# ORTHOPLAN-POL
## Large Polarizing Microscope

## Instructions

550-32/Engl.

# ORTHOPLAN-POL
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## Instructions


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# 1 Introduction

The ORTHOPLAN-POL is a large binocular polarizing microscope with very versatile possibilities of expansion. In addition to all the methods of investigation common in polarizing microscopy in incident and transmitted light all the methods used in general microscopy such as brightfield, darkground, phase contrast, fluorescence, etc. can be used as all the important structural components can be simply interchanged.

Further special attachments such as interference attachments for incident and transmitted light, spectral lamps, gas discharge lamps of up to 500W, microscope photometers for absorption, reflection, and diffuse reflection measurement, micro-hardness testers, etc. are available.

Characteristic of the ORTHOPLAN-POL in addition to its operational versatility is the remarkable operating convenience and excellent optical performance based on the new series of NPl-pol-free transmitted-light objectives.

The planetary gear for the vertical adjustment of the large object stage first used in the ORTHOPLAN® stand ensures reliable and delicate adjustment of the microscopic image.

All photomicrographic attachments for 35mm and large-format photography can be used. The combination with the ORTHOMAT® fully automatic 35mm camera or the 4 x 5″ large-format camera with fully automatic exposure control constitutes a most convenient-to-use polarizing photo-microscope.

# 2 Unpacking and assembling the microscope

The following components are packed in a special container:

1. Microscope stand with changing guides for all components to be attached
2. Microscope tube
3. Object stage with changing piece and condenser carrier
4. 1 or 2 Lamp Housings 100 or 100 Z
5. Components such as objectives, eyepieces, condenser, dustcover, etc.

Transformers and other heavy supplementary parts are packed separately. When the consignment is unpacked compare the items carefully with the packing note and ascertain that no small parts are left among the packing material.
All the mechanical and optical components are cleaned and packed in dustproof wrappings prior to despatch. After unpacking any contamination with dust or dirt must be scrupulously avoided, particularly touching the objective and eyepiece lenses.
Any accidental fingermarks on glass surfaces must be carefully removed immediately with a soft piece of chamois leather or a well-washed linen rag. Even slight traces of finger sweat can rapidly attack the surfaces of high-quality optical glasses.

**Workroom and workplace**

The workroom must fulfil some basic requirements. It should be as free as possible of dust, and oil- or chemical vapours which could attack optical and mechanical parts. In addition it should not be exposed to great temperature variations or vibrations. The socket for the built-in illuminator should be fitted with a 10amp fuse.
Ascertain correct type of current and voltage.

# 3 Technical description

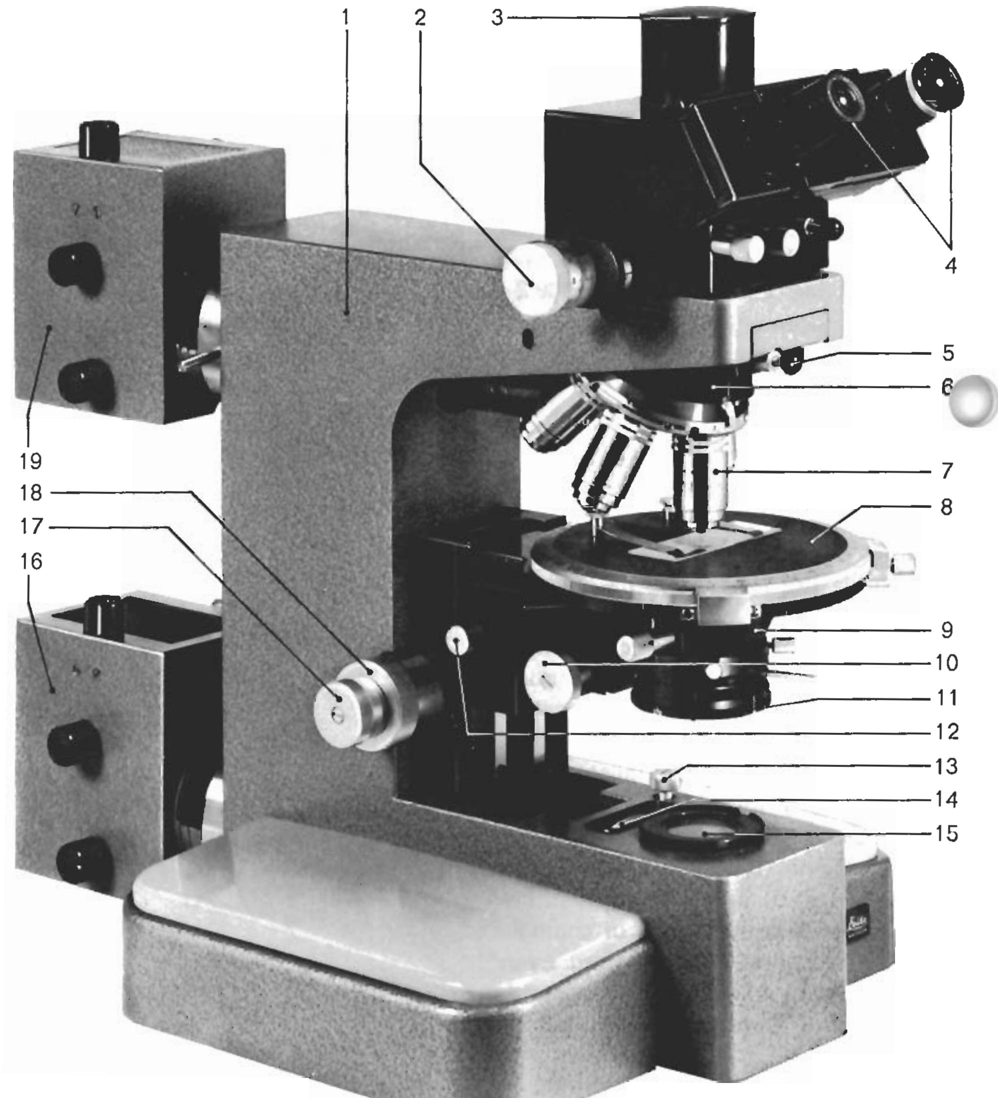



Fig. 1 **ORTHOPLAN-POL**

1 ORTHOPLAN stand
2 Analyser drum
3 Pol-photo tube
4 Eyepieces
5 Lever for operating the additional lens
6 Objective centring revolving nosepiece
7 Pol-NPI objectives
8 Object stage
9 Pol-condenser
10 Vertical adjustment of the condenser
11 Rotating mount of the polarizer
12 Clamping screw on the object stage changing device
13 Lamp condenser
14 Field diaphragm
15 Dustglass with filter support
16 Lamp Housing 100 for transmitted light
17 Fine adjustment
18 Coarse adjustment
19 Lamp Housing 100 for incident light

## 31 Stand

The ORTHOPLAN-POL consists of the basic stand (Fig. 1.1) with the Lamp Housing 100 (Fig. 1.16) attached and the built-in field diaphragm (Fig. 1.14) in the foot. The coaxial coarse and fine adjustment (1.17, 18) actuates the object stage (1.8) and has a total lift of 40mm. Within this range the fine adjustment operates without limit. The object stage (1.8) can in addition be vertically adjusted in the changing guide (1.12). The precision, robustness, and freedom from maintenance of the planetary gear used here offers high accuracy and reliability of adjustment. One turn of the fine adjustment knob (1.17) corresponds to a vertical displacement of the object stage through $^1/_{10}$mm, i.e. one drum division to 1 $\mu$m. A detailed description of this device is available to technically interested persons in our brochure "The planetary gear of the ORTHOPLAN, a precision transmission in microscope design" 512-101.

### 3.2 Illuminator

For ordinary microscopic work the ORTHOPLAN-POL microscope is equipped with a 12v 60W bulb in the Lamp Housing 100 (Fig. 2). The lamp is connected to the mains via a continuously regulating transformer (Fig. 19); it is centred in its mount and inserted in the lamp housing in place of the reflector. The centring knobs (2.21 and 23) serve for the vertical and lateral adjustment of light sources to be inserted in the lamp housing from below, such as halogen and gas-discharge lamps. By focusing of the lamp condenser (2.22) a uniform illumination of the microscopic field of view is achieved. Colour-, conversion-, or light suppression filters can be inserted, and spectral lamps can also be used. The lamp housing is firmly joined to the stand after the securing ring (2.25) has been locked. Lamp and method of mounting are identical for use with transmitted- and with incident light. Section "Accessories", p. 28 deals with other light sources and lamp housings.

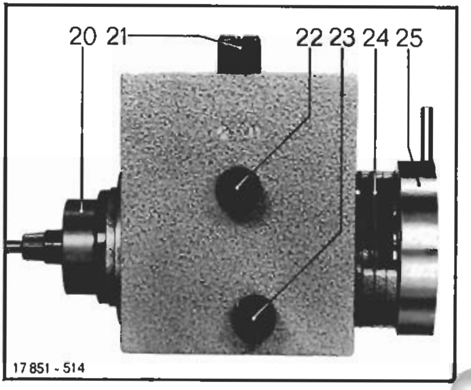



Fig. 2 **Lamp Housing 100**

20 Lamp mount for the 12v 60W bulb
21 Knob for vertical adjustment
22 Knob for the adjustment of the lamp condenser
23 Knob for lateral adjustment
24 Filter holder
25 Securing ring

## 3.3 Pol-photo tube

The Pol-photo tube FSA 50 (Fig. 3) is equipped with a binocular inclined eyepiece tube with automatic sharpness compensation and accepts eyepieces of 23.2mm dia. The built-in analyser, which can be rotated through 360°, has vernier readings (3.27) to an accuracy of 0.1°; it can be engaged and disengaged on a horizontal slide (4.33) running on ball bearings. A built-in, centring and focusing Bertrand lens (4.34) allows the binocular observation of interference-figures. A pinhole stop (3.32) in conjunction with an additional lens (1.5) in the revolving nosepiece or in the objective centring clutch (Fig. 6) allows the masking of the interference figure of small objects.

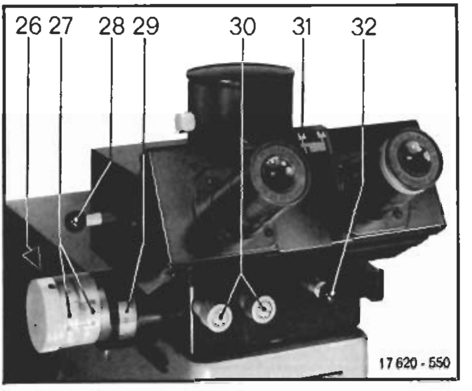



Fig. 3 **Pol-photo tube**

26 Clamping screw for the analyser drum (concealed)
27 Analyser drum with vernier reading
28 Lever for operating the deflecting prism
29 90° reading of the analyser rotation
30 Centration of the Bertrand lens
31 Index for interpupillary distance
32 Lever for operating the pinhole stop

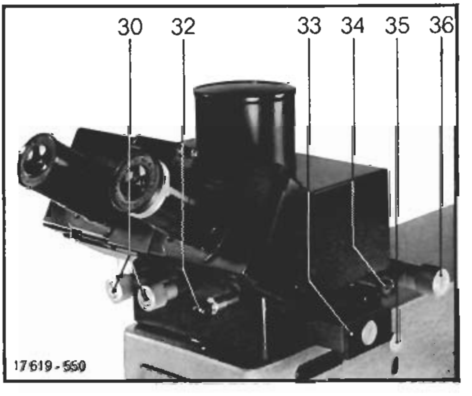



Fig. 4 **Pol-photo tube**

33 Analyser slide
34 Lever for operating the Bertrand lens
35 Locking lever for the bayonet lock
36 Focusing knob of the Bertrand lens

## 34 Revolving nosepiece, objective centring clutch

The revolving nosepiece (Fig. 5) has threads for five objectives, each of which can be individually centred from the front.

Two slots displaced at 90° to each other have been provided for compensators (5.40); if no compensator is inserted, the blank slide (5.40) must always be pushed in to protect the instrument from dust.

The tube lens system has been arranged so that the compensators are situated in the infinity beam. This fully preserves the focus of the object during the insertion of a compensator, in addition the image does not drift out of the field when the compensator is being tilted. An additional lens (5.5) is also built-in for the observation of the interference figures of small objects.

Instead of the revolving nosepiece (Fig. 5) an objective centring clutch (Fig. 6) for the individual change of objectives can be used. The technical details are the same as with the centring objective revolving nosepiece.

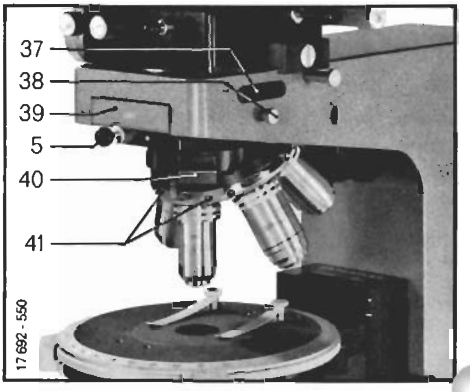



Fig. 5 **Revolving nosepiece**

5 Lever for operating the additional lens
37 Slot for filters in the filter slide
38 Screw for securing the revolving nosepiece
39 Engraved tube factor
40 Compensator in the compensator slot
41 Centring screws for the objective

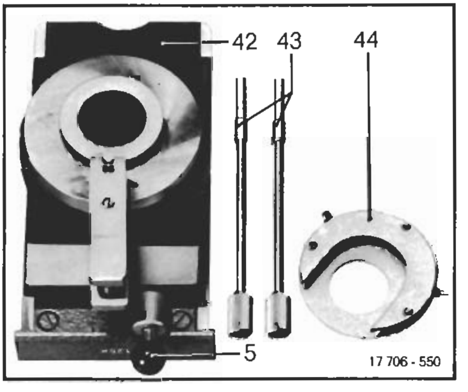



Fig. 6 **Objective centring clutch**

5 Lever for operating the additional lens
42 Objective centring clutch with compensator slot
43 Centring key
44 Centring ring

## 35 Object stage

The object stage No. 837 (Fig. 7) has a diameter of 150mm and runs on ball-bearings. The rotation of the stage can be read to an accuracy of 0.1° by means of verniers (7.47). A 45° click stop (7.49) can be engaged at any desired starting position of the stage. The stage can also be arrested in any position (7.48). The annular stage insert (7.46) can be removed for the use of a universal rotating stage. The object is held in position by means of two stage clips (7.45). An attachable mechanical stage can be used for adjustment in the two co-ordinate directions.

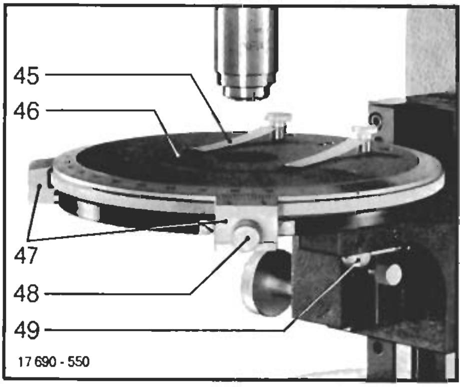



Fig. 7 **Object stage**

45 Stage clip
46 Annular stage insert
47 Verniers for reading the angle graduation
48 Screw for clamping the object stage
49 Lever for engaging the 45° click stops.

## 36 Polarizing condenser

The polarizing condenser No. 702 f (Fig. 8) is equipped with a swing-out achromatic condenser top (8.50), aperture 0.90 As, with aperture diaphragm (8.56) and sliding filter polarizer (8.54), which can also be rotated, with 90° interval readings. A slot for λ/4-plates (8.53) has been provided.

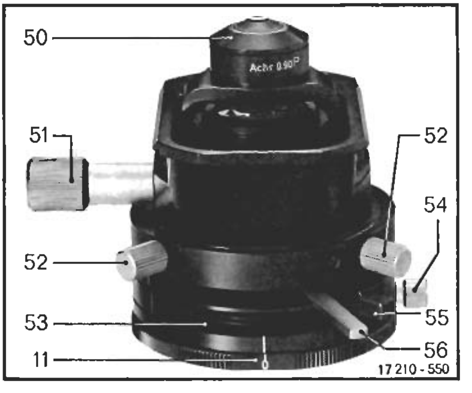



Fig. 8 **Pol-condenser**

11 Rotating mount of the polarizer
50 Swing-out condenser top
51 Knurled knob for operating the condenser top
52 Centring screw for the condenser
53 Slot for a λ/4-plate
54 Screw for clamping the polarizer
55 λ/4-plate in position
56 Lever for operating the aperture diaphragm

## 37 Objectives

Normally the NPI-Pol planachromats are used as objectives for transmitted light. All objectives with the exception of the low-power objective 6.3/0.20 have a spring-loaded front lens mount in order to avoid damage to the specimen and the valuable lens systems as far as possible. Each microscope objective has a number of technical data engraved on its mount, which are important to the user. These data are explained with the aid of the NPI 25/0.50 objective:

170/0.17
NPI 25/0.50 P

where **170** is the distance in mm from the screw-on shoulder of the objective to the rim of the tube. This distance is the so-called mechanical tube length. LEITZ transmitted-light objectives are corrected for this distance. With binocular tubes this tube length cannot be adhered to because of the optical elements such as prisms or beam splitters contained in the tube. By a suitable choice of tube lenses the image is placed in the new intermediate-image plane without adverse effect on its quality. The additional factor introduced by the tube lens is engraved on the revolving nosepiece or on the objective centring clutch.

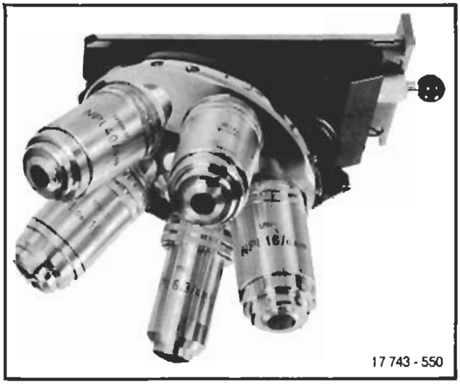



Fig. 9
NPI-objectives for transmitted light

**0.17** is the coverglass thickness for which our transmitted-light objectives are computed. Deviations from this thickness cause deterioration of the image quality, particularly with objectives of medium to high magnification. Weakly magnifying objectives have a – instead of 0.17 engraved on their mounts. This means that they can be used both **with** and **without** coverglass on the object.

**NPI** indicates the state of correction of the objectives, here ordinary plano objectives.

**25** is the reproduction ratio or the objective magnification (size ratio of the intermediate image and object).

**0.50** is the numerical aperture of the objective, which is responsible for its resolving power.

A **P** behind the indication of magnification and aperture denotes that the objective is strain-free and suitable for observations and measurements in polarized light. All NPl objectives have an adjustment length of 45mm and are parfocal on the revolving nosepiece. As a result, no more than slight refocusing with the fine adjustment is necessary after a change of magnification.

Oil immersion objectives are distinguished by their engraving "Oel" and a black ring on the lower rim of the objective mount. It is a characteristic feature of an immersion objective that the refraction of the rays will be decreased or altogether eliminated when they emerge from the coverglass, and with large angles of aperture total reflection from the surface of the coverglass will also be eliminated. This makes it possible for rays of a larger angle of aperture to enter the microscope objective, which means an increase in its numerical aperture and therefore in its resolving power. Here the immersion oil has approximately the same refractive index $n = 1.515$ as the coverglass and the front lens of the microscope objective. The focal length and working distance of an immersion objective are usually very short. For this reason great care is necessary during work with such objectives. The coarse adjustment should be used only until the immersion objective dips into the oil (lateral observation). Focusing must be carried out with continuous microscopic control and exclusively with the fine adjustment. Air bubbles must be eliminated from the immersion oil. Only LEITZ immersion oil or, for fluorescence observations, LEITZ non-fluorescing immersion oil should be used. Generally the condenser 702 f will be adequate also for oil immersion objectives. If, however, the full aperture of the immersion objective is to be used, a condenser top of aperture 1.33 is essential. Here, immersion oil must be introduced also between the condenser top and the underside of the microscope slide.

After the end of the observation all optical surfaces under immersion oil must be most carefully cleaned with a soft rag moistened with xylene, and polished with a dry rag. Never use alcohol (methylated spirits) for cleaning objectives and condensers. Pressure should be avoided during cleaning.

Objectives for investigations in incident light are strain-free achromats computed for a mechanical tube length of 215mm. The data engraved on their mounts have the same significance as those on the mount of transmitted-light objectives. Naturally no coverglass is placed on the object when these objectives are used.

## 38 Eyepieces

Normally a pair of GF 10x eyepieces is used for binocular observation; one of these eyepieces has crosslines and a focusing eyelens. The crosslines eyepiece has a fixed orientated position in the right-hand eyepiece tube of the binocular tube. In addition an eyepiece with a graticule, 10mm = 100 intervals, and with a pair of crosslines is supplied for measurements of size. Naturally, paired eyepieces of other magnifications or with counting or micrometer graticules can be used.

## 39 Vertical illuminator

For polarizing investigations in incident light the stand is equipped with the vertical illuminator. In addition to a plane glass this contains the compensating prism (trapezoidal prism according to Berek), which produces a homogeneously linearly polarized field. Depending on the application, polarizing inserts with filters (Fig. 11) or prisms (Fig. 12) are available; the polarizers can be rotated through 90°. The objectives are mounted in the objective centring clutch of the vertical illuminator on their centring ring, and can be conveniently centred or exchanged from the front. The field diaphragm (16.66), the aperture diaphragm (16.65) and a half stop (15.64) are housed in the light tube. The first can be critically focused on the object. The aperture diaphragm can be unilaterally de-centred, and critical centration is obtained when it is moved against the stop (15.63). All controls are arranged for ready accessibility and operation without interference with the work.

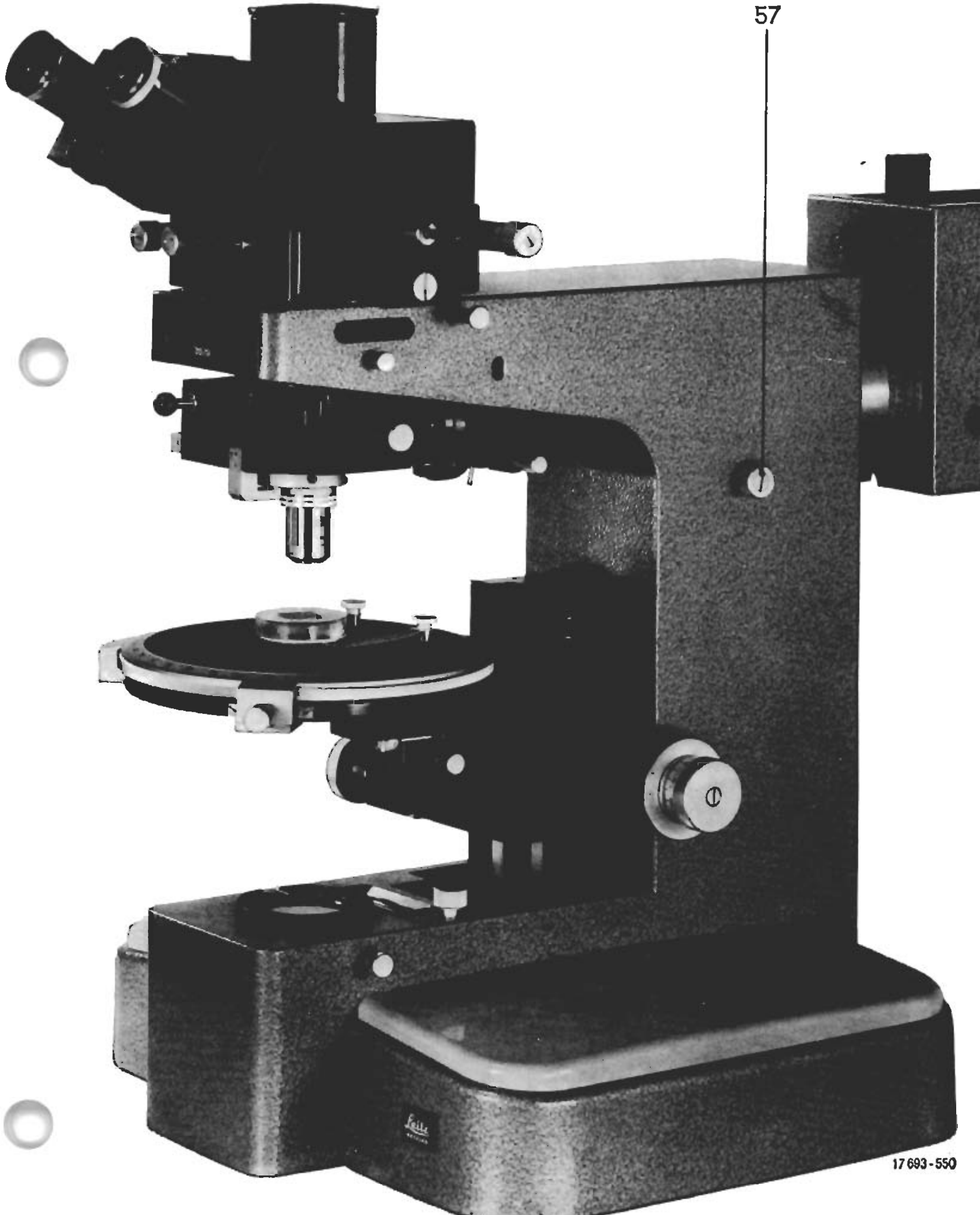



Fig. **10**
ORTHOPLAN-POL with pol-vertical illuminator
57 Knurled knob for operating the additional lens

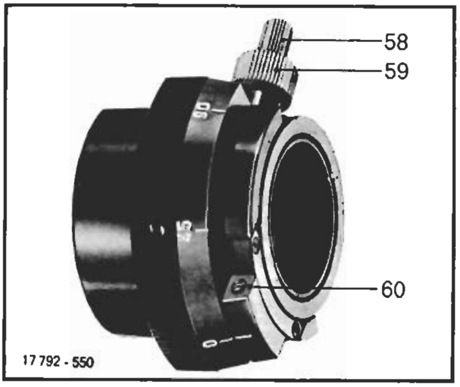



Fig. 11

Polarizing insert with filter
58 Clamping screw
59 Screw for clamping the illumination tube
60 Screw for adjusting the index marking
A re-adjustment with screw 60 can be carried out if the index does not precisely face zero at optimum extinction position.

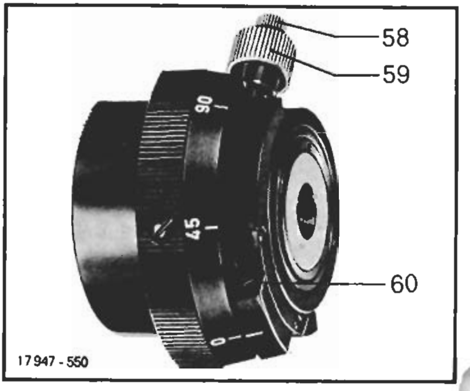



Fig. 12

Polarizing insert with prism
58 Clamping screw
59 Screw for clamping the illumination tube
60 Screw for adjusting the index marking

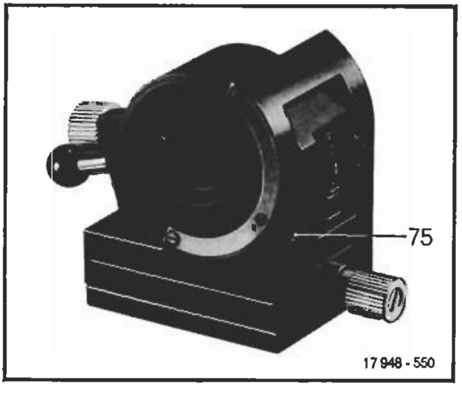



Fig. 13

Polarizing insert for the MPV microscope photometer
75 Screw for adjusting the polarizer

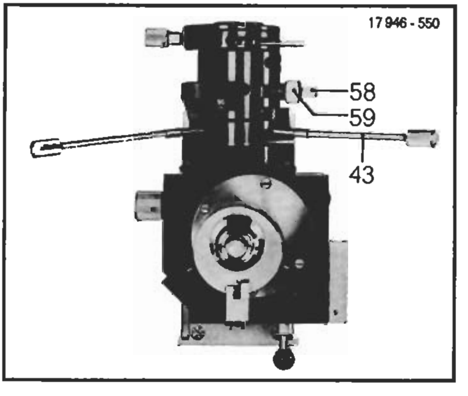



Fig. 14

Centring the field diaphragm on the pol-vertical illuminator
First align the objective with the optical axis, now the field diaphragm can be centred with the aid of the two centring keys 43. See also centring the field diaphragm, page 19.

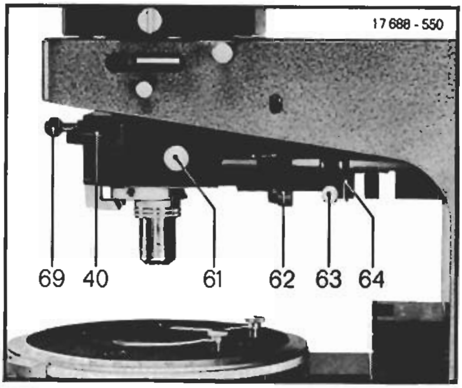



**Fig. 15 Pol-vertical illuminator**

40 Compensator slot with empty slide closed
61 Knurled knob for focusing the field diaphragm
62 Knurl for rotating the polarizer
63 Vertical adjustment of the aperture diaphragm
64 Knurl for engaging the half stop
69 Lever for inserting the plane glass or deflecting prism

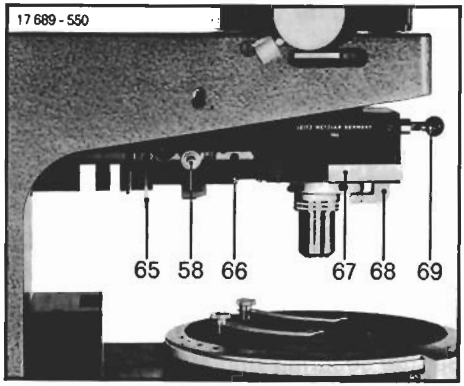



**Fig. 16 Pol-vertical illuminator**

58 Knurled screw for clamping the polarizer insert and polarizer
65 Lever for adjusting the aperture diaphragm
66 Lever for setting the field diaphragm
67 Lever for unlocking the objective holder
68 Holder for the objectives (objective centring clutch)
69 Lever for engaging the plane glass or deflecting prism

## 310 Compensators

Two compensators of fixed phase difference belong to the basic outfit: the $\lambda$-plate and the $\lambda/4$-plate. The vibration direction of n$\gamma$ is always engraved with the sign $\gamma$. The compensators are inserted in one of the two compensator slots on the revolving nosepiece, on the objective centring clutch, or on the vertical illuminator.

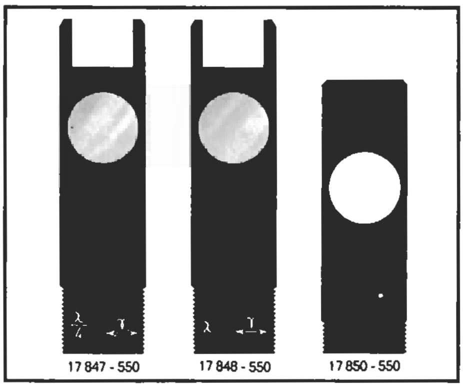



Fig. 17
Compensators and empty slide

## 41 Illuminator

Insert the bulb (18.71) into the lamp mount (18.20) so that the projecting small lug on the base of the bulb will fit in the small recess of the lamp mount. This is the only position in which the bulb can be pushed into the mount and secured by a right hand turn. Now finger marks must be wiped from the glass envelope. Push the lamp mount into the lamp housing (18.70) to the stop. Set the securing ring (18.25) so that the red dot faces the red dot on the lamp housing. Push the lamp housing into the opening of the stand and lock it with the securing ring. It is now firmly connected with the stand. Plug the lamp cable into the transformer, ascertain that the voltage set on the transformer agrees with the mains voltage. Connect the transformer to the mains.

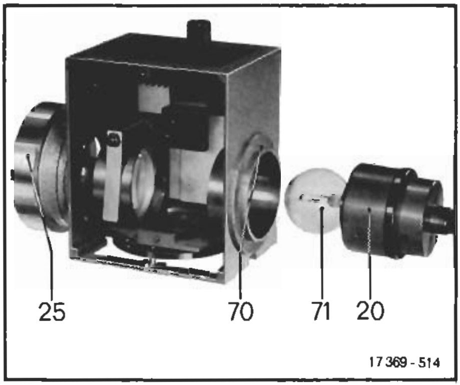



Fig. **18**
Lamp housing open, showing lamp mount with bulb
20 Lamp mount
70 Lamp housing
71 Bulb

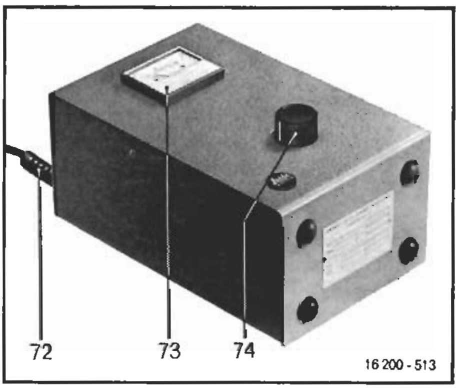



Fig. **19**
Transformer for the 12v 60W low voltage lamp
72 Mains cable
73 Ammeter
74 Knurled knob for switching the transformer on and off

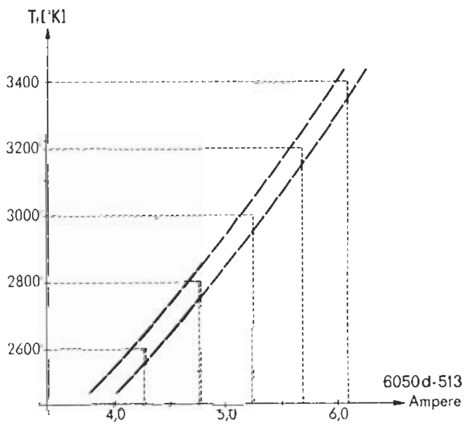



Fig. **20**
Colour temperature curve

## 42 Object stage

Loosen clamping screw (1.12), insert the object stage into the changing guide of the stand, and raise it to its topmost position by means of the coarse adjustment (1.18).
Adjust the object stage in the changing guide until the index mark on the right hand side of the stage agrees with the lower marking _ ⌶ on the stand. Secure the stage with clamping screw (1.12).

## 43 Condenser

Lower the vertical adjustment of the condenser with knob (21.10). Insert the condenser into the fork changer, so that the two centring screws (21.52) and the aperture diaphragm lever (21.56) face the front. Now raise the condenser fully again.

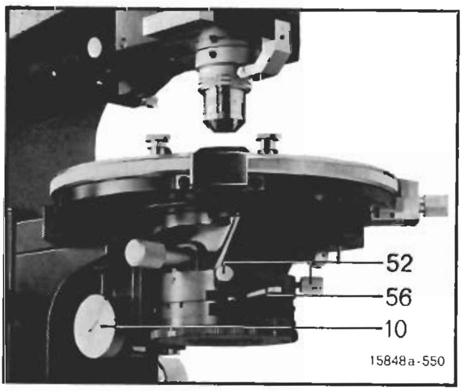



Fig. 21
Condenser inserted in the fork changer
10 Vertical condenser adjustment
52 Centring screws
56 Aperture diaphragm

## 44 Revolving nosepiece or objective centring clutch

Lower the object stage with coarse adjustment (1.18). Loosen the clamping screw (5.38) and insert the revolving nosepiece or the objective centring clutch into the horizontal dovetail changer as far as possible. Now retighten the clamping screw (5.38).

## 45 Pol-photo tube

Depress the locking lever (4.35) and set the tube into the bayonet changer from above. The locating lug on the underside of the tube must drop into the slot of the support ring. Release the locking lever. The tube is now firmly secured to the stand.
Insert the pair of eyepieces into the tube, with the crosslines eyepiece in the right-hand tube. Orientate the latter so that the lines of the cross run vertically and horizontally respectively. They thereby mark the vibration direction of the polarizer (vertical) and of the analyser (horizontal) when both are engaged and set at zero. If the eyepiece is inserted at an angle of 45°, the lines of the cross correspond to the vibration directions of a compensator or to those of a birefringent object in diagonal position.

## 5 Setting for observations in parallel transmitted light (direct observation)

Switch on the lamp with the regulating knob (19.74) on the transformer.
Turn in the NPI 16/0.40 objective by rotating the revolving nosepiece.

**51 With the objective centring clutch:** Screw the objective into the centring ring. Open the objective centring clutch with the left hand. Push the objective with the centring ring screwed to it onto the conical attachment of the clamp from the right. Turn it to the left as far as possible and release the clutch (Fig. 22). Push the lever (3.28) of the deflecting prism into the tube; this directs the entire light to the binocular part of the tube. (Lever pulled out: the light reaches the photo part of the tube.) The levers for Bertrand lens (4.34), pinhole stop (3.32) and additional lens (1.5) are pulled out, i.e. these devices are disengaged. Adjust the distance between the eyepiece tubes to your interpupillary distance. Adjust the eyelens of the right-hand eyepiece until the cross lines appear sharp.

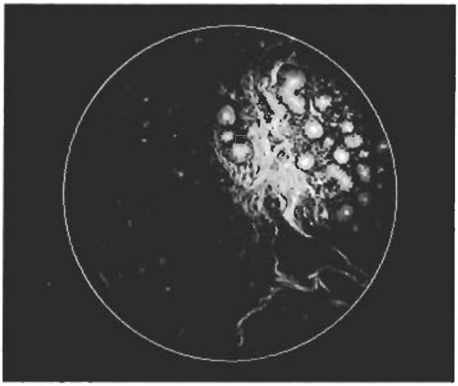

Fig. 22
ORTHOPLAN-POL with objective centring clutch

Engage the analyser by pushing the horizontal slide towards the right into the tube as far as possible. Release the clamping screw (3.26) on the analyser drum and zero both scales (3.27 and 29). The vibration direction of the analyser corresponds to the direction of the horizontal of the crosslines in the eyepiece. Swing in the condenser top (8.50) with the rotating knob (8.51). Open the aperture diaphragm (8.56) as well as the field diaphragm (1.14) in the foot of the stand. Ensure that the illuminating lens (1.13) is inserted in the beam path (it is swung out of it only for low-power observation, e.g. when the 1/0.04 objective with special condenser is used). Place a transmitted-light specimen, e.g. a thin polished section, on the object stage and fix it with the two stage clips. Critically focus the specimen by raising the object stage towards the objective with the coarse adjustment (1.18) observing this operation in the tube. Carry out the final focusing with the fine adjustment (1.17).

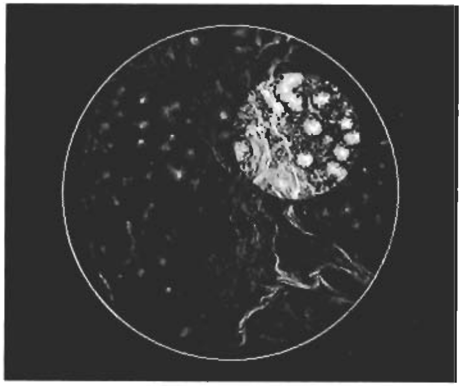
**52 Centring the objectives:** the centring keys (6.43) supplied with the instrument are placed onto the threaded pins of the objective used. Steadily rotate the object stage and make a note of the point in the specimen around which all the other points revolve. Move this point, which represents the axis of rotation of the stage, critically to the centre of the crosslines by adjusting the centring keys. Remove the centring keys. The centration of the objectives is preserved even when they are changed, but occasional slight readjustment of the centration will be necessary.

**5 3 Centring the condenser:** close the field diaphragm (1.14). Vertically adjust the condenser (1.9) until a sharp image of the field diaphragm is obtained simultaneously with that of the object. With the aid of the two centring screws (8.52) move the field diaphragm into the centre of the field of view. Open the diaphragm so that it just moves beyond the edge of the field of view. This prevents unnecessary heat and flare in the specimen.

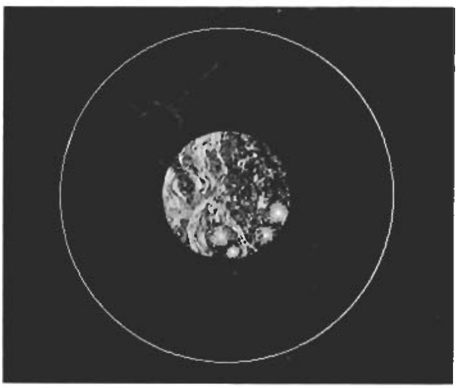
Fig. **23**
Centring the field diaphragm



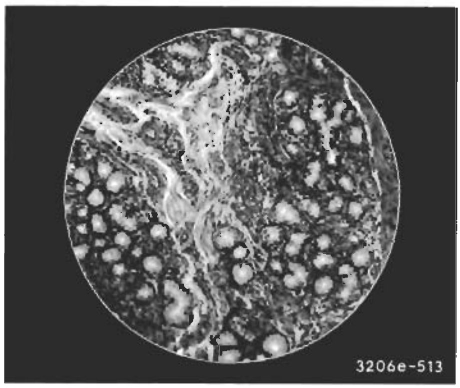
a Field diaphragm unsharp



b field diaphragm after focusing



c field diaphragm centred




d field diaphragm open

The optimum position of the condenser thus obtained should be checked and if necessary corrected whenever the objective or the specimen is changed.
Turn in the polarizer (8.11) and after releasing the clamping screw (8.54) zero it. Its vibration direction now corresponds with the vertical of the crosslines in the eyepiece. Now polarizer and analyser are crossed.
The aperture diaphragm (8.56) determines resolution, contrast, and depth of field of the microscopic image. Normally it is closed so that it transmits ⅔ of the full objective aperture. You can check this by turning in the Bertrand lens and observing the rear focal plane of the objective. If the aperture diaphragm is closed further the resolving power of the objective and therefore the performance of the microscope rapidly deteriorate. Since the aperture varies with the individual objectives, the aperture diaphragm must be readjusted every time the objective is changed.
The condenser top (8.50) remains in the beam path with all objectives of larger aperture. With objectives of small aperture it is swung out so that the entire field of view will be illuminated.
See table.

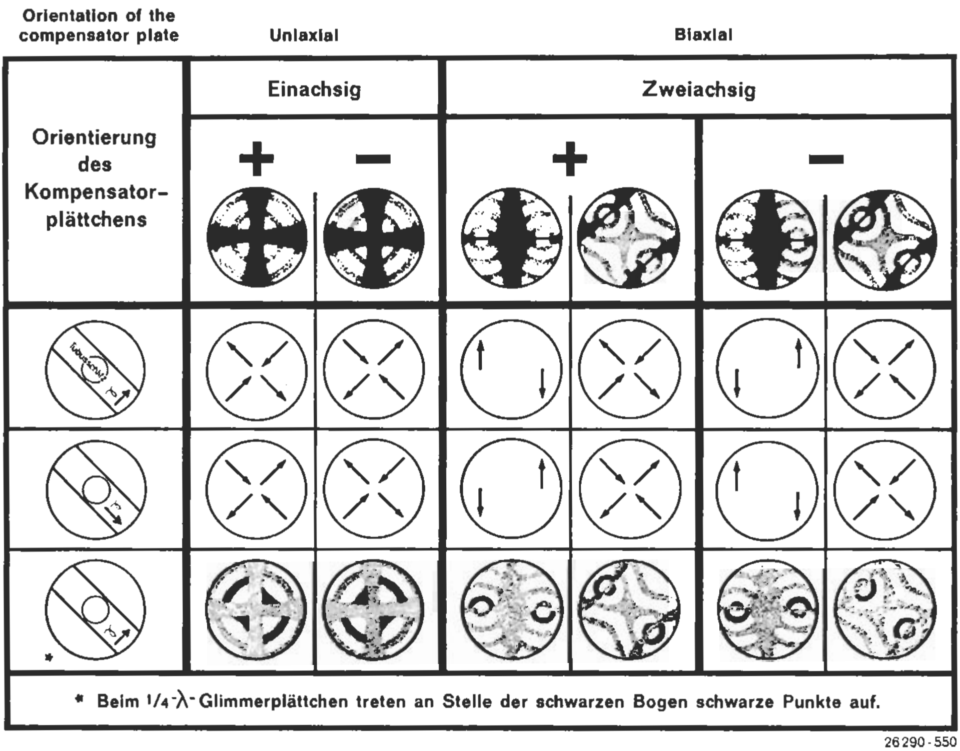
| Objective aperture | Condenser top | Vertical adjustment of the condenser |
|---|---|---|
| $> 0.25$ | remains swung in | approximately in topmost position. A sharp image of the field diaphragm must appear |
| $< 0.25$ | swing out | with visual observation approximately in topmost position; the image of the field diaphragm can be disregarded. For photomicrography lower the condenser until a sharp image of the field diaphragm appears. |

Even illumination of the field of view is obtained by adjustment of the lamp condenser in the lamp housing. The microscope is now ready for operation.

# 6 Setting for observations in convergent transmitted light (conoscopy)

For the observation of interference figures objectives of large aperture are always recommended in order to accommodate the widest possible axial angle. The microscope must be adjusted as described under section 5. Centre the observation objective, e.g. P 50/0.85. Move the specimen into the centre of the crosslines. Completely open the aperture diaphragm (8.56) and field diaphragm (1.14). Turn in and focus the Bertrand lens (4.34) and (4.36). Move the image into the centre of the field of view with the aid of the two centring screws (3.30). With conoscopy of very small objects, especially with an oil immersion objective of high magnification and large aperture such as NPl Oel 100/1.30, any disturbing surrounding field can be eliminated by the use of the additional lens (1.5) in the revolving nosepiece or in the objective centring clutch and of the pinhole stop (3.32).

Sequence of setting: turn in Bertrand lens (4.34), insert additional lens (1.5), and re-focus (4.36). Now insert the pinhole stop (3.32) into the beam path.




* with the ¼-λ mica plate black dots replace the black arcs.

Fig. 24
Table for the determination of the optical character

# 7 Setting for incident light with the vertical illuminator

Insert and clamp (11.59) the polarizer insert with the filter polarizer (Fig. 11) or prism polarizer (Fig. 12) in the light tube of the vertical illuminator. Release clamping screw (11.58) and zero the polarizer. Retighten the clamping screw. Fully push the vertical illuminator into the horizontal dovetail changer of the microscope in place of the revolving nosepiece or the objective centring clutch and tighten the clamping screw. Attach the lamp housing to the top aperture of the microscope stand and secure it. Switch on the lamp and the additional lens (10.57). Swing in the deflecting compensating prism or plane glass with lever (15.69). Lever pushed in = prism turned in. Lever pulled out = plane glass turned in (see symbols on the lever).

The compensating prism is always used when the highest quality with regard to polarized light is demanded. It must, however, be considered that owing to the construction of the prism the aperture of the objective and therefore the resolution of the microscopic image is impaired. The plane glass is to be preferred for observations at high magnifications, i.e. when high resolution is essential, as well as in photomicrography.

Screw the incident-light objective into the objective centring ring (6.44) and insert it in the objective holder (16.68) of the vertical illuminator. During this operation depress the lock on lever (16.67), insert the objective in the holder from the right and rotate it to the left as far as possible. Release lever (16.67); the objective is now locked in position.

Push the specimen onto a microscope slide with a little plasticine and align it with the handpress (inserting a thin sheet of paper in order to protect the surfaces). Place the slide on the object stage and focus. Centre the objective as described in section 5.2. Close the field diaphragm with lever (16.66) and focus it with the knurled screw (15.61) of the lamp condenser. If necessary centre it with the centring key (14.43). Open the diaphragm far enough so that the entire field of view is just observed. Vertically adjust the aperture diaphragm with the screw (15.63). Improve the contrast of the microscopic image by closing the aperture diaphragm with lever (16.65) but only far enough for it to observe about ⅔ of the objective aperture.

Check: with the Bertrand lens and the plane glass turned in the aperture diaphragm can be observed in the tube in the rear focal plane of the objective. If necessary the half stop (15.64) (observation with the compensating prism turned in) can be used. Ensure that the analyser (3.27 and 29) in the tube is also zeroed and turned in. If the extinction with crossed polarizer and analyser does not agree with the zero position of the scale, e.g. with polarizing inserts supplied at a later stage, maintain the zero position of the analyser reading, and rotate the polarizer until maximum extinction (darkness) has been reached. Now readjust the index mark on the polarizer is accordingly with screw (11.60). The microscope is now ready for investigations in polarized light.

# Supplementary equipment and accessories for the ORTHOPLAN-POL

**Attachable mechanical stages:**

The object stage can be equipped with an attachable mechanical stage No. 42 instead of the conventional stage clips. This considerably facilitates the systematic scanning and finding of areas of interest in the specimen. The traversing area in the x- and y-directions is 40 x 20mm. The mechanical stage holder accommodates both microscope slides of 76 x 26mm and 48 x 28mm format.

For planimetric analyses (point counting methods) a version with interchangeable arresting buttons – attachable mechanical stage No. 40 – is available.

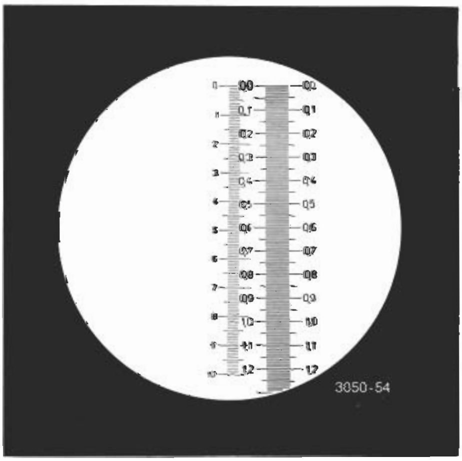



Fig. **25**

Graduation of the graticule in the eyepiece and image of the object micrometer

**Measuring and counting devices:**

For simple angle measurements, e.g. on crystal faces, the rotating object stage with its verniers reading to 0.1° is used. The reference mark is the crosslines in the eyepiece.

For linear measurements of the object the GF 10x M eyepiece with graticule, 10mm divided into 100 intervals, is used; this eyepiece forms part of the basic outfit. The measurements can be carried out independently of the set interpupillary distance owing to the automatic sharpness conmpensation in the binocular part of the tube.

The micrometer value of the objective used must be known before the start of the measurement. The micrometer value is the distance in the object plane of which an image is formed by the objective just on one interval of the graticule graduation in the micrometer eyepiece. Although these micrometer values are tabulated, the user is advised to determine them himself with the aid of a stage micrometer because the optical constants of the objectives are subject to minor variations.

Example:

Determination of the micrometer value with the aid of a stage micrometer 2mm = 200 intervals and a micrometer eyepiece with graticule 10mm = 100 intervals (visual observation).

Make the zero lines of the micrometer eyepiece and of the stage micrometer coincide. The micrometer value is read at this setting at the end of the micrometer eyepiece scale.

Examples:

If 1.220mm on the stage micrometer equals 100 intervals of the micrometer eyepiece, the micrometer value = 1.220 : 100 = 0.01220mm = 12.20 $\mu$m. With low-power objectives, which do not form an image of the graduation of the stage micrometer across the entire graduation of the micrometer eyepiece, only 10 intervals of the micrometer eyepiece are used for comparison. If, therefore, 0.36mm of the stage micrometer equals 10 intervals of the micrometer eyepiece, the micrometer value = 0.36 : 10 = 0.036mm = 36 $\mu$m.

The screw micrometer eyepiece is used for the most accurate measurements with the microscope. Detailed information about this will be found in List 513-17.

For the indirect determination of volumes, areas, and sizes, eyepieces with graticules for point counting methods in conjunction with the attachable mechanical stage No. 40 with interchangeable click stop buttons are available.

**Compensators**

A number of compensators covering various ranges for the measurement of path differences (phase differences) are available in addition to the $\lambda$ and $\lambda/4$-plates included in the basic outfit and serving for the determination of the vibration direction and the character of the birefringence in the object.

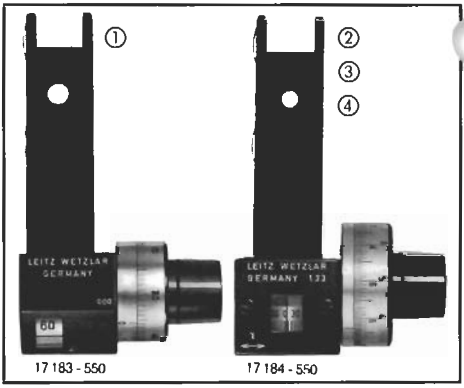



Fig. **26**
Compensators
Elliptical compensator
Tilting compensator

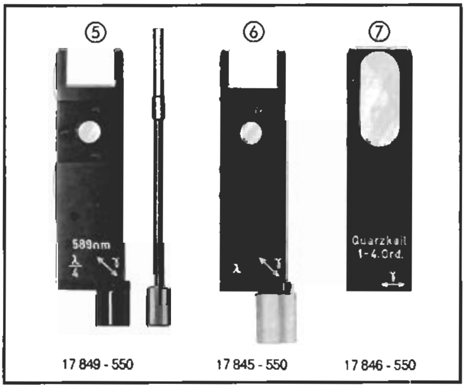



Fig. **27**
Compensators
$\lambda$ and $\lambda/4$ Senarmont-compensator
Quartz wedge I—IVth order

① The compensator according to Brace-Köhler

with $\lambda/10$-plate
with $\lambda/20$-plate
with $\lambda/30$-plate

permits accurate measurement of very small path differences up to the path difference of the compensator plate.

② Tilting compensator of measuring range up to IV orders.

③ Tilting compensator of measuring range up to X orders.

④ Tilting compensator of measuring range up to XXX orders.

⑤ Slide with $\lambda/4$-plate in sub-parallel position for the measurement of path differences up to 1 order according to the Senarmont method. Two versions are available:

a) For wave length 589nm (Na line),

b) For wave length 546nm (Hg line).

Precise reading of the rotating analyser is required for the measurement. Setting accuracy is considerably increased if a half shadow device with intermediate image system is used in the tube.

⑥ Slide with $\lambda$ plate in sub-parallel position, serves for the determination of the vibration direction with very weak birefringence.

⑦ Quartz wedge I–IV order.

8. For observation in circularly polarized light a $\lambda/4$-plate is available, the mount of which fits in the slot of the polarizing condenser. The $\lambda/4$-plate which forms part of the basic outfit is used above the objective.

**Tube with intermediate image formation:**

For measurements in which an image of the compensator and one of the object are to be shown simultaneously, or when the normal position (extinction) or diagonal position of the object must be set very accurately with half shadow devices, a tube is used in which compensating wedges, half shadow plates, half shadow wedges, etc. can be inserted in the intermediate-image plane. Graticules with appropriate graduations are also available for measuring and counting methods. The built-in analyser can be read to an accuracy of 0.1°.

## Universal rotating stage

After removal of the annular stage insert a universal rotating stage for crystallographic measurements can be inserted in the standard object stage. Observation is possible both in the orthoscopic and in the conoscopic beam. The special UM objectives are used in the objective centring clutch. The condenser top is replaced by one of long intercept length for universal rotating stage work (see list No. 550-10).

## Interference devices

### a) Transmitted light

Pol-interference device according to Jamin/Lebedeff.

The transmitted-light interference device for the ORTHOPLAN-POL opens up new fields of application. This device produces interference by means of polarizing systems. It is possible to measure both path- and phase differences, as well as to differentiate and qualitatively determine morphological properties of objects in interference contrast. The device consists of an interference condenser interchangeable in a dovetail guide, the rotating stage with slide and beam-splitting plate and the interchangeable revolving nosepiece with three objectives (see list 550-27).

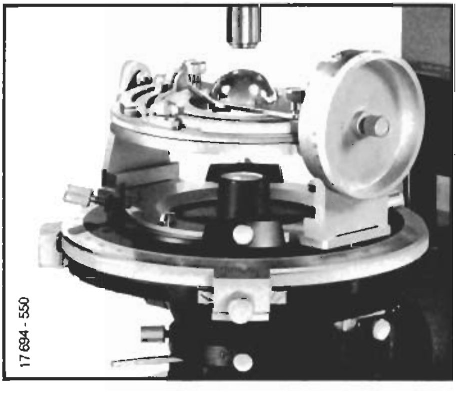



Fig. 28
ORTHOPLAN-POL with universal rotating stage

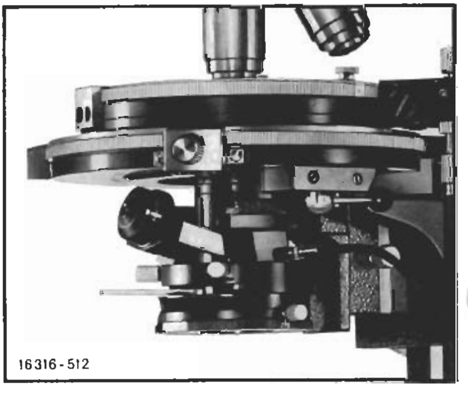



Fig. 29
Pol interference device according to Jamin/Lebedeff

**b) Incident light:**

Interference contrast objectives according to Françon.

For the qualitative assessment of polished ore- and metal sections etc. in incident-light interference contrast three interference contrast objectives are available:

Objective 8/0.15;
Objective 16/0.22;
Objective 25/0.20.

They are used between crossed analyser and polarizer on the pol-vertical illuminator. Contrast or interference colour is set on the objective. No further accessories are required.


Fig. 30
Pol-interference contrast objectives according to Françon

**Polarizing condensers:**

The usually supplied pol condenser 702 f including a high-quality filter polarizer will be adequate for most requirements. The state of polarization of the light can be equated with that of light that has passed through a calcite prism.

When work is carried out with light sources of high radiation density, such as Hg- and xenon lamps, only polarizing condensers with built-in "pre-polarizers" (702 fv or 702 p) should be used in order to avoid damage to the polarizing filters owing to excessive heat. Condensers with a calcite polarizer can, however, be supplied for special requirements.

**Special light sources, filters, monochromators**

The 12v 60W low-voltage lamp, which forms part of the basic outfit, is completely satisfactory for all conventional microscopic and photomicrographic work.

The Lamp Housing 100 or 100 Z (version with centring reflector) also accommodates halogen lamps and gas discharge lamps of up to 100W.

Spectral lamps, such as the Na-lamp and Hg/Cd-lamp can also be inserted in the lamp housing for measurements in monochromatic light.

If lamps of very high intensity are required the Lamp Housing 250 should be used for gas discharge lamps such as Hg- and xenon lamps of up to 250W. In the Lamp Housing 500 lamps of up to even 500W can be used.

In addition to the above-mentioned spectral lamps, filters and monochromators for work at certain wave lengths are supplied. Depending on the requirements of monochromasia there is a choice between glass filters, interference band filters, interference line filters or an interference graduated filter with which the wave lengths of the light can be continuously varied.

For the highest demands of accuracy both prism and grating monochromators can be attached to the microscope. Our list No. 621-20 contains all the necessary details.

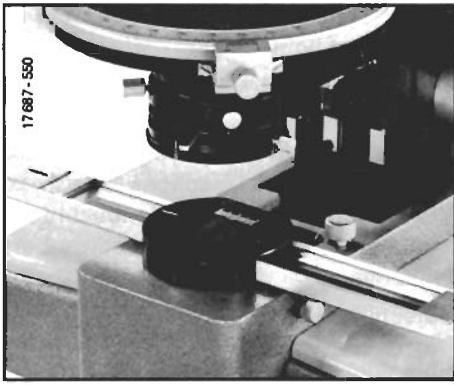



Fig. **31**
ORTHOPLAN-POL with interference graduated filter

**Micro-hardness tester:**

The micro-hardness tester permits hardness tests according to the Vickers and the Knoop methods. It consists of the indenting body with interchangeable diamond and built-in 40x objective, the control unit, and the micrometer eyepiece. The indenting body is attached to the pol-vertical illuminator like an objective. After the object site has been lined up the diamond which is mounted at an angle of 90° to the objective is turned in by actuation of a flexible shaft. A magnet stop ensures always perfect orientation of the diamond.

After the application of the desired load (2–400p) the diamond can be lowered into the specimen pneumatically; the load applied will be fully effective during this operation. The return occurs immediately after the lift-off button has been pressed. The user can therefore measure the indentation immediately after it has been made.

For further details please consult our list No. 560-21.

**Photomicrographic attachments:**

Various devices are available for photomicrography:

1. ORTHOPLAN-POL with micro attachment for the LEICA® and LEICAFLEX®
   Attachment camera with CB 100 Polaroid back
2. ORTHOPLAN-POL with ORTHOMAT fully automatic microscope camera
3. ORTHOPLAN-POL with automatic 4x5″ camera.

**1)** The micro attachment for the LEICA with a GF 10x eyepiece is directly mounted on the photopart of the pol-photo tube. After the deflecting prism in the tube has been swung out the microscopic image can be viewed in the observation tube of the micro-attachment. A line index outlines the picture area. The exposure is determined with the MICROSIX-L exposure meter attachable on the right. All LEICA camera bodies can be used to house the film (please state on order whether the existing LEICA is of the screw-thread or bayonet type). The micro-attachment includes a vibration damper so that shocks cannot be transmitted during photography.

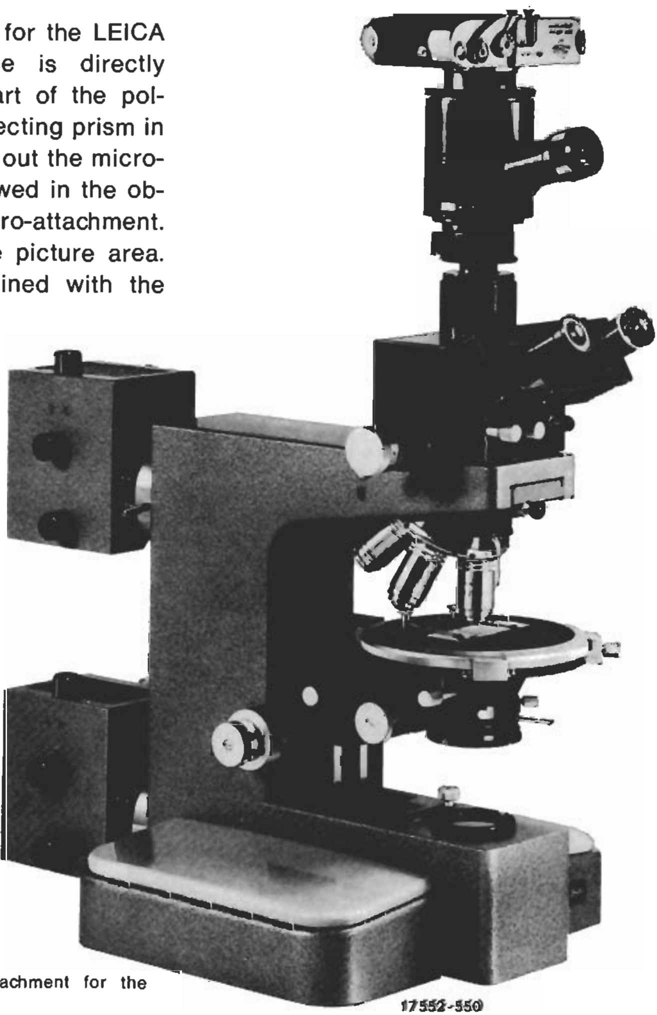



Fig. 32
ORTHOPLAN-POL with micro-attachment for the LEICA

**2)** The attachable ORTHOMAT microscope camera for 35mm photography permits the fully automatic recording of the microscopic image by the operation of a single button. After it is switched on, the camera is immediately ready for action. The image is focused in the binocular part of the tube, a graticule in the eyepiece outlines the picture area. Before the picture is taken the deflecting prism in the tube is swung out. Both the shutter speed and the film transport after exposure are automatically controlled. Depending on the size of the object and contrast differences, the camera is switched to integrating or spot measurement; in addition the area percentage of the object – both in brightfield or in darkground – is set with the aid of a selector disc and therefore allowed for in the exposure setting.
The speed of the film material used can be set to an accuracy of 1° DIN (ASA factor 1.25). Warning lights indicate the function of the camera, such as "shutter open", "end of film", "flash synchronization switched on", etc.

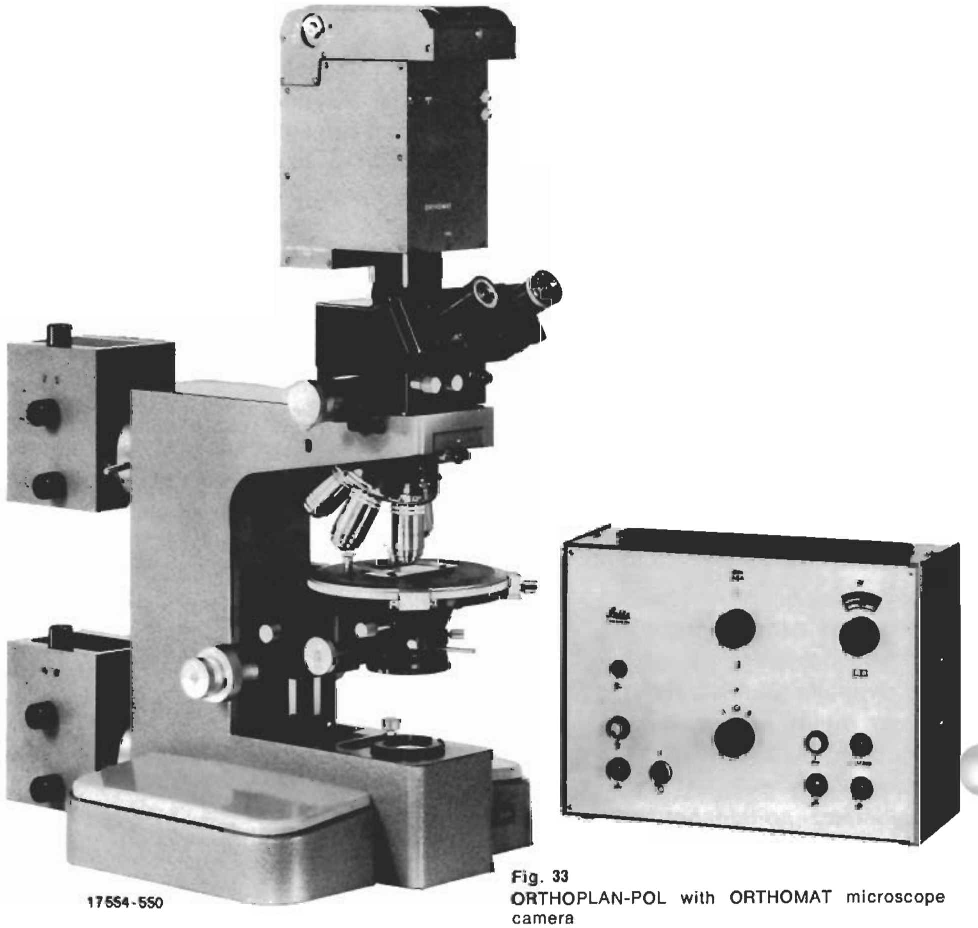



Fig. 33
ORTHOPLAN-POL with ORTHOMAT microscope camera

**3)** A camera carrier is supplied for the automatic 4 x 5″ large-format camera, which can be attached to the stand with the 2 bayonet locks. Bellows holder with shutter, camera bellows, and mirror reflex attachment can be vertically adjusted along a guide rail; in addition the camera can be rotated; magnification and area of the microscopic image can thus be set.

The image is focused on a groundglass screen with a clear glass cross. A window next to the focusing screen indicates the measuring field covered by the photo-multiplier. After the image has been focused the mirror in the reflex attachment is swung out, which automatically closes the camera shutter. Operation of the cable release automatically exposes the plate or sheet film in the cassette correctly. The set film speed, object brightness, and bellows extension are allowed for. Film speed can be set to an accuracy of 1° DIN (ASA factor 1.25) on the control unit for the camera, and the brightness and darkness proportion of the object can also be set on a selector disc.

A special holder allows the use of Polaroid materials for instant photographs in black and white and in colour.

Instead of the automatic 4 x 5″ camera a camera without automatic exposure control can be supplied. Here the exposure must be determined with our MICROSIX-L exposure meter in the usual manner.

Details about our photomicrographic devices for the ORTHOPLAN-POL will be found in our list No. 512-82.

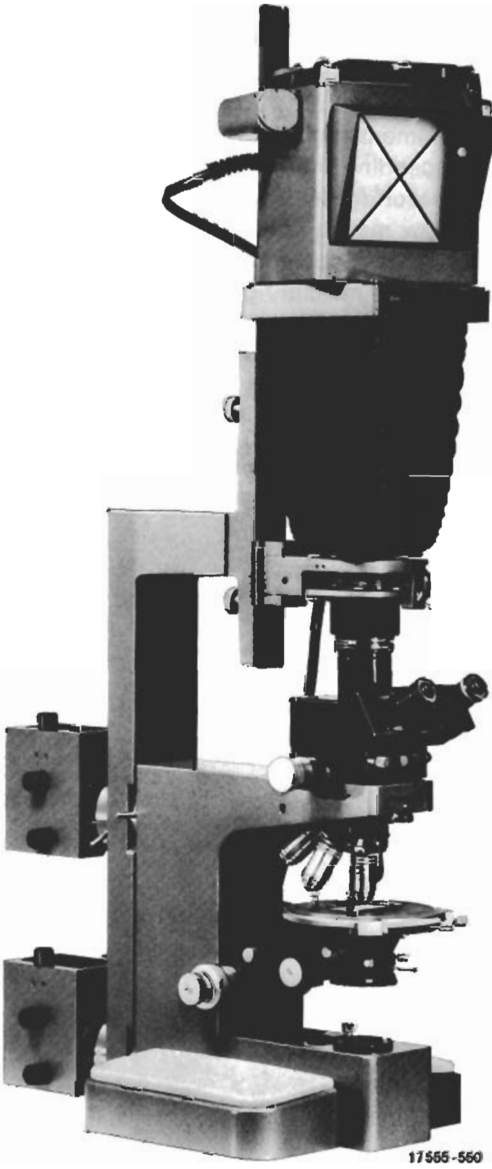



Fig. **34**
ORTHOPLAN-POL with 4 x 5″ large-format camera

**MPV Microscope photometer:**

With the MPV microscope photometer absorption, reflection, diffuse reflection, and fluorescence measurements of microscopic preparations can be carried out. The instrument is mounted on the ORTHOPLAN-POL like an accessory; it permits accurate and reproducible measurements and is very simple to operate. Depending on the optical systems used measuring fields within the range from a few mm to about 0.5 $\mu$m can be set. Interchangeable and continuously adjustable measuring stops make it possible to match the measuring fields with objects of the most varied shapes and sizes. The object structure can also be observed outside the measuring field, which is clearly outlined in the photometer observation tube. Photo-electric measuring devices with photo-multipliers of high sensitivity and differential spectral characteristics complete the equipment.

Moving-spot galvanometers, pointer instruments with amplifiers, as well as compensating pen recorders can be connected as measuring instruments. For the illumination interference band filters, precision interference line filters as well as an in-line mirror monochromator and, as stabilised light sources, low-voltage lamps and high pressure mercury- and xenon lamps are available. For continuously recurring measurements a set of fixed stops can be supplied.

Further details are contained in list No. 620-18.

Design subject to alteration without notice.

**ERNST LEITZ GMBH D 6330 WETZLAR**
**GERMANY**

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### 35 Object stage

The object stage No. 837 (Fig. 7) has a diameter of 150mm and runs on ball-bearings. The rotation of the stage can be read to an accuracy of 0.1° by means of verniers (7.47). A 45° click stop (7.49) can be engaged at any desired starting position of the stage. The stage can also be arrested in any position (7.48). The annular stage insert (7.46) can be removed for the use of a universal rotating stage. The object is held in position by means of two stage clips (7.45). An attachable mechanical stage can be used for adjustment in the two co-ordinate directions.

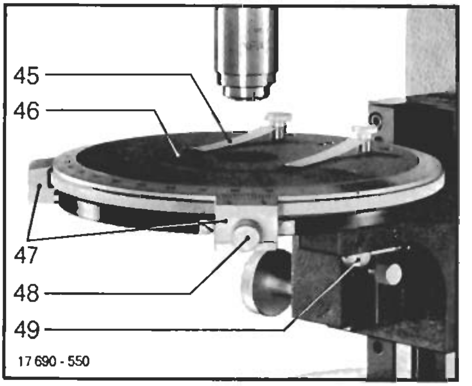


Fig. 7 **Object stage**

45 Stage clip
46 Annular stage insert
47 Verniers for reading the angle graduation
48 Screw for clamping the object stage
49 Lever for engaging the 45° click stops.

### 36 Polarizing condenser

The polarizing condenser No. 702 f (Fig. 8) is equipped with a swing-out achromatic condenser top (8.50), aperture 0.90 As, with aperture diaphragm (8.56) and sliding filter polarizer (8.54), which can also be rotated, with 90° interval readings. A slot for λ/4-plates (8.53) has been provided.

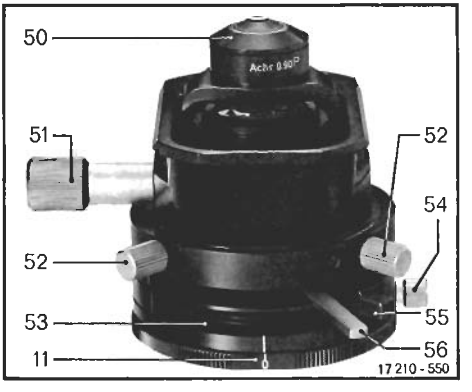


Fig. 8 **Pol-condenser**

11 Rotating mount of the polarizer
50 Swing-out condenser top
51 Knurled knob for operating the condenser top
52 Centring screw for the condenser
53 Slot for a λ/4-plate
54 Screw for clamping the polarizer
55 λ/4-plate in position
56 Lever for operating the aperture diaphragm

## 37 Objectives

Normally the NPl-Pol planachromats are used as objectives for transmitted light. All objectives with the exception of the low-power objective 6.3/0.20 have a spring-loaded front lens mount in order to avoid damage to the specimen and the valuable lens systems as far as possible. Each microscope objective has a number of technical data engraved on its mount, which are important to the user. These data are explained with the aid of the NPI 25/0.50 objective:

170/0.17
NPI 25/0.50 P

where **170** is the distance in mm from the screw-on shoulder of the objective to the rim of the tube. This distance is the so-called mechanical tube length. LEITZ transmitted-light objectives are corrected for this distance. With binocular tubes this tube length cannot be adhered to because of the optical elements such as prisms or beam splitters contained in the tube. By a suitable choice of tube lenses the image is placed in the new intermediate-image plane without adverse effect on its quality. The additional factor introduced by the tube lens is engraved on the revolving nosepiece or on the objective centring clutch.

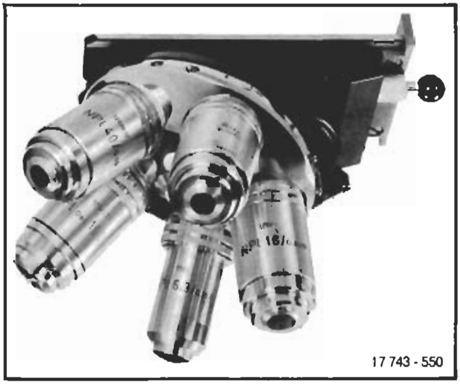


Fig. **9**
NPI-objectives for transmitted light

**0.17** is the coverglass thickness for which our transmitted-light objectives are computed. Deviations from this thickness cause deterioration of the image quality, particularly with objectives of medium to high magnification. Weakly magnifying objectives have a – instead of 0.17 engraved on their mounts. This means that they can be used both **with** and **without** coverglass on the object.

**NPI** indicates the state of correction of the objectives, here ordinary plano objectives.

**25** is the reproduction ratio or the objective magnification (size ratio of the intermediate image and object).

**0.50** is the numerical aperture of the objective, which is responsible for its resolving power.

A **P** behind the indication of magnification and aperture denotes that the objective is strain-free and suitable for observations and measurements in polarized light. All NPI objectives have an adjustment length of 45mm and are parfocal on the revolving nosepiece. As a result, no more than slight refocusing with the fine adjustment is necessary after a change of magnification.

Oil immersion objectives are distinguished by their engraving "Oel" and a black ring on the lower rim of the objective mount. It is a characteristic feature of an immersion objective that the refraction of the rays will be decreased or altogether eliminated when they emerge from the coverglass, and with large angles of aperture total reflection from the surface of the coverglass will also be eliminated. This makes it possible for rays of a larger angle of aperture to enter the microscope objective, which means an increase in its numerical aperture and therefore in its resolving power. Here the immersion oil has approximately the same refractive index $n = 1.515$ as the coverglass and the front lens of the microscope objective. The focal length and working distance of an immersion objective are usually very short. For this reason great care is necessary during work with such objectives. The coarse adjustment should be used only until the immersion objective dips into the oil (lateral observation). Focusing must be carried out with continuous microscopic control and exclusively with the fine adjustment. Air bubbles must be eliminated from the immersion oil. Only LEITZ immersion oil or, for fluorescence observations, LEITZ non-fluorescing immersion oil should be used. Generally the condenser 702 f will be adequate also for oil immersion objectives. If, however, the full aperture of the immersion objective is to be used, a condenser top of aperture 1.33 is essential. Here, immersion oil must be introduced also between the condenser top and the underside of the microscope slide.

After the end of the observation all optical surfaces under immersion oil must be most carefully cleaned with a soft rag moistened with xylene, and polished with a dry rag. Never use alcohol (methylated spirits) for cleaning objectives and condensers. Pressure should be avoided during cleaning.

Objectives for investigations in incident light are strain-free achromats computed for a mechanical tube length of 215mm. The data engraved on their mounts have the same significance as those on the mount of transmitted-light objectives. Naturally no coverglass is placed on the object when these objectives are used.

## 38 Eyepieces

Normally a pair of GF 10x eyepieces is used for binocular observation; one of these eyepieces has crosslines and a focusing eyelens. The crosslines eyepiece has a fixed orientated position in the right-hand eyepiece tube of the binocular tube. In addition an eyepiece with a graticule, 10mm = 100 intervals, and with a pair of crosslines is supplied for measurements of size. Naturally, paired eyepieces of other magnifications or with counting or micrometer graticules can be used.

## 39 Vertical illuminator

For polarizing investigations in incident light the stand is equipped with the vertical illuminator. In addition to a plane glass this contains the compensating prism (trapezoidal prism according to Berek), which produces a homogeneously linearly polarized field. Depending on the application, polarizing inserts with filters (Fig. 11) or prisms (Fig. 12) are available; the polarizers can be rotated through 90°. The objectives are mounted in the objective centring clutch of the vertical illuminator on their centring ring, and can be conveniently centred or exchanged from the front. The field diaphragm (16.66), the aperture diaphragm (16.65) and a half stop (15.64) are housed in the light tube. The first can be critically focused on the object. The aperture diaphragm can be unilaterally de-centred, and critical centration is obtained when it is moved against the stop (15.63). All controls are arranged for ready accessibility and operation without interference with the work.

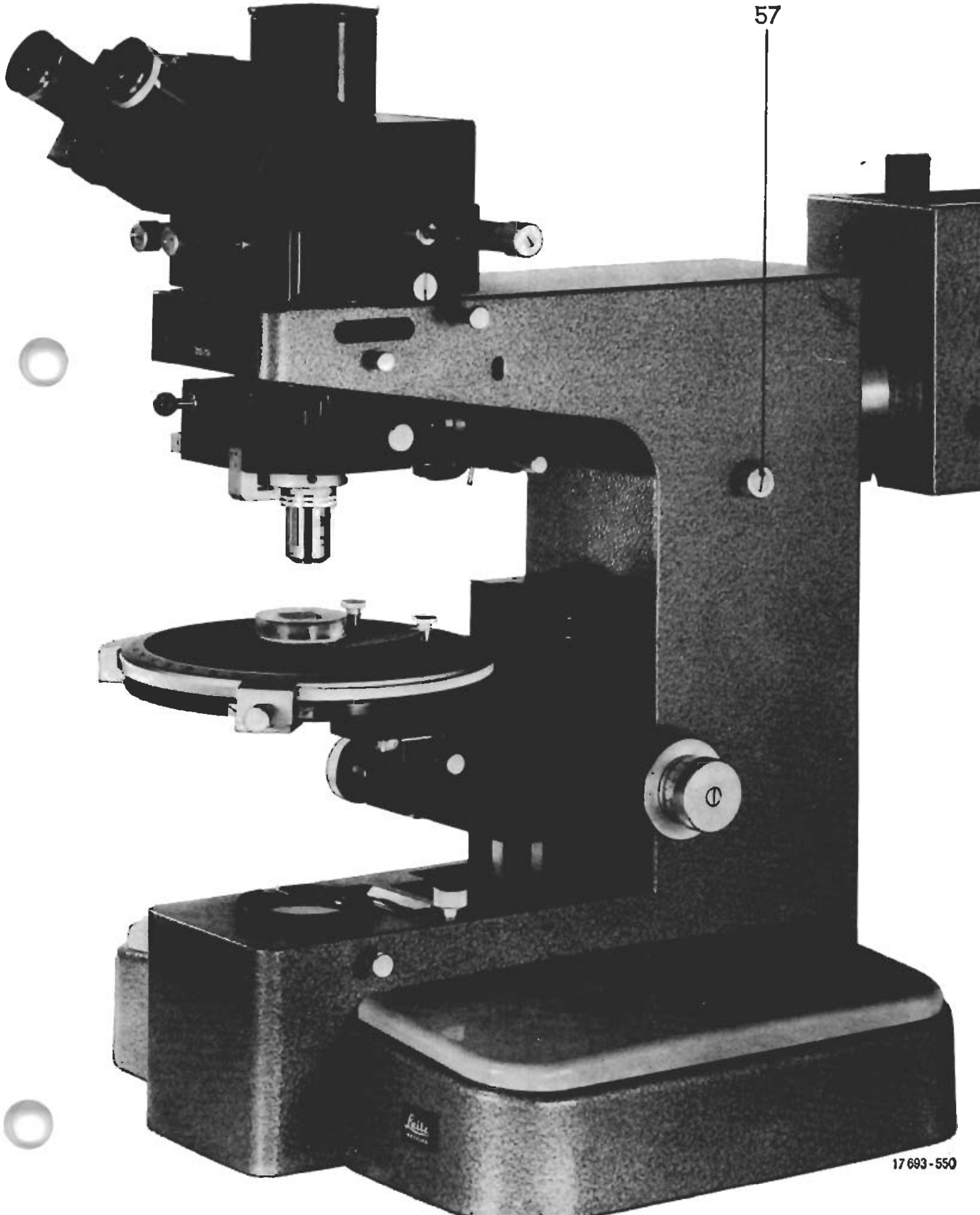


Fig. **10**
ORTHOPLAN-POL with pol-vertical illuminator
57 Knurled knob for operating the additional lens

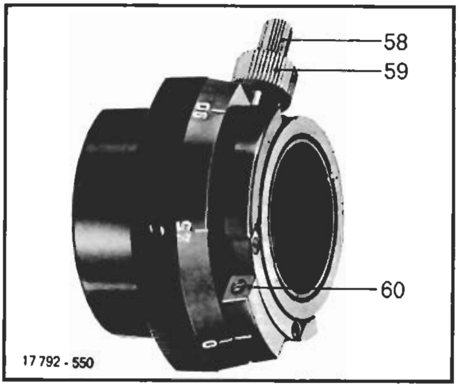


Fig. 11

Polarizing insert with filter
58 Clamping screw
59 Screw for clamping the illumination tube
60 Screw for adjusting the index marking
A re-adjustment with screw 60 can be carried out if the index does not precisely face zero at optimum extinction position.

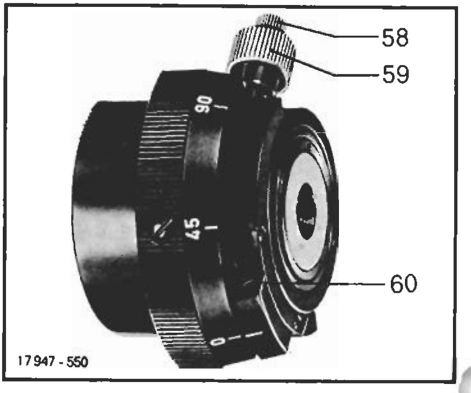


Fig. 12

Polarizing insert with prism
58 Clamping screw
59 Screw for clamping the illumination tube
60 Screw for adjusting the index marking

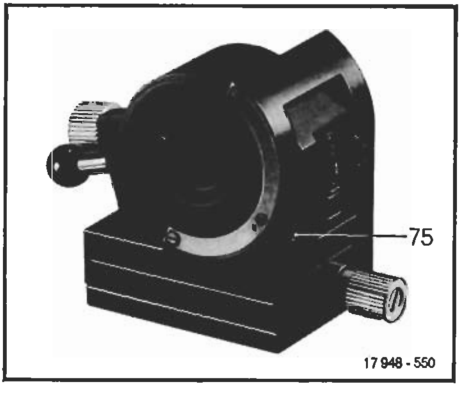


Fig. 13

Polarizing insert for the MPV microscope photometer
75 Screw for adjusting the polarizer

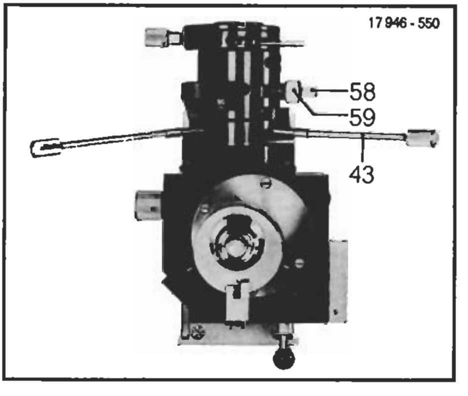


Fig. 14

Centring the field diaphragm on the pol-vertical illuminator
First align the objective with the optical axis, now the field diaphragm can be centred with the aid of the two centring keys 43. See also centring the field diaphragm, page 19.

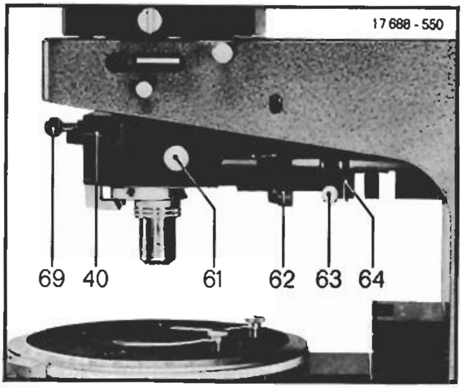


**Fig. 15 Pol-vertical illuminator**

40 Compensator slot with empty slide closed
61 Knurled knob for focusing the field diaphragm
62 Knurl for rotating the polarizer
63 Vertical adjustment of the aperture diaphragm
64 Knurl for engaging the half stop
69 Lever for inserting the plane glass or deflecting prism

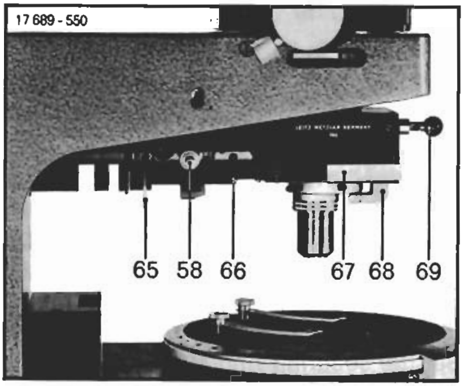


**Fig. 16 Pol-vertical illuminator**

58 Knurled screw for clamping the polarizer insert and polarizer
65 Lever for adjusting the aperture diaphragm
66 Lever for setting the field diaphragm
67 Lever for unlocking the objective holder
68 Holder for the objectives (objective centring clutch)
69 Lever for engaging the plane glass or deflecting prism

## 310 Compensators

Two compensators of fixed phase difference belong to the basic outfit: the $\lambda$-plate and the $\lambda/4$-plate. The vibration direction of n$\gamma$ is always engraved with the sign $\gamma$. The compensators are inserted in one of the two compensator slots on the revolving nosepiece, on the objective centring clutch, or on the vertical illuminator.

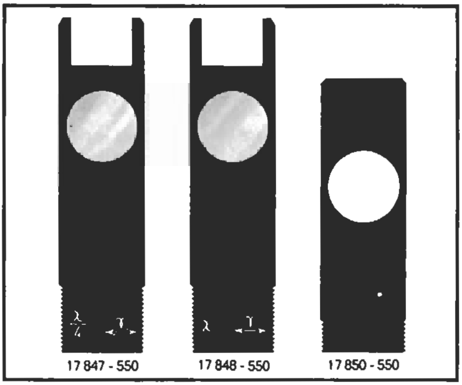


Fig. 17
Compensators and empty slide