In the case where a mechanical shaker is not available, as in field work, hand shaking when carefully executed will give results commensurate with a mechanical shaker. Experience indicates that when using the portions of sand indicated above, hand shaking for about 200 double horizontal shakes will give a satisfactory separation.

The accuracy of the weighing depends upon the precision of the balance used. Weights should be taken to 0.1 gram, with the understanding that the weights may be slightly in error when the total weight is greater than 100 frame.

The interpretation of a mechanical analysis depends primarily upon two features, the size of separation as determined for each sieve and the method of plotting and recording results.

At least two methods are available to determine directly the separation of a sieve, either to measure the three principal diameters of representative sand grains and to compute their average diameter or to count and weigh the grains and to compute the volume of the average particle obtained by dividing the weight of the average grain by its specific gravity. There is thus obtained the mean volume of the average grain which is considered to be a sphere and its diameter computed and taken as the separation of the sieve. The former procedure is recommended as giving the best results for large gravel; also for the extremely small grains of sand such as will pass a sieve of 200 meshes to the inch. A pair of calipers may be used to measure the diameters of the larger particles and a microscope to measure the smaller particles. The second procedure is the one commonly used for sieves ranging from 4 to 140 meshes per inch and requires the accurate separation of the sample, the counting and weighing of the grains and the determination of the specific gravity of the grains. It will be observed that the rating of a nest of sieves in this manner is at best a tedious and difficult procedure.

Whatever the method used in determining the sizes of the grains the securing of an accurate sample is of first importance. The procedure is as follows: a sample of sand is put through the sieve in exactly the same manner as in making a mechanical analysis. Each sieve is then shaken a little by hand and the last particles going through are shaken over the next finer sieve. The last material remaining on the next finer sieve is considered the separation of the sieve.

Experience indicates that the results of the determinations of the sizes of separation are dependent almost entirely upon the selection of proper samples, because two determinations of the separation of a sieve using portions of the same sample should give the same results to the required accuracy when reasonable care is used. Owing to characteristic variation in the sizes and shapes of the grains it is desirable to use several kinds of sand from different locations or sources in order to determine the average separation. Where sieves are required largely for the mechanical analysis of a particular sand the procedure may properly be limited to determinations of the sizes of separation with this material only.

A comparative method of rating sieves also suggests itself in the event that there is available a nest of sieves already rated. A representative sample of sand may then be analyzed in the usual manner by the rated sieves and again may be separated into weighed portions by the unknown sieves. By plotting the percentages of the total weight on the curve of the analysis as determined by the first set sieves, the separations of the unknown sieves may be read directly. The comparative method has obvious advantages and in general is one of the methods now used by the Bureau of Standards to test 100 and 200 mesh cement sieves.

Because the method of rating a nest of sieves by counting and weighing the grains is a very tedious and expensive procedure, investigations have been made from time to time to determine whether or not there is any definite relation or relations between the width of opening of a screen and the size of separation. In view of the fact that in the past screens have been made with little if any attention to definite specifications or tolerances of mesh and diameters of wire, it is not surprising that these investigations were not satisfactory and did not indicate whether or not such a relation exists. Part of the difficulty undoubtedly was attributable to the personal factor and also to the use of grains of sand of different degrees of sharpness.

In Table 2 are shown the openings of the standard screens and the probable sizes of separation that may be obtained with sieves built under the accompanying specifications, especially in regard to tolerances of mesh and

Table II.—Relation Between Sizes of Opening and Sizes of Separation of Sieves.

Sieve Opening, mm.	Mesh. inches.	Ratio wire Diameter to Opening.	Ratio Size of Separation to Opening.	Corresp'd'g Size of Separation. mm.
8.00	2.54	0.25	1.09	8.72
5.66	3.56	0.26	1.09	6.17
4.00	5.1	0.25	1.09	4.36
2.83	7.0	0.29	1.09	3.08
2.00	9.9	0.28	1.09	2.18
1.41	12.7	0.42	1.10	1.55
1.00	17.8	0.43	1.10	1.10
0.71	22.9	0.56	1.10	0.78
0.50	30.5	0.66	1.10	0.55
0.36	40.6	0.72	1.11	0.40
0.25	58.4	0.74	1.11	0.28
0.17	78.7	0.88	1.11	0.19
0.125	119.4	0.71	1.11	0.14
0.088	170.2	0.69	1.11	0.10
0.062	248.9	0.65	1.20*	0.07

*Ratio assumed for twilled cloth. For plain woven cloth ratio is 1.11 and separation is 0.068 mm.

diameter of wire. Experience indicates that many sieves used for the mechanical analyses of sand would not come within these specifications especially because the spacing of the wires in one direction is not correct and within these specifications. Moreover, it is not uncommon to find the wires used in the cloth to be of larger diameter and unsatisfactory on this account.

The committee is not in accord as to the value of factors to be applied to determine the separation of a sieve with relation to its average width of opening. It is obvious, however, that the use of the accompanying specifications should result in a material improvement in the manufacture of testing screens; also that the use of such factors would be of great assistance in many cases in determining the relation between analyses made by different investigators and expressed by either one of the two standards of measurement. Moreover, it is apparent that the use of the standard screens in specifications of material required has obvious advantages as compared with the use of such terms as will define the sizes of the particles, or of selected arbitrary percentages by weight of the particles.

Furthermore, the committee is not in accord as to the standard of measurement which can best be adopted for rating sieves required for the mechanical analysis of sand. It is, of course, true that the principal use of such analyses, so far as this Association is concerned, is for the determination of the characteristics of sand required or used for filtration purposes. Moreover, up to the pre-