

Motic[®]

GM-161/ GM-171 Series Gemology Microscopes Instruction Manual



Note

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

WWW.MOTIC.COM

MOTIC INCORPORATION LTD.



Dear Customer,

Thank you for choosing a Motic Microscope.

We are constantly improving our instruments and adapting them to the requirements of modern research techniques and testing methods. This may involve modification to the mechanical as well as optical components of our microscopes.

Therefore, all descriptions and illustrations in this instruction manual, including all specifications are subject to change without prior notice.

Best regards,

Your Motic Team

Correct operation ensures the microscope's long-term proper usage. Contact your local Motic distributor for maintenance needs or contact Motic directly through our website www.motic.com.

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1. PLEASE FOLLOW THESE INSTRUCTIONS CAREFULLY

1.1 Use:

This microscope is to be used for observation purposes only.

1.2 Do not disassemble:

Disassembly may lead to possible damage of the instrument and voidance of warranty. If a problem is discovered, please contact the Motic dealer nearest you.

1.3 Avoid getting burnt:

Wait for the bulb and surrounding parts to cool down before changing. Keep flammable objects (gasoline, alcohol, cloth, paper, etc.) away from the bulb to avoid the possibility of a fire.

1.4 Check input voltage:

The label on the back of the microscope clearly specifies the microscope's input voltage which must be compatible with the local power supply. Using the microscope with a non-specified voltage rating can lead to damage of the instrument.

1.5 When changing the bulb please note:

Only specified halogen bulbs and fluorescence tubes may be used.

Before changing the bulb, turn off the power and unplug the power cable to avoid being electrocuted.

When changing the bulb, do not let the bulb get dirty. The outer surface of the bulb must not be contaminated with dust or fingerprints etc.

1.6 Storage:

Before moving the microscope, be sure the power is switched off.

Microscope working temperature and humidity requirements:

- Room temperature: 5°C ~ 35°C;
- Maximum relative humidity: 65%

1.7 Operation:

This microscope is a high precision instrument and must be handled and operated with extreme care.

Jolting or aggressive operation can lead to damage of the instrument.

2. NOMENCLATURE

2.1 GM-161B

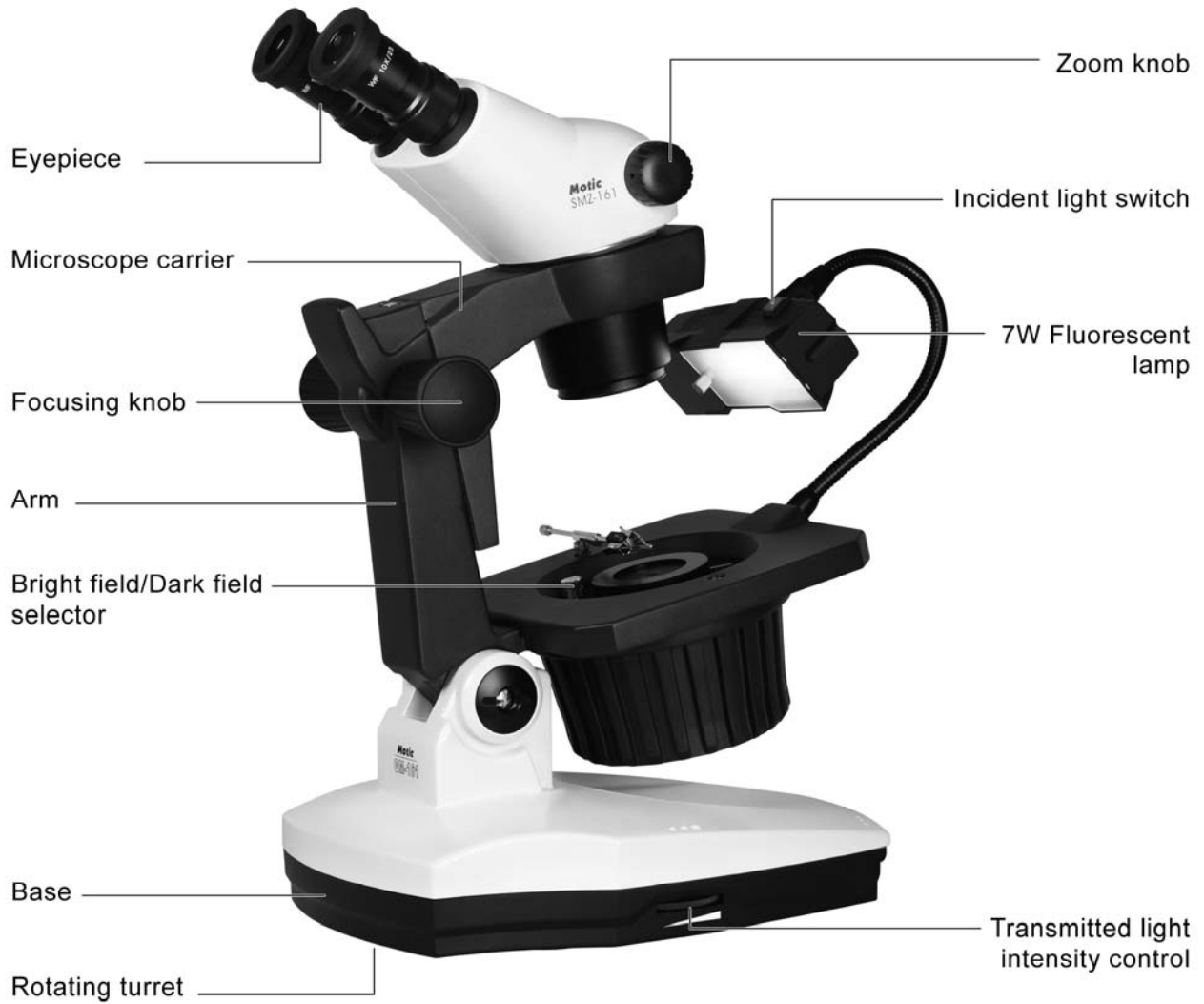


Fig.1

2.2 GM-171T

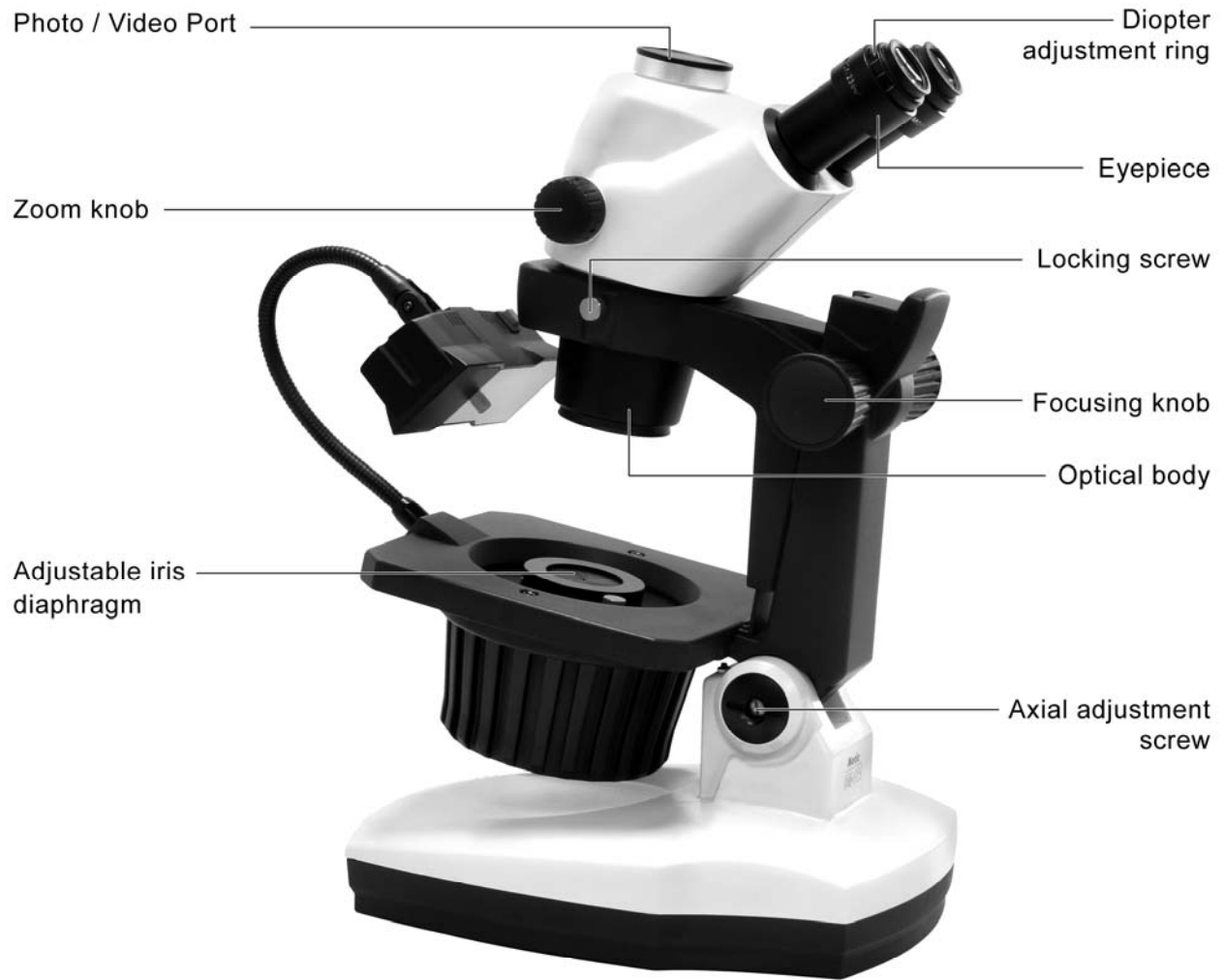


Fig.2

3. INTRODUCTION

Thank you for purchasing a Motic GM-161/ GM-171 series Gemology Microscope. Before using this instrument, please be sure to carefully read the instruction manual in order to ensure proper use, maintenance and care of the instrument.

The GM-161/ GM-171 series Gemology Microscope is highly effective in the observation of minerals and crystals, the appraisal of precious stones, and may also be employed in chemical and biological research. The microscope's magnification system produces high definition, high resolution, and life-like colour stereo images. An extra wide field of view (23mm at 10X of GM-171; 20mm at 10X of GM-161); a continuous zoom system (from 7.5X-50X of GM-171; 7.5x-45X of GM-161); the ability to configure the microscope with different eyepieces and objective lenses changing the total zoom range from 2.25X to 200X of GM-171 and 2.25X to 180X of GM-161, make this microscope a welcome addition to any laboratory.

The instrument's working distance is 110mm with a focusing range of 92mm. Select the desired illumination method from bright field, dark field (for excellent dark field results, illumination vertical distance should be approx.30mm), or daylight incident illumination. The microscope arm is able to tilt from 0° ~ 45° allowing for the adjustment of observation eye point height and angle. The entire microscope can be rotated 360°, making it more convenient for multiple users to observe. This instrument also employs a high performance, safe, economical and reliable electric switching circuit.

The GM-161/ GM-171 Series Gemology Microscope comes with a photo/ video port, which provides excellent image quality output and a multitude of professional optional accessories to select from.

4. INSTRUMENT CONFIGURATION AND FUNCTIONS

Stereo Configuration:

4.1 Main body:

- The optical body supplies a 1:6.7 zoom ratio of GM-171 and 1:6 zoom ratio of GM-161, which provides the microscope with long depth of field and stereoscopic capability. Throughout the magnification change process, the microscope remains parfocal and parcentered (for specific alignment and calibration instructions see the Microscope Adjustment and Operation section).
- The zoom adjustment knobs (Fig.3) are located on both sides of the optical body, rotate these knobs to change the magnification strength. For the specific magnification strength, see the values on the adjustment knob (the current magnification strength is aligned with the 0 on the body).
- The optical body is inserted into the microscope carrier and the holding screw located on the left side of the carrier is used to secure the body to the frame.



Fig.3

4.2 Binocular Observation Tubes: (GM-171B)

- Equipped with N-WF10X/F.N.23 eyepieces.
- Adjust the two eyepiece tubes to adjust the interpupillary distance (interpupillary adjustment range: 48-75mm).
- The diopter adjustment rings on the eyepieces are used to adjust the diopter scale ($\pm 5^\circ$) of the eyepieces.

4.3 Binocular Observation Tubes: (GM-161B)

- Equipped with N-WF10X/F.N.20 eyepieces.
- Adjust the two eyepiece tubes to adjust the interpupillary distance (interpupillary adjustment range: 50-75mm).
- The diopter adjustment rings on the eyepiece tubes are used to adjust the diopter scale ($\pm 5^\circ$) of the eyepieces.

4.4 Trinocular Observation Tubes: (GM-171T/ GM-161T)

The trinocular tube structure is the same as outlined above with the addition of a port at the top of the microscope body that allows for the addition of a camera or video camera.

- There is a fixed 50:50 beam splitter for the trinocular models GM-161T/GM-171T. Binocular eyepiece observation and trinocular digital imaging can be done simultaneously. 50% of the lights will enter eyepieces and 50% of the lights for camera. The brightness could be fully satisfied with the board-band anti-reflection technology and high brightness in illumination.
- At the top of the trinocular tube, there is a locking screw that is used to secure the adapter for the imaging device. After fitting the adapter, this locking screw should be tightened.



Fig.4

4.5 Microscope Carrier:

- The microscope carrier is connected to the vertical bracket, which composes the microscope arm. The focusing knobs are located on both sides of the arm (Fig.5). By rotating them, the optical body (provided it has been installed) can be moved up and down allowing users to bring the specimen into focus (Fig.6). To adjust the tension of the focusing knobs, use a small screwdriver (Fig.7) to tighten or loosen the coarse focus torque adjustment rings located on the insides of the focusing knobs (Fig.8).



Fig.5

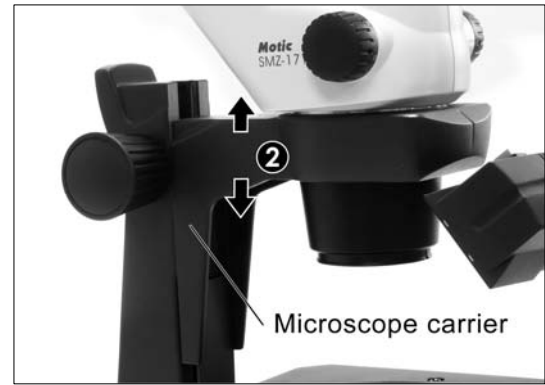


Fig.6



Fig.7

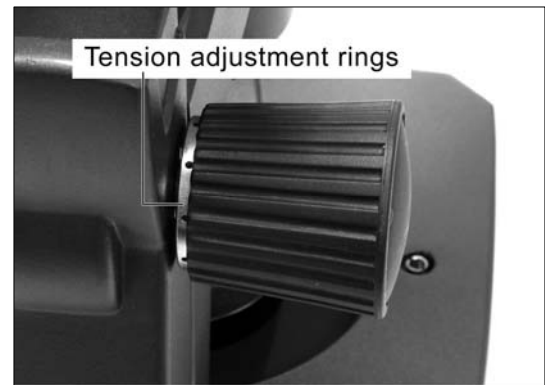


Fig.8

- If, when trying to focus, the body and frame keep sliding downwards adjust the coarse focus torque adjustment rings to tighten the mechanism.
- The focus travel range is 92mm. The focusing knobs are equipped with a slip control function, which means when the end of the travel range is reached the knobs will keep spinning in order to avoid excessive force being exerted on the gears.

4.6 Base:

- The tilting axis on the base allows users to angle the microscope arm (bracket, microscope carrier and optical body) from 0° ~ 45° as observation requires (Fig.9). Adjust the screws located inside the axis where the arm meets the base to loosen or tighten the rotating action (Fig.10).
- Installed within the base are the illumination switching circuits.
- The 2.5A (labeled T2.5A) fuse and MAIN power switch are located on the backside of the base. (Fig.11)

The halogen transmitted illumination intensity adjustment dial/power switch is located on the right side of the base. Rotate the dial to turn the transmitted illumination on and off and adjust intensity. (Fig.12)

- On the underside of the base is located a circular rubber turret which allows the microscope to be rotated 360°. (Fig.13)



Fig.9



Fig.10

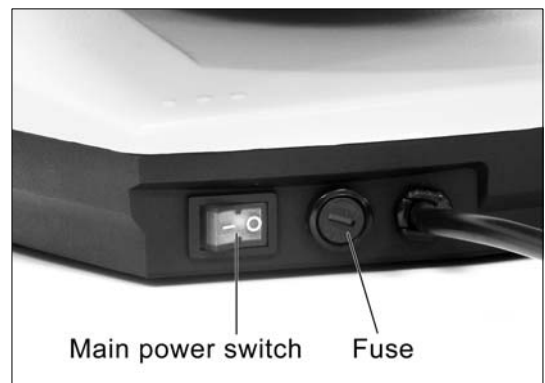


Fig.11

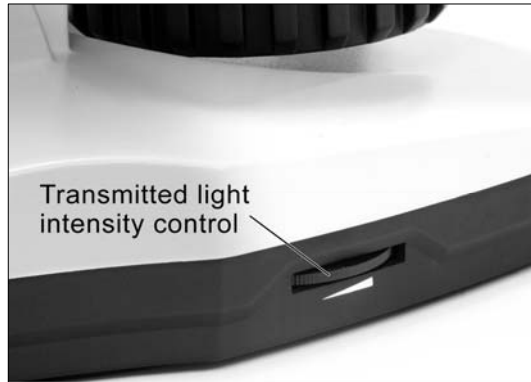


Fig.12



360°

Fig.13

4.7 Illumination:

This microscope provides three modes of illumination: transmitted bright field/ dark field and incident.

4.7.1 Transmitted illumination

Transmitted illumination is provided by a 30W/ 6V halogen bulb (Fig.14), light diffuser dish, carriage, light barrier, and $\text{Ø}41\text{mm} \sim \text{Ø}2\text{mm}$ adjustable diaphragm. Turn the main power on (Fig.15); rotate the adjustment dial on the right side of the base to turn illumination on (Fig.16), rotate the bright field/ dark field selector to choose the desired transmitted illumination mode (Fig.17); and use the diaphragm adjustment handle on the stage to set the diameter of the light beam. (Fig.18)

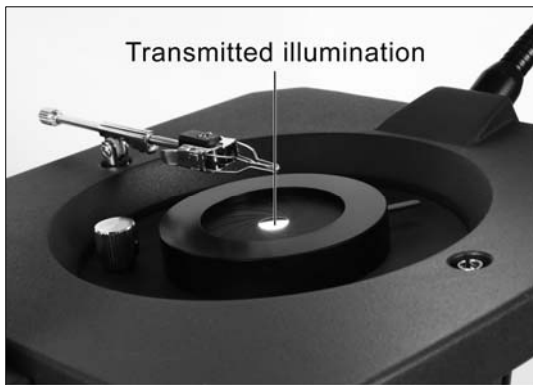


Fig.14

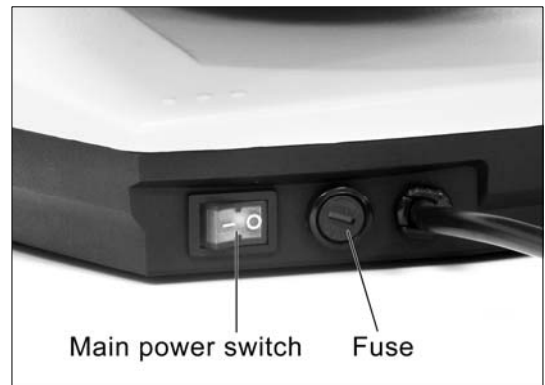


Fig.15

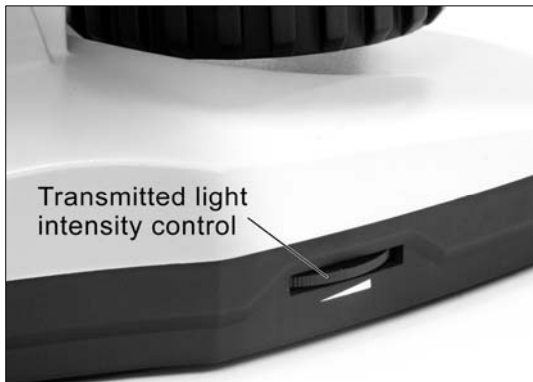


Fig.16



Fig.17

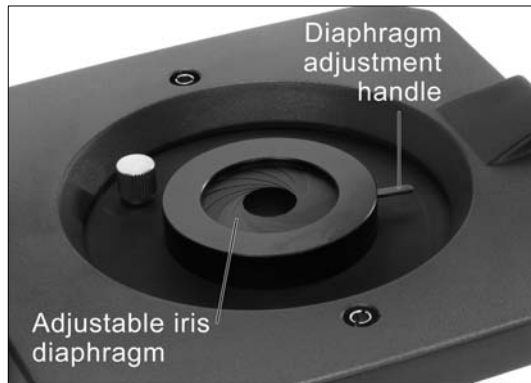


Fig.18

4.7.2 Incident illumination

Incident illumination is provided by a 7W daylight fluorescent tube-bulb. (Fig.19)

Press the incident illumination power switch, located on the lamphouse, to turn on and off. (Fig.20)

Adjust the gooseneck mount to achieve desired incident angle. (Fig.19)



Fig.19



Fig.20

4.8 Stage:

The stage contains gemstone holder receptacles on both the left and right sides. Users may insert the clamp into either, as observation requires.

5. ACCESSORIES

5.1 Gemstone Holder:

The Gemstone holder (Fig.21) is made of spring-loaded steel wire. The holder may be inserted into the receptacles on either the left or right side of the stage depending on the user's preference (Fig.21). The holder may be extended or retracted; rotated to the left or right; or angled upwards or downwards as required.

NOTE: Do not exert excessive force on the steel wires of the holder as this may cause the wires to bend, permanently damaging the instrument.



Fig.21

5.2 Polariser:

The polarising unit consists of a polariser and an analyser (with holding screw) and is generally used with bright field transmitted illumination. (Fig.22)

Attach the analyser (with the holding screw) to the bottom of the objective lens and tighten the holding screw to secure. Place the polariser over the diaphragm on the stage. Rotate the analyser until the light seen in the field of view is at its darkest [point of extinction], at this point the polariser and analyser are properly orthogonal.

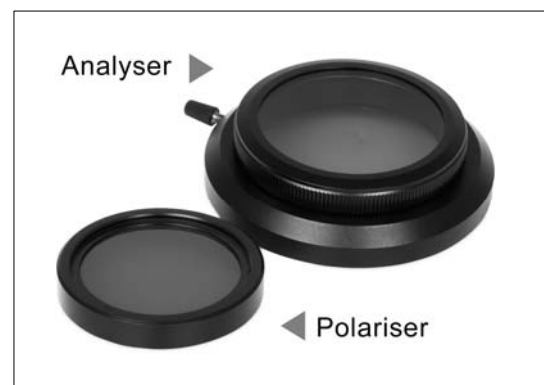


Fig.22

5.3 Diamond Holder and 10X measurement eyepiece

The **diamond holder device** (Fig.24) is made up of a base (the underside of which is installed with a magnet), an adjustable screw bolt, and a spring-loaded bolt. The focal plane of the 10X eyepiece contains a diamond cut measurement reticule (Fig.23). Place the **diamond clamp device** on the diaphragm on the stage so the handle of the threaded bolt is facing the incident illumination source while the handle of the spring loaded bolt is facing the microscope arm (Fig.25). Use jewel tweezers to insert a diamond into the clamp so the pointed end is facing the spring loaded bolt (with the four holes in the end). Adjust the threaded bolt until the diamond is in the center of the clamp. Replace one of the original eyepieces with the 10X measurement eyepiece and adjust the position of the clamp until the diamond is located in the center of the crosshairs at which point proper measurement can begin.

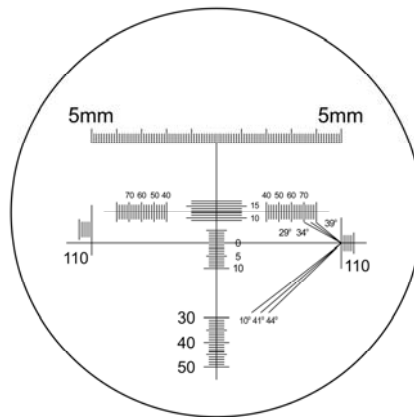


Fig.23



Fig.24

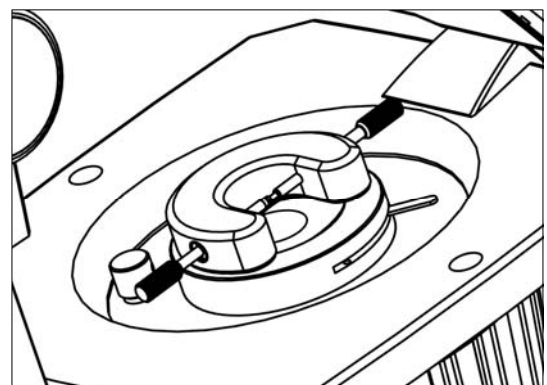


Fig.25

5.4 Eyepieces

Equipped standard with N-WF10X/23 eyepieces of GM-171 and N-WF10X/20 eyepieces of GM-161, the GM-171 has optional N-WF12.5X, N-WF15X, N-WF20X eyepieces to choose from.

The GM-161 has optional N-WF15X, N-WF20X eyepieces to choose from.

5.5 Auxiliary objectives (Fig.26)

The design of this microscope allows users to install the following auxiliary objectives:

- Select the appropriate objective according to working distance and total magnification requirements.
- Screw on the desired objective. After the objective has been installed, the working distance will be changed and microscope adjustments will have to be made accordingly.



Fig.26

5.6 Immersion cell (Fig.27)

Pour the appropriate amount of solution into the immersion cell (Note: solution is corrosive, do not let it splash outside of the cell). Place the desired gem into the cell. Ensure the microscope is in an upright position, keeping the stage level. Next, carefully place the cell into the diaphragm receptacle.



Fig.27

5.7 Diffuser (Fig.28)

The light-diffusing unit is placed directly on the diaphragm on the stage and is generally used with bright field transmitted illumination to remove hot spots.



Fig.28

5.8 Photo adapter

- The photo adapter is installed into the top of the trinocular port of the microscope. Through the adapter a camera may be connected to the microscope allowing users to photograph the specimen.

Note: Different cameras have different adapters. Please contact the manufacturer of the camera for the correct adapter.

- Before installing the adapter, make sure it is firmly connect to the camera. The camera adapter may be purchased directly from your local camera supplies shop.
- The same method can be applied to connect a digital camera to the microscope.

5.9 C-mount camera adapter

- The c-mount camera adapter is inserted into the top of the trinocular tube of the microscope. After which a digital application or video camera can be connected allowing for observation and/or demonstration through a monitor. Use a standard video camera to connect to a video capture device or use a digital camera to import microscope images to the computer for digital processing.
- There are two kinds of video camera adapters, CS and C mount adapters, select the appropriate model according to your camera.
- Select the appropriate c-mount camera adapter according to the size of the chip sensor.

1/3" chip sensor — 0.5X c-mount camera adapter

1/2" chip sensor — 0.65X c-mount camera adapter

2/3" chip sensor — 1X c-mount camera adapter

5.10 Large Gem Plate (Fig.29)

The large gem plate can be used directly on top of the diaphragm on the stage for samples too large for the standard gem holders. The plate comes equipped with a black/white plate and a frosted glass plate. Choose the plate suited for your application.



Fig.29

6. MICROSCOPE ASSEMBLY

6.1 Unpacking the microscope

The microscope's various components are all packaged separately. When opening the packaging be extremely careful and be sure not to misplace any parts. Ensure you have assembled all of the components in their proper places before removing the packing box. If damage to the instrument is discovered upon opening the packing box, immediately contact the carrier and supplier.

6.2 Microscope assembly

- When moving the various components, especially the optical components, fingers and oily materials should not come in contact with the surface of the lenses. Fingerprints and oil stains on the lenses will result in poor image quality and possibly damage to the instrument.
- Place the microscope's optical body into the body support (microscope carrier) and tighten the holding screw located on the left of the support to secure the optical body.
- Remove the packing material from the eyepieces and other optical components (without touching the lens surfaces). Being very careful not to touch the lens surfaces, slide the eyepieces into the observation tubes.

7. MICROSCOPE ADJUSTMENT AND OPERATION

7.1 Interpupillary distance

Adjust the two eyepiece tubes until a single circular field of view can be seen through the two eyepieces (Fig.30 and Fig.31). If two separate circular fields of view appear, the interpupillary distance is too large. If two overlapping fields of view appear, the interpupillary distance is too small.



Fig.30



Fig.31

7.2 Focus and diopter adjustment

- Adjust the height of the focusing mechanism according to the working distances listed in the appendix. Next, rotate the diopter adjustment rings on the observation tubes until the O lines up with the marker line on the side of the tube (the zero position). (Fig.32)



Fig.32

- Rotate the zoom adjustment knob to the lowest magnification and use the focusing knobs to bring the specimen into focus. Next, rotate the zoom adjustment knob to the maximum magnification and adjust the focusing knobs until a clear image is seen through the right eyepiece.
- Adjust to the lowest magnification, again making sure the image seen through the right eyepiece remains in focus throughout the process. If the image is not in focus, adjust the diopter ring on the right observation tube until a clear image is seen (while making this adjustment, make sure not to adjust the focusing knobs).
- Adjust the diopter ring on the left tube until a clear image is seen throughout the change from lowest magnification to highest. At this point the microscope should be completely parfocal at all magnifications completing the diopter adjustment process.

7.3 Magnification and working distance

- Rotate the zoom adjustment knob until the desired magnification is achieved. If necessary, the eyepieces may be changed or an additional objective lens may be installed (see section on additional objectives installation at the bottom of page 8).
- The microscope's total magnification = eyepiece magnification strength x magnification changer magnification strength x additional objective lens magnification strength.
- When there is no additional objective, its magnification value in the equation may be replaced with 1.
- The working distance can be changed from 110mm (when no additional objective has been installed) to 38.6mm (when a 2X additional objective has been installed). Standard configuration (no additional objective) has a working distance of 110mm.

7.4 Changing the bulb



The bulb and the lamphouse become very hot during and after a period of operation.
 Risk of burn – Do not touch the bulb during or immediately after a period of operation.
 Make sure the bulb has cooled sufficiently before attempting to replace the lamp.

- Before changing the bulb, do not forget to turn off the power and unplug the power cable from the power source.

7.4.1 Replacing the transmitted illumination halogen bulb

- When changing the transmitted illumination halogen bulb, tilt the microscope arm 45°. (Fig.33)
- Loosen the large lamp housing screw at the bottom of the heat dispersal (Fig.34) unit and open the panel to change the bulb (Fig.35 and Fig.36). Once the bulb has been changed, close the panel, retighten the screw (Fig.37) and return the microscope to an upright position.

(**NOTE:** If the bulb footings are too long and the bulb sticks out too far, cut them shorter as this will affect dark field illumination)



Fig.33

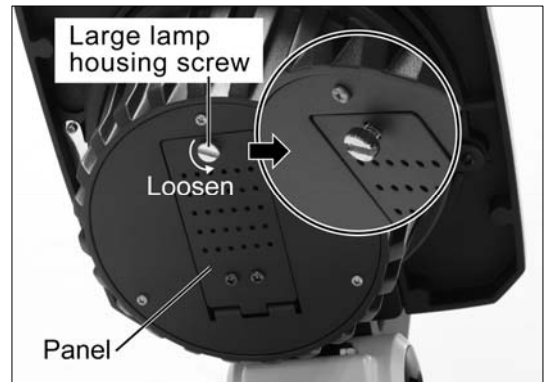


Fig.34

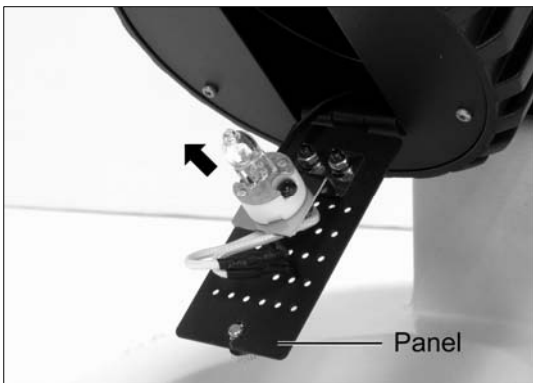


Fig.35

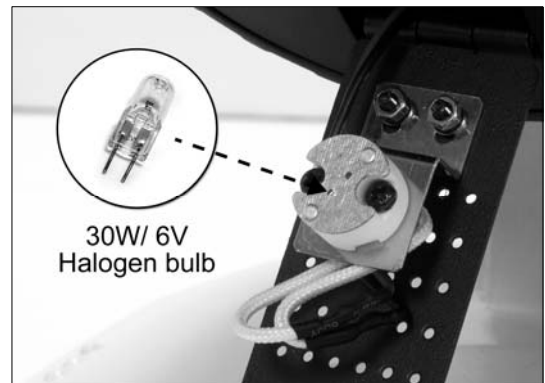


Fig.36

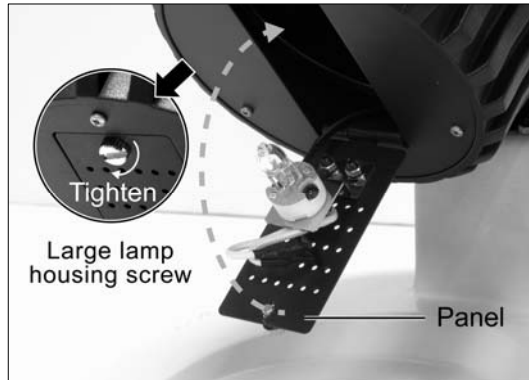


Fig.37

7.4.2 Replacing the fluorescent bulb

- When replace the 7W incident illumination fluorescent bulb, first, rotate the screw on the white panel to the left or right (Fig.38) and then remove the panel (Fig.39). Next, grab the right side of the housing and while **pulling in from the backside (Fig.40), pull outwards to remove the socket** (Fig.41). Remove the bulb from the socket (Fig.42); replace with a new one; push the socket back into the lamp housing; and replace the white panel.
- Remember, the surface of the bulb must remain clean. Fingers must not come in contact with the glass surface. Residue left behind by fingers touching the glass affects heat distribution.

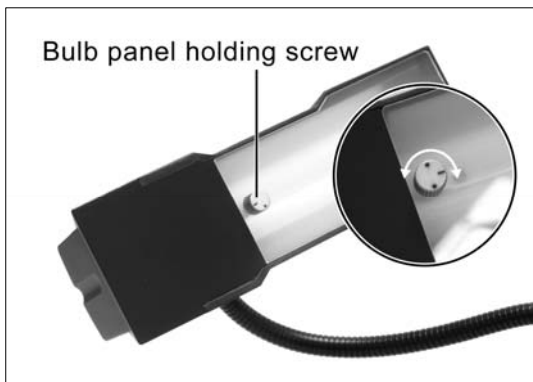


Fig.38

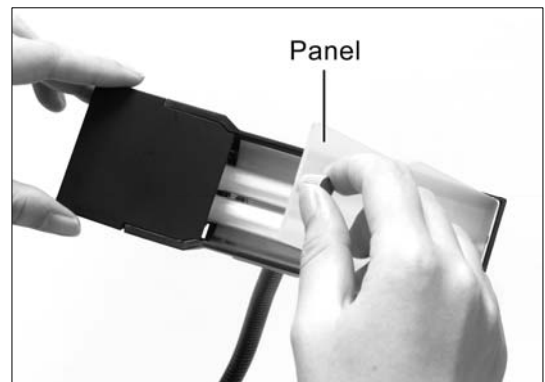


Fig.39



Fig.40



Fig.41

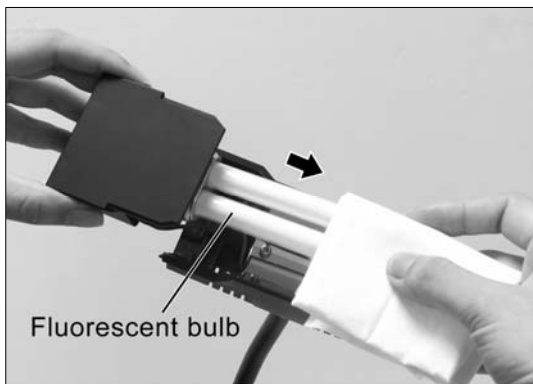


Fig.42

7.5 Microscope operation

- Once the microscope is properly assembled, make sure the local power supply voltage is compatible with the specified voltage of the microscope before plugging the power cable in. Once plugged in, turn on the main power switch and select the desired illumination mode.
- Begin observation of the specimen using the appropriate magnification and illumination mode. If further accessories are necessary for observation, install the required accessories and begin observation again according to the aforementioned steps. At this point the angle of the microscope body may also be adjusted, as observation requires.
- Once observation is complete, turn off illumination, turn off the power and remove the specimen. Return the microscope body to an upright position (if the observation angle was adjusted) and place the dust cover tightly over the microscope. If the microscope is not to be used for an extended period of time, pull the power cable out from the power source.

8. CAMERA AND VIDEO EQUIPMENT INSTALLATION

8.1 Camera installation and use

- The camera equipment includes a camera port, a camera adapter and a camera. Among which, the camera port is supplied by Motic while the adapter and camera may be purchased elsewhere.
- Once the microscope has been assembled, loosen the holding screw on the camera/ video port and remove the cap. Next, insert the camera and adapter into the port.
- After focusing the microscope, pull out the beam splitter on the backside of the main body. Next, adjust the height of the camera until a clear image is observed through the camera [You may need to rotate the camera until the image achieves similar direction.]. At this point, tighten the holding screws you loosened in the second step.

8.2 Video installation and use

The video device includes a video camera, a c-mount camera adapter and a camera port. Among which, the camera port is supplied by Motic while a video camera may be purchased elsewhere. Purchase the appropriate c-mount camera adapter (0.5X for 1/3", 0.65X for 1/2" or 1X for 2/3") from Motic according to the size of the camera's chip sensor.

- Connect the c-mount camera adapter to the camera (Note: the video adapter and camera can be either a CS or C mount type, make sure they are both the same).
- Loosen the holding screw on the camera/video port, remove the cap, insert the video camera and tighten the holding screw. Next, connect the export terminal of the video camera to the video input terminal of the monitor.
- After focusing the microscope, pull out the beam splitter on the backside of the main body and adjust the video camera until a clear and focused image is gained.

9. OPERATION SAFETY MEASURES

- Before connecting the power, ensure the local power supply voltage is the same as the microscope's specified voltage.
- Before connecting the power, be sure the main power switch is turned off.
- Rotate the illumination adjustment dial at the side of the microscope to the off position before turning the microscope power on and off. If not done, the life of the bulb will be shortened and damage the electrical components. The microscope comes with the desired regional power supply as selected by the distributor. Users should not change this setting without permission from the manufacturer.
- Users should adhere to local operation safety regulations. The user must bear full responsibility for the safe use of this instrument.

10. MICROSCOPE MAINTENANCE AND CARE

In order to properly care for the microscope and avoid corrosion, it should be kept away from dust, water, water vapor and corrosive materials. If dust or water works their way into the microscope, it may result in mildew growth damaging the instrument. Please be aware that once mildew contaminates the microscope, even after it has been thoroughly cleaned, it will easily become contaminated again. Oil and fingerprint stains will affect image quality. Hands and oily materials should be kept away from the outer surfaces of the optical components.

10.1 Prevention against dust

When not in use, the instrument should be covered with the dust cover that comes with your microscope. Do not, under any circumstances, leave the eyepiece tubes exposed. Eyepieces should be kept in the observation tubes (when frequently using the microscope), and packing paper or lens caps should be placed over the eyepieces. If the eyepieces and other optical components are not to be used for an extended period of time, they should be placed in a dry cardboard box with the addition of a desiccating agent in order to prevent dust and moisture collection.

10.2 Prevention against water and moisture

The microscope must be kept away from sources of water including water faucets, tanks, sinks, etc. The instrument should be kept in a low humidity environment (relative humidity should be kept below 85%). If the eyepieces and other optical components are not to be used for an extended period of time, they should be placed in a dry cardboard box with the addition of a desiccating agent. If the environmental conditions of the current location are exceedingly moist and humid, Motic recommends use of a dehumidifier within the lab.

10.3 Proper cleaning techniques

- If the surface of an optical lens is dusty, use a pipette to blow off the dust.
- If fingerprints or oil stains are discovered, or the use of a pipette is unable to remove dirt, wipe with an oil-free cotton swab or lens cloth lightly dipped in a mixture of pure alcohol and ether (mixed specifically at 3:7 or 2:8 to leave no residue on the lens). Be extremely careful when wiping the lens clean. Do not, under any circumstances, use any sort of corrosive solution to clean the lens.
- Under no circumstances should dry a cotton swab, dry cloth or dry lens cloth be used to wipe the lens as this will cause scratches and damage the surface of the lens. Do not use water to clean the lens, as this will leave a residue on the lens surface, as well as possibly resulting in the formation of mildew.
- The light barrier and glass ring in the carriage and the frosted glass must be kept clean. If oil stains or dust appear on the surfaces, use a cotton swab dipped in mixture of pure alcohol and ether to carefully clean as such contamination will affect observation results using transmitted illumination.

10.4 Moving the Microscope

- Try to move the microscope as little as possible.
- If it is absolutely necessary to move the microscope, be sure the eyepieces, optical body, focusing mechanism and the adjustment rings are secured in place before moving the microscope. As well, be sure the power is turned off and the cord unplugged.
- When moving the microscope use both hands, one under the base and the other firmly holding the top of the vertical bracket.
- The microscope should be kept in an upright position the entire time it is being moved.

11. TROUBLESHOOTING

Problem	Possible reasons and solutions
Lamp does not illuminate	<ol style="list-style-type: none"> 1. Power is not switched on. 2. Check the power cable is firmly connected. 3. Fuse may be blown. If so, replace fuse or contact your local distributor. 4. Bulb may be burnt out. If so, replace bulb or contact your local distributor. 5. Ensure the local power supply is compatible with the instrument. 6. If the problem cannot be solved through the above means, please contact your local distributor.
Flickering bulb	Bulb may not be secured in socket, insert bulb firmly into socket.
Unable to bring specimen into focus	<ol style="list-style-type: none"> 1. Specimen may be too large, microscope working distance insufficient to bring object into focus. 2. Governor rings (tension adjustment rings) may be too loose causing the microscope body to slide downwards. 3. Lens may be dirty. If so, wipe clean. For specific cleaning instructions see the Microscope Maintenance and Care section of this manual.
Low definition or unclear image	<ol style="list-style-type: none"> 1. Unable to bring specimen into focus, see section above for possible reasons and solutions. 2. Objective lens may be dirty. If so, wipe clean. For specific cleaning instructions see the Microscope Maintenance and Care section of this manual. 3. Eyepiece may be dirty. If so, wipe clean. For specific cleaning instructions see the Microscope Maintenance and Care section of this manual.

NOTE:

- If a problem is encountered while using the GM-161/ GM-171 and none of the measures outlined above are able to solve the problem, please contact the Motic representative nearest you as we are more than happy to provide you with any assistance you may require. Please note that attempting to disassemble the microscope on your own may lead to further damage and voidance of the warranty.
- Users please be advised: Motic reserves the right to make changes to its products, as it deems necessary. As a result, the content of this user manual may not entirely reflect the specific characteristics of the current product.

APPENDIX A (GM-171 OPTICAL DATA)

Eyepiece	Mag.(X)	Standard Objectives		Auxiliary Objectives			
				1.5X		2X	
		WD110mm		WD 56.3mm		WD 38.6mm	
		Mag. (X)	FD (mm)	Mag. (X)	FD (mm)	Mag. (X)	FD (mm)
10X/23*	0.75	7.5	30.67	11.25	20.44	15	15.33
	1	10	23	15	15.33	20	11.5
	2	20	11.5	30	7.67	40	5.75
	3	30	7.67	45	5.11	60	3.83
	4	40	5.75	60	3.83	80	2.875
	5	50	4.6	75	3.07	100	2.3
12.5X/18*	0.75	9.375	24	14.06	16	18.75	12
	1	12.5	18	18.75	12	25	9
	2	25	9	37.5	6	50	4.5
	3	37.5	6	56.25	4	75	3
	4	50	4.5	75	3	100	2.25
	5	62.5	3.6	93.75	2.4	125	1.8
15X/16*	0.75	11.25	21.33	16.875	14.22	22.5	10.67
	1	15	16	22.5	10.67	30	8
	2	30	8	45	5.33	60	4
	3	45	5.33	67.5	3.56	90	2.67
	4	60	4	90	2.67	120	2
	5	75	3.2	112.5	2.13	150	1.6
20X/13	0.75	15	17.33	22.5	11.56	30	8.67
	1	20	13	30	8.67	40	6.5
	2	40	6.5	60	4.33	80	3.25
	3	60	4.33	90	2.89	120	2.17
	4	80	3.25	120	2.17	160	1.625
	5	100	2.6	150	1.73	200	1.3

Note: "WD" = Working Distance "Mag." = Magnification "FD" = Field Diameter

Note: * - High eyepoint eyepiece

APPENDIX B (GM-161 OPTICAL DATA)

Eyepiece	Mag.(X)	Standard Objectives		Auxiliary Objectives			
				1.5X		2X	
		WD110mm		WD 56.3mm		WD 38.6mm	
		Mag. (X)	FD (mm)	Mag. (X)	FD (mm)	Mag. (X)	FD (mm)
10X/20*	0.75	7.5	26.67	11.25	17.78	15	13.33
	1	10	20	15	13.33	20	10
	2	20	10	30	6.67	40	5
	3	30	6.67	45	4.44	60	3.33
	4	40	5	60	3.33	80	2.5
	4.5	45	4.44	67.5	2.96	90	2.22
10X/23	0.75	7.5	30.67	11.25	20.44	15	15.33
	1	10	23	15	15.33	20	11.5
	2	20	11.5	30	7.67	40	5.75
	3	30	7.67	45	5.11	60	3.83
	4	40	5.75	60	3.83	80	2.88
	4.5	45	5.11	67.5	3.41	90	2.56
15X/16*	0.75	11.25	21.33	16.88	14.22	22.5	10.67
	1	15	16	22.5	10.67	30	8
	2	30	8	45	5.33	60	4
	3	45	5.33	67.5	3.56	90	2.67
	4	60	4	90	2.67	120	2
	4.5	67.5	3.56	101.25	2.37	135	1.78
20X/12*	0.75	15	16	22.5	10.67	30	8
	1	20	12	30	8	40	6
	2	40	6	60	4	80	3
	3	60	4	90	2.67	120	2
	4	80	3	120	2	160	1.5
	4.5	90	2.67	135	1.78	180	1.33
20X/13	0.75	15	17.33	22.5	11.56	30	8.67
	1	20	13	30	8.67	40	6.5
	2	40	6.5	60	4.33	80	3.25
	3	60	4.33	90	2.89	120	2.17
	4	80	3.25	120	2.17	160	1.63
	4.5	90	2.89	135	1.93	180	1.44

Note: "WD" = Working Distance "Mag." = Magnification "FD" = Field Diameter

Note: * - High eyepoint eyepiece



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