An instrument for measuring internal threads has been produced and successfully used at the Belorussian Polytechnic Institute (Fig. 1). The instrument consists of a threaded plug-gauge cut in half. One half 1 is mounted on frame 2 of the instrument, and the other half 3 is connected to bracket 4 which turns on spherical centers.

The gauge is inserted in the closed condition into the measured threaded hole. Spring 5, which provides the required measuring effort [0.7-1 kg-wt (6.9-9.8 N) depending on the diameter of the measured thread], turns bracket 4 until firm contact is established between the thread of the gauge and the measured thread. The deviation of the tested thread diameter from that of the reference gauge is read on micrometer 6, which is mounted on the instrument frame. The micrometer’s measuring stem rests against bracket 4. The axis of the micrometer’s measuring stem and that of the read gauge are mounted at the same distance R from the turning axis of the bracket, thus providing a transfer ratio of 1. In Fig. 1 the micrometer is shown for greater clarity at a larger distance from the bracket axis than from the gauge, in reality, however, $R_1 = R$. Stop screw 7 serves to limit the expansion of the gauge in the nonoperative condition.

The two halves of the gauge are located in their mounting blocks (Fig. 2) by means of their cylindrical stems 1 and the face of collar 2. One block is fixed to the frame of the instrument, and the other to the turning bracket. Screws 3 and 4 serve to fix the half-gauges to the blocks. Moreover, screws 4 and 5 also serve to eliminate any tapering of the gauge which could be produced by bending due to the measuring effort or other reasons. Thus, for instance, in setting gauge M12 (with a complete thread profile) the tapering due to the bending of half a gauge under the effect of the measuring effort amounted to 5 μ. The tapering is eliminated by tightening or loosening screws 4 and 5 and thus producing the required deformation. The position of the half-gauges is adjusted so as to eliminate during measurement any deviation from the shape of their mean thread cylinder. The setting of the half-gauges can be made by means of a flat micrometer or a caliper gauge with three test cylinders for checking the mean diameter of the thread.

For measuring the referred mean diameter of the thread, the instrument is provided with half-gauges which have a complete thread profile and a length of thread equal to that of a standard go-gauge, whereas, for measuring their own mean diameter the half-gauges are provided with a shortened profile and a length of 1.5 turns. The operating part of the half-gauges is cut down to width b (see Fig. 1). The mean diameter of the plug gauge, which is cut in half, is selected to equal the expected mean diameter of the measured thread. This reduces the errors due to variations in the helix angle of the lateral surfaces of tested threads. The truncation of the operating part speeds up the measurements considerably, since it enables one to insert the truncated gauge into the tested hole without screwing it in. Moreover, the narrow effective surface of the half-gauges almost completely eliminates the effect of surface dirt on the precision of measurements, provided that the measuring effort is adequate and the measured thread is rotated with respect to the instrument during measurements.

The layout of the instrument is shown in Fig. 3.

A plain caliber gauge with three test cylinders is used for setting purposes. The size of the gauge is computed in the same manner as that of block gauges for setting optimeters in testing the mean thread diameter by the method of three test cylinders. The expected mean diameter of the tested thread is then taken as the nominal mean diameter.

Experience has shown that for an extensive use of the instrument it is simpler to set it to zero by means of an accurately made thread ring-gauge. The caliper gauge with the wires is then preserved as a reference setting gauge,
which is periodically used in determining the corrections for setting the instrument by the ring-gauge, which wears out gradually. The relationship between the dimensions of the operating (ring) and reference setting gauges is determined in the following manner. The instrument is first set to zero by the reference gauge and then inserted into the operating gauge (ring) and its deviation is measured on the micrometer scale. In any further settings of the instrument by the ring-gauge, the micrometer readings are adjusted so that they account for the previously established correction.*

The value of the mean diameter \( d_2 \) corresponding to the zero setting of the instrument is equal to (this and subsequent formulas refer to a metric thread with \( \alpha / 2 = 30^\circ \))

\[
d_2 = M - 3d' + 0.866S + \delta_1 d_2 + \delta_2 d_2 + \delta_3 d_2,
\]

where \( M \) is the size of the caliper gauge, \( d' \) is the best diameter for the test cylinders \( (d' = 0.577S) \), \( S \) is the nominal thread pitch of the split plug gauge, \( \delta_1 d_2, \delta_2 d_2, \) and \( \delta_3 d_2 \) are the corrections for the errors due to half the profile angles, the thread pitch of the split gauge, and the deviation of the test cylinder diameters from their nominal values.

\[
\delta_1 d_2 = (0.5 d' - 0.3 \delta S) \delta d.
\]

Correction \( \delta_1 d_2 \) has a positive sign when the deviation \( \delta d' \) of the test cylinder diameter from normal and the deviation \( \delta \alpha \) of half the profile angle of the plug-gauge thread from the nominal are of the same sign. Correction \( \delta_2 d_2 \) has a negative sign for other combinations of \( \delta d' \) and \( \delta \alpha \).

\[
\delta_2 d_2 = 0.866 \delta S,
\]

where \( \delta S \) is the error in the pitch of the plug-gauge thread over one turn.

\[
\delta_3 d_2 = \frac{1.5 \left( \delta d' + \delta d_1 + \delta d_3 \right)}{2},
\]

where \( \delta d_1, \delta d_2, \) and \( \delta d_3 \) are the errors of the test cylinders.

When the instrument is set by means of the ring-gauge, it is desirable to keep the position of the gauge with respect to the instrument the same for all tests.

The measurement error of the instrument is determined in the main by the instability of instrument readings and the errors due to micrometer readings, the means of setting the instrument to zero, the kinematic circuit of the instrument, manufacturing of the instrument, the location of the split gauges, and deviations from a set measurement temperature.

Let us determine the measurement error on a specific example of measuring an M16 thread on steel components.

The instability of measurements was evaluated by testing the same quantity 200 times (the instrument was set by a threaded ring-gauge 200 times). The mean value of every 10 measurements was plotted on a graph. The first setting was altered after 110 measurements, and amounted to less than 0.2 \( \mu \). The curves showing the distribution of the sets of measurements 1-110 and 111-200 and the evaluation of the discrepancy between their mean values have confirmed the size and nature of the deviation from the original setting of the instrument. A histogram of the instantaneous distribution of instrument readings was plotted after a correction for the displacement of the original setting had been applied. Subsequent mathematical treatment has shown that the experimental distribution of the reading

*Calculations show that the use of a ring for setting the instrument to zero provides an additional error not exceeding 0.1-0.15 \( \mu \), which can be neglected in practice.