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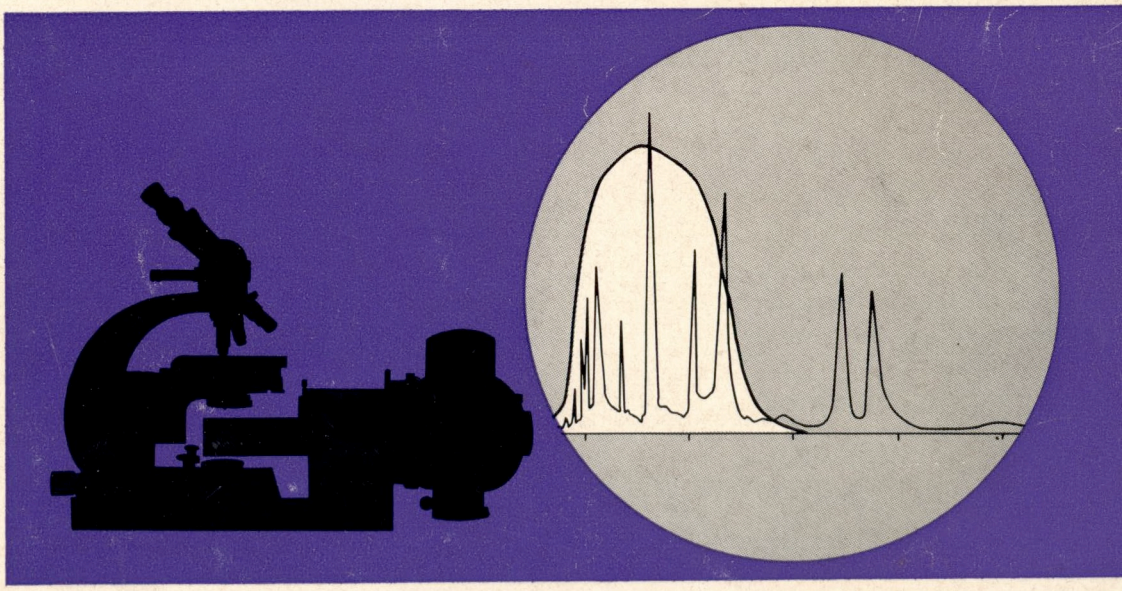
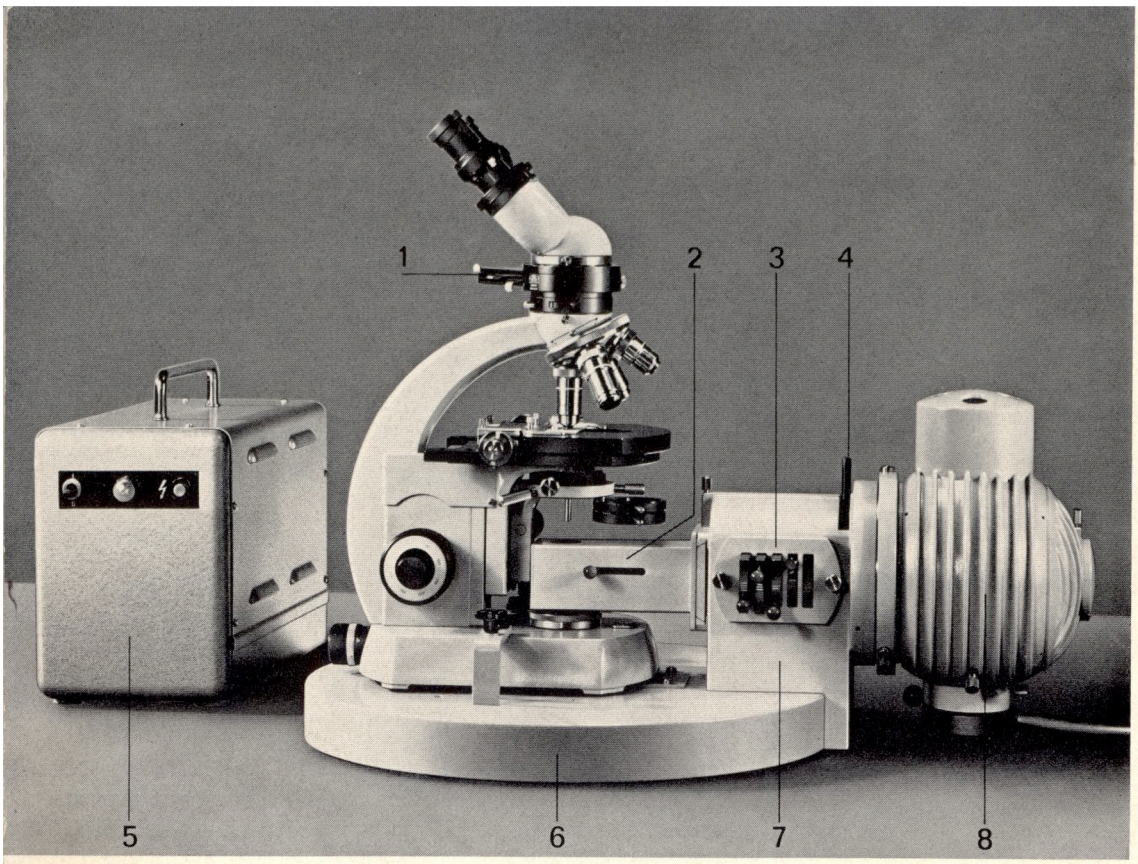
CARL ZEISS

STANDARD Fluorescent Microscopes

Operating Instructions





1 STANDARD RA fluorescent microscope

1 = barrier filter insert (page 14) in intermediate tube
2 = FI reflector attachment (page 16)
3 = filter-slide insert with exciter filters (page 12)
4 = diaphragm near illuminator
5 = choke (page 12) for fluorescent illuminator
6 = base plate
7 = illuminator carrier
8 = lamp housing of fluorescent illuminator (page 11)

Any STANDARD RA or WL microscope can be converted into a rugged and versatile fluorescence microscope offering maximum ease of operation. Conventional excitation of fluorescence and fluorescence with superimposed phase contrast can be achieved just as easily as dark-field illumination for the fluorescent antibody technique. Fluorescence microscopy by reflected light is, however, possible only with our large fluorescence microscope.

These instructions supplement the operating instructions G 41—120 (RA) or G 41—130 (WL) supplied with the microscope. They only cover the supplementary parts required to convert the microscopes for fluorescence as well as their operation using this technique.

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

Formation of a fluorescent image

When illuminated with short-wave light, many objects become self-luminous: the light they emit is of longer wavelength than the exciting light. This phenomenon, called fluorescence, can also be observed through a microscope. It is usually rather weak so that a light source providing powerful excitation in the blue region is indispensable.

Together with the short-wave exciting radiation, the source also emits light of longer wavelength which must be absorbed by exciter filters, since it would cover up the faint fluorescence and make its observation impossible. The long-wave fluorescence radiation then emitted by the excited object passes so-called barrier filters which absorb the short-wave component of the light. As a result, the eye sees a self-luminous object.

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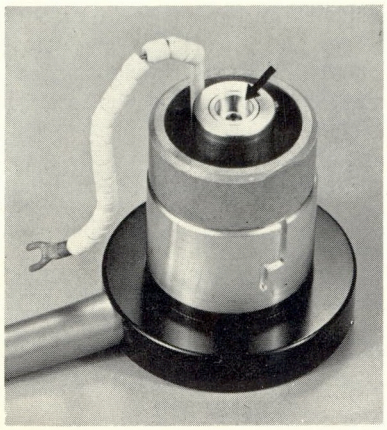
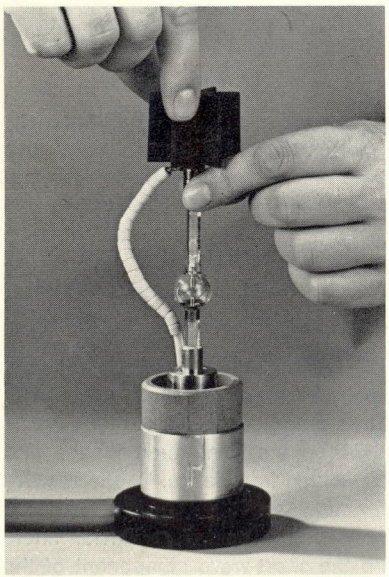


2 Lamp socket for HBO 200 W/4. The socket is supplied with the guide (arrow) in place.



3 When screwing the cooling attachment in place, hold the upper end with one hand.

1.1 Assembling the fluorescence microscope

Place the microscope on the **base plate** (6 Fig. 1) so that the two orienting pins engage the microscope base. Fasten the microscope by the mounting brackets.

If the illuminator carrier (7 Fig. 1), 47 62 70, is not supplied together with the base plate, fasten it by introducing the four screws supplied with the carrier from below through the base plate.

Insert the **reflector attachment** (2 Fig. 1) from one side into the slide of the illuminator carrier as far as it will go and tighten the screw.

Mount the **intermediate tube** (1 Fig. 1). Slip the barrier-filter insert (1 Fig. 1) into the large aperture of the intermediate tube and lock it by the lateral screw.

The **filter-slide insert** (3 Fig. 1) is normally installed in the illuminator carrier with the exciter filters in place.

If these components are supplied separately:
To insert the different exciter filters into the filter-slide insert, remove the slides after loosening the screw on one side. Insert the exciter filters which can be distinguished by the characteristics described on page 13. The exciter filter BG 12 goes into slide I, BG 3 into II, UG 5 into III, UG 1 into IIII and BG 38 into the fixed slide. Then introduce the filter-slide insert into the illuminator carrier and clamp it by two screws.

Insert the **HBO 200 W/4 lamp** into the socket. The lamp socket is supplied with a guide and a lock screw in place (Fig. 2). After loosening the grub screw on one side with the aid of a screwdriver these parts can be removed from the lamp socket. First screw the guide and then the lock screw to the metal base of the lamp which carries the type designation (short neck). Tighten the lock screw with a coin. Then introduce the lamp vertically from above into the lamp socket and tighten the lateral grub screw of the socket. The lamp is now firmly in place. Screw the cable of the star-shaped cooling attachment to the upper end of the lamp, holding this with one hand to avoid any undue stress on the quartz

bulb of the lamp. The cooling attachment should be reasonably tight. Poor contacts give rise to resistance which may lead to considerable additional heating of the lamp.

Wipe fingerprints from the lamp bulb using first a clean cloth and alcohol and then distilled water, to avoid their burning in.

NOTE: When exchanging a burnt-out lamp, unscrew the guide and the star-shaped cooling attachment and use them on the new lamp.

Attach the **lamp housing** to the dovetail ring of the illuminator carrier. Turn the housing through 90° to insert the lamp (Fig. 4).

Introduce the socket with the lamp very carefully into the lamp housing. To facilitate orientation, the socket is guided by a groove. Finally, clamp the socket in place.

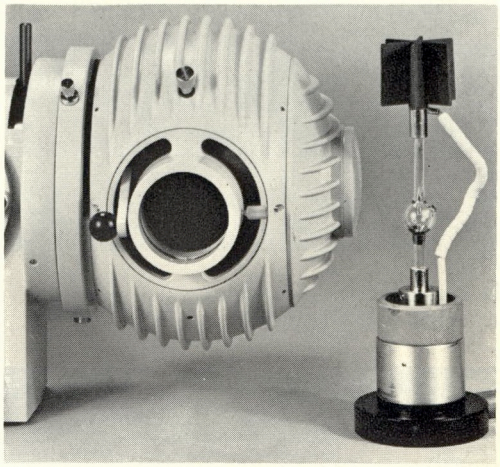
The aforementioned "safety groove" prevents the socket from falling out in the case of accidental slackening of the clamp screw.

Rotate the complete illuminator on the illuminator carrier until it is in working position and clamp it.

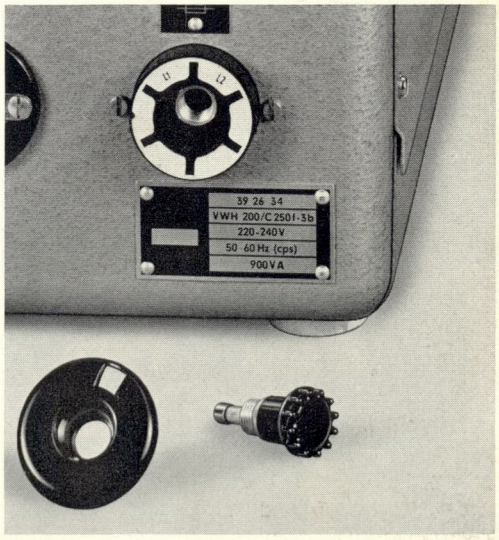
Preparing the **choke** for operation:
Unscrew the locking knob of the clip-on cap with indicator window and replace the cap so that the inscription L 1 or L 2 on the neck of the lamp is also visible in the window. L 1 stands for a connected load of 3.6 amps, L 2 for one of 4.2 amps.

Voltage and frequency can be read through an opening in the side wall of the choke. After removing the side wall, a black selector disk can be set to the desired values.

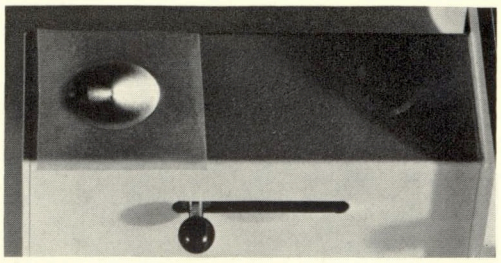
Electrical connections: Connect lamp socket to choke, choke to 220-volt AC (or 240 volts, if the selector disk has been set accordingly). For other AC voltages use the step-up transformer 39 25 28 (100 – 110 – 115 – 127 – 240 / 220 v, 50 . . . 60 Hz, 1000 va).



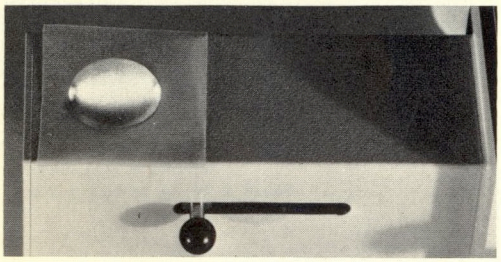
4 Lamp housing rotated for insertion of lamp.



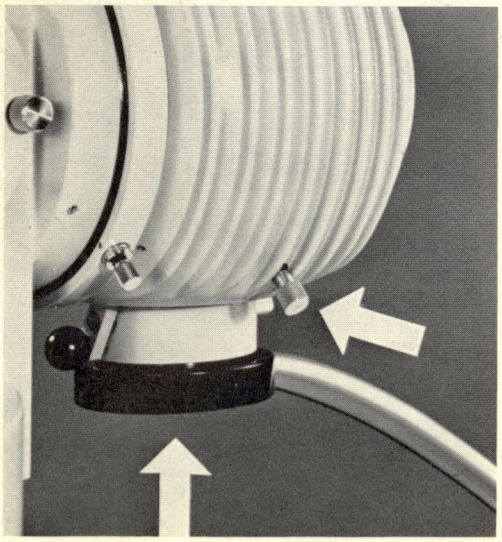
5 Clip-on cap removed for setting choke for operation with L 1 or L 2 lamps.



6 Adjustment of light source: wrong . . .



7 . . . correct . . .



8 . . . by means of lamp socket and adjusting screw.

1.2 Basic adjustment

1.2.1 . . . of the light source in the illuminator

Switch on the choke and briefly press the starting button. A cold lamp usually starts immediately; a hot lamp must first be allowed to cool down slightly. Close diaphragm (4 Fig. 1). Shift the mirror in the reflector attachment towards the observer (moving it into the light path). Place a sheet of paper on the opening of the reflector attachment and pull out all exciter filters. As the diffusion disk of the illuminator is swung out, the image of the light source becomes visible. Center the source image by turning the lateral adjusting screw and shifting the lamp socket vertically (Fig. 8). The field between the two points of extreme brightness (anode and cathode) must be in the center of the opening (Fig. 7).

1.2.2 . . . of the microscope on the base plate

Switch on the base illuminator and shift the mirror in the reflector attachment towards the fluorescent illuminator (moving it out of the light path). The fluorescent illuminator is thus cut off. Focus on the specimen using a 10× or 16× objective and image the diaphragm in the microscope base (lamp field stop) in the usual manner, centering it with the aid of the condenser centering screws. Switch off the base illuminator.

Shift the mirror towards the observer, thus bringing in the fluorescent illuminator. Use the filters mentioned under 2.1.2., page 7. Swing out the auxiliary condenser lens I. Close the illuminator diaphragm and rack the condenser up or down until the diaphragm image appears in sharp focus in the field of view. Do not disturb condenser centering screws once this position has been fixed.

If the diaphragm image should not lie in the center of the field, loosen the mounting brackets holding the microscope on the base plate and slightly shift the microscope to center the image. Should this amount of shift be insufficient, use a screwdriver to loosen the two screws of the orienting bar holding the microscope so that the bar can be shifted. Then retighten the screws and the mounting brackets.

Working with the fluorescence microscope

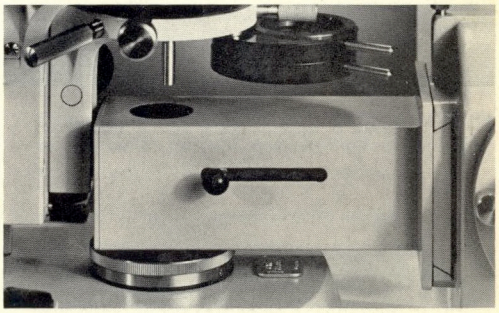
The effect of the frequently weak fluorescent image can be enhanced by using the microscope in subdued light or at least in front of a dark background.

2.1 Excitation of fluorescence

1. Switch on the choke and briefly press the starting button. A cold lamp will usually start without delay, while a hot lamp must first be allowed to cool down slightly.
2. Move the exciter filter I and the barrier filter 47 into the light path. For fluorescence microscopy the diffusion disk of the illuminator must always be swung out. Rack the condenser fully up.

   With phase-contrast condensers set the revolving disk to J.
3. If a low-power objective (2.5× to 6.3×) is used, swing out or unscrew the condenser front lens and swing in the auxiliary condenser lens I.
4. If a 10× or 16× objective is used, swing in condenser front lens, swing out auxiliary lens I and use the coarse and fine adjustment to focus on the specimen.
5. Close the diaphragm near the illuminator and slowly rack the condenser down until the diaphragm image on the specimen is in sharp focus or at least almost sharply defined.
6. Center the diaphragm image in the field of view by means of the condenser centering screws. The condenser is thus centered.
7. Open the diaphragm until its edge just disappears beyond the edge of the field.
8. Move exciter and barrier filters into the light path (for filter combinations, see table opposite). Open the aperture diaphragm of the condenser fully.

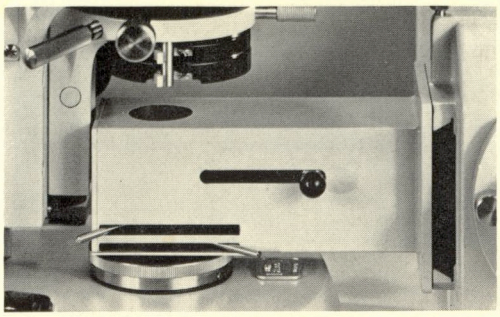
   Since the fluorescent object is self-luminous, here this diaphragm does not have the usual effect of controlling image contrast. A small aperture will only reduce the illuminance of the specimen.



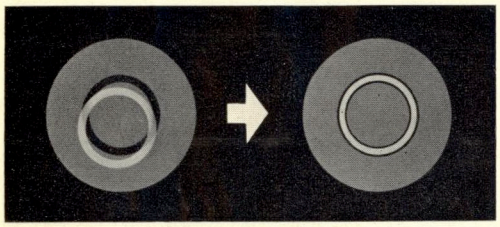
9 Fluorescent illumination:
reflector attachment in position, auxiliary lens I swung out.

Some filter combinations

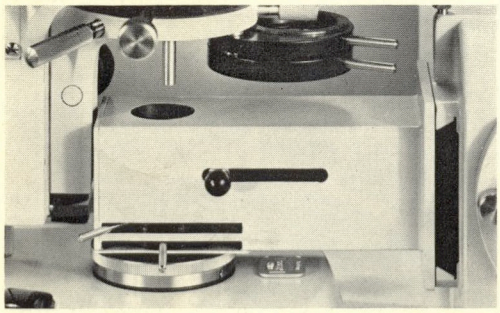
Exciter filters	I BG 12	II BG 3	III UG 5	IIII UG 1
Barrier filters	53/44	50/44	47/–65	41



10 Phase-contrast setting:
lever of polarizing filters in initial position.



11 Adjustment of annular diaphragm of condenser.



12 Phase-contrast fluorescent setting:
position of polarizing-filter levers,
auxiliary lens I swung out.

9. To obtain optimum brightness of the fluorescent image, it may be of advantage to connect the condenser front lens and the specimen slide by means of immersion oil. It is urgently recommended to use only our non-fluorescing immersion oil with a refractive index n_D of 1.515 (n_e = 1.518).

2.2 Phase-contrast fluorescence

The fluorescent image and the phase-contrast image may be viewed either separately or simultaneously. In the latter case, a phase-contrast image is superimposed on the fluorescent image, which can be infinitely attenuated with the aid of a light regulator, thus permitting perfect adaptation to the fluorescent radiation. See also page 16.

The following equipment is required for this technique: achromatic-aplanatic phase-contrast fluorescence condenser, 46 52 78; Fl/Ph reflector attachment, 47 72 23; the NEOFLUAR Ph phase-contrast objectives; and the centering telescope, 46 48 20.

Phase-contrast procedure using the base illuminator.

1. Switch on the base illuminator, set the condenser (with immersed N. A. 1.4 front lens) to J. Swing out the mirror in the reflector attachment.
2. Use a 10× or 16× objective, swing in the auxiliary lens I and focus on the specimen with the aid of the coarse and fine adjustment.
3. Close the diaphragm in the microscope base and slowly rack the condenser down until the diaphragm image is sharply defined on the specimen. Center the diaphragm image in the field of view by means of the condenser centering screws. The condenser is now centered.
4. Open the diaphragm in the microscope base until its edge just disappears beyond the edge of the field.
5. Move the annular diaphragm of the condenser revolving disk engraved in **blue** into

the light path (for Ph 2 objective, annular diaphragm 2) and replace one eyepiece by the centering telescope. Focus on the phase annulus by shifting its two knurled collars.

6. Set the polarizing filters in the reflector attachment as shown in Fig. 10. Move the upper, shorter lever fully towards the observer and the lower longer lever fully towards the illuminator. With a dark background, the bright annular diaphragm can usually be seen in this position.

   If necessary move the upper lever slightly until maximum darkness is obtained in the background.

7. Use the condenser adjusting knobs to center the image of the annular diaphragm and the phase annulus as is usual for phase contrast (Fig. 11).

   Replace the centering telescope by the eyepiece.

Changing to phase-contrast fluorescence

8. Now also move the lower lever towards the observer as far as it will go, thus cutting off the base illuminator of the microscope.

9. Switch on the fluorescent illuminator. Swing in the mirror in the reflector attachment and swing out the diffusion disk of the fluorescent illuminator. Swing out the auxiliary lens I. Move the exciter and barrier filters into the light path. For combinations, see page 7.

10. Stop down the illuminator diaphragm, slightly adjust the condenser vertically until the diaphragm image is optimally focused on the specimen and open the diaphragm until it just disappears behind the edge of the field of view.

    The diaphragm image must be centered on the field of view. If this is not the case, the adjustment described under 1.2.2 has not been performed with the necessary accuracy.

11. Superimpose phase contrast on the image by means of the lower lever (Fig. 12). This lever serves to attenuate the phase-contrast image continuously so that it can be adapted to the intensity of the fluorescent radiation. The upper lever always remains its initial position.

2.3 Fluorescent antibody technique

For this technique, fluorescence is excited by dark-field illumination. To obtain a sufficiently bright fluorescent image, the thin exciter filters are used in the filter-slide insert (page 4). The N. A. 1.2/1.4 ultracondenser is used for illumination. Viewing objectives with numerical apertures between 0.65 and 1.0 may be employed. Immersion objectives with N. A. 1.0 or higher must have an iris diaphragm to reduce the aperture.

1. Immerse the condenser:
   Apply a sufficient quantity of immersion oil without bubbles to the condenser front lens to cover the entire lens surface. Place the specimen in position and rack the condenser up until perfect bubble-free connection to the specimen slide is achieved.

2. Switch on the fluorescent illuminator. Swing out the diffusion disk of the illuminator. Move the exciter and barrier filters into the light path. For combinations, see page 7.

3. Center the field illuminated by the condenser with respect to the optical axis of the objective:
   First focus the specimen with a low-power objective (6.3× to 16×) by means of the coarse and fine adjustment. The field of view will appear only partly illuminated. With closed illuminator diaphragm slowly vary the vertical adjustment of the condenser until the spot of light is as small as possible and almost sharply defined (diaphragm image).

Use the centering screws of the condenser carrier to move this spot of light into the center of field. When changing the focus of the microscope, small punctiform objects in the center of the field must remain radially symmetric. If they move laterally, the illumination needs readjustment.

4. Dark-field adjustment with viewing objective: Move viewing objective into position and focus on specimen. If an immersion objective is used, immerse it beforehand and close the illuminator diaphragm to the stop. Center the image of the closed diaphragm visible on the specimen by means of the centering screws of the condenser carrier. Do not open the illuminator diaphragm further than is necessary to make its image disappear beyond the edge of the field of view. In the case of immersion objectives slowly open their iris diaphragm, but only far enough to keep the background sufficiently dark.

Equipment details

3.1 Illuminator

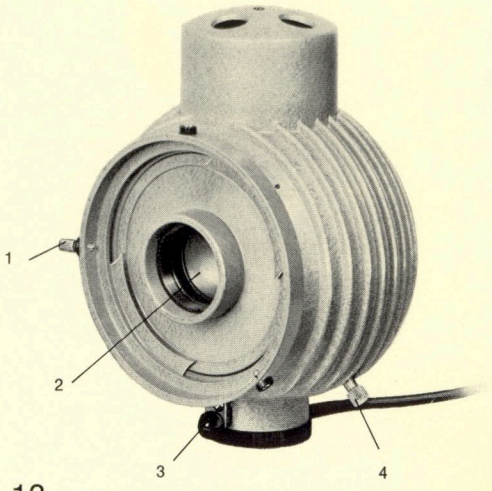
The lamp housing, 47 25 10, is mounted on the illuminator carrier of the base plate. The permanently adjusted lamp condenser images the light source at infinity. An iris diaphragm is not included in the lamp housing. The diaphragm incorporated in the illuminator carrier assumes the function of the lamp field stop.

Light source

For emission curve, see page 15.
The HBO 200 W/4 super-pressure mercury lamp, 38 16 15, serves as radiation source. Its light, which is very rich in ultra-violet and blue, and its high luminance of 33 000 stilbs make it well suited for all aspects of fluorescence microscopy. Its energy distribution corresponds approximately to that of the mercury vapor spectrum. A weak continuum produced by the glowing electrodes is, however, superimposed on these lines. Due to unavoidable manufacturing tolerances for the internal resistance of the lamp a distinction is made between L 1 and L 2 lamps. The choke is designed for two different connected loads and must be set in accordance with the inscription on the lamp (page 5).

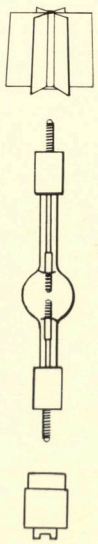
Due to their high operating pressure of 35 to 70 atm gage (= 500 to 1000 lbs./sq. in.), these lamps must for safety reasons be switched on only when they are in the closed lamp housing. The star-shaped cooling attachment, which is screwed to the upper end of the lamp facilitates dissipation of the heat generated. Super-pressure mercury lamps need a few minutes "heating time" after starting, before they reach their full efficiency. The required operating pressure must first be built up by evaporation of the mercury.

If in the course of time, the upper end of the lamp should oxidize, it is advisable to clean the contact (by means of fine emery paper).

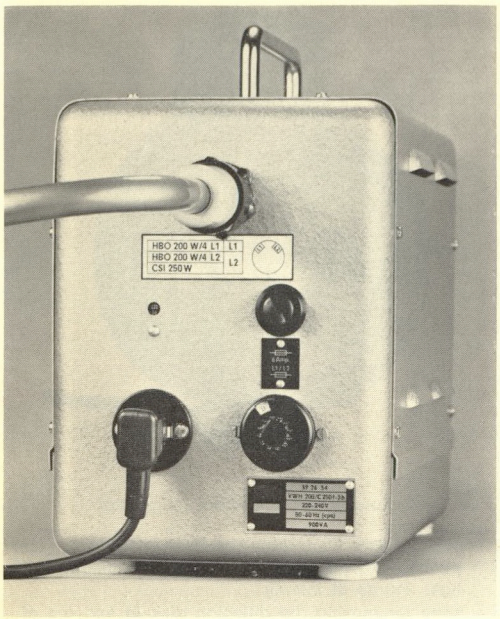


13 Lamp housing of fluorescent illuminator

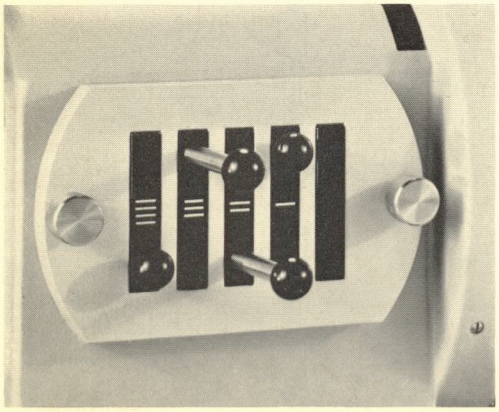
1 = clamp screw for locking the lamp housing
2 = **permanently adjusted lamp condenser** imaging the light source at infinity
3 = knob for moving the diffusion disk in and out of the light path
4 = screw for centering the light source



14 HBO 200 W/4 super-pressure mercury lamp. Top: cooling attachment; bottom: guide.



15 Choke, 39 26 34, for fluorescent illuminator



16 Filter-slide insert, 47 72 18, for exciter filters

Choke

The lamp must be operated on alternating current. The connection to the power supply is made via the choke, 39 26 34 (VW H 200/C 250 f-3 b). A step-up transformer is required for connection to AC voltages other than 220 or 240 volts (page 5).

3.2 Exciter filters

For transmission curves, see page 15.

The filter-slide insert, 47 72 18, in the illuminator carrier has four movable filter slides and a fifth one which is fixed and remains in the light path all the time. It will accommodate five exciter filters.

Exciter filters with a diameter of 32 mm can be supplied in two thicknesses. The thick filters are for normal use. Only in exceptional cases, e. g. for exciting fluorescence by dark-field illumination or reflected light, thinner filters should be used.

Slide	Exciter filter
Permanently mounted	**BG 38** always in the light path. Attenuates or suppresses disturbing red in the background.
I	**BG 12** absorbs red completely.
II	**BG 3** sharp-cutting filter, higher transmission.
III	**UG 5** transmits a noticeable amount of red.
IIII	**UG 1** transmits almost exclusively ultraviolet.

The **BG 38 filter** is distinguished by high transmission over a large wavelength range with a sharp cut in the ultraviolet (at about 300 mμ) and a gradual slope towards the visible spectrum. As will be pointed out in describing the other filters, this filter is designed to attenuate or suppress disturbing red in the background. This red-absorbing filter is closest to the light source and, in addition, protects the other filters against excessive heating. It is permanently mounted in the light path.



Distinguishing characteristic: light blue color.
2.5 mm thick, 46 78 85.

BG 12 exciter filter with peak transmission at approx. 400 mμ. Its passband ranges from 330 to 500 mμ so that the three peaks of the hg-spectrum at 365, 404 and 435 mμ are fully covered. Excitation of fluorescence is accordingly high. Red is completely absorbed. Together with BG 38, BG 12 forms the exciter filter I. Transmission characteristics remain unchanged.

Distinguishing characteristic: pure blue color.
4 mm thick, 46 78 84
3 mm thick, 46 78 89



Compared with the BG 12 filter, the **BG 3 exciter filter** has a steeper slope towards the long-wave region and substantially higher transmission in the UV region. Its passband extends from about 270 to 480 mμ with a wide, high peak from about 320 to 400 mμ. In addition, there are considerable sidebands in the red above 700 mμ and in the infrared region. When this filter is used alone for fluorescence microscopy, the background has a red color. Besides the mercury lines in the visible blue and violet, it is above all the lines around 365 mμ which pass almost unattenuated. Excitation with the BG 3 exciter filter is richer in UV radiation than with the BG 12, but contains slightly less exciting blue. BG 3 combined with BG 38 forms the exciter filter II. Red is suppressed almost completely.

Distinguishing characteristic: darker blue than BG 12. If a glowing lamp filament is observed through this filter, the filament will be seen to have a red fringe, which is not the case with the BG 12.
4 mm thick, 46 78 83
2.5 mm thick, 46 78 88

The **UG 5 exciter filter** with a passband from about 220 to 420 mμ has a wide, high peak from about 300 to 370 mμ and a sideband above 680 mμ. Its slope is even steeper than that of the preceding filters. The Hg-lines at 365 mμ are transmitted almost unattenuated, while only a fraction of the energy of the lines at 404 mμ passes. Combined with BG 38, this filter forms the exciter filter III. Red is only attenuated.

Distinguishing characteristic: Held against the sky, the UG 5 appears violet.
3 mm thick, 46 78 81
2 mm thick, 46 78 86

The **UG 1 exciter filter** has a passband from about 300 to 400 mμ (peak transmission at 350 mμ) and a sideband above 710 mμ. Consequently it will transmit only the 365 mμ group of the intense mercury lines. Its transmission terminates with a steep slope at the boundary between UV and the visible region. Red transmission is so low that the background in the fluorescence microscope will appear practically black even without any additional filter. UG 1 and BG 38 together make up the exciter filter IIII.

Distinguishing characteristic: Held against the sky, the UG 1 appears almost black.
3 mm thick, 46 78 82
1.5 mm thick, 46 78 87

3.3 Barrier filters

For transmission curves, see page 15.

The barrier-filter insert, 47 25 47, is located in the intermediate tube, 47 30 59. Each of its three slides contains two barrier filters and a clear aperture.

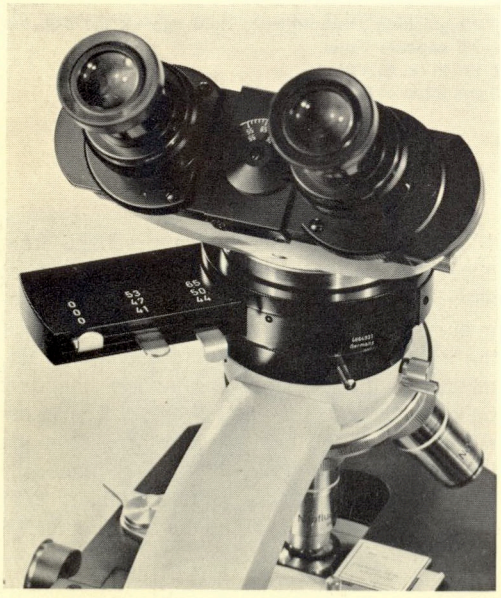
The barrier filters 41, 44, 47, 50 and 53 are sharp-cutting filters with more or less steep slopes towards the short-wave region. The designation of the barrier filters indicates the position of the cut and is an abbreviation of the cut-off wavelength. The wavelength region in which the transmission of the filters is about 10 % has been chosen as characteristic of the sharp cut.

Example: The barrier filter 41 has a transmittance of 0.1 (= it transmits 10 % of the incident radiation) at a wavelength of about 410 mμ. Below this wavelength hardly any exciting light or fluorescence light is allowed to pass.

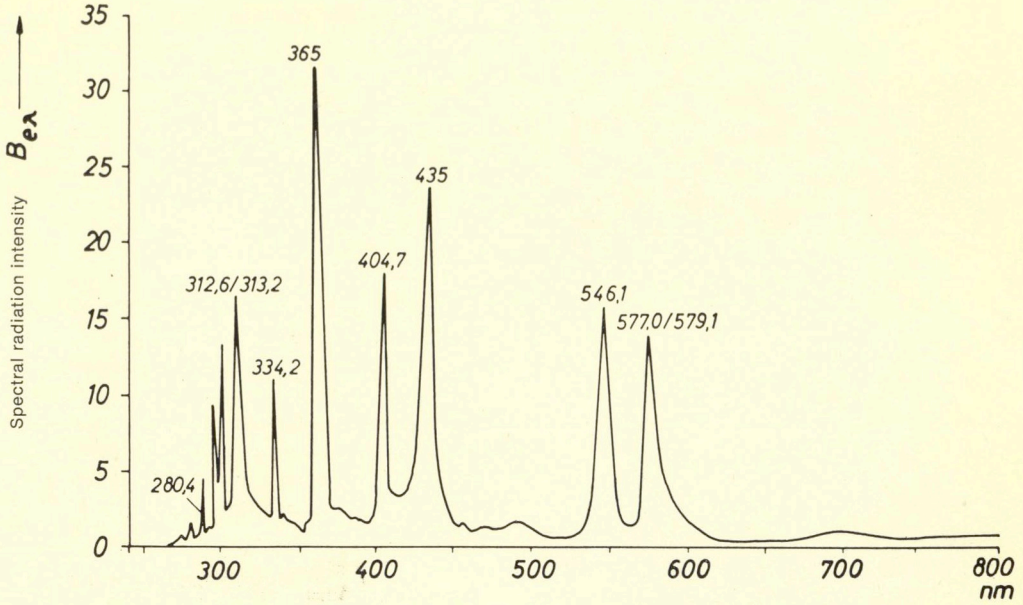
The lighter barrier filters 41, 44 and 47 are free from disturbing intrinsic fluorescence, while the darker barrier filters 50 and 53 may fluoresce noticeable when directly exposed to exciting light. This can be recognized by a red veil spreading over the entire image (not to be confused with a red background). Such disturbances can be avoided by using a barrier filter 44 or 47 in conjunction with a filter 50 or 53. In this case the greater part of the exciting light is absorbed by the filter 44 or 47 and the residual component passed will not cause any disturbing fluorescence in filter 50 or 53.

The barrier filter –65 (passband approx. 350 to 650 mμ) has a gradually sloping cut towards the long-wave region and may be called a "minus red filter". It is used in conjunction with one of the filters 41, 44 or 47 and attenuates the red background.

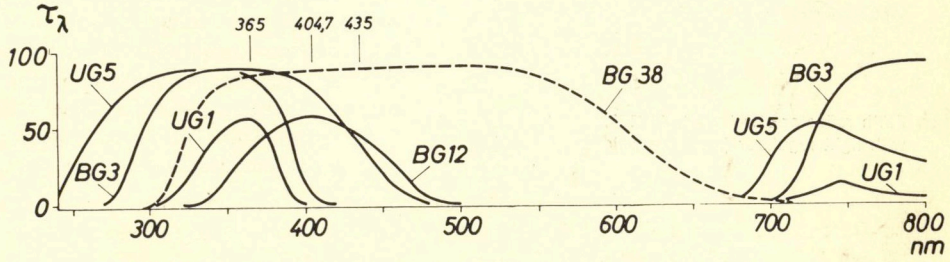
In this respect it is more effective than BG 38 of the exciter filters, but in contrast to the latter it not only attenuates the red background (passed by the exciter filter), but also the red fluorescence of the specimen.



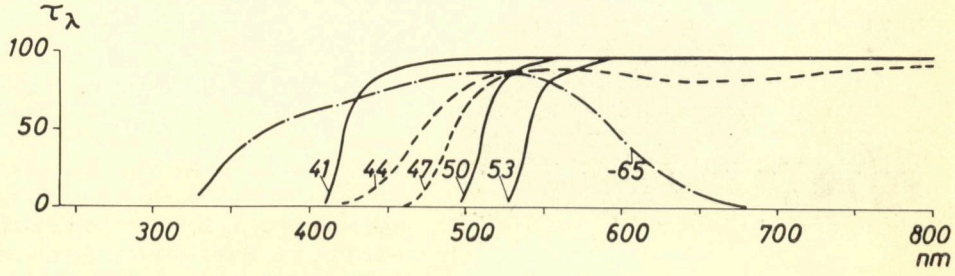
17 Barrier filter insert, 47 25 47.
Barrier filters 47 and 44 in the light path.



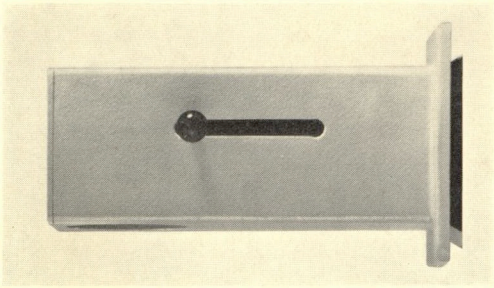
Spectral emission of HBO 200 W superpressure mercury lamp (nm = mμ)



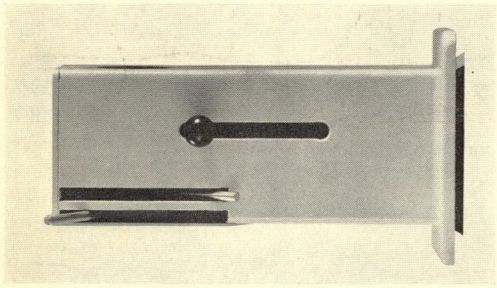
Spectral transmission of exciter filters



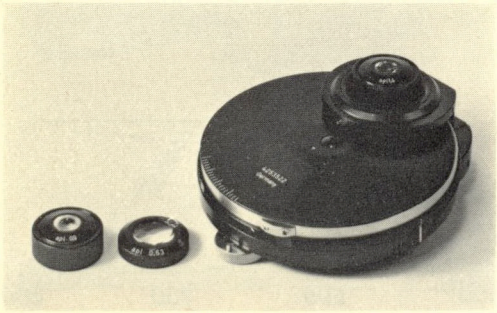
Spectral transmission of barrier filters



18 Fl reflector attachment, 47 72 22.
Mirror can be moved into and out of the light path to allow use of fluorescent or base illuminator.



19 Fl/Ph reflector attachment, 47 72 23,
with light regulator (rotatable polarizing filters).



20 Phase-contrast fluorescence condenser, 46 52 78.

3.4 Reflector attachment

The Fl reflector attachment, 47 72 22, located directly at the illuminator carrier, reflects the light from the fluorescent illuminator into the condenser when the mirror is in the light path. If the front-surface mirror is moved towards the illuminator by the lateral knob, the illuminator in the microscope base may be used in the usual manner.

A modified version is the **Fl/Ph reflector attachment,** 47 72 23, which has a partially silvered mirror as well as two rotatable polarizing filters. With the mirror in the light path the light from the fluorescent illuminator reaches the specimen, while the base illuminator may at the same time be used to produce a phase-contrast image (see page 8). In this case, the condenser 46 52 78 is required.

When the upper polarizing filter is at right angles to the annular polarizing-filter diaphragm in the condenser, a dark background is obtained. The base illuminator then illuminates the specimen only through the usual phase-contrast annulus. The lower polarizing filter acts as a light regulator by more or less attenuating the effective light in accordance with its position in relation to the upper filter. The fluorescence light, however, is not affected by the polarizing filters.

3.5 Condensers

For fluorescence illumination we recommend N. A. 1.3 and 1.4 condensers. Condensers of smaller aperture are not suited, since they will absorb part of the exciting light. In addition to the bright-field condensers N. A. 1.3 Z, 46 52 53, and N. A. 1.4 Z, 46 52 57, mention should here be made of the phase-contrast fluorescence condenser and the N. A. 1.2 / 1.4 ultra-condenser.

Achromatic-aplanatic phase-contrast fluorescence condenser, 46 52 78

Bright field in J position –

N. A. 1.4 for fluorescence work, with immersed front lens,

N. A. 0.32 without front lens,

N. A. 0.9 with front lens, 46 52 56,

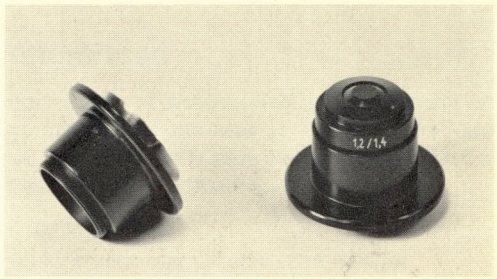
N. A. 0.63 with front lens, 46 52 55

Phase contrast with immersed N. A. 1.4 front lens with annular diaphragms 2 and 3 engraved in white.

Superposition of phase-contrast on fluorescent image with immersed N. A. 1.4 front lens with annular polarizing-filter diaphragms 2 and 3 engraved in **blue.**

Dark-field (not for excitation of fluorescence) with immersed N. A. 1.4 front lens in D position with objective apertures of 0.65 to 1.0 and maximum specimen-slide thickness of 1.2 mm.

Ultracondenser, 1.2 / 1.4 N. A., 46 55 00
for dark-field illumination, preferably for the fluorescent-antibody technique. Immersion condenser for objectives with an effective aperture of 0.75 to 1.0 (100× objective with iris diaphragm) and maximum specimen-slide thickness of 1.2 mm.



21 N. A. 1.2/1.4 ultracondenser, 46 55 00, on condenser holder Z, 46 55 42. Left: condenser holder Z alone.

3.6 Objectives

As with the condensers, high numerical apertures are of advantage in the objectives as well. This holds above all for our NEOFLUAR objectives, apochromats and planapochromats. The simpler design of the NEOFLUARS, which have less lens elements, leads to enhanced contrast and brilliance in the fluorescent image.

The following high-power objectives are recommended:

Achromat, 40×, 0.85 N. A., oil	46 17 06
Apochromat, 40×, 1.0 N. A., oil, with iris (always open iris diaphragm)	46 17 36
Planachromat, 63×, 0.90 N. A., o. D. for uncovered specimens	46 08 60

References

The number of publications on the subject of fluorescence microscopy is so large that we shall here name only a few comprehensive works. These textbooks contain further references.

M. Haitinger:
Fluoreszenz-Mikroskopie, 2nd edition,
168 pages, Akad. Verlagsgesellschaft
Geest & Portig KG, Leipzig 1959

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in Handbuch der Histochemie, vol. I/2,
294 pages, Gustav Fischer Verlag,
Stuttgart 1966

L. Stockinger:
Vitalfärbung und Vitalfluorochromierung
tierischer Zellen,
vol. II, D 1 of Protoplasmologia,
96 pages, Springer-Verlag, Vienna 1964

Edited by R. C. Nairn:
Fluorescent Protein Tracing,
280 pages, E. & S. Livingstone Ltd., Edinburgh
and London 1962

U. S. Department of Health:
Fluorescent Antibody Techniques,
73 pages, Superintendent of Documents,
U. S. Government Printing Office,
Washington 25, 1960

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

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

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