of a hill and the tracks run into the quarry on the level so that as the quarry is extended a greater height of quarry face is obtained. In some places, however, it is necessary to open a quarry by excavating in a fairly level surface, and then the rock must be hauled up an incline to the surface.

In almost every quarry the variations in the rock in different parts make it advisable to have an extensive face and tracks radiating to different points in order to obtain a mixture of uniform composition by combining the rock high in lime with that low in lime.

Formerly the rock was quarried in benches by the use of small drills and small blasts. Now, however, the companies have found it more economical to blow down enormous masses of rock at one time, at some blasts more than 60,000 tons. To do this a series of churn drill holes is put down about ten to fifteen feet back from the quarry face and about the same distance apart and driven to the level of the bottom of the quarry, which is usually about 100 feet. These holes are then charged with dynamite and exploded simultaneously by an electric detonator. 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. In recent years trucks have been largely substituted for cars 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