INSTRUCTION MANUAL
OF
SCANNING ELECTRON MICROSCOPE

SS-SERIES
MODEL: SS-130, SS-60, SS-40

INTERNATIONAL SCIENTIFIC INSTRUMENTS, INC.

TABLE OF CONTENTS

1. OPERATING VACUUM SYSTEM

START-UP

1. Check the following:
   (1) POWER switch OFF.
   (2) D.P. switch OFF.
   (3) HV switch OFF.
   (4) VALVE CONTROL switch SHUT (Push SHUT Button).
2. Connect the input power supply cable to the power outlet.
   NOTE: The input power should be single phase and the voltage should be between 95V and 105V.
3. Turn on the cooling water for the oil diffusion pump (D.P.) and check that the flow rate is about 2L/min.
4. Depress POWER switch and the switch button will light red. Depress the rotary pump (R.P.) switch, and the button will light red. (This switch returns to the original position on release. The R.P. should now start to pump).
5. Depress the oil DIFFUSION PUMP switch and the button will light red. Wait about 15 minutes until D.P. unit becomes hot.
6. Depress OPER of VALVE CONTROL which will start evacuation of microscope body with R.P.
   Set the EMISSION/VACUUM toggle switch to VAC.
   When the vacuum meter indicator reaches 70μA to 100μA, the system is automatically changed over to the D.P.
7. When the meter indicator reaches the green zone, the vacuum pilot lamp (green) lights. The equipment is now ready for operation, but it is recommended to wait an additional few minutes before turning on the H.V. switch.

INTRODUCING AIR INTO THE MICROSCOPE BODY

1. Rotate EMISSION dial to the full counterclockwise position. Set HV switch to OFF. The switch button lamp goes off.
2. Depress VALVE CONTROL switch AIR. The leak valve is operated after several seconds and air is introduced into the body of the microscope. The body interior reaches atmospheric pressure after about 40 seconds.

3. The microscope is now ready for specimen introduction, filament replacement, column liner removal, or accessory attachment. To reactivate, depress VALVE CONTROL switch OPER. The instrument is then automatically evacuated as described in number "6" of Start-Up section.

SWITCHING INSTRUMENT OFF

1. Rotate EMISSION dial fully counterclockwise. Set HV switch to OFF and the switch button lamp will go off.
2. Depress SHUT of VALVE CONTROL switch. Depress D.P. switch to turn OFF and the switch button lamp will go off. Wait about 20 minutes until D.P. unit has cooled.
3. Depress POWER switch to turn OFF. Both R.P. switch lamp and POWER switch lamp will go off, R.P. will stop. R.P. leak valve is operated automatically to introduce air into R.P.
4. Turn off D.P. cooling water.
5. Turn the switch on the indoor switch board off, if available.

MEASURES TO BE TAKEN IN THE EVENT OF A POWER FAILURE

If power fails, turn HV switch, D.P. switch, and POWER switch off and depress the SHUT button of VALVE CONTROL switch. Wait about 20 minutes until D.P. unit cools. When power has returned, follow the procedure described under "4" thru "7" of the Start-Up section.

MEASURES TO BE TAKEN IN THE EVENT OF WATER FAILURE

If water stops flowing, the thermostat in the D.P. senses a rise in temperature and automatically switches off power to the D.P. HV switch button lamp and D.P. switch button lamp will go off and the equipment will shut itself down. Depress HV switch and D.P. switch to turn off. Depress SHUT button of VALVE CONTROL switch. Wait about 40 minutes until D.P. unit cools. After the water supply has been restored, follow the procedure described under "5" thru "7" in the Start-Up section after resetting the D.P. thermostat as described below.

The thermostat switch is located on the D.P. body. It is reset by pushing it firmly after the pump has cooled. Be careful not to touch the pump if it is hot.

As soon as D.P. switch is turned ON, the power supplies (such as lens power supply, but not HV power supply) are turned on. Both the objective lens and D.P. are water cooled. A temperature sensor is provided in both the objective lens and D.P. Excessive temperature rise in the objective lens causes the lens power supply and D.P. to be shut off. This in turn results in the HV being automaticlly switched off. Depress HV switch and D.P. switch to set to OFF. Check that the water flow rate is sufficient and allow a few minutes for the system to cool. Operation may be continued by following steps "5" thru "7" in the Start-Up section.

2. INTRODUCING SPECIMEN

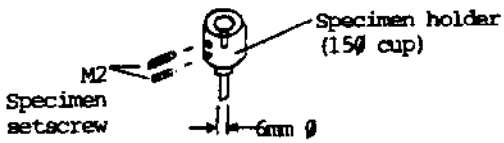
(LARGE SIZED UNIVERSAL STAGE TXYRZ)

MODE 1 AND 2 OPERATION

1. Rotate EMISSION dial fully counterclockwise. Set HV switch to OFF. The switch button lamp goes off.
2. Introduce air into the microscope body as described in "OPERATING VACUUM SYSTEM."
3. Rotate the stage clamping knob clockwise to set to UNCLAMP. The knob is located at the rear right side of the specimen chamber. Set the T (Tilt) dial to zero degrees. Set the Z (working distance) control to the triangular mark (▶), or below.
4. Unlock the snap lock on the left side of specimen chamber and open the chamber door.

   NOTE: Do not leave the specimen chamber at atmospheric pressure longer than necessary.

FIG. 1



5. Loosen the specimen holder setscrew and pull out the holder (refer to Figure 1). When the position of the setscrew makes screwdriver insertion difficult, use the rotation control to position the screw.

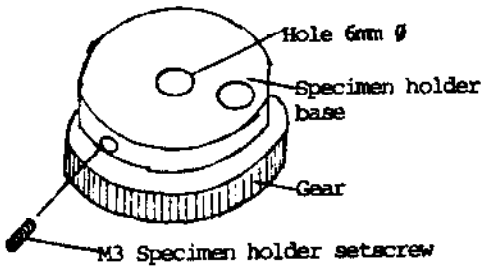
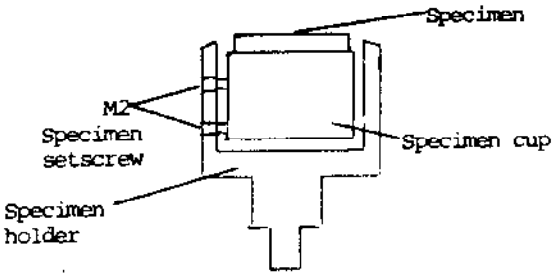


FIG. 2

6. Loosen two specimen setscrews to take out the specimen stub from the holder (Refer to Figure 2).



7. Insert the specimen stub in the appropriate specimen holder after mounting the specimen on a stub.
   Tighten the two setscrews provided. Leaving the set screws loose can result in the transmission of vibration to the specimen.

NOTE 1: The indicated Z (working distance) setting refers to the distance between the bottom of the objective lens and the plane which coincides with the lip of the specimen holder. If the specimen is mounted in such a way that it stands proud of the specimen holder lip, care must be taken not to run the specimen into the bottom of the objective lens.

NOTE 2: Various methods are available to fix the specimen to the stub. An instant adhesive, double surface scotch tape, or electrically conductive paint (silver paste, etc.) may be used. Good electrical contact between the specimen and the stub must be provided. If the specimen itself is not electrically conducting, the specimen should be coated with a thin metal film.

8. Insert the specimen holder into the hole in the specimen stage and tighten the setscrew provided. Note that failure to tighten the specimen holder fixing screw can result in the introduction of vibration which will result in poor image quality.
9. Close the specimen chamber door, then close the snaplock.

NOTE: Be sure that the vacuum seal provided between the specimen chamber and door is free of dust and is properly in place.

10. Evacuate the microscope body referring to "OPERATING VACUUM SYSTEM."

NOTE 1: An extended evacuation time can be caused by specimen outgassing or contamination of the vacuum seal between the specimen chamber door.

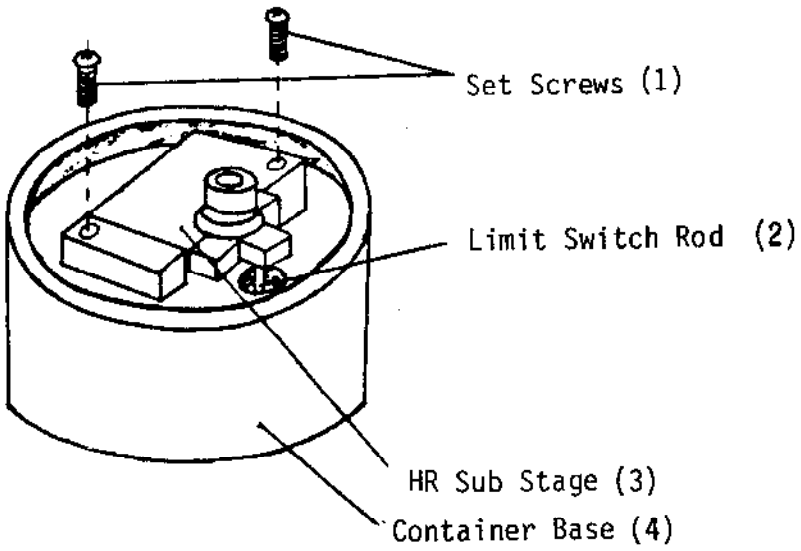
NOTE 2: Make sure that the stage clamp is in the "UNCLAMP" position.

11. The HV can be turned on after evacuation when the vacuum pilot lamp (green) lights. It is recommended, however, to wait an additional few minutes after the lamp turns on before switching on the HV.
12. Set Z (working distance) to the desired setting.

HR MODE OPERATION

Install the HR substage on the large universal stage (TXYRZ). The substage is moved with the universal stage controls.

1. Removal of substage from storage container:
   Remove the HR substage from its container after loosening the two set-screws(1). These screws are used to secure the substage to the universal stage. Care should be taken on removing the substage not to damage the limit switch rod (2).



NOTE 1: As HR stage is usually used with the specimen raised into the objective lens, the amount of stage movement must be limited in order to avoid contact between the substage and the objective lens pole piece hole. This control is performed by the limit switch rod. If the rod should become bent, however, the limit switch settings are no longer correct and this can result in damage to the substage and the objective lens.

NOTE 2: Keep HR stage in its container case when not in use. Secure the setscrews (1) at all times.

2. Rotate EMISSION dial fully counterclockwise. Set HV switch to off. The switch button lamp will go off.
3. Introduce air into the microscope body as described in "OPERATING VACUUM SYSTEM."

4. Rotate the stage clamping knob clockwise to set to UNCLAMP. The knob is located at the rear right side of the specimen chamber. Set the T (tilt) dial to zero degrees. Set the Z (working distance) control to the triangular mark (►).
5. Open the snaplock on the left side of specimen chamber and open the chamber door.

   NOTE: Do not leave the specimen chamber at atmospheric pressure longer than necessary.

6. Mounting HR stage to the standard stage (Refer to Figure 1):
   Install HR stage, taken out from the container case, referring to Figure 1. Two setscrews M3 x 14 (made of phosphorous bronze) being set to the case are to be used for mounting.
   (1) Adjust the X, Y stage controls with the motor drive push buttons to obtain a reading of 275 on both the X and Y position indicator dials.
   (2) Approximately adjust the position of the slot in the specimen rotating stand (9) to line up with the rotation transmission pin (5) of the HR stage before setting HR stage on the main stage.
   (3) Carefully place HR stage on the rotation stand of the standard stage.

   NOTE: Take care not to bump the limit switch rod (11) against the limit switch (12).

   (4) Slowly rotate R (rotation) dial of the standard stage back and forth until the rotation transmission pin (5) engages the rotation transmission groove (8) on the specimen rotation stand.

   NOTE: Never bump the limit switch rod (11) against the switch (12).

   (5) Secure HR stage with the setscrews (3) after checking proper engagement of rotation transfer mechanism. Confirm that R (rotation) dial has no sticky positions during one revolution. If it has some sticky positions, loosen the setscrews (3) at that position then tighten them again.

   NOTE: Never rotate R (rotation) dial with the setscrews (3) loose.

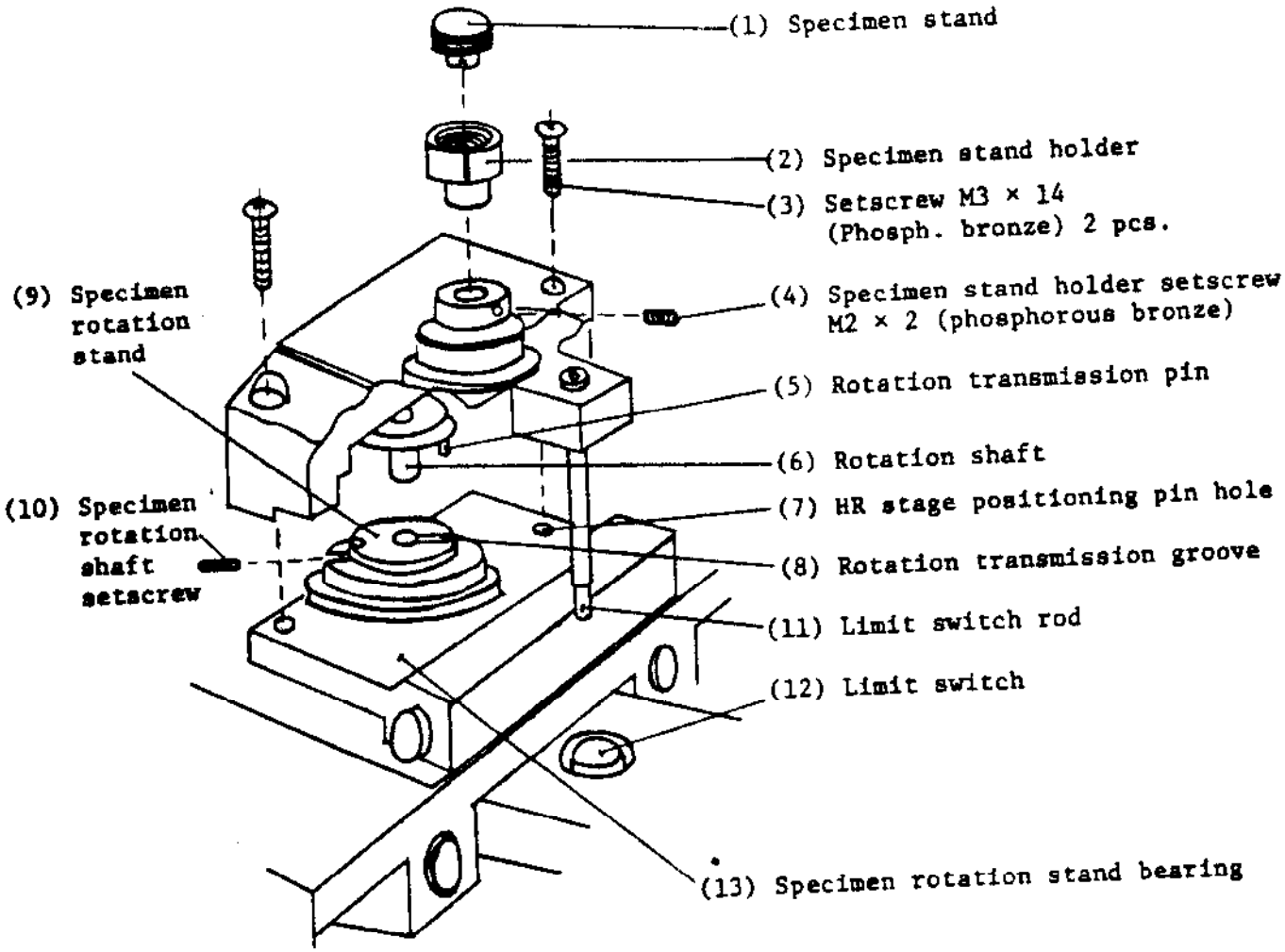

(1) Specimen stand
(2) Specimen stand holder
(3) Setscrew M3 × 14
(Phosph. bronze) 2 pcs.
(4) Specimen stand holder setscrew
M2 × 2 (phosphorous bronze)
(5) Rotation transmission pin
(6) Rotation shaft
(7) HR stage positioning pin hole
(8) Rotation transmission groove
(9) Specimen
rotation
stand
(10) Specimen
rotation
shaft
setscrew
(11) Limit switch rod
(12) Limit switch
(13) Specimen rotation stand bearing

Fig. 1

7. How to use the specimen stand:

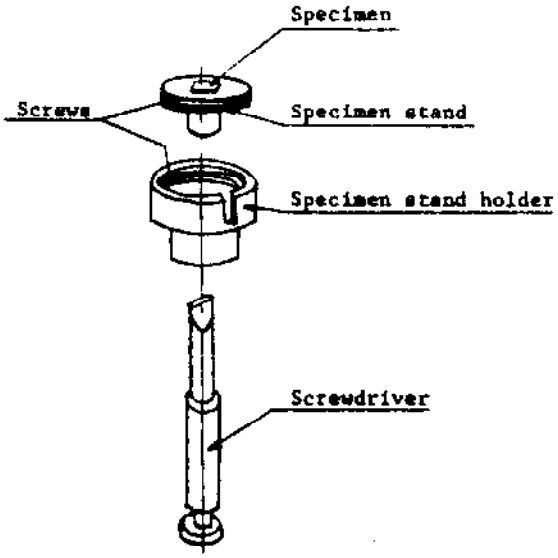


Fig. 2

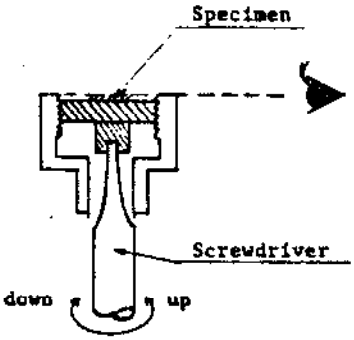


Fig. 3

(1) Place the specimen on the specimen stand (1) and adjust the specimen height. Adjust the specimen height to the upper surface of specimen stand holder (2) (Refer to Figure 2 & 3)

(2) Fix it to HR stage with one of the specimen stand holder screws (4) M2 x 2 (phosphorous bronze) as shown in Figure 1.

8. After completion of specimen mounting, close the specimen chamber door and close the snaplock.

NOTE: Check that the vacuum seal provided between the specimen chamber and door has no dust and is properly seated.

9. Evacuate the microscope body as described in "OPERATING VACUUM SYSTEM."

NOTE: An extended evacuation time can be caused by specimen outgassing or contamination of the vacuum seal between the specimen chamber and door.

10. The HV can be turned on after evacuation when the vacuum pilot lamp (green) lights. It is recommended, however, to wait an additional few minutes after the lamp turns on before switching on the HV.

11. Rotate Z (working distance) dial to adjust the red indication line of dial to HR indication line (red). Set the Z (working distance) to the desired setting. For HR operation, set the red indicator on the Z control to the HR indicator line (red) on the stage.

    NOTE: The objective lens pole piece insert must be removed before attempting to raise the specimen into the HR position (Refer to "ADJUSTING SCREEN IMAGE").

3. SPECIMEN HANDLING

(REFER TO FIG. 1, FIG. 2, AND FIG. 3)

MODE 1 AND 2

1. Specifications: Max. 102mmØ x 25mmt
2. Size of specimen holder (five kinds):
   (1) 15mmØ x 15mmt
   (2) 32mmØ x 25 mmt
   (3) 76.5mmØ x 25mmt
   (4) 102mmØ x 25mmt
   (5) 102mmØ x 0.5mmt
3. Specimen movement range:
   (1) X direction (motor control provided by two push buttons) 55mm (0 to 550 on the digital position indicator dial).
   (2) Y direction (motor control provided by two push buttons) 55mm (0 to 550 on the digital position indicator dial).
   (3) R (rotation) (being moved by rotating the rotation knob) 360°, endless (0 to 99 on the digital position indicator dial) 3.6°/division.
   (4) T (tilt) (moved by rotating the tilt control -10° to +70°.
   (5) Z (working distance) (moved by rotating the working distance knob) 8mm to 40mm.

   NOTE: Controls on the specimen stage sound a buzzer when the end of X, Y travel has been reached. Power to the motor is automatically cut off.

4. Electrical Feedthroughs
   (1) Connector for measuring specimen current (coaxial connector) . . . . . 1 pc.
   (2) Connector for supplying voltage to the specimen (25 terminals) . . . . . Option
5. Accessory parts:
   Three: For secondard electron detectors . . . . . 1 pc.
   e.g. for Robinson detectors . . . . . 1 pc.
   e.g. for X-ray detectors . . . . . 1 pc.

6. Moving the Specimen:

(1) The amount of possible specimen movement depends upon size of specimen. Charts are provided (Figure 2, 3) showing the ranges of X, Y, T, and Z movement as a function of specimen size.

(2) The specimen stage X, Y movements are motor driven. The speed of movement is selected by depressing one of the five SPEED push buttons. The speeds corresponding to each push button are shown in the chart below. The direction of movement is controlled by the arrowed MOVEMENT push button. The rotation control is manual. Clockwise rotation of the stage control results in clockwise rotation of the image.

STRICT OBSERVANCE: When opening or closing the specimen chamber door, do it after setting the dials approximately to the following positions:

X 450
Y 275
T . . . . 0°

Opening and closing of the door with the stage settings far from these positions can result in the stage bumping the chamber when opening the door.

Motor Drive Speeds

Speed Select	Drive Speed (X, Y) (Microns/Sec)
H	200 (continuously)
1	100 (continuously)
2	15 (0.25μ/pulse)
3	3 (0.25μ/pulse)
S	1.5 (0.25μ/pulse)

(3) The specimen can be tilted by rotating T (tilt) knob. The angle is indicated on a graduated ring on the stage door.

STRICT OBSERVANCE: Never rotate T dial when the stage is CLAMPED.

7. Measuring the Specimen Current:
   (1) The connector for measuring specimen current is installed at the bottom right of specimen chamber door (BNC-P-55U). When not measuring specimen current, keep the grounding plug provided attached to the connectors; failure to do this will result in specimen charging.
   (2) When measuring specimen current, attach the connector to a suitable micro-ammeter.

8. Applying Voltage to the Specimen (Option):
   This connector is used when observing semi-conductor specimens under bias voltage conditions. A 25 pin connector (one pin is grounded) is provided at the lower left of the stage door (DB-255). The connector should be covered with the dust cap provided when not in use. The terminal numbers on the specimen stage correspond to the terminal numbers on the stage door connectors. The electrical specification of the connection system is as follows:

   Current rating: 1A
   Resisting voltage: DC 300V
   Insurating resistance: Larger than 5,000Ω

9. How to Use Specimen Stage Clamp:
   It is recommended to set the stage clamp in the CLAMP position when observing a specimen at high magnification. This eliminates the effects of vibration. The clamp control is located at the back of the specimen chamber right hand side. Rotating the control clockwise sets it in the UNCLAMP position, and rotating counterclockwise sets it in the CLAMP position. Do not apply force when the limits of movement are reached. The image will move when clamping or unclamping the stage. This is normal.

   STRICT OBSERVANCE 1: Never rotate T dial and Z dial under the clamped condition. The X, Y and R controls can, however, be moved with the stage clamped.

   STRICT OBSERVANCE 2: Never open or close the door under the clamped condition.

HR MODE

1. Size of specimen: 8mmØ x 5mmt
2. Specimen stand: Flat stand and concaved stand (two kinds)
3. Specimen movement range:
   (1) X direction: Max. 6.5mm (243 to 307 on the digital position indicator dial)
   (2) Y direction: Max. 6.5mm (243 to 307 on the digital position indicator dial)
   (3) R (rotation) (moved by rotating the rotation knob)
   360°, endless (0 to 99 on the digital position indicator dial)
   3.6°/division
   (4) T (tilt) (moved by rotating the tilt control) -10° to +30°
   (5) Z (working distance): Limited range above and below HR position as indicated by red marks on Z control.
4. Accessory Parts:
   One position: For secondary electron detector
5. Shifting the Specimen:
   (1) The specimen stage X, Y movements are motor driven. The speed of movement is selected by depressing one of the five SPEED push buttons. The speeds corresponding to each push button are shown in the chart below. The direction of movement is controlled by the arrowed MOVEMENT push button. The rotation control is manual. Clockwise rotation of the stage control results in clockwise rotation of the image.

   STRICT OBSERVANCE: When opening or closing the specimen chamber door, do it after setting the dials approximately to the following positions:

   Motor Drive Speeds

Speed Select	Drive Speed (X, Y) (Microns/Sec)
H	200 (continuously)
1	100 (continuously)
2	15 (0.25μ/pulse)
3	3 (0.25μ/pulse)
S	1.5 (0.25μ/pulse)

X 450
Y 275
T . . . . 0°

Opening and closing of the door with the stage settings far from these positions can result in the stage bumping the chamber when opening the door.

REMARK: The stage is provided with a protection system to prevent driving the specimen into the bore of the objective lens. When the limits are reached, a buzzer sounds, and power to the driving motor is cut off. The stage can now only be driven in a direction such that the specimen moves away from the objective lens wall. If the tilt control is set beyond the -10° to +30° settings, a warning buzzer sounds.

STRICT OBSERVANCE: Open or close the specimen chamber door only after setting the stage controls to the following positions:

X 275
Y 275
T . . . . 0°
Z . . . . The position of the triangular mark (►).

The door may not be opened unless setting it lower than this position. Open and close the door only after setting the control at or below this mark.

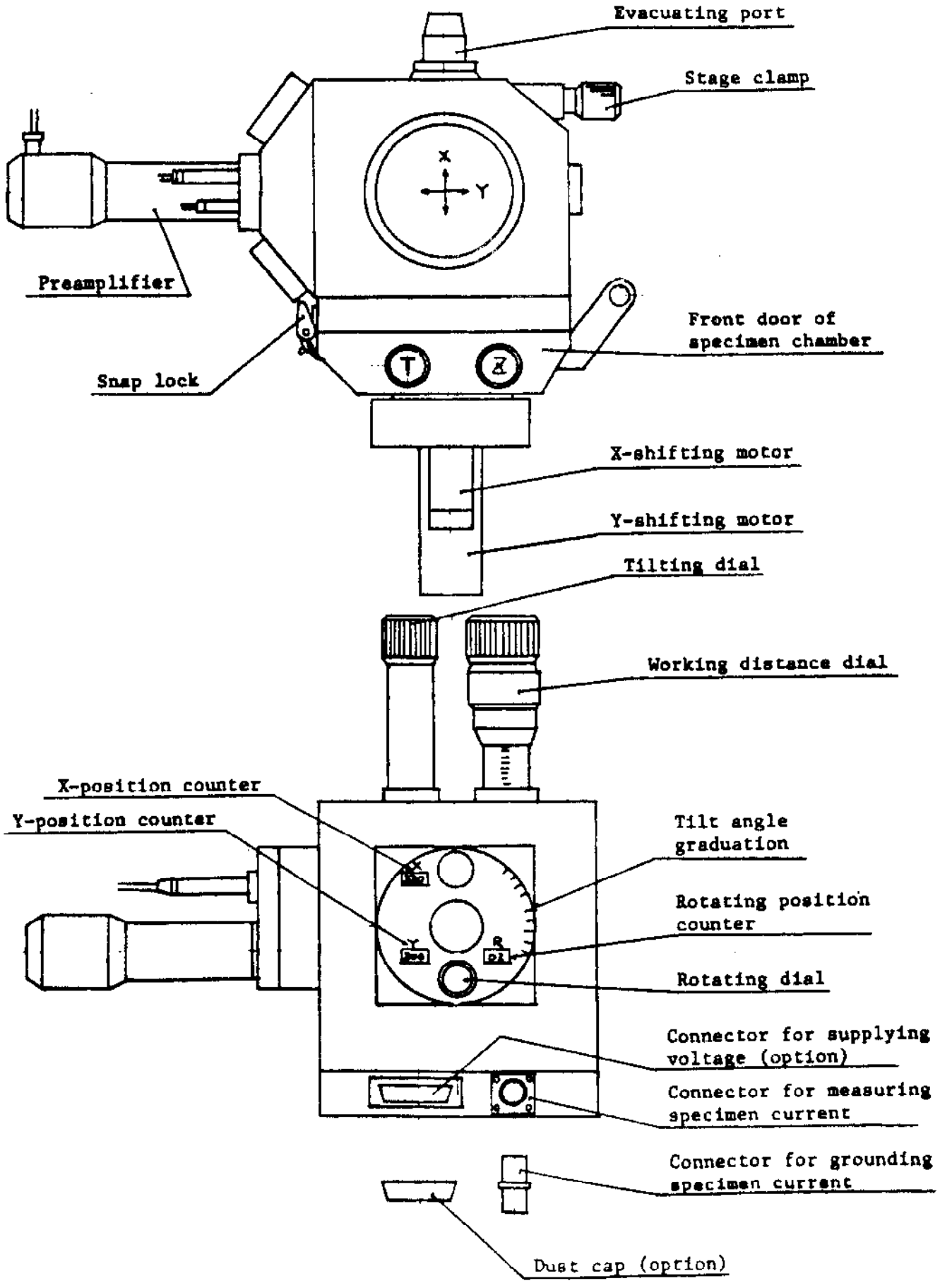
(2) When uneven surface of the specimen is required for observing, the specimen is recommended to be tilted. In this case, rotation of T dial tilts the specimen. Adjust the required angle to the right side graduation on the front panel of stage.

STRICT OBSERVANCE: Never rotate T dial under the set condition of stage clamping dial to CLAMP.

(3) When observing the image in the HR Mode, the Z control should be set so that the red mark on the control knob is set to the red lines on the control shaft.

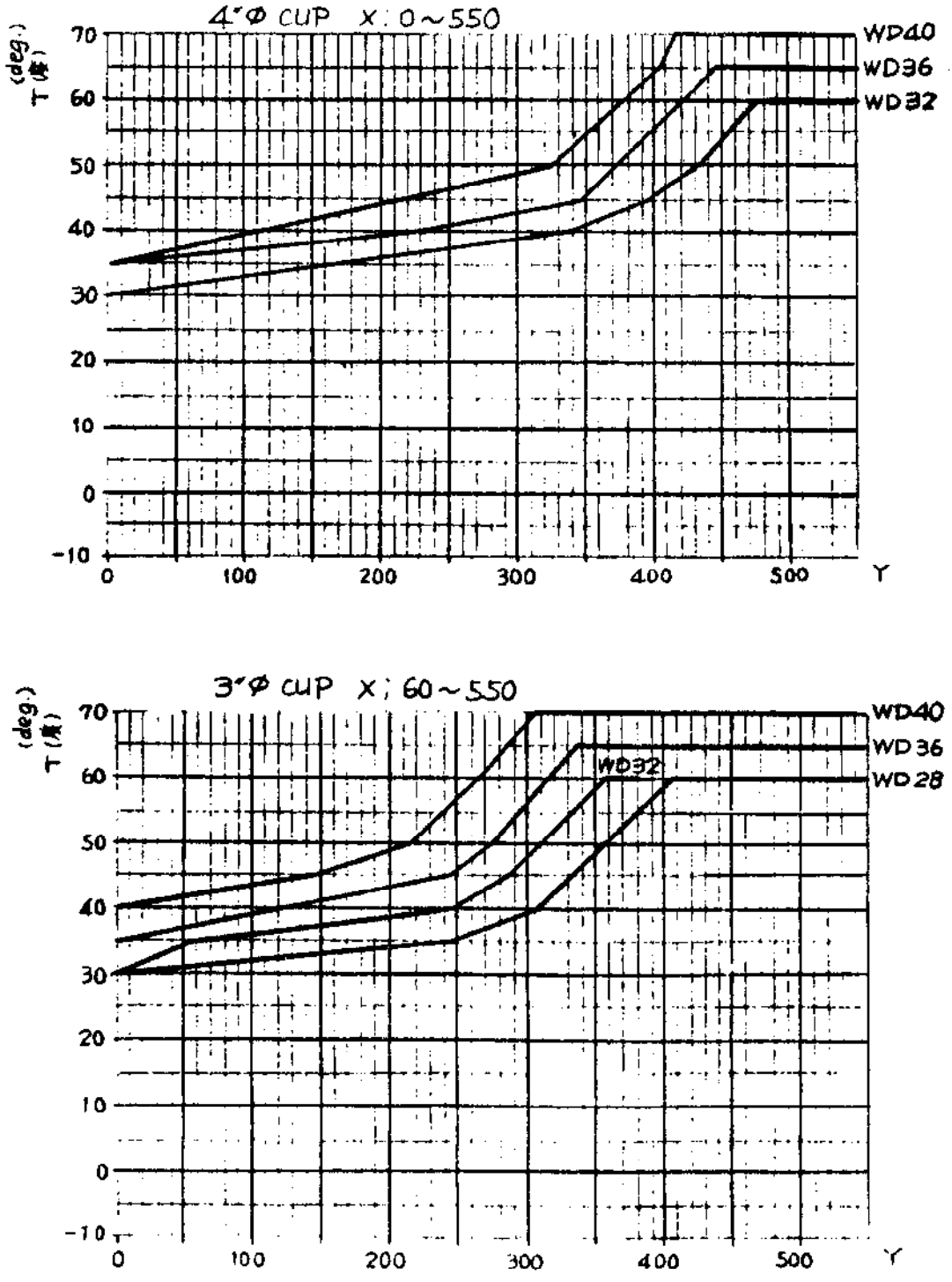
REMARK: Z control can be used in the range from 8 to 40mm even when using HR stage. The MODE 1 or MODE 2 buttons should be depressed in this case.

1) Do not move the Z control with the stage clamped.
2) Never attempt to raise the specimen into the HR position with the pole piece insert in place.

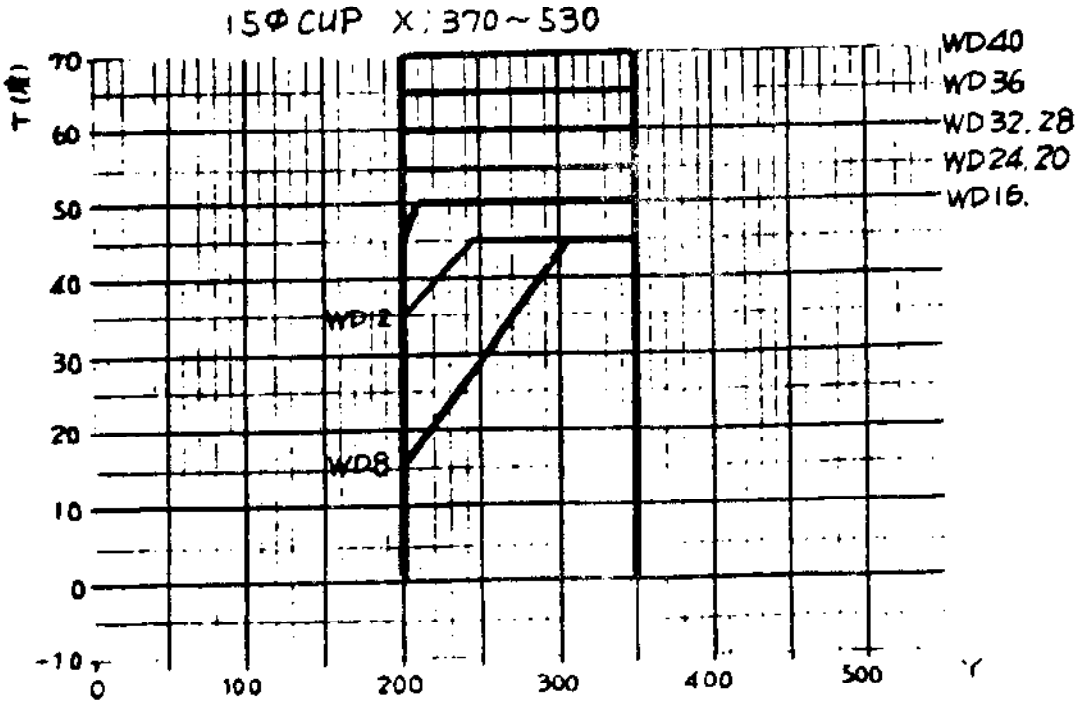

Evacuating port
Stage clamp
X
Y
Preamplifier
Front door of specimen chamber
Snap lock
X-shifting motor
Y-shifting motor
Tilting dial
Working distance dial
X-position counter
Y-position counter
Tilt angle graduation
Rotating position counter
Rotating dial
Connector for supplying voltage (option)
Connector for measuring specimen current
Connector for grounding specimen current
Dust cap (option)

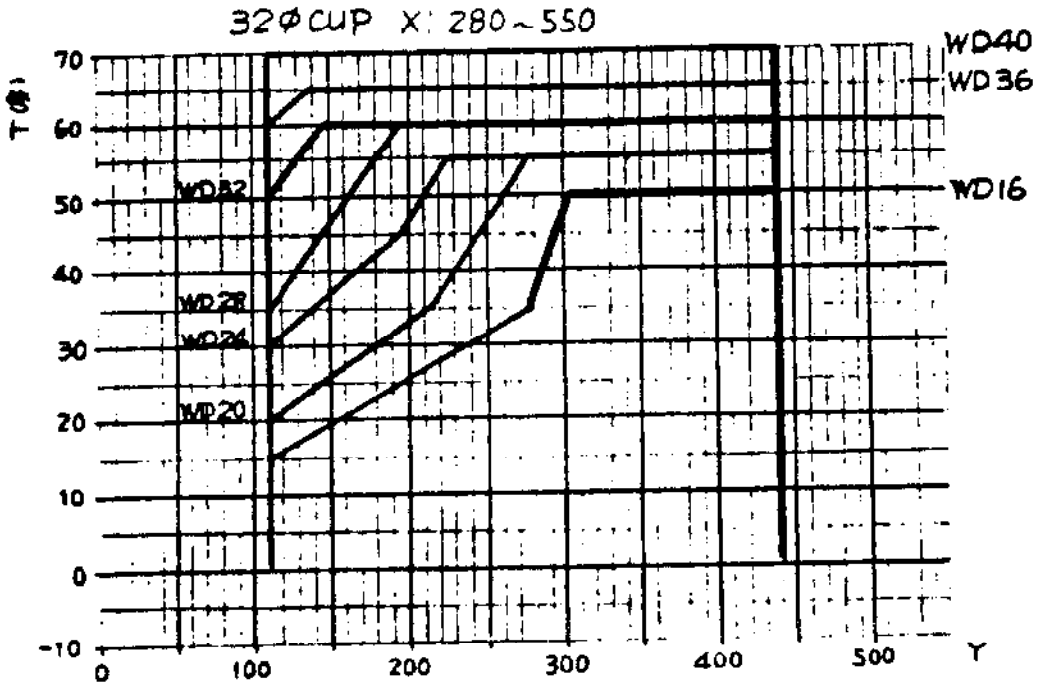
SPECIMEN STAGE MOTION FOR TXYR-Z (4")

SPECIMEN CENTER
X: 450
Y: 275



Graph 1


15Φ CUP X: 370~530
T(秒)
70
60
50
40
30
20
10
0
-10
0
100
200
300
400
500
Y
WD40
WD36
WD32, 28
WD24, 20
WD16.
WD12
WD8


32Φ CUP X: 280~550
T(秒)
70
60
50
40
30
20
10
0
-10
0
100
200
300
400
500
Y
WD40
WD36
WD16
WD32
WD28
WD24
WD20

Graph 2

4. REPLACING ELECTRON GUN CARTRIDGE

1. Set HV switch to OFF. The switch button lamp will go off.
2. Introduce air into the microscope body referring as outlined in "OPERATING VACUUM SYSTEM."
3. Swing the electron gun back on its hinge (Refer to Figure 2). Make sure that the contact rod touches the gun cartridge before touching the cartridge by hand.

   NOTE: Be careful that no dust or other contamination enters the gun chamber during cartridge exchange.
4. Rotate the electron gun cartridge retaining ring counterclockwise to dismount. Then, pull out the cartridge from its base (Refer to Figure 1).

   NOTE: If the instrument has been in operation just prior to cartridge placement, it will be hot (in excess of 200°C). Wait until it cools, or handle with a clean dry cloth. Failure to observe these precautions can result in severe burns.

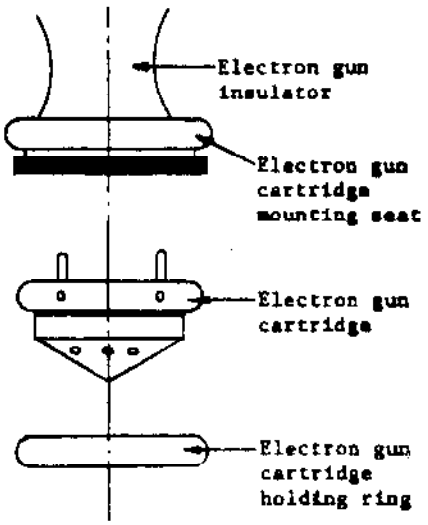


Fig. 1

5. Insert a new cartridge into the cartridge mounting seat (the orientation of cartridge does not matter as long as the pins are properly aligned). Screw the cartridge, holding ring to the mounting seat.
6. Swing the gun closed, making sure that the grounding rod does not prevent closure. Check that the gun vacuum seal is clean and properly seated.
7. Evacuate the microscope body as described in "OPERATING VACUUM SYSTEM."

NOTE: In the event that evacuation time is excessively long, this is probably due to contamination of the gun "O" ring. Let air into the instrument, clean the "O" ring and groove, and lightly coat with vacuum grease.

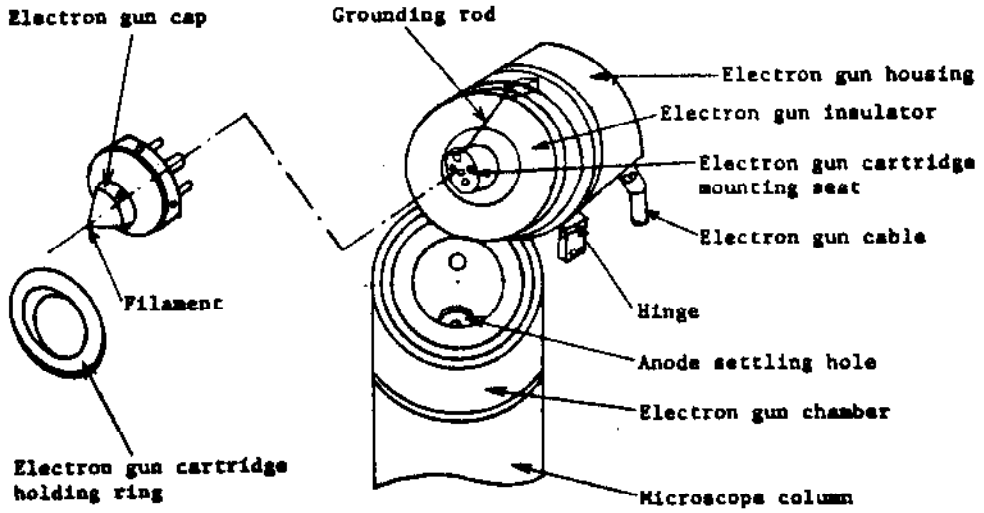


Fig. 2

NOTE: The electron gun is provided with two cartridges as shown in Figure 3 below. When operating in the AUTO mode, it is essential to set the toggle switch to either the HB or LL position depending on which cartridge is in operation. When operating in the MANUAL mode, however, the toggle switch is no longer in operation and it doesn't matter where it is set.

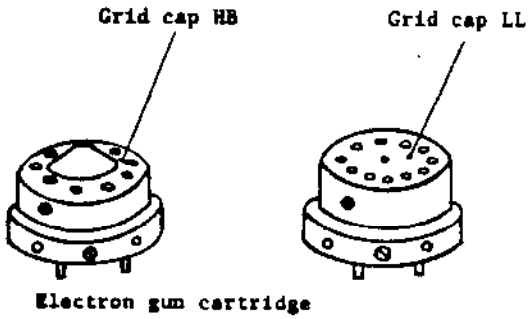


Fig. 3

5. DISPLAYING SCREEN IMAGE

1. Insert specimen into instrument and evacuate, following the procedures outlined in "OPERATING VACUUM SYSTEM" and "INTRODUCING SPECIMEN".
2. Check the following items:
   (1) CH1/CH2 switch set to CH1.
   (2) SIG/XRAY of CH1 set to SIG.
   (3) SIG/XRAY of CH2 set to SIG.
   (4) SCAN MODE switch set to MAP.
   (5) DUAL MAG switch set to OFF.
   (6) SCAN SPEED switch set to RED.
   (7) MAGNIFICATION switch set to LOW magnification.
   (8) Switch the automatic CONTRAST/BRIGHTNESS unit OFF (Option).
   (9) Set DYNAMIC FOCUSING dial to 0 degrees.
   (10) When operating in HR mode, HR button of OPERATION MODE controls should be depressed, HR substage should be mounted and Z (working distance) control set to HR position as described in "INTRODUCING SPECIMEN". Pole piece insert must be removed.

   When operating in MODE 1, depress MODE 1 button or OPERATION MODE SWITCH. Z (working distance) control should be set somewhere between 8 and 40mm. Pole piece insert must be removed.

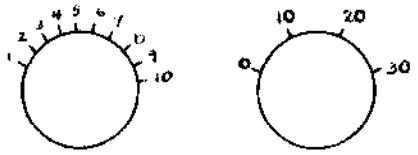
   NOTE: Adjust the black indicating line of Z dial to the graduation of 8mm to 40mm.

   When operating in MODE 2, depress MODE 2 button on OPERATION MODE switch. Z (working distance) control should be set somewhere between 8 and 40mm. Pole piece insert must be in place.

3. Set HV switch to ON. The switch button lamp lights. Set VACUUM/EMISSION switch to EMISSION. The needle will slowly rise to a value dependent on the accelerating voltage selected. The approximate values are shown in the table below:

High Voltage (KV)	Meter Indication (μA)
30	Approx. 54
20	Approx. 37
10	Approx. 18
5	Approx. 9
2	Approx. 4

NOTE: On the SS-40, one HV knob is used in 5 steps.
On the SS-60 and SS-130, two knobs are used as shown below:



For SS-60, Max. voltage is 30kV
For SS-130, Max. voltage is 40kV

4. Gradually rotate BRIGHTNESS dial of CH1 clockwise, and a scanning area of about 5cm (height) x 6cm (width) will come visible at the middle of the CRT. Adjust the BRIGHTNESS control so that the scanned area is just visible.
5. Emission Operation:
   (1) Manual Emission Operation: Set AUTO/MANUAL switch to MANUAL with EMISSION control dial fully counterclockwise. Slowly rotate EMISSION control dial clockwise. The EMISSION meter indicator will gradually move to the right but will eventually move much slower as the knob is turned. Set the EMISSION control at, or slightly below, this setting. Rotate BIAS dial to obtain the emission current settings as follows:

   At 30kV of high voltage: in case of gun cartridge HB - 100 to 150μA
   in case of gun cartridge LL - 70 to 100μA

   (2) Auto Emission Operation: Set AUTO/MANUAL switch to AUTO with EMISSION control fully counterclockwise. Using HB cartridge, turn HB/LL switch to HB, and when using LL cartridge, turn the switch to LL. The EMISSION meter will gradually increase and stop at a certain position. Rotate BIAS dial to set the emission current to the following value:

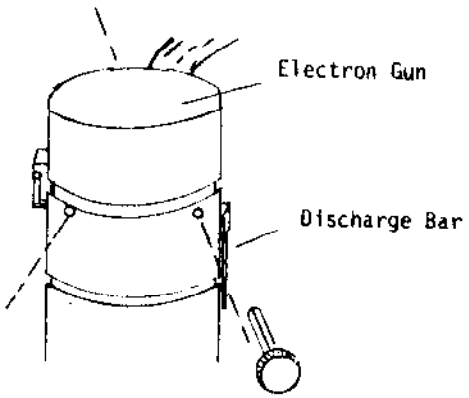
   At 30kV of high voltage: in case of cartridge HB - 100 to 150μA
   in case of cartridge LL - 70 to 100μA

   REMARK: If the EMISSION meter does not move on increasing the EMISSION control setting, then the filament is probably burned out. Replace the filament as outlined in "REPLACING ELECTRON GUN CARTRIDGE".
6. Set SPOT SIZE dial (AUTO BEAM SYSTEM for SS-60 and SS-130. Refer to appropriate section for settings) to 12 O'clock (with knob pushed in) and CONTRAST dial to approximately 2 O'clock.

7. Set SCAN MODE switch to Line. Depress WFM of SCAN SPEED switch. Adjust the four GUN ALIGNMENT controls (TILT and SHIFT) for maximum displacement (upwards) of the waveform on the CRT.

   REMARK: If any of the four controls does not cause the signal to go through a maximum, then set each control to its middle position and adjust the mechanical alignment of the electron gear with the four screws provided to obtain a maximum signal. Now adjust each of the four GUN ALIGNMENT controls to obtain a maximum signal.

   NOTE: After the correct mechanical alignment of the electron gun has been realized, the alignment screws should be lightly tightened to prevent subsequent movement of the gun.



   REMARK: If the waveform on CRT moves up and out of the field of view, decrease the CONTRAST, BRIGHTNESS or SPOT SIZE settings. (AUTO BEAM for SS-60 and SS-130) If the waveform on the CRT is set too low, then increase the CONTRAST, BRIGHTNESS or SPOT SIZE settings.

8. When using AUTO/MANUAL switch in MANUAL position:
   (1) When the adjustments outlined in item "6" are finished, rotate EMISSION dial clockwise slightly and check that level of the waveform on the CRT does not vary. If it varies, repeat once more the adjustment in item "6" at this new EMISSION control setting.
   (2) Rotate EMISSION dial counterclockwise. The waveform should move down on the CRT. Rotate the dial clockwise until the waveform stops to increase. The filament current is now correctly set.

9. When using AUTO/MANUAL switch in AUTO position: Filament saturation is automatically set, and the correct filament current is applied to the system is properly adjusted. It is recommended periodically to compare the waveforms obtained in the AUTO and MANUAL modes. They should be the same in both cases. Screwdriver adjustable controls are provided for setting the correct filament current for both LL and HB cartridges. The relation between the filament current and emission current is as shown in the figure below. The filament current should be set at the saturation point as shown.
   (1) HB/LL switch is set to the HB position when using the high brightness cartridge. The potentiometer at the RHS of the HB/LL toggle switch should be adjusted in the same way as the EMISSION control in the MANUAL operating mode. Once set, however, it should require only infrequent adjustment.
   (2) HB/LL switch is set to the LL position when using the long life cartridge. The potentiometer at the CHS of the HB/LL toggle switch should be adjusted with a screwdriver in the same way as the EMISSION control in the MANUAL operating mode. Once set, however, it should require only infrequent adjustment. Setting of the filament current beyond the saturation point will produce only a slight increase in emission current but will significantly shorten filament life.
10. Depress WFM of SCAN SPEED once more to set to OFF. Set SCAN MODE switch to MAP. Rotate COARSE FOCUS control right and left to adjust the focus observing the image on the CRT.
11. Axis Aligning of Projection System: This operation is carried out by minimizing image shift on changing the Spot Size control.

NOTE: The AUTO BEAM SYSTEM is standard on the SS-60 and SS-130 models and is <u>not</u> available as an option on the SS-40.

NOTE: AUTO BEAM SYSTEM USE
This system was designed to control the diameter of the Electron Beam and the amount of the Electron Beam applied to the specimen. Generally, additional lens adjustments of the Electron Beam application system will cause undesirable shifts in the Electron Beam axis or cause image defocusing. This system was designed to compensate for this. Having this system, the Scanning Electron Microscope

is virtually free from electron beam axis shifts and image defocus despite turning the AUTO BEAM SYSTEM control knob from the fully counterclockwise position to the fully clockwise position. Turning the AUTO BEAM SYSTEM knob results in varied image brightness. Turning the AUTO BEAM SYSTEM knob fully counterclockwise, the diameter of the Electron Beam applied to the specimen will get smaller and the amount of electrons will decrease resulting in a decrease in image brightness. Turning the knob fully clockwise, the diameter of the Electron Beam will get larger and the amount of electrons will increase resulting in an increase in brightness. The best images can be obtained with the proper adjustment of this control at the desired magnification. Generally, the following is recommended:

Magnification	Knob Position
5,000 or less	11th stop or more clockwise
5,000 - 20,000	6th - 13th stop
20,000 - 50,000	3rd - 8th stop
50,000 or more	1st - 5th stop

The AUTO BEAM SYSTEM control has a direct correlation between the signal-to-noise ratio on the CRT.

In the LC position continuous variation of the Spot is possible by turning the knob at the right of the AUTO BEAM control knob.

(1) Set the SPOT SIZE control (AUTO BEAM SYSTEM control on the SS-60 and SS-130 models) close to the fully clockwise position. Rotate MAGNIFICATION dial to display an image of about 5,000X. Then rotate COARSE FOCUS control to focus the image. Select a distinctive feature and move it to the center of the screen. Rotate the SPOT SIZE control (AUTO BEAM SYSTEM control on the SS-60 and SS-130 models) counterclockwise maintaining reasonable image brightness and control with the BRIGHTNESS and CONTRAST controls. If the selected image feature moves, return it to the center of the field of view with the GUN ALIGNMENT X, Y SHIFT controls.

(2) Maximize the image brightness using the GUN ALIGNMENT TILT controls.

(3) Repeat steps (1) and (2) two or three times to obtain only slight image shift on changing the SPOT SIZE control (AUTO BEAM SYSTEM control on the SS-60 and SS-130 models).

NOTE: It should not be necessary to readjust the SHIFT controls until the next cartridge exchange.

REMARK 1: If a GUN ALIGNMENT TILT control must be set to its extreme clockwise or counterclockwise position, follow the process we outlined under item "6" above, then perform operations (1) and (2) again.

REMARK 2: The above procedure is only applicable if the filament is properly saturated. Check saturation periodically during alignment. The alignment procedure outlined here under item "11" need only be carried out under normal conditions after cartridge exchange.

12. Set SCAN SPEED switch to V1 or V2. The image is now displayed on the whole CRT area.
13. Shifting the Specimen in X, Y Directions: Shifting the specimen in X, Y is carried out using the SPECIMEN MOVEMENT switch. The shifting speed is selected using the SPECIMEN SPEED switch:

Specimen Speed	Specimen Movement
H	About 200μ/second (continuously)
1	About 100μ/second (continuously)
2	About 15μ/second (0.25μ/pulse)
3	About 3μ/second (0.25μ/pulse)
S	About 1.5μ/second (0.25μ/pulse)

At a working distance of 8mm, the specimen image will move horizontally on the CRT if the left and right push buttons are pressed. The image will move up and down if the upper and lower buttons are pressed. The image movement axis is rotated as the working distance is increased.

14. To switch the instrument off for specimen exchange, turn the EMISSION control fully counterclockwise and depress the HV switch. The HV switch light will go out.

REMARK: When operating in the AUTO mode, there is no need to turn down the EMISSION control. The instrument can be switched off by simply depressing the HV button.

6. ADJUSTING SCREEN IMAGE

MODE 1 OPERATION

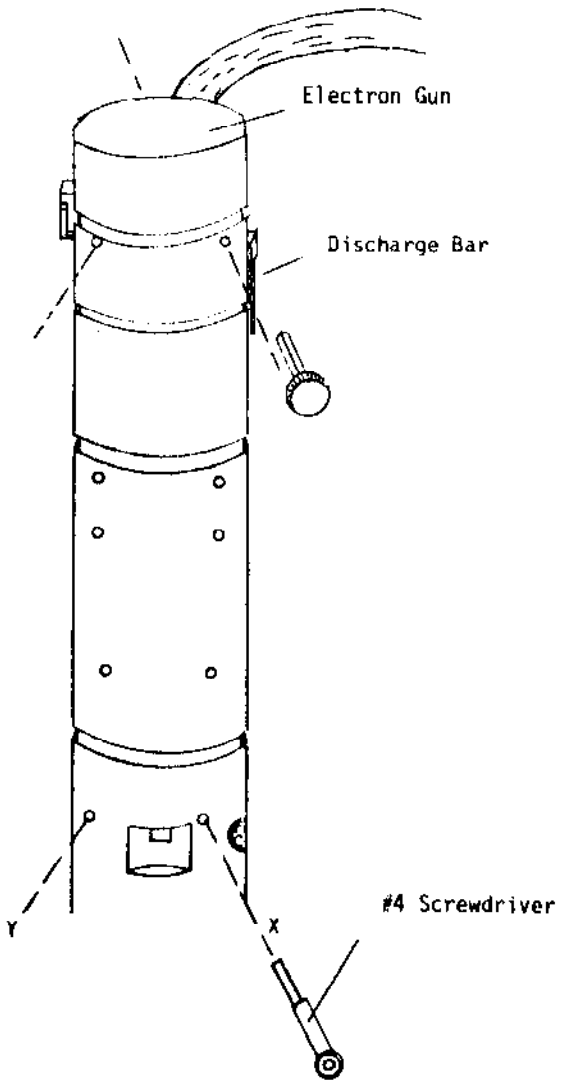
1. Confirm that the items of "DISPLAYING SCREEN IMAGE" are finished.
2. Set each switch, dial, etc., to the condition of "DISPLAYING SCREEN IMAGE", Item 2.
3. Set OPERATION MODE switch to MODE 1. Rotate Z (working distance) dial of the specimen stage to adjust the black indicating line of dial to the graduation of 8mm. Set WORKING DISTANCE switch to 8mm.

   NOTE: The objective lens pole piece insert should be removed for MODE 1 operation as described in the following section, "MODE 2 OPERATION".

4. Lens axis alignment:
   (1) Centering the objective lens aperture: Set the TILT X and Y dials of LENS ALIGNMENT to their mid position. Set the IMAGE SHIFT controls to their mid position.
      a) Set SCAN-3 switch on the panel to OFF and OL switch to OFF. Set the MAGNIFICATION control to minimum.
      b) Focus the image using the SECOND CONDENSER control and bring some distinctive feature to the center of the viewing screen.

      NOTE: The direction of image shift on operating the specimen stage controls will be quite different to that in the normal operating mode. This is quite normal.

      c) Rotate SECOND CONDENSER control about ±45° and observe the movement of the distinctive feature.
      d) Adjust the position of the objective aperture in both the X and Y directions using a watchmaker's screwdriver (No. 4) to minimize the amount of image shift on changing the SECOND CONDENSER setting.
      e) Set SCAN-3 switch to ON and OL switch to ON.
   (2) Aligning the objective lens:
      a) Set MAGNIFICATION to about 100X. Bring a distinctive feature to the center of the CRT. Focus the image with the COARSE FOCUS control.
      b) Bring the distinctive feature back to the center of the CRT using the LENS ALIGNMENT TILT controls.



c) Gradually raise the magnification, repeating the operations (1) and (2) up to a magnfication of about 20,000X.

NOTE 1: An alternative means of aligning the objective lens is to use the OL WOBBLER. If this is switched on, the objective lens current is automatically varied. The object, again, is to adjust the LENS ALIGNMENT TILT control to minimize image movement at the center of the CRT. It is often most convenient to use the first alignment technique described for coarse alignment (WOBBLER OFF) and the WOBBLER for fine alignment.

NOTE 2: As the magnification is increased, the presence of any astigmatism becomes troublesome. It is necessary, therefore, to adjust the stigmator prior to objective lens alignment.

NOTE 3: Centering the objective lens aperture as described in section 4-(1) is only necessary if the column liner has been removed or if an aperture is changed using the optional variable aperture mechanism.

NOTE 4: Centering the objective lens as described in section 4-(2) should be checked periodically if operating at high magnification (50,000X or more). It should be performed everytime the column liner is replaced.

d) Set SCAN SPEED switch to V2. In order to select a general area on the specimen, it is recommended to operate at low magnification in the range of 30X to 100X. Rotation of ZOOM dial from the full counterclockwise to the full clockwise position changes the magnification by 3X.

e) For selecting the specimen position, refer to the items of "SPECIMEN HANDLING" and item 13 "Shifting the Specimen" of "DISPLAYING SCREEN IMAGE".

NOTE: Focus will normally require adjustment when moving the specimen due to changes in the brightness of the specimen from location to location. When the Z (working distance) control is changed, it will also be necessary to refocus the image with the COARSE FOCUS control. This should be set to a value close to that indicated on the Z control graduation scale.

f) Changeover MAGNIFICATION switch to set to the required magnification.

NOTE: As the magnification increases, it will be necessary to more critically focus the image.

g) At very high magnification it is difficult to move the specimen precisely with the SPECIMEN MOVEMENT controls. Changing the area of observation should be accomplished using the IMAGE SHIFT X, Y controls. The amount of movement available in both directions is 40 microns.

h) Set SCAN SPEED switch to RED when the specimen position of interest has been selected for detailed observation. Finely focus rotating FOCUS dial. It is normally best to focus at one magnification step higher than that required for observation.

NOTE: How to use SPOT SIZE control (for SS-60 and SS-130, see previous AUTO BEAM SYSTEM description). The brightness of the image on the CRT is changed by rotating SPOT SIZE. With the control rotated fully clockwise, the beam diameter at the specimen is minimized, but the image brightness is much decreased and it becomes grainy. With the SPOT SIZE control fully counterclockwise, the SPOT SIZE minimum and signal level becomes very high. The correct setting of the SPOT SIZE control is dependent upon a number of parameters, in particular, the magnification. The values listed below are a rough guide to the correct setting in various magnification ranges for the SS-40 only (see the AUTO BEAM SYSTEM noted previously):

At 5,000X or lower, set the dial at 10 O'clock.
At 5,000 to 20,000X, set it at 12 O'clock.
At 20,000X to 50,000X, set it at 3 O'clock.
At 50,000X to higher, set it fully clockwise (Min.)

i) If sharp focus is not obtained following the steps outlined in item (h), this may be due to astigmatism. This is recognized if the image distorts out in one direction or one side of focus distorts out at right angles to that direction on the other side of focus. In this case, set the FOCUS control to a point mid-way between the two distorted image settings. Adjust the STIGMATOR X, Y controls to obtain best focus. Repeat this procedure two or three times.

NOTE 1: To adjust the STIGMATOR controls, it is recommended that a symbolically shaped feature such as a circle, two edges at right angles to one another, etc., be selected. The correction should first be made at relatively low magnification then increasing magnification up to the maximum to be used.

NOTE 2: If astigmatism is still present after performing the procedure outlined under item 10 and the STIGMATOR controls are at their limits, then a large uncorrectable observation is present. The cause is likely to be due to one of the following:
- The emission current is not saturated. Refer to "DISPLAYING SCREEN IMAGE".
- The specimen is charged or magnetized.

- The objective lens aperture, column lines, etc., is contaminated. Refer to "REPLACING ANODE, COLUMN LINER, and OBJECTIVE LENS APERTURE".
- The objective lens may not be properly aligned.

j) Set SCAN SPEED switch to V1. The CONTRAST and CH1 BRIGHTNESS controls should be adjusted to produce an image with the contrast and brightness required. If the CONTRAST control is set beyond about 12 O'clock, the image will become noisy. It is often advisable to vary the SPOT SIZE control in conjunction with the BRIGHTNESS and CONTRAST controls to obtain the image quality desired.

k) How to use CH1/CH2 switch: If the standard secondary electron detector signal is connected to the JN1 connector or the back of the instrument, and a second detector (e.g. Robinson backscattered electron detector) is connected to JN2, then signal selection is performed as follows. Depress CH1 and corresponding SIG button to display the secondary electron image. The brightness of the image is controlled by the BRIGHTNESS CH1 knob. Depress CH2 and the corresponding SIG button to display the image using the second detector (e.g. Robinson backscattered electron detector). Brightness of the image is controlled by the BRIGHTNESS CH2 knob. *Contrast is adjusted in each case using the CONTRAST control. If an X-ray detection system is connected to JN3 and another X-ray detection system is connected to JN4, the X-ray signals can be selected as follows: Depress CH1 and the corresponding X-ray button to select the input to JN3 for X-ray mapping. Depress CH2 and the corresponding X-RAY button to select the input to JN4 for X-ray mapping.

l) How to use RED POSITION X and Y: Set SCAN SPEED switch to V1 or V2, and select the field of view to be photographed. If some feature within the field of view has to be in focus while some other parts are out of focus due, for example, to the sample being very rough, depress the RED button and move the raster with the RED POSITION controls to scan the part of the field of view which has to be in focus.

m) How to use ON/OFF switch of MODE 1: This switch turns the top secondary electron detectors ON and OFF in the MODE 1 operating mode. The switch is normally placed in the ON position when

operating at magnifications above about 500X. It should be set in the OFF position for magnifications below about 500X. If the switch is left in the ON position at low magnification, a bright region will appear in the center of the field of view.

MODE 2 OPERATION

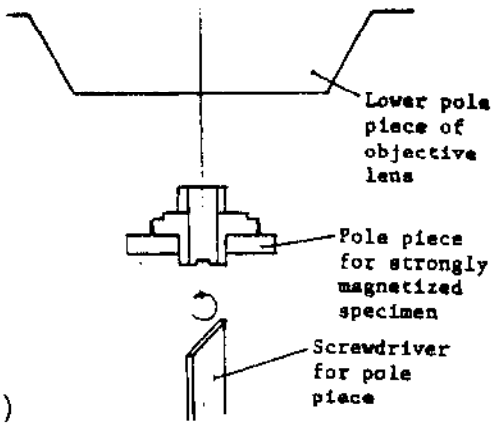
If the specimen being examined is magnetized or charged, this can adversely affect the distribution of the objective lens, resulting in poor image quality. In this case, screw the pole piece insert into the objective lens and operate with the MODE 2 button depressed.

1. Preparation:
   (1) Set HV switch to OFF. The switch button lamp goes off.
   (2) Introduce air into the microscope body referring to "OPERATING VACUUM SYSTEM".
   (3) Rotate the stage clamping dial of the specimen device clockwise to set to UNCLAMP. Rotate T (tilt) dial to set to zero degrees. When using Z (working distance) dial at HR position, rotate Z dial to adjust the black indicating line of dial to the graduation 8mm.
   (4) Open the snap latch provided at the left side of specimen chamber body and open the chamber door.

   NOTE: Do not expose the interior of specimen chamber to the atmosphere for longer than necessary.

   (5) Switch the OL toggle switch to the OFF position, then screw the pole piece insert into the bottom of the objective lens. Do not use force when tightening the insert (Refer to the figure).
   (6) Close the door, then close the snap latch.

   NOTE: Check the vacuum seal between the chamber and door for dust and check that it is properly seated.



(7) Evacuate the microscope body, referring to "OPERATING VACUUM SYSTEM".

NOTE: Sometimes the evacuation time is extremely long. This can be due to specimen outgassing or contamination of the gasket between the specimen chamber and door.

(8) HV switch can be turned on when the vacuum pilot lamp lights, but it is recommended to wait an additional few minutes.

(9) Rotate Z (working distance) dial to the desired working distance (8 - 40mm).

(10) Set OPERATION MODE switch to MODE 2.

2. Set the OL Switch to ON:

(1) Confirm that all items of "DISPLAYING SCREEN IMAGE" are finished.

(2) Set each switch and dial as indicated in item 2 in "DISPLAYING SCREEN IMAGE".

(3) If the adjustments as described in "Centering Objective Lens Aperture" have been completed for MODE 1 operation, there is no need to repeat them again. Follow the alignment procedure outlined for MODE 1.

HR MODE OPERATION (WARNING: REMOVE POLE PIECE INSERT)

1. Mount the substage to the main stage as described in "HR Mode Operation" section of "INTRODUCING SPECIMEN".
2. Remove pole piece insert.
3. Rotate Z (working distance) knob of specimen stage to adjust the red indicating line of dial to HR mark.

NOTE: Rotate Z dial after setting both X and Y controls to a reading of 275 on the stage position indicator using the SPECIMEN MOVEMENT controls.

4. Set OPERATION MODE switch to HR.
5. Check that all items of "DISPLAYING SCREEN IMAGE" are finished.
6. Set each switch and dial to the condition of item "2" of "DISPLAYING SCREEN IMAGE".
7. Lens Axis Alignment: If the adjustments as described in "Centering Objective Lens Aperture" have been completed for MODE 1 or 2 operation, there is no need to repeat them here. Follow the alignment procedure outlined under 4-(2) "Aligning the Objective Lens".

8. Follow the same procedures outlined for MODE 1 OPERATION. Note that the Z axis must be maintained in the HR position.

   NOTE: The amount of movement available with the IMAGE SHIFT X, Y controls is limited to 10 microns in the HR operating mode.

SELECTING OBJECTIVE LENS APERTURE (For SS-40 and SS-60 Only)

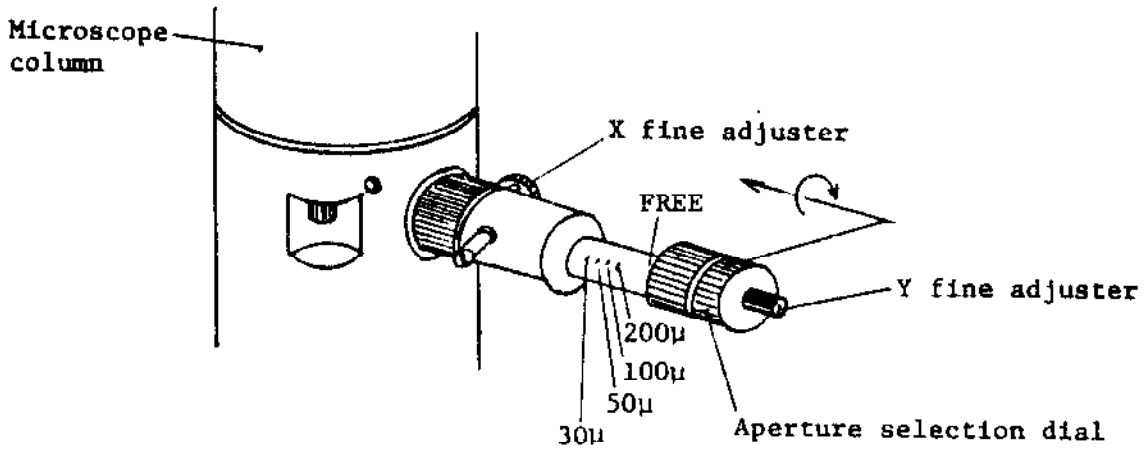
A variable aperture mechanism containing five different kinds of apertures is provided as the standard accessory:

30 diameter, 50 diameter, 80 diameter, 100 diameter, and 200 diameter.

1. 80 diameter is used for general purpose operation.
2. 30 or 50 diameter are used for ultra high resolution operation. 30 diameter is recommended for use with the optionally available LaB_6 filament.
3. 30 or 50 diameter apertures can be used where great depth of field is required. This is usually only required in the middle to low magnification range. Here, a large spot size can be used which compensates for the low current level normally obtained with a small aperture.
4. 100 or 200 diameter apertures are used for X-ray analysis in situations where high beam currents are required to generate sufficient X-ray intensity. 100 diameter is especially recommended for use with EDX (Energy Dispersive X-ray Analysis) systems.

VARIABLE OBJECTIVE LENS APERTURE (Standard on SS-130; optionally available on the SS-40 and SS-60)

1. Set the AUTO BEAM SYSTEM control knob to the 5kX range and the CONTRAST knob to the 2 O'clock position.
2. Pull the VARIABLE OBJECTIVE LENS APERTURE unit to the fully OUT position from the column axis (FREE position, see below):



At the last line position (FREE) rotate the Aperture Exchange knob counterclockwise until it stops. This is the FREE position. Use the other marks indicating 200μ, 100μ, 50μ, and 30μ as appropriate, referring to the above information concerning size in relation to beam current.

3. SCAN MODE control to LINE and DEPRESS WFM button on the SCAN SPEED.
4. Rotate the X and Y FINE adjustment knobs located on the VARIABLE APERTURE unit clockwise or counterclockwise to bring the WFM line on the CRT to the highest position.
5. Rotate the GUN ALIGNMENT TILT X, Y controls clockwise and counterclockwise to bring the WFM line on the CRT to the highest position.

NOTE: If the TILT X, Y control are turned fully clockwise or counterclockwise for this adjustment, or if it is impossible to obtain maximum height of the WFM line, mechanical alignment is required.

BEFORE mechanical alignment, set all TILT X, Y and SHIFT X, Y control to center (1½ turns). Refer to the Mechanical Alignment procedures.

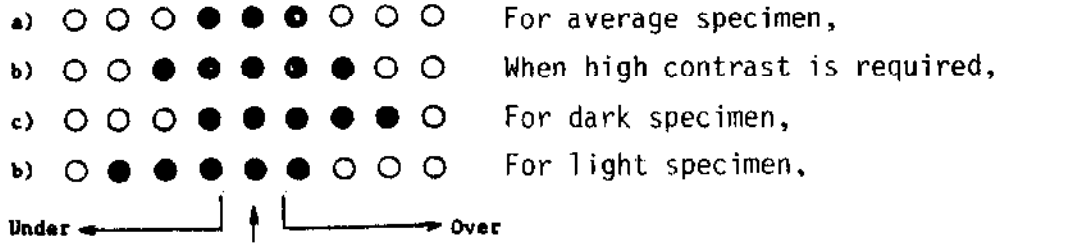
7. TAKING PHOTOGRAPH

1. Follow the procedure outline in "ADJUSTING SCREEN IMAGE" to select a field of view and adjust the instrument prior to taking a picture.
2. Follow the instructions provided with the camera to load the film and become familiar with how one adjusts the camera aperature setting.

   REMARK: Preset the lens aperature as follows:

   (1) 6 x 9 roll film camera - preset the aperture to 11 using ASA 100 sensitivity film. Magnification ratio: 0.65
   (2) When using 6 x 9 roll film camera mount Polaroid attachment for 600 series - preset the aperture to 32 using type 677 film (ASA 3,000) and 11 using type 665 film (ASA 75) Magnification ratio: 0.8
   (3) 35mm roll film camera - preset the aperture to 11 using ASA 100 sensitivity film. Magnification ratio: 0.3
   (4) 4" x 5" Polaroid camera (50 series) - preset the aperture to 8 for type 55 (ASA 50) and 22 for type 52 (ASA 400). Contraction ratio: 1

3. In general, a different contrast and brightness setting is required for photography than is required for image observation on the viewing screen. The procedure for setting the contrast and brightness for photography is described below.
4. Set SCAN SPEED switch to RED. The CONTRAST/BRIGHTNESS LED lamps will light. The LED display consists of nine lamps in total and the middle lamp is always lit when SCAN SPEED is set to RED.
5. When taking photograph with the P1 SCAN SPEED switch depressed, adjust the CONTRAST and BRIGHTNESS dials to obtain the lamp illumination patterns shown below:



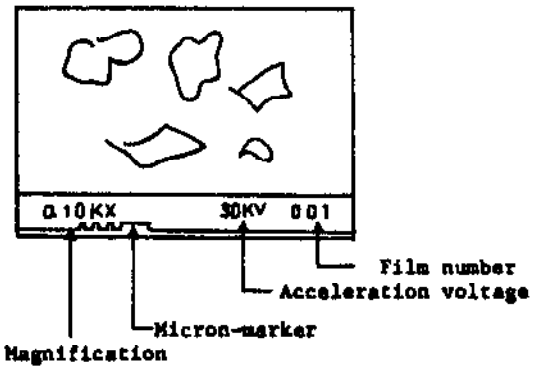
When taking photograph with P2 SCAN SPEED switch depressed, adjust the CONTRAST and BRIGHTNESS dials to obtain the lamp illumination pattern

shown below:

For average specimen,

The settings for higher contrast, dark and light specimens are as shown in Figure 1 above with the illuminated lamp pattern moved one place to the left.

6. Depressing either the P1 or P2 SCAN SPEED switch turns on the photo CRT and starts the single record scan. The scan time is 80 seconds in the case of P1 and 180 seconds in the case of P2. The magnification, accelerating voltage, film numbers and micron marker are automatically printed on each photograph. The photo switch selected is illuminated during the record scan and goes out at the end of the scan. The instrument returns automatically to the SCAN SPEED in operation prior to depressing P1 or P2.



7. Advance the film or insert a new sheet of film.

NOTE: The film number is automatically advanced one digit every time the photo button is depressed. The film numbers can be set back to 001 by depressing the FILM NO. RESET button.

How to use P1 and P2 of SCAN SPEED switch: Low and medium magnification pictures should be recorded using the P1 SCAN SPEED. High magnification images or images of specimens producing a very low signal level (poor signal-to-noise) should be taken using the P2 SCAN SPEED.

8. HOW TO USE DYNAMIC FOCUSING

When observing a tilted specimen, especially at low magnification, there are bound to be regions towards the edge of the film which are out of focus when the center is in sharp focus. The DYNAMIC FOCUSING control is used for correcting this defect.

1. Read out the tile angle of the specimen from the indicator on the specimen stage door. Set the DYNAMIC FOCUSING dial to this angle.
2. Rotate FOCUS dial to focus on some feature at the middle part of screen image, and the whole screen will be well focused.

NOTE 1: It is normally sufficient to adjust DYNAMIC FOCUSING idal as described ablve. If, however, the specimen is very rough or is mounted at an angle to the specimen stub surface, then the DYNAMIC FOCUSING control is best set by observing the screen and adjusting until best overall focus is obtained.

NOTE 2: As DYNAMIC FOCUSING is only necessary at low magnifications, it is automatically turned off at high magnification even where the knob is set to some angle other than zero.

9. DISPLAYING BACK-SCATTERED ELECTRON (BSE) IMAGE

Back-scattered electrons (BSE) are incident electrons which are back-scattered out of the specimen. They range in energy from zero to the energy of the incident electron beam. There is, however, a very large population of BSE's with energies close to that of the incident electrons. The BSE intensity is influenced by surface topography and the materials present at the surface of the specimen. There are often significant differences between the SE (secondary electron) and BSE images. Display SE (secondary electron) image according as described in "DISPLAYING SCREEN IMAGE" and "ADJUSTING SCREEN IMAGE" and depress DET HV switch. The BSE (back-scattered electron) image will become visible by rotating the SPOT SIZE dial counterclockwise. It may be necessary to pull out the SPOT SIZE control to further increase the specimen current. It will be necessary to refocus the image and readjust the STIGMATOR. In order to obtain SE (secondary electron) image again, rotate SPOT SIZE dial clockwise and push in if it is in the pulled out position. Depress DET HV switch again.

NOTE: The back-scattered electron image cannot be observed in the HR mode.

10. HOW TO USE LINE, SPOT, LP, AND X-RAY

Enery dispersive X-ray analysis systems (EDX) are often used with SEMs. This is a powerful tool for performing the non-destructive analysis of elements from small selected regions of the specimen surface. Connect the EDX system to the JN3 (X-ray) and JN5 (LP1) sockets on the back of the instrument. The following operations can now be performed:

(1) Spot Analysis (SPOT)
The beam can be positioned on a selected spot of the specimen surface for qualitative or semi-quantitative analysis of the elements present in that region.

(2) Line analysis (LINE, L.P.)
A simple line on the specimen surface can be scanned to determine the concentration distribution of a specific element. The distribution can be displayed on the CRT in the line profile (L.P.) mode.

(3) Area Analysis (X-Ray)
By scanning an area of the specimen surface, the distribution of a selected element can be determined. This can be displayed as an image on the CRT.

1. Display SE image (secondary electron image) as described in "DISPLAYING SCREEN IMAGE" and "ADJUSTING SCREEN IMAGE".

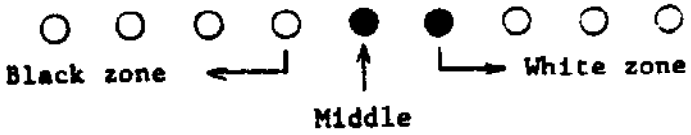
   NOTE: It is often useful to monitor the specimen current during X-ray analysis (Refer to "SPECIMEN HANDLING").

2. To obtain area analysis display (X-ray map), depress the X-ray button associated with CH1. An X-ray distribution image (dot map image) will appear on the CRT. The EDX system output which is applied to the JN3 connector should have a pulse amplitude of 5VP-P. The polarity of the pulse does not matter as a polarity switch is provided on the printed circuit board associated with this signal display.
3. When performing spot analysis, first observe the image, SE (secondary electron) or BSE (back-scattered electron). Depress the SCAN MODE SPOT button and move the spot on the CRT to the desired location for analysis using the POSITION X, Y controls. This can be done using the image afterglow as a reference. Analysis can now be performed on that spot.

4. When performing line analysis, first observe the image SE or BSE. Depress the SCAN MODE LINE button and move the line which appears on the CRT to the desired position on the specimen using the POSITION Y control. This can be done using the image afterglow as a reference. The X-ray analysis will now be performed along that line. The concentration of a specific element can be displayed on the CRT by depressing the SCAN MODE L.P. switch. The output signal requirements for the EDX system connected to the JN5 (LP1) connectors are:

   Output impedance: 100 or lower
   Output voltage: from 0 to -10V

5. In both the line and L.P. SCAN MODES, the brightness of the display is fixed and is not affected by the BRIGHTNESS control. Therefore, the trace can be photographed without adjusting the CONTRAST and BRIGHTNESS. When photographing the X-ray area analysis map, adjust the BRIGHTNESS control to get the LED display pattern shown below.



6. The LINE and L.P. controls can be used to show the intensity distribution along a line or the specimen of signals other than X-RAY, e.g., secondary or back-scattered electron. Display an image such as the secondary electron image by depressing the SCAN MODE MAP control. Select a field of view of interest and a suitable magnification. Depress the SCAN MODE LINE button and position the line on the screen to the location desired using the POSITION Y dial with reference to the image afterglow. Depress the SCAN MODE L.P. button and the distribution of the secondary electron intensity along that line will be displayed on the CRT.

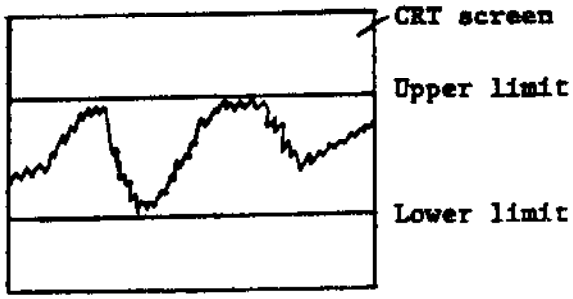
11. HOW TO USE WAVEFORM MONITOR

Depress WFM button of SCAN ~~SPEED~~ mode switch.

1. How to use for setting emission current saturation: Having completed the alignment of the column as outlined in "DISPLAYING SCREEN IMAGE", turn the filament off by rotating the EMISSION control fully counter-clockwise. To properly adjust the filament current, gradually turn the EMISSION control clockwise observing the waveform on the CRT. The waveform will rise up on the CRT and may go through a number of maxima. It will be found eventually that the waveform no longer changes on the screen as the EMISSION setting is increased. The point at which this happens corresponds to correct EMISSION control setting, i.e., saturation. Now adjust the GUN ALIGNMENT X, Y TILT controls to maximize the signal on the CRT.

   NOTE: Setting the EMISSION control beyond the saturation point will significantly shorten filament life. Use the WAVEFORM MONITOR to set the CONTRAST and BRIGHTNESS controls for photography.

2. Rotating the CONTRAST control clockwise increases the amplitude and the DC level of the signal on the CRT. Increasing the BRIGHTNESS control increases the DC level only of the signal on the CRT. A number of test micrographs should be taken to determine the correct settings of BRIGHTNESS and CONTRAST. Note the upper and lower limits of the signal on the CRT with a felt tip pen. For future photographs simply use the CONTRAST and BRIGHTNESS controls to set the waveform between these two limits.

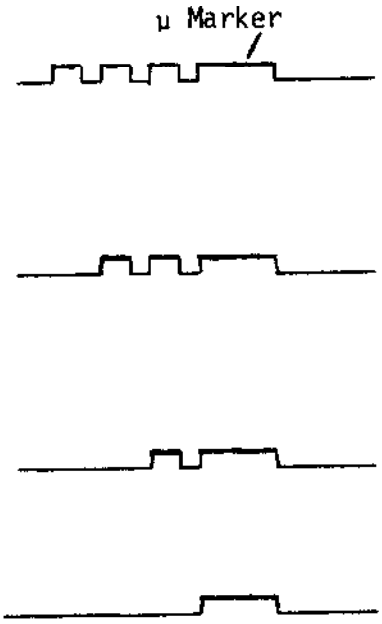


3. The WAVEFORM MONITOR can also be used in conjunction with the GAMMA CONTROL (option). Refer to "HOW TO USE GAMMA CONTROL".

12. HOW TO USE MICRON MARKER

Occasionally, it may be necessary to determine the size of features within a field of view. When this is the case, the use of the Micron Marker becomes very convenient. The Micron Marker, shown in Figure 1, is displayed at the lower part of the micrograph. The length of the mark at the right varies according to the magnification of the image. Four types of scales are provided:

Figure 1



(1) Three vertical deflections indicates that the μ Marker represents 100μ.

(2) Two vertical deflections indicates that the μ Marker represents 10μ.

(3) One vertical deflection indicates that the μ Marker represents 1μ.

(4) No vertical deflections indicates that the μ Marker represents 0.1μ.

The Micron Marker is linked to the MAGNIFICATION knob, ZOOM control, and Z (Working Distance) control.

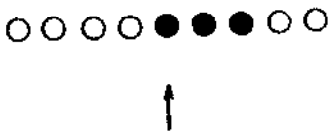
NOTE: In the Dual Magnification mode, the Micron Marker corresponds to the low magnification side of the image.

13. HOW TO USE DUAL MAGNIFICATION

If the instrument is equipped with the DUAL MAG system, it will permit simultaneous observation of a low magnification image on the left half and a high magnification image on the right half of both the Viewing and the Photo CRT's.

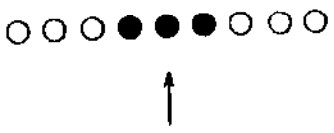
1. To engage the Dual Magnification, depress selector buttons X2, X5, X10 as desired on the DUAL MAG control. Dual Magnification is displayed in the V1, V2, and PHOTO P1 and P2 scan modes.
2. When Dual Magnification is ON, a rectangular frame is displayed on the low magnification (left side) image. The area within the frame represents the field of view displayed on the right side of the CRT and changes size when Dual Magnification is changed. The POSITION X, Y controls are used to locate the frame anywhere within the low magnification field of view.
3. Adjust the CONTRAST and BRIGHTNESS knobs for CH1 or CH2 so that the LED CONTRAST/BRIGHTNESS display is as shown in Figure 1 below:

Figure 1



4. Depress the P1 button of the SCAN SPEED. When the P1 button lights, then goes off, the photograph has been completed.
5. When photographing in P2, adjust the LEDs as shown in Figure 2 below:

Figure 2



6. Depress P2. When the P2 button lights, then goes off, the photograph has been completed.

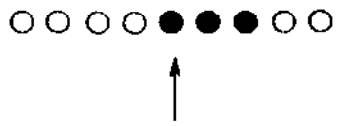
14. HOW TO PRODUCE TWO DIFFERENT TYPES OF IMAGE SIMULTANEOUSLY

Different types of image can be displayed simultaneously on the left and right hand side of the CRT if a number of detectors or accessory units are available on the SEM. The selected signal into CH1 is displayed on the left of the screen while the selected signal into CH2 is displayed on the right hand side.

NOTE 1: EDX unit is necessary for displaying X-ray image. And, two sets of X-ray analyxers are necessary for observing two different X-ray images simultaneously.

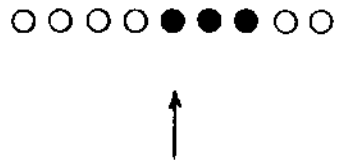
NOTE 2: If an SE and BSE image should be displayed simultaneously, a separate BSE detector (optional) must be installed on the instrument.

1. Set SCAN SPEED switch to V1. Then, set DUAL MAG switch to X1. Operate SIG/XRAY switch of CH1 to select the signal for display on the left of the CRT. Operate SIG/XRAY switch of CH2 to select the signal for the right of the CRT.
2. How to take a photograph:
   (1) Displaying images other than X-ray:
      a) Set CH1/CH2 switch to CH1.
         Set DUAL MAG switch to OFF.
         Set SCAN SPEED switch to RED.
         Bring the scanning area to the middle of the CRT with RED POSITION X and Y dials.
         In the case of the secondary electron (SE) image or back-scattered electron (BSE) image, set CONTRAST dial and BRIGHTNESS dial of CH1 to obtain the LED illumination pattern shown below.



In the case of displaying another detector signal (not X-ray), adjust the CONTRAST dial on the detector module and adjust CH1 BRIGHTNESS control to obtain the above illumination pattern.

(2) Then, set CH1/CH2 switch to CH2. Operate CONTRAST dial provided at the signal device (Option) and BRIGHTNESS dial of CH2 to obtain the LED illumination pattern shown below.

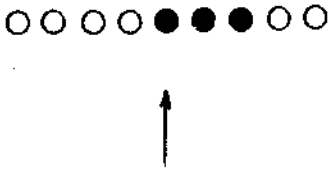


(3) Set DUAL MAG switch to X1. Depress P1 of SCAN SPEED switch to take photograph.

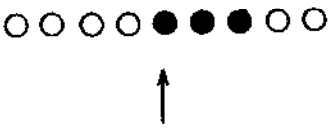
(4) When taking photograph with SCAN SPEED switch set to P2, the LED illumination pattern should be as shown below.

3. X-Ray Image:

(1) Follows the procedure outlined in item "a" of 2-(1). Adjust the BRIGHTNESS dial of CH1 to obtain the LED illumination pattern shown below.

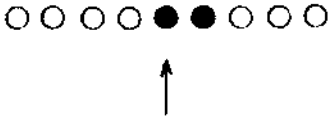


(2) Follow the steps outlined in item (2) above. Adjust the BRIGHTNESS dial of CH2 to obtain the LED illumination pattern shown below.



(3) Set DUAL MAG switch to X1. Depress P1 of SCAN SPEED switch to take photograph.

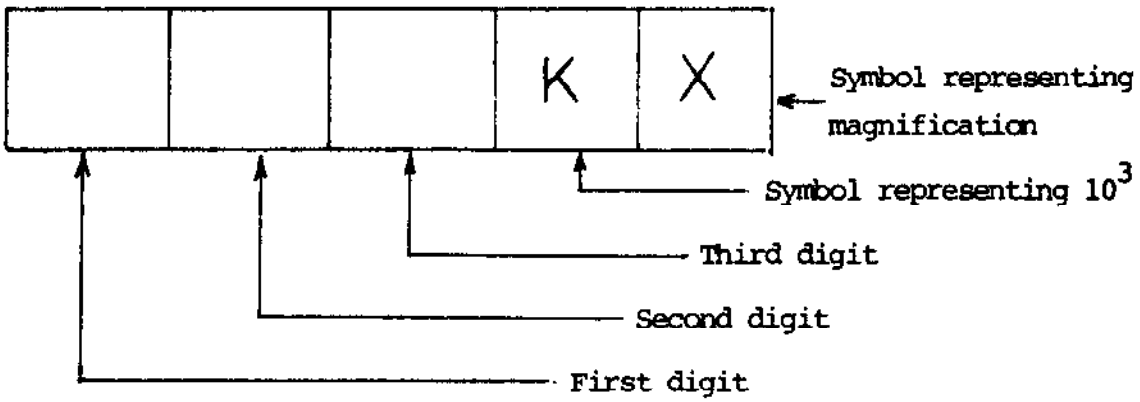
(4) When taking photograph with SCAN SPEED switch set to P2, the LED illumination pattern should be as shown below.



15. AUTOMATIC DIGITAL TYPE MAGNIFICATION INDICATOR

The digital magnification display on the instrument takes account of the accelerating voltage used and the working distance selected (i.e., distance between speciemn surface and bottom of objective lens).

1. All that is required is to correctly focus the image. The magnification can then be read out directly. How to read the magnification:



The decimal point which is indicated at the left lower of the figure is shifted according to the magnification. For example, the magnification is displayed as shown below:

200 Times	.200 kX
2,000 Times	2.00 kX
20,000 Times	20.0 kX
200,000 Times	200 kX

NOTE: In the case of DUAL MAG operation, the magnification indicator indicates the magnification of the left hand part of the screen, i.e., the low mag image. The magnification of the right hand part of the screen may be determined by multiplying the indicator magnification with the magnification ratio selector (X2, X5, or X10).

16. HOW TO USE FILAMENT IMAGE

If trouble is experienced in saturating the filament as described in "DISPLAYING SCREEN IMAGE" it is useful to be able to display the filament image. This is particularly useful when using the optionally available LaB_6 source.

1. Check the following items:
   (1) Set SIGNAL PROCESSING (option) switch to NORMAL.
   (2) TILT CORRECTION dial (option) set to zero degrees.
   (3) Y-MODULATION switch (option) set to OFF.
   (4) Depress CH1 and SIG associated with CH1. Depress CH2 and SIG associated with CH2.
   (5) Set AUTO CONTRAST/BRIGHTNESS (option) to off.
   (6) Set GAMMA CONTROL (option) to OFF.
   (7) Set SCAN MODE switch to MAP.
   (8) Set SCAN SPEED switch to V2.
   (9) Set MAGNIFICATION switch to the lowest magnification.
2. Depress the push button switch of FILAMENT IMAGE. The lamp lights. Set CONTRAST dial and BRIGHTNESS dial of CH1 to near 12 O'clock. Rotate EMISSION dial clockwise to increase the emission current. Rotate SPOT SIZE dial counterclockwise and the image of the filament will become visible.
3. When the filament is below saturation, the halo as shown in Figure 1 becomes visible.
4. As the EMISSION setting is increased, the ring merges into the central spot and we obtain the image shown in Figure 2.

   NOTE: If the filament image is difficult to see, depress the objective lens using the COARSE FOCUS control.

5. Depress FILAMENT IMAGE switch button. The lamp will go out.

Figure 1

Figure 2

17. REPLACING FILAMENT

1. Loosen the grid cap rotation stop screw, and rotate the grid cap counterclockwise to dismount from the filament holder. Then, loosen four filament center adjusting screws to take out the filament from the filament holder (Refer to Figure 1).

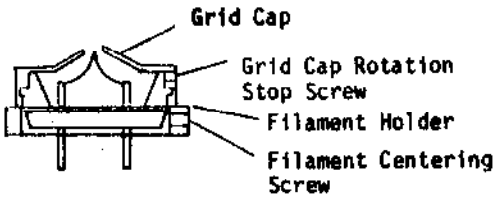


Figure 1

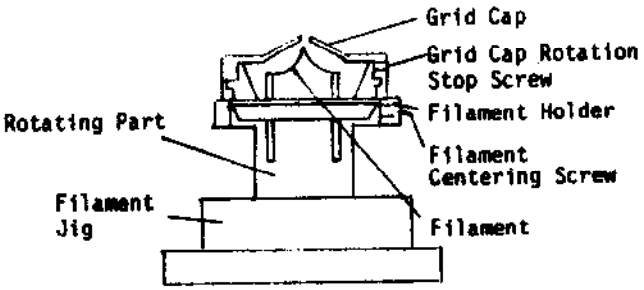


Figure 2

2. Clean the grid cap and filament holder referring to "CLEANING ELECTRON GUN CARTRIDGE AND ANODE". It is especially important to clean the hole in the center of the grid cap and the surfaces close to the hole. Contamination of this region can result in electrical discharge.
3. Carry out the following procedures referring to Figure 2 for mounting a new filament: Insert the filament into the filament setting jib (accessory). The orientation of the filament does not matter. Place the filament holder upon the filament base, then slowly screw the grid cap onto the filament holder. Screw the grid cap in until the tip of the filament is flush with the top surface of the grid cap hole.
4. Adjust the four filament center adjusting screws to bring the tip of filament to the center of the hole in grid cap. This centering operation should be performed rotating the filament setting jig while observing the top of the grid cap. After finishing the centering, carefully tighten the four filament centering screws, being careful not to misalign the filament. Check the centering with an eyepiece of 5X to 10X.
5. In the case where the HB grid cap is used. After finishing operation, rotate the grid cap counterclockwise one revolution and carefully tighten the grid cap rotation stop screw. Be careful not to overtighten the screw as this can misalign the filament. In the case where the LL grid cap is used. After finishing operation, rotate the grid cap counterclockwise one and a half revolutions and carefully tighten the grid cap rotation stop screw. Be careful not to overtighten the screw as this can misalign the filament.

18. REPLACING ANODE, COLUMN LINER, OBJECTIVE LENS APERTURE, ETC.

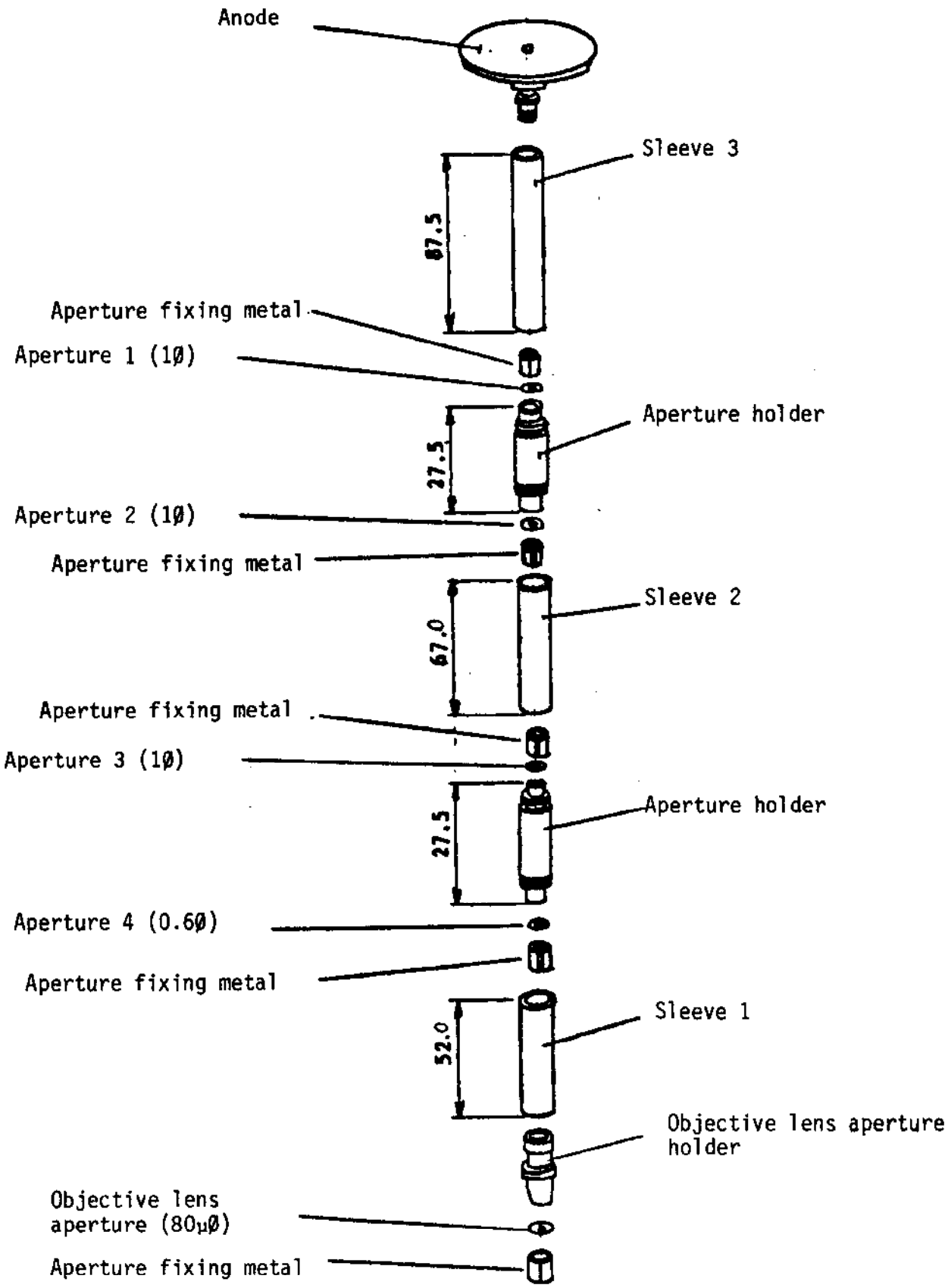
1. Depress HV switch to set to OFF. The switch lamp goes out.
2. Introduce air into the microscope body referring to "OPERATING VACUUM SYSTEM".
3. Tilt the electron gun on its hinge to the left. Make sure that the ground rod contacts the electron gun cartridge.
4. The anode and column liner assembly which includes the objective lens aperture can be removed by pulling up the anode.
5. Close the gun chamber to prevent contaminants from entering the system. Be careful not to bump the discharge bar against the hinge of the gun chamber.
6. After inspection and cleaning, if necessary, reassemble, referring to Figure 1. Carefully reinsert the assembly after opening the gun. Make sure that the anode is properly seated by applying slight pressure to its upper surface.
7. Evacuate the microscope body referring to "OPERATING VACUUM SYSTEM".

NOTE 1: If the evacuation time is excessively long, there may be some contaminants on the electron gun vacuum seal. The aperture 1, 2, 3, 4, and objective lens aperture shown in Figure 1 can be cleaned and reused by baking in vacuum, as they are made of molybdenum. It is recommended, however, that they be replaced. Frequency of replacing or cleaning the anode, apertures and column liner is shown below as a rough guide:

(1)	Anode	Every 3 months (for replacing & cleaning)
(2)	Aperture 1	Every 6 months (for replacing)
(3)	Aperture 2, 3, and 4	Every one year (for replacing)
(4)	Sleeve 1, 2, and 3.	No replacement required
(5)	Aperture holder . .	No replacement required
(6)	Aperture Retaining Ring	No replacement required
(7)	Objective lens Aperture holder	No replacement required

NOTE 2: As a rough guide, it may be expected that the objective aperture should be replaced every three months. An indication of the condition of the aperture can be obtained from the stigmator setting. If one of the controls, or both, have to be set far from their mid position, this usually indicates that the objective aperture is contaminated.

Fig. 1


Anode
Sleeve 3
87.5
Aperture fixing metal
Aperture 1 (1Ø)
Aperture holder
27.5
Aperture 2 (1Ø)
Aperture fixing metal
Sleeve 2
67.0
Aperture fixing metal
Aperture 3 (1Ø)
Aperture holder
27.5
Aperture 4 (0.6Ø)
Aperture fixing metal
Sleeve 1
52.0
Objective lens aperture holder
Objective lens aperture (80μØ)
Aperture fixing metal

19. CLEANING ELECTRON GUN CARTRIDGE AND ANODE

1. Contamination of the electron gun cartridge and anode may cause electric discharge in the electron gun chamber. Especially, contamination on the outside and inside surfaces of grid cap tip hole causes slight discharge which may cause poor image quality. They, therefore, must be kept clean at all times.

2. Polish them with a wooden rod wound by gause or cotton, applying metal polishing paste to the cotton. After removing the black contamination, wash the parts in benzene, acetone, ether, ligroine, etc. An ultrasonic cleaner is most effective here.

   NOTE 1: Make sure that all polishing paste is removed from the parts.

   NOTE 2: Check the parts after cleaning with a 10X eyepiece to make sure that no dust or chemical residue remains.

20. REPLACING SCINTILLATOR (LOWER SE DETECTOR)

The scintillator requires replacement periodically in order to maintain optimum equipment performance. A poor scintillator is often evidenced by bright dots or flashed in the image. It might also cause the image brightness under small SPOT SIZE operating conditions to be low. To replace the scintillator follow the steps outlined below:

1. Rotate EMISSION dial fully counterclockwise. Set HV switch to OFF. The switch button lamp goes out.
2. Introduce air into the microscope body referring to "OPERATING VACUUM SYSTEM".

   NOTE: Rotate the specimen stage clamping dial fully clockwise to keep the stage UNCLAMP.

3. Pull back the rubber light shield located at the specimen chamber end of the preamplifier cover. Two set screws will now become visible. Loosen these screws and slowly pull back the preamplifier case from the photomultiplier case. The preamplifier can now be removed together with the photomultiplier (Refer to Figure 1).
4. Slowly rotate the photomultiplier case counterclockwise to remove it.
5. Loosen four screws securing the detector seat to remove the detector.
6. Dismount the collector mesh which is fixed to the light guide and slowly detach the scintillator cap from the light guide by pulling it. The scintillator can now be removed. It is best if this operation is performed using lint-free gloves so as to avoid contaminating the components of the detector.
7. Place the new scintillator on the light guide facing the aluminum with the coated surface away from the light guide. Carefully replace the scintillator cap. Place a drop of silver paste at the edge of the scintillator making electrical contact between the scintillator and the cap. Secure the collector mesh to the light guide.
8. Secure the detector seat with four screws.

   NOTE 1: Care should be taken to avoid contaminating any of the detector components.

   NOTE 2: Be careful that the o-ring seal between the detector and

specimen chamber is free of dust or fibers and is properly seated.

9. Carefully screw the photomultiplier case to the detector seat.
10. Carefully insert the preamplifier and photomultiplier into the photomultiplier case as far as it will go and tightly screw the preamplifier setscrew. Draw back the light shielding rubber from the photomultiplier case to the base of the preamplifier case.
11. Evacuate the microscope body referring to "OPERATING VACUUM SYSTEM".

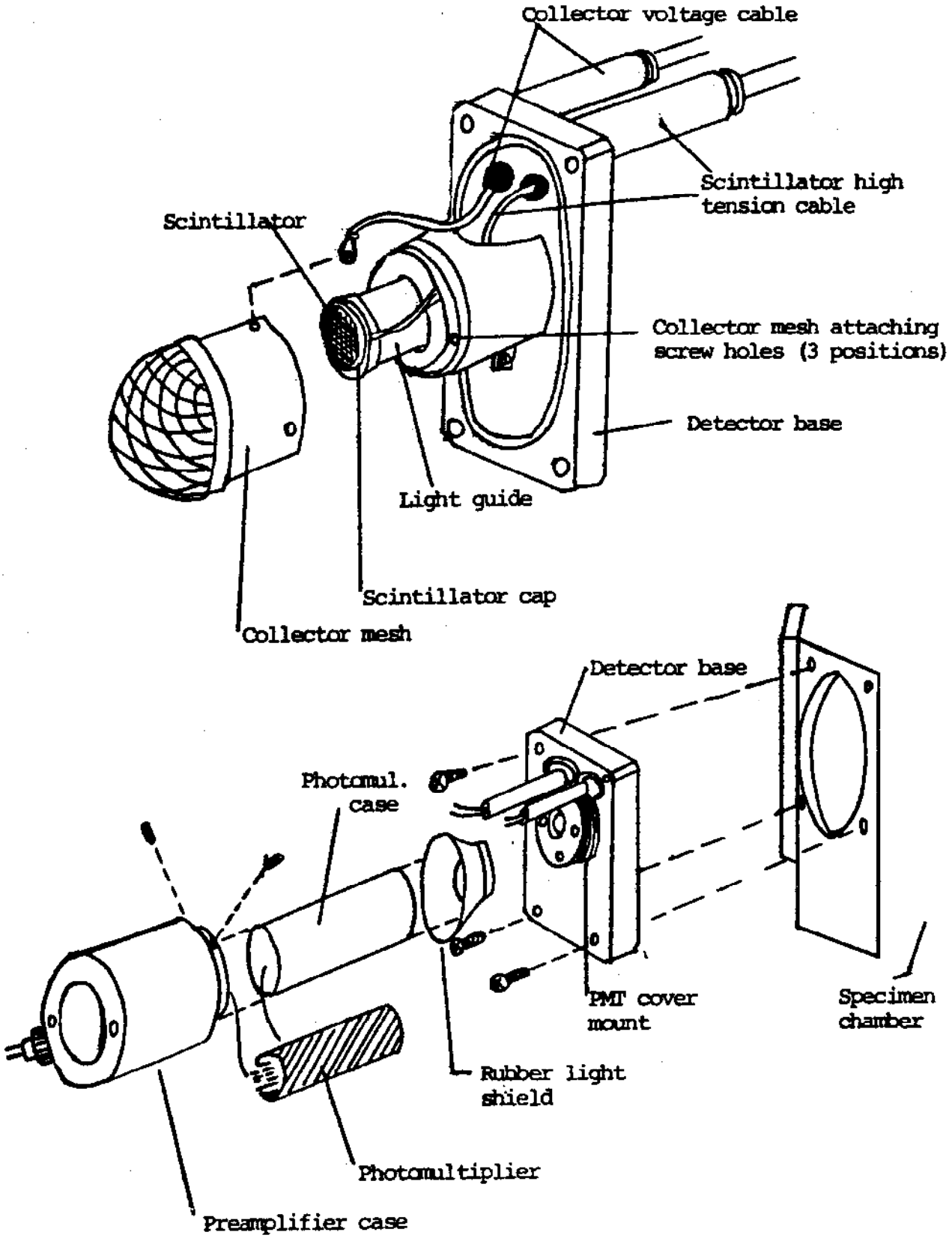

Collector voltage cable
Scintillator high tension cable
Scintillator
Collector mesh attaching screw holes (3 positions)
Detector base
Light guide
Scintillator cap
Collector mesh
Detector base
Photomul. case
PMT cover mount
Specimen chamber
Rubber light shield
Photomultiplier
Preamplifier case

Figure 1

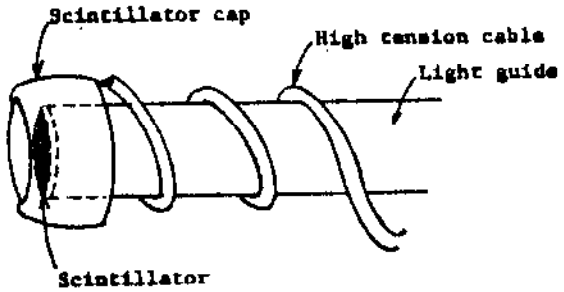
21. REPLACING SCINTILLATOR (UPPER SE DETECTOR)

The scintillator requires replacement periodically in order to maintain optimum equipment performance. A poor scintillator is often evidenced by bright dots or flashes in the image. It might also cause the image brightness under small SPOT SIZE conditions to be low. To replace the scintillator, follow the steps outlined below:

1. Depress HV switch to set to OFF. The switch button lamp goes out.
2. Introduce air into the microscope body referring to "OPERATING VACUUM SYSTEM".
3. Pull back the rubber light shield located at the specimen chamber end of the preamplifier cover. Two set screws will now become visible. Loosen these screws and slowly pull back the preamplifier case from the photomultiplier case. The preamplifier can now be removed together with the photomultiplier (Refer to Figure 1).
4. Slowly rotate the photomultiplier case counterclockwise to remove it.
5. Loosen four screws securing the detector seat to remove the detector.
6. Rotate the detector cap counterclockwise to remove, then loosen the scintillator cap fixing screw and dismount the cap from the light guide. Detach the scintillator and replace with a new one. Again mount the cap on the light guide as well as the detector cap on the detector (Refer to Figure 1). Care should be taken to avoid contaminating any of the detector components. Apply a drop of silver paste to the outside edge of the scintillator to make electrical contact between the scintillator and cap.

NOTE 1: When installing the scintillator make sure that the coated side is away from the light guide.

NOTE 2: When fixing the scintillator cap to the light guide, wind the high tension cable closely around the light guide.



NOTE 3: Make sure that the contact between the scintillator and light guide is good. Take care not to scratch the coated surface of the scintillator.

7. Secure the detector seat with the four screws provided.

   NOTE: Be careful that the o-ring seal between the detector and microscope body is free of dust or fiber and is properly seated.

8. Carefully screw the photomultiplier case to the detector seat.
9. Carefully insert the preamplifier and photomultiplier into the photomultiplier as far as it will go and tightly screw the preamplifier case setscrew. Draw back the light shielding rubber from the photomultiplier case to the base of the preamplifier case.
10. Evacuate the microscope body referring to "OPERATING VACUUM SYSTEM".

    NOTE: If the evacuating speed is slow, it is probably due to contamination of the o-ring seal between the detector and the microscope body.

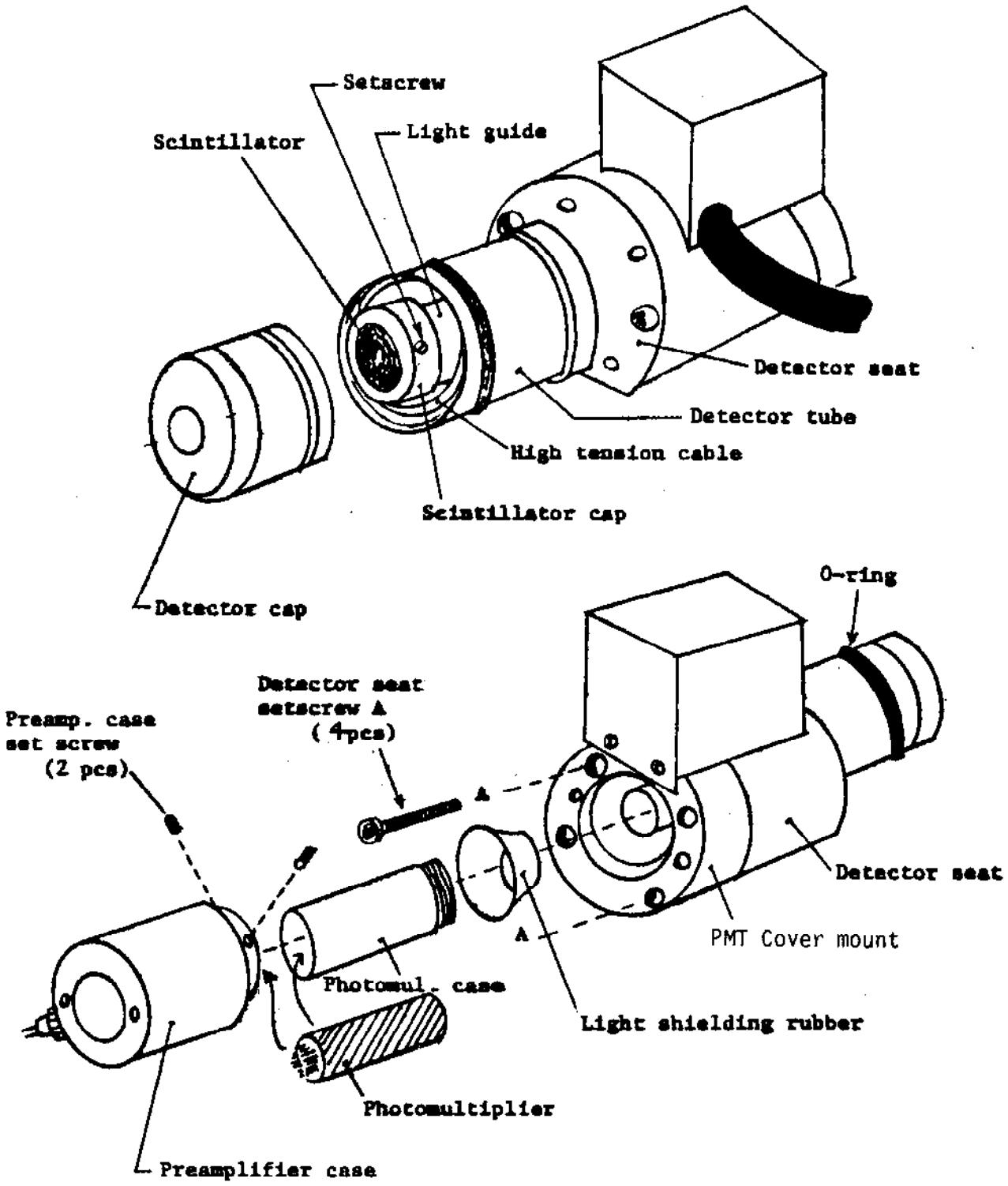

Setscrew
Scintillator
Light guide
Detector seat
Detector tube
High tension cable
Scintillator cap
Detector cap
O-ring
Detector seat setscrew A (4pcs)
Preamp. case set screw (2 pcs)
A
Detector seat
PMT Cover mount
A
Photomul. case
Light shielding rubber
Photomultiplier
Preamplifier case

Fig. 1

22. MAIN SPECIFICATIONS FOR ISI SS-40, SS-60, AND SS-130 (AS NOTED)

Resolving power:	40Å (guaranteed) (35Å for SS-60 at 30kV in HR, 30Å for SS-130 at 40kV in HR)
Magnification:	X500 to X200,000 in HR mode. X10 to X200,000 in Mode 1 and 2. Maximum 3 times zooming possible at each step. Automatic digital type magnification display provided (linked to acceleration voltage, working distance, and zoom). Print out: Acceleration voltage, magnification and film number.
Acceleration voltage:	For SS-40; 2, 5, 10, 20, and 20kV For SS-60; 30kV, 1kV steps For SS-130; 40kV, 1kV steps
Electron lens:	Magnetic field type, 3 stage
Axis alignment of electron gun:	Electromagnetic 2 stage deflection type (shift and tilt)
Astigmatism correction:	Electromagnetic type, 8 poles
Electron beam scanning:	Electromagnetic 2 stage deflection type
Lens asix alignment:	Electromagnetic 2 stage deflection type (tilt)
Dynamic focus:	-10 to +70 degrees, tilt correction possible
Electron gun:	Tungsten hairpin type fialment (cartridge replacing system) Cartridge: 2 kinds, for high brightness and for long life Filament heating: Auto and manual control possible
Specimen stage and specimen chamber:	Universal stage, type TXYRZ Specimen size: 102mm dia. x 25mmt 102mm dia. x 0.5mmt 76.5mm dia. x 25mmt 32mm dia. x 25mmt 15mm dia. x 15mmt Specimen shift: X 56mm, Y 56mm

	Specimen rotation: R 360° Specimen tilt: T -10° to +70°, continuous Specimen movement: Vertical direction, Z 32mm (WD: 8mm to 40mm) continuous Specimen current measuring terminal: 1 pc. HR stage: Specimen size: 8mm dia. x 5mm5 Specimen shift: X 6.5mm, Y 6.5mm Specimen rotation: R 360° Specimen tilt: T -10° to +30°
Specimen movement:	X and Y, motor driven
Signal detecting mode:	Secondary electron Backscattered electron
Observation and Photographing:	Viewing Mode 2: 1 frame/0.32 sec. Viewing Mode 1: 1 frame/8 sec. Reduced area Mode: 1 frame/0.08 sec. (limited visual field), position shift possible Photographing Mode 1: 1 frame/80 sec. Photographing Mode 2: 1 frame/160 sec. Line analysis Mode: Position shift possible Spot analysis Mode: Position shift possible Waveform monitor Mode: Position shift possible
Simultaneous display Mode for high and low magnification image:	Magnification ratio: 1/1, 1/2, 1/5, 1/10 (4 steps) Position display of magnified image: Position display of magnified image within the low magnification image. Selection of magnified image visual field Simultaneous display of images of different kind (Requires additional optional detector)
Indicator for photographing:	LED indication (used in reduced area scan mode)
Micron marker:	Magnification scale displayed on photograph: (100μ, 10μ, 1μ, 0.1μ - 4 kinds)

DD-SS40

Electromagnetic image shift:	HR Mode: X and Y, 10μ Mode 1 and 2: X and Y, 40μ
Coarse working distance:	8, 15, 23, 33, and 45mm (5 steps)
Meter read out:	Vacuum/Emission (2 positions)
Evacuation system:	Fully automatic motor driven system Safety devices: For power, water, and vacuum failure Oil diffusion pump: 40L/sec., 1 set (with water cooled baffle) Oil rotary pump: 160L/min., 1 set
Installation requirements:	Power Supply: Single phase, AC 100V (95 to 105V) 50/60Hz, 2.5kVA Ground: 3rd class grounding (grounding resistance: 100 or less) Cooling water: Flow rate - Approximately 2L/min. Pressure - Approximately 1kg/cm^2 Faucet - 9mmØ in outer diameter Drain port - 20mmØ or larger in inner diameter Power stability requirements: 10mV/m or lower Magnetic field requirements: 3 millioersted or lower Humidity: 60% or lower Temperature: 20° ±5°C
Standard components:	Main body: 1 set Power supply unit: 1 set Oil rotary pump: 1 set Standard accessories: 1 set (the details annexed) Instruction manual: 1 copy

24. AUTOMATIC CONTRAST/BRIGHTNESS
(OPTION)

1. Normally, image quality is adjusted by turning the CONTRAST, BRIGHTNESS, and SPOT SIZE controls (AUTO BEAM SYSTEM for the SS-60 and SS-130 as previously noted) for optimum viewing and photography. In practice, however, there may be times when it may be difficult to obtain constant contrast and brightness levels, especially when taking a micrograph because of large signal level changes.
2. To use the Auto Contrast/Brightness start with a normal image on the viewing CRT. Leaving the manual CONTRAST and BRIGHTNESS controls in the normal operating positions, switch on the ACB unit. Adjust the AUTO CONTRAST to provide approximately the same contrast. Then adjust the BRIGHTNESS control to provide approximately the same brightness.
3. When viewing the image, if it is determined that the contrast level is too high, turn the AUTO CONTRAST control counterclockwise (ccw). If the contrast is too low, increase the AUTO CONTRAST control.
4. When the brightness level of the image is too high, turn the BRIGHTNESS control ccw. If the brightness is too low, turn the BRIGHTNESS control clockwise (cw).
5. To photograph the image using the Auto Contrast/Brightness sytem, proceed as described in PHOTOGRAPHING the IMAGE section. The image contrast and brightness desired must be determined by taking several micrographs while making adjustments with the Auto Contrast/Brightness controls. Once the correct settings are determined, lock the Auto Contrast/Brightness controls and note the dial readings. Contrast and brightness can be continually reproduced on micrographs, even though the signal level changes from area to area or sample to sample. Minor changes in manual CONTRAST and SPOT SIZE controls can be made as well without effecting the image quality. However, the ACB system has a limited range and, as a result, will not compensate for extreme changes in the manual operating controls.
6. The ACB system also incorporates a TIME CONSTANT control. The image contrast and brightness is dependent on response time for signal processing. When an image contains excessive bright or dark regions due to large signal level differences, the response time of the system may produce unusual effects. View the image in the normal Scan Mode and select the TIME CONSTANT that produces the best results. The TIME CONSTANT position will vary with specimens and magnifications. TIME CONSTANT values are as follows:

NOTE: Positions 2 and 3 are most commonly used.

Position 1:	0.6 sec.
Position 2:	1.2 sec.
Position 3:	6.0 sec.
Position 4:	12.0 sec.
Position 5:	60.0 sec.
Position 6:	120.0 sec.

7. The contrast and brightness obtained will be reproduced. From time to time, however, minor adjustments of the ACB controls may be required.

NOTE: If correct manual exposure has been determined with the LED CONTRAST/BRIGHTNESS display, adjust the CONTRAST and BRIGHTNESS controls on the ACB unit to reproduce the same on the LED display. This will provide the same exposure via the ACB unit.

25. HOW TO USE GAMMA CONTROL
(OPTION)

1. Since a linear amplifier is used as the video signal amplifier, low level signals are cut off with respect to the operating range of the CRT when brightness is matched with high level signals.
   In order to make it possible to form images on the CRT both with high and low level signals, the GAMMA CONTROL is used to emphasize (or intensify) video signals in the high and low contrast region. Depending on the correction required, four different gamma positions are provided to match the input signal:
   Position 1: Relationship of input signal versus output signal is Gamma curve of $X^{2/3}$.
   Position 2: Relationship of input signal versus output signal is Gamma curve of $X^{\frac{1}{2}}$.
   Position 3: Relationship of input signal versus output signal is Gamma curve of $X^{1/3}$.
   Position 4: Relationship of input signal versus output signal is Gamma curve of $X^{\frac{1}{4}}$.
   In addition, a FINE control is provided for varying the signal in each position. By turning this control from its maximum counterclockwise (ccw) position to its maximum clockwise (cw) position, it is possible to shift the range for weak signals from low to high brightness regions of the video signal.
2. When it is desirable to observe low signal regions as well as high signal regions during microscopy, set the GAMMA CONTROL to one of the 1 through 4 positions as required.
3. The CONTRAST and BRIGHTNESS controls can be operated in the same manner as in the normal mode. If the contrast is too high and detail is washed out, adjust the FINE control until fine detail is observed.
4. To conveniently select the proper amount of Gamma correction, depress the V1 button and the WFM button of the SCAN SPEED. While observing the line profile, the GAMMA CONTROL should be adjusted to compress the highlights (high peaks) as desired.
5. If Gamma correction is only desired in one area of the field of view, depress the LINE button. This will disable the vertical scan. Then the line can be positioned with the POSITION Y knob to the area of interest and Gamma correction performed.

6. After the required amount of Gamma correction has been obtained, depress OFF, the WFM button and disengage the LINE button (if used) to view the image. To photograph the image, follow the appropriate procedure.

26. HOW TO USE SIGNAL PROCESSING (OPTION)

1. SIGNAL PROCESSING provides a first derivative, absolute value, or second derivative of the detector signal. It is useful for emphasizing edges of specimen detail by differentiating detector signals. In addition, the signal can be viewed in the POSITIVE or NEGATIVE mode.
2. To engage SIGNAL PROCESSING, turn the selector knob from the NORMAL position to one of the remaining three Signal Processing positions. Derivative positions 1, 2, and 3 are described as follows:

   Position 1: Video signals are subjected to first time derivative processing to form a light leading edge and dark trailing edge.

   Position 2: Video signals are subjected to absolute value processing to form light leading and trailing edges.

   Position 3: Video signals are subjected to second derivative processing to form light and dark leading and trailing edges.
3. Depending upon which derivative position is used, images will appear quite different as compared to normal images. Also, the signal processed image is only two dimensional. To minimize the two dimensional effect, unprocessed signal can be mixed with the derivative signal by turning the MIXING control clockwise (cw). When the MIXING control is fully ccw, there is no derivative signal added; when the control is fully sw, 50% of derivative signal is mixed with the unprocessed signal.
4. There may be times when it is difficult to resolve detail in dark areas. When this occurs, the image can be viewed in the NEGATIVE mode to enhance the detail. Also, photographic slides can be made directly from the SEM with the NEGATIVE image mode. To engage NEGATIVE imaging, switch the POLARITY toggle to NEGATIVE. Obtaining micrographs with Signal Processing and/or Negative imaging is the same as other modes of operation.

27. HOW TO USE Y-MODULATION (OPTION)

1. Normally the detector signal modulates the brightness of the CRT to form an image. The change in brightness is observed as image contrast. There are times when the difference in the signal level is low, making it difficult to observe detail in the sample. At times, it may also be difficult to judge whether details in the specimen are concave or convex.
2. Y-Modulation imaging is an aid to help overcome the problems mentioned above. This is accomplished by mixing the detector signal with the vertical sweep signal. When the signals are mixed in this manner, the detector signal simultaneously modulates the vertical sweep which provides a two dimensional image.
3. To display a Y-Modulation image, switch on the Y MODULATION toggle. Signal level can be varied with the AMPLITUDE control to the desired level. The line density of the image is dependent on the number of scan lines. Line density is coarse in the fast viewing mode; density increases in slower viewing and photo modes respectively.
4. Use the same exposure as used for normal micrographs.

28. HOW TO USE SCAN ROTATION (OPTION)

1. The image can be rotated while viewing with the Specimen Stage ROTATION control. However, rotation about the center of the viewing CRT can only be obtained when the Stage X and Y controls are in the center of travel. Also, mechanical positioning of the sample at higher magnifications is extremely difficult. Furthermore, the relationship between the sample and the detector is changed when the stage is moved.
2. When using the SCAN ROTATION, it is possible to rotate the image around the center of the CRT, regardless of sample position or magnification, by electronically rotating the scanned area on the sample. The image can be rotated continuously from 0° to 360° and can be observed conveniently in viewing modes V1 and V2. When using SCAN ROTATION, the relationship between the sample and the detector remains unchanged. As a result, image contrast and brightness is not effected. This allows for convenient framing of area of interest.
3. The image rotates when the Z knob of the Specimen Stage is changed since the electron beam rotates while passing through the electron optics system. This becomes apparent when the X and Y Stage controls move the image on the CRT as some angle other than 90° - 270° (left-right) and 0° - 180° (up-down) respectively. As the Z control of the Specimen Stage is changed, normal stage motion can be maintained by using the SCAN ROTATION.
4. To avoid confusion, it must be remebered that when the SCAN ROTATION is set to 90° or 270°, the horizontal stage motion becomes vertical and vice versa. When set to 180°, the image is upside down.

29. HOW TO USE TILT CORRECTION
(OPTION)

1. When a specimen is tilted as described in the SPECIMEN STAGE HANDLING section, foreshortening of the image in the vertical direction occurs. In other words, the vertical magnification is less than the horizontal magnification. The more the sample is tilted, the greater the ratio between the vertical and horizontal magnification. This effect is quite normal when the sample is examined in the oblique position with respect to the electron beam. Therefore, during routine operation, the Tilt correction should be set to the 0° position.
2. At times, depending upon the magnification, it may be difficult to resolve small detail in the sample, especially at higher tilt angles. When this occurs, set the TILT CORRECTION control to match the tilt angle indicated on the Specimen Stage. Vertical and horizontal magnification are the same when proper TILT CORRECTION is used.
3. TILT CORRECTION can also be used when approximate measurements of detail on the specimen are required. However, for this purpose it is recommended that the Specimen Stage be set to 0° TILT as well as the TILT CORRECTION control.
4. When a negative tilt angle on the Specimen Stage is used and Tilt correction is desired, set the TILT CORRECTION control to the positive angle corresponding to the negative angle indicated on the Specimen Stage.

SUMMARIZED OPERATING INSTRUCTION
SS-40, SS-60, AND SS-130

START-UP

REFER TO THE START-UP AND VACUUM SYSTEM OPERATION PROCEDURES IN THE MAIN INSTRUCTION MANUAL FOR DETAILED INFORMATION.

1. Turn on the cooling water for the D.P.
2. Depress POWER button and R.P. button ON.
3. Depress D.P. button; leave VACUUM control in SHUT and wait 15 - 20 minutes.
4. Depress OPER button. Switch EMISSION/VACUUM toggle to VAC.
5. After a few minutes, the Vacuum lamp will light (green) (the meter in the green zone).
6. Wait 2 - 3 minutes before proceeding.

IMAGING

REFER TO THE IMAGING PROCEDURE IN THE MAIN INSTRUCTION MANUAL FOR DETAILED INFORMATION.

1. DUAL MAG button (option) to OFF and AUTO CONTRAST/BRIGHTNESS toggle (option) OFF.
2. Set HIGH VOLTAGE to 5, 15, or 30kV. For SS-60, 1-30kV. For SS-130, 1-40kV.
3. Depress CH1/CH2 button to CH1 and SIG/X-RAY button to SIG.
4. SCAN SPEED button to RED (reduced). Keep MAGNIFICATION control at 100X or lower.
5. Depress HV button ON and EMISSION/VACUUM toggle to EMIS.
6. Adjust BRIGHTNESS control of CH1 so that scanning area becomes visible on the CRT.
7. Rotate EMISSION control clockwise to obtain saturation. If AUTO EMISSION is used, switch toggle to AUTO.
8. Turn SPOT SIZE control (AUTO BEAM SYSTEM on SS-60 and SS-130; not available on SS-40) to 12 O'clock and CONTRAST control to approximately 2 O'clock.
9. Align Beam as required.
10. Rotate GUN ALIGNMENT, TILT X and Y knobs to verify alignment.
11. Depress WFM button of the SCAN SPEED. Using the Waveform Monitor, recheck saturation. If waveform falls off, realign Gun.

12. Depress MAP button on SCAN MODE. Depress WFM button OFF.
13. Adjust the COARSE FOCUS knob to obtain focus. Set WORKING DISTANCE control (8mm, 15mm, 23mm, 45mm) to conform with Z control on the Specimen Stage.
14. Observe the image in V1 SCAN SPEED.

IMAGE ADJUSTMENT

REFER TO THE IMAGE ADJUSTMENT PROCEDURES IN THE MAIN INSTRUCTION MANUAL FOR DETAILED INFORMATION.

1. Depress the V2 SCAN SPEED button.
2. Select the Specimen position (X, Y, and ROTATION) with the Specimen Stage at low magnification. REFER TO THE SPECIMEN STAGE HANDLING PROCEDURE IN THE MAIN INSTRUCTION MANUAL FOR DETAILED INFORMATION.
3. Change the MAGNIFICATION control to the desired magnification. The magnification is continuously variable by 3X by rotating the ZOOM control from fully counterclockwise to fully clockwise. This control can be used at each magnification step.
4. The Specimen position at high magnification can be obtained by using the IMAGE SHIFT X and Y controls.

5a. Select the Appropriate Aperture (VARIABLE Aperture unit standard on SS-130; optionally available on SS-40 and SS-60).

5b. Depress the RED (reduced) SCAN SPEED button.

6. Adjust COARSE and FINE FOCUS controls to obtain focus.
7. Correct Astigmatism if necessary.
   (1) Rotate FINE FOCUS control to obtain focus.
   (2) Rotate STIGMATOR X control to obtain sharpest image.
   (3) Rotate STIGMATOR Y control to obtain sharpest image.
   (4) Repeat 1, 2, and 3 several times if necessary.
8. Depress V1 SCAN SPEED button.
9. Adjust the CONTRAST and BRIGHTNESS controls to obtain good image quality.
   Adjust SPOT SIZE control (AUTO BEAM SYSTEM) as recommended below:
   10 O'clock position at 5,000X or lower.
   12 O'clock position between 5,000 and 20,000X.
   3 O'clock position between 20,000 and 50,000X.
   MIN position at 50,000X or higher.
   REFER TO MAIN INSTRUCTION MANUAL FOR SS-60 AND SS-130 SETTTING.

PHOTOGRAPHING THE IMAGE

REFER TO THE PHOTOGRAPHING THE IMAGE PROCEDURE IN THE MAIN INSTRUCTION MANUAL FOR DETAILED INFORMATION.

1. Load the Film.
2. Depress RED (reduced) SCAN SPEED button. Adjust CONTRAST and CH1 BRIGHTNESS controls so that the three center LEDs of the CONTRAST/BRIGHTNESS PHOTO DISPLAY light.
3. Focus, referring to the IMAGE ADJUSTMENT procedure before taking photograph.
4. Depress P1 SCAN SPEED button.
5. Photograph is finished when the P1 or P2 button light goes out.
6. Remove Film from Camera.

THE INTERNATIONAL SCIENTIFIC INSTRUMENTS 'SS' SERIES

SCANNING ELECTRON MICROSCOPES

The SS Series of SEM have a special final lens configuration. The lens system may be used in four ways depending upon the information required from the specimen.

HIGH RESOLUTION HR MODE

The specimen, maximum diameter 7mm, is moved up inside the final lens field where a detector collects only pure secondary electrons, see figure 1. In this position the instrument is capable of very high resolution even at low kV. Only -10° to +30° of tilt are available in this mode. The specimen sub stage may be lowered into the conventional specimen position for operation in Modes 1 and 2 if desired.

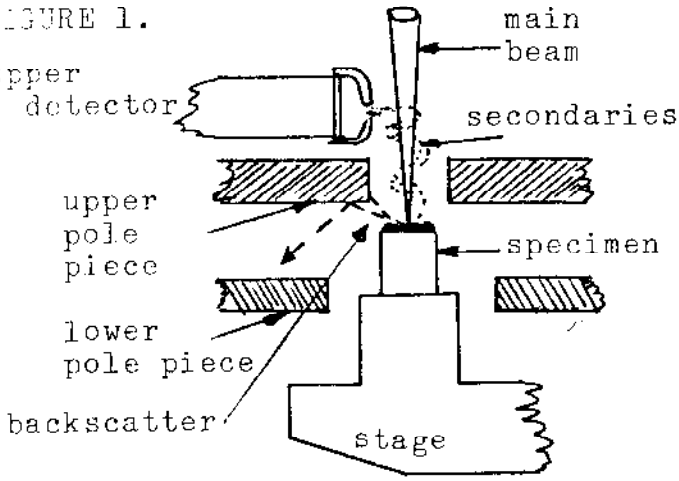
MODE 1 TWO DETECTORS OR ONE DETECTOR

This mode of operation uses the microscope like a conventional SEM except that TWO detectors are used, providing a considerable signal gain. Samples up to 108mm may be examined with tilting up to 70°. At magnifications lower than 500X the upper detector is switched off (sub panel MODE 1 OFF/ON) to remove the bright signal from the centre of the image. Mode 1 uses pure secondary electrons as well as some secondaries that have been generated off axis by backscattered electrons returning having hit the final lens, figure 2. B.

MODE 2

This mode uses an insert which is screwed into the final lens, with the objective lens switched off for fitting or removal. Only one detector is in operation, making the instrument operate totaly like a conventional SEM. As a result of fitting the insert the image is more conventional -- there are many more backscattered electrons contributing to the image -- but resolution is lost due to the reduction in signal as only a single detector is used and the secondary to backscatter ratio is reduced. See figure 3.

FIGURE 1.



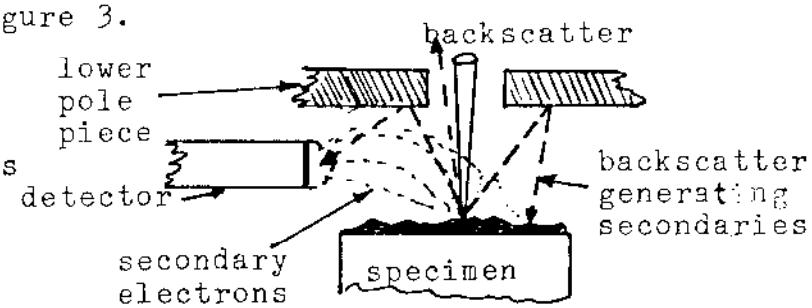


FIGURE 2. B.

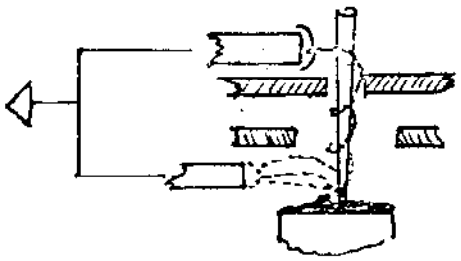


FIGURE 2. A.

Double Detectors

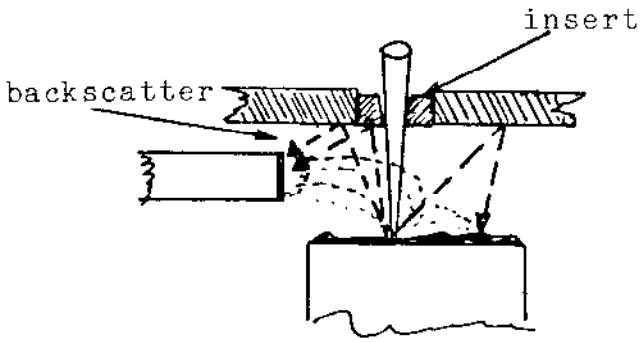


FIGURE 3.

1. SWITCHING ON

1.1 Switch on the MAINS SUPPLY
1.2 Switch on the WATER at 2 litre/minute
1.3 Open the sub panel and press POWER
1.4 Press RP
1.5 Press DP, the electronics will also switch on.
1.6 WAIT 20 minutes in the SHUT position.
1.7 Press OPER, on the front of the column unit.
The RP will evacuate the system down to a set level, the DP automatically opens to the column at this level.
The vacuum may be monitored on the EMISSION/VACUUM METER.
1.8 When the vacuum level reaches the green sector of the meter the VL light indicates that the instrument is ready for operation.

2. SWITCHING OFF

2.1 Turn down the FILAMENT control or switch the AUTO/MAN switch to MAN.
2.2 Press HV to switch off the high volts.
2.3 Press SHUT, on the column unit.
2.4 Press DP to switch off the DP
2.5 WAIT 20 minutes
2.6 Press POWER which switches off the RP and the instrument.
2.7 Turn off the WATER
2.8 Switch off the MAINS SUPPLY

********** EMERGENCY STOP **********

A. If the WATER FAILS
Follow 2.1 to 2.4
(The DP and the electronics will switch off)
(automatically if the DP is too hot due to)
(lack of cooling water.)
Close down the instrument as in 2.6 to 2.8

B. If the POWER FAILS
Follow 2.1 to 2.4, switch off as 2.6 and 2.8
WAIT 20 minutes and then switch off WATER.

IF THE POWER RETURNS DO NOT SWITCH THE

INSTRUMENT BACK ON WITHIN 30 MINUTES

****

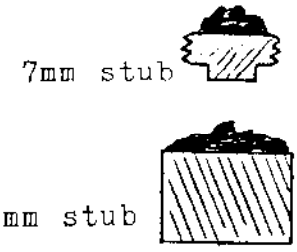
3. SPECIMEN MOUNTS

The ISI SS Series of scanning electron microscopes have two basic specimen stages, either a 7mm stub HIGH RESOLUTION STAGE or, a STANDARD STAGE which takes 15mm to 108mm specimen holders.

For low tilt studies (less than 30°) and most work with small samples the HR operating condition will almost always produce the best images. The HR stage and samples may be used in the range covered by the standard stage, that is using long working distances and high tilt angles.

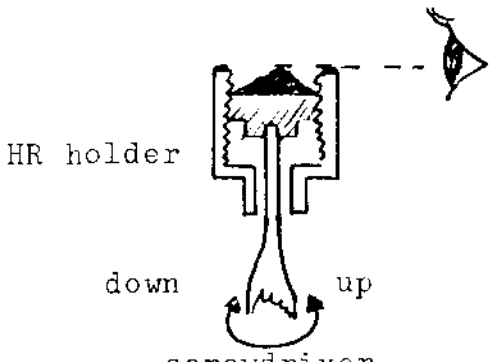
When a specimen stub is mounted in a cup it may be adjusted to a eucentric position. The flat wafer holders are automatically at the eucentric position.

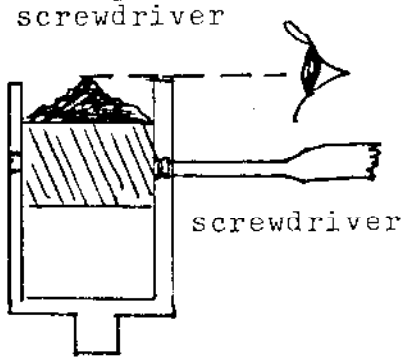
3.1 Place the specimen onto a stub and place the stub into a holder.
3.2 Adjust the height of the specimen to set the area of interest level with the top of the cup.
3.3 High Resolution holders allow the specimen to be screwed up or down.
3.4 Standard Stage holders have clamping screws that hold the stub in position.
3.5 The holders fix into the stages by way of a single clamping screw.



4. INSERTING A SPECIMEN

4.1 Press AIR to let the column down to atomosphere.
4.2 Turn the stage clamp (on the right hand side of the specimen chamber) to UNCLAMP.
4.3 Lower the Z below 8mm and turn the tilt to ZERO.
4.4 Release the door clamp and open the door.
4.5 FOR STANDARD STAGE
Rotate the specimen to find the holder clamping screw, release the screw and remove the holder.
OR release the stub clamping screws and remove the stub.
FOR HIGH RESOLUTION STAGE
Rotate the specimen to find the holder clamping screw, release the screw and remove the holder.
4.6 Place the stub in the holder as in 3.1 to 3.5.
4.7 Check the Z to see that the specimen will not hit any of the detectors and gently close the door.
4.8 Press OPER whilst holding the door closed, clamp the door when the system has started pumping.
4.9 When the VL lamp is lit the system is ready for operation.





standard 15mm holder

5. FITTING THE HIGH RESOLUTION STAGE

5.1 Let the column to AIR as in 4.1 to 4.4

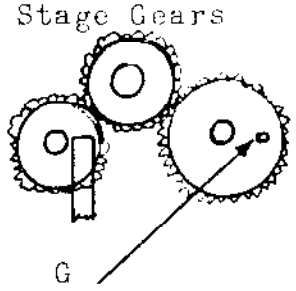
5.2 Remove the specimen holder, 4.5.

5.3 Set the stage SPEED to H and move to the position X 275 and Y 275. This is indicated on the stage door.

5.4 Release the HR stage from its box by loosening the set screws.

5.5 Remove the set screw and turn the stage up side down. Look at the position of the gear location pin 'G'.

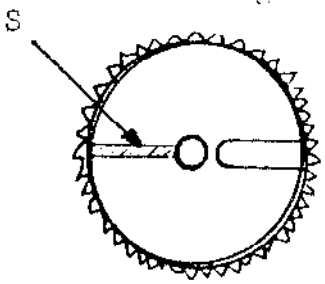
Sub Stage Gears



5.6 Look at the position of the narrow slot on the standard stage 'S'.

5.7 Rotate the narrow slot so that the location pin will fit into the slot when the HR stage is lowered onto the standard stage.

Standard Stage



5.8 Turn the rotation control slightly to engage the pin in the slot. In the correct position the HR sub stage will rotate.

5.9 Hold the stage in position and fix with the two set screws.

5.10 Turn the rotation control and check that the sub stage rotates easily. If the stage tightens in one directionease the set screws and re seat the stage to obtain a smooth rotation.

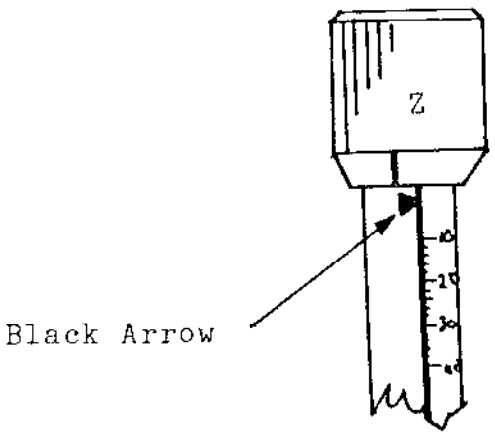
5.11 Drive the stage to check that the automatic stop and warning buzzer are operating.

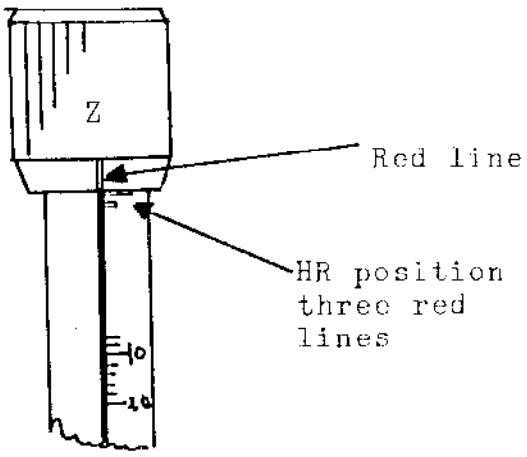
5.12 Check that the warning buzzer operates at 30^{o} tilt.

5.13 FOR SPECIMEN EXCHANGE THE HR STAGE MUST BE LOWERED TO A POSITION BELOW THE BLACK ARROW ON THE 'Z' CONTROL.

5.14 The HR position is reached by turning the 'Z' control anticlockwise to the RED marks. Set the RED line on the 'Z' control with the centre RED line on the shaft

5.15 DO NOT TILT THE HR STAGE MORE THAN THIRTY DEGREES WHEN IN THE HR MODE OF OPERATION, THAT IS A 'Z' LESS THAN 8mm.





6. NORMAL OPERATING PROCEDURE

6.1 Mount and load a specimen as in 3 and 4.

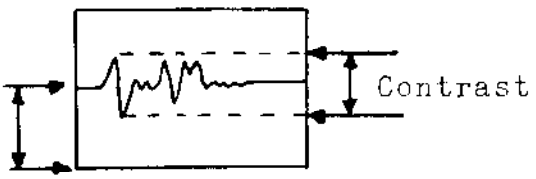
6.2 Whilst the specimen is pumping down set the controls as listed below:
SUB PANEL
PRESS..... CH 1.. (CH 1) SIG..(CH 2) SIG..(SCAN MODE) LINE..(DUAL MAG) OFF..(OPERATION MODE) either HR,MODE 1 or MODE 2.
CENTRE..... (POSITION) ½turn from ccw..(GUN ALIGNMENT) 1½ turns from ccw..(LENS ALIGNMENT) 1½ turns from ccw Dynamic Focus to 0°..Emission to HB (when using the pointed cathode) to LL (when using the rounded cathode) AUTO/MAN to MAN.. Filament control to ccw..Bias ½ turn from ccw..High Voltage at the kV required.. Working Distance at the set level, see 'Z' control..OL.WOBB towards operator.. Scan 3 on..OL on.. Spot Size 10 o'clock..Mode 1 switch on.
MAIN PANEL
Image Shift 5 turns from ccw.. Zoom ccw..Scan Speed RED WFM Red. Position ½ turn from ccw..Contrast 10 o'clock.. Brightness CH 1 at 10 o'clock..Magnification to minimum.. Focus Coarse and Fine 5 turns from ccw.. Stigmators on 5.

IF THE INSTRUMENT HAS BEEN IN USE THERE IS NO NEED TO TOUCH ANY OF THE POTENTIOMETERS EXCEPT.. Filament and Magnification.

6.3 When VL lights select the High Voltage required and press KV.

6.4 Switch EMISSION/VACUUM meter to emission a standing current will be displayed, for example:

2kV 3uA
5kV 7uA
10kV 14uA
20kV 28uA
30kV 40uA



6.5 A line will be displayed on the CRT its distance up the screen being related to the brightness setting, the higher the brightness the higher the line is up the CRT.

6.6 Slowly increase the Filament heating control from ccw. The line on the CRT should begin to have variations in its profile. The variations relate to the setting of the Contrast control, they increase in magnitude as the contrast control is turned cw.

6.7 The signal (line) on the CRT will rise as the filament control is turned cw, it will then drop slightly. If the control is turned cw a little further the line will rise again until it reaches a point where increases in the control do not change the position of the line, double check this point.

6.8 Adjust Gun Alignment TILT X & Y to obtain a signal maximum. The highest peaks possible at this setting.

6.9 Check the Filament control turning slightly anticlockwise then clockwise to see that it is set at a position no further than maximum signal. Recheck 6.8

6.10 Press WFM to release the button.
6.11 Press MAP (sub panel, Scan Mode).
6.12 The speed of scan may be changed using V1, V2, or RED.
6.13 Focus, using the coarse control.
6.14 Increase the magnification to 500X.
6.15 Re focus and switch on OL WOBB.
6.16 Adjust Lens Alignment Tilt to set the point of minimum shift onto the centre of the CRT.
Adjust one control at a time, watch the image as the shift is reduced. When the image shift is at a minimum the image will move in a new direction (see diagram).
At this point move to the other tilt control and adjust it in the same way, until the shift is minimum or the shift changes direction.

6.17 Repeat 6.16 at a higher magnification keep repeating the alignment to a level twice the magnification that you intend to work. Switch off OL WOBB.
At high magnifications it is often more simple to rock the focus control through focus and then adjust the tilt controls for minimum shift.
6.18 The instrument is now fully aligned, for normal use the following controls should be used;

Scan Speed: Use RED for focus and astigmatism correction to judge the quality of an image prior to photography use the slow scans V1, V2.

Specimen Speed : Select the stage speed to suit the mag. the higher the number the slower the speed.

Movement : The buttons may be used singly or two together in order to move in the desired direction.

Image Shift : Only use the electrical controls when in Mode 1 or 2, they will degrade the image in HR at very high resolution.

Contrast & Spot Size : These two controls are used to obtain a satifactory signal for display. Start working with the Spot Size about 10 o'clock and optimise the contrast on the CRT. If the contrast control is being used so high as to cause the CRT to look noisy, the spot size is too small. If the contrast control has to be turned right down, make the spot size smaller.

Working Distance & 'Z' : If you change the W/D or 'Z' you will need to change the W/D control on the sub panel to retain focus. The W/D control is a very coarse focus adjustment

Stigmators : These should be used like fine focus controls, focus the image and then use each stigmators in turn to improve the image, use the RED. position on the Scan Speed. This reduced raster may be moved to the best position for stigmating by the RED. POSITION controls.

Lens Alignment : This should be adjusted at the working high voltage for maximum performance.

Bias : Suggested EMISSION VALUES adjust bias to :-
2kV 20-40uA : 5kV 40-80uA : 10kV 60-100uA
20kV 80-120uA : 30kV 100-150uA

7. PHOTOGRAPHY

7.1 When you have an area suitable for image recording the following procedure should be used.

7.2 Increase the magnification two or three times the level to be used for the photograph.

7.3 Focus and correct the astigmatism. Is the image stable, is there any drift? Go to aslow scan, is there any charging? Stage CLAMPED ?

7.4 Reduce the magnification to the level to be photographed, adjust the Zoom to give a round figure magnification. Press RED.

7.5 Adjust the contrast and brightness to obtain THREE GREEN LIGHTS at the CENTRE of theCONTRAST/BRIGHTNESS display. The contrast sets the number of lights, brightness sets the position.

7.6 Check the image on slow scan V1 or V2. Shift ? Charging ? Focus Drift ?

7.7 Open the film (Polaroid), or the shutter (120/220, or 35mm).

7.8 Select a photo speed P2, 160 sec. or P1, 80 sec.

7.9 Should you wish to abort an exposure press PHOTO RETURN on the sub panel.

7.10 DATA on the sub panel indicates the data for the next photograph when in V1 or V2.

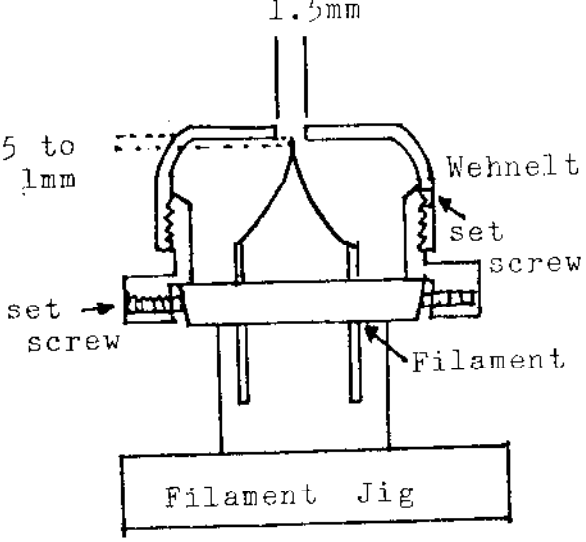
8. MAINTENANCE

GUN AND FILAMENT

8.1 To remove the cathode assembly let the column to AIR, 4.1

8.2 Open the gun chamber and allow the bar to touch the cathode.

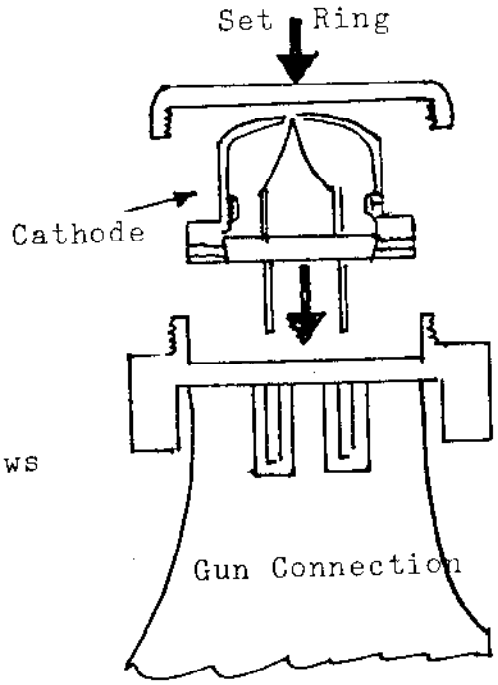
8.3 If the instrument has been in use the cathode will be VERY HOT. Use a thick glove to unscrew the SET RING, and pull away the CATHODE.



8.4 Two cathodes are provided LONG LIFE, with a rounded end, and HIGH BRIGHTNESS, with a pointed end. Use LL except when using X-ray analysis or high resolution.

8.5 The cathodes must be VERY CLEAN before fitting a filament.

8.6 Clean each part of the cathode with a metal polish and then a solvent to ensure that all traces of dirt, and the polish, are removed. Check the componants with a 10X hand lens. THEY MUST BE ABSOLUTELY CLEAN to achieve maximum performance from your instrument.



8.7 Sit the filament in the jig and place the filament holder over the filament.

8.8 Screw the Wehnelt onto the filament holder, adjust the filament set screws to centre the filament in the aperture. The filament should be 0.5 to 1 mm from the top of the aperture for LL. See 8.10 for HB.

8.9 When the positions are correct lock the filament centring screws firmly, and lock the Wehnelt set screw. A guide to filament depth LL is to turn the filament to be level with the top of the aperture and then unscrew the Wehnelt by 1½ turns, then lock the set screw.

8.10 For HB cap screw the Wehnelt down until the filament is level with the top of the aperture and then unscrew the cap by 1 turn.

8.11 Place the Cathode into the gun socket and clamp with the set ring.

8.12 Check that the chamber and 'O' ring are free from dust, close the chamber and evacuate the system press OPER.

ANODE AND COLUMN LINER

8.13 To remove the liner let the column to air and open the gun chamber.

8.14 Pull out the anode, the liner is attached to it.

8.15 Prior to performing very high resolution study the liner should be cleaned. Also when the astigmatism becomes difficult to correct.

8.16 Clean the liner as in 8.6.

8.17 Clean the apertures by heating to orange

heat in a vacuum evaporator. Rest the apertures on a molybdenum boat.
For normal operation the final aperture should be 80μm, for high resolution 50μm.

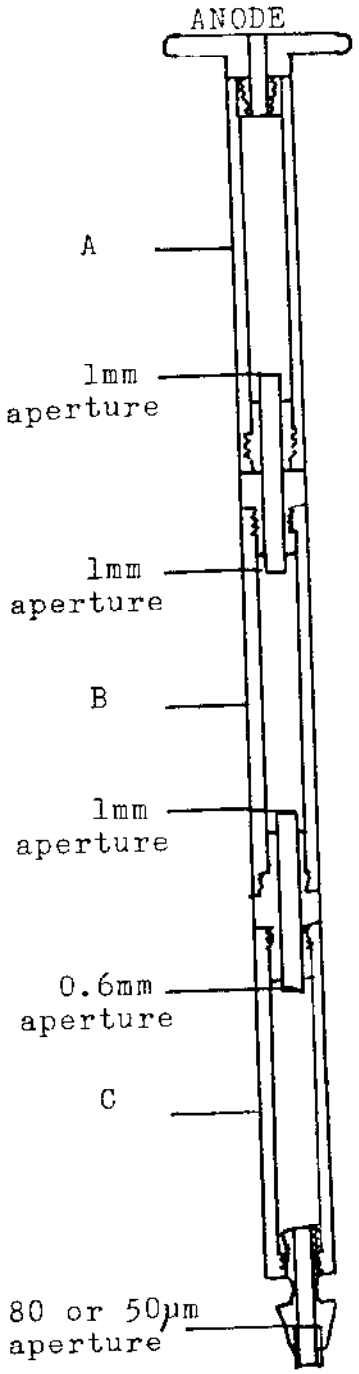
8.18 Re assemble the liner after checking and lower it into the column. When it is in position PUSH the anode firmly to check it is correctly seated.

Sleeve A is 87.5mm long with a 1mm diameter aperture at its base.

Sleeve B is 67mm long with a 1mm aperture at its head and a 1mm diameter aperture at its base.

Sleeve C is 52mm long with a 0.6mm diameter aperture at its head and an 80 or 50μm aperture at its base.

8.19 A full column alignment is not required after cleaning a liner, unless the final aperture is changed to the 50μm diameter.



SS Series Liner Tube.

9. GUN ALIGNMENT

9.1 After changing a filament the gun alignment may not be as simple as described in 6.

9.2 Set the controls as described in 6.2.

9.3 When VL lights select 10kV, press HV.

9.4 Watch the EMISSION meter and wait a few minutes for the current to settle, press HV off. Increase the high voltage by ten kV, switch on and wait a few more minutes, press HV off. Increase to 30kV press HV. wait for the current to settle.

9.5 Watch the CRT and increase the filament control, if a signal does not appear DO NOT TURN THE CONTROL PAST 2 O'CLOCK.

9.6 Turn the contrast control to 12 o'clock, check the settings as listed in 6.2.

9.7 Turn Gun Alignment X ¼ turn ccw. Turn G.A. Y ½ a turn ccw then 1 turn cw, watch the CRT for a signal. Signal go to 9.12.

9.8 No signal, turn G.A. X ½ turn cw. Turn G.A. Y 1 turn ccw, watch the CRT for a signal. Signal go to 9.12.

9.9 No signal, turn G.A.X ¼ turn cw. Turn G.A. Y 1 turn cw, watch the CRT for a signal. Signal go to 9.12.

9.10 No signal, turn G.A. X 1 turn ccw. Turn G.A.Y 1 turn ccw, watch the CRT for a signal. Signal go to 9.12.

9.11 No signal, set ALL controls as in 6.2 and repeat 9.5 onward at 30kV.

9.12 Signal. Adjust gun alignment tilts to obtain maximum signal. Re check the filament control position by turning ccw and then cw to ensure that it is not being set too high.

9.13 If after repeating this procedure there is still no signal check the cathode assembly, if the liner was also cleaned remove it and re check the componants for dirt.

10. TOTAL COLUMN ALIGNMENT

10.1 Follow 6.1 to 6.9, if there is no signal follow 9.5 to 9.13.

10.2 When the gun is aligned the final aperture may be adjusted.

10.3 Reduce the contrast control to 8 o'clock, check magnification is minimum.

10.4 Switch OL off. Focus the image with SECOND CONDENSER, reduce signal to a satisfactory level with SPOT SIZE.

10.5 Increase the magnification to step 5, focus with Second Condenser.

10.6 Rock the Second Condenser through focus, 1 hour sweep.

10.7 Using a screwdriver adjust first the left screw (L) to the position of minimum image shift, then the right screw (R) to the position of minimum shift.

10.8 Repeat 10.7 until the alignment does not improve.

10.9 Trim the alignment for no image shift using GUN ALIGNMENT SHIFT X & Y. Rock the Second Condenser over 3 hours through focus and trim the shifts for zero movement. From time to time check LINE WFM to see that GUN ALIGNMENT TILTS are at maximum signal.

10.10 On completion of this alignment check 6.13 to 6.18 for final lens alignment, this is with OL switched ON; spot size 10 o'clock, contrast 10 o'clock as two starting points.