INSTRUCTION BOOK

FLUORESCENCE EQUIPMENT

VICKERS LIMITED
VICKERS INSTRUMENTS
YORK. CROYDON.

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16. SALCOMBE CLOSE
SALE CHESHIRE

FLUORESCENCE EQUIPMENT

ERRATUM

Erratum p. 15-16 Fluorescence equipment for M32 Patholux

The instructions for fitting the HBO 200 mercury vapour lamp are *incorrect*. The long leads goes to the lateral electrode. The short lead goes to the top electrode.

If incorrectly carried out damage may well result to the lamp.

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FLUORESCENCE EQUIPMENT

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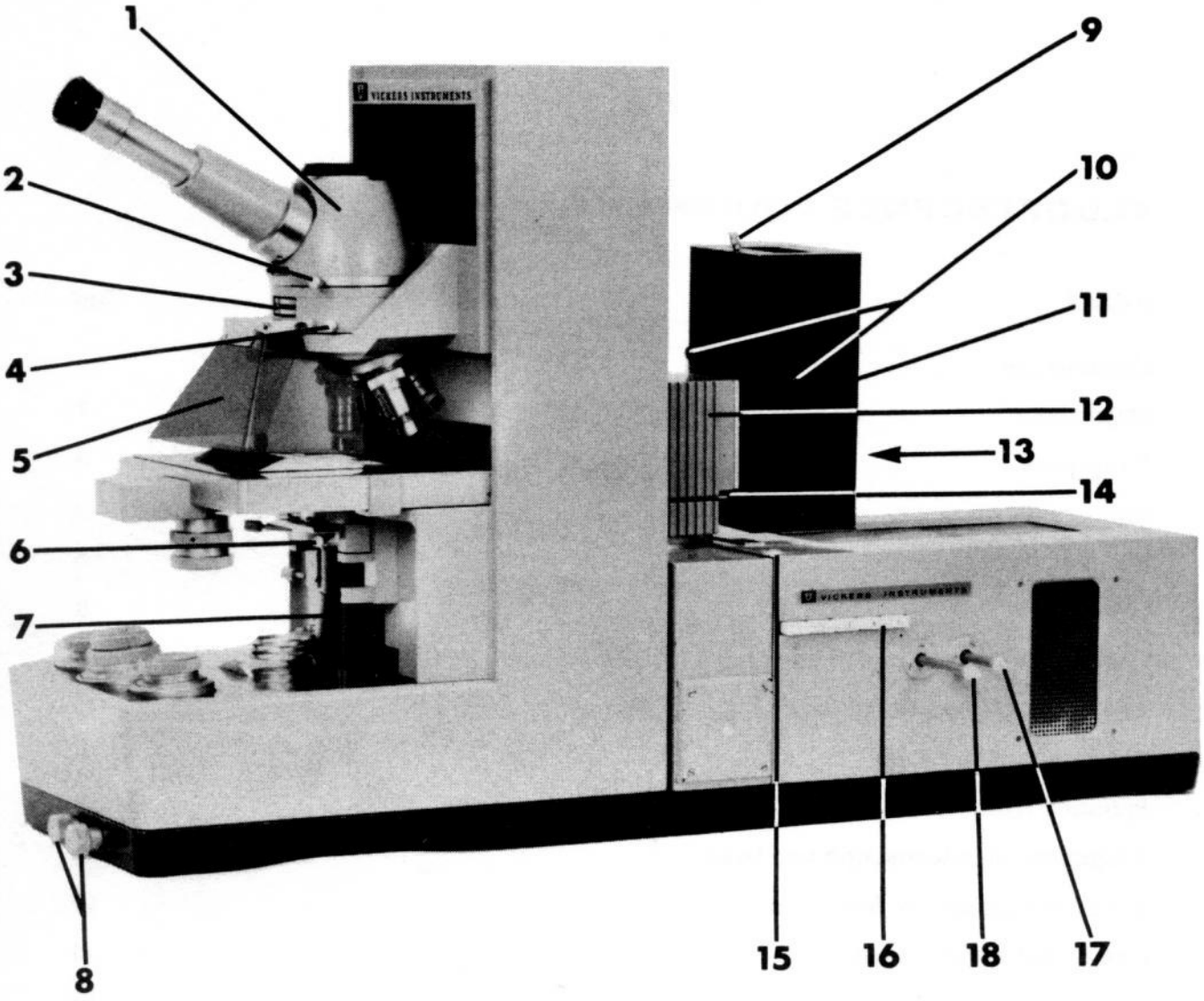

FIG. 1

1. Prism box
2. Clamp screw for prism box
3. Barrier filter unit
4. Clamp screw for barrier filter unit
5. Light shield
6. Centring condenser screws (2)
7. Adjustable light shield
8. Lamp centring controls (2) for mercury vapour lamp
9. Clamp screw for light baffle
10. Lamp centring controls (2) for tungsten halogen lamp
11. Light baffle
12. Mirror unit
13. Lamp filament focus control (not visible on illustration) for tungsten halogen lamp
14. Field iris control for tungsten halogen lamp
15. Securing screws for mercury vapour lamp cover
16. Filter push buttons for mercury vapour lamp
17. Lamp focusing rod for mercury vapour lamp
18. Field iris control rod for mercury vapour lamp

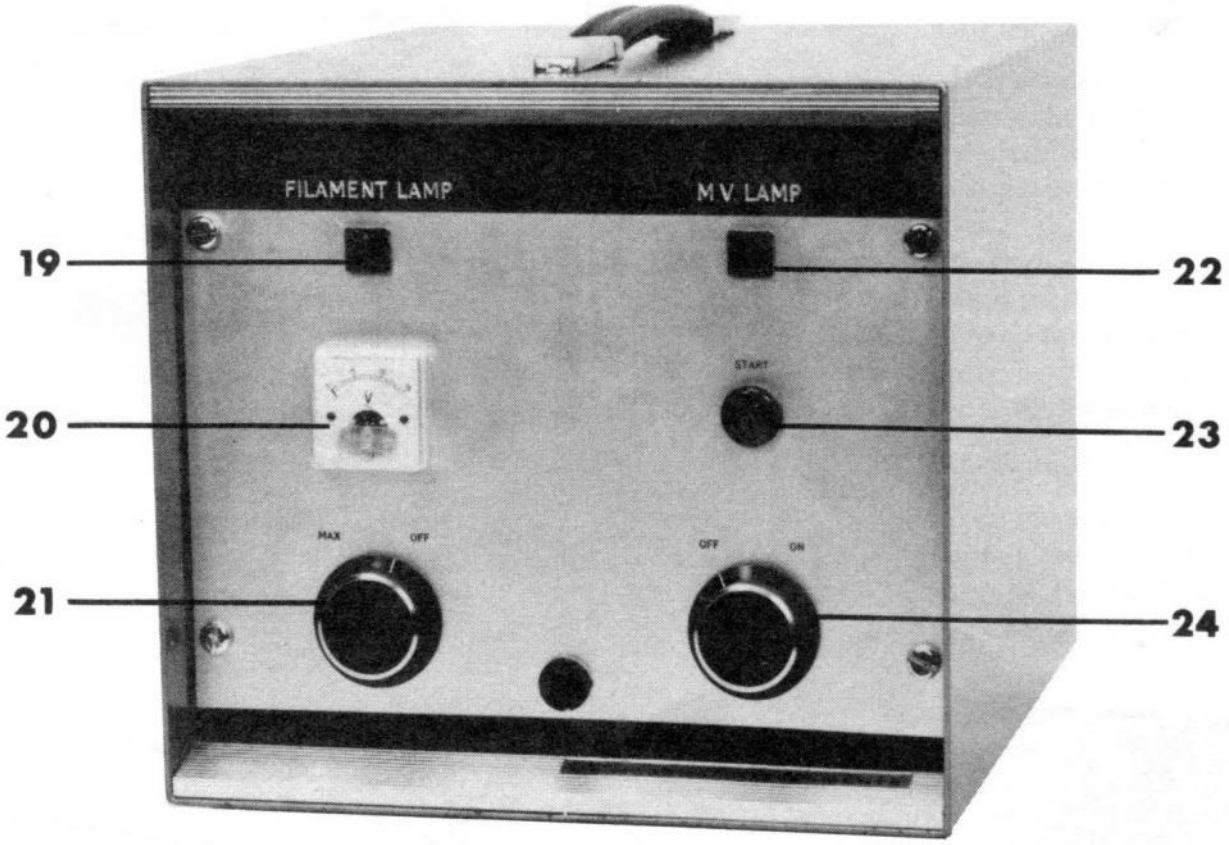

FIG. 2

19. Mains indicator for tungsten halogen lamp
20. Voltmeter for tungsten halogen lamp
21. Voltage regulator for tungsten halogen lamp
22. Mains indicator for mercury vapour lamp
23. Start button for mercury vapour lamp
24. On/Off switch for mercury vapour lamp

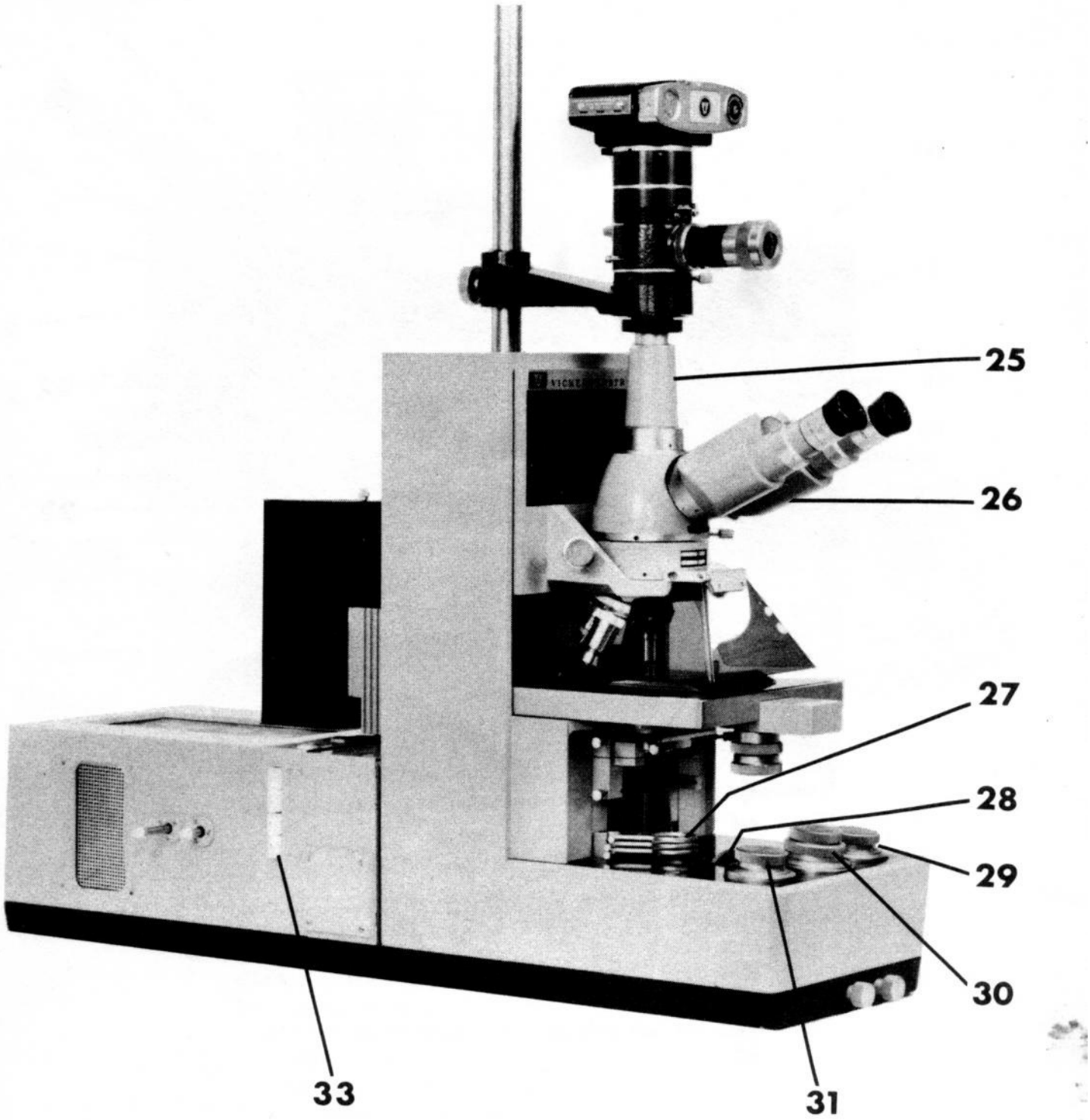

FIG. 3

25. Projection tube
26. Binocular head
27. Filter holders
28. Field iris control
29. Light dimming control
30. Coarse and fine motion controls
31. Substage focusing control
32. Filter push buttons for tungsten halogen lamp

FLUORESCENCE MICROSCOPY

General Information

For general information on fluorescence microscopy reference should be made to specialist texts such as "Fluorescent Protein Tracing" edited by R.C. Nairn, published by E.S. Livingstone Ltd.

CONDENSERS

The bright field condenser, M320940, specially designed for fluorescence, is a simple 2-lens Abbe type with a high numerical aperture of 1.2 immersed. More complex condensers are undesirable as they tend to reduce the intensity of illumination and may themselves fluoresce. This condenser fully illuminates the field of a 16 mm. objective, even when using Complan (wide field) eyepieces.

The dark ground condenser, M320910, is an immersion one, designed for use with high power objectives. It makes it easier to obtain a completely black background although the total intensity of irradiation of the specimen is less than that obtainable with a bright-field condenser and the latter is less critical in its adjustment.

The phase contrast fluorescence condenser allows observation of the specimen by phase contrast or fluorescence or a combination of both. This is very convenient with some specimens in enabling non-fluorescent areas to be shown up in some detail and related to the fluorescent portions of the image. This condenser can be used for both ultra-violet and blue light illumination.

OBJECTIVES

Any Vickers objectives can be used for fluorescence work. In general, though, the greatest possible illumination is wanted in fluorescence work. The illumination is proportional to the square of the numerical aperture and inversely proportional to the square of the magnification given by the objective. On this basis, figures of merit can be assigned to objectives as follows :-

Objective	Magnification	N.A.	Figure of Merit $= \left(\frac{\text{N.A.}}{\text{Magnification}}\right)^2 \times 10^5$
MO25111 Microplan	10X	.25	63
MO25411 Microplan	20X	.50	63
MO23911 Apochromatic	20X	.65	105
MO25211 Microplan	40X	.70	31
MO23611 Fluorite (oil immersion)	50X	.95	36
MO22611 Achromatic) MO23511 Fluorite) (oil immersion	100X	1.20	17

In general, as would be expected, the image illumination falls with increasing magnification. The 20X Apochromatic objective and the 50X Fluorite, though, provide relatively good illumination for their magnification. The 20X Apochromatic, in particular, is very well suited to fluorescence work.

The 100X Achromatic and Fluorite objectives can be provided with iris diaphragms fitted in their mounts (then being M022643 and M023541 respectively). These will be found particularly useful in fluorescence work where glare from brightly fluorescent objects in the field of view can be much reduced by the appropriate use of the iris.

EYEPIECES

The 10X Complan eyepiece (wide field) is generally suitable for most purposes, but where fluorescence is weak the 8X compensating eyepiece is to be recommended. This is because the image brightness is inversely proportional to the square of the magnification and therefore the 8X eyepiece will give a much brighter image than the 10X eyepiece.

IMMERSION OIL

Some microscope immersion oils fluoresce strongly and others, not initially fluorescent, become so on exposure to the shorter wavelengths of light.

For these reasons special "non-fluorescing" immersion oils are supplied. M322245 is a low viscosity oil having an extremely low level of fluorescence and is intended for both objectives and condensers. M322247 is a high viscosity oil having a low level of fluorescence and is offered as an alternative for use with condensers only.

MICROSCOPE HEADS

A binocular head does, of course, lead to comfort in using a microscope, especially when it is in use over long periods. For fluorescence use it must be remembered, though, that binocular heads are wasteful of light, nearly half the light being lost in the beam splitter and the remainder being distributed between the two eyes. This is of little consequence in ordinary microscopy where plenty of light is available, but in fluorescence microscopy, images may be faint and it is recommended that a monocular head should be available.

FILTERS

Primary Filters for Mercury Vapour Lamp

A 4 mm. thickness of BG.38 is mounted in the base in front of the HBO.200 lamp to absorb heat and suppress the red emission. The ultra-violet blue light transmitting filter is BG.12 of which from 1 up to 6 mms. can be inserted into the light path to suit different requirements.

The ultra-violet transmitting filter is UG.2 of which from 1 up to 3 mms. can be inserted. The transmission characteristics of BG.12 and UG.2 are shown in the respective tables at the end of the book.

Barrier Filters

The transmission characteristics of these filters are shown in the tables at the end of the book.

Mixed illumination is achieved very efficiently by means of a fixed dichroic filter which transmits at a maximum in the ultra-violet and blue region of the spectrum and reflects at a maximum in the green, yellow and red.

DARK ADAPTATION

When dealing with faintly fluorescing objects it is well to work in a room where the illumination can be reduced to the minimum necessary for convenience of working. In general, though, probably no advantage is obtained by working in total darkness.

ASSEMBLY OF THE MICROSCOPE

The Objectives and Changer

Screw the objectives into the revolving changer. It is usual practice to do this in ascending order of magnification in an anti-clockwise direction. Rotate the coarse motion (30) anti-clockwise to its fullest extent, then attach the objective changer and clamp into position.

The Barrier Filter Unit and Light Shield

Place the barrier filter unit (3) onto the cone fitting of the platform and secure with clamp screw (4). Swing the light shield (5) down into position.

The Prism Box

Place the prism box M320580 (1) on top of the barrier filter unit and secure with the clamp screw (2). By turning the black knurled disc at the front of the box a fully reflecting prism can be swung into the light path to direct the light to the eyepiece for visual observation or swung out to allow all the light to go to the camera. For storage and transit a black dust cover is fitted to the top of the prism box. Remove this by prising off with the thumb nail and clamp the projection tube (25) to the cone fitting.

Binocular and Monocular Heads

(See page 8 for notes on the use of binocular and monocular heads in fluorescence work).

To attach the binocular head, slacken off the clamp screw at its lower end, place over the cone fitting on the front of the prism box, orientate correctly and clamp. The correct orientation is with the clamp screw at "4 o'clock".

The monocular head is attached similarly with the clamp screw, for convenience, at "4 o'clock".

The Condenser

To insert the condenser, rotate the substage focus control (31) anti-clockwise to its fullest extent and rack the microscope mechanical stage forwards. Insert the condenser slide into the upper slot of the substage and clamp in position with the knurled head on the left. Raise the condenser.

The Substage Light Shield

Swing out the filter holders (27) and insert the adjustable light shield (7) under the condenser, the clamp screw on the light shield being loosened so that the shield is of minimum length. The wider conical end should be downwards and the lip fitting in the recess above the window in the microscope base. Raise the inner component of the light shield until it is nearly in contact with the under side of the condenser and secure by tightening the clamp screw lightly. The clamp screw must be loosened before racking the condenser down.

The Re-imaging Tube

Insert the re-imaging tube into the aperture at the back of the microscope, which normally takes the tungsten halogen lamp housing. The microscope can now be placed on to the fluorescence base, ensuring that its plastic feet locate in the four holes in the base.

N.B. When the Patholux microscope is used on the fluorescence base the controls (28) and (29) are inoperative, their function being replaced by (18) and (21) respectively. The field iris control (28) should be rotated fully clockwise and left in this position.

ASSEMBLY OF THE BASE

The tungsten halogen lamp housing has a split tube, the front part of which is unscrewed and removed. Insert the shortened tube into the mirror unit (12). The lamp housing is then covered by the light baffle (11) and clamped in position by the screw (9). See "Lamp replacement" on pages 15 and 16 for details of inserting the mercury vapour and tungsten halogen lamps.

Connect the control box to the base and connect the mains lead to a suitable plug. The mains lead is colour coded :-

Live	:	Red
Neutral	:	Black or Blue
Earth	:	Green

THE PRIMARY FILTER UNITS

The primary filters for the H.B.O.200 mercury vapour lamp are introduced by means of the set of push buttons numbered 1 to 5 and on the right hand side of the lamp house.

The primary filters for the tungsten halogen lamp are introduced by means of the vertical bank of push buttons on the left hand side of the lamp house. These are numbered 6 to 9.

Whereas the mercury lamp filters are introduced by pressing the buttons in, the tungsten halogen lamp filters are removed from the light path by pressing the buttons in.

Mercury Vapour Lamp Primary Filters

Push Button Station	Thickness mm.	Glass Grade	Code No.
1	1	B.G.12	M151526
2	2	B.G.12	M151527
3	3	B.G.12	M151528
4	1	U.G.2	M151529
5	2	U.G.2	M151530

Tungsten Halogen Lamp Filters

Push Button Station	Thickness mms.	Glass Grade	Integrated Visible Transmission	Code No.
6	2	O.N.11 Neutral	23%	M151537
7	2	O.N.10 "	7%	M151534
8	2	O.G.R.1 Green		M151535
9	3	R.G.1 Red		M151536

ALIGNMENT OF MICROSCOPE AND BASE

Ensure that the field iris is fully open by pushing the control rod (18) fully to the left.

The bright field condenser should be used for alignment and a monocular head is recommended as images may be faint before satisfactory alignment is achieved.

Switch on the mercury vapour lamp by means of the control (24). If the lamp fails to strike, press the start button (23) briefly at intervals until it does. The neon lamp (22) does not indicate that the lamp is struck, but only that the switch (24) is on and that the control box is connected to the mains.

Trip in filter number 3 of the primary filter unit on the right of the base and barrier filters number 1 on the lower ring and number 2 on the upper ring. Using a 10X or 20X objective, focus a normally stained section. Close down the field iris by pushing rod (18) to the right and focus it by use of the substage focus control (31). Centre the iris image by means of the condenser centring screws (6), opening up the field iris as it comes on to centre.

Focus the lamp electrodes using the sliding movement of the rod (17) and centre by means of the controls (8). A spherical mirror behind the mercury lamp collects radiation which would otherwise be wasted.

The primary image of the lamp and the image formed by this mirror should be positioned side by side and not superimposed.

The adjustment of the mirror is carried out at the factory and should not be altered.

Defocus the lamp to obtain even illumination.

Insert the required filters and replace the slide used for setting up purposes by the fluorescent specimen to be studied.

RECOMMENDED FILTER COMBINATIONS FOR BRIGHT FIELD

Filters	Blue Light	U.V. Light
Primary	1 and 3 (Visual use) 1, 2 and 3 (Photographic use)	5
Barrier	2 (upper ring) 1 (lower ring)	0 (upper ring) 2 (lower ring)

A brighter image is obtainable by oiling the condenser to the slide (see section on "Immersion Oil", page 8).

THE USE OF FIELD AND APERTURE IRISES

In fluorescence microscopy the use of irises is rather different from that in ordinary bright field microscopy. The fluorescence continues to get brighter as the field iris is opened up beyond the extent of the field of view and maximum brightness is obtained when the iris is fully open. With some specimens it may be necessary to close down the field iris to an extent which provides a compromise between desirable brightness and undesirable glare. The aperture diaphragm should be fully open. Since the fluorescing specimen can be regarded as self-luminous the diaphragm does not control the image contrast. Closing it only reduces the intensity of the fluorescence.

THE USE OF THE DARK GROUND CONDENSER

Ensure that the microscope and base are aligned, using a bright field condenser initially as described on page 12.

Approximately centre the condenser in the mount by means of the centring screws before placing it on the microscope.

Replace the bright field condenser by the dark ground condenser, after putting the substage focusing movement to the lowest point of its run.

Rotate the milled ring at the lower end of the condenser so that the engraved scale reading opposite the index mark agrees with the thickness in mms. of the specimen slide in use. Place a large drop of the fluorescence free immersion oil on the top lens of the condenser and rack it upwards until it just makes contact with the slide. Care must be taken to avoid forming air bubbles in the oil. Fully open the field iris (18). Focus the specimen using a 10X or 20X objective. An annulus or circle of light will be seen which must be centred by means of the condenser centring screws. Adjust the condenser milled ring to obtain a circle of light. Swing in the 40X objective re-centring the condenser if necessary. The same procedure is followed when swinging in the 100X objective.

a) 100X Objective fitted with iris diaphragm :
To achieve dark ground illumination the iris of the objective should be stopped down so that direct light cannot enter the objective.

b) Standard 100X objective :
A funnel stop should be inserted to stop down the objective to 0.95 N.A.

RECOMMENDED FILTER COMBINATIONS FOR DARK GROUND

Filters	Blue Light	U.V. Light
Primary	2	4
Barrier	1 (upper ring) 1 (lower ring)	0 (upper ring) 2 (lower ring)

USE OF THE PHASE CONDENSER

Set up the instrument, using the bright field condenser, as described on page 12.

Replace the bright field condenser by the phase condenser, first making sure that no annulus is in position. Switch on the tungsten halogen filament lamp and adjust the meter voltage to somewhere between 5 and 10 volts. The red filter should be in the light path of the tungsten halogen illumination system (i.e. filter button No. 9 in the 'out' position). The remaining filters should be removed from the light path (i.e. filter buttons 6, 7, and 8, in the 'in' position).

Using the lowest power phase objective available, preferably the 20X Apochromatic, focus the field iris control (14) of the tungsten halogen system by means of the substage focusing control (31) and centre it by means of the upper pair of condenser centring screws.

Using the auxiliary microscope, focus the lamp filament in the back aperture of the objective by means of the control (13) behind the lamphouse and centre it by using the pair of controls (10). Swing in the phase annulus indicated by two red bands on the changer plate of the condenser. Using the auxiliary microscope, centre the condenser annulus to the objective annulus by means of the lower pair of screws on the condenser.

The fluorescence of the specimen should now be seen against a background of non-fluorescing parts of the specimen shown in red light phase illumination.

The background brightness can be varied by means of the filament lamp control on the supply unit.

The 40X objective is also used with the annulus marked by two red bands. Oil immersion objectives are used with the annulus marked by three red bands.

RECOMMENDED FILTER COMBINATIONS FOR PHASE USE

Filters	Blue Light	U.V. Light
Primary	3	5
Barrier	2 (upper ring) 1 (lower ring)	0 (upper ring) 2 (lower ring)

H.B.O. 200 MERCURY VAPOUR LAMP

The ultra-violet and blue light source is the Osram H.B.O.200 which has proved to be very satisfactory for fluorescence use. Its characteristics are shown in the curve on page 22.

Lamp Life and Safety

The rated life of the lamp is given by the lamp manufacturer as 200 hours. By the end of this period of usage, however, the luminous flux will, on the average, show a fall of 20%. Although the lamp may continue to run after 200 hours this is not recommended owing to the internal vapour pressure when hot, being 35 to 70 atmospheres with a consequent increased risk of explosion when the bulb is run beyond its rated life.

The lamp must not be run without the cooling fin being attached to the upper terminal, otherwise the life will be reduced considerably.

Lamp Handling

When cold the mercury vapour lamp is under no appreciable internal pressure and is safe to handle without protective gloves and goggles. Consequently, it is not necessary to break old lamps before disposal.

The lamp must be so handled as to avoid contamination of the envelope with grease from the fingers. If, however, the lamp is accidentally contaminated, firstly clean the cold lamp with alcohol (methylated spirit) and then with distilled water. If this is not done, then fingerprints, etc. will be burned on to the lamp envelope and will become permanent.

Lamp Replacement

PLEASE NOTE: With current models delete paragraphs 1 and 2 under lamp replacement and insert:

Remove the electrical plug from the rear of the base and withdraw the tungsten halogen lamp housing with the light baffle (11) backwards. Ensure that all filter buttons are in the "out" position and that the controls rods (17) and (18) are placed centrally. Remove the four corner screws on the lamp housing coverplate (not shown in illustration). Remove the right hand access screw on the power input socket at the rear of the base. (The correct screw is proud of the socket). Slide the coverplate slightly to the rear and lift it free. The lamp baffling within the housing may now be removed.

The lower lamp collet clamp screw may be released to accept the lamp, after removing the access aperture coverplate on the left hand side of the housing. The coverplate is a large slotted cheese head plug. A screwdriver of sufficient length may now be inserted so as to release the lower lamp clamp screw and to fasten it after the lamp has been fitted.

IMPORTANT: The knurled knob at the back of the housing is for factory adjustment ONLY and should NEVER be touched by the user.

H.B.O. 200 MERCURY VAPOUR LAMP

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Lamp Replacement

To obtain access to the lamp, open the lid on top of the lamphouse. It is unsafe to do this when the lamp is hot.

Remove the electrical plug from the back and withdraw the tungsten halogen lamp housing with the light baffle (11) backwards. Ensure that all filter buttons are in the "out" position and that the control rods (17) and (18) are placed centrally. Release the two large screws (15) (there is no need to take them right out) and lift the lid.

Unscrew and remove the knurled head, electric lead and the cooling fin unit from the top of the lamp. Unscrew the knurled head on the lateral (starting) electrode and remove the lead it holds. Unscrew the knurled ring holding the base of the lamp in the collet by turning it anti-clockwise and lift out the old lamp.

The new lamp is inserted, carrying out the above operations in reverse. The end carrying the printing must go downwards through the knurled ring into the collet while the lamp envelope is held in a clean cloth to avoid contamination. Position the lateral electrode to face the right hand side of the lamp house (as viewed from the microscope user's point of view). This electrode must be positioned between the two insulated posts on the right hand side of the lamp. Turn the knurled ring of the collet clockwise until the lamp is held securely. Put the shorter lead from the right hand

side of the choke on to the lateral electrode. Place the cooling fin unit over the top electrode of the lamp, the deep counterbore being underneath. IT IS IMPERATIVE THAT THE ARROW ENGRAVED ON THE COOLING FIN SHOULD BE POSITIONED IN LINE WITH, AND ADJACENT TO, THE CORRESPONDING ARROW ON THE TOP OF THE CONDENSER HOUSING BRACKET. Put on the longer lead from the connector on the left hand side of the choke and clamp with the large knurled head. Take care that the lamp is not stressed in handling.

THE TUNGSTEN HALOGEN LAMP

As these 12V 100W lamps are comparatively expensive it is advisable that attention be paid to operating them at the correct voltage and a voltmeter (20) is provided on the control box for this purpose. The graph on page 23 shows the operating characteristics of the lamp. It will be noted that the mean life when operated at 10 volts is 400 hours, but that it is only about 50 hours when operated at 12 volts. The lamp contact pins should be periodically checked for signs of oxidation and cleaned if necessary (see below for lamp removal).

Handling the Tungsten Halogen Lamp

Please note that it is important not to contaminate the quartz envelope of the lamp by handling with bare fingers. When inserting the lamp, handle only by the cardboard sleeve, since the high content of sodium in the skin can contaminate the quartz, (this lamp is quartz, not glass) and cause shortened life. When handling the lamp we recommend that you use a clean white handkerchief.

Should the lamp be accidentally touched by the fingers it should be washed in normal household alcohol with a lint-free cloth and allowed to dry.

The lamp should not be removed until it has cooled completely. When hot, the lamp retains a pinkish glare and when cooled it becomes clear.

Lamp Replacement

Remove the lamp baffling (11) which is secured to the lamp housing by means of the screw (9).

The lid of the lamp housing is removed by sliding it upwards. Remove the old lamp, replace with the new one ensuring that it is pressed securely into the socket so that there is no gap between its ceramic base and the lamp holder.

Barrier Filter Unit, M321395

Enclosed within the barrier filter unit are two knurled discs, the upper disc having four stations and the lower disc three.

The filter unit is assembled so that the knurled disc is presented to the observer. The station positions are given below.

Upper Disc

Station No.	Filter
0	Blank 1.5 mm. clear glass
1	O.G.4/1.5 mm.
2	O.G.1/1.5 mm.
3	O.G.5/1.5 mm.

Lower Disc

Station No.	Filter
0	Blank 3 mm. Clear Glass
1	G.G.9/1.5 mm. + clear glass/1.5 mm.
2	G.G.4/1.5 mm. + Wratten 2E + clear glass/1.5 mm.

Mercury Vapour Lamp Primary Filters

Push Button Station	Thickness mm.	Glass Grade	Code No.
1	1	B.G.12	M151526
2	2	B.G.12	M151527
3	3	B.G.12	M151528
4	1	U.G.2	M151529
5	2	U.G.2	M151530
*	2	AL. Blanking Plate	M151546

*Optional filter obtainable on request.

Tungsten Halogen Lamp Filters

Push Button Station	Thickness mm.	Glass Grade	Integrated Visible Transmission	Code No.
6	2	O.N.11 Neutral	23%	M151537
7	2	O.N.10 Neutral	7%	M151534
8	2	O.G.R.1 Green		M151535
9	3	R.G.1 Red		M151536
*	3	O.G.3 orange		M151538
*	3	O.G.4 yellow		M151539
*	2	O.B.8 daylight blue		M151540
*	2	O.B.2 Blue green		M151545
*	2	K.G.1 Heat Absorbing		M151533
*	2	AL. Blanking Plate		M151546

*Optional filters obtainable on request.

CAMERA EQUIPMENT

The 35 mm. Camera is attached to the microscope as described in the camera instruction book. The correct exposure is ascertained by a test strip. Fast artificial light films, such as Kodak High Speed Ektachrome, Type B, Agfa CK and Ansco T100, are recommended.

SUMMARY TABLE OF RECOMMENDED FILTER COMBINATIONS

		Blue Light	Ultra-Violet
Bright Field	Primary Filter	1 and 3 (visual use) 1, 2 and 3 (photography)	5
	Secondary Filter	2 (upper ring) 1 (lower ring)	0 (upper ring) 2 (lower ring)
Dark Field	Primary Filters	2	4
	Secondary Filter	1 (upper ring) 1 (lower ring)	0 (upper ring) 2 (lower ring)
Phase Fluorescence	Primary Filter	3	5
	Secondary Filter	2 (upper ring) 1 (lower ring)	0 (upper ring) 2 (lower ring)

CARE OF THE MICROSCOPE

Cleaning The Optics

It is essential that the optical surfaces of the microscope are kept scrupulously clean. Dust should be removed with a clean camel hair brush. Smeared surfaces should have dust particles removed in the same manner before wiping with a suitable material, such as Goddards Lens Cloth, well washed fine linen or lens tissues, lightly moistened with industrial alcohol.

While the use of industrial alcohol is recommended for cleaning Vickers Instruments optics, it may not be suitable for use with other manufacturers equipment.

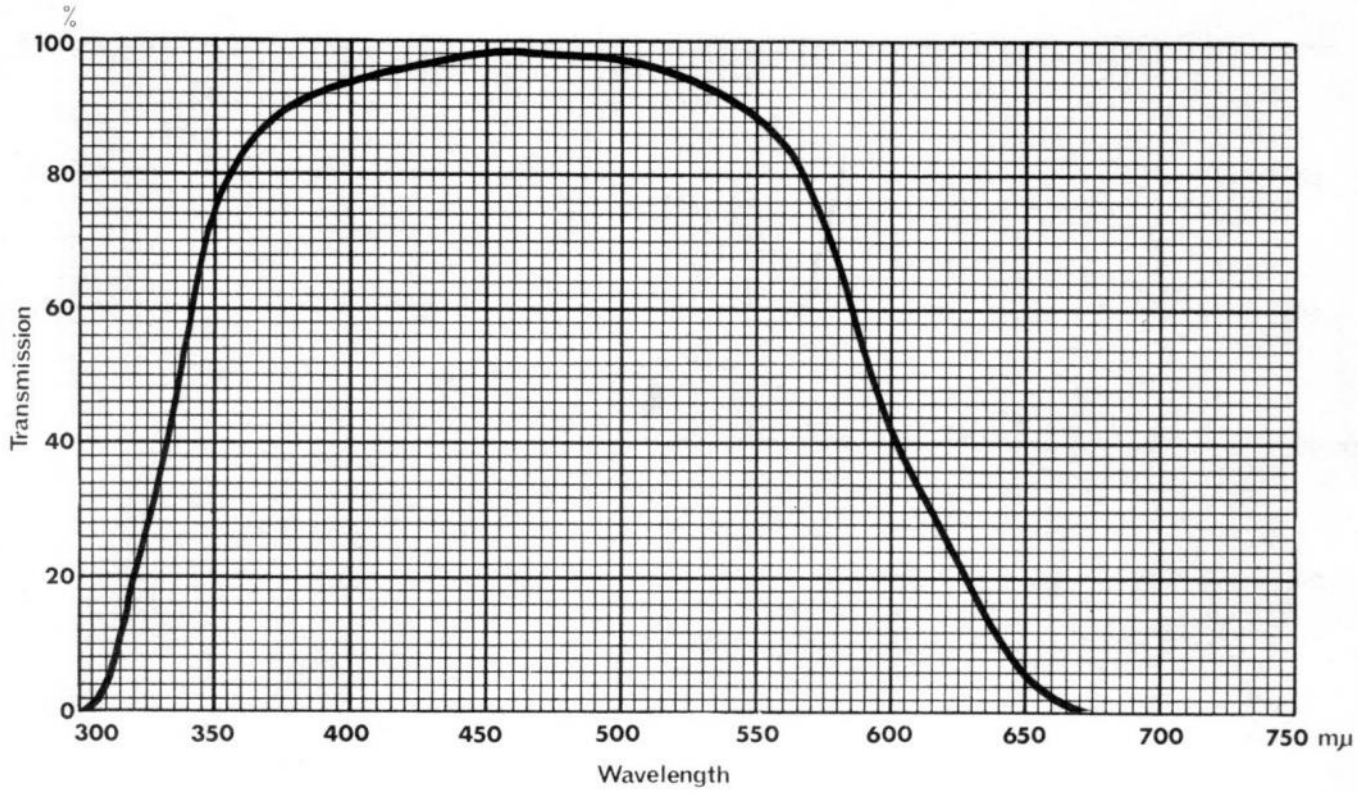
Cleaning the Paint Surfaces

The paint surfaces can be cleaned with a soft cloth lightly moistened with industrial alcohol and afterwards polished with a dry cloth. The microscope is finished with an epoxy resin paint which is extremely durable, but any injurious chemicals which may accidentally come into contact with it should be removed as quickly as possible.

Servicing

The mechanical movements have been lubricated before leaving the factory and should only require attention after prolonged use. If servicing is necessary, the user should contact Vickers Instruments or their agents.

4mm BG 38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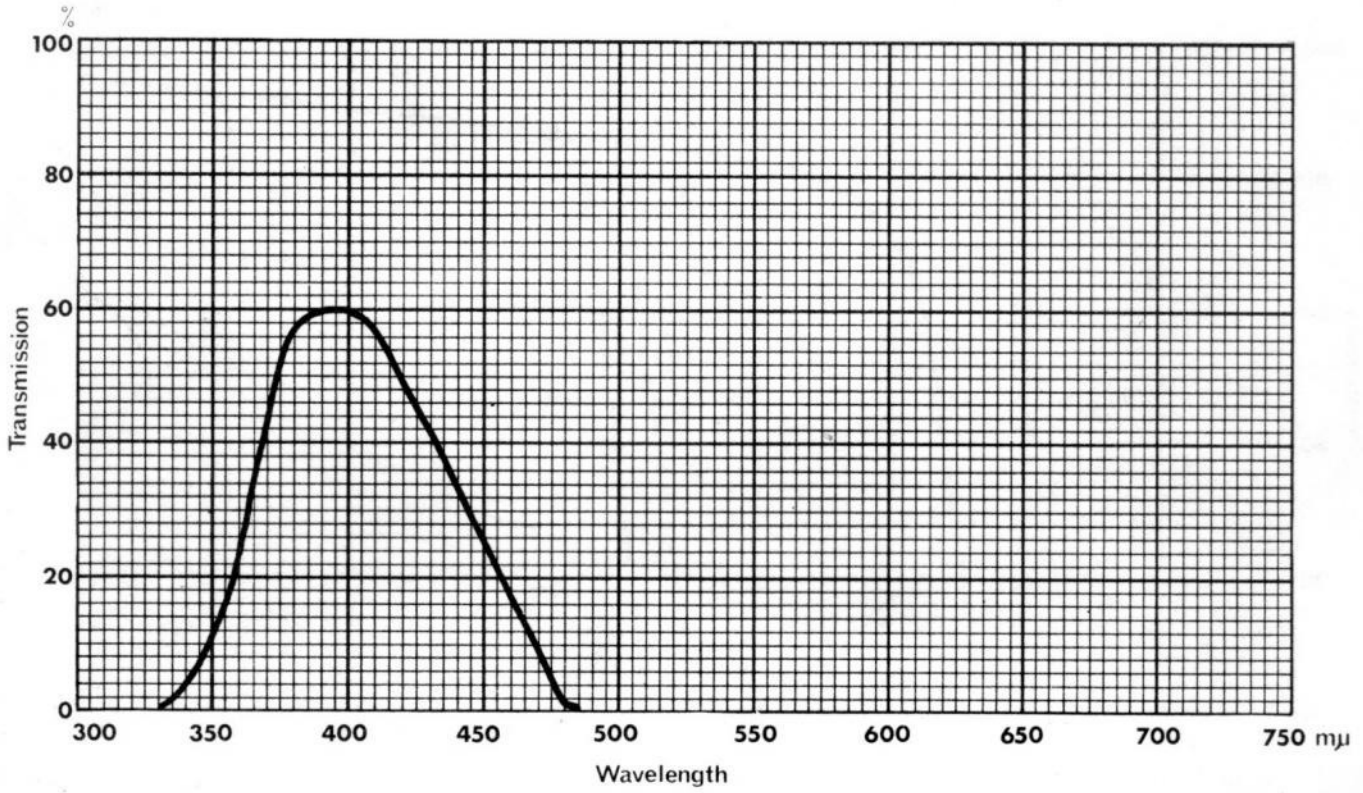
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Transmission
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400
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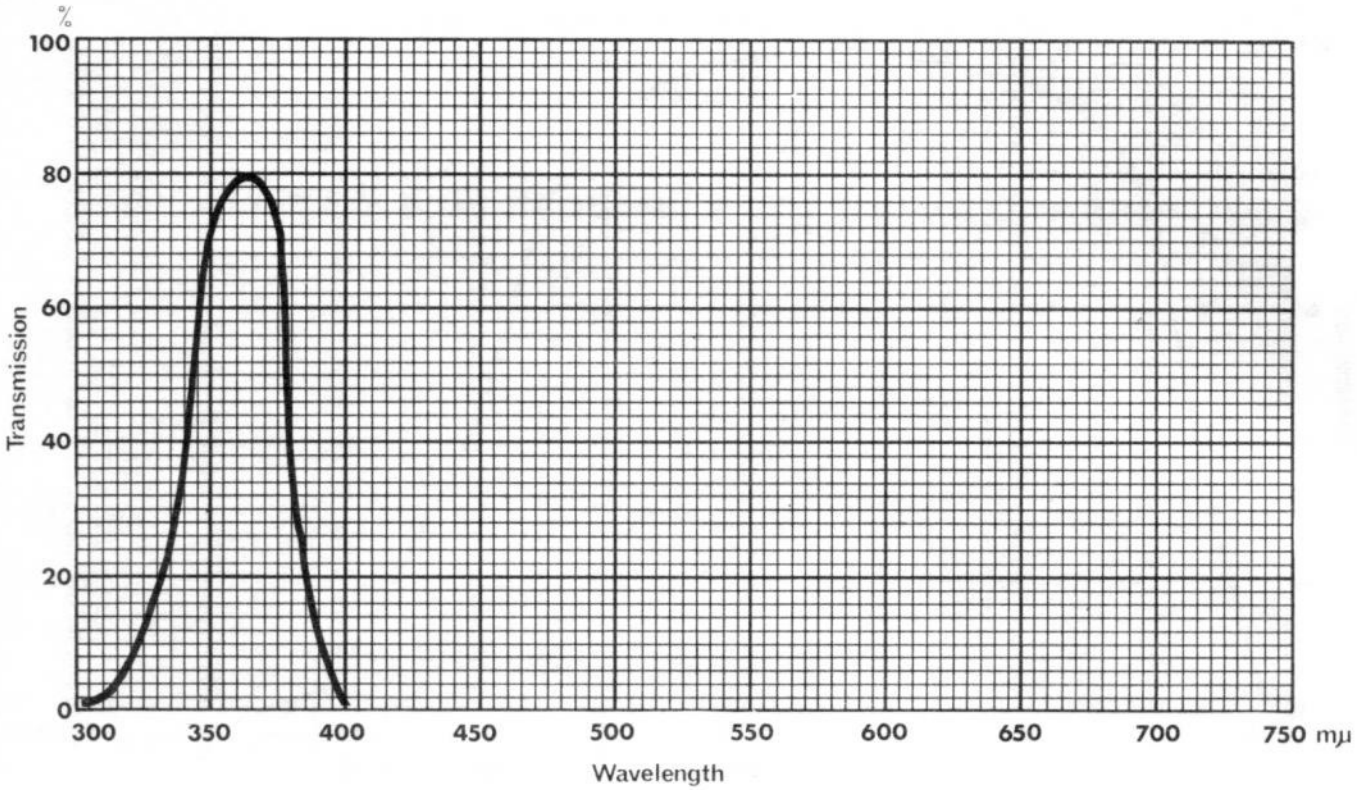
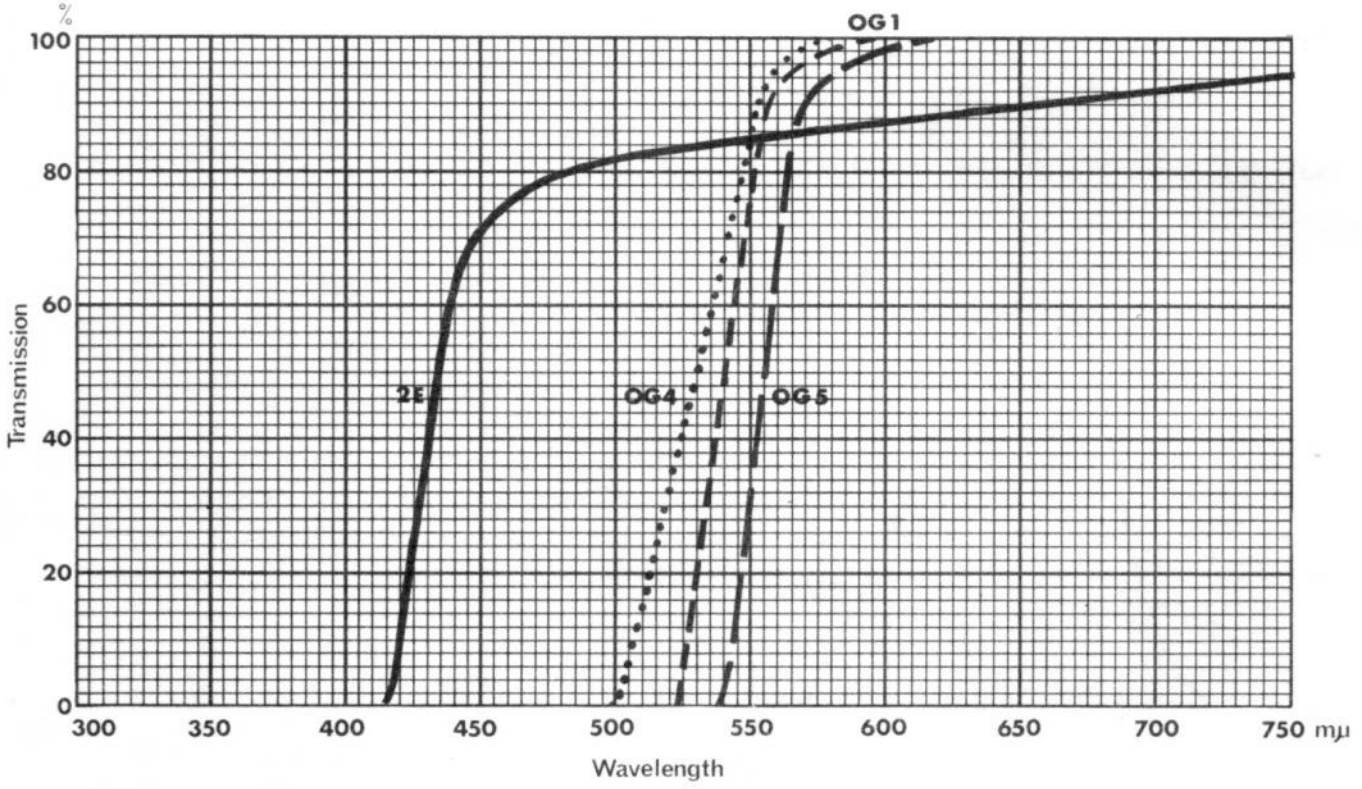
500
550
600
650
700
750 mμ
Wavelength

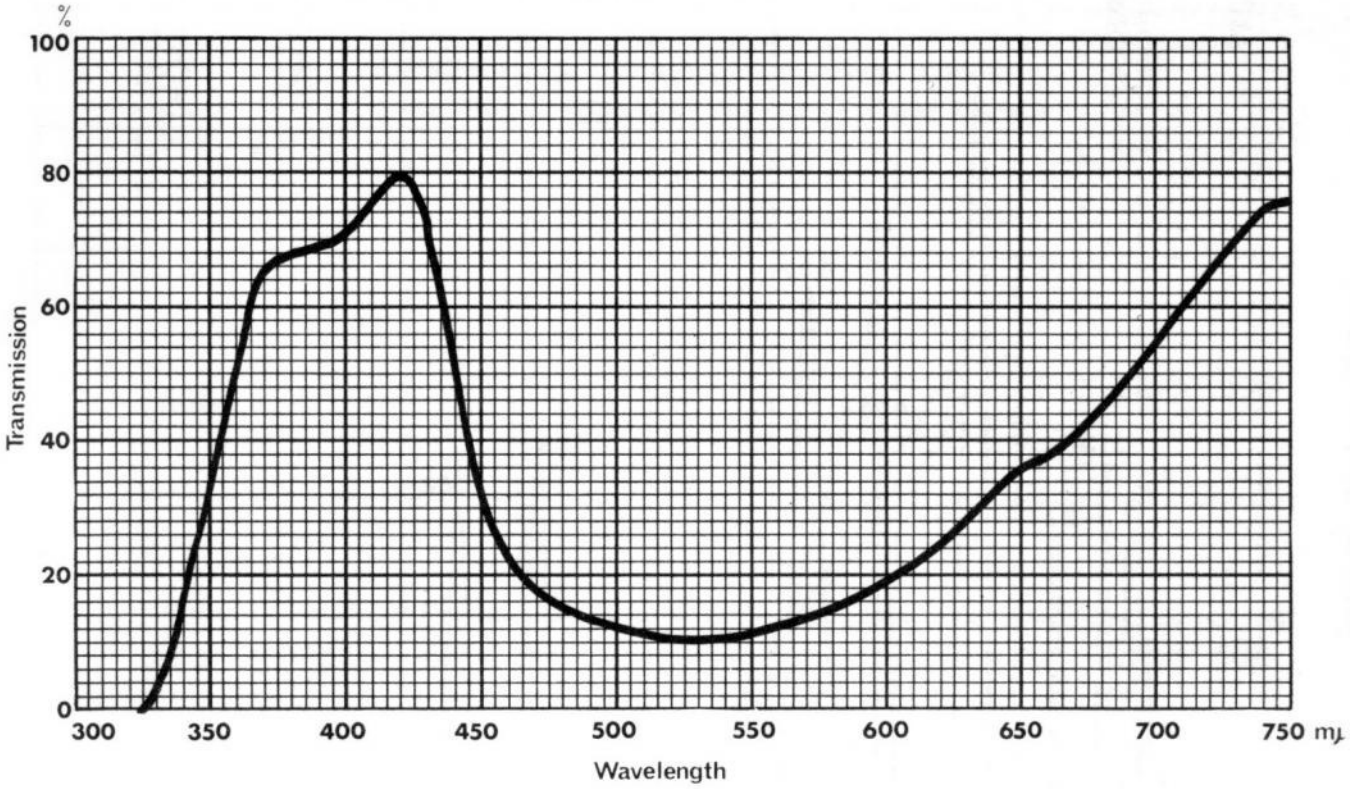
2 mm UG2

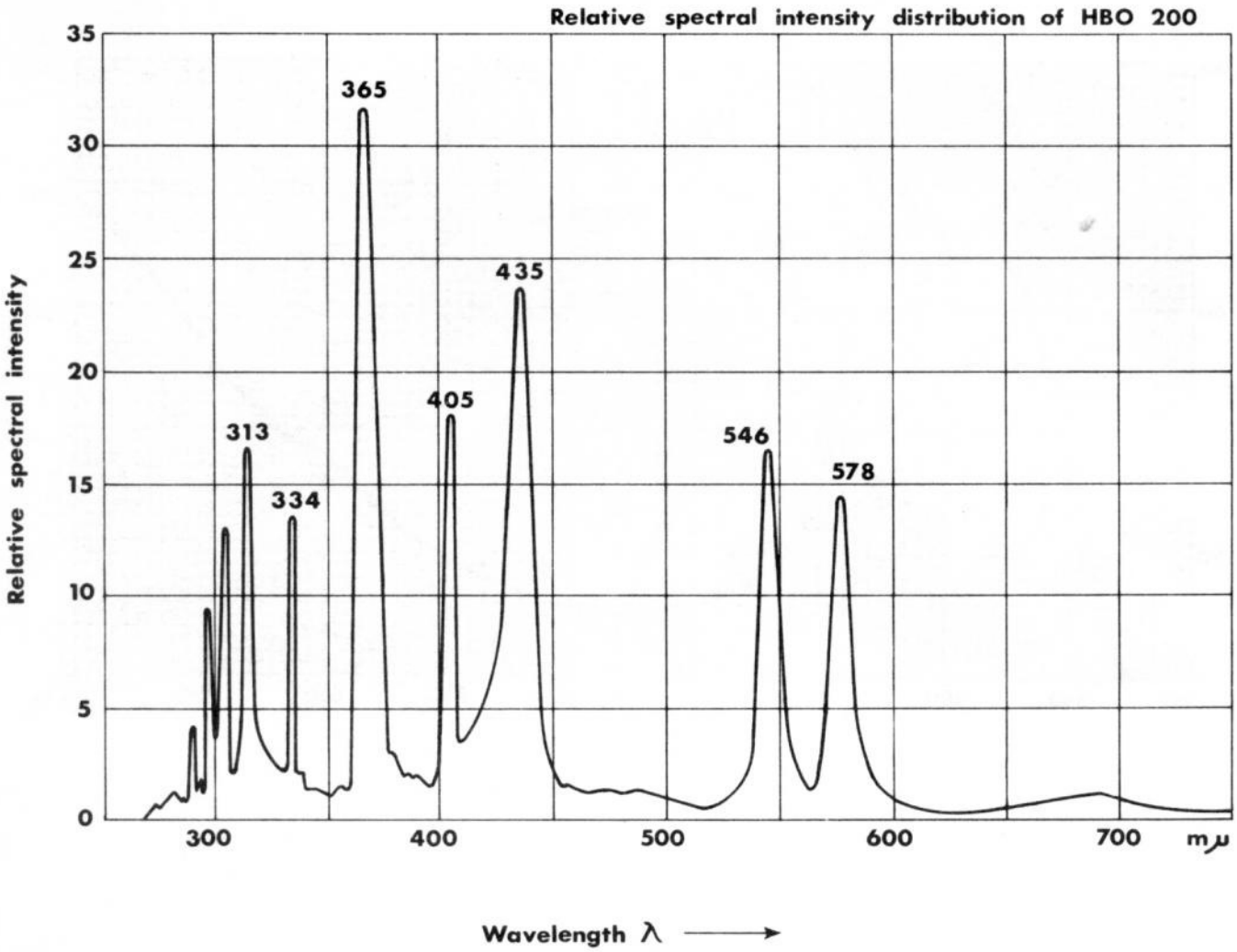


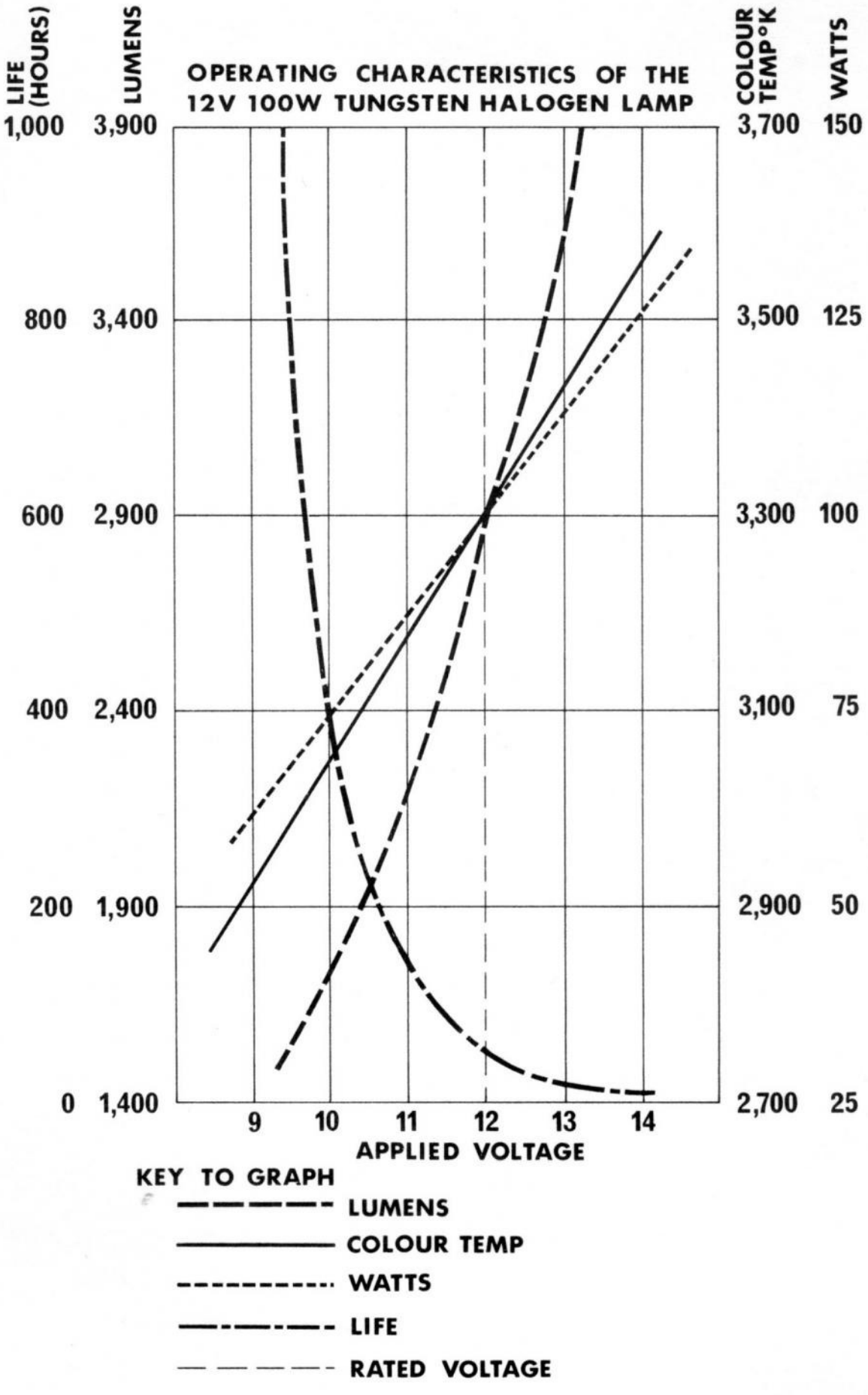
Barrier Filters



Dichroic beam splitter




Relative spectral intensity distribution of HBO 200
Relative spectral intensity
35
30
25
20
15
10
5
0
365
435
405
313
334
546
578
300
400
500
600
700
mμ
Wavelength λ ⟶


OPERATING CHARACTERISTICS OF THE
12V 100W TUNGSTEN HALOGEN LAMP
LIFE (HOURS)
LUMENS
COLOUR TEMP°K
WATTS
1,000
3,900
3,700
150
800
3,400
3,500
125
600
2,900
3,300
100
400
2,400
3,100
75
200
1,900
2,900
50
0
1,400
2,700
25
9
10
11
12
13
14
APPLIED VOLTAGE
KEY TO GRAPH
LUMENS
COLOUR TEMP
WATTS
LIFE
RATED VOLTAGE

Patholux Bulb

A1215

12v 100w

Philips.

7023.

