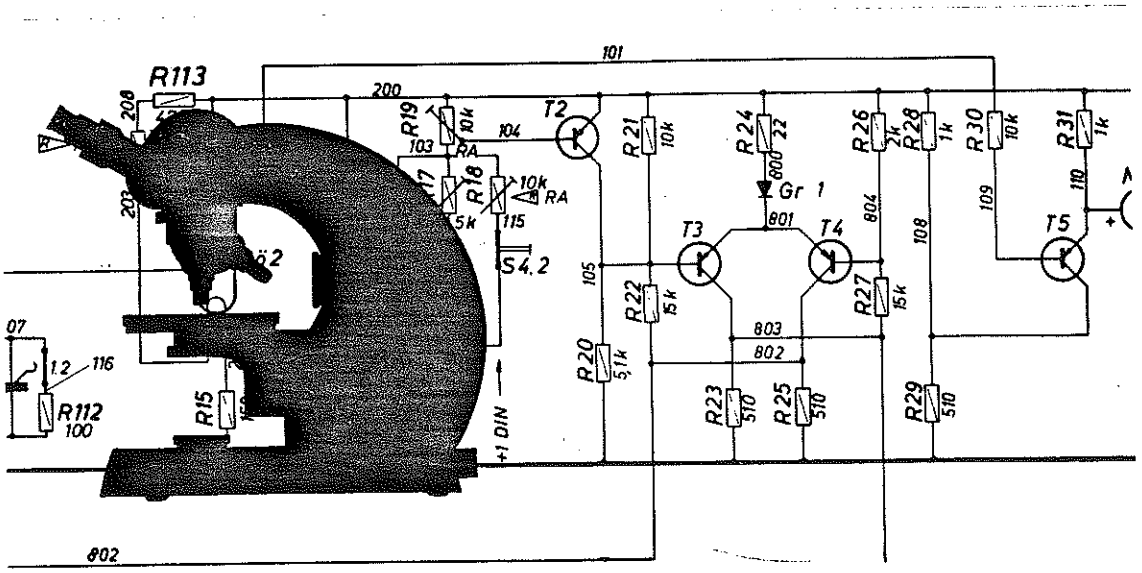
CARL ZEISS

PHOTOMICROSCOPE II

Operating Instructions



CONTENTS

These instructions describe and illustrate the operation and the different models of the PHOTOMICROSCOPE II. Please take time to read this booklet very carefully. Only this will enable you to make full use of the countless possibilities which this instrument offers for practical work.

The two basic models of the PHOTOMICROSCOPE II are distinguished by their illuminating system:

a) Microscope stand for centerable and interchangeable condensers. Great versatility, because adaptation to any presently known microscopic technique is possible.

b) Microscope stand with a pancratic condenser. Complete instrument for simplified operation in bright-field and phase-contrast work. Pages 32–34 describe the possibilities offered by this equipment.

The procedures described in these Instructions all refer to transmitted light.

The book by Michel "Die Mikrophotographie" and the booklet G 41-100 "Microscopy from the very beginning" being supplied with the instrument, a detailed explanation of microscope terminology has intentionally been omitted in this manual.

The six-digit figures appearing in the text are catalog numbers. Orders for separate components or accessories should always include the serial number on the instrument base. This will avoid unnecessary correspondence or even the shipment of improper parts.

The figures 1 to 31 shown in brackets refer to the illustrations on the folded page.

The fully automatic PHOTOMICROSCOPE in brief:

Large research microscope. Can be converted for any presently known microscopic technique using transmitted or reflected light.

35 mm camera neatly incorporated in microscope stand ensuring consistently perfect adjustment.

Instant readiness of camera – pressing a single button triggers the following operations: shutter opens and closes after automatic exposure timing, film is advanced, shutter is reset for next exposure.

Automatic photomultiplier-controlled exposure up to 1/100 sec.

Film-speed range of automatic exposure control from 2.5 to 8,000 A.S.A. = 5 to 40 DIN.

In addition to measurement of average brightness, spot readings for photomicrography of fluorescent objects, in dark field and in polarized-light microscopy.

Meter indicating light intensity and exposure duration.

Blank-exposure key and double-exposure lock with manual override.

Possibility of exposing additional data together with the micrograph.

Automatic film advance by electric motor.

Shutter locks if instrument is out of order.

Specimens can be viewed even during exposure. Built-in OPTOVAR magnification changer.

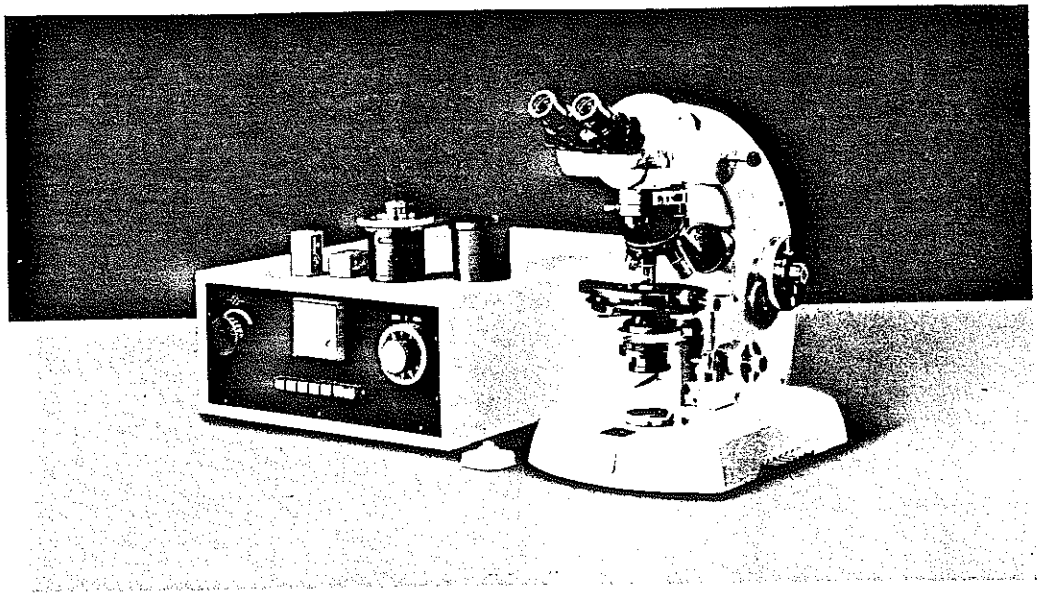
With the aid of a wide-field system, oversize object fields can be obtained even at high magnifications.

Largely simplified illuminating procedure in the model equipped with a pancratic condenser.

Convenient filter control in microscope base.

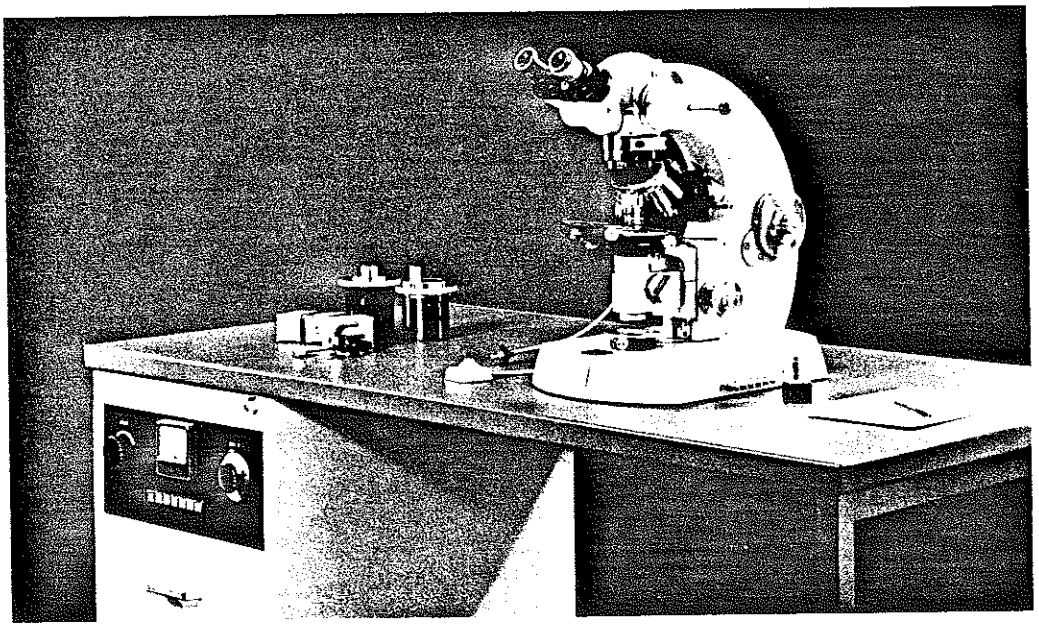
Automatic exposure control available as table-top instrument or built into a practical work table with drawers.

Possibility of connecting 60-watt illuminator, microflash unit, projection attachment, large-format photomicrographic camera, television camera.



1 PHOTOMICROSCOPE II with automatic exposure control as table-top instrument

2 ... with automatic exposure control built into a work table



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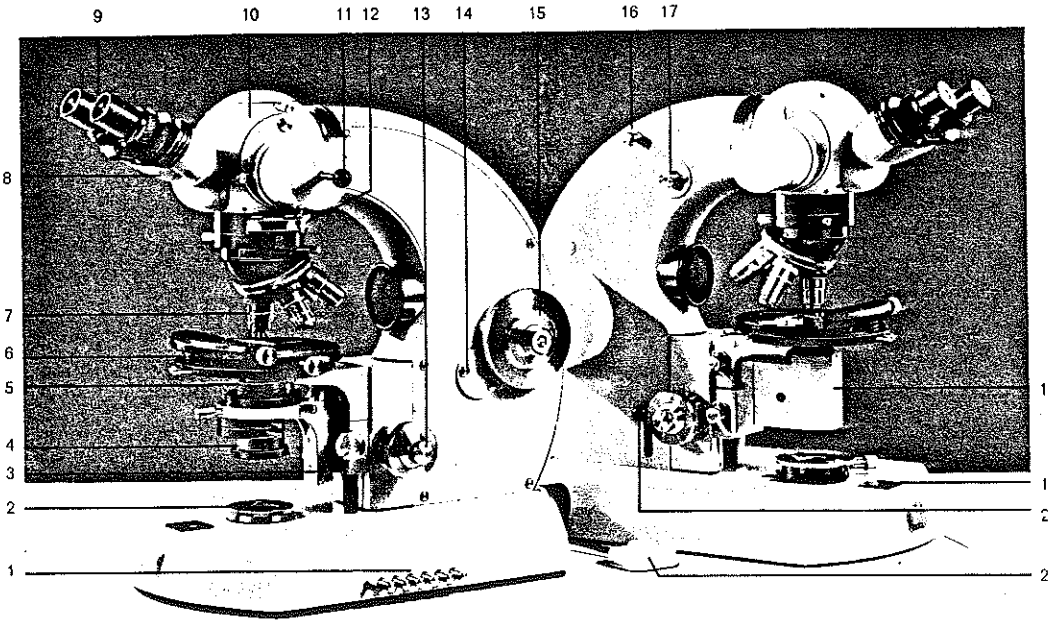

3 Controls of PHOTOMICROSCOPE II

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4 ... of automatic exposure control

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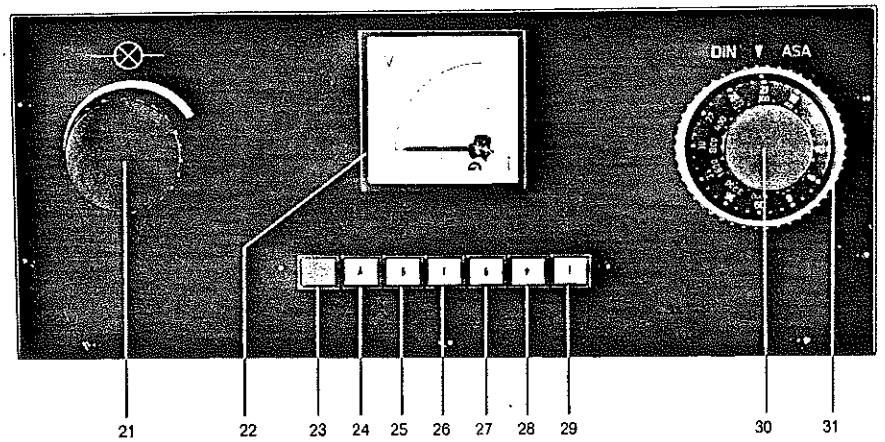


Blanl
with

1 = Filter control

Marking	Filter
Yellow	Conversion filter, 46 78 50, blue, for day-light color film (yellow mount)
Green	VG 9 green filter, 46 78 05
2× light gray	two 0.5 gray filters, 46 78 40
Medium gray	0.12 gray filter, 46 78 41
Deep gray	0.03 gray filter, 46 78 42

Pressing the black button returns any filter that may be in the light path to its original position. The designation of the perfectly neutral gray filters indicates their transmittance. Example: the 0.12 filter has a transmittance of 12 %. By combining the different gray filters, the illuminance can be varied by a ratio of 1:2 over a range from 100 % to less than 1 %.

Filters can be replaced or exchanged for other types after removing the bottom of the base.

2 = Lamp field stop in diaphragm insert.

3 = Vertical adjustment knob of condenser. The stiffness of motion can be varied: turn the two-hole disk with the aid of a two-pin wrench supplied with the instrument. Clockwise rotation results in greater stiffness, counterclockwise rotation in greater ease of motion.

4 = Auxiliary condenser lens serving to illuminate the full aperture. Is permanently in light path.

5 = Condenser aperture diaphragm; for use, see page 25.

6 = Specimen stage, page 9.

7 = Revolving nosepiece, page 7.

8 = Inclined binocular body, page 6.

9 = Eyepieces.

10 = Tube head, page 6.

11 = Reflecting system; for beam control, see page 6.

12 = OPTOVAR magnification changer, page 7.

13 = Coarse and fine adjustment knobs, page 8.

14 = Small button. Depressed with a suitable pin during exposure results in double exposure, because it prevents film transport.

15 = Film magazine with frame counter, 47 20 26. The counter indicates the number of frames exposed. The film transport mechanism is locked
if there is no film in the camera.
or the film is broken,
or the film supply is exhausted.
If the loaded film magazine is stored outside the microscope, it should always be kept in the black protective cover supplied. For film magazine with data recording, see page 15.

16 = Knob pulled out: **Measurement of average brightness** over ⅔ of the negative size (normal position).
Knob pushed in: **Spot measurement** covering the area of the small circle on the reticule (Fig. 20), for instance, if small object areas are of importance in the case of extreme contrast or if their luminance is decisive for proper exposure. Particularly useful for fluorescence and dark-field photomicrography and polarized-light microscopy in the case of very similar patterns. The overall sensitivity of the exposure control is automatically increased in this position.

17 = With the aid of a cable release screwed into this socket, the beam-splitting prism can be moved out of the light path for special purposes so that 100 % of the available light will reach the film. At the same time, the camera shutter is opened and will remain open as long as the cable release is pressed. Film advance is automatic. For flash photography, see also 28.

18 = Pancratic condenser, page 32.

19 = Meter having two functions.

Light indicator: In the taking position, the pointer indicates the light intensity available. This means that the pointer will deflect to somewhere between 0 and 1, depending on the intensity of the light, or all the way to the right if there is too much light. In this case, the automatic exposure control will be locked, since even an exposure of 1/100 sec would be too long. Filters must then be used.

Exposure indicator: As soon as the key [A] is depressed, the pointer moves from 0 to 1 in accordance with the duration of the exposure. In other words, it will move rapidly in the case of short exposure times and more slowly with longer exposures. This allows the duration of the exposure to be checked by the speed with which the pointer moves.

20 = Knob controlling reflecting mirror. Upwards: transmitted light. Downwards: reflected light.

21 = Voltage control for 6-v, 15-w base illuminator and 60-watt illuminator (12 volts, 60 watts).

22 = Voltmeter. Black scale applies to base illuminator, red scale to 60-watt illuminator.

23 = Master key [~] with signal lamp.

24 = Key [A] for **automatic** exposure. Lights up during exposure.

24 a = Remote-control button with same function as [A].

25 = Key [B], opens the shutter for as long as the key is depressed.

26 = Key [T], opens the shutter until it is closed by

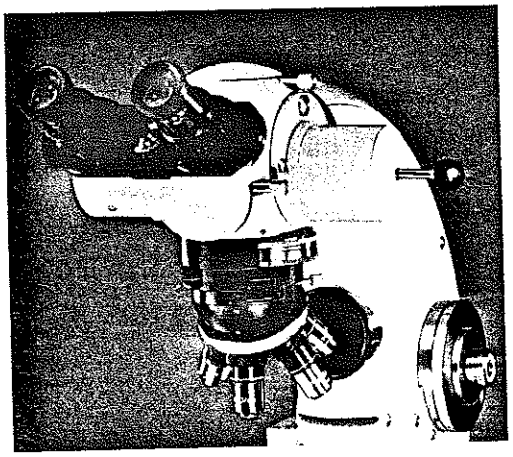
27 = Key [0]. Key [T] lights up during exposure.

28 = Flash shutter control key [f]. If this key is locked down with a microflash unit connected to the instrument and the cable release screwed into the socket 17, the shutter will close immediately after the flash has fired.

29 = Key [!] **indicating trouble** and **producing blank exposures.** If this key flashes, except during film transport, the automatic control will at the same time be locked
if there is no film in the camera,
or the film is broken,
or the film supply is exhausted.
Pressing this key will produce a blank frame, i. e. the film will be advanced by one frame without operation of the shutter.

30 = Film-speed control serving to adapt the automatic exposure control to the speed of the film used. Advances in steps of 3 DIN from 6 to 39 DIN or double A.S.A. values from 3.2 to 6,300 A.S.A..

31 = Outer ring with index for 30, serving for fine adjustment. Can be turned to either side by 1 DIN (A.S.A. factor 1.26) from any position of the main control knob. It is thus possible to reach any DIN step between 5 and 40 DIN and to cover the A.S.A. range from 2.5 to 8,000 in multiples of 1.26.



5 Tube head with binocular body and revolving nosepiece

The microscope in detail

Tube head

All image-forming components are combined in the tube head which is thus the microscope proper.

The eyepieces of the **inclined binocular body,** 47 30 10, can be adjusted over a range from 55 to 75 mm to suit the interpupillary distance of the observer. The distance set can be read on the small wheel between the eyepiece tubes.
The eyepiece tubes can be screwed in or out to focus on the reticule which is conjugated with the film plane (page 15).
Should the sharpness of the picture seen in one of the eyepieces be unsatisfactory, turn the eyepiece tube corresponding to the ametropic eye until both eyes see a perfectly sharp image.

The OPTOVAR magnification changer directly below the reflecting system has two knurled wheels, the bottom one of which holds the 1.25×, 1.6× and 2× optical system as well as a PH system which in conjunction with the eyepiece acts as a centering telescope for viewing the exit pupil of the objective.

Beam control by reflecting system (11)

Slide position:

white	red	black	colorless
Normal viewing position,	**Viewing position** if image is too bright in position I,	**Photomicrography** and viewing,	**For special purposes**
all light used for observation	1/3 of light transmitted to observer's eyes, 2/3 vertically upwards; photometry, television camera, etc.	1/2 light to the film, 1/2 to the observer's eyes, small portion of the latter beam used for exposure measurement	all light reflected vertically upwards, for projection, large-format camera, cine camera, photometry, etc.

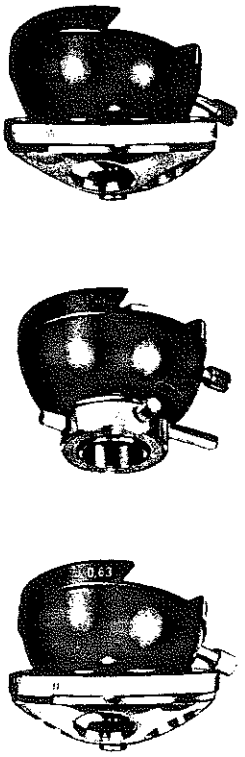
In the PH position, the upper wheel serves to focus, for example, on the image of the aperture diaphragm or, in the case of phase contrast, on the image of the annular diaphragm and the phase annulus of the objective.
Like the Bertrand lens used in polarized-light microscopy, it may be used for monocular and binocular viewing of interference figures and for photographing interference phenomena.

The standard quintuple revolving nosepiece, 47 31 59, may be replaced by the quintuple nosepiece with wide-field system or the single nosepiece.

The **single nosepiece,** 47 31 16, is useful for special-purpose work, for instance with heating stages or universal-stage objectives. In addition, it is used if more objectives are needed than can be mounted on a revolving nosepiece or if each objective must be separately centered.
Objectives screwed into centerable change rings, 46 62 56, can be quickly and easily attached to the single dovetail nosepiece and centered with the aid of two socket wrenches.

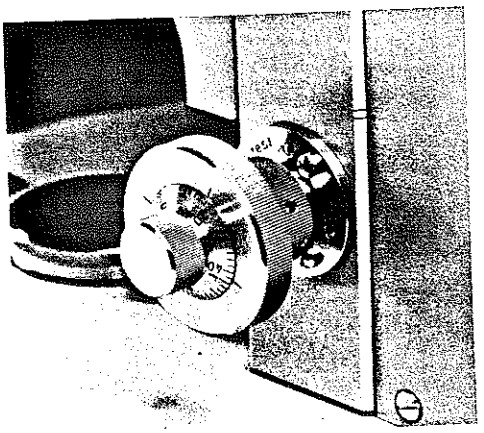
The quintuple nosepiece with wide-field system, 47 31 55, includes an 0.63× optical system which reduces the magnified image produced by the objective (thus increasing the area covered) and forms this image in the plane of the eyepiece field stop. Viewed through 12.5× Kpl wide-angle eyepieces, this aerial image covers a 2.5 times greater surface at the same total magnification as the one produced by a standard revolving nosepiece with 8× Kpl eyepieces.
Field-flattening "Plan"-type objectives must be used for wide-field observation.

The openings accept special-purpose inserts, the wide opening on the left, which is normally closed by a dust plug, the analyzer slide for polarized-light microscopy, the barrier-filter insert for fluorescence microscopy or the differential interference-contrast slide;
the narrow opening on the right (below the OPTOVAR), retardation plates or compensators for polarized-light microscopy.



6 Nosepieces; from top to bottom:
Quintuple revolving nosepiece, 47 31 59,
single dovetail nosepiece, 47 31 16, with centerable change ring, 46 62 56,
quintuple revolving nosepiece with 0.63× wide-field system, 47 31 55

Mention should be made here of the booklet 41-101 entitled "Optical systems for the microscope", which describes our complete line of microscope optical systems. All pertinent data of objectives, eyepieces and condensers are summarized in the form of tables supplemented by detailed descriptions of the different correction categories.



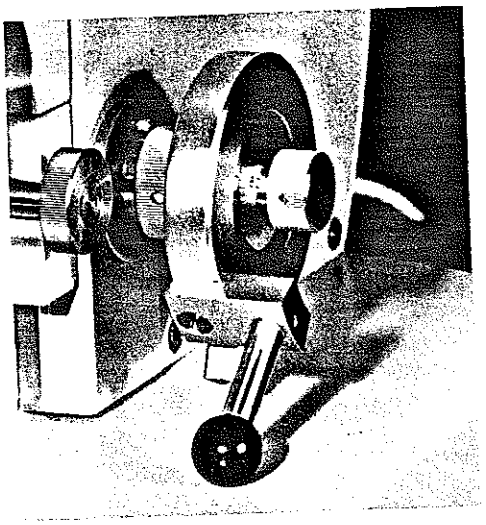
7 Coarse and fine adjustment knobs

Total magnification

is determined by multiplying the initial magnification of the objective by the OPTOVAR factor and the eyepiece magnification.
If the revolving nosepiece with wide-field system is used, allowance must in addition be made for the factor 0.63×.

Controls

The coarse and fine adjustments are coaxial. The coarse adjustment displaces the specimen stage vertically by about 34 mm, the fine adjustment by 2 mm. The excursion ranges are limited by stops. The fine-adjustment range is marked by two lines at the side of the rack and pinion (Fig. 7). The fine adjustment should initially be set to the middle of its range. One interval on the fine-adjustment scale is equivalent to a vertical displacement of 2 µ = 0.002 mm.
Regulating the motion: The stiffness of the coarse adjustment can be increased by turning the knurled collar behind the right-hand coarse-adjustment knob towards "fest". The motion of the knob should neither be too easy nor too stiff.
Should the fine-adjustment knob turn too easily, this can be corrected by turning both knobs clockwise.



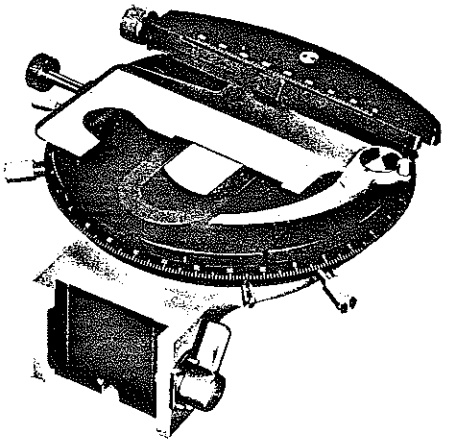
8 Focusing lever, 47 10 18

The focusing lever, 471018, attached to the coarse-adjustment knob allows the rapid relocation of the focusing plane after lowering the specimen stage by simply returning the lever to a stop which is in this case the top of the microscope base.

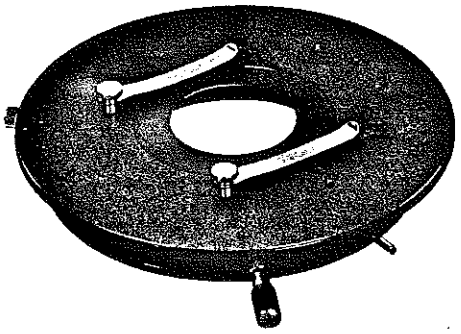
Specimen stages

All our specimen stages can, on principle, be used on the PHOTOMICROSCOPE. However, in order to allow the specimen to be oriented in the field of view, we recommend that a rotating stage be used at all times.
The catalog numbers for the specimen stages include the stage carrier.

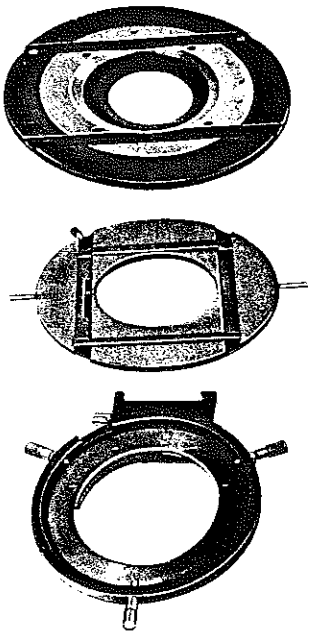
Circular mechanical stage
ungraduated: 47 35 56
graduated: 47 35 57 (Fig. 9)
Motion range 50×75 mm
The rotating stage can be centered in relation to the optical axis of the microscope to ensure that the specimen remains in the field of view during rotation. For this purpose we supply a centering cross with the individual coordinates of every stage: Place this centering cross on the stage and set the scale of the mechanical stage to the coordinates indicated. If a low-power objective is used, focus on the cross lines. To facilitate recognition of the cross, close the aperture diaphragm down as far as possible. Insert two socket wrenches into the centering piece (Fig. 11) and move the cross lines to the center of the field. Since a cross-hair eyepiece is not generally available, the center of the field can be marked by the centered, closed lamp field stop (Fig. 44). Finally, proceed in the same manner with an objective of higher power.
The graduated scales allow any point on the specimen to be quickly relocated. With the aid of verniers, this can be done with an accuracy of 1/10 mm. The two coordinates applicable to a certain specimen point (e.g 14.1/112.7) may then be noted down on the data card. This point will again be in the field of view as soon as the scales have been set to the above values.
The rotary and back and forth motions can be clamped by means of lateral screws.



9 Graduated circular mechanical stage, 47 35 57



10 Glide stage, 47 35 54



11 Glide stage, disassembled for lubrication. From bottom to top: centering piece, base plate, stage top turned upside down.

Glide stage 47 35 54

Motion range 28×32 mm

The stage top follows the pressure of the hand. It can be rotated by means of two grips. The rotary motion can be clamped by a screw.

The stage can be centered in relation to the optical axis of the microscope to ensure that the specimen will remain in the field of view while the stage is rotated: turn the stage while observing with a 10× or 16× objective. The approximate position of the center of rotation can be easily recognized. Move the center into the middle of the field with the aid of the two socket wrenches. For more accurate centering, use a cross-hair eyepiece to mark the center of the field.

Specimen slides are held down by two stage clips. In addition, the stage top is provided with holes for mounting an attachable mechanical stage to guide the specimen. If the stage has not been used for some time, shift it several times in all directions to ensure smooth motion of the top.

To preserve the gliding properties of the stage and to ensure perfect results at any magnification, the stage should be lubricated at intervals of about six months. 10 cc of suitable oil, 47 33 91, are supplied with the stage.

Lubrication of glide stage

Turn stage centering screws back. Press base plate with stage top against the relieved spring bolt and lift it off. Separate base plate from stage top by pushing them apart. Now make a note of the position of the guide frame, which is important for assembly. Clean all gliding surfaces carefully with xylol. With your finger apply a very thin film of oil to the gliding surfaces of stage top and guide frame. The less oil is used, the better. Then reassemble the stage. Be sure that the spring bolt lies in the cutout of the base plate.

After reassembling the stage, move the stage top several times in all directions to distribute the oil uniformly. The top must not move too easily. This would indicate that there is too much oil between the gliding surfaces. It is advisable then to center the stage at least approximately.

Illumination

Base illuminator

The instrument is generally used with a 6-v, 15-w lamp incorporated in the base. The light output of this lamp is entirely sufficient for ordinary microscopic work. If special requirements are made of the light intensity or the spectral characteristics of the radiation, suitable accessory light sources may be used (page 13).

In the majority of cases it will be sufficient to operate the lamp at lower than rated voltage. This will considerably increase its burning life. The lamp should only be overrun, i. e. operated on more than 6 volts, for brief periods because overvoltage will excessively reduce its life. See the table opposite.

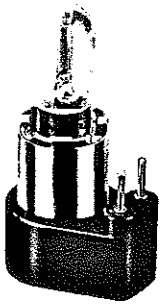
Lamp data

	Base illuminator	60-watt illuminator
Rated voltage	6 volts	12 volts
Current	2.5 amps	5 amps
Luminance	850 stilbs	1,250 stilbs
Color temperature	2,850° K	3,050° K
Luminous area	1.6×1.8 mm	3.2×3.2 mm
Catalog No.	38 01 77	38 02 16

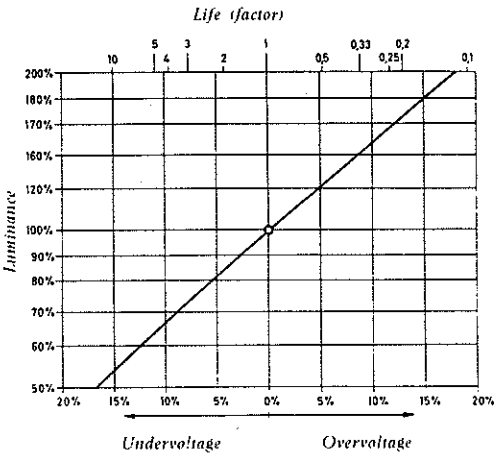
The variable transformer incorporated in the automatic control unit feeds the 6-v, 15-w base illuminator with 0 . . . 10 volts. Readings can be taken on the black scale of the voltmeter.

The voltage selector has taps for 100–110–115–127–220–240 volts and is not accessible from the outside. To set the instrument for another AC voltage, slightly withdraw the automatic control unit after loosening the screws at the rear.

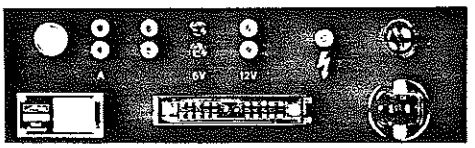
Should the **fuse** blow, a new one can be inserted on the primary side at the back of the automatic control.



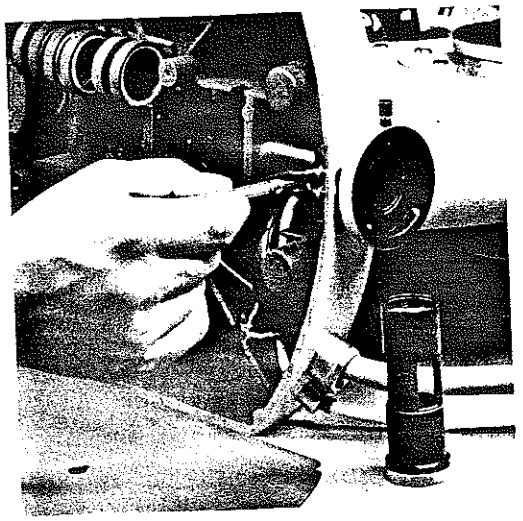
12 6-v, 15-w lamp in socket



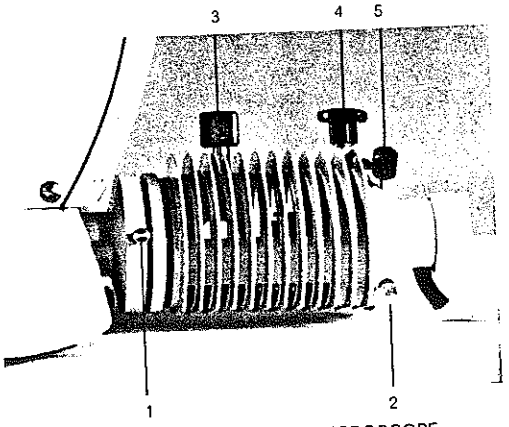
13 Relationship between voltage, luminance and life of low-voltage lamps



14 Sockets at rear of exposure control.
Top from left to right: exposure control cable, remote control (24 a), spare sockets, 6-v and 12-v, flash terminal, power fuse.
Bottom: principal cable, power cable.



15 60-watt illuminator: Fitting the connecting tube, Right: collector tube of base illuminator



16 60-watt illuminator on PHOTOMICROSCOPE
1 = clamp screw of illuminator
2 = clamp screws of spring bolts (counterparts of 5)
3 = knob for controlling diffusion disk which is usually in the light path during work with the microscope
4 = clamp screw of lamp socket
5 = centering screws of lamp socket

For 100–127 volts, use a 2-amp slow-blow fine-wire fuse,
for 220–240 volts, use a 1-amp slow-blow fine-wire fuse.
An additional 6-v, 15-w illuminator (e. g. that of the microflash unit) can be connected at the back of the automatic exposure control.

60-watt illuminator

Instead of the 6-v, 15-w base illuminator, the 60-watt illuminator may be firmly connected to the microscope stand. For this purpose, the collector tube with lamp condenser, 46 70 50, must be removed after unscrewing the bottom plate and replaced by the connecting tube, 46 70 41 (Fig. 15). The 60-watt illuminator is mounted in the usual manner with the aid of a dovetail ring, like a body tube, for example.
The variable transformer is identical to the one for the base illuminator and supplies voltages from 0 ... 20 volts. When this equipment is used, the red scale of the voltmeter applies.
The relationship between voltage, luminance and burning life is illustrated in Fig. 13.

Centering the 60-watt illuminator

1. Switch lamp on. Swing out diffusion disk 3 and slightly loosen both clamp screws 2 of the spring bolts and screw 4.
2. Place a sheet of paper on the diaphragm insert in the microscope base and shift the lamp socket until the lamp filament is imaged on the paper, varying the diaphragm setting as required.
3. Turn the centering screws 5 until the filament is exactly in the center of the light exit opening. Tighten both screws 2. The lamp is thus centered.
4. For perfect illumination, the lamp filament should be imaged in the plane of the aperture diaphragm of the condenser. To check this, hold a sheet of paper as close to the condenser as possible (swing out filter holder and auxiliary lens) and slightly shift the lamp socket. Then tighten the screw and swing in the diffusion disk.

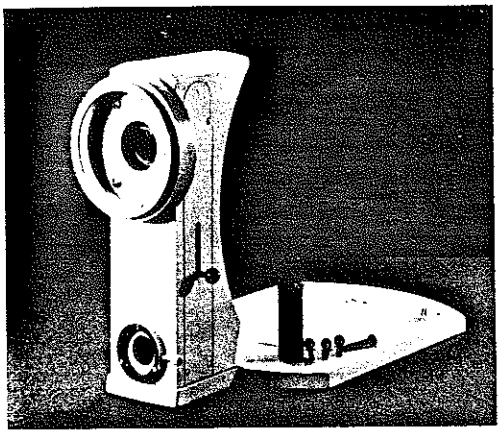
Special-purpose illuminator

The special-purpose illuminator, 47 20 17, allows the multi-purpose microscope illuminator to be firmly connected to the PHOTOMICROSCOPE. As a result, all the gas-discharge lamps generally used for special microscopic work can also be employed in conjunction with this instrument.
Moreover, an additional 60-watt illuminator can be connected. The lever on the left-hand side of the equipment is placed in bottom position for use of the multi-purpose illuminator and in top position for use of the 60-watt illuminator.

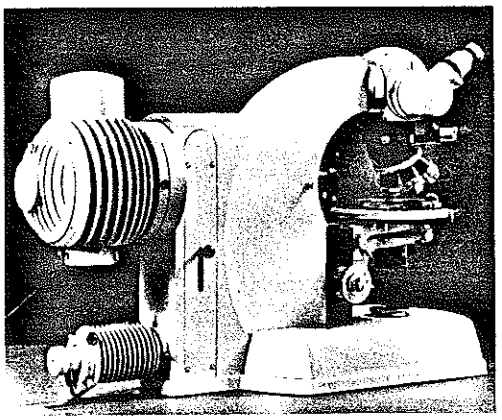
Assembly

1. Tilt the PHOTOMICROSCOPE to one side, unscrew the bottom plate and remove the collector tube normally housing the 6-v, 15-w illuminator, after loosening one screw with the aid of a screwdriver (Fig. 15). Then mount the orienting tube supplied with the special-purpose illuminator in the microscope base in the reverse order.
2. Unscrew the four rubber feet of the microscope and place the instrument on the base plate so that the orienting tube slightly projects into the opening of the special-purpose illuminator. Then insert the four fixing screws from below through the base plate into the tapped holes from which the rubber feet were removed, thus connecting the microscope firmly to the special-purpose illuminator.

For **inserting and centering** the lamp, see Operating Instructions G 41-320 for the Multi-Purpose Microscope Illuminator.



17 Special-purpose illuminator, 47 20 17, with orienting tube and fixing screws



18 Multi-purpose microscope illuminator and 60-watt illuminator on special-purpose illuminator

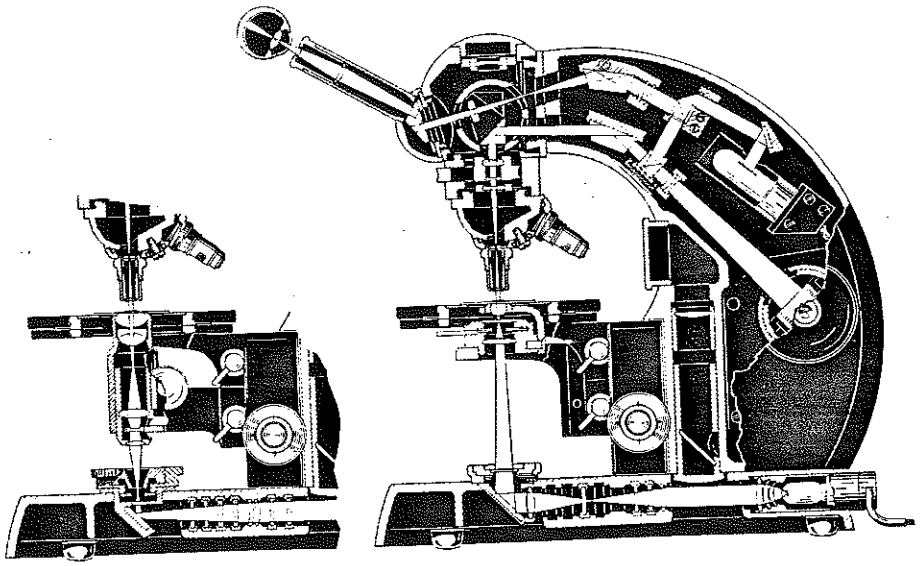
Camera

Light path

When the reflecting system snaps into the exposure position, a permanently installed projective forms a 3.2× magnified image of the object in the film plane. Before the beam reaches the projective, about half the light energy is deflected to the eye by a prism, via a focusing reticule. A small part of this energy is transmitted to the photomultiplier tube.

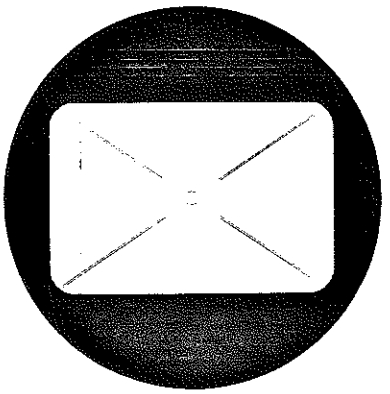
The field of view covered in the exposure position is seen magnified.

19 Light path with the microscope in exposure position. Left: pancratic condenser



The light path used in the microscope makes it necessary to insert the film negatives into the enlarger with the emulsion side facing the lamp, in order to obtain unreversed enlargements.

The focusing reticule is provided with double diagonal cross lines. A small circle in the center marks the area that is measured for spot readings. On the left, a dashed line delimits a small strip in which auxiliary data will appear on the film negative if the data-recording film magazine No. 47 20 27 (see below) is used.
The focusing reticule is optically conjugated with the film plane. The image will only be sharply focused on the film if the reticule and the microscopic image are seen sharply defined on the reticule. It should therefore become a habit to start work on the PHOTOMICROSCOPE by setting the interpupillary distance and then focusing the double lines of the diagonal cross in both eyepiece tubes. It is advisable frequently to check this setting.

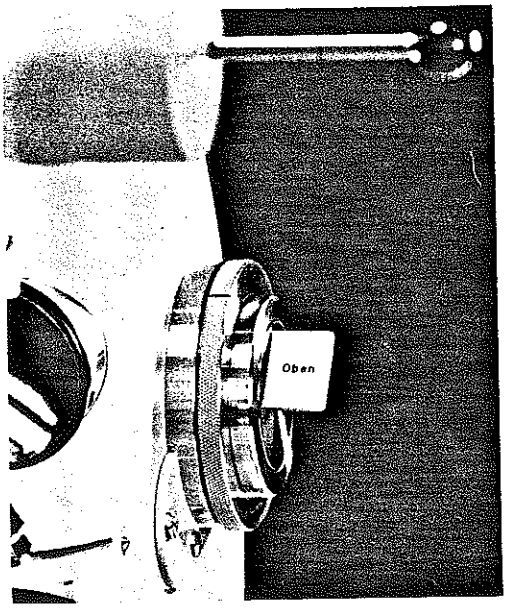


20 Viewing tube in exposure position: double diagonal cross lines

The heart of the **automatic exposure control** is a type 931 A photomultiplier tube (spectral type S-4). For monochrome photography, all our color filters with the exception of the RG-2 red filter can be used without restriction.
It should, however, be remembered that a spot reading of a red particle will result in overexposure because the photomultiplier is insensitive in the red region of the spectrum.

For the standard film magazine, 47 20 26, see the folded page (15).

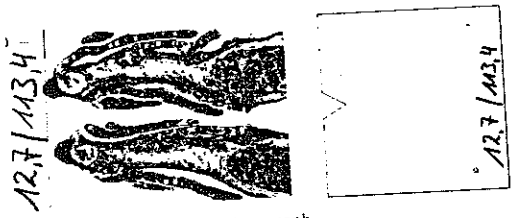
The data-recording film magazine, 47 20 27, allows hand-written notes to be recorded on the micrographs. An Astralon data card with one side matte is provided, on which the area available for notes is marked by two punched holes (Fig. 22). Pencil notes can be erased as often as necessary.



21 Data-recording film magazine

The data card is slipped below the leaf spring of a slide and inserted with the latter right down into a slot in the front of the magazine. The data field of the card overlaps the film by 4 mm on one of the short sides of the format. This area is marked in the field of view by a dashed line. A set of 25 data cards can be ordered under the No. 47 20 91.

Contrary to the film magazine No. 47 20 26, the magazine No. 47 20 27 has no frame counter. Furthermore, film transport is locked only at the end of the film.



22 Data recorded on micrograph
Right: data card

Color filters

With monochrome photography, these filters transform color contrast into brightness contrast. They are thus suitable for stressing or subduing certain object portions in stained specimens. A filter which has the same color as a certain part of the object will reduce the contrast of this portion. On the other hand, its contrast will be enhanced if a filter of complementary color is used.

If panchromatic material is used, all our filters may be employed for monochrome photomicrography.

The exposure control automatically makes allowance for the required filter factor.

Color photomicrography

For optimum color temperature, the base illuminator should be operated on 6 volts, the 60-watt illuminator on 12 volts. Too intense light should be subdued with the aid of neutral-tint gray filters and not – as is admissible with black-and-white film – by reducing the lamp voltage.

If possible, an achromatic-aplanatic condenser should be used for color photography. Condensers which are not corrected for color require extremely precise adjustment, since they tend to produce a cast. Best results in natural color will be obtained with NEOFLUAR objectives or with field-flattening Planapochromats.

Both artificial-light and daylight film may be used, but the daylight color film sold on the market is generally fresher. The color temperature can be adapted to daylight film by inserting the conversion filter, 46 78 50, contained in the filter set.

Experience has shown that histological sections above all are freqently reproduced rather dull in spite of correct staining. This is due to the fact that color film is designed for a rather wide contrast range which is not normally achieved by stained transparent specimens. It is therefore advisable to stain these specimens slightly more intensely.

Schwarzschild effect

The phenomenon that sensitized material becomes less sensitive with increasing exposure time is called the Schwarzschild effect. This failure of the reciprocity law has not yet been eliminated in all photographic emulsions. Some manufacturers of color film will, on request, supply correction values which should be applied for critical photography.

Image scale on the film

The image scale is the relation between a distance in the picture and the corresponding distance in the object. For the film negative, it can be approximately determined by multiplying the initial magnification of the objective by the OPTOVAR factor and the projective factor of 3.2 (in the case of wide-field systems, plus the factor 0.63).

Image scales to be obtained with the standard equipment

Objective	OPTOVAR		
	1.25×	1.6×	2×
1	4 : 1	5 : 1	6.3 : 1
2.5	10 : 1	12.5 : 1	16 : 1
4	16 : 1	20 : 1	25 : 1
6.3	25 : 1	32 : 1	40 : 1
8	32 : 1	40 : 1	50 : 1
10	40 : 1	50 : 1	63 : 1
16	63 : 1	80 : 1	100 : 1
25	100 : 1	125 : 1	160 : 1
40	160 : 1	200 : 1	250 : 1
63	250 : 1	320 : 1	400 : 1
80	320 : 1	400 : 1	500 : 1
100	400 : 1	500 : 1	630 : 1

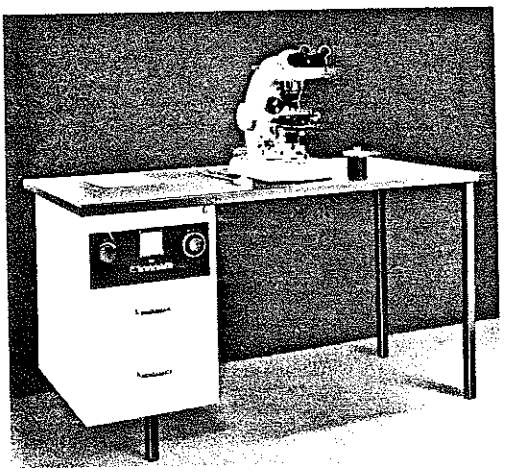
Image scales to be obtained with wide-field system

Objective	OPTOVAR		
	1.25×	1.6×	2×
2.5	6.3 : 1	8 : 1	10 : 1
4	10 : 1	12.5 : 1	16 : 1
6.3	16 : 1	20 : 1	25 : 1
10	25 : 1	32 : 1	40 : 1
16	40 : 1	50 : 1	63 : 1
25	63 : 1	80 : 1	100 : 1
40	100 : 1	125 : 1	160 : 1
100	250 : 1	320 : 1	400 : 1

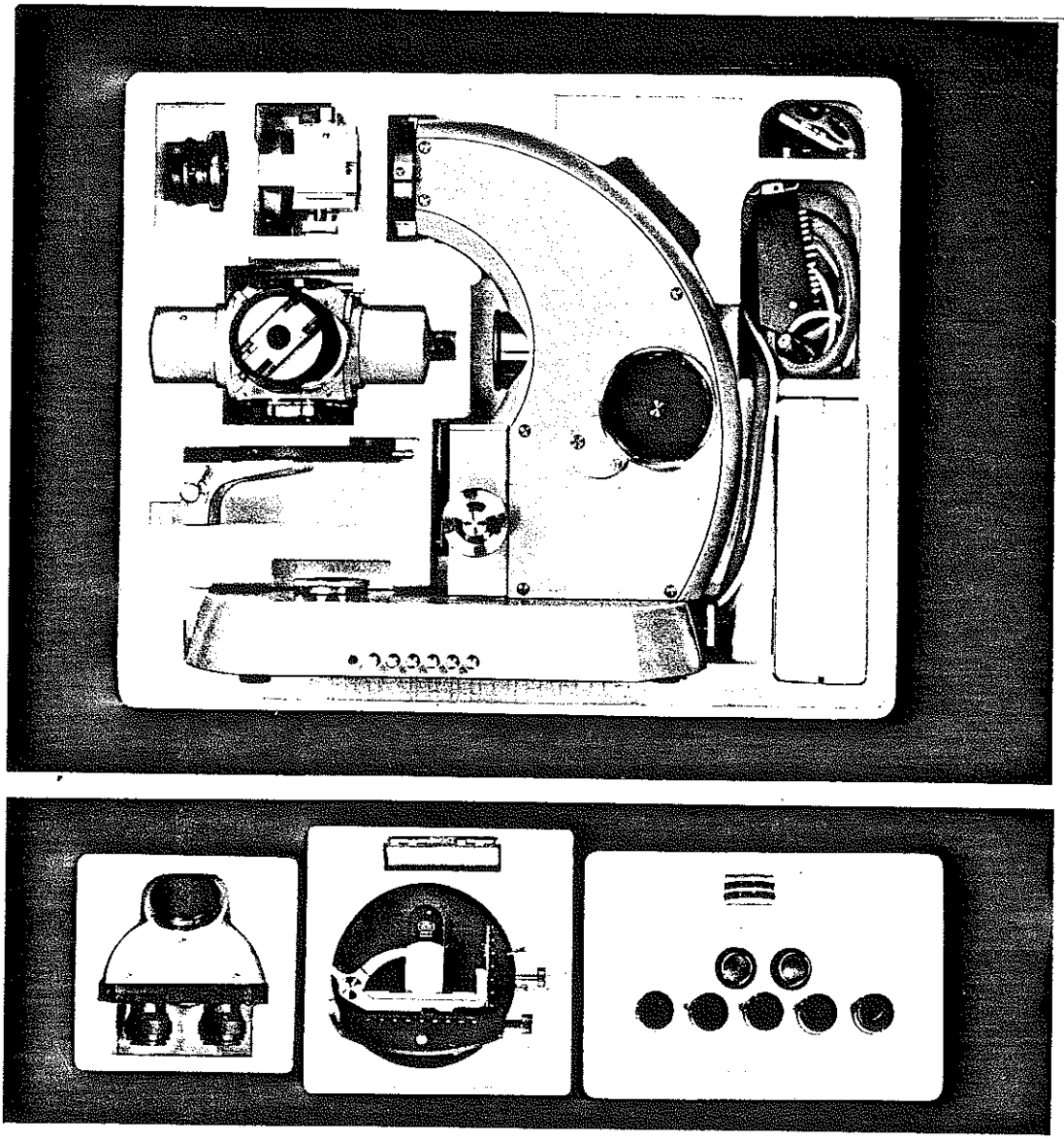
Any optical system has admissible tolerances of magnification. The values given in the table above, rounded off to standard figures, can therefore not be considered as absolute. Accurate determination of the image scale is only possible with the aid of a stage micrometer.

Work table

On request, the PHOTOMICROSCOPE II is supplied with a sturdy work table. In addition to the built-in exposure control chassis with power supply units, this table has two drawers with special wooden inserts providing ample room for accessories. The table top is made of durable plastic.



23 PHOTOMICROSCOPE II with work table



Unpacking the instrument

The PHOTOMICROSCOPE is supplied in a Styropor case which has accurately shaped compartments for the stand and the different components. Although this case is ideal for shipment, the microscope should not be stored in it for prolonged periods, since the unavoidable humidity of the air would be trapped in the well-insulated case and might act on the instrument. The Styropor case should, however, be kept for later use, should it ever become necessary to ship the instrument again.

Unpack the microscope and its components with the extreme care which is indispensable when handling such a valuable precision instrument. On no account should the various knobs and other controls be used as handles.

Assembling the microscope

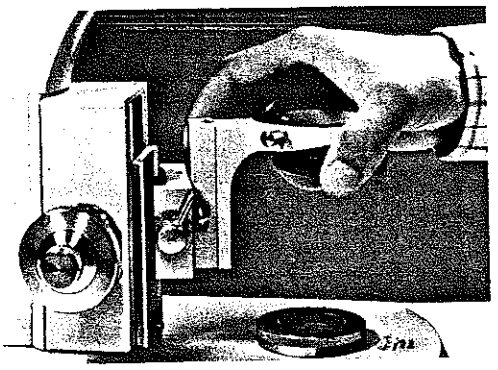
It is advisable to practice the operations described below a number of times until a certain skill has been acquired. This will at the same time serve to familiarize the operator with the design and function of the different mechanical components.

To attach the **condenser carrier** (Fig. 25) or the **pancratic condenser,** move the clamping lever right up and hold its right-hand guide rib against the flank of the dovetail guide. Then pivot it to the left until it snaps into position, push it down to the stop and clamp the lever.

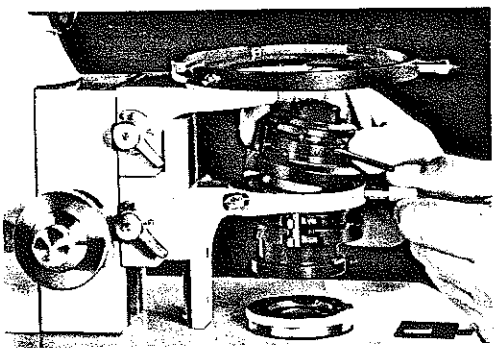
Not applicable to pancratic condenser:
Slightly tilt the **condenser** and with its dovetail ring press the spring bolt of the condenser carrier back until the condenser can be inserted. Then turn the condenser so that its controls are in a convenient position. The notch provided in the dovetail ring of the phase-contrast condensers must be engaged by the spring bolt (if necessary, turn the condenser until it snaps home).

Attaching the specimen stage
Move the clamping lever of the stage carrier up. Slide the stage carrier (without the stage) from above onto the dovetail guide until it rests against the condenser carrier. Then clamp the lever.
Condenser carrier and stage carrier must always be right down in the dovetail guide so that they touch. Otherwise "inexplicable" errors will occur.
Centerable stages are detached from the stage carrier for shipment: Press the dovetail ring of the stage at a slight angle against the spring bolt in the centering piece of the stage carrier (the spring bolt must engage the notch) until it is perfectly seated in the centering piece.
The two-pin wrench supplied with the stage serves for screwing the attachable mechanical stage on and off, the two socket wrenches for centering the stage.

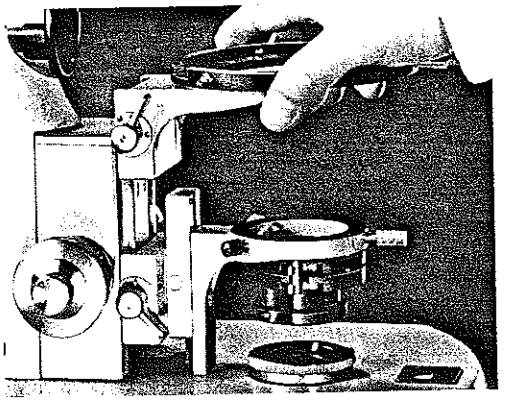
Finally rack the condenser up as far as it will go.



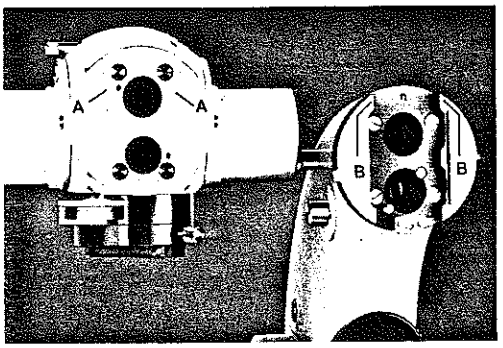
25 Attaching the condenser carrier



26 ... the condenser

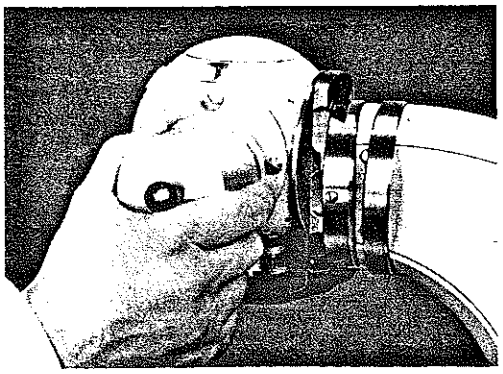


27 ... and the stage carrier



28 How the tube head engages the stand . . .

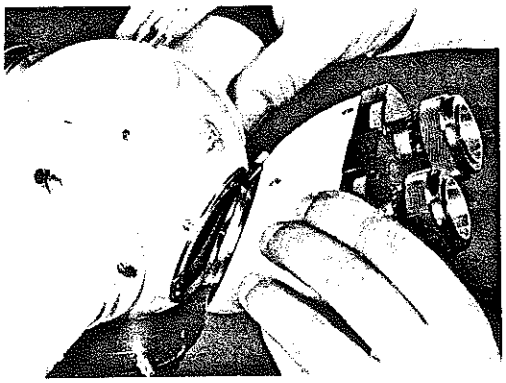
Before mounting the **tube head,** slip the sealing ring on the connecting flange of the stand back after loosening the small screw. Take the **tube head** in both hands and hold it high enough for the two upper guide edges (B) of the stand to engage the cutouts (A). Then slide the tube head down to the stop and adequately tighten the screw on one side, but without using force.
Slip the sealing ring back over the connection thus made and tighten the stud bolt which should be located on the left. This ensures perfect light-tightness.



29 . . . and how to hold it for correct mounting

To attach the **tube,** slightly loosen the clamp screw in the tube head. Press the dovetail ring of the slightly inclined tube against the spring bolt until the tube snaps into position. Then tighten the clamp screw.
The black plastic pinhole diaphragm supplied with the binocular body is not required in the PHOTOMICROSCOPE. It should be removed to avoid vignetting of the field of view.

Slip the **eyepieces** into the body and screw the **objectives** into the revolving nosepiece.

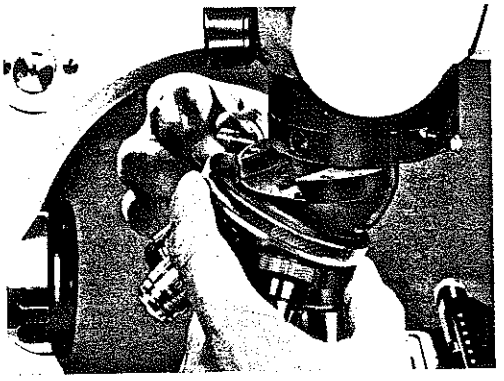


30 Attaching the tube

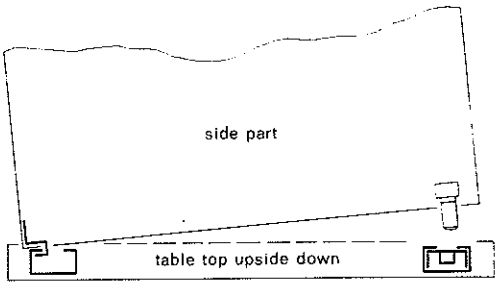
Attach the **revolving nosepiece** from the rear left, push it right forward to the stop and tighten it with the clamp screw. The single nosepiece is attached from the front, on the right, like the vertical illuminator.

Move the **lever** (20) up for transmitted light.

For microscopes supplied with a work table:
For shipment, the **table** is dismantled into the side part with two drawers, the table top, the leg portion, and the automatic control unit.
Two people are required to assemble the table.
First pull out the two drawers to the stop, lift them slightly and remove them from the side part.
Place the table top in its packing upside down on a table or the floor. Insert four of the clamping members supplied into the opening in the front edge and two into the rear edge. Attach the two legs by their screws, push them out to the left and tighten the screws firmly with the aid of the hexagon socket wrench. Attach the side part so that the sheet-metal projection on the rear engages the rear edge of the table top (Fig. 32). Next, shift the side part out towards the edge and secure the clamping members of the front edge by two screws. Then turn the table round and put it on its feet.
Slip the rails over the lateral angles of the automatic control unit and insert the complete unit into the table. Secure the threaded studs projecting through the rear wall by cap nuts and washers.
Insert the drawers.



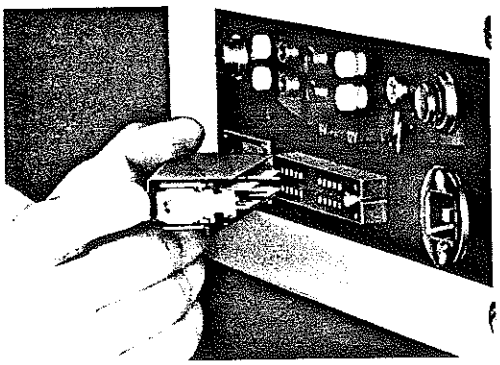
31 . . . and the revolving nosepiece with objectives



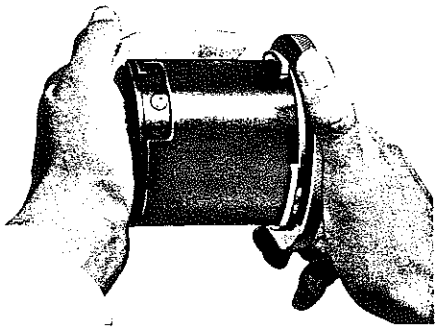
32 Table: assembly of table top and side part

Electrical connections: Attach the thick power cable as shown in Fig. 33 and push it in until it snaps home. Secure the white automatic-control cable by its screw-type connector.
Before connecting the instrument to the 50 to 60-Hz AC power supply, check its voltage setting. The voltage selector is normally set at 220 volts. Should a different voltage be set at the factory, this will be indicated by a label at the rear of the automatic control unit.

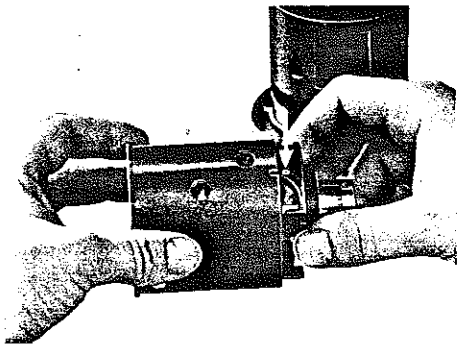
The instrument is now **ready for operation:** all keys must trigger the functions described on page 5. With the film magazine in place, this will only be the case if it is loaded.



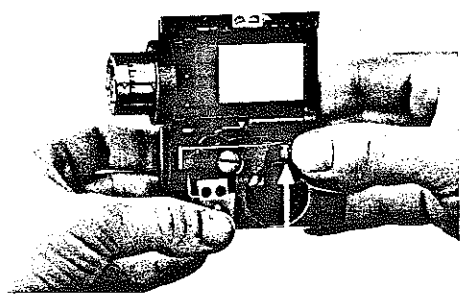
33 Attaching the power cable



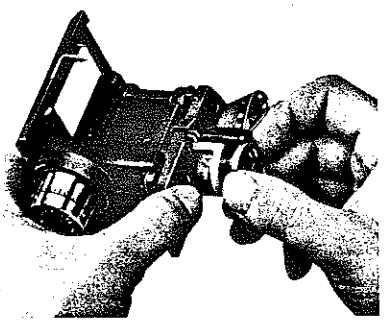
34 Opening the film magazine



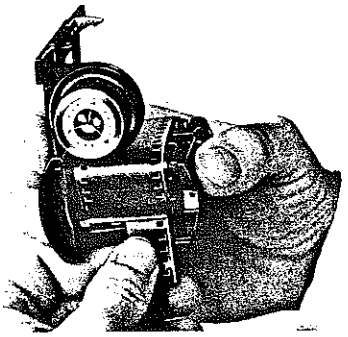
35 Removing the spool holder



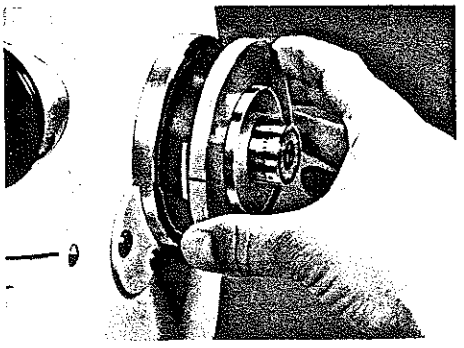
36 Cover snapping back



37 Inserting the cartridge



38 Loading the film



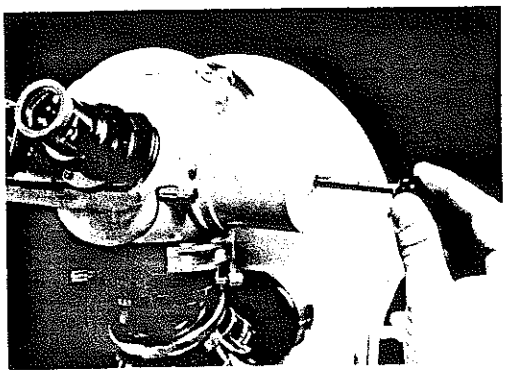
39 Inserting the film magazine

Loading the film magazine

Press on the underside of the magazine, turn the upper part and remove the inner portion.
Remove the spool holder from the inner portion. Be sure to insert the spool holder only if the pin (arrow) engages the cutout in the inner portion.
Pressure on the slotted knob (arrow, Fig. 36) will cause the cover to snap back.
Insert the cartridge and pull the film over the rollers with its emulsion side up so that the sprocket wheel engages the sprocket holes.
Slip the film in behind the spool and attach it as usual. Tauten the film by turning the spool. Close the cover, which snaps home.
Assemble the film magazine, insert it into the microscope (red mark) and lock it in position by clockwise rotation.
Set the film-type reminder dial in accordance with the film used. Make the usual two blank exposures (e. g. by pressing the key B) and set the frame counter of the magazine to "35".
Set the film-speed selector (30 or 31) to the speed of the film used.

Calibration . . .

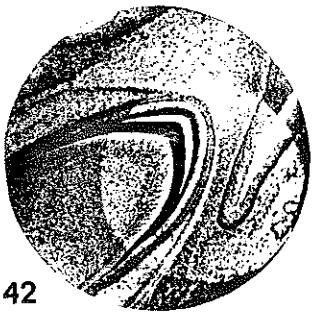
in the usual sense of the word is no longer necessary. The engraved values apply without restriction for black-and-white film and approximately for color film, which has a considerably smaller exposure latitude. Since the characteristics of color emulsions may vary according to type and make, slight deviations may here be encountered as in amateur photography. Therefore, should color micrographs be taken which are not optimally exposed, it is advisable to vary sensitivity of the exposure control by 1 or 2 DIN.



40 Setting the reflecting system (11)

41

Image of lamp field stop unsharp and decentered



42

Image of lamp field stop in focus

Working with the PHOTOMICROSCOPE

Centerable condensers

For pancratic condenser, see page 32.

Bright field

1. Place the specimen on the stage and switch on the lamp by means of the master key [~]. Control brightness by varying the lamp voltage (21) or move one or more gray filters into the light path by means of the filter control (1).

2. Set the reflecting system (11) to the black ring. Set the eyepiece tubes for the interpupillary distance required and focus each eyepiece on the cross of double lines in the field of view by slowly turning the respective eyepiece tube inwards. Failure to do this will result in blurred micrographs.
   Then return the reflecting system to the red or white ring.

3. Rack the condenser up to its top position. With phase-contrast condensers set the revolving disk to I (bright-field position).

4. Focus on the specimen with the aid of the coarse and fine adjustments, using a low-power objective.
   To illuminate the large object fields imaged by scanning objectives (up to an initial magnification of about 6.3×), unscrew or swing out the condenser front lens (depending on type of condenser). The auxiliary lens (4) below the condenser is always left in the light path.
   Exception: remove the condenser when using a 2.5× objective with a wide-field system.

5. Close down the lamp field stop (2) in the microscope base and slowly rack the condenser down until the image of the lamp field stop is sharply defined on the specimen

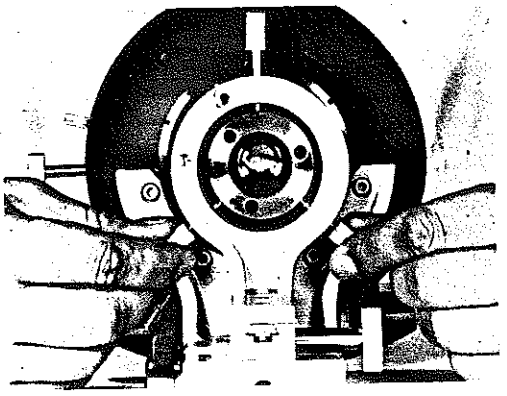
(Fig. 42). With condensers which are not of the achromatic-aplanatic type, the color reversal from red to green may serve as an indication in the case of higher magnifications.

6. Turn the two centering screws (Fig. 43) of the condenser until the image of the lamp field stop lies in the center of the field (Fig. 44). The condenser is thus centered.

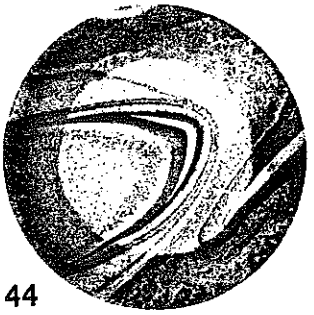
7. Open the lamp field stop until the entire field of view is evenly illuminated (Fig. 45).

8. Use the aperture diaphragm (5) to control image contrast and resolution.
   A compromise must be sought here because an open diaphragm is equivalent to high resolution and low contrast, while a stopped-down diaphragm means reduced resolution but high contrast.
   First open the diaphragm fully, then carefully close it down until a change in contrast is just noticeable. This is not always easy to determine by the image alone. As a rule of thumb it may therefore be said: Set the OPTOVAR magnification changer to PH and use the upper knurled wheel to focus on the objective aperture. The diaphragm image that is now visible should only in exceptional cases be smaller than two thirds of the diameter of the objective aperture. Check items 5 to 8 whenever objectives are changed.

9. With 100× objectives not only these but also the front lens of the N.A. 1.3 or N.A. 1.4 condenser should be optically connected with the underside of the specimen slide by means of immersion oil. Only then will the objective aperture be completely filled with light. The N.A. 1.4 front lens of the achromatic-aplanatic condensers should always be immersed, even when dry objectives are used, to preserve their high correction.
   To facilitate the application of immersion fluid, the mounts of the immersion objectives can be arrested in retracted position by clockwise rotation. However, the 63× N.A. 1.25 NEOFLUAR "oil" must be swung in with the revolving nosepiece so that it penetrates the oil from one side.

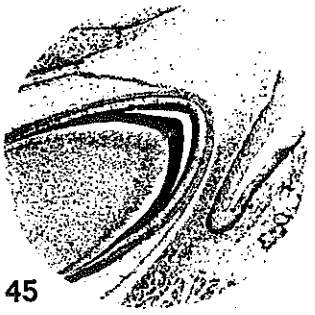


43 Centering the condenser



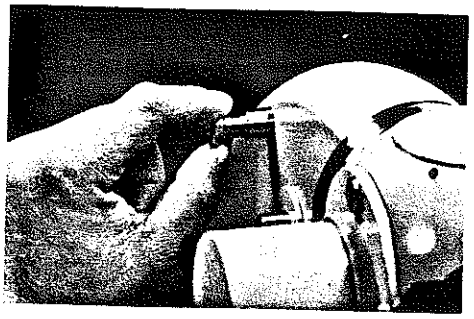
44

Image of lamp field stop centered



45

Open lamp field stop



46 Knob (16) for measurement of average brightness pulled out

47 Meter (19)

48 Rewinding the film

10. **Exposure:**

Set the reflecting system to the black ring and pull out the knob (16) for measurement of average brightness.

Trigger the automatic exposure by depressing key [A].

Check the duration of exposure on the meter (19).

After the last exposure has been made, the film transport mechanism will be locked and the key [!] will flash at the same time. Turn the film magazine in the microscope counterclockwise and remove it. Use the crank to rewind the film clockwise.

Press key [!] to unlock the film transport mechanism.

To interrupt an exposure, for instance if the meter indicates that a very long exposure time will be needed, either press the master key [~] twice, followed by the key [!].

or

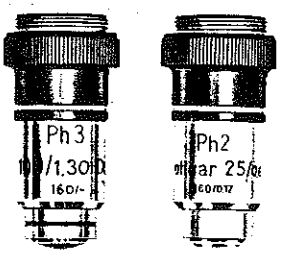
set the film-speed selector (30) to 39 DIN.

Do not press the key [!] during exposure as this will disturb the sequence of operations for the following exposures as well. Should the key be pressed inadvertently, the error can be corrected by briefly pressing the key [B].

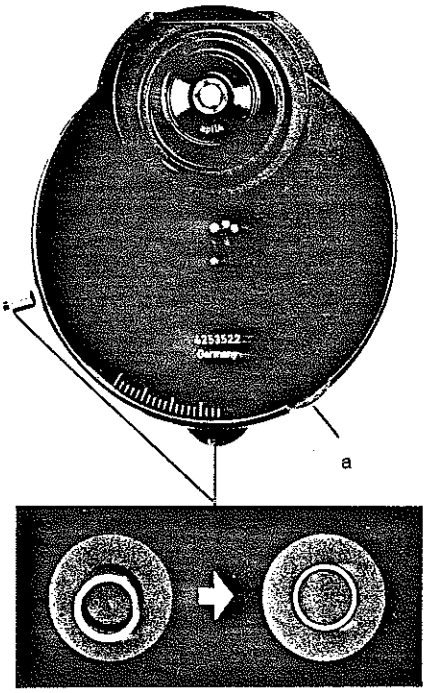
Phase contrast

For this technique, phase-contrast objectives (engraved with red Ph) and a phase-contrast condenser are needed. Phase-contrast objectives, above all Ph NEOFLUARS, can also be used for bright-field work if a slightly lower image quality is accepted. However, we do not recommend them for critical bright-field photomicrography.
Achromatic-aplanatic phase-contrast condensers must be equipped with an N.A. 1.4 front lens. Their high optical correction will be utilized only if the underside of the specimen slide is connected with the N.A. 1.4 condenser front lens by means of immersion oil. This holds for any objective, regardless of its initial magnification. The only exception is the dry long-focus achromatic-aplanatic condenser IV Z/7.

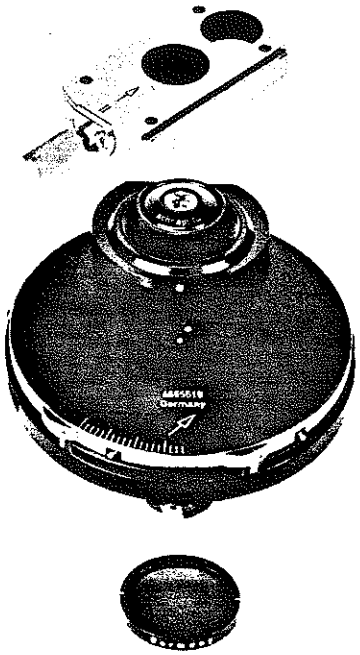
1. Proceed as described for bright-field illumination, items 1 to 7, but use a low-power Ph objective. Insert a green filter.
2. To change over to phase contrast, insert the annular diaphragm of the condenser which corresponds to the objective employed.
   The objective with engraved red Ph 2 corresponds to the position 2 of the condenser's revolving disk, the Ph 3 objective to position 3.
3. Set the OPTOVAR to PH and use the upper knurled wheel to focus on the phase annulus and annular diaphragm that are visible in the objective pupil.
4. Obtain coincidence between the image of the annular diaphragm and the phase annulus (Fig. 50). To do this use the two adjusting knobs on the condenser. Set the OPTOVAR to the desired magnification factor.
5. After every exchange of objectives check the setting of the lamp field stop and set the condenser to the annular diaphragm corresponding to the objective employed. Recentering of the annular diaphragm is required only if the specimen is changed.
6. **Initiate the exposure** as described on page 26.



49 Phase-contrast objectives



50 Phase-contrast condenser:
adjusting knobs for centering the annular diaphragm.
a = iris diaphragm for bright-field position J.



51 Equipment for differential interference contrast: polarizing filter, 47 36 00, strain-free differential interference-contrast condenser, 46 52 79, Inco slide II, 47 44 31

Nomarski differential interference contrast,
CNRS licence

Differential interference contrast shows structures of unstained transparent objects with an optical path difference (thickness × refractive index) in relief. Objects having optical path difference from about $^1/_{10}\,\lambda$ to 1 λ are specially suited. The method is characterized by an azimuth effect which is comparable to unilateral oblique illumination. With the aid of the rotary stage any structure can easily be moved to the most favorable position.

A Wollaston prism in the condenser splits the light beam. The two partial beams then penetrate the object at a distance which is just short of the resolving power of the optical system. In the object the optical path difference gives rise to differences in path length. The two beams are then recombined by a Wollaston prism in the differential interference-contrast slide. By shifting this Wollaston prism out of its center position, an additional path difference is superimposed on the object path difference. This lights up the background field (in color) and is responsible for the brightness of the object structures – which is accompanied by interference colors. However, these two changes in brightness do not occur in the same direction, but vary the contrast.

In the case of color contrast, identical structural elements appear in the same color in the image and can therefore be recognized at a glance.

The equipment comprises a polarizer (e. g. the polarizing filter, 47 36 00), the strain-free differential interference-contrast condenser, 46 52 79, with N.A. 1.4 front lens (for immersion only!) and the type II differential interference-contrast slide, 47 44 31 (Inco slide). Normal bright-field objectives, the 16×, 40× and 100× Planachromats, are used for observation.

Orienting the polarizer

1. Insert the polarizing filter into the microscope base or the filter holder below the condenser

so that the vibration direction, which is marked by two lines, is from right to left (east–west) when the filter holder is in the light path.

2. Insert the Inco slide instead of the dust plug into the wide opening in the tube head as far as it will go. Then retighten the screw at the side.
3. Remove the condenser, auxiliary condenser lens, objective and eyepieces and carefully rotate the polarizer until the interference fringes are imaged with optimum sharpness. If the dark fringe does not appear in the middle of the field, center it with the aid of the knurled screw of the Inco slide.
4. Do not turn the polarizer thus oriented any further. Check the orientation at intervals while working.

Adjusting for differential interference contrast

5. Insert the condenser, objective and eyepieces. Set the condenser to position I. Put the Inco slide out of operation (withdraw it to the stop).
6. Use a 16× objective to focus the bright-field image (page 24). Connect the N.A. 1.4 front lens of the condenser to the underside of the specimen slide by means of immersion oil.
7. Insert the Inco slide and turn its knurled control until the object image shows optimum relief or until satisfactory color contrast is achieved.
   Areas of greater optical density may be imaged either as valleys or hills. This depends on the imagination of the observer which varies individually and is influenced by physiological factors. Which is actually the case can easily be distinguished by focusing on an impurity or an scratch somewhere else on the slide.
8. Change the condenser setting when exchanging objectives.
   Position I applies to 16× objectives,
   position II to 40× objectives,
   position III to 100× objectives.
   Open or close down the lamp field stop and aperture diaphragm as usual.
9. **Initiate exposure** as described on page 26.

Dark field

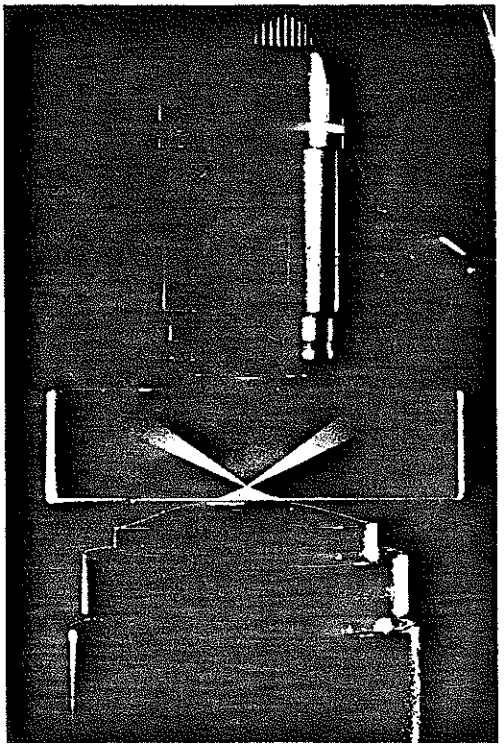
Dark-field illumination can be achieved with one of the special dark-field condensers or the achromatic-aplanatic condenser V Z (in D-position, with N.A. 1.4 front lens). The following dark-field condensers are supplied on a type Z condenser holder:

Dry dark-field condenser, 0.7/0.85 N.A., 46 55 06, for objectives of N.A. 0.4 to 0.6 and specimen slides not thicker than 6.5 mm.

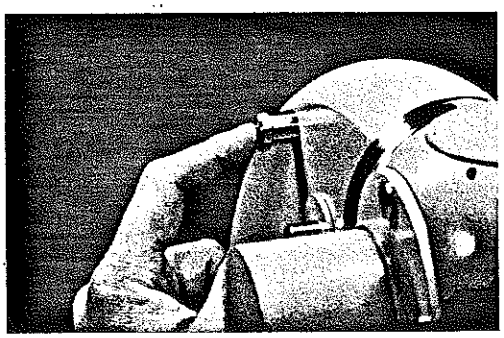
Dry dark-field condenser, 0.8/0.95 N.A., 46 55 05, for objectives of N.A. 0.6 to 0.75 and specimen slides not thicker than 6 mm.

Ultracondenser, 1.2/1.4 N.A., 46 55 00, immersion condenser for objectives of N.A. 0.75 to 1.0 and specimen slides not thicker than 1.2 mm.

The light emerging from the condenser does not enter the objective directly. The image is formed only by the light reflected or diffracted by the specimen. The field of view remains dark wherever there are no object structures. The dark-field condensers illuminate the specimen by a hollow cone of light, the interior limit of aperture of which must be larger than the numerical aperture of the objective. The designation of the condensers reveals the interior and exterior limits of aperture of the illuminating cone of rays.
Ordinary bright-field objectives are used, the numerical apertures of which must, however, lie within certain ranges. Immersion objectives must always have an iris diaphragm to enable their high aperture to be reduced for dark-field work. This illuminating technique calls for a high-power light source such as the base illuminator. If particularly exacting demands are made, we recommend use of the 60-watt illuminator or the lamps of the multi-purpose microscope illuminator. The objects to be studied are embedded in a medium of higher refractive index than air between meticulously clean specimen slides and cover glasses.



52 Dark-field illumination shown in an opal-glass model. The object is normally located at the vertex of the hollow cone of light.



53 Knob (16) for spot measurement

Procedure with Ultracondenser or achromatic-aplanatic condenser V Z

1. Immerse the condenser (use V Z condenser in D-position with N.A. 1.4 front lens):
   Apply a sufficient quantity of immersion oil without bubbles to the condenser front lens to cover the entire lens surface.
   Place the specimen in position and rack the condenser up until perfectly bubble-free connection with the specimen slide is achieved.
2. Center the field illuminated by the condenser with respect to the optical axis of the objective:
   First focus the specimen with a low-power objective (6.3× to 16×), using the coarse and fine adjustment. The field of view will appear only partly illuminated. With closed lamp field stop, slowly vary the vertical adjustment of the condenser until the spot of light is as small as possible and almost sharply defined (image of lamp field stop).
   Use the centering screws of the condenser carrier to move this spot of light into the center of the field.
   When changing the focus of the microscope, small punctiform objects in the center of the field must remain radially symmetric. If they move laterally, the illumination needs readjustment.
3. Dark-field adjustment with viewing objective:
   Move the viewing objective into position and focus on the specimen. If an immersion objective is used, immerse it beforehand and close down the diaphragm to the stop. Center the image of the closed lamp field stop by means of the centering screws on the condenser carrier. Do not open the lamp field stop further than is necessary to make its image disappear beyond the edge of the visual field. In the case of immersion objectives slowly open the iris diaphragm but only far enough to keep the background sufficiently dark.
4. **Initiate the exposure** as described on page 26, but push in the knob (16) for spot meas-

urement (Fig. 53) and shift the specimen so that a visible object particle coincides with the measuring circle in the center of the format.

Procedure with dry dark-field condenser
To adjust for dark-field illumination, proceed as above, but do not apply any immersion oil between the condenser front lens and the specimen slide.

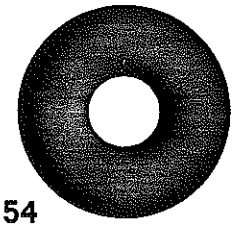
Procedure with phase-contrast condenser
With objectives up to N.A. 0.32 (16× magnification) use the annular diaphragm 3 of the phase-contrast condenser for dark-field illumination. Fully open the lamp field stop. The annular diaphragm must first be adjusted as usual in phase work.

Oblique illumination

Oblique illumination is obtained with phase-contrast condensers in the J-position. However, only achromatic-aplanatic condensers will illuminate the field of view satisfactorily.
In the case of low-contrast specimens, this type of illumination will enhance image contrast, though less than the phase-contrast technique. At the same time a certain relief effect is produced even with flat objects due to the asymmetric incidence of the light, which may, however, lead to misinterpretation. Caution should therefore be used when interpreting the image.

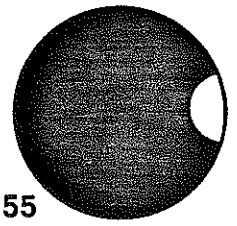
Procedure

1. Adjust for bright-field illumination as described on page 24, items 1 to 7.
2. Set the OPTOVAR to PH and focus on the objective aperture using the upper knurled wheel. Stop down the aperture diaphragm until its diameter is about one half to one quarter the objective aperture (Fig. 54). Move the revolving disk of the condenser far enough out of its position J for almost half of the diaphragm image to disappear (Fig. 55).
3. Change back to viewing of the specimen.
4. **Initiate exposure** as described on page 26.



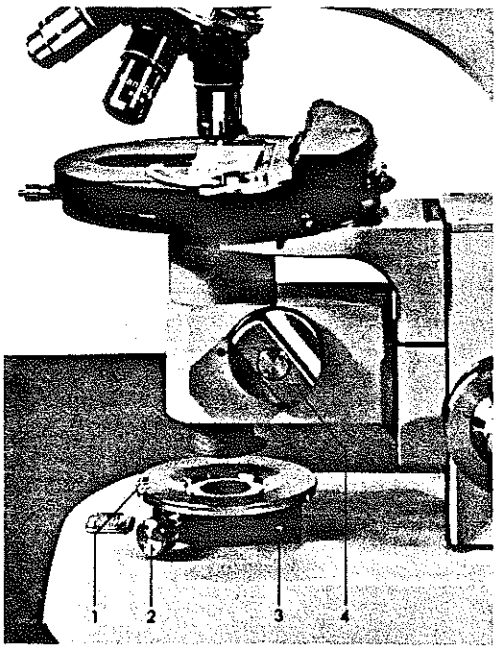
54

Correct size of aperture-stop image



55

Aperture diaphragm decentered for oblique illumination



56 Pancratic condenser

1 = Aperture diaphragm. The engraved figures are a measure of the opening obtained. 1 = full aperture, 2 = ½ aperture, etc. Lever 2 serves as an index.

2 = Knob for shifting aperture diaphragm. Lateral movement of the lever shifts the aperture diaphram in azimuth.

3 = If necessary, the image of the lamp field stop can be readjusted here by means of socket wrenches.

4 = Condenser control knob with engraved aperture values.

Pancratic condenser

The pancratic condenser solves the problem of microscope illumination in a neater manner than any other, by means of a single control knob. An optical system of variable focal length images the aperture diaphragm in the focal plane of the condenser. At the same time, an image of the lamp-condenser opening is formed on the specimen as a constantly centered field stop. If the illuminating aperture is increased by rotation of the knob, the illuminated field is reduced at the same time. With any objective from 2.5 to 100× the field reproduced by it is thus automatically illuminated as the condenser is adjusted for the objective aperture. The product of field diameter and aperture remains constant.

As usual, the illuminating aperture can be reduced by means of an aperture diaphragm which in this case is located in the microscope base. The requirements of Köhler illumination are thus fully satisfied.

The correction of the pancratic condenser is of the achromatic-aplanatic type.

If illuminating apertures higher than 0.9 are required, the front lens can be unscrewed and replaced by the N.A. 1.3 condenser head, 46 52 91. In this case, the aperture values engraved on knob 4 of Fig. 56 are no longer applicable.

Bright field

1. Place the specimen on the stage and switch on the lamp by means of the master key [~]. Control brightness by varying the lamp voltage (21) or move one or more gray filters into the light path by means of the filter control (1).

2. Set the reflecting system (11) to the black ring. Set the eyepiece tubes for the interpupillary distance required and focus each eyepiece on the cross of double lines in the field of view by slowly turning the respective eyepiece tube inwards. Failure to do this will result in blurred micrographs.

Then return the reflecting system to the red or white ring.

3. Focus on the specimen with the aid of the coarse and fine adjustments, using a low-power objective.

4. Set condenser control knob to aperture value of objective. The two terminal stops for low and high-power objectives and a central notch for medium-power objectives facilitate the setting.
   The field of view is now evenly illuminated.

5. Use the aperture diaphragm (1, Fig. 56) to control image contrast and resolution as is usual with any condenser.
   Here a compromise must be sought, because an open diaphragm is equivalent to high resolution and low contrast, while a stopped-down diaphragm gives good contrast, but reduced resolution.
   First open the diaphragm fully, then carefully close it down until a change in contrast is just noticeable. This is not always easy to determine by the image alone. As a rule of thumb it may therefore be said: set the OPTOVAR magnification changer to PH and use the lower knurled wheel to focus on the objective aperture. Only in exceptional cases should the diaphragm image now visible be smaller than two thirds of the diameter of the objective aperture.
   The aperture diaphragm is centered if the edge of the diaphragm insert is opposite the index of lever 2 in Fig. 56.

6. After every change of objectives, repeat items 4 and 5.
   If in the case of low-power objectives the image of the lamp field stop should be decentered in relation to the field of view, readjustment is possible at the diaphragm insert (3, Fig. 56) with the aid of two socket wrenches.

7. **Initiate exposure** as described on page 26.

Oblique illumination

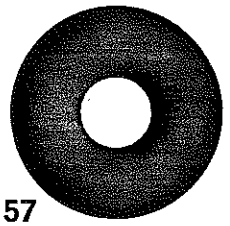
See introduction on page 31.

1. Proceed as for bright-field illumination, items 1 to 3.

2. Set OPTOVAR to PH and stop down aperture diaphragm until its diameter is about ½ to ¼ of the objective aperture. Turn the knob 2, Fig. 56, to shift the diaphragm image until one half of it has disappeared behind the edge of the field (Fig. 58).

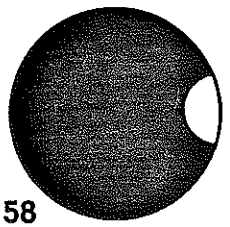
3. Set the OPTOVAR to the desired magnification factor.

4. **Initiate exposure** as described on page 26.



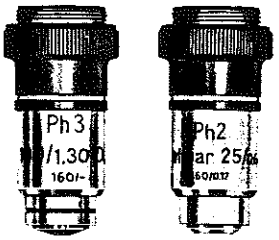
57

Correct size of aperture-stop image for oblique illumination

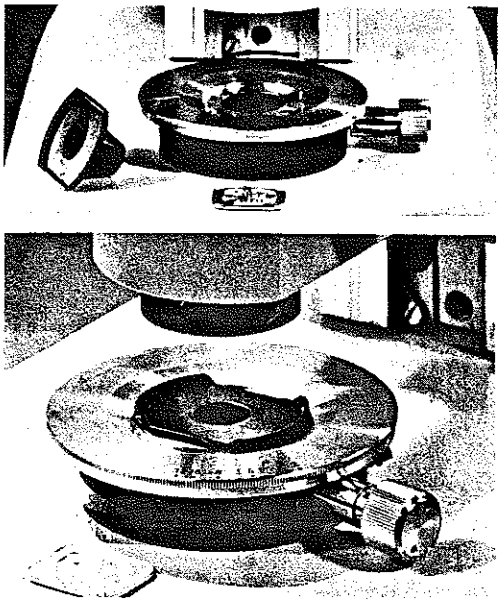


58

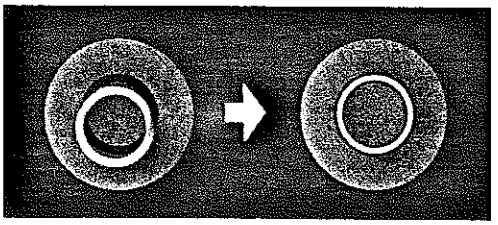
Aperture diaphragm decentered for oblique illumination



59 Phase-contrast objectives



60 a) Annular phase-contrast diaphragm removed
b) In place in diaphragm insert



61 Obtaining coincidence between annular diaphragm and phase annulus.

Phase contrast

The pancratic condenser is supplied with an annular diaphragm that can be inserted in the plane of the aperture diaphragm. Its image can be adapted to the size of the phase annulus of any PH phase-contrast objective thanks to the zoom optical system.

1. Proceed as for bright-field illumination, items 1 to 3, but use a low-power Ph objective. Insert green filter.

2. Insert annular diaphragm into diaphragm insert (plane of aperture diaphragm). Set OPTOVAR to PH and use the lower knurled wheel to focus on phase annulus and annular diaphragm which are visible in the objective pupil.

3. Turn the condenser control knob until the image of the annular diaphragm corresponds to the size of the phase annulus. Obtain perfect coincidence between annular diaphragm and phase annulus (Fig. 61). For this purpose move lever 2, Fig. 56, while turning the knob. Set the desired magnification factor on the OPTOVAR.

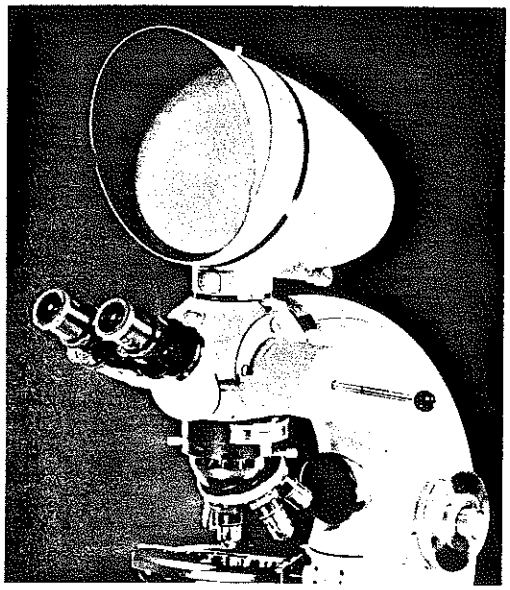
4. After every change of objectives, repeat item 3.

5. **Initiate exposure** as described on page 26.

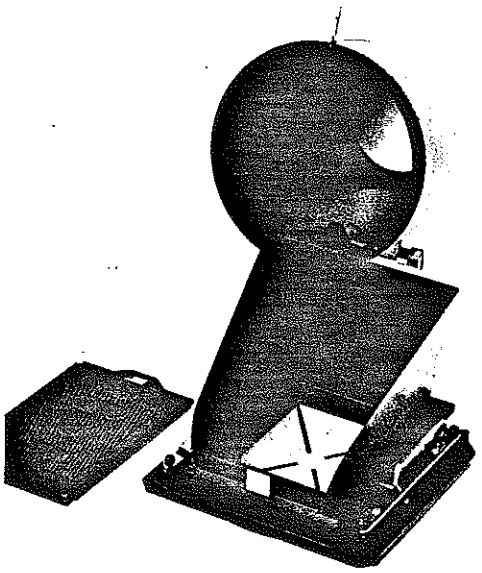
Care of microscope

Your microscope is a valuable precision instrument. It should be properly treated to ensure perfect functioning and long life. Please observe the following rules:

- Protect the microscope against its enemy number one: dust. Use the dust cover, 47 93 01, whenever the instrument is not needed.
- See to it that the eyepieces are always in place. All other openings through which dust may enter (e. g. the openings in the tube head) should likewise be closed.
- Remove dust from optical elements exclusively by blowing or by dabbing them with a damp cotton wad. Rubbing may produce tiny scratches.
- All glass surfaces, lenses and mirrors should be cleaned with a dust-free linen rag or cotton wad – never with leather.
- Optical elements should be treated with solvents only if breathing on them (or distilled water) does not do the trick. Small quantities of acetone, xylol or pure benzene may be used as solvents. Never use alcohol, which will destroy the cement between the optical elements.
- In no case must solvents come into contact with guides, for they will destroy the film of grease ensuring smooth and easy motion.
- Residues of immersion oil, fingerprints and traces of grease – above all on objective front lenses and eyepiece eyelenses – impair the performance of the microscope. Check frequently for cleanliness.
- Never oil the precision guides, rack and pinion movements, screws or other moving parts. This would definitely cause damage.



62 Projection attachment, 47 30 85



63 9×12 cm / 4×5″ photomicrographic insert, 47 30 84, and 9×12 cm sheet-film and plate holder, 47 61 29

Further accessories

Projection attachment

The projection attachment, 47 30 85, is mounted directly on the top of the tube head like a body tube. The 15 cm Fresnel lens used as ground glass provides uniform illumination right out to the edge of the field. The 6-v, 15-w base illuminator is entirely sufficient for bright-field work with low and medium-power objectives. In the case of illuminating techniques involving a certain loss of light, with strongly absorbing specimens and high-power objectives, preference should, however, be given to the 60-watt illuminator.

The viewing screen should be set up so that no bright surroundings or windows are in the viewing direction. Best results are obtained in subdued room light.

The image scale on the ground-glass screen is the product of the initial magnification of the objective and the factor 10. In other words, the aerial image produced by the objective is magnified 10× by the optical system in the projection attachment.

The ground-glass screen 47 30 81 may be exchanged for two other inserts:

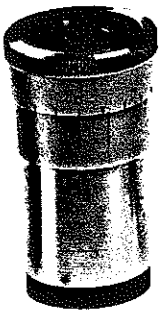
Ground-glass insert, 47 30 83, with rotating and sliding scale. The transparent millimeter scale allows any object point to be measured on the ground glass.

9 × 12 cm / 4 × 5″ photomicrographic insert, 47 30 84, for use in conjunction with:
9×12 cm sheet-film and plate holder, 47 61 29,
LINHOF 9×12 cm double sheet-film and plate holder,
Polaroid 4×5″ sheet-film holder, type 545.
With this negative size, of course, longer exposure times are required. The capping shutter may therefore be operated by hand without danger of blurring. The shutter is closed when the red line on the shutter knob is in a vertical position.

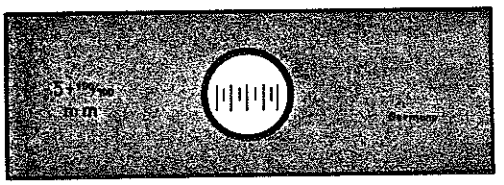
Length measurements under the microscope

These can be effected with the aid of an eyepiece designed to take micrometer disks (eyepiece micrometer), the 10:100 micrometer disk, 47 40 11, and, for calibrating the latter once and for all, the stage micrometer 5+100/100, 47 40 20. The scale of the stage micrometer consists of 5 whole millimeters and 1 mm subdivided into 100 intervals (1 interval = 10 µ).

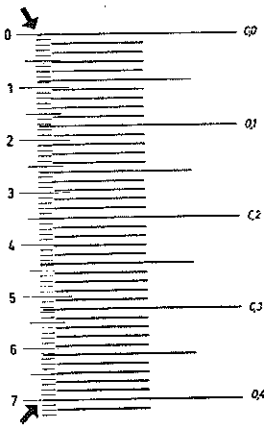
1. Insert micrometer disk into eyepiece (which must be designed to take reticules). To do this, unscrew the lower, black part of the eyepiece. Remove the ring above the field stop and replace it after inserting the micrometer disk (scale facing up). Screw eyepiece together again.
2. Point eyepiece towards a bright surface and turn focusing eyelens counterclockwise until the scale is in sharp focus. Then slip the eyepiece into its tube.
3. Place stage micrometer on specimen stage and use coarse and fine adjustments to focus on the scale. Turn the eyepiece in its tube until the two scales are parallel and side by side.
4. Determine the number of micrometer-disk divisions corresponding to a certain length of the stage micrometer. In Fig. 66, 70 intervals of the micrometer disk correspond to 0.4 mm (400 µ) on the stage micrometer.
5. Determine the micrometer value, i. e. the true length corresponding to an interval of the micrometer-disk scale.
   Example: 400 µ : 70 = 5.7 µ.
   To determine the length of an object distance, it will henceforth only be necessary to multiply the number of divisions by the micrometer value.
   The micrometer value applies only to the objective/OPTOVAR/eyepiece combination used for calibration. Since it is also a function of tube length, special care should be taken always to use identical settings on the eyepiece tubes of the inclined binocular body.



64 Eyepiece for micrometer disks

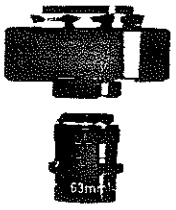


65 Stage micrometer 5+100/100, 47 40 20



66 Calibrating the eyepiece micrometer:
Scales of eyepiece micrometer (left) and stage micrometer (right) side by side in the field of view.

67 Luminar holder, 47 25 51, with rectangular stop in place. 16 mm, 25 mm and 40 mm LUMINARS.



68 Luminar holder, 47 25 52, and 63 mm LUMINAR

69 Spectacle-lens condensers and auxiliary lens 4 for spectacle-lens condenser 4.

Image scales as referred to the film negative:

LUMINAR	Image scales	Object field size in mm
16 mm	14:1 – 22:1	2.6×1.7 – 1.6×1.1
25 mm	8:1 – 14:1	4.5×3 – 2.6×1.7
40 mm	4:1 – 8:1	9×6 – 4.5×3
63 mm	2:1 – 4:1	18×12 – 9×6

Low-power photography with LUMINAR objectives

The LUMINAR equipment may be used on the PHOTOMICROSCOPE in conjunction with a 35 mm single-lens reflex camera equipped with a focal-plane shutter. Image scales in the film plane are between 2:1 and 22:1. In this case, the integral automatic camera cannot be used. Transparent specimens are illuminated by means of the illuminator incorporated in the microscope and a suitable spectacle-lens condenser.

The Luminar head, 47 20 50, attached to the stand instead of the tube head, supports the objective and the camera. The telescopic extension provided for variation of the camera extension can be clamped in any desired position with the aid of two screws. It is normally supplied with a bayonet thread suited for attachment of the CONTAREX camera. However, single-lens reflex cameras of other manufacture can also be attached, provided that their lens is interchangeable. If a special adapter is desired in the Luminar head, the required details should be specified in the order.

LUMINARS are high-performance photomicrographic objectives designed for single-stage image formation. To ensure that the focusing movement of the microscope stage is sufficient for satisfactory focusing of the specimen, LUMINARS are supplied with holders of different height.
The iris diaphragm of LUMINAR objectives must be fully opened for photography by transmitted light. It serves to increase the depth of field if three-dimensional objects have to be photographed by reflected light. The diaphragm is engraved with factors by which the exposure time determined for full aperture must be multiplied.

Every LUMINAR has a **spectacle-lens condenser** of its own. A clip-on stop, which is located directly beneath the specimen when the condenser is properly set, serves as a fixed field diaphragm. In the spectacle-lens condenser 4 for the 63 mm LUMINAR the clip-on stop is replaced by an auxiliary clip-on lens 4.

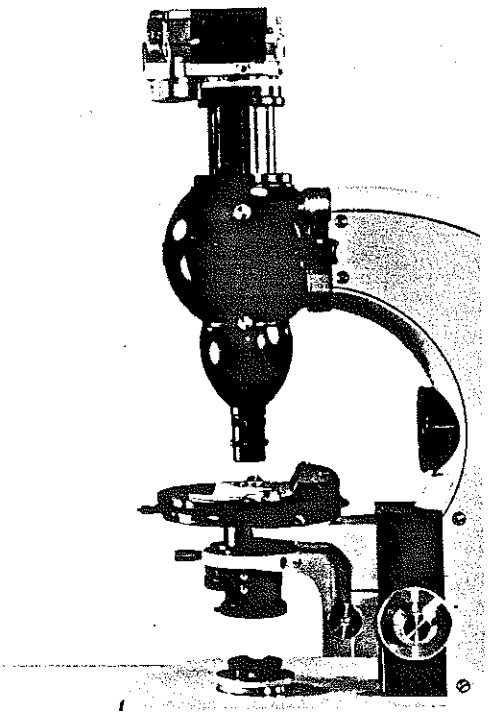
With all LUMINARS, the **BL illuminating lens,** 46 70 90, is inserted into the light-exit opening in the microscope base. It may only be omitted if the microscope is equipped for use of the pancratic condenser.

Assembly

1. Remove the tube head of the microscope and replace it by the Luminar head, 47 20 50.
2. Screw the LUMINAR into the corresponding Luminar holder and attach the latter in the usual manner with its dovetail ring to the Luminar head. Then clamp it.
   With the LUMINARS from 16 to 40 mm first insert the rectangular stop, 47 25 53, from above into the Luminar holder. Its correct position may be checked by looking from above into the telescope tube: turn the Luminar holder until the two visible rectangular stops are properly located.
3. Remove the lens of the CONTAREX and attach the camera – red dot facing red dot – with the aid of the bayonet mount to the telescope tube.
4. Insert the spectacle-lens condenser corresponding to the LUMINAR used (identical color of engraving) and rack it fully up by means of the condenser movement.
5. Insert the BL illuminating lens, 46 70 90, into the light-exit opening of the microscope base. This does not apply if the microscope is equipped for use of the pancratic condenser.

Procedure

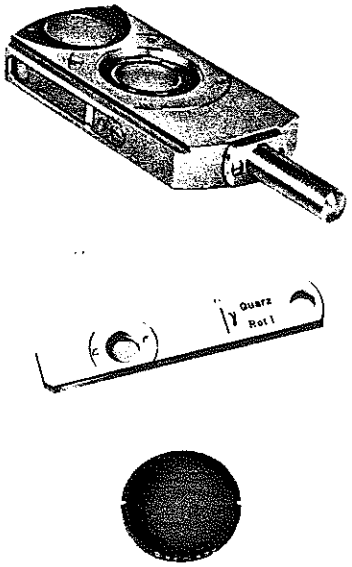
6. Switch on the base illuminator and (if necessary) also the light filters.
   With 16 to 40 mm LUMINARS swing auxiliary condenser lens in, with 63 mm LUMINAR swing it out.
7. Look into the camera viewfinder and focus on the specimen using the coarse and fine adjustments of the microscope. Obtain the desired image scale by varying the camera extension (drawing out the telescope tube) and refocus.



70 LUMINAR equipment on PHOTOMICROSCOPE

LUMINAR	Luminar holder	Spectacle-lens condenser Diameter of clip-on stop
16 mm 46 25 11	47 25 51 with rectangular stop 47 25 53	**1** 3.5 mm
25 mm 46 25 13		**2** 6 mm
40 mm 46 25 15		**3** 9 mm
63 mm 46 25 17	47 25 52	**4** without clip-on stop, but with auxiliary lens 4, 46 55 80

8. Control image contrast and resolution by means of the lamp field stop (2) acting as aperture diaphragm.
   A compromise must be sought here, because a wide open diaphragm means high resolution and low contrast, while a stopped-down diaphragm reduces the resolution but enhances contrast.
   Always open the iris diaphragm of the LUMINARS fully.
9. If the camera used does not have a through-the-lens light metering system, determine the required exposure with the aid of a series of calibration exposures.
   The exposure determined with a hand-held meter through the camera viewfinder or, with the camera removed, through the telescope tube at f/2 may serve as a guide.



71 Simple polarizing equipment, 49 36 01: polarizing filter, 47 36 00, first-order red retardation plate, 47 37 00, simple analyzer slide, 47 36 63.

Simple polarizing equipment

The polarizing equipment, 49 36 01, if used on the PHOTOMICROSCOPE, serves for simple polarized-light work with moderately to strongly refracting objects and for qualitative work, such as determining optical characteristics. A rotary stage is indispensable here as it is for polarized-light work in general.

The polarizing filter, 47 36 00, is used as polarizer in the lower swing-out filter holder of the condenser carrier. The two white lines on the edge of its mount indicate the vibration direction and should lie in right–left (east–west) direction, like the grip of the filter holder.

The simple analyzer slide, 47 36 63, which has a fixed polarizing filter, is inserted into the wide opening in the tube head instead of the dust plug. It is secured in the tube head by means of the screw on one side. When the slide is pulled out all the way, a quartz plate is in the light path, which eliminates the analyzer effect of prisms.

Accurate crossing of analyzer and polarizer with the resulting optimal darkness of the background field is achieved by slightly turning the polarizer. Only birefringent elements will then light up if the stage is rotated.

The first-order red retardation plate, 47 37 00, is inserted into the narrow opening in the tube head. It has two vibration directions oriented at right angles to each other, in which the light is transmitted at different speed. These two directions make a 45° angle with the vibration directions of polarizer and analyzer. The direction marked γ on the mount indicates the plane of vibration of the light passing at lower speed.

In "plus position", the specimen appears in a 550 mμ (first-order red) higher interference color, e. g. blue. The vibration direction of the slower wave train in the specimen is then parallel to the γ-direction of the retardation plate.

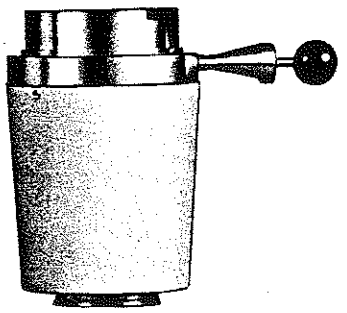
In "minus position", the interference color is correspondingly lower, e. g. yellow (vibration direction of faster wave train parallel to γ-direction).

On request, we shall be pleased to supply the Michel-Lévy color chart SE 40–554.

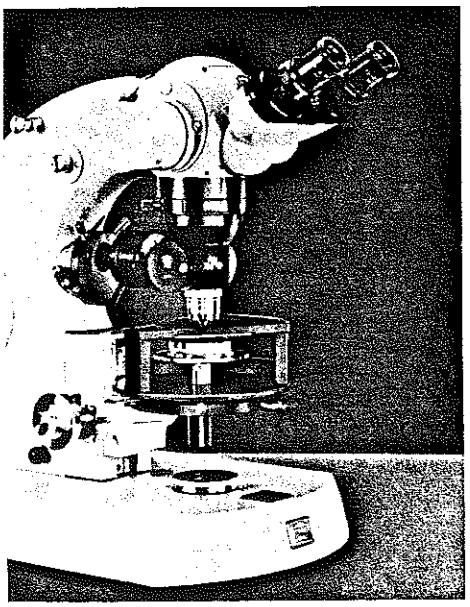
The microscope tube with pointer, 47 79 15, serves to attach a Siemens & Halske television camera: it is fitted on the tube head in place of a cover. The television camera tube (Vidicon) is located in the plane of the aerial image produced by the microscope. The movable pointer, the tip of which is imaged together with the specimen, is located in the same plane. Any object detail in the field of view can thus be pointed out without difficulty.

In order not to fall short of useful magnification, it is advisable to use the OPTOVAR for additional magnification.

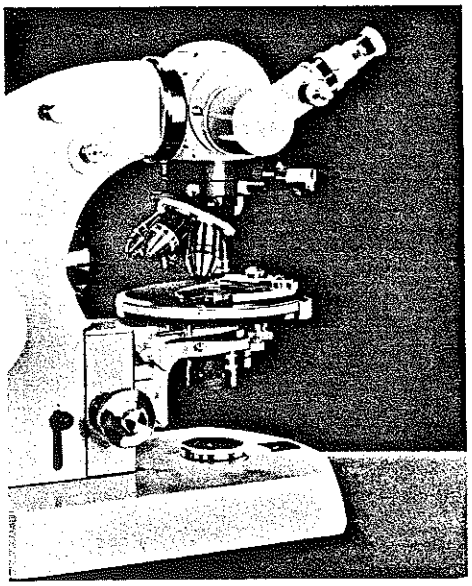
In monochrome television, certain colors of the object can be stressed or subdued with the aid of color filters. Particularly well suited for this purpose is the continuous interference-filter monochromator.



72 Microscope tube with pointer, 47 79 15, for Siemens & Halske television camera



73 PHOTOMICROSCOPE II M for reflected light



74 PHOTOMICROSCOPE II POL

Reflected-light microscopy

The PHOTOMICROSCOPE is equally well suited for transmitted and vertical illumination. The following four vertical illuminators can be supplied:

a) Type III D vertical illuminator for bright-field illumination (standard metallographic magnifications). With revolving nosepiece.
b) Type II C vertical illuminator for bright field, dark field, differential interference contrast. With single nosepiece.
c) Type III C vertical illuminator for bright field, dark field, differential interference contrast. With revolving nosepiece.
d) Type II E vertical illuminator for photometric work, but also for bright field, dark field and differential interference contrast. With single nosepiece.

The EPIPLAN objectives, which are practically free from flare, have an optimally flattened field. As a high-power light source, the 60-watt illuminator is attached to the microscope base. The stage for polished specimens holds objects up to 40 mm thick in a perfectly horizontal position and at the same time prevents damage to both the object and the objective.

Parts and procedures for reflected-light work are described in the Operating Instructions G 41-655.

Polarized-light microscopy

Any PHOTOMICROSCOPE can be converted into a polarizing microscope. For this purpose, the following accessories are required: POL condenser carrier with polarizer, rotary polarizing stage, analyzer slide, polarizing tube or inclined binocular POL body, crossline eyepiece and compensators. In addition, strain-free optics are needed between polarizer and analyzer (auxiliary lens, condenser, objectives, nosepiece with POL telan system).

In this case, the present instruction manual is supplemented by the Operating Instructions G 41-500 for polarizing microscopes.

Large-format camera

In addition to photography with the integral 35 mm camera, photomicrographs can be obtained on larger negative sizes, in this case, however, without automatic exposure control. Apart from photomicrography with the 9×12 cm photomicrographic insert of the projection attachment (Fig. 63), several camera attachments can be used.

The vertical photo tube, 47 30 23, on the tube head carries the basic unit for focusing and the camera attachment. The following equipment is available:

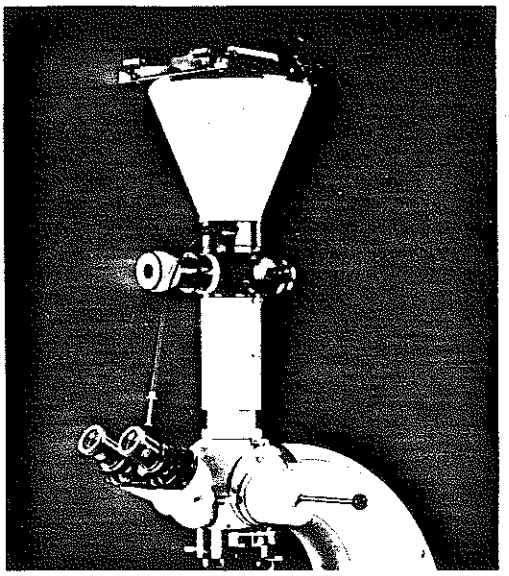
6.5×9 cm camera attachment,

Camera attachment for LINHOF Rollex backs, for the 56×72 mm size,

Polaroid 3¼×4¼" camera attachment for film pack adapters,

9×12 cm / 4×5" camera attachment.

The latter may also be used with Polaroid film. Photoelectric light measurement is possible. Work with the photomicrographic camera is described in the Operating Instructions G 41-410.



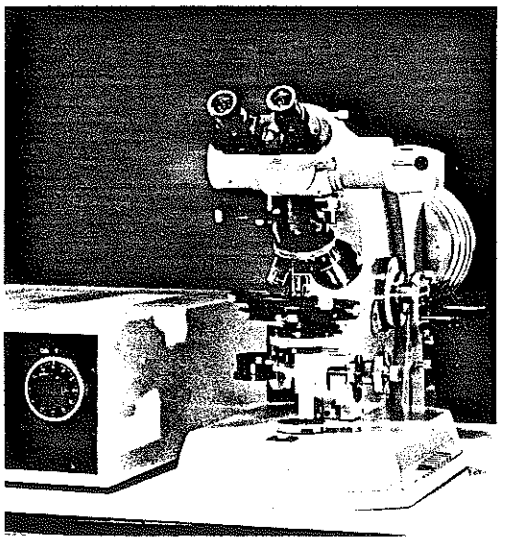
75 9×12 cm camera attachment

Fluorescence microscopy

Any PHOTOMICROSCOPE can be converted into a fully fledged fluorescence microscope offering maximum ease of operation. In addition to conventional excitation of fluorescence, not only fluorescence with superimposed phase contrast is possible but also the fluorescent-antibody method with dark-field illumination. The following equipment is required: special-purpose and fluorescent illuminators (HBO 200) with exciter filters, barrier-filter insert, a condenser with a numerical aperture of at least 1.3 suitable for the type of illumination used, and NEOFLUAR objectives.

The possibility of making spot measurements guarantees fully automatic exposure control in this case also.

Detailed information on fluorescence microscopy in connection with the PHOTOMICROSCOPE and the properties of the filters will be found in the Operating Instructions G 41-350.



76 PHOTOMICROSCOPE II converted into a fluorescence microscope