Mi. T. 47

Screw micrometer eyepiece

For precision measurements with the microscope

In the conventional eyepiece for microscopic measurement the accuracy of the result is limited by the degree of precision of the incorporated scale and is influenced by the magnification of the instrument. Fractions of the intervals of the graduation have to be ascertained by estimate.

Such guesswork is eliminated, and a far greater precision of measurement and accuracy of reading is achieved with the eyepieces shown in the illustration by the provision of a micrometer screw and drum, so that for precision work this type is preferable to all others. At the same time this precision design is robust enough for routine work in industrial plants.

The measuring procedure is described below. It should be understood that this lengthy explanation does not do justice to the actual speed and simplicity of the measuring method with this eyepiece.

The screw micrometer eyepiece, code no. 519 061, is inserted in the microscope in place of the standard eyepiece. It contains a stationary graduation of 12 0.5 mm intervals; the eyepiece is focused on this scale. An index line can be moved across the entire range of the scale by means of a micrometer screw. The micrometer drum is graduated into 100 parts, one complete revolution corresponds with one interval of the eyepiece scale, one interval on the drum therefore represents 1/1000 part of the scale interval. In the measuring process the microscope is focused on the object in the usual way, and the magnified image of the object as it appears in the micrometer plane of the eyepiece is measured in the following way: The index line is successively adjusted to both end points of the distance to be measured, and the values found are read off the scale in the field of view and off the drum.

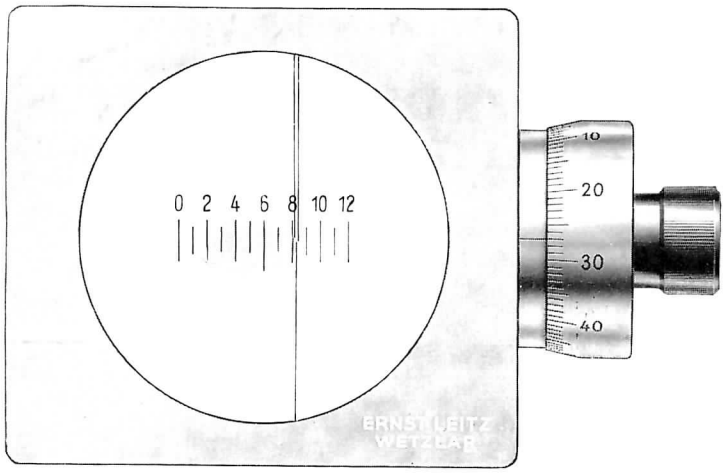
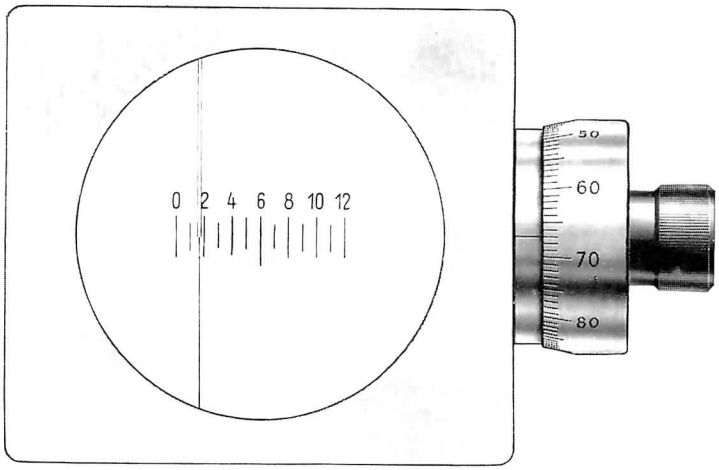


Fig. 1 reading: 827

Fig. 2 reading: 167



Example:

The measuring operation is preferably started at the line of the scale interval showing the higher value, i. e. at the right end of the object, as shown in Fig. 1. The distance of the index line to the right of the interval line marked 8 is shown on the micrometer drum at 27 intervals. The total reading is therefore 827.

As shown in Fig. 2, setting the index line to the left end of the object produces a reading of 167 (scale line 1 and 67 on the graduation of the micrometer drum).

By subtracting the lower value from the higher the length measured in the image plane is obtained:

827
−167
660 intervals.

When the screw micrometer eyepiece is used on one of the conventional microscopes, an intermediate optical system attached to the eyepieces, which compensates a necessary displacement of the image plane and thereby preserves the optimum performance of high-power objectives, increases the object magnification by the factor 1.25; thus, a drum interval of only 0.004 mm has to be introduced for the back projection on to the object.

In order to compute the actual length in the object plane the number of intervals is multiplied by the factor 0.004 and divided by the initial magnification of the objective employed. Any microscope tube factor would also have to appear in the denominator. These relationships are expressed by the following short formula:

$$\text{Length in the object} = \frac{\text{numbers of intervals} \times 0.004 \text{ mm}}{\text{objective magnification} \times \text{tube factor}}$$

Assuming the use of a 10 x object and 1 x tube factor in the example, the length in the object will be

$$\frac{660 \times 0.004}{10 \times 1} \text{ mm} = 0.264 \text{ mm}$$

However, since the listed data of the magnifying power of microscope objectives and the factor 0.004 represent only mean values, the objectives must, for exact measurement, first be calibrated as follows: With the objective produce a sharp image of a stage micrometer and determine the intervals of the micrometer drum coinciding with the available maximum length of the stage micrometer scale (one interval of the eyepiece scale equals 100 intervals of the drum). By dividing the length of the micrometer scale measured by the number of drum intervals corresponding with this length the exact length corresponding to one interval of the drum is ascertained. For instance, if 1026 intervals of the drum (10 in field of view and 26 on drum) cover a distance of 0.4 mm on the stage micrometer, the calibration value is:

$$0.4 \text{ mm} : 1026 = 0.00039 \text{ mm}$$

In our example this calibration value results in the following true length of the object:

$$660 \times 0.00039 \text{ mm} = 0.25 \text{ mm}$$

The calibration values obtained in this way include the magnification of the objective used and any tube factor other than 1 x.

In microscopes with extensible tubes a round calibration value (e. g. 0.001 mm or 0.0001 mm) can be set by changing the tube length and thereby the magnification of the intermediate image in the eyepiece. The tube extension calculated must obviously not be changed during measurement; it should be read off a scale or where this is absent marked on the tube, and recorded for the appropriate objective, so that the setting can be reproduced at any time.

Technological measuring usually calls for the determination of the length in the object simply as 1/1000 (calibration value 0.001 mm) of the number of drum intervals. This calibration value will be obtained with suitable adjustment of a 4 x objective (total magnification 50 x). For frequent measurements of this kind it will be an advantage to use a special measuring tube of fixed setting.

A second version of this screw micrometer eyepiece, with bayonet changer for use in technological measuring microscopes, is available under Code No. 810 213. If this eyepiece forms part of the standard outfit of the microscope the associated calibration values will be determined in the factory and supplied with the instrument .

On the other hand, eyepieces No. 810 213 supplied subsequently require calibration as described above. In this connection attention is drawn to the fact that the measuring microscope with bayonet-type eyepiece has nos extensible tube. The factor 0.004 does not apply to the eyepiece No. 810 213, because this type contains no intermediate optical system. If absolute accuracy is not required the factor 0.005 instead of the exact calibration value can be introduced into the formula.

Screw Micrometer Eyepiece, in case	Code No.
a) for insertion in a standard microscope tube, magnification 12.5 x	519 061
b) with bayonet lock for mounting on the toolmakers' microscope, magnification about 10 x	810 213
For calibration:	
Stage micrometer 0.01 mm, in case,	
for transmitted light (2 mm = 200 parts)	513 106
for incident light (1 mm = 100 parts)	563 011

Design subject to alterations without notice.

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