHEN SEWELL, Birmingham, Alabama

IN any building of consequence—and especially in hospitals—the question of interior finish is of large importance.

Among permanent finishing materials interior marble is unique in many ways; it is in fact at the head of the list for numerous purposes.

Marbles may be had in almost infinite variety, not all of them suitable for interior use. Even those properly classified as interior marbles are adapted to different uses.

In the consideration of interior marbles for hospitals it is taken for granted that those characterized by a riot of rich coloring and highly prized for their decorative effect, would be ruled out. They are usually expensive, often unsound, and require a good deal of filling and patching. As a matter of good taste their use in a hospital would be very restricted.

The marbles that are best adapted for hospital use are all included among those classified in the trade as white marbles and monotone marbles. A limited use of Verde Antique, or black marble, or even such a rich material as black and gold for floor border and for base, might at times be appropriate, but it would seem that in a hospital, simple richness of texture combined with sanitary qualities of the first order would be ruling considerations. This combination is exhibited to a high degree in the

NOTE—Reprinted courtesy *Hospital Progress*.

white marbles and in the sound monotones.

WHITE MARBLE

By white marble is understood in the trade not a pure white material, for that is very rare, but a marble with a white ground mass, with more or less veining and clouding of some shade of gray.

Such marbles, when suitable for interior use, are invariably almost pure calcium carbonate, the percentage of this material rarely falling below 98.5 and generally running around 99. They are fine-grained, *i.e.*, the calcium carbonate is in the form of fine crystals so small that close examination is required to distinguish them individually. The microscope reveals that in the ground mass the crystals are closely packed and interlocked, with practically nothing in the way of a magma or cementing material and no open spaces between them.

These marbles are called by the mineralogist and geologist, "saccharoidal marbles," because of the resemblance of a broken surface to that of hard and finely crystalline loaf sugar. They are the typical marbles and are possessed of a combination of qualities which give them a wider range of usefulness than any other kind of building stone.

All of them are susceptible of being carved and cut so as to bring out the finest and most delicate details. They are susceptible of any sort of finish from a mere broken surface to the most brilliant polish; their porosity is always low. The highly polished surfaces are for all practical purposes impervious and are very easy to clean. A greasy film, for example, can be removed from a surface of polished marble much more easily than from glass. This is true of all marbles as well as the saccharoidal kinds.

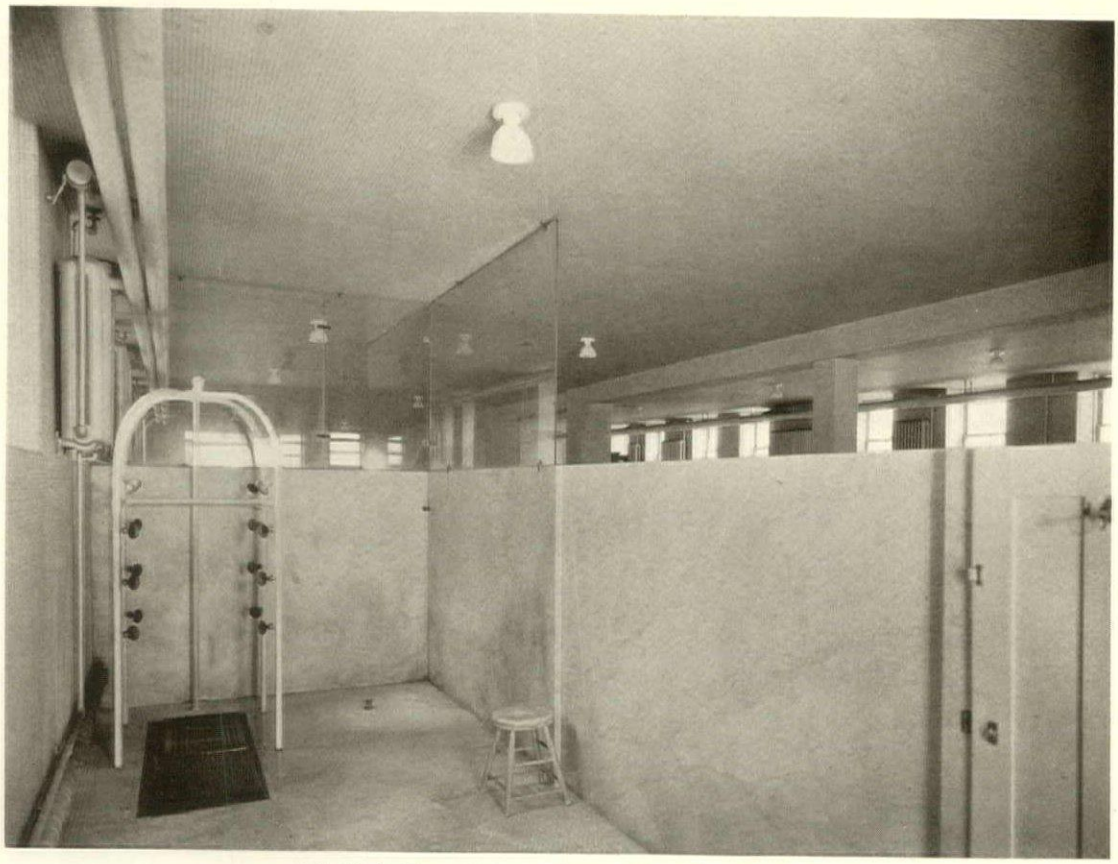
LIGHT-DIFFUSING PROPERTIES

The finely crystalline white marbles are, with few exceptions, quite translucent, so that even rough slabs as much as two inches thick will transmit an appreciable amount of light. Owing to this quality and to the texture of the material, light falling upon a polished surface of white marble is not reflected in a glare as from the face of a mirror or other glassy surfaces. More of the light penetrates the polished surface and is diffused from the crystal faces beneath, than is reflected from the surface. A brilliant light as viewed in a surface of polished white marble is greatly softened and subdued and is diffused and scattered in every direction, so that polished white marble greatly contributes to uniform illumination without the unpleasant effects of direct reflection from glassy surfaces.

A somewhat similar effect in the diffusion of light can be obtained with white paint with a dull finish. But the polished marble surface is incomparably superior from the standpoint of cleanliness and freedom from germs. It is claimed by some that a marble surface is inimical to germs and prevents their growth. It is quite certain that the marble itself cannot be a culture medium. Whether it actually has germicidal properties remains to be determined, but the known properties of some solids, of concentrating films of gases such as oxygen at their surfaces in a highly active condition, suggests that there might be something in the suggestion. In any case it is evident that no finishing material can be kept free of objectionable organisms with more ease than polished marble.

CLEANLINESS

For utilizing and diffusing all available light in such a manner as not to be trying to



Marble bath partitions in Sacred Heart Sanitarium,
Milwaukee, Wisconsin.

sensitive eyes, no finishing material is superior to polished white marble, and no other material combines to a greater degree, these qualities and that of inherent cleanliness. If white marble *looks* clean, it *is* clean, an advantage which would seem to be of the first importance in a hospital for both practical and psychological reasons. It is an excellent material for walls and floors of operating rooms, toilet rooms and all public spaces of hospitals. Because it is obtainable in slabs of very large proportions, it entails a minimum of joints.

White marble is always sound, *i.e.*, free from cracks. Waxing, filing and patching are not permitted; it is the one class of marbles which to be merchantable in the trade must be free of such defects. In this respect, any of the domestic monotones are in the same class, but there are numerous monotones valued for their peculiar qualities of color and texture which are not obtainable in perfectly sound blocks and which are therefore subject to more or less patching and filing.

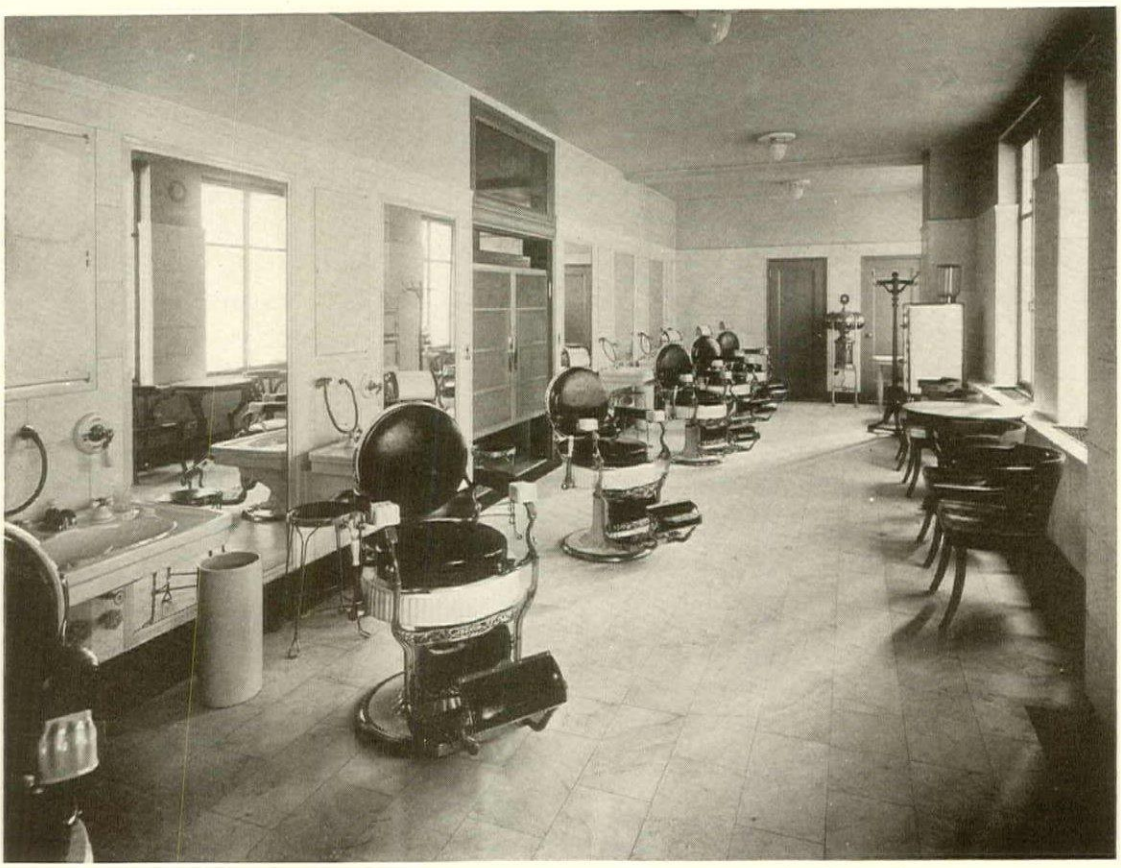
It has been stated that absolutely pure white marble is very rare; what there is is highly valued for statuary, memorial tablets, etc. But if it were available in greater quantities it is probable that in large areas or masses it would have a depressing effect and would lack the charm resulting from those variations of tone and color which save the actual white marbles from the deadlines of mechanical uniformity and which place them in the category of beautiful, natural materials defying successful imitation.

Since the days of the Romans men have tried to imitate marble in cheaper materials, and not one real success has been achieved. These imitations have been urged upon the public often under names intended to convey the idea of marble, always with the plea that they are as good as marble.

The latest attempts have been to sell slabs of opaque white glass instead of marble. One such product was called Carrara Glass; the Carrara district in Italy is the most widely known source of white marble. Another product has been given a name suggesting glass but is being advertised under the slogan, "Better than Marble." One and all pay their tribute to marble as the goal to be attained. But no adequate substitute for marble has yet been produced.

MONOTONES

The monotone marbles are so-called not because they are of a uniform shade or tone, for many of them on close examination are seen to contain many colors more or less intimately mixed, and many white marbles and some black ones are much more nearly uniform in color and shade, but probably because the general effect of the so-called monotones from the standpoint of color, is soft and neutral. Etymologically this is no justification for the name, but it has become established in the trade, and the marble trade is tenacious of its customs. The monotone marbles generally are of a warm gray tone with an undertone of buff or pink or pinkish-brown; sometimes it is the gray that is the undertone. Among



Marble walls and floor help to produce sanitary conditions in the Barber Shop of the Book Building, Detroit, Michigan.

imported marbles, Tavernelle and Botticino are good examples of monotone marbles. Among domestic marbles the Tennessee and Missouri marbles are all monotones; at least this is true of those most commonly used.

Most of the monotones are crypto-crystalline limestones, or else are made up of fragments of calcareous fossils (which have become crystalline without destroying the organic forms) imbedded in a matrix or cement of calcareous material which is either non-crystalline or crypto-crystalline. When exposed to the weather this cementing material is more easily removed by solution than the fossil fragments, so that in old weathered surfaces the fossil fragments often stand out beyond the general surface by a small fraction of an inch. The weathering process is slow and is no cause for uneasiness as to the durability of the stone; where it has advanced far enough to be easily observed it gives to the surface of the stone a texture that is wonderfully attractive. If without injuring the stone this process could be so accelerated that the texture could be produced in a short time, it is safe to say that it would create a great demand for these stones for exterior use in many cases in which architects search the earth for stones to give them just this effect.

The Tennessee marbles, and the Missouri marbles from the Burlington limestone district, are obtainable in large, sound blocks. Hence they are "sound monotones," and waxing, filling and patching are not permitted. The other monotones commonly used are unsound and less desirable for use in hospitals, although their peculiar color values justify their use in other places.

BEST FOR HOSPITALS

Of all the marbles available, white Italian, the fine-grained domestic white marbles like Alabama and Vermont, and the sound monotones, are peculiarly suited for use in hospitals. As between the white marbles and the monotones, the brighter and more cheerful effect produced by the white marbles, and the fact that they cannot look clean without being clean, would seem to give them a margin of preference. In other desirable qualities there is no basis for preference except that of taste. Among the white marbles the tone of the background varies from a bluish-white, as in ordinary grades of white Italian, to a warm creamy tone, as in Alabama. Some people prefer the colder tone, some the warmer.

The fact that a good deal of dust and dirt may be present upon the monotones without being conspicuous, may make them a little preferable in such places as school buildings, but should count against them in hospitals where cleanliness should be of the order of virtue demanded of Cæsar's wife. It is not intended to imply that in a school conditions should not be above reproach; but an amount of ordinary dust and dirt that would seriously mar the appearance of white marble will be inconspicuous on a monotone marble and from the standpoint of health may be tolerated until school is out for the day and the caretakers can do their work.

MARBLE FLOORS

It would seem that no part of the finish of a hospital is more important than the finished floor surfaces, especially in corridors, operating rooms and toilet rooms. The following quotation from a letter written by the general manager of the May Department Stores Company, and published in THROVGH THE AGES (March, 1924) covers the argument for marble floors

The New Central Market at Omaha, Nebraska, is a model of cleanliness with its counters, walls, base and trim of marble. The counters and walls are of Madre Veined Alabama; the base of Westfield Green; the trim of Napoleon Gray.

so well that no marble man could better it. After describing their unsatisfactory experience with wooden floors and stating that following a thorough investigation of all available material they had decided upon marble, the writer continues:

"The deciding factors in our choice were: first cost, appearance, cleanliness, economy, quietness, safety and health. We are convinced that we have made a wise decision and selected the material that best complies with the requirements and meets the exactions most fully.

"The first cost of marble is not prohibitive. As a matter of fact, when we took into consideration the lasting qualities of this material, we found it to be one of the least expensive materials we could have used. The wooden floor had to be replaced every three or four years—an inconvenience as well as an expense—whereas the durability of marble is practically unlimited.

"The marble floors add more to the appearance of the store than any other improvement of equal cost, not only in themselves, but because they enhance the appearance of fixtures and merchandise as nothing else can do.

"The floors not only look cleaner, but are cleaner, because both employees and customers respect their appearance and do not throw paper and trash on them, as they do on wooden or carpeted floors. Furthermore, it is easier to remove dirt as well as staining liquids from marble. We have never had a stain on our marble floors that we have not been able to remove without injuring the appearance of the marble.

These stains include red and black ink, shoe blacking, patent medicine, fruit juices and flavoring syrups.

PRACTICAL ADVANTAGES

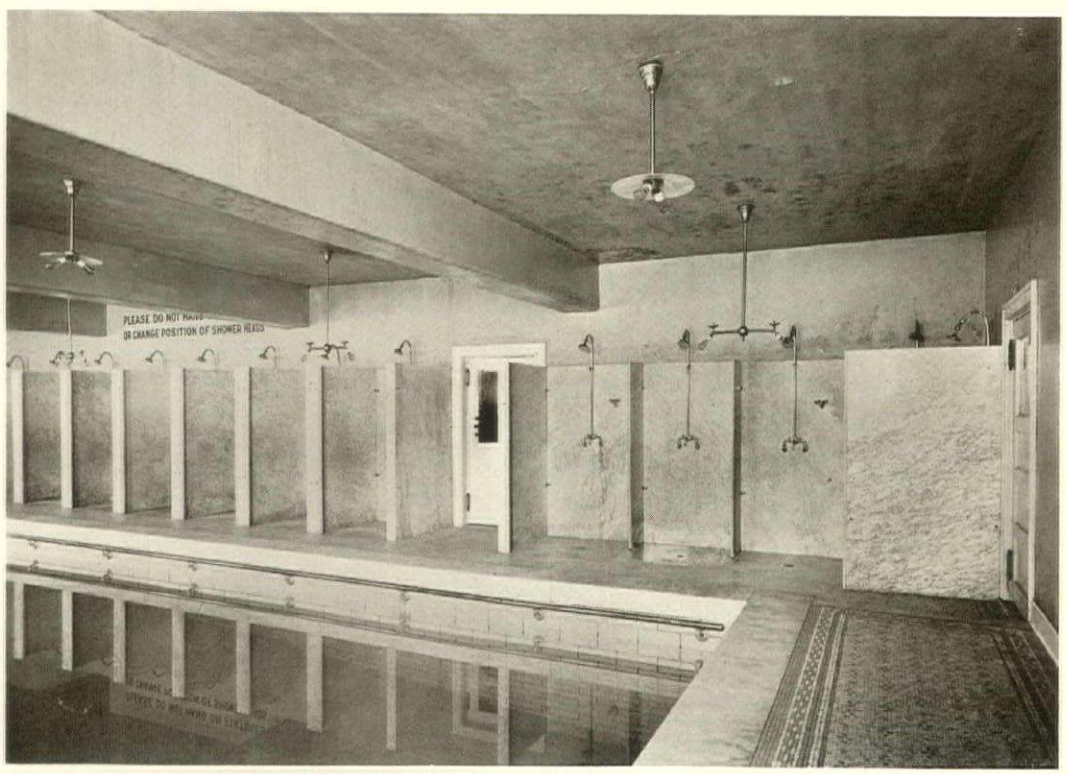
"When we scrubbed our wood floors by hand, it required thirty women working twelve hours to finish the job, and we could only do it once a week. When we scrubbed the floor nightly by machine it required ten men, two machines and four and a half hours each night. Since installing the marble floors, two men do the work every night and do the job well. So much for their economy.

"The noise of thousands of footsteps is subdued on marble floors. They make a quiet store.

"People do not slip and fall on marble floors when rain and slush are tracked in. They are safe floors.

"We notice that the lighting fixtures, inverted bowls, etc., do not need to be cleaned oftener than every three or four weeks now that marble is used. Formerly they were not cleaned often enough when we cleaned them every week. This is fairly evident proof that the amount of dust in the air has been materially reduced. This probably has a direct bearing on the general health of our employees, in particular, and perhaps of our customers also.

"In addition to these advantages, there are two others worth mentioning. We had noted that it was almost impossible to make dustproof the partitions between our show windows and general store. We have discovered that since putting in the marble floors our show windows are much cleaner than they were when we had the old wooden floors, due to the fact that no dust remains on the marble to be stirred up and forced



The shower baths, as well as the edge of the pool, are of marble in the Y.M.C.A. at Binghamton, N.Y.

through the partitions into the store."

Marble is obtainable in slabs of any reasonable size; it has a very appreciable amount of elasticity and is less likely to crack from temperature changes or from minute movements of the supporting structure than any other available material. It is attractive, easy to clean, and is as permanent as the building itself. When first cost, maintenance, permanence, attractiveness and all other factors are considered, marble is, in the long run, an economical finish for those parts of a hospital where its use is specially indicated.

CLEANING MARBLE

1. Do not use soap, nor any cleaning powder containing soap.

The persistent use of soap will finally leave a film upon the surface of any wall or floor finish; this film forms in spite of thorough rinsing. It will make floors slippery and will finally cause a superficial oily appearance in delicately colored marbles, which detracts greatly from their appearance.

2. For cleaning polished wall marble, clean water and clean rags or sponges are all that is necessary as a rule. Occasionally a little mild alkali should be added to the water to remove the greasy film which will ultimately form in the atmosphere of a city. It is well to wash the marble with sponges and dry with a soft cloth. A little Javelle water added to the water used in cleansing is useful, not only for its cleansing properties but for its qualities as a disinfectant.

3. For cleaning marble floors, water with a little alkali, together with some scouring agent like diatomaceous earth, is a good combination. There are proprietary preparations which unite the necessary ingredients; some of them, however, contain soap and should be avoided or at least adopted only after it has been demonstrated that they have been freed of the objectionable qualities of soap.

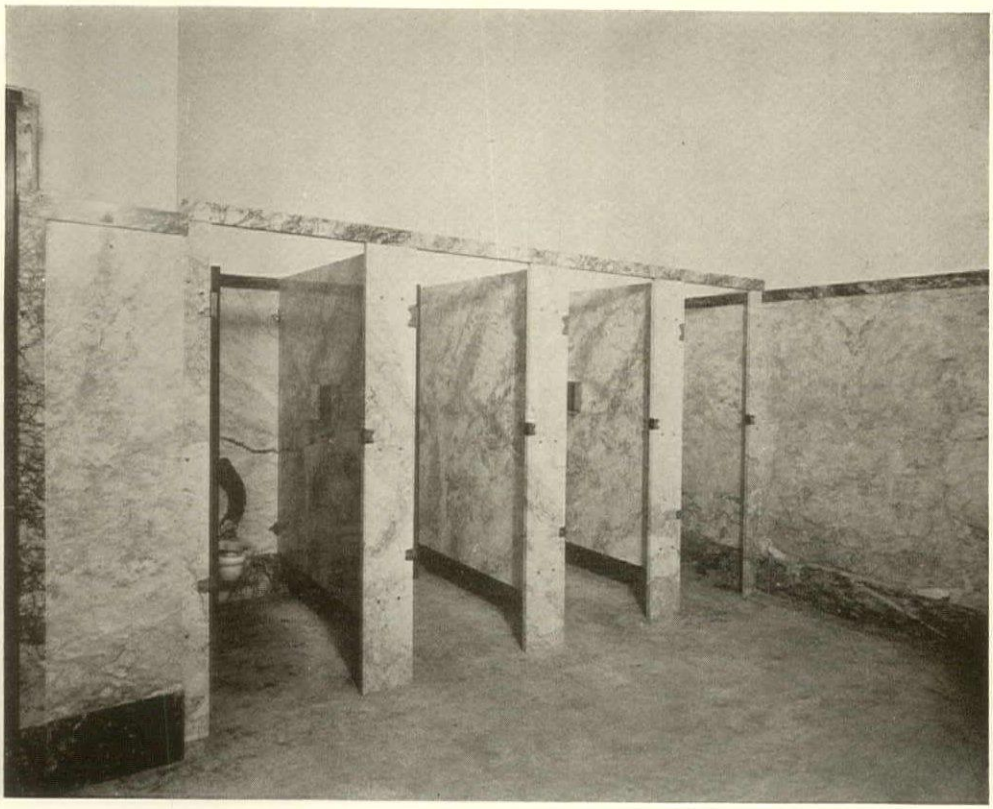
4. As marble (except Verde Antique) is essentially calcium carbonate (or sometimes calcium magnesium carbonate), acids should not be used in cleaning it.

5. If oil, ink or other substance likely to discolor marble is dropped or splashed on it, prompt action will greatly diminish the trouble of removing it. Even the thinnest of fluids will penetrate marble but slowly, and prompt application of absorbent rags or paper is often all that is needed.

OTHER SUGGESTIONS

If several hours or days have elapsed, other measures are required. Any organic coloring matter can be bleached out by persistent application of rags or blotting paper kept moistened with Javelle water; any alkaline or non-acid bleaching agent may be applied to marble without injury; the same is true of any solvent except acids and soap solutions. There is a proprietary preparation on the market known as Wyandotte Detergent, which is not only useful for cleaning marble floors, but for removing stains from either wall or floor marble. There are probably other preparations with similar qualities. The only known stain which will penetrate marble and which cannot be removed is iron rust. Rust will not penetrate unless the marble is in contact with rusting iron for a long time; under such circumstances there is an affinity which produces what seems almost a solid solution. No interior marble will ever be stained with iron rust if in setting it is kept free from contact with pipes or other iron or steel parts of the structure.

If grease or oil is promptly removed, no penetration will occur. If left for some time, grease stains may remain. They can be re-



Alaska marbles insure sanitary conditions in the toilets of the King County Court House, Seattle.

moved in a number of ways. Clean white blotting paper applied to the stain and heated with a hot iron; clean rags or waste or a pat of plaster of Paris kept saturated with gasoline and in contact with the grease stain (airplane gasoline is the most effective); a little quicklime slacked in contact with the stain; dry Portland cement kept in contact with the spot for several hours or a day or more; exposure to direct sunlight where possible; all these methods are effective. Sometimes one is more effective, sometimes another. But one or several of them will always completely remove either oil or grease. In marble shops if a piece of marble is stained by oil and a few days are available, it is customary to expose it to direct sunlight; this method is always sure but it takes time.

With ordinary care and attention nothing should ever happen to require the use of any of these methods. Prompt action in case of accidental application of grease, ink or similar substances, will prevent staining. As for iron rust, one would have to inspect hundreds of buildings and hundreds of thousands of square feet of marble for every instance found. Marble may become dingy and apparently stained from sheer neglect, especially in basements and toilet rooms; but even in such case it may always be restored to its pristine freshness by the application of Javelle water or by the use of the proprietary preparation above mentioned, either with or without Javelle water.

6. The only thing really needed is a moderate amount of care and attention from the beginning. Then the marble will continue clean and fresh and no elaborate methods will be required.

A LIST OF THE WORLD'S MARBLES

By J. J. McCLYMONT

Note—In a past issue, Mr. McClymont proposed, for the sake of convenience, to divide the different marbles into four groups. These arbitrary groupings were as follows:

GROUP A — Any marble or stone sold to the trade in fair-sized slabs or blocks of commercial size, rectangular shape and guaranteed by the seller to be sound, free from natural defects, that can be finished at a minimum cost, and sold to the consumer as sound marble.

GROUP B — Any marble or stone sold to the trade in slabs or blocks of fair or medium size, generally rectangular shape guaranteed to be sound and free from natural defects, the finishing of which, because of texture, the size of slabs, the shape and size of blocks, is somewhat more expensive than those in Group A.

GROUP C — Any marble or stone that cannot be sold as sound but contains a minimum amount of natural defects, such as dry seams, old fractures, partially or completely healed surface voids, etc., to be treated by the manufacturer in the most approved manner, reinforced where necessary by liners on back or metal inlays and sold to the consumer as semi-sound marble.

GROUP D—All marble, stone and so-called serpentine marbles, and Onyx, which, by their peculiar formation are known to be fragile, such as Breccias and nearly all highly colored marbles and serpentines, and that are sold to the trade in irregular shaped blocks or slabs without a guarantee as to their soundness, treated by the manufacturer in the most approved manner, reinforced where necessary by liners on back or metal inlays and sold to the consumer as unsound marble.

Kachin Hills of Burma
The Tawmaw Mines, which produce Burmese Jade, Burmese Emerald Jade, Burmese Mauve Jade and Burmese White Jade, are located on a plateau of the Kachin Hills.

Kadur District Quarries—See Green Quartzite.

Kahurangi
Natives' name for New Zealand Jade.

Kainach Quarries—See Kainachthaler.

Kainachthaler
Quarry near Kainach, Styria, formerly Austria-Hungary.
White and gray banded.
Takes high polish.

Kakkinaras
Modern Pentelic is quarried near this place.

Kallithos
South Dover Marble Company's Quarry, near South Dover, New York.

Kansas Limestone—See Silverdale.
Quarry at Silverdale, Kansas.

Kansas Marble—See Silverdale.

Kapunda Dark Gray
Quarry at Kapunda, South Australia.
Dark gray with white veins.

Kapunda Light Gray
Quarry at Kapunda, South Australia.
Gray with dark, almost black, veins.

Kapunda White
Quarry at Kapunda, South Australia.
White with clouds of light gray.

Karatchair Quarry—See Verte Antico (Modern).

Karystos
Same as Carystus.

Kasota Pink—Also Kasota Pink Fleuri.
Quarry at Kasota, Le Sueur County, Minnesota.
Reddish-pink slightly variegated.
Takes medium polish.

Kasota Pink Veine

Quarry at Kasota, Le Sueur County, Minnesota.

Reddish-pink slightly mottled and with light veins.

Takes medium polish.

Sawed across the bed, otherwise same as Kasota Pink.

Kasota Stones

See Pink Kasota Fleuri.
Pink Kasota Veine.
Yellow Kasota Fleuri.
Yellow Kasota Veine.

Quarry at Kasota, Le Sueur County, Minnesota.

Kasota Yellow

Quarry at Kasota, Le Sueur County, Minnesota.

Yellow with mottling of darker shade.

Takes low polish.

Kasota Yellow Fleuri

Same as Kasota Yellow, except sawed across the bed.

Brownish yellow slightly mottled, showing bed veins.

Kato Stone

Same as Mankato.

Katrineholm

Near Katrineholm, in the Province of Sodermanland, Sweden, are reported large deposits of marble.

Kediri

Same as Wadjak. See Java Marbles.

Keller—See Inyo.

Kennack Cove—See Cornish Serpentine.

The Carn Kennack Quarries are located near Kennack Cove.

Kennesaw—See Georgia White.

Kent—See Hassock.

Kentucky

No Kentucky marbles are in general use for interior decoration, although according to the Kentucky Geological Survey of 1923, a large number of deposits are available and several quarries are in operation. One or two were opened since 1921.

Quarries producing Dark Gray are the
Poindexter Quarry, Cynthiana.
City Quarry, Flemingsburg.
Hamilton Quarry, Lexington.

Quarries producing Grayish-White are:
Slaughter House Quarry, Georgetown.
Estes Quarry, Lebanon.

Light Gray banded marble is quarried at the Blanton Quarry, Frankfort.

A Medium Gray Crystalline is quarried at the W. J. Sparks Quarry, Rockcastle.

Quarries producing Medium Gray are:
Somers Quarry, Georgetown.
Headley Quarry, Lexington.
Work House Quarry, Frankfort.

Pink Marble is quarried at the Quincy Ward Quarry, Cynthiana.

White Marble is quarried at the Silman Quarry, Stephensburg.

Undeveloped deposits reported are:
Dark Gray at Danville.
Medium Gray at Reservoir Knob, Somerset.
Pink at Paris.

Kerry County, Ireland

For marble produced in this county see Golden Breccia and Irish marbles.

Kersantite Rock
Somewhat similar to Gray Granite.

Kersanton (Granite)—See Granitello.

Kerwith Sands—Same as Maen Midgee.

Khio—See Porta Santa.

Kiel's Green
Eastman Quarry, West Rutland, Vermont.
Cream to flesh colored. (Vermont Geological Survey.)
Takes medium polish.

Kiel's Green (Eastman's)
Eastman's Quarry, West Rutland, Vermont.
Bright green mingled with white.
Takes medium polish.

Kilchrist Loch
Near this loch or lake marble has been quarried from time to time for more than a century. The only ones we list are the Skye Marbles. (From Watson's British and Foreign Marbles.)

Kildare—See Irish Black and Irish Drab.

Kildown Cove and Kildown Point
Cornish Serpentine from the quarries near Spernic are located in the neighborhood of Kildown Cove.

Kilkenny Bird's-Eye
Same as Kilkenny Black Fossil.

Kilkenny Black
Archer's Grove or Butler Grove Quarries, Kilkenny County, Ireland.
Deep black.
Takes high polish.

Kilkenny Black Fossil
Black Quarries, near Kilkenny, Kilkenny County, Ireland.
Black with white fossils.
Takes high polish.

Kilkenny Marbles
Black Madrepore.
Gray Fossil.
Kilkenny Black.
Kilkenny Black Fossil.
According to Watson, water power was introduced into the Gray Fossil quarries as long ago as 1730.

Killarney Red or Royal Red
Quarry at Killarney, Ireland.
Striped with white and red.
Takes high polish.

Killin Serpentine
Quarried at Killin, Perthshire, Scotland.

King's County Marble—See Irish Gray.

King's County Stone
Quarry in King's County, Ireland.
Reddish mottled, fairly uniform.

Kingsteignton
Quarried near Torquay, Devonshire, England.
Light pinkish-gray with numerous white fossils.

Kingwood Stone—American Golden Quartzite.

Kintail
Quarried at Rathmullin, Donegal County, Ireland.
Black.

Kitley Park

Quarried at Kitley Park, Devonshire, England.
One variety is green; another, sometimes called marble, is a rose colored spar.

Klagenfurt—See Crastaler.

Kleber Quarries

See Algerian Onyx
Algerian Serpentine.
Giallo Antico.
Numidian Pavonazzo.
Numidian Red.
Numidian Rose.
Mr. Brindley says marble from these quarries were not used in Ancient Rome; however, there seems to be no doubt but what the Romans worked them.
They were not being worked in 1923.

Knox Pink

Also French Pink and Rose Pink.
Quarry near Knoxville, Tennessee.
Deep reddish-pink, slightly mottled.
Takes high polish.

Knoxville Belt or Knoxville Marbles—See Tennessee Marbles.

Kolar—See Black Dolerite.

Kollithos—Dover Marble.

Quarry at South Dover, New York.

Kommersoen, Norway

Marble deposits are located near this place.

Koolmard Marble

Same as Ringborg Greens.

Kooringa County Mines—See Australian Malachite.

Kootenay

Quarry at Lardo, British Columbia, Canada.
Light gray with parallel lines of darker shade.

Kornool

Quarry at Beejapore, India.
Yellowish or creamy gray.

Kramsach Quarries—See Breche De Kiefer.

Kreistadt Quarries—See Podolsk.

Krimchi

Quarry near Jaisalmer, Rajputana, India.
Deep red.
Takes high polish.
Is available in small quantities.

Kristel

An old Algerian quarry not in use in 1923.

Kronprinzen Von Preussen—See Red Brilon.

Kundol—See Steatite (Soapstone).

Kunzendorf Quarries—See Gray Kunzendorfer Marbles.

Kurkura Stone

Quarry near Jaisalmer, Rajputana, India.
Dull orange or buff, slightly banded and with numerous small brown specks. (Watson)
Takes high polish.

Kurnool

Quarried at Beejapore, India.
Yellowish or creamy gray.

A HANDBOOK OF MARBLE

It is the purpose of the National Association of Marble Dealers, to publish as soon as possible, a handbook on marble. The material contained in this book will be contributed by those best qualified to speak in an authoritative manner on the various matters treated. This is the eleventh installment and contains part of the third chapter, written by John Stephen Sewell, President of the Alabama Marble Company. These extracts will probably undergo some slight changes before appearing later in book form.

CHAPTER III—Sawing Marble

IN loading a block onto a gang car, several points require special attention.

1. It must be so placed that the sawing will be in exactly the desired direction relative to the grain and the "color" (*i.e.*, the veining and clouding). The color nearly always occurs in a rather definite arrangement, and its scheme of distribution on the faces of the sawn slabs may be very largely predetermined by the angle which the saws make with certain lines in the block which depend on the known mode of occurrence of the color.

2. The block must be so set that the saws can be brought down entirely through it. It is a common practice to have a thick slab of unsound or otherwise worthless marble or stone securely and solidly set on the gang car, and to load the blocks on this. When the saws begin to cut into this slab, they are known to be entirely through the block. Sometimes heavy strips of marble are used instead of a large slab, upon which to rest a block. In such cases, slight irregularities on the bottom of a block may project below the tops of the strips, and the saws must be brought down clear through these irregularities; two or three slabs still connected by only a fraction of a square inch of unsawed material may easily be broken so as to destroy their value, in subsequent attempts to separate them, after removal from the gang, or in the process of removal itself.

3. The block must be rigidly set on the gang car so that no rocking or other motion relative to the car is possible.

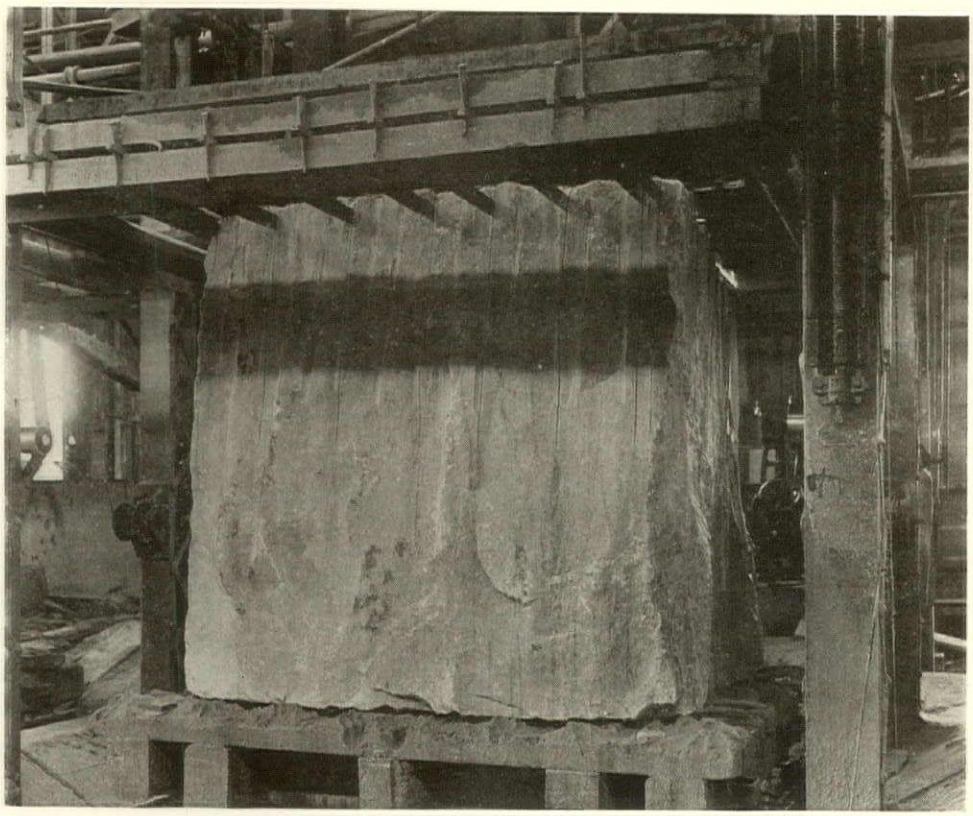
4. The gang car must be rigidly braced in position under the saws so that it cannot move under the drag of the saws.

5. The saw blades must be set accurately, so that they will swing back and forth in planes parallel to the motion of the gang.

Neglect of points 3 and 4 will result in crooked sawing and uneven thickness of slabs. If this is not too bad, it may be corrected on the rubbing bed, but the increased cost of rubbing may exceed the total cost of sawing.

Until the saws have come down pretty well into the block, no lateral support is necessary. But before the saws are entirely through the block, some kind of bracing must be provided to prevent the slabs from toppling over sideways; and where the blocks are unsound—as in the case of many of the richly variegated marbles—it is necessary to be on the lookout for this danger as soon as the saws begin to get through any unsoundness which intersects the slabs. Sometimes the upper parts of slabs must be removed, one at a time, as soon as the saws have gone through the unsoundness. This necessitates stopping the gangs from time to time, and of course adds greatly to the cost of sawing.

In lifting the sawed slabs from the gang car, if the marble is sound, and there are no pebbles lodged in the saw cuts, rope slings may be placed around the block of slabs and



Block of marble being cut into slabs of varying thickness by gang saws.

they may be lifted together; as they are separated by the saw cuts, they are drawn together in this operation; pebbles in the saw cuts—or incomplete saw cuts—may result in disastrous breakage.

It is better to use slings with small steel beams at the bottom and a cross brace at the top, so the block can be lifted without squeezing the slabs together.

It is only necessary to look at a gang to realize that, for good work, it must be kept true, well lined up and free from vibration. It looks rather crude—but it is not as crude as it looks. It falls far short of the perfection of modern automatic machinery and yet if kept in good order and operated by a good sawyer, it is capable of surprisingly accurate work. A good sawyer can tell by the sound it makes when the gang has encountered hard or soft spots in the marble; he can vary the rate at which the saws are fed down and so maintain the maximum possible rate of sawing and yet keep the saw cuts straight. Unless the sawyer is known to be possessed of this sixth sense, however, it is best to regulate the rate so as to make it slow enough to be safe, based on experience with the kind of marble that is to be sawed. It costs much less to make good saw cuts than to correct bad ones.

Usually a sawmill—at least the gang part of it—is run twenty-four hours per day, six days in the week. Sometimes two and sometimes three shifts of men are employed. Only the actual sawyers and generally a man to look after motors, bearings, etc., are on duty at night. The loading and unloading are usually done in ordinary working hours. The work of the sawyers is not hard nor exhausting, and the men

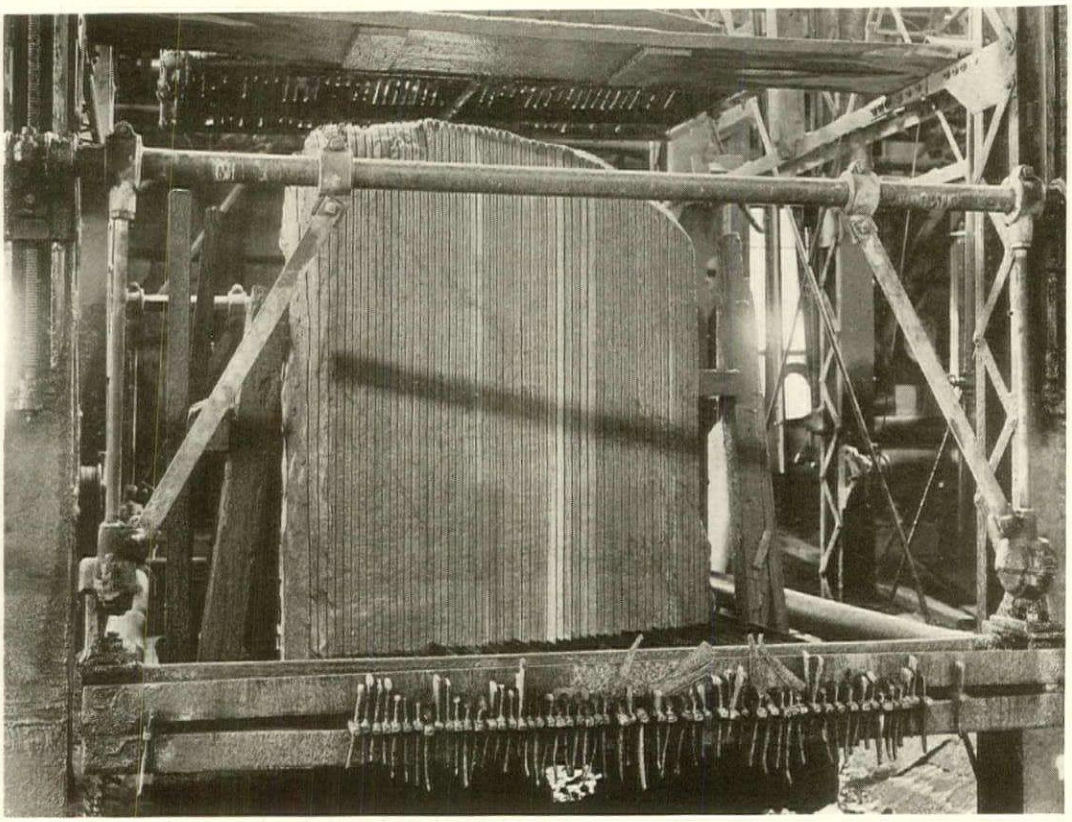
usually prefer a twelve-hour shift, and to be paid by the hour.

Where there are eight or more gangs, and they are run twenty-four hours per day, the cost of power, materials (such as sand, saw blades, etc.), upkeep and payrolls (including the mill foreman) is, at the present time, not far from one dollar per gang hour, based on the total number of gang hours theoretically possible. With a good volume of business and reasonably good management, the gangs ought to be actually cutting about 85 per cent of the theoretical total time. With blocks of varying size and some special sawing, they will average a little less than one cubic foot of marble sawed once per gang hour. This results in a mill cost of around $1.20 per cubic foot for each sawing in line with figures previously given. This is based on the thin slabs, and small sizes ordinarily used in interior work and contains no allowance for general expense.

If gangs could be kept constantly on sound rectangular blocks as large as they would take, the cost would be much less; and it is somewhat less when marble is sawed into thick slabs and large pieces. But irregularities in the size and shape of blocks and occasional blocks with hidden defects always add a great deal to the cost.

POSSIBILITY OF IMPROVING SAWING METHODS

The fundamental principle applied in the modern gang is still the same as in the days of Pliny; a strip of steel or iron scratches its way through the marble by means of water-borne sand. Where the ancients probably used but one saw blade at a time and operated it by man power, we have gangs cap-



Block of marble after sawing has been completed.

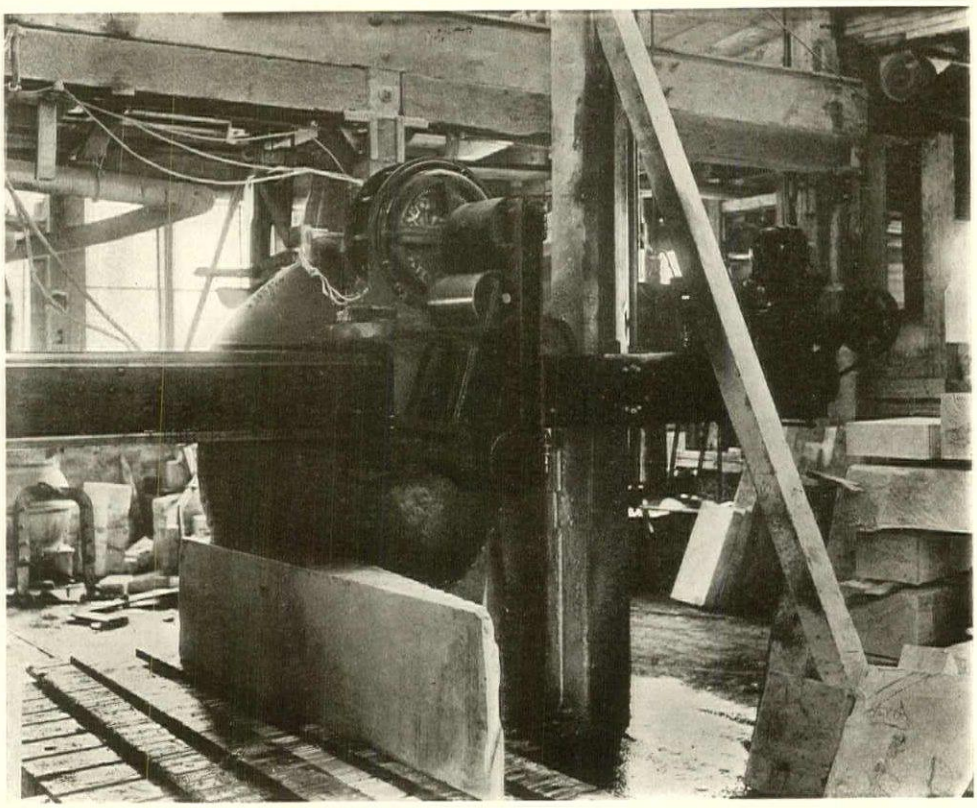
able of taking as many as eighty blades at one time, we operate them by mechanical or electrical power, and even supply the sand and water by mechanical means. But fundamentally, the operation remains the same as it was over two thousand years ago.

There are some improvements which are obviously possible. The present method of setting the blades for sawing a new block is primitive and time consuming. Unquestionably a little ingenuity expended upon this operation would increase its accuracy and certainty, and reduce the time consumed to possibly one-fourth of that now required. This might make it possible to gain an hour every four to six days. The effect on the cost would be very little.

By making the frames and all parts of gang saws very heavy and very rigid, and by running the gangs as fast as the proper feeding of the sand into the saw cuts and under the blades will permit, the rate of sawing might be increased by 20 per cent to 25 per cent; but the capital investment would probably be more than doubled. The operating payroll of a mill is less than half of the total direct cost. Maintenance and repairs are a serious item, and would probably be heavier with heavier gangs driven to the limit. So the items of cost that would be reduced by a slightly greater rate of sawing obtained as above are a relatively small part of the total cost, and there are other items that would be increased. No one has ever tried the experiment, so no one knows just what the result would really be. It would probably cost from $50,000 to $100,000 to find out, and it is doubtful whether any concern doing it could control the results for its own exclusive benefit, if they were favorable.

If there could be made available some abrasive that would cut three or more times as fast as sand, and not cost more than ten times as much per ton—or if its lasting qualities were proportional to its higher price, in case it were very expensive—the situation would be very different. The cost of sand probably amounts to 5 per cent to 10 per cent of the total direct operating cost of a mill. It is evident that a very great increase in the cost of the abrasive would be justifiable, if the rate of sawing could be doubled or tripled. But to come within practicable limits, the new abrasive would have to cost much less or last much longer than any of the modern artificial abrasives. If the rate of sawing were very greatly increased, the time expended in loading and unloading and in setting the saws would assume increased importance among the items of cost; but it is quite certain that it could be very materially reduced by methods already available and exemplified in other industries.

At present, the prospect of a new abrasive that would be economical to use for general sawing purposes in the marble industry is extremely remote. It is only necessary to set an ideal standard, to emphasize this fact. Such a new abrasive ought to be nearly or quite as hard as black diamonds—or carbons, as they are sometimes called—fully as tough, available in grains of uniform size and not more than $\frac{1}{32}$ inch in diameter—at a price not exceeding—probably—$100 per ton. The price would depend, however, upon the rate of sawing and the durability of the abrasive. The cost of abrasive per cubic foot sawed might be as high as 40 cents or 50 cents, if the output were thereby doubled. It might be nearly twice as much, if the output were tripled. With such an abrasive in use, it is probable that wear and tear on saw blades, pumps, etc., would be increased; more power would be required; and output could not increase quite in proportion to the increase in the



Diamond saw of type where saw is fed against the work.

rate of sawing, because the time spent in overhauling the gangs and in loading and unloading would become an increasing percentage of total working hours.

The exact limit of practicable cost of a new abrasive could be determined only by experiment. But it would not, in any case, be necessary to reduce the unit cost of sawing, although this would, of course, be desirable. The main thing would be a great increase in output; this might even justify some increase in the unit cost of sawing, for the greater net return on the investment due to quicker and larger turnover at a smaller margin of profit would apply to sawing marble, just as to merchandising or to making Ford cars. The cost of sawing represents about 10 per cent of the total cost, finally set in place, of average marble wainscoting. Even if it could all be saved, it would not be a very great saving for the owners of buildings, but any real improvement along the lines suggested would yield a large return in the trade, just the same. An abrasive that would yield such results, however, would almost certainly make possible also great economies in finishing, and that would very considerably reduce the cost of marble finish in buildings. The production of such an abrasive is certainly not in sight at the present time.

TWO TYPES OF DIAMOND SAWS

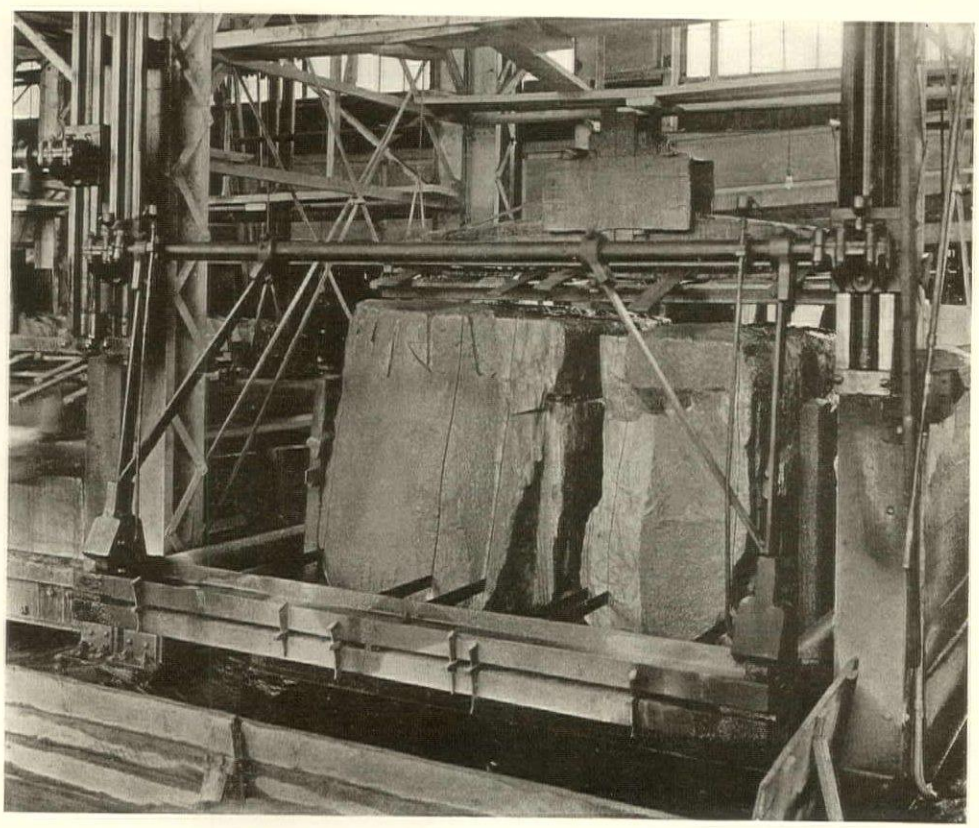
It has been already mentioned that diamond saws are of two types, in one of which the work is fed against the saw, while in the other the saw is fed against the work. The first is arranged like a planer; the work is laid on a movable platen, and fed against

the saw just as it would be against a tool, in an ordinary planer. This type is more convenient where wide slabs are to be cut into many narrow strips.

The second type of diamond saw has a carriage on which the saw is mounted, which travels along an overhead track made of I beams or channels. The work is mounted on a car which runs under the overhead track carrying the saw, on an ordinary rail track at right angles to the direction of motion of the saw. This type of diamond saw is more convenient where long strips are to be cut into short pieces. The first type is more convenient also for making special and oblique cuts, as in sawing a long, rectangular piece to octagonal shape, preliminary to turning in a lathe. For general use in a plant devoted to interior marble work, the first type is probably better. In a plant devoted to exterior work, there should be at least one of each type, but if more than two are needed, the majority would probably better be of the second type.

In an interior marble plant, if there is a little surplus of gang capacity, there is no absolute necessity for a diamond saw at all, although it is a great convenience.

The rate of cutting of diamond saws could probably be very materially increased by the use of a greater peripheral speed; but that would introduce a good deal of difficulty and expense in making and keeping the steel wheels true enough to avoid destructive vibration when running at the greater speed. Presumably actual practice represents a fair compromise between conflicting conditions, but it is very doubtful whether any thorough investigation of this subject has ever been made.



Small gang saw cutting blocks into large slabs.

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Knoxville, Tenn.	Tennessee Producers Marble Co.	B. L. Pease
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New Orleans, La.	Albert Weiblen Marble and Granite Co.	Albert Weiblen
Oklahoma City, Okla.	Taylor Marble and Tile Company	G. W. Taylor
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