column 3, numerals indicate the type of apparatus and letters the type of loading. For instance, symbol 3J means that the consolidometer is of the fixed ring type and is loaded by means of a jack.

Differences in design may be attributed generally to differences in cost of construction and variations of opinion relative to ease of operation and to elimination of experimental errors including those due to friction.

CONSOLIDOMETERS—CYLINDER WITH HOLLOW PISTON

C. A. Hogentogler: In 1926 the Bureau of Public Roads constructed three consolidometers of the hollow piston type in accordance with plans furnished by Dr. Charles Terzaghi. The original design calls for but one porous stone, that shown at the base of the apparatus in Figure 1. About a year later a second stone, that shown at the top of the sample, was added as an improvement.

Recognizing the possibility of friction in the necessarily close fit of the piston within the cylinder, a slightly larger similar apparatus which utilized ball bearings between the two walls was constructed sometime later.

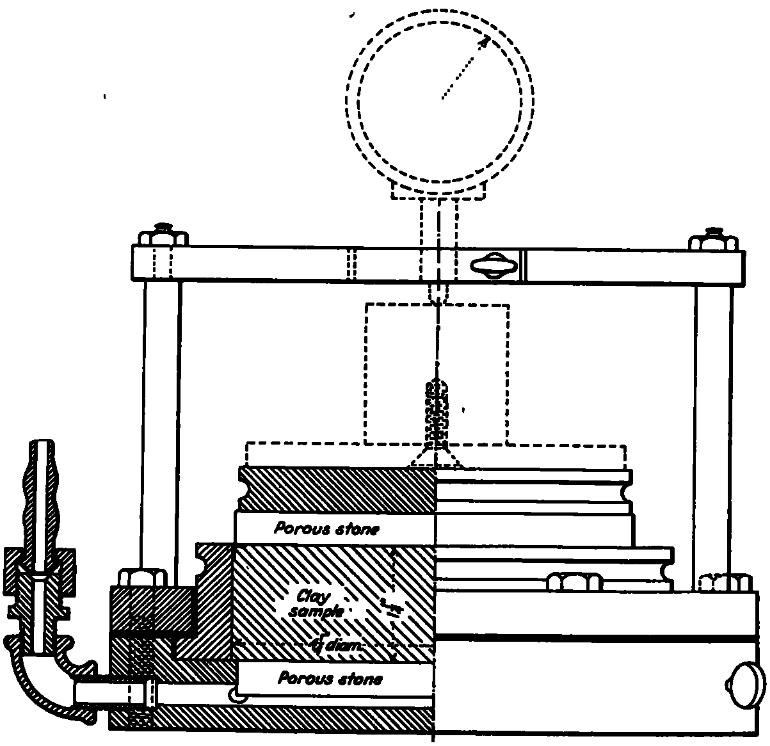

Figure 3. Fixed Ring Consolidation Device

However, comparison of data from the two types of apparatus gave no indication of friction in the original designs and they have given satisfactory service since.

H. L. Lehmann: We are using two types of soil compression devices. One is the Casagrande design described by P. C. Rutledge in a paper entitled "Recent Improvements in Soil Testing Apparatus," Harvard University Publication School of Engineering No. 165, 1935-36. The other is the type designed by Dr. Charles Terzaghi and described in *Public Roads*, Vol. 12, No. 4, June 1931.

Figure 6 shows the bronze cylinder, base and piston of the Terzaghi device. The cylinder is 2.75 in. diameter inside and 5.7 in. long and fits the base to form a watertight joint. It is bolted to the base with six screws. The base contains a recess for a porous stone of the same diameter as the cylinder to allow free drainage of the water which is expelled from the lower face of the sample into a series of grooves in the base that connect to standpipes on either side. The piston is 6.2 in. long and the base is 2.75 in. in diameter. There is also a recess in the base for a porous stone to allow free drainage of the water expelled from the upper face of the sample. The water is drained through an overflow orifice located above the stone. A thick bronze bearing plate fits over the top of the piston to distribute the pressure evenly over the sample. Micrometer dials placed on opposite sides of the cylinder indicate movement of the piston to 0.0001 in.

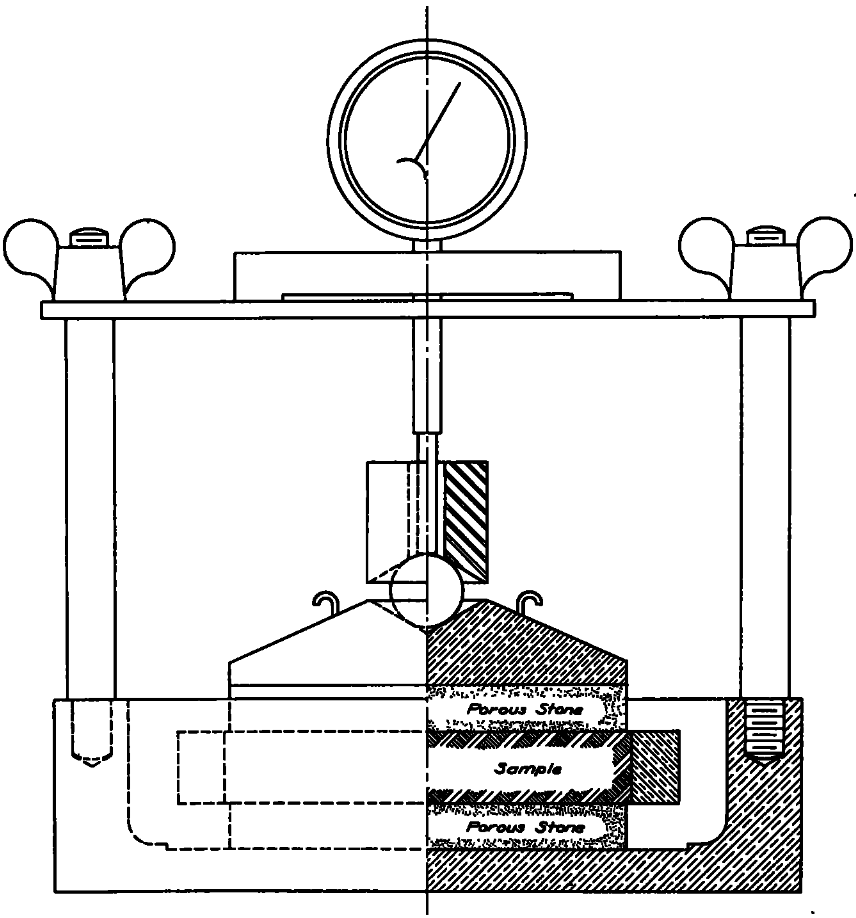

Figure 4. Consolidation Instrument with Floating Ring

Prof. R. G. Hennes: The consolidometer or oedometer we use is the same as shown in Figure 84, "Engineering Properties of Soils" (same as Fig. 1, this paper). It is used primarily for disturbed samples (remolded or from liquid limit). Normal loads of 0.8, 1.6, 2.4, 3.2 kg. per sq. cm. are applied.

Bendel, Dr. L.: The type of oedometer used in the Federal Technical School, Zurich, employs a yoke type of loading in

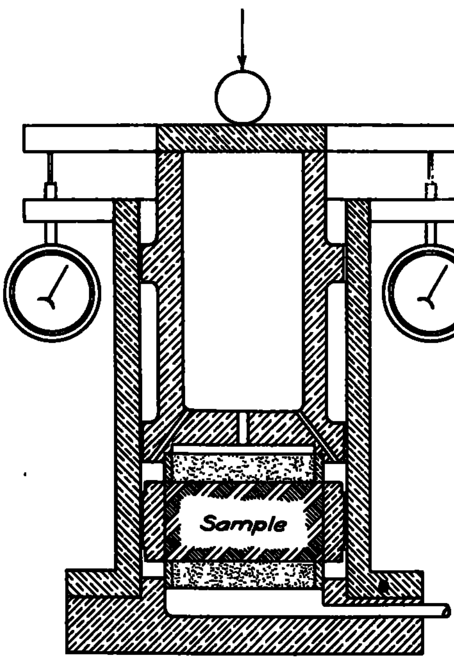

Figure 5. Piston with Floating Ring

which is utilized a large container of water.

CYLINDER WITH MUSHROOM PISTON

C. A. Hogentogler: The mushroom piston type apparatus shown in Figure 2 was developed by the Bureau of Public Roads in an effort to make a combination compaction and consolidometer machine. It was felt that this would facilitate the making of consolidation and swell tests on samples which had been compacted. In this instance, the Proctor cylinder was made in two parts, as shown in Figure 2. It has advantages from the construction angle, utilizes but one micrometer dial, has a minimum area of sliding surfaces in contact and insures that the sample cannot tilt during test. This design was so satisfactory that similar instruments were made up in different sizes for other work. Including all sizes, there are now 43 consolidometers of this type in use in the Subgrade Laboratory.

FIXED RING CONSOLIDOMETERS

Prof. D. M. Burmister: Two consolidation devices used at Columbia University, illustrated in Figure 7, are modified from the fixed ring type developed by Casagrande, and from the floating ring type developed by Moran and Proctor. The sizes vary from 2.5 in. diameter for 3-in. undisturbed samples to 3.5 in. and $4\frac{1}{4}$ in. for large size undisturbed samples 5 in. in diameter or samples cut by hand from test pits. The containing rings vary from $\frac{5}{8}$ in. for a fixed ring to 1 in. for the 2.5-in. diameter floating ring device and to $1\frac{1}{2}$ in. in thickness for the $4\frac{1}{4}$ in. diameter device. Removable extension rings are used on the fixed ring type of device for flooding the upper porous stone. The bottom of the sample is flooded by means of the standpipe. A celluloid cover reduces evaporation of moisture.

Sample Preparation: The preparation of the sample requires the greatest of care in order to minimize disturbance, loss of moisture, etc. The sample is prepared in a moist cabinet. A section is cut from a representative undisturbed sample and laid on the containing ring of the consolidation device, which has been fixed in place on the turntable of the sample trimming device illustrated in Figure 8. A trimming knife notched and shaped accurately to fit the sample into the ring as it is rotated on the turntable is used. When the sample has entered the lower ring, the excess material is carefully screeded off flush with the ring by means of a steel straightedge.