

INSTRUCTION MANUAL
FOR
MODEL H-7650
TRANSMISSION ELECTRON MICROSCOPE
(USER'S OPERATION & MAINTENANCE, Ver.01.03 upward)

**Please read through this manual carefully
and store it in a safe place.**

- Before using the instrument, read the safety instructions and precautions carefully.
- Keep this manual in a safe place nearby so it can be referred to whenever needed.

HITACHI

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3. Hitachi High-Technologies Corporation assumes no liability for any direct, indirect, or consequential damages arising from use not described in this manual.
Utmost care must be exercised when using the instrument.
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FOREWORD

Thank you very much for purchasing the Hitachi Model H-7650 Transmission Electron Microscope. It is designed for observation and evaluation of the specimens prepared for TEM by using an electron beam accelerated with 100 kV as a light source.

This instruction manual provides instructions for the persons who have a basic knowledge of electron microscope. A wrong handling of the Model H-7650 may result in not only improper images but also specimen damage.

Before using the Model H-7650, be sure to read this manual carefully and use this product correctly.

First, be sure to read these precautions on safety.

After reading the manual, keep it in a safe place nearby so it can be referred to whenever needed.

ABOUT THIS INSTRUCTION MANUAL

- This instruction manual explains the operating procedure, maintenance and caution on the Model H-7650 TEM.
- First of all, be sure to read the precautions at the beginning of this manual and "SAFETY SUMMARY."
- For operation and maintenance of the options for the Model H-7650, refer to the respective instruction manuals. The instruction manuals of the option for the Model H-7650 are listed below.
 - ◇ Instruction manual of H-7501SS one-touch specimen holder (for user's operation)
 - ◇ Instruction manual of H-7501MS 3-specimen holder (for user's operation)
 - ◇ Instruction manual of H-7502MS one-touch 3-specimen holder (for user's operation)
 - ◇ Instruction manual of H-7501RS specimen rotation holder (for user's operation)
 - ◇ Instruction manual of H-7501DS specimen double tilt holder (for user's operation)

- The basic format of the manual is as follows. Refer to it in your reading.

- (1) Pages, diagrams and tables are numbered consecutively in each section.

Example: (page) 1-10, (diagram) Fig. 1-10,
(table) Table 1-10

- (2) Smaller groups of description than section and sub-sections are numbered as follows.

(1), (2), (3) ...

CAUTION

The effective dose equivalent of leakage x-ray radiation from the H-7650 TEM is 2 $\mu\text{Sv/h}$ maximum under its actual operating conditions. According to the recommendation Publ. 60 of the International Committee on Radiation Hazard Prevention (ICRP) in 1990, the average effective dose equivalent over 5 years should not exceed 20 mSv/year. It is therefore required to restrict usage time so that the reference value will not be exceeded. In particular, note that there are stipulations on effective dose equivalent with respect to certain locations of the human body, or with respect to a user in pregnant condition, etc. Besides, the International Electrotechnical Commission Standard IEC 61010-1 states that the effective dose equivalent must not exceed 5 $\mu\text{Sv/h}$, and the above figure of the H-7650 TEM is far below this effective dose limit per unit time. It also conforms with the Japan Analytical Instruments Manufacturers Association Standard JAIMAS 1010-2001. However, confirmation is not obtained with regard to the laws or directives on radiation of each individual country, so one must check the related laws of the relevant country and use the instrument under conditions that conform with those laws. It is recommended that the users establish their own working time standards for using this instrument.

It is essential also to operate the instrument carefully taking into account the following fundamental precautions.

- (1) Use the instrument within the application range and by the method specified in the catalog, instruction manual and other relevant document. Note that long usage under the conditions given below may cause the x-ray leakage amount to exceed the stipulated value, so avoid usage under these conditions.
 - (a) Usage with the condenser lens movable aperture completely pulled out from the column.
 - (b) Usage with emission current greater than 20 μA flowing.
 - (c) Usage with the movable aperture inserted for the purpose of interrupting the electron beam.
 - (d) Usage with parts used to protect the instrument eliminated or replaced with substitute parts.
 - (e) Usage after making modifications such as unlocking safety devices.

- (2) Since the laws related to radiation hazard prevention are subject to modification without prior notice, sufficient measures must be taken to conform with the modifications before use of the instrument. The users should set up their own work management standards for using the instrument.

WARRANTY

The Model H-7650 TEM is warranted as follows, based on the specifications indicated in this manual, only when it is used according to the instructions given therein.

Hitachi High-Technologies Corporation will not indicate warranties, express or implied, as to product quality, performance, value of commodity and applicability for a particular purpose.

No oral or written information given by this company's dealer, distributor, agent or employee without an approval procedure determined by the company shall create a warranty if such information does not match product performance.

(1) Scope of Warranty

- (a) If the instrument becomes faulty due to a defect in Hitachi High-Technologies Corporation workmanship, it will be repaired free of charge.
- (b) A substitute part may be used for repair or replacement with an equivalent component may be made instead of partial repair.

(2) Period of Warranty

Within one year from the date of initial installation

(3) Disclaimer of Warranty

This warranty will not be valid for the following failures and/or cases even during the period of warranty.

- (a) Failure due to operation at a place not meeting the installation requirements specified by Hitachi High-Technologies Corporation.
- (b) Failure due to power supply voltage/frequency other than specified by Hitachi High-Technologies Corporation or due to abnormal power supply.
- (c) Corrosion or deterioration of the tubing due to impurities contained in gas, compressed air or cooling water supplied by user.
- (d) Corrosion of the electric circuits or deterioration of the optical elements due to highly corrosive atmosphere, dusty environment, etc.
- (e) Failure due to use of hardware, software or spare parts other than supplied by Hitachi High-Technologies Corporation.
- (f) Failure or damage to the basic software, application software or data due to improper handling or maintenance by user.
- (g) Failure due to maintenance or repair by a service agent not approved or authorized by Hitachi High-Technologies Corporation, or failure resulting from disassembly or modification by user.
- (h) When the instrument is disposed of or resold without informing Hitachi High-Technologies Corporation.
- (i) Failure due to relocation or transport after initial installation.
- (j) When the instrument is disassembled, modified or subjected to parts replacement without Hitachi High-Technologies Corporation approval, or reinstalled without informing Hitachi High-Technologies Corporation.
- (k) Consumables and parts limited in period of warranty.
- (l) Parts excluded from warranty in the instruction manual, etc.
- (m) Failure due to force majeure including fire, earthquake, storm, flood, lightning, social disturbance, riot, crime, insurrection, war, radioactive pollution, contamination with harmful substance, etc.

- (n) Failure of the hardware, or damage to the basic software, application software or data due to computer virus infection.
- (o) Failure of the personal computer connected with the instrument, or damage to the basic software, application software or data due to power interruption or momentary power voltage drop caused by lightning.
- (p) Failure of the personal computer connected with the instrument, or damage to the basic software, application software or data due to disconnection of main power to the personal computer without taking the specified normal shutdown procedure.

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(4) Warranty Card

Warranty card will not be reissued. Keep it in a safe place.

INSTALLATION, RELOCATION AND AFTER-SALE TECHNICAL SERVICE

- (a) Installation at delivery will be carried out by our installation service staff or the engineers authorized by Hitachi High-Technologies Corporation. User shall not attempt to install the instrument.

For installation, the user is requested to take responsibility of preparing utilities, referring to “23. Installation conditions” in “1.3 Standard Specifications” of Section 1.

When relocation of the instrument becomes necessary after initial installation (delivery), be sure to notify your local Hitachi High-Technologies Corporation sales or service representative, partly because possible troubles involved in relocation may be prevented.

For after-sale service, also contact the Hitachi High-Technologies Corporation representative. And for service after the warranty period, please consult us about a maintenance & inspection contract.

- (b) For 10 years after delivery of this instrument, maintenance service is available so that the instrument can operate. During this time period, maintenance of such system components as a personal computer and printer to be updated frequently in the market may entail a request for purchasing a substitute because the possible period of their repair is limited. Even after 10 years from the delivery, maintenance can be provided if system components are available.

CUSTOMERS' PRACTICE COURSE AND TRAINING

Customers' practice course or training (to be charged) can be received at the Hitachi High-Technologies Corporation facility or at the site so that the instrument will be used safely and exactly. For receiving procedure, contact Hitachi High-Technologies Corporation.

DISPOSAL OF THIS INSTRUMENT

This instrument uses lead (toxic) and FRP (non-biodegradable) in some parts. Lead is mounted to the electron gun section, column and evacuation pipe, viewing chamber, camera chamber and operation console. FRP is used in the operation table and operation panel.

In other parts, the materials that will directly harm the environment are not used as of March 2004.

However, changes are apt to be made in relevant laws and/or regulations. So be sure to consult a qualified specialist when planning to dispose of the instrument.

OTHER PRECAUTIONS

(1) Handling of Chemicals

- (a) The user is responsible for following the relevant legal standards and regulations in the handling and treatment of chemicals used for cleaning of this instrument.
- (b) Chemicals shall be handled, stored and discarded as instructed by the respective suppliers.

(2) Notice on This Instruction Manual

- (a) The Information contained in this document is subject to change without prior notice for further improvement.
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(3) During Use

Gazing at the monitor screen for long hours may cause a vision impairment due to fatigue, etc. The customer is recommended to establish work management standards and follow them.




SAFETY SUMMARY



General Safety Guidelines

Before operating the Model H-7650 TEM, read the following instructions carefully.

The hazard warnings which appear on the warning labels on the instrument or in the manual have one of the following alert headings consisting of an alert symbol  and a signal word DANGER, WARNING or CAUTION.



: The alert symbol shown at left precedes every signal word for hazard warnings, and appears in safety related descriptions in the manual.



DANGER : Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING : Indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury.



CAUTION : Indicates a hazardous situation which, if not avoided, can result in minor or moderate injury, or serious damage of the product.

NOTICE : Indicates a potentially hazardous situation which, if not avoided, can result in damage to property.

The warning by safety alert symbol + signal word DANGER is not used for this instrument.

In addition, the following signal word is used for ensuring proper use of the product.

NOTE: Used to indicate an instruction for ensuring correct trouble-free use of the instrument and accurate measurement therewith.



SAFETY SUMMARY



General Safety Guidelines (Continued)

Precautions on Use

- Before using this product, read the instruction manual carefully until an adequate understanding is acquired.
- Keep this manual in a safe place nearby so it can be referred to whenever needed.
- Follow the procedure indicated in this manual for handling the product.
- The instructions on safety in this manual should always be followed after confirming an adequate understanding of their contents.
- Be sure to observe all the hazard warnings attached to the instrument or provided in the manual. Failure to do so could result in personal injury or damage to the instrument.
- Be sure to follow the original usage of this product and that specified in the instruction manual.
- Never modify the instrument, use unspecified parts nor operate the instrument with safety devices removed, because it is dangerous.
- Do not perform any operation or action other than described in this manual. When in doubt, contact your dealer or the nearest Hitachi High-Technologies Corporation service office.
- The electron beam used in this instrument will give rise to x-rays. So avoid using the instrument with its cover or door removed, or with any particular part attached.
- When using a chemical, adequate room ventilation should be secured under the customer's responsibility. Inadequate ventilation could endanger human health.



SAFETY SUMMARY



General Safety Guidelines (Continued)

- Keep in mind that the hazard warnings in this manual or on the instrument cannot cover every possible case, as it is impossible to predict and evaluate all circumstances beforehand. Be alert and use your common sense.

The above precautions should be observed strictly. Otherwise, not only will the correct result of microscopy be unobtainable, but also human injury may be caused.

Precaution during Use

If an abnormal condition such as abnormal noise, odor or fuming occurs during operation of the instrument, turn off power supply immediately. Then, after providing proper safety measures as required, contact our nearest service office.

Caution on Installation, Maintenance and Relocation

- Installation at delivery should not be performed by the customer. For ensuring safety and high accuracy in operation of the instrument, qualified technical personnel from Hitachi High-Technologies Corporation service office or its authorized service agent will carry out installation when the instrument is delivered to the customer.
- At the time of installation, it is requested for the customer to check that all the standard accessories have been delivered. If the instrument is operated without any standard accessory equipped, it might become faulty to cause an unsafe condition. So if any standard accessory is lost or damaged or if you have any question on it, consult with the installer, your dealer or Hitachi High-Technologies Corporation service office.



SAFETY SUMMARY



General Safety Guidelines (Continued)

- Maintenance to be performed by the customer should be within the scope described in this instruction manual.
Before proceeding to maintenance, be sure to attain a clear understanding of maintenance items described in the instruction manual. Do not carry out any maintenance items other than those contained in the instruction manual, or a failure in the instrument or personal injury will result.
- After installation of the instrument, do not relocate it because the finely adjusted electron-optics may be affected by possible shock during relocation.
- Contact the nearest Hitachi representative if warning labels are deteriorated or damaged.



SAFETY SUMMARY



Safety Instructions in This Manual

Shown below are the safety instructions contained in this manual and their relevant sections in it. Note that the indication “ DANGER” d⚠; not apply to this instrument.



WARNING Indications

Electric Shock

- Electric shock could cause fatal or serious injury. At filament exchange, be sure to ground the Wehnelt and shield ring with the supplied grounding rod. (Section 4. MAINTENANCE)

Low Temperature

- Because liquid nitrogen is as cold as $-196\text{ }^{\circ}\text{C}$, its contact with body or its splash into an eye may result in frostbite. Pay attention not to touch liquid nitrogen. Before handling of liquid nitrogen, put on protective goggles and leather gloves. If a large amount of liquid nitrogen is injected rapidly, it may splash to cause frostbite. To prevent this, inject liquid nitrogen gradually (Section 2. OPERATION)

High Temperature

- The surface temperature of oil rotary pump reaches about $70\text{ }^{\circ}\text{C}$ while it is operating. Touching it could result in burns. (Section 4. MAINTENANCE)
- The Wehnelt and filament holder are at high temperature and could cause burns. At filament exchange, wait 10 to 20 minutes for the Wehnelt temperature to drop, and wear gloves for handling it. (Section 4. MAINTENANCE)



SAFETY SUMMARY

WARNING Indications (Continued)

Beware of Pinching Your Fingers

- Be careful not to get your fingers caught in moving parts or you may be injured. Before putting your hands into the camera chamber, be sure to turn **OFF** the POWER switch.
(Section 4. MAINTENANCE)
- Do not touch the electron gun while it is moving. You may get your fingers caught and suffer injury.
(Section 4. MAINTENANCE)

Oxygen Shortage

When dry nitrogen gas is used for vacuum leak of the instrument, suffocation may occur due to oxygen deficiency. So ventilation is required. While the gas is unused, the dry nitrogen gas valve must be kept closed.

(Section 2. OPERATION, Section 4. MAINTENANCE)

Beware of Explosion

This instrument uses a lithium battery for memory backup. A mistake in handling the battery could cause it to explode. Absolutely avoid disassembling the battery or tossing it into a flame.

(Section 4. MAINTENANCE)



SAFETY SUMMARY

CAUTION Indications

Heavy Weight

The air compressor weighs approximately 26 kg. Don't try to lift it unreasonably, or you may be injured.

(Section 4. MAINTENANCE)

The oil rotary pump weighs approximately 30 kg. Don't try to lift it unreasonably, or you may be injured.

(Section 4. MAINTENANCE)

Eye Injury due to Drain Scattering

Be sure to open the drain cock gradually when draining the compressor. The interior of the tank is pressurized, so if the drain cock were opened abruptly, drain would spatter out and may injure your eyes.

(Section 4. MAINTENANCE)

Inhalation of Hazardous Substance

Inhalation of a large amount of organic solvent could result in toxic symptoms. Be sure to ventilate the room well when using such substances for cleaning, etc.

(Section 4. MAINTENANCE)

Eye Injury due to Scattering of Hazardous Substance

Spattering of an organic solvent could cause injury to the eyes. One should wear protective goggles when using such substances.

(Section 4. MAINTENANCE)



SAFETY SUMMARY

CAUTION Indications (Continued)

Overhead Danger

The column of this instrument has protrusions. Hitting your head against those protrusions may result in injury. So attention should be paid to overhead danger when you stand up from the chair.
(Section 2. OPERATION)

Handling

- Troubleshooting of the air compressor by the user should be confined to confirming the symptoms (Table 4-5). Inspection and repair by a person other than the service engineers may result in loss of a part related to safety.
(Section 4. MAINTENANCE)
- Troubleshooting of the RP by the user should be confined to confirming the symptoms (Table 4-7). Inspection and repair by a person other than the service engineers may result in loss of a part related to safety.
(Section 4. MAINTENANCE)
- The lithium battery must be handled separately from general waste matter. When lithium battery replacement is required, be sure to contact the dealer from whom you purchased the instrument or your nearest Hitachi service agent. Entrust the replacement to a qualified service engineer. (Replacement will be provided at charge after the guarantee period of the instrument.)
(Section 4. MAINTENANCE)



SAFETY SUMMARY



Locations of Warning Labels

The following warning labels are stuck on the Model H-7650 electron microscope.

Read each warning labels carefully and confirm the contents while pointing to the relevant component.

Check the warning labels occasionally, and clean and keep intact them so that they can be read clearly at a safe distance.

If the warning labels cannot be read due to deterioration, ask the nearest Hitachi representative to supply new ones.

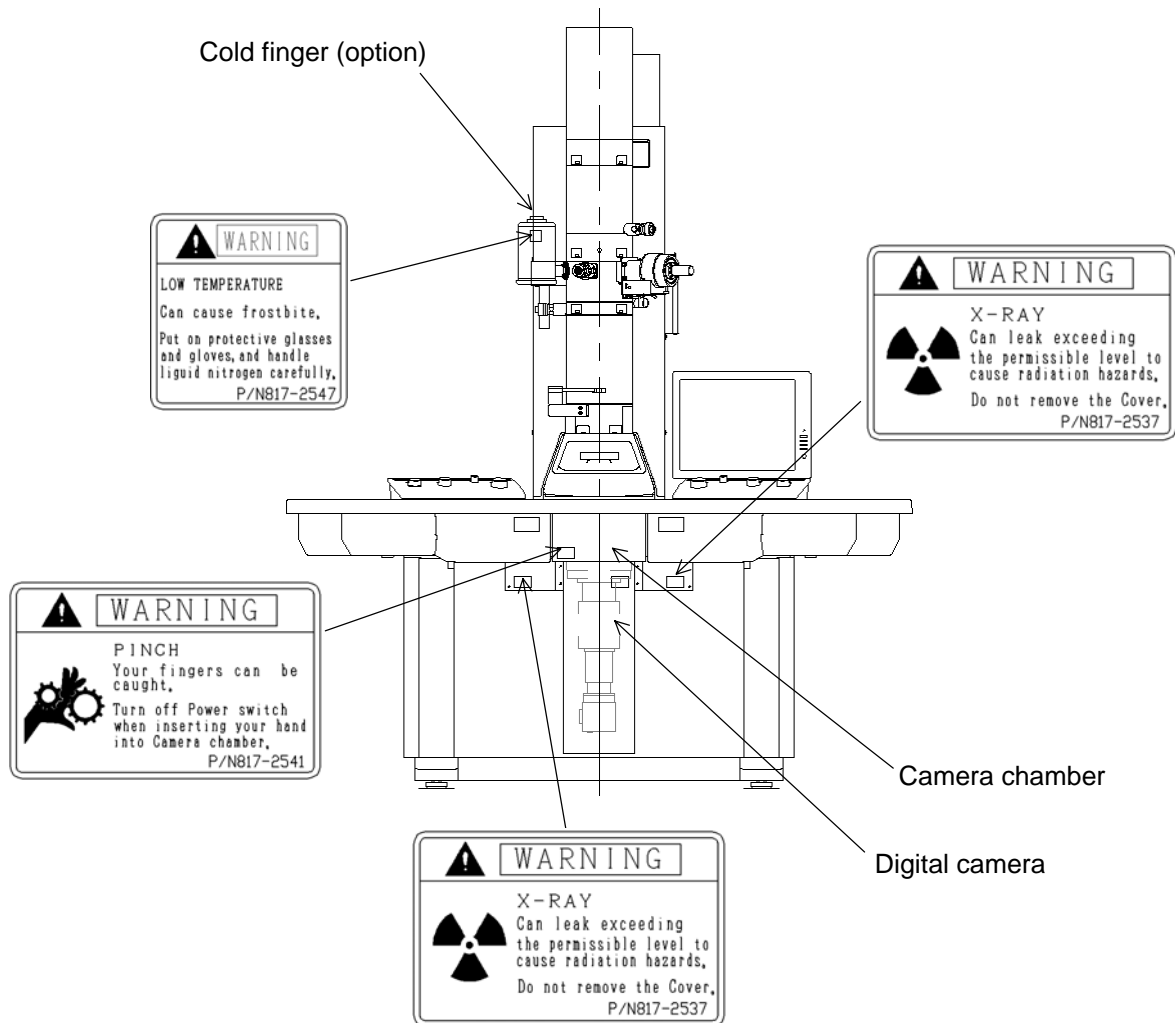


Fig. S-1. Model H-7650 TEM Main Unit (front face)



SAFETY SUMMARY



Locations of Warning Labels (Continued)

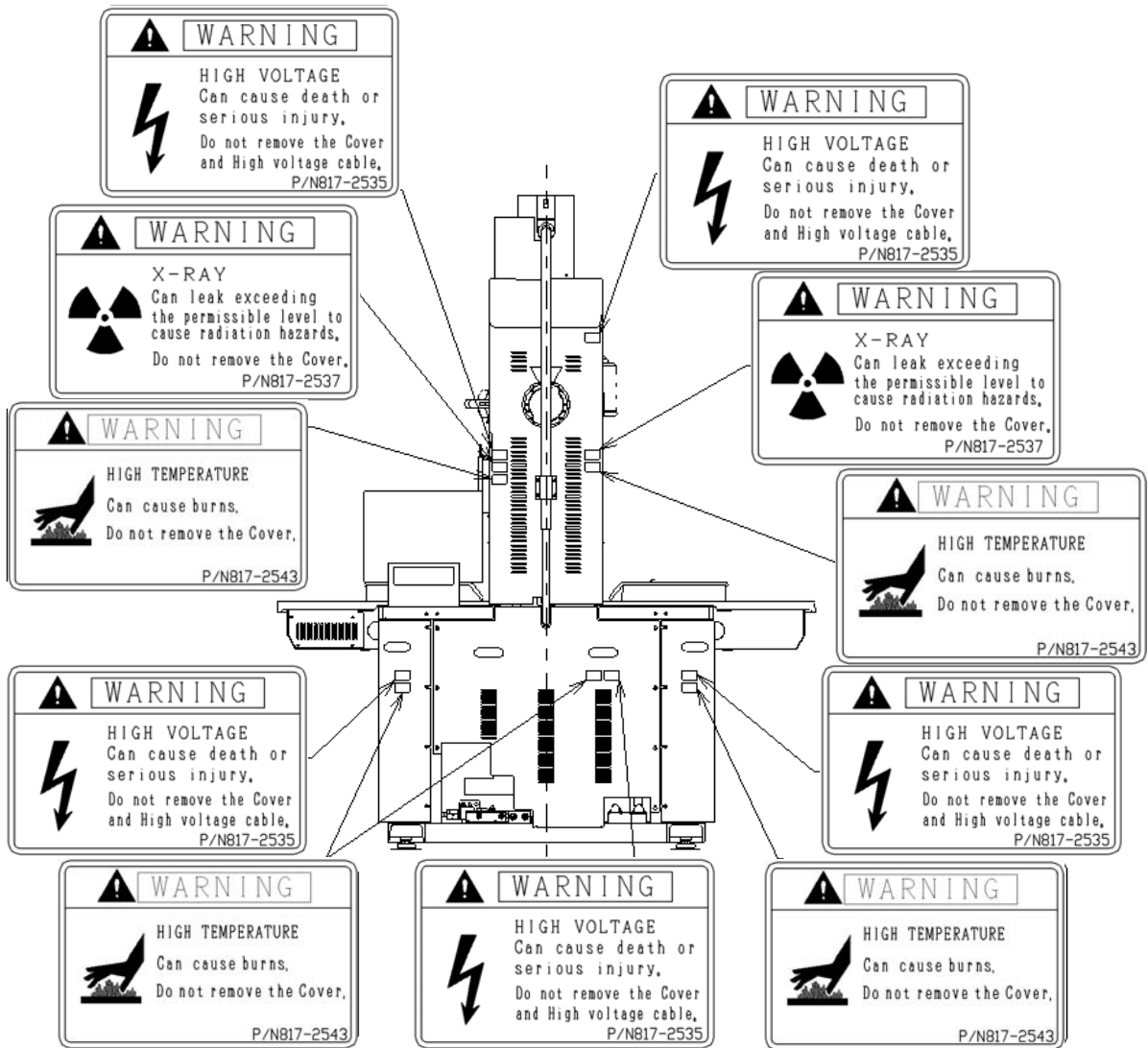


Fig. S-2. Model H-7650 TEM Main Unit (rear face)



SAFETY SUMMARY



Locations of Warning Labels (Continued)

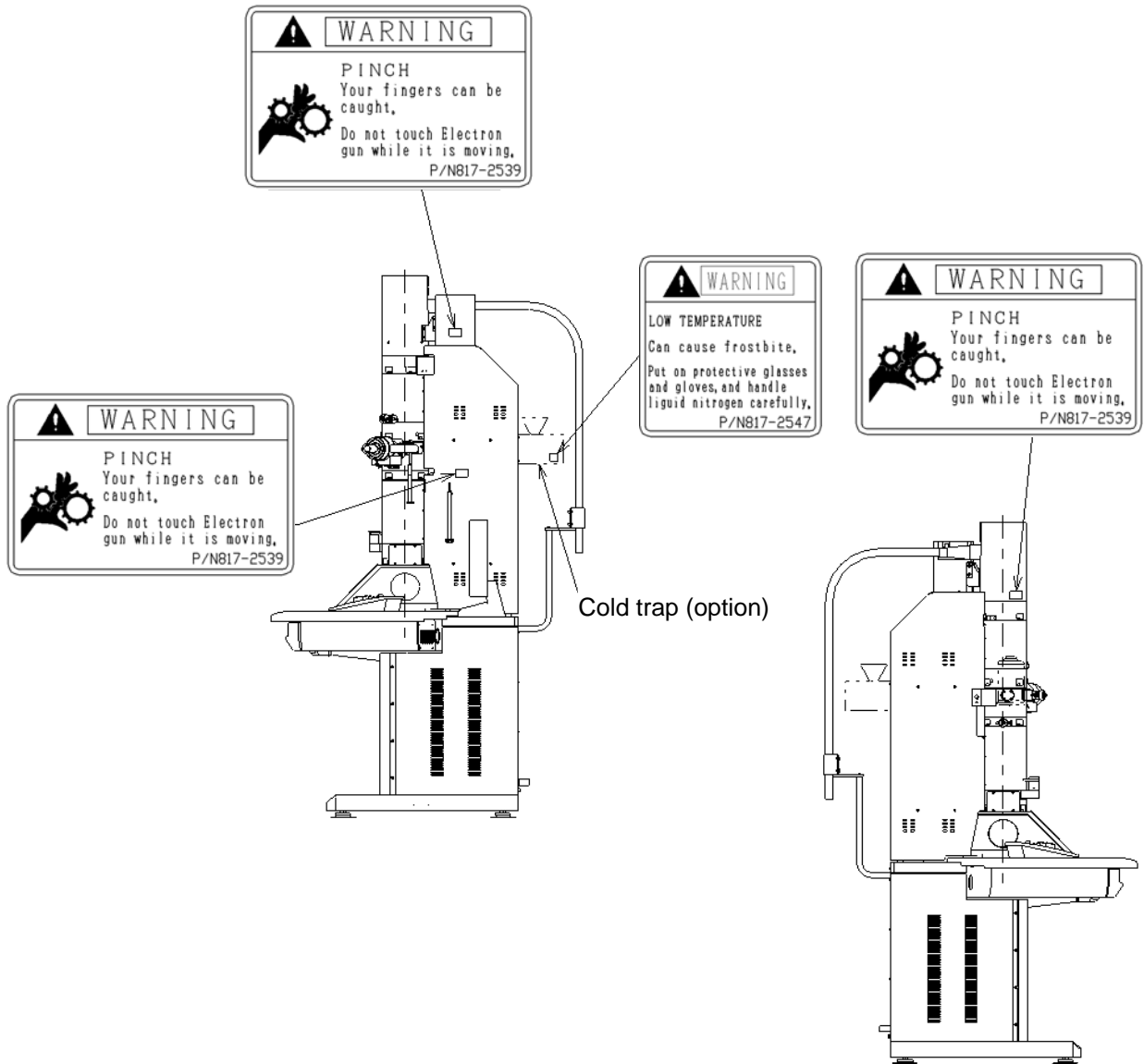


Fig. S-3. Model H-7650 TEM Main Unit (side face)



SAFETY SUMMARY



Locations of Warning Labels (Continued)

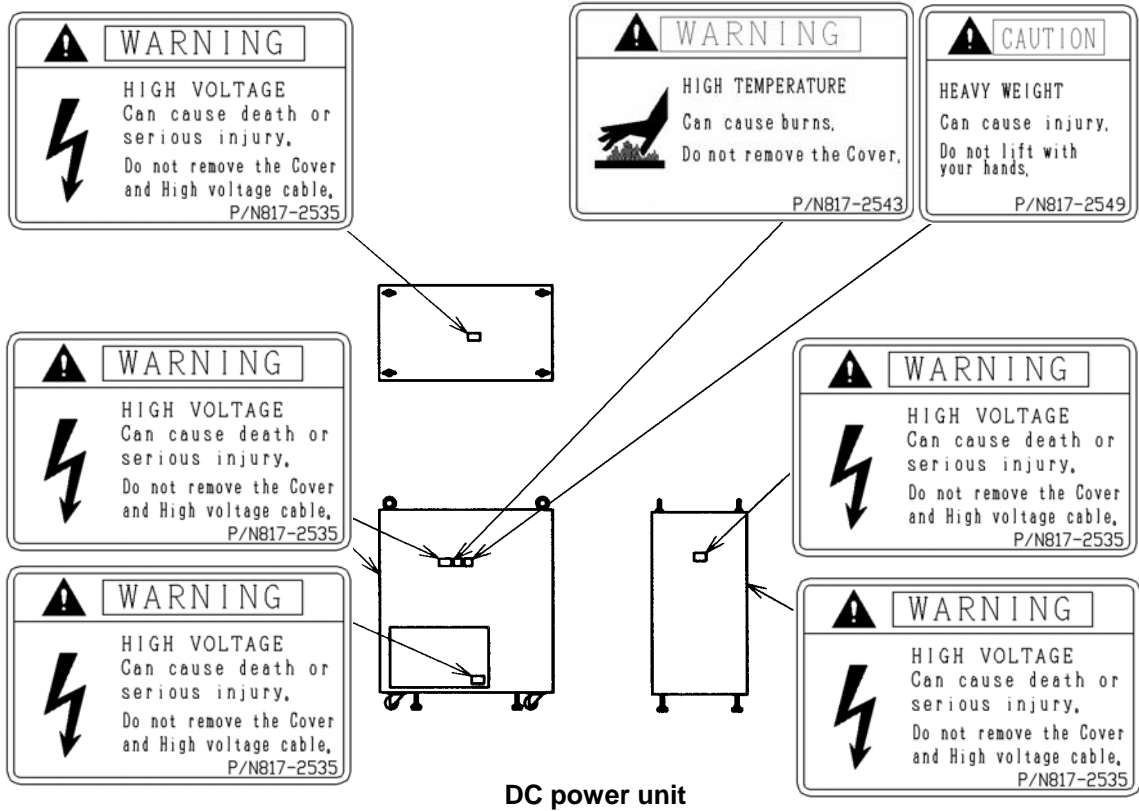


Fig. S-4. Model H-7650 TEM Accessory (DC power unit)



SAFETY SUMMARY



Locations of Warning Labels (Continued)

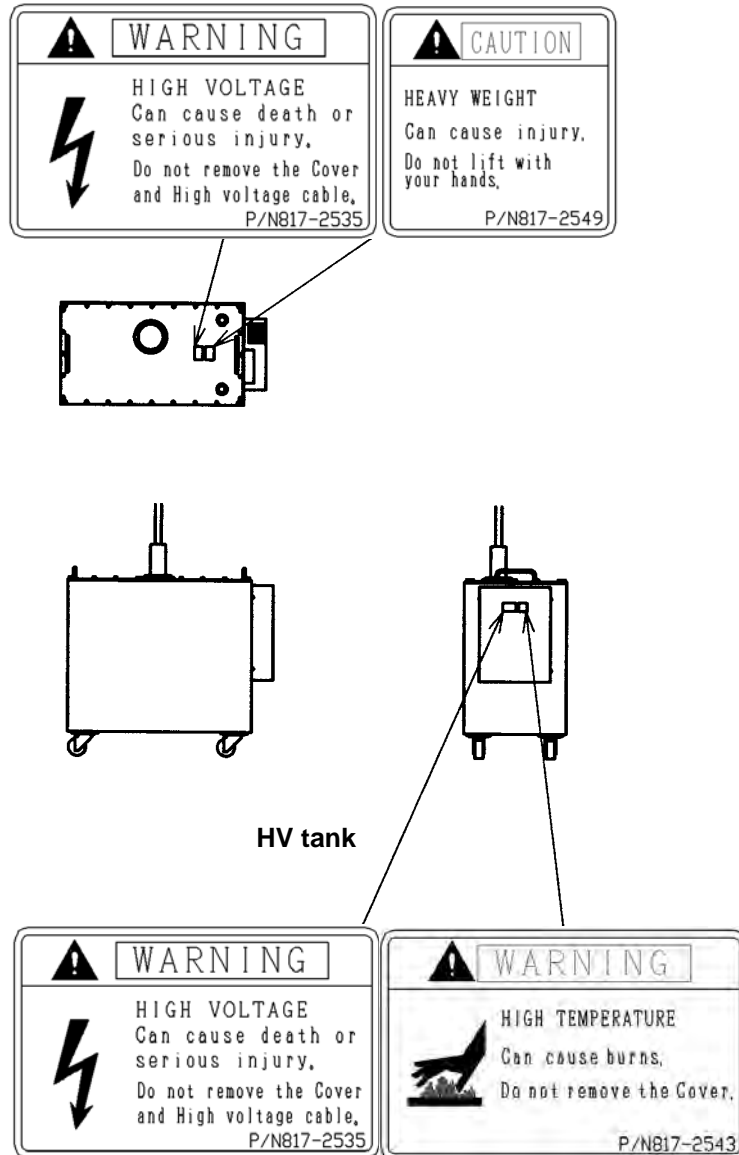


Fig. S-5. Model H-7650 TEM Accessory (HV tank) (left and right side faces)



SAFETY SUMMARY



Locations of Warning Labels (Continued)

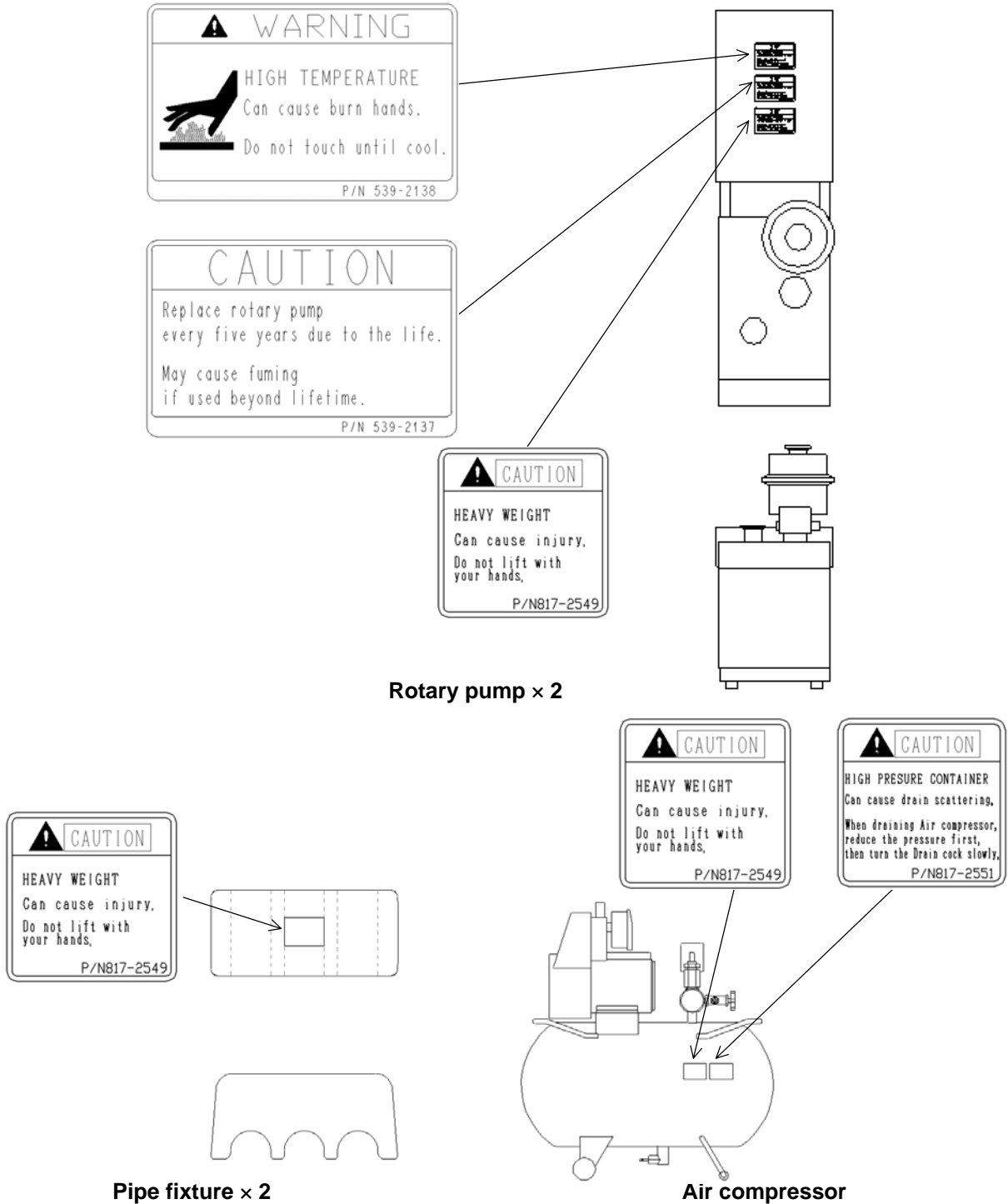


Fig. S-6. Model H-7650 TEM Accessory (other)



SAFETY SUMMARY

Precautions for Proper Use

Scintillator for Digital Camera

This instrument uses a scintillator (fluorescent material) for converting an electron beam to light in its digital camera. If an intense electron beam hits the scintillator, it may be damaged to cause spots in an image. Usually, such spots can be removed by background correction, but may not be correctable when damage is heavy. For using the instrument, observe the following precautions.

- (1) Avoid image observation with the condenser lens aperture removed.
- (2) Avoid image observation while changing the lens current level. Particularly, near a current level of 0 A, a large current flows only to damage scintillator.
- (3) Use a beam spot size of No. 3 or less.
- (4) Use an emission current of 10 μ A or less.

Degassing after LaB₆ Emitter Replacement

After replacing the LaB₆ emitter, set a degassing time at 2 hours or longer. Abrupt degassing will deteriorate vacuum level in the electron gun section, which may damage the emitter.

Setting of TEM Adjustment

The adjustment window in the software is protected by means of password.



SAFETY SUMMARY

Precautions for Proper Use (Continued)

Cassette Receiver

For using both digital camera and films, the exposed film should be recovered from the cassette receiver, because it may otherwise be exposed again.

COOLING Water

- (1) For cooling water, use tap water of a low residual chlorine concentration (0.5 ppm or lower). In case residual chlorine concentration is high, a circulatory temperature-controlled bath should be used. High concentration will corrode the water line to cause leakage.
- (2) Cooling water needs to be run at about 2 L/min through 2 lines.
- (3) Fasten the joint between the cooling water supply port and hose with a tapered screw for pipe.
- (4) The hose from the drain port should be led to a drainage ditch and fastened firmly so that it will not come out of the ditch.
- (5) After operation, be sure to close the main valve of cooling water supply port.
- (6) The water supply/discharge hoses are made of soft vinyl chloride. As the hoses are used longer, they will harden to degrade elasticity. Therefore, the hoses need to be replaced periodically and checked for water leakage before their use.
- (7) If freezing of cooling water can be predicted in a cold climate, it is requested to use antifreeze solution and circulatory temperature-controlled bath.
- (8) Attention should be paid to the temperature of cooling water. A large difference from the room temperature will result in condensation.



SAFETY SUMMARY

Precautions for Proper Use (Continued)

Data Backup

Computer data may become unusable due to a failure or malfunction of the instrument. As a countermeasure, transfer the contents of hard disk into a floppy disk periodically. Such a periodic data transfer is called "backup."

Application Software of Computer

In the personal computer (PC) of this instrument, never install any other application software than specified. Otherwise, not only may an unexpected action window be displayed, but also the instrument may be adversely affected and its system may not operate normally. The instrument will not be warranted if it cannot function normally due to installation of unspecified application software.

Computer Virus

- If program or data is broken suddenly or an unexpected action or window is displayed, then it is probable that the personal computer (PC) is infected with a computer virus.
- Computer virus refers to a vicious program which trespasses on your PC stealthily, moves it forcibly and breaks the data.
- A program for eradicating computer viruses is called a "vaccine program."
- PC may be infected with a computer virus when using a replaceable recording medium such as a floppy disk that contains a virus. An infected PC may infect other PC by propagating a virus through a recording medium. Avoid using a recording medium which may contain a virus.



SAFETY SUMMARY

Precautions for Proper Use (Continued)

- If there is a fear of infection with a computer virus, a vaccine program should be run for check.
- However, some viruses cannot be eradicated by your vaccine program. In this case, make a backup copy of the hard disk in advance.
- Customer is responsible for preparing a vaccine program and eradicating computer viruses.

Lens Current

If each lens current is changed with a specimen loaded, the current increases so that the specimen may be damaged and the scintillator of digital camera and the fluorescent paint on screen may burn. So attention should be paid to change of each lens current.

Power Interruption

- If a momentary drop of power voltage occurs due to power failure, lightning, etc., the PC used for the instrument may become faulty or the OS, application software and data may be broken.
- As a countermeasure against a momentary drop of power voltage, use of an AC uninterruptible power equipment or the like is recommended.



SAFETY SUMMARY

Precautions for Proper Use (Continued)

Personal Computer (PC)

- Do not turn off the PC power supply alone in negligence of the entire system. If the PC power supply is cut off individually while HD or FD is accessed, data and software saved in the drives may be broken.
- Be sure to turn on/off the PC power supply by the key switch of column power supply (COL.).

Water Leakage

This instrument is not equipped with a water leak detector. When tap water is used for coolant, there is a risk of water leakage through the pipe corroded or cracked due to a change in water quality or pressure. In case a coolant circulator or the like cannot be used, be sure to purchase and install the water supply unit (option). This unit is provided with a pressure-reducing constant flow valve and prevents leakage of large-volume water with the aid of a water leak sensor.

TERMINOLOGY

Following is a list of abbreviations and/or special terms that appear in the text of this manual, and is intended for your reference.

ABS (Auto Brightness Set)Auto brightness setting
ACC.VOLTAGE (accelerating voltage)
AF (Auto Focus)Auto Focus
AIR.....Airleak (exposure to air) of vacuum section.
AMF (Auto Multiple Frame)Automatic successive photographing
AP. (Aperture).....Movable aperture (plate)
API (Auto Pre-Irradiation)
ATS (Auto exposure Time Set)
AV-1~3 (Auto Valve-1~3).....Auto valves 1 to 3 for vacuum use

BD (Beam Deflector)Electromagnetic deflector
BH (Beam Horizontal).....Beam horizontal shift
BRIGHT (brightness)
BT (Beam Tilt)

C1 (Condenser lens-1)First Condenser lens
C2 (Condenser lens-2)Second Condenser lens
CALIB. (Calibration))Calibration
CAUX (Condenser lens-3).....Condenser lens for analysis kit (option)
CCArea (Capture Comment Area)Area for entering photographing information
COL. (column)
CS (Condenser lens Stigmator)

DIFF (diffraction).....Electron beam diffraction (mode)
DP (Diffusion Pump).....Oil diffusion pump

EVAC (evacuation)
EXP. (exposure)

F/C (Fine/Coarse).....	Fine/coarse adjustment selection
FOCUS.....	Focusing
F-ZOOM.....	Fine probe (FA) observation mode
GH (Gun Horizontal).....	Electron gun axial alignment deflector (horizontal shift)
GT (Gun Tilt).....	Electron gun axial alignment deflector (tilt)
GV (Gun Valve).....	Electron gun vacuum valve
HC (High Contrast).....	High contrast viewing mode
HR (High Resolution).....	High resolution viewing mode
HV (High Voltage).....	High accelerating voltage
I1 (Intermediate lens-1)	
I2 (Intermediate lens-2)	
IA (Intermediate lens Alignment).....	Intermediate lens axial alignment deflector
IMAGE ROT. (Image Rotation)	
IS (Intermediate lens Stigmator)	
ISF (Image Shift).....	Image shift function using electromagnetism
LaB ₆	Filament using lanthanum hexaboride single crystal
LD (=LOW DOSE)	
LED.....	Liquid crystal monitor
LENS MODE.....	Observation conditions (mode)
LOW DOSE.....	Electron beam reduced irradiation mode (function)
LOW MAG (Low Magnification).....	Low magnification viewing mode (×50 to ×1,000)
LV-1~3 (Leak Valve-1~3)	
MODU. (modulation).....	Function for varying accelerating voltage or objective lens current
MV-1~9 (Main Valve-1~9).....	L-type main valves 1 to 9 for vacuum use
OBJ. (Objective lens)	
OM (Objective Mini-lens).....	Objective auxiliary lens

OPT.DENSITY (Optimum Density).....	Optimum electron beam density (optimum film blackness)
OS (Objective lens Stigmator)	
OSP (Objective lens Stigmator Preset)	Objective lens stigmator presetting function
P1 (Projector lens-1)	
P2 (Projector lens-2)	
PA (Projector lens Alignment)	Projector lens axial alignment deflector
PHOTO (photographing)	Photographing or photo recording mode
PROBE (electron probe)	
RP (Rotary Pump)	Oil rotary pump
SCAN.....	Visual field selection mode in low dose mode
SPEC (specimen)	
SPOT (beam spot).....	Status in which electron beam is converged into a spot
SPOT (spot screen).....	Fluorescent screen for focusing, which contains detection elements for partial photometry
STEM (Scanning Transmission Electron Microscope) (option)	
STIGMONITOR	Astigmatism correction monitor for enlarged images at low and medium magnifications
SV (Separate Valve).....	Vacuum valve for separating viewing chamber and column
TEM (Transmission Electron Microscope)	
TMP (Turbo Molecular Pump) (option)	
TX	Function for correcting brightness escape during beam tilt in X direction
TY	Function for correcting brightness escape during beam tilt in Y direction
UNDO	Function for returning to previous status after conducting a certain operation

WHOLE (whole screen).....Large fluorescent screen for observation
(containing detection elements for overall
photometry)

WOB. (wobbler).....Wobbler, or focusing monitor

ZOOM.....Mode for enlarging specimen image ($\times 200$ to
 $\times 600k$)

MODEL H-7650 TRANSMISSION ELECTRON MICROSCOPE (USERS' OPERATION AND MAINTENANCE)

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1. OVERVIEW

1.1 Functions

1.1.1 Introduction

The Model H-7650 electron microscope has been designed so that a wide field of view is obtainable in the low and medium magnification range frequently used for research in medical science and biology, and for research and development of pharmaceuticals, polymer materials, etc. and that biological specimens can be observed with a high contrast. Accelerating voltage is 120 kV at maximum. Focal distance is selectively usable between high-resolution and high-contrast applications by means of a double-gap objective lens. Both TEM main unit and standard-equipped digital camera system are integrally controllable by one personal computer (PC). On the liquid crystal display (LCD), magnification and other imaging conditions are displayable and settable. In addition, TEM images shot with the digital camera can be displayed on the same LCD. The auto focus and auto stigma functions characteristic of the Model H-7600 are incorporated as standard. Since the mounted digital camera is capable of displaying max. 18 frames per second, focus adjustment and astigmatism correction can be carried out while watching the LCD and a checked image can be saved as it is. Thanks to a high sensitivity of the camera, image observation can be started from an electron beam dose as low as 10^{-12} C/cm² order where nothing can be seen on the fluorescent screen.

Therefore, specimen damage due to electron beam irradiation can be minimized.

System configuration is selectable according to application including the evacuation system (selection of oil diffusion pump or turbo molecular pump, selection or avoidance of cold trap) and the camera chamber for film exposure (installation selectable).

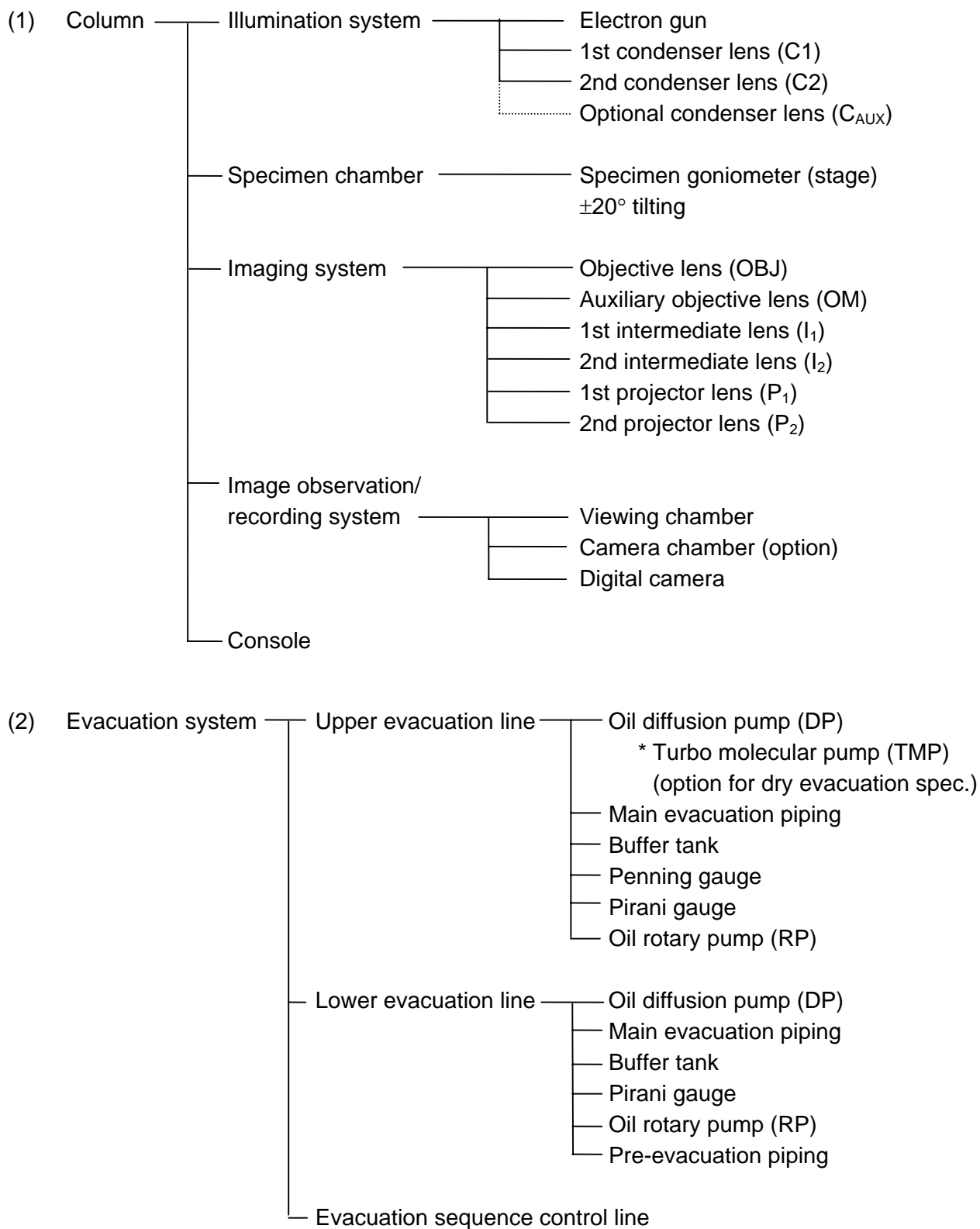
1.1 Functions

1.1.2 Composition

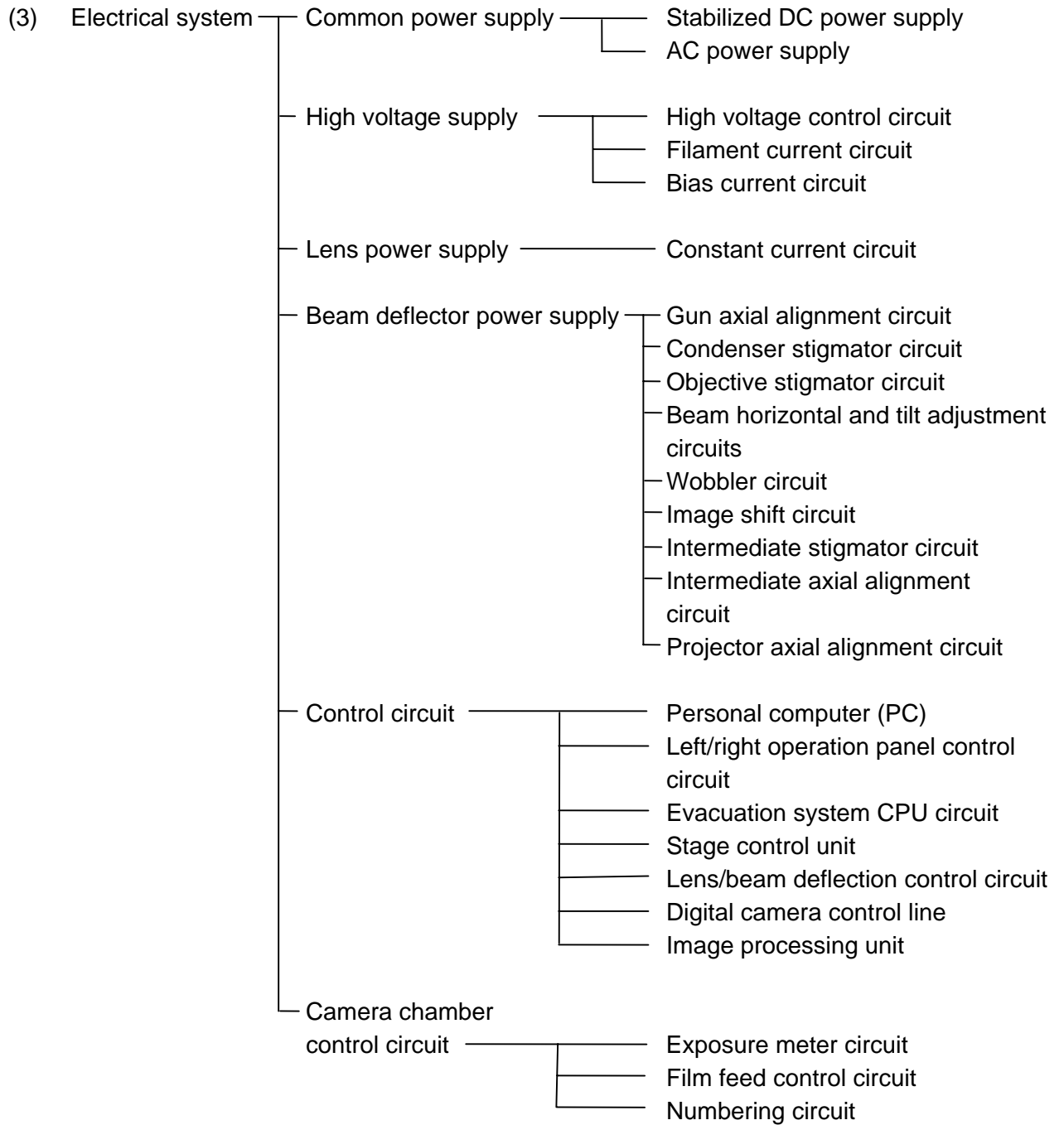
The composition of each version is shown below.

	Type A	Type B	Type C
Digital camera	Standard (AMT ER-B)	Option	Option
Auto focus Auto stigma	Standard	Option (It depends on the specification of the camera.)	No setting
Film camera	Option	Option	Option
Digital AMF	Standard	No setting	No setting
Digital Low dose	Standard	No setting	No setting
CCD Control	Standard	No setting	No setting
Image viewer (Image processing)	Standard	No setting	No setting
Thumbnail (Image management)	Standard	No setting	No setting
Automatic tilt function	Option	No setting	No setting
Auto search	Option	No setting	No setting
Analysis kit	Option	Option	Option

1.1.3 Configuration



1.1 Functions



1.1.4 Names of Major Components

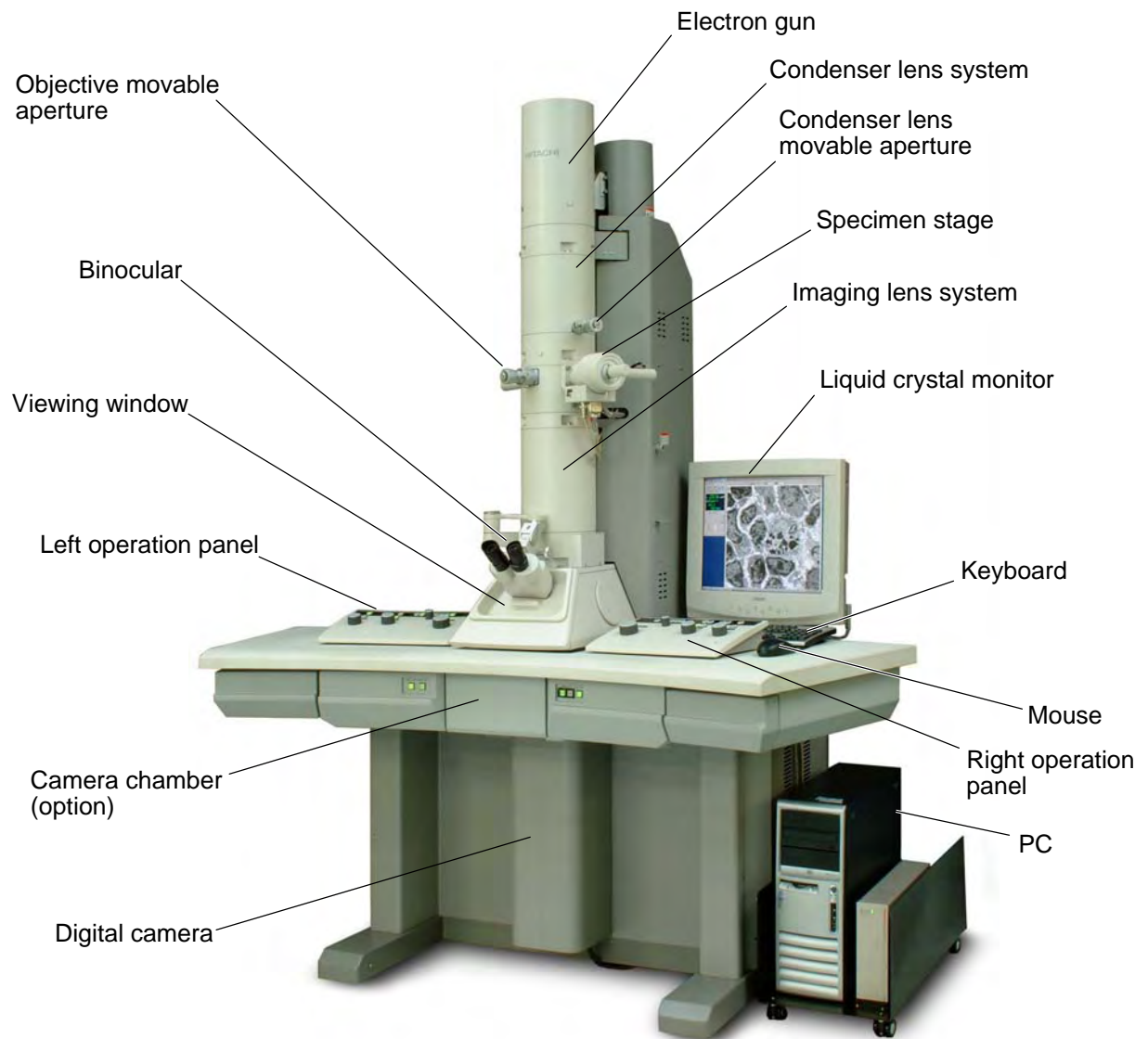
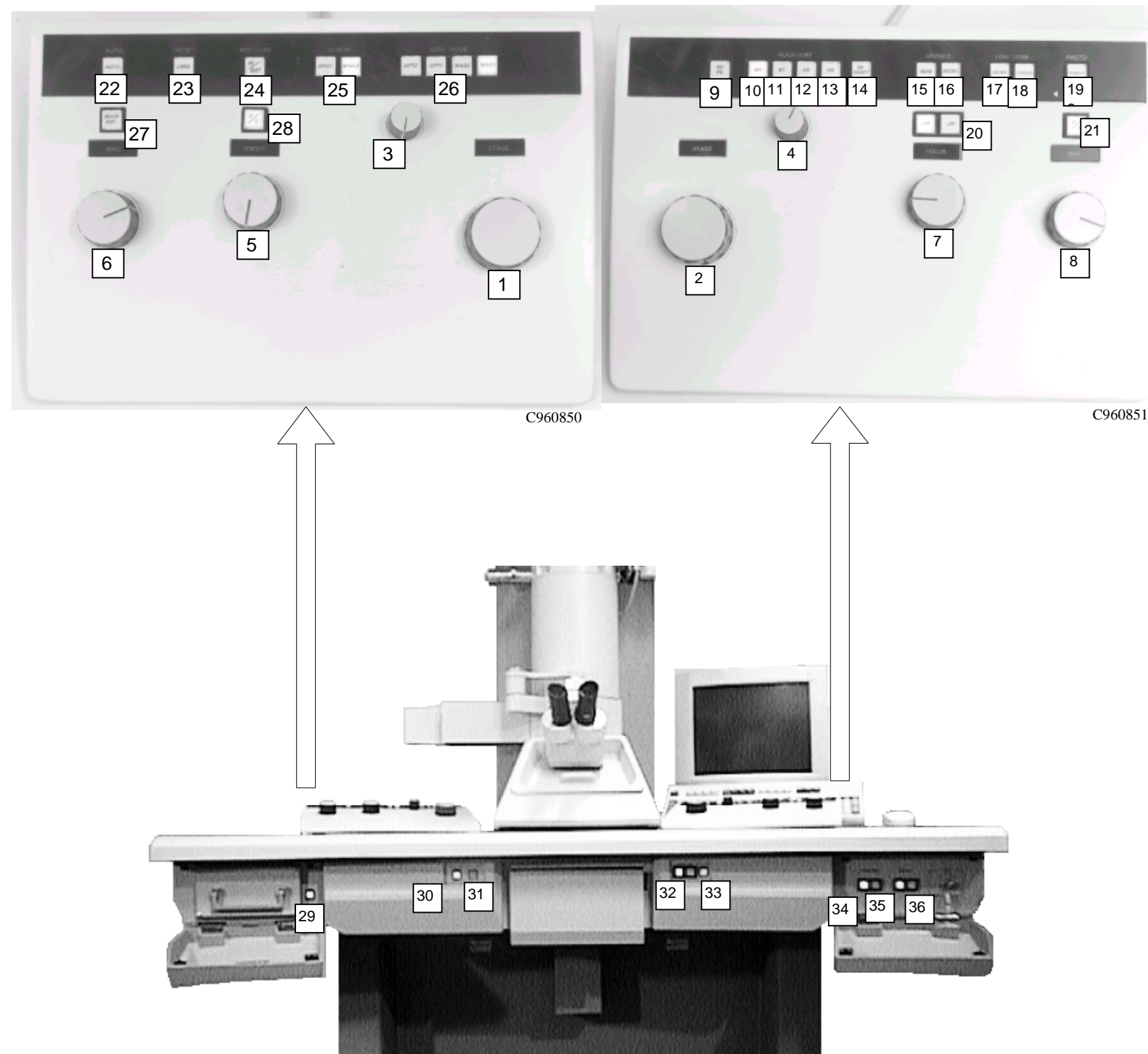


Fig. 1-1 Appearance of Model H-7650

1.1.5 Control Knobs and Switches on Operation Panels



Knob/Switch Indication	Purpose or Function
(1) STAGE (left operation panel)	Specimen motion in X direction
(2) STAGE (right operation panel)	Specimen motion in Y direction
(3) Multi-knob (left operation panel)	Beam axis alignment and its correction
(4) Multi-knob (right operation panel)	Beam axis alignment and its correction
(5) BRIGHT	Brightness variable
(6) MAG	Magnification changeover
(7) FOCUS	Focusing
(8) DIFF	Focusing in DIFF mode
(9) BD PS	Setting of BD data (BD PRESET)
(10) BH	Setting of beam shift (BH)
(11) BT	Setting of beam shift (BT)
(12) CS	Setting of condenser lens stigmator
(13) OS	Setting of objective stigmator
(14) BD RESET	Loading of set BD stigmator value
(15) WOB.	Focusing and astigmatism correction
(16) MODU.	Adjustment of voltage center (current center)
(17) LOW DOSE	Field finding/focusing in LOW-DOSE mode
(18) AUTO FOCUS	Activation of Auto Focus
(19) PHOTO	Image recording switch (option)
(20) ×10, ×20	Setting of focus variation step
(21) F/C	FINE/COARSE selection for DIFF knob
(22) HV	Automatic application of accelerating voltage
(23) LENS	Resetting of lens data
(24) Option	Unused unless option specified
(25) WHOLE, SPOT	Screen up/down
(26) ZOOM, ZOOM, DIFF, LOW MAG	Lens mode selection
(27) IMAGE ROT.	Image rotation changeover
(28) F/C	FINE/COARSE selection for BRIGHT knob
(29) PR EVAC (option)	Pre-evacuation chamber EVAC/AIR selection
(30) PANEL LAMP	Brightness selection for each switch lamp
(31) ROOM LAMP	Lighting of room lamp
(32) CAMERA EVAC	Camera chamber (option) EVAC/AIR selection
(33) FULL/HALF	Film FULL/HALF size selection
(34) COLUMN EVAC	Column EVAC/AIR selection
(35) GUN EVAC	Gun EVAC/AIR selection
(36) POWER	Key switch for power supply

1.1.6 Outline of Personal Computer (PC) for Control

Regarding the functions of Model H-7650 TEM, the methods of calling each window and setting conditions and others are outlined here. For details, refer to "3. SOFTWARE FUNCTIONS." Mouse operations used in this manual and the name of each window part are described below.

(1) Mouse Operations

(a) Mouse cursor

When moving the mouse, an arrow on the screen moves in response. The arrow is called "mouse cursor."

(b) Clicking

This action refers to pressing the left switch of mouse once and releasing it.

(c) Double clicking

This indicates that you press the left switch of mouse twice in succession.

(d) Dragging

This is an action of moving the mouse with its left switch held down.

(2) Names of Window Parts

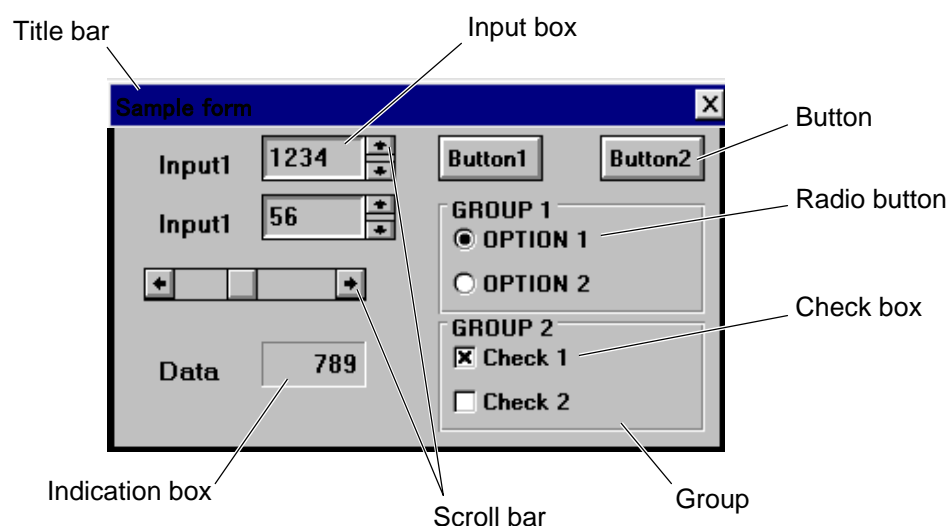


Fig. 1-2 Sample Form

1.1 Functions

(a) Title bar

On this bar, the name of the relevant window is indicated. The window can be moved by dragging the title bar with the left mouse switch held down.

(b) Control menu box

Window can be closed by double clicking. Or when you click once, a menu appears. According to the menu, the window can be closed.

(c) Button

The function of a button is executed by moving the mouse cursor on it and clicking the mouse.

(d) Scroll bar

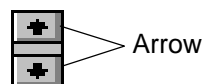
There are two kinds of scroll bars. Both bars are used for input or selection of data instead of the keyboard. The set data is indicated in the input box.

- 1) Data is settable by clicking the arrow at the left or right end with the mouse or dragging the marker on the bar with the mouse.



Scroll bar marker

- 2) Data is settable by clicking the arrow at the top or bottom with the mouse.



Arrow

(e) Input box

Into this box, input data with the keyboard or scroll bar. With the keyboard, data is input from the left side of the box and added on the right side as the number of digits increases. After input of the final value, be sure to press the enter key.

(f) Indication box

This box only indicates data. No data can be input here. Data is indicated in right justification.

(g) Radio button

This is used for specifying only one among multiple choices ordinarily. When clicking a radio button with the mouse, a dot, or "bullet" appears in the button center to notify your selection.

(h) Check box

This is used for specifying multiple choices among multiple candidates ordinarily. When clicking a check box, a check mark appears in it to notify your selection.

(i) Group

In display of multiple functions on a window, display may be divided in blocks of function. This method is called "grouping."

(3) Configuration of Control Window

(a) Initial display

- 1) The electron microscope system program can be started by turning the POWER switch key to COL.ON.
- 2) The initial screen will be displayed on the monitor and the initial setting of each control unit will be executed. Upon normal execution of the initial setting, the version of each control unit and PASSED messages will be reported. The initial display screen will automatically close and then the control window will be called.

1.1 Functions



Fig. 1-3 Initial Display Screen

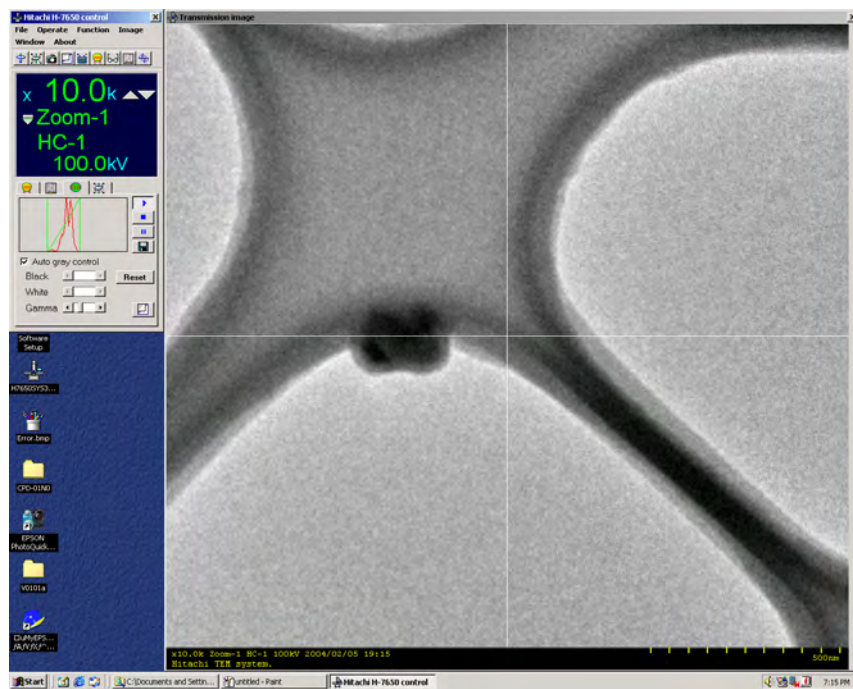


Fig. 1-4 Control Window

1.2 System Diagnosis

1.2.1 Air Tubing of Evacuation System

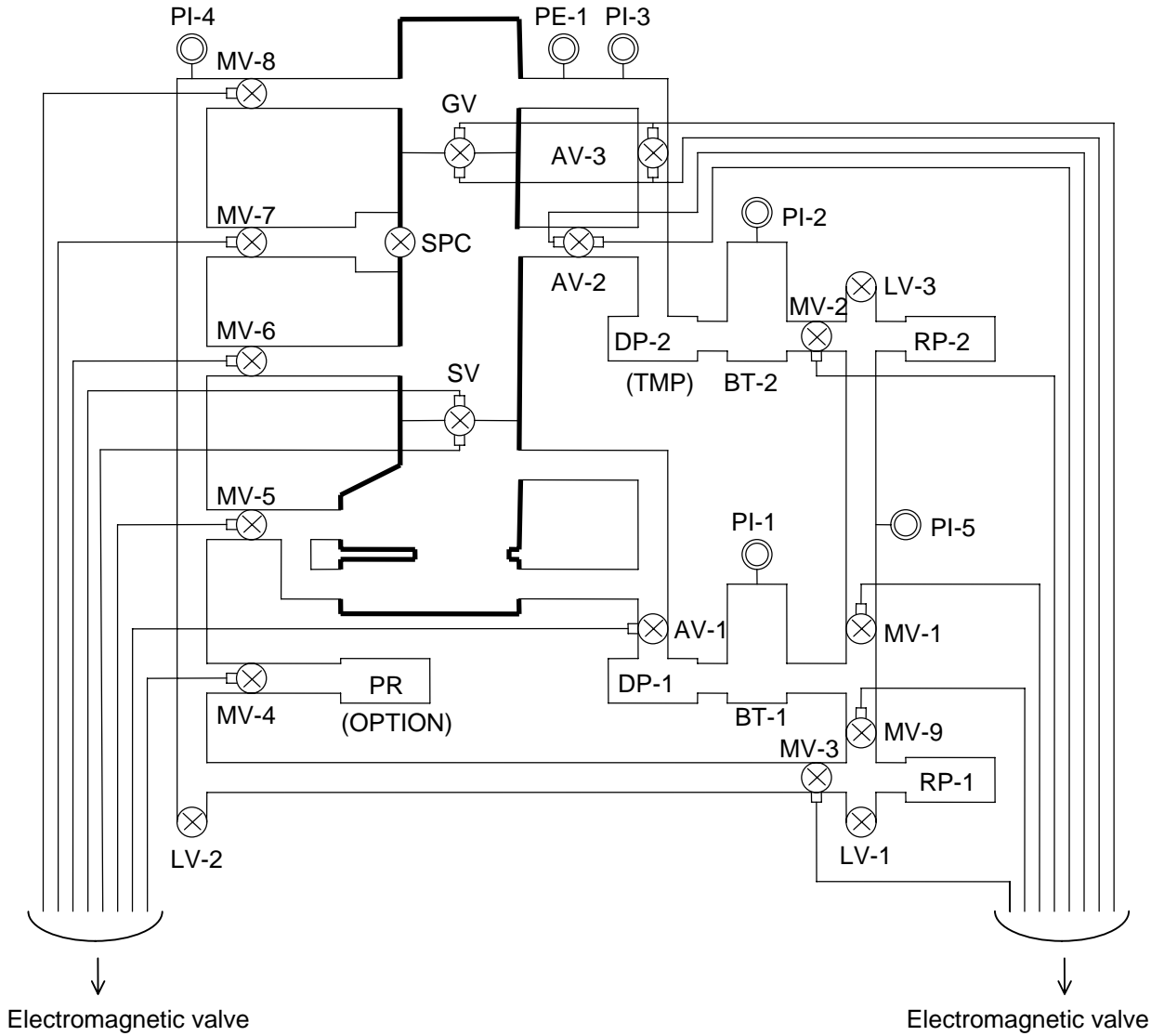


Fig. 1-5 Air Tubing of Evacuation System

* DP-2 is replaced with TMP when DRY Vacuum specification is selected.

1.2 System Diagnosis

1.2.2 Cooling Water Piping

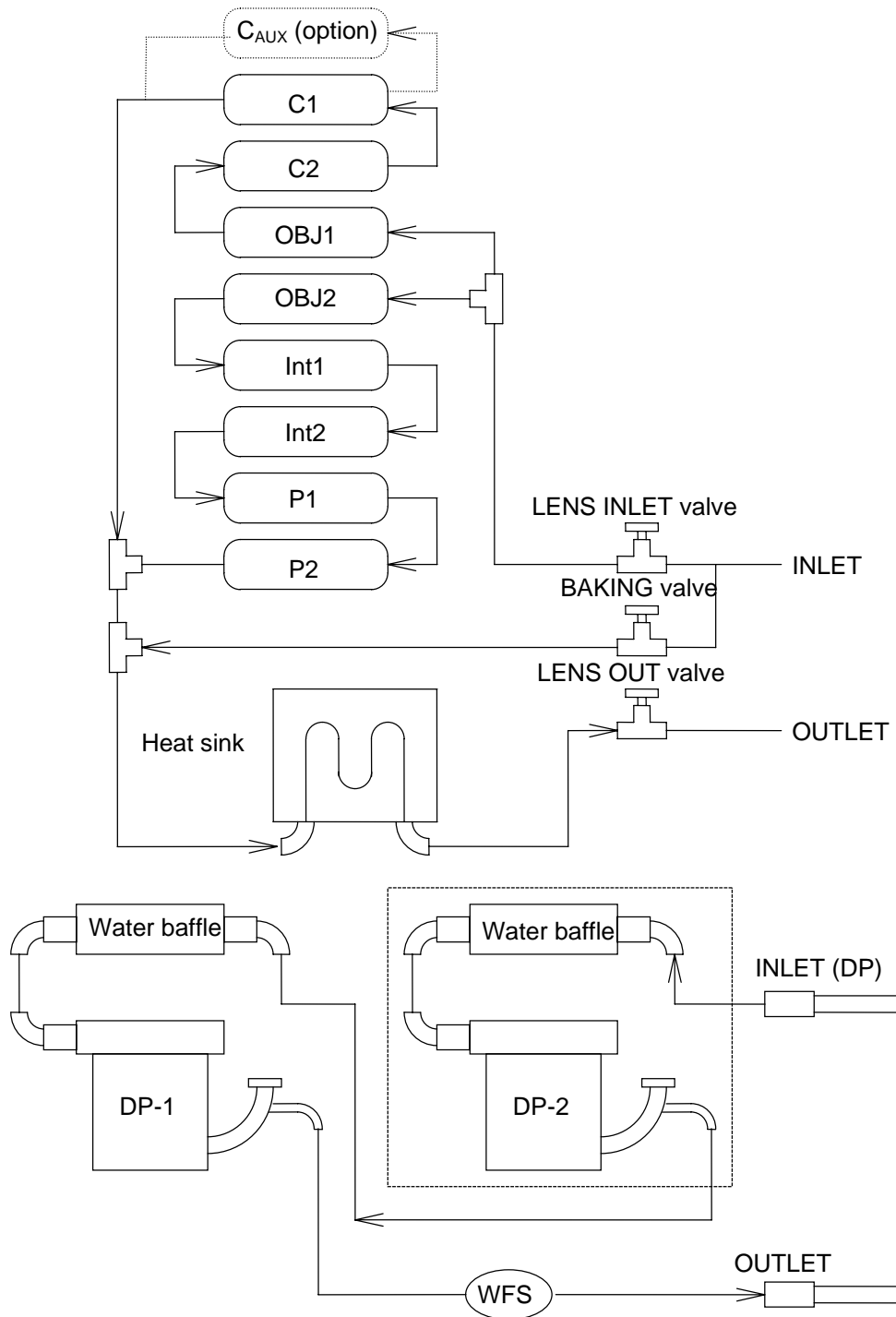


Fig. 1-6 Cooling Water Piping

* The cooling water path enclosed by dashed lines (DP-2) is not provided for DRY vacuum specification.

1.3 Standard Specifications

Table 1-1 Standard Specifications

Item	Specification/Configuration	Remarks
1. Resolution	0.204 nm (lattice image)	Digital image
2. Max. tilt angle of specimen image	$\pm 20^\circ$	HIPER-stage
3. Accelerating voltage	40 to 120 kV (variable in 100 V/step) Applied voltage fine adjustment function (within -2048 V to 2047 V in 1 V/step)	Linked with lens system and BD system in 1 kV/step
4. Magnification (on film face) ZOOM (HC mode) (HR mode) LOW MAG	$\times 200$ to $\times 200,000$ (30 steps) $\times 4,000$ to $\times 600,000$ (20 steps) $\times 50$ to $\times 1,000$ (10 steps)	<ul style="list-style-type: none"> • Rotation-free image • Magnification direct readout • Visual field diameter 160 mm on fluorescent screen at $\times 700$ min.
5. Image rotation Magnification range (HC mode) Rotation angle range	$\times 1,000$ to $\times 40,000$ (18 steps) $\pm 90^\circ$ (15° step)	<ul style="list-style-type: none"> • 100-kV guarantee • Magnification accuracy not guaranteed for 40 kV and 60 kV
6. Electron diffraction camera length Selected area diffraction	HC mode 0.05 to 8.0 m (10 steps) HR mode 0.05 to 2.0 m (10 steps)	<ul style="list-style-type: none"> • ZOOM and DIFF images coincide in direction. • Digital camera system unusable in this mode
7. Spot size Parenthesized value effective with analysis kit	HC mode 0.8 to 4 μm dia. (60 to 160 nm) (5 steps) HR mode 0.6 to 2 μm dia. (40 to 120 nm) (5 steps)	Analysis kit available at option
8. Filament	<ul style="list-style-type: none"> • DC heating • Tungsten hairpin type • Single-crystal LaB₆ emitter 	Option
9. Anticontamination function/device	<ul style="list-style-type: none"> • Column mild baking function • Dry vacuum system selection • Cold trap in specimen chamber evacuation pipe • Cold finger in objective lens 	Option Option Option
10. Specimen damage reducing function	<ul style="list-style-type: none"> • Super-low dose • Preparatory irradiation function (API: Auto Pre-Irradiation) 	Super-low dose function usable with film function (option) incorporated

1.3 Standard Specifications

(cont'd)

Item	Specification/Configuration	Remarks
11. Digital camera system (Type A only)	No. of pixels : 1,024 × 1,024 Frame rate : 18 [frame/second] Visual field range: 16 mm × 16 mm (on fluorescent screen) Coupling method: Lens Scintillator : Fluorescent material	
12. Auto focus (Type A and B only)	Applicable magnification: ×200 to ×20k Focus correction range: ±25 μm (at ×20k) Focus correction accuracy: ±5 μm (at ×20k) Auto stigma: ×200 to ×5k	Accelerating voltage 60 kV or higher, exposure amount 5×10^{-12} to 2×10^{-11} C/cm ² (at 1 s, 8×10^{-12} to 2×10^{-11} C/cm ² at 60 kV)
13. Electron gun Bias Filament	<ul style="list-style-type: none"> • Semi-fixed bias • Automatic emission current control function incorporated • DC heating • Filament operation time integrating function incorporated • Tungsten filament • LaB₆ emitter • Auto gun lift system • 2-stage deflection electromagnetic beam alignment 	(Bias voltage preset system) (Filament voltage preset system) (Shaped filament and pointed filament usable) Option (Pneumatically driven)
14. Condenser lens Number of lens stages Condenser stigmator Beam tilt Condenser lens movable aperture	<ul style="list-style-type: none"> • 2-stage condenser lens system • Electromagnetic stigmator • Tilt angle ±2.0° (at 100 kV) • COS-winding electromagnetic 2-stage deflection coil • 3 systems independent of each other (For instantaneous changeover between bright and dark field images) • Click stop with 4 openings Bore diameter: 20, 50, 100, 200 μm 	(Or 3 stages: Option for analysis kit specification) (In HC/HR mode)

(cont'd)

Item	Specification/Configuration	Remarks
<p>15. Specimen stage (HIPER-stage)</p> <p>Movable range</p> <p>Functions</p>	<ul style="list-style-type: none"> • Eucentric side entry goniometer stage • Specimen grid: 3.0 mm dia. (standardized one) • X, Y ±1 mm • Z ±0.3 mm • Specimen tilting ±20° • Stage control interlinked with magnification • Collective monitor display of stage information such as specimen position and tilt angle • Memory storage of 20 specimen positions and automatic feed to those positions • Micro trace function (Specimen position tracing display) • Field search function 	<ul style="list-style-type: none"> • Specimen observable at same position in all observation modes • Motor drive under CPU control • Range specification by dragging with mouse
<p>16. Imaging lens system</p> <p>Objective lens</p> <p>Objective lens movable aperture</p> <p>Focusing</p> <p>Intermediate lens</p>	<ul style="list-style-type: none"> • Rotation-free image available in each observation mode (within ±5°) • Field rotating function incorporated • Vertically symmetrical objective yoke structure • Composite objective lens • Electromagnetic stigmator • Intrinsic astigmatism correcting function dependent on preset memory for each accelerating voltage • Click stop with 4 openings • Bore diameter: 10, 20, 50, 80 μm • Wobbler type focusing monitor • 2-way wobbler • Amplitude variable in 10 steps • Frequency variable from 0 to 20 Hz • Focusing and astigmatism correction by stigmonitor • Optimum focus • Auto through-focus • 2-stage intermediate lens • Stigmator built in • Electromagnetic deflection coil 	<ul style="list-style-type: none"> • All modes CPU-controlled • Focus step and magnification interlinked • Defocus amount directly readable • 5 independent stigmator systems • Available in 3 types of conditions, interlinked with magnification (OF-1, 2, 3)

1.3 Standard Specifications

(cont'd)

Item	Specification/Configuration	Remarks
Field limiting movable aperture (option) Projector lens	<ul style="list-style-type: none"> • Click stop with 4 openings Bore diameter: 50, 100, 200, 400 μm • 2-stage projector lens • Electromagnetic deflection coil (Electron diffraction image alignment coil) 	
17. Viewing chamber Fluorescent screen	<ul style="list-style-type: none"> • Fluorescent screen up/down mechanism by motor drive • Main screen 160 mm dia. • Focusing screen 33 mm dia. (Also used for spot exposure) 	
18. Exposure meter (functional with optional camera chamber mechanism)	<ul style="list-style-type: none"> • Beam current detection system (Digital display of detected electron density) • Detection amount 10^{-8} to 10^{-12} coulomb/cm² • Shutter operation linked with full-automated exposure meter • Shutter time 0.5 to 100 s • Exposure difference automatically compensated for each accelerating voltage 	<ul style="list-style-type: none"> • Optimum exposure indicated by green pilot lamp • ABS and ATS built in • ABS (Auto Brightness Set): Sets optimum brightness at selected exposure time (priority given to brightness). • ATS (Auto exposure Time Set): Sets optimum exposure time at brightness under observation (priority given to timer).
19. Camera system (option) Film feeding No. of loadable film frames Film size	<ul style="list-style-type: none"> • Automatic film feeding linked with shutter operation (double exposure prevented, multiple exposure possible) • No-film feeding preventive function with film detection mechanism • Equipped with camera chamber leak buzzer • One-touch changeover of full/half size by pneumatic drive • Auto through-focus photographing sequence incorporated • 50 film frames (standard) • 82.5 \times 118 mm (Japan) 3-1/4 \times 4 inch (other countries) 	<ul style="list-style-type: none"> • 100 fields recordable (with 50-frame film loaded)

(cont'd)

Item	Specification/Configuration	Remarks
Exposure size Film marking	<ul style="list-style-type: none"> • Full size 113 × 76 mm (Japan), 95 × 76 (other countries) Half size 76 × 53 mm (Japan), 76 × 46 (other countries) • Character printout through monitor Magnification, operator code, film number, accelerating voltage, comment (in up to 20 characters), micron marker and photographing date printable 	
20. Plate reservoir (option)	<ul style="list-style-type: none"> • Automatic evacuation (incorporation in front left of main unit console) • Capable of accommodating 2 cassette magazines 	
21. Evacuation system Vacuum pump Vacuum gauge	<ul style="list-style-type: none"> • Vacuum sealed with liner tube • Fully automated vacuum sequence control with vacuum sensor • Oil diffusion pump (DP) of evacuation rate 570 L/s × 2 units Water baffle and buffer tank provided • Oil rotary pump (RP) of evacuation rate 160 L/min × 2 units • Pirani gauge × 5 sets • Penning gauge × 1 set 	<ul style="list-style-type: none"> * Evacuation rate in DRY vacuum specification (option) • DP 570 L/s × 1 unit • TMP 340 L/s × 1 unit
22. Safety devices	Against: <ul style="list-style-type: none"> • Power interruption • Water shutoff • DP overheating • High voltage discharge • Power transistor overheating • Vacuum failure 	
23. Installation conditions Power requirements Grounding terminal Cooling water	Single-phase 100 V AC ± 10%, 50/60 Hz, 6 kVA 100 Ω or less, class D grounding Flow rate.....2 L/min or more × 2 lines Pressure 50 to 200 kPa Temperature.... 10 to 20 °C Drain..... Natural drain Water inlet Rc 3/8 connector	Auto transformer (option) is required for 115, 200, 220 and 240 V AC. Two tapered screws of internal thread for Rc 3/8 pipe are required when circulator is used.

1.3 Standard Specifications

(cont'd)

Item	Specification/Configuration	Remarks
Installation room	Dimensions: 300 (W) × 300 (D) × 250 (H) cm or more Entrance/exit: 100 (W) × 200 (H) cm or more Temperature 15 to 30 °C Humidity 30 to 60% RH or less	Screw of internal thread for pipe × 2 pcs 120 (W) × 200 (H) cm or more with cold trap
24. Dimensions and weight	Main instrument: 180 (W) × 120 (D) × 220 (H) cm, 930 kg Power unit: 70 (W) × 38 (D) × 75 (H) cm, 150 kg HV transformer: 69 (W) × 38 (D) × 67 (H) cm, 190 kg Oil rotary pump (RP): 20 (W) × 2 (units) × 48 (D) × 30 (H) cm, 27 kg × 2 (units) = 54 kg Air compressor: 64 (W) × 28 (D) × 53 (H) cm, 27 kg	
25. Standard equipment	Main instrument 1 HV transformer 1 RP 2 Standard accessories 1 set Standard tools..... 1 set Instruction manual 1	

1.4 Outline of Automatic Specimen-tilting Image Acquisition Function (option)

Automatic specimen-tilting image acquisition function is an option for Model H-7650. This function enables the user to automatically acquire image data while tilting a specimen. Image escape in specimen tilting can be corrected using the electromagnetic image shift function (ISF) and specimen stage, and the acquired images can be saved in the PC for control. The Model H-7650 with this function is different from the standard Model H-7650 in the following points.

- (1) The position of the objective lens aperture is lower (more distant from specimen).
- (2) Bore diameter of the objective lens aperture is different.
- (3) When the cold finger (option) is mounted, the shape of the part at its tip is different.
- (4) Specimen tilting is controllable from the PC.

1.4.1 Specifications

Table 1-7 lists the operational specifications of the automatic specimen-tilting image acquisition function.

Table 1-7 Specifications

Digital Camera	Applicable Magnification	Tilting Step	Tilt Angle
AMT ER-B camera	×10k max.	5.0° max.	Within ±60°

Note 1) Correction may be ineffective depending on specimen and field of view.

Note 2) Correction may stop halfway if specimen drift is excessive.

1.4 Outline of Automatic Specimen-tilting Image Acquisition Function (option)

1.4.2 Diameter of Image Field

When the 60° tilting mechanism is mounted, image field will be restricted because of the objective movable aperture. Table 1-8 lists the effective image field diameters at different positions of the objective movable aperture.

Table 1-8 Image Field Diameter at each Position of Objective Movable Aperture

Objective Movable Aperture	No. 1	No. 2	No. 3	No. 4
Image field diameter on fluorescent screen at $\times 0.7k$	160 mm	120 mm	80 mm	40 mm
Magnification for full imaging on fluorescent screen	$\times 0.7k$ min.	$\times 1.2k$ min.	$\times 2.5k$ min.	$\times 4.0k$ min.
Magnification for full camera image field	$\times 0.2k$ min.	$\times 0.2k$ min.	$\times 0.3k$ min.	$\times 0.5k$ min.

Note: The fluorescent screen has a diameter of 160 mm.

2. OPERATION

2.1 Startup and Shutdown

2.1.1 Operation in Emergency

(1) Emergency Stop

The Model H-7650 transmission electron microscope is not equipped with an emergency stop button.

(2) Power Interruption

If power interruption occurs, the instrument will shut down completely. Even after power supply is recovered, the instrument will remain inactive. Start up the instrument according to "Startup" in 2.1.2.

(3) Water Interruption

If water interruption occurs, the instrument will shut down completely. Even after power supply is recovered, the instrument will remain inactive. Start up the instrument according to "Startup" in 2.1.2.

(4) Safety Device

Shutdown status varies with safety device. If normalcy is automatically restored just before activation of a safety device, you may continue microscopy with no measure taken. However, if accelerating voltage or lens current turns off due to activation of a safety device, the voltage or current remains off even after normalcy is automatically recovered.

2.1 Startup and Shutdown

2.1.2 Startup (from power-on to column evacuation)

(1) Check of Cooling Water

Cooling water has 2 lines; one for evacuation system (DP cooling water) and the other for lens system cooling (lens coil and heat sink cooling water). For water cooling of the lens system, there are 3 cooling water valves; LENS IN, LENS BAKING (for mild baking) and LENS OUT valves from the left as shown in Fig. 2-1.

Before operation, confirm the following.

- The LENS IN and LENS OUT valves are open.
- The LENS BAKING valve is closed.

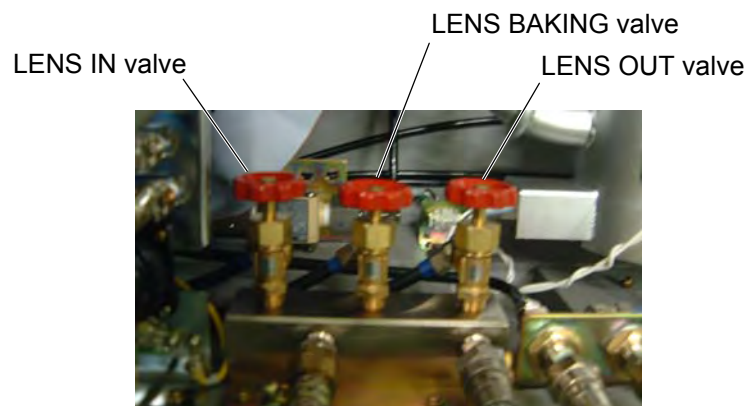


Fig. 2-1 Location of Cooling Water Valves (main unit rear)

NOTE: Usually, the flow rate of cooling water has been factory-regulated. So avoid valve operation unless absolutely required. After checking opening/closing, return each valve to the original status. Cooling water should be turned on/off from the cooling water circulator or by means of the tap water valve.

(2) Power Supply

Turn on the main circuit breaker on the switchboard to supply power.

(3) DC Power Supply Switch

Turn on the MAIN switch of DC power supply. Usually, this switch may be kept ON.

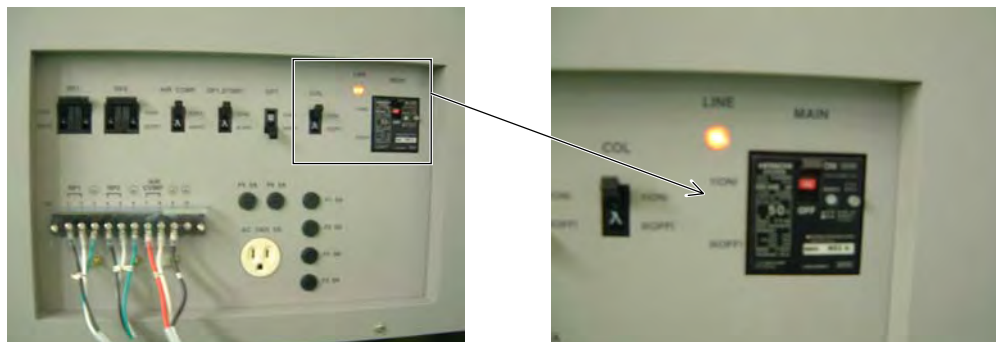


Fig. 2-2 DC Power Supply and MAIN Switch (in ON status)

(4) EVAC ON Operation

Turn the key switch of power supply to the EVAC ON position. Make sure the GUN EVAC and COLUMN EVAC switches on the front panel are “flickering in green.” The instrument reaches a high vacuum in about 20 to 30 minutes. Then, the EVAC switches stop “flickering in green” and “remains lit in green.”



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Fig. 2-3 Key Switch of Power Supply

2.1 Startup and Shutdown

(5) How to Check EVAC/AIR Switches

The respective EVAC and AIR selector switches on the front operation panel stand for vacuum states of the relevant column blocks. When you press each switch once, it is left in the pressed status (ON). When you press the switch again, it returns to the original status (OFF). Table 2-1 shows the relation between the selector switch lamps and selected states.

When the column is in the AIR or CLOSE state, the instrument won't reach a high vacuum (cannot be set in EVAC state) though the key switch of power supply is turned to EVAC ON. And while the DP warms up, each EVAC switch of GUN, COLUMN and CAMERA "flickers in green."

Table 2-1 EVAC/AIR Switches

Selected State	EVAC Switch		AIR Switch	
	Lamp	Switch	Lamp	Switch
Open to atmospheric air (AIR state)	Lamp off	OFF	Orange flickering	ON
Valve closed (CLOSE state)	Lit, green	OFF	Lit, orange	OFF
		(ON)		(ON)
Under evacuation	Green flickering	ON	Lamp off	OFF
Evacuated state (EVAC state)	Lit, green	ON	Lamp off	OFF

The procedure for selecting each state is shown in Fig. 2-4. For changing from the EVAC state to CLOSE state, press the EVAC switch. For further changing to the AIR state, press the AIR switch. Reversely for transition from the AIR state to CLOSE state, press the AIR switch. And for advancing to the EVAC state, press the EVAC switch.

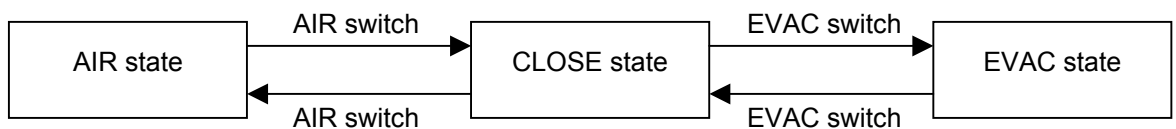


Fig. 2-4 EVAC/AIR Switch Operation

NOTE: As is known from Table 2-1, the CLOSE state is also set when both selector switches are pressed. However, for transition to the AIR/EVAC state from the ON status of both switches, the procedure is reverse to that in the above figure. To avoid confusion, the procedure shown in Fig. 2-4 is recommended.

2.1.3 COL.ON Operation

(1) Turning POWER switch key to COL.ON

- (a) Turn on the POWER switch of digital camera controller. Usually, this switch may be left on. (Type A only)

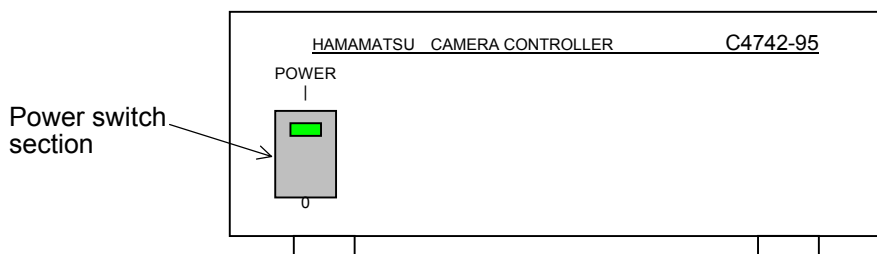


Fig. 2-5 Digital Camera Controller

- (b) Turn the POWER switch key to the COL.ON position, and PC power supply will turn on. Then, the electron microscope system program starts.



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Fig. 2-6 POWER Switch Key

NOTE: Start of the control system takes about 3 minutes after turning the POWER switch key from OFF to COL.ON.
And before the instrument is evacuated to a high vacuum after start of the control system, accelerating voltage cannot be applied.

2.1 Startup and Shutdown

(2) Initial Screen

- (a) The initial screen appears on the monitor as shown in Fig. 2-7 and initial setting of each control unit proceeds.



Fig. 2-7 Initial Screen

- (b) If an error is detected in the initial setting, an error message window as shown in Fig. 2-8 will open and the communication line to the error-detected unit will be disconnected.

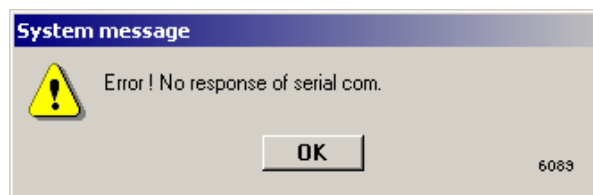


Fig. 2-8 Error Message (example)

- (c) In addition, a window as shown in Fig. 2-9 opens. On this window, press the **Close** button to terminate the initial setting. According to “error messages” in 4.5, take a proper measure or contact Hitachi representative.

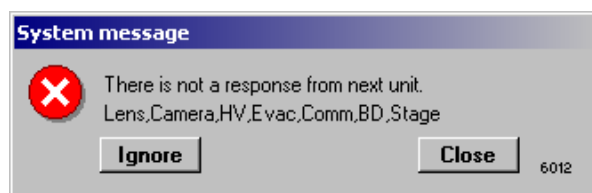


Fig. 2-9 System Error Message

(3) Control Window

When the initial setting is normal, the initial screen will close automatically, and the control window (Easy operation window) and digital camera image (Transmission Image window) appear as shown in Fig. 2-10. For details and operation method of the control window, refer to “configuration of control window” in 3.1.2.

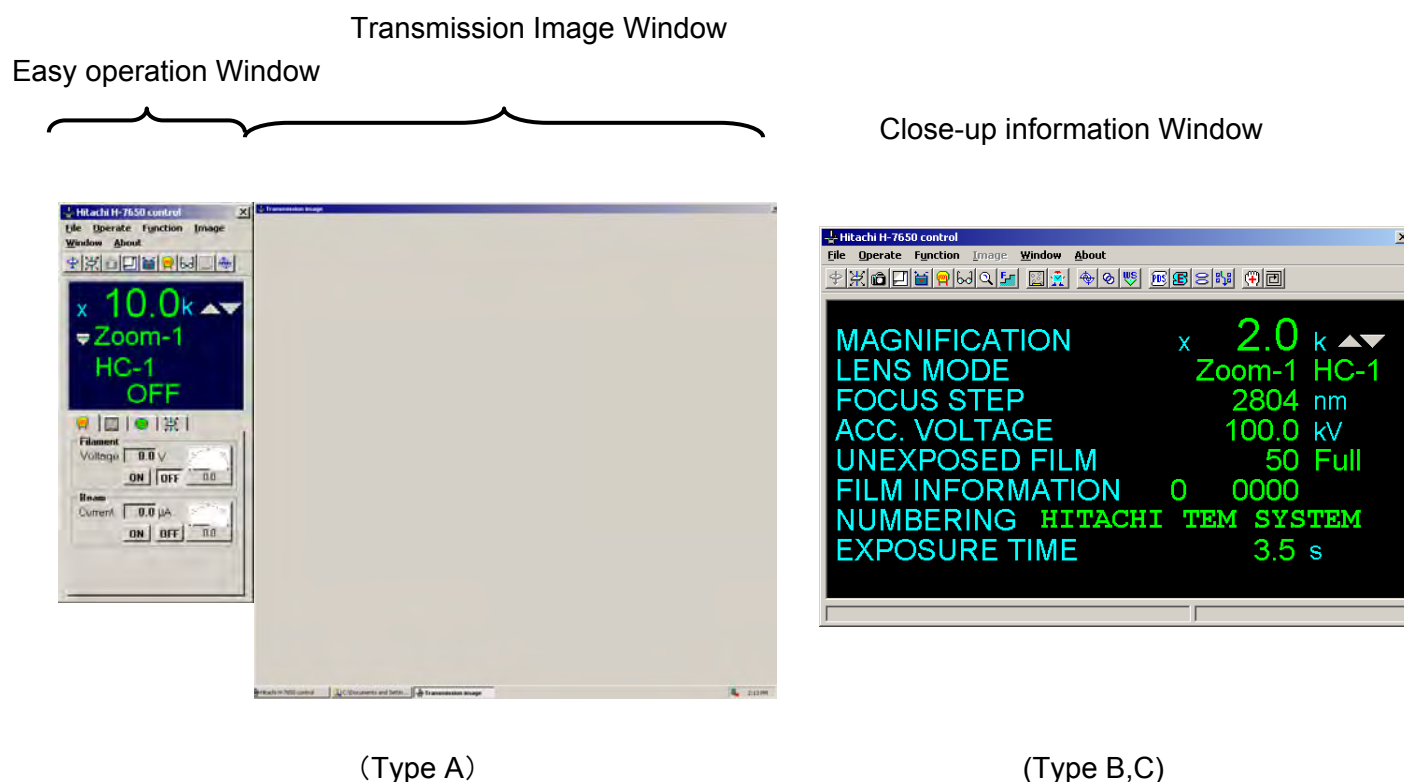


Fig. 2-10 Control Window

2.1 Startup and Shutdown

2.1.4 Application of Accelerating Voltage and Generation of Electron Beam

For observing an electron microscope image on the fluorescent screen or with the digital camera, an accelerating voltage must be applied to generate an electron beam. Implement the following procedure.

(1) Full Auto Mode up to Generation of Electron Beam

This is effective when an automatic sequence is set with an accelerating voltage, filament voltage, emission current, etc. already input properly. For change of accelerating voltage setting, refer to “Acc. voltage” in 3.3.2 (1). For change of filament voltage and emission current settings, refer to “Filament/Bias” in 3.3.2 (4).

(a) Use the following method for checking whether an automatic sequence is set or not. If it is evident that an automatic sequence has already been set, go to (b).

- 1) Select Operate - HV Control - Filament/Bias to open the Filament/Bias control window.

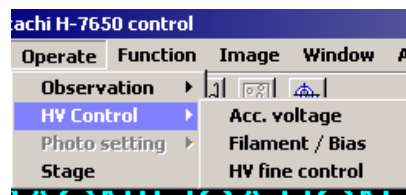


Fig. 2-11 HV Control Menu

- 2) Confirm that the Auto setup radio button in the Filament setup time group on the Filament/Bias control window is turned on and that Auto radio button in the Emission current group is also turned on. If the Manual side is selected, an automatic sequence will not be set. So, select the Auto side and click the **Set** button at the top right of this window.

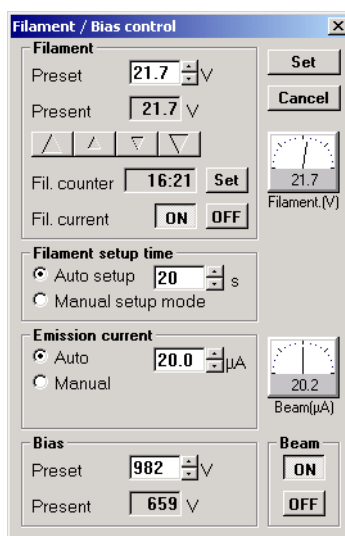


Fig. 2-12 Filament/Bias Control Window

- (b) In the control area on the Easy operation window, click the HV tab to display the HV control area.

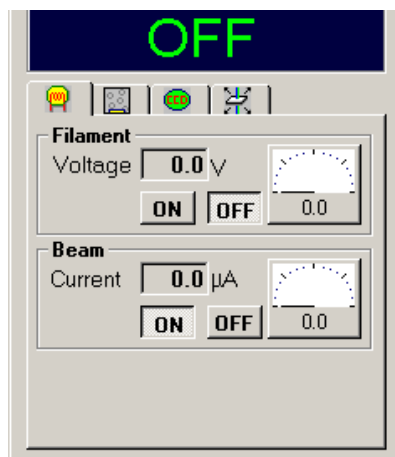


Fig. 2-13 HV Control Area

2.1 Startup and Shutdown

- (c) Press the HV switch on the left operation panel. A step-up sequence starts and the HV switch flickers in green. However, this is ineffective unless the column is under a high vacuum. If ineffective, an error message will be reported. Wait until a high vacuum is reached.

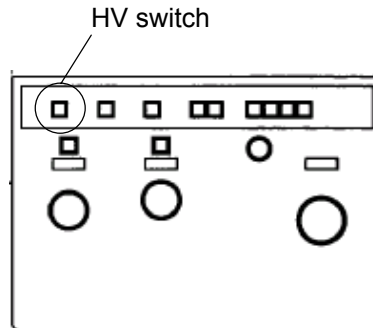


Fig. 2-14 Left Operation Panel

- (d) The HV/Filament meter window as shown in Fig. 2-15 automatically opens. Accelerating voltage rises continuously until the determined level is attained.

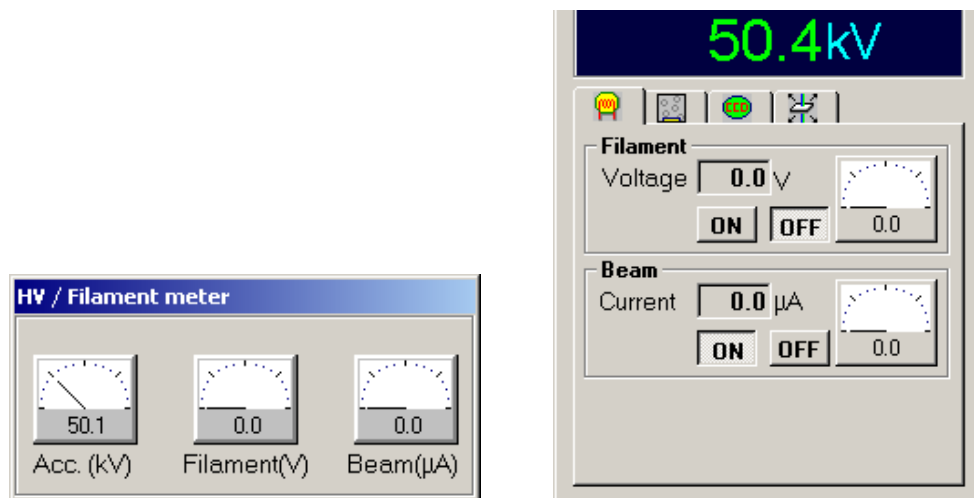


Fig. 2-15 During Rise of Accelerating Voltage

- (e) In succession, the filament voltage rises until the set level is attained. Then, the HV/Filament meter window will close automatically.

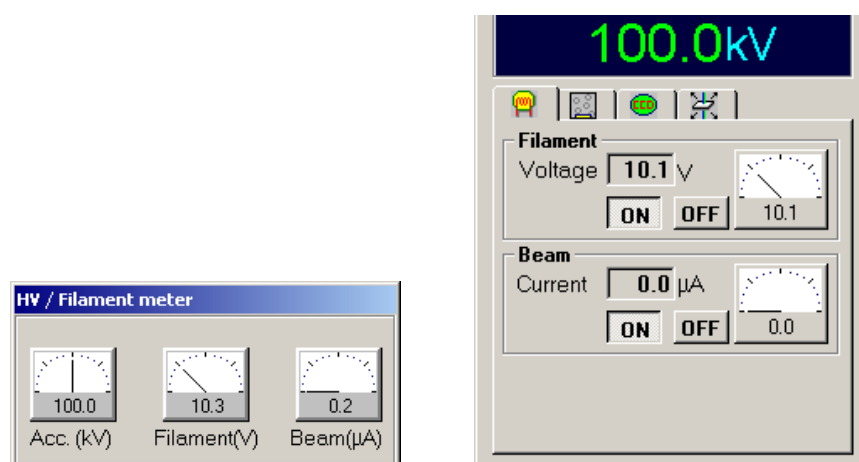


Fig. 2-16 During Rise of Filament Voltage

- (f) Now, a bias voltage is set and an electron beam is generated at the determined emission current.

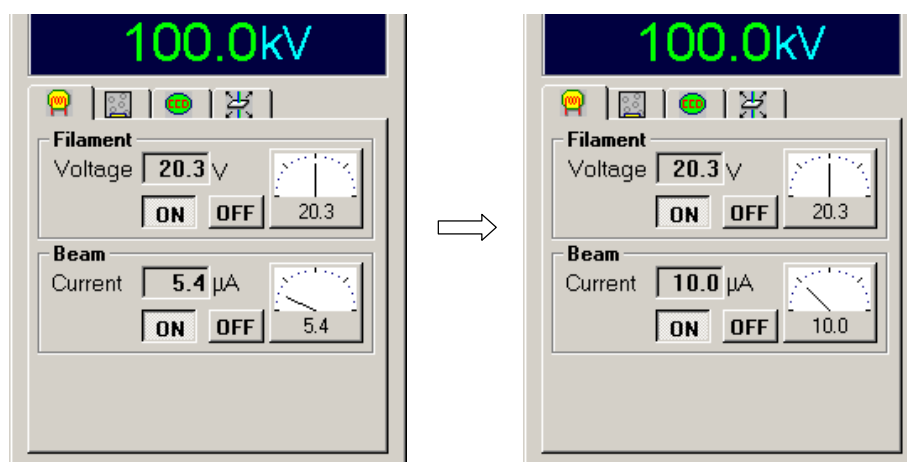


Fig. 2-17 Setup of Bias Voltage

NOTE: Shortly after raising the filament voltage, the bias voltage changes gradually until the filament temperature stabilizes. During this process, image may be defocused.

NOTE: When the specimen chamber evacuation switch is set at AIR, the bias voltage setup sequence does not function. This switch must be set at EVAC.

NOTE: If the **OFF** button in the Beam group on the Easy operation window is pressed, the bias voltage setup sequence does not function. Press the **ON** button.

2.1 Startup and Shutdown

(2) Application of Accelerating Voltage Alone

Perform this operation when accelerating voltage needs to be stabilized more than usual for high resolution imaging or the like.

- (a) Generate an electron beam by applying an accelerating voltage according to (1).
- (b) Click the **OFF** button in the Filament group on the Easy operation tab. Filament voltage is then reduced to 0.0 V and electron beam emission stops. The accelerating voltage is now applied without beam emission.

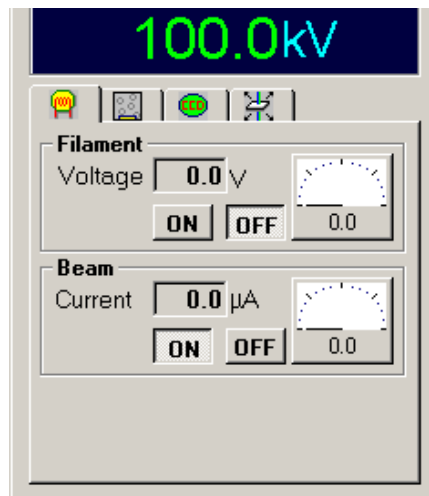


Fig. 2-18 Filament OFF Status

- (c) For resuming the beam emission, click the **ON** button in the Filament group.

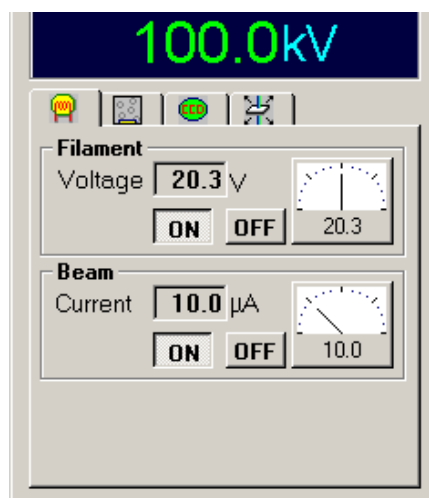


Fig. 2-19 Filament ON Status

- (3) Bias Blanking (method of stopping electron beam generation without turning off accelerating voltage and filament voltage)

This operation is effective for temporarily stopping the projection of electron beam to a specimen.

- (a) Generate an electron beam by applying an accelerating voltage according to (1).
- (b) Click the **OFF** button in the Beam group on the Easy operation tab. Bias voltage output is maximized while keeping the filament voltage applied, and electron beam emission stops. The accelerating voltage and filament voltage remain applied. This mode is called “bias blanking.”

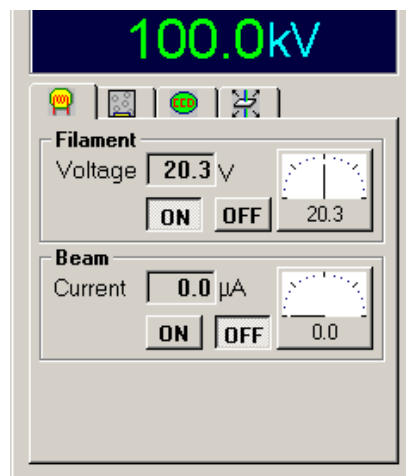


Fig. 2-20 Bias Blanking Mode

- (c) For resuming the beam emission, click the **ON** button in the Beam group.

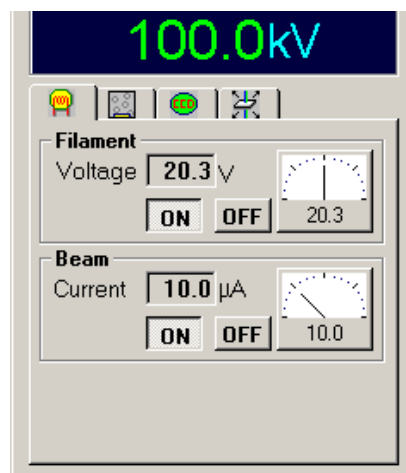


Fig. 2-21 Bias Blanking Released

2.1 Startup and Shutdown

(4) Change of Accelerating Voltage

Follow the instructions given here for changing the accelerating voltage from the status where electron beam is emitted. Filament voltage application and electron beam generation after accelerating voltage setup are dependent on the auto or manual sequence whichever selected.

(a) Select Operate - HV Control - Acc. voltage to open the Acc. voltage control window.

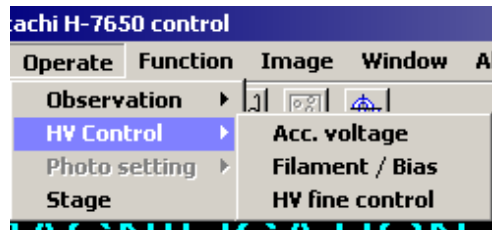


Fig. 2-22 HV Control Menu

(b) Input the desired accelerating voltage value in the Preset input box in the HV preset data set group on the Acc. voltage control window. Or use the up/down arrow button. Reference accelerating voltage values (40, 60, 80, 100, 120 kV) have been prepared as button icons in the HV preset data set group. For selecting a reference accelerating voltage value, click the relevant button icon, and the desired accelerating voltage value is read in the Preset input box.

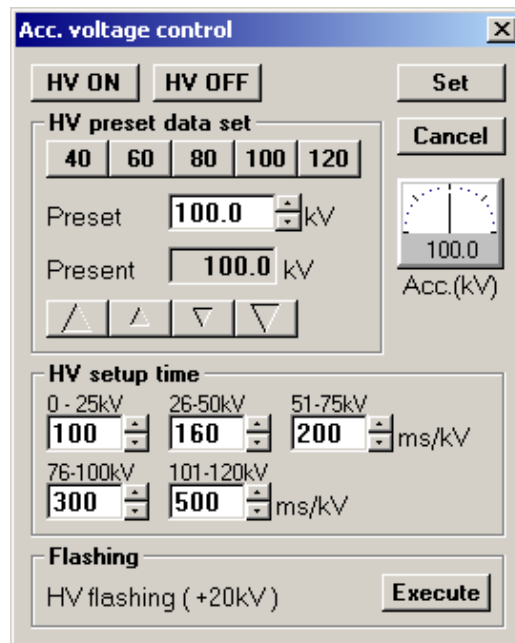


Fig. 2-23 Acc. voltage control Menu

- (c) Determine the input value by clicking the **Set** button at the top right.
- (d) Press the HV switch on the left operation panel. Or click the **HV ON** button at the top left of the Acc. voltage control window.

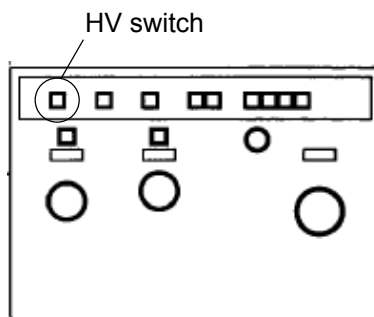


Fig. 2-24 Left Operation Panel

- (e) Filament voltage turns off, bias voltage is set at the Preset level and electron beam emission stops. Then, accelerating voltage rises or falls continuously until the desired level is reached.
 - (f) Subsequently, filament voltage is applied and electron beam is emitted according to the auto or manual sequence whichever selected.
- (5) Change of Filament Voltage

Follow the steps below to change the filament voltage due to change of the filament with time, etc. This is not required routinely.

- (a) Generate an electron beam according to (1).
- (b) Select Operate - HV Control - Filament/Bias to open the Filament/Bias control window.

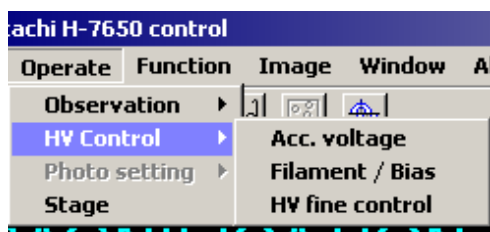


Fig. 2-25 HV Control Menu

2.1 Startup and Shutdown

- (c) Turn on the Manual radio button in the Emission current group.

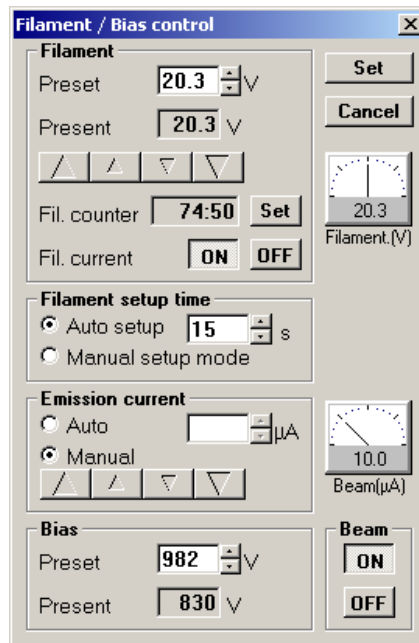


Fig. 2-26 Filament/Bias control Window

- (d) Change the Present value in the Filament group by clicking the up/down arrow button in this group. Clicking the **Set** button at the top right determines the input value.

NOTE: As the filament voltage is raised, the emission current begins changing. However, the emission current remains the same at a certain filament voltage and higher. This status is called “filament saturation.” The filament voltage in the filament saturation status should be input as the preset value.

- (6) Change of Emission Current

Carry out the following procedure for a change of emission current, e.g., when a brighter or darker beam is temporarily required. For details of the Filament/Bias control window shown below, refer to “Filament/Bias” in 3.3.2 (2).

- (a) Generate an electron beam in the routine procedure.

- (b) Select Operate - HV Control - Filament/Bias to open the Filament/Bias control window.

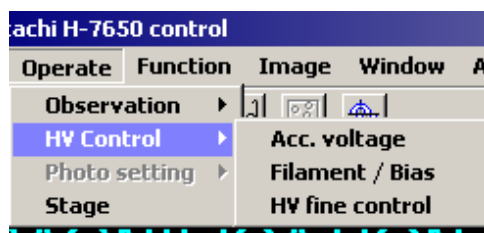


Fig. 2-27 HV Control Menu

- (c) Turn on the Auto radio button in the Emission current group.

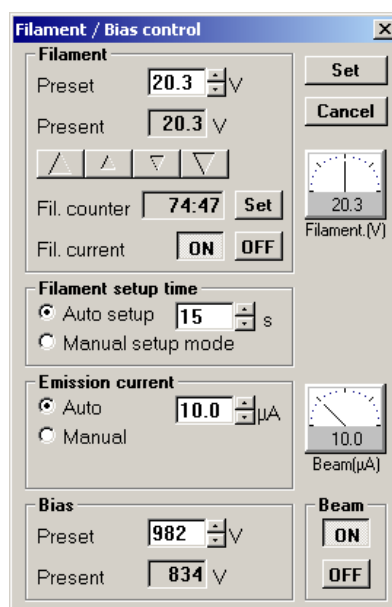


Fig. 2-28 Filament/Bias control Window

- (d) Input the desired emission current value in the Auto input box and click the **Set** button at the top right of this window.
- (e) Bias voltage will be automatically set so as to obtain the input emission current.

NOTE: An appropriate emission current varies with the kind of filament. Its value ranges from 5 to 15 μA for a standard tungsten hairpin type filament, and from 5 to 10 μA for an optional LaB_6 emitter.

2.1 Startup and Shutdown

2.1.5 COL.OFF Operation

(1) Turning Off Accelerating Voltage

On the left operation panel, press the HV switch twice in succession to turn off accelerating voltage. Bias voltage and filament voltage also turn off automatically interlinked with accelerating voltage.

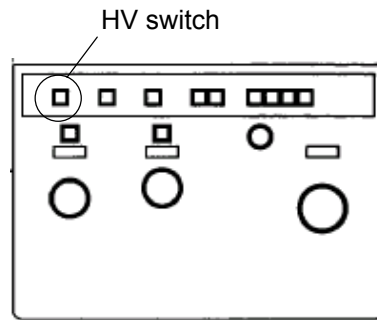


Fig. 2-29 Left Operation Panel

(2) COL.OFF Operation by POWER Switch Key

Turn the POWER switch key from the COL.ON position to the EVAC ON position (COL.OFF status).



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Fig. 2-30 POWER Switch Key

(3) COL.OFF

The shutdown message window opens on the monitor screen. After a few seconds, the COL. power supply turns off. All the switch lamps on the left and right operation panels turn off.

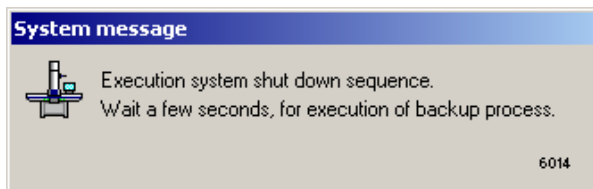


Fig. 2-31 Shutdown Message

NOTE: For the next COL.ON operation, wait for about 10 sec after COL. power supply has turned off. Otherwise, the fuse may be blown or the circuit breaker turns off due to a rush current.

NOTE: Usually, the PC power switch need not be turned on/off.

NOTE: Avoid installing any other application software in the PC of this instrument. If installed, a longer time will be taken for shutting down the PC and the COL. power supply may turn off while the PC is activated. In this case, there is a risk of the PC becoming faulty or the data and software saved in the hard disk, etc. being damaged.

(4) Caution on Closing of Control Software

- (a) When the software is closed in the normal procedure, a window as shown in Fig. 2-32 opens to confirm closing of the control window. Click the **Cancel** button here. For COL.OFF, use the POWER switch key when the control software has started up.

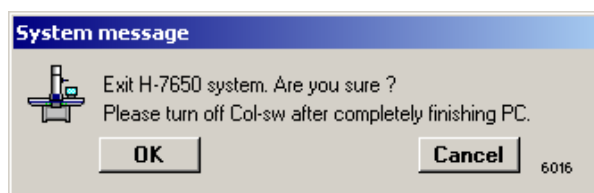


Fig. 2-32 System Message

2.1 Startup and Shutdown

- (b) If you clicked the **OK** button in error, use of the POWER switch key should be avoided. Instead, restart the control software with the key kept at COL.ON. Then, perform COL.OFF operation.

NOTE: If you turned the POWER switch key up to EVAC ON in error, return the key to COL.ON and carry out step (b). If the key remains at EVAC ON, the timer starts and after about 2 minutes, the COL. power supply turns off. Until the timer reaches the end, the Windows must be shut down. Otherwise, there is a risk of the PC becoming faulty or the data and software saved in the hard disk, etc. being damaged.

2.1.6 Stop of Evacuation System

It is recommended to run the evacuation system continuously in order to maintain a high vacuum quality and reduce the influence by contamination. For continuous operation of the evacuation system alone, keep the POWER switch key at EVAC ON. For stopping the evacuation system as well, follow these steps:

(1) Off Operation by POWER Switch Key

Turn the POWER switch key to the OFF position. Even in the OFF status, RP continues running for about 20 minutes. After this time period, the RP stops and the evacuation system is inactivated.



C960918

Fig. 2-33 POWER Switch Key

(2) Turning Off Power Supply

Turn off the main circuit breaker on the switchboard to cut off power supply. There is no need for turning off the MAIN switch of DC power supply.

(3) Stop of Coolant

After inactivation of the DP, stop the coolant. Usually, the flow rate of coolant is regulated. For stopping the coolant, therefore, close the tap water valve or turn off the power supply to coolant circulator without manipulating the valves at the rear of column.

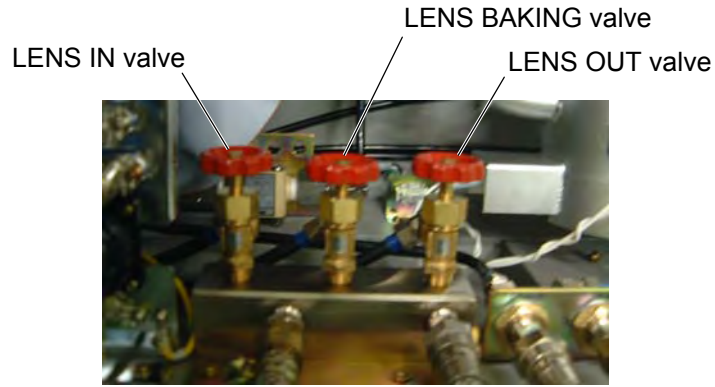


Fig. 2-34 Coolant Valve Location (rear of main unit)

2.2 Basic Operations before Microscopy

2.2 Basic Operations before Microscopy

For operations described here, an electron beam must be generated with an accelerating voltage applied. A specimen need not be loaded.

NOTE: The operations described here must always be performed on the fluorescent screen. If a spot-shaped beam is projected into the digital camera, its scintillator might be damaged.

2.2.1 Notes on Magnification

(1) Film Magnification

The Model H-7650 transmission electron microscope can mount a film camera at option. When using this camera, an electron microscope image is exposed on a photographing film. A magnification on this film is called “film magnification.” The magnification data to be marked on a photographing film stands for film magnification. Unless otherwise specified, “magnification” in this manual indicates “film magnification.”

(2) Printer

The Model H-7650 is standard-equipped with a digital camera. When an electron microscope image is shot with this camera, it will be saved in the hard disk, etc. of PC and can be pasted as image data to a document file. The pasted image data can be output with a printer. Output in 143 dpi (dot per inch) will present a square image whose one side is about 182 mm long. Since a scale bar is marked in a digital image, it should be used for calibrating magnifications.

(3) Magnification Display

Film magnification is displayed on the Easy operation window.

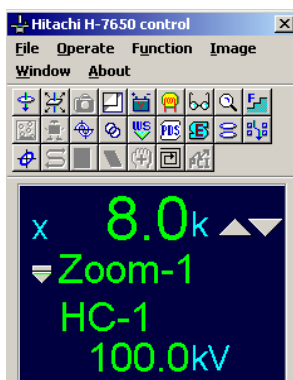


Fig. 2-35 Easy operation Window

2.2.2 Specimen Exchange (with H-7501SS standard specimen holder)

(1) Specimen Unloading

- (a) Set the specimen holder on the specimen exchange table.



Fig. 2-36 Specimen Exchange Table

- (b) Return the retainer <1> with tweezers as directed by the arrow until the spring <4> is hooked.

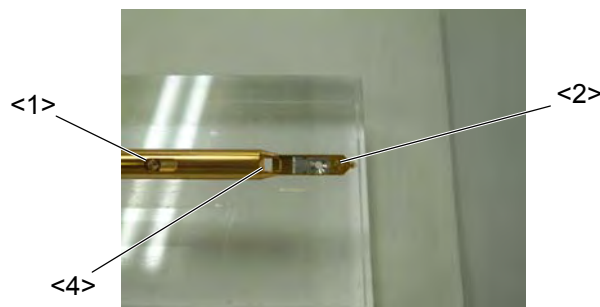


Fig. 2-37 Retainer

- (c) Remove the grid retainer <2> from the specimen holder using tweezers.



Fig. 2-38 Grid Retainer

- (d) Take out a specimen from the recess of specimen holder <3> shown below.

2.2 Basic Operations before Microscopy

(2) Specimen Loading

- (a) Place a specimen in the recess of specimen holder <3>.

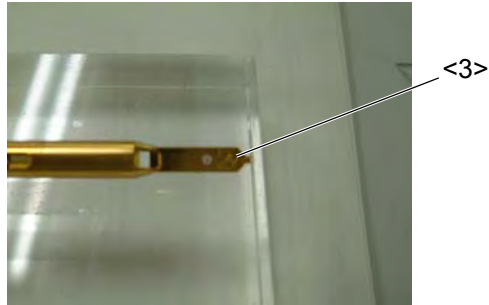


Fig. 2-39 Recess

- (b) Put the grid retainer <2> at the specimen setting position. Align the notch on each side of the grid retainer with the longitudinal axis of specimen holder.



Fig. 2-40 Grid Retainer

- (c) Raise the spring <4>, and the grid retainer <2> will be fixed.

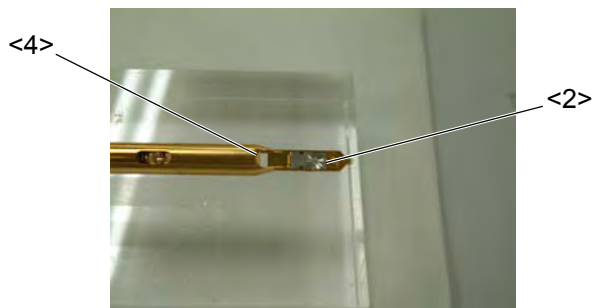


Fig. 2-41 Spring

- (d) Make sure the grid retainer <2> is held completely by the spring <4>. For confirmation, hold the specimen holder manually and tap its part outside the O-ring and near the grip with your finger. Avoid tapping with tweezers, otherwise the holder might be damaged.

NOTE: If the grid retainer is not mounted securely to the specimen holder, the specimen may be damaged due to spring action.

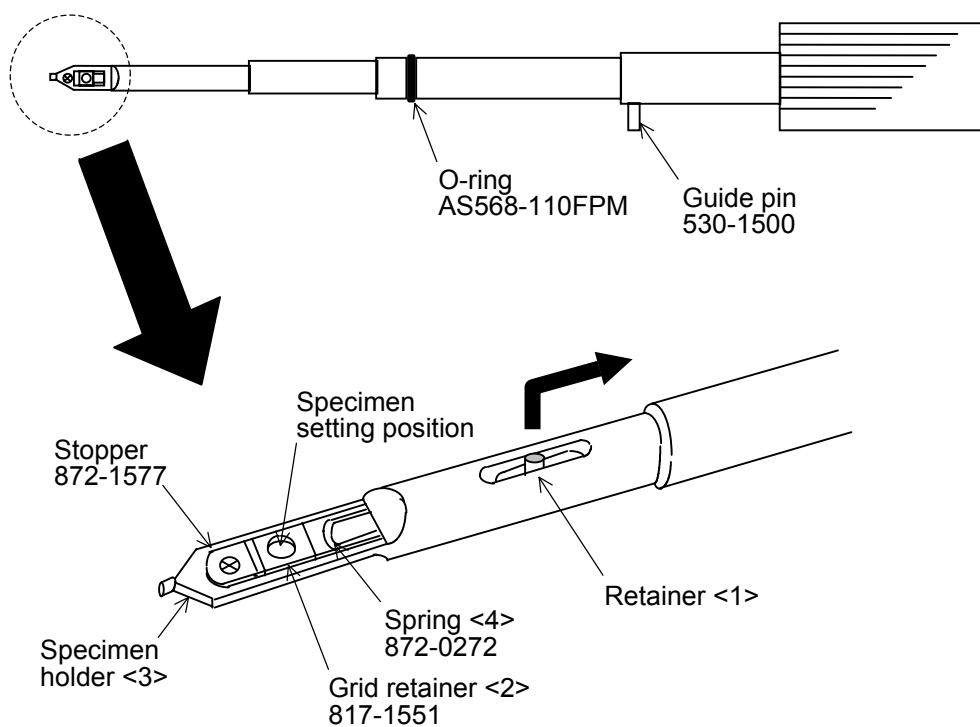


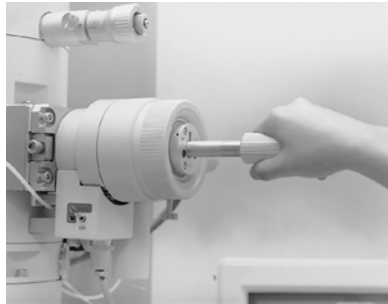
Fig. 2-42 Schematic Diagram of Specimen Holder

2.2 Basic Operations before Microscopy

2.2.3 Handling of Specimen Holder

(1) How to Insert Specimen Holder

- (a) Insert the specimen holder, aligning its guide pin with the cylinder groove of specimen stage, until it stops. The cylinder is now at position A. Then, the AIR red lamp comes on.



B960855

Fig. 2-43 Insertion of Specimen Holder (position A)

NOTE: At this time, the specimen holder is locked so that it will not turn. If the holder is turned forcibly, the lock mechanism may be broken.

- (b) Turn the specimen chamber evacuation switch to EVAC.

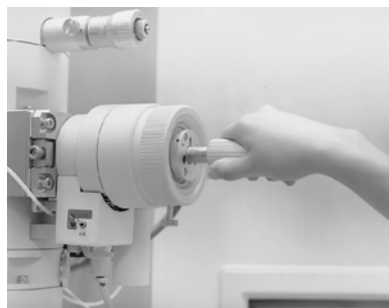


B960859

Fig. 2-44 Specimen Chamber Evacuation Switch

NOTE: Unless the specimen holder is properly set at the position A, evacuation will not start. In this case, the specimen chamber evacuation lamp (red lamp) does not light. Push the specimen holder manually in the inserting direction until the red lamp is lit.

- (c) Upon completion of evacuation, the red lamp goes out. The lock release lamp (green lamp) lights to indicate that the lock mechanism of specimen holder is released (for about 15 seconds).



B960856

Fig. 2-45 Release of Specimen Holder Lock Mechanism

- (d) Hold the grip of specimen holder manually and turn it clockwise at 45° until it stops. At this time, the holder receives a force to draw into the column due to vacuum. So without releasing your hand from the holder, push it in slowly until it stops (position B). At the stop position, turn the holder counterclockwise at 15° and insert it in the axial direction until it stops. (The holder is now at position C.)

NOTE: Insertion of the specimen holder is allowed while the green lamp is lit. Once the green lamp is turned off, the lock mechanism is activated to inhibit insertion of the holder. If this occurs, turn the specimen chamber evacuation switch to AIR, and then to EVAC for re-evacuation. After completion of pre-evacuation, the specimen holder can be pushed in.

NOTE: Upon insertion of the specimen holder, the green lamp goes out. For inserting the specimen holder from position B to C, pre-evacuation is not required.

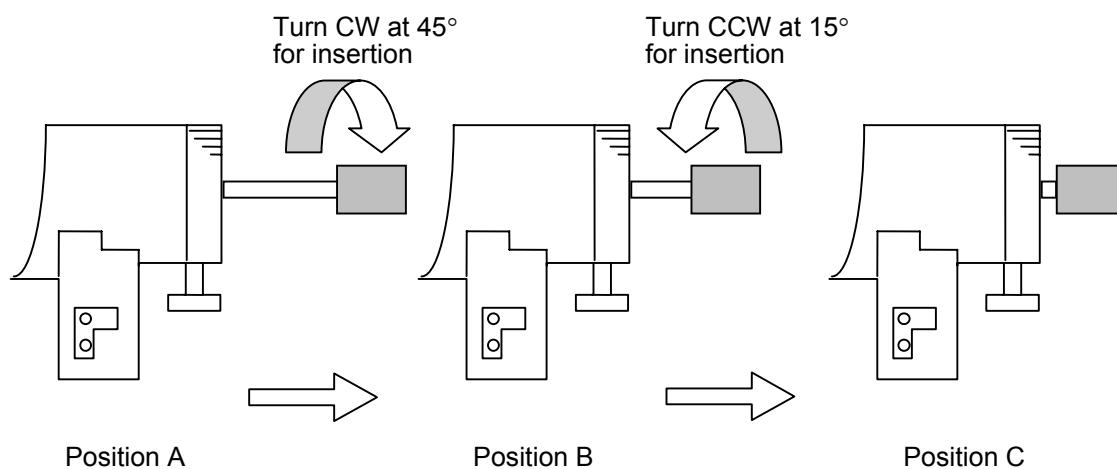


Fig. 2-46 Holder Insertion

2.2 Basic Operations before Microscopy

(2) How to Take out Specimen Holder

- (a) From position C, draw out the specimen holder until it stops and turn it clockwise at 15° until stops. (The holder is now at position B.) At the present position, draw out the holder again until it stops, and turn counterclockwise at 45° until stops.

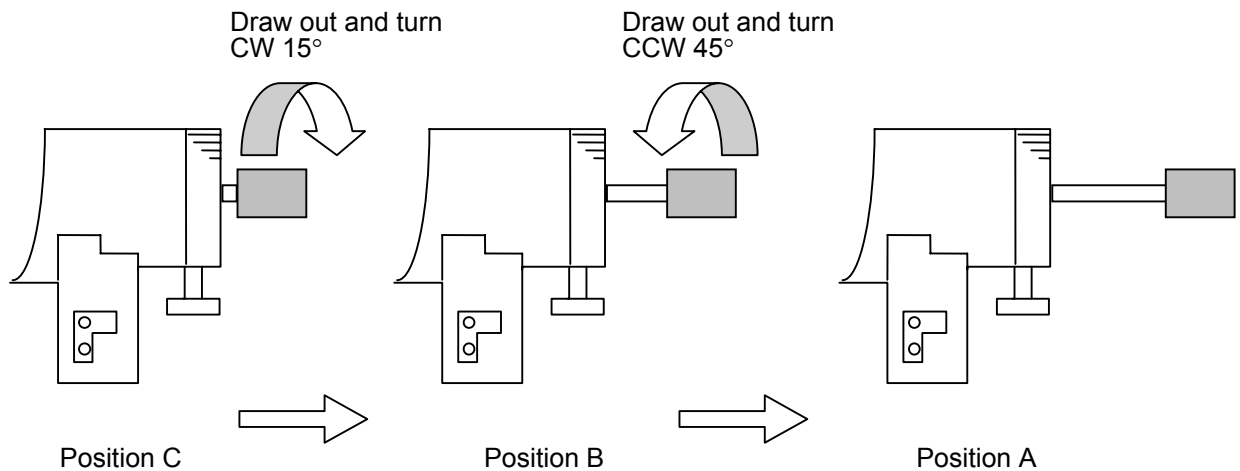


Fig. 2-47 Holder Takeout

NOTE: When the holder comes to position A, the lock mechanism is activated to inhibit insertion of the holder to position B.


- (b) Turn the specimen chamber evacuation switch to AIR. After a few seconds, the red lamp lights on the specimen chamber evacuation panel to notify the completion of air leak.



B960858

Fig. 2-48 Specimen Chamber Evacuation Switch

- (c) Extract the specimen holder.

 WARNING
Oxygen Shortage
<p>When dry nitrogen gas is used for vacuum leak of the instrument, suffocation may occur due to oxygen deficiency. So ventilation is required. While the gas is unused, the dry nitrogen gas valve must be kept closed.</p>

 CAUTION
Overhead Danger
<p>The column of this instrument has protrusions. Hitting your head against those protrusions may result in injury. So attention should be paid to overhead danger when you stand up from the chair.</p>

- (3) Specimen Tilt Angle (HIPER-stage)

Specimen tilt restriction is imposed. When the standard specimen holder is inserted, maximum tilt angle is $\pm 20^\circ$.

NOTE: If a specimen is tilted beyond the maximum tilt angle, the tip of holder may come in contact with the cold finger (option) or objective movable aperture to cause breakage. Therefore, this angle limit should be followed strictly.

NOTE: The allowable maximum tilt angle varies with holder. Use each holder within the allowable maximum tilt angle described in its instruction manual.

2.2 Basic Operations before Microscopy

2.2.4 Operation of Movable Aperture

(1) Control Knobs of Condenser Lens Movable Aperture

Figure 2-49 shows an external view of the condenser lens movable aperture unit.

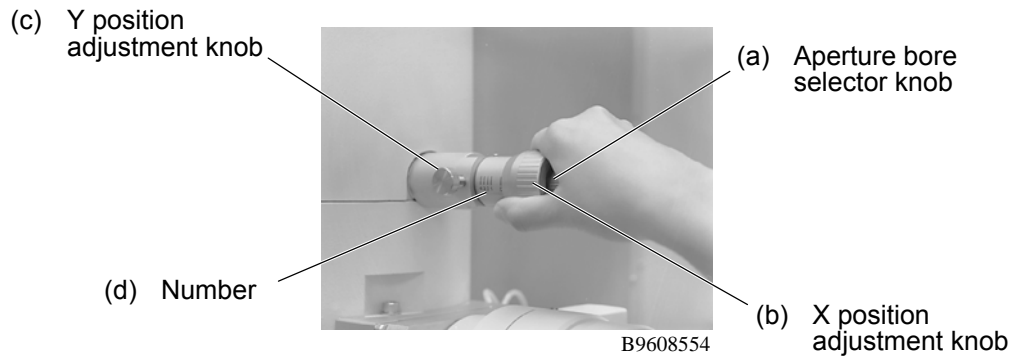


Fig. 2-49 Condenser Lens Movable Aperture

(a) Aperture Bore Selector Knob

A smaller-diameter aperture bore can be selected by turning this knob clockwise. And a larger-diameter aperture bore can be selected by turning the knob counterclockwise. The movable aperture can be removed from the electron beam path by turning the knob completely in the counterclockwise direction.

(b) X Position Adjustment Knob

This knob adjusts the aperture bore position in the in/out direction of the movable aperture.

(c) Y Position Adjustment Knob

This knob adjusts the aperture bore position perpendicularly with respect to the in/out direction of the movable aperture.

(d) Number

Indicates the movable aperture bore No. presently selected. At the "0" position, the movable aperture is off the electron beam path.

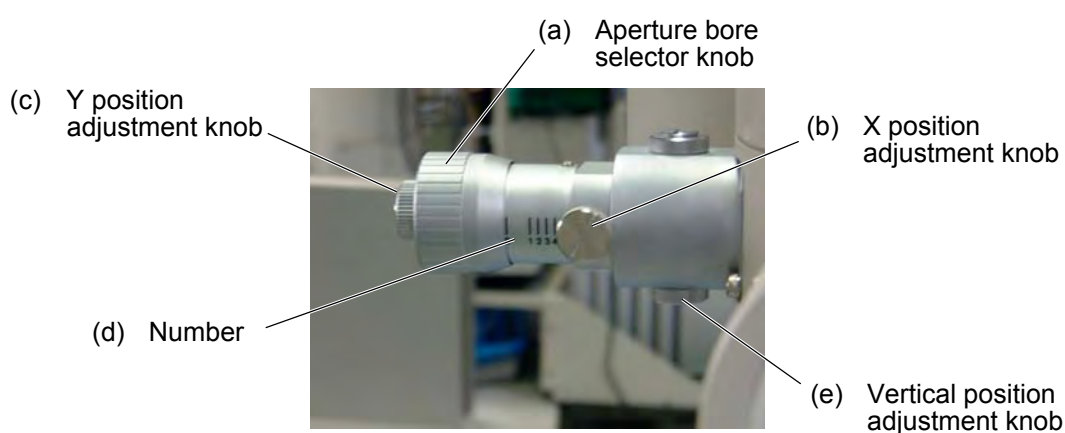
(e) Aperture Bore Diameter

Table 2-2 Bore Diameter of Condenser Lens Movable Aperture

Bore No. of movable aperture	No. 1	No. 2	No. 3	No. 4
Bore diameter	200 μm	100 μm	50 μm	20 μm

(2) Control Knobs of Objective Lens Movable Aperture

Figure 2-50 shows an external view of the objective lens movable aperture unit.

**Fig. 2-50 Objective Lens Movable Aperture**

(a) Aperture Bore Selector Knob

A smaller-diameter aperture bore can be selected by turning this knob clockwise. And a larger-diameter aperture bore can be selected by turning the knob counterclockwise. The movable aperture can be removed from the electron beam path by turning the knob completely in the counterclockwise direction.

(b) X Position Adjustment Knob

This knob adjusts the aperture bore position in the in/out direction of the movable aperture.

(c) Y Position Adjustment Knob

This knob adjusts the aperture bore position perpendicularly with respect to the in/out direction of the movable aperture.

2.2 Basic Operations before Microscopy

(d) Number

Indicates the movable aperture bore No. presently selected. At the "0" position, the movable aperture is not aligned with the electron beam path.

(e) Vertical Position Adjustment Knob

The vertical position of the objective lens movable aperture is adjustable by this knob. Because the vertical position has been factory-adjusted and fixed, the user is not required to adjust the position.

(f) Aperture Bore Diameter

Table 2-3 Bore Diameter of Objective Lens Movable Aperture

Bore No. of movable aperture	No. 1	No. 2	No. 3	No. 4
Bore diameter	80 μm	50 μm	20 μm	10 μm

NOTE: Please do not expand electron beams more than fluorescent boards when magnification \times inserts real aperture 10 μm diameter by 30,000 or less and it takes a picture of the image. Irregular brightness is occasionally caused in the image. Because scattering by the irradiation system might be generated, it is recommended to use it with focusing lens movable aperture No2 and Spot size No4 or less. Besides this, when scattering with the sample mesh is generated, the mesh of a hall that is smaller than 200 meshes is recommended. The emission current is lowered, and please the doing observation and take a picture of the focus match again when you do not satisfy the above-mentioned condition if you do not darken brightness when taking a picture in the film and CCD camera.

(3) Control Knobs of Field Limiting Movable Aperture (option)

Figure 2-51 shows an external view of the field limiting movable aperture unit (option).

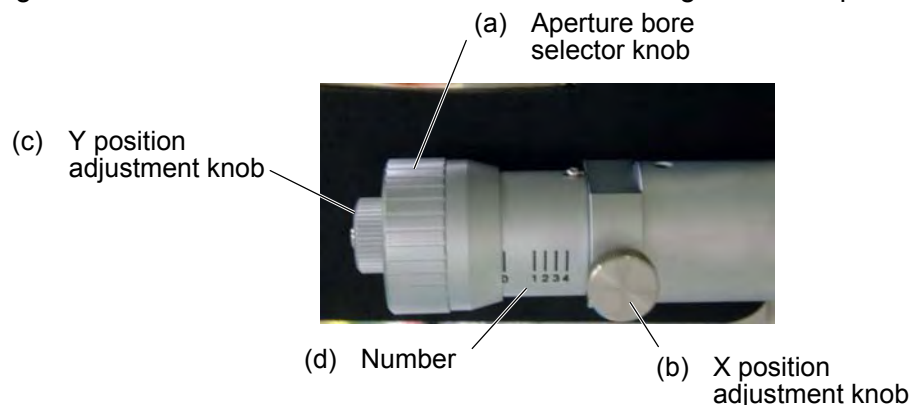


Fig. 2-51 Condenser Lens Movable Aperture (option)

(a) Aperture Bore Selector Knob

A smaller-diameter aperture bore can be selected by turning this knob clockwise. And a larger-diameter aperture bore can be selected by turning the knob counterclockwise. The movable aperture can be removed from the electron beam path by turning the knob completely in the counterclockwise direction.

(b) X Position Adjustment Knob

This knob adjusts the aperture bore position in the in/out direction of the movable aperture.

(c) Y Position Adjustment Knob

This knob adjusts the aperture bore position perpendicularly with respect to the in/out direction of the movable aperture.

(d) Number

Indicates the movable aperture bore No. presently selected. At the "0" position, the movable aperture is deviated from the electron beam path.

(e) Aperture Bore Diameter

Table 2-4 Bore Diameter of Field Limiting Movable Aperture (option)

Bore No. of movable aperture	No. 1	No. 2	No. 3	No. 4
Bore diameter	400 μm	200 μm	100 μm	50 μm

2.2 Basic Operations before Microscopy

2.2.5 Adjustment of Condenser Lens System

(1) Securing of Electron Beam Path

- (a) For electron beam to reach the fluorescent screen directly, remove the condenser lens movable aperture, objective lens movable aperture and field limiting movable aperture (option) from the optical axis as they may block the electron beam.
- (b) When a specimen is introduced, set the specimen holder at position B according to (2) of 2.2.3.

(2) Centering of Electron Beam

- (a) Press the ZOOM1 switch on the left operation panel.

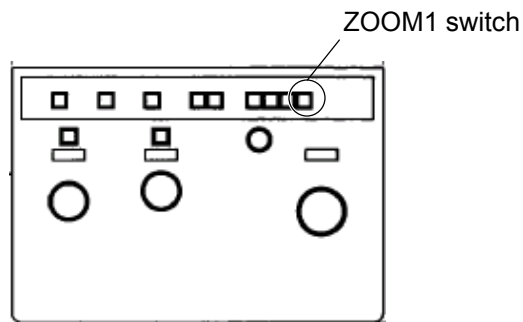


Fig. 2-52 Left Operation Panel

- (b) Press the LENS RESET switch on the left operation panel.

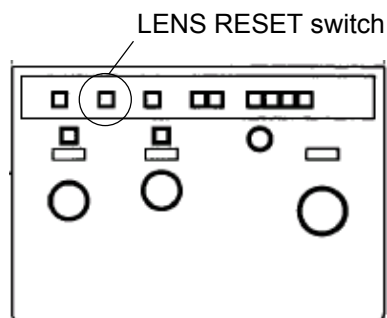


Fig. 2-53 Left Operation Panel

- (c) Set magnification at about 5,000 \times by the MAG knob on the left operation panel.

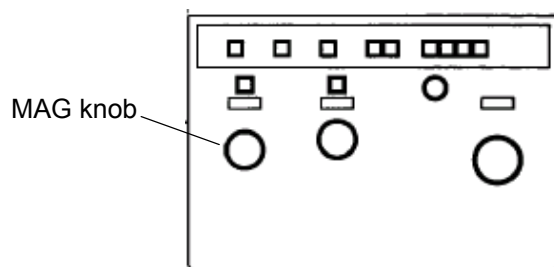


Fig. 2-54 Left Operation Panel

- (d) Manipulate the BRIGHT knob on the left operation panel until the beam is formed into a spot.

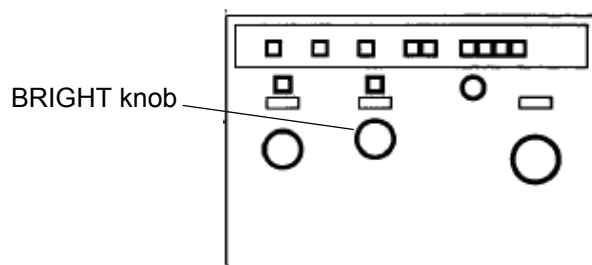


Fig. 2-55 Left Operation Panel

- (e) Press the BH switch on the right operation panel to set BH for the multi-knobs on the left and right operation panels. Then, move the electron beam to the center of the fluorescent screen by manipulating the multi-knobs.

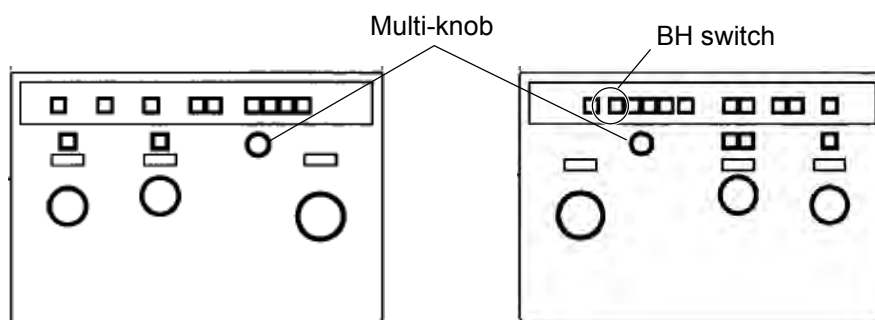


Fig. 2-56 Left and Right Operation Panel

2.2 Basic Operations before Microscopy

(3) Positional Adjustment of Condenser Lens Movable Aperture

- (a) Insert the condenser lens movable aperture, referring to 2.2.4 (1).
- (b) Broaden the electron beam by the BRIGHT knob. If the beam spot does not change in a concentric manner, the aperture bore is deviated from the optical axis. Manipulate the X and Y knobs of the condenser lens movable aperture so that the beam spot is broadened concentrically. Make sure the electron beam can be broadened by manipulating the BRIGHT knob.

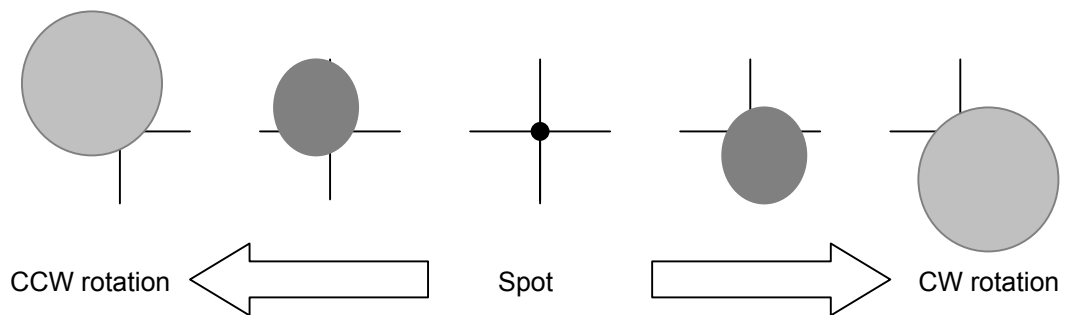


Fig. 2-57 Condenser Lens Movable Aperture not Aligned

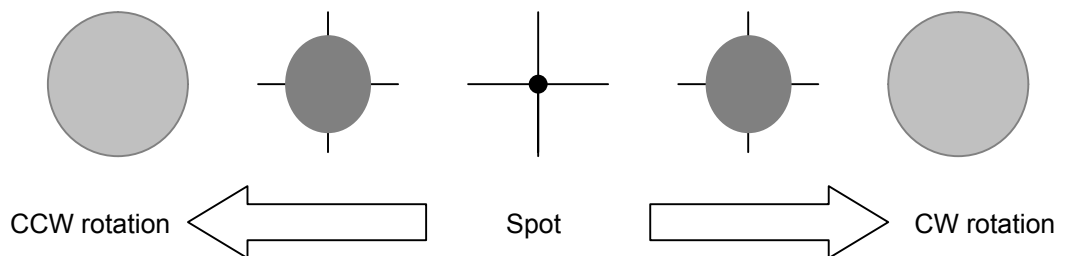


Fig. 2-58 Condenser Lens Movable Aperture Aligned

2.2.6 Adjustment of Electron Gun

(1) Unsaturated Filament Image

- (a) Manipulate the BRIGHT knob on the left operation panel until the beam is formed into a spot.

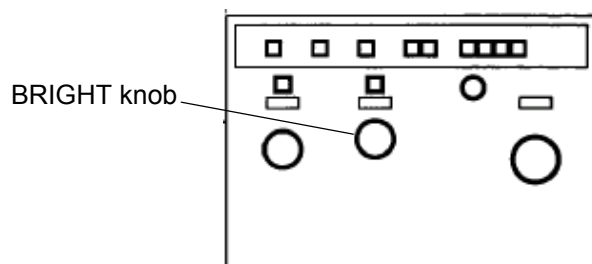


Fig. 2-59 Left Operation Panel

- (b) Select Operate - HV Control - Filament/Bias to open the Filament/Bias control window.

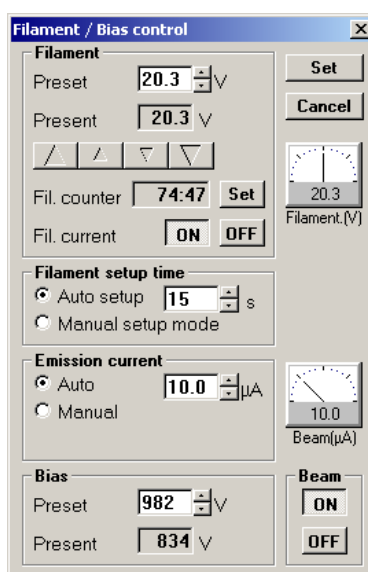


Fig. 2-60 Filament/Bias control Window

2.2 Basic Operations before Microscopy

- (c) Reduce the filament voltage by about 2 V using the arrow-mark button in the Filament group, and a shadow of the filament appears at the center of the beam spot on the fluorescent screen, so a doughnut-like spot is formed as shown in Fig. A or B of Fig. 2-61. Now, the filament is not saturated.

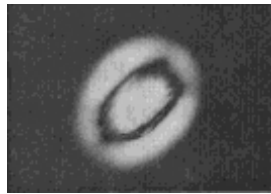


Fig. A Axis properly aligned

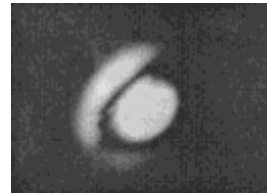


Fig. B Axis not aligned

Fig. 2-61 Filament Image

(2) GH/GT Adjustment

If the filament image in the unsaturated status is as shown in Fig. B, the optical axis of electron gun is not aligned. In this case, form a symmetrical filament image as shown in Fig. A in the following procedure.

- (a) Click Function - BD control to open the BD control window.



Fig. 2-62 Function Menu

- (b) In the BD data (X, Y) group, click the **GT** button, and each multi-knob on the left and right operation panels will be set to GT. Then, manipulate the multi-knobs X and Y on the left and right operation panels so that the image is corrected as shown in Fig. A.

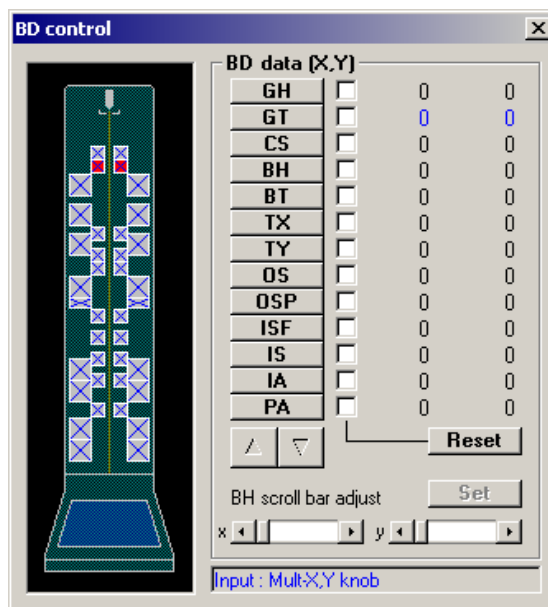


Fig. 2-63 BD control Window

- (c) If the beam spot moves from the center of the fluorescent screen after correction, set GH by clicking the **GH** button in the BD data (X, Y) group and move the beam spot to the center using the multi-knobs on the left and right operation panels.
- (d) Set BH by clicking the **BH** button in the BD data (X, Y) group or pressing the BH switch on the right operation panel.

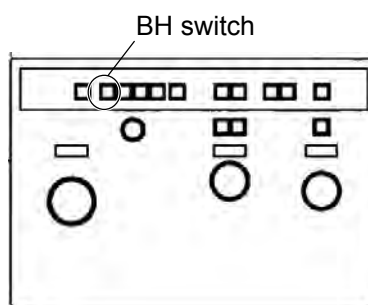


Fig. 2-64 Right Operation Panel

- (e) Close the BD control window by pressing the close button at the top right of this window.

2.2 Basic Operations before Microscopy

- (f) Using the arrow-mark button in the Filament group on the Filament/Bias control window, raise the filament voltage. The beam will return to the original spot. The filament is now in the saturated status.

2.2.7 Adjustment of Spot Size

- (1) Selection of Spot Size

Changing the spot size alters not only the size of the beam spot when formed, but also the dose of irradiating beam. For observation of a specimen vulnerable to beam irradiation, select a smaller spot size in advance. To select a spot size, follow the procedure given below.

- (a) Click Operate - Observation - Lens mode to open the Lens mode set window.

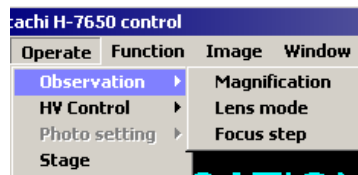


Fig. 2-65 Observation Menu

- (b) A spot size is selectable in the Spot number input box in the Spot number select (Micro) group. For usual operation, select "1" or "2." When a brighter electron beam is necessary, a larger value should be selected.

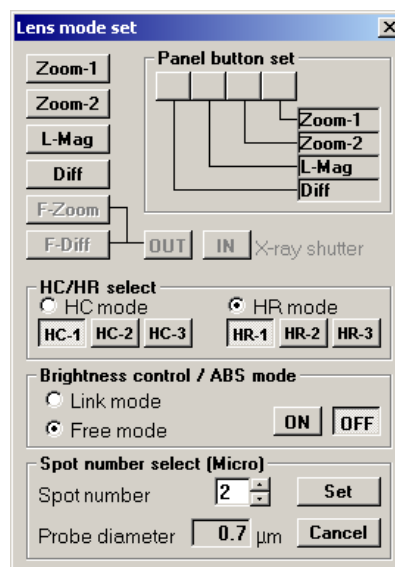


Fig. 2-66 Les mode set Window

- (c) Spot size is selectable in 5 steps. The relation among each lens mode, selection step and spot size is listed in Table 2-5.

Table 2-5 Selection Step and Spot Size in each Lens Mode

No.	1	2	3	4	5
HC (μm dia.)	0.8	1.0	2.0	3.0	4.0
HR (μm dia.)	0.6	0.7	0.8	1.0	2.0

- (d) When the analysis kit (option) is mounted, F-Zoom and F-Diff buttons on the Lens mode set window are validated as shown in Fig. 2-67. "X-ray shutter" denotes the shutter for the detector of X-ray spectrometer. It is validated when F-Zoom is selected. OUT opens the shutter and IN closes it. For X-ray analysis, the shutter should be used in the OUT status.

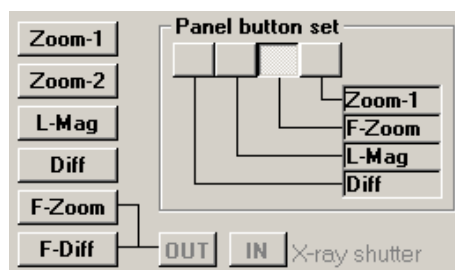


Fig. 2-67 Lens mode set Window

Table 2-6 Selection Step and Spot Size in F-Zoom Mode (option)

No.	1	2	3	4	5
HC (μm dia.)	0.06	0.08	0.10	0.12	0.14
HR (μm dia.)	0.04	0.06	0.08	0.10	0.12

(2) Adjustment of Spot Size

BH data can be stored independently for each lens mode (HC/HR) and each spot size. While changing the spot size sequentially, adjust BH so that the beam spot comes to the center of the fluorescent screen.

2.2 Basic Operations before Microscopy

2.2.8 Astigmatism Correction of Condenser Lens

(1) Astigmatism of Condenser Lens

- (a) Insert the condenser lens movable aperture according to 2.2.4 (1).
- (b) Move the BRIGHT knob on the left operation panel.

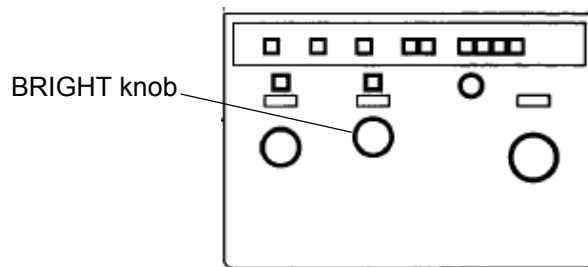


Fig. 2-68 Left Operation Panel

- (c) When the condenser lens system does not have astigmatism, the electron beam will broaden in a concentric manner as shown in Fig. 2-69A. But if it has astigmatism, the electron beam will broaden elliptically as shown in Fig. 2-69B.

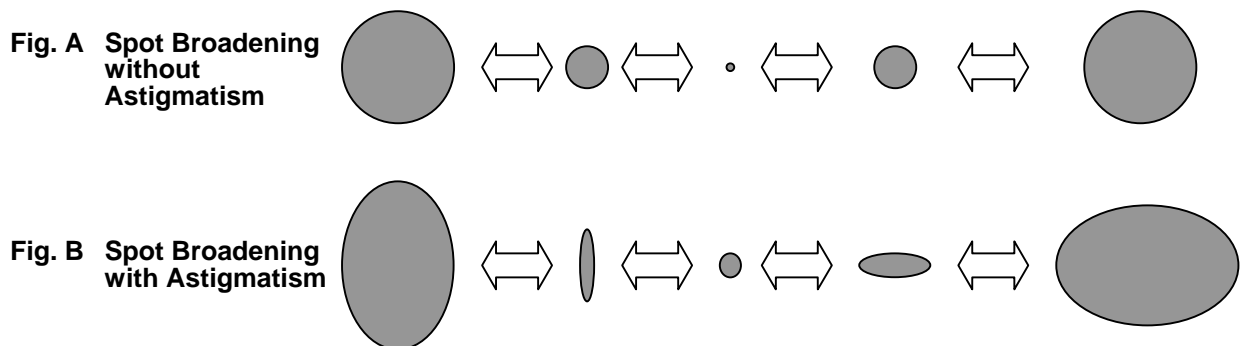


Fig. 2-69 Schematic Astigmatism of Beam Spot

(2) Astigmatism Correction of Condenser Lens

- (a) If the spot is distorted as shown in Fig. 2-69B, press the CS switch on the right operation panel for assigning CS to the multi-knobs on the left and right operation panels.

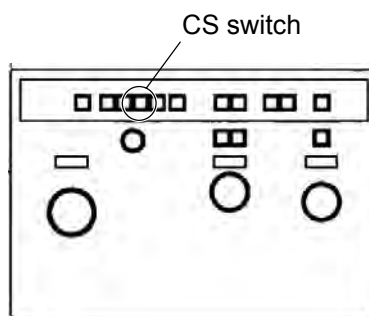


Fig. 2-70 Right Operation Panel

- (b) Adjust the multi-knobs so that the spot changes concentrically.

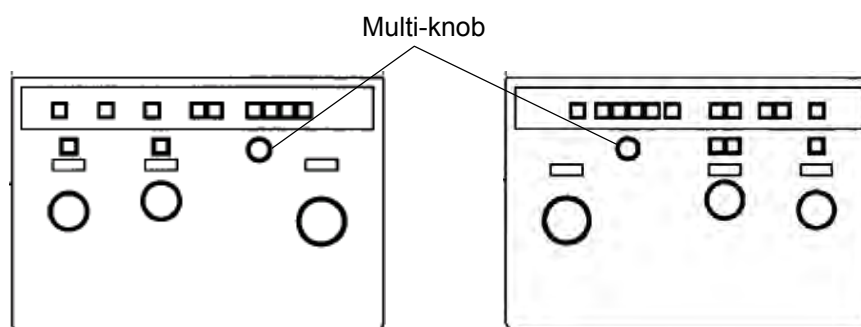


Fig. 2-71 Left and Right Operation Panels

- (c) If the spot moves from the center of the fluorescent screen upon manipulating the multi-knobs, press the BH switch on the right operation panel to set BH. Then, adjust the multi-knobs so that the spot comes to the center of the fluorescent screen.

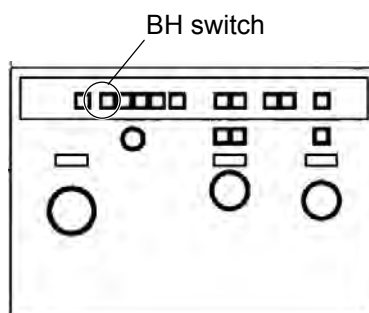


Fig. 2-72 Right Operation Panel

2.3 Image Observation

2.3 Image Observation

For image observation, a specimen needs to be introduced into the microscope column. Introduce a specimen, referring to 2.2.3.

2.3.1 Observation in LOW MAG Mode

(1) Field Selection

For observation of an image after completion of routine axial alignment, you should begin with selection of an appropriate field and focus its image. In the LOW MAG mode, a wide range can be observed. So this mode is advantageous for field selection.

- (a) Click the STAGE tab on the Easy operation window. Where in the specimen is now observed is now displayed.

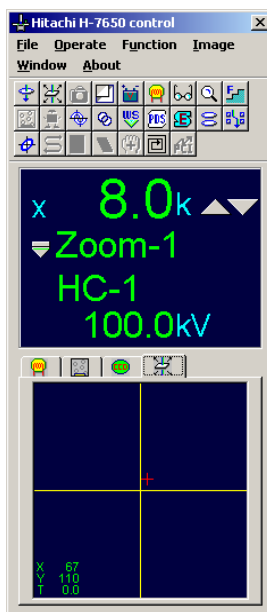


Fig. 2-73 Easy operation Window (STAGE tab)

- (b) On the left operation panel, press the LENS MODE switch, LOW MAG.

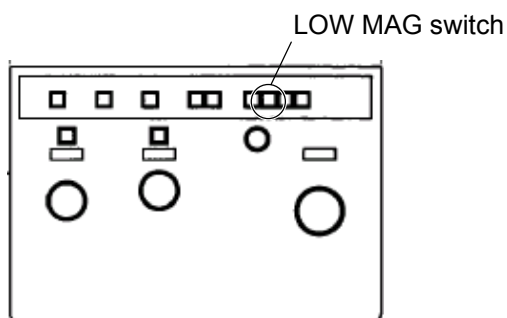


Fig. 2-74 Left Operation Panel

- (c) Magnification in the LOW MAG mode is selectable from 50 \times to 1,000 \times in 10 steps. Use the MAG knob for selection.

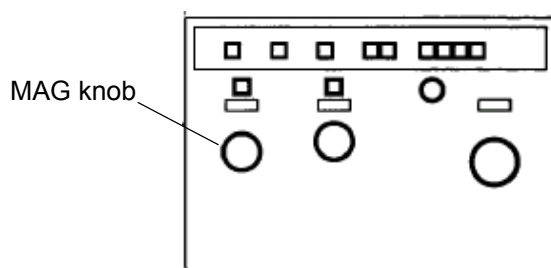


Fig. 2-75 Left Operation Panel

- (d) When the objective lens movable aperture has been inserted, remove it from the electron beam path.



Fig. 2-76 Objective Lens Movable Aperture

2.3 Image Observation

- (e) Bring the desired field to the center of the fluorescent screen by manipulating the STAGE knob on the left/right operation panel.

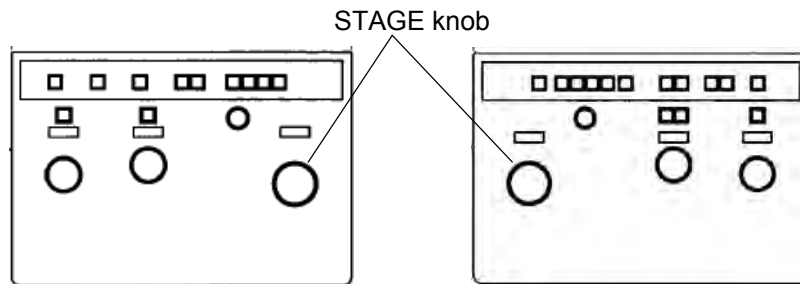


Fig. 2-77 STAGE Knob

- (f) Focus the image by the FOCUS knob on the right operation panel.

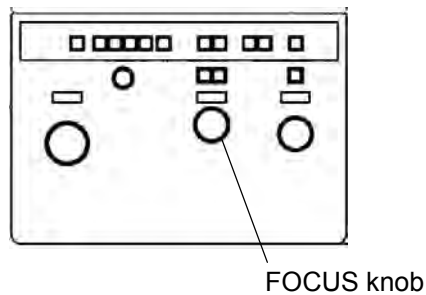


Fig. 2-78 Right Operation Panel

NOTE: In the LOW MAG mode, an image is to be focused by changing the first intermediate lens current level.

- (g) For enhancing contrast, insert the field limiting movable aperture (option).
- (h) Set the ZOOM mode by pressing the ZOOM switch on the left operation panel and observe the image.

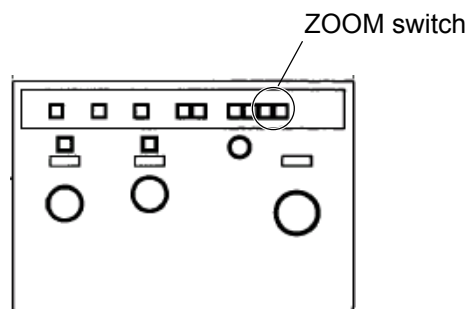


Fig. 2-79 Left Operation Panel

NOTE: In observation of a specimen vulnerable to irradiation by electron beam, carefully prevent the electron beam from being formed into a spot on the specimen. Otherwise, the specimen may be damaged due to charge-up.

(2) Adjustment of Field Position at each Magnification Step

If the central field does not match between the ZOOM and LOW MAG modes, positional adjustment is required in the following procedure.

- (a) In the ZOOM mode, bring the image of a referential specimen area to the center of fluorescent screen.
- (b) Press the LENS MODE switch, LOW MAG on the left operation panel.

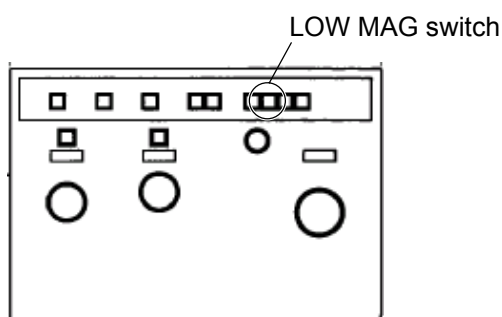


Fig. 2-80 Left Operation Panel

- (c) Click Function and then BD control to open the BD control window.



Fig. 2-81 Function Menu

2.3 Image Observation

- (d) Click the **IA** button in the BD data (X, Y) group. The multi-knobs on the left and right operation panels are now set in the IA mode.

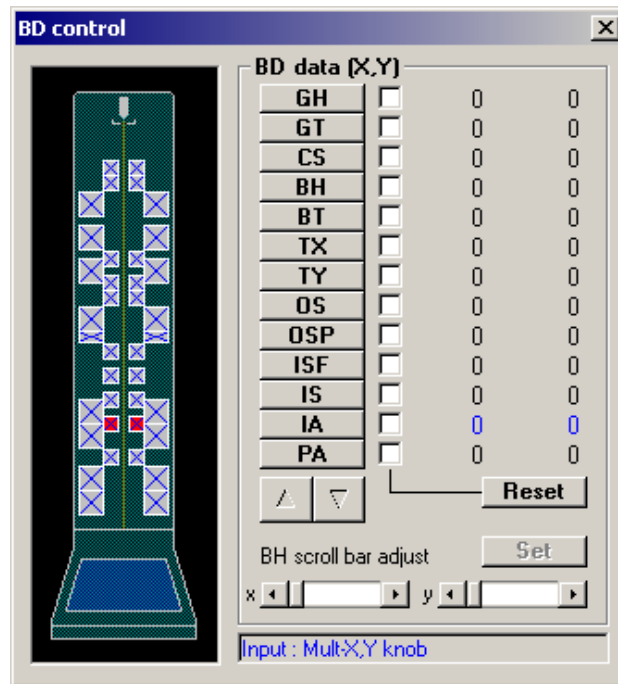


Fig. 2-82 BD control Window

- (e) Find the image of the referential specimen area selected in (a) and bring it to the center of the fluorescent screen using the multi-knobs on the left and right operation panels.

NOTE: Avoid moving the specimen in this step.

- (f) Repeat the above procedure at all magnification steps available.

2.3.2 Adjustment of Imaging System

(1) Adjustment of Specimen Z Position (Height)

NOTE: Unless Z position is adjusted, objective lens current level may be significantly deviated to degrade magnification accuracy. Adjust Z position immediately after specimen exchange.

- (a) Load a specimen and reset the lens data by pressing the LENS RESET switch on the left operation panel.

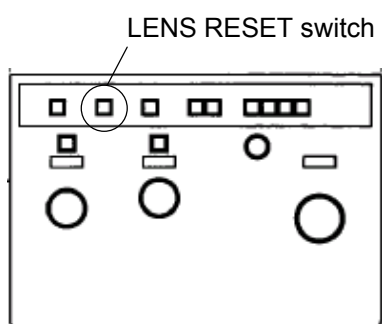


Fig. 2-83 Left Operation Panel

- (b) Set a magnification of 20,000 \times and focus the image by the Z control knob at the bottom of specimen stage.

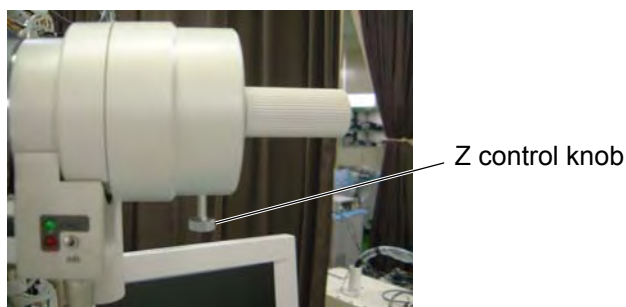


Fig. 2-84 Z Control Knob

NOTE: Avoid moving the FOCUS knob in this step.

2.3 Image Observation

(2) Voltage Center

Axis of the imaging system can be aligned by matching the point, which does not move during a cyclic change of accelerating voltage, with the center of the fluorescent screen. After Z position adjustment, follow these steps:

- (a) Turn the MAG knob on the left operation panel to set a magnification within a range from 5,000 \times to 10,000 \times .
- (b) Press the MODU. switch on the right operation panel. An image on the fluorescent screen moves radially.

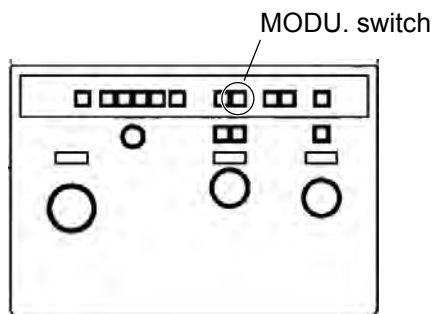
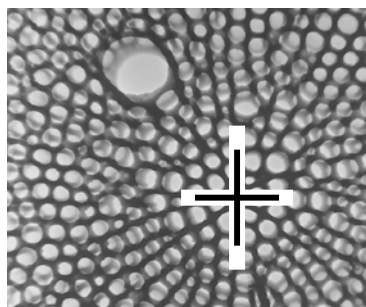


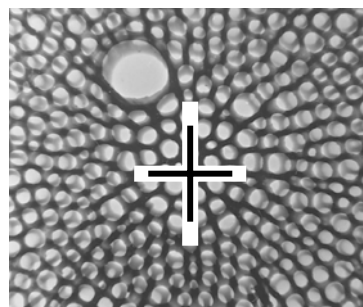
Fig. 2-85 Right Operation Panel

- (c) Just after pressing the MODU. switch, BT is automatically assigned to the multi-knobs on the left and right operation panels. However, when returning to this step after (f), press the BT switch on the right operation panel.
- (d) From the movement of the entire image, judge the voltage center and match the center of image movement with that of the fluorescent screen using the multi-knobs X and Y on the left and right operation panels.



C821483

Fig. A Voltage center is not aligned.



C821485

Fig. B Voltage center is aligned.

Fig. 2-86 Movement of Entire Image (crosshairs indicate voltage center)

- (e) Assign BH to the multi-knobs on the left and right operation panels by pressing the BH switch on the right operation panel.
 - (f) Adjust the multi-knobs so that the center of electron beam is aligned with that of the fluorescent screen.
 - (g) Repeat the above steps (c) to (f) until both electron beam center and voltage center come to the center of the fluorescent screen.
 - (h) After completion of this adjustment, stop the radial image movement by pressing the MODU. switch.
- (3) Adjustment of BT Shift Compensation (TX, TY)

If the electron beam moves significantly due to BT operation, the shift compensation should be adjusted in the following procedure.

- (a) Click Function - BD control to open the BD control window. Turn on the Reset check box for BT. Then, click the **Reset** button on this window for resetting BT to zero.

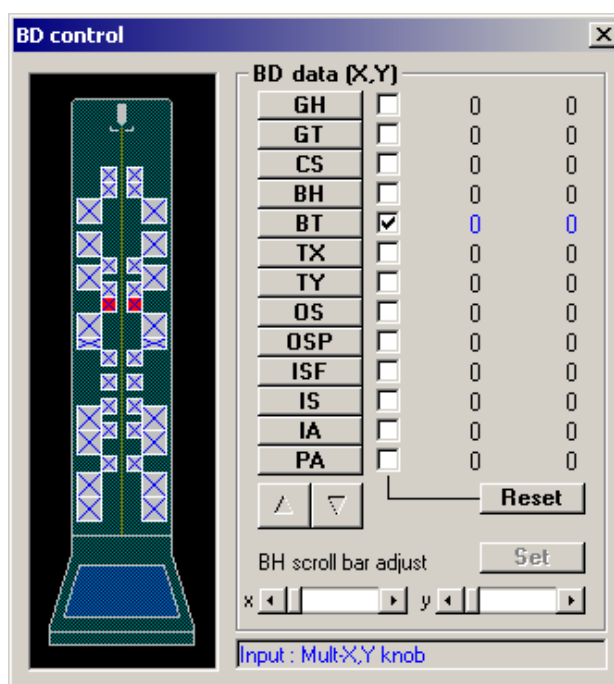


Fig. 2-87 BD control Window (turning on BT check box)

2.3 Image Observation

- (b) Assign BH to the multi-knobs by pressing the BH switch on the right operation panel and move the electron beam to the center of the fluorescent screen.
 - (c) Assign BT to the multi-knobs by pressing the BT switch on the right operation panel. Adjust the X multi-knob on the left operation panel to set a value of about 200 on the X side alone of BT.
 - (d) Assign BT-X shift compensation to the multi-knobs by clicking the TX button on the BD control window.
 - (e) Move the electron beam to the center of the fluorescent screen by the multi-knobs on the left and right operation panels.
 - (f) Reset BT to zero by clicking the **Reset** button on the BD control window.
 - (g) Repeat the steps (b) to (f) until the electron beam will not be moved when operating the X side of BT.
 - (h) Make the same adjustment on the Y side of BT.
- (4) Insertion of Objective Lens Movable Aperture (observation of electron beam diffraction image in DIFF mode)

Image contrast can be enhanced by blocking the electron beam which is widely scattered by a specimen, using the objective lens movable aperture. Contrast will be higher when the inserted objective lens movable aperture has a smaller bore diameter. Insertion of this aperture is also required for observation of an electron beam diffraction image and recording it with a film camera (option).

For introducing this aperture properly onto the optical axis of electron beam, carry out the following procedure.

- (a) When the field limiting movable aperture (option) is mounted, it should be inserted according to 2.2.4 (3).
Select an aperture bore that can cover the target field.

- (b) Press the lens mode selector switch DIFF on the left operation panel. Lens mode is now changed to DIFF and an electron beam diffraction image appears on the fluorescent screen.

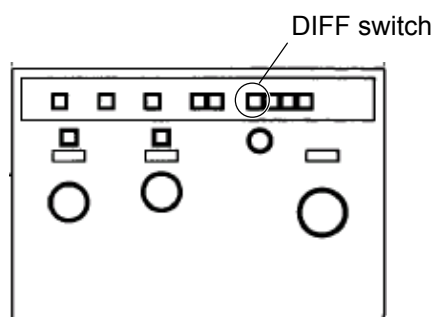


Fig. 2-88 Left Operation Panel

NOTE: The DIFF mode cannot be set while an image is observed with the digital camera. A DIFF image necessitates the fluorescent screen for its observation. In the DIFF mode, the fluorescent screen will not rise.

NOTE: The operations described here must always be performed on the fluorescent screen. If a spot-shaped beam is projected into the digital camera, its scintillator might be damaged.

- (c) Camera length is variable by the MAG knob on the left operation panel. Set a camera length of about 2.0 m.

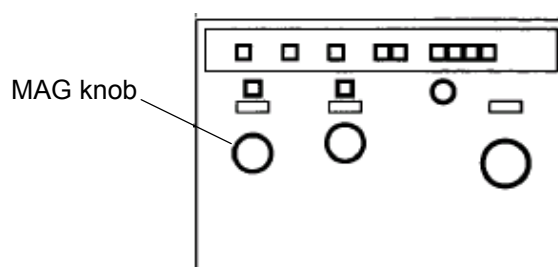


Fig. 2-89 Left Operation Panel

2.3 Image Observation

- (d) Minimize the DIFF spot diameter using the DIFF knob on the right operation panel.

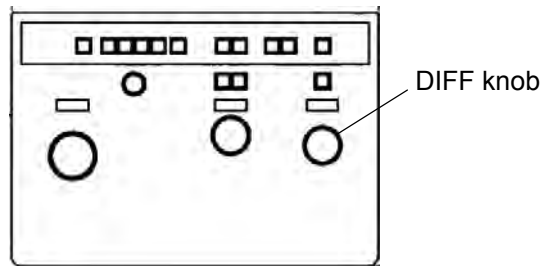


Fig. 2-90 Right Operation Panel

- (e) Insert the objective lens movable aperture according to 2.2.4 (2).
- (f) Adjust the X and Y knobs of this aperture so that the shadow of the aperture becomes concentric with the beam spot with the center located on the optical axis of electron beam. Remove the field limiting movable aperture, select the lens mode selector switch ZOOM on the left operation panel and start image observation.

NOTE: If a specimen is not aligned with the optical axis, the shadow of the objective lens movable aperture cannot be observed.

- (g) Adjust image brightness by the BRIGHT knob on the left operation panel so that an exposure time of about 10 to 30 seconds usually suffices recording of an electron beam diffraction image (when the film camera option is set).

2.3.3 Observation with Digital Camera

(1) Observation of Live Image

- (a) Click the CCD tab on the Easy operation window. A histogram, camera control buttons, etc. appear in the control area.

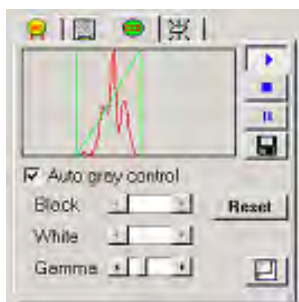


Fig. 2-91 CCD Control Area

- (b) Click the Run button in the control area. The large viewing fluorescent screen rises and a live image (max. 18 f/s) is displayed on the Transmission image window.

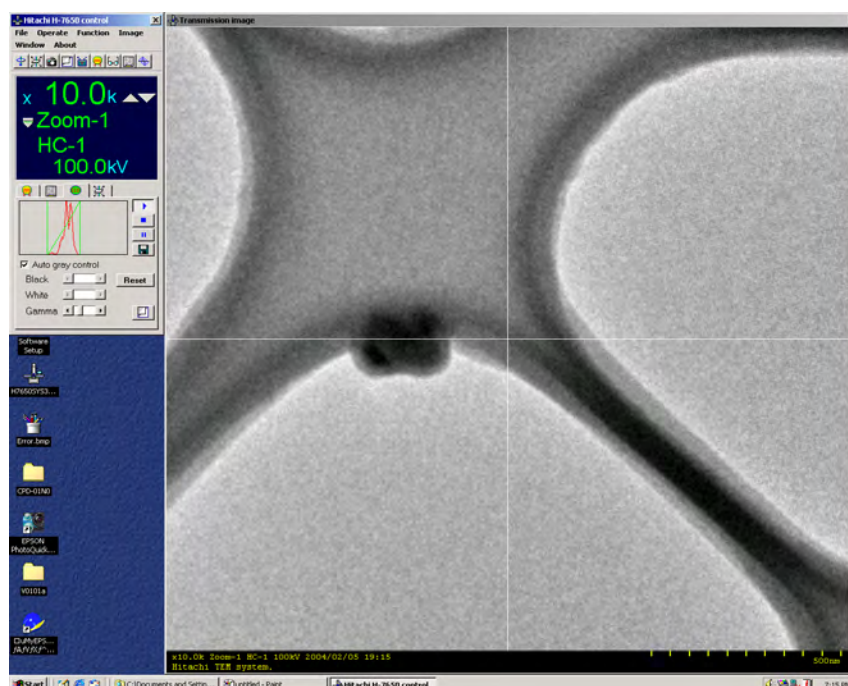


Fig. 2-92 Live Image of TEM

2.3 Image Observation

- (c) Adjust the BRIGHT knob on the left operation panel so that the histogram comes close to the center.

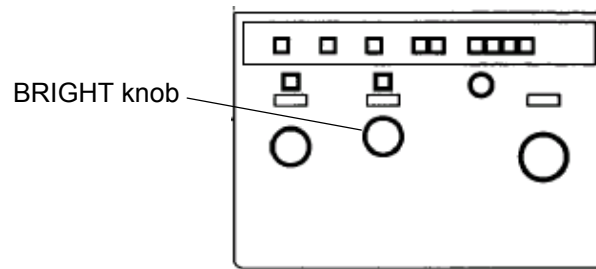


Fig. 2-93 Left Operation Panel

- (d) When image observation is carried out at a low beam dose, turn on the Auto gray control check box. Automatic control will function so that the histogram is brought close to the center by reducing the frame rate.

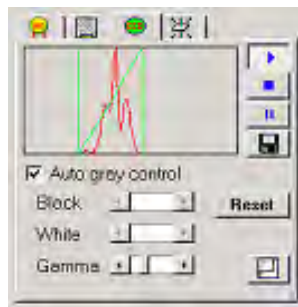


Fig. 2-94 Auto gray control Check Box

2.3.4 Focusing

(1) Manual Focusing

- (a) An image can be focused by turning the FOCUS knob on the right operation panel. Using the $\times 10$ and $\times 20$ switches, focus step is selectable among $\times 1$, $\times 10$, $\times 20$ and $\times 200$ (press both switches for $\times 200$).

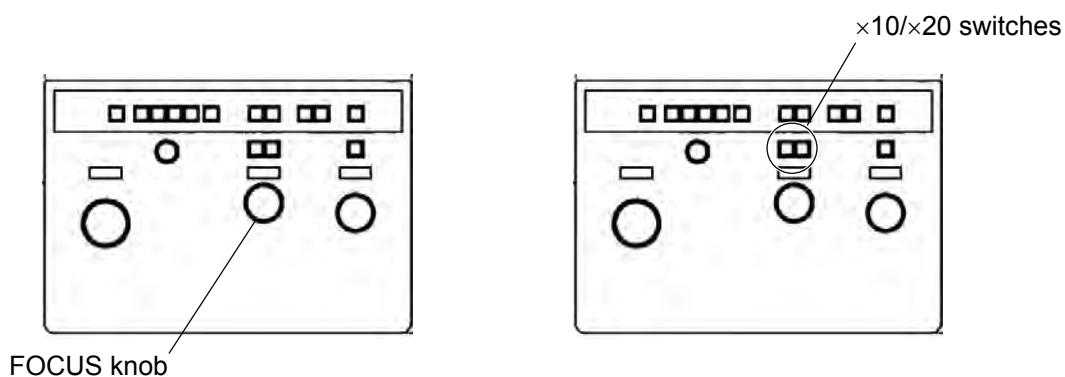


Fig. 2-95 Right Operation Panel

- (b) For image observation with the binoculars, bring the spot (focusing) fluorescent screen by pressing the SPOT switch on the left operation panel. Turn off room lamps in order to enhance image contrast.

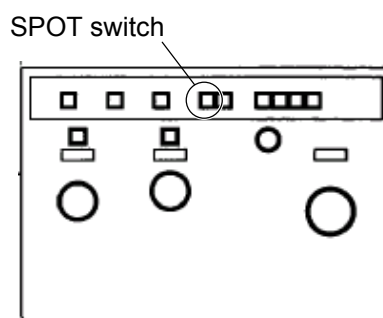


Fig. 2-96 Left Operation Panel

2.3 Image Observation

- (c) Adjust the binocular focusing knob so that the focus of binoculars matches the scribed line on the focusing fluorescent screen.



Fig. 2-97 Binocular Focusing Knob

- (d) For image observation with the digital camera, press the Run button in the CCD control area.

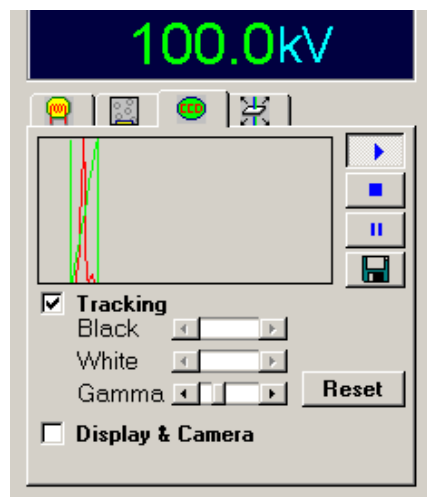


Fig. 2-98 CCD Control Area

- (e) After selecting the desired field and magnification, carry out adjustment, and then focus the image by the FOCUS knob on the right operation panel.

- (f) The image can be photographed in the best contrast when the image is slightly underfocused (at a reduced objective lens current level with the FOCUS knob turned counterclockwise). The optimum amount of underfocus varies from 30 μm to 20 nm depending on magnification.

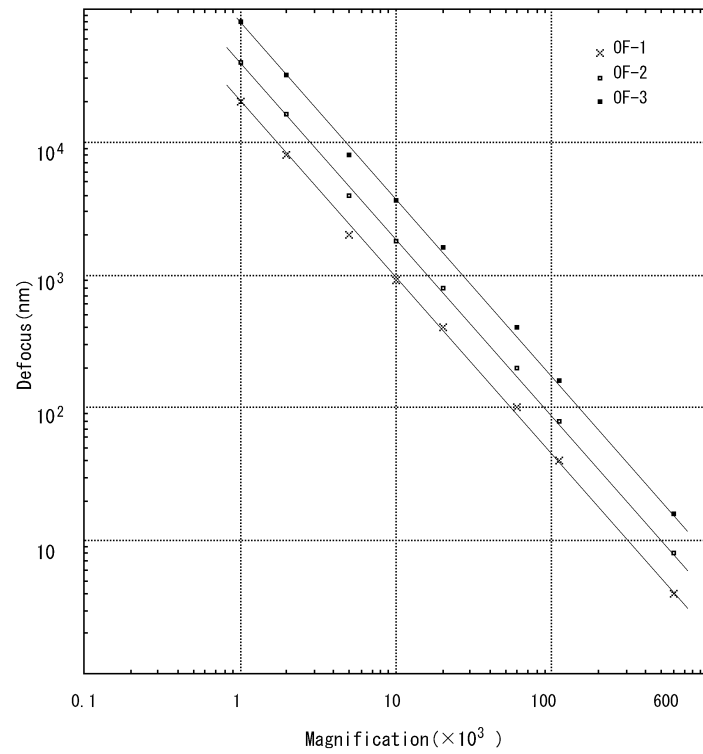


Fig. 2-99 Optimum Underfocus

2.3 Image Observation

(2) Focusing by Wobbler

Focusing can be expedited by utilizing the wobbler function. When it is self-evident that the wobbler function is assigned to the WOB. switch on the right operation panel, go to (c). If it is unknown or you know that a different function is assigned, begin with (a).

(a) Click Function and then Wobbler condition to open the Wobbler condition window.

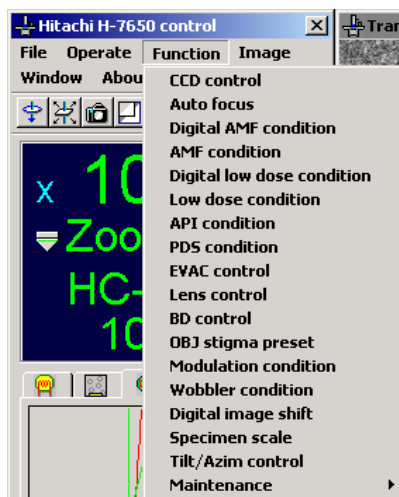


Fig. 2-100 Function Menu

(b) Turn on the Wobbler radio button in the Wobbler select group and determine your selection by clicking the **Set** button. To close the Wobbler condition window, click the close button at its top right.

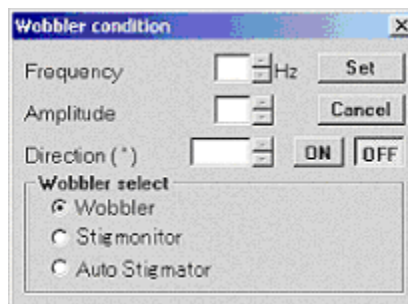


Fig. 2-101 Wobbler condition

- (c) Press the WOB. switch on the right operation panel. The tilt angle of the electron beam incident on the specimen is varied periodically.

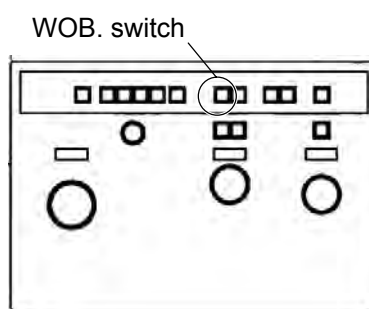
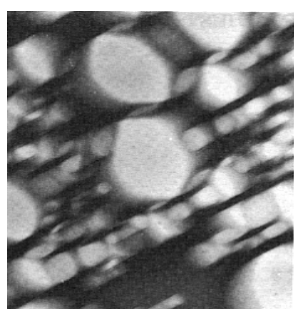
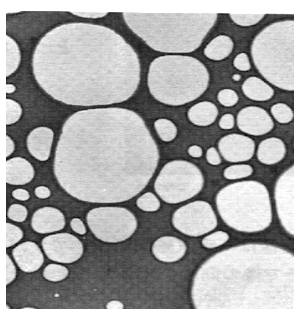


Fig. 2-102 Right Operation Panel

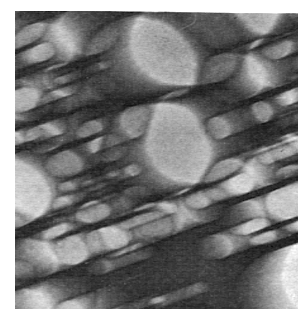
- (d) If the image is defocused, it appears doubly or drifts as shown in Fig. 2-103A or C. Just focus is obtained when image drift is stopped as shown in Fig. 2-103B.



A: Overfocus



B: Just focus



C: Underfocus

Fig. 2-103 Image Focusing with Wobbler

2.3 Image Observation

(3) Adjustment of Wobbler

Since the wobbler is changeable in its frequency, direction and amplitude, it should be used according to the specimen orientation, magnification, etc. The frequency, direction and amplitude are changeable in the following procedure.

- (a) Open the wobbler condition window by clicking Function and then Wobbler condition.

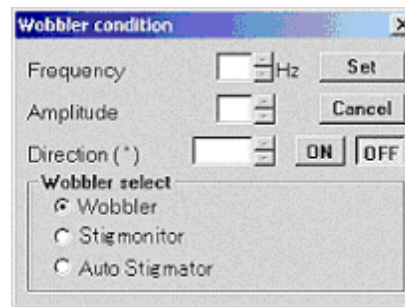


Fig. 2-104 Wobbler condition

- (b) Select Wobbler in the Wobbler select group.
- (c) For wobbler frequency, input its value (max. 20 Hz, in 1-Hz increments) directly in the Frequency input box or set it by the up/down arrow keys. Determine your selection by the **Set** button.
- (d) For wobbler amplitude, input its value (among 10 steps) directly in the Amplitude input box or set it by the up/down arrow keys. Determine your selection by the **Set** button.
- (e) For wobbler direction, input its angle value (in increments of 1°) directly in the Direction input box or set it by the up/down arrow keys. Determine your selection by the **Set** button.

NOTE: If image movement is not easy to determine because brightness is split into two levels, adjust BT shift compensation according to 2.3.2 (3). If this phenomenon persists, wobbler amplitude should be set at a lower step.

(4) Usage of Auto Focus

Focusing can be automatically carried out by the auto focus function.

(a) Set the digital camera in the RUN status.

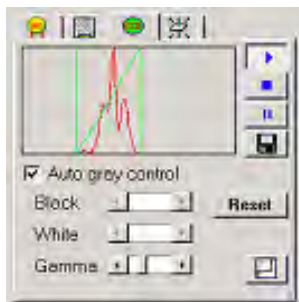


Fig. 2-105 CCD Control Area

(b) Press the AUTO FOCUS switch on the right operation panel.

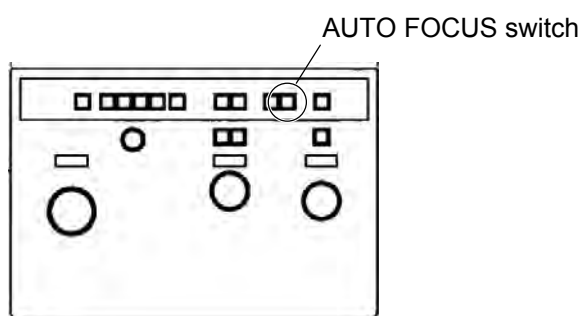


Fig. 2-106 Right Operation Panel

NOTE: Even when an image is not observed with the digital camera, the control sequence of auto focus advances. In this case, a proper objective lens current will not be reached.

2.3 Image Observation

2.3.5 Astigmatism Correction of Objective Lens

(1) Principle of Astigmatism Correction

- (a) Astigmatism of the objective lens appears as an image that has another different-focus image at right angles. Because focuses are not symmetrical, the image is seen to drift in one direction.

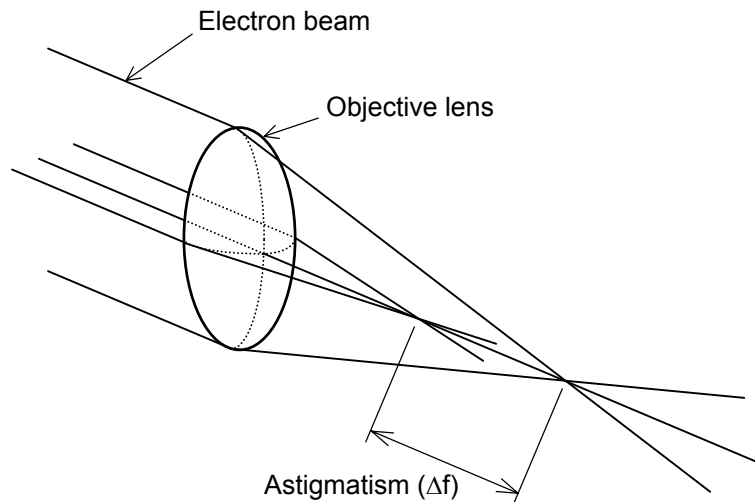


Fig. 2-107 Principle Diagram of Objective Lens Astigmatism

(2) How to Correct Objective Lens Astigmatism

- (a) For a specimen, use a film hole specimen for astigmatism correction (commercially available microgrid).
- (b) Assign OS to the multi-knobs on the left and right operation panels by pressing the OS switch on the right operation panel.

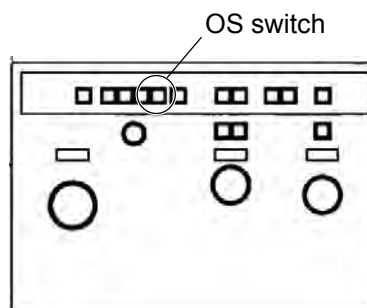


Fig. 2-108 Right Operation Panel

- (c) Adjust the FOCUS knob to obtain just focus. Next, focus the image slightly higher than the just focus, and an overfocus fringe appears outside the film hole as shown in Fig. 2-109A.

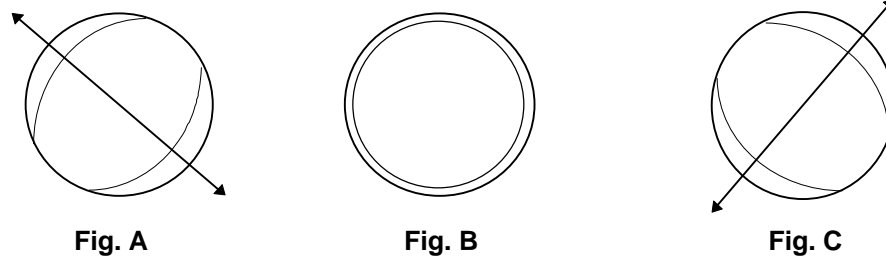


Fig. 2-109 Schematic Diagram of Objective Lens Astigmatism Correction

- (d) Manipulate the multi-knob X/Y until the fringe width becomes even over the entire circumference of the film hole as shown in Fig. B.
- (e) Bring the image close to just focus from overfocus by the FOCUS knob in order to narrow the fringe width.
- (f) If the image becomes as shown in Fig. C in narrowing of the fringe width, astigmatism remains in the arrow direction. So, carry out step (e) again.
- (g) Astigmatism correction of the objective lens has now been completed.
- (h) The correction value can be saved and loaded as desired. For saving, press the BD PS switch on the right operation panel when OS is assigned to the multi-knobs. For loading the saved value, press the BD RESET switch when OS is assigned to the multi-knobs.

2.3 Image Observation

(3) Principle of Stigmonitor

The stigmonitor is helpful for efficient astigmatism correction of the objective lens at low and medium magnifications. The operating principle of the stigmonitor is shown in Fig. 2-110. The electron beam tilted at θ is rotated azimuthally pivoting on a certain point of the specimen. This allows the system to observe a focal difference between the X and Y axes, i.e., astigmatism as an image movement ΔX . Astigmatism can be corrected by adjusting the objective lens stigmonitor so as to minimize the image movement. If it is obvious that the stigmonitor function is assigned to the WOB. switch on the right operation panel, move on to (b). If it is not obvious or a different function is assigned, start from (a).

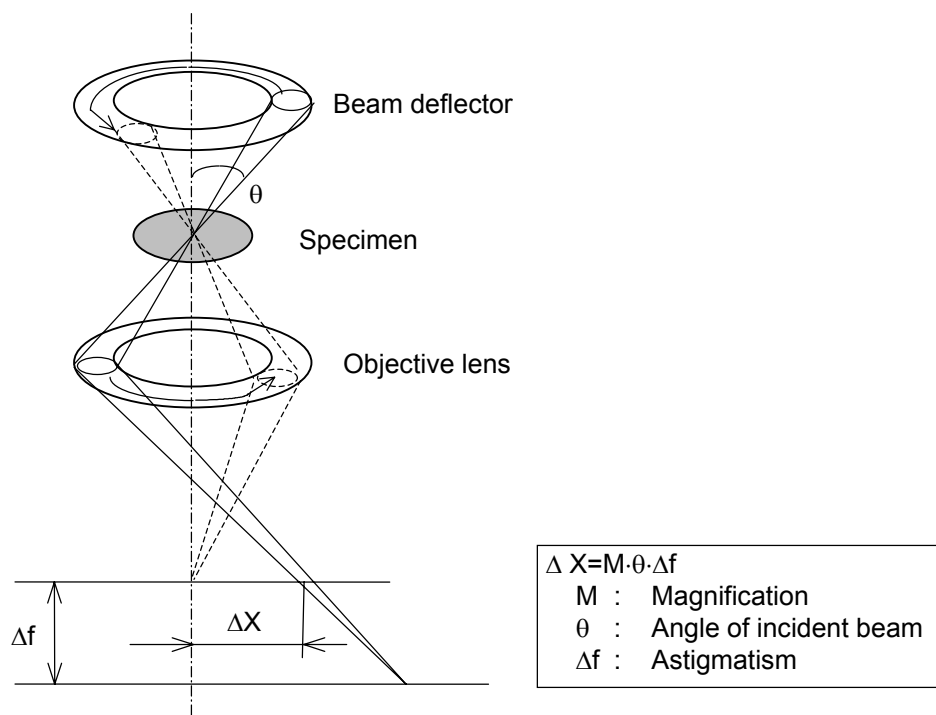


Fig. 2-110 Principle Diagram of Stigmonitor

- (a) Click Function and then Wobbler condition to open the Wobbler condition window. Turn on the Stigmonitor radio button in the Wobbler select group and determine your selection by clicking the **Set** button. Close the Wobbler condition window by clicking the Close button at the top right.

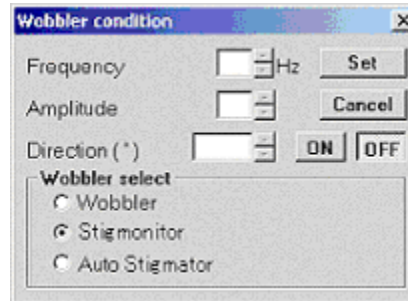


Fig. 2-111 Wobbler condition

- (b) Press the WOB. switch on the right operation panel to activate the stigmonitor.

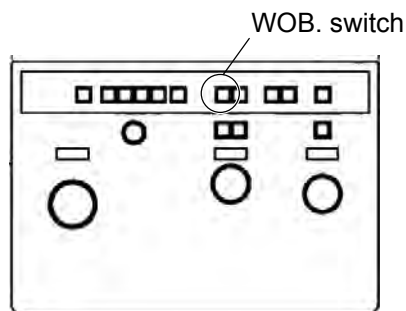


Fig. 2-112 Right Operation Panel

2.3 Image Observation

- (c) When astigmatism is not corrected, a rotary movement in a certain orientation can be seen. If without astigmatism, the rotary movement occurs concentrically with respect to the just focus point. And if with astigmatism, the rotary movement occurs even at the just focus point.

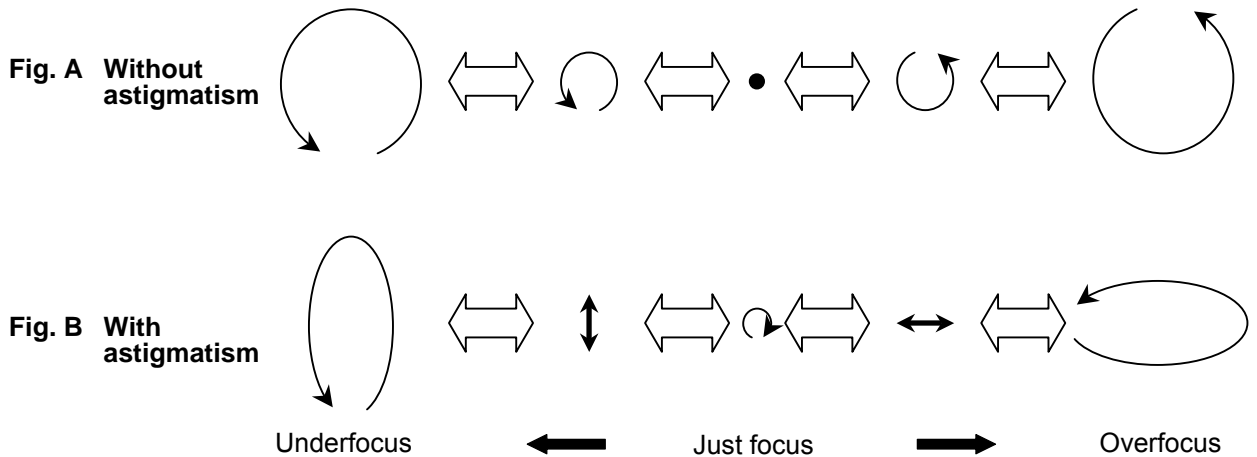


Fig. 2-113 Image Movement by Stigmonitor (schematic diagram)

- (d) Obtain the just focus by the FOCUS knob. If astigmatism is noticeable, adjust image focus so as to minimize the rotary movement, referring to the image movement with respect to the just focus in Fig. 2-113B.
- (e) Assign OS to the multi-knobs on the left and right operation panels by pressing the OS switch on the right operation panel.
- (f) Adjust the multi-knobs so that image movement is minimized. The same status as shown in Fig. 2-113A should be attained.
- (g) While shifting the focusing position, make sure the status shown in Fig. A is maintained.
- (h) Astigmatism is correctable by repeating the procedure from (e) to (h).
- (i) For stopping the stigmonitor, press the WOB. switch again.

(4) Automatic Astigmatism Correction Function (auto stigmator)

Astigmatism of the objective lens is automatically correctable through selection of the auto stigmator function. When it can be confirmed that the wobbler function is assigned to the WOB. switch on the right operation panel, go to (b). If it cannot be confirmed or a different function is assigned, begin with (a).

- (a) Open the Wobbler condition window by clicking Function and then Wobbler condition. Turn on the Auto Stigmator radio button in the Wobbler select group and determine your selection by clicking the **Set** button. Close the Wobbler condition window by clicking the Close button at its top right.

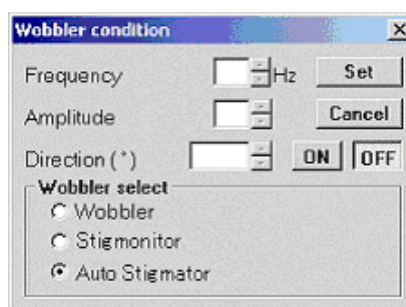


Fig. 2-114 Wobbler condition

- (b) Set the digital camera in the Run status.

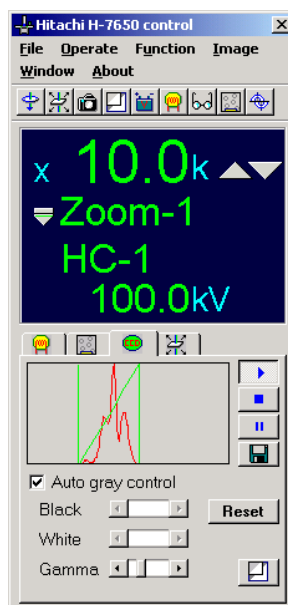


Fig. 2-115 CCD Control Area

2.3 Image Observation

- (c) Press the WOB. switch on the right operation panel. The control sequence of the auto stigmator function automatically progresses.

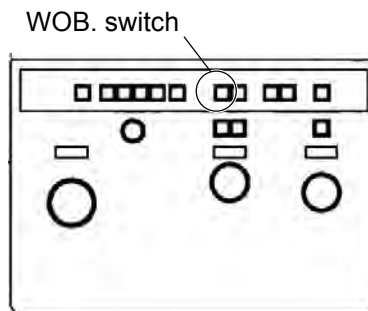


Fig. 2-116 Right Operation Panel

NOTE: Even when an image is not observed with the digital camera, the control sequence of auto stigmator advances. In this case, a proper objective lens current will not be reached.

2.3.6 Image Rotation

- (1) Usage of Image Rotation

Field rotation function (image rotation) is usable within an image rotation angle range of $\pm 90^\circ$ (in steps of 15°) when magnification ranges from 1,000 \times to 40,000 \times (18 steps).

- (a) Press the IMAGE ROT. switch on the left operation panel. The switch does not function outside the above magnification range.

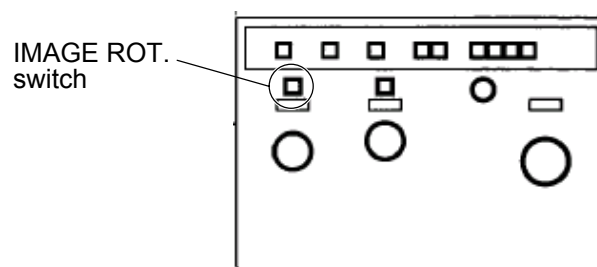


Fig. 2-117 Left Operation Panel

- (b) The image can be rotated by the MAG knob under IMAGE ROT. while keeping the present magnification. Rotation angle will be displayed together with magnification on the monitor.

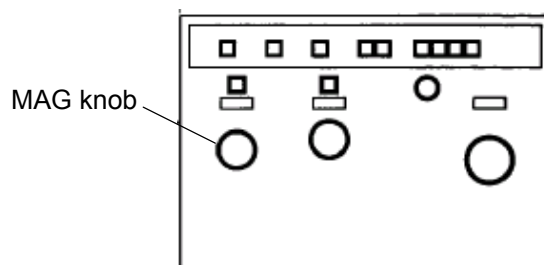


Fig. 2-118 Left Operation Panel

- (c) For changing the image magnification, press the IMAGE ROT. switch again to release the image rotation mode.

2.3.7 HC and HR Modes

(1) Magnification and Camera Length Range

The ZOOM mode of Model H-7650 comprises 2 modes; HC mode for zooming at a reduced objective lens current level and HR mode for zooming at a raised objective lens current level. In the HC mode, a wide field is observable at lower magnifications. Usually, images are observed and photographed in the HC mode, and the HR mode is used for image observation and recording at 200,000 \times and higher magnifications. In each mode, magnification is settable within the following range. When the analysis kit is mounted, F-Zoom and F-DIFF mode options are added to both HC and HR modes.

HC mode	ZOOM-1	200 \times to 200,000 \times
	ZOOM-2	200 \times to 200,000 \times
	DIFF	0.05 m to 8.0 m
	F-Zoom	200 \times to 200,000 \times (option)
	F-DIFF	0.05 m to 8.0 m (option)
HR mode	ZOOM-1	4,000 \times to 600,000 \times
	ZOOM-2	4,000 \times to 600,000 \times
	DIFF	0.05 m to 2.0 m
	F-Zoom	4,000 \times to 600,000 \times (option)
	F-DIFF	0.05 m to 2.0 m (option)
LOW MAG mode	50 \times to 1,000 \times	

2.3 Image Observation

(2) HC/HR Mode Changeover

(a) Click Operate, Observation and then Lens mode. The Lens mode set window opens.

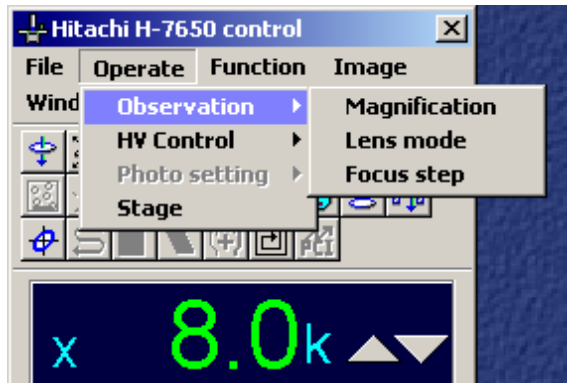


Fig. 2-119 Operate Menu

(b) On this window, select the HC or HR mode by the HC or HR mode radio button in the HC/HR select group. When the analysis kit (option) is mounted, select F-Zoom and F-Diff.

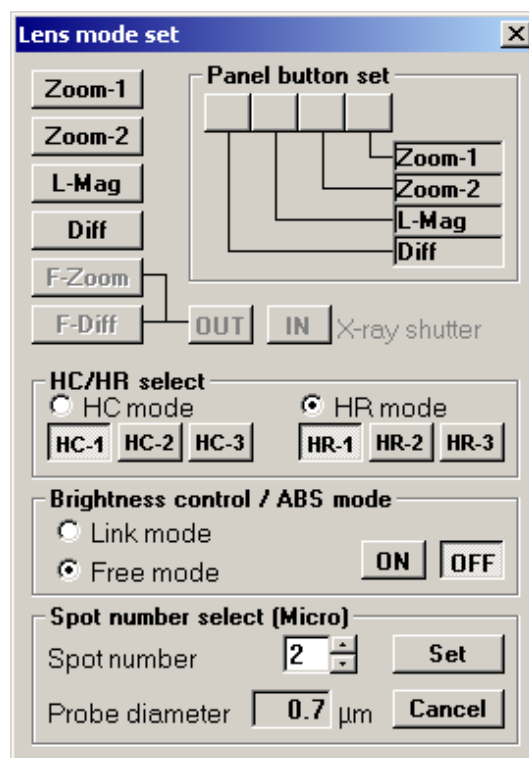


Fig. 2-120 Lens mode set Window

2.3.8 Specimen Anticontamination Devices (option)

When a specimen is irradiated with an intense beam for a long time, it will be contaminated and image contrast will fall in the contaminated area. For preventing the contamination, the Model H-7650 is equipped with <1> cold trap (P/N 817-0538) and <2> cold finger (P/N 817-0537). For using these devices, liquid nitrogen needs to be injected.



WARNING

Low Temperature

Because liquid nitrogen is as cold as $-196\text{ }^{\circ}\text{C}$, its contact with body or its splash into an eye may result in frostbite. Pay attention not to touch liquid nitrogen. Before handling of liquid nitrogen, put on protective goggles and leather gloves.

If a large amount of liquid nitrogen is injected rapidly, it may splash to cause frostbite. To prevent this, inject liquid nitrogen gradually.

2.4 Image Recording with Digital Camera

2.4 Image Recording with Digital Camera (Type A only)

2.4.1 Setting Method (Type A only)

(1) Manual Setting

- (a) Select Function and then CCD control. The CCD control window opens.

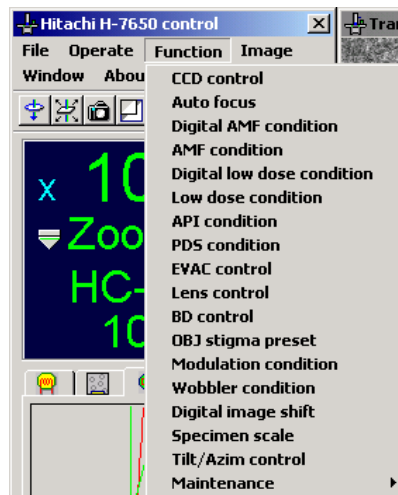


Fig. 2-121 Function Menu

- (b) Turn off the Check box in the Camera control group. Entries for Live (ms), Rec. exp (ms) and Integrate are now allowed.

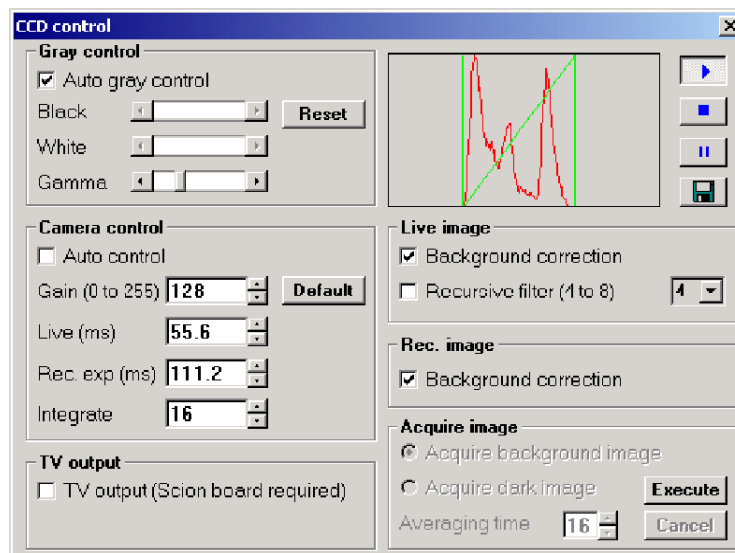


Fig. 2-122 CCD control window

- (c) In the Live (ms) input box, input a live image display speed. It is defaulted to 55.6 ms (18 frames/s). Beyond 55.6 ms, input values are limited to integer multiples of 55.6. Below 55.6 ms, any desired value can be input. Determine the value by the Enter key.
- (d) In the Rec. exp (ms) input box, input an exposure time for acquiring one image. It is defaulted to 222.4 ms. Usually, input a value 4 times as large as the one input for Live (ms). Determine your value by the Enter key.
- (e) In the Integrate input box, input the number of the images to be integrated. It is defaulted to 16. Usually, the default value is employed. Determine the input value by the Enter key.
- (f) Since settings are to be saved, they are not always required for image recording.
- (2) Default Setting
- (a) Turn on the **Default** button in the Camera control group.

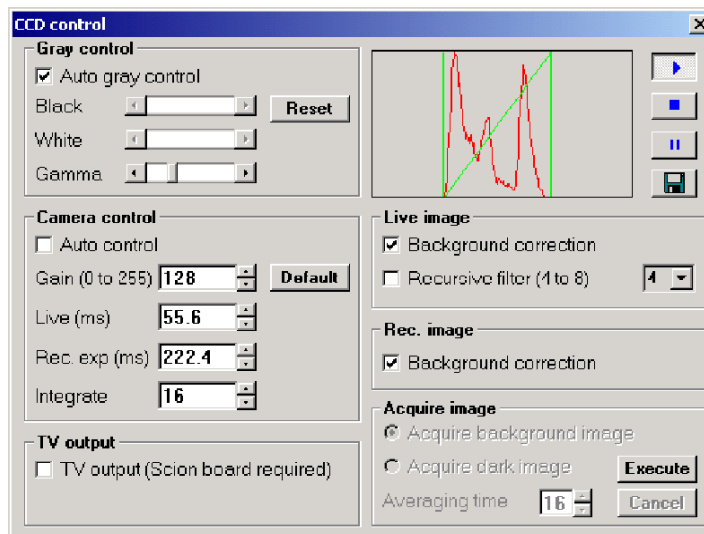



Fig. 2-123 CCD control Window

- (b) By default, Live (ms), Rec. exp (ms) and Integrate are set at 55.6 ms, 222.4 ms and 16 frames, respectively.
- (c) Since settings are to be saved, they are not always required for image recording.

2.4 Image Recording with Digital Camera

(3) Photographing Procedure

- (a) On the Easy operation window, click the CCD tab to display the CCD control area. Then, click the Run button  to display a live image.

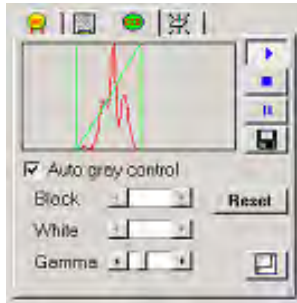


Fig. 2-124 CCD Control Area

- (b) While the live image is displayed, click the Freeze button .

2.4.2 Saving Method (Type A only)

(1) Saving by "Save as" Function

- (a) Click File - Save option to open the Save option window.

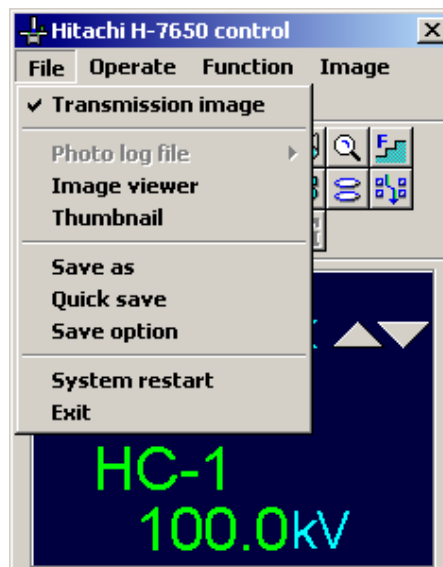


Fig. 2-125 File Menu

- (b) Turn on the Save as radio button in the Save icon select group.

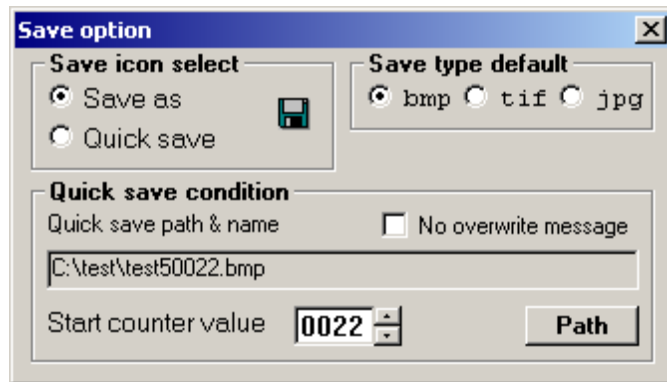



Fig. 2-126 Save option Window

- (c) Since settings are to be saved, they are not always required for image recording.
- (d) Under display of a still image, click the Save button  in the CCD control area.

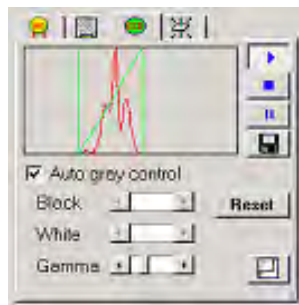


Fig. 2-127 CCD Control Area

2.4 Image Recording with Digital Camera

- (e) The Save image window now opens. Input a directory and a file name, and click the **Save** button.

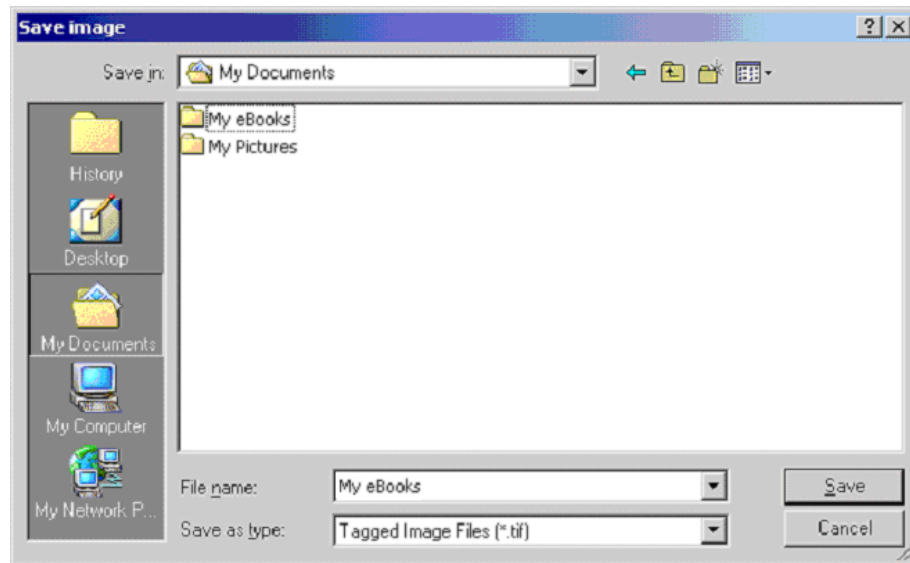


Fig. 2-128 Save image Window

- (2) Saving by “Quick save” Function

- (a) Turn on the Quick save radio button in the Save icon select group.

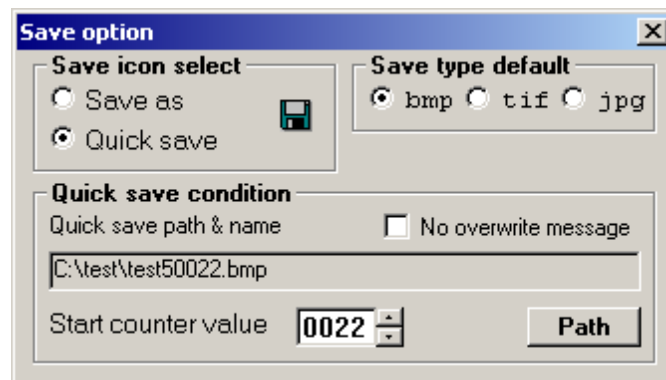



Fig. 2-129 Save option Window

- (b) Specify a directory and a serial file name by clicking the **Path** button in the Quick save condition group.
- (c) A number to be added to the serial file name should be input in the Start counter value input box in the Quick save condition group.

- (d) Since settings are to be saved, they are not always required for image recording.
- (e) While a still image is displayed, click the Save button  in the CCD control area.

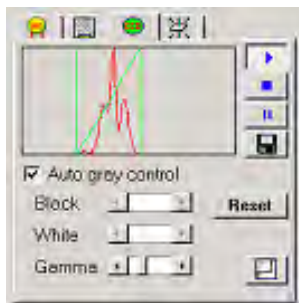


Fig. 2-130 CCD Control Area

- (f) In the directory specified above, the file name is created and saved in the serial number.

2.4.3 Image Saving Format (Type A only)

(1) BMP File Format

- (a) On the Save option window, turn on the bmp radio button in the Save type default group.

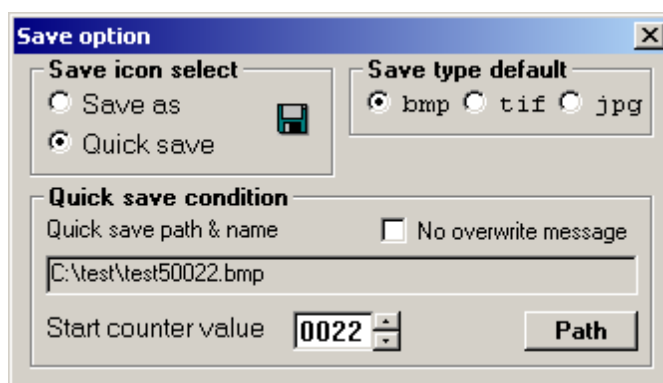


Fig. 2-131 Save option Window

- (b) When an image is then saved according to 2.4.2, the file format is BMP. The bit depth of image data is compressed to 8 bits according to the BMP file format.

2.4 Image Recording with Digital Camera

(2) TIFF File Format

- (a) On the Save option window, turn on the tif radio button in the Save type default group.

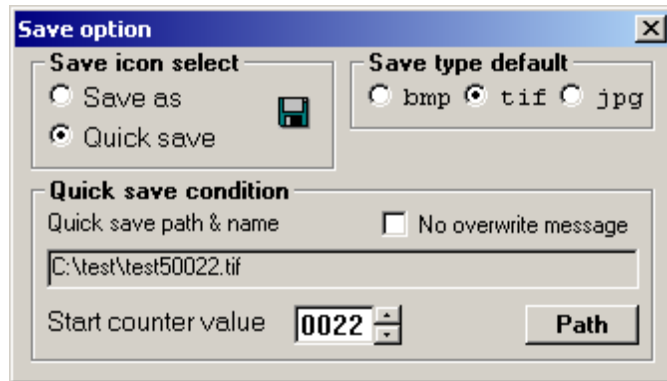


Fig. 2-132 Save option Window

- (b) When an image is then saved according to 2.4.2, the file format is TIFF. The bit depth of image data remains at 16 bits according to the TIFF file format.

(3) JPEG File Format

- (a) On the Save option window, turn on the jpg radio button in the Save type default group.

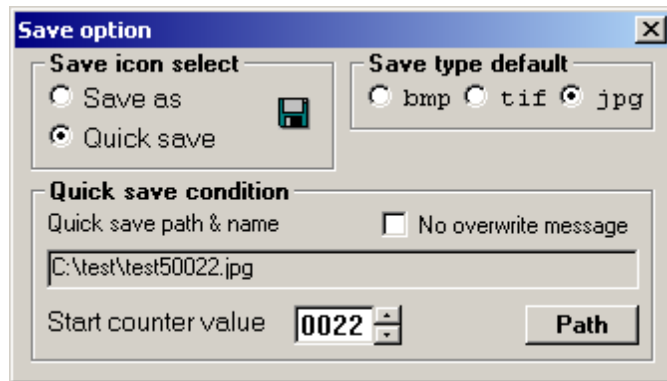


Fig. 2-133 Save option Window

- (b) When an image is then saved according to 2.4.2, the file format is JPEG. The bit depth of image data is compressed to 8 bits according to the JPEG file format.

2.4.4 Gain Control (Type A only)

(1) Gain of Digital Camera

The digital camera standard-equipped with the Model H-7650 is capable of changing camera sensitivity by controlling electrical gain. Gain should be reduced for recording a bright image such as a low-magnification image and should be enhanced for recording high-magnification images and the specimens vulnerable to beam damage.

Gain has 256 steps from 0 to 255 and relative sensitivity (with respect to gain 0) is widely variable as shown in Fig. 2-134.

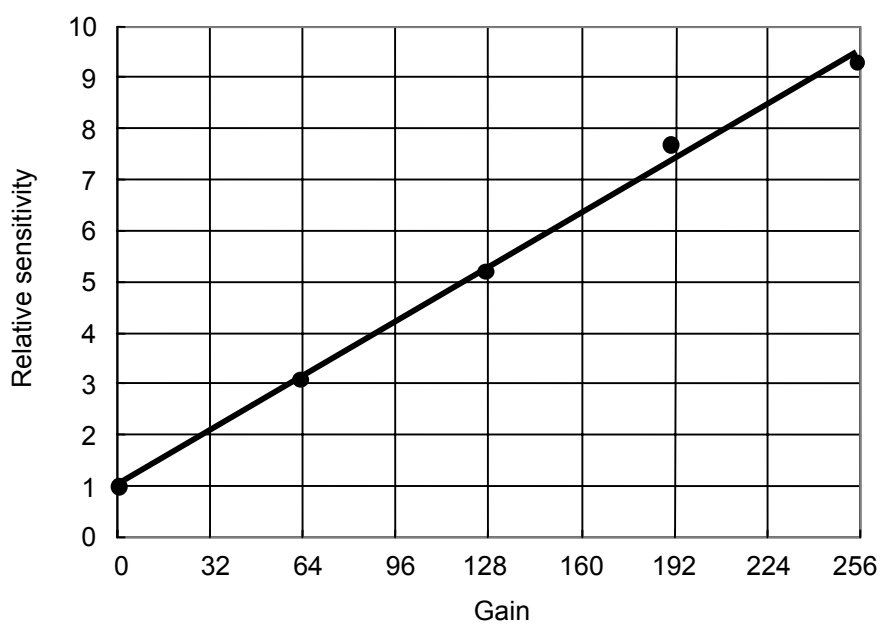


Fig. 2-134 Relative Sensitivity of Digital Camera

2.4 Image Recording with Digital Camera

(2) Gain Changing Procedure

- (a) Open the CCD control window by clicking Function and then CCD control.

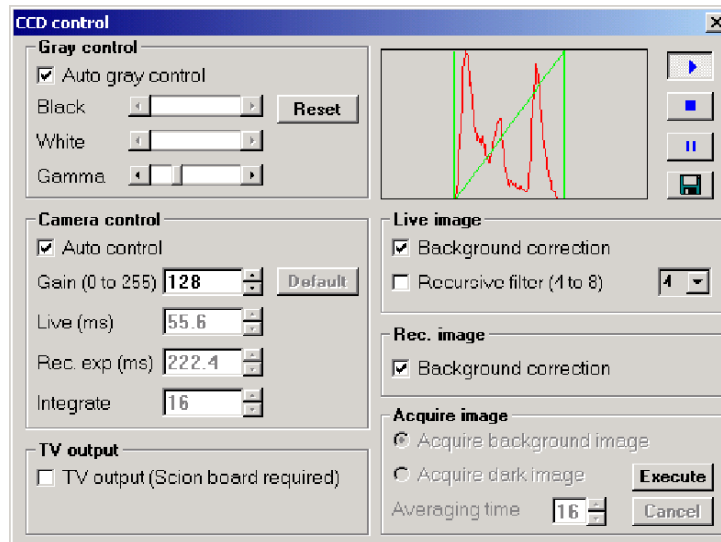


Fig. 2-135 CCD control Window

- (b) Input a value within 0 to 255 into the Gain (0 to 255) input box in the Camera control group.
- (c) Determine the input value by the Enter key.
- (d) The input value will be saved and remain valid till the next change.

2.4.5 Background Subtraction (Type A only)

(1) Background Subtraction Process

The digital camera used in the Model H-7650 incorporates the function for correcting an unevenness of sensitivity due to the background of scintillator and the dark current of camera. The function can be validated independently for each of still and live images. The respective validation procedures are shown below.

(a) Click Function - CCD control to open the CCD control window.

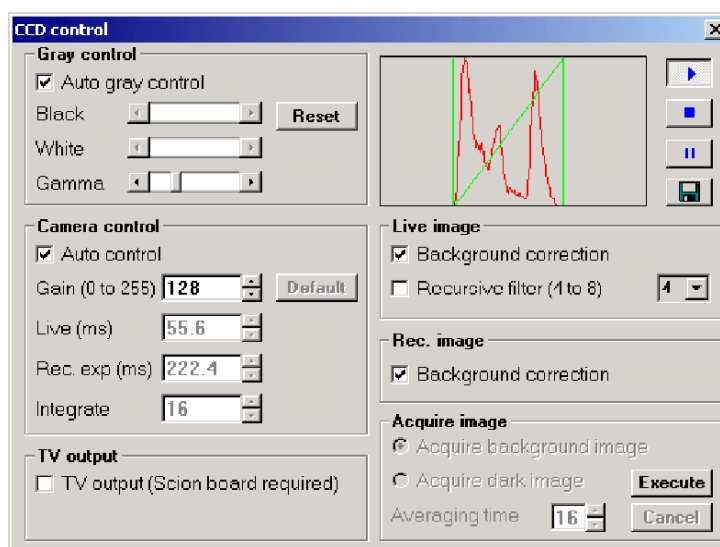


Fig. 2-136 CCD control Window

- (b) For background correction of a still image, turn on the Background correction check box in the Rec. image group.
- (c) For background correction of a live image, turn on the Background correction check box in the Live image group.
- (d) The input value will be saved and remain valid till the next change.

2.4 Image Recording with Digital Camera

(2) Ho to Acquire Background Data

It is necessary to reacquire background data if sensitivity changes or becomes uneven due to deterioration of the scintillator or if the scintillator is contaminated or damaged.

Carry out the following procedure.

- (a) Draw out the specimen holder up to position B according to (2) in 2.2.3.
- (b) Emit an electron beam and set a magnification of about 100k \times in the HC ZOOM mode.
- (c) Turn the BRIGHT knob on the left operation panel so that the electron beam is formed evenly on the fluorescent screen.

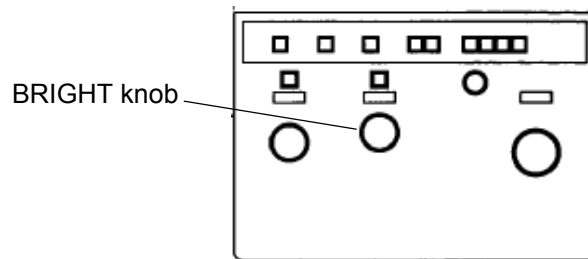


Fig. 2-137 Left Operation Panel

- (d) Open the CCD control window by clicking Function and then CCD control.
- (e) Select Default for Camera control, referring to (2) in 2.4.1.
- (f) Set gain at 128, referring to (2) in 2.4.4.

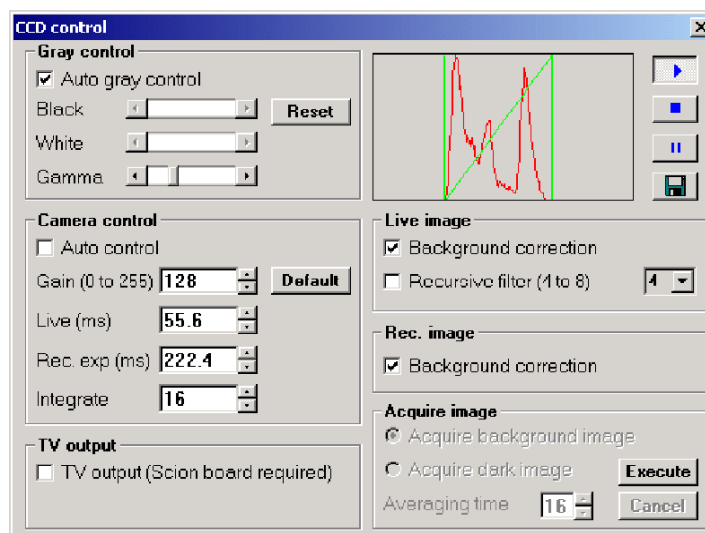


Fig. 2-138 CCD control Window

- (g) On the Easy operation window, click the CCD tab to display the CCD control area. Then, click the Run button  to display a live image.

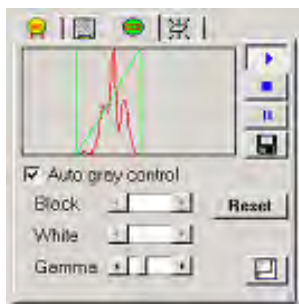


Fig. 2-139 CCD Control Area

- (h) Bring the histogram to the center by turning the BRIGHT knob on the left operation panel.
- (i) Click the **Execute** button in the Acquire image group.

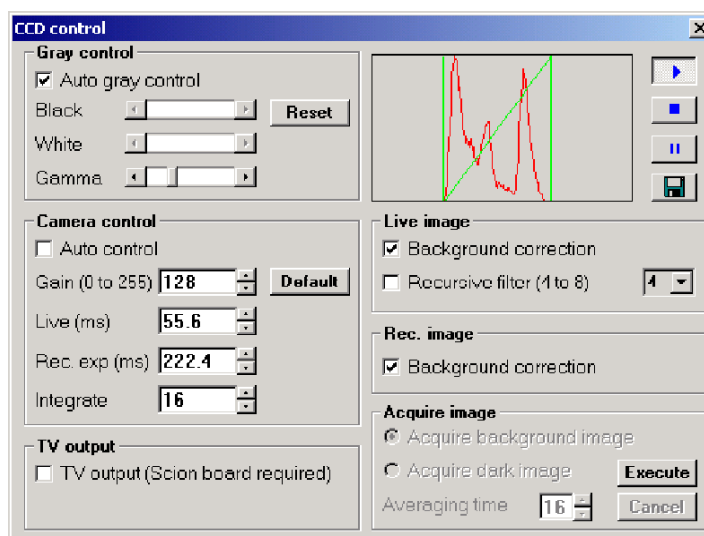


Fig. 2-140 CCD control Window

2.4 Image Recording with Digital Camera

- (j) Click the **Acquire** button for Acquire background image in the Acquire image group.

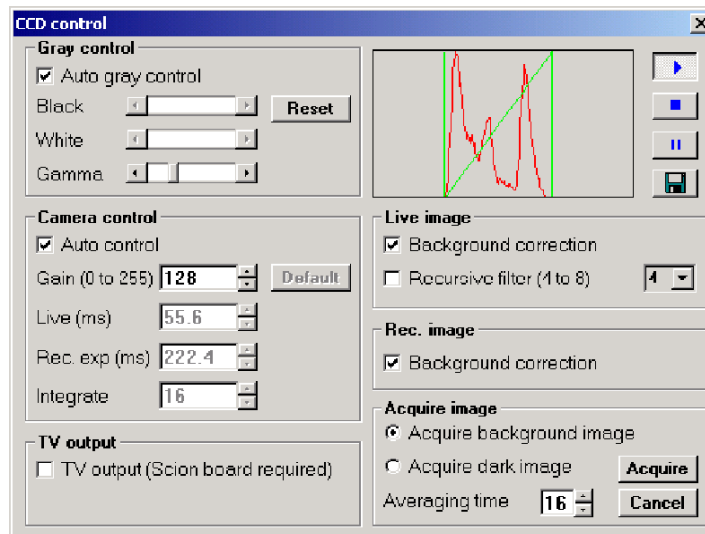


Fig. 2-141 CCD control Window

- (k) Acquisition of background data starts.

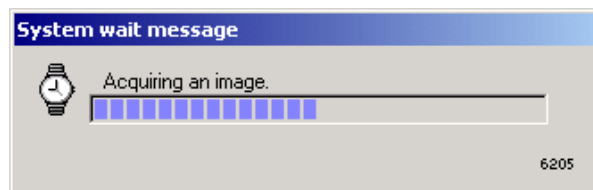


Fig. 2-142 Message Window

NOTE: Before completion of this acquisition, avoid any access to the Model H-7650.

(3) How to Acquire Dark Current Data

Once dark current data has been acquired, it need not be reacquired. However, it is recommended to require this data in the following cases.

- For regular use at any gain other than the standard gain value 128
- After change of the camera head

How to acquire this data is shown below.

- (a) When an accelerating voltage is applied, set Filament OFF status and stop beam emission according to (2) in 2.1.4.

- (b) Close the fluorescent screen.

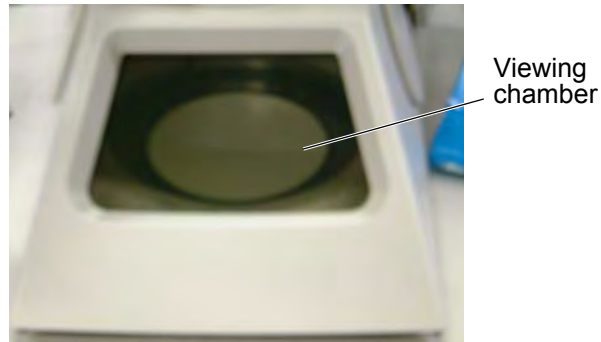


Fig. 2-143 Fluorescent Screen

- (c) Put the lid on the viewing chamber.



Fig. 2-144 Viewing Chamber

- (d) Turn off the room lamps to prevent entrance of stray light.
- (e) Open the CCD control window by clicking Function - CCD control.
- (f) Set Default for Camera control according to (2) in 2.4.1.
- (g) Set gain at 128 according to (2) in 2.4.4. For using other gain value in a special case, set the value here.

2.4 Image Recording with Digital Camera

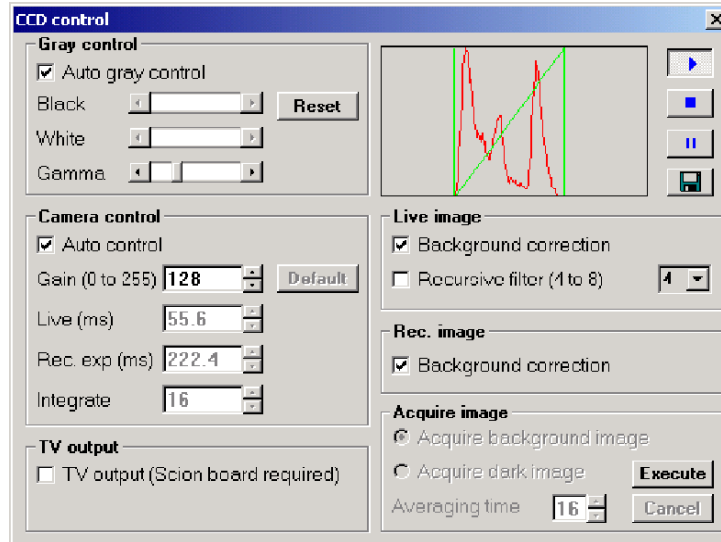



Fig. 2-145 CCD control Window

- (h) On the Easy operation window, click the CCD tab to display the CCD control area. Then, click the Run button  to display a live image.

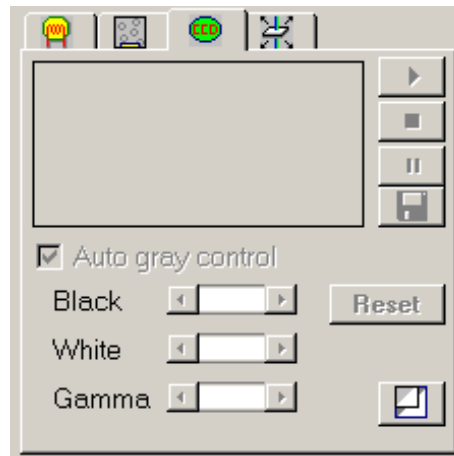


Fig. 2-146 CCD Control Area

- (i) Click the **Execute** button for Acquire dark image in the Acquire image group.

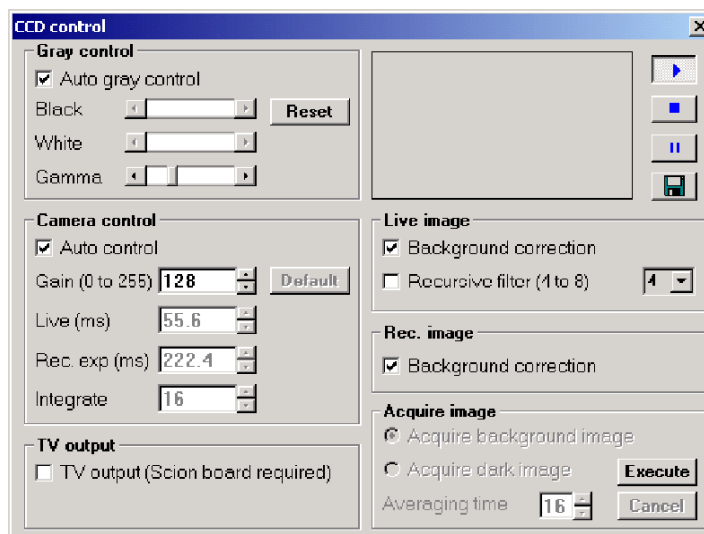


Fig. 2-147 CCD control Window

- (j) Click the **Acquire** button for Acquire dark image in the Acquire image group.

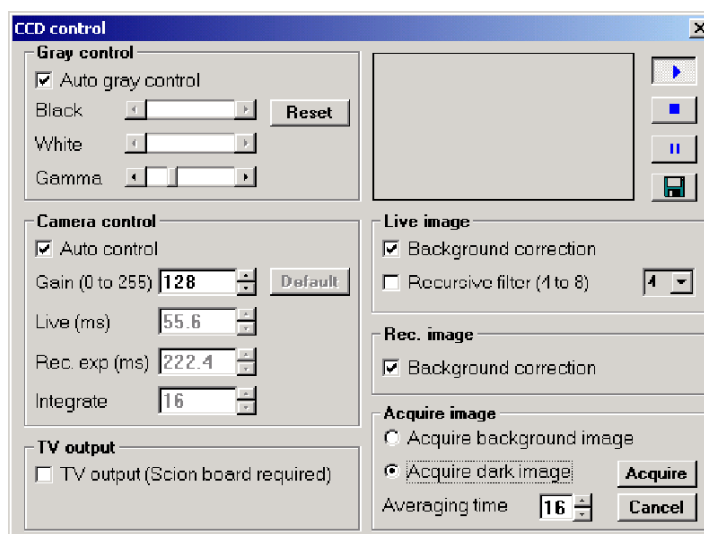


Fig. 2-148 CCD control Window

2.4 Image Recording with Digital Camera

(k) Acquisition of dark current data starts.

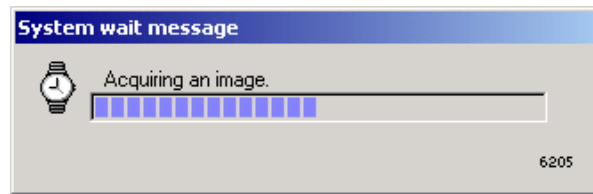


Fig. 2-149 Message Window

NOTE: Before completion of this acquisition, avoid any access to the Model H-7650.

2.5 Image Recording with Film Camera (option)

2.5.1 Photographing Method

For image recording after completion of field selection, magnification setting and focusing, you must begin with determination of photographic conditions, etc. Photographic conditions are settable by 3 methods; ATS mode, ABS mode and manual mode. Every method presents a negative film having almost the same photographic density.

Before image recording, (1) setting of photographic density and (2) setting of exposure time are required.

(1) Setting of Photographic Density

- (a) Click Operate, Photo setting and Exposure time. The Exposure time window now opens.



Fig. 2-150 Operate Menu

- (b) Input a photographic density for the Optimum density (at 100 kV) input box in the Density setting group. Standard value is $4.97\text{E-}11 \text{ C/cm}^2$ for using electron microscope film FG made by Fuji Photo Film.

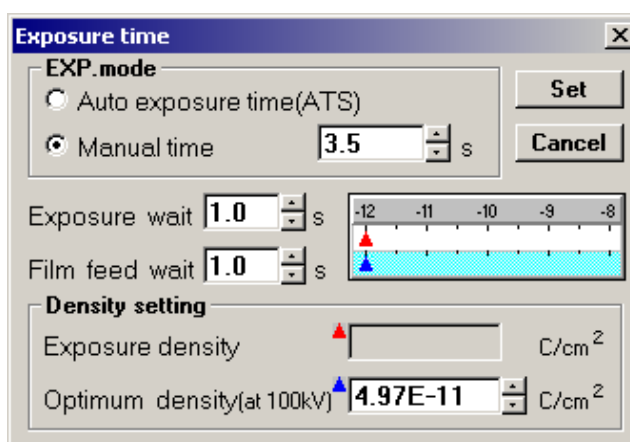


Fig. 2-151 Exposure time Window

2.5 Image Recording with Film Camera (option)

(c) Determine your input by clicking the **Set** button.

NOTE: For using both digital camera and films, the exposed film should be recovered from the cassette receiver, otherwise it may be damaged through re-exposure.

(2) Setting of Exposure Time

(a) Click Operate, Photo setting and Exposure time to open the Exposure time window.

(b) Input an exposure time in the Manual time input box in the EXP. mode group.

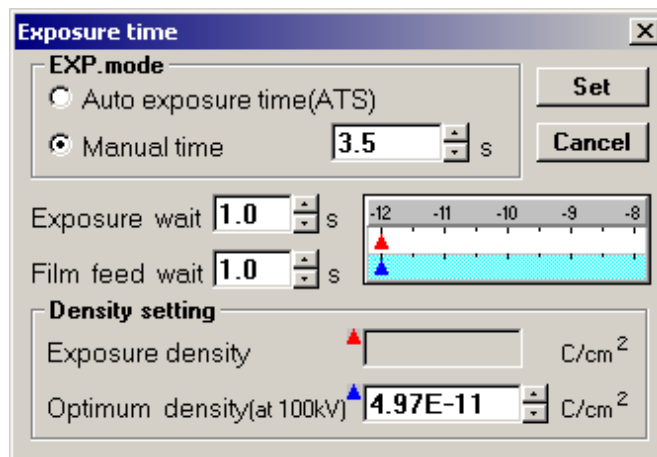


Fig. 2-152 Exposure time Window

(c) Determine your input by clicking the **Set** button.

(3) Usage of Automatic Exposure Time Setting Mode (ATS: AUTO EXPOSURE TIME SET)

This mode provides a function for automatically setting an exposure time so as to obtain the optimum photographic density of film under a given brightness.

(a) Setting of ATS Mode

- 1) Click Operate, Photo setting and then Exposure time to open the Exposure time window.

- 2) Turn on the Auto exposure time (ATS) radio button in the EXP. mode group.

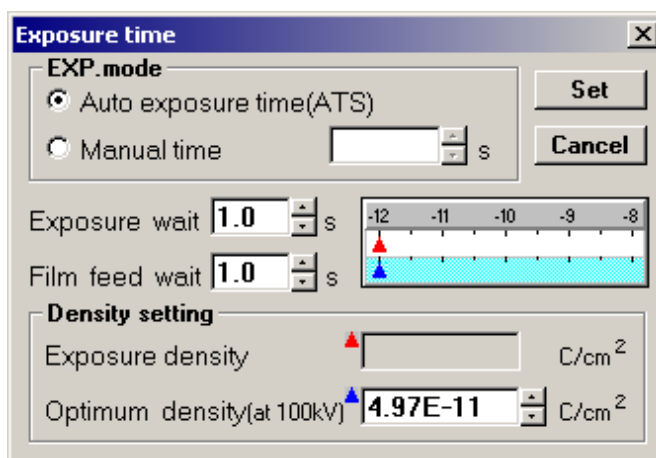
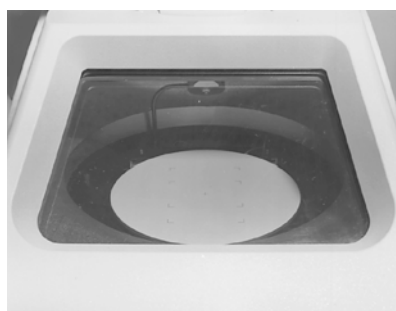


Fig. 2-153 Exposure time Window

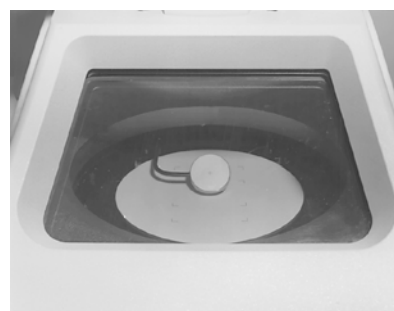
- 3) Determine the input by clicking the **Set** button.

(b) Photographing Procedure

- 1) Develop a TEM image on the large (main) fluorescent screen or spot (focusing) fluorescent screen. Electron beam dose is measured and an appropriate exposure time is automatically calculated.



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Fig. 2-154 Large and Spot Fluorescent Screens

NOTE: If there is a significant brightness change in the large fluorescent screen (due to the shadow of grid, uneven thickness of specimen, etc.), calculation may entail an error. In this case, the spot fluorescent screen should be used.

2.5 Image Recording with Film Camera (option)

- 2) The exposure time for obtaining the photographic density set in (1) of 2.5.1 is indicated at the EXPOSURE TIME position. At this time, the green lamp of exposure indicator lights on the right operation panel.
- 3) Start photographing by pressing the PHOTO switch on the right operation panel.

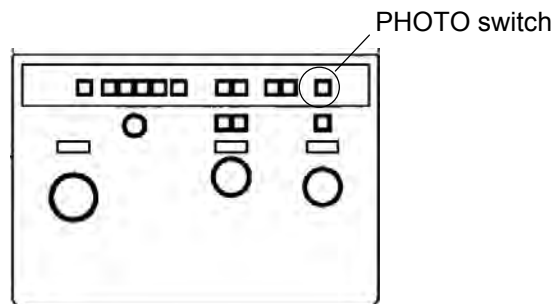


Fig. 2-155 Right Operation Panel

(4) Usage of Automatic Brightness Setting (ABS: AUTO BRIGHT) Mode

This mode provides a function for automatically setting a brightness level so as to obtain the optimum photographic density of film in the set exposure time.

(a) Setting of ABS Mode

- 1) Click Operate, Observation and then Lens mode to open the Lens mode set window.

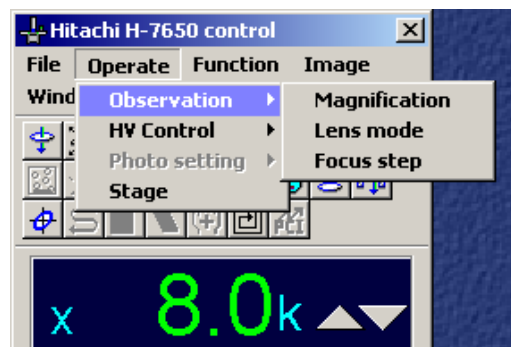


Fig. 2-156 Observation Menu

- 2) On the Lens mode set window, click the **ON** button in the Brightness control/ABS mode group. Beam dose is now automatically controlled.

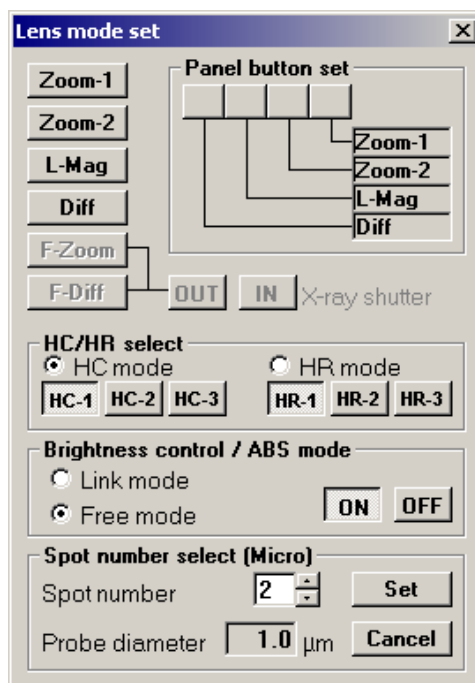
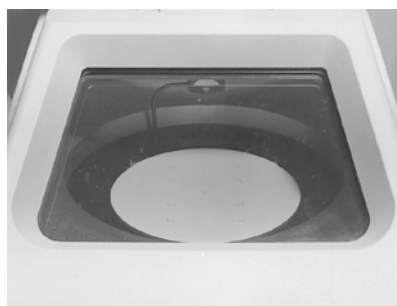


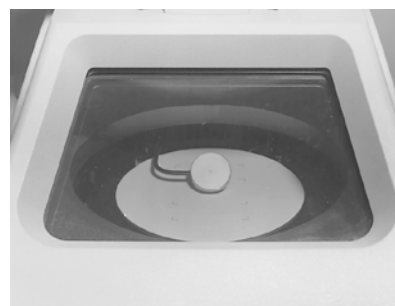
Fig. 2-157 Lens mode set Window

(b) Photographing Procedure

- 1) Develop a TEM image on the large fluorescent screen or spot fluorescent screen.



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Fig. 2-158 Large and Spot Fluorescent Screens

NOTE: If there is a significant brightness change in the large fluorescent screen (due to the shadow of grid, uneven thickness of specimen, etc.), calculation may involve an error. In this case, the spot fluorescent screen should be used.

2.5 Image Recording with Film Camera (option)

- 2) Set the ABS mode according to (a) above. Electron beam dose is measured and brightness is automatically controlled to an appropriate level.
- 3) When the optimum exposure level is reached, the green lamp of exposure indicator lights on the right operation panel.

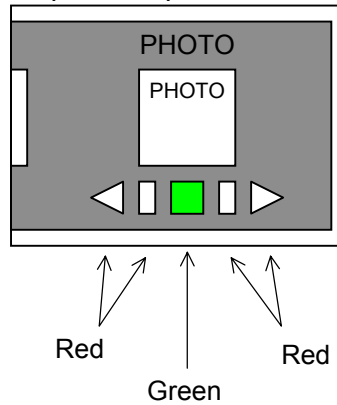


Fig. 2-159 Exposure Indicator Lamp

- 4) Start photographing by pressing the PHOTO switch on the right operation panel.

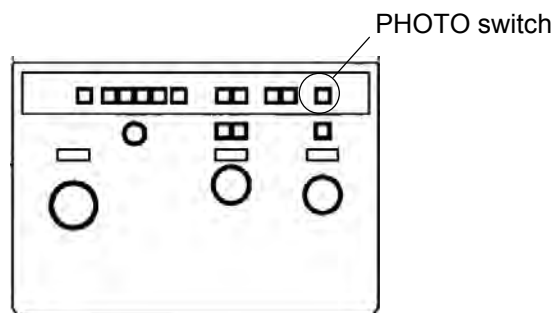


Fig. 2-160 Right Operation Panel

NOTE: If the set photographic density of film corresponds to an extremely high or low brightness level, message characters CANNOT ADJUST will be indicated on the monitor for reporting a failure to set brightness automatically. In this case, employ manual operation or the ATS mode for photographing.

NOTE: The ABS mode can be released by turning the BRIGHT knob on the left operation panel.

(5) Manual Method

(a) Setting of Manual Mode

- 1) Click Operate, Photo setting and then Exposure time to open the Exposure time window.

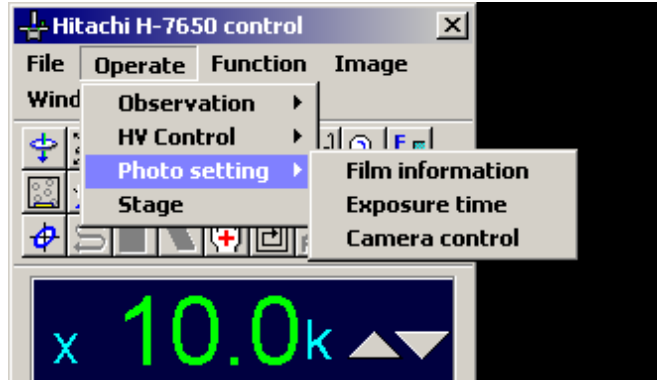


Fig. 2-161 Photo setting Menu

- 2) Click the Manual time radio button in the EXP. mode group.

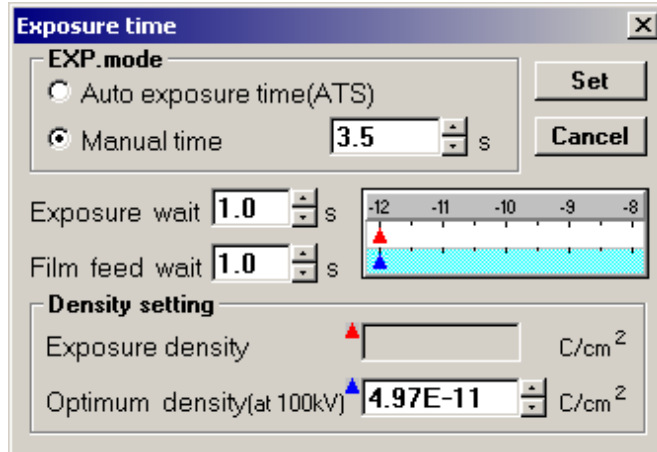


Fig. 2-162 Exposure time Window

- 3) Determine your input by clicking the **Set** button.

2.5 Image Recording with Film Camera (option)

(b) Photographing Procedure

- 1) Develop a TEM image on the large fluorescent screen or spot fluorescent screen.

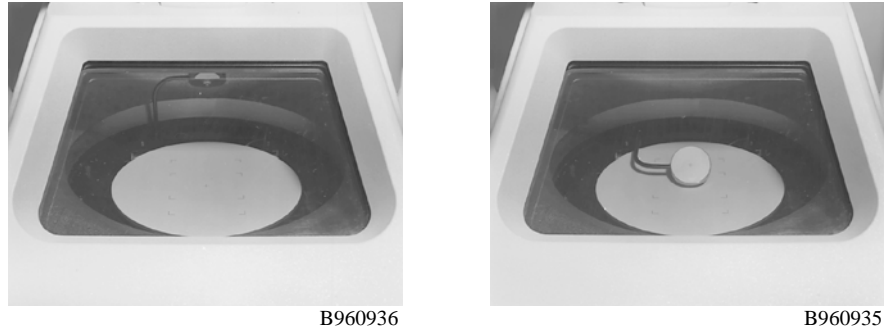


Fig. 2-163 Large and Spot Fluorescent Screens

NOTE: If there is a significant brightness change in the large fluorescent screen (due to the shadow of grid, uneven thickness of specimen, etc.), calculation may involve an error. In this case, the spot fluorescent screen should be used.

- 2) Adjust brightness by turning the BRIGHT knob on the left operation panel.

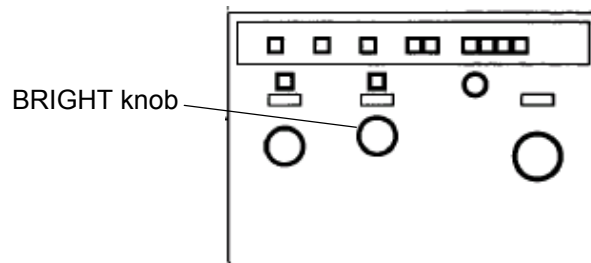


Fig. 2-164 Left Operation Panel

- 3) When the optimum level is reached, the green lamp of exposure indicator lights on the right operation panel.

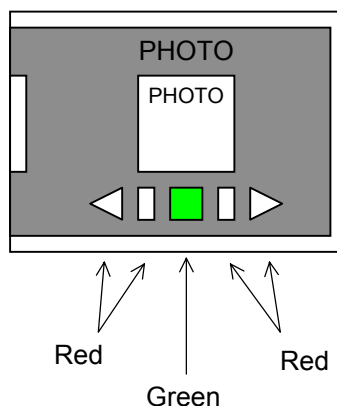


Fig. 2-165 Exposure Indicator Lamp

- 4) Start photographing by pressing the PHOTO switch on the right operation panel.

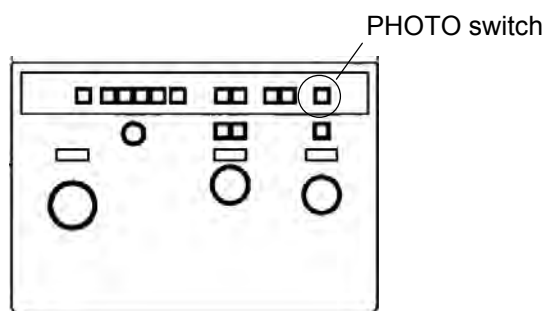


Fig. 2-166 Right Operation Panel

NOTE: Please do not expand electron beams more than fluorescent boards when magnification \times inserts real aperture $10\mu\text{m}$ diameter by 30,000 or less and it takes a picture of the image. Irregular brightness is occasionally caused in the image. Because scattering by the irradiation system might be generated, it is recommended to use it with focusing lens movable aperture No2 and Spot size No4 or less. Besides this, when scattering with the sample mesh is generated, the mesh of a hall that is smaller than 200 meshes is recommended. The emission current is lowered, and please the doing observation and take a picture of the focus match again when you do not satisfy the above-mentioned condition if you do not darken brightness when taking a picture in the film and CCD camera.

2.5 Image Recording with Film Camera (option)

2.5.2 Setting of Photographing Conditions

(1) Film Field Size Changeover (FULL/HALF)

Model H-7650 allows selection of film exposure field size.

FULL size	: 113 × 76 mm	(1 field when using 82.5 × 118 mm film)
HALF size	: 53 × 76 mm	(2 fields when using 82.5 × 118 mm film)
FULL size	: 95 × 76 mm	(1 field when using 3 1/4 × 4 inch film)
HALF size	: 46 × 76 mm	(2 fields when using 3 1/4 × 4 inch film)
FULL size	: 113 × 76 mm	(1 field when using 90.0 × 120 mm film)
HALF size	: 53 × 76 mm	(2 fields when using 90.0 × 120 mm film)

There are two selection methods; (a) and (b). Use either method as you desire.

(a) Selection by FULL/HALF Switch on the Right Side Of Camera Chamber

- 1) Select either FULL or HALF.



Fig. 2-167 FULL/HALF Switch

- 2) When the FULL size is selected, the switch is lit brightly, and it is lit dimly when the HALF size is selected.
- 3) The selected field size is indicated in the information area.

NOTE: If size is changed with a film already loaded, the film is fed without exposure and the effective size is obtainable from the next film.

(b) Selection by Window Operation

- 1) To open the Film information window, click Operate, Photo setting and then Film information.

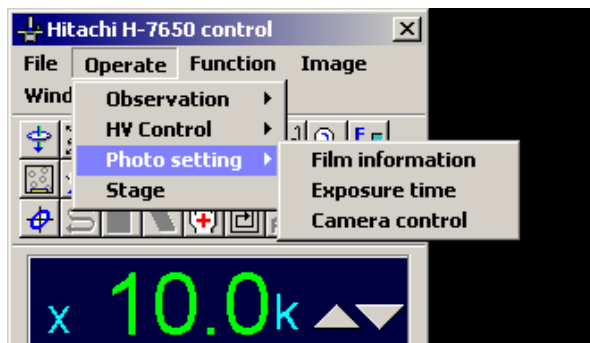


Fig. 2-168 Photo setting Menu

- 2) Select field size by clicking the Full or Half radio button in the Film select group on the Film information window.

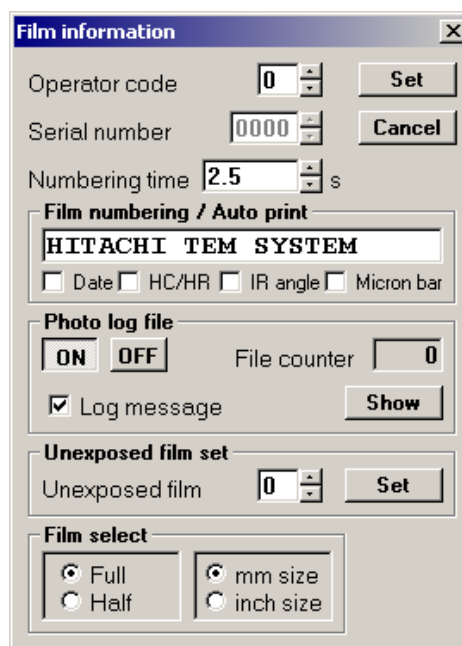


Fig. 2-169 Film information window

- 3) The selected field size is indicated in the information area.

NOTE: If size is changed with a film already loaded, the film is fed without exposure and the effective size is obtainable from the next film.

2.5 Image Recording with Film Camera (option)

(2) Comment Input

On a film, you can input a comment or set printout of date and micron marker (bar). Carry out the following procedure.

- (a) Click Operate, Photo setting and then Film information, and the Film information window will open.



Fig. 2-170 Photo setting Menu

- (b) On the Film information window, input characters directly in the comment input box in the Film numbering/Auto print group. A maximum of 20 characters (14 characters when micron bar is set) can be input.



Fig. 2-171 Film information window

- (c) Determine your input by the **Set** button.

(3) Auto focus link Function (Type A only)

In image recording, auto focus can be activated. This link function can be validated in the following procedure.

- (a) Click Operate, Photo setting and then Camera control, and the Camera control window will open.

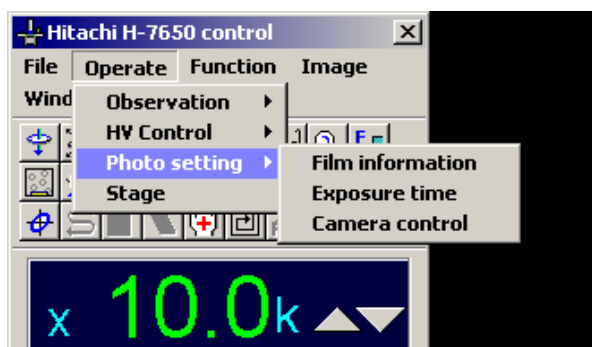


Fig. 2-172 Photo setting Menu

- (b) On this window, turn on the Auto focus link check box in the Photo group.

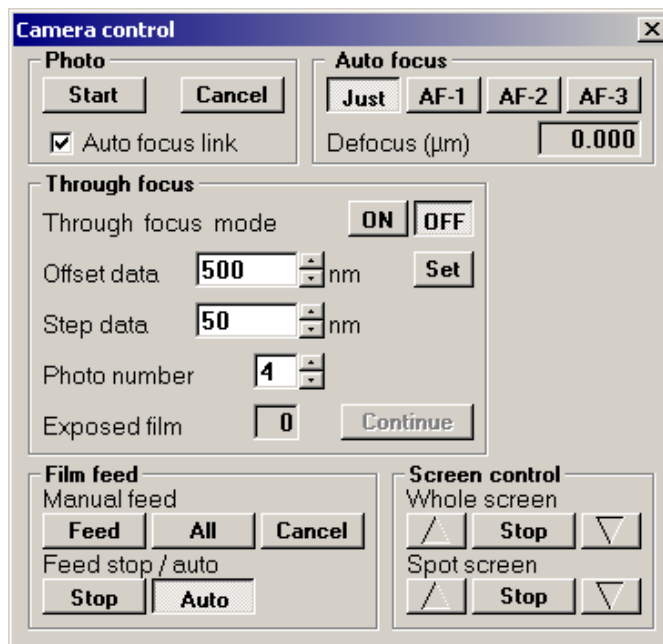


Fig. 2-173 Camera control Window

- (c) For details, refer to 3.3.3 in “3. SOFTWARE FUNCTIONS.”

2.5 Image Recording with Film Camera (option)

2.5.3 Film Exchange (Option)

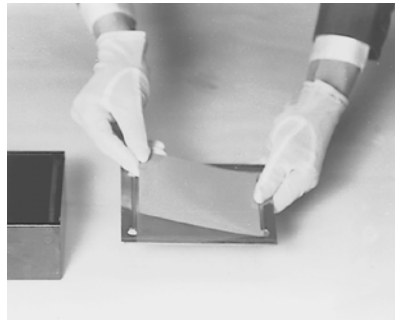
Films can be taken out even when there are unexposed films in the instrument. Film exchange should be carried out in the following procedure when there are no unexposed films remaining inside the instrument.

(1) Film Loading into Film Cassette Magazine

The method of loading a new film in the film cassette magazine is explained here.

NOTE: The following operations should all be carried out under a safe light in a dark room so that the film will not be exposed to light.

(a) Load a film into the cassette.



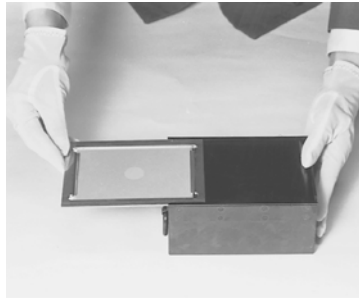
948-A-29

Fig. 2-174 Loading Film into Cassette

NOTE: If a film is not loaded correctly in the cassette, it may slip off the cassette, causing the feed mechanism to be caught halfway.

NOTE: During loading, pay attention not to touch your fingers to the emulsion-coated surface.

- (b) Place the film-loaded cassette into the film cassette magazine. A maximum of 50 films can be loaded in the standard magazine.



948-A-30

Fig. 2-175 Placing Film Cassette in Film Cassette Magazine

- (c) Put the shield plate in finally.



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Fig. 2-176 Shield Plate

(2) Exchange of Cassette Receivers

Explained here is the method of taking out the film receiver, which contains the exposed film, from the camera chamber and introducing an empty film receiver yet to receive exposed films.

- (a) Press the EVAC switch in the CAMERA EVAC block to set the CLOSE status.

2.5 Image Recording with Film Camera (option)

- (b) Press the AIR switch in the CAMERA EVAC block to set the AIR status.



B960909

Fig. 2-177 CAMERA EVAC/AIR Switch

- (c) When the buzzer sounds, open the front cover of the camera chamber. By pulling the grip, draw out the table which mounts the cassette receiver and cassette magazine.



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Fig. 2-178 Front Cover of Camera Chamber

- (d) Pull out the cassette receiver by raising the grip as shown in Fig. 2-179. The area A in this figure serves as a lock mechanism for prevention of film exposure. Raising the grip as directed by the arrow will lock the lid.

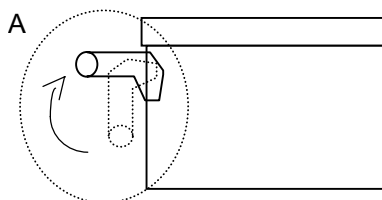
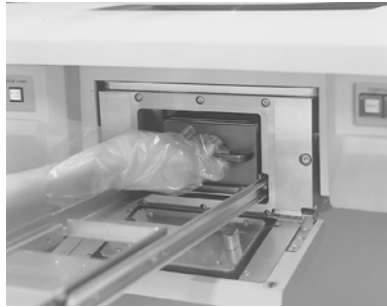


Fig. 2-179 Cassette Receiver

- (e) Introduce an empty cassette receiver.



B960923

Fig. 2-180 Insertion of Cassette Receiver

- (f) Release the locked status of the lid by lowering the grip with its lever pushed as directed by the arrow shown below.

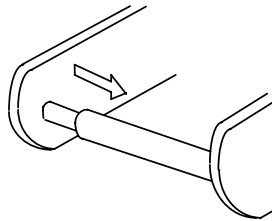


Fig. 2-181 Releasing Lock of Cassette Receiver

NOTE: If the receiver is inserted without unlocking, the front cover of the camera chamber won't close.

- (g) Return the table, which mounts the cassette receiver and cassette magazine, to the original position.

2.5 Image Recording with Film Camera (option)

- (h) Close the front cover of the camera chamber.



Fig. 2-182 Front Cover of Camera Chamber

- (i) Press the AIR switch in the CAMERA EVAC block to set the CLOSE status.
- (j) Press the EVAC switch in the CAMERA EVAC block to start evacuation. The EVAC switch lamp will flicker.
- (k) When the EVAC switch lamp comes on to indicate the end of evacuation, cassette receiver exchange is completed.
- (3) Exchange of Film Cassette Magazines

Explained here is the method of inserting the cassette magazine, which accommodates unexposed films, into the camera chamber.

- (a) Effect steps (a) to (d) in (2) to take out the cassette receiver.
- (b) Further pull out the grip of the table which mounts the cassette receiver and cassette magazine.

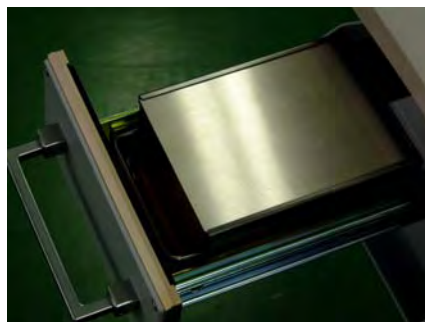
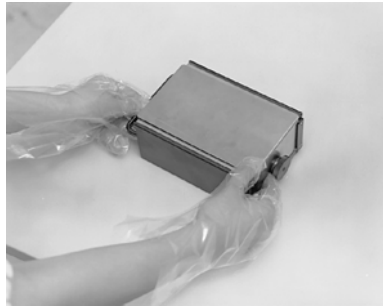


Fig. 2-183 View with Grip Pulled out

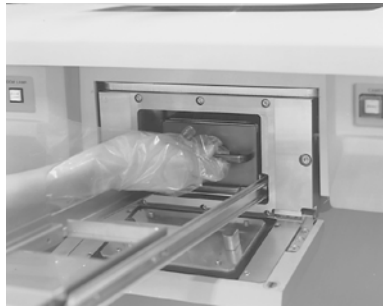
- (c) Take out the cassette magazine and attach the L-shaped shield plate to a new cassette magazine.



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Fig. 2-184 L-shaped Shield Plate

- (d) Insert the cassette magazine into the camera chamber.



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Fig. 2-185 Insertion of Cassette Magazine

- (e) Carry out step (e) onward in (2) to evacuate the camera chamber.
- (4) Film Pre-evacuation (usage of optional plate reservoir tank)

Since a new photographing film contains much moisture, it takes a long time for the instrument to dry the film adequately and reach a high vacuum. Therefore, pre-evacuation of unexposed films is recommended. For pre-evacuation, follow these steps:

2.5 Image Recording with Film Camera (option)

- (a) Open the cover under the table on the left side of main unit and press the PR EVAC switch of the plate reservoir tank on the inside.

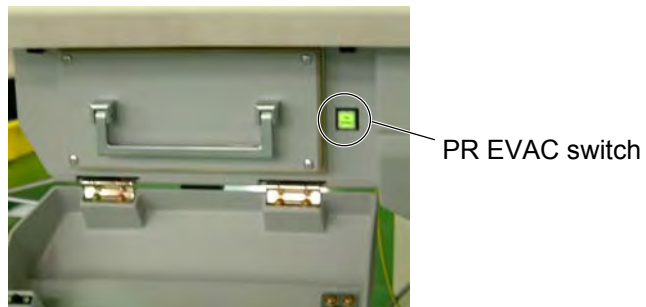


Fig. 2-186 PR EVAC Switch

- (b) The lamp of the PR EVAC switch flickers. When buzzer stops ringing, air leak is over.
- (c) Pull the drawer lever of plate reservoir tank toward you.

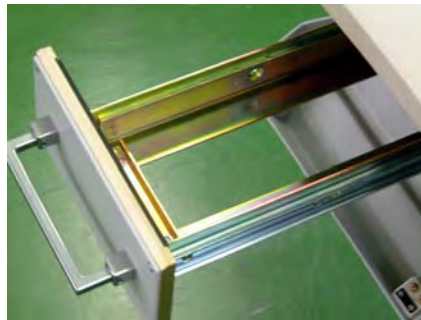


Fig. 2-187 Plate Reservoir Tank

- (d) Place the new film-loaded cassette magazine onto the drawer rails and close the door with the drawer lever pushed down.

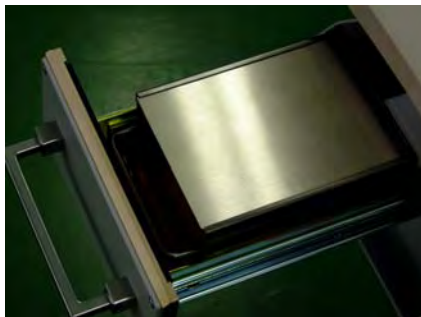


Fig. 2-188 Cassette Magazine Placed on Drawer Rails

- (e) Press the PR EVAC switch again, and evacuation will start.



Fig. 2-189 PR EVAC Switch

- (f) When the lamp of PR EVAC switch comes on, pre-evacuation is completed.

NOTE: Make sure the drawer of the plate reservoir tank is closed. Unless closed, pre-evacuation cannot be carried out normally.

3. SOFTWARE FUNCTIONS

3.1 Outline of Operation Window

3.1.1 Startup of H-7650 Control Software

- (1) Turn the POWER key switch to the COL. ON position, and the electron microscope system program will start.
- (2) The initial screen shown in Fig. 3-1 appears on the monitor and initial setting of each control unit will be carried out.
The initial screen automatically closes, and then the control window appears.



Fig. 3-1 Initial Screen

- (3) If an error occurs in initial setting, an error message window is displayed and the communication line with the defective unit is closed. (Refer to 2.1 1 in this instruction manual.)

3.1 Outline of Operation Window

3.1.2 Configuration of Control Window

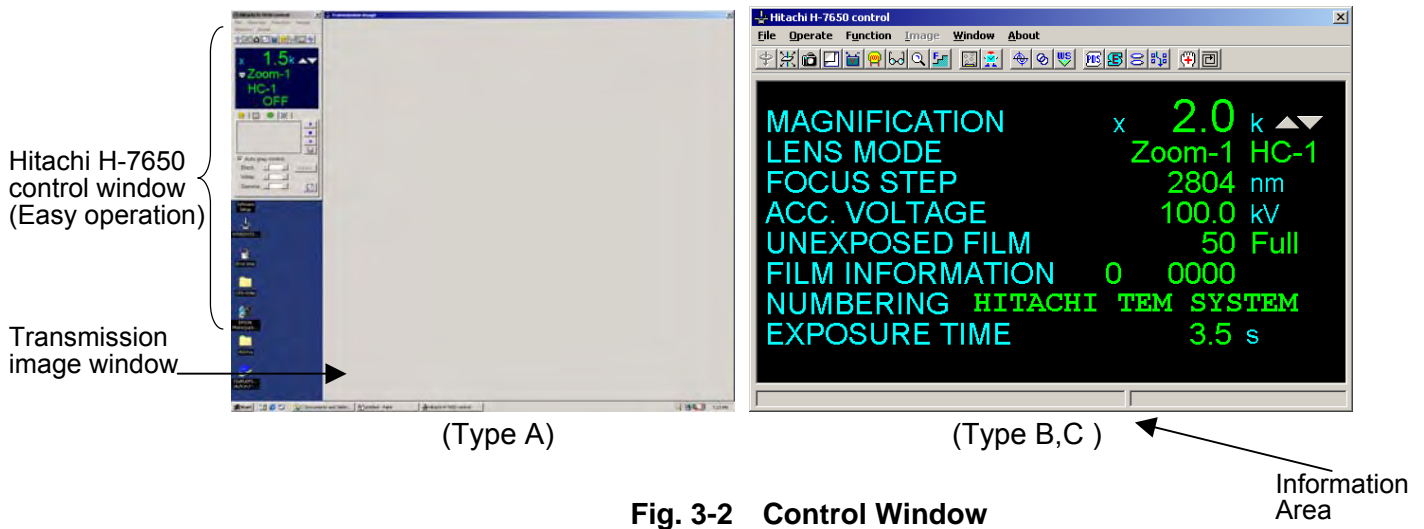


Fig. 3-2 Control Window

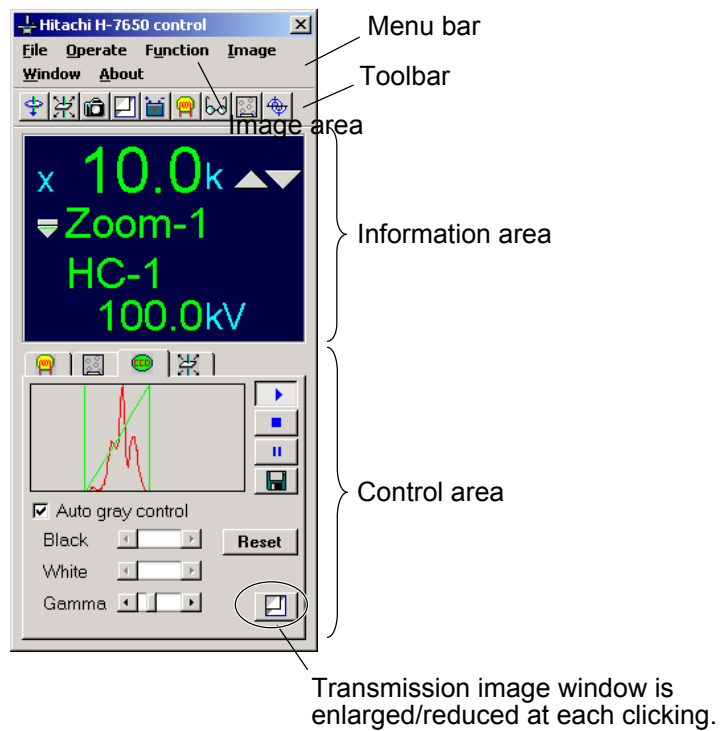


Fig. 3-3 Hitachi H-7650 control Window


















(1) Menu Bar

The commands necessary for H-7650 operation can be accessed by opening the relevant menu. The commands are divided into menus. Some commands will be executed as soon as they are selected, and others will be executed when you select an option in the dialog box which is displayed upon their selection.

(2) Toolbar




The functions of frequently used commands can be promptly provided by selecting their tool icon buttons. Bring the mouse cursor to an icon button, and the corresponding command name will be indicated. The command is selectable just by clicking the button. You can delete unnecessary buttons and add new buttons by selecting Function – Maintenance – Customize toolbar on the menu bar.

Table 3-1 Icons on Toolbar

Icon	Name	Function
	Transmission image	Display of SSCCD image
	Stage	Stage control
	Camera control	Control of camera mechanism (option)
	View	Switching of Easy operation
	HV control	Setting of accelerating voltage
	Filament/Bias	Setting of filament/bias
	LENS	Setting/change of observation mode
	Magnification	Enlarged display of magnification/camera length
	Focus step	Setting of focus step
	Film information	Photographing film information (option)
	Exposure time	Setting of photographing film exposure time (option)
	Auto focus	Automatic focusing
	Modulation	Setting of modulation
	Wobbler	Setting of wobbler
	PDS	Personal data set
	EVAC	Display of evacuation system condition
	LENS CONTROL	Display/control of LENS current

3.1 Outline of Operation Window

(cont'd)

Icon	Name	Function
	BD CONTROL	Display/control of BD current
	OBJ stigma preset	Saving/loading of objective astigmatism correction amount
	API	Preparatory irradiation on specimen

(3) Information Area

In this area, the basic TEM status is indicated. Double-clicking on each indication will call a condition setting window.

(4) Control Area

Some commands used for TEM operation/image observation can be accessed from the control area at any time. Those commands are selectable by clicking their tabs.

(5) Image Area

Digital camera image is displayed.

CAUTION: Do not change display setting of the control window from the initial values, because screen display may become inappropriate. If the setting happened to be changed, then open the Display Properties window from the control panel of Windows, and match Screen area and Font size settings with those shown in Fig. 3-4.

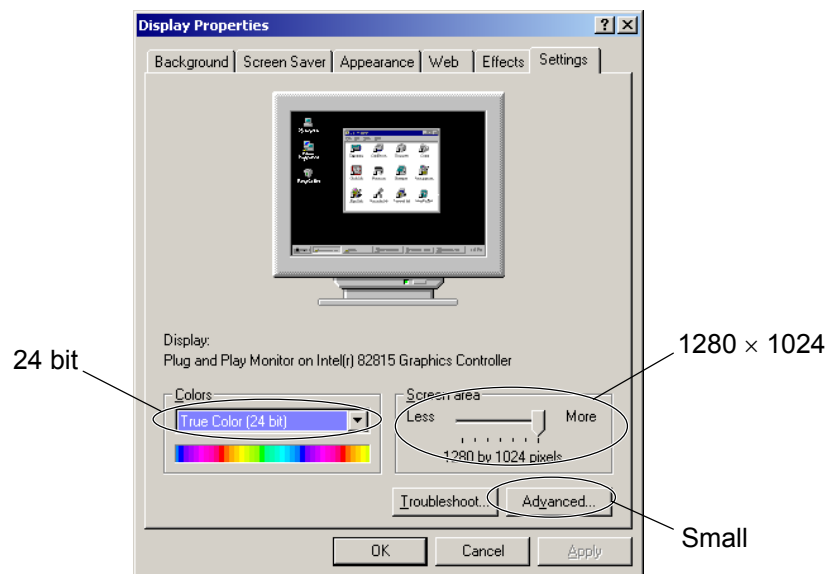


Fig. 3-4 Display Properties Window

3.2 File Menu (Hitachi H-7650 control window)

Click File in the Hitachi H-7650 control window, and the pull-down menu shown in Fig. 3-5 will appear.

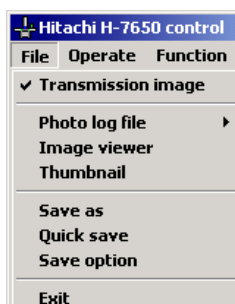



Fig. 3-5 File Menu

3.2.1 Transmission image (Type A only)

Upon startup of the system program, the Hitachi H-7650 control window and Transmission image window shown in Fig. 3-6 appear. The Transmission image window provides the moving picture display of TEM images and displays a static image after image capture.

The Transmission image window size is changeable. You can enlarge/reduce the window size as shown in Figs. 3-7 and 3-8 by clicking the  button on CCD control tab in the Hitachi H-7650 control window.

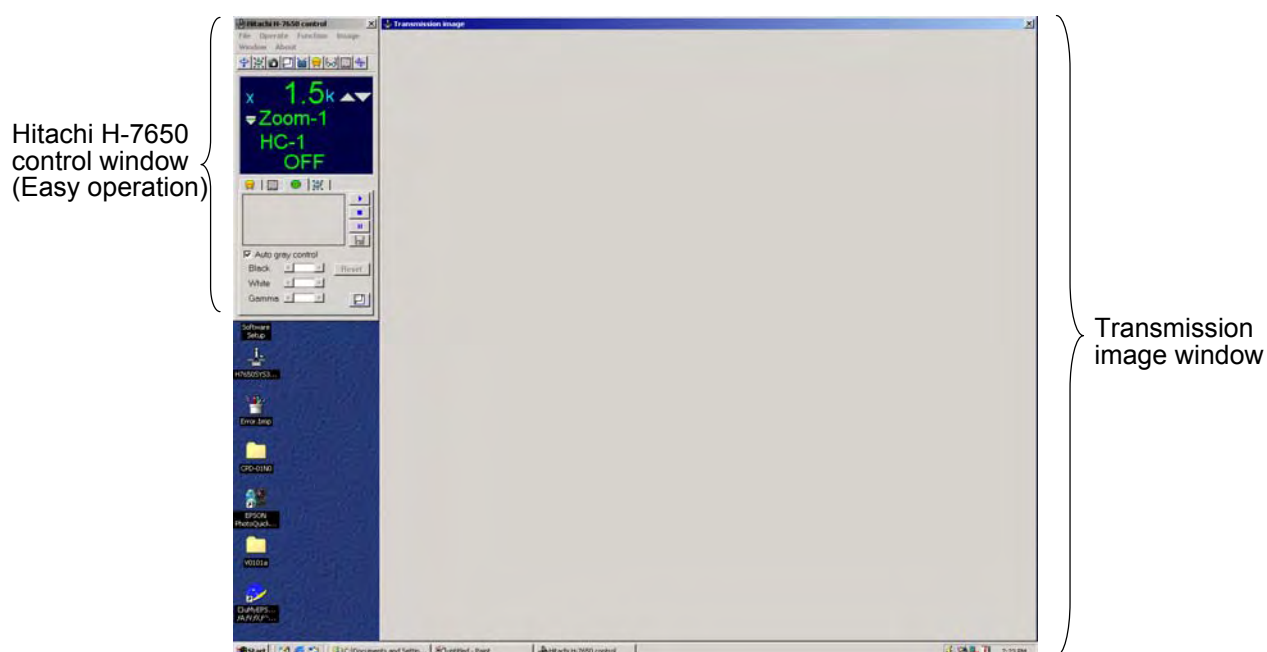


Fig. 3-6 Transmission image Window

3.2 File Menu (Hitachi H-7650 control window)

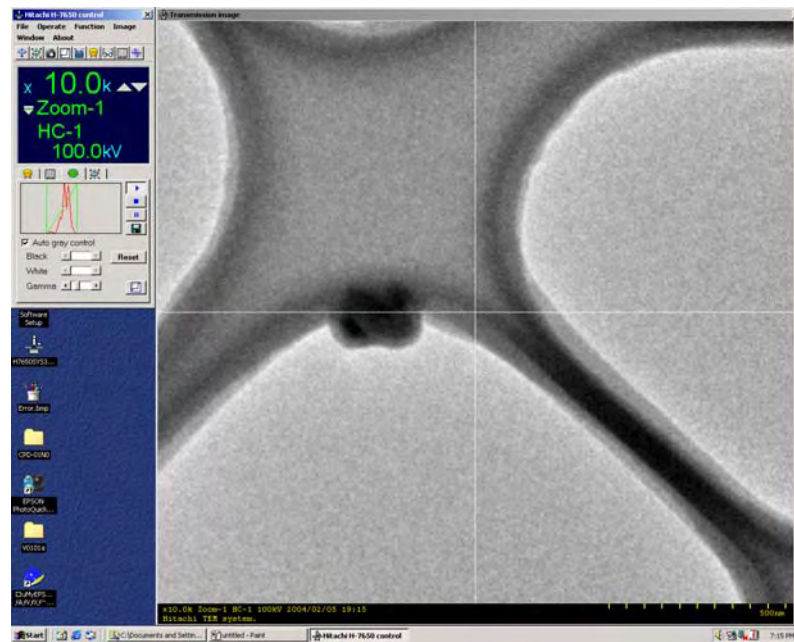


Fig. 3-7 Transmission image Window (Full display)

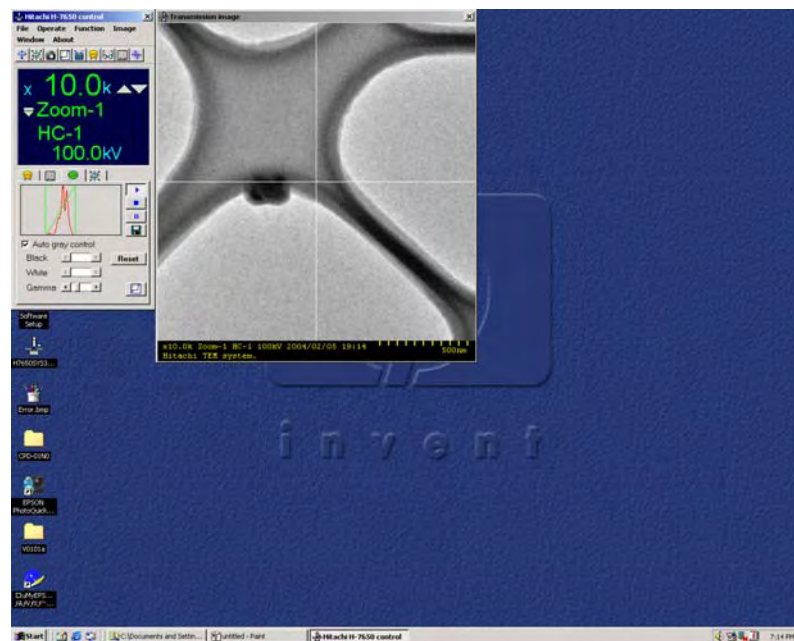


Fig. 3-8 Transmission image Window (Half display)

When you click the right button of the mouse on the Transmission image window, the pop-up menu shown in Fig. 3-9 appears. The window size can also be changed by selecting Size from the pop-up menu.

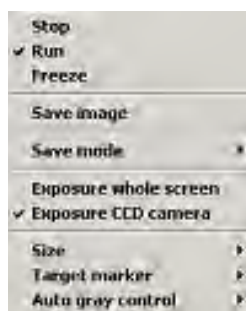


Fig. 3-9 Pop-up Menu

(1) Stop

Stops the moving picture display of TEM images and lowers the large-sized fluorescent screen (Whole screen). Use this command for observation on the fluorescent screen.

(2) Run

Starts the moving picture display of TEM images with the digital camera system.

(3) Freeze

Stops the moving picture display and captures an image.

(4) Save image

Saves the image captured with the Freeze function. When you select this command, the window shown in Fig. 3-10 opens. Specify a folder and file name, then click the Save button. To abandon the saving, click the Cancel button.

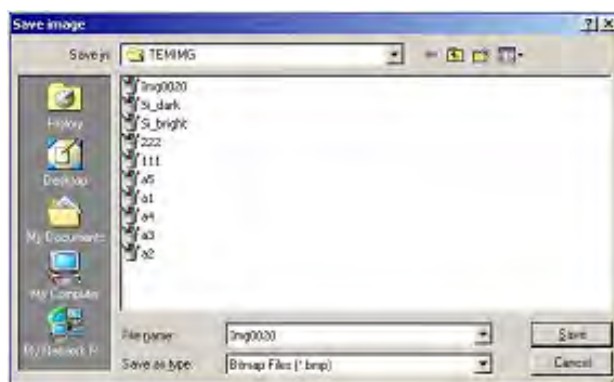


Fig. 3-10 Save image Window

3.2 File Menu (Hitachi H-7650 control window)

(5) Save mode

You can make settings for saving an image in which the photographic conditions and micron marker displayed at the bottom of the Transmission image window are embedded.

(a) Embed none

The photographic conditions and micron marker are not embedded in an image to be saved.

(b) CCArea embed

An image is saved with the photographic conditions and micron marker embedded the same as at the bottom of the Transmission image window.

(c) Property embed

An image is saved with its photographic data also embedded.

(6) Exposure whole screen

The main fluorescent screen is lowered to allow image observation on the fluorescent screen.

(7) Exposure CCD camera

The main fluorescent screen is raised to allow image observation and saving with the CCD camera.

CAUTION: In the Diff mode, protection is applied to prevent the spot beam from damaging the scintillator. When you conduct the operation for opening the main fluorescent screen, the system message shown in Fig. 3-11 will appear. Click OK, then open the main fluorescent screen in the ZOOM mode.

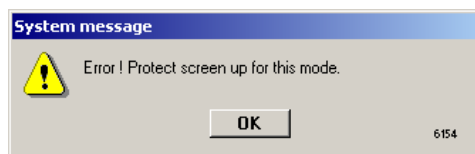


Fig. 3-11 System message Window

(8) Size

This is a function for changing the size of the Transmission image window.

(a) Full display

The Transmission image window is displayed in full size as shown in Fig. 3-7.

(b) Half display

The Transmission image window is displayed in half size as shown in Fig. 3-8.

The viewing area is the same as in the Full display mode. Only the display size is reduced.

(9) Target marker

This is a function for displaying a line that indicates the central location in the Transmission image window. Figure 3-12 shows an example of target marker display.

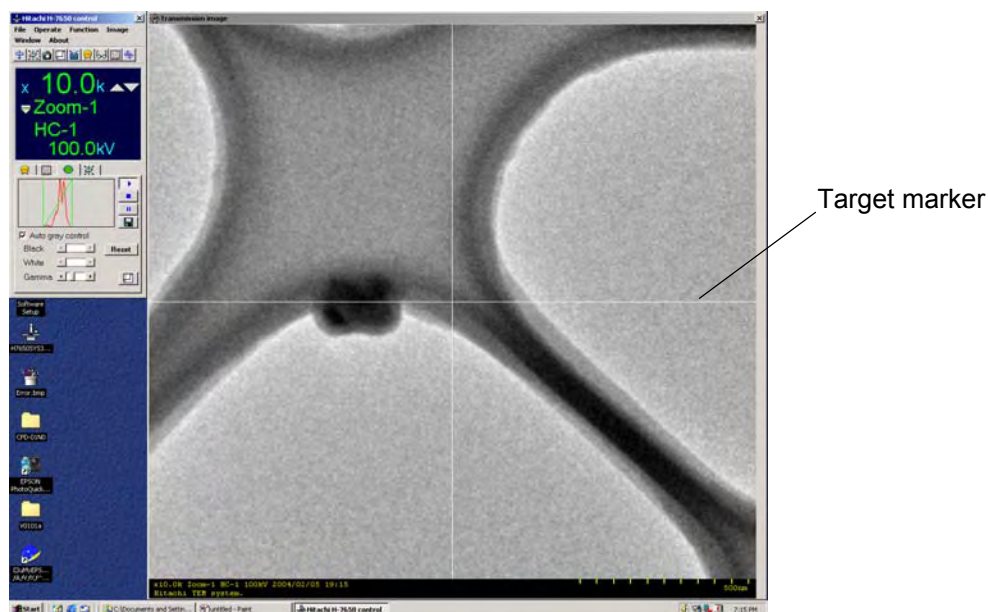


Fig. 3-12 Example of Target Marker Display

3.2 File Menu (Hitachi H-7650 control window)

(a) Off

Erases the target marker.

(b) White

Displays the target marker in white line.

(c) Black

Displays the target marker in black line.

(10) Auto gray control

You can specify automatic/manual brightness adjustment for the displayed image.

(a) OFF

Turns off the Auto gray control function to manually adjust the brightness of displayed image.

(b) ON

Turns on the Auto gray control function to automatically adjust the brightness of displayed image.

3.2.2 Photo log file (applicable only when sheet film camera (option) is set)

This function is available only when the optional film mechanism (film camera kit) is mounted. The function cannot be selected from the pull-down menu when the film mechanism is not provided.

The function is used for automatically saving photographic conditions in a log file at the time of photographing.

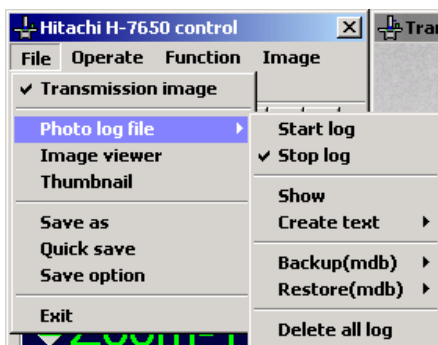


Fig. 3-13 Photo log file Menu

(1) Start log

When this command is checked, photographic conditions are automatically recorded in the Photo log file at the time of photographing.

(2) Stop log

When this command is checked, photographic conditions are not recorded in the Photo log file.

3.2 File Menu (Hitachi H-7650 control window)

(3) Show

Dragging this command will open the Photo log file window shown in Fig. 3-14. Note that Show remains gray and cannot be executed when Restore (mdb) is in execution or the Photo log file window has already opened.

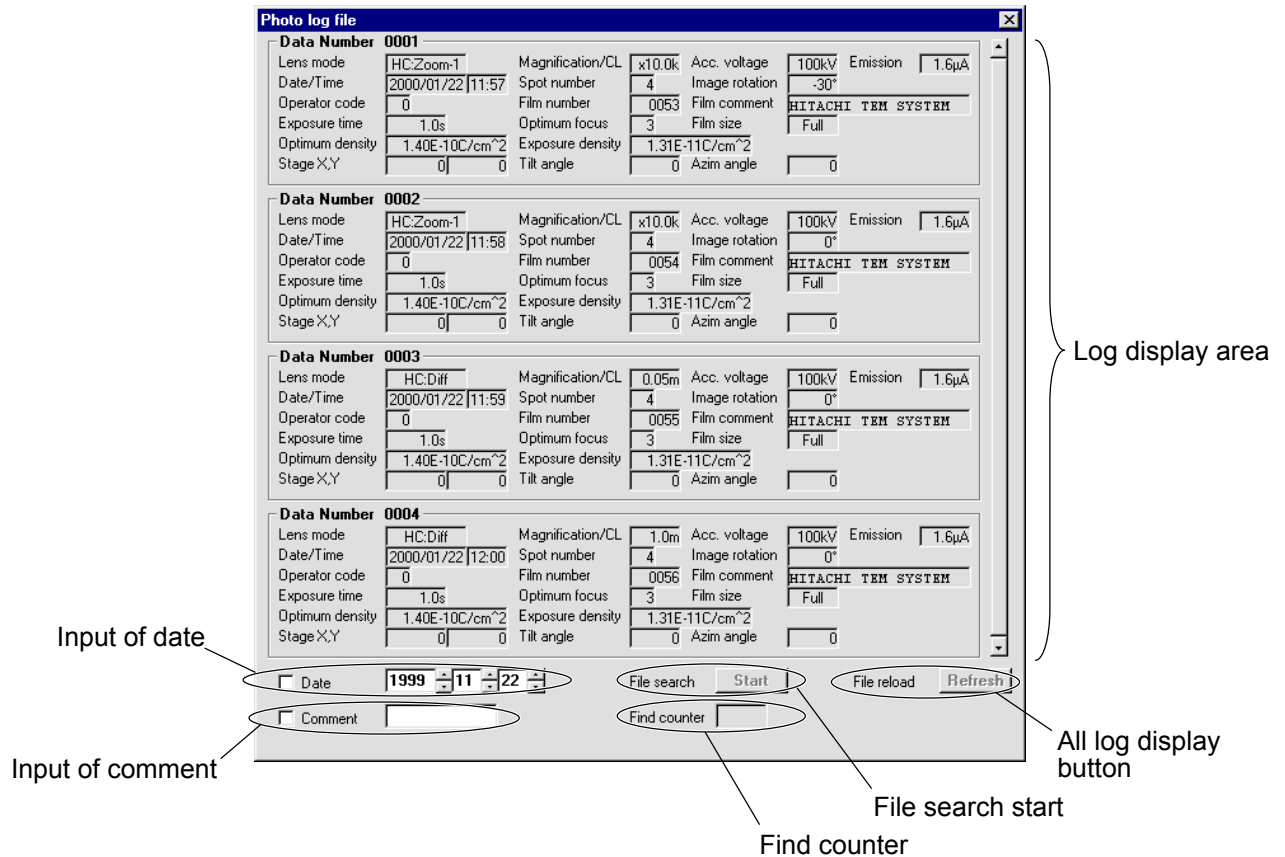


Fig. 3-14 Photo log file Window

In the Photo log file window, 4 photographic condition sets registered in the database are displayed in the ascending order of Data Number. When there are 5 or more photographic condition sets registered, the remaining ones can be seen in blocks of 4 sets by using the scroll bar.

In this window, the database is searched for a photographic condition set corresponding to the input Date and/or Comment.

The search function is explained below.

(a) Search by Date

- 1) Input a search condition in the Date input box using the keyboard or scroll bar. Date data is settable within 1.1.1 to 9999.12.31.
- 2) After input, press the Enter key to check if your setting is correct. If the setting is wrong, the input box becomes blank to validate it. For February, input of 29th day is effective regardless of year.
- 3) Search by Date is possible with the following keys: year, month and day. Any key can be excluded from the search conditions by leaving its input box blank.
- 4) After setting your search condition, put a check mark in the Date check box to validate the search condition. File Search Start is now executable.
- 5) Execute search by clicking the Start button. Note that the check mark will disappear from the check box and search will not be executed if all the search condition keys are blank.

(b) Search by Comment

- 1) Input a search condition in the Comment input box using the keyboard. Up to 8 characters can be input. The database can be searched for a photographic condition set containing the input character string.
- 2) After setting your search condition, put a check mark in the Comment check box to validate the search condition. File Search Start is now executable.
- 3) Execute search by clicking the Start button.

(c) Search by both Date and Comment

- 1) Set Date and Comment search conditions.
- 2) Put a check mark in each of the Date and Comment check boxes to validate the search conditions. File Search Start is now executable.
- 3) Execute search by clicking the Start button.
- 4) Upon execution of search, the photographic condition sets that match the search conditions are displayed in the ascending order of Date Number on the Photo log file window. File reload Refresh is now executable. Displayed in the Find counter indication box is the number of photographic condition sets that match the search conditions.
- 5) Clicking the Refresh button will return the Photo log file window to the initial status, excluding Date and Comment search conditions.
- 6) If you attempt to photograph an image and register the photographic conditions in the database with the Photo log file window open, the latest photographic conditions will be indicated after photographing.

3.2 File Menu (Hitachi H-7650 control window)

(4) Create text

Select Create text from the File menu, and a new set of commands will appear as shown in Fig. 3-15.

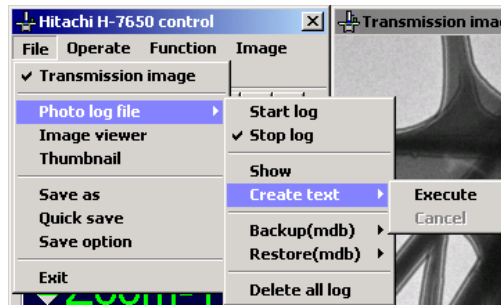


Fig. 3-15 Create text Menu

(a) Execute

A text file of photographic conditions can be created. However, Create text cannot be executed when any of Create text, Backup (mdb) and Restore (mdb) is being executed or the System message window for Delete all log is displayed.

(b) During creation of a text file, the main window displays a message “Execute creating photo log text files.” and a progress bar. Text file creation is completed when the progress bar indication reaches 100%. After completion, a message “Create photo log text files successful.” is displayed. After 1.5 seconds, the message and progress bar disappear. Note that photographing is impossible during creation of a text file.

(c) Cancel

For halting creation of a text file, select Cancel.

(d) When a text file creation is successful, a text file named photo_sp.txt or photo_tb.txt is created. Photo_sp.txt stands for a file whose data is separated by space, and photo_tb.txt stands for a file whose data is separated by tab.

(5) Backup (mdb)

Select Backup (mdb) from the File menu shown in Fig. 3-16, and a different set of commands will appear.

(a) Execute

Upon selection of Execute, the PHOTO LOG FILE BACKUP window opens to allow backup of a log file.

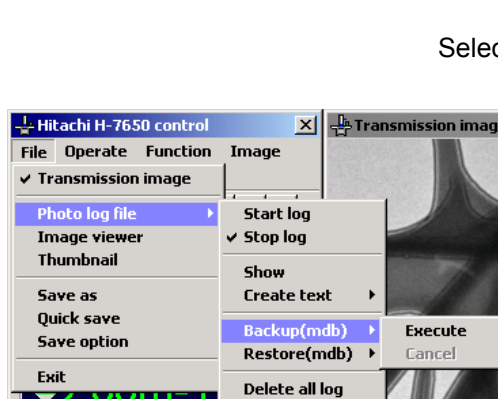


Fig. 3-16 Backup (mdb) Menu

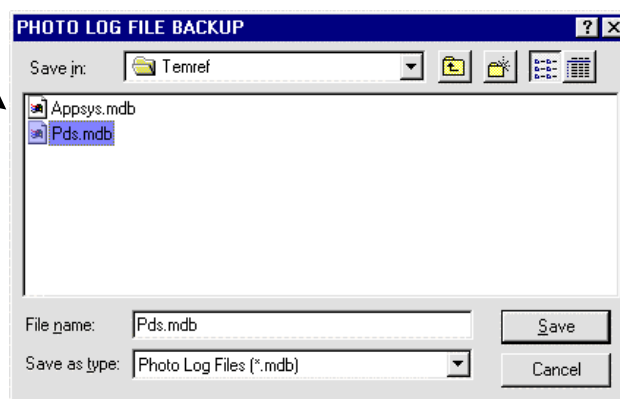


Fig. 3-17 PHOTO LOG FILE BACKUP Window

(b) Specify a saving location and file name and click the Save button. A new database and backup photo log table will be created and backup of photographic conditions will start. Note that backup is impossible when the file name is Appsys.mdb, Pds.mdb or it is invalid.

(6) Restore (mdb)

Select Restore (mdb) from the File menu shown in Fig. 3-18, and a different set of commands will appear.

(a) Execute

Upon selection of Execute, the Photo log file restore window opens.

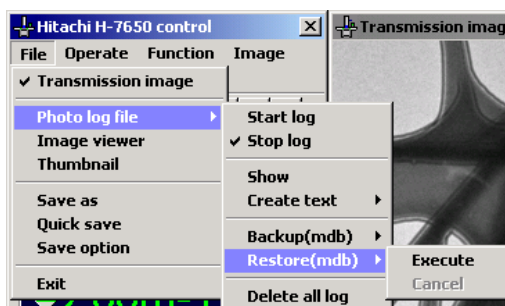


Fig. 3-18 Restore (mdb) Menu

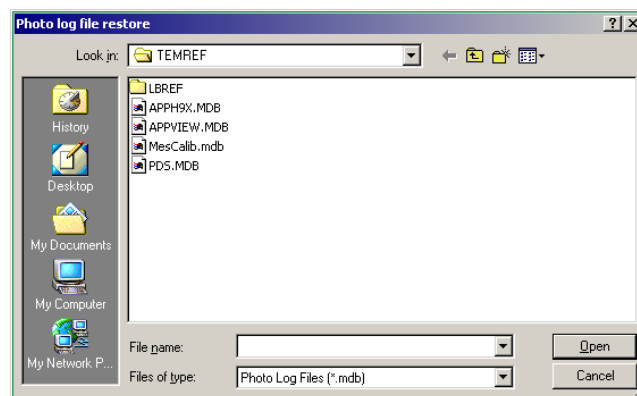


Fig. 3-19 Photo log file restore Window

3.2 File Menu (Hitachi H-7650 control window)

- (b) Determine the file name and click the Open button. Restoring of photographic conditions will start. Note that restoring is impossible when the file name is Appsys.mdb. If restoring is attempted in this case, the Photo log file restore window will close. Restoring is not possible either unless the file contains a backup photo log table even when its name is other than Appsys.mdb.
- (c) Cancel

For halting the restoring operation, select Cancel. When the operation is halted, the progress bar disappears and a message "Canceled execution!: 6320" appears. A restore photo log table under creation will be deleted and Appsys.mdb will be optimized.

(7) Delete all log

Upon selection of this command, the system message shown in Fig. 3-20 appears. Note that the command cannot be executed when any of Create text, Backup (mdb) and Restore(mdb) is being executed or the System message window has already opened.

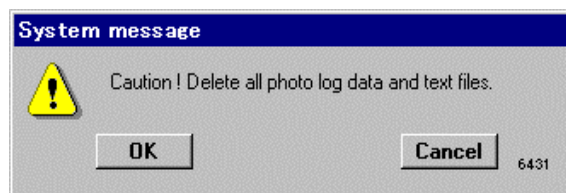


Fig. 3-20 System message Window

- 1) When the OK button is clicked, the photographic conditions and text file (photo_sp.txt or photo_tb.txt) are deleted and the System message window closes.
- 2) Clicking the Cancel button cancels the deletion of photo log data and text file and closes the System message window.

3.2.3 Image viewer(Type A only)

Described below is the procedure for activation of EM viewer. For the image processing procedure, refer to the separately issued instruction manual for EM viewer.

(1) Activation of EM Viewer

- (a) As shown in Fig. 3-21, select Image viewer from the File menu in the Hitachi H-7650 control window. The Open image window will appear. Select a file for image editing and click the Open button.

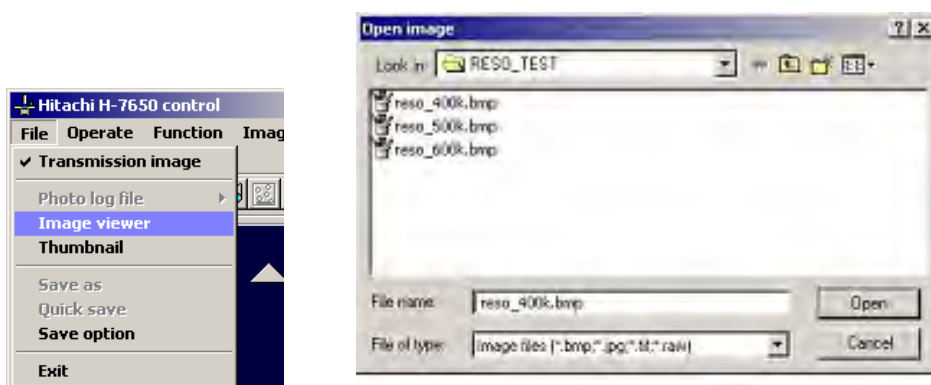


Fig. 3-21 Image viewer Menu and Open image Window

- (b) EM viewer is activated to display the selected image on the EM viewer window as shown in Fig. 3-22.

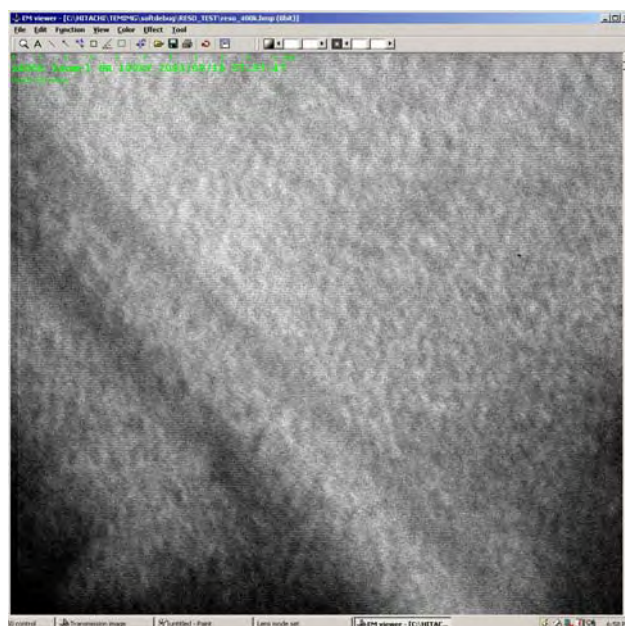


Fig. 3-22 EM viewer Window

3.2 File Menu (Hitachi H-7650 control window)

3.2.4 Thumbnail (Type A only)

Described below is the procedure for activation of Thumbnail. For the image management procedure, refer to the separately issued instruction manual for EM viewer.

(1) Activation of Thumbnail

- (a) As shown in Fig. 3-23, select Thumbnail from the File menu in the Hitachi H-7650 control window. The Open IDB (thumbnail) window will open. Listed IDB names stand for databases created at the time of image saving. They are especially referred to as IDB. Every image is managed in a master database for each folder. For the file name, a folder name is automatically registered. “#TEMIMG.mdb” is registered at default. In case of image saving in a different folder, a new master database is created for image management for the folder.

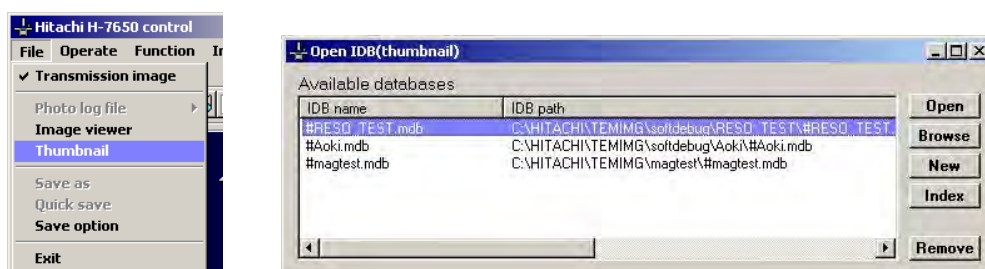


Fig. 3-23 Thumbnail Menu and Open IDB (thumbnail) Window

(b) Thumbnail

In Fig. 3-23, select an IDB name and click the Open button. The registered images will be displayed on the Thumbnail window as shown in Fig. 3-24.



Fig. 3-24 Thumbnail Window

3.2.5 Save as (Type A only)

This is a function for saving an image in the specified saving location and file name. Upon selection of Save as, the Save image window shown in Fig. 3-25 opens.

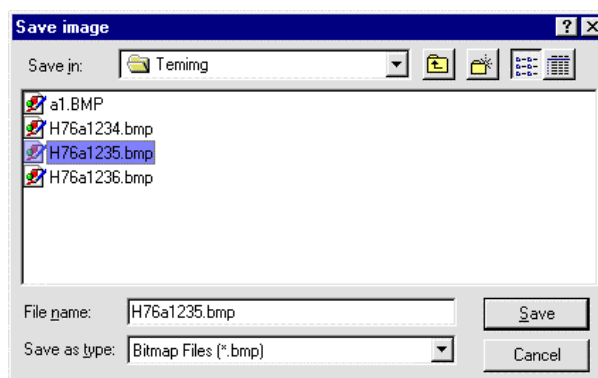


Fig. 3-25 Save image Window

- (1) When you click Save, the images captured with the digital camera are saved and the saved information are registered in the image database. Note that image saving is limited to the files in "c:\Hitachi\temimg" and "c:\Hitachi\imgdata".
- (2) The saved image is recorded with the date set by PC. And if an image is saved in the same file name as before, the capture conditions, etc. in the database will be updated.
- (3) Up to 9999 sets of data can be registered in the image database. Upon registration of the 9999th data, a message window appears.

3.2.6 Quick save (Type A only)

An image can be saved instantly without displaying the Save image window. Saving conditions are settable in the Save option window. For details, refer to 3.2.7.

3.2 File Menu (Hitachi H-7650 control window)

3.2.7 Save option (Type A only)

Image saving conditions are settable. Upon selection of this command, the Save option window opens.

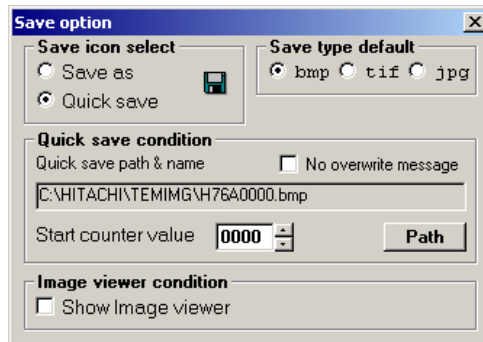



Fig. 3-26 Save option Window

(1) Save icon select

The function of the  button is settable by the radio button.

(a) Save as

Refer to 3.2.5.

(b) Quick save

Refer to 3.2.6.

(2) Save type default

The default file format of the image to be saved is settable by the radio button.

(a) bmp

(b) tif

(c) jpg

(3) Quick save condition

The image saving location and file name can be entered for execution of Quick save.

(a) Quick save path & name

The image saving location and file name for Quick save are indicated.

(b) No overwrite message

If the file name entered for saving is already used, a message box appears to caution you on overwriting. When a check mark is put in the No overwrite message check box by clicking, the image data will be overwritten and saved without displaying the message box.

(c) Start counter value

You can set an initial value of the total number of saved images using the scroll bar or keyboard.

(d) Path Button

When you click the Path button in the window, the Save image window shown in Fig. 3-25 opens. In this window, you can set an image saving location and file name.

(4) Image viewer condition

When a check mark is put in the Show image viewer check box by clicking, EM viewer is automatically activated to display the saved image on the EM viewer window at the time of saving.

3.2.8 Exit

- (1) Upon selection of this command, the System message dialog box opens.
- (2) Clicking the OK button will terminate the H-7650 system program.
- (3) Clicking the Cancel button will restore the H-7650 system program.

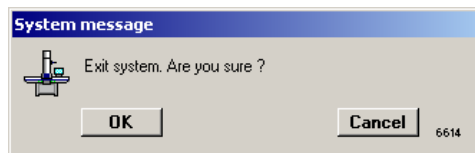


Fig. 3-27 System message Dialog Box

3.3 Operate Menu (Hitachi H-7650 control window)

3.3 Operate Menu (Hitachi H-7650 control window)

3.3.1 Observation

Select Observation from the Operate menu, and a new set of commands will appear as shown in Fig. 3-28.

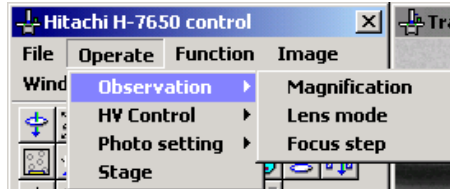


Fig. 3-28 Observation Menu

(1) Magnification

- (a) Clicking Magnification in the Operate menu shown in Fig. 3-29 will open the enlarged magnification display window in Fig. 3-30. In the Zoom or LOW MAG mode, the magnification is indicated, but the camera length is indicated in the ZIFF mode. Image rotation is effective in a magnification range of $\times 1,000$ to $\times 40,000$ in the HC mode.



Fig. 3-29 Magnification Menu

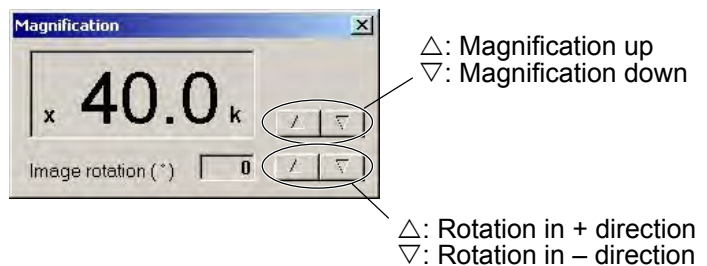


Fig. 3-30 Magnification Window

- (b) Double-clicking on section A in Figs. 3-31 and 3-32 will call the enlarged magnification display window the same as in (a).

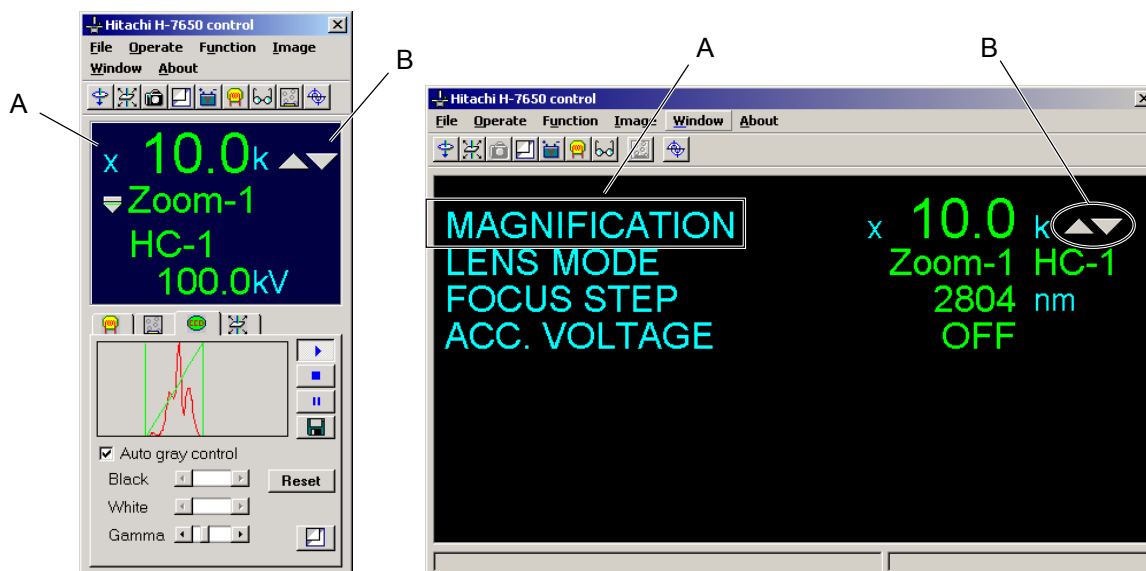


Fig. 3-31 Easy operation Window

Fig. 3-32 Close-up information Window

- (c) The magnification value can be changed by clicking the manual change buttons in the window (section B in Figs. 3-31 and 3-32).

(2) Lens mode

- (a) Clicking Lens mode in the Operate menu shown in Fig. 3-33 will open the Lens mode set window in Fig. 3-34. In the Zoom or LOW MAG mode, HC or HR condition is indicated.

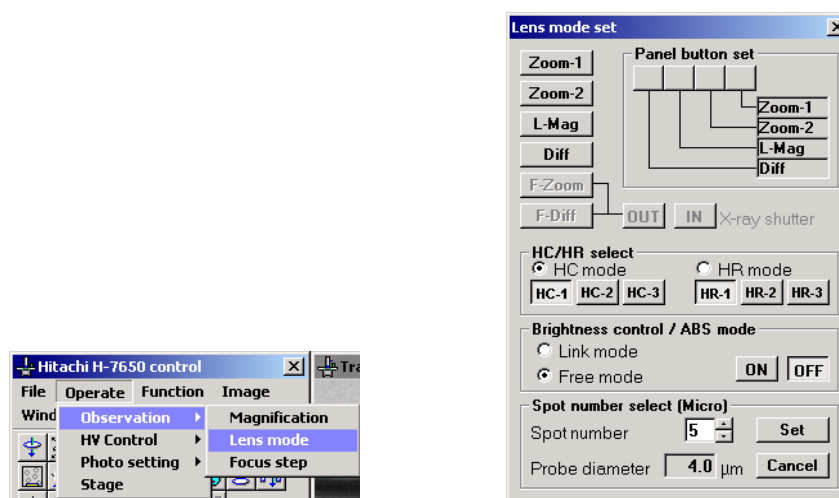


Fig. 3-33 Lens mode Menu

Fig. 3-34 Lens mode set Window

3.3 Operate Menu (Hitachi H-7650 control window)

- (b) Double-clicking on section A in Figs. 3-35 and 3-36 will open the Lens mode set window the same as in (a).

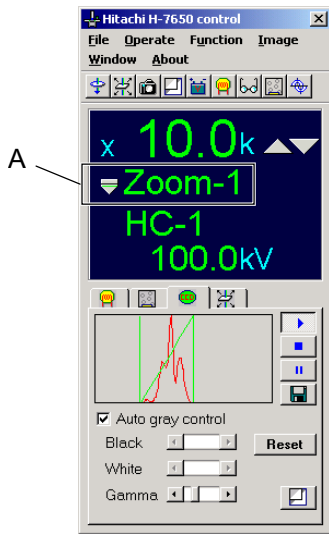


Fig. 3-35 Easy operation Window

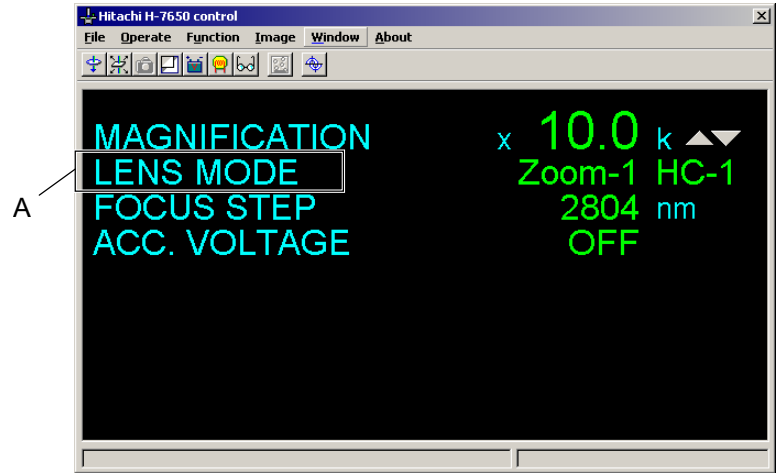


Fig. 3-36 Close-up information Window

- (c) The lens mode is selectable by clicking the relevant lens mode button shown in Fig. 3-37. Note, however, that the grayed option modes cannot be selected.

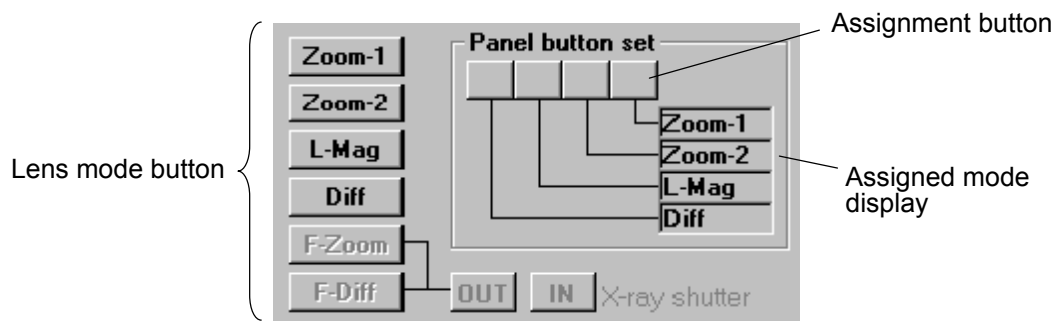
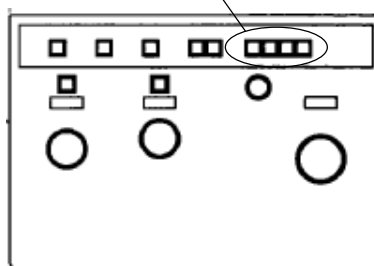


Fig. 3-37 Lens Mode Button

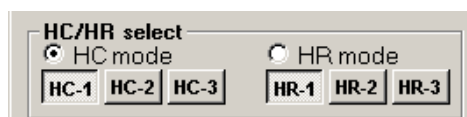
- (d) You can assign a desired mode to the lens mode selector switch in the following procedure.

- 1) Select a lens mode selector switch shown (Fig. 3-38), to which a mode is to be assigned, by the assignment button (Fig. 3-37). The pressed status of this button means that it is selected.

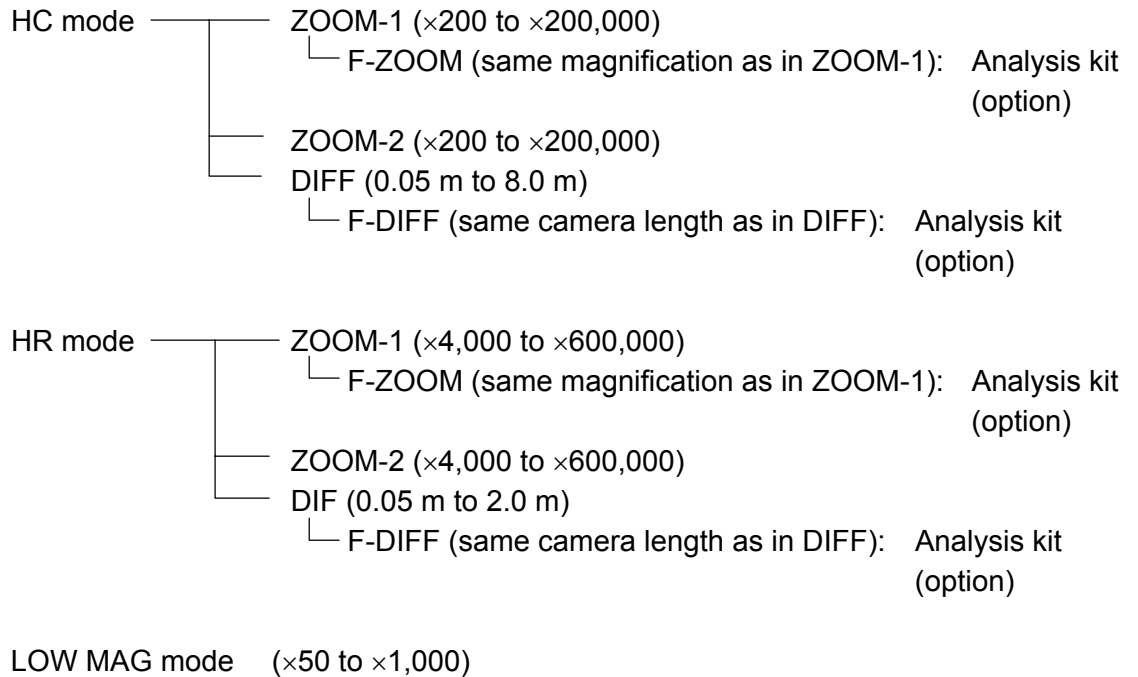
Lens mode selector switch

**Fig. 3-38 Left Operation Panel**

- 2) Then, click a lens mode button for mode assignment. The lens mode cannot be changed by clicking the assignment button.
 - 3) When you click the selected assignment button again, the assignment function is released. The assigned mode remains stored in memory even after turning off the power supply.
- (e) In the ZOOM and DIFF modes, HC or HR mode is selectable by the radio button in the HC/HR select group shown in Fig. 3-39. Appearance of a dot in the center of each radio button denotes selection of the button. For each of the HC and HR modes, 3 BD systems (BH, BT) are selectable (HC-1, HC-2, HC-3, HR-1, HR-2 and HR-3 switches in Fig. 3-39).

**Fig. 3-39 HC/HR select Group**

3.3 Operate Menu (Hitachi H-7650 control window)



(f) Brightness control/ABS mode

In the Free mode, the brightness (C2 lens current) is constant at different magnifications.

In the Link mode, the brightness (C2 lens control) is controlled so as to be constant at magnifications of $\times 2,000$ to $\times 40,000$ in the HC mode.

ABS is a function for controlling the current value on the fluorescent screen so as to provide a suitable brightness for the exposure level on a film. FULL film size alone is effective.

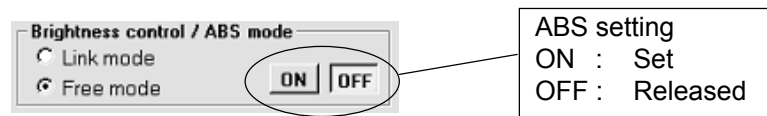


Fig. 3-40 Brightness control/ABS mode Group

(g) Spot number select (Micro)

The spot size can be changed. Specify a new spot number and then click the Set button.

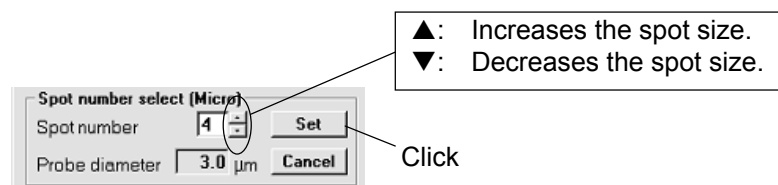


Fig. 3-41 Spot number select (Micro) Group

(3) Focus step

- (a) Clicking Focus step in the Operate menu shown in Fig. 3-42 will open the Focus step/Defocus amount set window in Fig. 3-43. In this window, a shift of focal point due to one step of the FOCUS knob (Fig. 3-44) is displayed. This shift is automatically set for the selected magnification. It is also possible to set a desired focus step value and defocus amount display function.

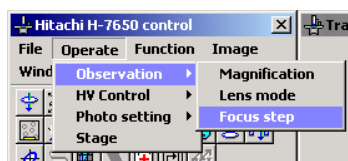


Fig. 3-42 Focus step Menu

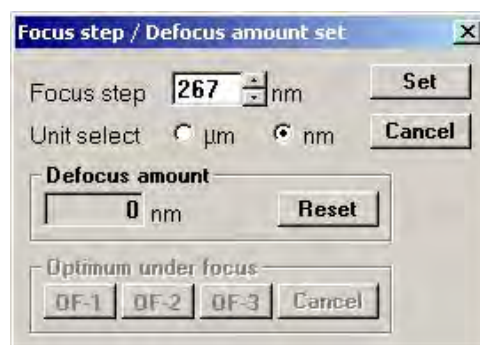


Fig. 3-43 Focus step/Defocus amount set Window

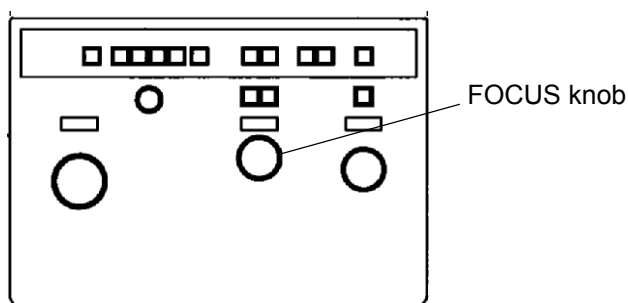


Fig. 3-44 Right Operation Panel

- (b) The amount of defocus from the current in-focus status is displayed in the Defocus amount indication box shown in Fig. 3-45.

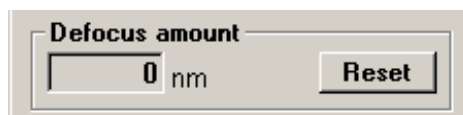


Fig. 3-45 Defocus amount Indication Box

3.3 Operate Menu (Hitachi H-7650 control window)

- (c) Double-clicking on section A in Fig. 3-46 will open the Focus step/Defocus amount set window the same as in (a).

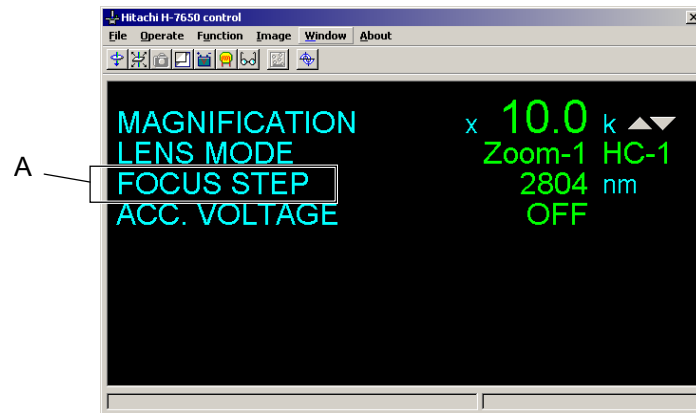


Fig. 3-46 Close-up information Window

How to Set Focus Step

- 1) Select either nm or μm unit by the Unit select button.



Fig. 3-47 Unit select Buttons

- 2) Input a step value in the data input box using the scroll bar or keyboard. Input is allowed within 1 to 9999 nm or 1 to 50 μm .

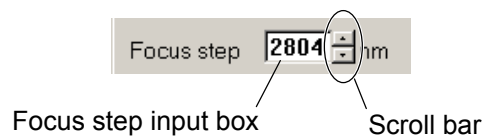


Fig. 3-48 Focus step Input Box

- 3) For registration of the input value, press the Set button. If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed.

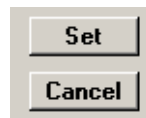


Fig. 3-49 Set/Cancel Buttons

- 4) When you change the magnification, the focus step value is reset and the preset value is taken.
- (d) Defocus Amount Display

Whenever turning the FOCUS knob on the right operation panel shown in Fig. 3-44, the corresponding defocus amount is displayed. When you want to know the defocus amount with reference to the present in-focus status, reduce the indication of defocus amount to 0 nm by pressing the Reset button. After that, change the focus by the FOCUS knob (Fig. 3-44), and a defocus amount will be displayed. In defocus amount display, a sign “+” indicates underfocus and “-” stands for overfocus.

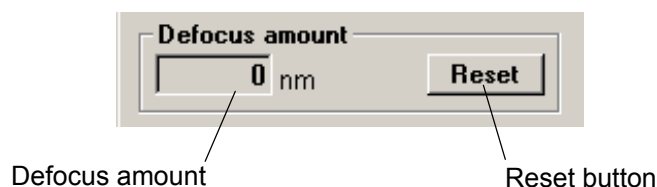


Fig. 3-50 Defocus amount Indication box

- (e) Optimum under focus (when optional film mechanism is provided)
- 1) When the optional film mechanism is set, display of the Optimum under focus group area becomes effective as shown in Fig. 3-52. Click any of OF-1, OF-2 and OF-3 buttons in the Optimum under focus group. The pressed status will be displayed.
 - 2) For releasing the optimum focus function, click the OF button which is pressed.
 - 3) The optimum focus level is linked with the magnification as shown in Fig. 3-51. You can select an optimum level according to the magnification and specimen. The optimum focus level changes with the film enlarging ratio and defocus amount, so set a value that appears to be optimum.

3.3 Operate Menu (Hitachi H-7650 control window)

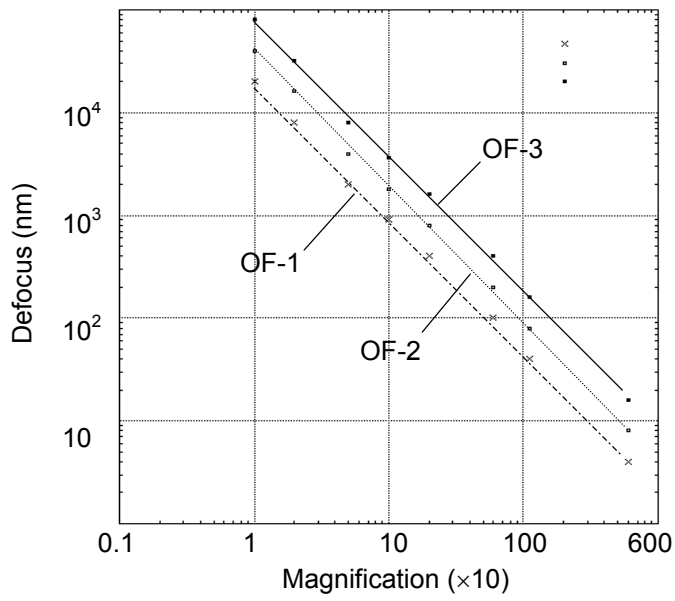


Fig. 3-51 Optimum Underfocus and Magnification

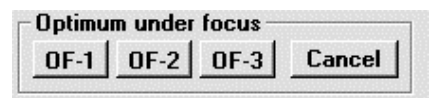


Fig. 3-52 Optimum under focus Group

3.3.2 HV Control

Select HV Control from the Operate menu, and a new set of commands will appear as shown in Fig. 3-53. You can make settings for the accelerating voltage, filament and bias.

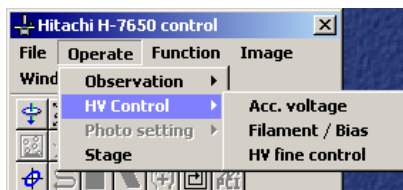


Fig. 3-53 HV Control Menu

(1) ACC. voltage

Clicking ACC. voltage in the Operate menu shown in Fig. 3-54 will open the Acc. voltage control window in Fig. 3-55. In this window, you can turn on/off the accelerating voltage, assign a preset value of accelerating voltage and execute flashing as described below.

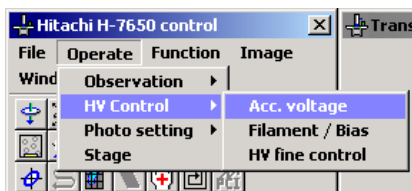


Fig. 3-54 Acc. Voltage Menu

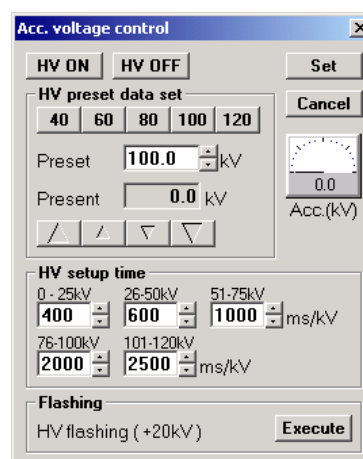


Fig. 3-55 Acc. voltage control Window

(a) Turning On/Off Accelerating Voltage

Upon clicking the HV ON button in the Acc. voltage control window, the preset accelerating voltage (refer to (b) below) is applied. The voltage turns off when you click the HV OFF button.



Fig. 3-56 HV ON/OFF Buttons

3.3 Operate Menu (Hitachi H-7650 control window)

(b) How to Assign a Preset Value of Accelerating Voltage

- 1) Enter a preset voltage in the Preset data input box within 0.1 to 120.0 kV (in 0.1 kV steps) with the scroll bar or keyboard. Or specify a preset voltage by clicking the 40, 60, 80, 100 or 120 kV preset button (20 kV step).

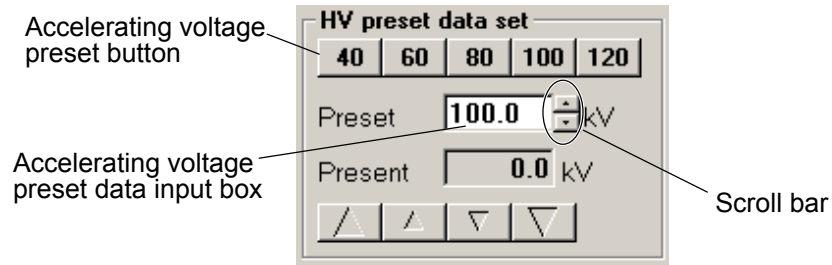


Fig. 3-57 HV preset data set Group

- 2) For registration of the input value, press the Set button. If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed. Once a preset voltage has been assigned, it is automatically applied just by pressing the HV key.

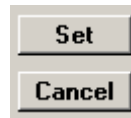


Fig. 3-58 Set/Cancel Buttons

(c) How to Operate Accelerating Voltage Manually

- 1) The accelerating voltage can be stepped up and down by clicking the manual setting buttons in the HV preset data set group.

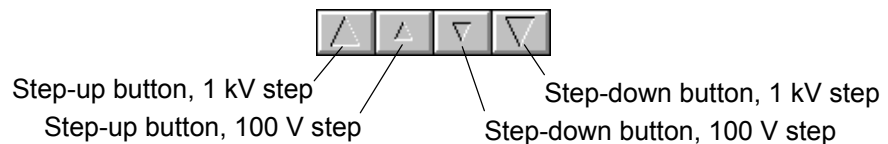


Fig. 3-59 Manual Setting Buttons for Accelerating Voltage

- 2) The current accelerating voltage value is displayed in the Present data indication box.

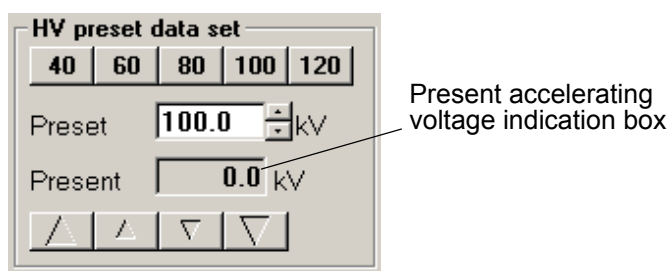


Fig. 3-60 HV preset data set Group

- 3) The manually set accelerating voltage value is reset by turning off the accelerating voltage once. When the voltage is turned on again, the HV preset voltage will be applied.
- (d) How to Set Automatic Accelerating Voltage Setup Time
- 1) This time is settable in the data input box for each accelerating voltage range in the HV setup time group. Set your data using the scroll bar or keyboard.

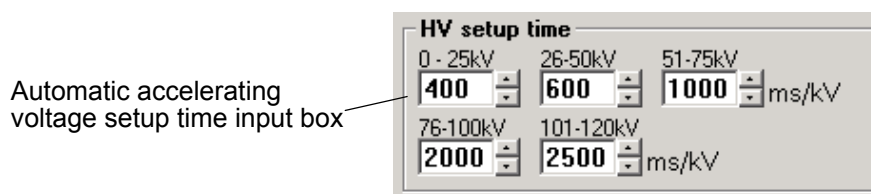


Fig. 3-61 HV setup time Group

- 2) Table 3-2 shows the settable automatic voltage setup time in each accelerating voltage range. The time is settable in steps of 1 ms/kV.

Table 3-2 Automatic Voltage Setup Time

Accelerating Voltage Range (kV)	Settable Time (ms/kV)	Initial Value (ms/kV)
0 to 25	20 to 2500	400
26 to 50	30 to 2500	600
51 to 75	40 to 2500	1000
76 to 100	50 to 2500	2000
101 to 120	60 to 2500	2500

3.3 Operate Menu (Hitachi H-7650 control window)

(e) Flashing Procedure

- 1) When you click the Execute button in the Flashing group, a flashing voltage of 20 kV is output in addition to the present HV. Note, however, that no flashing voltage will be output when the accelerating voltage is at 0 kV.

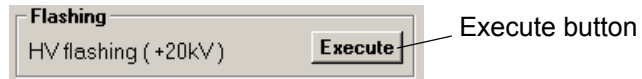


Fig. 3-62 Flashing Group

- 2) The indicator on the status bar changes during the flashing operation.
- 3) Execution of flashing will entail cancellation of FINE voltage output (refer to 3.3.2 (3)) or HV MODULATION when it is active.
- 4) For execution of flashing, make sure that the Fil. Current ON/OFF button is turned off and then click the Execute button.

(2) Filament/Bias

Clicking Filament/Bias in the Operate menu shown in Fig. 3-63 will open the Filament/Bias control window in Fig. 3-64. In this window, you can assign preset values of filament voltage and bias voltage, perform manual voltage setting and make settings for the total filament ON time and emission current (automatic emission current control function).

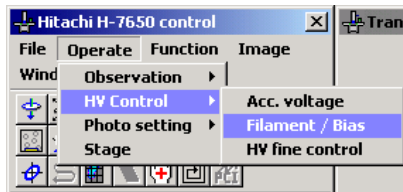


Fig. 3-63 Filament/Bias Menu

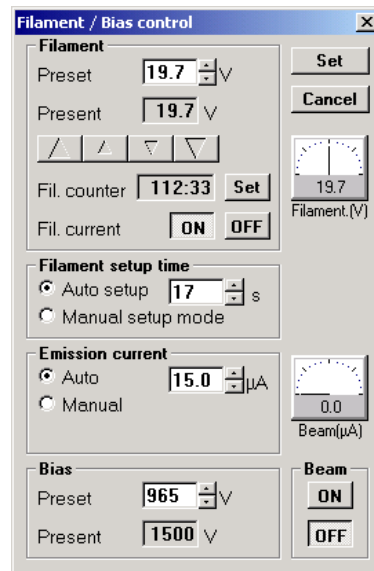
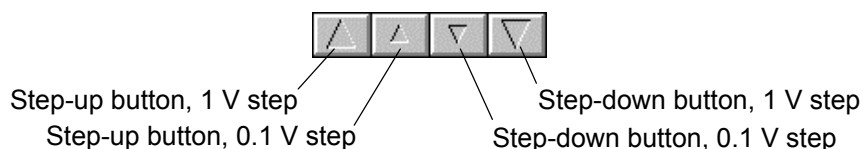


Fig. 3-64 Filament/Bias control Window

(a) How to Change Filament Voltage

- 1) The current filament voltage value is displayed in the Present data indication box.
- 2) You can step up and down the filament voltage by clicking the manual change buttons in the Filament group.

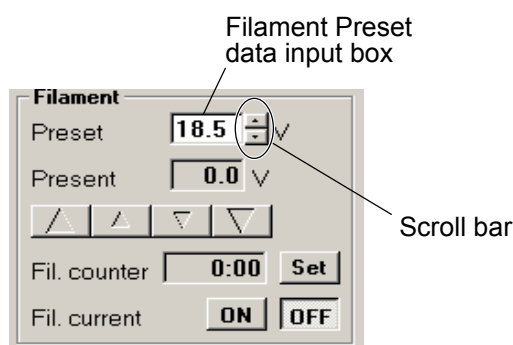
**Fig. 3-65 Manual Change Buttons for Filament Voltage**

- 3) The manually set filament voltage value is reset by turning off the accelerating voltage once. When the filament voltage is turned on again, the preset voltage will be applied.

(b) How to Assign a Preset Value of Filament Voltage

The filament voltage rises to the preset level when the filament is turned on after application of an accelerating voltage.

- 1) Assign a preset value of filament voltage in the Preset data input box in the Filament group. The preset value can be assigned within 0.0 to 40.0 V (in 0.1 V steps) using the scroll bar or keyboard. In case of the LaB₆ filament, its maximum preset value is marked on the container. In filament voltage setting, the value should be input.

**Fig. 3-66 Filament Group**

3.3 Operate Menu (Hitachi H-7650 control window)

- 2) For registration of the input value, press the Set button after assignment in above step 1). If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed.

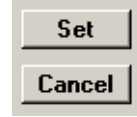
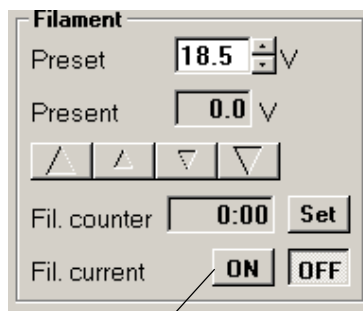


Fig. 3-67 Set/Cancel Buttons

- 3) For output of the preset filament voltage, click the Fil. Current ON button in the Filament group. When Auto setup is selected in the Filament setup time group (Auto setup mode), the preset voltage can be output by pressing the HV switch (Fig. 3-69) again. In the Auto setup mode, the filament voltage automatically rise to the preset level after application of an accelerating voltage. For turning off the filament voltage, click the Fil. Current OFF button or turn off the accelerating voltage.



Fil. Current ON/OFF Buttons

Fig. 3-68 Filament Group

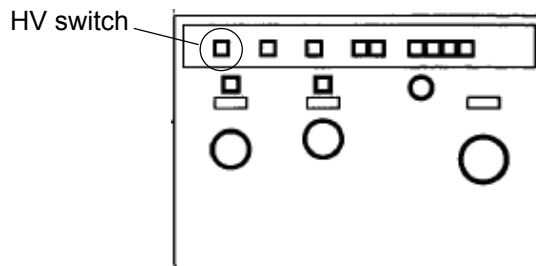


Fig. 3-69 Left Operation Panel

- 4) When you assign a preset value of filament voltage and select the Auto setup mode, the filament voltage will automatically rise after application of an accelerating voltage.

(c) How to Set Total Filament ON Time

The total filament ON time is displayed in the Fil. counter indication box. The time should be reset after filament exchange.

- 1) Click the Set button, and the total filament ON time setting mode will start.

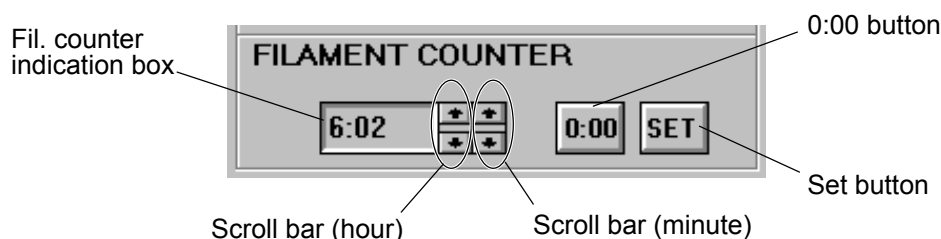


Fig. 3-70 Total Filament ON Time Setting Mode

- 2) When you press the 0:00 button, the total filament ON time is reset to 0:00. For changing to a desired time, input is allowed within 0:00 to 999:59 (999 hours and 59 minutes) (in 1 hour and 1 minute steps) using the scroll bar or keyboard.
- 3) Clicking the Set button registers the data entered in step 2) and terminates the total filament ON time setting mode.
- 4) When the total filament ON time exceeds 999:59, it returns to 0:00.

(d) How to Set Filament Voltage Setup Time

You can set a filament voltage setup time and mode (auto or manual) after application of an accelerating voltage.

- 1) Enter a filament voltage setup time in the Setup time input box in the Filament setup time group. The time is settable within 5 to 999 sec (in 1 sec steps) using the scroll bar or keyboard.

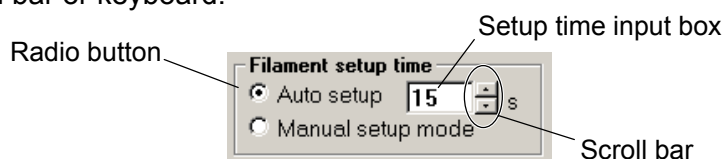


Fig. 3-71 Filament setup time Group

- 2) When Auto setup is selected in the Filament setup time group, the filament voltage automatically turns on and rises to the preset level after application of an accelerating voltage.

3.3 Operate Menu (Hitachi H-7650 control window)

- 3) When Manual setup mode is selected in the Filament setup time group, the filament voltage turns on and automatically rises to the preset level by clicking the Fil. current ON button in the Filament group after application of an accelerating voltage.
- 4) All the settings in steps 1) to 3) can be registered by clicking the Set button.

(e) How to Assign a Preset Value of Bias Voltage

The preset bias voltage is applied when the filament is turned on after application of an accelerating voltage.

- 1) Assign a preset value of bias voltage in the Preset voltage input box in the Bias group. The preset value can be assigned within 0 to 1500 V with the scroll bar or keyboard. The maximum bias voltage value is linked with the accelerating voltage and it is obtainable by the following equation.

$$\text{Maximum value} = E \times (1 + 0.9785 \times 10^{-6} \times E) / 258.71$$

When the accelerating voltage is 100 kV, a value of 100×10^3 needs to be substituted for E in the equation.

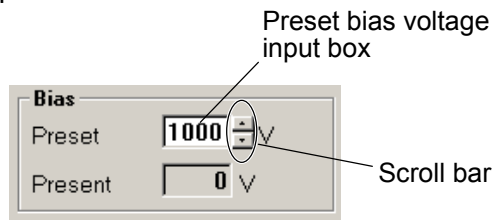


Fig. 3-72 Bias Group

- 2) For registration of the input value, press the Set button. If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed.

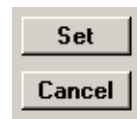


Fig. 3-73 Set/Cancel Buttons

- 3) The bias voltage automatically rises to the preset level in linkage with application of an accelerating voltage.

- 4) Upon clicking the OFF button in the Beam group, the bias voltage becomes maximum and the beam current no longer flows. For output of the preset voltage, click the ON button in the Beam group. When Auto is selected in the Filament current group, the preset voltage can be output by pressing the HV switch again.



Fig. 3-74 Beam Group

(f) How to Set Bias Voltage Manually

- 1) The bias voltage can be stepped up and down by the manual setting buttons displayed when Manual is selected in the Filament current group. The variation width of bias voltage is linked with the accelerating voltage. The following step values are available at an accelerating voltage of 100 kV.

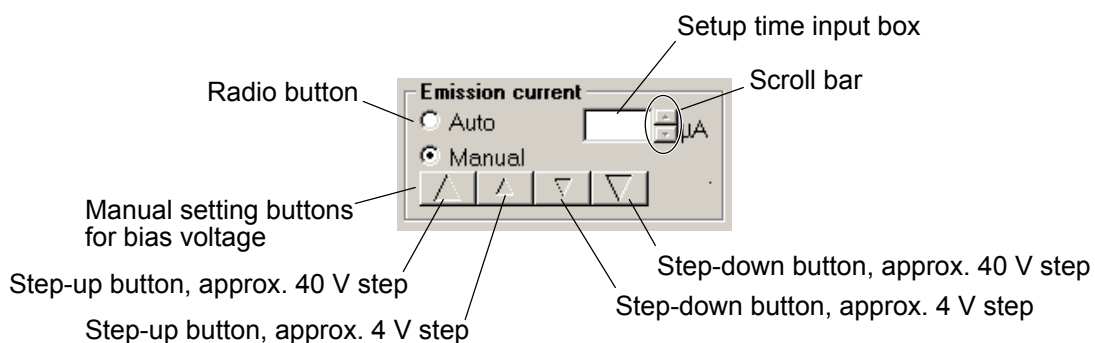


Fig. 3-75 Emission current Group

- 2) The current bias voltage value is displayed in the Present bias voltage indication box in the Bias group.

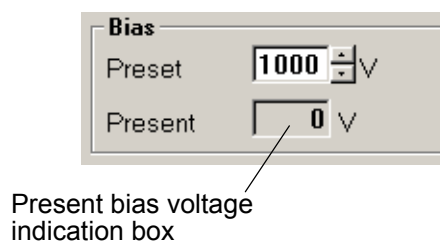


Fig. 3-76 Bias Group

3.3 Operate Menu (Hitachi H-7650 control window)

- 3) The manually set bias voltage value is reset by turning off the accelerating voltage once. When the bias voltage is turned on again, the preset voltage will be applied.

(g) Automatic Emission Current Control Function (AECC)

AECC is a function for automatically correcting the bias voltage so that the emission current is output at the constant level.

- 1) Select Auto in the Emission current group and input an emission current value in the input box. After input, click the Set button at the top right of the window.

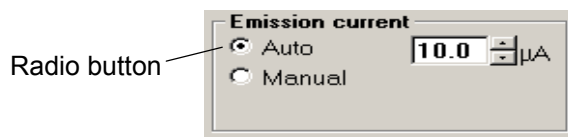


Fig. 3-77 Emission current Group

- 2) AECC is started shortly after a filament voltage turns on following application of an accelerating voltage.
- 3) When the beam is turned off, AECC will be canceled. When the beam is turned on again, AECC will be restarted.
- 4) When you select Manual in the Emission current group, AECC is released to allow manual setting of an emission current.

(3) HV fine control

Clicking HV fine control in the Operate menu shown in Fig. 3-78 will open the HV fine control window in Fig. 3-79. HV fine control is a function for changing the accelerating voltage (main accelerating voltage) set in the Acc. voltage control window in a range of -2048 to 2047 V (in 1 V steps) (sub accelerating voltage).



Fig. 3-78 HV fine control Menu

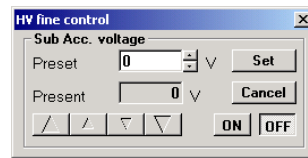
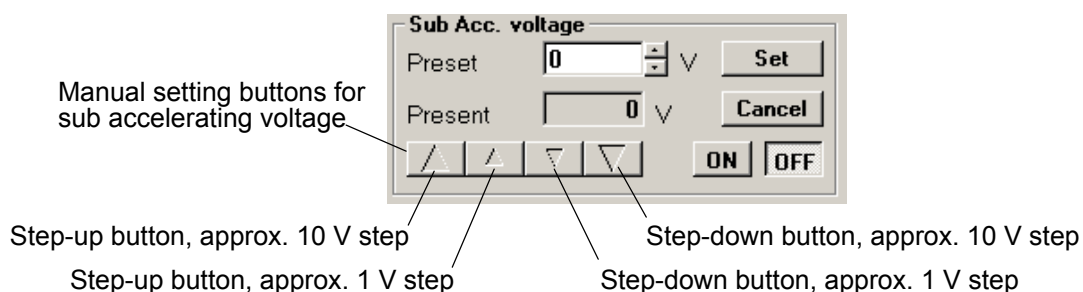


Fig. 3-79 HV fine control Window

(a) How to Set Sub Accelerating Voltage Manually

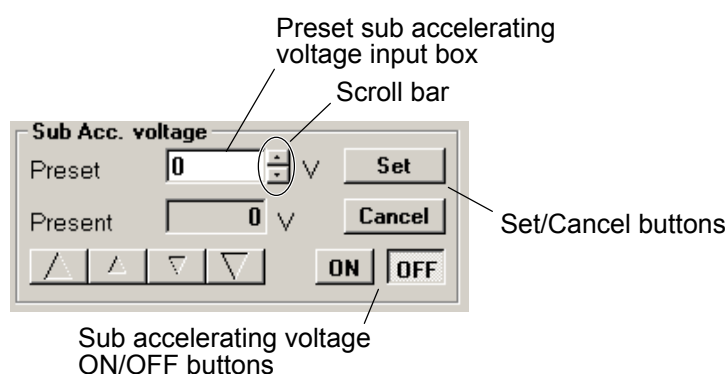
- 1) The sub accelerating voltage can be stepped up and down by clicking the manual setting buttons in the Sub Acc. voltage group. (These buttons do not function when the accelerating voltage is turned off).

**Fig. 3-80 Sub Acc. voltage**

- 2) The current sub accelerating voltage value is displayed in the Present data indication box.
- 3) The manually set sub accelerating voltage is reset by turning off the accelerating voltage once. When the accelerating voltage is turned on again, the sub accelerating voltage is not output.

(b) How to Assign a Preset Value of Sub Accelerating Voltage

- 1) Assign a preset value of sub accelerating voltage in the Preset data input box in the Sub Acc. voltage group. The preset value can be assigned within -2048 to 2047 V using the scroll bar or keyboard.

**Fig. 3-81 Sub Acc. voltage Group**

- 2) For registration of the input value, press the Set button. If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed.

3.3 Operate Menu (Hitachi H-7650 control window)

- 3) For output of the preset voltage, click the sub accelerating voltage ON button in the Sub Acc. Voltage group. For turning off the sub accelerating voltage, click the sub accelerating voltage OFF button or turn off the accelerating voltage.
- 4) The sub accelerating voltage turns off if HV Modulation or Flashing is used during application of the voltage.

3.3.3 Photo setting (applicable only when sheet film camera (option) is set)

Select Photo setting from the Operate menu, and a new set of commands will appear as shown in Fig. 3-82. You can set conditions necessary for image observation.

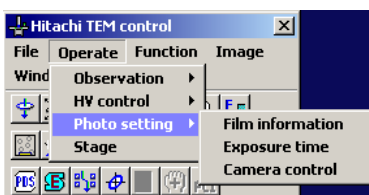


Fig. 3-82 Photo setting Menu

- (1) Film information

Clicking Film information in the Operate menu shown in Fig. 3-83 will open the Film information window in Fig. 3-84. This window is also called by double-clicking section A in Fig. 3-85. In the window, you can set the information to be printed on a film such as operator code and serial film number. In addition, the film size is settable here. Figure 3-85 shows a window displayed when the optional sheet film camera is provided. When the option is not provided, the window displays MAGNIFICATION (CAMERA LENGTH), LENS MODE, FOCUS STEP and ACC. VOLTAGE alone.



Fig. 3-83 Film information Menu



Fig. 3-84 Film information Window

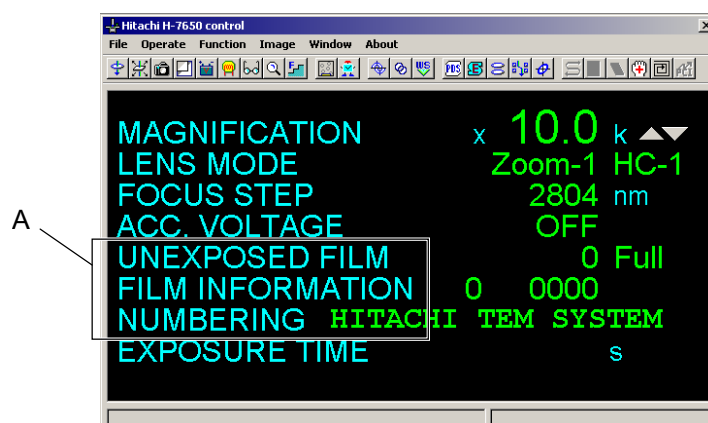


Fig. 3-85 Close-up information Window

(a) How to Set Information to be Printed on Film

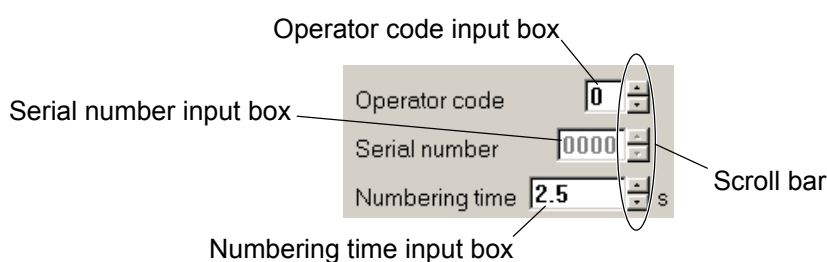


Fig. 3-86 Input Area for Information to be Printed on Film

- 1) Input an operator code in the Operator code input box using the scroll bar or keyboard. The operator code is settable within 1 to 9.
- 2) Input a serial film number in the Serial number input box using the scroll bar or keyboard. The serial film number is settable within 0000 to 9999. The serial film number is independent for each operator code. However, this number cannot be set for operator code 0. This code is used for indicating the total number of film exposures. The serial film number for each operator code is updated after each photographing.
- 3) Input a numbering time in the Numbering time input box using the scroll bar or keyboard. The numbering time is settable within 0.0 to 100.0 sec (in 0.5 sec steps).

- (c) For registration of the input value, press the Set button. If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed.

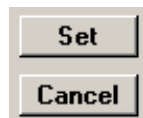


Fig. 3-87 Set/Cancel Buttons

- (d) Film select

The film size is selectable by the radio button.

- 1) Full/Half

When Full is selected, one exposure field is available on a film. When Half is selected, two exposure fields are available in half size on a film. Upon selection of Half, auto focus does not function in exposure of the second field and the digital camera cannot be used for image observation and recording.

- 2) mm size/inch size

You can select mm size or inch size for the film size.

- (e) Indication and Setting of Number of Films

In the information area (section A in Fig. 3-88), the number of unexposed films and the selected film size are indicated. They are updated when films are transferred to the cassette receiver. The number of unexposed films is settable in the Unexposed film set group.

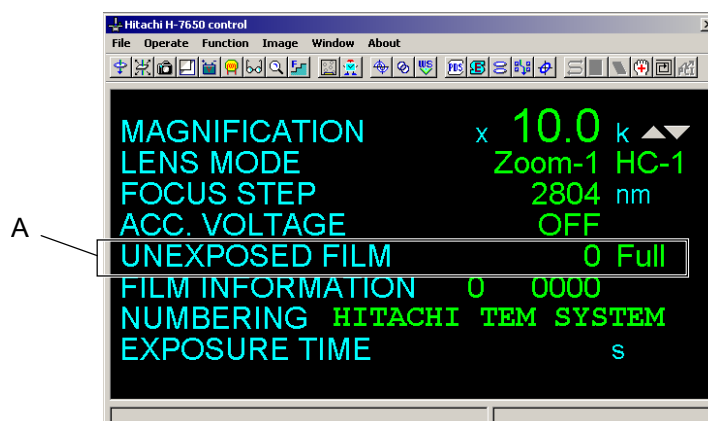


Fig. 3-88 Close-up information Window

3.3 Operate Menu (Hitachi H-7650 control window)

- 1) Put the cassette magazine in the camera chamber and carry out evacuation.
- 2) Input the number of unexposed films accommodated in the cassette magazine into the Unexposed film input box in the Unexposed film set group. A maximum of 50 films can be set. The input number must coincide with the number of films loaded in the cassette magazine.

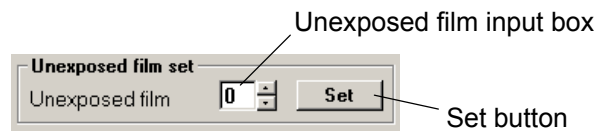


Fig. 3-89 Unexposed film set Group

- 3) By pressing the Set button, the input value is registered and at the same time, the shield plate of the cassette magazine is automatically fed.
- 4) If the input value is wrong, then press the **Cancel** button to retrieve the previous value. Cancellation is valid until the **Set** button is pressed.



Fig. 3-90 Set/Cancel Buttons

(f) Photo log file

Photographic conditions can be saved in a log file by selecting the ON button in the Photo log file group. (For details, refer to 3.2.2.)

(2) Exposure time

Clicking Exposure time in the Operate menu shown in Fig. 3-91 will open the Exposure time window in Fig. 33-92. In this window, you can set an exposure time (Manual time), exposure wait time (Exposure time), film feed wait time (Film feed wait) and optimum electron dose (Optimum density).

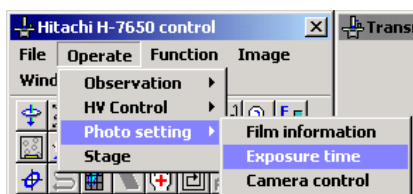


Fig. 3-91 Exposure time Menu

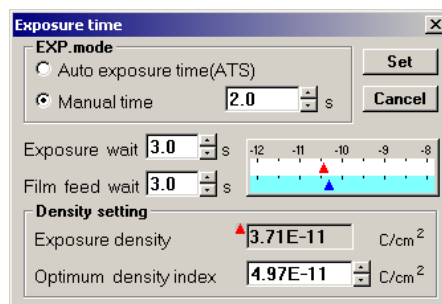


Fig. 3-92 Exposure time Window

- (a) Select a photographing mode by the Auto exposure time (ATS) or Manual time radio button in the EXP. mode group. After selection, press the Set button.

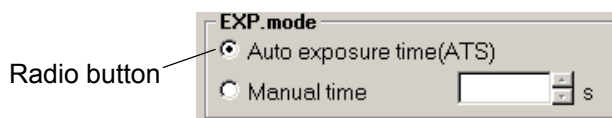


Fig. 3-93 EXP. mode Group

- 1) Selection of Manual time enables you to set a desired exposure time. For details, refer to (b) below.
- 2) When Auto exposure time is selected, the optimum exposure time will be automatically set on the basis of the optimum electron dose (Optimum density) and electron dose on the fluorescent screen (Exposure density). Whenever the electron dose on the fluorescent screen changes, the optimum exposure time is updated.

3.3 Operate Menu (Hitachi H-7650 control window)

(b) How to Set Exposure Time and Optimum Electron Dose

Once an optimum exposure time is set, it need not be adjusted for each photographing unless the kind of film is changed or a unique specimen is photographed. For the first setting, take the following procedure.

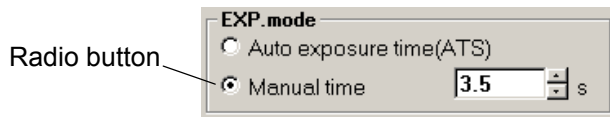


Fig. 3-94 EXP. mode Group

- 1) Click the Manual time radio button in the EXP. mode group and press the Set button.
- 2) Input an exposure time in the Manual time input box using the scroll bar or keyboard. The exposure time is settable within 0.1 to 1000.0 sec (in 0.1 sec steps). (For usual photographing, input a value in a range of 2.0 to 4.0 seconds as a standard.)
- 3) Adjust the brightness on the fluorescent screen with the BRIGHT knob (Fig. 3-95). Carry out image recording at different brightness conditions and find the optimum electron dose (Exposure density). Once you determine the optimum electron dose, input its value in the Optimum density input box using the scroll bar or keyboard. (For Optimum density, input a value in a range of 2.5×10^{-11} to 4.5×10^{-11} C/cm² as a standard.)

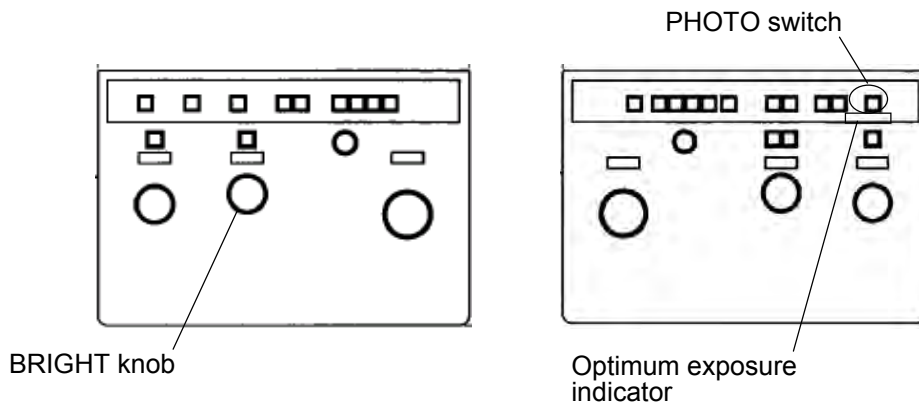


Fig. 3-95 Right/Left Operation Panels

- 4) For registration of the input value, press the Set button. If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed.

- 5) The optimum exposure condition is always arranged when the green lamp of the optimum exposure indicator (Fig. 3-95) is lit on the right operation panel once the optimum exposure dose has been set in the above procedure.
- 6) Exposure wait time (Exposure wait) stands for a wait time till start of exposure with the shutter open after the fluorescent screen is moved to the full-open position. Film feed wait time (Film feed wait) denotes a wait time till film feed after the shutter closes to terminate exposure. Both wait times are settable within 0.0 to 10.0 seconds. However, they are set only for special photographing. Use the initial values for usual photographing.

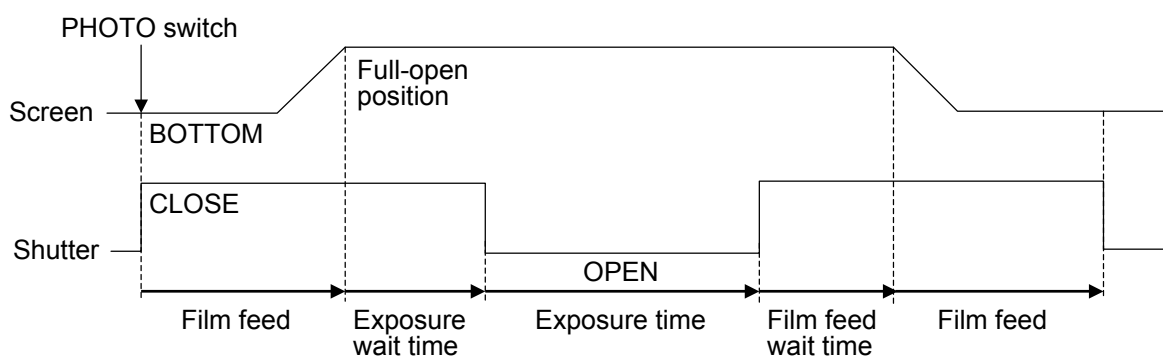


Fig. 3-96 Photographing Sequence

(3) Camera control

Clicking Camera control will call the Camera control window shown in Fig. 3-97. In this window, you can carry out automatic photographing, film feed and screen control.



Fig. 3-97 Camera control Menu

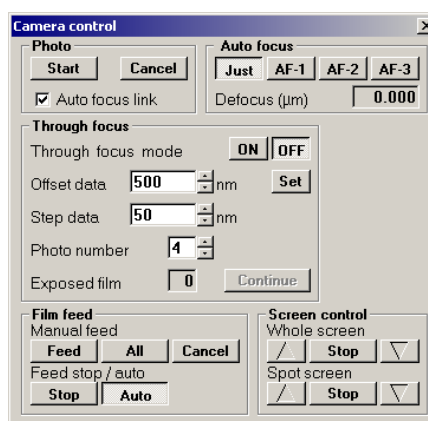


Fig. 3-98 Camera control Window

3.3 Operate Menu (Hitachi H-7650 control window)

(a) Photographing

When you click the Start button in the Photo group, photographing starts according to the conditions set in the Exposure time (3.3.3 (2)) and Film information (3.3.3 (1)) windows. Photographing will start even with no contrast on the image (when no beam is emitted or the beam has been spread fully with the BRIGHT knob for example). It is therefore necessary to check the image on the fluorescent screen or with the digital camera in advance. The Focus knob is valid even during photographing. So avoid manipulating the knob.

(b) The through-focus function serves to take a series of micrographs while automatically shifting the focus little by little.

- 1) Click the Through focus mode ON button in the Through focus group. Input an offset value in the Offset data input box using the scroll bar or keyboard. This value determines how much an image is defocused from the in-focus point for starting sequential photography. The offset value is settable within -9999 to 9999 nm. For starting from the overfocus status, the offset value must have a minus (-) sign, and have a plus (+) sign for starting from the underfocus status.

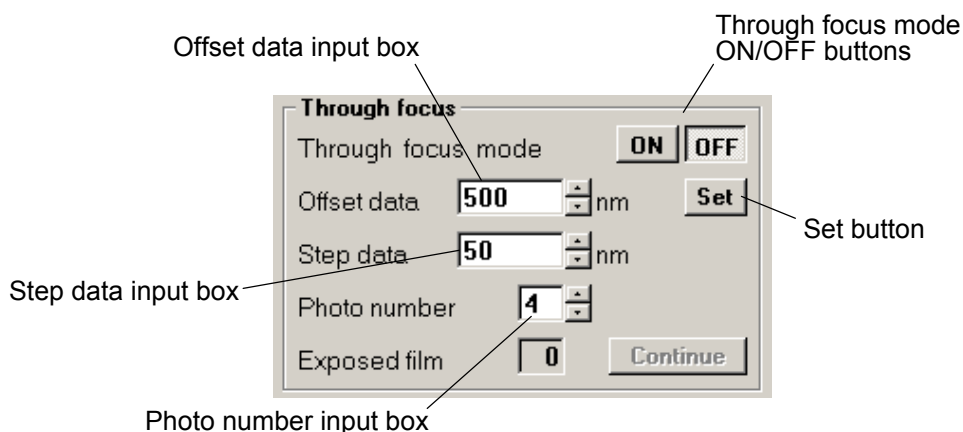


Fig. 3-99 Through focus Group

- 2) Input a focus step value in the Step data input box using the scroll bar or keyboard. This value determines the amount of change in focus after each photographing. The step value is settable within -9999 to 9999 nm. A minus (-) step value is required for taking photographs toward the overfocus side. Also for taking photographs toward the underfocus side, a plus (+) step value needs to be input.
- 3) Input the number of photographs in the Photo number input box using the scroll bar or keyboard. This number is settable within 1 to 99.
- 4) For registration of your input values in 1) to 3), press the Set button.

- 5) After registration in 4), click the Through focus mode ON button. Then, press the PHOTO switch on the right operation panel. Through-focus photography will start.



Fig. 3-100 Through focus mode ON/OFF Buttons.

- 6) The number of films exposed in the through-focus mode is displayed in the Exposed film indication box. When the set number of films are exposed, the through-focus function is automatically terminated. This function can also be stopped by pressing the PHOTO switch on the right operation panel or the screen button on the left operation panel during photographing.

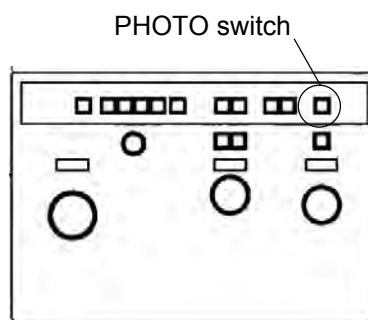


Fig. 3-101 Right Operation Panel

- 7) If the cassette magazine becomes empty during through-focus photography, it will be suspended. In this status (a window for through-focus photography is displayed and the screen is raised), leak air into the camera chamber and carry out film exchange to resume through-focus photography. After film exchange, specify the number of unexposed films with reference to 3.3.3 (1) and click the Continue button.

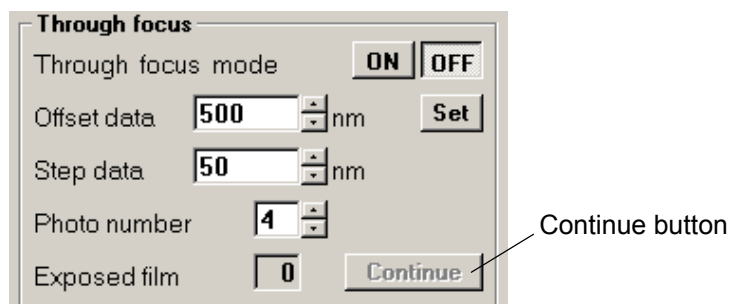


Fig. 3-102 Through focus Group

3.3 Operate Menu (Hitachi H-7650 control window)

(c) Film feed

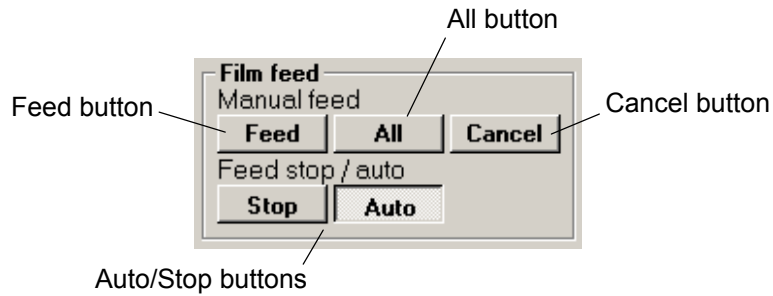


Fig. 3-103 Film feed Group

- 1) Upon clicking the Feed button in the Film feed group, the film is fed to the exposure position. If a film is already fed to the exposure position, it will be fed from this position to the cassette receiver. Note, however, that when a film is presently at the first half-size field, it will be fed to the next exposure position. Clicking the All button will feed all the films yet to be exposed to the cassette receiver. Clicking the Cancel button will stop film feed.
- 2) The Auto/Stop buttons in the Film feed group are used for multiple exposure. For usual photographing, select Auto. For multi-exposure photography, click the Stop button with a film fed to the exposure position by clicking the above-mentioned Feed button. The film will not be fed after its exposure, so you can expose it as many times as desired. After completion of multiple exposure, feed the film by the Feed button or return to the automatic sequence by clicking the Auto button before the final exposure in multi-exposure photography.

(d) Screen control

The buttons in the Screen control group move the Whole or Spot fluorescent screen vertically.

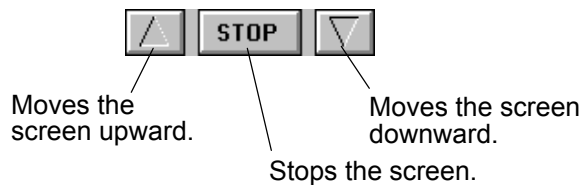


Fig. 3-104 Buttons in Screen control Group

(e) Optimum under focus

Refer to 3.3.1 (3)-(e).

3.3.4 Stage

Clicking Stage in the Operate menu shown in Fig. 3-105 will display the Stage control window in Fig. 3-106.

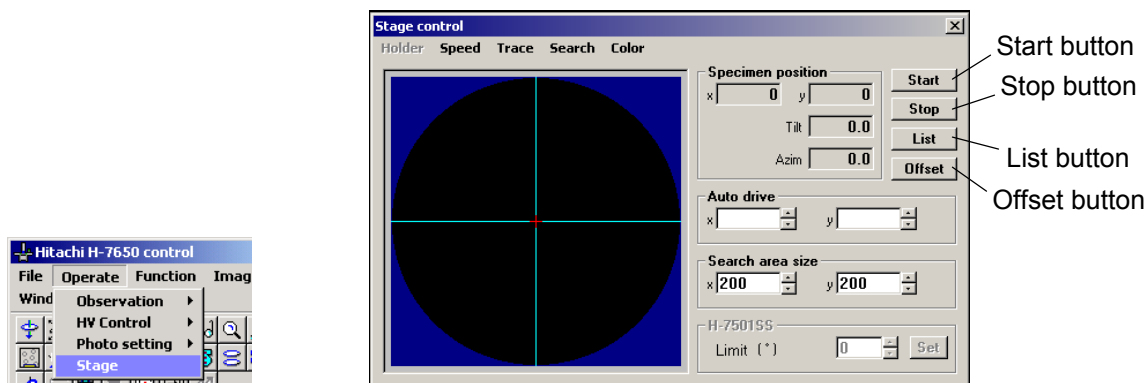


Fig. 3-105 Stage Menu

Fig. 3-106 Stage control Window

- (1) In the Specimen position indication box, the present X and Y coordinates of a specimen are indicated in μm . When you click the List button, the specimen position memory list will appear. In this list, 20 specimen positions can be stored. A specimen position stored in memory is indicated by list number on the graphics. By using the scroll bar, 20 specimen position memories can be checked in this list. When you click the List button again, the list disappears and the previous display returns.

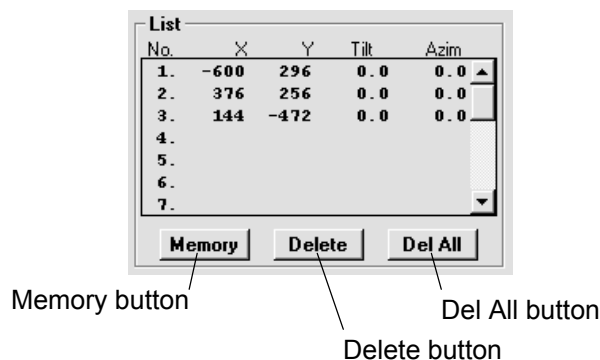


Fig. 3-107 Specimen Position Memory List

- (2) How to Store Specimen Position in Memory (see Figs. 3-106 and 3-107)
- Determine the specimen position by double-clicking on the graphics.
 - Move the specimen to the position by clicking the Start button.

3.3 Operate Menu (Hitachi H-7650 control window)

- (c) Display the specimen position memory list by clicking the List button.
 - (d) Select a list number for data storage by clicking it with the mouse.
 - (e) Click the Memory button. The present specimen position is registered and at the same time, the list number appears on the graphics.
 - (f) Clicking the Delete button after selection of a list number will erase the relevant memory.
 - (e) Clicking the Del All button will erase all the specimen positions stored in memory.
- (2) How to Move Specimen (Auto drive) (see Figs. 3-106 and 3-107)
- (a) Display the specimen position memory list by clicking the List button.
 - (b) Select a stored list number by clicking it with the mouse. The selected list number turns from yellow to green, and the relevant X and Y coordinates in memory are indicated in the Auto drive input box.
 - (c) Click the Start button. The specimen begins moving to the position determined by the X and Y coordinates.
 - (d) For movement to a desired coordinate location, input the destination coordinates in the Auto drive input box using the scroll bar or keyboard. Or click the mouse on the graphics, and the clicked location will be read in the Auto drive input box. Then, click the Start button. The specimen will begin moving.
 - (e) Clicking the Stop button will stop specimen movement.
- (3) Stage control Menu Bar
- (a) Holder

You can set a specimen holder to be used.

From the pull-down list, select the model of the holder to be used and set it by pointing. A check mark will be put before the set holder. As a standard, H-7501SS is set and other holders are settable when prepared at option. The specimen stage control method varies with the type of holder. Therefore, setting change is mandatory when using an optional holder.

(b) Speed

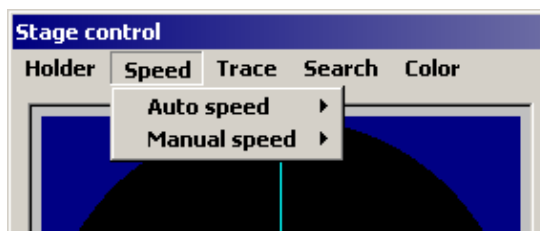


Fig. 3-108 Speed Menu

- 1) Auto speed
You can set a moving speed in Auto drive and Search.
Values 10 and 1 stand for maximum and minimum speeds, respectively.
- 2) Manual speed
You can determine the moving speed of the specimen stage in manual operation.
Values 10 and 1 stand for maximum and minimum speeds, respectively.

(c) Trace

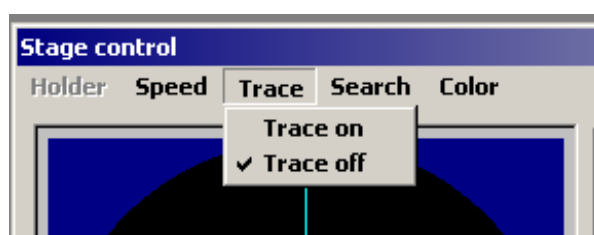


Fig. 3-109 Trace Menu

Clicking Trace on will activate the trace mode. When this mode is activated, a check mark is put before it. In this mode, a moving course of the specimen stage can be traced to allow efficient search for a specimen field of interest. Even after the Stage control window is closed, the moving course is retained in the trace mode. However, a moving course of the specimen stage with the window closed will not be stored in memory.

3.3 Operate Menu (Hitachi H-7650 control window)

- 1) Trace on
Validates the trace mode.
- 2) Trace off
Invalidates the trace mode.

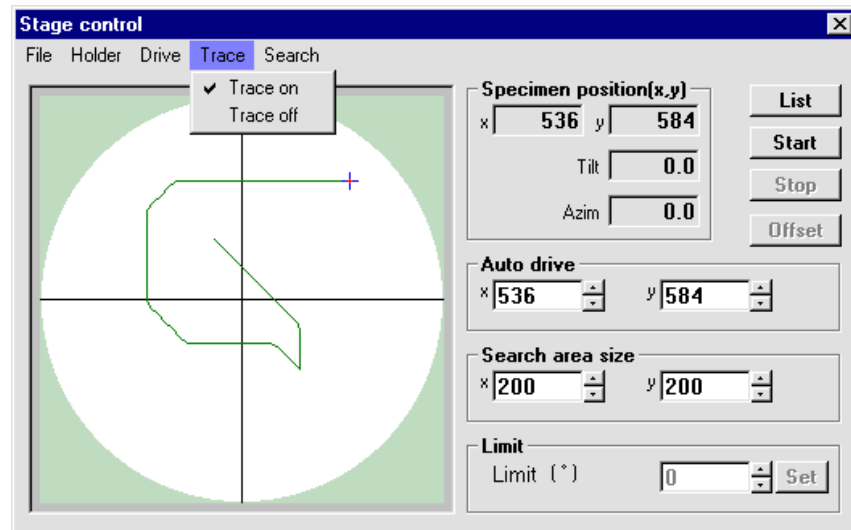


Fig. 3-110 Trace Mode Window

- (d) Search

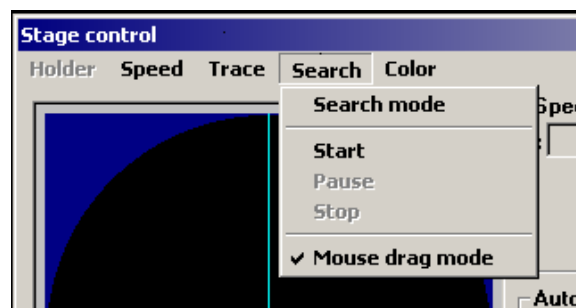


Fig. 3-111 Search Menu

1) Search mode

Clicking Search mode will activate the specimen field search mode. When this mode is activated, a check mark is put before it. At this time, the search area is displayed on the graphics. This area can be set within 0 to 990 from the X and Y input boxes in the Search area size group by use of the scroll bar or keyboard. Search will start when you click the Start button in the Stage control window. And it will stop when the Stop button is clicked. The moving distance in the Y direction is automatically corrected in linkage with the magnification, so the entire visual field can be searched on the fluorescent screen. While the search mode is selected, the specimen position moving (Auto drive) function does not work.

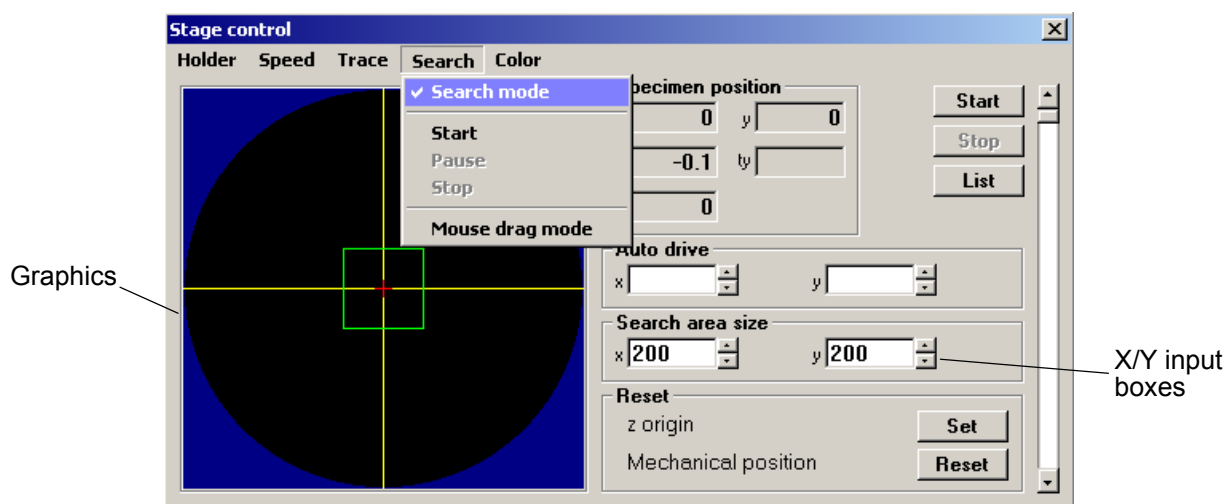


Fig. 3-112 Search mode Window

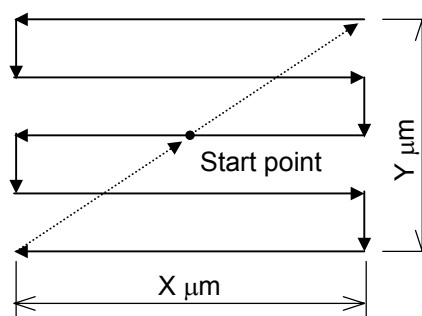


Fig. 3-113 Procedure for Field Search

2) Start

Starts search.

Same as the Start button in the Stage control window.

3) Pause

Suspends search.

3.3 Operate Menu (Hitachi H-7650 control window)

- 4) Stop
Stops search.
Same as the Stop button in the Stage control window.
- 5) Mouse drag mode
When Mouse drag mode is clicked, you can specify a search area and change the search position by dragging the mouse on the graphics. If Mouse drag mode is not selected, the search area needs to be set from the X and Y input boxes in the Search area size group in the Stage control window by using the scroll bar or keyboard. This area is settable within 40 to 99 μm in steps of 10 μm .

(e) Color (Black/Blue/Red)

You can specify the color of the frame line on the graphics to show the center marker, cross cursor and search area.

(f) Limit

This is a function for limiting the specimen tilt angle. The tilt angle varies with the specimen holder. With the standard specimen holder, the specimen can be tilted up to 20°. So input is allowed within $\pm 20^\circ$ for Limit. When 0° is input, the specimen is not tilted.



Fig. 3-114 Limit Group

3.4 Function Menu (Hitachi H-7650 control window)

This menu contains functions for efficient TEM image observation, etc. Clicking this menu will present the list shown in Fig. 3-115. If an optional function is added, it will be included in this list.

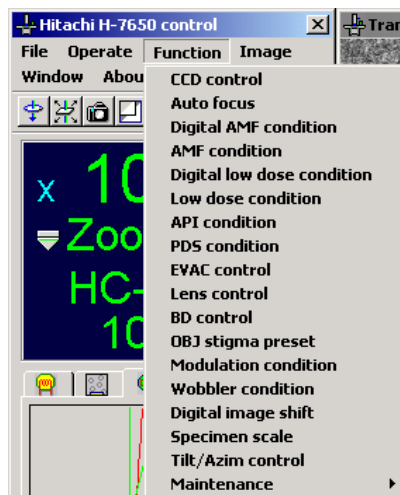


Fig. 3-115 Function Menu in Hitachi H-7650 control Window

3.4.1 CCD Control (Type A only)

This is a function for controlling the digital camera. Clicking CCD control in the Function menu shown in Fig. 3-116 will open the CCD control window. When the Transmission image window is not displayed, the buttons are indicated in gray and cannot be pressed.

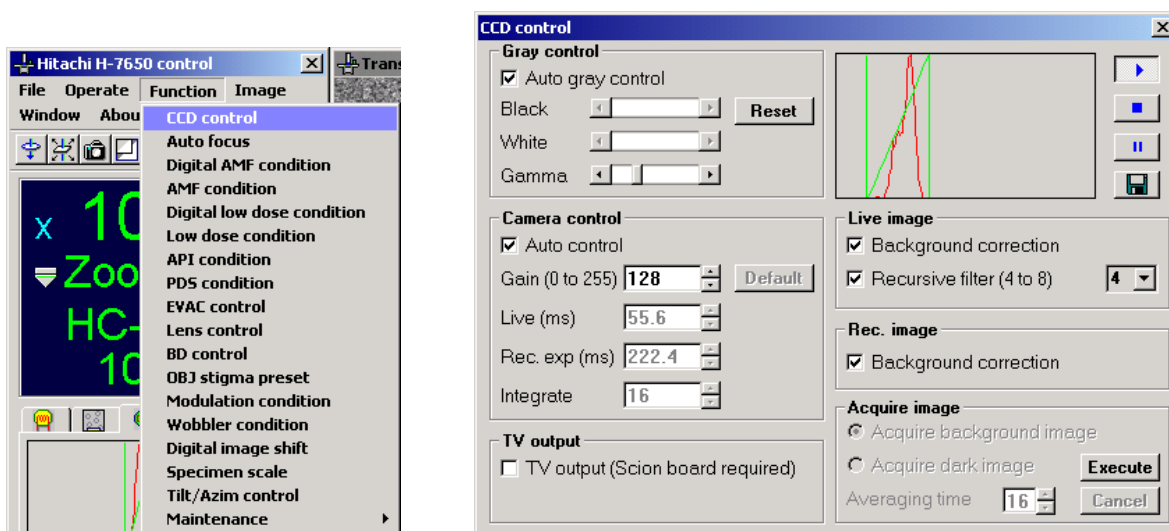


Fig. 3-116 CCD control Menu and CCD control Window


3.4 Function Menu (Hitachi H-7650 control window)

(1) Histogram Display Area and Image Control Buttons


In the Run status, the histogram and black/white/gamma level are graphically displayed in real time.




Fig. 3-117 Histogram Display Area

(a) Run button: 


Starts the moving picture display of TEM images in the Transmission image window. When the main fluorescent screen is closed, it will open.

(b) Stop button: 

Stops the moving picture display of TEM images in the Transmission image window.

(c) Freeze button: 

Stops a moving picture to display it as a still image.

(d) Save button: 

Saves a moving picture captured with the Freeze function. The Save image window shown in Fig. 3-118 appears. Specify a folder, file name and file type, then click the Save button. For the file type, you can select any of TIFF format (*.tif), Windows Bitmap format (*.bmp) and JPEG format (*.jpg).

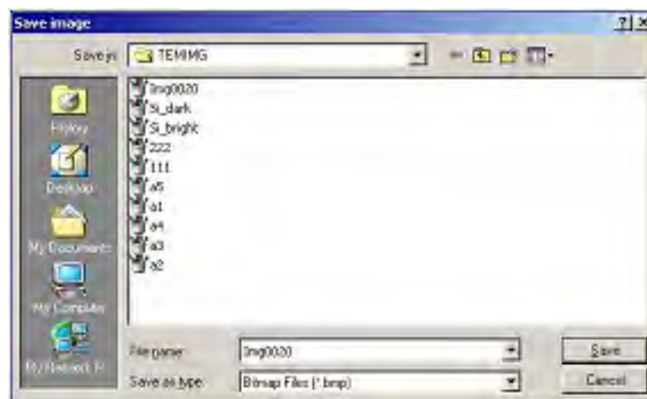


Fig. 3-118 Save image Window

- (e) If the histogram peak reaches the right end, the fluorescent screen is automatically lowered to prevent the digital camera from burning and a system message (Too bright) appears. In this case, spread the beam to suppress the overall brightness and then raise the fluorescent screen.
 - (f) In image observation at low magnifications, an image may be too bright with the beam spread to the maximum by the BRIGHT knob on the right operation panel. In such a case, reduce the beam spot size for use.
 - (g) When the optional sheet film camera is provided, image observation/recording with the digital camera is impossible while waiting for recording of the second half-size field.
- (2) Gray control

When you turn on the Auto gray control check box (by placing a check mark), the histogram is automatically adjusted. When the Auto gray control check box is turned off (by removing the check mark), you can carry out gray control using Black, White and Gamma from the histogram at image display.

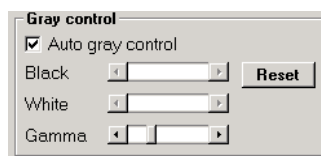





Fig. 3-119 Gray control Group

- (a) Black scroll bar: 

Sets the rise of histogram at image display.
- (b) White scroll bar: 

Sets the fall of histogram at image display.
- (c) Gamma scroll bar: 

Sets the gray level for image display.

3.4 Function Menu (Hitachi H-7650 control window)

(3) Camera control

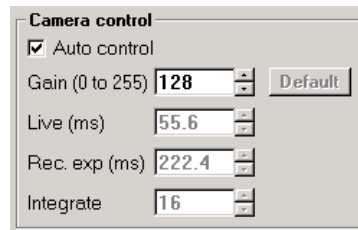


Fig. 3-120 Camera control Group

(a) Auto control

When the Auto control check box is turned on, Auto control is automatically activated to allow you to fix Live (ms) and change Gain. When the check box is turned off, you can change the Live, Rec. exp and Integrate values.

(b) Live (ms):

Sets and indicates an image display speed. This speed is settable within 0.1 to 55.6 ms (in 0.1 ms steps) using the keyboard. If a value of 55 or more is input, it is automatically rounded down to 55.6.

(c) Rec. exp (ms):

Sets and indicates an exposure time for image capture. This time is settable in steps of 1 ms within 1 to 111 ms and in steps of 111.2 ms within 111.2 to 9896.8 ms using the keyboard. If a value of 112 or more is input, it is automatically rounded down to a multiple of 111.2. Note that the maximum value is 9896.8 ms.

(d) Integrate:

Sets and indicates the integrated number of images. This is a function for image integration to enhance the S/N ratio of captured image. This number is settable within 1 to 48 using the keyboard. If a value of 49 or more, it is automatically rounded down to 48.

(e) Gain (0 to 255)

Controls the gain in the camera control unit.

(f) Default

Returns each of the Gain, Live, Rec. exp and integrate values to the default. This is a function for setting a exposure time and integrated number of images for image display and capture.

(4) TV output

- TV output (Scion board required)

Provides NTSC output from the rear of PC. For auto focus or any other automatic function, be sure to turn on this check box.

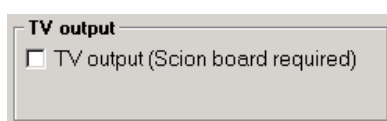


Fig. 3-121 TV output Group

(5) Live image

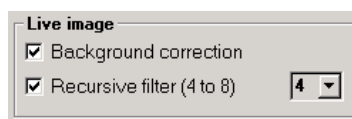


Fig. 3-122 Live image Group

(a) Background correction

This is a function for background correction on a moving picture. Before use of this function, record a background image with Acquire image. This function serves to mask burning of the scintillator.

(b) Recursive filter (4 to 8)

Applies a recursive filter. For the degree of filtering, values 4 to 8 are selectable.

3.4 Function Menu (Hitachi H-7650 control window)

(6) Rec. image

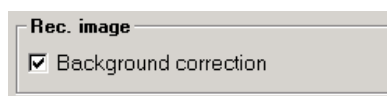


Fig. 3-123 Rec. image Group

- Background correction

This is a function for background correction on a still image. Before use of this function, record a background image and dark image with Acquire image. The function serves to mask burning of the scintillator.

(7) Acquire image

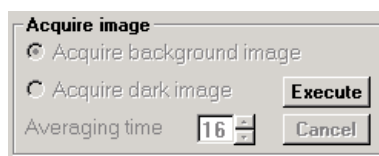


Fig- 3-124 Acquire image Group

(a) Execute button

When you press this button, the Acquire image mode starts. In this mode, the scintillator protecting function stops and the Execute button changes to the Acquire button. Once a background image or dark image is recorded, the normal condition is retrieved.

(b) Acquire background image

Validated by pressing the Execute button. By selecting this mode and pressing the Acquire button, a background image is recorded. Before pressing the Acquire button, adequately spread the electron beam and adjust the TEM brightness so that the peak of histogram in the CCD control window is brought to almost the center.

Image recording is carried out as many times as Averaging time in (d) and the average value thus obtained is registered as a background image.

It is recommended to perform this operation once a week.

(c) Acquire dark image

Validated by pressing the Execute button. By selecting this mode and pressing the Acquire button, a dark image is recorded. Before pressing the Acquire button, close the fluorescent screen to prevent the electron beam from entering the camera. Image recording is carried out as many times as Averaging time in (d) and the average value thus obtained is registered as a dark image.

It is recommended to perform this operation once a week.

(d) Averaging time

Recording is carried out as many times as the set number of recordings and the average value obtained for each picture element is stored as image data.

3.4.2 Auto Focus (Type A only)

This is a function for correcting the image focus automatically. In response to a positional deviation of image, which occurs when tilting the electron beam, the electron lenses are automatically controlled so that the image focus can be corrected without using the FOCUS knob. Clicking Auto focus in the Function menu shown in Fig. 3-125 will open the Auto focus window.

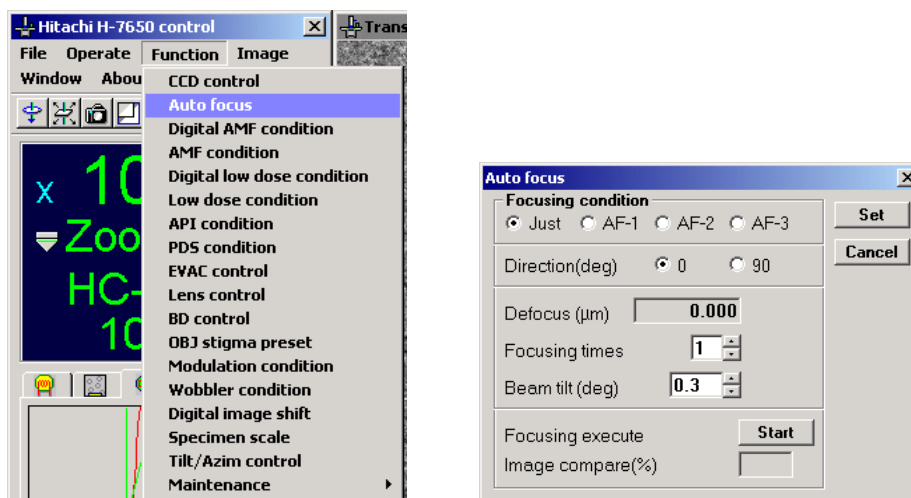


Fig. 3-125 Auto focus Menu and Auto focus Window

3.4 Function Menu (Hitachi H-7650 control window)

(1) Focusing condition

You can select any one of just focus and underfocus-side defocus amounts corresponding to 3 kinds of optimum focuses (OF-1 to OF-3) by the radio button

(Just AF-1 AF-2 AF-3).

Particularly for a thin-sectioned biological specimen, a proper underfocus-side defocus amount will enhance the contrast to make an image sharper.

(2) Direction (deg)

The direction of correction is selectable by the radio button (0 90).

(3) Defocus: Defocus (μm)

The underfocus-side defocus amount selected by the radio button in the Focusing condition group is indicated.

(4) Focusing times input box: Focusing times


The number of auto focus operations is settable within 1 to 3 using the button or keyboard. (In 3 auto focus operations, correction takes about 3 seconds.)

(5) Beam tilt input box: Beam tilt (deg)

The beam tilt angle is settable within 0.1 to 0.5° by use of the button or keyboard. (Normally use at 0.3°.)

For registration of your input value, press the Set button. If the input value is wrong, then press the Cancel button to retrieve the previous value. Cancellation is valid until the Set button is pressed.

(6) Focusing execute

Click the Start button, and auto focus will start. The same operation is activated by clicking the icon () or pressing the AUTO FOCUS switch on the right operation panel.

(7) Image compare: 

The image coincidence degree calculated in image correlation is indicated in the Image compare box. If the indicated value is 5% or less, auto focus is ineffective. For use of auto focus, pay attention to the following.

- (a) It is recommended to use auto focus at an accelerating voltage of 30 to 120 kV.
- (b) Use auto focus under the exposure condition within 5×10^{-12} to 2×10^{-11} C/cm² (at 1 s). (At an accelerating voltage of 60 kV, use within 8×10^{-12} to 2×10^{-11} C/cm² (at 1 s).)
- (c) Axial alignment is required. Particularly, the voltage center and objective aperture center should be aligned exactly, referring to 2.3.2 and 2.2.4.
- (d) The following table lists correctable defocus amounts (correctable range) in auto focus as a reference.

Table 3-4 TEM Magnification and Correctable Range

Accelerating Voltage	TEM Magnification	Correctable Range
60 to 120 kV	* 0.7 to 4.0k	±100 μm max.
60 to 120 kV	* 5.0 to 15k	±50 μm max.
60 to 120 kV	* 20k	±25 μm max.

- (e) Auto focus is usable at a magnification of ×100,000 or lower.
- (f) Auto focus may not function properly depending on the feature (pattern) of a specimen even when the above conditions are satisfied. In such a case, lower the magnification by a few steps, and then execute auto focus again. (Due to the characteristic of auto focus, it is recommended to start correction from a lower magnification.)

3.4 Function Menu (Hitachi H-7650 control window)

- (g) Auto focus may not function properly in the HR mode or at image rotation.
- (h) Auto focus may not function normally when the Image compare value is low (10% or less).
- (i) Avoid activating auto focus with no beam emitted. It may not function normally.
- (j) When the optional sheet film camera is set, auto focus will not function in recording of the second half-size field.

3.4.3 Digital AMF Condition (Type A only)

Digital AMF is a function for sequentially capturing and saving digital images of 1024 × 1024 pixels in linkage with the stage movement.

With this function, multiple images are joined together after they are captured. If images at different gray levels are joined together, the joint line may be noticeable. To avoid this as much as possible, it is recommended to invalidate Auto gray control in the CCD control window before activation of this function.

Clicking Digital AMF condition in the Function menu shown in Fig. 3-126 will open the Digital AMF window.

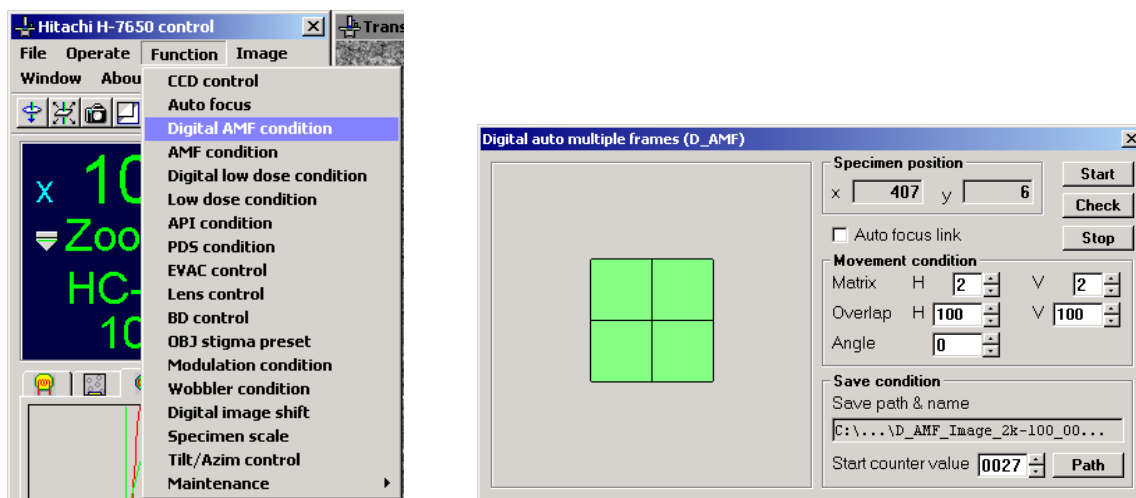


Fig. 3-126 Digital AMF condition Menu and Digital auto multiple frames Window

(1) Specimen position

The stage coordinates are indicated.

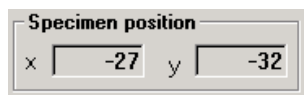


Fig. 3-127 Specimen position Group

(2) Auto focus link: Auto focus link

When this check box is turned on, auto focus will be executed at image capture.

(3) Movement condition

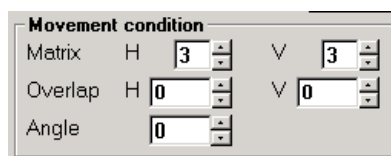


Fig. 3-128 Movement condition Group

(a) Matrix

Set a number of captured images.

- 1) Make your setting independently for Horizontal and Vertical.
- 2) Settable range : 1 to 4
- 3) Default value : 3
- 4) Minimum step : 1

(b) Overlap

Set an amount of overlapping between images.

- 1) Make your setting independently for Horizontal and Vertical.
- 2) Unit : Pixel
- 3) Settable range : 0 to 100
- 4) Default value : 5
- 5) Minimum step : 0.1

3.4 Function Menu (Hitachi H-7650 control window)

(c) Angle

Set a rotation correction value at stage movement.

- 1) Unit : ° (degree)
- 2) Settable range : -10 to 10
- 3) Default value : 0.0
- 4) Minimum step : 0.1

(4) Save condition

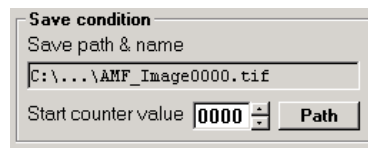


Fig. 3-129 Save condition Group

(a) Save path & name

The save path and file name are indicated.

(b) Start counter value

Se an initial value of serial number for Quick save file.

(c) Path button

Clicking this button will open the Save image window shown in Fig. 3-130. Set a save path and file name.

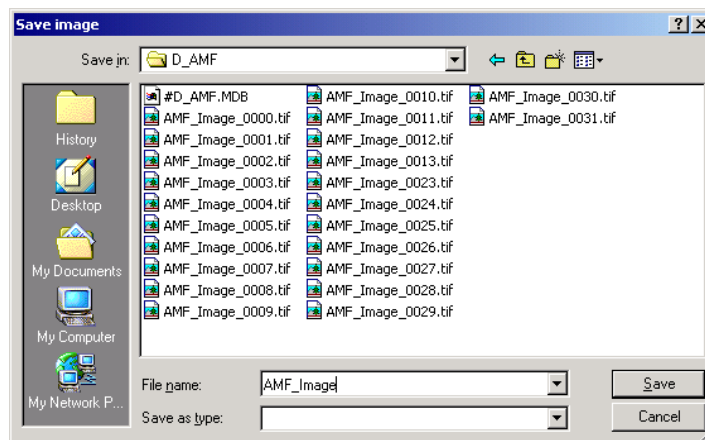


Fig. 3-130 Save image Window

(5) Start Button

Click this button, and sequential image capture will start under the set conditions. Upon completion of capture, the stage is moved to the position at start and a system message appears as shown in Fig. 3-131.

- (a) Figure 3-132 shows the sequence of image capture.
- (b) When the Start button is clicked with CCD in the Stop or Freeze status, it is put in the Run status.
- (c) You can capture as many images as the number set for Matrix in the Movement condition group.
- (d) Images are saved in the save path and file name specified in the Save condition group. After saving, Start counter value is automatically updated. Note that the value is updated to 0 after it reaches 9999.

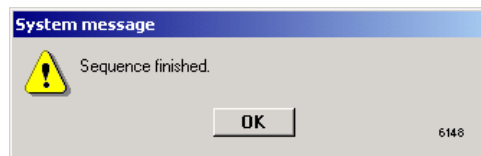


Fig. 3-131 System message Window

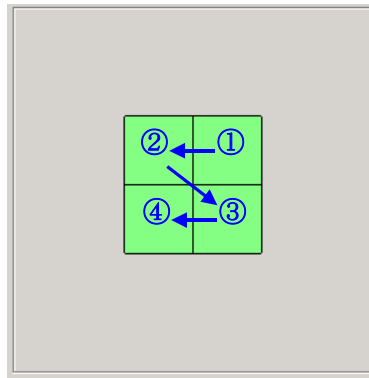


Fig. 3-132 Sequence of Image Capture and Image Check

3.4 Function Menu (Hitachi H-7650 control window)

(6) Check Button

Click this button, check of the image capture position will start under the set conditions. Upon completion of check, the stage is moved to the position at start and a system message appears as shown in Fig. 3-131.

- (a) Images are checked in the same sequence as for image capture. Refer to Fig. 3-132.
- (b) When the Check button is clicked with CCD in the Stop or Freeze status, it is put in the Run status.
- (c) You can check as many images as the number set for Matrix in the Movement condition group.

(7) Stop Button

- (a) When the Stop button is clicked during image capture, the processing is halted and the stage stops at the present position.
- (b) When the Stop button is clicked during image check, the processing is halted and the stage moves to the check start position.

(8) Position Display Area

As shown in Fig. 3-133, the positions obtained according to your setting for Matrix in the Movement condition group are graphically displayed. The position at which image capture and check has been finished is discriminated by color.

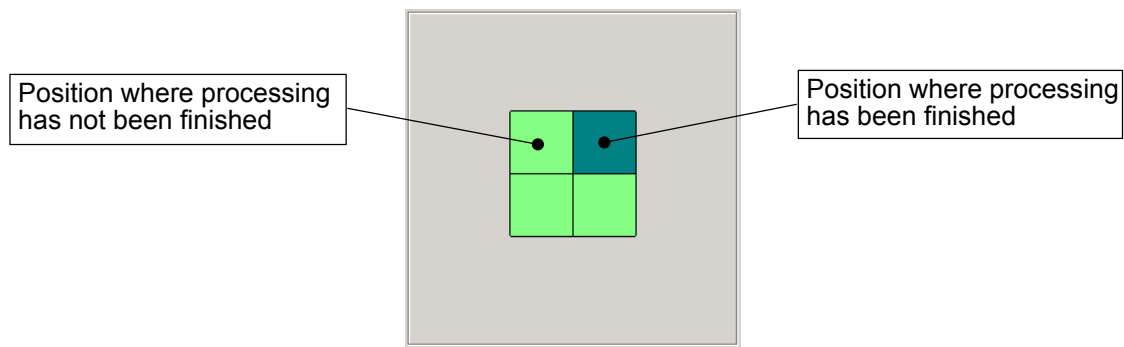


Fig. 3-133 Position Indication Area

- (9) As shown in Fig. 3-134, you can specify an area to be skipped at image capture and check by clicking the relevant position. The specified position is discriminated by color.

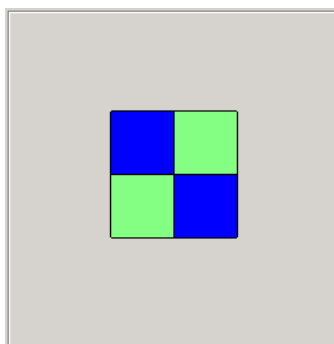


Fig. 3-134 Selection of Area to be Skipped

- (a) You can cancel the selection by clicking the position specified as a skip area again.
- (b) The skip area can be specified even during the course of image capture/check.

3.4.4 AMF condition (applicable only when sheet film camera (option) is set)

AMF is a function for sequentially photographing adjacent visual fields with sheet films in linkage with the stage movement. This option is selectable when the film camera kit is provided. Clicking AMF condition in the Function menu shown in Fig. 3-135 will open the AMF window.

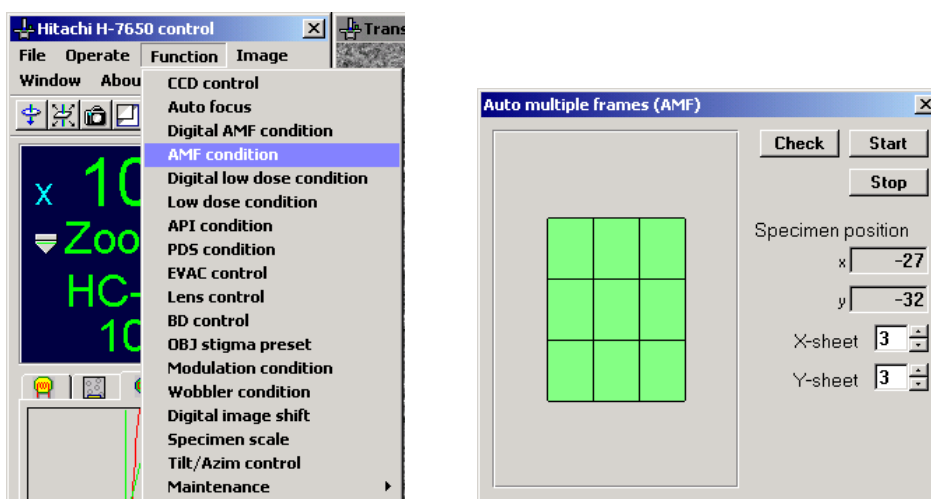


Fig. 3-135 AMF condition Menu and AMF Window

3.4 Function Menu (Hitachi H-7650 control window)

(1) X-sheet/Y-sheet Input Boxes

Input a number of exposures, or film sheets in each of the X and Y directions using the scroll bar or keyboard.

You can input an odd number within 1 to 11. After input with the keyboard, be sure to press the Enter key. When the input number is valid, an exposure field image will be graphically displayed.

In addition, you can specify an unnecessary area for recording by moving the mouse cursor to the exposure field image on the graphics and clicking it.

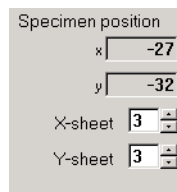


Fig. 3-136 Specimen position and X/Y-sheet Input Boxes

(2) Check Button

By clicking this button, the photographing area specified by X-sheet and Y-sheet can be checked while moving it field by field. Clicking the Stop button during check will stop the check mode and retrieve the initial position.

(3) Start Button

In response to clicking of this button, sequential photography starts.

During photographing, avoid changing the brightness, exposure time, emission current, etc. which concern the photographic density of film, otherwise the density would become uneven among the fields.

The amount of overlapping between fields is automatically set. Clicking the Stop button during photographing will stop the photographing mode and retrieve the initial position.

(4) If Check or Start cannot be executed (continued), any of the following messages will appear in the message area.

(a) AREA ERROR

The specified photographing area is wider than the movable range of the specimen stage. Narrow the photographing area.

(b) MAG ERROR

Photographing is impossible at the present magnification.

(c) MODE ERROR

Photographing is impossible in the present lens mode. Select the ZOOM or LOW MAG mode.

(d) FILM SIZE ERROR

Half size is selected. Change to full size.

(e) NO FILM

There is no unexposed film. Carry out film exchange. For the exchange procedure, refer to 4.3.3.

(f) EVAC WAIT

The evacuation system is not at a high vacuum during film exchange, etc.

(g) AMF FINISHED

The AMF mode has been finished.

(h) SHEET SETTING ERROR

The number of film sheets in the X or Y direction cannot be set. Check the set value and input a proper value.

(i) STAGE BUSY

The stage unit is under motion. Stop the stage.

(j) CAMERA BUSY

The camera unit is now working. Wait until image recording, through-focus photography, film feed or any other camera work is terminated.

NOTE: If the number of remaining unexposed film sheets is insufficient for the set number of exposures, "NO FILM" appears at the bottom right of the window after exposure of the final sheet.

3.4 Function Menu (Hitachi H-7650 control window)

3.4.5 Digital Low Dose Condition (Type A only)

The low dose function is intended to reduce specimen damage due to electron beam irradiation. The field to be photographed can be protected from electron beam irradiation during focusing, astigmatism correction and axial alignment, which are to be carried out in an area near the one to be photographed. Thus, you can minimize irradiation of the electron beam to the inside of the field to be photographed.

Upon execution of photographing, the electron beam is irradiated to the field to be photographed on a specimen, an electron microscope image is recorded with the TV camera and it is stored as digital data. A series of operations can be performed on the Digital low dose condition window. Clicking Digital low dose condition in the Function menu shown in Fig. 3-137 will open the Digital low dose condition window.

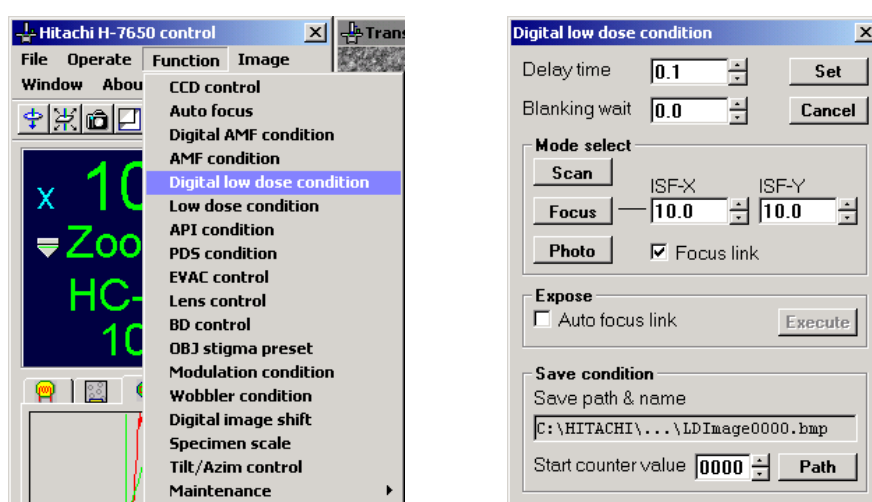


Fig. 3-137 Digital low dose condition Menu and Digital low dose condition Window

(1) Photographing Wait Time Input

You can input a wait time till execution of photographing following electron beam irradiation to the area to be photographed on a specimen after magnification and axial data are set for low dose photographing conditions. The wait time is given by adding the input value for Delay time to that for Blanking wait. Note that the minimum wait time is 0 second.

(a) Delay time:

Input a time period till start of photographing after magnification and axial data are set for low dose photographing conditions. This time is settable within -100.0 to 100.0 seconds. When you want to use beam blanking as a shutter, input a negative value. Photographing will start before beam blanking is released. In this case, however, photographing may not be carried out normally due to a lack of exposure time according to the Live time set in the CCD control window. So check the Live time and input an optimum exposure time.

(b) Blanking wait:

Input a wait time till releasing of beam blanking after magnification and axial data are set for low dose photographing conditions. This time is settable within 0 to 100.0 seconds.

(2) Set Button

Validates the input in (1) above. When the sum of input values for Delay time and Blanking wait is a negative value, the input value for Blanking wait is automatically adjusted so that the sum becomes 0.

(3) Cancel Button

Invalidates the input in (1) above and retrieves the previous value (value validated by the Set button).

(4) Mode select

Lens conditions, etc. in each low dose mode can be output by clicking the Scan, Focus and Photo buttons. For changing the output condition, it is necessary to carry out magnification changeover and brightness adjustment as in usual operation with any one mode selected. The final status is stored as conditions in each mode. Note that the conditions are not stored in any other lens mode than ZOOM-1. To minimize specimen damage, avoid changing the lens mode in process of low dose observation/photography.

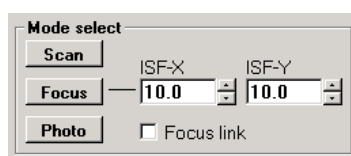


Fig. 3-138 Mode select Group

3.4 Function Menu (Hitachi H-7650 control window)

(a) Scan button

Clicking this button will select the Scan mode. This mode is used for selecting the field of view. Arrange a dark state at a low magnification in the Zoom-1 mode in order to minimize specimen damage.

(b) Focus button

Clicking the Focus button will select the Focus mode. This mode is used for focusing and astigmatism correction. Set a magnification 2 to 3 times higher than for photographing. Upon selection of the Focus mode, image shift X and Y values are automatically output and the electron beam is shifted from the field to be photographed on a specimen.

(c) ISF-X/ISF-Y input boxes

You can input image shift (ISF) values in the Focus mode within -10.0 to 10.0 μm in both X and Y directions. Make setting so that the electron beam is not irradiated to the field to be photographed on a specimen.

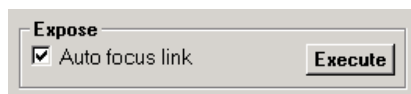
(d) Photo button

Clicking the Photo button will select the Photo mode. This mode is used for setting the magnification for photographing with a low dose. Set a photographing magnification as in usual operation.

(e) Focus link: Focus link

For photographing with a low dose, you can select or avoid focusing current correction (Focus link) in response to magnification change. The focus is changed in response to magnification change in execution of Low dose expose from the Focus mode. When Focus link is avoided, the same focusing current adjusted in the Focus mode will be output at the time of photographing.

(5) Expose

**Fig. 3-139 Expose Group**

(a) Auto focus link

Upon pressing the Execute button, auto focus is executed before photographing.

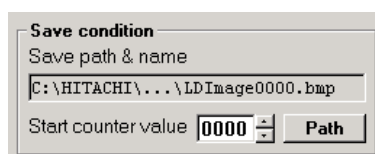
(b) Execute button

Selecting a low dose mode will validate the Execute button. By clicking this button, photographing is executed in the mode selected in the Mode select group. Note that the photographing operation differs depending on the selected mode.

Table 3-5 Operation when Execute Button is Clicked

Mode	Operation
Scan	Photographing is executed in Scan mode.
Focus	Photographing is executed in Photo mode. Upon completion of photographing, the mode is changed to Focus mode.
Photo	Photographing is executed in Photo mode.

(6) Save condition

**Fig. 3-140 Save condition Group**

(a) Save path & name

The location and file name for saving the photographed image are indicated.

(b) Start counter value: 

Set a serial number of file name.

3.4 Function Menu (Hitachi H-7650 control window)

(c) Path button

This button opens a window for setting a location for saving the photographed image. The Save image window shown in Fig. 3-141 will open. Specify a saving location and file name.

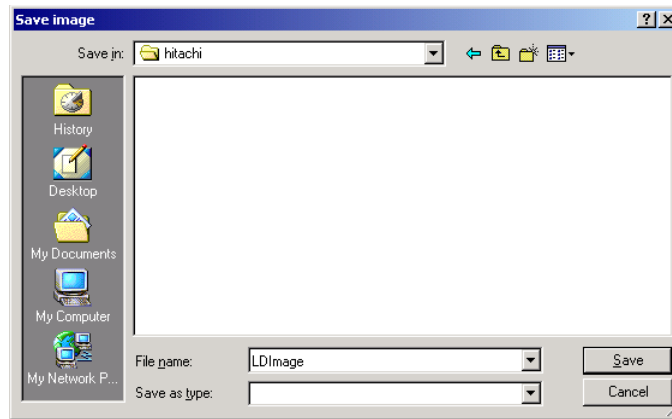


Fig. 3-141 Save image Window

(7) How to Use Digital low dose


Given below is how to use Digital low dose.

- (a) With no specimen inserted, click the Scan button in the Digital low dose condition window to activate the Scan mode.
- (b) Change to the magnification at which field selection is possible, and turn the BRIGHT knob on the right operation panel until the image is darkened to an observable limit.
- (c) Insert a specimen to be observed.
- (d) Move to the specimen area not to be photographed using the specimen goniometer stage.
- (e) Click the Photo button in the Digital low dose condition window to activate the Photo mode.
- (f) Set a photographing magnification.
- (g) Carry out image capture in the specimen area not to be photographed, and adjust the brightness properly. In the Photo mode, the magnification and brightness in this state are reproduced.

- (h) Click the Scan button in the Digital low dose condition window to activate the Scan mode.
- (i) Using the specimen goniometer stage, adjust the position so that the field to be photographed is brought to the center of the image display area.
- (j) Click the Focus button in the Digital low dose condition window to activate the Focus mode. The field of view will shift automatically through image shift as much as the ISF-X and ISF-Y values at the right of the button.
- (k) Focus the beam within the focus-adjustable range. If the beam is excessively spread, it will be irradiated to the field to be photographed. It is therefore recommended to focus the beam as far as possible.
- (l) Adjust the focus on the field in the Focus mode.
- (m) Click the Execute button in the Exposure group. The Photo mode is activated automatically to carry out image capture. Photographing and exposure are carried out at the timing based on Delay time and Blanking wait. The image is saved in the path and file name specified in the Save condition group. After completion of image capture, the Focus mode is retrieved.

3.4 Function Menu (Hitachi H-7650 control window)

3.4.6 Low Dose Condition (applicable only when sheet film camera (option) is set)

The low dose function is intended to reduce specimen damage due to electron beam irradiation. When the condition is preset for each mode, the field to be photographed can be protected from electron beam irradiation during focusing, astigmatism correction and axial alignment, which are to be carried out in an area near the one to be photographed. Thus, an electron microscope image can be recorded with minimum specimen damage in the field to be photographed. Clicking Low dose condition in the Function menu shown in Fig. 3-142 will open the Low dose condition window. This window can also be called by clicking the icon (). Note that the menu and icon cannot be selected unless the optional sheet film camera is set.

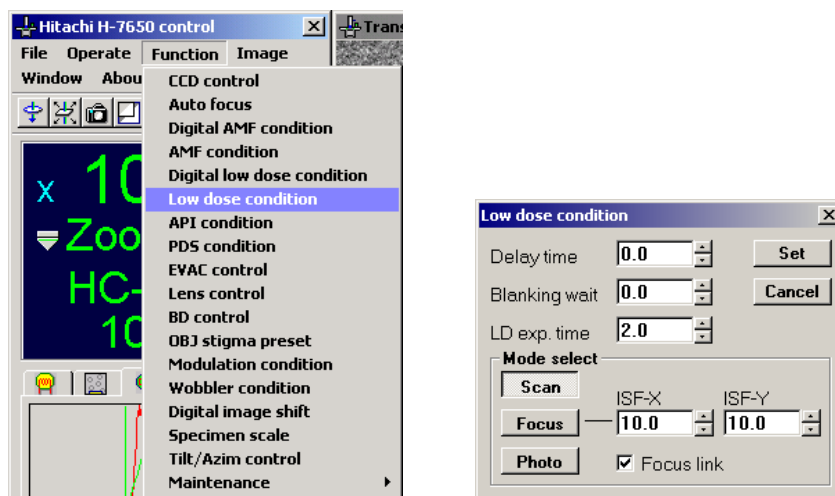


Fig. 3-142 Low dose condition Menu and Low dose condition Window

(1) Mode select

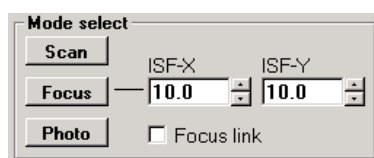



Fig. 3-143 Mode select Group

- (a) Lens conditions in each mode can be set by clicking the Scan, Focus and Photo buttons. For changing the set condition, it is necessary to carry out magnification changeover and brightness adjustment as in usual operation with any one mode selected. The final status is stored as conditions in each mode. The same modes are also selectable by the LOW DOSE switch on the right operation panel.

(b) Scan mode

Arranges the viewing conditions for selecting the field of view. Usually, a dark state is arranged at a low magnification in the ZOOM mode in order to minimize specimen damage. For field selection in the Diff mode, the viewing conditions in this mode can be registered.


(c) Focus mode

Arranges the viewing conditions for focusing and astigmatism correction. Usually, a magnification for focusing with a low dose is set 2 or 3 times higher than for photographing. Upon selection of the Focus mode, image shift X and Y values are automatically output. In the ISF-X and ISF-Y input boxes, you can input image shift (ISF) values in the Focus mode. Input a value within -10.0 to 10.0 μm in both X and Y directions using the  button or keyboard.


(d) Photo mode: Focus link

Arranges the conditions for photographing with a low dose. A photographing magnification needs to be set in the relevant window. The Focus link check box allows you to select or avoid focusing current correction (Focus link) in response to magnification change. By turning on the Focus link check box, you can set the LINK function between the focusing (OBJ) current and Focus mode. If Focus link is avoided, the same focusing current adjusted in the Focus mode will be output at the time of photographing. Focus and Photo conditions can be registered in the same lens mode (HC, HR, ZOOM or DIFF).


(2) Delay time Input Box: 

A time period till opening the exposure shutter can be input with reference to the beam blanking end time point. Input a desired value within -100.0 to 100.0 seconds using the  button or keyboard. When a minus (-) value is input, the shutter will open first, and then exposure will start at the end of beam blanking.

(3) Blanking wait Input Box: 

A time period from film feed for photographing to release of beam blanking can be input. Input a desired value within 0.0 to 100.0 seconds using the  button or keyboard.


(4) LD exp. time Input Box: 

An exposure time period in low-dose photography can be input. Input a desired value within 0.1 to 1000.0 seconds using the  button or keyboard.

3.4 Function Menu (Hitachi H-7650 control window)

3.4.7 API condition (specimen damage minimizing function)

API (Auto Pre-Irradiation) is a function for preparatory irradiation intended to prevent drift and damage of a specimen due to its heat exchange by acclimatizing the specimen to the electron beam before image observation or recording when the specimen is a beam-sensitive biological one.

Clicking API condition in the Function menu shown in Fig. 3-144 will open the API condition window. This window can also be opened by clicking the icon ().

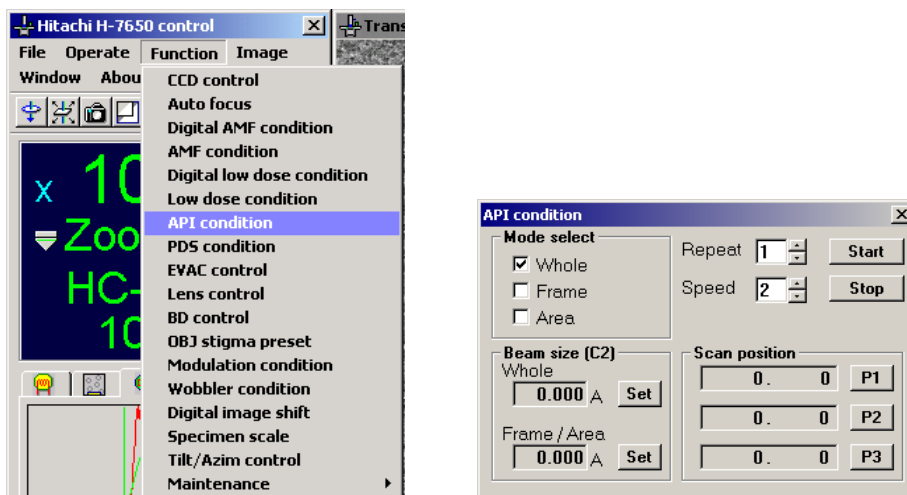


Fig. 3-144 API condition Menu and API condition Window

(1) Mode select

The API function has Whole mode, Frame mode and Area mode. These modes are usable in combination with one another. When two or mode modes are selected, they will be executed in the order of Whole, Frame and Area.

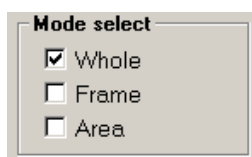


Fig. 3-145 Mode select Group

(a) Whole mode: Whole

In this mode, the entire field is irradiated with the electron beam. First, the beam is spread beyond the fluorescent screen, and then gradually focused with time. The diameter of the finally focused beam needs to be adjusted by the BRIGHT knob on the left operation panel and then registered.

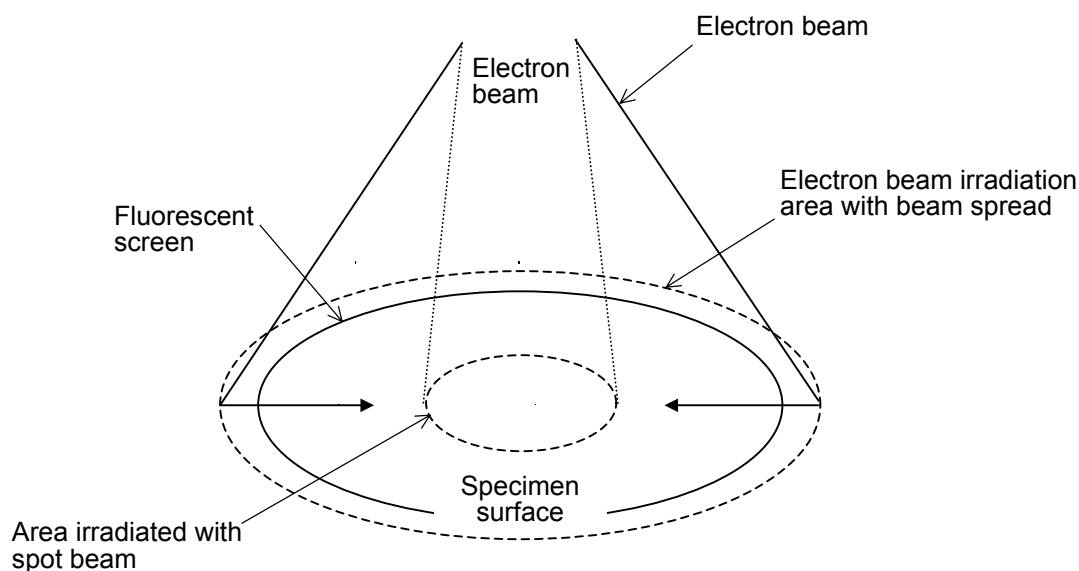


Fig. 3-146 Schematic Diagram of Whole Mode (pre-irradiation function)

(b) Frame mode: Frame

The electron beam is scanned along the perimeter of the area to be irradiated. The spot diameter of this electron beam needs to be adjusted by the BRIGHT knob on the left operation panel, and then registered.

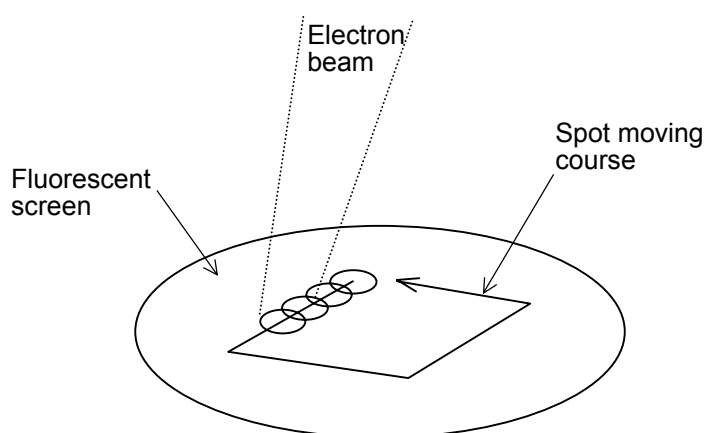


Fig. 3-147 Schematic Diagram of Frame Mode

3.4 Function Menu (Hitachi H-7650 control window)

(c) Area mode: Area

The entire area of microscopic interest is irradiated by scanning the electron beam. While keeping the beam diameter constant, the beam is moved toward the inside of the area. The spot diameter of the electron beam needs to be registered by using the BRIGHT knob.

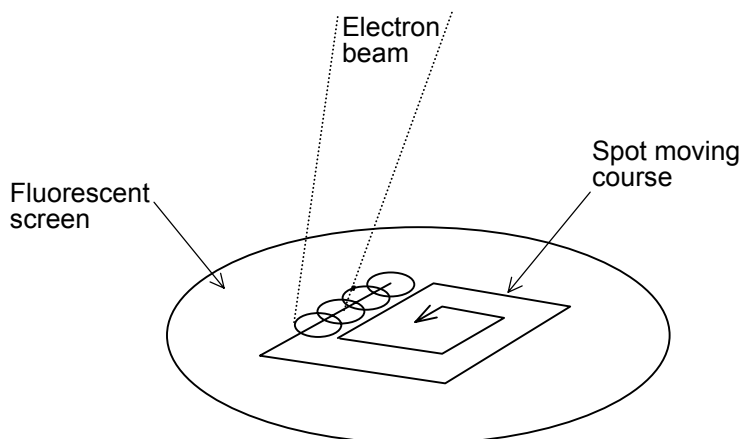


Fig. 3-148 Schematic Diagram of Area Mode

(2) Beam size [C2]

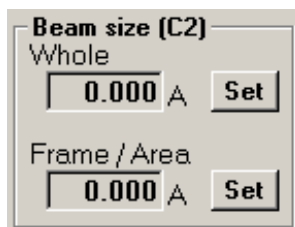


Fig. 3-149 Beam size [C] Group

- (a) The Set button for Whole registers the diameter (current value) of the electron beam finally focused in the Whole mode. Adjust the beam diameter by the BRIGHT knob on the left operation panel and press the Set button for Whole.
- (b) The Set button for Frame/Area registers the diameter (C2 current value) of the electron beam used in the Frame/Area mode. Determine the beam diameter by the BRIGHT knob and press the Set button for Frame/Area.
- (c) The beam diameter (current value) in the Whole mode, which is to be determined by the BRIGHT knob, has a restriction that it cannot be set on the underfocus side from the spot status.

(3) Scan position

The P1, P2 and P3 buttons in the Scan position group are used to determine the irradiation area in the Frame and Area modes. Each coordinate point is based on the center of the fluorescent screen.

- (a) On the left operation panel, set the multi-knob to BH.
- (b) Turn the multi-knob so that the beam center comes to the P1 point, and press the P1 button. The P1 point is now registered, and the X and Y coordinates of BH are displayed.
- (c) In the same way as above, bring the beam center to the P2 and P3 points, and press the P2 and P3 buttons. After specification of 3 points for an irradiation area, the fourth point will be automatically calculated.

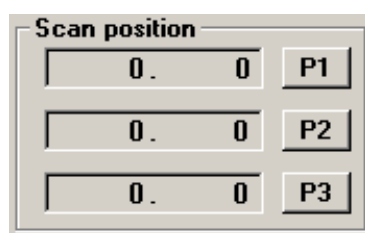


Fig. 3-150 Scan position

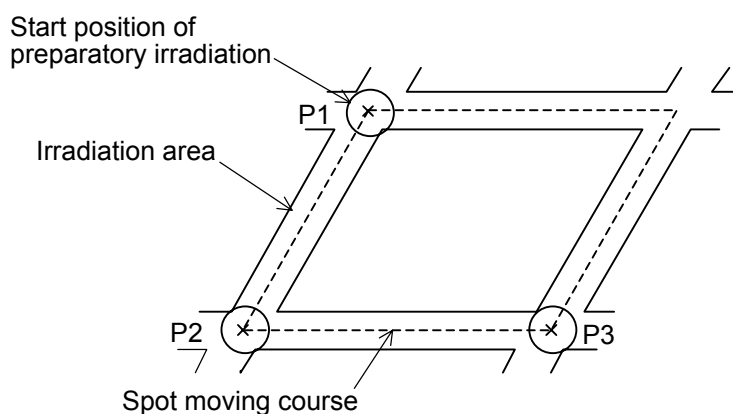


Fig. 3-151 Determination of Irradiation Area in Frame/Scan Mode

- (4) Repeat data input box: Repeat

You can input a number of repetitions within 1 to 10 using the button or keyboard.

- (5) Speed data input box: Speed

You can input a scan speed within levels 1 to 3 using the button or keyboard.


When the Whole mode is combined with the Frame or Area mode in the Mode select group, the set number of repetitions is applied to the Frame or Area mode. This means that the Whole mode will be executed only once.

3.4 Function Menu (Hitachi H-7650 control window)

- (6) Click the Start button, and the API function will be executed. However, an error buzzer sound is emitted 3 times and the API function will not be executed if an invalid value is set for any parameter. So input each parameter value correctly in the procedure instructed in (3) and (4). The API function can be stopped by clicking the Stop button during execution of this function.

3.4.8 PDS condition

The PDS (Personal Data Set) condition function is available for storing (registering) lens system conditions and beam deflector system conditions. The conditions stored with this function can be called up for setting the lens system and the beam deflector system.

As shown in Fig. 3-152, select "PDS condition" from the Function menu. The Personal data set (PDS) window will then appear. Alternatively, you can open this window by clicking the  icon.

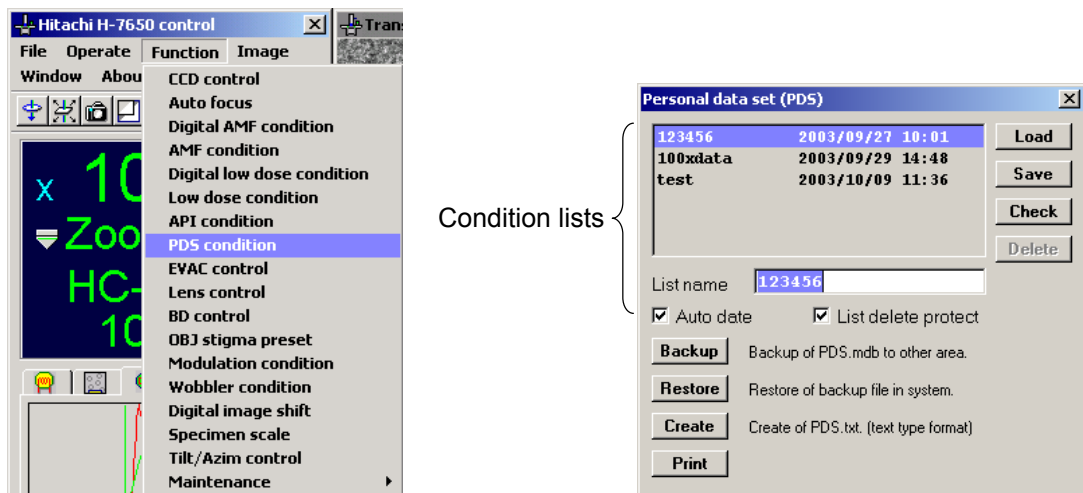


Fig. 3-152 PDS condition Menu Item and Personal data set (PDS) Window

- (1) PDS condition Lists

Up to 20 PDS condition lists can be stored. Using the scrollbar, you can check all the list names in the PDS window. To select a list, click its name. The name of the selected list will be highlighted in blue.

- (a) Load button: 

Pressing this button calls up the currently selected PDS condition list and sets up the lens/beam deflector system conditions specified in it. In this step, the present lens/beam deflector system conditions will be overwritten. As required, store the present lens/beam deflector system conditions as a PDS condition list beforehand.

- (b) Save button: **Save**

Pressing this button stores the current lens/beam deflector system conditions as a PDS condition list. A name entered in the List name box is assigned to this PDS condition list.

- (c) Check button: **Check**

Pressing this button presents the detailed information regarding the currently selected PDS condition list. Thus, you can view its contents in the PDS check window shown below. To close the PDS check window, click the Return button on it.

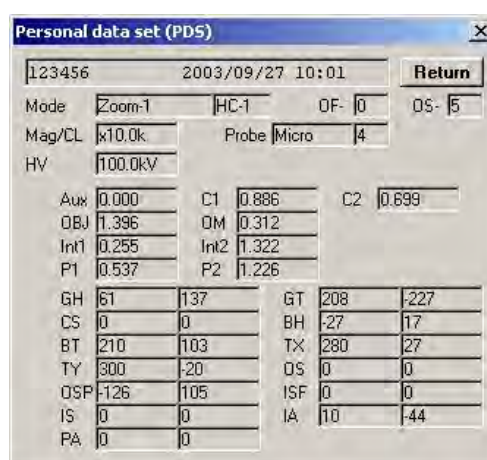


Fig. 3-153 PDS Check Window

- (d) Delete button: **Delete**

Pressing this button removes the currently selected PDS condition list. Note that if the check box of "List delete protect" is turned on (), it is not allowed to delete the selected PDS condition list. For its removal, turn off the check box of "List delete protect" and then click the Delete button.

- (e) List name: List name

In this text box, enter a list name for storing the present lens/beam deflector system conditions. A list name may be up to 12 alphanumeric characters long. After entering a list name, you can edit it using the mouse.

3.4 Function Menu (Hitachi H-7650 control window)

(f) Auto date: Auto date

With this check box turned on () , the date and time is automatically updated at the time of storing the present lens/beam deflector system conditions.

(g) List delete protect: List delete protect

With this check box turned on () , the stored PD condition list concerned cannot be deleted.

(The Delete button becomes ineffective.)

(2) Backup Button: **Backup** Backup of PDS.mdb to other area.

Using this button, you can save a group of 20 PDS condition lists onto a floppy disk (FD) or hard disk (HD).

Note that if the remaining free space of HD becomes insufficient, a trouble may occur in operation of the TEM system program. For saving ten or more groups of PDS condition data, use floppy disks.

(a) Clicking the Backup button opens the PDS data backup window shown below.

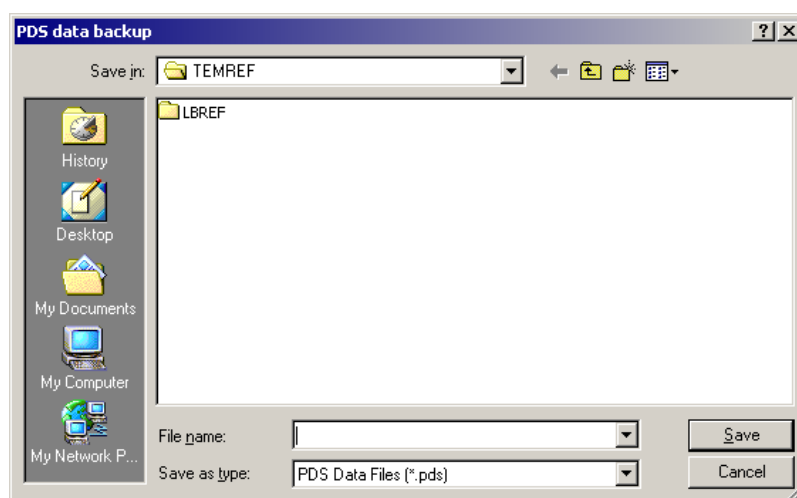


Fig. 3-154 PDS data backup Window

(b) In the File name input box, enter a file name through the keyboard, and then click the Save button. Thus, a group of 20 PDS condition lists can be saved as a backup file.

- (3) Restore Button: **Restore** Restore of backup file in system.

Using this button, you can call up PDS data saved in a FD or HD and add it as an applicable PDS condition list.

- (a) Clicking the Restore button opens the PDS data load window shown below.

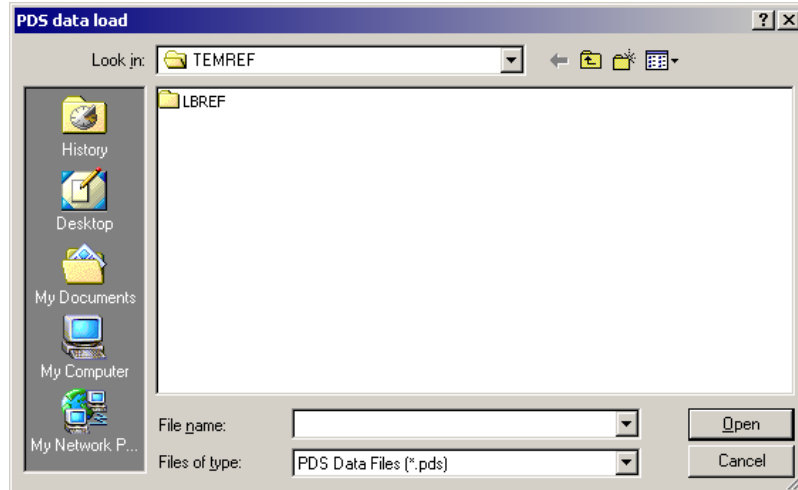


Fig. 3-155 PDS data load Window

- (b) Select the file to be called up, or enter its name in the File name input box through the keyboard. Then, click the Open button, and the PDS data concerned will then be added as an applicable PDS condition list.

- (4) Create Button: **Create** Create of PDS.txt. (text type format)

Using PDS data (“mdb” file), you can create the following two text files to be used for data management. To prevent inadvertent overwriting, rename the files names just after their creation.

- (a) PDS_sp.txt : A text file in which space characters are used as delimiters in data.
 (b) PDS-tb.txt : A text file in which tab characters are used as delimiter in data.


- (5) Print Button: **Print**

Clicking this button prints out a text file. Note that the Print button can be made active only where the printer driver has been set up.

3.4 Function Menu (Hitachi H-7650 control window)

3.4.9 EVAC control

The EVAC control function is available for displaying the current states of the evacuation system. In the graphic display on the EVAC control window, the AIR state is indicated in red, the CLOSE state in yellow, and the EVAC state in blue. The current vacuum level of each block and the temperatures of the DP-1 and DP-2 are always indicated also.

As shown in Fig. 3-156, click “Evac control” on the Function menu. The EVAC control window will then appear. Alternatively, you can open this window by clicking the  icon.

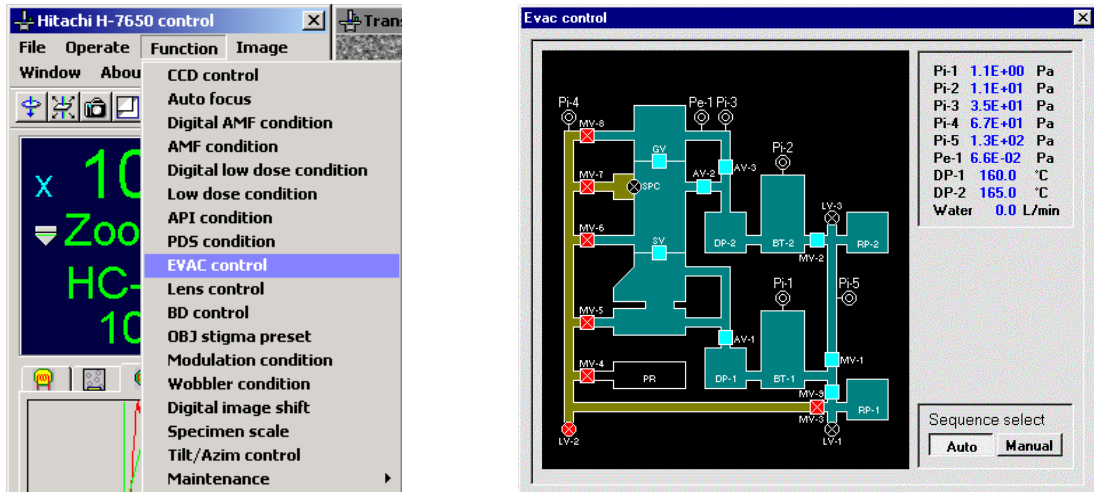


Fig. 3-156 Evac control Menu Item and EVAC control Window

(1) The Sequence select field indicates the Auto or Manual mode of the evacuation valve sequence.

(a) Auto mode: Auto

Select this mode for common practice. Full-automatic evacuation is performed.

(b) Manual mode: Manual

This mode is to be used for maintenance servicing. Since the Manual mode is password-protected, it is not allowed for the user to select the Manual mode in common practice.

- (2) Figure 3-157 shows the EVAC control window of the Dry evacuation version (option). In the Dry evacuation version, the electron gun and microscope column are evacuated by the turbo molecular pump. The observation chamber and camera chamber are evacuated by the oil diffusion pump.

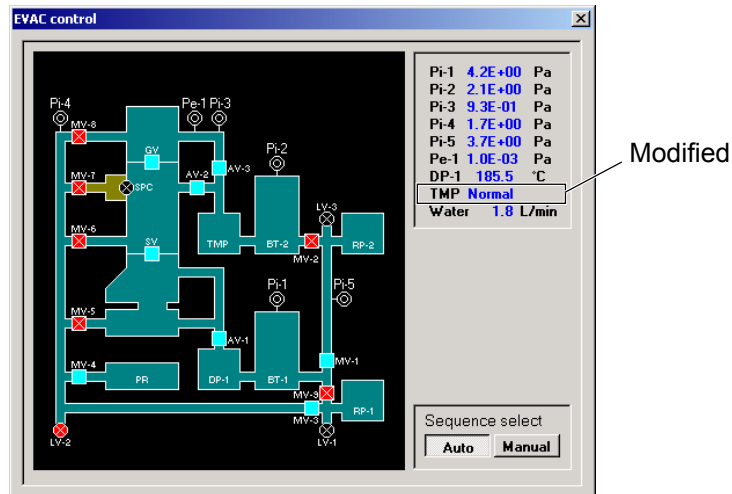



Fig. 3-157 Evac control Window (Dry evacuation version)

- (3) The PR (plate reservoir) is available as an option.

3.4 Function Menu (Hitachi H-7650 control window)

3.4.10 Lens control

The Lens control function allows you to view each lens current and select a lens for adjusting its current. To increase/decrease each lens current, use the DIFF SPOT knob equipped on the right operation panel.

As shown in Fig. 3-158, click “Lens control” on the Function menu. The Lens control window will then appear. Alternatively, you can open this window by clicking the  icon.

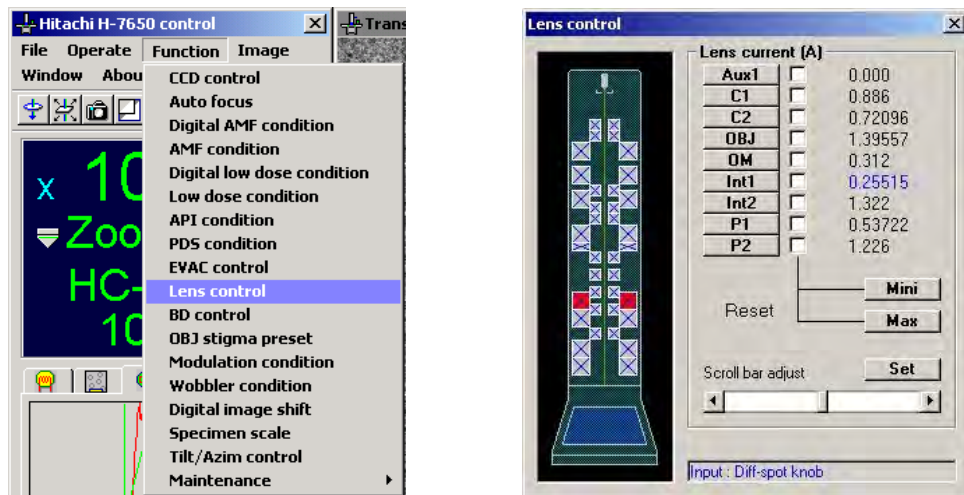


Fig. 3-158 Lens control Menu Item and Lens control Window

- (1) In the Lens current field of the Lens control window, click one of the Aux1, C1, ... P2 buttons. Thus, each current value of the Aux1 to P2 lenses can be changed. When one of the lens buttons is clicked for selection, the graphic element corresponding to the selected lens is highlighted in red. In this state, the lens current concerned can be adjusted using the DIFF SPOT knob on the right operation panel. To deselect the lens button being selected, just click it again. Since the current value of each lens is linked with an accelerating voltage, the maximum allowable current value varies depending on the accelerating voltage being applied. Note that when the accelerating voltage function is turned off, it is not allowed to set up a lens current. Shown below is a list of maximum allowable current levels corresponding to accelerating voltages to be used in common practice.

NOTE: The Aux1 lens is optionally available. Its selection is not accepted unless it is provided.

Table 3-6 Maximum Allowable Lens Current Levels

	120 kV	100 kV	80 kV	70 kV	60 kV	50 kV
AUX1	1.878 A	1.700 A	1.506 A	1.455 A	1.293 A	1.175 A
C1	1.878 A	1.700 A	1.506 A	1.455 A	1.293 A	1.175 A
C2	1.878 A	1.700 A	1.506 A	1.455 A	1.293 A	1.175 A
OBJ	2.144 A	1.940 A	1.719 A	1.661 A	1.475 A	1.340 A
OM	0.559 A	0.506 A	0.449 A	0.418 A	0.385 A	0.350 A
Int1	1.878 A	1.700 A	1.506 A	1.455 A	1.293 A	1.175 A
Int2	1.878 A	1.700 A	1.506 A	1.455 A	1.293 A	1.175 A
P1	1.878 A	1.700 A	1.506 A	1.455 A	1.293 A	1.175 A
P2	1.878 A	1.700 A	1.506 A	1.455 A	1.293 A	1.175 A

- (2) Mini Reset Button: 

Clicking this button sets up 0.0 A for a lens with its check box turned on ()

- (3) Max Rest Button: 

Clicking this button sets up a maximum allowable current value corresponding to each accelerating voltage for a lens with its check box turned on () . For maximum allowable current levels corresponding to accelerating voltages, refer to Table 3-6.

- (4) Scroll bar adjust

As in the above item (2), you can adjust each selected lens current in this field.

- (5) Set Button

Clicking this button sets up the lens current being indicated.



Fig. 3-159 Scroll bar adjust and Set Button

3.4 Function Menu (Hitachi H-7650 control window)

(6) Reset Switch

Using the LENS Reset switch on the left operation panel, you can reset lens current values changed in the above items (2) to (5).

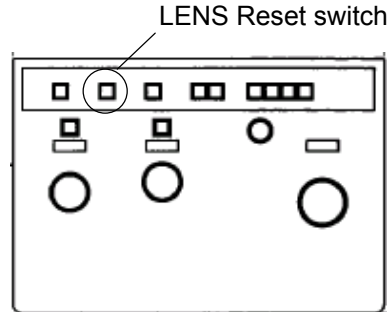



Fig. 3-160 Left Operation Panel

NOTE: If a lens current is changed with a specimen inserted, the specimen may be damaged or a burn-in may occur on the fluorescent coating of the screen. To prevent this, take care not to leave a specimen inserted.

3.4.11 BD control

The BD control function is available for controlling a current applied to the beam deflector (BD) coil.

As shown in Fig. 3-161, click "BD control" on the Function menu. The BD control window will then appear. Alternatively, you can open this window by clicking the  icon.

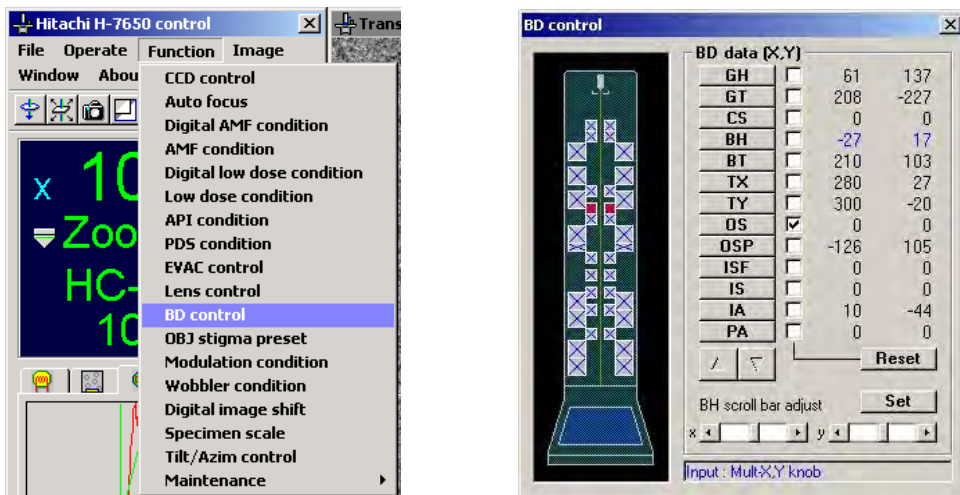


Fig. 3-161 BD control Menu Item and BD control Window



- (1) In the BD data field of the BD control window, click one of the GH, GT, ... PA buttons. Thus, the BD to be controlled can be selected. When one of the coil buttons is clicked, the graphic element corresponding to the selected coil is highlighted in red. To deselect the coil button being selected, just click it again. Using the ALIGNMENT select switch on the right operation panel, you can also select BH, BT, CS or OS. The output value of each coil can be adjusted in the range of -2048 to 2047 by turning the multi-knob X on the left operation panel or the multi-knob Y on the right operation panel.
- (2) Clicking the screen size change button  presents a row of lens buttons for BD coil selection as shown in Fig. 3-162. For restoration, click the button .



Fig. 3-162 BD Coil Selection

- (3) Reset Button: 

Clicking this button resets a BD with its check box turned on ()

- (4) Scroll bar adjust

As in the above item (2), you can adjust the output value of the BD coil being selected.

- (5) Set Button

Clicking this button sets up the output value of the BD coil under adjustment.

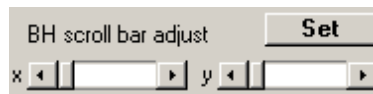



Fig. 3-163 Scroll bar adjust and Set Button

3.4 Function Menu (Hitachi H-7650 control window)

3.4.12 OBJ stigma preset

The OBJ stigma preset function is available for storing offset data for correction of objective lens astigmatism. Up to five offset conditions can be saved for each of HC and HR, i.e., up to ten offset conditions can be saved in total. Each saved offset conditions can be called up as required.

As shown in Fig. 3-164, click “OBJ stigma preset” on the Function menu. The OBJ stigma preset window will then appear. Alternatively, you can open this window by clicking the  icon.

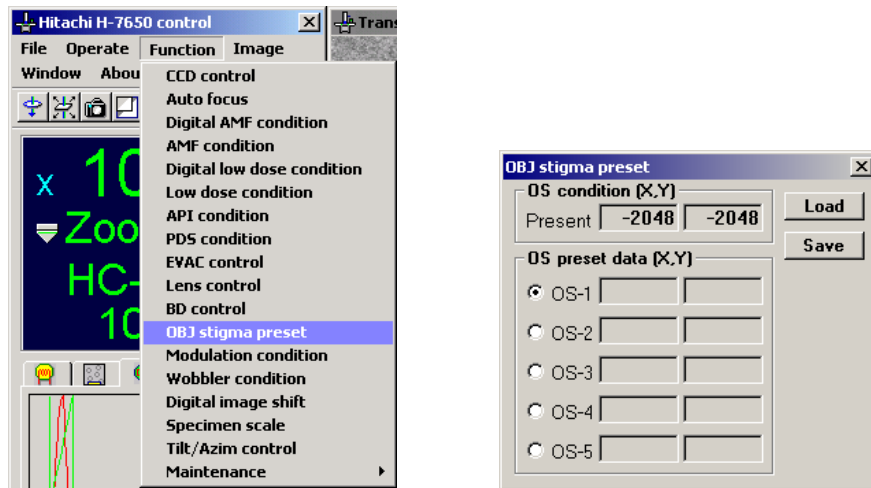
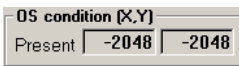


Fig. 3-164 OBJ stigma preset Menu Item and OBJ stigma preset Window

- (1) OS condition [X, Y]: 

The Present indication box shows an offset value of objective astigmatism correction being selected. It can be changed by turning the OS-assigned multi-knob.

- (2) OS preset data [X, Y]

The OS preset data field indicates a list of OS preset data being held in the memory areas OS-1 to OS-5.

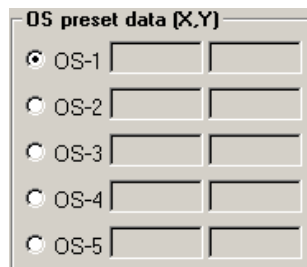




Fig. 3-165 OS preset data [X, Y]

- (3) Save Button: **Save**

For saving the Present data of OS condition [X, Y] being indicated, select one of the memory areas OS-1 to OS-5 of OS present data [X, Y] by turning on its radio button (), and then click the Save button. The data thus saved is indicated in the OS preset data field.

- (4) Load Button: **Load**

For loading any existing OS preset data, select its corresponding one of the memory areas OS-1 to OS-5 of OS preset data [X, Y] by turning on its radio button (), and then click the Load button. The data thus loaded is indicated in the Preset indication box of OS condition [X, Y].

- (5) Note that the amount of change to be made by turning the multi-knob is linked with the magnification being selected.

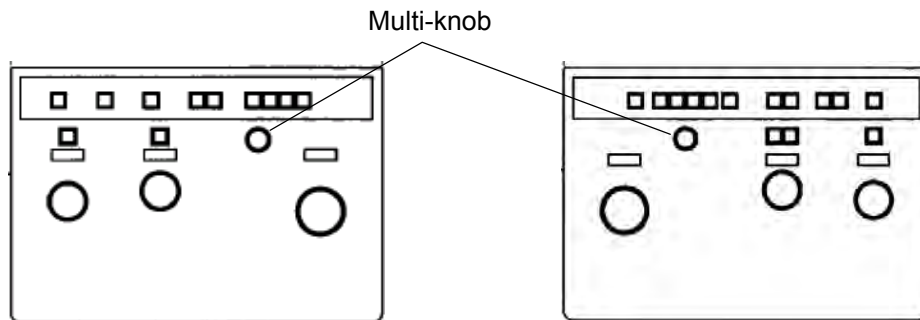


Fig. 3-166 Left and Right Operation Panels

3.4 Function Menu (Hitachi H-7650 control window)

3.4.13 Modulation condition

The Modulation condition function allows you to set up the frequency and amplitude of HV modulation (voltage center adjustment)/OBJ modulation (current center adjustment). As shown in Fig. 3-167, click “Modulation condition” on the Function menu. The Modulation condition window will then appear.

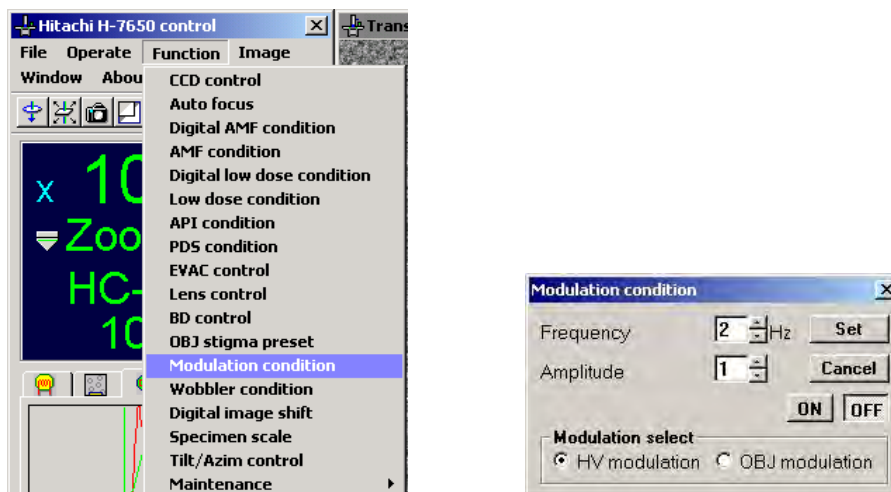


Fig. 3-167 Modulation condition Menu Item and Modulation condition Window

(1) Modulation select

Select HV modulation or OBJ modulation by turning on its radio button () , and then click the Set button.

(a) HV modulation: HV modulation

Use this function for voltage centering through accelerating voltage adjustment.


(b) OBJ modulation: OBJ modulation

Use this function for current centering through objective lens current adjustment.



(2) Frequency Input Box: Frequency Hz

Specify a frequency using the spinner button or through the keyboard. The allowable frequency range is 1 to 10 Hz. After specifying a frequency, click the Set button.

- (3) Amplitude Input Box:

Specify an amplitude using the spinner button  or through the keyboard. The allowable amplitude range is 1 to 10 (amplitude-magnification linkage is provided). After specifying an amplitude, click the Set button.

- (4) ON/OFF Button:

Clicking the button starts HV modulation or OBJ modulation which has been turned on in the Modulation select field. To stop the HV/OBJ modulation, click the button. Note that the ON/OFF button is operatively associated with the icon  and the MODU switch on the right operation panel. Instead of using the ON button, you may click the icon or press  the MODU switch to start HV/OBJ modulation.

3.4.14 Wobbler condition

The Wobbler condition function is available for setting up the frequency, amplitude and azimuth of wobbler operation and the frequency and amplitude of stigmonitor operation.

As shown in Fig. 3-168, click “Wobbler condition” on the Function menu. The Wobbler condition window will then appear.

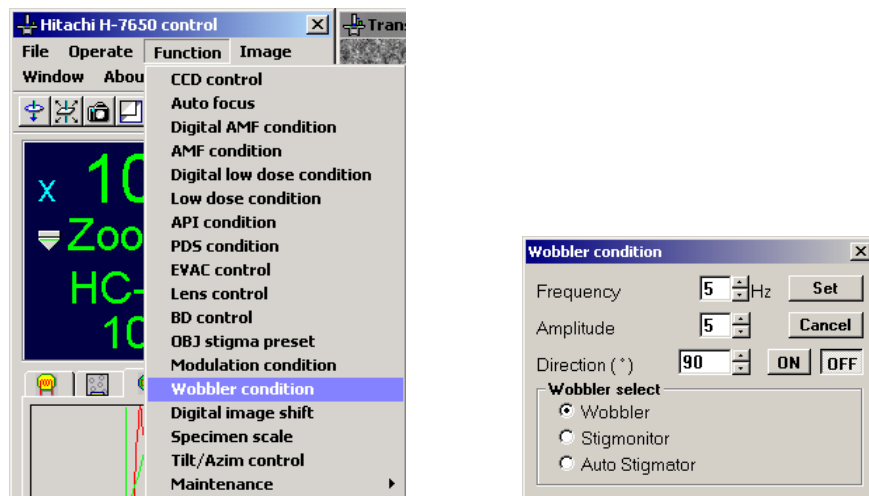



Fig. 3-168 Wobbler condition Menu Item and Wobbler condition Window

- (1) Wobbler select

Select Wobbler, Stigmonitor, or Auto Stigmator by turning its radio button () , and then click the Set button.

3.4 Function Menu (Hitachi H-7650 control window)

(a) Wobbler: Wobbler

Use this function for focus adjustment.

(b) Stigmonitor: Stigmonitor

Use this function for astigmatism correction at an intermediate/low magnification.


(c) Auto Stigmator: Auto Stigmator

Use this function for automatic astigmatism correction at an intermediate/low magnification.


(2) Frequency Input Box: Hz

Specify a frequency using the spinner button  or through the keyboard. The allowable frequency range is 1 to 20 Hz. After specifying a frequency, click the Set button.




(3) Amplitude Input Box:

Specify an amplitude using the spinner button  or through the keyboard. The allowable amplitude range is 1 to 10. Set up a wobbler amplitude so that the beam will be within the bore of the objective movable aperture even when the wobbler is active. After specifying an amplitude, click the Set button.

(4) Direction Input Box:

Specify an azimuth (direction) using the spinner button  or through the keyboard. The allowable azimuth range is 0 to 180°. After specifying an azimuth, click the Set button. Note that azimuth data cannot be set up under the condition that "Stigmonitor" is selected.

- (5) ON/OFF Button:

Clicking the button starts Wobbler, stigmonitor, or Auto-Stigmator operation that has been selected in the Wobbler select field. To stop the operation, click the button. Note that the ON/OFF button is operatively associated with the icon  and the WOB switch on the right operation panel. Instead of using the ON button, you may click the icon  or press  the WOB switch to start the Wobbler or Stigmonitor operation. In the Wobbler/Stigmonitor operation, automatic correction is made so as to provide an almost uniform degree of amplitude on the fluorescent screen at different magnifications.

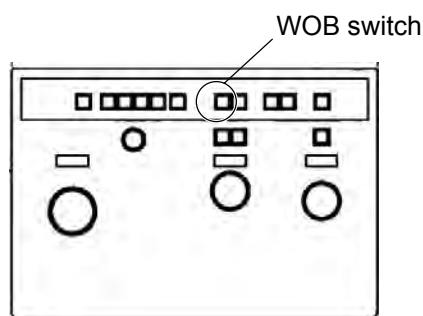


Fig. 3-169 Right Operation Panel

- (6) Using the Auto Stigmator
- In the Wobbler select field, turn on the radio button () of Auto Stigmator. Then click the Set button.
 - Connect a digital camera to display an image on the monitor.
 - Click the button, or press the WOB button on the right operation panel to start the Auto Stigmator operation.
 - The following table shows the astigmatism correction range and operating conditions for the purpose of reference.

Table 3-7 Astigmatism Correction Range and Operating Conditions

Operating magnification	×1k to ×5k
Operating MODE	HC-ZOOM 1
Accelerating voltage	80, 100, 120 kV
Correction range	2 μm or less
Exposure	8×10^{-12} to 2×10^{-11} A/cm ²

3.4 Function Menu (Hitachi H-7650 control window)

- (e) Before execution of the Auto Stigmator operation, be sure to perform axial alignment. For voltage centering and objective aperture centering in particular, perform axial alignment correctly referring to 2.3.2.
- (f) For some kinds of specimens, normal correction may not be made. For correction, use a specimen that can provide clear features in imaging.
- (g) If adequate correction cannot be made with the Auto Stigmator operation, repeat correction as many times as required or perform correction by using the OBJ stigma preset function. For details of the OBJ stigma preset function, refer to 3.4.12.
- (h) Note that the buttons and keys on the operation panel are made nonfunctional during execution of the Auto Stigmator operation.
- (i) Only the standard camera specified for the H-7650 is applicable.
- (i) Enumerated below are the error messages to be issued:
 - 1) Mode error.
Issued if the Auto Stigmator operation is attempted in a lens mode other than HC-ZOOM 1.
Check that the lens mode HC-ZOOM 1 is selected.
 - 2) Magnification error.
Issued if the Auto Stigmator operation is attempted at a magnification of 5.0k or higher.
Check that a magnification of less than 5.0k is selected.
 - 3) Acc. voltage error.
Issued if the Auto Stigmator operation is attempted at an accelerating voltage other than 80, 100 and 120 kV.
Check that an accelerating voltage of 80, 100 or 120 kV is applied.
 - 4) Can't execute with a current condition.
Issued if the Auto Stigmator operation is attempted in a state other than 0° image rotation.
Cancel an image rotation if it is specified.
 - 5) AS unit: Cannot correct!
Issued if image features are not clear.
For correction, use a specimen that can provide clear features in imaging.
 - 6) OS data out of range.
Issued if the amount of astigmatism correction calculated exceeds the allowable range for correction. Carry out axial alignment. For voltage centering and objective aperture centering in particular, perform axial alignment correctly referring to 2.3.2.

3.4.15 Digital image shift

The Digital image shift function allows you to determine the critical dimensions and area of a specimen through the use of the image shift coil. In CD measurement of a specimen, enter coordinate points to determine a distance between them. In area measurement, triangle-based approximation is performed.

Note that this function is suitable for measurement at a high magnification of 10k \times or more. For measurement at a low magnification, use the Specimen scale function.

- (1) Set the multi-knobs X and Y to ISF coil.
- (2) As shown in Fig. 3-170, click "Digital image shift" on the Function menu. The Digital image shift window will then appear.

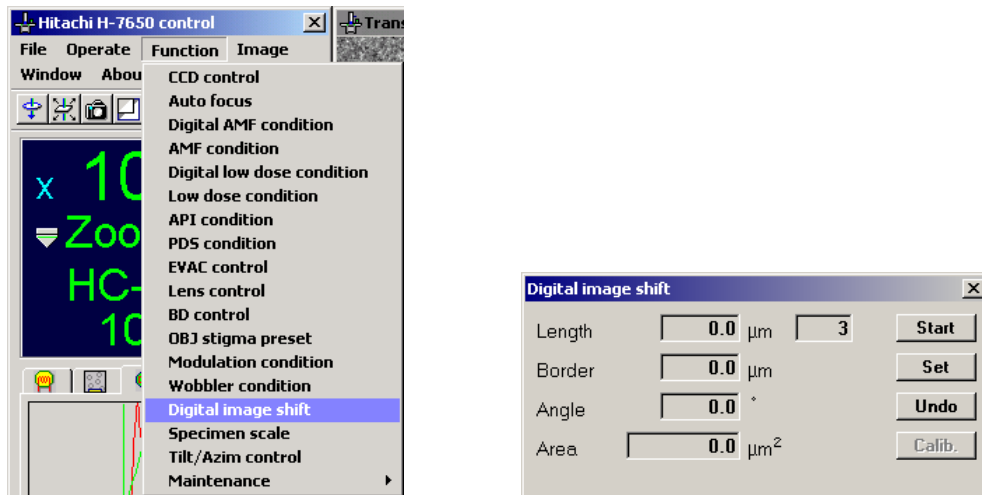


Fig. 3-170 Digital image shift Menu Item and Digital image shift Window

- (3) Length Indication Box: μm

This box indicates a distance from the reference point to the last specified point on the path of all the coordinate points specified in succession.

- (4) Border Indication Box: μm

This box indicates a circumferential length of a closed region on the path of all the coordinate points specified in succession.

- (5) Angle Indication Box: °

This box indicates an angle formed by the last three specified points.

3.4 Function Menu (Hitachi H-7650 control window)

(6) Area Indication Box: μm^2

An area value of a closed region on the path of all the coordinate points specified in succession is calculated through triangle-based approximation, and the result thus attained is indicated in this box.

(7) Specified Point Count Indication Box:

This box indicates the number of specified coordinate points. Up to 999 coordinate points are specifiable.

(8) Start Button:

Clicking this button starts measurement. All the indicated values can be reset by clicking this button during measurement.

(9) Set Button:

Clicking this button defines the current coordinate point. A value measured at that point of time is indicated in each indication box.

(10) Undo Button:

Clicking this button resets the last specified point and its corresponding value measured. Thus, you can return to the previous indications.

(11) How to Measure a Specimen

(a) Using the image shift coil, set the start reference point of the specimen concerned (point "a" indicated below) to the center of the fluorescent screen. Then, click the Start button.

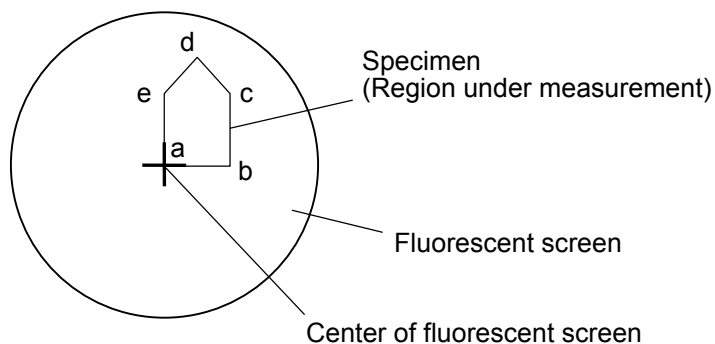


Fig. 3-171 Specimen Setting at the Start of Measurement

- (b) Further, using the image shift coil, bring the next visual field position of interest (point “b” indicated below) to the center of the fluorescent screen. Then, click the Set button.

- A distance from the reference point is indicated in the Length indication box.

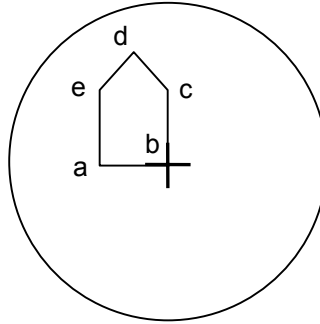


Fig. 3-172 Specimen Setting at the Second Measurement Point

- (c) Further, using the image shift coil, bring the third visual field position (point “c” indicated below) to the center of the fluorescent screen. Then, click the Set button.

- 1) The Length indication box indicates a distance from the reference point “ab+bc”.
- 2) The Border indication box indicates a circumferential length “ab+bc+ca”.
- 3) The Angle indication box indicates an angle “ $\angle abc$ ”.
- 4) The Area indication box indicates a triangle area “abc”.

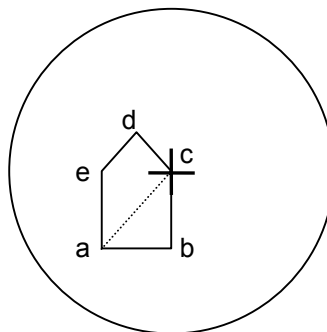


Fig. 3-173 Specimen Setting at the Third Measurement Point

- (d) Further, using the image shift coil, bring the fourth visual field position (point “d” indicated below) to the center of the fluorescent screen. Then, click the Set button.

- 1) The Length indication box indicates a distance from the reference point “ab+bc+cd”.
- 2) The Border indication box indicates a circumferential length “ab+bc+ca+da”.

3.4 Function Menu (Hitachi H-7650 control window)

- 3) The Angle indication box indicates an angle " $\angle bcd$ ".
- 4) The Area indication box indicates a triangle area " abc " plus a triangle area " acd ".

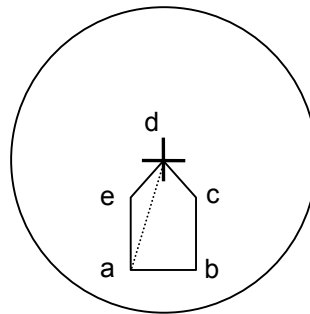


Fig. 3-174 Specimen Setting at the Fourth Measurement Point

- (e) Repeat the above step in the same manner to set up the last visual field position (point "e" indicated below). Thus, you can carry out specimen measurement. If it is desired to make measurement with different visual fields, click the Start button to reset the data being indicated.

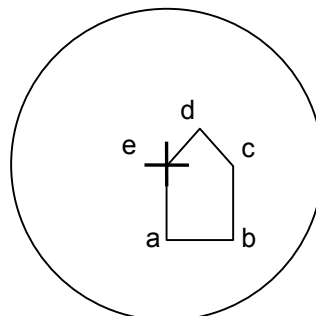


Fig. 3-175 Specimen Setting at the Fifth Measurement Point

- (12) Area calculation with this function is performed through triangle-based approximation. Therefore, measurement is not allowed if polygons are formed by drawing intersecting lines from coordinate points as in the example shown in Fig. 3-176, in which coordinate points are specified in the order of "abcd".
- In such a case, specify the coordinate points in the order of "abcdef" as exemplified in Fig. 3-177. Note that measurement is allowed even if "c" and "f" are located at the same coordinate point.

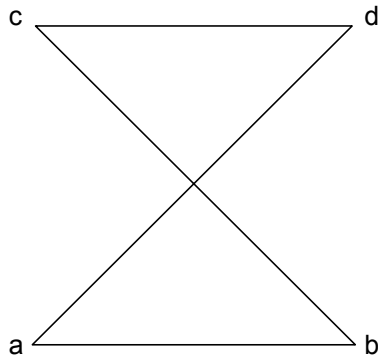


Fig. 3-176 Measurement not Allowed (example)

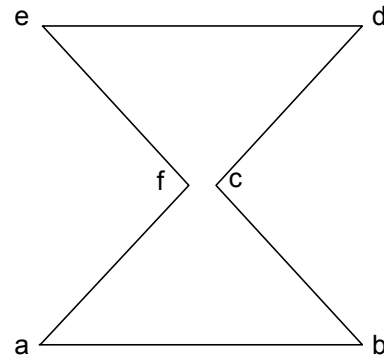


Fig. 3-177 Measurement Allowed (example)

- (13) Calib. Button: 

Clicking this button opens the Digital image shift calibration window. Thus, the calibration mode can be set up for adjusting the amount of movement of the image shift coil. Regarding the X and Y directions of the image shift coil, perform calibration for each lens system (reduction lens system, magnification lens system). Two calibration methods are available; in one method, calibration is made in reference to the size of the fluorescent screen, and in the other method, calibration is made by measuring a specimen having a known length.

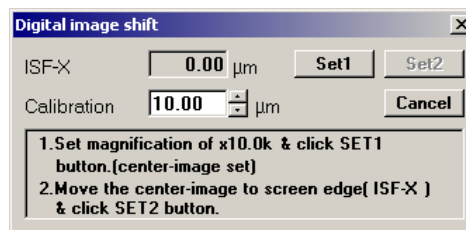


Fig. 3-178 Digital image shift Calibration Window (1)

3.4 Function Menu (Hitachi H-7650 control window)

(a) Calibration in reference to the size of the fluorescent screen

- 1) First, calibrate the reduction lens system ISF-X.
 - a) Select the lens mode HC:ZOOM, and set up a magnification of 10k \times .
 - b) By moving the stage, bring the reference specimen to the center of the fluorescent screen.
 - c) Click the Set1 button.
 - d) By moving the ISF-X only, bring the reference visual field to an edge position of the fluorescent screen.
 - e) In the Calibration input box, specify 10.0 μm (the radius of the fluorescent screen at a magnification of 10k \times). Then, click the Set2 button.
This completes the calibration of the reduction lens system ISF-X.
- 2) Then, the calibration mode of the reduction lens system ISF-Y is provided.

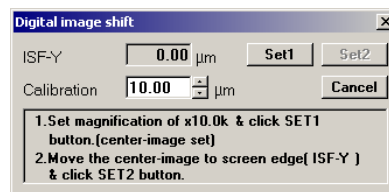


Fig. 3-179 Digital image shift Calibration Window (2)

- a) By moving the stage, bring the reference specimen to the center of the fluorescent screen.
- b) Click the Set1 button.
- c) By moving the ISF-Y only, bring the reference visual field to an edge position of the fluorescent screen.
- d) In the Calibration input box, specify 10.0 μm (the radius of the fluorescent screen at a magnification of 10k \times). Then, click the Set2 button.

This completes the calibration of the reduction lens system ISF-Y.

- 3) Then, the calibration mode of the magnification lens system ISF-X is provided.

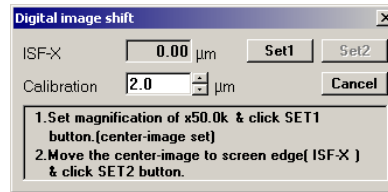


Fig. 3-180 Digital image shift Calibration Window (3)

- Select the lens mode HC:ZOOM, and set up a magnification of 50k \times (film magnification).
- By moving the stage, bring the reference specimen to the center of the fluorescent screen.
- Click the Set1 button.
- By moving the ISF-X only, bring the reference visual field to an edge position of the fluorescent screen.
- In the Calibration input box, specify 2.0 μm (the radius of the fluorescent screen at a magnification of 50k \times). Then, click the Set2 button.

This completes the calibration of the magnification lens system ISF-X.

- 4) Then, the calibration mode of the magnification lens system ISF-Y is provided.

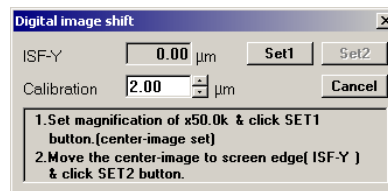


Fig. 3-181 Digital image shift Calibration Window (4)

- By moving the stage, bring the reference specimen to the center of the fluorescent screen.
- Click the Set1 button.
- By moving the ISF-Y only, bring the reference visual field to an edge position of the fluorescent screen.
- In the Calibration input box, specify 2.0 μm (the radius of the fluorescent screen at a magnification of 50k \times). Then, click the Set2 button.

This completes the calibration of the reduction lens system ISF-Y.

3.4 Function Menu (Hitachi H-7650 control window)

- 5) Thus, all the calibration steps has been completed. Click the Save button to store the calibration condition data concerned.

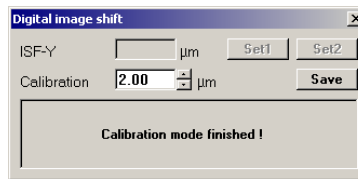


Fig. 3-182 Digital image shift Calibration Window (5)

- (b) Calibration through measurement of a known specimen

Calibration can also be made by measuring a specimen having a known length. For this calibration, take procedural steps similar to Item (a) - "Calibration in reference to the size of the fluorescent screen".

In this calibration, enter the known length of the specimen in the Calibration input box, and click the Set2 button at the steps 1)-e), 2)-d), 3)-e), and 4)-d).

3.4.16 Specimen scale

The Specimen scale function allows you to determine the critical dimensions and area of a specimen through use of the specimen stage. In CD measurement of a specimen, enter coordinate points to determine a distance between them. In area measurement, triangle-based approximation is performed.

Note that this function is suitable for measurement at a low magnification of 50k \times or less.

For measurement at a high magnification, use the Digital image shift function.

As shown in Fig. 3-183, click "Specimen scale" on the Function menu. The Specimen scale window will then appear.

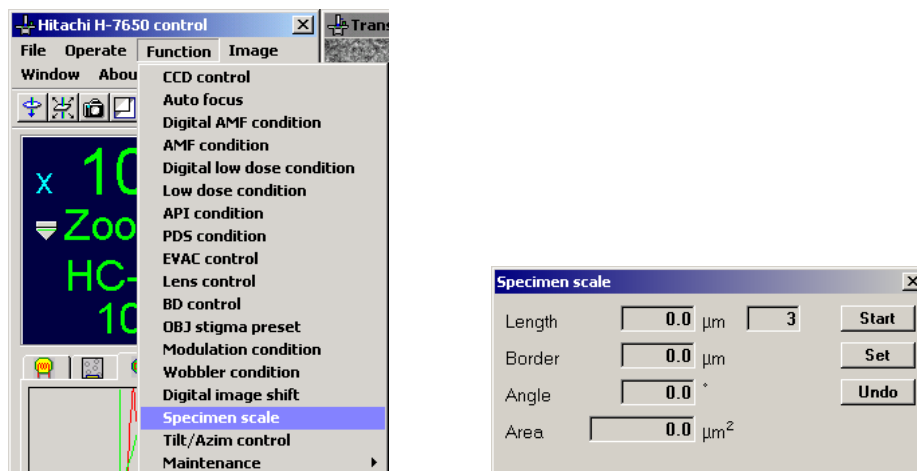


Fig. 3-183 Specimen scale Menu Item and Specimen scale Window

- (1) Length Indication Box: μm

This box indicates a distance from the reference point to the last specified point on the path of all the coordinate points specified in succession.

- (2) Border Indication Box: μm

This box indicates a circumferential length of a closed region on the path of all the coordinate points specified in succession.

- (3) Angle Indication Box: $^{\circ}$

This box indicates an angle formed by the last three specified points.

- (4) Area Indication Box: μm^2

An area value of a closed region on the path of all the coordinate points specified in succession is calculated through triangle-based approximation, and the result thus attained is indicated in this box.

- (5) Specified Point Count Indication Box

This box indicates the number of specified coordinate points. Up to 999 coordinate points are specifiable.

- (6) Start Button:

Clicking this button starts measurement. All the indicated values can be reset by clicking this button during measurement.

- (7) Set Button:

Clicking this button defines the current coordinate point. A value measured at that point of time is indicated in each indication box.

- (8) Undo Button:

Clicking this button resets the last specified point and its corresponding value measured. Thus, you can return to the previous indications.

3.4 Function Menu (Hitachi H-7650 control window)

(9) How to Measure a Specimen

- (a) Using the image shift coil, set the start reference point of the specimen concerned (point "a" indicated below) to the center of the fluorescent screen. Then, click the Start button.

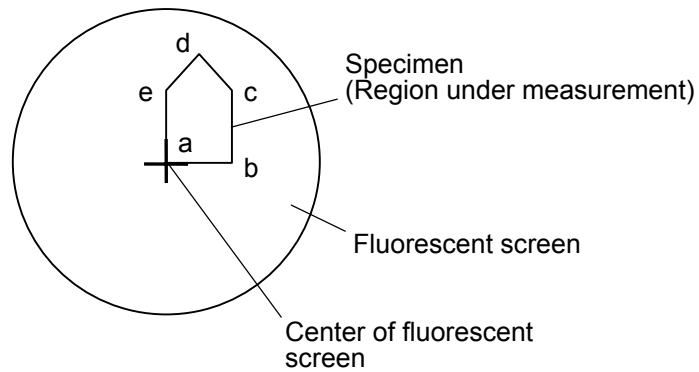


Fig. 3-184 Specimen Setting at the Start of Measurement

- (b) Further, using the image shift coil, bring the next visual field position of interest (point "b" indicated below) to the center of the fluorescent screen. Then, click the Set button.

- A distance from the reference point is indicated in the Length indication box.

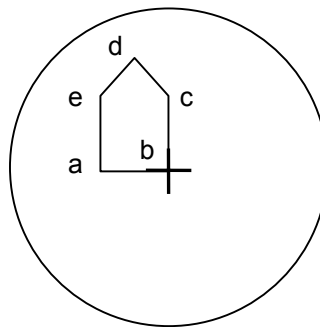


Fig. 3-185 Specimen Setting at the Second Measurement Point

- (c) Further, using the image shift coil, bring the third visual field position (point “c” indicated below) to the center of the fluorescent screen. Then, click the Set button.
- 1) The Length indication box indicates a distance from the reference point “ab+bc”.
 - 2) The Border indication box indicates a circumferential length “ab+bc+ca”.
 - 3) The Angle indication box indicates an angle “ $\angle abc$ ”.
 - 4) The Area indication box indicates a triangle area “abc”.

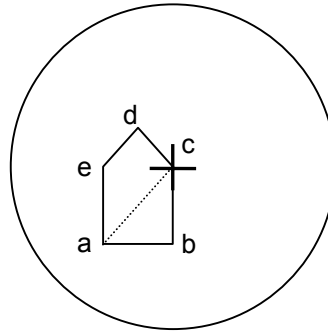


Fig. 3-186 Specimen Setting at the Third Measurement Point

- (d) Further, using the image shift coil, bring the fourth visual field position (point “d” indicated below) to the center of the fluorescent screen. Then, click the Set button.
- 1) The Length indication box indicates a distance from the reference point “ab+bc+cd”.
 - 2) The Border indication box indicates a circumferential length “ab+bc+ca+da”.
 - 3) The Angle indication box indicates an angle “ $\angle bcd$ ”.
 - 4) The Area indication box indicates a triangle area “abc” plus a triangle area “acd”.

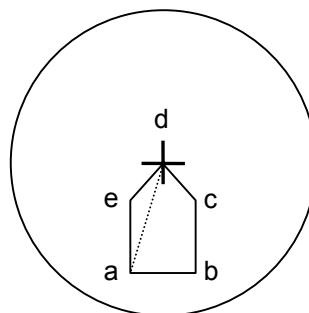


Fig. 3-187 Specimen Setting at the Fourth Measurement Point

3.4 Function Menu (Hitachi H-7650 control window)

- (e) Repeat the above step in the same manner to set up the last visual field position (point “e” indicated below). Thus, you can carry out specimen measurement. If it is desired to make measurement with different visual fields, click the Start button to reset the data being indicated.

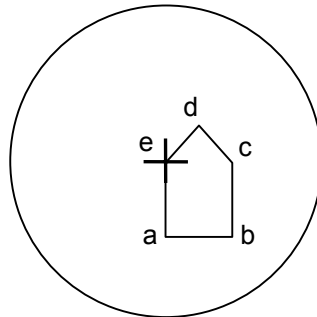


Fig. 3-188 Specimen Setting at the Fifth Measurement Point

- (10) Area calculation with this function is performed through triangle-based approximation. Therefore, measurement is not allowed if polygons are formed by drawing intersecting lines from coordinate points as in the example shown in Fig. 3-189, in which coordinate points are specified in the order of “abcd”.
- In such a case, specify the coordinate points in the order of “abcdef” as exemplified in Fig. 3-190. Note that measurement is allowed even if “c” and “f” are located at the same coordinate point.

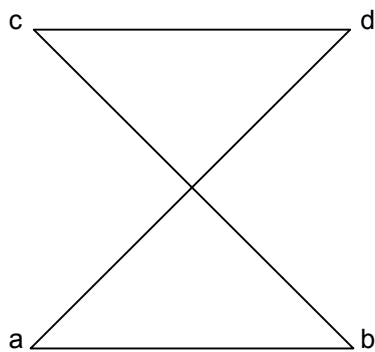


Fig. 3-189 Measurement not Allowed (example)

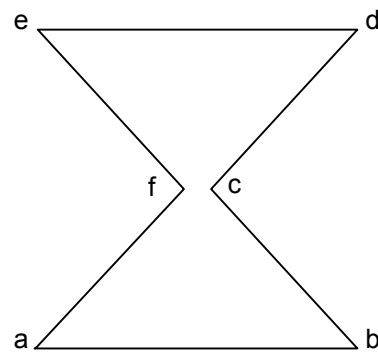


Fig. 3-190 Measurement Allowed (example)

3.4.17 Tilt/Azim control (Type A : option)

The Tilt/Azim control function allows you to control stage tilting operation.

As shown in Fig. 3-191, click “Tilt/Azim control” on the Function menu. The Tilt/Azim control window will then appear.

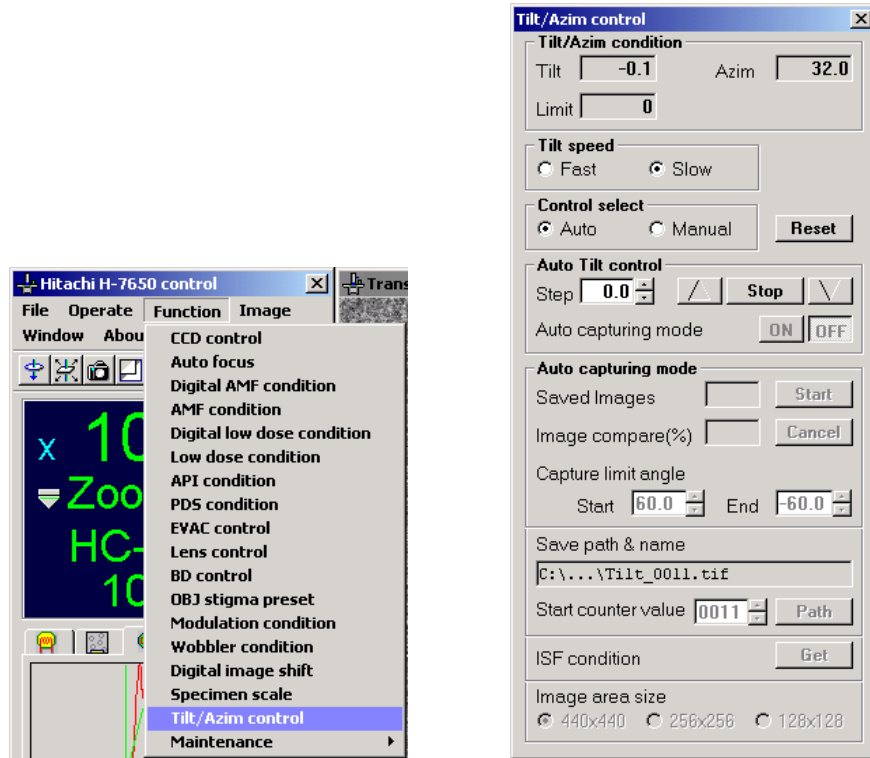


Fig. 3-191 Tilt/Azim control Menu Item and Tilt/Azim control Window

(1) Precheck before Use

Before using this function, be sure to check the following conditions:

- (a) Referring to Section 2 in this instruction manual, carry out routine axial adjustment.
- (b) For 60° tilting, only the standard holder is applicable.
- (c) In the use of this function, the specimen position should be kept within the range of ± 300 . For use with some types of holders, the visual field may be eclipsed at the time of 60° tilting.
- (d) At the time of high-angle tilting, the visual field may be eclipsed. Use a specimen mesh having a hole part of 50 μm or more. Check beforehand that the visual field will not be eclipsed by manual tilting.

3.4 Function Menu (Hitachi H-7650 control window)

- (e) At the time of saving image data, an overwrite is automatically performed on an identically named file if it is held at the destination of saving. Check the file names and locations beforehand. Rename a file or relocate it if necessary.
- (f) In image processing, the accuracy of correction is on the order of a few pixels. Therefore, at a tilt step of 2° or less, the image formed on completion of correction may deviate from its original position taken at the start of correction. Check the image that has been taken in.
- (g) Table 1-8 shows the relationship between objective aperture diameters and applicable magnifications. Select an objective aperture diameter according to the purpose of observation.
- (h) Normal operation is not guaranteed in the use of a specimen having a low contrast or scarce features.

(2) Description of Tilt/Azim control Window

The components of the Tilt/Azim control window are described in Table 3-8 with reference to Fig. 3-192.

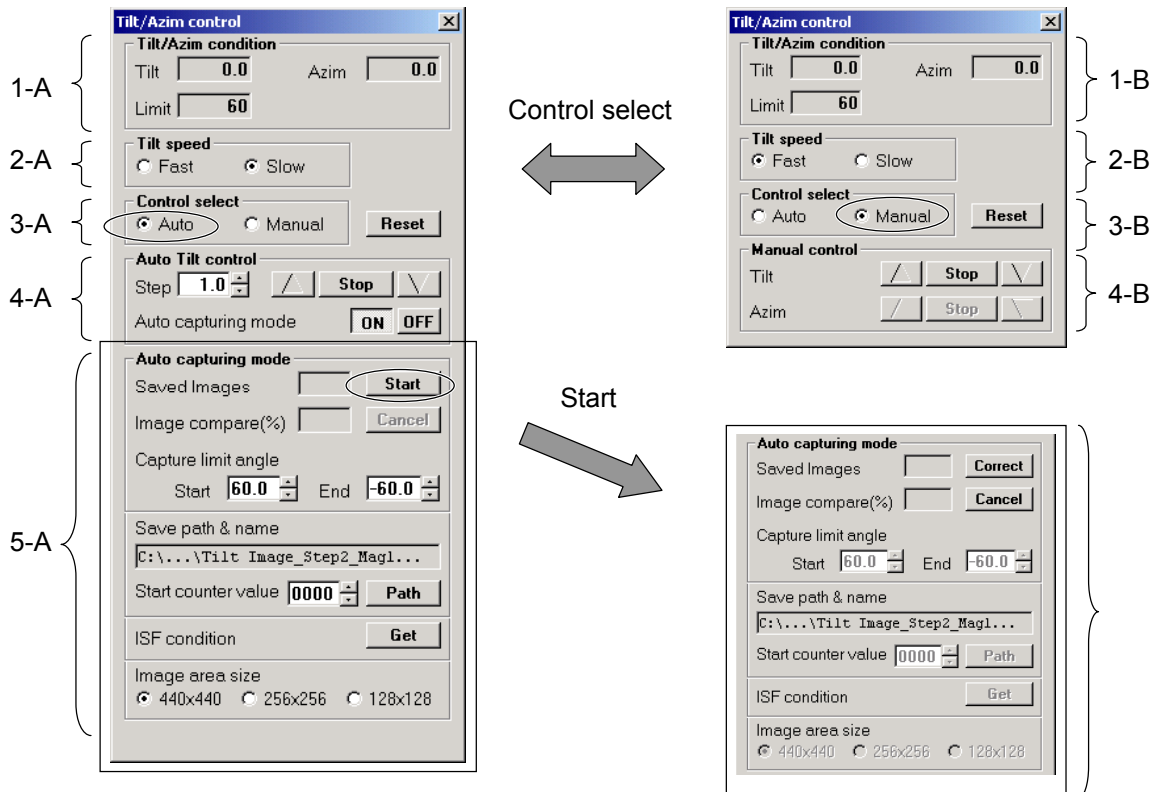


Fig. 3-192 Description of Tilt/Azim control Window

Table 3-8 Description of Window Components

Code	Function	Designation	Description	Remarks
1-A 1-B	Tilt/Azim condition	Tilt	The Tilt box indicates a tilt angle in the Y-axis direction.	
		Azim	The Azim box indicates a tilt angle in the X-axis direction.	
		Limit	The Limit box indicates a limit value in tilting in the Y-axis direction.	
2-A 2-B	Tilt speed	Fast	A tilt speed in the Y-axis direction is set to 0.5 second per degree of angle.	
		Slow	A tilt speed in the Y-axis direction is set to 5.0 seconds per degree of angle.	
3-A 3-B	Control select	Auto	Select Auto for carrying out automatic specimen tilting.	
		Manual	Select Manual for performing manual specimen tilting.	
—	—	Reset	Pressing this button resets the current angle of specimen tilting to 0°.	
4-A	Auto Tilt control	Step	Specify the amount of tilt per action in automatic specimen tilting.	
		△·Stop·▽	Use these button for controlling/stopping automatic tilting in the Y-axis direction.	
		Auto capturing mode	Specify whether or not to carry out automatic image capturing/saving.	
4-B	Manual control	Tilt △·Stop·▽	Use these buttons for controlling/stopping manual tilting in the Y-axis direction.	
		Azim △·Stop·▽	Use these button for controlling/stopping manual tilting in the X-axis direction. Note that these buttons are not effective when the automatic tilt image capturing function is used.	
5-A 5-C	Auto capturing mode	Saved Images	This box indicates the number of images saved.	
		Image compare (%)	This box indicates the degree of matching in image comparison.	
		Capturing limit angle	Specify an angle to be taken at the start of tilting and an angle to be taken at the end of tilting.	
		Save path & name	This box indicates the destination of saving image data and its file name.	
		Start counter value	This box indicates a count number at the start of saving.	
		Path	Click this button for setting up the destination of saving image data and its file name.	
		ISF condition-Get	Click this button for automatic adjustment of the image shift function.	

3.4 Function Menu (Hitachi H-7650 control window)

(cont'd)

Code	Function	Designation	Description	Remarks
5-A 5-C	Auto capturing mode	Image area size	Specify a limitation for the correction image area.	
		Cancel	Click this button to cancel automatic capturing.	
5-A		Start	Click this button to start automatic capturing at a specified tilt angle.	
5-C		Correct	Click this button to perform correction in automatic tilting and capturing.	

(3) Operation of the Automatic Tilt/Image Capture Function

(a) Holder selection

For using the automatic tilt function, it is required to set a specimen tilt angle to 60°. In the Tilt/Azim control window, check that "Tilt/Azim condition – Limit" is 60. If not, select Holder – Holder – Option 1:60 in the Stage control window as shown in Fig. 3-193. Thus, you can set up a specimen tilt angle to 60°.

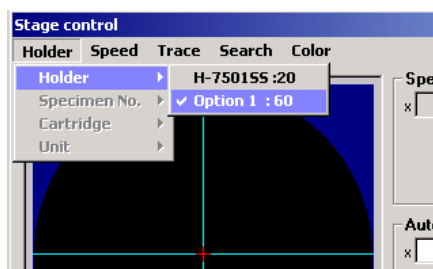


Fig. 3-193 Selection of Option 1:60

(b) Specimen loading

Set a specimen on the standard holder, and load it into the specimen chamber .

(c) Target marker indication

With the target marker turned on, you can easily check a visual field deviation due to tilting. As shown in Fig. 3-194, select Image – Target marker – White in the Hitachi H-7650 control window. The white target marker will then appear on the Transmission image window.

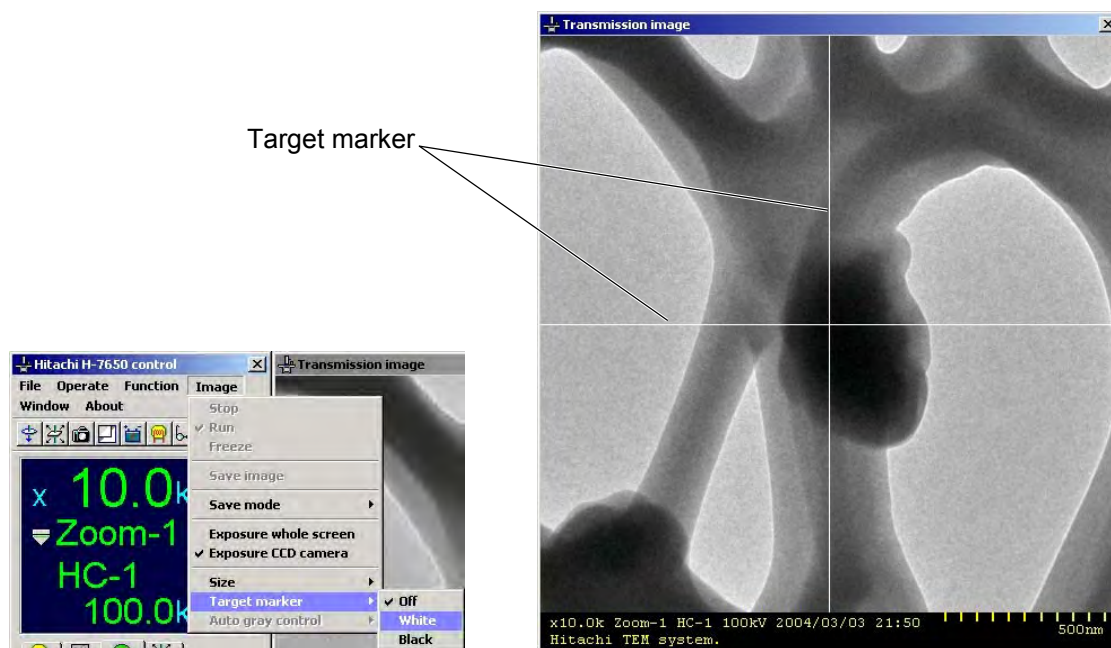


Fig. 3-194 Image Menu Items and Target Marker

(d) Tilt speed setting

As shown in Fig. 3-195, select Fast or Slow in the Tilt speed field. Selection of Fast sets up a tilt speed of 0.5 second per degree of tilt angle, and selection of Slow sets up a tilt speed of 5.0 seconds per degree of tilt angle. Unless the indication is dimmed, a changeover of a tilt speed is allowed even during tilting operation.



Fig. 3-195 Tilt speed

3.4 Function Menu (Hitachi H-7650 control window)

(e) Tilt control setting

As shown in Fig. 3-196, select Auto in the Control select field to set up the automatic tilt control mode. To set up the manual tilt mode, select Manual in this field. Clicking the Reset button clears the current angle of specimen tilt to 0°.

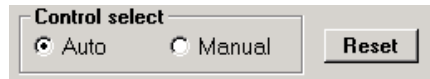


Fig. 3-196 Control select

(f) Tilt angle step setting

As shown in Fig. 3-197, specify the amount of tilt per action in automatic tilting in the Step input box. It is recommended to specify a step angle value of 5.0° or less.

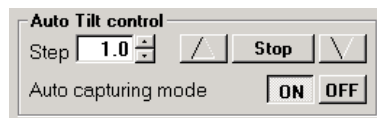


Fig. 3-197 Auto Tilt control

(g) Automatic image capture setting

In the Auto capturing mode field shown in Fig. 3-197, click the ON button to set up the automatic image capturing mode. Then, the Auto capturing mode field shown in Fig. 3-198 will be effective.

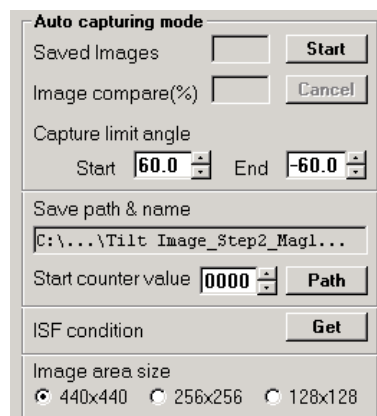


Fig. 3-198 Auto capturing mode

(h) Automatic tilt angle range setting

In the Capture limit angle field shown in Fig. 3-199, specify an angular range of automatic tilting. Since an automatic tilt action is made from the positive (+) side to the negative (-) side, make setting so that “Start” (start angle of tilting) is larger than “End” (end angle of tilting). The allowable maximum range of automatic tilting is $\pm 60^\circ$. Note that an image may not be observed or recorded due to interference with a mesh or the like if a tilt is made up to the limit of $\pm 60^\circ$, depending on the specimen and visual field.

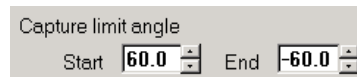


Fig. 3-199 Capture limit angle

(i) Image save setting

Specify the destination of saving captured image data and its file name. In the Save path & name field shown in Fig. 3-200, click the Path button. The Save image window will then appear as shown in Fig. 3-201.

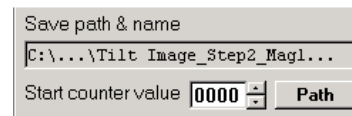


Fig. 3-200 Save path & name

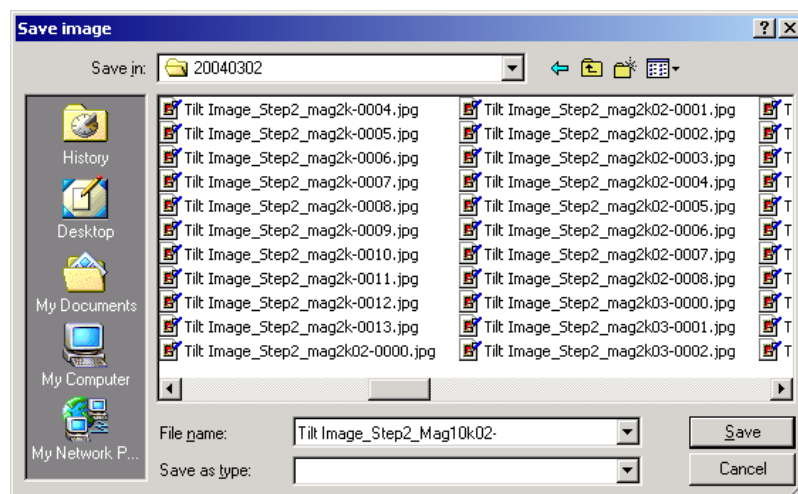


Fig. 3-201 Save image Window

3.4 Function Menu (Hitachi H-7650 control window)

On the Save image window, determine the destination of saving captured image data, enter a file name in the File name input box, and click the Save button. Then, in the Start counter value box shown in Fig. 3-200, specify a start sequence number to be suffixed to the file name concerned. Then, the destination of saving captured image data and its file name will be indicated in the Save path & name field. Note that an automatic overwrite is made if there is an identically named file in the destination of saving. To avoid this, check the destination of saving image data and its file name beforehand. If an identically named file is found, relocate it as required.

(j) Limitation of correction image region

In the Image area size field shown in Fig. 3-202, you can adjust the visual field for correction of deviation in imaging. In common practice, select “440 × 440”. If a partially high contrast of imaging is contained in the visual field, an image deviation may be corrected with respect to the visual field. In such a case, select “256 × 256” or “128 × 128”. Thus, you can correct a deviation of the visual field at the center position of imaging.

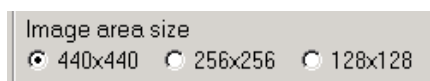


Fig. 3-202 Image area size

(k) Image shift function adjustment

The angle of X-Y intersection or the amount of step in the use of the ISF (image shift function) may vary depending on the magnification and objective lens current. In the ISF condition field shown in Fig. 3-203, click the Get button for automatic adjustment of the angle of X-Y intersection or the amount of step in the use of the image shift function. When a change has been made in magnification or objective lens current, be sure to click the Get button.



Fig. 3-203 ISF condition Get Button

- (l) Start of the automatic tilt/image capture function

In the Auto capturing mode field shown in Fig. 3-204, click the Star button. The specimen stage will then be automatically tilted to the start angle of image capturing. At this step, the visual field will deviate as the specimen stage is tilted. For correction of image deviation, use the STAGE knob on the left/right operation panel shown in Fig. 3-205.

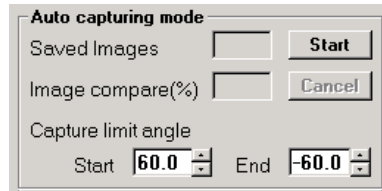


Fig. 3-204 Auto capturing mode Start Button

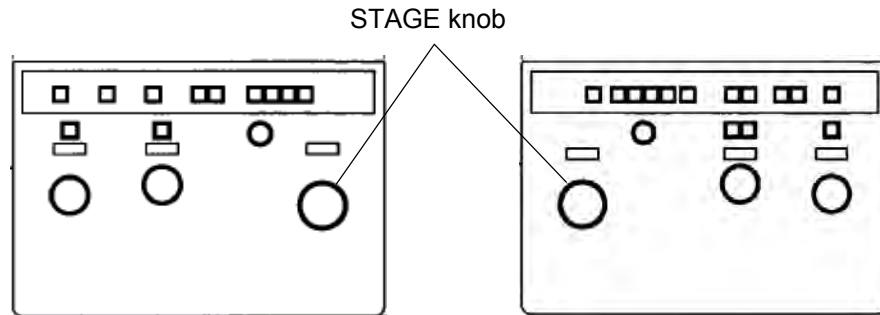


Fig. 3-205 STAGE Knob

- (m) Start of automatic tilt image capturing

When the specimen stage is set to the start angle of image capturing, the Start button in the Auto capturing mode field changes to the Correct button as shown in Fig. 3-206. Clicking this Correct button starts automatic tilt image capturing.

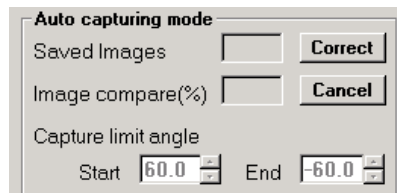


Fig. 3-206 Auto capturing mode Correct Button

3.4 Function Menu (Hitachi H-7650 control window)

In automatic tilt image capturing, the specimen is tilted while a deviation of the visual field is corrected by the image shift function and the specimen stage. For each tilt step specified in (f), the System wait message shown in Fig. 3-207 is presented to indicate the progress of auto focusing. Then, the System wait message shown in Fig. 3-208 is presented to indicate the progress of image acquisition. At the same time, automatic counting is performed in the Save images box (the number of images saved) and the Start counter value (file sequence number) in the Auto capturing mode field as shown in Fig. 3-209. Further, for each execution of visual field correction, the degree of image matching is indicated in the Image compare box.

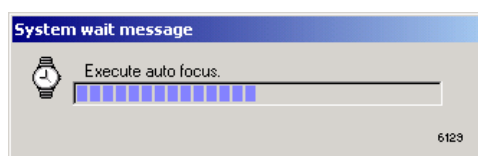


Fig. 3-207 System wait message – Progress of auto focusing

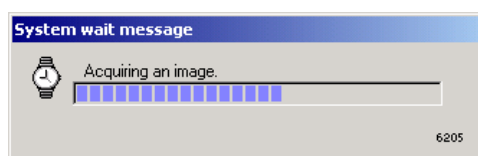


Fig. 3-208 System wait message – Progress of image acquisition

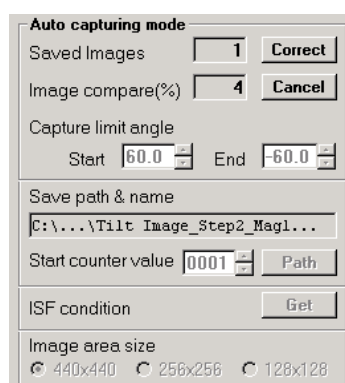


Fig. 3-209 Auto capturing mode

(n) Occurrence of Comp. Error

If the visual field deviates significantly due to specimen drift or any other cause, it may become impossible to correct the visual field deviation by the image shift function and the specimen stage. In this case, the degree of image matching (indicated in the Image compare box) decreases below the specified limit.

This causes the Comp. Error message to appear. That is, as shown in Fig. 3-210, the System message is issued, requesting you to stop automatic tilt image capturing. Clicking the OK button in the System message window makes the Correct button in the Auto capturing mode field effective as shown in Fig. 3-209. Then, using the STAGE knob equipped on the left/right operation panel shown in Fig. 3-211, adjust the visual field to the center, and click the Correct button. In this manner, you can continue automatic tilt image capturing.

For abortion of automatic tilt image capturing, click the Cancel button.

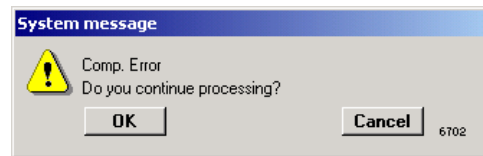


Fig. 3-210 System message (Comp. Error)

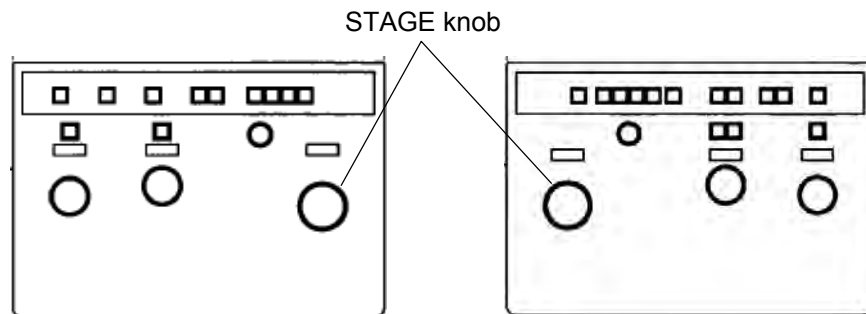


Fig. 3-211 STAGE Knob

3.4 Function Menu (Hitachi H-7650 control window)

(o) Termination of automatic tilt image capturing

At the end of automatic tilt image capturing, the System message shown in Fig. 3-212 is presented. In this message window, click the OK button to top operation. Click the Reset button shown in Fig. 3-213 for resetting the tilt angle of the specimen stage to 0°.

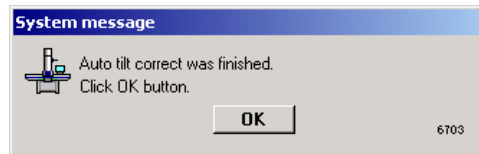


Fig. 3-212 System message – End of automatic tilt image capturing

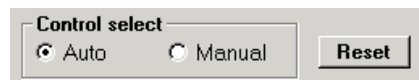


Fig. 3-213 Reset Button

(4) Operation of the Automatic Tilt Function

The specimen stage can be tilted automatically in steps of specified degrees of tilting. In the Auto Tilt control field shown in Fig. 3-214, click the OFF button of the Auto capturing mode item. Then, the Auto capturing mode will be ineffective as shown in Fig. 3-215. Table 3-9 shows a list of the buttons for the automatic tilt function. The Tilt/Azim condition function and the Tilt speed function are the same as those described in (3).

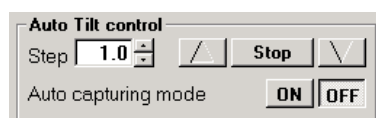


Fig. 3-214 Auto Tilt control

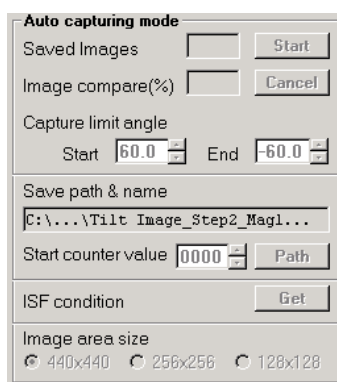


Fig. 3-215 Auto capturing mode

Table 3-9 Automatic Tilt Function Buttons

Indication		Function
Step		Specify the amount of tilting per action in the use of the automatic tilt function.
Auto capturing mode	ON	Clicking the ON button sets up the automatic tilt image capturing mode. (The Auto capturing mode is made effective.)
	OFF	Clicking the OFF button resets the automatic tilt image capturing mode. (The Auto capturing mode is made ineffective.)
△		The specimen is tilted in the positive (+) direction through an angle specified in the Step box. On completion of the tilting, it is stopped automatically.
Stop		Clicking this button stops specimen tilting.
▽		The specimen is tilted in the negative (-) direction through an angle specified in the Step box. On completion of the tilting, it is stopped automatically.

(5) Operation of the Manual Tilt Function

The specimen stage can also be tilted manually.

- (a) In the Control select field shown in Fig. 3-216, turn on the radio button of Manual. The Tilt/Azim control window will then be displayed as shown in Fig. 3-217.

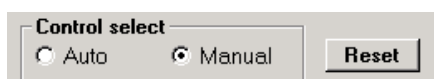


Fig. 3-216 Control select

3.4 Function Menu (Hitachi H-7650 control window)

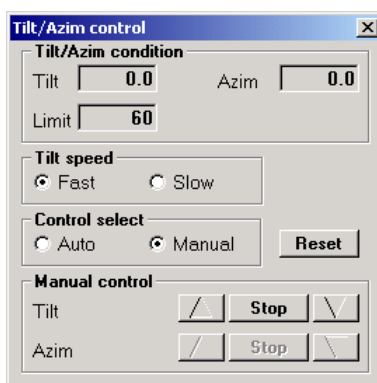


Fig. 3-217 Tilt/Azim control Window (with Manual selected)

- (b) Table 3-10 shows a list of buttons for the manual tilt function. The Tilt speed can be adjusted even during manual tilting operation. Note that the Azim button is dedicated for double-axis tilt holder setting. In other cases, the Azim button is ineffective as shown in Fig. 3-271.

Table 3-10 Manual Tilt Function Buttons

Designation	Indication		Function
Tilt/Azim condition	Tilt		This box indicates a tilt angle in the Y-axis direction.
	Azim		This box indicates a tilt angle in the X-axis direction.
	Limit		This box indicates a limit angular value in tilting in the Y-axis direction.
Tilt speed	Fast		A tilt speed of 0.5 second per degree in the Y-axis direction is set up.
	Slow		A tilt speed of 5.0 seconds per degree in the Y-axis direction is set up.
Reset			Clicking this button resets specimen tilting to 0°.
Manual control	Tilt	△	The specimen is tilted in the positive (+) direction on the Y axis.
		Stop	Specimen tilting in the Y-axis direction is stopped.
		▽	The specimen is tilted in the negative (-) direction on the Y axis.
	Azim	△	The specimen is tilted in the positive (+) direction on the X axis.
		Stop	Specimen tilting in the X-axis direction is stopped.
		▽	The specimen is tilted in the negative (-) direction on the X axis.

(6) Operation for Semi-automatic Tilt Image Capturing (automatic tilting – manual image capturing)

Using the automatic tilt function and the Freeze and Save button in the CCD control window, you can conduct semi-automatic tilt image capturing.

- (a) As shown in Fig. 3-214, click the OFF button of Auto capturing mode in the Auto Tilt control field on the Tilt/Azim control window. Thus, the Auto capturing mode (automatic image capturing) can be made ineffective.
- (b) In the Auto Tilt control field shown in Fig. 3-214, specify a tilt angle step for the specimen stage.
- (c) Using the [▽] or [△] button, start specimen tilting. The specimen state is automatically stopped at the tilt angle step specified in (b).
For details of the above items (a) to (c), refer to the foregoing section (4).
- (d) Using the Freeze button in the CCD control window, you can freeze the image being displayed. In this case, correction of visual field deviation and auto focusing are not carried out automatically. Conduct these adjustments manually as required.
- (e) To save the image being displayed, click the Save button in the CCD control window. For details of the above items (d) to (e), refer to 3.4.1 - (1).

3.4 Function Menu (Hitachi H-7650 control window)

3.4.18 Maintenance

The Maintenance menu item is available for maintenance checkup, e.g., initial setting and adjustment of each unit of the H-7650.

The commands listed below “TEM adjustment” are password-protected. Unless these commands are unprotected, they remain ineffective. For details, refer to 4.7.1.

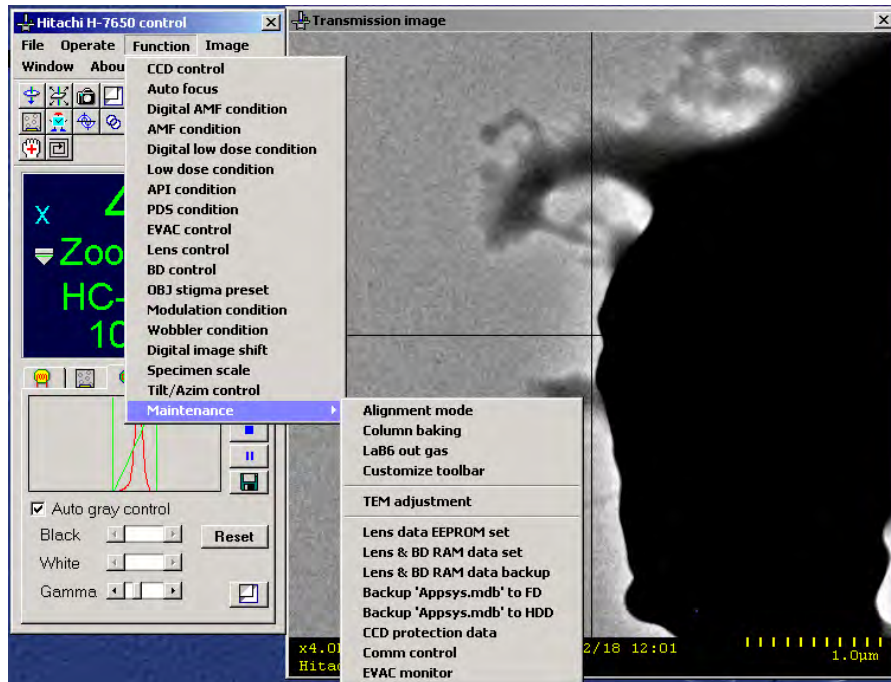


Fig. 3-218 Maintenance Menu

3.5 Image Menu (in the Hitachi H-7650 control window) (Type A only)

Using the Image menu, you can make Transmission window setting and carry out digital camera control.

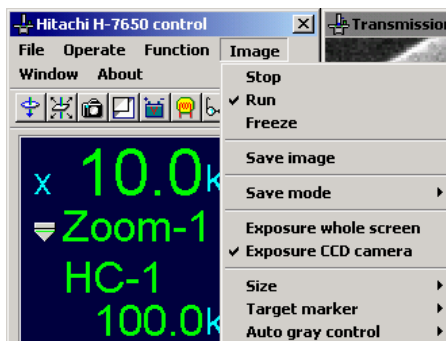


Fig. 3-219 Image Menu

3.5.1 Stop (Type A only)

Selecting this menu item stops displaying the dynamic TEM image concerned in the Transmission image window and turns off the main fluorescent screen display.

3.5.2 Run (Type A only)

Selecting this menu item starts displaying the TEM dynamic image concerned in the Transmission image window. The main fluorescent screen display is turned on if it has been off.

3.5.3 Freeze (Type A only)

Selecting this menu item stops displaying the TEM dynamic image concerned temporarily and presents its still picture.

3.5 Image Menu (in the Hitachi H-7650 control window)

3.5.4 Save image (Type A only)

Selecting this menu item allows you to save a TEM image that has been captured by the Freeze command. The save image window shown in Fig. 3-220 will appear. In this window, specify the desired folder, file name, and file type, and then click the Save button. One of the following three file types can be selected; TIFF format (*.tif), Windows Bitmap format (*.bmp), and JPEG format (*.jpg).

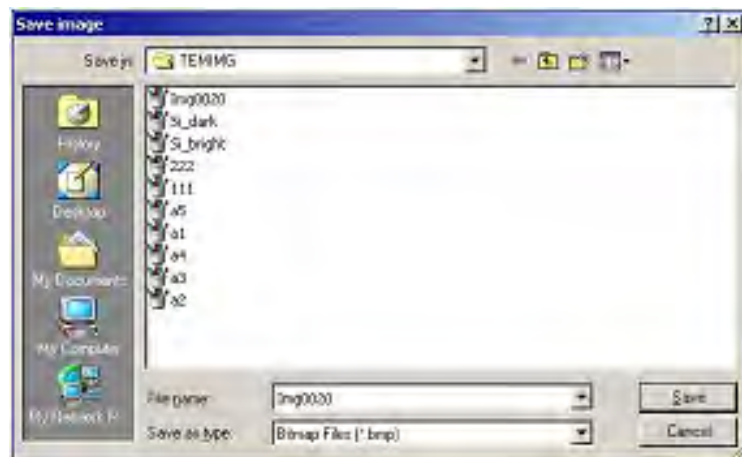


Fig. 3-220 Save image Window

3.5.5 Exposure whole screen (Type A only)

The main fluorescent screen display can be turned off for enabling fluorescent-screen image observation.

3.5.6 Exposure CCD camera (Type A only)

The main fluorescent screen displayed is turned on to enable digital-camera image observation and saving.

NOTE: In the Diff mode, protection is provided for the main fluorescent screen to prevent the scintillator from being damaged by a spot beam. Therefore, even if it is attempted to turn on the main fluorescent screen display, the System message shown in Fig. 3-221 will be issued to indicate that the main fluorescent screen display cannot be turned on.

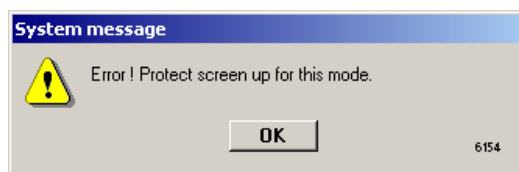



Fig. 3-221 System message

3.5.7 Size (Type A only)

The micron marker is always indicated at the bottom of the Transmission image window. This micron marker changes as the Transmission image window is enlarged or reduced by clicking the  button in the CCD control field on the Hitachi H-7650 control window. As shown in Figs. 3-223 and 3-224, the scale bar also changes according to the window size.

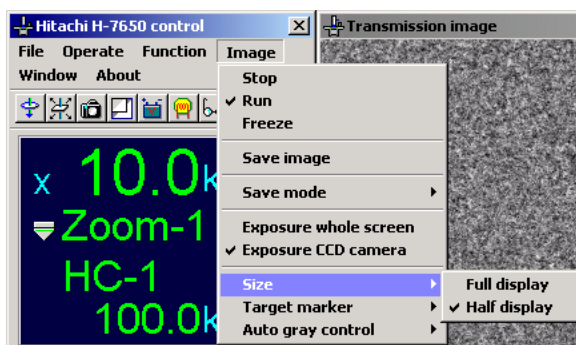


Fig. 3-222 Size Menu Item

- (1) Full display

As shown in Fig. 3-225, the Transmission image window is presented in the maximum size.

3.5 Image Menu (in the Hitachi H-7650 control window)

(2) Half display

As shown in Fig. 3-226, the Transmission image window is presented in the half size.

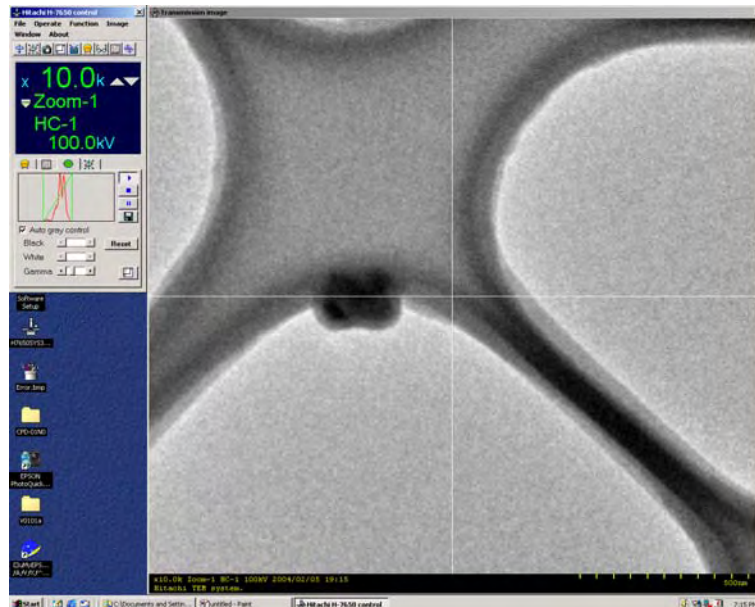


Fig. 3-223 Transmission image Window in an Enlarged Layout

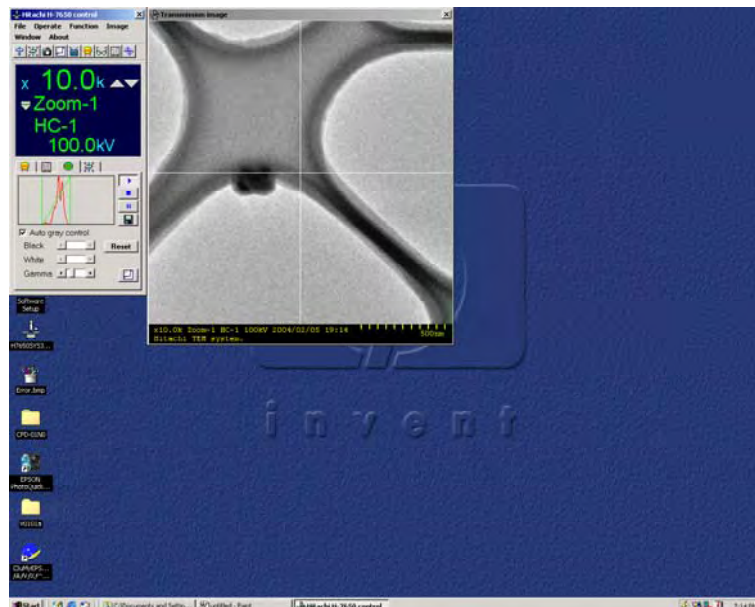


Fig. 3-224 Transmission image Window in a Reduced Layout

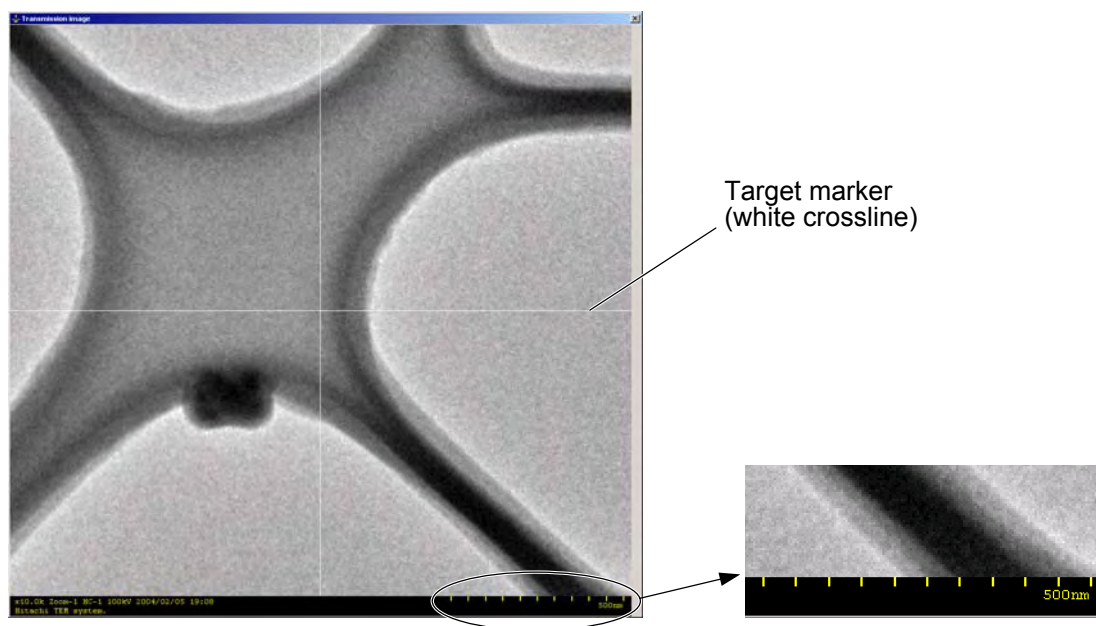


Fig. 3-225 Transmission image Window: Enlarged

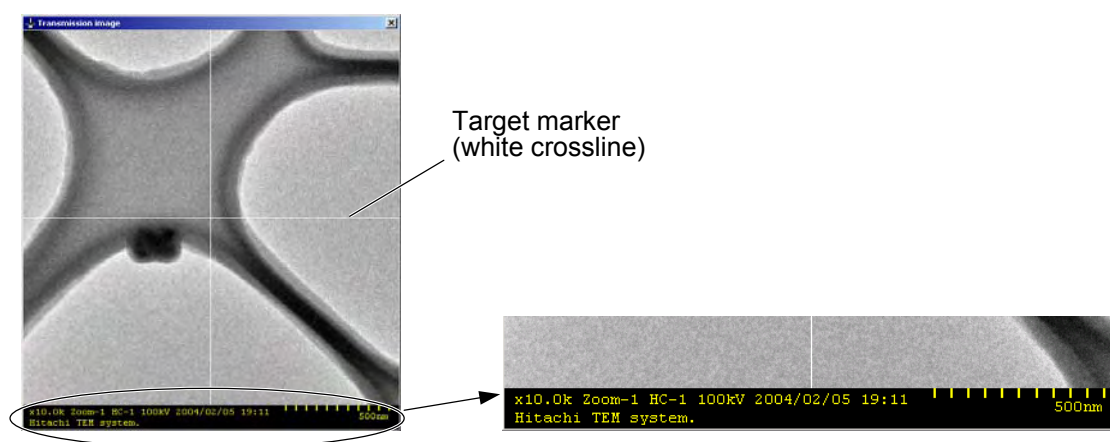


Fig. 3-226 Transmission image Window: Reduced

3.5 Image Menu (in the Hitachi H-7650 control window)

3.5.8 Target marker (Type A only)

The Target marker function is available for drawing the crossline indicating the center position in the Transmission image window. As shown in Fig. 3-227, bring the mouse pointer to “Target marker” on the Image menu. The three optional items will then appear.

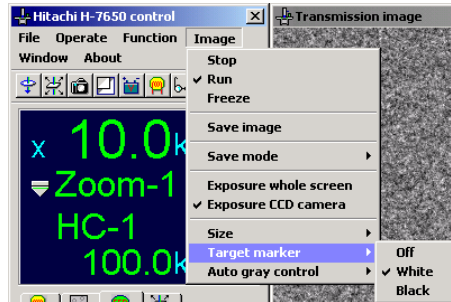


Fig. 3-227 Target marker Menu Item

- (1) Off

Selecting this item turns off the Target marker.

- (2) White

Selecting this item displays the Target marker in white as shown in Figs. 3-225 and 3-226.

- (3) Black

Selecting this optional item displays the Target marker in black as shown in Fig. 3-228.

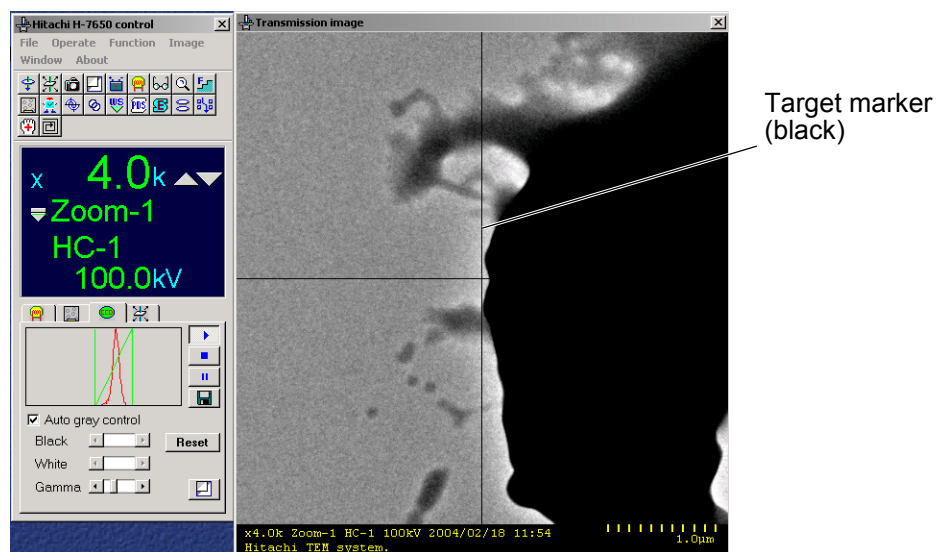


Fig. 3-228 Example of Target Marker Indication (Black)

3.5.9 Auto gray control (Type A only)

The Auto gray control menu item is functionally equivalent to that in the CCD control window. As shown in Fig. 3-229, bring the mouse pointer to “Auto gray control” on the Image menu. The two optional items will then appear.

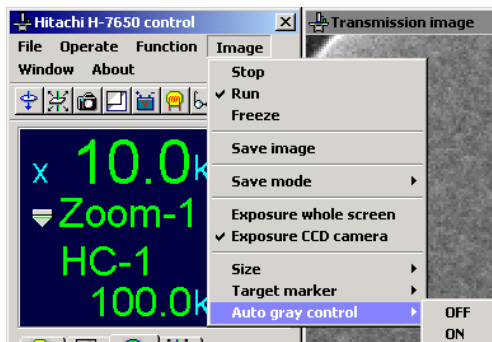


Fig. 3-229 Auto gray control Menu Item

- (1) OFF

Selecting this optional item turns off the Auto gray control function.

- (2) ON

Selecting this optional item turns off the Auto gray control function.

NOTE: In the Diff mode, protection is provided for the main fluorescent screen to prevent the scintillator from being damaged by a spot beam. Therefore, even if it is attempted to turn on the main fluorescent screen display, the System message shown in Fig. 3-230 will be issued to indicate that the main fluorescent screen display cannot be turned on.

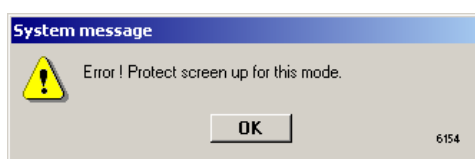


FIG. 3-230 System message

3.6 Window Menu (in the Hitachi H-7650 control window)

3.6 Window Menu (in the Hitachi H-7650 control window) (Type A only)

Using the Window menu, you can make TEM control setting.

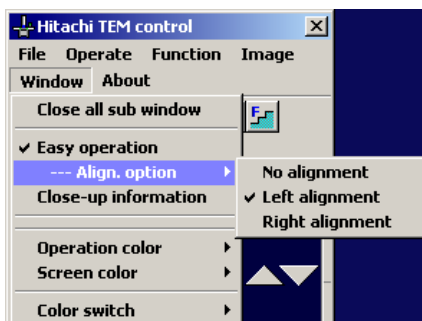


Fig. 3-231 Window Menu

3.6.1 Close all sub window (Type A only)

Clicking this menu item closes all the sub windows except the main window.

3.6.2 Easy operation (Type A only)

Clicking this menu item presents the Easy operation window shown below, which is a limited control window form for facilitating Transmission image operations. The control area is provided at the lower part of the Easy operation window. On this area, you can check various information efficiently.

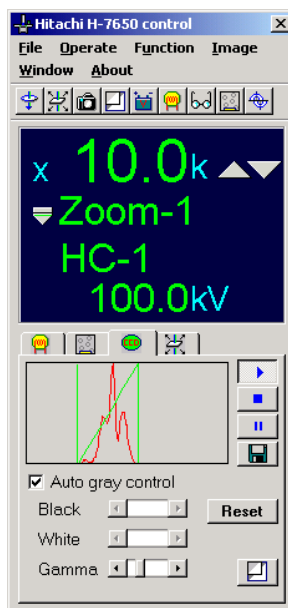


Fig. 3-232 Easy Operation Window

3.6.3 --- Align, option (Type A only)

(1) No Alignment

Selecting this item presents the previous display layout in the Easy operation window.

(2) Left Alignment

Selecting this item presents the left-aligned layout in the Easy operation window as shown in Fig. 3-233.

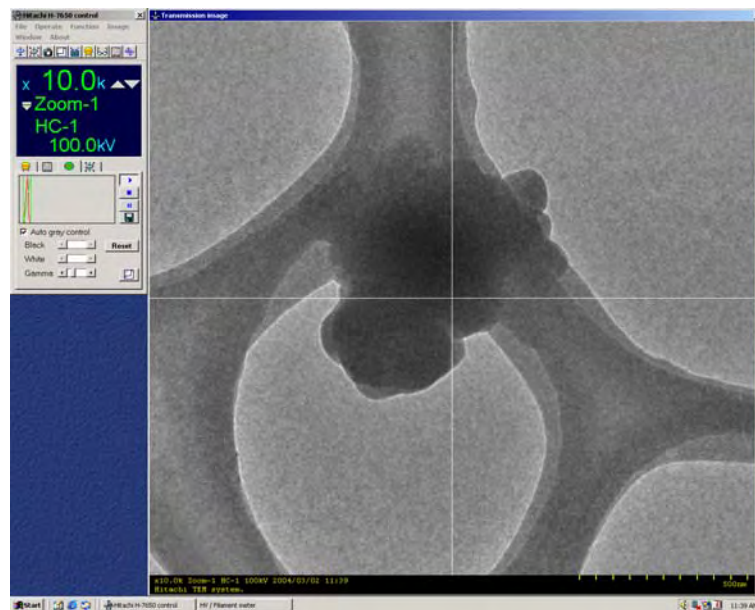


Fig. 3-233 Left-aligned Layout

3.6 Window Menu (in the Hitachi H-7650 control window)

(3) Right Alignment

Selecting this item presents the right-aligned layout in the Easy operation window as shown in Fig. 3-234.

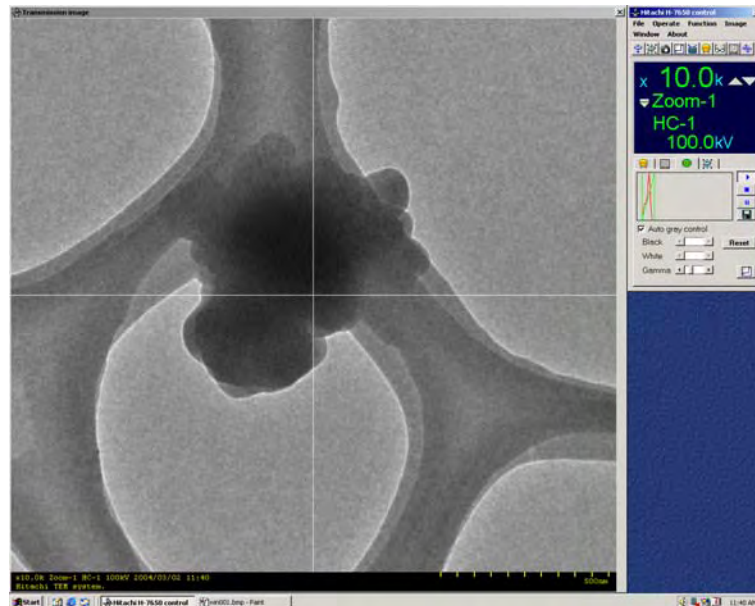


Fig. 3-234 Right-aligned Layout

3.6.4 Close-up information (Type A only)

Selecting this menu item opens the Close-up information window that indicates operating conditions in an enlarged form.

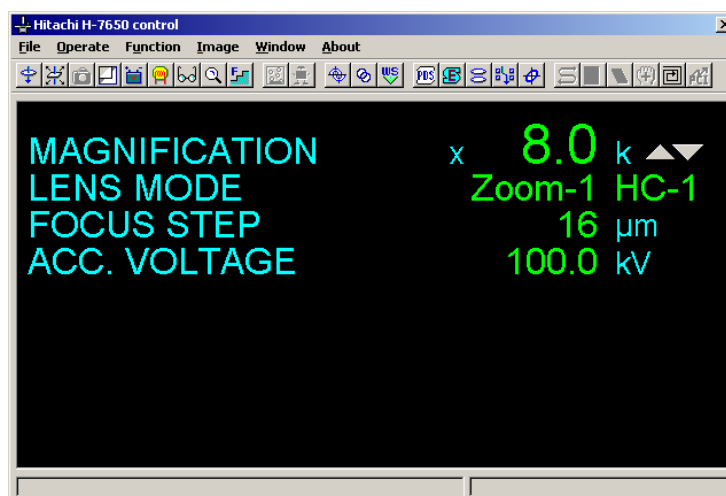


Fig. 3-235 Close-up information window

3.6.5 Operation color

Through this menu item, you can assign operation colors in the Hitachi H-7650 control window. The following four colors are selectable; gray (light), gray, green, and blue.



Fig. 3-236 Operation color Menu Item

3.6.6 Screen color

Through this menu item, you can select a background color on the image area in the Transmission image window. The following four colors are selectable; gray (light), gray, gray(dark), and blue.

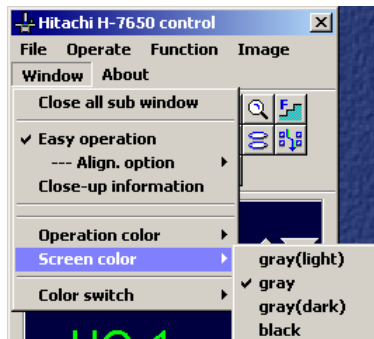


Fig. 3-237 Screen color Menu Item

3.6 Window Menu (in the Hitachi H-7650 control window)

3.6.7 Color switch

Through this menu item, you can adjust the brightness of the entire screen color. Selecting the Dark item decreases the brightness, and selecting the Bright item restores the brightness to normal.



Fig. 3-238 Color switch Menu Item

3.7 About Menu

3.7.1 About H-7650

As shown in Fig. 3-239, click “About H-7650” on the About menu. The version information window regarding the system program will then appear. This information window contains a list of the options equipped in the TEM being used. To close this window, just click the OK button.

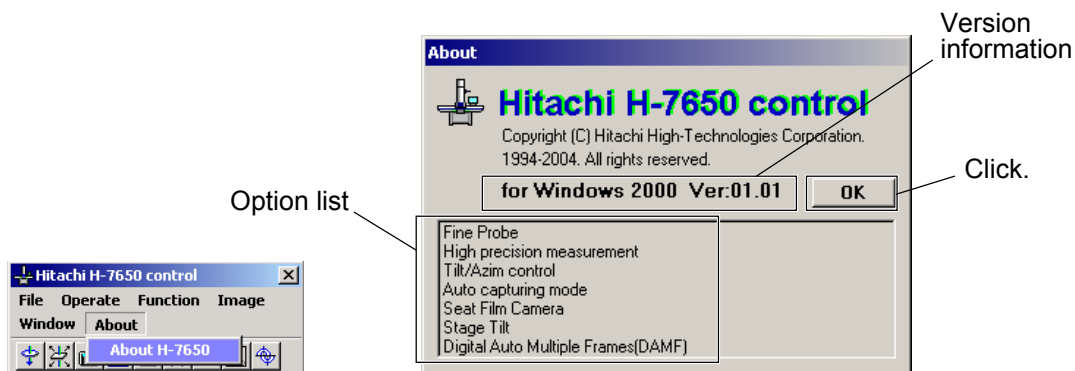


Fig. 3-239 About Window

3.8 Information Area (in the Hitachi H-7650 control window)

3.8 Information Area (in the Hitachi H-7650 control window)

The main information regarding the TEM is presented. Figure 3-240 shows a window indicating the TEM equipped with an optional sheet film camera. In cases where no optional devices are mounted, the items MAGNIFICATION (camera length), LENS MODE, FOCUS STEP, and ACC. VOLTAGE are indicated.

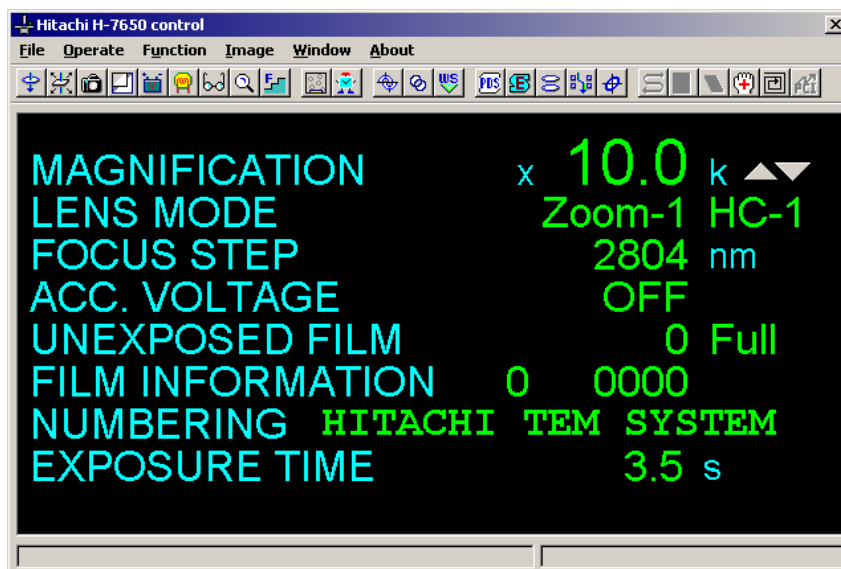


Fig. 3-240 Hitachi H-7650 control Window

3.8.1 MAGNIFICATION Label: Enlarged display of magnification (camera length)

Double-clicking the MAGNIFICATION (camera length) label brings up the magnification enlarged display window. For details, refer to 3.3.1.

3.8.2 LENS MODE Label: Selection of observation mode

Double-clicking the LENS MODE label brings up the observation mode selection window. For details, refer to 3.3.1.

3.8.3 FOCUS STEP Label: Setting of focus step/defocus indication

Double-clicking the FOCUS STEP label brings up the focus step setting window. For details, refer to 3.3.1.

3.8.4 ACC. VOLTAGE Label: Accelerating voltage manual operation/flashing

Double-clicking the ACC. VOLTAGE label brings up the Acc. voltage control window. In this window, you can turn on/off the accelerating voltage function, specify a preset accelerating voltage level, determine an automatic rise time for accelerating voltage, and carry out flashing operation.

3.8.5 UNEXPOSED FILM/FILM INFORMATION/NUMBERING Label: Film condition setting (available in cases where an optional sheet film camera is mounted)

Double-clicking the UNEXPOSED FILM/FILM INFORMATION or NUMBER label brings up the Film information window.

3.8.6 EXPOSURE TIME Label: (Available in cases where an optional sheet film camera is equipped)

Double-clicking the EXPOSURE TIME label brings up the Exposure time window.

3.9 Control Area (Hitachi H-7650 control window: Easy operation)

3.9 Control Area (Hitachi H-7650 control window: Easy operation) (Type A only)

The Hitachi H-7650 control window (Easy operation) is provided for presenting limited main information on the TEM. On the control area in this window, you can check various information with ease.

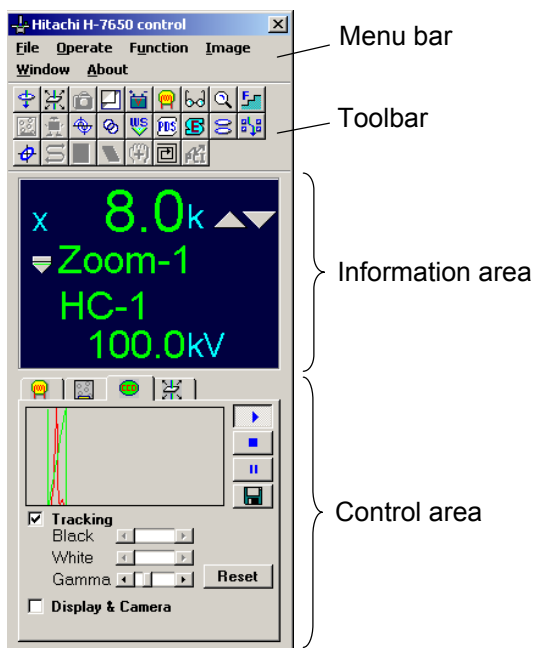


Fig. 3-241 Hitachi H-7650 control Window (Easy operation) (Type A only)

3.9.1 Filament/Bias control (Type A only)

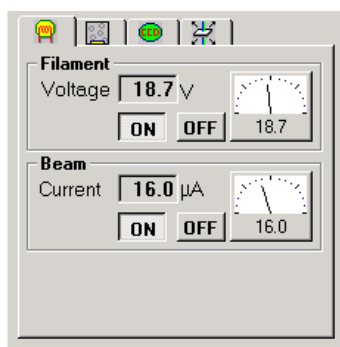



Fig. 3-242 Filament/Bias control

- (1) The filament voltage and emission current being applied are indicated.

- (2) By clicking the ON/OFF button, you can turn on/off the filament voltage and emission current.
- (3) Through the Filament/Bias control window, you can make other detailed settings. This window can also be opened by clicking the  icon on the toolbar.

3.9.2 Film information/Exposure time (Available in cases where an optional sheet film camera is equipped)

Figure 3-243 shows the Film information/Exposure time window to be presented in cases where the TEM is equipped with an optional sheet film camera, and Figure 3-244 shows the Film information/Exposure time window to be presented in cases where the TEM is not equipped with an optional sheet film camera.

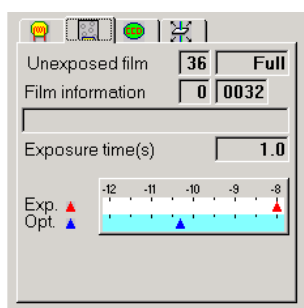


Fig. 3-243 Film information/Exposure time (Equipped with an optional sheet film camera)

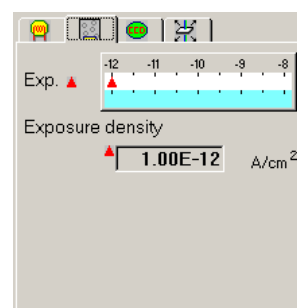




Fig. 3-244 Film information/Exposure time (Not equipped with an optional sheet film camera)

- (1) The number of unexposed film frames, film print information, and exposure time are indicated.
- (2) For other detailed settings, you can use the Film information window and the Exposure time window. To open the Film information window, click the  icon on the toolbar, and to open the Exposure time window, click the  icon on the toolbar.

3.9 Control Area (Hitachi H-7650 control window: Easy operation)

3.9.3 CCD control (Type A only)

In the CCD control window, you can conduct the basic CCD control functions.

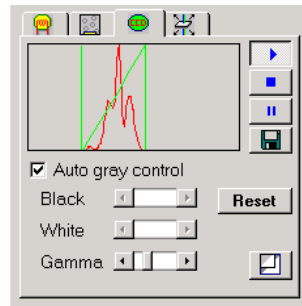


Fig. 3-245 CCD control

3.9.4 Stage control Tab (Type A only)

The current specimen stage information is presented. Figure 3-246 shows the Stage control window to be displayed for the Type-2 TEM. In the case of the Type-1 TEM, "Tilt" is not indicated.

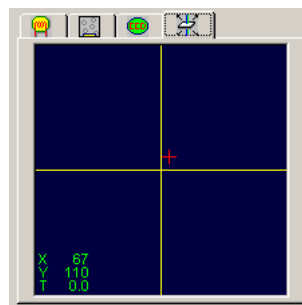


Fig. 3-246 Stage control

4. MAINTENANCE

4.1 Cautions on Use and Maintenance of Electron Microscope

This chapter explains the maintenance to be carried out by the user in routine operation and the periodic maintenance to be performed by the service engineers (Hitachi). Request Hitachi for the latter maintenance.

4.1.1 Cautions on Routine Operation

The electron microscope consists mainly of mechanical, electrical, evacuation and electron optical systems. The functions of each system are combined to enable the instrument to operate normally as a microscope. As with the human body, a malfunction in even one of the sections will adversely affect the whole system. A number of cautions required to keep the entire system operating properly at all times are given here. Suitable maintenance is also necessary to maintain the microscope in top condition and provide photographs of good quality.

4.1.2 Periodic Maintenance

The H-7650 microscope has a high vacuum structure to minimize contamination. But after long hours of use, contamination will form in the electron beam path in the column due to the accumulation of particles of sample and because of outgassing from evacuated sections. This causes an increase of electron beam chargeup and/or astigmatism, resulting in a drop in image quality and resolution. Periodic maintenance by the service engineers (Hitachi) is required to keep each unit of the evacuation system operating correctly so as to maintain the high vacuum.

4.1.3 Frequency of Maintenance

Although maintenance in general depends on the frequency of use of the microscope, the user should observe the cautions on routine operation and the periodic maintenance items 2 given in Table 4-1. Request the service engineer for items 1 and 3 to 5. An overall inspection at least once a year is recommended for stable operation of the microscope over a long time.

4.1.4 Maintenance Contract

For details on a maintenance contract, consult your nearest Hitachi representative or the dealer from whom you purchased the instrument.

4.1 Cautions on Use and Maintenance of Electron Microscope

Table 4-1 Cautions on Routine Operation, and Periodic Maintenance

Cautions on Routine Operation (for user)			Periodic Maintenance (for service engineer)		
Item	Frequency	Description	Item	Frequency	Description
1. Cleaning at filament exchange	At filament exchange	Cleaning of Wehnelt cylinder	1. Maintenance of oil rotary pump (RP)	6 months	Change of oil
2. Caution on and maintenance at specimen exchange	Daily	<ul style="list-style-type: none"> • Check and cleaning of specimen retainer • Greasing of specimen holder O-ring 	2. Cleaning of movable aperture	6 months	<ul style="list-style-type: none"> • Cleaning of aperture plate • Greasing of O-ring
3. Check and maintenance at film exchange	Daily	<ul style="list-style-type: none"> • Check of packing surface • Setting of film • Greasing of packing • Check of cassette shape 	3. Cleaning of Penning gauge	6 months	Cleaning of electrodes
4. Inspection of air compressor	Weekly	<ul style="list-style-type: none"> • Carry out draining • Check of operating pressure 	4. Replacement of nickel-cadmium battery	1 year	Useful life is about 1 year
5. Inspection of rotary pump	Weekly	Check of oil level	5. Maintenance of digital camera	1 year	Cleaning of lens and other parts
6. Inspection of cooling water	Weekly	<ul style="list-style-type: none"> • Check of water temperature and flow • Flow of oil diffusion pump (DP) cooling water appears on EVAC window. Make sure flow rate is from 1.5 to 2.0 L/min. 			
7. Mild baking of column	After shutting down instrument for one week	Baking of column interior through use of heat generated by lens coil			

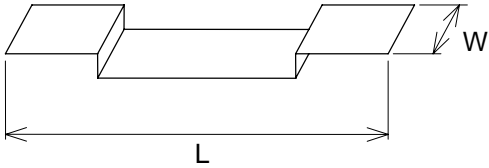
- NOTES:**
1. Even if the electron microscope is not used for a long time, it should be evacuated once a week.
 2. If an abnormality is found during the above inspections, contact Hitachi.
 3. Request the service engineer for items 1 to 5

4.2 Prior to Maintenance

Prepare the following items prior to maintenance. These are the minimum requirements for operating the microscope in good condition at all times.

4.2.1 Tools, Instruments, Consumables

Table 4-2 Tools, Instruments, Consumables

Item	Name	Remarks
Tools	Accessory tool set for EM	
Instruments	Vacuum evaporator Ultrasonic cleaner	Output 100 W or more
	Molybdenum board (for aperture cleaning)	 <p>MO board, 0.05 mm thick 7 mm W × 75 mm L</p>
	Beaker (& beaker stand)	1 L & 500 mL, one each
	Heater or gas burner Hair dryer Stereo-microscope	Approx. 1 kW For filament setting
Consumables	Vacuum grease Acetone Absolute ethanol or alcohol Gauze Cotton swabs Bamboo sticks Gas spray Metal polisher	Apiezon L Hi-Gauze Asahi Kasei product (or equivalent one)

4.2 Prior to Maintenance

4.2.2 Consumables (1 to 2 years' supply) for Electron Microscope

Table 4-3 Consumables for EM

Part Name	Part No.	Quantity	Remarks
Filament	777-0179	2 boxes	10 filaments ea.
Wehnelt assembly	542-0174	1	
Condenser lens movable aperture plate	817-2167	1	
Objective movable aperture plate	817-1397	1	
Film cassette	817-0230	10	Spares
O-ring (for specimen holder)	L456759	1	
" (for condenser lens/ objective movable aperture)	L456711	1	
RP oil (for main unit)	G469023	1	4 L
Fluorescent screen			
WHOLE	817-1170	1	
SPOT	817-0365	1	
Scintillator	817-4527	1	
Bamboo sticks	G743002	1	
Vacuum grease	G465003	1	Apiezon L
Oil mist trap	539-1992	2	

4.3 Maintenance in Routine Operation

Filament exchange, specimen exchange, film exchange, and mild baking of the column are maintenance items to be carried out by the user, and should be performed while observing the cautions explained below.

4.3.1 Filament Exchange

(1) Method of Checking if Filament is Broken

Take the following procedure to check if the filament is broken.

- (a) Check if the HV switch lights up normally.
- (b) Check if the accelerating voltage agrees with the setting.
- (c) Call out the filament/bias setting in the window and check if filament voltage is set at a suitable value. (Filament voltage setting varies with LaB₆ and W filaments.)

<Reference>

W filament : 18 to 22 V

LaB₆ filament : 25 to 30 V (inscribed on LaB₆ case)

- (d) Reduce the bias voltage, and check if emission current varies on the BEAM METER.
- (e) Make sure the EVAC/AIR switch of specimen chamber is not at **AIR**. It must be at **EVAC** for emission current to be output.



Fig. 4-1 EVAC/AIR Switch

- (f) Turn the POWER switch to **COL.OFF** once and then make a restart.

If emission current still doesn't flow after the above checks in (a) to (f), it indicates the filament is broken and must be replaced.

4.3 Maintenance in Routine Operation

- (2) Filament Exchange (by the user)
 - (a) Click the HV switch (for auto application of accelerating voltage) twice to turn **OFF** the HV.
 - (b) Return the POWER switch from **COL.ON** to **EVAC ON**.



Fig. 4-2 POWER Switch

- (c) Ignite the filament for a long period, and if the filament is broken, wait 10 to 20 minutes for the Wehnelt temperature to drop. (Wait 40 to 60 minutes in the case of the optional LaB₆ filament.)
- (d) Click **EVAC** of the GUN EVAC switch to set up the CLOSE status, then click **AIR** to airleak the gun.
- (e) When the gun reaches atmospheric pressure after vacuum leak, the buzzer sounds and the gun is lifted automatically and swings to the right.

WARNING

Beware of High Voltage

Electric shock could cause fatal or serious injury. At filament exchange, be sure to ground the Wehnelt and shield ring with the supplied grounding rod.

Beware of Pinching Your Fingers

Do not touch the electron gun while it is moving. You may get your fingers caught and suffer injury.

Beware of High Temperature

The Wehnelt and filament holder are at high temperature and could cause burns. At filament exchange, wait 10 to 20 minutes for the Wehnelt temperature to drop, and wear gloves for handling it.

- (f) Using a cloth or vinyl gloves, turn the shield ring counterclockwise and remove it.

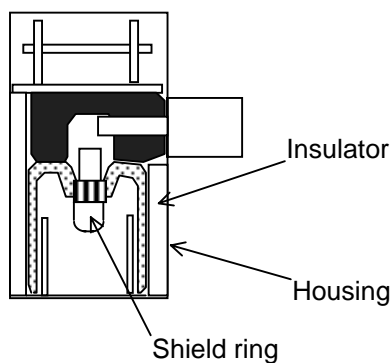


Fig. 4-3 Electron Gun Sectional View

- (g) Loosen the Wehnelt setscrew. Turn the Wehnelt about 90° counterclockwise and pull down to detach it.

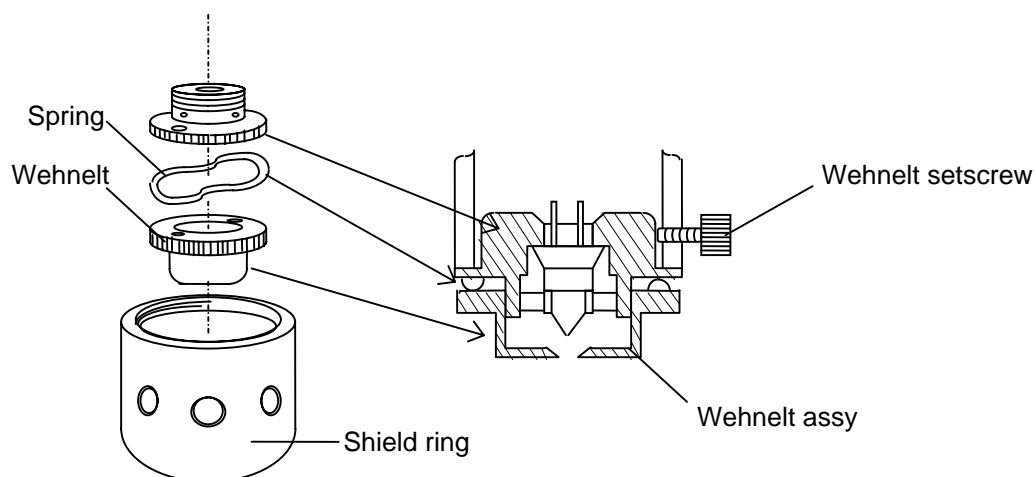


Fig. 4-4 Wehnelt Assy

- (h) Remove the Wehnelt using the Wehnelt height adjusting tool.

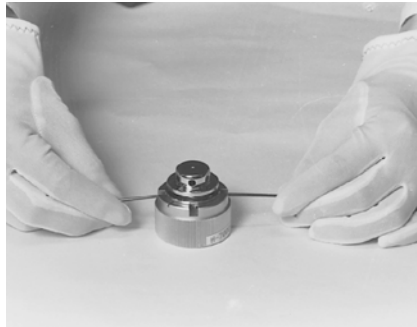


948-A-27

Fig. 4-5 Removal of Wehnelt

4.3 Maintenance in Routine Operation

- (i) Loosen the filament centering screw, and detach the broken filament.



948-A-26

Fig. 4-6 Removal of Broken Filament

- (j) Cleaning of the Wehnelt

Polish the asterisked part (*) of the Wehnelt shown in Fig. 4-7 with metal polishing agent, then wipe that part several times with gauze moistened with acetone. After this, dry it with a dryer. If not particularly contaminated, then wipe only the Wehnelt hole part using acetone and dry it with a dryer.

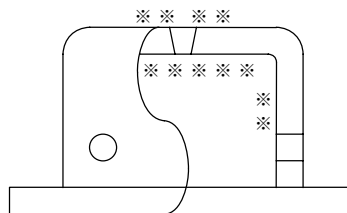



Fig. 4-7 Wehnelt

Clean with particular care the asterisked part that is irradiated with the electron beam.

 CAUTION
Inhalation of Harmful Substance Inhalation of a large amount of organic solvent could result in toxic symptoms. Be sure to ventilate the room well when using such substances for cleaning, etc.
Injury due to Spattering of Harmful Substance Spattering of an organic solvent could cause injury to the eyes. One should wear protective goggles when using such substances.

(k) Setting of filament

Note that there is a restriction on the attachment direction of the filament. Align the filament position with the attachment direction mark on the filament holder. (Fasten it at nearly the center.)

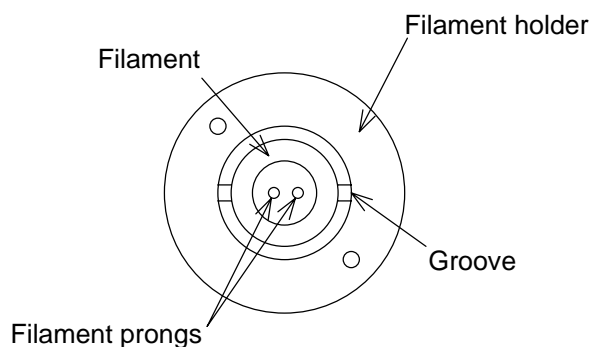


Fig. 4-8 Setting Position

- (l) After adjusting the height, align the Wehnelt hole center with the filament tip using the filament centering screw. Use of a stereo-microscope facilitates the centering.
- (m) Adjust the height and centering of the Wehnelt in which the filament is attached. A gap of 0.2 to 0.5 mm is allowed between the Wehnelt bottom face and the filament tip. Narrowing this gap increases the brightness but shortens the life of the filament. Conversely, widening the gap reduces the brightness while extending the filament life. Height should be adjusted in accordance with your purpose.

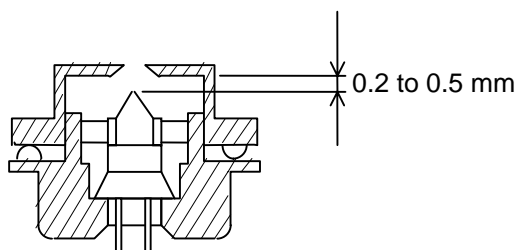


Fig. 4-9 Sectional View of Filament

NOTE: Since the optional LaB₆ filament is adjusted to the optimum position at the factory before shipment, height and centering adjustment by the user is unnecessary.

4.3 Maintenance in Routine Operation

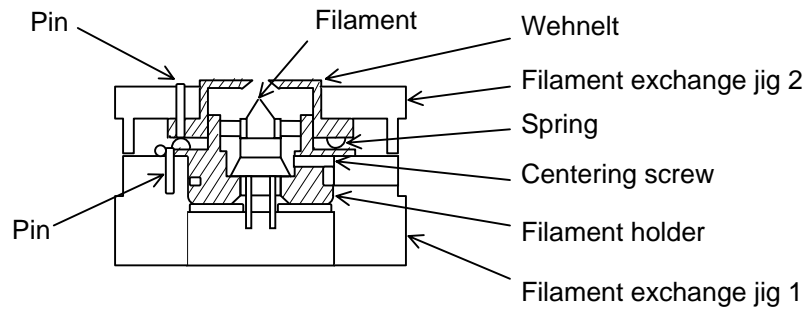


Fig. 4-10 Filament Position Adjustment

NOTE: When you adjust the height of a filament, for prevention of the biting of a screw, please remove a foreign substance, metal rubbish, etc. by blower, and clean the screw part of Wehnelt cap and a Filament holder.

NOTE: Jig 2 has a scale that is equally divided into eight. One turn varies the height of the Wehnelt cap by 0.5 mm.

- (n) Align the Wehnelt with the electron gun-side guide pins and turn 90° clockwise, then fasten with the Wehnelt retaining screws. After this, set the shield ring in place.



Fig. 4-11 Attachment of Wehnelt

- (o) Click the **AIR** switch of GUN EVAC to set the CLOSE status. The electron gun returns to the column side and evacuation is enabled. When the gun has completely returned, click the **EVAC** switch to start evacuation.

⚠ WARNING

Beware of Pinching Your Fingers

Do not touch the electron gun while it is moving. You may get your fingers caught and suffer an injury.

- (p) When the GUN EVAC lamp on the bottom right panel changes from flashing to steady lighting, set the POWER switch to **COL.ON**.



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Fig. 4-12 POWER Switch

- (q) When the EVAC switch of GUN EVAC lights up, high voltage can be applied. But in consideration of electron gun contamination and filament life, it is recommended to apply high voltage and ignite the filament after a sufficient evacuation (for at least 30 minutes normally).

NOTE: When using the optional LaB₆ filament, evacuate the electron gun to the order of 10⁻⁵ Pa. The LaB₆ filament tip incurs considerable vaporization depending on the vacuum degree and its life may be shortened.

- (r) Call out the filament/bias setting window, and carry out filament voltage setting according to section 3.3.2 and electron gun axial alignment as in section 4.7.2. If the kind of filament is not changed, then a value nearly equal to the previous filament voltage setting may be used.

4.3 Maintenance in Routine Operation

4.3.2 Cautions and Maintenance at Specimen Exchange

Observe the following cautions in the use of the side-entry specimen holder.

- NOTES:**
1. If the specimen is not held firmly by the grid retainer, it will be susceptible to vibration and specimen drift may occur. Also, the specimen may drop into the tilting device.
 2. Contamination on the vacuum part of the holder may cause specimen charge-up or contamination and/or specimen drift.
 3. Contamination on the O-ring may cause a drop in vacuum level at specimen insertion or unsmooth movement of the specimen stage.
 4. Contamination or scratch on the sapphire tip of the holder could result in unsmooth movement of the specimen stage.

(1) Check at Specimen Exchange

(a) Check of grid retainer

Press lightly at the two bold arrow positions shown in the figure below and make sure the specimen is held firmly.

(b) Check for O-ring contamination

Check if the O-ring is contaminated. If contaminated, wipe it clean and then apply a little vacuum grease to it.

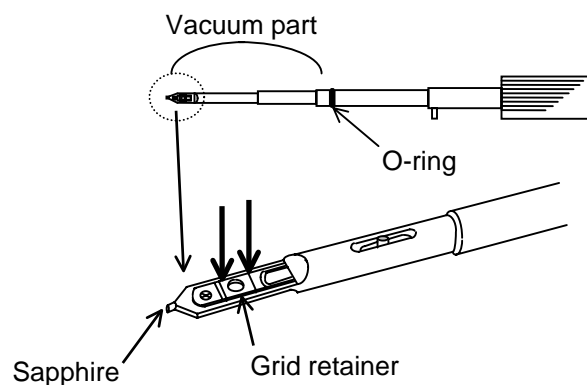



Fig. 4-13 Specimen Holder

(2) Maintenance

- (a) About once a month, clean especially the vacuum part of the holder tip with gauze that is moistened with absolute ethanol. After cleaning, dry it completely with a dryer.

 CAUTION
Inhalation of Harmful Substance Inhalation of a large amount of organic solvent could result in toxic symptoms. Be sure to ventilate the room well when using such substances for cleaning, etc.
Injury due to Spattering of Harmful Substance Spattering of an organic solvent could cause injury to the eyes. One should wear protective goggles when using such substances.

- (b) Cleaning and greasing of O-ring

Detach the O-ring carefully so as not to scratch the O-ring itself or its groove, then clean it and apply a little vacuum grease. If a scratch is found, then replace the O-ring with a new one.

4.3.3 Cautions and Maintenance at Film Exchange (option)

(1) Checks in Routine Operation

- (a) Check of cassette magazine and cassette receiver when loading film

Check the packing on the camera chamber front lid and the packing on the film pre-evacuation chamber. There should be no contamination on the packing surfaces. If there is contamination, wipe the surfaces and apply a little vacuum grease.

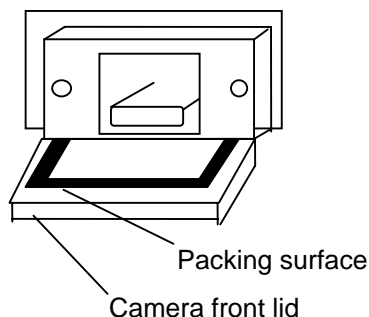


Fig. 4-14 Camera Front Lid

4.3 Maintenance in Routine Operation

(b) Inspection of cassette

When loading film into the cassette, insert it to the prescribed position whereby the film doesn't protrude from the cassette. When the cassette has been used for a long time, it may become deformed or warped and cannot be fed normally in the camera chamber. Do not use it any longer if deformed or warped.



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Fig. 4-15 Inspection of Cassette

(c) Caution on evacuation

Before starting evacuation of the camera chamber, make sure the front lid of the camera is closed. And after evacuation, check that CAMERA EVAC is operating normally and that the sound of the oil rotary pump (RP) has diminished. If pre-evacuation with the RP is made for a long time with the camera front lid open, the oil in the RP will deteriorate rapidly and the normal function will be lost.


(2) Maintenance

(a) Cleaning and greasing of packings

The packings of the camera chamber front lid and the film pre-evacuation chamber should be removed about once every two months for cleaning the packing surfaces. Apply a little vacuum grease to them after cleaning.

(b) Deformation of cassette

Check the cassette once a month for deformation or warp. If there is any deformation or warp, replace it with a new one.

 WARNING
Beware of Pinching Your Fingers Be careful not to get your fingers caught in moving parts or you may be injured. Before putting your hands into the camera chamber, be sure to turn OFF the POWER switch.

4.3.4 Inspection and Maintenance of Air Compressor

- (1) Carry out inspection of the air compressor according to the table below. Be sure to turn **OFF** the POWER switch for maintenance.


 CAUTION
<p>Beware of Drain Spattering</p> <p>Be sure to open the drain cock gradually when draining the compressor. The interior of the tank is pressurized, so if the drain cock were opened abruptly, drain would spatter out and may injure your eyes.</p>

Table 4-4 Air Compressor Inspection & Maintenance

Inspection Item (by user)	Procedure	Inspection Frequency
Drain accumulation	Turn drain plug of air tank (Fig. 4-16) to release drain.	Weekly
Operation of control devices (pressure gauge, pressure switches, safety valves)	Check if pressure gauge (Fig. 4-16) indicates a range of 3.5 to 5.0 MPa. If there is an abnormality, contact the service engineer.	Daily
Abnormal vibration, sound, etc.	If there is an abnormality, contact the service engineer.	Daily

- NOTES:**
- When not operated for a long time:
When the compressor is not operated for a long time, the lifetime of the grease used will be shortened due to humidity, so evacuation should be carried out for at least 30 minutes once a month.
 - The service engineer mentioned in the table refers to your nearest Hitachi representative.

4.3 Maintenance in Routine Operation

(2) Troubleshooting of Air Compressor

If a trouble occurs during use, inform the service engineer (Hitachi) of the symptoms, with reference to the table below. (The service engineer will remedy the problem.)


 CAUTION
<p>On Handling</p> <p>Troubleshooting of the air compressor by the user should be confined to confirming the symptoms (Table 4-5). Inspection and repair by a person other than the service engineers may result in loss of a part related to safety.</p>

Table 4-5 Air Compressor Troubleshooting

	Symptom	Probable Cause
Compressor rotates	Pressure doesn't rise, or takes much time to rise.	Drain accumulated, leakage from stop valve
		Packing, thread, or seal worn
		Leakage from safety valve
		Air valve faulty
		Clogging of suction filter
		Wear of piston ring
		Starting unloader faulty
		Faulty indication of pressure gauge
	Pressure rises above maximum level.	Pressure switch faulty
		Faulty indication of pressure gauge
	Abnormal sound produced.	Push solenoid faulty
		Contact of piston with air valve
		Bearing faulty
Wear of rider ring		
Inadequate installation		
Motor is overheated.	Seizure of sliding part	
	Abnormality of motor	
Compressor doesn't rotate	Motor does not hum.	Pressure switch faulty
		Protector has operated
	Motor hums.	Voltage drop
		Leakage from air valve
		Starting unloader faulty

(3) Names and Functions of Air Compressor Components

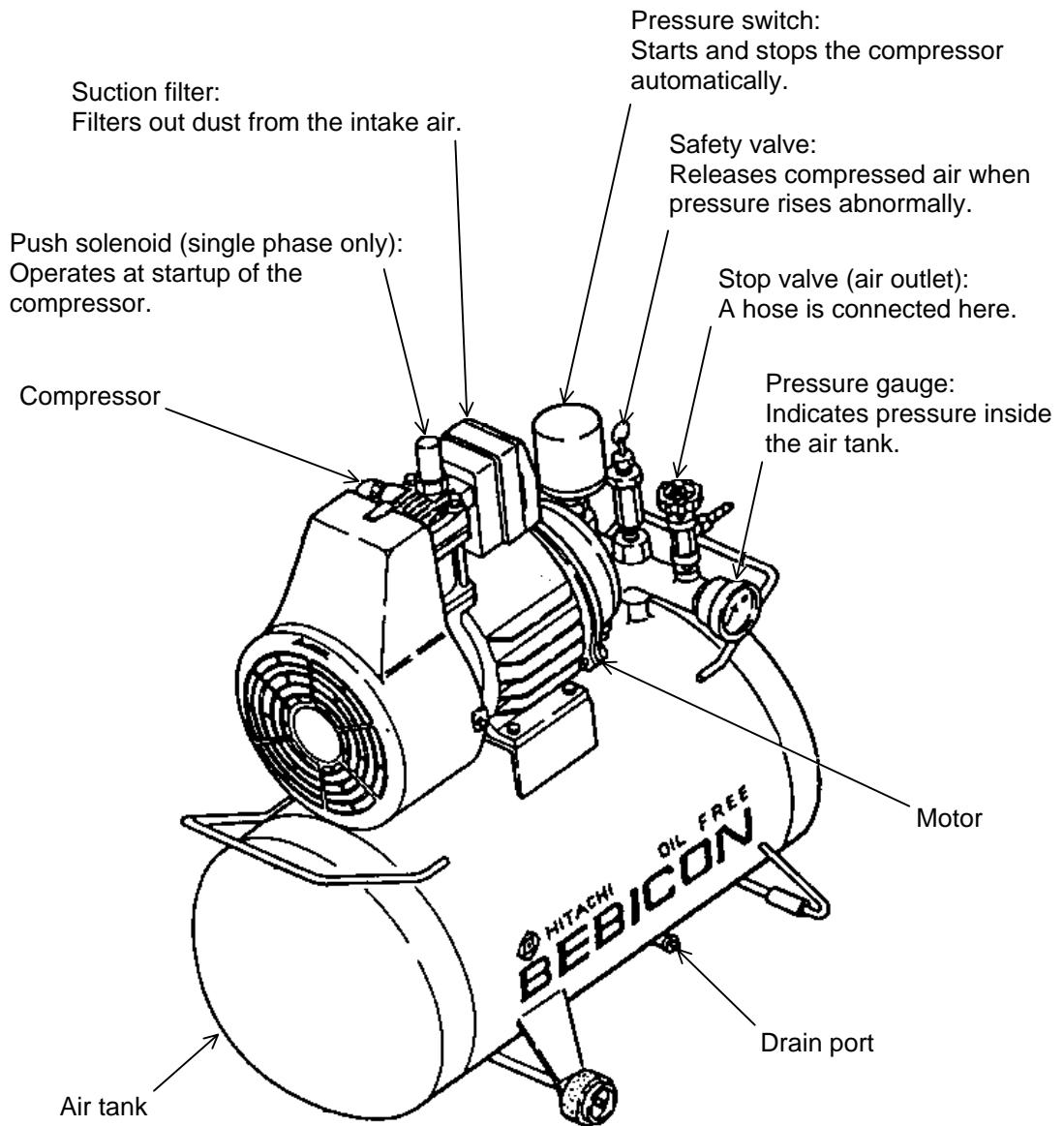


Fig. 4-16 Air Compressor


⚠ CAUTION

Heavy Item

The air compressor weighs approximately 26 kg. Don't try to lift it unreasonably, or you may be injured.

4.3 Maintenance in Routine Operation

4.3.5 Inspection and Maintenance of Oil Rotary Pump (RP)

 WARNING
High Temperature The surface temperature of oil rotary pump reaches about 70 °C while it is operating. Touching it could result in burns.

(1) Inspection during Routine Operation

- (a) Check the oil level once a week by means of the oil level gauge. Replenish oil if it is low. To replenish, stop the RP and inject oil from the plug (oil inlet). (Oil level gauge is located above the drain plug.)

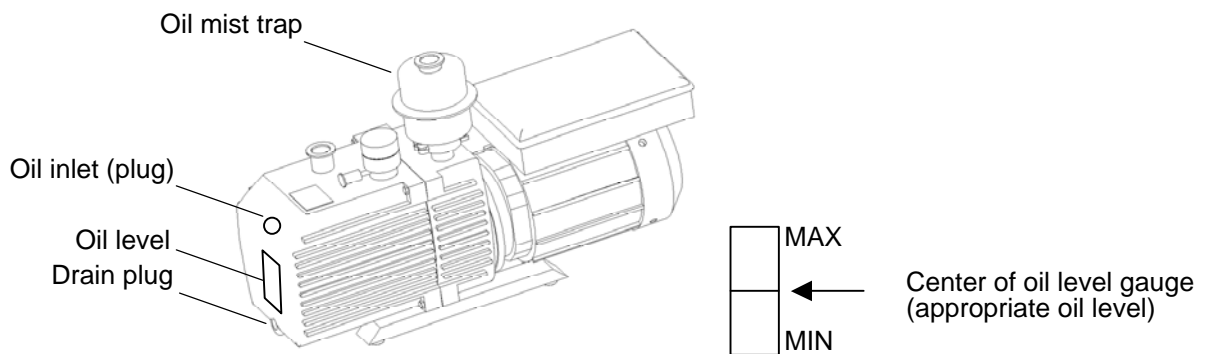


Fig. 4-17 Oil Rotary Pump

- NOTES:**
1. Insufficient amount of oil could cause a drop in pump performance. And too much oil could result in the oil spattering out. A suitable amount should thus be provided.
 2. The rotary pump has a certain useful lifetime. When five years have elapsed, the pump should be replaced with a new one.

(2) Maintenance (by Hitachi)

(a) Oil change

The oil should normally be changed within 6 months, but if water vapor or a gas harmful to oil has been evacuated, the oil will deteriorate more quickly and cause a drop in pump performance, in which case the oil should be changed more frequently.

(b) How to change oil

- 1) Turn **OFF** the microscope POWER switch and wait about 15 to 20 minutes for the RP to stop.
- 2) Turn and remove the drain plug to drain oil from the pump interior. The pump should be tilted so as to drain all the old oil from it.

 **CAUTION**
Heavy Item

The oil rotary pump weighs approximately 30 kg. Don't try to lift it unreasonably, or you may be injured.

- 3) When all of the old oil has been drained, fasten the drain plug firmly in place and inject the prescribed amount of new oil from the oil inlet. Use the following type of RP oil.

Table 4-6 RP Oil

RP Model	Oil Quantity	Oil Manufacturer
TRIVAC D8C	1.0 to 1.5 L	MR-100 Matsumura Sekiyu

4.3 Maintenance in Routine Operation

(3) Troubleshooting of RP

Refer to the table below for troubleshooting of the RP.


 CAUTION
On Handling Troubleshooting of the RP by the user should be confined to confirming the symptoms (Table 4-7). Inspection and repair by a person other than the service engineers may result in loss of a part related to safety.

Table 4-7 Troubleshooting of RP

Symptom	Probable Cause
1. Doesn't rotate	<ul style="list-style-type: none"> • Power failure • Motor faulty • Power cord disconnected, circuit protector OFF
2. Does not start	<ul style="list-style-type: none"> • Oil viscosity increases at low temperature in winter, etc. (below 9 °C) whereby starting is difficult. • Remote switch of motor faulty • Fault inside pump (abnormal meshing, sleeve bearing worn, etc.)
3. Poor evacuation performance (vacuum level doesn't rise, evacuation rate slow)	<ul style="list-style-type: none"> • Air leak due to faulty evacuation tubing. • Internal contamination or adsorbed gas due to faulty evacuation tubing. • Tubing too thin or too long • Deterioration of oil • Deterioration of valve spring • Deformation of valve • Deformation of oil valve • Fault inside pump
4. Sound too large	<ul style="list-style-type: none"> • Gas ballast valve is open • Oil level too low • Fault in evacuation system on pump suction side • Loose screws on motor coupling or pump coupling • Motor sound is large
5. Oil leakage	<ul style="list-style-type: none"> • Leakage from oil seal • Leakage from drain plug • Leakage from box and suction plate • Oil spattering from evacuation port
6. Backstreaming of oil	<ul style="list-style-type: none"> • Valve is not in close contact with cylinder surface • Backstreaming from oil seal • Deformation or wear of oil valve
7. Considerable vibration	<ul style="list-style-type: none"> • Temperature is low (vibration increases when starting at low temperature) • Off-centering of motor and pump shafts

4.3.6 Cooling Water Inspection & Maintenance of Cooling Water System

Below is a cooling water system diagram for the H-7650 microscope. Two systems of cooling water (for the lens system and evacuation system) are required. As for the lens system, current does not flow except when the POWER switch is at COL.ON, and cooling is therefore unnecessary. So the water cooling valve shown in the diagram or the water supply tap for INLET (LENS) may be left closed. The water supply tap for INLET (LENS) should be closed when the evacuation system alone is operated continuously for long hours.

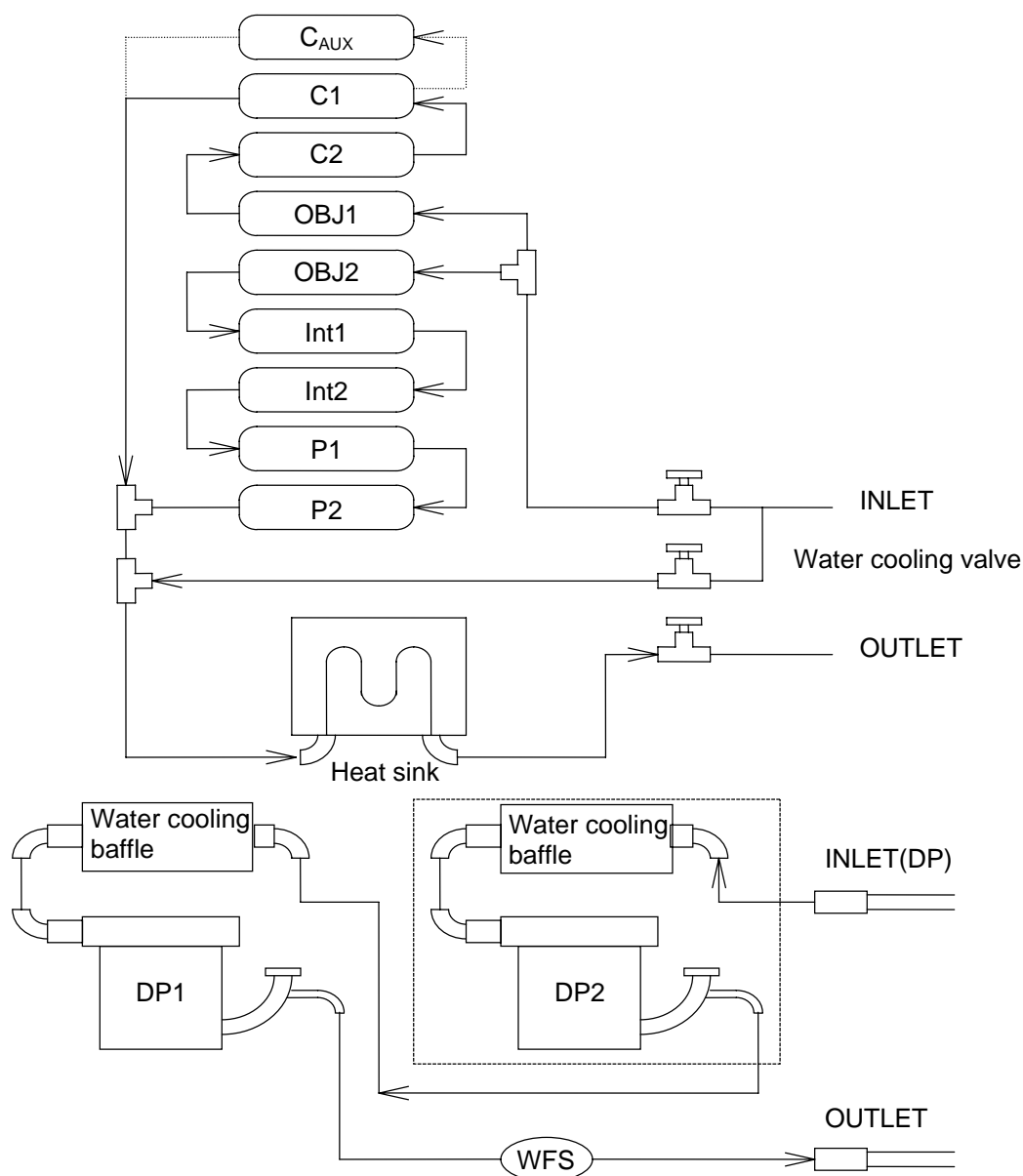


Fig. 4-18 Cooling Water System Diagram

4.3 Maintenance in Routine Operation

(1) Flow Rate and Temperature of Cooling Water

- (a) The flow rate and temperature of cooling water are restricted as in the table. The cautions given below should also be observed.

Table 4-8 Cooling Water Flow Rate & Temperature

Cooled System	Water Temperature	Flow Rate
Lens system	10 to 20 °C	Approx. 1.5 to 2 L/min
Evacuation system (DP)	10 to 20 °C	Approx. 1.5 to 2 L/min

NOTES: 1. Water temperature

If the water temperature differs from the room temperature, condensation will form on the cooled sections and this will lead to corrosion. If the difference from room temperature is 5 °C or greater, the optional cooling water circulator should be utilized.

2. Flow rate

If the cooling water flow exceeds 2 L/minute at the water outlet side of each system, stress due to the flow velocity, etc. will be applied to the inner walls of cooling water piping and will thus have an adverse effect on the instrument.

3. Water quality

If iron, calcium and other elements are included in the water supply, the lens magnetic circuit or DP cooling pipe may become clogged, or corrosion may occur to result in a breakdown. If the water flow rate decreases or the DP or lens magnetic circuit overheats, request the service engineer for repair at once.

Be sure to use a filter if impurities or sand is mixed in the supplied water.

4. Water leak detection

This instrument is not equipped with a water leak detector. A change in quality or pressure of cooling water could cause corrosion or cracks in the flow path and result in water leakage. If the optional cooling water circulator cannot be employed, be sure to purchase and install an optional water supply unit.

Besides having reducing and constant flow valves, the water supply unit has a water leak sensor for preventing a large water leakage.

(2) Routine Check of Cooling Water

(a) When using tap water

- Check if the water flow at the outlet side is low versus the opening of the water supply tap, or if the water temperature is abnormally high.
- When a filter is used at the water supply side, check the filter for contamination or clogging.

(b) When using a cooling water circulator

- Check for cleanliness of the circulated water, and if contaminated, replace it with distilled water.
- Improper functioning of the temperature control may cause overheating of the DP as well as contamination or drift. Ask for repair in such case.

NOTE: Two systems, water cooling and air cooling, are available for the optional cooling water circulator. Note that tap water may be used for the primary cooling in the water cooling system. In this case, be sure to purchase and install an optional water supply unit for the purpose of water leak detection.

4.3.7 Column Mild Baking Function

This function utilizes the heat radiated from the lens coil to bake the inside of the column for outgassing the gas molecules adsorbed on the inner wall. This increases the vacuum level and reduces contamination. (Refer to section 4.7.3 for details.)

- (1) Click **Maintenance - Column baking** on the menu bar to call out the related window.
- (2) Change the cooling water path as in steps (a),(b) below to form the path for baking. The valves shown in Fig. 4-19 are provided on the rear of the main unit.
 - (a) Open the mild baking valve fully.
 - (b) Close the LENS INLET valve.

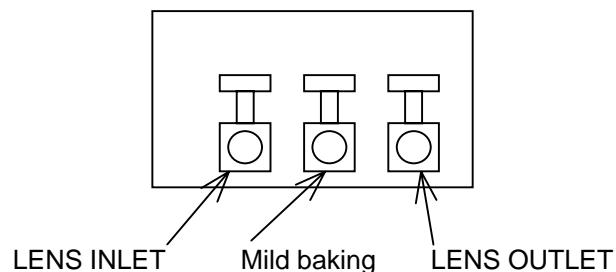


Fig. 4-19 Water Cooling Valves (main unit rear)

4.3 Maintenance in Routine Operation

- (3) Enter a baking time and click **Start** to begin baking. (A minimum of about 12 hours is required for baking in order to obtain a good effect in reduction of contamination.)
- (4) To suspend the baking, click **Cancel** and then click **Quit** to return to the normal operation. But when the cooling time is interrupted, the lens will be heated. So make sure the cooling is sufficient before changing the cooling water path (step 7) for the next operation.

<p>NOTICE: There is a possibility of damaging the lens coil. So do not open the LENS INLET valve while the lens is hot.</p>
--

- (5) Allow a lens cooling time of 4 hours after baking. The entire software function is halted during this time. Do not open the LENS INLET valve during this period.
- (6) Clicking the **Quit** button when cooling is finished terminates the mild baking mode.
- (7) Change the cooling water path as in (a),(b) below and the path returns from the one for baking to the normal one.
 - (a) Open the LENS INLET valve fully.
 - (b) Close the mild baking valve.
- (8) The mild baking is thus finished. If you forget to open the LENS INLET valve and then apply the accelerating voltage, a safety device will work and put the instrument in COL.OFF status.

4.4 Periodic Maintenance

This section describes the maintenance items to be carried out mainly by the service engineers. Items for the user to carry out are confined to checking the symptoms with respect to an error message. Contact the service engineer (Hitachi) for locating the cause of and remedying the error.

4.4.1 Cleaning of Movable Apertures (Hitachi)

Contamination of the movable apertures will cause the symptoms explained below and result in image disturbance. Cleaning of the apertures must be done periodically or whenever image disturbance occurs.

The standard movable apertures in the H-7650 are of O-ring sealed type.

(1) Contamination of Condenser Lens Movable Aperture

This will disable astigmatism correction of the beam spot when the spot size is reduced or astigmatism correction of a STEM image.

(2) Contamination of Objective Movable Aperture

This will increase the intrinsic astigmatism of the objective lens, and may disable astigmatism correction in the worst case. Image quality will also deteriorate.

(3) Contamination of Selected Area Aperture (option)

This will cause the edge part of the aperture to appear on a selected area image, or cause distortion of the diffraction spot.

(4) How to Remove Each Movable Aperture

- (a) Set the knob of the objective lens movable aperture at "1". Set the knobs of the condenser lens movable aperture and selected area aperture at "0".



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Fig. 4-20 Movable Aperture

4.4 Periodic Maintenance

- (b) Set the entire column at atmospheric pressure by pressing EVAC/AIR switch of COLUMN EVAC on the right sub panel. With the column in evacuated status, pressing **EVAC** switch of COLUMN EVAC closes the entire column, and then pressing the **AIR** switch puts the entire column at atmospheric pressure.

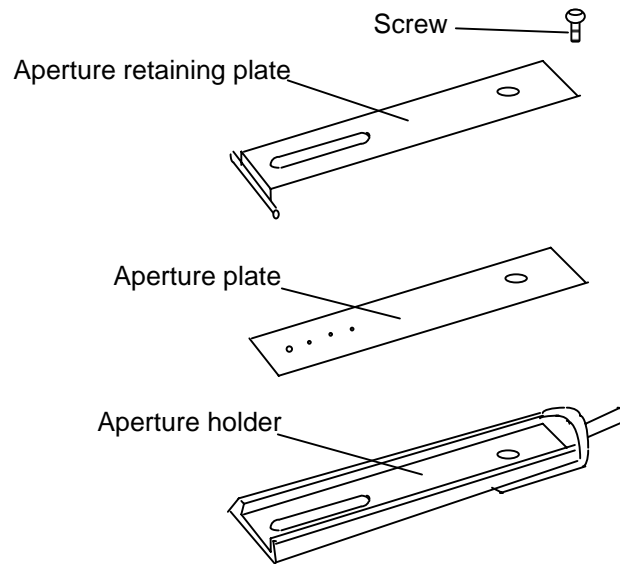


Fig. 4-21 Condenser Lens Movable Aperture/Selected Area Aperture

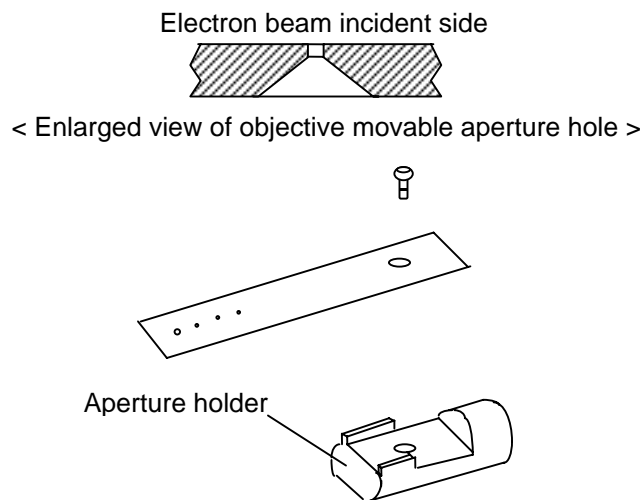


Fig. 4-22 Objective Movable Aperture

- (c) Loosen the column retaining screw M4 × 2, and pull the movable aperture out of the column.
 - (d) Remove the aperture screw, then remove the aperture retaining plate and aperture plate using a tweezers.
 - (e) Clean the movable aperture according to step.
 - (f) After cleaning, reassemble the aperture into the column.
- (5) Cleaning of Each Movable Aperture

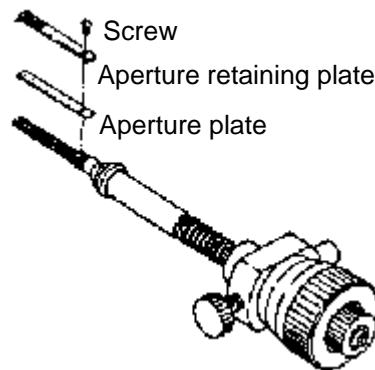


Fig. 4-23 Selected Area Movable Apertures (option)

- (a) Aperture plate
 - 1) Attach a molybdenum board inside the vacuum evaporator, set the aperture plate on the board, and then evacuate.
 - 2) When the vacuum reaches about 1.33×10^{-3} Pa, gradually apply current until the molybdenum board is red-heated. Increase the current until the board becomes incandescent. (The current at that point is about 40 to 50 A.) Let it incandesce for 5 to 10 seconds, and remove the contamination around the aperture hole. After stopping the heating, wait for 5 minutes before exposing it to air.
 - 3) Absolutely avoid touching the aperture plate with bare hands.

4.4 Periodic Maintenance

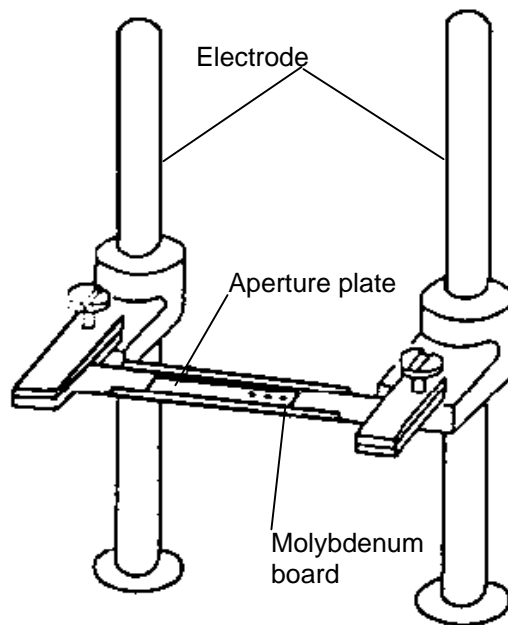


Fig. 4-24 Cleaning of Aperture Plate

(b) Aperture retaining plate and aperture holder

If contaminated, first polish with metal polishing agent, wipe a few times with gauze moistened with acetone, and after the cleaning, dry thoroughly with a dryer.

(c) O-ring

Remove the O-ring carefully with a bamboo stick or the like so as not to scratch it, wipe it with gauze moistened with alcohol, then apply a little vacuum grease to it.

⚠ CAUTION

Inhalation of Harmful Substance

Inhalation of a large amount of organic solvent could result in toxic symptoms. Be sure to ventilate the room well when using such substances for cleaning, etc.

Injury due to Spattering of Harmful Substance

Spattering of an organic solvent could cause injury to the eyes. One should wear protective goggles when using such substances.

4.4.2 Maintenance of Penning Gauge (Hitachi)

Since a high voltage of 3000 V is applied to the electrodes of the Penning gauge, the resultant electric field causes a gradual contamination of the surroundings. The result is that high voltage may leak, a correct vacuum level may not be read, and/or accelerating voltage may not be applicable. (The Penning gauge serves to provide vacuum protection for the accelerating voltage.)

If any of the above symptoms occur, contact your nearest Hitachi service agent.

4.4.3 Replacement of Backup Battery (Hitachi)

(1) H-7650 Control Unit

Although stored in the RAM area for EVAC, a backup battery provides protection so that data will not be deleted when power is turned off.

NOTE: Although the battery is an auto recharging type, it has a useful life of about 1 year. Request the service agent for battery replacement about once a year.

(2) Backup Battery Replacement

Use the type of battery described below for battery replacement.

Table 4-9 Recommended Backup Battery

Type	GB50H-3X
Manufacturer	Nippon Denchi
Quantity	Two

WARNING

Beware of Explosion

This instrument uses a lithium battery for memory backup.
A mistake in handling the battery could cause it to explode.
Absolutely avoid disassembling the battery or tossing it into a flame.

4.4 Periodic Maintenance

WARNING

The lithium battery must be handled separately from general waste matter. When lithium battery replacement is required, be sure to contact the dealer from whom you purchased the instrument or your nearest Hitachi service agent. Entrust the replacement to a qualified service engineer. (Replacement will be provided at charge after the guarantee period of the instrument.)

4.4.4 Maintenance of Digital Camera System (Hitachi)

Remove dust adhering to the surfaces of optical lens, mirror and scintillator of the digital camera system by using a blower. If fingerprints or the like adhere to the optical lens surface, wipe them off using a lens cloth.

4.5 Error Messages (for user's reference)

An error message will appear if an error occurs in the system. The message may appear in the status bar of the control screen or in the error message window. If an error that hinders the system operation occurs, a message that requests restart of the system program, for example, will appear in the error message window. The occurrence of an error that requires an urgent remedy will cause an error message to appear in the control area.

NOTICE: The user should check only the symptoms with respect to an error message. Contact the service engineer for locating the cause of and remedying the error.

4.5.1 Error Messages Requiring an Urgent Remedy

If an error occurs that requires an urgent remedy, the system COL. power and EVAC power will be turned OFF in about 3 seconds. Note that the buzzer will sound in the case of errors related to water leakage. To stop the buzzer, turn OFF the DC power supply main breaker or the switch on the switchboard.

Table 4-10 Error Messages Requiring an Urgent Remedy

Message	Details	Remedy
RP-1 FAILURE	Appears if an abnormality occurs in oil rotary pump (RP) 1.	Contact our nearest service agent.
RP-2 FAILURE	Appears if an abnormality occurs in oil rotary pump (RP) 2.	Contact our nearest service agent.
WATER LEAKAGE (option)	Appears if the water leak sensor detects a water leakage.	Contact our nearest service agent.
WATER LEAKAGE SENSOR ERROR (option)	Appears if an abnormality occurs in the water leak sensor.	Contact our nearest service agent.

4.5 Error messages (for user's reference)

4.5.2 Error Messages Appearing in Control Area

Table 4-11 Error Messages Appearing in Control Area

Message	Details	Remedy
ABS CANNOT ADJUST	Appears when brightness cannot be set upon executing the auto brightness set (ABS) mode. ABS mode is reset if it cannot be executed.	Set FULL size for the film.
ABS MODE CANCEL	Appears when the ABS mode is reset when brightness cannot be changed with BRIGHT knob in the ABS mode selected status or at viewing mode changeover.	Don't manipulate the BRIGHT knob during the ABS operation.
FILM SETTING ERROR	Appears when film could not be set at the prescribed position.	Since the remaining number of exposures has reached "0", load new film.
SCREEN MOTOR ERROR	Appears when screen could not be moved to the prescribed position, or when screen up/down mechanism malfunctions.	Contact our nearest service agent.
FILM CASSETTE JAMMED	Appears when film could not be moved to the photographing position or the cassette receiver, or when film feed mechanism malfunctions due to deformation of film cassette.	Contact our nearest service agent.
OVER CURRENT OCCURRED	Appears when overcurrent is produced due to discharge, etc. during accelerating voltage application.	Try re-applying accelerating voltage at 80 kV or less. If discharge occurs again, contact our nearest service agent.
POOR VACUUM	Appears when accelerating voltage cannot be applied because of low vacuum level in the column when pressing the accelerating voltage switch.	Wait until electron gun and column reach a high vacuum before applying accelerating voltage.
HV UNIT OVER HEAT	Appears if the HV unit heats up abnormally.	Contact our nearest service agent.
HV UNIT POWER FAILURE	Appears if an abnormality occurs in the HV unit power system.	Contact our nearest service agent.
TMP FAILURE	Appears if an abnormality occurs in the turbo molecular pump (TMP) (option).	Contact our nearest service agent.
AIR PRESSURE DOWN	Appears if the pressure in air compressor drops abnormally.	Contact our nearest service agent.
WATER PRESSURE DOWN	Appears if the flow of cooling water drops.	Contact our nearest service agent.

(cont'd)

Message	Details	Remedy
DP-1 OVER HEAT	Appears if oil diffusion pump (DP) 1 heats up abnormally.	Contact our nearest service agent.
DP-2 OVER HEAT	Appears if oil diffusion pump (DP) 2 heats up abnormally.	Contact our nearest service agent.
DP-1/2 SENSOR ERROR	Appears if an error occurs in DP-1 or DP-2 thermal sensor.	Contact our nearest service agent.
WARNING: SERIAL DATA MISMATCH (a)	Appears if an error occurs in serial communication data.	Contact our nearest service agent.
WARNING: SERIAL COM. ERROR (b)	Appears if an error occurs in serial communication port (device).	Contact our nearest service agent.
WARNING: PARALLEL COM. ERROR (c)	Appears if an error occurs in parallel communication port (device).	Contact our nearest service agent.
VALVE I/O ERROR	Appears if a valve did not operate normally within the prescribed time in the evacuation sequence.	Contact our nearest service agent.

4.5.3 Error Messages Appearing in Window

These errors mainly occur when the cable of a unit is disconnected.

Table 4-12 Error Messages Appearing in Window

Message	Details	Remedy
LENS/BD UNIT PORT ERROR	Appears if an abnormality occurs in the communication port of lens system unit.	Contact our nearest service agent.
CAMERA UNIT PORT ERROR	Appears if an abnormality occurs in the communication port of camera control unit.	Contact our nearest service agent.
HV UNIT PORT ERROR	Appears if an abnormality occurs in the communication port of HV control unit.	Contact our nearest service agent.
EVAC UNIT PORT ERROR	Appears if an abnormality occurs in the communication port of evacuation system control unit.	Contact our nearest service agent.
WOBLER UNIT PORT ERROR	Appears if an abnormality occurs in the communication port of wobbler control unit.	Contact our nearest service agent.
OPTION PORT ERROR	Appears if an abnormality occurs in the communication port of option unit.	Contact our nearest service agent.

4.5 Error messages (for user's reference)

(cont'd)

Message	Details	Remedy
STEM UNIT PORT ERROR	Appears if an abnormality occurs in the communication port of STEM control unit.	Contact our nearest service agent.
STAGE UNIT PORT ERROR	Appears if an abnormality occurs in the communication port of stage control unit.	Contact our nearest service agent.
PANEL PORT ERROR	Appears if an abnormality occurs in the communication port of operation panel control unit.	Contact our nearest service agent.
Thermo SW working! (LENS UNIT RESET)	Appears if an unforeseen error occurs in the lens system control unit.	Check the cooling water, since it is normal for the error to appear when the thermo SW operates.
Thermo SW working! (CAMERA UNIT RESET)	Appears if an unforeseen error occurs in the camera control unit.	Check the cooling water, since it is normal for the error to appear when the thermo SW operates.
Thermo SW working! (HV UNIT RESET)	Appears if an unforeseen error occurs in the HV control unit.	Check the cooling water, since it is normal for the error to appear when the thermo SW operates.
Thermo SW working! (EVAC UNIT RESET)	Appears if an unforeseen error occurs in the evacuation system control unit.	Check the cooling water, since it is normal for the error to appear when the thermo SW operates.
Thermo SW working! (COMM UNIT RESET)	Appears if an unforeseen error occurs in the communication control unit.	Contact our nearest service agent.

4.6 Troubleshooting (for user's reference)

4.6.1 Evacuation Sequence Does Not Proceed

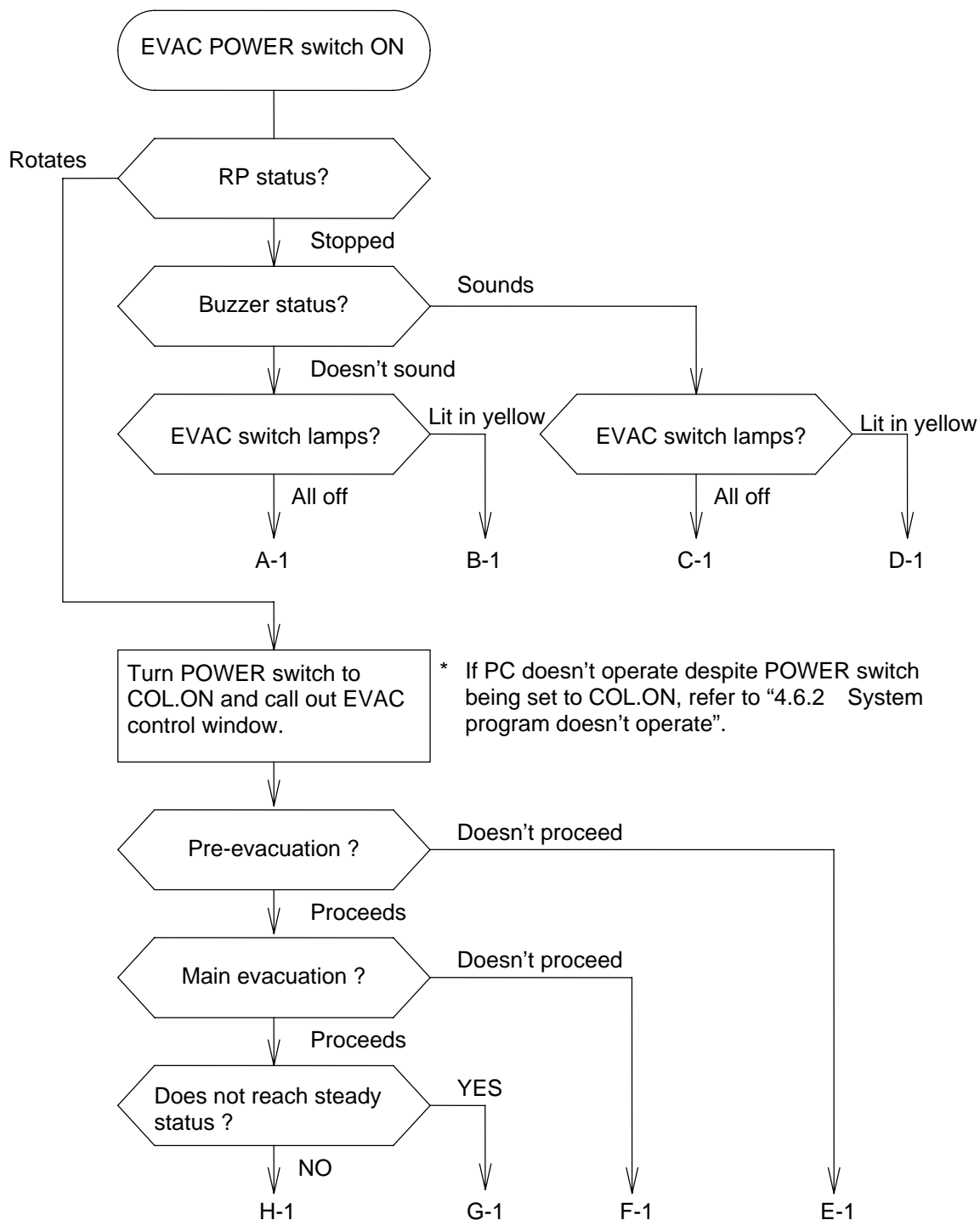


Fig. 4-25 Troubleshooting of Evacuation Sequence

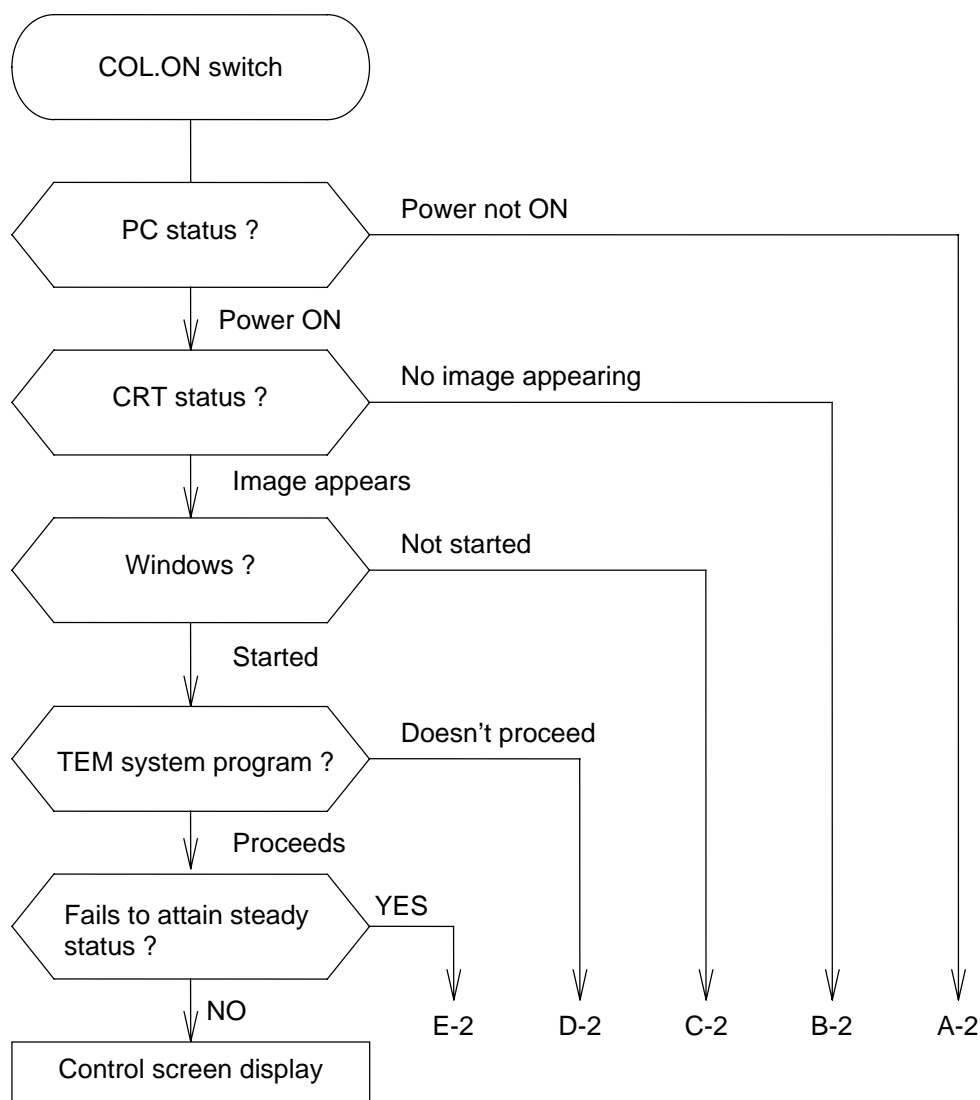
Refer to Table 4-13 for the probable causes of the above troubles.

4.6 Troubleshooting (for user's reference)

Table 4-13 Causes of and Remedy for Evacuation Sequence Not Proceeding

Symptom	Probable Cause	Remedy
A-1	Fault in RP-1 or RP-2	Inspect DC power supply breaker or power cable for RP-1, RP-2.
	Malfunction of valve	Check for air pipe disconnection or deterioration.
B-1	Abnormal drop of pressure in air compressor	Check air compressor power cable, drain cock, etc.
	Faulty connection of DP-1 or DP-2 thermal sensor	Attach sensor securely and connect its cable correctly.
	Overheating of DP-1, DP-2	Check cooling water temperature and level.
	Fault in TMP (option)	Refer to section 4.6.9.
C-1	Sensor detects water leak	Check the cooling water tubing, etc.
	Misconnection or breakdown of water leak sensor	Attach sensor securely and connect its cable correctly.
D-1	Cooling water level low	Check if cooling water flow is from 1.5 to 2.0 L/min.
E-1	Gun lift sensor faulty	Attach sensor securely and connect its cable correctly.
	Pirani gauge faulty	Check vacuum degree on Pirani gauge. If gauge is broken, replace it.
	Vacuum insufficient	Check the vacuum level of each block.
F-1	DP heater faulty	If DP temperature does not rise, replace DP heater.
	Vacuum insufficient	Check the vacuum level of each block. If raw film is inserted in camera chamber, much time will be needed for reaching high vacuum.
G-1	Cooling water temperature is high	If cooling water temperature is above 20 °C, DP cannot be cooled sufficiently and overheat error will occur, whereby evacuation sequence will stop. Although self-reset will occur when DP is cooled, the error will recur.
	Penning gauge faulty	Check the vacuum degree of Penning gauge. If gauge is contaminated, clean or replace it.
H-1	Unforeseen error has occurred	Contact your nearest Hitachi service agent and inform them of the error in detail.

4.6.2 System Program Doesn't Operate



* For the error messages that appear after display of the control screen, refer to section 4.5.

Fig. 4-26 Troubleshooting of System Program

Refer to Table 4-14 for a description on probable causes of the above errors.

4.6 Troubleshooting (for user's reference)

Table 4-14 Causes of and Remedy for System Program Failing to Operate

Symptom	Probable Cause	Remedy
A-2	Misconnection of PC power supply	Check PC main unit, CRT power switch, and cable.
	Evacuation sequence faulty	If "RP fails to rotate" error occurs, PC power supply is not ON. Refer to section 4.6.1.
B-2	CRT brightness not adjusted properly	Readjust the CRT brightness and contrast.
	CRT monitor cable misconnected	Check the monitor cable connecting PC main unit and CRT.
C-2	PC not started correctly	Check if key on keyboard or mouse button is kept depressed, or if FD is left inserted in the drive.
	Windows not started correctly	Windows startup file has been damaged. Reinstall the Windows program.
	PC failure	Follow the instructions of error message appearing on CRT. If error message doesn't appear, contact the service engineer.
D-2	TEM system program not started correctly	If icon (execution file) for TEM system program is not registered in Windows startup folder, reinstall the TEM system program referring to section 4.7.7.
	TEM system program file faulty	If file necessary for TEM system program is damaged or not registered, an error message will appear. Reinstall the TEM system program referring to section 4.7.7.
E-2	Communication failure between units	Check the communication cable connection with reference to the faulty unit name indicated on error message window.
	Unit failure	Check if cable or connector is disconnected with reference to the faulty unit name indicated on error message window. If error message recurs upon restarting the system, contact the service engineer.

4.6.3 Accelerating Voltage Not Applied

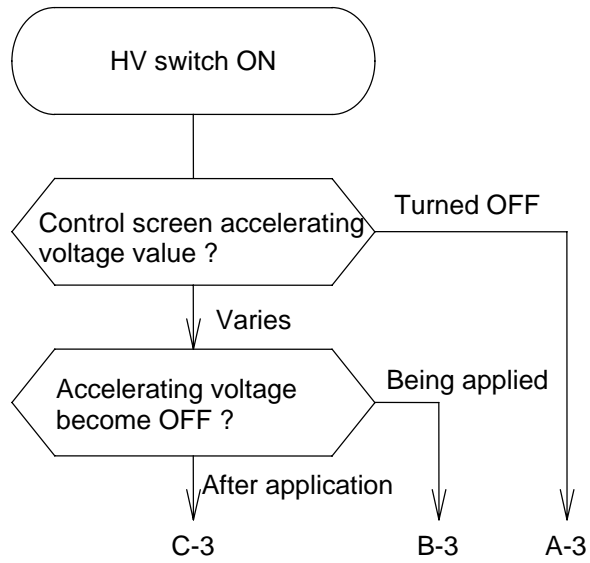


Fig. 4-27 Troubleshooting of Accelerating Voltage

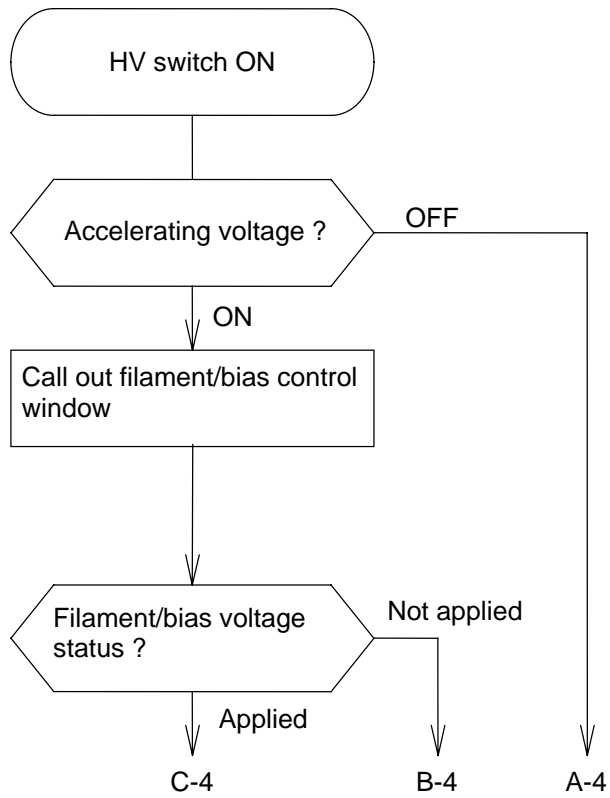
Refer to Table 4-15 for a description on probable causes of the above errors.

4.6 Troubleshooting (for user's reference)

Table 4-15 Causes of and Remedy for Accelerating Voltage Not Being Applied

Symptom	Probable Cause	Remedy
A-3	Low vacuum status	If error message "POOR VACUUM" appears, wait until column reaches a high vacuum.
	Vacuum status monitoring cable misconnected	Check vacuum status and valve status on EVAC control window, and if error message "POOR VACUUM" appears despite both statuses being good, check the connection of vacuum status monitoring cable.
	Error in accelerating voltage presetting	If accelerating voltage is preset at 0 kV in HV preset window, the accelerating voltage will not be applied.
	Control panel misconnection	Check whether control panel connecting cable is disconnected.
B-3	Electric discharge inside column	Electron gun is contaminated and requires cleaning.
	High vacuum not attained	Lengthen the time for incrementing voltage, which is set on filament voltage auto increment setting window, just after reaching the vacuum level at which accelerating voltage may be applied from the low vacuum status.
C-3	Overheat protection activated	Unit power is turned OFF by protective circuit when HV unit, lens unit or DC power supply overheats. Check whether cooling water of lens unit, or heat radiating slit of HV unit or DC power supply is shut off.
	High vacuum not attained	If accelerating voltage is applied just after reaching the vacuum level at which it may be applied from the low vacuum status, the voltage is apt to be turned OFF. Carry out the flashing operation.
	Overcurrent produced	In filament voltage auto increment mode, filament voltage and bias are set after applying accelerating voltage. If filament voltage and bias are excessive, the accelerating voltage will be turned OFF by the overcurrent protective circuit. Make adjustment on the filament/bias control window.

4.6.4 Electron Beam Not Emitted

**Fig. 4-28 Troubleshooting of Electron Beam**

Refer to Table 4-16 for a description on probable causes of the above errors.

4.6 Troubleshooting (for user's reference)

Table 4-16 Causes of and Remedy for Electron Beam Not Being Emitted

Symptom	Probable Cause	Remedy
A-4	Accelerating voltage inadequate	Refer to section 4.6.3.
B-4	Filament voltage auto increment mode not selected	If filament voltage manual increment mode has been selected on accelerating voltage/filament voltage auto increment time setting window, it will not be incremented automatically. Refer to section 3.3.2 for the manual increment mode.
	Faulty filament	If filament is broken, then clicking the ON button after setting filament preset voltage will not set the voltage. Replace the filament.
	Status of specimen chamber EVAC switch	If specimen chamber EVAC switch is at AIR, bias will be at maximum voltage and beam will not be emitted. Set the EVAC switch at EVAC regardless of presence/absence of specimen holder, for setting the bias preset voltage.
C-4	Filament/bias preset voltage inadequate	If proper filament and bias preset voltages have been set, then adjustment is required. By increasing bias voltage, beam will fail to appear. Refer to section 3.3.2.
	GV or SV valve is closed or faulty	<ul style="list-style-type: none"> If viewing chamber or camera chamber does not reach high vacuum status, SV valve is closed. In this case, beam is not emitted, so wait until high vacuum is reached. GV and/or SV valve is faulty. Contact service engineer for repair.
	Axial alignment of column inadequate	Carry out axial alignment of column as in 4.7.2.
	Movable aperture not adjusted properly	Adjust the position of condenser lens aperture or objective lens aperture.
	Articles dropped or left behind	Specimen, specimen holder or other object was dropped into electron beam path and obstructs the beam.
	Photographing shutter faulty	Beam is cut off if photographing shutter is left closed. Check the air tube for shutter drive, etc.

4.6.5 Magnification Not Selected Normally

Check with reference to the following table if magnification cannot be selected normally.

Table 4-17 Causes of and Remedy for Magnification Not Being Selected Normally

Symptom	Probable Cause	Countermeasure	Remedy
Magnification doesn't change though MAG knob is turned	Lens system CPU has overrun	Try restarting with the POWER switch.	_____
	Lens system overcurrent prevention fuse has blown	Contact your nearest service agent.	Have the service engineer make repair.

4.6.6 Brightness Doesn't Change

Table 4-18 Causes of and Remedy for Brightness Not Changing

Symptom	Probable Cause	Countermeasure	Remedy
GT/GH, BT/BH and other deflection systems don't operate	DC power supply protective fuse has blown	Contact your nearest service agent.	Have the service engineer make repair.
Only one system doesn't operate	Coil broken	Contact your nearest service agent.	Have the service engineer make repair (replace coil).
	Misadjustment of knob at faulty location	Contact your nearest service agent.	Have the service engineer make repair (adjustment).
	Drive circuit fuse has blown	Contact your nearest service agent.	Have the service engineer make repair (replace fuse).

4.6 Troubleshooting (for user's reference)

4.6.7 Focus Not Obtainable

Check according to the following table if focus cannot be obtained.

Table 4-19 Causes of and Remedy for Focus Not Being Obtained

Symptom	Probable Cause	Countermeasure	Remedy
Focus not changed even by turning FOCUS knob	Objective lens control circuit faulty	Contact your nearest service agent.	Have the service engineer make repair.
	Fuse has blown	Contact your nearest service agent.	Have the service engineer make repair (replace fuse).
Focal position largely deviates	Objective focusing current largely deviates from setting	Press LENS switch and return to initial value.	Obtain focus with Z control knob of tilt device.

4.6.8 Photographing Doesn't Work Normally

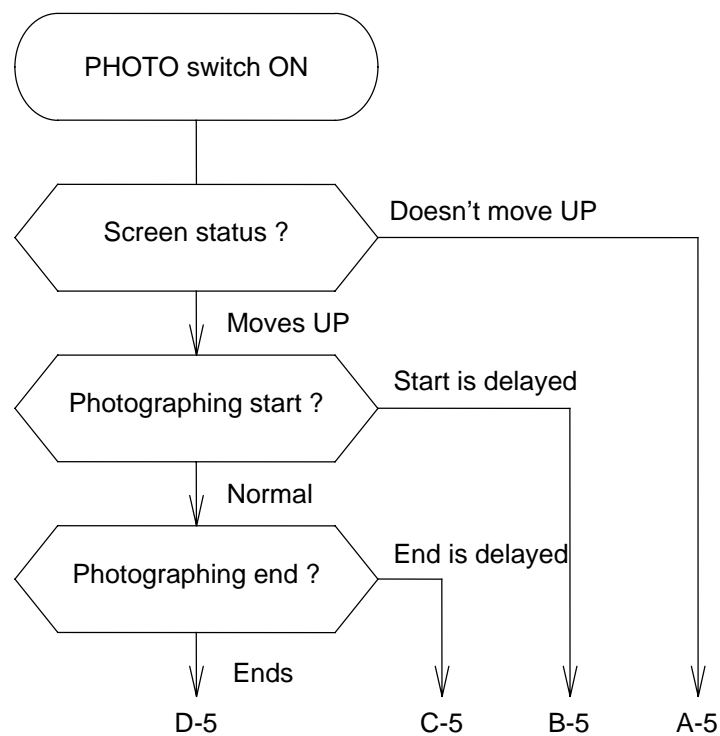


Fig. 4-29 Troubleshooting of Photographing

Refer to Table 4-20 for a description on probable causes of the above errors.

Table 4-20 Causes of and Remedy for Photographing Not Working Properly

Symptom	Probable Cause	Remedy
A-5	Film feed mechanism faulty	Film cassette is caught on rails when feeding it toward photo position, whereby photo sequence is halted. Take out film cassette and replace deformed part.
	Screen up/down mechanism faulty	Adjust screen up/down mechanism or replace faulty parts.
	Failure in registering remaining films	Photographing will not be made when remaining film number is 0. If unused film number in feed magazine differs from unused film number that was registered, system will attempt to feed even if there is no film. Two attempts will be made so as to prevent misfeeding, but photo sequence will be halted.
	Low vacuum status	At low vacuum, separate valve (SV) is closed and photographing will not be made. Wait until SV is opened.
B-5	Failure in setting photo standby time	Check if photo standby time is set at other than default value on normal exposure condition setting window.
C-5	Failure in setting film feed standby time	Check if film feed standby time is set at other than default value on normal exposure condition setting window.
	Failure in setting exposure time	Check the time set at MANUAL TIME in EXP.TIME group on normal exposure condition setting window. If electron beam density is low with AUTO TIME MODE selected, exposure time will be extended.
D-5	Film feed mechanism faulty	Film cassette that has finished photographing is caught on rails when feeding it toward cassette receiver, whereby photo sequence is halted. Take out film cassette and replace deformed part.

4.6 Troubleshooting (for user's reference)

4.6.9 Turbomolecular Pump (TMP) Doesn't Work Properly

- (1) If the TMP (option) incurs a fault at startup of operation or during operation, carry out the troubleshooting indicated in the table below. If a relevant precedent is not found in the table, contact the service engineer.

Table 4-21 Troubleshooting

Trouble Example	Check Location	Remarks
POWER ON lamp does not come on	<ul style="list-style-type: none"> • Connection of power cable • Connection of remote control • Fuses F4 (C16), F1 (C18) • Power voltage (100 V ± 10%) 	Inspection is required.
Rotor doesn't turn	<ul style="list-style-type: none"> • Check cable connecting TMP and controller • Fuse F4 (C15) 	
Doesn't attain rated revolution 30 minutes after EVAC ON	<ul style="list-style-type: none"> • Pressure at air intake and exhaust • Leak rate • Fuse F3 (C14) • Whether power failure occurred after EVAC ON 	Pressure should be 13.3 Pa (0.1 Torr) or less
Rotor stopped during baking	<ul style="list-style-type: none"> • Baking temperature • Cooling unit function • Whether power failure occurred 	Temperature should be 120 °C or less
Rotor stopped during normal operation	<ul style="list-style-type: none"> • Pressure at air intake and exhaust • Leak rate • Whether power failure occurred • Whether there is excessive vibration • Noise source 	Pressure should be 13.3 Pa (0.1 Torr) or less
Rotor dropped during operation	Check cable connecting TMP and controller	

- (2) The following lamps come on when there is an abnormality in the TMP. Turn OFF the POWER switch to make a status check, and report the details to the service engineer (Hitachi).

“OVER TEMPERATURE”.....When motor and electromagnet are overheated.

“FAILURE”• Interior of control unit is overheated.
• Motor and electromagnet are overheated.
• Inverter is overloaded.

“EMERGENCY OPERATION”.....• When power failure occurs.
• When vibration or impact is applied successively because the rotor contacts the protective dry bearing.
• When cable is not connected between TMP and control unit.

- (3) Restart after Operation of Safety Function

The “FAILURE” and “EMERGENCY OPERATION” signals that are emitted at detection of excessive vibration and motor overload are continued until the EVAC switch and power distribution panel switch are turned OFF. After eliminating the cause of the abnormality, turn ON the power distribution panel and EVAC switches and make a restart. In other cases, the rotor operation can be restarted by pressing the EVAC switch.

4.7 Software Adjustments

4.7 Software Adjustments

4.7.1 Maintenance Menu on Hitachi H-7650 Control Window

Upon bringing the pointer to Maintenance on the Function menu, the menu shown in Fig. 4-30 appears.

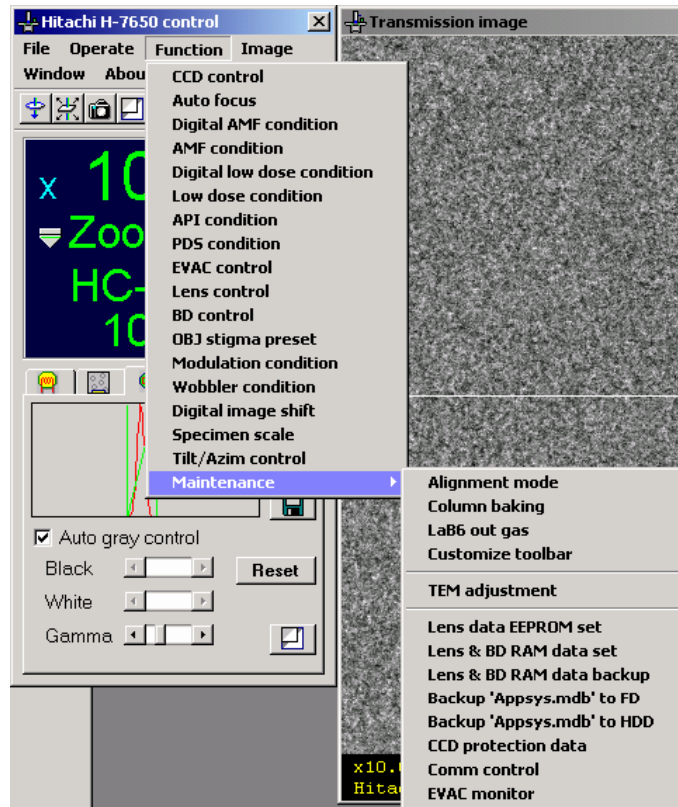


Fig. 4-30 Maintenance menu

Following is an explanation of the windows selected.

4.7.2 Alignment Mode

This is used for axial alignment of the electron microscope. Axial alignment of the column and electron gun should be carried out at filament exchange or when disassembling the column for cleaning, etc. Since the column axis may deviate, its alignment must be performed by our service engineers or trained technicians. And the column axial alignment must be performed at an accelerating voltage of 100 kV. By clicking Alignment mode on the Maintenance menu as shown in Fig. 4-31, the Alignment mode window will open.

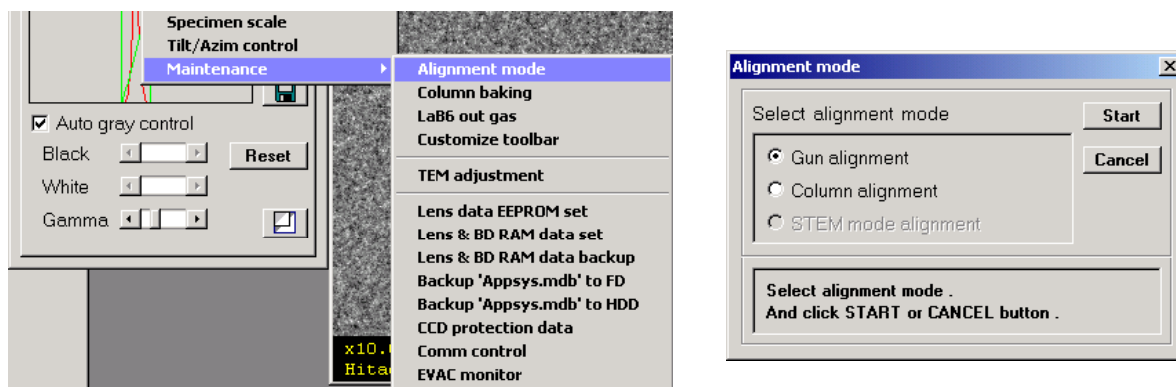


Fig. 4-31 Alignment mode Menu & Alignment mode Window

Upon selecting the Column alignment or Gun alignment radio button and clicking **Start** button, another Alignment mode window will appear. Perform the axial alignment indicated by the step number.

(1) Gun Alignment

- (a) Clicking Gun alignment and then **Start** button initiates axial alignment of the electron gun.

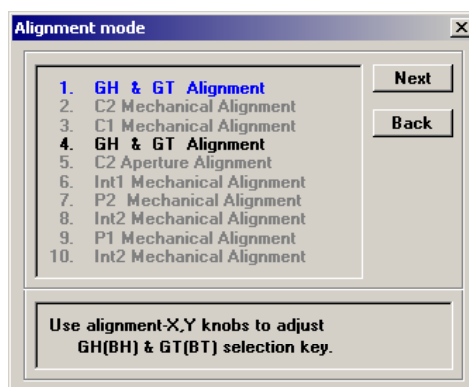


Fig. 4-32 Gun alignment Window

4.7 Software Adjustments

- (b) The GH & GT Alignment mode in step 1 begins. The BH and BT multi-knobs now apply to GH and GT. Bring the beam spot to the center of the fluorescent screen with GH, and reduce the filament voltage to obtain an unsaturated image of the filament. Refer to section 3.3.2 for the method of reducing filament voltage.
- (c) Adjust the image as shown in A of Fig. 4-33 using GT. If the beam spot deviates from the fluorescent screen center, bring it back to the center using GH.



Fig. 4-33 Filament image

- (d) Click **Next** button and the GH & GT Alignment mode in step 4 begins. Adjust the beam spot to the fluorescent screen center using GH. Click **Next** button again and the End window will appear. Either Save or Cancel can be selected here. Select Save to memorize the axial alignment data. Upon selecting Save, the axial alignment mode is ended. Carry out the subsequent alignment with BH.
 - (e) Press the **LENS** switch on the left control panel and set the magnification to $\times 2,000$. Insert the condenser lens movable aperture into the column and adjust the aperture position. Since the BH data will be recorded individually for each spot size, change over the spot size and adjust the beam to the fluorescent screen center for each spot size.
After filament exchange, set the filament voltage on the filament/bias setting window and also realign the voltage/current centers for image observation.
- (2) Column Alignment (for user's reference)

This procedure is normally unnecessary. It is required when the column has been disassembled for cleaning or the like. Column alignment must be performed at an accelerating voltage of 100 kV.

NOTE: Special training is required for conducting axial alignment of the column. Persons who have not undergone such training must not perform the alignment given in this section. Contact our nearest service agent (Hitachi) when column alignment is required.

4.7.3 Column Baking (column mild baking function)

- (1) The mild baking function is one with which the column is heated by means of the self-heating action of the lens. This function is effective after introducing air into the column following cleaning of the column interior or for eliminating contamination. The following description concerns the software function for baking; refer to 4.3.7 for the actual baking procedure.
- (2) Click Column baking on the Maintenance menu and the Column baking window will open.

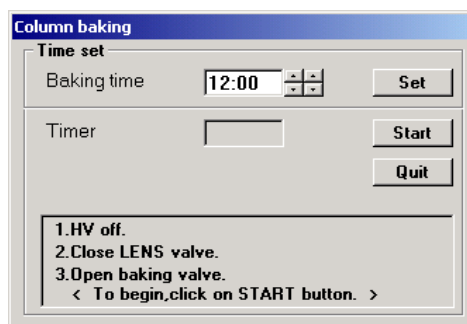


Fig. 4-34 Column baking Window

- (3) Enter in the Baking time input box the baking time set with the scroll bar or keyboard. A maximum baking time of 50 hours 59 minutes can be set. Click the **Set** button after making the setting. In the baking process, the column is heated during the set baking time, followed by the lens cooling mode and natural cooling of the column. The maximum lens cooling time is 4 hours.
- (4) Now turn the accelerating voltage OFF as indicated on the window. Then close the lens input valve and open the baking valve.
- (5) Click the **Start** button and baking starts. After the start of baking, protection is applied to the control panels and other items to prevent operation of the TEM.
- (6) When the baking process is all finished, the Column baking window cannot be closed. Although it can be closed forcibly via the **Cancel** button in an emergency, don't open the lens valve right away. An abrupt temperature difference might damage the lens and other precision components inside the column.

4.7 Software Adjustments

4.7.4 LaB₆ Outgassing (option)

The LaB₆ outgassing function (option) is for outgassing the LaB₆ filament after its exchange or after exposing the electron gun section to air. Outgassing is performed by turning OFF the accelerating voltage and gradually increasing the LaB₆ filament voltage.

- (1) As shown in Fig. 4-35, click LaB6 outgas on the Maintenance menu and the LaB6 outgas window will open.

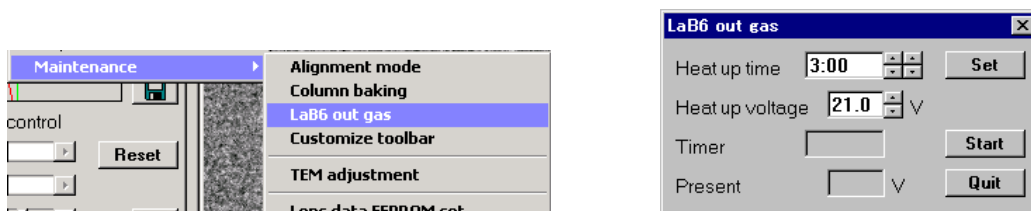


Fig. 4-35 LaB6 outgas Menu & LaB6 outgas Window

- (2) Enter in the Heat up voltage input box, using scroll bar or keyboard, the voltage to be set to the LaB₆ filament. The maximum setting allowable is indicated on the case accommodating the LaB₆ filament.
- (3) Enter in the Heat up time input box, using scroll bar or keyboard, the time for reaching the Heat up voltage. Time is settable in a range from 30 minutes up to 10 hours 59 minutes.
- (4) After setting the Heat up voltage and Heat up time, click the **Set** button.
- (5) Now click the **Start** button and outgassing starts. The elapsed time is indicated at Timer while the output voltage is indicated at Present. When the Heat up time has elapsed and the Heat up voltage is output, this voltage is retained. To cancel the process, click the **Quit** button.
- (6) By double-clicking the control menu box at the top left of the window, the LaB6 outgas window will close.

NOTE: Set a Heat up time of at least two hours after replacing the LaB₆ filament. An abrupt outgassing may cause a considerable deterioration in the electron gun vacuum level and/or damage to the LaB₆ filament.

4.7.5 Customize Toolbar

This is a command used for setting the toolbar. It allows you to add or delete icon buttons as you wish. Clicking Customize toolbar on the Maintenance menu opens the Customize toolbar window.

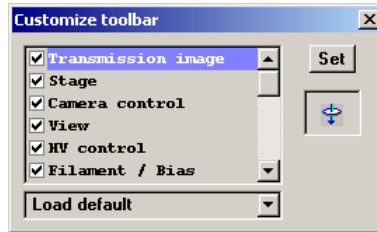


Fig. 4-36 Customize toolbar Window

- (1) Select an item to be set by using the scroll bar on the window. The icon corresponding to the selected item appears in the indication box.
- (2) Validate the check mark at the left of the item, then click **Set** button and the selected item is added to the toolbar.
- (3) To delete an item from the toolbar, remove the check mark from the item and click **Set** button.
- (4) Selection of Default operation from the pull-down menu sets up the default status (in which check marks appear at all of the items).

4.7 Software Adjustments

4.7.6 Password Check

By clicking the item indicated below on the Maintenance menu in Fig. 4-30, the Password check window shown in Fig. 4-37 will open. A password is thus requested, so the user need not intervene.

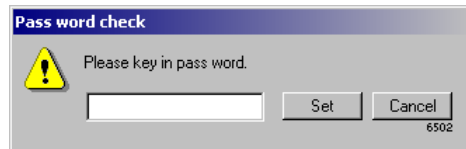


Fig. 4-37 Password check Window

- TEM adjustment
- Lens data EEPROM set
- Lens & BD RAM data set
- Lens & BD RAM data backup
- Backup 'Appsys.mdb' to FD
- Backup 'Appsys.mdb' to HDD
- CCD protection data
- Comm control
- EVAC monitor

4.7.7 Installation of TEM System Program

Set the POWER switch at COL.ON. Make sure your personal computer (PC) is operating on the Windows system. If the Windows is not activated, contact your nearest service agent (Hitachi).

Insert the TEM system program disk into the CD-ROM drive and open the CD-ROM drive from the Windows Explorer. The drive contains an Installer Setup.EXE for the TEM system program. Since files stored in the CD-ROM are compressed, use the Installer to decompress them. Execute the Setup.EXE. This can be done by double-clicking with the mouse. The Installer automatically sets the operating environment required for the TEM system program and control. A termination message appears when the installation is finished. Check if the TEM system program icon is registered in the Windows startup folder. Take the TEM system program disk out of the CD-ROM drive and terminate the Windows program. Do not turn OFF the power switch on the PC.

After checking that the Windows is terminated, return the POWER switch to EVAC ON and turn OFF the COL. power supply. The PC power is turned OFF about one second later.

Turn the POWER switch to COL.ON again and the TEM system program is executed.

To allow configuring the H-7650 control environment in the Windows system, the TEM system program must not be installed in a PC other than the one mounted in the H-7650.

Avoid installing in another PC.

4.8 Spare Parts for Electron Microscope

The spare parts listed below are required for normal operation of the electron microscope, and should be prepared in advance. Please consult with our sales representative if you have any question concerning cost, etc.

Table 4-22 Spare Parts for H-7650 (for 5 years' use)

No.	Qty	Part No.	Part Name
1	1	817-1759	Electron gun fixed aperture (1)
2	1	817-1824	Electron gun fixed aperture (2)
3	1	817-1605	Condenser fixed aperture (1)
4	1	817-2088	Condenser fixed aperture (2)
5	1	817-2052	Condenser fixed aperture (C)
6	2	747-1491	Auto-valve (BV-2A)
7	2	747-1761	Electromagnetic valve (3 port)
8	2	747-1760	Electromagnetic valve (4 port)
9	1	817-0495	O-ring set
10	1	L536072	DP heater (700 W)
11	1	K439000	Penning vacuum gauge
12	2	K433004	Pirani vacuum gauge
13	2	817-0246	Shield plate (cassette magazine)
14	5	J853403	Lamp (OL-385-BPC)
15	1	J853101	Pilot lamp E10
16	2	817-2098	DC latch
17	2	817-2924	Rotary pump

4.8 Spare Parts for Electron Microscope

Table 4-23 H-7650 Standard Accessories (P/N 817-2465)

No.	Qty	Part No.	Part Name
2-010	1	817-2466	Accessories (1) *
2-020	1	817-2467	Accessories (2) *
2-030	1	N312014	Single-end wrench 22
2-040	1	817-1968	Single-end wrench 24
2-050	4	747-2388	Cooling water hose (7 m)
2-060	1	F830010	Air tube (blue, 10 m)
2-070	1	747-2386	Specimen holder
2-080	1	817-0274	Special lifter (column)
2-090	1	N315012	Hexagonal wrench key (B=17)
2-100	1	542-3149	Compressor inspection list

(*) These are given in separate list.

Table 4-24 H-7650 Accessories (1) (P/N 817-2466)

No.	Qty	Part No.	Part Name
3-010	1	J821772	Fuse ST4 1A
3-020	1	J821774	Fuse ST4 2A
3-030	1	J821775	Fuse ST4 3.15A
3-040	1	J821777	Fuse ST4 5A
3-050	1	J821771	Fuse ST4 500MA
3-060	1	J853403	Lamp OL-385-BPC
3-070	1	J853101	Pilot lamp E-10
3-080	1	777-0179	Filament (set of 10)
3-090	2	L456759	O-ring AS568-110 FPM
3-100	2	L456841	O-ring AS568-251 FPM

Table 4-25 H-7650 Accessories (2) (P/N 817-2467)

No.	Qty	Part No.	Part Name
3-010	1	562-1381	Hexagonal wrench key B=6 (spec.)
3-020	1	432-2551	Hexagonal wrench key B=5 (spec.)
3-030	1	542-0199	Filament alignment tool (1)
3-040	1	542-0200	Filament alignment tool (2)
3-050	2	L992000	Suction cup
3-060	1	542-1706	Hexagonal wrench key B=3 (spec.)
3-070	2	432-2660	Magnet yoke removal jig
3-080	2	562-2136	Alignment knob
3-090	1	872-0165	Apiezon grease
3-100	1	F276001	Teflon tape
3-110	4	747-2319	Hose adapter 1
3-120	1	N315000	Hexagonal wrench key B=1.5