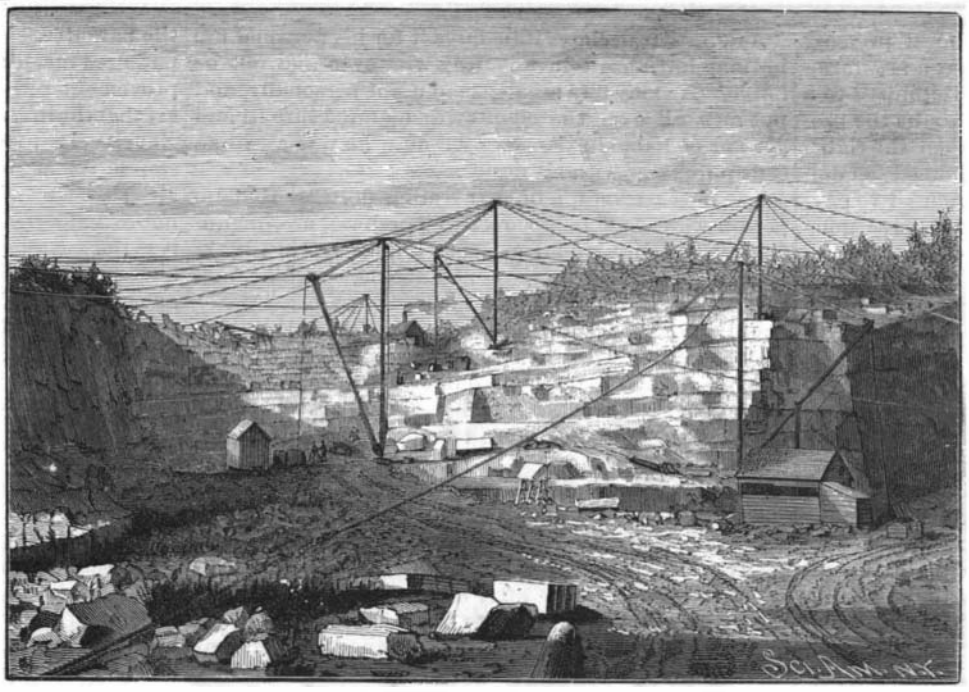
OUR BUILDING STONE SUPPLY.

We have received from Mr. George P. Merrill, of Washington, D. C., a valuable article upon the above subject, from which we derive the following. The article in full will appear in an early issue of the SCIENTIFIC AMERICAN SUPPLEMENT.

That upward of $25,000,000 is invested in the stone quarries of the United States is doubtless scarcely realized by the majority of persons. But from the tenth census it appears that during the year ending May 31, 1880, there were in active operation in the United States 1,525 quarries of building and ornamental stones of all kinds, representing an invested capital of $25,415,497, and giving employment during the busy season to upward of 40,000 men. The total product of the combined quarries was 115,380,133 cubic feet, valued in the rough at $18,365,065.



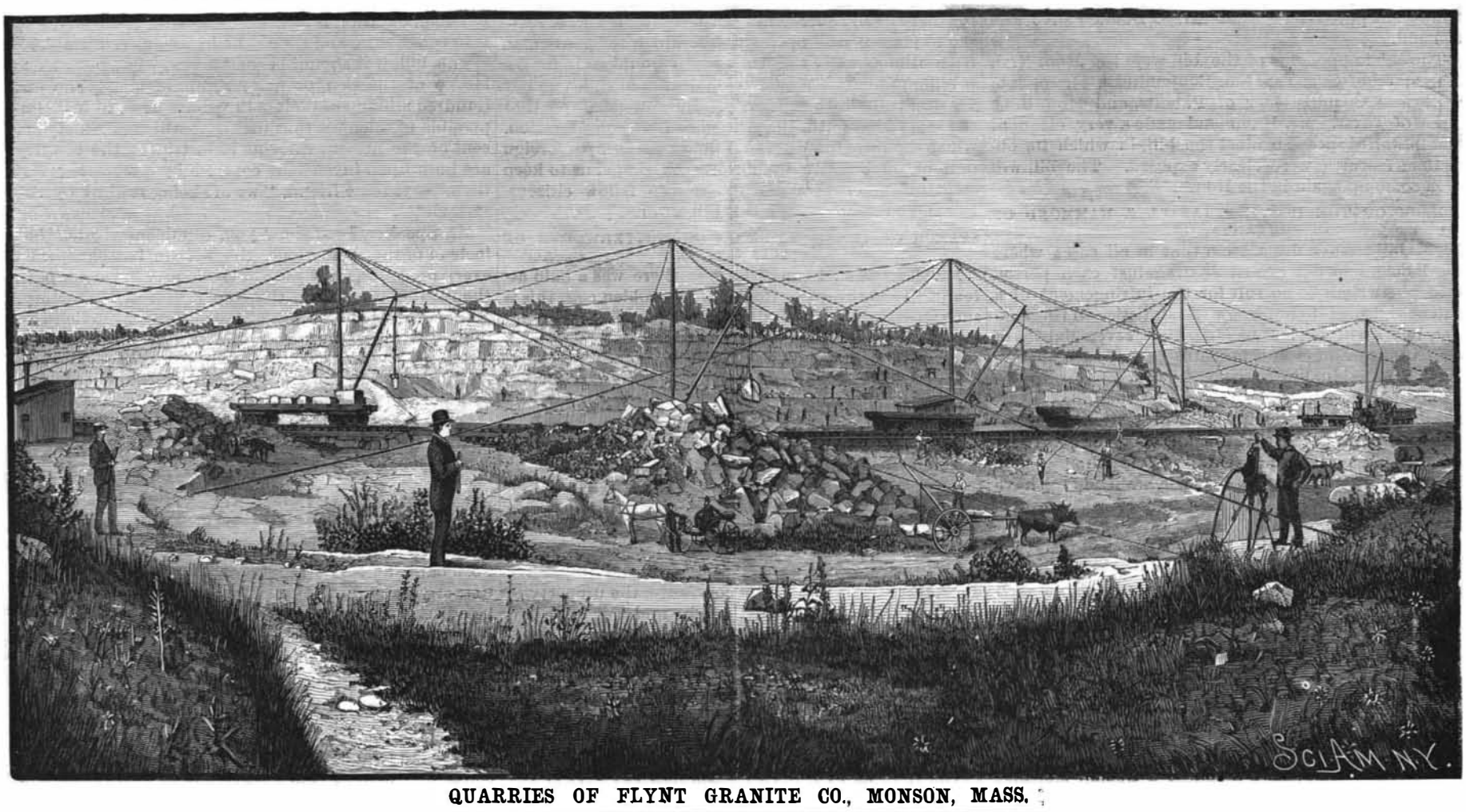
GRANITE QUARRIES, HALLOWELL, ME.

Granites came first into use in this country, probably more on account of their ready accessibility than from any desire on the part of the people for so refractory a material, the matters of transportation and cost of working being then as now the controlling items in deciding what substances were to be employed. As early as 1650, a building long known as the "stone house of Deacon John Phillips" was erected in Boston from rough stone found in the immediate vicinity or brought as ballast from England. Another early stone building was the "Old Hancock House," which was constructed from bowlders of Braintree (Quincy) granite. Neither of these is now standing. In 1749–54 Kings Chapel, which is still standing on the corner of School and Tremont Streets, was erected. This also was of bowlders of the Quincy stone, and was a seventy times seven days' wonder to all who beheld it. Considering the methods employed in getting out the stone, it was a remarkable structure, for we are told that the bowlders were broken by first heating by fire, and then letting fall heavy iron balls upon them from a considerable height. Crude as was the method, the building still stands in a better state of preservation than many that have been erected since; and singularly enough, the wonder does not seem to have been that the stone could be worked at all by these means, but rather that enough good stone was obtainable, and it was universally conceded that enough more like it could not be found to build another!

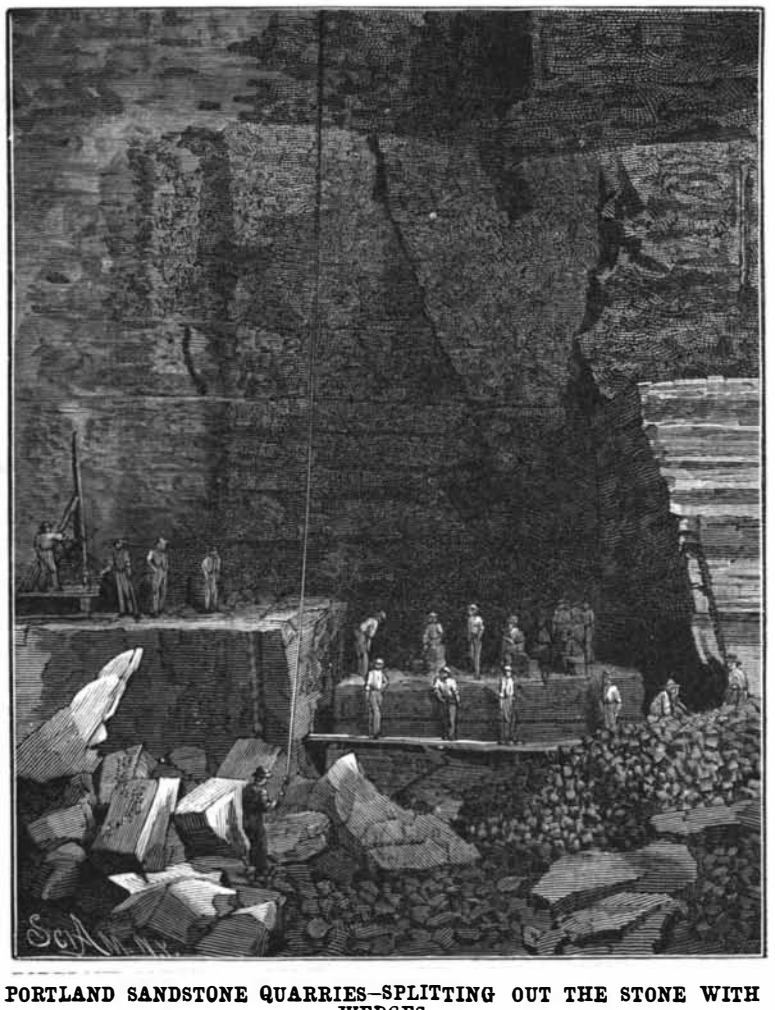
The granite bowlders dotting the Quincy commons continued to furnish for many years the chief stone used in the vicinity for foundations, steps, and like purposes. Early in the present century, however, granite began to be brought into the city from Chelmsford or Westford (Hitchcock says the latter), and stone buildings became more common.

In 1818–19, stone from the same source was also shipped to Savannah, Ga., for the construction of a church at that place, but this also was obtained largely from bowlders, and such a thing as a permanent quarry systematically worked was almost unknown.

The demand for large quantities of stone for the construction of the Bunker Hill Monument caused the opening of extensive quarries in Quincy in 1825, and the construction of what has been called the first railway in America to transport the quarried material. From this date the development of the quarrying industry has gone on constantly and rapidly.



QUARRIES OF FLYNT GRANITE CO., MONSON, MASS.



PORTLAND SANDSTONE QUARRIES—SPLITTING OUT THE STONE WITH WEDGES.

The Quincy granites are exceedingly tough and hard, of a coarse texture, and deep blue gray color; they give an appearance of peculiar solidity and strength to all buildings in which they are used, while the fact that they admit of a high lustrous polish renders them peculiarly adapted to the finer grades of monumental and decorative work. For the latter purposes they are coming more and more in vogue, and appearances indicate that with present prices and tastes the days of Quincy granite for merely rough building purposes are over, and henceforth it must be known more properly as an ornamental stone.

Nevertheless, there are few stones that have exercised a more pronounced effect upon American architecture. In Boston alone, out of the 312 buildings with exterior walls constructed wholly or in part of granite, 162 are of the Quincy stone.

At about the date of the opening of the "Bunker Hill Quarry" at Quincy, a granite quarry was also opened in the adjacent town of Gloucester, a "town heretofore noted only for its fishery interests," and not long after others were opened at Anisquam, but which were soon after abandoned. Quarries at Rockport just beyond Gloucester were opened in 1827, and are now in a flourishing condition, though the first year's business is said to have resulted in a net loss of $15. The celebrated quarries at Bay View, now the property of the Cape Ann Granite Company, were opened in 1848. This is now one of the best equipped in all its appliances of any quarry in the coun-

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OUR BUILDING STONE SUPPLY.

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try. The material, of which there is an annual output valued at nearly a quarter of a million dollars, is coarse, but exceedingly strong, and of a blue gray or greenish color.

In the Hallowell granite quarries, situated some two or three miles out of the town, the rock lies in the form of huge imbricated sheets of all thicknesses up to eight or ten feet. So slightly do they adhere to one another that it is but necessary to free the stone at the sides by a few drill holes and blasts to obtain blocks of almost any required size. The material is almost white in color and of so fine and even a grain that it can be utilized for all manner of constructive purposes, excepting, perhaps, interior decorative work. One can but experience a feeling of surprise on passing into the companies' shops to find himself surrounded on all sides by sculptors of American, Spanish, and Italian nativity busily engaged in reproducing from plaster models by dint of hammer and chisel a great variety of imitative forms, not of course excepting the winged figures which in our youth and ignorance of the possibilities of anatomy we have been taught to suppose represent the future forms of those who are sufficiently good in this world to be rewarded in the next.

To Maine belongs the credit of producing the only red or pink granite that can at all successfully compete in our markets with the imported Scotch granites or those from the Bay of Fundy, New Brunswick, though excellent varieties for general building, and which are used to a less extent, occur in several other States.

The celebrated Concord, N. H., granites are from quarries in the immediate vicinity of the city from whence they derive their commercial name, and are quarried to the value of some $200,000 annually. This stone closely resembles that of Hallowell, Me., and is used for similiar purposes. Although popularly known as the Granite State, New Hampshire ranks but fifth as a granite producer, being preceded by Maine, Massachusetts, Rhode Island, and Connecticut. Granites of excellent quality also occur in the Archæan formations of the Appalachian system as far south as northern Georgia, though they are now but little quarried. Near Richmond, Va., occurs an excellent bed of this stone, which furnished the material for the State, War, and Navy department buildings in Washington.

Ever since the discovery of the wonderfully beautiful effects produced in marbles by the early sculptors and decorators, these stones appear to have been regarded by the people at large with a sort of veneration amounting in some cases almost to fetichism; and any stone to which the name is now applied seems generally accredited with possessing all the qualities of beauty and excellence of those first used. This is, however, far from the case; and while the name includes stones of rare beauty, it is also made to cover others suitable only for general building purposes, and which are perhaps poor at that.

From a scientific standpoint, there is no difference between a marble and ordinary limestone or dolomite, the rocks having precisely the same composition and origin, but one possessing such color and structural peculiarities as render it desirable for ornamental or decorative work, while the other through the lack of these same qualities is relegated to the more ordinary purposes of general construction.

Of the $2,000,000 worth of marbles anuually produced in the United States, more than one-half is from quarries in Vermont, and the remainder nearly altogether from Massachusetts, New York, Pennsylvania, Maryland, and Tennessee. The material is imported to the value of about $600,000 annually, the supply coming largely from Italy, though smaller amounts are brought from France, Belgium, Portugal, Egypt, and Algeria.

The narrow belt of limestone from whichis obtained the supply of Vermont marble extends from a point beyond the Canadian line throughout the entire length of the State, and thence through western Massachusetts and Connecticut to Long Island Sound. Since early in the present century numerous quarries have been opened along this belt, but at the present writing the most extensive lie within the limits of the little village of West Rutland, cozily nestling among the green hills of central Vermont. The quarries themselves, to which the village owes its entire business prosperity, lie along the western base of a low range of hills, which, to the ordinary observer, give no sign of the vast wealth of material concealed beneath their gray and uninteresting exteriors.

In the quarry the stone is found in layers from two to four feet in thickness, often mottled and streaked, and varying in color from pure white to deep blue gray and almost black. These layers, instead of lying horizontally one upon another, are at the surface steeply inclined and almost on edge, so that the same quarry at the same time may be producing marbles of half a dozen grades of color and quality.

In quarrying, the best beds are selected, and upon their upturned edges excavation is commenced; first by blasting, to remove the weathered and worthless material, and afterward by channeling, drilling, and wedging, no powder being used lest the fine, massive blocks become shattered, and rendered unfit for use. The quarry thus descends with almost perpendicular walls to a depth of sometimes more than 200 feet, when the beds are found to curve, and pass under the hill.

The descent to the bottom of the pit is by means of numerous flights of wooden and suspiciously shaky-looking steps, bolted to the quarry wall. At the bottom, everything is cold and dripping wet, and the atmosphere of that heavy feeling that can be described only by the suggestive word *dank*.

Steam channeling machines moving slowly back and forth over their narrow roadbeds spitefully strike upon the rock clanging blows with long chisels, which rapidly produce deep grooves some two inches in width and of any desired depth up to several feet. Closely after these follow the gadding machines, which drill or bore circular holes along the bottom and sides of the blocks, into which wedges are introduced and the stone split from its bed. The Wardwell channeling machine, which is the one most commonly in use, cuts a continuous groove at the rate of 75 to 150 square feet per day, thus doing the work of from 25 to 50 men by the old hand process. As the expense of operating the machine is only about $10 per day, the advantages of this method are obvious. It is claimed for the diamond gadder that it will do its work at the rate of 180 feet a day in rock of as soft and even a texture as marble. By the old hand methods, 12 feet was considered a fair day's work. Three men are required for each channneler and two for each gadder, while a large force is employed in handling the loosened blocks and preparing the way for the machines.

In spite of their threatening aspect, accidents at the quarries are, we are told, very rare. Nevertheless, it is with a feeling of relief, as well as one of weakness at the knees from continuous climbing, that we find ourselves once more on the surface, and breathing the dry, pure air which comes wafted gently down the valley.

The marbles of New York are also largely suitable only for general building, owing to this same defect. Two varieties from Chazy and Plattsburg, in Clinton County, are, however, notable exceptions. In these the process of metamorphism has not been carried to the same extremes as in the Vermont stone, and the resultant effects of pink and red fossil shells embedded in a gray and reddish background are very pleasing. Under the names of "Lepanto" and "French gray," these stones are now in the market, and, with the exception of those of Tennessee, have been more used for furniture and interior decorations than any other American marble.

The finest marble for general decorative work which the country yet affords is undoubtedly that of Hawkins and adjacent counties in eastern Tennessee. Since its first introduction into the Capitol building at Washington, this stone has been a universal favorite, and justly so. In colors varying from light pinkish, mottled with white, through all shades to deep chocolate red, it offers sufficient diversity to suit the most fastidious, while the closeness and compactness of its texture, with almost absolute freedom from flaws, renders the production of larger surfaces, without recourse to the process of filling, than is possible in any other marble, native or foreign, with which the author is acquainted.

One of the most unique marbles in this country is found in the beds of Devonian limestone near Charles City, Iowa. The rock is of exceedingly fine and compact texture, non-crystalline and full of fossil shells and corals. The colors are dull, varying from light drab to brownish, but it acquires a smooth surface and quite uniform polish, showing to beautiful advantage the fossil remains, often six or ten inches in diameter, firmly embedded in the fine drab ground-mass.

Of limestones other than marbles, stones used only for general building, but which, owing to color and lack of polish, are unsuitable for decorative work, we have time and space to notice only the fine grained, light colored varieties of Indiana, Illinois, and Kentucky. These are often oolitic in texture, and vary from almost white through dull cream color to drab. The evenness of the grain of these stones, their softness, and at the same time toughness, render them adapted, in a remarkable degree, to general building and highly carved work, especially for country residences, and in cities where there is but little smoke or gaseous exhalations from manufactories.

The quarrying of sandstone, or *freestone*, as it is so often called, appears to have begun with the itinerant working of the extensive beds of Triassic brownstone in the vicinity of Portland, Connecticut.

The present industry is comprised in three large quarries, extending from a point near the ferry northward along the river for some three-fourths of a mile. These vary from 50 to 150 feet in depth, and their total yield of stone of all grades, during the time of their operation, has been roughly estimated at 4,300,000 cubic feet.

The total product of the three quarries for this year was 781,600 cubic feet, valued at not less than $650,000. In their present condition, the approaches to these quarries are more interesting than beautiful. The ground is strewn with huge blocks of stone, about and among which swarm the busy workmen and the ever-present small boy and omnivorous goat. The beds of stone lie nearly horizontal; and in quarrying, a natural point face is often selected as the quarry wall, which is followed down to any practicable depth, leaving thus an absolutely perpendicular wall on three sides, from 100 to 150 feet in height. The fourth side is usually less abrupt, allowing passageway for teams and workmen. In getting out stone, large masses of several hundred tons weight are first loosened from their bed by means of blasting, the drill holes being sometimes twenty feet in depth, ten inches in diameter, and charged with from twenty-five to seventy-five pounds of powder. These large blocks are then broken up by cutting, with picks, long grooves, into which iron wedges are inserted at intervals of a few inches from one another. Workmen armed with heavy hammers then pass along this line, dealing telling blows upon the wedges, until the stone yields to the strain, and falls apart. The blocks are then attached to a steam windlass and drawn to the surface.

Very little of the stone is dressed at the quarries, nearly all being shipped in the rough to New York and other large cities, where it is worked up as occasion demands.

Massachusetts, New Jersey, Pennsylvania, and Maryland also furnish large quantities of this material, while the deep blue gray "bluestones" or flagstones of New York and Pennsylvania, and the "Euclid bluestones" and "Berea grits" of Ohio, are almost too well known to require especial notice. The first mentioned of these are found in New York State, in a comparatively narrow belt west of the Hudson River, mainly in Albany, Greene, and Ulster Counties, and belongs geologically in great part to the Hamilton group of the Devonian formations. But one of the most important sandstones at the present day is that known as the Berea grit, or more popularly perhaps the Ohio freestone of Ohio.

This stone occurs in beds from ten to seventy-five feet in thickness and occupying a belt of country extending from the southeastern corner of Ashtabula County westward into Erie County, and then southward to the Ohio River. In quantity, it is needless to say it is inexhaustible. In color it is light, almost buff, of fine and even texture, and soft enough to work readily and evenly in any direction. It is by far the most common sandstone now in use, both for general building and for trimming purposes, in the United States.

The Flynt Granite Company was established in 1839, and has been in successful operation up to the present time. The extensive quarries, located at Monson, Mass., yield a granite in which mica is replaced by hornblende, as in the Quincy and Rockport granites. The stones are, therefore, much less affected by chemical agents than those in which mica is present, while the uncommonly small percentage of the alkalies, soda and potash, both in the light and dark varieties, greatly increases the power of resisting atmospheric influences. The iron in these granites is in the form of magnetic oxide, which is unchangeable. Those constituents which favor disintegration are present in such unusually small proportion that these granites should remain practically unchanged for an indefinite length of time, and they are, consequently, peculiarly well adapted for building purposes.

Two Men on the Foot Plate.

"There can be no doubt that the presence of two men on the foot plate, each having the glass gauge in full view, is a great safeguard against low water. . . . The regulation of the feed must then be left entirely in the hands of one man, and if he commits an oversight, and allows the water to get too low, the other man cannot so clearly see and correct the mistake."—*Railroad Gazette.*

Our esteemed contemporary appears to be in error. No experienced fireman would think of trying a gauge cock, touching a throttle, or criticising or offering advice to his engineer. The etiquette of the foot board makes the engineer supreme, while he is running his engine, in all that pertains to its management, and for *any one* to offer him advice *then* is to assume he does not understand his business. This is the reason "traveling engineers" do not get better results, and why they tend to disorganize and cause trouble in *many cases*, as engineers will frequently quit the road before they will submit to be dictated to by another engineer. What chance, then, does the *Gazette* suppose a *fireman* would stand in "assisting" his engineer by trying his water? The writer once saw a new, but "fresh," fireman knocked senseless with a copper hammer in the hands of the engineer, because the fireman observed, "Jim, your water is getting low, isn't it?" and at the same time trying a gauge cock.

Many glass gauges on locomotives have a brass tube around the glass, with a narrow slit in it toward the engineer only, thus cutting off the fireman's view of the water, unless he gets over on the engineer's side to see it.