FINENESS OF CEMENT DETERMINED BY AN AIR ANALYZER.

THE fineness of cement is one of its most important and at the same time one of its most indefinite characteristics. Its importance is recognized in the tendency toward higher fineness requirements in cement specifications and in the general belief that the finer a cement is ground the greater its cementing value. Its indefiniteness is due to the almost universal method of determining fineness by means of the No. 100 and No. 200 sieves. The inadequacy of these sieves is evident when one considers that at least 75 per cent. of the total cement is required to pass the No. 200 sieve. It is also well known that a considerable portion of the cement passing the No. 200 sieve is comparatively inert because the larger particles in this portion are still too coarse to be readily acted upon by water.

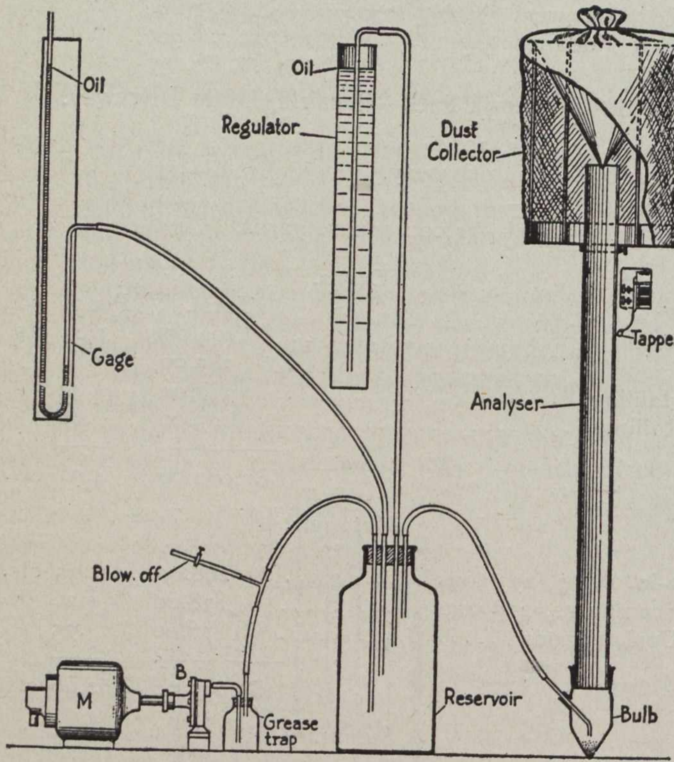

Fig. 1.—Bureau of Standards Air Analyzer and Auxiliary Apparatus.

What is needed is some means of determining the amount of hydraulically active material in cement. At the present time, however, we do not know what size of particles should be regarded as the upper limit of active material, and thus the logical mode of procedure would seem to be first to develop some method of separating still further the "fines" from the No. 200 sieve, and then to establish a dividing line between inert and active particles.

The terms flour and impalpable powder are frequently used to designate the hydraulically active material. It is believed preferable to limit these terms to that very fine portion of cement beyond the finest perceptible grit, which probably does not constitute all of the hydraulically active material.

In order to find some better means for the mechanical analysis of that portion of cement passing through the No. 200 sieve, Messrs. J. C. Pearson and W. H. Sligh, of the United States Bureau of Standards, went into the subject with great care and detail, spending over two years in their researches. Their experience in the design of a suitable device, as outlined in Technologic Paper No. 48 of the Bureau, leads to the conclusions that:—

1. The apparatus should insure as far as possible a constant velocity and uniform stream lines in the fluid as it passes through the separating chamber.

2. The fluid should not be appreciably retarded by the resistence of the material under examination or by constrictions or obstructions in that part of the apparatus beyond the separating chamber unless the amount of such retardation can be determined by pressure gauges or compensated by special devices.

3. All particles of the material should be completely and continuously exposed to the action of the fluid, so that any which are capable of passing through the separating chamber may have every opportunity to do so.

4. The separating chamber should have no places of lodgment for material.

5. The apparatus should be capable of separating fair-sized samples, preferably 25 g. or more. Thus, representative samples are more nearly insured and the percentage error in the separations is reduced.

More difficult than the mere design and construction of a satisfactory elutriator is its calibration or standardization. The mechanical analysis involves separations in terms not only of percentages, but also of sizes, and the determination of the size of very small and irregularly-shaped particles can be most readily accomplished by averaging microscopic measurements on a large number. Herein lies the one great obstacle to the furtherance of elutriation methods, for if the fineness curves of different cements are to be at all comparable, the sizes of separation must be determined with considerable accuracy. It is not sufficient simply to state that the average diameter of a lot of particles which lie on the dividing line between two fractions is so many thousandths of an inch, or so many hundredths of a millimeter, but it is necessary to define what is meant by the diameter of an irregular particle, and to state explicitly how the diameters are measured. For example, if the diameters of a number of particles as seen in the microscope are measured in one direction without regard to their orientation (which is, perhaps, the easiest and most direct method) the average diameter so determined will be very approximately the mean of the average length and breadth of the particles as seen in the microscope. This average diameter, however, is greater than the cube root of the product of the average length, breadth, and thickness of the particles, which is generally taken to be the true mean diameter and the true index of "size" in the sense of volume. But the measurement of three diameters of microscopic particles is exceedingly laborious, and the most one can expect for practical purposes is to establish some reduction factor which will give the true mean diameter when applied to the simpler measurements.

Still another condition enters which magnifies the differences in these systems of measurement: The separation of powders by flotation methods obviously depends on the "floating power" of the particles, a property which presumably bears as close a relation to shape and surface condition of the particles as to their actual size and weight, and we may, therefore, anticipate a greater range in diameters of particles so separated than, for example, in uniform sieve separations.

Descriptions of existing apparatus are given by the authors. These relate to Goreham's flourometer, the