Service Manual

for the

MODEL S-430 AND S-450 SCANNIG ELECTRON MICROSCOPES

November 1977
Part No. 531-E600

MODEL S-430 AND S-450

SCANNING ELECTRON MICROSCOPES

Table of Contents

Table of Contents (cont'd)

Table of Contents (cont'd)

Section I

HOW TO USE THIS SERVICE MANUAL

This manual applies to the Model S-430 and S-450 Scanning Electron Microscopes and systematically covers, in the troubleshooting procedures, the information required for locating faulty points starting with various phenomena appearing in the instrument. For using this manual effectively, the following items should be observed.

(1) Understand the outlined compositions of the instrument.

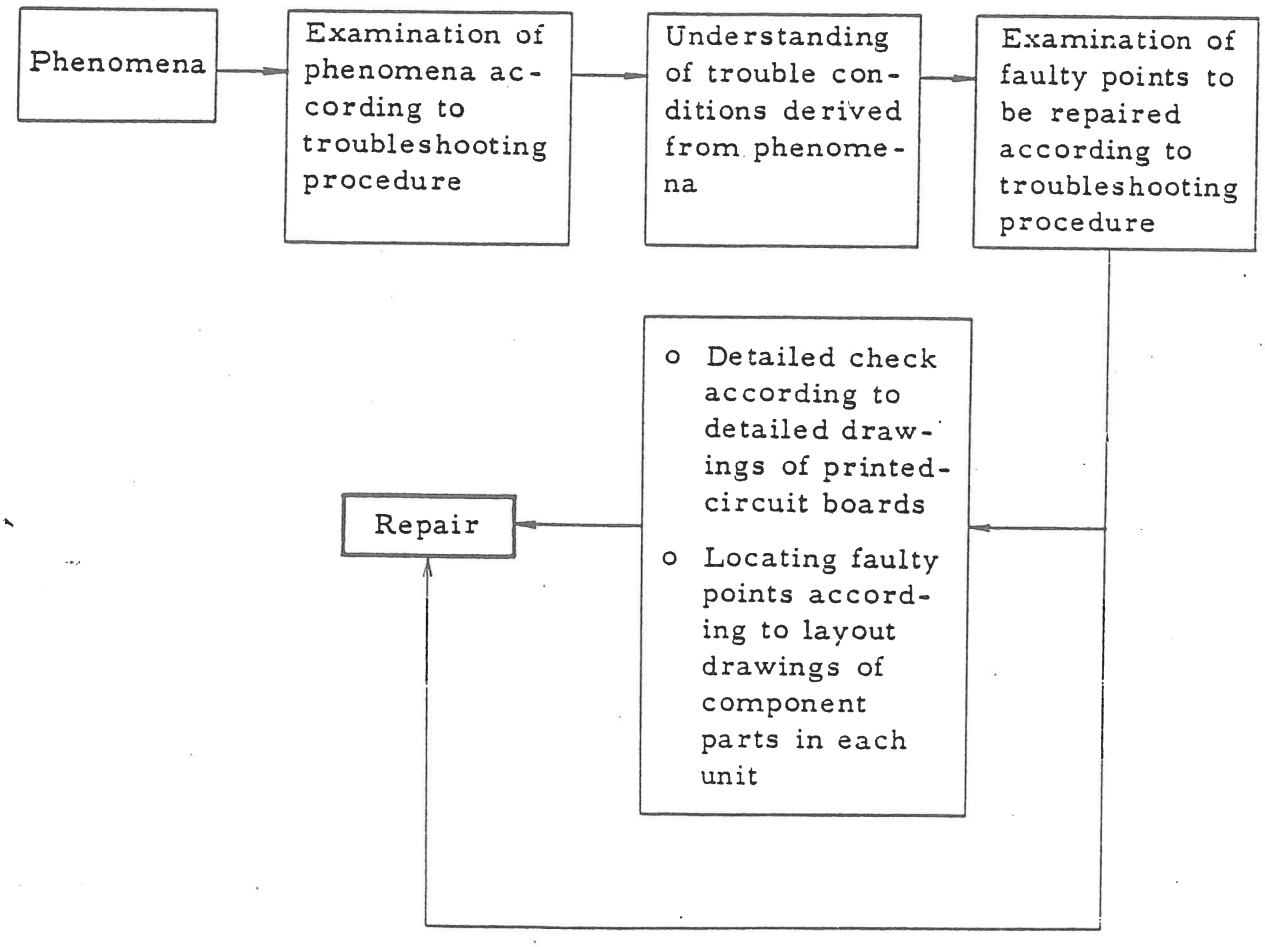
(2) Understand the composition and function of each display unit.

(3) Understand the meanings of phenomena derived from faulty conditions when a trouble occurs, and examine such faulty points to be repaired according to the troubleshooting procedure.

(4) Prepare extension cords for checking details of circuits according to the troubleshooting procedure.

(5) Prepare a circuit tester having an impedance of 20 kΩ/V or higher to be used for circuit checks.

General troubleshooting procedures are as follows:



Section II

PRECAUTIONS ON HANDLING

For the safety of the instrument as well as of the serviceman, the following precautions should be taken into account on the handling.

2-1 PRECAUTIONS FOR TRANSPORT

(1) Do not lift the instrument by holding the table. The strength of the table fitting is not sufficient for bearing the total weight of display unit and the column. Should the table be lifted, the display unit might slip off and crash down. Hence, it is recommended to disconnect the table for transport. Do not hold the instrument by means of the evacuating pipe, the secondary electron detector or the objective aperture fixed to the main console.

(2) The prepared pieces for transport should be applied to the main column before transportation. The specimen stage unit of S-430 should be removed and replaced by the prepared blind lid before transport. For S-450, the stage should be prefixed by the prepared screws. Both for S-430 and S-450, the sleeve for condenser aperture inside the column and the photomultiplier tube inside the detector housing should be removed before transport.

2-2 PRECAUTIONS FOR POWER CONNECTION

(1) When removing the front and rear cover of display unit, turn off the power switches marked "EVAC POWER" and "DISPLAY POWER" without fail.

(2) Connect the grounding wire correctly. Otherwise, not only will the instrument fail to operate normally but there may be a shock hazard. Refer to item 3-3-4.

(3) Following units are dangerous with high voltages and should be handled carefully.

- o High voltage transformer : max 30 kV
- o High voltage units for CRT and the post acceleration : max 10 kV
- o Unit for photomultiplier : max 600 V
- o PC-4 unit : max 600 V
- o CRT : 10 kV
- o Printed board "SG" : max 600 V
- o Secondary electron detector : max 10 kV

(4) When replacing a fuse, turn off the main switch on the distribution board.

(5) When replacing the scintillator, turn off the DISPLAY switch without fail.

(6) Interval of min 5 sec should be maintained for the on-off operation of the "DISPLAY" switch. This is a precaution against the preheated CRT.

(7) Interval of min 5 sec should be kept for the on-off operation of the "EVAC" switch. Otherwise, mis-operation of the evacuating sequence may occur. The intervals are needed for the charge and discharge of the capacitors.

2-3 PRECAUTION ON VACUUM CHECK

When the vacuum is checked by means of Geissler discharge tube, the MANUAL-AUTO switch of the printed board for evacuating sequence should be turned to MANUAL position, or the EVAC POWER switch should be turned off. Otherwise, mis-operation may happen because of discharging impulses.

2-4 PRECAUTIONS ON TEMPERATURE RISE

Temperature of the following units may run up to more than 55°C during normal operation.

- o Oil diffusion pump
- o Oil rotary pump
- o Power supply unit
- o Heat radiators for power IC's
- o Upper part of the condenser lens

2-5 OTHER PRECAUTIONS

(1) Absolutely avoid touching the scintillator surface by hand.

(2) Keep vessels containing flammable organic solvent away from the instrument.

(3) Do not leave solder fragments inside the instrument to avoid "short-circuit" troubles.

(4) Characteristics of photomultiplier are quite sensitive to light. Keep it protected from light radiation at all times.

(5) Avoid any mechanical shock to the CRT and the photomultiplier.

Section III
INSTALLATION

3-1 UNPACKING

3-1-1 Removal of Shipping Crate

(1) Remove the top and four side shipping panels.

(2) Remove the shipping frames from the bottom panel of the shipping crate.

3-1-2 Unpacking Procedure

(1) Main Console

Carry the main console (column, evacuating system, and rack) into the installation room using a fork lift or by other appropriate means.
Exercise care to avoid jolting the instrument.

(2) Display Unit

Exercise the same care as with the column.

(3) Other Units

Carry the other units into the installation room before unpacking from their cartons. Keep the cartons upright and use extreme care.

3-1-3 Unpacking

(1) Unpacking the Main Console

Remove all vinyl covers from the main console. The instrument should be kept free of dust after uncovering.

(2) Unpacking the Display Unit

Remove all vinyl covers from the display unit. Untie the connector cords (interconnecting cables) from the chassis.

(3) Unpacking of Other Units

(a) Take the other units out of the cartons.

(b) Place large units (compressor, rotary pumps, etc.) directly on the floor.

(c) Lay small, delicate, or fragile components (such as electron gun, etc. which require careful handling) on soft paper spread over the floor.

3-1-4 Check of Parts

On unpacking all components as outlined in procedures 3-1-1 through 3-1-3, check for damaged or missing parts against the shipping list.

3-2 INSTALLATION

3-2-1 Installation Requirements

(1) General

Good environmental surroundings, normal for laboratory equipment should be provided.

Avoid installing the instrument in the following locations:

(a) Adjacent to the building power distribution room

(b) Adjacent to an elevator

(c) Adjacent to high-power equipment (for example, electric furnace, etc.) or its power source

(d) Adjacent to arcing or high-frequency instruments

(e) Corrosive gas atmosphere

(f) Direct sunlight

(g) Dust

(h) Location subjected to frequent or severe vibrations

(i) Avoid grounding the instrument with other electrical equipment

(2) Room Temperature and Humidity

(a) Room temperature : 15° ~ 30°C

Room temperature variation should not exceed 5°C during operation.

(b) Humidity : Less than 70 %

It is recommended that the room be air-conditioned.

(3) Power Supply

115, 200, 208, 220, 230, or 240 V AC ± 10 %, 50/60 Hz, 1.8 kVA

Notes 1 : Auto transformer (option) should be used at 200, 208, 220, 230 or 240 V area.

2 : The voltage fluctuation of the AC power line should be very slow.

(4) Grounding Terminal

It is recommended to connect the instrument to a grounding terminal having a resistance of 50 Ω or less. The grounding terminal should be exclusive for the instrument only and not in common with other equipment.

(5) Water Facilities

Normal tap water, with minimum requirements as shown, is needed.

Flow rate	: 2 ~ 4 ℓ/min
Water pressure (at the inlet port of water pressure relay)	: 0.5 ~ 2 kg/cm^2
Water temperature	: 10 ~ 25°C

Normal drainage is adequate. A filter is recommended in case of water containing excess impurities.

(6) Stray Magnetic Field (at the installation site)

Condition	Mode and scan speed	DC component [1]	AC Components [2]: Same frequency component as that of the AC line supplied to the Model S-430/S-450. — Observation (Scan speed ⏬ ▽ □)	AC Components [2]: Same frequency component as that of the AC line supplied to the Model S-430/S-450. — Photographing (All SCAN SPEED settings)	AC Components [2]: Same frequency component as that of the AC line supplied to the Model S-430/S-450. — Under conditions other than mentioned at left.	AC Components [2]: Different frequency component from that of the AC power supply used in the Model S-430/S-450.
Maximum allowable magnitude		50 mGauss	5 mGauss		0.6 mGauss [3]	0.6 mGauss
Maximum allowable fluctuation [4]		1 mGauss/5 min	1 mGauss/5 min		0.3 mGauss/5 min	0.3 mGauss/5 min

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

Horizontal component : 300 mGauss

Vertical component : 350 mGauss

2) All values of AC components are effective values.

3) If this value is less than 2 mGauss, 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.

(7) Vibration

For optimum performance, the instrument should be installed in a ferro-concrete or steel-concrete building meeting the following conditions;

(a) Situated on the first floor

(b) No vibration source such as large machine tools, etc. in near proximity

(c) Free from traffic vibration sources such as highway or railroad

(8) Site Requirements

(a) Space required :

A room of about 4 m x 3.5 m (13 ft x 11.5 ft) is recommended.

(b) Durability of floor :

$$\frac{\text{Floor strength}(kg/m^2)}{3} \geqq \frac{\text{Total weight of instruments installed in the room (kg)}}{\text{Floor area of the room } (m^2)}$$

(c) Dimensions of entrance :

0.85 m wide x 1.7 m high
(34 inches wide x 67 inches high) (minimum)

(d) Others :

Sliding curtains around the instrument is convenient.
Photographic dark room in the immediate area is also convenient.

(9) Installation Layout (See Fig. 3-1.)

3-2-2 Installation Layout

Place the main console and display unit as shown in Fig. 3-1. Leave some leeway for the table as it is not fixed at this point. Install the main console on the spacer provided. (Refer to Fig. 3-1.)

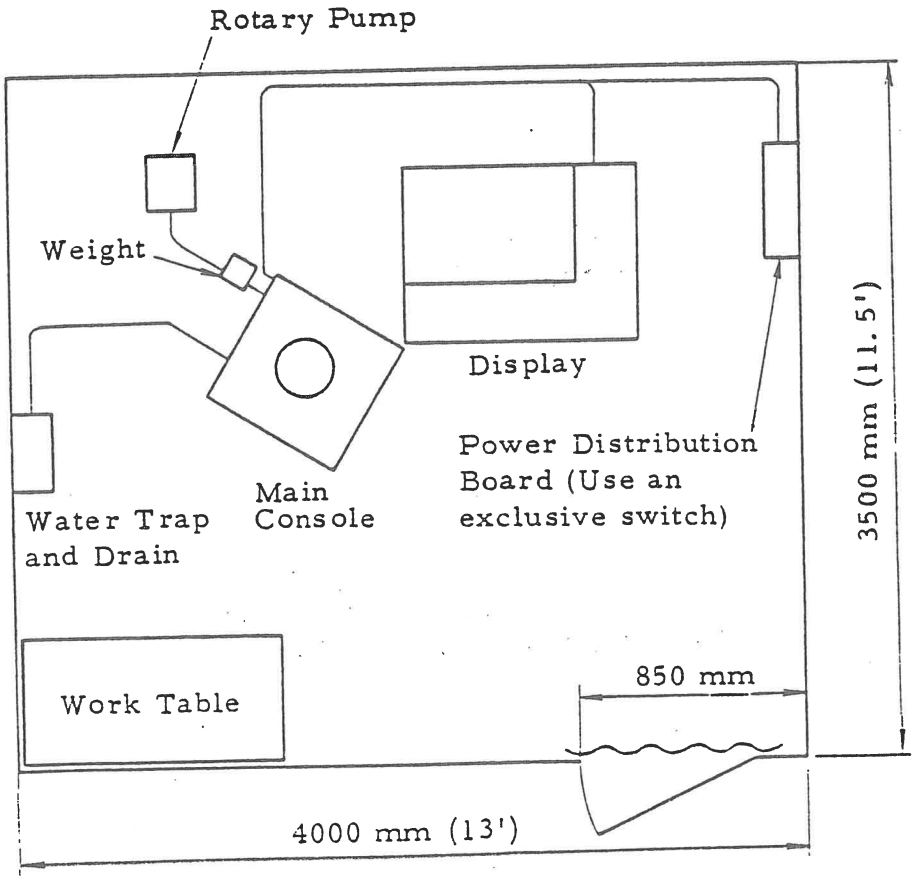


Fig. 3-1 Installation Layout

3-3 ASSEMBLY

3-3-1 Assembly of Display Unit (See Fig. 3-2.)

(1) Mount the display unit on a floor as flat as possible.
If the console rack is unstable, insert the attached rubber sheets into the clearances between each leg and the floor, so that the table is mounted stably.

(2) Insert the photo CRT unit into the hole on the left side of the table so that the camera fixing stay is positioned on the display unit side, and fix the photo CRT unit securely using the attached setscrews at the upper corners.

Mount the CRT-HV connectors and grounding wire for the photo unit.

(3) Mount the display unit at an easy-to-operate place on the table.
Connect the display unit connectors as follows:

Connect CN-300, CN-34, CN-1, and CN-5 to the power supply inside the table, connect CN-2 to the photo CRT unit, and also connect CN-29 to the HV transformer without fail. (For the standard high-resolution CRT, mount CN-3 and CRT-HV connectors.)

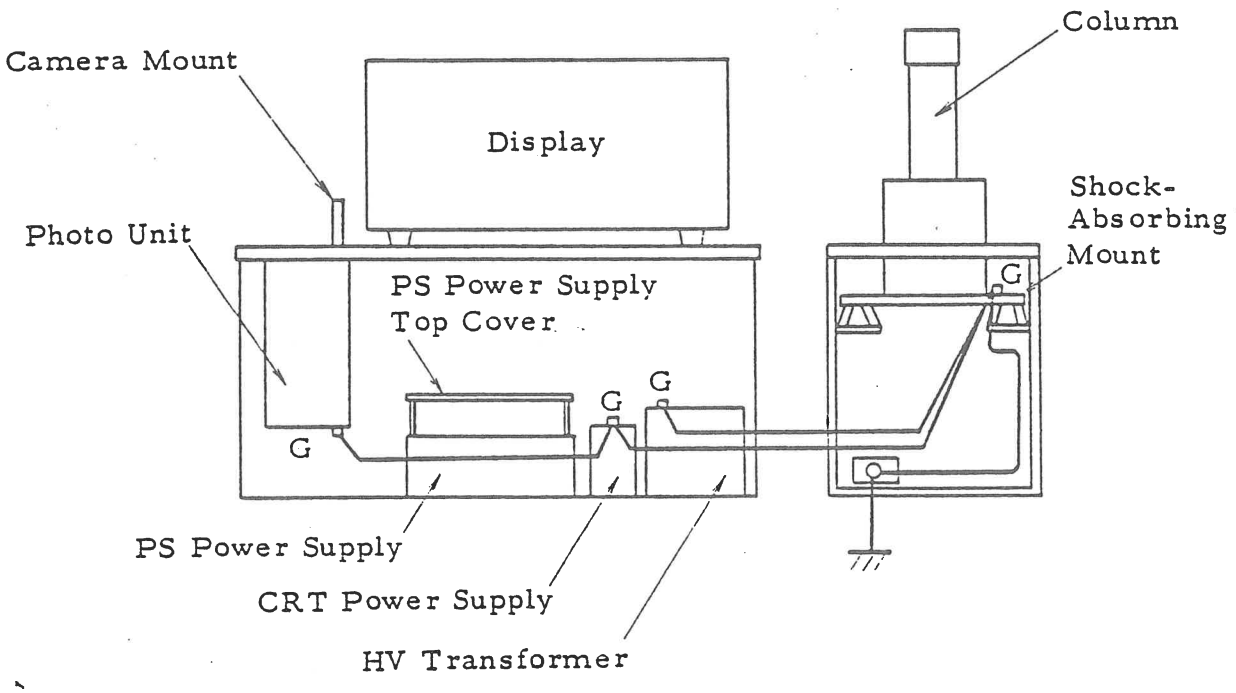


Fig. 3-2 Earth Wiring Diagram for Column and Display Unit (Rear View of Console Rack)

3-3-2 Removal of PS Power Supply PC Board Holder (See Fig. 3-3.)

Detach the top cover from the PS power supply, and also exfoliate the fixing materials from the PC board holder.

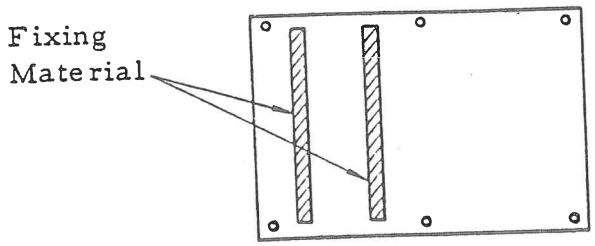


Fig. 3-3 Top Cover

3-3-3 Wiring between Column and Display Unit

(1) Connect DEF, condenser, gun alignment, detector, 100 V AC power cord, and high voltage cable from the power supply to the column. For fixing cables to the column console rack, see Fig. 3-4.

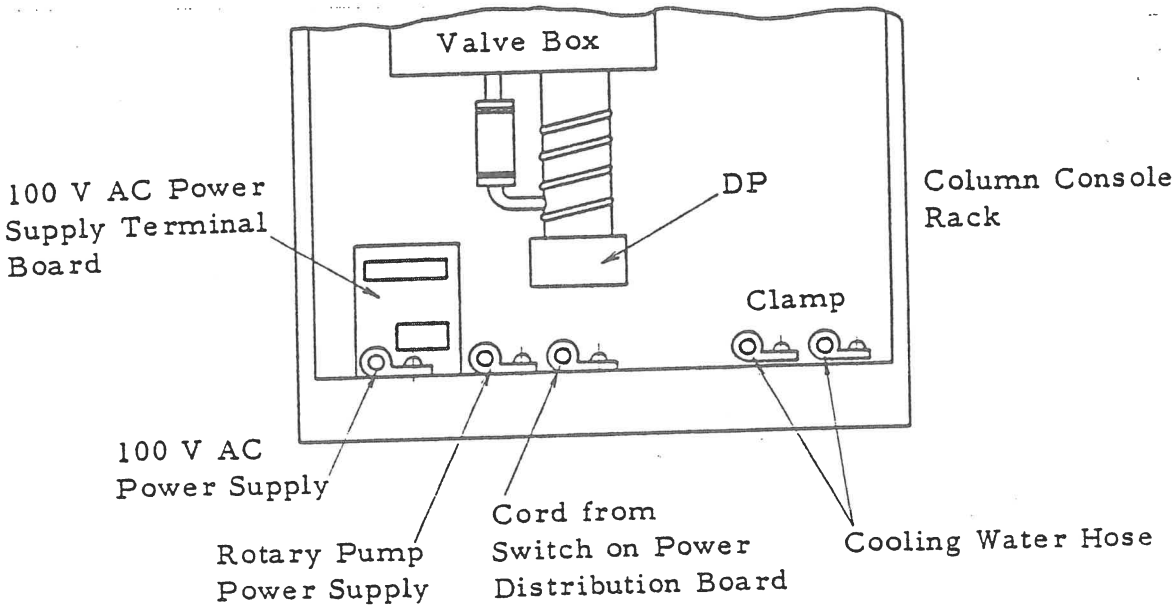


Fig. 3-4 Rear View of Column Console Rack

(2) Mount the HV cable to the HV transformer inside the table. Fix the cables to the column by the fixture mounted on the rear cover when the assembly work is finished.

(3) Connection of Detector Cords (See Fig. 3-5.)

Bind the detector cords as shown in Fig. 3-5 so that they do not touch the photomultiplier HV unit.

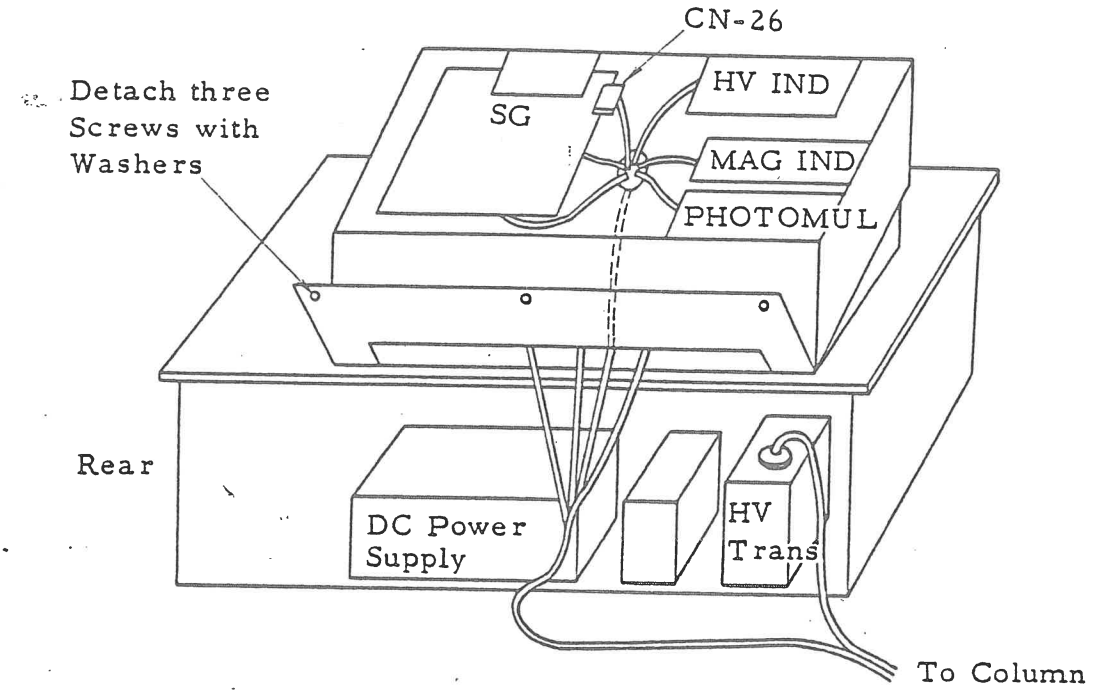


Fig. 3-5 Top View of Display Unit

(4) Connection of 100 V AC

(a) Connect 100 V AC from the switch box on the room power distribution board to the power terminals on the rear of the column. Connect one end of the grounding wire to the column console rack and the other end to ground. Turn off the EVAC and DISPLAY switches on the front panel of the column without fail before starting the connection work.
For cord connection, see Fig. 3-6.

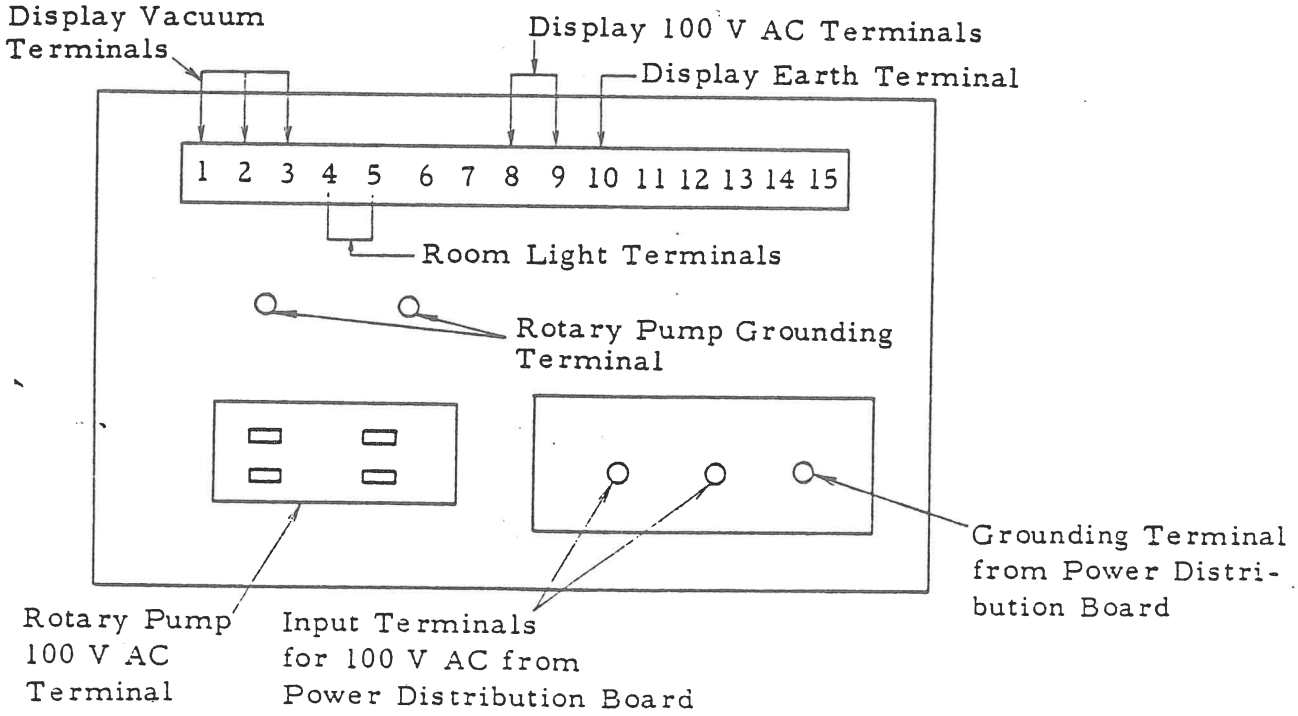


Fig. 3-6 Connection of Terminal Board on Column Console Rack

(b) When the switch on the room power distribution board is employed for the auto transformer, make sure using a circuit tester that the output voltage of the output terminal is 100 V.

(5) Connection of Auto Transformer

When mounting this instrument at a place where the line voltage is other than 100 V AC, the auto transformer must be used.

- Make sure that the output voltage of the auto transformer is 100 V after installation. If the output voltage is not 100 V, perform tap selection of the auto transformer or line voltage value. For the AC input wiring and ground wiring with the auto transformer installed, see Fig. 3-7.

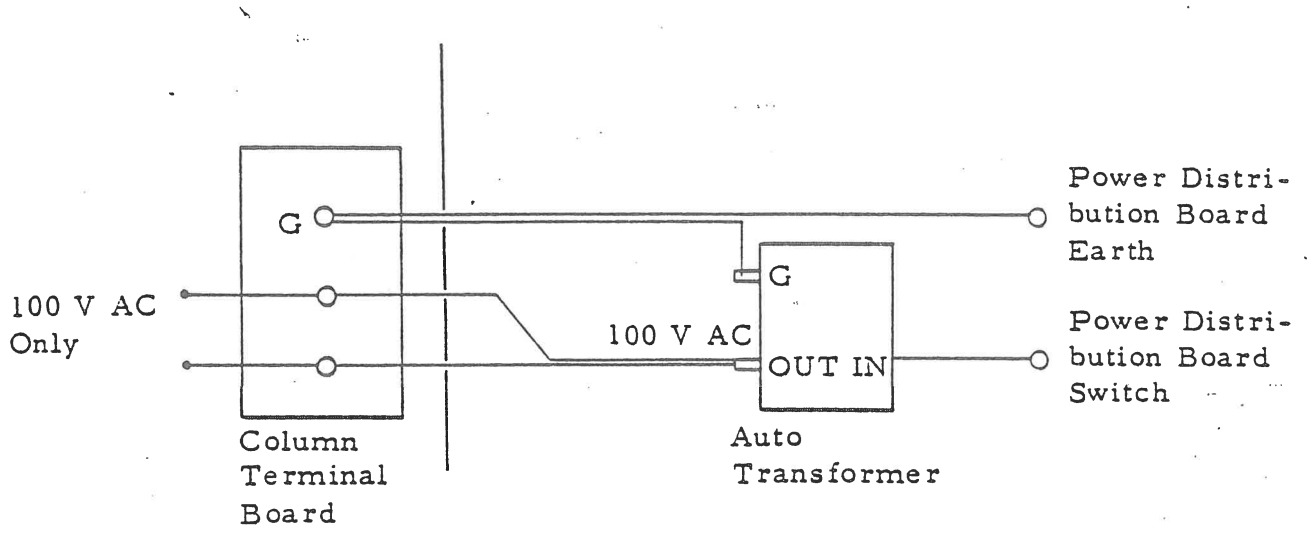
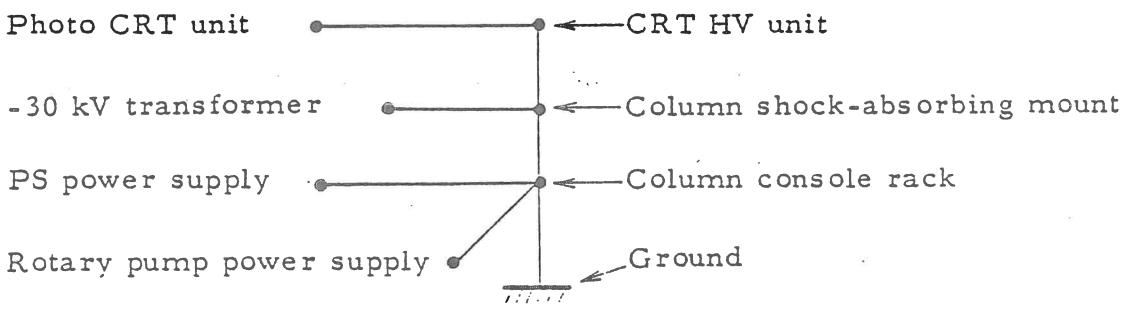


Fig. 3-7

3-3-4 Grounding Connection (See Fig. 3-2.)

Connect grounding wire as specified below, otherwise image troubles and other failures may result.



3-3-5 Assembly of Rotary Pump (See Fig. 3-8.)

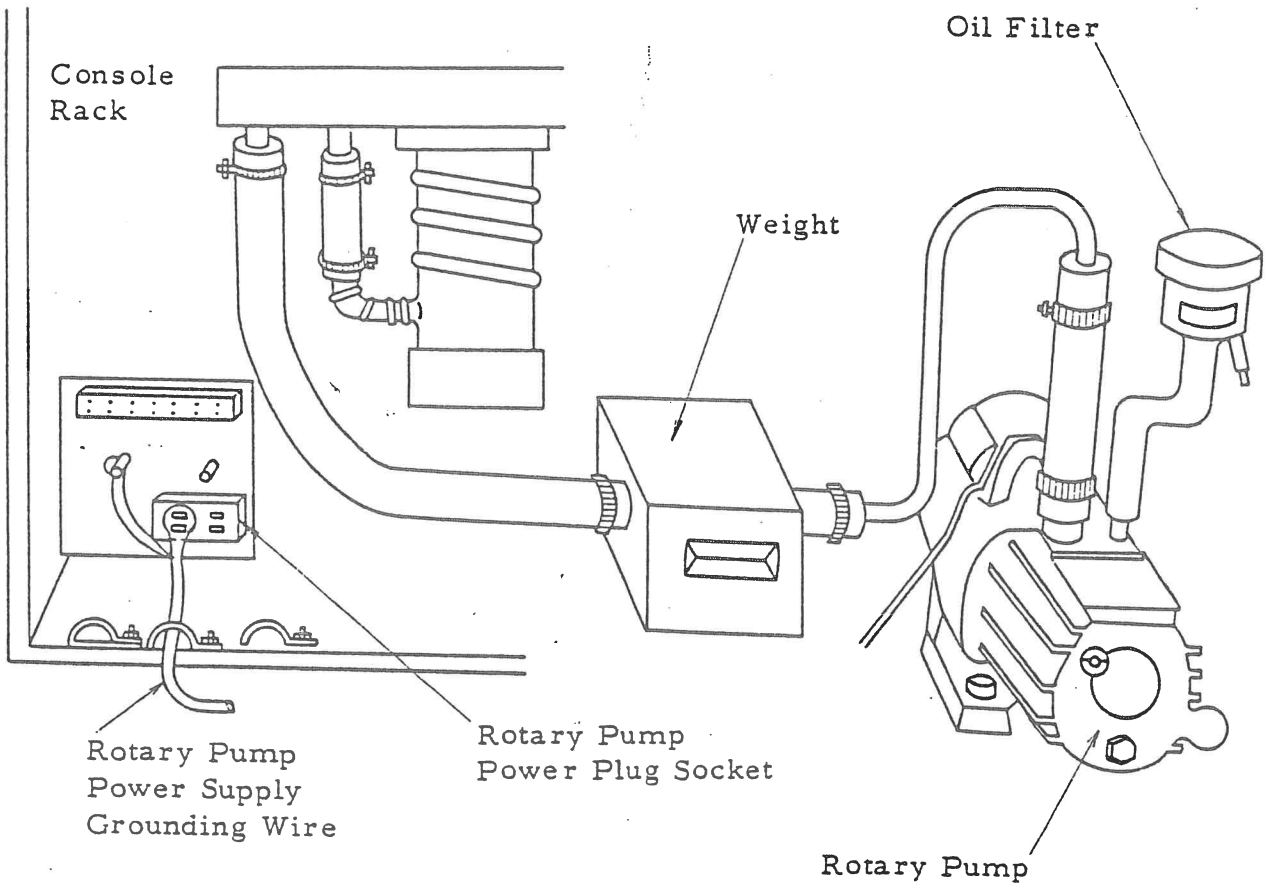


Fig. 3-8 Assembly of Rotary Pump and Evacuating Pipe

(1) Detach seal washers and butterfly nuts for transportation from the mounting part of the oil filter, and assemble the oil filter.

(2) Insert the rubber tube to the rotary pump to connect the rotary pump and weight to each other.

Connect the weight and evacuating valve box by the 1 m rubber tube.

(3) Connect the rubber tube connecting the weight and evacuating valve box to the oil diffusion pump heater via the left side (on the power terminal board side) of the column console rack.

(4) Clamp the connecting part of the rubber tube by the fastener so it won't slip out.

(5) Insert the 100 V AC connector and grounding wire to the power terminal board of the column console rack.

3-3-6 Mounting of Water Supply Hoses (See Fig. 3-9.)

(1) Connect the water supply hoses as shown in Fig. 3-9. It is recommended for facilitating the insertion of the water supply hoses to the city water faucet to apply a thin coat of vacuum grease to the faucet.

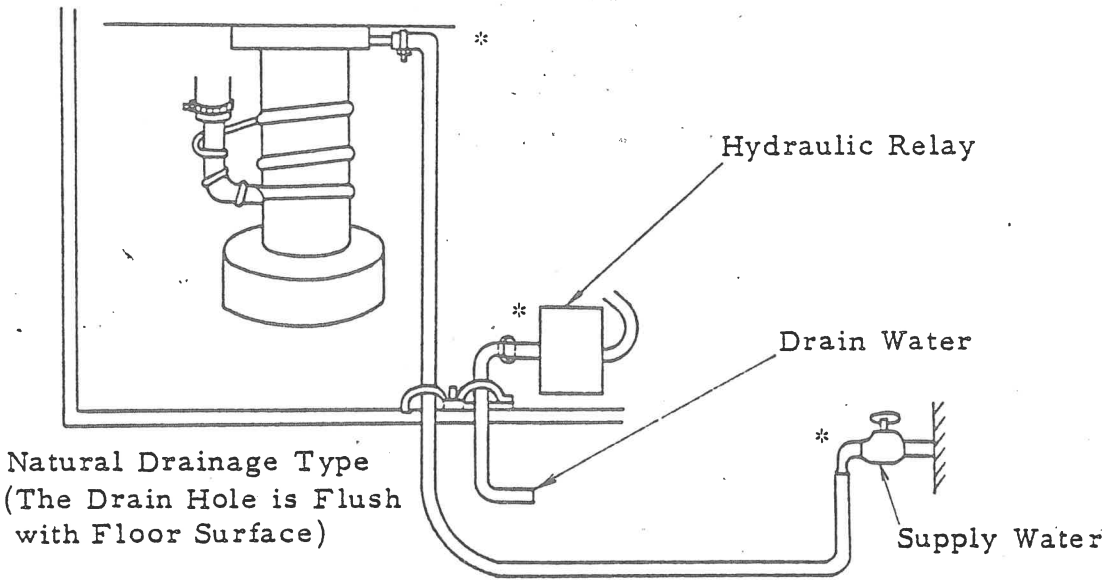


Fig. 3-9 Installation of Water Supply Hoses

(2) Clamp three inserting parts of the water supply hoses by using fasteners to fit respective port grooves.

(3) The water supply port (city water plug) should be lower than 1 m. The drain hole should be flush with the floor surface. In addition, a water circulator, if employed, should be mounted lower than 1 m.

3-3-7 Assembly of Main Console

o Removal of fixing bolts of main console

After detaching the front and rear covers, remove four fixing bolts connecting the load plate and console rack to each other, and also remove the spacer between the load plate and the console rack.

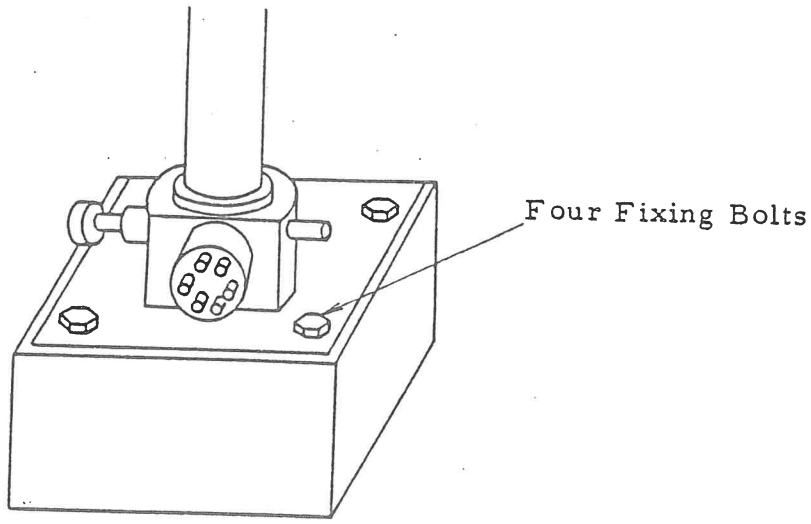


Fig. 3-10 Removal of Fixing Bolts

3-3-8 Assembly of Fixed Aperture Assembly

(1) After detaching the front cover from the column, make sure that the evacuating sequence auto/manual switch is at auto.

(2) Run cooling water to the oil diffusion pump.

(3) Turn on the switch on the power distribution board.

(4) Turn on the EVAC POWER switch on the front panel of the column.

(5) Depress the EVAC pushbutton.

(6) After 4 ~ 5 minutes, set the EVAC pushbutton to AIR.

(7) After vacuum leak of the column, open the electron gun assembly as shown in Fig. 4-5, and insert the fixed condenser aperture. For the S-450/S-430 fixed condenser aperture, see Fig. 4-6.

3-3-9 Assembly of Column Table

(1) In Case of S-430 Instrument

Insert four screws with washers at the rear of the table into the console rack. If these screws cannot be inserted, loosen them to allow their insertion.

(2) In Case of S-450 Instrument

(a) Perform vacuum leak of the column.

(b) Set the specimen feed knobs of the specimen goniometer stage to the following specimen exchange position.

←→(X) : 20 ↕ (Y) : 20

⊣⊢ (Z) : EX ⟳ (T) : 0°

(c) Detach the four fixing screws for transportation from the specimen goniometer stage. See Fig. 3-11.

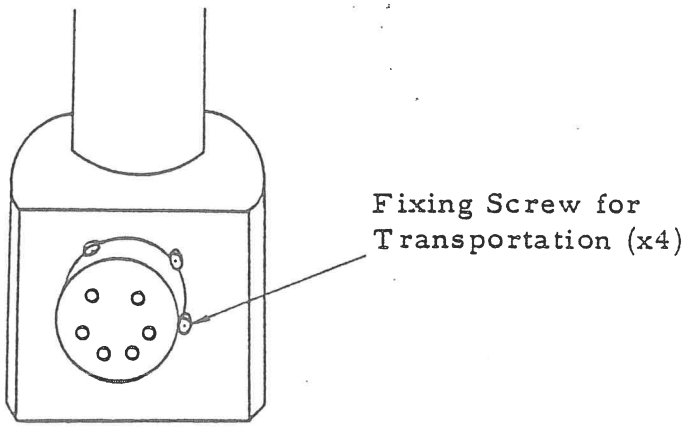


Fig. 3-11 Fixing Screws for Transportation

(d) Pull the specimen goniometer stage out of the column, and detach it from the specimen goniometer stage arm holder while supporting it by both hands.

(e) With the specimen goniometer stage (including the arm) detached from the column console rack, mount the table onto the column console rack in the same manner as with S-430.

(f) Mount the specimen goniometer stage while taking care not to allow the specimen goniometer stage arm to touch the table hole, otherwise vibration troubles may result.

(g) Mount 4 mm dia. chrome-plated screws into the mounting positions of the fixing screws for transportation for the purpose of good appearance.

3-3-10 Installation of Head Amplifier (See Fig. 3-12.)

(1) Insert the photomultiplier tube into the head amplifier case.

(2) Clean the cathode face of the photomultiplier tube using gauze.

(3) Apply a drop of silicone oil for photomultiplier tube to the center of the cathode face of the photomultiplier tube.

(4) Insert the head amplifier into the cylinder, and lightly turn the head amplifier clockwise and counterclockwise two or three times after allowing the cathode face of the photomultiplier tube to make contact with the light guide face. See Fig. 3-12.

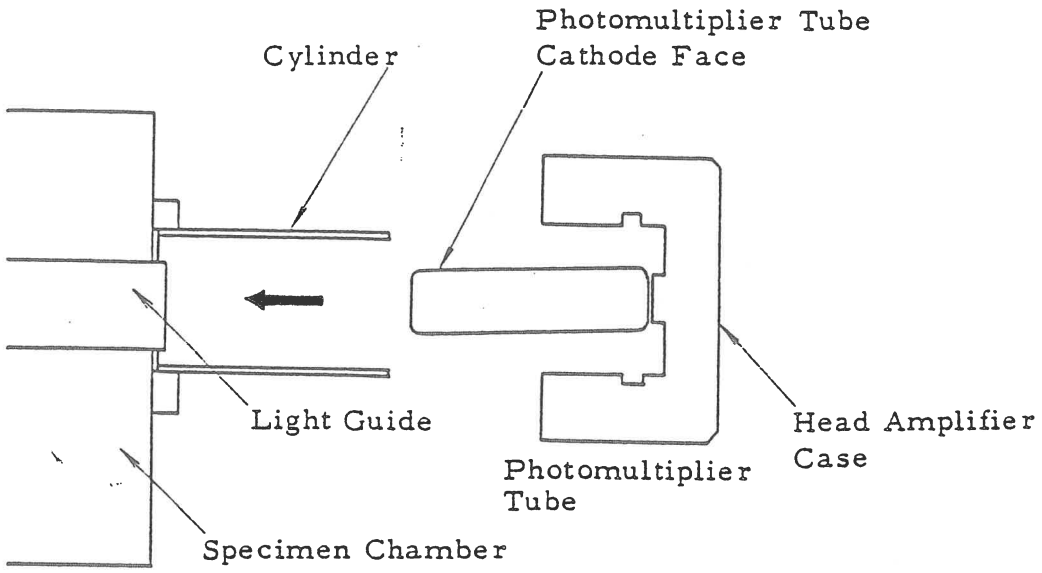


Fig. 3-12 Installation of Head Amplifier

(5) Fix the head amplifier to the cylinder using three setscrews.

3-3-11 Assembly of Specimen Goniometer Stage of S-430

Mount the specimen goniometer stage mounting flange in the direction specified in the disassembly procedure.

3-3-12 Confirmation of Assembly

After completion of all assembly work, check all assembly procedures thoroughly for correctness. For the bundled wires of the column console rack, see Fig. 3-13.

(1) Don't Forget to Connect the Grounding Wire.

Connect the grounding wire to the shock-absorbing mount by utilizing the grounding terminal screw on the shock-absorbing mount at the rear of the specimen chamber.

(2) Fix the connector wiring to the console rack at A and B.

Connection

① Electron gun alignment

② Condenser lens ——— S-450

③ Objective lens and stigmator ———

④ Post-stage accelerating voltage

⑤ Head amplifier (DC signal), photomultiplier high voltage

⑥ Grounding

⑦ Relay

⑧ Display 100 V power supply

⑨ Lens, deflector, detector cords

⑩ Rotary pump 100 V power supply

⑪ 100 V power supply from power distribution board

⑫ Cooling water hose

⑬ Cooling water hose

⑭ Rotary pump evacuating pipe

②' Condenser lens ——— S-430

③' Objective lens/stigmator ———

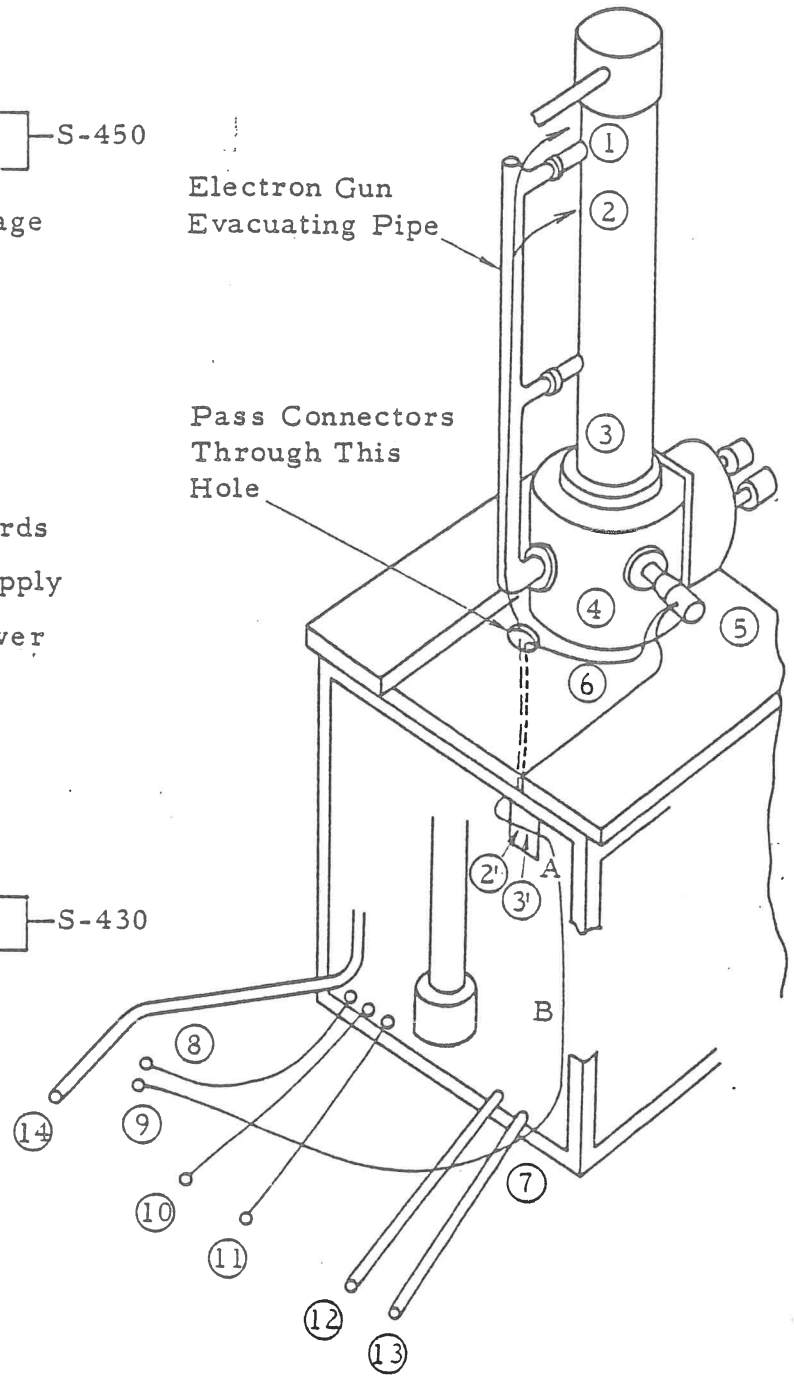


Fig. 3-13 Connection of Connectors to Column

Section IV

COMPOSITION OF MODEL S-430 AND S-450

4-1 OPERATING PRINCIPLE

Fig. 4-1 shows the block diagram of operating principle of Model S-430/S-450. The electron beam emitted from the electron gun is focused by three electromagnetic lenses and irradiated onto the specimen surface to form an electron probe. Various information can be obtained from the specimen by means of the interaction between the electron probe and the specimen surface (or material).

Of this various information, the secondary electron serves as a substantial information source in SEM. The secondary electron produced from the specimen surface is captured and accelerated to bombard the plastic scintillator where it is converted into light. The light thus obtained is then fed to the photomultiplier after passing through the light guide and converted into an electric signal, which is then amplified by both preamplifier and main amplifier to be an intensity modulation signal of the electron beam on CRT. The electron beam scanning on CRT synchronizes with scanning of the electron probe on the specimen.
Contrast of the final image is formed according to the change in intensity of the emitted secondary electron which depends upon variations of specimen profiles. A three-dimensional image having a sufficient depth of focus is also formed by a fine electron probe.

The magnification in SEM is determined according to the ratio of the constant scan range (12 cm in the lateral direction and 9 cm in the longitudinal direction) of the electron beam to the scan range of the electron probe on the specimen surface and can be selected optionally and continuously by the magnification control.
For example if the scan range on the specimen surface is 12 μm x 9 μm, magnification is x10,000.

4-2 COMPOSITION OF MAIN CONSOLE

Fig. 4-2 shows the schematic diagram of the microscope column, which is composed mainly of the electron gun having an electromagnetic axial alignment system, condenser lenses inclusive of a self-cleaning aperture, objective lens, deflection coils and stigmator coil, objective lens movable aperture, secondary electron detector, specimen goniometer stage, and evacuating system. These elements will be summarized below :

4-2-1 Electron Gun

Fig. 4-3 is a sectional view of the electron gun. Its axial alignment is done by mechanical horizontal alignment screws and electromagnetic alignment knobs. The acceleration voltage ranges from 1 kV to 30 kV (plus 50 kV at option).

The mechanical axial alignment can be done by four semi-fixed horizontal alignment screws. The electrical axial alignment knobs employ an X, Y system with coils supplied with a current of ±250 mA maximum.

The gap between the anode and the Wehnelt cylinder is as follows:

Acceleration Voltage	Gap	Remarks
1 ~ 2 kV	2 mm	Replacement part
5 ~ 30 kV	5 mm	Standard

(Continuously variable system for electron gun anode : Option)

The electron gun insulator on the atmospheric air side is sealed with Freon gas to prevent discharge. The Freon gas is introduced through the Freon gas inlet and then sealed if discharge occurs due to high humidity, etc. The filament is set so that the distance between the filament tip and the Wehnelt cylinder tip is 0.1 mm to 0.2 mm, and then the filament tip is positioned at the center of the Wehnelt hole by adjusting the four filament centering screws.

The emission current under normal operation is about 120 μA at an acceleration voltage of 20 kV. If the filament tip is excessively protruding with reference to the Wehnelt hole, the emission current increases and the saturation point becomes indefinite or the emission current will not be saturated.

On the contrary, if the filament tip is excessively withdrawn with reference to the Wehnelt hole, the emission current decreases and the maximum intensity cannot be obtained.

4-2-2 Condenser Lenses

Fig. 4-4 shows a schematic sectional view of the condenser lenses.
Two condenser lenses are substantially unified and connected in series, thus requiring one power supply only. The resistance value of the condenser lenses connected in series is about 24 Ω. Inserted inside the lens magnetic yoke is a self-cleaning aperture and a helisert spring (Fig. 4-5, 4-6), which serve to prevent contamination of the magnetic yoke and electron beam path due to scattering of the beam. The aperture (1 mm ID x 6 mm OD x 10 μm thickness) is made of molybdenum.

Of the four apertures inserted into the condenser lens assembly the first aperture requires no cleaning since it is subjected to irradiation with a dense electron beam. However, it is recommended to clean the second aperture once every four months and the third aperture once every two months.

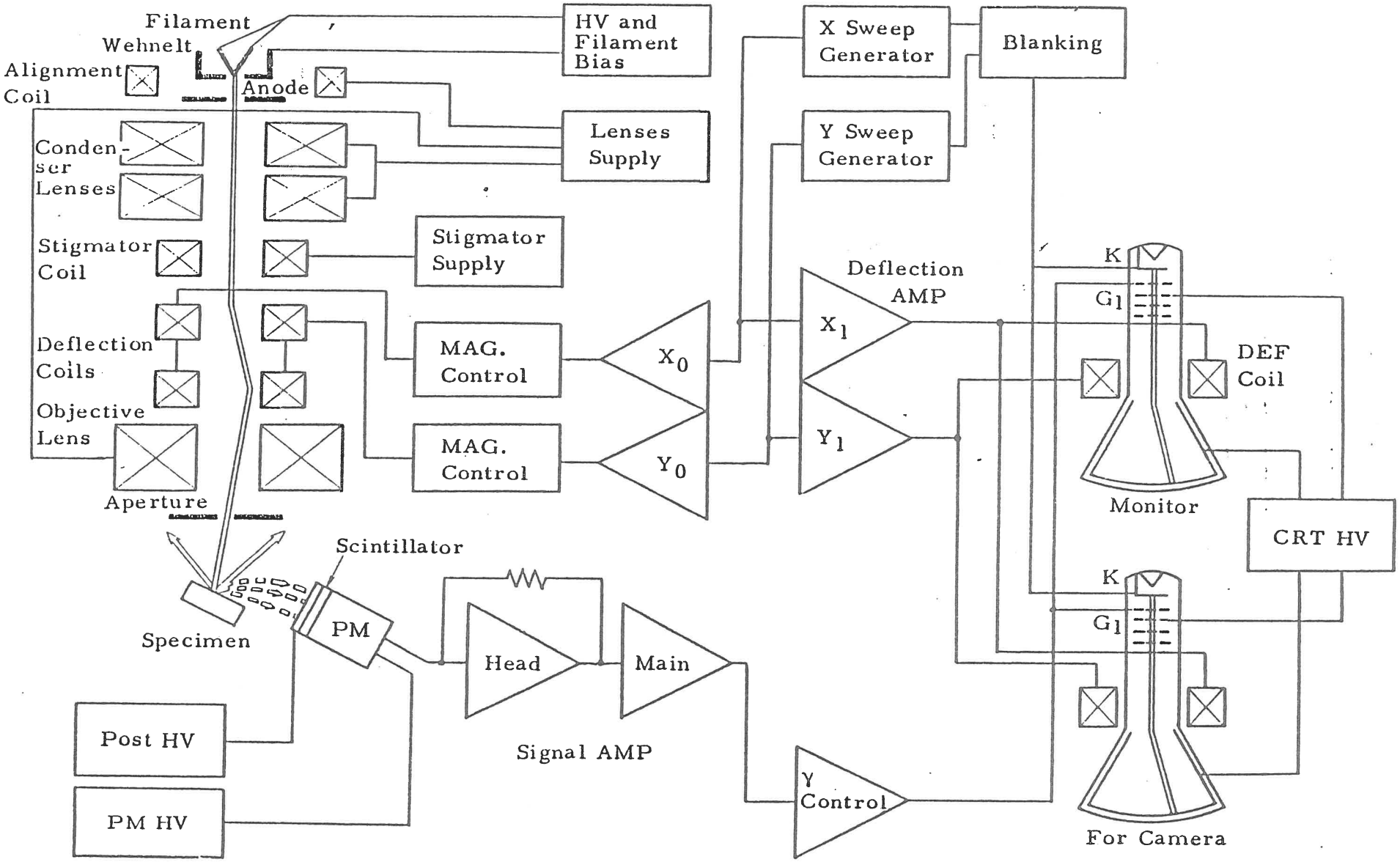


Fig. 4-1 S-430/S-450 Scanning Electron Microscope Block Diagram

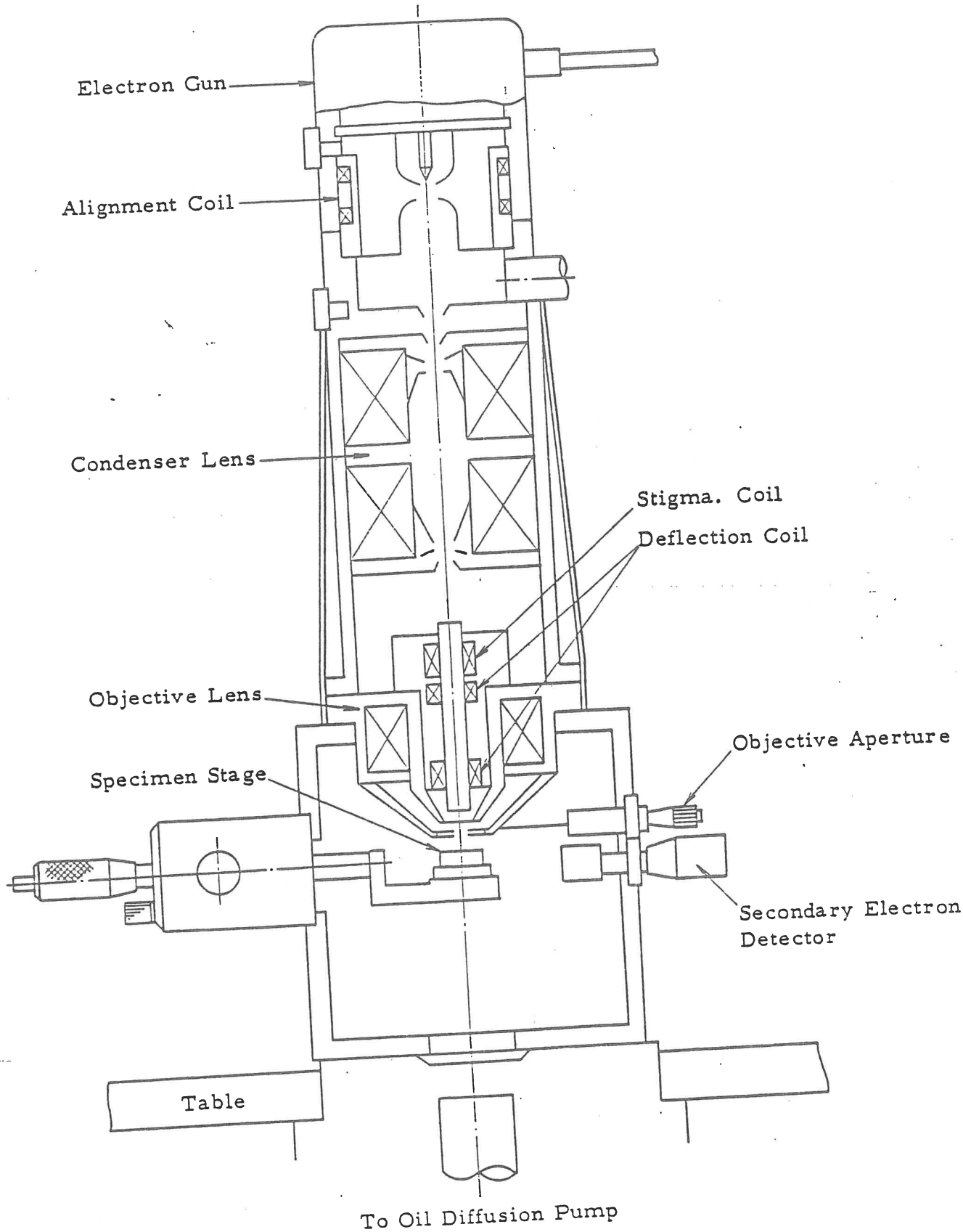


Fig. 4-2a Sectional View of S-430 SEM Column

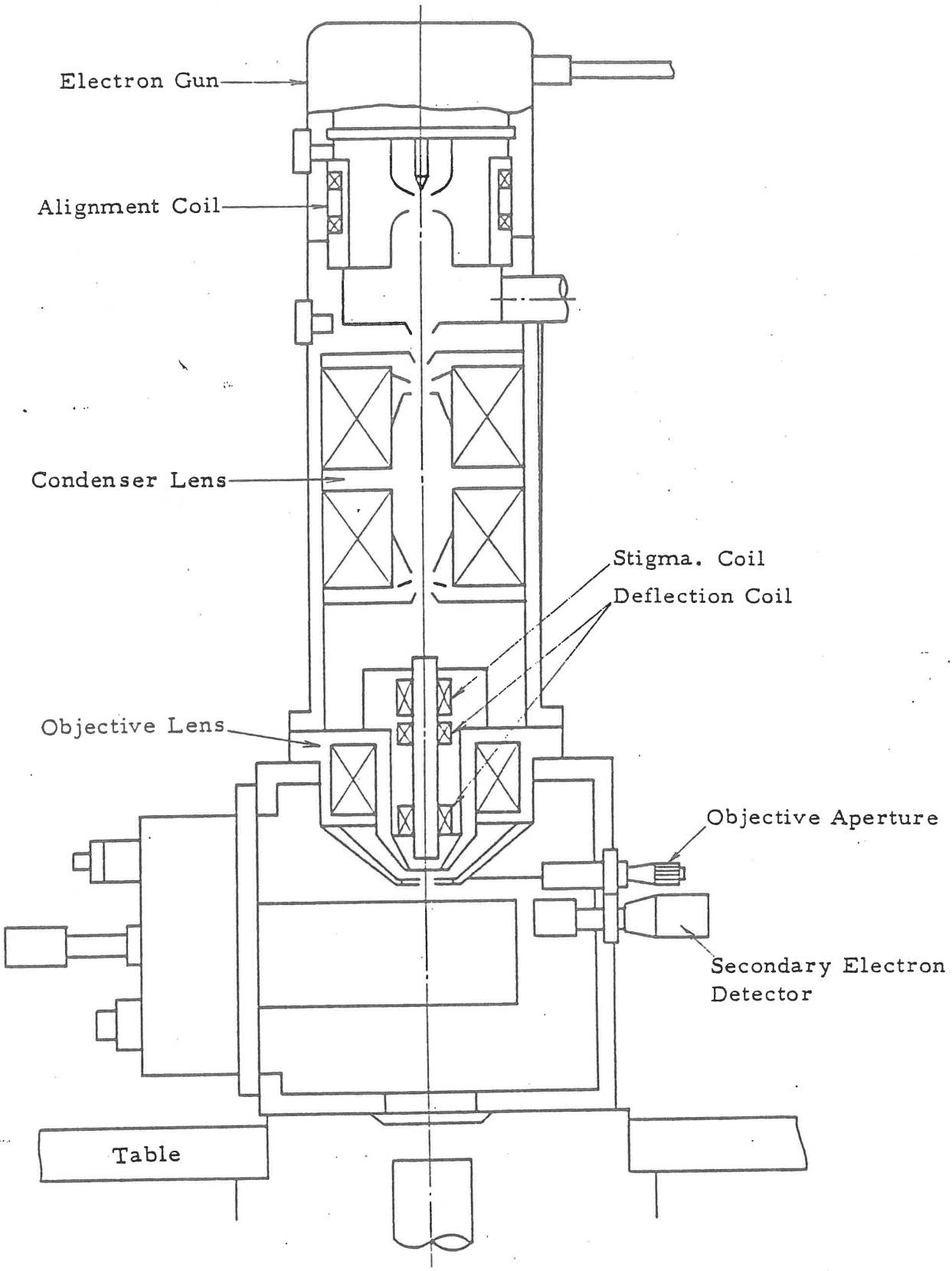


Fig. 4-2b Sectional View of S-450 SEM Column

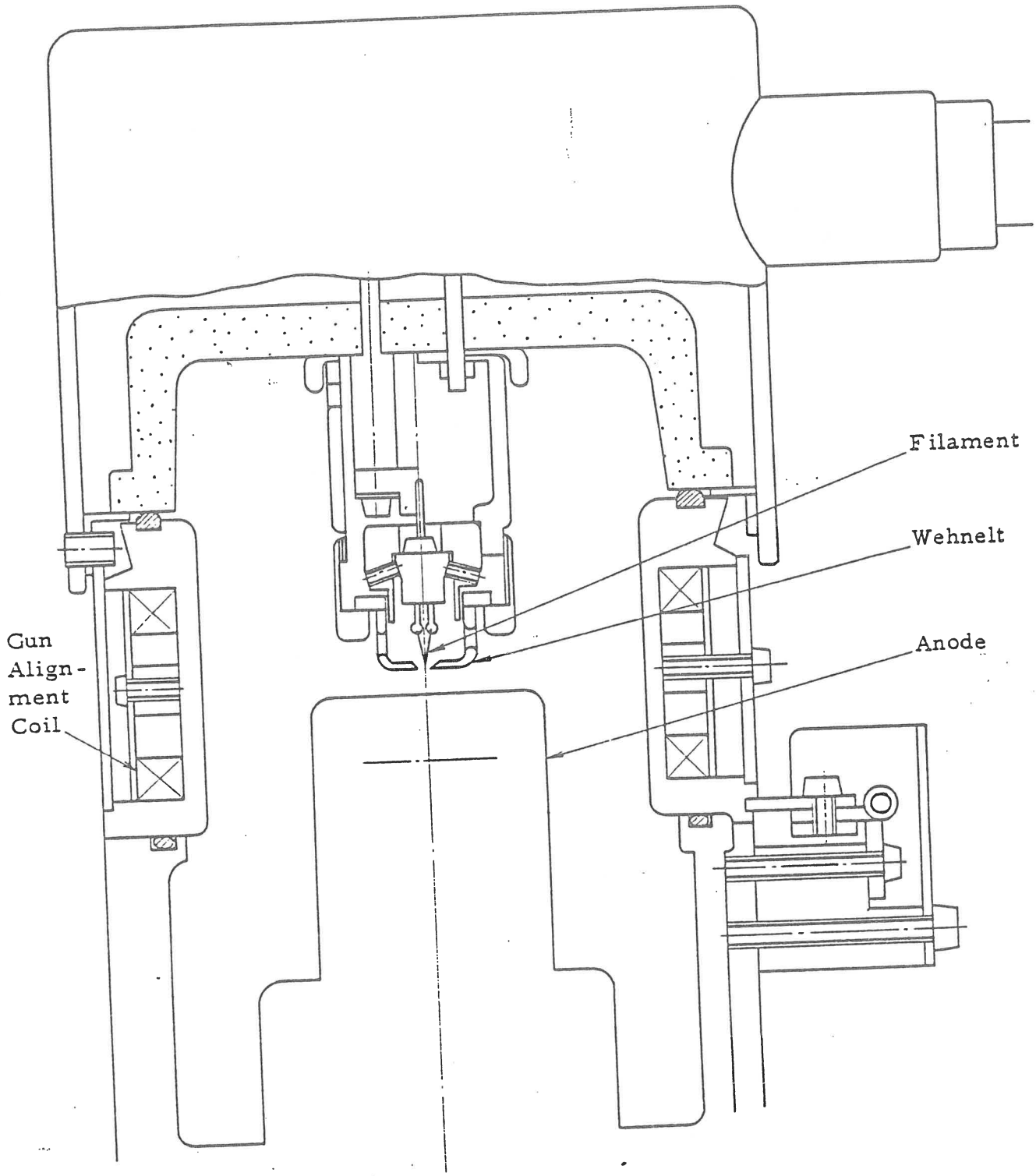


Fig. 4-3 Sectional View of S-450/S-430 Electron Gun

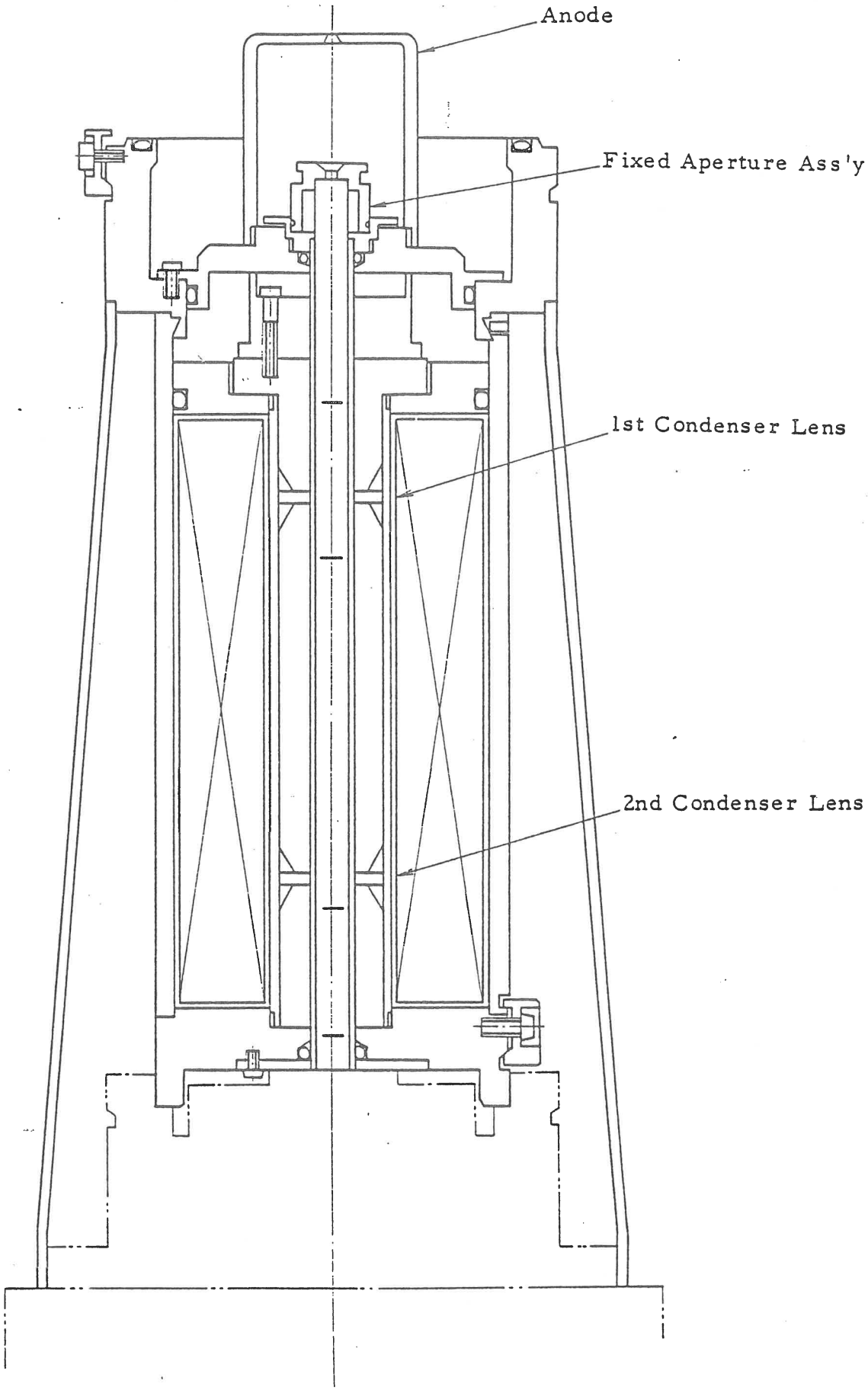


Fig. 4-4a Sectional View of Condenser Lens for S-430

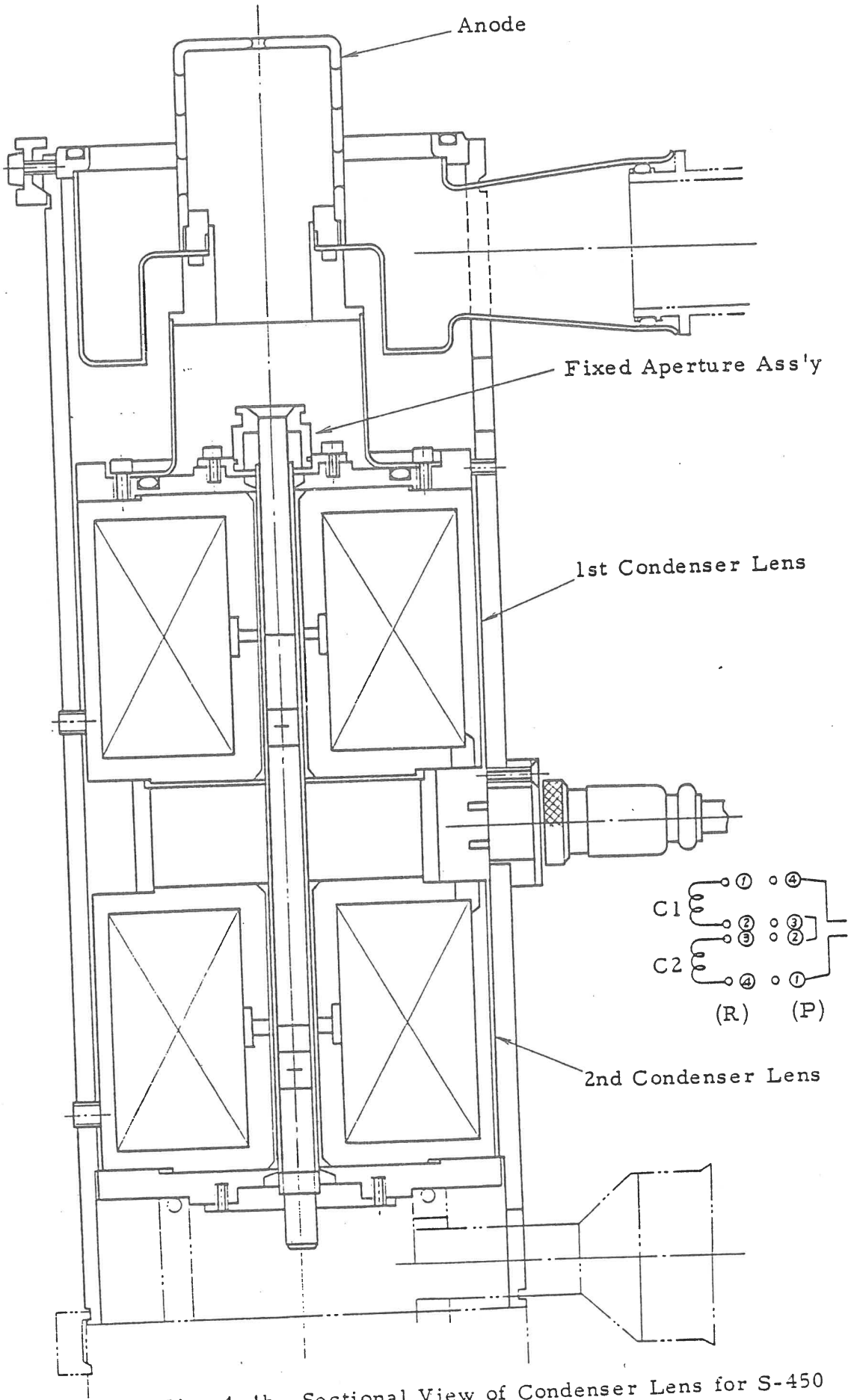


Fig. 4-4b Sectional View of Condenser Lens for S-450

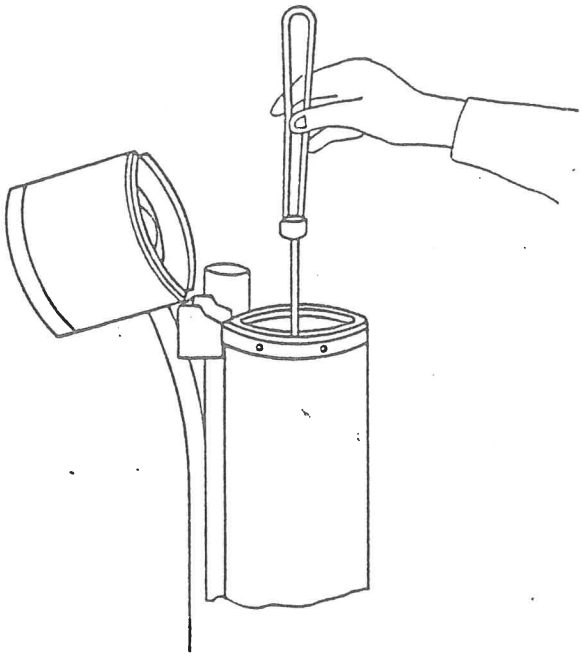


Fig. 4-5

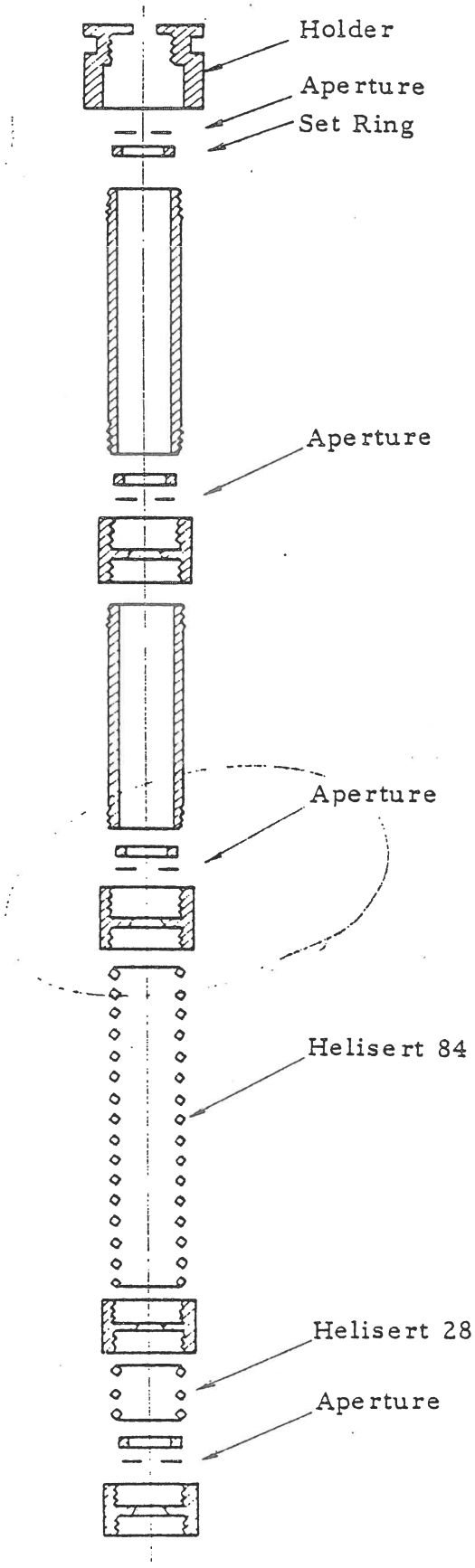


Fig. 4-6 Fixed Aperture Ass'y

4-2-3 Deflection Coils and Stigmator Coil

Fig. 4-7 shows a schematic sectional view of both deflection coils and stigmator coil assembled inside the objective lens. The deflection coils employ a toroidal system. The angle alignment of the 1st and 2nd deflection coils has been factory-adjusted and locked before shipment of the instrument.

4-2-4 Objective Lens

Fig. 4-7 shows a sectional view of the objective lens. It is directly fixed to the specimen chamber assembly.

At the lower pole piece hole section, a pole piece protection cylinder of 1.4 mm dia. is provided. An objective lens movable aperture is set to the principal plane of objective lens.

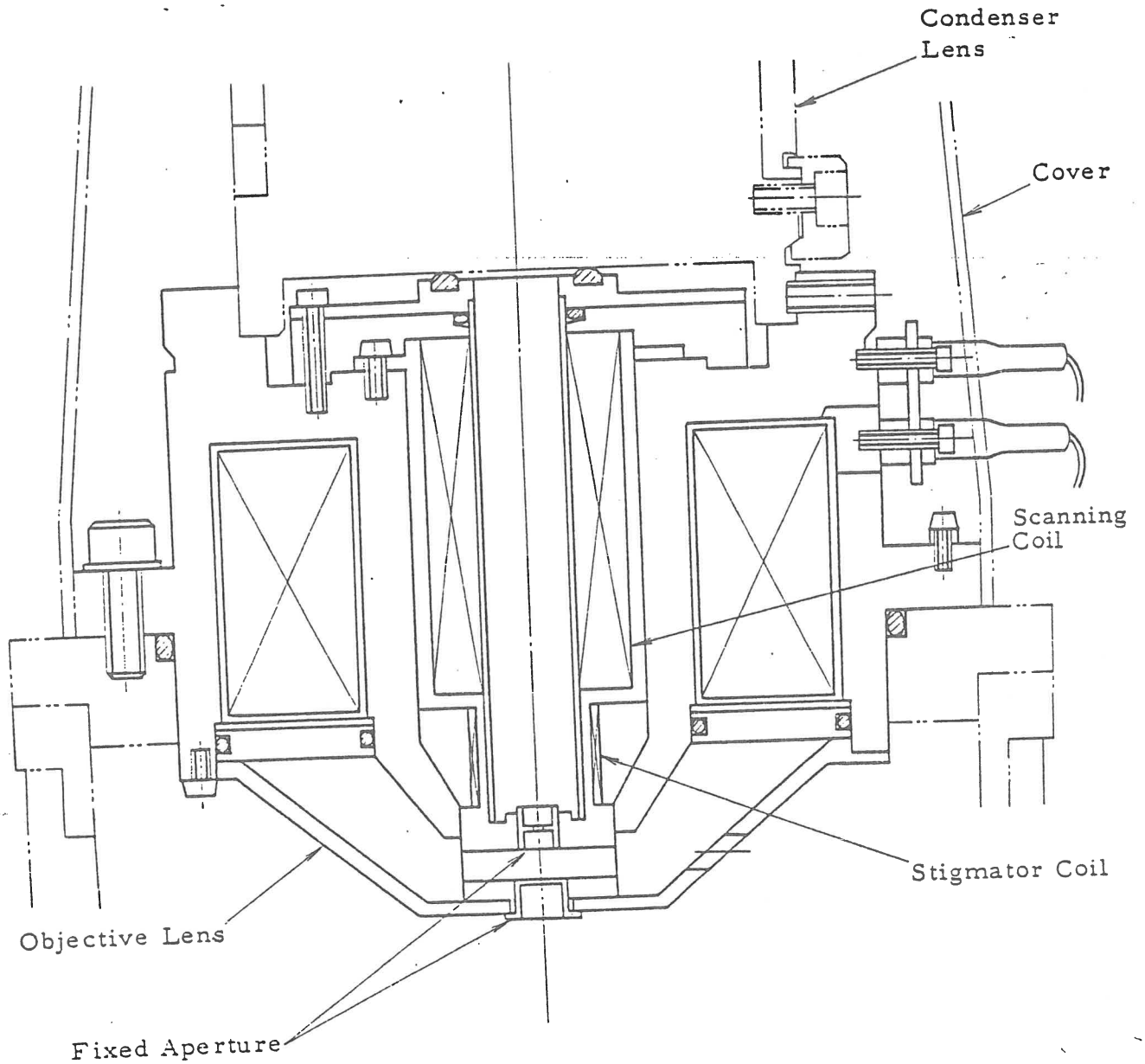


Fig. 4-7a Sectional View of Objective Lens, Scanning Coil, Stigmator Coil for S-430

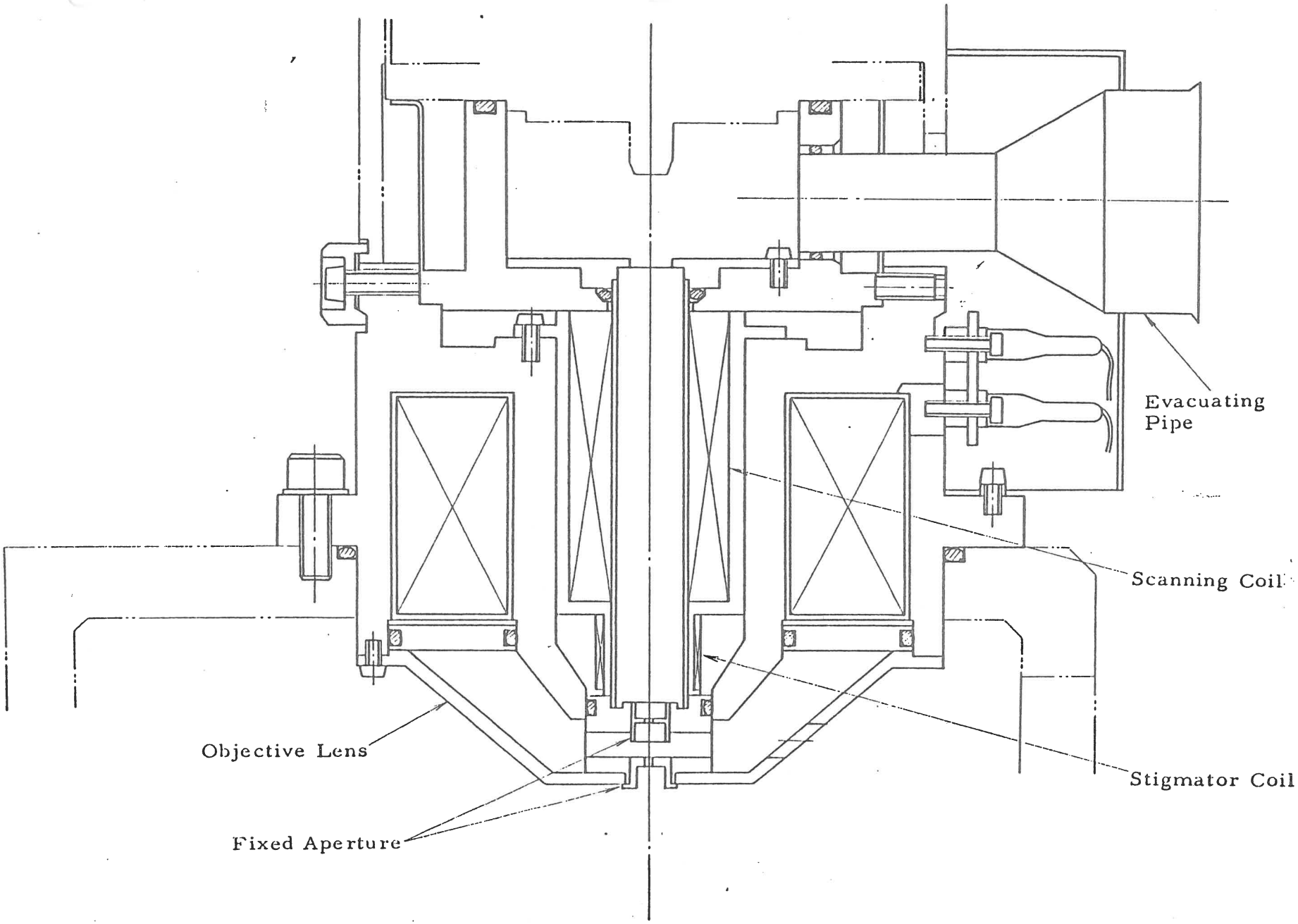


Fig. 4-7b Sectional View of Objective Lens, Scanning Coil and Stigmator Coil for S-450

4-2-5 Objective Lens Movable Aperture

Fig. 4-8 shows a sectional view of the objective lens movable aperture. It is made of molybdenum and 10 μm in thickness. The aperture plate is provide with four holes; 100 μm, 200 μm, 300 μm, and 400 μm in diameter. These different holes are used as follows :

100 μm dia. (notch 4) :	For long depth of focus
200 μm dia. (notch 3) :	For ordinary uses
300 μm dia. (notch 2) :	For specimens forming a poor contrast, which require a relatively large electron beam current.
400 μm dia. (notch 1) :	For x-ray analysis (dispersive type)

The depth of focus in SEM can be obtained by :

$$2\Delta f = \frac{(\frac{\gamma}{M} - \alpha)}{d}$$

where $2\Delta f$: Depth of focus

α : Semi-angular aperture of electron probe to be irradiated onto the specimen

M : Magnification

d : Final spot diameter

γ : Resolution of CRT

For example, when semi-angular aperture $\alpha = 3 \times 10^{-3}$ radian, magnification M = x1,000, final spot diameter d = 100 Å, and resolution of CRT γ = 0.1 mm, then the depth of focus $2\Delta f$ is about 33 μm.

Be careful particularly when baking and cleaning the aperture plate of objective lens movable aperture since it is very thin and apt to break easily.

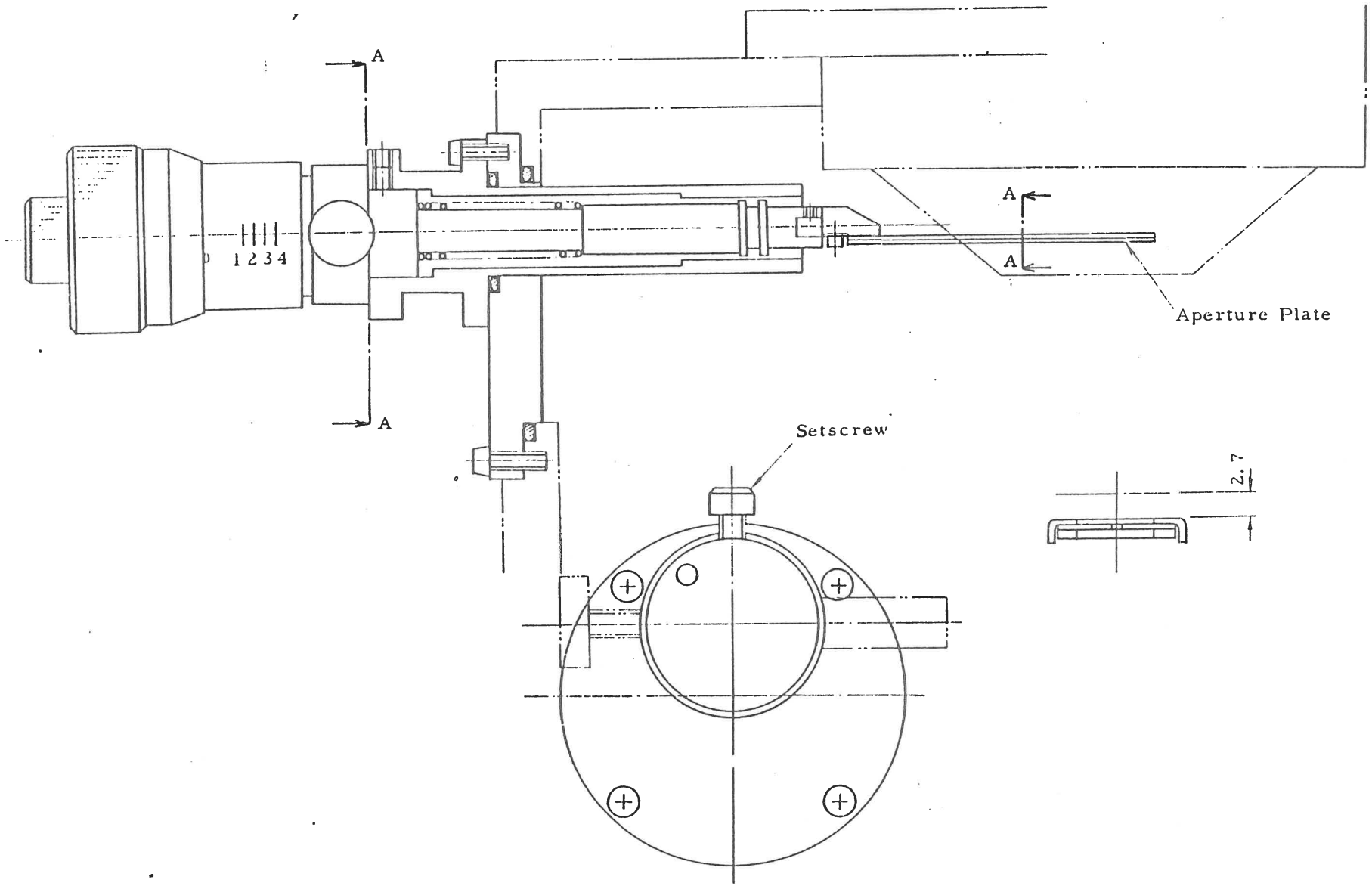


Fig. 4-8 Objective Movable Aperture for S-430, S-450

4-2-6 Secondary Electron Detector

Fig. 4-9 shows the construction of the secondary electron detector. Silicone oil should be used to bond the glass scintillator to the light guide and also ıe light guide to the glass surface of the photomultiplier. However, be careful not to let the silicone oil bubble, otherwise the light transmission efficiency lowers. All soldering joints of lead wires for the secondary electron acceleration voltage (POST HV + 10 kV) should be free from sharp ends so as to prevent discharging.

4-2-7 Specimen Goniometer Stage (S-430)

Fig. 4-10 shows a schematic sectional view of the specimen goniometer stage. It is of a draw-out type with X, Y, Tilting, and Rotation control modes. Table 4-1 shows the performance and accuracy of the stage. The vibration resistance depends upon mounting site conditions, etc. However, if the amplitude of indented image edges due to vibrations is within 0.5 mm at a magnification of x100,000 (it is recommended to use a magnetic tape as specimen) when the instrument is mounted in a place subjected to relatively little vibration, the specimen goniometer stage may be considered normal. If the specimen goniometer stage vibrates, check the following points.

1. If the Y-movement guide is loose.
2. If the fixed screw is loose.
3. If X-, Y-movement knobs or other part is loose.

Table 4-1 Performance and Accuracy of Specimen Goniometer Stage

(a) Performance

Knob	Movable Range	Minimum Graduation	Movement per Knob Rotation
X-movement knob	0 ~ 20 mm	10 μm	0.5 mm
X-movement knob	0 ~ 10 mm	10 μm	0.5 mm
Z (Working Distance)	5 ~ 15 mm Semi-fixed	———	———
Rotation	0° ~ 360°	———	180°
Tilting	-20° ~ +70°	5°	———

(b) Accuracy

Item	Accuracy
Image drift when specimen goniometer stage is being stopped (X, Y)	Less than ±2 μm
Meandering of specimen goniometer stage (X, Y)	Less than 5 μm Range (within 4 mm)
Reproducibility of specimen goniometer stage (X, Y)	Less than 5 μm Range (within 4 mm)

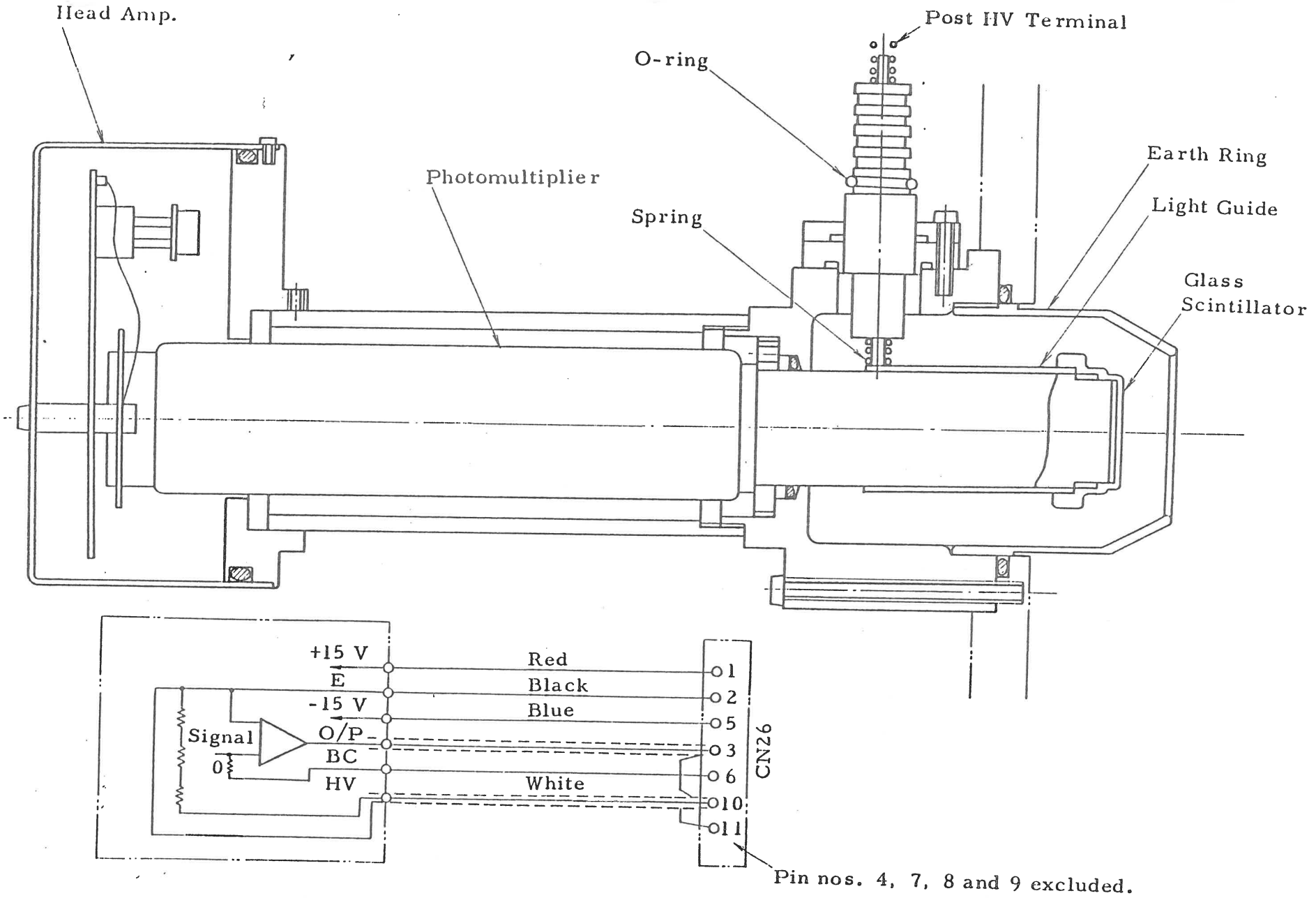


Fig. 4-9 Secondary Electron Detector for S-430, S-450

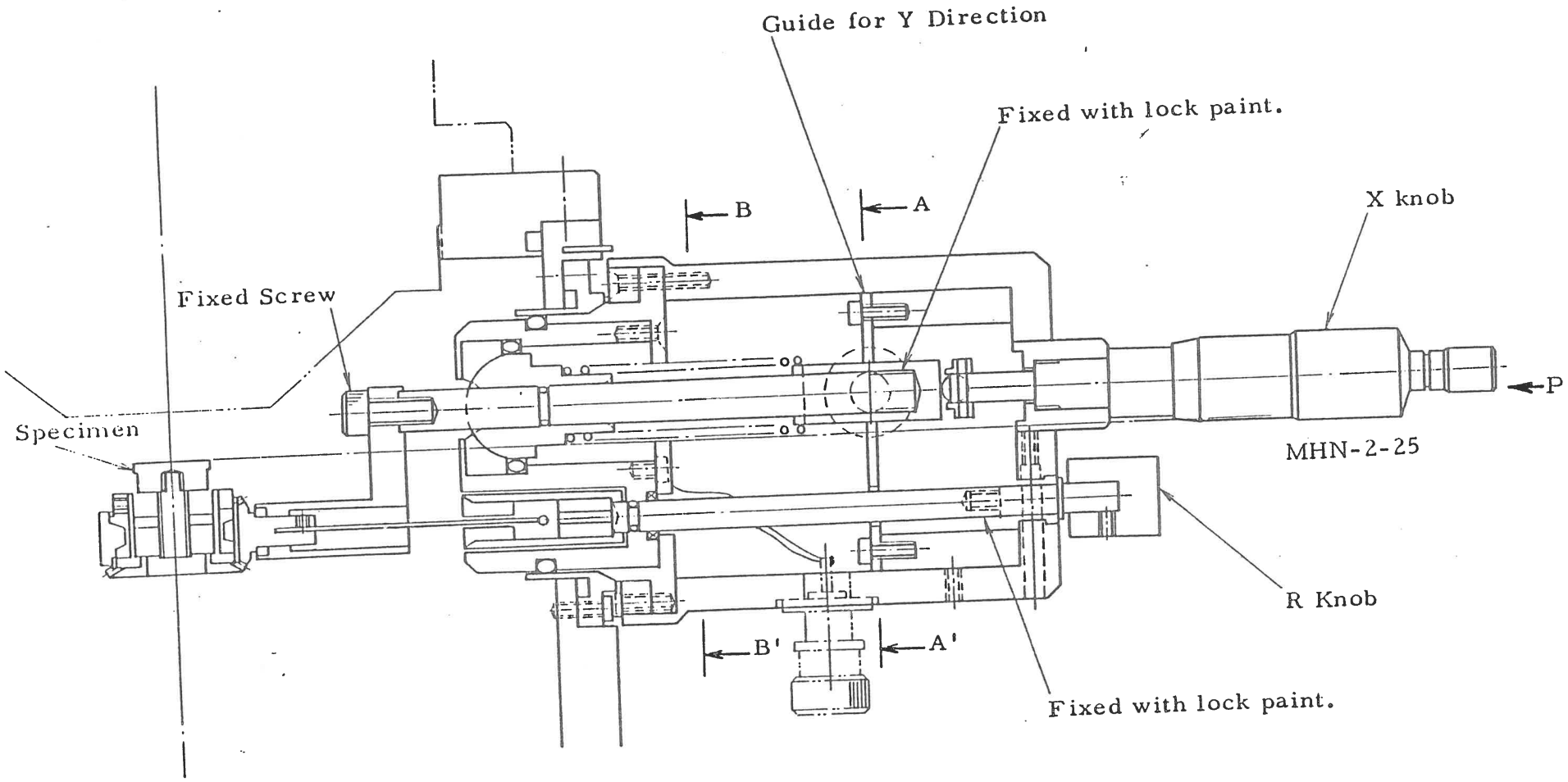


Fig. 4-10a Specimen Stage for S-430

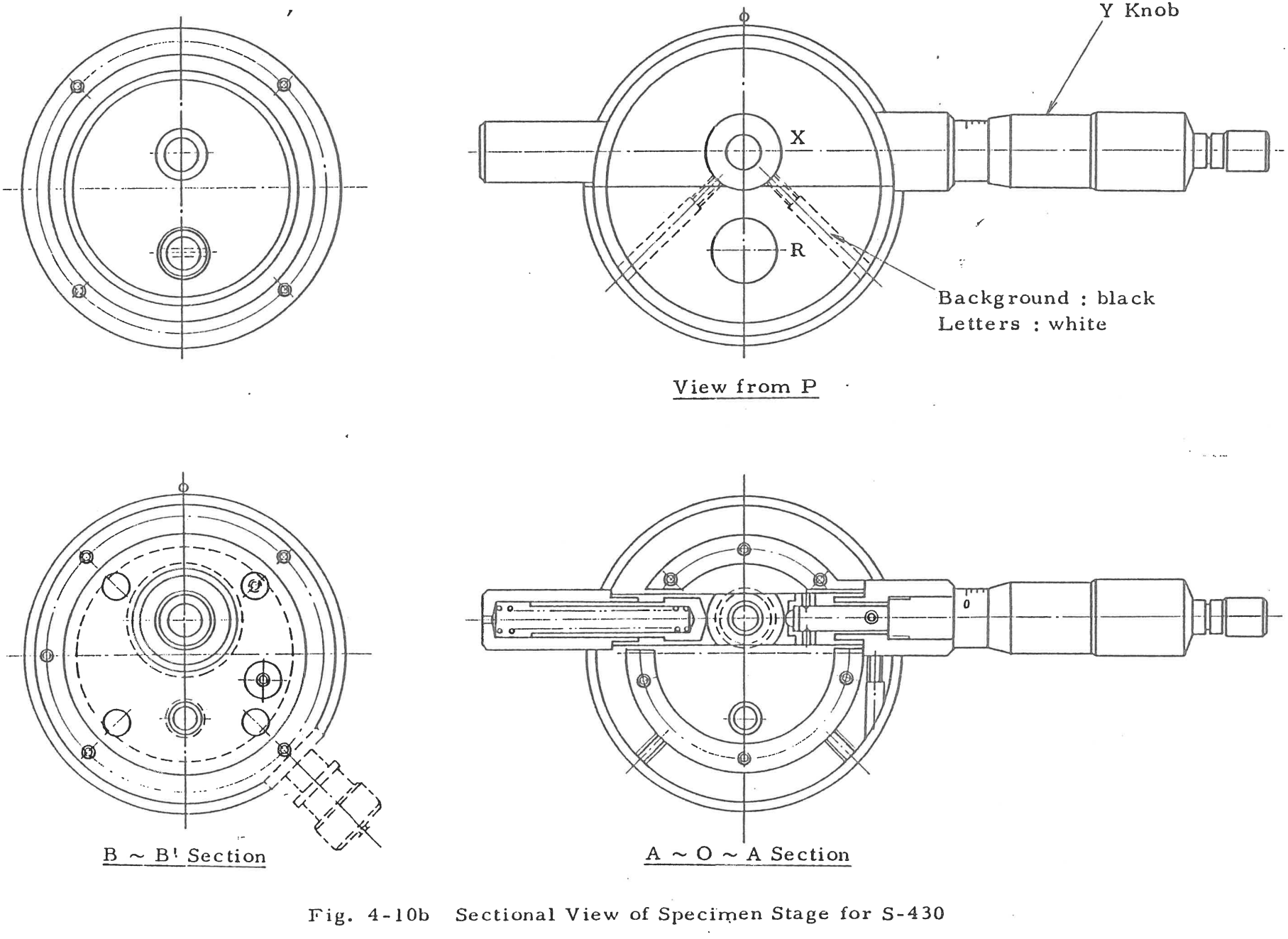


Fig. 4-10b Sectional View of Specimen Stage for S-430

4-2-8 Specimen Goniometer Stage (S-450)

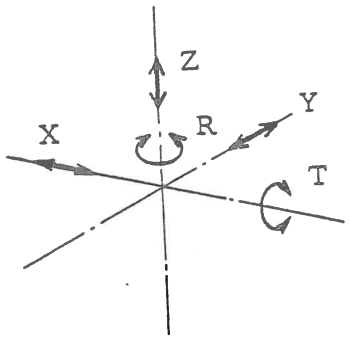
(1) Composition

The specimen goniometer stage is provided with five kinds of specimen moving mechanisms.

- o Specimen rotation (called R and indicated by ( ) mark)
- o Specimen tilting (called T and indicated by ( ) mark)
- o Vertical movement of specimen (called Z and indicated by ( ) mark)
- o Plane movement (called Y and indicated by ( ) mark)
- o Plane movement (called X and indicated by ( ) mark)

These movements can be indicated by the three-dimensional orthogonal axes as follows :

Electron Beam Irradiating Direction



The above mechanisms serve as the main guide portions of the specimen goniometer stage. Fig. 4-11 indicates a sectional view of the specimen goniometer stage, Fig. 4-12 indicates the front view of the specimen goniometer stage as viewed from the front of the column, and Fig. 4-13 indicates the plan of the specimen goniometer stage.

The specimen goniometer stage including the above guide portions is composed of the following :

- o Each guide portion
- o Drive knobs and drive shafts
- o Specimen goniometer stage base assembly
- o Specimen goniometer stage lock assembly

(2) Construction

Fig. 4-11 ~ 4-13 indicate the entire construction.

- o For the X, Y knobs and drive assembly, see Fig. 4-14.
- o For T, R, Z, and X lock knobs and drive shafts, see Fig. 4-15.
- o For R, T, R, Z, and Z lock drive assembly, see Fig. 4-16.
- o For R guide and T mount, see Fig. 4-17.

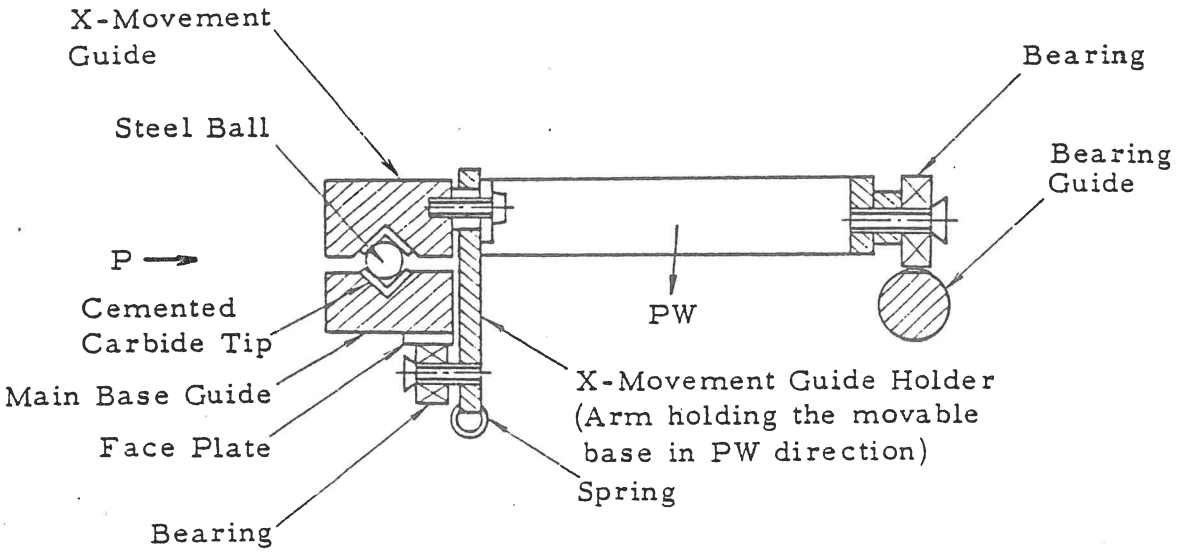
- For Z guide and Y-movement mount, see Fig. 4-18.
- For X movement mount and Y-guide base, see Fig. 4-19.
- For X base guide, see Fig. 4-20.
- For Y drive lever assembly, see Fig. 4-21.

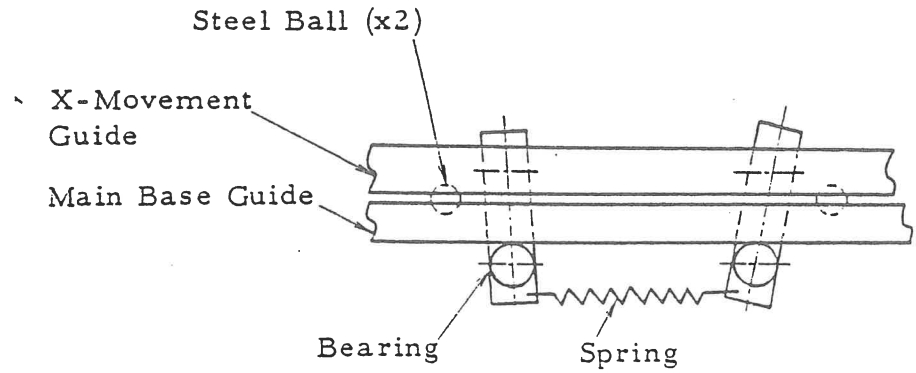
Read the above figures carefully, and locate the actual parts correspondingly. Now, the major parts of the specimen goniometer stage will be detailed.

(a) Linear Guide

System for both X and Y movement, except that their shapes differ from each other due to their compositions. A cemented carbide (TOSHIBA TANGALLOY G5) tip is bonded to the V-grooved aluminum base by epoxy resin. This guide is supported at three points consisting of two steel balls in the V-groove and one bearing opposite to the guide.

The following figure indicates the X-movement guide assembly as an example.





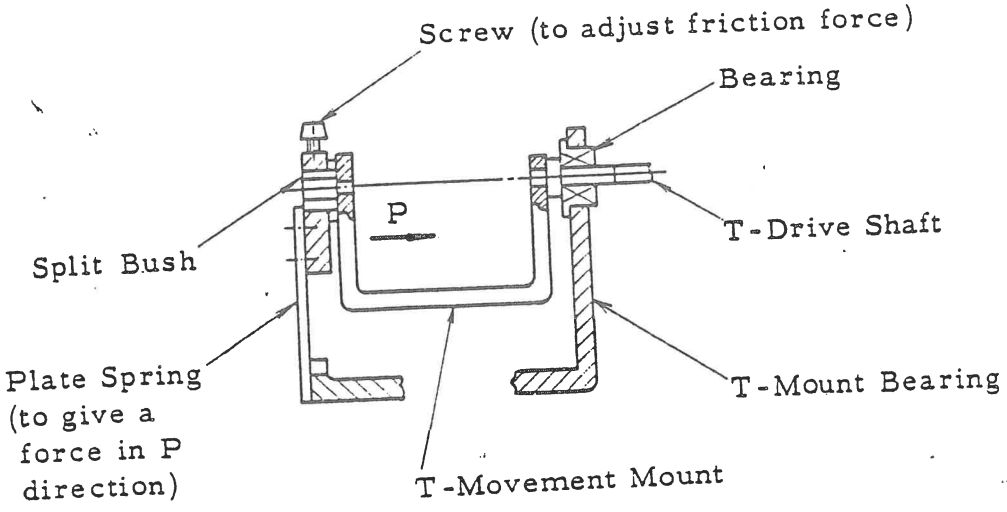
P Arrow View

(b) Z Guide

This guide adopts the slide system using a bearing and a stainless steel shaft. The shaft is V-grooved and supported by nylon ball and spring for the purpose of preventing rotation and eliminating play.

(c) T Guide

This guide adopts a swing system by holding one end using a bearing and holding the other end by a Delrin split bush.



(d) R Guide

This adopts the full ball bearing system using 48 nylon balls which are employed for electrically insulating the specimen stage.

(e) Drive System of Each Movement

X ... The movable mount is directly moved by the microhead via a steel ball for eliminating the effect of rotating force.

Y ... Same system as for X, provided that a lever is employed, since the operating direction differs from that of X-movement by 90°.

Z ... Rack pinion system

T ... Direct movement using rotating knob

R ... Worm plus worm gear shaft

Each knob and movement mount are connected by the spline expansion/contraction and universal joint system.

(f) Y-Drive Lever Assembly

The movable range of the X-component is secured by using a slide bear (made by ORIGIN). The rotating shaft of each lever employs a pivot bearing (ORIGIN) and a pivot (quenched SKD) to eliminate play.

(3) Performance

Reproducibility	:	5 μ
Backlash	:	10 ~ 40 μ
Linearity	:	Less than 1 μ
Vibration resistance	:	About 1 μ in amplitude
Hysteresis	:	3

Specifications

Movable range X, Y	:	0 ~ 40 mm
Z	:	0 ~ 30 mm (WD: 5 ~ 35)
T	:	-20 ~ 90°
R	:	360° continuous

(4) Disassembly and Assembly of Specimen Goniometer Stage

The specimen goniometer stage assures an accuracy of μ order. However, it is designed in such a structure that the above accuracy can be obtained automatically when the work is done according to the following procedure while observing precautions described below.

o Precautions Before Disassembly

(a) Understand the construction thoroughly referring to Figs. 4-11 ~ 4-21.

(b) Wear gloves so as not to contaminate any part during disassembly.

(c) Disassemble the unit on a table while taking care so as not to lose parts in the course of the disassembly work. Be careful since 6 steel balls and 48 nylon balls are apt to roll.

(d) Disassemble the unit for each block, and keep disassembled parts for each block in good order.

o Disassembling Procedure

This specimen goniometer stage can roughly be divided into the following seven portions.

(a) Each knob assembly (Figs. 4-14 ~ 4-15)

(b) T mount and R assembly (Fig. 4-17)

(c) Z guide and Y-movement mount (Fig. 4-18)

(d) X-movement mount and Y-guide base (Fig. 4-19)

(e) X-base guide assembly (Fig. 4-20)

(f) Y-drive lever assembly (Fig. 4-21)

(g) Other specimen stage base assembly (Figs. 4-11 ~ 4-13 indicating the entire view)

o Procedure

(a) Disassembly of Base Assembly and Specimen Goniometer Stage

1) Loosen screws (11) (12) (Fig. 4-17) to disconnect the absorption current wiring, and also detach the cover.

2) Loosen screw (13) (Fig. 4-11) to separate the base assembly from the specimen goniometer stage.

(b) Disassembly of Knob Assembly

1) Loosen two screws (1) (Figs. 4-15 and 4-16) at the tip of each knob drive assembly.

2) Turn knob base (2) (Fig. 4-15) counterclockwise.

3) Detach two springs (3) (Fig. 4-14) at the tips of X and Y knobs having the same shape.
Loosen three screws (4) (Fig. 4-14) to detach the component.

4) Loosen base (5) (Fig. 4-14) counterclockwise.

(c) T Mount and R Assembly

After opening the T-mount bearing, loosen screw (6) (Fig. 4-11).
Pull the T-mount and R assembly in the screw direction.

(d) X-Movement Mount, Y-Movement Mount, Z-Guide, and Y-Movement Mount Assembly

1) Loosen spring (10) (Fig. 4-13).

2) Loosen screw (14) (Fig. 4-13) to detach two bearings.

3) Pull these parts in the direction opposite to the knobs.

(e) Z-Guide and Y-Movement Mount

1) Detach spring (7) (Fig. 4-13).

2) Loosen two screws (9) (Fig. 4-13) to detach the bearing.

3) Loosen two screws (8) (Fig. 4-13) to detach the part.

(f) X-Base Guide Assembly

Loosen two screws (15) (Fig. 4-11).

(g) Y-Lever Assembly

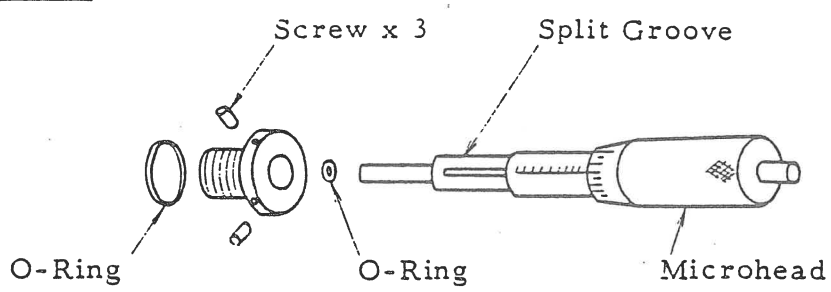
Loosen two screws (16) (Fig. 4-11).

Now, disassembly of each block is completed.

The cautions on disassembly and assembly of each part are as given below.

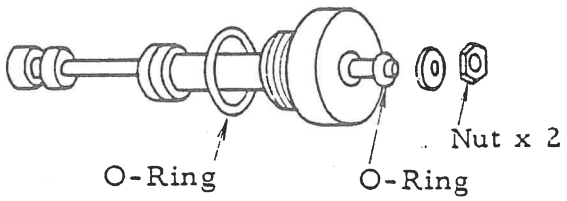
(a) Knob Assembly

X, Y Knob



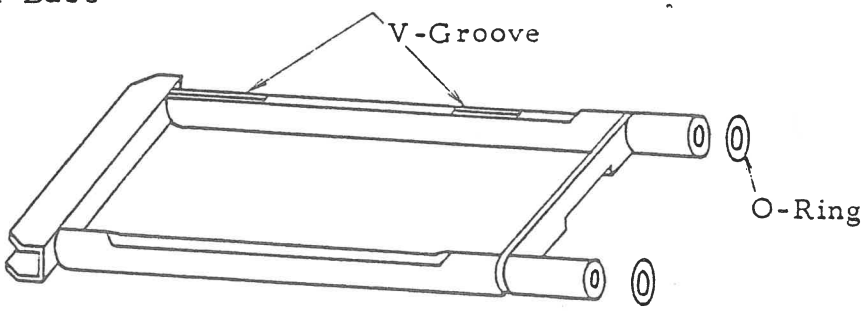
Clamp three screws evenly to assure smooth rotation of the microhead.

T, R, Z, Z-Lock Knobs



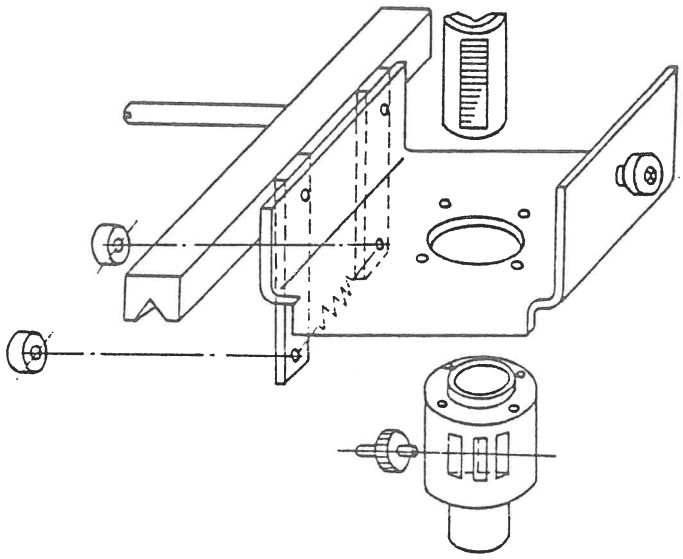
Eliminate play of the shaft by locking the shaft using these two nuts.

(b) X-Base



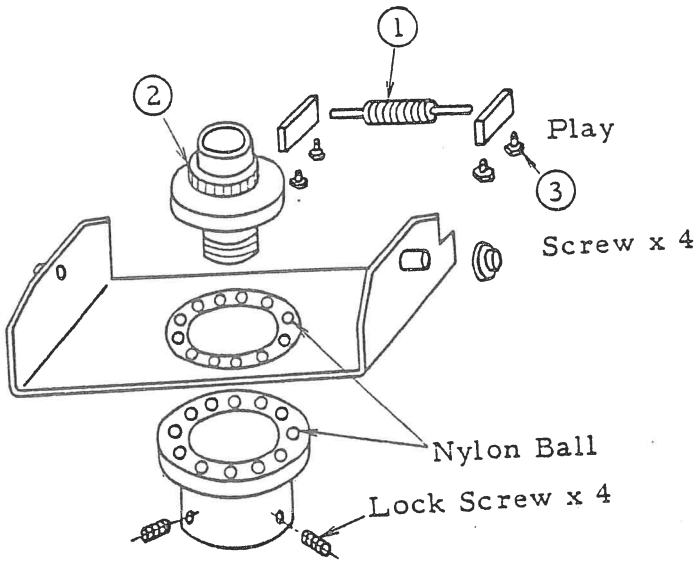
Obtain overall parallelism.

(c) Y-Movement Mount and Z-Guide Assembly



(d) T-Mount and R-Guide Assembly

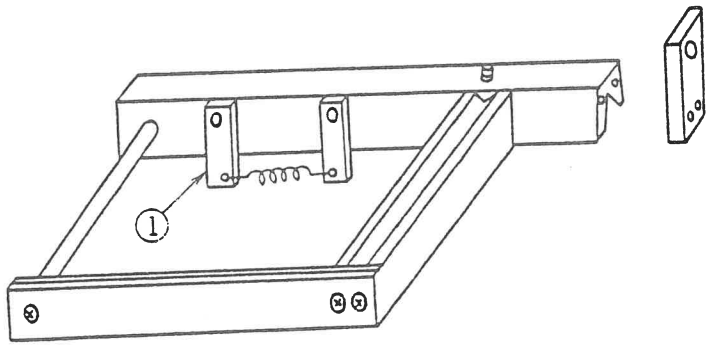
TR Assembly



Adjust screws (3) to eliminate play at (1) and (2).

Clamp lock screws without fail.

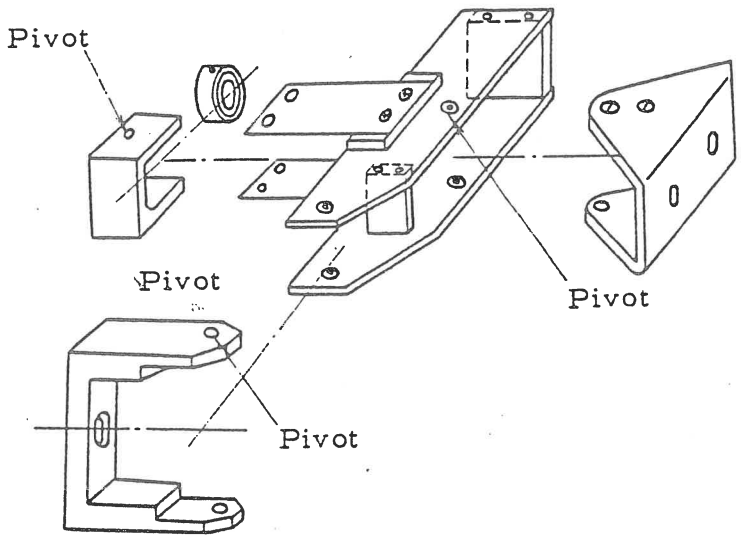
(e) X-Movement Mount and Y-Base Guide



(1) should move smoothly.

(f) Y-Lever Assembly

Y-lever assembly (D#25310583)



Clamp the pivot lightly and make sure that no play exists.

(5) Troubleshooting

(a) Noticeable Backlash (X, Y)

1) Check if each knob screw is securely clamped.

2) Check if spring (A) (Fig. 4-13) is normally fixed to the tip of X, Y knob.

3) Check if bearing (B) (Fig. 4-13) is properly mounted.

4) Check Y-lever pivot (C) (Fig. 4-13) for play.

5) Check if springs (D), (E) (Fig. 4-13) are properly mounted.

6) Check if Y-guide shaft (F) (Fig. 4-13) is securely clamped.

7) Check if slide bearing (G) (Fig. 4-11) is properly mounted without looseness.

(b) Poor Reproducibility (X, Y)

1) Same as 1) ~ 6) in (a) above.

2) Check if four steel balls (H) (Figs. 4-11 and 4-12) are mounted to each guide assembly.

3) Check steel ball faces (H) (Figs. 4-11 and 4-12) of each guide assembly for dust deposit.

(c) Vibration

1) Same as 1) ~ 7) in (a) above.

2) Check if T-mount shaft brake (I) (Fig. 4-11) is securely mounted without looseness. (Check if the T-knob torque exceeds 500 g/cm).

3) Check if R-ball holder (J) (Fig. 4-11) is securely mounted.

4) Check if a 1 ~ 2 mm gap exists in the specimen goniometer stage base lock K (Fig. 4-11).

5) Check if the table and column contact each other.

6) Check if the city water pressure is higher than specified. Adjust it to a flow rate of 2 liters/min.

7) Check if external vibrations are noticeable.

8) Check screws of each part of the column for looseness.

9) Check the rear cover of the console rack for looseness.

(d) Each knob does not move.

Check the screw (L) (Fig. 4-11) at the tip of knob drive shaft for looseness Disassemble and check it.

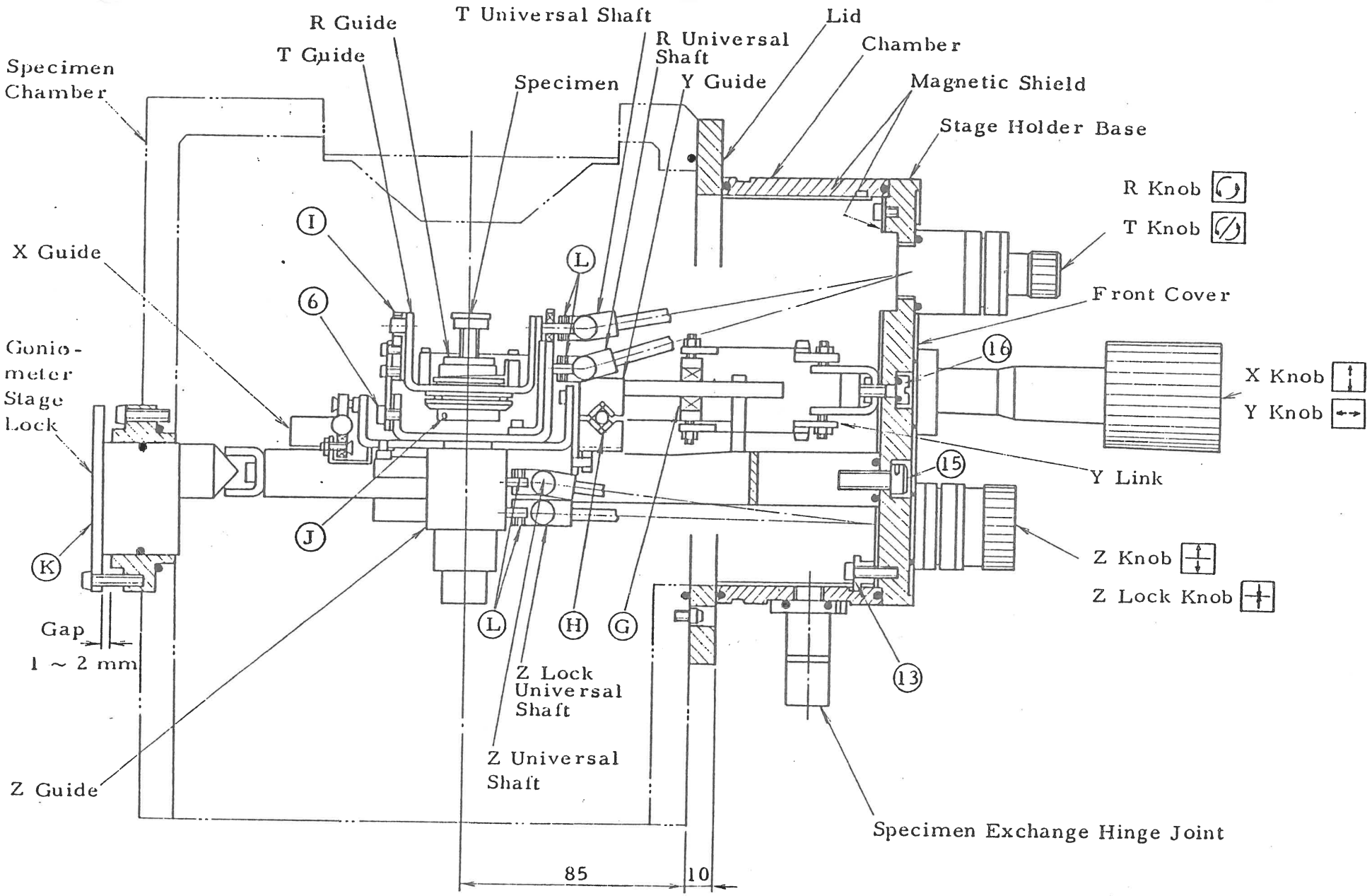


Fig. 4-11 Sectional View of Specimen Goniometer Stage

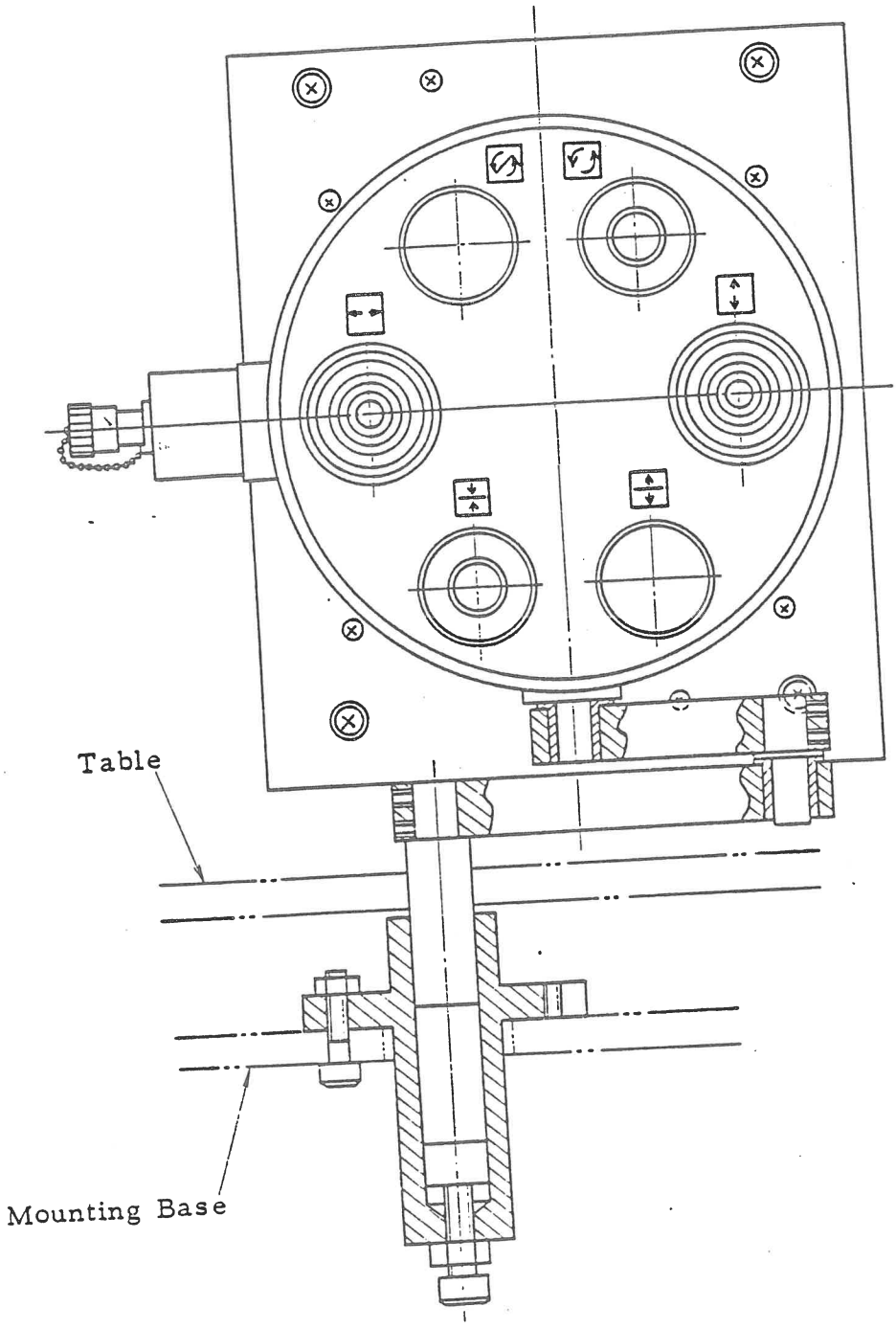


Fig. 4-12 Front View of Specimen Goniometer Stage

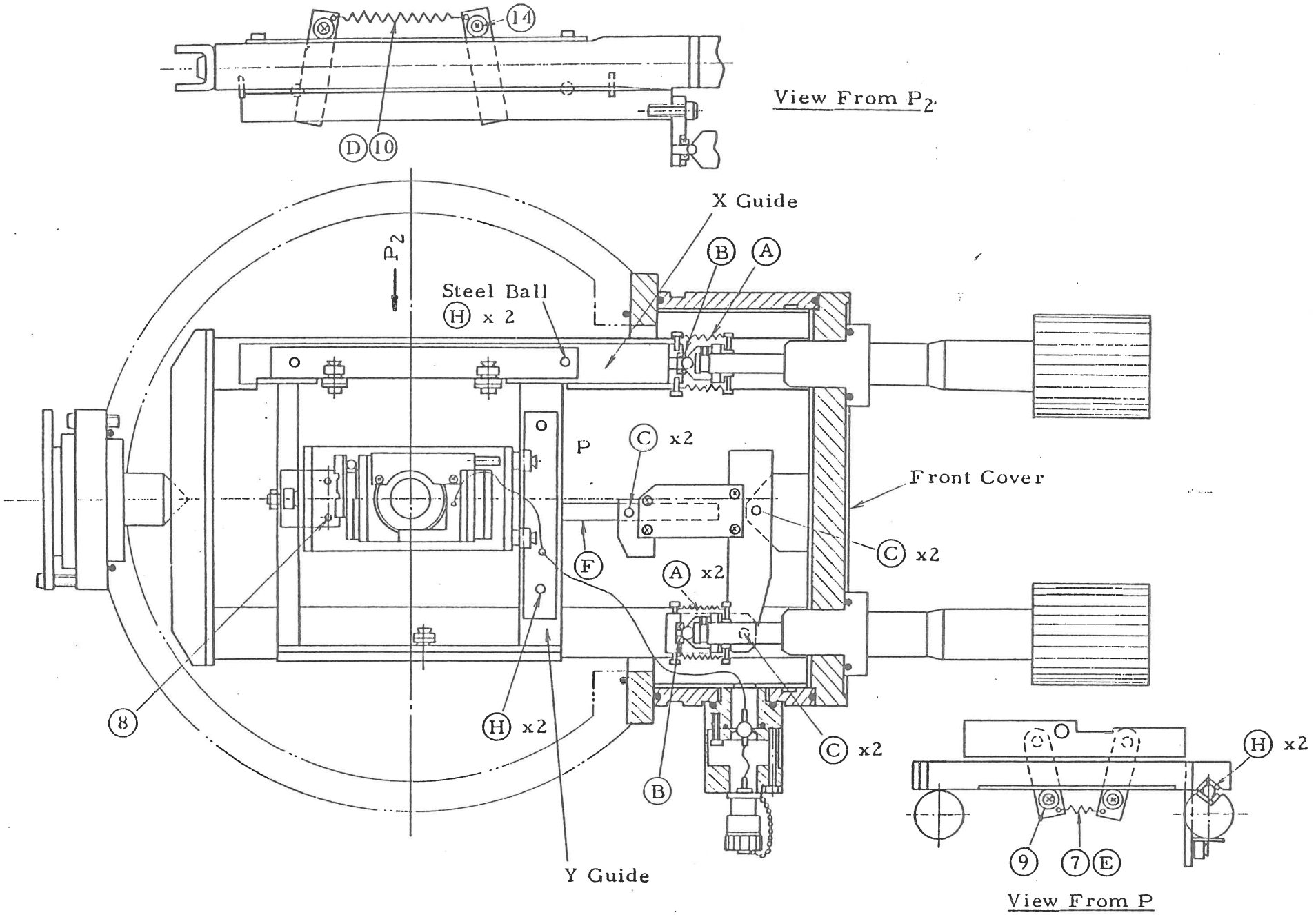


Fig. 4-13 Plan of Specimen Goniometer Stage

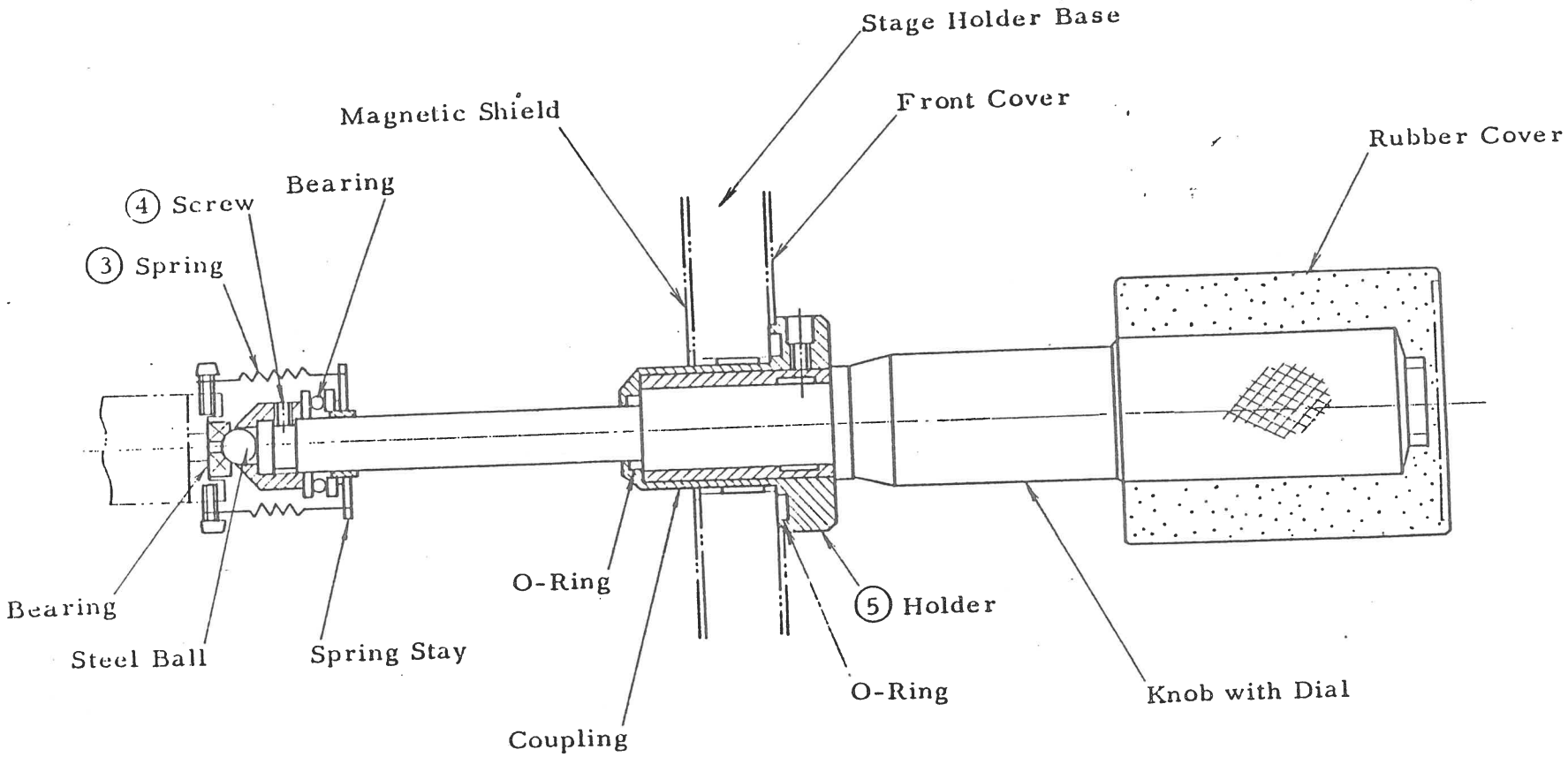


Fig. 4-14 Construction of X, Y Knobs and Drive Assembly

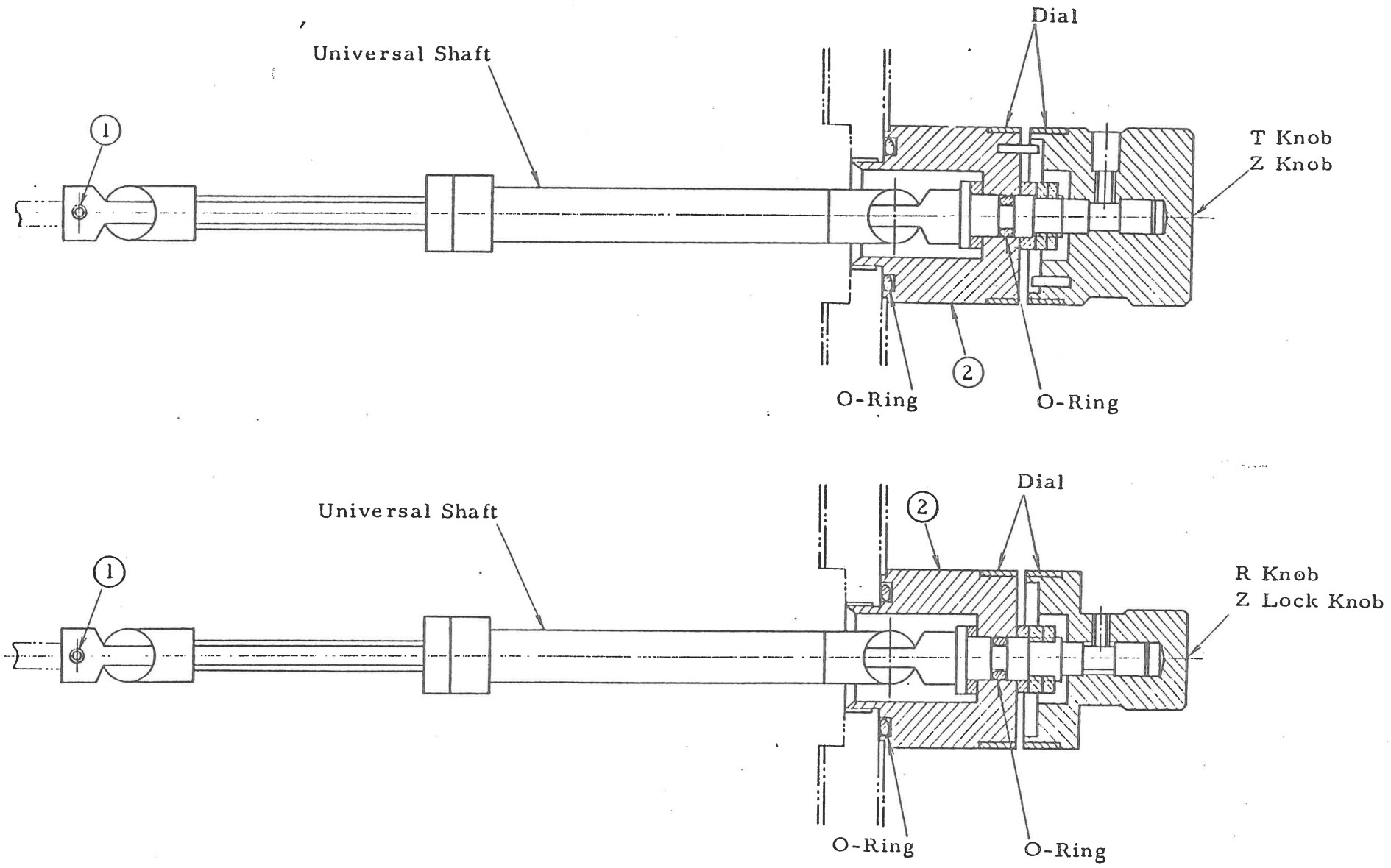
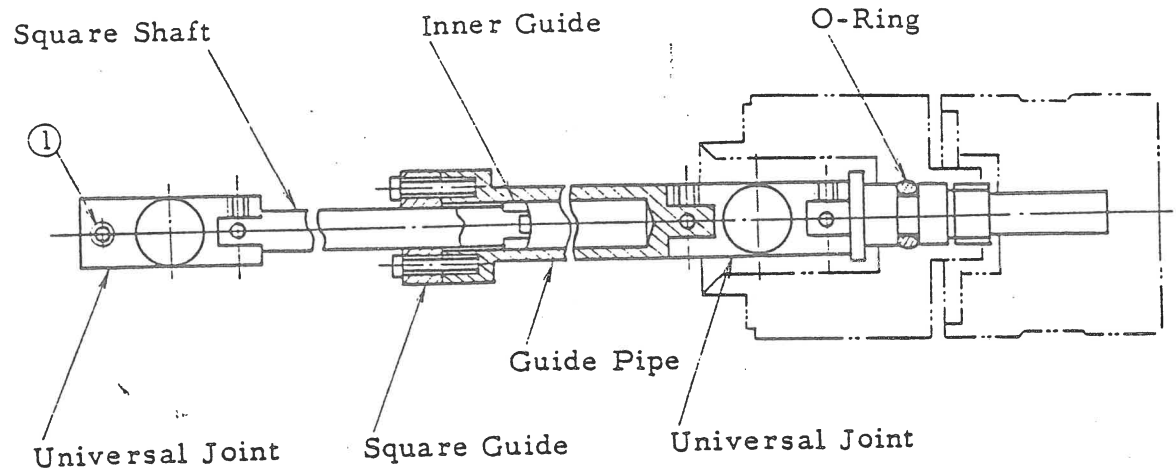
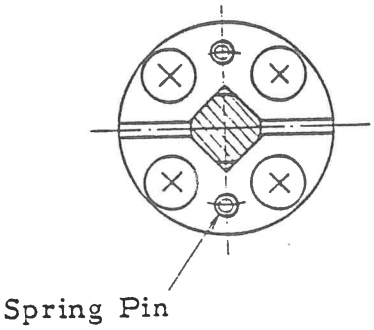
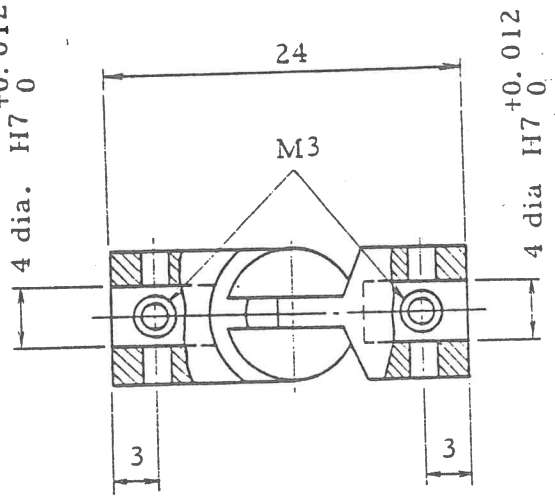


Fig. 4-15 Construction of T, R, Z, and Z Lock Knobs and Drive Shaft







Universal Joint

Fig. 4-16 Construction of Each Drive Shaft

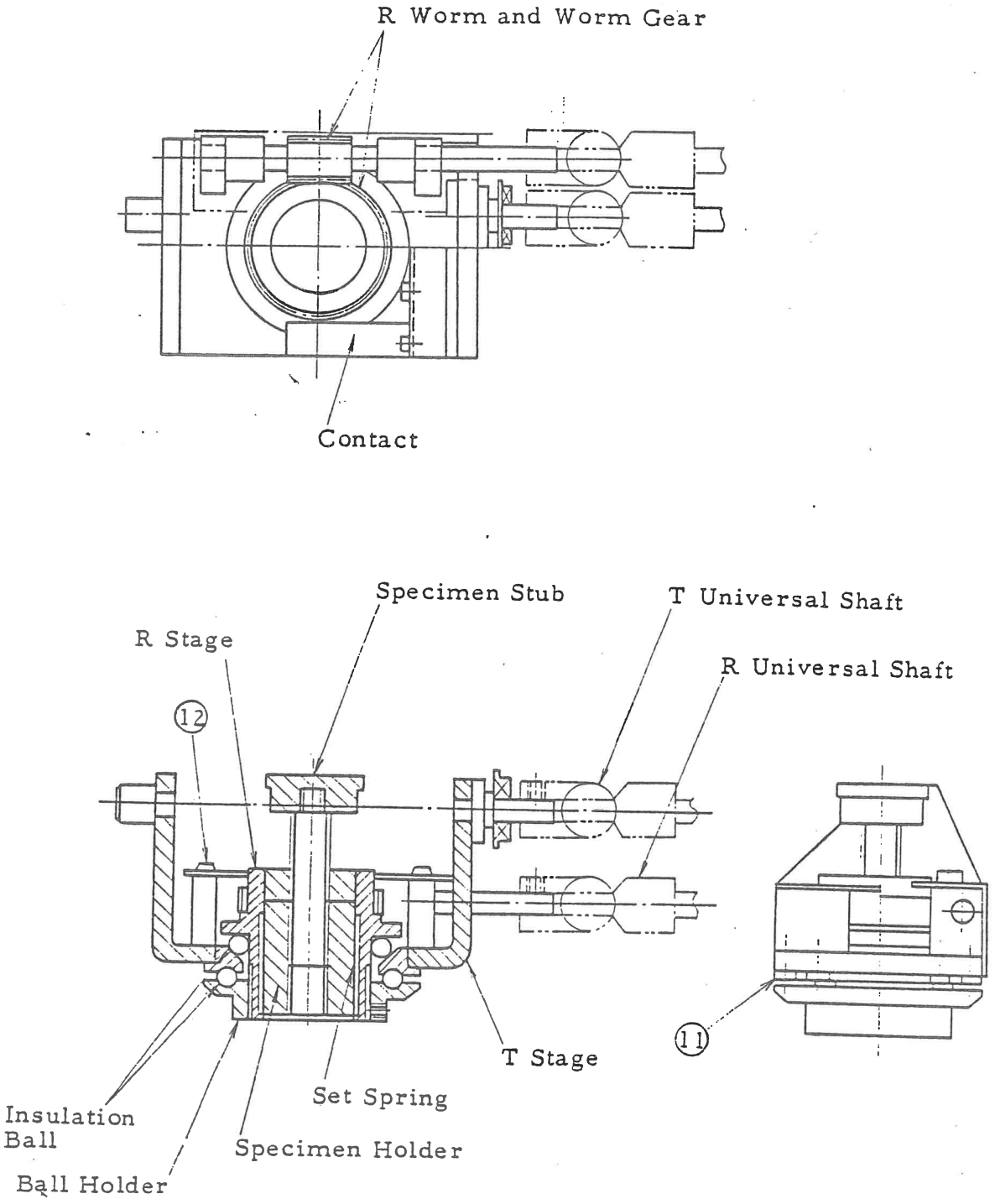
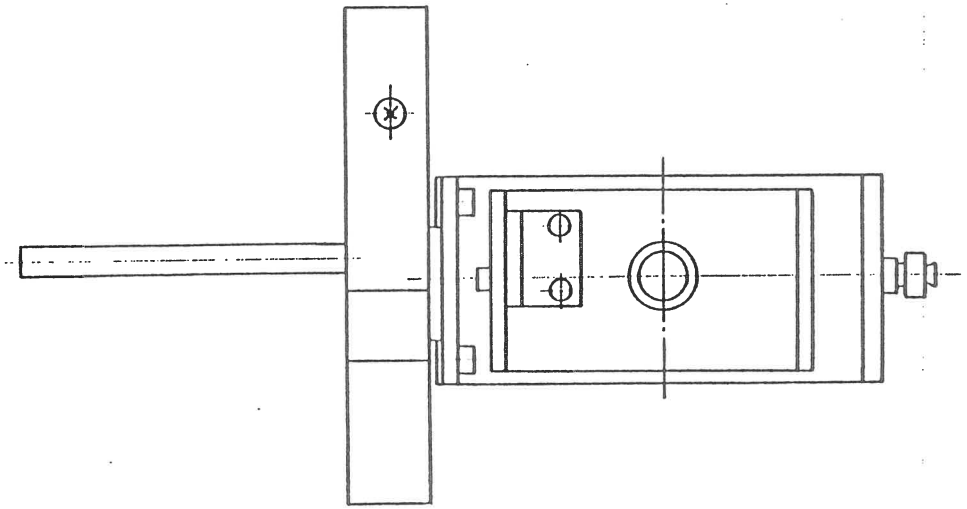
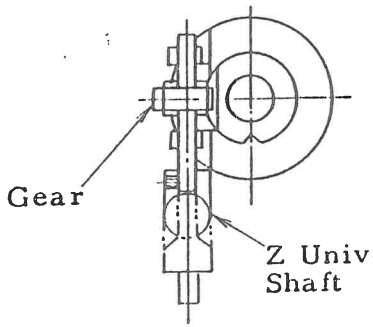
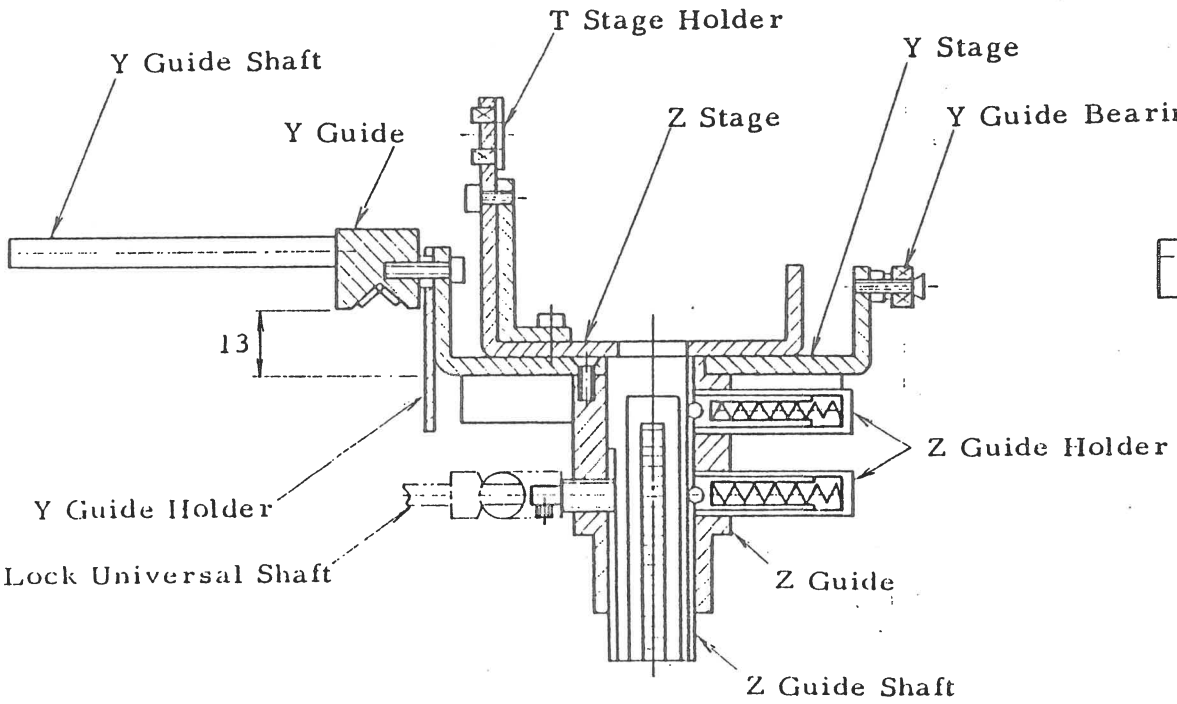
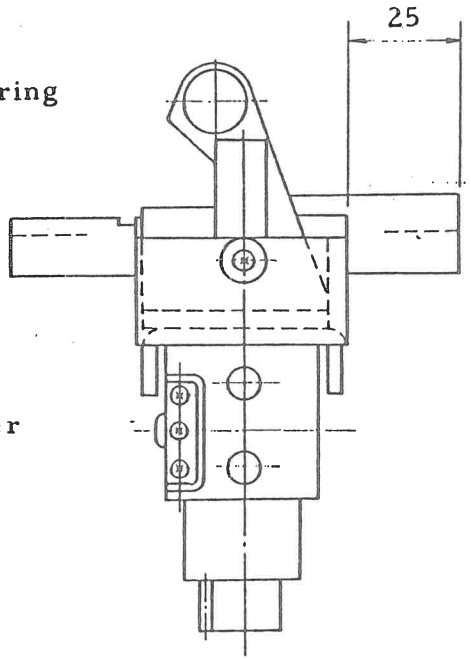


Fig. 4-17 Construction of R Guide and T Mount




Gear
Z Universal Shaft


T Stage Holder
Y Guide Shaft
Y Stage
Y Guide
Z Stage
Y Guide Bearing
13
Z Guide Holder
Y Guide Holder
Z Lock Universal Shaft
Z Guide
Z Guide Shaft


25

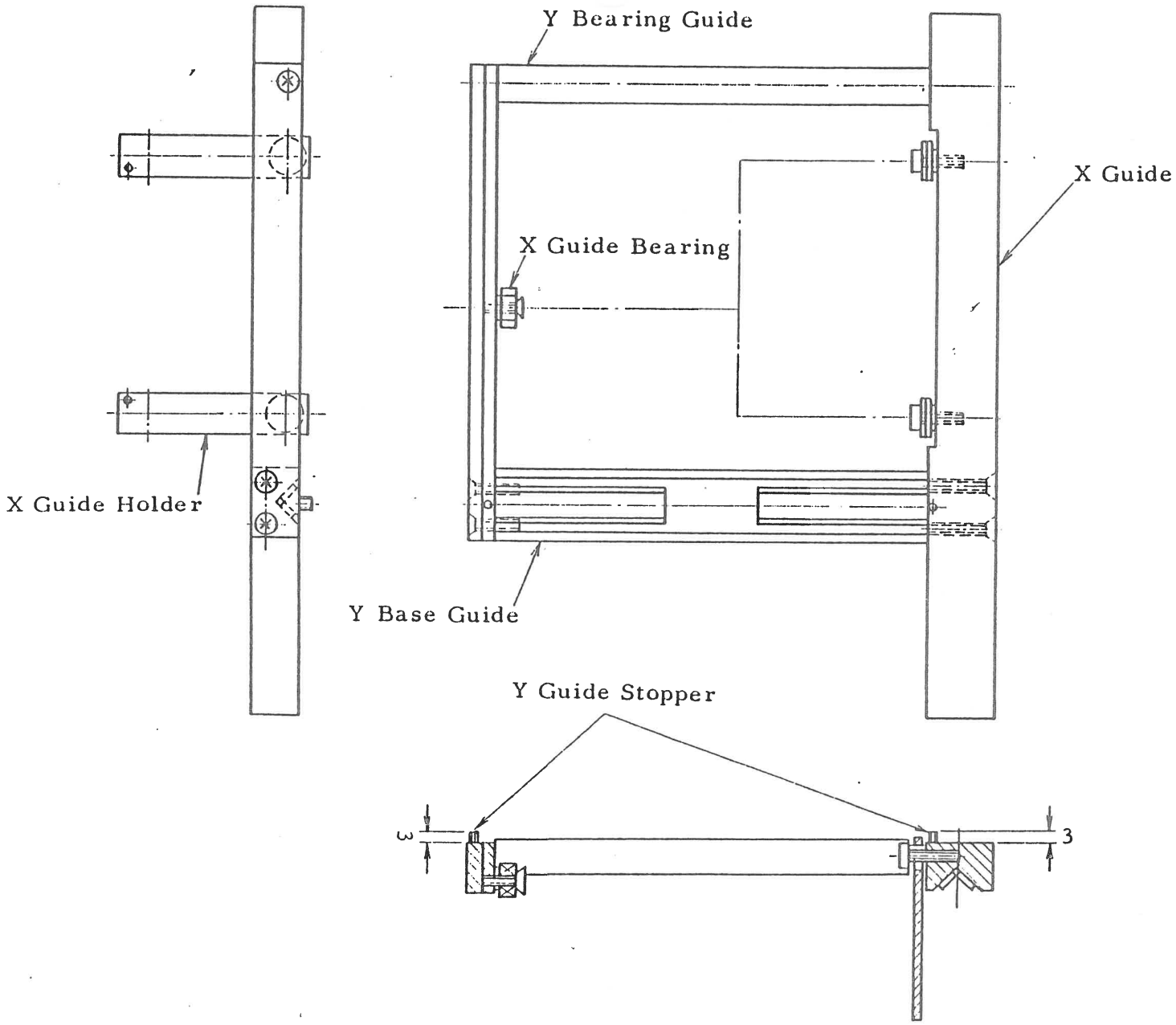


Fig. 4-19 Construction of X-Movement Mount and Y-Guide Base

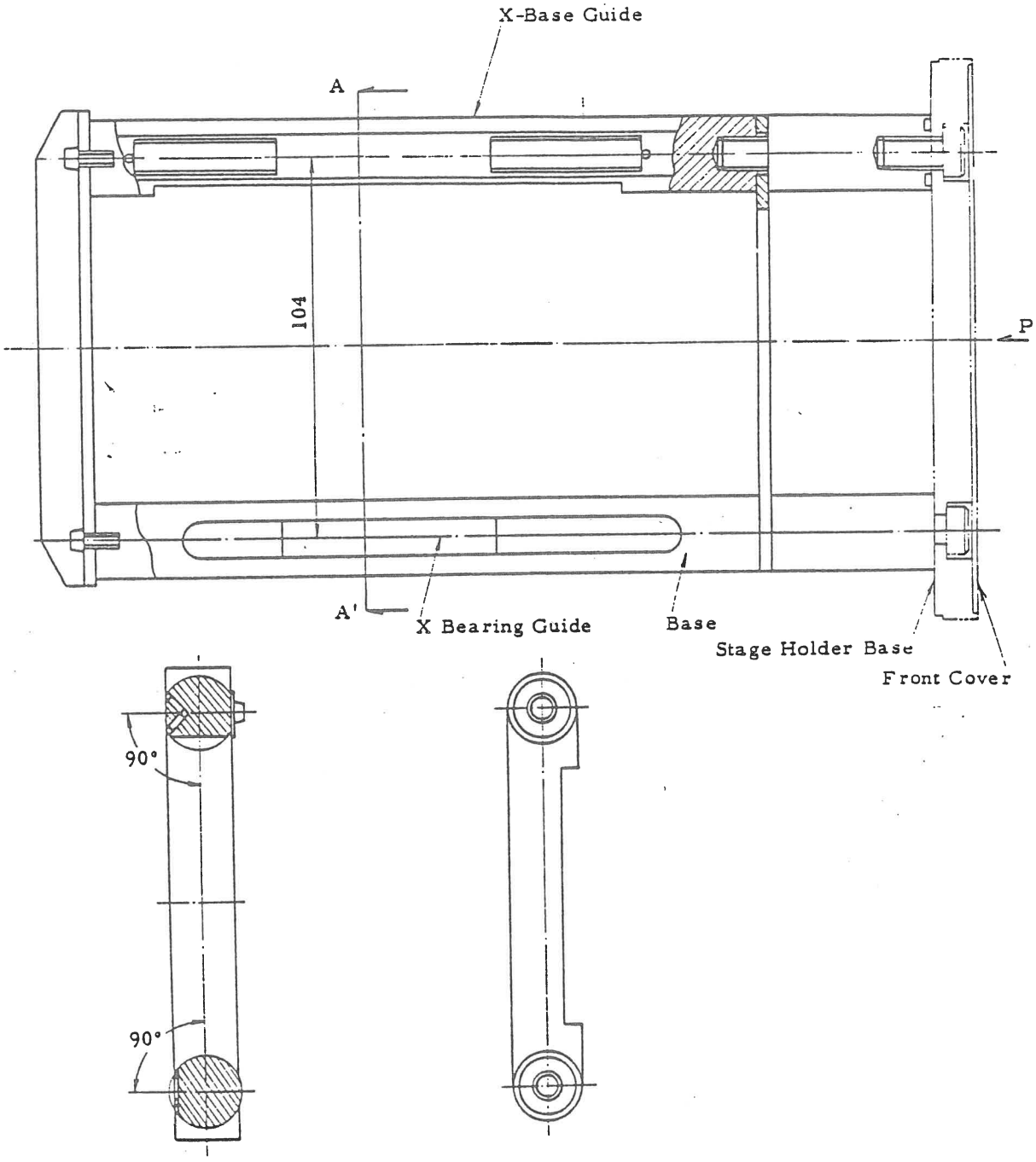


Fig. 4-20 Construction of X-Base Guide Assembly

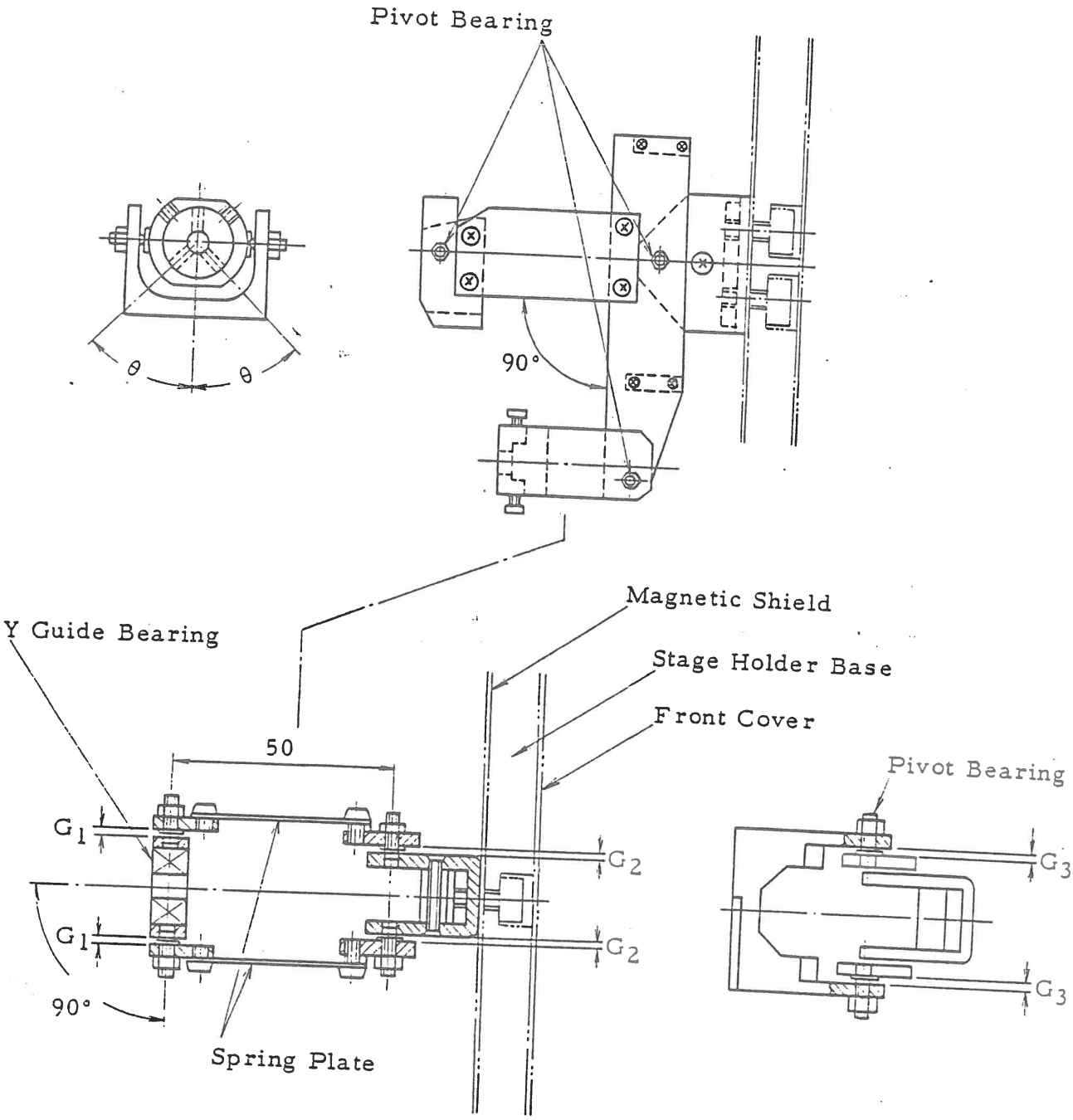


Fig. 4-21 Construction of Y-Drive Lever Assembly

4-3 COMPOSITION OF DISPLAY UNIT

4-3-1 Function of Each PC Board

Name of PC Board	Function
HEAD AMP	SE signal pre-amplifier
AL/STG	Gun alignment amplifier Stigmator amplifier Image shift amplifier
DEF AMP	CRT X and Y deflection amplifier Column X and Y deflection amplifier Spot killer circuit
MAG IND CONTROL	Magnification indicator control HV ON-OFF switch
HV INDICATOR	Emission meter circuit
SG-VA	Sawtooth wave generator Video amplifier Blanking signal generator
B/C-METER	Brightness and contrast indicator
MAG IND	Digital magnification indicator
MAG SW	Magnification selector
SCAN SPEED	Scanning speed selector
LENS	Cond lens power supply Obj lens power supply Acc voltage selector Working distance selector Focus monitor circuit Photo speed selector
PS-1	DC power supply
PS-2	DC power supply
PS-4	CRT HV 600 V, 100 V
PC-H10	CRT HV (photo and view) Post HV
PC-H30	Gun Acc HV Filament power supply
PC-HPM	Photomultiplier HV

4-3-2 Block Diagram of Display Units

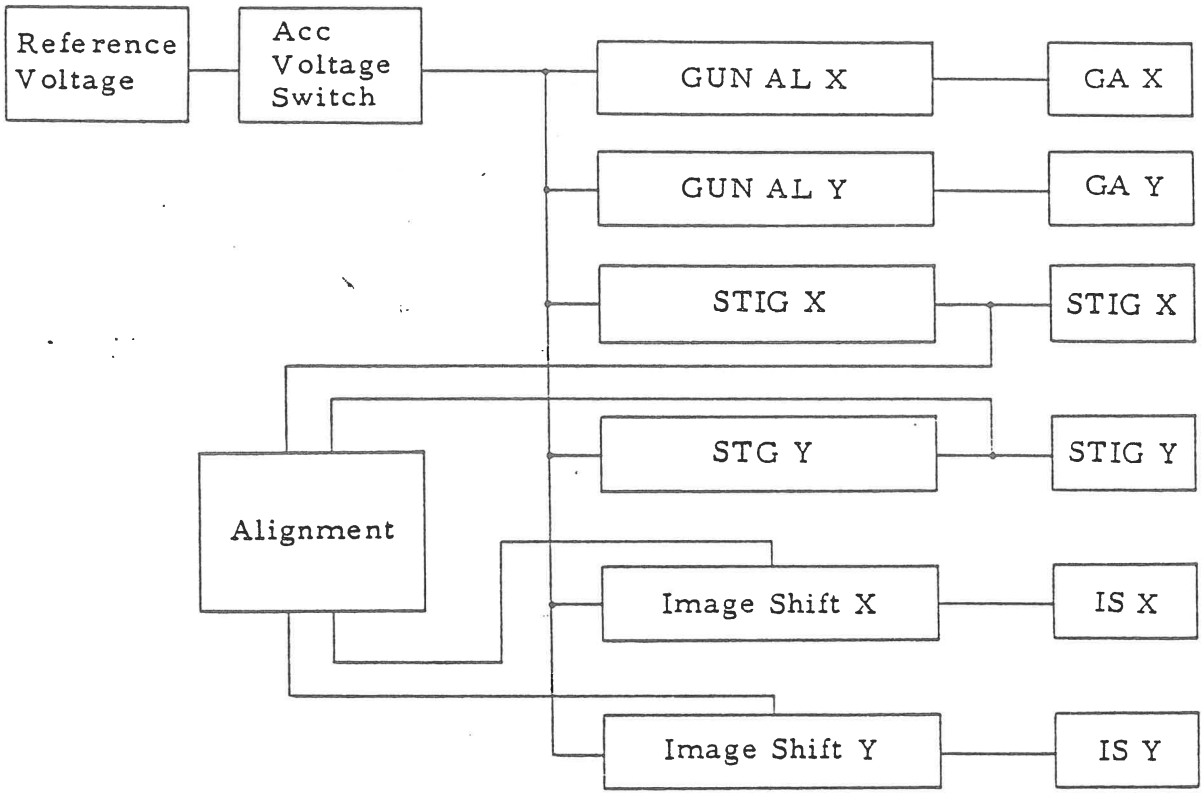


Fig. 4-22 Alignment and Stigmator Circuit

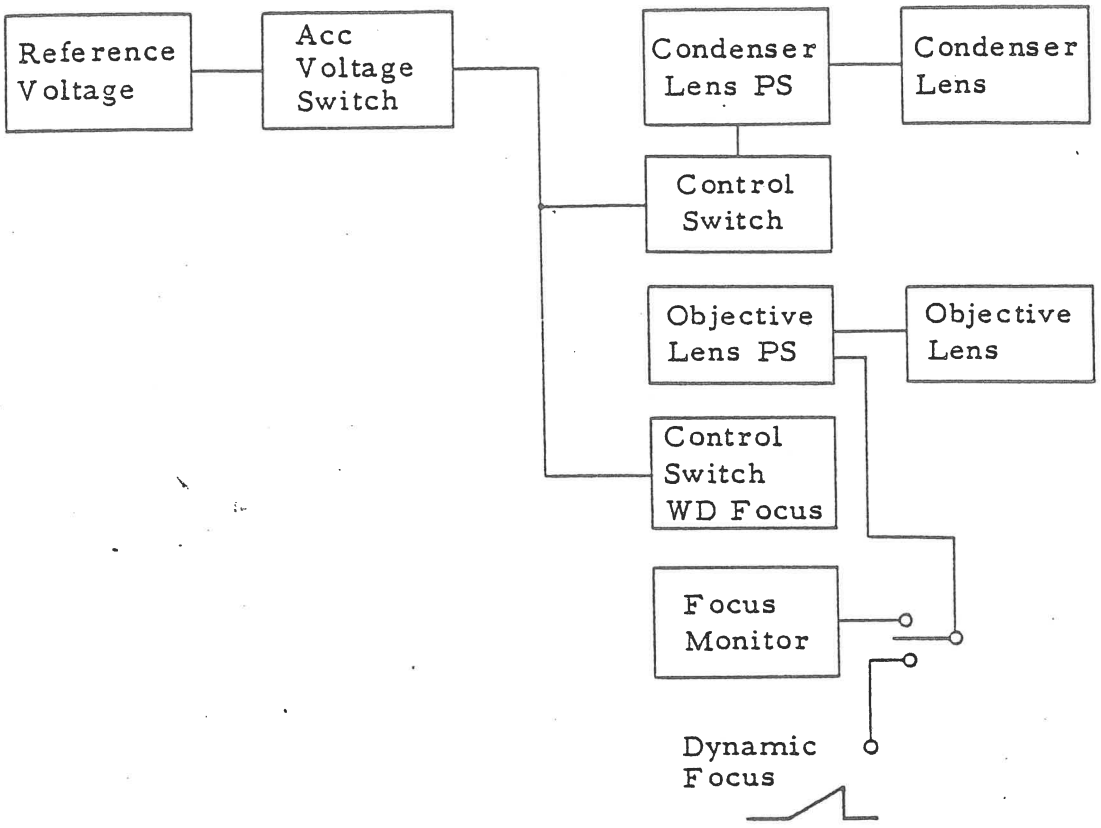


Fig. 4-23 Lens Current Power Supply

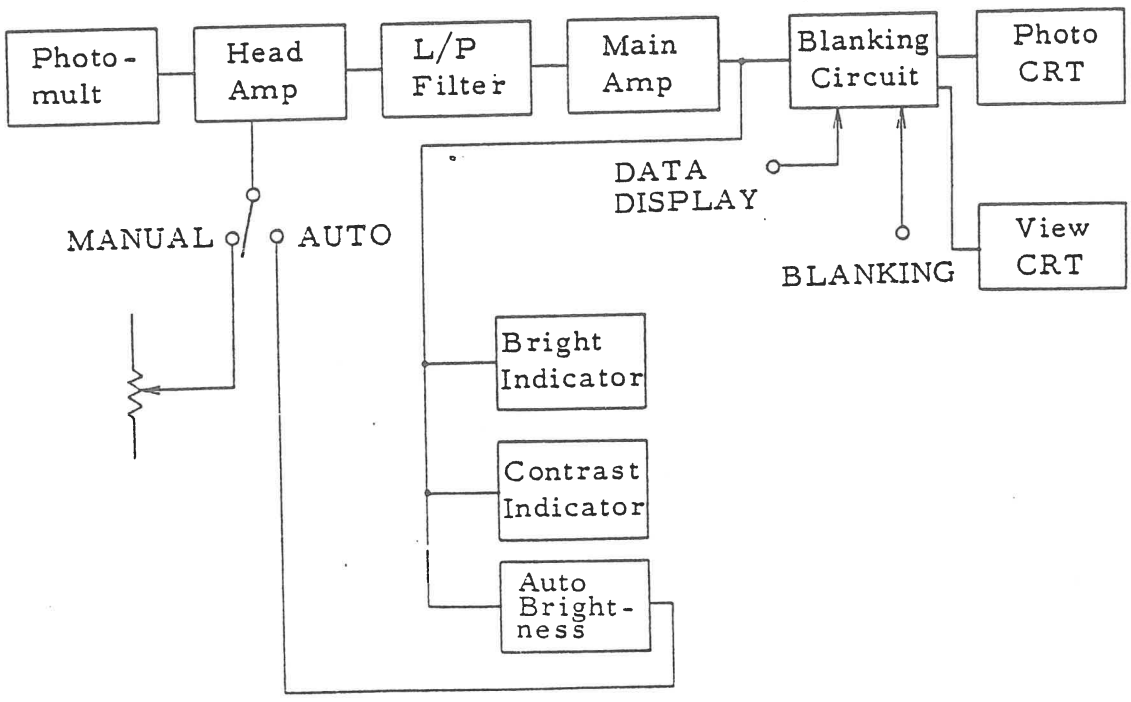


Fig. 4-24 Video Signal Amplifier Circuit

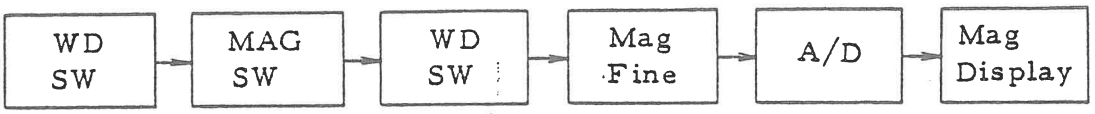


Fig. 4-25 Magnification Indicator Circuit

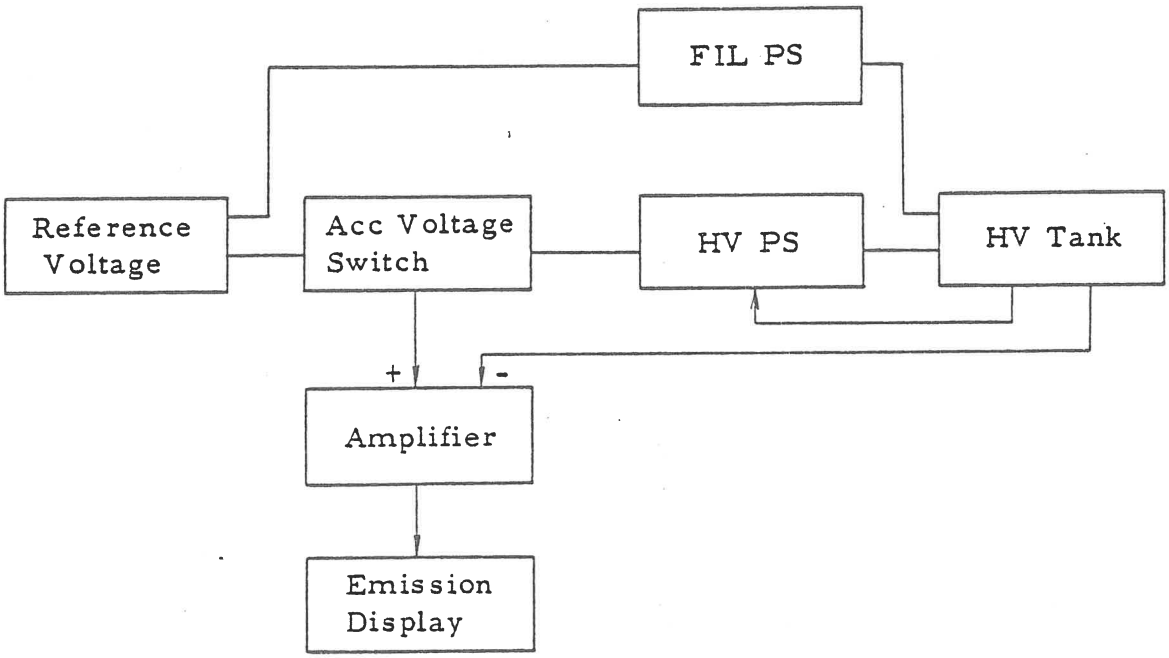


Fig. 4-26 Gun, HV and Emission Current Indicator

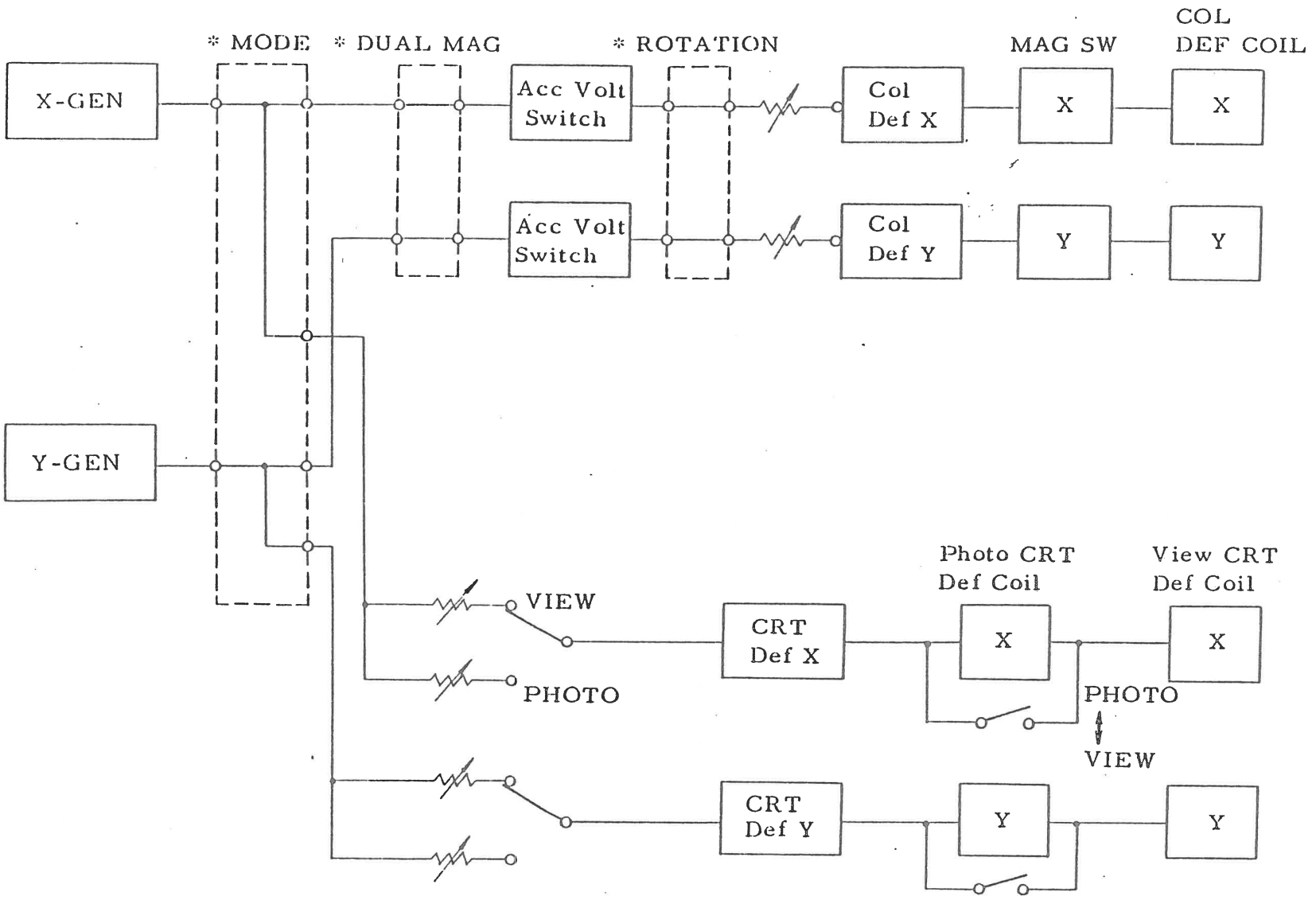


Fig. 4-27 Sawtooth Wave Generator and Deflection Amplifier Circuit

Section V

EVACUATING SYSTEM

5-1 COMPOSITION OF EVACUATING SYSTEM

Fig. 5-1 indicates the block diagram of the evacuating system.
Unlike conventional EMs, valves V1 ~ V3, LV1, and LV2 shown in Fig. 5-1 are assembled into one valve box.
The valves are opened or closed by vertically moving the valve directly coupled to the solenoid.
Fig. 5-2 indicates an external view of the valve box.

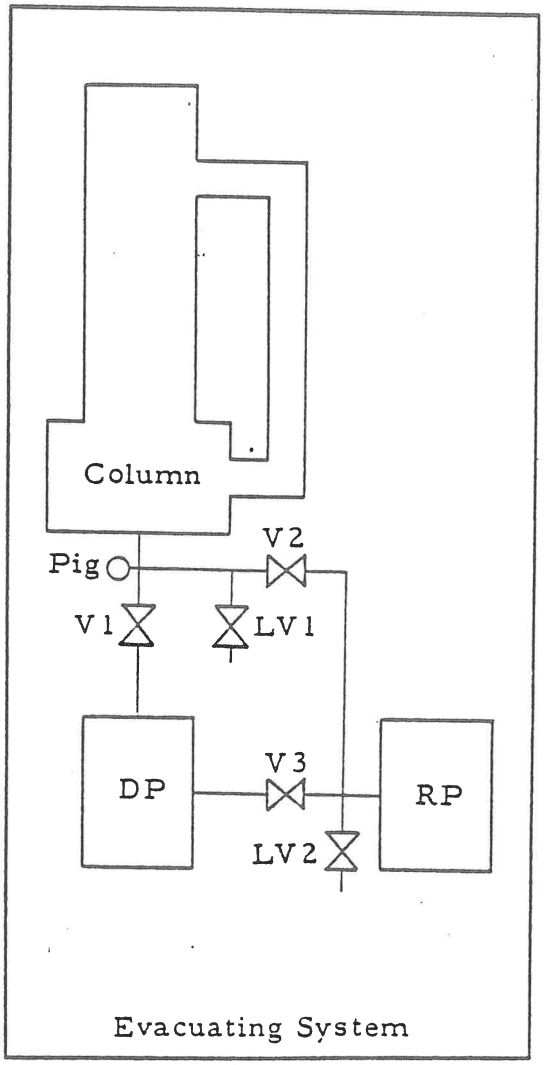


Fig. 5-1 Evacuating System

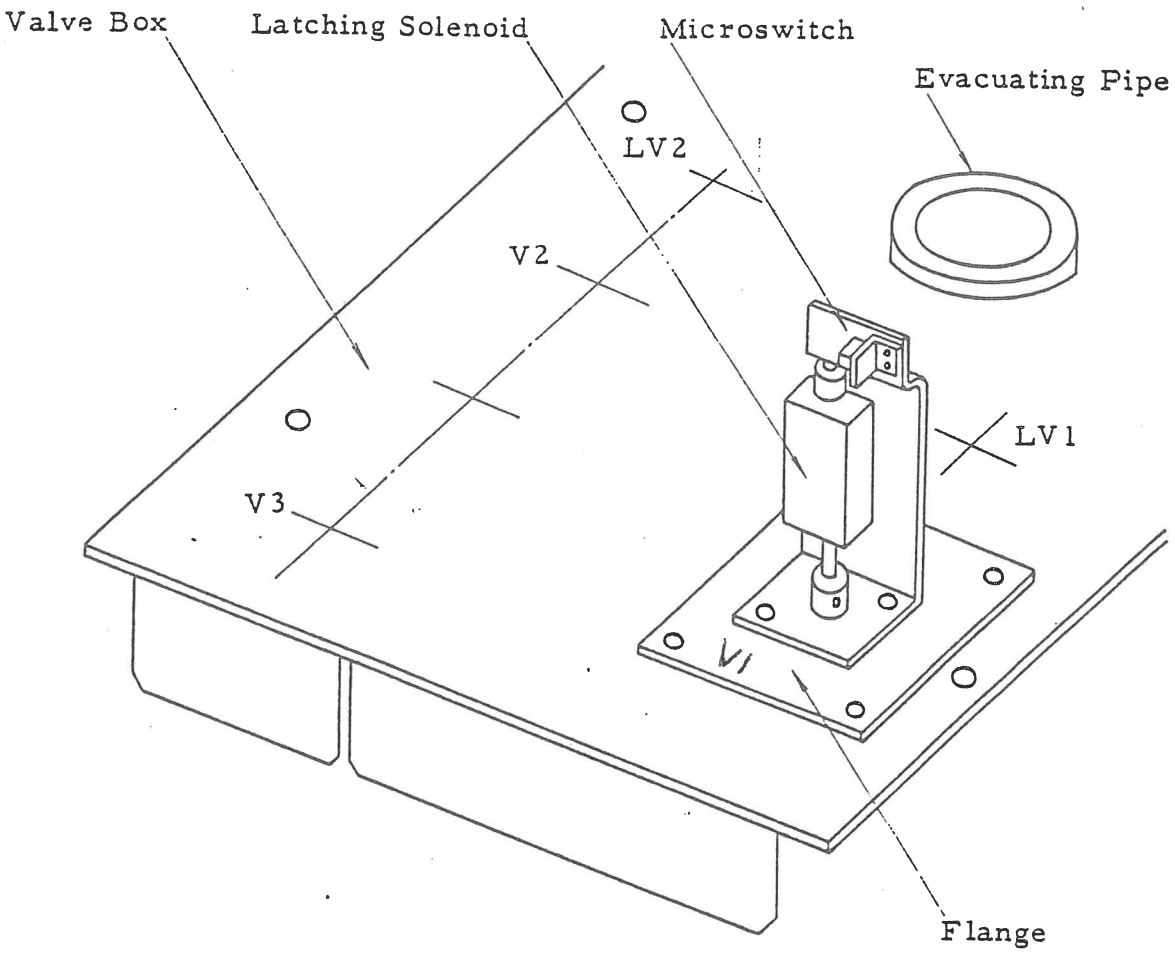


Fig. 5-2 External View of Valve Box

(1) The valve box is provided with a built-in evacuating passage.
Namely, this valve box may be regarded as a valve concentration system plus built-in evacuating pipe.
The evacuating pipe connected to RP is provided below V3.
The evacuating pipe shown in Fig. 5-2 is connected to the bottom of the specimen chamber.

(2) Fig. 5-3 indicates the valve construction.
The valve can be disassembled together with the latching solenoid by detaching the flange.

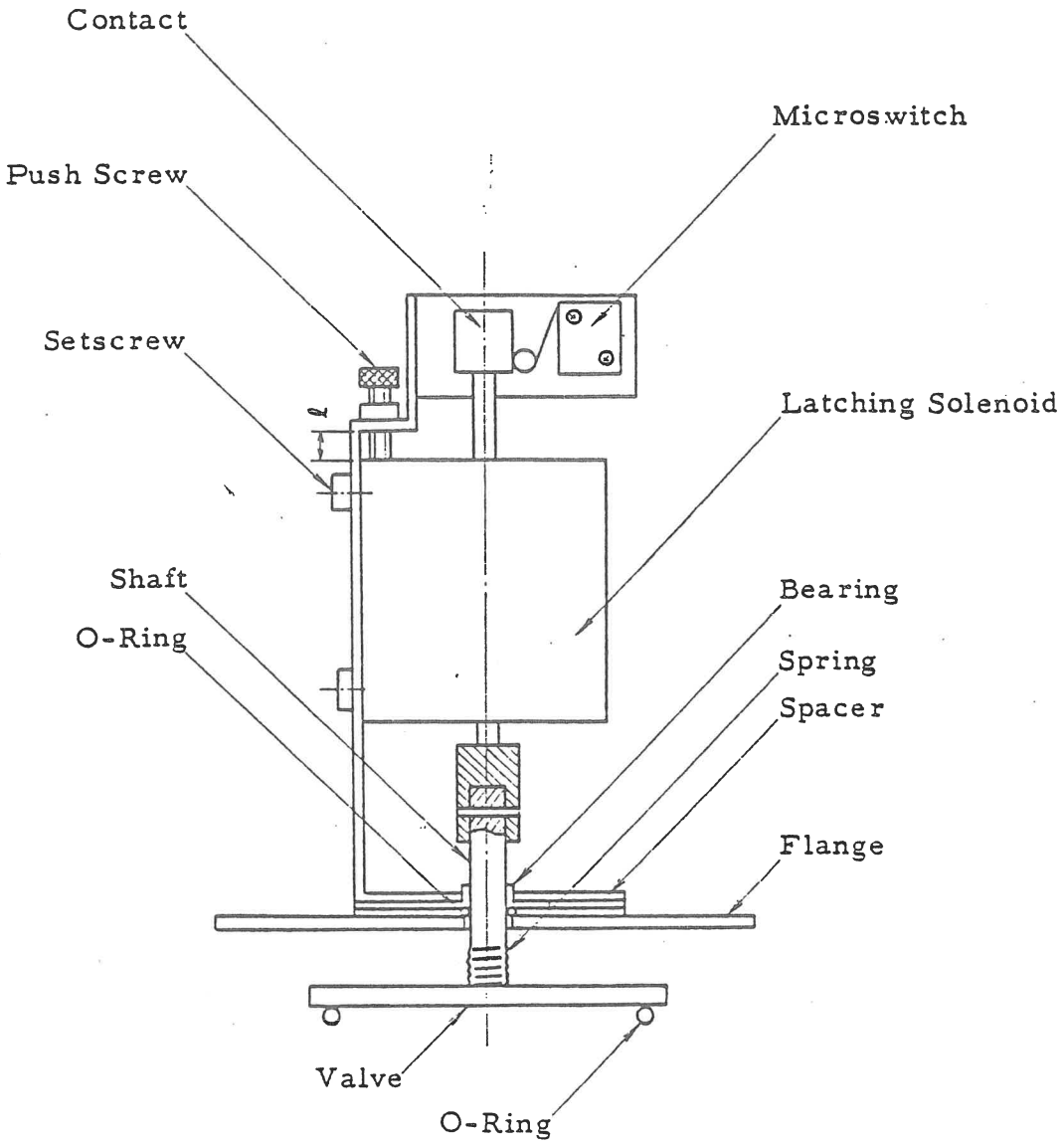


Fig. 5-3 Valve Construction

The latching solenoid is positioned by the push screw so as to maintain normal holding force. The ℓ dimension must be maintained before and after disassembling.

5-2 EVACUATING SYSTEM SEQUENCE

5-2-1 Composition of Sequence

Fig. 5-4 indicates the composition of the evacuating system and its flow chart. This sequence is fully automated. When turning on the EVAC switch, the microscope column is kept under high vacuum or atmospheric pressure according to the AIR selector switch setting.

5-2-2 Safety Measures

(1) Power Interruption

If power interruption occurs the instrument operates in the same manner as if the power supply were turned off. All valves are closed and air leaks from the rotary pump (RP). After power recovery, the instrument is reset to the status before power interruption according to the sequence.

(2) Water Interruption

The buzzer informs the operator of a water interruption.
The DP is turned off to close V1 simultaneously, for the purpose of preventing backstreaming of oil into the column.

(3) Vacuum Leak

If the vacuum in the microscope column becomes > 0.01 Torr, the high voltage is automatically turned off.
If it deteriorates to > 0.1 Torr, V1 is closed. Then, the back pressure of DP is evacuated for 30 seconds, and pre-evacuation is done.

(4) Malfunction of Valves

The valve operation is always checked by microswitches. If a valve malfunctions, the sequence stops operating to insure safety.

(5) Overheat of DP

If DP heater temperature exceeds 250°C, the DP heater power supply is automatically turned off.

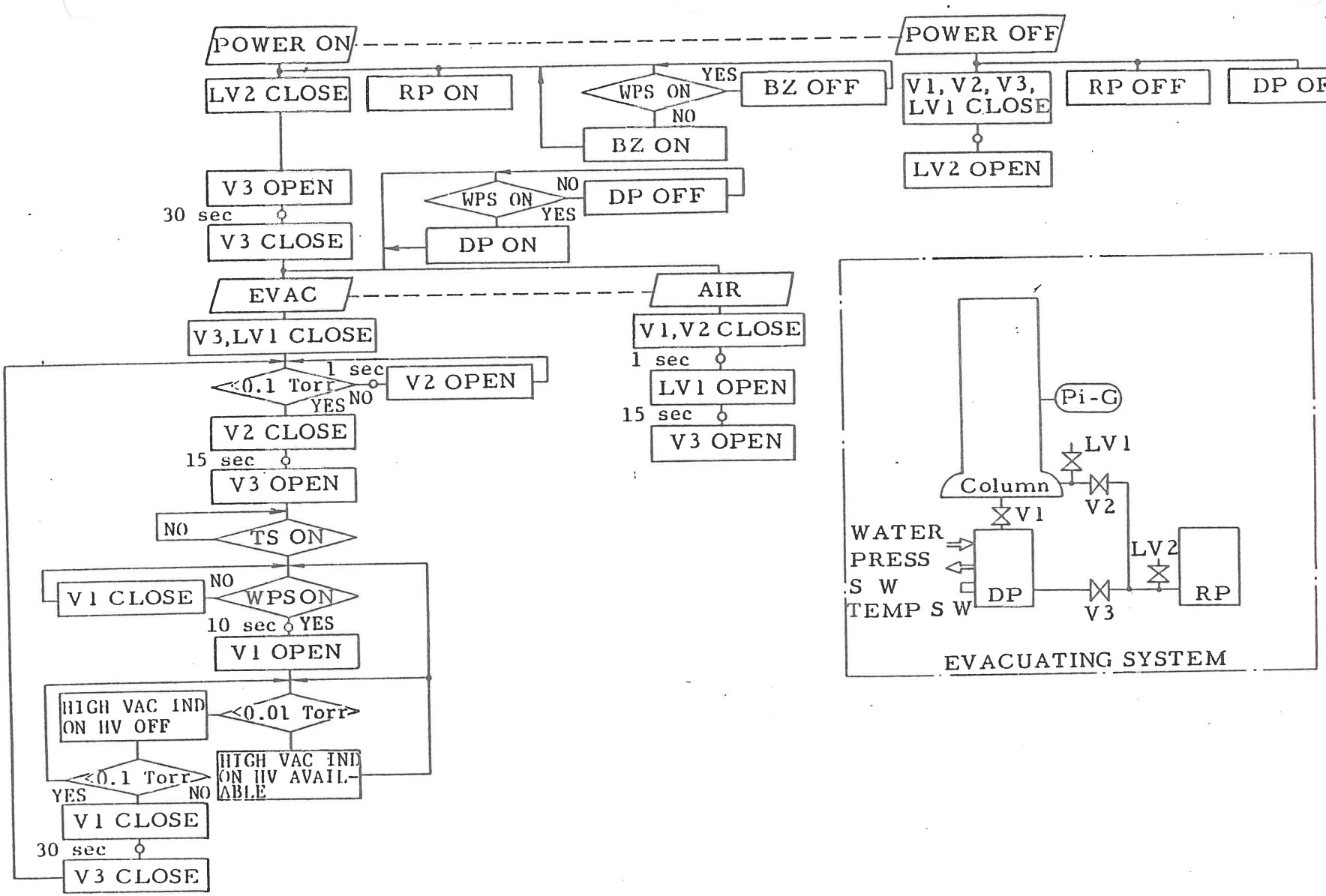


Fig. 5-4 Model S-430/450 Evacuating System Flow Chart

5-2-3 Valve Circuit

Each valve in the valve box is driven by latching solenoid. When the current flows as shown in Fig. 5-5, the valve moves vertically by switching operation.
Once the valve operates, the piston is fixed by the built-in permanent magnet, and it will not be operated unless a force exceeding 10 kg is applied.

Resistor Re is always connected with the other coil and cancels the magnetic force of the permanent magnet.

The coil rating is a short-time rating, so continuous long-time current flow to the coils is not permitted.
The maximum allowable current flowing time is about 1 minute.
In this sequence, this time is set to 0.3 sec.

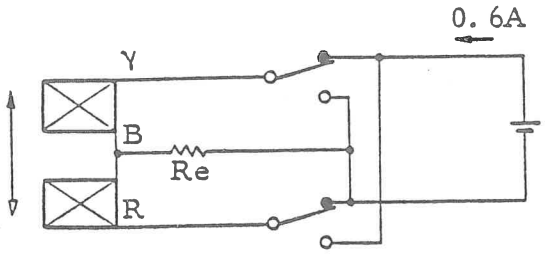


Fig. 5-5

5-2-4 Circuit Composition

The evacuating sequence circuit is composed of three PC boards PC-12, PC-14, and PC-15, and external control switch. For details, see the circuit diagram.

Each PC board functions as follows;

(1) PC-12 :

This is the automatic control PC board for the evacuating sequence system. It opens and closes each valve automatically by the external switch. It also contains the Pirani vacuum gauge circuit.

(2) PC-14 :

This PC board accommodates the power supply and manual switch required for valve operation. The manual valve open/close operation can be done by this PC board only.

(3) PC-15 :

This PC board is used for connecting the valve body and PC boards. It comprises a surge absorber and resistor Re.

This sequence is designed to be solid-state using semiconductors except the valve current polarity switching and vacuum gauge output relays.
It features high reliability with various safety circuits.

5-2-5 Operating Principle of Circuit

The evacuating system sequence employs digital ICs (TTL, Hitachi HD25 series). It includes the NAND, NOR, INVERT gates and a one-shot multivibrator as a timer. For each digital IC operation, refer to respective manuals.

Now, the specially designed evacuating system sequence circuits will be described.

(1) One-Shot Multivibrator Time Reduction Circuit

Fig. 5-6 indicates this circuit diagram, and Fig. 5-7 indicates the time chart. When the input changes from L to H, IC17 is triggered, and one pulse determined by R and C is outputted. If the input remains unchanged as H, Q11 remains turned off, and the time constant is determined by R51 and C14.

When the input returns to L again after triggering IC17, Q11 turns on, and the time constant is determined by R66 and C14. Accordingly, the pulse is completed within a remarkably reduced time as compared with the former.

This is designed to obtain a 15-sec delay time securely until V3 is open after V2 and V4 have been closed.

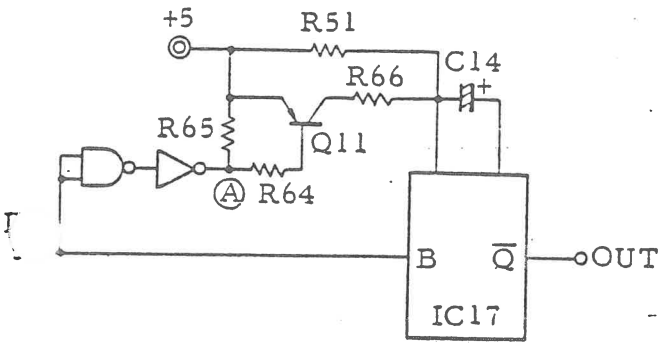
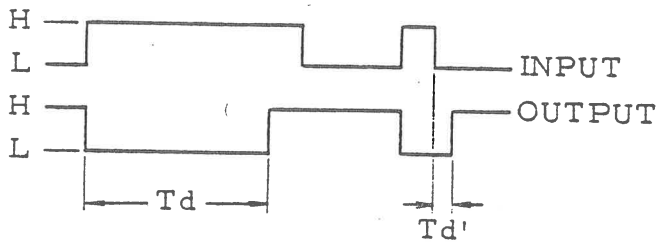


Fig. 5-6



$Td = 0.7 \cdot R51 \cdot C14$
$Td' = 0.7 \cdot R66 \cdot C14$
$R51 \gg R66$

Fig. 5-7

(2) Valve Drive Circuit

Fig. 5-8 indicates the V1 valve drive circuit.

A relay is employed to switch the polarity of the current flowing to the latching relay. The breaking capacity of this relay is 3 A at 30 V DC, but it decreases to less than 1 A at 100 V DC. Accordingly, the current is not fed to the relay during its switching operation for the purpose of protecting the relay, and this circuit flows the latching solenoid current for 0.3 sec only.
The solenoid current is given with a delay of the chattering time (0.1 sec) after the relay contact has been closed by utilizing an idle contact of this relay.
Fig. 5-9 indicates the time chart at each point.
R28, C14, R32, and C16 produce a delay time of 0.1 sec, while R26, C13, R30, and C15 produce a current flowing time of 0.3 sec.
R serves as the discharge protection resistor for capacitors C13 ~ C15.
Q and R15 compose the solenoid coil current limiter circuit.

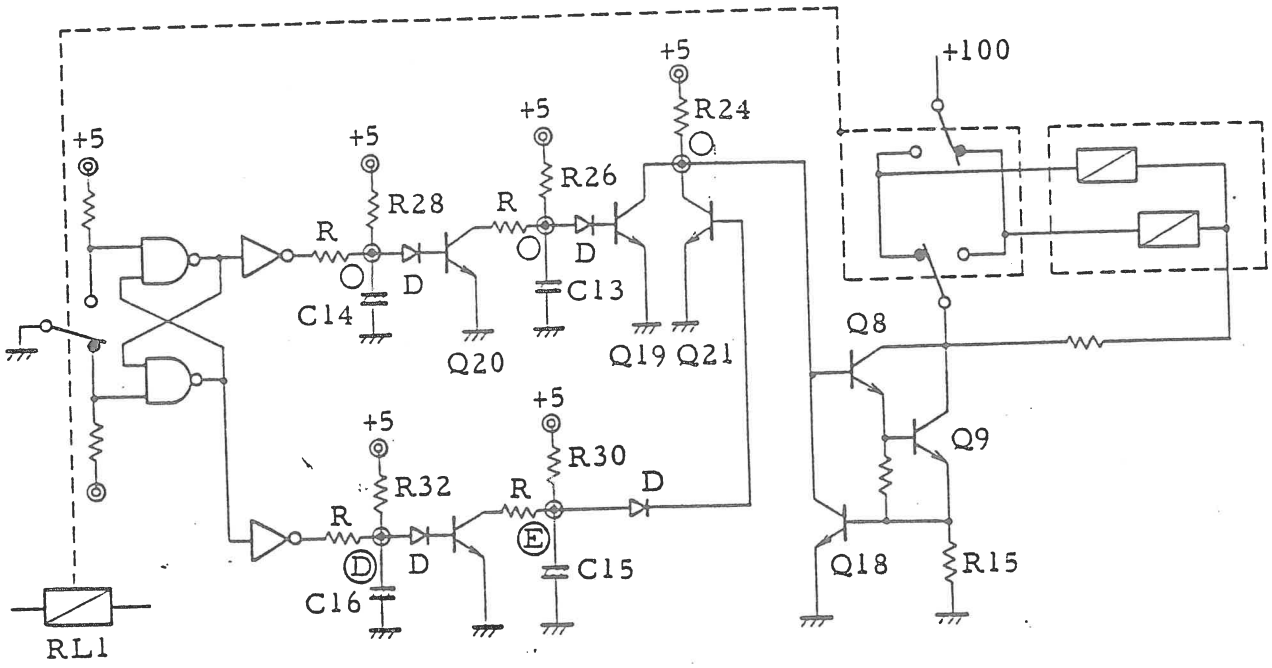


Fig. 5-8

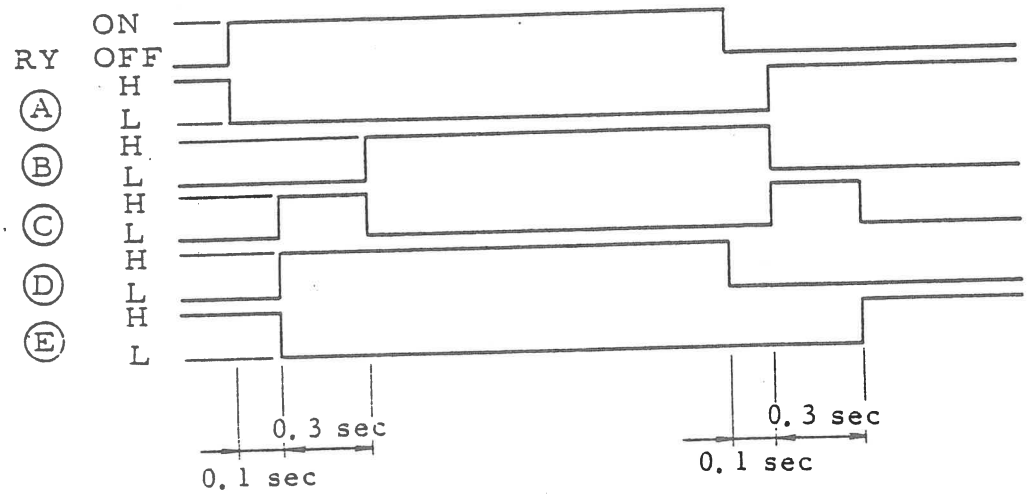


Fig. 5-9

5-2-6 Troubleshooting

(1) Check the Power Supply Circuit

(a) Check if 100 V AC is applied

(b) Check if fuses are blown out

(c) Check if the specified voltages are obtained

(2) Check PC-14 (after detaching PC-12 from the connector)

(a) If 100 V DC does not appear, output transistors Q8, Q9, etc. may be faulty.

(b) Operate each valve with SW1 set to MANUAL, to see if they operate normally. If the relays operate normally with 100 V DC applied but a valve does not operate normally yet, transistors Q18 ~ Q22 may be broken.

(3) Check PC-12 by Connecting it to PC-14

(a) Check power supplies (+8 V, ±15 V) for vacuum gauge.
The meter should deflect when changing VR1.
If the meter remains at zero, the measuring probe may be broken.

(b) Check if digital IC output versus each input meets the truth value table. (However, since HD2523 is an open collector type IC, its output does not always meet the truth value table.) Check its peripheral circuit too.

5-2-7 Adjustment of Vacuum Gauge .

(1) Adjust the VR-01 until the vacuum gauge registers 100 at the atmospheric pressure.

(2) For adjusting the meter relay contact, evacuate the microscope column for at least 1 hour. (This adjustment may be done at once when the microscope column has been evacuated continuously.)
Switching point of fine and coarse evacuation :
Leak the column at first.
Perform evacuation soon after completion of leak and adjust the VR-03 knob so that coarse evacuation is switched to fine evacuation 100 to 110 seconds later. At that time, the vacuum gauge should register about 20.

(3) Adjust the HV relay contact by turning the VR-02 knob so that the HV relay operates when the vacuum gauge registers 10-15 (HIGH Lamp).
The degree of vacuum is about 5×10^{-4} mmHg at that time.
When checking vacuum leakage, evacuate the microscope column 5 hours or more continuously after a vacuum of 5×10^{-5} mmHg or better has been attained. Then, shut off the instrument. The degree of vacuum should be about 5×10^{-2} mmHg (vacuum gauge indicates about 20) after leaving the instrument 10 hours. It may also be inspected qualitatively by confirming the absence of evacuating noise of the rotary pumps when starting evacuation next morning after stopping the instrument the previous day.

Note : It should be noted when adjusting the Pirani gauge that it takes several minutes until the gauge registers the degree of vacuum exactly since the transient response of the measuring bulb is slow with reference to the vacuum change.

5-2-8 Manual Operation of Evacuating System

Observe the following procedure.
(Switch position : AUTO/MANUAL control assembly on the printed circuit board. PC-14))

(1) Ordinary evacuating system operation :

(a) AUTO/MANUAL switch ——→ AUTO

(b) V1 ~ V3, LV1 switches ——→ OFF

(2) When evacuating the entire microscope column by manual operation :

(a) Make sure the AUTO/MANUAL, and V1 ~ V3 plus LV1 switches are set as in (1) above.

(b) AUTO/MANUAL switch ——→ MANUAL

(c) V3 switch ——→ ON (30 seconds)

(d) V3 switch ——→ OFF

(e) V2 switch ——→ ON

(f) Wait about 2 minutes until the Pirani gauge registers about 20.
Then, V2 ——→ OFF

(g) V3 switch ——→ ON

(h) V1 switch ——→ ON

(i) Wait about 3 minutes until the Pirani gauge registers 10.
Now, evacuation is completed.

5-3 ASSEMBLY OF EVACUATING SYSTEM UNIT

5-3-1 Removal of DP and Valve Unit

(1) After turning off the EVAC main switch, wait for a while until DP is cooled down. Detach in advance connectors of PC board which may interfere with the removal of DP and valve unit.

(2) Insert wooden blocks below DP so as not to drop DP directly. Have at least two workers carry the DP and valve unit, since they are heavy.

(3) Detach three screws indicated by arrows in Fig. 5-10.

(4) Detach the nut shown by arrow in Fig. 5-11.

(5) Hold the DP unit by hands so that it will not move.

(6) Have one worker remove the wooden blocks while the DP unit is being held by another worker as described above, and detach the DP and valve unit slowly from the console rack.

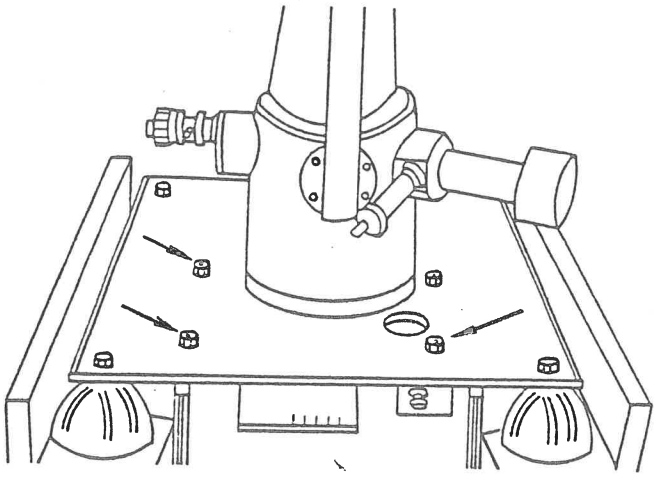


Fig. 5-10

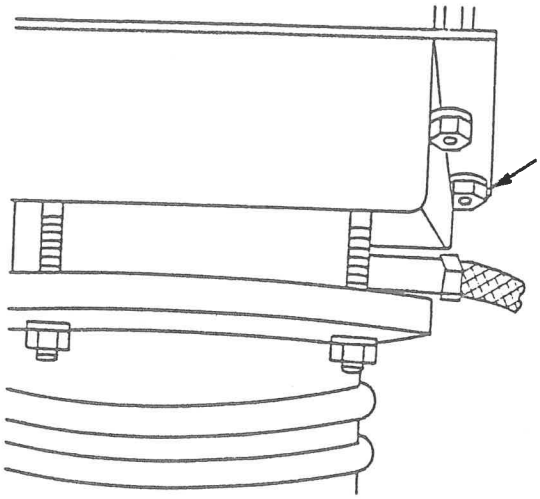


Fig. 5-11

5-3-2 Installation of DP and Valve Unit

Reverse the above procedure while taking care so as not to cause deviation or off-centering of axis when connecting the main evacuating pipe and valve box (see Fig. 5-12) to each other.

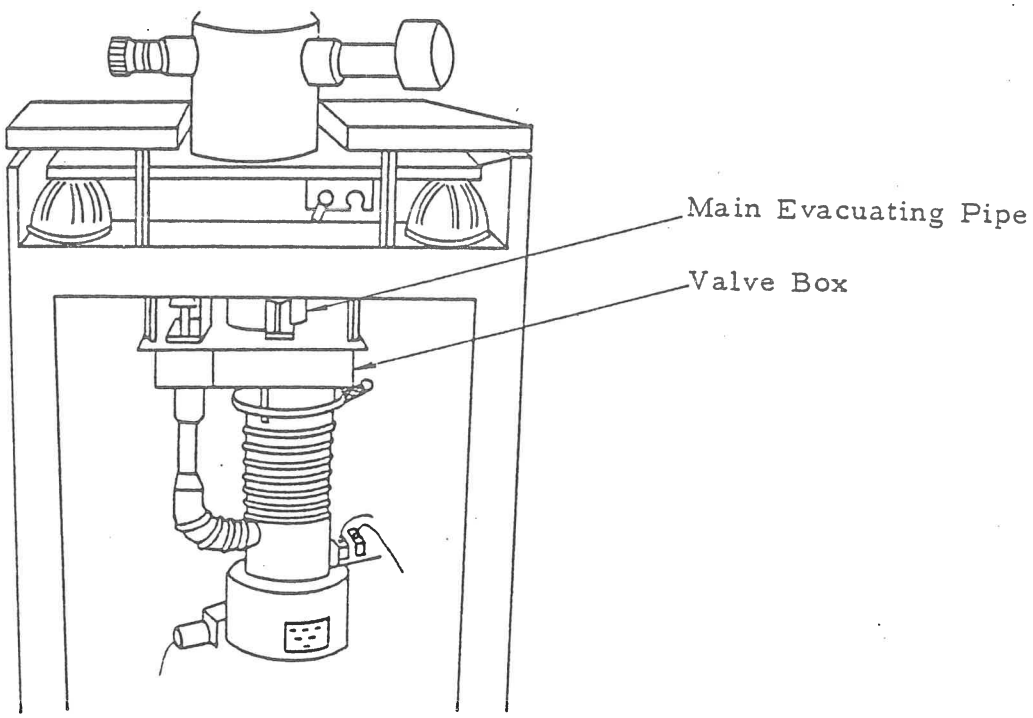


Fig. 5-12

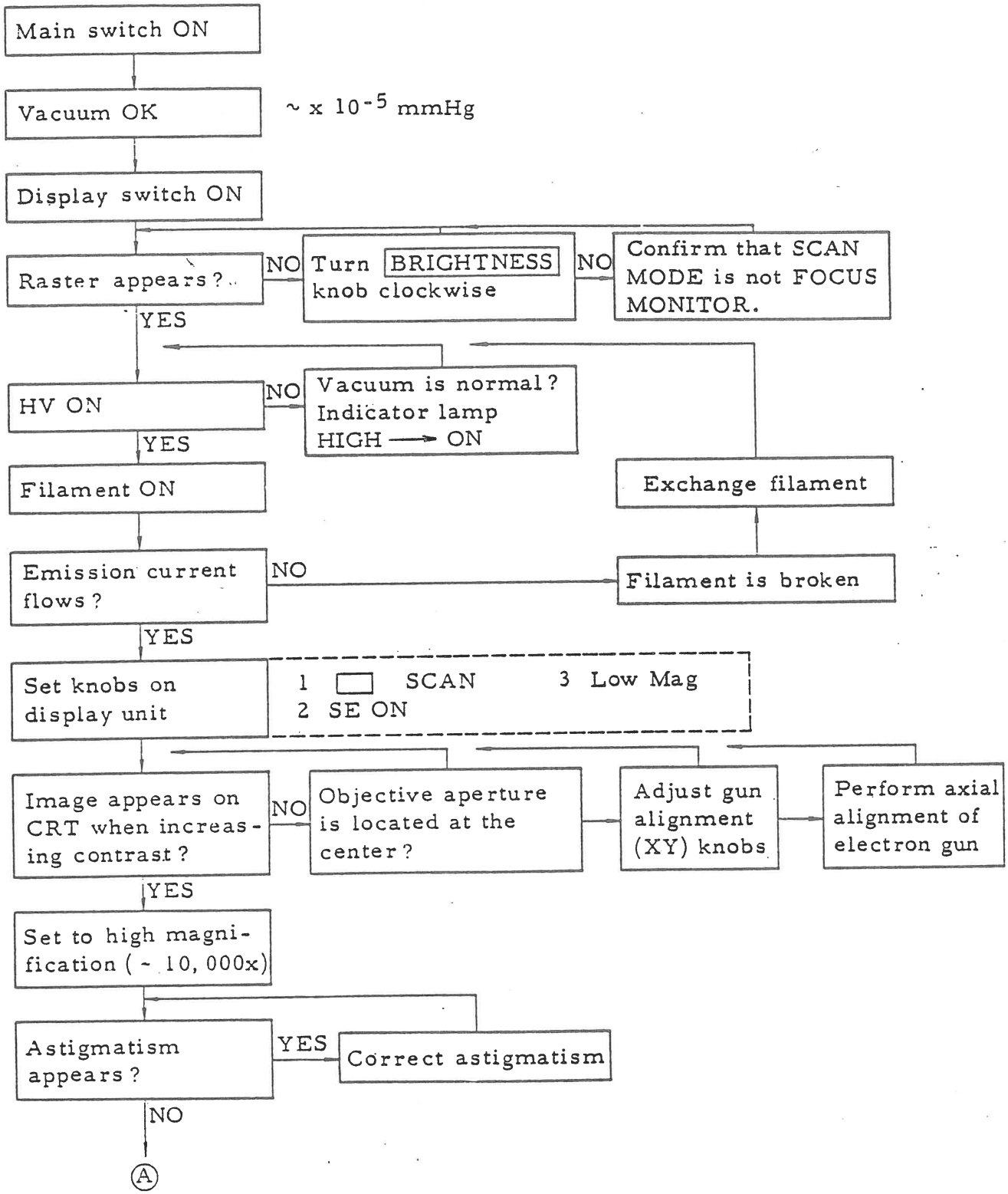
Section VI

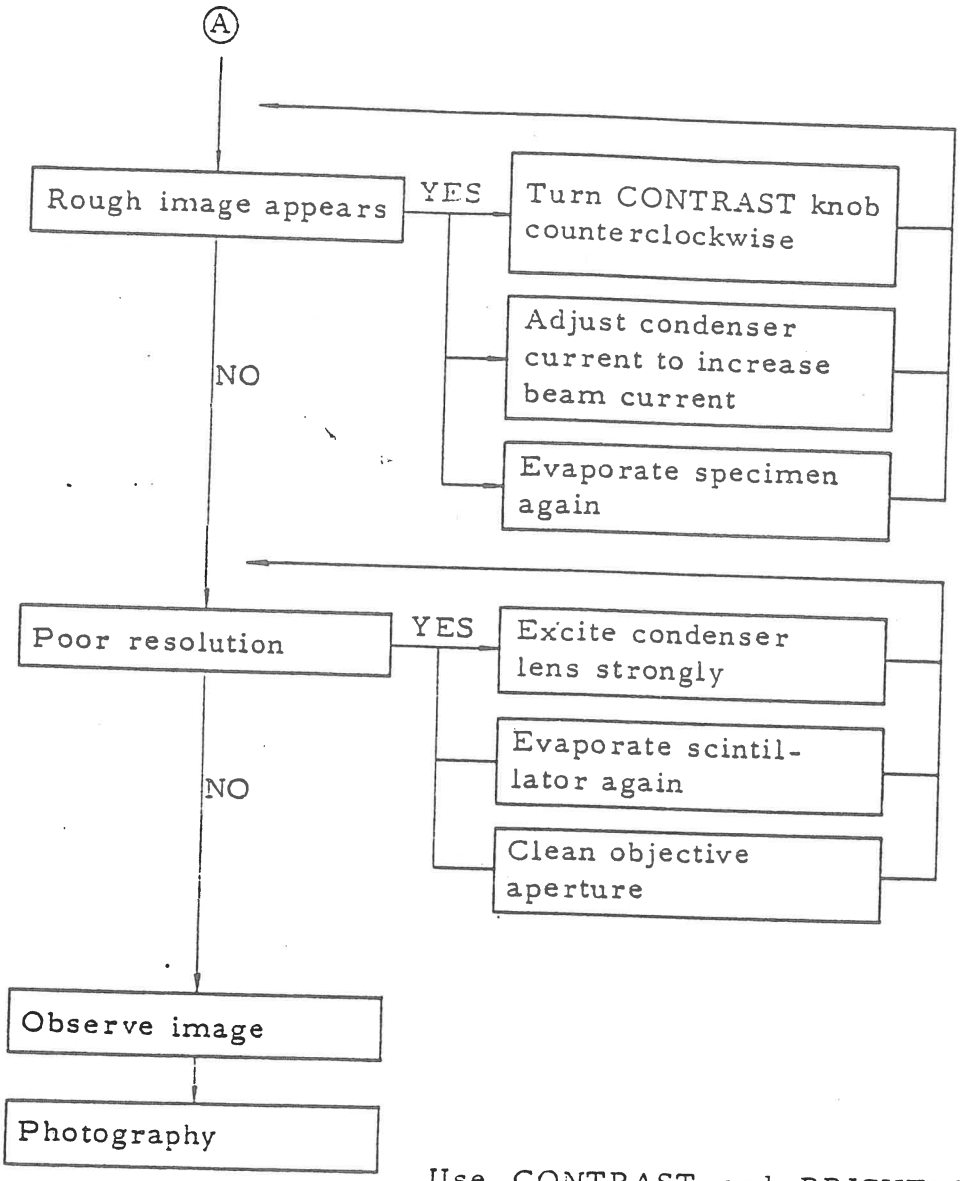
TROUBLESHOOTING

Para. 6-1 thru para. 6-10 indicate troubleshooting block diagrams. Since it becomes very complicated to sort out troubles in detail and all of these troubles cannot be described, this section describes the methods of locating causes of troubles from symptoms which may be produced in the display unit, regarding the basic items.

If a trouble occurs, locate its possible cause from the symptoms according to this troubleshooting block diagram, and find the unit to be examined.

6-1 OPERATING PROCESS CHART IN ORDINARY OPERATION

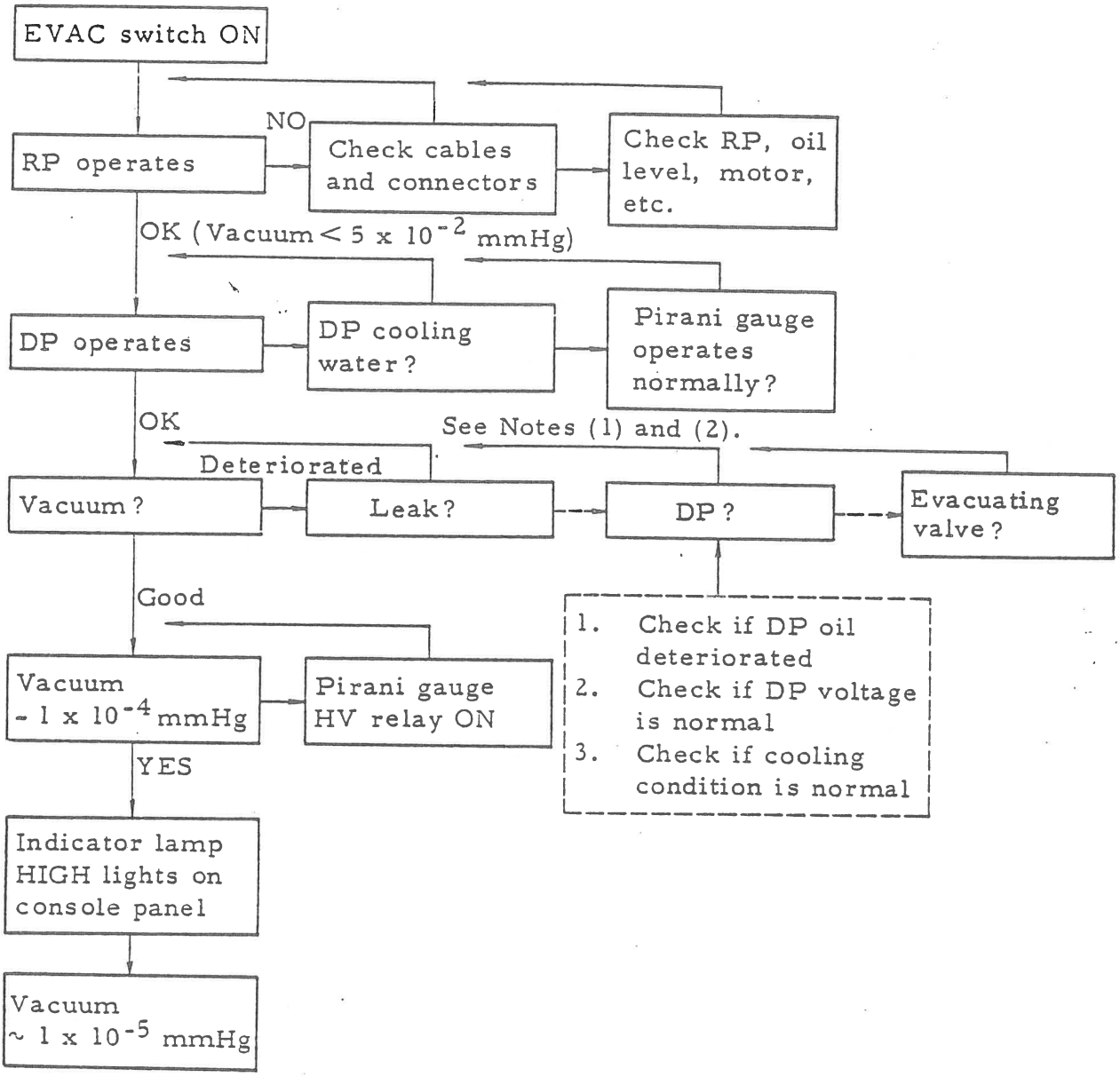




Use CONTRAST and BRIGHTNESS meters.

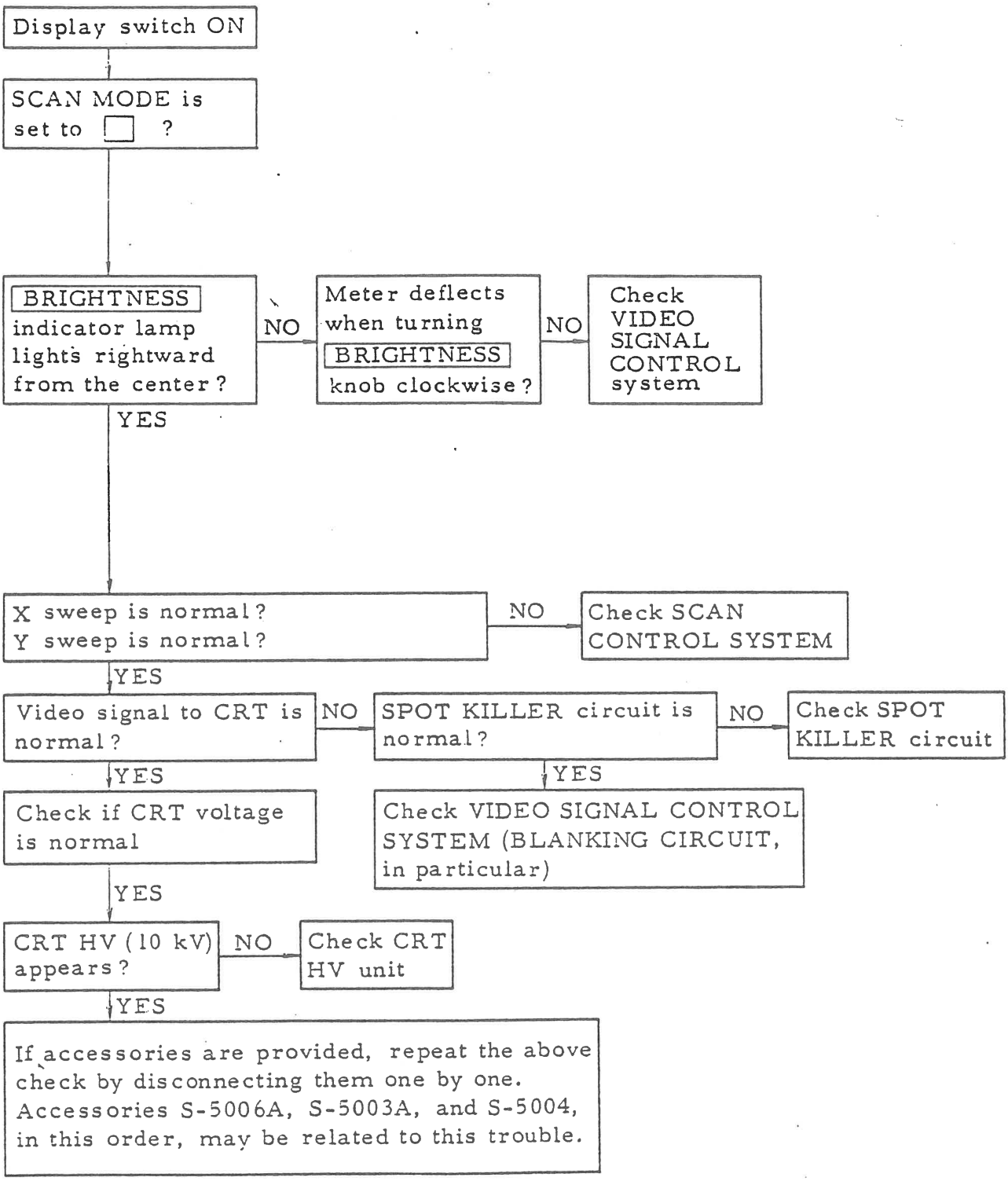
Note : For details of operation, see instruction manual.

6-2 EVACUATING SYSTEM DOES NOT OPERATE NORMALLY



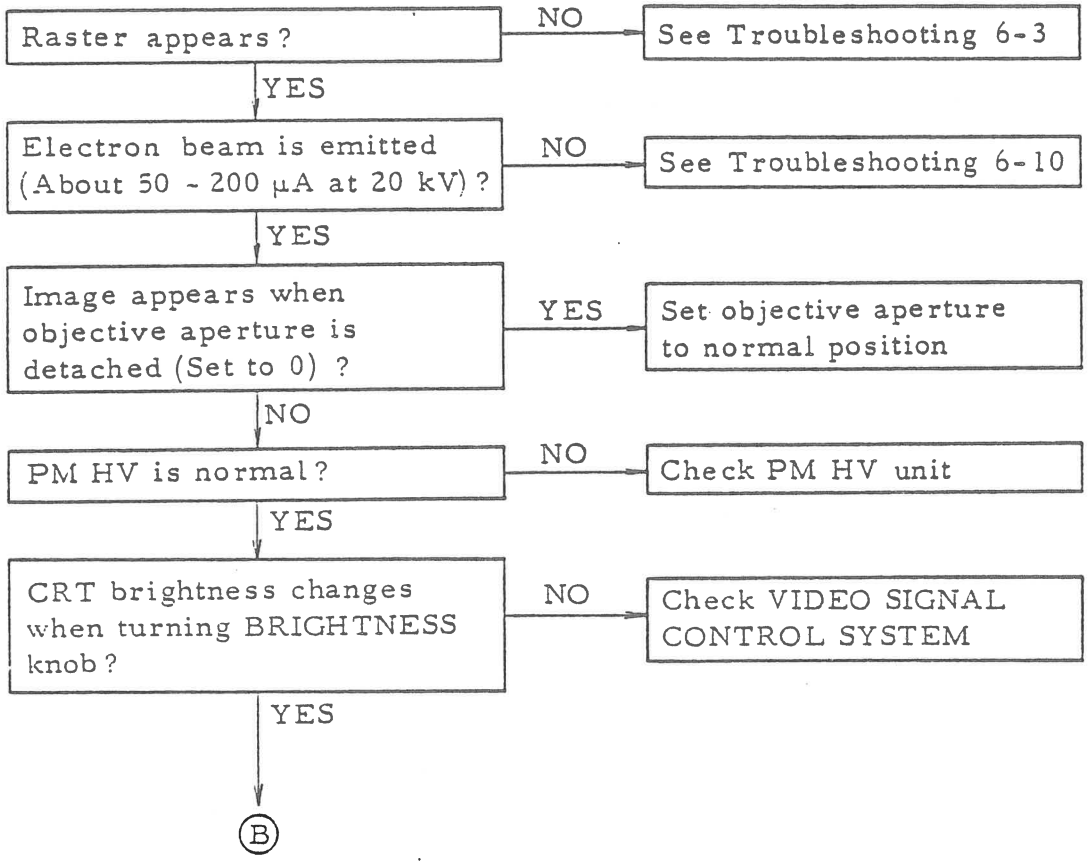
Notes : (1) See Schematic Diagram of Evacuating System.
(2) See Evacuating System Sequence.
(3) See Adjusting Method of Vacuum Meter.
(4) Confirm auto-manual setting before check.

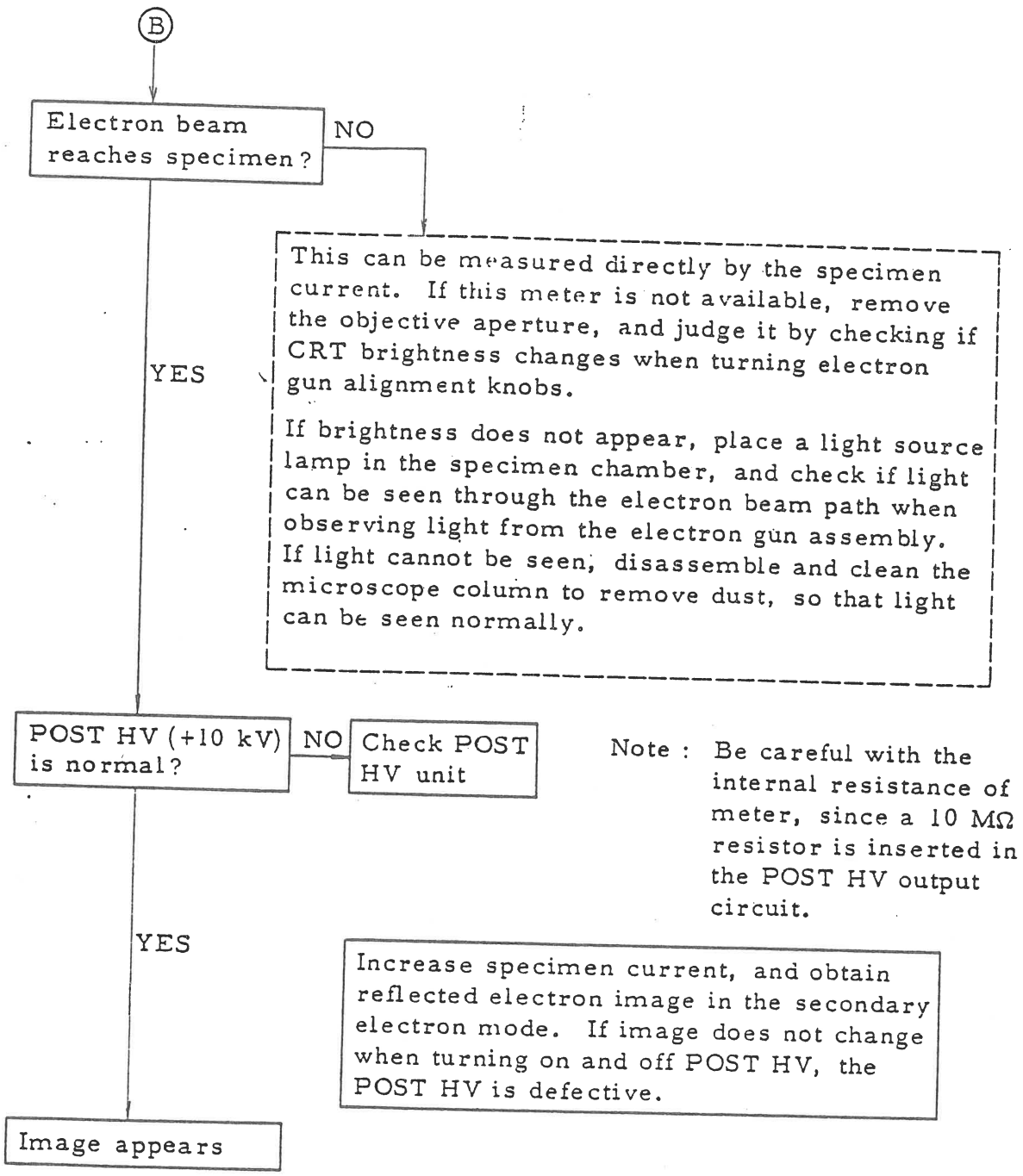
6-3 ABSENCE OF RASTER ON CRT



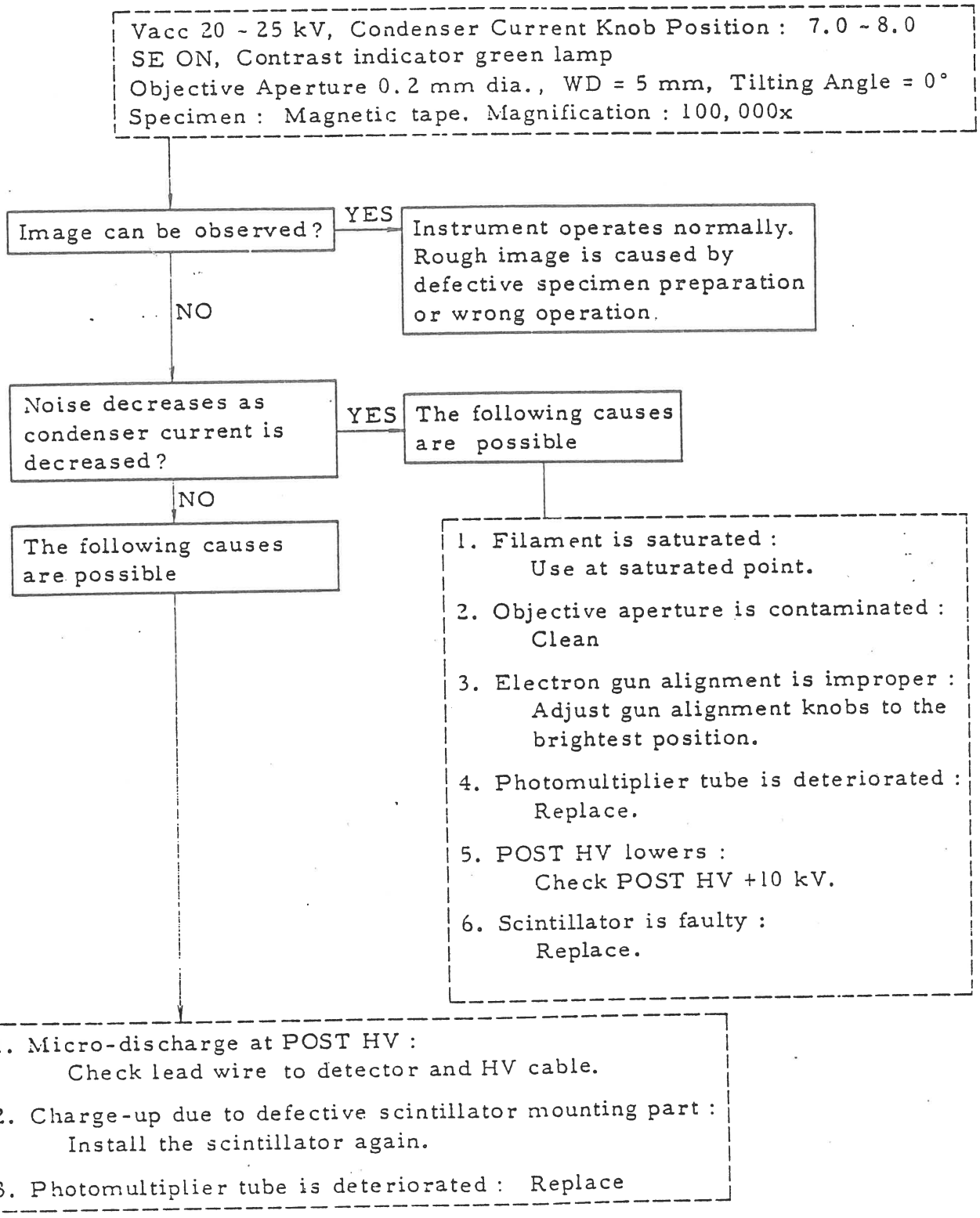
6-4 ABSENCE OF IMAGE ON CRT

Electron Gun HV	ON (20 kV)	COND LENS	Scale 5.
Filament Current	ON	SIGNAL SELECTOR Switch	OFF
CONTRAST	Fully clockwise	SCAN SPEED	□
SE	ON	MAGNIFICATION	Minimum magnification



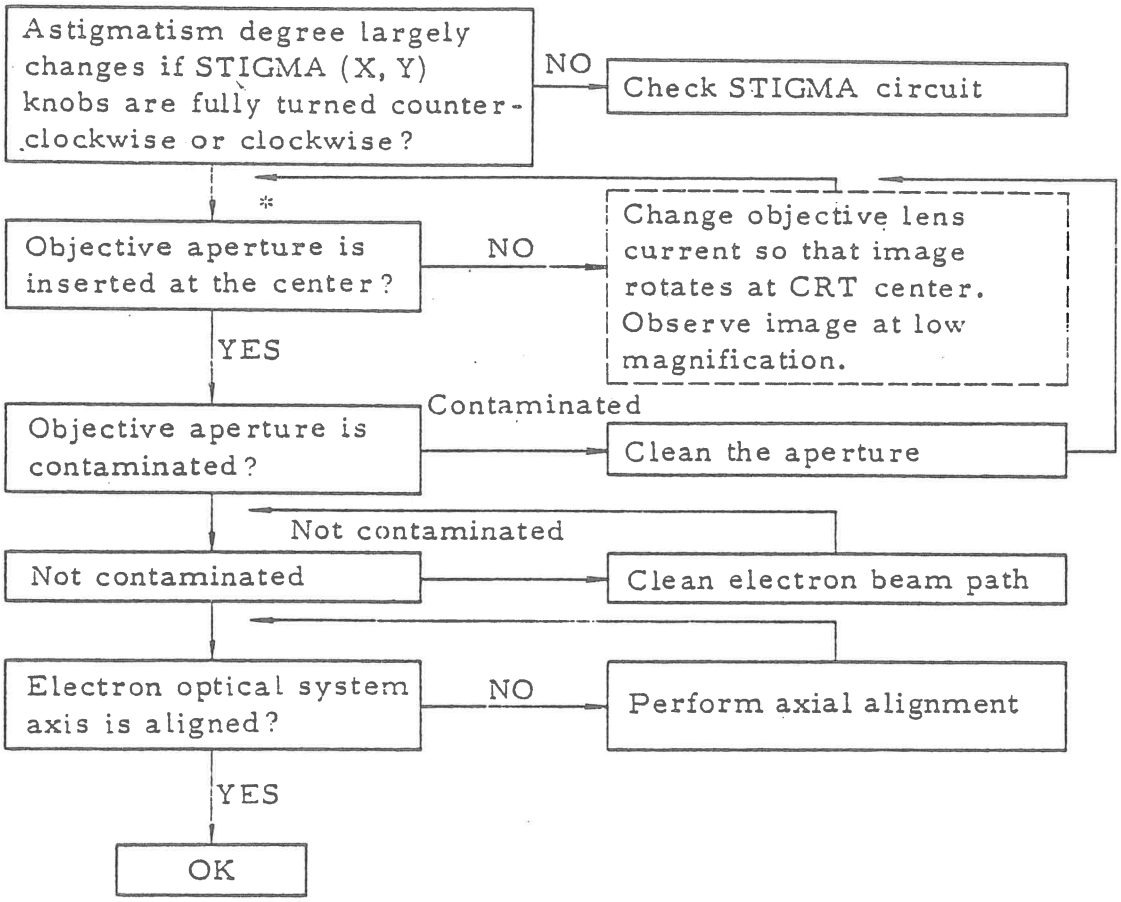

B
Electron beam reaches specimen?
NO
YES
This can be measured directly by the specimen current. If this meter is not available, remove the objective aperture, and judge it by checking if CRT brightness changes when turning electron gun alignment knobs.
If brightness does not appear, place a light source lamp in the specimen chamber, and check if light can be seen through the electron beam path when observing light from the electron gun assembly. If light cannot be seen, disassemble and clean the microscope column to remove dust, so that light can be seen normally.
POST HV (+10 kV) is normal?
NO
Check POST HV unit
Note : Be careful with the internal resistance of meter, since a 10 MΩ resistor is inserted in the POST HV output circuit.
YES
Increase specimen current, and obtain reflected electron image in the secondary electron mode. If image does not change when turning on and off POST HV, the POST HV is defective.
Image appears

6-5 ROUGH IMAGE APPEARS

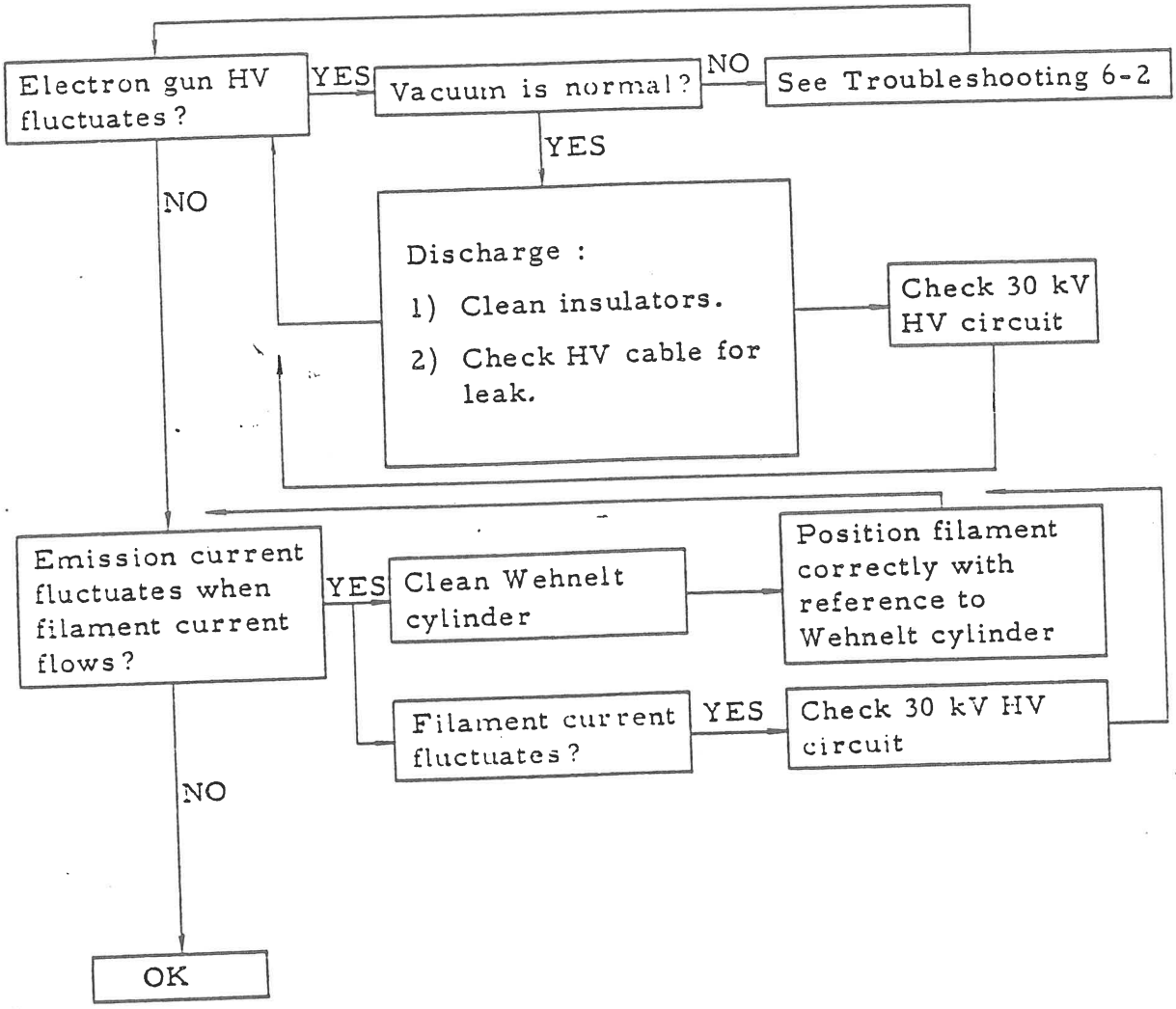


6-6 ASTIGMATISM CORRECTION IMPOSSIBLE

For examining astigmatism correction, use a conductive specimen such as magnetic tape, which does not require any evaporation. If specimen evaporation is needed, appearance of astigmatism or image drift may be caused by evaporation failure.



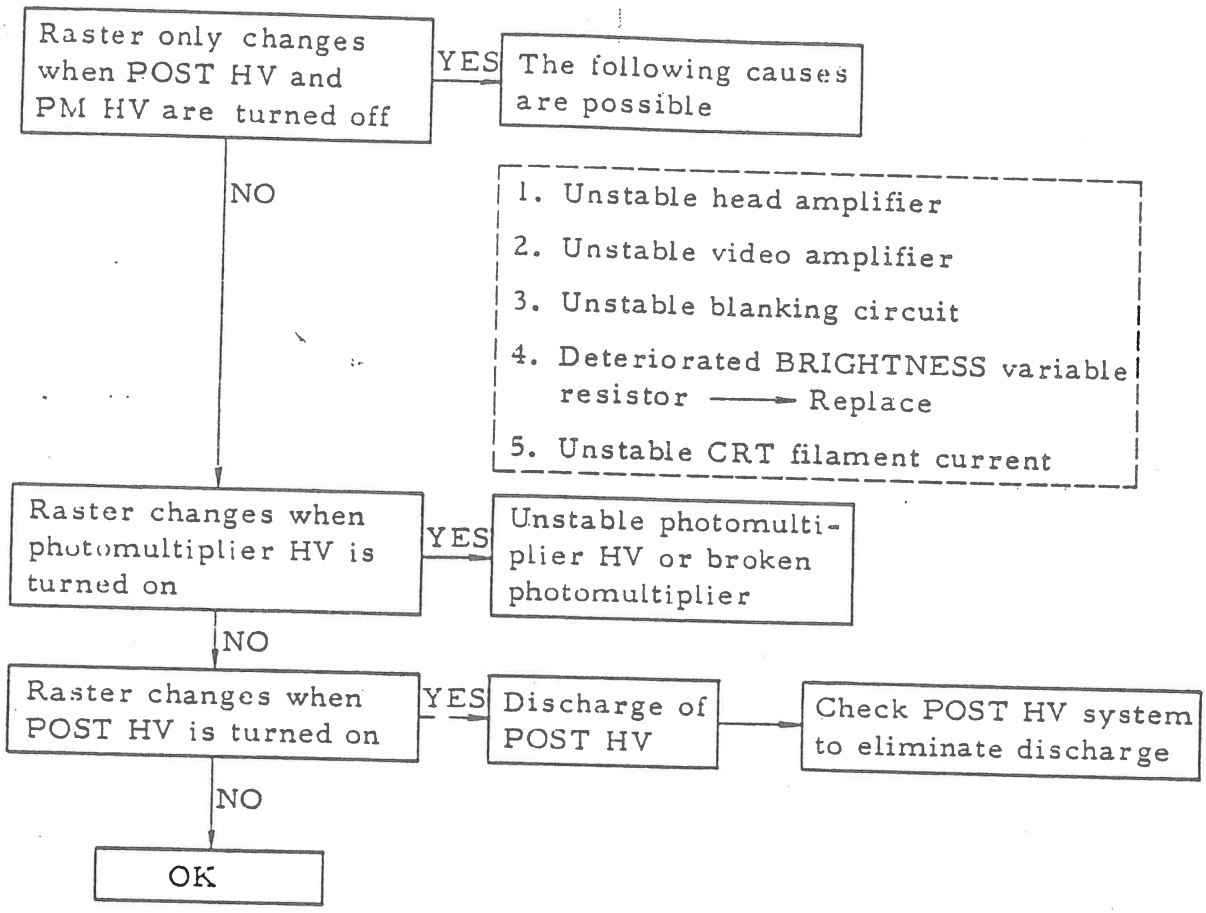
6-7 EMISSION CURRENT FLUCTUATES



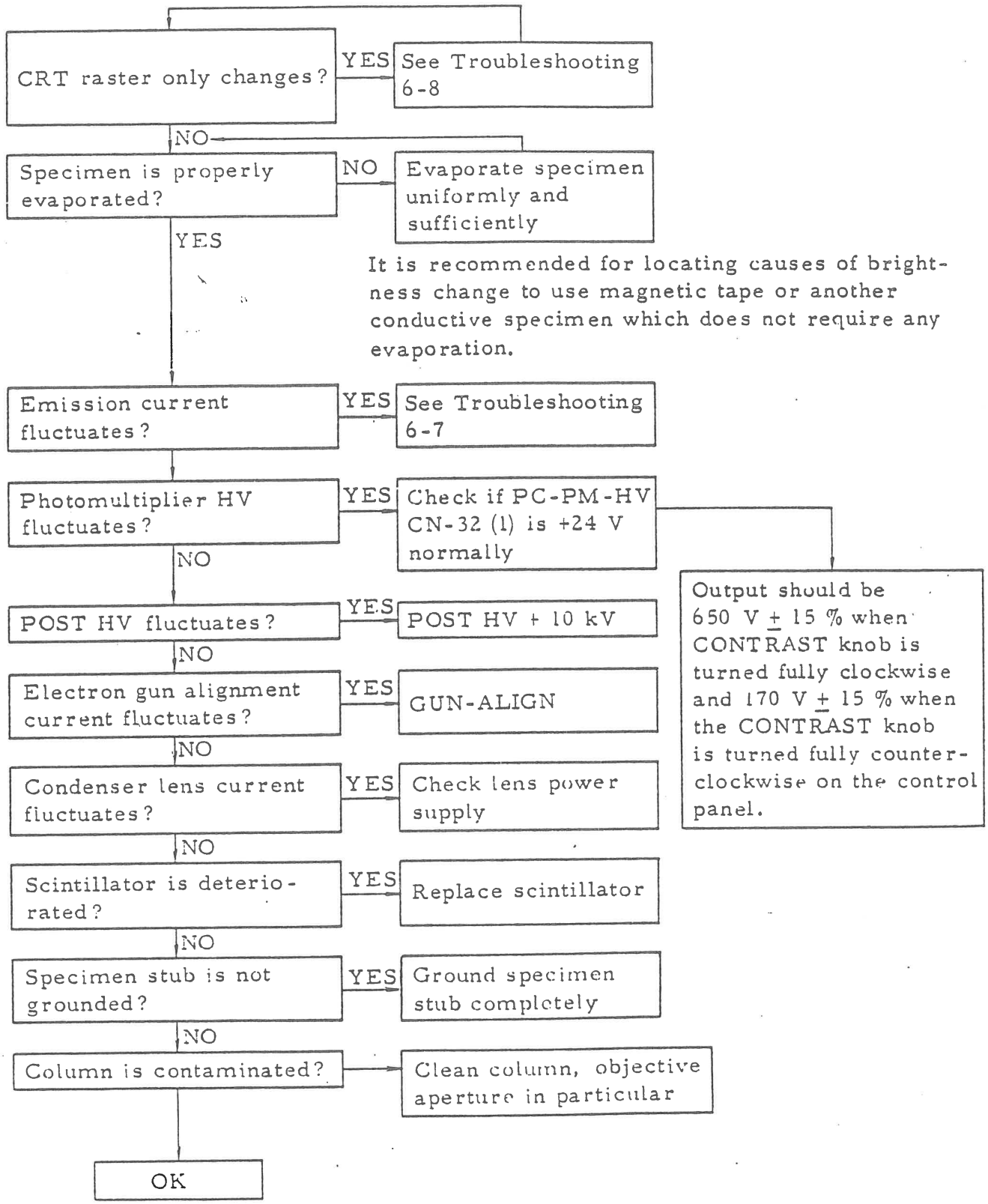
Notes : 1. If electron gun HV fluctuates, it can be checked by fluctuating HV indication value on the emission meter (20 μA at 20 kV, for example).

2. Evacuation is fully automated. However, if the timing of the vacuum interlinking switching relay of the Pirani gauge is deviated, vacuum may be poor, irrespective of normal meter indication.

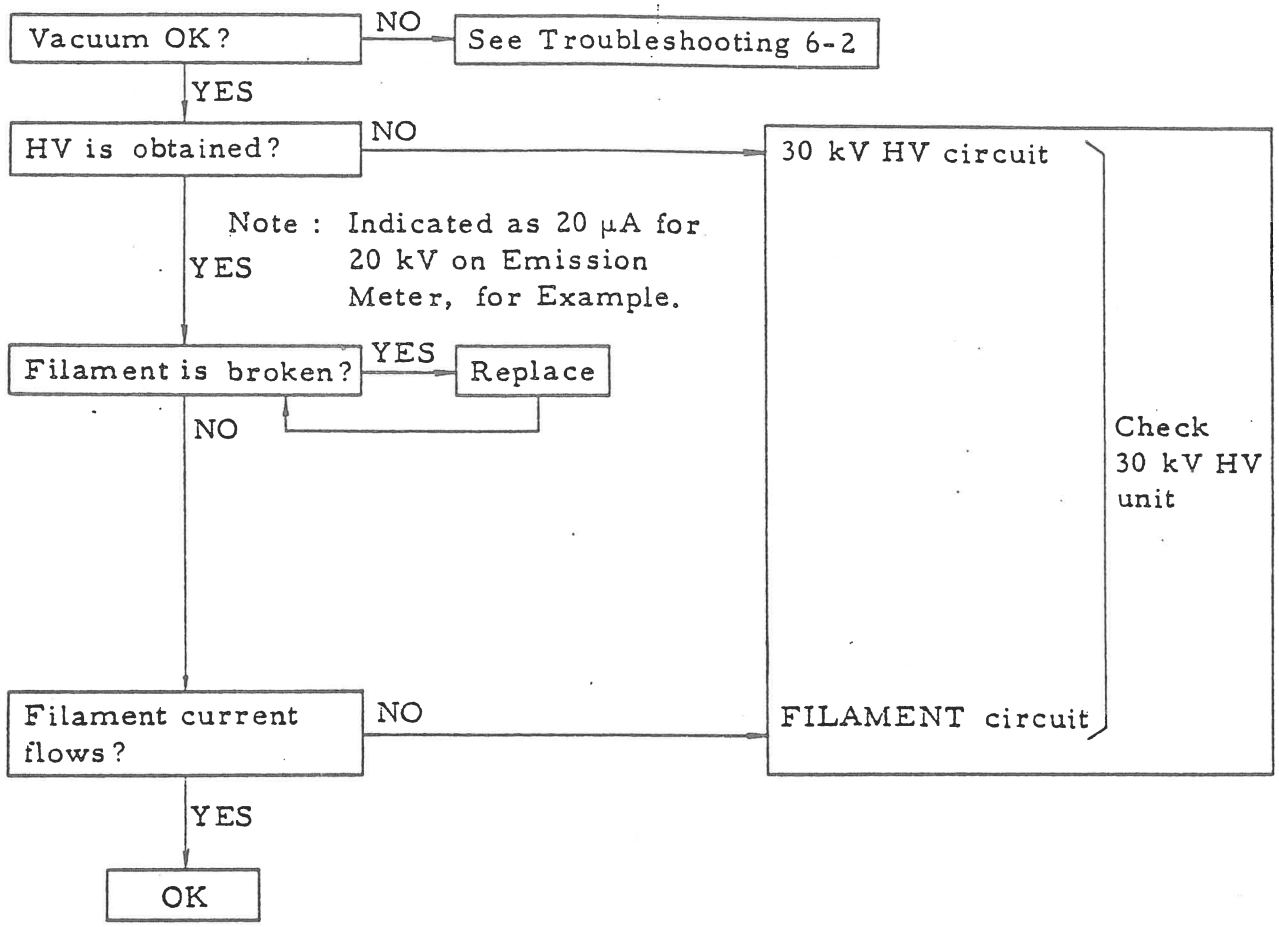
6-8 RASTER ONLY APPEARS ON CRT AND BRIGHTNESS CHANGES



6-9 BRIGHTNESS CHANGES WHEN OBSERVING IMAGE



6-10 ELECTRON BEAM IS NOT EMITTED



Section VII

AXIAL ALIGNMENT OF ELECTRON OPTICAL SYSTEM

For the axial alignment of the S-430 instrument, refer to the instruction manual. The following description covers the axial alignment of the S-450 instrument when the condenser magnetic path has been detached or when the current center axis is adjusted.

7-1 AXIAL ALIGNMENT OF S-450 INSTRUMENT

(1) For applying the accelerating voltage, see the instruction manual.

(2) The condenser axial alignment should be done by servicemen only.

(3) Detach the condenser exciting current connector from the column.

(4) Set the SE switch to OFF and set the MAG to the minimum magnification mode.

(5) Adjust the electron gun horizontal alignment knob (See Fig. 7-1.) so that the maximum intensity can be obtained with the electrical gun-alignment control knob set to about the midpoint.

(6) Bring a characteristic specimen surface (hereinafter referred to as "object") to the CRT center and focus it.

(7) Flow the first condenser lens current (for independently flowing the current to the first and second condenser lenses, see Figs. 7-2 and 7-3 as well as description), and set the condenser lens current selector switch to 4 ~ 5.

(8) If the object set in step (6) is deviated from the CRT center under the condition in step (7), adjust the first condenser lens (hereinafter referred to as C1) axial alignment knob to bring the object to the CRT center.

(9) Turn off the C1 current, and flow the second condenser lens (hereinafter referred to as C2) current.

(10) If the object is deviated from the CRT center under the condition in step (9), adjust the C2 axial alignment knob to bring the object to the CRT center.

(11) Repeat steps (7) ~ (10) for axial alignment.

(12) Reset the condenser lens exciting current connector as before, and turn on the SE switch.

(13) If the object largely escapes from the CRT center, repeat steps (7) ~ (12) until the escape is minimized.

7-2 METHOD OF OPERATING C1 AND C2 INDEPENDENTLY

(1) Detach the condenser lens exciting current connector.

(2) When it is desired to operate C1 only, short between (+)(1) and (-)(1) and also between (+) (2) and (-) (2) of the connector respectively by using clip wires prepared by servicemen.

(3) When it is desired to operate C2 only, short between (+) (1) and (-) (3) and also between (+) (2) and (-) (4) in the same manner as above.

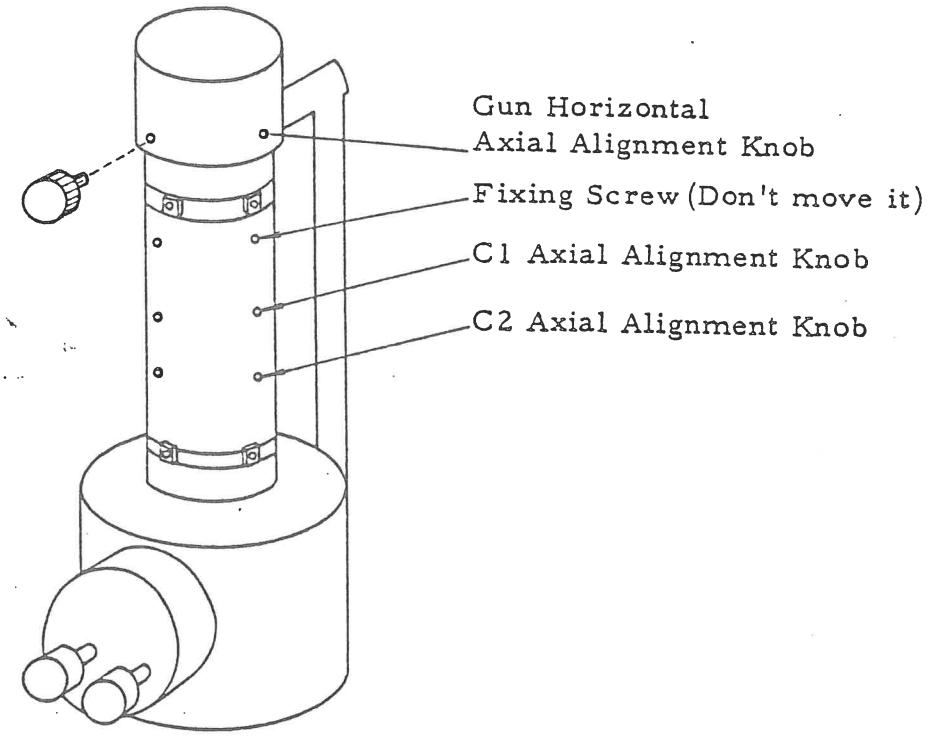


Fig. 7-1 Axial Alignment Knob Layout

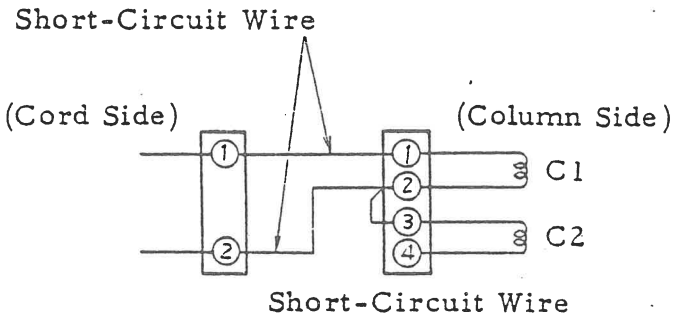


Fig. 7-2 When Operating C1 Only

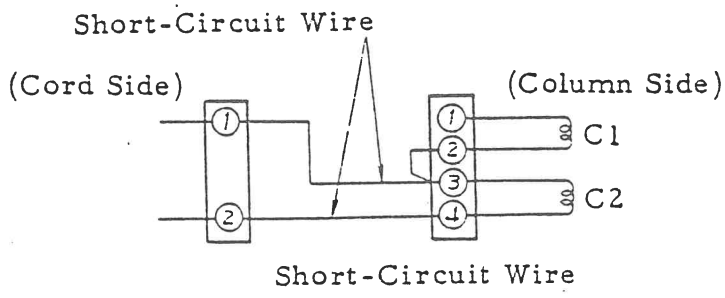
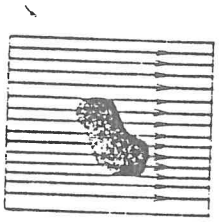
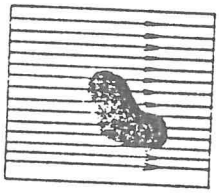
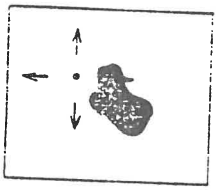
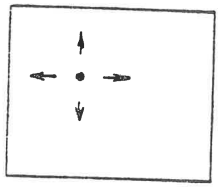
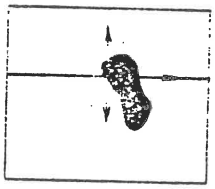
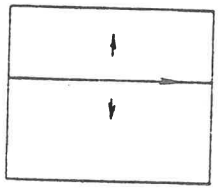
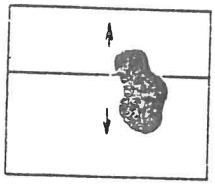
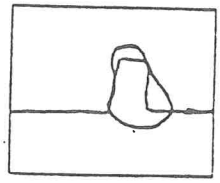
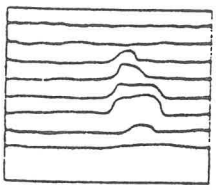


Fig. 7-3 When Operating C2 Only

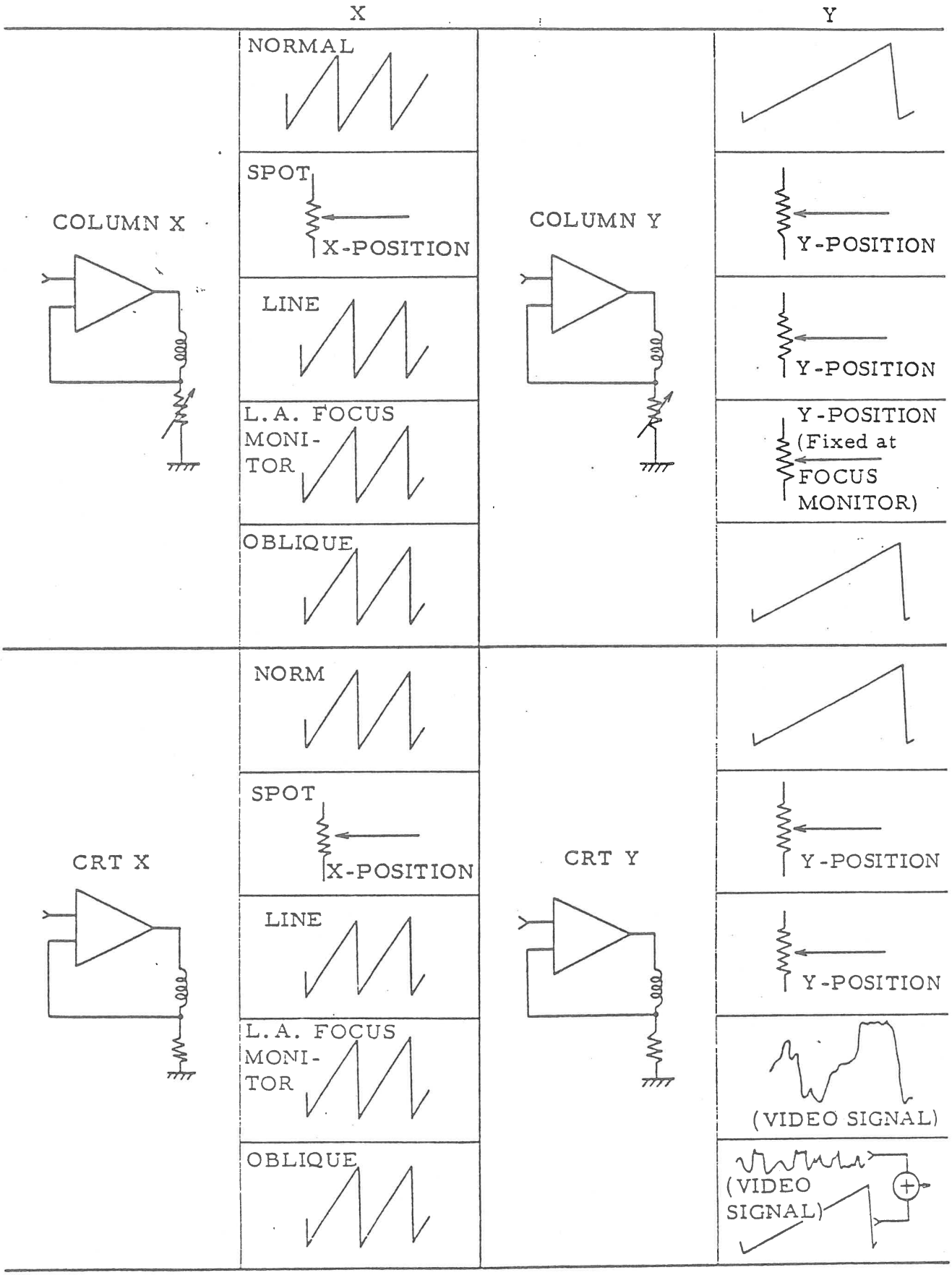
Section VIII

CIRCUIT ADJUSTMENT DATA

8-1 CRT IN VARIOUS SCAN MODES AND SCANNING SYSTEM OF ELECTRON BEAM ON SPECIMEN

MODE	Electron Beam on Specimen	CRT Electron Beam	CRT Grid	Use
NORMAL			VIDEO SIGNAL	Image Observation
SPOT			Fixed bias	Information analysis from an optionally selected point on image (qualitative and quantitative analyses by x-ray analysis and others)
LINE			VIDEO SIGNAL	Setting of line analysis position
FOCUS MONITOR LINE ANALYSIS			Fixed bias	CRT display of distribution of signal intensity (ex. x-ray intensity) on optional line of image (line analysis)
OBLIQUE			Fixed bias	Line analysis on entire specimen surface (an image like a relief can be obtained)

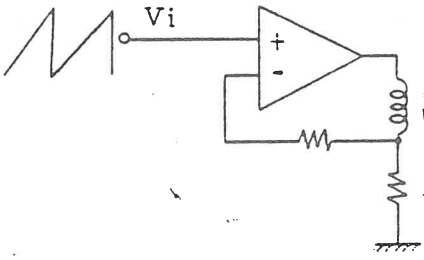
8-2 CURRENT WAVEFORM OF EACH BEAM DEFLECTOR CIRCUIT IN VARIOUS SCAN MODES



8-3 VARIOUS SYSTEMS OF BEAM DEFLECTOR CIRCUIT

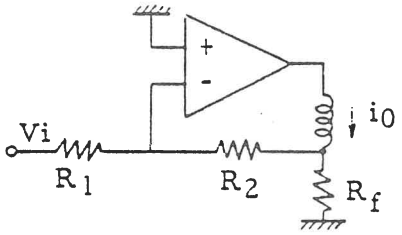
The deflection coils of microscope column and CRT are driven by the following circuits.

(1) Non-Reverse Type
(for deflection of CRT in various models)



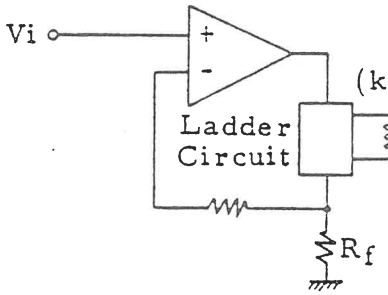
$$i_0 = \frac{1}{R_f} \cdot Vi$$

(2) Reverse Type
(for deflection of CRT in various models)



$$i_0 = \frac{-1}{R_f} \cdot \frac{R_2}{R_1} \cdot Vi$$

(3) Non-Reverse Current Variable Type
(for SSM, HSM-2, 2A column deflection)

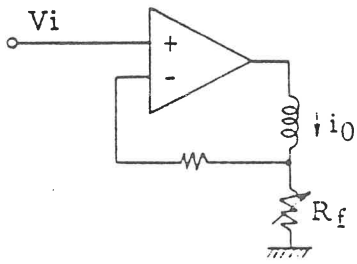


$$i_0 = \frac{1}{R_f} \; Vi \times k$$

(k : Shunt ratio of ladder circuit)

Note : Magnification is selected by switching k.

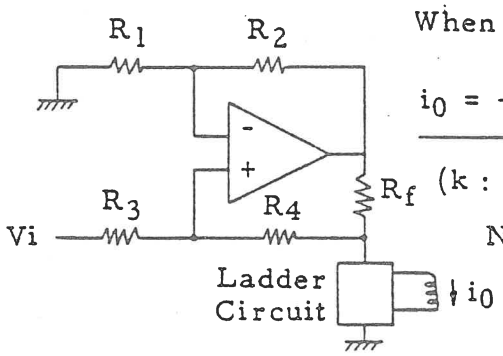
(4) Non-Reverse Current Variable Type
(S-500 S-550, S-400 and S-700 column deflection)



$$i_0 = \frac{1}{R_f} \; Vi$$

Note : Magnification is selected by switching R_f.

(5) Positive Feedback Type (Current Variable)
(for HHS-2R column deflection)



When $R_1 = R_2 = R_3 = R_4$

$$i_0 = \frac{1}{R_f} Vi \times k$$

(k : Shunt ratio of ladder circuit)

Note : Magnification is selected by switching k.

8-4 DC POWER SUPPLIES

Unit	Output Voltage (±2 %)	Output Current	Ripple Max.	Short-Circuit Current 30~60 %	Drooping Current 105~200%	Volt. Setting	Use
PS1	+20 V	3.35 A	20 mVp-p	1 ~ 2 A	3.5~6.7A	P	DEF;CDLXY
							CRTX-SLOW
		3.35 A	20 mVp-p	1A~2 A	3.5~6.7A	P	CRTY
	+50 V	0.5 A	50 mVp-p			P	CRTX-TV
	+15 V ± 20 %					F	
	-50 V	0.5 A	50 mVp-p			P	CRTX-TV
	-15 V ± 20 %					F	
	+36 V	1 A	30 mVp-p	0.3~ 0.6 A	1.05~ 2.0A	P	ACC HV (30 kV)
	-15 V	0.02 A	15 mVp-p			F	ACC HV (30 kV)
	+24 V	1.5 A	24 mVp-p			P	10 kV HV PM HV
PS2	+5 V	0.5 A	10 mVp-p	0.15~ 0.3 A	0.525~ 1.0A	F	SG VA
	+15 V	0.5 A	15 mVp-p	0.15~ 0.3 A	0.525~ 1.0A	F	
	-15 V	0.5 A	15 mVp-p	0.15~ 0.3 A	0.525~ 1.0A	F	
	+24 V	0.7 A	24 mVp-p	0.21~ 0.42A	0.37~ 0.74A	F	CRT HEATER
	+38 V	2.0 A	2 Vp-p	Fuse blown		N	LENS
	+20 V	1.3 A	1 Vp-p	Fuse blown		N	AL/STG/IS
	-20 V	1.3 A	1 Vp-p	Fuse blown		N	
	2 V	0.05 A				AC	
	8 V	1 A				AC	S5006
	19.4 V	0.1 A				AC	
	19.4 V	0.1 A				AC	

(cont'

Unit	Output Voltage (±2 %)	Output Current	Ripple Max.	Short-Circuit Current 30~60 %	Drooping Current 105~200%	Volt. Setting	Use
PS4	+550 V	0.1 mA	100 mVp-p				CRT
	+100 V	4 mA	10 mVp-p				CRT
H10	-10 kV	100 μA	1 Vp-p			P	CRT HV POST HV
PM HV	-650 V	0.1 mA	100 mVp-p			P	PM HV

P : Provided
N : Non-regulated
F : Fixed
AC : Alternating Current

8-5 HV POWER SUPPLIES

8-5-1 Protective Circuit

(1) The CRT HV power supply operates simultaneously when the DISPLAY switch is turned on.

(2) Interlinkage with Vacuum

The 30 kHV power supply, POST HV power supply, and PM HV power supply are operable when the column is under high vacuum. (When the column is under high vacuum, connector V5 pins ①-④ are shorted in the evacuating system rack. In order to operate these power supplies under low vacuum of column, short pins ①-④ on the plug side after disconnectir connector V5.)

(3) Interlocking with Specimen Exchange Chamber Peep Window

When the specimen exchange chamber is attached, PM HV is not operated unless the peep window for specimen exchange is closed. (A microswitch is assembled to the lid.)

8-5-2 30 kHV Power Supply

(1) DC Power Supply

CN31 ① +36 V
② 0
← Applied under high vacuum only

③ -15 V
④ 0
← Applied at all times

(2) Output

	Voltage	Current	Ripple	Frequency	
HV	1 ~ 30 kV	200 μA max	300 mVp-p max	30 ~ 36 kHz	Variable by VR1 on PC-H30
FILAMENT power supply	0 ~ 2.3 V	2.3 A	0.1 Vp-p	16 ~ 18 kHz	
BIAS voltage		———			Self bias

8-5-3 POST HV Power Supply

(1) DC Power Supply

CN33 ① GND
② +24 V
③ 0
← Applied under high vacuum only

(2) Output

+10 kV ±10 % (variable by VR1 on PC-H10)

8-5-4 PM HV Power Supply

(1) DC Power Supply

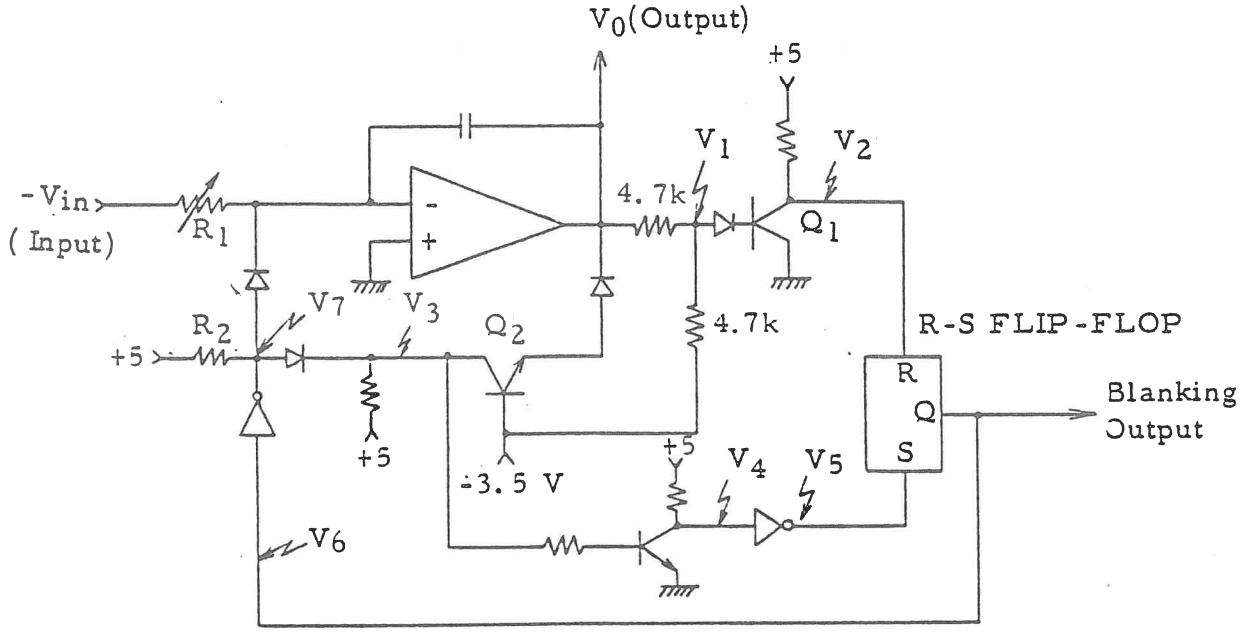
CN32 ① +24 V
② 0
← Applied under high vacuum only
③ GND

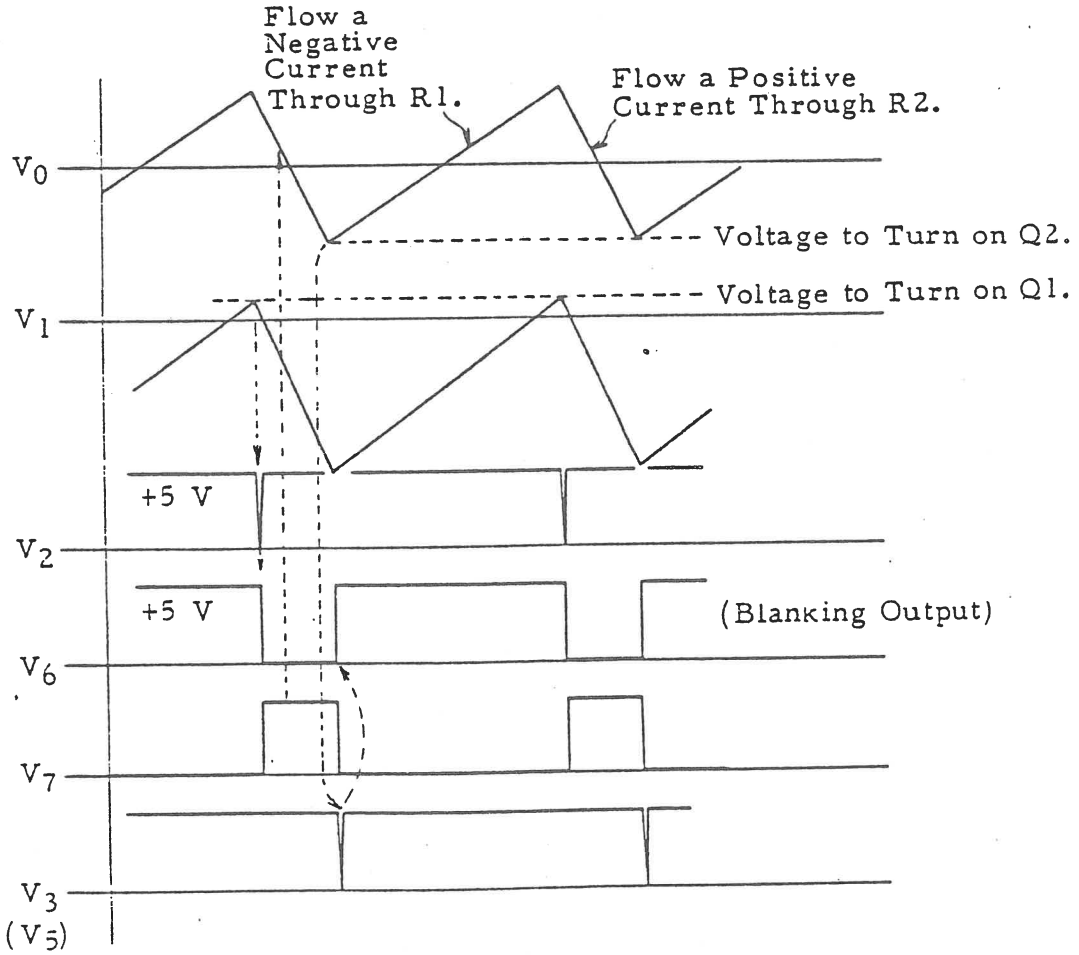
(2) Output

Max 650 V ±5 % (variable by VR1 on PC-HPM)

Min 170 V ±15 %

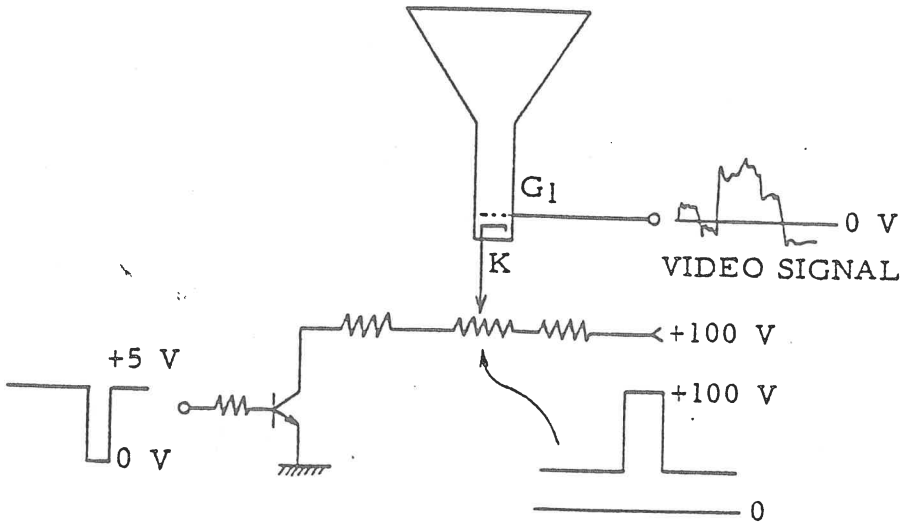
8-6 PRINCIPLE CIRCUIT DIAGRAM OF SAWTOOTH WAVE GENERATOR CIRCUIT



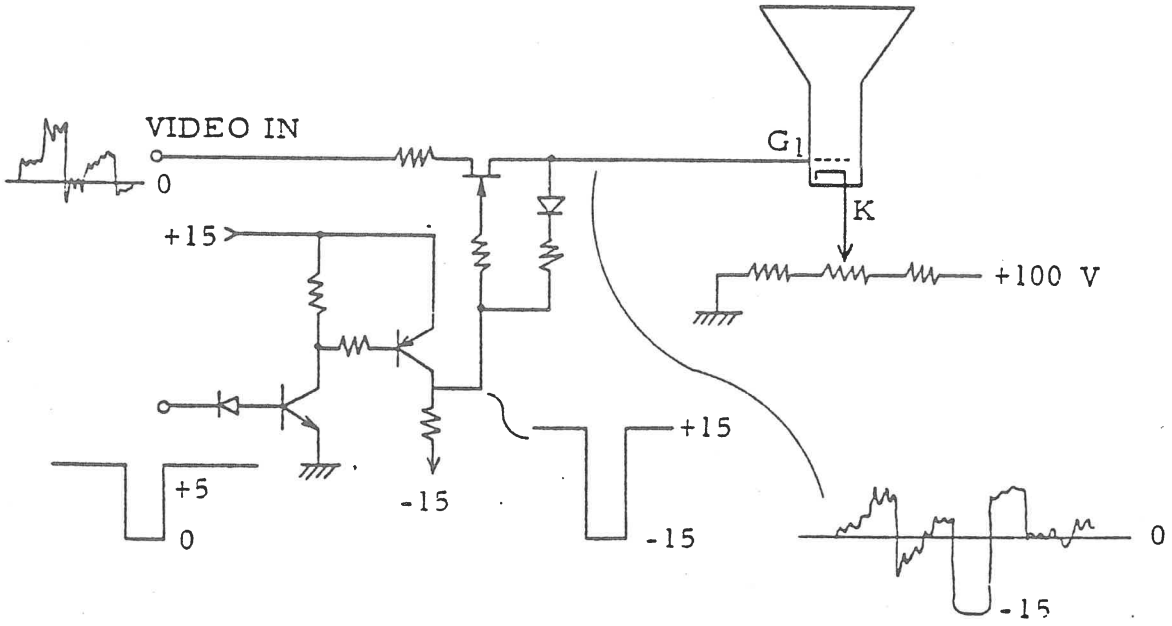


8-7 PRINCIPLE CIRCUIT DIAGRAM OF BLANKING CIRCUIT

(1) SSM, HSM-2, 2A, 2B, HHS-2R and Other Cathode Blanking

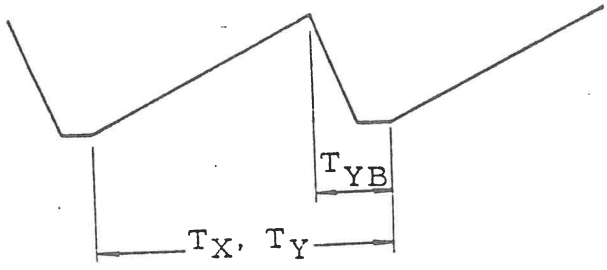


(2) S-500, S-550, S-700 and S-400 Grid Blanking

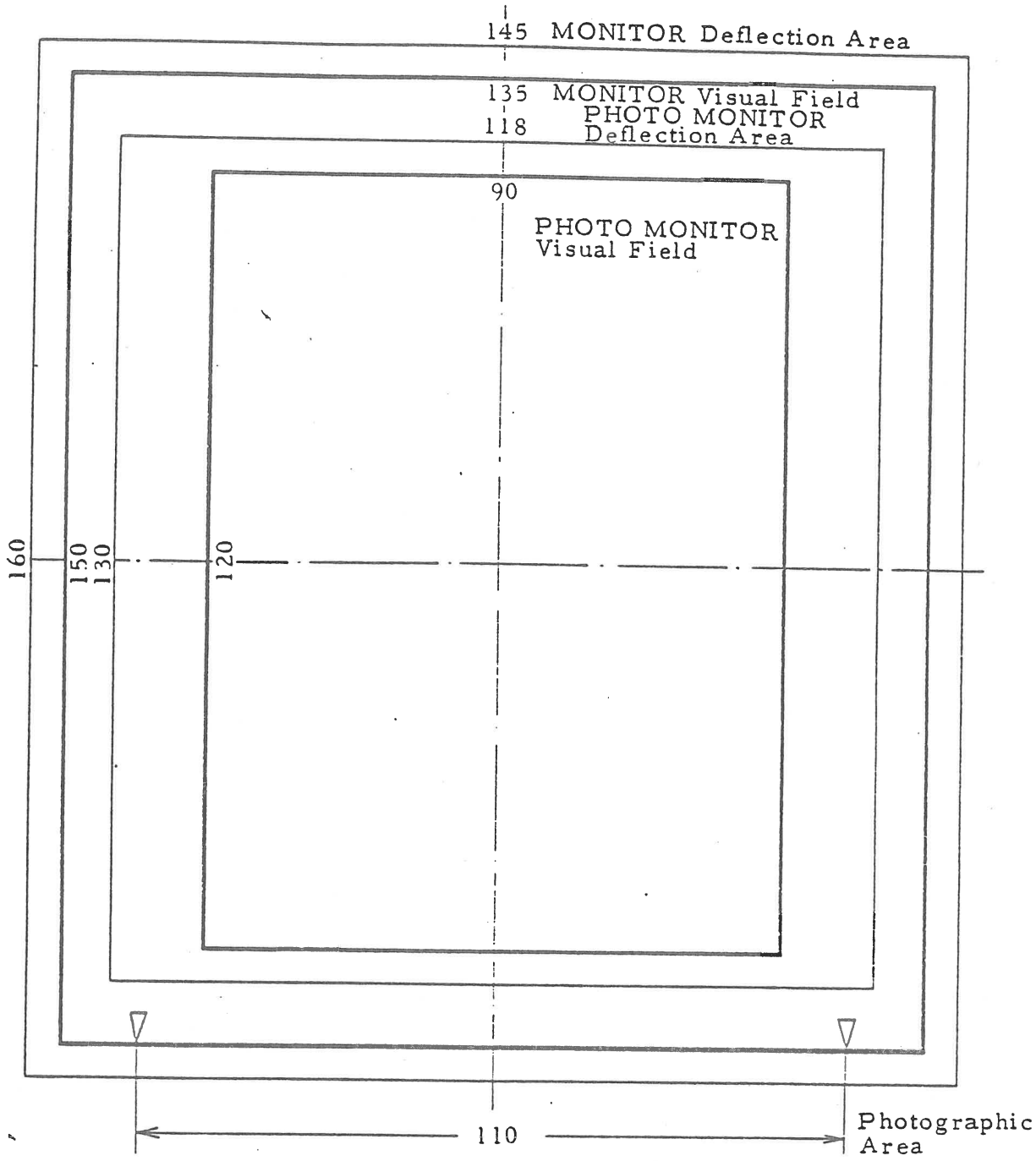


8-8 SCAN SPEED

MODE		T_X	T_{XB}	T_Y	T_{YB}	Number of Lines	LINE SYNC
VIEW	□	0.12 ms	0.05 ms	0.025 s	0.002 s	500	
		0.12 ms	0.05 ms	0.025 s	0.002 s		
	▽	1.0 ms	0.15 ms	0.5 s	0.005 s	500	
		1.0 ms	0.15 ms	0.5 s			
	▽	20 ms	5 ms	10 s		500	YES
		16.7 ms	1.7 ms	8.4 s			
	▽	40 ms	10 ms	40 s		1000	YES
		33.3 ms	3.3 ms	33.3 s			
	□	0.33 ms	0.03 ms	0.060 s		167	YES
		0.33 ms	0.03 ms	0.066 s			
PHOTO	1	20 ms	5 ms	50 s		2500	YES
		16.7 ms	1.7 ms	41.7 s			
	2	40 ms	10 ms	100 s		2500	YES
		33.3 ms	3.3 ms	88.3 s			
	3	80 ms	8.3 ms	200 s		2500	YES
		83.3 ms	5 ms	208 s			
	4	160 ms	5 ms	400 s		2500	YES
		166.7 ms	11.7 ms	417 s			



8-9 VISUAL FIELD SIZE OF EACH MONITOR CRT



Note : Magnification of image displayed on each monitor:

1. MONITOR ——→ Indication on magnification meter x 1.23
2. PHOTO MONITOR ——→ Same as indication on magnification meter

o LENS

No.		Check Point	Adjusting Position	Specification
1	Check the power supply voltage.	CN10	———	+38 V +15 V -15 V
2	Check the connection of connectors. CN17 (OBJ VR) CN12 (POWER TRANSISTOR) CN12 (STANDARD) CN13 (LOAD)			
3	Check the reference voltage (ZD)	TP1	———	+8.3 ± 0.5 V
4	Adjust the reference voltage. at 30 kV	TP2	VR8	5.80 V ±0.02 V
5	Check the linkage of HV. at 25 kV 20 15 10 5 4 3 2	TP2	——— ——— ——— ——— ——— VR9 VR2 VR1	5.29 ± 0.05 V 4.74 ± 0.05 V 4.10 ± 0.04 V 3.35 ± 0.03 V 2.37 ± 0.02 V 2.12 ± 0.02 V 1.83 ± 0.02 V 1.50 ± 0.01 V
6	Check the condenser lens. 30 kV notch 1 2 3 4 5 6 7 8 9	TP6	———	0.635 V 0.883 V 1.131 V 1.379 V 1.627 V 1.875 V 2.123 V 2.371 V 2.62 ± 0.1 V (Corresponds to 1.19 A)
7	Ripple of condenser lens.	TP6		0.4mV or less (2×10^{-4} or less)

o LENS (cont'd)

No.		Check Point	Adjusting Position	Specification
8	OBJ LENS 20 kV WD [1] 5 mm [2] 10 [3] 15 [4] 25 [5] 35 o Adjust obj lens current to medium current by using the VR3~VR7 at each WD with FOCUS FINE and FOCUS COARSE knobs set at middle positions. o The obj lens current becomes minimum at fully counterclockwise position of FOCUS C. knob and maximum at the fully clockwise position. o Each current should be overlapped. (1.5 % or more)	TP10	VR3 VR4 VR5 VR6 VR7	(mA) Min: 689 / 572 / 513 / 432 / 396 Med: 752 / 635 / 567 / 477 / 423 Max: 815 / 698 / 621 / 522 / 450 ±1 % / ±0.2 % / ±1 %
9	OBJ FINE o The obj lens current increases when OBJ FINE knob is rotated in clockwise direction. 20 kV	TP10	——	+10 ± 2 mV

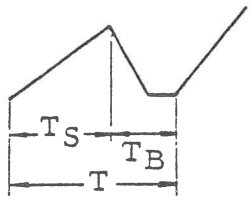
o AL/STG/IS

No.		Check Point	Adjusting Position	Specification
1	Check the reference voltage. at 30 kV	LENS TP17 TP18	 —— ——	 +5.58 V ±1 % -5.58 V ±5 %
2	Check the power supply voltage.	LENS CN10 AL/STG CN6		 +20 V -20 V +15 V -15 V
3	GUN ALIGNMENT (±0.21 A ± 6 %) X Y	AL/STG R21 R22		 +5.58 V ±2 % -5.58 V ±2 %
4	STIGMATOR (±0.17 A ± 6 %) X Y o Stigmator current is shut down with STG SW set to OFF.	 TP32 TP34 TP32 TP34		 +5.58 V ±2 % -5.58 V ±2 % 0 ±5 mV 0 ±5 mV
5	STIG-ALIGNMENT STIG X ; Fully clockwise STIG Y ; Fully clockwise VR15 Fully counterclockwise ⟶ fully clockwise VR12 VR13 VR14	LENS IC8 ⑥ IC9 ⑥ IC10 ⑥ IC11 ⑥ CN6-8 -9 -10 -11		 -5.58 V +5.58 V -5.58 V +5.58 V -5.58 V ⟶ +5.58 V -5.58 V ⟶ +5.58 V -5.58 V ⟶ +5.58 V -5.58 V ⟶ +5.58 V

o AL/STG/IS (cont'd)

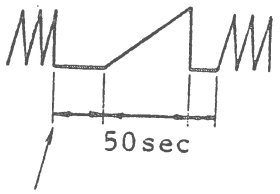
No.		Check Point	Adjusting Position	Specification	
6	IMAGE SHIFT (±0.178 A)				
	o STIG X, Y: Middle position				
	STIG AL VR12~15: Middle position				
	I S X: Fully counter-clockwise ⟶ fully clockwise	TP63		-8.37 V ≀	±7.5 %
	I S Y: Fully counter-clockwise ⟶ fully clockwise	TP66		+8.37 V	±7.5 %
	o STIG X, Y: Fully clockwise I S X, Y: Middle position				
	LENS VR15 Fully counter-clockwise ⟶ fully clockwise	TP63		+1.12 V	changes
	LENS VR12 Fully counter-clockwise ⟶ fully clockwise	TP63		+1.12 V	
	LENS VR13 Fully counter-clockwise ⟶ fully clockwise	TP66		+1.12 V	
	LENS VR14 Fully counter-clockwise ⟶ fully clockwise	TP66		+1.12 V	
7	Circuit must not be oscillated. Ripple: GA, STG, IS			0.5 mVp-p or less (1×10^{-4})	

o SG

No.		Check Point	Adjusting Position	Specification			
1	Check the power supply voltage. o Power supply must not be oscillated.	CN27 ① ② ③ ④ ⑤		) 2 V AC +15 V 0 -15 V			
2	CN18 (SCAN SPEED circuit board) should be connected.						
3	SCAN SPEED ⧖ X amplitude adjustment X zero adjustment	 TP8 TP8	 VR7 VR8	 8 V_{PD}(±0.4 V) 0 (±0.1 V)			
4	SCAN SPEED ⧖ Y amplitude adjustment Y zero adjustment	 TP9 TP9	 VR9 VR10	 8.8 Vp-p(±0.4 V) 0 (±0.1 V)			
5	SCAN SPEED adjustment:X 			T (ms)	T_B (ms)		
	□	TP8	VR1	0.12	0.05		±10%
	⧖		VR2	1.0	0.15		"
	▽▽		VR3	2.0 16.7	5 1.7		*
	▽		VR4	40 33.3	10 3.3		*
	□		(2)	0.33	0.03		±10%
6	SCAN SPEED adjustment:Y			T (s)	T_B (s)		
	□	TP9	C18	0.025	0.002	40 frames	±10%
	⧖		C20	0.5	0.005	500 lines	±10%
	▽▽		C20	10 8.4		500 lines	±10%
	▽		C22	4.0 33.3		1000 lines	±10%
	□		(C20)	0.060 0.066		167 lines	*

* Synchronized with LINE

o SG (cont'd)

No.		Check Point	Adjusting Position	Specification		
7	PHOTO operation (1) (CN7 should be connected) When depressing the PHOTO SW, the PHOTO lamp is lit.					
8	PHOTO operation (2) PHOTO SPEED [1]	TP9				
9	PHOTO SCAN SPEED: X			T (ms)	T_B (ms)	
	[1]	TP8	VR3	20	5	*
				16.7	1.7	
	[2]		VR4	40	10	*
				33.3	3.3	
	[3]		VR5	80	5	*
				83.3	8.3	
	[4]		VR6	160	5	*
				166.7	11.7	
10	PHOTO SCAN SPEED: Y			T(s)		
	[1]	TP9	C24	50		
				41.7		
	[2]			100		
				88.3		
	[3]			200		
				208		
	[4]			400		
				417		

* Synchronized with LINE

o SG (cont'd)

No.		Check Point		Adjusting Position	Specification		
11	Linkage of accelerating voltage CN7 (HV SW circuit board) should be connected.	X CN52	Y		X Vp-p	Y	
	X, Y 30 kV	⑦	⑨		6.2	6.8	
	25				5.7	6.2	
	20				5.1	5.6	
	15				4.4	4.8	
	10				3.6	3.9	
	5				2.5	2.8	
	4						
	3						
	2						
12	Change of XY output for CRT.						
	V-X amplitude	CN23-4		VR14	1.76 Vp-p		Roughly adjust.
	P-X amplitude	CN23-4		VR15	2.0 Vp-p		
	V-X zero adjustment	CN23-5		VR16	+5 ~ -5 V		Check variable range.
	P-X zero adjustment	CN23-5		VR17	+5 ~ -5 V		
	V-Y amplitude	CN23-6		VR18	4.4 Vp-p		Roughly adjust.
	P-Y amplitude	CN23-6		VR19	0.88 Vp-p		
	V-P zero adjustment	CN23-7		VR20	+5 ~ -5 V		Check variable range.
	P-Y zero adjustment	CN23-7		VR21	+5 ~ -5 V		
	TV-X zero adjustment	CN23-5		VR300	+5 ~ -5 V		

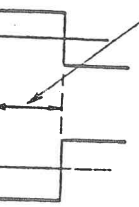
o DEF

No.		Check Point	Adjusting Position	Specification	
1	Check the power supply voltage.	CN23-1		+15 V	
		-2		0	
		-3		-15 V	
		CN34-1		+20 V	
		-2		0	
		-3		-20 V	
		-5		+15 V	
		-6		0	
		-7		-15 V	
		-9		+20 V	
		-10		0	
		-11		-20 V	
		-13		+15 V	
		-14		0	
		-15		-15 V	
2	Check of CRT-DEF o RL1 operates with VIEW mode. o RL1 does not operate with PHOTO mode.				
	<VIEW>				
	X amplitude (1.76 Ap-p)	TP6	SG VR14	1.76 Vp-p	
	zero (position)		VR16	0	±0.1 V
	Y amplitude (2.2 Ap-p)	TP8	VR18	4.4 Vp-p	
	zero	TP8	VR20	0	±0.1 V
	<PHOTO>				
	X amplitude (2.0 Ap-p)	TP6	SG VR15	2.0 Vp-p	
	zero	TP6	VR17	0	±0.1 V
	Y amplitude (0.4 Ap-p)	TP8	VR19	0.88 Vp-p	
	zero	TP8	VR21	0	±0.1 V

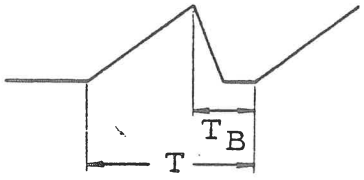
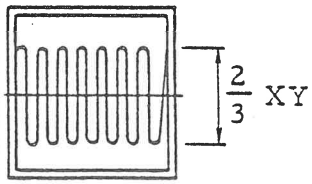
o DEF (cont'd)

No.		Check Point	Adjusting Position	Specification	
3	Adjustment of COL DEF o Connect the CN21 (MAG SW circuit board) o Connect the CN20 (DEF coil) o Insert the F1 and F2. o Set the display panel to VIEW [▒] mode. o Turn the MAG FINE VR fully counterclockwise. o Set the HV to 30 kV.				
	o X amplitude adjustment	TP2	SG VR12	Vp-p	±0.02 V
	o Amplitude becomes 1/3 when turning the MAG FINE VR fully clockwise.	TP2	———	Within 3 %	
	o Y amplitude adjustment	TP4	SG VR13	Vp-p	±0.02 V
	o Amplitude becomes 1/3 when turning the MAG FINE VR fully clockwise.	TP4	———	Within 3 %	
4	Adjustment of COL DEF oscillation. o RL2 on the DEF circuit board operates at notch 7 or higher position of MAG COARSE SW. o Turn the MAG FINE VR fully counterclockwise. o Set the HV to 30 kV. o Set the diaplay panel to VIEW [ ] (TV) mode.				
	o Adjust the VR so as not to oscillate when the MAG COARSE SW is changed from low mag position to high mag position or vice versa.	X: TP2 Y: TP4	VR1, 2, 3 VR4, 5		

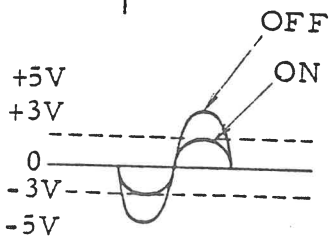
o DEF (cont'd)

No.		Check Point	Adjusting Position	Specification
5	SPOT KILLER VIEW [▒] o Check waveform with the CN24 (CRT coil) disconnected.	DEF TP9 SG TP12	+14 V 0 -14 V +14 V 0 -10 V	Operation display 

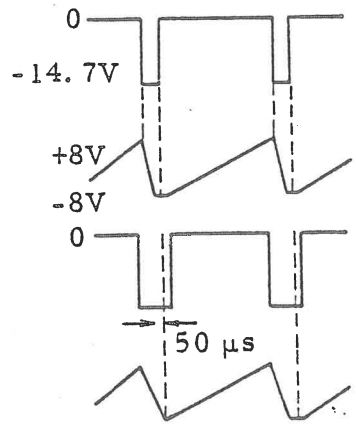
o FOCUS MONITOR

No.		Check Point	Adjusting Position	Specification
1	Set the FOCUS MONITOR to ON. o X waveform is as follows at any SCAN SPEED.  	SG TP8	(VR4)	T (ms) / T_B (ms): 40 / 10; 33.3 / 3.3 8 Vp-p Synchronized with LINE.
2	Y waveform (COL-Y)	SG TP9	None	0
3	X waveform (CRT-Y) o Apply sine wave of 200 Hz and 4 Vp-p ripple to CN28 (EXT SIG) and the waveform at right will be seen.	DEF TP7	None	

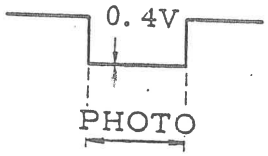
o VIDEO AMP

No.		Check Point	Adjusting Position	Specification
1	Connect CN27 (power supply), CN26 (HEAD AMP), CN7 (HEAD AMP BRIGHTNESS)			
2	Turn the BRIGHTNESS knob from fully counterclockwise to fully clockwise position.	TP13		-15 V ≀ +1 V
3	TV out	TV out		Voltage of +0.5V higher than that of TP13.
4	The HEAD AMP must not be oscillated.	TP13		
5	GAMMA CONTROL o Disconnect the CN26 (HEAD AMP). o Connect oscillator to the CN26. o Apply sine wave (1 kV, 0.2 Vp-p) through the CN26 ③. o Turn off the INVERT SW. o The waveform changes when the GAMMA SW is turned on and off.	TP20		
6	Check of frequency response. o Check the frequency at the position where the output (gain) becomes half when the SCAN SPEED is changed while applying a signal with oscillator through the CN26 ③. Input 0.05 Vp-p INVERT OFF	TP16		3MHz or higher 70 kHz within ±15 % 16 kHz within ±15 % 16 kHz within ±15 % 500 kHz within ±15 %

o VIDEO AMP (cont'd)

No.		Check Point	Adjusting Position	Specification
7	GRID BLANKING o ⧖ o ▣ REDUCE o Check the voltage for the external signal terminal. CN02 (11) (EXT. BLK'NG) CN66 (EXT. WHITE)	TP16 TP8 TP16 TP8		
	TTL			
	LOW	TP16		-14 V
	HIGH	TP16		+14 V
8	CATHODE BLANKING o Connect the CRTs to the CN35 and CN8. o Connect the CN27 (power supply). o Connect the CN7 (VIEW BRIGHT VR) o Make sure of the check points at right.	CN35-1 -2 -3 -4 -5 -6 CN8-1 -2 -3 -4 -5 -6		+27 V +36 V 0 +12 V V.CRT-K VIDEO SIGNAL 0~+550V Variable +550V +12V +24V P.CRT-K VIDEO SIGNAL

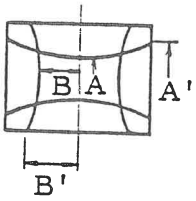
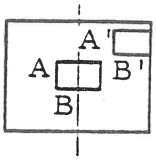
o VIDEO AMP (cont'd)

No.		Check Point	Adjusting Position	Specification
8	o Raster appears on the viewing CRT at ▒ position. o Adjust brightness of the viewing CRT. VG = +0.6 V VIEW BRIGHT VR : Middle position		VR22	Raster : Grey
	o PHOTO CRT Make sure that the PHOTO CRT is in blanking condition with VIEW mode and is released with PHOTO mode.	CN8-5		
	Set the VG at +0.6V and adjust the PHOTO CRT with PHOTO mode.		VR23	exposure meter
	Adjust the raster focus.		VR24	
9	Check enhanced brightness at SCAN SPEED □ (TV) mode. The V_G should be higher than that of any other SCAN SPEED.	TP16		+2V higher (±0.5 V)

o CRT

No.		Check Point	Adjusting Position	Specification
1	VIEW C924 P7 PHOTO C818 P4			These apply to the CRT delivery regulations for S-500, S-550 and S-700.
2	VIEW CRT-1 o Orientation and intersection perpendicularity of raster. o Deflection center o Adjust the raster amplitude to 145W x 160H. (The mask is 135Wx150H and exposure area is 110W x 150H). * The above adjustment is done by using [圖] mode.		Deflection coil SG VR16, 20 SG VR14, 18	Within ±1° Within ±1 mm of CRT center. ±1 mm
3	VIEW CRT-2 o Set the SCAN SPEED to [□] mode. o Adjust the deflection center of X scanning raster.			
4	PHOTO CRT o Orientation and intersection perpendicularity of raster. o Deflection center o Adjust the raster amplitude to ~~118W x 130H~~ 110x150 (The exposure area is 90W x 120H.)		Deflection coil and furnished magnet. SG VR17, 21 SG VR15, 19	Within ±0.7° Within ±1 mm of CRT center. ±1 mm

o CRT (cont'd)

No.		Check Point	Adjusting Position	Specification
4	PHOTO CRT (cont'd) o Linearity of circumference of CRT (pincushion) $\frac{\lvert A-A' \rvert}{A} \times 100 \leqq 2.0\ \%$ $\frac{\lvert B-B' \rvert}{B} \times 100 \leqq 2.0\ \%$  		Deflection coil.	±2.0 %
	o Magnification error at center and circumference of CRT. In case of A ≒ B ≒ 1 cm on CRT image.  $\frac{\lvert A-A' \rvert}{A} \times 100 \leqq 20\ \%$: D $\leqq 20\ \%$: T $\frac{\lvert B-B' \rvert}{B} \times 100 \leqq 20\ \%$: D $\leqq 20\ \%$: T Remarks: D: Display alone T: Display plus microscope column.			Within 20 %

o STG. MONITOR/DYNAMIC FOCUS

No.		Check Point	Adjusting Position	Specification
1	STIG. MONITOR o Turn on the STIG MONITOR SW and make sure that the oscillator output is of sine wave. o OBJ LENS current This current changes when the VR of AMP is turned from fully counterclockwise to fully clockwise.	LENS TP16 LENS TP10	VR11 ———	2 Hz 10 Vp-p 0 ↓ 50 mVp-p
2	DYNAMIC FOCUS  	LENS TP10	———	0 ↓ 0.8 Vp-p

o ABC

No.		Check Point	Adjusting Position	Specification
1	o Set the ABC SW to AUTO. Turn off the INVERT SW.			
	o Make sure that the ABC input TP21 is connected to the VIDEO AMP output TP20.			
	o Connect the HEAD AMP. Set the SCAN SPEED to ▭ mode.			
	o Adjust the VR331 so that the signal at TP21 becomes zero.	TP21	VR331	0 V
	o The above condition should not be changed when the SCAN SPEED is set to ▣ and ▣ modes.	TP21		0 V
	o Also, it should not be varied even at the SIGNAL INVERT.	TP21		0 V

o B/C COLOR BAR (BRIGHTNESS, CONTRAST COLOR BAR)

No.		Check Point	Adjusting Position	Specification
1	BRIGHTNESS COLOR BAR o Adjust the VR1 so that half of the color bar LEDs are lit when the voltage of TP20 (meter input) on the SG circuit board is set to 0V.		B/C VR1	 light
2	CONTRAST COLOR BAR o Make sure that half of the color bar LEDs are lit when the voltage of TP20 (color bar input) on the SG circuit board is set to the following. { 500 Hz sine wave { 1.6 Vp-p		None	 light

o MAG INDICATOR-1

No.		Check Point	Adjusting Position	Specification
1	Check of power supply.	CN4-10 -11 -12		+15 V 0 -15 V
2	WD switch : [3] (15 mm) FOCUS COARSE: Middle position LOW MAG SW: OFF MAG FINE: Fully counterclockwise position. MAG COARSE: Fully counterclockwise position.	MAG, IND, CONT IC3 ⑥	MAG, IND, CONT VR1	0.326V
3	The voltage in item 2 above becomes triple when the MAG FINE knob is turned fully clockwise.	IC3 ⑥	——	0.978V
4	Return the MAG FINE knob fully counterclockwise.			
5	The above voltage changes when changing over the WD switch.			

	(mm)			(V)	
1	35	IC3 ⑥	None	0.178	±2 %
2	25	IC3 ⑥	None	0.230	
3	15	IC3 ⑥	None	0.326	
4	10	IC3 ⑥	None	0.412	
5	5	IC3 ⑥	None	0.559	

No.		Check Point	Adjusting Position	Specification
6	WD switch: [3], MAG FINE: Fully clockwise position. o The above voltage changes when rotating the FOCUS COARSE knob.			

Fully clockwise	IC3 ⑥	None	0.392 V	±2 %
Middle position	IC3 ⑥	None	0.326 V	
Fully counterclockwise	IC3 ⑥	None	0.268 V	

o MAG INDICATOR-1 (cont'd)

No.		Check Point	Adjusting Position	Specification
7	WD switch: [1], MAG FINE: Fully counter-clockwise position. FOCUS COARSE: Middle position. o The reading of the mag indicator increases by 1 digit at IC3 output of 0.98 V when the MAG FINE knob is rotated clockwise.	IC3 ⑥	None	0.294 V ±2 %

o MAG INDICATOR-2

No.		Check Point	Adjusting Position	Specification
1	The voltage of 0.326 V is given on the analog output (IC3 output) when setting the MAG to OFF, MAG FINE to fully counterclockwise position and FOCUS COARSE to middle position. Adjust the VR3 so that the DIGITAL DISPLAY NUMBER becomes "33".	LED	VR3	33
2	Figures at right show the resistance for each notch of the MAG COARSE switch.			

Notch 1	33
2	82
3	160
4	330
5	820
6	1.60 k
7	3.30 k
8	8.20 k
9	16.0 k
10	33.0 k
11	82.0 k
12	160 k

EMISSION COLOR BAR

	Check Point	Adjusting Position	Specification
Connect the HV (H30) circuit board and HV tank to the respective fixed positions.	CN3-19 -20 -21 -22		+15 V 0 -15 V + 5 V
Turn on the HV switch.	CN3-23		+5 V
Change the HV 2 kV ~ 30 kV	LED		2 kV lamp lights ~ 30 kV
EMISSION COLOR BAR Acc. voltage: 30 kV Emission current: 150 μA	H 30 circuit board.		0.594 V ±1.2 %
Emission color bar output	LED		15 pcs ±1 pc
Acc. voltage: 15 kV	H 30 circuit board.		0.545 V ±2.5 %
Emission current: 150 μA mission color bar output	LED		15 pcs ±1 pc

Section IX

PARTS EMPLOYED

Table 9-1 Transistors Employed

Model	Part No.	Mfg.	Type	Material	Case	Max Ratings				h_{FE}	Use	Replacement			
						Pc(W)	Ic(A)	V_{CBO}	V_{CEO}			HITACHI	NEC (Note 2)	TOSHIBA	OTHER
2SA537(H)B	J321016	HITACHI	PNP	Si	TO-39	0.75	-0.7	-60	-50	50 ~ 100	MED POWER, MED SPEED		2SA717	2SA594-0	
2SA530(H)	J321013	HITACHI	PNP	Si	TO-18	0.2	-0.1	-50	-35	35 ~ 120	MED SPEED AMP/SWITCH		2SA603	2SA499-0	
2SA548(H)B	J321024	HITACHI	PNP	Si	TO-18	0.2	-0.1	-50	-35	60 ~ 120	GENERAL PURPOSE	2SA530(H)	2SA603	2SA499-0	
2SC321(H)B	J323018	HITACHI	NPN	Si	TO-18	0.36	0.2	40	15	60 ~ 120	HIGH SPEED SWITCH		2SC943	2SC979-0	
2SC665(H)B	J323035	HITACHI	NPN	Si	TO-3	*50	7	130	80	50 ~ 130	HIGH POWER AMP/SWITCH		2SD151	2SC521A	
2SC680A		HITACHI	NPN	Si	TO-66	*12.5	2	200	140	45 ~ 180	HIGH VOLT SWITCH			2SC779-0	
2SC1706	J323160	HITACHI	NPN	Si	TO-18										
2SC708(H)B	J323047	HITACHI	NPN	Si	TO-39	0.75	1	60	50	50 ~ 100	MED POWER AMP/SWITCH		2SC1008	2SC512-0	
2SC830(H)B	J323052	HITACHI	NPN	Si	TO-66	*25	3	100	55	60 ~ 120	MED POWER AMP/SWITCH		2SD283	2SD103-0	
2SC937*	J323113	HITACHI	NPN	Si	TO-3	*22	2.5	1200	500	30 ~ 100	HIGH VOLT SWITCHING		2SC1325	2SC1172-0	
2SC984(H)C	J323065	HITACHI	NPN	Si	TO-1	0.35	0.5	100	50	100 ~ 200	MED SPEED SWITCH	2SC1781(H)	2SC943	2SC979-0	
2SC1707(H)B	J323162	HITACHI	NPN	Si	TO-18	0.2	0.1	40	30	100 ~ 200	RF AMPLIFIER		2SC943	2SC979-0	
2SC1781(H)B	J323180	HITACHI	NPN	Si	TO-18	0.35	0.5	70	50	110 ~ 170	GENERAL PURPOSE		2SC943	2SC979-0	
$N_{13}T_1$		NEC									PROGRAMMABLE UJT				
PT-500		SHARP									PHOTO TRANSISTOR				
2N4392	J326750	SILI-CONIX	N-J	FET	TO-18						ANALOG SWITCH				E112
1T400	J326725	INTERSIL	N-J	FET	TO-18						ANALOG SWITCH				

Notes : (1) Manufacture of asterisked parts may be discontinued and replaced with substitutes in the future.

(2) Since these parts are classified according to the h_{FE} values, it is necessary to select those having an h_{FE} value close to the characteristics table value.

(3) For substitutes not covered in this table, select them referring to the characteristics table.

Table 9-2 Diodes Employed

Model	Part No.	Mfg.	Material	Case	Max Ratings		I_R Max	TOFF	Use	Substitutes			
					I_F(mA)	Vp(V)	(μA)			HITACHI	NEC	TOSHIBA	
1N34A(H)	J311000	HITACHI	Ge		50	-60	-10	140 ns	SMALL SIG		SD34	1N60	(Note 1)
1S84(H)	J312005	HITACHI	Si	DO-7	100	-200	-1	20 μs	HIGH VOLT SW		1S955		
*1S1219		HITACHI	Si	DO-7	150	-45	-0.1	4 ns	SMALL SIG	1S2074(H)	1S954	1S1586	
1S2074(H)	J312008	HITACHI	Si	DO-35	150	-45	-0.1	4 ns	SMALL SIG		1S954	1S1586	
1S1420(H)	J311005	HITACHI	Si	DO-7	30	-30	-1	———	LEVEL SHIFT		1S1300		V_F = 2V (I_F = 2 mA)
V03C	J313005	HITACHI	Si		1300	-200	-20	2 μs	RECTIFIER		F14B	1S1886	SAME AS 1S1948
V06C	J313008	HITACHI	Si		1100	-200	-20	3 μs	RECTIFIER		F14B	1S1886	SAME AS 1S2080
V09E	J313012	HITACHI	Si		800	-400	-10	0.4 μs	HIGH SPEED				SAME AS 1S2245
1S2080(H)	J313105	HITACHI	Si		1300	-200	-20	2 μs	RECTIFIER		F14B	1S1886	SAME AS V03C
S02C	J313063	HITACHI	Si		10 A	-200	-4 mA	———	RECTIFIER		ZIR2S		SAME AS 1S1280
1S689	J312007	HITACHI	Ge		6 A	-200	-5 mA	———	RECTIFIER				LOW V_F (0.6 V MAX)
Y-16-LC	J311043	HITACHI	Si		3	-12 kV	-4	———	HIGH VOLT				
EDH-12		ORION	Si		100	-12 kV	-10	0.5 μs	HIGH VOLT				
SR103D	J315608	NEC	Gap										
M4C-1	J342000	HITACHI	Si		1.2 A	-200	-100	———	RECTIFIER STACK				LED (REF)
S2HB40	J342806	SHINDEN GEN	Si	TO-3	8 A	-400	———	———	RECTIFIER STACK				
5082-7731	J315801	HP											
5082-4684	J315813	HP											
5082-4984	J315803	HP											
RLD9-210PT	J315900	OKAYA											

Note : Use a germanium diode as substitute without fail.

Table 9-3 Zener Diodes Employed

Model	Part No.	Mfg.	V_Z		Z_{ZT} (Ω)	Max Ratings		α_{TYP}	Substitutes			
			V_Z(V)	I_{ZT}(mA)		P_D(W)	* (mA)		HITACHI	NEC	TOSHIBA	
AW01-06	J314000	HITACHI	5.2 ~ 6.8	60	9	1	160	0.025 %/°C		RD6.2FB		HIGH POWER (1 W)
AW01-09	J314003	HITACHI	8.5 ~ 9.6	25	3	1	105	0.053 %/°C		RD9.1FB		
AW01-10	J314004	HITACHI	9.4 ~ 10.6	25	5	1	95	0.058 %/°C		RD10FB		
AW01-12	J314006	HITACHI	11.4 ~ 12.7	25	8	1	75	0.065 %/°C		RD12FB		
AW01-15	J314008	HITACHI	13.5 ~ 15.6	15	12	1	65	0.072 %/°C		RD15FB		
AW01-30	J314015	HITACHI	28 ~ 32	10	15	1	32	0.083 %/°C		RD30FB		
HZ4(H)	J314204	HITACHI	3.4 ~ 4.5	5	47	0.4		2.1 mV/°C		RD4A	02BZ3.9	
HZ5(H)	J314207	HITACHI	4.3 ~ 5.4	5	45	0.4		2.1 mV/°C		RD5A	02BZ4.7	GENERAL PURPOSE
RD5A	J314504	NEC	4.3 ~ 5.4	10	40	0.25		0.01 %/°C	HZ5(H)		02BZ4.7	
RD6A	J314505	NEC	5.2 ~ 6.4	10	30	0.25		0.03 %/°C	HZ6(H)		02Z6.2A	
RD7A	J314506	NEC	6.2 ~ 8.0	10	12	0.25		0.04 %/°C	HZ7(H)		02Z6.8A	
RD9A	J314507	NEC	7.5 ~ 10.0	10	10	0.25		0.055 %/°C	HZ9(H)		02Z9.1A	
1S2190	J314500	NEC	7.7 ~ 8.7	10	20	0.25		0.01 %/°C		1S550	1S212	LOW TEMPERATURE COEFFICIENT
1S2191	J314501	NEC	7.7 ~ 8.7	10	20	0.25		0.005 %/°C		1S551	1S213	
1S2192	J314502	NEC	7.7 ~ 8.7	10	20	0.25		0.002 %/°C		1S552	1S214	

Note : V_Z : ZENER VOLTAGE
I_{ZT} : TEST CURRENT
Z_{ZT} : DYNAMIC IMPEDANCE (MAX)
α_{TYP} : ZENER VOLTAGE TEMPERATURE COEFFICIENT

* : Permissible Current

Table 9-4 Linear IC Substitutes

HITACHI	NEC	FAIRCHILD	NS	TEXAS INSTRU-MENTS	RCA	INTERSIL	MOTOR-OLA	PMI	ANALOG DEVICES	BURR BROWN	TELE-DYNE	
*HA17741M	μPC741C	*741HC	LM741CH	SN72741L	CA3741CT	741CTY	$MC1741C_G$				741CE	OP AMP
		*709HC	LM709CH	SN72709L			$MC1709C_G$				709CE	OP AMP
HA17715M		*715HC										OP AMP
		776/776CH	*LM312H									OP AMP(Note 1)
		740/740CH	LH740A/CH			*ICL-8007-CTV			AD503J/K/S			OP AMP(Note 1)
									AV540J/K/S			
	*μPC53A											OP AMP
	*μPC154A		LM725/725CH									OP AMP
								*OP-05CJ				OP AMP(Note 2)
				SN72810N								COMPARATOR
								*CMP-01CJ				COMPARATOR
HA17723		*723DC	LM723CD				MC1723CL				723CN	VOLT REGULATOR
		LM309K	*LM309K				MLM309K					VOLT REGULATOR
						8013C			*AD533JH	4201J/4203J		MULTIPLIER
									*429B		4457	MULTIPLIER
									*40J		1026-02	OP AMP

Notes 1. Linear IC741 is employable for emergency remedy or for circuit operation check.

2. Linear IC741 is employable for emergency remedy or for circuit operation check. However, be careful since the specified stability often may not be obtained.

Table 9-5 Digital IC Substitutes

Functions	HITACHI	TEXAS	MITSUBISHI	NEC	NSE	SIGNETICS	FAIR-CHILD	MOTOROLA
16-bit Data Selector/Multiplexer	HD2548	SN74150N		μPB2150C				
8-bit Data Selector/Multiplexer (with Strobe)	HD2549	SN74151N	M53351P	μPB2151C		N8230A		
8-bit Data Selector/Multiplexer		SN74152N						
Dual D-type Edge-Triggered Flip-Flops	HD2510	SN7474N	M53274P	μPB214C	DM8510N	N7474A	7474	MC7474P
Dual J-K Master-Slave Flip-Flops (with Preset and Clear)	HD2516	SN7476N	M53276P	μPB224C	DM8500N	N7476B	7476	MC7476P
Gated J-K Master-Slave Flip-Flops		SN74104N						
Gated J-K Master-Slave Flip-Flops		SN74105N						
Dual J-K Master-Slave Flip-Flops (Vcc-14, GND-7)	HD2530	SN74107N	M53307P				74107	
Monostable Multivibrator	HD2543	SN74121N	M53321P			N8162A		
Dual Retriggerable Monostable Multivibrators	HD2561	SN74125N						
Quad 2-input Positive NAND Gates	HD2503	SN7400N	M53200P	μPB201C	DM8000N	N7400	7400	MC7400P
Quad 2-input Positive NAND Gates (with Open Collector Output)	HD2509	SN7401N	M53201P	μPB215C	DM8001N	N7401A	7401	MC7401P
Hex Inverters	HD2522	SN7404N	M53204P	μPB235C	DM8004N		7404	MC7404P
Hex Inverters (with Open Collector Output)	HD2523	SN7405N	M53205P	μPB236C	DM8005N		7405	MC7405P
Quad 2-input Positive NAND Gates	HD2550	SN7408N		μPB234C			7408	
Dual 4-input Positive NAND Gates	HD2504	SN7420N	M53220P	μPB203C	DM8020N	N7420A	7420	MC7420P
BCD-to-Seven Segment Decoder/Driver (with 15 V Output)	HD2532	SN7447N		μPB2047C				
4-bit Binary Counters	HD2520	SN7493N	M53293P	μPB223C	DM8533N	N7493A		MC7493P
BCD-to-Seven Segment Decoder/Driver (with 15 V Output)	HD2532	SN7447AN		μPB2047C				
Triple 3-Input Positive NAND Gate	HD2507	SN7410						
Quadruple 2-input Positive NAND Gate with Open Collector	HD2528	SN7403						
Synchronous 4-bit Binary Up/Down Counter	HD2542	SN74193						

Note : It is recommended to use a ceramic-sealed package.

Section X

MAINTENANCE

10-1 PERIODICAL MAINTENANCE AND INSPECTIONS

Inspect the following parts periodically once every six to 12 months so the instrument will operate normally.

(1) Once every 6 months, shut off the cooling water to the oil diffusion pump with the column under the high vacuum working condition. Check the following items.

(a) The 100 V AC for the oil diffusion pump turns off.

(b) The alarm buzzer sounds.

(2) Check the oil filter of the oil rotary pump for clogging once every 6 months.

If the oil receiving vinyl pipe of the oil filter is clogged with oil, replace the oil filter, otherwise the evacuating capacity deteriorates.

(3) Check the oil rotary pump for the specified oil level once every 6 months.

(4) Check fuses for normal condition once every year. Replace them if faulty.

(5) Check the specimen chamber and specimen goniometer stage for ingress of foreign substances.

Foreign substances may cause image troubles or absence of image when photographing a specimen current image.

(6) Cleaning of the electron optical system.

10-2 CLEANING OF S-430 FIXED APERTURE

(1) For the method of cleaning the condenser lens aperture, see the instruction manual.

(2) Cleaning of objective lens fixed aperture

(a) Turn off HV power supply.

(b) Depress AIR switch on the evacuating system operation panel.

(c) Detach four setscrews of the objective lens assembly. See Fig. 10-1.

(d) Detach the main evacuating pipe by removing one upper and four lower setscrews of the pipe. See Fig. 10-1.

(e) Loosen the setscrews of the objective lens movable aperture, and pull out the aperture slowly. See Fig. 10-2.

(f) Evenly screw in the attached four objective lens lifting screws into the four holes other than the objective lens mounting screw holes, and lift the upper part of the column by separating it from the objective lens assembly. See Fig. 10-1.

(g) Detach DEF and condenser lens connector setscrews from the console rack, and remove all connectors.

Be careful during this work since very fine wires are employed.

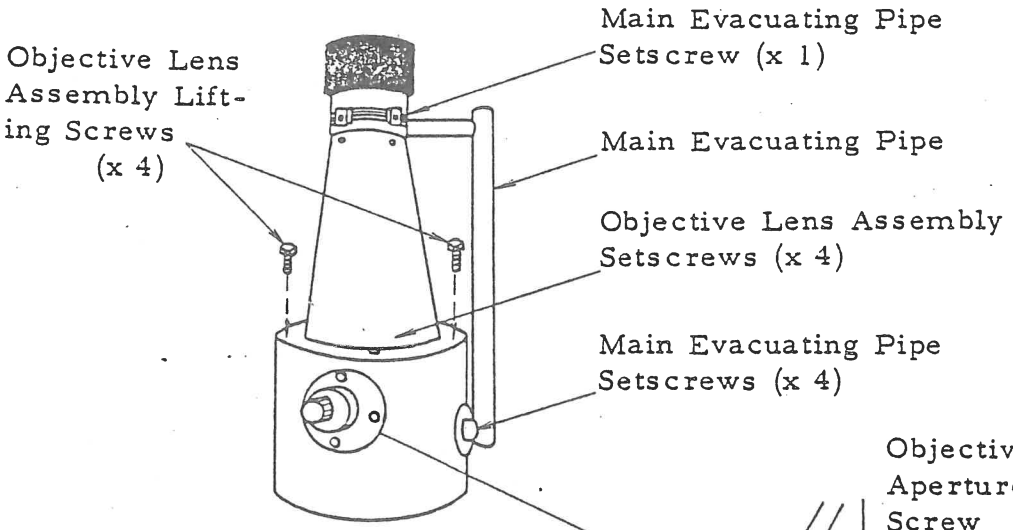


Fig. 10-1 Column of the S-430

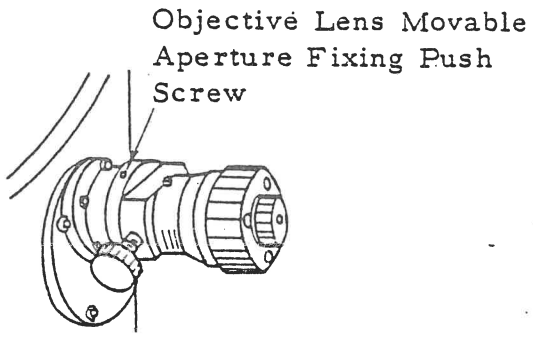


Fig. 10-2 Objective Lens Movable Aperture

(h) After winding the cords detached in step (g) around the column, lift the magnetic path and lay it on its side, and detach the aperture by the following method using the attached aperture take-off tool (Fig. 10-3).

(i) Screw in the take-off tool shown in Fig. 10-3 clockwise by 2 ~ 3 pitches into the female screw inside the objective lens fixed aperture with the internal column head protruding from the outer cylinder by 2 ~ 3 mm, and then screw in the internal column clockwise until it no longer moves while holding the outer cylinder. After fixing the internal column securely, turn the outer cylinder counterclockwise to detach the fixed aperture.

(j) For assembling the fixed aperture, reverse the above procedure.

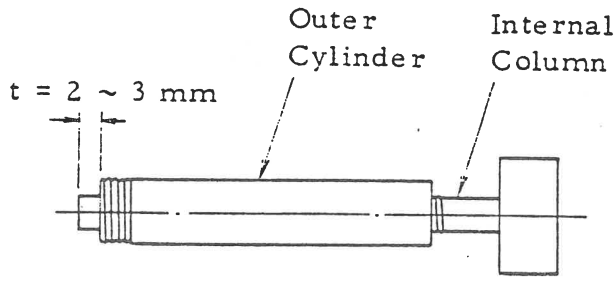


Fig. 10-3 Aperture Take-Off Tool

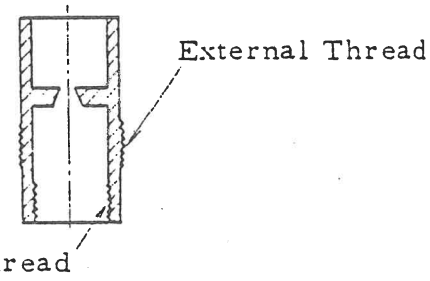


Fig. 10-4 Sectional View of Objective Lens Fixed Aperture

10-3 CLEANING OF S-450 FIXED APERTURE

(1) For the method of cleaning the condenser lens aperture, see the instruction manual.

(2) Cleaning of objective lens fixed aperture

(a) Turn off the HV power supply.

(b) Depress the AIR switch on the evacuating system operation panel.

(c) Vacuum is lost completely after about 30 seconds. Detach the specimen goniometer stage from the column. (Set each specimen control knob to the specimen exchange position.)

(d) Screw in the take-off tool shown in Fig. 10-3 clockwise by 2 ~ 3 pitches into the female screw inside the objective lens fixed aperture with its internal column head protruding from the outer cylinder by 2 ~ 3 mm, and detach the fixed aperture by turning the internal column clockwise while holding the outer cylinder.

(e) For assembling, reverse the above procedure.

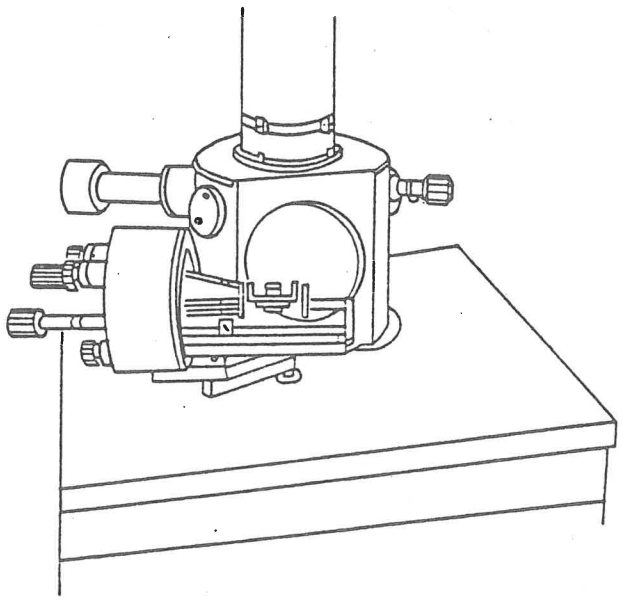


Fig. 10-5 Specimen Goniometer Stage Detached Outside the Column

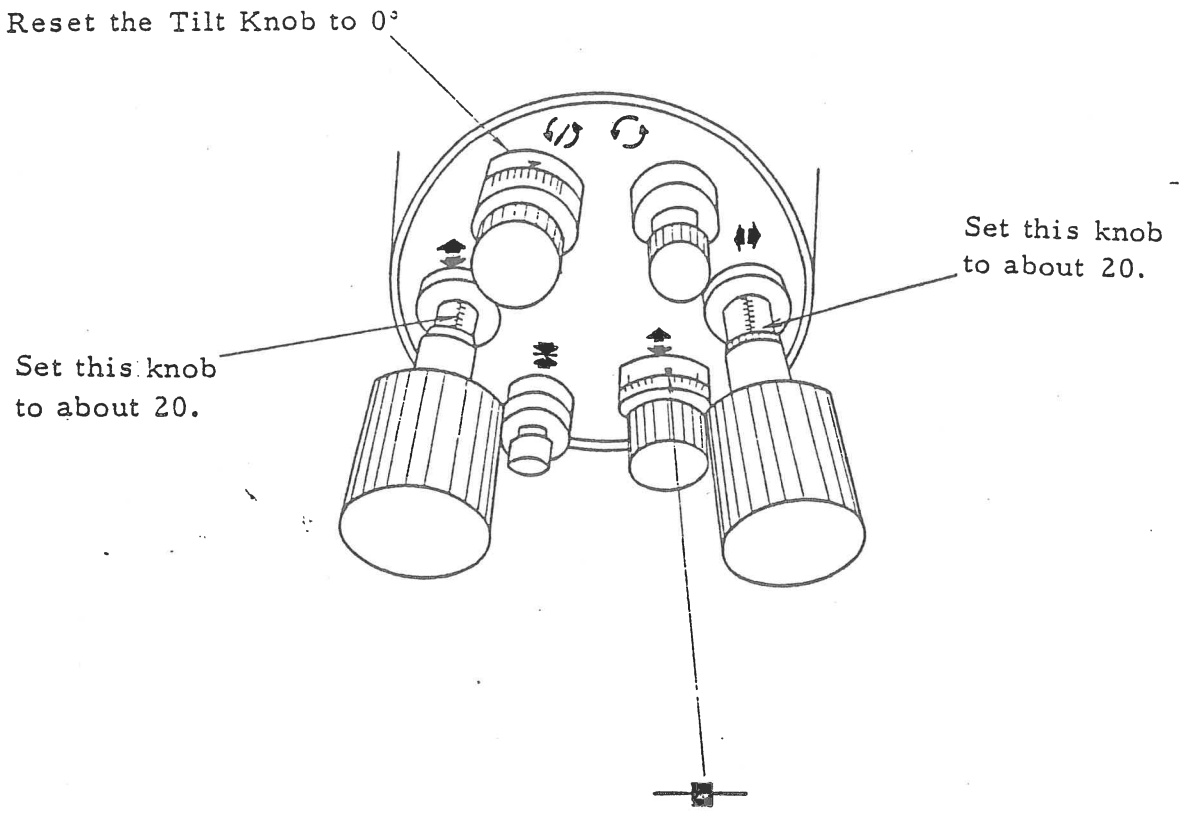


Fig. 10-6 Items to be Checked before Detaching the Specimen Goniometer Stage Outside the Column

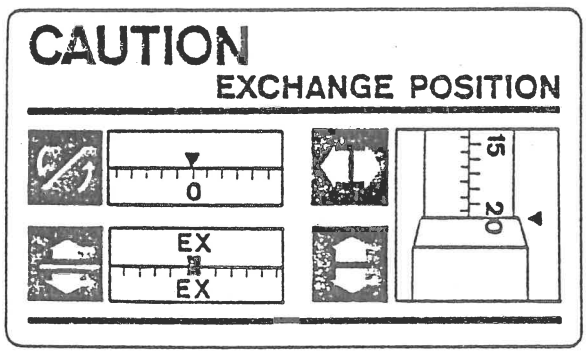


Fig. 10-7 Specimen Exchange Position

Schematic Diagrams

for the

MODEL S-430 AND S-450
SCANNING ELECTRON MICROSCOPES

Schematic Diagrams
for the
MODEL S-430 AND S-450 SCANNING ELECTRON MICROSCOPES

		DWG. NO.
(1)	Coil Wiring	35318020
(2)	10 KV PM HV	35318021
(3)	Magnification Indicator	25318022
(4)	DEF AMP	25318023
(5)	Power Supply-1	25318024
(6)	Power Supply-2	25318025
(7)	30 KV HV	25318026
(8)	Wiring Diagram	25318027
(9)	Lens Power Supply	25318028
(10)	Alignment PS, Stigmator PS, Image Shift PS	25318029
(11)	Scan Generator Video Amp	15318030
(12)	Evacuating Sequence	15318031
(13)	PS-4	35339175