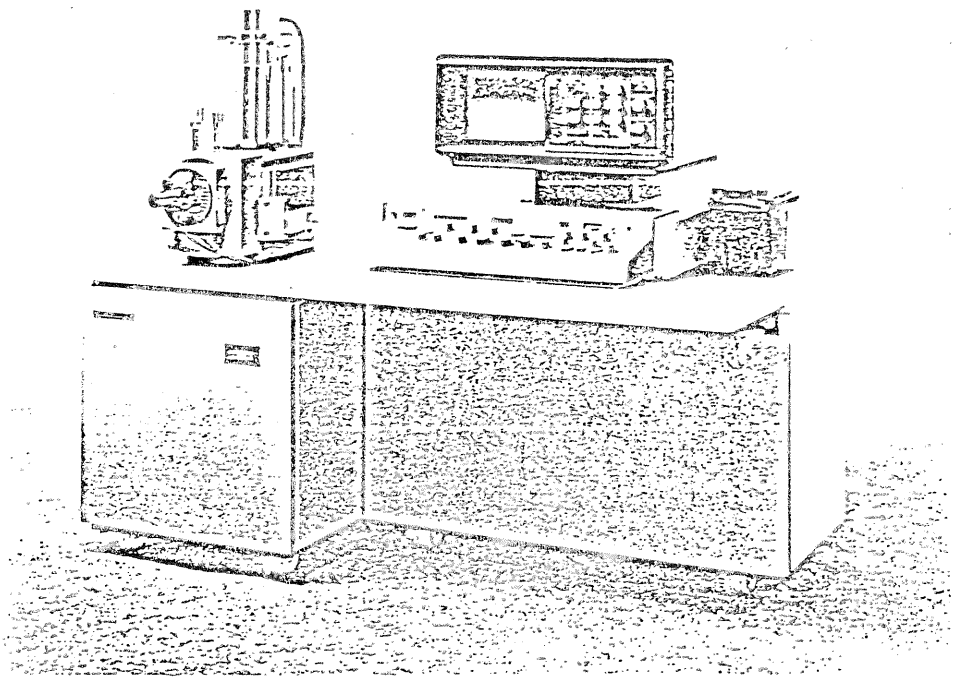
ISI
INSTRUCTION MANUAL
FOR
SX-40
SCANNING ELECTRON
MICROSCOPE



INTERNATIONAL SCIENTIFIC INSTRUMENTS, INC.
1457 McCarthy Boulevard
Milpitas, CA 95035

OBTAINING AN IMAGE

1. Check the following settings:

A.	MAGNIFICATION	Lowest Setting
B.	SCAN SPEED	V1
C.	WFM	ON
D.	SCAN MODE	Line
E.	EMISSION	Manual and Fully CCW
F.	CONTRAST & SPOT SIZE	11 o'clock position
G.	BRIGHTNESS	9 o'clock position
H.	SPECIMEN SPEED	H
I.	VACUUM LEVEL LAMP	ON
J.	BIAS	11 o'clock position
K.	VACUUM/EMISSION METER	EMISSION position

2. Turn on OPERATION switch.

3. Turn up the EMISSION control until the waveform peaks. Stop at the point where the waveform reaches its maximum height and do not increase the EMISSION control beyond this point.

4. Adjust your BIAS control for a reading between 100 and 150 on the meter.

5. Peak the waveform with the GUN ALIGNMENT TILT controls.

6. Select MAP on the SCAN SPEED switch and release the WFM button.

7. Choose a comfortable SCAN SPEED (V1, V2, RED) for your viewing.

	inch	cm.	mm.	µm	nm.	Ang.
inch	1	2.54	25.4	25,400	25,400,000	254,000,000
cm.	.393	1	10	10^4	10^7	10^8
mm.	.0393	10^{-1}	1	10^3	10^6	10^7
µm.	.000 0393	10^{-4}	10^{-3}	1	10^{-3}	10^4
Ang.	.000 000 00393	10^{-8}	10^{-7}	10^{-4}	10^{-1}	1

TABLE OF CONTENTS

1. VACUUM SYSTEM OPERATION

START-UP

Check the following items:

(1) POWER button OFF
(2) D.P. button OFF
(3) OPERATION button OFF
(4) VACUUM CONTROL button SHUT

1. Turn on the cooling water for the Diffusion Pump and make sure the flow rate is approximately 2 L per min. @20° C.
2. Depress the POWER button and the button will light.
3. Then push the rotary Pump button, and the button will light. This button automatically returns to its original position when released. The Rotary Pump will be energized and evacuation will start.
4. Depress the Diffusion Pump button and the button will light. Wait about 20-25 min. for pump to warm-up.
5. Press the Vacuum Control OPER. button - column will be evacuated by the Rotary Pump. When the vacuum meter indicates a value of 70-100, the vacuum valve cycles to the Diffusion Pump.

NOTE: When the vacuum meter reaches the green zone, the vacuum indicator lamp will light GREEN. This means that operation may begin (however, it is recommended to wait 2-3 minutes before activating the OPERATION button).

ADMITTING AIR INTO THE COLUMN

If the filament has been manually saturated, turn the emission knob counter-clockwise (CCW) or; if the filament has been automatically saturated, put the Auto/Manual toggle back to MANUAL making sure the EMISSION knob is fully CCW.

NOTE: It is recommended to wait 2-3 minutes to allow the filament to cool. This will prolong filament life.

1. Switch OPERATION button OFF and the light will go OFF.
2. Depress Vacuum Control AIR button.

NOTE: Several seconds after the Vacuum control AIR button has been pressed, the column Leak Valve energizes. The column will reach atmospheric pressure in approximately 40 seconds.

3. After completion of work in the stage, column, or gun area, press the Vacuum Control OPER button (see START-UP procedure).

SHUT-DOWN

1. Turn the Emission Control fully CCW.
2. OPERATION button OFF. Lamp will go OFF.
3. Depress Vacuum control SHUT button.
4. Depress D.P. button. Lamp will go OFF.

   NOTE: Wait for about 20 minutes for the D.P. to cool.
5. Turn POWER button OFF. R.P. and POWER button lamps will go OFF. At the same time the R.P. will stop. The R.P. Leak Valve is automatically actuated to admit air into the Rotary Pump.
6. Turn the cooling water OFF.

POWER FAILURE

IMPORTANT: When electrical power failure occurs:

(1) Switch OFF OPERATION button
(2) Switch OFF D.P.
(3) Switch OFF POWER
(4) Depress Vacuum control SHUT button.

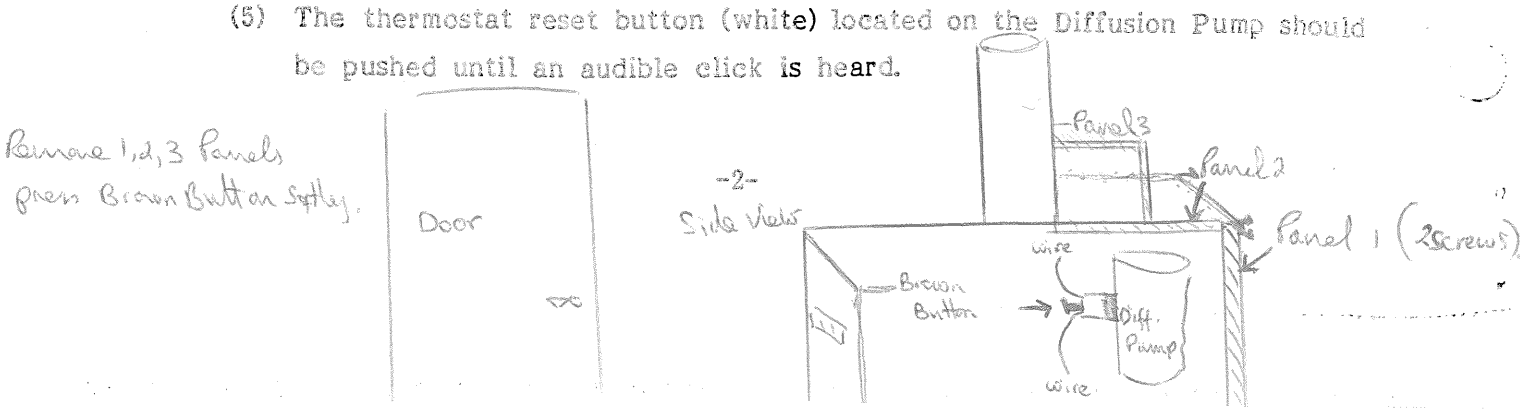
   NOTE: Allow approximately 20 minutes for the D.P. to cool.

(5) Follow START-UP procedure when power returns.

WATER FAILURE

IMPORTANT:

(1) When water flow stops, a thermostat is actuated which automatically switches off the heater for the Diffusion Pump and turns off the lamp in the D.P. button on the control panel.
(2) The OPERATION and D.P. buttons should be pushed OFF.
(3) Depress the Vacuum control SHUT button.
(4) Restore the cooling water.
(5) The thermostat reset button (white) located on the Diffusion Pump should be pushed until an audible click is heard.



NOTE: If the water is restored within 5 minutes, normal operation may resume. If the D.P. has been off for more than 5 minutes, ie., water not restored soon enough, a reheating period of 15-20 minutes must be observed.

(6) After water supply is restored, follow the START-UP procedures.

2. SPECIMEN EXCHANGE

UNIVERSAL STAGE TXYRZ

1. Depress OPERATION button OFF. Button lamp will go OFF.
2. Turn the stage CLAMP knob fully clockwise (CW) to the UNCLAMP position. (Located on the right side of the chamber.)
3. Turn the TILT control to 0°.
4. To open the stage door, unlock the snaplock located on the left side of the specimen chamber and door.

   NOTE: Do not expose the inside of the chamber to the atmosphere for a long period of time.

SPECIMEN HOLDER REMOVAL

1. Turn the ROTATION knob until the set screws are conveniently positioned for loosening.
2. After loosening the Specimen Holder set screw, pull the Specimen Holder up and out. (see figure 1)
3. Loosen the two set screws in the Specimen Holder that hold the Specimen Stub and take it out. (see figure 2)

SPECIMEN EXCHANGE

1. Mount the Specimen Stub in the Specimen Holder.
2. Securely tighten the Stub using the two set screws.

   NOTE: Each specimen should be attached to the Stub by means that are best suited to the individual specimen. Silver conducting paint is commonly used. Non-conductive specimens should be coated to prevent charging.

FIG. 1

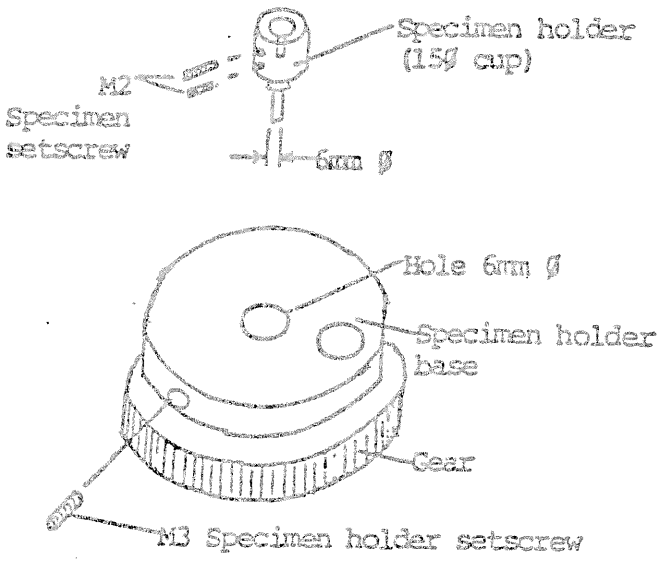
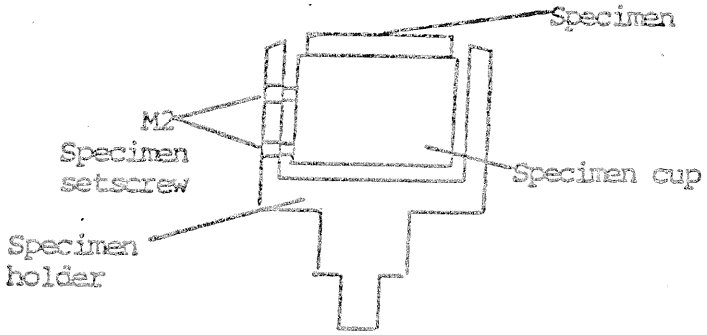

Specimen holder
(15ℊ cup)
M2
Specimen
setscrew
6mm ℘
Hole 6mm ℘
Specimen holder
base
Gear
M3 Specimen holder setscrew

FIG. 2


Specimen
M2
Specimen
setscrew
Specimen cup
Specimen
holder

IMPORTANT: When the Z control is in the 8 mm position and the top of the specimen is higher than the Specimen Holder, the Z control Working Distance (WD) readout will not be accurate and care should be taken while closing the door not to strike the bottom of the pole piece with the specimen.

NOTE: If the specimen is higher than the Specimen Cup, the actual WD can be determined by subtracting the height of the specimen above the Specimen Cup from the Z control readout position.

NOTE: Repeat this for the 31.8 mm and 3" diameter Specimen Holders.

3. Close the door of the specimen chamber and snaplock the door.

IMPORTANT: Periodically check the seal between the stage door and the specimen chamber for cleanliness. Dust or other foreign particles could cause a vacuum leak.

4. Evacuate the column (Press the Vacuum control OPER. button).

NOTE: If the evacuation speed is too slow, the specimen may be outgassing or debris may be present (as described above) on the stage door vacuum seal.

5. When the VAC INDICATOR lights, the OPERATION button may be depressed.

NOTE: It is recommended to depress the OPERATION button after waiting 2-3 minutes.

6. Set the WD Z knob black line to the desired working distance scale of 8 to 65 mm.

3. SPECIMEN STAGE HANDLING

1. Specification

1-1 Specimen size

Max. 15mm dia. x 1mm ht.

1-2 Specimen holder size (7 kinds)

(1) 15mm dia. x 15mm ht.

(2) 32mm dia. x 25mm ht.

(3) 76.5mm dia. x 25mm ht.

(4) 100mm dia. x 25mm ht.

(5) 100mm dia. x 1mm ht.

(6) 125mm dia. x 1mm ht.

(7) 150mm dia. x 1mm ht.

1-3 Specimen movable range

(1) X direction

80mm (0 to 800 at digital counter reading)

(2) Y direction

37.5mm (0 to 375 at digital counter reading)

(3) R (rotation) (Adjust the rotation dial)

360° endless (0 to 99 at digital counter reading)

3.6°/division

(4) T (tilt) (Adjust the tilt dial)

-10° to 90°

(5) Z (working distance) (Adjust the working distance dial)

8mm to 65mm

1-4 Connector provided

(1) Connector for specimen current measurement — 1 pc. (BNC type coaxial connector)

(2) Connector for voltage supply to specimen (50 terminals) — option

1-5 Detector ports

3 Available: 1 position for secondary electron detector with two spares.

2. Specimen movement.

Movable range of the specimen depends on the specimen size. A graph is provided for the movable range of the specimen holder using X,Y,T, and Z as the variables. The equipment should be used with strict adherence to the graph.

2-1 Depression of ◁ ▷ of SPECIMEN MOVEMENT on the panel shifts the CRT image right and left. Depression of ▷ shifts the image from left to right. Depression of ▽ △ shifts CRT image up and down. Depression of △ moves the image from bottom to top.

Rotate R dial for specimen rotation. Clockwise rotation of R knob rotates the CRT image counter-clockwise.

NOTE: Close or open the specimen chamber door only after shifting the following controls to these approximate positions:

X —— 650

Y —— 100

T —— 0°

In case the door is opened or closed in excess of these parameters, the specimen holder may collide with the specimen chamber.

2-2 When an angled view of the specimen is required, rotation of the "T" control will tilt the specimen.

Adjust the desirable angle according to the scale provided by the indicator on the right-hand side at the front of the stage.

NOTE: Never rotate TILT control under a "CLAMPED" condition. (A "Clamp-Unclamp "knob is on the right-hand side of the chamber.)

2-3 A longer working distance (WD) becomes necessary when the larger specimen holder is utilized or when the lower magnifications and greater depth of field are desired. In this case, the working distance can be changed from 8mm to 65mm by rotating "Z" (working distance) dial.

NOTE: Do not rotate Z dial beyond the range of 8mm to 65mm.
Rotate Z dial only after setting the stage clamp knob to the "UNCLAMP" position.

3. Measuring Specimen current

3-1 The connection for measuring the specimen current is installed at the lower right position of the specimen chamber door. Keep the grounded BNC connector installed there until a specimen current measurement is to be carried out. This is to prevent image drift.

3-2 When measuring the specimen current, use the provided plug (BNC-P-55U) after attaching a cable. Connect the tip of the cable to the input of a micrometer. (option)

4. Voltage feed thru connection (option)

This connection is used for specimen observation while supplying bias voltage to a semiconductor. The terminal is composed of 50 pins and is installed at the lower left position of the specimen chamber door. The terminals should be covered with a supplied dust cap when not in use. When used, connect a cable to two provided plugs (DB-25s) to supply or take out signals.

Terminal numbers inside the chamber will correspond to numbers at the terminal blocks on the stage door.

Electrical rating of the connection system as follows:

Current rate —— 1A

Durable voltage —— DC 300V

Insulating resistance —— 5,000M or more

5. How to use specimen stage clamp

Set the specimen stage clamp knob to CLAMP, if a vibration problem has occurred when observing the image at high magnification.

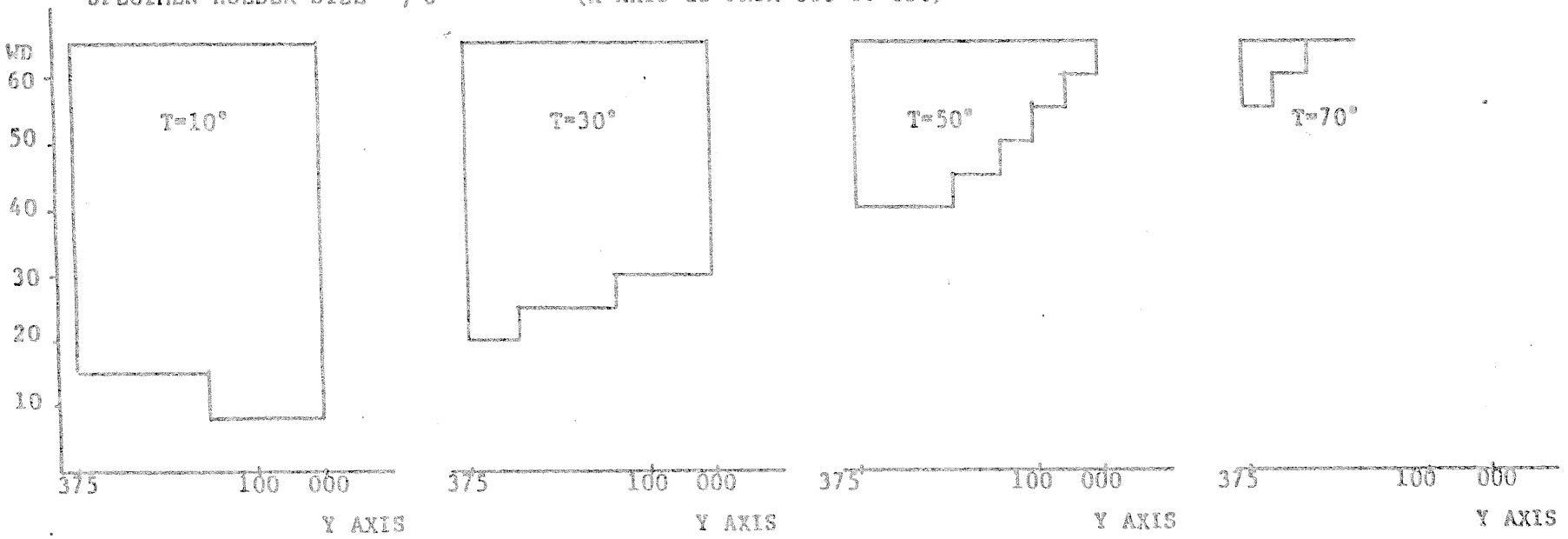
The stage clamp knob is provided at the right side of the specimen chamber. Clockwise rotation sets it to UNCLAMP and the counter-clockwise rotation to CLAMP. Rotate the knob as far as necessary for clamp or unclamp operation. However, do not continue to turn once rotation has stopped. The image may shift a little at the moment of clamping or unclamping. This merely confirms it is functioning.

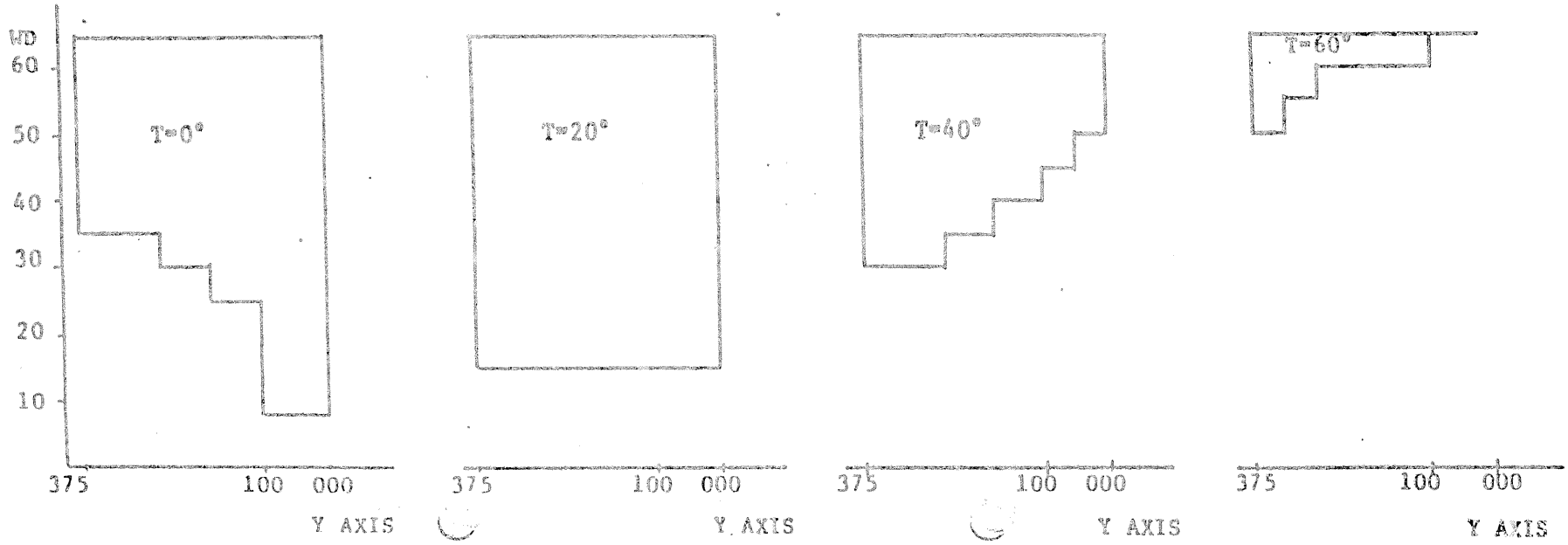
NOTE: 1: Do not use T (tilt) or Z (working distance) controls under the clamped condition. X-direction shift, Y-direction shift, and R (rotation) controls are permissable and not effected by a CLAMPED condition.

NOTE: 2: Do not open or close the specimen chamber door under the clamped condition.

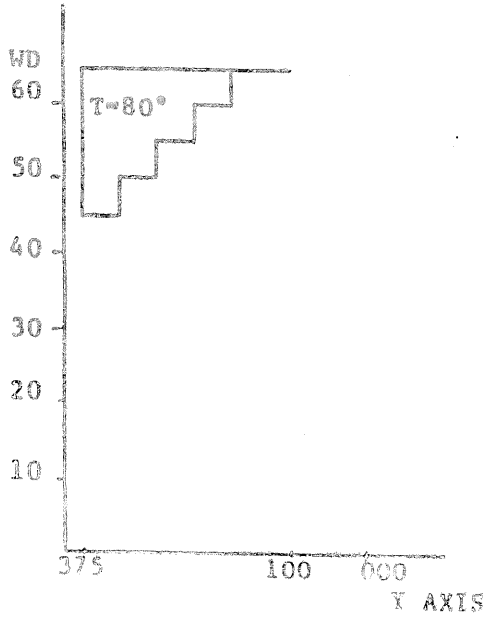
The following graphs illustrate how much sample area may be viewed with different sample holders under various stage parameters. For instance, with a 15mm holder and a tilt of 0° to 20°, your sample can be observed from 8 to 65mm in the "Z" axis and from approximately 30 to 150 in the "Y" axis.

SPECIMEN HOLDER SIZE ϕ6" (X AXIS IS FROM 000 TO 650)

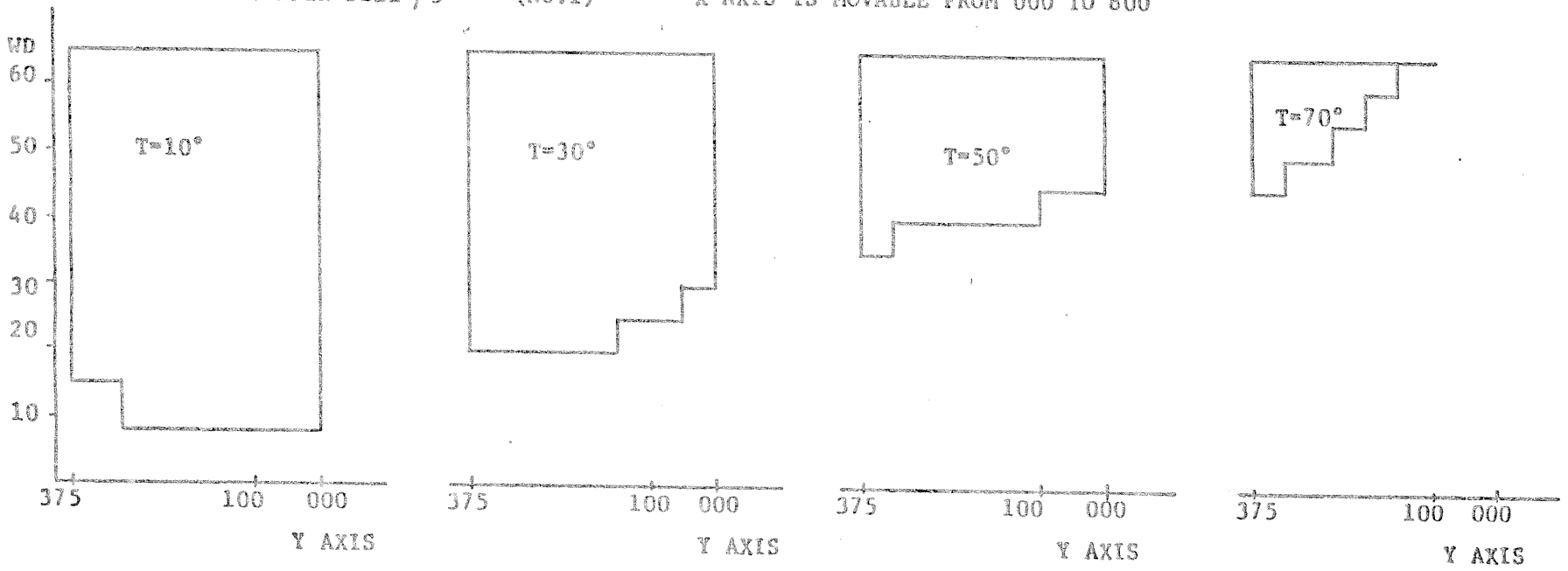


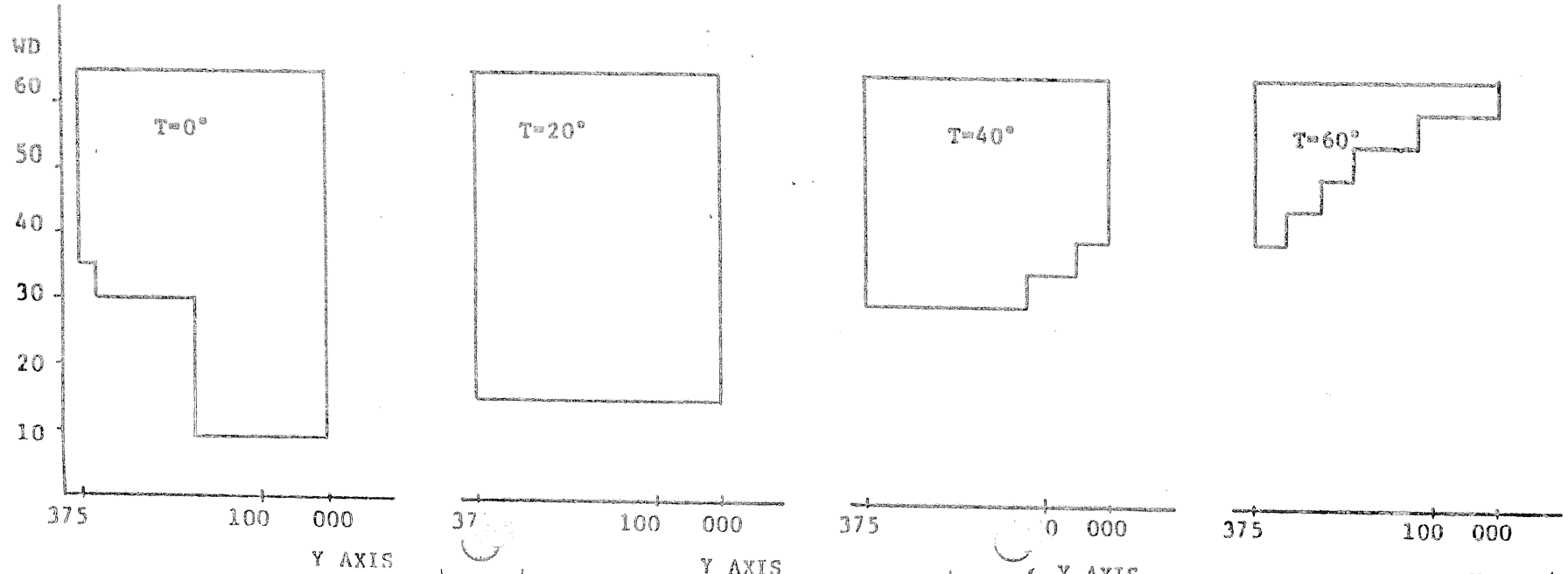


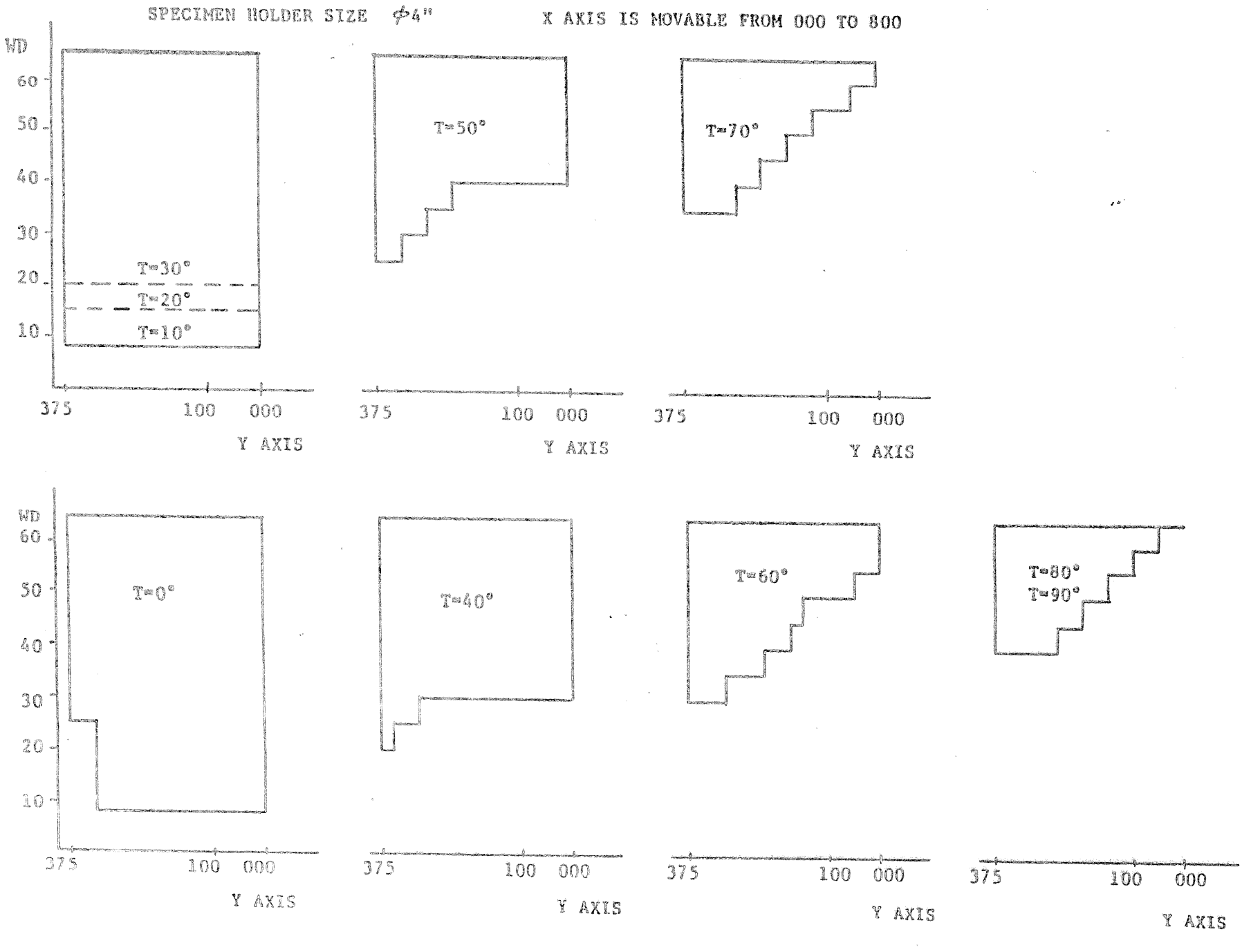
SPECIMEN HOLDER SIZE ϕ5" (NO.2) X AXIS MOVABLE FROM 000 TO 800



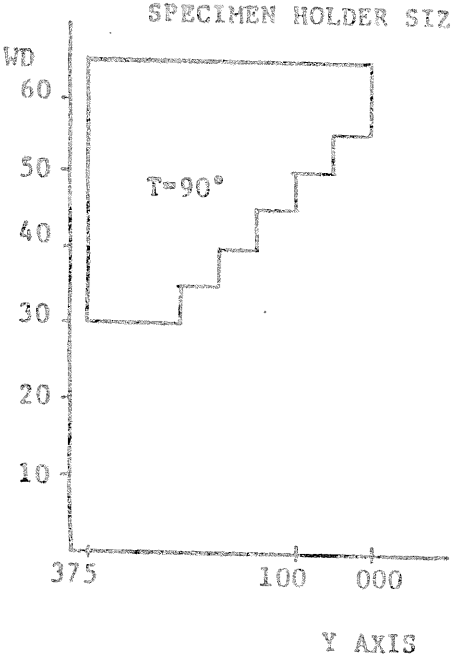
SPECIMEN HOLDER SIZE ϕ5" (NO.1) X AXIS IS MOVABLE FROM 000 TO 800

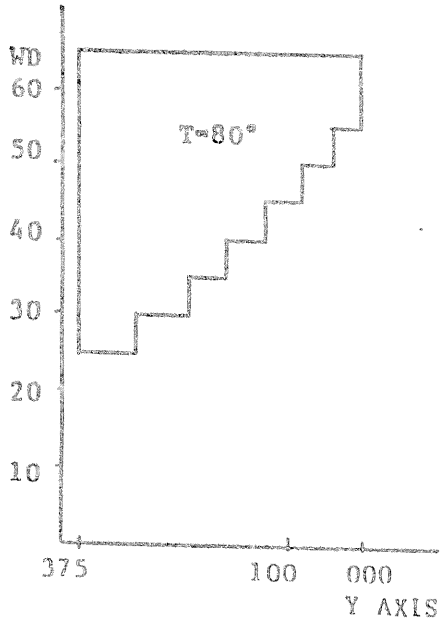


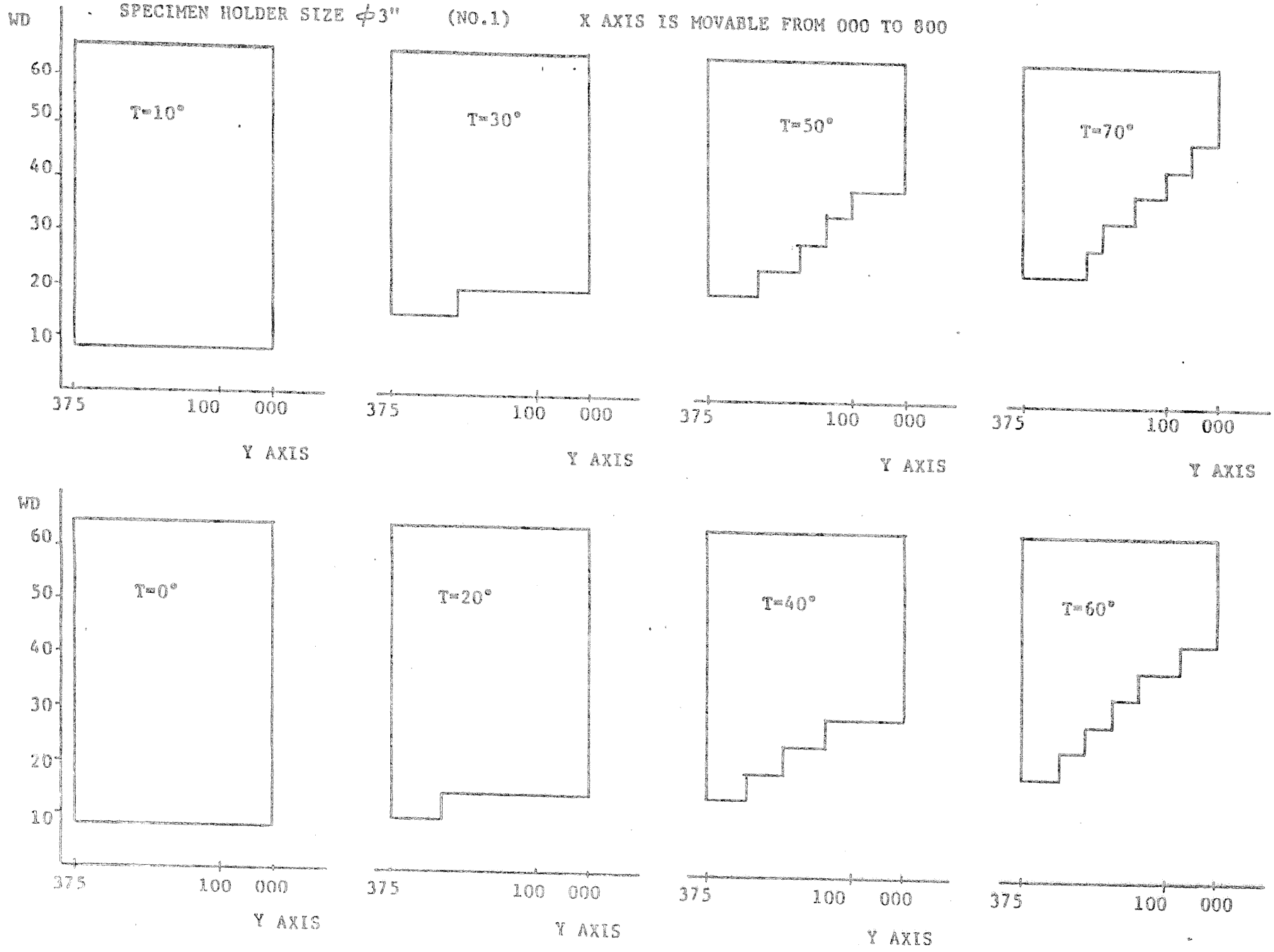



SPECIMEN HOLDER SIZE φ4"
X AXIS IS MOVABLE FROM 000 TO 800
WD
60
50
40
30
20
10
T=30°
T=20°
T=10°
T=50°
T=70°
T=0°
T=40°
T=60°
T=80°
T=90°
375
100
000
Y AXIS

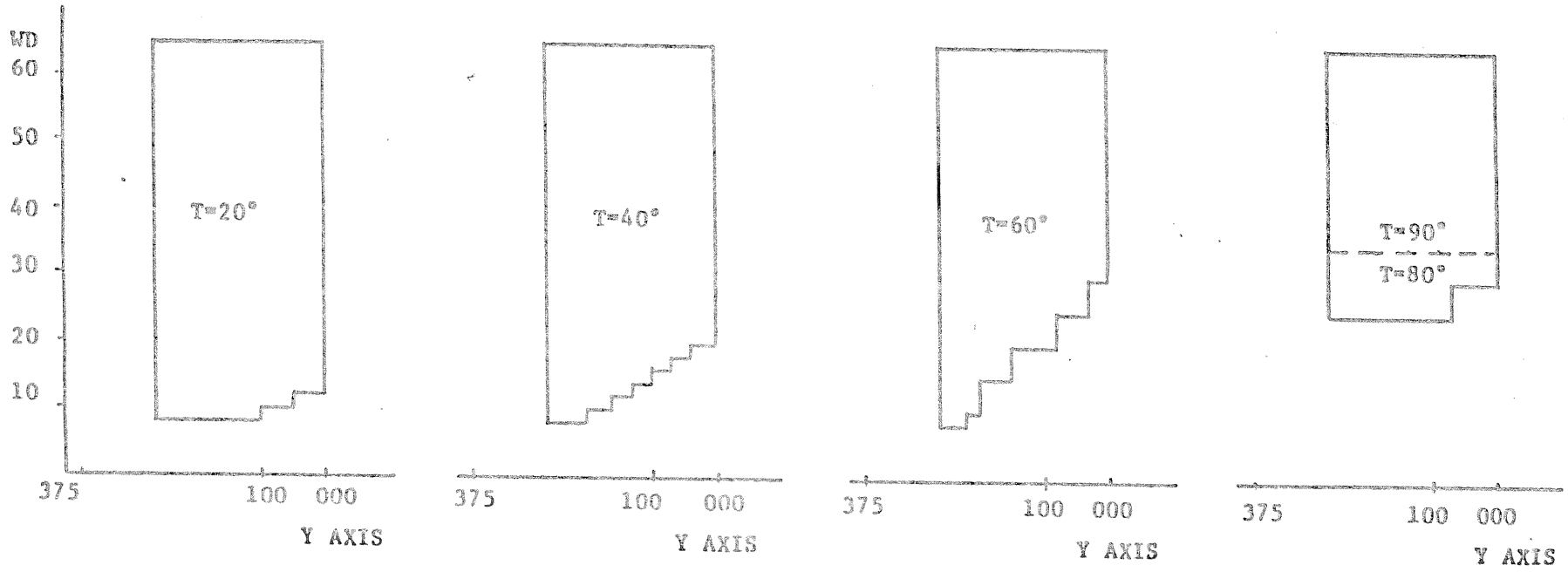
SPECIMEN HOLDER SIZE ϕ3" (NO.2) X AXIS IS MOVABLE FROM 000 TO 800

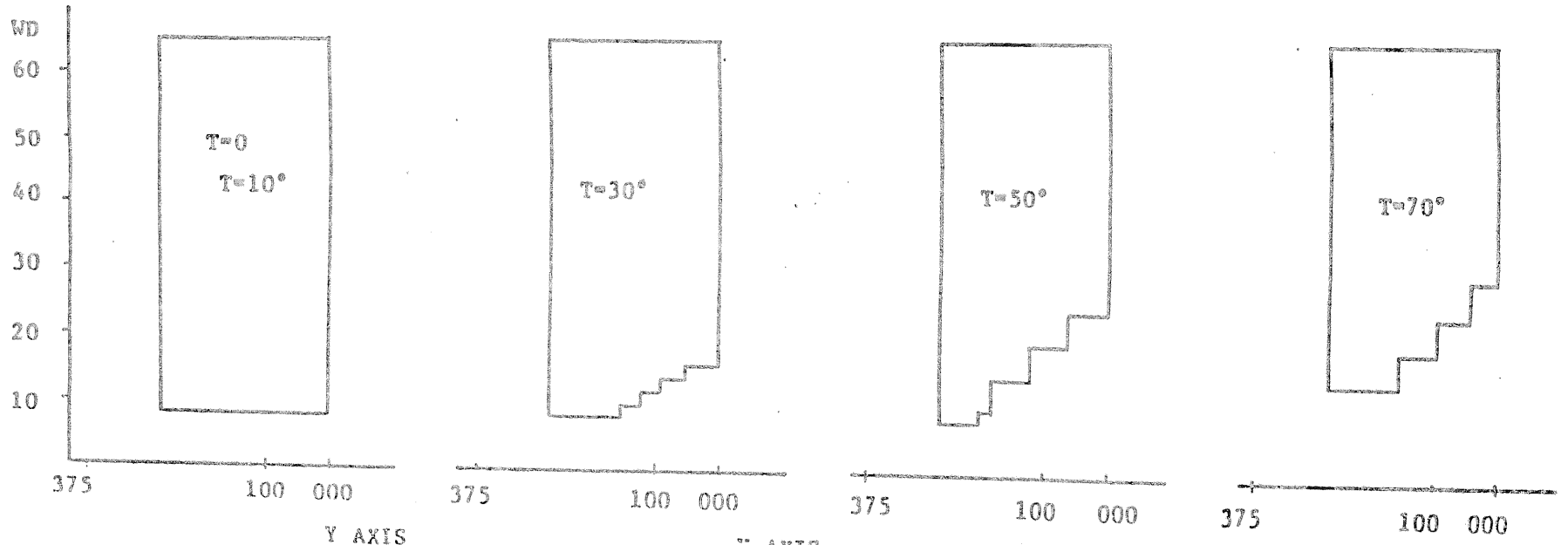




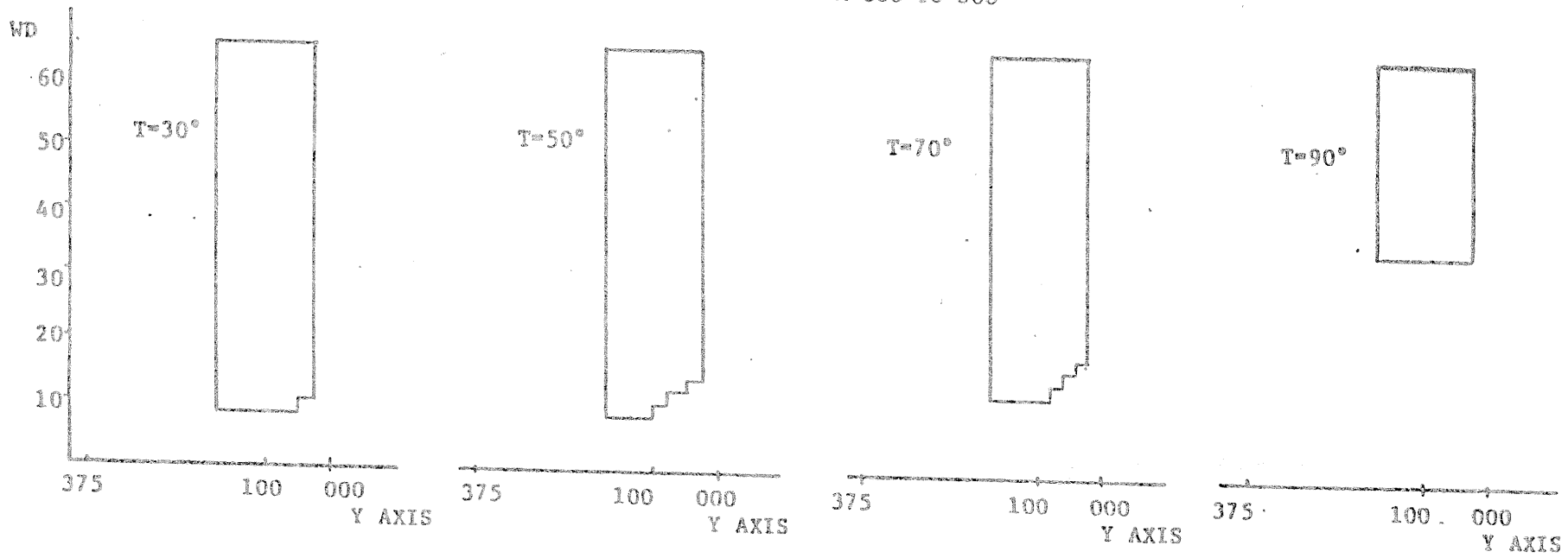

SPECIMEN HOLDER SIZE φ3" (NO.1)
X AXIS IS MOVABLE FROM 000 TO 800
WD
60
50
40
30
20
10
T=10°
T=30°
T=50°
T=70°
T=0°
T=20°
T=40°
T=60°
375
100
000
Y AXIS

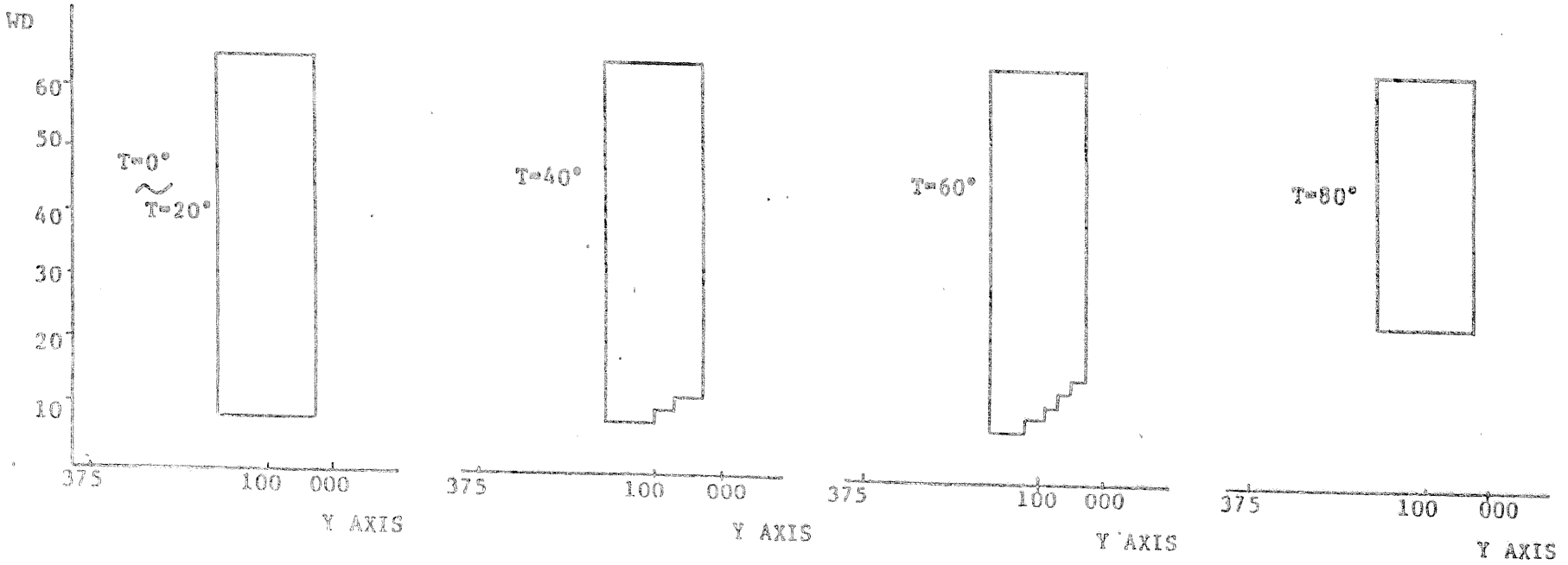
SPECIMEN HOLDER SIZE ϕ32 X AXIS IS MOVABLE FROM 000 TO 800





SPECIMEN HOLDER SIZE ϕ15 X AXIS IS MOVABLE FROM 000 TO 800





4. IMAGING PROCEDURE

1. Confirm the following:
   a) Your specimen is securely mounted in the stage.
   b) A clean electron gun cartridge with a good filament is installed.
   c) The system is evacuated and the vacuum lamp (Vacuum Level) is on.

2. Preset the switches, dials, etc. on the control panel of the main body as follows:

	Switch, dial	Setting
1	CH1/Ch2 switch	CH1
2	DET HV switch	OFF (Lamp is out)
3	SIG/X-RAY switch of CH1	SIG
4	SIG/X-RAY switch of CH2	SIG
5	SCAN MODE switch	MAP
6	DYNAMIC FOCUS dial	0°
7	ECP switch	OFF (Lamp is out)
8	LAB6 switch	OFF (Lamp is out)
9	FILAMENT IMAGE switch	OFF (Towards the operator)
10	EMISSION/VACUUM switch	EMISSION
11	SPOT SIZE dial	12 o'clock (PUSHED IN)
12	SCAN SPEED switch	RED (REDUCED AREA)
13	AUTO switch of FOCUS	OFF (Lamp is out)
14	MONI switch of STIGMATOR	OFF (Lamp is out)
15	WORKING DISTANCE dial	Adjust to approximate secimen height
16	MAGNIFICATION dial	Lowest mag.
17	AUTO switch of CONTRAST/BRIGHTNESS	OFF (Lamp is out)
18	SPECIMEN SPEED switch	H
19	Tilt (T) fo specimen stage	0°
20	X, Y counter of specimen stage	X=650, Y=100
21	DUAL MAG switch (option)	OFF
22	GUN ALIGNMENT X, Y dial	12 o'clock

3. FILAMENT SATURATION (Manual)

Set AUTO/MANUAL switch to MANUAL.

Set EMISSION control fully counter-clockwise.

Depress the OPERATION switch to "ON". The switch will illuminate confirming this condition.

The EMISSION meter should indicate the values shown in Table 1.

TABLE 1

HIGH VOLTAGE	Meter Indication
30KV	About 54μA
20KV	About 36μA
10KV	About 18μA
5KV	About 9μA
2KV	About 4μA

Slowly rotate the EMISSION control clockwise.

The needle on the EMISSION meter will rise to a point where further adjustment yields little increase in current indication.

Adjust the BIAS control to preset the emission current to a value shown in Table 2.

TABLE 2

HIGH VOLTAGE	Electron Gun Cartridge	Meter Indication
30KV	HB	100 to 150μA
	LL	70 to 100μA
20KV	HB	80 to 130μA
	LL	50 to 80μA
10KV	HB	60 to 80μA
	LL	40 to 70μA
5KV	HB	50 to 80μA
	LL	30 to 60μA
2KV	HB	50 to 80μA
	LL	30 to 60μA

(2) When using AUTO EMISSION,

1. Set the HB/LL switch for the appropriate cartridge you have installed.
2. Set AUTO/MANUAL switch to AUTO.
3. Depress the OPERATION switch.
4. The EMISSION meter needle will rise and stop at a certain value.
5. Adjust the BIAS control to set an emission current value as shown in Table 2.

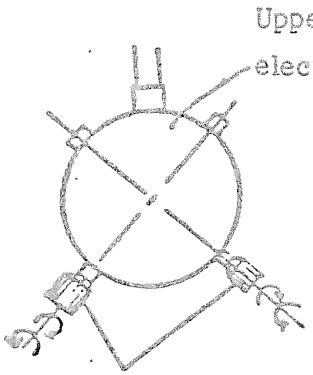
NOTE: If a bad filament has been installed or the AUTO-EMISSION adjustment located adjacent to the LL/HB select switch is turned down, there will be no indication of emission current. Check these items under that condition.

4. Adjust the BRIGHTNESS control for a barely visable RED (Reduced Area) raster under room lighting conditions. Adjust the CONTRAST control until an image appears. CONTRAST and SPOT SIZE controls work in conjunction. Larger spot size means you will require less signal from the CONTRAST control and visa-versa. If through manipulation of these two controls, you are still unable to obtain an image, check for correct gun alignment.

5. Gun Alignment:

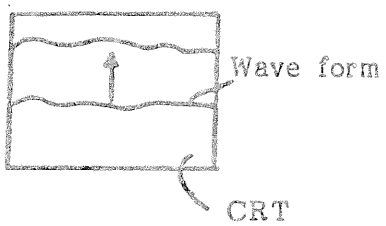
(1) Center your "GUN ALIGNMENT TILT X & Y" controls on the upper control panel. Set your SPOT-SIZE and CONTRAST controls to the 11 o'clock position. Adjust the two mechanical knobs on the front upper part of the gun chamber CW or CCW until maximum signal strength is acquired.

Another procedure is to depress WFM and adjust the wave form on the CRT to its highest peak value using the same mechanical knobs. When this procedure is complete, depress the WFM switch to OFF.



Alignment screw knob

Fig. 4



Wave form ——maximum level

(2) Adjust the GUN ALIGNMENT TILT X and Y controls on the upper control panel and insure the CRT image is maximized or the wave form level of WFM is peaked. If either control reaches a left or right limit and the signal level is still increasing, return the controls to their center position and realign the image with the mechanical knobs.

6. Confirming filament saturation.

(1) When using MANUAL EMISSION, saturation occurs at a point where further adjustment does not increase signal levels. If upon increasing your EMISSION control, the signal level goes down, remain at that point and realign your mechanical and electronic gun alignment controls. Repetition of these steps should optimize beam center and filament saturation points.

The graph in Fig. 5 illustrates this saturation point for which you are striving.

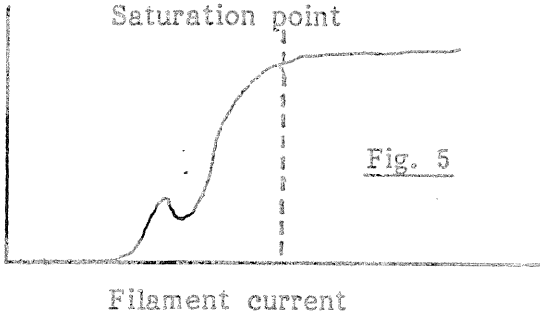


Fig. 5

NOTE: When the EMISSION dial is rotated further than saturation point, filament life is substantially reduced.

(2) When using AUTO EMISSION SATURATION. The ideal method for confirming the AUTO EMISSION saturation point is to first determine the MANUAL saturation point and adjust the AUTO for the same point.

a. Saturate the filament manually in V1 scan mode at the lowest mag in WFM. Mark this point on your CRT screen with a felt-tip pen.

b. Beside the AUTO LL/HB select switch are two potentiometers, one for each type of gun cartridge. Adjust the appropriate one with a jeweler's screwdriver so that in the AUTO position, the waveform matches the mark made on the screen for MANUAL. As long as that filament is used you may keep the AUTO-MANUAL switch in AUTO and merely turn on and off the OPERATION switch; however, if a new filament is installed, you should re-confirm the AUTO-MANUAL saturation points.

NOTE: As previously discussed with the graph demonstrating the saturation point, filament current in excess of this point substantially shortens filament life.

c. Depress the WFM switch again and return to a scanning raster.

7. Adjust the coarse focus control for a sharp image. Since the magnification necessary to obtain focus depends on the specimen, the lowest mag is not always best for coarse focusing. Switch up in mag until the image is out of focus then readjust your focus.

8. V2 SCAN SPEED is very useful as an aid to search for areas of interest. For a closer observation after locating an area, it is recommended to select V1 scan.

9. For a temporary shutdown, if in MANUAL emission, rotate the EMISSION control counter-clockwise and depress the OPERATION switch to OFF. If in AUTO EMISSION, simply turn the OPERATION switch off. To get an image back, reverse the procedures.

10. If you cannot obtain an image, check the WD (Working Distance) switch. Your sample may be higher or lower than it's designated setting. Change the settings until an image appears.

11. Begin your observations at low mags and in association with this utilize the stage motor speed control switches (X & Y) to match your mag settings. "H" moves the sample at 200 microns per second, "M" 70 per second and "S" 35 per second. The X & Y image shift controls should be used as you approach magnifications above 30KX. Be sure they have been centered to five turns a piece before reaching these mags.

5. IMAGE ENHANCEMENT

1. SPOT SIZE control.

In conjunction with the KV selected for your applications, this is the most important control to determine the resolution you desire. Final enhancement will be rendered by proper use of your stigmator controls, but first a basic description for using the SPOT SIZE control.

The strength of your image signal will increase as you rotate this control counter-clockwise; yet, the resolving power of your instrument will decrease. The following chart indicates normal SPOT SIZE settings for different magnifications.

Magnification	SPOT SIZE dial
Less than 5,000X	10 o'clock
5,000X to 20,000X	12 o'clock
20,000X to 50,000X	3 o'clock
More than 50,000X	MIN.

Once beyond the one o'clock setting, the image will become noticeably noisy. As you progress on the instrument, it will be necessary for you to acquire the ability to focus through that noise, which will be indicated on your screen much the same way as snow is sometimes present on your T.V. screen.

Your visual CRT screen is a long-life persistence tube. As you scan an image, it is retained for a period of time. The record CRT screen is a short-life persistence tube; therefore, a visual image that seems excessively noisy will not necessarily be so on your photograph. Do not assume a slightly noisy image on the visual screen will produce a bad photograph.

(1) If a sharp focus cannot be obtained as you increase magnifications, the image may be astigmatic. This phenomenon will be evident in the form of a stretching of the image in different directions just above and just below the point where focus seems almost at hand. If this is the case, return the focus control to the point where there is no stretching. Rotate STIGMATOR X & Y controls respectively to make the image as sharp as possible.

(2) Adjust your coarse focus control again and if any elongation of the image appears as you go through focus, repeat STIGMATOR X & Y adjustments again.

a. When the amount of astigmatism is great, it is easier to correct the astigmatism at each magnification range, continuing up until you reach the desired mag.

b. If, however, you are able to reach magnifications of 15,000X and above without image stretching while maintaining a relatively sharp image, little correction for astigmatism is necessary.

c. Rotate the STIGMATOR X control for your sharpest focus.

d. Rotate the STIGMATOR Y control for your sharpest focus.

e. As you approach higher and higher mags, sample structure becomes visibly larger and astigmitism correction is harder to judge. It is recommended to bring a fine structure more suitable for correction into view.

NOTE: If the specimen displays astigmatic characteristics at low magnifications, is uncorrectable at higher mags or your stigmator controls are in their limits, (Towards 10 or 0 on their settings), the following items should be checked:

(1) The emission current is not saturated. Refer to the item 4 "IMAGING PROCEDURES".

(2) The specimen is electrically or magnetically charged.

(3) Contamination of the lens aperture, sleeve, etc. Refer to "OBJECTIVE LENS APERTURE EXCANGE" and "ANODE, SLEEVE, AND APERTURE REPLACEMENT" (Column Liner).

(3) How to use STIGMATOR MONITOR

Fig. 7

Take focus of the image with FOCUS dial. Depress V1 of SCAN SPEED switch. Depress MONI. switch of STIGMATOR. The switch lights. A circular image having no astigmatism comes out as soon as the cross marker comes out on CRT. If not, the above mentioned NOTE may be the cause. Rotation of STIGMATOR X dial shifts the circular visual field to the right or left and STIGMATOR Y dial shifts upward or downward. Adjust the center of the circular visual field to the cross point of cross marker with STIGMATOR X, Y dials. Once more depress MONI. switch to set to OFF. The switch goes off. A sharp image having no astigmatism should appear.

Fig. 8

NOTE 1: The STIGMATOR MONITOR is only a rough standard for correcting astigmatism. Astigmatism correction at higher magnification should be finely adjusted according to the previous adjustment procedures.

NOTE 2: If instead of one focused spot on the screen, a circular swirling field similar to a hurricane is displayed, your image is out of focus and you must adjust your focus.

2. After any radical changes such as large changes in KV, Working Distance, or movement to a different area of your sample that may be charging, you should check and if necessary carry out any corrections for astigmatism.

3. Optimizing the visual image.

(1) Spot size and contrast controls determine how much signal you will see, how noisy it will be, and how much detail or resolution will be available. Brightness sets the overall D.C. brightness of the visual and also the record CRT during photo mode. You may set these controls for what pleases you until you are ready for a micrograph. Usually in a dark room, minimal brightness is advised and just enough contrast to see image detail. CONTRAST control does not necessitate checking STIGMATOR alignment but SPOT SIZE changes do.

(2) WAVE FORM MONITOR (WFM)

It is possible to use WFM to observe the function of CONTRAST and BRIGHTNESS controls as well as saturation of the filament. Depress WFM of SCAN SPEED switch. The switch will light. The wave form of signal will come out on the CRT. The clockwise rotation of CONTRAST control makes the amplitude of the wave form larger and the reverse makes it smaller. Clockwise rotation of BRIGHTNESS dial of CH1 brings the whole wave form upward on the CRT and the reverse brings it downward. It can be helpful to utilize it for the quality selection of the relationship between the contrast and brightness graphically displayed on the CRT. That is, notice the upper and lower limits on the CRT for CONTRAST adjustment as well as the interaction between BRIGHTNESS movements. You will be able to determine an optimum setting for visual or photo images.

4. How to use AUTO FOCUS

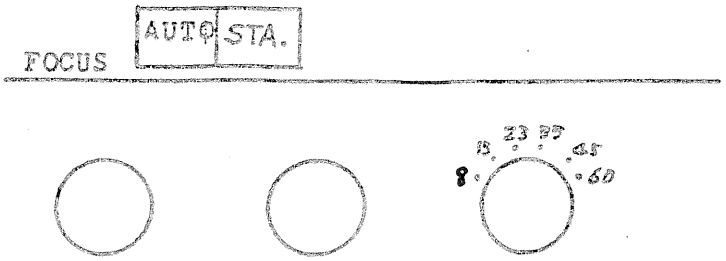


Fig. 9

Set the WORKING DISTANCE dial to a suitable value for the upper and lower positions of specimen.

Specimen stage Z dial	W.D. dial
8 to 17	8
15 to 25	15
23 to 35	23
33 to 47	33
45 to 65	45

Depress AUTO switch to set to ON. The switch will light. Depress and release "STA" switch. The screen image on CRT will go out for about five seconds, and a focused image should appear after five seconds.

NOTE 1: The focusing is adjustable by rotating FOCUS COARSE control and FINE control even in the "ON" condition of AUTO FOCUS.

NOTE 2: Again depress STA. switch to operate AUTO FOCUS when the image has defocused for either operation of X, Y, or Z axis of the specimen stage. Some specimens cannot be focused well even by operation of the auto focus if the surface topgraphy is poor or the sample emits very low signal contrast.

The operating range of auto focus is up to the magnification of 20,000X for a normal specimen. Focusing at a higher magnification is carried out with the manual operation or with the fine adjustment of FOCUS FINE dial after operating the auto focus.

Depress AUTO switch to set to OFF. The lamp will go out.

5. How to use AUTO CONTRAST/BRIGHTNESS

When determining the image quality, the controls of CONTRAST, BRIGHTNESS, and SPOT SIZE are adjusted, but the photography can take excessive time due to inexperienced operators or unfamiliar samples. It is recommended to utilize the automatically controlled contrast/brightness function in order to simplify this operation.

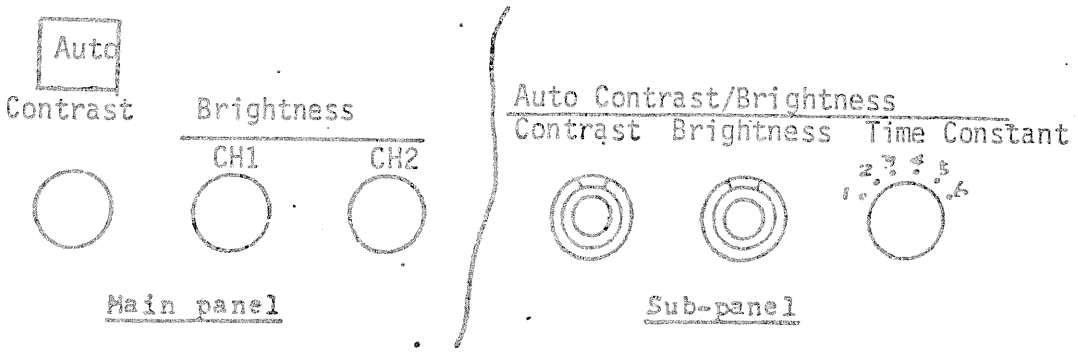


Fig. 10

Depress AUTO switch to set to ON. The switch lamp lights. The image contrast and brightness are determined by the preset level of CONTRAST control and BRIGHTNESS control AUTO CONTRAST/BRIGHTNESS. (Section on the sub-panel) Judge the quality of a photograph you have taken. If the contrast is strong, gradually rotate (AUTO) CONTRAST dial counter-clockwise or if weak, rotate it clockwise.

NOTE 1: Since the preset CONTRAST and BRIGHTNESS controls depend on the film speed sensitivity and the preset camera lens aperture, try to take several photographs until a suitable contrast and brightness is obtained.

NOTE 2: CONTRAST and SPOT SIZE dials in AUTO may be set to any suitable position, but since AUTO control is limited:

(1) Rotate CONTRAST together with the SPOT SIZE control until you at least have a visual image.

(Remark) How to use TIME CONSTANT

It is normally set at 3, image conditions or longer photo speeds may necessitate a change. An excessive area of signal strength may or may not be desireable. Depending on the case, adjust the time constant so that an excessive area either does or does not appear. TIME CONSTANT is marked with "1" the shortest, through "6" the longest.

CHANNEL 1 and CHANNEL 2 (SX-40)

In a standard situation, the secondary electron signal is applied to Connector JN1.

When the signal Connector JN2 is used for accessories, depress the CH 1 and SIG buttons on the CH 1 SIG/X-RAY selector. If X-ray detector signals are applied to Connector JN3, X-RAY images may be seen by selecting the X-RAY button on the CH1 SIG/X-RAY selector. Brightness adjustment is controlled by turning the CH 1 BRIGHTNESS knob.

Switching to CH 2, an X-RAY and X-RAY map image on the CRT can be obtained from the X-ray detector signals coming from Connector JN4. In this case, brightness adjustment can be controlled by turning the CH 2 BRIGHTNESS knob.

NOTE: CHANNEL 1 and CHANNEL 2 have independant brightness controls, and the CONTRAST knob on the front panel is common to both channels.

6. DYNAMIC FOCUS (SX40)

This control is used when a sample is viewed at low magnification and high tilt angles. When the tilt angle is high, the vertical distance of the beam travel could exceed the depth-of-field of the objective aperture. If this is the case, the top and bottom of the image will be defocused. The DYNAMIC FOCUS control compensates for this by keeping the beam focused throughout the vertical scan.

1. Set the DYNAMIC FOCUS control to correspond with the tilt angle indicated on the TILT control on the Specimen Stage.

2. While observing the center of the CRT, focus the image as accurately as possible. The image should now be in focus from top to bottom.

3. Although the DYNAMIC FOCUS is generally used as described above, good top to bottom focus may not be obtained. If this occurs, it is due to the sample surface not being parallel to the Specimen Stub, in which case, the true tilt angle differs from the indicated tilt angle on the Specimen Stage.

4. Adjust the DYNAMIC FOCUS control until the entire image from top to bottom is in focus while observing the image in the "normal" SCAN MODE.

5. In some cases, it may be advantageous not to use the DYNAMIC FOCUS since the "depth effect" may be enhanced by viewing an image that is partially out of focus. Set the DYNAMIC FOCUS control to 0°.

7. OBTAINING A BSE (BACKSCATTERED ELECTRON) IMAGE

1. Switch DET HV button OFF on the Operation panel.

2. Increase the Spot Size until a satisfactory image is obtained on the CRT. It may be necessary to pull out the SPOT SIZE knob for a greater increase in Spot Size. Also, it may be necessary in some cases to correct astigmatism.

8. SPOT, LINE, LINE PROFILE, & X-RAY CONTROLS

An energy dispersive X-ray analyzer (EDX) is used to perform non-destructive elemental analysis of small specimen areas. The EDX system detects X-rays emitted from a specimen when bombarded by electrons with energies of several thousand volts. The following analysis can be done with Connectors JN3 X-RAY and JN5 LP1:

1. Spot - Here the electron beam is held stationary on a select point on the specimen. Qualitative and quantitative analysis of the elements present can be performed.
2. Line - By scanning the electron beam along a line on the specimen, the concentration, distrubution of a specific element can be measured. The distribution can be displayed on the CRT by switching the MAP MODE button to the LP button.
3. Area/X-ray - Scanning the electron beam over an area of the specimen surface, the two dimentional concentration, distribution of a specific element can be measured (displayed on CRT).

1. Obtain the Secondary Electron image referring to the IMAGING and IMAGE ENHANCEMENT procedures.

   NOTE: It is recommended that specimen current measurements be made before beginning X-ray analysis. Refer to SPECIMEN HANDLING. Be careful not to run the specimen into the detector.

2. Depress the X-RAY button of CHANNEL 1 to perform Area analysis. The distribution of specific elements can be displayed on the CRT. The output from the EDX (to be supplied to Connector JN3/X-RAY1) is 5 volts peak to peak. A switch has been supplied on the PC board of the system for switching the correct polarity.

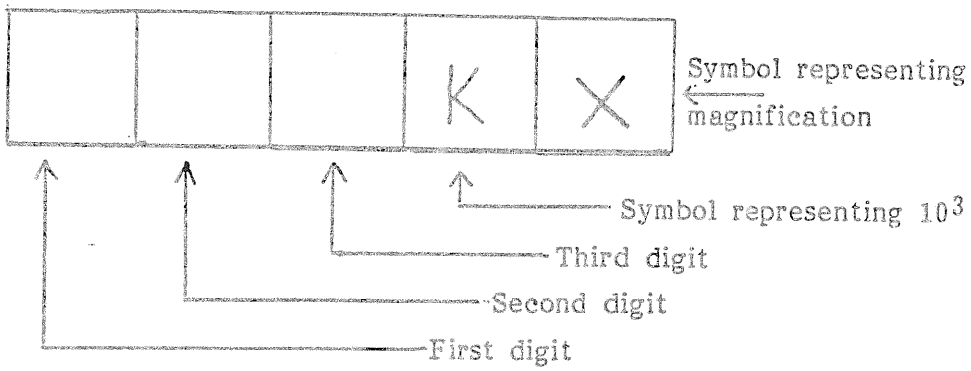
3. For Spot analysis, find the area of interest. While observing the Secondary Electron image, depress the SPOT button on the SCAN MODE. Using the afterglow of the Secondary image as a guide, turn the X, Y POSITION knobs to bring the bright spot to the area for analysis. Use the EDX to perform the analysis.

4. For Line analysis, select the position of the horizontal line by observing the Secondary image. Depress the LINE button on the SCAN MODE. Use the afterglow image as a guide and position the line with the Y POSITION knob. Use the EDX to perform elemental analysis on that line. If the SCAN MODE is in the LP position, the concentration distribution of specific elements can be displayed. In the Line analysis mode, the brightness of the trace is fixed and cannot be altered with the BRIGHTNESS knob. A picture can be taken. Refer to the PHOTOGRAPHING the IMAGE procedures.

If the CHANNEL 1 or CHANNEL 2 SIG/X-RAY button is in the SIG position, Line analysis as described above can be done with detected signals other than X-ray. Depress the MAP button on the SCAN MODE to obtain an image on the CRT of detected signals (for example: Secondary Electron). Find the position for analysis. Then depress the LINE button on the SCAN MODE. Using the afterglow, turn the Y POSITION knob to bring the bright line to the position for analysis. Then by switching the SCAN MODE to the LP position, the density distribution of the signal (for example: Secondary Electron) on a line can be displayed on the CRT.

9. DIGITAL MAGNIFICATION

1. The automatic digital magnificataion display is coupled to all operating conditions, thereby providing correct magnification at all times. To obtain optimum accuracy, carefully focus the image. The reading is interpreted as illustrated below:



Decimals are displayed at the lower left side of the digits.
See examples below:

.200kX:	Magnification is 200X
2.00kX:	Magnification is 2000X
20.0kX:	Magnification is 20,000X
200kX:	Magnification is 200,000X

2. When using the Dual Magnification mode, the magnification displayed is for the low magnification (CHANNEL 1) only. To obtain the high magnification (CHANNEL 2), multiply the displayed value by the factor being used: 2X, 5X, 10X (refer to Dual Magnification procedure).

10. PHOTOGRAPHING THE IMAGE (DATA)

NOTE: Before taking a micrograph, the following procedures must be completed:

AREA SELECTION, FOCUSING, ASTIGMATISM COMPENSATION, & MAGNIFICATION SELECTION (described in IMAGE ENHANCEMENT)

CAMERA OPERATION-

NOTE: Before taking a micrograph, be sure to load camera and adjust aperture.

Aperture Adjustment-

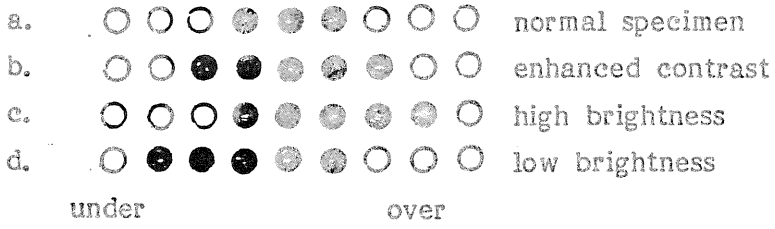
1. 6 x 9 roll film camera - aperture is f11 for ASA 100 film magnification correction ratio - 0.65
2. 6 x 9 roll film camera with series 600 polaroid attachment -
   aperture is f32 for type 667 ASA 3000 film
   aperture is f11 for type 665 ASA 75 film
   magnification correction ratio - 0.8
3. 35mm roll-film camera - aperture is f11 for ASA 100 film
   magnification correction ratio - 0.3
4. 4 x 5 Polaroid Land Camera/50 Series -
   aperture is f8 for type 55 ASA 50 film
   aperture is f22 for type 52 ASA 400 film
   magnification correction ratio - 1.0

10. PHOTOGRAPHING THE IMAGE (Cont.)

1. Depress the RED (reduced) button on the SCAN SPEED. The LED CONTRAST/BRIGHTNESS display will light. The LED display consists of 9 lamps. The middle lamp is always lit when the RED button is depressed.

2. Before taking a micrograph by depressing P1 of SCAN MODE, rotate the CONTRAST and BRIGHTNESS knobs to preset the LED display as shown if Figure 11 below.

Fig. 11



Usually, it is recommended to shift the LEDs to the right for low level signals as shown in (c). When signal level is high, shift the LEDs to the left as shown in (d). When higher contrast is required, increase the number of LEDs as shown in (b).

3. When taking a micrograph by depressing P2 of the SCAN MODE, rotate the CONTRAST and BRIGHTNESS controls to adjust the LED display as shown in Figure 12 below:

Fig. 12

4. Depressing the P1 and P2 buttons of the SCAN SPEED will automatically take a micrograph. Simultaneously, the magnification, accelerating voltage, film number, and Micron Marker are recorded on the film.

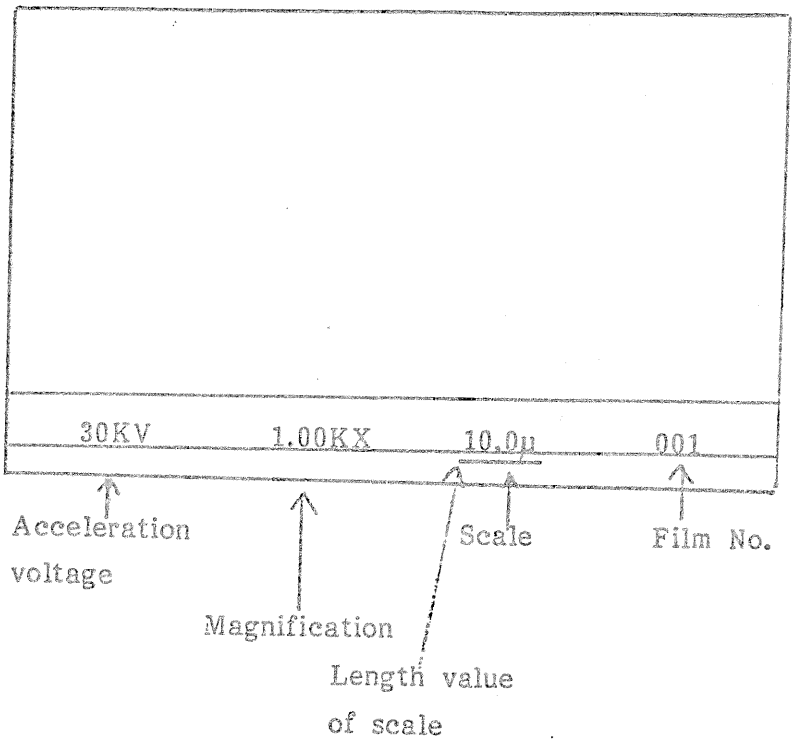


Fig. 13

NOTE: To reset the film number to 001, depress the FILM NO. RESET button.

The micrograph is automatically taken by depressing the PHOTO P1 or P2 button. Use the P1 button when photographing a normal specimen. when the signal-to-noise ratio is poor (sample dependent) use the P2 button. Longer recording time improves the signal-to-noise ratio.

Exposure time in PHOTO: 80 sec.
Exposure time in P1: 80 sec.
Exposure time in P2: 160 sec.

When taking a micrograph in the Dual Magnification mode, (option) shift the LED display two lamps to the right.

5. A condensed explanation of the CONTRAST/BRIGHTNESS LED Lamps would be: Contrast controls how many lamps are lit and brightness controls the position of the lamps. If you have too much or too little contrast according to your lamps and can't adjust them with your contrast control, then change your spot-size accordingly. (Refer to SPOT SIZE USE). Depending on your magnification, you may have to re-adjust your focus and stigmator controls, but the lamps should fall back into the spectrum of three lamps in the center.

11. DUAL MAGNIFICATION OPERATION (OPTION)

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 CRTs.

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.

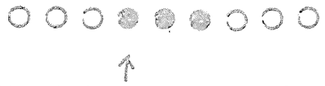
3. Adjust the CONTRAST and BRIGHTNESS knobs for CH1 or CH2 so that the LED CONTRAST/BRIGHTNESS display is as shown in Figure 14 below:

Fig. 14

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 15 below:

Fig. 15



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

12. SIMULTANEOUS IMAGING OF DIFFERENT SIGNALS (OPTION)

The image from CH1 can be displayed on the left half of the CRT while simultaneously imaging the signal from CH2 on the right half of the CRT. The SE (Secondary Electron) signal is fed into CH1 in all cases. Since the right and left halves are independently operated, images of different kinds can be simultaneously observed on the same CRT.

NOTE: EDX unit is necessary for displaying X-ray images. Two X-ray signals can be observed if the EDX system has two outputs.
Detectors other than the standard detector SE/BSE are optionally available. Refer to the IMAGE ENHANCEMENT procedure for signal connections.

1. Set the SCAN SPEED to the V1 position. Then set the DUAL MAG button to X1. Use the SIG/X-RAY button of CH1 for the left image and the SIG/X-RAY button of CH2 for the right image. Focusing and Astigmatism correction may be required. Refer to the IMAGE ADJUSTMENT procedure.

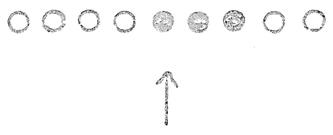
2. Depress the RED (reduced) button of the SCAN SPEED and position the reduced area on the right or left half of the CRT with the POSITION X and Y controls for focusing.

3. Photograph the Dual image as follows:
   (A) Image other the X-ray -
   Set CH 1/CH 2 button to CH 1
   Switch DUAL MAG off
   Depress RED (reduced) button on SCAN SPEED
   Bring the scanned area to the middle of the CRT with the POSITION X, Y control.
   With the Secondary Electron (SE) image or the Backscattered Electron (BSE) image, adjust the CONTRAST and BRIGHTNESS controls so that the LEDs of the CONTRAST/BRIGHTNESS display light as shown in figure 16 .

Fig. 16

Then set the CH 1/CH 2 button to CH 2. Adjust the CONTRAST control provided on the optional device and the BRIGHTNESS control of CH 2 so that the LEDs light as shown if Figure 17.

Fig. 17

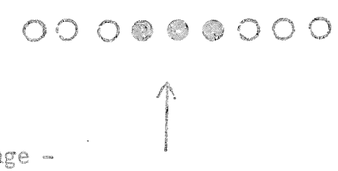


The LEDs to the right of middle should be ignored if they should light.

Depress X1 on the DUAL MAG. Depress P1 of the SCAN SPEED to take the micrograph.

When taking a micrograph with P2, the LEDs should light as shown in Figure 18 below for CH 1 and CH 2.

Fig. 18



The LEDs to right of middle should be ignored if they should light.

(B) X-ray image -

Using the same procedure as previously mentioned, adjust the BRIGHTNESS control for CH 1 so that the LEDs light as shown if Figure 19.

Fig. 19

Ignore the lights to the right of center.

Again, using the same procedure, adjust the BRIGHTNESS control so that the LEDs light as shown in Figure 20.

Fig. 20

Ignore the lights to the right of center.

Depress X1 on the DUAL MAG. Depress P1 button of the SCAN SPEED to take the micrograph.

When taking a micrograph with P2, adjust the LEDs so that they light as shown in Figure 21 below.

Fig. 21

Ignore the lights to the right of center.

13. 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 imput 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 $X^{1/2}$.

   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 $X^{1/4}$.

   In addition, a FINE control is provided for varying the signal in each position. By turning this control from its maximum counter-clockwise (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 VI 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 disengage 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.

14. 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 CW, 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.

15. 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. 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.

16. 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 samples 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. This allows for convenient framing of the 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 at some angle other then 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 remembered 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.

16. 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 samples 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 fro 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. 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 at some angle other then 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 remembered 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.

17. 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.

18. ELECTRON CHANNELING PATTERN (OPTION)

1. Main specification

   Electron beam diameter —— 2μØ

   Electron beam tilt angle —— $\pm 5 \times 10^{-2}$ rad.

   Limited visual field area —— 50μØ

2. Components

   (1) Backscattered electron detector ———— 1

   (2) Amplifier for back scattered electron detector — 1

   (3) Mode selector (AMS) ———— 1

   (4) Cable ———— 1

   (5) Objective lens holder for ECP ———— 1

   (6) Aperture, 200μØ ———— 1

3. Preparation

   (1) Change the aperture no. 3 from 1mmØ to 200μØ; refer to item 22 ANODE, SLEEVE, APERTURE REPLACEMENT (Column Liner)

   (2) Remove the objective lens aperture holder; refer to item 23 "OBJECTIVE LENS APERTURE EXCHANGE" and insert the objective lens holder for ECP.

   (3) Install the back scattered electron detector as described in the operation manual of "BACKSCATTERED ELECTRON IMAGE OBSERVING DEVICE". Connect the cables from the back scattered electron detector and secondary electron detector pre-amplifier to the rear of the mode selector. SE detection goes to JKM3 and BSE detector to the BSE power supply. (Fig. 22) Install cables JKM1-JN1 and JKM2-JN2 as shown on Fig. 24.

4. Operation

   (1) Mount the specimen on the specimen holder. Refer to item 2, "SPECIMEN EXCHANGE". Mount it so the upper surface of the specimen is level with the top of the specimen holder.

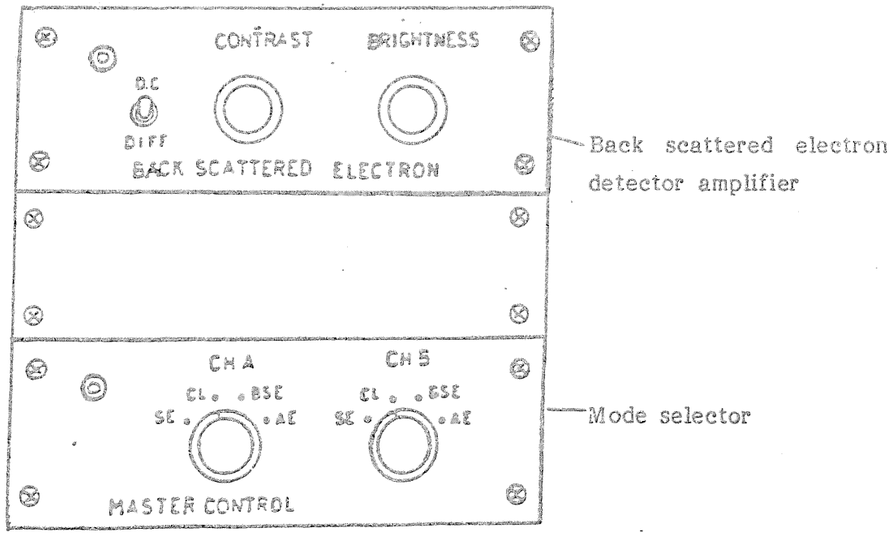
   (2) Adjust the working distance control (Z) to 15mm.

   (3) Set HV switch to 30KV.

(4) Obtain a back scattered electron image on the CRT referring to item 4 "IMAGING" and item 5 "IMAGE ENHANCEMENT". Set CHA switch of the mode selector (AMS) to SE and CHB switch to BSE.
Set SIG/X-RAY switch of CH1 on the control panel to SIG and SIG/X-RAY switch of CH2 to SIG. A secondary electron image and back scattered electron image can be optionally selected by changing over CH1/CH2 switch.
When the CH1/CH2 is switched to CH1 (secondary electron image), the image contrast is adjusted by CONTRAST dial on the control panel and the brightness by BRIGHTNESS dial of CH1.

When the CH1/CH2 is switched to CH2 (backscattered electron image), the image contrast is adjusted by the CONTRAST dial of the back scattered electron detector amplifier in the mode selector (AMS) and the brightness by both the BRIGHTNESS dial of the above mentioned amplifier and the BRIGHTNESS dial for CH2 on the control panel.

Fig. 22



(5) Set the DC/DIFF switch of the backscattered electron detector amplifier to DIFF. The image signal will be differentiated and contrast enhanced.

(6) Set the following controls:

Control	Condition
MAGNIFICATION	Fully counter-clockwise
ZOOM	Fully counter-clockwise
WORKING DISTANCE	8mm
COARSE FOCUS	Fully clockwise

(7) Depress the ECP switch on the control panel. The light will come on. Adjust the FOCUS control to obtain a clear image.

Fig. 23

(8) The quality of the pattern image is determined by the following table.

Apparatus	Control	Effect
Back scattered electron detector amplifier	CONTRAST	Determines image contrast
	BRIGHTNESS	Determines brightness of CH2
SEM control panel	BRIGHTNESS of CH2	Determines brightness
	SPOT SIZE*	Determines electron beam diameter

*As the amount of image signal is changed, readjust CONTRAST and BRIGHTNESS controls.

(9) Electron beam tilt angle (rocking angle)

The rocking angle can be changed by selecting the following MAGNIFICATION dial positions.

MAGNIFICATION dial	Reduction ratio of rocking angle
Full counter-clockwise	1
1 step clockwise	0.6
2 steps clockwise	0.43
3 steps clockwise	0.3
4 steps clockwise	0.2
5 steps clockwise	0.15

(10) Connection diagram

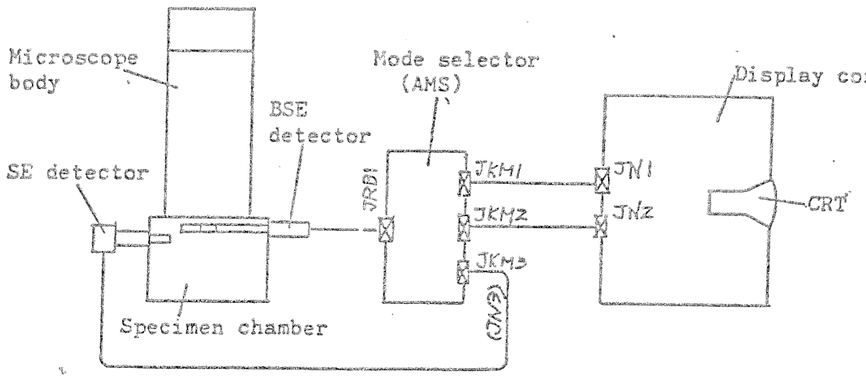


Fig. 24

The electron channeling pattern (ECP) option enables you to obtain information of crystal orientation from a crystalized specimen by angle scanning the incident beam at one point or plane on the specimen. Fig. 25 shows the electron beam diagram when observing the usual SEM image and the alternate ECP mode. The difference between the electron beam diagrams, is the focusing capability of the 2nd condensor lens (CL2) and the ON - OFF condition of the 2nd set of scan coils (SC2). In normal SEM image observation, CL2 (pt.A) provides a crossover image for the objective lens (OL). Scanning coils SC1 and SC2 are energized and the incident beam scans the specimen surface through two stages with two sets of scan coils. In the ECP operating mode, as shown on the left hand diagram of Figure 25, the operating conditions of CL2 are such that the crossover produced is located at the front focal point (Point B) of the objective lens (OL). Maintaining the excitation current of the objective lens the same as for SEM imaging, results in a parallel beam striking the sample. The second scan coil is turned off, and scanning is performed by the top coil only. Since the objective lens focuses all electrons emminating from a point in the plane of the top scan coil into a point on the surface of the specimen, this results in the beam being caused to rock about a point on the surface during scanning.

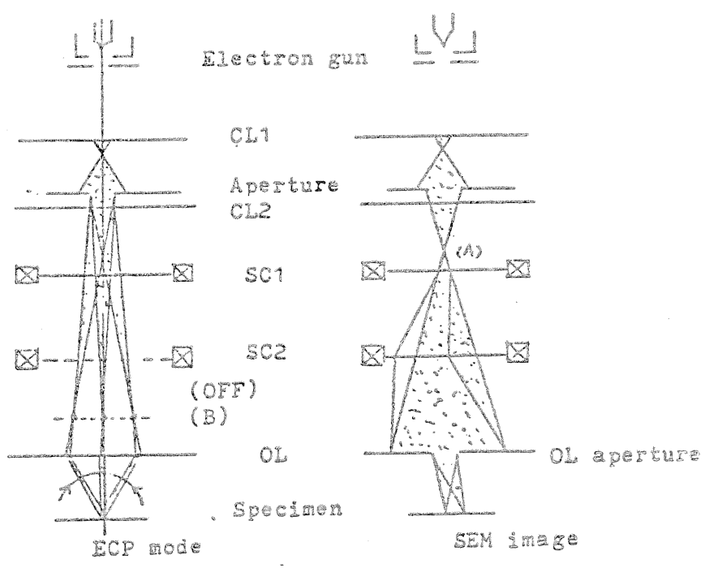


Fig. 25

19. HOW TO USE ALPHA NUMERIC DISPLAY (OPTION)

This device is used for recording various data pertaining to the image such as type of specimen, date, etc. onto the photograph. It is possible to record alphabet, numerals, symbols, etc. in 14 rows with 32 letters to each row.

1. Operation

   1-1 Set SCAN SPEED switch to V1.

   1-2 Depress the PAGE key. The pilot lamp will light and operation may begin.

   1-3 The letters will be typed from the upper left of the screen. A cursor mark (_) is displayed on CRT screen indicating where the next entry will appear.

   1-4 Depress the BREAK key to delete all displayed letters.

2. Function of keys

   PAGE———— "ON" display

   BREAK———— delete all displayed characters.

   ALT MODE——— Unused

   CTRL———— Unused

   LINE FEED——— shifts the carriage to the left end of next row.

   RETURN———— shifts the carriage to the left end of the same row.

   RUB OUT———— retreats the carriage by one character.

   SHIFT———— used when displaying the upper character on the key on which upper and lower characters are indicated. Depressing and holding SHIFT while making an entry displays the upper character.

   SPACE———— deletes one character and advances the carriage by one character.

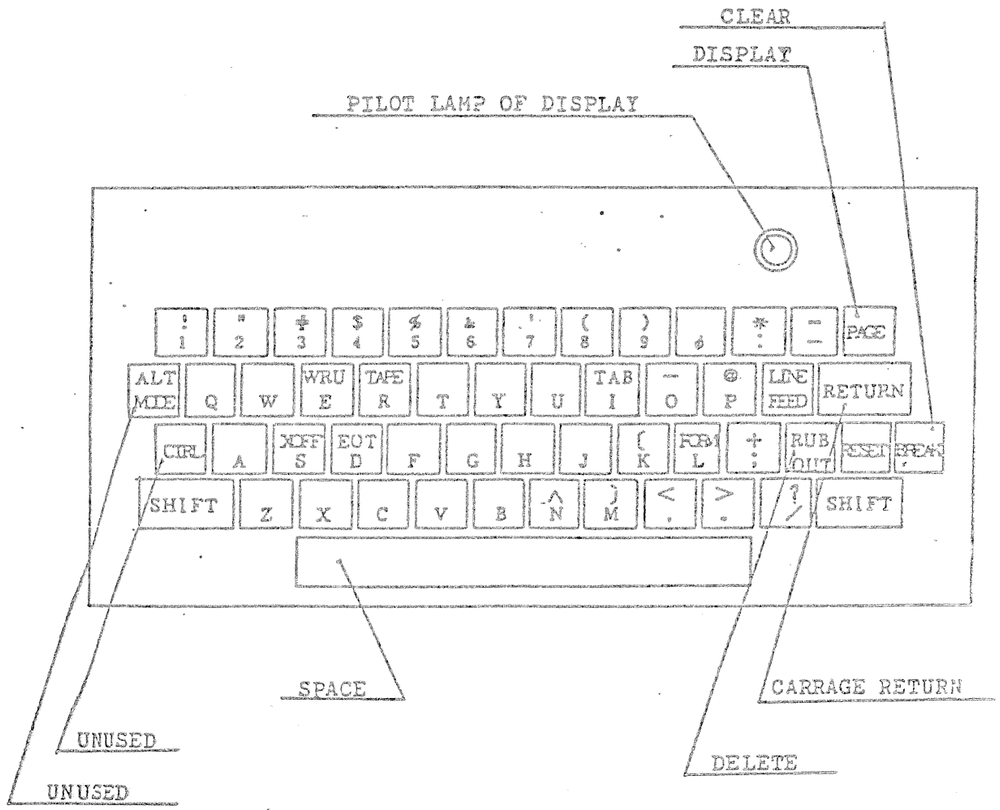

CLEAR
DISPLAY
PILOT LAMP OF DISPLAY
PAGE
ALT MODE
WRU
TAPE
TAB
LINE FEED
RETURN
CTRL
XOFF
EOT
FORM
RUB OUT
RESET
BREAK
SHIFT
SHIFT
SPACE
CARRAGE RETURN
UNUSED
UNUSED
DELETE

Fig. 26

20. GUN CARTRIDGE EXCHANGE

1. Depress OPERATION button OFF. Lamp will go OFF.

2. Admit air into the column referring to the VACUUM SYSTEM OPERATION procedure.

3. Open the Electron Gun by tilting to the left side of the Electron Gun Chamber on the top of the column (refer to Figure 27).
   WARNING: Immediately touch the Discharge Bar to the Electron Gun Cartridge. Be careful not to drop any dust or particles into the Electron Gun Chamber or on the Cartridge Base.

4. The Gun Cartridge is held in place by a retaining ring. Turn the ring CCW.

5. Pull the Electron Gun Cartridge out of the Base. Refer to Figure 28.
   WARNING: If the Gun Cartridge is removed immediately after the instrument is turned off, the Cartridge will be VERY HOT - TEMPERATURES GREATER THAN 200°. Handle the Electron Gun Cartridge with protective material.
   DO NOT USE SYNTHETIC GLOVES.

6. Insert the new Electron Gun Cartridge into the Gun Cartridge Base.
   NOTE: The direction of the Electron Gun Cartridge is unimportant. Reinstall the retaining ring on the Gun Cartridge.

7. Close the Electron Gun. Be sure to hold the Discharge Bar out of the way.

8. Evacuate the column referring to the VACUUM SYSTEM OPERATION section.
   NOTE: If the Vacuum pumping speed is too slow, the O-ring of the Electron Gun Chamber has been contaminated.

Fig. 27

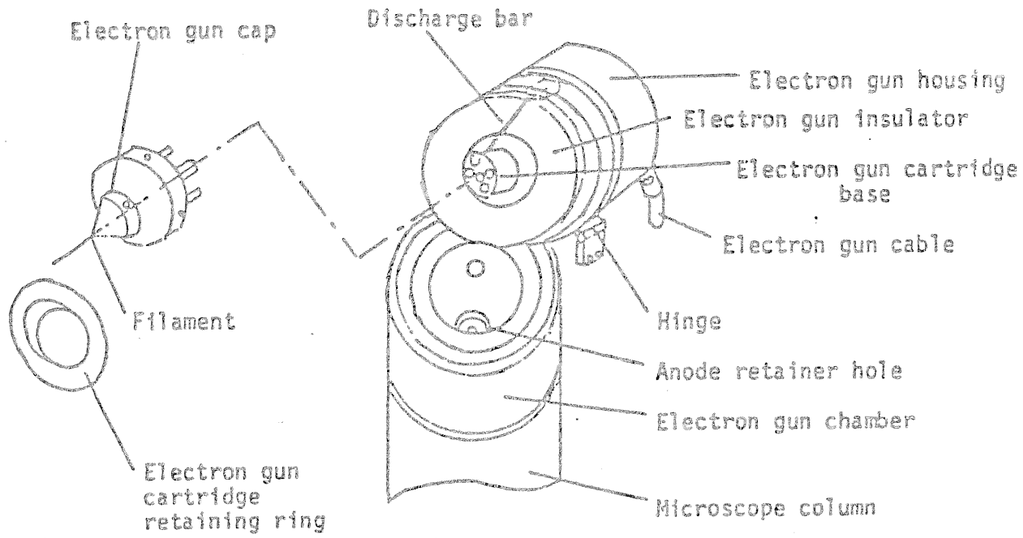
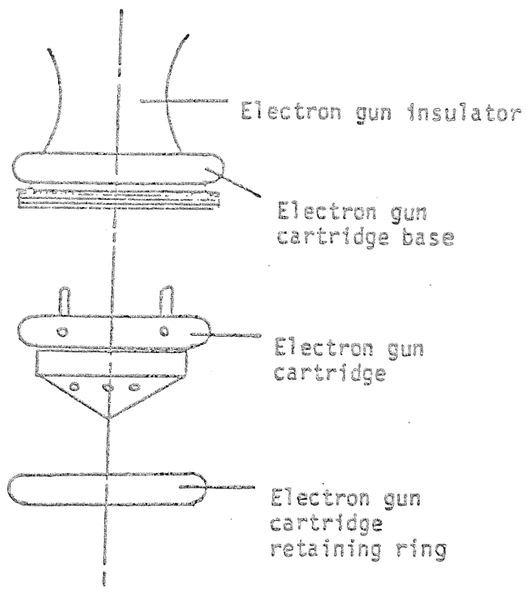

Electron gun cap
Discharge bar
Electron gun housing
Electron gun insulator
Electron gun cartridge base
Electron gun cable
Filament
Hinge
Anode retainer hole
Electron gun chamber
Electron gun cartridge retaining ring
Microscope column

Fig. 28


Electron gun insulator
Electron gun cartridge base
Electron gun cartridge
Electron gun cartridge retaining ring

9. Two types of Gun Cartridges have been supplied. One is a high brightness (HB) which incorporates a conical grid cap. The other is a long life (LL) which incorporates a flat grid cap. The Cartridges are identical except for the grid caps.

Typical Emission Current for the two types of cartridges are as follows:

HB - High Brightness - 100 to 150μa

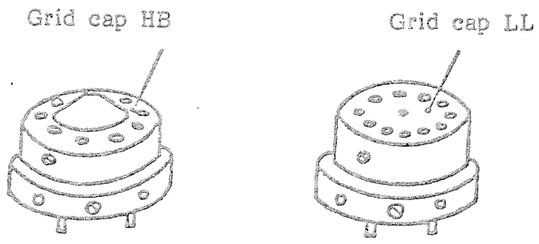
LL - Long Life - 70 to 100μa

The high brightness cartridge is used when optimum performance is required. It is also recommended when an Energy Dispersive X-ray system (EDX) is used. Normal filament life with the HB cartridge is approximately 30 to 40 hours.

The long life cartridge is used for routine work up to about 30kX magnification. Expected filament life with the LL cartridge is approximately 100 hours.

When AUTO EMISSION is used, the selector toggle must correspond to the type of cartridge used, and the AUTO/MANUAL toggle must be in the AUTO position. The filament is saturated when the OPERATION button is depressed. When either type cartridge is exchanged, AUTO saturation must be readjusted with the corresponding recessed screw driver adjustment. The same technique is used when the filament is manually saturated (manual saturation is the same with both types of cartridges). Refer to Figure 29.

Fig. 29



Electron gun cartridge

21. FILAMENT EXCHANGE

1. With the Grid Cap removed from the gun, loosen the lock screw for the Grid Cap. Turn the Grid Cap CCW and remove it from the Filament Holder. Loosen the four Filament Centering set screws and remove the Filament from the Filament Holder (refer to Figure 30).

   NOTE: To clean the Grid Cap and Filament Holder, refer to the ELECTRON GUN AND ANODE CLEANING section. The outer and inner part of the hole (located in the Grid Cap) must be cleaned carefully. Any contamination will cause discharge.

2. To mount a new Filament, refer to Figure 31. Insert the Filament into the Filament Mounting Jig. This jig is a standard accessory. It is not necessary to be concerned with the direction of the filament. Put the Filament Holder on the Filament and carefully screw the Grid Cap on to the Filament Holder. Then rotate the Grid Cap so that the top surface is flush with the tip of the Filament (the same height).

3. Adjust the four Filament Centering screws to center the tip of the Filament in the center of the hole in the Grid Cap. For this adjustment, rotate the Filament Mounting Jig. This will make centering easy to check. After centering adjustments are completed, carefully tighten the four Filament Centering screws. Check by using a eyepiece of 5-10X. Repeat the centering procedure as necessary.

   Final adjustment for the HB Grid Cap -

   After finishing the above procedure, being sure the Grid Cap is at the same height as the Filament tip, turn the Grid Cap counter-clockwise (CCW) one turn. Carefully tighten the Grid Cap set screw. Tightening too much will cause the Grid Cap to tilt so that the tip of the Filament will shift from the center of the hole.

   Final adjustment for the LL Grid Cap -

   Again, be sure the Grid Cap is at the same height as the Filament tip. Then, carefully turn the Grid Cap 3/4 turns. Carefully tighten the Grid Cap set screw. If too tight, the Grid Cap will tilt and the Filament tip will shift from the center of the hole.

Fig. 30

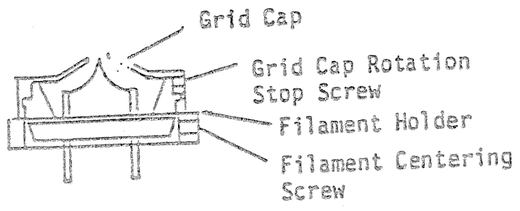
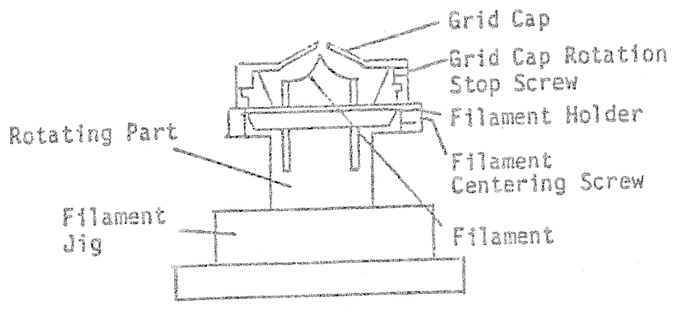

Grid Cap
Grid Cap Rotation Stop Screw
Filament Holder
Filament Centering Screw

Fig. 31


Grid Cap
Grid Cap Rotation Stop Screw
Filament Holder
Rotating Part
Filament Centering Screw
Filament Jig
Filament

22. ANODE, SLEEVE, AND APERTURE REPALCEMENT

1. Turn off the OPERATION button. Lamp will go off.

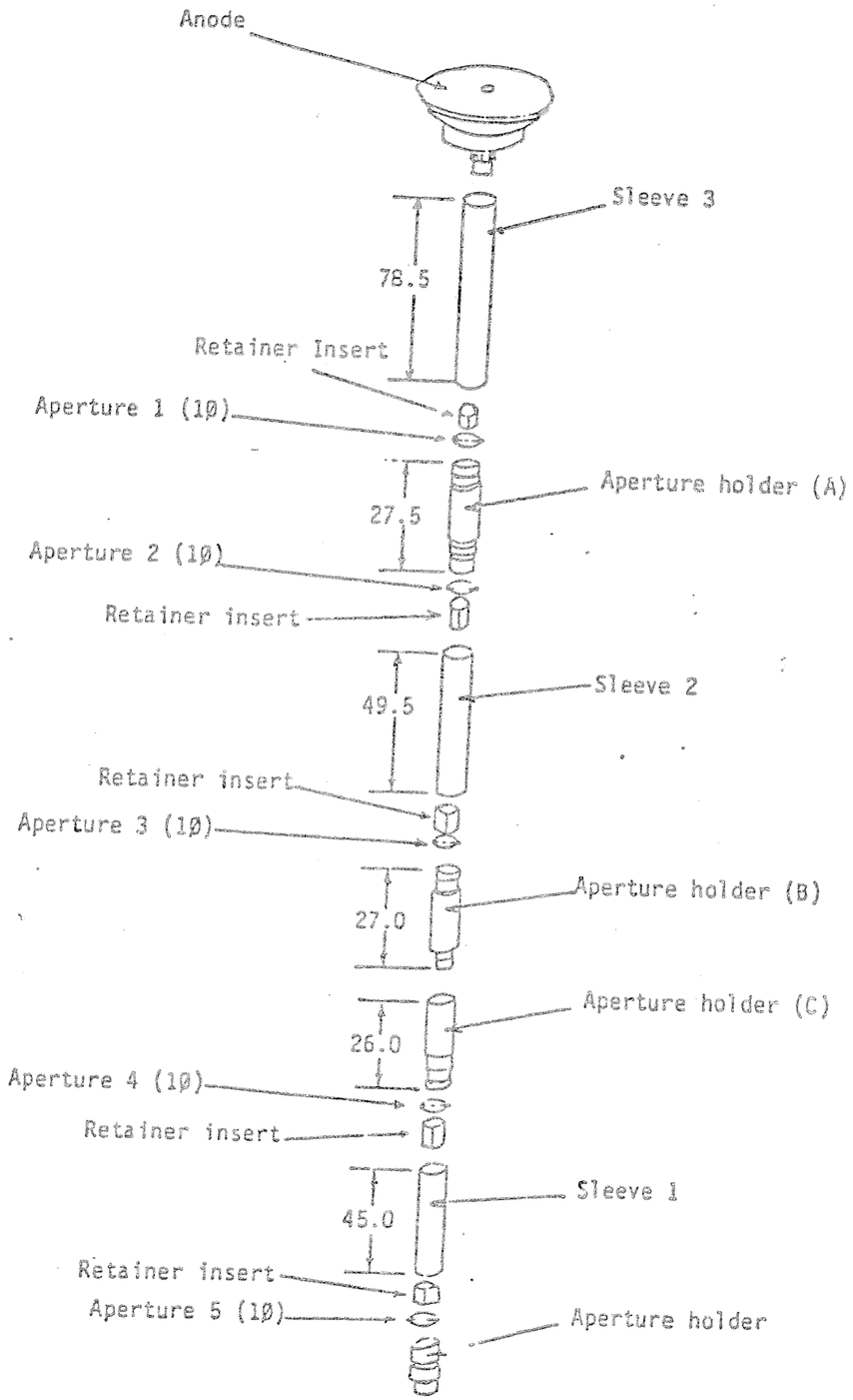
2. Admit air into the column referring to the VACUUM SYSTEM OPERATION procedure. Open the Electron Gun Chamber by tilting it to the left. Be sure that the Grounding Bar touches the Electron Gun Cartridge.

3. Grasp the Anode and pull up gently to remove the Column Liner. After taking out the Anode and Column Liner, close the Electron Gun Chamber to prevent dust from entering the Electron Chamber and Column. Be sure the Grounding Bar does not interfere with closing the Gun Chamber. After cleaning and/or replacement of the Anode and Column Liner, assemble referring to Figure 32.

4. Insert the clean Anode and Column Liner into the column. When in place, push down to firmly seat the Anode in the column. Evacuate the column referring to the VACUUM SYSTEM OPERATION procedure.

   NOTE: If the pump down is too slow, the cause may be dust or foreign particles on the Vacuum Seal of the Electron Gun Chamber.

Fig. 32


Anode
Sleeve 3
78.5
Retainer Insert
Aperture 1 (1Ø)
Aperture holder (A)
27.5
Aperture 2 (1Ø)
Retainer insert
49.5
Sleeve 2
Retainer insert
Aperture 3 (1Ø)
Aperture holder (B)
27.0
Aperture holder (C)
26.0
Aperture 4 (1Ø)
Retainer insert
Sleeve 1
45.0
Retainer insert
Aperture 5 (1Ø)
Aperture holder

23. OBJECTIVE LENS APERTURE EXCHANGE

1. Turn the OPERATION button OFF. The lamp will go OFF.

2. Admit air into the column referring to the VACUUM SYSTEM OPERATION procedure.

3. Turn the STAGE CLAMP knob to UNCLAMP. Release the Stage Door snap-lock and open the Stage.

4. Remove the Objective Lens Aperture Holder from the Objective Lens using the Aperture Holder tool. To remove the Aperture from the Aperture Holder, remove the Lens Aperture Stop by rotating it CCW. Insert the thinner end of the provided tool into the bottom of the Aperture Holder and push the Aperture out through the top. Install the new Aperture with the larger hole diameter down. Replace the Aperture Stop.

5. After cleaning the Aperture or replacing with a new one, place the Aperture Holder assembly into the Objective Lens with the tool provided.

   NOTE: Refer to the ELECTRON GUN CARTRIDGE AND ANODE CLEANING section for proper cleaning methods.

6. Close the Specimen Stage door and evacuate the system referring to the VACUUM SYSTEM OPERATION procedure.

   NOTE: When pump down is too slow, the cause may be dust or fiber adhering to the Vacuum Seal on the Specimen Chamber.

24. CLEANING ELECTRON GUN CARTRIDGE, ANODE, SLEEVES & APERTURES

Cleanliness is one of the most important requirements to obtain best results from any electron optical column. The following procedure is recommended for thorough and effective column parts cleaning.

1. The following parts must be cleaned when they are badly contaminated:

   ELECTRON GUN CARTRIDGE GRID CAP & FILAMENT HOLDER
   SLEEVES, 1, 2, and 3
   APERTURE HOLDERS A, B, C, and D
   APERTURES 1, 2, 3, 4, and 5
   OBJECTIVE APERTURE STOP
   OBJECTIVE APERTURE HOLDER

2. Disassemble the Column Liner, Electron Gun Cartridge and Objective Aperture Holder. Save the Objective Aperture for cleaning with another procedure.

3. Clean all parts with a metal polish such as Wenol or Pol-Metalputz.
   WARNING: These polishes are available from all microscope accessory suppliers. Do not use Wenol with Plus K additive. Use a cotton swab saturated with metal polish to clean the inside diameter of the sleeves, aperture holder, etc. The smaller diameters can be cleaned by wrapping a small tissue such as Kimwipes around a wooded stick. To clean the outer surfaces, saturate the tissue or cloth with polish until all contamination is removed. Where the contamination is quite heavy on the Electron Gun Cartridge and Anode, a cleaning agent such as Comet, Ajax, etc. can be used with water. Remove all traces of cleaning agent and place parts in a beaker of acetone or equivalent solvent in an ultrasonic cleaner for several minutes. As the ultrasonic cleaning action removes the remaining cleaning agent, the solvent will discolor. Keep changing the solvent until it remains clean, then follow up with a final rinse in alcohol or methanol and dry the parts thoroughly.

4. Prior to assembling the parts, inspect with a 5-10X magnifying lens. A speck of dust or lint in a critical area could defeat the entire cleaning procedure.

5. Depending upon what they are made of, there are several procedures for cleaning apertures. A platinum aperture can be cleaned very effectively by holding a carbon-free flame such as an alcohol burner or propane torch with a pair of platinum tipped tweezers. The aperture should be heated until it is cherry red for 30-60 seconds. To clean molybdenum apertures (supplied with the instrument), place in tungsten boat in Vacuum Evaporator. Again, heat until cherry red for a minute or two or until color of entire aperture is uniform. Turn off heat and allow to cool before admitting air into the system. If air is admitted into the evaporator before the apertures cool down, the apertures will oxidize.

6. When the column parts are cleaned successfully, the Stigmator controls should be near the center when Astigmatism is corrected. When the quality of the image deteriorates, there is a tendency towards over-reacting and going through the entire cleaning process when it may not be necessary. If severe astigmatism is encountered and can not be corrected with controls, the problem is generally dust or lint on the Objective Aperture or in the Objective Aperture Holder. When the stigmator controls gradually shift towards one end, this is usually an indication of contamination build-up. In either case, cleaning or replacing the Objective Aperture and/or cleaning the Objective Aperture Holder may be all that is required. However, when astigmatism is corrected and the controls are near the center but image quality is poor, the Column Liner is usually the cause and requires cleaning.

   NOTE: Do not clean the bore of the microscope column with a solvent such as acetone. If the center hole is cleaned with a solvent or reagent, its component parts may be damaged. The center bore does not reugire cleaning.

7. Clean the Anode with the same procedure as described in number 3 previously. The surface of the Anode Aperture must be thoroughly cleaned. To prevent discharging in the instrument after assembly, dry the Anode and the Anode Aperture after cleaning with a blow dryer.

25. SCINTILLATOR REPLACEMENT

1. Periodically the Scintillator has to be changed to maintain optimum performance. If bright spots or horizontal lines are observed on the CRT, this is an indication that the aluminum and/or phosphorus coating on the Scintillator is deteriorating. When the SPOT SIZE control has to be positioned past 11 o'clock, in the counter-clockwise direction to maintain a sufficient noise free signal, it is an indication that the efficiency of the Scintillator is deteriorating. Rotating the SPOT SIZE control counter-clockwise increases the Electron Beam Spot Size which results in a decrease in resolution. When any of the above mentioned symptoms occur, the Scintillator must be changed to regain optimum performance.

2. Admit air into the instrument as per the VACUUM SYSTEM OPERATION procedure. Turn the STAGE CLAMP knob on the Specimen Chamber to the UNCLAMP position.

3. Referring to Figure 33, slide back the rubber light shield (located at the end of the Preamplifier) toward the Photomultiplier cover until the two Preamplifier set screws are exposed. After loosening these two screws, carefully pull out the Preamplifier from the Photomultiplier cover. The preamplifier and the Photomultiplier can be removed as an assembly and set aside.

4. After loosening the four detector set screws, remove the detector. Be careful not to bump the internal parts of the detector against the stage opening. Remove the Collector Mesh from the Light Guide (note the distance between the Mesh and the Scintillator) and remove the Scintillator Cap from the Light Guide. Remove the Scintillator without contaminating the Scintillator Cap or the Light Guide with fingerprints or dust. It is recommended to use vinyl gloves.

5. With the coated aluminum surface kept toward the sample, mount a new Scintillator on the Light Guide. Place a small drop of silver conducting paint on the inner edge of the Scintillator Retaining Ring to make contact between the Scintillator and the retaining ring. Also, be sure the conductive paint has thoroughly dried before installing the detector.

Attach the Collector Mesh to the mount on the Light Guide, always being careful not to contaminate the parts with fingerprints or dust. Blow with Freon gas, etc. to remove dust. Carefully insert the Preamplifier and the Photomultiplier into the Photomultiplier Cover as far as it will go, and then tighten the set screws in the Preamplifier. Slide the light shield back in place.

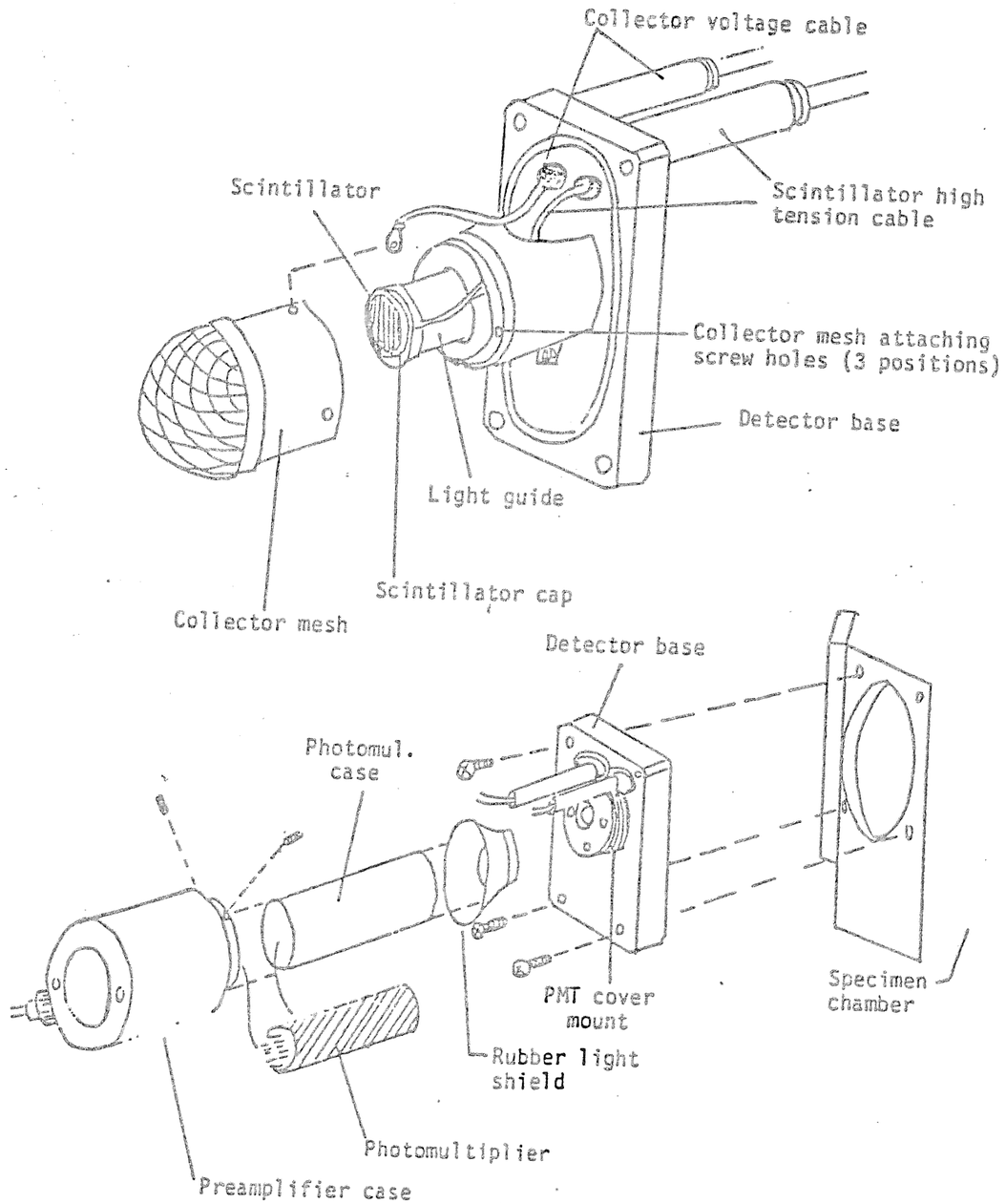
6. Evacuate the instrument referring to the VACUUM SYSTEM OPERATION procedure.

   NOTE: If the pumping speed is too slow, foreign material is adhering to the Vacuum Gasket on the detector base. Do not clean the surface of the Scintillator with reagent or wipe with a cloth. When foreign materials adhere to the surface, remove with air stream, etc. Do not clean the Light Guide (made of acrylic resin) with any type of reagent. Use a soft piece of gauze, taking care not to damage or scratch the end surface.

7. To check the Scintillator high voltage contact, turn the instrument on and leave the EMISSION control in the counter-clockwise position. Adjust the brightness to an acceptable level and turn the CONTRAST control CW. If proper high voltage contact has been made to the Scintillator, no noise (bright spots) should appear on the CRT until the CONTRAST control is in the 2-3 o'clock position. Should noise appear before this position is reached with the CONTRAST control, a problem with the high voltage contact to the Scintillator is indicated.

   NOTE: If contact between the Scintillator and the Ring is causing the problem, a small drop of silver conducting paint at the aluminum/ring interface is recommended. Do not allow silver paint to come in contact with the Light Guide, as damage may result from the solvent in the silver paint.

Fig. 33


Collector voltage cable
Scintillator
Scintillator high tension cable
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

26. MAIN SPECIFICATIONS

1. Resolving power	60 Angstrom (guaranteed), (Acceleration voltage: 30KV at 8mm of working distance)
2. Magnification	X10 to X200,000 (24 steps selectable) provided with zoom of X1 to X3 provided with automatic digital magnification indicator
3. Acceleration voltage	30KV, 20KV, 10KV, 5KV, 2KV (5 steps selectable) provided with digital high tension indicator
4. Electron gun	Tungsten hair pin type filament (Cartridge replacing system)
Cartridge	2 kinds (high brightness, long life)
Filament heating	Preset and manual control
Alignment	Mechanical and Electromagnetic
. Electro-optics system	
Lens	Magnetic field type, 3 step contraction
Objective lens aperture	200μØ, fixed provided with auto-focus
Dynamic focus	-10° to +70°, tilt correction possible
Astigmatism correction	Electromagnetic system, 8 poles provided with STIG. MONITOR
6. Specimin device and specimen chamber	
Specimen size	Max. 150mmØ x 10mm thick
Specimen shift	X: 80mm,. Y: 37.5mm (motor driven)
Specimen tilt	T: -10° to 90°, continuous
Specimen rotation	R: 360°, continuous
Specimen vertical shift	Z: 57mm (WD: 8mm to 65mm)
Specimen current measuring terminal	BNC conntector 1 pc
Feed through terminal	50 pins (option)

7. Signal detecting mode	Secondary electron and back scattered electron
8. Observation and photographing	Visual —— 12 type CRT (green) 1 pc Photo —— 8 type CRT 1 pc High resolving power, Non-persistent afterflow type.
9. Scanning mode	Photo mode 1 80sec/frame Photo mode 2 160sec/frame Visual mode 1 1.6sec/frame Visual mode 2 0.06sec/frame Reduced Area mode 0.16sec/frame provided with wave form monitor
10. Analysis mode	Spot mode X, Y positions variable Line mode Y position variable Line profile mode
11. Photographing indicator	LED indication (set at reduced area)
12. Auto-contrast/brightness	Built in
13. Film numbering	3 figure digital indication, provided with zero reset
14. Photographing data print	Acceleration voltage, magnification, micro-scale, film number
15. Meter indication	Vacuum/Emission (current two way selectable)
16. Electromagnetic type image image shift	X, Y: $\pm$ 20μm

17. Dual Mag (option)

Magnification ratio of high & low magnification image 1/1, 1/2, 1/5, 1/10 (4 steps selectable)
Magnified image position indicator.
Image position indicator is displayed on low image.
Magnified image selection
Magnified observation is possible selecting optional position of low magnified image display
Simultaneous indication of different images

18. Evacuation system

Fully automatic motor driven system
Safety device for Electric power suspension
Cooling water suspension
Decreased vacuum

19. Installation requirement

Power supply	Single phase 100V (95 to 105V) 50/60 Hz, 1.7KVA
Ground	3rd class ground (grounding resistance: less than 100 ohms
Cooling water	Flow rate: 1 to 1 1/2 liters/min. Pressure: 14.2 lbs/sq. in., or more Faucet: O.C. 9mmØ, Drain: I.D. 15mmØ or more
Electric field noise intensity	Less than 10mV/m
Magnetic field noise intensity	Less than 3 milli oersted
Room temperature	20° ± 5° C
Humidity	Less than 60%
Floor vibration	Full amplitude: 5μm (3Hz), 0.5μm (30Hz)

20. Standard component

Main body	1 set	
Oil rotary pump	1 set	
Standard accessories	1 set	(Details pg. 80)
Operational manual	1 set	

24. STANDARD ACCESSORIES

1.	Electron gun cartridge (high brightness)	2 pcs.
2.	Electron gun cartridge (long life)	1 pc.
3.	Filaments	5 pcs.
4.	Anode, sleeves (3 sleeves, 4 aperture holders, 5 aperture holders)	1 set
5.	Aperture (1mmØ)	13 pcs.
6.	Objective lens aperture (200μØ)	4 pcs.
7.	Objective lens aperture stop	1 pc.
8.	Objective lens aperture holder	1 pc.
9.	Specimen holder (15mmØ)	1 pc.
10.	Specimen holder (32mmØ)	1 pc.
11.	Specimen holder (3"Ø)	1 pc.
12.	3" and 4" Ø wafer holder	1 pc.
13.	5"Ø IC wafer holder	1 pc.
14.	6"Ø IC wafer holder	1 pc.
15.	Clips for IC wafer	5 pc.
16.	Connector for specimen current measurement (BNC-P-55U)	1 pc.
17.	Connector for grounding	1 pc.
18.	Tool for objective aperture holder removal	1 pc.
19.	Tool for objective lens aperture removal	1 pc.
20.	Filament alignment jig	1 pc.
21.	Tweezers	1 pc.
22.	Watchmaker's screwdriver (#1-6)	1 set
23.	Water hose	20 m
24.	Hose clamps (inner diameter: 16mmØ)	4 pcs.
25.	O-ring (for detector port, 1516-G7)	2 pcs.
	O-ring (for electron gun chamber, 1516-G12)	1 pc.
	O-ring (for specimen chamber)	1 pc.
26.	Accessory container	1 pc.
27.	High voltage insulating oil (3.5 L)	1 can
28.	Blank cover for electron gun chamber	1 pc.

NOTE: The quantity includes the standard items provided with the basic instrument.