Instruction Manual

for

MODEL S-450
SCANNING ELECTRON MICROSCOPE

Part No. 531-E250
YT-Y (MT-LT)

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MODEL S-450

SCANNING ELECTRON MICROSCOPE

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PRECAUTIONS ON HANDLING

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

1. PRECAUTIONS FOR TRANSPORT

(1) Do not lift the instrument by holding the table. The strength of table fitting is not sufficient for bearing the weight of display unit, approximately 200 kg. Should the table be lifted, the display unit might slip off and crash. Hence, it is recommended not to exert force to the table for transport.

(2) The housing supports should be fitted correctly by fixture before transport.

2. PRECAUTIONS FOR POWER CONNECTION

(1) When removing the front, rear and top covers of housing and display unit, turn off the AC power without fail. The high voltage circuit within the unit constitutes a shock hazard.

(2) Connect the grounding wire correctly. Otherwise, not only will the instrument fail to operate normally but there is a shock hazard.

(3) Avoid touching the connector of high voltage unit and the cable head of high voltage transformer. The high voltage unit and the high voltage transformer are at voltages as high as 10 ~30 kV, so handling of dangerous parts such as high voltage connector and cable head should be left to the servicemen.

(4) Do not touch the areas marked DANGER. These areas are applied with high voltage.

(5) Do not touch the rear of cathode-ray tube. The cathode-ray tube is applied with 10 kV.

(6) When replacing a fuse, turn off the main switch on the distribution board, and make sure that the AC power supply is cut off. If not, AC power line near the fuse box may cause shock.

(7) When replacing the scintillator, turn off the main switch on the distribution board, and make sure that the AC power supply to the display is cut off. Some parts around the scintillator may be carrying high voltage (approx. 10 kV).

(8) Allow interval of at least five seconds between turning on or off of the [EVAC], [DISPLAY] main switch and [EVAC] [AIR] switch.

(9) Replace the oil filter of the oil-sealed rotary pump every six months.

(10) Set the specimen goniometer knobs for specimen replacement to X = +20, Y = +20, Z = Z number and T = 0.

(11) Don't touch the alignment screw of the column except gun alignment screw.

(12) When observing at magnification lower than 100x, set WD ≦ 15 mm and select notch [3] (200 μm) or [4] (100 μm) of the objective lens aperture.

3. GENERAL PRECAUTIONS

The maintenance items other than those described in this manual should be left to the servicemen.

4. MEASURES FOR EMERGENCY CASE

(1) Turn off the main switch on the distribution board.

(2) If water is leaking, close the valve of cooling water to cut off the water supply.

(3) After taking steps (1) and (2), carry out other suitable measures.

(4) Inform the service shop.

5. SPECIMEN IRRADIATING CURRENT

Table 2-2 in the instruction manual indicates the summary of specimen current vs. condenser lens switch setting. It should be noted that the specimen irradiating current changes greatly with the filament setting condition and/or objective aperture diameter.

6. DYNAMIC FOCUS

Set up the following conditions to place the dynamic focus in operation.

(1) Set the WORKING DISTANCE switch on the operation panel to 3.

(2) Set the FOCUS COARSE knob  to the middle point by turning it 5 revolutions from the minimum end.

(3) Tilt the specimen at a large angle.

(4) Operate the Z control of the specimen stage to make rough focusing of the image.

(5) Focus the image on the CRT center (vertically) with the FOCUS knobs  .

(6) Turn gradually the AMPLITUDE knob clockwise from the minimum end so that the image becomes in focus over the full range of CRT.

Notes:

1. Dynamic focus cannot be adjusted correctly when the scan speed is set at  or  position. Use it with the scan speed set at  ,  or  position.
2. The magnification and the dynamic focus do not interlink with each other. Readjustment is required when the magnification is changed.
3. Operate the specimen stage within the range described in the instruction manual because it is limited by specimen size and tilt angle.

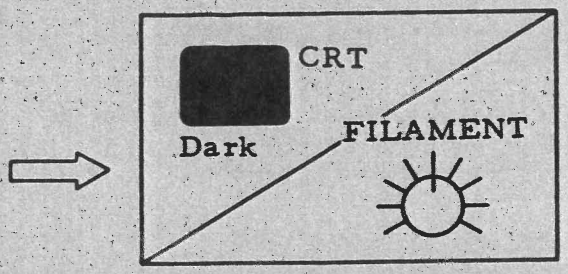
7. FOCUS MONITOR

When the focus monitor is used in combination with the auto data display unit (S-5006A) and the BACKGROUND switch is at BLACK position, the waveform on the CRT may sometimes disappear. However, this phenomenon is not a failure of the instrument.

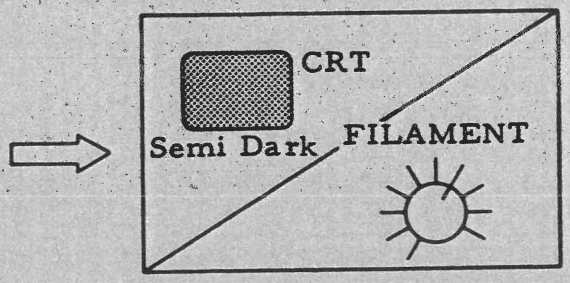
8. SETTING OF FILAMENT SATURATION POINT

Turn the FILAMENT control gradually clockwise while watching the EMISSION CURRENT meter (color bar). When the color bar (illumination) does not fluctuate any more, stop turning the control and return it by half a division.

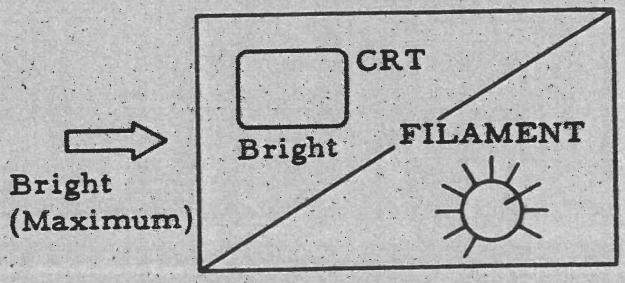
o FILAMENT unsaturation point



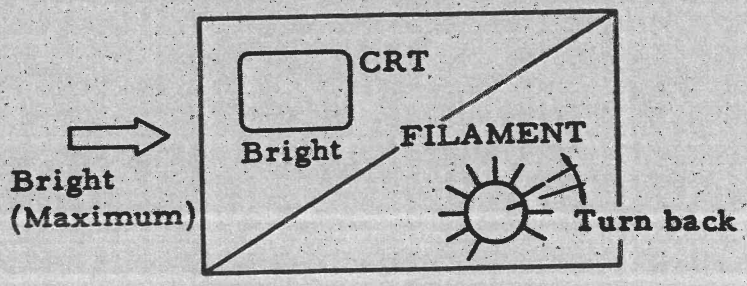
o FILAMENT unsaturation point



o Maximum brightness ... FILAMENT saturation point

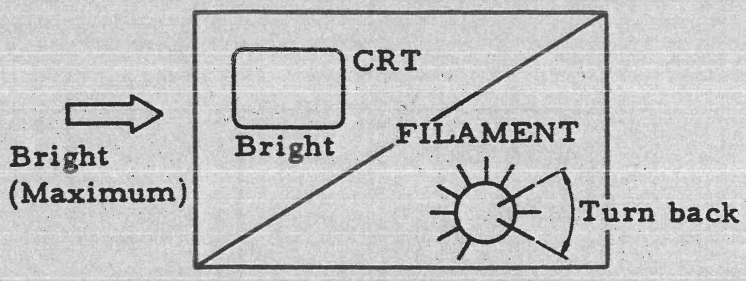


o Maximum brightness ... Turn the filament control counterclockwise by half a division from the stable point of color bar.



o Maximum brightness ... Filament may be burnt out due to overheating.

Turn the filament control counterclockwise to the saturation point.



9. OTHERS

Keep the instrument installation room under the following conditions even if non-operating the instrument.

Room temperature : 5 ~ 35°C (This is also applicable to the DP cooling water temperature.)

Humidity : Less than 70 %

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

SPECIFICATIONS

1. Standard Specifications

o Resolution	:	60 Å guaranteed
o Magnification range	:	20 ~ 200, 000x, 1 ~ 3x zooming
o Electron optical system		
Filament	:	Pre-centered hair-pin type filament
Bias	:	Auto bias system
Beam current	:	200 μA max.
Accelerating voltage	:	2, 3, 4, 5, 10, 15, 20, 25, 30 kV
Lens system	:	3-stage reduction system
Stigmator	:	8-pole electromagnetic system (X, Y)
Deflection coil	:	2-stage electromagnetic deflection system
Objective lens aperture	:	Movable aperture (0.1, 0.2, 0.3, 0.4 mm dia. openings)
o Specimen goniometer stage		
X-movement	:	0 ~ 40 mm (continuous)
Y-movement	:	0 ~ 40 mm (continuous)
Tilting angle	:	-20 ~ +90° (continuous)
Rotation angle	:	360° (continuous)
Z-movement	:	5 ~ 35 mm (semi fixed) : Working Distance (=WD)
Specimen size	:	102 (4") mm dia. x 6 mm H (max.), 15 mm dia. x 10 mm H (max.)
Specimen exchange	:	Draw-out system
o Display unit		
CRT	:	Viewing CRT (Afterglow type 150 x 135 mm) x 1
		Photographing CRT (Non-afterglow type 120 x 90 mm) x 1
Scanning speed (Raster scan)	:	For viewing X : 0.12 ~ 40 msec
		Y : 0.025 ~ 40 sec
		For photographing X : 20 ~ 160 msec (50 Hz) 17 ~ 166 msec (60 Hz)
		Y : 50 ~ 400 sec (50 Hz) 40 ~ 420 sec (60 Hz)

Electrical image shift	:	±25 μm (X, Y) at 30 kV and WD = 30 mm
o Scanning mode	:	Full frame rapid scan
		Slow scan
		Photo scan
		Reduced area rapid scan
o Image mode	:	Dynamic focus
		Focus monitor
		Stigma monitor
		Auto brightness
		Polarity reverse
		Gamma control
o Evacuating system		
System	:	Fully automated, solenoid valve control system
Vacuum gauge	:	Pirani gauge x 1
Ultimate vacuum	:	5×10^{-6} Torr
Vacuum pump	:	DP 400 ℓ/sec x 1, RP 160 ℓ/min x 1
Evacuating time (For specimen exchange)	:	About 3 min.
o Safety device	:	Safety devices for power interruption, water supply interruption, and vacuum deterioration are provided.
o Power supply	:	115, *200, *208, *220 or *240 V AC ± 10 %, 50/60 Hz, 2.5 kVA
		Power consumption : 1.8 kVA
		* For 200, 208, 220 and 240 V area, an auto-transformer is required.
o Water facilities		
Flow rate	:	2 ~ 4 ℓ/min (0.5 ~ 1 gpm)
Water pressure	:	0.5 ~ 2 kg/cm^2 (7 ~ 29 psi)
Water temperature	:	10 ~ 25°C (50 ~ 77°F)
Water supply port	:	x 1, outer dia. of faucet 10 mm dia. (city water hose should be connectable)
Drainage	:	Natural drainage (It is recommended to use a filter in case of water containing much fur and impurities.)

o Ambient conditions

Temperature : 15 ~ 30°C (59 ~ 86°F)

Humidity : Less than 70 %

Stray magnetic field (at the installation site):

		DC component[1]	AC Components[2]		
			Same frequency component as that of the AC line supplied to the Model S-450		Different frequency component from that of the AC power supply used in the Model S-450
Condition	Mode & scan speed		Observation ▽▽, ▽, □	Under conditions other than mentioned at left.	
			Photographing All SCAN SPEED settings		
Maximum allowable magnitude		50 mG	5 mG	0.6 mG[3]	0.6 mG
Maximum allowable fluctuation[4]		1 mG/ 5 min	1 mG/ 5 min	0.3 mG/ 5 min	0.3 mG/5 min

Notes : 1) The components due to terrestrial magnetic field are excluded from the values.
Terrestrial magnetic field in Japan :

Horizontal component : 300 mG

Vertical component : 350 mG

2) All values of AC components are effective values.

3) If this value is less than 2 mG, it may be left out of consideration when observing intensity-modulated images.

4) AC and DC stray magnetic field fluctuation is defined as varying monotonously and gradually with time lapse. Thus, magnetic field fluctuation with pulse or step waveform should not occur.

o Dimensions

Main console : 610 (W) x 620 (D) x 1500 (H), 172 kg

Display : 1100 (W) x 750 (D) x 1160 (H), 120 kg

Rotary pump	:	200 (W) x 478 (D) x 293 (H) x 1, 27 kg x 1
Weight	:	200 (W) x 180 (D) x 160 (H), 40 kg
* Cold trap	:	Optional accessory

2. Standard Equipment

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

Section 1

FUNCTIONS

1-1 CONTROL KNOBS AND SWITCHES OF DISPLAY UNIT

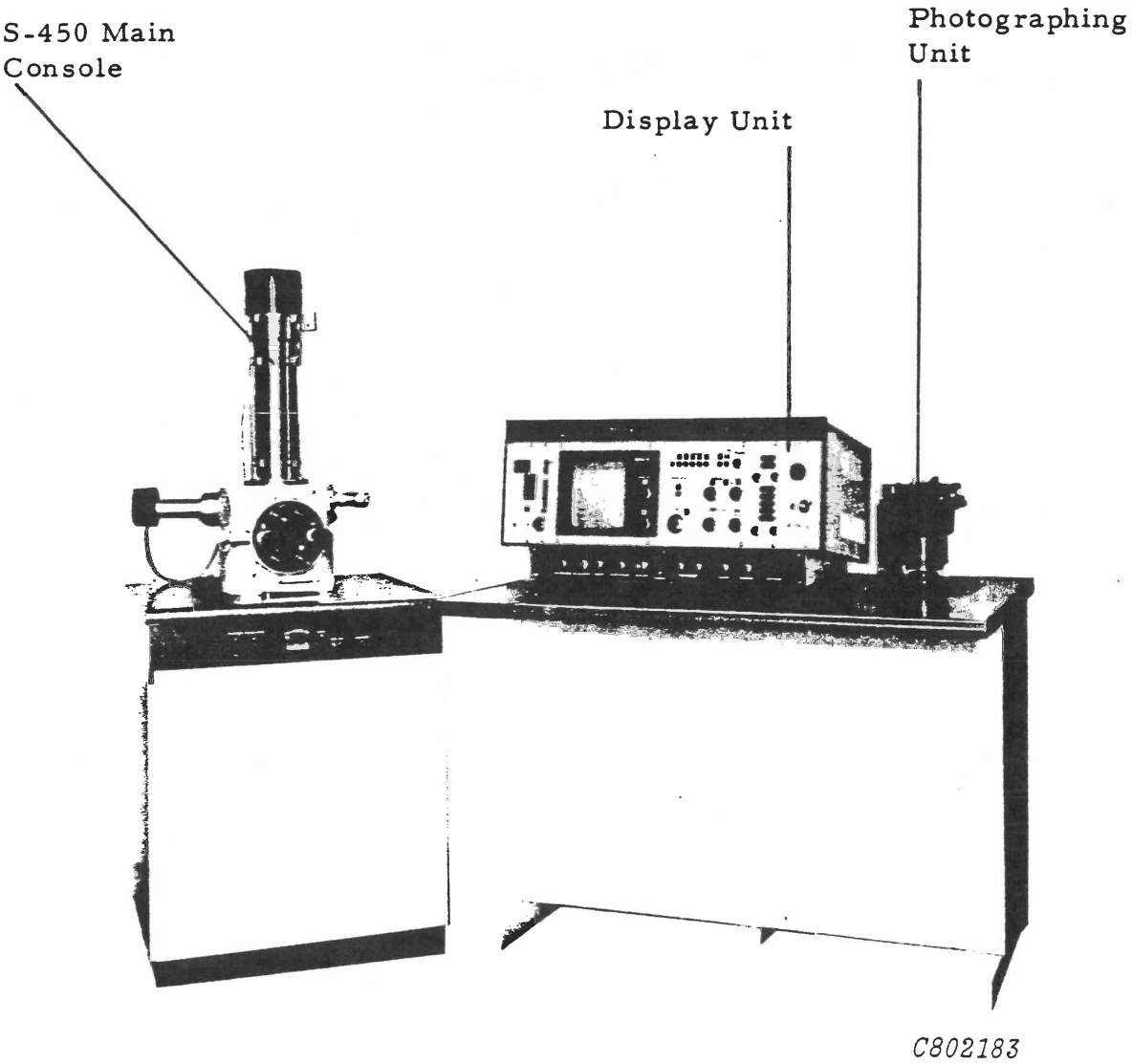


Fig. 1-1 Outer View of Model S-450 SEM
(inclusive of optional accessories)

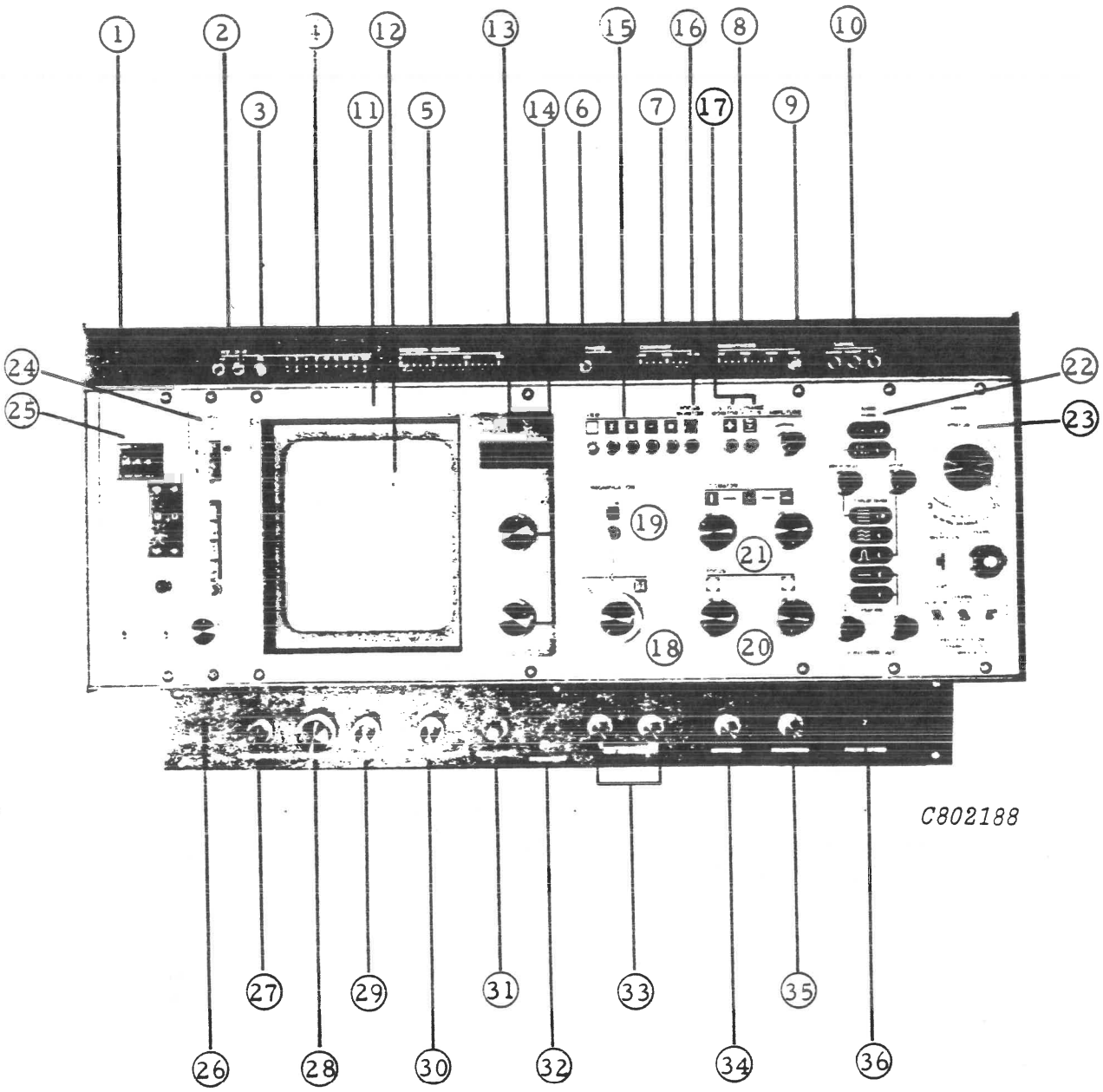


Fig. 1-2 Display Unit (including some optional accessories)

① Display Panel

② [HV (kV)] [ON] [OFF] : High voltage ON-OFF switch

③ [SE] : Post-accelerating voltage ON-OFF switch

ON ..... Secondary electron image (SE)

OFF..... Back-scattered electron image (BSE)

④ [2 ~ 30] : Accelerating voltage indicator

⑤ [EMISSION CURRENT] : Emission current color bar indicator

⑥ [PHOTO] : Photographing switch

⑦ [CONTRAST] : Contrast color bar indicator

⑧ [BRIGHTNESS] : Brightness color bar indicator

⑨ [AUTO] : Automatic brightness control switch

⑩ [SIGNAL] : Signal processing switches

[GAMMA] : Gamma control switch

[INVERT] : Polarity inverting switch

[EXT] : External signal switch (e. g. x-ray signal)

⑪ Main Control Panel

⑫ : Viewing CRT

⑬ [MAGNIFICATION] : Magnification indicator (digital)

⑭ [IMAGE SHIFT] : Electric field moving control

⑮ [VIEW] : Scanning mode selector switch

[□] : Full rapid scan

[▽▽] : Slow scan

[▽▽] : Slow scan

[▽] : Slow scan

[□] : Rapid scan (reduced area)

⑯ [FOCUS MONITOR] : Focus monitor switch

⑰ [STIG MONITOR] : Stigma monitor switch

[DYNAMIC FOCUS] : Dynamic focus switch

⑱ [COARSE-FINE] : Magnification selector

COARSE (outer knob) ..... Stepwise

FINE (inner knob) ..... Continuous

⑲ [LOW] : Quick low magnification selector

⑳ FOCUS : Focus control knob

㉑ STIGMATOR : Stigmator knob

㉒ X-RAY MODE UNIT : (For x-ray analysis, option)

㉓ RASTER ROTATION/ DYNAMIC FOCUS/TILT COMPENSATION UNIT : (Option)

㉔ SPLIT SCREEN DUAL MAGNIFICATION UNIT : (Option)

㉕ DATA DISPLAY UNIT : (Option)

㉖ Sub Control Panel

㉗ VIEW BRIGHTNESS : Brightness control knob for viewing CRT

㉘ ACC VOLTAGE (kV) : Acclerating voltage selector knob

㉙ FILAMENT : Filament current control knob

㉚ WORKING DISTANCE : Magnification/focus control knob for changing working distance

㉛ COND LENS : Condenser lens current control knob

㉜ STIGMATOR : Stigmator ON-OFF switch

㉝ GUN ALIGNMENT : Electric alignment control knob for gun

㉞ CONTRAST : Contrast control knob

㉟ BRIGHTNESS : Brightness control knob

㊱ PHOTO SPEED : Photographing speed selector switch

1-2 CONTROL KNOBS AND SWITCHES ON MAIN CONSOLE

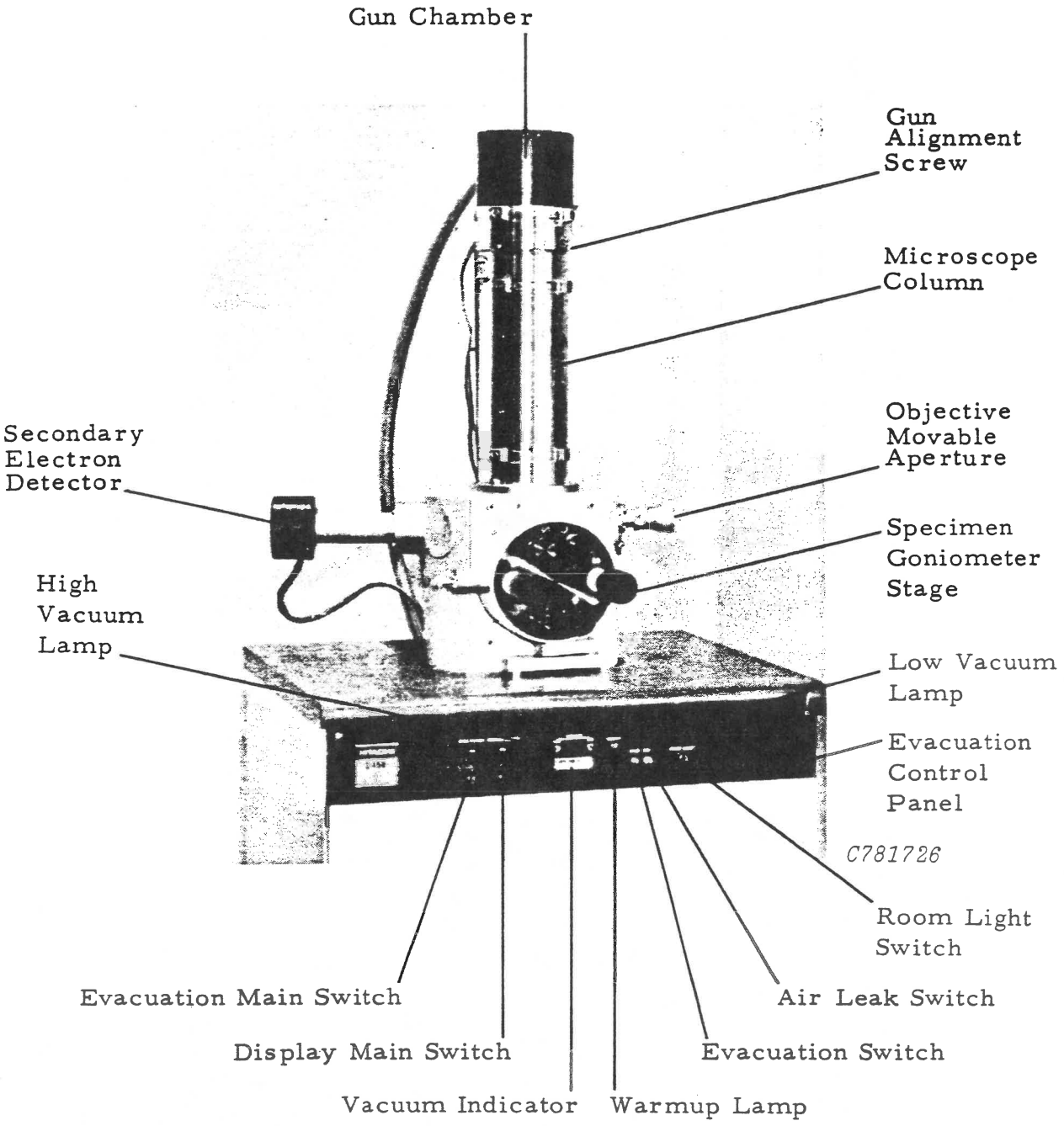


Fig. 1-3 Microscope Column and Evacuating System

(1) Column

(a) Specimen Chamber and Specimen Goniometer Stage

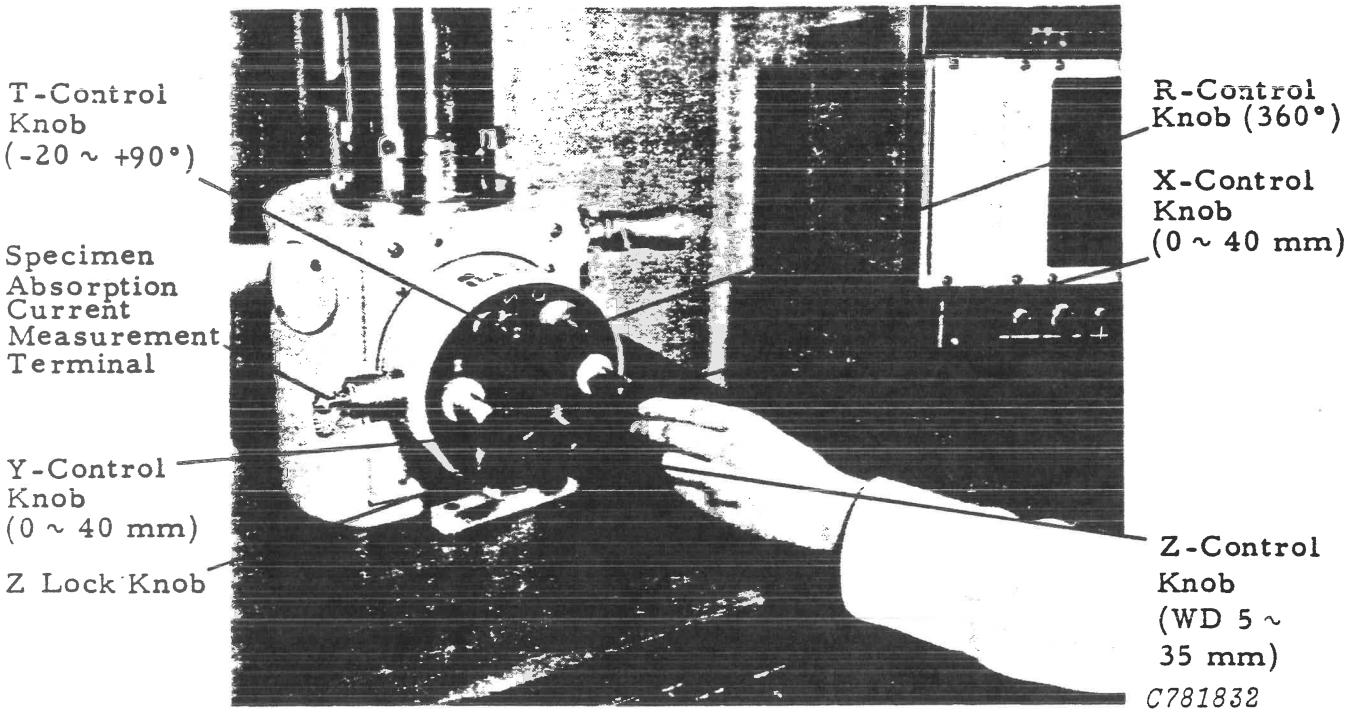


Fig. 1-4 Specimen Chamber and Specimen Goniometer Stage

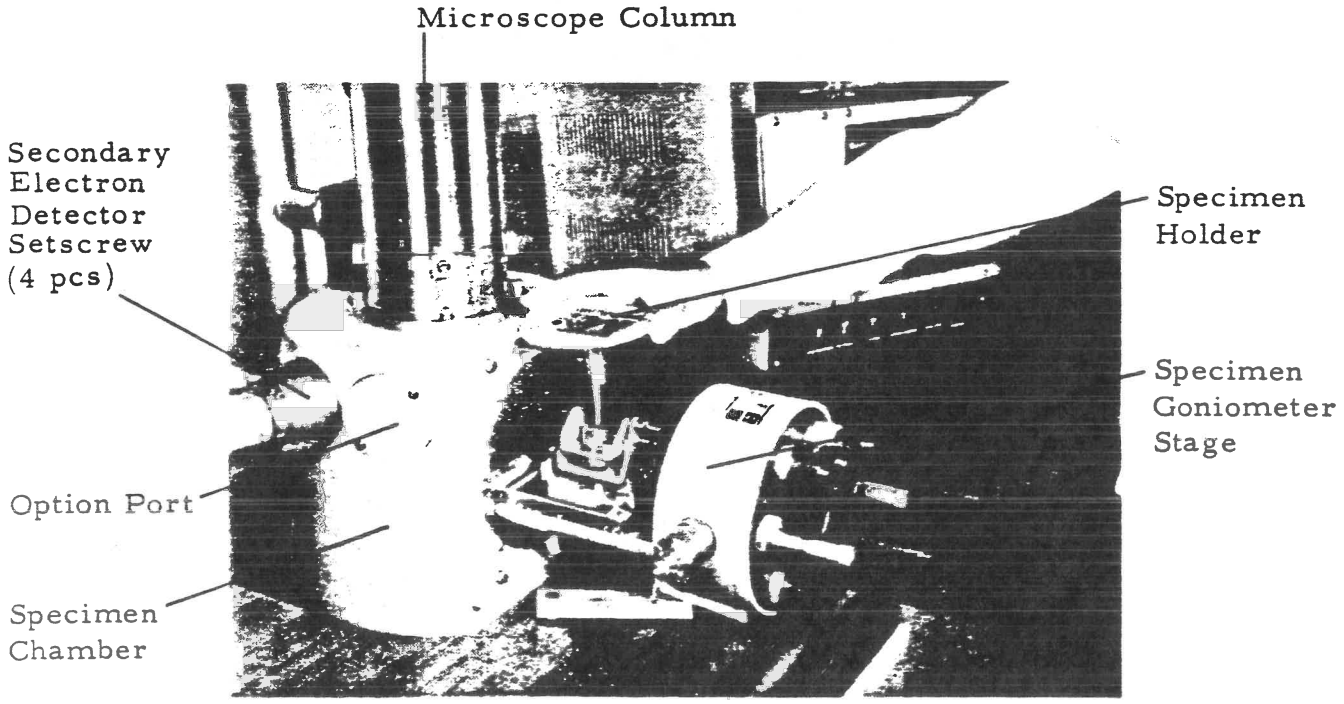


Fig. 1-5 Specimen Chamber and Specimen Goniometer Stage

(b) Column (See Fig. 1-3.)

(2) Ecacuating System

(a) Evacuating System Operation Panel (See Fig. 1-3.)

- o [EVAC] : Pushbutton switch for evacuating the column. When depressing this switch, the column is automatically evacuated until it reaches high vacuum from atmospheric pressure.
- o [AIR] : Pushbutton switch for introducing air into the column. When depressed, air is admitted to the column.
- o [VACUUM] Meter : Meter indicating vacuum degree. It indicates 100 μA under atmospheric pressure and less than 10 μA at ultimate vacuum.
- o [WARM UP] Lamp : Lights when the diffusion pump has not completely reached operating condition (or, when it has not been warmed up completely). It takes about 15 minutes to warm up the diffusion pump from room temperature.
- o [LOW] Vacuum Lamp: Lights when the column is pre-evacuated to low vacuum by rotary pumps.
- o [HIGH] Vacuum Lamp: Lights when the column is evacuated to high vacuum by diffusion pump, and accelerating voltage is applicable.

Note : Don't manipulate the AUTO/MANUAL switch for the evacuation valves in the evacuating system rack.

(b) Block Diagram of Evacuating System

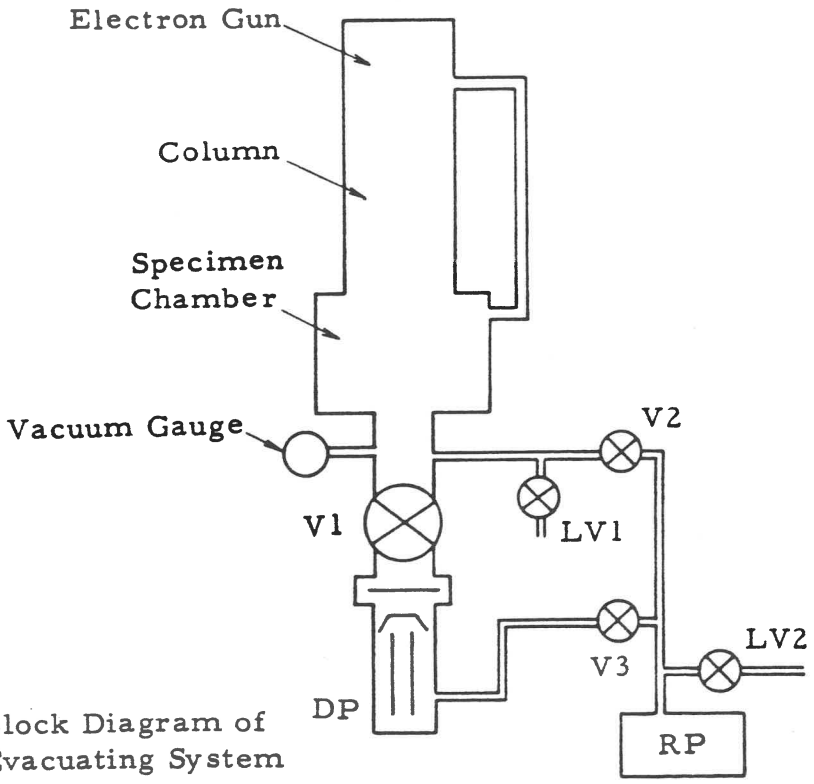


Fig. 1-6 Block Diagram of Evacuating System

Section 2

OPERATION

2-1 PRELIMINARY OPERATION

2-1-1 Evacuation

(1) Turn on the knife switch of the power distribution board in the room.

(2) Run tap water for cooling the oil diffusion pump (DP).

(3) Turn on the [EVAC] main switch. The rotary pump will start operating.

(4) Depress the [EVAC] pushbutton switch.

(5) The automatic evacuation proceeds and ends up in about 20 minutes with the [HIGH] vacuum lamp on.

2-2 OPERATION

2-2-1 Specimen Exchange

(1) Depress the HV (kV) [OFF] pushbutton switch on the display unit.

(2) Set three control knobs of the specimen stage to X = 20, Y = 20, and T = 0°, and the Z-control knob to [EX].

(3) Depress [AIR] switch on the evacuating system control panel.

(4) About 30 seconds later, pull out the specimen stage.

(5) Remove the specimen holder.

(6) Remove the specimen stub for the previous observation from the specimen holder (Fig. 2-1).

(7) Mount a new specimen on the specimen stub (Fig. 2-2).

(8) Fix the specimen stub on the specimen holder (3) securely.

(9) Loosen the specimen holder (1) and (2), adjust the specimen height to the gauge and fasten. Adjustment height depends on specimen stub. For the position, see Figs. 2-3 and 2-4.

(10) Mount the specimen holder assembly on the specimen stage.

(11) Install the specimen stage in the specimen chamber.

(12) Depress the [EVAC] pushbutton switch.

(13) As the [HIGH] vacuum lamp lights up, the evacuation is completed.

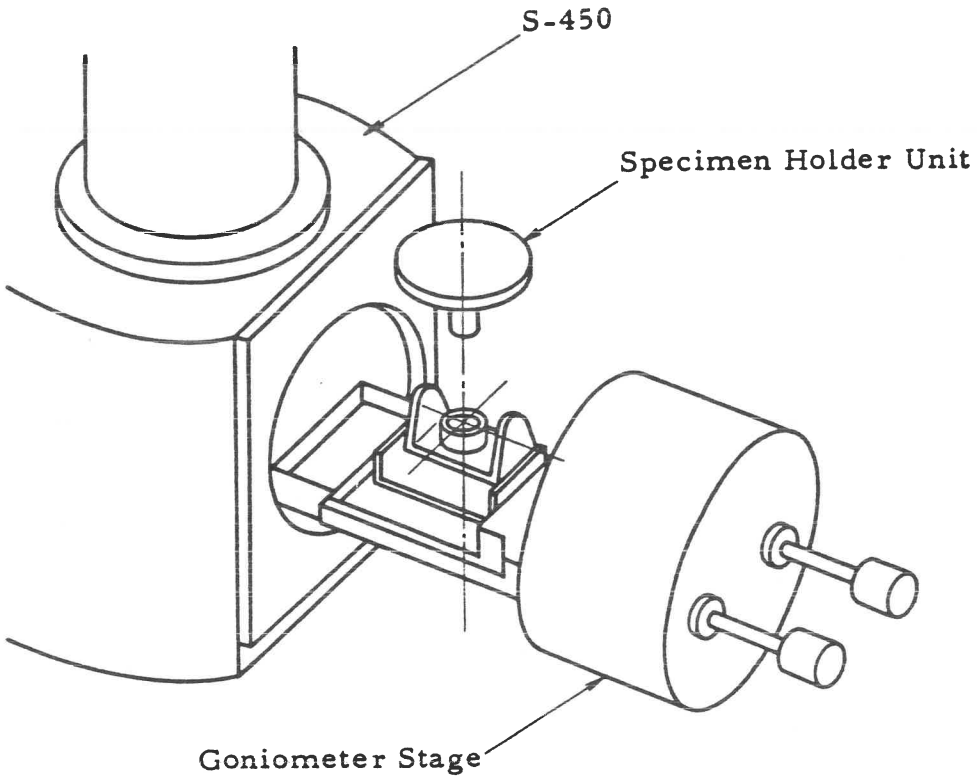


Fig. 2-1 Specimen Replacement

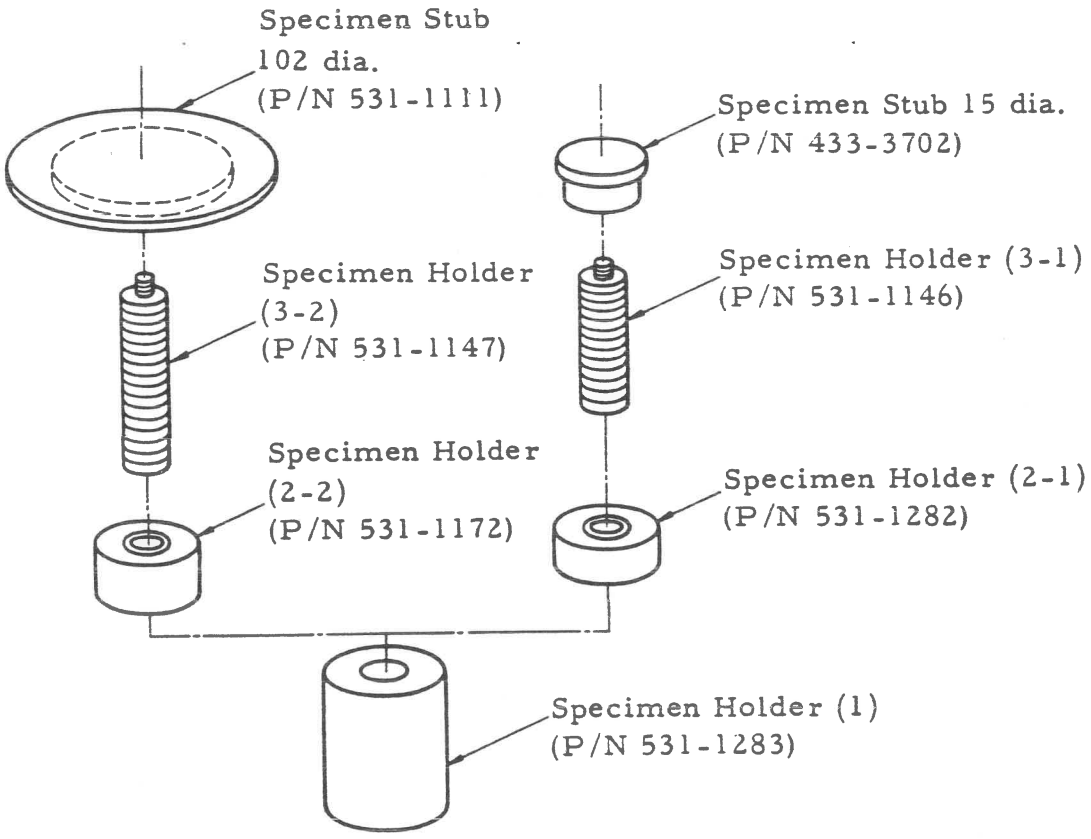


Fig. 2-2 Construction of Specimen Holder and Specimen Stub

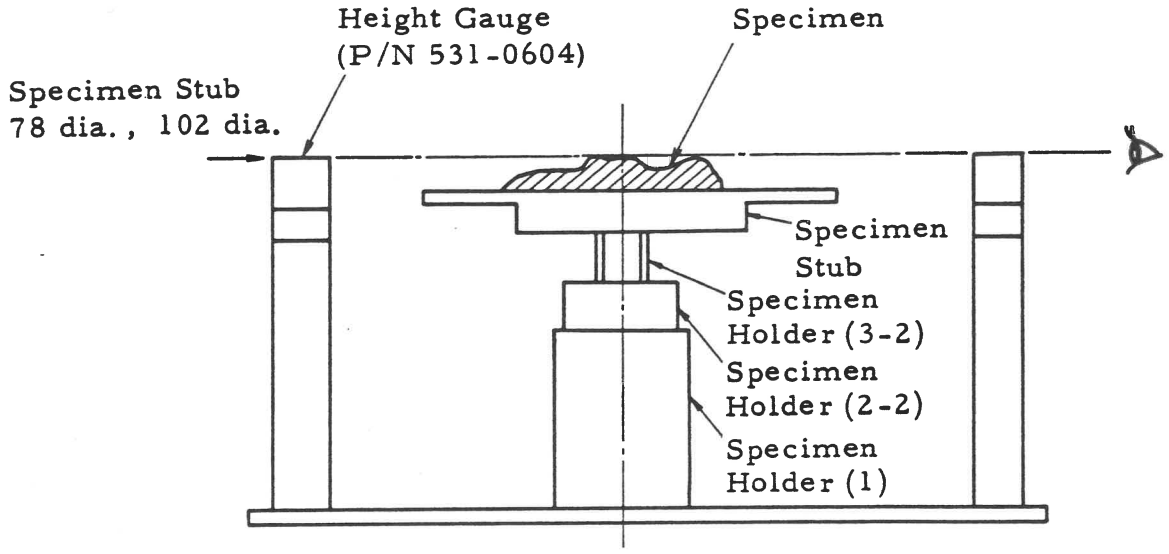


Fig. 2-3 Specimen Height Adjustment (specimen stub 78 dia., 102 dia.)

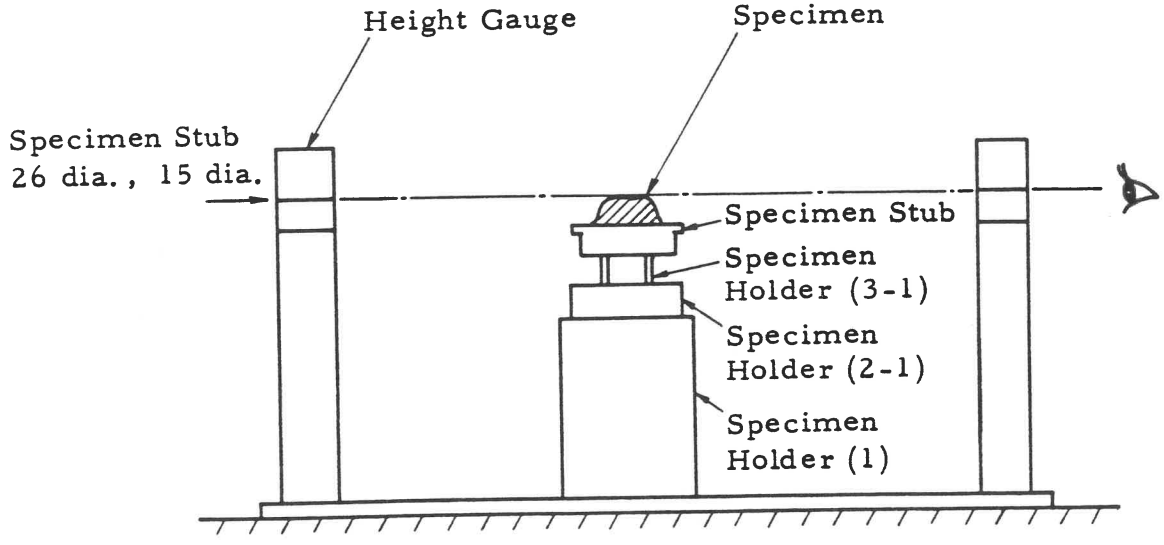


Fig. 2-4 Specimen Height Adjustment (specimen stub 26 dia., 15 dia.)

o Preparation of Specimen and Precautions

(a) The specimen must be completely dried before it is placed under high vacuum. Particularly, the biological specimens which contain much water should be subjected to the critical point drying or freeze-drying process, as the situation requires, following the fixation and dehydration.

(b) Set the dried specimen on to the specimen stub using a suitable specimen fixing paste. Select the best suited fixing paste and method for the particular specimen. Some examples of specimen setting are illustrated in Fig. 2-5. Use a minimum amount of silver paste or the like which contains solvent.

(c) The electrically non-conductive specimens should be coated with evaporation-deposited metal film such as Au, Au + Pd, Pt + Pd. The evaporation mount is shown in Fig. 2-6.

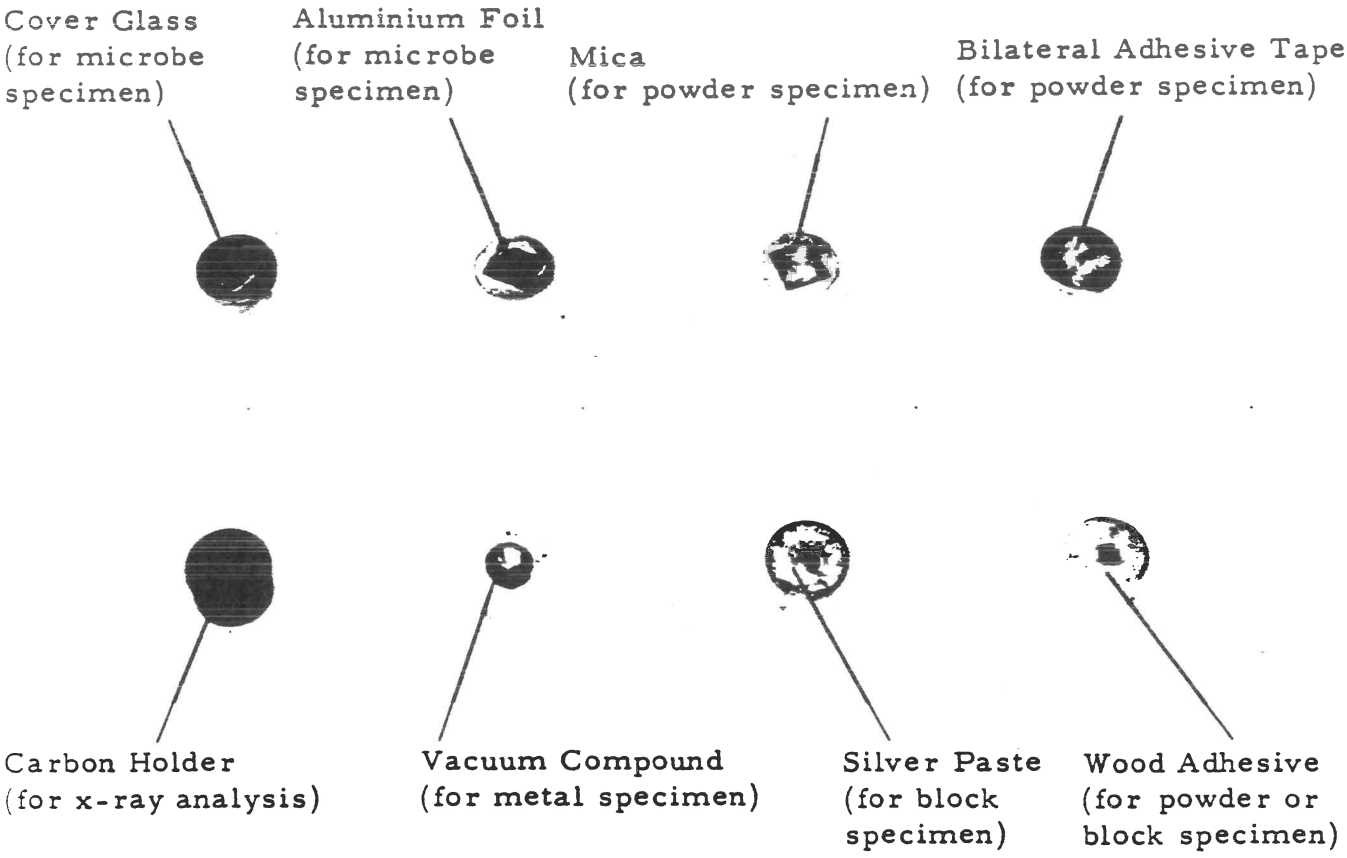


Fig. 2-5 Examples of Specimen Setting on Specimen Stub

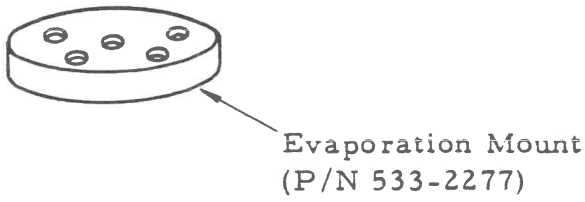


Fig. 2-6 Evaporation Mount

o Restriction of Specimen Height

(a) Standard Specimen Height

Although there may be specimens of different thicknesses, thickness of specimens placed on the standard specimen goniometer of the Model S-450 is specified as follows depending upon the size of the specimen stubs.

Specimen Stub Diameter (mm)	Standard Specimen Thickness (mm)
102	6
78	6
26	10
16	10

WD (distance between lower surface of objective lens and upper surface of specimen) changes with the specimen height, whereby inconvenience will be caused in handling specimen goniometer. Adjust the specimen height according to paragraph 2-2.

(b) Allowable Specimen Displacement Range

(i) Displacement of Specimen in Z Direction and Tilt Angle

Even when the specimen height is set to a standard in paragraph 2-2-1, displacement in Z direction (displacement in specimen height direction) is related with the specimen tilt angle. For example, if a large specimen stub is excessively tilted, it would hit the objective lens. In such a case, the angle should be reduced or the sample position should be lowered.

Figs. 2-8 through 2-11 illustrate specimen sizes, scale Z number* on Z displacement knob, and movable ranges in function of specimen tilt angle θ.

* Indicates working distance (WD) at a specimen tilt angle of 0, or distance between the lower surface of the objective lens and specimen. Take reading of a graduation on the Z-control knob as illustrated in Fig. 2-7 at a standard point corresponding to the particular specimen stub employed.

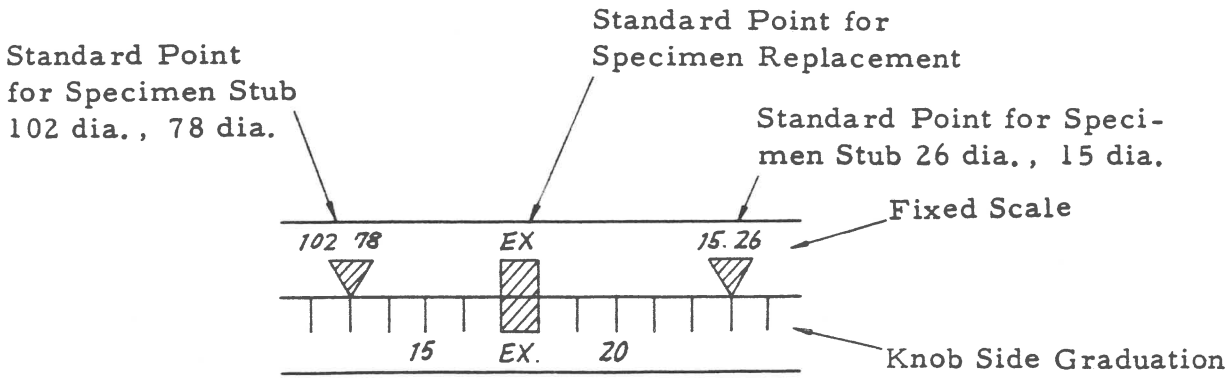


Fig. 2-7 Graduations of Z-Control Knob

15 dia. Specimen Stub

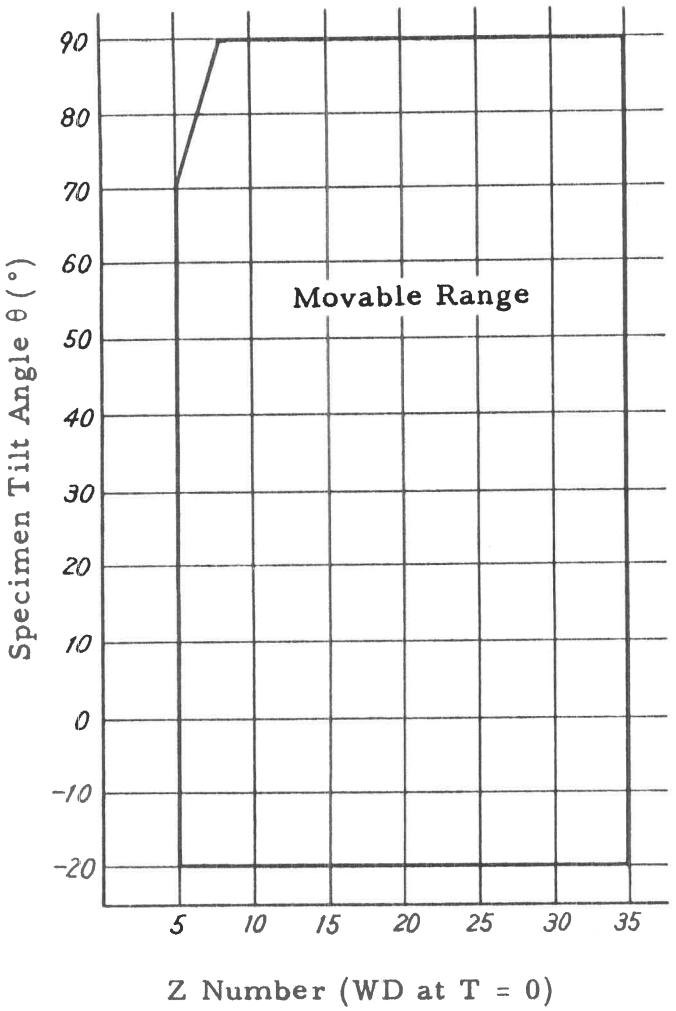


Fig. 2-8 Relationship between Z Number and Specimen Tilt Angle on 15 dia. Specimen Stub

26 dia. Specimen Stub

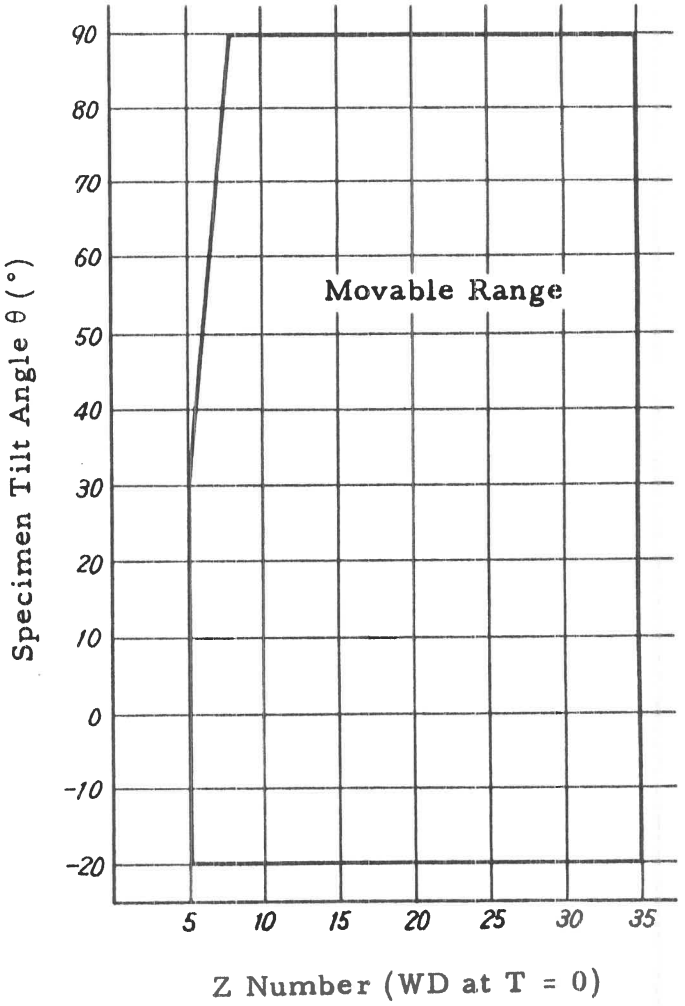


Fig. 2-9 Relationship between Z Number and Specimen Tilt Angle on 26 dia. Specimen Stub

3" dia (78 dia.) Specimen Stub

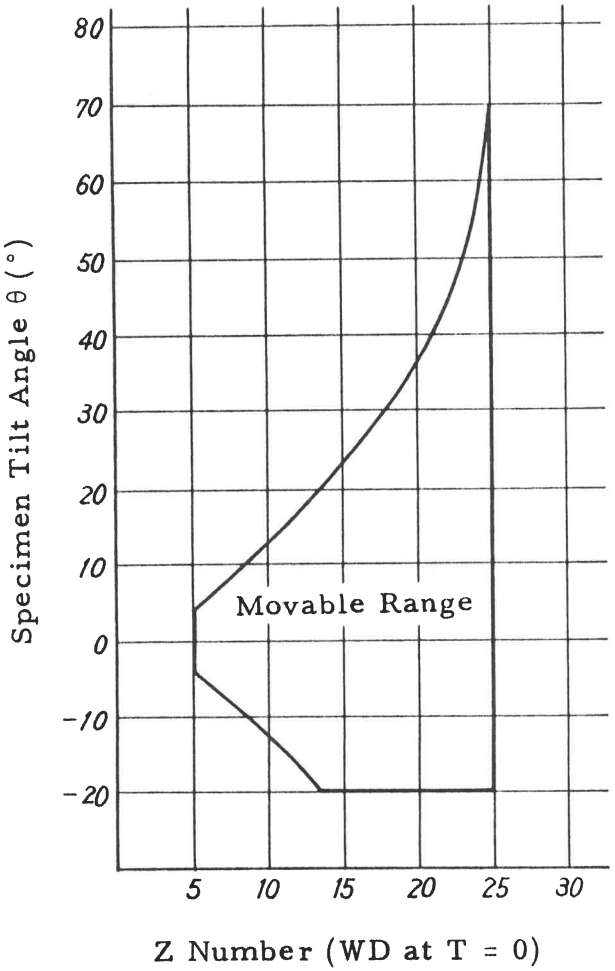


Fig. 2-10 Relationship between Z Number and Specimen Tilt Angle on 78 dia. Speciemen Stub

4" dia. (102 dia.) Speciment Stub

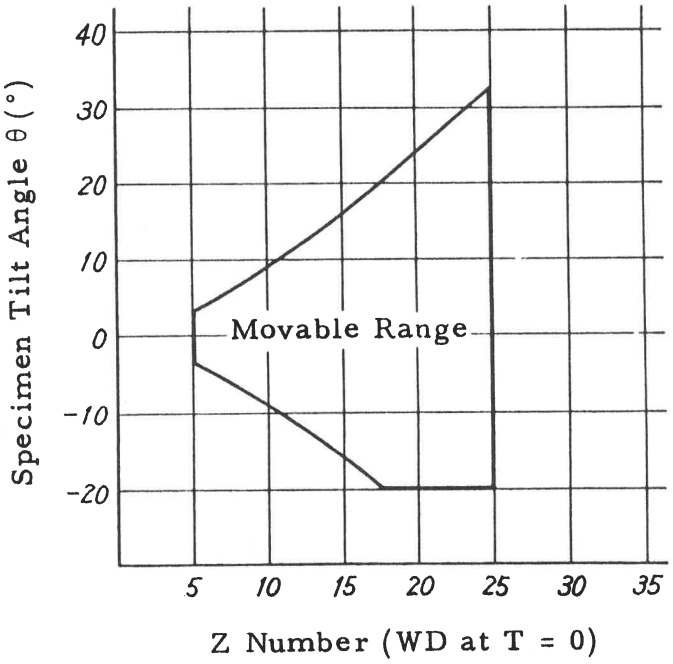


Fig. 2-11 Relationship between Z Number and Specimen Tilt Angle on 102 dia. Specimen Stub

(ii) Horizontal Displacement Range

So long as paragraph (i) is satisfied, displacement is available by up to 40 mm regardless of the specimen stub size.

(c) Special Usage (when specimen is thick)

When the sample is thicker than the standard and the specimen height adjustment carried out in paragraph 2-2-1 is unavailable, obtain a movable range of Z and specimen tilt angle θ. Carry out operation within the obtained range.

(i) Obtain the dimension by which the standard setting height is surpassed.

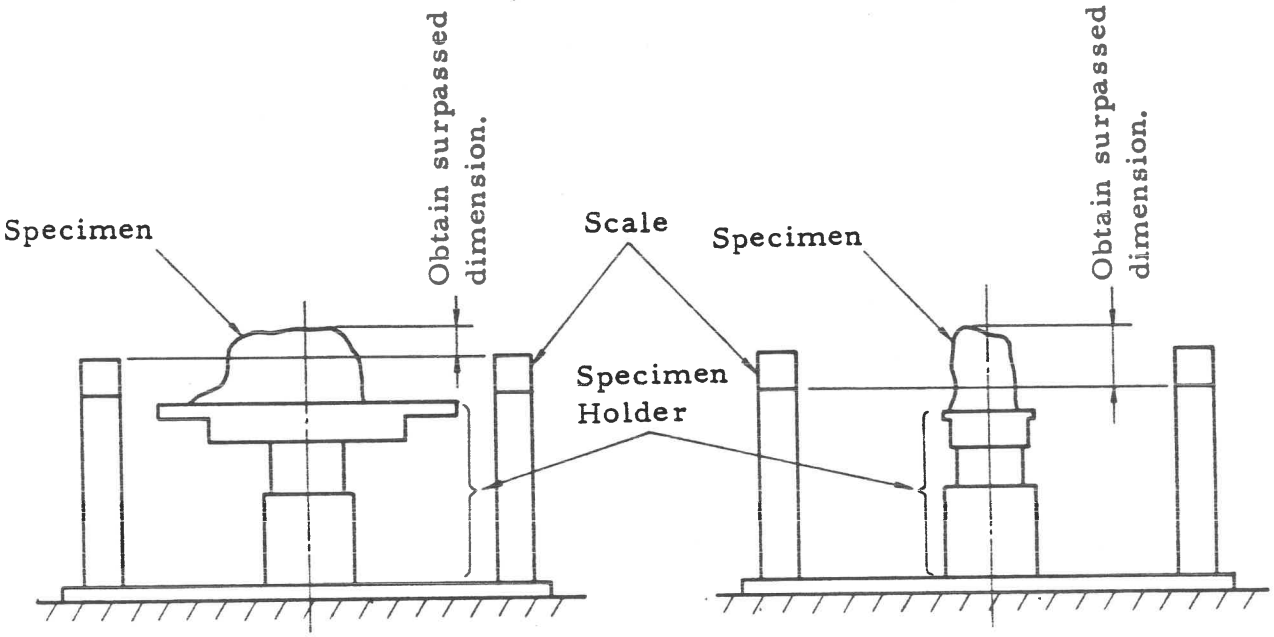


Fig. 2-12 Specimen Height Setting in Special Usage

(ii) Make selection from among Figs. 2-8 through 2-11 according to the particular specimen size.

(iii) Measure by means of the scale the amount by which the standard setting height is surpassed, and apply that value to a corresponding graph.

(iv) Take reading of the allowable range (Fig. 2-13).

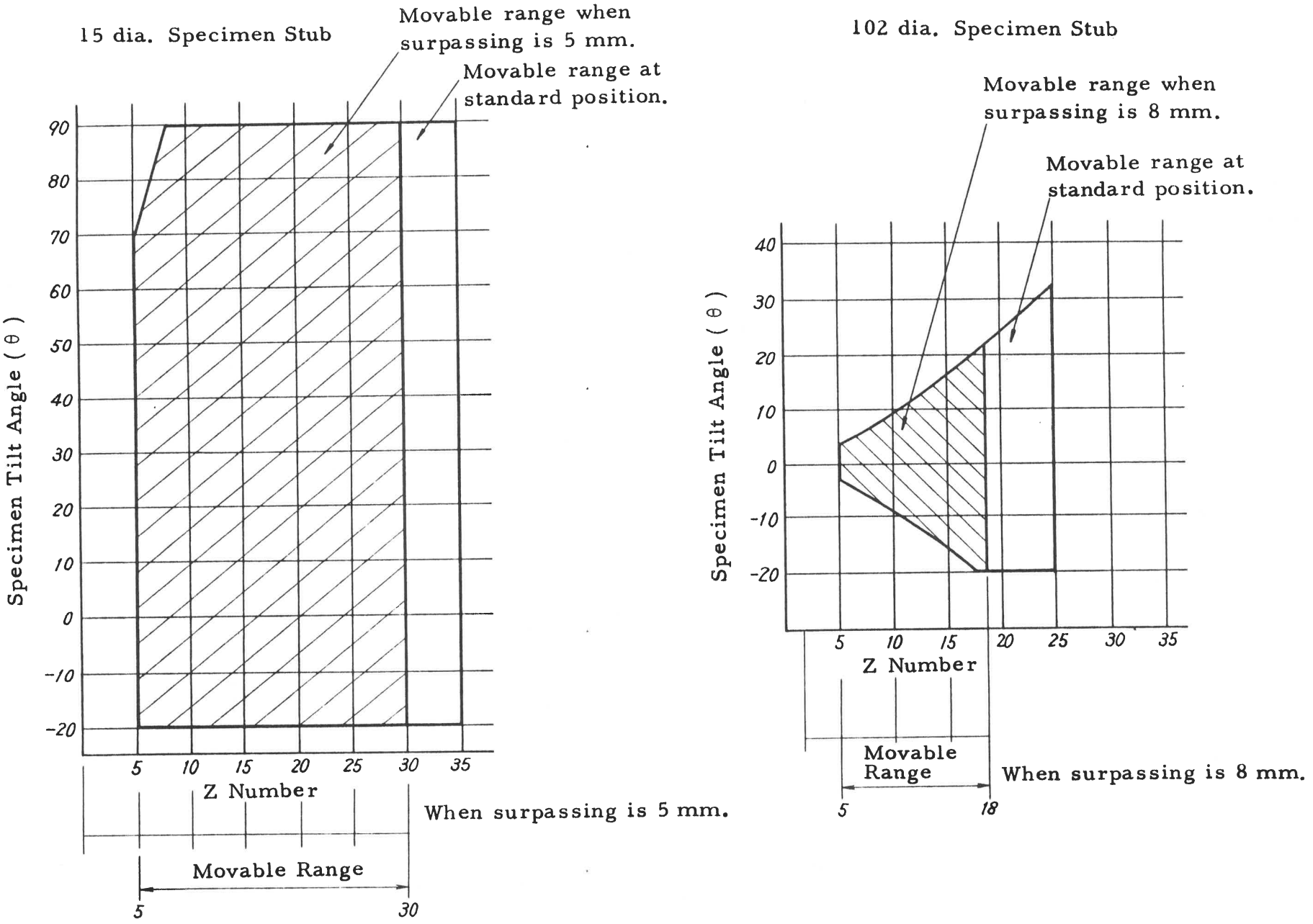


Fig. 2-13 Example of Movable Range of Z and θ when Surpassing Standard Height Seeting

2-2-2 Observation of Secondary Electron Image

(1) Preliminary Operation

Turn on the [DISPLAY] main switch (on the evacuation control panel).

↓

Set the [VIEW] switch at [ ] .

↓

When the raster appeared on the screen of the [VIEW CRT], turn the [VIEW BRIGHTNESS] control knob so as to the CRT brightness to a suitable level.

(2) Setting of Conditions

Set the [WORKING DISTANCE] control knob in accordance with the specimen height.

Position	No. 1 :	WD 5 mm
	No. 2 :	WD 10 mm
	No. 3 :	WD 15 mm
	No. 4 :	WD 25 mm
	No. 5 :	WD 35 mm

Set the [COND LENS] control knob from 3.5 to 4.5.

↓

Turn the [COARSE] knob of [MAGNIFICATION] fully counterclockwise.

↓

Set the [ACC VOLTAGE] selector to, say, 20 kV.

↓

Turn the [FILAMENT] control knob fully counterclockwise.

↓

Turn on the [HV (kV)] [SE] switch.

↓

Turn on the [HV (kV)] [ON] switch.

↓

Turn the [FILAMENT] control knob until the emission current is saturated. (See Fig. 2-14.)

↓

An image appears on the [VIEW CRT].

↓

Turn the [GUN ALIGNMENT] control knob so that the maximum image brightness is obtained. If the image is too bright, turn the [CONTRAST] and [BRIGHTNESS] control knobs counterclockwise. A convenient way to carry out this adjustment is to depress the [FOCUS MONITOR] pushbutton switch and find out the maximum brightness by use of waveform on the CRT. (Fig. 2-6 (b))

(3) Note on Observing under Low Magnification

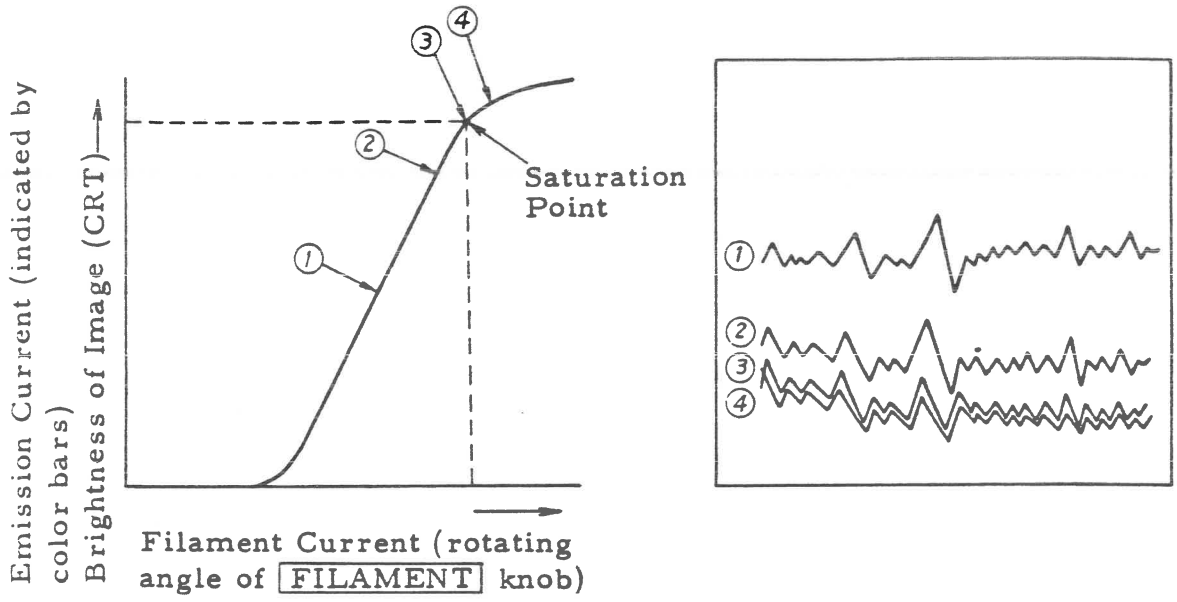
When observing at magnification lower than 100x, set WD ≦ 15 mm and select notch [3] (200 μm) or [4] (100 μm) of the objective lens aperture.

Note : Measures for too high or too low emission current

(i) When the emission current indication goes beyond the green bar, the filament is protruding out of the Wehnelt hole too much. Reset the filament.

(ii) If the [FILAMENT] control knob is turned excessively so as to bring the emission current to the over saturation, the service life of filament may be extremely reduced.

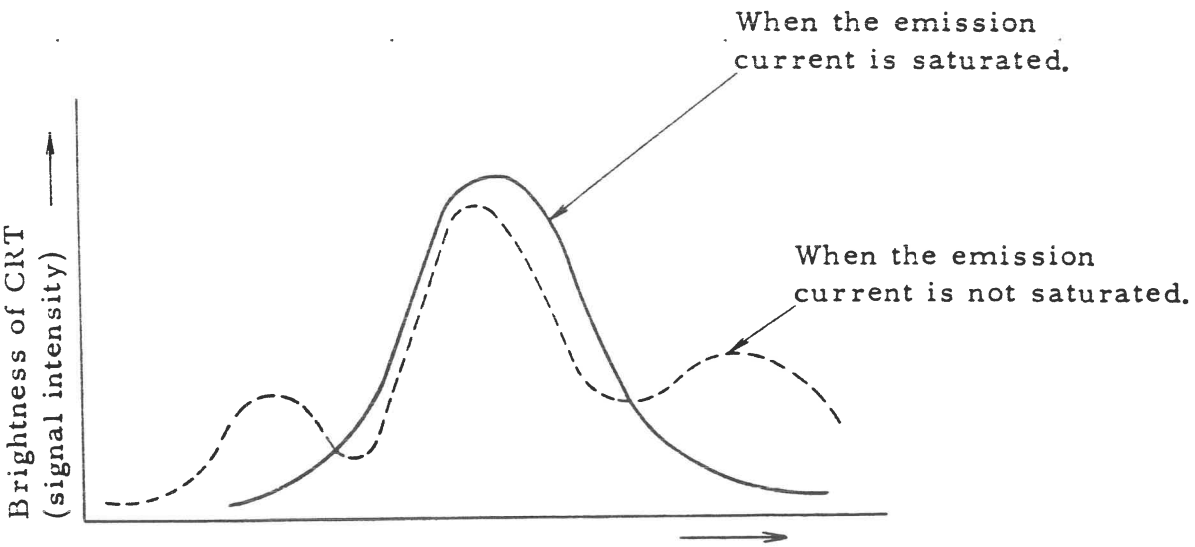
(iii) If the emission current fails to flow, the filament is burnt out or recessed with respect to the Wehnelt hole. Reset the filament.



(a) Image Brightness vs Filament Current

(b) Waveforms Appearing on CRT with the FOCUS MONITOR Depressed

Note : When the saturated emission current lies within the green range with the accelerating voltage set to 20 kV, the filament setting is done correctly.



(c) ALIGNMENT Control Knob vs Brightness

Fig. 2-14 Saturation Point of Emission Current

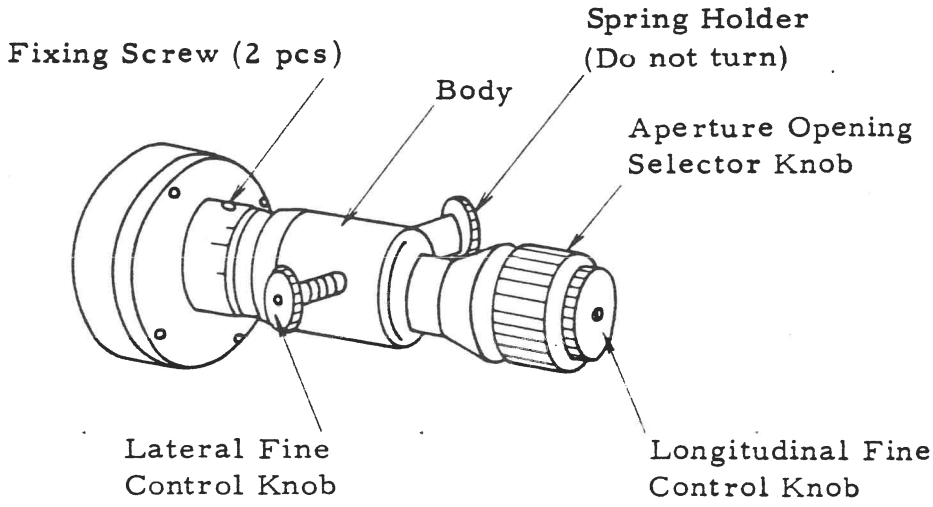
2-2-3 Centering of Objective Lens Aperture

(1) Turn the aperture opening selector knob to set the objective lens aperture scale to [2] or [3]. See Fig. 2-7.

(2) Adjust [COARSE] knob of the [FOCUS] control of the operation panel so as to obtain approximate focusing. Perform centering of the objective lens aperture by turning the two control knobs (lateral and longitudinal fine control knobs) of the objective lens aperture so that the image on CRT will not drift horizontally or vertically when the [COARSE] knob is turned clockwise or counterclockwise to (under-focus or over-focus side). See Fig. 2-15.

(3) Finally adjust the knobs so that the image on CRT will not drift at the maximum magnification to be observed.

(4) Adjust the [BRIGHTNESS] knob until optimum brightness of the image on CRT is obtained.



Graduation	0	1	2	3	4
Aperture opening diameter (μm dia.)	Blank	400	300	200	100

Fig. 2-15 Objective Lens Aperture

2-2-4 Focusing and Astigmatism Correction

(1) Turn the [STIGMATOR (X, Y)] knobs six turns in the same direction and return them three turns so that the arrows point vertically upward.

(2) Turn the [COARSE] and [FINE] knobs of [MAGNIFICATION] control so as to obtain a magnification of about 100x.

(3) Turn the [COARSE] and [FINE] knobs of [FOCUS] control to bring the image into focus.

(4) Turn the [MAGNIFICATION] knob to a magnification of about 10,000x, and adjust the [COARSE] and [FINE] knobs of [FOCUS] knobs to bring the image into focus in the same manner as in step (3). In this case, a sharp image is not always obtained even if just focused.

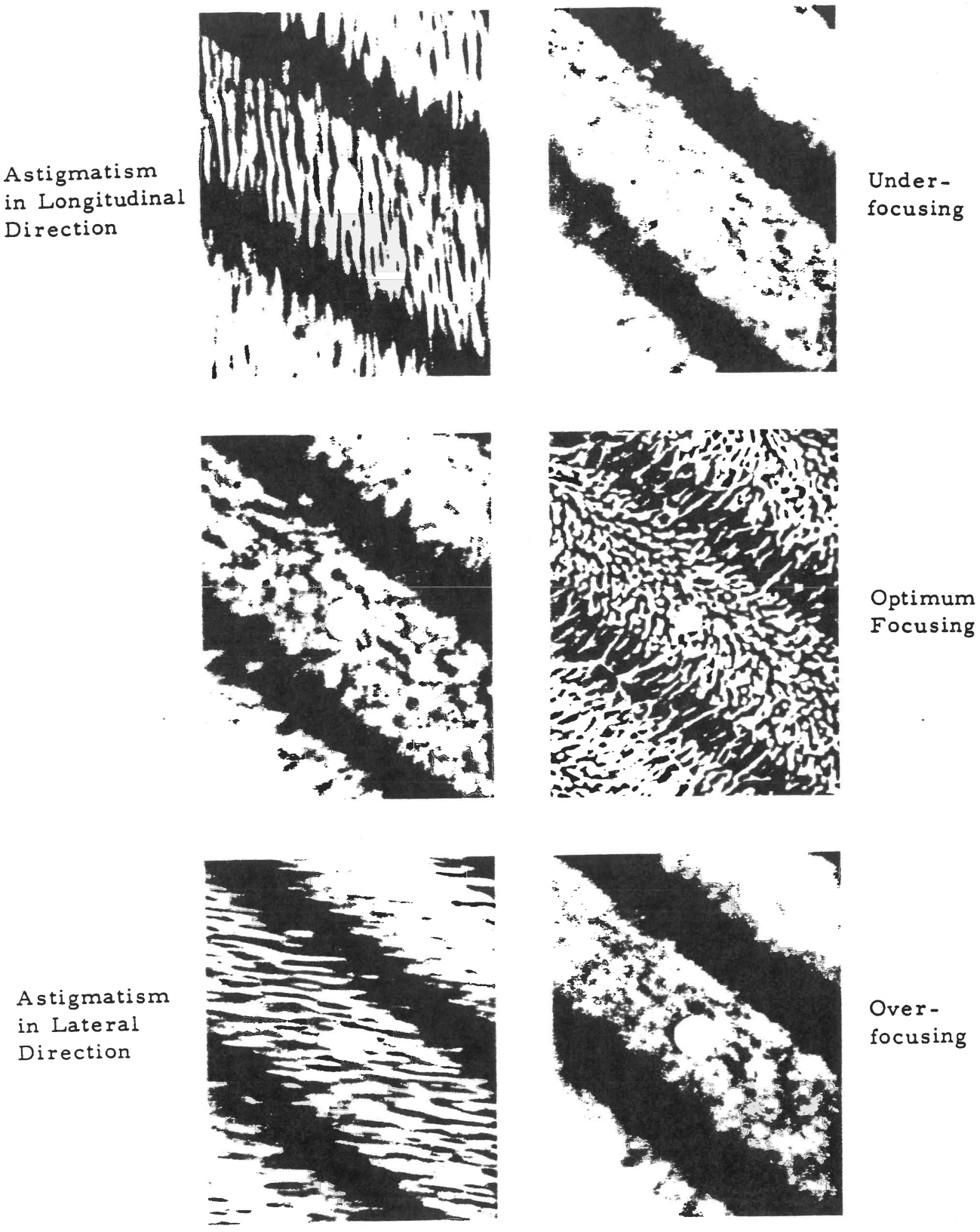
(5) If astigmatism appears, the image on CRT will be unidirectionally blurred. The direction of blur differs by 90° when the image is under-focused and over-focused. Turn both [STIGMATOR (X, Y)] knobs and the [FINE] knob of [FOCUS] knobs alternately until the image is not blurred any longer.

(6) Depress the [STIGMA MONITOR] pushbutton and make sure that an image as shown in Fig. 2-16 is seen. If the astigmatism is fully corrected, the sharpest image is obtained when just-focused.

(Since the [STIGMATOR] is of the X-Y system, astigmatism is corrected by the "cut and try" method by suitably turning the X and Y knobs.)

(7) It is recommended to perform focusing and astigmatism correction at a magnification 2 or 3 times higher than the final desired magnification. Then, observe the image at the lower magnification, and high accuracy observations can be done.

(8) Now, focusing and astigmatism correction are completed in the [□] mode. Depress the [▽▽] or [▽] pushbutton switch of the [VIEW] selector and perform fine focusing adjustment again.



(a) Astigmatism Appears (b) No Astigmatism Appears

Fig. 2-16 Astigmatism Correction

2-2-5 Selection of Factors Determining Image Quality

The following procedure should be taken for obtaining a clear image after completion of focusing and astigmatism correction described in the above paragraphs.

(1) Setting of [ACC VOLTAGE] Knob

Table 2-1 indicates the relation between the acceleration voltages and image quality. The resolution of the secondary electron image, for example, is generally improved as the acceleration voltage is increased, but the image quality becomes harder. Accordingly, an acceleration voltage of 20 kV is often employed for ordinary observations. However, it is necessary to increase or decrease this voltage according to purposes.

Table 2-1 Acceleration Voltage and Image Quality

Acceleration Voltage (kV)	1 2 5 | 10 15 20 25 | 30 .....
Resolution	Low ← → High
Charge-up	Little ← → Much
Contamination	Much ← → Little
Effect by disturbances	Large ← → Small
Image quality	Soft ← → Hard
Non-evaporated observation	Easy ←
X-ray analysis	X-ray
Scanning transmission image	STEM
Secondary electron signal	Much ← → Little

(2) Setting of [COND LENS] switch

When turning the [COND LENS] control knob from 0 to 10, the condenser current increases, and when turning from 10 to 0, it decreases.
Table 2-2 indicates the relation between the condenser current and image quality. When the condenser current is increased, for example, the resolution is improved, but the image becomes rough since the specimen illuminating current decreases.

Table 2-2 Condenser Current and Image Quality

Condenser Current	Small ⟷ Large
COND LENS control knob	0 — 4 — 5 — 6 — 9 — 10
Specimen current (A)	10^{-7} 10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12}
Resolution	Low ⟷ High
Secondary electron signal	Much ⟷ Little
Roughness of image	Fine ⟷ Rough
Secondary electron image	SE
Reflected electron image	RE
Absorbed electron image	AE
Scanning transmission image	STEM
X-ray analysis (EDX)	EDX

Note : The above values of knob scale and specimen current are approximate ones.

(3) Selection of Objective Lens Aperture Opening Diameter

Table 2-3 indicates the relation among opening diameter of objective lens aperture, focal depth, resolution, and specimen current. Notch 2 or 3 is normally employed for ordinary observations.

Table 2-3 Objective Aperture and Image Quality

Notch No.	1	2	3	4
Aperture opening diameter (μm dia.)	400	300	200	100
Depth of focus	Shallow ⟷ Deep			
Resolution	Low ⟷ High			
Specimen current	Large ⟷ Small			

(4) Setting of [WORKING DISTANCE] Knob

The working distance means the distance between the lower face of the objective lens and the specimen. It is set by adjusting the specimen height with respect to the height gauge. Table 2-4 indicates the relation between the working distance and image quality. The working distance is normally set to 15 mm or 25 mm. If a high resolution is required, it is set to 5 mm.

· Table 2-4 Working Distance and Image Quality

Focus position	1	2	3	4	5
Working distance (mm)	5	10	15	25	35
Depth of focus	Shallow ←			→ Deep	
Resolution	High ←			→ Low	

2-2-6 Photo Recording

(1) Check the following items before starting photo recording.

(a) Check if rough image appears. If the image is rough, slightly turn the [COND LENS] control knob from 10 to 3.5 referring to 2-2-5 (2). When the [COND LENS] knob is turned, focusing also changes a little. Perform focusing again by turning the [FINE] knob of [FOCUS] knobs.

(b) Check if the focusing and astigmatism correction have been done sufficiently. If astigmatism persists, or the image is blurred unidirectionally, or the image is out of focus, repeat steps (4) ~ (7) in 2-2-4.

(2) Adjust the [CONTRAST] and [BRIGHTNESS] knobs so that the [CONTRAST] and [BRIGHTNESS] indicators fall to the center of green zone (with the film speed ASA200 and the camera lens stop at 5.6).
The [BRIGHTNESS] control is automatically set so that the green zone is always indicated when depressing the [AUTO] switch.

(3) Set the [PHOTO SPEED] selector to [2] (100 sec).

(4) Depress the [PHOTO] switch. A single frame is swept on the CRT screen to be recorded on the film.

(5) When the exposure is ended, the image of the original scanning speed is restored on the [VIEW CRT].

Note : Since both sides (about 11 mm wide each from the end) of viewing CRT are out of photo recording area, set the imagefield to be photographed within the photo recording area.

(6) Kinds of Film and Setting of Brightness;

The indications of the [BRIGHTNESS] indicator and [CONTRAST] indicator have been adjusted to meet the sensitivity of the film employed by

the user during installation so that an optimum value can be shown with the [PHOTO SPEED] switch set to [2]. It is necessary to adjust the lens stop for an optimum exposure if photography is made using a film having a sensitivity other than specified above.

Reference : Kinds of Film and Processing Method

(a) The ordinary monochrome film is employed for photographing SEM images. Table 2-5 indicates typical ones. It is recommended to use a large film such as Brownie size when a high enlargement magnification is required.

Table 2-5 Kinds of Film

Kinds of Film			Sensitivity (ASA)
Roll film (Brownie size)			100 ~ 400
Polaroid	Card-size	105	75 (Positive/negative)
		107	3000 (Positive)
	4" x 5"	P/N 55	50 (Positive/negative)
		52	400 (Positive)

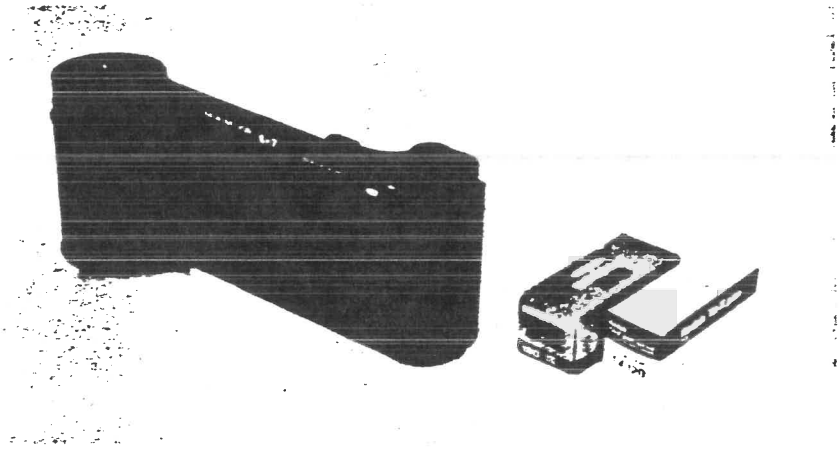
(b) Fig. 2-17 indicates the film holders employed for various film.

(c) Table 2-6 indicates the DPE processing of film except Polaroid film.

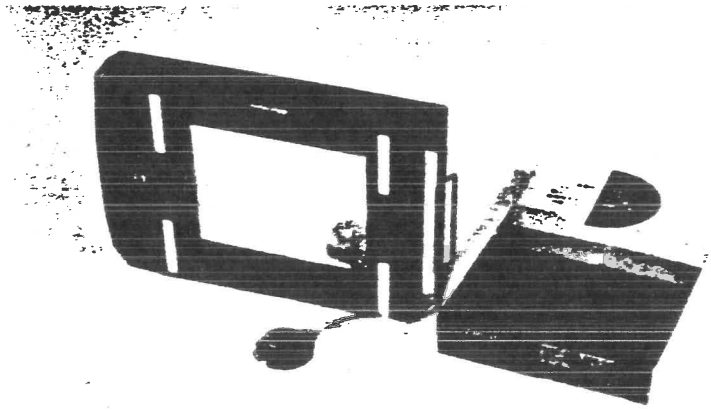
Table 2-6 Film Processing Method (Example)

	Processing Solution	Processing Time (min)	Cautions
Development	D-76	7 ~ 9	Use developing solution while adding supplement. Prolong the developing time by 10 % for every development.
	Polydol	8	
	Microdol-X	10 ~ 12	
	D-76 (1 : 1)	7 ~ 9 (23°C)	Discard developing solution after completion of each development.
Stop	Acetic acid 15 cc/1 ℓ water	0.5	
Fixing	Ordinary type	5 ~ 10	Exchange solution when the time required for making the unexposed part of film transparent is doubled.
	Rapid type	3 ~ 5	
Rinsing	Water	15 ~ 30	Running water

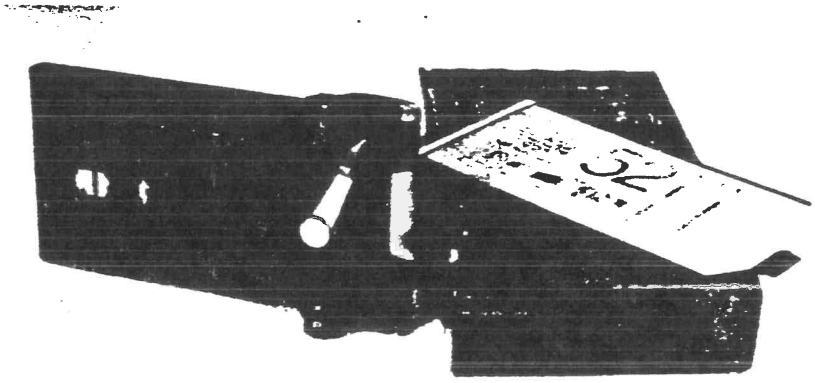
The above processing time indicates an example of TRI-X.



120 Roll Film Holder Photographing Ratio : 1 : 0.6



Polaroid Type 107 Film Holder Photographing Ratio : 1 : 0.8



Polaroid 4" x 5" Sheet Film Holder Photographing Ratio : 1 : 1

Fig. 2-17 Film Holders

2-2-7 Filament Exchange

(1) Depress the HV (kV) [OFF] switch on the display unit.

(2) Depress the [AIR] switch to air-leak.

(3) Remove four gun housing fastening metals (Fig. 2-18 (a)).

(4) Fix four gun aligning screws securely.

(5) Put a pair of gloves on your hands.

(6) Open the gun housing (Fig. 2-18 (a)).

(7) Loosen the Wehnelt fixing nut by turning counterclockwise and dismount the Wehnelt assembly.

(8) Make the filament assembly rest on the filament exchange jig (Fig. 2-18 (b)).

(9) Loosen four filament centering screws.

(10) Turn the Wehnelt cylinder counterclockwise and remove it.

(11) Replace the filament with new one.

(12) Fasten four filament centering screws lightly.

(13) Clean the inside of the Wehnelt hole with absorbent, cotton, soaked in polishing paste and acetone.

(14) Mount the Wehnelt cylinder.

(15) Adjust the distance "L" between the Wehnelt tip and the filament tip to 0.2 ~ 0.5 mm by use of the adjuster nut.

(16) Fasten the Wehnelt cylinder and the nut tightly.

(17) Center the filament by use of four filament centering screws.

(18) Ascertain that the filament is exactly centered with a magnifying lens.

(19) Assemble the Wehnelt assembly into the gun housing.

(20) Fasten the Wehnelt fixing nut tightly.

(21) Close the gun housing.

(22) Depress the [EVAC] switch.

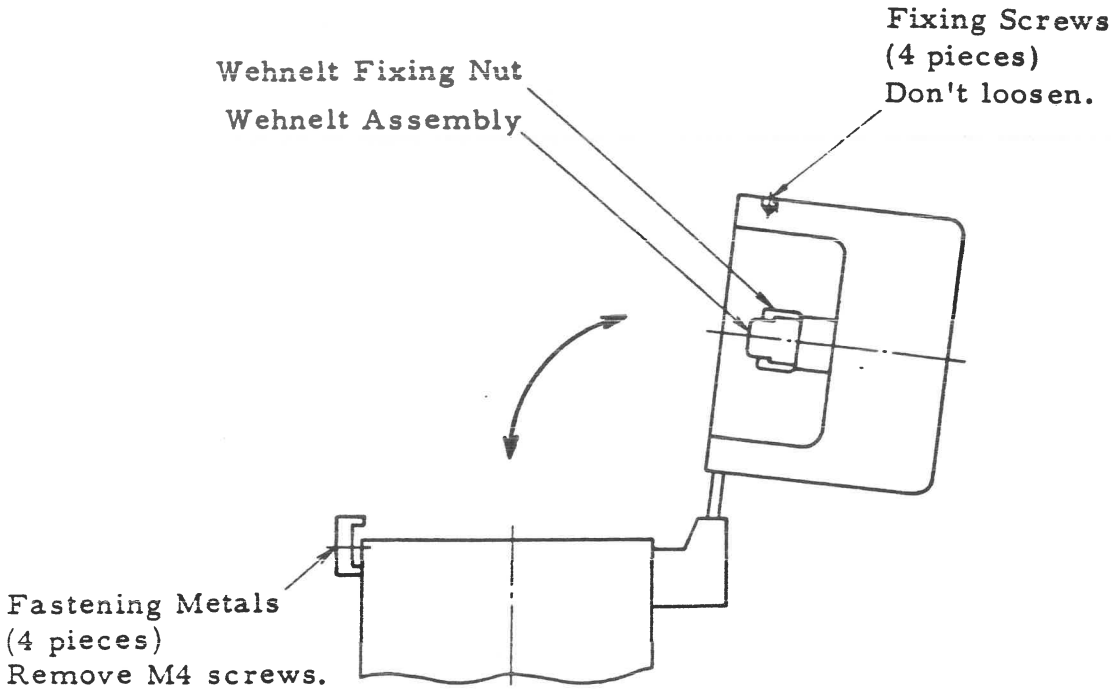
(23) Fit up the gun housing fastening metals (4 pieces).

(24) The [HIGH] vacuum lamp lights up and the evacuation is completed.

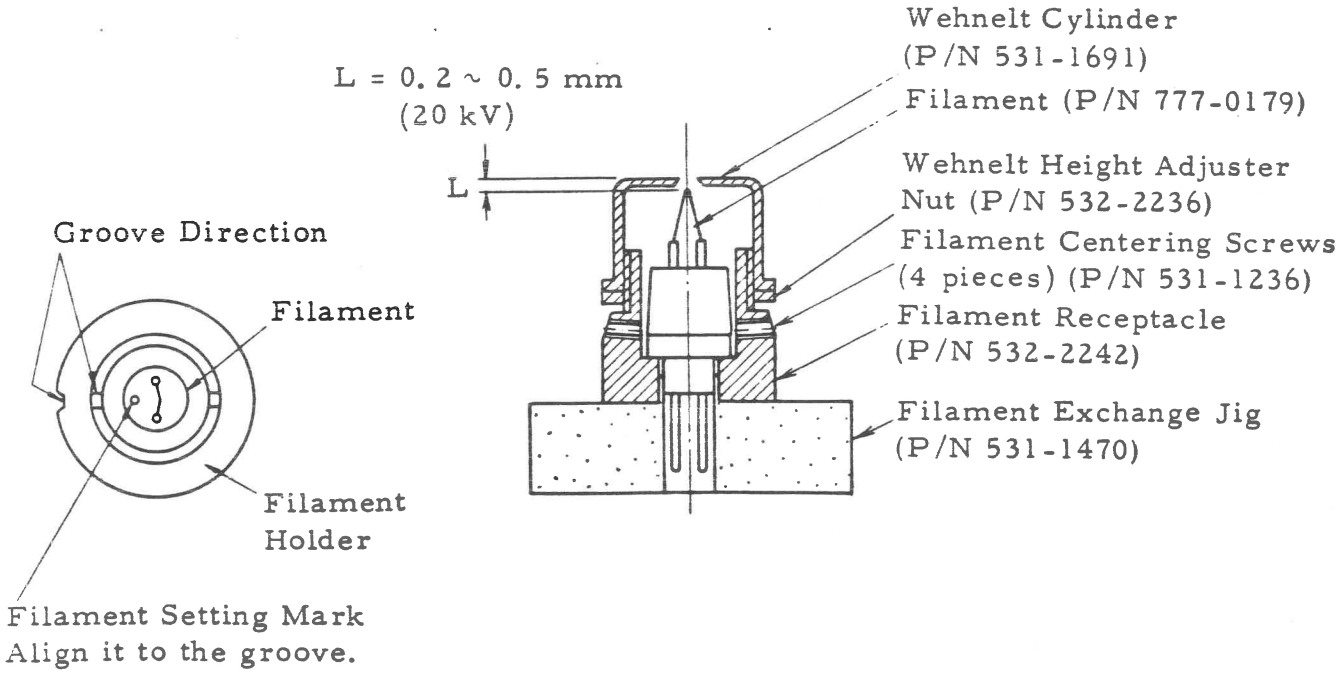
(25) Depress the HV (kV) [ON] switch.

(26) Turn the [FILAMENT] control slowly to the saturation point.

(27) If the [EMISSION CURRENT] reading is greatly deviated, readjust the distance "L" between the filament and the Wehnelt cylinder. The smaller "L" is, the greater becomes the emission current, and vice versa.
The proper level is 1 ~ 3 divisions lower than the yellow bar on the [EMISSION CURRENT] indicator at the acceleration voltage of 20 kV, 25 kV.



(a) Opening the Gun Housing



(b) Filament Setting

Fig. 2-18 Filament Exchange

2-2-8 Axial Alignment of Electron Gun

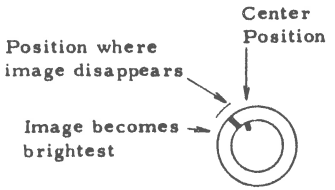
(1) Mount the specimen on the specimen goniometer stage, and evacuate the column.

(2) Make sure that the [HIGH] vacuum lamp lights.

(3) Obtain the secondary electron image according to the procedures in 2-2-2 "Observation of Secondary Electron Image". Set the [MAGNIFICATION] knob fully counterclockwise and the [VIEW] switch to [□]. Proceed to the next step.

Image Appears

(4) Set the [ALIGNMENT (X, Y)] knobs toward the center to such an extent that the image does not disappear.



(5) Adjust the four electron gun axial alignment screws (see Fig. 1-3) until the image becomes brightest.

(6) Set the [ALIGNMENT (X, Y)] knobs closer to the center and perform step (5). Repeat these steps several times until the image becomes brightest at the center position of the [ALIGNMENT (X, Y)] knobs finally.

(7) Fix the four electron gun axial alignment screws. Now, axial alignment is completed.

Image does not Appear

(8) Turn the [COND LENS] knob from 10 to 3.5.

Image Appears

(9) Turn the [COND LENS] knob from 3.5 to 10 to such an extent that the image does not disappear.

(10) Adjust the four electron gun axial alignment screws until the image becomes brightnest.

(11) Repeat steps (9) and (10) until a sufficiently bright image is obtained at the [COND LENS] knob position ordinarily employed.

(12) Perform steps (4) to (7).

Image does not Appear

(13) Set the objective aperture to [0].

Image Appears

(14) Perform steps (9) and (10).

(15) Set the objective aperture to a suitable position according to the purpose.

(16) Perform centering of the objective aperture according to procedures in 2-2-3.

(17) Perform steps (4) to (7).

Image does not Appear

(18) Locate the position where the image appears by turning the [FILAMENT] knob counterclockwise, and then turn it clockwise to such an extent that the image does not disappear. (Perform this step carefully.)

(19) Adjust the four electron gun axial alignment screws until the image becomes brightest.

(20) Repeat steps (18) and (19) until the image becomes brightest with the emission current saturated.

Note : If the image is too bright after the above operation, turn the [COND LENS] knob from 3.5 to 10 to such an extent that the image does not disappear.

(21) Perform steps (15) and (16).

(22) Perform steps (4) to (7).

2-3 SHUTDOWN

(1) Depress the HV (kV) [OFF] switch.

(2) Turn off the [DISPLAY] main switch.

(3) Ascertain that [HIGH] vacuum lamp is lit.

(4) Turn off the [EVAC] main switch.

(5) Turn off the knife switch on the distribution board in the room.

(6) About 15 minutes later, stop cooling water supply.

2-4 CAUTIONS ON OPERATION

When operating the instrument, take consideration of the following items.

(1) Wear clean gloves on your hands whenever exchanging specimens or filament.

(2) Avoid giving a shock to the instrument (particularly while taking photograph).

(3) Avoid using an excess amount of conductive paste for setting the specimen onto the specimen stub. Otherwise, (a) it may be hard to dry up in the air, and (b) the evacuation takes longer time with insufficiently dried paste.

(4) Avoid reducing the condenser lens current excessively while turning on the emission current and the [SE] switch. If the condenser current level is too low (less than 2.4), the electron beam bombarding the specimen is too intensive and the signal intensity to the secondary electron detector grows so high that the scintillator may be damaged.

(5) When the image is observed with a large specimen at a short working distance, the specimen tilt angle is to be set to around 0°.

2-5 METHOD OF EVAPORATING THE SPECIMEN

2-5-1 General Remarks on Evaporation

Electrically non-conductive specimens require deposit of vacuum-evaporated metal film in general so as to make them conductive. Particularly when observing a biological or fibrous specimen having a complicated profile, wrong evaporation often causes image troubles. If the evaporated film is too thin or the specimen is not evaporated evenly along its topographical profile, a uniform image quality cannot be expected and a certain part of the image becomes too bright while another part too dark. Furthermore, in worst cases, a lateral bright line appears on the image, the astigmatism grows and the resolution is reduced. To prevent such a failure, the specimen should be evaporated taking care of the following items.

(1) Use a vacuum evaporator with gimbal mechanism and evaporate the specimen at a higher tilt angle.

(2) Evaporate the specimen slowly for 1 to 2 minutes.

(3) Evaporation should be done under a high vacuum better than $2 \sim 5 \times 10^{-5}$ Torr.

(4) Keep the specimen more than 10 cm away from the evaporation source so as to prevent specimen temperature rise due to thermal radiation.

(5) Gold has generally been used as an evaporated metal. However, simultaneous evaporation of gold and palladium (Au-Pd), platinum and palladium (Pt-Pd), and carbon and platinum (C-Pt) permits coating the specimen surface stably with very fine particles (about 25 Å) so that an image without any charge-up can be obtained with a relatively thin evaporated film. For the simultaneous evaporating method of carbon and platinum, refer to 2-5-2.

(6) The evaporated film thickness should be to such an extent that there is no charge-up. The film thickness is about 200 Å normally, but the thinner, the better.

2-5-2 Platinum-Carbon Evaporation Method

(1) Carbon rods are used as electrodes. The carbon rod is ground flat at one end and pointed conically at the other end. See Fig. 2-19.

(2) Wind a platinum wire of about 0.1 mm dia. x 3 cm long on the conical tapered tip.

Note : It is easier to mount the platinum wire already wound onto the tapered carbon tip while holding the platinum wire using tweezers. This also eliminates damage of carbon tip.

(3) Apply a current to the carbon rod in the atmosphere to heat the platinum wire so that platinum is fused at the conical tip of the carbon rod.

(4) Set the fused side in the direction of the specimen mounted onto the gimbal mechanism.

(5) Evacuate the instrument until a high vacuum better than $2 \sim 5 \times 10^{-5}$ Torr is obtained.

(6) Apply a current to the carbon rod while operating the gimbal mechanism at a relatively high revolution.

(7) Stop evaporating when platinum has completely been evaporated.

(8) Wait about 3 minutes, admit air and take out the specimen.

2-5-3 Gold-Palladium Alloy and Platinum-Palladium Alloy Evaporating Method

The evaporating method is the same as in gold evaporation. However, since these substances feature high melting points, be careful not to damage the specimen through thermal radiation. The gold-palladium alloy and platinum-palladium alloy wires for evaporating SEM specimens are available on the market.

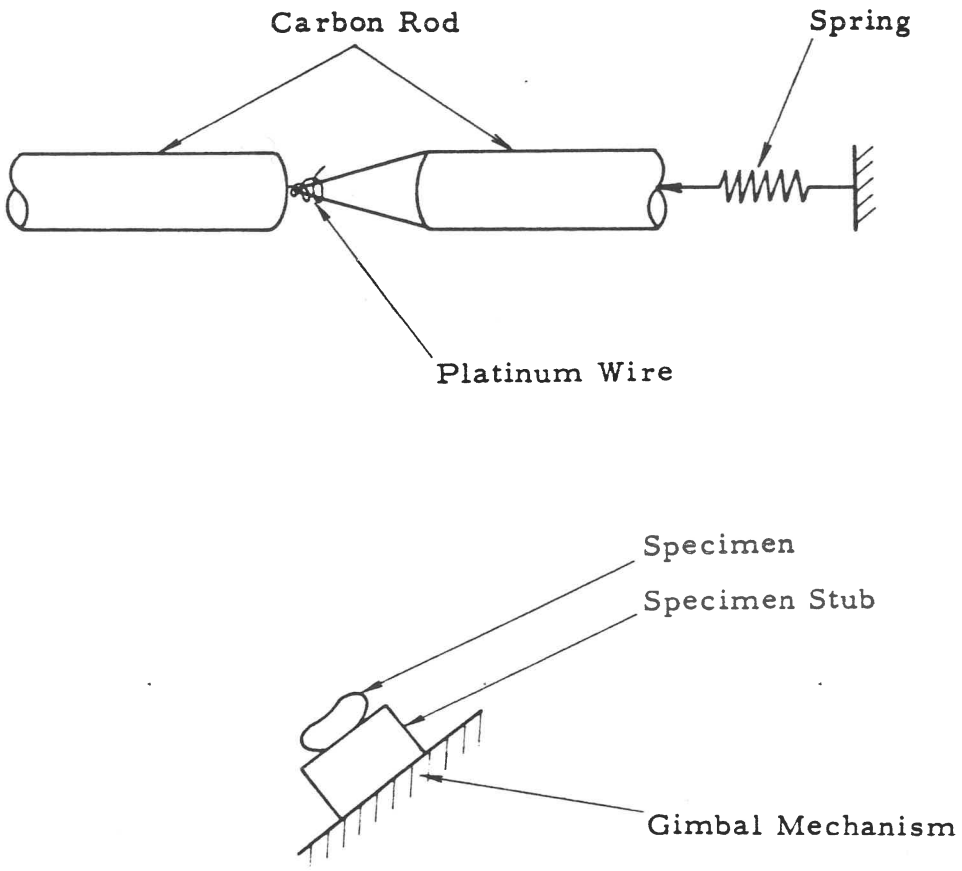


Fig. 2-19 Carbon-Platinum Evaporating Method

Section 3

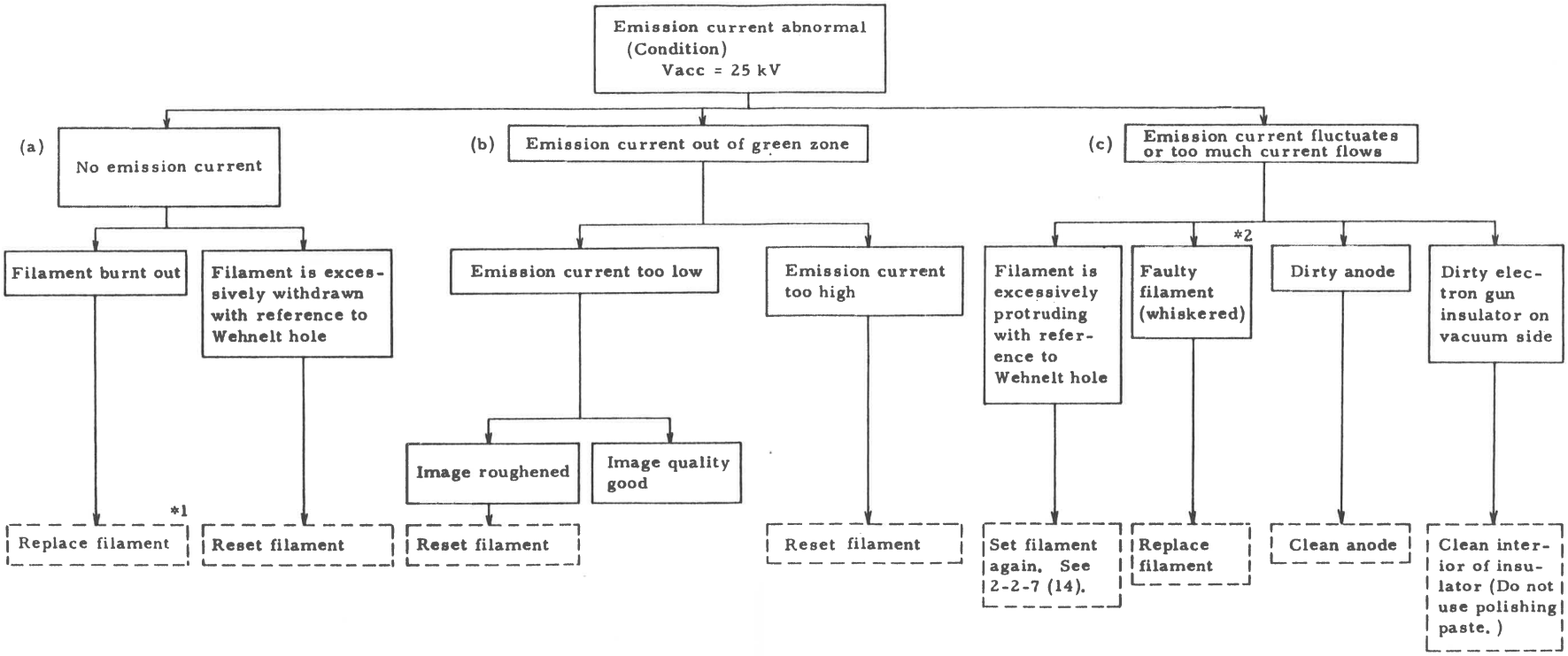
MAINTENANCE

3-1 MAINTENANCE OF COLUMN

3-1-1 Filament Exchange

(1) When the emission current becomes irregular, the filament should be replaced (see Fig. 3-1).

(2) For filament exchange procedure, see 2-2-7. Clean the Wehnelt cylinder and the anode when the filament is exchanged.



*1 Clean the Wehnelt cylinder when replacing the filament.

*2 If the filament whisker comes to contact with the Wehnelt cylinder, the apparent emission current grows so high that the [EMISSION CURRENT] indicator deflects beyond the colored zone.

Fig. 3-1 Troubleshooting Chart for Abnormal Emission Current

3-1-2 Exchange or Cleaning of [COND] Fixed Aperture

Replace or clean the [COND] fixed aperture once every three months as follows ;

(1) Depress the HV (kV) [OFF] switch.

(2) Depress the [AIR] pushbutton switch on the evacuating system operation panel.

(3) When the column has reached atmospheric pressure (about 30 seconds), open the electron gun assembly. Wear clean gloves for the following steps.

(4) Place an aluminum foil of 20 x 20 cm on the work table. All parts should be placed on it after removal.

(5) Remove the anode by turning it counterclockwise.

(6) Pull out the aperture ass'y straight upward by using the condenser lens aperture ass'y pick-up tweezers. See Fig. 3-2.

(7) Disassemble the aperture according to Fig. 3-2.

(8) Clean all parts other than the [COND] fixed aperture with absorbent cotton wound around a bamboo stick and soaked in acetone. It is recommended to use an ultrasonic cleaner, if available.

(9) Bake the aperture plates in a vacuum evaporator, then reassemble all parts cleaned in the above to the original state.

(10) Insert the aperture ass'y into the column by using the condenser lens aperture ass'y pick-up tweezers.

(11) Mount the anode by turning it clockwise into its seat.

(12) Close the electron gun assembly after pulling out the stopper knob at the flip-top hinge of the electron gun assembly.

(13) Depress the [EVAC] pushbutton switch on the evacuating system operation panel.

(14) Evacuation is completed when the [VACUUM] meter registers about 10 μA.

3-1-3 Baking of Aperture Plates

(1) Mount the molybdenum board in the vacuum evaporator. See Fig. 3-3.

(2) Heat up the molybdenum board after evacuating the vacuum evaporator. Continue applying the current until the molybdenum board becomes incandescent. Do not apply too high a current to prevent the molybdenum board from being melted.

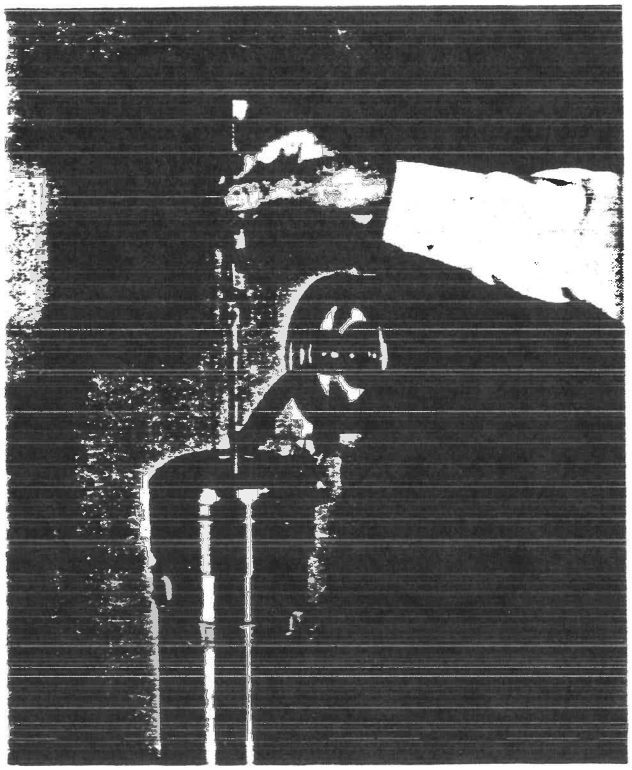
(3) Let air into the vacuum evaporator about 5 minutes after completion of baking.

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

(5) Evacuate the vacuum evaporator and bake the aperture up to the incandescent point. Do not apply the current continuously to prevent the aperture plate from being melted.

(6) Let air into the evaporator about 5 minutes after completion of baking, and remove the baked aperture by means of tweezers.

Note : Avoid touching the baked aperture plates directly in hand.



C781841

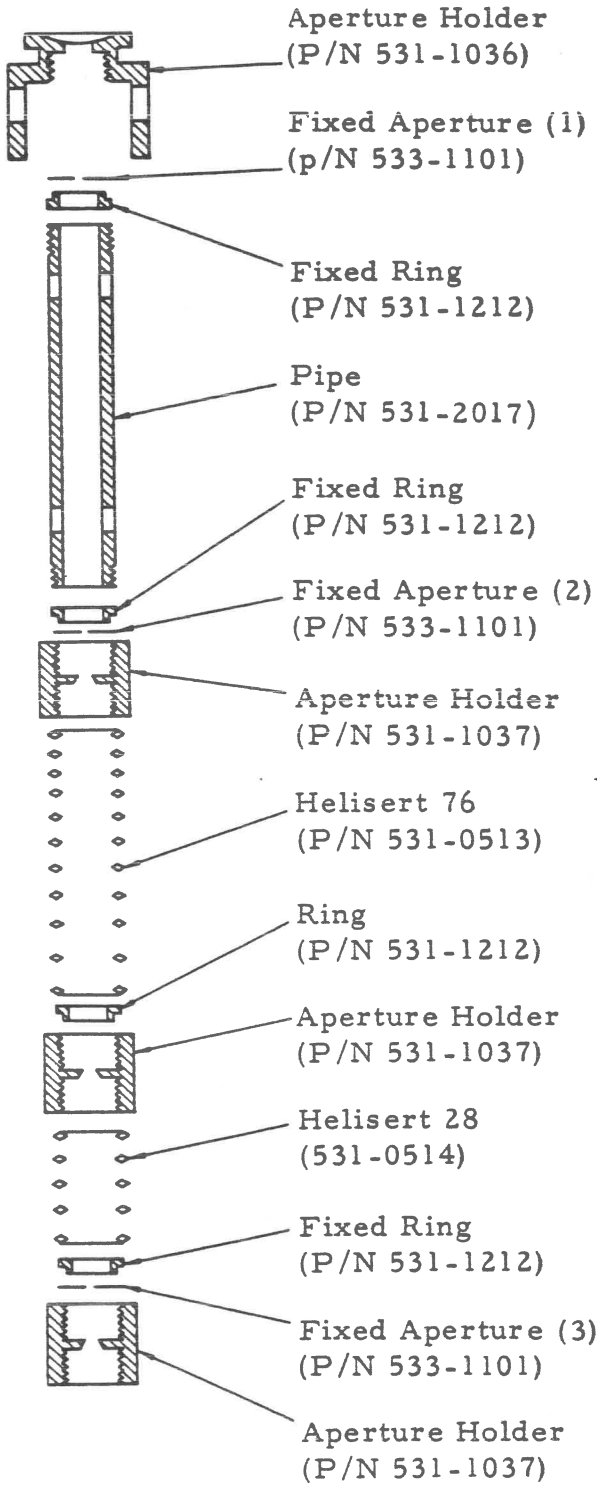


Fig. 3-2 Cleaning of COND Fixed Aperture Plates

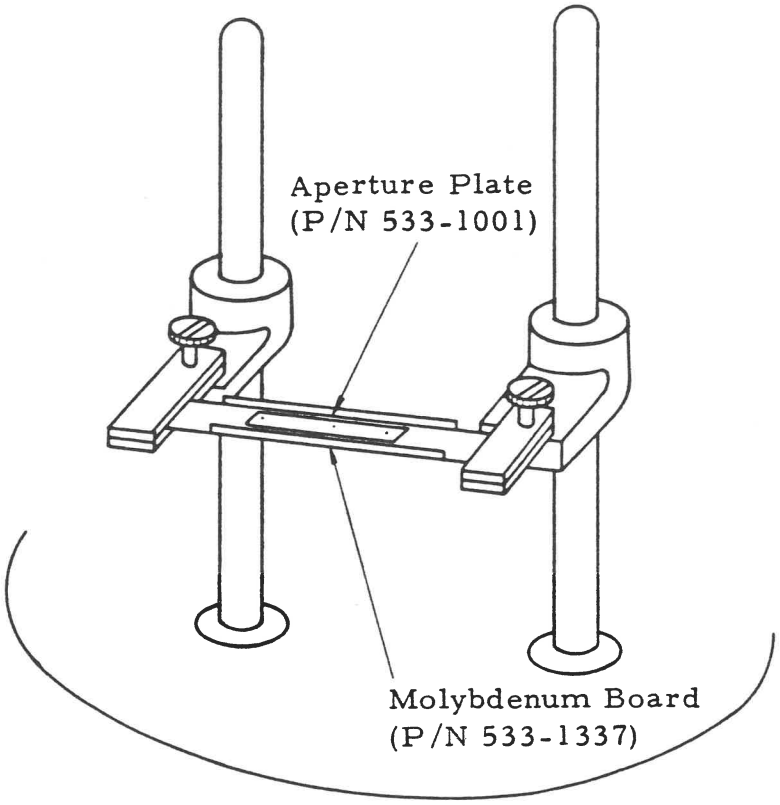


Fig. 3-3 Baking of Aperture Plate

3-1-4 Exchange or Cleaning of Objective Aperture Plate

When the [STIGMATOR (X, Y)] on the display unit operation panel fails to eliminate astigmatism, the objective aperture plate must be cleaned.

(1) Depress the HV (kV) [OFF] switch.

(2) Depress the [AIR] pushbutton switch on the evacuating system operation panel.

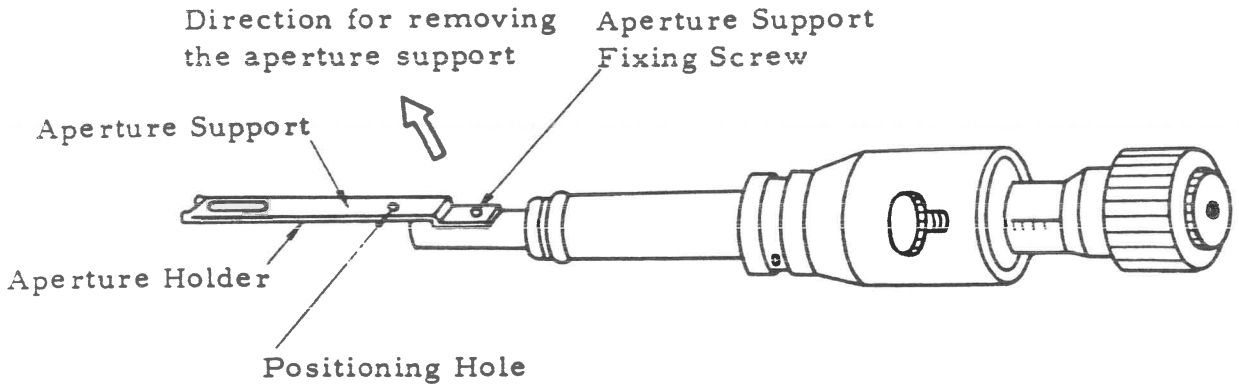
(3) The air introduction to the column will be completed in about 30 seconds. Wear gloves for the following steps.

(4) Place an aluminum foil of about 20 x 20 cm on the work table. All parts removed by the following steps should be placed on the foil.

(5) Turn the aperture hole selector knob to set the objective movable aperture at position [0]. See Fig. 2-15.

(6) Remove 2 fixing screws. See Fig. 2-15.

(7) Holding the body of the objective aperture assembly, pull it out straightly. See Fig. 3-4.



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

Fig. 3-4 Cleaning of Objective Movable Aperture

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

(9) Remove the aperture support by using tweezers.

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

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

Note : Cleaning should be done carefully.

(12) Mount the baked objective lens aperture plate onto the aperture holder, and set the positioning hole of the objective lens aperture plate to that of the aperture holder.

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

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

(15) Remove the specimen goniometer stage, and insert the objective lens aperture straight into the specimen chamber while monitoring the tip of the aperture from the inside of the specimen chamber. Be careful not to insert the aperture plate upside down. See Fig. 3-4 (Note).

(16) Fasten two fixing screws. See Fig. 2-15.

(17) Depress the EVAC pushbutton switch on the evacuating system operation panel.

(18) End up the evacuation as the VACUUM meter indication has attained to approximately 10 μA.

3-1-5 Cleaning of Objective Fixed Aperture

(1) Depress the [AIR] button of the evacuation panel.

(2) Air is let into the specimen chamber in about 30 seconds.

(3) Draw out the goniometer stage (see Fig. 2-5), raise it gently about 15 mm upward, and pull it again toward you. Then the entire goniometer stage can be drawn out of the specimen chamber.

(4) In the same way as in paragraph 3-1-4, take out the objective movable aperture.

(5) Introduce an aperture taking-out stick through the hole of the specimen goniometer stage, insert it into the lower pole piece hole of the objective lens, rotate it clockwise about three turns, and pull it toward you to take out the first aperture.

(6) Take out the second aperture in the following manner.
Rotate the outer side of aperture taking-out stick by 1.5 to 2 turns, and tighten completely the inner side of the stick with the outer side fixed by left hand. Then tighten the outer side in the counterclockwise direction to take out the second aperture.

Notes 1) The instrument performance largely depends upon the objective pole piece. Therefore carry out operation carefully not to allow dust on the surface.

2) Take care not to damage the scintillator surface in the specimen chamber.

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

(8) After cleaning, proceed to reassembly in the procedure reverse to (3) through (6).

(9) Depress the [EVAC] pushbutton on the evacuation system control panel.

(10) Evacuation is completed as soon as the vacuum indicator points about 10 μA.

3-2 MAINTENANCE OF SECONDARY ELECTRON DETECTOR

3-2-1 Replacement of Scintillator

The scintillator coated with fluorescent substance has a long service life, and hence need not be replaced frequently. However, when the image quality is degraded, it must be replaced.

(1) Depress the [AIR] pushbutton switch on the evacuating system operation panel.

(2) The air admission into the specimen chamber is finished in about 30 seconds.

Wear gloves for the following operation.

(3) Put an aluminium foil (of square of 20 cm) on the table, and place removed parts thereon.

(4) Loosen flange setscrews (4 pcs) for the secondary electron detector, to remove it from the specimen chamber (see Fig. 2-4).

(5) Remove the high-voltage connector by loosening its two setscrews by means of a hex key wrench (Fig. 3-6).

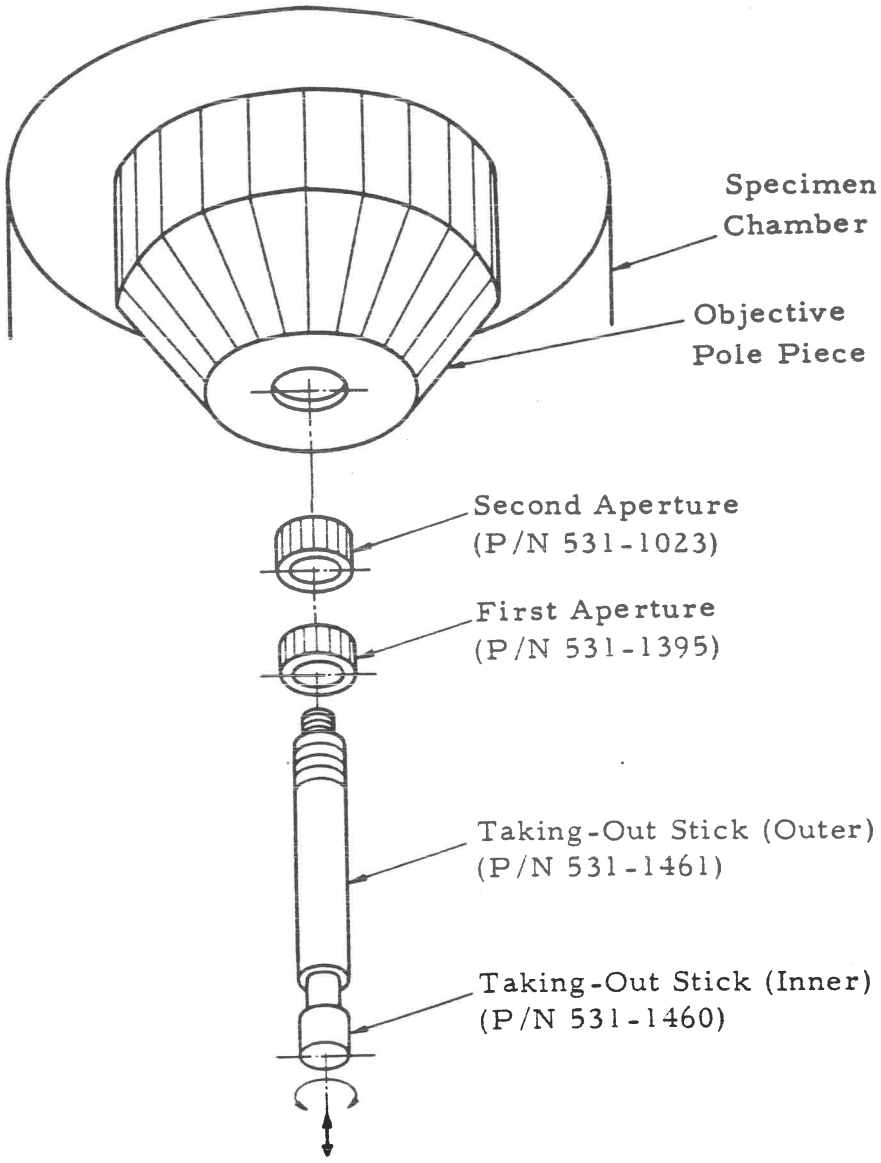


Fig. 3-5 External View of Objective Bottom Pole Piece

(6) Remove the ground ring setscrews (3 pcs) by means of the hexagon key wrench.

(7) Remove the hold ring for the scintillator by rotating it counterclockwise referring to Fig. 3-6.

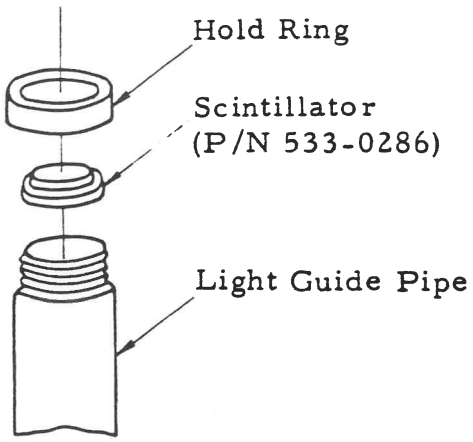


Fig. 3-9 Assembling of Scintillator

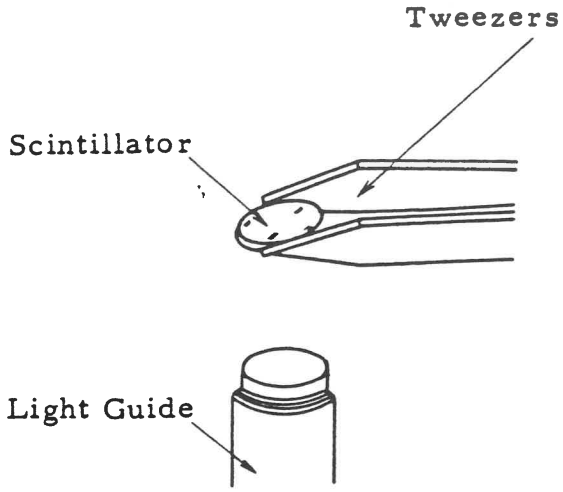


Fig. 3-10 Mounting of Scintillator

3-3 MAINTENANCE OF OIL-SEALED ROTARY PUMPS

See the attached "Handling instruction for the Hitachi oil-sealed rotary pump".

3-4 TROUBLESHOOTING

The troubleshooting described below concerns the failures under the normal operation, and does not cover those encountered at the time of installation.

3-4-1 Evacuation System Fails

(1) Power failure.

(2) The EVAC main switch (non-fuse breaker) is turned off.
If the cause is unknown, contact the serviceman.

(3) Overheated DP due to clogged DP cooling water pipe (contact your nearest representative).

3-4-2 Deterioration of Vacuum (low vacuum range)

(1) Air Leak

(a) Wrong mounting of the specimen goniometer stage in the specimen chamber.

(b) Poor fixing of the evacuating pipe between the electron gun and specimen chamber.

(2) Faulty Pirani Gauge

If faulty, the pointer of the Pirani gauge fluctuates. Contact your nearest representative.

(3) Faulty Oil-Sealed Rotary Pumps

(a) Very little or excessive RP oil.

(b) Faulty motor.

(4) Malfunction of Evacuating System Valve

(a) Defective DC (+24 V) power supply.

(b) Defect of valve proper. (Contact your nearest representative.)

3-4-3 Deterioration of Vacuum (high vacuum range)

(1) Low pumping speed of DP due to shortage of DP oil.

(2) Malfunction of evacuating system valve.

(a) Air leak.

(b) Defect of valve proper. (Contact your nearest representative.)

(3) Faulty Pirani Gauge

3-4-4 Abnormal Emission Current

See Fig. 3-1.

3-4-5 Absence of Image on CRT

(1) Poor electron gun axial alignment. (Contact your nearest representative.)

(2) Faulty head amplifier :

If so, the needle of the [BRIGHTNESS] meter does not deflect when turning the [BRIGHTNESS] knob. Contact your nearest representative.

(3) The post-stage acceleration high voltage is not applied.

(4) The photomultiplier high voltage is not applied.

(5) [COND LENS] switch turned excessively toward "9".

(6) Excessively counterclockwise turning of [CONTRAST] knob.

(7) Poor adjustment of objective lens aperture. Set the longitudinal fine control knob of the objective lens aperture to about mid-point and the objective lens aperture to position [0]. If the image does not appear on CRT yet, check further.

(8) Too high magnification.

3-4-6 Noisy Image Appears

(1) Faulty scintillator. Replace.

(2) [COND LENS] switch turned excessively toward "9".

(3) [CONTRAST] knob turned excessively clockwise.

Section 4

EXCHANGING PARTS

4-1 CONSUMABLES AND SPARE PARTS

4-1-1 Consumables

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

4-1-2 Spare Parts

A list of "Recommended Spare Parts" for long term operation is provided on the following pages.

Table 4-1 Consumables

Part No.	Part Name	USE	Remarks
D529000	Conductive paint		30 g
G370250	Metal polishing paste		50 g
G743002	Bamboo stick		10 pcs
S370061	Absorbent cotton		
S370059	Gauze		
S269003	Aluminum foil		
G465001	Vacuum grease	For vacuum seal	
533-1101	Condenser lens aperture plate		
533-1001	Objective lens aperture plate		
777-0179	Filament		10 pcs
533-0286	Scintillator		
	Acetone	For cleaning	
533-1337	Molybdenum board	For baking aperture plate	
S263003	Nylon gloves		
532-0292	DP oil (LION S)		100 cc
	RP oil (MATSUMURA SEKIYU MR-100)		4 ℓ
531-0513	Helisert 76	For condenser lens	
531-0514	Helisert 28	For condenser lens	

Note : Those bearing no part number should be provided by user.

Table 4-2 Spare Parts

Part No.	Part Name	Location	Remark
L456529	O-ring AS568-239 NBR	Electron gun, condenser lens	
L456464	O-ring AS568-115 NBR	Condenser lens	
L456008	O-ring P10A NBR	Condenser lens	
L456462	O-ring AS568-113 NBR	Objective lens	
L456015	O-ring P20 NBR	Objective lens	
L456547	O-ring AS568-257 NBR	Specimen goniometer stage (front plate)	o
L456026	O-ring P36 NBR	Specimen goniometer stage (lock)	o
L456005	O-ring P8 NBR	X, Y control knobs	o
L456002	O-ring P5 NBR	R, T, Z, ZL control knobs	o
L456501	O-ring AS568-211 NBR	SE detector	
L456411	O-ring AS568-012 NBR	Objective movable aperture	o
L456515	O-ring AS568-225 NBR	Specimen chamber port	
L456510	O-ring AS568-220 NBR	Pipe	
L456405	O-ring AS568-006 NBR	Valve	o
L456408	O-ring AS568-009 NBR	Valve	o
L456527	O-ring AS568-237 NBR	Valve	o
L456461	O-ring AS568-112 NBR	Valve	o
L456462	O-ring AS568-113 NBR	Valve	
L456525	O-ring AS568-235 NBR	DP evacuating pipe	
531-1437	DP heater (2.5")		
J821030	Fuse 5 A		o
J821025	Fuse 0.5 A		o
J821026	Fuse 1 A		o
J821027	Fuse 2 A		o
J821028	Fuse 3 A		o
J821021	Fuse 0.2 A		o
433-3702	Specimen stub 15D		
433-3703	Specimen stub 26D		
531-1145	Specimen stub 3" (78 dia.)		

Table 4-2 Spare Parts (cont'd)

Part No.	Part Name	Location	Remark
531-1111	Specimen stub 4" (102 dia.)		
K433004	Pirani gauge bulb		
J386012	Photomultiplier R268		
531-0601	Holder (15 dia. x 4)		
531-0602	Holder (6 dia. x 10)		
531-0603	Holder (low mag.)		
533-2277	Holder for evaporation		

Note : The parts with o in the "Remark" column are important ones.

Section 5

METHODS OF OPERATING OPTIONAL ACCESSORIES

5-1 MODEL S-4023 SPLIT SCREEN/DUAL MAGNIFICATION UNIT

This is used for (1) simultaneous observation of two images formed by different signals from the same visual field, and (2) simultaneous observation of two images at different magnifications with the CRT screen split into two sections.

5-1-1 Composition

The Model S-4023 is made up of the following parts:

(1) Control unit ... of single NIM size and connected to the option port of the display unit

(2) Printed circuit board for switch circuit ... mounted inside display unit

(3) Set of connecting cords

5-1-2 Function

(1) Two images formed by different signals from the same visual field can be simultaneously observed with the CRT screen split into upper and lower halves.

(2) By splitting the CRT screen into two, the magnified image of an optional area of the image displayed on the upper half can be simultaneously displayed on the lower half.

5-1-3 Control Panel

Fig. 5-1 shows the external view of the control panel. The function of each switch and control is described below.

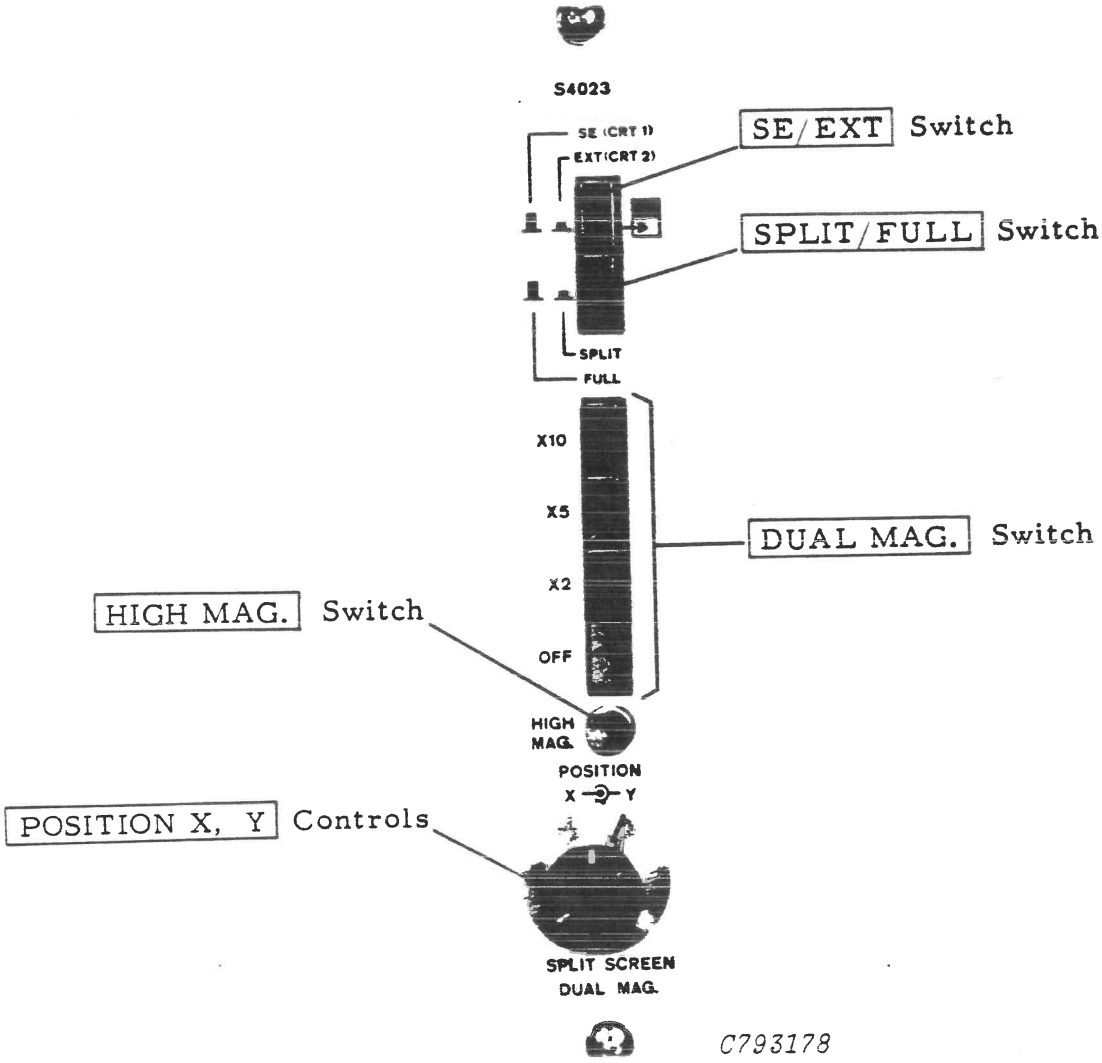


Fig. 5-1 Control Panel

- SE EXT Switch:
  selects image signal on the lower half of screen at SPLIT mode
- SPLIT/FULL Switch:
  selects either SPLIT or FULL image mode
- DUAL MAG. Switch:
  sets magnification for a high magnification image by DUAL MAG. mode
- HIGH MAG. Switch:
  permits display of only high magnification image at DUAL MAG. mode
- POSITION X, Y Controls:
  shifts X and Y positions of selected area for a high magnification image at DUAL MAG. mode

5-1-4 Operation

(1) When This Unit Is not Used

SPLIT/FULL switch ⟶ FULL

DUAL MAG. switch ⟶ OFF

In this status, the S-4023 is not yet in combination with the microscope.

(2) SPLIT Mode

SPLIT/FULL switch ⟶ SPLIT

DUAL MAG. switch ⟶ OFF

As shown in Fig. 5-2, the CRT screen is divided into upper and lower halves. Both halves display an image of the same visual field. Either SE (secondary electron) or EXT signal (connected to EXT signal input on the display unit) is selected by SIGNAL-EXT switch on the display unit as an image signal for the upper half. Image signal for the lower half is the same as that for the upper half when turning the SE/EXT switch to SE, and is EXT signal when turned to EXT.

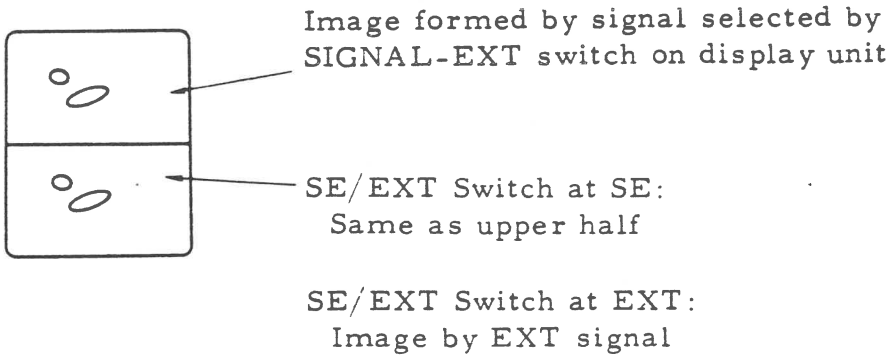


Fig. 5-2 SPLIT Mode

(3) SPLIT + DUAL MAG. Mode

SPLIT/FULL switch ⟶ SPLIT

DUAL MAG. switch ⟶ 2x, 5x, 10x

As shown in Fig. 5-3, the CRT screen is divided into two. The upper half displays a low magnification image (its magnification is shown on the display unit), and the lower half magnifies and displays at 2x, 5x or 10x the selected area of the low magnification image. The bright rectangular frame showing the area being displayed at a high magnification appears on the upper half, and its position can be shifted by manipulating the POSITION X, Y controls.

Selection of image signal is carried out the same as in the afore-mentioned "SPLIT mode". If the HIGH MAG. switch is turned ON at this SPLIT + DUAL MAG. mode, both the upper and lower halves display a high magnification image.

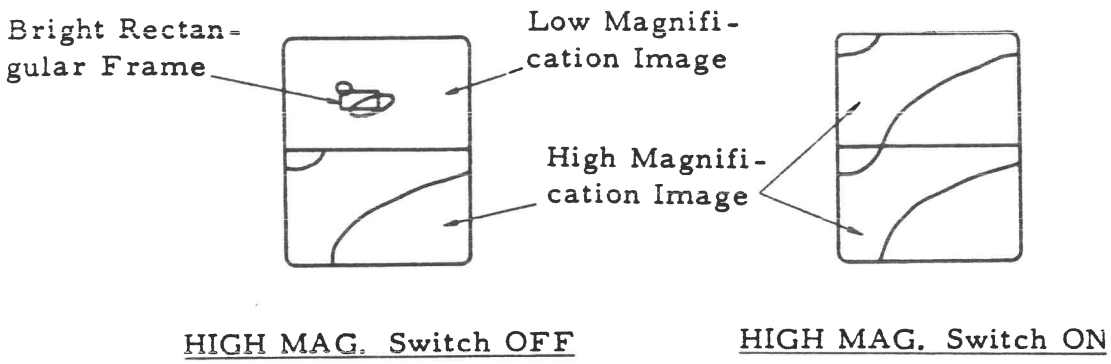


Fig. 5-3 SPLIT + DUAL MAG. Mode

(4) FULL Image + DUAL MAG. Mode

SPLIT/FULL switch → FULL

DUAL MAG. switch → 2x, 5x, 10x

The CRT screen is not divided by this mode as shown in Fig. 5-4. When the HIGH MAG. switch is at OFF, a low magnification image and a bright rectangular frame are displayed. For displaying the high magnification image of a selected area of the low magnification image, manipulate the POSITION X, Y controls to mask the specific point of interest, and then turn ON the HIGH MAG. switch.

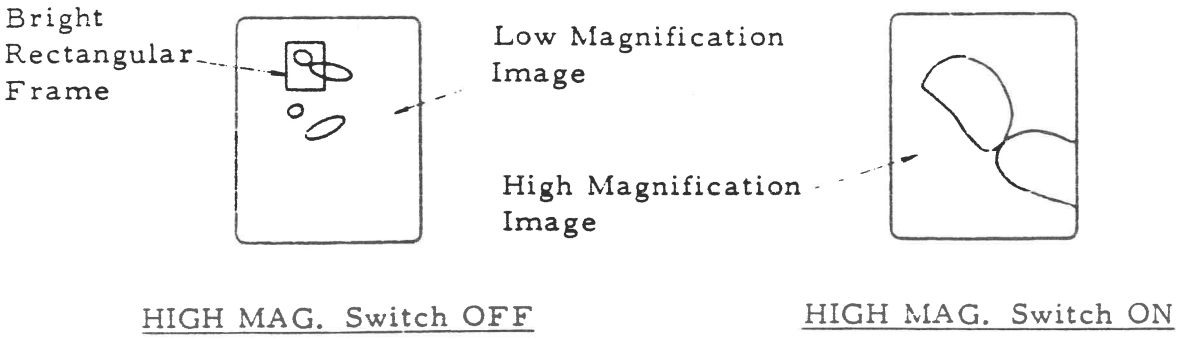


Fig. 5-4 FULL Image + DUAL MAG. Mode

(5) Combination with Data Display Unit (S-5006A)

If the HIGH MAG. switch is turned ON with SPLIT + DUAL MAG. mode or FULL image + DUAL MAG. mode selected, "A" is displayed after the scale value of the micron marker for magnification of 2x, "B" for 5x and "C" for 10x, as shown in Fig. 5-5.

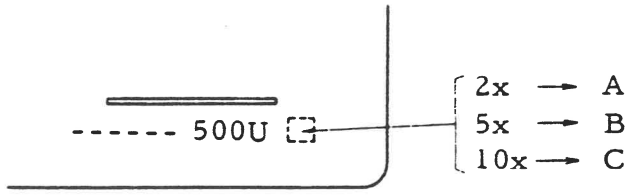


Fig. 5-5 Relation with Micron Market Display

5-1-5 Operational Precautions

(1) If SPLIT mode or SPLIT + DUAL MAG. mode is selected, the top part of the lower half of screen may be distorted. However, this does not cause any problem in photo recording.

(2) The area marked by the rectangular frame at DUAL MAG. mode has been adjusted to be coincident with the visual field of high magnification image on the observation CRT. However, the photographing field is slightly narrow in the horizontal direction as compared with the observation field. Therefore, the visual field of high magnification image is a little smaller than the masked field.

5-2 MODEL S-5006A AUTOMATIC DATA DISPLAY UNIT

The Model S-5006A Automatic Data Display Unit is used for displaying the film frame number, beam accelerating voltage and other characters or numerics on both viewing and photographing CRTs of the Scanning Electron Microscope.

5-2-1 Outer View

Fig. 5-6 shows an outer view of the Model S-5006A and switches and controls on it.

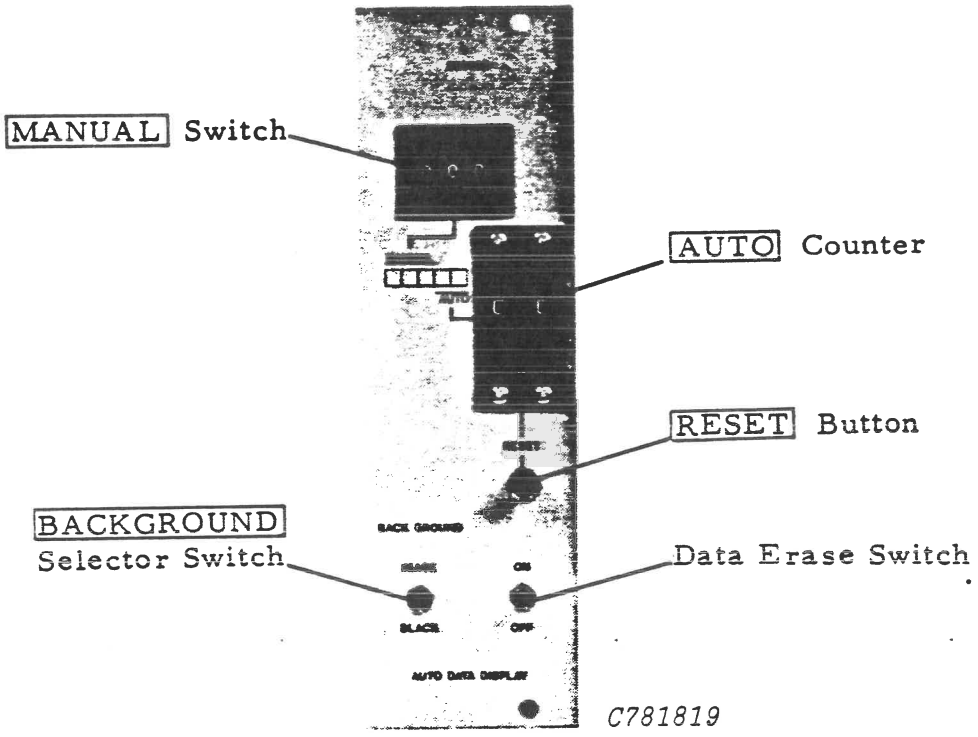


Fig. 5-6 Panel Layout of Model S-5006A

5-2-2 Major Specifications

(1) 5-Digit Numerical Display

The three higher digits can be preset manually. Since the two lower digits are counted up by +1 as a photographic exposure is finished, they can be used as film frame number.

(2) 2-Digit Accelerating Voltage Display with Unit

Interlocked with the ACC VOLTAGE selector on the Display Panel, the reading of accelerating voltage is displayed together with its unit, kV.

(3) Micron Reading and Bar Display

A scaling bar having a length proper to the particular magnification is displayed on the CRT screen, and the reading and unit for the bar length are indicated. In Fig. 5-7, for instance, the length of scaling bar is 5 μ.

The displays are automatically changed in interlock with the [MAGNIFICATION] and [WORKING DISTANCE] selectors on the Display Panel. The unit micron (μ) is displayed as "U".

(4) When photographing a high magnification image in combination with the Model S-4023 Split Screen/Dual Magnification Unit, the micron display is followed by a character A, B or C, depending upon the setting of the MULTIPLE RATIO selector on the Model S-5003A; 2x, 5x or 10x, respectively. In the example shown in Fig. 5-7, the micron display is followed by B, which means that the MULTIPLE RATIO is 5x, and the actual length of the scaling bar is 5 μ x 1/5 = 1 μ.

(5) The data display mentioned in the above can be erased by switch operation. The data background can be selected by a switch to be either specimen image or block backgound.

5-2-3 Display Example

Fig. 5-7 shows an example of display when the Model S-4023 Split Screen/Dual Magnification Unit is combined.

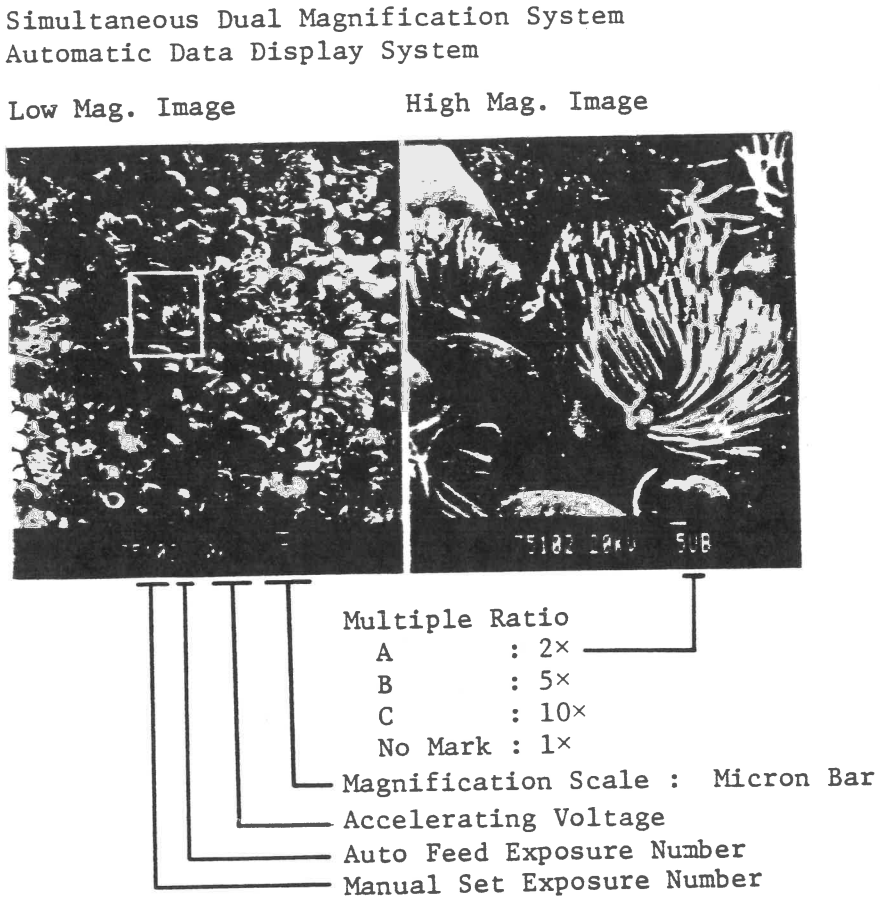


Fig. 5-7 Display Example

5-2-4 Functions of Switches and Controls

The functions of switches and controls on the Model S-5006A Automatic Data Display Unit, as shown in Fig. 5-6, are described below.

(1) [MANUAL] Switch

The three higher digits of the numeric display can be preset manually by use of this switch.

(2) [AUTO] Counter

The two digits following the three higher digits preset by (1) are indicated on this counter and counted up by +1 as a photographic exposure is finished.

(3) [RESET] Button

This button is to reset the [AUTO] counter mentioned in (2). Once the 2-digit display is reset to 0 by this button, it is not affected by further depressing the button.

(4) [DATA ERASE] Switch

When this switch is turned to [OFF], no data is displayed.

(5) [BACKGROUND] Selector Switch

When this switch is set to [BLACK], the data background turns black as shown in Fig. 5-7. When this switch is set to [IMAGE], the characters are displayed on the specimen image.

Notes 1. The size and position of display characters may vary more or less depending upon the scanning speed. But this may be disregarded.

2. When different cameras are used, the display may be shifted downward to be partly excluded from the effective field of the film frame, due to the variation in the camera optics. In such a case, shift the display position properly by use of a knob for VR1 provided on the left side of the Model S-5006A.

5-3 MODEL S-4004 X-RAY MODE UNIT

The Model S-4004 X-ray Mode Unit is designed for providing various scanning modes for carrying out the non-dispersive x-ray analysis with the Scanning Electron Microscope and for processing the signals derived from the x-ray rate meter and pulse height analyzer into the waveforms suited for the CRT display.

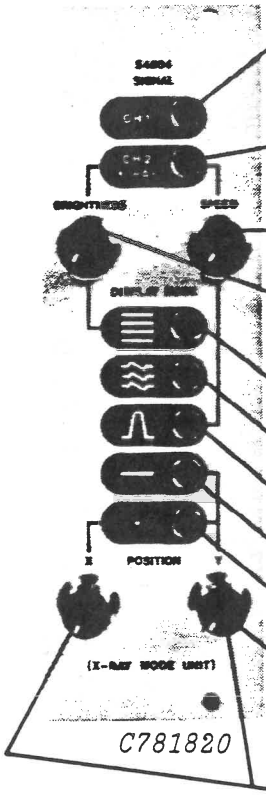
5-3-1 Major Specifications

- o Scanning Modes : Raster scan
  Oblique
  Line analysis
  Line set
  Spot
- o Signal Input Terminals : For x-ray pulse height analyzer signal (TTL)

  For x-ray rate meter signal
  (0 ~ +10 V, 0 ~ -10 V, polarity selectable within the unit)

  For video signal
  (To be used for observing AE or TE signal image.)

5-3-2 Description of Control Panel



CH1 : For observing AE, RE or TE signal. (AE, RE or TE signal device is optionally available.)

CH2 X-RAY : To be depressed when observing the x-ray signal.

SPEED : To set the scanning speed for line analysis in the x-ray mode.

BRIGHTNESS : To adjust the brightness when observing the plane analysis image using the x-ray signal.

RASTER SCAN

OBRIQUE

LINE ANALYSIS

LINE SET

SPOT

LINE SET Y

SPOT POSITION X, Y

Fig. 5-8 Panel Layout of Model S-4004 X-Ray Mode Unit

5-3-3 Operational Instructions

(1) Selection of Signals

Select the pushbutton switches depending upon the signals to be observed as shown in Table 5-1.

Table 5-1 Signal Selection

Pushbuttons / Signals	EXT	CH1	CH2 X-RAY
SE	OFF	OFF	ON
AE and others	ON	ON	OFF
X-RAY	ON	OFF	ON

(2) Selection of Scanning Modes

Select the scanning modes as shown in Fig. 5-8.

5-4 6 x 7 CAMERA UNIT

This unit comprises a camera for photographing the CRT image on a scanning electron microscope or scanning image observation device of an electron microscope.

5-4-1 Composition

The 6 x 7 Camera Unit consists of the following components.

(1)	Main Body (with lens)	1
(2)	Mamiya Adapter	1
(3)	6 x 7 Roll Film Holder	1
(4)	Focusing Hood	1
(5)	Flange	1
(6)	Spacer 67	1
(7)	Lens Hood	1
(8)	Setscrew (M6)	1

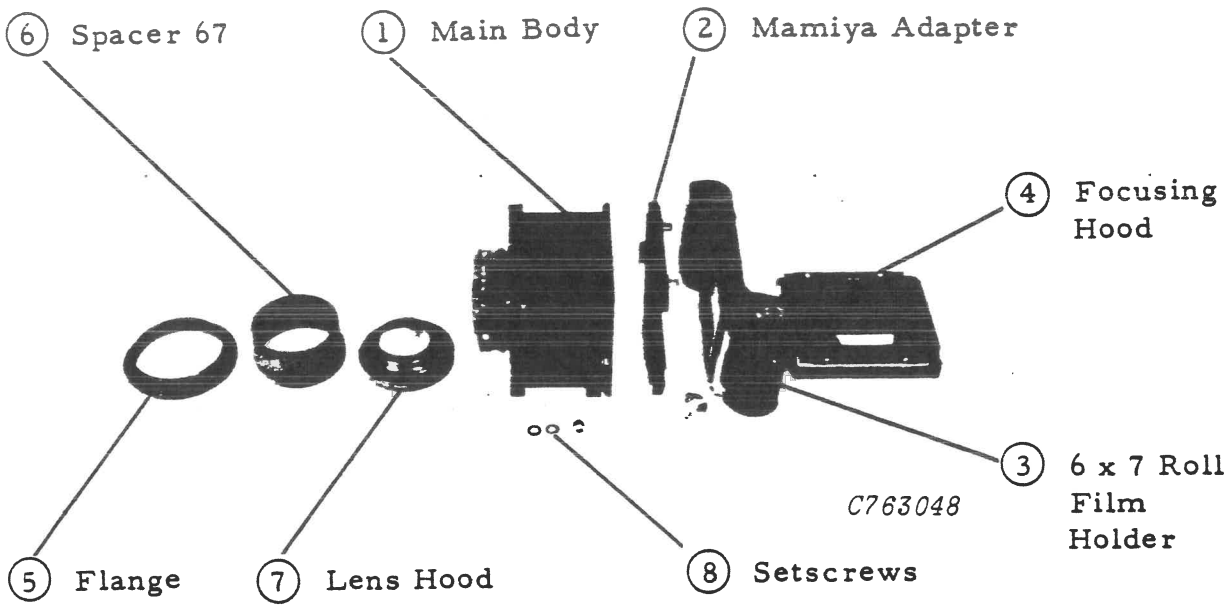


Fig. 5-9 Composition of 6 x 7 Camera Unit

5-4-2 Major Specifications

(1) Lens : 65 mm, f6.3

(2) Aperture : f6.3 ~ 32

(3) Shutter : Manual, speed settings: T, 1 ~ 1/400 sec

(4) Magnification : Approx. 1 : 0.6

(5) Film : #120 roll film (10 exposures)

(6) Dimensions : 190 (L) x 206 (W) x 116 (H) mm

5-4-3 Use with S-450/S-430

(1) Installation

The 6 x 7 Camera Unit mounted on the Display Unit of S-450/S-430 is shown in Fig. 5-10.

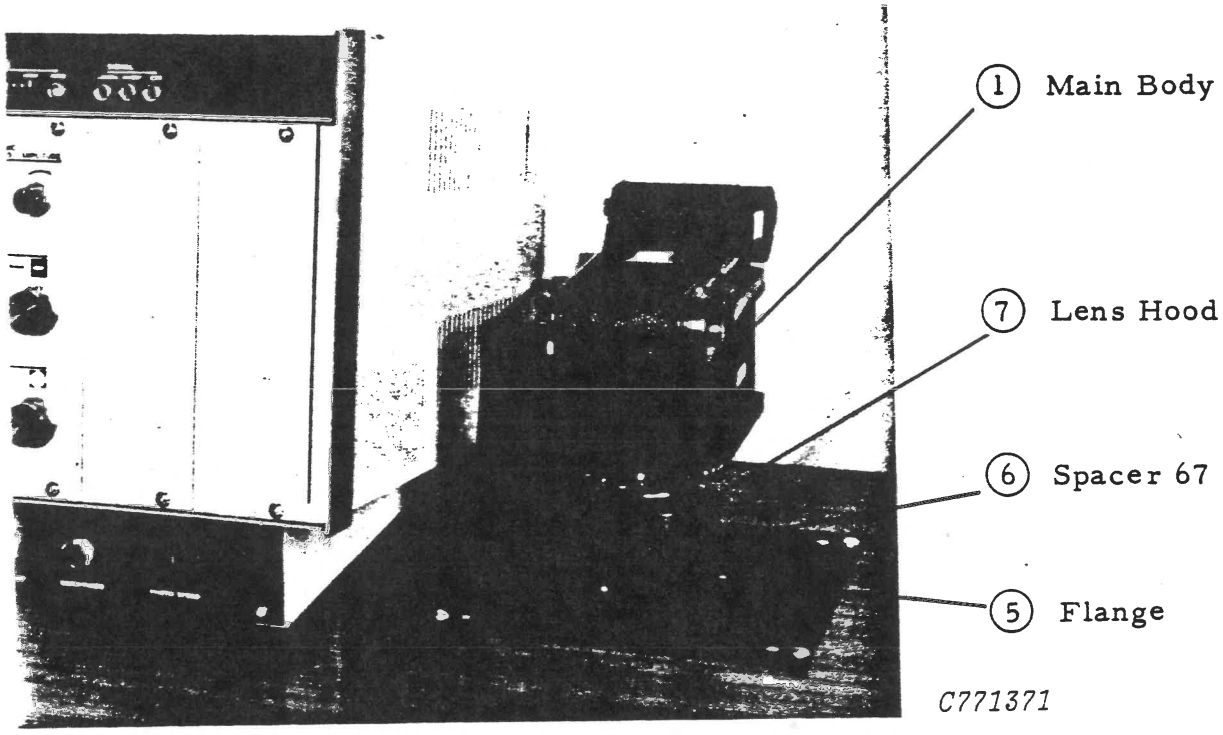


Fig. 5-10 An Outer View of 6 x 7 Camera Unit

The installing procedures are as described below.

1) Mount the flange (5) onto the panel of photographing CRT. (When the unit is delivered with S-450/S-430, the flange is mounted before shipping.)

2) Fix the main body (1) onto the camera support of Display Unit by use of setscrew.

3) Insert the spacer 67 (6) into the flange (5).

4) Put the lens hood (7) onto the front of lens.

(2) Focusing Adjustment

o Preparation

After having installed the 6 x 7 Camera Unit, the focus is to be adjusted through the following procedures.

1) Depress the adapter stoppers at both sides of main body to remove the Mamiya adapter and the 6 x 7 roll film holder.

2) Mount the focusing glass in place of Mamiya adapter and fix it with adapter stoppers.

3) Remove the hood from the focusing glass.

4) The shutter operating procedures are shown in Fig. 5-11.

(A) Shutter Open

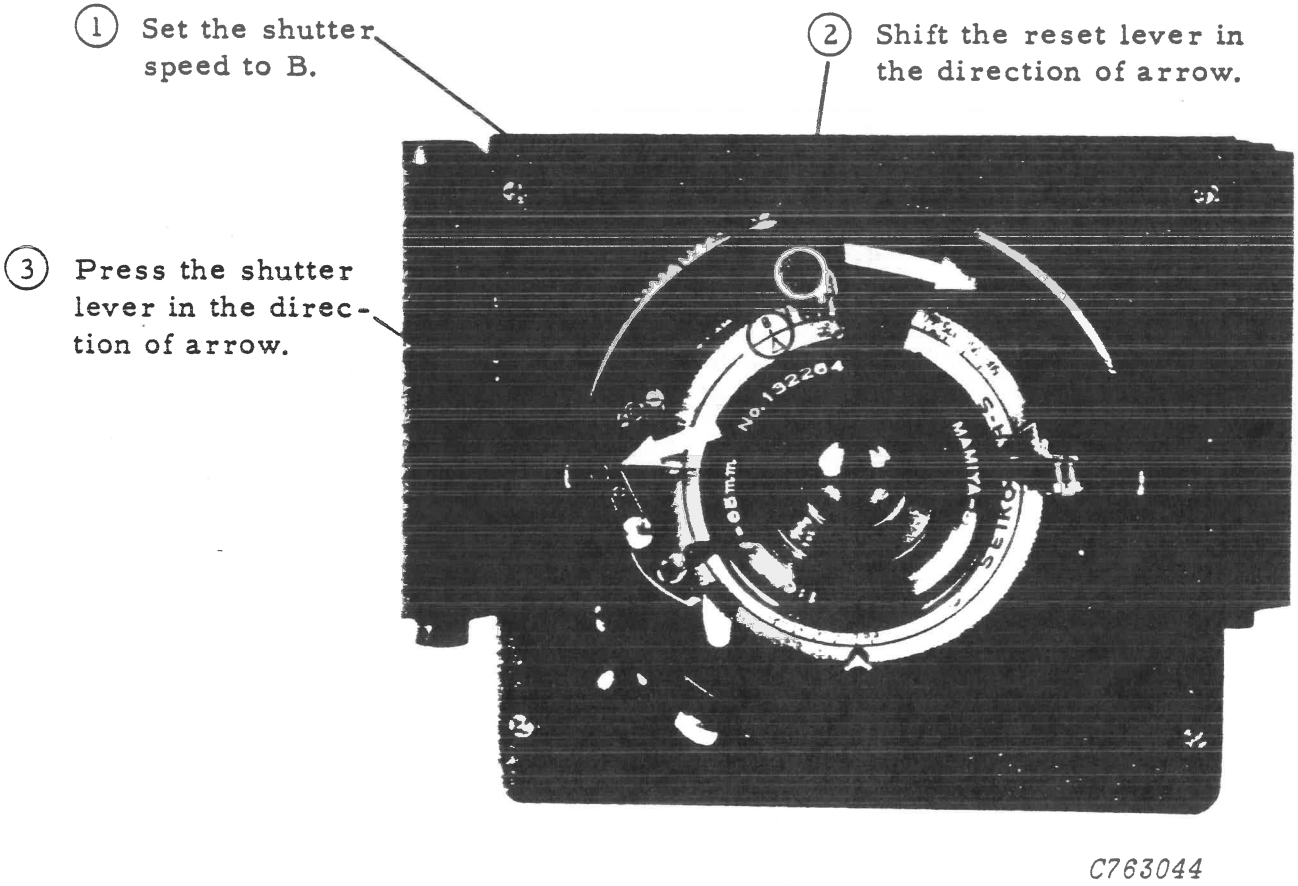
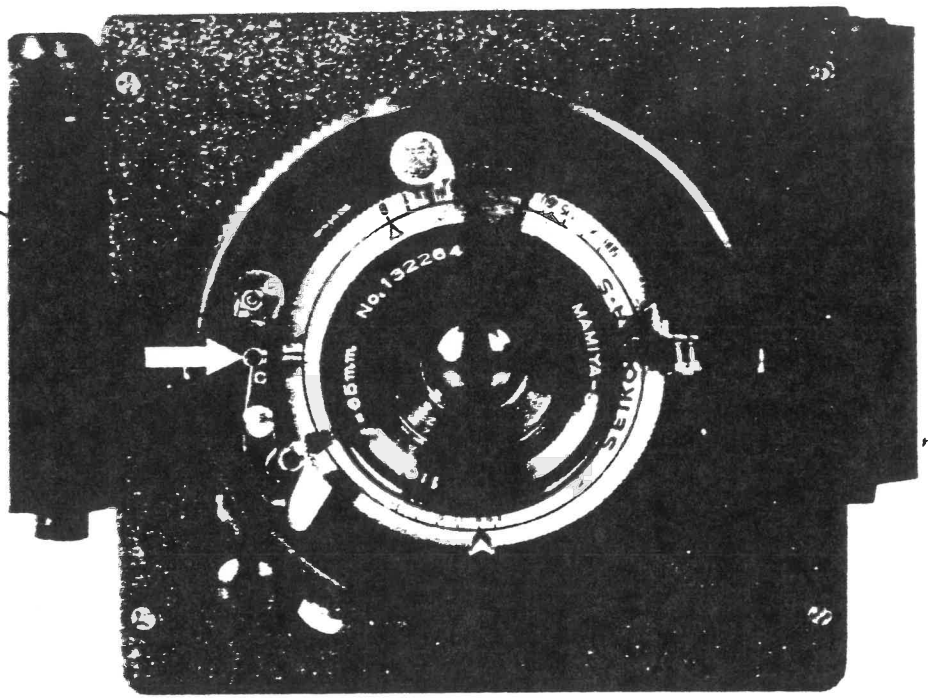


Fig. 5-11 Shutter Operating Procedures (1/2)

(B) Shutter Closed

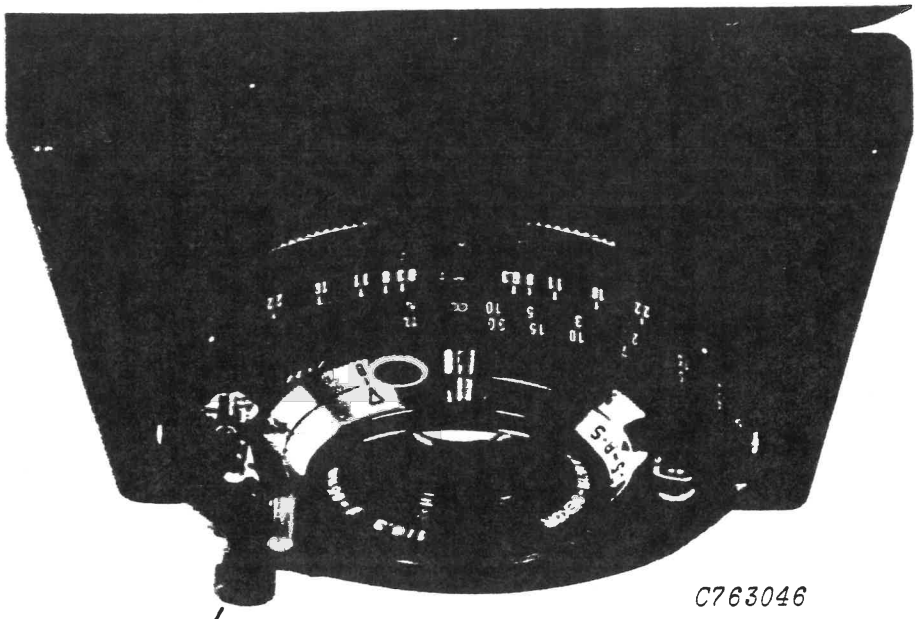
④ Press the shutter lever in the direction of arrow, and the shutter will close.



C763045

Fig. 5-11 Shutter Operating Procedures (2/2)

5) Set the range ring of lens to infinity (∞).



C763046

Set ∞ mark of range ring to ▼ mark.

Fig. 5-12 Setting of Range Ring

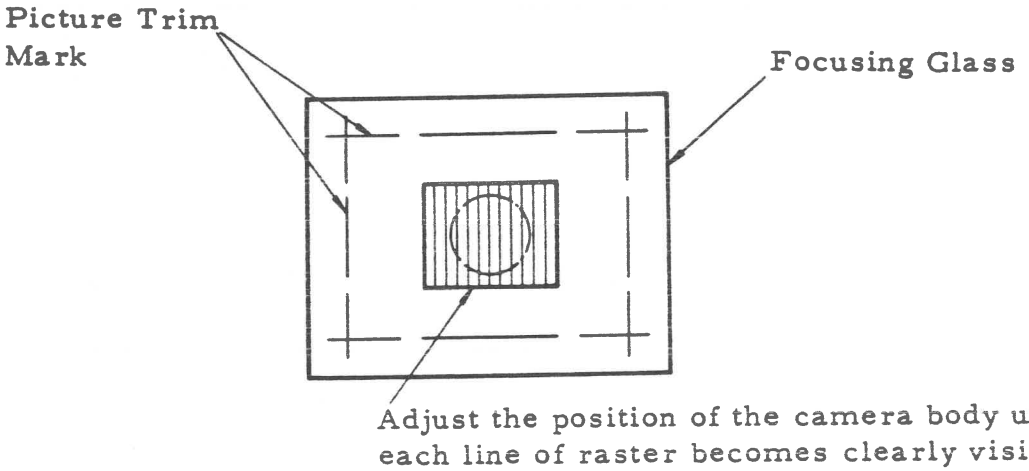
o Focusing Procedures

1) Turn ON the MAIN switch of Display Unit and depress [PHOTO] button of FOCUS MONITOR switch.

2) Set the aperture ring of lens to 6.3.

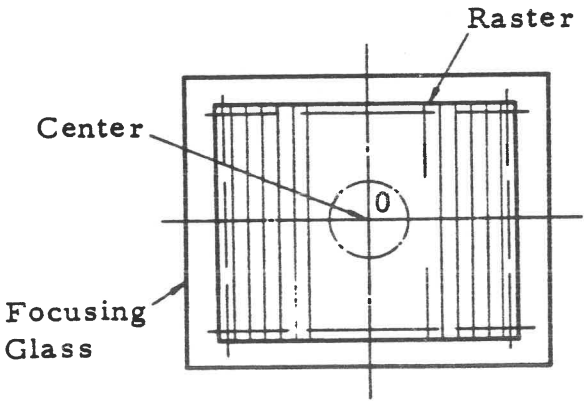
3) Turn BRIGHTNESS control of Display Unit clockwise, and the raster will be seen on the focusing glass.

4) Loosen the setscrew of the camera body a little and shift the body to and fro until each line of raster becomes clearly visible on the glass.

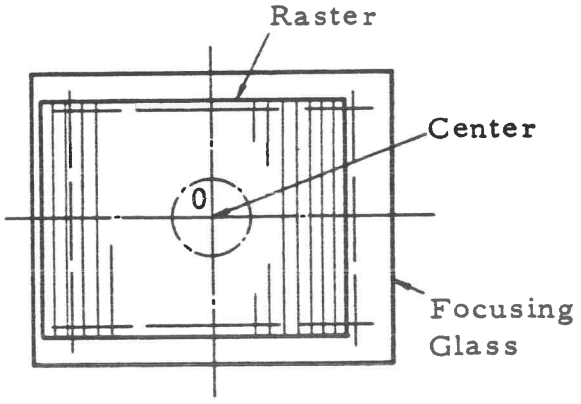


5) If the picture trim mark is not centered exactly, shift the camera body to left or right. After setting properly, fasten the camera body with the setscrew.

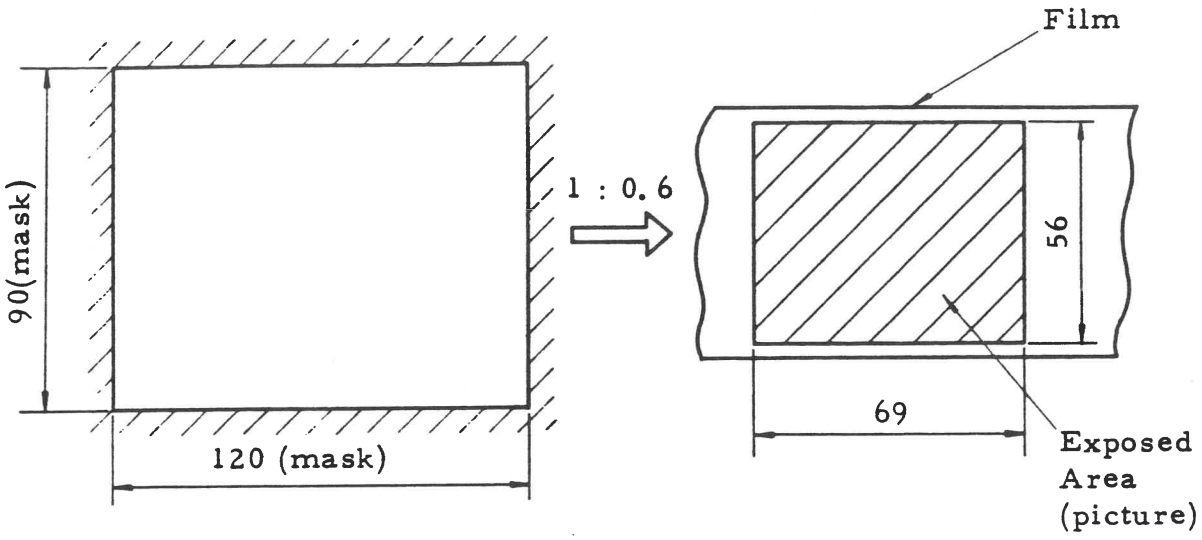
(A) Picture Trim Mark Centered



(B) Picture Trim Mark not Centered Properly



6) The magnification, or the ratio of image size on the CRT screen to picture size on the film is 1 : 0.6.



On the CRT Screen (PHOTO) On the Film

7) Set the aperture ring of lens to 8.

8) Remove the focusing glass from the camera body, and mount the Mamiya adapter and the 6 x 7 roll film holder in its place.
Now, the installation and adjustment of camera have been completed.

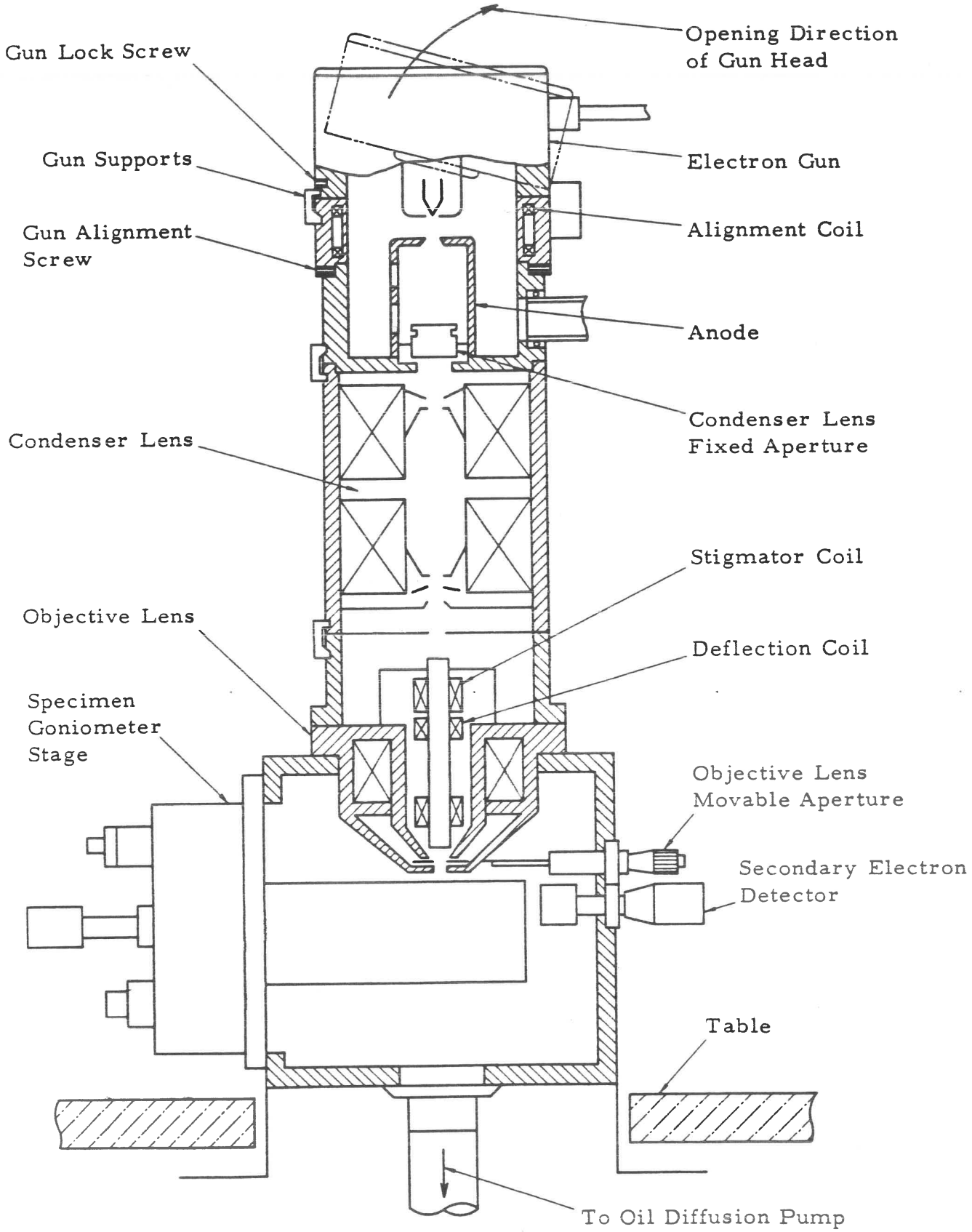
5-4-4 General Precautions

(1) The recommended film is #120 roll film of SS (ASA = 100) or TRI-X (Kodak, ASA = 400).

(2) For loading the film in the camera, read the instructions attached to the 6 x 7 roll film holder.

(3) When the Camera Unit is not used for a long time with film loaded, it is recommended to insert a plate at the front of 6 x 7 roll film holder.

(4) For the details of photographing procedures, see Instruction Manual for S-450/S-430.



Sectional View of S-450 SEM Column

SERVICE MEMO

INSTRUMENT: MODEL S-430 & S-450 SEM

SHEET NO. 177

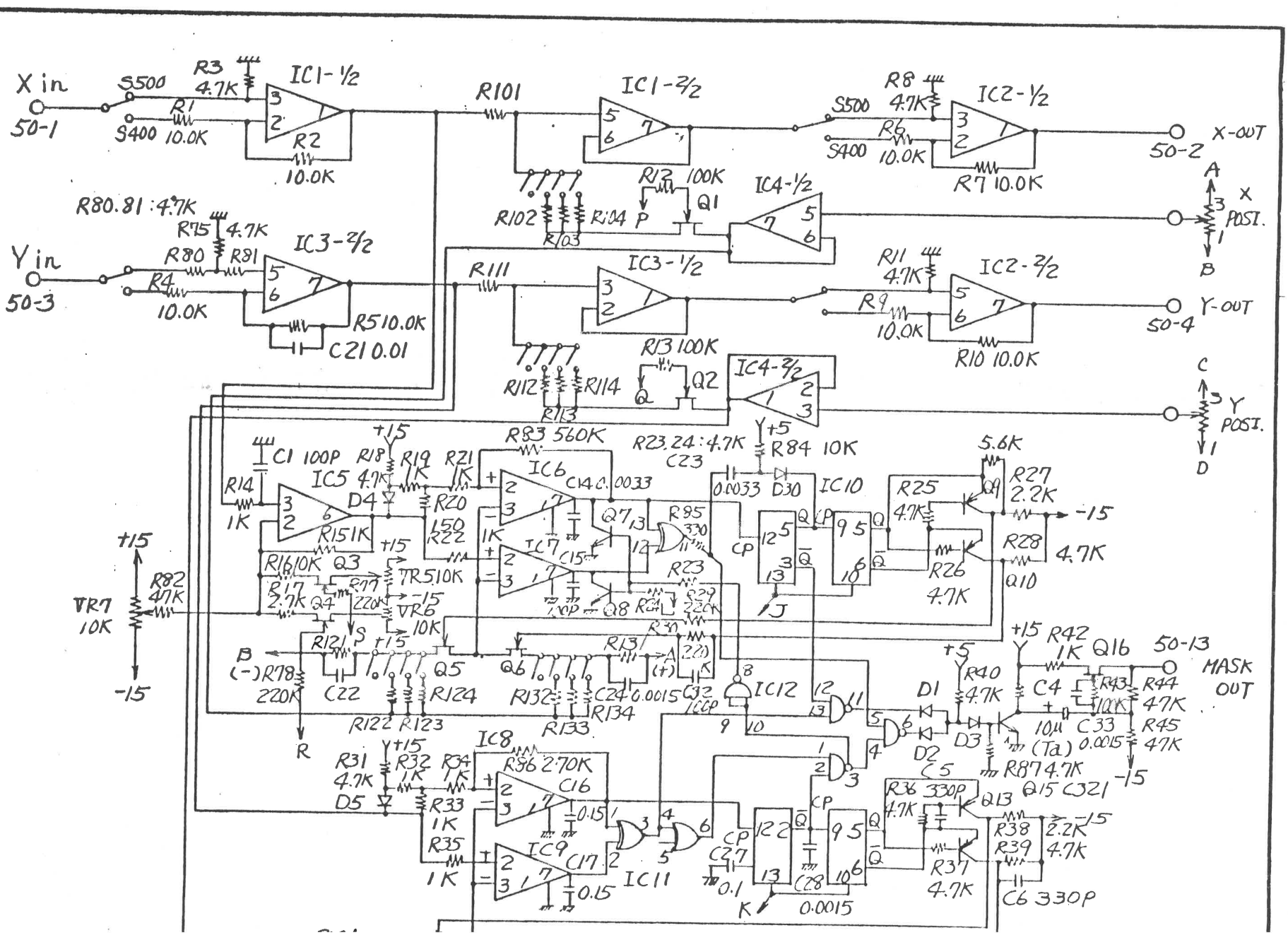
SUBJECT: CIRCUIT DIAGRAMS OF S-430, S-450 SEM ACCESSORIES

DATE: May 22, 1978

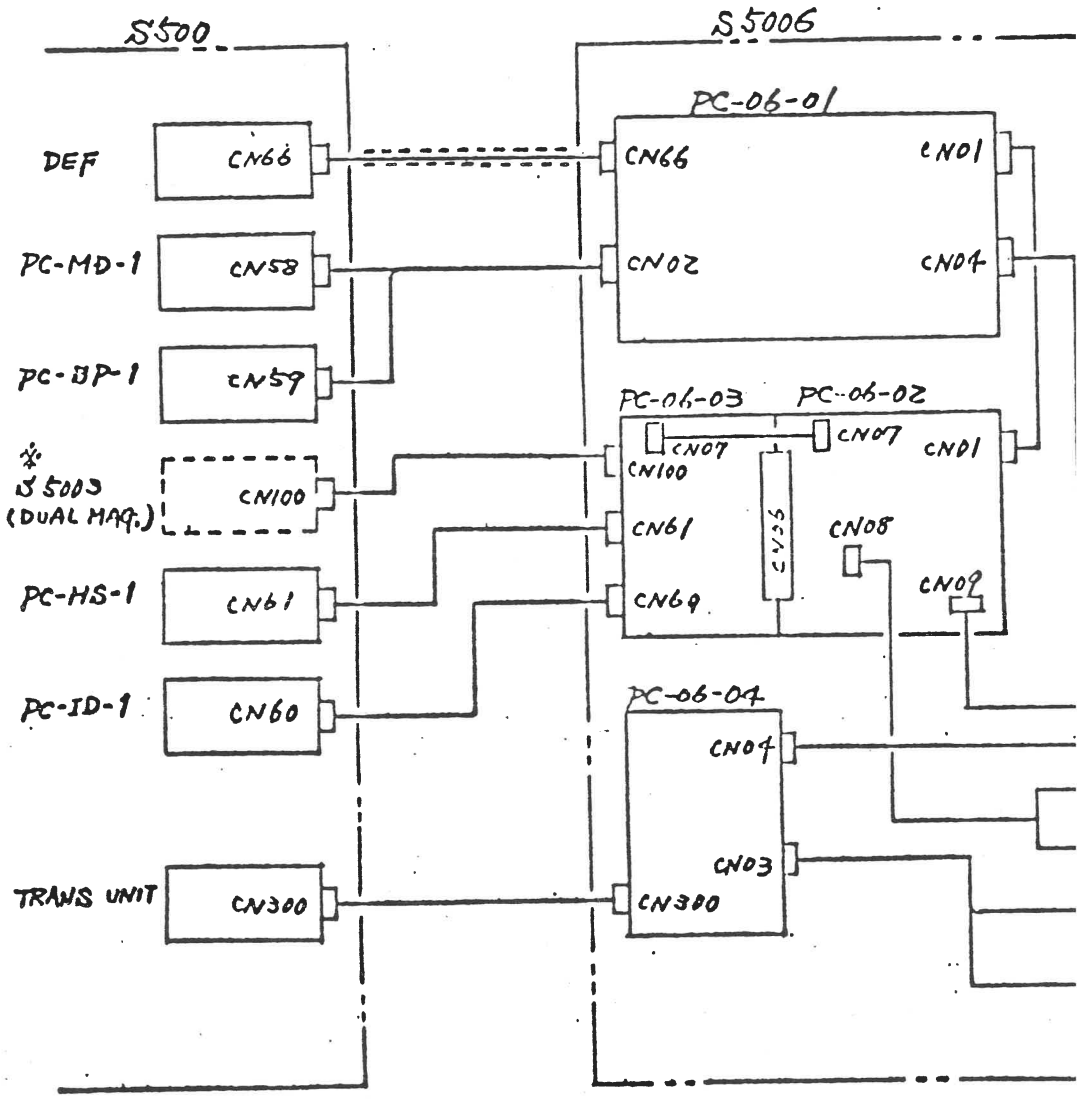
Hitachi, Ltd. Tokyo Japar

The circuit diagrams of the various accessories for S-430 and S-450 SEMs are being sent separately for use by the servicing technicians.

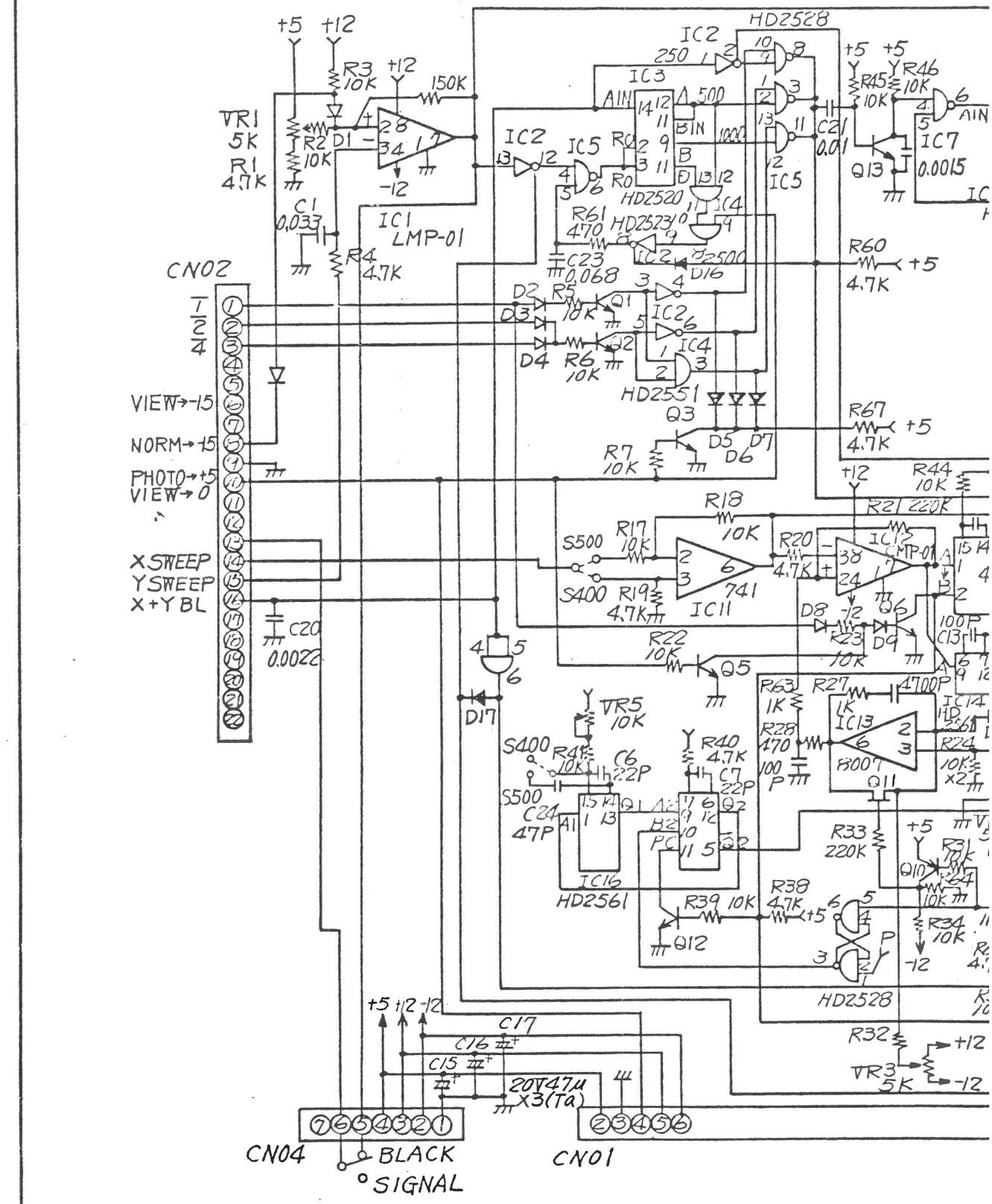
No.	TITLE	DWG. NO.
1	S5003A DUAL MAG CONTROL UNIT	35318032
2	S5006 WIRING DIAGRAM	35339182
3	S5006A PC-06-01	35318033
4	S5006 PC-06-02	35339184
5	S5006 PC-06-03	35339185
6	S5006 PC-06-04	35339186
7	S5006 AUTO COUNTER WIRING DIAGRAM	35339187
8	S5006 THUMB WHEEL SW WIRING DIAGRAM	35339188
9	S4007 WIRING DIAGRAM	35318034
10	S4007 PC-07-01	35318035
11	S5008/S5009 CIRCUIT DIAGRAM	35318036
12	S5031 PC-31-01	35339191
13	S5032 WIRING DIAGRAM	35339192
14	S5032 PC-32-01	35339193
15	S5032 PC-PMHV-1	35339194
16	ATT. PS. WIRING DIAGRAM	35339196
17	S4004 X-RAY MODE UNIT-1	35318037
18	S4004 X-RAY MODE UNIT-2	35318038
19	S4004 X-RAY MODE UNIT-3	35318039

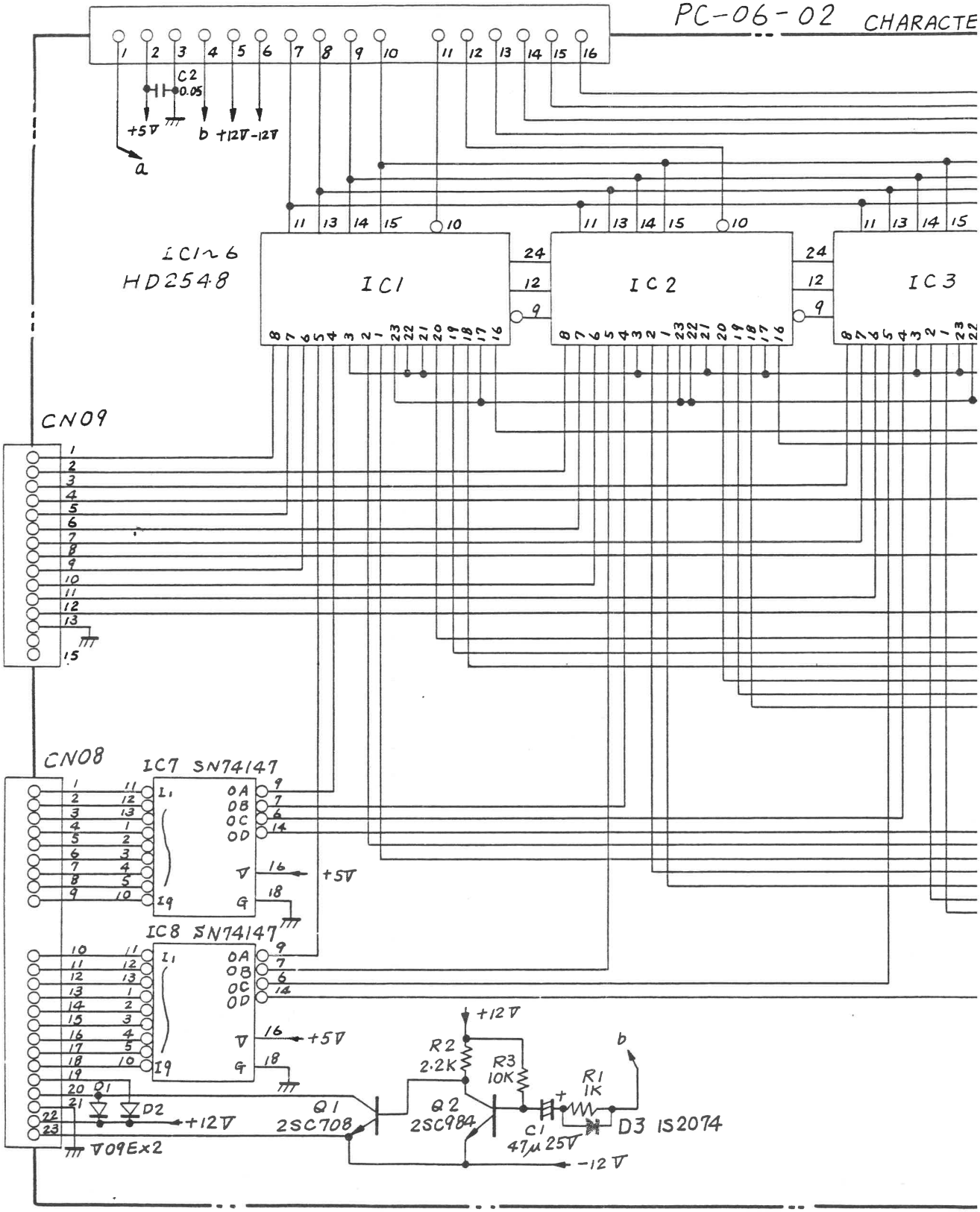


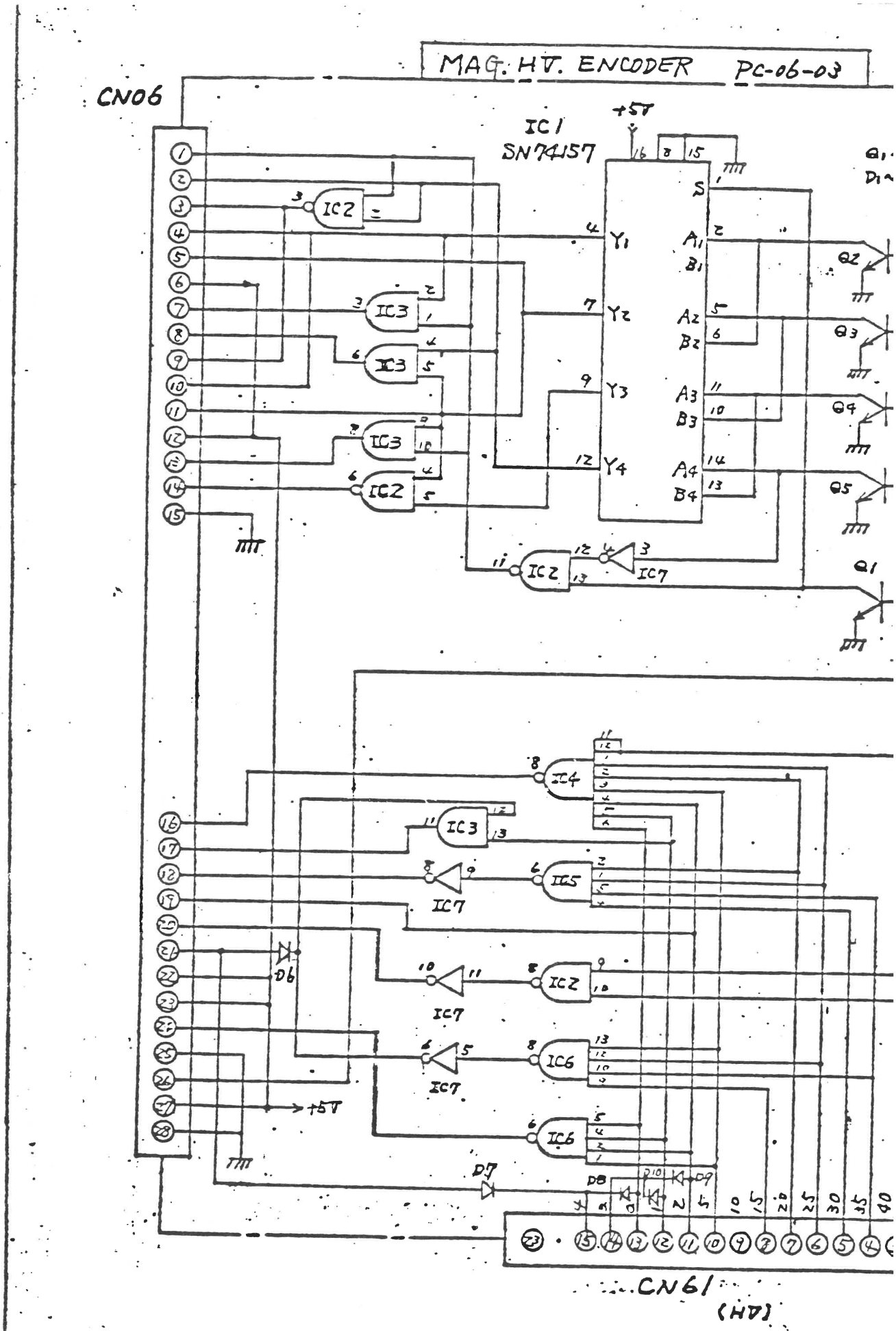
NAKA DWG. PAPER A3. (420X297) (単位mm) 01200SHT-5

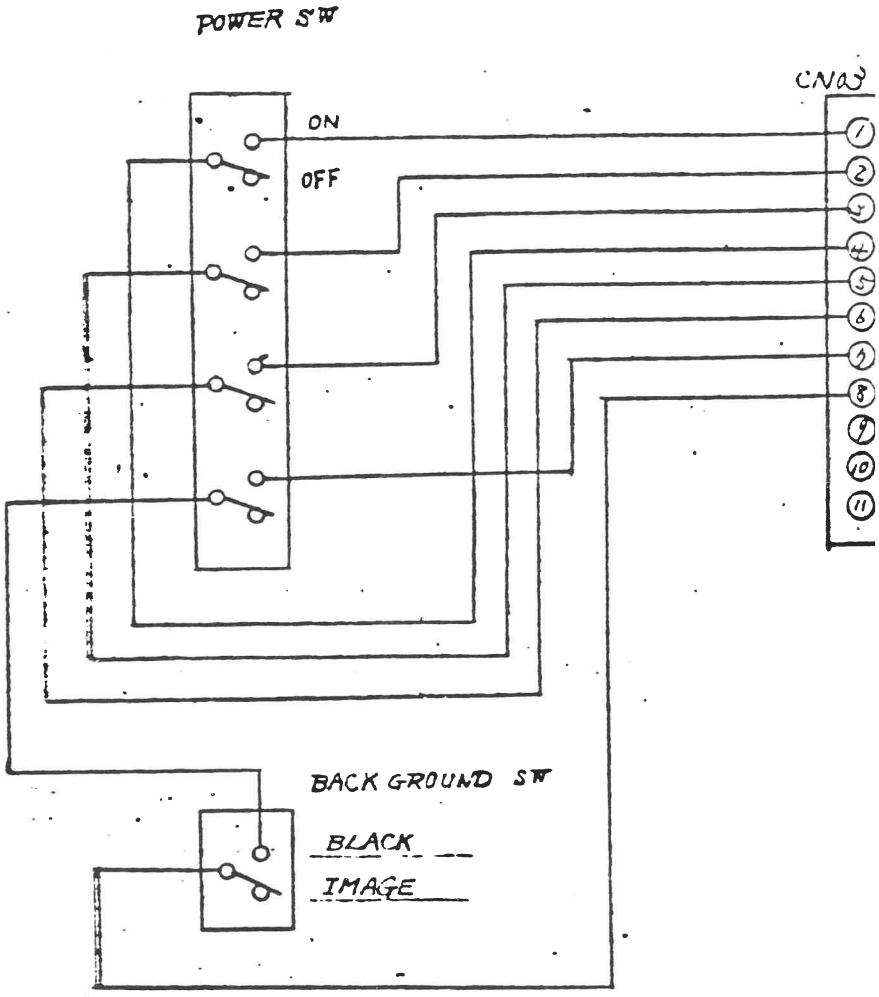


※ S5003; OPTIONAL


+5 +12
VR1 5K
R1 4.7K
R2 10K
R3 10K
150K
C1 0.033
R4 4.7K
IC1 LMP-01
CN02
1/2/4
VIEW→-15
NORM→-15
PHOTO→+5
VIEW→0
XSWEEP
YSWEEP
X+YBL
C20 0.0022
IC2 HD2528
IC3
IC5 HD2520
IC4 HD2523
IC2 HD2500
R61 470
C23 0.068
R5 10K
Q1
D2
D3
D4
R6 10K
Q2
IC2
IC4
HD2551
Q3
D5
D6
D7
R7 10K
R60 4.7K
R67 4.7K
R44 10K
R21 220K
R18 10K
R17 10K
S500
S400
R19 4.7K
IC11 741
R20 4.7K
IC12 LMP-01
D8
R23 10K
D9
Q6
100P
C13
R22 10K
Q5
D17
VR5 10K
R41 10K
C6 22P
R40 4.7K
C7 22P
S500
C24 47P
IC16 HD2561
R39 10K
Q12
R63 1K
R27 1K
4700P
R28 470
100P
IC13 M5007
Q11
R24 10K x2
R33 220K
R38 4.7K
R34 10K
HD2528
R32
VR3 5K
C17
C16
C15
20V47μ
X3(Ta)
CN04
BLACK
SIGNAL
CN01

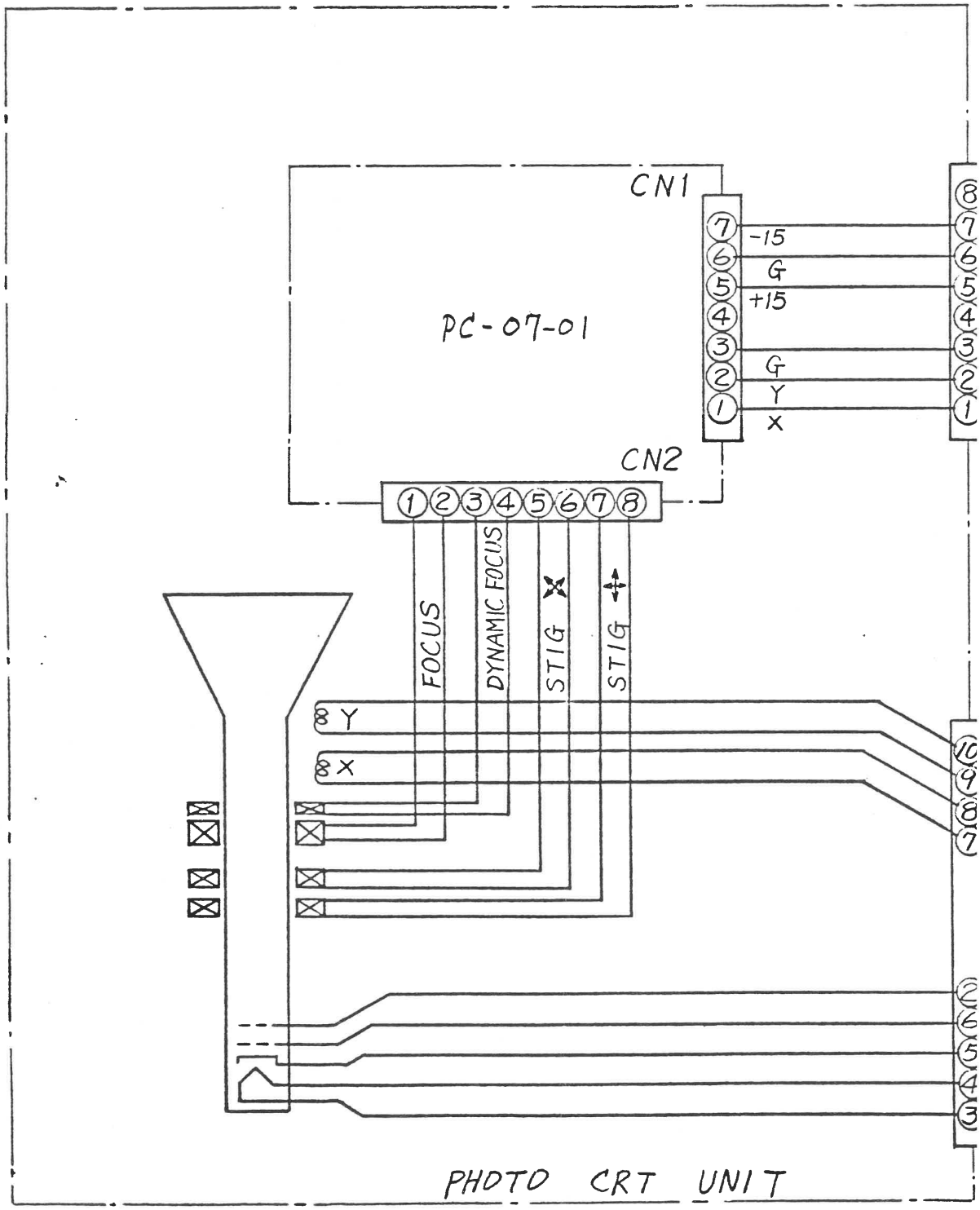

PC-06-02 CHARACTE
C2
0.05
+5V
b +12V -12V
a
IC1~6
HD2548
IC1
IC2
IC3
CN09
CN08
IC7 SN74147
IC8 SN74147
+5V
+12V
D1
D2
V09Ex2
Q1
2SC708
Q2
2SC984
R2
2.2K
R3
10K
R1
1K
C1
47μ 25V
D3 IS2074
-12V

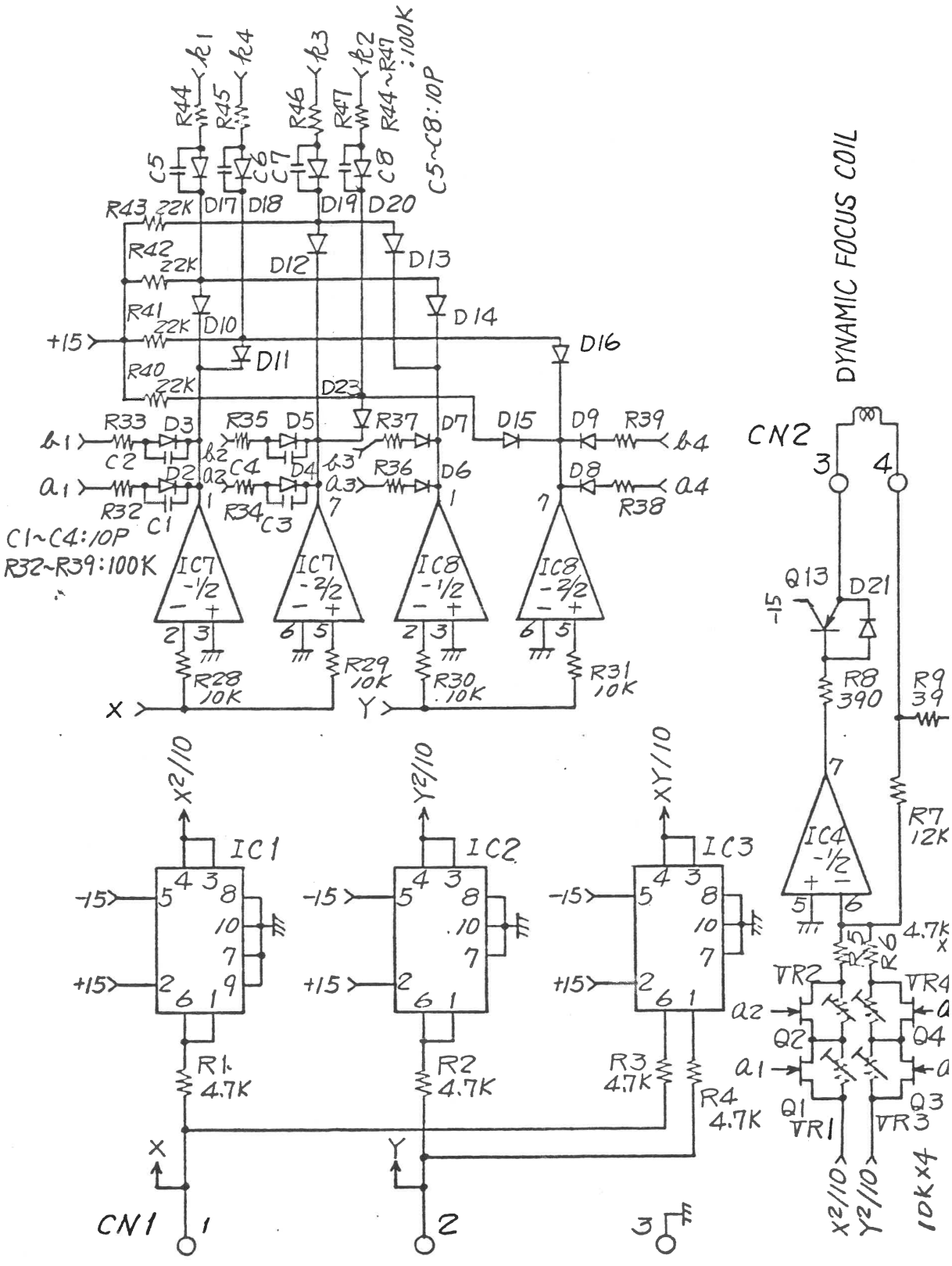

MAG. HT. ENCODER PC-06-03
CN06
IC1
SN74157
+5T
IC2
IC3
IC4
IC5
IC6
IC7
Y1
Y2
Y3
Y4
A1
B1
A2
B2
A3
B3
A4
B4
S
Q1
Q2
Q3
Q4
Q5
D6
D7
D8
D9
D10
+5T
CN61
(HT)

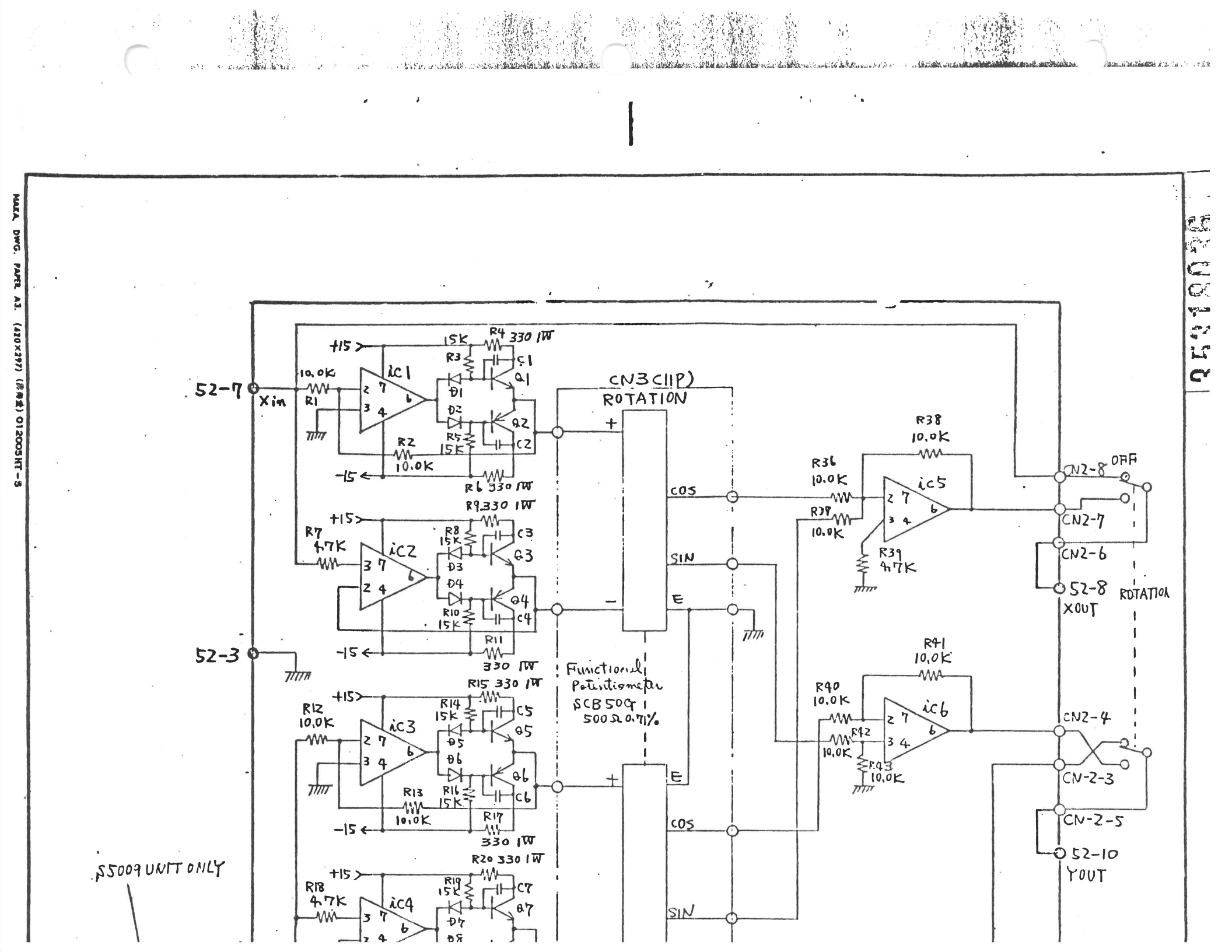

POWER SW
ON
OFF
CN03
1
2
3
4
5
6
7
8
9
10
11
BACK GROUND SW
BLACK
IMAGE

AUTO COUNTER(R)
RESET S
9 open
9→0 close
D1 type
AUTO COUNTER(L)
9 open
9→0 close
D2 type

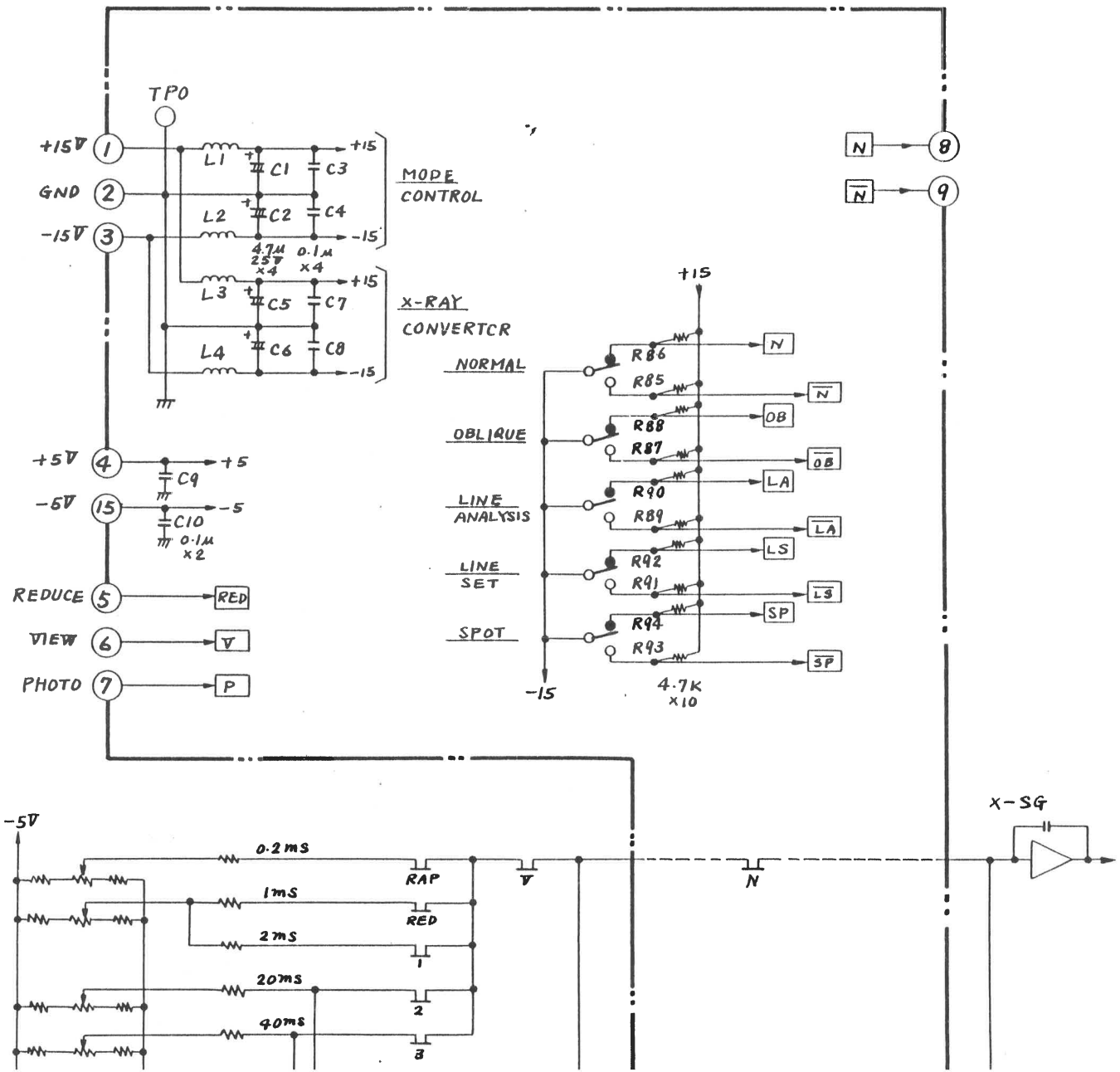
NAKA DWG. PAPER A3 (420×297) (厚さ0.1) 012005HT-5

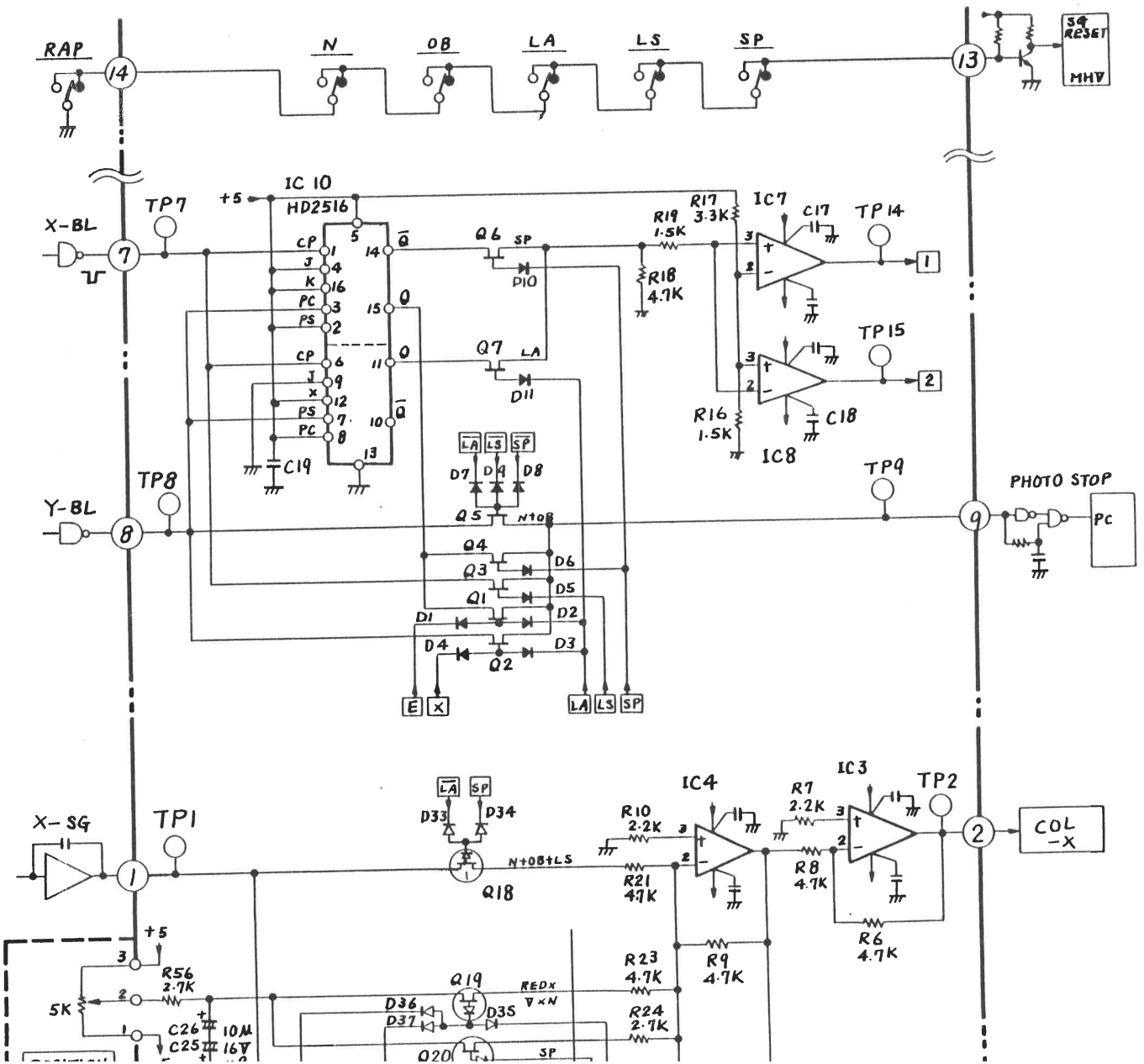

CN1
PC-07-01
7
6
5
4
3
2
1
-15
G
+15
G
Y
X
CN2
1 2 3 4 5 6 7 8
FOCUS
DYNAMIC FOCUS
STIG
STIG
Y
X
PHOTO CRT UNIT

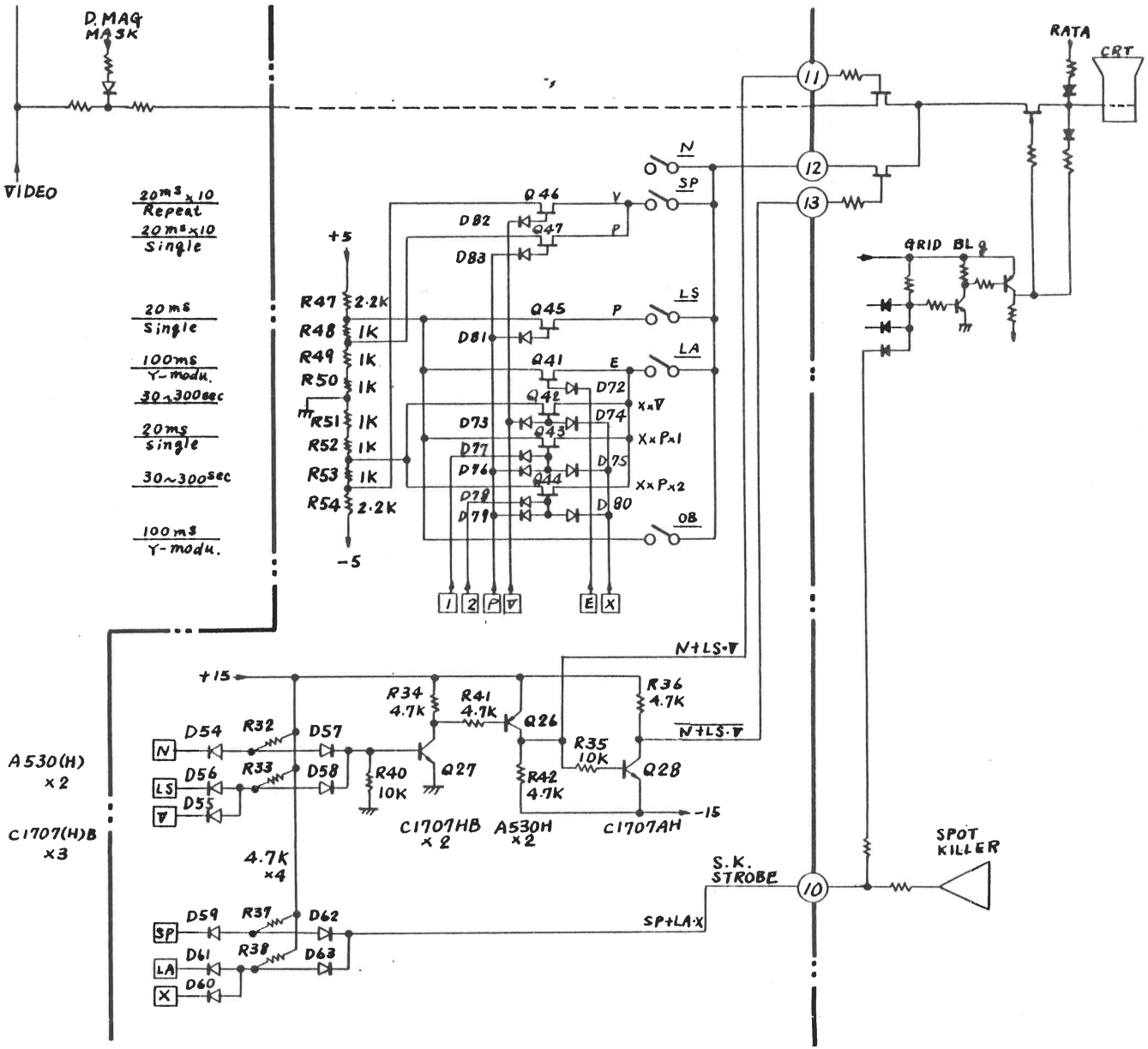

DYNAMIC FOCUS COIL
C1~C4:10P
R32~R39:100K
C5~C8:10P
R44~R47:100K
CN1
CN2
IC1
IC2
IC3
IC4
IC7
IC8
X2/10
Y2/10
XY/10
10K×4

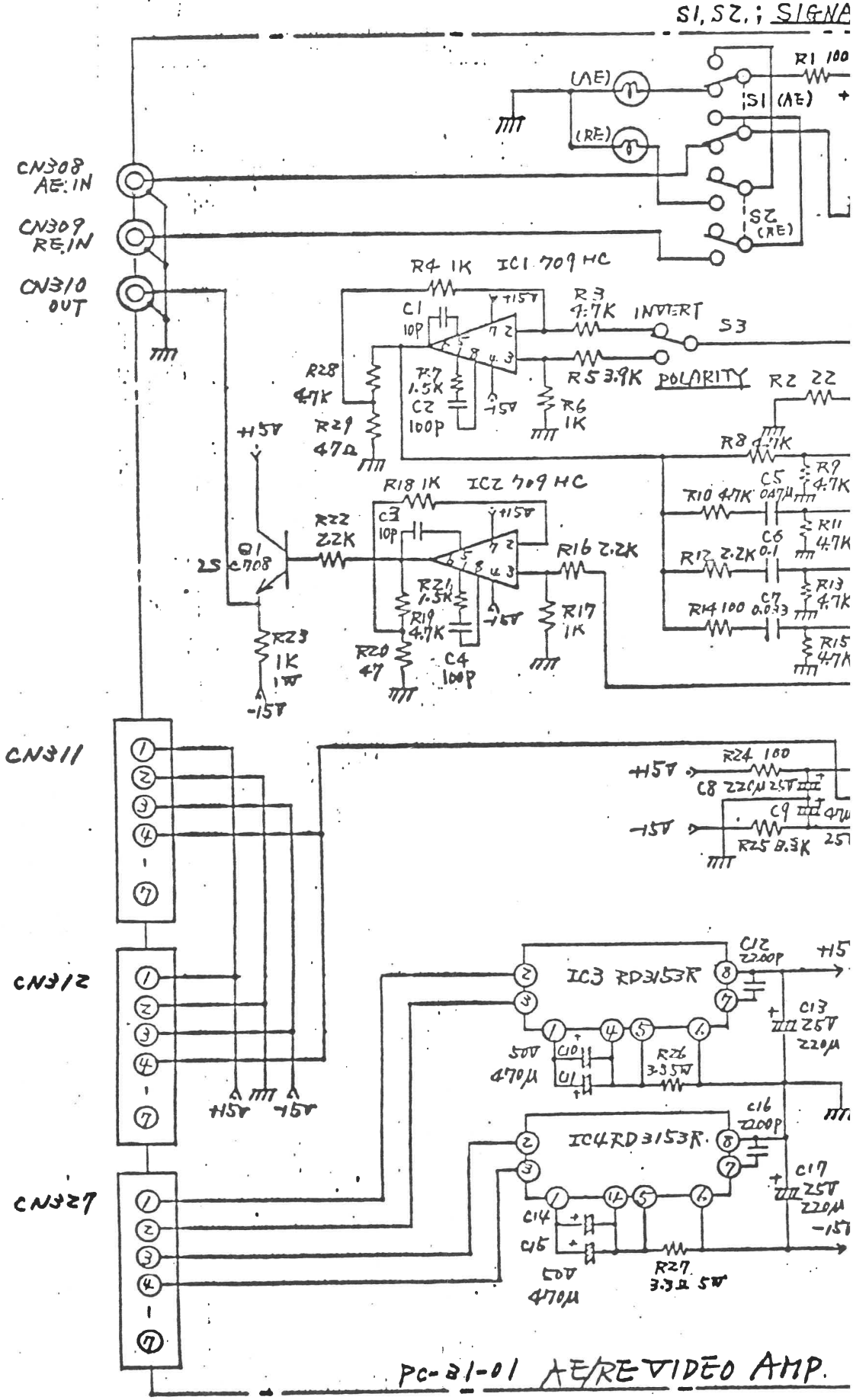


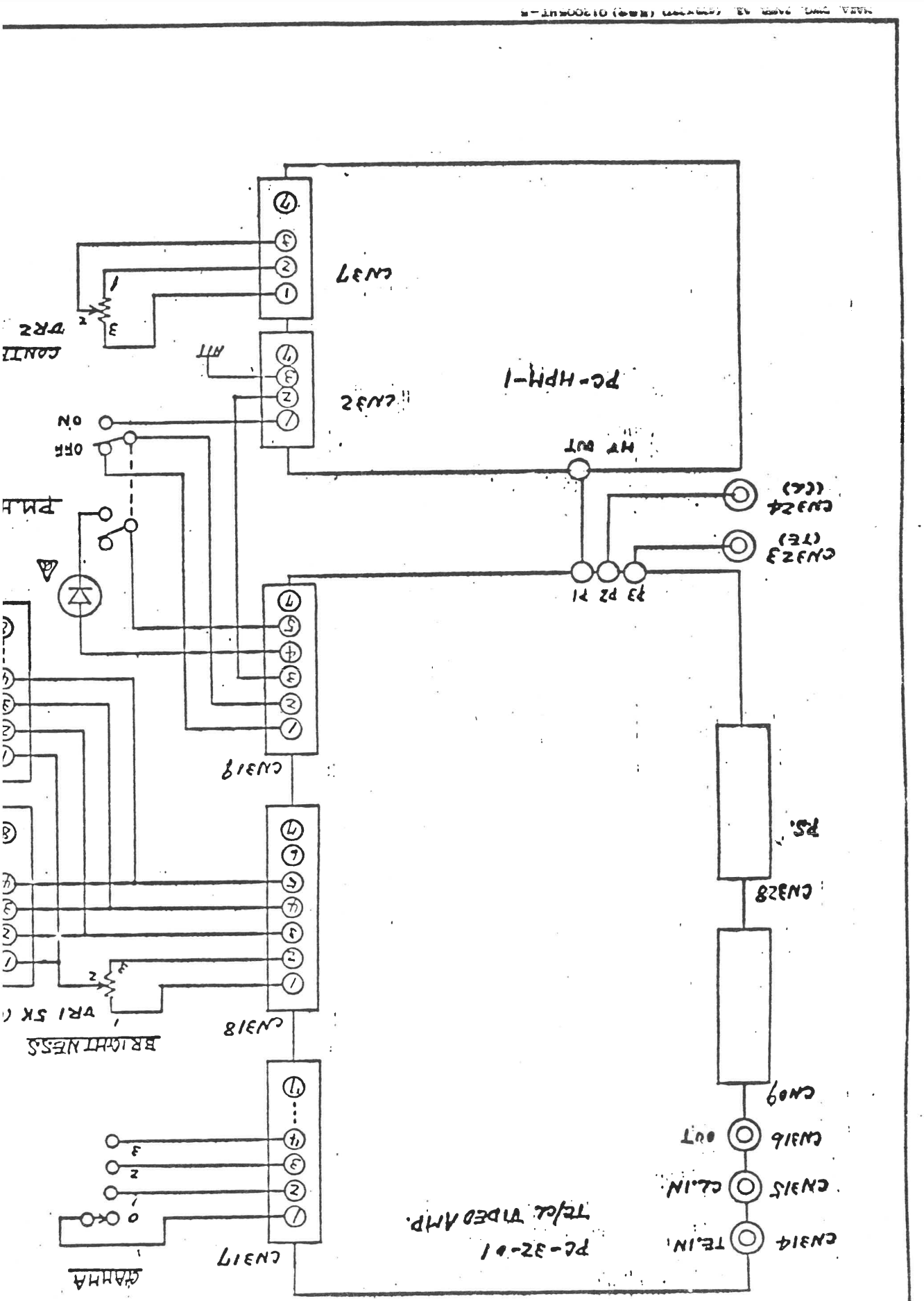
MAEA DWG. PAPER A3. (420×297) (単位mm) 012005KT-5


TP0
+15V
GND
-15V
L1
L2
L3
L4
C1
C2
C3
C4
C5
C6
C7
C8
+15
-15
4.7μ 25V ×4
0.1μ ×4
MODE CONTROL
X-RAY CONVERTCR
+5V
-5V
C9
C10
0.1μ ×2
+5
-5
REDUCE
VIEW
PHOTO
RED
V
P
N
OB
LA
LS
SP
NORMAL
OBLIQUE
LINE ANALYSIS
LINE SET
SPOT
R86
R85
R88
R87
R90
R89
R92
R91
R94
R93
4.7K ×10
0.2ms
1ms
2ms
20ms
40ms
RAP
RED
1
2
3
X-SG

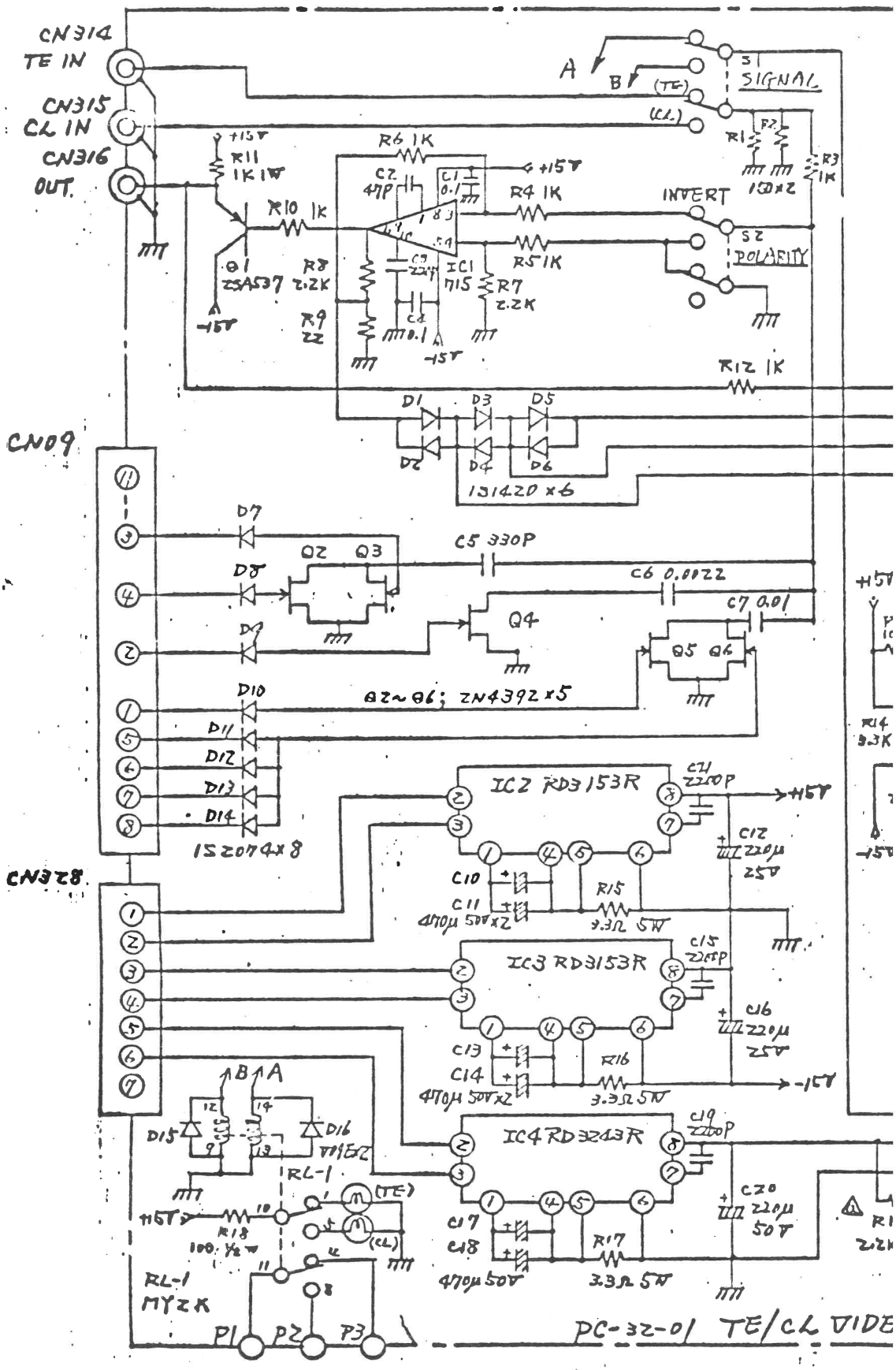

RAP
14
N
OB
LA
LS
SP
13
SG RESET
MHV
IC 10
HD2516
+5
X-BL
TP7
7
CP
J
K
PC
PS
Q
Q6 SP
D10
R19 1.5K
R17 3.3K
IC7
C17
TP14
R18 4.7K
Q7 LA
D11
TP15
R16 1.5K
C18
IC8
C19
TP8
Y-BL
8
D7
D9
D8
Q5 N+OB
TP9
9
PHOTO STOP
PC
Q4
Q3
Q1
D6
D5
D2
D1
D4
D3
Q2
E
X
LA
LS
SP
X-SG
TP1
1
D33
D34
Q18
N+OB+LS
IC4
IC3
TP2
R10 2.2K
R21 4.7K
R7 2.2K
R8 4.7K
R6 4.7K
2
COL -X
+5
3
R56 2.7K
5K
C26 10M
C25 16V
Q19
REDx
D36
D37
D35
V×N
R23 4.7K
R9 4.7K
R24 2.7K
Q20
SP


D.MAG MASK
VIDEO
RATA
CRT
20ms x10 Repeat
20ms x10 Single
20ms Single
100ms Y-modu.
30~300sec
20ms single
30~300sec
100ms Y-modu.
+5
-5
R47 2.2K
R48 1K
R49 1K
R50 1K
R51 1K
R52 1K
R53 1K
R54 2.2K
Q46
Q47
Q45
Q41
Q42
Q43
Q44
D82
D83
D81
D72
D74
D73
D77
D76
D75
D78
D79
D80
N
SP
LS
LA
OB
V
P
E
X×V
X×P×1
X×P×2
1
2
P
V
E
X
GRID BLO
11
12
13
N+LS·V
+15
R34 4.7K
R41 4.7K
R36 4.7K
Q26
R35 10K
Q28
R42 4.7K
Q27
R40 10K
-15
C1707HB ×2
A530H ×2
C1707AH
A530(H) ×2
C1707(H)B ×3
D54
D56
D55
R32
R33
D57
D58
4.7K ×4
D59
D61
D60
R37
R38
D62
D63
SP+LA·X
S.K. STROBE
SPOT KILLER


S1, S2.; SIGNA
R1 100
(AE)
S1 (AE)
(RE)
S2 (RE)
CN308 AE IN
CN309 RE IN
CN310 OUT
R4 1K IC1 709 HC
C1 10P
+15V
R3 4.7K INVERT
S3
R28 47K
R7 1.5K
C2 100P
-15V
R6 1K
R5 3.9K POLARITY
R2 22
R29 47Ω
+15V
R8 4.7K
R9 4.7K
C5 0.47μ
R10 47K
R11 4.7K
C6 0.1
R12 2.2K
R13 4.7K
C7 0.033
R14 100
R15 4.7K
R18 1K IC2 709 HC
C3 10P
R22 22K
Q1 2SC708
R16 2.2K
R21 1.5K
R19 4.7K
R20 47
C4 100P
R17 1K
R23 1K 1W
-15V
CN311
CN312
CN327
+15V
R24 100
C8 220μ 25V
-15V
C9 47μ
R25 8.3K
IC3 RD3153R
C12 2200P
C13 25V 220μ
C10 50V 470μ
C11
R26 3.3Ω 5W
IC4 RD3153R
C16 2200P
C17 25V 220μ
C14
C15
50V 470μ
R27 3.3Ω 5W
PC-81-01 AE/RE VIDEO AMP.

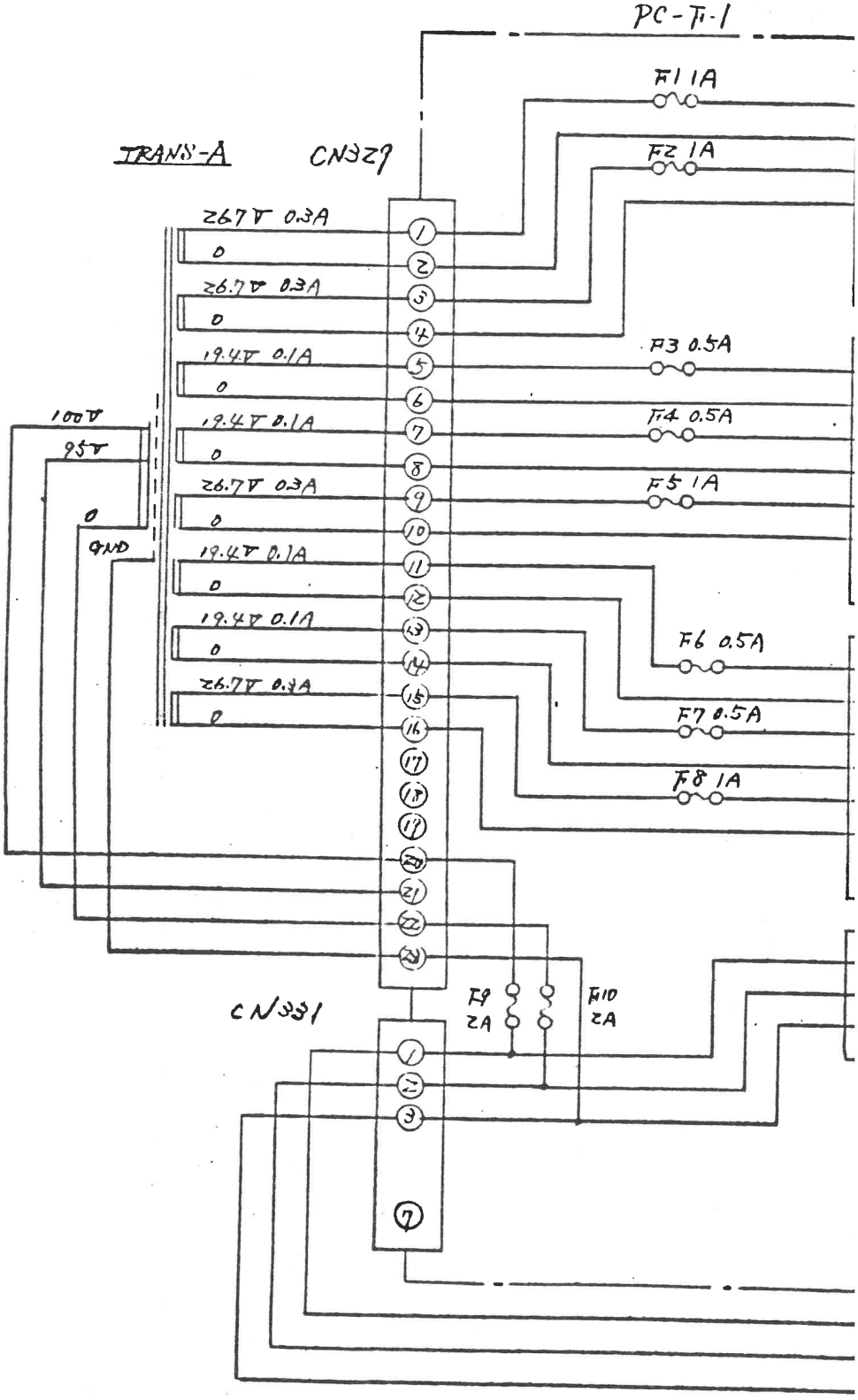

PC-32-01
TE/AL VIDEO AMP.
CN17
CN18
CN19
CN37
CN32
PC-HPH-1
CN14
CN15
CN16
CN09
CN28
PS.
CN24
CN23
HT OUT
TE.IN
CL.IN
OUT
ON
OFF
VR1 SK
VR2
BRIGHTNESS
CONTRAST

35339192


CN314
TE IN
CN315
CL IN
CN316
OUT
A
B
(TE)
(CL)
SIGNAL
INVERT
POLARITY
+15V
-15V
R1
R2
R3 1K
150×2
R4 1K
R5 1K
R6 1K
R7 2.2K
R8 2.2K
R9 22
R10 1K
R11 1K 1W
R12 1K
C1 0.1
C2 47P
C3 22P
C4 0.1
IC1 NJ15
Q1 2SA537
D1
D2
D3
D4
D5
D6
1S1420×6
CN09
D7
D8
D9
D10
D11
D12
D13
D14
1S2074×8
Q2 Q3
Q4
Q5 Q6
C5 330P
C6 0.0022
C7 0.01
Q2~Q6; 2N4392×5
CN328
IC2 RD3153R
IC3 RD3153R
IC4 RD3243R
C10
C11
470μ 50V×2
C12 220μ 25V
C13
C14
470μ 50V×2
C15 220P
C16 220μ 25V
C17
C18
470μ 50V
C19 220P
C20 220μ 50V
R15 9.3Ω 5W
R16 3.3Ω 5W
R17 3.3Ω 5W
R18 100Ω ½W
D15
D16
RL-1
RL-1 MY2K
P1
P2
P3
PC-32-01 TE/CL VIDE

CT-3
C4 0.15μ
R3 3.3K
Q1
C830
C8
0.47
C7 1μ
C6 100μ
50V
CT-1
Q2
C830
Q3
C708
R9
3.3

PC-PMHT-1


PC-T-1
TRANS-A
CN327
F1 1A
F2 1A
F3 0.5A
F4 0.5A
F5 1A
F6 0.5A
F7 0.5A
F8 1A
F9 2A
F10 2A
26.7V 0.3A
0
26.7V 0.3A
0
19.4V 0.1A
0
19.4V 0.1A
0
26.7V 0.3A
0
19.4V 0.1A
0
19.4V 0.1A
0
26.7V 0.3A
0
100V
95V
0
GND
CN331