weighing 300g. (10.6 oz.), the base being cut at right angle with the axis. A conical ring of hard rubber, 4 c.m. (1.57-inch) high and 7 c.m. (2.75-inch) middle diameter, placed on a plate-glass, is filled with Portland cement paste (about 300g.) having the above described consistency, and is put under the needle. The moment when the normal needle can no more go through the paste is considered as the initial set. The time which elapses till the needle does not leave any distinct mark on the pat, is the time of setting.

The setting of Portland cement is influenced by the temperature of the air, and that of the water used for mixing, the setting being quicker at a high temperature and slower at a low one; therefore it is necessary, in order to obtain uniform results, to make the tests with cement and water at 15-18° C., the temperature of the air, also that of the apparatus and sand being the same.

The general belief that Portland cement loses some of its strength by long storage is erroneous, as long as the cement is kept in a dry place free from draught. The specifications calling for fresh cement should, therefore, be dropped.

IV.—**Constancy of Volume:**—Portland cement must be of constant volume. The normal test consists in checking that a pure cement pat placed on a plate-glass where it is kept moist, and after 24 hours immersed in water, shall not show, later on, any distortion or cracking of the edges.

Comment:—For this test, the pat made for the verification of the time of setting is immersed in water, 24 hours after adding water for mixing when cement is slow-setting, or in any case after the final set. For quick-setting cement, this length of time may be shortened. The pats, especially for slow-setting cement, must be kept moist after the initial set, to store them in a covered box being the best way to keep them so. This precaution shall avoid cracks due to quick drying. Such cracks generally appear in the centre of the pat, and may be confounded with cracks due to swelling by untrained testers.

When hardening under water, if the pat shows distortion and checking, it is a certain proof of unsoundness of cement, i.e., owing to an increase of volume the cement cracks and the initial cohesive strength already gained is destroyed, the total disintegration of cement being even liable to follow.

The above indicated proofs of unsoundness appear on the pat usually after 3 days; in any case, a test of 28 days is conclusive.

V.—**Fineness:**—Portland cement must be so fine that it leaves on a sieve of 900 meshes to the square centimetre, not more than 5 per cent. of the sieved cement. The width of mesh of the sieve shall be 0.222 m.m.

Comment:—The test shall be made with 100g. (3.52 oz.) of cement.

It is difficult to obtain true sieves on the market and some variation must be allowed, as long as the width of mesh is neither below 0.215 m.m., nor above 0.240 m.m.

As Portland cement is nearly always used with sand, in many cases even with a high percentage of that material, the fineness of cement is very important, for the finer is the cement used, the greater is the strength of the mortar, (the particles possessing cementing qualities are then more numerous.) But it would be misleading to judge of the quality of a cement only by its fitness.

VI.—**Strength of Cement:**—Portland cement shall be tested for compressive strength on a mixture of cement and sand, according to the normal test, hereafter given, the cubes used being of 50 sq. c.m. (7.75 sq. inch) in section.

Comment:—As it is not possible to ascertain the sand carrying capacity of a cement from tests made on pure cement paste, especially when it is purposed to compare cements manufactured by different firms, it is necessary to test the strength of a cement with the addition of sand.

Mortar Portland cement working nearly always in compression, and the compressive strength of a mortar being easy to test, the test by compression is the only strength test maintained.

In order to obtain the necessary uniformity of testing, the same apparatus and accessories are recommended, as those used at the Royal Testing Laboratory at Gross-Lichterfelde.

VII.—**Compressive Strength:**—Slow-setting cements must give at least 120 kg./c.m.^{2} (1,706 lbs. per sq. inch), when mixed to three parts in weight of normal sand for each part of Portland cement, and hardened for 7 days—1 day in moist air and 6 days in water—; if the hardening is continued for 21 more days in the air at 15°-30° C., the compressive strength must be at least 250 kg./c.m.^{2} (3,555 lbs. per sq. inch). In case of contest, the 28-day test only is conclusive.

Portland cement, to be used under water, must, after 28 days—1 day in moist air, 27 days in water—give a compressive strength of at least 200 kg./c.m.^{2} (2,884 lbs. per sq. inch).

For quick-setting cement the compressive strength after 28 days is usually less than the figures above given; therefore, the time of setting must be always investigated when testing the strength of a cement.

Comment:—As cements differ often one from another by their sand-carrying capacity, a property which may be considered as very important from a practical standpoint, it is absolutely necessary to make the tests with high percentages of sand, especially when comparing different cements. The normal proportion shall be 3 parts of sand to 1 part of cement in weight, as with this proportion of sand the strength of different cements is easily tested by compression.

But when the exact strength of a cement is wanted, it is advisable to make a series of tests with higher percentages of sand.

A Portland cement having a higher strength carries very often more sand and for that reason, as well as because it gives a higher strength for the same proportion of sand, it can command a higher price.

The greatest quantity of Portland cement being used for construction work, and as it is not possible to test its strength in a relatively short time, the test by compression after 28 days—1 day in moist air, 6 days in water, 21 days in air to 15°-30° C.—should be the standard test for strength.

For Portland cement used in hydraulic works, the test after 27 days' immersion in water shall give the necessary data for practical purposes.

In order to obtain uniform data, the sand used everywhere should have the same composition and size of grain (normal sand). The German normal sand is extracted from a stratum of tertiary quartz of the "Braunkohlen" formation near Freienwalde, A.O. The raw sand, nearly white, is mechanically washed and artificially dried. The dry sand is sieved with sieves shaken by mechanical power. A first sieve retains the largest grains, while another one lets past the dust. Each day, a sample taken from the daily production is tested for size of grain and purity by the Royal Testing Laboratory at Gross-Lichterfelde.

For testing the size of grains a sieve is used, formed of a brass sheet, 0.25 m.m. thick, bored with circular holes between 1.350 and 0.775 m.m. in diameter. When the normal sand has been completely tested and approved, it is put in sacks, and each sack is sealed with the seal of the Royal Testing Laboratory.