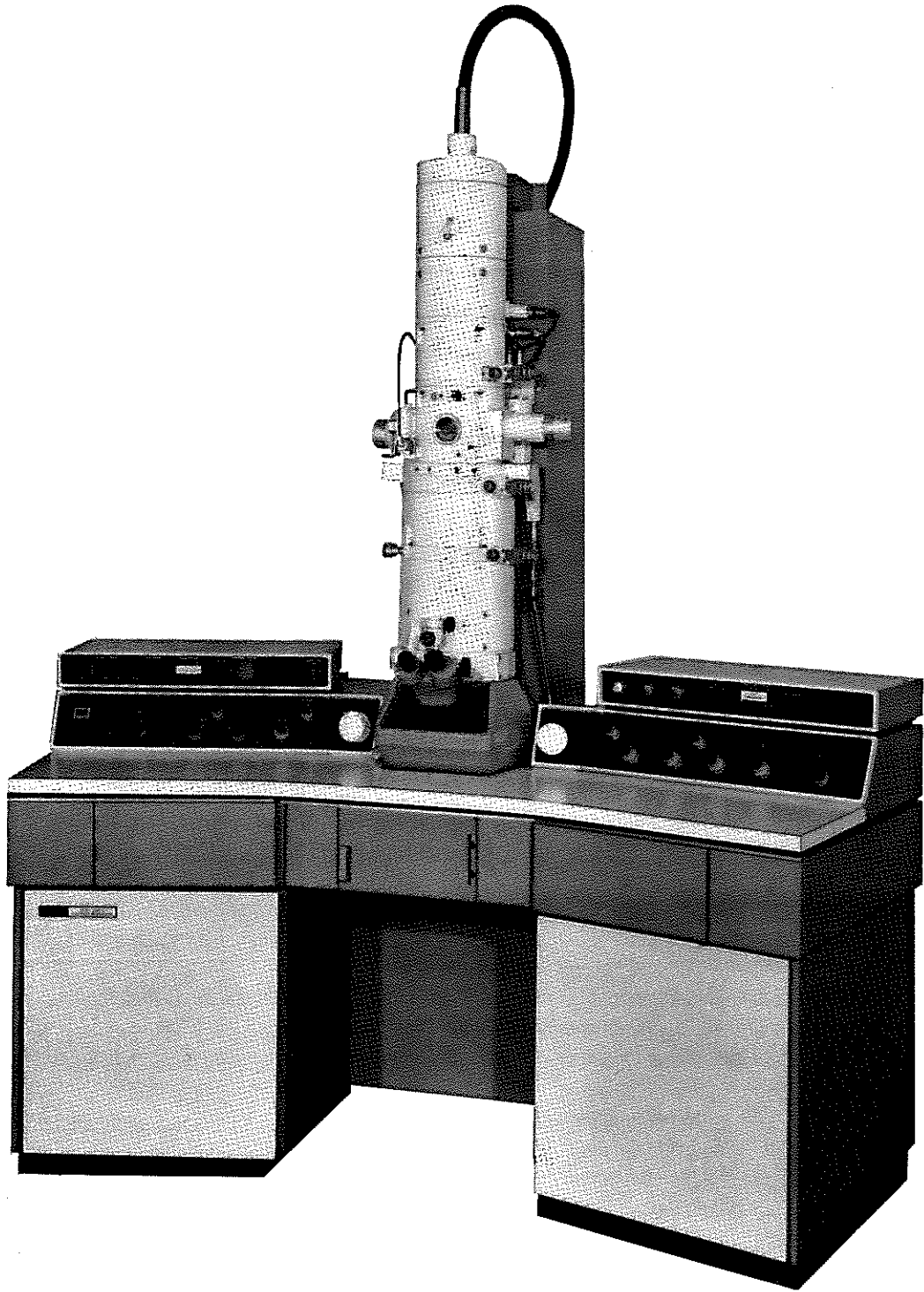


JEM-100CXII ELECTRON MICROSCOPE



# 1. GENERAL

## 1.1 Introduction

The JEM-100CXII is, in itself, classifiable as an extremely advanced, high performance electron microscope. Moreover, by using certain sophisticated attachments in conjunction with the JEM-100CXII, the basic instrument can be expanded into a "total system" of "analytical" electron microscope, thus enabling the operator to perform a wide range of measurements, etc.

Its fully automated vacuum system, state of the art electronic circuits and logical and compact design facilitate both operation and maintenance. For example, startup, shutdown and photography can be executed by a simple pushbutton operation. Magnification and camera length can be directly read out regardless of any change in the accelerating voltage, and recorded together with the film number on the film. The focus, once set, almost never requires readjustment because it compensates for change in the accelerating voltage and magnification. However, if required, correct focusing can be obtained using an image wobbler device or optimum focusing for photography can be automatically obtained by a simple switch operation. Moreover, this microscope provides very stable and excellent images at low to high magnifications (90X to 800,000X) and a variety of electron diffraction patterns instantly.

There are further merits to be found in this instrument. The available attachments permit specimens to be heated, cooled, tilted, or elongated in-situ and also enable various signals from the specimen to be observed (Fig. 1. 1).

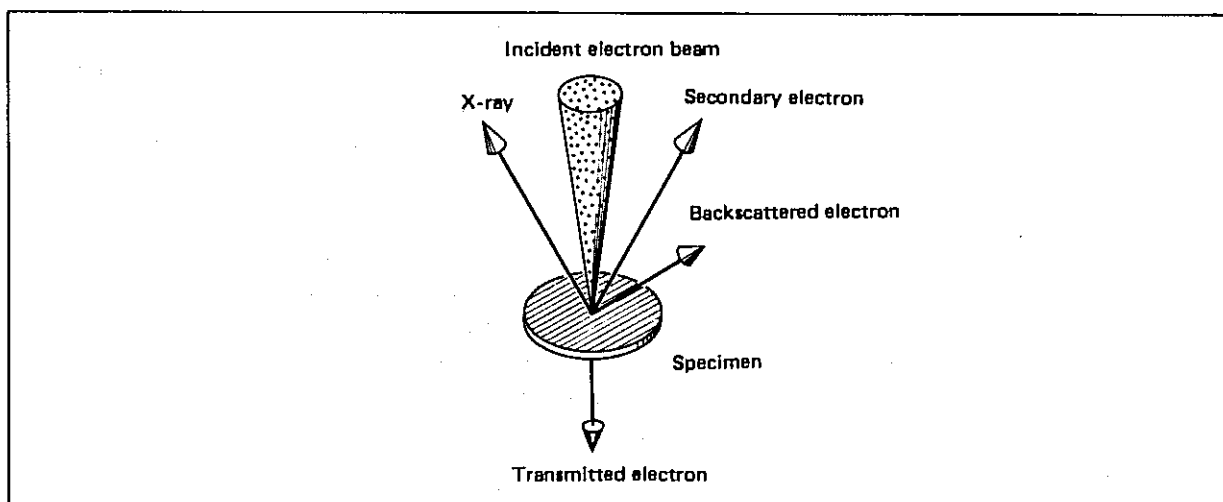


Fig. 1. 1 Specimen signals

The following table lists the main attachments and the possible combinations for use with the electron microscope system. For details on attachments not listed, refer to the relevant specification lists and catalogues.

Table 1. 1 Main attachments

Abbreviated designation	Full designation	Description
TEG	Top Entry Goniometer	This specimen stage enables the specimen to be tilted up to 30° in any direction (using the BLG specimen holder) and rotated (using the BRS specimen holder). Specimen exchange is unaffected with the TEG installed.
SEG	Side Entry Goniometer	This specimen stage, which is equipped with a Z-control, enables the specimen to be tilted up to 45° in all directions (using the BST tilting holder). The incorporated airlock-type specimen exchange mechanism provides for easy mounting of several types of specimen holders; e.g., the BSR rotating holder, the SHH heating holder, the SCH cooling holder, and the SEH elongating holder, thereby expanding the range of research fields.
ASID	High Resolution Scanning Attachment	This attachment permits high resolution secondary electron images and transmission scanning images to be obtained by scanning the specimen with a fine electron probe obtained by utilizing a special three-stage demagnification lens system. The BEI backscattered electron detector enables composition and topographical images to be observed. Other accessories include a variety of signal processors (YMD, GMC, and VCA) and a waveform monitor. The TVS monitor enables an image to be observed dynamically and also recorded in conjunction with an ordinary VTR.
EDS	Energy Dispersive X-ray Spectrometer	This spectrometer permits simultaneous elemental analysis of a micro-area (200Å in diameter) by highly efficient X-ray detection. The element range is $_{11}\text{Na}$ to $_{92}\text{U}$ . Since the analysis time is short, specimen damage is slight; moreover, by using the specially designed SSH specimen holder, background noise can be suppressed to a large extent.
IMA	Image Analyzer	This analyzer permits measurement of precipitate distribution and particle distribution when used in conjunction with the ASID. Direct analysis from the image signals reduces measuring time and errors. Logical operation and data processing can be performed rapidly by computer programming.

Abbreviated designation	Full designation	Description
ASEA	Scan Energy Analyzer	This high resolution energy analyzer permits elemental analysis in a micro-area of the specimen (several tens of angstroms in diameter), to be carried out by measuring the energy spectrum of the transmitted electrons. This device is especially useful for analyzing light elements such as Li, Be, etc.
FEG	Field Emission Gun	This gun provides a highly coherent electron beam having a brightness several hundred times higher than that of a thermionic type gun. Consequently, this type of electron gun greatly improves the performance in conventional electron microscopy (CEM) or scanning electron microscopy (SEM, STEM).
AIM	Image Intensifier	This intensifier allows bright and sharp images to be displayed on the CRT screen for viewing by a large audience. It is also suitable for observing the dynamic behaviour of specimens and for observing beam-sensitive specimens. An ordinary VTR can be used in conjunction with this device for image-recording.
A35/70	Roll Film Cameras	These cameras permit electron microscope images to be recorded on 35 mm and 70 mm roll film, respectively. Both or either of these cameras can be used in conjunction with a standard camera.
AD	High Resolution Electron Diffraction Stage	Provides transmission electron diffraction patterns in the case of ordinary specimens and reflection electron diffraction patterns in the case of bulk specimens. Specimen exchange can be carried out without breaking the column vacuum. The AHC High Resolution Electron Diffraction Hot Stage, the ACC High Resolution Electron Diffraction Cold Stage and AND Charge Neutralizer for non-conductive or partially conductive specimens are also available.

## 2. SPECIFICATIONS

This chapter covers the specifications relative to setting up and operating the instrument.

### 2.1 Performance

- **Guaranteed resolution (high resolution and standard specimen cartridges):**
  - 1.4 Å (lattice).
  - 3 Å (point to point).
- **Accelerating voltage:** 20, 40, 60, 80, 100 kV.
- **Magnification (digital display, film print-out)**
  - High resolution specimen cartridge: 1.04 times that of standard.
  - Standard specimen cartridge: 1,000X to 850,000X in 23 steps.
  - Wide field-high contrast specimen cartridge: 340X to 300,000X in 23 steps.
  - Low magnification mode (LOW MAG): 100X, 200X, 400X and 600X.
- **Electrical stability**
  - Accelerating voltage:  $2 \times 10^{-6}$  / min or less.
  - Objective lens current:  $1 \times 10^{-6}$  / min or less.
- **Electron diffraction (camera length, selected area image magnification: digital display, film print-out)**
  - Selected area electron diffraction (minimum field of view : 0.2 μm in diameter)

**Table 2.1 Camera length and magnification**

	Camera length (6 steps)	Magnification (11 steps)
High resolution specimen cartridge	STANDARD × 0.96	STANDARD × 1.04
Standard specimen cartridge	80 ~ 1,200 mm	13,000X ~ 280,000X
Wide field-high contrast specimen cartridge	240 ~ 3,500 mm	4,500X ~ 94,000X

- High dispersion diffraction camera length: 4.3 to 58 m.
- Micro-beam diffraction camera length: 200 mm.
- High resolution diffraction camera length: 312 mm (EM-AD high resolution diffraction stage: optional extra).

## 2.2 Electron optics system

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### 2.2.1 Illuminating system

- Electron gun (cool beam type)
  - Filament: Pre-centered hairpin type tungsten filament, DC heating.
  - Bias: Self bias, continuously variable.
  - Alignment: Electromagnetic 2-stage interlocking system.
  - Anode chamber airlock mechanism and electron gun lift: Built-in, pneumatic control.
- Condenser lens (electromagnetic, double condenser type)
  - Apertures (molybdenum film): 20, 200, 300, 400  $\mu\text{m}$  in diameter (click-stop).
  - Stigmator: Electromagnetic type, complete with centering device.
  - Alignment: Electromagnetic 2-stage interlocking system.
- Beam tilting angle: Max.  $6^\circ$  in all directions.

### 2.2.2 Image forming system

- Image forming lens system: Distortion-free, electromagnetic 4-stage system (objective lens, 1st and 2nd intermediate lenses, projector lens).
- Objective lens focal length
  - High resolution specimen cartridge: 1.6 mm (minimum focal step, 40  $\text{\AA}$ ).
  - Standard specimen cartridge: 1.7 mm (minimum focal step, 45  $\text{\AA}$ ).
  - Wide field-high contrast specimen cartridge: 5.0 mm (minimum focal step, 180  $\text{\AA}$ ).
- Apertures (molybdenum film)
  - Objective lens apertures: 20, 40, 60 and 120  $\mu\text{m}$  in diameter (click-stop).
  - Field limiting apertures: 20, 80, 250 and 1,000  $\mu\text{m}$  in diameter (click-stop).
- Stigmator: Electromagnetic type, complete with centering device.

## 2.3 Specimen chamber

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- Specimen exchange: Airlock mechanism.
- Loading capacity: 6 specimens.
- Specimen anticontamination device: Built-in (contamination rate, less than 0.1  $\text{\AA}/\text{min}$ ).
- Specimen movement range:  $\pm 1$  mm (built-in SPECIMEN POSITION indicator (CRT) for easy selection of desired field of view).

## 2.4 High resolution diffraction chamber

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- High resolution electron diffraction stage (complete with airlock mechanism): Choice of 3 (EM-AD, EM-AHC, EM-ACC) – optional extras.

## 2.5 Viewing chamber

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- Viewing window
  - Front frame: 236 mm X 134 mm.
  - Side frames: 90 mm X 80 mm.
- Fluorescent screen: 160 mm in diameter.
- Binoculars (10X): Built-in.
- Beam stopper: Built-in.

## 2.6 Camera chamber

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- Film
  - Standard size: 65 mm X 90 mm.
  - Large size: 80.9 mm X 99.6 mm (available to order).
  - Loading capacity: Up to 50.
  - Feeding: Fully automatic (single film feeding also possible).
  - Exchange mechanism: Airlock type.
- Shutter: Automatic exposure (manual exposure also possible).
- Data recording: 8-digit automatic recording (magnification/camera length: 3 digits; film number: 5 digits).
- Desiccator: Built-in.

## 2.7 Vacuum system

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- Vacuum pumps
  - Oil rotary pumps: 100 l/min, two units.
  - Oil diffusion pumps: 400 l/sec, two units.
- Ultimate pressure:  $10^{-7}$  Torr order (specimen chamber).
- Vacuum gauges: 3 Pirani tubes (anode chamber, column, camera chamber).
- Vacuum valves: Automatically controlled pneumatic and solenoid valves.

## 2.8 Installation requirements

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### 2.8.1 Power supply and cooling water

- Power supply: Single phase, 200/220/240 V, 50/60 Hz, 4.5 kVA.
- Grounding terminal: 100  $\Omega$  or less.
- Cooling water
  - Flow rate: 5 l/min or more.
  - Pressure: 1 ~ 5 kg/cm<sup>2</sup>.

- Temperature: 20 ±5 °C.
- Faucet: 14 mm O.D. (for 1/2" hose).
- Drainage: Twin hose system.

**2. 8. 2 Installation room**

- Floor space: 2,800 mm (width) X 3,000 mm (depth) or more.
- Ceiling height: 2,580 mm or more.
- Doorway: Width: 800 mm or more.  
Height: 1,800 mm or more.
- Room temperature: 20 ±5 °C.
- Humidity: Below 80%.
- Tolerable external magnetic fields: Less than 3 milligauss.
- Floor strength: Better than 350 kg/m<sup>2</sup>.

**2. 8. 3 Dimensions and weight (mm and kg)**

**Table 2. 2 Dimensions and weight**

	Width	Depth	Height	Weight
Main console	1,980 (78")	1,420 (56")	2,500* (98.5")	1,200 (2,650 lbs)
Power supply console	530 (21")	650 (26")	830 (38")	160 (350 lbs)
Pump box	660 (26")	300 (12")	495 (20")	100 (220 lbs)
Air-compressor	Diameter 380 (15")		800 (32")	45 (99 lbs)

\*The height of the main console increases to 2,570 mm (8' 5") when the electron gun is hoisted.

**2. 9 Warranty**

With the exception of damage resulting from natural disasters and careless handling, this instrument is guaranteed for a period of one year after installation, during which time any and all faults or failures will be repaired free of charge at the installation site.

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*Notes: These specifications are subject to change without prior notice.*



### 3. COMPOSITION AND CONSTRUCTION

This chapter deals with instrument composition and layout to the extent required for operating purposes.

#### 3.1 Composition

This instrument consists of a main console (incl. column), a power supply console, a pump box, an air compressor, etc., as shown in Fig. 3. 1. For detailed dimensions, refer to Subsect. 2. 8.

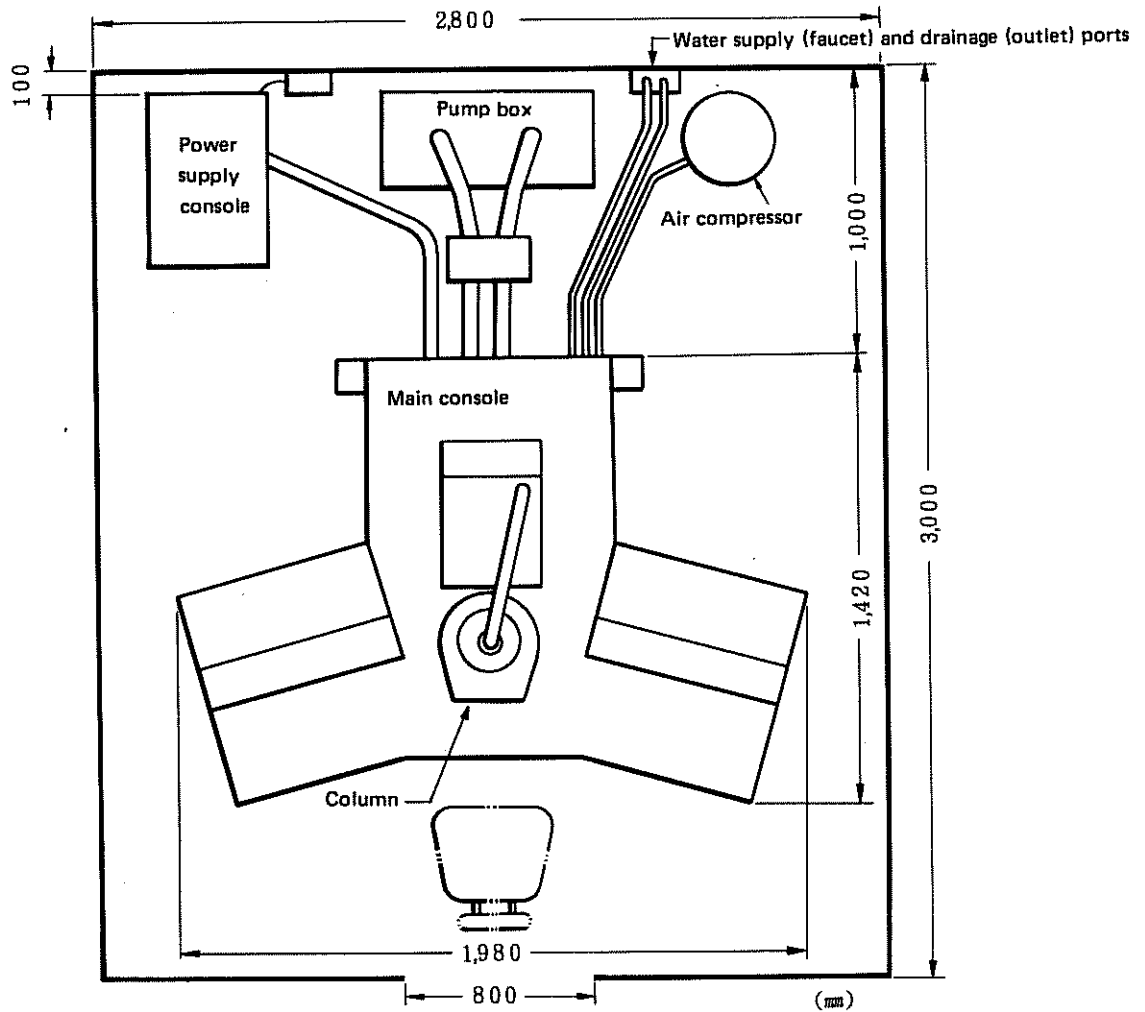
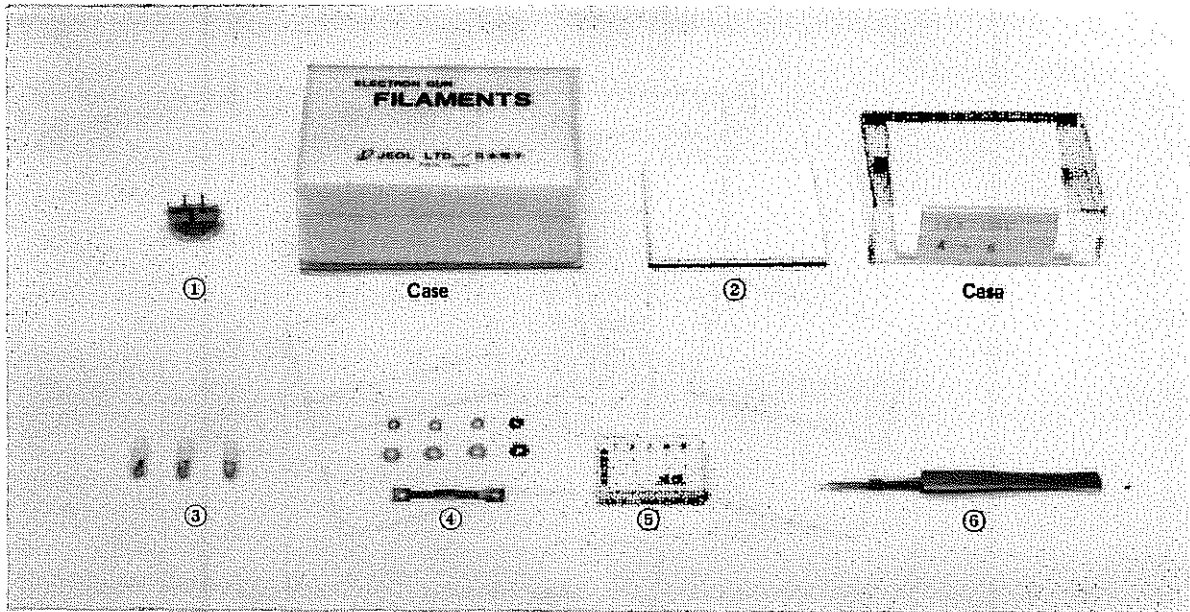


Fig. 3. 1 Composition and layout diagram

**3.2 Accessories**

The standard accessories for this instrument are listed below. However, this list (especially the quantity) is subject to change. Moreover, although some of the items are not used by the users, they should nevertheless be carefully stored as they will be required for servicing purposes.

Index No.	Name	Figure	Quantity	Purpose
①	Electron gun filaments complete with container	3.2	6	Spares
②	Small fluorescent screen complete with container		1	Spare
③	Condenser lens, objective lens and field limiting aperture foils (capsulated)		One each	Spares
④	Boat and washers		1 set	For cleaning aperture foils
⑤	Specimen grid case		1	For storing specimen grids
⑥	Tweezers		1	For exchanging specimens



**Fig. 3.2 Accessories (1)**

⑦	Dispensing magazine, receiving magazine	3.3	One each	Spares
⑧	Cassettes		25	Spares

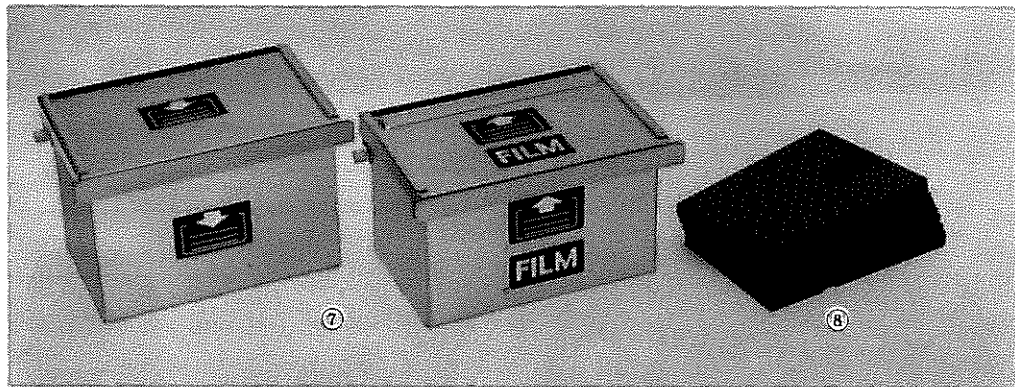


Fig. 3.3 Accessories (2)

Index No.	Name	Figure	Quantity	Purpose
⑨	Hand blower	3.4	1	For removing dust
⑩	Suction disks		2	For removing the viewing chamber window glass
⑪	Vacuum greases (Fomblin and Apiezon)		2	For O-rings
⑫	Compressor oil (in a bottle)		1	For replenishment purposes

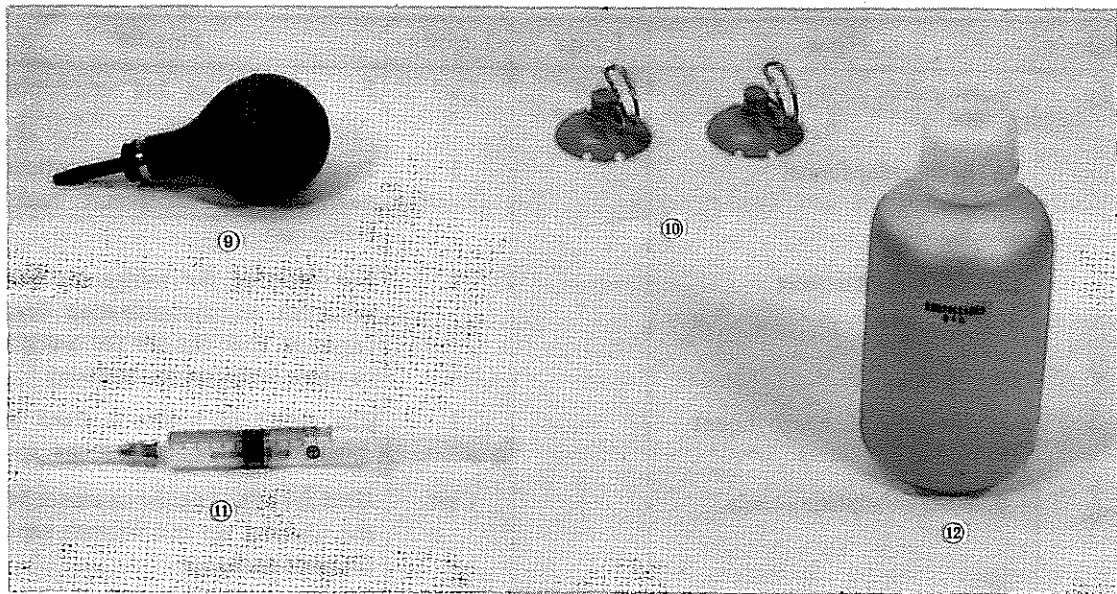


Fig. 3.4 Accessories (3)

⑬	Standard tools	3.5	1 set	For disassembling and reassembling the column
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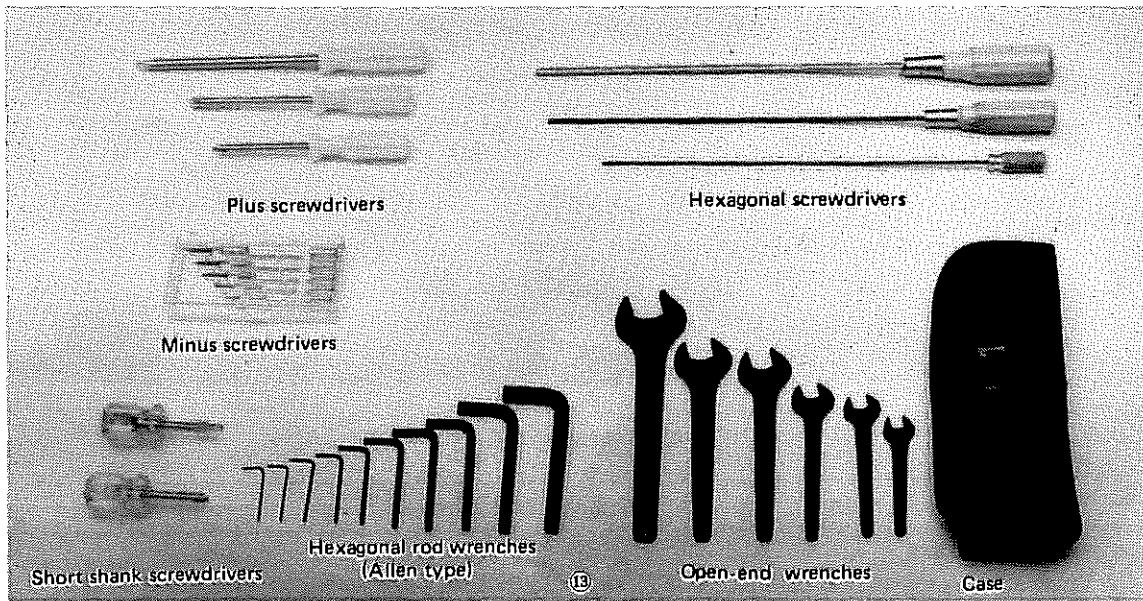


Fig. 3.5 Accessories (4)

Index No.	Name	Figure	Quantity	Purpose
⑭	Special tools	3.6	1 set	For disassembling and reassembling the column
	a. Refrigerant funnel		1	For filling the specimen anticontamination device refrigerant tank with refrigerant
	b. Refrigerant drainer		1	For draining the refrigerant from the specimen anticontamination device refrigerant tank (heater for quick return to room temperature, built-in)
	c. Specimen exchange mount		1	The specimen holder is fixed on this mount when exchanging the specimen
	d. Wehnelt adjusting tools		1 set	Used for adjusting the clearance between the filament tip and Wehnelt cap during filament exchange
	e. Objective lens tool		1	Used for reassembling the objective lens
	f. Objective lens pole piece setting tool		1	Used for installing and removing the objective lens pole piece
	g. Projector lens pole piece setting tool		1	Used for installing and removing the projector lens pole piece

Index No.	Name	Figure	Quantity	Purpose
	h. Beam displacement compensating knobs	3.6	2	Used for compensating beam displacement
	i. Intermediate lens shifting knobs		2	Used for aligning the intermediate lens

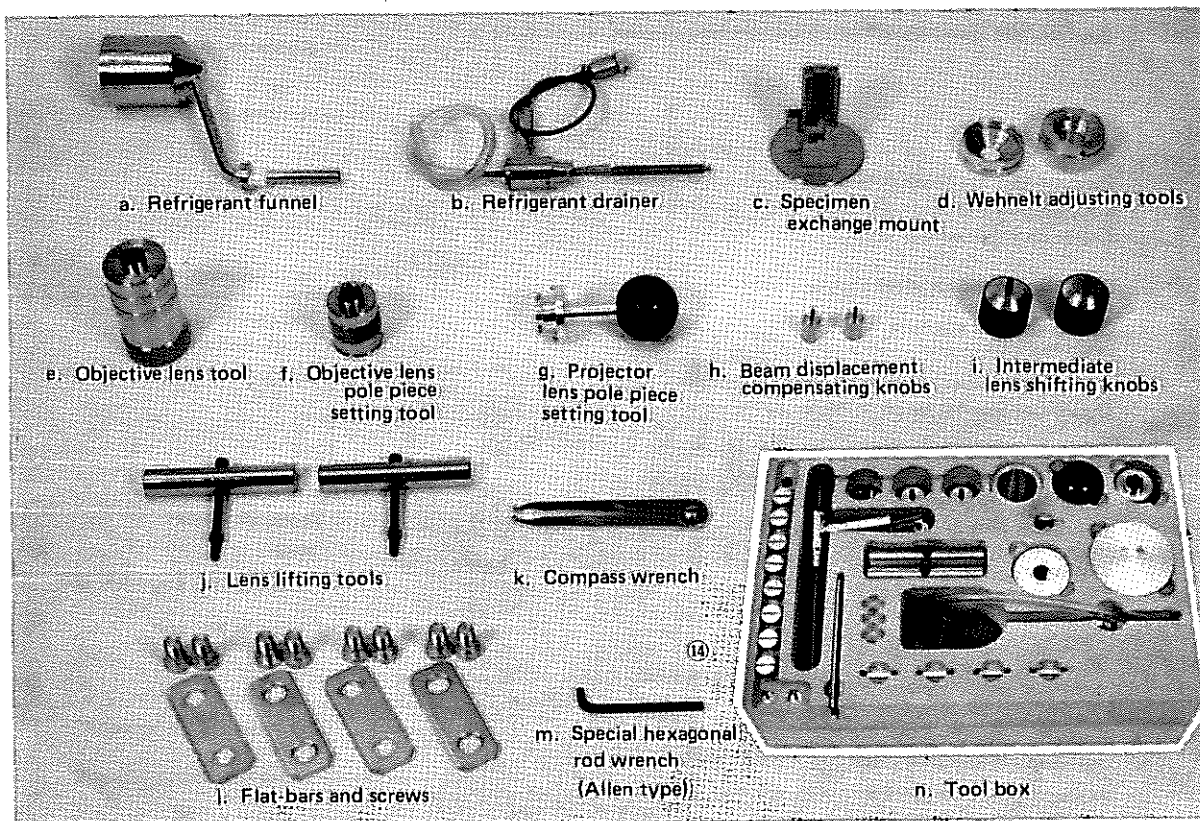


Fig. 3.6 Accessories (5)

j. Lens lifting tools		2	Used for disassembling and reassembling the column
k. Compass wrench		1	Used for tightening and loosening special screws (nuts)
l. Flat-bars and screws		1 set	Used for linking the upper anode chamber and the lower anode chamber when hoisting the column
m. Special hexagonal rod wrench		1	Used for tightening and loosening screws located in awkward places
n. Tool box		1	For storing special tools, etc.

### 3.3 Construction of column

The essential column parts are as shown in Fig. 3.7.

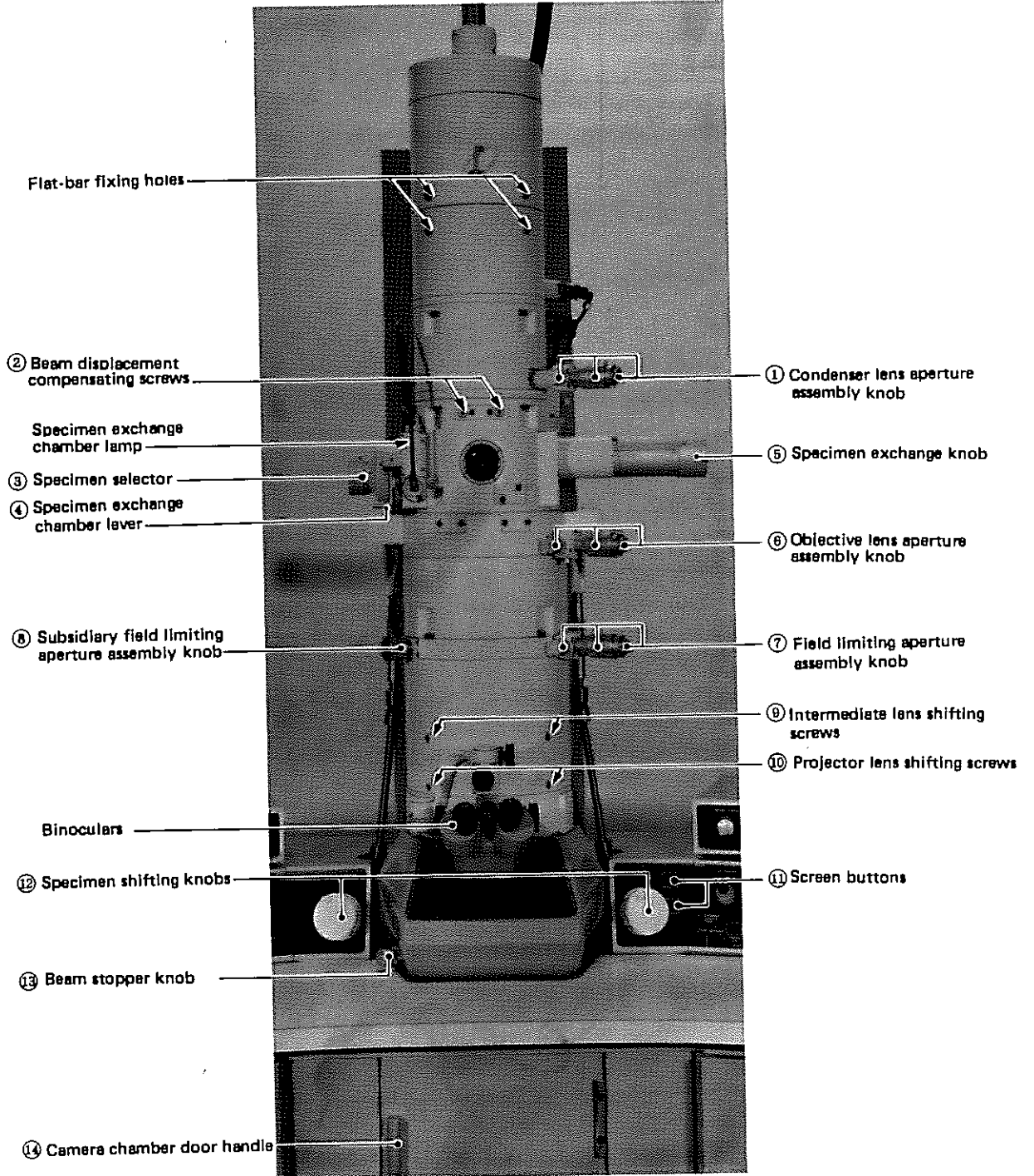


Fig. 3.7 External view of column

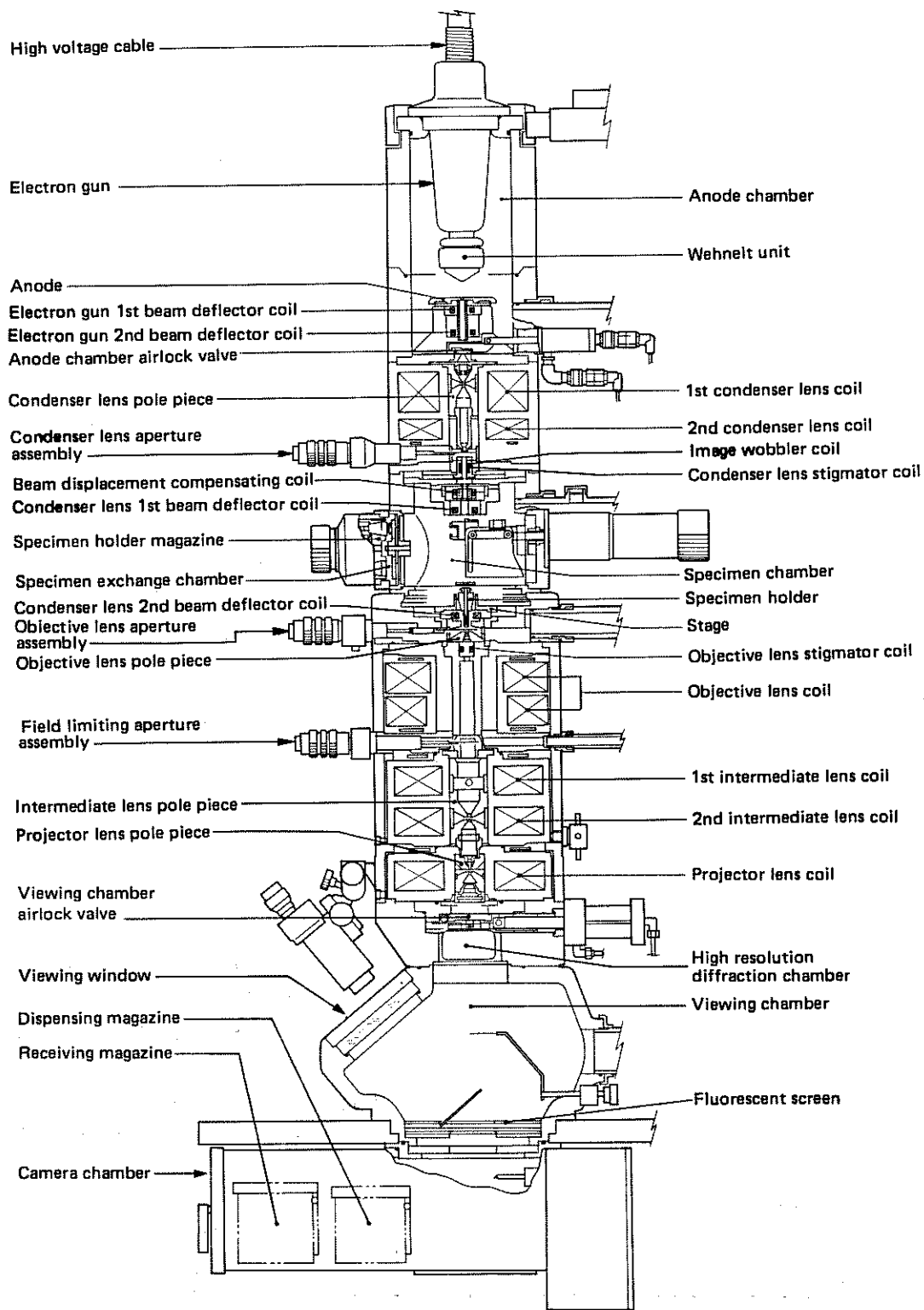


Fig. 3. 8 Cross section of column