Leitz

PANPHOT

Instruction Book

ERNST LEITZ GMBH · WETZLAR

PANPHOT

INSTRUCTIONS FOR ASSEMBLY AND USE

The purpose of this amply illustrated book is to make users quickly familiar with the PANPHOT Photomicrographic Apparatus and to assist them in assembling and manipulating it correctly, while hints are also given on adequate treatment to retain its high efficiency. The book presupposes a general knowledge of microscopic technique and photomicrographic work.

Since obviously the scope of this book does not permit dealing fully with all the numerous applications which the PANPHOT offers as a universal microscope with camera and source of light combined, the manufacturers and their agents will be glad to give their additional advice on the adaptability of the apparatus for any special requirements for which its use may be contemplated.

Owners are requested, when making technical enquiries or ordering replacements and supplementary items, to state the serial number of their PANPHOT engraved on the upper portion of the microscope changing piece (as indicated in Fig. 6).

Illustrations and descriptions may not conform in every detail to instruments supplied as efforts are constantly made to improve designs in the light of modern research.

ERNST LEITZ GMBH WETZLAR

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*) See separate Instructions for Phase Contrast Equipment, publication No. 8306.

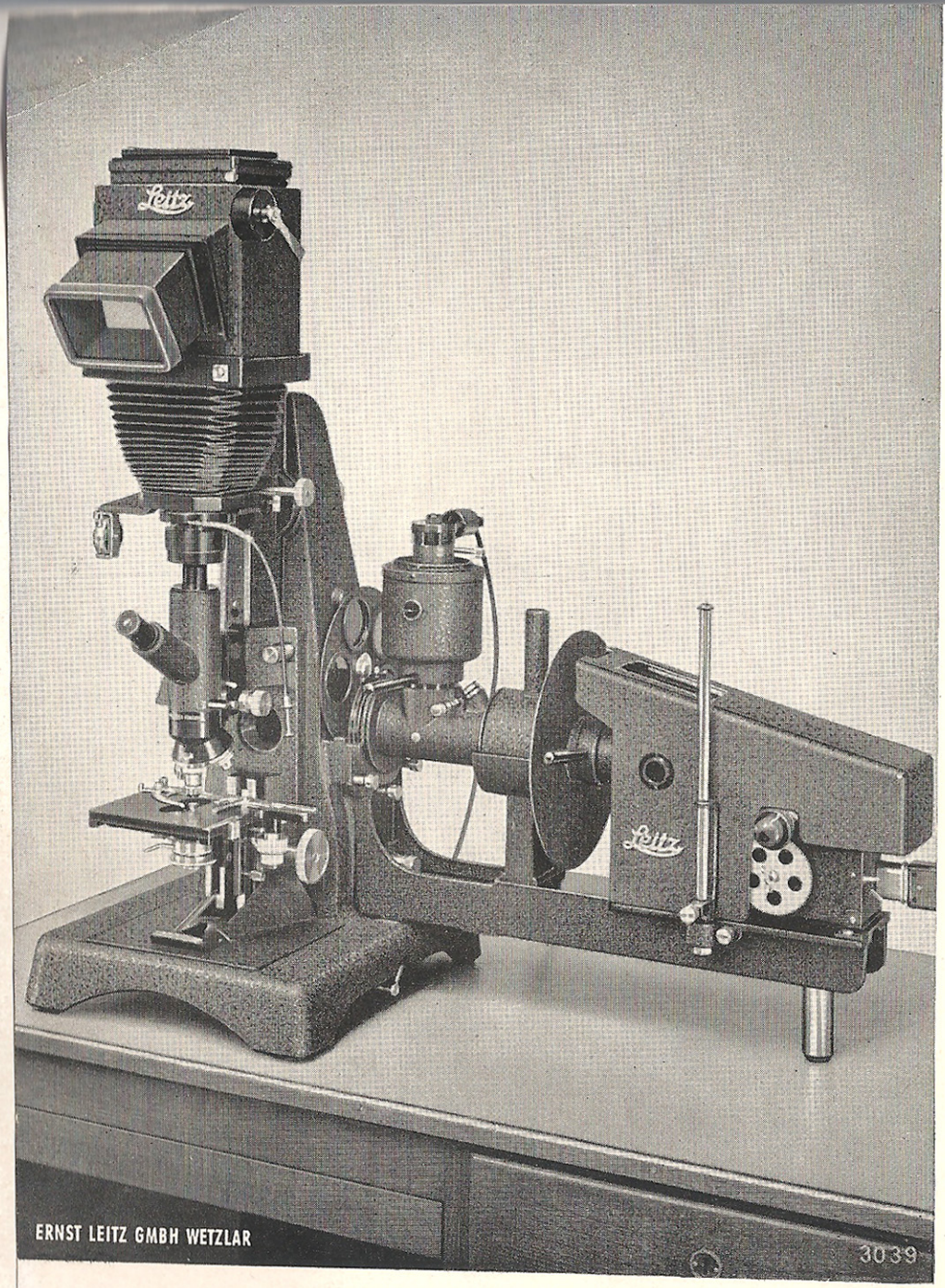


Fig. 1

1. General Directions

Work Room and Work Place

The PANPHOT should be set up in a room where it is not subjected to major changes of temperature or vibrations which might impair the quality of the photomicrographs. It should also be protected from dust and oil or chemical vapours which in the course of time are harmful not only to precision mechanical parts but above all to optical components.

Provision should be made for darkening the room when the range of uses includes micro drawing, wall projection and fluorescence work.

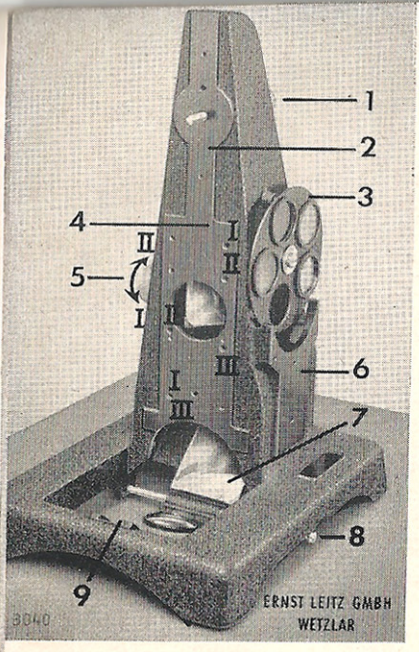
For appropriate setting up and convenient manipulation a special working desk (code IWNDI) is very advantageous. This not only accommodates all interchangeable fittings and accessories in three drawers but has a sliding drawing board for projection drawing and may be fitted with a resilient table top (code IXDKI) if vibrations have to be eliminated.

The PANPHOT filament and arc lamps must always be used with their appropriate resistances or transformers. They take the loads and require electrical wiring, plugs and fuses as stated below:

	Electrical load	Fuse required
(a) Filament lamp:		
on D.C. with resistance	6 amps	6 amps
on A.C. „ „	6 „	6 „
on A.C. with transformer	0.3—0.5 „	6 „
(b) Arc lamp:		
on D.C. with resistance	10 amps	15 amps
on A.C. „ „	15 „	20 „
on A.C. with transformer	16 „	20 „
on A.C. with rectifier	10 „	10 „

Fuses for higher amperages may be required if simultaneously other electrical apparatus is connected to the same supply circuit.

If both A.C. and D.C. are available it is recommended to connect the filament lamp to the A.C. mains through the regulating transformer, while the D.C. supply is much more advantageous for the arc lamp yielding a more intense and above all steady light point in this instance.



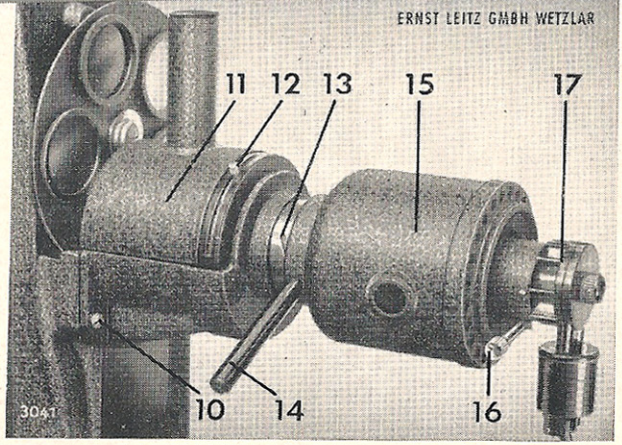


Fig. 3 **Filament lamp attachment (on upright)**
10 Screw for fitting lamp attachment, 11 metal cover for heat-absorbing filter or cooling trough, 12 macro iris diaphragm, 13 helical mount, 14 handle for condenser lens, 15 filament lamp housing, 16 knurled clamping screw for lamp socket (17).

Fig. 2 **Base with upright**
1 knurled screw bolt to attach camera holder, 2 machined surface taking camera holder, 3 revolving filter holder, 4 machined front with holes for locating pins to fit microscope changing piece or ring illuminator bracket (I), and large transmitted light stage (upper position II, lower position III), 5 control knob for central deflecting mirror (position I for transmitted light, position II for incident light), 6 machined side to fit illuminating arrangement, 7 base mirror, 8 lever controlling swing-out supplementary condenser lens, 9 dovetailed holder for illuminating mirror.

Setting up the PANPHOT

The PANPHOT outfit is delivered with its main components and accessories packed separately. When unpacking and assembling the various items care should be exercised that smaller parts are not overlooked in the packing material.

All mechanical and optical components are meticulously cleaned before they are despatched, hence dust and dirt must be kept away from them, and especially glass surfaces, above all the lenses of objectives and eyepieces, should not be touched.

Finger prints which are made by accident and might spoil in a relatively short time the surfaces of high-grade optical glass due to the chemical reaction caused by the perspiration of the fingers must be instantly removed by a suitable chamois leather or a soft linen cloth.

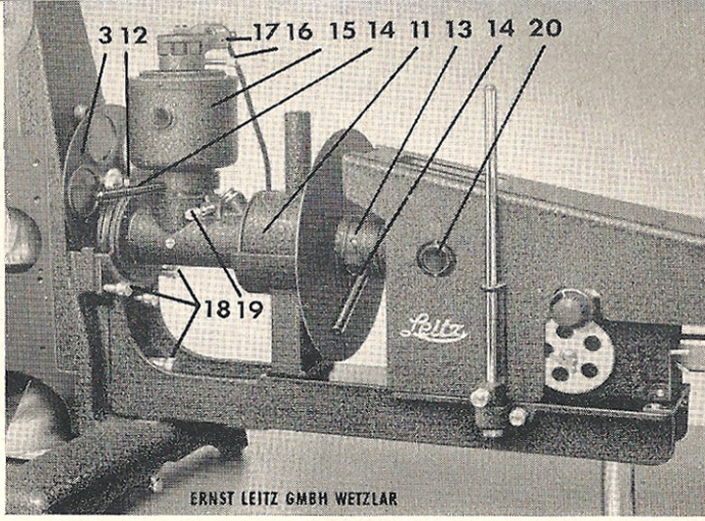


Fig. 4 **Base with upright and alternative illuminating arrangement**

3 Revolving filter holder, 11 metal cover for heat-absorbing filter or cooling trough, 12 macro iris diaphragm, 12 helical mounts, 14 levers for condenser lens adjustment, 15 filament lamp housing, 16 clamping screw for lamp socket, 17 filament lamp socket, 18 four knurled screws for fitting lamp attachment to upright, 19 control for swing-out mirror for alternative illumination, 20 arc lamp observation window (also provided on filament lamp housing).

Basic Outfit for Transmitted Light (Fig. 1):

1. **Base with upright** should be placed on working table as shown in Fig. 2.
2. **Attaching the illuminating arrangement.**

(a) Filament lamp (Fig. 3):

Screw lamp housing (15) horizontally to condenser mount on cooling trough bracket, slide lamp socket (17) into filament lamp housing against the stop and clamp using knurled screw (16).

Fit threaded end of condenser adjusting lever (14) through helical slot (13) to condenser lens mount.

(b) Alternative illuminating arrangement (Fig. 4):

Attach lamp bracket to base and upright (6) by means of 4 knurled screws (18) using accompanying pin to tighten them. Screw filament lamp housing (15) vertically on to condenser lens mount, insert socket with lamp (17) as far as it will go and fix with clamping screw (16). Fit threaded ends of condenser lens adjusting levers (14) through helical slots (13) to lens mounts of both the filament and the arc lamp.

Attach heat-absorbing filter to or accommodate cooling trough in the bracket in front of the arc lamp and put on metal cover (11).

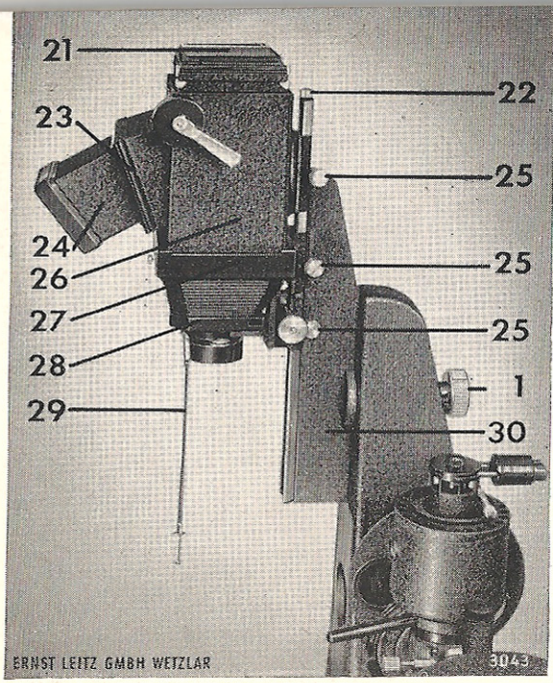


Fig. 5 **Upright with camera**

1 Knurled screw bolt for fitting camera holder, 21 attachable darkslide, 22 stop screw, 23 ground glass screen in metal frame, 24 detachable light-screening box, 25 clamping screws for camera saddle stands, 26 mirror reflex housing, 27 darkslide holding frame, 28 lens panel, 29 wire release, 30 camera holder.

3. **Attaching the camera with mirror reflex housing** (Fig. 5)

Fit camera holder with prismatic bar (30) to upright making use of locating pins and the screw bolt (1) to be manipulated behind the upright.

Remove stop screw (22) at upper end of prismatic bar, push on camera saddle stands from above and fix lens panel (28) at about 8" (20 cm) from the lower end of the prismatic bar by means of clamping screw (25). Also fix darkslide holding frame (27) at a suitable position.

Screw wire release to shutter (see also Fig. 17, page 34).

Mount mirror reflex housing (26) by fitting it to prismatic bar on the darkslide holding frame (27) of the camera so that both components make a light-proof connection. Tighten clamping screw (25).

Replace stop screw (22) on top of prismatic bar to prevent the reflex housing from being accidentally shifted up too high.

Insert ground glass screen (23) into grooves on front of reflex housing and slide on the light-screening box (24). The clear glass screen or a metal darkslide (21) is fitted on top, the former only being required in that position to protect the reflex housing from dust (see also Fig. 17).

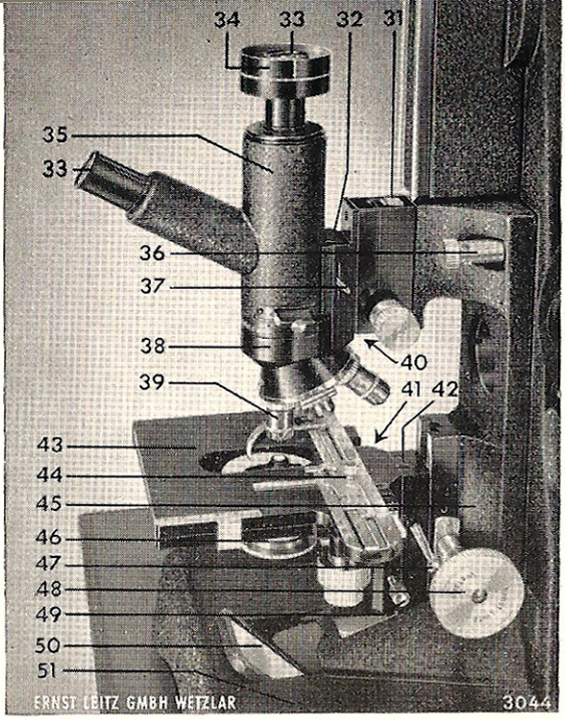


Fig. 6 **Base with upright and microscope**

31 serial No. on microscope changing piece, 32 upper dovetail slide, 33 eyepieces, 34 light-screening sleeve, 35 photo tube, 36 fixing screws for microscope changing piece, 37 clamping lever for body tube, 38 revolving objective nosepiece, 39 objectives, 40 nosepiece clamping screw, 41 object stage clamping screw, 42 lower dovetail slide, 43 object stage, 44 object holders, 45 microscope changing piece, 46 substage, 47 stage coarse focusing clamp, 48 rack and pinion control, 49 substage clamp, 50 illuminating mirror, 51 light-screening cover.

4. **Attaching the microscope** (outfit for transmitted light, Fig. 6)

Fit microscope changing piece (45) to upright (4) making use of the locating pins and the 2 knurled screws (36) which are tightened by the accompanying pin.

Insert the object stage (43) into the lower dovetail slide (42) and clamp (41) in such a position that the top surface of its bracket is flush with the upper end of the slide. (The stage is lowered in this slide only in the event of very high objects being examined in incident light or with objectives having an unusually long working distance.) Focusing of the stage is made possible by the rack and pinion control (48) after the clamp (47) has been loosened. Re-tightening is only necessary with very heavy objects. The object holders (44) are adjustable for all usual object slide sizes up to 4" (100 mm) in length. They can be completely removed (laterally) for accommodating even larger specimens. The scales and verniers for reading the cross motion of the mechanical stage for one particular object point are independent of the adjustment of the object holders.

Fit substage (46) to dovetail slide (42) by inserting it from below against the stop and clamp by means of screw (49). To remove condenser from its horizontal slide holder (65), lower substage holder by rack and pinion (70) and when replacing it make sure that the two centring screws (66) face the observer (see Fig. 11).

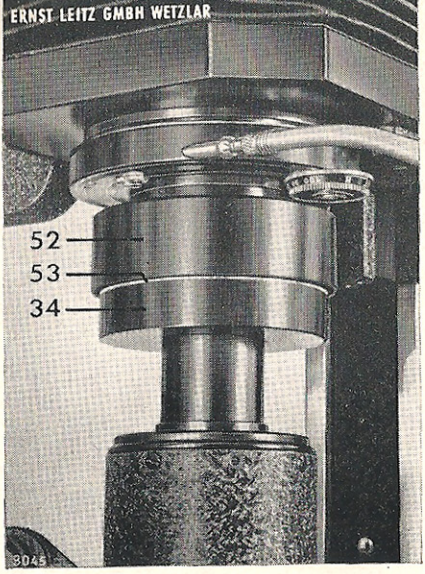


Fig. 7 **Light-proof connection of microscope and camera**
34 light-screening sleeve for photo tube,
52 light-screening sleeve of camera,
53 white orientation line.

Push illuminating mirror (50) into inclined dovetail holder (9) against the stop. Attach revolving objective nosepiece (38) to upper dovetail slide (32) of the microscope changing piece from below and secure in top position by clamping screw (40). To protect the objectives against damage, lower the object stage by rack and pinion control (48) before fitting nosepiece.

The objectives are usually fitted to the nosepiece in the factory and should be left in position. If special requirements call for subsequent fitting of the objectives, make sure that they are screwed on in accordance with their magnifications to obtain the proper sequence from the lowest to the highest powers.

Insert photo tube (35) into upper portion of dovetail slide (32) where it is locked by lateral lever (37).

Put light-screening sleeve (34) on eyepiece holder of photo tube.

Insert eyepieces (33) into inclined observation tube and the vertical photo tube, preferably using a 6 or 8× eyepiece for carrying out the first visual observations and adjustments. The tubes should always be protected from dust by leaving eyepieces in position or putting on dust caps.

To provide light-proof connection between microscope and camera, lower lens panel of camera (28) until the edge of the upper light-screening sleeve (52) coincides with the white orientation line (53) of the lower sleeve (34) as illustrated in Fig. 7. If the upper sleeve is lowered beyond the orientation line the micrometer movement might become blocked.

Place light-screening cover (51) on the base of the apparatus.

Putting the Illuminating Arrangement into Operation

(a) Filament lamp

The PANPHOT makes use of a low-voltage lamp 6 volts 5 amps furnishing a very intense light of a spectral composition well suited for microscopic and photomicrographic work. For special requirements its load may be increased to 6 amps.

The low-voltage lamp is connected to A.C. mains through a transformer or resistance while in the case of D.C. only a resistance can be used. Before establishing the mains connection make sure that the transformer or resistance supplied is labelled for the mains voltage available.

The transformer incorporates a rheostat operated by a knob which is combined with a switch. A turn to the right switches on the current while further operation increases the lamp load which can be checked on the ammeter scale. A complete left turn switches off the current. For ordinary visual observations a load of about 2—3 amps will be found sufficient. The maximum load of 6 amps (indicated by red line on ammeter) will be required only in the case of dark field and phase contrast examinations, work in polarized light, micro drawing, and photomicrography. If the supply voltage is subject to frequent fluctuations it is advisable not to run the lamp at its maximum load.

The resistance supplied for D.C. includes a separate rheostat which is connected to the lamp and the fixed resistance respectively. To prolong the life of the low-voltage lamp, it is recommended to switch on the current with the rheostat turned to its starting position and to gradually increase the load and consequently the intensity of the lamp.

Continuous use of the filament lamp at maximum load shortens its life considerably. Hence the lamp should be run below 6 amps for ordinary visual observations and only a light blue filter as incorporated in the revolving filter holder (3) be interposed for daylight similarity of the illumination.

The 6 volt 5 amp lamp ist supplied for the PANPHOT with a prefocus cap so that subsequent adjustments when replacing the lamp are dispensed with.

Exchanging the lamp: Loosen clamping screw (16) and pull out lamp socket. To remove bulb from socket loosen lateral fixing screw by means of a screw driver when bulb will be raised by spring pressure. Press replacement bulb into socket until fixing screw comes to rest in the groove of its base, then tighten screw again and slide lamp socket into sleeve as far as it will go. Secure by clamping screw.

In the past a number of PANPHOT outfits were supplied with screw cap bulbs and centring mounts. The latter is clamped in position in the same manner as the pre-focus lamp socket and centring effected by means of the two centring screws until the illuminated circle is brought to the centre of the base mirror (7) that can be observed after the light-screening cover (51) has been removed (see also page 25). Additional lamp adjustment must be carried out, by means of the centring screws, on the ground glass screen in accordance with instructions on page 15.

Finally, optimum illumination is attained during observations by operating the adjusting lever (14) of the condenser lens.

(b) Arc lamp

To make use of the arc lamp (Fig. 8) as source of light, first swing out the deflecting mirror by pushing in knurled head 19 and locking it to the right.

In accordance with safety regulations a red terminal screw for earthing the PANPHOT is provided at the rear of its base which can thus be connected to the water mains, heating system or the like.

The arc lamp cannot be directly connected to the electric mains but requires a special resistance (or a transformer or rectifier for A.C.) which must be made and labelled for the supply voltage and type of current available.

The electrical data are as follows:

(a) D.C. arc lamp for 10 amps and 55 volts
(b) A.C. arc lamp for 15 amps and 45 volts.

Make sure that the electrical supply circuit is adequately wired and a sufficiently strong fuse provided for these requirements as explained on page 5.

Pairs of **cored carbons** are used as follows:

(a) D.C. arc lamp: horizontal positive carbon 8×135 mm
vertical negative carbon 8×110 cm

(b) A.C. arc lamp: horizontal carbon 8×135 mm
vertical carbon 10×110 mm

If D.C. can be made available this should always be preferred on account of the more intense and steady light point obtained. To overcome the less advantageous conditions of A.C. operation to a certain extent a higher load (15 amps) is used in this instance, unless a rectifier can be provided for operating the lamp on D.C.

Before connecting up resistance or transformer and operating the arc lamp please follow the Instruction Card supplied with every equipment.

Before starting the arc lamp insert the heat-absorbing filter which is not required when a cooling trough is employed.

When replacing carbons (see Fig. 9) switch off current (preferably by removin plug from wall socket).

Raise lamp housing (54) and clamp in top position (55). Adjust co-axial carbon controls (58) to have their white markings aligned, then turn them to the right to bring carbon holders (57) to their starting position. Use insulated tool, as shown in Fig. 9, to lift holder and put in horizontal carbon from behind (reverse insertion in the case of old type spring holders) and similarly secure vertical carbon from above so that the tips of the carbons are about $\frac{1}{4}$" (5 mm) apart.

After the lamp housing has been lowered the lamp can be started by switching on the current and bringing the carbons into contact by turning their controls (58) to the left and reversing this operation the moment the arc has formed. This can be observed through the inspection window in the housing. Once normal operation is established the distance between the tips of the carbons should be approximately $\frac{1}{6}$"—$\frac{1}{4}$" (4—7 mm).

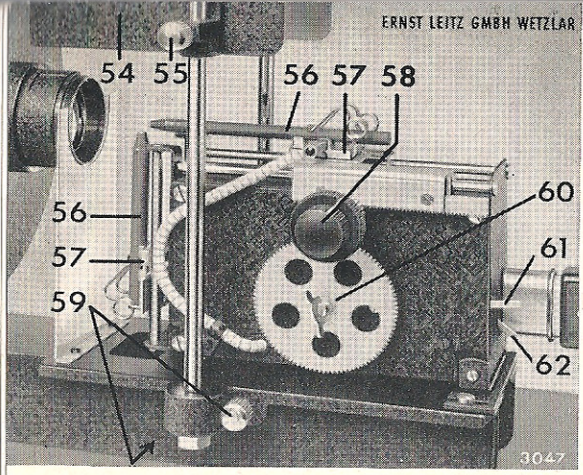


Fig. 8 **The arc lamp**

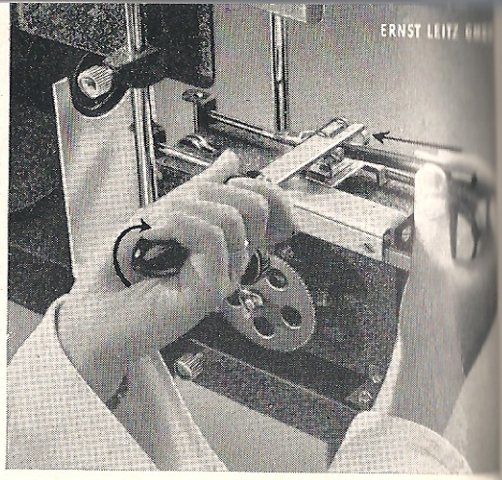


Fig. 9 **Replacing the carbons**

54 lamp housing, 55 clamping screw for housing, 56 carbons, 57 carbon holders, 58 co-axial carbon controls, 59 arc lamp centring screws, 60 clockwork winding key, 61 clockwork starting and stopping lever, 62 lever for accelerating or slowing down clockwork.

The built-in clockwork regulates the carbon feed. It is started after the arc has been formed by moving the lever (61) from "0" position upwards. The clockwork must be wound (by means of key 60) whenever new carbons are inserted.

With A.C. the tips of both carbons show an even glow, whereas with D.C. a luminous crater of high intensity forms on the horizontal positive carbon. If this is not the case the terminals of the plug in the wall socket should be turned round and suitably marked for future instantly correct use.

After the lamp has been started it must be checked whether the clockwork regulation meets the speed of the carbon consumption. A lever (62) allows of continuously adapting the clockwork to the required carbon feed, the S position making for speeding up the carbon movement and an adjustment towards L effecting a lessening of speed.

The position of the tips of the carbons should occasionally be checked through the observation window, and regularly before taking photomicrographs, since variations in the material of the carbons or voltage fluctuations may be responsible for a less regular burning down of the carbons than the clockwork is set for. Above all the vertical carbon must not cover up the tip of the horizontal one or the latter pass beyond the tip of the vertical carbon. Corrections are possible through independent adjustment of the co-axial controls, holding one knob whilst the other is turned. The smaller front knob controls the vertical carbon whereas the horizontal carbon is operated by the larger knob.

The clockwork is stopped by shifting down lever (61) after the current has been switched off.

The arc lamp is properly aligned by means of the centring screws (59) situated at the front and the bottom of the lamp bracket. With the deflecting mirror (5) in position I and the light-screening cover (51) removed from the base the circular light spot is brought into the centre of the base mirror (7). The final adjustment of the illumination is made on the ground glass screen of the mirror reflex housing. First, using the filament lamp, a specimen in position on the object stage is properly focused on the screen with the diaphragms of the centred substage fully opened. Then the arc lamp illumination is switched on and centred by adjusting the condenser lens (lever 14) until the ground glass screen is evenly illuminated throughout without any colour fringes becoming visible. For additional instructions relating to the vertical illuminators see pages 44 and 54.

General Directions for Microscopy

Besides accurate adjustment of the illumination, selection of the correct objective is also essential for obtaining the optimum image. The magnification tables (pages 59—61) naturally simplify the task of choosing the objective, but in order to understand the optical relations and to assess the quality of the microscopic image, knowledge of a few basic principles and rules is required; these necessary data may be briefly formulated as follows.

The total magnification of a microscope is calculated by multiplying the magnification factors of the objective and the eyepiece. With the PANPHOT, the value thus obtained must be multiplied by the factory 1.25 (see page 18); in photomicrography the length of the bellows extension must also be taken into consideration. Thus in order to calculate the image scale on the ground glass screen, the microscope magnification is multiplied by the length of the bellows extension in cm. and divided by 25. Since the microscope magnification is based on the principle of the conventional distance of vision (25 cm.), with a bellows length of 25 cm. the magnification is the same, while with an extension of 50 cm. for example, the magnification is doubled.

The decisive factor in assessing the efficiency of an objective-eyepiece combination is not the image scale achieved, but the resolving power; the latter is a measure of the smallest distance at which two adjacent specimen details are shown clearly separated in the image.

With the types of illumination and filters used on the PANPHOT the resolving power is dependent mainly on the **numerical aperture** of the objective; the higher the N.A., the higher the resolving power (see table of objectives). In any case, care must be taken to ensure that the objective aperture is high enough to give perfect resolution of the required specimen details. The sole duty of the additional eyepiece magnification should be to suitably enlarge the details which the objective resolves by means of its aperture, in order to make such details comfortably accessible to the eye.

The selection of the correct objective is further facilitated by the following rule for the range of **useful magnification: —**

> The objective aperture should lie between $^1/_{500}$th and $^1/_{1000}$th of the required total magnification.

Thus for an image scale of 500 : 1, an objective with an aperture between 0.50 and 1.00 will be required.

Conversely, according to this rule, the useful magnification lies between 500 and 1,000 times the aperture of the objective used. Example: for the Apochromat 40/0.95 the useful magnification lies between 475× and 950×.

Since the highest objective aperture attainable with standard methods (oil immersion) is 1.4, the maximum degree of resolution is reached with a magnification of about 1,400×, and beyond this limit no further increase in the resolving power is to be expected. Total magnifications which exceed the range of the useful magnification thus give an unexploited "empty" magnification, while conversely (below the range of the useful magnification) the capacity of the objective is not fully utilized.

Within the range of the useful magnification the results are by no means uniform.

With equal total magnification the following variations are possible: —

Low-power objective with low aperture + high-power eyepiece:	high field capacity (larger diameter of sharply defined object field), but reduced resolution.
High-power objective with high aperture + low-power eyepiece:	lower field capacity, but higher degree of resolution.

The most expedient optical combination must therefore be selected according to the characteristic properties of the specimen and the individual qualities required in the photomicrograph.

The rule of the useful magnification applies both for visual examination and similarly for photomicrography. Here it is based on the conventional range of vision of 25 cm., from which a photomicrograph of 9×12 cm. (3½" × 4½") is normally observed.

Thus in the actual practice of photomicrography, it may easily prove necessary to fall below or to exceed the range of useful magnification. The former is the case when taking photomicrographs on 35 mm. miniature camera film, which are to be enlarged afterwards. Here the selection of the objective will depend on the final image scale of the subsequently enlarged miniature negative. For example, the image scale of a LEICA photograph (24×36 mm.), which is to be enlarged about 4 times to 9×12 cm., should be about a quarter of the value of the useful magnification.

Conversely, if photomicrographs are to be observed from a greater distance than 25 cm., e. g. when viewed as wall projections, the image scale must exceed the range of useful magnification corresponding to the ratio by which the conventional range of vision (25 cm.) is exceeded in the proposed observation distance. In other words, with an observation distance of 1 metre (40"), the image scale must lie between 2,000 and 4,000× the aperture, i.e. 4 times the useful magnification, if the details of the specimen are to remain clearly resolved at the greater distance.

Microscope objectives are classified as Achromats, Fluorite Systems and Apochromats according to their correction; there are also dry systems and immersion systems. Through the use of intermediate media with a high refractive index (e. g. cedar oil), immersion systems attain a much higher numerical aperture (up to about 1.40) than that reached by dry systems (up to about 0.95). The correction of *Achromats* meets all standard requirements in microscopy. They are corrected for the yellow-green range of the visible spectrum, in which the maximum sensitivity of the human eye lies. Thus with photomicrography in black and white, a yellow-green filter will be required as a rule. Low-power Achromats are combined with Huygens eyepieces in the microscope, and objectives with an aperture of over 0.30 are preferably used together with Periplanatic eyepieces. This gives a somewhat greater field capacity (extent of clearly defined field).

Fluorite systems have particularly good general correction, and are characterised above all by their increased colour correction; this is achieved through

the use of fluorite (fluorspar). Thus fluorite objectives are primarily suited for critical examinations where the image quality must be particularly high. They are also especially suitable for dark-field work and for photomicrography in natural colours. Fluorite objectives must only be used with Periplanatic eyepieces.

Apochromats possess the highest degree of colour correction at present attainable. These objectives are therefore to be specially recommended for research work of a most exacting nature, for dark-field examinations and for colour photomicrography. They must only be used in combination with Periplanatic eyepieces.

For microscopic examinations and measurements in polarized light, achromats are most suitable. Fluorite systems cannot be manufactured completely free from strain, and are therefore only of limited serviceability for polarization measurements. But they can be used to very good effect in all cases in which particular demands are made of the resolving quality. Apochromatic objectives are not free from strain.

Microscopic objectives are corrected to a certain **tube length.** A variation in the tube length affects the resolving quality, particularly when using objectives of higher numerical aperture. If constructional reasons render it impossible to maintain the standard tube length in certain individual instruments, then **optical intermediate systems** are built in (in the PANPHOT for example, it is in the revolving nosepiece holder) which compensate for the different tube length, but at the same time affect the magnification of the objectives themselves. In order to calculate the image scale, the microscope magnification must be multiplied by the factor of the intermediate system. For objectives designed for a tube length of 170 mm. for examinations in ordinary or polarized transmitted light (engraved with "170"). and for the objectives on the ULTROPAK, the factor is 1.25×*). But in the Vertical Illuminators, the optical intermediate system is so calculated that the specified magnifications of the individual objectives are retained almost unaltered and apply for calculating the total microscope magnification.

Objectives engraved with "0.17" (for work in transmitted light) are corrected to an average **cover glass thickness** of 0.17 mm., i. e. cover glasses with a thickness of from 0.12 to 0.22 may be used. Thinner or thicker cover glasses impair the quality of the image, while with thick cover glasses and high-power objectives (oil immersions), fine focusing may prove to be impossible. Objectives

*) The factor engraved on the particular tube used must also be taken into consideration, if necessary. See also pages 15 and 16.

which can also be used without a cover glass are engraved with a dash (—), while objectives which can be used only without a cover glass are engraved with an "0".

The objectives for the Vertical Illuminators and the ULTROPAK (examinations in incident light) are corrected for use without a cover glass. But as will be seen from the tables, a few objectives may also be used with cover glasses.

The basic outfit of the PANPHOT includes a photo tube with lateral inclined monocular tube.

Microscopic observation should be carried out with both eyes alternately, keeping both eyes open. With a little practice only the image in the microscope will be seen, and the other eye will look "into space". It is particularly important to work with relaxed eyes which are not accommodated to close range, and for the body to be in a comfortable position.

The use of a **photographic tube with binocular observation** is to be strongly recommended, since it combines all the advantages of working with both eyes, it permits observation with relaxed eyes focused in parallel, corresponding to normal vision. Symptoms of tiredness are thus avoided almost completely, even with prolonged work. In addition, sense of space and image quality appear enhanced, since the optimum properties of both eyes are exploited simultaneously and supplement each other. The pairs of eyepieces for the binocular tube are optically matched and engraved with the letter "B".

Finally, it should be stressed that generally speaking, all microscopic examinations should be started with a low-power objective; the magnification is then increased by using objectives of higher power until the desired resolution and the best definition of the details required are obtained. For this purpose, **eyepieces** with 6× to 12× magnification are suitable; eyepieces of higher powers are generally only used for measuring and counting purposes.

The Microscope Illumination

Resolution, definition and general character of the image are influenced to a decisive degree by the microscope illumination. Thus besides the selection of the correct objective and the image scale, the basic prerequisites for good photomicrographs include careful adjustment and focusing of the illumination to suit the particular specimen.

An efficient microscope illumination must meet the following requirements: —

(1) The illuminating system must supply the microscope with a beam of light sufficiently large in diameter as required for the particular objective and eyepiece combination in use.

(2) The illuminating system must offer the possibility of varying the diameter of the beam within the limits required.

Whether and to what extent the first requirement is met can be seen by the degree to which the microscopic field of view is completely and uniformly illuminated. In addition, on removing the eyepiece and looking into the tube, the exit pupil (generally the rear lens of the objective) must similarly appear completely and uniformly illuminated.

But the maximum beam diameter required by the individual objective-eyepiece combinations varies in size. The greatest beam diameter is not required by the high-power combinations, but by the low-power objectives, which cover a large field of the specimen. The illuminating apparatus must therefore be so calculated, that it can give the full beam diameter necessary for the lowest-power objectives. This naturally gives an excess of light when using objectives of higher power; this excess cannot be exploited and may even prove harmful by reducing the contrast, producing reflections, and warming the specimen unnecessarily. It is therefore essential that the beam diameter should be reduced to the most expedient extent in each particular instance. This is achieved by means of two diaphragms arranged in the beam path of the illuminating system.

The first diaphragm controls the beam diameter in the specimen. If it is closed, it becomes visible in the microscope as a field of view stop or a field of light diaphragm. It thus renders it possible to partly fulfil requirement (2) above by controlling the diameter of the beam used to illuminate the field of view through opening and closing the diaphragm.

The purpose of the second diaphragm is to meet this requirement for the beam diameter in the exit pupil or rear lens of the objective. Thus after removing the eyepiece, this diaphragm (when closed) must be visible as an aperture diaphragm, i. e. as a circular limitation of the illuminated part of the rear lens of the objective.

If both diaphragms are opened just to the point where their peripheries disappear from the field of view of the microscope or from the rear lens of the objective, then the beam diameters thus obtained are the maximum expedient amount of light for the particular objective-eyepiece set being used. It would be pointless to open the diaphragms beyond this setting and might even prove of disadvantage for the reasons specified above.

For medium and high-power objectives, field of view diaphragms and aperture stops are necessary in order to reduce the beam diameters to furnish the most expedient amounts of light. For the lowest power objectives on the other hand, they are no longer necessary, provided the illuminating apparatus is not too large altogether. But an aperture diaphragm is nevertheless advisable with such objectives. Through varying the illuminating aperture it is possible to distinguish more easily between closely similar details in the specimen, and to heighten the definition in depth of thick specimens.

(a) Illumination for working with transmitted light

The requirements specified above can be met by substages of various designs. In principle, the actual position of the diaphragms in the beam path is immaterial, provided they act in the sense described above. This is also the case with the so-called Köhler illumination, in which the field of view diaphragm is situated between the source of light and the microscope mirror. With this arrangement, the iris diaphragm in the microscope condenser is used as an aperture diaphragm.

The **two-diaphragm bright field condenser** fulfils all the requirements which must be met by a microscope illuminating apparatus. Both the effective diaphragms are situated inside the condenser (behind the mirror), and are thus most comfortably accessible for convenient manipulation; secondary images are also avoided. The condenser is corrected to such an extent that the efficiency of the diaphragms is ideal for all purposes. The troublesome unscrewing of condenser lenses, otherwise necessary when changing from high to low power objectives, is completely dispensed with; the necessary changes in the condenser system are effected by simply operating a lever. With medium and high-power objectives, the full condenser is used. The lower iris diaphragm can be clearly seen as field-of-view diaphragm with appropriate vertical adjustment of the condenser (in the closed position), while the upper iris diaphragm acts strictly as an aperture diaphragm. With low-power systems, a part of the condenser is cut out by operating the lever at the side. The lower iris diaphragm then acts as an aperture diaphragm, and the upper diaphragm remains out of action. The engraved figures give the diameter of the upper diaphragm (aperture diaphragm) in millimetres.

The mineralogical substage "a" is also equipped with aperture and field-of-view diaphragms; it thus corresponds to the two-diaphragm bright field condenser in every respect. But for general work in polarized light the mineralogical substage "b" with aperture diaphragm and swing-out front lens is always adequate.

Even when the detailed optical significance of these two diaphragms may not always be fully appreciated in practice, through the simultaneous trial manipulation of both diaphragms, the microscopist will of necessity obtain the optimum image quality.

The optical system situated between the source of light and the microscope condenser guides the beam in a form adapted to suit the two-diaphragm condenser. An iris diaphragm (12) situated near the source of light is not used in combination with the two-diaphragm bright field condenser, and is usually left fully open; it is designed to act as an aperture diaphragm in macro work without eyepiece and with MILAR or SUMMAR objectives. The two-diaphragm bright field condenser is then replaced by simple condenser lenses.

(b) Illumination for work in incident light

In order to avoid reflections when using the vertical illuminators (bright-field work in incident light), it is important that the illumination should be restricted to the specific field of view given by the particular objective in use. Apart from this, the same requirements have to be met as those described above for optimum illumination with transmitted light. Ordinary and polarizing vertical illuminators are fitted with 2 diaphragms, an aperture diaphragm and a field-of-view stop, although the polarizing model has a diaphragm at the front collector lens. Both diaphragms always retain the same function as compared with the two-diaphragm bright field condenser. However, even when using low-power objectives, no part of the illuminating system is swung out. In the ULTROPAK, the light is guided to the specimen through a ring condenser surrounding the objective (dark field work in incident light); thus the illuminating rays do not reach the object directly but are guided onto the specimen. Despite this, the same requirement applies for the ULTROPAK: with every objective, the light must be guided in such a manner that the specimen field covered by the objective is completely and uniformly illuminated. The various condensers for the individual ULTROPAK objectives meet this requirement; they are also adjustable vertically, thus rendering it possible to obtain the most effective illumination in each instance.

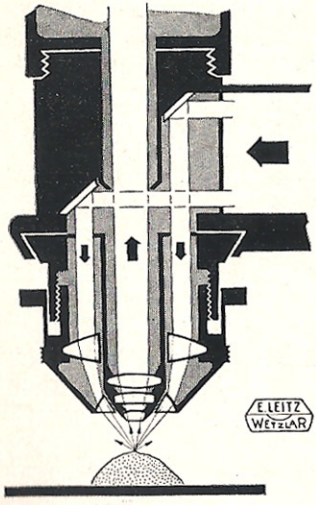


Fig. 10: **Path of rays in the ULTROPAK**

2. PANPHOT Outfit for Biological Work

Microscopy by Transmitted Light (Bright Field)

The PANPHOT microscope must be equipped with the necessary items as shown in Fig. 11.

1. Switch on **filament lamp** and run it at a load of 3½ amps. **Deflecting mirror** (19) must be swung in to direct the light into the illuminating system.
2. Open **macro iris diaphragm** (12) completely and make use of it only in the case of macrophotographs with the large diameter transmitted light stage (pages 38/39).
3. Set **revolving filter holder** (3) so that its free aperture or the light blue filter is in the path of rays.
4. Bring **central deflecting mirror** (5) to position I for transmitted illumination.
5. Raise **swing-out condenser lens** in base using lateral lever (8) and leave in position except for macrophotographs.
6. Place **specimen** on object stage.
7. Raise **condenser** (67) by means of rack and pinion control (70) to top position and open aperture and field of view iris diaphragms by moving diaphragm lever (71) to the rear and by revolving the milled ring (69) to the left as far as it will go.
8. Move low-power **objective,** preferably type 10/0.25, into position.
9. Slide **deflecting prism** (74) into the body tube and **focus specimen** with the aid of rack and pinion control (48) and micrometer screw (76) whilst observing through the inclined eyepiece. To protect objective front lenses and specimens against accidental damage adopt the following **focusing procedure:** Rack up the object stage while looking across it from the side and bring the specimen close to the front of the objective, i. e. at a somewhat shorter distance than is indicated by the free working distance in the objective tables so that final focusing is achieved by slightly separating specimen and objective with the aid of coarse and fine adjustments. After this preliminary the change-over to higher magnifications can be easily effected by simply revolving the nosepiece and by a slight correction to the micrometer screw since objectives fitted to the nosepiece in the factory are properly matched.
10. The **top-lens of the two-diaphragm bright field condenser** (73) is used for high and medium power objectives inclusive of type 10/0.25 but swung out of position for low powers using the lateral knurled head (72). The two diaphragms act as aperture and field of view diaphragms; with the top-lens in position the upper diaphragm controls the aperture and with the top-lens swung out the lower diaphragm takes over this function.

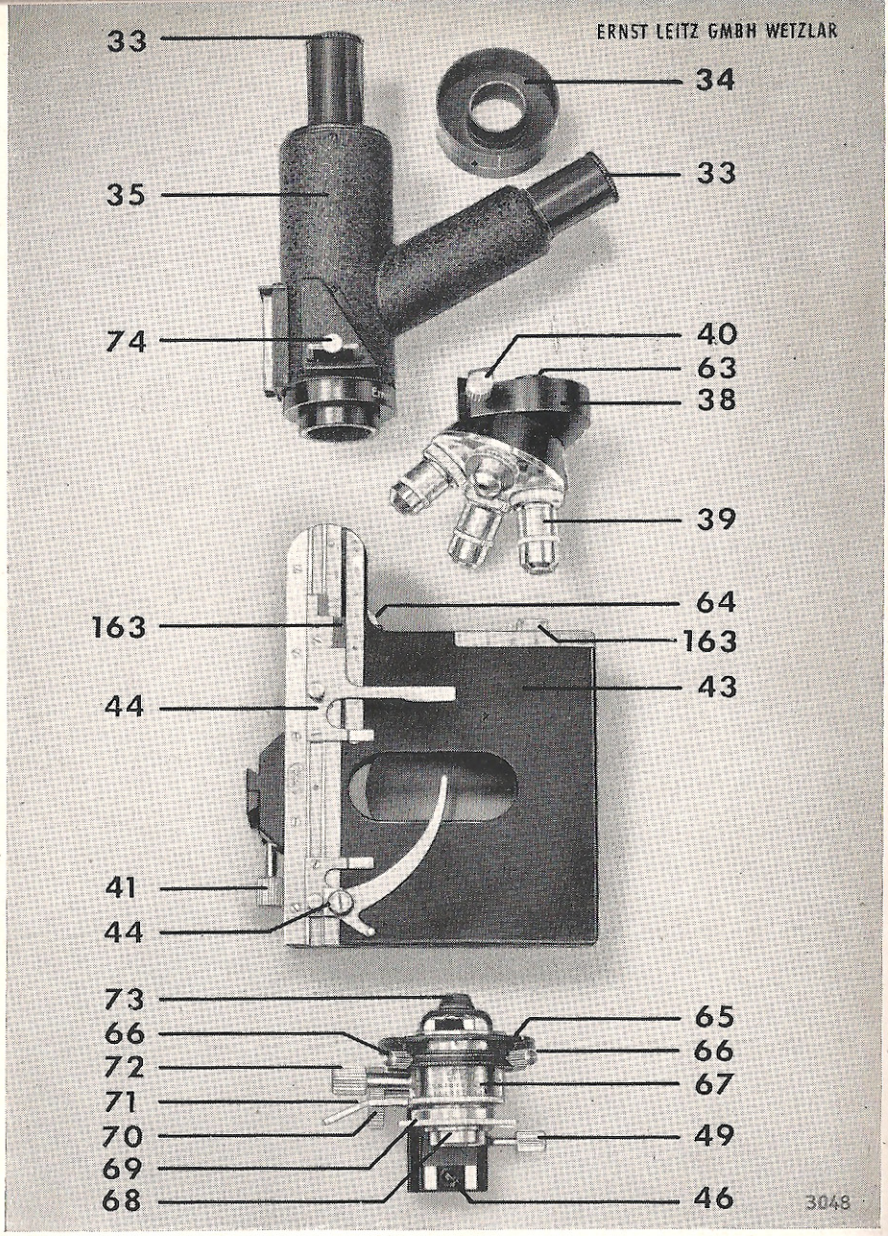


Fig. 11. **Microscope fittings for biological work (transmitted light)**

33 eyepieces, 34 light-screening sleeve for photo tube, 35 photo tube, 38 revolving objective nosepiece, 39 objectives, 40 clamping screw of nosepiece carrier, 41 clamping screw of stage bracket, 43 object stage, 44 object holders, 46 substage, 49 clamping screw of substage, 63 optical intermediate system, 64 co-axial stage controls, 65 horizontal dovetail slide for condensers, 66 condenser centring screws, 67 condenser, 68 lower condenser mount, 69 milled diaphragm control ring (field of view), 70 rack and pinion control for substage focusing, 71 diaphragm control lever (aperture), 72 knurled head for operating the swing-out top-lens, 74 deflecting prism on slide.

To obtain an even illumination throughout the field of view the condenser must be properly centred; proceed as follows: Start off with both the diaphragms fully opened, then close **field of view diaphragm** (69) until it appears fully in the field of view. Lower substage by operating lateral rack and pinion control (70) until the edge of the diaphragm image is sharply focused. This vertical adjustment of the condenser must be retained also when changing over to other objectives.

A slight correction of the condenser adjustment will become necessary only in the event of other specimens being used that differ in the thickness of their object slide. If the edge of the diaphragm image can no longer be brought into sharp focus, the condenser should be raised to its top position.

Move diaphragm image into centre of field of view by means of centring screws (66) and open diaphragm to such an extent that the edge of its image just disappears beyond the field of view simultaneously on all sides. When changing over to another objective the diaphragm setting must be re-adjusted according to the field of view of that particular objective and centred again, if necessary.

11. **Optimum illumination of the field of view** is brought about by adjusting the condenser lens (lever 14), and on no account should it be attempted to obtain the desired brightness of the image by vertical adjustment of the condenser or by closing the aperture diaphragm. The light intensity should always be regulated by means of the lamp.

(If a filament lamp with screw cap in centring mount, as mentioned on page 12, is used, a slight raising of the lamp socket, after loosening clamping screw 16 and setting condenser lens (14) to its middle position, may result in an improvement of the illumination, since these screw-cap bulbs are not always fully standardized as the prefocus lamps.)

The microscopic image is first viewed with the **aperture diaphragm** fully opened, i. e. with maximum illumination aperture. Gradual closing of the diaphragm will then find the aperture best suited to rendering a clear image of the details of the specimen to be studied. With full illumination aperture the **resolving power** is at its maximum, while smaller apertures with partially closed diaphragm increase contrast and thereby reveal more details of the specimen. Optimum image conditions are generally to be expected when the diaphragm aperture, as observed in the tube with the eyepiece removed, is about two thirds of the diameter af the rear lens of the objective (see also page 20).

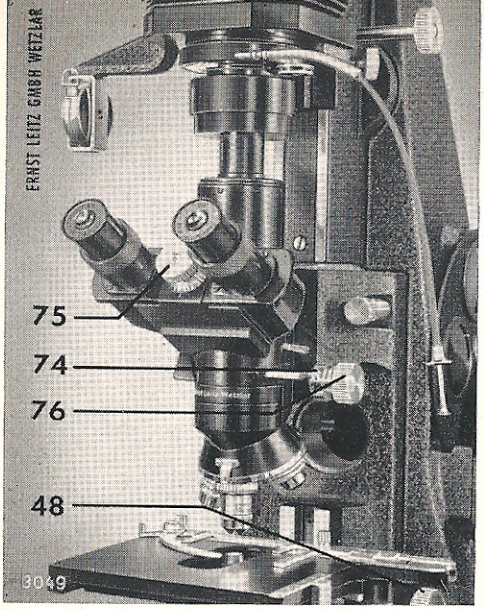


Fig. 12: **Combined monocular-binocular photo and observation tube**

48 rack and pinion control, 74 deflecting prism of photo tube, 75 milled head for interpupillary adjustment, 76 micrometer screw.

To use an **oil immersion objective,** slightly lower object stage, put a drop of immersion oil on to the cover glass of the specimen, swing oil immersion lens in position and carefully raise object stage while looking sideways across the stage surface until the front lens comes into contact with the oil drop. Insert Periplanatic eyepieces and focus image by operating micrometer screw. This method protects specimen and front lens alike by minimising the risk of damage through accidental collision.

Air bubbles in the immersion oil will impair the quality of the image and must therefore be avoided. They are easily detectable as luminous globules after removing the eyepiece of the observation tube and should be eliminated by wiping off all immersion oil using a soft linen cloth. The front of the immersion lens should regularly be cleaned after use by applying xylol or benzine very carefully with a clean soft cloth. Alcohol of any kind must not be used.

The **binocular observation tube** with photo tube combined requires paired eyepieces (with engraving "B") and must be set to the interpupillary distance of the observer by means of knurled head (75). To establish even sharpness in either eyepiece set right eyepiece tube to "0"and while covering the left eye focus image sharply by means of the micrometer screw. Then, without altering this focusing adjustment, cover right eye and adjust left eyepiece tube until the microscopic image is also in sharp focus for the left eye.

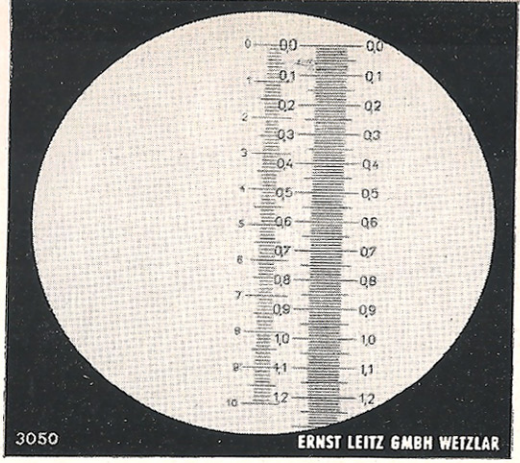


Fig. 13: **Determining the micrometer value**
In the illustration it is 12.20 μ

Measuring under the Microscope (transmitted light)

Similarly applicable to incident light.

The measurement of lengths in a microscopic specimen is normally carried out with the aid of a micrometer eyepiece (10 mm divided in 100 intervals), either by visual observation through the inclined tube or on the ground glass screen of the mirror reflex attachment (23).

Before starting measurements, it is necessary to determine the **micrometer value** of the objective used. This value represents the longitudinal dimension in the plane of the object which corresponds to one interval of the eyepiece scale. The objective tables contained in most catalogues on biological microscopes show the micrometer values for the various systems as measured with the 6× micrometer eyepiece (10 mm = 100 parts) and a stage micrometer of 2 mm divided in 200 intervals. They are valid for the magnification obtained with a tube length of 170 mm and have to be divided by 1.25 in the case of the PANPHOT its body tube having an optical intermediate system of that magnification*). The values given in the tables will usually be found sufficiently accurate, but individual determinations of micrometer values should be made for each objective — also in view of possible slight variations of the optical data — whenever most exacting measurements are essential. When working with a binocular body the usual procedure is to set the interpupillary adjustment to 65 mm to avoid a discrepancy in the micrometer value and use one eyepiece only. However, each observer can also determine the micrometer values with binocular vision for his or her particular interpupillary distance. When making comparison measurements on the ground glass focusing screen direct values are obtained even in the case of the bellows extension deviating from 25 cm since the microscopic image and the scale of the micrometer eyepiece are always magnified to the same degree.

Procedure for **determining the micrometer value** with the aid of a stage micrometer 2 mm = 200 intervals and an eyepiece micrometer scale 10 mm = 100 parts (visual observation method see Fig. 13):

*) The micrometer values listed on page 58 refer to the PANPHOT no modification being necessary in this instance.

The zero lines of the images of the eyepiece and stage micrometer scales are made to coincide, and the micrometer value is read off at the end of the eyepiece scale by ascertaining the length of the stage micrometer that corresponds to the eyepiece scale and dividing that figure by 100. If, for instance, 1.220 mm of the stage micrometer cover the 100 intervals of the eyepiece scale the micrometer value is as follows: 1.220 : 100 = 0.01220 mm =12.20 microns. With low power objectives the image of the stage micrometer scale will not extend across the whole length of the eyepiece scale so that the comparison and calculation are based on 10 intervals of the eyepiece micrometer: If 0.36 mm of the stage micrometer coincide with 10 intervals of the eyepiece scale the resulting micrometer value is 0.36 : 10=0.036 mm = 36 microns.

Measuring example: Let a scale of Hipparchia Janira measured with an objective 45/0.65 (No. 6 L) have a length equalling 65 intervals of the eyepiece micrometer so the actual length is arrived at by multiplying the number of intervals (65) by the micrometer value (0.0026 mm of the objective concerned) yielding 0.169 mm = 169 microns.

For most exacting measurements under the microscope use should be made of a **screw micrometer eyepiece.** This is so designed that a built-in micrometer screw with a drum graduated into 100 intervals moves a measuring line accurately across the whole length of the eyepiece scale. One interval of the latter is covered by one complete revolution of the micrometer drum so that one interval of the drum graduation represents $^1/_{100}$ of the eyepiece scale interval (full directions are given in a special leaflet No. D 8146).

All micrometer eyepieces are fitted with adjustable eyelenses to allow an accurate focusing af the scales according to the individual eyesight of the observer.

For measurements of depth in specimens, i. e. in the direction of the optical axis, the graduation of the microscope micrometer drum can be used but only approximate values can be expected in this way. For accurate measurements of that kind a dial gauge should be suitably fitted to the microscope so that the vertical displacement of the objective can be ascertained, provided both points of reference are situated in the same medium and near the centre of the field of view.

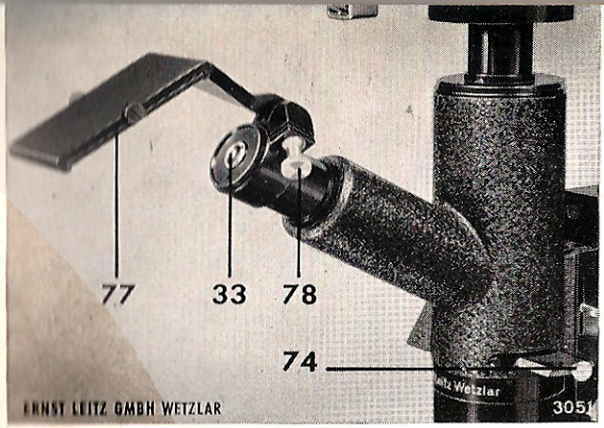


Fig. 14: **Inclinable mirror for micro drawing**
33 eyepiece, 74 deflecting prism of photo tube, 77 inclinable drawing mirror, 78 clamping screw for attaching mirror.

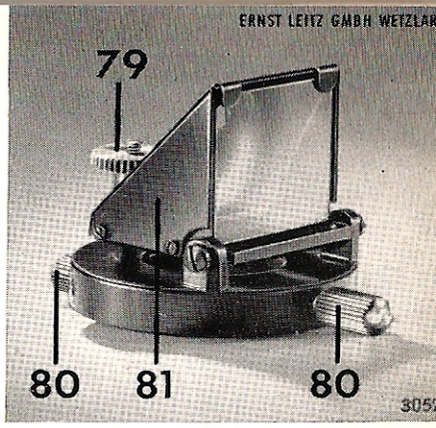


Fig. 15: **Projection prism**
79 adjusting screw for tilting prism, 80 screw to clamp prism to photo tube, 81 prism.

Micro Drawing and Micro Projection

For drawing and projection purposes use is generally made of the photo tube with inclined monocular observation tube fitted with a 6× Huygens eyepiece. Either the filament lamp or the arc lamp can be employed for such work.

The **inclinable drawing mirror** (77) is attached to the lateral observation tube, after removal of the eyepiece, and clamped in such a way that the upper edge of the clamping collar is flush with the end of the tube so that the eyepiece can be returned to its normal position (Fig. 14). When a special working desk is available the drawing board under the table top is pulled out and fixed in position by its supports (as shown in Fig. 23). Direct vision is possible at any time since the mirror can be swung back.

To exclude extraneous light coming from the PANPHOT when drawing micro images a folding screening device will be found advantageous, or the room should be darkened.

The **projection prism** (Fig. 15) is employed in conjunction with a 6× Huygens eyepiece or a 4× projection eyepiece, also in the case of high-power objectives. It is mounted on top of the photo tube after the camera bellows has been shifted upwards and the light-screening sleeve removed from the tube. When the prism is put on, both its clamping screws (80) should be turned back and then fastened moderately tightly. The throw is adjusted by the knurled screw (79).

Micro-projection requires complete darkening of the room. When using the arc-lamp projection distances of 6 to 9 feet can be realized depending on the type of objective and eyepiece used as well as the type of specimen.

Dark Field Microscopy

For most investigations an immersion dark field condenser D 1.20 A is used in conjunction with an achromatic oil immersion objective 100/1.30 ($^1/_{12}$) or, when optimum image quality is desired, a Fluorite oil immersion Fl 95/1.32*). An essential accessory is an IRTIS adapter with iris diaphragm or a drop-in diaphragm to stop down the objective aperture and bring it below the condenser aperture. Otherwise part of the illuminating rays would impair the dark field image. For dark field work with medium power objectives, particularly serial examinations, the dry dark field condenser D 0.80 is recommended which is especially easy to adjust. Its central stop should always be kept in position to suppress stray light.

To slide in a dark field condenser in place of the ordinary bright field model, the substage should first be lowered (control 70) to avoid collision with the object stage. The supplementary condenser lens (8) in the PANPHOT base is swung out of the illuminating beam.

1. Before inserting the dark field condenser adjust it to the centre of its mount using the two centring screws. Then slide condenser into position on the substage (holder 65), but do not raise it vertically.
2. Place a drop of immersion oil (not too small) on the surface of the condenser.
3. Put dark field preparation on stage, focus with the objective 10/0.25 (old type No. 3) and lower condenser if brilliance is inadequate.
4. Raise condenser, using rack and pinion control (70) while observing from the side, until the drop of oil comes into contact with the lower side of the object slide (when it will briefly appear illuminated).
5. Looking into the tube with the preparation sharply focused, bring the condenser still closer to the object slide until the ring of light originally observed becomes as small a point of light as possible. By operating the two centring screws of the condenser move this point into the centre of the field of view.

*) The special dark field objective Fl 95/1.15 (code FLUNK) with suitably reduced aperture is most advantageous.

6. The revolving nosepiece is now turned to a high-power objective. In the case of a higher aperture than 1.15 screw off the objective head and fit it to the IRTIS adapter with iris diaphragm (with old type objectives) or remove objective (if it is the latest type) from the nosepiece and insert drop-in funnel diaphragm before screwing it back.

7. When using an oil immersion objective, place a drop of immersion oil (not too small) on the surface of the cover glass, and with careful observation from the side, raise the stage until its front lens just dips into the oil drop. With the IRTIS adapter with iris diaphragm in position operate micrometer screw until maximum brilliance obtains in the field of view; the structure will become faintly visible at the same time. Then close iris diaphragm to establish a perfect dark field in which the structures of the specimen appear framed in a bright periphery. Use micrometer screw to check correct focusing. When making use of a drop-in diaphragm re-focus the image by means of micrometer screw.

   A suitable test specimen for adjusting a dark field is a preparation of mouth spirillae which can be easily prepared at any time.

   For more particulars see "Directions for Dark Field Microscopy" (list Micro No. 8409).

Accessories for Work in Transmitted Polarized Light

Two **polarizing filters** serve for general examinations in polarized transmitted light.

The analyser fits over the optical intermediate system on the nosepiece bracket (63), after the body tube has been taken off. Make sure that the groove of the analyser mount engages the pin on the nosepiece. Attach polarizer to lower condenser mount (68) and rotate it for the various polarization effects. When both filters are so adjusted that the planes of vibration are at right angles to each other the so called crossed position is established for examinations. The effect may somewhat differ from that customary with mineralogical equipments in that no complete darkness is obtained in the field of view owing to certain properties of the filters and the fact that ordinary biological objectives are not wholly free from strain, but for general polarizing work in biology the arrangement is entirely satisfactory.

To enable the specimen to be rotated in the required way between crossed polarizing filters, a small revolving stage can be mounted on the mechanical stage.

For most critical examinations in polarized light and particularly measurements (mineralogy etc.) use should be made of the specialized equipments dealt with on pages 49—53.

Accessories for Fluorescence Microscopy

Fluorescence examinations are made possible by the arc lamp due to the high percentage of UV rays in this source of light. The UG black glass filter required is screwed into the revolving filter holder of the PANPHOT upright, while the UV protective filters are screwed under the field lenses of the eyepieces or mounted on top in the case of the high-power Periplanatic eyepieces. The 2.5 mm. protective filter is intended for visual observations and for colour photography, a 3—5% copper sulphate solution being used in the cooling trough at the same time. **Blue light fluorescence** is obtained with the aid of the 4 mm. BG filter and the OG yellow-orange filter as a suppression screen.

The LEITZ special fluorescence objectives which incorporate a euphos glass are advantageous in that they dispense with the use of special euphos cover glasses and are thus particularly suitable for smear preparations.

Incident Light Examinations with the ULTROPAK

Loosen clamping screw (49), remove substage and lower object stage. Detach revolving nosepiece complete with objectives, taking care that after loosening of the fixing screw (40) the whole fitting is held firmly in the hand to prevent it from falling on the object stage and being damaged.

Slide **light-screening tube** (91) into central aperture of microscope changing piece so that the lateral guiding screw engages a groove (92) on the left hand side. Attach **ULTROPAK illuminator** with bracket into the dovetail slide (32) from below and secure it by the clamping screw (40). Switch central deflecting mirror (5) to its incident light position II. For tall objects or objectives with long working distance the object stage can be lowered in its dovetail slide (42) and clamped (see also page 9).

In addition to its standard type the ULTROPAK is also supplied with built-in polarizing filters (Fig. 16). The polarizer rotates through 90° (lever 90) and can be swung out of operation (control 89). The analyser (82) is placed on the optical intermediate system mounted in the bracket of the ULTROPAK, the orientation pin of which must engage the groove in the analyser mount. Both types of ULTROPAK have a slot (88) to introduce diaphragms.

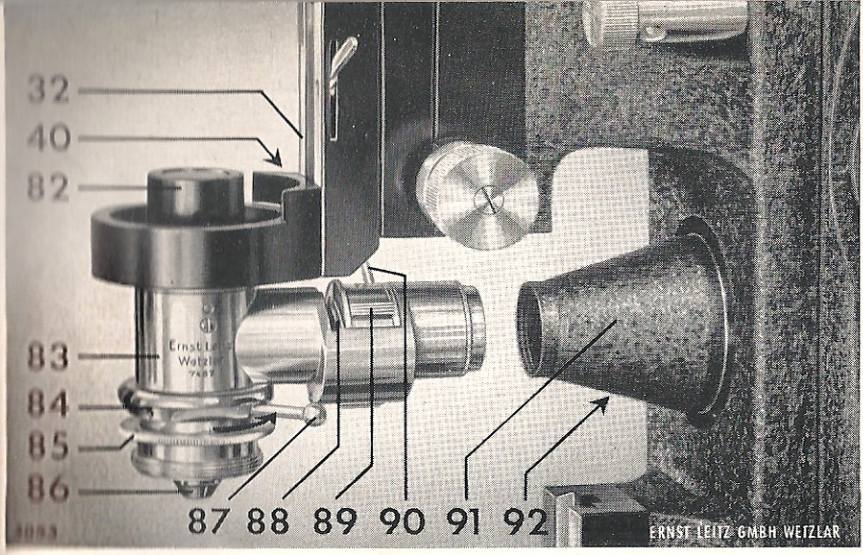


Fig. 16: **ULTROPAK with polarizing arrangement**

32 upper dovetail slide, 40 clamping screw of ULTROPAK bracket, 82 analyser, 83 polarizing ULTROPAK, 84 bayonet changing mount for ULTROPAK objectives, 85/86 UO objective with ring condenser adjustment, 87 handle to facilitate objective changing and locking in position, 88 slot to receive sector diaphragms or filter discs, 89 control for swinging polarizer in or out, 90 lever for rotating polarizer, 91 light-screening tube, 92 groove on left side of central aperture taking guiding screw to orientate tube 91.

The illuminating rays are guided on to the specimen concentrically through a ring condenser situated around the objective (Fig. 10). The ring condenser (85) can be vertically adjusted to vary the incidence of the illumination in accordance with the surface structure of the specimen.

The special *relief condenser* is used for the inspection of objects having an even surface whose structure cannot be revealed by other types of illumination. This condenser which can also be vertically adjusted fits all UO dry objectives but intermediate adapters and light-screening funnel stops have to be used.

To fit relief condenser to a UO objective, screw out objective proper and fit it to the relief condenser mount. Put funnel stop over objective, with the engraving towards the object, and screw intermediate adapter (with the designation for the particular objective used) to the relief condenser mount, the other end of the adapter taking the relief condenser proper. For examining moist materials or those embedded in liquids UO dry objectives can be supplemented by dipping cones and UO immersion objectives by immersion caps.

A set of objective stops allows of varying the depth of focus according to requirements.

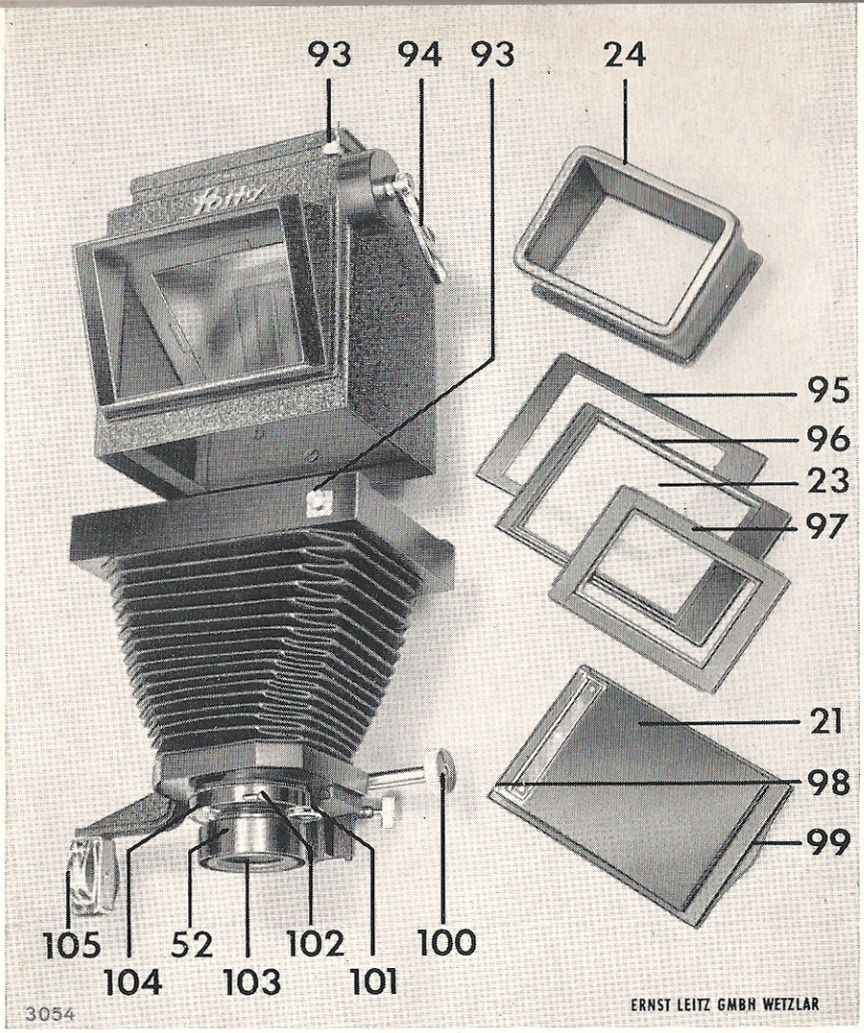


Fig. 17: **Camera components**

21 attachable 9×12 cm darkslide, 23 ground glass focusing screen in frame, 24 light-screening attachment, 93 lock for focusing screen or darkslide, 94 lever to change position of reflecting mirror (aligned with lever), 95 clear glass focusing screen in frame, 96 groove along focusing screen frame to slide in light-screening attachment, 97 adapter for plates 6.5×9 cm (or adapter for quarter plates) fitting 9×12 cm darkslide, 98 locking lever (for opening the darkslide), 99 sliding sheath of darkslide, 100 rack and pinion to camera front for focusing macro objectives, 101 shutter adjusting dial (only to be operated in a clockwise direction): T=time exposure, the wire release opens the shutter and closes it after the release is pressed a second time, B=long instantaneous exposures, when the shutter remains open as long as the wire release is pressed; always close shutter before setting it to another exposure time; the numbers 100—1 indicate $^1/_{100}$ of a second up to one second, 102 tapered thread for wire release, 103 thread for macro objectives, 104 shutter lever allowing of direct operation of shutter (if wire release is not at hand), 105 steel tape measure to read bellows extension.

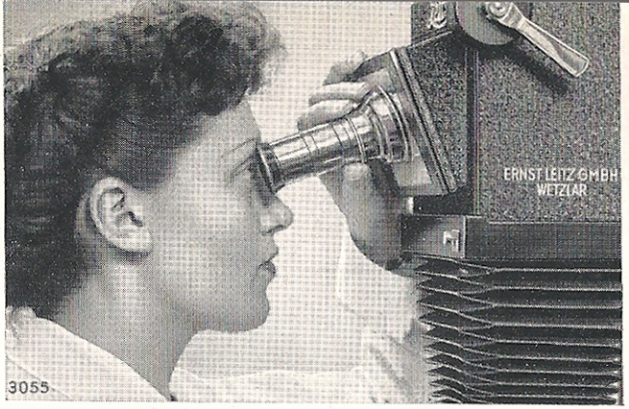


Fig. 18: **Focusing on the clear glass screen**

Taking Photomicrographs (Fig. 17)

After the microscopic image has been focused in the observation tube and the specimen area to be photographed brought into the field of view, the final image adjustment is made on the ground glass screen of the reflex housing (23). The best **photographic eyepiece** for most types of work is the 8× Periplanatic eyepiece which is replaced by a 6× Huygens type in the case of low-power objectives (i. e. 3.5/0.10 or 6/0.18). The observation eyepiece should be of the same type as the one used in the photo-tube.

1. Slide **deflecting prism of photo-tube** (74) out of action.
   Open central shutter by pressing wire release (29) after adjusting dial (101) has been set to T. Swing deflecting mirror of reflex housing into position so that its lever (94) points 45° to the rear (Fig. 18). If the image on the ground glass screen is lacking in brilliance even with a lamp load of 5.5—6 amps change over to arc lamp illumination (see page 12).
2. **Check focusing of image** on ground glass screen (23) by slightly re-adjusting the micrometer screw (76).
   To focus with utmost precision minute structual details of critical specimens replace ground glass screen by **clear glass focusing screen** (95) and use focusing magnifier (Fig. 18) after it has been first focused on the line cross in the centre of the glass plate. The magnifier should be in contact with the glass plate but the eye should not be too close to its eyelens. After these preliminaries the micrometer screw is actuated until the microscopic image is sharply defined in the magnifier.
   The ground glass screen and the darkslide frame are so arranged that accurate focus obtains in either case, only the mirror having to be swung forward (lever in vertical position) to project the image on to the photographic plate.

3. **The image section to be photographed** can be varied and finally selected by vertical movement of the reflex housing (26). After such adjustment its clamping screw (25) must be tightened again and the darkslide frame (27) of the camera raised against the housing to obtain a light-proof connection. Check focusing adjustment. To obtain reductions or circular images the reflex housing can be dispensed with and the darkslide mounted directly on the upper bellows frame (see page 42).

4. Open **field of view diaphragm** only to such an extent that the edge of its image just disappears from the ground glass screen. The **aperture diaphragm** is adjusted according to the requirements of the specimen and its structure. All details must be clearly recognizable and uniform sharpness prevail all over the ground glass screen. Check even illumination by operating handle 14.

5. **To determine the magnification M on the ground glass screen** measure the bellows extension at the level of the darkslide, using tape measure (105), and calculate as follows:

$$M = M_{\text{objective}} \times M_{\text{eyepiece}} \times M_{\text{body tube}} \times \frac{\text{bellows extension (in cm)}}{25}$$

Example:

magnification of objective	= 10×
magnification of eyepiece	= 8×
magnification of body tube with noespiece, centring clutch or ULTROPAK)	= 1.25×
bellows extension	= 35 cm.
conventional distance of vision on which all values are based	= 25 cm.

$$M = 10 \times 8 \times 1.25 \times \frac{35}{25} = 140 \times$$

A simpler procedure to ascertain the magnification is the use of a stage micrometer 2 mm divided in 200 intervals (placed on the object stage instead of a specimen) the extended image of which is measured on the ground glass screen.

Example:

1 interval of the stage micrometer ($^1/_{100}$ mm) equals 10 mm on the ground glass screen; 10 divided by $^1/_{100}$ = 1000, the magnification therefore being 1000 ×.

6. Select suitable **photographic filter** and set revolving filter holder accordingly. For orthochromatic plates use is mostly made of the yellow-green

Fig. 19: **Detaching the darkslide**

filter. Other filters may be inserted into the frame situated between the revolving filter holder and the macro diaphragm (12). Check focusing after having placed a filter into the illuminating beam.

7. Attach loaded **darkslide** (21) to top frame of reflex housing and fix in position by locking lever.
8. Swing out **deflecting mirror** its lever (94) coming to rest in the vertical position.
9. Close **shutter** (use wire release 29) and set time of exposure (dial 101). Factors to be considered when selecting an exposure time are the brilliance of the illumination, the colour composition and the thickness of the specimen, the power of the objective, the setting of the aperture diaphragm, the bellows extension, the filter density and the sensitivity of the photographic plate. Determining the correct time of exposure is therefore a matter of experience, no exact rules or tables being applicable.
10. Pull out **sheath of darkslide** (99) allowing it to be slightly held in its runners.
11. **Release shutter** for time of exposure selected.
12. Close darkslide by pushing back sheath and detach it from reflex housing as shown in illustration above.

Photomicrographs can also be made with the aid of the LEICA camera affording all the possibilities of the 35 mm miniature photography system with its special advantages for colour and series photographs as well as for living specimens under the microscope.

The necessary supplementary equipment includes the MIKAS micro attachment and the LEICA mirror reflex housing respectively, the latter taking an intermediate adapter or a special bellows. The technique to be adopted when such equipment is used on the PANPHOT is the same as described in detail in the Instructions for the ARISTOPHOT vertical camera.

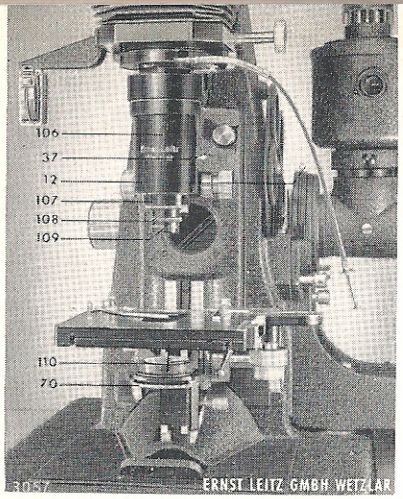


Fig. 20: **Wide photographic tube**

12 macro diaphragm, 37 clamp for securing tube, 70 rack and pinion control for vertical adjustment of stage, 106 wide photographic tube, 107 standard objective thread, 108 iris diaphragm of macro objective, 109 objective (MILAR 50 mm.), 110 large spectacle lens condenser.

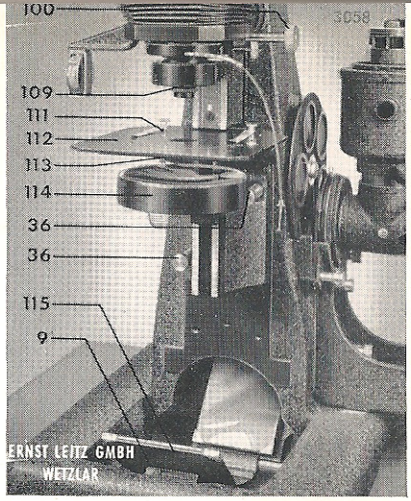


Fig. 21: **Large transmitted light stage**

9 dovetail slide for illuminating mirror, 36 knurled screws holding large transmitted light stage, 100 rack and pinion control on camera front to focus macro objectives, 109 objective, 111 stage inset diaphragm, 112 large object stage, 113 small illuminating lens, 114 large illuminating lens, 115 large mirror.

General Features Photography (Macrophotography) without Eyepiece in Transmitted Light

1. Photographing general features with the wide photographic tube in conjunction with the MILAR and SUMMAR objectives of 24 to 65 mm. focal length for low magnifications of from 2 to 20 times (Fig. 20).

The **objectives** 24 to 50 mm focus are screwed to the bottom end of the tube through an intermediate adapter while the MILAR 65 mm (or a SUMMAR 64 mm) is fitted directly (Fig. 20). The type of objective is chosen according to the image ratio required and with the aid of the table on page 57. The two-diaphragm condenser is replaced by the **spectacle lens condenser** on slide (110) and racked up to its top position. The pivot lens in the base (8) is swung out of operation. The macro diaphragm (12) acts as an aperture diaphragm in this instance.

Rack and pinion (48) is used to focus the image on the ground glass screen as in the case of photomicrographs. The bellows extension is varied to obtain the correct setting for the image area required on the plate.

The **even illumination** of the image may be improved upon by adjusting the lamp condenser (lever 14). As to filters, times of exposure and changing of darkslides the same applies as described on page 37.

2. Photographing general features (of specimens up to 2" dia.) with the large transmitted light stage and MILAR or SUMMAR objectives of from 24 to 100 mm. (Fig. 21).

Raise camera bellows, detach microscope changing piece, after screws 36 have been loosened, together with body tube, nosepiece, object stage, substage, illuminating mirror (50) and remove light-screening cover (51).

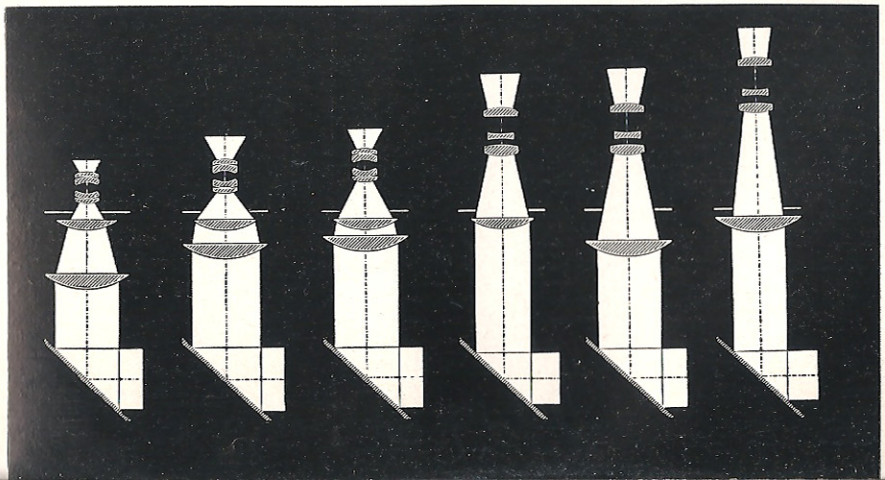
Fit large transmitted light stage (112) to the PANPHOT upright and secure by tightening the knurled screws (36) using the pin provided for the purpose. Objectives of 50 mm or shorter focal length require clamping of the stage in the upper position (4 II), while for longer focus lenses it is clamped in the lower position (4 III); see Fig. 2. Attach both the illuminating lenses underneath the large stage and insert **large mirror** (115) into the dovetailed holder on the front of the PANPHOT base. Put on a **stage inset diaphragm** (111) as required for the particular specimen, making sure that the right side is facing upwards.

Screw MILAR or SUMMAR **objective** to camera front (103) using the appropriate intermediate adapter recognizable by the focal length engraving. The choice of the objective depends on the image ratio required and is facilitated by the table on page 57. The macro diaphragm (12) controls the aperture. The **use and adjustment of the illuminating lenses** for the various objectives is explained in Fig. 22.

To focus the image on the ground glass screen of the reflex housing, operate rack and pinion control on camera front (100)). Adjustment of the objective and also of the reflex housing have to be varied for setting the image ratio desired.

Fig. 22: **Use and adjustment of the illuminating lenses of the large object stage.**

Lens: 24 mm. 35 mm. 42 mm. 65 mm. 80 mm. 100 mm.



Uniform illumination of the image is arrived at by varying the setting of the lamp condenser (lever 14) and the illuminating lens (114) along its dovetail slide. Consult page 37 for directions on filters, exposure times and use of darkslides.

If the image ratio desired is not obtainable even with the bellows extension at a minimum the mirror reflex housing can be put out of operation and the ground glass screen (and likewise the darkslide) attached to the upper frame of the bellows. For details see page 42 and Fig. 25.

Drawing General Features with the Large Transmitted Light Stage and Objectives 24 to 100 mm. (Fig. 23)

To manipulate the equipment for this type of work follow the instructions given on page 39, only a **carrying arm with mirror system and objective holder** taking the place of the mirror reflex housing. A rack and pinion is provided on the holder to enable the objective which is selected in accordance with the image ratio required to be accurately focused on the table top or the sliding drawing board of the special working desk (Fig. 23). This arrangement which should be used with daylight or room lighting screened off allows of the microscopic image to be accurately and conveniently traced on drawing paper.

Fig. 23: **Drawing general features with the large transmitted light stage.**

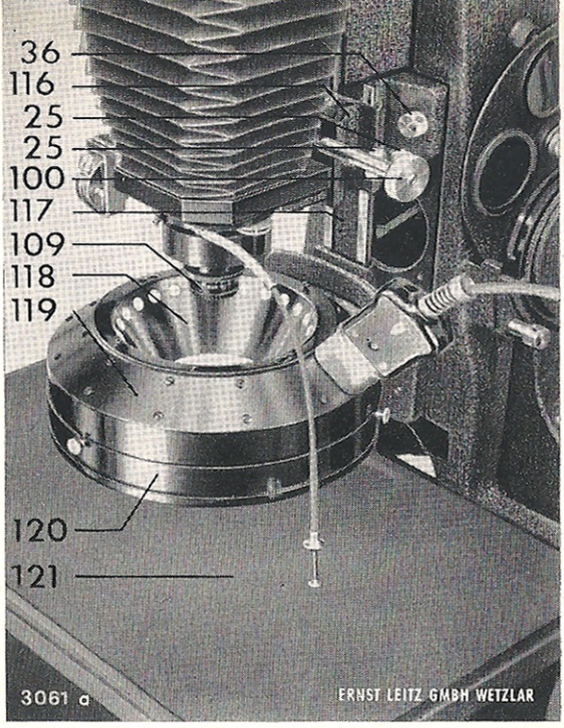


Fig. 24: **Ring illuminator on the PANPHOT**

25 clamping screws for the saddle stands, 36 knurled screws to fit prismatic bar bracket, 100 rack and pinion to camera front for focusing macro objectives, 109 objective, 116 intermediate bracket, 117 prismatic bar taking ring illuminator, 118 reflector I, 119 ring illuminator housing, 120 detachable mount for opal disc, 121 wooden macro stage.

Macrophotography (without Eyepiece) in Incident Light (Fig. 24)

Raise camera bellows, detach microscope changing piece (after loosening screws 36) including body tube, nosepiece, object stage, substage, illuminating mirror (50) and light-screening cover (51). The alternative illuminating arrangement is not employed in this instance. The attachable ring illuminator is adaptable to most incident light photographs, but one or two MONLA microscope lamps can also be successfully used.

Slide **ring illuminator** (119) on **prismatic bar** (117) (with the white dot pointing upwards) and also insert intermediate bracket (116) to hold the saddle stand of the camera front) from above (its white dot upwards). Then attach complete equipment to PANPHOT upright tightening the knurled screws of the bracket by means of a pin.

Place **wooden macro stage** (12) over the PANPHOT base.

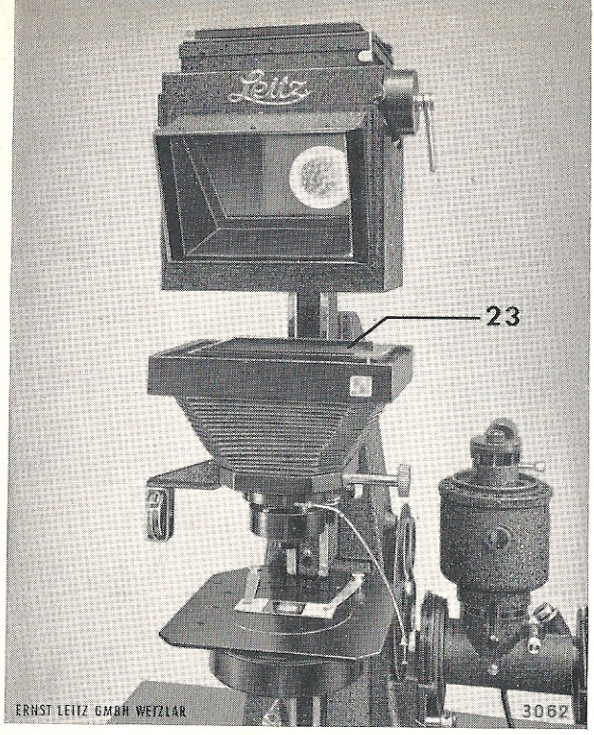


Fig. 25:

Focusing the image over the deflecting mirror on the ground glass screen in the upper bellows frame.

23 ground glass focusing screen in upper bellows frame.

Screw **objective** (of the MILAR or SUMMAR series) to camera front (103) using engraved intermediate adapter as required. Select focal length of objective for image ratio required by reference to table on page 57. For objectives of 50 mm and shorter focal length interpose extension collar (123) to compensate for the height of the ring illuminator housing. This extension collar is superfluous when no ring illuminator is used.

To focus the image on the ground glass screen of the mirror reflex housing operate rack and pinion on camera front. The positions of objective and reflex housing will vary according to the image ratio. If a definite image scale or possibly a circular image desired appear to be unobtainable with the reflex camera even with the bellows extension brought to a minimum then the focusing screen and the darkslide respectively should be placed directly on to the upper frame of the bellows (23). With the reflex housing pushed upwards against the stop and the mirror at its 45° position the latter can be successfully utilized for viewing and focusing the image on the lower ground glass screen as illustrated in Fig. 25.

When working with objectives of longer focal length in conjunction with the ring illuminator, remove intermediate bracket (116) to enable the illuminator to be brought closer to the objective so that the larger field covered can be completely illuminated.

For further instructions see page 37.

Accessories for the ring illuminator (Fig. 26)

In addition to the interchangeable reflector I (118) included in the standard equipment reflector II and III can also be supplied for best results with objectives 100—120 mm, and 150—180 mm focal length respectively. The regular ring-shaped opal disc can be replaced by a large opal disc particularly advantageous for glossy objects, while an opal glass cylinder of 90 mm dia. in mount can be added for oblique illumination and dark field effects. Adjustable sector diaphragms (125) can also be made use of for special lighting effects.

The 12 low-voltage bulbs (8 volts 0.6 amps) are connected in series and necessitate the use of a small regulating resistance. If one of the bulbs burns out and the illuminator does not light up use forklike circuit testing tool for shorting the lamp socket connections one by one until the equipment lights up and the bulb that must be replaced has thus been found.

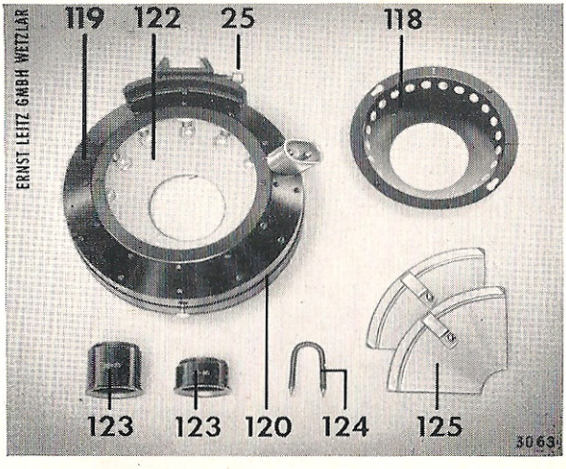


Fig. 26:
Ring illuminator components.

25 clamping screw for saddle stand, 118 reflector I, 119 illuminator housing, 120 detachable mount for opal disc, 122 ring-shaped opal disc, 123 intermediate extension collars for objectives of short focal length, 124 circuit testing tool, 125 sector diaphragms.

3. PANPHOT Outfit for Metallographic Work

The various components of the basic outfit are assembled in the same way as described on pages 6—10. Substage and illuminating mirror are not required, and instead of fitting a revolving objective nosepiece a vertical illuminator is inserted into the upper dovetail slide (32) from below and clamped in position (40) after the light-screening attachment (91) with built-in illuminating lens and lateral black glass mirror (for centring the source of light) has been inserted into the central aperture of the microscope changing piece (with the orientating pin engaging the groove (92) in the sleeve).

The **vertical illuminator** is so designed that the objective is used not only for producing the magnified image but also as a condenser for the illuminating rays for the opaque specimens (see page 22). The bracket of the vertical illuminator also carries the appropriate optical intermediate system (63) which should always be fitted in such a way that its engraving faces the observer.

The vertical illuminator takes special incident light objectives computed for "infinity" and engraved accordingly (∞). These objectives (133) are screwed to quick-change collars and fitted to the illuminator from below by turning them to the right until they are secured on the spring holder (131). If the illuminator is not used for some time its interior can be protected from dust by a quick-change collar fitted with a screw cap.

When using **the arc lamp** as the source of light the illuminating beam **must be centred** by adjusting the centring screws (59, Fig. 8) in such a way that the circular light spot on the rear face of the light entrance tube of the vertical illuminator, as seen over the black glass deflecting mirror of the light screening attachment, falls into the centre of that tube. Varying the setting of the lamp condenser (lever 14) will produce blue and red fringes around the light spot. Even illumination of the microscopic image as formed by the vertical illuminator is obtained when the lamp condenser setting effects a merging of the colour fringes just before they become clearly blue or red.

It is advisable to check the illumination also on the ground glass screen when changing the objective or before making a photomicrograph, slight improvements, if found at all necessary, being achieved by subsequent correction of the lamp condenser setting (lever 14).

Adjusting the Image of the Vertical Illuminator

1. Switch on **filament lamp** and increase its load up to 5 amps. Make sure that **deflecting mirror** (19) is swung into the beam of light.

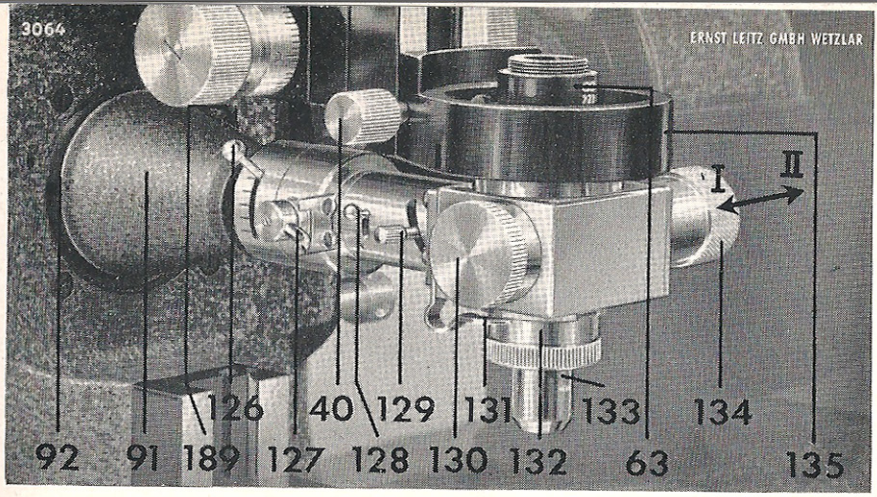


Fig. 27: **Vertical illuminator**

40 clamping screw of bracket, 63 optical intermediate system, 91 light-screening attachment, 92 groove in sliding sleeve to engage orientating screw, 126 aperture diaphragm, 127 half-stop, 128 field of view diaphragm, 129 illuminating lens to focus diaphragm (128), 130 screw cap of illuminator housing, 131 spring holder to take quick-change objective collars (132), 133 objective, 134 knurled head to slide into position compensating prism (I) or a plane glass plate (II), 135 vertical illuminator bracket, 189 black glass deflecting mirror on right side of attachment.

Retain macro diaphragm (12) in its fully opened position. Rotate **filter holder** (3) to use free aperture or a light filter. Set **central deflecting mirror** to incident light position II (Fig. 5).

2. Select low-power **objective** with quick-change collar screwed on and fit to spring holder of the vertical illuminator.
3. Place **object** on the mechanical stage after having mounted it on plasticine and a metal object slide and levelled it by means of the **hand press** in the case of polished ore and metal specimens. Lower stage in its dovetail slide (42) for tall objects and secure it by means of lateral clamping lever (see page 9).
4. Open **aperture diaphragm** by shifting lever (126) upwards and close **field of view diaphragm** completely by a downward movement of lever (128).
5. Move **plane glass plate** into operating position by sliding knurled control to the right against the stop (134 II).
6. Slide in **deflecting prism** of the observation tube (74) and **focus the object** through the eyepiece by operating the rack and pinion control (48) and the micrometer screw (78). Always bring the object close to the objective while looking sideways across the stage and focus the image **while lowering the stage** to avoid collision of specimen and delicate objective front lenses. Also set the micrometer motion to middle position as indicated by index lines before starting that procedure which usually results in an image situated in a light spot with a periphery not sharply defined and not quite central in the field of view.

7. Focus **field of view diaphragm** by adjusting lever (129) of illuminating lens thus bringing out a well defined periphery of the light spot and move it to the centre of the field of view by giving a slight turn to the knurled head (134). Then open diaphragm to such an extent that the edge of the illuminated field so far seen just disappears off the field of view or from the ground glass screen in the case of the mirror reflex housing being used. This ensures that the illumination is limited to the amount of light actually required for optimum image quality with the exclusion of all rays that might cause glare.

   The field of view diaphragm must be re-adjusted whenever a different type of objective is put into use.

8. **Check uniform illumination** by displacing the lamp condenser lever (14) and set it for even light distribution. The brilliance of the image is varied to suit requirements by regulating the lamp load. On no account should it be attempted to achieve a lowering of the light intensity by closing the aperture diaphragm. Additional instructions should be followed when using a filament lamp with screw cap and centring mount (see page 25).

To increase contrast of the microscopic image and to bring out finest structural details of specimens gradually close the **aperture diaphragm.** With full illuminating aperture maximum **resolution** is obtained but for the above reason a cutting down of aperture will often be found necessary. Most favourable image conditions are usually made possible when the diaphragm opening corresponds to about $\frac{2}{3}$ of the rear lens diameter of the objective as seen with the eyepiece removed from the tube (see page 20).

The **half-stop** (127) affords a simple means for obtaining special illuminating effects.

When using an **oil immersion objective** lower object stage, place a drop of immersion oil on the specimen and raise the object stage, observing it from the side, until the oil drop makes contact with the front lens of the objective. View the image through the observation tube, preferably using a Periplanatic eyepiece, and operate micrometer screw for accurate focusing (to remove air-bubbles in the immersion oil follow instructions on page 26). For general visual observations and photomicrography the plane glass plate should always be employed, since it ensures that the objective aperture and its resolving power can be used to the full. The compensating prism (after Berek) also incorporated in the vertical illuminator and put into the path of rays by sliding in knurled control 134 to the left (I) should only

be employed for specimen surfaces of a low reflecting power (i. e. coal specimens). The prism yields a high light intensity in the field of view, but it should never be overlooked that this is brought about by a marked limitation of the aperture and of the resolving power of the objective.

To clean the plane glass plate, unscrew lateral cap (milled rim 130), take out plate and apply soft camel hair brush for the removal of dust particles. The plane glass plates now in use are 0.8 mm thick, and a reflection-increasing coating is provided on one side which must face the object.

Directions for the photo-tube with binocular observation and **photomicrography** will be found on pages 26 and 35.

Photographing General Features with the Plane Glass Illuminators

(for macro work with the ring illuminator see page 41).

1. Using MILAR 50 mm. or SUMMAR 42 mm. objectives for object field diameters up to 10 mm. (Fig. 28)

Insert **wide photo tube** (106) into the upper dovetail slide (32) and see that it is tightly held by lateral clamp (37), screw **objective** with the appropriate intermediate collar (107) to bottom of tube, and attach **plane glass illuminator, 10 mm. type** (136), to dovetail slide underneath the tube clamping it by milled screw (40).

An adjustable **mirror for oblique illumination** may take the place of the 10 mm plane glass illuminator.

The image is viewed on the ground glass screen and focused by means of rack and pinion (48). The bellows is extended as required for any desired image section of the object. Uniform illumination is checked by varying the lamp condenser setting (14). For directions on times of exposure and the handling of darkslides please see page 37.

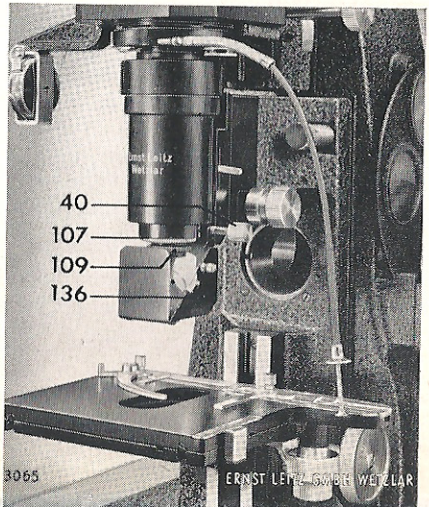


Fig. 28: **General features equipment for incident light illumination of objects up to 10 mm dia.**

40 clamping screw of plane glass illuminator, 107 intermediate objective collar, 109 objective, 136 plane glass illuminator for objects 10 mm dia.

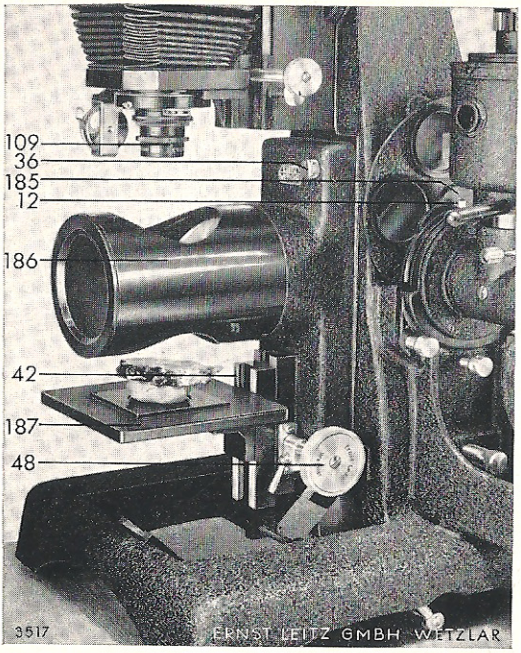


Fig. 29:

General features arrangement for incident light illumination of objects up to 60 mm dia.

12 macro diaphragm and holder for square filters or framed illuminating lens, 36 knurled fixing screws for large plane glass illuminator, 42 dovetail slide, 109 objective, 185 additional framed illuminating lens, 186 large plane glass illuminator, 187 special object stage with rack and pinion vertical adjustment (48).

2. Using 100 mm. or 120 mm. objectives for object field diameters up to 60 mm. (Fig. 29)

Detach microscope changing piece from front of upright and fit **large plane glass illuminator, 60 mm. type** (186), using milled fixing screws (36).

Insert special framed **illuminating lens** (185) in the holder in front of the macro diaphragm (12). Screw **objective** of 100 or 120 mm focal length into camera front (103) interposing the appropriate and specially engraved intermediate collar.

Adjust the object stage (187) by vertical displacement along its dovetail slide (42), after clamp has been loosened, or by rack and pinion (48) to suit the size of the macro specimen.

View the image on the ground glass screen and focus by means of rack and pinion of the camera front (100). Select the bellows extension according to the magnification or the image section desired on the screen and the plate. Check illumination for even light distribution over the whole screen by varying the setting of the lamp condenser (14). For judging the time of exposure and for directions on the handling of darkslides see page 37.

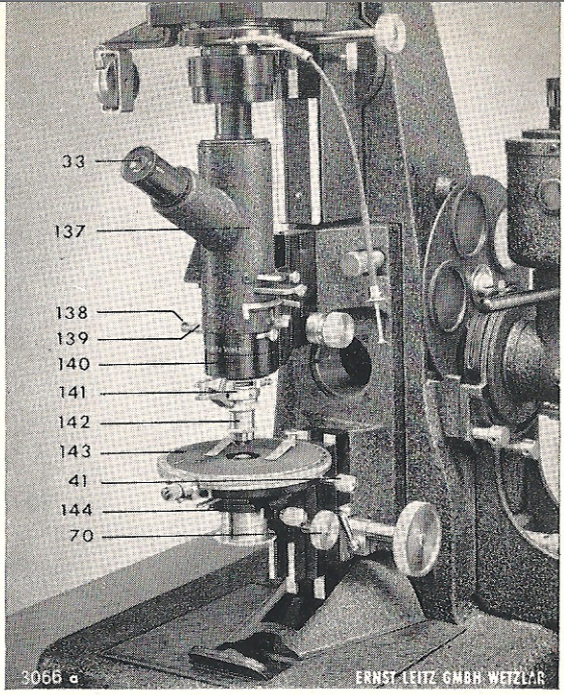


Fig. 30:

The PANPHOT polarizing microscope.

33 eyepieces, 41 clamping screw of object stage, 70 substage focusing knob, 137 photo tube with lateral observation and polarizing arrangement, 138 left stop screw of analyser slide, 139 slide with analyser, 140 objective centring clutch on bracket, 141 objective centring collar, 142 objective (free from polarization), 143 graduated rotating stage with clamping device, 144 substage with polarizer.

4. PANPHOT Outfit for Mineralogical Work

Work in Transmitted Polarized Light

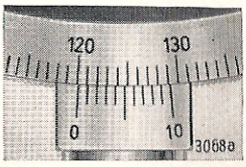
The main components (Fig. 32) of the instrument are assembled as described on pages 6—10. The mechanical stage is replaced by a graduated rotating stage with clamping device (143) and the ordinary biological substage by a polarizing substage (144), while the objective centring clutch (140) takes the place of the revolving nosepiece and the photo tube with lateral observation and polarizing arrangement (137) is fitted instead of the ordinary type.

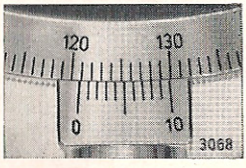
The centred **rotating stage** can be secured in any position by its clamping device (164). The angle of rotation can be read accurately to $^1/_{10}$ degree of an arc by means of a 360° graduation and a vernier the use of which is clearly explained in the illustrations below.

Fig. 31:
Vernier reading

Setting on the left: 120.2°

Setting on the right: 120.8°





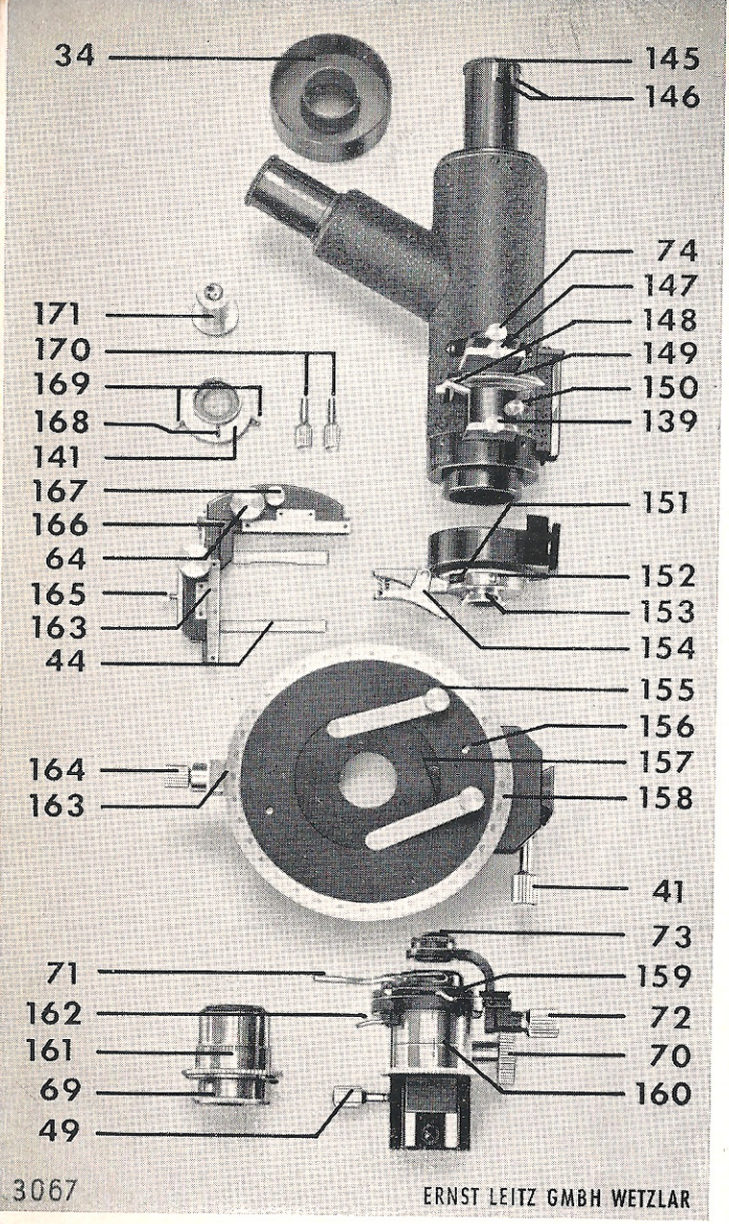


Fig. 32:

Main components of the PANPHOT Polarizing Microscope.

34 light-screening sleeve for photo tube, 41 clamping screw of object stage, 44 object holder, 49 clamping screw of substage, 64 control heads of attachable mechanical stage, 69 milled ring for adjusting field of view diaphragm, 70 substage focusing knob, 71 lever of aperture diaphragm, 72 milled head to operate swing-out top lens (73), 74 deflecting prism on slide for lateral observation tube, 139 analyser slide, 141 objective centring collar, 145 orientation lug of cross line eyepiece, 146 slots for accommodating cross line eyepiece, 147 Bertrand auxiliary lens on slide, 148 lever to rotate analyser, 149 angle scale for analyser rotation, 150 fixing screw for analyser, 151 compensator slot, 152 sliding collar to close slot, 153 precision fitting to take objectives in centring collars, 154 clamp to secure objective centring collar, 155 object clips, 156 screw holes for fitting attachable mechanical or universal rotating stages, 157 detachable ring plate, 158 360° graduation, 159 clamping lever for substage on slide, 160 polarizer of substage model b, 161 polarizer of substage model a, 162 clamping lever for polarizer, 163 vernier, 164 rotation clamping device, 165 clamping screw for sliding object holder, 166 attachable mechanical stage (PIRUX), 167 fixing screw for PIRUX, 168 orientation pin of objective centring collar which must engage the centring clutch (154) when an objective is fitted. 169 centring screws, 170 centring keys, fitting square ends of screws (169), 171 Bertrand auxiliary lens in mount fitting underneath eyepiece.

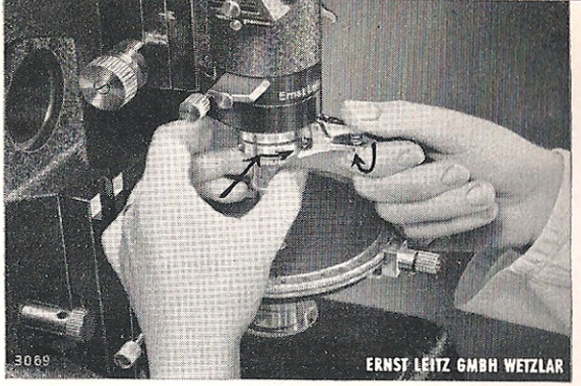


Fig. 33:
Fitting the objective to the centring clutch.

The rotating object stage accommodates an **attachable mechanical stage** (166) with scales and verniers for a traversing range of 30×30 mm for the specimen. One of the object holders is adjustable by a clamping screw (165).

The polarizing **substage model b** incorporates an aperture diaphragm (71) and a swing-out top-lens (73). The latter is put into operating position for all medium and high-power objectives and is swung out (72) for all low powers of less than 10× initial magnification. The condenser is mounted on a slide (which is clamped by lever [159]) and can therefore be detached for a dark field or phase contrast condenser to take its place. The rotatable polarizer (160) with 90° orientation markings can be clamped (162) in any position.

As an alternative the more versatile polarizing **substage model a** can be fitted. Its polarizer has a graduation with 5° intervals and incorporates a second diaphragm (69) controlling the field of view. In its operation and function it is identical with the two-diaphragm bright field condenser fully described on page 21. The lower iris diaphragm is extensible for focusing to enable small image sections to be isolated for special inspection.

If substage a or b is required for bright field examinations in ordinary transmitted light the polarizer is removed from its cylindrical mount.

The optical components used in outfits for observations and particularly measurements in polarized light must be free from strain i. e. non-polarizing. **Microscope objectives** fulfilling this requirement are distinguished from the ordinary types by the engraving **P.**

The **objective centring clutch** (140) allows of a rapid change-over from one objective to another the initial centring always being retained. The objective is fitted from the side, with its centring collar (141) permanently screwed on, to the tapered end of the changing device and secured by turning to the right until the orientation pin (168) engages the clutch (154) proper (Fig. 33).

Objectives and centring collars ordered together with microscope outfits are correctly centred at the factory and, to avoid re-adjustment, collars should not be separated from the objectives.

If subsequent **re-adjustment of objectives** becomes necessary for some reason or other the following procedure should be adopted: Place a mineralogical specimen of abundant structural detail on the rotating stage and focus image with an eyepiece having cross lines. While rotating the stage ascertain the centre of the image and then determine the setting at which a suitably chosen point of the microscope image near the centre image rotation reaches its maximum separation from the centre of the cross lines. Reduce this separation of the points mentioned to about half its amount by adjusting the two screws (169) on the centring collar by means of the keys (170). Then move the specimen by mechanical stage operation or by hand until the specimen point selected for this procedure coincides with the centre of the cross line eyepiece. When rotating the stage again the centre of image rotation will be much nearer the cross line centre than before, but to make the image rotate accurately around the centre of the cross line eyepiece, a repetition of the procedure using another easily distinguishable specimen point close to the centre of image rotation may be necessary.

With some experience perfect centring of an objective should be accomplished after about three adjustments.

Particularly for slight corrections of the centring of objectives the following method is recommended as an alternative: Ascertain centre of image rotation, shifting the specimen, if necessary, to bring an easily recognizable point of the specimen into that centre. Then move it into coincidence with the centre of cross lines employing the centring keys but leaving the specimen in position. A second minor adjustment may be found necessary.

The **compensator slot** (151) in the centring clutch accomodates gypsum and mica plates or the Berek compensator as the most popular accessories of that type.

The **polarizing tube** incorporates an anastigmatic **analyser** (139) on slide, with 90° rotation and graduation with intervals of 1°. The tube is available with or without Bertrand auxiliary lens on slide (147).

A Bertrand auxiliary lens cannot be fitted subsequently to the simpler tube, but with this form of tube conoscopic observations can also be achieved by means of an adjustable Bertrand lens (17) which can be screwed to 5×, 6×, or 8× eyepieces. Photo and observation tubes are slotted (146) to ensure correct positioning of the crossline or micrometer eyepieces having small lugs (145) to engage the slots (146). For visual observations the deflecting prism (74) is moved into position on its slide which must be partially withdrawn when the image is to be projected and viewed on the ground glass screen or for taking the photomicrograph.

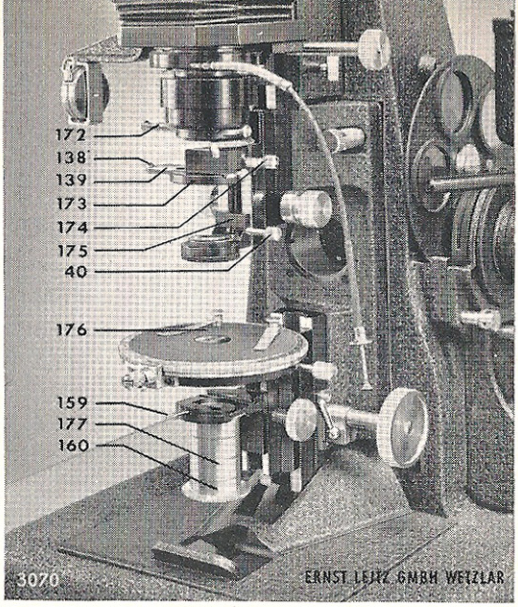


Fig. 34:

General features arrangement for polarized light.

40 clamping screw for objective bracket, 138 left stop screw of analyser slide, 139 slide with analyser mounted on it, 159 clamping lever for condenser slide, 160 polarizer of substage model b, 172 slide for adapting lenses, 173 bracket for analyser and adapting lens slides, 174 clamping screw for bracket (173), 175 bracket with objective, 176 spectacle lens condenser, 177 intermediate extension collar for polarizer.

Focusing of the microscopic image and photomicrography are carried out in the manner described on pages 23 etc. and 35 respectively.

The PANPHOT is well suited for use with the Integrating Stage, Universal Rotating Stages, Heating Stage after Weygand etc., and for directions the special pamphlets on these equipments should be consulted.

In the case of examinations with one of the universal rotating stages the special condenser supplied must be fitted to the substage condenser slide and the ring plate inset removed from the rotating object stage.

Photographing General Features (Macrophotography) without Eyepiece in Transmitted Polarized Light (Fig. 34)

The standard polarizing tube is replaced by a **special 64 mm. objective** (175) and the **bracket with adapting lens slide** (173) which takes a 25 or 40 cm. lens depending on the bellows extension. The **analyser** of the polarizing tube is taken out after the left stop screw (138) of its slide has been screwed off and fitted to the bracket (173). The condenser is removed from its horizontal dovetailed holder (159) and the intermediate extension collar (117) interposed between the sleeve and the polarizer of the substage. The spectacle lens condenser (176) takes the place of the ring plate inset (157) of the rotating object stage.

The directions on focusing and photographing given on page 38 also apply to the above equipment.

If subsequent **re-adjustment of objectives** becomes necessary for some reason or other the following procedure should be adopted: Place a mineralogical specimen of abundant structural detail on the rotating stage and focus image with an eyepiece having cross lines. While rotating the stage ascertain the centre of the image and then determine the setting at which a suitably chosen point of the microscope image near the centre image rotation reaches its maximum separation from the centre of the cross lines. Reduce this separation of the points mentioned to about half its amount by adjusting the two screws (169) on the centring collar by means of the keys (170). Then move the specimen by mechanical stage operation or by hand until the specimen point selected for this procedure coincides with the centre of the cross line eyepiece. When rotating the stage again the centre of image rotation will be much nearer the cross line centre than before, but to make the image rotate accurately around the centre of the cross line eyepiece, a repetition of the procedure using another easily distinguishable specimen point close to the centre of image rotation may be necessary.

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The **compensator slot** (151) in the centring clutch accomodates gypsum and mica plates or the Berek compensator as the most popular accessories of that type.

The **polarizing tube** incorporates an anastigmatic **analyser** (139) on slide, with 90° rotation and graduation with intervals of 1°. The tube is available with or without Bertrand auxiliary lens on slide (147).

A Bertrand auxiliary lens cannot be fitted subsequently to the simpler tube, but with this form of tube conoscopic observations can also be achieved by means of an adjustable Bertrand lens (17) which can be screwed to 5×, 6×, or 8× eyepieces. Photo and observation tubes are slotted (146) to ensure correct positioning of the crossline or micrometer eyepieces having small lugs (145) to engage the slots (146). For visual observations the deflecting prism (74) is moved into position on its slide which must be partially withdrawn when the image is to be projected and viewed on the ground glass screen or for taking the photomicrograph.

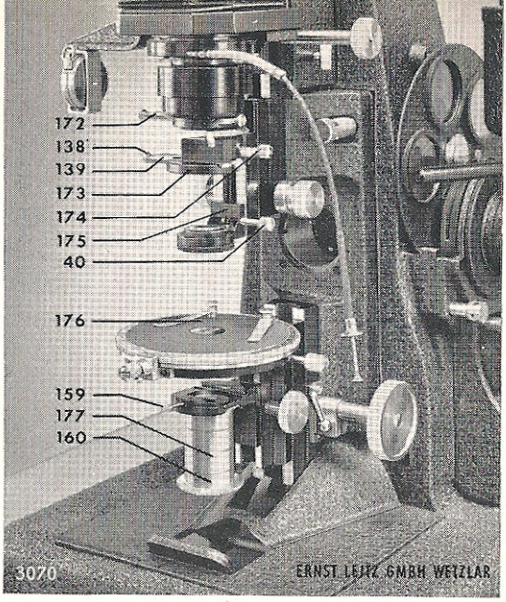


Fig. 34:

General features arrangement for polarized light.

40 clamping screw for objective bracket, 138 left stop screw of analyser slide, 139 slide with analyser mounted on it, 159 clamping lever for condenser slide, 160 polarizer of substage model b, 172 slide for adapting lenses, 173 bracket for analyser and adapting lens slides, 174 clamping screw for bracket (173), 175 bracket with objective, 176 spectacle lens condenser, 177 intermediate extension collar for polarizer.

Focusing of the microscopic image and photomicrography are carried out in the manner described on pages 23 etc. and 35 respectively.

The PANPHOT is well suited for use with the Integrating Stage, Universal Rotating Stages, Heating Stage after Weygand etc., and for directions the special pamphlets on these equipments should be consulted.

In the case of examinations with one of the universal rotating stages the special condenser supplied must be fitted to the substage condenser slide and the ring plate inset removed from the rotating object stage.

Photographing General Features (Macrophotography) without Eyepiece in Transmitted Polarized Light (Fig. 34)

The standard polarizing tube is replaced by a **special 64 mm. objective** (175) and the **bracket with adapting lens slide** (173) which takes a 25 or 40 cm. lens depending on the bellows extension. The **analyser** of the polarizing tube is taken out after the left stop screw (138) of its slide has been screwed off and fitted to the bracket (173). The condenser is removed from its horizontal dovetailed holder (159) and the intermediate extension collar (117) interposed between the sleeve and the polarizer of the substage. The spectacle lens condenser (176) takes the place of the ring plate inset (157) of the rotating object stage.

The directions on focusing and photographing given on page 38 also apply to the above equipment.

knurled head (134) until, on opening the diaphragm, the periphery of its circular image just disappears off the field of view (or off the ground glass screen). Re-adjustment of the diaphragm is required whenever the objective is changed to adapt it to the field covered by the particular objective put into use on the centring clutch.

8. **Check illumination** for optimum uniformity by adjusting lamp condenser lever (14). Never try to vary the brilliance of the image by closing of the aperture diaphragm but regulate lamp load to suit requirements.

Observation of the microscopic image is started with the aperture diaphragm fully open i. e. the maximum illuminating aperture. This is then gradually reduced by operating the diaphragm until object details are clearly seen on account of the enhancing of contrast as compared with the conditions prevailing under maximum resolution with full illuminating aperture. Most favourable image conditions are usually experienced when the diaphragm opening is about $\frac{2}{3}$ the diameter of the rear lens of the objective as seen with the eyepiece removed from the tube (see page 20).

The **half-stop** (127) and the knurled **screw for oblique illumination** (183) serve the purpose of obtaining special lighting effects in the case of specimens that may be found difficult to examine under customary incident illumination.

The screw holes (188) are provided in the supplementary collector for fitting a diaphragm slide after Stach carrying graded centre stops and an aperture diaphragm.

For instructions on the use of oil immersion objectives page 46 should be consulted.

For examinations and particularly measurements in incident polarized light, when it is usually important to retain the linear polarization of the illumination, the use of the compensating prism is recommended regardless of the restriction of the objective aperture involved. The plane glass plate may, of course, also be employed (the change-over being instantaneous by pulling the control head (134) to the right against the stop (II). Field of view diaphragm or illuminated field respectively are centred in accordance with the instructions given in paragraph 7. The lateral screw cap with milled rim (130) of the illuminator housing can be taken off to give free access to the plane glass that can be removed for cleaning from dust particles by means of a soft camel hair brush.

For **directions on photomicrography** please see page 35.

5. Tables

Macrophotographs 1:3 – 7.5:1 (plates 9x12 cm or $3^1/_4$"x $4^1/_4$")

(For image ratios 10:1 – 30:1 page 62 should be consulted)

Image ratio	Maximum object size (round values) in cm.*)	Focal length of objective	Object distance **)	Bellows extension***)	Object to ground glass
			Round values in cm.		
1 : 3	24×33	12 cm	48	15	66
1 : 2	16×22	12 cm	35	17	55
1 : 1	8×11	12 cm	23	23	49
		10 cm	18.5	18.5	40
2 : 1	4×5.5	12 cm	17	35	55
		10 cm	13.5	28	44.5
		8 cm	11	22	35.5
		6.5 cm	9	18	29
3 : 1	2.7×3.7	12 cm	15	48	66
		10 cm	12	38	52.5
		8 cm	9.5	30	42
		6.5 cm	7.5	24.5	34
		50 mm	6	19	26.5
		42 mm	5	16	22
4 : 1	2×2.8	12 cm	14	60	77
		10 cm	11	48	62
		8 cm	9	38	50
		6.5 cm	7	31	40
		50 mm	5.5	24	31
		42 mm	4.5	20	26
		40 mm	4.5	19	25
		35 mm	3.5	17	22
5 : 1	1.6×2.2	10 cm	10.5	58	71
		8 cm	8.5	46	57
		6.5 cm	7	37.5	46
		50 mm	5	29	36
		42 mm	4	24	30
		40 mm	4	23	29
		35 mm	3.5	20	25
		30 mm	3	17.5	21.5
7.5 : 1	1.1×1.5	8 cm	8	66	76
		6.5 cm	6.5	54	62
		50 mm	5	42	48
		42 mm	4	35	40
		40 mm	4	33	38
		35 mm	3	29	33
		30 mm	3	25	29
		24 mm	2	20	24

*) The maximum object sizes are based on an effective plate area of 8×12 cm.
**) The object distance is measured from object to front lens apex of objective.
***) The bellows extension is the distance of the ground glass screen from the rear lens apex.

Optical Data of Microscope Objectives

for biological and polarizing work by transmitted light

Objective designation	new [1]	old	Focal length mm.	Free working distance mm.	Micrometer value [2] (with 6 x Huygens eyepiece)	Cover glass correction [3]	Type of eyepiece	Non-polarizing objectives
Achromatic dry systems	2.5/0.05	–	32.6	20	45 µ	DO	H	P [4]
	3.5/0.10	1 h	31.6	23	34 µ	DO	H	
	6/0.18	2	24.5	17	21 µ	DO	H	
	10/0.25	3	16.3	5.7	12 µ	DO	H	
	13/0.40	3 b	13.3	3.4	8.8 µ	DO	H	
	25/0.50	4 b	7.1	0.88	4.7 µ	D	P	
	45/0.65	6 L	4.0	0.60	2.6 µ	D	HP	
	63/0.85	7	2.9	0.29	1.9 µ	D !	P	
Achromatic immersion objectives (W = water)	ÖI + W10/0.25	16mmÖI+W	16.1	0.58	21 µ	DO	H	
	ÖI + W22/0.65	8mmÖI+W	8.1	0.32	5.3 µ	DO	P	
	W 50/1.00	1/7 W	3.6	0.44	2.3 µ	D	P	
	W 90/1.20	10 W	2.1	0.09	1.3 µ	D	P	
	ÖI 100/1.30	1/12 ÖI	1.8	0.14	1.2 µ	D	P	
Fluorite dry systems	FI 42/0.85	6 FL	4.3	0.38	2.8 µ	D !	P	
	FI 70/0.90	8 FL	2.7	0.22	1.8 µ	D !	P	
Fluorite oil imm. objectives	FI ÖI 54/0.95	1/7 FL	3.4	0.22	2.2 µ	DO	P	(P) [5]
	FI ÖI 70/1.30	1/10 FL	2.5	0.20	1.6 µ	D	P	
	FI ÖI 95/1.32	1/12 FL	1.9	0.14	1.3 µ	D	P	
	FI ÖI 114/1.32	1/16 FL	1.6	0.08	1.0 µ	D	P	
Apochrom. dry systems	Apo 12/0.30	16 mm	13.0	2.5	9.6 µ	DO	P	
	Apo 24/0.65	8 mm	7.3	0.85	5.0 µ	D	P	
	Apo 40/0.95	4 mm	4.4	0.12	3.0 µ	D ! [6]	P	
	Apo 60/0.95	[7] 3 mm	3.0	0.12	1.9 µ	D ! [6]	P	
Apochrom. oil imm. objectives	Apo ÖI 60/1.32	[7] 3 mm	3.2	0.16	2.1 µ	D	P	
	Apo ÖI 60/1.40	[7] 3 mm	2.9	0.14	1.9 µ	D	P	
	Apo ÖI 90/1.32	2 mm	2.0	0.13	1.3 µ	D	P	
	Apo ÖI 90/1.40	2 mm	1.9	0.08	1.3 µ	D	P	

[1] The figure in front of the oblique stroke indicates the initial magnification and that behind the stroke the numerial aperture of the objective.

[2] Calculated for monocular photo tube of the PANPHOT.

[3] D: for cover glass 0.17 mm thick (± 0.05 mm must be adhered to).
O: for objects without cover glass, DO: suitable for use with and without cover glass.
D!: Cover glass thickness of 0.17 ± 0.01 mm must be adhered to or adequate compensation made when correction mount for glasses of 0.12—0.22 mm is provided on the objective.

[4] These objectives carrying the engraving P are supplied free from polarization.

[5] These systems are not wholly free from polarization and their suitability is therefore restricted in the case of polarization measuring work.

[6] These objectives incorporate a cover glass correction mount (0.12—0.22 mm).

[7] Not available for the present.

Magnification Table for the PANPHOT

Visual observations in transmitted light

The values given refer to both monocular and binocular observation and are based on the conventional distance of vision of 25 cm. The total magnifications for the various objective-eyepiece combinations are 25% higher than the usual multiplication of the initial magnifications would indicate owing to the optical intermediate systems used in the PANPHOT tubes. Magnifications that surpass the numerical aperture of the objective used by more than 1000 times do not increase the resolving power any further but may be useful for measuring and counting purposes.

	Designation of objectives		new *)	old	Type of eyepiece	Total magnifications with Huygens and Periplanatic eyepieces			
						6 ×	8 ×	10 ×	12 ×
Dry objectives	Low power		2.5/0.05	–	H	18	24	30	36
			3.5/0.10	1 h	H	27	35	44	55
			6/0.18	2	H	45	60	75	90
	Medium		10/0.25	3	H	75	100	125	150
			13/0.40	3 b	H	105	140	175	210
			25/0.50	4 b	P	190	250	310	375
	High power		45/0.65	6 L	HP	335	450	560	670
		Fl	42/0.85	6 Fl	P	315	420	525	630
			63/0.85	7	P	465	620	775	930
		Fl	70/0.90	8 Fl	P	525	700	875	1050
Immersion objectives	Water	W	50/1.00	1/7 W	P	375	500	625	750
		W	90/1.20	10 W	P	675	900	1125	1350
	Water and Oil	Öl + W	10/0.25	16 mm	H	75	100	125	150
		Öl + W	22/0.65	8 mm	P	165	220	275	330
	Oil	Fl Öl	54/0.95	1/7 Fl	P	400	540	675	800
		Fl Öl	70/1.30	1/10 Fl	P	525	700	875	1050
		Fl Öl	95/1.32	1/12 Fl	P	710	950	1200	1425
		Öl	100/1.30	1/12	HP	750	1000	1250	1500
		Fl Öl	114/1.32	1/16 Fl	P	850	1150	1425	1700
	Apochromatic dry systems	Apo	12/0.30	16 mm	P	90	120	150	180
		Apo	24/0.65	8 mm	P	180	240	300	360
		Apo	40/0.95	4 mm	P	300	400	500	600
		Apo	60/0.95	3 mm	P	450	600	750	900
	Apochromatic Oil immersions	Apo Öl	60/1.32	3 mm	P	450	600	750	900
		Apo Öl	60/1.40	3 mm					
		Apo Öl	90/1.32	2 mm	P	675	900	1125	1350
		Apo Öl	90/1.40	2 mm					

*) See footnotes 1) and 7) on page 58.

Microscope Objectives for Work in Incident Light

(a) Metallographic work with the ordinary vertical illuminator:

Objectives					Cover glass correction[3]	Total magnifications with eyepieces			
Type	Designation	Magnification	Focal length mm.	Num. aperture		6 ×	8 ×	10 ×	12 ×
Achromatic dry systems	M 32	8×	32	0.14	DO	45	65	80	95
	M 23	11×	23	0.20	DO	65	85	110	130
	M 16	16×	16	0.28	DO	95	130	160	190
	M 11	22×	11	0.40	DO	130	180	220	260
Fluorite Oil immersion	JM 3.3	75×	3.3	1.25	O	450	600	750	900
Hemi-apochromat	HM 6.3	40×	6.3	0.70	O	240	320	400	480
Apochromatic dry system	AM 4	60×	4.2	0.95	O	360	480	600	720
Oil immersion (Hemi-apochromat)	HJM 3	85×	3.0	1.36	O	510	680	850	1020

(b) Mineralogical work with the polarizing vertical illuminator:[1])

Objective designation			Cover glass Correction[3]	Total magnifications with eyepieces		
new[2]		old		5 ×	8 ×	10 ×
Achromat	P 5.5/0.15	P 1b	DO	27	44	55
Achromat	P 16.5/0.40	P 3b	DO	82	132	165
Fluorite system	P Fl 45/0.85	P 6 Fl	O	225	360	450
Oil immersion	P 12.5/0.25	P 16 mm	DO	62	100	125
Oil immersion	P 25/0.65	P 8 mm	DO	125	200	250
Fluorite Oil immersion	P Fl 60/0.95	P $^1/_7$ Fl	DO	300	480	600
Fluorite Oil immersion	P Fl 80/1.30	P $^1/_{10}$ Fl	(D)O	400	640	800
Fluorite Oil immersion	P Fl 105/1.32	P $^1/_{12}$ Fl	(D)O	525	840	1050
Fluorite Oil immersion	P Fl 125/1.32	P $^1/_{16}$ Fl	(D)O	600	960	1200

[1]) See note on page 61.
[2]) See note [1]) on page 58.
[3]) See note [3]) on page 58.

Optical Data of the ULTROPAK-Objectives

	UO Objectives	Numerical aperture	Working distance in mm.	Cover glass*) correction	Total magnification with eyepieces 6 ×	8 ×	10 ×	Ring condenser	Special Attachments
Achromatic objectives, Dry systems	3.8	0.12	33	DO	29	38	48	K 3.8	Provision for using dipping cones
	5	0.15	26.3	DO	38	50	62	K 5	
	6.5	0.18	16.2	DO	49	65	81	K 6.5	
	11	0.25	5.8	DO	83	110	138	K 11	
	11 I.A.	0.25	5.8	D	83	110	138	K 11	
	22 I.A.	0.45	2.2	D	165	220	275	K 22-100	For use with dipping cone only
	22	0.45	2.2	DO	165	220	275	K 22-100	
	50	0.65	0.7	O	375	500	625	K 22-100	
Achromatic objectives, Water immersions	23	0.55	0.65	O	172	230	290	K 22-100	Can be supplied with immersion cap, if desired
	55	0.84	0.57	O	410	550	690	K 22-100	
	75	0.90	0.45	O	560	750	940	K 22-100	
	90	1.0	0.42	O	675	900	1125	K 22-100	
Fluorite systems, Oil immersions	23	0.55	0.65	O	172	230	290	K 22-100	
	60	0.85	0.57	O	450	600	750	K 22-100	
	75	1.0	0.51	DO	560	750	940	K 22-100	
	100	1.0	0.48	DO	750	1000	1250	K 22-100	

*) See note 3) on page 58.

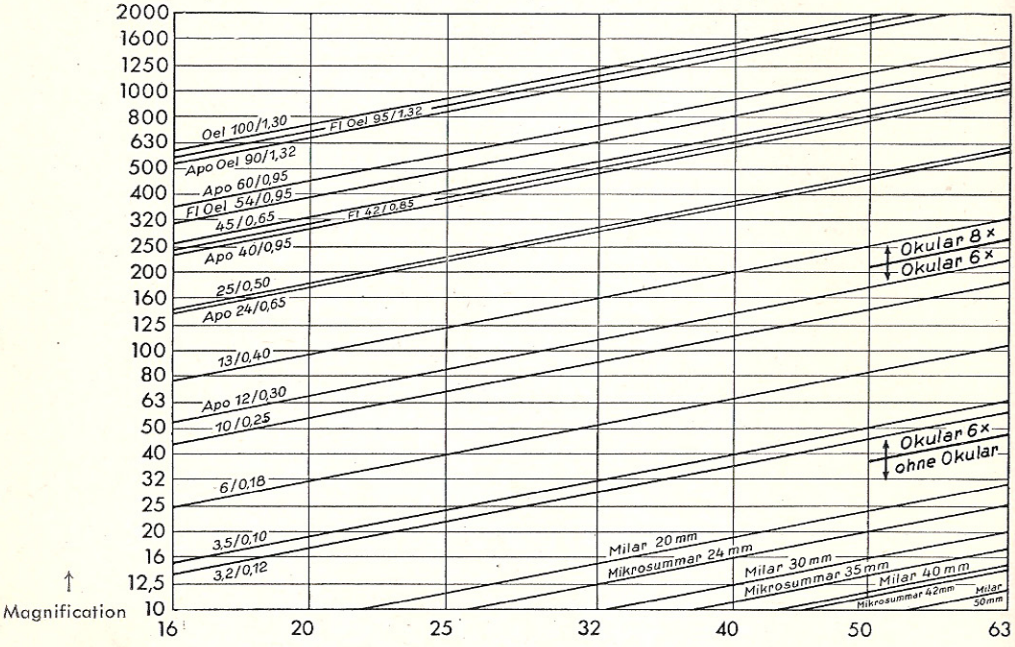
Note

The microscope objectives for examinations in incident light as listed above and on the preceding page can also be used for observations in transmitted light in conjunction with a substage, in some instances even with specimens under a cover glass (as will be seen from the cover glass particulars in the tables). The objective P Fl 45/0.85, however, should be replaced by the P 50/0.65 (D). For transmitted light the plane glass in the vertical illuminator must be used in a horizontal position, i. e. at right angles to the optical axis.

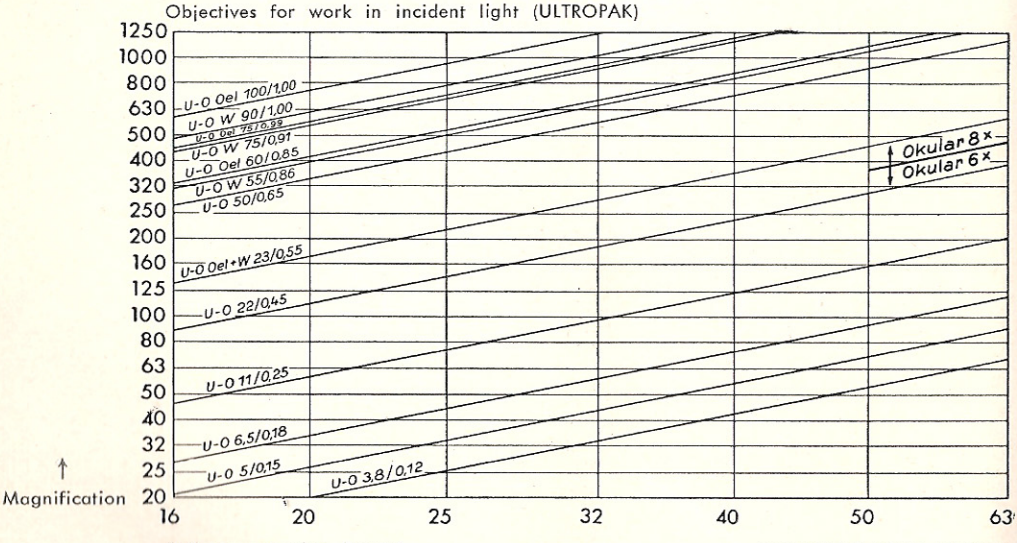
If work in transmitted light has to be carried out on a large scale it is recommended to employ a separate set of objectives specially made for the purpose and preferably permanently fitted to a revolving nosepiece on bracket or with individual centring collars for the objective centring clutch.

Magnifications and Bellows Extensions

Objectives for work in ordinary or polarized transmitted light.

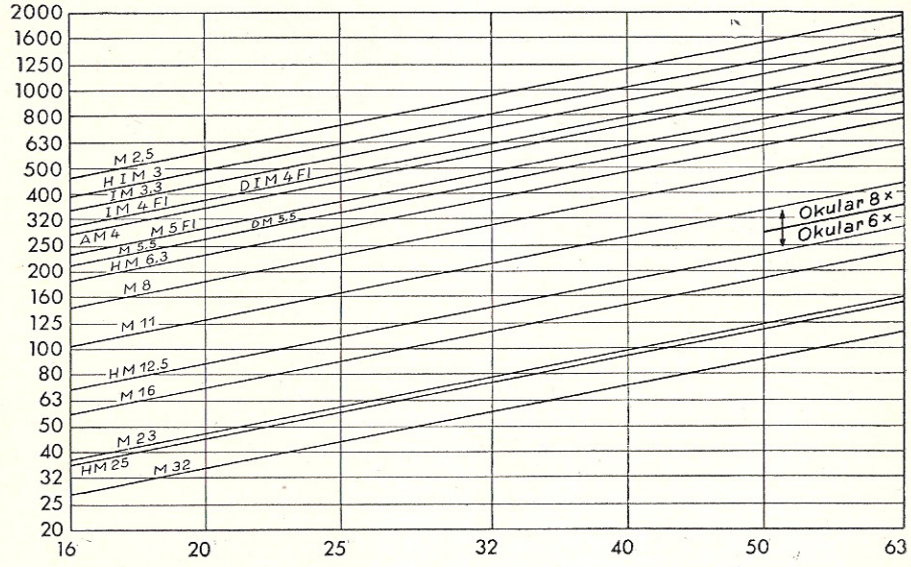


Objectives for work in incident light (ULTROPAK)



Magnifications and Bellows Extensions

Objectives for work in ordinary incident light (vertical illuminator)



↑ Magnification

Bellows extension (in cm.) →

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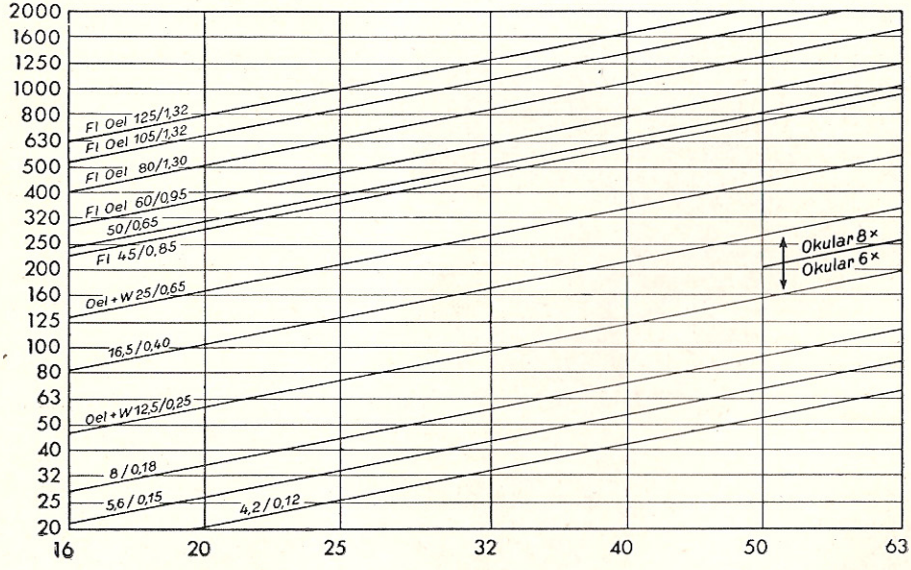
Objectives for work in polarized incident light (polarizing vertical illuminator)



↑ Magnification

Bellows extension (in cm.) →

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6. General Hints on the Handling of Optical Apparatus

Whenever the PANPHOT is not in use it should be protected from dust by a cover of suitable size made of linen, canvas*) or a material customary with office machines. A dust cap should be used on the observation tube or an eyepiece left in position to prevent the penetration of dust, and for the same reason the top opening of the mirror reflex housing should always be closed by a darkslide, or the clear glass screen may be used for the purpose.

Lacquered parts are cleaned with a soft linen cloth or chamois leather moistened in benzine, if necessary. Alcohol should not be used.

All optical components require special care. Dust particles on glass surfaces are best removed by a soft camel hair brush, while other dirt may necessitate the use of a soft leather cloth or a well washed linen cloth dipped in benzine or xylol. Alcohol is unsuitable also in this instance. It should only be applied when finger prints have to be removed from the ground glass screen. Oil immersion objectives must be cleaned immediately after use to avoid hardening of the oil on the front lens. If this precaution has been overlooked a soft linen cloth moistened with xylol carefully applied will put the objective into satisfactory condition.

Objectives must not be taken apart. If defects occur, by accidental dropping for instance, objectives should be sent to the factory or the nearest Leitz agency. This is also recommended for other parts of the outfit or the complete PANPHOT in the case of defects arising from damage or other influences.

*) A cover made of this material, with zip-fastener, is quoted for on request.

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