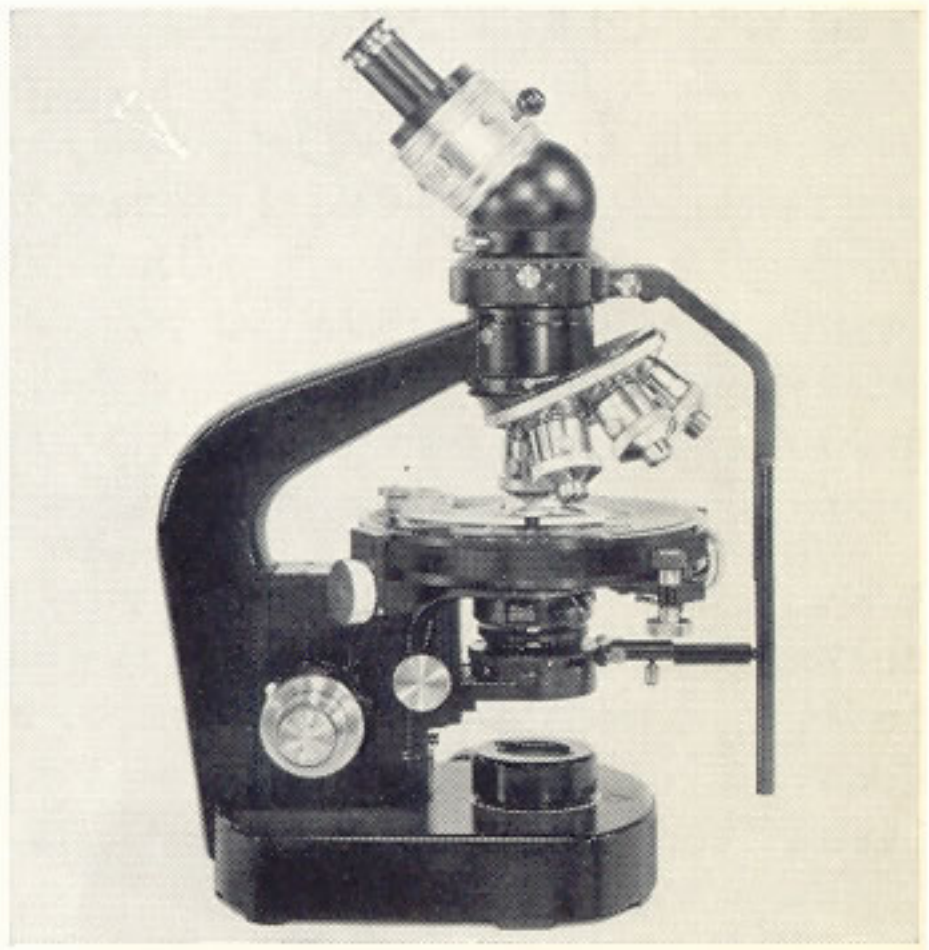
Polarising Microscope

Wild M21



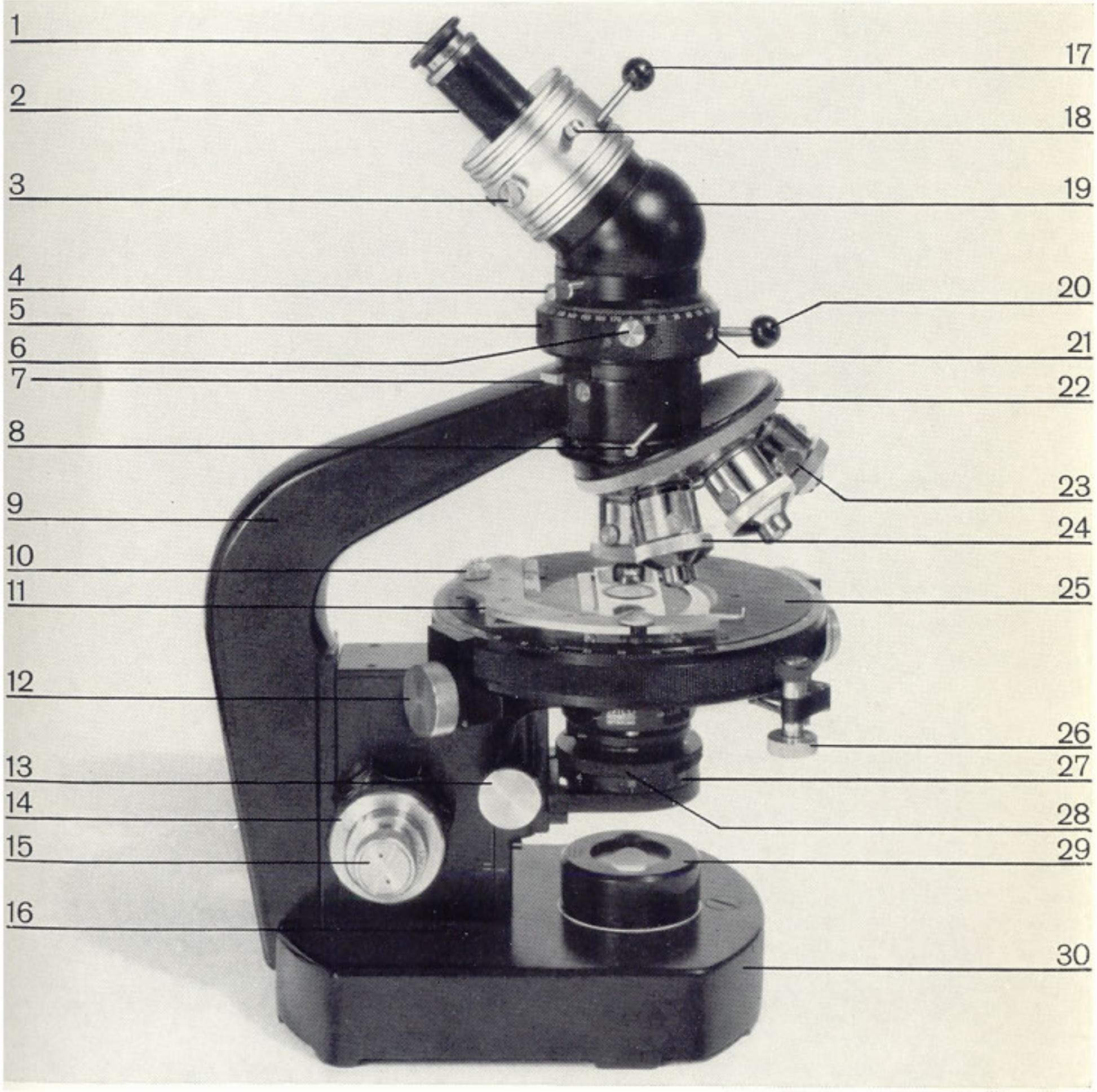
Instructions for use

WILD
HEERBRUGG

Contents Page

The reference numbers quoted in the text refer to the two fold-out illustrations on pages 3 and 22.
A brief survey of the theoretical aspects of polarising microscopy is given in our Polarisation Optics Sheets.

1 Cross-hair eyepiece
2 Eyetube with orientating slits
3 Clamping screw of Bertrand lens focusing sleeve
4 Tube clamping screw
5 Analyser rotating ring with scale
6 Clamp for 5
7 Compensator in slot
8 Clamp of nosepiece
9 Limb
10 Control knob of mechanical stage Cp
11 Attachable mechanical stage Cp
12 Clamping screw of rotating stage
13 Condenser focusing knob
14 Coarse adjustment control
15 Fine adjustment control
16 Range of fine adjustment
17 Control lever of Bertrand lens and iris
18 Centring screw for Bertrand lens
19 Monocular inclined tube Fp
20 Control lever of analyser
21 Threaded socket for attachment of synchronising bracket
22 Sextuple nosepiece
23 Objective centring screw
24 Objective in centring mount
25 Rotating stage with 360° scale and verniers
26 Fine stage control
27 Slot for auxiliary preparations
28 Polariser in rotating mount
29 Centring insert of built-in lamp
30 Base



Introduction

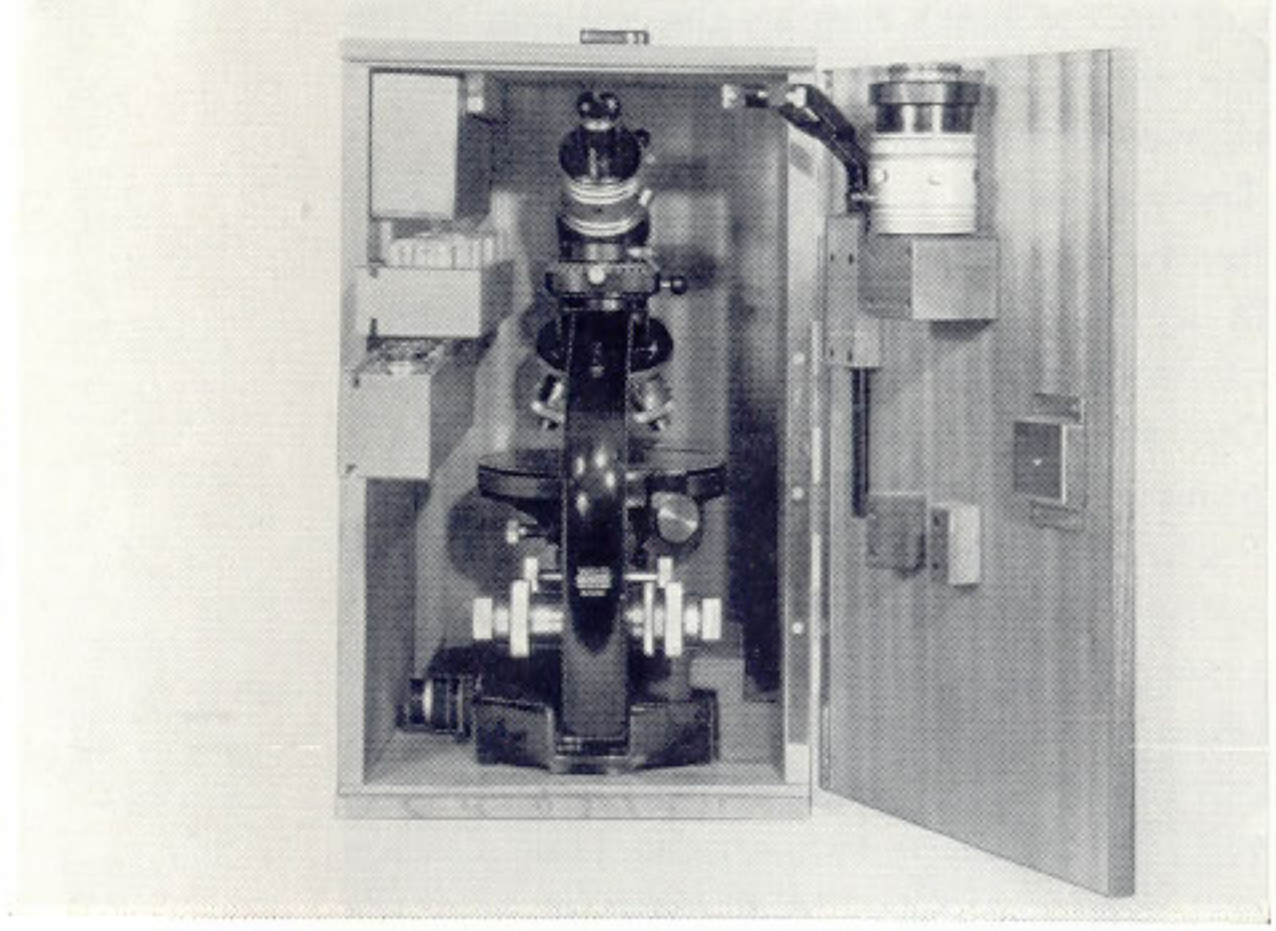
In the Wild M21 Polarising Microscope you have a research instrument which incorporates the most recent practical and theoretical developments in the field of microscope construction and design. We have also taken considerable care to ensure that your microscope is a precision instrument of the highest optical and mechanical quality. In this respect we offer the following guarantee:

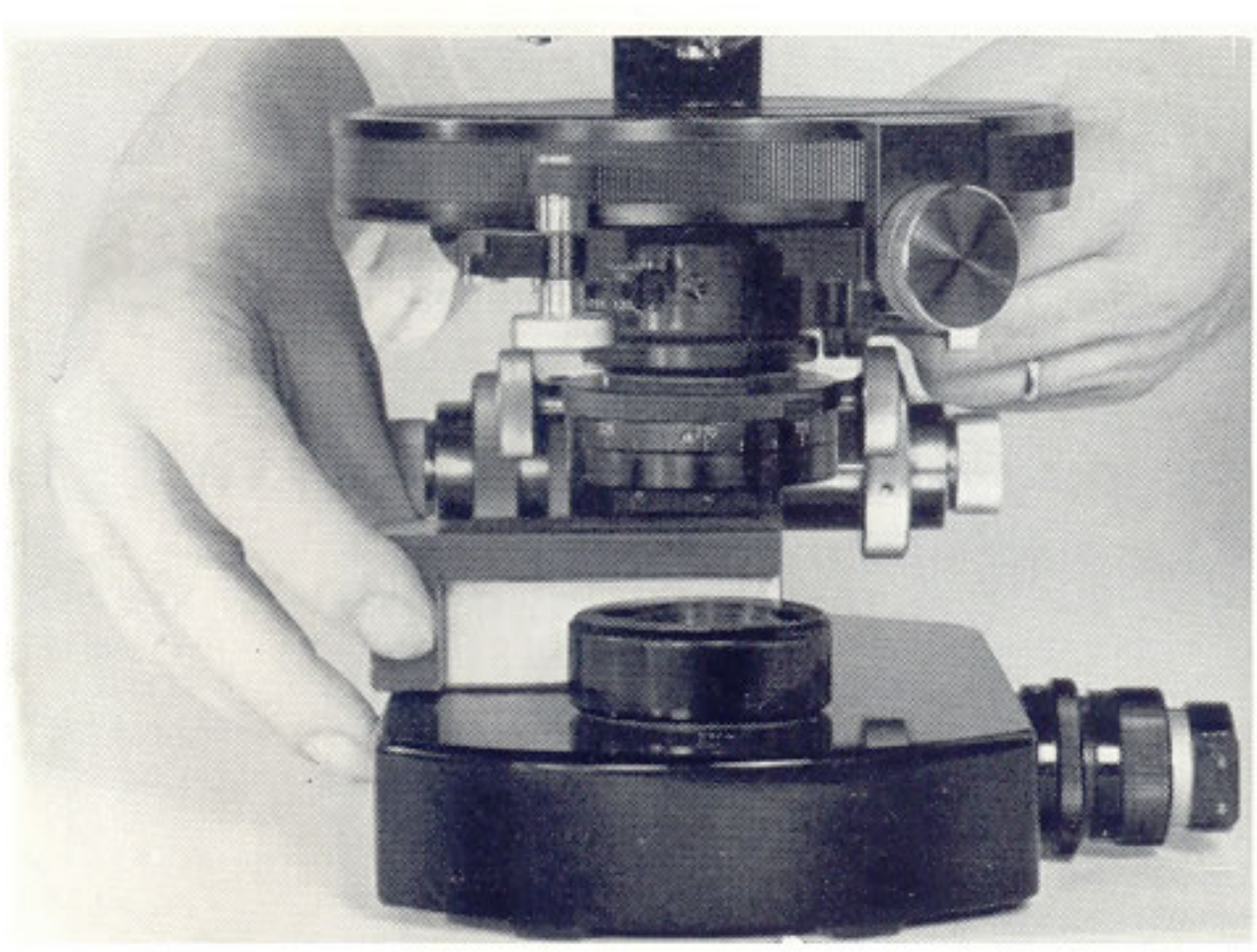
We vouch for the quality of every one of our instruments. Our guarantee covers all faults in materials and manufacture. It does not, however, cover damage resulting from careless or improper handling.

It is obvious that a precision instrument such as the M21 must be handled carefully and used correctly if it is to give full satisfaction and reliability over a long period of time. We therefore advise you to read through this booklet from cover to cover **before** you begin to use the microscope and to make yourself conversant with every feature of the instrument, and every part of the working instructions, so that you can obtain the maximum benefit from the equipment which you have purchased.
Both our local representatives and our specialists in Heerbrugg will be pleased to assist you in dealing with any problems concerning microscopy.

Page 5: Above: fig.1 M21 in cabinet
Below: fig.2 Removing the wooden block which takes the weight off the fine adjustment mechanism during transit

Unpacking and setting up the instrument





Unpacking

For transport the M21 is screwed to the base of its cabinet. When the screw is removed from the underside of the base the instrument can be taken out. Next slide out the wooden support (fig. 2), which relieves the fine adjustment of the weight of the stage during transit, and remove the paper packing. Take the mirror out of the top accessory drawer and fit it into its mount (in the base of the microscope). If the built-in lamp "S" has been ordered instead of the mirror it will be found fitted into the base (without bulb).

Setting up the instrument

Now raise the limb (9) with the coarse adjustment (14). Extract the objectives from their containers, in the middle drawer, and insert them one by one into the quadruple or sextuple nosepiece, being careful to avoid fingering the front lenses. It is best to insert the objectives in sequence, so that as the nosepiece is turned in a clockwise direction progressively higher powers come into position below the tube. The nosepiece may be removed for this purpose by turning the small lever (8) and sliding it off the dovetail guide. When replacing the nosepiece make certain that it is pushed home before clamping. Instructions for cleaning the optics are given on page 21.

The quick change nosepiece is fitted to the stand in the same way as the revolving

nosepieces. By pressing the clamping lever the objective centring ring (with, for example, a 10 × objective) can be inserted from the side into its circular dovetail mount. By turning the ring through approx. 90°, towards the front of the microscope, a stud comes into contact with the spring-loaded locking pin of the clamping lever and secures the objective centring ring. The centring ring thus always lies in the same position (i.e. once an objective has been centred in its ring it remains centred) provided it is inserted from the same side. Instructions for objective centring are given later.

Take a medium power cross-hair eyepiece (Pol 10 ×) from the lower accessory drawer in the cabinet and insert it in the tube (2) so that the orientation pin fits into the central slot in the top of the tube.

The fine adjustment controls (15), which like most other controls on this stand are bilateral, should be adjusted until the movement lies in the centre of its range (indicated by two white lines (16), engraved on the right hand side of the instrument). The drum of the fine control is graduated into 100 divisions, each division representing a vertical movement of 1 μ. However, since there is practically no play in the fine adjustment, the scale can be estimated successfully to 0.5 μ.

If the movement of the coarse adjustment (14) is too light or too stiff it may be varied by turning the black ring on the column of the co-axial coarse and fine movements, on the right side of the stand.

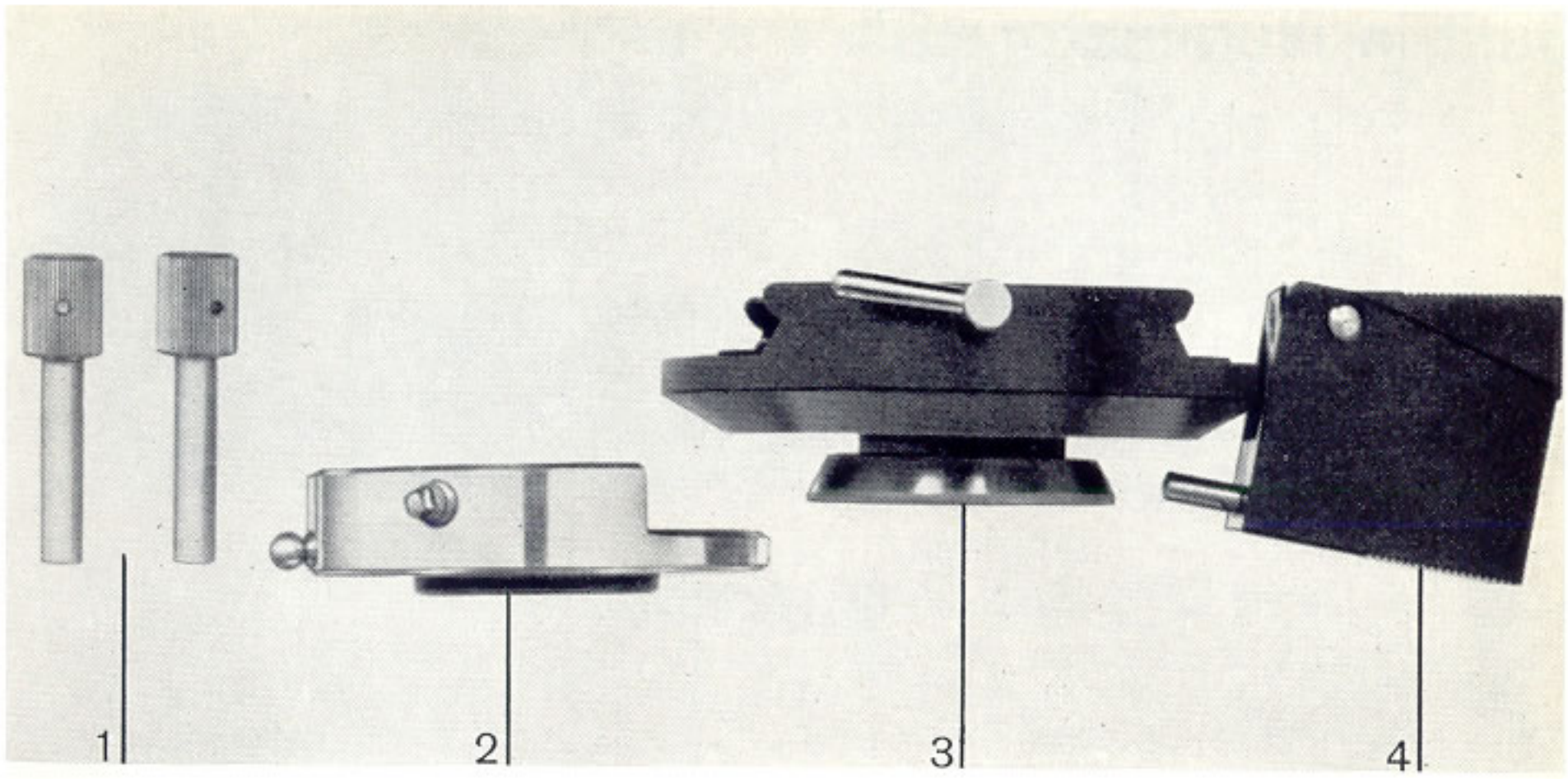
The movement of the rack and pinion condenser focusing mechanism can be adjusted in a similar way, by turning the bilateral control knobs in opposite directions.

Our swing-out condenser NA 0.65/1.30, engraved "Pol", is recommended for use with the M21. The attachment of this condenser is carried out as follows:

Lower the condenser mount by means of the focusing knob (13) and swing the polariser out to one side. Swing out the front lens of the condenser by turning the control knob (34) and push the condenser up into the mount. Fix in position with the locking screw. The condenser knob (34) should be on the same side of the instrument as the built-in lamp. Swing the condenser front lens and the polariser back into position. The condenser iris diaphragm (=aperture diaphragm) is actuated by a lever on the right hand side of the condenser. The condenser is pre-centred within narrow tolerances.

Page 7: Above: fig. 3 Individual components of the quickchange mount Z
1 centring keys
2 centring ring
3 mount with dovetail ring
4 clamping lever

Below: fig. 4 M21 with quick-change mount Z and synchronising bracket


1
2
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4

Built-in illuminator "S"

Components

a) Step or fully variable regulating transformer

b) Lamp-housing with lamp-socket, pre-centred bulb, collector and field diaphragm

c) Clamping lever

d) Centring insert with reflecting prism

Installation

1 Set the mains voltage selector on the transformer to the appropriate value (e.g. 220 V).

2 Connect the transformer to the mains, using the connecting cable provided.

3 Connect the lamp to the transformer with the special cable supplied.

4 Loosen the milled ring b5 and withdraw the lamp socket b2. Insert the special bulb (6 V/20W) b3 into the socket (the bulb is packed in the top drawer of the cabinet).

5 Push the lamp and socket back into the housing and clamp in position with ring b5 (the lamp filament will then lie in the correct image plane).

If the built-in illuminator "S" is obtained subsequent to the purchase of the microscope it should be fitted as follows:

1 Remove the mirror and mirror mount from the base plate socket and in its place insert the centring insert a, in such a way that the spring clip of the insert fits into the slot at the front of the socket.

2 Slide the insert into the centre of the white circle engraved on the base plate.

3 The clamping lever c is inserted after removing the lever hole cover and is screwed into the side of the base, then unscrewed by one turn. The lever is used to clamp the lamp housing in position.

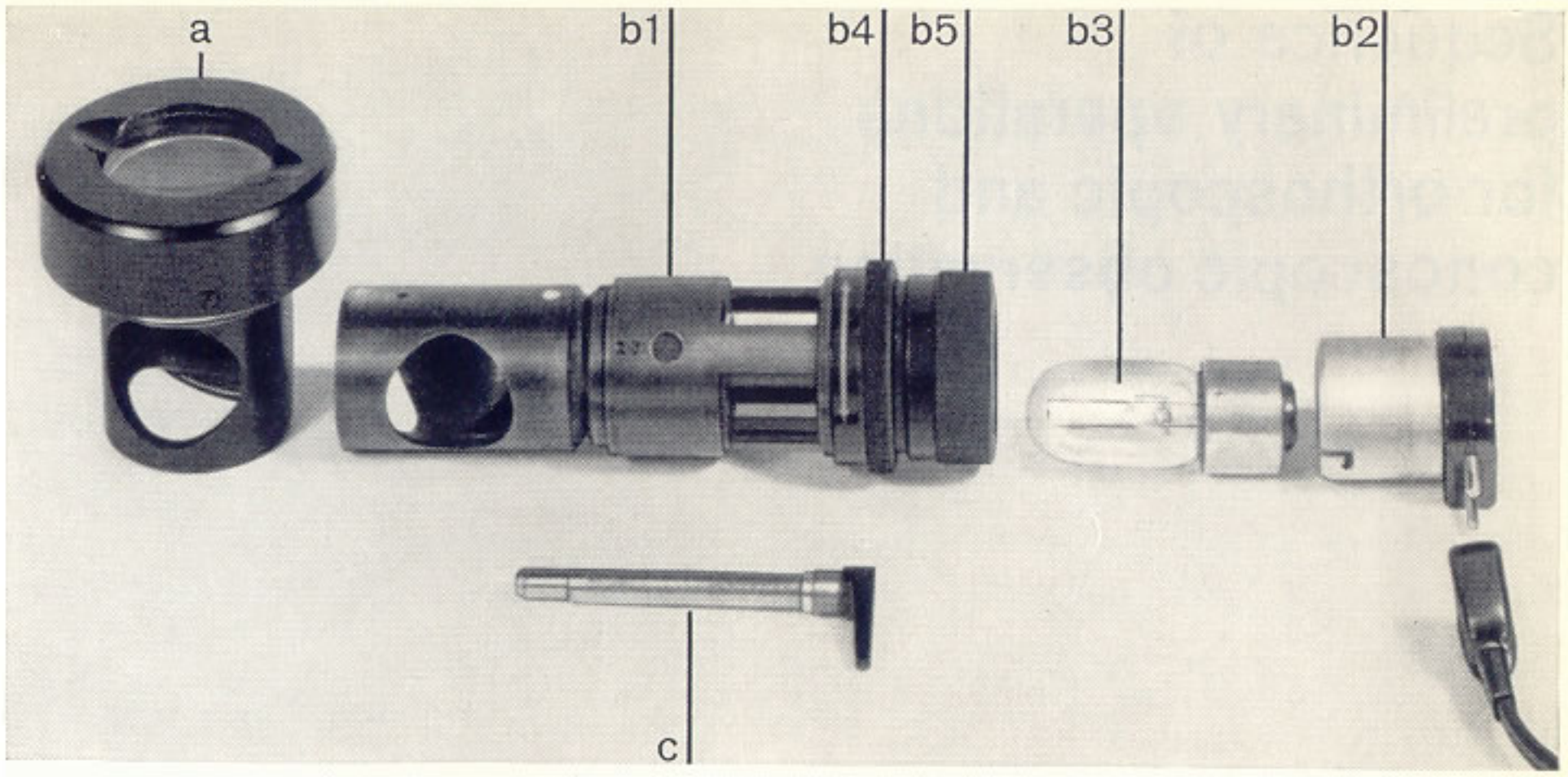
4 Lift out the cover plate from the same side of the base, to expose the opening for the lamp housing b. Push the housing home into the base (the white spot should be uppermost) and lightly clamp into position with lever c (see fig. 6).

5 Turn the milled ring b4 (field diaphragm control) as far as it will go, in an anticlockwise direction.

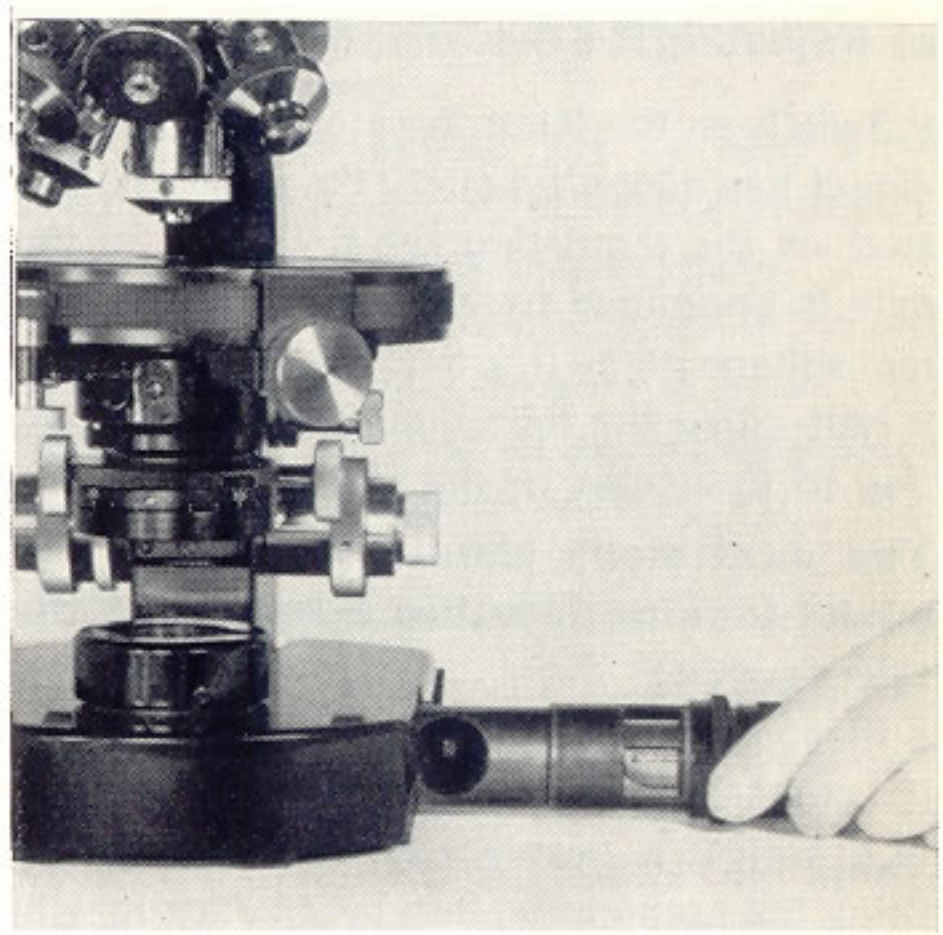
6 Loosen clamping ring b5 (turn anticlockwise) and withdraw the bulb socket b2.

7 Insert the pre-centred 6 V/20 W bulb with bayonet mount b3 into the lamp socket b2, replace in lamp housing and lock into position with the clamping ring b5.

The sliding head of the centring insert is attached to the cylindrical stem by a grease covered friction plate. If it should become detached (e.g. when lifting the insert out of the base) it may be replaced by simply pressing the two parts together. The mirrors in the insert and the lamp housing are surface silvered and must not be touched with the fingers. Dust should be removed either with a fine soft brush (damped in ether) or with a rubber blow-ball.



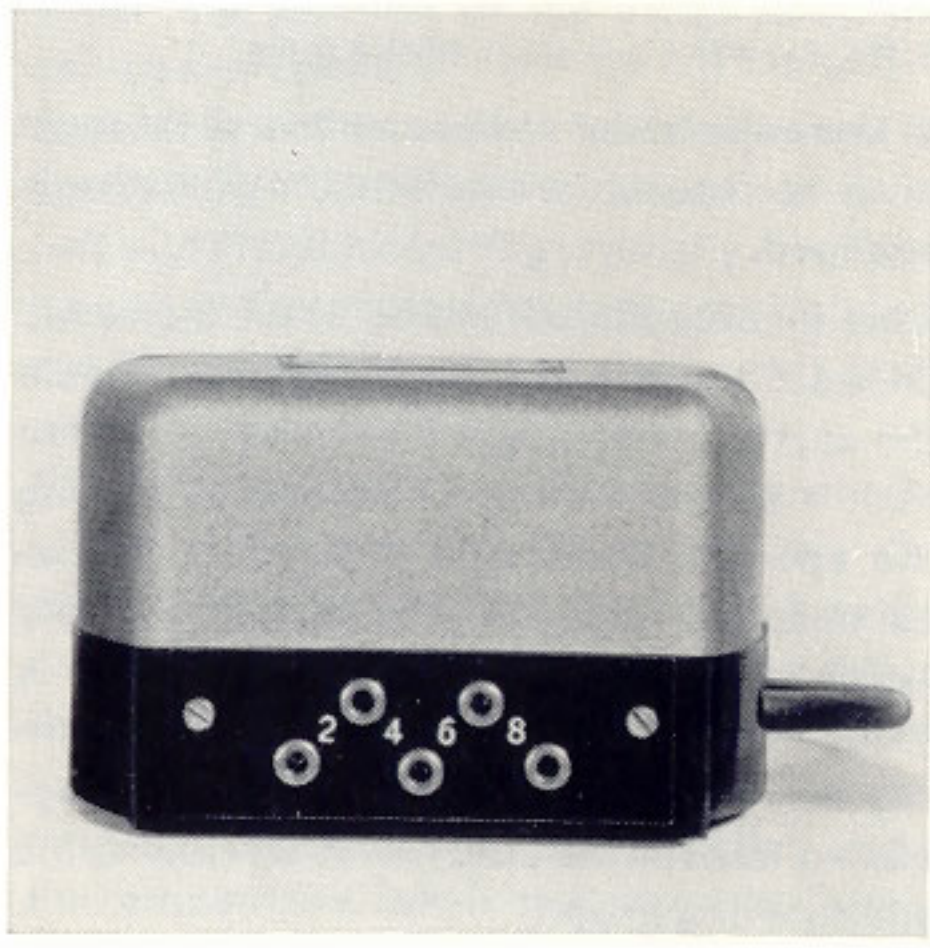
Above: fig. 5 Individual components of the built-in lamp "S"
a centring insert
b1 lamp holder
b2 bulb socket
b3 bulb
b4 field diaphragm control
b5 clamping ring
c clamping lever

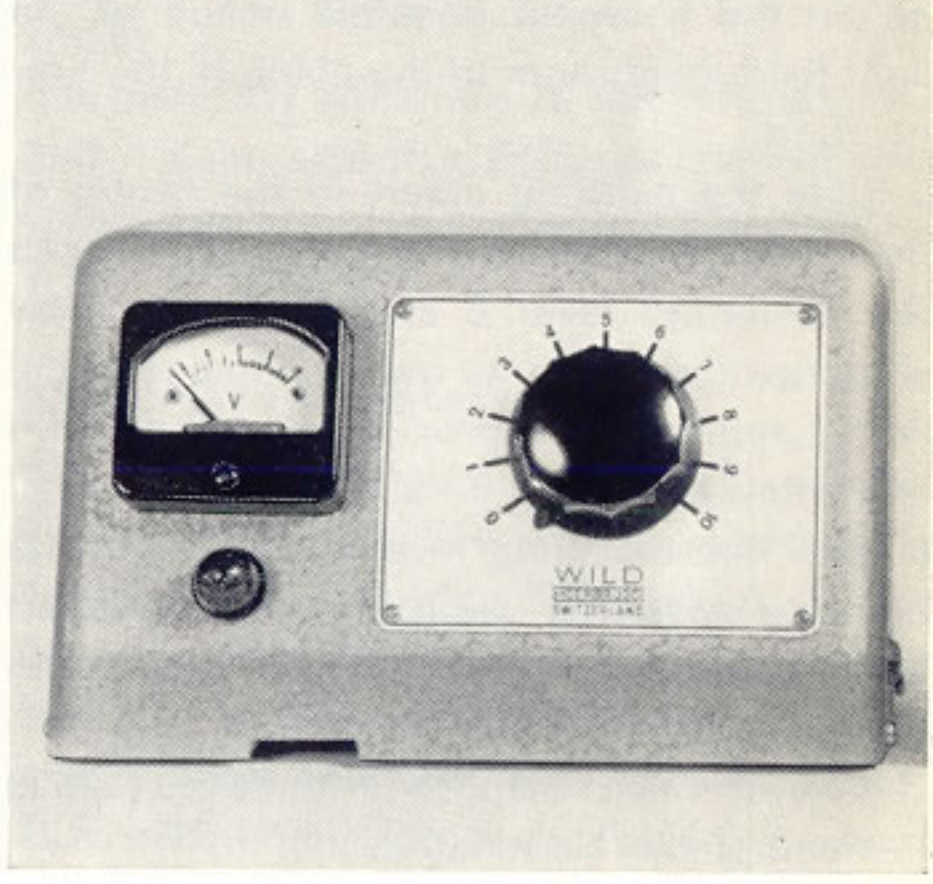


Centre: fig. 6 Inserting the built-in lamp "S"

Below, left: fig. 7 Step transformer 2/4/6/8 V

Below, right: fig. 8 Regulating transformer with voltmeter





Sequence of preliminary operations for orthoscopic and conoscopic observation

a) Adjusting the field diaphragm

1 Switch on the lamp transformer. The step model has a toggle switch; the other is operated via the regulating knob. The life of the bulb is prolonged by using it within the correct voltage range (i.e. below 6 V).
2 Half close the field diaphragm by turning ring b4 (indicated by the red arrow).

The next steps should be carried out whilst looking into the eyepiece of the microscope:

3 Place a slide on the stage and focus using the coarse adjustment and low magnification (e.g. with 10× eyepiece and 10× objective). Bring the preparation into precise focus with the fine adjustment.
4 By raising or lowering the condenser obtain the sharpest possible image of the light field diaphragm in the plane of the preparation.
5 Slide the centring insert to the centre of the white circle on top of the base. Loosen the clamping lever c and turn or slightly withdraw the "S" lamp until the image of the field diaphragm is approximately in the centre of the field of view.
6 Lock the clamping lever c and finish the centring operation using the centring insert a. If necessary open the field diaphragm slightly to asist precise centring.
7 Open the field diaphragm until the field is just completely illuminated.

For every change in magnification the field diaphragm must be adjusted to the field of view. It may also be necessary to slightly adjust the centring of the diaphragm.

b) Adjusting the aperture (condenser) diaphragm

After carrying out steps 1–7 above, the aperture diaphragm must be adjusted as follows:

1 Remove the eyepiece from the tube and look down the tube with the naked eye.

2 Slowly close the aperture diaphragm until about ¼ of the field is obscured. This rule applies to all orthoscopic observations and is essential for the best results.

3 Replace the eyepiece in the tube.

4 The adjustment of the aperture diaphragm must be repeated every time the objective is changed.

Only in exceptional cases, when increased contrast or depth of field are required, should the aperture diaphragm be closed more than this. It should be noted also that by closing the aperture diaphragm more than the recommended amount, the resolution and hence the efficiency of the objective, is greatly reduced. If necessary the light intensity may be reduced by filters or by the regulating transformer, but **never** by closing the aperture diaphragm.

c) Centring the objective

1 Place the lowest power objective in position below the tube.

2 Focus the cross-hairs of the eyepiece by moving the eyelens in and out with a spiral movement.

3 Focus on a small discrete structure in the preparation e.g. a small mineral grain, or one of the scale numbers of the stage micrometer with photographic scale (test preparation, code no. 8411).

4 Locate the structure observed in the centre of the eyepiece cross, then rotate the stage whilst observing the specimen. If, on rotation, the structure does not wander but remains under the junction of the cross-hairs, the objective is centred.

Objectives which are out of centre may be centred by following the directions given below. Although centring is greatly simplified by use of the micrometer test preparation it can be carried out using a convenient small structure in a normal preparation:

Move the preparation so that the cross in the centre of the eyepiece lies exactly over the centre of the top circle of the figure 8 on the micrometer scale. Turn the stage and adjust the centring screws of the objective mount (or of the centring ring if the Z mount is used) until the centre of the circle remains under the cross-hairs when the stage is rotated through 360°. All the objectives should be centred in this way.

The objectives should not be held when rotating the nosepiece, otherwise time-consuming recentring may be necessary.

Note that the photographic scale of the test preparation (3 mm divided in $^1/_{100}$ mm) enables it to be used as an ordinary stage micrometer as well as for centring.

d) Orthoscopic observation

When all objectives have been centred preparations can be examined by orthoscopic methods and (unless carelessly handled) the objectives will require little or no further recentring. The field diaphragm and aperture diaphragm, however, should be re-adjusted each time the objective is changed (see **a** and **b**).

It is generally preferable to examine sections first in plane-polarised light and then between crossed polarisers (i.e. analyser and polariser in the "O" position).

e) Conoscopic observation

The interference figure lies in the back focal plane of the objective and is observed by conoscopic methods. The polariser and analyser should be in the crossed position (i.e. both at "O") and a high power objective with a high aperture (e.g. 40× achromat; N.A. 0.65) should be used. The front lens of

the swing-out condenser should be in position and the condenser should be accurately focused.

It may be necessary to open the field and aperture diaphragms almost to their full extent so that the back focal plane of the objective is fully illuminated.

The simplest method of observing the interference figure is to remove the eyepiece and look into the tube with the naked eye. The figure will be quite small, but sharp.

A substantial improvement in the interference figure is obtained by using the Bertrand lens, which is built into the straight and inclined monocular tubes. When in position the Bertrand lens acts with the eyepiece to form an auxiliary microscope, which enlarges the interference figure. The Bertrand lens is focused with its iris diaphragm open, by sliding the chromed sleeve up and down the tube, locking it with the clamping screw when the best position has been found. The actual tube length of the microscope is not altered by this focusing process. The two centring screws on the sleeve are then used to centre the figure in relation the eyepiece crosshairs and then the iris diaphragm of the Bertrand lens is adjusted until the required sharpness and contrast is obtained.

The interference figure can be observed using the binocular tube, in which case a separate auxiliary microscope is required (see page 15).

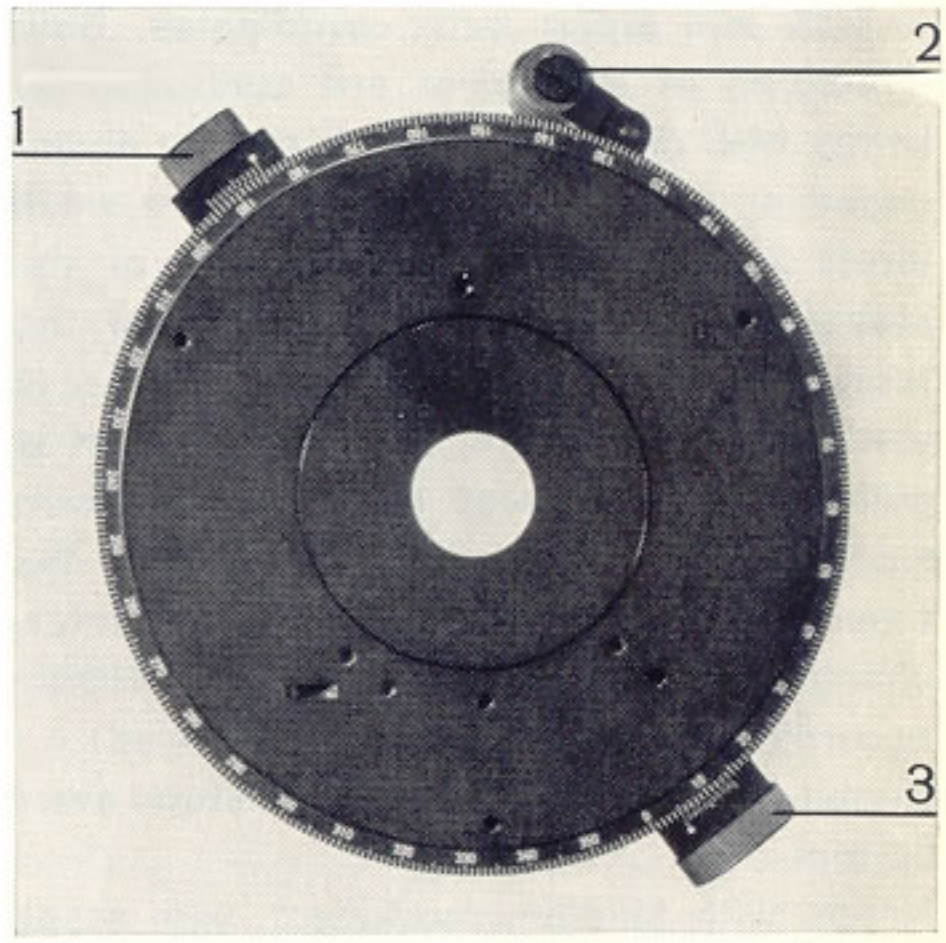
Stages

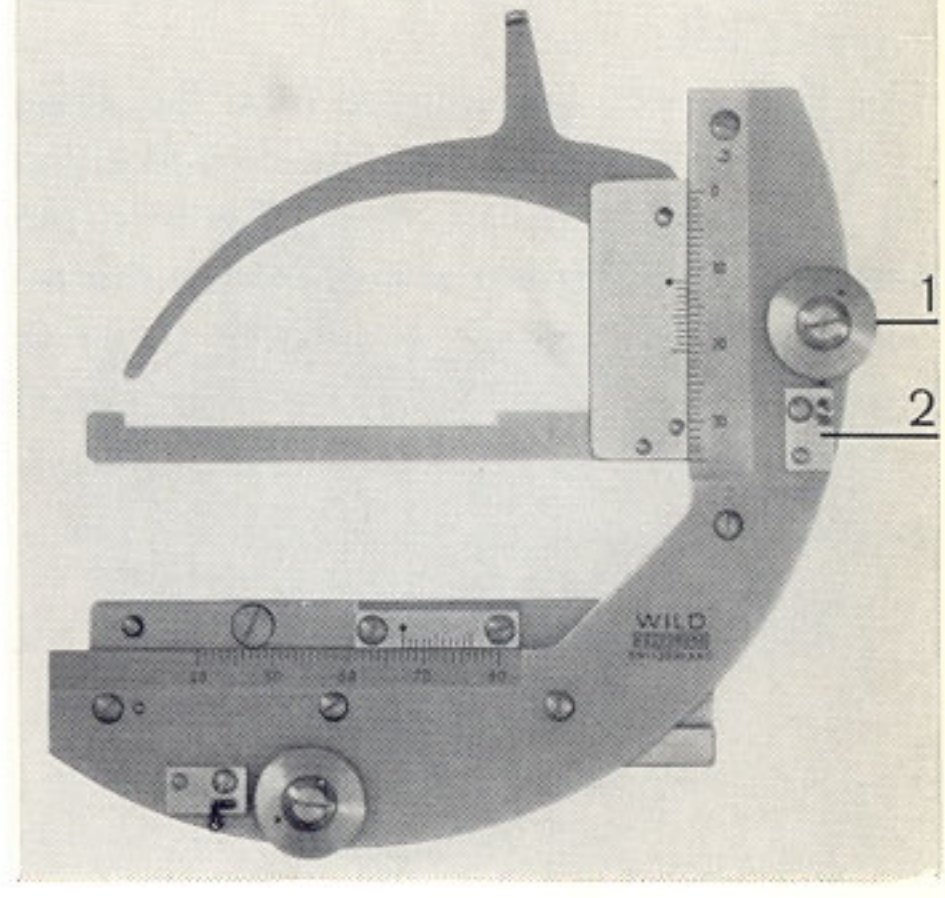
a) Ball-bearing mounted rotating polarisation stage Rp with 360° scale, two verniers and clamping screw.

b) Ball bearing mounted rotating polarisation stage Qp with 360° scale, two verniers, clamping screw, 45° stage stop positions (can be disengaged and adjusted) and swing-in fine stage control.

The M21 Polarising Microscope is delivered with either an Rp or a Qp stage. The stages are mounted securely on the stand in the factory and are precisely centred around the optical axis of the microscope. The precision mounting ensures a light and easy movement, and the stage can be locked in any position by a clamping screw (12). The knurled knob (32) allows the 45° stops to be inserted or withdrawn as and where required. A spring mechanism allows the fine adjustment to be swung out of contact with the stage when not in use. The top of the stage is bored to accept stage clips, the attachable mechanical stage Cp or a universal stage.

The Cp attachable stage has a movement of 25×30 mm, with scales and verniers reading





Above: fig. 9 Plan view of rotating stage Qp
1 knob for inserting 45° stops
2 fine control
3 clamping screw

Below: fig. 10 Attachable mechanical stage Cp
1 control knob
2 lever controlling engagement of click-stops

to 0.05 mm along both coordinates. Both directions of movement are controlled by knobs with click-stops which can be disengaged or changed if necessary. The small levers controlling the engagement of the stops are located in slots alongside the respective control knobs. When the lever is vertical the stops are engaged, when it is pulled along the slot and pressed down sideways into the horizontal position the stops are disengaged. Three different interchangeable stage movements are available according to the control knobs employed:

Knobs with Fine movement, with stops every 0.2 mm

Knobs with Medium movement, with stops every 0.3 mm

Knobs with Coarse movement, with stops every 0.5 mm

The knobs may be removed from the stage by unscrewing the central portion and lifting off the knurled collar, marked with a red spot. When attaching a knob giving the required movement care should be taken to ensure that the red spot lies above the slot in the spindle.

Tubes

a) Monocular inclined tube Fp

b) Monocular straight tube Ep

c) Binocular inclined tube Gp

The Fp and Ep tubes (the latter is primarily intended for photographic work) are suitable for both conoscopic and orthoscopic observations. Pushing the lever (17) will bring the Bertrand lens into position, while moving the lever from side to side actuates the built-in diaphragm which permits the observation of interference figures without background glare. The Bertrand lens may be focused by loosening screw (3) and sliding the chromed collar along the tube. Centring of the Bertrand lens is carried out by two centring screws (18). The tube is attached to the stand by a dovetail ring base, and can be removed by loosening screw (4) and gently lifting. To replace the tube the spring-mounted bolt forming part of the locking screw should first be located within the dovetail and the tube then turned until the orientation pin sits in the appropriate slot on the top of the stand. Screw (4) can then be tightened so that the tube is locked in position.

The binocular inclined tube Gp (engraved "Pol") is particularly useful when the instrument is used for long periods at a time and greatly reduces eye fatigue in such conditions. The analysing effect of the prisms in the binocular head is eliminated by an appropriately orientated quartz plate, built into the

lower opening of the tube. The fixed eyetube is also provided with three orientating slits for use with the Pol cross-hair eyepiece. A normal eyepiece can be used in the focusing eyetube.

The binocular inclined tube may be used for both orthoscopic and conoscopic observations. For conoscopic work an accessory microscope (such as that used in the Wild phase-contrast outfit, code no. 6077) is inserted in the focusing eyetube. This permits observation of the back focal plane of the objective, in which lies the interference figure. The interference figure can be focused by adjusting the focusing eyelens of the accessory microscope.

The binocular tube fits on the stand in the same way as the monocular tubes previously described.

Fig. 11 Inclined binocular tube Gp

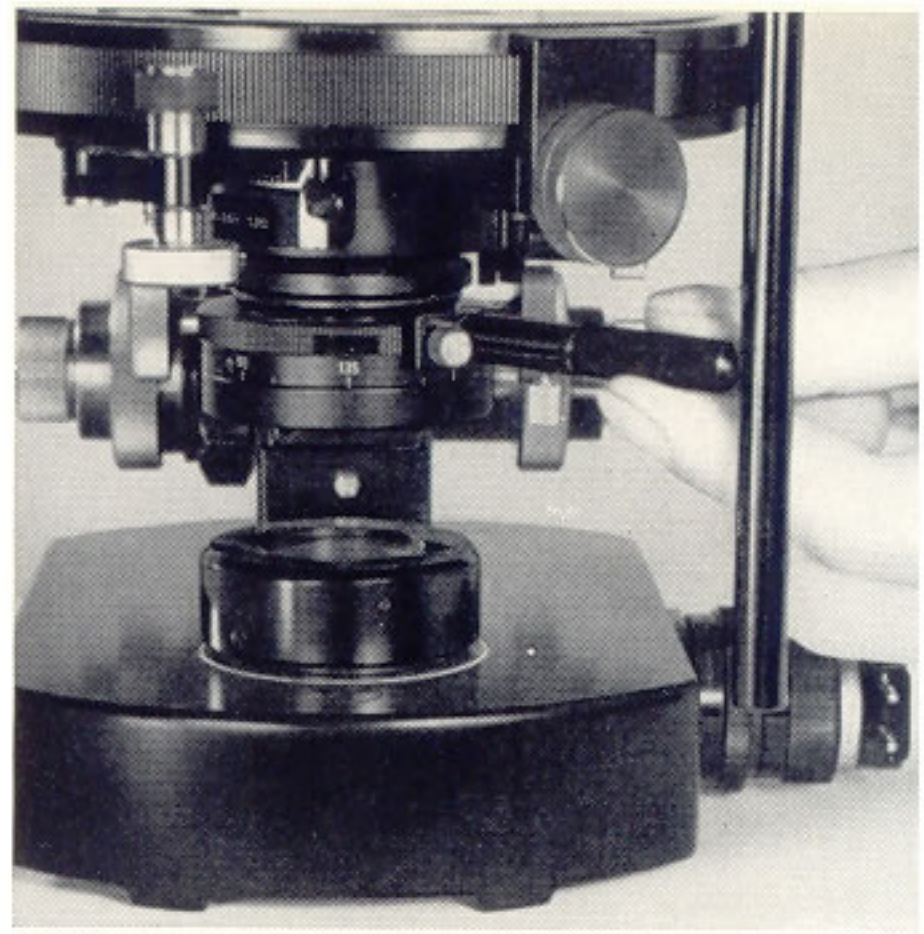


Fig. 12 Adjusting the synchronising bracket so that the polariser and analyser are exactly in the crossed position

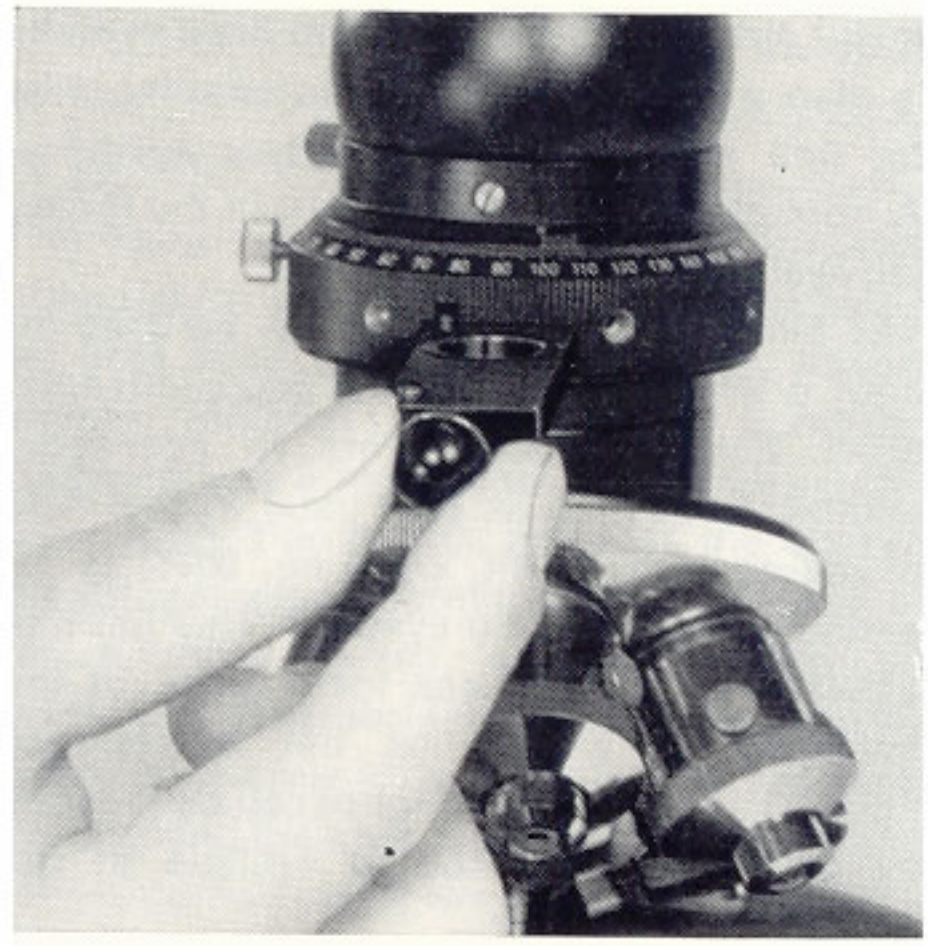


Fig. 13 Removing the analyser with the scale in the 100° position

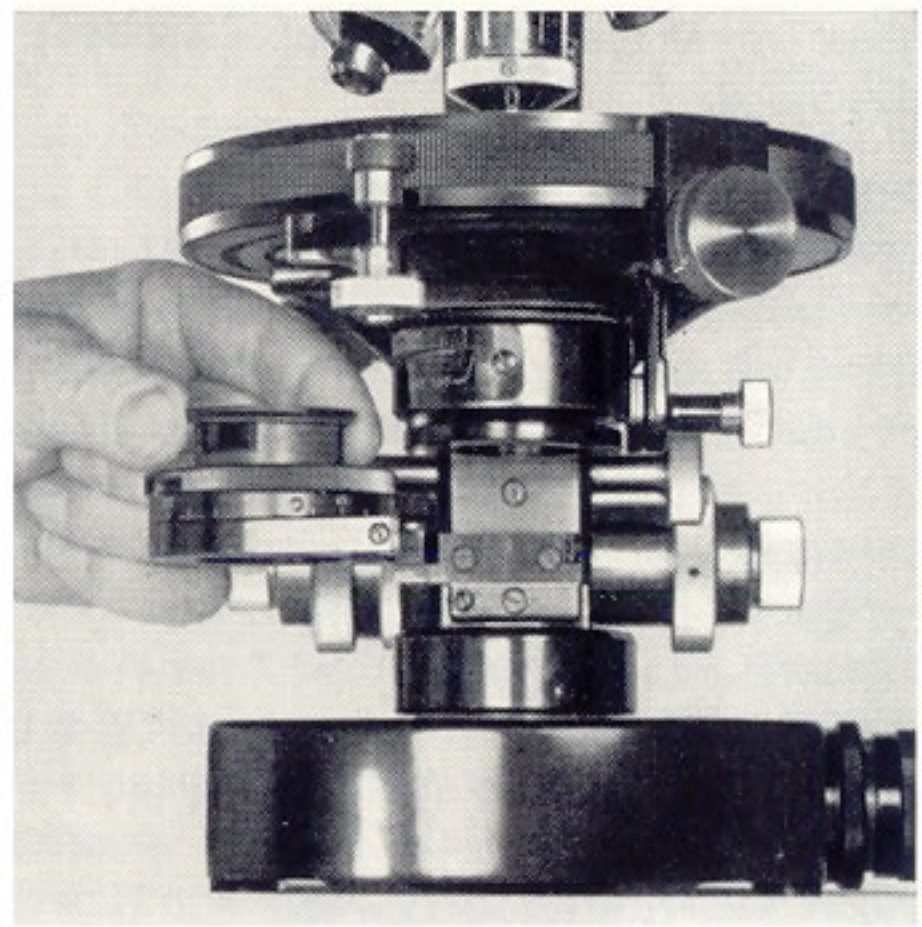


Fig. 14 Removing the polariser

Polariser

The polariser, which is a polarising filter in a metal mount, can be rotated through 360° and has click-stops at 90° intervals. The polariser mount is graduated at 15° intervals and numbered every 45°. When the zero point is opposite the reference mark on the left side of the mounting bracket (35) the direction of vibration of the polariser is North-South, i.e. parallel to the vertical line of the cross-hair eyepiece.

A slot between the 135° and 315° positions allows insertion of compensators at 45° to the vibration direction (27) and is used when the polariser and analyser are rotated in conjunction. The polariser can be swung out for cleaning or removal (see fig. 14) and to permit the M21 to be used as a research instrument for other methods of microscopy (in which case, of course, the analyser must also be withdrawn from the optical path). When inserting the filter, the peg on the metal rim must engage the slot in the mount.

Analyser

The analyser comprises a second polarising filter, in a sliding mount which can be rotated through 180° by a rotary mechanism with a double 180° scale, built into the body of the microscope. The analysing filter may be removed completely in the 100° position. The scales and verniers of the analyser allow its position to be read to 0.1°. In the 0° position the vibration direction of the analyser is East-West (i.e. at exactly 90° to that of the polariser).

A slot for compensators and wedges (aperture 4×12 mm) is located below the analyser, at 45° to the main vibration direction (7) and can be closed with sliding cover when not in use. Other makes of compensators may be used with the Wild M21 providing their stop studs are suitably positioned.

Synchronising bracket

In certain circumstances it is preferable to rotate the polariser and analyser in their crossed positions rather than to rotate the stage in the conventional manner. In such cases the synchronising bracket (fig. 4) is recommended. The wide upper end of bracket is fixed by two screws to the rotating analyser mount, using the sockets located one each side of the analyser slot. The T-shaped attachment rod is then attached to the polariser mount via two screws, which are inserted into their appropriate sockets. The outer end of the T-rod has a knob which is fitted into the groove on the inner surface of the bracket. The eccentric, knurled shaft of the T-rod is then rotated until the polariser and analyser are exactly crossed, whereupon the clamping screw of the shaft is tightened. The crossed polarising elements can now be rotated through 180° and their angular position read to 0.1° from the analyser scale. The analyser itself may be slid in and out of the light path in all positions.

Objectives

For precise observations in polarised light objectives must be strain-free and centrable. We supply Pol achromats in centring mounts for use with the 6- or 4-place revolving nosepieces. These objectives are calculated for use with a mechanical tube length of 160 mm and for a coverglass thickness of 0.17 mm. The 20×, 40× and 100× objectives are springmounted to protect the objective front lens and the preparation. Centring is carried out by two screws (23). A knurled ring (24), which is larger in diameter than the other parts of the objective, is used to unscrew the objective from the nosepiece and also protects the centring screws from inadvertent displacement. The large ridged rim of the nosepiece should be used to swing objectives into position; the objectives themselves should not be touched once they have been centred and should never be used as levers to rotate the nosepiece.

Normal achromats may also be used for polarising microscopy, if they are engraved "Pol", which indicates that they have been specially tested and found to be free from strain. However, such objectives should **not** be used in a revolving nosepiece, but should be fixed in a centring ring for use with the quick-change mount Z, described earlier. Each objective can be fitted with a centring ring, so that they can be quickly inserted into the Z mount and centred by means of the two centring keys provided.

Eyepieces

Note: The 100 × is an **oil immersion** objective and should always be used with a film of immersion oil between the front lens and the cover slip.

Good polarising eyepieces are constructed on the same lines as measuring eyepieces, that is with a focusing eyelens and an accurately centred graticule (i.e. cross-hairs). To facilitate the precise orientation of the cross-hairs in relation to the vibration planes of the polariser and analyser, the eyepiece mount is fitted with a pin which engages slots at 90° and 45° in the rim of the tube. The cross-hairs are focused by adjusting the eyelens whilst observing a neutral background with the eye relaxed.
Normally a Huyghenian cross-hair eyepiece is used for polarising work but for high power dry and oil immersion systems we recommend the use of compensating eyepieces, which give better chromatic correction.

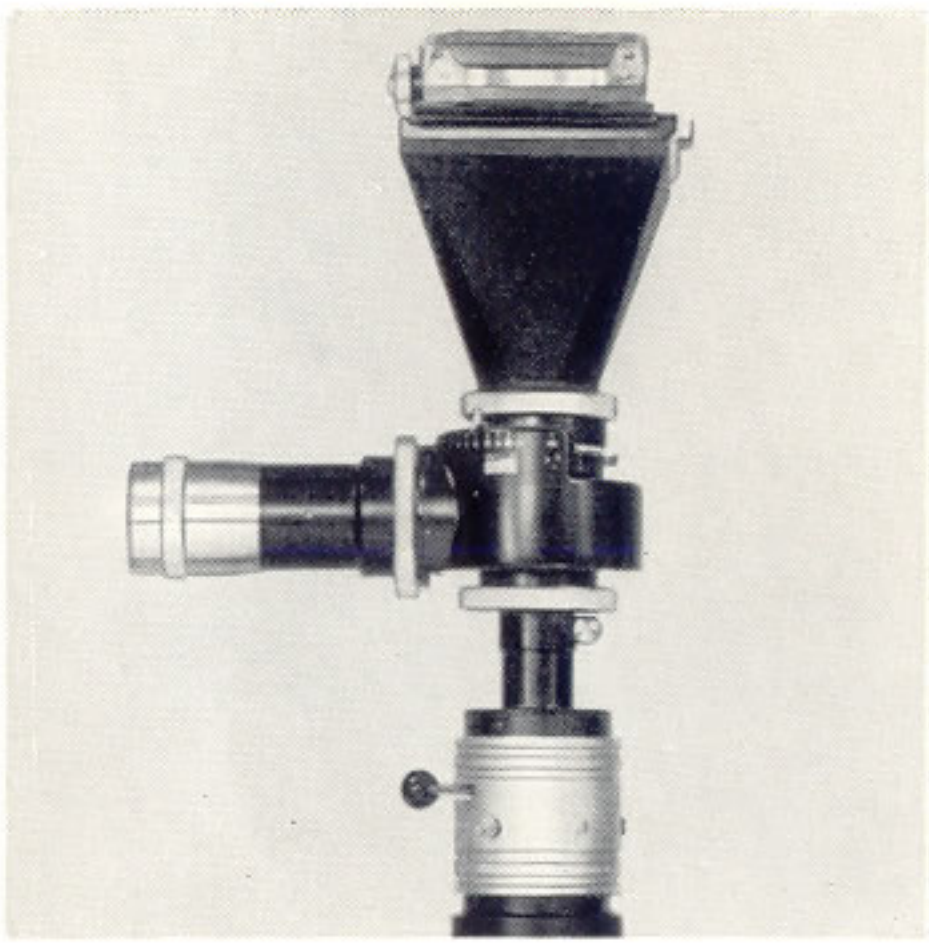


Fig. 15 Monocular straight tube Ep and Wild camera with focusing telescope

Care and packing of the M21

Care of the instrument

Dust is the microscope's greatest enemy and when not in use the instrument should always be either stowed in its cabinet or covered by a plastic dust cover.

If necessary the **external** parts of the optical components may be cleaned with a soft brush or with a soft, well-laundered linen rag.

A few drops of **xylol** may be used to remove stubborn deposits, but all traces of the xylol must be removed with a dry cloth afterwards.

Under no circumstances should the objectives be dismantled, otherwise their optical capabilities may be considerably reduced.

From time to time the mechanical parts of the microscope should be wiped clean with a chamois leather or a soft cloth. **Never oil the movements** of the coarse and fine adjustment, condenser rack and pinion, slide or stage—oil may cause them to jam completely.

If the instrument breaks down or gives unsatisfactory results because of faulty handling it must be repaired by a skilled mechanic or, better still, by the makers.

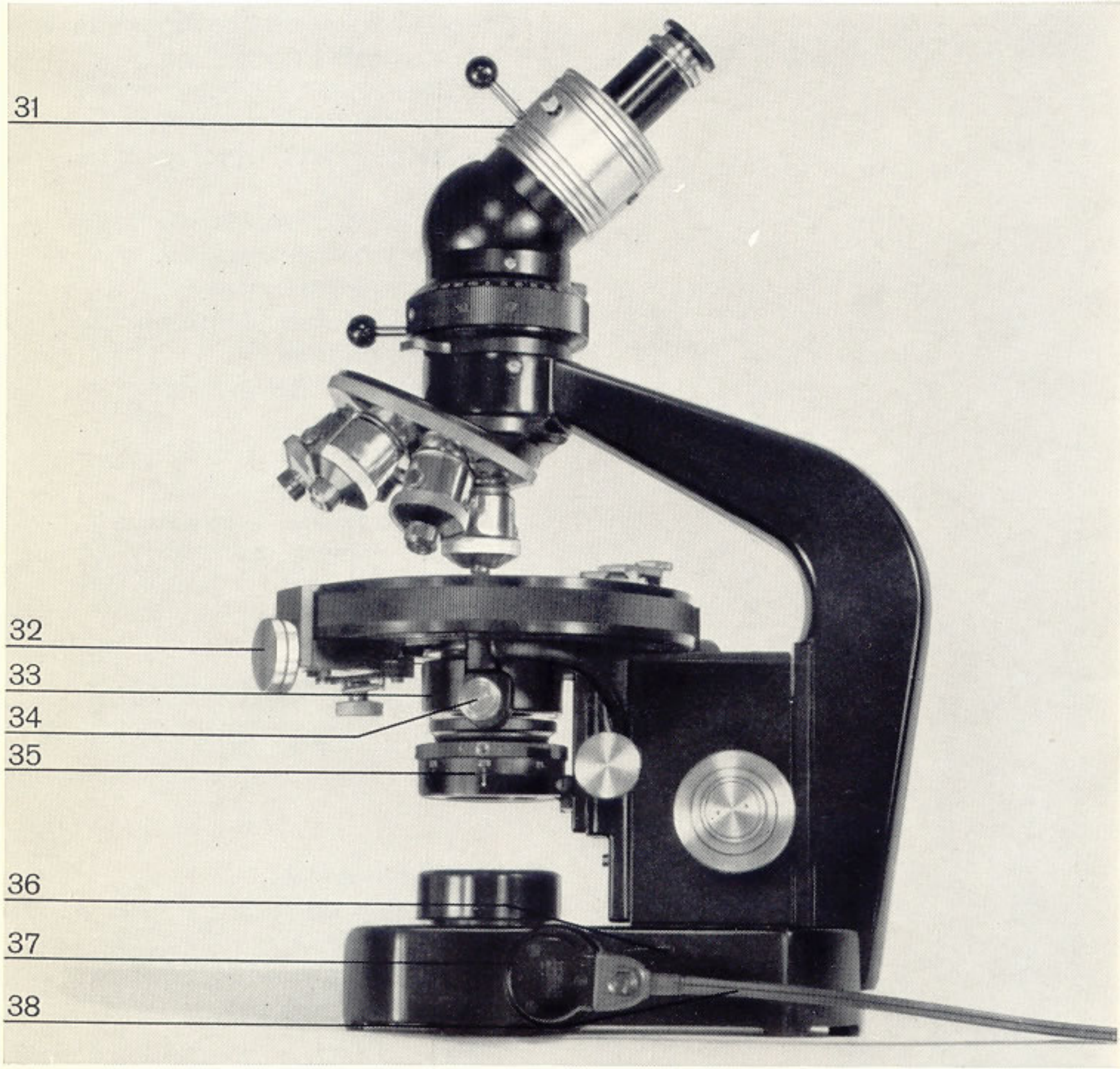
Packing the instrument

If the instrument has to be moved the objectives should first be unscrewed from the nosepiece and stowed in the middle drawer of the cabinet in their plastic containers. The eyepieces are then removed and stored in the sockets in the lower drawer. The mirror, or the bulb of the built-in lamp, should be wrapped in tissue paper and fitted in the top drawer of the cabinet. This drawer also holds the T-rod of the synchronising bracket and the cable of the built-in lamp and has a rack for compensators. The main portion of the synchronising bracket fits into a holder on the inside of the door.

When all the accessories have been stowed away the wooden block is inserted between the base and the fine adjustment movement. The stand is then placed in the cabinet and secured by the screw in the base. All free space around the instrument should be stuffed with tissue paper.

21 (blank)

31 Focusing sleeve of Bertrand lens
32 Knob for inserting and removing 45° stops
33 Swing-out condenser
34 Knob for swinging-out condenser front lens
35 Scale of polariser mount
36 Clamping lever for built-in lamp
37 Built-in lamp "S"
38 Connecting cable of built-in lamp



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Wild M4 stereomicroscope with magnification changer. Maximum magnification 160×. Suitable for visual observation and photomicrography.

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