at the bottom of the meniscus. This mark is etched into the glass by means of hydrofluoric acid applied with a camel's hair brush and allowed to remain ten or fifteen minutes. With this device and procedure one is enabled to mark flasks very rapidly with but little practice.

A MODIFIED BULB TUBE FOR NITROGEN APPARATUS.[1]

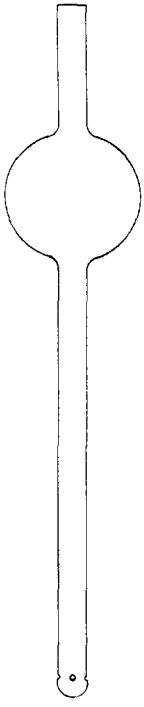


Fig. 2.

This bulb (Fig. 2) is of glass and consists of an upper stem 5 cm. long, a lower one 18 cm. long, and a bulb 5 by 5 cm. The bore of the stem is 7 mm. and thickness of walls about 1 mm. The free end of the lower stem is closed to a 2 mm. hole. Above this hole 6 or 7 mm., are arranged circularly around the tube four holes (diameter 2 mm.) equidistant apart. It is the experience in this laboratory that in using the plain open-end bulb tube with materials rich in nitrogen, such as sodium nitrate, cotton-seed meal, blood, etc., there is often loss of ammonia by non-absorption by the standard acid, as, at the beginning of the boiling, ammonia is copiously evolved and forced into the acid through one large orifice, hence coming in contact with only a small volume of the acid solution.

With this tube the ammonia is forced into the acid through five openings in as many different directions, thereby giving ample provision for complete absorption. It has now been in constant use for over fourteen months with perfect satisfaction, even in high-grade ammoniated materials. When distillation is complete, the tube is disconnected from the nitrogen apparatus and is used to stir the solution in titration.

[CONTRIBUTION FROM THE CHEMICAL LABORATORY, UNIVERSITY OF MICHIGAN.]

A ROTARY CEMENT KILN FOR USE IN THE LABORATORY.

BY E. D. CAMPBELL.

Received January 6, 1902.

IN the researches on the constitution of hydraulic cements which were begun in this laboratory about three years ago, the cements under examination were prepared in small crucible

[1] Read before the North Carolina Section of the American Chemical Society, on November 23, 1901.

furnaces, heated with gasoline. The material being burned, was formed into round or oval disks, and gradually raised during a period of three or four hours to the desired temperature, this latter being determined by means of three LeChatelier thermocouples passed through the walls of the furnace, and brought close to the material under treatment. This method of burning produces a clinker similar in appearance and properties to that burned in large fixed kilns. As the investigations progressed it soon became evident that time as well as temperature and chemical composition of the mixture was an important factor in determining the constitution of the resulting clinker. If then reliable knowledge regarding the constitution of cements produced by a modern rotary process was to be obtained, it became necessary to devise a small rotary, in which cement could be produced and in which the temperature and the time during which the material was heated, were under control. The small rotary which has been in use during the past year in this laboratory, has given such satisfactory results, that we have thought a description of the same would not be without interest to those engaged in studying the physics and chemistry of hydraulic cements.

The rotary proper consists of a piece of 8-inch (20 cm.) steam pipe 32 inches (81 cm.) long, provided with a collar and two shallow grooves turned to run on friction wheels attached to a cast-iron base having four long set screws for legs, by means of which the pitch of the rotary may be regulated. The rotary has attached to it the rim of a large 30-tooth sprocket wheel. The lining of the rotary was made of four sections of hard burned magnesite tubes. The tubes, two of which are shown at A in the cut, are 3 inches (7.5 cm.) inside and 6 inches (15 cm.) outside diameter, and 8.5 inches (21 cm.) long, and so shaped that when placed end to end they form a smooth joint inside and out. These tubes were molded under hydraulic pressure in special dies made for this work. The molding and burning was done by Harbison and Walker, of Pittsburg, Pa., who used the same material as they employ in the manufacture of magnesite bricks. In lining the rotary the magnesite tubes were supported concentric with the steel jacket and the annular space between the tubes and the jacket was filled with asbestos. At the ends of the magnesite tube S for a distance of about 2 inches, the asbestos was mixed with raw and burned fire-clay and sodium silicate, the

mixture and asbestos being firmly tamped to prevent any displacement of the magnesite tubes during rotation.

The tube is turned by means of a 1/7 H. P. electric motor, B, the speed being reduced by means of the pulley and worm gear C. The worm gear is connected by means of a sprocket chain to the sprocket wheel on the rotary, the gearing being so planned that the tube requires about one minute and twenty-five seconds to make a single revolution.

The heating of the tube is done by means of a Hoskins hydrocarbon burner supplied with low-boiling gasoline from a tank situated some distance from the furnace. A working pressure of from 50 to 60 pounds per square inch in the gasoline tank gives the most satisfactory results.

The temperature of the tube is controlled by means of a Le-Chatelier thermocouple, D, connected to the reflecting galvanometer E. In order to protect the wires of the thermocouple they are passed through a double-bored porcelain tube 7 mm. in diameter, which tube is covered for a distance of about 8 inches with platinum foil. It was found necessary to protect the porcelain tube in this way with platinum in order to avoid the slagging of the porcelain through contact with the basic clinker. The cold junction of the couple is maintained at 0° C. by immersion in a small beaker which is kept filled with ice during an experiment. This small beaker is contained in the larger beaker F, from which it is insulated by means of a thick felt packing.

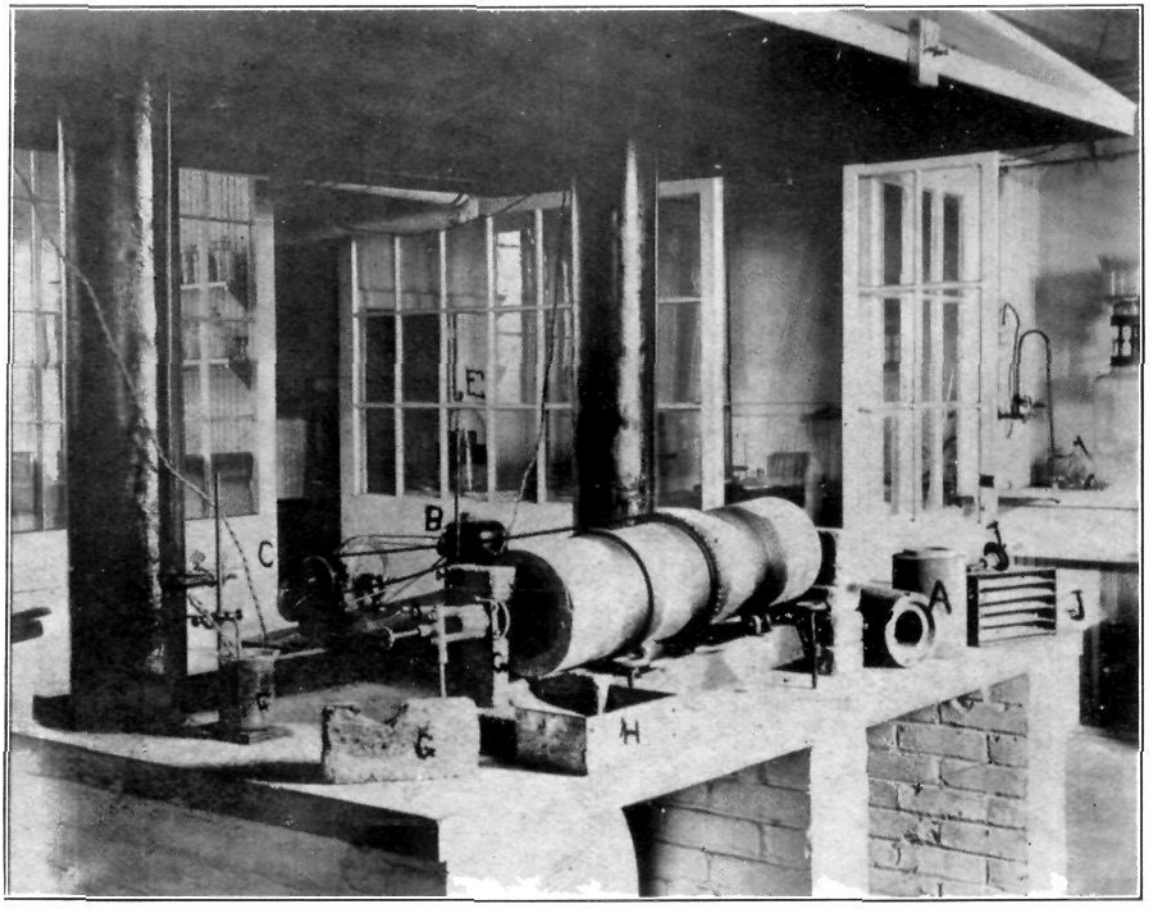
A number of experiments were made to determine the temperature of the inside of the furnace at different points. This was done by constructing a special thermocouple insulated in double-bored porcelain tubes long enough to reach the entire length of the furnace when inserted at the cooler or feed end. A series of experiments demonstrated that the temperature attained its maximum at a zone about 6 inches (15 cm.) from the hot or discharge end. From the hot zone the temperature falls off regularly to the cool or feed end. The fixed couple D projects about 3.5 inches (8.7 cm.) into the hot end of the furnace. At this point the temperature averages about 40° C. lower than at the hot zone, but on account of the intense heat at this latter point and the length of the porcelain tube required to reach it, it was found impracticable to keep the couple at this point, as the tubes would invariably sag and break after a comparatively short ex-

posure. The same difficulty of sagging and breaking of porcelain tubes was experienced to a much greater degree during the measurements of temperature along the axis of the furnace, so that after the general distribution of heat was determined in a number of cases, it was not deemed necessary to use anything but the short fixed couple to control the temperature. The temperatures found at one series of measurements were as follows: At the fixed couple 1460° C. (2660° F.); 6 inches (15 cm.) from the hot end 1500° C. (2732° F.); 8 inches (20 cm.) from hot end, end of section 1, 1487° C. (2709° F.); 12¼ inches (31 cm.) from hot end, middle of section 2, 1414° C. (2577° F.); middle of furnace, end of section 2, 1392° C. (2538° F.); middle of section 3, 1335° C. (2435° F.); end of section 3, 1286° C. (2347° F.); temperature of escaping gas at feed end of furnace, 1200° C. (2192° F.). While the above figures show the distribution of heat within the furnace, they do not show the maximum temperatures attainable. The temperature of the hottest section (section 1) of the furnace has been raised 130° C. higher than the above figures, or to nearly 1630° C. (2966° F.) at the hot zone. This is enough to give perfectly sound clinker from the most refractory materials and is too high for most mixtures.

In making an experimental burning the furnace is lighted and the galvanometer observed until the deflection shows that the desired temperature has been reached, the time required to bring the furnace to the working temperature being usually from forty-five minutes to one hour from the time of lighting. When the furnace has attained the desired heat, feeding of the prepared slurry is begun. When the furnace is working, the discharged end is closed by means of the bricks G suitably cut to admit the flame into the furnace and the clinker to drop into the asbestos-lined box H placed to receive it. The feed end of the furnace is partially closed by a brick with a shallow trough cut into it, serving to guide the prepared slurry into the furnace and a small pile of slurry is maintained at the feed end of the furnace, being replenished as fast as the material works down through the tube. With one revolution in one minute and twenty-five seconds, and a 6 per cent. pitch to the tube, the time of passage is from twenty-five to thirty minutes. During the first hour of feeding from 1,500 to 1,700 grams of prepared slurry can be fed, and after the

first hour from 1,000 to 1,200 grams per hour. This yields from 600 to 700 grams of clinker per hour from the time when the first pieces of clinker appear to the time feeding is stopped. The last material fed does not come through the furnace in less than forty-five minutes on account of there being nothing back of it to push it forward. When the first clinker has made its appearance, it may be examined, and if it seems overburned or underburned, the temperature can easily be lowered or raised, until the clinker has the desired appearance. When once the clinker shows the desired appearance the temperature can be maintained so as not to vary more than 10° during the entire run. This uniformity of temperature produces a corresponding uniformity in the resulting clinker, thus enabling the influence of temperature upon the resulting clinker to be easily studied.

In preparing the slurry for burning, the method employed will depend upon whether the conditions to be studied are those found in the "wet" or "dry" process. If it is desired to imitate the conditions found in the wet process, the marl or limestone used is dried and ground to practically all pass through a 100-mesh sieve, and the clay or shale is also dried or ground, if necessary. After the necessary analyses have been made, weighed portions of the clay or shale with the marl or limestone are thoroughly mixed with sufficient water to give a liquid slurry containing from 40 to 50 per cent. of water. This liquid slurry is evaporated down with frequent stirring until it has the proper consistency to work well. After evaporating and cooling, the slurry is thoroughly worked up and rolled out by means of an ordinary rolling-pin on rectangular pieces of galvanized iron, which can be placed in a drying rack, J. After rolling out to a thickness of 1/4 to 3/8 inch on these shelves, the slurry is cut by means of the thin cutting wheel, I, passed longitudinally and transversely so as to produce small cubes of approximately the same size, and when all the material has been rolled out and cut in this way, the shelves are put into the drying racks J, and thoroughly dried. After drying, the slurry is easily removed from the shelves, and the cubes separated by hand. The time required for rolling out and cutting about 4,500 grams need not exceed thirty minutes. About 4,500 grams of dried material are usually used, as this will yield from 2,500 to 2,800 grams of perfectly uniform clinker, the loss being very small during the work.


E
B
C
A
J
G
H

When the conditions of the dry process are under examination, the dried materials, clay or shale with marl or limestone, are mixed and well ground together in a laboratory jar mill. The mill at present in use, which has given very satisfactory results in grinding both raw material and clinker, was furnished by the Bonnot Co., of Canton, Ohio. After mixing and grinding dry, the material is moistened with just enough water to enable it to be rolled out and cut up like that used for the wet process.

ANN ARBOR, MICH.
December 16, 1901.

THE ALLOYS OF ALUMINUM.[1]

BY WILLIAM CAMPBELL AND JOHN A. MATHEWS.

Received December 7, 1901.

THE fact that aluminum can now be classed as one of the common metals, since it can be obtained at a moderate price, and of certainly as great purity as other commercial metals, has of late years made it the subject of many researches. Its alloys with nearly all the commoner metals have been made or attempted, but their adaptability to commercial uses has rested solely upon the ordinary tests and many statements of a very unscientific nature have been published about them.

While working in Professor Sir William Roberts-Austen's laboratory, at the Royal College of Science, the authors were engaged in examining anew some of these alloys in the light of recent advancement in those methods of alloy research which Professor Roberts-Austen has done so much to promote. Through the interest in our work which he exhibited and by means of the facilities which he provided us for carrying on metallographic and pyrometric observations we now have the honor to present the following results,—not as a completed investigation, but as the beginning of one which has, of necessity, been transferred from one laboratory to another. We expect to continue work upon some of these lines in the metallurgical laboratory of Columbia University. It has been thought best, therefore, to present the results already obtained by us in the laboratories at South Kensington in the following paper.

Professor Richards, whose researches upon the industrial applications of aluminum are so well known and which entitle him to be considered as the foremost authority upon the metallurgy of

[1] Read before the New York Section of the American Chemical Society, November 1, 1901.