

sure of primary current is the highest which has yet been used in this country, being about 2100 volts average on the feeder. This pressure is raised or lowered by increasing or decreasing the exciting current according to the load shown on the central station ammeter, which is graduated to single amperes, and is indicated by a Cardew volt meter, which, as elsewhere mentioned, is attached through a converter to the armature. Instead of having a compensator, as is used in the Westinghouse system, a table of loads and the corresponding pressures to be carried at the station is used. This method, though of course not absolutely perfect, owing to the rise of current with increase of voltage and vice versa, answers very well. The Cardew volt meter in the company's office in town, which is an excellent check upon the dynamo attendants' work, shows an average variation of two volts only in a night's run. The mains in town, which aggregate nearly 14 miles in length, are calculated for a loss of only 2 per cent. at full load, which gives a difference of $\frac{2}{3}$ of a volt per lamp up or down from the standard. The house wires, which are insulated with rubber and tape, are calculated for one per cent. loss only at full load. As most of the lights are taken in private residences, where the whole number are hardly if ever in use at one time, the loss of light through resistance of the house wiring is practically nil.

MEASURING INSTRUMENTS.

The Ayrton and Perry instruments have been used to a very considerable extent in this country, and until recently were the most accurate of all really portable electrical measuring instruments. There is a sample on the table before you. They are only suited for direct currents, and are open to the objection that they have considerable friction and a high temperature error if kept in circuit, which they should never be except only for a few seconds when taking readings.

The Weston volt meter is shown in Figs. 24 and 25, and on the table are a volt meter and an ammeter of this type. These volt meters have the great advantage of extreme accuracy and very high resistance, averaging about 20,000 ohms, so that the quantity of current passing is extremely small. They may be kept continually in circuit without any material variation in their readings. They require careful handling, of course, as do all electrical instruments; but they are the most accurate and reliable of all portable testing instruments for continuous currents. The volt meters contain a calibrating coil by which their constancy can be at all times tested. The writer has used quite a number of these instruments which he has checked with each other, and has sometimes compared the higher and lower scale by taking the P. D. difference between terminals of single cells of secondary batteries, and then, putting the whole of the cells in series, compared the reading of total E. M. F. of the battery. Several tests of this nature have come out within one quarter of a volt. The calibrations are in single volts on the higher scale, and, thirtieths, twentieths or tenths of volts on the lower scale. The ammeters read to tenths of amperes in the small sizes. In both the divisions of the scale are so wide that one quarter of these values can be read with perfect ease.

For the most perfect readings by these instruments they should be set quite level, and 5 feet away from any other instrument, or from any mass of iron or steel, and so placed that the index will point due west when at the centre of the scale, but these precautions are not necessary for ordinary testing of pressure in buildings, as the error can never be more than $\frac{1}{2}$ volt, if otherwise placed.

The Cardew volt meter (Fig. 26) is used for both direct and alternating currents, and is made to be used either vertically or horizontally.

The horizontal pattern has the advantage of being steadier than the vertical instrument owing to the disturbance caused by currents of air passing up the tube of the latter. All the more recent forms of this instrument have an adjusting screw outside of the case to bring the needle to zero, which should be done before the current is turned on. No adjustment should be made while the wire remains warm, as the section of the wire may be altered by any tension put upon it while in this condition and the calibration destroyed.

For alternating and direct currents Sir Wm. Thomson's latest instruments are the finest yet produced, but are more suited for standard or station than for use as testing instruments.

In the electrostatic instruments no current passes through the instru-