Instruction Manual

for

MODEL S-2300
SCANNING ELECTRON MICROSCOPE

Part No. 48E-9001
YN-G (HRR-LT)

MODEL S-2300
SCANNING ELECTRON MICROSCOPE

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AFTER-SALES SERVICE

For after-sales service of the instrument, the customer should consult with the local service agent.

The drawings and photographs contained in this manual illustrate main part names and part nos. (in **seven numerals** or **an alphabetic character plus six numerals**) for the order of spare parts.

PRECAUTIONS ON HANDLING

For the sake of safety, the following points should be taken into consideration.

1. PRECAUTIONS ON TRANSPORT

(1) Do not lift the instrument by holding the table. The microscope column and display unit weigh approx. 200 and 180 kg, respectively. The strength of table fitting is not sufficient for bearing these weights. Should the table be lifted, the table might slip off and an accident might occur. Hence, employ an appropriate method of transport other than lifting the table.

(2) Be sure to call servicemen in the event of transporting the instrument.

2. PRECAUTIONS ON INSTRUMENT

(1) Never attempt to access the inside of the instrument for check or repair since it involves a great danger. Should a trouble occur, promptly shut down the instrument and turn off the main switch on the power distribution board, then report to the local service agent.

(2) Secure ground connections.

3. GENERAL PRECAUTION

The maintenance not described in this manual should be done by the servicemen.

4. EMERGENCY OPERATION

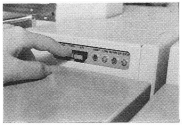
(1) Turn off the main switch on the power distribution board, and perform the operations described in "5. POWER INTERRUPTION/FAILURE".

(2) If water is leaking, close the valve of cooling water.

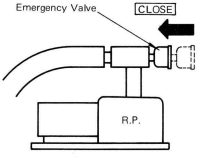
(3) After taking step (1) or (2), carry out other suitable measures.

(4) Inform the service shop.

5. POWER INTERRUPTION/FAILURE



(1) Press the **STOP** switch on the evacuating system operation panel.



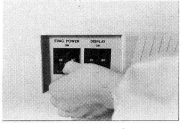
(2) Close the emergency valve of oil rotary pump.

Cautions

a) Do not open the emergency valve until power supply is recovered.

b) The emergency valve need not be closed except for power interruption or misoperation.

c) If the emergency valve is closed by mistake, then be sure to put the evacuating system in STOP status before opening the valve again.



(3) Turn OFF both **EVAC POWER** and **DISPLAY** switches.

(4) Turn off the power distribution board switch.

(5) Proceed as follows when power supply is recovered.

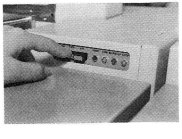
(a) Turn on **EVAC POWER** switch.

(b) Confirm **STOP** lamp is lighted.

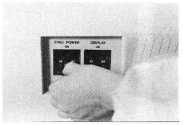
(c) Open the emergency valve of oil rotary pump.

(d) Turn **ON** the **DISPLAY** switch. This completes the procedures for re-energizing the instrument.

6. WATER INTERRUPTION



(1) Push **STOP** switch on the evacuating system operation panel. Confirm the **STOP** lamp lights up.



(2) Turn OFF both **EVAC POWER** and **DISPLAY** switches.

(3) Turn off the power distribution board switch.

7. OTHERS

(1) Keep the instrument room under the following conditions even when the instrument is not in operation.

- Room temperature . . . . . 15 to 30°C
- Humidity . . . . . Less than 70 % RH

Evacuate the instrument at least one day/week even if the instrument is not used for a long time.

(2) The D.P. cooling water drainage is of natural type and the maximum allowable height of the port is 10 cm above the floor.

(3) Use a reducing valve if the water pressure fluctuates excessively. Note that the water interruption protective device will operate and stop the instrument if the water pressure fluctuates too much. Set the water flow at 1 to 1.5 ℓ/min.

(4) When a water circulation bath is used, the water interruption relay-incorporated safety circuit will not be activated. Therefore, a flowrate switch need be provided.
Contact the local sales agent and servicemen.

(5) In the event cooling water supply is interrupted or its flow rate becomes inadequate, the overheat protective circuit is automatically activated. (Buzzer emits a continuous sound.)
In this case, press **STOP** switch on the evacuating system operation panel, wait until **STOP** lamp is lit and turn **OFF EVAC POWER** switch.
After eliminating the cause of overheat, turn **ON EVAC POWER** switch again. Note, however, that you must wait at least 15 minutes after overheat before turning on this switch.

(6) Avoid installing the instrument at a place where abrupt changes in current and/or magnetic field occur due to nearby power lines for equipment like a large magnet clutch etc.

(7) Make sure there is not a vibration source like a large machine tool or a highway, railway or the like in the near vicinity. And it is recommended to install the instrument on the first floor of the building.

SPECIFICATIONS

1. STANDARD SPECIFICATIONS

Resolution

4.5 nm (45 Å) guaranteed

Magnification range

20 ~ 200,000x

Electron optical system

Filament	Pre-centered hairpin type filament
Bias	Auto-bias system
Accelerating voltage	0.5 ~ 3 kV (0.1 kV STEP) 4, 5, 6, 7, 8, 10, 15, 20, 25 kV
Lens system	3-lens reduction system
Stigmator	8-pole electromagnetic system (X, Y)
Deflection coil	2-stage electromagnetic deflection system
Objective lens aperture	Movable aperture with 0.1, 0.2, 0.3, 0.4 mm dia. openings

Specimen stage

	Standard stage	Super eucentric stage
X-traverse	0 ~ 80 mm (continuous)	0 ~ 32 mm (continuous)
Y-traverse	0 ~ 40 mm (continuous)	0 ~ 32 mm (continuous)
Tilt angle	–20 ~ + 90° (continuous)	–90 ~ + 90° (continuous)
Rotation angle	360° (continuous)	360° (continuous)
Z-traverse	5 ~ 35 mm (working distance WD, continuous)	5 ~ 35 mm (working distance WD, continuous)
Specimen size	150 mm dia. max.	125 mm dia max.
Specimen exchange	air introduction	air introduction

Display unit

CRT ..... (afterglow type 9 inch) x 1: Conforms to EIAJ standard

Scanning speed (Raster scan):

	X period (msec)	Y period (sec)	No. of scan lines
□	0.064	0.0167	525 (interlace)
▣	1	0.5	500
▣	4	2	500
▬	20/16.7	20/16.7	1000
▬	40/33.3	40/33.3	1000
■	0.5	0.16	250
PHOTO 1	20/16.7	40/33.3	2000
PHOTO 2	40/33.3	80/66.7	2000
PHOTO 3	80/66.7	160/133.3	2000

*) Two values correspond to 50 and 60-Hz regions respectively.

Electrical image shift ..... ±20 μm (X, Y); at 25 kV and WD 15 mm

(cont'd)

Image mode	• Auto focus • Auto stigmator • Auto brightness/contrast control • Data display • Auto focus alignment • Signal monitor • Waveform monitor • Aperture alignment • Image shift • Twin photo • Gamma control • Polarity reversion • Focus memory
Evacuating system	Type . . . . . Automatic valve control Vacuum gauge . . . . . Pirani gauge Ultimate vacuum . . . . . 1 x 10^{-5} Torr Vacuum pump . . . . . Oil diffusion pump : 400 ℓ/sec x 1 Oil rotary pump : 160 ℓ/min x 1 Evacuating time . . . . . About 3 min
Safety device	Safety devices for water supply interruption and vacuum deterioration are provided.
Power supply	100 V AC ± 10 %, 50/60 Hz, 2 kVA Power consumption . . . . . 1.8 kVA
Water facilities	Flow rate . . . . . 1 ~ 1.5 ℓ/min (0.26 ~ 0.4 gpm) Pressure . . . . . 0.5 ~ 2 kg/cm² (7 ~ 29 psi) Use a reducing valve if water pressure fluctuates excessively. Temperature . . . . . 10 ~ 20°C (50 ~ 68°F) Supply port . . . . . Chemical faucet of 10 mm dia. (x 1) (City water hose should be connectable.) (It is recommended to use a filter if water contains much mineral deposit.) Drainage . . . . . Natural drainage
Ambient conditions	Temperature . . . . . 15 ~ 30°C (59 ~ 86°F) Humidity . . . . . Less than 70 % RH Vibration . . . . . Less than 5 Hz, 3 μmp-p
Dimensions	Main console . . . . . 600 (W) x 1000 (D) x 1520 (H) mm; 200 kg Display unit . . . . . 1100 (W) x 900 (D) x 1170 (H) mm; 180 kg Rotary pump . . . . . 200 (W) x 478 (D) x 293 (H) mm; 27 kg x 1 Weight . . . . . 200 (W) x 180 (D) x 160 (H) mm; 40 kg

2. STANDARD EQUIPMENT

Main console 1
Display unit 1
Rotary pump 1
Standard tools and attachments . . . . . 1 set
Instruction manual 1

Section I.
FUNCTIONS

1-1 CONTROLS ON DISPLAY UNIT

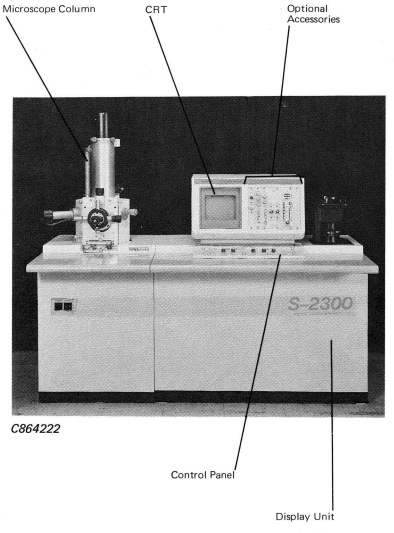


Fig. 1-1 Model S-2300 SEM (with super eucentric stage)

1-1-1 Control Panel

ACC VOLTAGE Display

Indicates accelerating voltage.

A voltage selected by **ACC VOLTAGE** switch is displayed. Display is extinguished with accelerating voltage turned off.

MAGNIFICATION Display

Indicates magnification and focal distance.

When shortening working distance, minimum magnification is limited.
Indicates focal distance (mm) when FOCUS mode is at MANUAL.

SCANNING SPEED Switches

Select scanning speed.

- : TV scan
- : Slow scan (Y cycle 0.5 sec)
- : Slow scan (Y cycle 2 sec)
- : Slow scan (Y cycle 20/16.7 sec, 50/60 Hz)
- : Slow scan (Y cycle 40/33.3 sec, 50/60 Hz)
- : Reduce area (scan within limited area)

In case a single switch is used for selecting two speeds, they are selected alternately.

IMAGE MODE Switch

Displays image brightness.
(signal monitor) and
(waveform monitor) are
selected alternately.

DATA DISPLAY Switch

Turns on/off data display.

TWIN Photo Switch

Used to expose the left or right half of image when photographing.

EMISSION CURRENT (μA) Display

Indicates emission current by color bar.

READY Lamp

Extinguished to indicate poor vacuum.

Flickers to indicate necessity of continuing evacuation further for a short time.

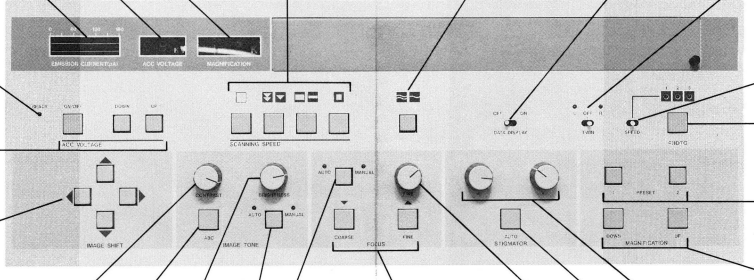
Stays lit to indicate attainment of adequate vacuum.

SPEED Selector Switches

Select film exposure time.

- **1** : 40 sec/frame
- **2** : 80 sec/frame
- **3** : 160 sec/frame

Lamp of the selected switch lights up and flickers during film exposure.



ACC VOLTAGE Switches

Set accelerating voltage.

- **ON/OFF** switch : Turns on/off accelerating voltage.
- **DOWN** switch : Changes high to low accelerating voltage.
- **UP** switch : Changes low to high accelerating voltage.

PHOTO Switch

Exposes film.
Press again for command cancellation.

PRESET Switches

Preset magnification.
Selection is possible between two values via **1** or **2**. Each preset value is alterable.

IMAGE SHIFT Switches

Electrically shift image field.

IMAGE SHIFT:

Electric field shifting controls

◀□ □▶ : X control

▲ □ □ ▼ : Y control

Upon depressing one each of X and Y pushbuttons simultaneously, the field is shifted diagonally.

Neutral presetting
Upon depressing two X pushbuttons simultaneously, the field shift due to image shift is reduced to zero (shifted to the center).

CONTRAST Control

Adjusts contrast.

Effective only when **ABC** mode selector switch is at MANUAL.

ABC Switch

Used for automatic image adjustment.

Functions only when the ABC mode selector switch is at AUTO.

BRIGHTNESS Control

Adjusts brightness.

Effective only when ABC mode selector switch is at MANUAL.

ABC Mode Selector Switch.

Selects AUTO or MANUAL (with lamp indication).

FOCUS Mode Selector Switch

Selects AUTO or MANUAL (with lamp indication)

FOCUS Switches

Mode	▼□ COARSE	▲□ FINE
MANUAL	Increases focal length (reduces objective lens current)	Reduces focal length (increases objective lens current)
AUTO	Auto focus coarse adjustment	Auto focus fine adjustment

STIGMATOR X, Y Controls

Correct astigmatism.

STIGMATOR AUTO Switch

Employed for automatic astigmatism correction.

FINE Control

Finely adjusts focus.

MAGNIFICATION Switches

Change magnification.

- **DOWN** : Changes high to low magnification.
- **UP** : Changes low to high magnification.

Fig. 1-2 Control Panel

1-1-2 Sub-Panel

The sub-panel is provided with controls which are not frequently used in routine operations.

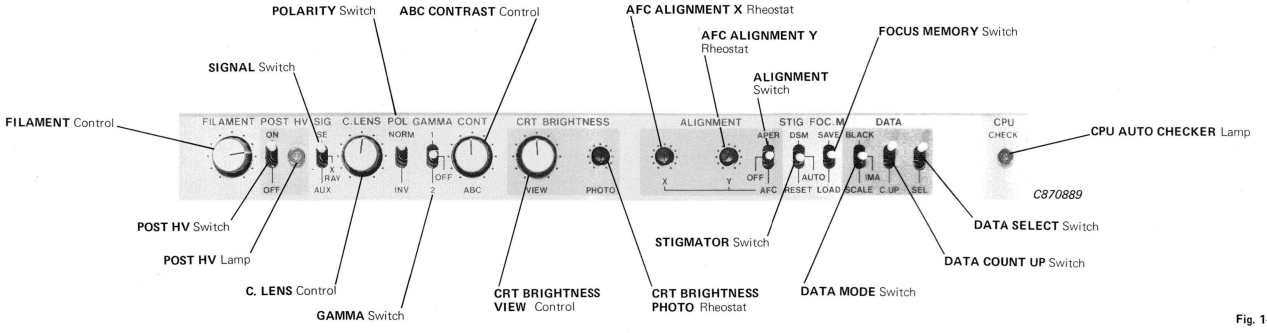


Fig. 1-3 Sub-Panel

FILAMENT Control : Adjusts filament heating current.

POST HV Switch : Applies post high voltage for collecting secondary electrons.

POST HV Lamp : Indicates application of post high voltage for collecting secondary electrons.

SIGNAL Switch : Selects signal to be displayed on CRT.
- **SE** ; Secondary electron signal
- **X-RAY** ; X-ray signal
- **AUX** ; Auxiliary input signal (such as reflected electron and cathodoluminescence signals)

C. LENS Control : Adjusts condenser lens current.

POLARITY Switch : Inverts image brightness and contrast.
Image is inverted at **INV.**

GAMMA Switch : Used to adjust the image.
- **1** ; Image contrast is increased
- **OFF** ; Normal image quality
- **2** ; Part of image with strong contrast is suppressed, and part with weak contrast is increased

CRT BRIGHTNESS VIEW Control : Adjusts brightness on viewing CRT.

CRT BRIGHTNESS PHOTO Control : Adjusts brightness on photographing CRT.

CPU AUTO CHECKER Lamp : Supervises CPU.
Always supervises whether the CPU is functioning normally.

ALIGNMENT Switch : Aligns the axis of objective movable aperture and adjusts auto focus function.
- **APER** ; Adjusts objective movable aperture so as to minimize image escape in **X** and **Y** directions when image blurs
- **AFC** ; Enables **X** and **Y** control so that image rotates around the center of CRT

AFC ALIGNMENT X Y Rheostats : Used for auto focus alignment.
Functions only when **ALIGNMENT** switch is at **AFC.**

STIGMATOR Switch : Selects astigmatism correction mode.
- **DSM** ; Monitors astigmatism correction. A cross mark appears on CRT. Adjust **X** and **Y** controls on control panel until image is focused around the intersection of this mark.
- **AUTO** ; Selects automatic astigmatism correction
- **RESET** ; Reduces the effect of automatic astigmatism correction to zero. Consequently, only manual astigmatism correction (with **X** and **Y** controls on control panel) becomes valid.

FOCUS MEMORY Switch : Saves focal length (objective lens current value).
- **SAVE** ; Saves current focal length
- **LOAD** ; Loads saved focal length

DATA MODE Switch : Selects data display form.
- **BLACK** ; Displays data on black background
- **IMA** ; Superimposes data on image
- **SCALE** ; Superimposes only micron scale and micron bar on image

DATA COUNT UP Switch : Enters a numeral at the film number location selected by **DATA SELECT** switch.

DATA SELECT Switch : Selects the location of film number.

1-1-3 Evacuating System Operation Panel

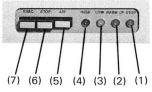


Fig. 1-4 Evacuating System Operation Panel

(1) **STOP** lamp:
Indicates that evacuation valve is at **STOP** position. Refer to item 1-2-3.

(2) **WARM UP** lamp:
Indicates that the diffusion pump (D.P.) is warming up.
The D.P. is not ready for operation while this lamp is lit.

(3) **LOW** lamp:
Lights when the column is at low vacuum conditions.

(4) **HIGH** lamp:
Lights when the column is at high vacuum. It permits high voltage operation.

(5) **AIR** switch:
This switch is used for introducing air into the column.

(6) **STOP** switch:
This switch, when depressed, stops the evacuating system operation.

(7) **EVAC** switch:
The column is automatically evacuated by depressing this switch.

1-2 CONTROLS AND SWITCHES OF MICROSCOPE COLUMN

1-2-1 Column

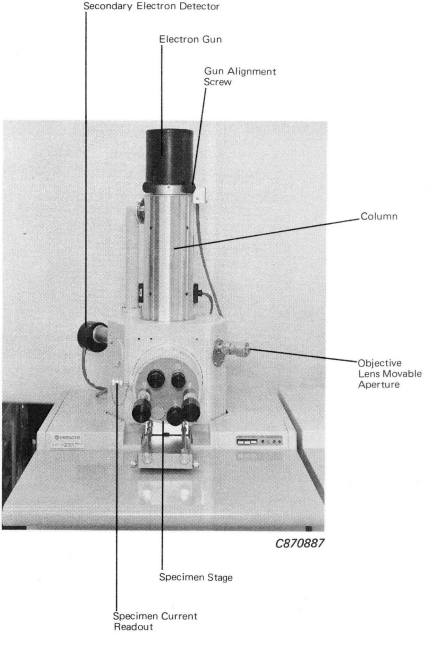


Fig. 1-5 Column and Specimen Stage (with standard stage)

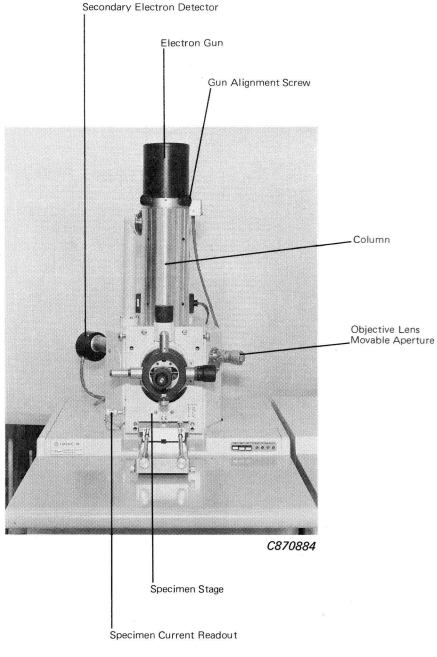


Fig. 1-6 Column and Specimen Stage (with super eucentric stage)

1-2-2 Specimen Chamber and Specimen Stage

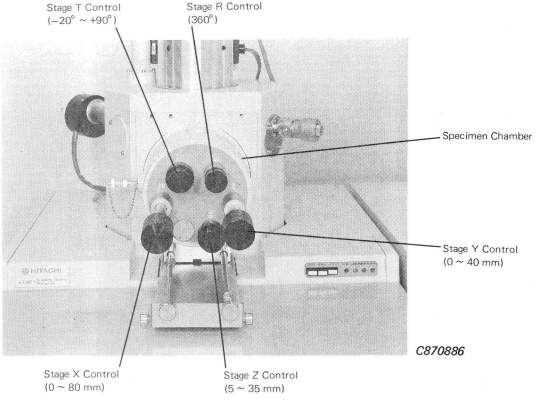


Fig. 1-7 Specimen Chamber and Specimen Stage (standard)

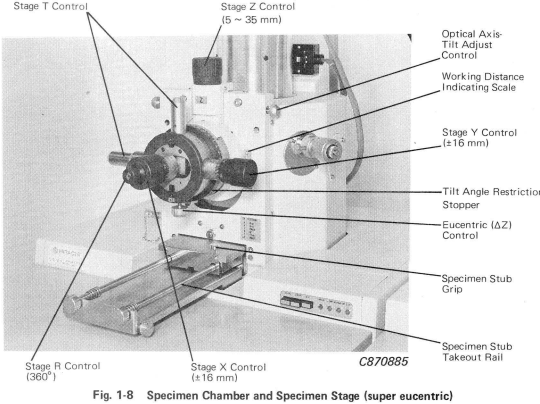


Fig. 1-8 Specimen Chamber and Specimen Stage (super eucentric)

1-2-3 Block Diagram of Evacuating System

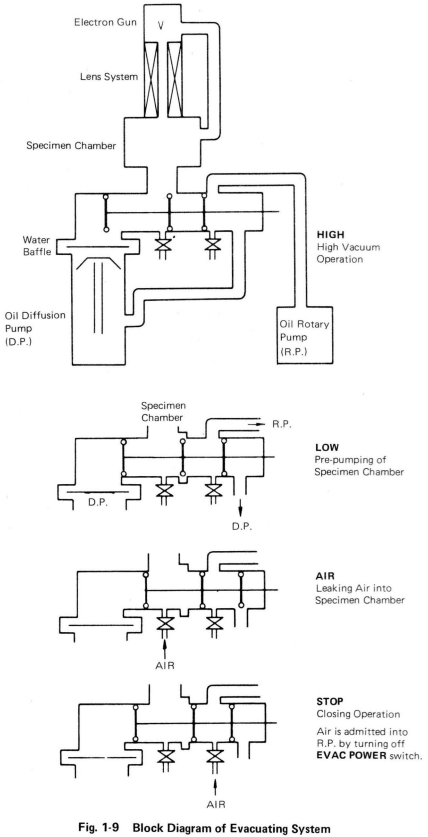
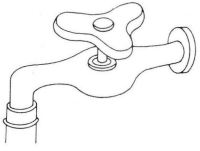


Fig. 1-9 Block Diagram of Evacuating System

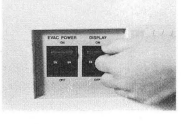
Section II.
OPERATION

2-1 PRELIMINARY OPERATION

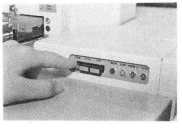


(1) Run cooling water at a flow rate of 1 to 1.5 ℓ/min.

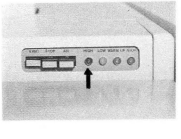
(2) Turn on the switch of the power distribution board.



(3) Turn on the **EVAC POWER** and **DISPLAY** switches.



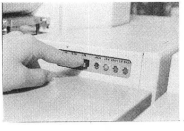
(4) Depress the **EVAC** switch.
WARM UP and **LOW** lamps are lighted.



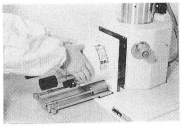
(5) Wait about 20 min until the **HIGH** lamp is turned on.

2-2 SPECIMEN EXCHANGE (WITH STANDARD STAGE)

(1) Press the **ACC VOLTAGE ON/OFF** switch to turn off accelerating voltage



(2) Press the **AIR** switch.
Air is admitted into the column in about 90 seconds.

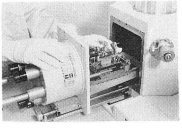


(3) Pull out the standard stage.

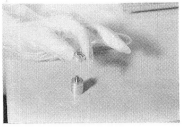
Caution

Be sure to set the standard stage controls as follows:

X	30 mm
Y	20 mm
T	0°
R	Free
Z	**EX** position



(4) Remove the specimen holder.



(5) Remove the specimen stub for the previous observation from the specimen holder.

(6) Mount a new specimen on the specimen stub.

(7) Fix the specimen stub on the specimen holder securely.

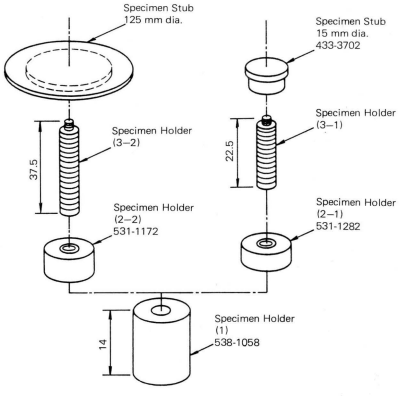


Fig. 2-1

(8) Loosen the specimen holders (1) and (2–1) or (2–2), adjust the specimen height to the gauge and fasten. Adjustment height depends on specimen stub. For the position, see Figs. 2-2 and 2-3.

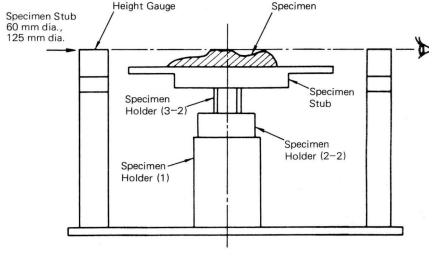


Fig. 2-2 Specimen Height Adjustment (specimen stub 60 mm dia., 125 mm dia.)

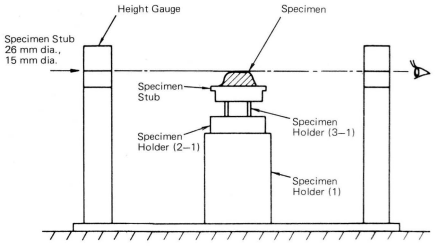
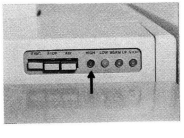


Fig. 2-3 Specimen Height Adjustment (specimen stub 26 mm dia., 15 mm dia.)

(9) Set the specimen holder assembly on the standard stage and push it in until it stops.

(10) Push in the standard stage and press the **EVAC** switch.
Evacuation automatically proceeds.



(11) Wait about 3 or 4 minutes until the **HIGH** lamp is lit on the evacuating system operation panel.

(12) The **READY** lamp starts flickering and then stays lit.
Press the **ACC VOLTAGE ON/OFF** switch to apply accelerating voltage and observe an image.

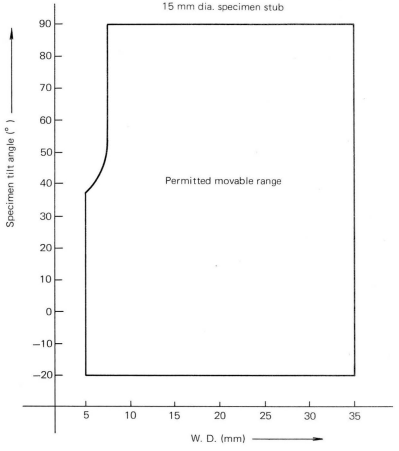
• Specimen Movable Range with Standard Stage

Kippwinkel

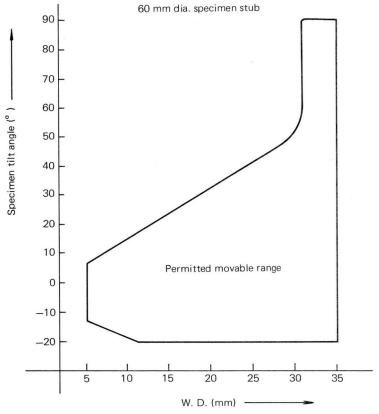
Graphs below indicate the interrelation between tilt angle and working distance when specimen is very thin, or can be regarded as nearly zero.

In case specimen has a considerable thickness, the working distance stands for the distance from the specimen top to objective lens.

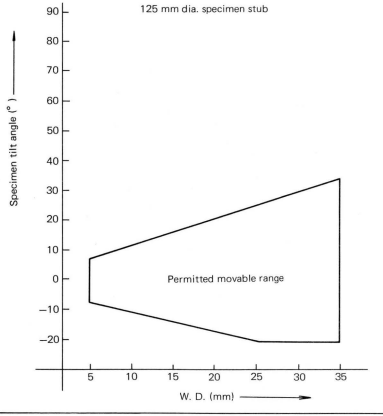
(1) Interrelation Between WD (Working Distance) and Specimen Tilt Angle With 15 mm Dia. Specimen Stub



(2) Interrelation Between WD and Specimen Tilt Angle With 60 mm Dia. Specimen Stub



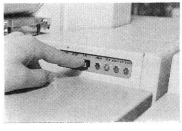
(3) Interrelation Between WD and Specimen Tilt Angle With 125 mm Dia. Specimen Stub



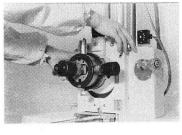
2-3 SPECIMEN EXCHANGE (WITH SUPER EUCENTRIC STAGE)

2-3-1 Specimen Exchange

(1) Depress the **ACC VOLTAGE ON/OFF** switch to turn off accelerating voltage.



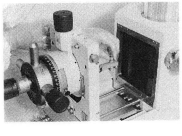
(2) Push the **AIR** switch.
Air is admitted into the column in about 90 seconds.



(3) Pull out the super eucentric stage.

Caution
Be sure to set the super eucentric stage controls as follows:

X	0 mm
Y	0 mm
T	0°
R	Free
Z	15 mm
ΔZ	Free

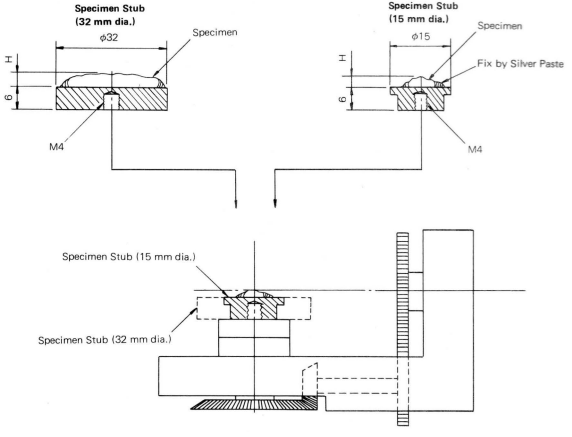


(4) Remove the specimen stub.

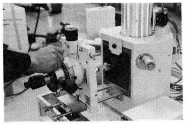
Caution
The specimen stub is removed by turning it counterclockwise by the right hand while holding the bevel gear in the rotating section of the specimen stub by the left hand. To use the instrument in the best condition, wear vinyl gloves for the purpose of eliminating contamination through bare hands.

(5) Set the specimen stub which is accommodated with a new specimen by reversing the procedure from step (4) above.

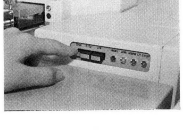
(6) A new specimen must be mounted on the specimen stub as instructed below.



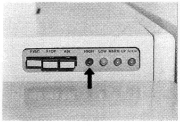
2 kinds of specimen stubs having a diameter of 32 or 15 mm have been prepared as a standard accessory.
Use them depending on the size of a specimen.
A eucentric adjustment of specimen height H is possible within a range of 6 mm.



(7) Return the super eucentric stage to the specimen chamber.



(8) Press the **EVAC** switch.



(9) Wait about 3 to 4 minutes until the **HIGH** lamp lights up.

(10) The **READY** lamp starts flickering, and then remains lit.
Press the **ACC VOLTAGE ON/OFF** switch to apply accelerating voltage and observe an image.

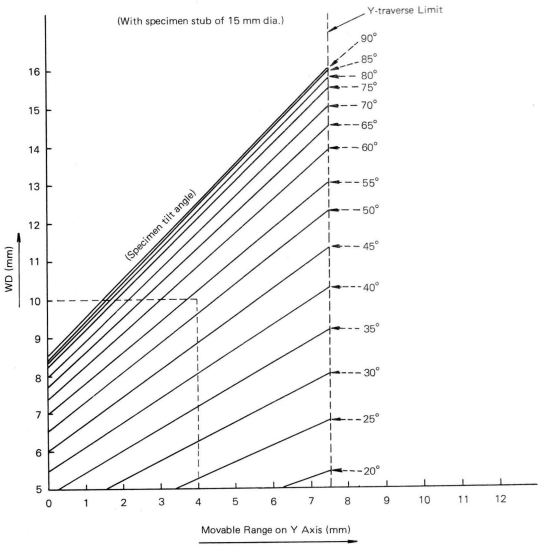
(11) Relationship among specimen stub size, working distance, specimen tilt angle and displacement.
In the case of tilted-specimen observation, the variable range is mutually restricted among specimen size, working distance, specimen tilt angle, etc. If this is neglected, a trouble might occur on maintenance of the instrument. So arrange each condition with reference to the tables (A) and (B) below.

(A) With specimen stub of 15 mm dia.

At working distance longer than 16 mm	X nonrestricted	Y traverse: ±7.5 mm (full range covered) Tilt angle: 0 ~ 90°
At tilt angle lower than 18°	X nonrestricted	Y traverse: ±7.5 mm (full range covered) Working distance: 5 ~ 35 mm
At working distance shorter than 16 mm or tilt angle higher than 18°	X nonrestricted	Refer to Fig. 2-4.

(B) With specimen stub of 32 mm dia.

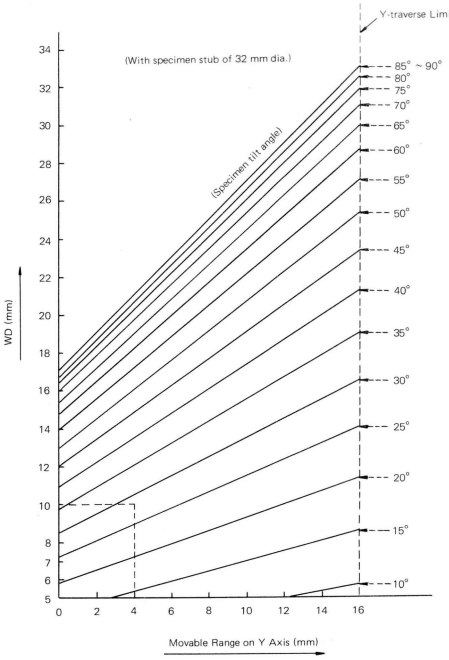
At working distance longer than 33 mm	X nonrestricted	Y ±16 mm (full range covered)	Tilt angle 0 ~ 90°
Tilt angle lower than 9°	Same as above	Same as above	Working distance 25 ~ 35 mm
At working distance shorter than 33 mm or tilt angle higher than 9°	Same as above	Refer to Fig. 2-5.	



Remarks
Y traverse is freely possible within a range of ±7.5 mm when the working distance is wider than 16 mm and the tilt angle is lower than 18°. In any other WD and tilt angle settings, the abscissa indicates the Y traverse range (absolute value). In case the ±Y range and tilt angle have been set, the ordinate reads the minimum WD. In case the WD and ±Y range have been set, you must select the tilt angle indicated by an oblique line which passes just below the crossing point of the WD and Y-range readings.
Example (indicated by dashed line in figure)
When WD and Y traverse range are 10 mm and ±4 mm, tilt angle must be lower than 50°.

Reference
WD when Y mm = ±7.5 mm (covers full specimen stub) equals $\sin\theta^\circ \times 16$.
WD when Y mm = 0 mm (specimen only tiltable) equals $\sin\theta^\circ \times 8.5$.

Fig. 2-4 Mutual Restriction among WD, Specimen Tilt Angle and Y Traverse



Remarks
Y traverse is freely possible within a range of ±16 mm when the working distance is wider than 33 mm and the tilt angle is lower than 9°. In any other WD and tilt angle settings, the abscissa indicates the Y traverse range (absolute value). In case the ±Y range and tilt angle have been set, the ordinate reads the minimum WD. In case the WD and ±Y range have been set, you must select the tilt angle indicated by an oblique line which passes just below the crossing point of the WD and Y-range readings.
Example (indicated by dashed line in figure)
When WD and Y traverse range are 10 mm and ± 4 mm, tilt angle must be lower than 25°.

Reference
WD when Y mm = ±16 mm (covers full specimen stub) equals $\sin\theta^{\circ} \times 33$.
WD when Y mm = 0 mm (specimen only tiltable) equals $\sin\theta^{\circ} \times 17$.

Fig. 2-5 Mutual Restriction among WD, Specimen Tilt Angle and Y Traverse

(12) If you think it tedious to follow the relationship among the specimen stub size, working distance, tilt angle and specimen displacement detailed in (11) above, you can use the fixture which is a standard accessory for helping visually read out each restriction. Carry out the following steps (a) to (f) before returning the specimen stage to the specimen chamber after mounting the specimen stub.

(a) Attach the furnished fixture to the specimen chamber.

(b) Pull back the super eucentric stage until the specimen stub on it comes right below the fixture, and then fix the stub by the specimen stub clip knob.

(c) Determine any one of the working distance, tilt angle and Y displacement. Adjust the remaining two factors so that the lower end of the fixture comes nearest to the specimen stub, and write down the values on a notebook or the like.

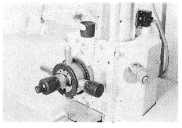
(d) Loosen the specimen stub clip knob and pull out the specimen stage slightly. After removing the fixture, return the stage to the specimen chamber.

(e) Actual operation must be performed below the limit recorded in (c).

(f) Shown below is an example of efficiently satisfying the steps (c), (d) and (e).

First, select a working distance and shift the Y-location up to the radius of the specimen stub. Next, tilt the specimen stage on the plus (+) and minus (–) sides until the specimen stub comes just before contact with the fixture. Matching with a higher angle on either (+) or (–) side at this time, set the (+) (–) tilt angle restriction stopper.

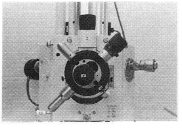
2-3-2 Working Distance (WD: 5 to 35 mm)



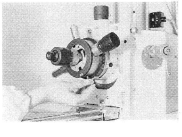
Working distance is mechanically indicated on the working distance scale. Set a desired distance in consideration of (11) and (12) in 2-3-1. The aforementioned instructions must be observed strictly when changing a working distance while a specimen is tilted.
Working distance is controllable freely either in vacuum or under atmospheric pressure.

2-3-3 Super Eucentric Control (1)

With the super eucentric specimen stage, image focus will not be affected upon shifting the field of view by the X/Y fine controls. Besides, image escape on CRT is only slight when tilting a specimen at the center of its visual field. For this tilting method, two conditions must be met as detailed below. One is to align the specimen tilting axis with the electron-optical axis. This axial alignment is unnecessary because the optical/tilting axis alignment knob has been factory-adjusted. Avoid tampering with the knob though it has been fixed. Should the knob be moved due to some reason, make readjustment with reference to 2-3-4.
The other is to align the specimen surface with the tilting axis. This can be accomplished by the following procedure.

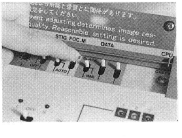


(1) Form an image at a low magnification and gradually tilt a specimen up to ±45°.

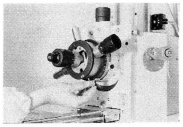


(2) In the course of tilting, the image on CRT will continue escaping in any direction. So, gradually turn the eucentric control knob in a direction permitting the image to return to the original location. Repeat this step until image escape is minimized. (Whenever manipulating the eucentric control knob, the image will blur. During this step, therefore, it must be brought into focus repeatedly by effecting the auto focus function.)

(3) Increase magnification and repeat steps (1) and (2) until a desired magnification is reached. Widen the tilt angle up to a desired level.



(4) Bring the image into just focus at a tilt angle of 0°, and then turn the FOC. M switch to SAVE.



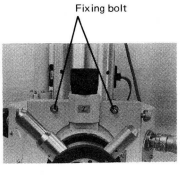
(5) Image escape will become wide upon tilting the specimen after shifting the field of view. This is due to topography of the specimen surface. In such a case, turn the FOC. M switch to LOAD and adjust the eucentric control knob until the image is just focused.

(6) After exchange to a new specimen, the above step (5) is recommended. This ensures a specimen observation with minimal image escape.

(7) Upon turning off the DISPLAY switch, the memory of focus current is erased. So the adjustments in (1) through (4) are required again before resuming operation.

(8) In case the eucentric control is not employed, the above steps (1) through (6) are unnecessary.

2-3-4 Super Eucentric Control (2)



As mentioned before, two conditions must be met for tilting a specimen at the center of its field of view. And one of the conditions has already been satisfied because of shipment after factory adjustment. If the adjuster should be manipulated due to some reason, however, the super eucentric control cannot offer the original function adequately unless readjustment is made by the following procedure.

(1) Loosen the fixing bolts (2) shown in the above photograph with the furnished hex. key wrench.

(2) Match the stage Y control with the scale division "0" and set a working distance (Z control) of 15 mm. (If an image is not present on CRT, select the field of view by adjusting the stage X and specimen rotation controls.)

(3) Form a low magnification image on CRT and tilt the specimen from 0° to about +45°. In this process, check the direction and degree of image escape on CRT.

(4) Return tilt angle to 0°.

(5) Tilt the specimen from 0° to about −45°. During this process, check and record the direction and degree of image escape on CRT.

(6) Compare the check data in (3) and (5) against Table 2-1, and select a corresponding method of adjustment.

Table 2-1

Direction of Image Escape	Degree of Image Escape	Adjusting Procedure
Same in both (+) and (−) tiltings	Almost same between (+) and (−) tiltings	(a)
	Wider in either (+) or (−) direction	(b)
Opposite between (+) and (−) tiltings		(c)

Note

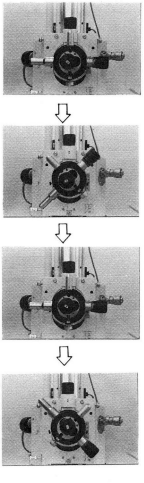
Example of selection of adjusting procedure

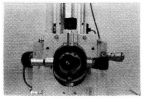
The image at the center of CRT escaped upward to a large extent upon tilting at +40°. It escaped upward to a small extent upon tilting at −40°. As a result, the direction of image escape is the same and the degree in one direction is larger than in the other. In this case, the adjusting procedure (b) must be selected.

(7) Adjusting procedure (a)

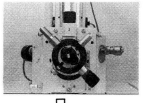
Use the optical axis-tilting axis alignment knob for this adjustment.

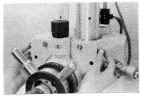
(i) Reconfirm that an image escapes in the same direction and to almost the same degree upon tilting the specimen as shown in the figures at the left.





(ii) After reconfirmation, tilt the specimen at about 45° in either (+) or (—) direction.

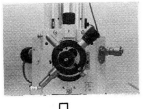




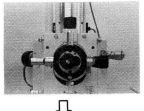
(iii) Adjust the optical axis-tilting axis alignment knob so as to return the escaped image to the center of CRT.

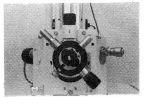
While gradually increasing the magnification, repeat this adjustment until image escape is minimized.
After adjustment, retighten the fixing bolts firmly.

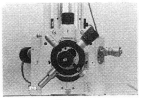
(8) Adjusting procedure (b).

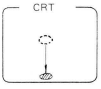


(i) First, conditions must be arranged so as to meet those corresponding to the adjusting procedure (a) by using the eucentric control knob. Confirm that the image escapes in the same direction and widely in either (+) or (—) direction upon tilting the specimen as shown in the figures at the left.

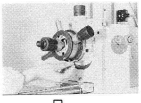


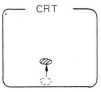




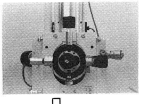


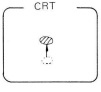
(ii) After confirmation, tilt the specimen at 45° in the direction in which image escape is larger.



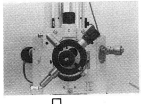


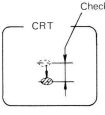
(iii) Turn the eucentric control knob slightly in the direction in which the escaped image is able to return to the center of CRT.



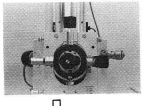


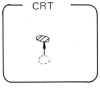
(iv) Return the tilt angle to 0°.



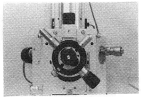


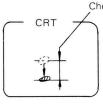
(v) Tilt the specimen at 45° in the same direction as above once again and check the degree of image escape.





(vi) Return the tilt angle to 0° once again.

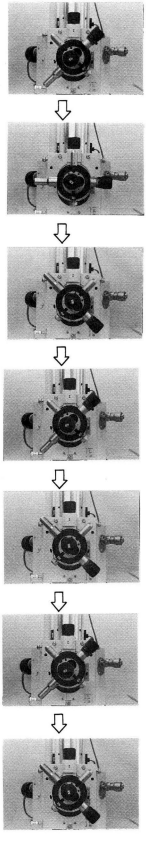




(vii) Tilt the specimen at about 45° in the direction opposite to that in (ii), and check the degree of image escape.

While gradually increasing the magnification, repeat this adjustment until the degree of image escape nearly equals between (+) and (−) 45° angles. After adjustment, effect the adjusting procedure (a) in (7).

(9) Adjusting procedure (c)



(i) Conditions must be arranged so as to meet those corresponding to the adjusting procedure (b) in (8), and then the adjusting procedure (a) in (7) must be effected.
First, confirm that the image escapes in the opposite directions.

(ii) After confirmation, form a low magnification image and tilt the specimen at about ±45°. Make adjustment as in 2-3-3 (1) and (2).

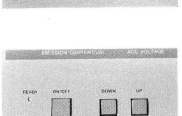
(iii) After minimizing image escape, tilt the specimen in both (+) and (−) directions and confirm that the image escapes in only one direction. (There is no problem even though the degree of image escape differs between the (+) and (−) directions.) If that is confirmed, effect the adjusting procedure (b) in (8), and then that (a) in (7).

(iv) In case image escape is minimal and has the same degree in opposite directions upon tilting the specimen in the (+) and (−) directions, the optical axis-tilting axis alignment knob need not be adjusted. In this case, tighten the fixing bolt firmly with the furnished hex. key wrench.

(10) The adjustments in (1) through (8) must be repeated while increasing the magnification as in 2-3-4 (1), (2). Adjustment is possible to such an extent that an image at the center of CRT does not fade out from CRT when tilted at about ±40° at a magnification of 4,000 to 5,000x. Although this adjustment is required only once, accuracy may vary after a wide change of working distance.

2-4 IMAGE OBSERVATION

(1) Confirm that the **HIGH** vacuum lamp is lit.



(2) When vacuum reaches a certain level, the **READY** lamp flickers (for about 1 min). Lower accelerating voltages (0.5 and 2 kV) can be normally applied in this status. But application of higher accelerating voltages (4 ~ 25 kV) may cause an electric discharge. So wait until the **READY** lamp lights up steadily before using the higher voltages.

(3) Press the **ACC VOLTAGE ON/OFF** switch to apply accelerating voltage. Use the **UP** switch for increasing the accelerating voltage, and the **DOWN** switch for reducing it. Listed below are selectable accelerating voltages.

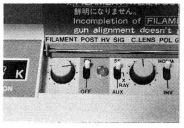
0.5 to 3 kV (in 0.1 kV steps)
3 to 8 kV (in 1 kV steps)
10 to 25 kV (in 5 kV steps)

For setting of accelerating voltage, refer to "2-5".

Note: When accelerating voltage is turned off, neither signal monitor nor waveform monitor is selectable by pressing the **SCANNING SPEED** ≋ / ≋ switches. This is because the CRT must be protected from burning.

(4) Confirm that emission current is flowing.

Note
Reading on the **EMISSION CURRENT** display (by means of color bar) starts rising at about 2 seconds after setting an accelerating voltage. This is required for preventing filament burnout due to an overcurrent.

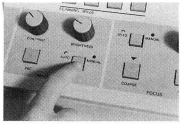


(5) Make the following settings of the switches inside the sub-panel.

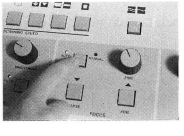
- **POST HV** switch turned on (this lights **POST HV** lamp)
- **SIG** switch set to **SE**

(6) Match the **C. LENS** knob (condenser lens current) with approximately 11 o'clock direction.
(Turning the knob clockwise improves resolution. Select an optimum position with reference to Table 2-5 in 2-15.)

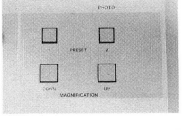
(7) Confirm that the axial alignment of the electron-optics has already been completed. (See 2-13 and 2-14.)



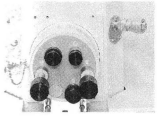
(8) Turn the **ABC** mode selector switch to **AUTO** and press the **ABC** switch a few times in order to adjust an image.
For image adjustment, refer to (2) and (3) of 2-9.



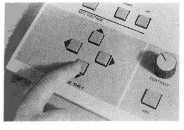
(9) Set the **FOCUS** mode selector switch to **AUTO** and press the **FOCUS COARSE** or **FINE** switch, thereby focusing an image by use of the auto focus function. For focusing, refer to (2) through (4) of 2-6.



(10) Set a magnification by the **MAGNIFICATION DOWN** or **UP** switch.
Magnification is indicated on the **MAGNIFICATION** display.
For magnification setting, refer to 2-8.



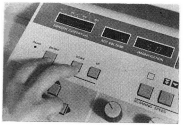
(11) At a low magnification, select the field of view by manipulating the ◁▷ (X), ⇳ (Y), ⟲ (T) and ↻ (R) knobs of specimen stage.



(12) At a high magnification (2,000x or higher), select the field of view by manipulating the electric field shifting switches **IMAGE SHIFT**. For usage of these switches, refer to "Control Panel" in 1-1.

2-5 SETTING OF ACCELERATING VOLTAGE

(1) Accelerating voltage is turned on by pressing the **ACC VOLTAGE ON/OFF** switch. Its value is 0.5 kV only when turning on the **DISPLAY** switch the first time. From the second time on, the value equals the previous setting before turning off accelerating voltage.

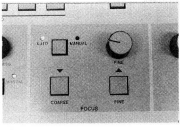


(2) For specimen exchange, etc., a high accelerating voltage (4 to 25 kV) may directly be turned off. Upon turning on again, the high accelerating voltage returns.
When you want to set a low accelerating voltage, however, the **ON/OFF** switch must be pressed (from OFF to ON) while depressing the **DOWN** switch, and setting will become possible from 0.5 kV.

(3) In case a low accelerating voltage need not be set immediately after turning on the display switch, the **ON/OFF** switch must be pressed (from OFF to ON) while depressing the **UP** switch, and setting will become possible from 3 kV.

2-6 FOCUSING

(1) Select a magnification and field of view in reference to (10) through (12) of 2-4.



(2) Coarsely adjust focus with the **FOCUS COARSE** and **FINE** switches in **AUTO** mode or ▲ and ▼ switches in **MANUAL** mode. Then finely adjust it by turning the **FINE** control.

(3) Usage of auto focus control

① The **AUTO**-mode **COARSE** switch is usable even if the profile of an image cannot be seen at all so far as the specimen is positioned within the determined range of working distance (5 to 35 mm). It is used for image observation just after insertion of a specimen and for focus adjustment at lower magnifications (1,000x or less).

② The **AUTO**-mode **FINE** switch is used for finely adjusting focus when an image has been focused to such an extent that its profile can be seen vaguely. Although depending on the conditions of a specimen, a just-focused image as excellent as that obtained by meticulous manual adjustment can be displayed up to 20,000 to 30,000x.

③ When the **COARSE** or **FINE** switch is depressed, CRT image disappears. After a few seconds, the buzzer sounds and the focused image is displayed. There are two kinds of buzzer sounds at the end of auto focus operation. The shorter sound indicates that the operation has been completed, while the longer sound notifies that the normal operation is impossible because the contrast is too strong or weak. In this case, reduce the contrast level or use the **ABC** function, and then depress the **COARSE** or **FINE** switch again.

④ When the auto focus control does not provide a high accuracy, auto focus alignment is required. (See 2-6 (5).)

⑤ The auto focus controls may not operate properly under the following conditions.

(a) The signal is too weak and image cannot be seen clearly in the TV scan mode. In particular, the **AUTO COARSE** control is difficult to operate. In such case it is recommended to employ manual focus control, referring to 2-6 (4). Note that the **AUTO FINE** control may function normally even if the **AUTO COARSE** control does not function.

(b) An excessive charge-up artefact occurs on specimen.

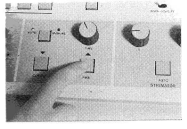
(c) The specimen consists of few structural components such as a silicon wafer, glass and polished surface. For such specimens, the **AUTO COARSE** control, in particular, is difficult to operate.

(4) Usage of manual focus control

① Turn the **FOCUS** mode selector switch to **MANUAL** mode.

② For a large focal length, press the ▼ switch, or the ▲ switch for a small focal length.

③ While the ▼ or ▲ switch is pressed, the **MAGNIFICATION** display indicates a current focal length. Pay attention since this value must be discriminated from working distance.



(5) Auto focus alignment

If the auto focus controls become incapable of adjusting focus accurately, perform auto focus alignment by the following method.

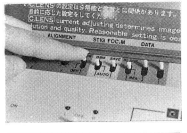
① Set a magnification of approximately 10,000 to 20,000x , and develop the image of an easy-to-observe specimen.

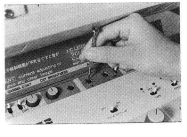
② Depress the **SCANNING SPEED** key ☐ (to select the TV scan mode).

③ Keep the **ALIGNMENT** switch on the sub-panel turned to **AFC**. On this occasion, **UNDER AFC ALIGNMENT** appears on the **CRT**.

④ Focus of the CRT image changes periodically. If the image moves in the top-bottom or left-right direction along with change of focus, adjust the **ALIGNMENT X** and **Y** rheostats by gradually turning with a screwdriver to that the image rotates with the axis at the center of CRT.

⑤ After adjustment, turn off the **AFC ALIGNMENT** switch.



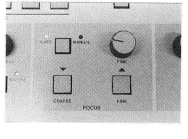


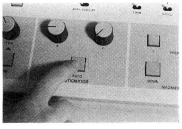
(6) If just-focus image is unobtainable by the auto focus function after the auto focus alignment, the objective lens movable aperture and the axis must be aligned again, referring to 2-13 and 2-14.

2-7 ASTIGMATISM CORRECTION

(1) Select a magnification and field of view with reference to (10) through (12) of 2-4.

(2) Bring an image into focus with the **FOCUS**-mode **AUTO, MANUAL** mode or **FINE** control.

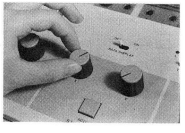




(3) If astigmatism is seen, the **STIGMATOR AUTO** switch should be pressed.

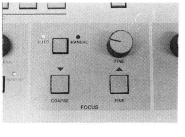
① On pressing the **AUTO** switch, image disappears from the CRT. After a few seconds, an astigmatism-corrected image appears. There are two kinds of buzzer sounds at the end of astigmatism correction.
The shorter sound indicates completion of astigmatism correction, while the longer sound reports that astigmatism correction is impossible.

② The auto stigmator control may not function normally. The cause is similar to that for the auto focus control. So eliminate undesirable conditions, referring to ⑤ of (3) "Usage of auto focus control" in 2-6. This trouble also occurs when defocus is significant.
It is therefore recommended to focus an image before employing the auto stigmator control.



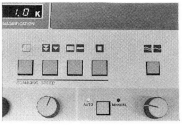
(4) In case the auto stigmator control does not function normally, the **STIGMATOR X/Y** controls can be utilized.
If correction is impossible even though the **X** and **Y** controls are turned fully, it is probable that the auto stigmator control is also providing a correction effect. Therefore, turn the **STIG** switch on the sub-panel to **RESET** in order to reduce that effect to zero, and then adjust the **X** and **Y** controls.

(5) In the event astigmatism correction is still impossible after implementing (4) above, the column inside is contaminated. So clean the objective and condenser apertures, referring to 3-3 and 3-4.



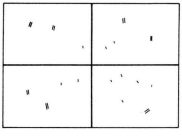
(6) Astigmatism correction by dynamic stigmator monitor

① Focus an image by using **FOCUS AUTO, MANUAL** mode or **FINE** control.

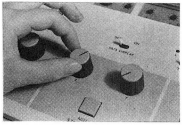


② Correction is possible when scanning speed mode is in any one of ▼, ▼, ▬ and ▬.

③ Turn the **STIG** switch on the sub-panel to **DSM**.



④ When the cross mark appears on the CRT, the image blurs entirely. However, watch carefully, and you will find a just-focused location.



⑤ Adjust the **STIGMATOR X/Y** controls until the image is focused at the intersection of the cross mark. This is enough to correct astigmatism.

⑥ Turn the **STIG** switch on the sub-panel to **AUTO**. The cross mark disappears and an astigmatism-free image appears.

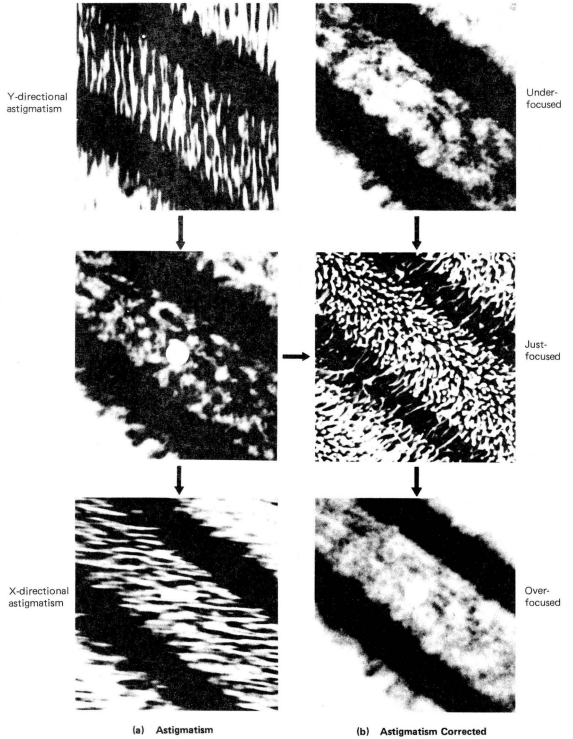
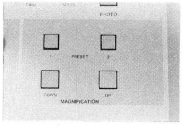


Fig. 2-6 Examples of Astigmatism Correction

(7) Figure 2-6 exemplifies confirmation of astigmatism presence/absence.

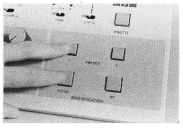
2-8 SETTING OF MAGNIFICATION



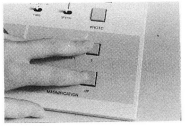
(1) Upon turning on the **DISPLAY** switch on the column side, magnification is set at 40x. **PRESET 1** and **2** settings are at 100x and 2,000x, respectively.

(2) Press the **PRESET 1** or **2** switch for fetching a preset magnification.

(3) For returning to the magnification before fetching a preset value, press again the same switch as in (2).
(This is unavailable if the **MAGNIFICATION DOWN** or **UP** switch is pressed before pressing the **PRESET** switch again.)

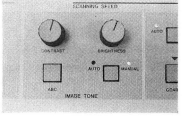


(4) In order to change a preset magnification, press the **MAGNIFICATION DOWN** or **UP** switch while depressing the **PRESET 1** or **2** switch. Preset magnification is updated to a value when releasing the **MAGNIFICATION** switch.



Note
Minimum magnification is restricted at each working distance.
(A substantial restriction is imposed particularly in the ☐ (TV) mode.)
Therefore, preset magnification may differ from your setting depending on its value.

2-9 PHOTO RECORDING



(1) Select a field of view. (Refer to (11) and (12) of 2-4.)
Determine magnification. (Refer to (10) of 2-4.)
Focus the image and correct its astigmatism.

(2) Automatic image adjustment

① Turn the **ABC** mode selector switch to **AUTO** mode.

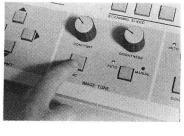
② Press the **ABC** switch, and both image brightness and contrast are automatically adjusted. This takes approx. 5 seconds.

③ Image recording is allowed after completion of automatic image adjustment by pressing the **ABC** button. In case proper brightness is unobtainable, the **CRT BRIGHT PHOTO** rheostat on the sub-panel must be adjusted with a blade-edge screwdriver. Brightness increases when turning the rheostat clockwise.

④ Press the **ABC** switch again if image adjustment does not reach optimum conditions even after about 5 seconds.
In case optimum adjustment is not accomplished after pressing the **ABC** switch repeatedly, the condenser current, objective aperture, specimen and other conditions need be checked.

⑤ In the event contrast cannot be optimized by **ABC** operation because of specimen conditions, etc., the **ABC CONT** control on the sub-panel should be adjusted followed by pressing the **ABC** switch again.
(The **ABC CONTRAST** control sharpens contrast when turned clockwise.)

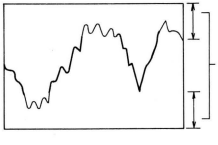
Note
The automatic image adjustment function cannot be activated by pressing the **ABC** switch on the control panel when the **POL** switch on the sub-panel is turned to **INV.**
(After about 2 seconds, the **CRT** displays **INV IMAGE CANNOT ACCEPT ABC**, and at the same time the buzzer sounds.)



(3) Manual image adjustment

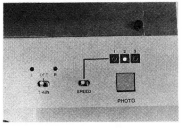
① Turn the **ABC** mode selector switch to **MANUAL**.

② Press the **SCANNING SPEED** ≋ / ≋ switch in order to activate the ≋ (signal monitor) mode.



③ Adjust the **BRIGHTNESS** and **CONTRAST** controls so that CRT waveform is scanned from top to bottom within the central zone in the lower figure. If scanning range is excessively smaller or longer than the central zone, optimum image tone is unavailable.

(4) Set data, referring to 2-11 "HOW TO USE DATA DISPLAY MODE".

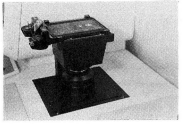


(5) Set the **TWIN** photo switch according to your microscopic purpose.

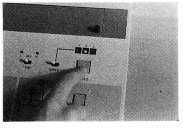
OFF : Exposes the full area on film.
RIGHT : Exposes only the right half of film.
LEFT : Exposes only the left half of film.

(6) Select an exposure time by **SPEED** switch. Lamp is lit at the selected switch.

1 : 40 sec/frame
2 : 80 sec/frame
3 : 160 sec/frame



(7) Load a film in the camera.
Refer to the instruction manual for the camera.



(8) Press the **PHOTO** switch.
Lamp flickers and raster is scanned on the CRT.
Avoid touching the instrument in the course of photographing.

Note
Photographing can be interrupted by pressing the **PHOTO** switch again.

Upon completion of raster scan, the lamp remains lit.

(9) Remove the film from the camera.

(10) Although brightness on the photographing CRT has been factory-adjusted, reference must be made to (2) of 2-10 in case further adjustment is required.

Notes
1. Do not press the ACC **VOLTAGE ON/OFF** switch during image recording, though accelerating voltage can be turned off for the sake of safety while photographing.
2. When employing the automatic image adjustment for photographing, make sure that the **ABC** mode selector switch is set at the **AUTO** mode.

2-10 CRT BRIGHTNESS CONTROL

(1) Turn the **CRT BRIGHTNESS VIEW** control on the sub-panel for adjusting brightness on the viewing CRT.
(Clockwise turn enhances brightness.)
Select a proper brightness so as to facilitate observation. Brightness on the photographing CRT remains unchanged.

(2) Insert a blade-edge screwdriver into the **CRT BRIGHTNESS PHOTO** rheostat in order to adjust brightness on the photographing CRT.
(Brightness increases upon turning the screwdriver clockwise.)
Note that CRT image brightness in the photo mode has been factory adjusted for films of ASA400 (TRI-X, Polaroid 4" x 5" type 52, etc.) with the camera aperture at 8.

For films other than the above, make adjustment with reference to Table 2-2.

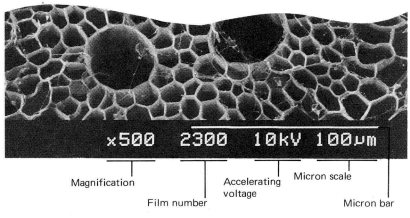
Table 2-2 CRT Brightness Control for Various Films

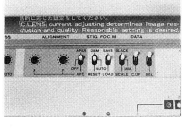
Type of Film				Sensitivity (ASA)	Brightness and focus adjustment
Roll film (Brownie)		SS	NEGATIVE	100	Increase brightness.
		SSS	NEGATIVE	400	Adjusted at F : 8.
		TRI-X	NEGATIVE	400	Same as above.
Polaroid	**Card-size**	105	POSITIVE/ NEGATIVE	75	Increase brightness.
		107	POSITIVE	3,000	Restrict aperture opening.
	4" x 5" (1 exposure)	P/N 55	POSITIVE/ NEGATIVE	50	Increase brightness.
		52	POSITIVE	400	Adjusted at F : 8.
	4" x 5" (8 exposures)	552	POSITIVE	400	Adjusted at F : 8.

2-11 USAGE OF DATA DISPLAY MODE

(1) Contents of display

- Display-enable scan speed: Scan speed ☐ ▼ ▼ ▬ ▬ for viewing
- Display symbol and character





(2) Switch operation (sub-panel)

DATA switches

BLACK	:	Displays data on black background
IMA	:	Displays data on image
SCALE	:	Displays micron bar scale alone

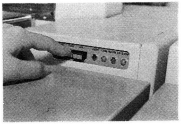
Film no. setting switches

SEL	:	Selects a digit to be set among 4 digits. A short cursor appears below a selected digit.
C. UP	:	Sets a value at a selected digit. At about 2 seconds after film no. setting, the cursor automatically disappears. When pressing **SEL** and **C. UP** switches simultaneously, only the lower 2 digits are reset. Display value in the lower 2 digits increments by 1 whenever recording an image. However, this does not occur if photographing is interrupted halfway.

Notes

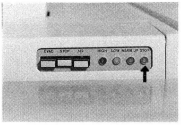
1. Film number is reset to zero when turning on the power supply.
2. Magnification data is not displayed in the **TWIN** mode.

2-12 SHUTDOWN

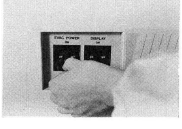


(1) Depress the **STOP** switch.

Note
Anterior to shutdown, confirm that the **HIGH** lamp is lit.

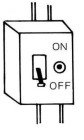


(2) Wait until the **STOP** lamp is lighted.

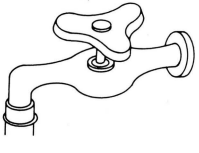


(3) Turn off the **EVAC POWER** and **DISPLAY** switches.

(4) Wait for about 20 minutes (until the oil diffusion pump cools down sufficiently).
WARMUP lamp comes on.



(5) Turn off the power distribution board switch.



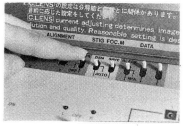
(6) Close cooling water valve.

2-13 ALIGNMENT OF OBJECTIVE LENS MOVABLE APERTURE

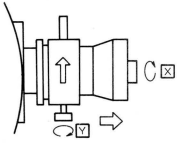
(1) Develop an image per 2-4.
Press the **SCANNING SPEED** ☐ (TV) switch. Select a magnification of approx. 5,000x.

(2) Select position of the objective lens movable aperture.

1 . . . . . 400 μm,
2 . . . . . 300 μm,
3 . . . . . 200 μm,
4 . . . . . 100 μm



(3) Turn the **ALIGNMENT** switch to **APER** on the sub-panel. On this occasion, image focus alters periodically and the image moves in the **X** and **Y** directions.
(CRT displays **UNDER APERTURE**.)



(4) Adjust the **X** and **Y** controls alternately until image escape is minimized.

(Aperture Movement)
On turning the **X** control in ↺ direction, aperture moves in ⇨ direction, and it moves in ⇦ direction on turning the **Y** control in ↻ direction, as shown at the left. When turning the **X/Y** control in the opposite direction, the above aperture movement is reversed.

(5) In case a higher magnification is required, repeat steps (3) and (4) at that magnification until image escape is minimized.

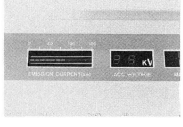
(6) After axial alignment, turn the **ALIGNMENT** switch to **OFF**.

Note
No image appears in the event the aperture bore is deviated substantially from the optical axis. In that event, set the lowest magnification possible, and widely adjust the **X** and **Y** controls so as to maximize CRT brightness.

2-14 ALIGNMENT AFTER FILAMENT EXCHANGE

(1) a) Confirm that the **HIGH** lamp is lit.
b) Set **MAGNIFICATION** at minimum.
c) Set the **SCANNING SPEED** at ☐ (TV).

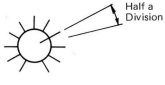
(2) Push the **ACC VOLTAGE ON/OFF** switch and select 25 kV.
Also confirm that the **SIG** switch on the sub-panel is turned to **SE** side.

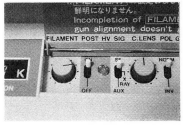


(3) Turn the **FILAMENT** control on the sub-panel gradually clockwise watching the **EMISSION CURRENT** meter (color bar). When the color bar (illumination) does not move any more, stop turning the control and return it by half a division.

When the **EMISSION CURRENT** meter reading is 150 μA or more, the filament tip is too close to the Wehnelt cylinder.
Reset the filament as per instructions given in item 3-2.
(Set the current at about 70 to 120 μA at 25 kV).

FILAMENT

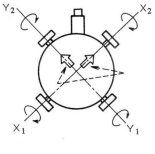




(4) Set the **C. LENS** control on the sub-panel to the middle position (or 12 o'clock position).

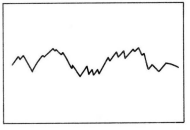
(5) Adjust the X_1 and X_2 screws as a pair, and the Y_1 and Y_2 screws similarly so as to maximize the CRT screen brightness.

If the CRT screen becomes too bright, reduce the brightness to a moderate level by operating the **BRIGHTNESS** and **CONTRAST** controls with the **ABC** mode selector switch at **MANUAL**.



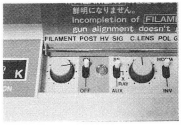
Notes

1. Left figure indicates the movement of the gun by manipulating the control screws.
   The electron gun makes reverse movement when turning the X_1 and X_2, or Y_1 and Y_2 controls simultaneously in the direction opposite to that shown in the figure.
2. After baking or replacing the objective movable aperture, first locate it at division 0, and then proceed to the axial alignment of gun. Repeat the gun alignment while shifting the aperture position sequentially from 4 to 1.



(6) Form an image, referring to 2-4.

Press the **SCANNING SPEED** ≋ / ▬ switch twice to select ≋ (waveform monitor). Adjust the **BRIGHTNESS** and **CONTRAST** controls so that the **CRT** waveform becomes roughly the same as the one shown in the left figure. ungefähr



(7) After returning the **FILAMENT** control counterclockwise, turn it gradually clockwise while observing the CRT waveform. Turn the electron gun adjustment screws X_1/X_2 or Y_1/Y_2 so as to maximize the waveform. If the waveform is deviated from the CRT screen, it should be brought back onto the screen by adjusting the **BRIGHTNESS** and **CONTRAST** controls.

(8) Turn the **FILAMENT** control half a division clockwise and carry out step (7).

(9) Repeat the steps (7) and (8) to obtain maximum CRT brightness. Confirm that the relation between the clockwise rotation of **FILAMENT** knob and the CRT screen brightness is held as described in the step (10).

(10) Setting of FILAMENT saturation point
After returning the **FILAMENT** control to the center (12 o'clock position), turn it gradually clockwise while watching the CRT until CRT waveform is maximized (reaches saturation point).
At this time, the filament control will be located at nearly 3 o'clock position.
In case the control is turned further clockwise beyond 3 o'clock position, the filament current over-saturates (filament overheats), which will shorten the filament life. To prevent this, return the filament control to the saturation point.

Notes

1. Return the filament control by about half a division from the saturation point except for image observation at a high magnification (10,000x or more).
   This will prolong the filament life.

2. Filament current rises gradually after setting the accelerating voltage. This slow-up mode is adopted for preventing filament burnout due to an overcurrent.

(11) After filament alignment is finished, keep the **FILAMENT** control in this condition.

(12) Proceed to the image observation.

Notes

1. If a satisfactory axial alignment cannot be achieved, it is assumed that the filament has not been centered correctly. So remove the Wehnelt assembly and make sure that the tip of the filament is located at the center of the Wehnelt.

2. A deviation may occur shortly after completion of the axial alignment (or start of heating the filament) though it has been made correctly. In case brightness has become lower or focus could not be obtained, perform the axial alignment again and confirm that a deviation has occurred. (Particular attention must be paid immediately after exchange to a new filament.)

2-15 OPERATING PARAMETERS AFFECTING IMAGE QUALITY

The following procedures should be noted for obtaining a clear/quality image.

(1) Setting of ACC VOLTAGE Switch

Table 2-3 indicates a relation between accelerating voltage and image quality. The resolution of the secondary electron image, for example, is generally improved as the accelerating voltage is increased, but the image quality becomes harder. Accordingly, an accelerating voltage of 25 kV is employed for ordinary applications. It is necessary to select the optimum voltage according to the type of specimens and/or applications.

Table 2-3 Accelerating Voltage and Image Quality

Accelerating voltage (kV)	0.5	25
Resolution	Low ←	→ High
Charge-up	Little ←	→ Much
Contamination	Much ←	→ Little
Effect by Disturbances	Large ←	→ Small
Image Quality	Soft ←	→ Hard
Uncoated Specimen Observation	Easy ←	
X-Ray Analysis		X-ray
Secondary Electron Emission	Much ←	→ Little

(2) Setting of Condenser Lens Current

When turning the **C. LENS** control clockwise, the condenser lens current increases, and when turning it counterclockwise, the lens current decreases.

Table 2-4 indicates a relation between the condenser lens current and image quality. When the condenser lens current is increased, for example, the resolution is improved, but the image becomes rough since the specimen current decreases. Therefore, set the control knob at 10 to 12 o'clock position at a low magnification and at 12 to 14 o'clock position at a high magnification.

When the **C. LENS** control is set before 9 o'clock position, a shadow may appear around low magnification images.

Table 2-4 Condenser Lens Current and Image Quality

Condenser Lens Current	Small ⟷ Large
C. LENS Knob (approx. position)	
Electron Probe Current	Large ⟷ Small
Resolution	Low ⟷ High
Secondary Electron Emission	Much ⟷ Little
Image Quality	Fine ⟷ Rough
Secondary Electron Image	S.E.
Reflected Electron Image	R.E.
Absorbed Electron Image	A.E.
X-Ray Analysis (EDX)	EDX

(3) Selection of Objective Aperture Opening Diameter

Table 2-5 indicates relations among opening diameter of objective lens aperture, depth of focus, resolution and electron probe current.

Table 2-5 Objective Aperture and Image Quality

Aperture Position	1	2	3	4
Aperture Opening (dia. in μm)	400	300	200	100
Depth of focus	Shallow ←			→ Deep
Resolution	Low ←			→ High
Probe current	Large ⟷			Small

(4) Setting of Working Distance

The working distance means the distance between the lower face of the objective lens and the specimen. It is set by adjusting the **WORKING DISTANCE (Z)** control of specimen stage.

Table 2-6 indicates a relation between the working distance and image quality.

Table 2-6 Working Distance and Image Quality

Working Distance (mm)	5	35
Depth of focus	Shallow ←	→ Deep
Resolution	High ←	→ Low

2-16 CAUTIONS ON OPERATION

When operating the instrument, observe the following instructions.

(1) Wear clean gloves whenever exchanging specimen or filament.

(2) Never cause vibration of the instrument (particularly while taking photographs).

(3) Do not apply too much conductive paste for fixing the specimen onto the specimen stub. Otherwise, (i) it may be hard to dry it in the air, and (ii) pre-evacuation takes a long time.

(4) Never reduce the condenser lens current excessively when the POST. HV switch is turned to ON. If the condenser lens current is too low, the electron beam bombarding the specimen is too high causing too much secondary electron emission from the specimen which may damage the scintillator.

(5) When working with a large specimen at a short working distance, the specimen tilt angle is restricted to a narrower range.

(6) **SCANNING SPEED** is set in mode in order to prevent the CRT from burning when turning off the accelerating voltage while signal waveform is observed on the signal monitor or waveform monitor with the **SCANNING SPEED** / switch pressed.

2-17 SPECIMEN COATING

2-17-1 Introduction

Electrically non-conductive specimens generally require metal coating. Particularly when observing a biological or fibrous specimen having complicated topographical details, the metal coating often causes image troubles.

If the coated film is too thin or the specimen is not coated evenly over the topographical details, a uniform image quality cannot be expected and a certain part of the image becomes too bright while another part too dark.

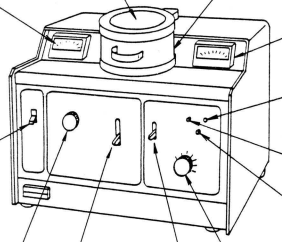
Furthermore, in the worst case, lateral bright lines appear on the image, astigmatism increases and resolution drops.

To prevent these problems, the specimen should be coated with care.

2-17-2 Evaporating Method with Ion Sputtering Device

In the case of an electrically non-conductive specimen, its surface must be subjected to metal coating by use of an ion sputtering device after fixed on the specimen stub. A coating film thickness of about 100 to 200 Å is adequate for usual observation.

Composition and Functions of Control Knobs and Switches (E-101 Ion Sputtering Device)



Window:
Electric discharge can be monitored through this window.

Vacuum Chamber:
Incorporates a target electrode in the upper section and can be opened/closed like a hinged door at the time of specimen exchange. Upon opening the chamber while pushing backward, it stops at about 45° position. For closing, pull in the 45° direction and lower.

Vacuum Meter:
Reads Pirani gauge vacuum on the Torr/Pascal scales.

Ion Current Indicator:
Reads ion current on the upper scale.

VACUUM Indicator Lamp:
Lit to indicate that high voltage is applicable.

POWER Switch:
Pushed up to turn on the power supply and the rotary pump starts evacuation. Pushed down to turn off the power supply and admit air into the pump.

HV Indicator Lamp:
Lit while high voltage is applied.

HV START/STOP Switch:
Pressed to turn on high voltage when the high voltage indicator lamp is extinguished and turn it off when the lamp is lit.

VACUUM CONTROL Knob:
A needle-type leak valve. Turned counterclockwise from CLOSE to increase leakage.

TIMER Set Knob:
Sets the electronic timer freely within a range of 0 to 10 minutes. When a set time has elapsed, high voltage is cut off.

MAIN VALVE Selector Lever:
Pushed up to evacuate the vacuum chamber (OPEN) and pushed down to CLOSE. Upon turning off the power switch with this valve set at CLOSE, the vacuum chamber retains vacuum.

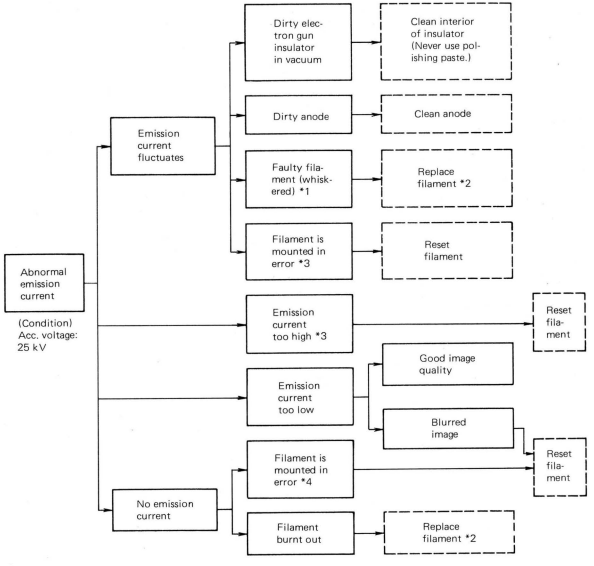
COATING/CLEANING Selector Switch:
Coating/ion bombardment hydrophilization selector switch. Turned upward to select coating and pushed down to select hydrophilization.

Also available as ion sputtering devices are the Model E-102, 105 and 106 which are capable of changing over high voltage and mounting different targets such as of Pt and Pt-Pd.

Section III.
MAINTENANCE

3-1 FILAMENT CHECK

(1) When the emission current becomes irregular, replace or reset the filament. Follow the steps described in Fig. 3-1.



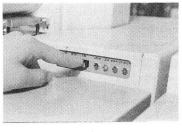
Notes *1 If the filament whisker contacts the Wehnelt cylinder, the apparent emission current flows so high that the **EMISSION CURRENT** indicator scales out.
*2 Clean the Wehnelt cylinder whenever replacing the filament.
*3 (tip is too close to Wehnelt cylinder)
*4 (too much clearance between tip and Wehnelt)

Fig. 3-1 Troubleshooting Chart for Abnormal Emission Current

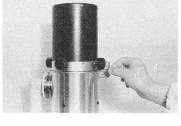
3-2 FILAMENT EXCHANGE

(1) Depress the **ACC VOLTAGE ON/OFF** switch to turn off the accelerating voltage.

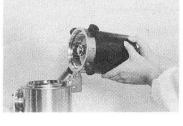
(2) Turn the **FILAMENT** knob fully counterclockwise.



(3) Depress the **AIR** switch and wait 1 to 2 minutes.



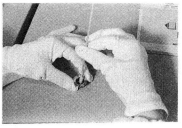
(4) Loosen the four setscrews (M4) around the gun.



(5) Open the flip-top gun housing to the right.

(6) Turn the fixing nut counterclockwise and dismount the filament assembly.

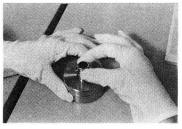
Note
Avoid replacing the filament shortly after its discontinuation since the assembly is still hot.
Wait until the assembly cools down adequately.



(7) Remove the Wehnelt cylinder. If the Wehnelt cylinder hole is contaminated, clean it with bamboo stick, absorbent cotton, polishing paste, acetone, etc.

Notes:

1. It should be aligned as shown in the figure below, but finally check it via the emission current. Set the current at 70 to 120 μA at 25 kV.
2. At a low magnification, filament setting is facilitated by using the tapered Wehnelt which is furnished with the instrument.



(8) Place the Wehnelt assembly on the filament exchange jig. Loosen the filament centering screw. Mount a new filament. Mount the Wehnelt cylinder and measure the distance " ℓ " between the filament and Wehnelt cylinder. (Do not turn the Wehnelt height adjuster nut except for a special reason.) Align the tip of filament with respect to the Wehnelt cylinder opening by adjusting the filament centering screw.

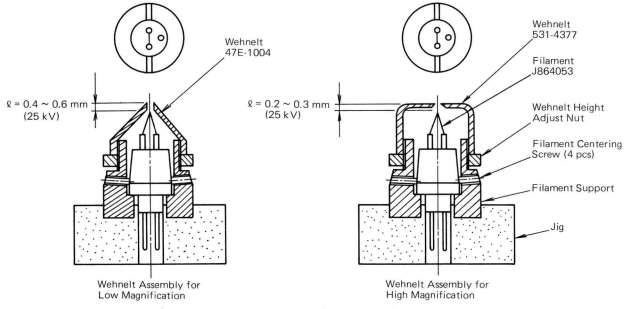
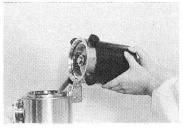
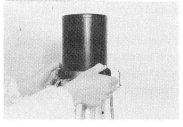


Fig. 3-2 Mounting Filament

(9) Mount the Wehnelt assembly.

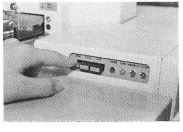


(10) Mount the gun and fix it by four setscrews (M4).
Carry out the reverse procedures in steps (6), (5) and (4).

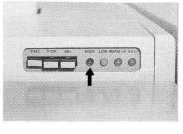


(11) Manipulate the gun alignment screws and align the gun with respect to the column.

Note
The alignment screws which are diametrically opposite must be turned in the same direction.



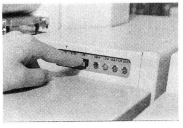
(12) Depress the **EVAC** switch.



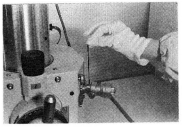
(13) When the **HIGH** vacuum lamp glows, proceed to the alignment described in item 2-14.

3-3 CLEANING OF OBJECTIVE APERTURE

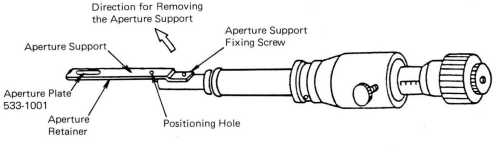
3-3-1 Cleaning of Objective Movable Aperture



(1) Depress the **ACC VOLTAGE ON/OFF** switch to turn off the accelerating voltage and the **AIR** switch to leak air into the column.



(2) Loosen the setscrew with a screwdriver (hexagonal head 4 mm dia.). Pull out the aperture holder straight.



Note
For the sake of easy understanding, this figure is drawn upside down.
In the actual mounting to the specimen chamber, insert the assembly into the objective lens with the aperture support downward.

Fig. 3-3 Cleaning of Objective Movable Aperture Holder

(3) Remove the aperture support fixing screw by using a watchmaker's screwdriver.

(4) Remove the aperture support by using tweezers.

(5) Remove the aperture plate by means of tweezers, and bake it in the vacuum evaporator.

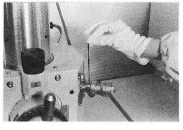
(6) Clean the aperture support and the aperture retainer by using a bamboo stick wound with absorbent cotton, soaked in polishing paste, and then in acetone.

(7) Mount the baked objective lens aperture plate onto the aperture retainer and set the positioning hole of the objective lens aperture plate to that of the aperture retainer.

(8) Mount the aperture support and slightly fasten the aperture support fixing screw.

(9) Clamp the aperture support fixing screw after making sure that the positioning hole of the objective lens aperture plate meets the positioning holes of both aperture support and aperture retainer.

(10) Remove the specimen goniometer stage and insert the objective lens aperture holder straight into the specimen chamber while monitoring the tip of the aperture from the inside of the specimen chamber. Be careful not to insert the aperture plate upside down. See Fig. 3-3 Note.

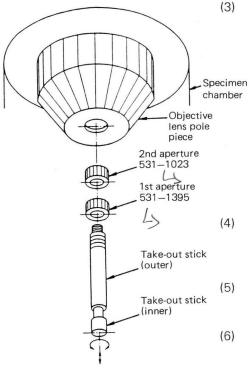


(11) Fix the aperture holder to the specimen chamber by reversing procedure in step (2). Depress the **EVAC** pushbutton switch on the evacuating system operation panel. After confirming that the **HIGH** lamp is lit, proceed to 2-13 "ALIGNMENT OF OBJECTIVE LENS MOVABLE APERTURE".

3-3-2 Cleaning of Fixed Apertures (1st, 2nd)

(1) Gently pull the specimen stage toward you.
Then the entire specimen stage can be drawn out of the specimen chamber.

(2) Introduce an aperture taking-out stick through the hole of the specimen stage, and insert it into the lower pole piece hole of the objective lens. Rotate the take-out stick clockwise about three turns, and pull it out to take out the 1st aperture.



(3) Taking out 2nd aperture
Rotate the take-out stick (outer) 1.5 to 2 turns, fix it by left fingers and tighten the take-out stick (inner) by rotating it until it stops. Then rotate the take-out stick (outer) reversely to the tightening direction to remove the 2nd aperture.

Cautions

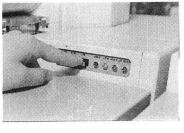
1. Performance of the instrument is largely influenced by the pole piece of the objective lens. Perform the work with utmost care. Also take care not to cause contamination.
2. Pay special attention not to damage the scintillator surface in the specimen chamber.

(4) Clean each fixed aperture with absorbent cotton (or a bamboo stick) and acetone.
Application of an ultrasonic cleaning, if available, is advisable.

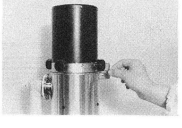
(5) After cleaning, proceed to reassembly in the procedure reverse to steps (1) through (4).

(6) Depress the **EVAC** switch on the evacuating system operation panel.

3-4 CLEANING OF CONDENSER FIXED APERTURE



(1) Depress the **ACC VOLTAGE ON/OFF** switch to turn off the accelerating voltage and the **AIR** switch to leak air into the column.



(2) Loosen the four setscrews of the gun and open the gun housing to the right. See item 3-2 FILAMENT EXCHANGE.

(3) Loosen the anode retainer spring shown in the picture. Remove it together with the anode plate.

(4) Pull out the condenser lens fixed apertures using furnished special tweezers.

(5) Loosen connecting tube and Helisert. Remove each fixed aperture. Mount a new fixed aperture. (Fixed apertures must be cleaned by baking.) New apertures should be examined by optical microscope.

The aperture must be clean, without contamination and free from fins made by machining. After assembling the aperture, blow off dust by spray, blower, etc.

Mount the gun on the column following the reverse of procedures (2) through (4).

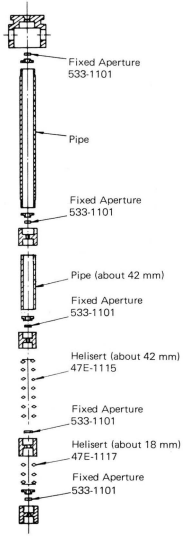


Fig. 3-4 Fixed Aperture Assembly

3-5 BAKING OF APERTURE PLATES

(1) Mount the molybdenum board in the vacuum evaporator as shown in the figure below.

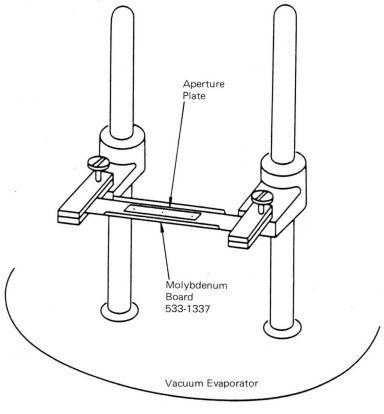


Fig. 3-5 Baking of Aperture Plates

(2) Heat up the molybdenum board after a thorough pumping operation (at 5×10^{-5} Torr or better).
Keep supplying the heating current until the molybdenum board gives incandescence. Too much current can cause melting of the molybdenum board resulting in damage.

(3) Wait for about 5 minutes after the baking operation.
Leak air into the vacuum evaporator.

(4) Mount the aperture at the center of the molybdenum plate.

(5) Evacuate the vacuum evaporator and bake the aperture upto the incandescent point. Do not apply a large current continuously to prevent the aperture from being damaged. (Flow current for 1 or 2 seconds at a time, and repeat this approx. 3 times.)

(6) Wait for about 5 minutes after completion of baking.
Leak air into the evaporator and remove the baked aperture with tweezers.

Caution
Do not touch the baked aperture plate with bare hands.
Refer to 3-3-1.

3-6 ULTRASONIC CLEANING WITH FREON SOLVENT

(1) Supply water into the wash-basin of the ultrasonic cleaner up to 10 to 20 % of its capacity.

(2) Fill Freon solvent (Du Pont: T-WD602) into a beaker to about half of its capacity.

(3) Put parts, which have been cleaned with polishing paste, into the beaker.

(4) Place the beaker in the wash-basin of the ultrasonic cleaner.

(5) Turn on the cleaner and clean the parts for 2 to 3 minutes.

(6) After the cleaning, take the parts out of the beaker and rinse them in distilled water for 2 to 3 minutes to remove Freon solvent.

(7) Put the rinsed parts into another beaker filled with clean ethyl alcohol.

(8) After substituting water adhering to parts with alcohol, take the parts out of the beaker with tweezers and place them on a sheet of clean filter paper to evaporate the alcohol.

Note
Freon solvent eliminates the residue of polishing paste used for polishing parts. Freon solvent has no polishing effect, however.

3-7 MAINTENANCE OF ROTARY PUMP

See the attached " **HANDLING INSTRUCTION FOR THE HITACHI ROTARY PUMP**".

3-8 TROUBLESHOOTING

3-8-1 Evacuation System Failures

(1) Power interruption

(2) Overheated D.P.
a) Check if D.P. cooling water is running or if water supply is adequate.

(3) **EVAC POWER** switch (no-fuse circuit breaker) is turned off.
Check if leakage occurs.
(If the cause is not clear, contact responsible service engineers.)

3-8-2 Vacuum Failures

(1) Air leak
a) Leak valve of R.P. at **CLOSE**
b) Improper mounting of specimen stage in specimen chamber
c) Incomplete mounting of electron gun
d) Contamination of O-ring face
e) Much moisture contained in specimen
f) Silver paste not yet dried

(2) Too little or too much R.P. oil

(3) Due to mounting or dismounting an accessory (RE unit, manipulator, etc.)
a) Contamination of O-ring face
b) Vacuum can be improved when the blind port plug is attached.

3-8-3 Abnormal Emission Current

See Fig. 3-1.

3-8-4 Image is Not Seen on CRT

(1) Poor electron gun alignment.
Make adjustment referring to 2-14.

(2) The POST HV is not applied. (**POST HV** switch is set to OFF on sub-panel.)

(3) **SIG** switch selection is wrong.

(4) The switch of x-ray mode unit (accessory) is not at ▤.

(5) **C. LENS** knob is turned excessively clockwise.

(6) **CONTRAST** knob is turned excessively counterclockwise.

(7) Poor adjustment of objective movable aperture.

(8) The magnification setting is too high.

3-8-5 Noisy Image

(1) **C. LENS** control is turned excessively clockwise.

(2) **CONTRAST** control is turned excessively clockwise.

(3) Positional selection of the objective movable aperture is improper.

3-8-6 Unable to Correct Astigmatism

(1) Poor alignment of objective movable aperture.

(2) Dirty objective lens aperture: Clean objective lens movable and fixed apertures.

(3) Dirty condenser fixed apertures: Clean them.

3-9 CAUTIONS ON MAINTENANCE

The following items should be noted for maintenance.

(1) Follow the maintenance procedures described in this manual.
Be sure to refer to **"PRECAUTIONS ON HANDLING"**.

(2) Maintenance work not described in this manual (such as disassembling, reassembling or repair) should never be carried out by customers.
Call responsible service engineers in your area without hesitation.

Section IV.
REPLACEMENT PARTS

4-1 CONSUMABLES AND SPARE PARTS

4-1-1 Consumables

The items shown in Table 4-1 should always be kept on hand for efficient normal operation.

Table 4-1 Consumables

Part No.	Part Name	Use	Remarks
D529000	Conductive paint		30 g
G370250	Metal polishing paste		50 g
G743002	Bamboo stick		10 pcs
S370059	Gauze		
G465001	Vacuum grease	For vacuum seal	
533-1101	Condenser lens aperture		
531-4245	Objective lens aperture plate	For movable aperture	
777-0179	Filament		10 pcs
533-0286	Scintillator		
533-1337	Molybdenum board	For baking aperture plate	
532-0292	D.P. oil (LION S)		100 cc
G469023	R.P. oil		4 ℓ
47E-1115	Helisert 42	For condenser lens	
47E-1117	Helisert 15	For condenser lens	

4-1-2 Spare Parts

Table 4-2 is a list of "recommended spare parts" for a long term operation.

Table 4-2 Spare Parts

Part No.	Part Name	Location	Remarks
L456529	O-ring AS568-239 NBR	Electron gun, condenser lens	
L456464	O-ring AS568-115 NBR	Condenser lens	
L456008	O-ring P10A NBR	Condenser lens	
L456459	O-ring AS568-110 NBR	Objective lens	
L456015	O-ring P20 NBR	Objective lens	
L456547	O-ring AS568-257 NBR	Specimen goniometer stage (front plate)	For standard ○ stage
L456026	O-ring P36 NBR	Specimen goniometer stage (lock)	○
L456005	O-ring P8 NBR	X, Y control knobs	○
L456002	O-ring P5 NBR	R, T, Z control knobs	○
L456515	O-ring AS568-225 NBR	Specimen chamber port	
L456463	O-ring AS568-114 NBR	Vacuum manifold	
L456764	O-ring AS568-116 NBR	Valve	
L456028	O-ring P40 NBR	Valve	
L456004	O-ring P7 NBR	Valve	
531-1437	D.P. heater		
J821030	Fuse 5 A		○
J821026	Fuse 1 A		○
J821027	Fuse 2 A		○
J821028	Fuse 3 A		○
J821025	Fuse 0.5 A		○
433-3702	Specimen stub 15 mm D		
433-3703	Specimen stub 26 mm D		
531-1145	Specimen stub 3" (78 dia.)		
K433004	Pirani gauge bulb		
J386012	Photomultiplier R268		
531-0601	Holder (15 mm dia. x 4)		
531-0602	Holder (6 mm dia. x 10)		
533-2277	Holder for evaporation		

Note
The parts marked "○" are especially important as spare parts.

Section V.
OPTIONAL ACCESSORIES

5-1 MODEL S-5303 DUAL MAGNIFICATION DISPLAY UNIT

Dual magnification is a system where two images, at different magnifications, are displayed on the CRT instantaneously.

The operator can first observe the specimen on the CRT at low mag and select an area of interest for high mag observation.

Then the selected area can be magnified and displayed at high mag on the CRT instantaneously. The magnification ratio is selectable in three steps, 1x, 2x and 5x. The selected area in the low mag image to be shown at high mag is also variable by X-Y position controls. The high mag image is useful for precise focusing and astigmatism correction while the low mag image is recommended for specimen survey.

5-1-1 Specifications

Magnification ratio 1x, 2x, 5x
Field selection . . . . . Any area in the low magnification image on CRT can be selected.
Scanning speed . . . . . , , , , **PHOTO**

5-1-2 Functions

Fig. 5-1 shows the operating panel of the S-5303 with all controls.
The X/Y POSITION controls allow area selection in the low magnification image. The magnification ratio selector switches allow selection of magnification ratio for the low magnification image to be shown at high magnification in three steps of 1x, 2x and 5x.
The HIGH MAG switch is used for high magnification display.

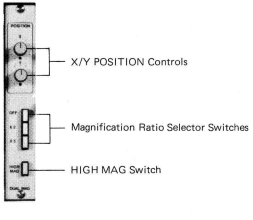
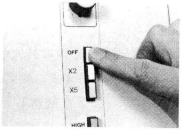
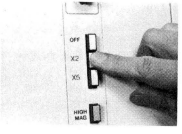


Fig. 5-1 Dual Mag Control Unit

5-1-3 Operation



(1) Low magnification image observation
Push a magnification ratio switch **OFF** and present a low mag image on CRT.

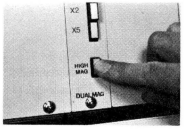


(2) Field selection for high mag observation

a) Push a magnification ratio selector **2x** or **5x**.

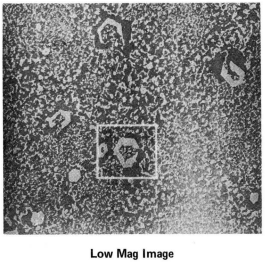
b) A bright rectangular frame showing the area to be shown at high mag appears on the CRT screen.

c) Manipulate **X** and **Y** position controls and mask the specific point of your interest.

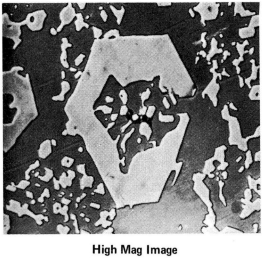


(3) High magnification image observation
Push a **HIGH MAG** switch. The selected area in low mag image is magnified by 2x (or 5x) and presented on the CRT screen.

(4) Photographing split image
Combination with the TWIN photo function of the main unit permits recording the low and high magnification images on a single photo.



Low Mag Image



High Mag Image

Low/High Magnification Images (magnification ratio: 5x)

5-2 MODEL S-5104 X-RAY MODE UNIT

This unit is designed for allowing various scanning modes in addition to the normal raster scan and S.E. signal processing. It is useful when the S-2300 is interfaced with EDX spectrometer system.

5-2-1 Specifications

(1)	Input signal terminal	
	a) For X-ray rate meter	0 to +10 V (CH ① used)
	b) For pulse height analyzer	TTL positive logic (CH ② used)
(2)	Scanning mode	
	a) Raster scan	For normal image observation or X-ray mapping
	b) Spot	For point analysis
	c) Line set	For line position setting
	d) Line analysis	For line analysis

5-2-2 Function

Fig. 5-2 shows the operating panel of the S-5104 with all controls.

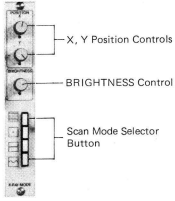
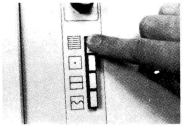


Fig. 5-2 X-Ray Mode Unit

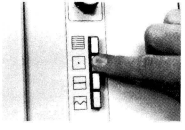
5-2-3 Operation



(1) Raster scan

Depress ▤ switch.

It allows raster scan mode for normal image observation. For the standard S.E. image observation, keep this button pressed in.

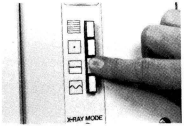


(2) Spot

Depress ⊡ switch.

It is used for point analysis coupled with EDX spectrometer. The spot position is variable by **X** and **Y** position controls.

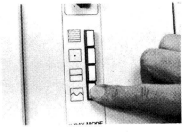
Note
If the CRT brightness is too high, it may cause "burning" of the screen phosphor. Reduce brightness via **CRT BRIGHTNESS VIEW** control on sub-panel.



(3) Line set

Depress ⊟ switch.

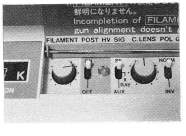
It allows line positioning for line analysis by EDX spectrometer. The line position is variable by Y-position control.

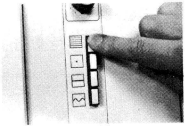


(4) Line profile

Depress ⩘ switch.

It permits line analysis of a selected area of a specimen. When the **SIG** switch of the microscope sub-panel is turned to **SE**, it allows secondary electron line profile. When the control is changed over to **X-RAY**, it presents X-ray signal line profile.





(5) X-ray mapping

X-ray mapping image based on X-ray signals from EDX spectrometer system can be presented on the CRT screen when ▤ switch is pressed in and the **SIGNAL SELECT** control on the microscope sub-panel is turned to **X-RAY**.
The X-ray image brightness is variable via **BRIGHTNESS** control on the X-ray mode unit.

5-3 MODEL S-5109 RASTER ROTATION/DYNAMIC FOCUS UNIT

5-3-1 Outline

This unit is combined with the scanning electron microscope for adjustment of a CRT image, permitting raster rotation and dynamic focus.

5-3-2 Functions

(1) Raster Rotation
Raster rotation means a function to rotate a CRT image around the CRT center by rotating the scanning direction of electron beam on a specimen, and it can be used for the following purposes.

(a) Turning an image toward an easy-to-observe direction.

(b) Selecting the analytical position (line analysis direction) in the line analysis mode.

(c) Reducing a sensitivity change caused by the movement of the x-ray source in x-ray analysis using a wavelength dispersive x-ray spectrometer by setting the line analysis direction perpendicular to the x-ray spectrometer direction.

(d) Coinciding the tilt direction of the specimen with the Y-axis scanning direction when using the dynamic focus and tilt compensation functions described later.

(2) Dynamic Focus
As the specimen tilt angle increases, the distance from the objective lens to the specimen changes according to specimen position, causing only a part of the visual field to be focused. The dynamic focus function changes the focal length of the objective lens in synchronization with electron beam scanning so as to obtain a focused image of the entire specimen surface.

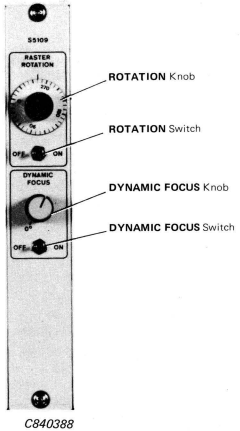


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Fig. 5-3 S-5109 RASTER ROTATION/DYNAMIC FOCUS Unit

5-3-3 Operation

Fig. 5-3 shows an external view of the unit.

(1) Raster Rotation

(a) Turn on the **ROTATION** switch.

(b) The angle scale of the **ROTATION** knob indicates the angle between the tilt direction of the specimen (moving direction of the specimen by turning the Y-movement knob of the specimen goniometer stage) and the Y-axis scanning direction of its image being displayed on CRT.

The angle at which the Y-axis of the specimen goniometer stage coincides with the Y-axis of the image on CRT differs according to the working distance.

Read the angle at the respective working distances from "Fig. 5-4 Angle at which Y-Axis of Specimen Goniometer Stage Coincides with Y-Axis of Image on CRT".

Caution

If the **ROTATION** switch is turned on with the scan speed set at ☐ (TV scan), raster rotation is not performed. Raster rotation is canceled when changing to ☐ (TV scan) from another scan speed.

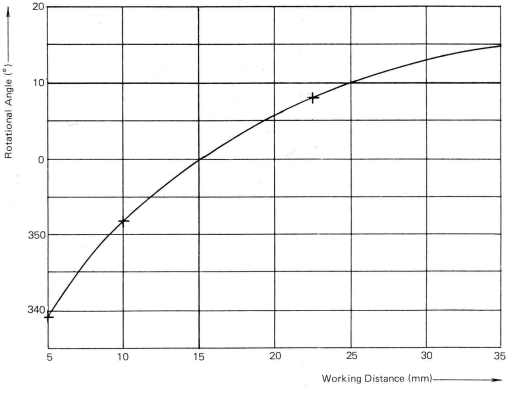


Fig. 5-4 Angle at which Y-Axis of Specimen Goniometer Stage Coincides with Y-Axis of Image on CRT

(2) Dynamic Focus

(a) Set the Y-axis of the specimen goniometer stage so that it coincides with the Y-axis scanning direction of the image on CRT. If the working distance is 15 mm, the two coincide with each other even with the **ROTATION** switch turned off. However, when the working distance is other than 15 mm, turn on the **ROTATION** switch, and set the rotational angle according to the above (1)-(b).

(b) While keeping the **DYNAMIC FOCUS** switch turned on and the **DYNAMIC FOCUS** knob turned completely counterclockwise, adjust the **FOCUS** control in such a manner that the image is in focus at about the center in the Y-axis direction of CRT and is out of focus evenly on the upper and lower sides.

(c) Turn the **DYNAMIC FOCUS** knob clockwise to adjust it so that a focused image of the entire observing area is obtained.

(d) It is recommended to perform steps (b) and (c) in the LINE ANALYSIS mode for easier operation as described below (only with Model S-5104 X-Ray Mode Unit).

1) While keeping the **DYNAMIC FOCUS** knob turned completely counterclockwise, set the line analysis position at the center of CRT by SCANNING mode ⊟ .

2) Adjust the **FOCUS** knob on the control panel of the display unit so that the sharpest waveform is obtained on CRT in SCANNING mode ⊟ .

3) Set the line analysis position to the lower edge of CRT in SCANNING mode again.
4) Adjust the **DYNAMIC FOCUS** knob until the sharpest waveform is obtained on CRT in SCANNING mode .

Caution

1. Set the scanning speed at , , or since the above adjustment cannot be done accurately at (TV) or (REDUCE AREA).
2. The image is sometimes out of focus by about 20 mm at the upper part of CRT screen when the scanning speed is set at .
3. It is recommended to perform readjustment to obtain better results whenever magnification is changed.

5-4 CAMERA UNIT

5-4-1 Specifications

(1) Image ratio : 1.0, 0.8, 0.6

(2) Lens : f = 75 mm

(3) Aperture : f5.6 to 22

(4) Focusing : Manual (with focusing unit)

(5) Film : Roll film 120
Polaroid type 52, P/N 55, 552
Polaroid type 107 (667), 105 (665)

(Film must be prepared on customer side.)

(6) Configuration
(a) See Table 5-3 "Composition of Camera and Film Unit".
(b) An assembly of various components is to be quoted and delivered depending on each customer's application. So all components in that table will not be delivered.

5-4-2 Composition

The camera unit need be composed according to the film used.
See Tables 5-1 through 5-3.

Table 5-1 Image Ratio of Camera and Film Size

Image Field on CRT	Image Ratio of Camera	Picture Size on Film After Lens / Exposable Area of Film	Polaroid 52, 55 4" x 5"	Polaroid 552 4" x 5"	Polaroid 107, 105	Roll Film 120, 220 6 cm x 7 cm
CRT 	x 0.6		NO	NO	NO	
	x 0.8		NO	NO		NO
	x 1.0				NO	NO
						

Table 5-2 Combination of Film, Image Ratio Selector Ring, Film Holder, etc.

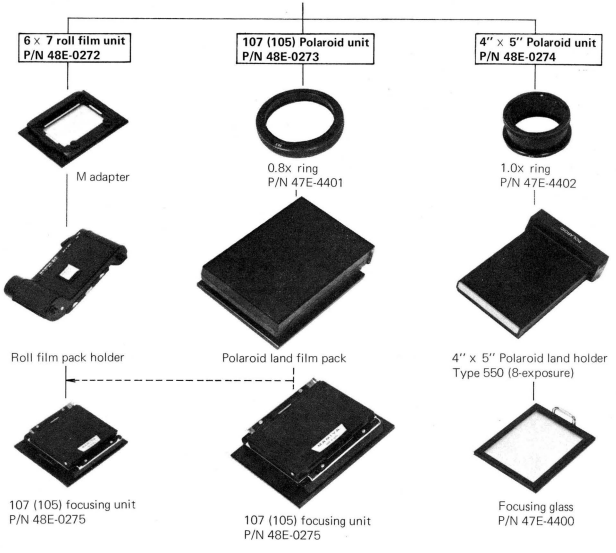
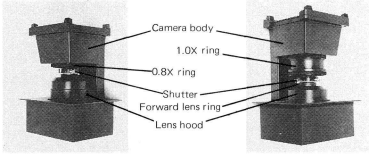


Table 5-3 Composition of Camera and Film Unit

Unit Name / P/N / Camera Unit	Camera Body	6 x 7 Roll Film Unit	107 (105) Polaroid Unit	4" x 5" Polaroid Unit	107 (105) Focusing Unit
	48E-0271	48E-0272	48E-0273	48E-0274	48E-0275
6 x 7 alone	○	○			
107 alone	○		○		○
4" x 5" alone	○			○	
6 x 7 and 107	○	○	○		
6 x 7 and 4" x 5"	○	○		○	
107 and 4" x 5"	○		○	○	○
6 x 7, 107 and 4" x 5"	○	○	○	○	

5-4-3 Assembly

(1) Shown below are the camera units to be combined with the exclusive CRT of S-2300.



(2) For detaching the camera, remove the setscrew from the camera body and lift it out.

Cautions

1. When attaching or detaching the camera body to/from the instrument, be sure to hold the camera body and the fastening ring at rear of the lens. If the lens hood is held or bent, a trouble might occur.
2. Take utmost care in handling the camera. If it is attached/detached forcibly or dropped carelessly, misoperation might happen.

5-4-4 Setting of Camera Aperture

(1) Selection of aperture
Select the aperture according to the kind of film as per Table 5-4.

Table 5-4 Film and Aperture Selection

Film		ASA	Aperture
Polaroid 4" x 5" film	**TYPE 52, 552**	400	F8
	P/N 55	50	5.6
Polaroid 107		3000	16
Type 120 roll film	**SS**	100	5.6
	TRI–X	400	8

(2) Adjust the aperture lever until a desired aperture position is reached.

(3) How to set camera aperture
If the aperture is fully opened in error upon exchanging the image ratio rings or setting the aperture, set it again as instructed below, referring to the figure below.

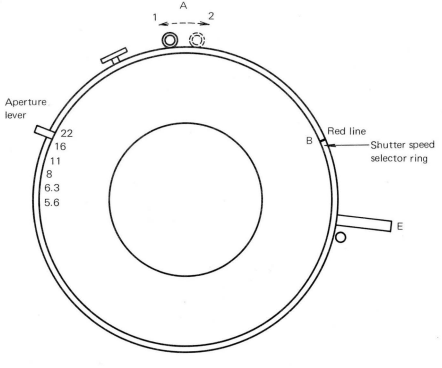
(a) Match the red line of shutter speed selector ring with "B".

(b) Eject the E knob (which is screwed in).

(c) Shift the A lever from 2 to 1.

(d) Screw in the E knob completely, and the shutter will open.

(e) Select a desired position by means of the aperture lever.



Note
The shutter closes when shifting the shutter speed selector ring from "B". Although the shutter opens when shifting the A lever from 1 to 2, the aperture lever becomes incapable of altering the restricting effect. (The aperture remains open.)
In such a case, make resetting with reference to "How to set camera aperture".

5-4-5 Focusing

(1) 6 x 7 Roll Film Unit

After assembly, conduct focusing in the following way.

(a) Push back the adapter stopper on each side of the main body and remove the Mamiya adapter and 6 x 7 roll film holder.

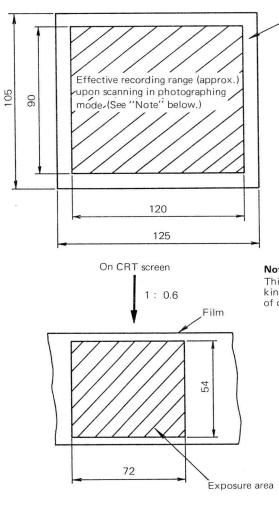
(b) Install the 6 x 7-exclusive focusing unit at the location from where the Mamiya adapter was removed, and fasten it by the adapter stoppers.

(c) Press the **PHOTO** switch to present a raster.

(d) Slightly loosen the camera body setscrew, and adjust the vertical position of the body until the raster becomes sharp.

(e) Detach the focusing unit from the camera body, and attach the Mamiya adapter and 6 x 7 roll film holder.

(f) The ratio of the image size on the CRT screen (upon scanning in photographing mode) to the exposure size on film is 1 : 0.6.



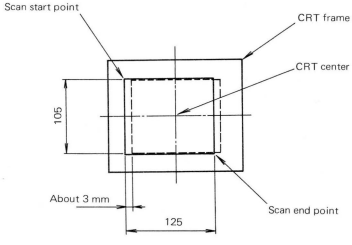
On 6 x 7 Roll Film

(2) Polaroid 4" x 5"

(a) Attach the film holder and 1x ring.

(b) Effect focusing by use of the 4" x 5"-exclusive focusing unit.

(c) Repeat focusing in the photographing mode.



Note
In case 4" x 5" (single exposure) and 6 x 7 unit configuration is employed upon shipment, the raster center is deviated about 3 mm toward the left as indicated by the solid line in the above figure.
For using 4" x 5" (8-exposure) and 107 unit configuration, contact servicemen.
When the 4" x 5" (8-exposure) and 107 units are equipped on shipment, positional adjustment of raster is unnecessary.

5-4-6 General Precautions

(1) For attaching or detaching the camera body to or from the instrument, be sure to hold the camera body and fastening ring at the back of the lens. If the lens hood is held or bent, a trouble might occur.

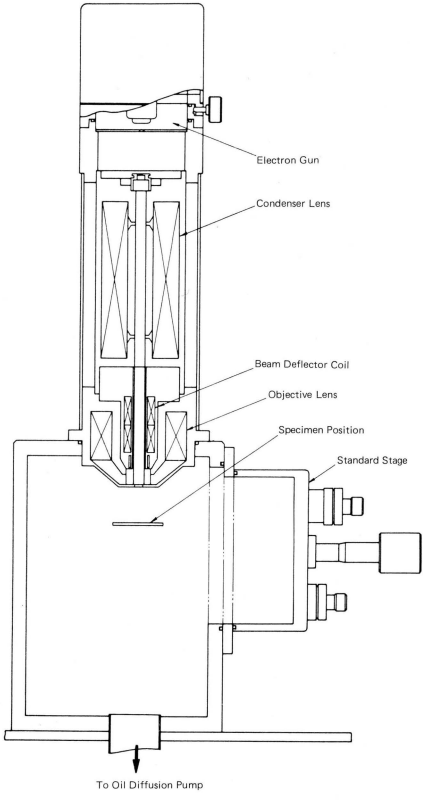
(2) Take maximum care in handling the camera. If it is attached/detached forcibly or dropped carelessly, misoperation might happen.

(3) For Type 120 roll film, use Tri-X (Kodak ASA 400) or SS (ASA 100).

(4) Film must be loaded according to the instructions provided on the film holder.

(5) Introduce the light shielding plate before the film holder when photographing is not conducted for a long time with a film loaded.

(6) For photographing procedure, refer to 2-9 of this manual.



A Cutaway View of the S-2300 Column