so that the prism faces are perpendicular to the collimator's optical axis. If it is impossible to set the reference face of the prism in a horizontal position by means of the table, the prism should first be fixed to a device which would provide such an adjustment. The autocollimator is placed in such a position that its objective is approximately at a level which divides the prism in half. If the optical axis of the objective is placed perpendicularly to the prism faces, it will then become possible to obtain an image of the collimator's graticule from any of the faces. An eyepiece micrometer reading is then taken which corresponds to the position of the graticule after the beam has been reflected from the first face of the prism. The table is then rotated through an angle equal to the central angle between the first and next face, thus bringing the graticule image reflected from the next face into the instrument's field of vision. If the position of the autocollimator images reflected from the first and next face coincide precisely, the angle of rotation will be exactly equal to that between the two faces. In the absence of coincidence, corrections should be applied.

If it becomes necessary to turn a rotating device through an angle differing from those provided by polyhedral prisms, angular standards (blocks), whose sets are available at any enterprise, should then be used.

Figure 4 shows the method for checking the table rotation through a given angle $\alpha$ by means of two angular standards 1, which are combined into a single block. One of the standards has a 90° angle between its faces. Such rectangular blocks can serve as a basis for obtaining combinations with any required angle.

LITERATURE CITED


MEASUREMENTS OF LONG LENGTHS UNDER WORKSHOP CONDITIONS

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The measurement of long lengths under workshop conditions in heavy engineering presents certain difficulties. Thus, in crane-building lengths up to 20 and 50 m with tolerances of the order of 5-10 mm are commonly specified. The error of the measuring device should not exceed $\frac{1}{6}$ of the tolerance [1], i.e., it should not exceed 1-2 mm. However, this condition is met only by measuring installations which are either difficult or inconvenient to use. Tape measures, which are normally used in engineering, provide satisfactory results only if the tape is placed over a plane surface of the measured component and is stressed by a standard amount. It is often impossible to attain such conditions. The use of sagging surveyor's tapes with a constant tensile effort of 10 kg-wt (98.0665 N) [2] does not provide the required precision, since articles of different lengths have to be measured.

The Central Scientific Research Institute of Technology and Machinery (TsNIITMASH) has developed a special optical distance gauge for lengths up to 30 m with a measurement error of $\pm 2$ mm [3]. This instrument requires special measurement conditions which it is difficult to meet in heavy engineering workshops.

It has been suggested by the TsNIITMASH [4] and the Krasnoyarsk Agricultural Institute (KSKhI) that the error due to sagging can be compensated by a corresponding tensile deformation of the tape.

The KSKhI has developed a special tape measure [5] suitable for measuring articles of the 4th class of accuracy with a length up to 40 m; in this tape the error is compensated automatically. The compensation is based on the fact
that the error due to sagging has an opposite sign to the tensile deformation

\[ \Delta_1 = - \frac{8 f^2}{3 l} \; ; \; \Delta_2 = + \frac{H l}{E F} \]

where \( \Delta_1 \) is the error due to the sagging of the tape, \( \Delta_2 \) is the extension of the tape due to stretching, \( f \) is the sagging deflection, \( l \) is the length of the tape, \( H \) is the tensile effort, \( F \) is the cross section of the tape, and \( E \) is the elasticity modulus of the tape.

Hence, it is possible to provide the tape with a deformation equal to the sagging error, i.e.,

\[ \Delta_1 + \Delta_2 = 0 \]

The schematic of a compensated tape measure is shown in Fig. 1.

A 20-m tape 2 is wound on drum 1. In measurements the tape is held by handle 3. The tape can be unwound to the required length by means of pawl 4 and ratchet wheel 5. The tape-measure handle is pressed against measured component 6 by stop 7 of its frame 8. The tape is then stretched by handle 9 until pointer 10 comes to rest against the corresponding division on scale 11 (the scale is calibrated in meters). The tape is stressed by spring parallelogram 12, from which drum 1 with its holder are suspended. The size of the component is read off the tape-measure scale by means of the pointer attached to stop 7.

The measurement error of a compensated tape measure depends on a number of factors, both inherent in tape measurements and peculiar to a compensated tape measure.

The first group comprises: the error in certifying the scale, temperature error, and the error in reading the scale. The second group includes errors due to the special features of a compensated tape design: the error due to a discrete variation in the tensile effort, the error produced by inaccurate determination of the compensation moment from the tensile scale, and the error caused by the difference in the height between the beginning and the end of the tape.

The maximum total measurement error of a compensated tape measure amounts to a value of the order of +3 mm with an instability of readings in the range of ±0.7 mm.

In testing the tape measures, their reading error was determined both at lengths for which their tension scale was calibrated and for intermediate lengths. The measurement error at intermediate lengths, as was to be expected, was found to be larger than at multiples of 2 m, for which the tension scale is calibrated, but the error did not exceed the calculated value.

The stability of readings was also tested by taking at definite intervals (4-6 m) a series of 10 readings, for which the readings deviation did not exceed ±0.2 mm.

The tension scale of the compensated tape measure is calibrated against a reference tape in such a way that the tensioning of the tape compensated the sagging error.

The tensile effort and sagging deflections were measured in calibrating the tape measures. Figure 2 shows the variations of the tensile effort with respect to the measured lengths for four tape measures. The uneven nature of the graph is due to the deviations of the tape scale from actual dimensions (Fig. 3) and to the subjective tendency of making the tensile scale more uniform. The latter circumstance artificially changed the tensile effort and the sagging deflection. Moreover, the uneven nature of the graph is also due to the nonuniform thickness of the tape along its length.