1st, The permanent bench marks of microscopic construction (*e.g.*, Russian bases at St. Petersburg); 2nd, the permanent bench marks consisting of lines traced on the edge of a series of polished surfaces (*e.g.*, bases of International Bureau and of the National Physical Laboratory). After careful consideration of the two systems it was decided to adopt the second one.

The apparatus installed was made by the Societe Genevoise pour la Construction d'instruments de physique Geneva. The general arrangement may be seen from Figs 2 and 3, the views being taken from the centre of the room looking towards the ends. The bench marks are permanently fixed to cement pillars. These pillars are isolated from the floor and extend down to solid rock. The bench marks are placed at 0^m, 4^m, 8^m, 10^m, 12^m, 50 ft., 16^m, 20^m, 66 ft., 24^m, 28^m, 30^m, 100 ft., and 32^m.

The distance between bench marks is determined by means of a standard invar bar 4 metres in length, standardized at the International Bureau of Weights and Measures at Paris. The bar is supported on a carriage which rolls over rails laid throughout the length of the base. This carriage, shown in Fig. 4, consists of two three-wheeled trucks supporting attachments for regulating vertical and horizontal movements. By this means the graduations on the bar and the bench marks may be brought very close together and the lines on the bar and bench marks sighted simultaneously by means of microscopes mounted on the carriage. Small two-candle power electric lamps are mounted on the piers to illuminate the graduations. The bar is protected by cases which rest on the support of the bar, the cases are notched at proper intervals to allow bringing the bar close to the bench mark and to uncover that portion of the bar in use.

The temperature of the bar is taken by means of two thermometers inside the case and read through openings in the latter. Suspended at equal intervals along the walls of the room and lying horizontally in cage guards are twelve delicate thermometers graduated to 0.1° C., it being possible to estimate to 0.01° C. By means of these thermometers an accurate determination of the room temperature may be obtained.

The rails which provide the runway for the carriage are supported every two metres by cast iron supports, these in turn being supported by cement piers isolated from the floor and carried down to solid rock. The iron supports are of U form to allow the tapes and wires to sag freely and to be freely manipulated. The supports used for suspending the tapes may be placed at any point along the runway and may be firmly clamped to the rails by means of two thumb-screws. The cord or wire which is fastened to the tape passes over a grooved pulley on the support and is attached to a weight to give the desired tension. The pulley is mounted on ball bearings and may be adjusted vertically or horizontally in order to bring the tape to the correct position. Intermediate supports which can be placed at any desired interval consist of pulleys mounted on ball bearings and are also adjustable.

As far as is known, only one set of apparatus exactly similar to that of the Dominion Government exists, this being one belonging to the Servian Government.

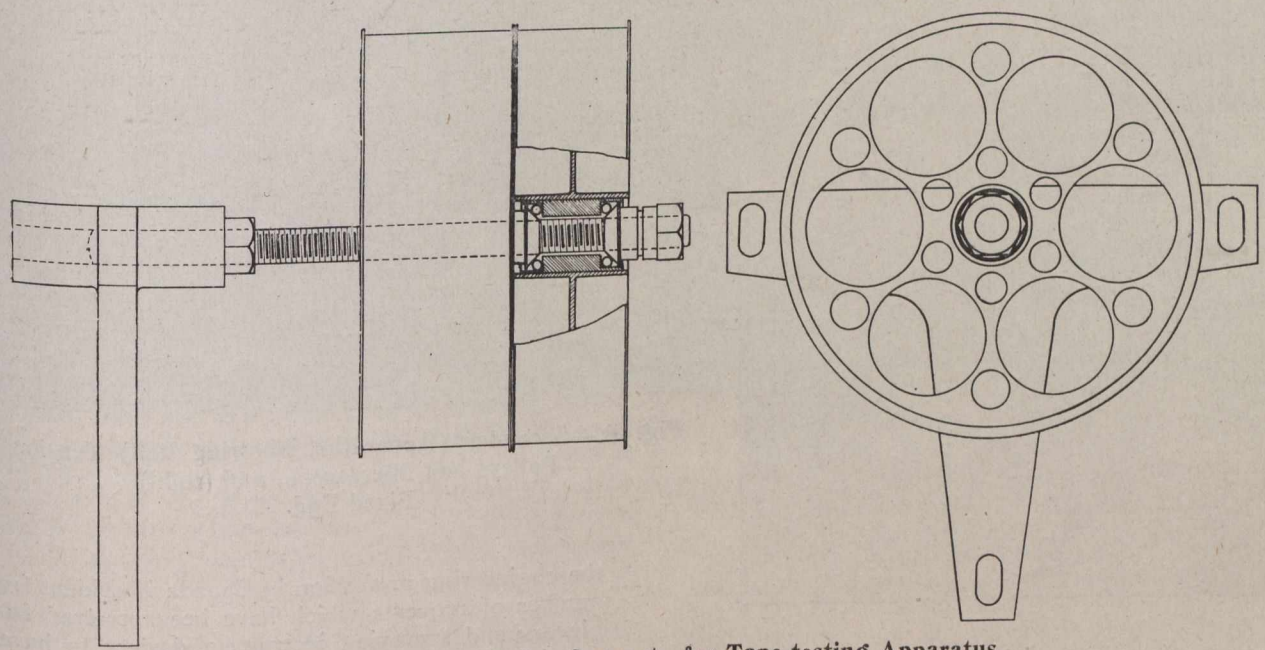

Fig. 5.—Intermediate Pulley Support for Tape-testing Apparatus.

The foregoing apparatus is used only to test the laboratory standards or when this method is specially requested by an engineer desiring to have tapes standardized. As previously mentioned, it is of extreme importance that the temperature of the room be as close to standard temperature as possible and also that the exact temperature be determined, as shown in the following example. If, during the comparison of a 100-ft. tape with the bench marks (the spacing of which does not appreciably alter with small variation of temperature), an error of 1/5° F. was made in determining the true temperature of the tape it would cause an error of .000124 ft. in the results due to dilation of the tape. The coefficient of dilation used is $C = .0000062$, which is an average value, but as this value has been found to vary with different tapes it is important that the temperatures during the test be kept as near as possible to the standard temperature (62° F.) at which the certificate is issued. If the tape is tested at 72° F., a variation of 10° F. from standard temperature, an error of .0000005 in the coefficient of dilation would cause an error of .0005 ft. in reducing the results to standard temperature.