Various types of movement are widely used in modern equipment, thus making it necessary to measure precisely the parameters of movement. For this purpose there exist a large number of various instruments which include speedometers, velocity meters, tachometers, and accelerometers.

Accurate and precise operation of these instruments is ensured by means of basic, reference means of measurement which serve to reproduce the values of movement parameters in the established system of units with higher precision than that of the tested instruments.

The D. I. Mendeleev All-Union Scientific Research Institute of Metrology (VNIIM) has developed basic means which serve as reference standards for measuring movement parameters.

Rotation is the commonest movement and, therefore, let us first examine the basic means which serve to reproduce and measure angular velocities.

Reference Tachometric Equipment. The majority of instruments which measure angular velocities (tachometers) cover ranges from 5 to 150,000 rpm with an error of ±0.05 to 3%. For checking, investigating and testing these instruments two reference tachometric installations have been developed which cover ranges of 5 to 60,000 rpm (TKhl-60) with an error of 0.1%, and of 5 to 150,000 rpm (OTKh3-150) with an error of 0.01%.

Equipment TKhl-60 comprises a five-step reduction gear driven by a dc shunt motor which is fed from ac mains through rectifiers. The main (middle) shaft of the reduction gear carries a stroboscopic disc which is illuminated with short flash lamp pulses of 50 Hz obtained by dividing the frequency of a 10,000 Hz crystal oscillator. Deviations of the oscillator frequency from its nominal value do not exceed ±0.01%.

Discrete angular velocity values of the main reduction gear shaft can be reproduced by the stroboscopic method every 50 rpm over a range of 100 to 3000 rpm. The other shafts of the reduction gear reproduce discrete values of angular velocities multiplied or divided with respect to the frequency of the main shaft by the value of the corresponding gear ratio. The stroboscopic disc is made in such a manner that the discrete values of angular velocities can be reproduced without the help of an auxiliary tachometer over the entire measurement range.

The equipment is provided with an additional reduction gear which has a vertical shaft, thus making it possible to test tachometers not only with horizontal, but also with vertical axes.

The error in measuring angular velocities amounts to 0.1% and is mainly due to the "reading" error, i.e., to the error of setting the angular velocities to the value at which the corresponding image of the stroboscopic disc is stationary.

Reference equipment OTKh3-150 (Fig. 1) is more complicated than the preceding one. This equipment in addition to the units used in set TKhl-60 also employs an angular velocity stabilizer, a frequency store, and a power amplifier. These components serve to obtain discrete values of angular velocities and automatically maintain these values with the required degree of precision for a prolonged time. The stroboscopic method is retained in this equipment only as an auxiliary procedure for obtaining the required value of the angular velocity and checking its synchronization.

Angular velocities from 60,000 to 15,000 rpm are obtained by means of an additional reduction gear which consists of a pair of gears (textolite and steel). The reduction gear is oiled with a drip oil can. The drops of oil falling on to the gear teeth are converted into an oil spray which provides good lubrication of the reduction gear bearings.

The angular velocity stabilizer of the equipment consists of a synchronous motor which synchronizes the speeds of the main shaft in the reduction gear driven by a shunt motor. Discrete values of the stabilized angular velocities are determined by the value of the frequency fed to the stabilizer from the frequency store. In turn the

All the previously described installations have been developed under the guidance of the author of this article by a group of collaborators headed by B. L. Suslov.

Device for Measuring Small Angular Velocities. At present it is very important to measure small angular velocities. An installation has been developed (Fig. 3) for measuring angular velocities in the range of $5 \cdot 10^{-4}$ to $2.5 \cdot 10^{-1} \text{ deg/sec}$ with an error of ± 1% (up to $10^{-3} \text{ deg/sec}$) and an error of ± 0.5% (up to $2.5 \cdot 10^{-1} \text{ deg/sec}$).

Two diffraction gratings are located with a small distance between them and displaced with respect to each other. One of them is fixed to the rotating platform and the other is stationary. The observed interference fringes are thus displaced. The interference fringes are counted over a given time interval by means of a photoelectric device and an electronic counter.

From the knowledge of the grating constant, the time interval, the number of fringes, and the platform radius, the angular velocity over a given time interval can easily be calculated.

Since the length of the gratings is finite, they will be displaced with respect to each other over a given time interval by their entire length, and the counting of fringes will become impossible. In order to eliminate this, a catching-up system is provided which displaces quickly the stationary grating in the direction of the platform movement by an amount equal to its length.