INSTRUCTIONS

JSM-T330A

SCANNING MICROSCOPE

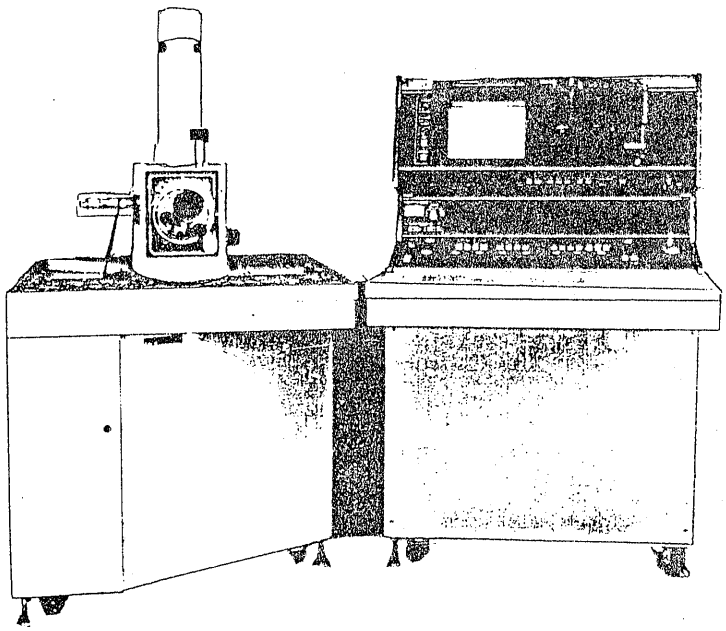
No. ISMT330A-2AE
(MP 168101)

JEOL LTD./JEOL TECHNICS LTD.
Tokyo Japan

8912008KP

PREFACE

Although JSM-T330A is easy to operate, you are requested carefully to read this instructions before starting its operation for better understanding of keypoints on operation and for full comprehension of operational techniques.



Description of this instruction manual may be slightly different from the factual microscope due to its subsequent modification.

PRECAUTIONS

1. Observe the specified requirements for installation of installing the microscope.
2. Do not forget to ground the microscope when installing it.
3. When the work is done on the microscope console table, take care that:
   (a) Nothing enters the console table.
   (b) Nothing such as water is spilled on the table.
4. Even when the microscope is not used for a long period of time, evacuate the column of microscope regularly to keep vacuum.
5. Be sure to turn off power always before connecting the Camera for Scanning Image cable.
6. Take care not to damage or let dust stick on O-rings and their mating surfaces when handling the parts with O-rings.
7. Do not put the microscope in the [VENT] condition for a long time (within several hours).

CONTENTS

ABBREVIATIONS USED IN THIS MANUAL

AC	:	Alternating Current
ACB	:	Automatic Contrast & Brightness Control
AES	:	Automatic Evacuation System
AFD	:	Automatic Focusing Device
AFT	:	Automatic Focus Tracer
ASD	:	Automatic Astigmatism Correction Device
CPU	:	Microprocessor
CRT	:	Cathode-Ray Tube
DP	:	Oil Diffusion Pump
FCS	:	Four-Crystal X-Ray Spectrometer
LED	:	Light Emitting Diode
MAC	:	Automatic Magnification Corrector
PMT	:	Photomultiplier Tube
RP	:	Oil Rotary Pump
TV	:	Television Mode (Image)
WD	:	Working Distance

* Abbreviations or word(s) squared as [ ] in this manual indicate those scribed on the control panel of this microscope, unless otherwise specified.

This microscope is subject to modifications for improvement of its performance. Consequently, there will be some difference between your scanning microscope and that explained in this manual.

CHAPTER 1 GENERAL DESCRIPTION, SPECIFICATIONS AND LAYOUT

1.1 General Description

This scanning microscope has been developed with emphasis on design for ensuring the easier operation and maintenance. Especially, it features simple specimen preparation and instrument operation that can produce images ranging from those in low magnification up to high resolution and high magnification by adopting the Automatic Focusing Device and Automatic Astigmatism Correction Device as aided by microprocessor.

Another feature is a high expandability e.g. grade up to X-ray microanalyzer.

Accordingly, JSM-T330 Scanning Microscope is an outstanding instrument for use in wide range of application such as research and development, quality control, audiovisual education, etc.

1.2 Specifications

1. Performance

Resolution:	4.5 nm (SEI, 30kV, WD = 8mm)
Magnification:	LGS 15X (WD = 48mm)～200,000X SGZ 35X (WD = 38mm)～200,000X Digital display and Automatic Magnification Corrector(MAC) are provided.
Image modes:	Secondary electron image(SEI) Backscattered electron image(BEI)

2. Electron Optical System(EOS)

Accelerating voltage:	H = 5, 10, 15, 20, 25, 30kV (6 steps) L = 0.5～3kV (26 steps, in 100V/step) Linked with objective lens hysteresis eliminating function. Side Entry Anode(SEA, optional)

Specimen size:	10mm dia. × 10mm H to 32mm dia. × 10mm H 10mm dia. × 20pcs, 51mm dia. to 5" dia. IC wafer (LGSHL, LGSHW, optional)
Specimen exchange:	Stage draw-out type Airlock type (optional with ALC2**/ALS)

(SGZ)

Specimen stage type:	Eucentric
Specimen movement range	
Horizontal:	X = 20mm, Y = 20mm
Tilt:	T = -10°～ +90° (max.)
Rotation:	R = 360° endless
Working distance(WD):	8～38mm* continuous
Specimen size:	10mm dia. × 10mm H to 32mm dia. × 10mm H 51mm dia. to 3" dia. IC wafer (SGZSHL, SGZSHW, optional)
Specimen exchange:	Stage draw-out type Airlock type (ALC/ALS, optional)

* WD varies dependently on specimen holder.

** Airlock chamber (ALC2) is installed on the specimen stage.

4. Detectors and Displays

SEI detector/BEI detector:	Scintillator and photomultiplier tube Semiconductor backscattered electron image detector (BEIS2), Transmitted electron detector (LG3TED), Cathodo-luminescence detector (CLD, CLDIR), X-ray detector (FCS/XCS, EDS) are optionally available.

Scanning mode:	Spot**/frame scan/line scan/ Y-modulation scan/TV scan
Scanning speed	
Observation:	0.22, 0.33, 10sec/frame, TV scan
Photographing:	QUICK 36sec/frame (50Hz)
	30sec/frame (60Hz)
	NOR 90sec/frame (50Hz)
	75sec/frame (60Hz)
Magnification display:	15X to 200,000X (digital display)
Display tube:	1 pc., 9" green CRT
Display area:	135mm X 180mm (max.)
Image quality control:	Rapid-exposure system (also used as exposure meter)
Auto image quality control:	Contrast and brightness by Automatic Contrast & Brightness control device(ACB)
Gamma control:	3-way (Video Control Device, VCD, optional)
Specimen tilt correction:	0 to approx. 85° (DFU)
Operation condition display:	Evacuation sequence/Acc.V./ magnification/film number
TV output terminal:	BNC-R connector (75 ohms)
TV output signal:	EIA or CCIR, composite, positive polarity, $1V_{p-p}$, H = 15.75kHz, V = 60Hz(EIA), V = 50Hz(CCIR)
Monitor TV:	TV monitor (TVM9, TVM20, optional)

** Scanning mode for EOS is spot and CRT is frame scan.

5. Scanning Image Photographing Device

Camera (optional):	Manual and automatic shutters (electromagnetic shutter) are built in.
CSI1:	For 6 × 7 roll film (photo/CRT mag.: 0.5)
CSI2:	For polaroid pack film (0.75)
CSI3:	For 35mm roll film (0.25)
CSI5:	For polaroid 4 × 5 film (1.0)
CSI6:	For polaroid autofilm (0.85)
Exposure meter:	Rapid-exposure system
Shutter:	Automatic shutter
Exposure monitor:	LED indication
Data recording:	ON (Base: Image/blank)/OFF Acc.V./magnification/micron bar/ micron value/film number 16 digits = 4 digits (manual) + 2 digits (auto or manual)/Full Key Board (optional with FKB)
Recording CRT(Option):	1 set,PRD1/PRD2/T220-UHR

6. Vacuum System

System control:	Fully automatic control (evacuation sequence indicated) (by Automatic Evacuation System, AES)
Ultimate pressure:	7×10^{-4} Pa (5×10^{-6} Torr) or better
Vacuum pumps	
Oil rotary pump (RP):	100 ℓ/min
Oil diffusion pump (DP):	420 ℓ/sec (with water cooling baffle)
Liquid nitrogen baffle (LNB):	Optional

Evacuation time:	Approx. 3 min, draw-out type 30 sec by airlock type (ALC/ALS, ALC2/ALS, optional)

7. Checkers/Safety Devices

Checkers

Auto checker:	LED indication for 4 check items
Multi-function checker:	For 10 check items (including optional 3 items)
Safety devices:	Protective devices built-in for solution of power and water failures, and vacuum pressure increase.

8. Others

Service outlet:	Built-in, 100V, 2A for attachment
Casters:	Provided for instrument movement.
Others:	Sputter coating device (SCD) is optional.

1.3 Installation Requirements

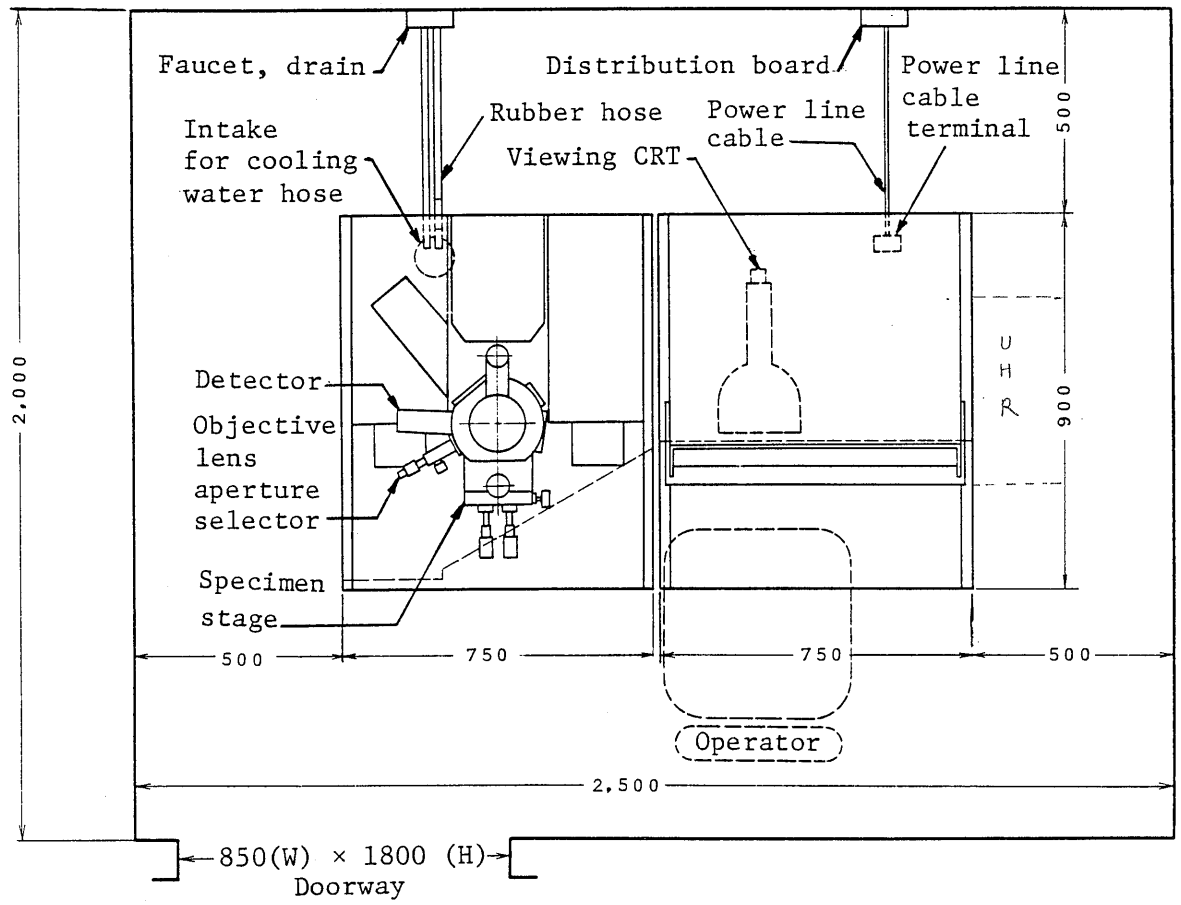
1. Power Supply and Cooling Water

Power supply:	Single phase 100V(±10%), 50/60Hz 2.0kVA (regulator power consumption 1.2kVA)
Grounding terminal:	Less than 100Ω
Cooling water:	Faucet (10mm O.D.) and drain; each 1 pc. Flow rate; 2 ℓ/min Water pressure; 0.05 ~ 0.2MPa Water temperature; 20 ±5°C (Water temperature at the outlet lower than 35°C)

2. Installation Room

Room temperature:	20 ±5°C
Relative humidity:	Less than 60%
Floor vibration:	Less than 2μm (5Hz) in X, Y and Z directions
Stray magnetic fields:	Less than 0.3μT

3. Installation Layout



(Unit: mm)

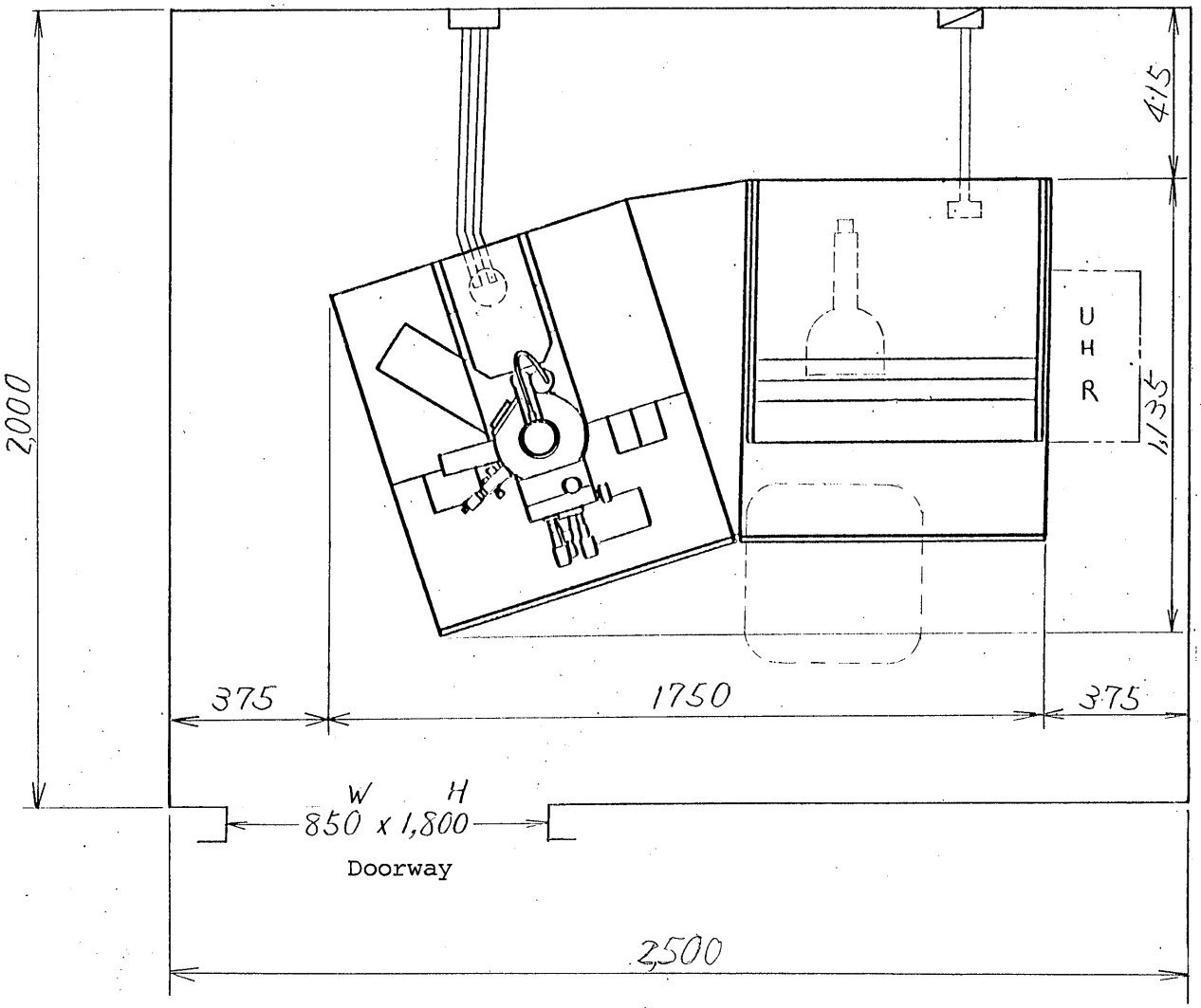
Fig. 1-1 Installation Example

Overall weight (basic instrument): Approx. 425 kg

Notes: 1. Fig. 1-1 shows a typical installation example. Be sure to maintain a service area on the left side and the rear even at only a small layout space available.

2. Install the microscope well apart from facilities producing vibrations or electromagnetic waves (such as roads, busy passages, railroads, elevators, air conditioners and their outlets, transmission lines, etc.)

3. This microscope is not required for any blackout curtain.



(Unit: mm)

With triangle table

Fig. 1-2 Installation Example II

CHAPTER 2 MICROSCOPE DESCRIPTION

2.1 Designation of Main Components

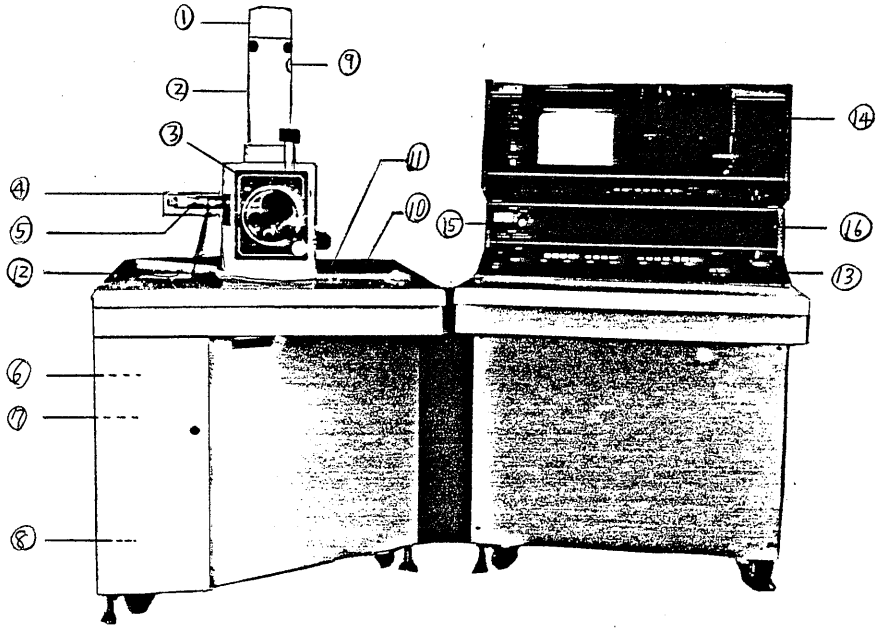


Fig. 2-1 Main Components

①	Electron gun:	Filament is attached.
②	Column:	The part where electron optical system is located.
③	Specimen stage:	LGS for large specimen/SGZ for small specimen
④	Detector:	Detects secondary electron and backscattered electron.
⑤	Objective lens aperture:	Select three steps variably by beam current or depth of focus.
⑥	Cabinet for small: pieces mount, etc.	Keep specimen mounts and other auxiliary pieces.

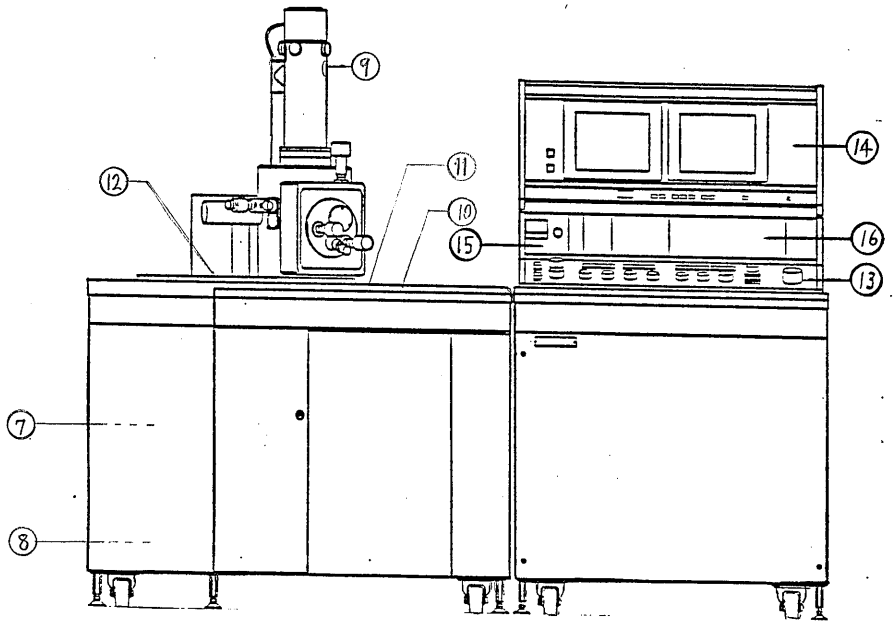


Fig. 2-1b

⑦	Tool box:	For accessories
⑧	File space:	Keeps instruction manual, etc.
⑨	SEA port:	Mounts Side Entry Anode (SEA,optional)
⑩	Gun bias control:	Controls in optimum to meet accelerating voltage.
⑪	SCD receiver:	Mounts sputter coating device (SCD, optional).
⑫	ALS receiver:	Mounts vacuum controller (ALS, optional) of airlock chamber.
⑬	Control panel:	Controls and switches are provided.
⑭	Display panel:	Displays the images and functions.
⑮	Checker:	Both auto checker and manual checker are provided.
⑯	Attachment housing:	Install optional devices.

2.2 Specimen Stage

2.2.1 Description of LGS

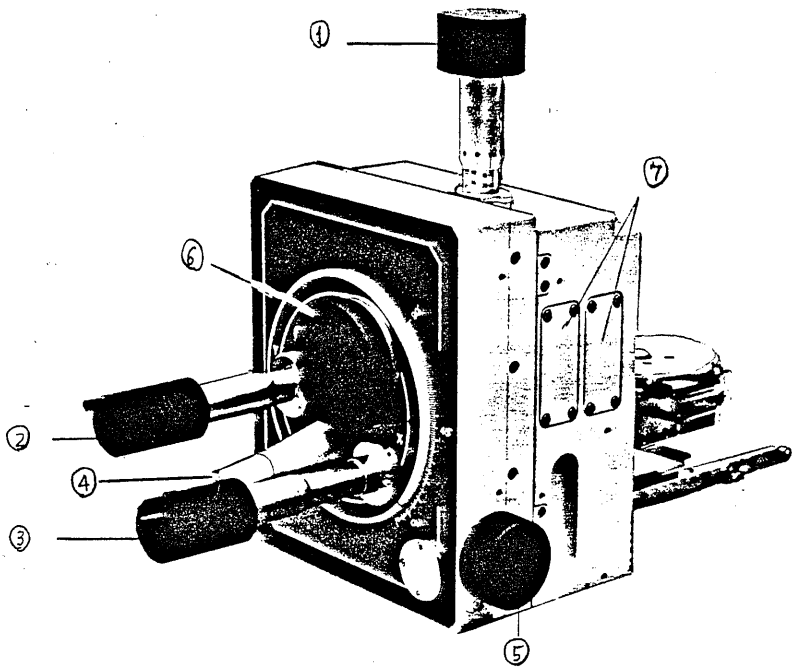


Fig. 2-2 LGS

① Z control: Sets up the working distance (WD).

② Y control: Moves in front/rear directions as seen from the specimen stage front.

③ R control: Rotates the specimen.

④ X control: Moves in right/left directions as seen from the specimen stage front (within the tilted frame at the time of tilt).

⑤ T control: Tilts the specimen.

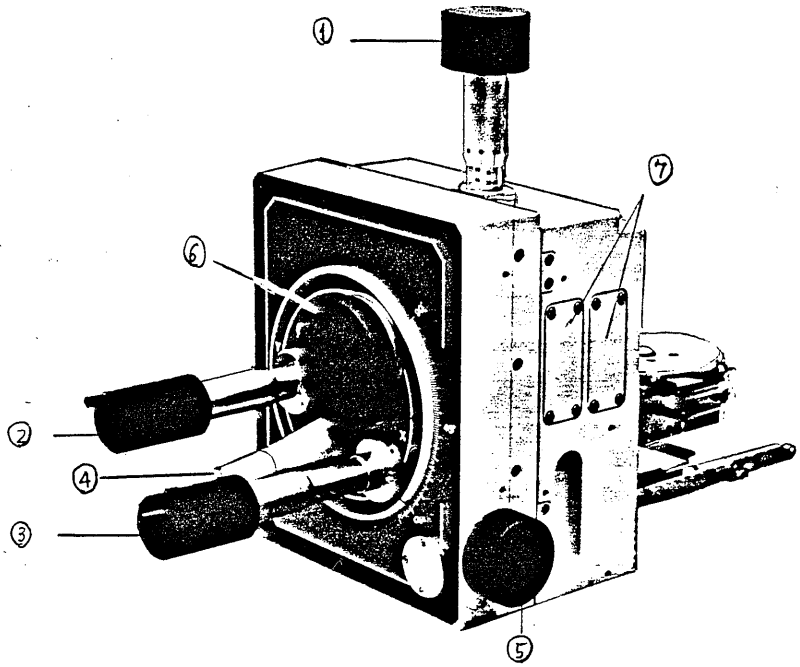


Fig. 2-2b

⑥ Viewing port: Window for viewing the specimen (AGS or ALC2 is optionally attachable.)

⑦ Attachment port: Connects the signal feed terminal for DMA and LGSHIC.

AGS : Additional Goniometer Stage
ALC2 : Airlock chamber
DMA : Digital microammeter
LGSHIC : IC Specimen Holder for LGS

2.2.2 Description of SGZ

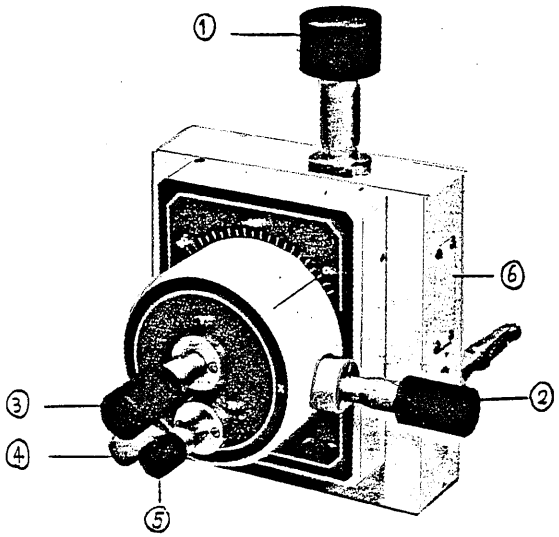


Fig. 2-3 SGZ

① Z control:	Sets up the working distance (WD).
② X control:	Moves in right/left directions as seen from the specimen stage front (within the tilted frame at the time of tilt).
③ Y control:	Moves in front/rear directions as seen from the specimen stage front.
④ T control:	Tilts the specimen.
⑤ R control:	Rotates the specimen.
⑥ Attachment port:	Connects the signal feed terminal for DMA and LGSHIC.

DMA : Digital microammeter

LGSHIC: IC Specimen Holder for LGS

2.3 Control Panel

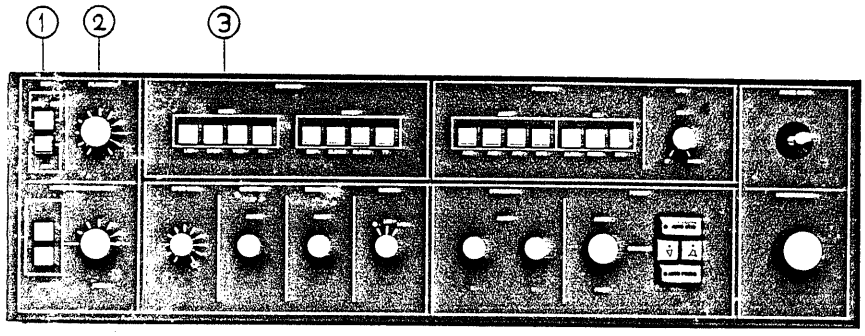


Fig. 2-4 Control Panel

① [DET] [SEI/BEI] : Selects the dector mode (LED lights).
[SEI] ; secondary electron image
[BEI] ; backscattered electron image

[HT] : Accelerating voltage (high) ON/OFF switch (LED lights at ON)

② [FILAMENT] : Controls the electron gun filament heating current.

Filament monitor lamp: The lamp lights if [FILAMENT] control is set at a position beyond 11 o'clock. If it does not light, the filament is burnt out.

③ [SCANNING]

[MODE] [LSP] : Line scan...for observation of signal waveforms (used for alignment, etc.)

[SPOT] : EOS scan is spot and CRT is frame scan (LED lights), used for X-ray analysis (spot analysis).

[YMD] : For Y-modulated images

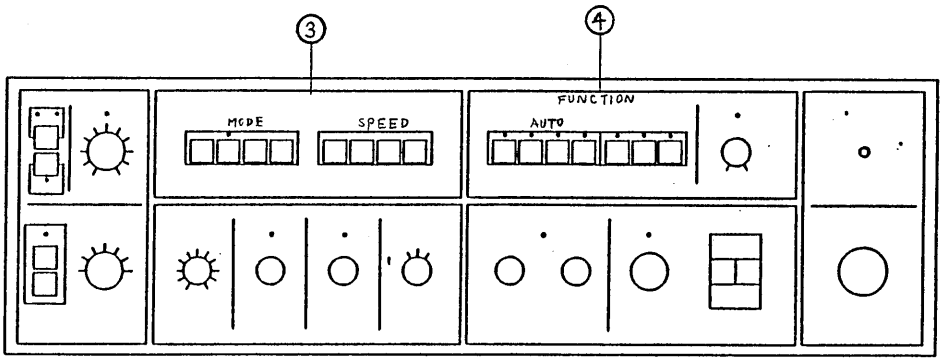


Fig. 2-4b

③ MODE PIC : For conventional images (select PIC once for TV mode changeover.)

SPEED EXP : For rapid exposure mode (in case of PIC)

SLOW1 : For observation and checking photo area (fast)

SLOW2 : For observation and checking photo ares (slow)

TV : For TV scan image (depress other SPEED switch for releasing it.)

④ FUNCTION : Set of Auto functions and OL conditions.

AUTO ACB : Automatic Contrast & Brightness Control (ACB) ON/OFF Switch ON (LED ON)

ASD : Automatic Astigmatism Correction Device (ASD) ON/OFF Switch ON (LED ON)

AFD : Automatic Focusing Device (AFD) ON/OFF Switch ON (LED ON)

AFT : Automatic Focus Tracer (AFT) ON/OFF Switch (At ON, LED ON)
The AFT works, when specimen height change causes defocus with the AFD ON.

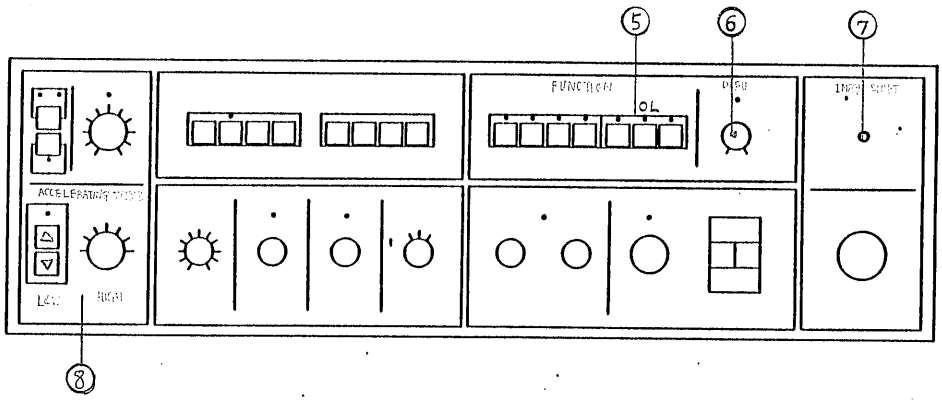


Fig. 2-4c

⑤ [OL] [ALIGN] : Focus Wobbler ON/OFF Siwtch; normal OFF
Turn ON when the objective aperture is to be aligned (TV mode). (At ON, LED ON)

[RESET] : Objective Lens Reset Switch
(At ON, LED ON : 2 sec.)

[DFU] : Tilt Correction ON/OFF Switch
(At ON, LED ON)

⑥ [DFU] : Dynamic Focus (Tilt Correction) Control

⑦ [IMAGE SHIFT] : Image Shift (Electromagnetic Imaging Field Fine Movement) Joystick

⑧ [ACCELERATING VOLTAGE] : Set the accelerating voltage

[HIGH] : Accelerating Voltage Changeover (kV);
Set to the fully counterclockwise position when the low accelerating range is used.

[LOW] : Low Accelerating Voltage Selection Switch
[△] UP (→ 3.0kV) [▽] DOWN (→ 0.5kV)
In changing low accelerating voltage to high accelerating voltage, turn the bias control fully in the clockwise direction in advance.

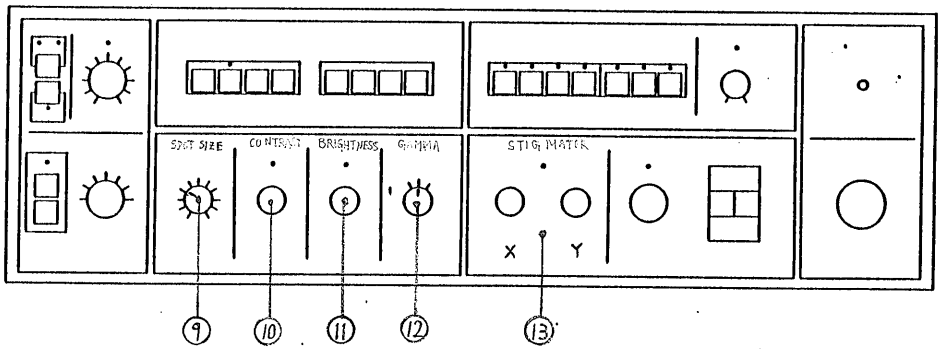


Fig. 2-4d

⑨ [SPOT SIZE] : Electron Probe Diameter Control

⑩ [CONTRAST] : Contrast Control
The LED lights up when the Automatic Contrast & Brightness Control (ACB) is ON.

⑪ [BRIGHTNESS] : Brightness Control
The LED lights up when the Automatic Contrast & Brightness Control (ACB) is ON.

⑫ [GAMMA] : Gamma Control; Normal [LIN]

⑬ [STIGMATOR] : Astigmatism Correction Device
(The LED flickers while the Automatic Astigmatism Correction Device is in operation.)

[X] · [Y] : Manual Correction Control
(If correction can not be made, reset the ASD.)

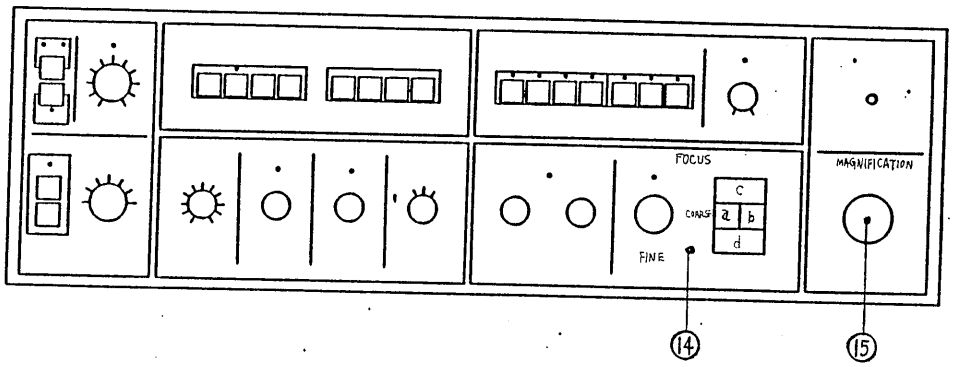


Fig. 2-4e

⑭ [FOCUS] : Focusing (The LED flickers while the AFD is in operation.)

[FINE] : Fine Control

a [COARSE] [▽] : Coarse Down Switch (MIN when the LED is ON.)

b [△] : Coarse Up Switch (MAX when the LED is ON.)

c [AUTO STIG] : Automatic Astigmatism Correction Device (ASD) Start Switch
When the ASD is ON, the device is started by pressing the switch once.
When the AFD is ON, the ASD and the AFD are also started by pressing the switch

d [AUTO FOCUS] : Automatic Focusing Device (AFD) Start Switch
When the AFD is ON, the device is started by pressing the switch once.

⑮ [MAGNIFICATION] : Magnification Changeover Knob

2.4 Display Panel

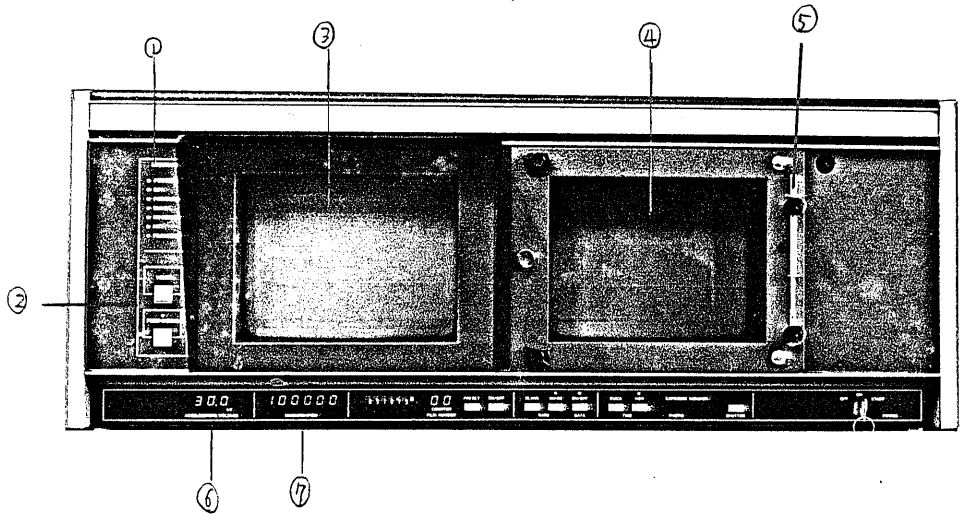


Fig. 2-5 Display Panel

①	SEQUENCE :	Indicates the vacuum sequence.
②	Vacuum control switch:	Controls the vacuum system.
	VENT :	Column and specimen chamber reach atmospheric pressure (admit air).
	PUMP DOWN :	Evacuates the column and specimen chamber to vacuum.
③	Viewing CRT:	For observation, focusing and ensuring the visual field.
④	Recording CRT:	(Option; PRD1)*
⑤	Camera for Scanning Image (CSI) mounting pin:	Mount the camera (CSI) as usual.
⑥	ACCELERATING VOLTAGE :	Indicates the current accelerating voltage in kV.
⑦	MAGNIFICATION :	Displays magnification (magnification may be erroneous when it flickers).

*PRD2/T220-UHR is standalone type(option).

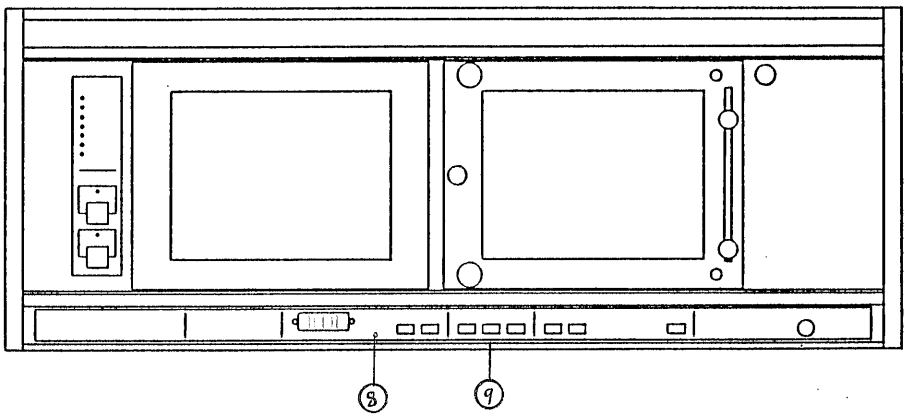


Fig. 2-5b

⑧ [FILM NUMBER] : Sets up the film number on digital switch and/or counter.

[COUNTER] : Automatically counts and displays the current film number (at counter ON)

[PRESET] : Film counter is set to the last two digits at digital switch by pressing this switch when counter is at ON.

[ON/OFF] : Turns the counter ON/OFF. At ON, 2 digits at the right of film number automatically counts at each photographing.

⑨ [BASE] [BLANK] : The background of data on photos is in black at ON.

[IMAGE] : The background of data on photos is in the image.

[DATA] [ON/OFF] : The data such as accelerating voltage, film number and micron marker are recorded at on photos when it is set to ON.

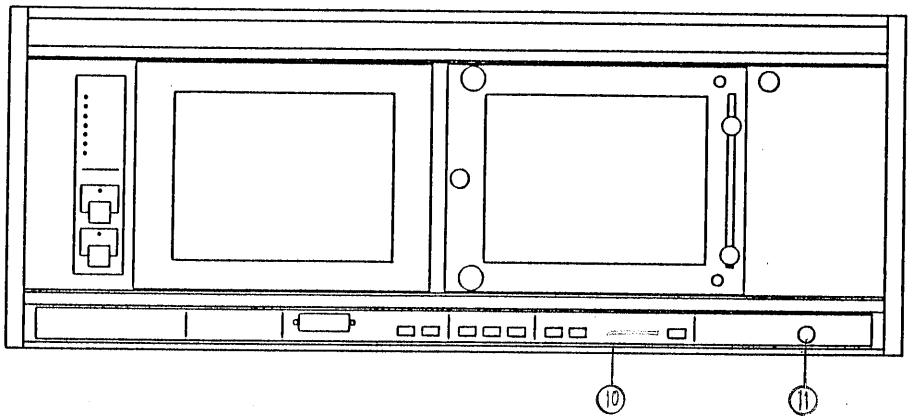


Fig. 2-5c

⑩ [PHOTO] [TIME] [QUICK] : For photographing quickly (36 sec: 50Hz, 30 sec: 60Hz)

[NOR] : For normal photographing (90 sec: 50Hz, 75 sec: 60Hz)

[EXPOSURE MONITOR] : All LEDs light at start of photography and each LED goes out in turn and all LEDs go out upon completion of photography.

[SHUTTER] : Auto shutter

⑪ [POWER] : Power key switch (turn to [START] at the startup)

2.5 Chacker Panel

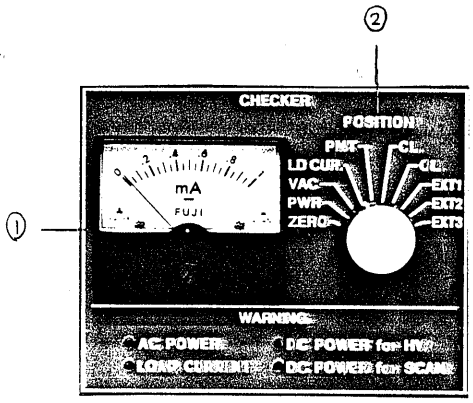


Fig. 2-6 Checker Panel

1. Manual Checker: For manual checkup

① Meter

② [POSITION] : Selects the checkup point.

[ZERO] : Adjusts zero point.

[PWR] : Supply power voltage (read 1 = 200V)

[VAC] : Vacuum gauge

[LD CUR.] : Load current of filament (read 1 = 200μA)

[PMT] : Applied voltage for photomultiplier tube (PMT) (read 1 = 2kV)

[CL] : Condenser lens current (read 1 = 2A)

[OL] : Objective lens current (read 1 = 2A)

[EXT1] ~ [EXT3] : For attachment (read 1 = 1mA)

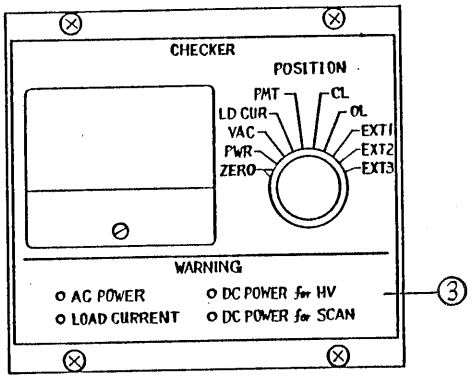


Fig. 2-6b

2. Auto Checker: For automatic checkup

③ WARNING : LED flickers if any one of following 4 items is in trouble.

AC POWER : 100VAC power supply fluctuates beyond ±10%.

LOAD CURRENT : Load currents of filament exceeds 0.75(150μA).

DC POWER for HT : High voltage power supply fluctuates beyond ±10%.

DC POWER for SCAN : Power supply for scanning system fluctuates beyond ±10%.

2.6 Rear Panel

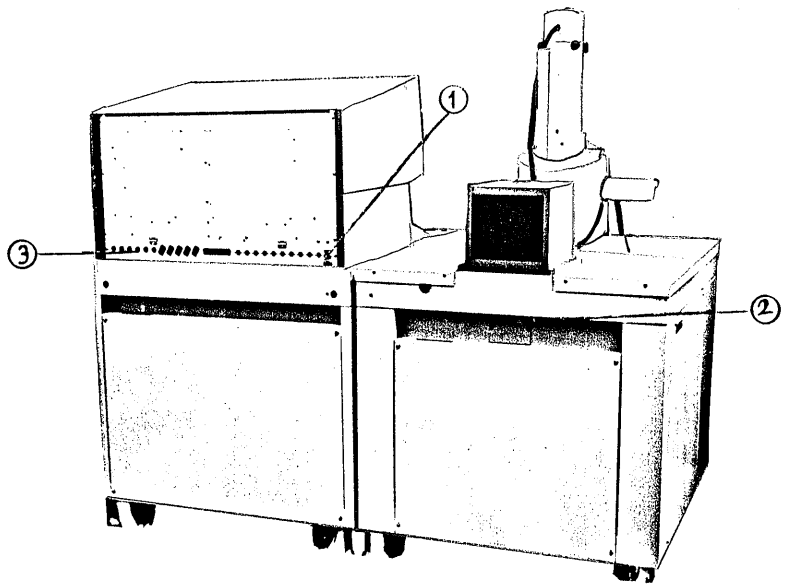


Fig. 2-7 Rear Panel

① TV signal output terminal: BNC-R connector
② Liquid nitrogen baffle
(LNB, optional) mounting
position
③ Connector port for several attachments

CHAPTER 3 OPERATION

3.1 Outline of Operating Procedure

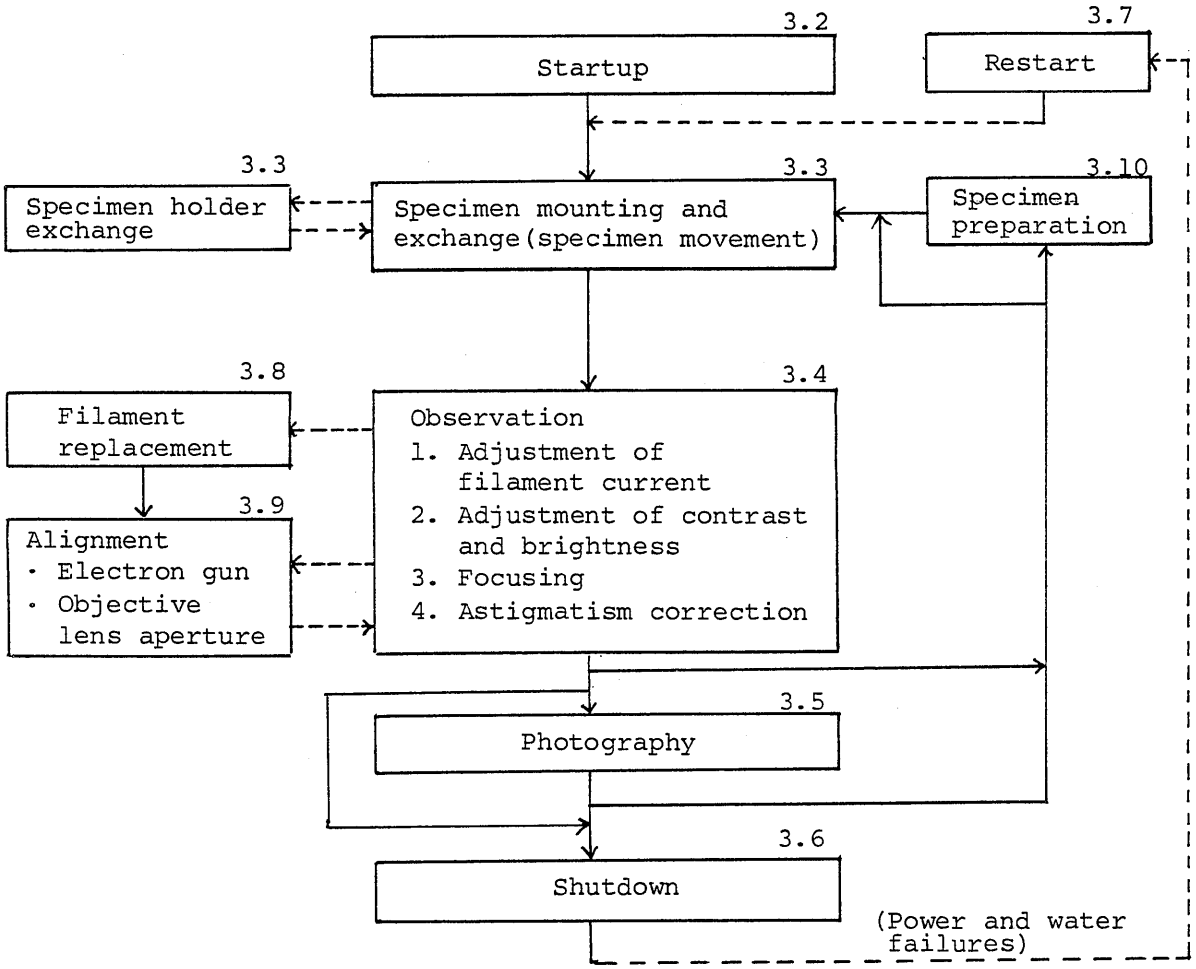


Fig. 3.1-1 Operating Procedure

——→ Routine operation

- - - - - - -→ As required

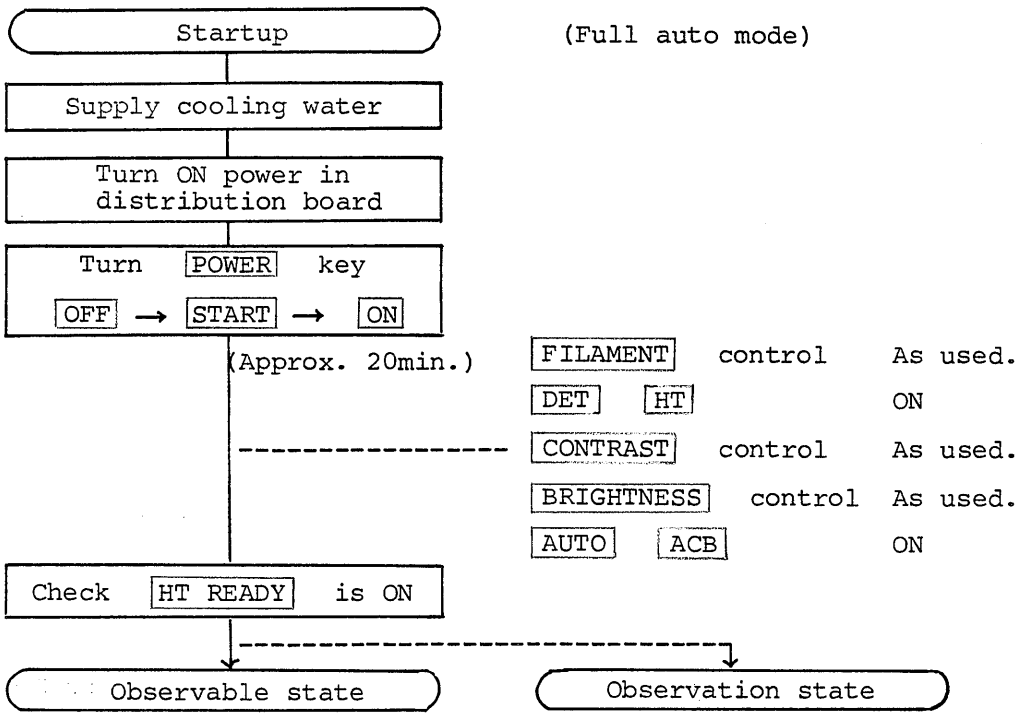
Note 1. When mounting the Camera for Scanning Image (CSI), be sure to install it prior to startup.

2. When mounting the attachments (especially for mounting and exchanging the specimen), please refer to each respective instruction manual for them.

COMMENTS

Full Auto (mode):	If the switches and controls are set before starting the scanning microscopy, focused image is obtained automatically.
AFT (mode):	Automatic focusing is performed after automatic detection of defocus caused by specimen height (WD)/accelerating voltage change.
Working distance (WD):	Distance between the Objective Lens lower pole and the specimen surface. WD is related to specimen movement range.

3.2 Startup



1. Turn on the tap to supply cooling water. Set the flow rate to around 1.5 ~ 2 ℓ/min.
   Note: The flow rate exceeding 2 ℓ/min may cause excessive cooling of the oil diffusion pump (DP) or vibration.
2. Turn ON the distribution board switch and insert the key into the [POWER] switch located at the right-hand bottom of the display panel. Turn the key fully to the [START] and release it (returns to [ON] .) The power display lamp of the sequence indicator on the left side of the display panel lights up and the oil rotary pump starts to rotate.

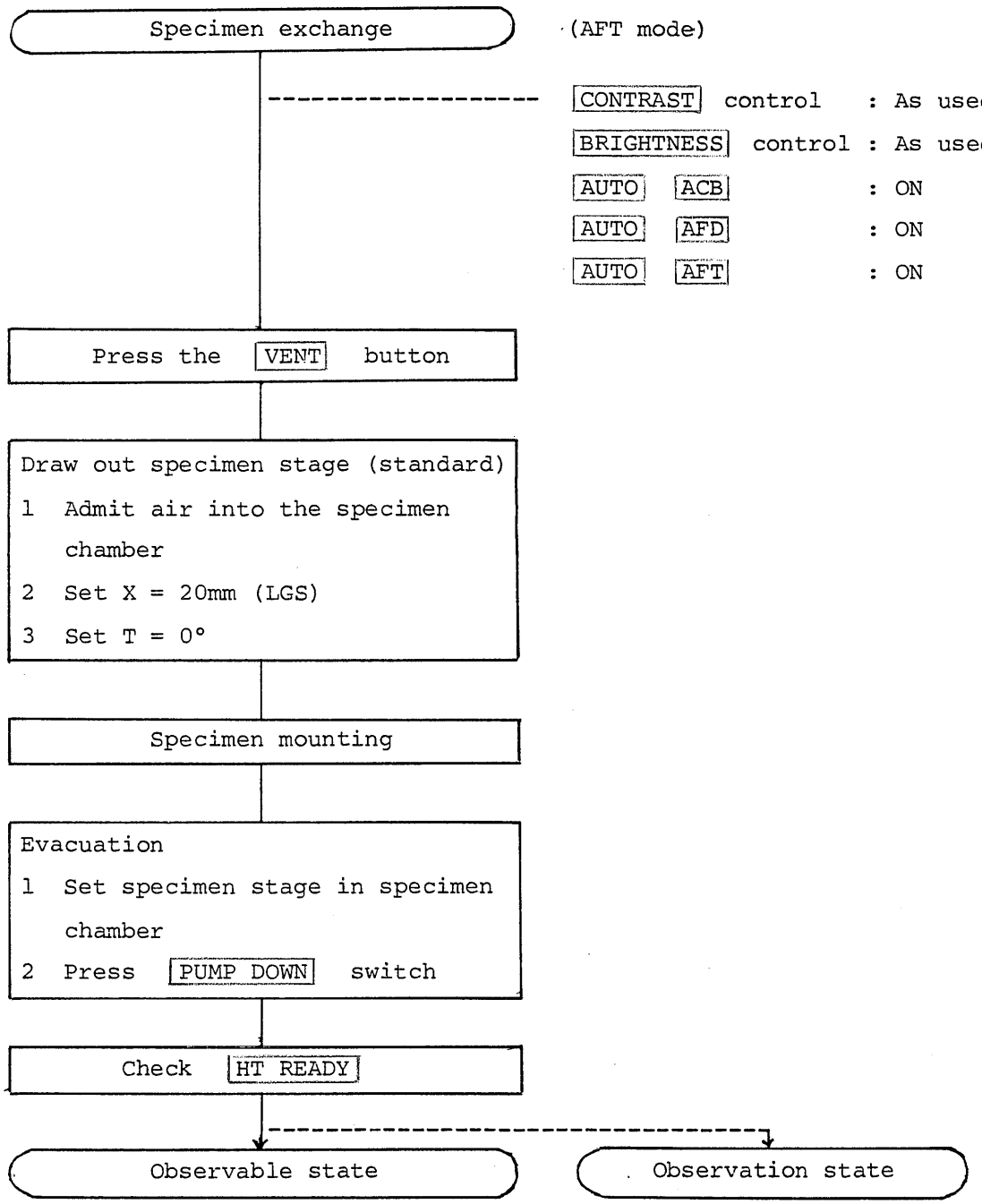
3. When all the operations are to be done automatically upto image observation with the full auto function, make the settings as follows. However, proceed to step 4 if they are set in stop operation.

[SEI] / [BEI]	Switch:	[SEI] ON (LED ON)
[HT]	Switch:	ON (LED ON)
[FILAMENT]	Control:	As used
[SPOT SIZE]	Control:	10~12 O'clock position
[CONTRAST]	Control:	As used
[BRIGHTNESS]	Control:	As used
[AUTO] [AFD]	:	ON (LED ON)
[AUTO] [ASD]		ON (LED ON)
[AUTO] [ACB]		ON (LED ON)

4. After pressing [MODE] [PIC] , press [SPEED] [TV] .
5. The microscope is automatically evacuated and the [SEQUENCE] [HT READY] light up in 15 to 30 min to make observation possible. (In the full auto mode, image is also focused.)

3.3 Specimen Mounting And Exchange/Specimen Movement

3.3.1 Specimen mounting and exchange



1. For auto focusing in the AFT mode, make the settings as follows.
   [AUTO] [ACB] ON, [AUTO] [AFD] · [AFT] ON (LED ON)
   Note: the [CONTRAST] and [BRIGHTNESS] controls are at the working positions.
2. Press the [VENT] button.
3. When the specimen chamber reaches atmospheric pressure in approx. 40 sec, set X = 20mm and T = 0°, then draw out the specimen stage.
4. Choose suitable specimen holders (refer to Fig. 3.3-1 and 3.3-6).
5. Fix the specimen to the specimen holders with fixing screws at a height suitable for observation.
   · 10mm dia./32mm dia. specimen holders.....Specimen holder rim top
   · 51mm dia./76mm dia. specimen holders (LGSHL; optional)
   .....Specimen holder rim top
   · IC wafer mount (LGSHW; optional) .....No adjustable type
   Notes: 1. In using specimen holders, refer to their instruction manuals.
   2. A specified magnification can be obtained with the Automatic Magnification Corrector without adjusting height; but encentric tilt, in this case, is not available.
6. Set the specimen stage in the specimen chamber and evacuate the chamber by pressing the vacuum control button [PUMP DOWN] .
7. In about 3 min, the [SEQUENCE] [HT READY] light up to indicate the microscope is ready for observation of images.
8. In the AFT mode, focused images appear.
   Note: If porous specimens or gassy specimens are mounted and when the wavelength dispensive X-ray spectrometer is used, evacuation may take more time.

3.3.2 Specimen mounting and specimen movement ranges for LGS

1. Specimen Mounting

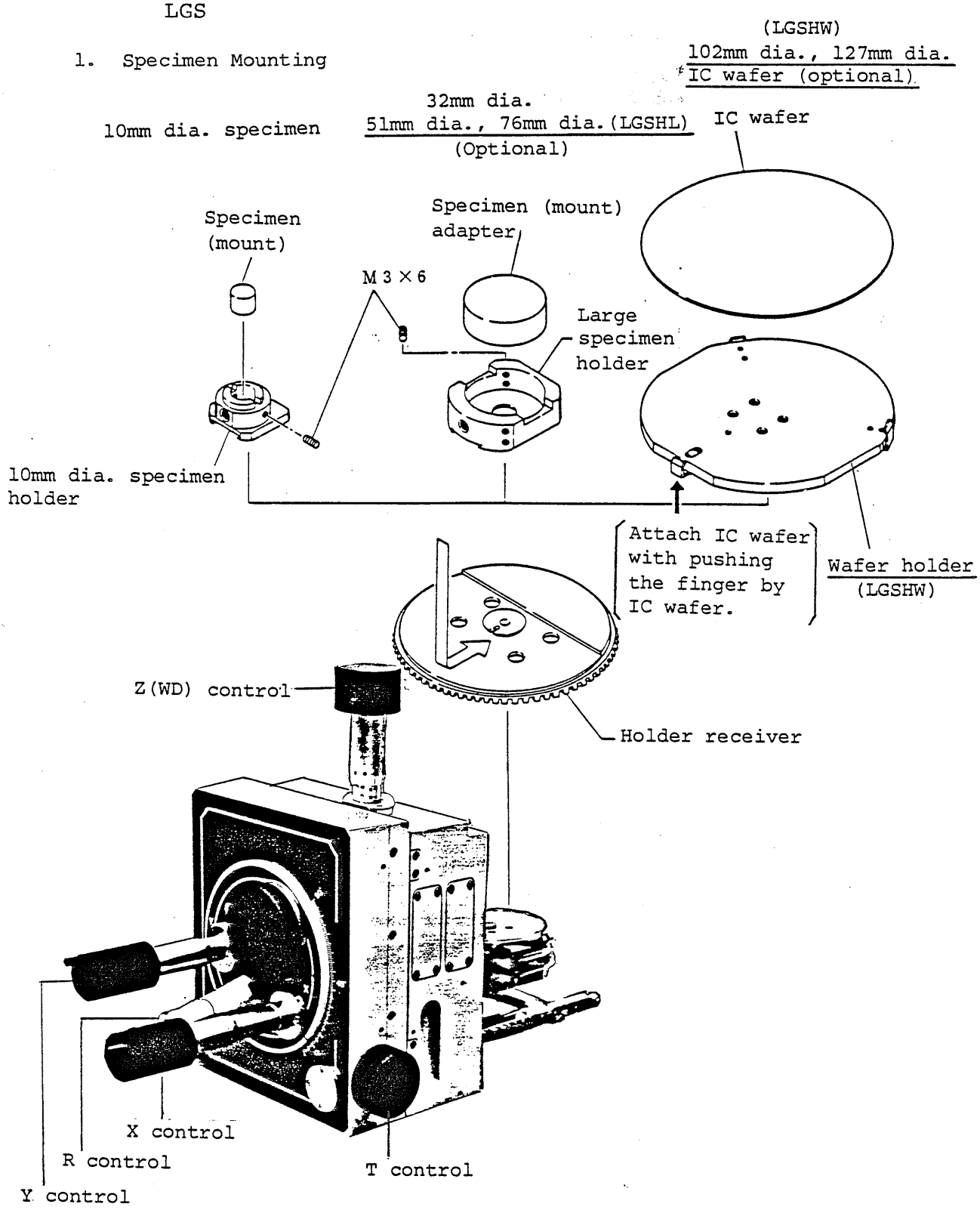


Fig. 3.3-1 Specimen Mounting (LGS)

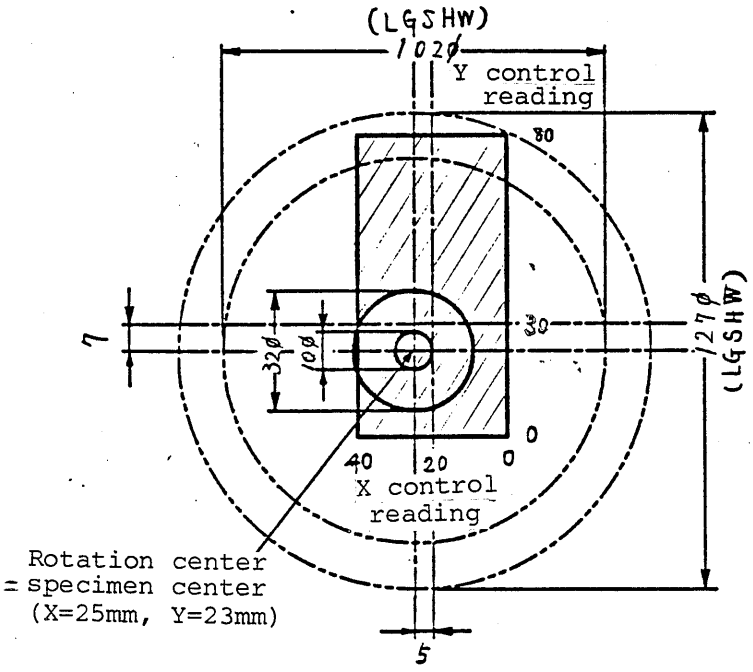
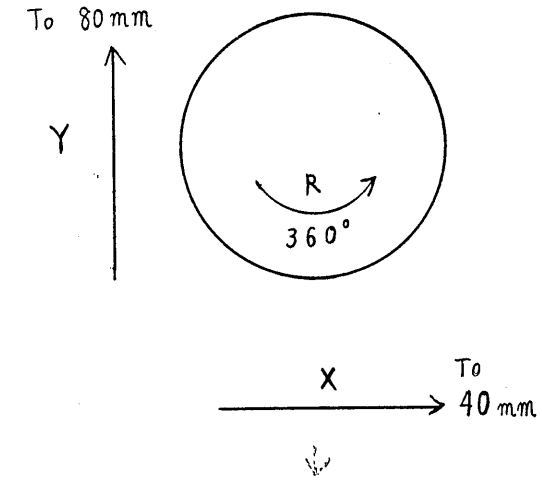


Fig. 3.3-2 Specimen Position (LGS)

Specimen and readings are corresponded as above.
Here, specimen holder (LGSHW) for 102mm dia. and 127mm dia. specimens is optional.

2. Specimen Movement (LGS)



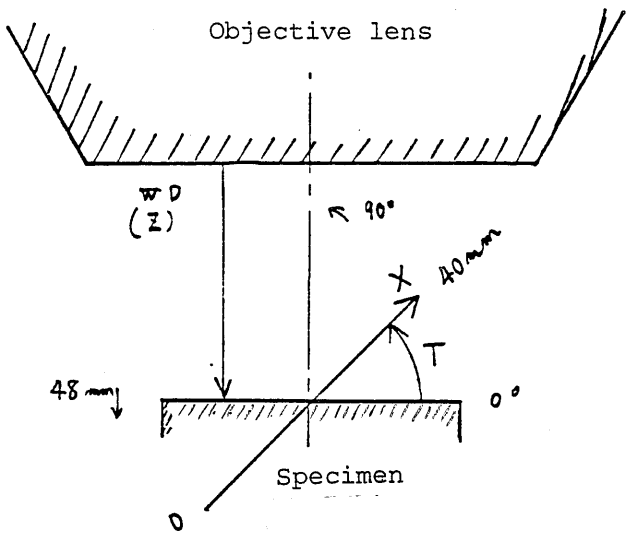


Fig. 3.3-3 Relation of Specimen Movement Direction with Its Tilt

In eucentric type, the specimen moves toward X inside the tilted frame. Accordingly, note carefully that X movement corresponds to Z movement direction at 90° tilt.

When the X control reading is 0mm, observation point is right-side on the specimen (view from above the specimen).

3. Specimen Movement Range

① Specimen movement range in 10mm dia. specimen for LGS
(Relation between WD (working distance) and specimen position.)

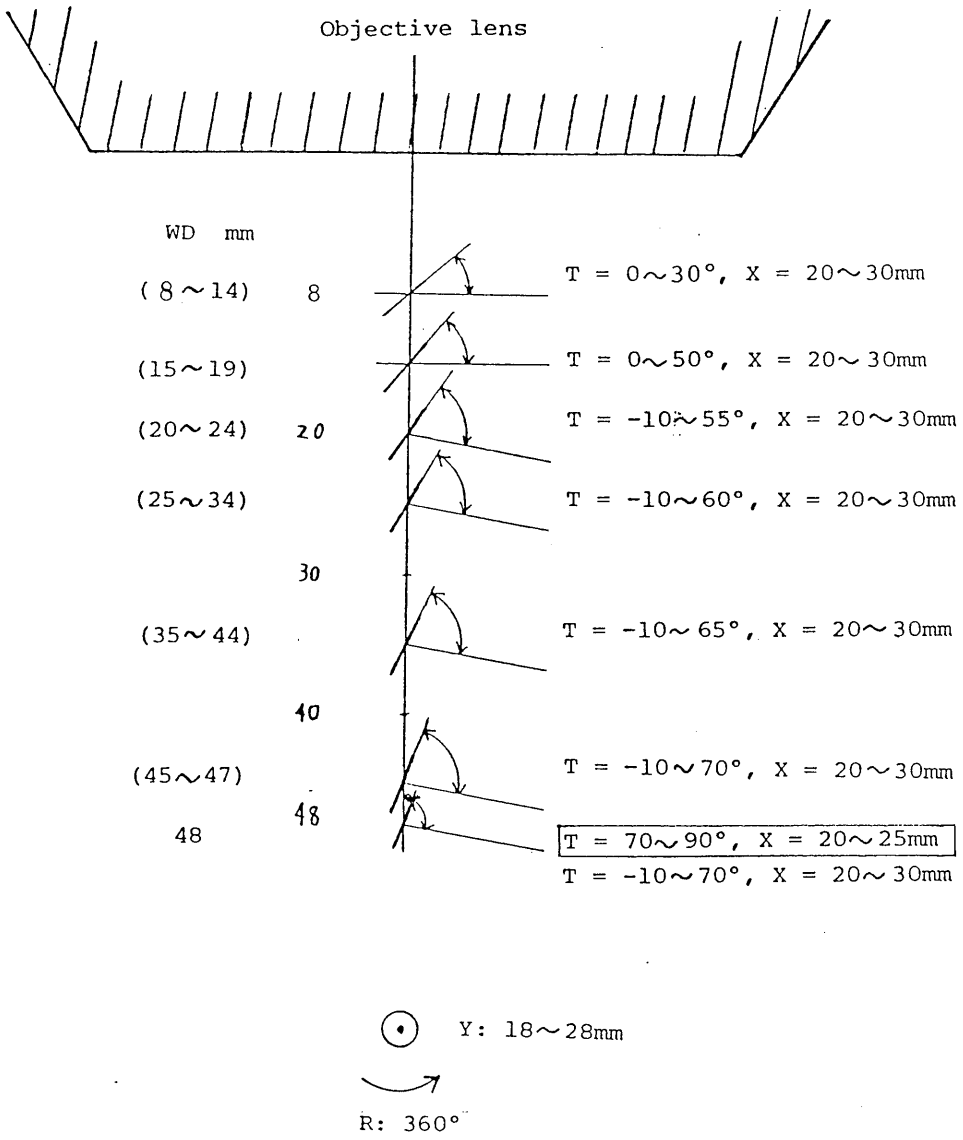
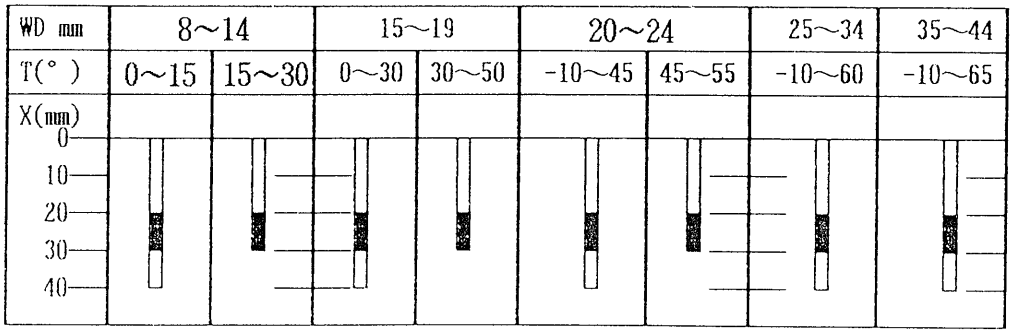
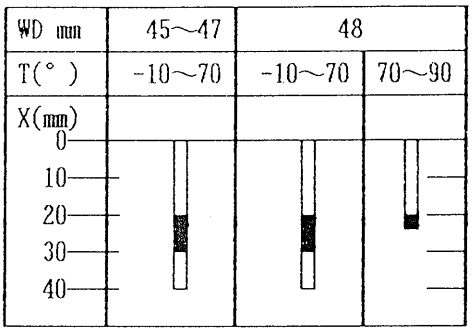


Fig. 3.3-4 Specimen Movement Range
(LGS, 10mm dia. specimen)

10mm dia. specimen for LGS: Y movement 10～80mm
(observable range 18～28mm), R movement at 360°



□ shows specimen movement range, ■ shows specimen observable range.



Mount and move the specimen within the above specimen movement range.

② Specimen movement range in 32mm dia. specimen for LGS
(Relation between WD (working distance) and specimen position.)

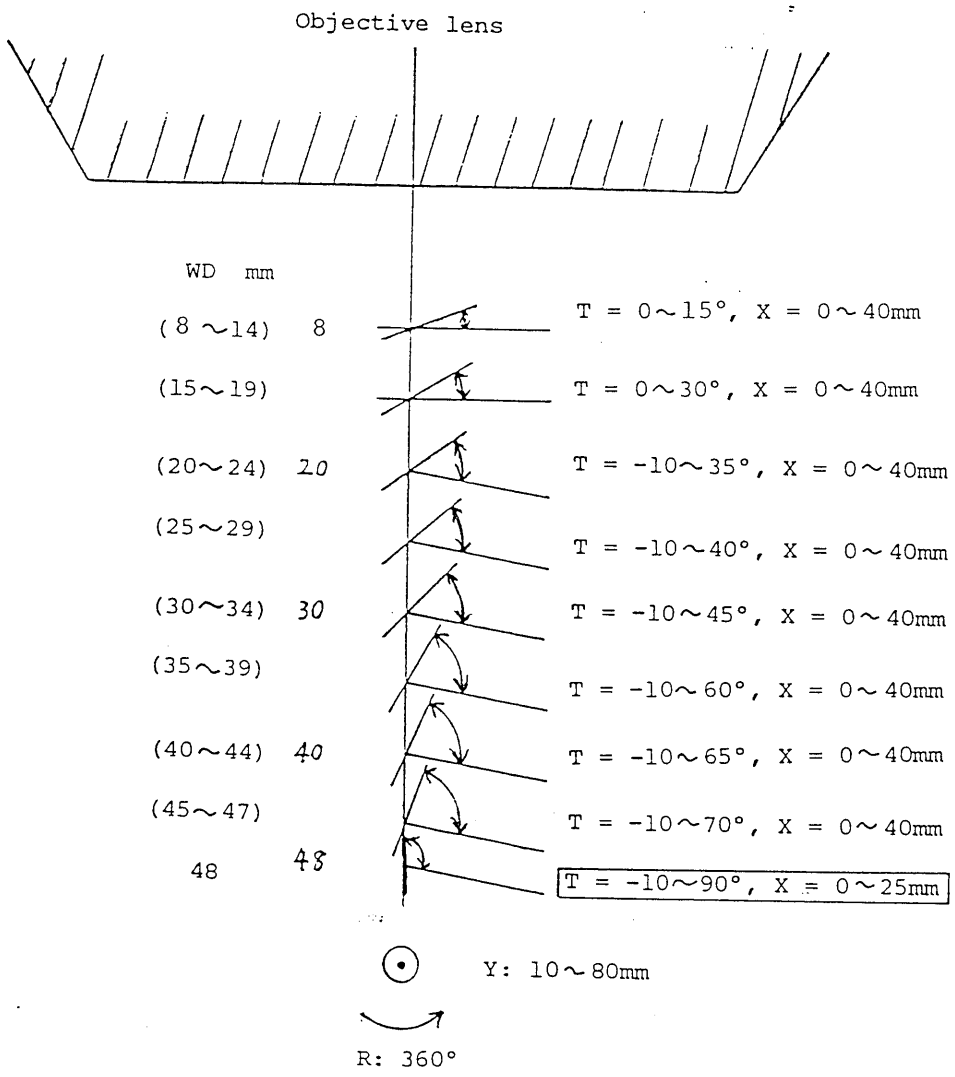


Fig. 3.3-5 Specimen Movement Range
(LGS, 32mm dia. specimen)

32mm dia. specimen for LGS: Y movement 10～80mm, R movement at 360°

WD mm	10～14	15～19	20～24	25～29	30～34	35～39	40～44
T(°)	0～20	0～30	-10～35	-10～40	-10～45	-10～60	-10～65
X(mm) 0							
10	■	■	■	■	■	■	■
20	■	■	■	■	■	■	■
30	■	■	■	■	■	■	■
40	■	■	■	■	■	■	■

■ shows specimen observable range.

WD mm	45～47	48
T(°)	-10～70	-10～90
X(mm) 0		
10	■	■
20	■	■
30	■	
40	■	

Mount and move the specimen within the above specimen movable range.

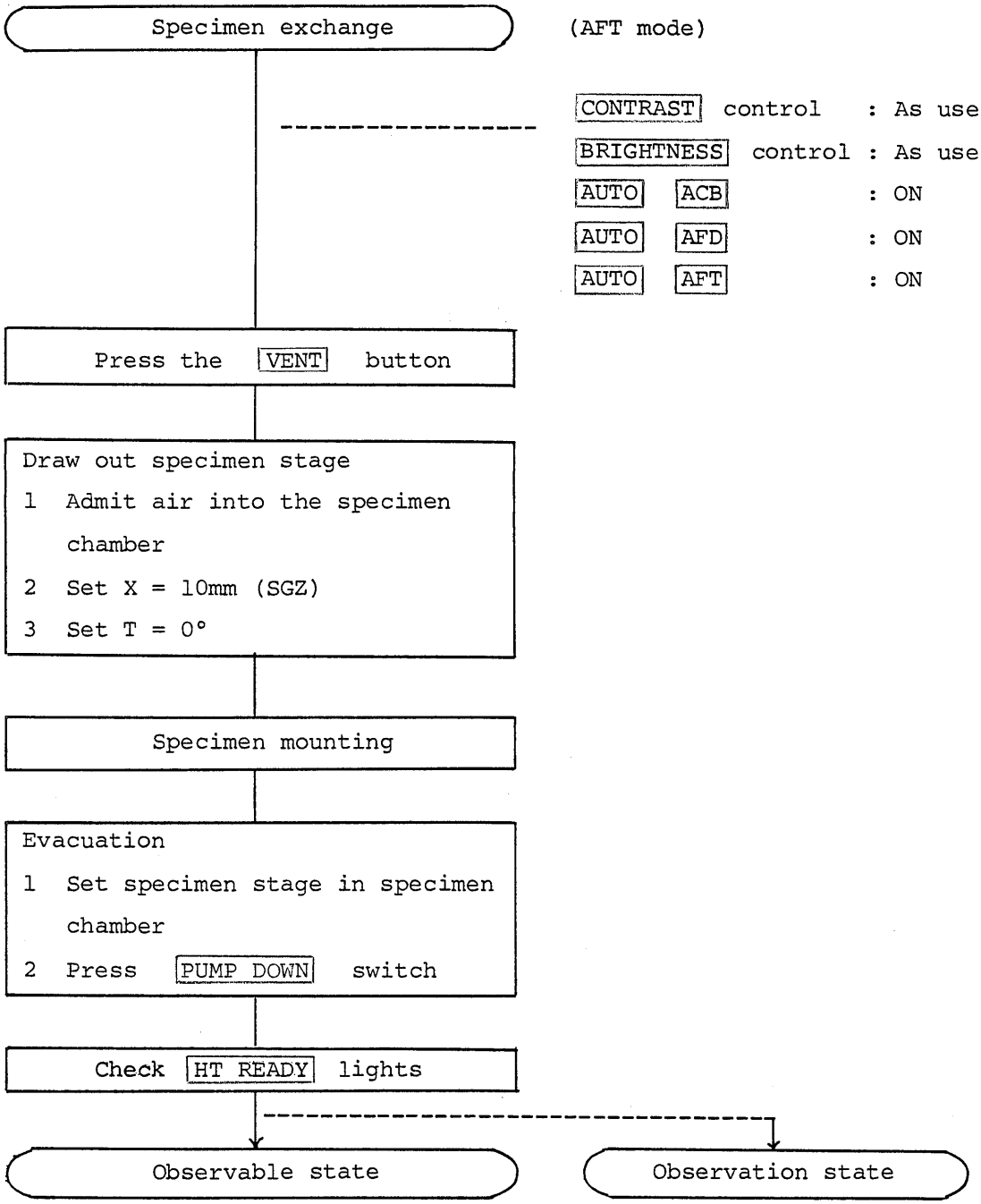
To change WD limited in X movement; set the X control within the specimen movement range and change WD in purpose.

Example: Changing WD (WD 45mm to 48mm)

① Set the X control at 0～25mm.

② Change WD to 48mm by Z control.

3.3.3 Specimen mounting and specimen movement ranges for SGZ



1. For auto focusing in the AFT mode, make the settings as follow.
   [AUTO] [ACB] ON, [AUTO] [AFD] · [AFT] ON (LED ON)
   Note: The [CONTRAST] and [BRIGHTNESS] controls are at the working positions.
2. Press the [VENT] button.
3. When the specimen chamber reaches atmospheric pressure in approx. 40 sec, set X = 10mm and T = 0°, then draw out the specimen stage.
4. Select the suitable specimen holders (refer to Fig. 3.3-6).
5. Fix the specimen to the specimen holders with fixing screws at a height suitable for observation.
   - 10mm dia./32mm dia. specimen holders....Specimen holder rim top
   - 51mm dia. specimen holder (SGZSHL; optional) .....Specimen holder rim top
   - IC wafer mount (SGZSHW; optional) .....No adjustable type

   Notes: 1. In using specimen holders, refer to their instruction manuals.
   2. A specified magnification can be obtained with the Automatic Magnification Corrector without adjusting height; but encentric tilt, in this case, is not available.
6. Set the specimen stage in the specimen chamber and evacuate the chamber by pressing the vacuum control button [PUMP DOWN] .
7. In about 3 min, the [SEQUENCE] [HT READY] light up to indicate the microscope is ready for observation of images.
8. In the AFT mode, focused images appear.
   Note: If porous specimens or gassy specimens are mounted and when the wavelength dispersive X-ray spectrometer is used, evacuation may take more time.

1. Specimen Mounting (SGZ)

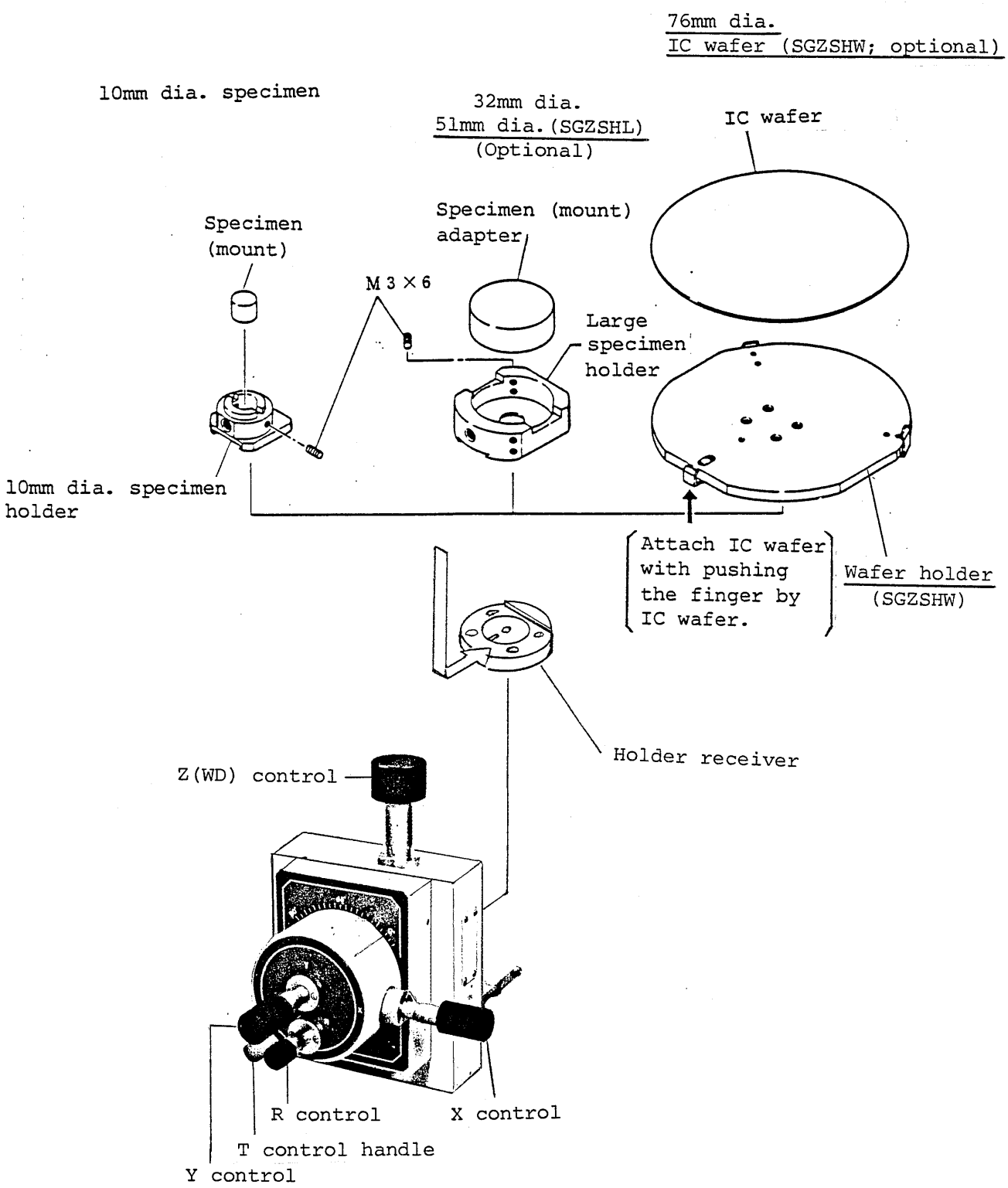


Fig. 3.3-6 Specimen Mounting (SGZ)

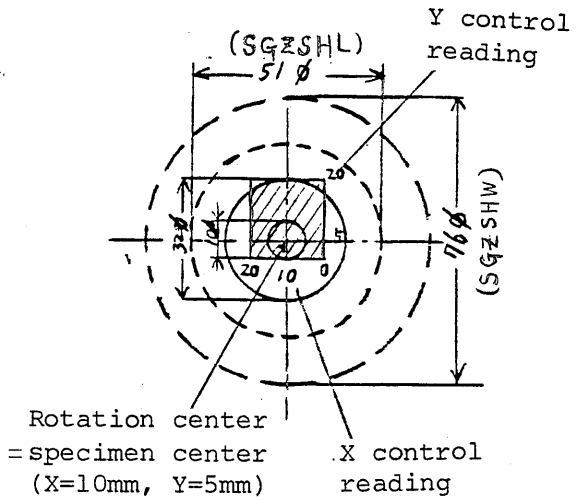


Fig. 3.3-7 Specimen Position (SGZ)

Specimen and readings are corresponded as above.
Here, specimen holder for 51mm dia. specimen (SGZSHL) and 76mm dia. specimen (SGZSHW) is optional.

2. Specimen Movement (SGZ)

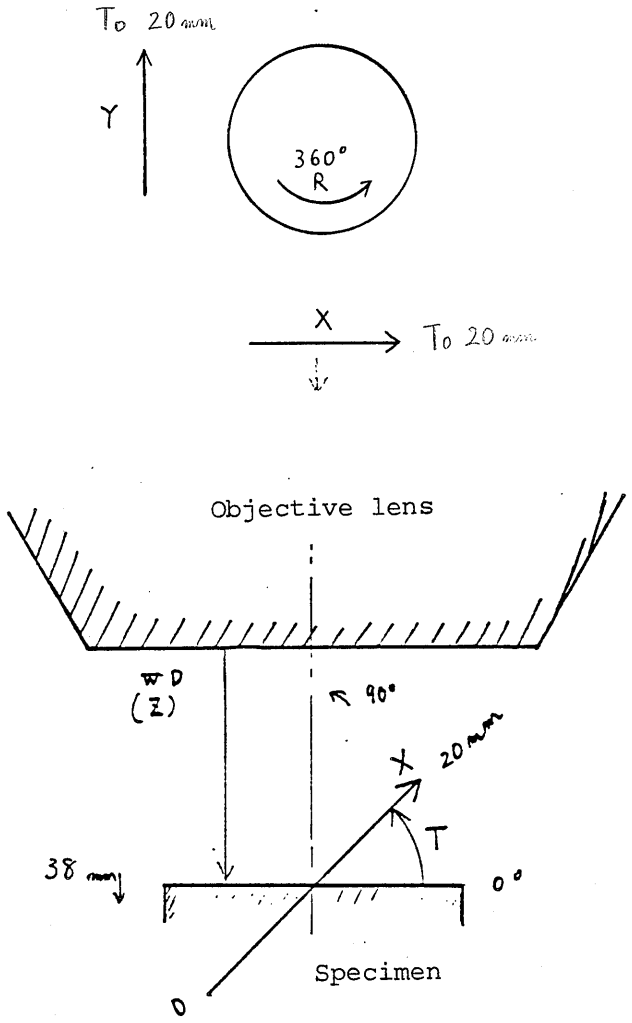


Fig. 3.3-8 Relation of Specimen Movement Direction with Its Tilt

In eucentric type, the specimen moves toward X inside the tilted frame. Accordingly, note carefully that X movement corresponds to Z movement direction at 90° tilt.

3. Specimen Movement Range

① Specimen movement range in 10mm dia. specimen for SGZ
(Relation between WD (working distance) and specimen position.)

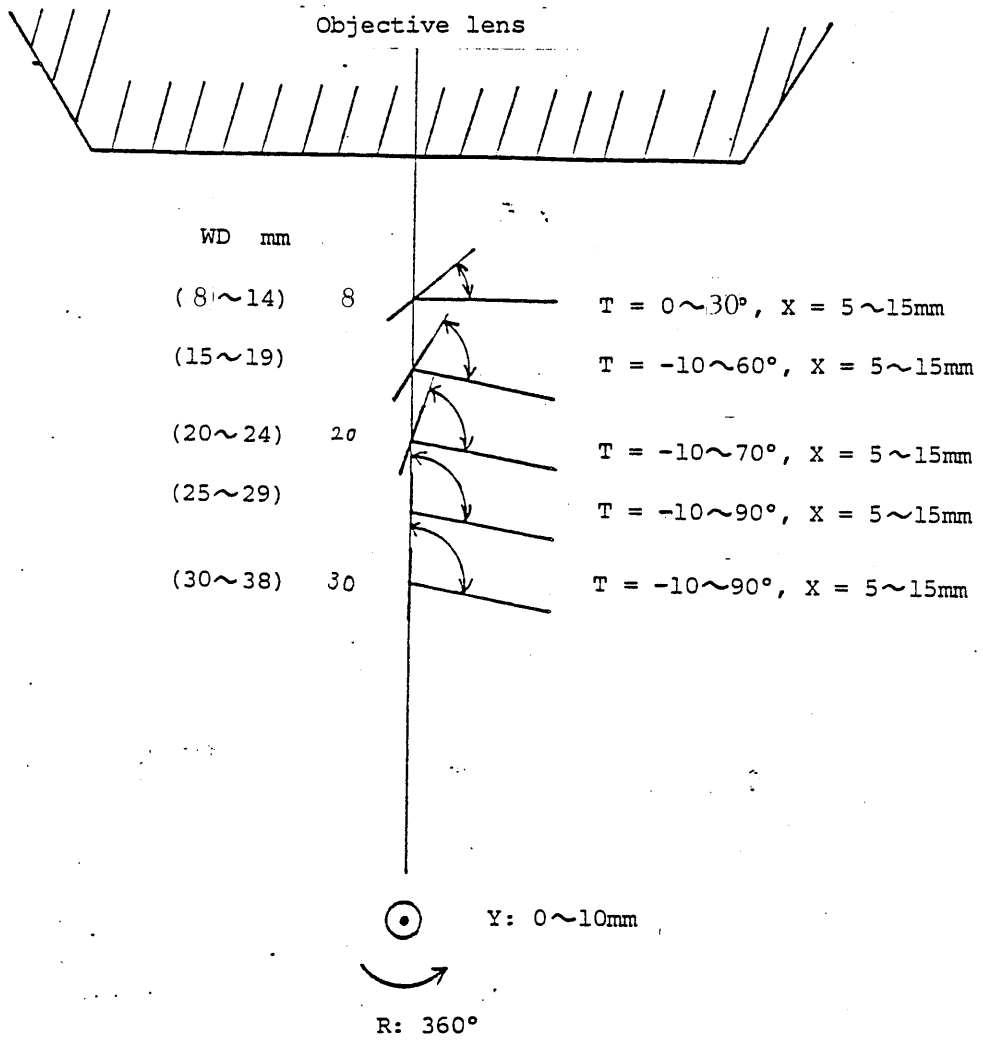


Fig. 3.3-9 Specimen Movement Range
(SGZ, 10mm dia. specimen)

10mm dia. specimen for SGZ: Y movement 0～20mm
(observable range 5～15mm), R movement at 360°

WD mm	8～14		15～19		20 ～24		25 ～29		30～38
T(°)	0～15	15～30	-10～45	45～60	-10～60	60～70	-10～70	70～90	-10～90
X(mm)									
0									
10									
20									

□shows specimen movement range, ■shows specimen observable range.

Mount and move the specimen within the above specimen movement range.

② Specimen movement range in 32mm dia. specimen for SGZ
(Relation between WD (working distance) and specimen position.)

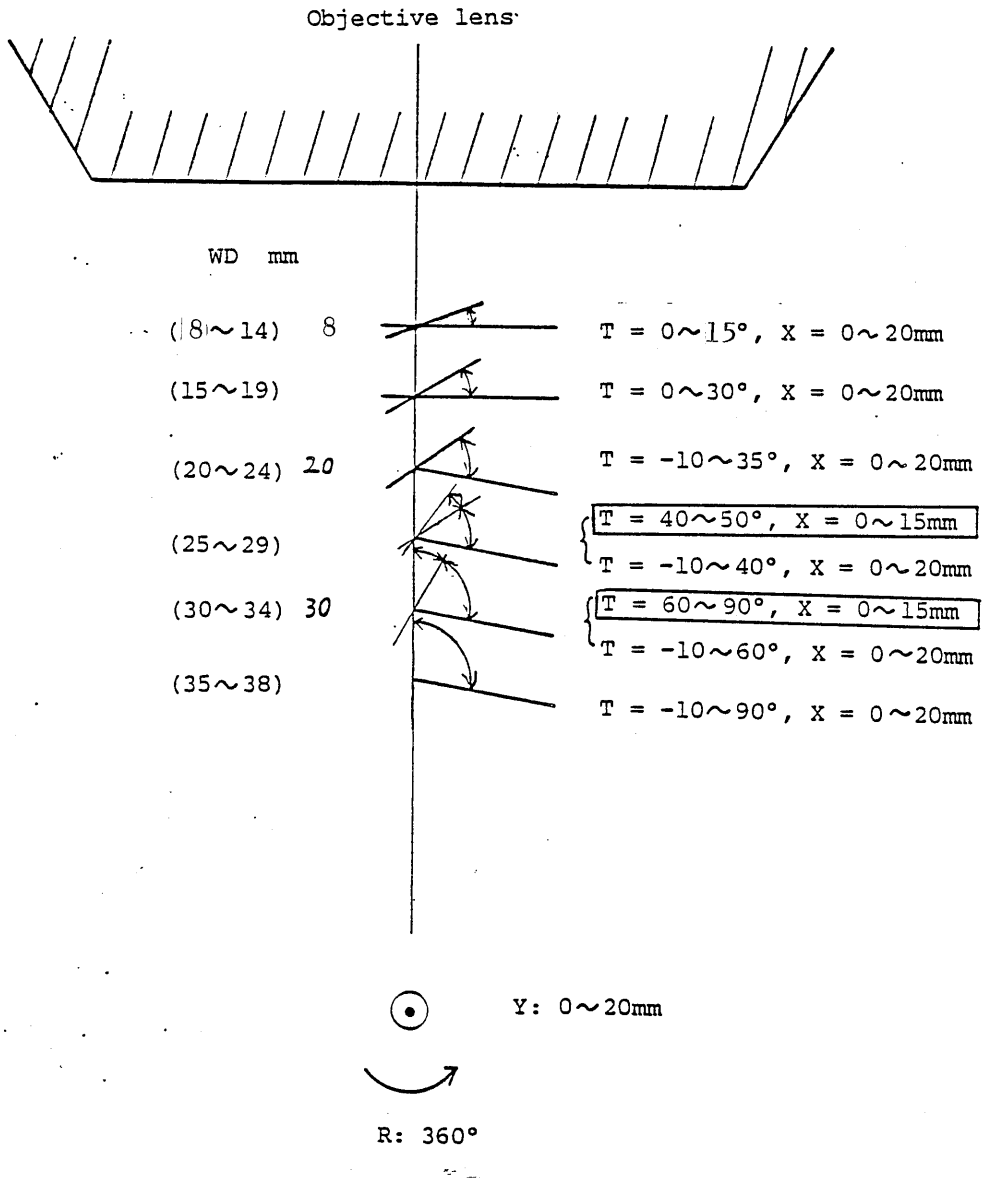


Fig. 3.3-10 Specimen Movement Range
(SGZ, 32mm dia. specimen)

32mm dia. specimen for SGZ: Y movement 0∼20mm, R movement at 360°

WD mm	8∼14	15∼19	20∼24	25∼29		30∼34		35∼38
T(°)	0∼15	0∼30	-10∼35	-10∼40	40∼50	-10∼60	60∼90	-10∼90
X(mm) 0								
10								
20								

■ shows specimen observable range.

Mount and move the specimen within the above specimen movement range.

To change WD limited in X movement or tilt; ( ) for tilt

Set the X(T) control within the specimen movement range and change WD in purpose.

Ex. Changing from T = 60°, WD = 38mm to T = 45°, WD = 25mm.

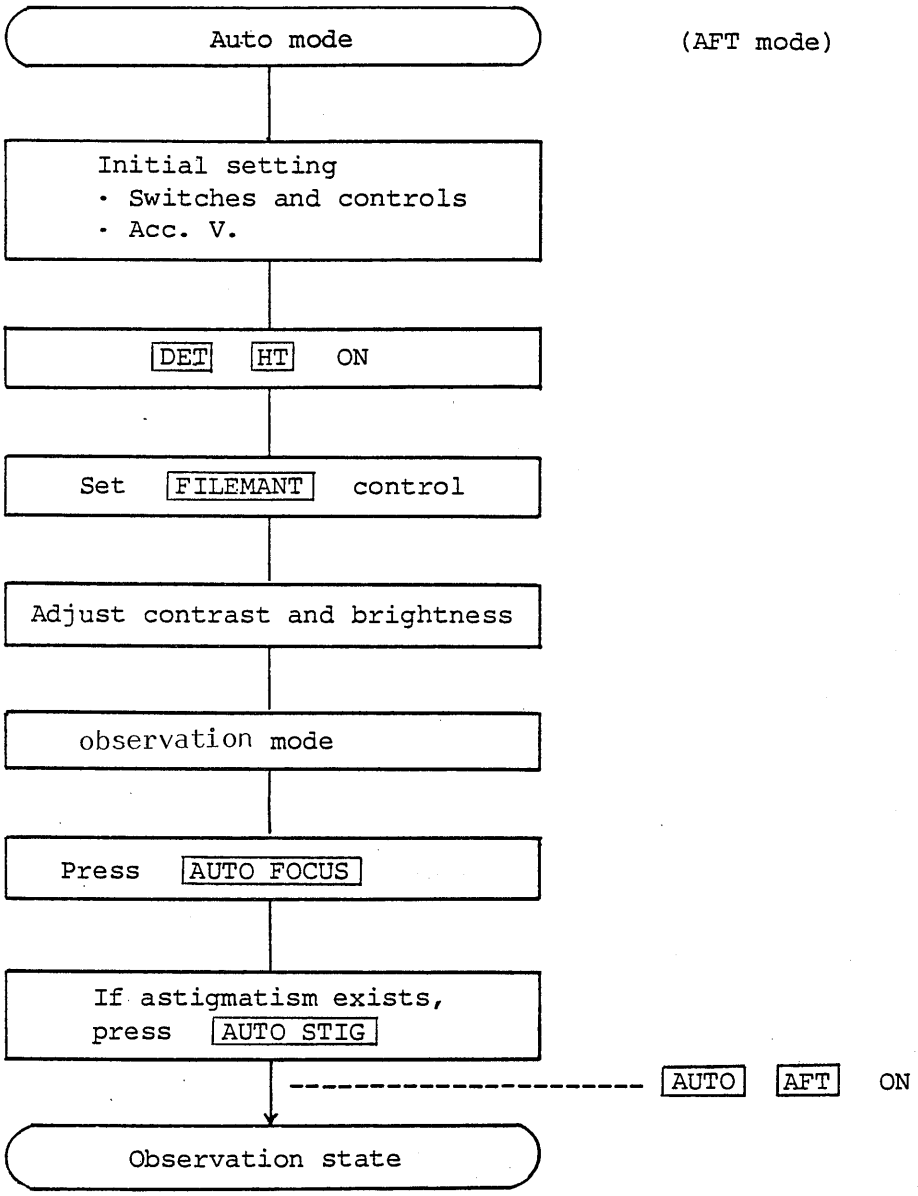
① Set the T control to 45°.

② Set the X control at 0∼15mm.

③ Change WD to 25mm by Z control.

3.4 Observation

3.4.1 Auto mode operation



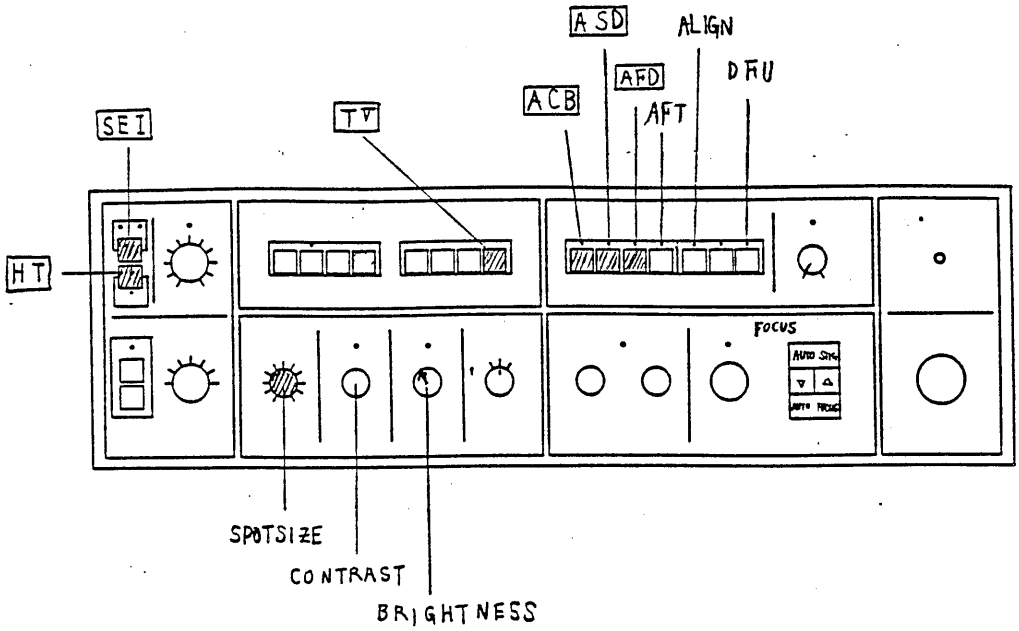


Fig. 3.4-1

1. Initial settings

When the settings are made as follows, images are easily obtained. (Others are as desired.)

[SEI] : Secondary electron image / [BEI] : Backscattered electron image

[DET] [HT] switch:	OFF (LED OFF)
[SPOT SIZE] control:	12～3 O'clock position
[CONTRAST] control:	Around the center position
[BRIGHTNESS] control:	11 O'clock position
[MODE] [TV] switch:	Pressed
[AUTO] [AFD] switch:	ON (LED ON)
[AUTO] [ASD] switch:	ON (LED ON)
[AUTO] [ACB] switch:	ON (LED ON)
[AUTO] [AFT] switch:	OFF (LED OFF)
[OL] [ALIGN] switch:	OFF (LED OFF)
[OL] [DFU] switch:	OFF (LED OFF)

Note: In changing the backscattered electron image to secondary electron image, set the [SPOT SIZE] to 9 to 10 o'clock position.

2. Setting of accelerating voltage (standard)

· HIGH range: Select from 5, 10, 15, 20, 25, 30kV.

LOW range: Set the HIGH range knob to the fully counterclockwise position and select 0.5 ~ 3kV with the button

· Side Entry Anode (SEA: optional)

The LOW range only can be used. In the HIGH range, the accelerating voltage becomes OFF.

Select the LOW range 0.5 ~ 3kV and insert the SEA.

When the HIGH range is used or SEA is not used, draw it out.

3. When the Image Selector (IMS: optional) or Multi Display Device (MID: optional) is mounted, select the [SEI] to obtain secondary electron images. (Change to the desired image later.)

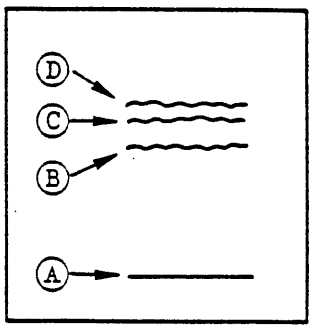


Fig. 3.4-2 LSP Mode

4. Press the [DET] [HT] switch to ON.
5. Adjust the [CONTRAST] control so that the checker meter reads approx. 0.25 with the [PMT] .
6. Set the [FILAMENT] control to the observation position.
   Reconfirm the position in Full Auto mode.
   Set the observation position immediately before the filament current saturation point (the second peak of the waveform obtained by the [LSP]) as follows.
   ① Turn the [FILAMENT] control clockwise. (The filament monitor lamp lights up at (a position) about 11 o'clock position.)
   ② Obtain a magnification of about 10,000X with the [MAGNIFICATION] control.
   ③ Press the [MODE] [LSP] and [SPEED] [EXP] switches.
   ④ Turn the [FILAMENT] control further in the clockwise direction to set the waveform to the second peak.

   Notes: 1. If the filament monitor lamp does not light up after the [FILAMENT] control has been turned beyond the 11 o'clock position, the filament has been burnt out and must be replaced with a new filament.
   2. The waveform usually rises as A → C → B → D. In the case of new filaments, however, the first peak sometimes gets higher than the second as A → D → B → C.

3. If the control is turned beyond the 3 o'clock position, the filament may be overheated and burnt out.

⑤ Turn back the [FILAMENT] control slightly so that the waveform comes immediately prior to the second peak.

⑥ Press the [MODE] [PIC] switch, then press the [SPEED] [TV] switch.

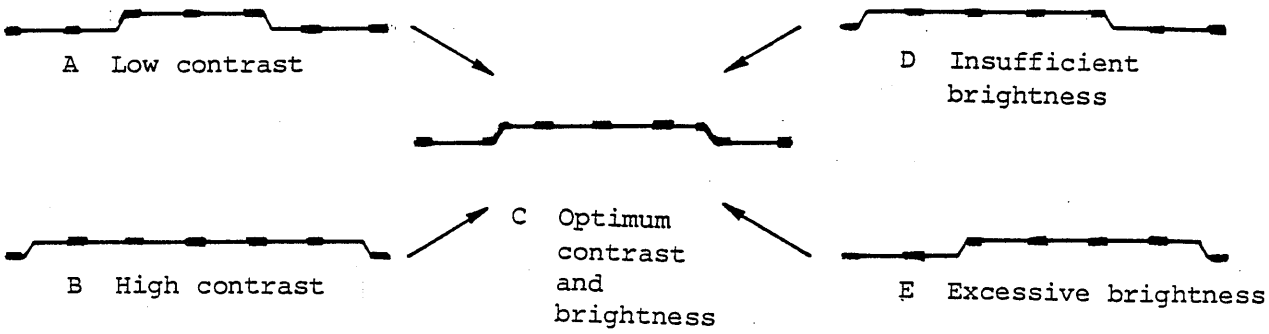


Fig. 3.4-3

7. Set magnification to a desired value with the [MAGNIFICATION] control.

   When contrast and brightness are proper, go to the step 10.

8. Press the [MODE] [PIC] , and [SPEED] [EXP] to show the exposure marker.
9. Adjust contrast and brightness with the [CONTRAST] and [BRIGHTNESS] controls.
10. Press the [SPEED] [TV] then press the [AUTO FOCUS] switch.
11. If astigmatism is observed, press the [AUTO STIG] switch.

    Notes: 1. When pressed with the [AFD] and [ASD] switches ON, both the AFD and ASD work.

    2. If the AFD is poor to work such as when specimens are flat and have low contrast or when there are few specimens, either change contrast and brightness and press the [AUTO FOCUS] again, or adjust focus with the manual [FOCUS] [COARSE] and [FINE] .

12. In the AFT mode, the AFD automatically works when specimen surface changes greatly due to change of the working distance or positions of specimens or when the accelerating voltage changes. In the AFT mode, set as follows.

[AUTO] [AFD] switch ON (LED ON)

[AUTO] [AFT] switch ON (LED ON)

Note: Readjust contrast and brightness. (Refer to 3.4.3 Using the Automatic Focus Tracer.)

3.4.2 Focusing and Astigmatism correction with automatic functions

AUTO Switch		Start Switching		FOCUS	STIGMATOR
AUTO AFD	AUTO ASD	AUTO FOCUS	AUTO STIG	AFD	ASD
OFF	OFF	—	—	×	×
OFF	ON		1	×	○
ON	—	1		○	×
ON	OFF		1	×	○
ON	ON		1	○	○

Table 3.4-I

○ : Operable

× : Not operable

— : Not related

Note: • When the magnification is 10,000 × or more, the combined work of AFD • ASD is effective in the range of the FOCUS FINE.

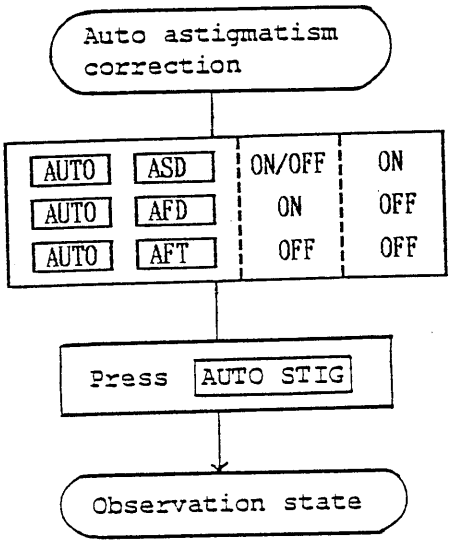
• "1" in Start Switching (AUTO FOCUS, AUTO STIG) means to press once.

1. How to use the Automatic Focusing Device (AFD)

   ① Normally, the [AUTO FOCUS] start switch is pressed once.

Note: When the AFD is used, if the specimen has low contrast or images are blurred due to noises, the device may not work properly. In this case, the amount of signals such as contrast should be increased.

- If the operation of the Automatic Focusing Device is abnormal, repress the AUTO FOCUS start switch after checking the contrast and brightness.



2. How to use the Automatic Astigmatism Correction Device

① Before starting the Automatic Astigmatism Correction Device, adjust focus.

② Press the AUTO STIG button once as usually.

When the AUTO AFD and ASD switches are pressed, auto focusing and auto astigmatism correction are performed at a time.

- When the AUTO ASD button is pressed and the AUTO AFD switch is OFF (LED OFF), astigmatism correction is performed but focusing is not performed, requiring focusing.

Note: When the ASD is used, if the specimen has low contrast or image are grainy due to noises, the device may not work properly. In this case, the amount of signals such as contrast should be increased.

3. Using the Automatic Focus Tracer (AFT)

The AFD automatically works when specimen surface changes greatly due to change of the working distance or position of specimens or the accelerating voltage.

In changing specimens, if the following settings are made before pressing the [PUMP DOWN] button, the image can be focused automatically at the completion of evacuation.

[AUTO] [AFD] and [AFT] switches ON (LED ON)

Note: The tracer may start when the [AUTO] [AFT] is pressed. When the AFT is used, if specimens have low contrast or images are grainy due to noises, the device may not work properly. In this case, the amount of signals such as contrast should be increased.

4. CRT Screen Message

when the filament current is off (filament monitor lamp off), the message "PLEASE CHECK THE FILAMENT" is displayed 5 seconds on the CRT by pressing the [AUTO FOCUS]/[AUTO STIG] start button with [SCANNING] [SPEED] at SLOW1 and the [AUTO AFD]/[AUTO ASD] switch at ON

5. CPU Resetting

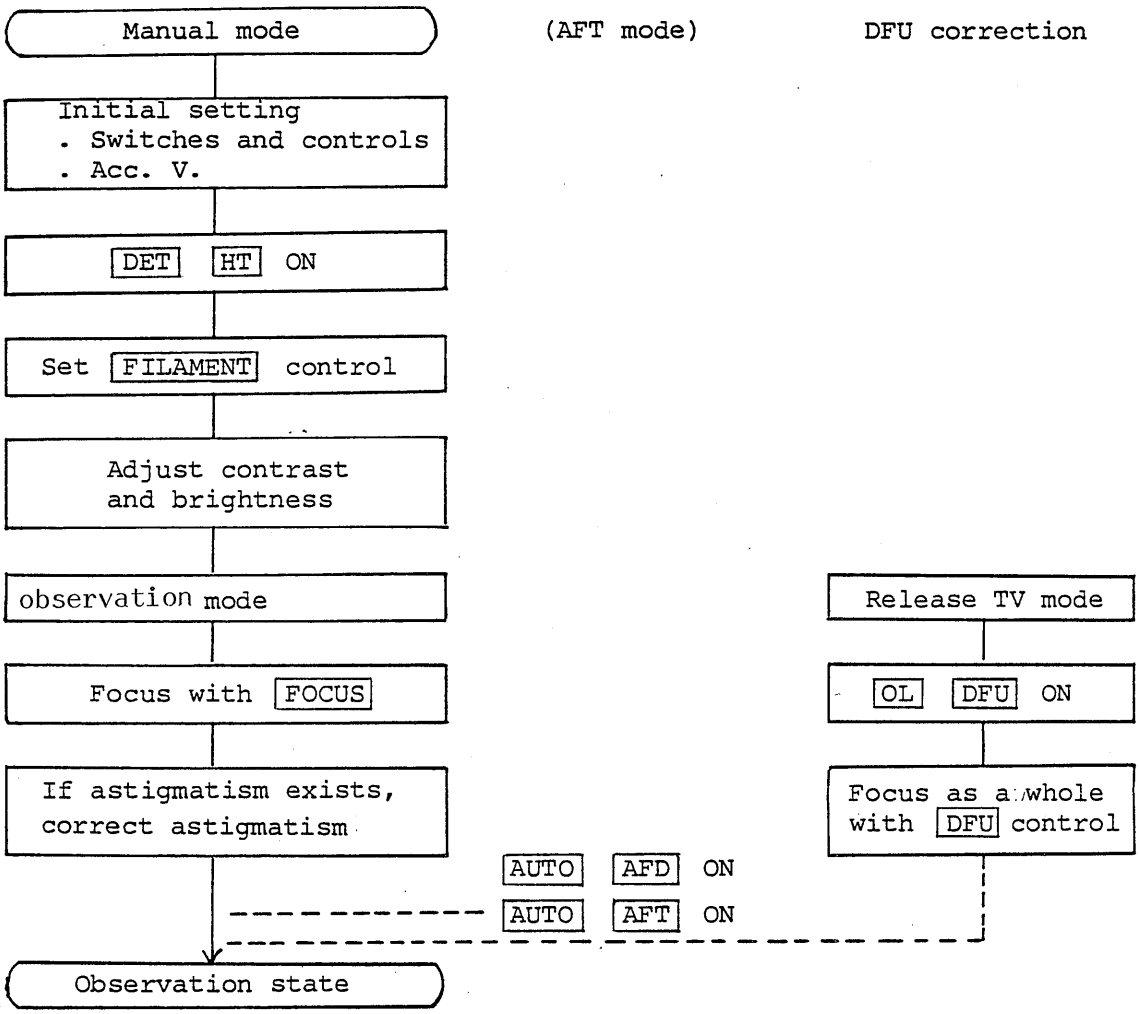
Ressetting is required in the following cases. (The CPU resetting switch is provided near TV signal outpot terminal on the rear panel)

(1)The LED light indicating the magnification goes out suddenly.

(2)Focusing and astigmatism cannot work with manual/AFD or ASD.

(3)Cannot input with FKB.

3.4.3 Manual Mode operation



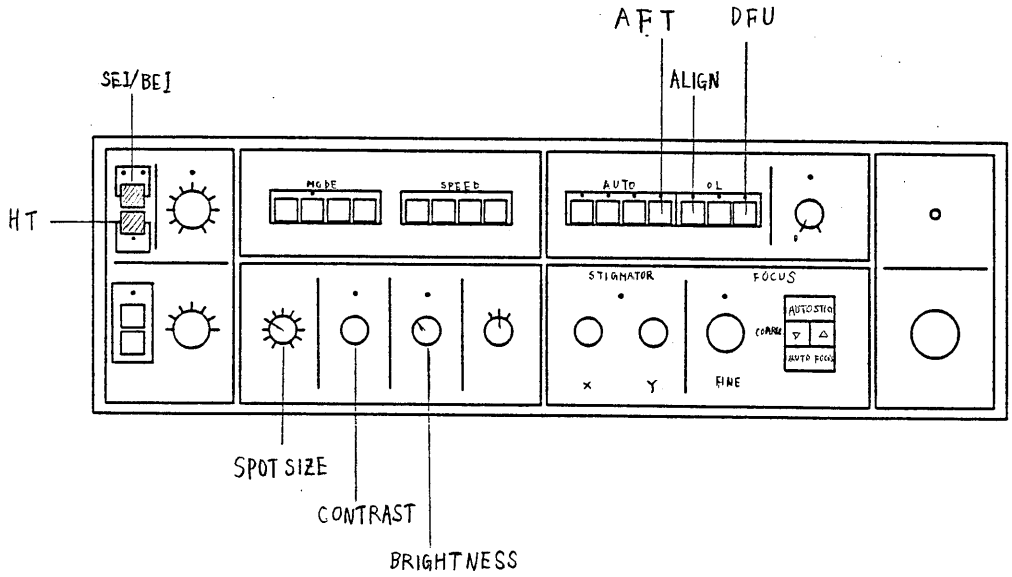


Fig. 3.4-4

1. When the settings are made as follows, images are easily obtained. (Others are as desired.)

   [SEI] : Secondary electron image / [BEI] : Backscattered electron image

   [DEI] [HT] switch: OFF (LED OFF)

   [SPOT SIZE] control: 9～10 o'clock position (SEI)
   2～3 o'clock position (BEI)

   [CONTRAST] control: Around the center of rotating range

   [BRIGHTNESS] control: 11 o'clock position

   [FOCUS FINE] control: Around the center of rotating range

   [AUTO] [AFT] switch: OFF (LED OFF)

   [AUTO] [ACB] switch: ON (LED ON)

   [OL] [ALIGN] switch: OFF (LED OFF)

   [OL] [DFU] switch: OFF (LED OFF)

   Note: In changing the backscattered electron image to secondary electron image, set the [SPOT SIZE] to 9～10 o'clock position.

2. Setting ot accelerating voltage (standard).

HIGH range: Select the voltage from 5, 10, 15, 20, 25 or 30kV.

LOW range: Set the HIGH range knob to the fully counterclockwise position and select 0.5～3kV with the button.

· Side Entry Anode (SEA: optional)

The LOW range only can be used. In the HIGH range, the accelerating voltage becomes OFF.

Select the LOW range 0.5～3kV and insert the SEA.

When the HIGH range or SEA is not used, draw it out.

3. When the Image Selector (IMS: optional) or Multi Display Device (MID: optional) is mounted, select the [SEI] to obtain secondary electron images. (Change to the desired image later.)

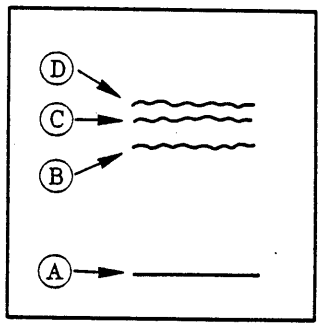


Fig. 3.4-5 LSP Mode

4. Press the [DET] [HT] switch to ON.
5. Adjust the [CONSTRAST] control so that the checker meter reads appros. 0.25 with the [PMT] .
6. Set the [FILAMENT] control to the observation position.
   Reconfirm the position once a day.
   Set the observation position immediately before the filament current saturation point (the second peak of the waveform obtained by the [LSP]) as follows.
   ① Turn the [FILAMENT] control clockwise. (The filament monitor lamp lights up at (a position) about 11 o'clock position.)
   ② Obtain a magnification of about 10,000× with the [MAGNIFICATION] control.
   ③ Press the [MODE] [LSP] and [SPEED] [EXP] switches.
   ④ Turn the [FILAMENT] control further in the clockwise direction to set the waveform to the second peak.

   Note 1. If the filament monitor lamp does not light up after the [FILAMENT] control has been turned beyond the 11 o'clock position, the filament has been burnt out and must be replaced with a new filament.
   2. The waveform usually rises as A⟶ C⟶ B⟶ D.
   In the case of new filaments, however, the first peak sometimes gets higher than the second as A⟶ D⟶ B⟶ C.

3. If the control is turned beyond the 3 o'clock position, the filament may be overheated and burnt out.

⑤ Turn back the [FILAMENT] control slightly so that the waveform comes immediately prior to the second peak.

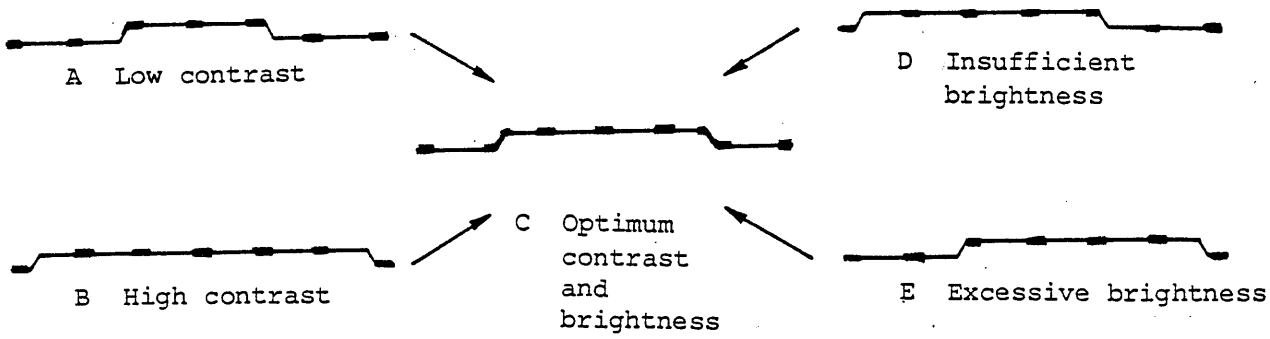


Fig. 3.4-6

7. Set magnification below 500X with the [MAGNIFICATION] control and press the [MODE] [PIC] .
   When the contrast and brightness are proper, go to the step 10.
8. Press the [SPEED] [EXP] to show the exposure marker.
9. Adjust contrast and brightness properly with the [CONTRAST] and [BRIGHTNESS] controls.
   Note: Press [AUTO] [ACB] , and if LED is kept on lighting, the contrast and brightness are maintained at a certain level.
10. Press the [SPEED] [TV] and set 12~3 o'clock with the [SPOT SIZE] control to observe TV images.
11. Adjust the focus with [△] · [▽] of [FOCUS] .
12. Set magnification to a desired value.
13. If the desired magnification exceeds approx. 1,000X , adjust the focus further with [FOCUS] [FINE] control.
    Note: If astigmatism exists, the image may be often in-focus (not just focus), even if adjusting the focus.
    If changing the focus at this time, it tends to be as follow:
    1. At low magnification.....It blurs much more.
    2. At high magnification....It appears blurred image.
    In case of such phenomenon, correct astigmatism.

3.4.4 Astigmatism Correction

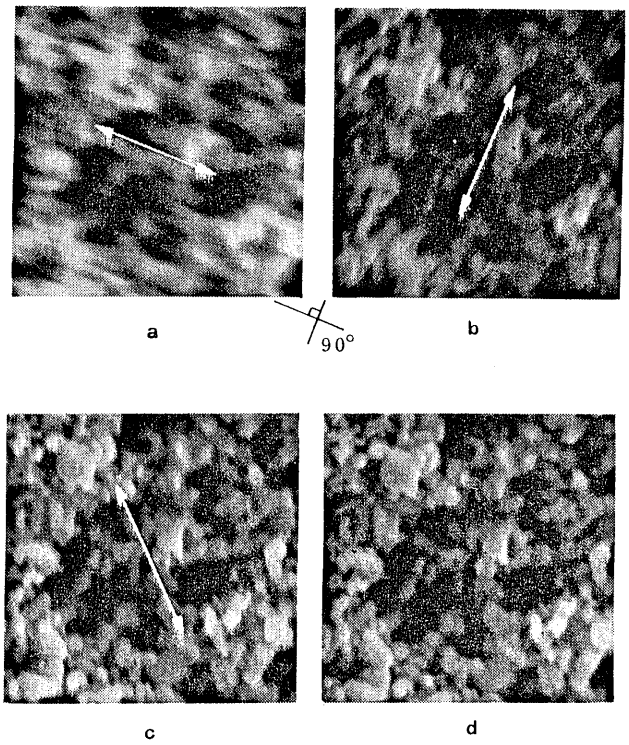


Fig. 3.4-7

1. Low Magnification (below 5,000X)
   - ① Adjust the focus most finely with X and Y controls of [STIGMATOR] .
   - ② Adjust focus with the [FOCUS] [COARSE] and [FINE] .
2. High Magnification (above 5,000X)
   - ① Turn X control of [STIGMATOR] largely clockwise and/or counter-clockwise. Ensure the changing image blurring (direction of astigmatism) and set it with X control at the medium direction of image blurring.
   - ② Adjust it also with Y control as same as X control.
   - ③ Readjust focus with the [FOCUS] [COARSE] and [FINE] .

3. When Astigmatism correction is hard:

Note 1. Repeat the above operation a few times if it is not easy to correct astigmatism.

2. Try again the operation of astigmatism correction by resetting astigmatism if astigmatism cannot be corrected with X and Y controls only.

3. Astigmatism resetting is required as follows.
Turn OFF the [AUTO] [AFD] , [AUTO] [ASD] switches and keep to press the [AUTO STIG] start button for a second or more.
Then, LED lamp is flashing and goes out when a astigmatism resetting have been finished.
The message of "ST RESETTING" is displayed on the CRT with [HT] switch at ON and [SCANNING] [SPEED] at SLOW1.

3.4.5 Tilt Correction (DFU)

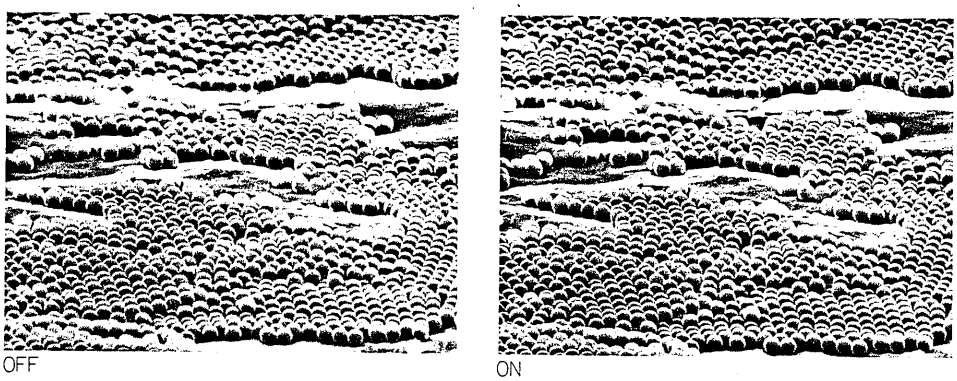


Fig. 3.4-8

Correct the focus according to tilt angle when the specimens are tilted so as to focus the whole viewing field.

1. Press any one except [TV] on the [SPEED] switch.
   (DFU cannot be used at TV mode.)
2. [OL] [DFU] switch ON (LED ON)
3. Set focus to the center of image with the angle control at 0°.
4. Turn the angle control clockwise until the whole screen comes in focus.

3.4.6 How to use the Gamma Control

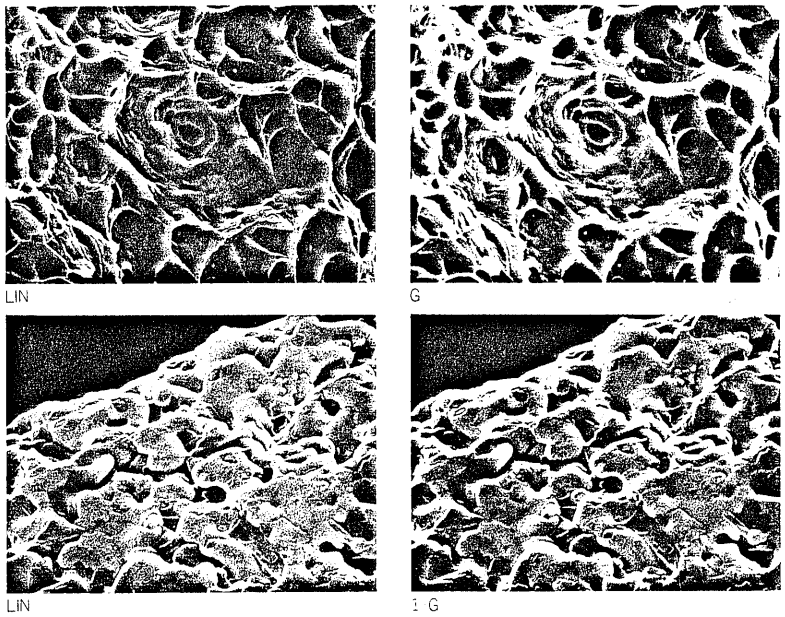


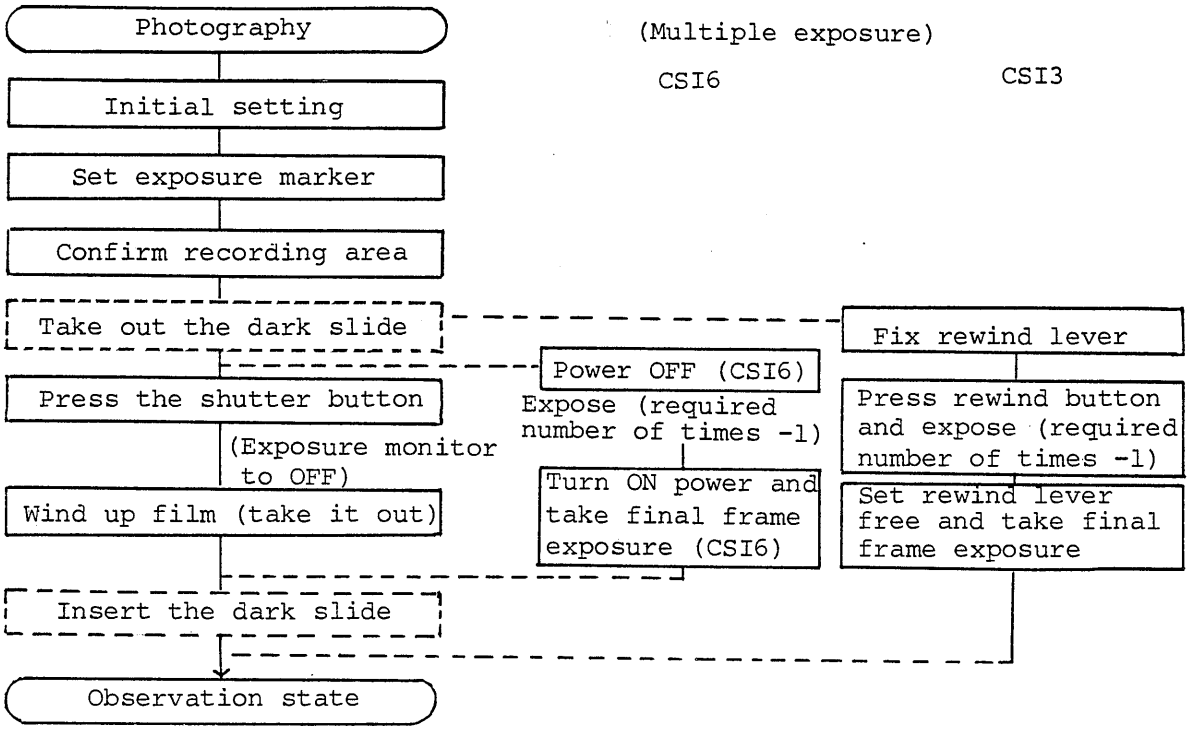
Fig. 3.4-9

Normally, use [LIN] (Linear) mode.
When image has partially darkness/bright-up, other part may be not optimum image quality to obtain optimum control and brightness at the desired position.
Then, use the Gamma control to correction of contrast and brightness at partially.

- Enhancement of dark detail ..... [G]
- Enhancement of bright-up detail ..... [1/G]

Also, Gamma Control is effective for photography.

3.5 Photography



1. Initial setting

   Ensure the followings after adjusting the focus of image at the observation state.

   - Shutter speed to [NOR] ([QUICK] if it needs to photograph quickly).
   - Set the film number with [FILM NUMBER] .

     First 4 digits ..... Set with 5 digits from the left at digital switch.

     Last 2 digits ..... Manual count: [ON/OFF] switch [OFF]
     Set with digital switch.

     Automatic count: [ON/OFF] switch [ON]
     Press [PRESET] switch after setting the initial value with 2 digits at right of digital switch.

- Power switch ON for CSI3 and CSI6
- Shutter speed of CSI3 camera side B
- Set up the aperture value of CSI according to the film

(Exposure marker standard)

Film Sensitivity		Recording CRT, ultrahigh-resolution CRT-UHR; NOR mode Aperture value (CSI3)	Ultrahigh-resolution CRT-UHR; UHR mode Aperture value (CSI3)
ISO	DIN		
50	18	F 8 (f11)	——
75～100	20～21	F11 (f16)	——
200	24	F16 (f22)	——
400	27	F22 (——)	f8 (f11): Develop in 4× sensitivity
3,000	36	ND4 filter + f22 (——)	f11 (f16)

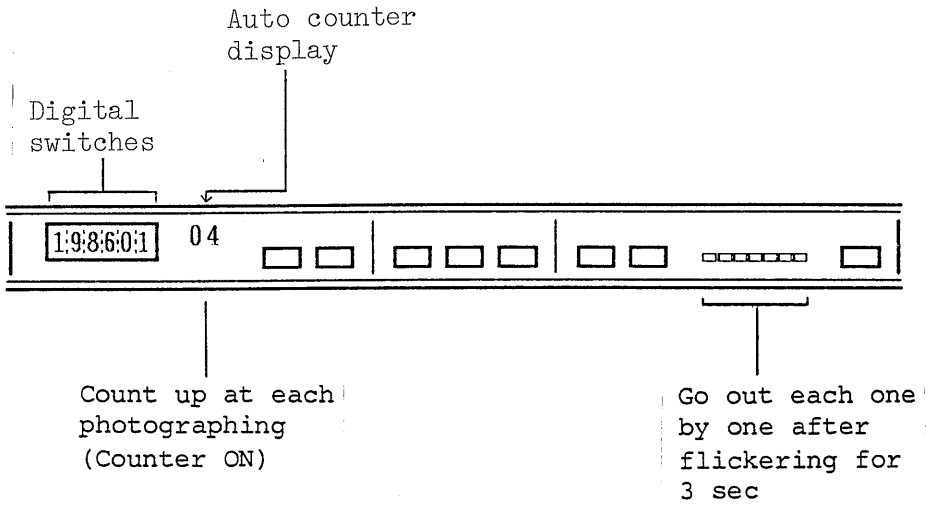


Fig. 3.5-1

2. Set the exposure marker.
3. Press [SPEED] [SLOW1] and confirm the recording area.
4. Make sure that the Camera for Scanning Image (CSI) is fixed with latch.
5. Take the dark slide out of the film holder if it is inserted (CIS3 has no dark slide).

   Note: For multiple exposure with CSI3, tape rewind lever to fix it to the body.

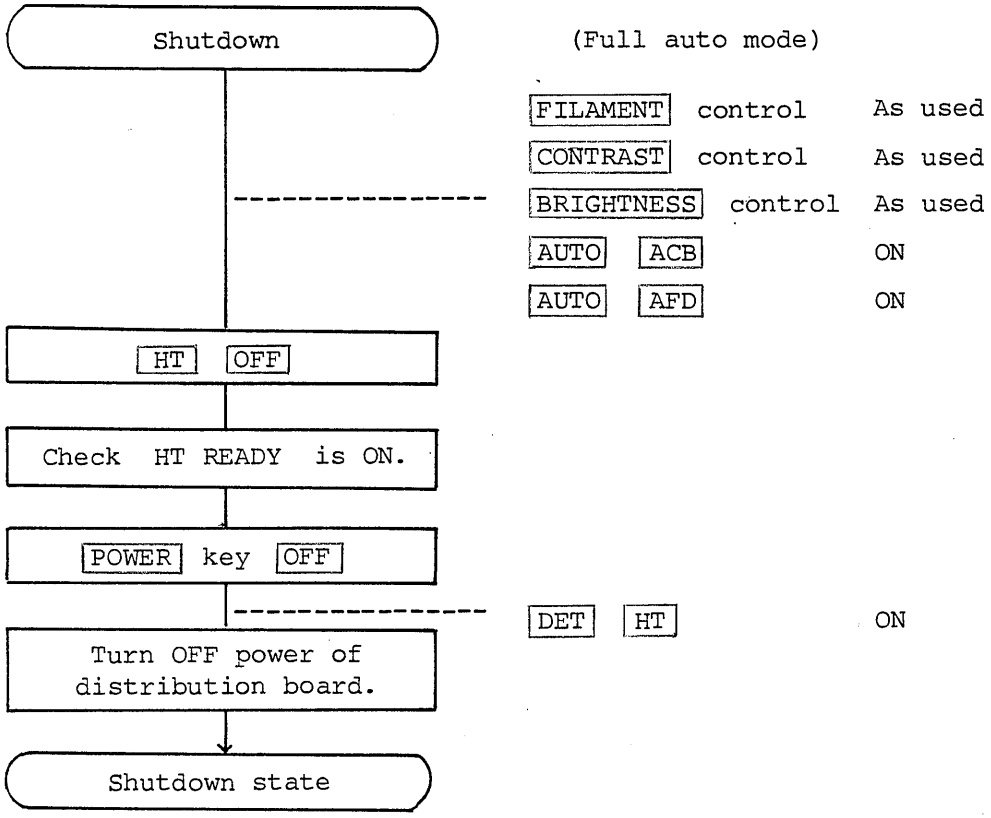
   For multiple exposure with CSI6, turn the power OFF.
6. Press the shutter button (either [SHUTTER] or CSI automatic shutter).

   Note: Do not apply any vibration nor impact to the microscope during photographing process.
7. At multiple exposure, expose with CSI6 at number of times (required number of times -1), with CSI3 at number of times (required number of times -1) while pressing rewind button, with other CSIs, expose at required number of times.
8. For multiple exposure with CSI3, expose the final frame by returning the rewind lever to original position.

   For multiple exposure with CSI6, expose the final frame by turning ON the power switch.
9. When [EXPOSURE MONITOR] completely turns off, the shutter closes and exposure completes, wind up the film (or take it out).

   Here, CSI3 and CSI6 wind it up automatically.
10. Insert the dark slide for removing the Camera for Scanning Image (CSI) or if it takes a long time until next photography.

3.6 Shutdown



Start from the step 1 when images are to be shown automatically only by starting the system with the full auto function after shutdown.
Start from the step 2 just to shut down the system.

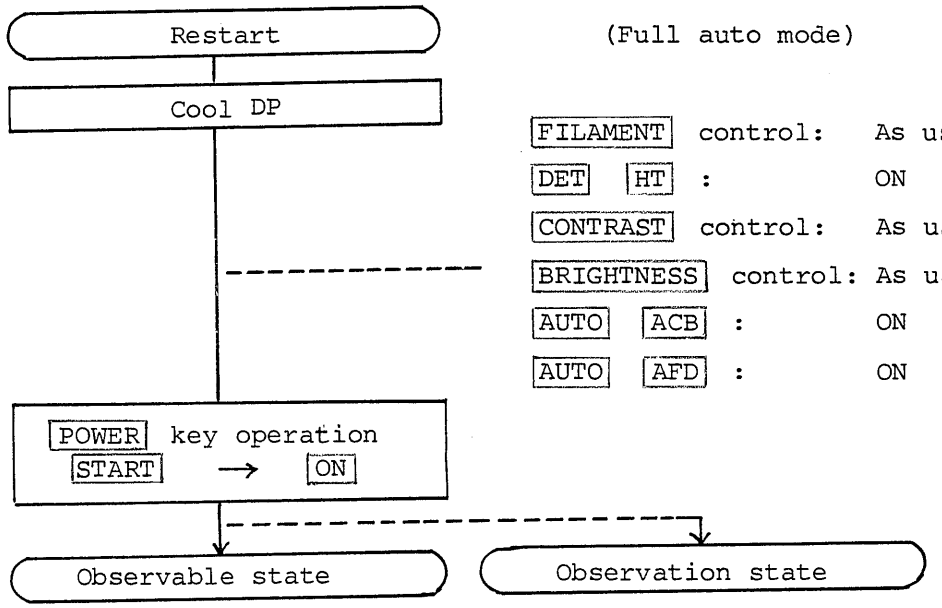
1. To utilize the full auto function, make the settings as follows.
   - FILAMENT control: As used.
   - CONTRAST control: As used.
   - BRIGHTNESS control: As used.
   - AUTO ACB and AFD switches: ON (LED ON)
2. Set the HT switch to OFF.
3. Make sure that the HT READY of SEQUENCE is ON.
4. Turn the POWER key switch to OFF . (The key can be pulled out.)

5. [DET] [HT] switch ON (for Full Auto mode)
6. Turn OFF the power switch on the distribution board, and close the tap.

Notes: 1. Even if cooling water is stopped right after turning off the power of the system, no troubles may result. However, keep supplying water until the heater of the oil diffusion pump (DP) cools down to room temperature (approx. 10 to 15 min).

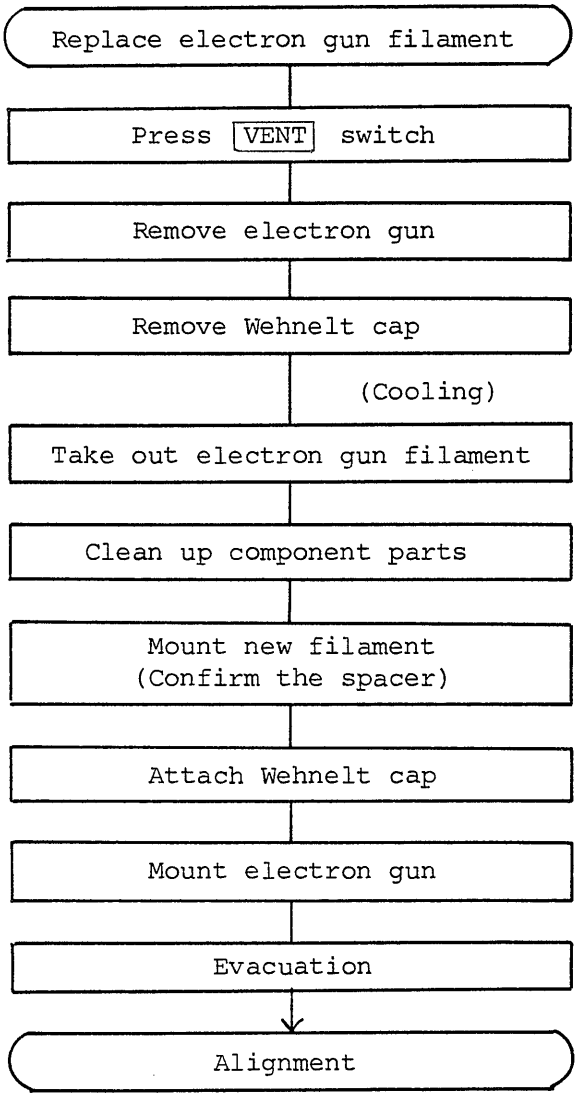
2. The system will not start again if the oil diffusion pump (DP) is not cooled to room temperature. (Refer to Restart.)

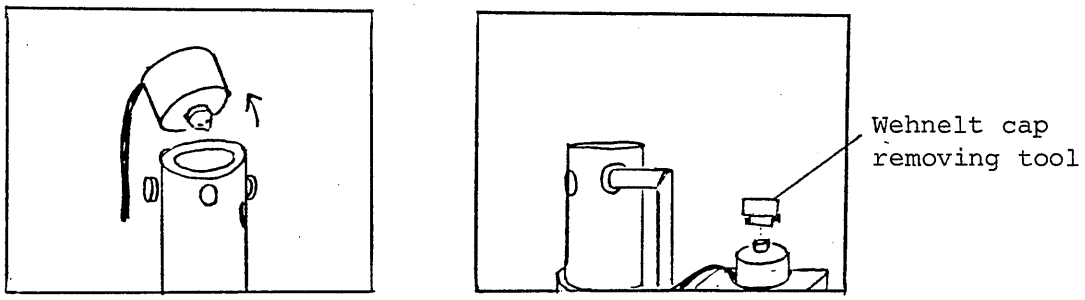
3.7 Restart



1. For restart after water failure, wait until DP cools down to the room temperature (do not turn the power ON until DP cools down to the reset temperature).
2. To utilize the full auto function, make the settings as follows:
   - FILAMENT control : As used
   - DET HT switch : ON (LED ON)
   - CONTRAST control : As used
   - BRIGHTNESS control : As used
   - AUTO ACB and AFD switches : ON (LEDs ON)
3. Turn the POWER key switch to ON from START after recovering from power or water failure.

3.8 Electron Gun Filament Replacement





a. Electron gun removal b. Wehnelt cap removal

Fig. 3.8-1 Electron Gun Removal

If the filament monitor lamp does not light up even when [FILAMENT] control is turned beyond the 11 o'clock position, it indicates the electron gun dilament is burnt out. In such a case, replace it by following the procedure described below:

1. Admit air into the column to atmospheric pressure (by pressing [SEQUENCE] [VENT]).
2. · Loosen the alignment screws (4 pieces).
   · Wipe off dust from the electron gun.
   · Lift it straight up.
   · Turn it in a manner that Wehnelt cap faces upward.
   · Then, position it on the vent cover.
   (Refer to Fig. 3.8-1)
   Note: Since the filament replacement exposes the column and specimen chamber to the atmosphere, perform the replacement work in as short a time as possible by observing the procedure.
3. Put the Wehnelt cap removing tool over the Wehnelt cap and secure them with fixing screw.
   Note: Be careful to handle the Wehnelt cap, as the used Wehnelt cap is highly heated.
4. Remove the Wehnelt cap from the Wehnelt unit base by pulling the tool upward and cool the cap down sufficiently.

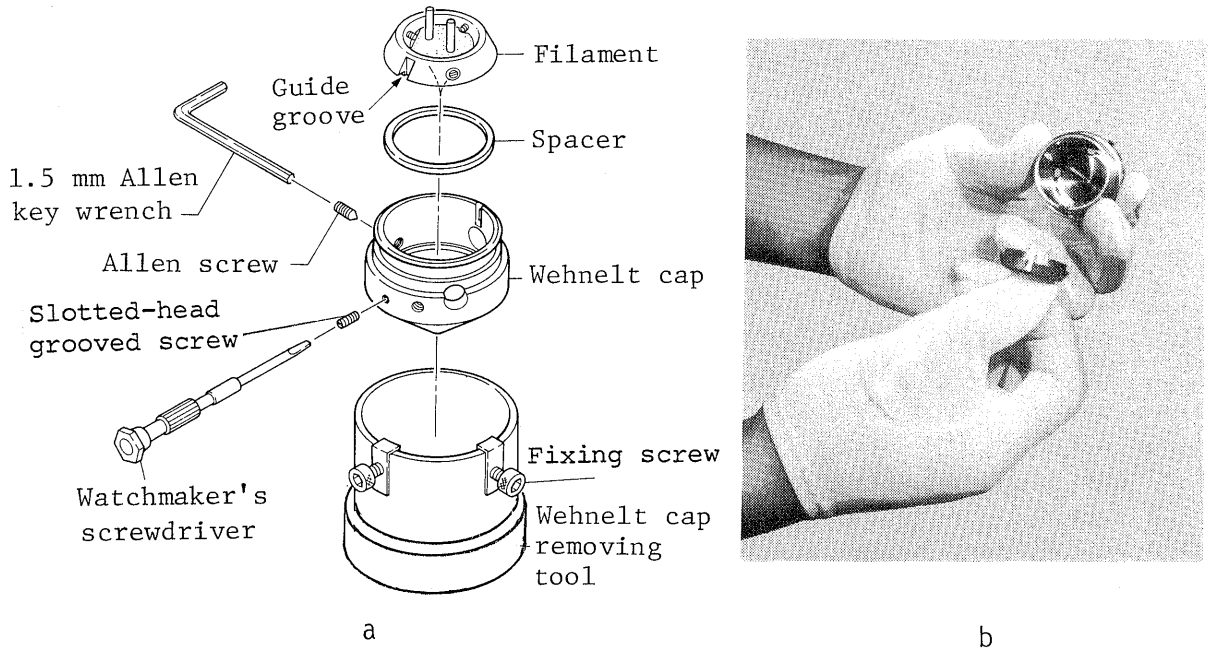


Fig. 3.8-2

5. Loosen 2 fixing screws and remove the Wehnelt cap removing tool from the Wehnelt cap.
   Loosen 3 Allen screws of Wehnelt cap with an Allen key wrench.
6. Loosen the slotted-head grooved screw with a watchmaker's screwdriver and take out the electron gun filament (refer to Fig. 3.8-2a).
7. Clean up the insulator surface of electron gun.
8. Reassemble the electron gun to the original position (here, keep evacuating if cleanup job takes a time).
9. Clean up Wehnelt cap.

(Comments)

Allen screw: For filament centering

Slotted-head grooved screw: Adjusting filament dirrection

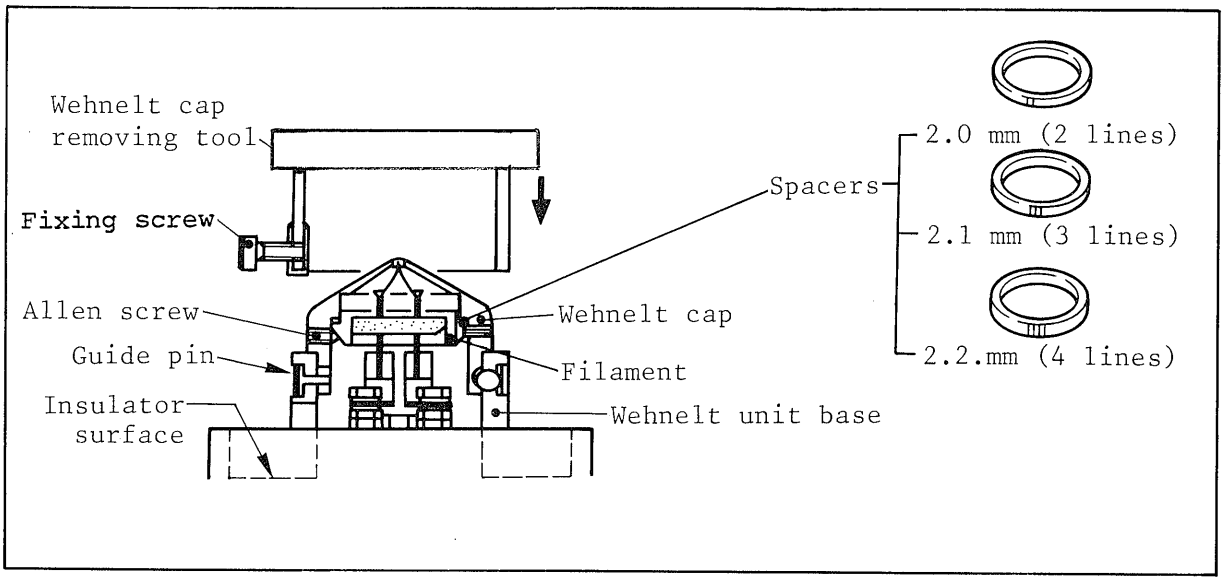


Fig. 3.8-3

10. Align the guide groove of new electron gun filament with the pin and secure the filament to the Wehnelt cap by tightening 3 Allen screws and slotted-head grooved screw.

    Note: Usually 2.1mm spacer should be used so that the tip of electron gun filament is sunken (about 0.2mm) from Wehnelt cap. If the tip of electron gun filament is protruded or sunken much from the end surface of Wehnelt cap, adjust the position by using the spacer of other thickness.

11. Lift the electron gun (admit air if in vacuum).

12. Align the guide pin with the pin groove and push down the Wehnelt cap onto the Wehnelt unit base.

13. Blow away dust and lint on the Wehnelt unit with a handblower and install the electron gun on the column.

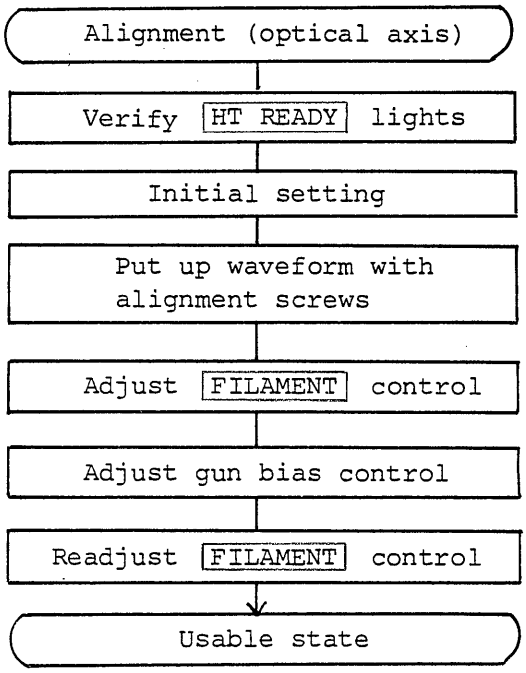
    Note: When turning the electron gun, be sure to turn it in the reversal direction to when placing it down so as not to twist the gun cable.

14. Reevacuate the column (by pressing [SEQUENCE] [PUMP DOWN] switch).

15. Align the beam axis when [SEQUENCE] [HT READY] light up.
    Note: Set the gun bias control to about 3 o'clock position so that the reading of checker [LD CUR.] does not exceed 0.7 (140μA), after aligning at accelerating voltage 30kV.
16. Adjust [FILAMENT] control at every several hours on the day of electron gun filament replacement.
    For 3 hrs right after replacement, it's better to align every 1 hour.

3.9 Alignment

3.9.1 Alignment (Optical Axis)



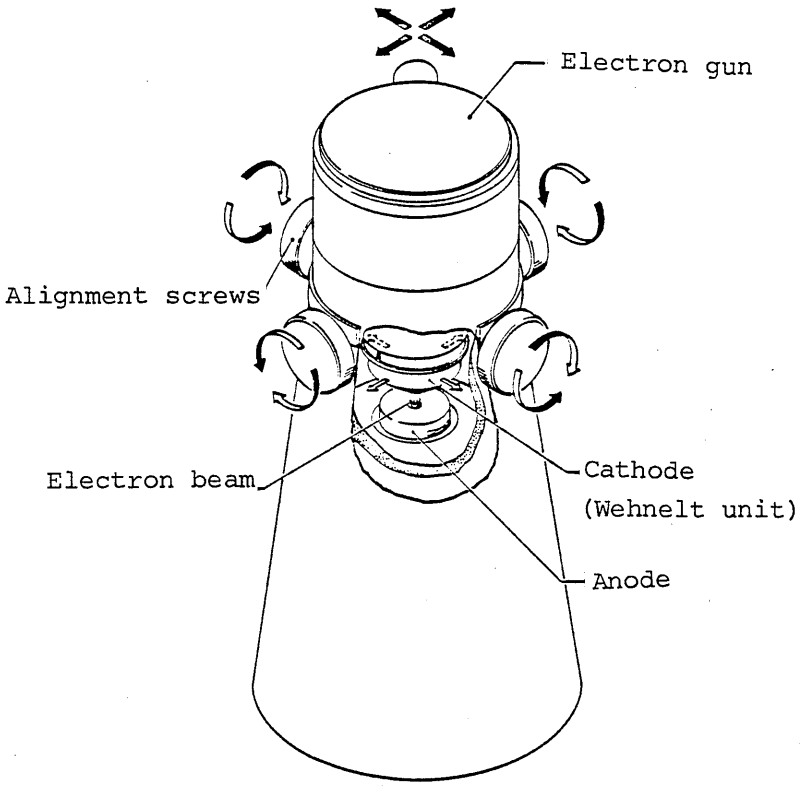


Fig. 3.9-1 Function of Alignment Screws & Electron Gun

Realignment is required for electron gun after replacing electron gun filament and objective lens aperture or cleaning them or disassembling column.

1. Evacuate the column and verify that [SEQUENCE] [HT READY] light.

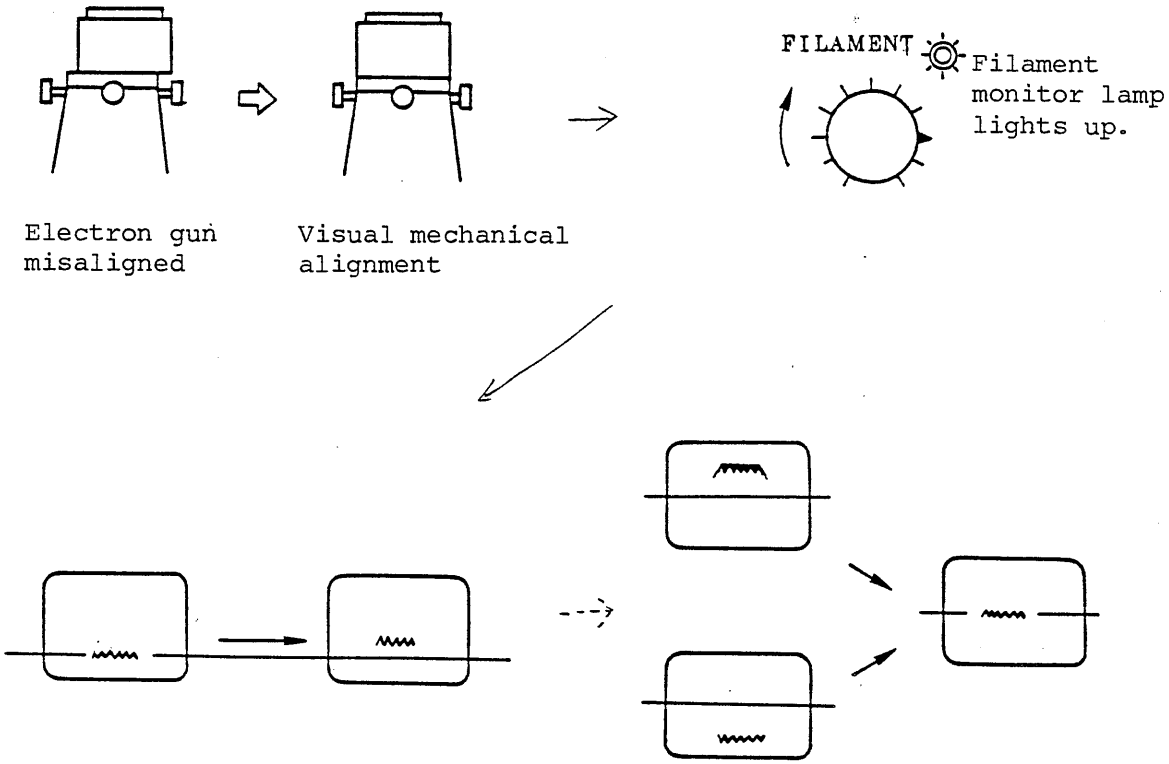


Fig. 3.9-2

2. Align the electron gun mechanically with 4 alignment screws.
3. Follow the procedure below: (Initial setting)
   - [DET] [HT] switch ON (LED ON)
   - [ACCELERATING VOLTAGE] control to [30]
   - Press [MODE] [LSP] switch.
   - Press [SPEED] [EXP] switch.
   - Set [BRIGHTNESS] control to 11 o'clock position.
   - Set [MAGNIFICATION] control above 5,000X .
   - Turn [FILAMENT] control to near the 3 o'clock position.

4. Ensure that the filament monitor lamp lights up.

   Note 1. If the filament monitor lamp does not light, the electron gun filament is burnt out and must be replaced.

   2. If [FILAMENT] control is turned beyond the 3 o'clock position, the filament may be overheated and be burnt out.

5. Adjust the position of electron gun with 4 alignment screws so that the waveform on CRT is shifted to the uppermost position.

   Note: When the shift of the waveform is small, or is so large that the waveform reaches the upper limit of the screen, set the waveform to around the center with [CONTRAST] control.

6. Turn [FILAMENT] control back to 9 o'clock position.

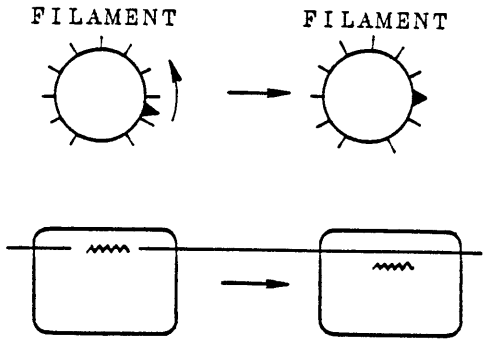


Fig. 3.9-3

7. Set the usable position of [FILAMENT] control.
   ① Check that the emission is close to the ideal curve shown in Fig. 3.9-4.
   ② Turn [FILAMENT] control slightly in the counterclockwise direction while monitoring the waveform on CRT and set the control to a position which is just before a sharp fall in waveform starts (slightly lower than the saturation point: A in Fig. 3.9-4).

   Note 1. The first and the second peak heights vary from filament to filament. In some new filament, the first peak may be sometimes higher than the second.

   Note 2. When alignment is poor, the waveform lowers by turning the control clockwise beyond the second peak. Then, perform alignment again.

8. Adjust gun bias control to make [LD CUR.] readings at checker fall within the range in the following table. Here, turn the gun bias control fully to clockwise direction for changing to high accelerating voltage from low accelerating voltage:

Accelerating voltage	0.5～3kV	5～30kV
Meter reading	0.3～0.5	0.5～0.6

Note: As the total using time of filament increases, the using position also approaches to 10 o'clock position.

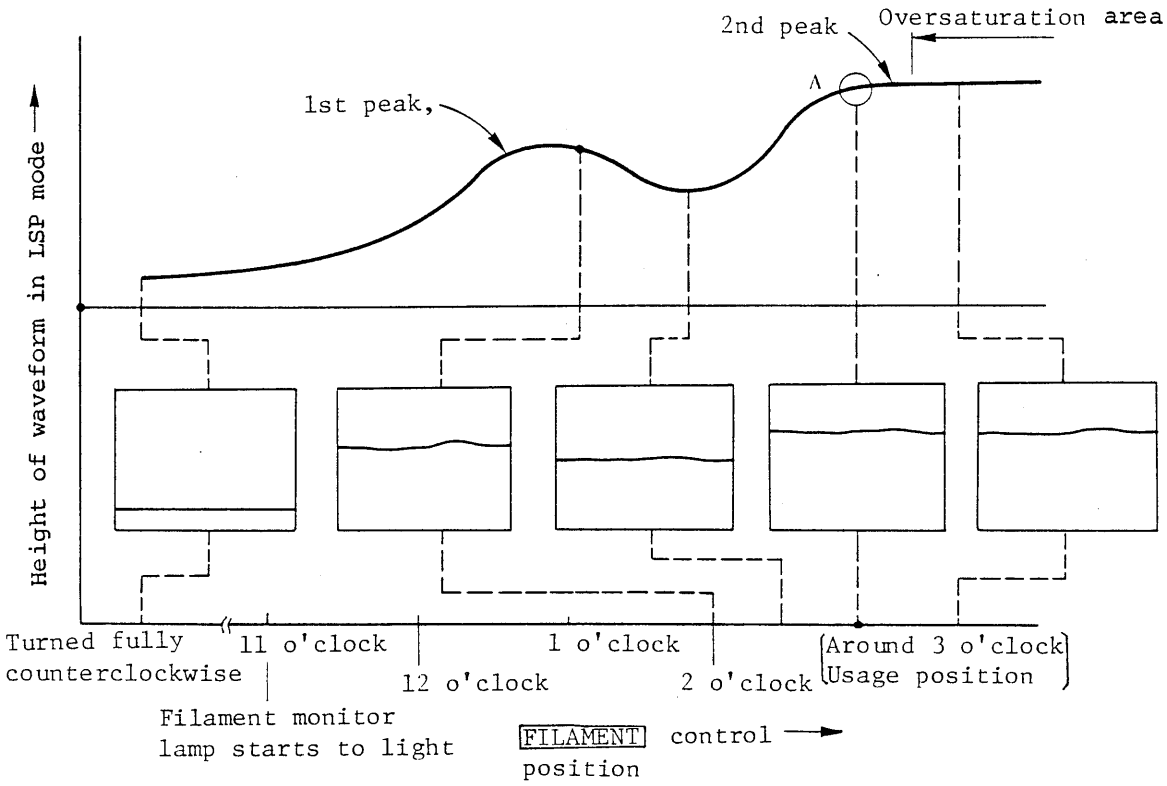


Fig. 3.9-4 [FILAMENT] Control Setting

9. Set [FILAMENT] control again to its final position.

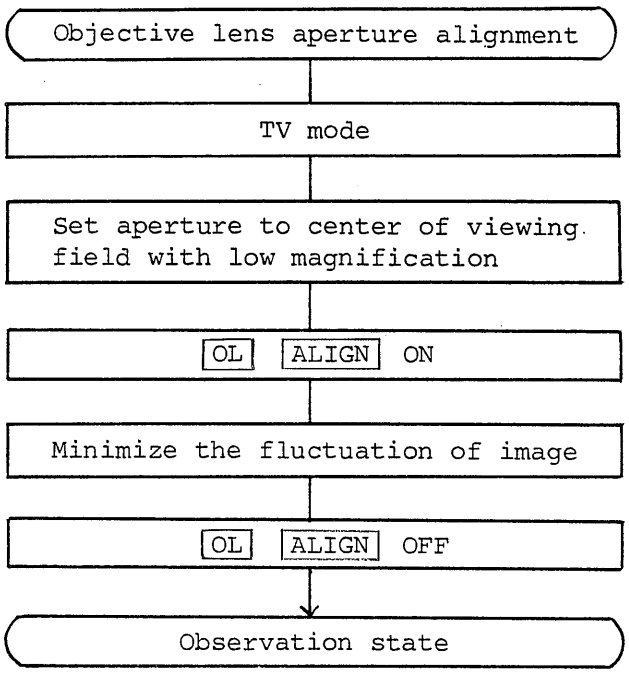
Note 1. If electron gun filament is used in the over-saturation state, it shortens the life of electron gun filament and causes to warp it.

2. When [FILAMENT] control is adjusted in position, perform the followings with reference to reading of [LD CUR.] at the checker:

① Set it so as not to exceed 0.7 (140μA).

② If the meter reading fluctuates, clean the Wehnelt cap. If whiskers are observed on the filament, replace the filament with a new one (whiskers are discernible with a loupe of about 15X).

3.9.2 Objective Lens Aperture Alignment



1. Press [MODE] [PIC] button and then [SPEED] [TV] button to set TV mode.
2. Set the aperture selector as below:
   No. 2 (200μmø) for standard
   No. 3 (600μmø) for X-ray analysis by FCS
3. Set magnification to 35X and adjust the aperture to the center of viewing field.
4. Set magnification to about 10,000X and focus the image, and correct astigmatism.
5. [OL] [ALIGN] button ON (LED ON)
6. Minimize the fluctuation of image with fine adjustment knobs (both in X and Y directions).
   Note 1. Repeat the operation when difficult to adjust them.
   2. If alignment is poor, astigmatism may grow larger.
7. After alignment completes, press [OL] [ALIGN] button to OFF (LED OFF).

3.10 Specimen Preparation

Perform the specimen preparation for microscope with the following keypoints in mind:

- The specimen must be shaped so as to fit the specimen holder.
- The specimen must be secured firmly in the specimen holder.
- The specimen itself must be conductive and also conductivity must be ensured between the specimen and specimen holder enough.

1. The specimens applicable to the microscope only after proper treatment

   Since the specimen is examined in vacuum and is subject to electron beam irradiation, the specimen must be appropriately treated before introducing into the specimen chamber. Otherwise, satisfactory micrographs cannot be obtained. Moreover, the microscope will be contaminated that requires to clean up the microscope each time it is used.

   a. Radioactive specimens
   b. Wet specimens (thick plant leaves, bulky soft animal tissues, etc.)
   c. Fine particles in volume; that is not secured.
   d. Magnetic materials
   e. Porous specimens, especially gas-absorbed specimens

   These specimens will evaporate, generate gas, take much time to evacuate by specimen dispersion or contaminate inside the column. Therefore, these specimens may cause astigmatism, deviation of electron beam probe in the magnetic field of specimens and make it impossible normally to observe theis images.

2. Securing the specimen

   Use conductive paint such as silver or carbon to secure the specimen to the specimen mount. Additionally, double-sided adhesive tape, vacuum compound, methyl cellulose solution, manicuring solution and various other adhesives can also be

used for securing the specimen to the mount.

3. Evaporation and sputtering

The metallic specimen has conductivity itself and therefore it can be observed just by securing it to the specimen mount or the specimen holder with conductive paint. In the case of non-conductive specimens, coat the conductive film evenly onto the surface of specimens with vacuum evaporator or sputtering device, after securing them onto the specimen mount, to prevent any buildup of surface charge and reduce damage by thermal effect of the electron beam and further to improve the secondary electron yield rate. Desirable evaporation film thickness: 5～30nm

4. Coating materials for evaporation and sputtering

- Vacuum evaporation material for complicated facial specimens

  Carbon: Continuous, not in aggregate form, uniform, highly evapolation in behind of micro structure

  Gold: Non-oxidization, extremely fine particles, low melting point, high secondary electron emission

- Sputtering material

  Gold foil is generally used as electrode material for sputtering. In addition, platinum-palladium alloy, chromium, silver, copper, aluminum, etc., are also available for sputtering.

Besides, the double coating method (e.g., one thin coat of carbon topped by one coating of gold) is widely used for various specimens.

3.11 Troubles in Operation

Reconfirm operation in the following cases. If the troubles can not be remedied, refer to TROUBLE-SHOOTING.

1. Power cannot be applied.
   - Power of 100VAC, single phase, 50/60Hz is not supplied.
   - The switch on the distribution board is OFF.
   - DP has not returned to the reset temperature yet after power or water failure.

   Refer to [START/RESTART] .

2. The specimen chamber can not be evacuated or admitted air.
   - Evacuation
     - RP evacuation sounds does not go off. ⟶ Check O-rings, etc.
     - [HT READY] is not ON. ⟶ Has evacuation been conducted for 3 min after pressing [PUMP DOWN] ?
     - ALS changeover switch is at [ALC] . ⟶ Change to [SEM] .
   - Admitting air
     - Have 30 sec passed after pressing [VENT] ? (It takes about 30 sec to reach atmospheric pressure.)
     - ALS changeover switch is at [ALC] . ⟶ Change to [SEM] .

3. Images do not appear.
   - [DET] [HT] switch is not ON (LED is not ON).
   - [FILAMENT] control is set to a wrong position.
   - Setting is other than [SEI] . (Especially, MDD, IMS.)
   - [HT READY] is not ON. (Evacuation has not been completed.)
   - The filament is burnt out.

   Refer to [OBSERVATION, PHOTOGRAPHY, FILAMENT REPLACEMENT] .

4. Images can not be focused.
   - Astigmatism exists.
   - Contrast and brightness are too low for the Automatic Focusing Device to work.
   - The working distance is off greatly.
   - Specimens are tilted.

- Reset focus.

Refer to [OBSERVATION, TILT CORRECTION].

5. Astigmatism cannot be corrected.

- Contrast and brightness are too low for the Automatic Astigmatism Correction Device to work.
- Images are not focused.
- Reset stigmator.

Refer to [ASTIGMATISM CORRECTION].

6. The Automatic Focus Tracer (AFT) does not work.

- Contrast and brightness are too low for the AFT to work.
- Structural viriation is too little for the AFT to work.
  → Press [AUTO FOCUS].
- [AUTO] [AFD] and [AFT] switches are not ON.

Refer to [AUTOMATIC FOCUS TRACER (AFT)].

7. Images cannot be photographed properly.

- The exposure marker is not set in optimum.
- The dark slide of the camera (CSI) remains inside.
- The aperture value of the camera (CSI) is not proper.
- After photographing, the film has not been wound up.

Refer to [PHOTOGRAPHY].

8. After the filaments have been replaced and aligned, images do not appear.

- [HT READY] is not ON. (Evacuation has not been completed.)
- [DET] [HT] is not ON.
- Alignment is not sufficient.
- The filament is burnt out.

Refer to [FILAMENT REPLACEMENT, ALIGNMENT].

3.12 Hot to Obtain Better Image and Photography

Although this microscope is designed for easy operation for all the operators, the better image and photography can be obtained with attention to the following points (except in case under the specified conditions):

1. Prepare the specimen in the method suitable for specific specimen.
2. Set the working distance (WD) in the range between 10mm and 15mm and tilt angle between 20° and 30°.
3. Select the accelerating voltage properly according to the specimen.
4. Adjust bias properly by the accelerating voltage.
5. Change [SPOT SIZE] according to each specific purpose.
   - High resolution ..... 7~8 o'clock position
   - Large volume of signals .....10~2 o'clock position
   - FCS · BEI · TV .....12~3 o'clock position
6. Adjust the focus in the viewing field for recording and correct astigmatism in as short a time as possible.
   Or, adjust the focus and correct astigmatism in the other viewing field.
7. Align the objective lens aperture if necessary.

CHAPTER 4 PRACTICAL USE OF SCANNING MICROSCOPE

4.1 General Description of Scanning Electron Microscope

4.1.1 Comparison of Microscopes

	Optical microscope	Scanning electron microscope	Transmission electron microscope
Emmission	Light	Electron beam	Electron beam
Medium	Atmosphere	Vacuum (below 10^{-4}Pa)	Vacuum (below 10^{-5}Pa)
Resolution	200 nm～	Approx. 5 nm	Approx. 0.14 nm～
Contrast	Absorption/ reflection	Secondary electron effect	Scattering/ diffraction
Lens	Optical glass lens	Electromagnetic lens	Electromagnetic lens
Depth of focus	Shallow	Very deep	Deep
Magnification change method	Lens replacement	Scanning width	Excitation of magnifying lens system
Specimen thickness	Usually 0.5μm min	Usually 10mm max.	Usually 1μm max.
Specimen preparation	Easy	Relatively easy	No easy

Table 4.1-1

3 types of microscopes that have been propagated are scanning microscope (generally quoted as scanning electron microscope), optical microscope and transmission electron microscope (image-forming-lens type electron microscope). All of them are excellent, but have each own specific limitation and defect.
Namely, optical microscope features (1) shallow focus depth and (2) insufficient resolution. On the other hand, transmission electron microscope can (3) only observe the specimen of very thin (usual thickness less than 1um = 10,000Å) transmitted image although its resolution is excellent and (4) it is not easy to prepare the specimen.
Contrarily, the scanning microscope developed as high resolution microscope on the basis of principles quite different from these 2 types of microscopes has settled down these 4 defects to ensure its excellent features.

4.1.2 Principle of Scanning Electron Microscope

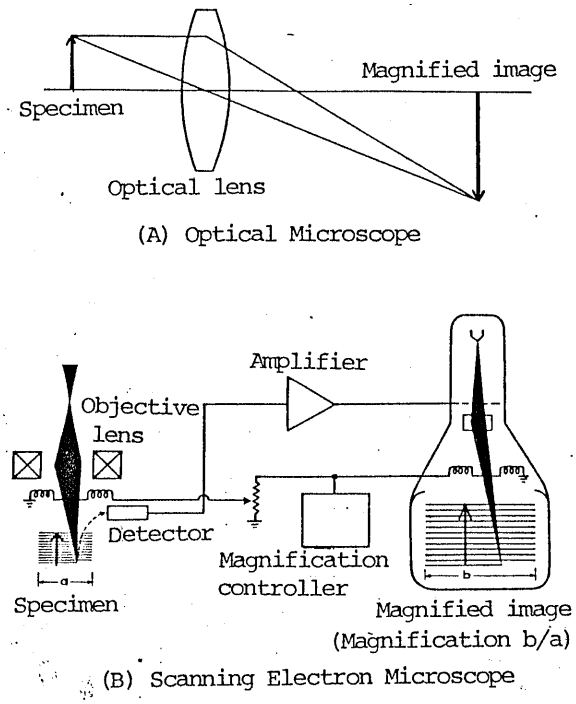


Fig. 4.1-1

The principle of the scanning electron microscope is as shown in Fig. 4.1-1. A finely focused electron probe scans the specimen surface and the secondary and back-scattered electrons, etc., are emitted from the specimen surface. These signals are then detected and are fed to a synchronously scanned CRT as an intensity modulating signal and thus displays a specimen image on the CRT screen. The CRT raster width devided by the electron probe scanning width determines the image magnification. Secondary and backscattered electron images can be observed in standard T330. Additionally, several signals can also be obtained from specimens by incorporating the attachments.

4.1.3 Signals Obtained from Specimens

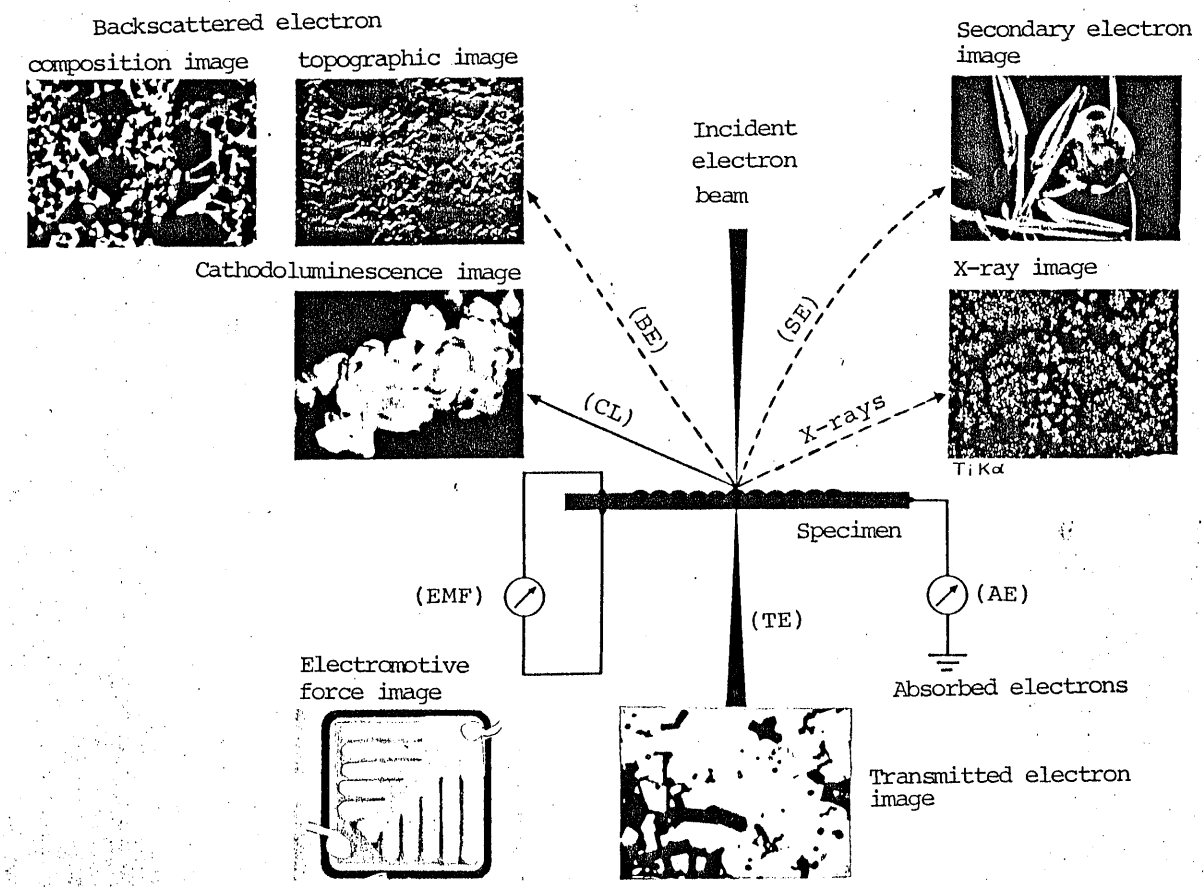


Fig. 4.1-2

1. Secondary Electrons (SE)
   As the low-energy electrons are emitted from the vicinity of specimen surface, emission is different depending on the composition and surface structure of specimen.

2. Backscattered Electrons (BE)
   Electrons are backscattered by specimen and have almost the same energy as that of incident electrons. Comparing with secondary electrons, the backscattered electrons allow to obtain information from the inner parts of the specimen. Composition images and topographic images can also be obtained by using a special detecting method.
3. Transmitted Electrons (TE)
   Electrons transmitted through a thin specimen. Comparing with an electron microscope of image-forming-lens type, a scanning electron microscope excels in giving a transmitted electron image of (1) less chromatic aberration and (2) allowing contrast enhancement.
4. X-rays
   X-rays emitted from specimen can carry out elemental analysis.
5. Cathodoluminescence (CL)
   Cathodoluminescence means light emission from specimen atoms which have excited by the incident electrons. The cathodoluminescence image is effective for observing fluorescent specimens.
6. Absorbed Electrons (AE)
   The electrons absorbed by the specimen are detected as a specimen absorbed current.
7. Electromotive Force (EMF)
   Using a PN junction in the specimen as a detector, it detects the electromotive force corresponding to the photoconductive effect by photons.
   The electromotive force image is effective for observing semiconductor specimens.

4.1.4 Composition of Scanning Microscope

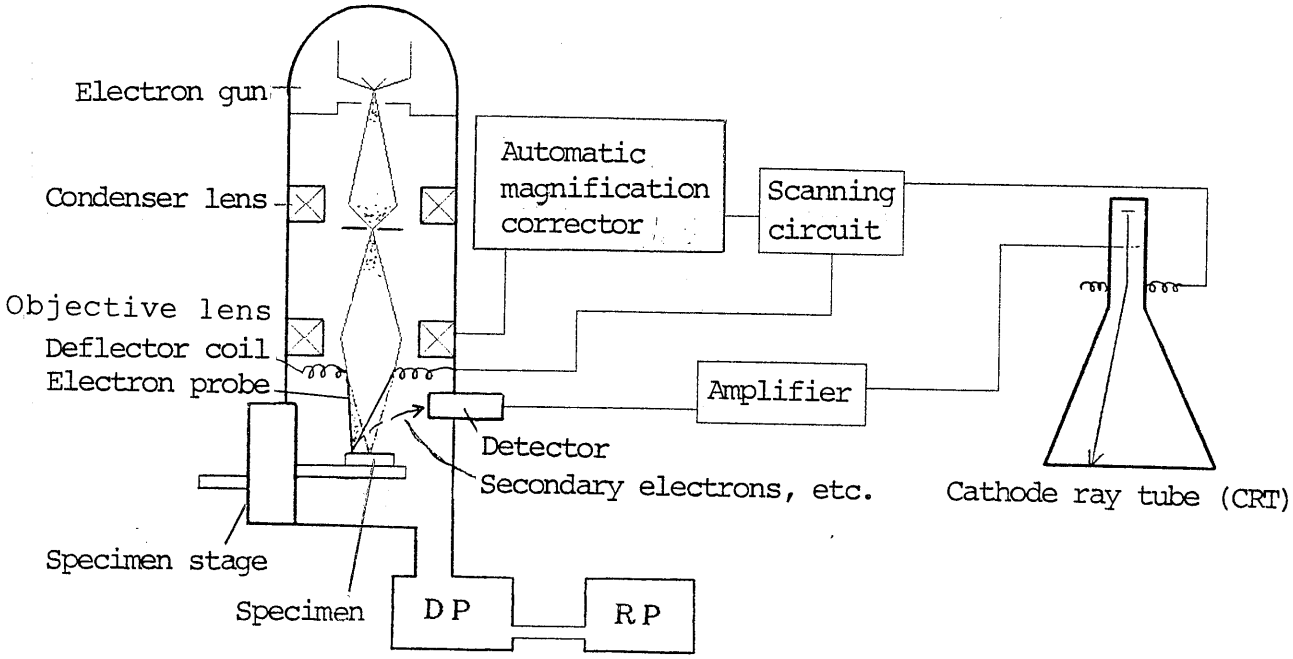


Fig. 4.1-3

Scanning microscope is composed of:

I Electron optical system

(1) Electron gun as source of electron beam

(2) Lens system to form electron fine probe

(3) Astigmatism correction device that makes the fine formed electron beam (electron probe) in true roundness

(4) Scanning system to control magnification

II Specimen stage

(5) Specimen stage equipped with movement mechanism

Ⅲ Display and recording system

(6) Detector that detects the signal generated by interaction of electron probe and specimen and amplified the signal by converting it to electric signal.

(7) Display and recording system that displays and records (photography)

Ⅳ Vacuum system and checker

(8) Vacuum system to evacuate

Besides, this microscope builds inside (9) the automatic and manual checkers to check up the operation status. Consequently, the microscope can grasp the using conditions such as load current* of filament, condenser lens current and objective lens current, and its inspection and maintenance are very easy.

* This is load current to flow to the filament circuit as reference of filament heating current.

4.1.5 Component Functions of Scanning Microscope

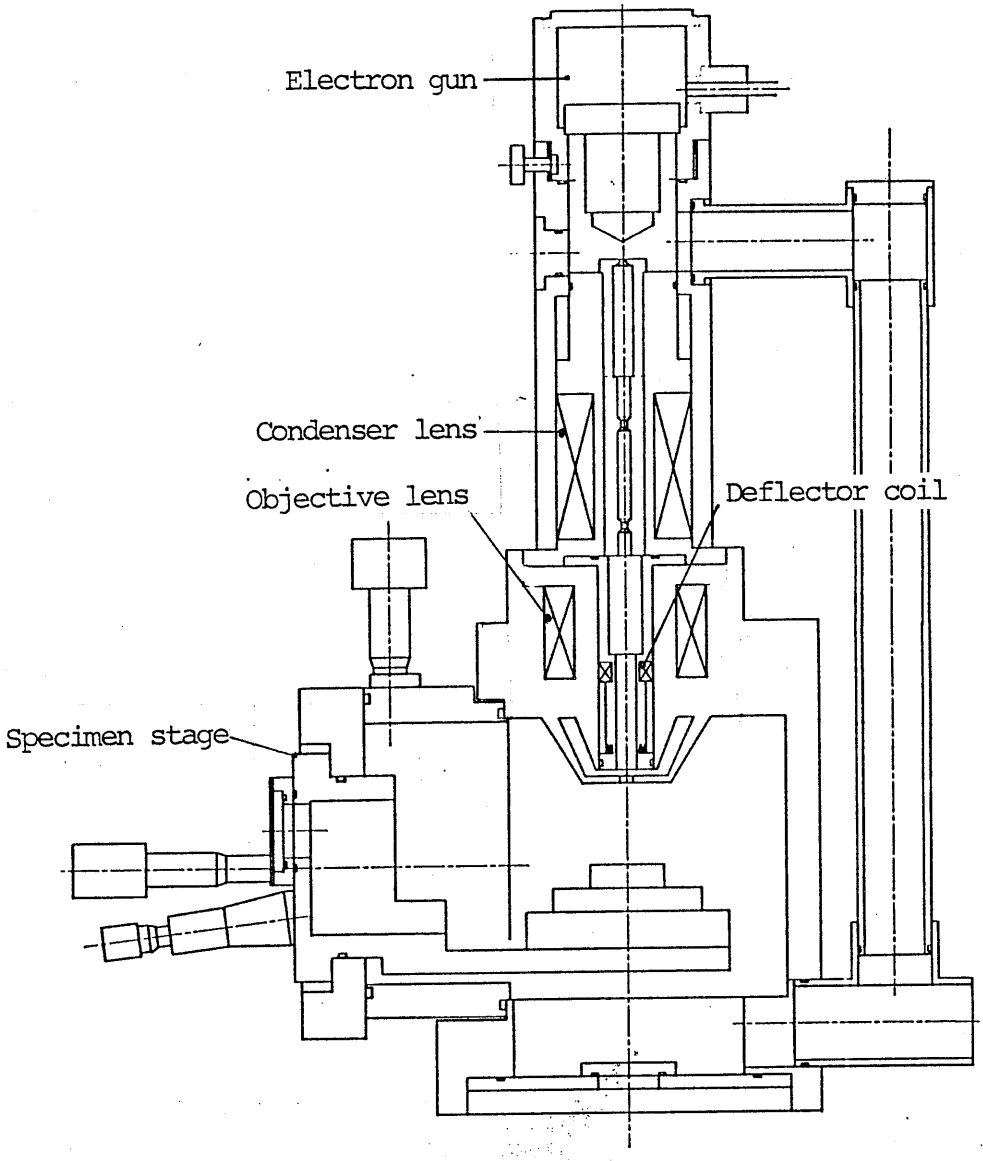


Fig. 4.1-4

I Electron Optical System

1. Electron Gun

   It is composed of Wehnelt and filament. Thermal electrons emitted from lead end of heated filament are concentrating and high voltage applied to anode accelerates the electrons to make electron beams.

2. Electromagnetic Lens System

   This system is composed of condenser lens and objective lens. These lenses reduce electron beams emitted from electron gun into electron probe in several nm ~ several 10nm and the electron probe is irradiated onto the surface of specimen.

3. Astigmatism Correction Device

   This device is composed of 2 sets of electromagnets each with a pair of 4 poles and corrects the electron probe into true roundness. Due to astigmatism, the forcus position is generally different by lens system and specimen in direction where sections of the electron probe intersect directly. Therefore, if it is in defocus, image is blurred and even if it is in focus, the image is dull focused by larger diameter of probe. For solution, the electron probe is made to formed more finely by meeting the each focus in the intersecting direction so as to obtain very sharp image.

4. Scanning System

   This system is composed of deflector coil to deflect electron probe horizontally and vertically and to operate over the surface of specimen and the scanning circuit. It controls magnification by changing the scanning width over the surface of specimen, and also controls the scanning speed.

5. Specimen Stage

This stage is equippped with the mechanism to move the specimen placed in vacuum in high precision so as to allow the observation of each specific position of specimen.

II Detection and Display System

6. Detector

This detector is composed of secondary electron correction electrode (collector), scintillator and photomultiplier tube (PMT).

The signal intensity of secondary electron and backscattered electron emitted from specimen are converted to intensity of light by scintillator, and then converted into electrical signals and amplified with PMT.

Optionally available are semi-conductor type backscattered electron detector, transmitted electron detector, X-ray detector, (infrared) cathodoluminescence detector and amplifier for electromotive force image.

7. Display and Recording System

This system is composed of control circuit for electrical signal from detector, CRT and camera. It displays on CRT screen the image obtained by signal from detector and photographs the image with camera for recording.

III Vacuum System and Checker

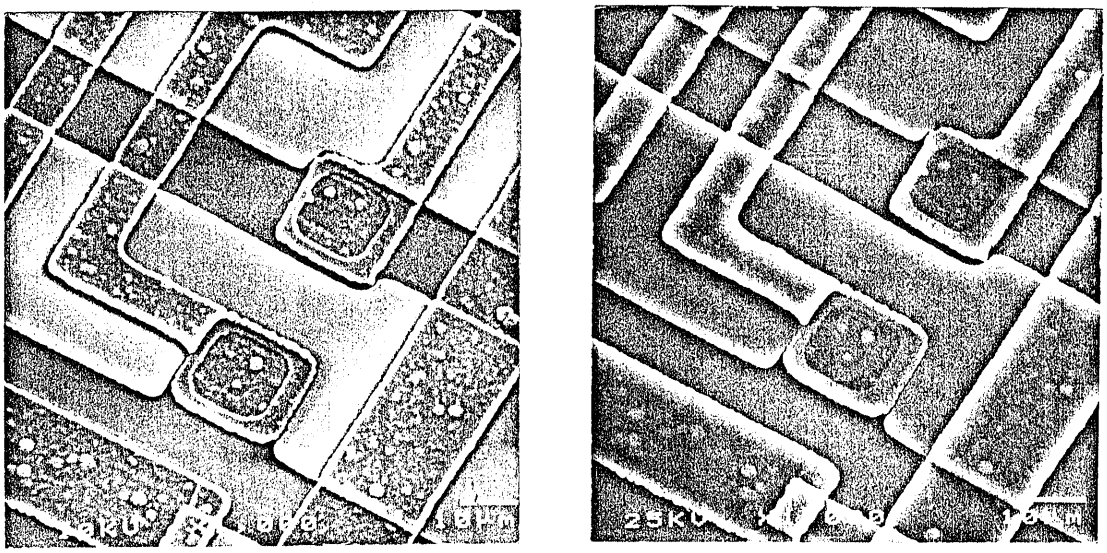
8. Vacuum Evacuation System

   This system is composed of oil rotary pump (RP) for roughing, oil diffusion pump (DP) for high-vacuum evacuating and the circuit to control the vacuum sequence. It evacuates to keep electron gun and the inside of lens (in column) in high vacuum in order to avoid scattering of electron beams. Vacuum system is controlled automatically.

9. Checker

   The checker is composed of auto checker for automatic checkup of 4 items and manual checker for manual checkup of 10 items.

4.2 Selection of Accelerating Voltage



Low accelerating voltage High accelerating voltage

Fig. 4.2-1

Accelerating Voltage (KV)	0.5～3　5～10～15～20～25～30	Remarks
Resolution	⟹ High	
Specimen charge-up	Good ⟸	No coating or insufficient coating specimen
Effect of specimen contamination	⟹ Less	Biological or high-polymer specimens; excessive beam irradiation
Specimen damage	Less ⟸	
Image quality	Soft ⟺ Hard	} Edge effect makes edge brighter.
Signal in concavity	⟹ Rich	

Table 4.2-1 Effects of Accelerating Voltage
(Inside ⟹ indicates an advantage.)

* Specimen charge-up:	A part of screen grows specifically brighter by charge-up of electron.
Specimen contamination:	Contamination of specimen makes image darker and/or edge becomes not sharp.

1. Most commonly used accelerating voltage is in the range between 20kV and 30kV, but it should be changed for special specimens and purposes.
   - Resolution
     Resolution is higher with higher accelerating voltage by the reasons that (1) electron gun is in higher brightness and (2) electron probe can be concentrated more finely.
   - Specimen Charge-up
     If accelerating voltage is higher, electrons penetrate to the specimen more deeply. This makes more electrons deposit in it and charge it up much more easily. Therefore, if the specimen is not coated or coated insufficiently, low accelerating voltage is preferable. Coat metal if high accelerating voltage is used.
   - Effect of Specimen Contamination
     Contamination indicates the contamination on the surface of specimen and its effect is much less with high accelerating voltage, as this makes electrons penetrate to the specimen more deeply.
   - Specimen Damage
     High accelerating voltage damages the specimen easily. Accordingly, coat the metal as a rule if high accelerating voltage is used. If the specimen is not coated or insufficiently coated, low accelerating voltage should be selected.

- Image Quality

  If the accelerating voltage is higher, signals from the edges of specimen are produced more due to the edge effect and this makes the image in higher contrast. Contrarily, if the accelerating voltage is lower, the image is softer as a whole with less edge effect.

  Moreover, generation of secondary electrons reaches to the peak in the range between 0.5kV and 1kV and this indicates that the optimum accelerating voltage is selectable dependently on the type of specimens.

- Signal in Concavity

  Electrons penetrates more deeply into the specimen, if the accelerating voltage is higher and this increases signals in concavity.

2. Adjust [LD CUR.] meter reading with bias control so as to fall within the range as specified in the following table in order to obtain the optimum image at the time of changing the accelerating voltage. However, turn the bias control fully clockwise before selecting meter reading at the time when changing the high accelerating voltage from low accelerating voltage.

Accelerating voltage	0.5 ~3kV	5 ~30kV
Meter reading	0.3 ~ 0.5	0.5~0.6

Table 4.2-2

Note: As the total use time of filament increases, use position approaches to 12 o'clock.
If the bias control is at same position:
A. Meter reading increases when accelerating voltage is changed over to high from low.
B. Meter reading decreases when accelerating voltage is changed over to low from high.

4.3 Effects of Electron Probe Diameter (SPOT SIZE)

[SPOT SIZE] control	Turned counter-clockwise	Turned clockwise
Condenser lens current	More	Less
Electron probe diameter	[Small]	
Resolution	[High]	
Incident electron beam current		[More]
Specimen damage	[Less]	
Secondary electron signal		[Rich]
Image quality	Noisy	Smooth
Image selection	Secondary electron image (SEI)	Backscattered electron image (BEI)

Table 4.3-1 Spot Size Effect (inside ▭ indicates an advantage.)

[SPOT SIZE] control is used to change excitation current of condenser lens and it has various effects as shown in Table 4.3-1, since incident electron beam current changes together with electron probe diameter.

It is cheifly used as below:

- High resolution — 7 o'clock ~ 8 o'clock
- Normal use position — 8 o'clock ~ 10 o'clock
- Rich signal use position — 10 o'clock ~ 2 o'clock
- Backscattered electron & TV mode — 12 o'clock ~ 3 o'clock
- X-ray analysis (FCS) — 12 o'clock ~ 3 o'clock
  (Set objective lens apeature to No. 3.)

4.4 Focusing and Astigmatism Correction (FOCUS & STIGMATOR)

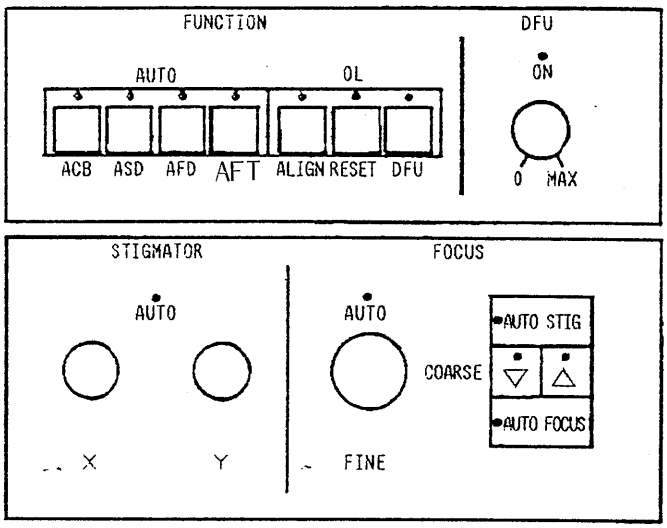


Fig. 4.4-1

4.4.1 How to Use Focusing Device (COARSE button & FINE control)

Focus by change objective lens current.

[▽]: Objective lens current decreases at each pressing. LED lights at minimum current (MIN).

[△]: Objective lens current increases at each pressing. LED lights at maximum current (MAX).

[FINE] control: Objective lens current increases by turning this control clockwise.

Automatic Magnification Corrector (MAC) corrects the magnification automatically by foucsing.

4.4.2 How to Use STIGMATOR (X control & Y control)

Use X control and Y control for manual correction of astigmatism. Correction with X control and Y control may fail if it is tried after operation of Automatic Astigmatism Correction Device (ASD). In such a case, reset astigmatism as follows.

Astigmatism resetting

Turn off the [AUTO] [AFD] , [AUTO] [ASD] switches and keep to press the [AUTO STIG] start button for a second or more. Then, LED lamp is flashing and goes out when a astigmatism resetting have been finished. The message of "ST RESETTING" is displayed on the CRT with [HT] switch at ON and [SCANNING] [SPEED] at SLOW1.

Try again the operation of astigmatism correction.

4.4.3 How to Use Automatic Focusing Device (AFD), Automatic Focus Tracer (AFT) And Automatic Astigmatism Correction Device (ASD)

AUTO Switch		Start Switching		FOCUS	STIGMATOR
AUTO AFD	AUTO ASD	AUTO FOCUS	AUTO STIG	AFD	ASD
OFF	OFF	—	—	×	×
OFF	ON		1	×	○
ON	—	1		○	×
ON	OFF		1	×	○
ON	ON		1	○	○

Table 4.4- 1

○ : Operable

× : Not operable

— : Not related

Note: • When the magnification is 10,000 × or more, the combined work of AFD • ASD is effective in the range of the FOCUS FINE.

• "1" in Start Switching (AUTO FOCUS, AUTO STIG) means to press once.

The above description summarizes operation of Automatic Focusing Device (AFD), Automatic Focus Tracer (AFT) and Automatic Astigmatism Correction Device (ASD).

1. Automatic Focusing Device (AFD) And Automatic Focus Tracer (AFT)

The AFD and AFT operate at both TV mode and SLOW mode with microprocessor (CPU) control.

Specimen can be positioned at any working distance between 8mm and 48mm.

In AFT mode, the focus is automatically adjusted by automatic detecting the defocus caused by specimen change or changeover of accelerating voltage.

Note, however, that magnification may change during auto mode operation and it is settled to the magnification set by MAGNIFICATION control after the operation.

The AFT operates at the [AUTO] [AFD] and [AFT] switches ON only.

Note: When the AFD or AFT is used, if the specimen has low contrast or images are grainy due to noises, the devices may not work properly. In such a case, the amount of signals such as contrast should be increased.

2. Automatic Astigmatism Correction Device (ASD)
   Astigmatism correction has been difficult job, but now it is easily corrected just by pressing the button. Moreover, both focus adjustment and astigmatism correction can be made at the same time. Note, however, that magnification may change during auto mode operation and it is settled to the magnification set by MAGNIFICATION control after the operation.

   Note: When the ASD is used, if the specimen has low contrast or images are grainy due to noises, the device may not work properly. In such a case, the amount of signals such as contrast should be increased.

3. Full Auto Function (at Instrument Startup)
   The focus adjustment and astigmatism correction can be made automatically by full auto function at the time of instrument startup.

   1 Set up filament switches for full auto function. Perform the following operation before turning HT ON.

   2 [AUTO] [AFD] switch ON

   3 [AUTO] [ASD] switch ON (OFF does not make astigmatism correction.)

4. Resetting

Resetting operation is required for the following cases

- Stigma reset: When manual correction of the astigmatism is not successful with X and Y controls after AUTO ASD operating.

  ↓

  Turn OFF the [AUTO] [AFD] , [AUTO] [ASD] switches and keep to press the [AUTO STIG] start button for a second or more. Then, LED lamp is flashing and goes out when a astigmatism resetting have been finished.
  The message of "ST RESETTING" is displayed on the CRT with [HT] switch at ON and [SCANNING] [SPEED] at SLOW1.

- CPU reset: When auto function works abnormally, press the CPU resetting switch at the rear panel.

5. Hard conditions for Operating Auto Function

- Signals in specimen are not enough and image is not clearly seen.
  → Adjust SPOT SIZE and CONTRAST controls.
- Structure of specimen is less.
  → Make viewing field with much structure
- Specimen is charged up and contrast is abnormal.
  → Adjust accelerating voltage, SPOT SIZE and CONTRAST controls.

4.4.4 Dynamic Focusing Unit (DFU)

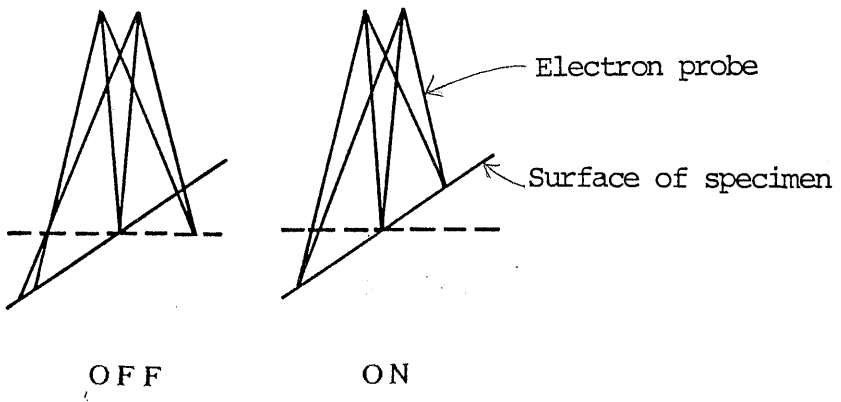


Fig. 4.4-2

Scanning microscope has a large depth of focus, but the focul length is different between center and both ends of the image when the specimen is largely tilted. This causes defocus. It occurs easily especially in low magnification.

Dynamic Focusing Unit (DFU) corrects objective lens current by synchronizing with scanning on the specimen so as to obtain the image with focus over the whole viewing field.

Use it in the following procedure:

1 Adjust focus to the center of viewing field with the specimen tilted.

2 Turn ON [FUNCTION] [OL] [DFU] switch.

3 Turn [DFU] control to focus the whole viewing field.

Note: It is usable at SLOW mode only (not at TV mode). Since the depth of focus is large at high magnification, the focus will be adjusted to almost whole viewing field without using DFU.

4.4.5 Selection of Objective Lens Aperture (MAP)

No.	1	2	3
Aperture diameter (μm ø) standard	100	200	350
Aperture diameter (μm ø) with FCS	100	200	600
Depth of focus	Deep ⟸		Shallow
Probe current	Less ⟹		More

Table 4.4-2 Effects of Objective Lens Aperture
(⟹ indicates an advantage.)

Use aperture at No. 2 as usual.

But aperture diameter can be changed so as to meet with each specific purpose and specimen as shown in Table 4.4-2.

E.g., · Extremely topographic specimen
Enlarge depth of focus — Small aperture diameter
· Poor signal specimen
Increase incident electron beam current — Large aperture diameter

Especially for X-ray analysis (FCS), use 600μmø aperture at No. 3 so as to use large aperture diameter in order to increase incident electron beam current.

Follow procedure in item「3.9.2 Objective Lens Aperture Alignment」for alignment at the time of changing aperture diameter.

4.5 Scanning System

4.5.1 Scanning Mode

LSP : It scans on the line of specimen surface that passes at the center of image and it comes at upper on the CRT if the signal is more rich.

SPOT: EOS scan is spot and CRT is frame scan. Irradiating position is at the center of image and this is usable for X-ray analysis (spot analysis) by EDS etc.

YMD : Y-modulated images are something like frame scan of LSP and it comes upper on the CRT if the signal is more rich.

PIC : This is usual mode for image observation. When TV mode is used from LSP, SPOT and YMD modes (or vice versa), select the mode after setting to SLOW mode with PIC.

4.5.2 Scanning Speed

SPEED	SLOW			TV	PHOTO	
	EXP	SLOW1	SLOW2		QUICK	NOR
Scanning speed	0.22 SEC	0.33 SEC	10 SEC	16.6mSEC	36 SEC 30 SEC	90 SEC (50Hz) 75 SEC (60Hz)

Scanning speed: This is the time when scanning line moves downward from upper position.
Time at EXP, SLOW1, SLOW2 and TV indicates the value when each of these switches is pressed.

4.5.3 TV Scanning

1. TV scanning is adjust at EIA type for V=60Hz (Japan/U.S.A. Standards) or CCIR type for V=50Hz.
   TV image signal can be output easily from TV output terminal.
   - Output terminal : BNC-R connector
   - Output impedance : 75 ohms
   - Output signal : Composite video signal, positive polarity, $1V_{p-p}$, H = 15.75kHz, V = 60Hz (EIA), 50Hz (CCIR)
2. Use of attachment together at TV mode
   At TV mode, following attachments cannot be used.
   - BCX, BEIS, CD32, DFU*, EMF, MCR, RRD, VCD
   - CLD/CLDIR, TED (usable if MDD is not mounted together.)

   DFU*: Dynamic Focus (Tilt correction)
3. If magnification display flickers at TV mode, the magnification may be out of correction range.

4.5.4 Automatic Magnification Corrector (MAC)

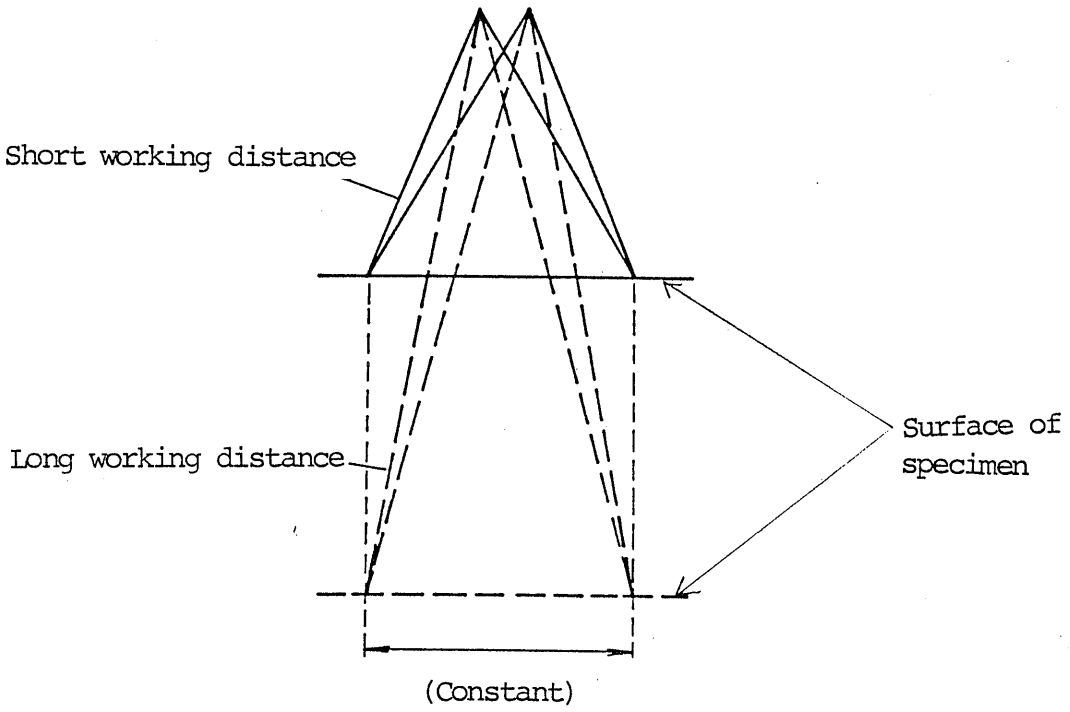


Fig. 4.5-1

It controls the deflector coil current to make magnification same as indicated by means of objective lens current when focusing the specimen.

1. Magnification display may be uncorrectly due to the characteristic of objective lens if working distance and accelerating voltage are largely changed.
   In such a case, corrected magnification can be ensured with the following procedure:
   ① Press [FUNCTION] [OL] [RESET] switch on the control panel.
   ② Adjust the focus of image.
   ③ Repeat the above steps ① and ② until the focus is stabilized.
2. If magnification display flickers at TV mode, the magnification may be out of correction range.

-	(15)	-	(35)	(50)	75
100	150	200	350	500	750
1,000	1,500	2,000	3,500	5,000	7,500
10,000	15,000	20,000	35,000	50,000	75,000
100,000	150,000	200,000			

Table 4.5-1

WD (mm)	Minimum magnification
～ 9	75X
9 ～ 18	50X
18 ～ 40	35X
40 ～	15X

Table 4.5-2

3. Magnification is just as specified (Table 4.5-1).
4. Minimum magnification is different for each working.

4.5.5 Viewing Field Fine Shift (Image Shift)

Maximum movement of viewing field is different for each working distance and accelerating voltage.

WD 20mm: ±10μm (30kV), ±55μm (1kV)

30kV: ±6.5μm (WD10mm), ±10μm (WD20mm),
±16.3μm (WD38mm), ±19.7μm (WD48mm)

4.6 Specimen Stage

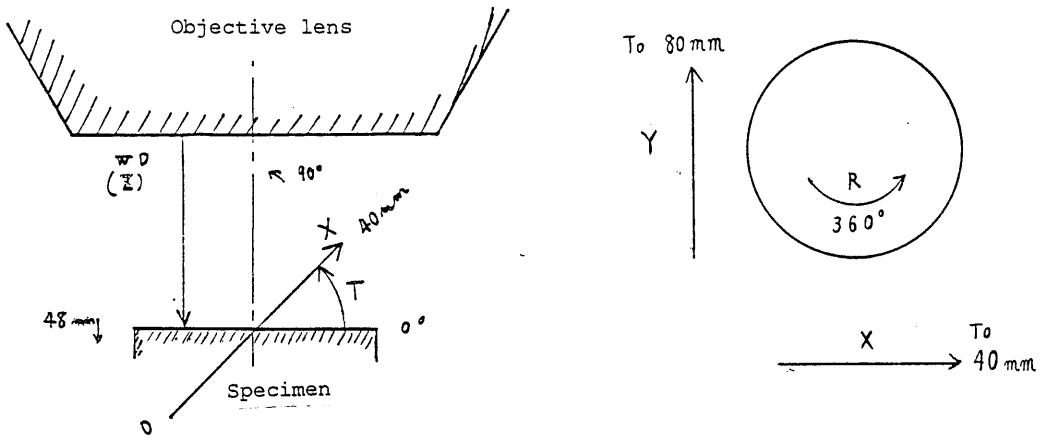


Fig. 4.6-1

Specimen stage has X and Y controls for lateral movement of specimen, Z control for vertical movement, T (tilt) control for counterclockwise movement as seen from the front of specimen stage and R control for rotary direction of the specimen.
Besides, Z direction is that for distance between objective lens and specimen (working distance: WD).

Note, however, that the movement range of specimen is different depending on the size of specimen, type of specimen stage and of attachment (only for mounting the specimen chamber).

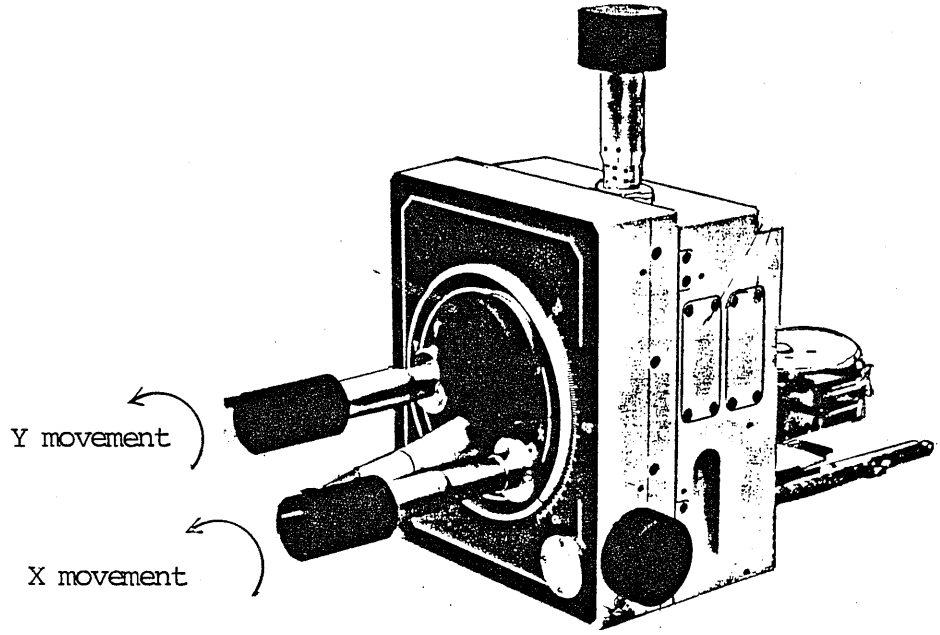
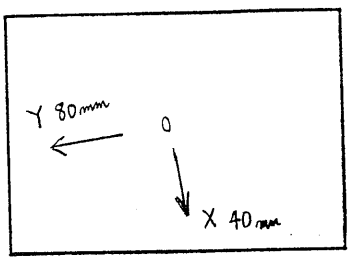
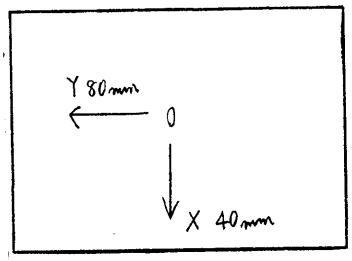


Fig. 4.6-2

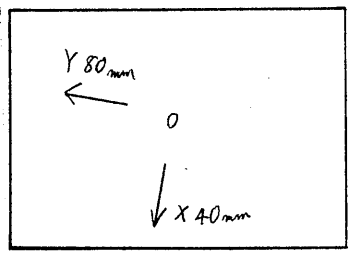
In case of movement as illustrated above, the viewing field rotates dependently on the working distance, and accordingly, each movement direction on CRT screen is also different as below.



WD 10mm



WD 20mm



WD 48mm

4.7 Detector

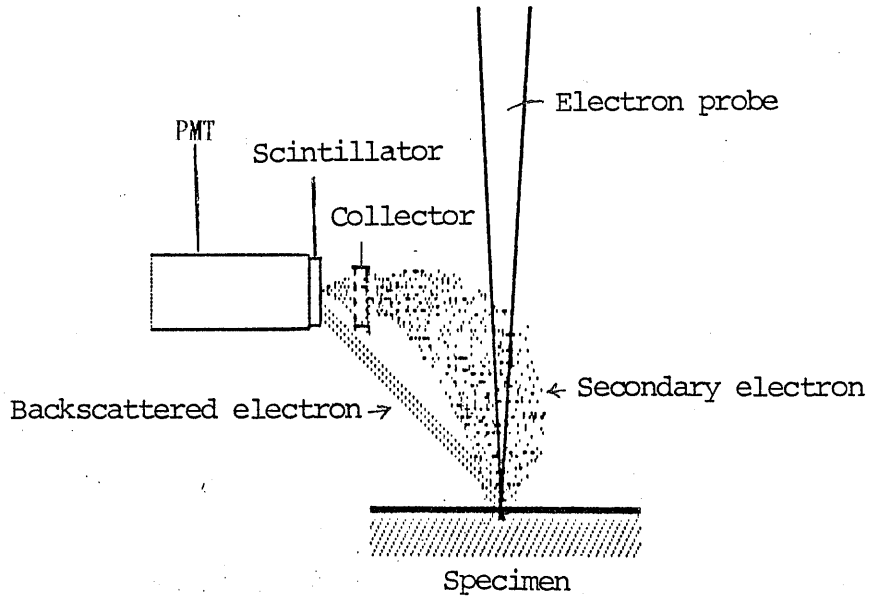


Fig. 4.7-1

In addition to secondary electrons, backscattered electrons are also ditected slightly into the detector as usual and this obtains the backscattered electron image (backscattered electron image mixed up with topographic and composition images) with collector's voltage as negative potential.

- Selection of secondary electron image or backscattered electron image:
  DET SEI : Secondary electron image
  DET BEI : Backscattered electron image

- Sensitivity is low for observation of backscattered electron image. For solution, increase the incident electron beam current by turning [SPOT SIZE] control clockwise. Observe the backscattered electron image at 12 o'clock~3 o'clock.
  But optional backscattered electron detector (BEIS) can be same as the observation of secondary electron image.
- The following detectors are supplied as optional.
  - Backscattered electron detector (BEIS)
  - Transmitted electron detector (TED)
  - X-ray detector (EDS and WDS)
  - Cathodoluminescence detector (CLD),
    Infrared cathodoluminescence detector (CLDIR)
  - Electromotive force (EMF)

4.8 Display System

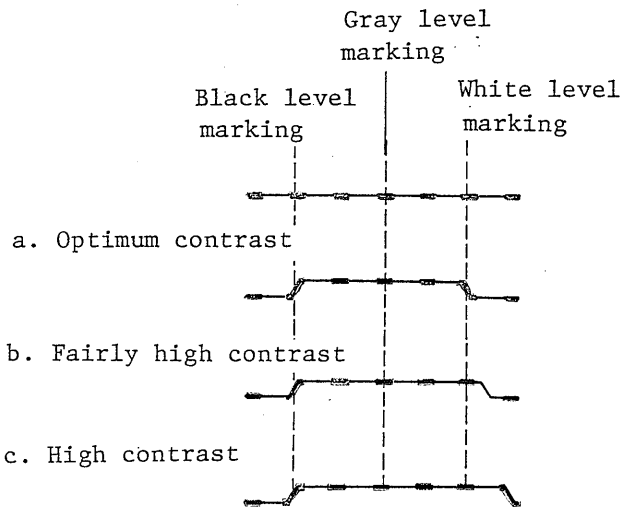


Fig. 4.8-1

4.8.1 Rapid Exposure

Appropriate image quality is obtained by setting the marker of rapid exposure in optimum.

The exposure marker has been adjusted so that the appropriate exposure is obtained for photography when the lens aperture of Camera for Scanning Image (CSI) is set to 11 and ISO 75 film is used.

Furthermore, an even better photograph that satisfies the nature and condition of specimen or a photo with image quality you want can be obtained by employing the following procedure.

1. Higher Contrast Images

   Turn [CONTRAST] control clockwise to make contrast higher (brightness of the whole image is also increased). Then, adjust so that the exposure marker width is made wider than the width of black level and white level marking.

   At the same time, always make the left edge of the exposure marker width align with the black level marking, by adjusting [BRIGHTNESS] control (image darkens when control turned counterclockwise).

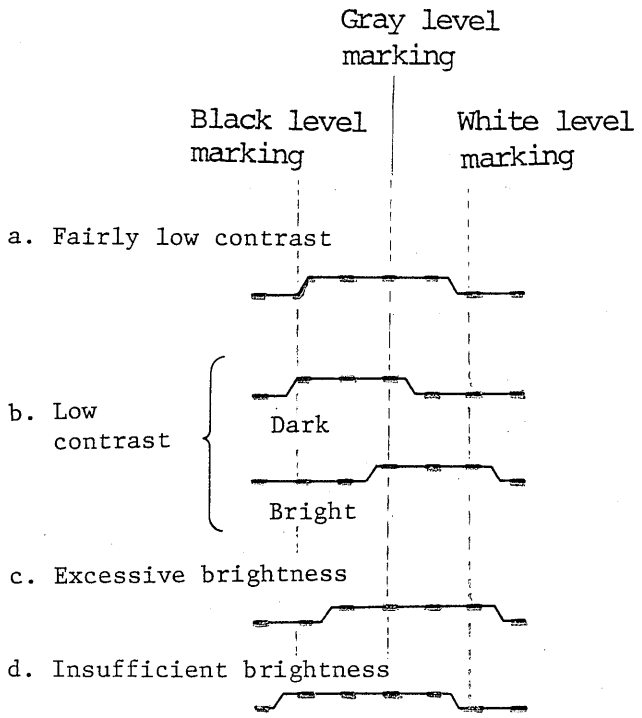


Fig. 4.8-2

2. Lower Contrast Images

   Turn CONTRAST control counterclockwise to make lower contrast (brightness of the whole image is also decreased) and adjust so that exposure marker width is made narrower than the width of black level marking and white level marking.

3. Change of Photo Brightness

   To brighten: Turn BRIGHTNESS control clockwise. But, brightness is excessive if the center of exposure marker width is positioned at the right of gray level marking.

   To darken : Turn BRIGHTNESS control counterclockwise. But, brightness is insufficient if the center of exposure marker width is positioned at the left of gray level marking.

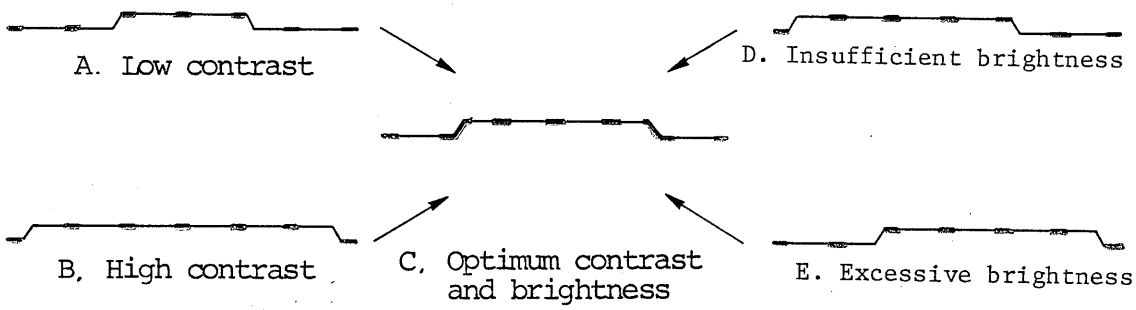


Fig. 4.8-3

4.8.2 Automatic Contrast & Brightness Control (ACB)

By presetting method, Automatic Contrast & Brightness Control (ACB) can maintain the optimum contrast and brightness if the contrast and brightness is kept by exposure marker within the range as illustrated in Fig. 4.8-3, even if brightness and magnification change. (Adjust with controls to obtain optimum contrast and brightness in magnification at approx. 1,000X).

1. Adjust the contrast and brightness with exposure marker to fall within the range as illustrated in Fig. 4.8-3.
2. Press [AUTO] [ACB] switch to turn ON (LED also turns ON).

Note: ACB does not operate at TV mode, but it does not brighten excessively.

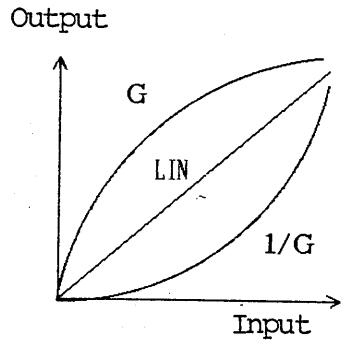


Fig. 4.8-4 I/O Characteristics of Image Signals

4.8.3 Gamma Control (GAMMA)

Usually, the control is set to [LIN]. This control is used especially when you change contrast of a part of image in case that the image quality of whole screen is optimum.

[G] : To emphasize the dark region details.

[1/G] : To emphasize the light region details.

4.9 Camera for Scanning Image (CSI)

4.9.1 Camera for Scanning Image (CSI) And Film

The various cameras for scanning image to meet with each specific film are available so as to eliminate the need for focusing job when you change the film size.

Type (holder)	Photo-graphing ratio to CRT	Available film and number of exposure
CSI1 (MRH) Fig. 4.9-1	0.5	Brownie roll film: J 120, ISO 50, 100, 200, etc. (negative); 10 exposures per roll
		Brownie roll film: J220, ISO 100, 400, etc. (negative); 20 exposures per roll
CSI2 (PPH) Fig. 4.9-2	0.75	Polaroid Land film pack; type 105 or 665, ISO 75 (positive/negative); 8 sheets per pack
		Polaroid Land film pack (positive) Type 611 (No coating type) ISO 200 Type 107 (ultrahigh speed) ISO 3,000 Type 667 (No coating type) ISO 3,000 8 sheets per pack
CIS3 Fig. 4.9-3	0.25	35mm roll film; J 135, ISO 50, 100, 200, 400 etc. (negative); 12, 20, 24 or 36 exposures per roll
CSI5 (PSH) Fig. 4.9-4a	1.0	Polaroid Land sheet film Type 51 (high contrast) ISO 200 Type 52 (wide latitude) ISO 400 Type 55 (positive/negative) ISO 50 Type 57 (ultrahigh speed) ISO 3,000 20 sheets per pack
CSI5 (PPH2) Fig. 4.9-4a	1.0	Polaroid Land film pack (positive) Type 552 (wide latitude) ISO 400 Type 553 (No coating type) ISO 800
CSI6 Fig. 4.9-5	0.85	Polaroid auto film (positive) Type 331 (high speed) ISO 400 10 sheets per pack

Table 4.9-1

MRH : Mamiya Roll Film Holder (Type 2, 6 X 7)
PPH : Polaroid Pack Film Holder (Type 2)
PSH : Polaroid Sheet Film Holder #545 (50A-PRH)
PPH2 : Polaroid Pack Film Holder 4 X 5 (SM-PRH1)

Note: Although MRH and PPH film holders are interchangeable, the whole screen cannot be photographed owing to their different film sizes if MRH is installed on CSI2. Also, installation of the PPH onto CSI1 lowers film utilization scope.

4.9.2 Specifications of Camera for Scanning Image

Type	Lens	Aperture	Shutter	Reduction ratio	Optional Holder	Others
CSI1	F=4.5, f=75mm	4.5 ~ 22	Manu & Auto	0.5	MRH	
CSI2	F=4.5, F=75mm	4.5 ~ 22	Manu & Auto	0.75	PPH	
CSI3	F=3.5. f=55mm	3.5 ~ 22	Manu & Auto	0.25		PSC
CSI5	F=4.5, f=75mm	4.5 ~ 22	Manu & Auto	1.0	PSH,PPH2	
CSI6	F=4.5, f=75mm	4.5 ~ 22	Manu & Auto	0.85		Power ON/OFF

Table 4.9-2

PSC : AC adapter for CSI3

CSI6 : Power supply switch is provided at the back of camera in addition to manual and automatic shutters.

F : Indicates brightness of lens, or ratio between focus distance f and lens diameter.

Automatic shutter: This shutter controls scanning and exposes one frame only and it can perform data ON/OFF.

Manual shutter : Shutter opens/closes at each pressing of this shutter irrespective of scanning. The manual shutter should be closed as usual, and when it opens, exposure monitor keeps on working.

4.9.3 Component Parts of Camera for Scanning Image

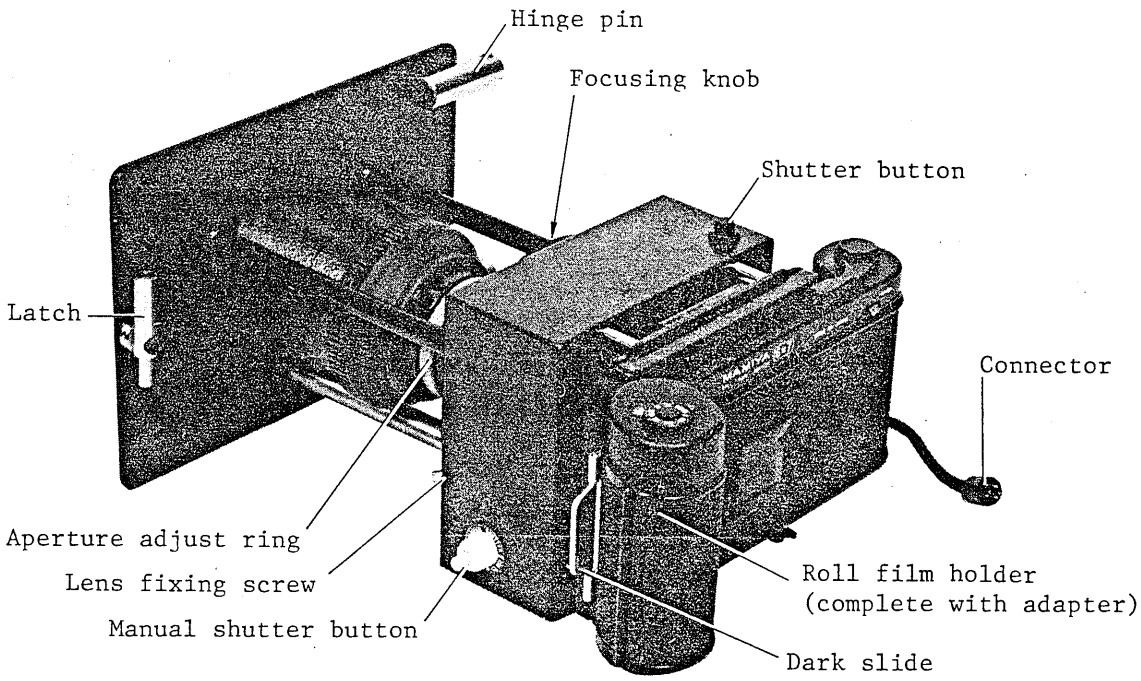


Fig. 4.9-1 CSI1

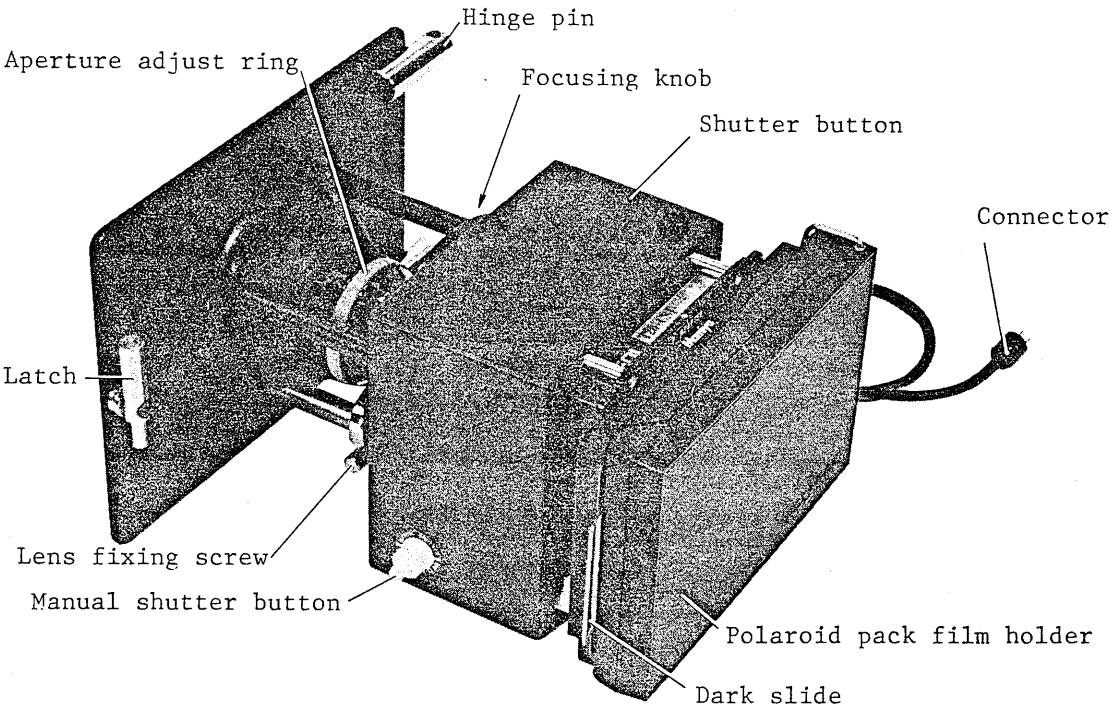


Fig. 4.9-2 CSI2

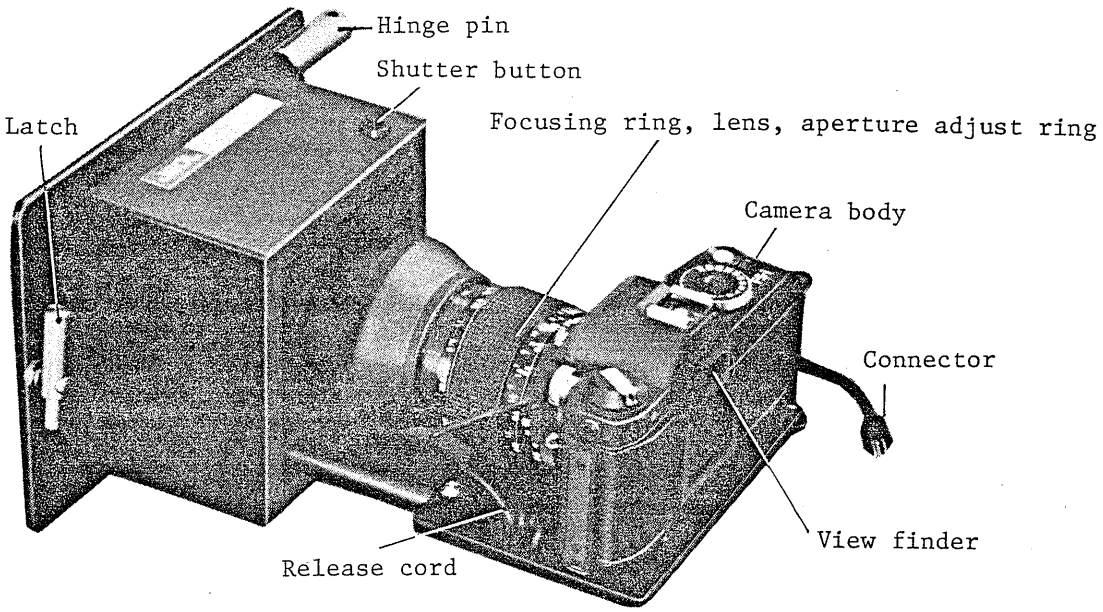
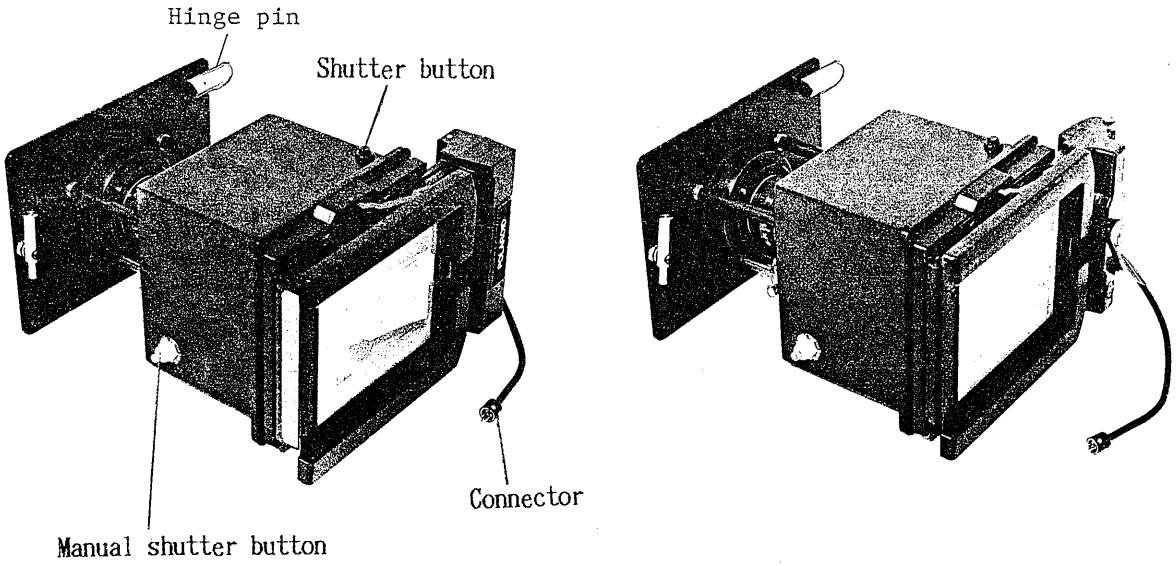


Fig. 4.9-3 CSI3



Polaroid #550
pack film holder

Polaroid #545
sheet film holder

Fig. 4.9-4 CSI5

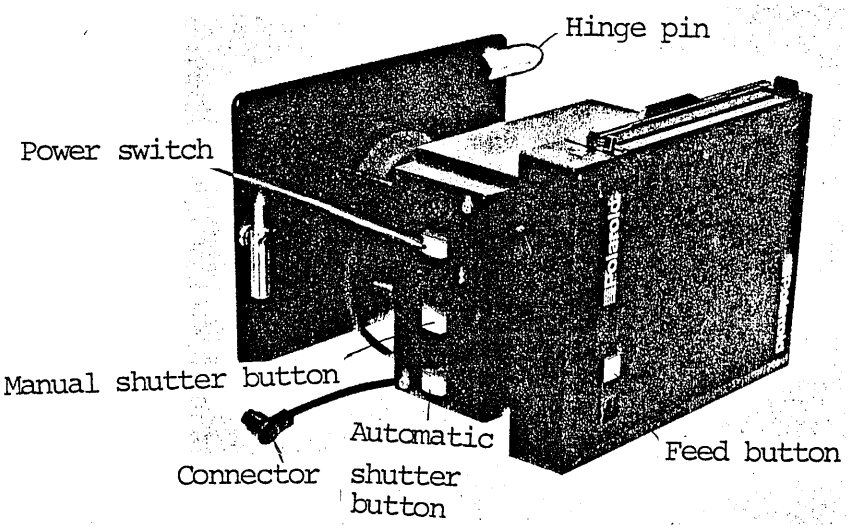

Hinge pin
Power switch
Manual shutter button
Automatic shutter button
Connector
Feed button
Polaroid

Fig. 4.9-5 CSI6

CSI5 Mounting

1. Focusing Glass

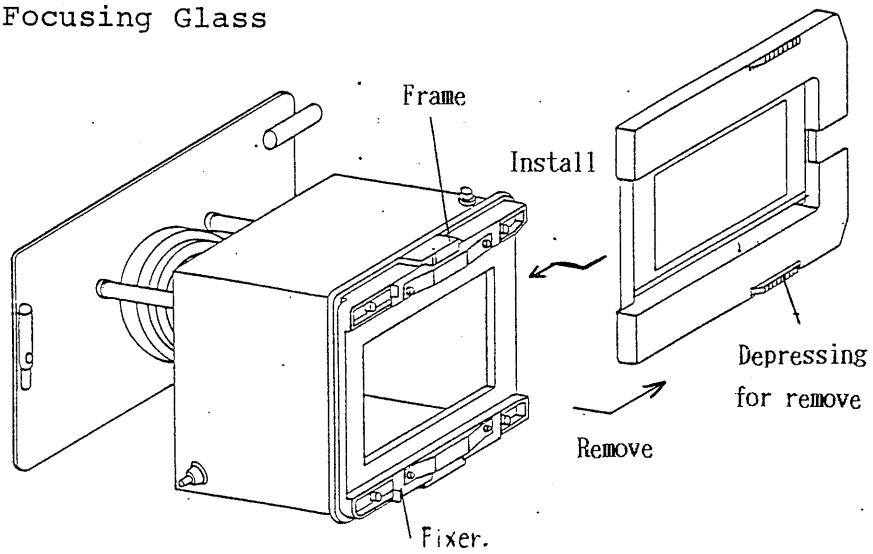


Fig. 4.9-6

Note: Frame should be slided for mounting PSH (#545) film holder. Refer to item 3 PSH for further details.

2. PPH2 (#550) Film Holder

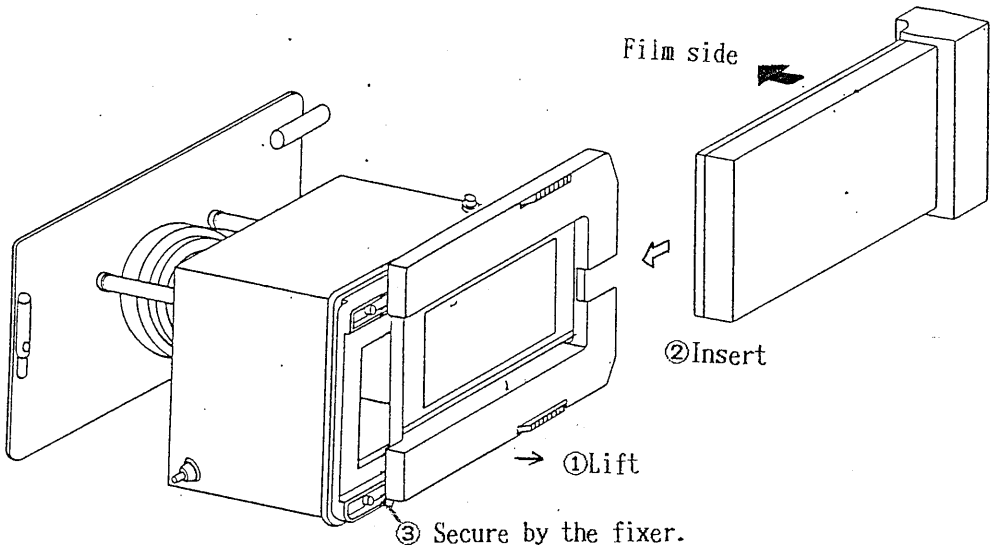


Fig. 4.9-7

Note: Focusing glass can be removed if PPH2 is fixed by the fixers.

3. PSH (#545) Film Holder

   a. Remove focusing glass, slide the frame fully to the left end and fix it.

   b. Install PSH same as PPH2.

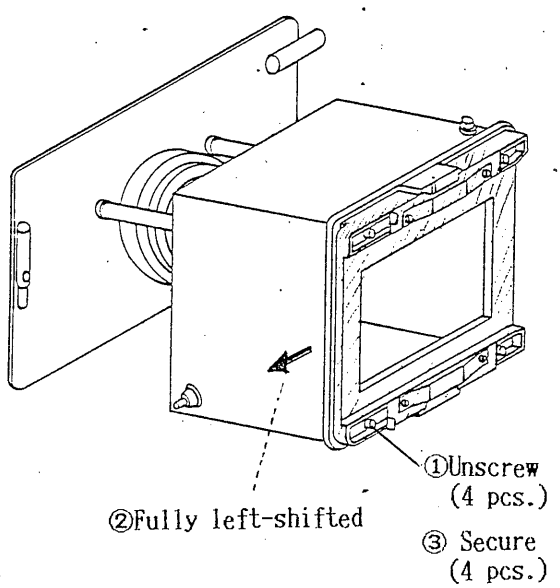


Fig. 4.9-8

Note: Mount the film holder after sliding the frame fully to the right end for replacing PSH with PPH2.
Shift of frame: Approx. 3mm

4.9.4 Aperture Value Setup

Film sensitivity ISO	Film sensitivity DIN	Recording CRT-PRD, Ultrahigh resolution CRT-UHR (NOR mode) Aperture value (CSI3)	Ultrahigh resolution CRT-UHR (UHR mode) Aperture value (CSI3)
50	18	f 8 (f11)	——
75~100	20~21	f11 (f16)	——
200	24	f16 (f22)	——
400	27	f22 (——)	f8 (f11): Develop in 4 X sensitivity.
3000	36	f22 with ND4 filter	f11 (f16)

Table 4.9-3

ND4 filter: This filter reduces quantity of light to 1/4. Purchased filter in 52mm dia. is available.

- Set up aperture value of CSI so as to meet the film (exposure marker standard).
- Ultrahigh resolution CRT-UHR has 2 modes:
  NOR mode; films with sensitivity up to ISO 400 (the resolution is a little lower than the cases at UHR mode).
  UHR mode; ultrahigh resolution recording mode
- Use of ultrahigh speed Polaroid film
  For recording CRT and ultrahigh resolution CRT-UHR (NOR mode), use usually polaroid films, type 105, 665, 52 and 55.
  Note: Types 107 and 57 are high speed type corresponding to ISO 3,000. Their film particle is rough in narrow latitude and resolution is low as compared with types 105, 665, 52 and 55. Accordingly, use of film types 105, 665, 52 and 55 is recommended, since it is difficult to take good photography with film types 107 and 57.

To use high speed film types 107 or 57, keep the following points in mind:

1. Fix the purchased screwing type filter in ND4 diameter 52mm to the front side of camera lens (this filter is not attached to the camera as standard).
2. Set the aperture to f22.
3. Adjust contrast a little lower on exposure marker to take photography.

4.9.5 Preparation of Camera for Scanning Image (CSI)

Each type of CSIs can be handled almost in the same method. Refer to item 3.5 Photography for details of photographing. CSIs have been preadjusted at the shipment from the factory and therefore specific adjustment is not particularly required.

1. Insert the hinge pin of CSI into the mounting pin at the front side of display panel CRT and the connector into the Socket of the display panel, aligning the white match-marks.
   (Perform this operation after turning OFF the power supply.)
2. Face CSI to CRT screen and fix it by latch.
3. Push the manual shutter button on the left side of CSI to open the shutter.
   Note: In case of CSI3, disconnect connector at the front of camera body, press the shutter button and look into the view finder. (Shutter speed should be at B.)
4. Set the lens aperture to 4.5 or 3.5 (open).
5. Attach a focusing glass into the port on film holder (not needed for CSI3).
   For CSI2, open rear cover of film holder and load the pack with focusing glass.
   For CSI6, open the cover at the back of CSI and load the pack with focusing glass.
6. Depress [MODE] [LSP] and [SHUTTER] on the display panel.
7. Adjust the focusing knob so that the scanning line of image on CRT can be clearly seen.
   Then, tighten the lens fixing screw while observing through the focusing glass with the loupe provided.
   For CSI3, adjust the focus by looking into view finder.

8. Insert the dark slide properly into the film holder prior to loading the film (not necessary for CSI3).
9. Remove the focusing glass, and attach the film holder containing the film.
   For CSI2 and CSI6, take out the pack.
10. Push the manual shutter button once again to close the shutter.
11. Turn the lens aperture adjust ring and set the aperture value according to the film speed in use.
12. For CSI3, set the shutter speed to B.
    Note: Connect the connector at the front of camera body.
    Connect the power connector to the camera body to use PSC.
13. For CIS6, turn ON power switch.

4.10 Auto Data Recording

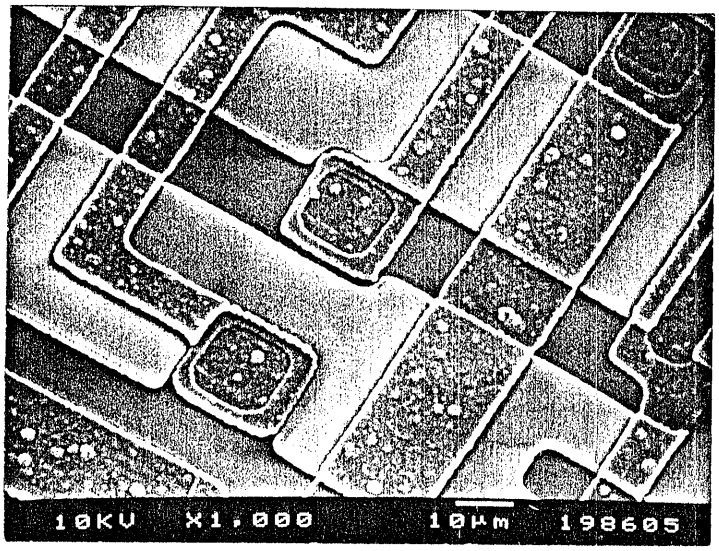


Fig. 4.10-1

The data displayed at SLOW mode is also recorded on the film when photographing (its lowest line and micron marker above the line).
This data display can be selected by [DATA] switch.

[ON/OFF] : Data is displayed at ON (LED also ON).
[IMAGE] : Background of data becomes image.
[BLANK] : Background of data blanks in black.

Note 1. The characters displayed with Character Display Device (CD32; optional) are also recorded on the film when photographing.
2. Both data and characters are not displayed at the mode other than [PIC] [SLOW1] .

4.10.1 Film Number

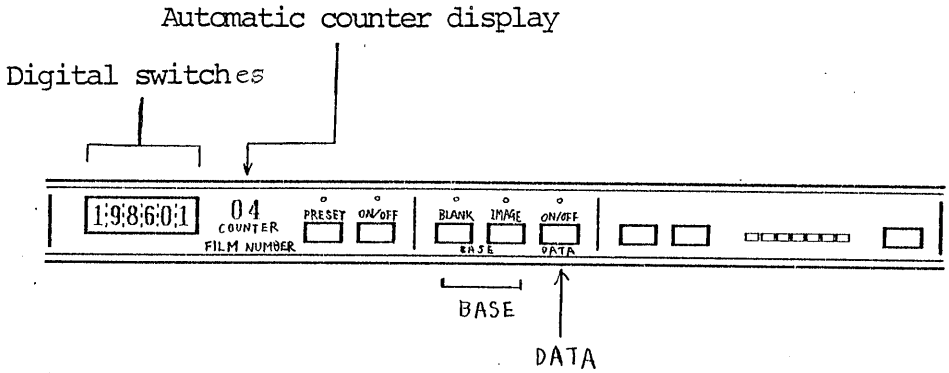


Fig. 4.10-2

Film number is displayed in 6 digits and lower 2 digits of the number are automatically or manually counted, and upper 4 digits are preset by the digital switch (namely, there figures can be used for year, month, date, classification number, etc.).

A. Manual Setup of 6 Digits (any numerals required)
   1. Turn ON/OFF switch to OFF (LED also OFF).
   2. Set 6 digits to any numerals required by the manual digital switch.

   Then, the preset numerals become film number.

B. Automatic Count of Lower 2 Digits from Numerals Required (e.g., 50)
   1. Turn ON/OFF switch to ON (LED also ON). (Then, automatic counter display lights up.)
   2. Set 2 digits at the right side of the manual digital switch to the numerals to be counted up.
   3. Press the [PRESET] switch (then, the numerals are automatically counted up from 50 for example).

   Note: Always set up upper 4 digits with digital switch.

   This automatic counter displays 00 at the start of instrument if this ON/OFF switch is set to ON (depressed).

4.10.2 Data Readout on Micrograph

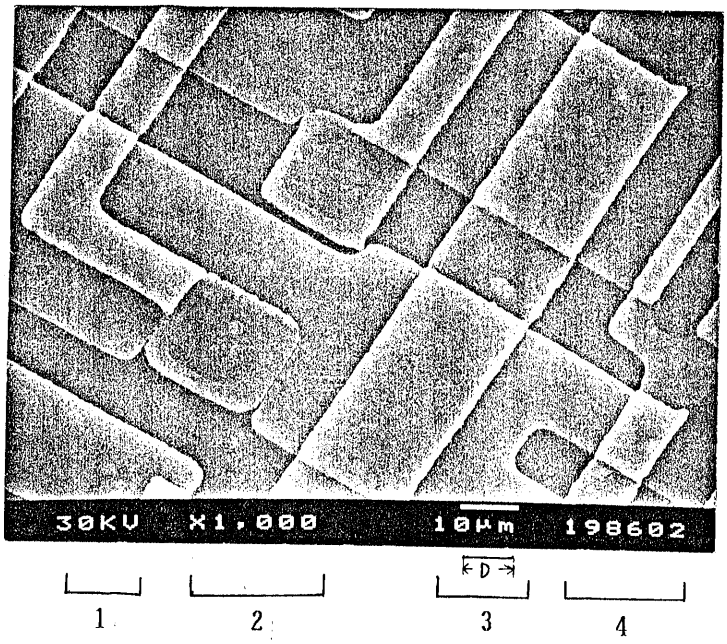


Fig. 4.10-3

1. Accelerating Voltage
   1～2 digits
   E.g. 0.5kV.....0.5kV, 30kV.....30kV
2. Magnification (image magnification on CRT = displayed magnification for observation)
   Magnification of micrograph is obtained by multiplying the recorded magnification with photographing ratio.
   E.g. The image magnification of micrograph taken by CSI1 and observed in 10,000X is calculated by the following equation:
   (10,000X) X 0.5 = 5,000 ... 5,000X
3. Micron Value
   1～4 digits in D size display
   E.g. 0.1µm..... D = 0.1µm, 1µm..... D = 1µm,
   1000µm..... D = 1,000µm

4. Film Number

6 digits and lower 2 digits of the number can be automatically counted up.

· Calculation of Magnification

To find the image magnification of micrograph, regardless of its size, measure the length D on the micrograph and calculate it according to the following equation:

$$\text{Magnification} = \frac{\text{Measured value of D (mm)}}{\text{Micron value } (\mu m)},$$

e.g. $\frac{25mm}{100\mu m} = \frac{25mm}{0.1mm} = 250\times$.

4.11 Photographing Time And Exposure Monitor (PHOTO)

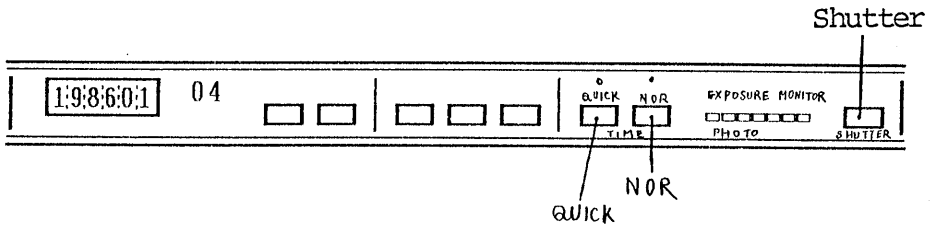


Fig. 4.11-1

1. 2 modes of photographing time are selectable and they are used in the following way:
   NOR : Normal photographing (50Hz zone; 90 sec, 60Hz zone; 75 sec)
   QUICK : Quick photographing (50Hz zone; 36 sec, 60Hz zone; 30 sec)
2. On exposure monitor, all LEDs light at first and then, each LED goes out in order from the left side and finally all the LEDs go out when the exposure is over.

Note: If exposed by manual shutter, this exposure monitor repeats the operation for the time the shutter opens.

4.12 Recording CRT (PRD/UHR)

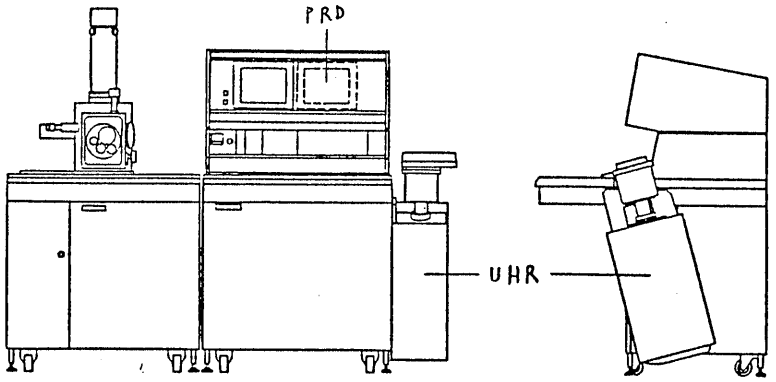


Fig. 4.12-1 PRD/UHR

Recording CRT (PRD1 etc.) is mounted in the control console of microscope.
PRD2 or ultrahigh resolution CRT (T220-UHR) is mounted at the right side of the control console.
The following components are provided on the T220-UHR panel:

1 CAMERA : Camera connector to connect the cable from CSI
2 BRIGHTNESS : Brightness adjust control
3 MODE : NOR/UHR select switch

UHR mode; For using ultrahigh speed film at ultrahigh resolution mode.
(ISO 400; develop in 4X sensitivity or ISO 3,000)

NOR mode; For using normal speed film at UHR (ISO 75～400).

4.13 Vacuum System

4.13.1 Operation of Vacuum System

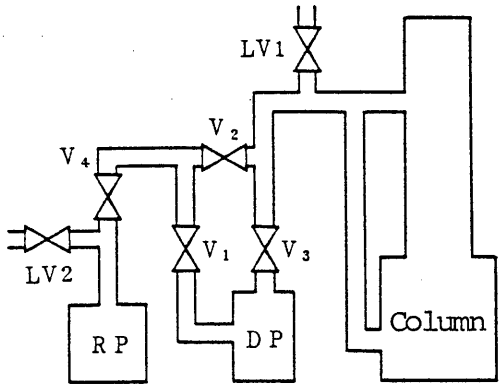


Fig. 4.13-1

Normal evacuation is performed automatically in accordance with sequence control just by switch operation of [VENT] and [PUMP DOWN].

Operational Conditions	Valve Status					
	V1	V2	V3	LV1	V4	LV2
POWER ON	○/×	○/×	×	○/×	×	×
(DP BACKING)	○	×	×	×	○	×
VENT	○	×	×	○	○	×
(PRE EVAC)	×	○	×	×	○	×
EVAC	○	×	○	×	○	×
POWER OFF (RP VENT)	○/×	○/×	×	○/×	×	○

○ : Open × : Close ○/×: Alternative

Note: [VENT] and [PUMP DOWN] switches do not work if the control is set to the Airlock System (ALS, optional) or Sputter Coarting Device (SCD, optional).
Besides, if the evacuation control is set to scanning microscope at the Heating Stage (HH/HS) or Cryo Unit (LG3CRU), column leaks and specimen and equipment may be damaged by pressing VENT switch on the display panel.

4.13.2 Sequence Indicator

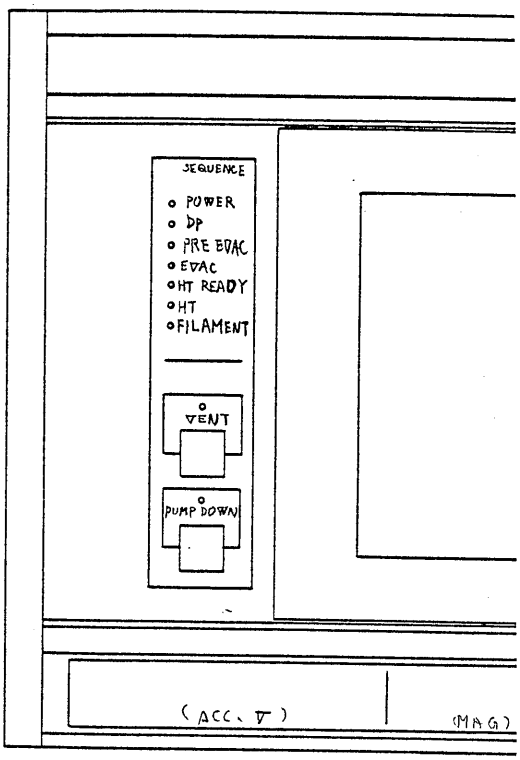


Fig. 4.13-2

⇩Sequence Process Direction at Evacuation

[POWER] : Lights up with POWER ON.

[DP] : Lighting during oil diffusion pump (DP) operation and operation sequence stops here if column is set to VENT.

[PRE EVAC] : Lights up on completion of column roughing.

[EVAC] : Lights up on completion of column evacuation.

[HT READY] : Lights up on completion of preparation for high tension application.

[HT] : Lights up with ACCELERATING VOLTAGE ON.

[FIL] : Lights up with filament heating current ON (Same as filament monitor).

⇧Sequence Process Direction at Admitting Air

VENT : Admit column air to atmospheric pressure, but do not press this switch during heating or cooling the specimen.

PUMP DOWN : Evacuate the column.

4.14 Checker Function

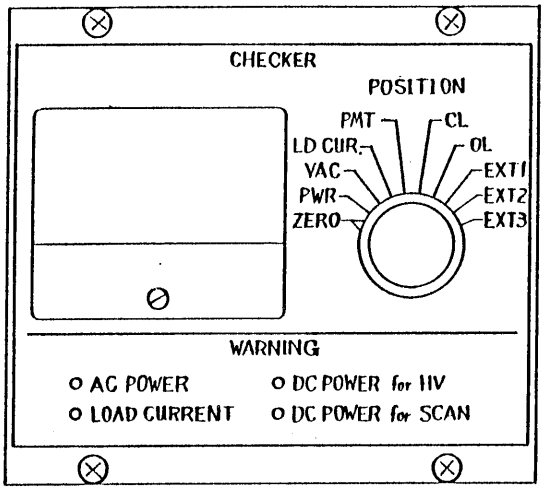


Fig. 4.14-1

This checking device enables automatic and manual check-up of the power supply system for convenience of maintenance and service. The device can also be used as a vacuum gauge or a load current meter.

1. Auto Checker (for automatic checkup; warning)
   This checker performs automatic checkup of following 4 items at all times. LEDs go out normally, but if any one of these items is faulty, the LED for the item flickers for warning.

   AC POWER : LED flickers when power supply 100VAC fluctuates beyond ±10%, namely, when the supply power drops below 90VAC or exceeds 110VAC. Especially, at about 90VAC, power supply relay sounds intermittent alarm continuously.

LOAD CURRENT	:	LED flickers when the load current of filament exceeds 0.75 (150μA). If it exceeds 0.75 (150μA), the filament is overheated. When this LED flickers, turn OFF HT and check the gun bias and filament spacer.
DC POWER for HT	:	LED flickers when high tension power supply fluctuates beyond ±10%, namely, when high tension power supply for detector and CRT is faulty.
DC POWER for SCAN	:	The LED flickers when the power supply for scanning system fluctuates beyond ±10%. This fault may cause to case the scanning and damage the CRT.

2. Manual Checker (for manual checkup; position)

Item	Description	Full Scale	Standard Value
ZERO	Zero point check of meter	——	0
PWR	100VAC power supply	200VAC	0.5
VAC	Vacuum	——	0.25 to 0.5
LD CUR.	Load current	200μA	0.5 to 0.6 (30kV)
CL	Condenser lens current	2A	Approx. 0.22 (10 o'clock direction, 30kV)
OL	Objective lens current	2A	Approx. 0.3 (WD 20mm, 30kV)
PMT	High tension for PMT	2kV	Approx. 0.25
EXT1	Optional	(1mA)	
EXT2	Optional	(1mA)	
EXT3	Optional	(1mA)	

This checker can easily checkup operation status of 7 main items and 3 optional items.

- Vacuum gauge: [VAC] identifies the evacuation status.
  At admitted air (column in atmospheric pressure); approx. 0.25
  At EVAC from PRE EVAC; approx. 0.3
  At completion of EVAC; approx. 0.5
- Load current meter: [LD CUR.] identifies filament heating condition.
  1. Following values are obtained as reference at accelerating voltage 30kV:
     0.5 max. ..... Undercurrent (insufficient heating)
     0.5 to 0.6 ..... Normal use
     0.7 min. ..... Overcurrent (excessive heating)

Note 1. Saturation point of filament progresses to counterclockwise direction, as it is used. Consequently, it may be at 0.4 to 0.5 if the filament used for long time is readjusted to the proper position.

2. It changes by setting gun bias, but keep it within 0.7.

2. When accelerating voltage is changed lower, the value at saturation point also decreases if setting of gun bias control is not readjusted. Normally, set up the gun bias control after changing to low accelerating voltage.

4.15 Panel And Composition

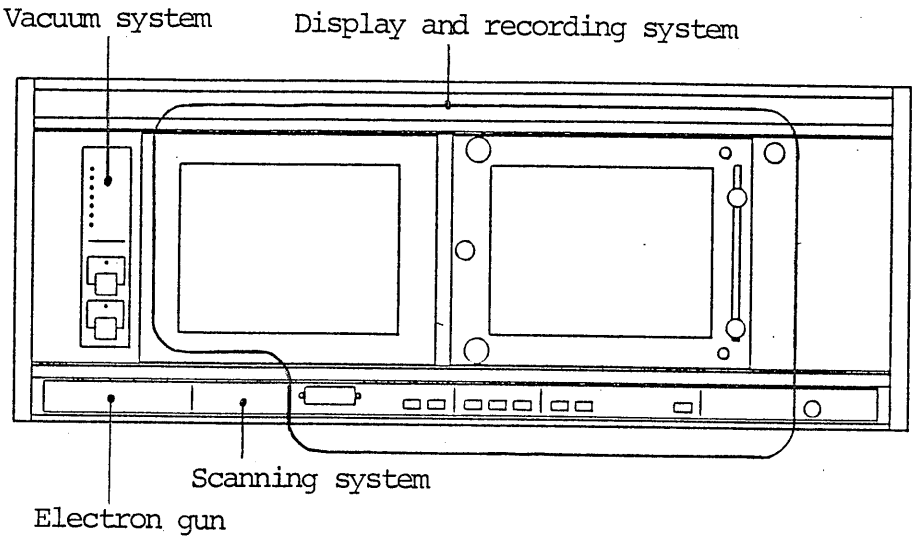


Fig. 4.15-1

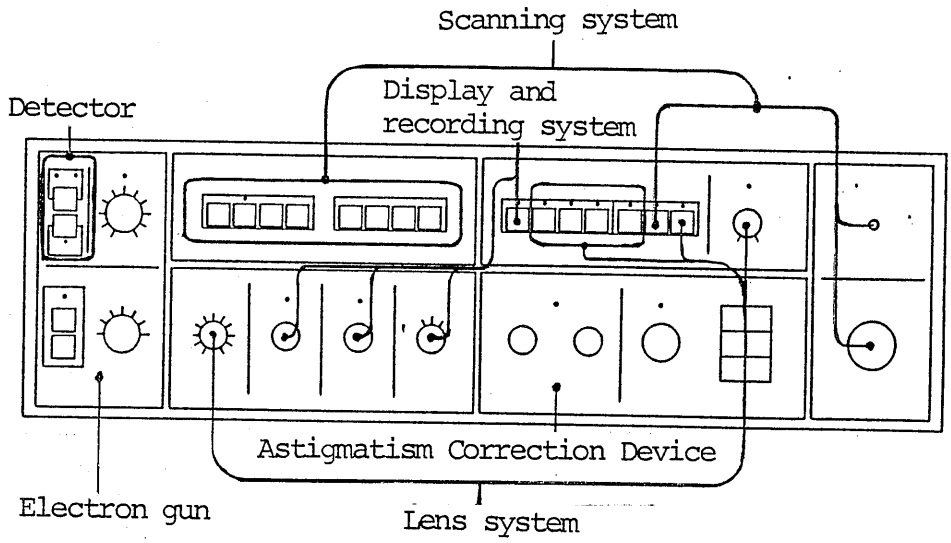
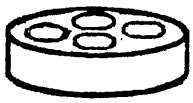
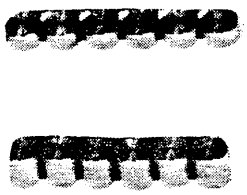


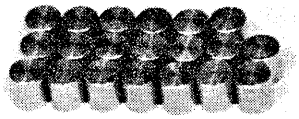
Fig. 4.15-2

LIST OF ACCESSORIES

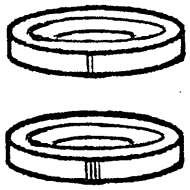
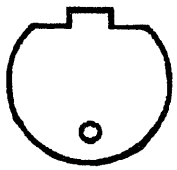
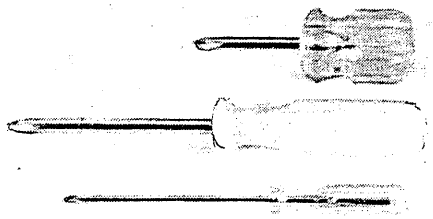
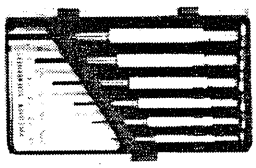
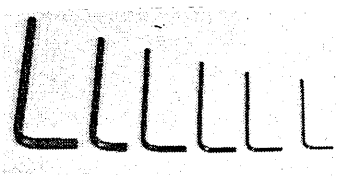
* SPECIMEN HOLDERS

Name	Appearance	Quantity
Specimen holder for 10 mm dia. specimens		1
Specimen holder for 32 mm dia. specimens		1
Adapter for 32 mm dia. specimens (5 mmh, 10 mmh)		1 pc. each
Adapter for 10 mm dia. specimens (4 pcs.)		1
Specimen stubs for 10 mm dia. specimens (5 mmh, 10 mmh)		6 pcs. each

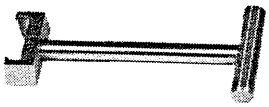
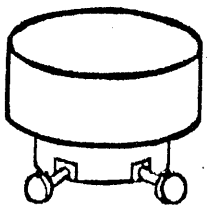
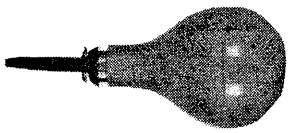
* STANDARD ACCESSORIES & TOOLS I

Name	Appearance	Quantity
Specimen stubs (10 mm dia. 5 mmh)		20
Specimen stubs (10 mm dia. 10 mmh)		20
Conductive paint		1
Vacuum grease		1
Fine grain metal polish		1
Condenser lens apertures (capsule)		1 set

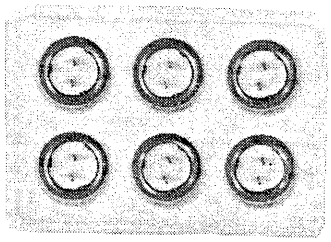
* STANDARD ACCESSORIES & TOOLS II

Name	Appearance	Quantity
Filament spacers (2~2.2 mm)		1 set
Base plate adjusting tool		1
Screwdriver, philips-headed		1 set
Screwdriver, watchmaker's (6 sizes)		1 set
Allen key wrench (6 sizes)		1 set
Tweezers		1

* STANDARD ACCESSORIES & TOOLS III

Name	Appearance	Quantity
Pole piece removing tool		1
Pole piece assembling tool		1
Wehnelt cap removing tool		1
Handblower		1
Pen light (with batteries)		1 set
Wrench, watchmaker's		1

* STANDARD ACCESSORIES & TOOLS Ⅳ

Name	Appearance	Quantity
Lupe (15X)		1
Beam deflector coil spacer		1
Electron gun filaments (6 pcs./box)		1
Standard sample		1
Fuses		30A 2 20A 1 8A 2 3A 2 2A(small) 2 1A(small) 1
Bearings		2

* PARTS LIST FOR INSTALLATION & TRANSPORTATION

Name	Quantity
Power cable	1
Water hose 10 m	1
Water tap	2
Plug	2
Water clamp	3
Exhaust port plug for RP	1
Packing (installed in the RP exahust port)	1
Vacuum hose clamp	3
Transporting fixture	1 set
Screws 3 mm dia.	1 set
Screws 4 mm dia.	1 set

JEOL service office

If you need to consult with JEOL about the instrument maintenance, please contact your nearest subsidiary company.

Or presume a JEOL homepage in such cases as the information about the product, the inquiry besides that if having an order in the center of the nearby service.

http://www.jeol.co.jp/	Japan
http://www.jeol.com/	USA
http://www.jeoleuro.com/	Europe