Nikon

Polarizing Microscope

OPTIPHOT-POL

INSTRUCTIONS

NIPPON KOGAKU K.K.

CAUTIONS

❶ Avoid sharp knocks!

Handle the microscope gently, taking care to avoid sharp knocks.

❷ When carrying the microscope

When carrying the microscope, hold its arm with one hand, supporting the bottom of the microscope base with the other. The instrument weighs about 10.5 kg. Do not have the lamp housing carry any load.

❸ Place for using

Avoid the use of the microscope in a dusty place, where it is subject to vibrations or exposed to high temperatures, moisture or direct sunlight.

❹ Power source voltage

In every case, make sure of the power source voltage by means of the input voltage change-over switch on the bottom of the microscope base.

❺ Light source

Halogen lamp bulb to be used is 12V–50W. Do not use 12V–100W halogen lamp bulb. If the lamp bulb of over-rated wattage is used, light adjusting circuit will damage.

Never connect the lamp housing cord to the house current socket directly.

❻ In lighting the lamp

Take care not to touch the lamp housing being lighted, and don't bring inflammable substances such as gasoline, thinner, and alcohol near to the lamp housing, as some parts of the lamp housing may take a high temperature while the lamp is being lighted.

❼ Exchanging the lamp bulb and fuse

Before replacing the lamp bulb or fuse, turn OFF the power switch and disconnect the plug of the power source cord.

In such cases as of replacement, do not touch the lamp bulb with bare hands, immediately after putting out the lamp.

❽ Dirt on the lens

Do not leave dust, dirt or finger marks on the lens surfaces.

They will prevent you from clear observation of the specimen image.

❾ Strain-free glasses

The optical elements of this microscope being constructed of strain-free glasses, take particular caution in handling the objectives and condenser lenses not to cause strain to them.

❿ Focus knobs

Never attempt to adjust the tightness of the right- and lefthand focus knobs by turning the one, while holding the other in this model microscope, because of causing disorder.

CARE AND MAINTENANCE

❶ Cleaning the lenses

To clean the lens surfaces, remove dust using a soft brush or gauze. Only for removing finger marks or grease, should soft cotton cloth, lens tissue or gauze lightly moistened with absolute alcohol (ethanol or methanol) be used.

For cleaning the objectives and immersion oil use only xylene.

Observe sufficient caution in handling alcohol and xylene.

❷ Cleaning the painted surfaces

Avoid the use of any organic solvent (for example, thinner, ether, alcohol, xylene etc.) for cleaning the painted surfaces and plastic parts of the instrument.

❸ Never attempt to dismantle!

Never attempt to dismantle the instrument so as to avoid the possibility of impairing the operational efficiency and accuracy.

❹ When not in use

When not in use, cover the instrument with the accessory vinyl cover, and store it in a place free from moisture and fungus.

It is especially recommended that the objectives and eyepieces be kept in an airtight container containing desiccant.

❺ Periodical checking

To maintain the performance of the instrument, we recommend to check the instrument periodically. (For details of this check, contact our agency.)

CONTENTS

I . NOMENCLATURE

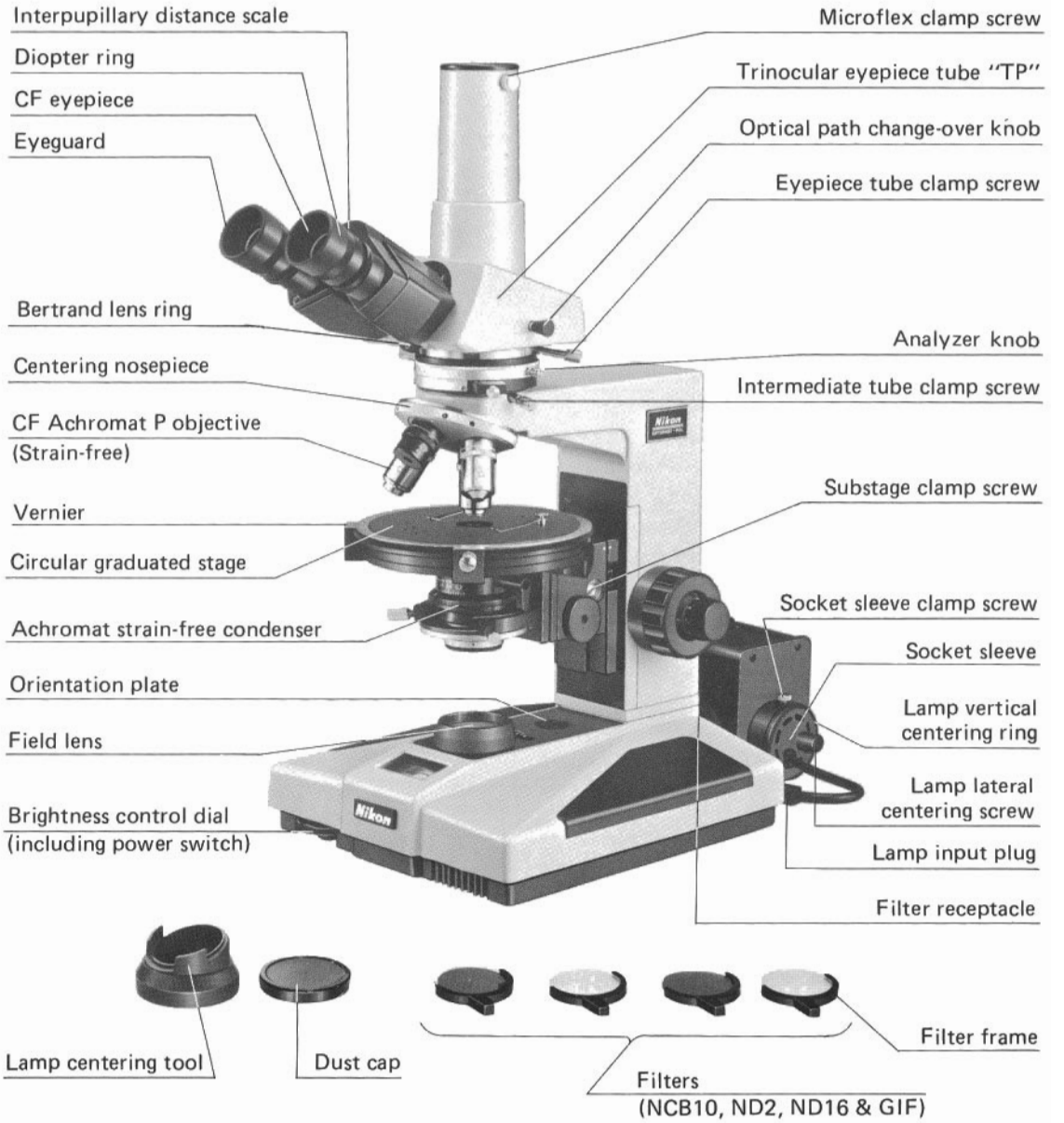


Fig. 1

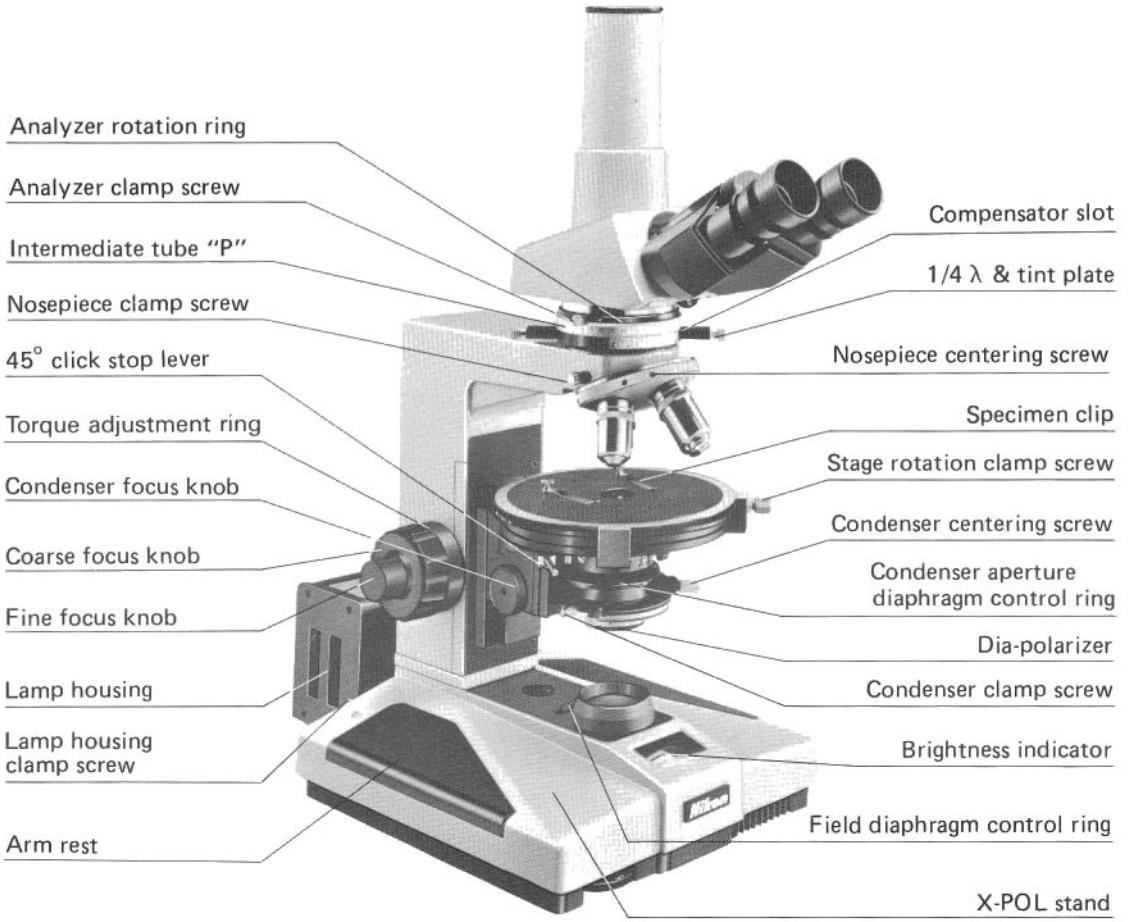
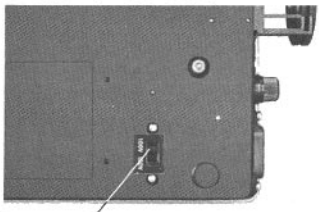

Analyzer rotation ring
Analyzer clamp screw
Intermediate tube "P"
Nosepiece clamp screw
45° click stop lever
Torque adjustment ring
Condenser focus knob
Coarse focus knob
Fine focus knob
Lamp housing
Lamp housing clamp screw
Arm rest
Compensator slot
1/4 λ & tint plate
Nosepiece centering screw
Specimen clip
Stage rotation clamp screw
Condenser centering screw
Condenser aperture diaphragm control ring
Dia-polarizer
Condenser clamp screw
Brightness indicator
Field diaphragm control ring
X-POL stand

Fig. 2

II. ASSEMBLY

- **To assemble the microscope, follow the procedure in the order given:**

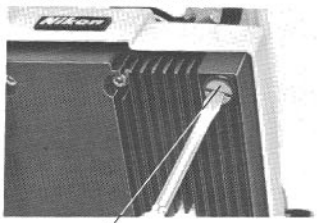
Bottom of the Base



① Power source voltage

Set the input voltage to the power source voltage by means of the change-over switch on the bottom of the base.

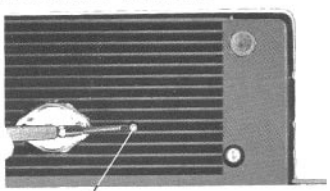
Bottom of the Base



② Leveling foot screw

For stable installation of the microscope, manipulate the adjusting screw at one foot on the bottom of the microscope base.

Bottom of the Base



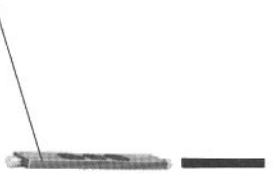
⑨ Adjustment of the lowest power source voltage

If the illumination is found too bright or unstable, when the switch is turned ON, make adjustment of the lowest voltage in the following way:

1) Turn the brightness control dial to OFF.
2) Turn the lowest voltage adjusting screw on the bottom of the microscope base counterclockwise to the limit, using a screw driver.
3) Turn the brightness control dial to ON. At this time, the lamp voltage will be highest, immediately after lighting.
4) In this condition, gently turn the lowest voltage adjusting screw clockwise, to set the voltage to nearly 4 on the indicator.

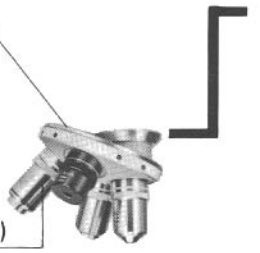
⑮ CF eyepiece

Insert the eyepiece CFW 10×CM into the right-hand sleeve, fitting the pin of the eyepiece in the right-hand notch of the sleeve. Into the left-hand sleeve, insert the CFW 10×.



⑬ 1/4 λ & tint plate

Remove the screw by the side of the 1/4 λ plate of the 1/4 λ & tint plate and insert it into the compensator slot of the intermediate tube "P", facing the positioning groove toward the operator side. Reattach the removed screw.

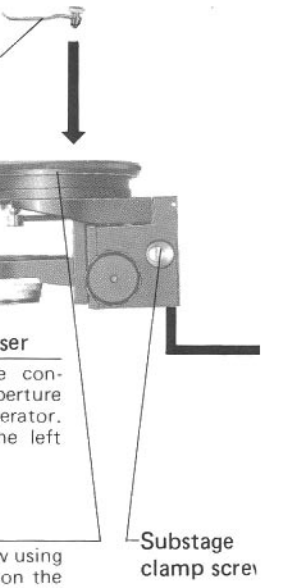


⑰ Centering nosepiece

Lower the stage sufficiently. Releasing the nosepiece clamp screw on the left side of the microscope arm, insert the nosepiece. Making sure of positive fitting of the pin on the microscope arm into the nosepiece groove, refasten the clamp screw.

⑯ CF Achromat P objective (Strain-free)

Mount the objectives on the nosepiece in such positions that their magnifying power increases as the nosepiece is revolved clockwise.



⑪ Specimen clip

Place the clip on the stage using holes on the stage surface.

Aperture number plate

⑱ Achromat strain-free condenser

Insert the condenser into the condenser carrier, facing the aperture number plate toward the operator. Fasten the clamp screw on the left side of the carrier.

⑩ Circular graduated stage

Release the substage clamp screw using a driver, and slide the substage on the dovetail fitting. In such a position that the top ends of the substage and the dovetail are at the same level, fasten the clamp screw.

Substage clamp screw

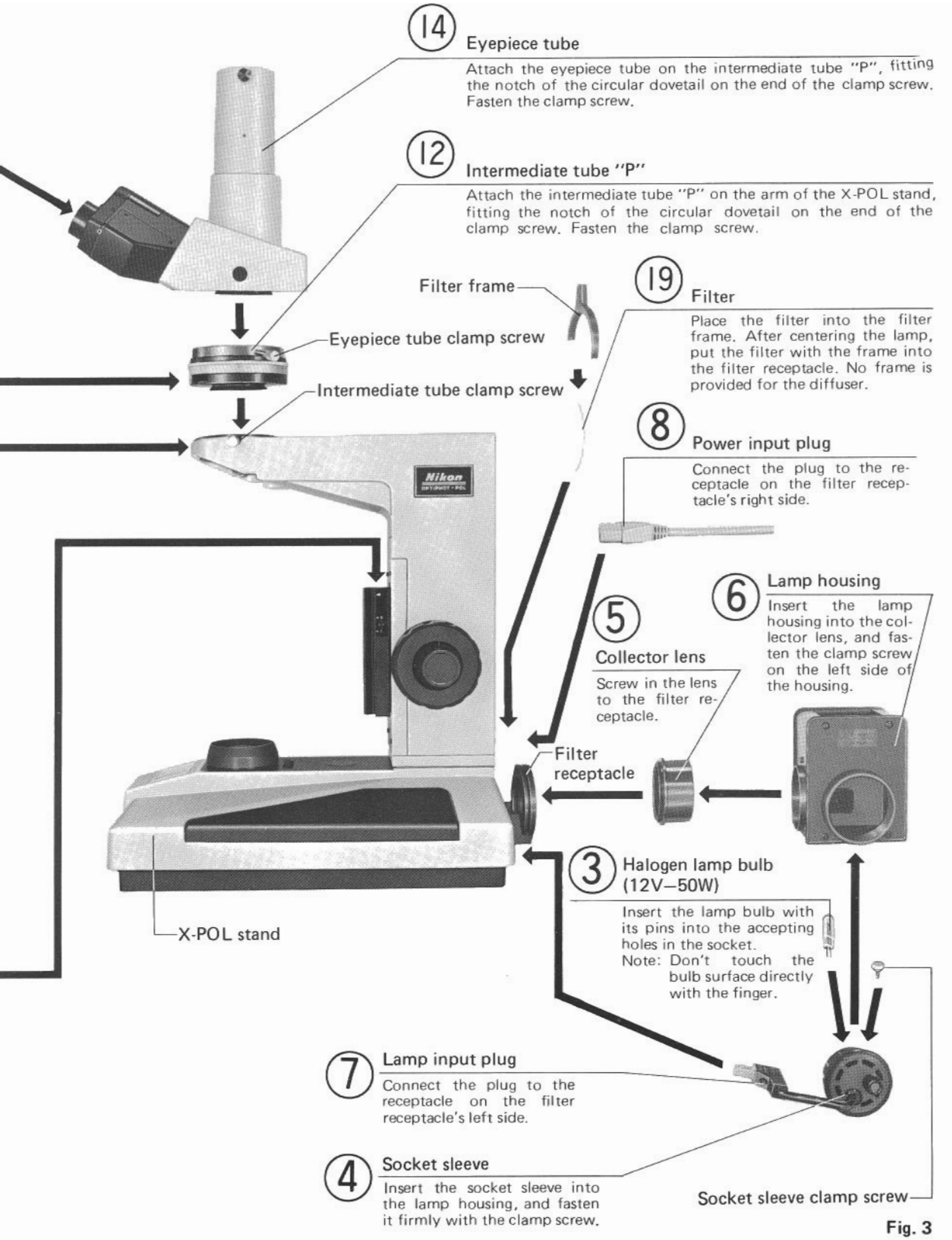

14
Eyepiece tube
Attach the eyepiece tube on the intermediate tube "P", fitting the notch of the circular dovetail on the end of the clamp screw. Fasten the clamp screw.
12
Intermediate tube "P"
Attach the intermediate tube "P" on the arm of the X-POL stand, fitting the notch of the circular dovetail on the end of the clamp screw. Fasten the clamp screw.
Filter frame
19
Filter
Place the filter into the filter frame. After centering the lamp, put the filter with the frame into the filter receptacle. No frame is provided for the diffuser.
Eyepiece tube clamp screw
Intermediate tube clamp screw
8
Power input plug
Connect the plug to the receptacle on the filter receptacle's right side.
6
Lamp housing
Insert the lamp housing into the collector lens, and fasten the clamp screw on the left side of the housing.
5
Collector lens
Screw in the lens to the filter receptacle.
Filter receptacle
3
Halogen lamp bulb (12V–50W)
Insert the lamp bulb with its pins into the accepting holes in the socket.
Note: Don't touch the bulb surface directly with the finger.
X-POL stand
7
Lamp input plug
Connect the plug to the receptacle on the filter receptacle's left side.
4
Socket sleeve
Insert the socket sleeve into the lamp housing, and fasten it firmly with the clamp screw.
Socket sleeve clamp screw

Fig. 3

III. PREPARATION

1. Centering the Lamp

1) Connect the power source cord to the socket.
2) Turn the brightness control dial to switch ON and adjust the voltage to 6 on the indicator.
3) Place the specimen on the stage, and focus on the specimen using 10× objective. In this case, open the condenser aperture and field diaphragms to the largest extent.
4) Roughly center the condenser lens using 10× objective, following the procedures given on P. 10 - 6.
5) Put the lamp centering tool on the field lens and onto the tool place a ND filter. (Fig. 4)

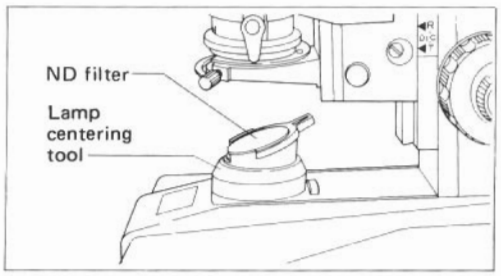


Fig. 4

6) Stop down the condenser aperture diaphragm, release the lamp housing clamp screw, and move the lamp housing back and forth (Fig. 5), until a sharp image of the lamp filament appears on the aperture diaphragm surface, which can be seen by the reflection from the ND filter.

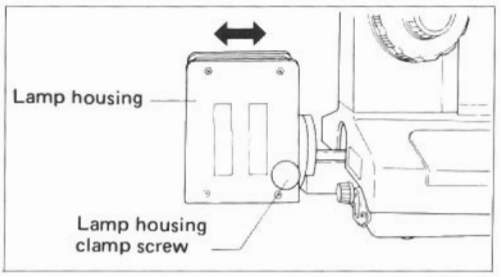


Fig. 5

7) Release the socket sleeve clamp screw (Fig. 6). Turning the lamp lateral centering screw and vertical centering ring, bring the filament image to the center, as shown in Fig. 7.

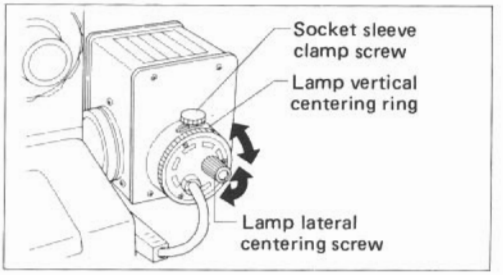


Fig. 6

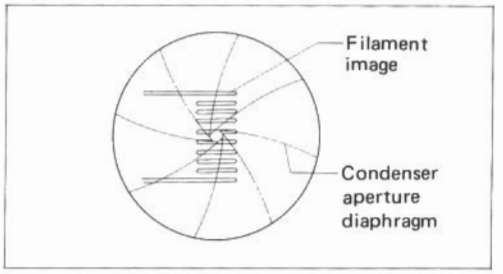


Fig. 7

8) As shown in Fig. 8, put the diffuser, with its matte surface faced toward the microscope stand, into the filter receptacle which is the closest to the microscope stand.

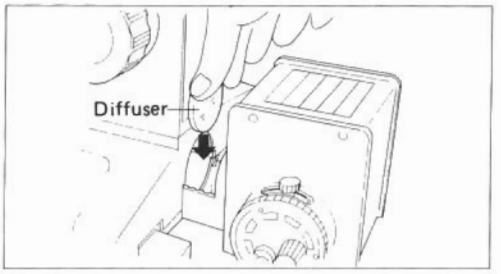


Fig. 8

The above centering procedure should be carried out, when replacing the lamp bulb.

2. Interpupillary Distance Adjustment

Place a specimen on the stage, and focus on the specimen.

As shown in Fig. 9, adjust the interpupillary distance, so that both the right and left view-fields become one.

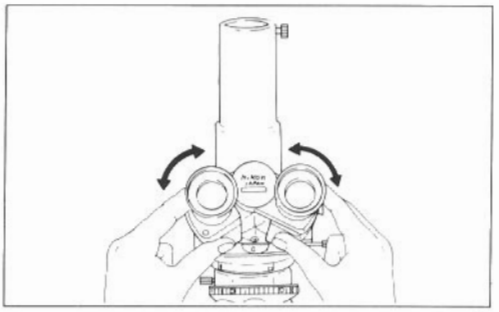


Fig. 9

3. Diopter Adjustment

Rotate the diopter ring on the eyepiece CFW 10× CM until the cross lines are seen clear. (Fig. 10)

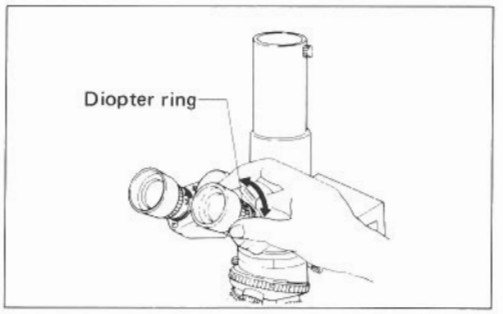


Fig. 10

(For binocular observation)

1) Mount the specimen on the stage. Swing the objective 10× into position, and bring the specimen image into focus looking into the right-hand eyepiece.
2) Without manipulating the coarse-and-fine focus knob, turn the diopter ring on the left-hand eyepiece to focus on the specimen.

4. Optical Path Change-over in the Trinocular Eyepiece Tube "TP"

(Fig. 11)

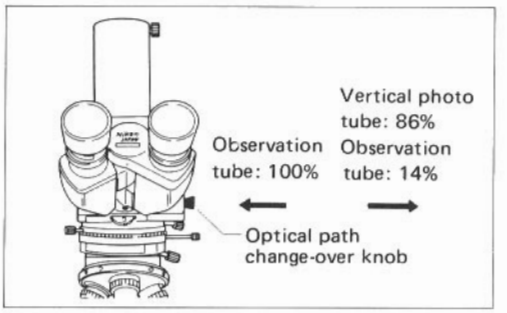


Fig. 11

※ Since the CF eyepieces are of high eye-point type, it is not necessary for the user putting on his spectacles to remove them. Only fold down the eyeguard rubber. (Fig. 13)

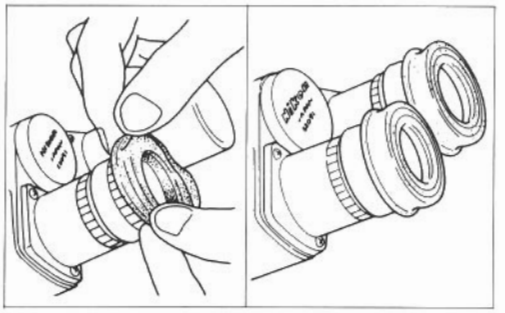


Fig. 12 Fig. 13

5. Centering the Objectives

1) Place the specimen on the stage, and focus on the specimen. Bring an appropriate target to the center of the cross lines in the eyepiece.
2) Insert the centering tools in the centering screws on the nosepiece. (Fig. 14)

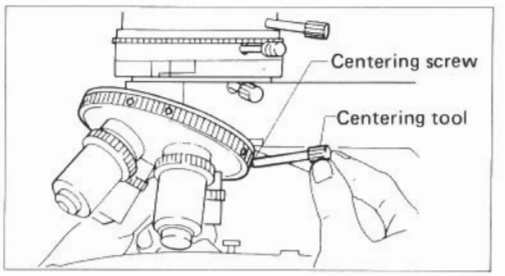


Fig. 14

3) Rotate the stage about 180°, and the target is displaced from the center of the cross lines. Move the objective using the centering tools so that the center of the cross lines comes to one half position of the displacement of the target. (Fig. 15)

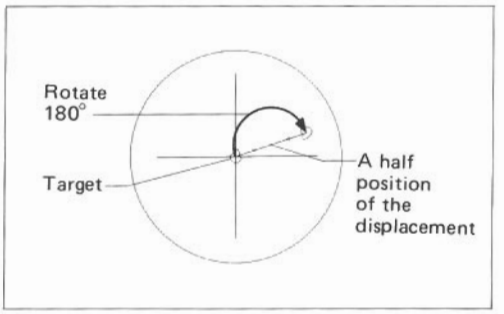


Fig. 15

- Repeat the above procedure two or three times, and the rotation center of the stage coincides with the cross lines center.
- Carry out centering for each objective.

6. Centering the Condenser Lens

1) Close the field diaphragm in the microscope base to its smallest size by means of the field diaphragm control ring. Rotate the condenser focus knob to move the condenser vertically so that a sharp image of the field diaphragm is formed on the specimen surface.
2) Bring the field diaphragm image to the center of the field of view by means of the condenser centering screws.
(Fig. 16–1)
3) Change over to the objective 40×, and adjust the field diaphragm so that the image of the diaphragm is about the same as the eyepiece viewfield stop, as shown in Fig. 16–2. If not centered, use the condenser centering screws again.

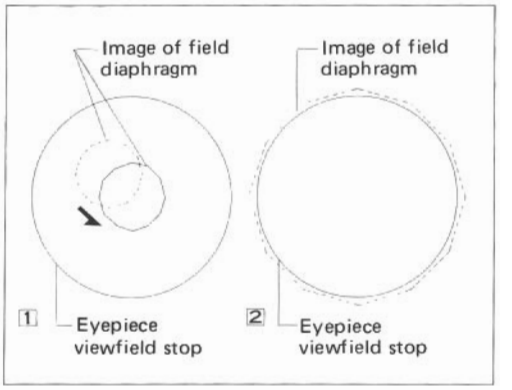


Fig. 16

IV. MICROSCOPY

1. Operating Procedure

1) Turn the brightness control dial (including power switch) to light the lamp.
2) Bring the analyzer and the Bertrand lens out of the optical path.
3) Place the specimen on the stage and swing the 10× objective into position. Focus on specimen.
4) Adjust the interpupillary distance and diopter. (Refer to P. 9)
5) Make certain of correct illumination. (Refer to P. 8)
6) Put the filters necessary into the filter receptacle.
7) Carry out the centering procedure for the objective. (Refer to P. 9)
8) Carry out the centering procedure for the condenser. (Refer to P. 10)
9) Bring the analyzer into the optical path.
10) Swing in the objective to be used and refocus on specimen.
11) Brightness is adjusted by selecting ND filters or by changing the lamp voltage to 6 ~ 12.

Table 1

<table>
<tr><th></th><th colspan="2">Orthoscopic microscopy</th><th>Conoscopic microscopy</th></tr>
<tr><td rowspan="2">Top lens of condenser</td><td>10× or higher</td><td>IN</td><td rowspan="2">IN</td></tr>
<tr><td>4× or lower</td><td>OUT</td></tr>
<tr><td>Bertrand lens</td><td colspan="2">OUT</td><td>IN</td></tr>
<tr><td rowspan="2">Aperture diaphragm</td><td>10× or higher</td><td>70% ~ 80% of the numerical aperture of the objective</td><td rowspan="2">Circumscribed the circumference of the conoscopic field of view (or fully opened)</td></tr>
<tr><td>4× or lower</td><td>Fully opened</td></tr>
<tr><td rowspan="2">Field diaphragm</td><td>10× or higher</td><td>Circumscribed the circumference of the eyepiece field of view</td><td rowspan="2">Circumscribed the circumference of the orthoscopic field of view</td></tr>
<tr><td>4× or lower</td><td>Fully opened</td></tr>
</table>

2. Manipulation of Each Element

1) Focusing

- The relation between the direction of rotation of the focus knobs and that of vertical movement of the stage is as indicated in Fig. 17.

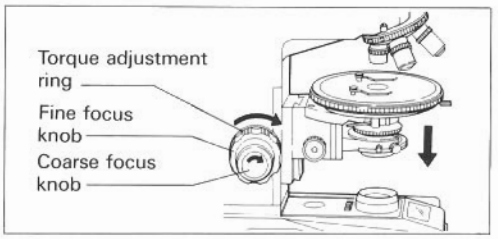


Fig. 17

- One rotation of the fine focus knob moves the stage 0.1mm.
  The graduation on this focus knob is divided into 1μm.
  One rotation of the coarse focus knob moves the stage 4.7mm.
- Tightness of the coarse-fine focus knob having been properly adjusted by the manufacturer, it should never be readjusted in this model microscope by turning the one knob while holding the other.

2) Condenser aperture diaphragm (A diaphragm)

(1) Orthoscopic microscopy

- The condenser aperture diaphragm is provided for adjusting the numerical aperture (N.A.) of the illuminating system of microscope.
  In general, when it is stopped down to 70 ~ 80% of the numerical aperture of the objective, a good image of appropriate contrast will be obtained. (Fig. 18)

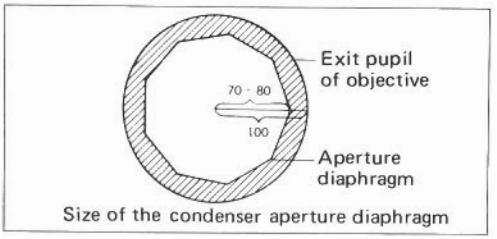


Fig. 18

- Remove the eyepiece from the eyepiece tube, adjust the size of the diaphragm, observing the image of the diaphragm which is visible on the bright circle of exit pupil of objective inside.
- When swinging out the top lens of the condenser (for microscopy using 4× or lower objective), fully open the condenser aperture diaphragm.

(2) Conoscopic microscopy

- In conoscopic microscopy, the condenser aperture diaphragm works as a field diaphragm on the conoscopic image surface. Stop down the diaphragm to such an extent that it circumscribes the circumference of the field of view of the conoscopic image (exit pupil of objective) to shut out the stray light.

3) Field diaphragm (F diaphragm)

- The field diaphragm is used for determining the illuminated area on the specimen surface in relation to the field of view of the microscope. Generally, it is stopped down to such an extent that the circumference of the illuminated area circumscribes that of the eyepiece field of view.

  [Note] This diaphragm does not work as the field diaphragm when the condenser top lens is swung out of the optical path. In this case the diaphragm is recommended to be fully opened because the numerical aperture of the illuminator will be cut off when this diaphragm is excessively stopped down.

4) Circular graduated stage

- The rotation angle of the stage is readable with the accuracy of 0.1° via a paired vernier scales.
  When the reading with one of the vernier scales is interrupted by the attachable mechanical stage type "E", read the other vernier and add ±90° to the reading.
- The 45° click-stop device comes to act at every 45° rotation, starting from a position where the click stop lever has been pulled toward the operator, giving convenience in switching over the observation from a crossed Nicols position to a diagonal position. (Fig. 19)

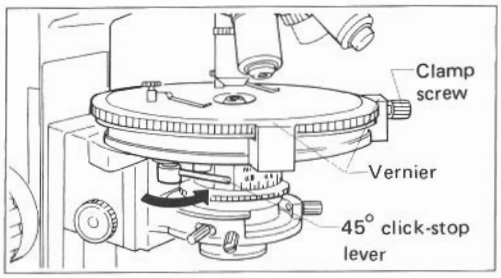


Fig. 19

For the click-stop release, turn the lever toward the microscope body.

- The stage can be clamped at any position using the stage rotation clamp screw on the right-hand vernier.

5) Objectives

- The CF Achromat P objectives (Strain-free) and CF eyepieces adopted in the Nikon POLARIZING MICROSCOPE OPTIPHOT-POL are designed on the basis of a concept "Chromatic Aberration Free".
  In every case use the CF objectives in combination with the CF eyepieces.

(1) Oil immersion objectives (Oil)

- Objective CF Achromat P 100× (Oil), an oil-immersion type, is to be immersed in oil between the specimen and front of the objective.
  To see if air bubbles are present in the immersion oil, which deteriorate the image quality, pull out the eyepiece from the eyepiece tube to examine the objective exit pupil inside the tube. To remove air bubbles, revolve the nosepiece slightly to and fro several times, apply additional oil, or replace the oil. Be careful not to rotate the nosepiece too far as to soil the ends of the other objectives with oil.
- To clean off the oil, pass lens tissue or soft cloth moistened with xylene lightly two or three times over the lens. It is essential at this time to avoid touching the lens with the part of tissue or cloth once used.

(2) Coverglass

- With the objectives engraved "160/0.17", use a coverglass of 0.17mm in thickness.
- The indication "160/—" on the objective means that no matter whether a coverglass is used or not, no decrease of image definition or of contrast will result.

6) Eyepieces

- To take full advantage of the CF eyepieces, use them in combination with the CF objectives.
- By inserting the eyepiece with cross lines and graduation (CFW 10×CM) into the eyepiece sleeve fitting the protractor pin into the right-hand side groove of the sleeve, the 0-direction of the analyzer and dia-polarizer are aligned with the cross lines direction.
  If the protractor pin is fitted to the upper right side groove of the sleeve, the cross lines will be aligned with the diagonal position of the polarizaiton.
- CF PL Projection lenses are exclusively designed for photomicrography. Do not use them for observation.
- For focusing with the observation tube of the trinocular eyepiece tube for photomicrography, use the eyepiece incorporating the photo mask.

7) Achromat strain-free condenser

- The top lens of the condenser is to be placed in the optical path for the orthoscopic and conoscopic microscopy provided that it is to be swung out when an objective of 4× or lower magnification is in use.
  [Note] For the orthoscopic microscopy, a lower numerical aperture illumination with the top lens swung out condenser was used to be recommended, however, this method is not effective especially for high magnification observation because of the lowered resolution. Hence, for the latter case, use of the top lens may rather be recommendable except the retardation measurement or the interference color observation for which it is necessary to make the illumination light flux as parallel as possible to the optical axis by swinging out the top lens or stopping down the aperture diaphragm.
- Thickness of the glass slide must be 1.7mm or less, otherwise, the field diaphragm

might fail to focus its image on the specimen.

8) Bertrand lens

(with the trinocular eyepiece tube "TP" or the binocular eyepiece tube "BP" in use)

- Bring the Bertrand lens into the optical path by turning the Bertrand lens ring leftward to observe the conoscopic image. (Fig. 20)

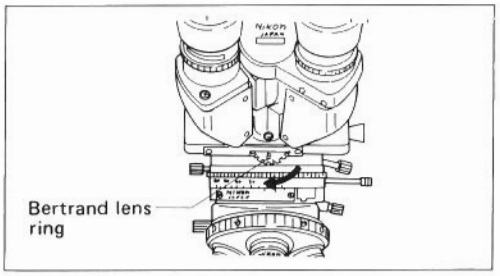


Fig. 20

- The conoscopic view field is as large as about 1/4 of the orthoscopic view field. (Fig. 21)

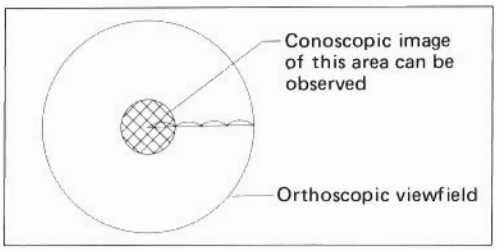


Fig. 21

- The conoscopic image may also be observed overlapping on the orthoscopic image through the binocular observation, one of the paired eyepieces being replaced with the accessory pin hole eyepiece and without the Bertrand lens in the optical path. (Fig. 22)

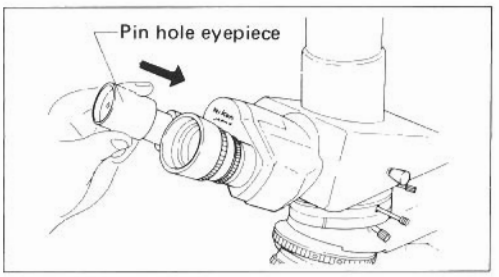


Fig. 22

In the above simultaneous observation of the conoscopic and orthoscopic images, the former image may appear deviated from the orthoscopic view field center, however, the deviated image represents the conoscopic light flux that covers the central part of the orthoscopic view field to the extent of about 1/18.

9) 1/4 λ & tint plate

- Removing the 1/4 λ plate side screw, hold the 1/4 λ & tint plate, the click stop groove facing the operator and insert it forward into the compensator slot.
  Then screw-in the above screw as it was. (Fig. 23)

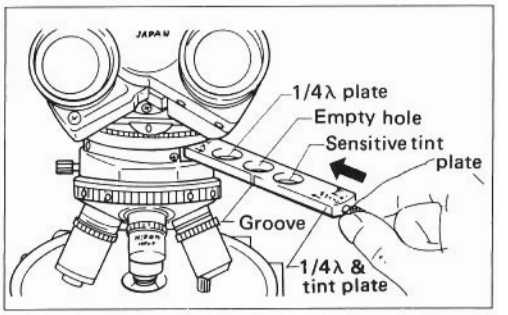


Fig. 23

- The tint plate has an empty hole at the center. By pushing it through the slot, the sensitive tint plate (530nm) is brought into the optical path and by pulling it out the 1/4 λ plate is brought into the optical path.

10) Dia-polarizer and analyzer

- When the both are set at 0 reading on the protractor scale, position of the polarization plane coincides with the orientation plate, which shows that the indication "P" of the X-direction is for dia-polarizer and the "A" of the Y-direction is for analyzer, on the microscope base. (Fig. 24)

  [Note] Some of the polarizing microscope's reference books or special works available in the market may explain that the X-direction is for analyzer and the Y-direction, for polarizer.

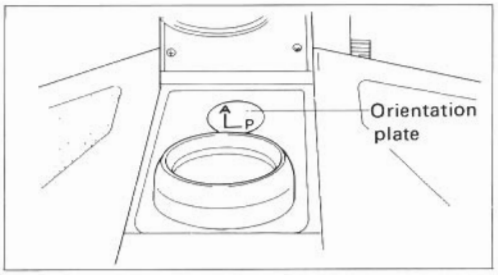


Fig. 24

- The dia-polarizer rotates 360°, and can be detached from the substage by pulling downward. (Fig. 25)
  For attaching the dia-polarizer, push it with the pin on the dia-polarizer into coincidence with the groove at the position of 0° on the bottom of the substage.

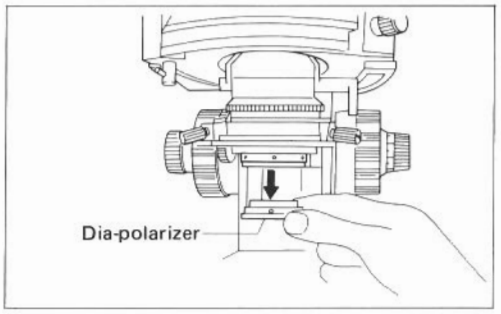


Fig. 25

- The analyzer rotates 180° via the rotation ring, the left-hand side clamp being released. The rotation angle readable with accuracy of 0.1° via the vernier.
  The analyzer can be taken out of the optical path by pulling out by the analyzer knob. (Fig. 26)

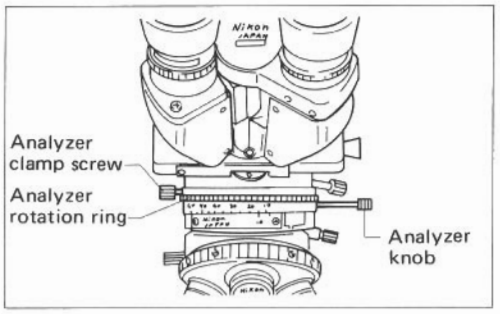


Fig. 26

11) Filters

- Put the filter with the frame into the filter receptacle between the microscope base and the lamp housing. The accessory filters are as shown below:

Table 2. Use of Filters

Type of filter	Use
Diffuser (Without frame)	To be inserted in all cases except for lamp centering
NCB 10 filter (Color balancing filter)	For general microscopy and color photomicrography
ND 2 filter (T=50%) ND 16 filter (T=6.25%)	For brightness adjustment
GIF (Green interference)	For retardation measurement and contrast-up in monochromatic photomicrography

12) Lowering the substage

- Releasing the clamp screw using a screw driver, as shown in Fig. 27, permits lowering the substage as far as 32mm from the observing position beyond the moving stroke of the focusing device.
  So, the microscope makes it possible to examine the thicker specimens (mainly in episcopic polarizing microscopy) and to use the universal stage.

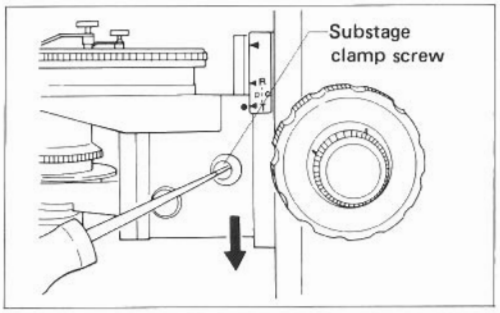


Fig. 27

13) Illumination system

- The optical system for illumination in the OPTIPHOT-POL microscope is constructed to fulfill the Koehler illumination requirements perfectly, and offers a bright, uniform field without any change-over manipulation.
- Halogen lamp 12V–50W (OSRAM 64610 or PHILIPS 7027) is used as a light source.

V. PHOTOMICROGRAPHY

Prepare the following equipments in addition to the OPTIPHOT-POL microscope main body.

★ Nikon Microflex
★ Trinocular eyepiece tube "TP"
★ CF PL Projection lens

1. CF PL Projection Lenses

The combined use of the CF P objectives and CF PL Projection lenses is essential.

For the same total magnification, select a combination of the highest possible objective power and lowest possible projection lens power to achieve the utmost image definition and contrast.

2. Illumination

1) Checking the illumination

Unevenness in the illumination will show up more conspicuously in photomicrography than in observation. Consequently, before taking a photograph, recheck the positioning and centering of the lamp and the correct adjustment of the condenser.

2) Selection of voltage and filter

The color temperature of the light source varies with the voltage being used. Therefore, in color photomicrography, the selection of voltage and filter is essential (for the result to be obtained).

Table 3. Standard Selection

Film		Voltage	Filter
Color film	Daylight type	9	NCB 10 is to be used
	Tungsten type	8	Remove NCB 10
Monochrome film		Over 6	Remove NCB 10 Contrast filter(green), etc. is usable

Table 3 shows the standard combination. Depending upon the make of the film, different color renditions may result. It is recommended that in addition to the NCB 10 filter a color compensation filter (CC filter), available from the film manufacturer, be used.

3. Shutter Speed

Desirable shutter speeds for least vibration **are 1/4 ~ 1/15 sec. Adjustment of the image brightness for color photomicrography should be made by means of the ND filters.**

4. Manipulation of Field and Aperture Diaphragm

In photomicrography, the adjustment of the field diaphragm is important for the purpose of limiting extraneous light which causes flare in the microscope image. **Stop down the diaphragm so as to get an illuminated area slightly larger than that of the picture field.** By adjusting the aperture diaphragm, a change of depth of focus, contrast and resolution of image is attainable. Select a size suited to the purpose. Generally speaking, the aperture diaphragm, is properly **stopped down to 70 ~ 80% of the aperture of the objective** being used.

5. Focusing

Focusing for photomicrography can be done with the observation tube of the trinocular eyepiece tube "TP" or by using the Microflex finder.

1) Adjust diopter

- **Using binocular of eyepiece tube:**

Use 4× or 10× objective.

Insert the mask eyepiece into either of right or left eyepiece sleeve that is accustomed to usual use. Adjust the diopter ring to bring the double cross line in the view field center into focus. (Fig. 28)

Then focus the specimen image also on the central area of the mask by means of the focus knob of the microscope.

The diopter of another eyepiece is to be adjusted by focusing specimen rotating the diopter ring without using the microscope focus knob.

Rotate the mask eyepiece so as the mask positions as shown in Fig. 32.

- **Using ocular finder:**
  Adjust the diopter ring so as the double cross line in the view field center can be seen clear and each line separated. (Fig. 29)

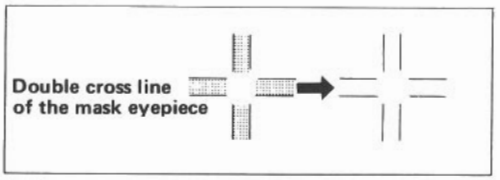


Fig. 28

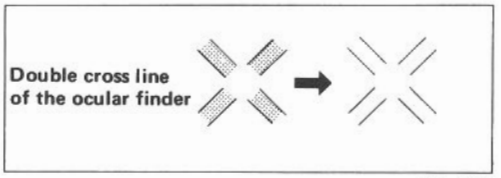


Fig. 29

2) Make focusing according to the magnification of objective to be used.

- **Using 40× or higher objective:**
  With diopter adjusted eyepiece make the specimen image sharp by rotating the microscope fine focus knob and make sure that both of the double cross line and the specimen image are seen crisply at the same time.
- **Using medium magnification objective 10×, 20×, etc.:**
  After focusing the same way as above, bring the specimen image to coincide with the double cross line so as their relative position is fixed and unchanged under observation by swinging your eye laterally. (Focusing by parallax method.)
- **Using 4× or lower objective:**
  Attach the focusing magnifier to the ocular finder. (Fig. 30)

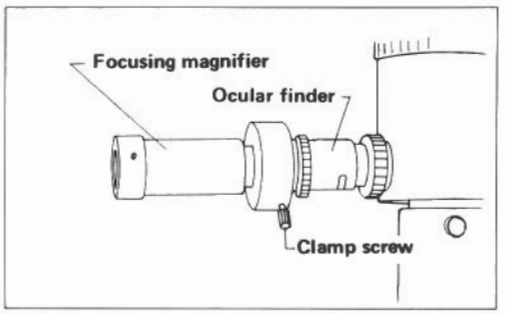


Fig. 30

The focusing magnifier is to be adjusted beforehand for viewing infinit distance (magnifier is set at the red line).
Viewing through the attached focusing magnifier, move it back and forth until the double cross line is seen clear. Then, focus the double cross line and the specimen image by rotating the fine focus knob as sharp as possible.

6. Picture composing

Compose the picture within the mask in the ocular finder corresponding to the film size in use by driving the microscope stage by lateral and longitudinal movement and rotation. (Fig. 31)

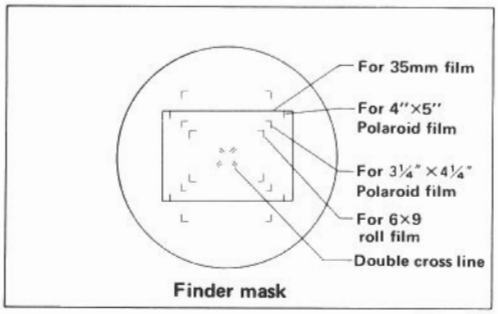


Fig. 31

When the mask eyepiece is used, select one out of masks in the view field suitable to the film size relative to CF PL Projection lens in use, in reference with Fig. 32 and Table 4.

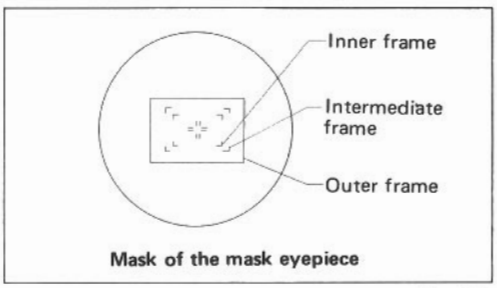


Fig. 32

Table 4

Mask	CF PL Projection lens	Film size			
		35 mm	6×9 cm	3¼"×4¼"	4"×5"
Inner frame	2 ×	×	—	—	—
	2.5 ×	—	—	—	—
	4 ×	—	—	◎	—
	5 ×	◎	—	—	△
Inter-mediate frame	2 ×	×	—	—	—
	2.5 ×	—	◎	△	—
	4 ×	◎	—	—	△
	5 ×	—	—	—	—
Outer frame	2 ×	×	—	◎	—
	2.5 ×	◎	—	—	◎
	4 ×	—	—	—	—
	5 ×	—	—	—	—

Note: Framing for picture composing will be more accurate by the ocular finder than the mask eyepiece.

7. Others

- As the intermediate tube "P" of OPTIPHOT-POL microscope builts in the depolarizer, it's not necessary to give care to the relation between the orientation of the polarizer, analyzer and the position of the Microflex.
- When using the 2× objective, it is recommended to remove the swing-out achromat condenser.
- For photomicrography, when focusing with the binocular observation tube, use the CF eyepiece, CF Photo eyepiece and CF Photo Mask eyepiece, with the magnification and other indications engraved in yellow, or in white with a white dot in addition.
- For the use of other photomicrographic attachments refer to the pertinent instruction manuals.

VI. ACCESSORIES

1. Sénarmont Compensator

To be inserted into the compensator slot of the intermediate tube "P" in place of the 1/4 λ & tint plate to measure the retardation with the accuracy of the λ unit. (Fig. 33)

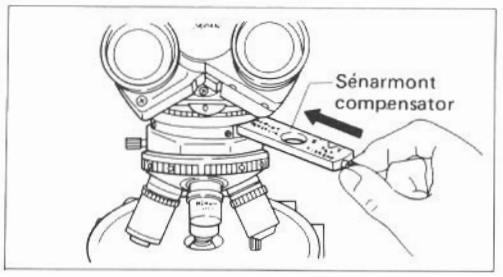


Fig. 33

1) Detecting of extinction position

Rotate the stage with the specimen under the crossed Nicols to find out the direction where the specimen part for measurement appears darkest.

2) Detecting of subtraction position

Rotate the stage 45° to bring it to the diagonal position from the extinction position and confirm that the interference color of the specimen part for measurement changes toward the lower order side by inserting the 1/4 λ & tint plate into the optical path. If the color changes toward higher order side, rotate the stage further by 90°.

3) Measurement

Inserting the filter GIF into the filter receptacle, replace the 1/4 λ & tint plate by the compensator.

Rotate the analyzer so as the specimen part for measurement becomes as dark as possible.

Let the angle of the above analyzer rotation be θ° then the retardation R (nm) will be obtained as follows:

$$R = \frac{\theta}{180}\lambda$$

where λ : wave length of the light used for the measurement

When the filter GIF is used: λ = 546nm

2. Quartz Wedge

The quartz wedge is used instead of the 1/4 λ & tint plate that is in the compensator slot of the intermediate tube "P". (Fig. 34)

With this wedge the retardation in the range of 1 λ ~ 6 λ can roughly be measured.

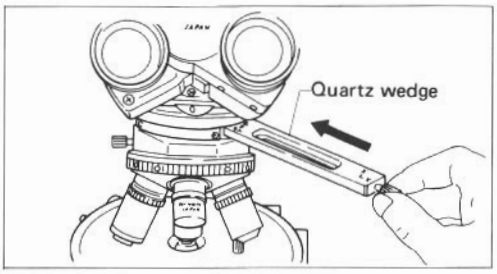


Fig. 34

1) Detecting of extinction position

Detect the position where the specimen part for measurement becomes darkest by rotating the stage under the crossed Nicols.

2) Detecting of subtraction position

Rotate the stage 45° to bring it to the diagonal position from the extinction position and confirm that the interference color of the specimen part for measurement changes toward the lower order side by inserting the quartz wedge into the optical path. If the color changes toward the higher order side, rotate the stage further by 90°.

3) Measurement

By sliding the quartz wedge along the slot, the interference color changes consequently.

The wedge sliding is to be stopped when the specimen part for measurement comes under the dark stripe, then compare the interference color of the view field beyond the specimen but under the same dark stripe with the Interference Color Chart to assume the amount of retardation.

If the view field is entirely filled with the specimen around the part to be measured, restrict the illumination of the view field except around the part for measurement by means of the field diaphragm, remove the specimen away the optical path and then compare the interference color with the chart.

3. Monocular Eyepiece Tube "AP"

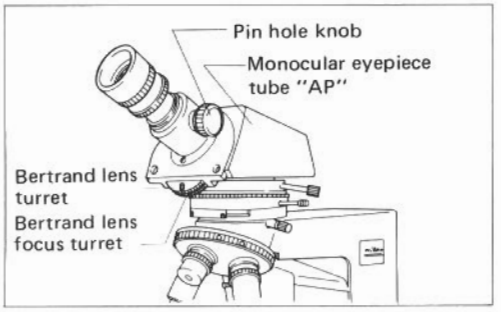


Fig. 35

1) Bertrand lens

The Bertrand lens is brought in and out of the optical path by turning the Bertrand lens turret.

The lens is in the optical path when the indication on the turret is B.

The Bertrand lens can be focused by turning the focus turret located under the Bertrand lens turret.

2) Pin hole knob

The pin hold can be put in or out of the optical path by operating the pin hole knob located right-hand side of the eyepiece sleeve.

By means of the pin hole, the conoscopic observation of the specimen area within 10$\mu m\phi$ (when a 100× objective is used) is possible.

4. Universal epi-illuminator

Used for episcopic polarizing microscopy, mounted between the X-POL stand and the intermediate tube "P".

1) Nomenclature

- Referring to Fig. 36, assemble in the order given.

① Remove the eyepiece tube and the intermediate tube "P" from the X-POL stand.

② Mount the universal epi-illuminator on the microscope arm, positioning the illuminator nearly parallel to the arm. Clamp the screw.

③ After releasing sufficiently the clamp screw on the lamp housing, to which the lamp bulb (12V–50W Halogen lamp) and socket is attached, insert the lamp housing into the universal epi-illuminator and clamp the screw.

④ Connect the lamp cord to the transformer.

⑤ Remove the accessory ND32 filter slider from the illuminator. Push in the polarizer slider until it clicks twice.

⑥ Place the filters.

⑦ Mount the intermediate tube "P" on the illuminator, fitting the notch of the circular dovetail on the end of the clamp screw. Fasten the clamp screw.

⑧ Referring to p.7, mount the eyepiece tube on the intermediate tube "P".

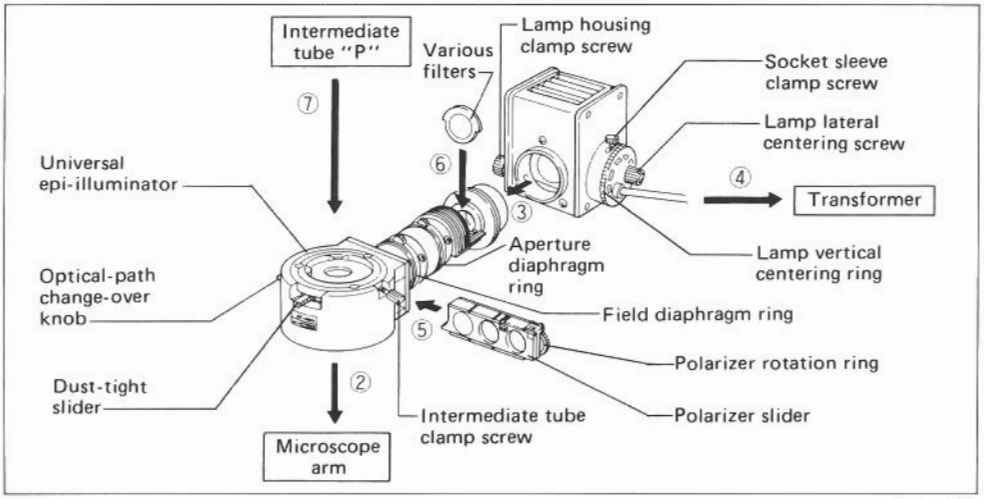


Fig. 36

2) Preparation

(1) Centering the lamp

① Make certain that the optical-path change-over knob is pushed to the limit.

② Turn ON the power switch on the transformer, set the voltage to 6V.

③ If the L900C filter is in the optical-path, remove this.

④ Fully open the aperture diaphragm.

⑤ Place the ND filter on the stage and focus on it using objective 10×.

⑥ Remove the eyepiece from the sleeve, looking into the exit pupil of objective, move the lamp housing back and forth to form a sharp image of the lamp filament on the diffuser of exit pupil.

⑦ Manipulate the lamp centering screws to center the filament image on the exit pupil.

⑧ Place the L900C filter.
If the image is found too dark with an objective of 40× or higher, remove the L900C filter.

(2) Orientation of polarizer (intermediate tube "P")

① Nearly focus on the ND filter on the stage using objective 40×.

② Set the polarizer graduation to "0".

③ Remove one eyepiece from the observation tubes.
Looking into the exit pupil of the objective, rotate the polarizer rotation ring to form the dark cross image on the exit pupil.
(Refer to Fig. 37)

Note : Take care not to touch the polarizer rotation ring while observing the specimen, or the orientation of the polarizer will get out of order.
If it is touched by mistake, readjust the orientation.

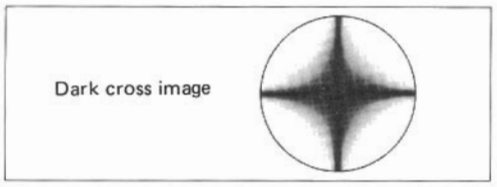


Fig. 37

3) Objectives

Use the objectives CF M Plan Achromat P series (Strain-free, 210/45).

4) For manipulation and microscopy, refer to diascopic polarizing microscopy.

5. Attachable Mechanical Stage Type "E"

To attach the attachable stage on the graduated stage, fit the two positioning pins on the rear side of the attachable stage into the two pin holes on the graduated stage surface, and clamp the screw using a driver or a coin.

Attachable mechanical stage is equipped with point counters, whose pitch is 0.2mm or 0.3mm. The counter can be replaced by releasing the head of the point counter by means of a coin and removing the milled part of the counter.

To release the click-stop of the point counter, release the click spring nut. (Fig.38)

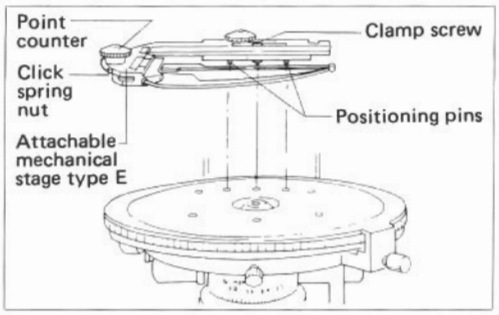


Fig. 38

6. Universal Stage

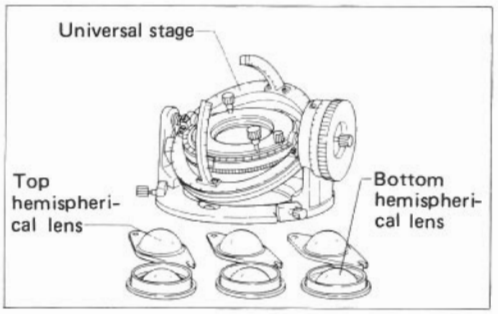


Fig. 39

When using the universal stage, lower the substage beforehand to face the white dot ● with the mark ◄ T on the microscope stand, referring to P. 15 12).

For using the universal stage, refer to the separate instructions on "Universal Stage".

VII. TROUBLE SHOOTING TABLE

Although nowhere you can find any disorder or derangement in the instrument, if you encounter some difficulty or dissatisfaction, recheck the use, referring to the table below:

1. Optical

Failures	Causes → Actions
Darkness at the periphery or uneven brightness of viewfield (No appearance of viewfiedl)	• Optical path in trinocular tube not fully changed-over → Changing-over to the limit (Refer to P. 9) • Centering nosepiece not in click-stop position (Objective not centered in optical path) → Revolve it to click-stop position • Lamp bulb not centered → Centering (Refer to P. 8) • Condenser not centered → Centering by using field diaphragm (Refer to P. 10) • Field diaphragm too much closed → Open it properly • Dirt or dust on the lens (Condenser, objective, eyepiece, slide) → Cleaning • Improper use of condenser → Correct use (Refer to P. 11) • Diffuser not set in or incorrectly positioned → Correct positioning (Refer to P. 8) • Revolving nosepiece not correctly attached → Correct attaching (Refer to P. 6) • Bertrand lens in the optical path → Flip out (Refer to P. 13 & 19) • Pin hole in the optical path (in monocular eyepiece tube "AP") → Swing out (Refer to P. 19) • Top lens of condenser incorrectly positioned → Swing in to the limit • 1/4 λ & tint plate, compensator or quartz wedge incorrectly positioned → Correct setting
Dirt or dust in the viewfield	• Dirt or dust on the lens (Condenser, objective, eyepiece, field lens) → Cleaning • Dirt or dust on the slide → Cleaning • Too low position of condenser → Correct positioning (Refer to P. 10)
No good image obtained (low resolution or contrast)	• No coverglass attached to slide or NCG objective used with coverglass → Correct use (Refer to P. 13) • Too thick or thin coverglass → Use specified thickness (0.17mm) coverglass (Refer to P. 13) • Immersion oil soils the top of dry system objective (especially 40×) → Cleaning • Dirt or dust on the lens (condenser, objective, eyepiece, slide) → Cleaning • No immersion oil used on immersion system objective → Use immersion oil (Refer to P. 13) • Air bubbles in immersion oil → Remove bubbles • Not specified immersion oil used → Use Nikon immersion oil

Failures	Causes →	Actions
	• Incorrect illumination →	Correct the illumination (Refer to P. 8)
	• Dirt or dust on the entrance lens →	Cleaning
Image quality deteriorated	• Condenser aperture too much closed →	Open properly (Refer to P. 12)
	• Too low position of condenser →	Bring it up to coincidence with field diaphragm image (Refer to P. 10)
	• Diffuser not inserted →	Insert it in correct position (Refer to P. 8)
Oneside dimness of image	• Centering nosepiece not in click-stop position →	Revolve it to click-stop position
	• Centering nosepiece not correctly attached. →	Insert it to the limit and clamp it firmly
	• Centering nosepiece not clamped →	Clamp tightly
Image moves while being focused	• Specimen rises from stage surface →	Place it stable
	• Centering nosepiece not in click-stop position →	Revolve it to click-stop position
	• Centering nosepiece not clamped →	Clamp tightly
	• Condenser not correctly centered →	Correct centering (Refer to P. 10)
	• Lamp bulb not correctly centered →	Correct centering (Refer to P. 8)
	• Optical path in trinocular tube not fully changed-over →	Changing-over to the limit (Refer to P. 9)
Image tinged yellow	• NCB 10 filter not used →	Use NCB 10 filter
	• Too low power source voltage →	Raise the voltage over 6 on the indicator
Too bright image	• ND filter not used →	Use ND filter

2. Manipulation

Failures	Causes →	Actions
No focused image obtained with high power objectives	• Upside down of slide →	Turn over the slide
	• Too thick coverglass →	Use specified thickness (0.17mm) coverglass (Refer to P. 13)
High power objective touches the slide, when changed-over from low power	• Upside down of slide →	Turn over the slide
	• Too thick coverglass →	Use specified thickness (0.17mm) coverglass (Refer to P. 13)
	• Eyepiece diopter not adjusted (Especially when changing-over low power objective 2×) →	Diopter adjustment (Refer to P. 9)

Failures	Causes →	Actions
Insufficient parfocality of objective(when changed-over)	• Eyepiece diopter not adjusted →	Diopter adjustment (Refer to P. 9)
Movement of image not smooth by moving the slide	• Attachable mechanical stage not tightly fixed →	Fix it tightly
No fusion of binocular images	• Interpupillary distance not adjusted →	Adjustment (Refer to P. 9)
Fatigue of observing eyes	• Incorrect diopter adjustment →	Correct adjustment (Refer to P. 9)
	• Inadequate brightness of illumination →	Use ND filter or change power voltage

3. Electrical

Failures	Causes →	Actions
Lamp does not light even though switched ON	• No electricity obtained →	Connect the cord to socket
	• No lamp bulb attached →	Attaching
	• Lamp bulb blown →	Replacement
	• Fuse blown →	Replacement
Unstable brightness of illumination	• Input voltage not adjusted to house current voltage →	Turn the change-over switch on the microscope bottom
	• House current voltage fluctuates too much →	Use transformer or the like (for adequate voltage)
	• Lowest voltage adjustment not made →	Make adjustment (Refer to P. 7)
Strong glare even at lowest voltage, when using low power objective	• Lowest voltage adjustment not made →	Make adjustment (Refer to P. 7)
Lamp bulb promptly blown	• Not specified lamp bulb used →	Use 12V–50W specified lamp bulb: (Halogen bulb: OSRAM 64610 or PHILIPS 7027)
	• Too high voltage of house current →	Use transformer for adjustment

Failures	Causes → Actions
Insufficient brightness of illumination	• Lamp bulb not centered → Centering (Refer to P. 8) • Condenser not centered → Centering (Refer to P. 10) • Condenser aperture too much closed → Open it properly (Refer to P. 12) • Too low position of condenser → Correct positioning (Refer to P. 10) • Not specified lamp bulb used → Use 12V-50W specified Halogen bulb • Dirt on lens (condenser, objective, eyepiece, field lens, filter) → Cleaning • Too low voltage → Raise the voltage
Fuse blown	• Not specified fuse used → Use 1A/250V or 0.75A/250V
Flickering or unstable brightness of lamp bulb	• Lamp bulb going to be blown → Replacement • Connector not connected securely → Secure connection • Fuse holder not firmly fastened → Firm fastening • Irregular change of house current voltage → Use stabilizer • Lamp bulb insufficiently inserted into the socket → Positive connection

REFERENCE

This manual instructs only how to manipulate the OPTIPHOT-POL microscope.

For the practical explanation on polarizing microscopy, refer to the following special works:

- **"AN INTRODUCTION TO THE METHODS OF OPTICAL CRYSTALLOGRAPHY"**

  — F. Donald Bloss —
  Holt, Rinehart and Winston

- **"ORE MICROSCOPY"**

  — Eugene N. Cameron —
  John Wiley & Sons. Inc.

- **"THE POLARIZING MICROSCOPE"**

  — F.A. Hallimond —
  Vickers Instruments

ELECTRIC SPECIFICATIONS

Power source	100/120V 220/240V 50/60Hz
Halogen lamp	12V–50W (OSRAM 64610 or PHILIPS 7027)
Fuse	100/120V 1A/250V 220/240V 0.75A/250V

We reserve the right to make such alterations in design as we may consider necessary in the light of experience. For this reason, particulars and illustrations in this handbook may not conform in every detail to models in current production.

Nikon

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