Classic paper

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The story of Portland cement

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THE STORY OF PORTLAND CEMENT. PART I

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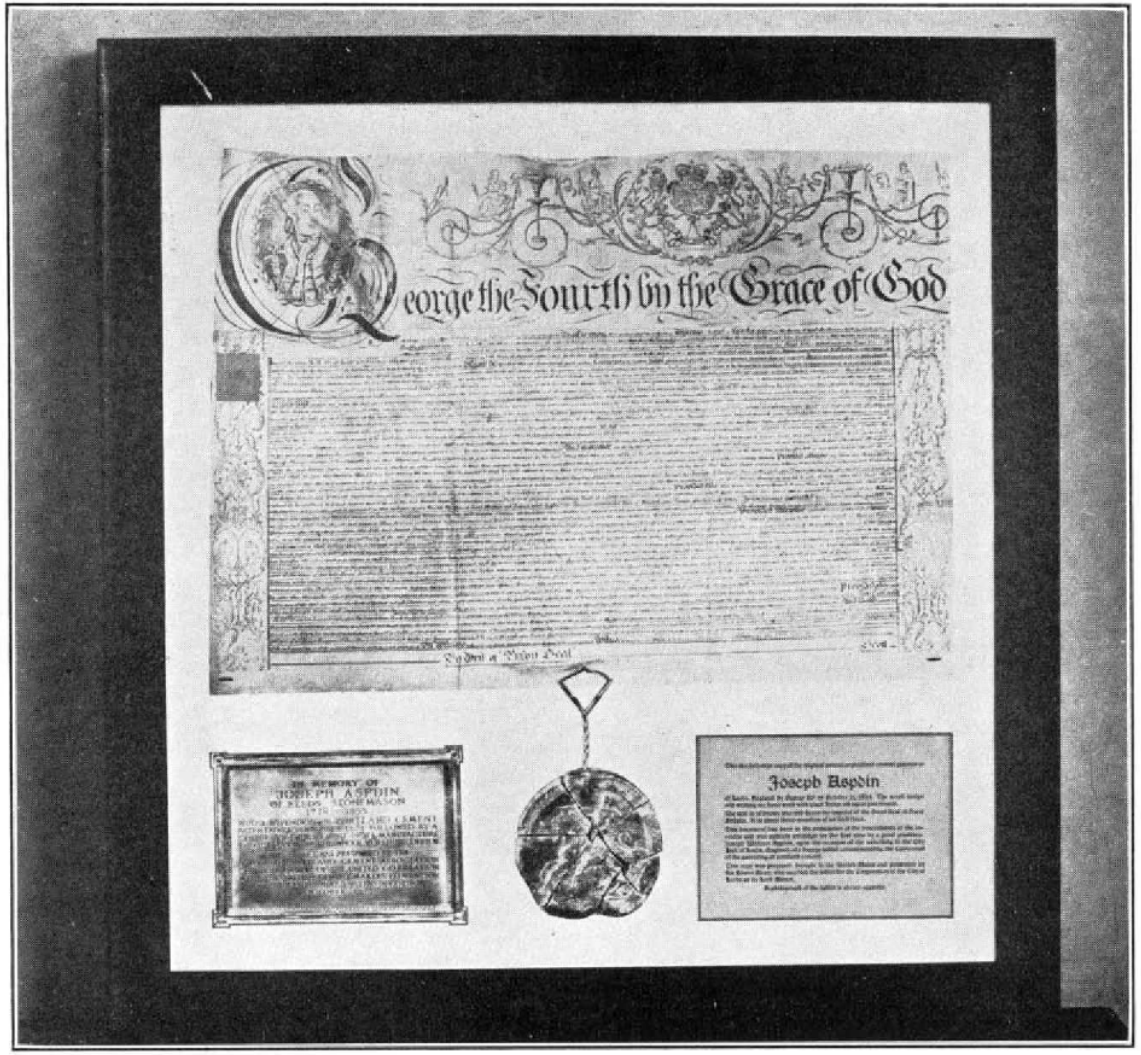
Since the dawn of history the building efforts of mankind have been wrapped up in a search for cementing materials with hydraulic capacities. The first crude hovels, chinked and plastered with a mixture of mud and sand, were examples of the first efforts along this line and as history grows clearer the efforts become more closely defined.

Portland cement, as it is known on the market today, is the culmination of that age-long search, although modern man is so used to miracles that he probably doesn't think much about it. To him the fine, grey dust contained in cement sacks does not conjure up visions of permanent rock-hard bridges, towers, dams, and highways. He probably doesn't realize that his concrete sidewalks were once mere limestone and clay—transformed by physics, chemistry, and sweat into a solid year-around footing which keeps him up out of the mud.

be very unhappy and dissatisfied until he did find it.

To the casual eye, portland cement is not mysterious. Its use is so common that the average mind has placed it in a class with flour, or sugar, or shoe leather. Mankind knows, in a general way, that if it takes a quantity of cement and sand and water it may mix these things together and make a stone which will harden in air or water. What it is that transpires within the mass to transform it from several separate things into one uniform solid, is a problem which doesn't weigh on the average mind very heavily. Naturally, after the effect is achieved, mankind is usually interested in results without speculating as to the probable cause.



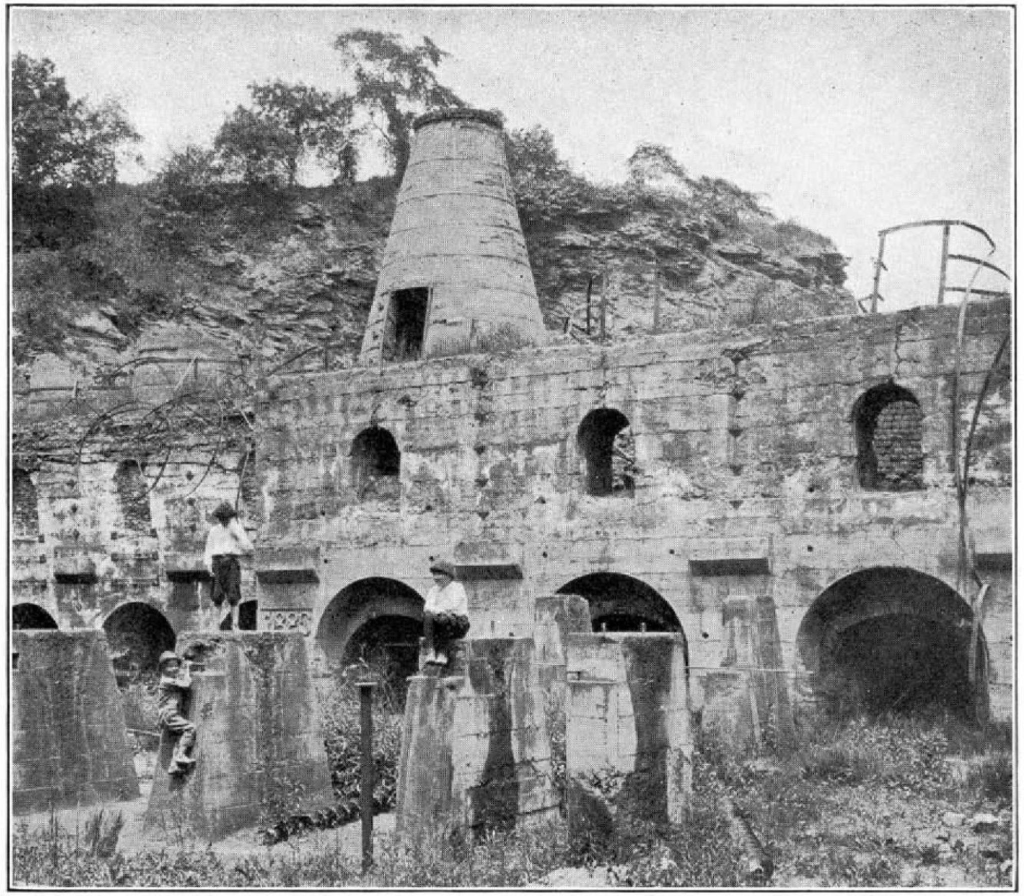
Aspdin's Patent

A copy of the patent which was granted to Joseph Aspdin in 1824 for the invention of portland cement.

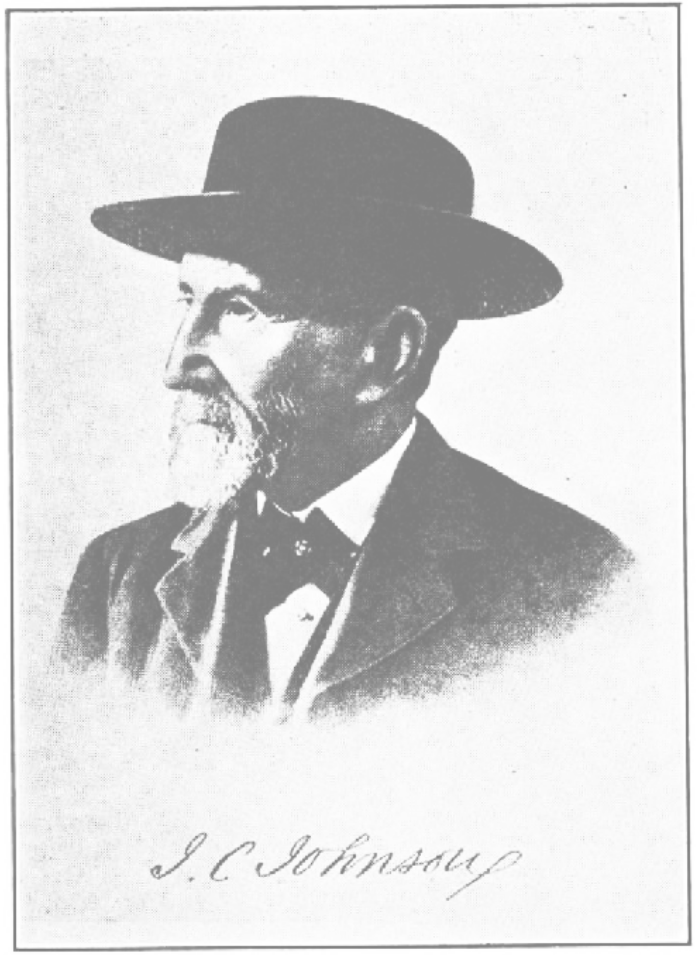
Aspdin was not the first cement maker, even though he is credited with the invention of what we now term "portland" cement. The actual invention of hydraulic cement is lost in antiquity, although Rome was the first nation known to have made extensive use of such a material. Both lime mortars and gypsum plasters were certainly known and used at an early date, for traces of these are found in the pyramids. The cement of Rome possessed qualities which were vastly superior to earlier types, and evidences of its lasting nature are presented in the foundations of Roman monuments and houses and in the rock-hard channels of various Roman waterways existing today.

The chief virtue of the Roman material lay in the puzzolan, or volcanic ash content, which was added to quicklime. This combination resulted in a hydraulic cement—a cement which could be used in underwater construction. Concrete made with this cement was prepared largely in the same way it is today. It is interesting to note that the Romans referred to their concrete as "*opus caementum*," literally "chip work" as referring to the particular nature imparted by the aggregate. The word "cement,"

Portland cement was imported into the United States in the early sixties, in limited amounts, and by the time the first home plant was established the imported brands were quite widely used by American engineers and builders. David O. Saylor, in 1872, produced the first portland cement of American manufacture. His plant was located at Coplay, Pa., in what is now the most important cement-producing area in the world—the Lehigh Valley. Shortly after his first manufacturing attempts, another plant was established in Indiana.



AN EARLY AMERICAN CEMENT PLANT

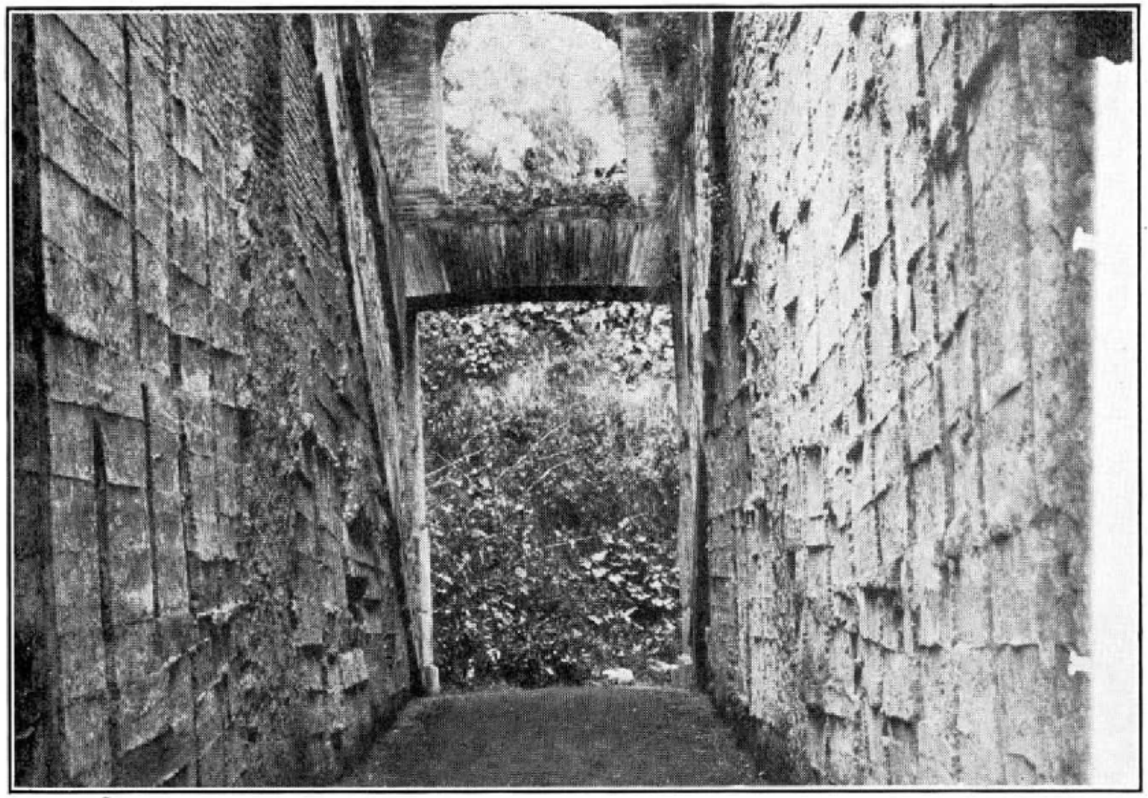


I. C. Johnson

Who claimed to have invented portland cement in 1845 while engaged with the J. B. White & Sons cement works at Swanscombe. Johnson believed, and stated with some authority, that he was the first to discover the clinkering process while engaged in a study of cement made by Aspdin.

provided in various combinations of raw materials such as calcium carbonates and silicates of aluminum. The processes of manufacture may differ somewhat with the natural state in which raw materials are found.

Several combinations are used in different cement manufacturing plants in the United States including: cement rock and limestone; limestone and clay; limestone and shale; marl and clay; chalk and clay; limestone and slag; oyster shells and clay. Cement rock is an argillaceous limestone which nearly approaches the correct proportions.



House of Augustus

This house was built on Palatine Hill in the first century B. C. The corridor shown presents an excellent view of the Roman concrete construction and the form marks left in the material after the forms were stripped off.

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marl, and other materials are used in plants which have ready access to these materials.

In Germany cement is made from chalk and clay, limestone and clay, or marl and clay. In England raw materials consist principally of chalk and clay; Belgian manufacturers also use chalk and clay, while marl and clay and chalk and clay are used in France.

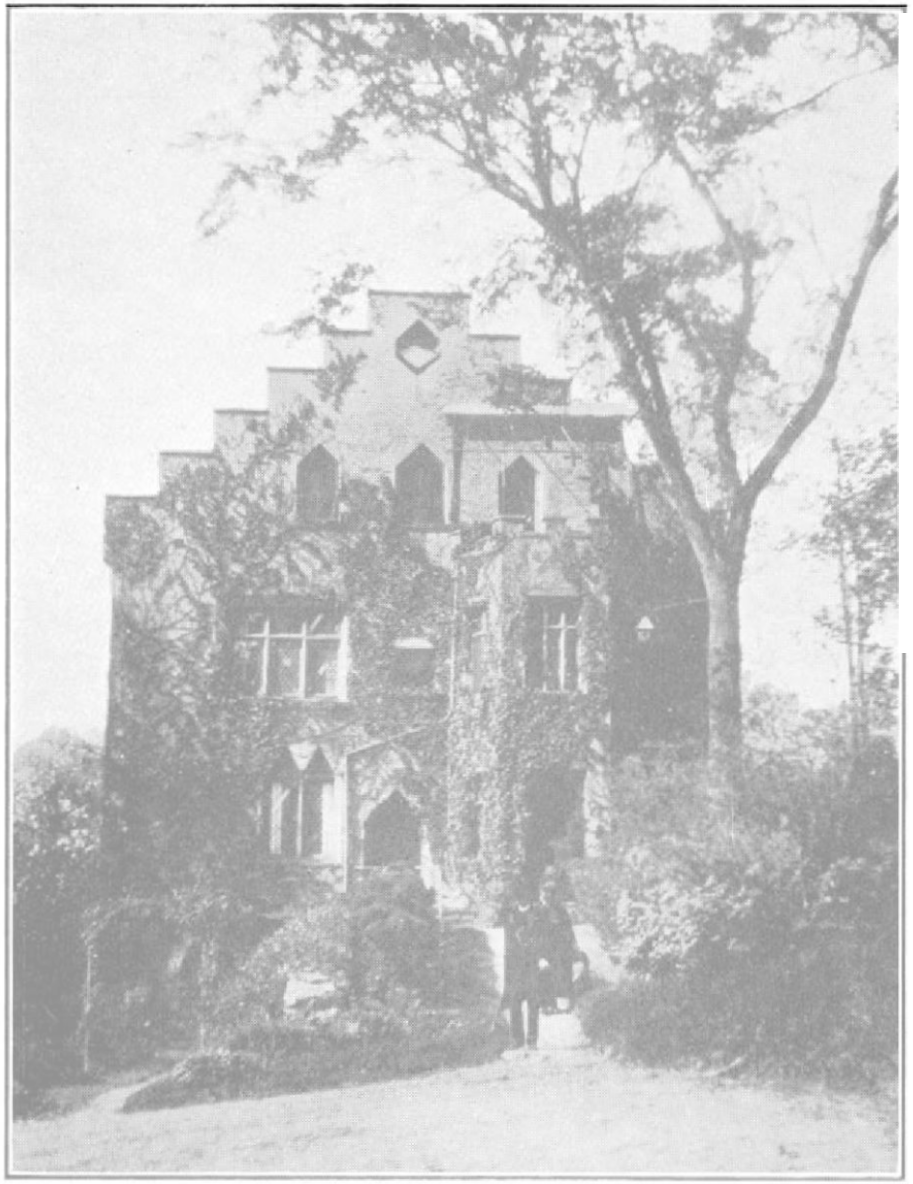
large output.

Portland cement being, essentially, an artificial mixture, it is necessary that the ingredients be properly proportioned and intimately mixed previous to calcining. This demand results in three distinct steps in manufacture: first, the pulverizing, proportioning, and mixing of the raw materials; second, heating the mixture to incipient fusion; and third, grinding the resulting clinker to commercial portland cement.

Manufacturers throughout the United States have more or less standardized the last two stages, the different plants varying chiefly in mechanical details. Two general processes, however, have been devised for the first stage—the dry process and the wet process.

The great bulk of raw materials used in manufacture is found in a dry state, and many of the plants in America handle the material in that condition throughout the entire process. When this process of manufacture is followed, the latent moisture of the raw materials must be removed to permit efficient pulverization.

In a typical dry process plant using limestone and shale for raw materials, preparation consists in crushing the stone as it comes from the quarry, drying out the latent moisture, and proportioning the mixture. Gyratory crushers or roll crushers assist the first steps of the process, whereinafter the materials are dried separately, in the usual practice, and proportioned.



HORACE GREELEY'S BARN

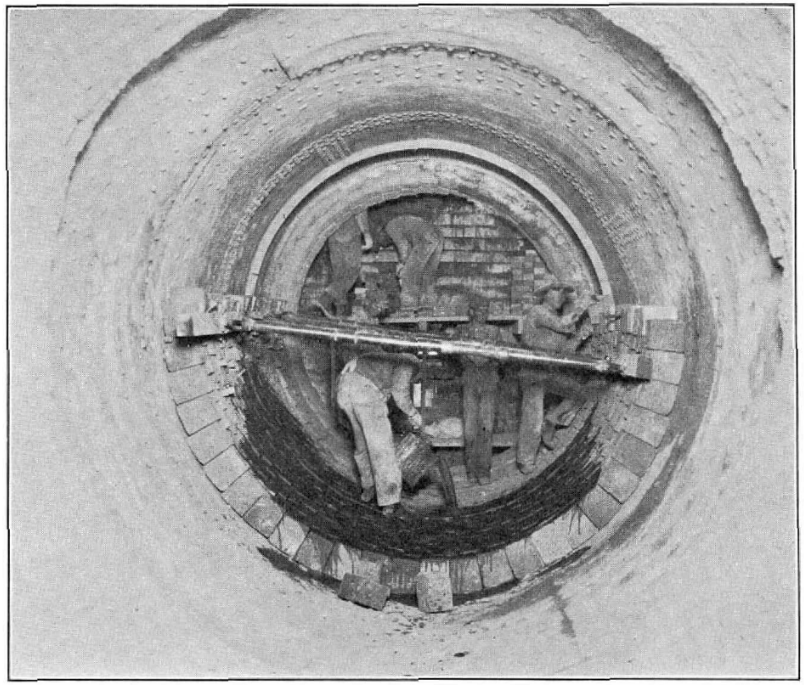
This structure, built 77 years ago, is one of the earliest concrete buildings in the United States. It was remodeled into a residence for Mrs. Clendenin, daughter of Greeley, and is still in an excellent state of preservation.

from which point on it goes through the same steps as dry process materials.

The kiln, in common use, is a brick-lined steel barrel, mounted on bearings slightly inclined to the horizontal. The slow rotary motion carries the material up the side where it slides down, taking about 5 or 6 hours to traverse the length of the tube. Spiral conveyors are used to introduce the material into the upper portion of the barrel. The lower end is closed by a movable brick wall, through the center of which pass the fuel pipes.

The degree of burning is governed by the supply of raw material, the speed of kiln rotation, and the flame temperature. A temperature of 2500 to 3000 degrees Fahrenheit is necessary to convert the material to clinker. The clinker results at the point of incipient fusion of the raw material, and

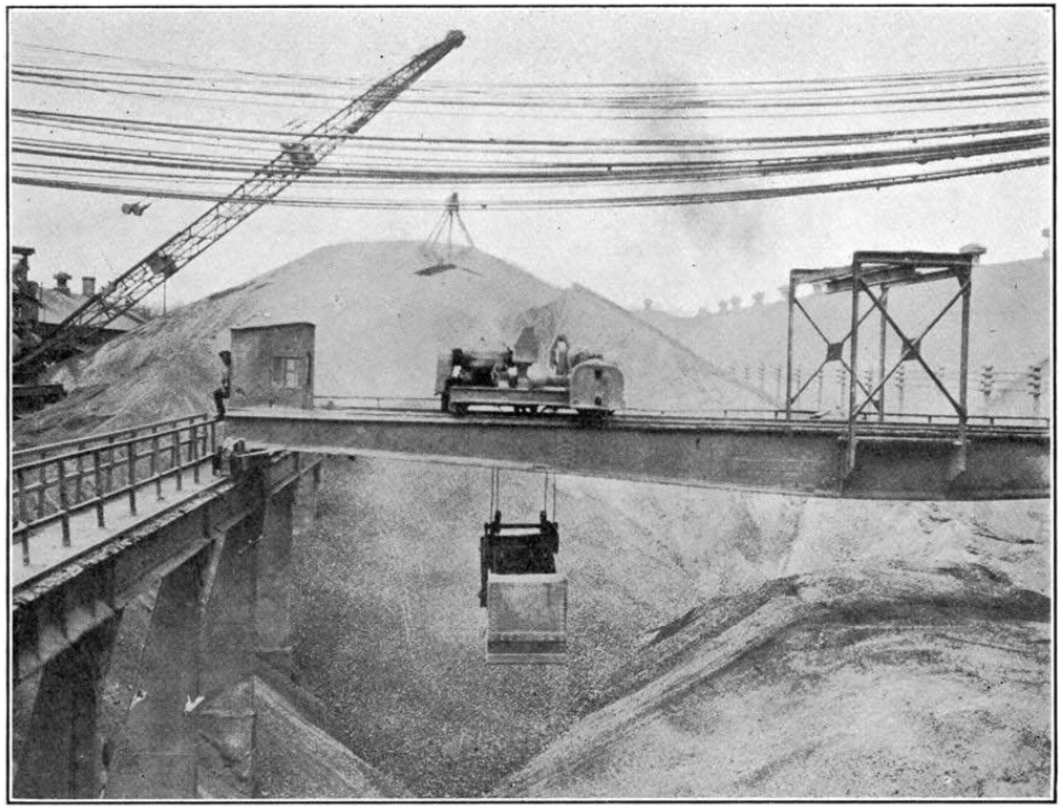
provides for a material mixture of high water content. This may be the result of added water or of the natural condition of the materials. The grinding and pulverizing is accomplished on the wet materials in various types of mills, producing a thick liquid called slurry. The slurry is pumped into the rotary kiln



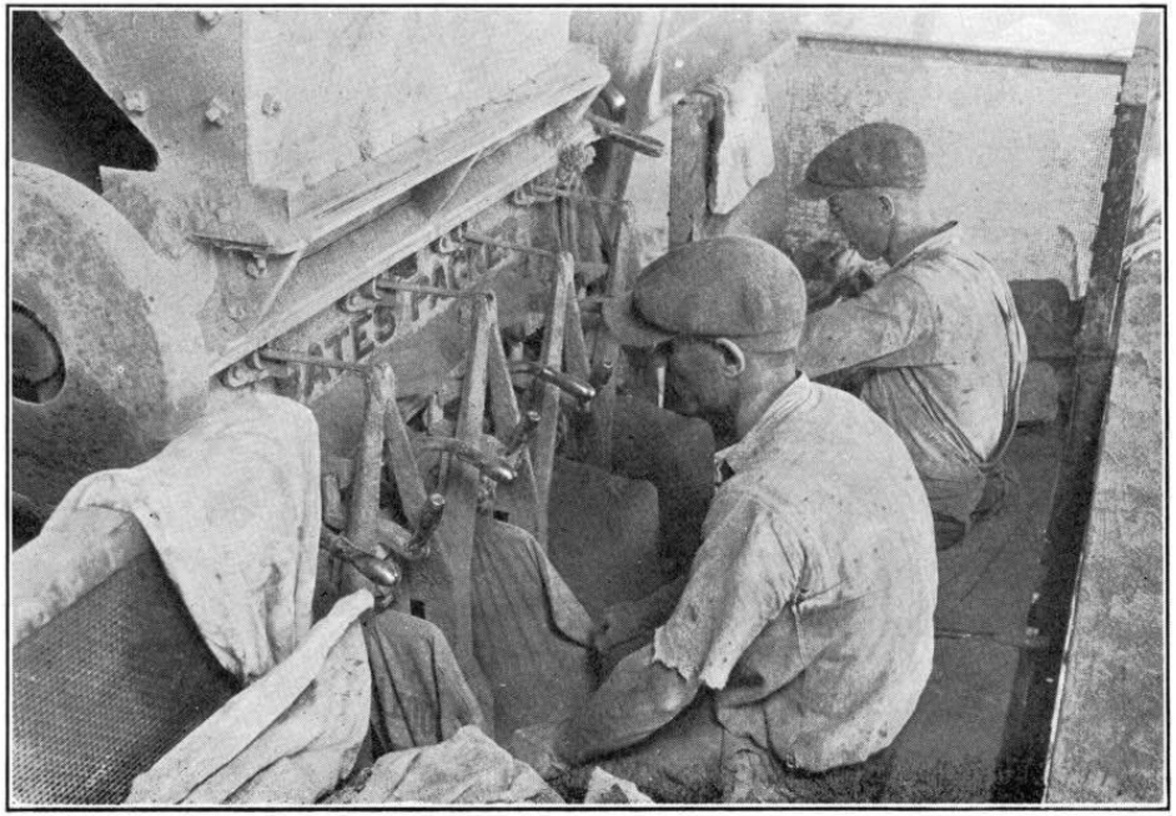
REPAIRING THE LINING OF A KILN

The final stage in the manufacture of portland cement is grinding of the clinker through a process similar to the one used in reducing dry raw materials for the kilns. Gypsum is added at this point to control the time of setting of the finished portland cement. Gypsum must be incorporated after the burning but before the final grinding to secure proper results. From 2 to 3 per cent is usually necessary.

The finished portland cement is then stored for sacking and shipment. Automatic sacking machines are used, replacing hand methods of former years, and insuring an exact content of 94 pounds per sack of cement.



Clinker Storage



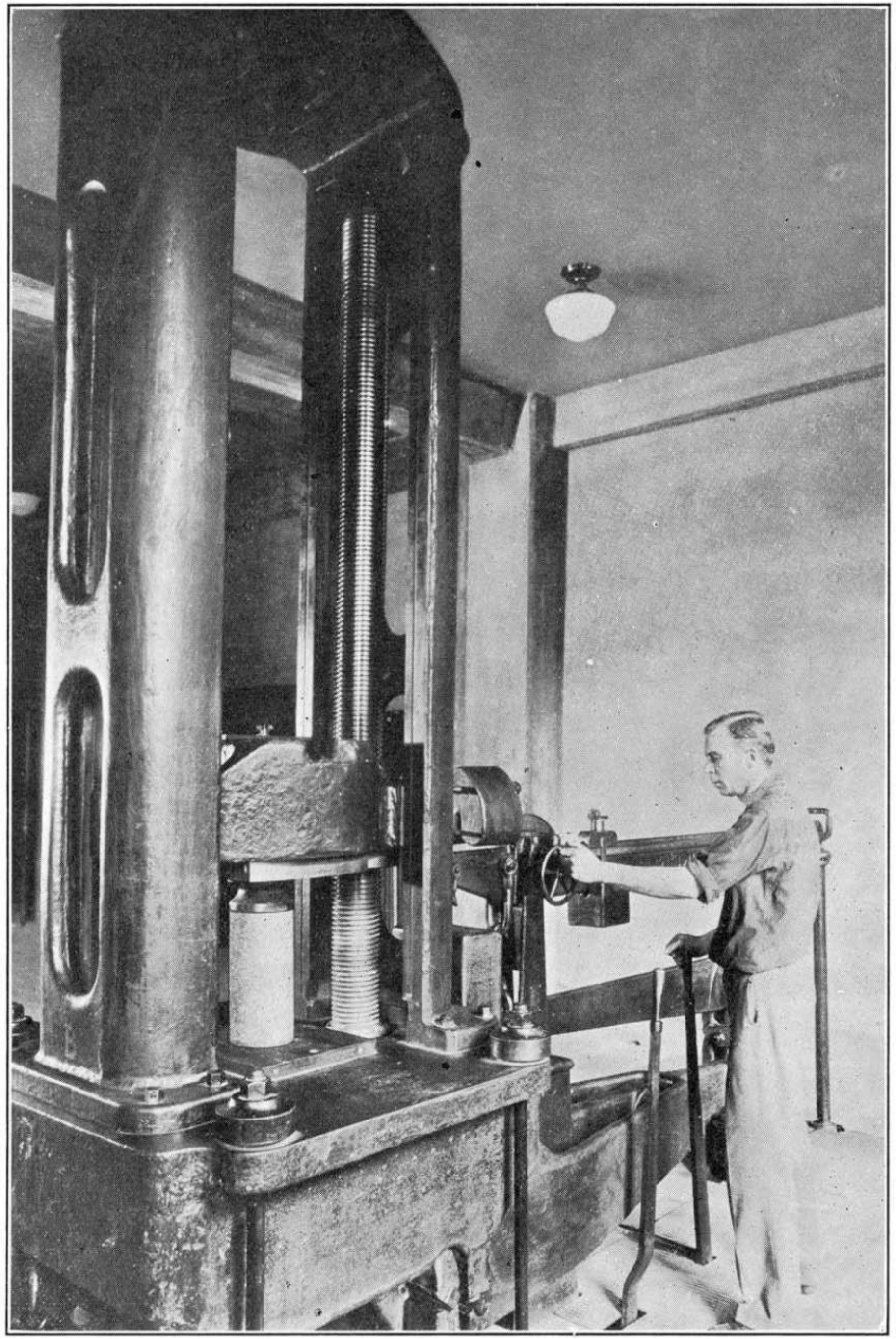
Workers Bagging Finished Cement

THE STOR

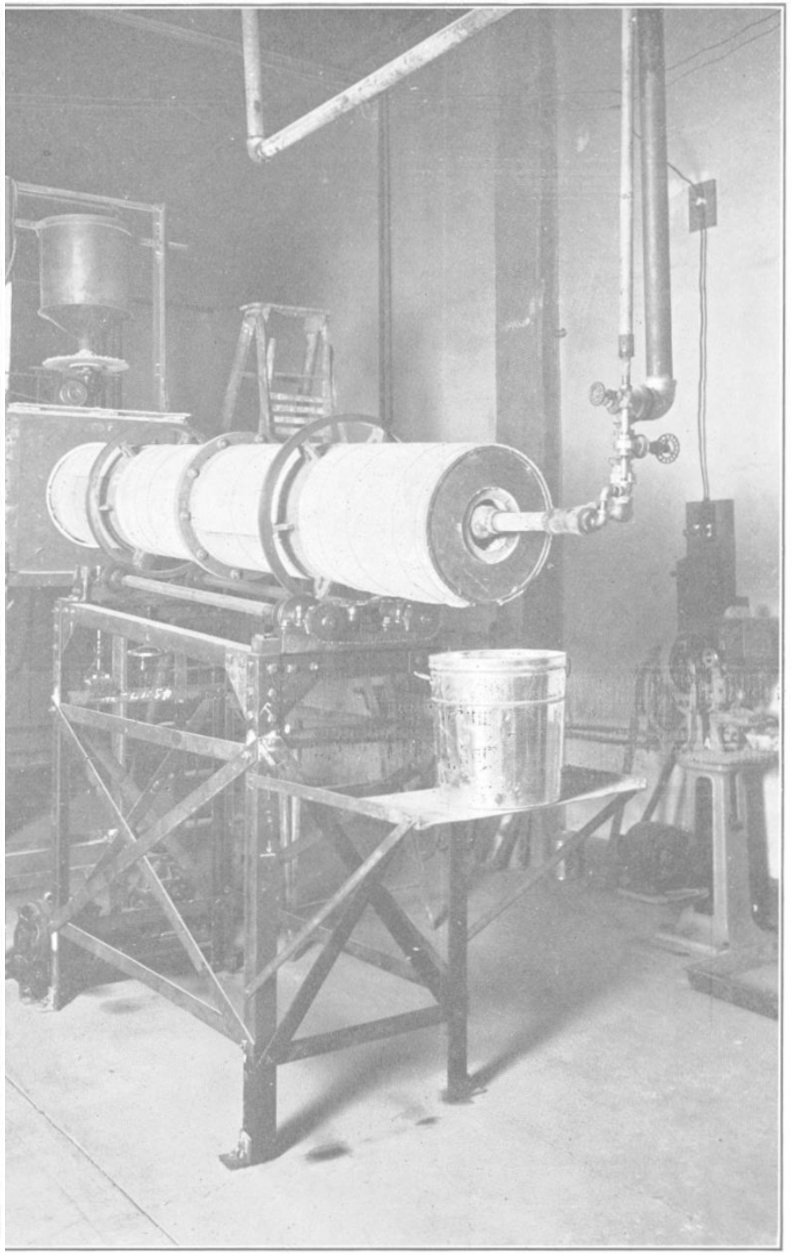
JOHN F. RYAN,

CONCRETE TEST CYLINDERS

Each cylinder is marked with a series numb reference number, age at which it is to be fra tured, and a "round" number. A "round" is complete set of cylinders to be broken at vario ages. A test consists of several "rounds" ea made on a separate day to insure average co ditions.

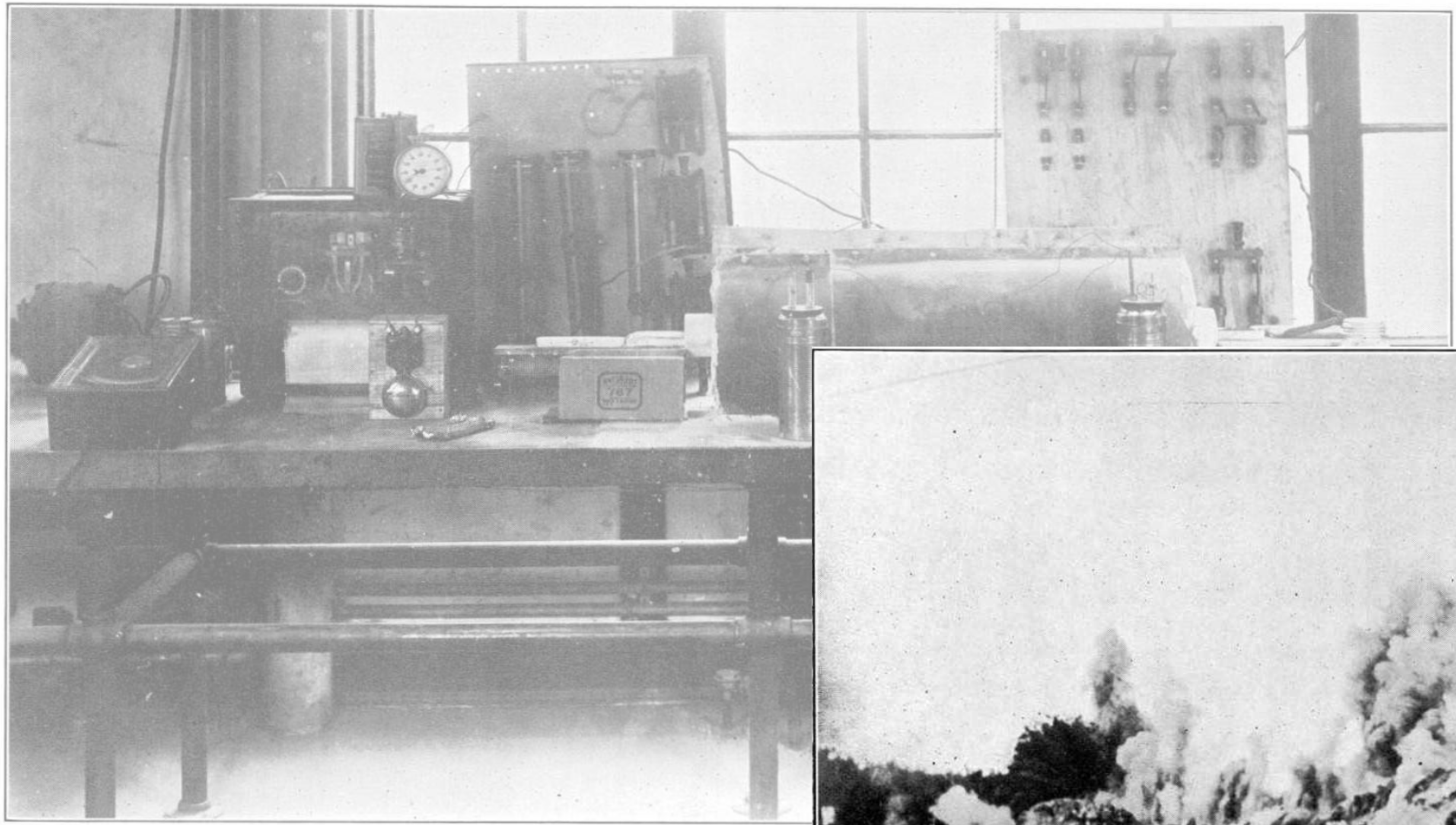


STRENGTH-TESTING MACHINE IN OPERATION

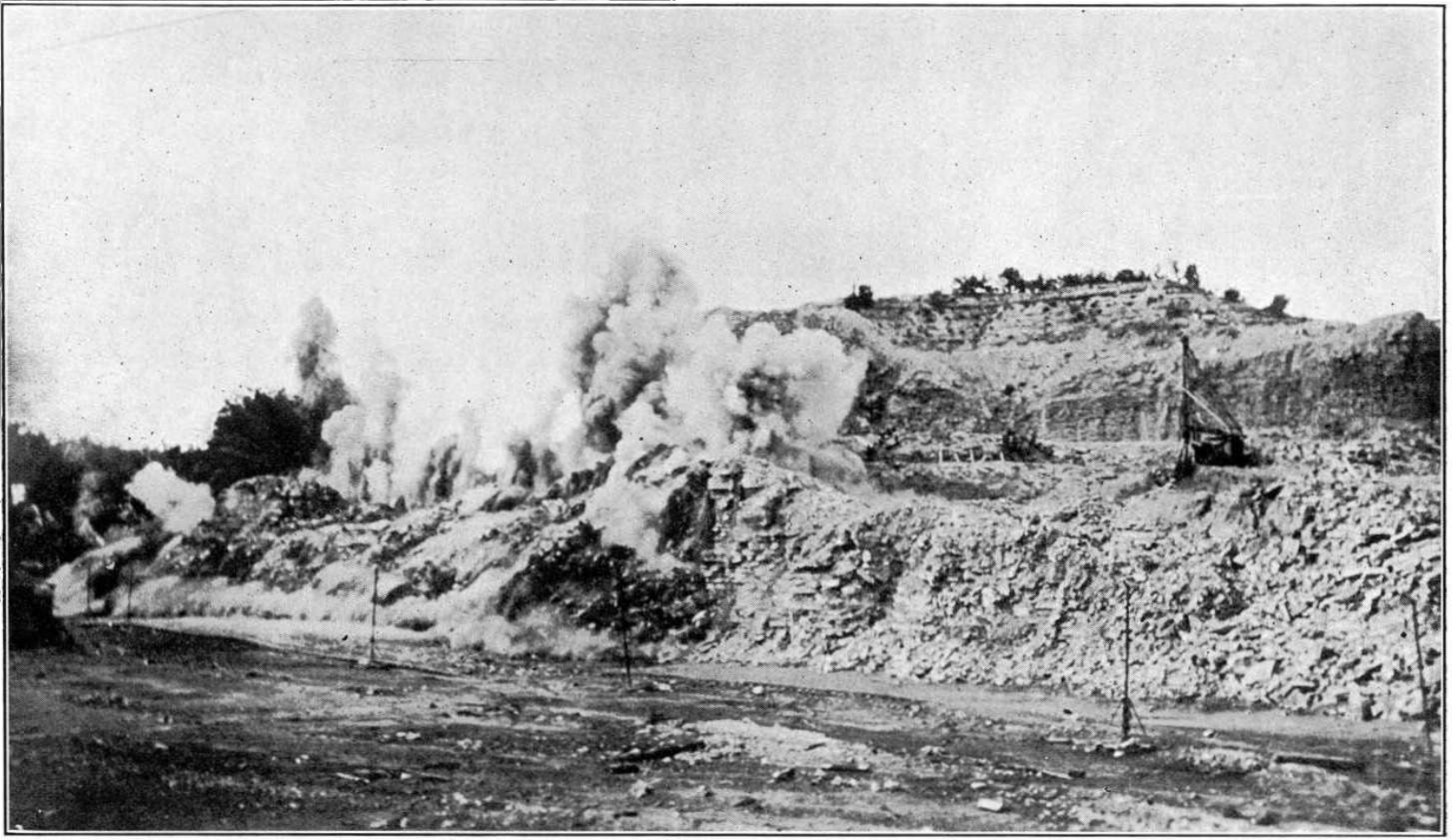


XPERIMENTAL ROTARY KILN, GAS FIRED, HAVING A CAPACITY OF ABOUT 10 POUNDS PER HOUR

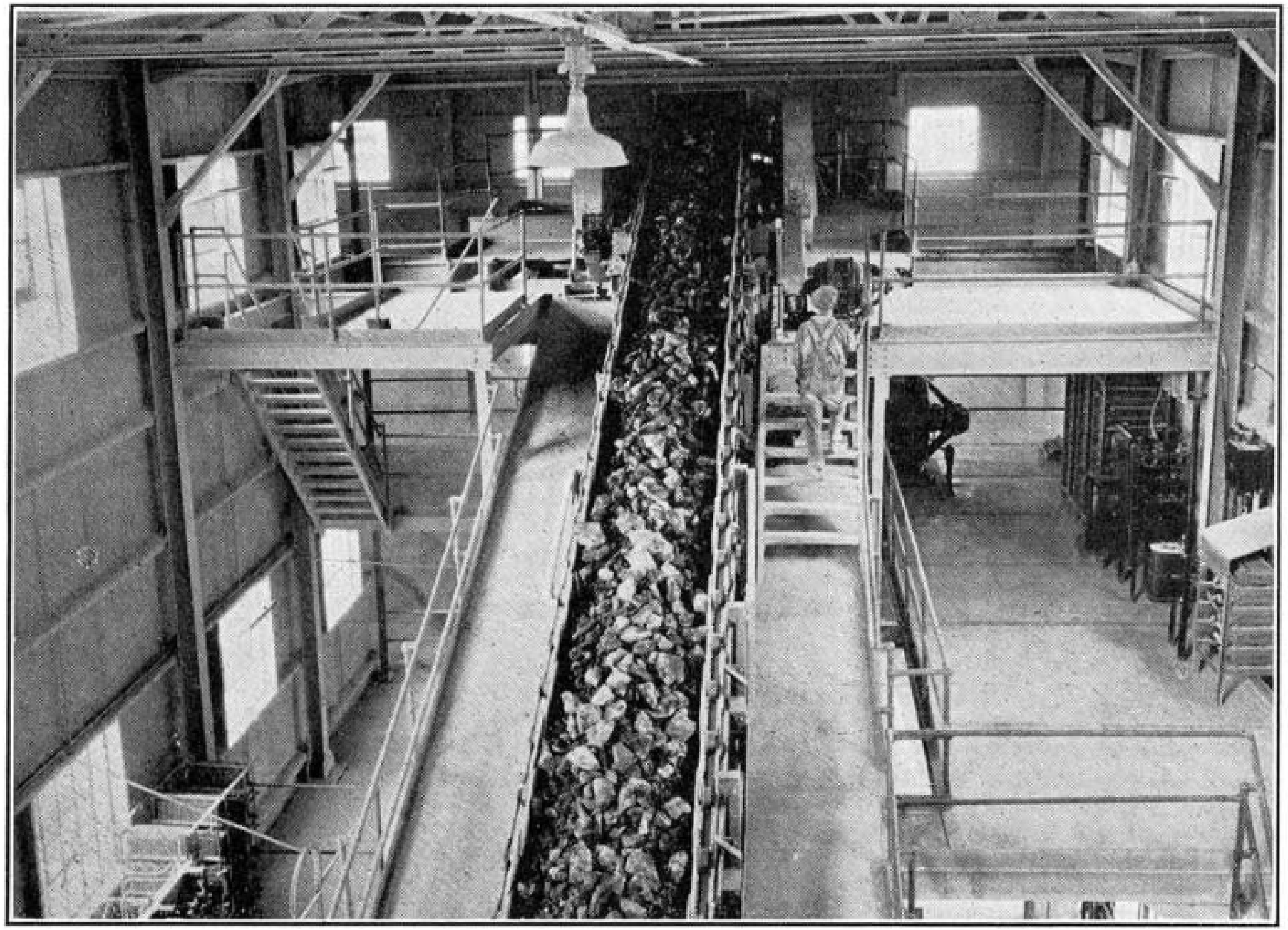
; furnace is part of the Portland Cement Association Fellowship's equipment Bureau of Standards. The compositions used in this kiln are determined vious experimental work. The capacity is adequate to permit the usual or cement properties on the products.



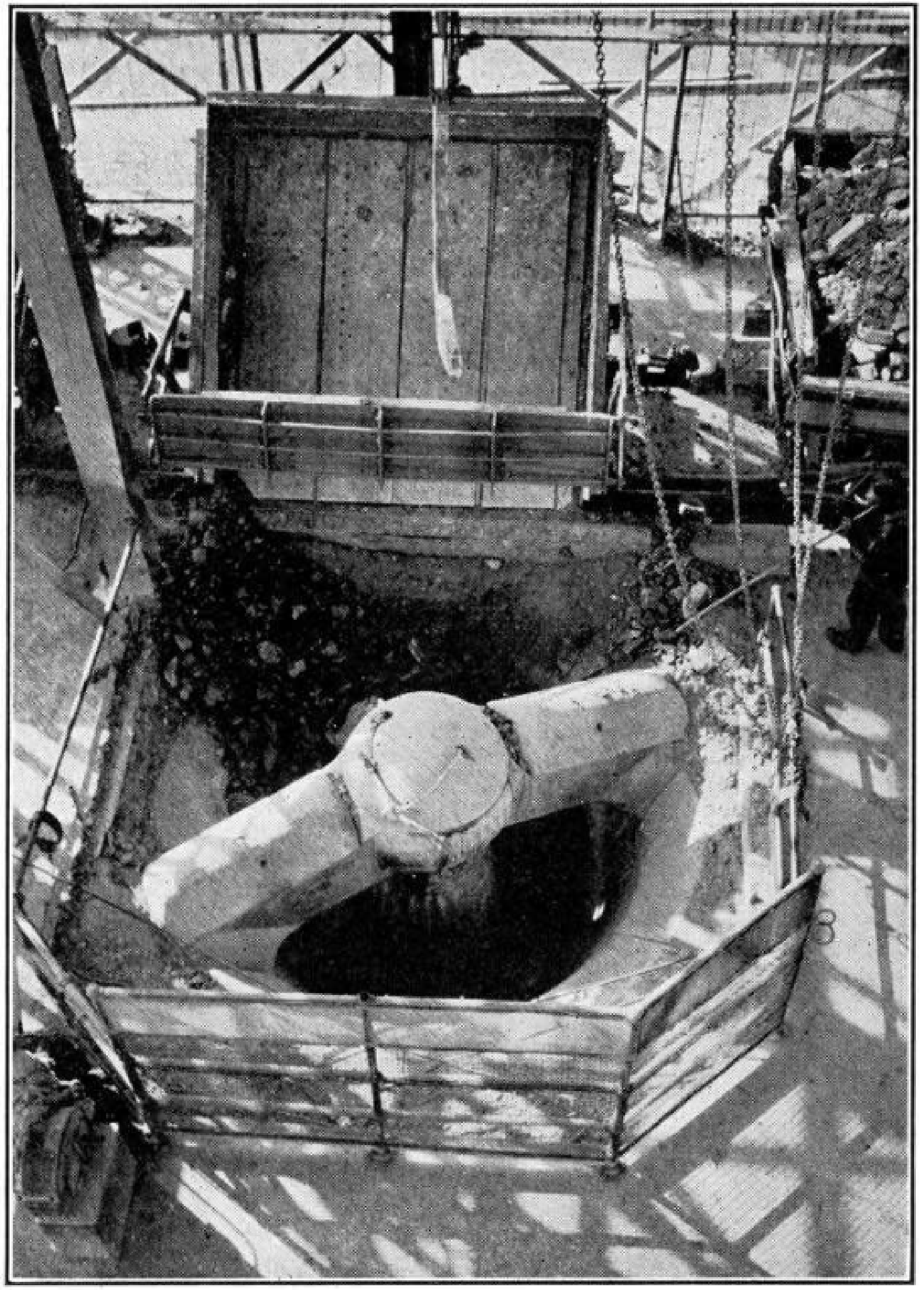
An Electric Furnace Used at the Bureau of Standards f
In this furnace mixtures of systematically varying compositions are bur
controllable to ± 10°. The capacity of this particular



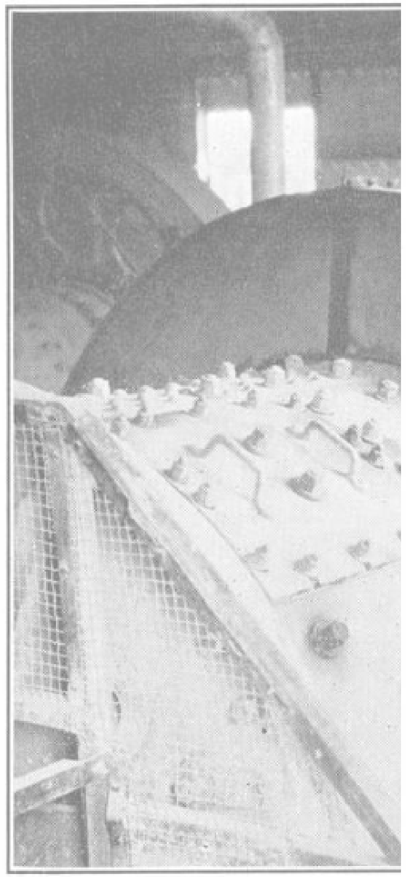
Taking a Mountain Down to Provide Raw Materials for Cement Manufacture



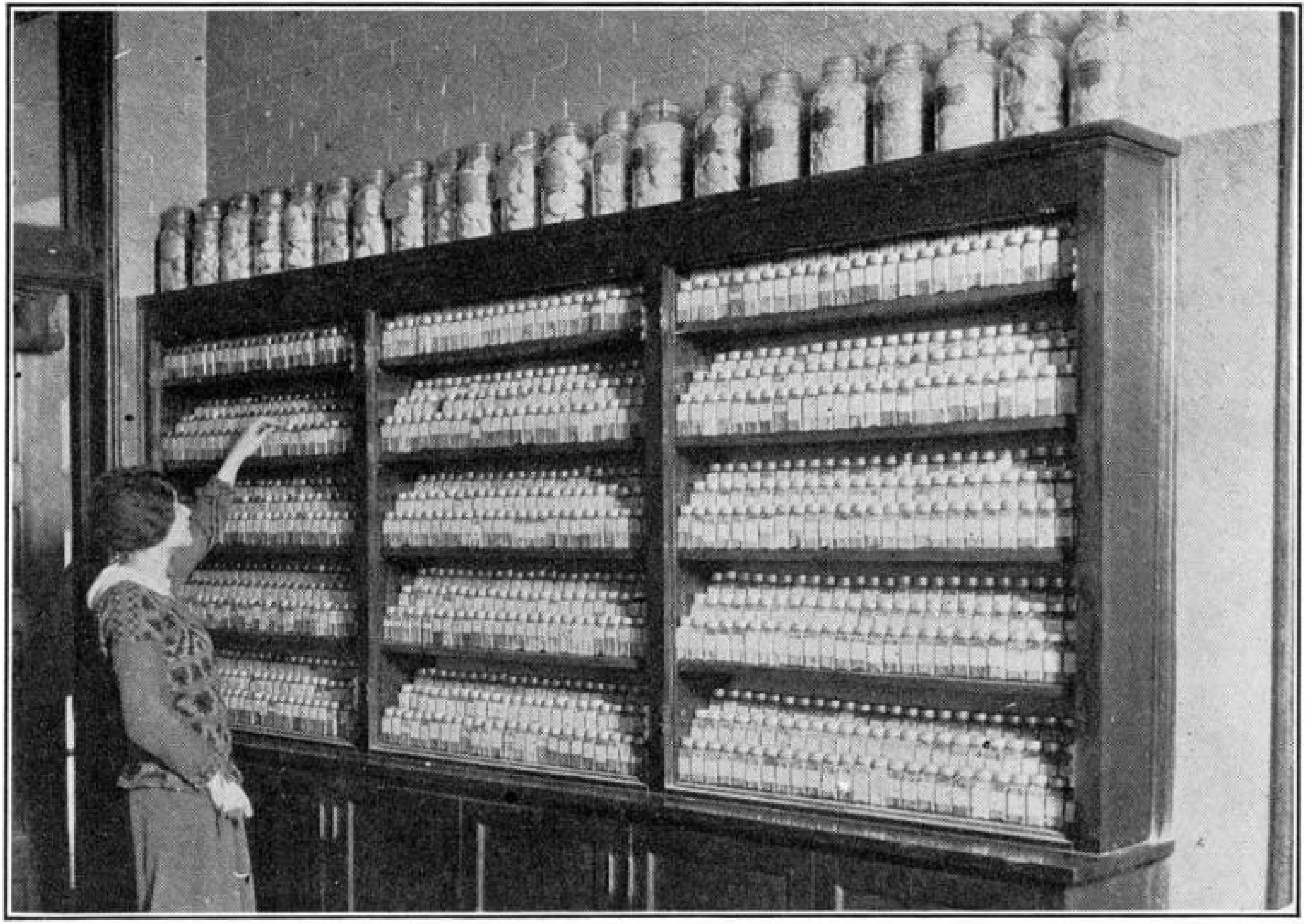
Conveying Raw Materials



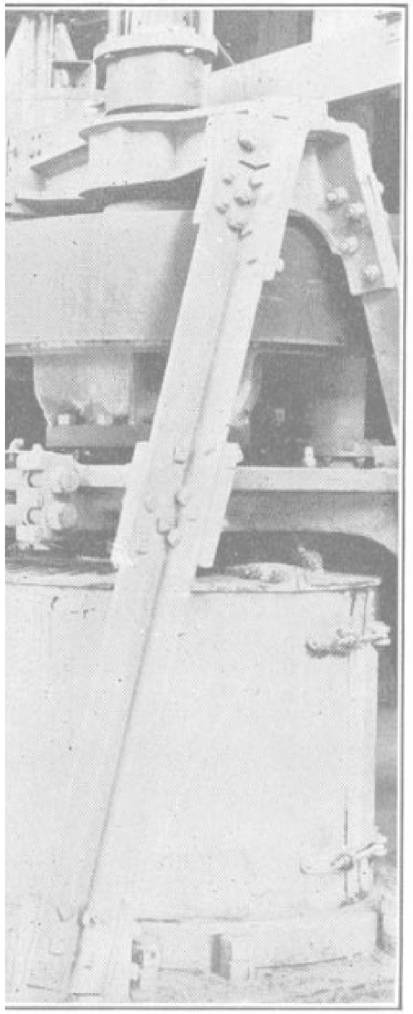
Gyratory Crusher at the Start of the Raw Material Pulverizing Process



DOUBLE CHAMBER



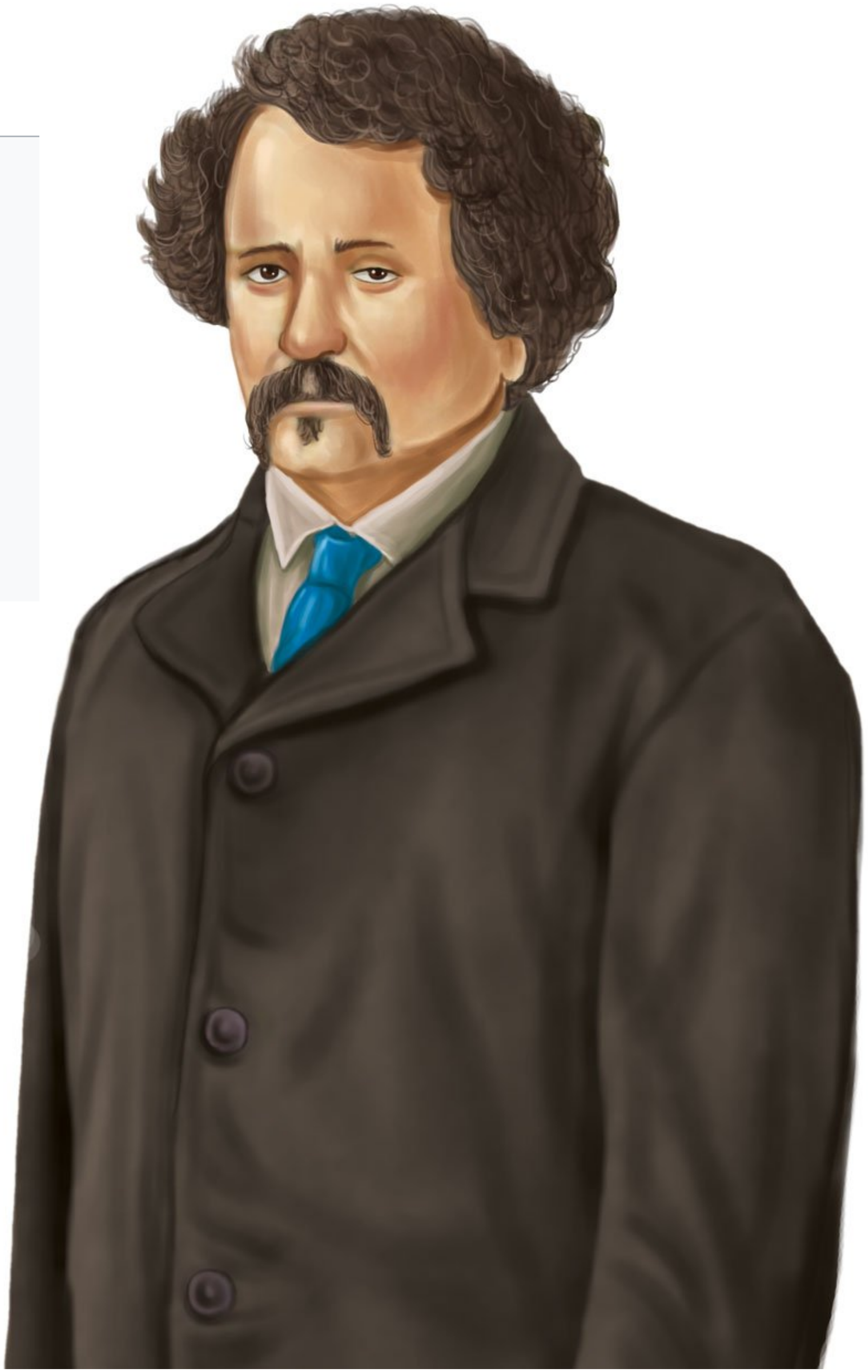
A PORTION OF THE LARGEST "SAND LIBRARY" IN THE WORLD, PORTLAND CEMENT ASSOCIATION, CHICAGO



MILLS

Joseph Aspdin

Born	25 December 1778 Leeds, England
Died	20 March 1855 (aged 76) Wakefield, England
Occupation(s)	Bricklayer, businessman, inventor, stonemason



Thank you