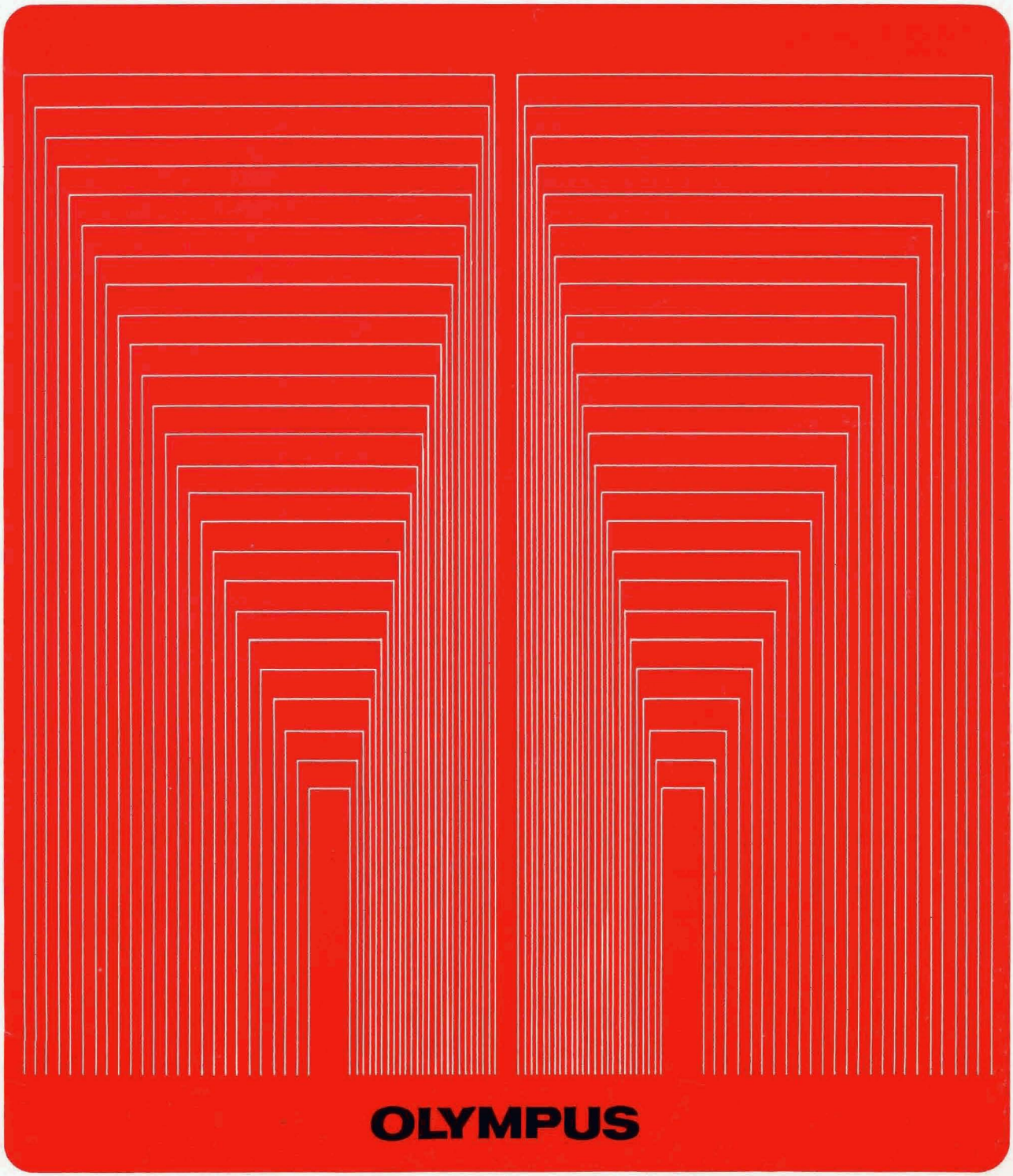
OLYMPUS SYSTEM MICROSCOPE
FOR METALLURGICAL USE

INSTRUCTION MANUAL MODEL BHM



OLYMPUS

O. C. A.

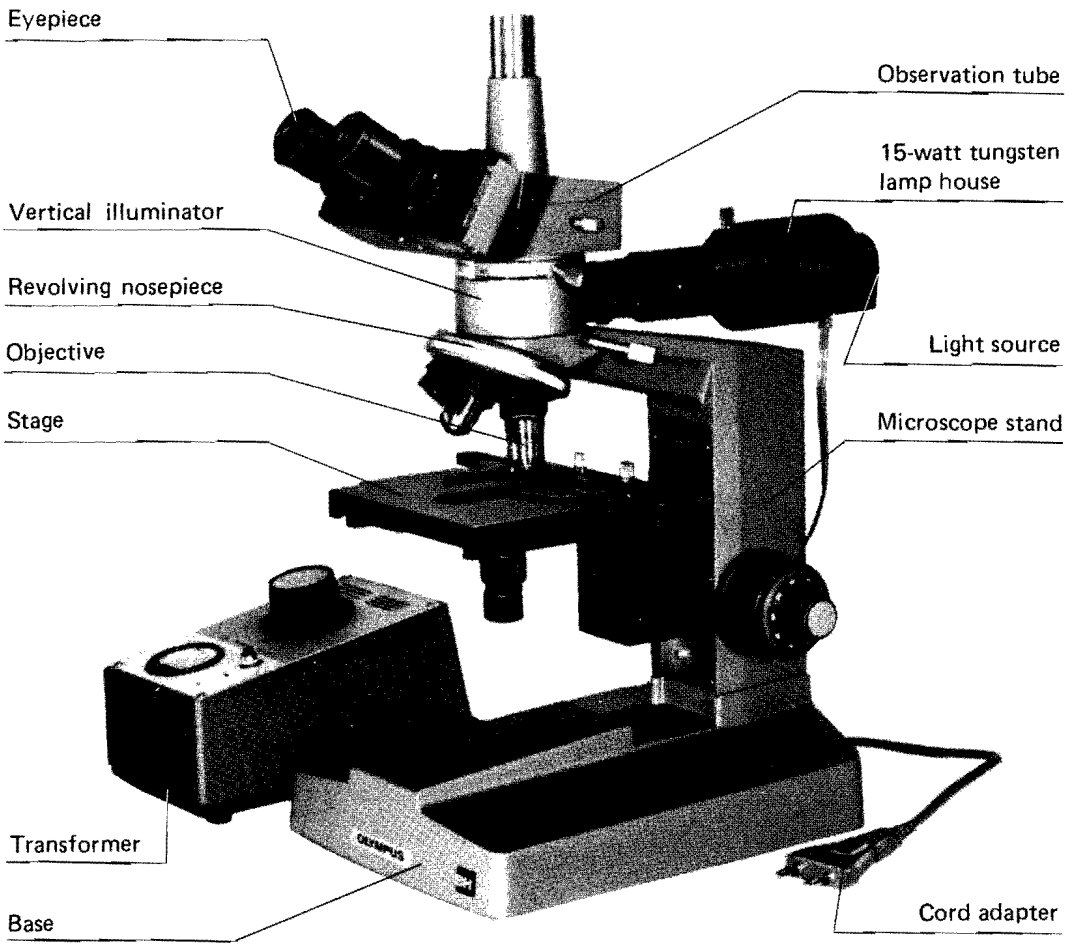
CONTENTS

I. STANDARD EQUIPMENT

Component			BHM			
Microscope stand with base		BHM-F-2	O	O	O	O
Revolving nosepiece		BH-RE	O	O	O	O
Observation tubes	Binocular tube, inclined 30°	BH-B I30	O	O		
	Trinocular tube, inclined 30°, with vertical photo tube	BH-TR30			O	O
Vertical illuminator for brightfield		BH-MA	O	O	O	O
15-watt tungsten lamp house		BH-LHM	O	O	O	O
Tungsten bulb, 6V 15W, 3 pcs.		LS15	O	O	O	O
Square mechanical stage with right-hand low drive controls		BH-SV	O	O	O	O
Transformer		TE-II	O	O	O	O
Objectives	M5X, M10X, M20X, M40X (set of four)		O		O	
	M Plan 5X, M Plan 10X, M Plan 20X, M Plan 40X, M Plan 100X (oil) (set of five)			O		O
Eyepieces	High eyepoint BiWF 10X, paired		O	O	O	O
Photo eyepiece FK3.3X					O	O
Metal slide plates (set of five)				O		O
Immersion oil, bottled				O		O
Eyepiece caps (2 pcs.)			O	O	O	O
Filter		32.5C	O	O	O	O
Vinyl dust cover			O	O	O	O

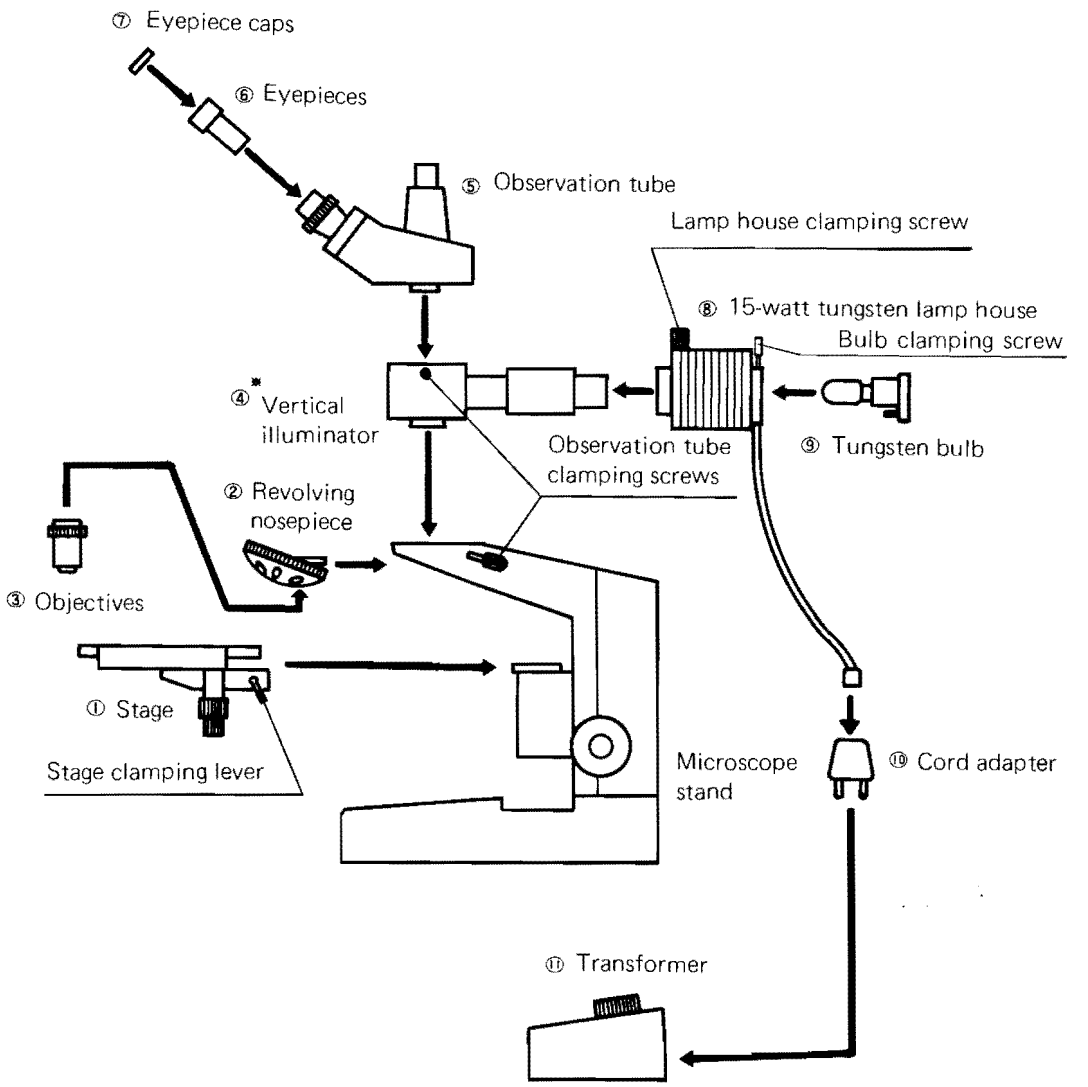
II. VARIOUS COMPONENTS OF THE MODEL BHM

The Olympus System Microscope for reflected light Model BHM consists of a modular, building-block system of various components and interchangeable accessories, as shown below.
A wide variety of combinations, standard or optional, is available according to your requirements.



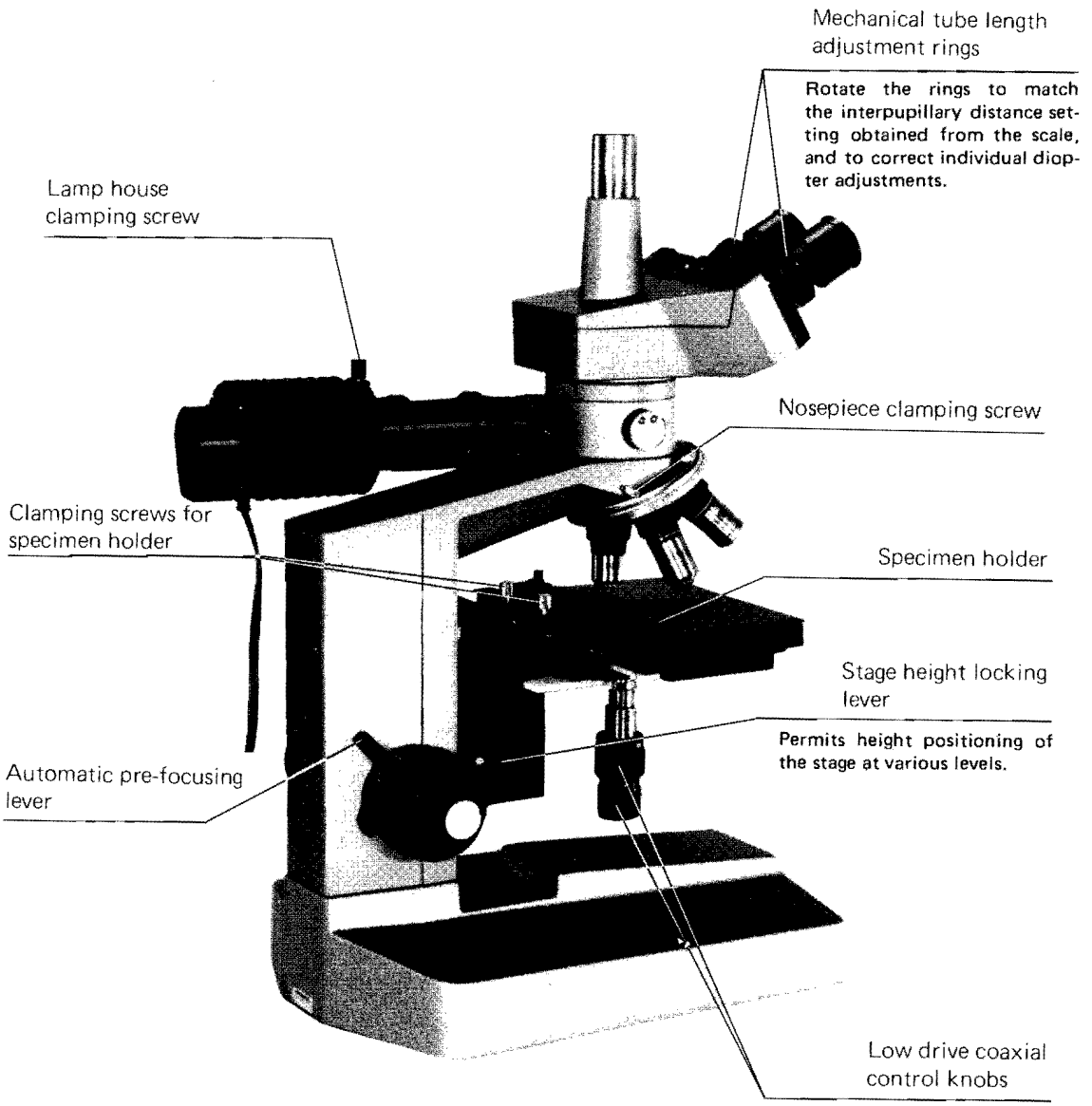
III. ASSEMBLY

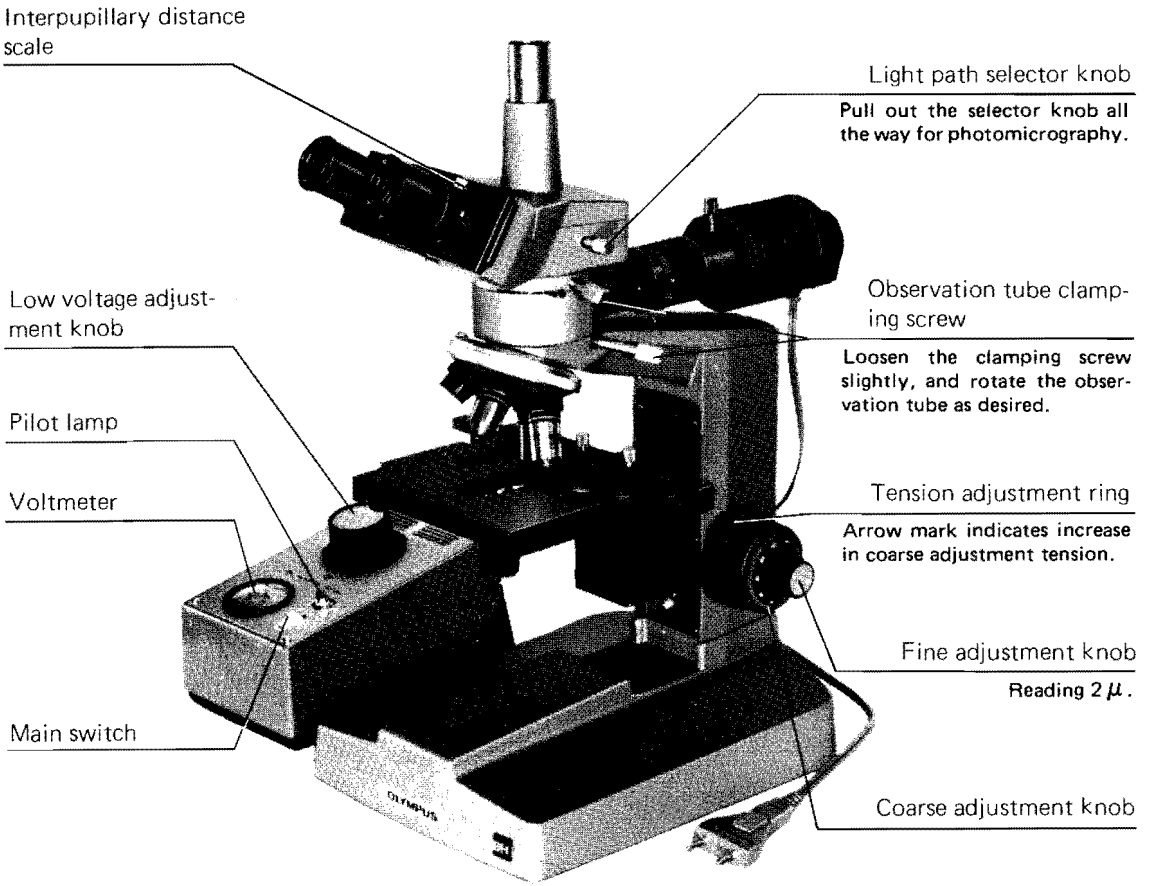
The picture below illustrates the sequential procedure of assembly. The numbers indicate the order of assembly of various components. Remove dust caps before mounting components. Take care to keep all glass surfaces clean, and avoid scratching the glass surfaces.

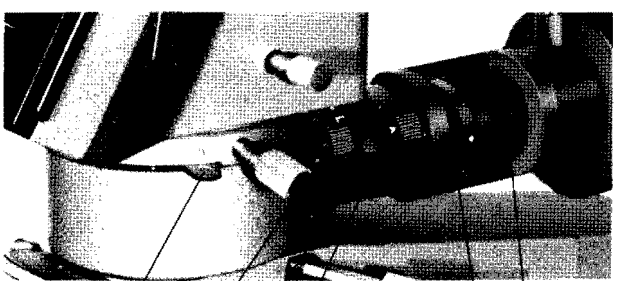


※ This unit should be attached on the microscope stand with the lamp house pointing away from the observer.

IV. IDENTIFICATION AND FUNCTION OF VARIOUS COMPONENTS




Interpupillary distance scale
Light path selector knob
Pull out the selector knob all the way for photomicrography.
Low voltage adjustment knob
Observation tube clamping screw
Loosen the clamping screw slightly, and rotate the observation tube as desired.
Pilot lamp
Voltmeter
Tension adjustment ring
Arrow mark indicates increase in coarse adjustment tension.
Fine adjustment knob
Reading 2 μ.
Main switch
Coarse adjustment knob


Analyzer rotation lever
Filter mount
Aperture iris diaphragm lever
Polarizer mount
Field iris diaphragm lever
High/low magnification selector lever
Position "L" for objective 5X and position "H" for objectives 10X and higher.

Summary of Putting the Microscope in Operation — Model BHM

A. Place a specimen on the mechanical stage (see page 13).

B. Adjust the stage height (see page 15).

C. Switch on the transformer.

D. Swing the 10X objective into the light path and coarse focus.

E. Make interpupillary and diopter adjustments (see page 14).

F. Swing in the desired objective.

G. Fine focus.

H. Correct the illumination system.

I. Adjust light intensity.

J. Adjust aperture iris diaphragm and field iris diaphragm (see page 12).

Cut off this page at the dotted line and put it on the wall near the microscope as a reminder of correct microscope operation.

V. OPTICAL SYSTEM

The optical system of the Series BH is divided into five sections: Objectives, Observation Tubes, Eyepieces, Illuminating System and Photomicrographic Equipment. The following section deals with objectives, eyepieces and illuminating system.

1. Objectives

A. Types

Two types of Olympus objectives are mentioned below, in accordance with their optical performance and corrections of various aberrations.

- **Achromats:**
  Corrected for chromatic aberration, and most popular for general use.

- **Plan achromats:**
  Capable of producing a flat image to the edge of the field. Recommended for visual observation of a large field and photomicrography of flat objects.

B. How to Use

- **Immersion objectives (engrave "HI" for homogeneous immersion):**
  To utilize the full numerical aperture of an immersion objective, the objective and specimen are immersed in an Olympus immersion oil, provided. Care should be taken to prevent oil bubbles from forming in the oil film between specimen and objective.
  After use, carefully wipe off the immersion oil deposited on the top lens surface of the objective with gauze moistened with xylene. Take care not to immerse objectives other than immersion objectives.

- **Special objectives:**

  - **Long working distance objectives:**
    Provide a longer working distance than standard objectives of equal power.

  - **Differential interference contrast objectives:**
    These strain-free objectives of high N.A. can be used not only for the differential interference contrast method, but also for brightfield.

2. Eyepieces

The eyepieces available with the Series BH are computed to correct slight residual errors left uncorrected in the objectives and designed to further magnify the primary image from the objective, limiting the field as viewed by the eye.

○ **Widefield eyepiece (WF):**
Color corrected and flat, wide field; high eyepoint, convenient for observers wearing eyeglasses.

○ **Compensating eyepiece (K):**
Corrected for chromatic aberration and astigmatism. For use with high power objectives.

○ **Photo eyepiece (FK):**
For photomicrographic use. Fully corrected for field flatness in combination with all Olympus objectives.

★ The eyepieces mentioned above can be used with drop-in eyepiece micrometer discs.

◎ **Use of eyepiece cap (for standard eyepiece)**
The eyepiece cap is recommended for those who wear eyeglasses. It prevents damage to the eyeglasses.

◎ **Use of eyepiece with eye shield**
The eyepiece WF10X incorporates a sliding eye shield. This eye shield can be pulled out to prevent glare and loss of contrast caused by ambient light hitting the eyepiece front lens.

■ Optical Data

*** BiK5X and BiWF15X are optionally available.

Objective / Eyepiece	Type	Achromats					Plan Achromats				
	Magnif.	M5X	M10X	M20X	M40X	M100X*	M Plan 5X	M Plan 10X	M Plan 20X	M Plan 40X	M Plan 100X*
	N.A.	0.10	0.25	0.40	0.65	1.30	0.10	0.25	0.40	0.63	1.25
	W.D.(mm)	27.00	7.60	2.10	0.50	0.35	3.30	7.10	0.72	0.39	0.16
	Focal length(mm)	31.46	19.58	10.15	5.39	2.25	33.59	21.46	9.57	5.40	2.10
	Resolving power(μ)**	3.4	1.3	0.84	0.52	0.26	3.4	1.3	0.84	0.53	0.27
BiK5X*** (Field Number 21)	Total magnif.	25X	50X	100X	200X	500X	25X	50X	100X	200X	500X
	Focal depth(μ)	166.0	32.0	10.4	3.3	1.1	166.0	32.0	10.4	3.3	1.1
	Field of view(mm)	4.2	2.1	1.05	0.53	0.21	4.2	2.1	1.05	0.53	0.21
BiWF10X (18)	Total magnif.	50X	100X	200X	400X	1000X	50X	100X	200X	400X	1000X
	Focal depth(μ)	98.0	18.4	6.1	2.0	0.7	98.0	18.4	6.1	2.0	0.7
	Field of view(mm)	3.6	1.8	0.9	0.45	0.18	3.6	1.8	0.9	0.45	0.18
BiWF15X*** (12)	Total magnif.	75X	150X	300X	600X	1500X	75X	150X	300X	600X	1500X
	Focal depth(μ)	75.4	13.9	4.7	1.6	0.5	75.4	13.9	4.7	1.6	0.6
	Field of view(mm)	2.4	1.2	0.6	0.3	0.12	2.4	1.2	0.6	0.3	0.12

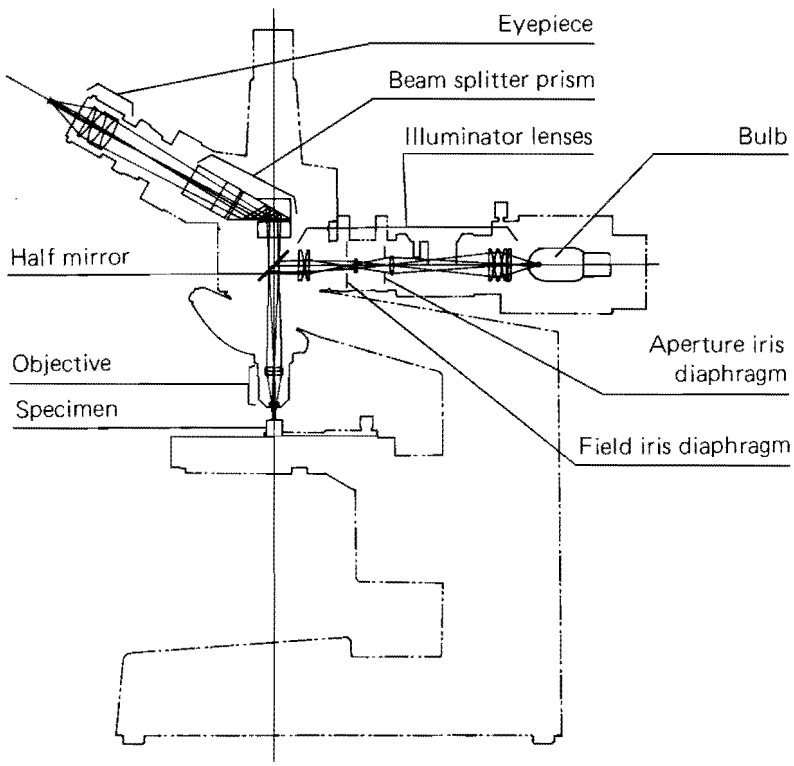
* Immersion objective. ** The resolving power is obtained when the objective is used with fully opened aperture diaphragm.

■ Nomenclature of Optical Components

- Working Distance: The distance from the specimen or cover glass to the nearest point of the objective. A longer working distance is covenient to avoid damage to the objective front lens or specimen, or when using a thicker cover glass.
- Numerical Aperture: Generally abbreviated N.A. A mathematical relationship that directly connects the resolving power and the light-gathering power of an objective with its aperture. N.A. is the product of the sine of half the angular aperture of a lens, and the refractive index of the medium through which the light passes. It is a very important constant for high power lenses. The N.A. values can be used for directly comparing the resolving power of all types of objectives, dry, water or oil immersion.
- Resolving Power: The ability of a lens to register small details. Resolving power is of vital importance in critical microscopy. The resolving power of a lens is measured by its ability to separate two points (line structure in the object may be considered as a row of points). The resolving power is now placed at $R=K\frac{\text{Wavelength}}{\text{N.A.}}$ K=constant

  The visible wavelength of the light employed is 400mμ to 700mμ. Decreasing the wavelength of the light employed increases the resolving power. The higher the resolving power of an objective, the closer the image will be to the true structure of the object.
- Focal Depth: The distance in micron between the upper and lower limits of sharpness in the image formed by an optical system is termed "focal depth." Structures outside these limits are more or less blurred and with low power objectives are apt to interfere with the image in focus. The smaller the aperture iris diaphragm setting and the lower the N.A., the larger the focal depth. Lack of focal depth is most apparent in photomicrography, particularly with low power objectives, as the image is projected on the film in one place.
- Field Number: A number that represents the diameter in mm of the image of the field diaphragm that is formed by the lens in front of it.
- Field of View Diameter: The actual size of the field of view in mm. This is derived from $\frac{\text{Field number of eyepiece.}}{\text{Objective power}}$

3. Vertical Illuminator



The reflected illumination system adopted in the Model BHM is based on the Koehler principle, with features as follows:

① Aperture iris diaphragm and field iris diaphragm operate effectively.

② The light source illuminates the full numerical aperture of the objective.

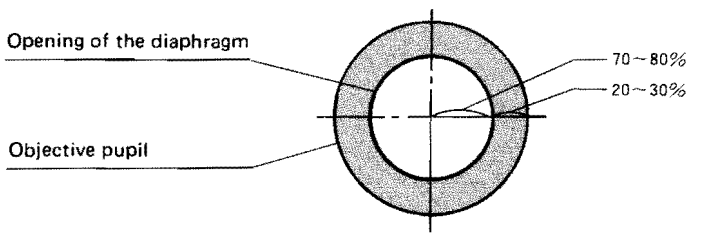
③ The entire field of view can be evenly illuminated.

④ The illuminator is provided with a high/low magnification selector lever to exactly match illumination with objective magnification in use.

⑤ Optimum light intensity can be easily obtained.

A. Aperture Iris Diaphragm

In order to achieve optimum objective performance, the opening of the aperture iris diaphragm should be matched to the numerical aperture of the objective in use. It is often preferable, however, to stop down the aperture diaphragm slightly more than indicated by the objective N.A. This will result in better image contrast, increased depth of focus and a flatter field. After completing focus adjustment, remove one of the eyepieces from the observation tube and look into the empty eyepiece tube. As you stop down the aperture iris diaphragm, the image of the iris diaphragm can be seen in the objective pupil. Adjust the opening of the diaphragm to match the N.A. of the objective in use. If the specimen is low in contrast, it is recommended to stop down to 70–80% of the objective N.A.



B. Field Iris Diaphragm

The field iris diaphragm controls the diameter of the ray bundle impinging on the specimen surface and thus increases image definition and reduces glare. For microscopic observation, it is necessary to stop down the field iris diaphragm until the diaphragm is just outside the field of view as you look through the eyepiece. For photomicrography, the field iris diaphragm must be stopped down in accordance with the field as viewed through the field of view eyepiece, focusing telescope, etc. in use.

VI. LIGHT SOURCE

The standard light source incorporates a 15W pre-centered tungsten filament bulb (LS15), combined with a socket for positive contact, eliminating the problems of defective contact and over-heating.

★ When used at the rated voltage 6V, the average life of the tungsten bulb LS15 is longer than 200 hours. This is, however, greatly reduced, if the bulb is used at higher voltage; for instance, the bulb life is reduced to 1/50 at 8V. Therefore, it is advisable to avoid prolonged use at readings over 6V (in the red zone).
If high intensity illumination is required, it is recommended to use the optional high intensity halogen illuminator.

★ Do not switch the tungsten bulb on at high intensity. It reduces bulb life.

VII. STAGES

1. Removal of Specimen Holder

1) Square mechanical stage with right-hand low drive controls Model BH-SV
The standard mechanical stage is provided with a spring-loaded specimen holder, which is capable of holding specimens up to 55mm x 85mm in size. The specimen holder is removable to obtain a large unobstructed stage surface. (Fig. 1)

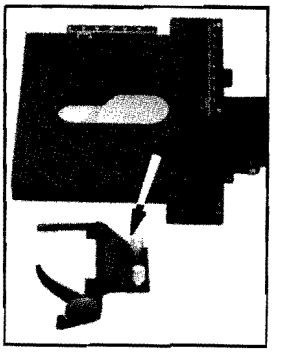


Fig. 1

2) Large mechanical stage Model BH-SIC
This 200mm x 161mm square mechanical stage has a traversing area of 110mm x 100mm, by means of coaxial low drive controls. It is possible to adjust the distance between the holders according to specimen sizes. For exceptionally large specimens, the holders can be removed. For use with IC wafers, masks or other special specimens, customer designed specimen holders can be utilized.

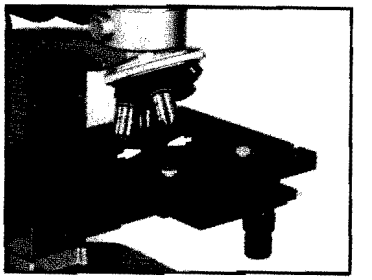


Fig. 2

2. Stage Spacer

In order to prevent interference between objectives and specimen holder it is recommended to use the stage spacer provided with the stage Model BH-SV and place it in the manner shown in Fig. 3, prior to placing a thin specimen on the stage. (Fig. 3)

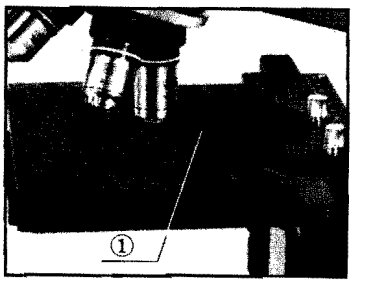


Fig. 3

3. Metal Slides

To level a specimen:

1) Put plasticine on a metal slide supplied.

2) Place a specimen on the plasticine, and press the specimen with a hand press until the specimen surface is properly leveled.

★ It is suggested to place a piece of tissue paper between the specimen and the plunger of the hand press in order to prevent scratching of the polished specimen surface. (Fig. 4)

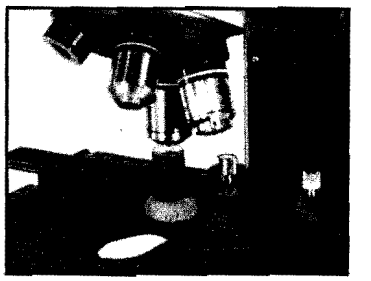


Fig. 4

VIII. OBSERVATION TUBE

1. Interpupillary Distance and Diopter Adjustments

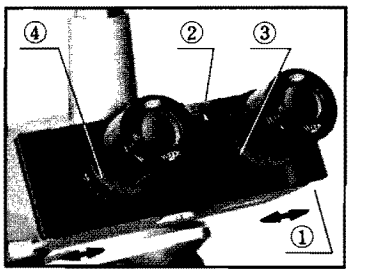


Fig. 5

1) Hold the knurled dovetail slides ① of the right and left eyepiece tubes with both hands and push the tubes together, or pull them apart laterally, whichever is required, while looking through the eyepieces with both eyes, until perfect binocular vision is obtained.

2) Memorize your interpupillary distance setting. Scale ② is provided for this purpose.

3) Rotate the tube length adjustment ring ③ on the right eyepiece tube to match your interpupillary distance setting which you obtained from the scale. (Fig. 5)

4) Look at the image through the right eyepiece with your right eye and focus on the specimen with the fine adjustment knobs.

5) Next, look at the image through the left eyepiece with your left eye and rotate the tube length adjustment ring ④ to focus on the specimen without using the coarse and fine adjustment knobs.

★ The mechanical tube length of the Olympus metallurgical microscope is standardized at 200mm.

2. Light Path Selection

The trinocular observation tube is provided with a light path selector lever to direct the light to the observation tube or to the photo tube.

Lever position	Amount of light	Application
Pushed in all the way	100% into binocular tube	(1) Normal observation (2) Dark specimens
Pulled out all the way	20% into binocular tube 80% into photo tube	(1) Photomicrography (2) Observation of excessively bright specimens

★ In case of long time exposure, it is necessary to darken the room or put a pair of light shield caps, provided with the trinocular tube, on the eyepiece tubes, in order to prevent light from coming on the film plane.

IX. FOCUSING ADJUSTMENT

1. Tension Adjustment of Coarse Adjustment Knobs

A tension adjustment ring ① is provided next to the right hand coarse adjustment knob. With this device the tension of the coarse adjustment is freely adjustable for either heavy or light movement, depending on operator preference. (Fig. 6)
However, do not loosen the tension adjustment ring too much, because the stage drops or the fine adjustment knobs slip easily.

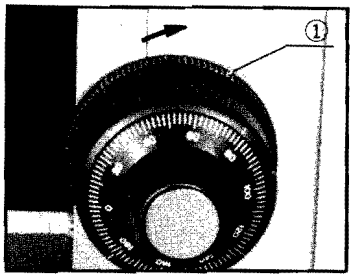


Fig. 6

★ Be careful not to rotate the right and left coarse adjustment knobs in the opposite directions simultaneously. (Fig. 6)

2. Automatic Pre-focusing Lever

This lever ① is provided to prevent possible contact between specimen and objective as well as to simplify coarse focusing. The lever is locked after coarse focus has been accomplished. This prevents further upward travel of the stage by means of the coarse adjustment knobs, and automatically provides a limiting stop if the stage is lowered and then raised again. The automatic pre-focusing lever does not restrict fine focusing. (Fig. 7)

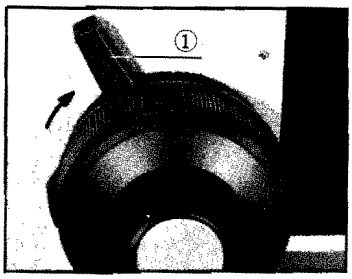


Fig. 7

3. Stage Height Locking Lever

In addition to the vertical movement of the stage by means of coarse and fine adjustments, the stage height position can be changed by means of the stage height locking lever ① . Maximum specimen height is 55mm with the standard objectives, and 37mm with the differential interference contrast attachment. (Fig. 8)

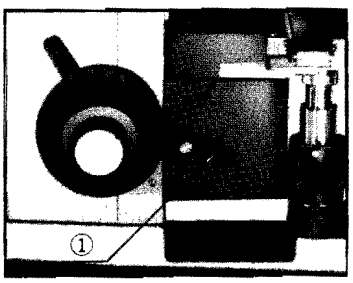


Fig. 8

X. TROUBLESHOOTING

Troubles	Causes	Remedies
1. Optical System		
(a) With the illuminator switched on, the field of view cannot be seen.	The field iris diaphragm is not opened sufficiently.	Open the field diaphragm fully.
(b) The field of view is cut off or illuminated irregularly.	The light path selector lever is stopped midway.	Push the lever all the way.
	The nosepiece is not clicked into position.	Slightly rotate the nosepiece until it clicks into position.
	The field iris diaphragm is stopped down excessively.	Open the diaphragm sufficiently.
	The bulb or lamp house is not correctly positioned.	Insert the bulb or lamp house all the way.
	The high/low magnification selector lever of the illuminator is not correctly positioned.	Position the lever correctly.
(c) Dust or dirt is visible in the field of view.	Dust or dirt on the bulb end.	Clean off the dust or dirt.
	Dust on half mirror.	
	Dirty specimen.	
	Dust on eyepiece.	
	Dust on the lower surface of the prism in the observation tube.	
(d) Excessive image contrast.	The aperture iris diaphragm is stopped down excessively.	Open the diaphragm.
	The high/low magnification selector lever is not correctly positioned.	Place the lever in correct position.
	The bulb or lamp house is not correctly positioned.	Push the bulb or lamp house all the way home.
(e) Resolution problems: 1) Image is not sharp. 2) Insufficient contrast.	The objective is not correctly positioned in the light path.	Slightly rotate the nosepiece until it clicks into position.
	Dirt on objective front lens.	Clean the objective.
	The immersion objective is used without immersion oil.	Apply immersion oil.
	Bubbles in the immersion oil.	Remove bubbles.
	The Olympus specified oil is not used.	Use the specified oil.
	The specimen is not properly illuminated.	Adjust the illumination.

Troubles	Causes	Remedies
(f) The field of view is partially out of focus. The image is partly out of focus.	The objective is not correctly positioned in the light path	Slightly rotate the nosepiece until it clicks into position
	The specimen is not correctly positioned on the stage.	Place the specimen on the stage and secure it with the specimen holder.
	The specimen surface is not at right angles with the optical axis.	Level the specimen surface correctly with a hand press.
	The high/low magnification selector lever is not properly operated (or the lever is positioned midway).	Turn the lever all the way until it stops in position.
(g) When objectives are changed, they are not parfocal.	Mechanical tube length adjustment rings on observation tube are not correctly adjusted.	Adjust the rings correctly.
2. Electric System		
(a) The light flickers and the intensity is varying.	The filament of the bulb is likely to burn out.	Replace the bulb.
	Loose electrical connection.	Secure the connection.
(b) The pilot lamp lights but the illuminator does not.	The bulb is burned out.	Replace the bulb.
	Loose electrical connection.	Secure the connection.
(c) Reduced bulf life.	Mains voltage is too high.	Use the tungsten bulb under 6V as well as possible, or use a high intensity light source, such as a halogen illuminator.
3. Focusing		
(a) Coarse adjustment is too tight.	Tension adjustment ring is tightened too much.	Loosen the adjustment ring properly.
	The user is trying to raise the stage passing over the upper focusing limit imposed by the engaged pre-focusing lever.	Unlock the pre-focusing lever.
(b) The stage drops and the specimen goes out of focus.	The tension adjustment ring is too loose.	Tighten the ring properly.
(c) The stage cannot be raised to the upper limit of the working range.	The pre-focusing lever is engaged in positioning the stage lower than the focusing position.	Unlock the pre-focusing lever.
	The stage height locking lever is engaged in a position lower than the focusing range.	Unlock the lever, and raise the stage to the proper height, then lock the lever.

Troubles	Causes	Remedies
(d) The stage cannot be lowered to the lower limit.	The stage is locked higher than focusing position.	Loosening the stage height locking lever, lower the stage to a proper height, and then lock the lever.
4. Observation Tube		
(a) Incomplete binocular vision.	Interpupillary distance is not correctly adjusted.	Correct the interpupillary distance.
	Diopter adjustment is incomplete.	Complete the diopter adjustment.
	Right and left eyepieces are not matched.	Use a pair of matched eyepieces.
	The user is unaccustomed with a binocular vision.	Prior to looking at the binocular image of the specimen, try to look the entire field of view, or look at a far away object before resuming microscopic observation.
5. Stage		
(a) The image moves easily when you touch the stage.	The stage is not correctly clamped.	Clamp the stage securely.
	The stage height locking lever is not tightened.	Tighten the lever securely.

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