bottom of the quarry, which is usually about 100 feet. These holes are then charged with dynamite and exploded simultaneously, an electric detonator being used. The rock is so easily shattered that these great blasts break most of the rock sufficiently to be loaded into cars. The larger blocks are broken by small charges of dynamite placed in holes made by small compressed-air hand drills.

Steam shovels are used for loading the rock into cars. In the quarries that are driven into the hillsides on the level, small locomotives or mules are used to haul the cars to the mill. Where the quarry is sunk below the level of the mill the cars are pushed by hand or hauled by mules to the foot of the incline, where they are attached to a cable to be hauled up the slope. One company uses trucks to transport the stone from the quarry to the mill. The rock is dumped into a storage bin or directly into the gyratory crushers.

PORTLAND CEMENT MANUFACTURE

In general there is little variation in the methods employed throughout the region for the manufacture of portland cement, although somewhat different types of machinery are used. The different stages in a dry-process plant include (1) coarse grinding, (2) drying, (3) fine grinding, (4) calcining, (5) cooling or seasoning, (6) mixing with gypsum and grinding the clinker, and (7) seasoning in storage houses preparatory to bagging or packing in barrels. These processes have been described in many publications that deal with the technical side of cement manufacture.

The first kilns used in the district were upright. They consisted of three compartments, an upper heating chamber, a middle clinkering chamber, and a lower cooling chamber. The pulverized rock was mixed with water and molded into bricks, which were first dried and then carefully placed in the upper chamber by hand. The material passed in turn through the other chambers and was withdrawn at the base. These kilns were not satisfactory, for much of the material was not uniformly burned, the amount of labor required was excessive, and scarcely more than 100 barrels of cement could be burned in each kiln daily. On the other hand, the fuel consumption in the upright kilns, which ranged from 45 to 65 pounds of coal to the barrel of cement, was much less than that required in the rotary kilns.

From the mills the cement is taken to the storage bins, where it remains for some time to season and is then withdrawn for shipment. It is shipped in paper or cloth bags that hold 95 pounds. Originally much was shipped in barrels that held 380 pounds. The Bates valve bag is widely used in the district. One company ships the finished cement in bulk in tight covered freight cars.