well known natural cements are of a similar composition, and hence the opinion was formerly prevalent, and still continues to a certain extent that a large proportion of magnesia is essential in a natural cement, though in a Portland cement it is inadmissable. It can, however, be shown that magnesia in natural cement, merely takes the place of lime, and that if the 30 per cent. of magnesium carbonate, which is naturally present in Rosendale limestone were replaced by calcium carbonate, the burnt rock would possess equally good hydraulic properties; if, however, the silica and alumina of the clayey constituents were absent, the burnt rock would not possess hydraulic properties, but would be merely a magnesian lime.

No limestone is perfectly uniform in any considerable quantity, and, hence, natural cements cannot be perfectly uniform. Portland cements differ from natural cements partly in that the calcium carbonate and the clayey materials are more thoroughly mixed, partly in that the burning takes place at a higher temperature. The thorough mixing permits a more complete burning, because in natural cement, if semi-fusion takes place, there are apt to be enclosures of unburned calcium carbonate, but in Portland cement the mixture is so intimate that the carbon dioxide is expelled at the same time as the combination of the lime silica and alumina takes place, and there are no such enclosures.

One of the best definitions of Portland cement is the following: "Portland cement is an artificial product obtained by finely pulverizing the clinker produced by semi-fusion of an intimate mixture of finely ground calcareous and argillaceous material, this mixture consisting approximately of one part of silica and alumina to three parts of carbonate of lime, or an equivalent amount of lime." It will be noticed that emphasis is laid upon the **thorough** mixing of the calcareous matter, which may be in the form of ordinary limestone or chalk or marl, with the argillaceous or clayey material, which may be in the form of clay or shale or slate, and in order to thorough mixing it is necessary that the materials shall be finely ground. The different constituents are ground separately, then mixed in the proper proportions, and then properly burned to a semi-fused mass. The burning must be done in such a manner that the mass obtained will be as uniform as possible. The various processes are not to our purpose just now, suffice it to say, that the most satisfactory has proved to be in the rotating kiln, the fuel employed being coal dust carried into the kiln by a blast of air, which provides oxygen for the combustion. The clinker produced is harder and more vitreous than that of natural cement, and it needs to be ground more finely. From 90 to 95 per cent. must be capable of passing through a hundred mesh sieve.

A very important condition is introduced by the higher temperature at which the burning takes place. As has been stated, natural cements frequently contain large quantities of magnesia but in Portland cement the magnesia content must be kept low, more than 3 per cent. being decidedly injurious. The reason is that magnesium silicates and aluminates formed by burning at a lower temperature react with water, and set, whereas, the substances produced at a higher temperature do not. Calcium silicate and aluminate do not lose their hydraulic properties if formed at a high temperature, but have them rather increased, and a Portland cement, while it does not set so rapidly as natural cement, has greater strength.

A good Portland cement is a mixture of calcium silicate and aluminate. A small quantity of magnesia may be allowed, a small quantity of iron, a small quantity of alkali, but their presence is no advantage, and any considerable amount of these impurities is detrimental. A cement might be made from a pure calcium silicate of proper constitution, but such a cement could not be fused at a temperature possible under the circumstances, and the presence of alumina is practically necessary. The best proportions are that the weight of lime is equal to 2.8 times the silica, together with 1.1 times the alumina. The proportion of calcium silicate and calcium aluminate may vary within narrow limits, the composition of the cement being expressed by the formula $x(_3CaO, SiO_2) + y(2CaO, Al_2O_3)$. The equivalent of lime in the silicate is three times that of the silica, and the lime in the aluminate is twice that of the alumina, so the equivalent of lime in the cement will be between two and three, and the best proportion is said to be that shown by the ratio $\frac{CaO}{SiO_2 + Al_2O_3} = 2.75$. If iron is present, ferric oxide plays the part of aluminium oxide.

The method in which setting takes place is somewhat similar to that of plaster of Paris, though not nearly so simple. There seems to be some doubt as to the precise result, but hydration certainly takes place with the formation of crystals. It is said that under the microscope crystals of calcium hydroxide are seen to grow rapidly and the grains of cement appear to swell, forming a mass of amorphous particles.

Very probably the reaction is something like that represented by the equations:—

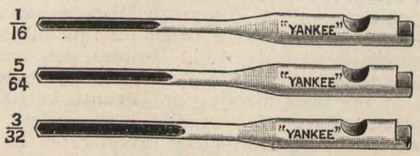
$$2Ca_3SiO_5, 9H_2O = 2CaSiO_3, 4Ca(OH)_2, 5H_2O.$$

$$Ca_2Al_2O_5, 2Ca(OH)_2, 10H_2O = Ca_4Al_2O_7, 12H_2O.$$

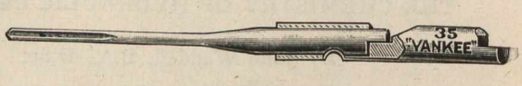
If reference be made to the proportion of calcium silicate and aluminate in cement it will be seen that if the reaction is exactly as above more lime would be produced by the decomposition of the silicate than would be used in the formation of the more basic aluminate. The lime, however, appears to be in an insoluble condition, since it does not give an alkaline reaction to phenolphthalein. The subject still requires investigation, though the general principles are pretty fully understood.

SPIRAL-RATCHET SCREWDRIVER.

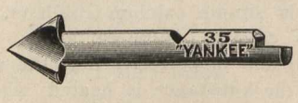
In view of the demand for a lightweight spiral-ratchet screwdriver, North Bros. Manufacturing Co., Philadelphia, Pa., have designed and are manufacturing the tool illustrated. It will be found of special value to



electricians, cabinetmakers, carpenters and mechanics having a large number of small screws to drive. It is small enough to be carried in the pocket, being only 7" long closed, and weighs, complete, less than 7



ozs. It has a double ratchet, and will drive screws in or pull them out, and is so arranged that it may be used as an ordinary screwdriver, either closed or extended. The convenient size and weight of this tool



should commend it to many. The length of the driver, with bit in chuck, is 9⅛", closed, and 12½" extended. Two screwdrivers, three drills and one countersink are furnished with the outfit.

Upon investigation by the chemist of an extensive railroad system regarding the best protection of structural work from rust, it was found that the value of the various paints used was directly dependent upon the size of the particles of pigment, that is to the fineness to which it had been ground. It is a common idea among paint users that grinding in oil is preferable to dry grinding. Experiment, however, showed that dry grinding, especially when combined with floating to remove large particles, was much more efficient than the same grinding done in oil.