CARL ZEISS
JENA

Accessories for microscopic measuring and counting

Description and Instruction Manual

	5:100	10·100
X 10	4.4	8.8
X 16	3.15	6.3
X 40	1.25	2.5
X 63	.8	1.6
X 100	.5	1.0

Progressive improvements made on our products forbid illustrations and text herein to be binding as to details of latest design. Copyright and right of translation reserved. Reproductions of illustrations – as far as available – will be gladly supplied to interested parties.

Accessories for microscopic measuring and counting

Description and Instruction Manual

Index

		Page
1.	Measuring with the Microscope	3
1.1.	Definition of measurement	3
1.2.	Measuring with eyepiece measuring discs	3
1.2.1.	Definition of the micrometer value	3
1.2.2.	Preparing the measurement	4
1.2.3.	Determining the micrometer value	5
1.2.4.	Measuring the specimen	7
1.3.	Measuring with the eyepiece screw micrometer	7
1.4.	Measuring the distance with the mechanical stage	10
2.	Using the stage micrometers	11
2.1.	Determining the scale number of the intermediate image	11
2.2.	Measuring the image scale in photomicrographs	12
3.	Counting with the microscope	13
4.	Accessories for measuring and counting	14
4.1.	Stage micrometer and scales	14
4.1.1.	Stage micrometers for objectives with a higher scale number	14
4.1.2.	Stage micrometer 70/0.5 with glass scale 100/0.5	15
4.2.	Eyepiece discs	16
4.2.1.	Eyepiece measuring discs	16
4.2.2.	Eyepiece squared micrometers	16
4.2.3.	Eyepiece measuring and counting disc	17
4.2.4.	Eyepiece graticule	18
4.2.5.	Eyepiece diaphragms according to Ehrlich	18
4.3.	Adjustable eyepieces and MF measuring projectives	19
4.3.1.	Adjustable eyepieces for achromats	19
4.3.2.	Adjustable eyepieces for apochromats, plane-field achromats, and plane-field apochromats	20
4.3.3.	Eyepieces PK 12.5×(14) m adjustable and PK 12.5×(16) m adjustable	22
4.3.4.	Eyepiece 12.5×(15) adjustable for SM XX	23
4.3.5.	MF measuring projectives	24
5.	Hints for measuring and counting	25
6.	Specification	32

In many cases it is necessary for the microscopist to measure proportions or count particles in the specimen he is examining. For this particular purpose we manufacture a number of measuring and counting accessories which are described and their operation illustrated herein.

1. Measuring with the microscope

1.1. Definition of Measurement

Measuring is a numerical comparison of the quantity to be measured, the measuring quantity, with a known quantity of a similar category, the standard.

1.2. Measuring with eyepiece measuring discs

1.2.1. Definition of the micrometer value

A direct comparison of the standard with the measuring quantity is impossible within the microscopic range, since the structure of the object can no longer be resolved by the naked eye. The technical effort required would be too great for bringing the standard, under microscopic observation, to the spot in the specimen to be measured. A way, therefore, must be found for measuring the object size indirectly, i. e. to find a point, where the object to be measured will be offered to the eye sufficiently large and furthermore may be compared with a standard. With the compound microscope this point offers itself directly in the form of the plane of the intermediate image. Fig. 1 illustrates these conditions. The measuring object (*1* or *7* resp.) will be represented in a magnified form in the plane of the intermediate image (*9* or *8* resp.) and it is feasible to introduce

Fig. 1

Diagram showing determination of micrometer value and the process of measuring *1* Stage Micrometer; *2* Objective; *3* Adjustable eyepiece with field diaphragm; *4* Graduation of the stage micrometer; *5* Graduation of the eyepiece micrometer; *6* Determination of the micrometer value: the divisions of the stage micrometer are brought to coincide with the divisions of the eyepiece micrometer; *7* Measuring object; *8* Measuring process: the measuring object is brought to coincide with the divisions of the eyepiece micrometer; *9* Position of the eyepiece micrometer on the field diaphragm of the eyepiece.

at this point a "substitute standard" (*5* or *8* resp.) with which the relevant spot in the specimen can be measured.
Since, however, the image of the specimen is being represented with a definite scale number of the optical arrangement in use, a way must be found for determining the true proportions within the specimen. The "substitute standard" in the plane of the intermediate image (*5*), mostly an eyepiece micrometer (*9*), is supplied by our company as an eyepiece measuring disc which must be compared (*6*) with a standard (*4*) which is used in place of the specimen (*1*) and the dimensions of which are accurately known.

This comparison is called: determination of the micrometer value.
The micrometer value states which length in the object corresponds to an interval of the graduation of the eyepiece measuring disc. Before the commencement of any measurement, the micrometer value of the optical equipment used must be known. It will vary with a change of the objective, of the eyepiece, the tube and with variations in the tube length.

As soon as constant conditions prevail for the measurements (i. e. objective, tube, tube length and eyepiece are not being varied), the micrometer values once determined can be re-employed for measurements ad infinitum.

1.2.2. Preparing the measurement

For the purpose of determining the micrometer value, a stage micrometer with the trade-mark facing the user is placed on to the microscope stage instead of the specimen.
As an eyepiece, a type with an adjustable eye lens is used (see para. 4.3.). An eyepiece measuring disc is placed on to the visual field diaphragm of the eyepiece. For this purpose the lower part of the adjustable eyepiece, together with the diaphragm, is unscrewed, then the micrometer is placed into the diaphragm with the graduation facing downwards, both parts are screwed, and finally the eyepiece is pushed into the tube of the microscope. The adjustable eye lens must be unscrewed until the micrometer graduations appear blurred. Then the eye lens is turned back until the graduation appears sharply in focus, in this manner the effect of accommodation, frequently occurring during obser-

vation, is widely eliminated. Now, the graduation of the stage micrometer can be brought into the centre of the field of vision and sharply focussed (see *6*, fig. 1).

1.2.3. Determining the micrometer value

The micrometer value is determined as follows: the image of the graduation of the stage micrometer („Standard") situated in the object plane is compared with the graduation of the eyepiece micrometer ("auxiliary standard"). As soon as y divisions of the stage micrometer coincide with y' divisions of the eyepiece micrometer, then the micrometer value m of the relevant objective is

$$m = \frac{y}{y'} \quad (1)$$

where the division value of the stage micrometer used for the micrometer determination is substituted for y.

Example 1:
17 divisions of the stage micrometer coincide with 21 divisions of the eyepiece micrometer. One interval of the stage micrometer corresponds to the length of 0.01 mm (value of the division).

Then $y = 17 \times 0.01$ mm, $y' = 21$

$$m = \frac{17 \times 0.01 \text{ mm}}{21} = 0.0081 \text{ mm}$$

$$\underline{\underline{m = 8.1\,\mu}}$$

In practice the micrometer value should not be determined from a single measurement, but from a series of measurements, since the measurement will contain residual errors of abberation of the optics, errors in observation, errors in the graduation of the "standard", etc. Furthermore, it is advisable to employ a measuring distance as great as possible for the purpose of keeping errors in the measurement low. In this connection it will be most unusual, if the intervals of the stage micrometer and those of the eyepiece micrometer do not accurately coincide. In order to facilitate the calculation, whole intervals of the eyepiece micrometer are assumed, the intermediate values of the stage

Y - stage Y
Y' - eyepiece Y'

micrometer intervals being estimated. In this connection the principal values of the two scales must be made to coincide.

(When working with the eyepiece screw micrometer – see para. 1.3. – it is advisable to use a specific number of whole scale divisions of the stage micrometer and to ascertain the fractional parts of the eyepiece intervals on the measuring screw.)

Whenever the graduation of the stage micrometer is being represented on a large scale, then the same edge of the divisons is invariably used for measuring.

It is recommendable to carry out several calibration measurements at different distances from the centre of the field of view by using a constant but not too small a number of intervals of the eyepiece micrometer.

The micrometer values m_n, arising from the series of measurements, are added up at the end of the measurement and divided by the number n of measurements. An average scale value $\bar{m}$ is obtained from this procedure.

$$\bar{m} = \frac{1}{n}(m_1 + m_2 + \ldots + m_n) = \frac{1}{n} \sum_{1}^{n} m_n \qquad (2)$$

Example 2:

With a stage micrometer with the graduation value 0.01 mm, the following series of measurements has been taken for the determination of the micrometer value with 40 intervals of the eyepiece measuring disc:

y′ (intervals on the eyepiece measuring disc)	y · 0.01 (mm)	m_n (mm)
40	0.102	0.00255
40	0.101	0.00253
40	0.100	0.00250
40	0.100	0.00250
40	0.101	0.00253
40	0.101	0.00253
40	0.102	0.00255

$\bar{m} = \frac{1}{7} \cdot 0.0177 = 0.00253$ mm $n = 7$ $\sum m_n = 0.01769$

$\underline{\underline{\bar{m} = 2.53\ \mu}}$

1.2.4. Measuring the specimen

The micrometer value as previously determined may now serve for measuring the relevant point in the specimen. The measurement is made in such a manner that the number of intervals of the eyepiece micrometer which cover the specimen detail, are counted out (intermediate values are estimated) and multiplied by the micrometer value (*8*, fig. 1) i. e.

$$l = n \cdot m \qquad (3)$$

l = length in the specimen; n = number of intervals; m = micrometer value. Since the micrometer value has a dimension, l possesses the same dimension.

Example 3:

A specimen detail to be measured has a length of 55 and a width of 30 intervals of the eyepiece micrometer. The micrometer value has been ascertained in example 2 ($\bar{m} = 2.53\ \mu$).

The point in the specimen has a length of

$$l_L = 55 \cdot 2.53 = 139.15\ \mu$$
$$l_L = 0.139\ \text{mm}$$

and a width of

$$l_B = 30 \cdot 2.53 = 75.90\ \mu$$
$$l_B = 0.076\ \text{mm}$$

1.3. Measuring with the eyepiece screw micrometer

The use of eyepiece micrometers frequently causes the inconvenience of the outer limits of the object not coinciding during the measurement with the graduation intervals of the micrometer, and intermediate values have to be estimated. The use of an eyepiece screw micrometer – supplied by this company – (figs. 2 and 3) simplifies such measurements and increases the measuring accuracy by a factor of 10.

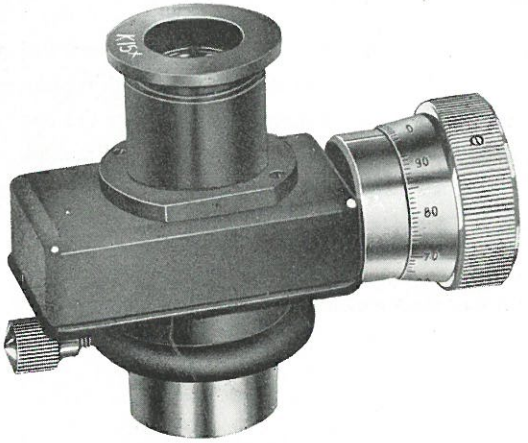


Fig. 2
Eyepiece screw micrometer – total view

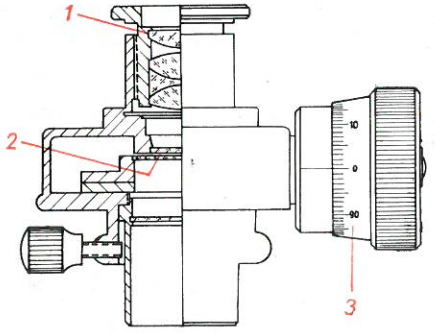
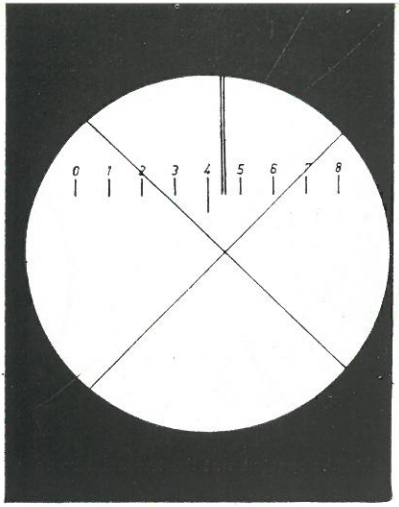


Fig. 3
Eyepiece screw micrometer – sectional diagram
1 adjustable eye lens
2 graticules
3 measuring screw

The adjustable eye lens (*1* fig. 3) permits direct focussing onto the graticule (*2* fig. 3). In relation to the latter a reference mark, consisting of a cross-line and double line (fig. 4), is laterally displaced in relation to the graduation by means of a lateral measuring screw. The centre of the double line corresponds to the intersection of the cross-line.

This type of set-up can increase the measuring accuracy by one power of 10, i. e. the micrometer value is smaller by a power of 10. The scale of the graticule is sub-divided into millimetre steps; 0.01 mm can be read off accurately from the drum of the measuring screw (fig. 4).



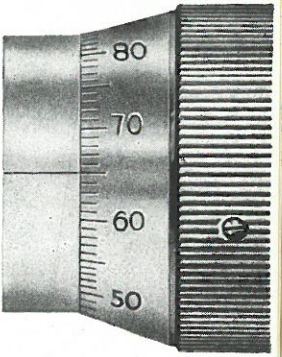


Fig. 4
Field of view of the eyepiece screw micrometer with lateral measuring screw

Example of actual reading:

Scale	4	mm
+ drum	0.65	mm
=	4.65	mm or
	463 intervals resp.	

In order to maintain the parfocality and correction of our microscope objectives, a shortened tube 23.2/91 must be envisaged when using this type of eyepiece, since this assembly causes the intermediate image plane to be situated higher up in the eyepiece.

The micrometer value is ascertained as described in para. 1.2.3.

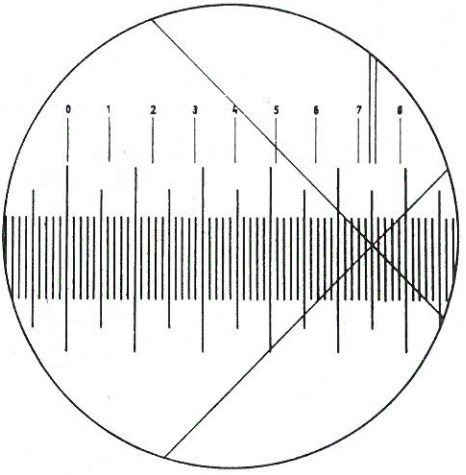


Fig. 5
Field of view of the eyepiece screw micrometer, together with the graduation of the stage micrometer, on ascertaining the micrometer value

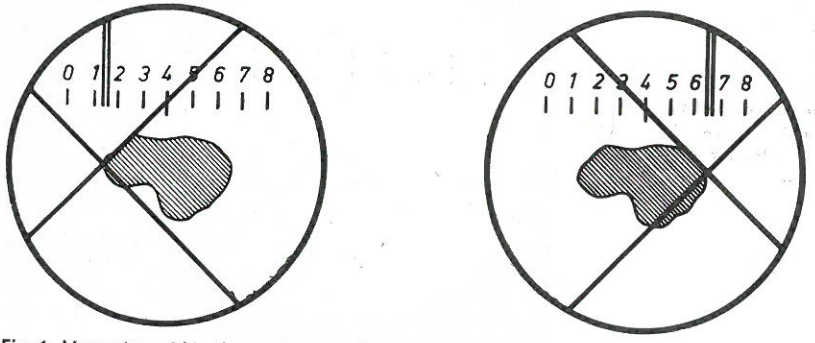


Fig. 6. Measuring within the specimen at the two extreme ends

The measurement of the specimen is carried out as follows:

The intersection of the cross-line is, for the moment, set onto the one extreme end of the distance to be measured and the value n_1 read off by determining within the eyepiece proper the position of the double line in whole units of the scale and the hundredths from the drum reading being added (see fig. 4). An analogous method is employed at the other extreme end n_2 of the distance to be measured. The difference between the two readings is the magnitude of the distance to be measured, as seen in the intermediate image which, when multiplied by the micrometer value previously determined, will produce the magnitude l within the object.

Therefore

$$l = (n_2 - n_1) \cdot m \qquad (4)$$

Example 4:

Let the readings found in fig. 6 be $n_1 = 142$ and $n_2 = 668$, the micrometer value previously measured is $m = 0.25\ \mu$.

$$l = (668 - 142) \times 0.25$$

$$\underline{\underline{l = 131.5\ \mu}}$$

1.4. Measuring the distance with the mechanical stage

With objects of large areas it may easily occur that these cannot be encompassed within the field of view of the microscope. A graduated mechanical

stage will permit the measuring of the specimen. The accuracy of this measurement depends on the vernier of the mechanical stage.

The measurement is carried out as follows:

An eyepiece cross-line disc (fig. 15) or a measuring and counting disc (fig. 14) is inserted into the adjustable eyepiece. The one end-point of the object is brought below the centre of the cross-line by moving the pinion heads of the mechanical stage, and the co-ordinates x_1 and y_1 of the mechanical stage are read off. Thereupon the other end is moved below the cross-line centre, and the coordinates x_2 and y_2 are ascertained. The distance measured may then be calculated in accordance with the following relation

$$l = \sqrt{(x_1-x_2)^2 + (y_1-y_2)^2} \qquad (5)$$

2. Using the stage micrometers

The stage micrometers do not solely serve for the determination of the micrometer value of the ocular micrometers or the graduation of the eyepiece screw micrometer. They may also be applied for the following purposes.

2.1. Determining the scale value of the intermediate image

When relating the image y^1 shown in the intermediate plane to the magnitude y of the object, the scale value will be obtained as

$$M = \frac{y'}{y} \qquad (6)$$

The objectives for a tube length of 160 mm will project a real image (see *1* and *9*, fig. 1) in the intermediate plane in the engraved scale. However with objectives having the tube length oo, the image will originate in the infinite, as in case of a magnifier. For this reason these objectives have been clearly designated with an x sign after their low-power magnification value. The real image will be projected in the intermediate image plane by means of a tube lens.

With the aid of the stage micrometer and an eyepiece micrometer, supplied as an eyepiece measuring disc, the scale of the intermediate image can be measured. This is accomplished, as shown in para. 1.2.3., by using formula (6).

In this case the interval division of the stage micrometer and that of the eyepiece micrometer must be known. With the determination of the scale number, two known distances are related to one another, in contradistinction to the determination of the micrometer value, where the graduation of the eyepiece micrometer is compared with the stage micrometer. The scale number is thus a magnitude without a dimension which will state how many times greater the object will be reproduced in the intermediate image plane by the optical system.

When using an eyepiece with field diaphragm (e. g. eyepiece PK 12.5 × [16] fig. 19 and fig. 20 in the centre) and a tube without length correction optics, the engraved scale number on our company's objectives for a tube length of 160 mm corresponds to that measured (it must be remembered that production tolerances may cause the engraved scale number to differ slightly from the measured one). For objectives with the tube length oo and the use of a tube lens with a factor of × 1, the magnification as measured will correspond to that engraved, within narrow limits.

In all other cases, i. e. with divergent tube factors and eyepieces, in which the visual field diaphragm ist situated between the field lens and the eye lens, scale numbers differing from those engraved will result.

2.2. Measuring the image scale in photomicrographs

The calculation of the image scale in the film plane, in accordance with known relations, will lead only to approximate values, since the actual values of M- or ^{V} Objective, ^{M} Projective, ^{V} Eyepiece, etc. respectively, may differ from the engraved values within a tolerance limit. The precise determination of camera length in the case of bellows cameras, raises difficulties, since the points of the system required (e. g. exit pupil of the microscope) are difficult to pinpoint.

The more practical determination of the image scale, both for low-power photographs and photographs taken with the compound microscope, will lead via one particular type of measurement.

This measurement is carried out in the following manner:

The stage micrometer is reproduced on the ground glass screen of the camera with the aid of pre-selected optics and length of camera. On the ground glass

screen as many intervals as possible of the image of the graduation are measured with a rule or preferably with a slide caliper.

The scale ratio then results from the quotient of the distance y′ measured to the distance y on the stage micrometer (viz. equation 6). Attention must be paid to identical units of measurement. It is possible to obtain standard scales by variations in the camera length.

Example 5:

With a slide caliper a distance of 30 mm has been measured on the ground glass scale for 6 intervals of the stage micrometer. The graduation value of the stage micrometer is 0.01 mm.

$$M = \frac{30}{6 \times 0.01}$$

$$\underline{\underline{M = 500 : 1}}$$

3. Counting with the microscope

A soon as particles are to be counted in a microscopic specimen in definite areas, our company's eyepiece squared micrometers (fig. 12)), eyepiece diaphragms according to Ehrlich (fig. 16) or the eyepiece measuring and counting disc (fig. 14) may be utilised.

These eyepiece discs for counting purposes are placed in the field diaphragm of the eyepiece, similar to the eyepiece measuring disc, and the eyepiece is used in the same manner, as described in para. 1.2.2.

The size of area in the object must also be determined for counting purposes. For this purpose the micrometer value must be determined as in paras, 1.2.2. and 1.2.3. It then corresponds either to the length of the edge of a square or to the radius of a quadrant in the object. From this value the total surface area of the individual squares or the quadrants can be determined in accordance with established geometrical relations.

Example 6:

5 divisions of the stage micrometer have been found to coincide with 4 divisions of an eyepiece squared micrometer. The graduation value of the stage micrometer is 0.01 mm.

$y = 5 \times 0.01$ mm $\qquad y' = 4$

m = length of edge of a square within the object

$$m = \frac{y}{y'} = \frac{0.05}{4} = 0.0125 \text{ mm}$$

$m = 12.5\ \mu$

An individual square therefore has a surface area of $F = m^2$!

$F = 12.5^2$

$F = 256\ \mu^2$

4. Accessories for measuring and counting

4.1. Stage micrometer and scales

4.1.1. Stage micrometers for objectives with a higher scale number

When dealing with objectives with a higher scale number or magnification respectively (greater than 10:1), stage micrometer 1/0.01 or 0.05″)/0.0005″) must be used.

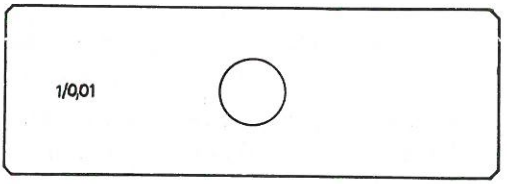


Fig. 7
Stage micrometer 1/0.01 for transmitted light

For transmitted light (fig. 7) the graduation has been applied to a glass slide and covered with a cover glass, 0.17 mm thick. For the purpose of locating the graduation more easily, it has been given a black circular surround. It is one millimetre long and divided into a 100 parts, so that one interval measures 0.01 mm (see 4 fig. 1).

For incident light, stage micrometers in millimetres or inches are supplied. The

graduation is situated on a circular disc (whose surface is ground) cemented to a metal object slide. The stage micrometer in millimetres has the same graduation as that for transmitted light; for the inch graduations 0.05″) are divided into 100 parts, so that an interval measures 0.0005″).

4.1.2. Stage micrometer 70/0.5 with glass scale 100/0.5

These two measuring scales have been provided for objectives with a low scale ratio number (smaller than 10:1), low-power objectives M and for the stereomicroscope SM XX.

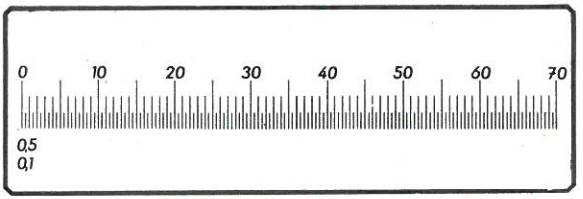


Fig. 8. Stage micrometer 70/0.5 Graduation 0.1 mm between 30 and 40 mm

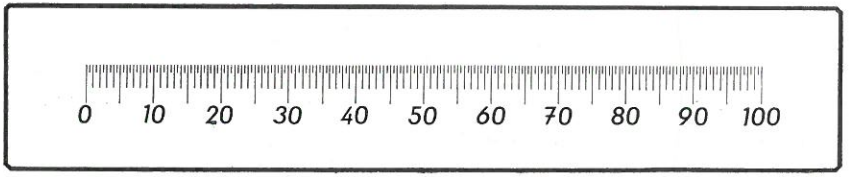


Fig. 9. Glass measuring scale 100/0.5

The stage micrometer 70/0.5 (fig. 8) possesses a continuous graduation with a graduation value of 0.5 mm; between 30 and 40 mm the graduation value is 0.1 mm.

The graduation of the glass measuring scale 100/0.5 (fig. 9) is 100 mm long, the graduation value being 0.5 mm. This type of glass measuring scale can be used for purposes other than those mentioned above for determining the image scale in photomicrographic pictures, by placing it on the focussing screen of the camera and then comparing the two graduations (see para. 2.2.) with one another.

4.2. Eyepiece discs

4.2.1. Eyepiece measuring discs

For those measurements described in para. 1.2., eyepiece micrometers are required as an "auxiliary standard" which are supplied by this company as eyepiece measuring discs. The eyepiece measuring discs 5:100 (5 mm in 100 parts, interval distance 0.05 mm – fig. 10) and 10:100 (10 mm in 100 parts, interval distance 0.1 mm – fig. 11) are supplied for the adjustable eyepieces with a plug-in diameter of 23.2.

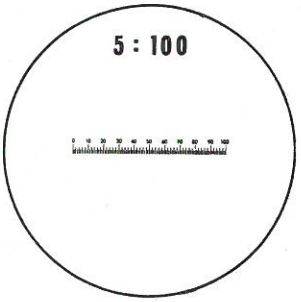


Fig. 10. Eyepiece measuring disc 5:100

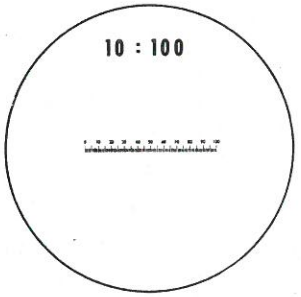


Fig. 11. Eyepiece measuring disc 10:100

An eyepiece measuring disc 10:100 for the eyepiece 12.5× (15) adjustable for SM XX is also contained in our production programme.

4.2.2. Eyepiece squared micrometers

Our eyepiece squared micrometers have been designed for counting purposes (see para. 3.).

Eyepiece squared micrometers 400/0.5 × 0.5 – (fig. 12) and 25/1 × 1 (fig. 13) are manufactured for adjustable eyepieces with a plug-in diameter of 23.2 mm. The first one has a large square with sides of 10 mm. It is divided into 400 small squares with sides of 0.5 mm. The micrometer 25/1 × 1 has a large square with 5 mm sides, which is sub-divided into 25 individual squares with 1 mm sides.

For the adjustable eyepiece 12.5 × (15) for SM XX our company supplies the eyepiece squared micrometer 25/1 × 1.

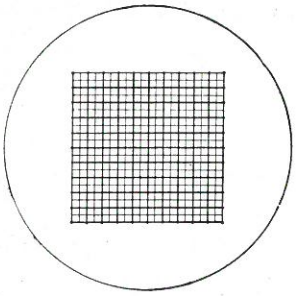


Fig. 12. Eyepiece squared micrometer 400/0.5×0.5

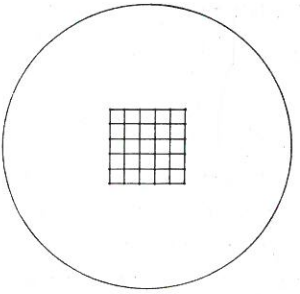


Fig. 13. Eyepiece squared micrometer 25/1×1

4.2.3. Eyepiece measuring and counting disc

This disc (fig. 14) is suitable for both measuring and counting purposes. Further it is possible with the aid of the disc to bring any particularly interesting section of the specimen into the centre of the field of view and to carry out distance measurements with the mechanial stage (para. 1.4.) for large-area specimens.

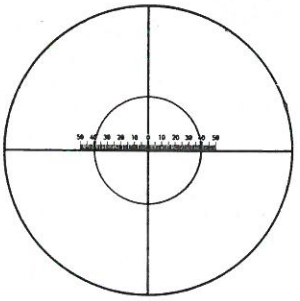


Fig. 14. Eyepiece measuring and counting disc

Its layout is as follows:

On a cross-line, the horizontal arm is divided in both directions into 50 parts of 0.1 mm each. In addition there is also a circle of 8 mm diameter which thus produces four counting quadrants.

This disc is manufactured for adujstable eyepieces with a plug-in diameter of 23.2 mm and for the eyepiece 12.5 × (15) for SM XX.

4.2.4. Eyepiece graticule

This disc (fig. 15) permits of moving an interesting part of the specimen into the centre of the field of view and, moreover, distance measurements be accomplished with its aid and the use of the mechanial stage, whenever such distances extend beyond the field of vision of the microscope (see para. 1.4.).

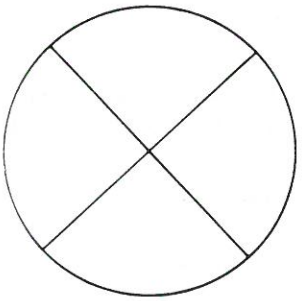


Fig. 15
Eyepiece graticule

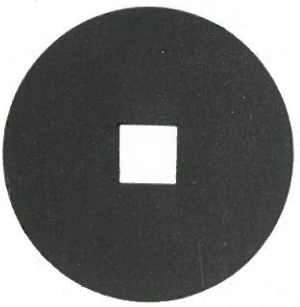


Fig. 16
Eyepiece diaphragm according to Ehrlich, sides of the square 4 mm
(enlargement twice full size)

4.2.5. Eyepiece diaphragms according to Ehrlich

These eyepiece diaphragms (fig. 16) are opaque diaphragms in the centre of which a square field has been left open for observation.

One set consists of seven pieces with a length of edge of 1 mm; 1.41 mm; 2 mm; 2.83 mm; 4 mm; 5.66 mm and 8 mm. The lengths of the sides are stepped in the ratio $\sqrt{1:2}$ and therefore the areas in the ratio 1:2.

These diaphragms are supplied for adjustable eyepieces with a plug-in diameter of 23.2 mm.

4.3. Adjustable eyepieces and MF measuring projectives

4.3.1. Adjustable eyepieces for achromats



Fig. 17
Eyepiece A 10 × (14)
adjustable – total view

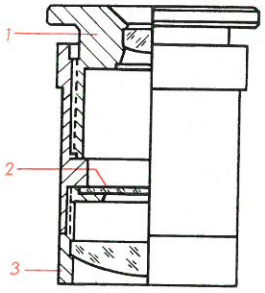


Fig. 18
Eyepiece A 10 × (14) sectional diagram
1 adjustable eye lens
2 eyepiece disc inserted into the field diphragm
3 demountable lower part with field lens

The eyepiece A 10 × (14) adjustable (figs. 17 and 18) ist available for the achromat series of our manufacture. The eyepiece is a Huygens type, i. e. the field diaphragm on which the eyepiece disc is placed, is situated between the field lens and the adjustable eye lens.

4.3.2. Adjustable eyepieces for apochromats, plane-field achromats and plane-field apochromats

For use in conjunction with the above mentioned objectives, eyepieces from the PK series, such as PK 6,3 × (19) adjustable, PK 12,5 × (16) adjustable, and PK 25 × (7) adjustable, are intended for measuring and counting purposes. The eyepiece PK 12,5 × (16), adjustable, (figs. 19 and 20 – centre) is designed as an orthoscopic type, i. e. the field diagram is a frontal diaphragm situated in front of the first lens. Alone with this type of eyepiece can the scale number of an objective be determined (see para. 2.1.).



Fig. 19

Eyepieces PK 6.3× (19), adjustable (left hand)
PK 12.5× (16), adjustable (centre)
and PK 25× (7), adjustable (right hand).

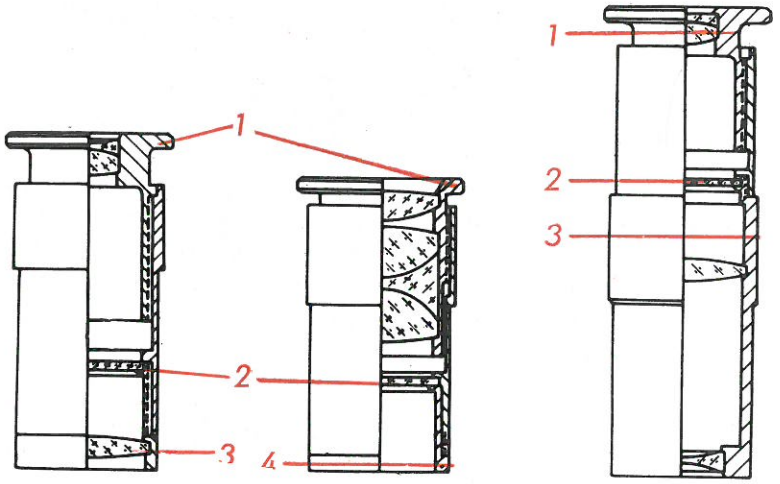


Fig. 20

Eyepieces PK 6.3× (19), adjustable (left hand)
PK 12.5× (16), adjustable (centre)
and PK 25× (7), adjustable (right hand).
Sectional diagram
1 adjustable eye lens
2 eyepiece disc inserted in the field diaphragm
3 demountable lower part with field lenses;
4 demountable lower part without field lens (frontal diaphragm)

The eyepieces PK 6.3× (19), adjustable (figs. 19 and 20 – left hand) and PK 25× (7), adjustable (figs. 19 and 20 – right hand) incorporate a central diaphragm, i. e. the field diaphragm is situated between the field lens and adjustable eye lens.

4.3.3. Eyepieces PK 12.5 × (14), adjustable and PK 12.5 × (16 m), adjustable

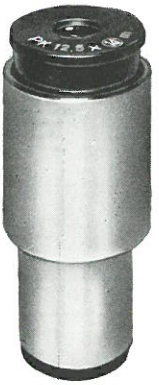


Fig. 21
Eyepiece PK 12.5× (14) m, adjustable
Total View

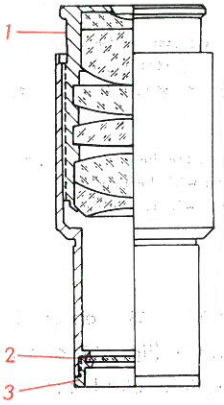


Fig. 22
Eyepiece PK 12.5× (14) m, adjustable – Sectional diagram
1 adjustable eye lens
2 eyepiece disc inserted into the field diaphragm
3 demountable lower part

The above mentioned eyepieces have been developed for the Large Universal Research Microscope Nu and our Large Incident-Light Camera Microscope NEOPHOT 2 – With the aid of these eyepieces an excellent flattening of the field of vision is obtained.

For microscope Nu use eyepiece PK 12.5 × (14) m, adjustable (figs. 21 and 22) and for microscope NEOPOHT 2 eyepiece PK 12.5 × (16) m.

4.3.4. Eyepiece 12.5 × (15), adjustable, for SM XX

We supply the above adjustable eyepiece for our stereomicroscope SM XX.



Fig. 23
Eyepiece 12.5× (15), adjustable,
for SM XX
Total View

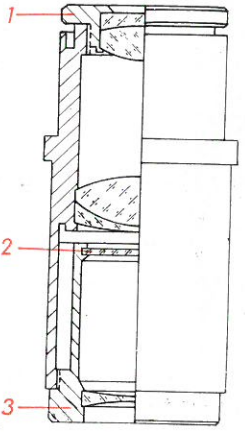


Fig. 24
Eyepiece 12.5× (15), adjustable,
for SM XX
Sectional diagram
1 adjustable eye lens
2 eyepiece disc inserted into the
field diaphragm
3 demountable lower part with field lens

In this instance too, the field diaphragm is situated between the field lens and the adjustable eye lens.
With the aid of intermediate sleeves 23.2/34, the standard type of adjustable eyepieces can be used together with stereomicroscope SM XX.

4.3.5. MF measuring projectives

When determining the size of or counting details of an object, it may often be advantageous to record at the same time a comparison scale or a counting grid on the photomicrograph.
Our MF measuring projectives 4:1 (figs. 25 and 26), as also K 4:1 and K 8:1 (figs. 27 and 28), which are however non-adjustable, since they are used with a constant camera length, are employed with our photomicrographic equipment "MF".
Should concurrently the true relations of size within the object be recorded, then in this instance too the micrometer value must be determined and quoted individually for each photomicrograph.
With our measuring projectives, the eyepiece disc is inserted into the demountable lower part and secured with a retaining ring.



Fig. 25
MF Measuring projective 4:1
Total View

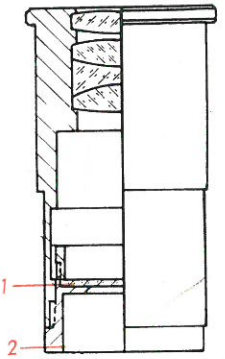


Fig. 26
MF Measuring projective 4:1
Sectional diagram
1 Eyepiece disc, secured with retaining ring
2 Demountable lower part

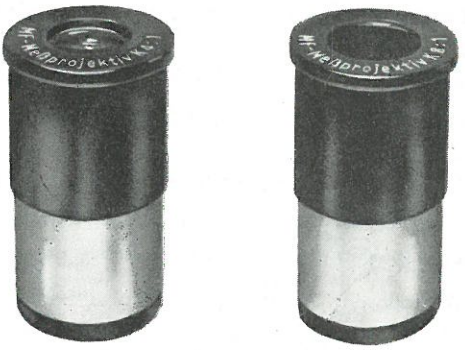


Fig. 27
MF Measuring projectives K 4:1 (left hand) and K 8:1 (right hand) Total View

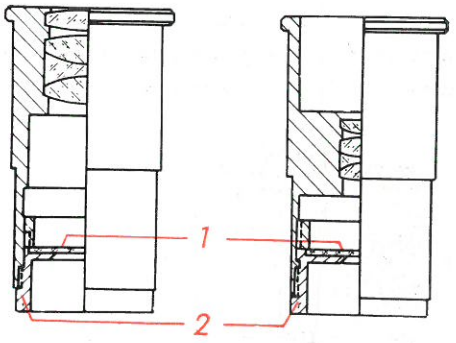


Fig. 28
MF Measuring projectives K 4:1 (left hand) and K 8:1 (right hand) Sectional diagram
1 Eyepiece disc, secured with retaining ring
2 demountable lower part

5. Hints for measuring and counting

Before commencing with the actual measurement or count, the operator must have a clear picture of his measuring problem, i. e. he must estimate the size of the object details to be measured and which object field is to be viewed in

this particular connection. Subsequently only the choice of optical combinations should be made, since failure to do this can only result in errors of measurement.

Based upon the object detail to be measured, the choice of numerical aperture of the objective (power of resolution) and the choice of the total magnification (actual resolution) must be made. It is highly desirable that measurements are made at the upper limit of useful magnification, for the purpose of obtaining an improved appraisal of the point to be measured in the specimen.

The following tables and graphs give the following information:

Tables 1 to 4:

Total magnification with adjustable eyepieces, object field areas resulting herefrom and average micrometer values for transmitted-light objectives (tables 1, 2 and 3) and for the stereomicroscope SM XX with a tube factor of $\times 1$.

The figures stated serve only as a guide; when carrying out accurate measurements, it is advisable to determine the micrometer values individually on one's own!

For incident-light objectives no tables have been compiled, since the tube factors vary amongst individual equipment.

Graph 1

Power of resolution for the numerical apertures from 0.01 to 1.4 based on

$$d = \frac{\lambda}{2A} \quad (\text{for } \lambda = 0.55\,\mu)$$

Graph 2

The "actual resolution", resulting from a suggestion by A. GRABNER[1]) which was, in fact, computed in accordance with our usual custom for angles of resolution of the eye of 4′ (corresponds to 1000 times the aperture).

---

1) Cf. A. GRABNER: „Objective, Eyepiece and the Eye – a balance of their interplay in microscopy", „MIKROSKOPIE" **10** (1955), No. 3/4, pages 83–119: in German.

Table 1: Achromats

Objective \ Eyepiece	A 10 × (14) adjustable	Eyepiece Screw Micrometer with tube 23.2/91	Eyepiece Screw Micrometer with tube 23.2/120
3.2/0.10 160/–	32 × 4.38 mm 40.8 µ	48 × 3.28 mm 3.20 µ	60 × 2.83 mm 2.62 µ
6.3/0.16 160/–	63 × 2.22 mm 20.3 µ	94.5 × 1.67 mm 1.60 µ	113.7 × 1.41 mm 1.32 µ
10/0.25 160/–	100 × 1.40 mm 13.1 µ	150 × 1.05 mm 1.00 µ	171.5 × 0.92 mm 0.88 µ
16/0.32 160/0.17	160 × 0.80 mm 8.2 µ	240 × 0.66 mm 0.63 µ	277.5 × 0.57 mm 0.54 µ
40/0.65 160/0.17	400 × 0.35 mm 3.3 µ	600 × 0.26 mm 0.25 µ	675 × 0.23 mm 0.22 µ
HI 100/1.25 160/0.17	1000 × 0.14 mm 1.3 µ	1500 × 0.11 mm 0.10 µ	1680 × 0,09 mm 0.09 µ

Code: Upper figure: total magnification with tube factor of × 1

Central figure: object field diameter with tube factor of × 1

lower figure: for adjustable eyepieces – micrometer value for eyepiece measuring disc 10:100

eyepiece screw micrometer – micrometer value for interval of 0.01 mm.

Table 2: Apochromats

Eyepiece / Objective	PK 6.3 × (19) adjustable	PK 12.5 × (16) adjustable	PK 25 × (7) adjustable	Eyepiece Screw Micrometer AK 15 x with tube 23.2/91	Eyepiece Screw Micrometer AK 15 x with tube 23.2/120
Plane-field apochromat 4/0.16 160/–	25 × 4.75 mm 34.1 µ	50 × 4.00 mm 25.2 µ	100 × 1.75 mm 11.0 µ	60 × 2.63 mm 2.52 µ	713 × 2.21 mm 2.10 µ
Apochromat 6.3/0.20 160/–	40 × 3.00 mm 21.6 µ	80 × 2.50 mm 16.0 µ	160 × 1.11 mm 6.9 µ	94.5 × 1.67 mm 1.60 µ	108 × 1.46 mm 1.39 µ
Apochromat 16/0.40 160/0.17	100 × 1.19 mm 8.4 µ	200 × 1.00 mm 6.3 µ	400 × 0.44 mm 2.7 µ	240 × 0.66 mm 0.63 µ	273 × 0.57 mm 0.55 µ
Apochromat 40/0.95 160/0.17	250 × 0.48 mm 3.4 µ	500 × 0.40 mm 2.5 µ	1000 × 0.18 mm 1.1 µ	600 × 0.26 mm 0.25 µ	678 × 0.23 mm 0.22 µ
Apochromat 63/0.95 160/0.17	400 × 0.30 mm 2.1 µ	800 × 0.25 mm 1.6 µ	1600 × 0.11 mm 0.7 µ	945 × 0.17 mm 0.16 µ	1070 × 0.15 mm 0.14 µ
Apochromat HI 100/1.40 160/0.17	630 × 0.19 mm 1.4 µ	1250 × 0.16 mm 1.0 µ	2500 × 0.07 mm 0.4 µ	1500 × 0.11 mm 0.10 µ	1680 × 0.094 mm 0.09 µ

Code: Upper figure: total magnification with tube factor of × 1

Central figure: object field diameter with tube factor of × 1

lower figure: for adjustable eyepieces – micrometer value for eyepiece measuring disc 10:100

eyepiece screw micrometer – micrometer value for interval of 0.01 mm

Table 3: Plane-field Achromats

Objective \ Eyepiece	PK 6,3 × (19) ad ustable	PK 12,5 × (16) adjustable	PK 25 × (7) adjustable	Eyepiece screw Micrometer AK 15 x with tube 23.2/91	Eyepiece screw Micrometer AK 15 x with tube 23.2/120
2.5/0.07 160/–	16 × 7.60 mm 53.8 µ	32 × 6.30 mm 40.0 µ	63 × 2.80 mm 17.2 µ	37.5 × 4.20 mm 4.00 µ	50 × 3.15 mm 3.02 µ
4/0.11 160/–	25 × 4.75 mm 34.1 µ	50 × 4.60 mm 25.2 µ	100 × 1.75 mm 11.0 µ	60 × 2.63 mm 2.52 µ	71.3 × 2.21 mm 2.10 µ
6.3/0.16 160/–	40 × 3.00 mm 21.0 µ	80 × 2.50 mm 15.5 µ	160 × 1.11 mm 6.8 µ	94.5 × 1.67 mm 1.55 µ	111.7 × 1.41 mm 1.33 µ
10/0.25 160/–	63 × 1.90 mm 13.4 µ	125 × 1.60 mm 10.0 µ	250 × 0.70 mm 4.4 µ	150 × 1.05 mm 1.00 µ	176.5 × 0.89 mm 0.85 µ
16/0.32 160/0.17	100 × 1.19 mm 8.4 µ	200 × 1.00 mm 6.3 µ	400 × 0.44 mm 2.7 µ	240 × 0.66 mm 0.63 µ	274 × 0.57 mm 0.55 µ
40/0.65 160/0.17	250 × 0.48 mm 3.3 µ	500 × 0.40 mm 2.5 µ	1000 × 0.18 mm 1.1 µ	600 × 0.26 mm 0.25 µ	678 × 0.23 mm 0.22 µ
HI 100/1.25 160/0.17	630 × 0.19 mm 1.3 µ	1250 × 0.16 mm 1.0 µ	2500 × 0.07 mm 0.4 µ	1500 × 0.11 mm 0.10 µ	1710 × 0.09 mm 0.09 µ

Code: Upper figure: total magnification with tube factor of × 1

Central figure: object field diameter with tube factor of × 1

lower figure: for adjustable eyepieces – micrometer value for eyepiece measuring disc 10:100

eyepiece screw micrometer – micrometer value for interval of 0.01 mm

Table 4: Stereomicroscope SM XX with eyepiece 12.5, adjustable and eyepiece measuring disc 10:100

Dialling drum	0.63 ×	1.0 ×	1.6 ×	2.5 ×	4.0 ×
Magnification	8 ×	12.5 ×	20×	32 ×	50 ×
dia. of object field	23.8 mm	15 mm	9.4 mm	6.0 mm	3.8 mm
Micrometer value for stage micrometer 70/0.5 for an interval value of 0.1 mm	117 µ	75 µ	47 µ	29 µ	19 µ

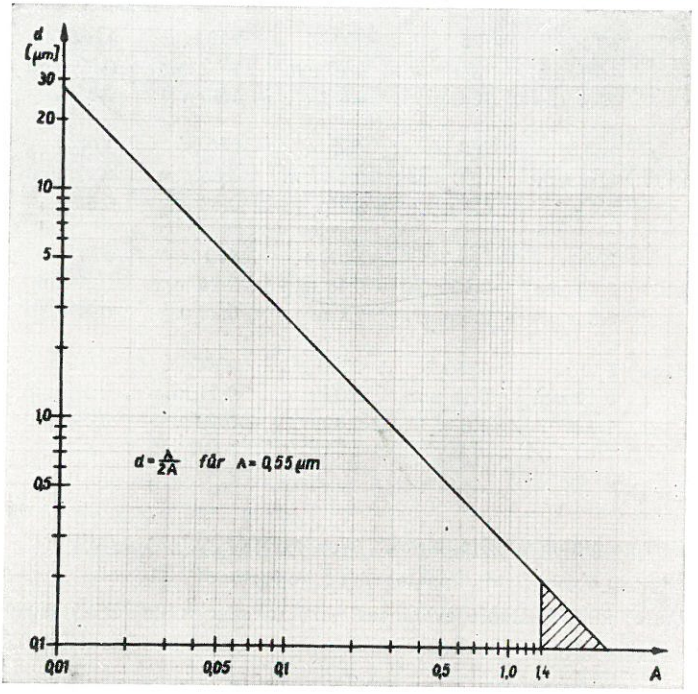
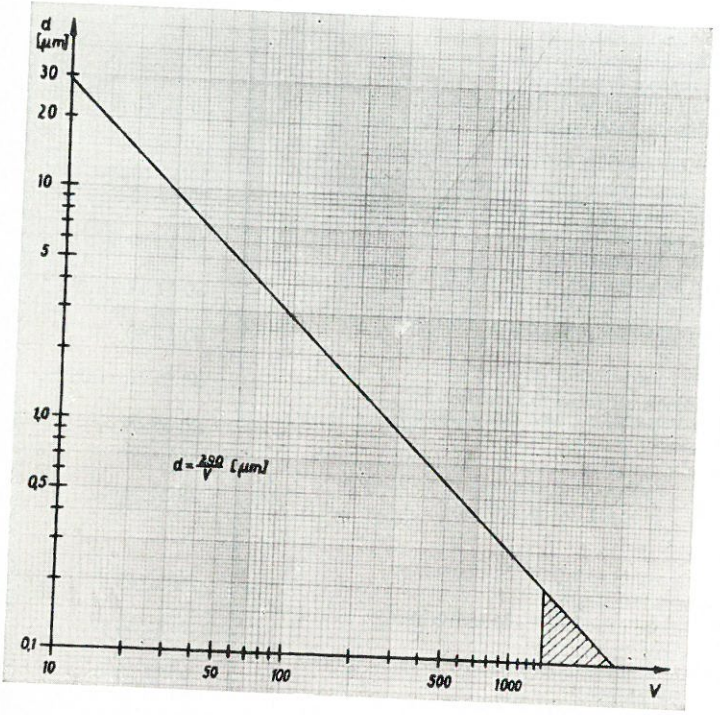


Diagram 1:

Resolution for numerical apertures from 0.01 to 1.4

Diagram 2:

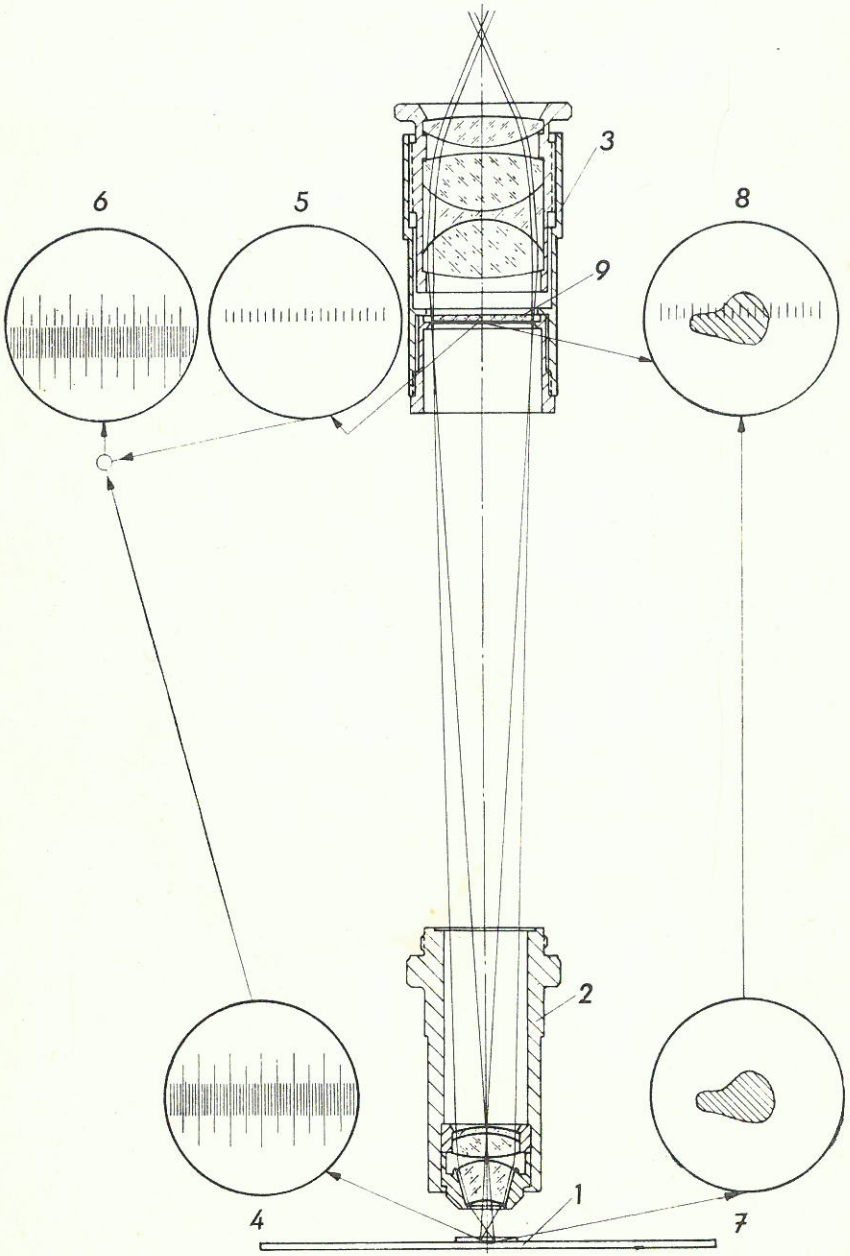
Actual resolution for total magnifications from × 10 to × 1400 for a power of resolution of the eye of 4'.



Specification

Accessories for measuring and counting

1. Adjustable eyepieces	
Eyepiece A 10 ×, adjustable (without measuring disc)	30 31 06 : 001.24
Eyepiece PK 6.3 × adjustable (without measuring disc)	30 33 13 : 001.24
Eyepiece PK 12.5 ×, adjustable (without measuring disc)	30 33 14 : 001.24
Eyepiece PK 25 ×, adjustable (without measuring disc)	30 33 15 : 001.24
Eyepiece 12.5 ×, adjustable for SM XX (without measuring disc)	30 31 65 A
Measuring projective 4:1 (without measuring disc)	30 32 38 A
Measuring projective K 4:1 (without measuring disc)	30 32 39 A
Measuring projective K 8:1 (without measuring disc)	30 32 40 A
2. Eyepiece measuring discs and graticules:	
Eyepiece measuring disc 5:100, in container	30 57 10 A
Eyepiece measuring disc 10:100, in container	30 57 10 B
Eyepiece measuring disc 10:100 (22 mm dia.) for SM XX, in container	30 57 10 D
Eyepiece squared micrometer 400/0.5 × 0.5, in container	30 57 14
Eyepiece squared micrometer 25/1 × 1, in container	30 57 48
Eyepiece squared micrometer 25/1 × 1 (22 mm dia.) for SM XX, in container	30 57 10 : 005.26
Eyepiece measuring and counting disc, in container	30 57 49
Eyepiece cross-line disc, in container	30 57 16
Eyepiece diaphragms, according to Ehrlich (1 set of 7 pieces), in container	30 57 36
3. Stage micrometers:	
Stage micrometer 1/0.01, in container (for transmitted light)	30 57 43 F
Stage micrometer 1/0.01, in container (for incident light)	30 57 43 C
Stage micrometer 0.05″)/0.0005″), in container (for incident light)	30 57 43 D
Stage micrometer 70/0.5, glass scale	30 57 43 H
Glass scale 100/0.5	30 57 25-01
4. Eyepiece screw micrometer AK 15, in container	30 57 31


6
5
3
8
9
2
4
1
7

VEB Carl Zeiss JENA

Sales Department for Microscopes
Telephone: Jena 2 70 42 · Telex: Jena 058 8622

Brochure No. 30-G 492-2

V-5-1 309 M(p) G-7/171/66