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CARL ZEISS

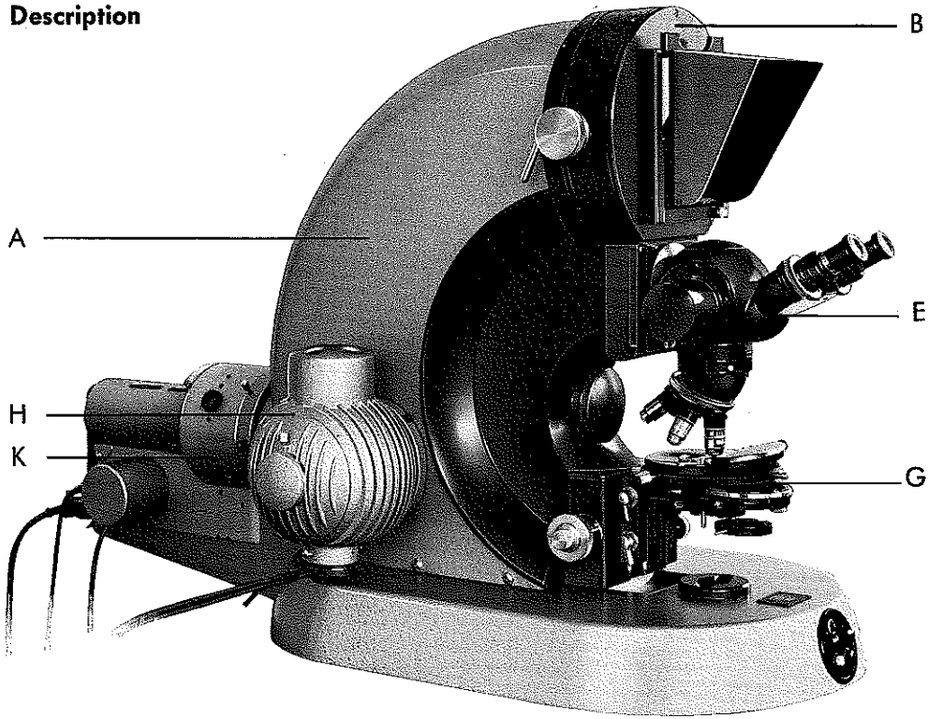
# ULTRAPHOT II

**Operating Instructions**

## Contents



## Description

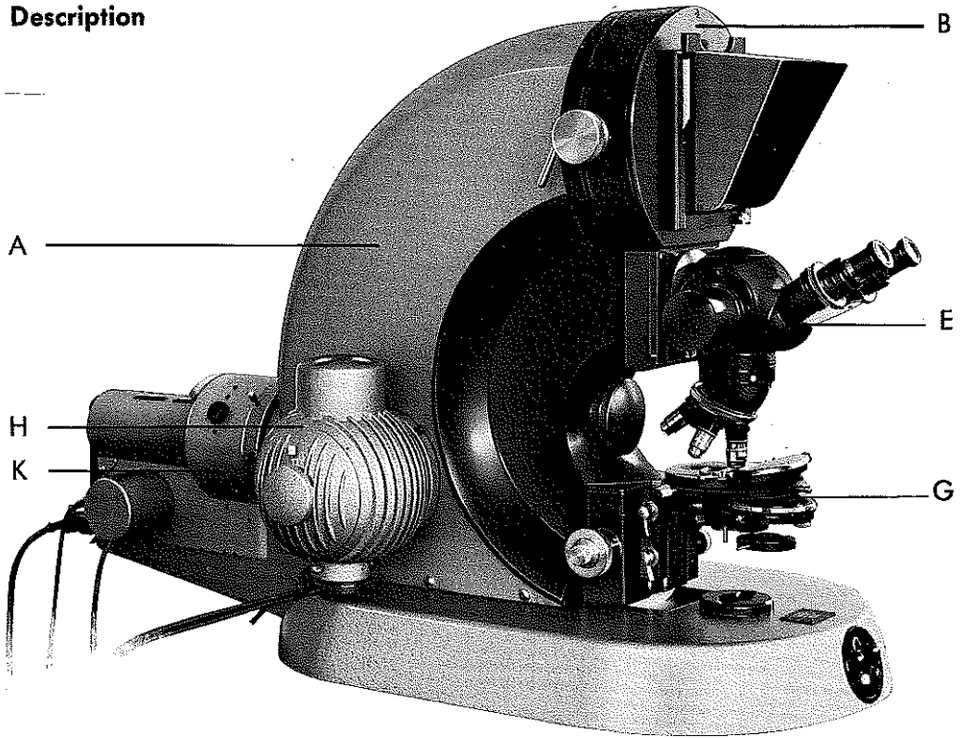



**1**

The Camera Microscope ULTRAPHOT II consists of various components which in part are interchangeable. This results in an exceptional versatility. The component parts of the apparatus are (Fig. 1):

A Stand
B 9×12 cm. (4×5") Photo Head, interchangeable with
C 35 mm. Photo Head, or
D Projection Head
E Tube Head, interchangeable with
F Luminar Head (for low-power photographs)
G Stage group with substage for transmitted light
H Illuminator for low-voltage filament bulb 12 V 100 W, or for high-pressure mercury lamp HBO 200
K Carbon Arc Lamp
L Instrument Table

## Description

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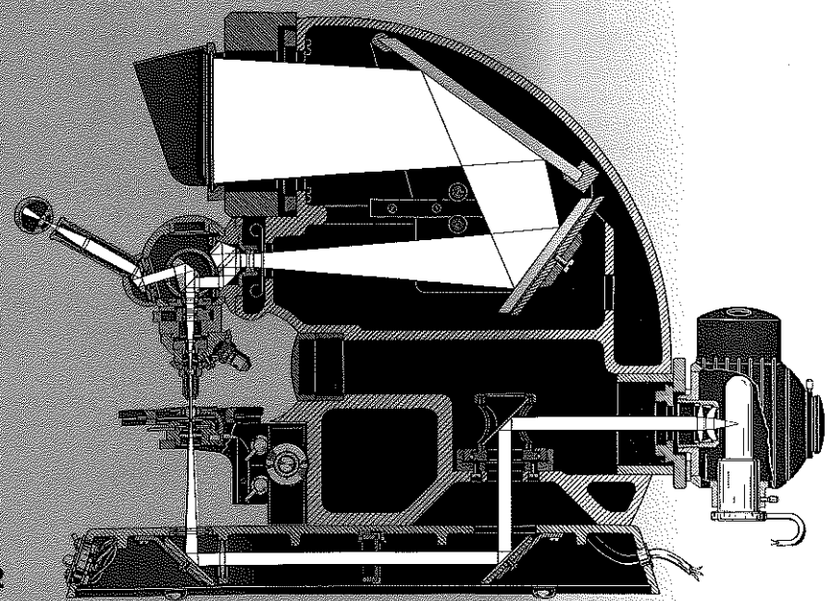
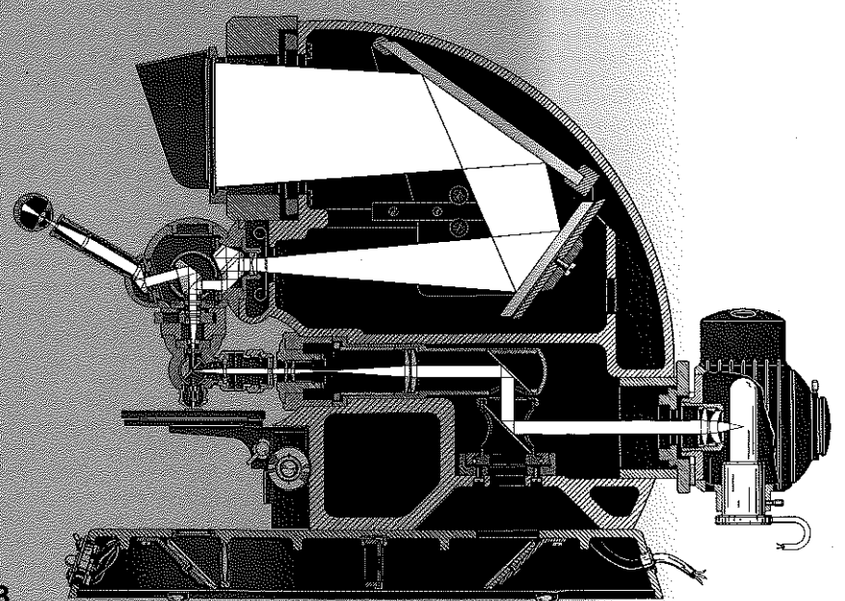
## Path of Rays in the Compound Microscope



2

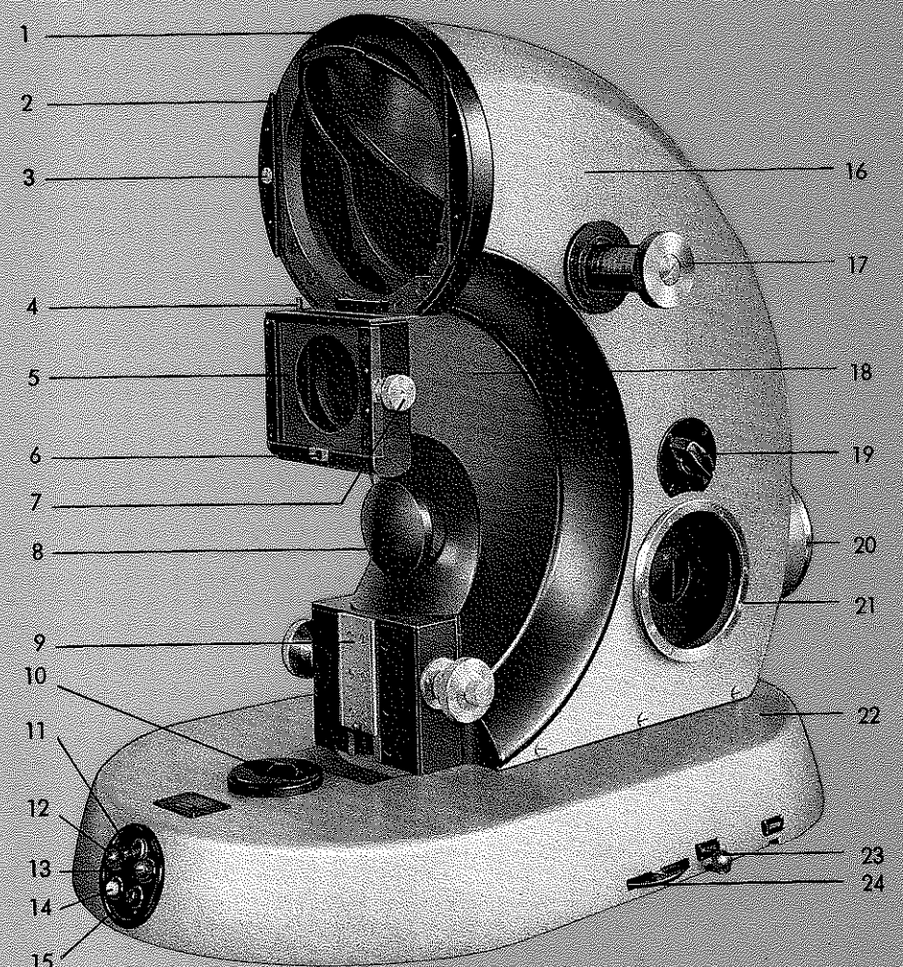
**Transmitted Illumination**

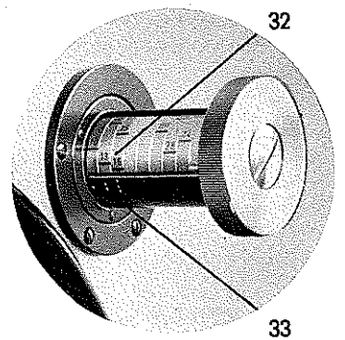


3

**Incident Illumination**

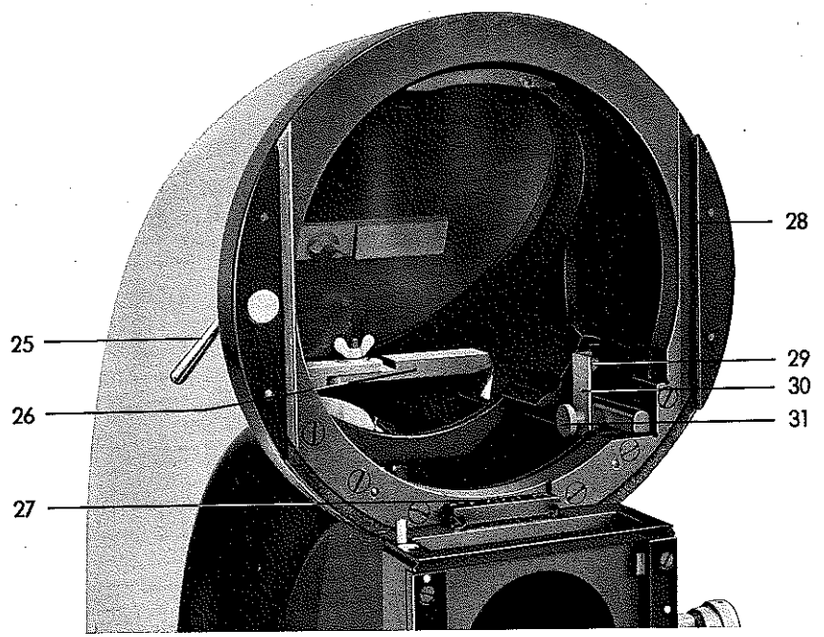
# A

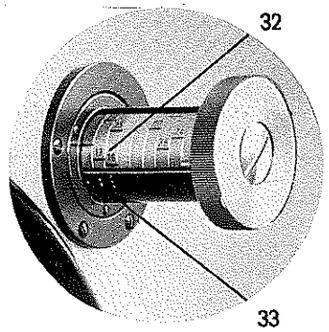



1 Attachment device for the Photo Heads
2 Mirror carriage
3 Clamping strip for the Photo Heads
4 Locking pin
5 Attachment device for the Tube Heads
6 Stop for the Tube Heads
7 Clamping screw for the Tube Heads
8 Cover for the light exit in epi-illumination
9 Clamping strip for stage and condenser carriers
10 Filter holder
11 Main switch of the automatic exposure device
12 Pilot lamp, lights up when main switch is turned on
13 Pilot lamp, lights up as long as shutter is electrically opened

**4**



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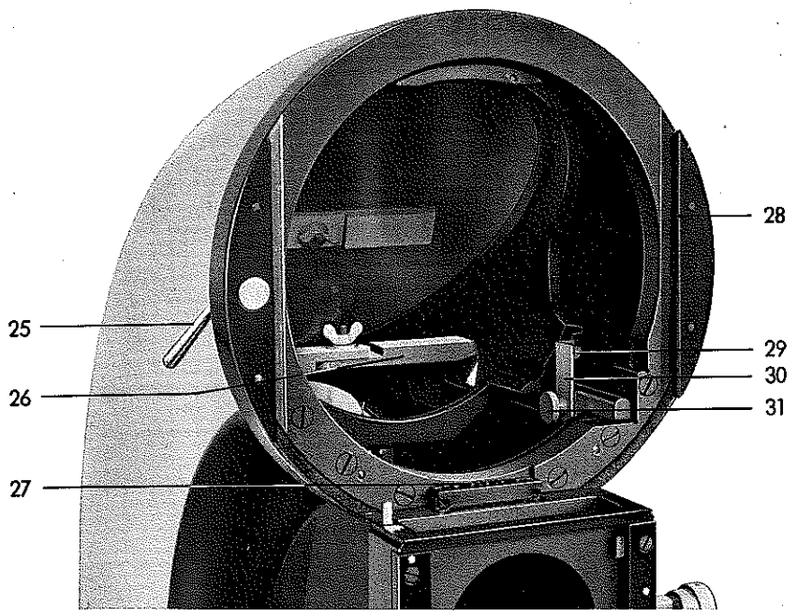




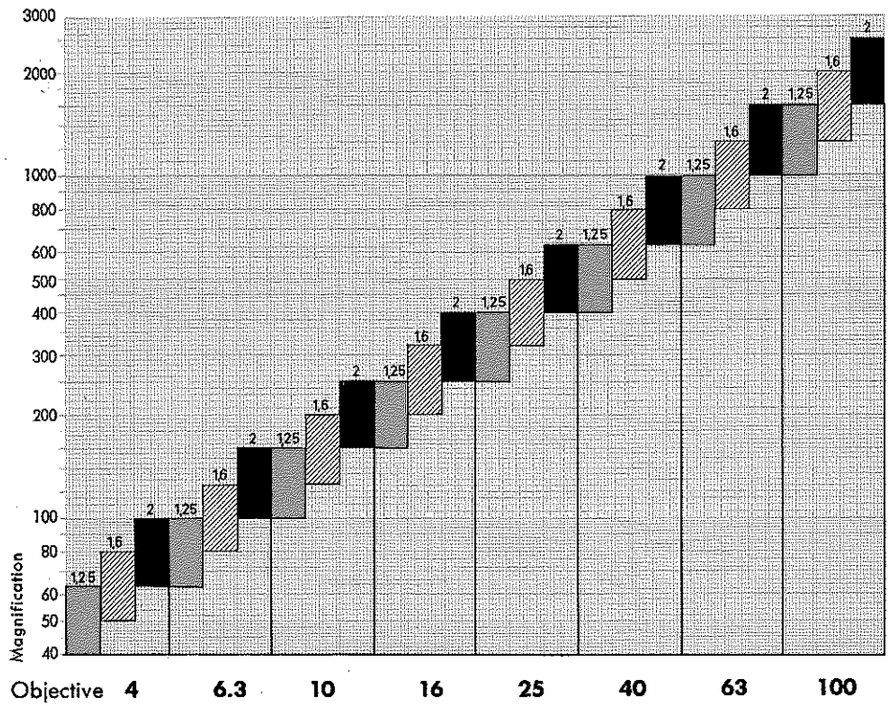

14 Push button for electric hand control
15 Push button for automatic control of the camera shutter
16 Metal cover for carrier of Tube Head, stage and substage
17 Knob for adjusting extension of the camera
18 Carrier for Tube Head, stage and substage
19 Setting knob for illuminators
20, 21 Ring dovetails, holders for the illuminators
22 Base
23 Switching lever for changing from illumination for Compound Microscope (position "Micro") to illumination for LUMINARS (position "Luminar")
24 Operating disk for the diaphragm (Luminous-field diaphragm at "Micro", aperture diaphragm at "Luminar")
25 Lever for clamping the Photo Heads
26 Provision for disengagement of the mirror carriage
27 Plug board for electric connection between stand and Photo Head
28 Guiding edge for the Photo Head
29 Fastening screw of retaining angle bar (A 30)
30 Retaining angle bar for supporting the mirror carriage during transportation
31 Fastening screw of (A 30)
32 Rings for adjusting the scales of magnification
33 Red reference points for Optovar positions 1.25, 1.6, and 2

## A Stand (Fig. 4)

The Carrier (A 18), mainly made of cast iron parts, is rigidly mounted to the box-shaped Base (A 22). This rests with four shock-reducing rubber feet on the surface supporting the instrument. It contains a part of the illuminating system for transmitted light (Fig. 2 and 3). The Carrier is partly enclosed by a metal cover (A 16). In the upper part of its interior it contains the camera space and in the lower the remainder of the parts for transillumination as well as the system for epi-illumination. On the outside of the metal cover, at its lower end, are three ring dovetails (A 20 and A 21), for attachment of the light sources; the third, opposite (A 21), is not visible in the illustration.
In addition, the Carrier and metal cover carry mounting devices
(A 1) for the Photo Heads
(A 5) for the Tube- or Luminar Heads, and
(A 9) on the pinion box: for stages and condensers for transillumination

Table 1

**Magnifications** on the focusing screen (B 7) **with the Compound Microscope**
Valid for ULTRAPHOT II as of serial No. 55 016 (excepting 6-place numbers).




The table shows the magnifications obtainable with the combination of individual objectives and the three positions of the OPTOVAR (E 18).

Factor 1.25 = colored field
Factor 1.6 = hatched field
Factor 2 = black field



## The Camera

The upper part of the interior of the carrier with metal cover constitutes the camera. The image is projected, by means of two mirrors (Fig. 2 and 3) upon the focusing screen (B 7) mounted in the front wall of the instrument above the Tube Head. The camera length is changed by horizontally displacing the mirrors. Both of them rest on a mirror carriage (A 2) which can be adjusted by a knob (A 17) extending laterally from the cover wall. Through this adjustment the camera length can be doubled. An advantage of the arrangement is that with relatively small dimensions a considerable variation in camera length is achieved. The range with the Compound Microscope is 50 to 80 cm., for survey photographs with the Simple Microscope 80 to 110 cm.

On the shaft of knob (A 17) for setting the camera length are placed interchangeable rings (A 32) which bear marks for the rapid setting of specific magnifications. The respective marks must lie in contact with the lower edge of the window, like the third ring (A 32), in Fig. 4. There are three such rings for the Compound Microscope. They are distinguished by black numbers. There is one for each of the three positions of the OPTOVAR (E 18). The relation is given by 1, 2, or 3 red dots (A 33) which correspond to the dots appearing under the factor numbers of the OPTOVAR (E 20).

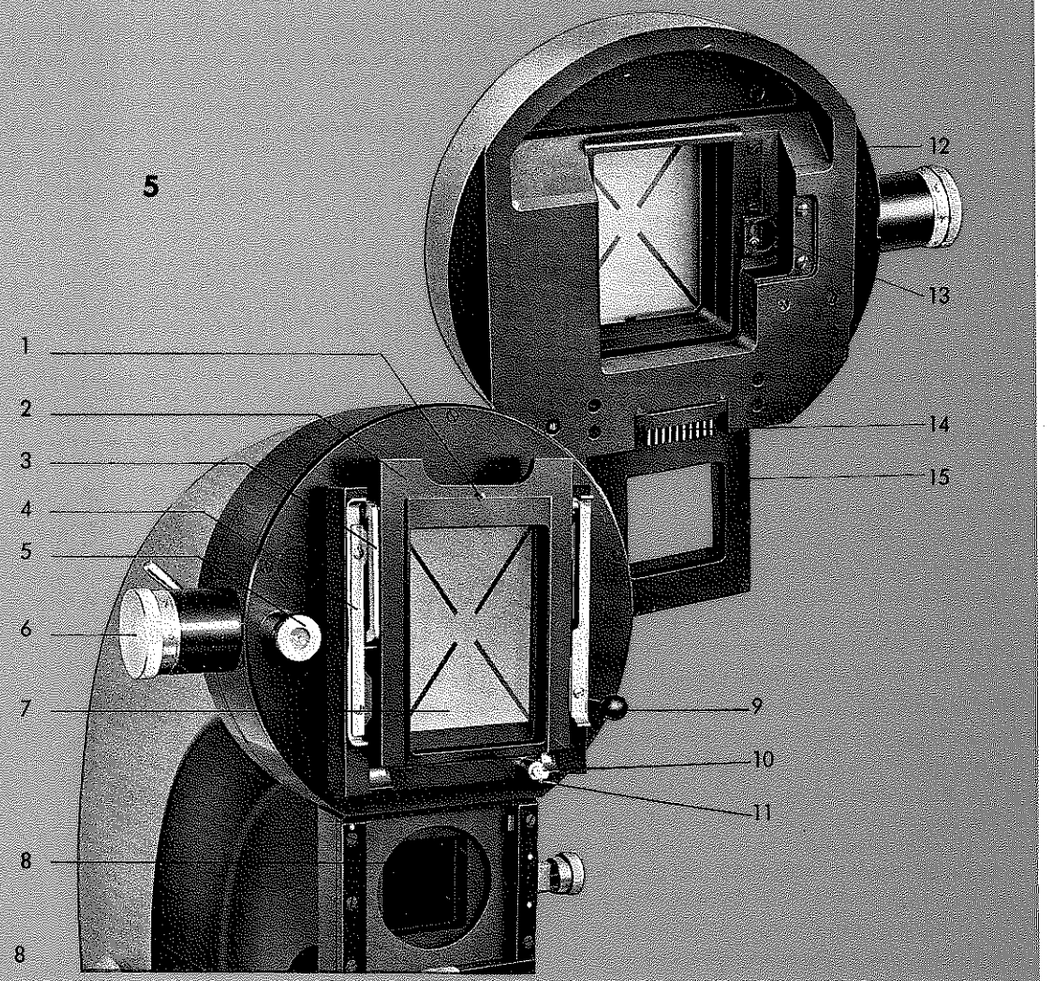
The numbers engraved on the rings indicate the factor by which the objective magnification must be multiplied in order to obtain the magnification on the focusing screen (B 7).

**Example:**
**Planachromat 40/0.65 is employed. The OPTOVAR is set on 1.6 (2 red dots). After focusing the image on the focusing screen, the camera factor 15 is indicated by the corresponding ring. Total magnification on the focusing screen 40×15× = 600×.**

A separate ring is provided for each of the five LUMINARS employed for low power photographs (Simple Microscope). The correlation between ring and LUMINAR is indicated by the same color of the engraving. The numbers engraved on the rings directly indicate the magnification on the focusing screen (Table 11, page 67). An additional ring with millimeter graduation is provided for cases in which such an unequivocal correlation cannot be determined beforehand. With this scale an optional table of magnifications can be set up.

B

5




## 9 x 12 cm. (4 x 5") Photo Head

1 Retaining knob for the light-excluding hood (here removed) of the focusing screen. The hood is set on this knob and pressed downwards

2 Frame of the focusing screen holding the ground-glass plate

3 Retaining clip of the focusing screen frame

4 Bolt for attaching a roll film or sheet film holder or a "Polaroid holder"

5 Dry cartridge with silica gel. If the contents are no longer blue, the cartridge is unscrewed and dried on a moderately warm heating plate until the dark blue color is restored

6 Selector knob for the sensitivity of the employed emulsion. The longest exposures are obtained with position "I", the shortest with position "8"

7 Focusing screen with clear diagonal strips

8 Shutter opening

9 Lever for opening and cocking the focal-plane shutter by hand. For cocking and closing the shutter by hand (p. 56, section 7) or by inserting the plate holder (p. 86, sections 10 and 11) the knob for mechanical release of the shutter (B 10) must not be in the depressed position.

10 Knob for mechanical release of the shutter. When pressed halfway in, the knob catches, the shutter remains open; pressed completely in, the knob passes the catch and the shutter remains open for as long as the knob is pressed

11 Release knob for the lock of the winding lever operated by the plate or film holder. This lock arrests the lever when a film pack or roll film magazine or a Polaroid holder is used

12 Contact face of the Photo Head

13 Window of yellow glass; behind it lies the photocell for automatic control of exposure

14 Terminal strip for electric connection between Photo Head and stand

15 Shutter housing

## B **9x12 cm. Photo Head** (for USA 4x5")

The Photo Head is attached to the upper end of the instrument. It carries the devices for focusing the image and for receiving the holders containing the film material. In its basic form it is designed for 9×12 cm. or 4×5" holders. The change from one size to the other is made by transposing the guide bars (page 52).

The interior of the Photo Head houses the essential part of the device for automatic exposure control and the shutter mechanism. After taking off the Tube Head (E) and after loosening clamping lever (A 25), the Photo Head can be removed from the instrument by pulling it upwards. In its place a simple Projection Head (Fig. 8) or a 35 mm. Photo Head (Fig. 6) can be inserted.

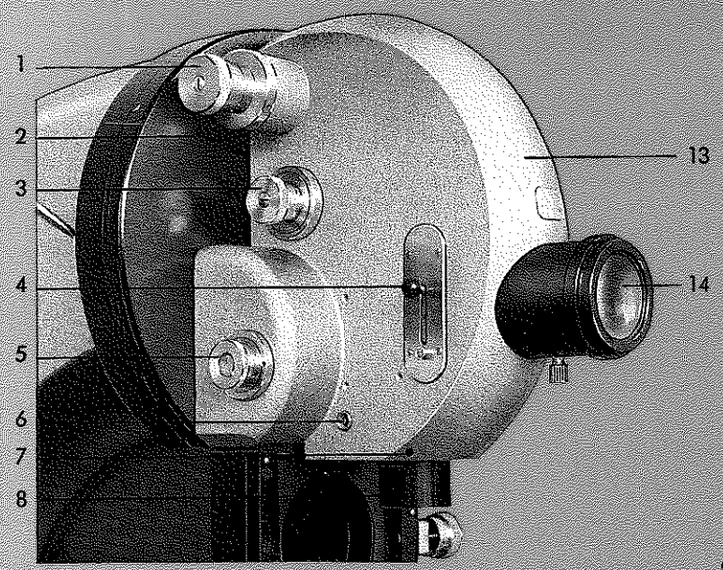
In taking a photograph, the image is focused on the focusing screen (B 7) located immediately above the Tube Head. It is a ground-glass plate provided with diagonal clear strips. The focusing screen need not be removed from the instrument when inserting a plate or film holder.

The holder is introduced from above between housing and frame (B 2) of the focusing screen. In so doing the frame springs back so that the plane of the photographic emulsion lies in the plane occupied by the ground glass during focusing. When introduced the holder depresses a lever (334, page 53) which automatically closes and cocks the shutter. This necessarily must be open while focusing the image. The arrangement avoids errors in manipulation, such as leaving the shutter open when removing the holder, or double exposures.

The holder should be introduced gently to avoid shock which could alter the plane of focus. Lever (B 9) at the right of the focusing screen serves for opening and cocking the shutter by hand. Knob (B 10) at the right and below the focusing screen is a hand release of the shutter for time exposures. When the knob is pushed halfway in, to the catch, the shutter remains open, but when pressed completely in and released, the shutter closes.

In the interior of the Photo Head, to the left of the focusing screen, is a photocell (B 13). It determines the brightness of the image through a window, closed by a yellow filter, facing the camera space. The correct exposure is automatically adjusted in accordance with the reaction of the photocell by an electronic control device located partly in the Photo Head beside the photocell, and partly in the interior of the base.

A prerequisite, naturally, is correct adjustment of the automatic device to the sensitivity of the film material employed. The procedure is described on page 58 and carried out with the aid of knob (B 6) having a scale for 8 sensitivity steps.

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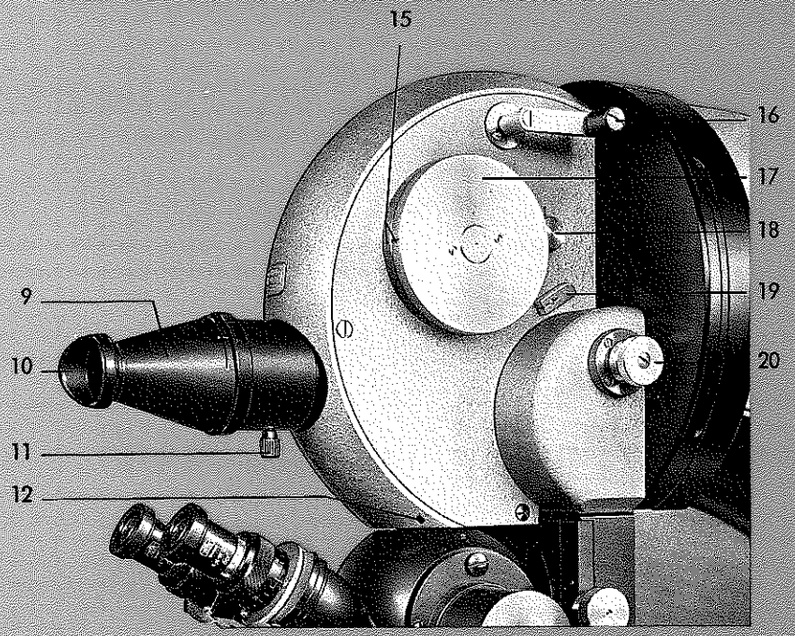



C



## 35 mm. Photo Head

1 Knob for mechanical shutter release
The shutter stays open as long as the knob is depressed; in that position it can be locked by giving it a half turn. The shutter remains open until the lock is released.

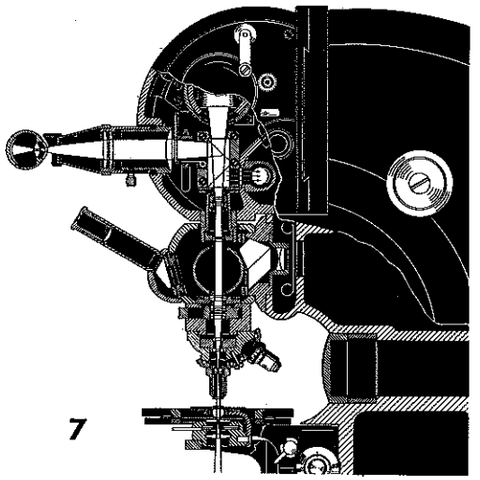
2 Base plate

3 Knob for adjusting the shutter speed. It is set on "B" for automatic exposures. To change the setting, the knob is pulled out to a stop and turned until the desired shutter speed lies beside the mark into which the knob snaps upon release

4 Knob for changing between clear disk with cross lines and ground-glass disk

5 Dry cartridge with silica gel

6 Synchronizing contact for flash exposures



7

7 Centering screw for projective (should **not** be manipulated by the user)

8 Projective

9 Light-excluding sleeve in front of the focusing eyepiece

10 Eyecup

11 Screw for clamping the focusing eyepiece (C 14) in the correct position for the observer's eye

12 Same as (C 7)

13 Housing

14 Focusing eyepiece without light-excluding sleeve. The eyepiece has a very high exit pupil in order to facilitate observation when passing from observation through the binocular tube. The light-excluding sleeve (C 9) should be attached if difficulty is experienced in locating the exit pupil.

15 **Green** marks on cassette and ring, to lie opposite one another when inserting the cassette

16 Handle for the film winding mechanism

17 Cassette

18 Film counting device. After inserting the cassette, set the number disk on 35 and make two blank exposures by pressing knob (A 14) or (C 1)

19 Lever for opening the light-excluding flap installed in the observation eyepiece for the purpose of preventing the entrance of stray light, during an exposure, through the eyepiece. It is opened if long exposures require checking of the focus. As far as possible this should be done with attached light-excluding sleeve

20 Selector knob for sensitivity of the film material

## C 35 mm. Photo Head

ULTRAPHOT II is designed primarily for photography with relatively large film sizes. However, frequently it is desirable also to use 35 mm. film. This can be accomplished by means of the well-known Attachment Camera equipped for the use of 35 mm. film. After releasing screw (E 13), the cover (E 12) can be removed from the Tube Head (E 1). A vertical tube is inserted in its place, carrying in its lower end lens 47 30 94. An Attachment Camera is mounted on the tube, and photographs can be taken on 35 mm. film as with any compound microscope. Directions are given in the instructions for the Attachment Camera (G 40–415).

Table 2
**Magnification with the 35 mm. Photo Head**

| Objective | Projective 3.2× with **OPTOVAR** in position | | |
|---|---|---|---|
| | **1.25×** total factor 4× | **1.6×** total factor 5× | **2×** total factor 6.3× |
| 1 | 4× | 5 × | 6.3× |
| 2.5 | 10× | 12.5× | 16 × |
| 4 | 16× | 20 × | 25 × |
| 6.3 | 25× | 32 × | 40 × |
| 10 | 40× | 50 × | 63 × |
| 16 | 63× | 80 × | 100 × |
| 25 | 100× | 125 × | 160 × |
| 40 | 160× | 200 × | 250 × |
| 63 | 250× | 320 × | 400 × |
| 100 | 400× | 500 × | 630 × |



The requirements for 35 mm. photomicrography are met in a more complete manner by the 35 mm. Photo Head (Fig. 6). It is equipped with automatic exposure device and automatic film advance. This instrument is mounted in place of the 9×12 cm. (4×5") Photo Head on the carrier of ULTRAPHOT II. Before doing so, the cover (E 12) is removed from the Tube Head (E 1). The Projective (C 8), attached in a centering mount at the lower end of the 35 mm. Photo Head, extends into the opening of the Tube Head.

The intermediate (air) image formed by the combination of microscope objective and OPTOVAR is projected by the Projective on the film at a further magnification of 3.2×. The total magnifications obtained with the various combinations are shown in table 2.

Switch on the photoelectric cell diaphragm by setting the ring around the drying cartridge (C 5) to position "1" which should usually remain switched in at position "2". Only if calibration photographs show that the change of the exposure obtainable with the selector switch (C 20) is too coarse by the factor 2, intermediate steps are possible by switching to **position "1".** This may occasionally be desirable for colour photographs. With the selector switch (C 20) in the same position **the exposure time will be increased by the factor 1.5 approx.**

The 35 mm. Photo Head can be used only in conjunction with the Tube Head (E 1). It cannot be used with the Luminar Head (F 1) for taking low-power photographs.

A beam-splitting system (Fig. 7) is mounted above the Projective (C 8). It sends approximately 1/3 of the light to the film, 1/3 to the photocell, and the remainder to the focusing disk. The focusing eyepiece (C 14) serves for observation of the focusing disk at an increased magnification. Before its use, after loosening screw (C 11), the focus of the eyepiece is first adjusted so that the plane of the disk appears sharp to the eye of the observer. The exit pupil lies very high, so that it is possible to easily pass from observation through the inclined binocular tube of the microscope to focusing of the image in the focusing eyepiece. If there is difficulty in locating the exit pupil, the light-excluding sleeve (C 9) should be attached. A clear-glass and a ground-glass disk are provided for focusing. One or the other is brought into the path of rays by moving knob (C 4) up and down.

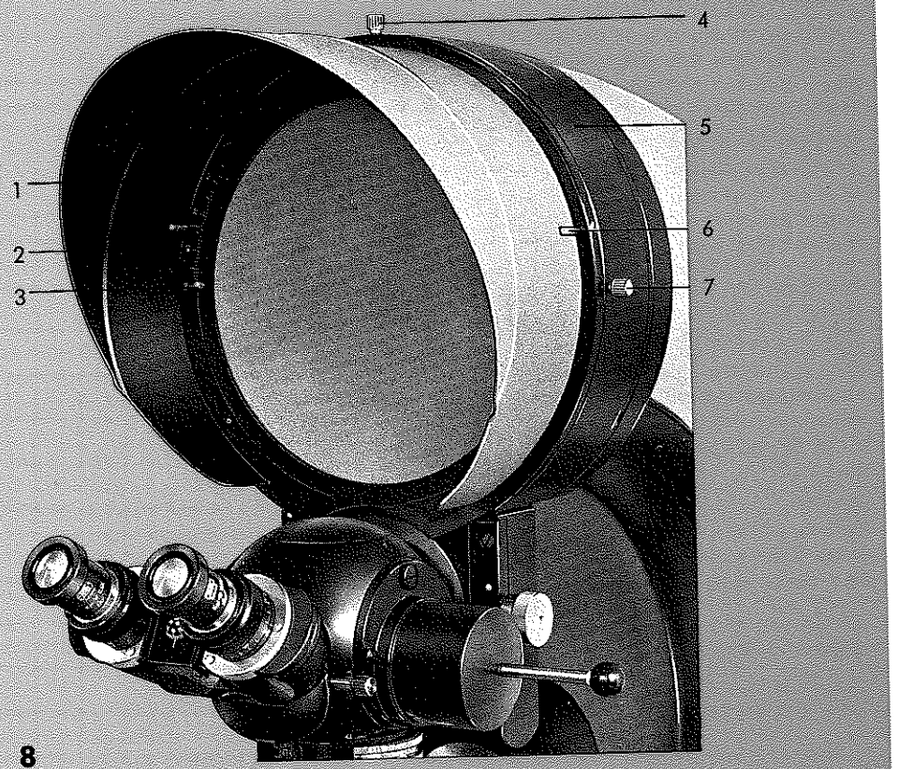
The film is contained in a drum-shaped cassette (C 17) and introduced into the housing of the 35 mm. Photo Head so that the **green** line on the knurled ring of the cassette lies beside the **green** mark (C 15). By turning right to a stop the cassette is locked in position, opened, and coupled with the mechanism for automatic film advance. Lever (C 16) serves for winding the spring of this mechanism.

A focal-plane shutter is employed. Shutter speeds for mechanical release are adjusted with knob (C 3). To change the speed, the knob is pulled out to a stop, turned until the desired number lies beside the fixed mark, and then allowed to snap in.

For hand operation the shutter is released either by pressing the white knob (A 14) on the base of the instrument or knob (C 1) of the camera. For time exposures the shutter is set on B, for instantaneous shots on the time selected (10 = 1/10 sec., 25 = 1/25 sec., 50 = 1/50 sec., 100 = 1/100 sec.).

If 35 mm. photomicrographs are to be made with automatic control of exposure, shutter knob (C 3) is set on B and selector knob (C 20) on the film sensitivity. Correct adjustment of the selector knob cannot be made on the basis of the film sensitivity supplied by the manufacturer. Instead, before beginning work with the apparatus, it is necessary to make a series of test exposures (page 58) on the film which is to be employed.

D




8

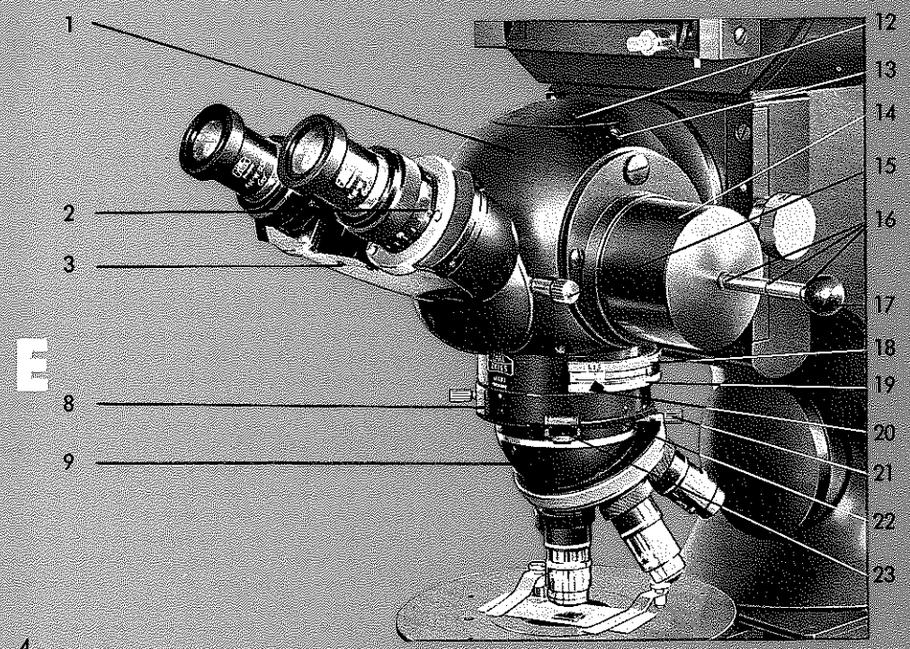
1 Hood
2 Scale for reading the angle of rotation
3 Handle for rotating the projection screen
4 Clamping screw for the projection screen
5 Housing
6 Fastening pin for the hood
7 Clamping screw for fastening the projection screen to the housing

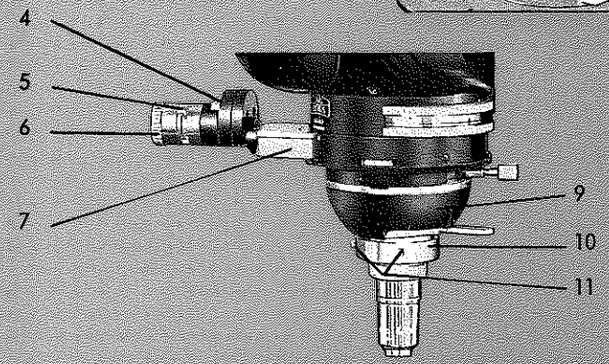
## Projection Head

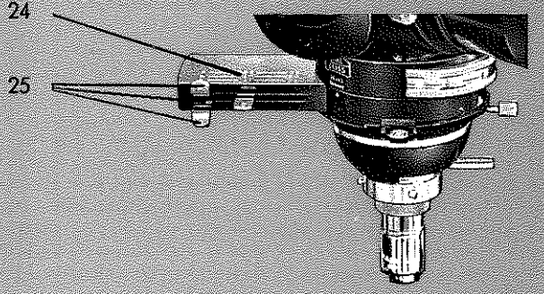
The Projection Head consists essentially of a housing (D 5) which serves as holder for a projection screen. This rests in a rotating mount having a scale on its periphery (D 2). If angles are to be measured with the device, it is a simple matter for the user to draw suitable lines on the projection screen with a sharp hard lead pencil.

The size of the image on the projection screen, having a diameter of 190 mm., is the same as on the focusing screen (B 7) of the 9×12 cm. Photo Head. Hence the magnifications given in table 1 (page 6), 11 (page 67), and 12 (page 75) also apply to the Projection Head.

To calculate the diameter of the maximum object area which can be imaged at a given magnification on the projection screen, it is necessary only to divide its diameter of 190 mm. by the magnification.




9



## Tube Head

1 Spherical housing
2 Scale on the eyepiece sleeve for correction of the tube length after adjustment of the interpupillary distance
3 Inclined binocular tube
4 Revolution counter on the analyzer slide
5 Clamp
6 Knob with scale for rotation of the analyzer
7 Analyzer slide
8 Closing piece of the slot for the analyzer slide
9 Objective changers; above: revolving nosepiece, below: holder for single objectives on centering change ring (E 10)
10 Centering change ring for single objectives, recommended if more than five objectives are used
11 Centering screws with the two accompanying watch keys
12 Cover
13 Clamping screw of the cover
14 Cylindrical guide tube for the beam-splitting slide
15 Clamp for the tube (E 3)
16 Colored ring marks for position of the beam-splitting slide (Table 4, page 22)
17 Rod with spherical knob for shifting the beam-splitting slide
18 Milled ring for switching the OPTOVAR systems (Table 3, page 20)
19 Milled ring for focusing the auxiliary microscope
20 Marking points
21 Clamping screw of the objective changer
22 Closing piece for the opening for insertion of compensators
23 Opening for insertion of compensators
24 Barrier-filter inset
25 Handles for switching the barrier filters in and out

## E Tube Head

All imaging parts of the Microscope are assembled in or attached to the Tube Head. It constitutes the Microscope in the stricter sense.

The housing (E 1) of this Tube Head is of spherical shape. It is connected to the carrier by means of a quick-change device in form of a plate bevelled at its sides like a dovetail (page 50). Suitable cutouts of the bevelled sides permit it to be easily hooked into the carrier, where it is clamped in position with clamping screw (A 7).

The spherical housing continues below in a cylindrical attachment in which the magnification changer OPTOVAR (E 18) is installed. It contains systems supplying magnifications of 1.25×, 1.6×, 2×, and also a system "Ph" for observing the exit pupil of the objective.

Table 3
**Magnifications when observing with eyepiece 8×**

| Objective | OPTOVAR | | |
|---|---|---|---|
| | **1.25** total factor 10× | **1.6** total factor 12.5× | **2** total factor 16× |
| | Red marking points (E 20) | | |
| | • | •• | ••• |
| 1 | 10× | 12.5× | 16× |
| 2.5 | 25× | 32 × | 40× |
| 4 | 40× | 50 × | 63× |
| 6.3 | 63× | 80 × | 100× |
| 10 | 100× | 125 × | 160× |
| 16 | 160× | 200 × | 250× |
| 25 | 250× | 320 × | 400× |
| 40 | 400× | 500 × | 630× |
| 63 | 630× | 800 × | 1000× |
| 100 | 1000× | 1250 × | 1600× |

Only the eyepieces supplied by us for this instrument are used for observation:

Kpl eyepiece 8× Cat. No. 46 39 20
and
Kpl eyepiece 8× for eyeglass wearers Cat. No. 46 39 22
Each has a field of view number of 18



The systems are successively brought into the path of rays by turning the upper knurled ring (E 18). System "Ph" is required for phase contrast and for microscopy with polarized light. The phase rings in the objectives are focused by turning the lower knurled ring (E 19).

Table 3 presents the magnifications obtainable in observations with our objectives in combination with eyepiece 8×.

An analyzer for microscopy in polarized light can be inserted (page 89) in an opening in the Tube Head which normally is occupied by a closing piece (E 8).

Below and at right angles to the opening (E 8) for the analyzer slide is a slot (E 23) for insertion of a quartz plate, a quartz wedge, or other compensators. The slot should always be kept closed, in instruments with serial numbers up to 55015 by means of the ring (E 22), in more recent instruments with a closing piece.

In fluorescence microscopy the same slot (E 23) also serves for insertion of barrier filters mounted on suitable sliders. Recently a "barrier filter inset" (E 24) was made available which permits convenient exchange and combination of different barrier filters. It contains three sliders, which are switched in and out by means of handles (E 25). Each slider has two barrier filters and one clear opening. This device can be used on ULTRAPHOT II having serial numbers beginning with 55 016 (excepting 6-place numbers).

The lower end of the cylindrical attachment to the Tube Head is developed as a changing device for objective holders (E 9). In instruments up to serial number 55 015 it is a ring dovetail with three-point contact; in instruments of higher serial number a dovetail slide.

The objective holder usally is a ball-bearing revolving nosepiece for five objectives. If a larger number of objectives is in frequent use, or if the objectives are to be individually centered, special holders are preferable which accommodate a single objective screwed into a centering change ring (E 10).

In Tube Heads of recent construction the revolving nosepiece is inserted from left rear to right front into the dovetail slide of the Tube Head. Holders for individual objectives and for the vertical illuminator are inserted from right front to left rear. The inserted holder must have good contact with the stop and be secured with knurled screw (E 21).

Inclined binocular tube (E 3) serves for visual observation. It is fastened with knurled screw (E 15). The interpupillary distance is adjusted by moving the eyepiece sleeves (E 2).

After adjusting the interpupillary distance and reading off its value, the eyepiece sleeves are screwed out to the extent that the reading on their scales agrees with the interpupillary distance. Failure to do so impairs parfocality of the objectives on the revolving nosepiece.

A slide carrying the beam-splitting system travels in the horizontal guide tube (E 14) of the Tube Head. With the rod (E 17) it can be arrested in four positions marked by catches. Each position of the reflecting system is indicated by

one of four colored rings on the rod. Table 4 gives a survey of the different functions.

The beam deflected to the camera in position II or III first traverses an additional prism system which raises the optical axis of the Microscope to the height of the optical axis of the camera passing through the counter of the spherical housing (E 1). Directly behind this prism is the Projective. It is a negative system with image-flattening effect. Its exchange is unnecessary. The required variation of magnification (Table 1, page 6) is effected with the OPTOVAR (E 18) and through appropriate adjustment of the camera length. The focal-plane shutter of the camera lies close behind the Projective.

For attaching the Tube Head see page 50.

Table 4
**Beam-splitting slide** (E 17)

| Position | I | II | III | IV |
|---|---|---|---|---|
| Ring color | White | Red | Black | Colorless |
| Function | The total light flux is conducted into the observation tube for visual observation. This is especially important for the examination of images having low brightness (dark field or fluorescence microscopy). | About 1/3 of the light flux serves for observation, the other 2/3 are conducted to the photographic emulsion in the camera. The preferred position for photomicrography (this position is shown in Fig. 2 and 3). | The total light flux is directed into the camera. Thereby the exposure time is greatly reduced if images of low brightness have to be photographed. | The total light flux passes through the Tube Head without deflection. After removing cover (E 12) the image can be received in the 35 mm. Photo Head or in a tube inserted for projection instead of the Photo Head. |

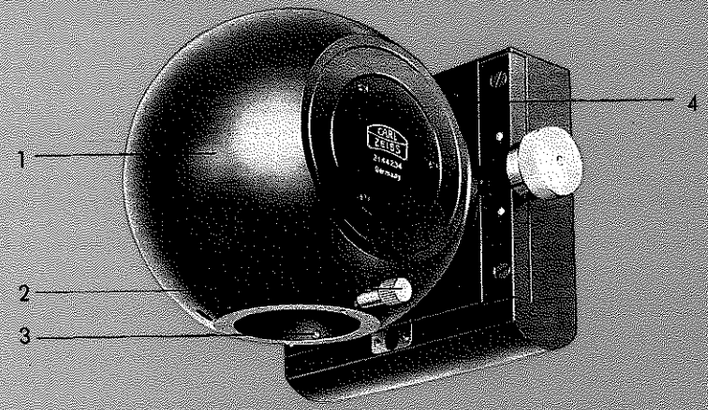


## F Luminar Head and Accessories

The size of the openings in the Tube Head does not suffice for low-power photographs with LUMINARS (Simple Microscope). Therefore a special Luminar Head (F 1) must be used for this purpose. It contains two front-surface mirrors, the changing device (F 4) for attaching the Head to the carrier, and on the lower side a three-point changer (F 3) for attaching the LUMINARS.

LUMINAR 2.5–5 (F 41) and the LUMINAR with a focal length of f = 100 mm. (F 31) are attached with their dovetails directly to the Luminar Head. For the others, due to their great differences in focal length, it is necessary to interpose holders differing in height, namely

a low holder 47 25 52 (F 21) for LUMINAR f = 63 mm. (F 22), and
a high holder 47 25 51 (F 11) for LUMINAR f = 16, 25, and 40 mm. (F 12).




F

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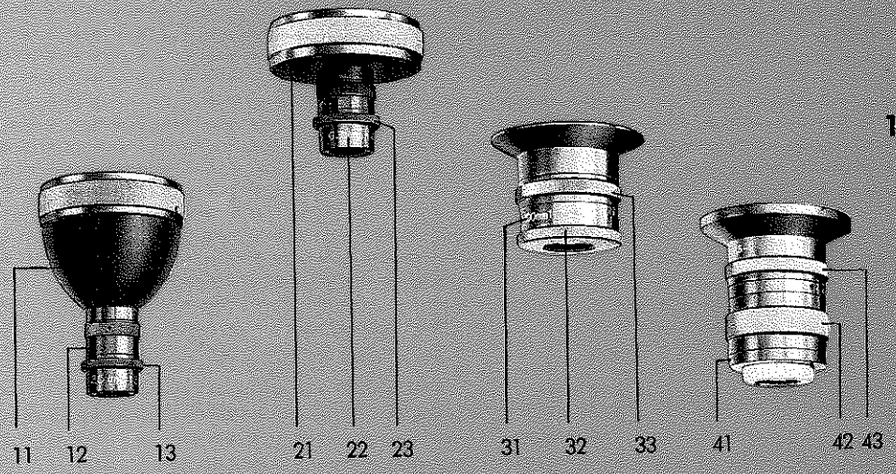


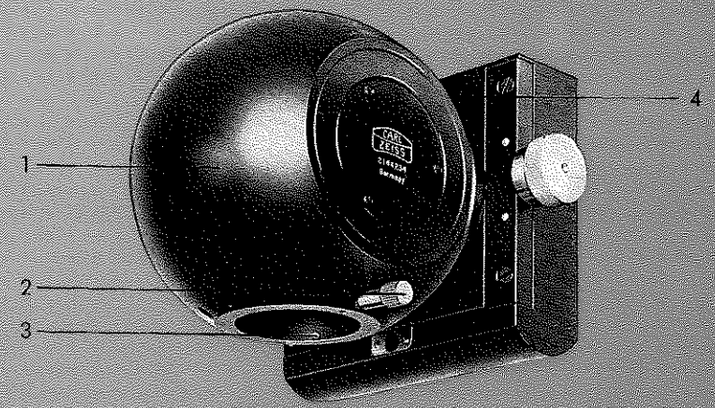

## Luminar Head

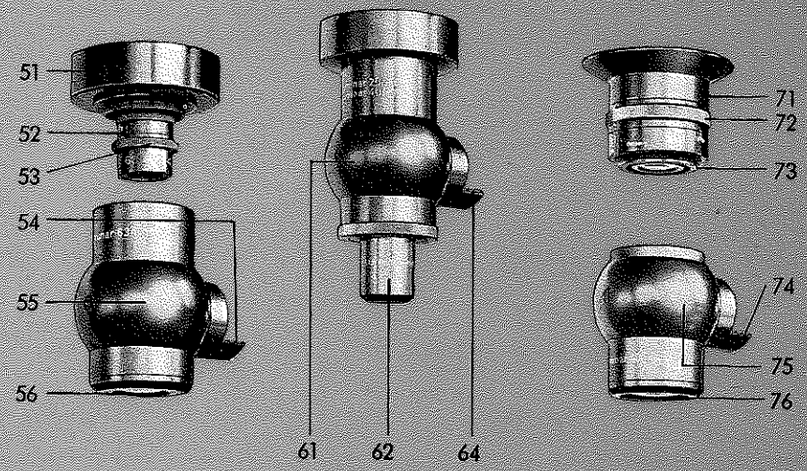
1 Luminar Head
2 Clamping screw
3 Contact points for ring dovetail of the Luminar holder
4 Changing device for attaching the Luminar Head to the carrier

11 Luminar holder for LUMINARS 16, 25, and 40 mm.
12 LUMINAR
13 Knurled ring for operating the iris diaphragm

21 Luminar holder for LUMINAR 63 mm.
22 LUMINAR 63 mm.
23 Knurled ring for operating the iris diaphragm
31 LUMINAR 100 mm.
32 Cap ring covering the thread for attachment of the survey illuminator (F 75)
33 Knurled ring for operating the iris diaphragm
41 LUMINAR 2.5–5
42 Knurled ring for focusing the image
43 Knurled ring for operating the iris diaphragm



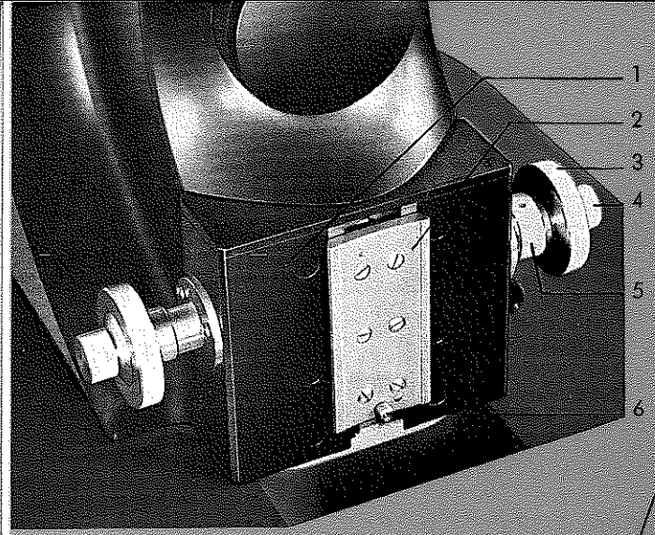


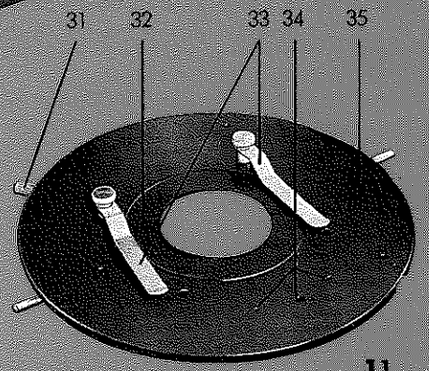

51 Holder for survey illuminator for LUMINAR 63 mm.
52 LUMINAR 63 mm; corresponds to (F 22)
53 Knurled ring for operating the iris diaphragm **(here basically to be set on scale line 2)**
54 Filter holder
55 Survey illuminator for LUMINAR 63 mm.
56 Field lens

61 Survey illuminator for Epi-LUMINARS 20, 25, and 40 mm.
62 Epi-LUMINAR 40 mm.
64 Filter holder

71 LUMINAR 100 mm; corresponds to (F 31)
72 Knurled ring for operating the iris diaphragm; corresponds to (F 33) **(here basically to be set on scale line 2)**
73 The thread for attaching the survey illuminator (F 75) is exposed after unscrewing the cap ring (F 32)
74 Filter holder
75 Survey illuminator for LUMINAR 100 mm.
76 Field lens



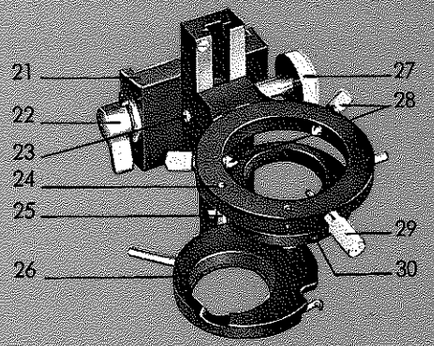

G




11


**Pinion Box**

1 Housing
2 Clamping plate to which stage and condenser carriers are fastened
3 Coarse adjustment knob
4 Fine adjustment knob
5 Brake for coarse adjustment
6 Stop for condenser carrier




**Stage carrier with centering piece**

11 Stage carrier
12 Centering screws for centering the stage
13 Clamping lever for clamping the stage carrier to the clamping strip (G 2)
14 Centering piece
15 Spring bolt

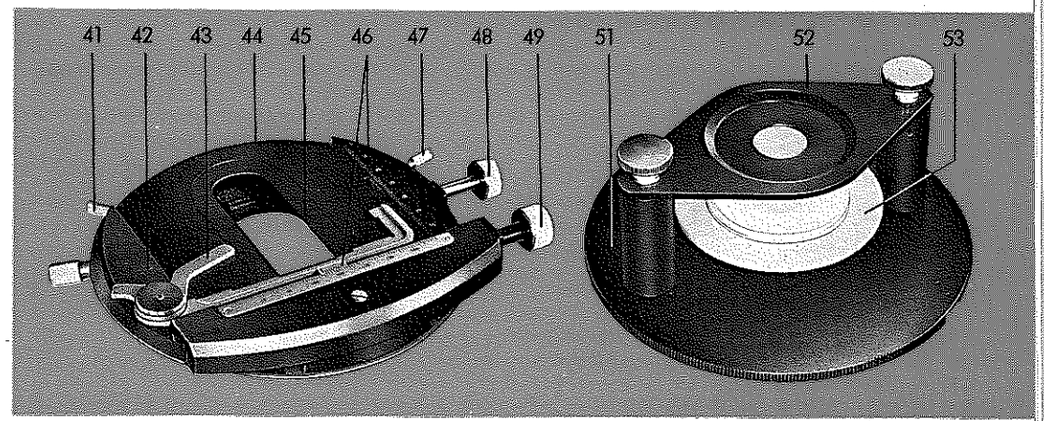


**Condenser carrier with rack and pinion**

21 Attachment piece with dovetail slide
22 Lever for clamping the condenser carrier to the clamping plate (G 2)
23 Screw for regulating the tension of the pinion movement
24 Condenser carrier

**Circular rotating and centering mechanical stage**

41 Screw for clamping stage rotation
42 Circular rotating and centering mechanical stage
43 Microscope slide holder
44 Stage plate, moved by knob (G 49)
45 Inset diaphragm




25 Stop for the filter holders
26 Filter holders, swung out
27 Pinion head for height adjustment of the condenser
28 Centering screws for centering the condenser
29 Spring bolt
30 Filter holder, swung in

**Rotating and centering gliding stage**

31 Screw for clamping stage rotation
32 Inset diaphragm
33 Stage clips
34 Holes for attaching a mechanical stage
35 Stage plate, movable directly by hand in a horizontal plane

46 Verniers
47 Knob for regulating the stiffness of the forward-backward movement
48 Pinion head for moving the microscope slide forward-backward
49 Pinion head for moving the microscope slide right-left

**Stage for polished specimens**

51 Stage plate, movable by hand in a horizontal plane
52 Bridge; after releasing the two screws it can be exchanged for another having a different opening
53 Plate with foam-plastic cushion as rest for the polished specimen. Is pressed by a spring against bridge (G 52)

## G Stage Ensemble

The stage ensemble consists of a pinion box (G 1–6), firmly connected with the lower part of the carrier, to which are attached the stages screwed to stage carriers (G 11) as well as the condenser carrier (G 24) for work with transmitted light.

### The Pinion Box

The pinion box contains a coarse and a fine adjustment. The two pinion axes are coaxial and operated by two pairs of knobs (G 3 and 4), a pair on each side of the box. On the coarse adjustment a brake (G 5), for regulating the stiffness of movement, is mounted near the right end of the axis. Turning the knurled ring (G 5) in direction of the arrow gradually tightens the movement. The brake should not be drawn up too tightly. Complete immobilization of the axis is impossible.

The coarse adjustment acts on a dovetail, located on the front side of the pinion box. The dovetail is rigidly connected with clamping strip (G 2). Stage and condenser carriers are readily attached to and detached from it (page 46).

The fine adjustment runs on roller bearings which have many advantages over ball bearings. It moves the entire pinion box up and down by about 2 mm. The range of movement is indicated by two white lines on the right side of the pinion box. The index line on the carrier should always lie approximately midway between these two lines.

An interval of the scale on the fine adjustment corresponds to about a 2 μ (= 0.002 mm.) movement in height of the specimen.

Stiffness of the fine adjustment can be regulated in instruments having serial numbers beginning with 55 042. If the stage sinks and the specimen goes out of focus, it only is necessary to slightly turn the right-hand fine adjustment knob (G 4) clockwise while holding the left-hand one stationary.



### The Stages

Any of our stages for the large Microscope models can be mounted on the stage carrier (G 11). For ULTRAPHOT II we supply above all the rotating gliding stage (G 35) or the circular rotating and centering mechanical stage (G 42). A rotating stage is always recommendable, because a specimen mounted on it can be suitably oriented in the photograph.

The large rotating polarizing stage is employed if the ULTRAPHOT II serves as Polarizing Microscope (page 92). It is screwed firmly to the stage carrier and is adjusted at the factory so that its axis of rotation coincides exactly with the optical axis of the Microscope. A special rotating centering gliding stage (G 51) is provided for the examination of polished specimens. With its aid the specimen is easily oriented.

All of the rotating stages run on ball bearings. The circular mechanical stage (G 42), the gliding stage (G 35), and the special stage for polished specimens (G 51) are inserted in a centering piece (G 14) screwed to the stage carrier. Two centering screws (G 12) operating against the pressure of a spring bolt (G 15) provide for moving the stage by 2 mm. in all directions from its central position. The axis of rotation of the stage can be brought into the center of the image at any time.

See page 49 for centering of the stages.

**The gliding stage** has a base plate (page 48) which is mounted rotatably in the centering ring. The rotation can be clamped with screw (G 31). The stage plate (G 35) is connected with the base plate by a thin film of grease. It is moved in two coordinates over the base plate with the aid of a guide frame and screwed against rotation. Stop screws limit the range of movement. It amounts to 12.5 mm. in all directions from the central position.

The stage should be greased about every six months to retain its smooth functioning. Suitable grease (Cat. No. 47 33 91) accompanies every stage.

See page 48 for greasing of the stage.

**The circular rotating and centering mechanical stage** rotates, like the gliding stage, on two ball bearings within the centering ring. The centering ring fits into the centering piece (G 14). The rotation can be clamped with screw (G 41). The microscope slide is fastened in a holder (G 43) which is moved transversely by a spindle ending in knob (G 49). Knob (G 48) serves for the forward-backward movement. To prevent unintentional forward-backward movement of the slide while carrying out a transverse movement, the former must have adequate tension. It can be regulated with screw (G 47). The adjustment is approximately correct if the movable plate (G 44) no longer sinks of its own weight while the

stage is held in a vertical position with the slide holder horizontal.

Brake screw (G 47) is n o t a clamping screw. It must not be drawn up too tight, since that would only destroy the mechanism but never completely clamp the stage plate.

The stage is provided with two scales and verniers which can be read to 1/10 mm. These serve for quickly relocating a specific spot on a microscope slide. A presupposition for this is that the stage is centered, i. e. that its axis of rotation coincides with the optical axis of the Microscope, and that in each case the slide sits squarely in its holder. If a spot is encountered on the slide which later is again to be found, the coordinates of this spot are read on the two scales and recorded, e. g. 15.7 and 118.4. The recorded spot will subsequently again be in the field of view of the Microscope if the slide is mounted as before on the same (centered) stage and the coordinates are adjusted to the recorded values.

As is customary in searching a slide, it is advantageous also here to employ a low-power objective, since precision of the scale readings is limited.

**The stage for polished specimens** (G 51) – like gliding stage (G 35) – is provided with a stage plate which glides, with interposition of a film of grease, on a rotatable base plate seated in a centering piece (page 74).

## The Condenser Carrier

This part is so constructed that the receptacle for the condensers at the same time acts as centering device with two centering screws (G 28) and a counterspring (G 29). The condensers are precisely adjusted in height with a rack and pinion movement operated by knob (G 27). The stiffness of this movement can likewise be regulated. For this purpose screw (G 23) is gently turned back and forth until the desired stiffness is obtained. Turning clockwise increases the stiffness, couterclockwise decreases it.

Two swing-out filter holders (G 26 and 30) are mounted below the condenser receptacle.



# The Illuminating Apparatus

## Path of rays (Fig. 2 and 3)

With the exception of the illuminators themselves, the illuminating apparatus is acommodated in the lower half of the instrument. It is so designed that any of the three illuminators simultaneously mounted on the instrument can be used for illumination with transmitted or incident light. A mirror rotatable about a vertical axis located at the intersection of the optical axes of the three illuminators serves for directing the emitted light rays in the desired direction. The mirror is adjusted with the setting knob (A 19) located closely above the right illuminator. The correct position in each case is marked by click stops and numbers (see table 5).

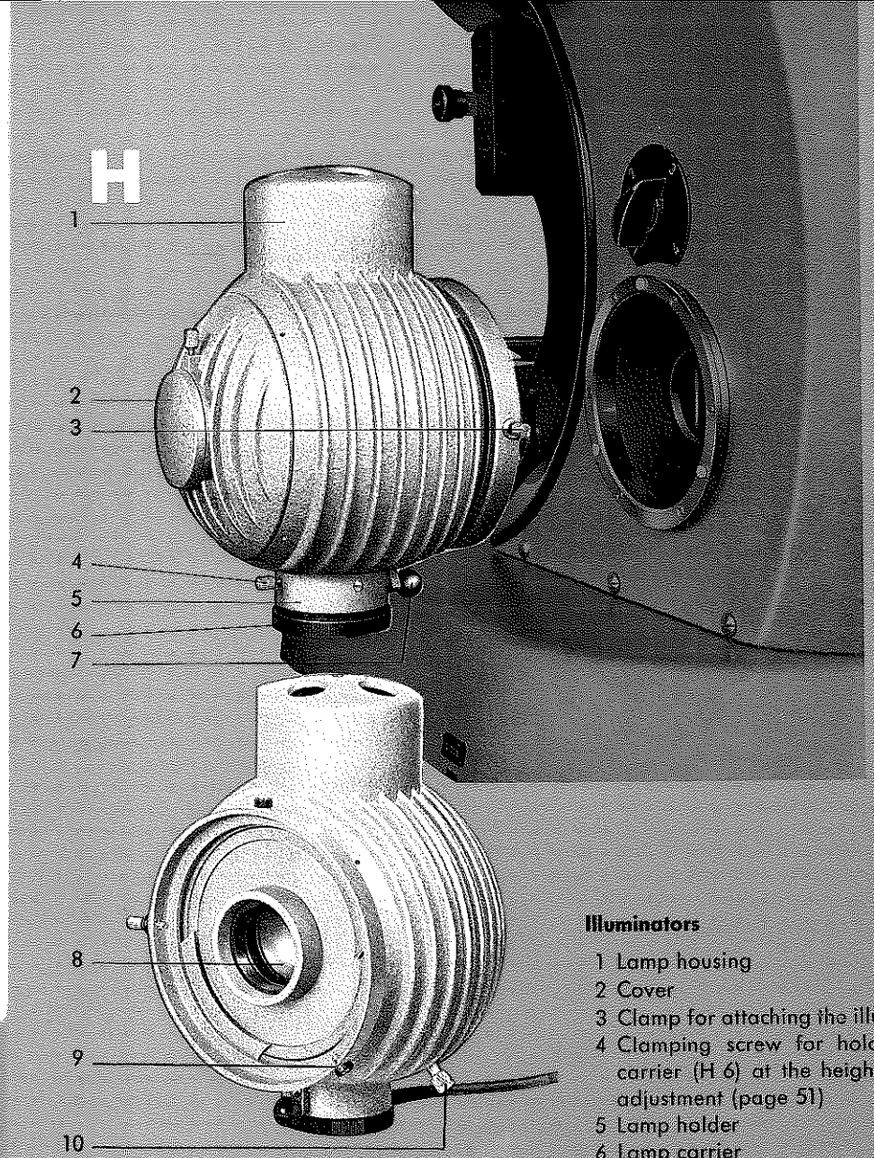
The mirror reflects the light on both sides. Therefore one of the lateral illuminators can be used for transillumination at the same time that the other serves for epi-illumination.

In the position for transillumination the light rays (Fig. 2) are conducted downwards into the base of the instrument and then into the illuminating apparatus of the Microscope by means of two additional, permanently adjusted mirrors. In addition, the base of the instrument contains a diaphragm which is operated from the outside by means of a knurled disk (A 24), a fixed auxiliary lens, and an auxiliary lens which can be swung in and out. The latter is swung out when working with the Compound Microscope (lever [A 23] on "Micro"). In this case the diaphragm regulates the size of the **luminous field.** The auxiliary lens is swung in for the illumination of large object fields in taking low-power photographs with LUMINARS (lever [A 23] on "Luminar"). In that case the fixed auxiliary lens acts as a long-focus condenser, the collector opening on the illuminator as non-variable luminous-field diaphragm, and the diaphragm (A 24) as **aperture** diaphragm. Diaphragms under the specimen are used (table 10, page 66) instead of an additional luminous-field diaphragm in front of the collector opening, which would lend itself to operating mistakes.

In the position for vertical-illumination (Fig. 3) the light rays are deflected upwards and enter the "illumination tube for incident light" by means of a fixed mirror. Besides auxiliary lenses this tube contains the centering aperture diaphragm for incident light (Fig. 64, page 97).

Table 5
**Setting Knob for rotatable mirror to establish mode of illumination** (A 19)

| Position for | Right illuminator | Rear illuminator | Left illuminator |
|---|---|---|---|
| Transillumination | 4 | 1 | 2 |
| Vertical illumination | 2 | 3 | 4 |




**Illuminators**

1 Lamp housing
2 Cover
3 Clamp for attaching the illuminator
4 Clamping screw for holding the lamp carrier (H 6) at the height found during adjustment (page 51)
5 Lamp holder
6 Lamp carrier
7 Knob for swinging the diffusion disk in and out
8 Collector
9 Three-point attachment for mounting the lamp housing
10 Screw for lateral adjustment of the light source



Table 6
**Light Sources and their Characteristics**

| Light source | Cat. No. of spare bulb | Voltage Volts | Current Amp. | Power consumption Watt | Luminous density Stilb | Color temperature °K | Luminous area mm. |
|---|---|---|---|---|---|---|---|
| Low-voltage filament bulb | 38 02 15 | 12 | 8 | 100 | 1500 | 3150 | 4×3.7 |
| Carbon arc lamp | Carbons see Table 7 | ~ | 10 | | 8000 | 4000 | 4 ϕ |
| | | = | 6 | | 16000 | | |
| High-pressure mercury lamp HBO 200 | 39 16 03 | ~53$^{+4*}_{-3}$) | 3.4–4.4 | 200 | 25000 | | 2.5×1.3 |
| | | =61 ± 4*) | 3.1–4.0 | | | | |

*) Exceeding these tolerances considerably shortens the life.

## Illuminators

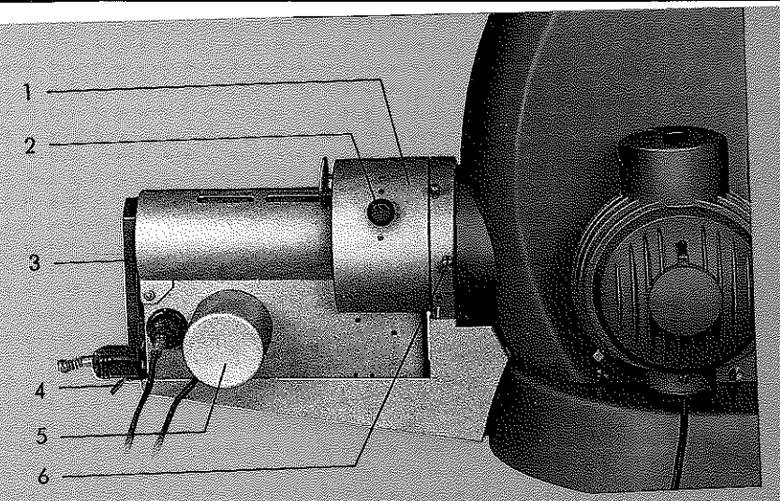
The following light sources are available for use on the ULTRAPHOT II:
A low-voltage filament bulb 12 V, 8 A,
a high-pressure mercury lamp HBO 200,
a high-pressure xenon lamp XBO 162 (in preparation), and
a microscope carbon arc lamp.

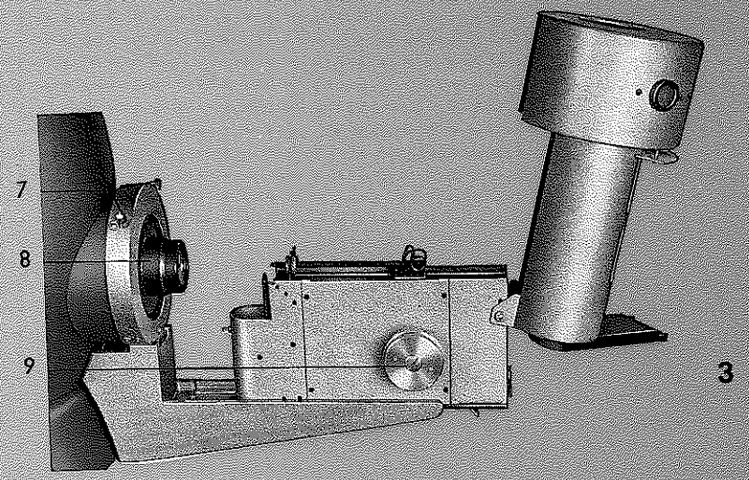
The low-voltage filament bulb and high-pressure mercury lamp are used most frequently. The pertinent data concerning these light sources are assembled in Table 6.
The low-voltage bulb as well as the mercury and xenon lamps are each held in a special socket which is installed in a lamp carrier (H 6). Every lamp carrier can be used in the lamp housing (H 1). It is inserted from below into the lamp holder (H 5); in so doing a slot provides for correct orientation. At the correct height the lamp carrier is clamped with screw (H 4).

The adjusting screw (H 10) beside the lamp holder serves for lateral displacing of the light source, in addition it can be adjusted in height by moving up and down in the holder (adjustment, page 51).

A diffusing disk is installed in the lamp housing (H 1). It is swung in front of the light cource by knob (H 7). A three-point attachment (H 9), for mounting the lamp housing on one of the ring dovetails (A 20–21) of the stand, is arranged centrally about the two-lens collector (aperture 0.62) (H 8).

If only one illuminator is used, it may be attached optionally to any of the three ring dovetails. If two illuminators are used, it is appropriate to mount them right and left. The illuminator which creates the greatest amount of heat, e. g. an HBO 200, belongs on the left-hand side.




3

## Carbon Arc Lamp

1 Cover

2 Ground-glass disk for observing the arc

3 Handle, to prevent swinging back the cover as long as the lamp is connected to the power supply

4 Spring catch; after depressing it the lamp housing can be pulled out backwards. A space of at least 60 cm. behind the work table is required for manipulation of the arc lamp

5 Housing of the servo-motor for the carbons

6 Clamping screw for holding the arc lamp on the ring dovetail (A 20)

7 Centering screws for the collector (K 8)

8 Collector for the arc lamp. Behind it lies the cooling cell which is filled with distilled water. Its window can be removed for cleaning the cell

9 Knobs for adjusting the position of the carbons at the arc gap



## Halide-metal CSI 250 W Lamp

This mercury lamp with additions of metal iodide has high efficiency in the longer wavelength region and an attenuating effect in the blue range. This lamp radiates white light which is appropriate for color photomicrography and polarized-light microscopy. Due to its large, homogeneous radiant area and its high luminance, this source is particularly well suited for all types of microscopic work requiring intense light. It is used for photomicrography, for projecting microscopic specimens, for work with heavily stained specimens and illumination methods in which a large portion of the available light is absorbed.

For color photomicrography with artificial-light film, we recommend the Lifa filter R 12 (manufacturer: Lichtfilterfabrik, Augsburg; in the United States, Kodak Wratten filter).

This lamp operates only on AC. Its light flickers in rhythm with the double line frequency and is therefore not suitable for cinematography.

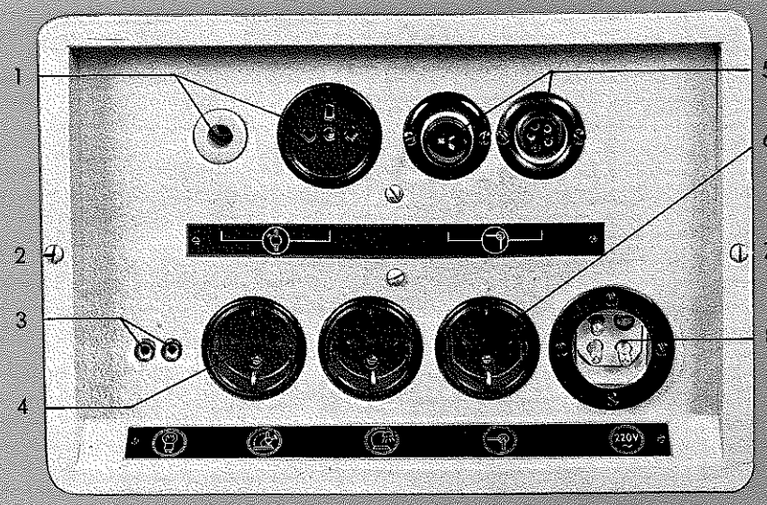
Due to its high operating pressure, this lamp must be operated only when its housing is closed.

**To start** the lamp, depress the starting key on the choke until the ignition hum stops (approx. 4 seconds). It serves no purpose to keep the key depressed for more than 10 seconds. Hot lamps must be allowed to cool off for a short while.

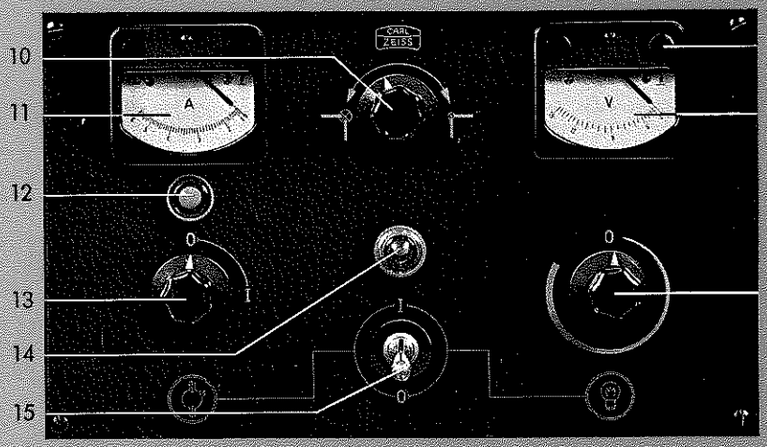
**Before the bulb is inserted** into the lamp housing, the diffusion disc should be swung out so the bulb will not hit it. This can be checked after the round cover at the back of the lamp housing has been removed. During operation, however, the cover must be firmly closed.

Table 7
**Carbon Arc Lamp**

| Supply voltage | Terminal voltage Volts | Current of the lamp Amp. | Resistor | | Carbons | | |
|---|---|---|---|---|---|---|---|
| | | | max. Ohm | Catalog No. | horizontal | vertical | Catalog No. 100 pairs |
| = 110 | 60 | 6 | 11.5 | 46 86 20 | 180×6 H | 115×6 D | 46 72 40 |
| = 125–220 | | | 35 | 46 86 25 | | | |
| ~ 110 | 50 | 10 | 9 | 46 86 21 | 180×6 D | 115×8 D | 46 72 45 |
| ~ 125–220 | | | 18 | 46 86 26 | | | |




L 14

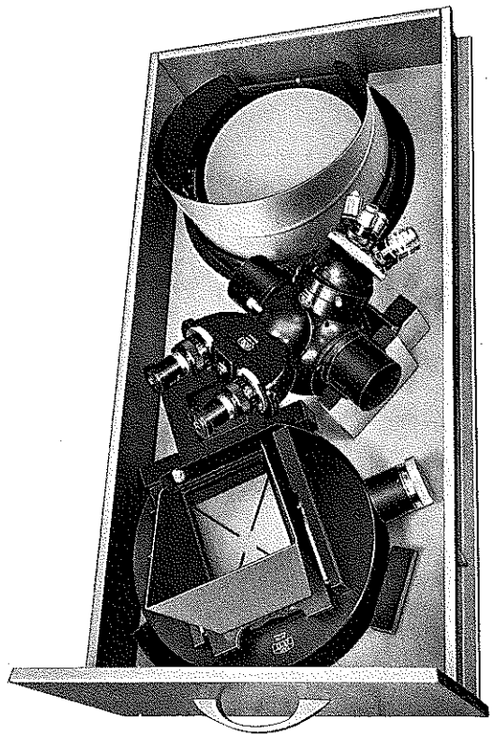





## Instrument Table

The ULTRAPHOT II is always delivered by us together with an instrument table. It resembles a desk. The table top affords sufficient work space, four drawers provide abundantly for storing the manifold accessories (Figs. 15–17, page 38). A fifth drawer, which is generally locked (by two screws in rear), contains all the required electric connecting devices with exception of the resistor or rectifier for the arc lamp. On the front panel of the drawer a voltmeter, an ammeter, switches and regulators are installed, on the rear panel the plugs for all electrical connections are located.

1 Outlets for connecting the lamp socket (H 6) of the high-pressure mercury lamp HBO 200
2 Fastening screw for drawer, same as (L 7). These screws are released if the drawer is to be pulled out, only after plug (L 8) is pulled
3 Connection for lamp socket of the low-voltage bulb 12 V
4 Socket for cable from the stand (A 16), carries 220 V AC
5 Connection for the screw plugs of the automatic carbon feed for the arc lamp
6 Connecting socket for resistor for the carbon arc lamp, or for rectifer, if it is to be connected with 220 V AC
7 Same as (L 2)
8 Socket for power-supply cable 220 V AC. The outlet must be grounded
10 Regulator for distance between carbons of the arc lamp
11 Ammeter for operation of the high-pressure mercury lamp HBO 200
12 Ignition key, to be briefly depressed if lamp HBO 200 does not ignite after switching on (L 13)
13 Closing switch for lamp HBO 200
14 Pilot lamp, indicates that switch (L 15) is on
15 Main switch
16 One of the four sockets for scale lamp 12 V 35 mA (Catalog No. 38 02 14)
17 Voltmeter for low-voltage bulb which can be operated at under-voltage, rated voltage of 12 V, or briefly at over-voltage up to 15 V
18 Switch and voltage regulator for the low-voltage bulb



**15**

**Drawer (Fig. 15)** accommodates the Projection Head (D), the Tube Head (E) with attached tube (E 3), and revolving nosepiece (E 9), as well as the 9×12 cm. (4×5") Photo Head (B).

**Drawer (Fig. 16)** accommodates the objectives, eyepieces, filters, focusing magnifier, nosepieces, and the vertical illuminator. A readily accessible compartment is reserved for 9×12 cm. (4×5") plate and film holders.

**Drawer (Fig. 17)** accommodates a stage with its carrier, the condenser carrier, as well as the accessories for low power photographs.

## Unpacking and setting up the ULTRAPHOT II

A room as quiet and free of vibrations as possible should be selected for setting up the instrument. Certain vibrations are dampened by rubber feet on the base; however, considerable expenditures would be required to eliminate all vibrations which can occur in a room subject to great vibration.

It is advantageous if the room can be darkened. At least the instrument should be so placed that the operator does not face bright surroundings and that no bright light strikes the instrument, especially the focusing screen (B 7).

First the instrument table is set up in the selected location. The drawers are tested whether they slide easily and whether their locks function smoothly. They will operate perfectly only if all drawers are properly pushed in to the stop. When unlocking with the safety key, the lock bolt automatically snaps out. Before depressing the lock bolt, care should be taken that the key does not lie in one of the drawers locked by it.

For transportation, all detachable parts excepting the Photo Head (stage on stage carrier, condenser carrier, Tube Head, and illuminators) have been removed from the metal cover (A 16) and the stand (A 18). The mirror carriage is screwed on by means of a metal angle bar (A 30) and its roller bearing disengaged by wooden wedges (A 26). Also the switching lever (A 23) is secured for transportation by a red screw. This protection, of course, must be removed.

Experience has shown that our manner of packing, wrapping in an abundance of paper and bedding in an excelsior cushion, is superior to shipment in a special packing case. Therefore the latter is not used. Before packing, all openings in the instrument are closed with their respective covers or carefully stopped with Styropor plugs. This effectively prevents entry of packing material into the interior. As a further protection against dust, the entire package is enclosed in a plastic bag. The other parts are packed in a similar manner.



**If occasion should arise to again ship the apparatus,** e. g. back to the factory for repairs, **we urgently recommend to pack it in the same manner.**

Without fail:

1. secure the mirror carriage (A 2) and the switching lever (A 23) in the same manner as we did when making shipment,
2. close all openings with the covering parts and materials originally used, which should be carefully preserved, and
3. protect the instrument with a plastic bag.

If this is not done, there may be damage during transportation and severe soiling of optical parts in the interior. Their elimination would entail considerable expense, to be met by the shipper.

The care taken in unpacking the instrument and its individual parts should be commensurate with the high value of this precision instrument. Special care should be taken not to use pinion heads and other operating elements as handles. Assembly of the apparatus should begin only after all individual parts have been unpacked and checked with the packing list.

First the base (A 22) of the instrument, carrying the stand (A 18) with attached 9×12 cm. (4×5") Photo Head (B) and the metal cover (A 16), is put in its place on the instrument table. Then the red screw holding the switching lever (A 23) and the blocks of the mirror carriage (A 26) and (A 30) are removed.

The further assembly is appropriately undertaken in the following steps which will, at the same time, familiarize the user with the various manipulations required in attaching or removing interchangeable parts:

1. After releasing lever (A 25) the Photo Head is pushed upwards and removed.
2. Disengagement wedges (A 26) and the retaining angle bar (A 30) of the mirror carriage marked with the red lacquer are removed by releasing screws (A 29 and A 31). Check whether by turning knob (A 17) the mirror carriage can be moved forwards and backwards to the stops. The movement is regulated by us so as to run rather stiff.
3. Reinstall the Photo Head.
   This is possible only if the mirror carriage (A 2) is not moved too far forwards. Correspondingly, a too far forward position of the mirror carriage also prevents removal of the Photo Head.

# Attaching the separately packed parts

## Inserting the bulbs into the lamp housings

Before attaching the lamp housing (H 1) to the metal cover (A 16) of the ULTRAPHOT II, the lamp socket (H 6) after releasing clamping screw (H 4) is pulled out of the holder (H 5).

**The low-voltage filament bulb 100 W** remains in the lamp housing for transportation. Before use, it is examined once more for cleanness. Smudges (fingerprints) are removed with a clean cloth, preferably moistened with alcohol as a solvent. Bulb and socket are then carefully reinserted into the holder (H 5). The socket can only be inserted if the longitudinal slot in its cylinder is so oriented that it can glide over the guide pin extending into the interior of the holder. Provisionally the socket (H 6) is inserted up to the stop.

**To insert a new filament bulb,** the lamp housing (H 1) is detached and the lamp socket (H 6) pulled out of its holder as described above. To remove the bulb it is held by its head, pressed into the socket, and removed from the bayonet by turning left. To insert a new bulb, the two different-sized bayonet blades must lie in the corresponding recesses of the lamp socket. The bulb is pressed in and turned right to the stop.

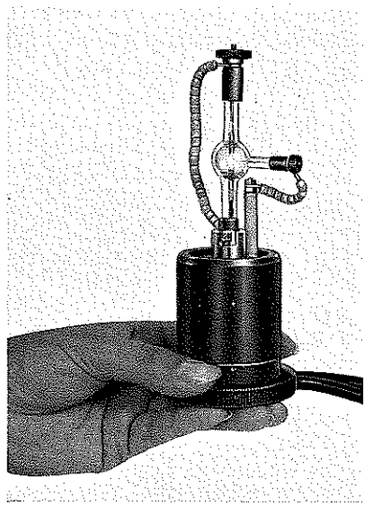
**The mercury lamp HBO** 200 is removed from the original factory-sealed package, inserted into the bayonet socket of its carrier, and connected by the two free ends of the feed wires (Fig. 18). In these manipulations care is required not to break the lamp. Before insertion into the lamp housing, this lamp also is to be carefully freed from any grease and other traces of smudge. Insertion is the same as with the filament bulb. Again attention is to be paid to correct orientation of the longitudinal slot. Special care is required not to injure the laterally projecting arm of the ignition electrode. Otherwise, the manufacturer's instructions accompanying the bulb apply.

Before operating the high-pressure mercury lamp HBO 200 for the first time, it is necessary to adjust the power-supply unit in the table drawer (L) to the correct current. This is indicated on each burner package or in the accompanying instructions. The procedure is as follows:

1. Break the power supply for the instrument by pulling the plug out of socket (L 8).
2. With a screwdriver release the two screws (L 2) and (L 7) on the rear of the drawer.
3. Pull out the drawer.



4. With the red screw in the base plate of the power-supply unit, the choke is set on I or II, depending on the designation of the lamp as "$L_1$" or "$L_2$". The same procedure is employed when replacing burners.



18

## Attaching the illuminators

The illuminator with the low-voltage filament bulb 100 W belongs on the right ring dovetail (A 21), the illuminator with the high-pressure mercury lamp HBO 200 on the left ring dovetail. The carbon arc lamp fits only the ring dovetail (A 20) on the rear of the instrument.

1. Unscrew the cap of clamping screw (H 3) far enough that the spring bolt can be sufficiently depressed.
2. Apply the illuminator to the ring dovetail in such a manner that the spring bolt rests against the bevelled edge and recedes when pressing the illuminator towards that edge.
3. Apply the contact face of the illuminator to the ring dovetail so that the two projecting contact points (H 9) likewise rest on the bevelled edge of the dovetail.
4. Turn the illuminator so that the lamp holder is exactly vertical and block the spring bolt (H 3) by vigorously drawing up the screw cap. Now the illuminator should be immovably attached.
5. Establish electrical connection of the illuminators and stand to the plugs on the rear panel of the instrument table (page 36). Connect the instrument table with the outlet of the 220 V AC supply line by means of socket (L 8) and the accompanying cable. A suitable step-up transformer must be employed if the supply line has a different voltage. Connection to direct current is not permissible.
6. Check whether the lamps operate properly. Switch on the main switch by moving lever (L 15) from 0 to 1. Pilot lamp (L 14) must light up. If not, check whether the instrument table is connected with the electric supply line. If necessary also inspect the main fuse.

**–1. Filament bulb.** Switch on by turning switch and regulating knob (L 18). With progressive turning of the knob the filament bulb must burn with ever increasing brightness. At the same time, the illumination of the voltmeter (L 17), indicating the voltage at which the filament bulb is operating, must light up. Besides illuminating the scale, this light also indicates that the filament bulb is switched on.

The operating voltage of the filament bulb should always be kept as low as possible. That saves the bulb and prolongs its life. Its rated voltage is 12. If need be it can be briefly overloaded up to 15 V. For color photographs it should invariably be operated at 12 V.

**–2. High-pressure mercury lamp.** Switch on by turning switch knob (L 13) from 0 to 1. Usually the burner ignites at once. This is indicated by the deflection of the pointer of the ammeter (L 11). At first it indicates a somewhat higher current than specified on the package in which the burner was delivered. During the warm-up period the correct current is gradually established. In general this takes 2 to 3 minutes. Here too, the illumination for ammeter (L 11) lights up when the mercury lamp is switched on.

If the lamp should not ignite at once, the ignition key (L 12) is briefly depressed.



**–3. The carbon arc lamp** is always fastened on the back the ULTRAPHOT II housing. With interposition of a resistor the carbon arc lamp can be connected to either **direct** or **alternating current.** Connection to direct current has the following advantages:

The arc lamp burns more quietly.

The current consumption and consequently development of heat is less.

The luminous densitiy of the crater is considerably higher.

For these reasons it is advisable to employ a dry rectifier if only alternating current is available.

The rectifier (Catalog No. 38 29 02) is for connection on its primary side to a 50/60 cycle alternating current of 110–125–150–220–240 V. It delivers a direct current of 4 or 6 amperes. It is set on 6 A for operating the arc lamp. The required resistor is located in the rectifier.

The control device, in the instrument table, for the carbon feed must invariably be connected to a 220 V alternating current of 40–60 cycles. The supplied DC voltage may never be less than 100 V, otherwise the burning of the arc lamp is unsteady.

## Inserting carbons in the arc lamp

1. Depress spring catch (K 4) and pull the lamp back to the stop.
2. Pull the electric plug and swing handle (K 3) upwards, and likewise the cover (K 1) of the housing.
3. Bring the two carbon holders forward resp. upwards to the stop by turning regulating knob (K 9) to the left.
4. Clamp the vertical carbon with aid of the accompanying spanner into its holder.
5. Retract the carbon holders backwards resp. downwards to the stop by turning the regulating knob to the right.
6. Insert the horizontal carbon from the back through the carbon guide ring and clamp its butt end in the carbon holder.
7. Turn the regulating knob to the left until the conical ends of the carbons almost touch, at equal distance from the intersection of their axes (Fig. 19).
8. Lower the housing cover (K 1) and handle (K 3), push the arc lamp in to the stop, and reinsert the electric plug.
9. Connect the arc lamp by means of the two screw plugs to the arc-control device in the drawer of the instrument table (L 5).

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## Igniting the arc

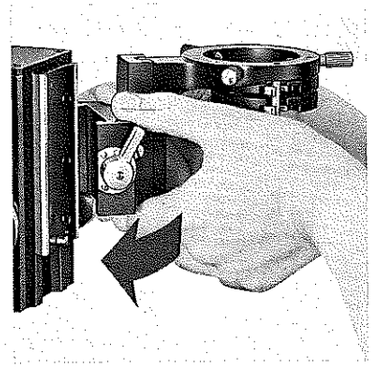
Switch on the arc lamp by depressing the black end of the switch on the plug below handle (K 3).

If properly connected, the carbon feed begins to work until the carbon tips meet. The behavior of the carbon tips is observed on the ground-glass disk (K 2) located on the lamp housing.

By slightly and jointly turning the regulating knobs (K 9) backwards the carbon tips are separated somewhat and the arc strikes between them. With direct current it is not the arc which acts as light source, but the glowing crater at the end of the horizontal carbon. If this is not the case, the plug below handle (K 3) must be reversed.

By turning the regulating knobs (K 9) the carbons are brought into the position shown in Fig. 19. They should be maintained in this position by the automatic carbon feed mechanism. For that purpose the regulating knob (L 10) for the carbon separation is adjusted so that the responding relay barely reacts with a change of the arc voltage.

The regulating mechanism can keep the carbon tips in precisely the once established location only if the carbons are consumed uniformly. This hardly ever is the case, due to inhomogeneities resulting from manufacturing conditions. Therefore, when using a carbon arc lamp, it is necessary from time to time to check the positions of the carbon tips and, if necessary, correct them with the regulating knobs (K 9).



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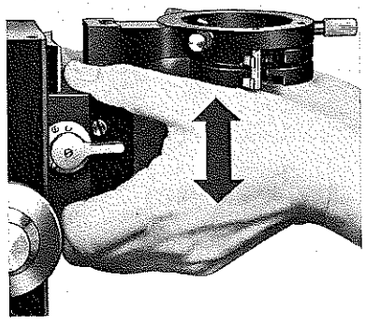

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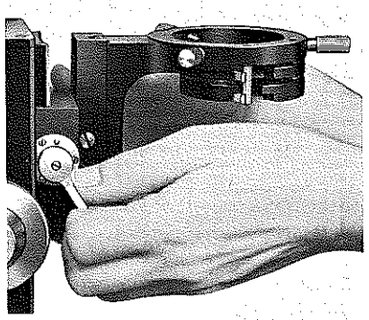


22

## Attaching the stage and condenser carriers

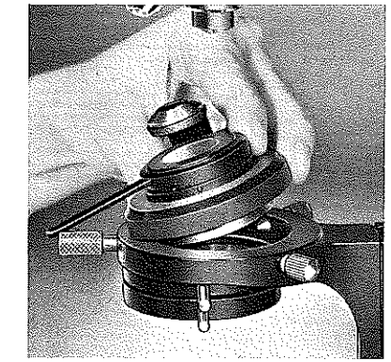
1. Set the clamping lever (G 22) into its uppermost position. Apply the right guide rib of the **condenser carrier** (G 21) to the bevelled right side of the dovetail (G 2) near its middle and swing the carrier to the left until the spring bolt snaps in (Fig. 20).

2. With the clamping lever (G 22) in middle position, where it lightly engages, slide the condenser carrier downwards until it meets the stop (Fig. 21).

3. Turn the clamping lever downwards until the condenser carrier is firmly held (Fig. 22).

4. Inserting the **condenser.**
Tilt it slightly (Fig. 23) and with its conical holding ring press the spring bolt (G 29) outwards. Next, place the condenser flat on the contact surface and rotate it until the spring bolt engages the notch in the holding ring.



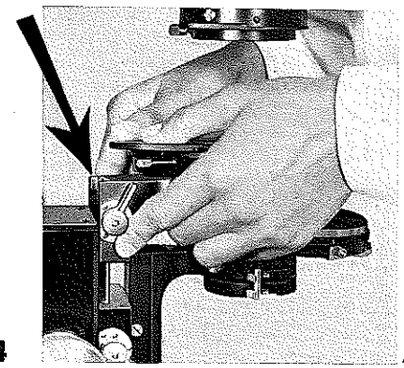


23

5. From above, by means of its clamping device (G 11), attach the **stage carrier** together with the stage to the dovetail (G 2). To do so the clamping lever (G 13) is brought into its uppermost position. First the lower right of the guide rib is set behind the right bevel of the dovetail, then the spring bolt at the left, and finally the upper part of the guide rib is placed behind the right bevel of the dovetail (arrow in Fig. 24).

6. Lower the stage carrier to the stop on the condenser carrier and turn the clamping lever (G 13) downwards until stage carrier is firmly held. With transillumination it is important that condenser carrier and stage carrier are always in good contact with their stops. If this is not the case, "unexplainable" adjustment errors can arise. Condenser carrier (G 21) is not required for vertical illumination and can be removed from the instrument.

7. Finally, the condenser is moved upwards to its stop with pinion (G 27).



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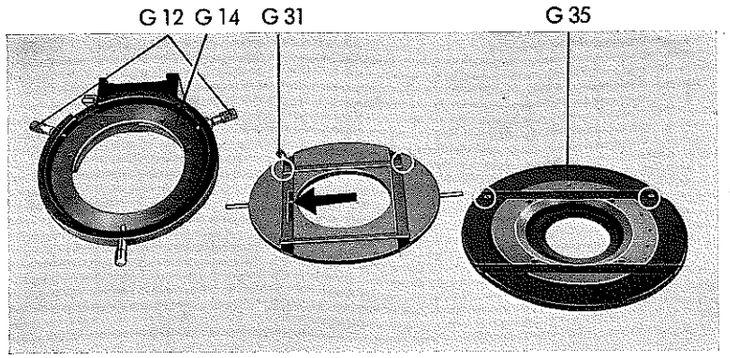



25

## Greasing the gliding stage (Fig. 25)

To insure satisfactory functioning of this stage under all magnifications, it should be relubricated semianually with the accompanying grease (Catalog No. 473391). The procedure is as follows: The centering screws (G 12) are turned back and the base plate with adhering stage plate is lifted out of the centering piece while pressing against the spring bolt (G 15). Then the two plates are pulled apart and their gliding surface as well as the guide frame thoroughly cleaned, if necessary using xylol. After drying, a very thin film of the grease is applied with a finger to the gliding surfaces, their grooves, as well as to the guide frame. The less grease used, the better. Next, the guide frame is replaced in the base plate. It lies correctly if the stop screw (arrow in Fig. 25) in the gluide groove of the base plate lies in the recess of the guide frame and limits its movement.

Replace the stage plate (G 35) on the base plate and guide frame, so that the guide groove with its two limiting screws of the stage plate lies over the projecting part of the guide frame having small notches on both sides (circular marks in Fig. 25).

Move the two plates back and forth over one another under moderate pressure in order to uniformly distribute the grease. The stage plate must not glide too easily over the base plate. If that should be the case, there is still too much grease between the gliding surfaces.

Finally return the adhering plates to the centering piece and at least approximately center them in order that the object stays in the field of view as the stage is rotated.



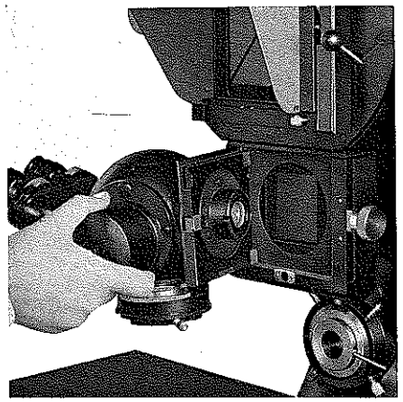
## Centering the stages

1. To locate the optical axis of the Microscope, an eyepiece with cross lines is placed in the tube. If that is not available, the image of the closed centered luminous-field diaphragm can be used for marking the center of the field of view (Fig. 45 C, page 63).

2. Mount a slide on the stage having numerous small particles evenly distributed, e. g. evenly dispersed dust particles, and focus with an objective 10× or 16×.

3. If the stage is rotated, its approximate center of rotation is readily recognized, even if it is located outside the field of view. By operating the two centering screws (G 12), the center of rotation is brought approximately into the center of the field of view. In general such an approximate centering suffices.

4. A still more precise centering is easily obtainable by repeating the procedure. To be sure, it cannot be permanently maintained. Rather it must be established anew after every change of objectives, and naturally also after every removal and reattachment of the stage. This is because small deviations of about 1/100 mm. are unavoidable in centering the objectives or in attaching the stages. However, in the microscopic field of view stretches of 1/1000 mm. are readily visible.



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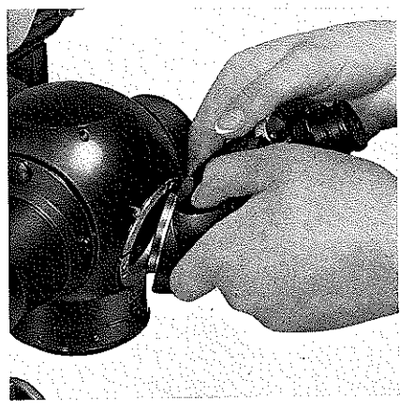


27

## Attaching the Tube Head and the Tube

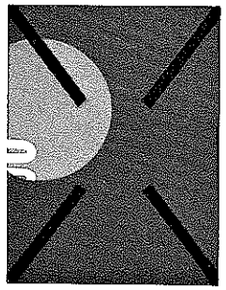
If use is to be made of the 9×12 cm. (4×5"). **Photo Head,** it has to be **attached before** mounting the Tube Head. This is necessary because the protruding Projective extends into the shutter housing (B 8 and B 15) of the Photo Head.

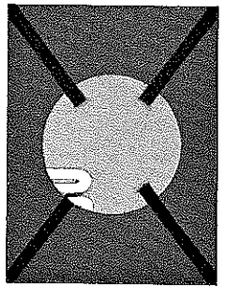
The Projective of the 35 mm. Photo Head extends into the opening (after removal of the cover) on top the Tube Head. Therefore, the latter must be attached **before** the **35 mm. Photo Head** is mounted.

1. **To attach the Tube Head** (E) clamping screw (A 7) is unscrewed up to the stop.
2. With the Tube Head turned somewhat towards the left, the left edge of the two bevelled sides of the attachment plate is applied to the counterstrip of the receptacle (Fig. 26).
3. The Tube Head is slightly raised until the upper edge of the attachment plate touches the upper strip of the receptacle.
4. The attachment plate of the Tube Head is swung completely into the receptacle.
5. The Tube Head is allowed to descend, down to the stop. In so doing, a projection on the right edge of the attachment plate engages a projection on the receptacle and prevents the Tube Head from accidentally falling off.
6. Clamping screw (A 7) is drawn tight; in so doing it is helpful to press the Tube Head into the receptacle with the left hand.
7. When **attaching the inclined binocular tube** (E 3), the knurled screw (E 15) is turned out far enough so that the spring bolt on the inside of the ring dovetail bed, blocked by it, can be completely pressed back.
8. The ring dovetail of the tube is pressed against this bolt (Fig. 27) until it glides behind the two opposite contact surfaces, after which screw (E 15) is drawn tight.



Before using the ULTRAPHOT II it is necessary to adjust the light source and to calibrate the automatic exposure device for the film material employed.



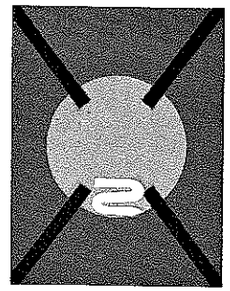


**28** incorrect correct **29**

## Adjusting the light sources

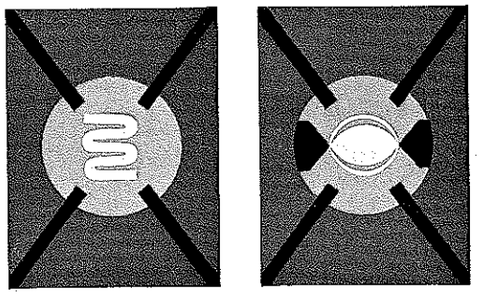
1. Switch on the light source and turn setting knob (A 19) so that its light passes through the light-exit opening in the base of the instrument (Table 5, page 31).
2. Attach objective 2.5×, 4×, or 6.3× to the revolving nosepiece and focus. Set OPTOVAR (E18) on 1.25. Push beam-splitting slide (E 17) into middle position (red ring) and open the camera shutter by lowering cocking lever (B 9) to its horizontal position. A bright spot appears on the focusing screen, probably not sharp nor lying in the center.
3. Set diaphragm (A 24) about on "5" and lever (A 23) on "Luminar".
4. Raise the stage to the top with pinion head (G 3) and focus the condenser with pinion head (G 27) until a sharp image of the diaphragm is formed on the focusing screen (B 7). If this image is not in the center of the focusing screen (Fig. 28), it is brought there by using the centering screws (G 28) of the condenser.

   Centering is facilitated if the size of the diaphragm is adjusted so that it barely extends beyond the ends of the clear diagonal strips of the focusing screen when it lies symmetrically between them (Fig. 29).
5. Swing the diffusing disk out of the beam with knob (H 7). A portion of the image of the light source may appear in the aperture of the diaphragm image as shown in Fig. 28.



**30**

6. If, when using the filament bulb or the mercury lamp, no part of the image of the light source appears, then the diaphragm is opened wide to locate it, and it is adjusted in horizontal direction by turning adjusting screw (H 10), in vertical direction by moving lamp socket (H 6) up and down after releasing clamping screw (H 4), until the image lies at the center of the screen. Fig. 30 shows part of the spiral of the filament bulb horizontally centered, diaphragm again closed, Fig. 31 shows the sprial completely centered; Fig. 32 shows the completely centered arc between the electrodes of the mercury lamp.



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7. The diffusion disk is again switched into the beam with knob (H 7). Both the filament bulb and the mercury lamp should regularly be used with swung-in diffusion disk. Only with very high magnifications is it occasionally permissible to remove the diffusion disk from the beam in order to increase the illumination intensity.

8. Adjustment of the carbon arc lamp is the same as in sections 1–5. Then the image of the crater is brought into the center of the focusing screen by operating the two centering screws (K 7).

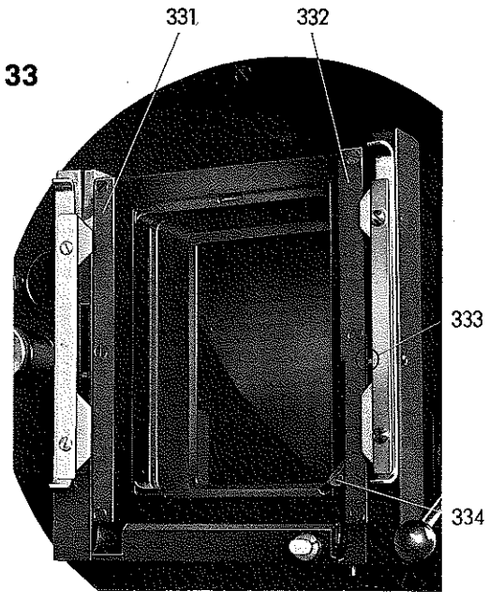


## Holders for 4 x 5" film pack, roll film, and magazines

The ULTRAPHOT II can readily be rearranged for the use of such holders. To do so, the two guide strips (Fig. 33), each attached to the Photo Head with three screws, must be dismounted and screwed to the frame of the focusing screen (Fig. 34 A).

1. First the frame of the focusing screen (B 2) is removed from the Photo Head by vigorously compressing the two retaining clips (B 3) and pushing the frame upwards and out.

2. The screws on both guide strips (331) and (332) are removed, the strips turned about their longitudinal axes, the screws inserted into the holes from the back, and the strips laid on the detached frame as in Fig. (34 A).

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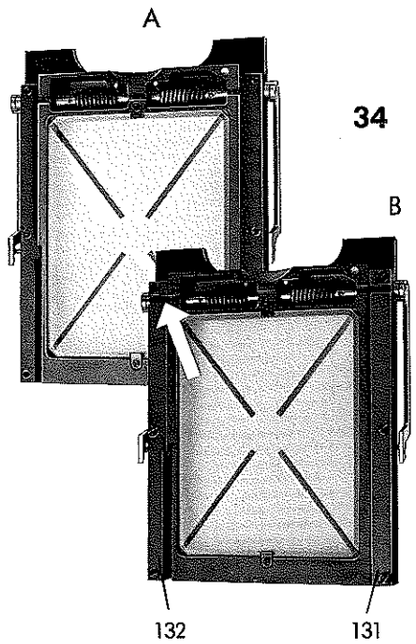
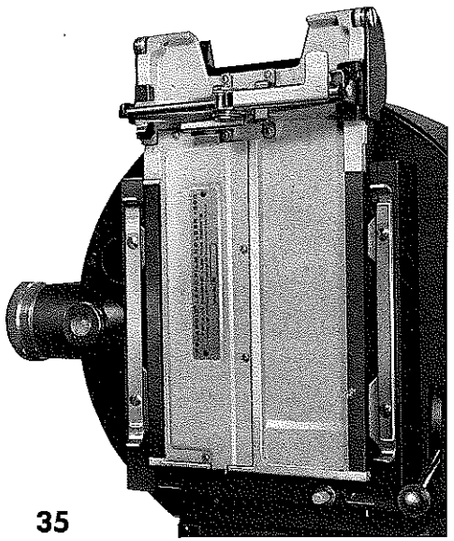



34

Strip (332) comes on the left, strip (331) on the right side of the frame. There they are screwed fast so that the flat grooves of the strips (arrow) lie at the top. The recess on the strip now lying on the left of the frame may not interfere with the cocking lever (334).

3. The focusing screen (Fig. 34 B) is then again attached to the Photo Head and pressed far enough downwards that the retaining clips (B 3) snap in behind the pin (333).

4. After focusing the image, the 4×5" double holder is inserted between the frame (B 2) of the focusing screen and the Photo Head. With holders that do not permit this, the frame is removed from the Photo Head (as in section 1) and the holder held with bolts (B 4) (Fig. 35).



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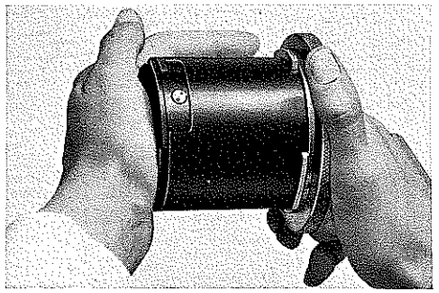
## 35 mm. Photo Head

### Loading daylight cartridges into the cassettes (C 17)

36



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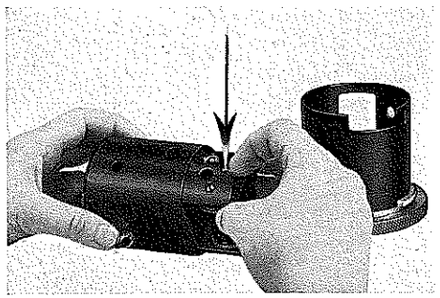

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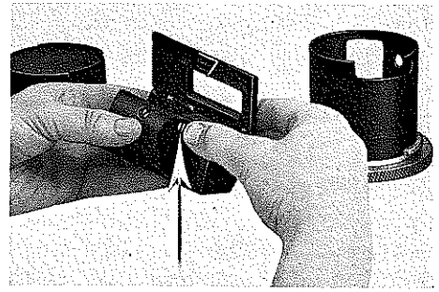
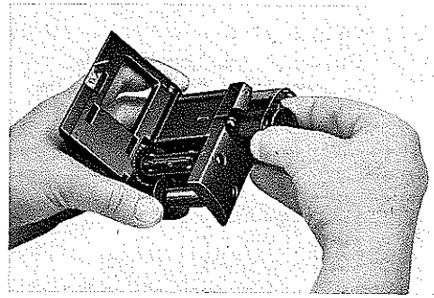
1. To remove the old film, turn the cassette left to the stop where it bears a green marking line (C 15) for reinsertion.
2. Pull the cassette out of its housing (C 13).
3. With the accompanying key rewind the film into the cartridge (Fig. 36).
4. Press against the bottom of the cassette (Fig. 37), turn the upper part, and pull out the released inner part.
5. In this lies the spool which must be taken out (please watch the pin [Fig. 38] in reassembling).





39



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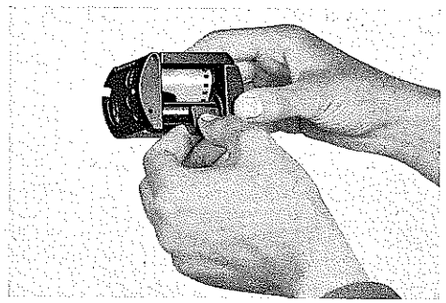

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6. Now press on the extending slotted bolt (Fig. 39), and the cover springs open.
7. Introduce the new cartridge (Fig. 40). Draw the film, emulsion side up, over the rollers so that its perforations lie over the teeth of the film advance roller. Close the cover and snap home.
8. From below fasten the film to the slot in the spool (Fig. 41) and draw it taut by turning the geared spool disk.
9. Reinsert the assembled cassette (C 17) into its housing (C 13) and lock in position by turning it clockwise. Set the film counting device (C 18) on "35" and make two blank exposures by pressing knob (A 14) or (C 1).

## Checking the automatic exposure device

### Focusing the specimen

1. Check whether the feed cable is connected with socket (L 8).
2. Switch on main switch (L 15) on the instrument table; the respective pilot lamp (L 14) must light up.
3. Switch on the main switch (A 11) of the automatic exposure device on the instrument; the pilot lamp (A 12), situated slightly below it, must light up. If this is not the case, check the microfuse "FN 1 0.2/250 C" located above the exit place of the feed cable, and if necessary replace it. If the carbon arc lamp is attached, this must be removed before changing the fuse.
4. Attach objective 10× or 16× to the revolving nosepiece of the Tube Head, and observing through the binocular tube (E 3), focus an optional specimen, with the magnification changer OPTOVAR set on 1.25 and the beam-splitting slide (E 17) on the Tube Head set on middle position (red ring mark).

### Adjusting the illumination

5. Set lever (A 23) on "Micro", provisionally close diaphragm (A 24) to "15–25", focus condenser with pinion (G 27) so that this diaphragm appears sharp in the field of view.
6. After completing adjustment 5, project the focusing image onto the focusing screen (B 7). On knob (A 17) set the factor ring (A 33 with one red dot), belonging to position 1.25 of the OPTOVAR, on "10". Open the shutter by lowering the cocking lever (B 9) to its horizontal position. Focus the image on the focusing screen by means of knobs (G 3 and 4), center diaphragm (G 28) and open it just enough to completely illuminate the image on the ground glass. Insert a green filter in the light-exit opening (A 10) of the base.

### Checking the shutter action

7. Close the shutter by lowering cocking lever (B 9) to the stop; press white release knob (A 14) and after some time let go. When knob (A 14) is pressed, the shutter must open and upon letting go, again close. Repeat this several times with varying time intervals.
8. Again cock the shutter; vigorously press mechanical release knob (B 10), and after some time let go. As under 7, the shutter must open on pressing knob (B 10) and close upon letting go.
9. Once more cock the shutter, press the mechanical release knob about halfway in, up to a noticeable click; the shutter must open and stay open.

   Vigorously press the same knob further in and let go; the shutter must close when the knob is let go.



### Checking functioning of the automatic exposure device

10. Open the shutter and once more scrutinize the sharpness and illumination of the image on the focusing screen. The automatic exposure device can function properly only if the focusing screen is completely illuminated up into the corners, because only then is the photocell (B 13) fully illuminated.
11. Insert an empty holder between the frame (B 2) of the focusing screen and the Photo Head and press it downwards. Shortly before reaching the lower stop a noticeable click announces cocking of the shutter. This should be done as gently as possible by relatively light pressure.

    The holder should not be pushed down violently, since otherwise there is danger of obtaining a photomicrograph which is not in perfect focus.
12. Set the sensitivity selector knob (B 6) on step "7" and by **brief** pressure on release knob (A 15) activate the automatic exposure device. Generally now the shutter will open and promptly close again, because the illumination intensity on the focusing screen (B 7) is too high. Therefore, sufficiently diminish the illumination intensity, by insertion of gray filters or reduction of the lamp voltage to 6–7 V with regulator (L 17), so that an exposure of 3–4 sec. is obtained. Naturally, in each case the shutter must first be cocked.
13. With a stop watch ascertain the exposures in each of the eight positions of selector knob (B 6). The exposure should increase or decrease by about the factor 2. The longest exposures are obtained with position 1 of the selector knob, the shortest with position 8.

Table 8
**Example of a graded series of exposures**

| Position of the selector knob (B 6) | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
|---|---|---|---|---|---|---|---|---|
| Exposure sec. | 135.5 | 71.9 | 36.5 | 19.3 | 10.1 | 5.6 | 3.3 | 2 |

## Calibrating the automatic exposure device

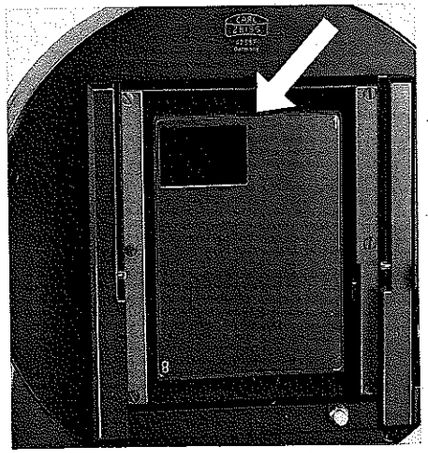
Pursuant to the preceding tests, it is well to immediately carry out calibration of the automatic exposure device. This calibration must be made for each photographic emulsion employed and with every change in the conditions of development. Due to the generally unknown influence of the Schwarzschild effect (reduced sensitivity of an emulsion with prolonged exposures), it is impossible to depend on the sensitivity ratings of the manufacturer which serve for normal amateur requirements.

For calibration, 8 photographs (Fig. 44) are taken, using the 8 positions of the sensitivity selector knob (B 6), on **one** plate (sheet film) with the aid of two diaphragms (Figs. 42 and 43) accompanying every instrument.

The plate or film is processed under the same conditions as are to be employed for the subsequent photomicrographs. The most satisfactory negative is selected from the eight, if necessary with the aid of a sample print. All subsequent exposures, using the same emulsion, are made with the selector knob (B 6) set on the step employed for the satisfactory trial exposure. After this, upon pressing the red push button (A 15), the instrument automatically determines and makes the correct exposure for any given intensity of the image appearing on the focusing screen.

The only requirement is to see to it that the **exposure is not less than 1 to 2 sec.** If the illumination intensity is so great that the correct exposure falls below that amount, it should be reduced by gray filters or by decreasing the lamp voltage.





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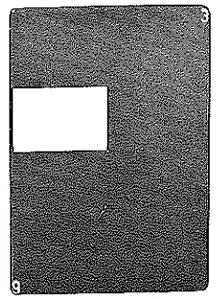
The following procedure is suitably adhered to in making **calibrating exposures:**

1. Focus the image as described on page 62 under sections 4–6. A specimen should be used having an approximately uniform structure over the entire image area.
2. Remove the frame with the focusing screen (B 2). To do so, the two retaining clips (B 3) are vigorously compressed, then the frame is pushed upwards and out. The diaphragm (Fig. 42) is so inserted into the camera opening lying behind the focusing screen that the number "1" is at the upper right. When inserting the diaphragm it is pushed from below against the leaf spring projecting outwards from the middle of the upper border of the opening (arrow in Fig. 42) and then allowed to snap into the groove at the lower border.
3. Set the sensitivity selector knob (B 6) on "1".
4. Reinsert the frame with the focusing screen (B 2) and snap it into position with vigorous pressure.



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5. Load the holder with the selected type of film or plate, insert it, and pull the slide.
6. By pressing the red push button (A 15) start the exposure and wait until it is completed.
7. Reinsert the slide and remove the holder.
8. Again remove the frame with the focusing screen (B 2).
9. Remove the first used diaphragm and replace it by the other, so that the number "2" is at the upper right.
10. Set the sensitivity selector knob (B 6) on "2".
11. Make the second exposure as under 4–8.
12. For the next four sectional photomicrographs the sensitivity selector knob is set on "3" through "6" and the respective diaphragms are so inserted (Fig. 43) that the numerals "3", "4", "5", and "6" appear successively at the upper right. Finally, for sectional photomicrographs "7" and "8" the first diaphragm is used again; however, now the numerals "7" and "8" must be visible at the upper right. The sensitivity selector knob (B 6) also must be set to position "7" and "8", respectively.
13. Develop the exposed plate (film), select the correct exposure, and for subsequent exposures use the same setting of the sensitivity selector knob (B 6).

**The following filters** of our production program can be used with the automatic exposure device without recalibration, provided panchromatic emulsions are used:

Yellow filters GG 3 and GG 14
Blue filter BG 23
Green filter VG 9
Orange filter OG 3
Interference-band filter green max. = 546 mμ (± 5 mμ) *
Interference broad-band filter green = 546 mμ *
If other filters are to be used, as e. g. red filter RG 2, it is necessary to recalibrate the automatic exposure device.

* These filters should be inserted so that their brighter appearing and more highly reflecting side faces the light source.

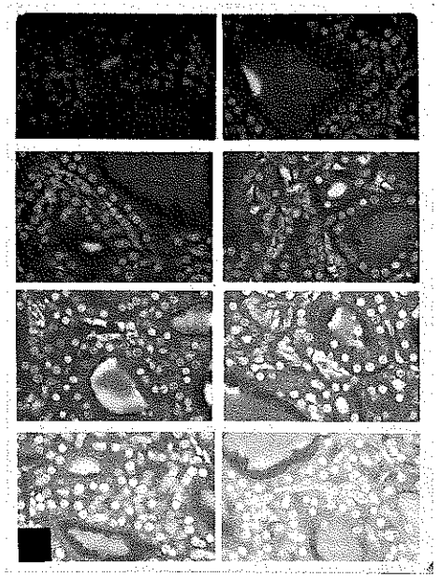

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Table 9
**Transillumination**

| | | Objektive magnification 1 | 2,5[1] | 4 | 6,3 | 10[2] | 16 | 25 | 40 | 63 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Condenser | 0.9 | without condenser | | Front lens swung **out** | | | Complete condenser with front lens swung **in** | | | | |
| | 0.9 POL | | | | | | | | | | |
| Phase-contrast condenser | II Z | | | | | | | | | | |
| | III Z | | | | | | | | | | |
| | IV Z | | | | | | | | | | |
| Condenser | 1.3 | | | not suitable | | | | | | | |
| | 1.3 POL | | | | | | | | | | |
| Achr. aplan. condenser | 1.4 | | | | | | | | | | |
| Phase-contrast condenser | V Z | | | | | | | | | | |
| Condenser diaphragm | | absent | | acts as **aperture** diaphragm | | | | | | | |
| Diaphragm (A 24) acts | | as **aperture** diaphragm | | as **luminous-field** diaphragm focus the condenser so that the diaphragm image appears as sharp as possible in the plane of the specimen | | | | | | | |
| Lever (A 23) on | | "Luminar" | | "Micro" | | | | | | | |

1) The specifications contained in this table assure the best illumination. They should regularly be followed in taking photomicrographs. If a change of condensers is found burdensome, the specifications for working with objectives 4 and 6.3 can be followed.

2) Frequently the field of objective 10 is completely illuminated with swung-in front lens of the condenser. However, this cannot be guaranteed due to the unfavorable ratio of the focal lengths of condenser and objective.





## Working with transmitted light

The compound microscope is used for microscope magnifications between 25× and 1600× (table 3, page 20), or for magnifications on the plane of the film between 40× and 2500× (table 1, page 6).

The simple microscope is used if photographs are to be taken at lower magnifications (survey photographs). The image in this case is formed in a single step (without eyepiece) by means of a series of objectives (LUMINARS) differing in focal length.

To obtain these magnifications, it is impossible to operate with a single illuminating device due to the great range of the employed object field (0.06 to 60 mm.) and a corresponding range in imaging apertures (0.01 to 1.4). The illuminating arrangements of the ULTRAPHOT II are so designed that a minimum of conversions are necessary.

# Compound Microscope

## Bright-Field Illumination

### Setting up the instrument

1. Attach condenser carrier and insert condenser (page 46).
2. Attach stage carrier and stage (page 47).
3. Attach Tube Head and binocular tube (page 50). Insert eyepiece in tube, set OPTOVAR (E 18) on 1.25.
4. Attach revolving nosepiece (E 9) to Tube Head and screw in the required objectives. It is to be noted that the new revolver on dovetail slide must be inserted from left rear and be seated firmly against its stop before it is clamped on. On the other hand, the holder for changing rings (E 10) as well as the vertical illuminator slides in from right front.

### Adjusting illumination and image

5. Switch on the illuminator.
   It is recommended to begin with the filament bulb. Another light source is required only if the intensity of the filament bulb no longer suffices, or if the observation procedure demands it, e. g. fluorescence examinations. It is assumed that the light source is adjusted (page 51).
6. Lever (A 23) stands on "Micro".
7. Setting knob (A 19) for illuminators stands so that the light from the filament bulb emerges from the light-exit opening (A 10) in the base of the instrument (table 5, page 31). Set the beam-splitting slider (E 17) in the Tube Head on the red ring.
8. Observing through the binocular tube (E 3), focus the specimen with a low-power objective (about 10×).
9. Close the luminous-field diaphragm (A 24) to the extent that only a fraction of the field of view is brightly illuminated (Fig. 45 A).
10. Focus the condenser (G 27) so that the image of diaphragm (A 24) appears as sharp as possible (Fig. 45 B).

    If the image is too bright, its luminous density is reduced by lowering the lamp voltage (L 18) or by using gray filters, until it is endurable or comfortable for the eye. The gray filters are preferably inserted in the filter holders (G 26) or (G 30) on the condenser carrier below the condenser.
11. With condenser centering screws (G 28) center the image of the luminous-field diaphragm in the field of view (Fig. 45 C) and open diaphragm (A 24) just sufficiently to illuminate the entire field of view.
12. Adapt the aperture of the illuminating beam to the requirements of the specimen by adjustment of the condenser diaphragm. In doing this, the ratio of the size of the aperture diaphragm to the exit pupil of the objective should be observed. For this purpose knurled disk (E 18) of the OPTOVAR is set on "Ph" and the image of the diaphragm focusing by means of the lower knurled ring (E 19). A simpler procedure, without changing the OPTOVAR, is to look down the microscope tube, after removing an eyepiece, to observe the exit pupil of the objective.

    The image of the condenser diaphragm should never be larger than the exit pupil of the objective, since otherwise scattered light is superimposed on the microscope image. Usually it will be necessary to make the image of the condenser diaphragm smaller than the objective opening. However, the aim should always be to keep it as large as is compatible with adequate depth of field and image contrast. Only in exceptional cases should it be reduced to a third or a quarter of the diameter of the objective opening.

    To fully utilize the capacity of the achromatic condenser, its front lens and the under side of the slide are connected by a drop of immersion oil. This is unnecessary only if low-power objectives are used.
    It is impossible to illuminate the specimen for observation with all low- and high-power objectives with the use of one condenser. Table 9, page 60, is a guide for suitable selections.
13. Provide the desired magnification by selecting a suitable objective and appropriate OPTOVAR factor (E 18) and repeat the adjustments according to sections 10 to 12.

    The resilient mount of immersion objectives can be locked in its upper position by a turn to the right. If the mount is released after application of the immersion fluid, the image appears in the microscope.

    To assure a good image, our immersion objectives should be used exclusively with our nongumming and nonfluorescent immersion oil ($n_D = 1.515$).
14. Photographing (see page 86).

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A Luminous-field diaphragm, out of focus

B Luminous-field diaphragm, in focus

C Luminous-field diaphragm, centered

D Luminous-field diaphragm, opened

### Other modes of illumination

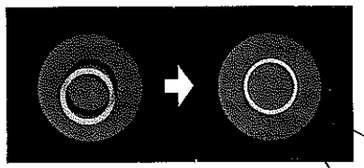
Other illumination procedures, for which any standard microscope can be equipped through the use of suitable accessories, are similarly applicable to the ULTRAPHOT II.

## Phase Contrast

Required are special phase-contrast objectives and a condenser which permits insertion and adjustment of the respective annular diaphragm. For best photomicrographs we recommend phase-contrast NEOFLUARS Ph and the achromatic-aplanatic phase-contrast condenser. The illumination is adjusted as in bright field (page 62). The only difference is in section 12:

12 **Ph** Bring into the path of rays the annular diaphragm of the condenser which is correlated with the employed objective. Annular diaphragm 1 is correlated with the objective engraved in red "Ph 1", annular diaphragm 2 with "Ph 2", and annular diaphragm 3 with "Ph 3" (see Instructions for Use G 40–160, Phase-contrast Equipment).

Set the knurled disk (E 18) of the OPTOVAR on "Ph" and with the lower knurled disk (E 19) focus the phase ring and the image of the annular diaphragm. With the adjusting knobs on the condenser for the annular diaphragms, bring the image of the annular diaphragm as nearly as possible into superposition with the phase ring. After this again set the OPTOVAR into position for observation of the specimen.



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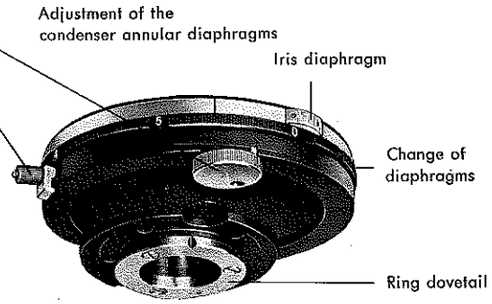




## Oblique Illumination

This mode of illumination increases the image contrast of objects low in contrast, however not to the extent obtainable with the phase-contrast procedure. At the same time it produces a plastic effect, also with relatively flat objects, due to the unsymmetrical light incidence. Frequently this leads to incorrect interpretation of images, therefore the method should be employed with caution. Oblique illumination can be produced with the aid of phase-contrast condensers. To be sure, good illumination of the field of view is obtainable only with a well-corrected condenser (achromatic-aplanatic condenser).

Adjustment of the illumination here is the same as in bright field (page 62). Oblique illumination is produced by modifying the adjustment given there under section 12:

12 **S** Observe the image of the aperture diaphragm as described in section 12 and reduce its diameter to ½–¼ that of the exit pupil of the objective (Fig. 47). Turn the disk for condenser diaphragms from position "J" (iris diaphragm in the path of rays) either right or left until the image of the diaphragm has barely half-vanished beyond the rim of the exit pupil of the objective (Fig. 48).

Then return to observation of the specimen. If examined details are unfavorably oriented to the direction of light incidence, this is readily corrected by rotating the stage of the Microscope.

## Dark Field

One of the customary dark-field condensers is used for producing dark-field illumination. Its manipulation on the ULTRAPHOT II is the same as on any microscope (Instructions for Use G 40–165, Dark-Field Condensers).

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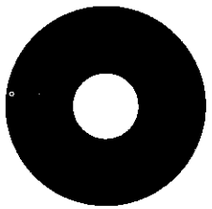

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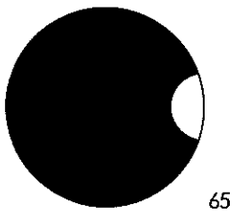


## Simple Microscope

For taking photographs with the simple microscope, **LUMINARS** are available having focal lengths of 16, 25, 40, 63, and 100 mm., as well as a special LUMINAR with variable focal length for the lowest magnifications.

In spite of the considerable variability of the camera length of ULTRAPHOT II, it is not possible to obtain an unbroken series of magnifications with the above-mentioned focal lengths. Therefore, a **supplementary system 0.8** (Catalog No. 46 25 80) is supplied which increases the respective focal lengths to the extent that the magnifications are decreased by the factor 0.8.

The supplementary system is applicable to LUMINARS 16 to 100 mm. It is inserted into the upper opening of the LUMINAR holder; in the case of LUMINAR 100 into the objective proper after the ring for holding filters normally located in this opening has been taken out.

Table 11 gives a survey of the magnifications obtainable with the individual LUMINARS and their combination with supplementary system 0.8. To ascertain the maximum size of an object which still can be included in the photograph at a specified magnification, it is only necessary to divide the length or the width of the focusing screen by the magnification. On the other hand, it also is easy to ascertain the maximum magnification which can be used to completely image on the focusing screen an object of a given size. The length with which it is to appear on the focusing screen is divided by its actual length. With the aid of such simple estimates it is easy to select the correct LUMINAR without much experimentation.

Table 10

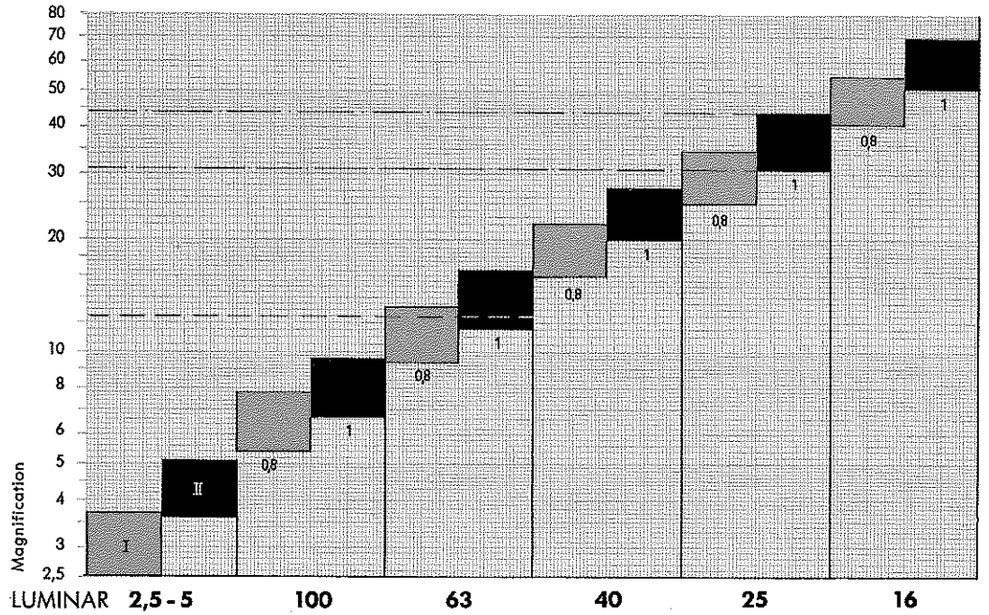
**LUMINARS with transillumination**

| **LUMINAR** | **16** | **25** | **40** | **63** | **100** |
|---|---|---|---|---|---|
| Distinguishing color | brown | orange | light green | light blue | white |
| Attachment | long holder (F 11) | | | short holder (F 21) | ring dovetail on LUMINAR itself |
| Correlated **spectacle-lens condenser** | 1 | 2 | 3 | 4 | 5 |
| Diameter of its attachment diaphragm | 3.5 mm. | 6 mm. | 9 mm. | 15 mm. | 27 mm. |



Table 11

**Magnifications of low power photographs** with LUMINARS in **transmitted light**




LUMINAR 2.5–5 cannot be used with the supplementary system 0.8×. The range of magnifications designated I is obtainable with the macro stage for transmitted light at its lower stop, that designated II at its upper stop.

Example 1:

An object 6.5 mm. long is to have a length of 80 mm. in the photograph. The required magnification is 80:6.5 = 12.5×. Consultation of table 11 shows that this is attainable with LUMINAR 63 mm. in combination with supplementary system 0.8× with great camera length, and without the supplementary system with shorter camera length. In all cases where these two possibilities exist, always select the one in which the LUMINAR alone functions.

Example 2:

What magnifications are obtainable with LUMINAR 25 mm. used without supplementary system 0.8×? Field 25 is located in the table, the upper and lower limitations of its black block are followed to the left until they intersect the magnification scale. There it is found that the highest magnification is 43.5×, the lowest 31×. These and all intermediate values are obtainable.

## Bright-Field Illumination

LUMINAR 16 to 100 mm.

### Setting up the apparatus

1. Attach condenser carrier (page 46).
2. Insert the spectacle-lens condenser correlated to the selected LUMINAR (table 10) and raise the condenser to the stop with pinion (G 27).

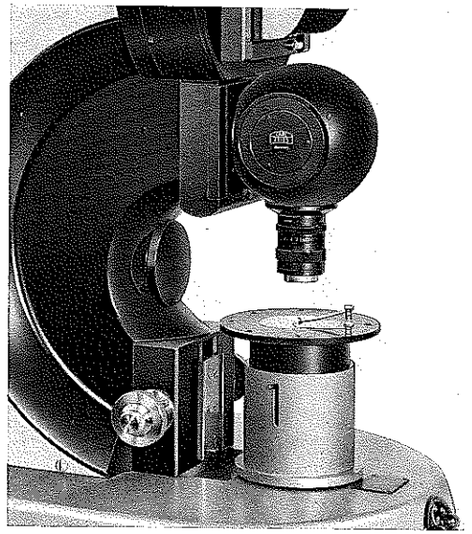
   Spectacle-lens condensers 1 to 3 are seated on holders having a ring dovetail with which, like other condensers, they are inserted in the condenser carrier. They can then be centered. Spectacle-lens condensers 4 and 5 are simply inserted from above into the condenser carrier. They are in correct position when their identification number faces the observer. In order that the spectacle-lens condenser may sit straight, the cut-outs in the centering rim should lie over the centering screws (G 28) and the spring bolt (G 29). The slip-on diaphragm should remain on the spectacle-lens condensers.
3. Attach the stage carrier and stage (page 47). If necessary, remove the stage diaphragm so that the spectacle-lens condenser can freely extend into the stage opening.
4. Attach Luminar Head (F 1) in place of Tube Head (E 1).
5. Screw the selected LUMINAR into the appropriate holder, and if required, insert and push to the stop the supplementary system 0.8 into the opening of the holder. The whole, after releasing clamping screw (F 2), is inserted from below into the Luminar Head (F 3). The iris diaphragm of the LUMINAR must onconditionally be fully opened, i. e. stand on "I".

### Adjusting the illuminator

6. Switch on the illuminator.

   The filament bulb always suffices here. Usually the illumination intensity supplied by it is much too great for the present purpose, so that it must be reduced by means of the voltage regulator (L 18) or through the insertion of an appropriate combination of gray filters.
7. Set lever (A 23) on "Luminar".
8. Set illuminator setting knob (A 19) so that the light from the filament bulb emerges from the light-exit opening (A 10) in the base of the instrument.
9. Open camera shutter (B 9) and with coarse adjustment (G 3) of the Microscope focus the specimen on the focusing screen (B 7).
10. Adjust the camera for the desired magnification (Table 11). For this, use is made of the magnification numbers on the knob (A 17) for adjusting the camera length. The numbers correlated to the employed LUMINAR have the same color as the marking on the LUMINAR. The line under the desired number must be brought to lie at the lower edge of the window.
11. Again focus the image on the focusing screen.
12. With aid of diaphragm (A 24) regulate the illuminating aperture, so that image contrast and sharpness are at their best. Here too, care should be taken to avoid excessive stopping down.
13. Photographing (page 86).





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## LUMINAR 2.5 – 5

As appears from table 11, page 67, the lowest magnification obtainable with a LUMINAR as described on page 68 is about 5.5×. The construction of ULTRAPHOT II does not permit the use of standard photographic objectives having focal lengths exceeding 100 mm.

For magnifications below 5.5× it is necessary to employ a special system like that of an inverted telesystem. Such is embodied in LUMINAR 2.5–5.

The fields, which can be imaged with such an objective, have diameters between 30 and 60 mm. Fields of this size cannot be illuminated with use of a standard microscope stage, the stage opening being too small. Also a special illuminating system is necessary. These requirements are met by the macro stage for transmitted light (Fig. 49).

**The macro stage for transmitted light** has a stage plate which can be adjusted at two different heights, and contains lenses for illuminating an object field having a diameter of about 60 mm.

At the lowest magnification only the area of the focusing screen (B 7) is completely illuminated, but not that of the ground-glass screen of the Projection Head (D).

Like the other LUMINARS, LUMINAR 2.5–5 has an iris diaphragm (F 43) and besides a focusing ring (F 42). The former, as usual, serves for stopping down only in photographing with incident light. For transmitted light it must be completely open, since otherwise, due to loss of resolving power, the image sharpness is reduced. The image is focused with ring (F 42).

The following is the procedure in working with LUMINAR 2.5–5:

### Setting up the apparatus

1. Remove stage carrier and stage as well as condenser carrier (G).
2. Set the macro stage (Fig. 49) on the base of the ULTRAPHOT II so that the projecting rim on its bottom fits over the light-exit opening (A 10) and thus centers the stage. The trade-mark must face the observer, because otherwise one of the three screws forming the three-point contact would come to lie in the depression in front of the pinion box (A 9). Before putting the stage into position, any required filters are placed in the light-exit opening (A 10), unless they are mounted in the rear opening of the LUMINAR.
3. Attach Luminar Head (F 1).
4. Attach LUMINAR 2.5–5 (F 41) in the same manner als LUMINAR 100, or as the holders of other LUMINARS.

5. For magnifications between **2.5**× and **3.6**× (maximum size of object about 50–30 mm. [2"–1 3/16"]) bring the **stage plate** into its **lower** position.

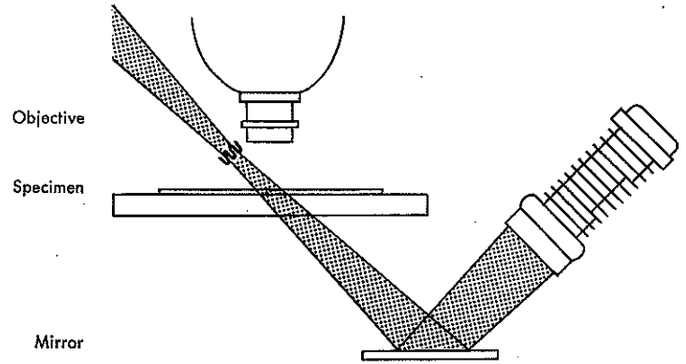
   For magnifications between **3.6**× and **5**× (maximum size of object 33 to 20 mm. [1 9/32" to 25/32"]) bring the **stage plate** into its **upper** position (Fig. 49).

**Adjusting the illumination**

6. Switch on the illuminator.
7. Set lever (A 23) on "Luminar".
8. Set illuminator setting knob (A 19) so that the light from the filament bulb emerges from the light-exit opening (A 10) in the base of the instrument.
9. Open camera shutter (B 9).
10. Mount the specimen on the stage plate and focus with the lower knurled ring (F 42) of the LUMINAR until the image is sharp on the focusing screen (B 7). If the focusing screen is unevenly illuminated, e. g. if a dark shadow appears in one corner, the centering of the illumination can be improved by turning the screws on the lower end of the macro stage in and out. This should be necessary only the first time the stage is used.
11. Vary the camera length until the specimen most advantageously fills the image field, continuously turning knurled ring (F 42) to keep the image in focus. With the employed low magnifications this is preferable to determining beforehand the most suitable magnification. The magnification employed in taking a photograph is best ascertained by applying a scale to the focusing screen to measure the distance between two conspicuous points and dividing it by the corresponding distance in the specimen.
12. Regulate the illuminating aperture with the aid of diaphragm (A 24).
13. Photographing (see page 86).



## Other illuminating procedures with LUMINARS

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Occasionally the necessity for oblique illumination can arise, for emphasizing spatial relations in the object, or for dark-field illumination to achieve adequate contrast.

**Oblique illumination** can be obtained by decentering the light source with screw (H 10) for its lateral adjustment, while diaphragm (A 24) is wide open. The effect is visible on the focusing screen. Fixed rules cannot be given. The most favorable effect must be sought by experimentation.

**Dark-field illumination.** Only unilateral dark-field illumination comes into consideration here. It can be brought about with the aid of a plane mirror (flat side of an ordinary microscope mirror) and a microscope illuminator on stand or mounted on the holder (Fig. 54) described on page 82, e. g. our low-voltage illuminator or our milti-purpose illuminator.

Mirror and illuminator are set up as in Fig. 50. The bulb is adjusted in its housing so that an image of the light source is formed close to the objective. Its location is ascertained with the help of a sheet of translucent paper. Here too, the most favorable effect must be sought by experimentation.

## Working with incident light

Transillumination is the standard procedure for the examination of objects which by nature are sufficiently thin to be translucent, likewise when it is possible to artificially prepare sufficiently thin sections of thicker, opaque objects. Vertical illumination on the other hand provides means for eximining the surface structure of opaque objects.

A distinction is made between the examination of unprepared surfaces and surfaces which have been subjected to various treatments. For the former, as a rule, relatively low magnifications are used in order to obtain an adequate depth of field. The illumination in this case preferably is dark-field, since the specimen usually reflects diffusely. In the second case, however, a polished surface usually is prepared, because the aim of the examination is to ascertain the microstructure of a more or less complex solid. The structural elements are visible under the microscope either due to differing physical characteristics (color, reflectivity, polarizing properties), or due to a relief produced by the method of preparation (polishing, etching).

Bright-field illumination is the method of choice for the examination of polished specimens. In special instances, the use of dark field or even phase contrast supplies additional information. There are no limits to the magnification in the observation of polished specimens (table 3, page 20).

Satisfactory results are obtainable only with objectives having a well-flattened image field, since the polished specimen presents a plane surface. The so-called EPIPLAN objectives are specially suitable.

The ULTRAPHOT II is converted for working with incident light by supplementing its equipment with an illuminating device developed for the purpose. It consists of the following for the compound microscope:

an illuminating tube (Fig. 51),
a diaphragm inset (Fig. 64, page 97),
the vertical illuminator (page 97).

The first two parts are installed in the carrier (A 18), the last is mounted in place of the revolving nosepiece (E 9) on the dovetail slide located at the lower end of the Tube Head. Contrary to the nosepiece, it is inserted from right front to left rear.

Up to serial number 55 015 the ULTRAPHOT II is equipped with a ring dovetail changer for objective holders (E 9), and, naturally, vertical illuminators for use on these instruments are similarly equipped.



**The vertical illuminator** (Fig. 65, page 97) consists of the illuminator-housing with a fixed tube lens, and the illuminating attachment. The housing has a lateral receptacle (653 in Fig. 65) for the reflectors, and below a receptacle for the change rings to which the objectives are screwed.

The illuminating attachment is firmly connected with the housing. The former contains the bright-dark-field slide (654), a slot for the insertion of filters mounted in ring holders, a swing-out gray filter (652), a lever (655) for operating the luminous-field diaphragm with centering device (656), and an opening with resilient positioning pin for the insertion of an interference gradation filter, should such be required.

The diaphragm inset (Fig. 64), contains the aperture diaphragm. Its opening is adjusted by a lever. Two screws below the light-exit opening serve for centering the diaphragm, or for decentering it if oblique illumination is to be used.

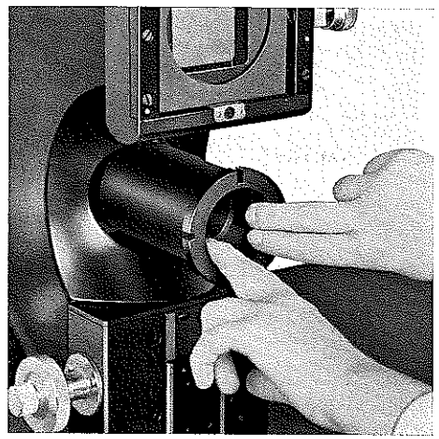
If the ULTRAPHOT II is ordered for use with vertical illumination, it is supplied with the illuminating tube (Fig. 51) and the diaphragm inset (Fig. 64, page 97). The illuminating tube is permanently installed in ULTRAPHOT II with serial numbers starting at 58 390 (6- and 7-place numbers excepted). In these instruments it is only necessary to insert the diaphragm inset in accordance with section 5 of the following.

Any user himself can readily **install** the **illumination tube** and **diaphragm inset** if these parts are subsequently ordered for an instrument originally supplied without them.

1. Pull cover (A 8) out of the knurled cylinder.
2. Unscrew the knurled cylinder.
3. Insert the illuminating tube so that one of the two notches separated by 90° points upwards, the other to the left (Fig. 51) and push in up to the stop. In so doing, a positioning pin inside the instrument body facing the tube flange must engage the left notch, so that the tube is oriented and can no longer turn.
4. Again screw in the knurled cylinder, up to the stop, but do not draw it so tight that it becomes difficult to unscrew it again.
5. Insert the diaphragm inset (Fig. 64) into the knurled cylinder, so that the positioning pin extending backwards from the rim engages the upper notch in the flange of the illuminating tube. Then the centering screws lie right and left below, so that they can easily be manipulated.

Illuminating tube and diaphragm inset can remain permanently in position.

**51**



**The specimens** which are to be observed with vertical illumination are mounted in suitable manner on the normal microscope stage. With polished specimens it is important that the polished surface is aligned precisely perpendicular to the microscope axis. For this purpose it is customary to squeeze the specimen, lying polished face down on a glass or metal microscope slide, into a piece of plasticine (with the aid of an alignment press). Frequently the procedure is found troublesome, although it alone protects the polished surface against being scratched up. In addition, there is the advantage of having the entire polished surface in full view as the specimen is mounted on an erect microscope.

Generally inverted microscopes are used only because the polished specimens are placed on them without any preliminary orientation of the polished surface. However, this convenience can also be obtained on an erect microscope with the aid of a special polished-specimen stage (G 51).

**The polished-specimen stage** carries on its stage plate (G 51) two pillars connected by a bridge (G 52) having a central opening. After releasing two screws, the bridge can be removed and, if necessary, replaced by one with a different opening. A plate covered by a foam plastic cushion is pressed by a spring against the under surface of the bridge. The plate is pushed down by a slight pressure on its rim in order to place the specimen on it, face up. When the plate is released, the spring raises it and the polished surface is pressed against the bridge which aligns it as simply and precisely as if it were placed on the stage of an inverted microscope.

This stage, like other stages, is inserted in the centering piece (G 14) mounted on the stage carrier. It is lubricated the same way as the gliding stage (page 48).

**For low-power photographs** the same LUMINARS can be used as with transmitted light. LUMINARS 2.5–5 and 16, 25, 40, 63, and 100 are used with laterally incident light (table 10, page 66), produced by a variable number of lamps arranged about the microscope stage.

We have designed a special holder for ULTRAPHOT II (Fig. 54, page 82) providing a wide range of suitable adjustments of the lamps. The most favorable illumination for photographs of this kind can only be found by experiment. Precise instructions cannot be given, since they depend too much on the nature of the object photographed.

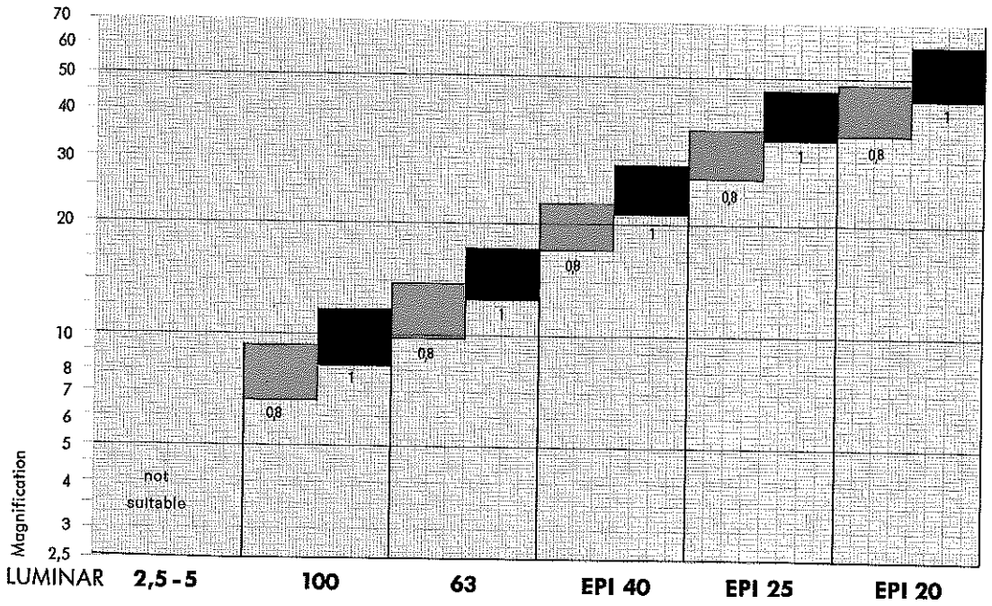
Low-power photographs with LUMINARS in vertical bright-field illumination require the objectives and survey illuminators shown in Table 13. The complete series of magnifications listed can only be obtained with aid of the supplementary system 0.8. With illuminators (F 55) and (F 61) it is inserted in their holder (F 51), with illuminator (F 75) in the LUMINAR. The obtainable magnifications are shown in tables 12 and 13. All survey illuminators contain **very thin plane-parallel plates. Therefore caution, do not poke into the illuminator.**

Epi-LUMINARS, 20, 25, and 40 are screwed from below into the special thread of the illuminator (F 61). LUMINAR 63 must be inserted into the interior of survey illuminator (F 55). That is possible after unscrewing holder (F 51). LUMINAR 63 must be screwed up to the stop into its thread. Then the lower part can again be attached. Both illuminators are attached with their ring dovetail to the Luminar Head (F 1) of the ULTRAPHOT II.



Table 12

**Magnifications available in low-power photographs**
with LUMINARS in **vertical bright-field illumination**




Illuminator (F 75) is screwed on thread (F 73) of LUMINAR 100 (F 71), usually protected by a covering ring. LUMINAR together with illuminator are attached by means of the ring dovetail of the LUMINAR to the Luminar Head (F 1).

The illumination of the ULTRAPHOT II is adjusted as in vertical illumination with the compound microscope. The diaphragm of the epi-illumination diaphragm inset (Fig. 64) is used also here as aperture diaphragm. It is closed to about 1.5 to 3 mm.

The illuminators must be aligned so that the pockets (F 54), (F 64), (F 74) for filters of 32 mm. diameters lie precisely in the beam of the emergent light. Uniform illumination is dependent on their precise alignment.

Table 13

**LUMINARS, vertical bright-field illumination**
(see also Table 12)

| for magnifications of ca. | to ca. | required **LUMINAR** | Suppl. system | Illuminating device for LUMINAR |
|---|---|---|---|---|
| 6.5× | 9 × | **100 mm.** (F 71) [1] [2] as for transillumination (F 31) | 0.8× | Survey illuminator for LUMINAR 100 (F 75) |
| 8.5× | 12 × | | — | |
| 10 × | 14 × | **63 mm.** (F 52) [2] as for transillumination (F 22) | 0.8× | Survey illuminator for LUMINAR 63 (F 55) |
| 12 × | 17.5× | | — | |
| 17 × | 23 × | **Epi 40 mm.** | 0.8× | Survey illuminator for Epi-LUMINAR 20, 25 and 40 (F 61) |
| 22 × | 29 × | | — | |
| 27 × | 36 × | **Epi 25 mm.** | 0.8× | |
| 34 × | 47 × | | — | |
| 35 × | 49 × | **Epi 20 mm.** | 0.8× | |
| 44 × | 62 × | | — | |

1) Every LUMINAR for ULTRAPHOT II, starting with serial No. 2 212 549, can be used; to LUMINARS with lower serial number the survey illuminator can be attached only with intermediate ring (Catalog No. 47 25 79). In that case d o n o t use supplementary system 0.8×.

2) Iris diaphragm (F 72) always fully opened.





## Bright-Field and Dark-Field Illumination

The two methods differ so little that they can be treated jointly.

**Preparing the instrument**
It is assumed that illuminating tube (Fig. 51) and diaphragm inset (Fig. 64) are attached to the instrument and that the light source is adjusted (page 51).

1. Attach Tube Head (E 1) together with binocular (E 3). Place eyepieces in the tube. Set OPTOVAR (E 18) on 1.25.
2. Insert vertical illuminator up to the stop, from right front to left rear in the dovetail on the lower end of the Tube Head (E 21).
3. Attach EPIPLAN objective mounted on change ring by placing the change ring in the receptacle provided for it at the lower end of the illuminator housing and locking it by depressing the handle towards the illuminating attachment.

   In making the adjustment it is best to use EPIPLAN 10×. If only examinations with bright-field illumination are carried out, standard EPIPLAN objectives are used. If examinations are to be made also with dark field, EPIPLAN HD objectives equipped with dark-field mirrors are required.
4. Attach stage carrier bearing the stage and mount the specimen on it. With fine adjustment (G 4) bring the stage close to the upper stop. Move the stage carrier upwards on the dovetail until the upper surface of the specimen lies close to the front of the objective, but not in actual contact with it (protection of the objective against damage).

**Adjusting illumination and image**

5. Switch on the illuminator; lever (A 23) set on "Micro".

   It is recommended always to begin with the filament bulb. More powerful light sources are employed only if the exposures exceed 20 to 30 secs.
6. Setting knob (A 19) is set so that the light from the illuminator emerges from the opening of the diaphragm inset for reflected light (page 97) (table 5 on page 31). Slider (E 17) in the Tube Head on red ring.
7. Bright-Field illumination:
   Insert the plane-glass ("H-Pl") or the prism ("H-Pr") reflector into the vertical illuminator (653 in Fig. 65). Set the bright-dark-field slide (654) on **bright field** (i. e. switch in the lens), swing out the gray glass, lower the luminous-field lever (655) to the stop, and set the aperture diaphragm (Fig. 64) on "2".

Dark-Field illumination:

Insert the dark-field reflector "D". Set the bright-dark-field slide into the vertical illuminator (654 in Fig. 65) on **dark-field (annular diaphragm switched** in), swing out the gray glass, lower the luminous-field lever to the stop, raise the aperture-diaphragm lever (Fig. 64) to the stop.

8. While observing through tube (E 3), focus the specimen with a low-power objective (about 10×).

9. Only with bright-field illumination:

   Raising lever (655), close the luminous-field diaphragm until its margin appears in the field of view. It is sharp without taking any special measures. Its diameter should be somewhat less than that of the field of view.

10. Only with bright-field illumination:

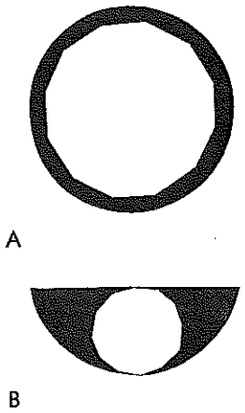
    Center the image of the luminous-field diaphragm in the field of view. This is done by appropriate adjustment of levers (656). Open the diaphragm sufficiently to illuminate the entire field of view.

11. Only with bright-field illumination:

    With OPTOVAR (E 18) in position "Ph", focus with (E 19) on the image of the aperture diaphragm and center it in the exit pupil of the objective with the centering screws (Fig. 64).

    If a plane-glass ("H-Pl") reflector is used, the image should lie in the center of the opening (Fig. 52 A), with use of a prism reflector ("H-Pr") within the semicircular area free for observation (Fig. 52 B).

    If the image of the aperture diaphragm travels as a polished specimen is rotated, the latter must carefully be realigned with an alignment press.



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A

B

12. Only with bright-field illumination:

    Return to position 1.25 of the OPTOVAR (E 18) and with the lever (Fig. 64) adjust the aperture diaphragm to suit the requirements of the specimen.

    In imaging polished preparations of metals, the error is often made of using too small an illuminating aperture, more rarely it is too large. If the aperture is too small, there is undue loss in resolving power, details are not adequately imaged. If too large, the image is deficient in contrast and there may be a loss in brightness towards the margin. Generally it will be found that an illuminating aperture between $^2/_3$ and $^4/_5$ of the objective aperture is correct. If nessessary, check as described under 11.

13. Obtain the desired magnification by attaching the objective required and setting the OPTOVAR (E 18) in accordance with table 12. Repeat the adjustments of section 9 to 12.

14. Photographing (page 86).



## Phase Contrast with Incident Light

The phase-contrast method can be applied only if an image of the aperture diaphragm can be formed in the path of rays. With incident light that is the case only with bright-field illumination and specularly reflection objects. Consequently, only p o l i s h e d preparations offer prospects of succes with this method.

For carrying out the method with the ULTRAPHOT II, special EPIPLAN Ph objectives are required and a phase-contrast diaphragm inset (Fig. 53). Epiplan Ph objectives are available in magnifications of 25, 40, 63, and 100×. They contain the phase rings.

The phase-contrast diaphragm inset (Fig. 53) contains, instead of the centering aperture iris diaphragm (page 97), a centering diaphragm carrier which is turned by a knob and into which can be inserted annular diaphragms correlated with the above objectives and two fixed diaphragms differing in size. The latter take the place of an iris diaphragm if phase contrast and bright field are used alternately. The diameters are such that best bright-field images are produced.

### Setting up the instrument

The starting point is the setup for bright-field and dark-field observation as described in page 77.

1. Detach the vertical illuminator from the instrument.
2. Take out the aperture-diaphragm inset (Fig. 64, page 97) and in its place insert the phase-contrast diaphragm inset (Fig. 53).
3. Replace the vertical illuminator.
4. Attach EPIPLAN Ph 25× objective.

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### Adjusting illumination and image

5. Switch on the illuminator.
6. Set setting knob (A 19) on vertical illumination for the lamp employed.
7. Insert the plane-glass ("H-Pl") reflector into the vertical illuminator, set the bright-dark-field slide (654) on bright field, swing out the gray glass (652), lower the luminous-field lever (655) to the stop, and switch in diaphragm "2" of the diaphragm inset by turning the knob so that the number "2" lies beside the index.
8. Focus the specimen and close the luminous-field diaphragm (655, page 97) until it just appears within the border of the field of view.
9. With pins (656) center the image of the luminous-field diaphragm in the field of view and then open the diaphragm (655) just enough to illuminate the entire field of view.

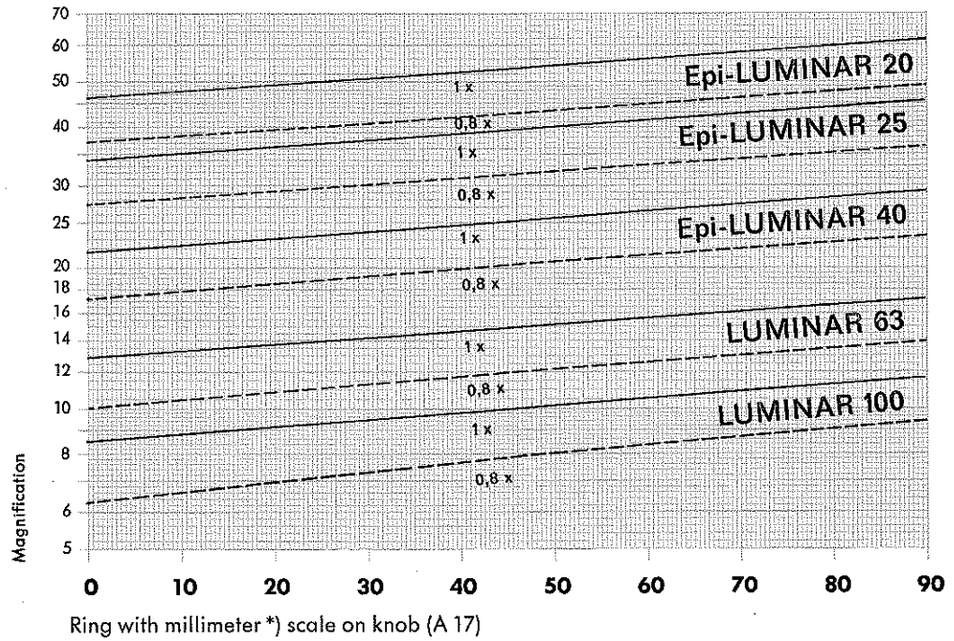
**Adjusting the phase-contrast image**

10. On the diaphragm inset (Fig. 53) swing in the annular diaphragm correlated with the employed EPIPLAN Ph objective by bringing the respective engraving, e. g. "Ph 25", beside the index.
11. Check whether the image of the specimen still is in focus; if necessary refocus.
12. Turn OPTOVAR (E 18) into position "Ph" and while observing through the Microscope, focus phase ring of the objective and annular diaphragm of the condenser by turning the lower knurled disk (E 19) on the OPTOVAR. Both must simultaneously be in focus.
13. Bring Ph ring and image of annular diaphragm into superposition by manipulating the two centering screws on the diaphragm inset.
14. Turn the magnification changer OPTOVAR back into observation position.

Table 14

**Magnification with survey illuminators for vertical illumination**

——— LUMINAR only  ———— LUMINAR with supplementary system 0.8×




*) This ring with millimeter scale (Catalog No. 47 25 00 U 53 Ta. 2) can subsequently be attached to any ULTRAPHOT II.





The supplementary parts required for photographs with incident light are described on page 76 and in table 13.

## Vertical Bright-Field Illumination

**Setting up the instrument**

Illuminating tube (Fig. 51 ) and diaphragm inset (Fig. 64) are already attached to the instrument.

1. Tube Head (E 1) is replaced by Lumi..ar Head (F 1).
2. Connect the selected LUMINAR with the correlated illuminator.
3. Attach the survey illuminator together with LUMINAR on the Luminar Head so that the filter pocket (F 64) faces the diaphragm inset.
4. Attach the stage on the stage carrier (page 47, section 6–7).

**Adjusting illumination and image**

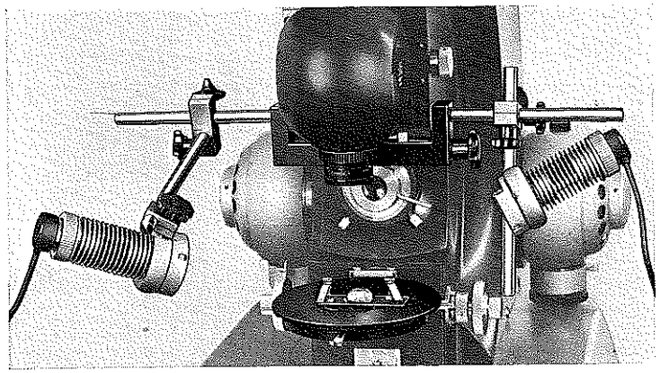
5. Switch on the illuminator.
6. Set setting knob (A 19) on vertical illumination for the lamp employed (table 5 on page 31).
7. Completely open aperture diaphragm (Fig. 64).
8. Open shutter (B 9) and while observing the focusing screen, focus the specimen by adjusting the height of the stage.
9. Check alignment of the illuminator.

For this purpose it is slightly moved back and forth after releasing clamping screw (F 2) while observing the illumination of the image. The distribution of illumination should be identical on both sides.

Alignment of the illumination was insufficient if the photograph shows a loss of brightness on one side.

The alignment can be checked even more precisely with Epi-LUMINARS 20, 25, and 40 if the stage plate bearing a piece of white paper is raised to within 1 to 2 cm. of the lower end of the LUMINAR. The alignment is correct if with aperture diaphragm "1" the light spot appearing on the paper is circular and uniformly bright.

10. Adjust the camera for the desired magnification (Table 14).
11. Refocus the image on the focusing screen.
12. While observing the image with a focusing magnifier on a clear strip of the focusing screen, adjust the aperture diaphragm until image contrast and resolution appear at their best. Too great a reduction of the aperture inevitable results in unsatisfactory photographs.
13. Photographing (page 86).



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## Vertical Dark-Field Illumination

This type of illumination for low-power photographs corresponds to the type we are accustomed to in daily life. Objects are irradiated with pencils of light having more or less high apertures, at random angles of incidence, and coming from random directions. Essentially it is the diffusely reflected light which is used for imaging. Occasionally there also are individual parts of the object appearing bright due to specular reflection (reflections). Depending on the specimen and the purpose of the photograph, such reflections are desirable because they enliven the picture, or undesirable because they obscure structural and color details.

With the ULTRAPHOT II this type of illumination is realized by the use of optional illuminators arranged to serve the purpose. The illuminators could be set up beside the instrument. However, their stands would usually be in the way. To avoid this we have developed a **holder for our low-voltage illuminators.**

The holder (Fig. 54) consists of a clamp bearing on either side a supporting rod. The clamp is opened sufficiently that it can be pushed over the lower end of the shutter housing behind the Luminar Head and clamped on there. One or more low-voltage (6 V 15 W )illuminators can be attached directly to the supporting rods.

Two additional supporting rods with cross clamps are available. These provide for an almost unlimited range of adjustment. Fig. 54 illustrates several examples.

Detailed working instructions cannot be given for such photographs. The most favorable illumination for a good, satisfactory representation of the specimes can be found only by experimentation. Frequently it is important to adapt the background very precisely to the brightness distribution. This is best accomplished by supplementary bright-field transillumination, appropriately adjusted in intensity.



## Disturbing reflections with vertical illumination and their elimination

There are two cases in microscopy with incident light in which reflections are disturbing:

**1. With vertical bright-field illumination.** Here the illuminating beam passes from the observation side through the objective upon the specimen. It is unavoidable that at every glass-air surface a portion of the light is reflected. Some of the light reflected by the more or less numerous surfaces present in the beam reaches the image together with the image-forming light reflected by the specimen. Depending upon the ratio of the two, that reflected from the optical surface either remains invisible or it covers the image with a disturbing veil. Naturally, the latter is more likely with specimens of low reflective power.

Due to the curvature of most reflecting optical surfaces, it can happen in unfavorable circumstances that the image on the focusing screen shows reflections of diaphragm opening, especially of the aperture diaphragm. The specific curvatures of lenses are essential factors in obtaining the desired image-forming characteristics of an objective. These curvatures cannot be selected with reference to the possibility of such diaphragm reflections airsing, hence it is pureley a matter of chance whether they occur.

There are various possibilities for diminishing or completely eliminating such reflections:

1. Providing the reflecting surfaces with a reflection-reducing coating.
2. Appropriate adjustment of aperture and luminous-field diaphragm.
3. Shifting of the image of the pupil by an auxiliary lens in the observation beam.
4. Use of a so-called antiflex device.

**A reflection-reducing coating** is employed as a matter of principle to glass-air surfaces of our objectives for observation with epi-illumination. This greatly reduces the phenomenon, without however completely eliminating it.

**Appropriate adjustment of the diaphragms** involves keeping the aperture diaphragm as large as possible, the luminous-field diaphragm as small as possible.

Both measures fully suffice to avoid impairment of the image through reflected light if highly reflecting specimens are used, e. g. all polished preparations of metals. But they do not suffice with darker objects, such as e. g. polished specimens of ores, coal, and plastics. With such materials, especially in the case of low-power EPIPLAN objectives 6.3×, 10×, and 16×, it is necessary to shift the image of the pupil or to employ the antiflex method.

The image of the exit pupil is shifted by means of an auxiliary lens which is centered on a slide ("auxiliary lens slide" 651, page 97). As shown in Fig. 65, the slide is inserted in the vertical illuminator. The lens can be moved in or out as required. It should be inserted only if it effects a visible improvement of the image contrast.

Beginning early in 1962, all vertical illuminators as shown in Fig. 65 (page 97) will be supplied with this slide. Previously delivered instruments can be subsequently equipped with it.

**The antiflex method** depends on the use of plane-polarized light for illumination. An analyzer mounted in the imaging beam behind the objective in crossed position to the polarizer extinguishes the light reflected at the lens surfaces. However, the imaging light is converted by a quartz plate in front of the objective from plane-polarized to elliptically polarized light. To have the quartz plate fully effective, it is necessary that the objective can be rotated. The above-mentioned EPIPLAN objectives are equipped with the antiflex device.

If the antiflex is to be obtained in working with these objectives, the instructions on page 78 after section 13 are to be supplemented by the following steps. If that is not desired, they can be used the same as ordinary objectives.

13. **a.** Place the polarizer for incident light (Fig. 57) into the cutout for insertion of filters. The pin should be pressed into the notch. Set the polarizer on "0".

**b.** Push in the analyzer. The simple analyzer (Fig. 57, page 90) is fixed in the correct position, the rotatable analyzer (E 6) is to be set on "0" or turned so that with the objective removed the field of view is as dark as possible. A front-surface mirror serves best as specimen.

**c.** Attach the objective, focus the specimen, and rotate the objective until the image shows maximum brightness.

**2. With vertical dark-field illumination.** Polarized light is also used here to diminish or eliminate reflections which in the form of glares occasionally obscure structural details as mentioned on page 82. For this purpose simple polarizing filters having a diameter of 32 mm. suffice. By rotating the filters a position can be found in which the disturbing reflections disappear. Often it is expedient to merely reduce but not completely eliminate them.



## Photographing with the 9 x 12 cm. Camera (In USA 4 x 5")

Also in photomicrography it is advisable to use sheet film instead of plates. Practically all emulsions are obtainable today in sheet film. We call attention particularly to fine-grain thin-coated film and to process films.

The holders supplied for our instruments accommodate besides plates also sheet film without supplementary fixtures. Before work begins, an adequate number of loaded holders should be on hand. The upper right drawer of the work table has a convenient compartment for receiving such holders.

After focusing the image it is necessary to decide which filter, if any, is to be used. The effect and choice of filters is treated in the literature.

In the following instructions it is assumed that the automatic exposure device has been calibrated (page 58) and that the sensitivity-selector knob (B 6) is adjusted to the found correct calibrating value. If a variety of emulsions is in frequent use, it is advantageous to note their calibrating values on gummed labels and paste these alongside the sensitivity-selector knob (B 6).

Naturally, the ULTRAPHOT II can also be operated without making use of the automatic exposure device. The shutter can be worked directly by hand, using a stop watch or other timer. That is always necessary when the specimen is of such a nature that the automatic procedure is not applicable. This exeptional situation exists if a large part of the object field, especially that used by the photocell for control, is dark. Such is the case in dark-field photomicrography and frequently in microscopy with polarized light. In these instances use is made of the classic method for determining the correct value by a series of trial exposures.

In the following working instructions it is assumed that with the compound microscope the image is first focused in the eyepiece. For low-power photographs with the simple microscope it is focused from the beginning on the focusing screen.

**The photograph**

1. Switch on automatic device with (A 11).

2. Set slider (E 17) on the Tube Head on the red or black ring. Open camera shutter by lowering the cocking lever (B 9) into its horizontal position.

   The image must appear on the focusing screen, even if not sharp.

3. Using the fine adjustment (G 4), provisionally focus the image with the naked eye.

4. Close luminous-field diaphragm (A 24) until the rim of its image about touches the vertical sides of the focusing screen (B 2). If necessary, recenter the diaphragm. Repeat after opening sufficiently to touch the horizontal sides.

5. Open the luminous-field diaphragm (A 24) far enough that its rim just disappears behind the corners of the focusing screen. That is important. The automatic exposure device cannot operate properly if the field of the ground glass is not fully illuminated up to its corners, because then the photocell (B 13) is not fully illuminated.

6. Adjust the desired magnification by swinging in the appropriate step of the magnification changer OPTOVAR (E 18) and changing the camera length. Preferably only the magnifications of the standard series shown in table 15 are selected.

7. Definitely focus the image. If necessary, employ the elongated focusing magnifier designed for the ULTRAPHOT II. Before using the first time, it is applied to the plane of the ground glass and, after releasing the knurled clamping ring, the upper part is moved back and forth in the lower part until the grain of the ground glass is in focus for the eye of the user, then clamped in that position. When focusing the image on the focusing screen, the magnifier is set on the aerial image appearing in one of the clear diagonal strips. The image must be in focus simultaneously with the edge of the strip.

Table 15

**Standard magnification series**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 50 | 60 | 80 | 100 | 125 | 160 | 200 | 250 | 320 | 400 |
| 500 | 600 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3200 | × |

8. Insert the filter, if used.

9. Check whether the sensitivity-control knob (B 6) is correctly adjusted.

10. Carefully insert the holder between the focusing screen and Photo Head and press it downwards to the stop.

    The exposure time with the automatic device should not be less than 1–2 sec. If there is any question, an exposure is made without pulling the slide from the holder, and timed. Should it prove to be too short, the intensity of illumination is reduced by lowering the operating voltage of the light source (only possible with the filament bulb and use of black-and-withe films), or by insertion of one or a combination of the gray filters supplied by us. Four constitute a set. Their transmittances are 50%, 50%, 12%, 3%. By appropriate combinations the intensity of illumination can be reduced in steps of 1:2 (table 16).

11. Whether the required exposure time will prove to be too long can usually be determined by observation of the image on the focusing screen. One of the more powerful light sources should be employed if, even with the room darkened, hardly anything is visible on the screen.



Table 16

**Transmittance of the gray filters**

| Gray filter | Illumination intensity % |
|---|---|
| without | 100 |
| 0.50 | 50 |
| 0.50+0.50 | 25 |
| 0.12 | 12 |
| 0.12+0.50 | 6 |
| 0.03 | 3 |
| 0.03+0.50 | 1.5 |
| 0.03+0.50+0.50 | 0.75 |
| 0.03+0.12 | 0.36 |

After having made a test in the foregoing manner, the **shutter** is **again cocked** by lowering the cocking lever (B 9) to the stop, **before withdrawing the slide** from the holder.

12. Completely remove the slide from the holder.

13. Start the automatic exposure device by a **brief** pressure on the red push button (A 15). Wait until the shutter has closed. While the shutter is open, the red pilot lamp (A 13), above the release button, lights up.

    During prolonged exposures, e. g. at high magnifications, it frequently is desirable to know whether the focus has changed during this period. When using objectives having a magnification of 40× or higher, it is possible to observe the image through the binocular tube. To do so, slider (E 17) in the Tube Head is set on the red ring. If the eyepiece tube is correctly adjusted to the value of the interpupillary distance (important, page 21), the microscopic image viewed through the binocular tube and that on the focusing screen are simultaneously in focus, independent of the camera length.

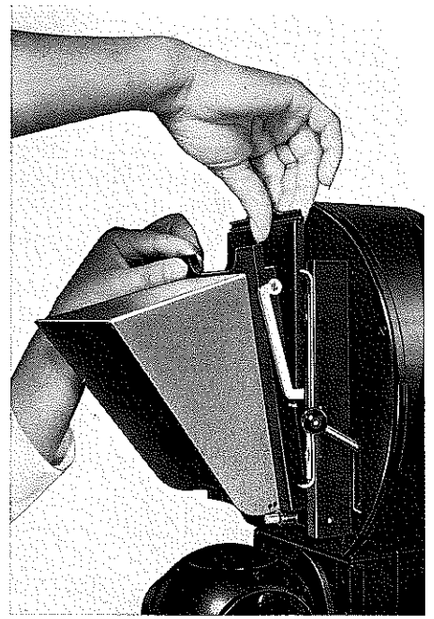
    During long exposure times it is possible to readjust the focus by careful use of the fine adjustment (G 4).

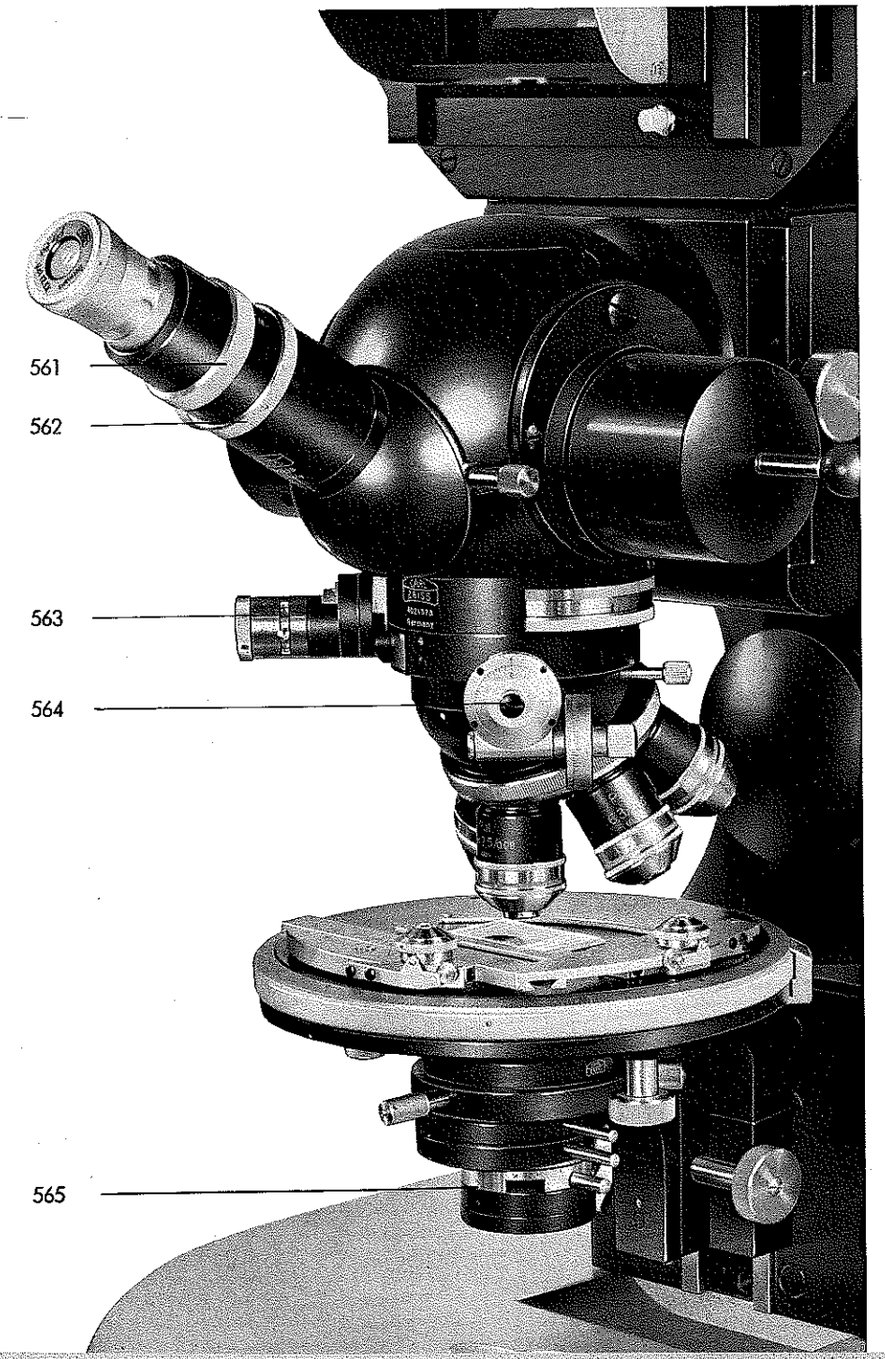
14. Reinsert slide into holder. Make sure that the frame of the focusing screen is not pulled back, so that light cannot fall upon the uncovered film material.

15. Remove the holder. For this purpose the focusing screen is pulled back (Fig. 55), freeing the holder so that it can be grasped.

16. Develop the plate or film **exactly the same way** as the calibrating exposures (developer, concentration, temperature, duration).

**55**






**56**



561 Knurled ring for focusing the centering telescope consisting of eyepiece and Amici-Bertrand lens for conoscopic observation on the exit pupil of the objective. The Amici-Bertrand lens for conoscopic observation on the left side of the tube. A scale indicates the required tube length for each eyepiece.

562 Tube iris diaphragm

563 Swing-out, rotatable analyzer (E 7)

564 Compensator

565 Swing-out and rotatable polarizer

## ULTRAPHOT II as Polarizing Microscope

By the addition of suitable supplementary parts, every ULTRAPHOT II can be used as a simple or also as a complete polarizing microscope. With few exceptions the supplementary parts are the same as used on our other polarizing microscopes.

The following supplementary parts are required if an ULTRAPHOT II is to be used as a polarizing microscope:

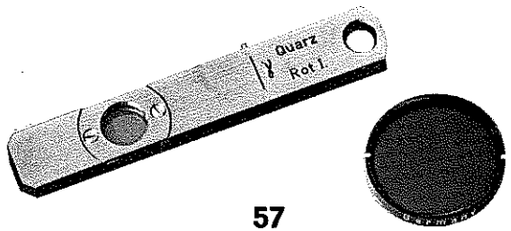
1. A polarizer
2. A polarizing rotating stage
3. An analyzer
4. A large polarizing tube with Bertrand lens or an inclined binocular tube POL.

Polarizer, analyzer, and tube, which latter in this case has notches for orientation of the inserted crosslines eyepiece, must be aligned to one another. This can be achieved only through special adjusting measures.

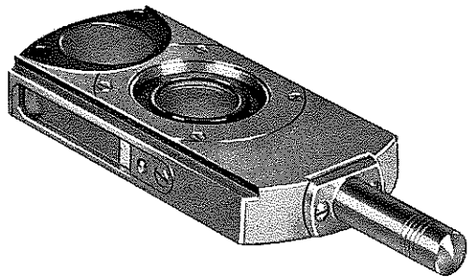
In addition, all optical elements located between polarizer and analyzer (condenser, objective, auxiliary lenses) must be free of strain. In routine mass production it is not possible to adequately exclude the presence of such strains which would interfere with polarizing microscopy. Therefore it is necessary to employ specially produced strain-free condensers and objectives as well as special objective carriers (revolving nosepieces, holders for individual objectives) because of their auxiliary lenses. Beginning with serial number 55 016 of the instrument, all structural elements of this kind are characterized by r e d - filled engraving and by the designation "POL". Under these conditions no noticeable depolarizing phenomena occur with the ULTRAPHOT II POL, neither in the observation nor in the photographic beam, which could falsify the interference images or colors.

A detailed description of the polarizing equipment is given in operating instructions G 40-540, Polarizing Microscopes.

## Simple Polarizing Equipment (49 36 01)




57



For general observations of medium to strongly refracting specimens in polarized light and for qualitative work, such as the determination of optical characteristics, the simplified polarizing equipment will meet the demands. It consists of a polarizer, an analyzer and a quartz plate of first-order red. However, even for noncritical polarizing work a rotary stage should be used.

**A filter polarizer** (47 36 00) is placed in the diaphragm insert in the microscope base (for transmitted light), or in the filter holder of the vertical illuminator. It is rotated until it crosses with the analyzer (black-out).

**The simple analyzer slider** (47 36 63) has a fixed polarizing filter. Its vibration direction is oriented to the vertical hair of the eyepiece cross-hair. The simple analyzer slider is located in the tube head in the opening (E 8). When the slider is pulled out all the way, a quartz plate is brought into the optical path, which eliminates the analyzer effect of prisms. After loosening the screw, the analyzer slider can be removed.

**The quartz plate first-order red** (47 37 00) is generally used to determine the optical characteristics of birefringent specimens. It is inserted into a slot in the tube head and has two perpendicular vibration directions through which the light passes at different speeds. These two vibration directions form 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 a lower speed.

In "plus position", the interference color of the specimen is 550 mμ higher (quartz plate of first-order red). The vibration direction of the slower wave in the specimen is then parallel to the γ direction of the quartz plate. In "minus position" the interference color, therefore, is 550 mμ lower (vibration direction of the faster wave parallel to γ direction).

The Michel-Lévy color chart, which is part of reprint S 40–554, will be supplied upon request.



## Fluorescence microscopy

The ULTRAPHOT II can also be used for fluorescence microscopy with transmitted and/or incident light. The direct-current carbon arc lamp as well as the high-pressure mercury lamp HBO 200 are suitable light sources. Two of the latter illuminators must be mounted simultaneously right and left on the ULTRAPHOT II, if combined transmitted and incident light is to be used. Contrary to the statement on page 52, section 8, it frequently is expedient in this instance to swing out the ground-glass disk from the illuminator housing with knob (H 7).

The coating of the mirrors in the illuminating beam of ULTRAPHOT II is such that they have a maximum of reflecting power also in the long-wave ultraviolet, important for the excitation of fluorescence.

**Exciter filters** BG 12/4 mm., BG 3/4 mm., UG 5/3 mm., and UG 1/3 mm. for fluorescence excitation with transillumination are placed singly or combined into the holder in the light-exit opening (A 10) in the base of the instrument. For excitation with incident light they are inserted, mounted in holding rings, in the filter pocket of the vertical illuminator.

A condenser of highest aperture should always be used for transillumination. The aperture is made fully effective by completely opening the condenser diaphragm and by establishing optical contact between front lens and lower side of the microscope slide by means of immersion oil.

A detailed description of this instrument as well as more specific data on fluorescence microscopy, a description of the properties of the filters, hints for the use of the equipment, and examples of microtechniques are contained in operating instructions G 40-215.

## Maintenance and Handling of the Instrument

A precision instrument like the ULTRAPHOT II deserves careful handling and protection against dust. Cleaning of the instrument should be confined to external surfaces.

The user should not attempt to lubricate slide bearings, pinion mechanism, or parts of the camera. Entrusting such operations to an expert saves unnecessary repair costs.

During long pauses in operation, the instrument should be covered by its protective hood. Eyepiece sleeves should be protected against entrance of dust either by eyepieces or dust caps.

Dust can be removed from optical parts with a soft brush which has first been well degreased in ether, adhering soil with a dust-free soft linen cloth. This can be slightly moistened with solvents, such as pure water, benzine, or xylol, but not alcohol. Solvents should never penetrate bearings. These preserve their gliding properties through the presence of a grease film which would be destroyed by solvents. The easy, steady movement of the bearings would be ruined.

If immersion oil was employed, it should be removed, immediately after completion of the work, from all optical and mechanical parts. Instead of a linen cloth, lens paper, procurable from us, can also be used (Catalog No. 46 29 75).

Our immersion objectives presuppose the use of our nongumming and nonfluorescent immersion oil ($n_D$ = 1.515), 15 cc. of which in a plastic bottle (Catalog No. 46 29 58) accompany the instrument. There also are available bottles with 50 cc. immersion oil (Catalog No. 46 29 51), 250 cc. (Catalog No. 46 29 53), and 500 cc. (Catalog No. 46 29 54).

**The two mirrors on the mirror carriage** (A 2) are front-surface mirrors. If they require cleaning, it is necessary first to remove dust and mineral particles. This is done by careful dabbing with a moistened wad of absorbent cotton; distilled water, acetone, alcohol, or benzine are suitable. Rubbing dusty mirrors with dry cloths or brushing off the dust is to be avoided, because scratches are likely to result. Cloudiness, fingerprints, etc., generally can be removed by wiping with a moist wad of absorbent cotton. Most suitable is a swab made by twisting a wad of cotton about the end of a small stick. Most contaminations can be removed with acetone.

Water drops drying on the mirrors often leave circular or oval rims, consisting mostly of calcium salts. These are removed with diluted acetic acid.

After removal of such contaminations, cleaning streaks are usually still in evidence. These are removed by breathing on the mirror followed by gentle polishing with a soft, clean cloth or a wad of clean absorbent cotton.

If contrary to expectations difficulties should arise, which cannot be remedied in accordance with these instructions, kindly advise us or our authorized representatives.

The illustrations are not binding in every detail for the design of the instruments.

We shall be glad to provide outs or glossy photographs for scientific publications. For reproduction of illustrations or text, please consult us.

Kindly contact your nearest Carl Zeiss representative or write directly to Carl Zeiss, Oberkochen/Wuertt., West Germany, on all questions of operation, maintenance, or repair of our instruments, and the supply of spare parts.

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