LAXCO

LMI-3000
Inverted Microscope

Version 4.0

User Manual

CONTENTS

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1. Operation Notice

1. The microscope is a precision instrument, please operate carefully: avoid vibrating or jolting the microscope during operation.

2. Do not operate the microscope under conditions of direct sunlight, high temperature, high humidity, dust, or close to sources of vibration. Ensure the work surface is flat.

3. When lifting or carrying the microscope, use one hand to hold the arm of the microscope (1) and another hand to carry the front base (2) (see Fig. 1).

   *The microscope will be damaged if the stage, focus knobs, or head while moving.

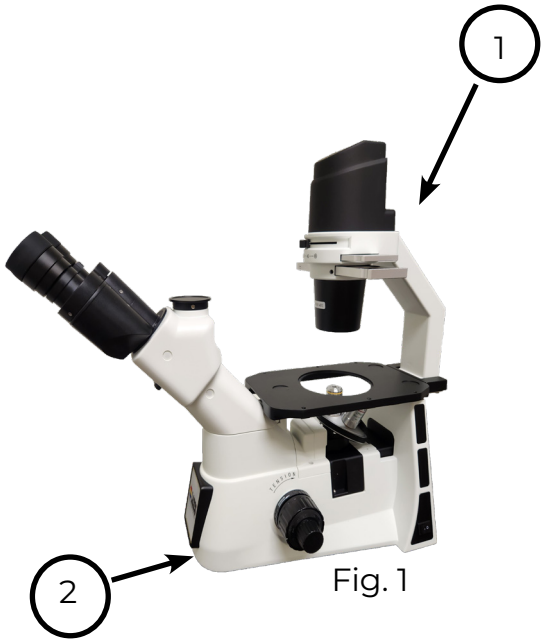


Fig. 1

4. The lamp may be hot when the microscope is on. Ensure there is enough space around the lamp housing for heat dissipation.

5. Ensure the microscope is properly grounded to avoid electric shock.

6. Ensure the power switch is in the “O” (off) position and wait until the lamp cools completely before replacing the bulb or fuse.

7. The input voltage is clearly marked on the back of the microscope. Ensure the power supply

Maintenance

1. Wipe the lens gently with a lens cloth. Carefully wipe off oil and fingerprints on the objective surfaces with a lens cloth moistened with a small amount of lens cleaning solution.

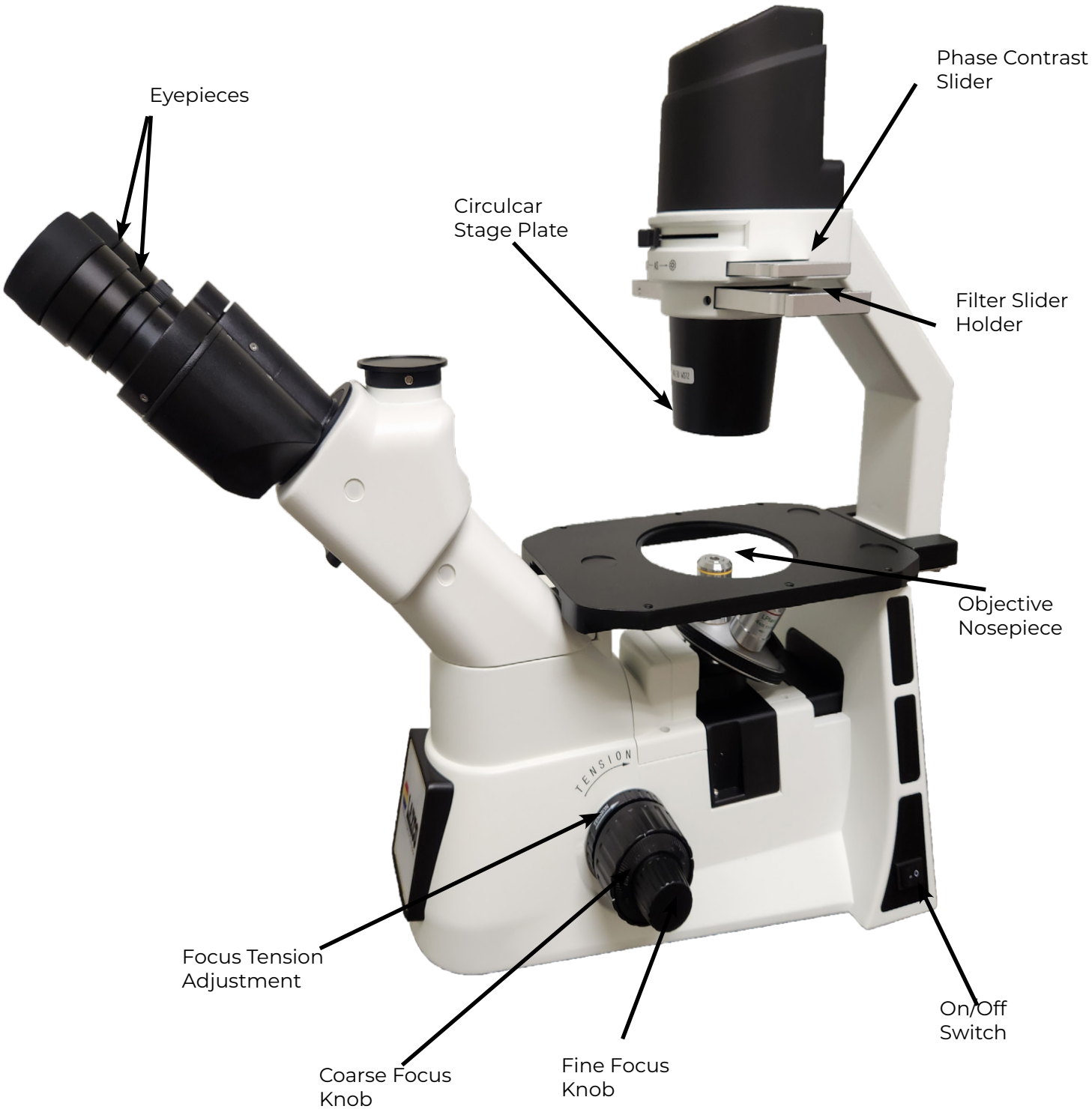
2. Lens cleaning solution is flammable. Turning on or off electronic devices (including the microscope) may produce a spark which could ignite the lens cleaning solution. Use these chemicals in a well-ventilated area.

3. Don’t use organic solutions to wipe the surfaces of the other components. Please use a neutral detergent if necessary.

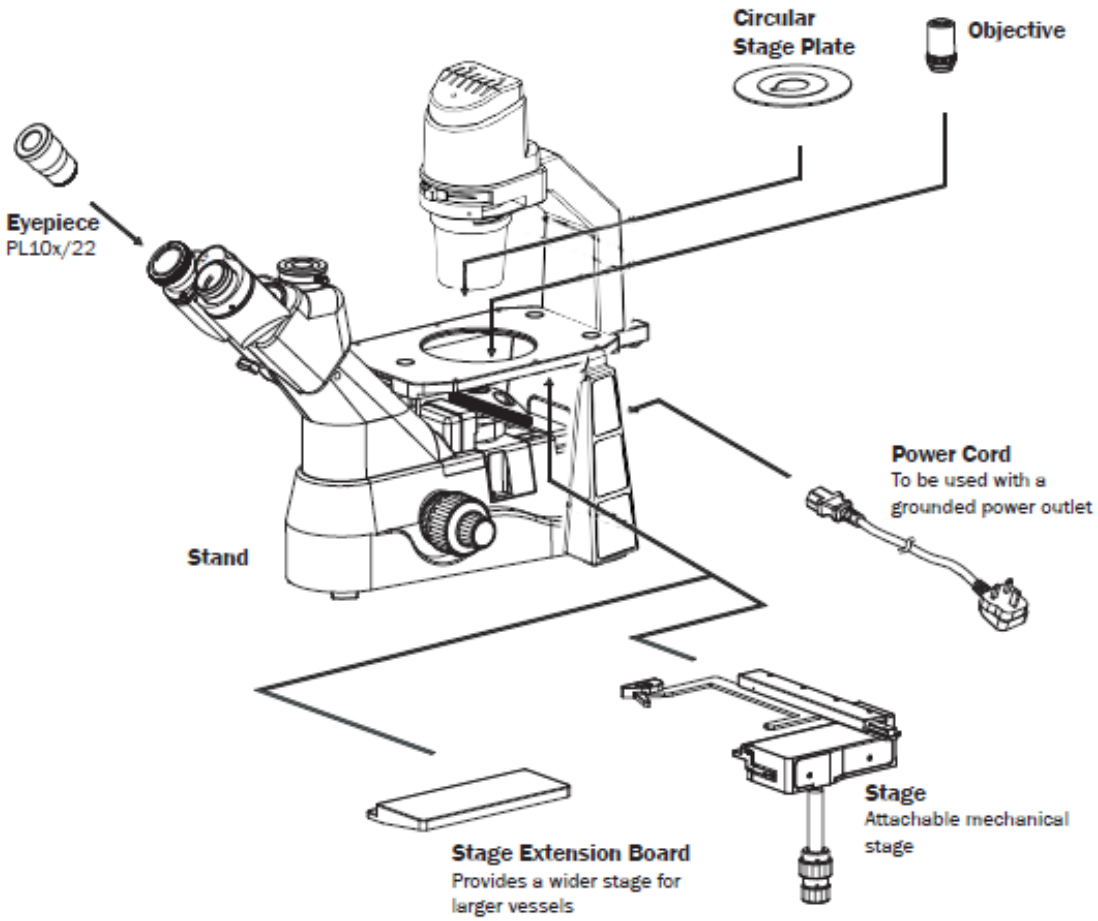
4. If the microscope is exposed to liquid during operation, power it off immediately and wipe it dry.

5. Never disassemble the microscope, the performance will be affected or the instrument will be damaged.

2. Instrument Components



3. Assembly


Circular
Stage Plate
Objective
Eyepiece
PL10x/22
Power Cord
To be used with a
grounded power outlet
Stand
Stage
Attachable mechanical
stage
Stage Extension Board
Provides a wider stage for
larger vessels

3. Assembly

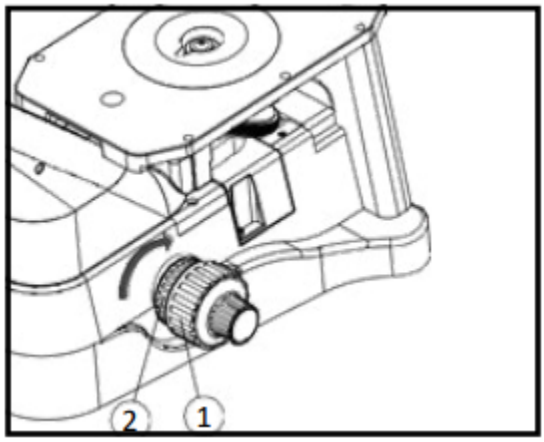


Fig. 6

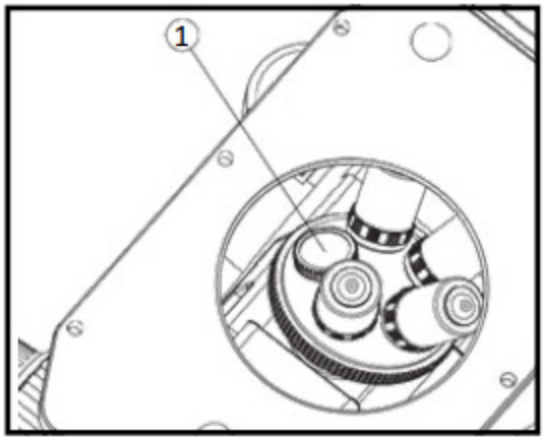


Fig. 7

Objective Assembly (Fig 6,7)

1. Rotate the coarse focus knob (1), until the objective nosepiece is at the lowest position. (Fig 6)

2. Install the objectives into the microscope nosepiece from the lowest magnification to the highest in a clockwise direction from the back of the microscope. Objectives can also be assembled by removing the metal/glass plate on the stage.

3. Cover any unused positions on the nosepiece with a dust cap (Fig 7) (1) to prevent contamination by dust and dirt.

4. Search and focus the sample with a low magnification objective (4x or 10x), then change to the higher magnification objective if required.

5. Turn the nosepiece to switch between objectives. The objective is in position when you hear a “click.”

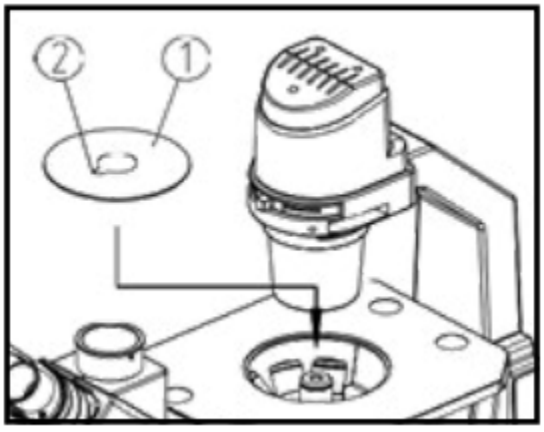


Fig. 8

Stage Plate Assembly (Fig 8)

1. Place the metal stage plate (1) into the opening in the stage with the “V” (2) facing the user. The glass stage plate allows the user to view which objective is being used.

2. Ensure that the stage plate is flush with the stage.

3. Assembly

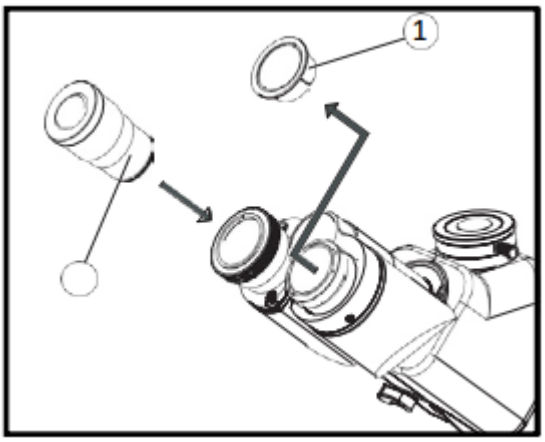


Fig. 9

Eyepiece Assembly (Fig 9)

1. Remove the eyetube cover (1).

2. Insert the eyepiece (2) into the eyetube.

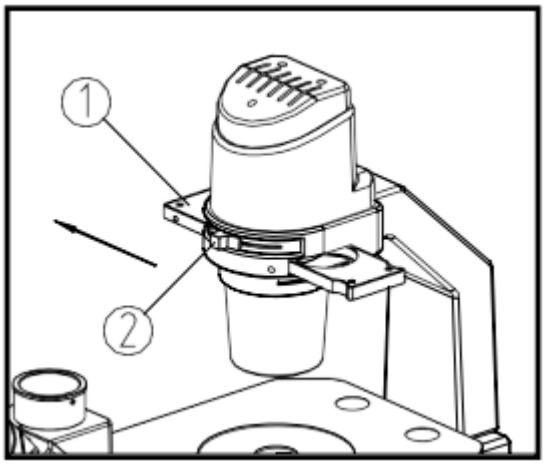


Fig. 10

Phase-contrast Slider Assembly (Fig 10)

1. Place phase-contrast slider (1) letter side up, into the holder from the right to the left.

2. To change setting, slide the correct phase ring into place.

   The phase ring is fully in position when you hear a “click”.

3. Keep the aperture adjustment lever (2) in the position during phase-contrast observation.

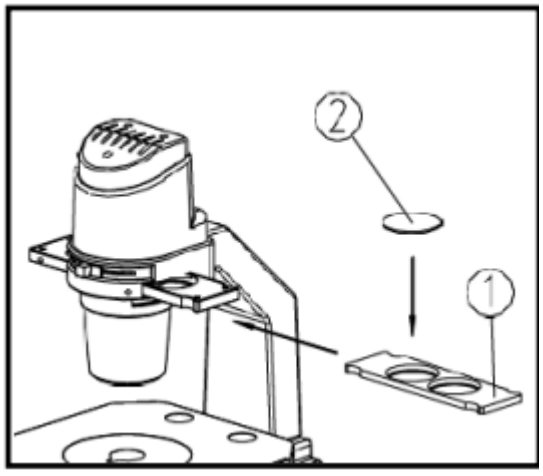


Fig. 11

Color Filter Assembly (For Transmitted Illumination) (Fig 11)

1. Turn the microscope off and allow the filter to cool before changing.

2. Slide out the filter holder (1), and place the color filter (2) in to the filter holder.

3. Ensure that the filter is flat and firmly pressed into the bottom of the filter holder. *Filters can be stacked if needed, but the thickness must not exceed 11mm.

3. Assembly

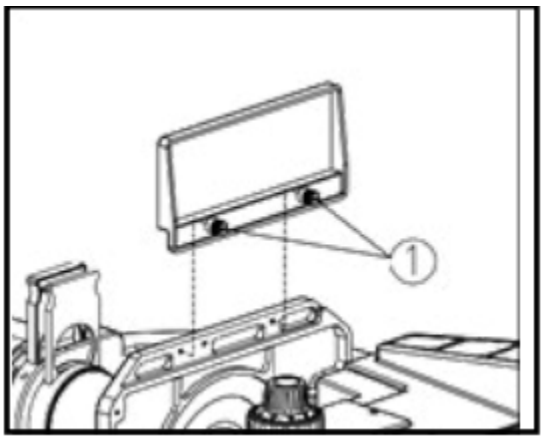


Fig. 12

Stage Extension and Mechanical Stage Assembly Optional (Fig 12)

The stage extension can be attached on both the left and right side of the stage to increase the stage size. The stage extension and the attachable mechanical stage both cannot be attached on the same side of the stage. For ease of use, it is recommended that the mechanical stage be attached to the right side of the stage and the stage extension be attached to the left side.

Attach the stage extension or mechanical stage as follows:

1. Screw the lock-screws (1) into the bottom of the stage extension.

2. Screw it into the bottom of the stage.

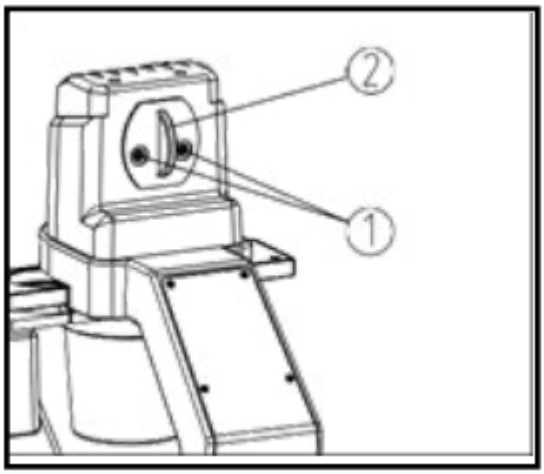


Fig. 13

Replacing the LED (Fig 13)

1. Remove the screws with allen wrench.

2. Remove the LED module (2).

3. Gently insert new LED module to avoid damage.

4. Replace screws (2).

5. Connect the power cored, and turn the On/Off switch to the “on” position.

* Before attempting to replace or remove the LED, unplug the microscope from all power sources, turn the power switch to the “off” position and allow the LED to cool completely.

4. Operation

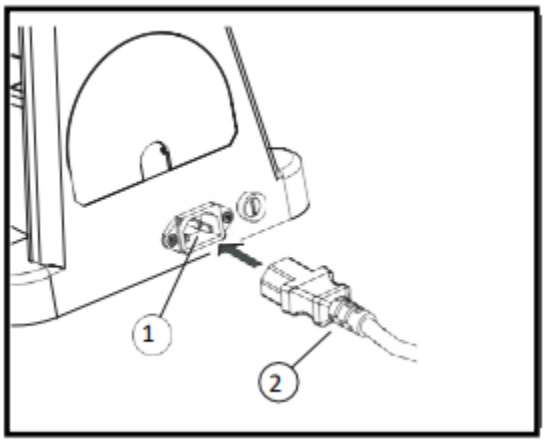


Fig. 14

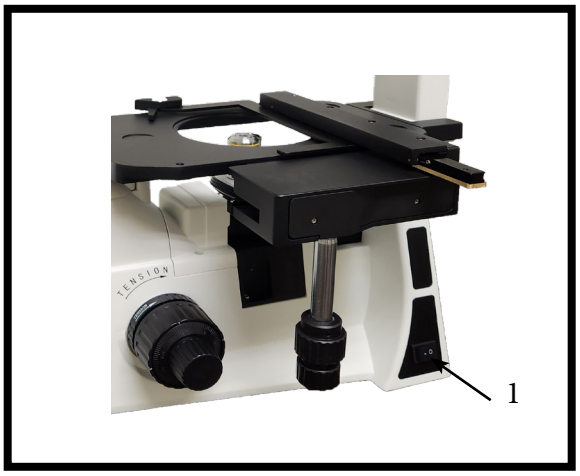


Fig. 15

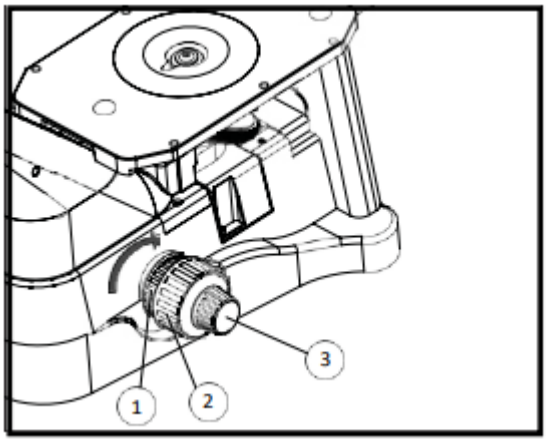


Fig. 16

Power Cord (Fig 14)

1. Turn the power switch to the “O” OFF position before connecting the power cord.

2. Insert the plug into the outlet on the back of the microscope.

3. Insert the 3-prong plug into a grounded outlet.

Set Illumination (Fig 15)

1. Plug the microscope into a power outlet and turn the power switch (1) to the “I” ON position.

2. Use the illumination dimmer control (2) to adjust brightness.

3. Turn the dimmer clockwise to brighten the light, and counter-clockwise to darken it.

Focus Adjustment (Fig 16)

1. Put a specimen on the circular central stage, and then move the lowest mag. objective (4X or 10X) into the light path.

2. View the specimen through the eyepieces and rotate the coarse focusing knob until the image is in focus.

3. Rotate the fine focusing knob to bring the specimen into clear focus.

Focus Tension Adjustment

If the coarse focus knob is difficult to rotate or the objective nosepiece “drifts” or loses focus this can typically be corrected by adjusting the focus tension.

1. Rotate the tension adjustment ring (1) according to the arrow direction in figure 16 to tighten the focus tension; rotate the tension adjustment ring in the opposite direction to loosen the tension.

4. Operation

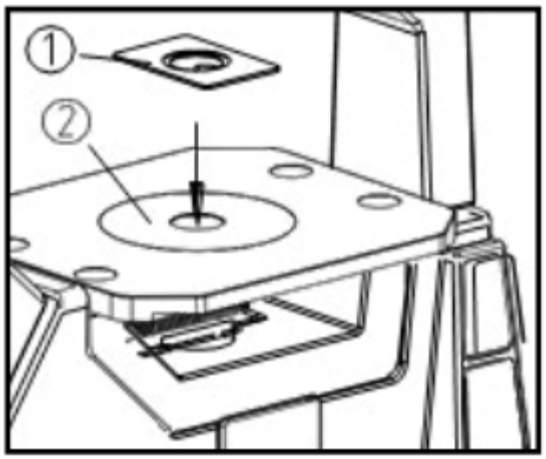


Fig. 17

Specimen Placement (Fig 17)

Several vessel holders are available for use with or without the mechanical stage. Refer to the Parts and Accessories section of this guide, for ordering information.

1. Place vessel holder on stage (2) or in mechanical stage clip.

2. Place vessel into holder.

3. Move the vessel holder manually or use the coaxial adjustment knobs on the mechanical stage to move the vessel.

*** Please select vessel with a thickness of 1.2mm, Petri dish, culture flask etc., for best observation.**

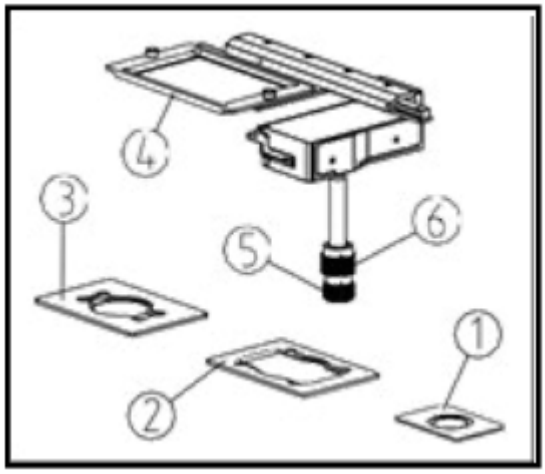


Fig. 18

Mechanical Stage (Optional) (Fig 18)

1. Place the multi-well plate on the mechanical stage age holder (4) when using 96 or 24 well plate.

2. Vessel Holders:

   - Yerasaki holder (2) for Terasaki board.
   - 35mm petri dish holder (1) for φ35mm petri dish.
   - Specimen slide holder (3) to for a φ54 petri dish and specimen slide.
   - Rotate the x/y stage adjustment knobs (5) (6) to move the specimen.

*** Carefully change the objective. The objective may collide with the circular central stage or the Petri dish holder when it is changed after observing with shorter working distance objective.**

***Make sure to take off the circular stage plate of the stage when use the mechanical moving stage.**

4. Operation

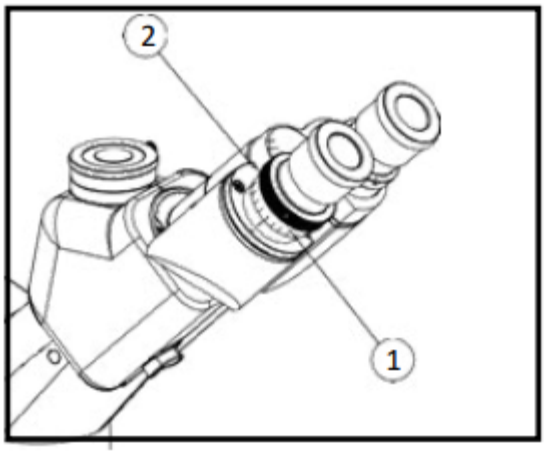


Fig. 19

Diopter Adjustment (Fig 19)

1. Look through the right eyepiece with your right eye and focus on a specimen using the coarse and fine focus adjustment knobs.

2. Once the image is clear in the right eyepiece, look through the left eyepiece with your left eye, turn the diopter adjustment ring (1) until the image is clear.

3. There is + or - 5 diopter on the diopter adjustment ring. The number on the scale that lines up with the "•" on the base (2) is your eye's diopter. Keep this index for future reference

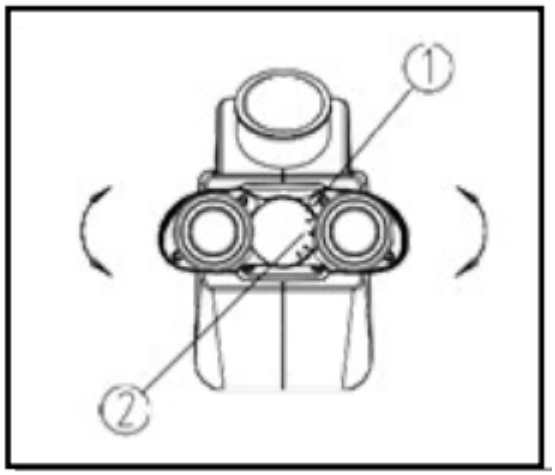


Fig. 20

Interpupillary Distance Adjustment (Fig 20)

1. While looking through both eyepieces, move the eyepieces together or apart until the field appears as one circle and viewing is comfortable

2. The number on the index (2) that lines up with the "." On the side (1) is the interpupillary distance of your eyes. Keep this index for future use.

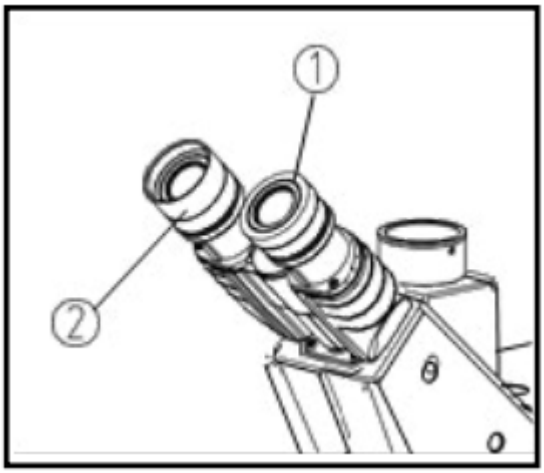


Fig. 21

Adjustment (Fig 21)

1. If the user wears glasses, turn the eyecup inward (1) to prevent glasses from touching the eyepiece and avoiding damage to the glasses and the eyepiece.

2. Open the eyecup (2) for users without glasses. In this mode, the eyecup can prevent unwanted outside light.

4. Operation

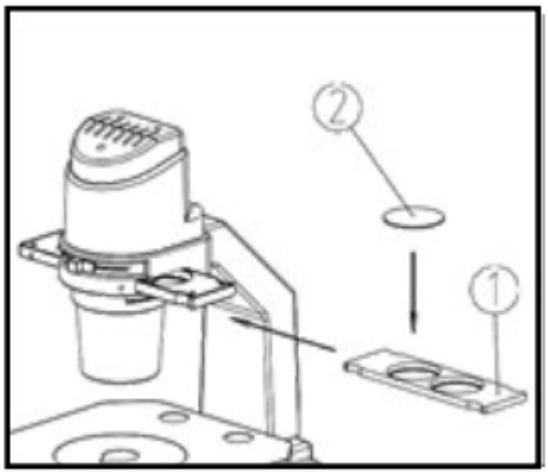


Fig. 22

Color Filters (Fig 22)

Color filters are used to enhance the viewing of a specimen and in photomicrography. Color filters (2) can overlay in the filter holder (1); ensure that they lay flat in the filter holder and the thickness doesn't exceed 11mm. Refer to Fig 23, for filter application.

COLOR FILTER	PURPOSE
IF550	Monochromatic contrast color filter (green) Used in phase-contrast observation
LBD	Color temperature transition color filter. Used in brightfield observation

Fig. 23

4. Operation

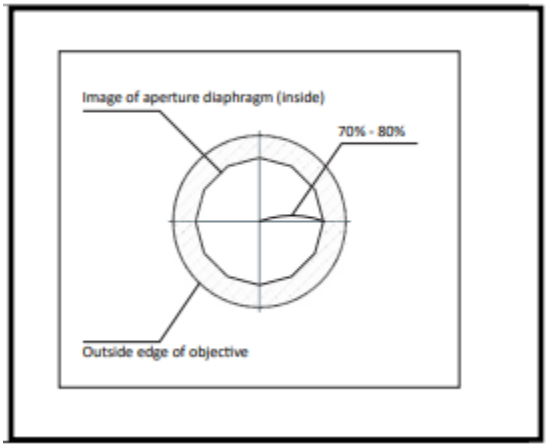


Fig. 24

Aperture Diaphragm Adjustment (Fig 24)

1. The aperture diaphragm determines the numerical aperture of the illumination in brightfield observation. If the N.A. of illumination matches the N.A. of the objective, you can obtain better resolution and contrast, and increase the depth of field.

2. Usually, adjust the N.A. to its 70%~80% when observing the specimen. Adjust the aperture diaphragm to " " when observing the bacteria specimen.

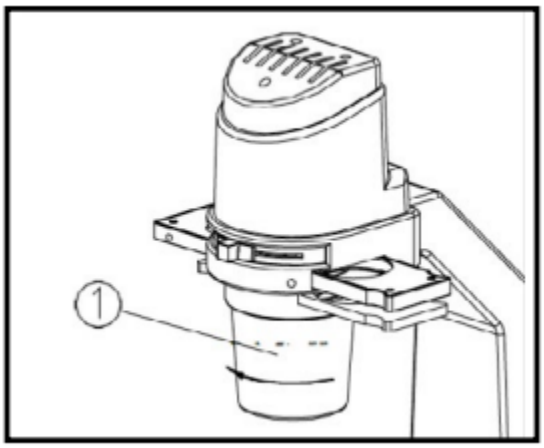


Fig. 25

Condenser Lens Removal (Fig 25)

1. The condenser lens can be removed to view specimens in large vessels. Unscrew the condenser lens (1) to increase the working distance

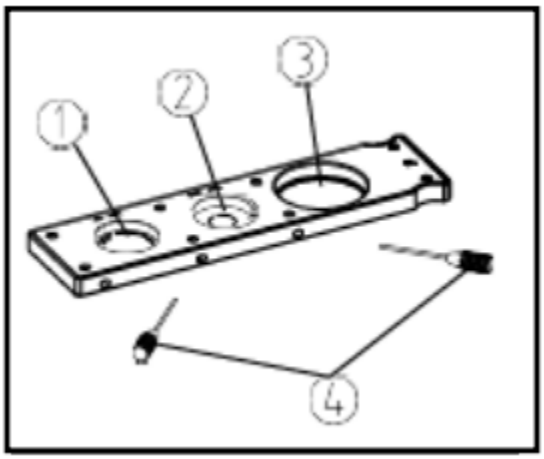


Fig. 26

Phase Contrast Slider (Fig 26)

Phase center adjustable slider

1. Phase ring for use with 4x and 10x phase contrast objectives. (1)

2. Phase ring for 20x and 40x phase contrast objectives (2).

3. Open position for brightfield observation (3).

4. Phase ring alignment tools (4).

4. Operation

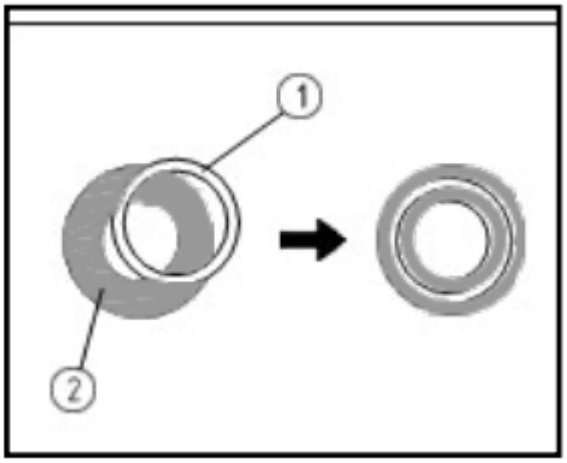


Fig. 27

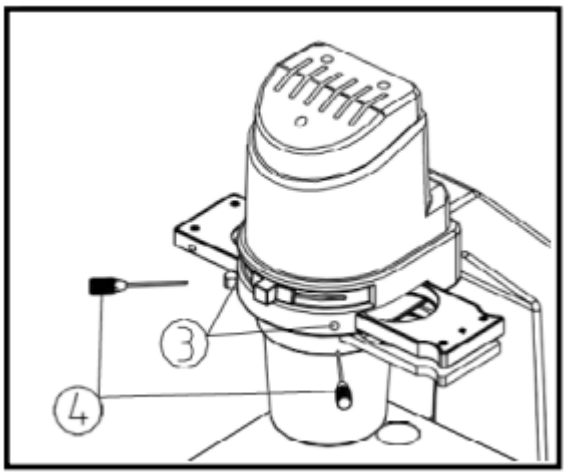


Fig. 28

Centering the Phase Contrast Annuli (Fig 27 & 28)

1. Place specimen on the stage and focus it.

2. Make sure the matched phase ring (in the phase-contrast objective) and the light ring (in the phase-contrast slider) are in the light path.

3. Loosen the lock screw of the centering telescope and observe the centering telescope (1) when pulling the upper part of it focus with the phase ring (2) of the focusing objective. Screw down the lock screw when it is in clear focus.

4. Insert the alignment tools (4) into two holes (3) in the phase-contrast slider, and then adjust them until the phase rings are aligned over each other.

5. Repeat steps for all phase ring/objective combinations.

- **If the phase rings are not centered, the user will not achieve optimal phase-contrast observation.**

4. Operation

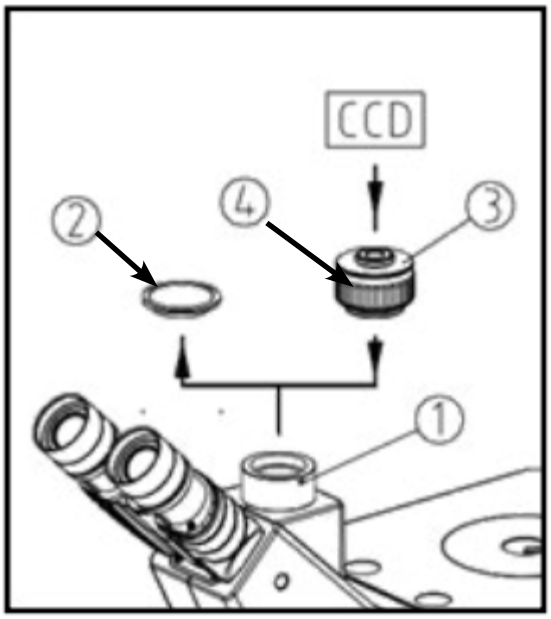


Fig. 29

C-mount Assembly (Fig 29)

1. Loosen the lock-screw (1) on the trinocular head and remove the dust-cover (2).

2. Remove the dust-cover caps of the c-mount adapter (3) and the camera. Insert the screw thread end of c-mount adapter onto the camera, and then install the c-mount into the camera port.

3. Tighten down the lock-screw.

4. During observation if the image displayed by the camera is not in parfocal with the eyepieces, adjust the focus ring (4) on the camera adapter until the image is in focus.

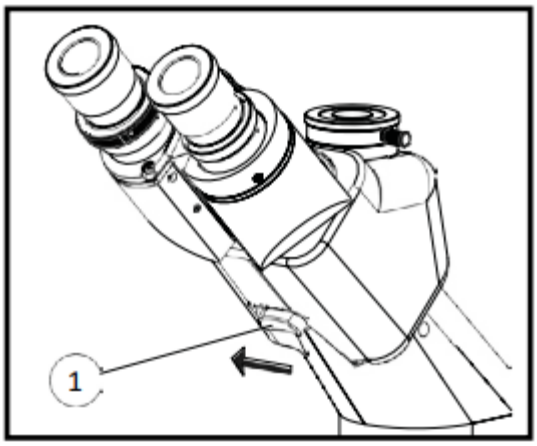


Fig. 30

Light Path Selection (Fig 30)

The light path selection lever (1) diverts the light from the eyepieces to the trinocular tube. When the lever is pushed to the right the specimen can be viewed through the binocular eyepieces. When the lever is pushed to the left the specimen can be viewed through the trinocular tube, typically used for attaching a camera. When the lever is pushed to the left, 80% of the light is directed to the trinocular tube and 20% is directed to the eyepieces so the specimen can be viewed through both the trinocular tube and the eyepieces.

5. Accessories

EYEPIECES	
PART #	DESCRIPTION
LMCP-PLN10X22	WF HP PL 10X Eyepiece, 22mm FOV
LMCP-PLN10X22TR	WF HP PL 10X Eyepiece w/Diopter Adjustment, 22mm FOV & Reticle
LMCP-PL14X16	WF HP PL 15X Eyepiece, 16mm FOV

FILTERS	
PART #	DESCRIPTION
LMCP-LBD	Φ45 Color Temperature Shift Filter
LMCP-XY-FCF	Φ45 Yellow Contrast Filter
LMCP-IF550	Φ45 Green Contrast Filter
LMCP-XY-FCF	Φ45 Neutral Color Temperature Filter

STAGE MICROMETERS	
PART #	DESCRIPTION
MP-SM100	1mm ruled with 0.01mm div
MP-SM100-C	1mm ruled with 0.01mm div, NIST Cert
MP-SM101	0.04" ruled with 0.001" div
MP-SM101-C	0.04' ruled with 0.001" div, NIST Cert

STAGE ACCESSORIES	
PART #	DESCRIPTION
LMCP-XDCPG	Glass stage plate
LMCP-XDCPM	Metal stage plate (Φ25 center hole)
LMCP-XDCPM2	Metal stage plate (Φ12 center hole)
LMCP-XDCPM3	Metal stage plate (crescent shaped hole)
LMCP-XDSGM	Mechanical Stage, Travel 120mm X 80mm
LMCP-XDSGEX	Stage Extension Plate
LMCP-XDSGHJ01	Φ35 Petri dish holder
LMCP-XDSGHJ02	Slides holder
LMCP-XDSGHJ03	Terasaki holder

C-MOUNT ADAPTERS	
PART #	DESCRIPTION
LMCP-CX50MCTV0.35	0.35X C-Mount Adapter, Focusable
LMCP-CX-50OCTV0.5	0.5X C-Mount Adapter, Focusable
LMCP-CX-50CV06.5	0.65X C-Mount Adapter, Focusable
LMCP-CX50CTV1	1X C-Mount Adapter, Focusable

CAMERA	
PART #	DESCRIPTION
SeBaCam5C	5MP Digital Color Camera, CMOS,w/SeBaView Imaging Sorftware
SeBaCam10C	10MP Digital Color Camera, CMOS, w/SeBaView Imaging Software
SeBaCam 1.7C	14MP Digital Color Camera, CMOS, w/SeBaView Imaging Software
SeBaCamCool1.4C SeBaCamCool1.4M	1.4MP Digital Camera, CCD, W/SeBaView Imaging Software. Available in Color and Monochrome

OBJECTIVES	
PART #	DESCRIPTION
LMCP-OLIP4	LWD Infinity Plan Achromatic Objective 4x/0.1 N.A. WD=22mm
LMCP-OLIP10	LWD Infinity Plan Achromatic Objective 10x/0.25 N.A. WD=7.94mm
LMCP-OLIP20	LWD Infinity Plan Achromatic Objective 40X/0.40 N.A. WD=7.66mm
LMCP-OLIP40	LWD Infinity Plan Achromatic Phase Contrast Objective 40x/0.60 N.Z. WD=3.71mm
LMCP-OLIP60	LWD Infinity Plan Achromatic Objective 60x/0.70 N.A. WD=2.50mm
LMCP-OLIPP2N4A	LWD Infinity Plan Achromatic Phase Contrast Objective 4x/0.13 N.A. WD = 10.4 mm
LMCP-OLIPP2N10	LWD Infinity Plan Achromatic Phase Contrast Objective 10x/0.25 N.A. WD = 7.3 mm
LMCP-OLIPP2N20	LWD Infinity Plan Achromatic Phase Contrast Objective 20x/0.40 N.A. WD = 6.8 mm
LMCP-OLIPP2N40A	LWD Infinity Plan Achromatic Phase Contrast Objective 40x/0.65 N.A. WD = 3.05 mm
LMCP-OLIPF4	LWD infinity Plan Fluorite Objective 4X/0.13 WD = 18.52mm
LMCP-OLIPF10	LWD Infinity Plan Fluorite Objective 10X/0.30 WD = 7.11mm
LMCP-OLIPF20	LWD Infinity Plan Fluorite Objective 20X/0.45 N.A. WD = 5.91mm
LMCP-OLIPF40	LWD Infinity Plan Fluorite Objective 40X/0.65 WD = 1.61mm
LMCP-OLIPF60	LWD Infinity Plan Fluorite Objective 60X/0.75 N.A. WD = 1.04mm
LMCP-OLIPP2F20	LWD Infinity Plan Fluorite Phase Contrast Objective 20X/0.45 N.A. WD = 5.91mm
LMCP-OLIPP2F40	LWD Infinity Plan Fluorite Phase Contrast Objective 40X/0.65 N.A. WD = 1.61mm

6. Troubleshooting

SYMPTOMS	POTENTIAL CAUSE	SOLUTION
LED is bright but the light in the field of view is not bright enough	The LED has burned out Dimmer is turned down	Replace LED Turn up the dimmer
Side of the field of view is dark or not even	The nosepiece is not in the correct position The color filter and its holder are placed incorrectly. The phase-contrast slider is not in the corrected position	Reposition nosepiece Insert the filter tray correctly Reposition slider
Stain or dust is observed in the field of view	Stains have accumulated on the specimen Stains have accumulated on the lens	Clean or change the specimen Clean the lens
Unclear Image	The nospiece is not in the correct position. Aperture is not open correctly Stain or dust has accumulated on the condenser, objective, eyepieces or base lens The thickness of specimen slide or Petri dish is not 1.5mm The phase ring of phase contrast slider is not matched with objective. The phase rings are not centered The light loop and the phase ring deviate when observing the edge of the Petri dish.	Reposition nosepiece Adjust the iris diaphragm Clean the lens Use a vessel with thickness of 1.5mm Use correct phase ring setting for objective Center phase rings Move the Petri dish to get the best phase-contrast effect.
Some parts of the image are not on the focal plane	Objective is not place in the light path. The specimen is placed on the stage incorrectly The optical effect of the Petri dish is not good.	Reposition nosepiece Reposition specimen Use a petri dish with a smooth surface

6. Troubleshooting

SYMPTOMS	POTENTIAL CAUSE	SOLUTION
Eyes tire easily seeing two fields of view	Interpupillary distance is wrong Diopter adjustment is wrong Eye not accustomed to binocular observation	Adjust the interpupillary distance Adjust the diopter See the entire view-field with steady observation
MECHANICS		
Coarse focus knob is too tight	Tension adjustment knob is too tight	Slightly loosen tension knob
Image drifts out of the focal plane or the stage drifts	Tension adjustment knob is too loose	Slightly tighten the tension knob
ELECTRICAL		
No illumination	No power The bulb is not installed correcly Dimmer is turned down The bulb burnt out	Check connection of power cable and plug into known working outlet Re-install bulb correcly Turn up the dimmer switch Replace the bulb
The LED burns out soon after	Not using the correct LED	Use the correct LED
The field of view is not bright enough	Not using the correct bulb Dimmer is turned down	Use the correct LED Turn up the dimmer switch
The bulb flickers or the brightness is not stable	The bulb is almost burnt out Lamp base is not connected to illumination device correctly	Replace the bulb Reconnect the lamp

7. Warranty Information

1. Statement of Limited Product Warranty

2. Laxco warrants its microscopes in respect to optical and mechanical components against defects in material and/or workmanship for 5 years from the date of original purchase to the original purchaser. Warranty for electrical items/components is 1 year from the date of original purchase. The warranty does not apply to any instrument which has become worn, defective, damaged or broken due to abuse, misuse, tampering, or unauthorized repairs. Under this warranty, Laxco Inc. will repair or replace, without charge to the purchaser, any part which upon our examination, appears to be defective in materials or workmanship.

3. Returned Goods Policy for Repair or Replacement Parts

4. To return goods for repair or replacement, please contact Laxco Customer Service at 425-686-3081.

   Please be prepared to supply the following information:

   - Your name, return shipping address and telephone number
   - Catalog/Model number of the item(s)you are returning
   - Serial Numbers if applicable
   - Description of the product's problem or reason for the return
   - Date the item was purchased.

The Customer Service Representative will issue you a Return Materials Authorization (RMA) number. Please label the outside of your shipping container with this number.

Thank you for purchasing our products. If you are unable to complete the installation of your products, contact Laxco Inc. customer support or with suggestions or comments on this manual? We are always working to meet the needs of our customers, and we appreciate your suggestions. Please e-mail us at sales@laxcoinc.com, making sure to include the title of this manual and the pertinent page numbers.

8. REFERENCE

Glossary of Microscopy Terms

A

Abbe Condenser: A simple condenser comprised of two lenses; corrects for chromatic aberration.

Aberration: Term used to describe any inaccuracy in focusing of light; derived from physical limitations of lenses and optics.

Aberration, Chromatic: Inaccurate focusing of red, green and blue light.

Aberration, Spherical: Inaccurate focusing of light due to curvature of lens surface.

Achromat: A classification of microscope objectives with simpler lenses corrected for chromatic aberration by bringing red and blue light to the same point of focus.

Aplanatic Achromatic: A term describing the level of optical correction; typically used for condensers. This term indicates that the optical device is corrected to produce a flat field (aplanatic) as well as to accurately focus red, green, and blue light (achromatic).

B

Beam Splitter: An optical device that divides the incoming light beam. The beam can be divided either in terms of wavelength (for example, reflecting shorter wavelengths but transmitting longer wavelengths) or partial reflection (for example, from a partially mirrored surface or at the angled surface of a prism).

C

C-mount: A type of camera adapter typically used to connect video cameras to a microscope.

CCD: Type of video camera using electronic chips as the detector. CCD stands for charged-coupled device. Light falling on the chip creates an electrical charge at a specific location.

Centering Telescope: A special eyepiece fitted with a focusing mechanism and a longer-than-usual focal length, used for observing the back focal plane of an objective. The centering telescope can be used for aligning components for phase contrast.

Concave: Referring to a lens surface; bowing inward.

Condenser: The optical component located nearest the specimen but between the specimen and the light source; responsible for the placement and angle of light approaching the specimen.

Contrast: Visibility of an object or feature against its background.

Convex: Referring to the curve of a lens surface; bowing outward.

Coverslip Thickness: The thickness of a piece of glass used to protect and contain the sample on the slide. This value, usually 0.17 mm, is an optical requirement of the microscope, usually engraved on the barrel of the objective.

D

Depth of Field: The vertical distance in the sample through which features are simultaneously in focus. High numerical aperture objectives have a “shallow depth of field” and image only a very thin slice of information from the specimen.

Diffraction: Bending of light at the edges of features.

Diopter Setting: The focus of one eyepiece with respect to the other to compensate for differences in focus between the microscopist’s eyes. A critical setting to avoid eyestrain and headaches.

Glossary of Microscopy Terms

E

Eyepiece: The optical component that provides the second step in magnification.

Eyepoint: The back focal plane of the eyepiece; the location at which the cornea of the eye is placed so that the information from the microscope can be imaged on the retina of your eye.

Eyepoint,High: A special optical design in which the eyepoint is raised about 18 mm above the top surface to accommodate people who wear eyeglasses.

F

Field Aperture: The opening controlling the diameter of the field to be illuminated. The opening is controlled by an iris called a field iris.

Field Curvature: One of the optical distortions. When the center of the image is in focus and the edges fall out of focus, the field is said to “have curvature.” When the image is in focus from the center to the edges, the field is said to be “flat.” Plan objectives are corrected to produce flat fields.

Field Number: A number, usually engraved on an eyepiece, referring to the diameter of a baffle or raised ring inside the eyepiece. Determines the viewing field for the eyepiece. See also “Field of View.”

Field of View (FOV): The actual diameter of the observable field in the sample; varies with the field number of the eyepiece, magnification of the objective and other intervening optics.

Filter: A device that changes either the intensity or the wavelength of light interacting with it.

Flatfield: See “Field Curvature.”

Focal Length: Distance between the optical center of a lens and the point at which it will focus light coming from infinity.

Focal Plane: An imaginary, two-dimensional plane at right angles to the optic axis, comprised of an infinite number at focal points. Since an image can only be formed when light comes to a focus, the focal plane can be thought of as an imaginary “screen” on which the image is formed.

Focal Point: The point at which light comes to a focus to form an image. Lens systems have two major, on-axis focal points; one at the focal length, on the side of the lens from which the light is approaching (the front focal point), and the second at the focal length behind the lens (the back focal point). There are also an infinite number of focal points, both on-axis and
off-axis, determined by the relevant placement of the object and the curvature and composition of the lens system.

Field Aperture: The opening controlling the diameter of the field to be illuminated. The opening is controlled by an iris called a field iris.

Focus: The ability of a lens to converge light waves to a single point.

Focusing Eyepiece: An eyepiece fitted with a mechanism for adjusting the space between its lenses and therefore for adjusting focus.

Glossary of Microscopy Terms

H

High Eyepoint: A design characteristic of eyepieces in which the back focal plane of the eyepiece is raised about 18 mm above the top of the eyepiece to accommodate microscopists who wear glasses.

I

Illumination, Axial: A contrast-enhancement technique for improving edge contrast. The condenser is closed most of the way, producing a highly coherent pencil of light.

Illumination, Phase Contrast: A contrast-enhancement technique used to image phase objects. Using a specifically designed annulus or ring placed at the front focal plane of the condenser, the zero-order background light is carefully placed into a special optical device (phase plate), mounted in the back focal plane of the objective. The phase plate has two functions: it reduces the intensity of the background light to approximately 15% of its original value and decreases its phase by one quarter of a wavelength. The light passing through a well-behaved phase-altering specimen (such as a cell) slows down by a quarter wave on that interaction, then another quarter-wave as it passes through the thickest part of the phase plate. As a result, when it meets the background light at the primary imaging plane, it is a half-wave out of step. The resulting destructive interference enhances contrast, making the object more visible against the background. Phase images often suffer from bright haloes at the edge of fine detail, partially due to the background light scattering when it hits the edge of the phase plate.

Image: The focusing of light in an organized fashion to reproduce information collected from the object. The more accurately the light is focused, the more accurately the object is represented in the image.

Image Analysis: Any type of measurement performed on the image, ranging from particle sizing and counting to determinations of motility or field-specific parameters such as orientation.

Immersion Medium: The material used between the uppermost surface of the sample and the objective. The immersion medium could be air, water, immersion oil, etc.

In Phase: A relationship between waves of light. When waves are “in phase,” the must be coherent (come from the same source, have the same wavelength, travel in the same direction, at the same point in time, vibrating in the same plane) and will reach their peak and fall to their trough at the same time. They are, literally, in step with each other. Phase annuli must be centered to produce in-phase images.

Infinity Corrected Optics: A special optical design involving at least two lenses in which the object is placed at the focal plane of the first lens, causing the imaging rays to emerge parallel to the optic axis or some principal ray. Since the emerging rays never focus to make an image, they are said to be carrying that information to “infinity.” The second lens then picks up the information as sets of parallel rays, and brings them into focus at its back focal plane. In a microscope, the objective is the first lens, the telan lens is the second.

Interpupillary Distance: The physical distance between centers of the pupils in the microscopist’s eyes; usually measured in millimeters.

Iris, Condenser: Iris controlling the angle at which light emerges from the condenser and approaches the sample; located at the front of the focal plane of the condenser.

Iris, Field: Iris controlling the size of the illuminated field in the sample. Usually located around the light port. Reducing the size of the field iris is one technique for controlling haze and glare.

Glossary of Microscopy Terms

K

Koehler Illumination: An approach to microscope alignment that separates the illuminating set planes from an imaging set. A major goal of this approach is to illuminate evenly the back focal plane of the objective for maximum resolution and evenly illuminated background.

L

Light, Polarized: Light in which the waves vibrate in only one direction, perpendicular to the direction of travel.

Long Working Distance (LWD): A term used for specially designed objectives and condensers providing more clearance between the surface near the sample and the sample itself. Especially useful for tissue culture and microtitre work.

M

Magnification: A mathematical relationship between the size of an image and the size of the original object. If the image is larger than the object, the term used is “magnification”; if the image is smaller than the object, the term used is “minification.”

Micron: A unit of length measurement. A micron (or micrometer) is 10-6 meters (0.000001 meters) or about 1/25,000 of an inch.

Microscope, Compound: A microscope providing magnification in two stages, the first through the objective and the second through the eyepiece.

Microscope, Inverted: A standard microscope configuration in which the sample is viewed from below. Especially useful when working with very thick samples such as tissue cultures and microtitre plates.

Microscope, Stereo: A standard microscope configuration based on two independent imaging paths, separated by approximately 10-12 degrees, resulting in a stereoscopic image characterized by great three-dimensionality and great depth of field. Frequently uses lower power (0.5 to 300x total magnification).

Microscope, Upright: A standard microscope configuration in which the sample sits face up on a stage, with the objectives mounted above it.

Microscopy: The art and science of making fine detail visible. The four major issues in microscopy today are magnification, resolution, contrast and measurement.

N

Neutral-DensityFilter: An amplitude object; an object that absorbs all colors of light equally.

Numerical Aperture (N.A.): A measure of information-collecting ability of a microscope optic. The numerical aperture is a product of the sine of half of the collecting angle and the refractive index of the immersion material. The greater the N.A., the better the resolving ability.

O

Object: The actual feature of interest or study under the microscope.

Objective: The optical component that gathers the information-bearing light from the specimen. Responsible for both the first step in magnification and for setting the limit of resolution for the entire system.

Optic Axis: The imaginary axis passing through an optical system, along which light travels.

Optics: Imaging components of the microscope. Examples include the objective, eyepiece and condenser.

Glossary of Microscopy Terms

P

Phase: A property of light in which waves are “in step” with each other. See also “In phase.”

Phase Contrast: A contrast-enhancement technique that detects phase objects. It uses a special ring, placed in the condenser to control location of the undiffracted light, and a matching phase plate, placed in the back focal plane of the objective. A wellbehaved phase sample will slow light by approximately one-quarter of a wavelength compared to the undiffracted background light. The phase plate is especially engineered to slow the diffracted light another quarter-wave. When the undiffracted light meets the diffracted light at the primary imaging plane to form the image, they will be out of step with each other by a half-wave, creating the condition of destructive interference and resulting in the darkening of the phase object and an improvement in contrast. Phase kits include a green filter (usually about 546 nm), which defines the wavelength for which the kit is optimized.

Photo Adapter: A special tube enabling cameras to be attached to the microscope.

Pixel: An electronic term used to describe the points of information used to map an image on a TV screen or computer monitor. Literally, a picture (“pix”) element (“el”). Each pixel carries at least the x,y location in the map and an intensity value (based on 256 gray levels).

Plan: An optical correction for objectives and condensers, indicating that the optical component has been corrected to produce a flat viewing field.

Primary Image: The first magnified image formed in the microscope.

Primary Image Plane: The location of the first magnified image formed by the objective.

R

Refraction: Bending of light as it passes, at an angle, across a boundary between materials of different refractive index; governed by Snell’s Law.

Refractive Index (n or ri): A number describing the relationship between the velocity of light in a material of interest compared to the velocity of light in a vacuum or air. The slower the velocity in the material, the higher the refractive index.

Resolution (R): The smallest distance by which two objects can be separated and still be imaged as two independent objects.

Reticle: A small disk with an engraved or photographic pattern such as a ruler or grid, placed in the eyepiece, in the primary image plane, so that the pattern will superimpose on the image of the specimen. Used for measurement (length, angle, counting, etc.).

S

Snell’s Law: The law governing refraction, relating to angles of approach and exit as light passes, at an angle, from one material to a second material of different refractive index. Snell’s Law states that light will bend toward the normal (an imaginary reference line drawn perpendicular to the surface at the point of entrance) as it passes from lower to higher refractive index.

Glossary of Microscopy Terms

T

Telan Lens: An auxiliary lens used in conjunction with an infinity corrected objective to bring light to a proper focus. In some systems, the telan lens will also correct the objective's residual chromatic aberration. See also "Tube lens."

Trinocular Port: A special eyepiece, usually narrower in design than conventional eyepieces, used in the photo tube of the microscope to project a real image to the film plane or detector of a camera system.

Tube Length, Fixed: An optical design approach in which the object is placed at some distance in front of the objective, causing the image to focus at a specific distance behind the objective. Typical distances for the mechanical tube length in these systems are either 160 mm or 170 mm.

Tube Length, Mechanical: The distance from the objective shoulder to the seat of the eyepiece. When replacing objectives, the mechanical tube lengths must match.

Tube Length, Optical: The distance between the back focal plane of the objective and the primary image plane.

Tube Lens: In infinity corrected optics, a lens that works along with the objective to form the image at the primary image plan. See also "Telan lens."

W

Wavelength: The distance along a wave from peak to peak or trough to trough. In microscopy, wavelength is often correlated to the color and energy of light.

White light: Light containing all three primary colors: red + green + blue.

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