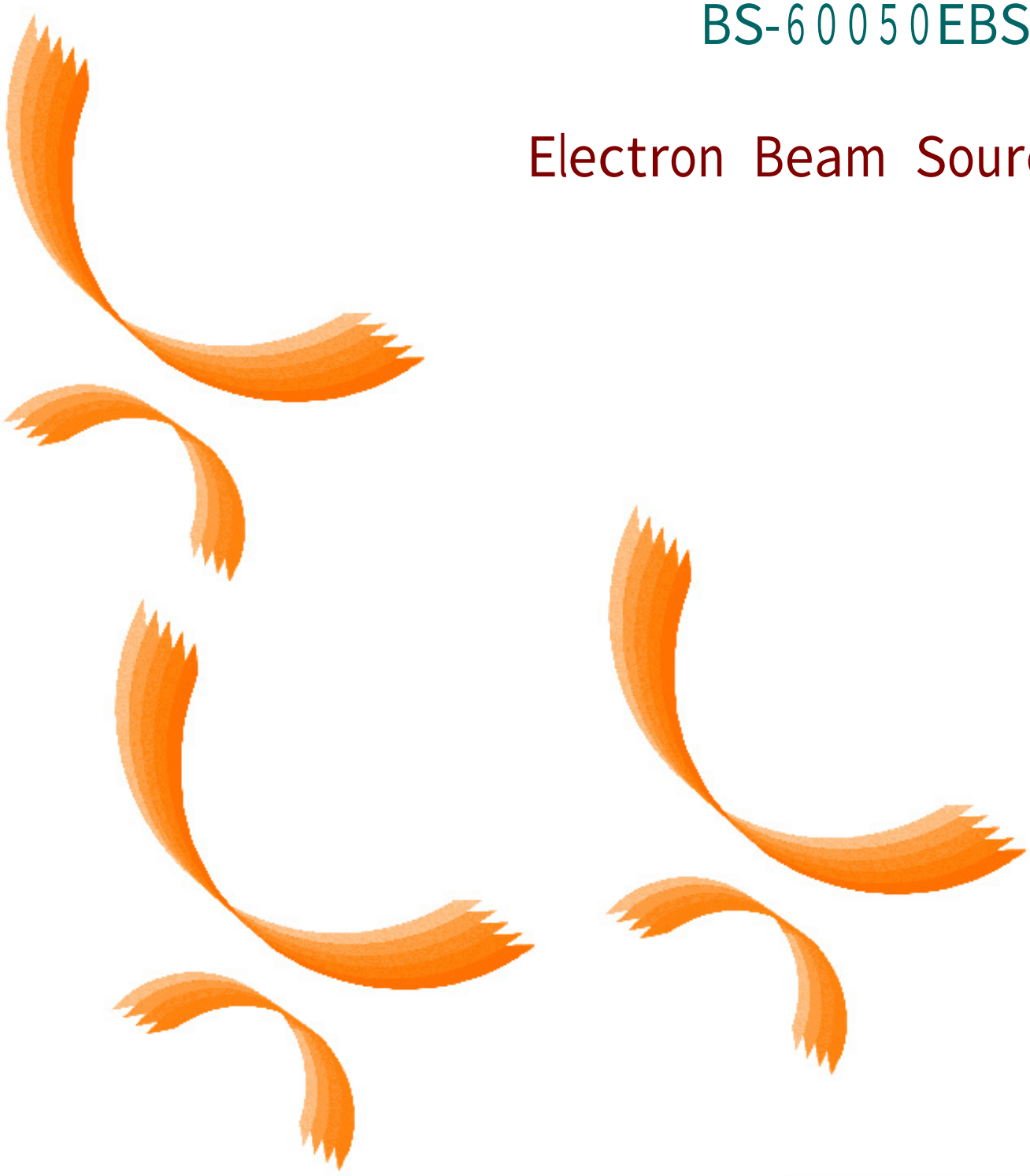
INSTRUCTIONS

BS-60050EBS

Electron Beam Source



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SAFETY PRECAUTIONS

For the proper use of the instrument, be sure to read the following safety precautions prior to starting operation or maintenance. They contain important information related to safety. Contact your JEOL service office whenever you are unclear about any operation or maintenance.

The signs for safety precautions and their meanings used in this instruction manual are as follows:

⚠ WARNING: A potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION: A potentially hazardous situation which, if not avoided, could result in minor or moderate injury. Also could mean a potentially hazardous situation which could result in serious damage to facilities and acquired data.

Use the instrument in a proper manner and within the scope of the purposes and usage contained in the brochures and instruction manuals. Never make modifications such as removing protective parts, exchanging component parts, and defeating safety measures.

Be sure to read the "Safety Precautions" given in the instruction manuals of the optional attachments for information about the attachments of this instrument.

⚠ WARNINGS

- Turn off the power switch of the power supply and make sure that the power is shut off, before performing inspection, repair, maintenance or other activities in the evaporation chamber, which is equipped with the electron beam gun. In addition, if possible, turn off the switch on the distribution board. Working with the power on could result in electric shock.
- Turn off the power switch of the power supply and make sure that the power is shut off, before touching the electron beam gun. In addition, if possible, turn off the switch on the distribution board. Touching the electron beam gun with the power switch on could result in electric shock.
- Properly ground the electron beam gun and the crucible you want to use when installing them. Insufficient grounding could damage the electron beam gun, or result in electric shock.
- Be sure to ground the evaporation chamber, which is equipped with the electron beam gun. Failure to do so could damage the electron beam gun, or result in electric shock.
- Do not perform maintenance, such as filament replacement, immediately after using the electron beam gun. Touching the electron beam gun right after using it could cause burns.

⚠ CAUTIONS

- Use the specified JEOL product for the power supply of the electron beam gun. Do not use any other product. Any damages resulting from the use of an unspecified power supply are not covered by the warranty.
- Install the electron beam gun in a place free from any magnetic field other than geomagnetism. An external magnetic field can affect the electron beam, preventing the electron beam gun from achieving the prescribed performance or damaging the electron beam gun or other parts. In particular, use nonmagnetic materials for the evaporation chamber shutter.
- It is necessary to shield the parts to which high voltage is applied from vapor atmosphere by covering them with a metal plate. Failure to do so might have an adverse effect on the deposited film or cause frequent discharges that could cause damage.
- Set the pressure of the cooling water introduced into the electron beam gun to 0.3 MPa or less. Applying a pressure higher than this value might cause water leakage or damage to the electron beam gun.
- Irradiating a sample with the electron beam produces X-rays. Since a low accelerating voltage of 10 kV or less is used, a normal evaporation chamber can sufficiently block them. However, for a special evaporation chamber, or whenever you deem it necessary, check for X-ray leakage to make sure that no X-ray escapes out of the evaporation chamber.
- Other than the material to be deposited, do not place any magnetic material or anything magnetized near the electron beam gun. An external magnetic field caused by magnetic material might affect the electron beam, preventing the electron beam gun from achieving the prescribed performance, or damaging the electron beam gun or other parts.
- Do not use magnetic material for the crucible you want to use. Using magnetic material might prevent the electron beam gun from achieving the prescribed performance, or damage the electron beam gun or other parts.
- Do not install parts other than genuine JEOL parts on the electron beam gun. Doing so might degrade the performance or damage the electron beam gun or other parts.

Contents

〔Ⅰ〕General

This electron beam source is used for vacuum evaporation. It deflects a generated electron beam using a magnetic field, and then the deflected electron beam irradiates an evaporation material to heat and vaporize the material. By passing a direct current through the scan coils, you can move the electron-beam irradiation position. In addition, by passing an alternating current through the coils, you can enlarge the beam irradiation area.

This electron beam source features: a) high thermal efficiency because it directly heats the evaporation material, b) evaporation of materials of high melting point, and c) evaporation for many hours due to a long-life filament.

Specifications

1) Beam generation method:	Directly heated cathode
2) Electron beam output:	Up to 10 kW (1.0 A at 10 kV)
3) Accelerating voltage range:	–4 kV to –10 kV (When the electron beam source is installed on an iron chamber, in order to use the source at –6 kV accelerating voltage, it is necessary to place nonmagnetic foots 20 mm or more in thickness, beneath the chamber.)
4) Electron beam deflection angle:	270° With combined use of permanent magnet and electromagnet
5) Electron beam scan:	
Spot position movement:	Max. φ 50 mm (at –6 kV)
Scan width:	Max. φ 50 mm (at –6 kV)
X scan frequency:	Max. 50 Hz
Y scan frequency:	Max. 500 Hz
6) Workable pressure:	7.0×10^{-2} to 5.0×10^{-5} Pa
7) Cooling water:	5 L/min or more Water supply, water temperature 30 ℃ or less Pressure difference: 0.15 to 0.3 MPa
8) External dimensions:	177 (W) × 284 (D) × 130.5 (H) mm
9) Weight:	Approximately 14 kg

〔Ⅱ〕Construction

The electron beam source consists of the electron beam generator, the electron beam deflector and the electron beam scanning section.

The electron beam generator is of a diode type. It generates an electron beam by a filament and a Wehnelt (G38 grid) kept at a high negative potential (accelerating voltage) and an anode kept at a ground potential.

The electron beam deflector incorporates a set of permanent magnet and electromagnet, yokes and polepieces, which deflect the electron beam 270° and makes the deflected electron beam irradiate an evaporation material while maintaining an intended beam shape.

The electron beam scanning section is of an electromagnetic type. It scans the electron beam irradiated onto the evaporation material with a X scan frequency of 50 Hz and a Y scan frequency of 500 Hz.

These sections are water cooled, in order to suppress temperature increase.

Please note that the parts list and the assembly drawing of this electron beam source are described on pages later than 19.

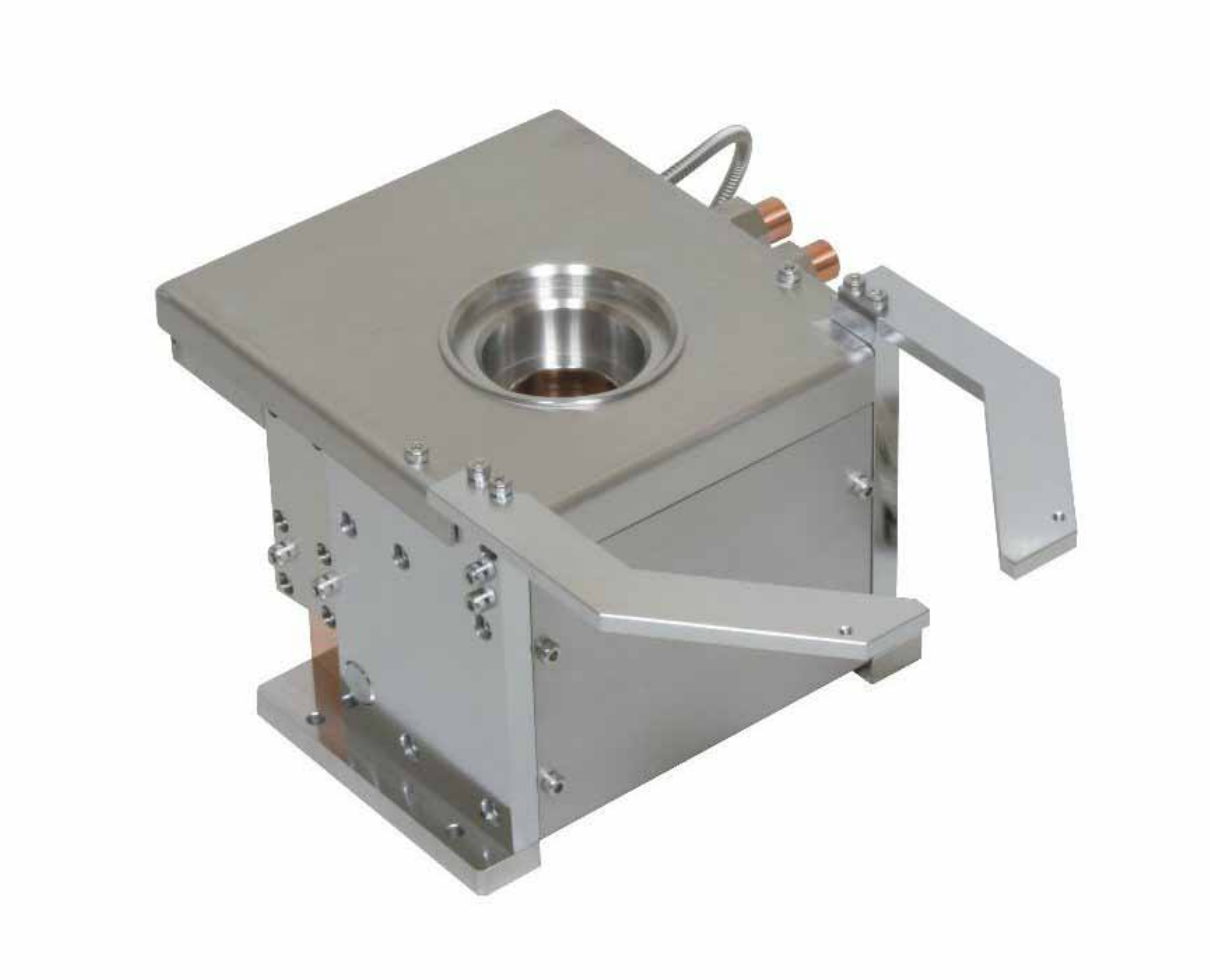
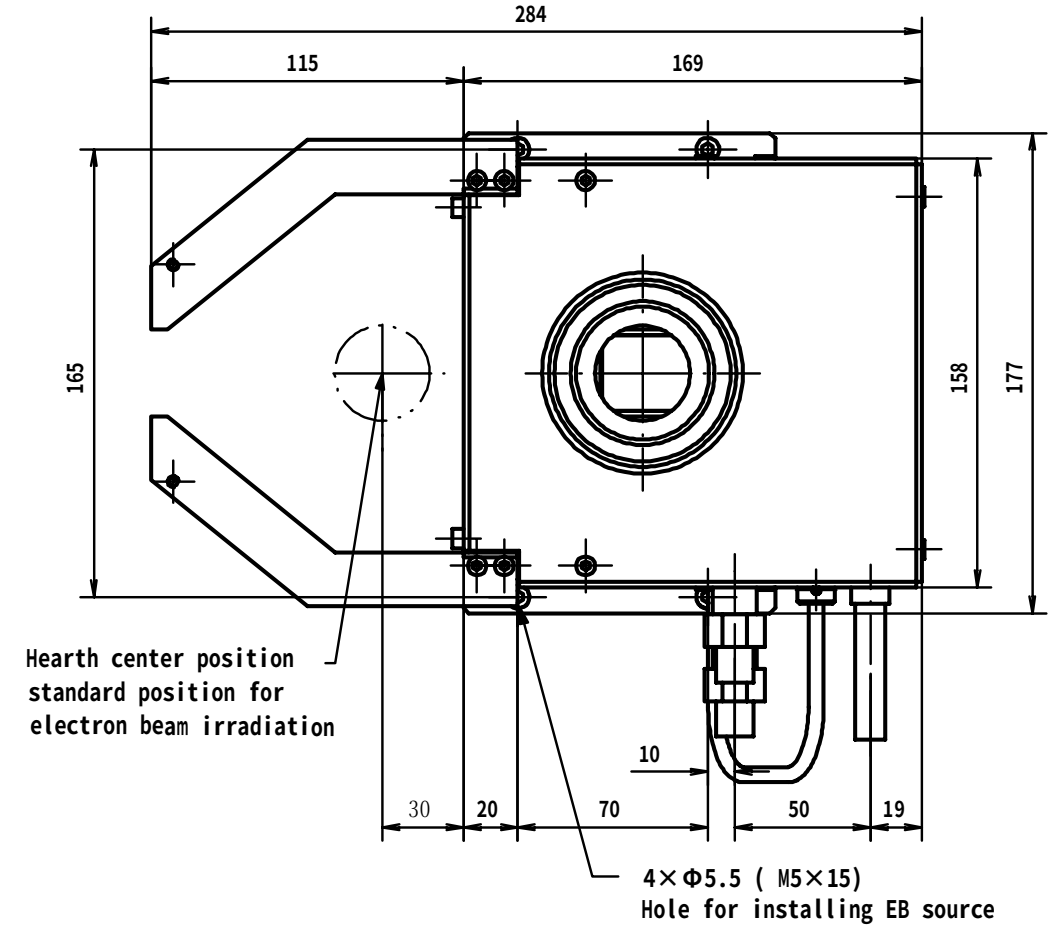


Fig. 1


284
115
169
165
158
177
Hearth center position
standard position for
electron beam irradiation
10
30
20
70
50
19
4×Φ5.5 (M5×15)
Hole for installing EB source

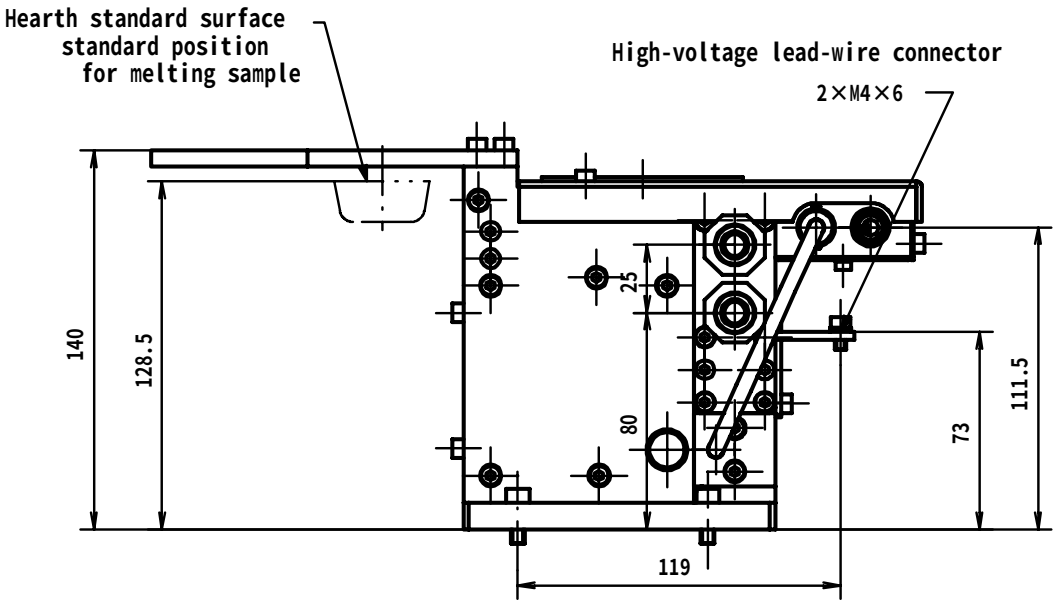

Hearth standard surface
standard position
for melting sample
High-voltage lead-wire connector
2×M4×6
140
128.5
25
80
73
111.5
119

Fig. 2

〔Ⅲ〕 Installation

Fasten the basic unit of the electron beam source to the base plate of the evaporation chamber using four M5 bolts.

This beam source does not include a hearth as a standard component. Provide a hearth which is designed to place the center of the evaporant at the standard position for electron beam irradiation shown in **Fig. 2**.

Recommended hearth

Diameter	35 mm in diameter
Depth	15 mm

Water-cooled copper hearth

In order to avoid the interference of the stainless-steel plate fastening screws for the beam source (hearth side) and the hearth, please note the following points: If the hearth is circular, separate the hearth at least 3 mm from the head of the beam source. In this case, the outside diameter of the hearth should be 800 mm or less. If the hearth is rectangular, separate the hearth at least 5 mm from the head of the beam source.

⚠ Caution

Do not use a magnetic material for the hearth to use. If you use a magnetic material, the performance in the specifications might not be met or the electron beam source or other components might break.

The evaporation chamber requires the following components.

(1) High-voltage feedthrough terminal

10 kV (12 V between terminals), 40 A	2
(JEOL standard component BS-63050HV25GA	2)

(2) Low-voltage feedthrough terminal

30 V, 3 A	1
(JEOL standard component BS-63010LV series	1)

(3) Cooling water inlet

Water supply: water temperature 30 ℃ or less	
5 L/min or more	2

Place the high-voltage feedthrough terminals as near the beam source as possible so that you can easily shield the high-voltage section.

When you connect the high-voltage feedthrough section, first remove the covers (G22, G21) (**Fig. 3**), next remove the bolts (G56) and the stopper (G58) (**Fig. 4**), and then remove the scan

coil case in the direction of the arrow (→) (**Fig. 4**). Then, connect two copper wires 3 mm or more in diameter from the high-voltage feedthrough terminals through the high-voltage lead plate (G43) (**Fig. 5**). These wires must be placed at a sufficient distance from other components.

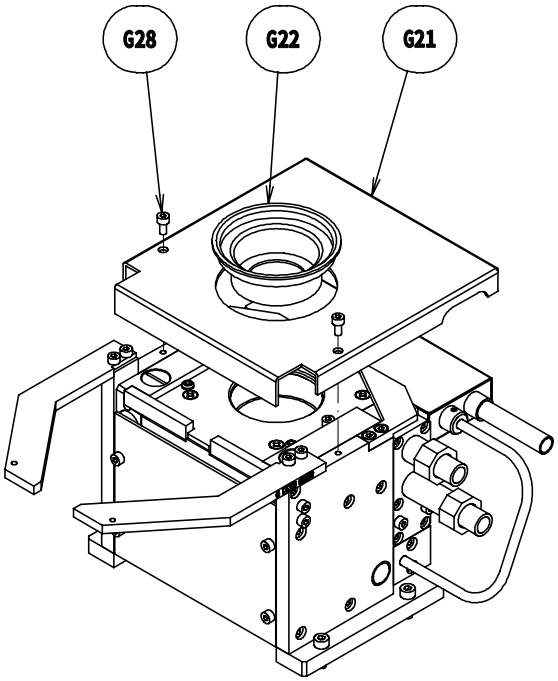


Fig. 3

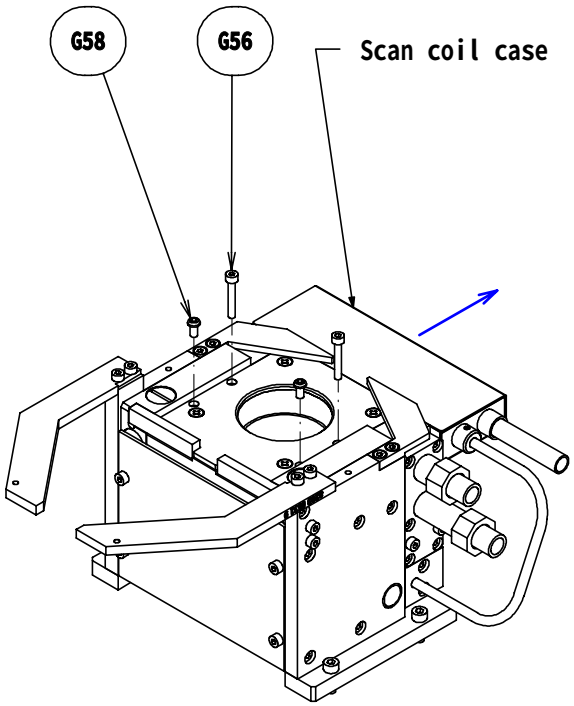


Fig. 4

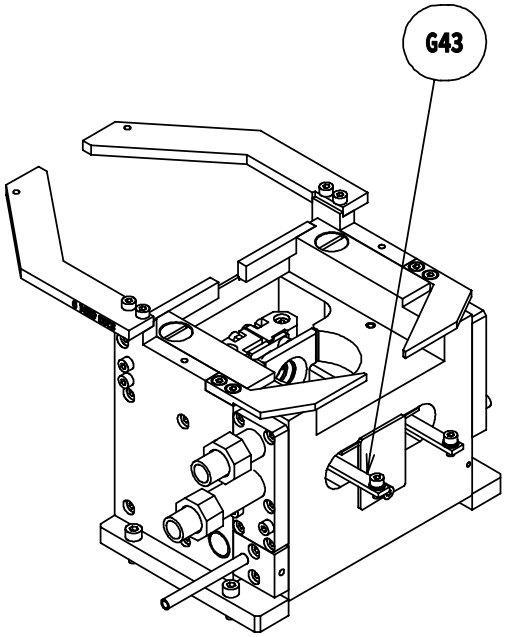


Fig. 5

⚠ Caution

Shield the path of the wires, from the high-voltage terminals in the evaporation chamber to the high-voltage terminals in the basic unit of the electron beam source, using a cover so that gas generated during evaporation does not enter the path of wires. If the vacuum on the path deteriorates, this causes abnormal discharge.
Place the high-voltage cover at a position where the cover does not interfere with attaching or removing the scan coil case.

Connect the cable from the low-voltage feedthrough terminal on the terminal plate in the scan coil case, to the scan coils and the electromagnet with red, black, yellow, blue, white and green wires of matching colors.

Connect the electron beam source to the faucet and drain using metal pipes with a diameter of about 10 mm from the cooling water inlet for the beam source and a brazed hexagonal cap nut (**Fig. 6**).

For the electron beam to pass above the electron beam source, at least 75 mm clearance is needed above the top surface of the basic unit of the beam source. In particular, be careful when you install a shutter.

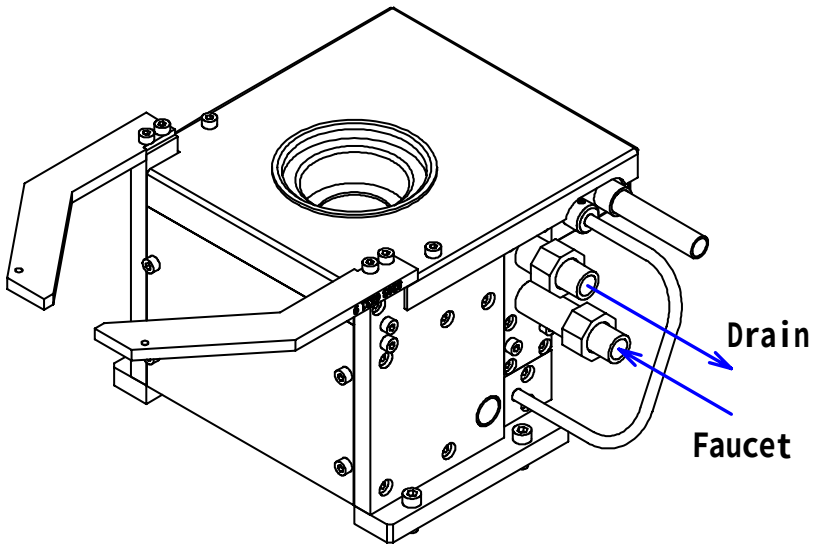


Fig.6

⚠ Warning

- In the installation of the electron beam source, before carrying out necessary work or touching the basic unit of the electron beam source, turn off the switch of the power supply for the beam source and make sure that the power is shut off. If you work while the power switch is on, you might get an electric shock.
- Before installing the basic unit of the electron beam source and the hearth to use, make sure to ground these components. If grounding is not sufficient, this might cause malfunction of the beam source or electric shock.
- Make sure to ground the evaporation chamber where the electron beam source is installed. If the chamber is not grounded, this might cause malfunction of the beam source or electric shock.

⚠ Caution

- Install the electron beam source in a place free of magnetic fields (except for earth magnetism). If stray magnetic fields exist, this gives negative influence to the electron beam, and the performance in the specifications might not be met or the electron beam source or other components might break. In particular, use a nonmagnetic material for the shutter of the evaporation chamber.
- Set the pressure for introducing cooling water to the electron beam source at 0.3 MPa or less. If you apply a pressure greater than 0.3 MPa, this might cause water leakage or the breakage of the electron beam source.
- X-rays are generated because the electron beam irradiates the sample. Since the accelerating voltage is as low as 10 kV or less, an ordinary evaporation chamber can sufficiently prevent X-ray leakage. But if you use a special evaporation chamber or if you think it is necessary, check the X-ray leakage and make sure that X-rays do not leak outside of the evaporation chamber.
- Do not place a magnetic material (except for an evaporant) or a component that generates a magnetic force near the electron beam source. If stray magnetic fields arising from them exist, they give negative influence to the electron beam, and the performance in the specifications might not be met or the electron beam source or other components might break.
- After using the electron beam source, cool it sufficiently and vent the evaporation chamber. If you vent the chamber while the beam source is hot, the components of the beam source might break.

〔Ⅳ〕 Operation

(1) Degassing of filament

When you use the filament for the first time, you have to pass a current through the filament and degas it. When the vacuum reaches 7.0×10^{-2} Pa or less, turn on only the filament switch on the operation panel. Then, turn the EMI volume from 0 to Max, by taking three minutes and keep this status for five minutes. After that, turn the EMI volume from Max to 0, and then turn it off.

(2) Polarity of scan coils

If you mistakenly wire the scan coil of the electron beam source, proper beam scanning cannot be done. Check to see if the wiring was done properly by the following two procedures.

1) When you operate the electron beam source and turn the X position knob in the front of the operation panel, the electron beam moves to a line that connects the beam source (filament) and the hearth. (That is, when you turn the X position knob clockwise and the meter swings to the "+" direction, the electron beam moves to the beam source (filament) side.)
2) When you turn the Y position knob, the electron beam moves to the direction perpendicular to the X direction. (That is, when you turn the Y position knob clockwise and the meter swings to the "+" direction, the electron beam moves to the right side of the hearth as seen from the beam source.)

(3) Adjustment of electron beam irradiation position with variations of accelerating voltage

You can easily adjust the electron beam irradiation position with the DEF current of the electromagnet, so that the beam irradiates the target position exactly.

If you change the accelerating voltage, the electromagnet enables you to easily position the electron beam.

When you want to set the accelerating voltage, remove the blank panel in front of the operation panel (by removing two screws on the both ends of the panel), and then adjust the ACC ADJ (VR15) (**Fig. 7**).

When you want to set the DEF current, adjust the XP BALANCE (VR10) (**Fig. 7**).

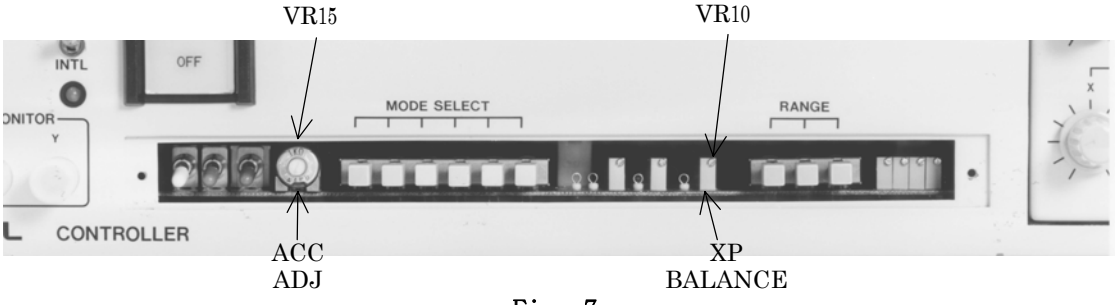


Fig. 7

List 1

Accel. voltage (kV)	DEF voltage (mV)	Offset voltage (mV)
4	438	0
5	512	0
6	580	0
7	652	0
8	738	0
9	844	0
10	1090	0

An example of a combination of the DEF voltages and offset voltages with accelerating voltage variations for the stainless-steel chamber is shown in **List 1**, provided that the hearth is placed at the standard position for electron beam irradiation. The combination of the DEF and offset voltages varies depending on the material of the chamber or the position of the hearth. For more details on setting the offset voltage, For setting the offset voltage, refer to Section 3-3 in the instruction manual for the JST-F SERIES Power Supplies.

If the deflection magnetic field is strengthened by magnetic adjustment, the beam spot becomes better (in terms of spot shape and spot diameter), but the scan area tends to become relatively narrow. To the contrary, if the deflection magnetic field is weakened, this leads to a relatively large spot diameter, but the large spot enables beam irradiation over a wider area. Thus, depending on the purpose of use (with an emphasis on the beam spot or the scan range), you can fully utilize the capabilities of the electron beam source by optimizing its working conditions.

When you set the DEF current, first set this current to a higher current, and then turn the adjustment volume counterclockwise to set the appropriate current.

⚠ Caution

Sometimes when you change the DEF current, the hysteresis of the electromagnet remains and the reproducibility of the beam position cannot be obtained. To prevent this phenomenon, when you change the DEF current, make sure that you turn off the power switch for the electron beam source. Then, turn on the power switch again to generate the beam.

〔V〕 Maintenance

When you use the electron beam source for a long time, the insulator section and the high-voltage section gradually become contaminated. If you use the beam source while these sections are contamiated, an abnormal discharge might occur. Clean them at least once a week or every two weeks. Depending on the type of evaporant or the frequency of use, it is necessary to clean them more frequently.

Use a Scotch-Bright pad or a wire brush for cleaning. When you use a wire brush, it should be made of brass so that any brush fragments do not adhere to the electromagnet. The use of a sandblast is restricted to the evaporation-preventing cover, because the use of the sandblast for other components might cause excessive wear on them.

Note that after cleaning the components, wash them with alcohol.

⚠ Caution

Be careful so that the scourings produced by the wire brush do not fall inside the electron beam source. This might cause malfunction of the beam source.

(1) Cleaning anode

If the Wehnelt (G38 grid) surface and the anode are contaminated, an abnormal discharge might occur. Clean them periodically depending on the frequency of use. Use a Scotch-Bright pad or sandpaper for cleaning. Polish the Wehnelt (G38 grid) and the anode surfaces facing each other. To remove the anode, follow the procedures below.

1. Remove the covers (G22, G21) (**Fig. 3**).
2. Remove the cover (G23) (**Fig. 8**).
3. Remove the bolts (G56) and slide the scan coil case in the direction of the arrow (→) (**Fig. 9**).

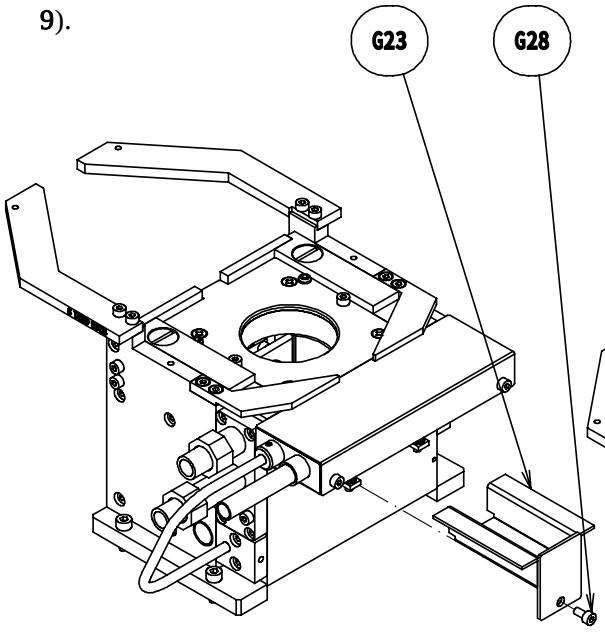


Fig. 8

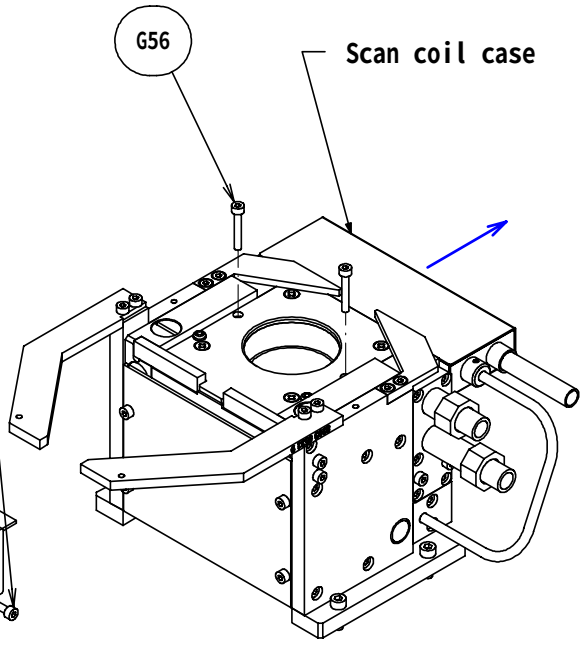


Fig. 9

4. When you remove the bolts (G45) (**Fig. 10**), you can remove the anode (G42) (**Fig. 11**).

When you finish cleaning the anode (G42), before returning it to the original position, first vacuum the contamination produced by evaporation located on the attaching groove in the basic unit, using a cleaner.

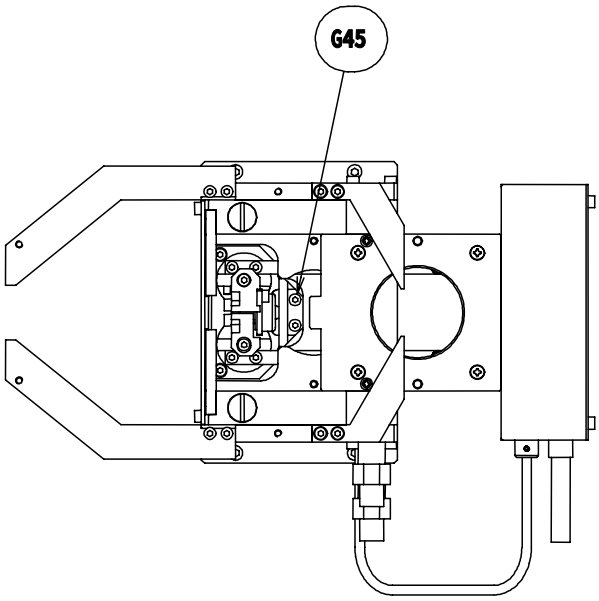


Fig. 10

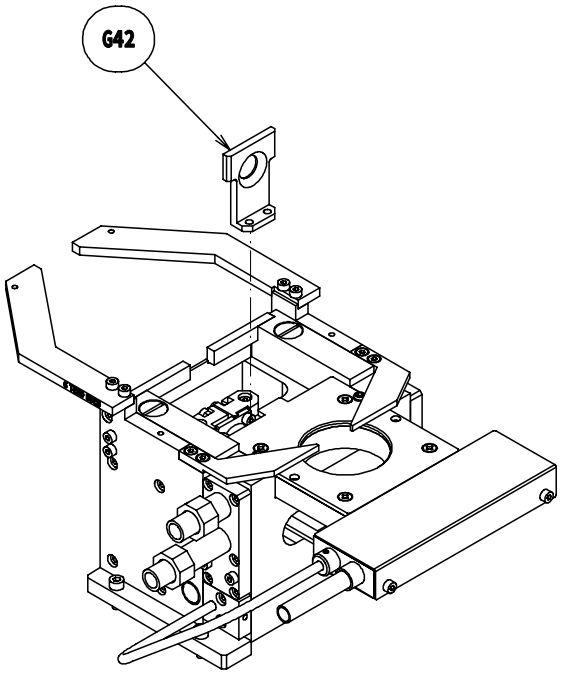


Fig. 11

(2) Cleaning grid assembly

To remove the grid assembly, first remove the covers (G22, G21) (**Fig. 3**). Next, slide the scan coil case (**Fig. 12**) and remove the bolts (G45). Then, you can remove the grid assembly (**Fig. 13**).

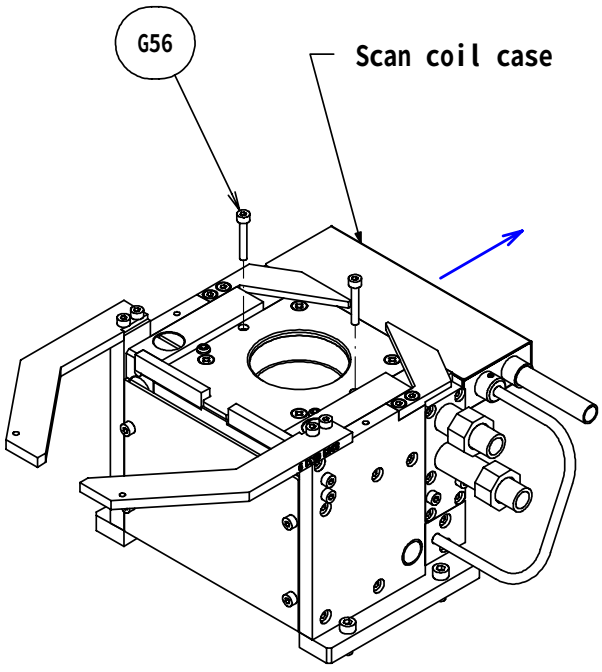


Fig. 12

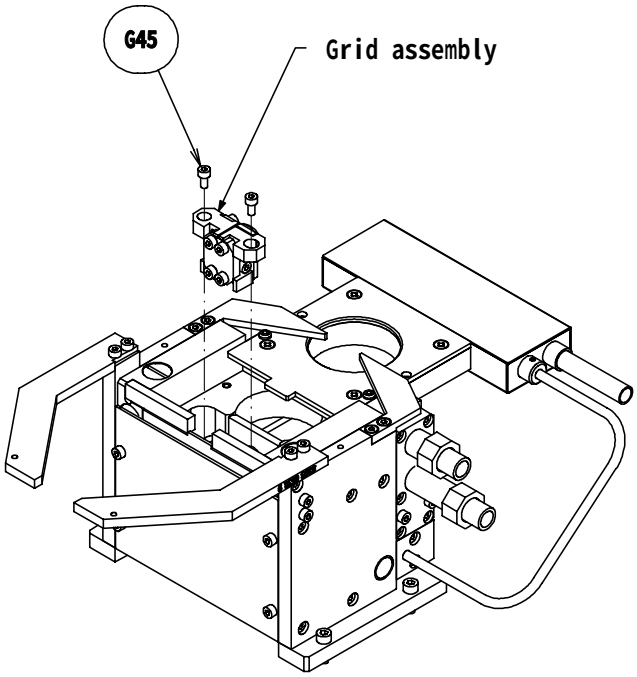


Fig. 13

While disassembling the grid assembly, clean the components by following the procedures below, step by step.

Filament (G44)

Loosen the bolts (G45) and extract the filament (G44) upward (**Fig. 14**).

Wehnelt (G38 grid) & supporting electrode (G39 grid)

When you remove the bolts (G45), you can remove the Wehnelt (G38 grid) and the supporting electrode (G39 grid) (**Fig. 15**).

Polish both the outside and the inside of the Wehnelt (G38 grid) cylinder for cleaning.

Clean the top and side surfaces of the supporting electrode (G39 grid). Ion sputtering during evaporation wears the supporting electrode. Replace it with a new one before its shape changes with its edge becoming worn. This electrode is a consumable part.

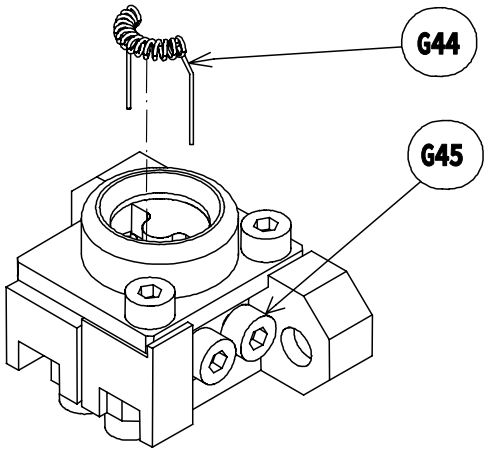


Fig. 14

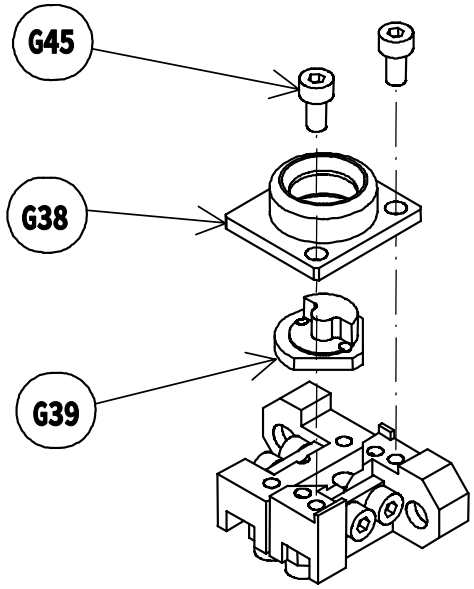


Fig. 15

Supports (G41)

Remove the four bolts (G45) and the supports (G41). Polish the supports so that the groove where the filament was attached does not remain (**Fig. 16**).

Insulator (G40)

If the insulator (G40) becomes badly contaminated, remove the bolts (G45) and polish it. If the insulator has a crack in it, replace it with a new one (**Fig. 16**).

Holders (G36, G37)

Clean the contamination from the V groove using a Scotch-Bright pad. Note that if the surface of the V groove is badly worn, the filament will not attach properly, causing a problem. So, clean it with to the minimum extent (**Fig. 16**).

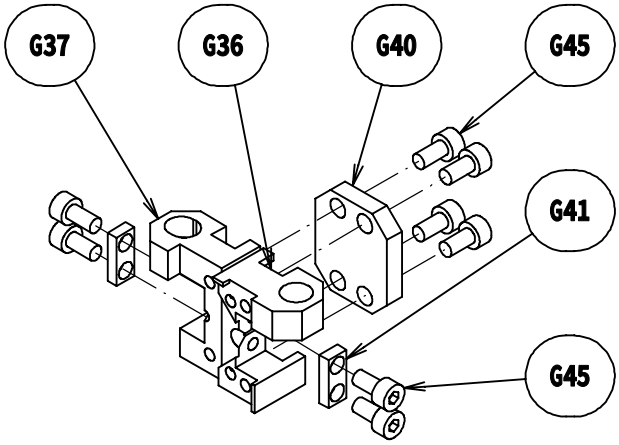


Fig. 16

To assemble the grid assembly, follow the procedures below.

1. Align the insulator (G40) with the grooves of the holders (G36, G37) and fasten it to the holders using the bolts (G45).
2. Lightly attach the left and right supports (G41) to the holders using the four bolts (G45).
3. As shown in **Fig. 17**, position the supporting electrode (G39) so that the bottom surface of the electrode contacts the concave portion of the grid assembly. Then place the grid (G38) on the supporting electrode. When placing the grid (G38), carefully attach it to the electrode so that it exactly contacts the wall of the electrode, and then loosen the bolts (G45). If the supporting electrode (G39) is not attached properly (displace from the correct position), this might break the filament and deteriorate the beam shape. So, properly attach it.
4. Install the filament. While lightly holding down the head of the filament, push the leg of the filament into the electrode along the V groove.
5. When the filament reaches the deepest position of the grid assembly, fasten it by turning the bolts (G45) alternately while keeping its position.
6. Insert the grid assembly into its proper position (**Fig. 12**) and fasten it using two bolts (G45). Return the scan-coil case to its original position and fasten it using two bolts (G56) (**Fig. 11**). Putting the evaporation-preventing cover (G22, G21) completes the assembling of the grid assembly.

⚠ Caution

The distance between the filament and the anode is important for the electron beam source. When you install the filament, make sure that the leg of the filament contacts the bottom of the grid assembly along the V groove, by viewing it from the gap between the supports (G41) and the insulator (G40).

After replacing the filament, when you use it for the first time, degas it according to the procedure in (1) in "Ⅳ Operation."

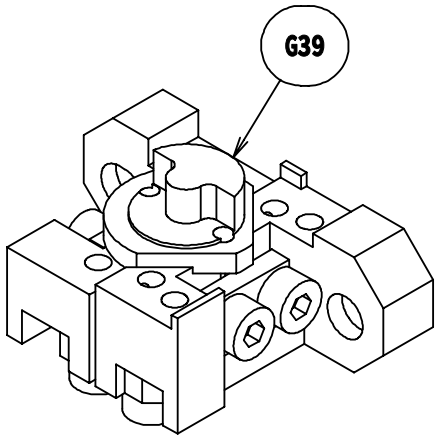


Fig. 17

(3) Other cleaning

If the electron-beam source chamber (surroundings of the grid assembly) becomes badly contaminated, remove the entire grid assembly unit and clean it. To remove and disassemble the grid assembly unit, follow the procedures below.

1. Remove the covers (G22, G21) (**Fig. 18**).
2. Remove the bolts (G56, G58) and remove the scan coil case in the direction of the arrow (→) (**Fig. 19**).

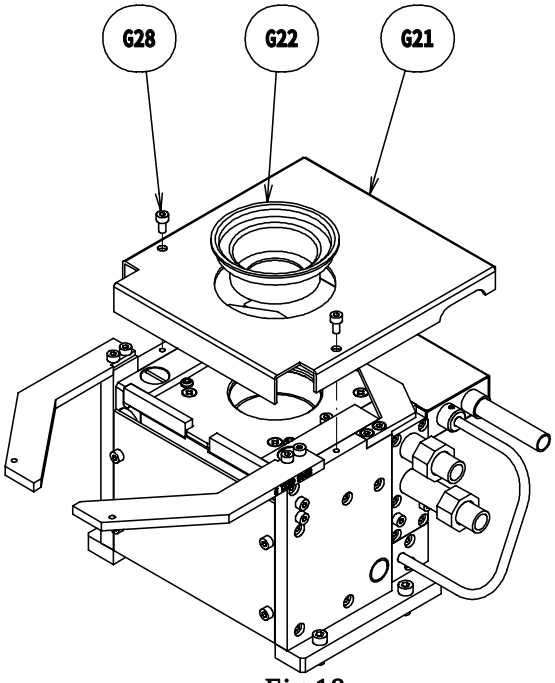


Fig.18

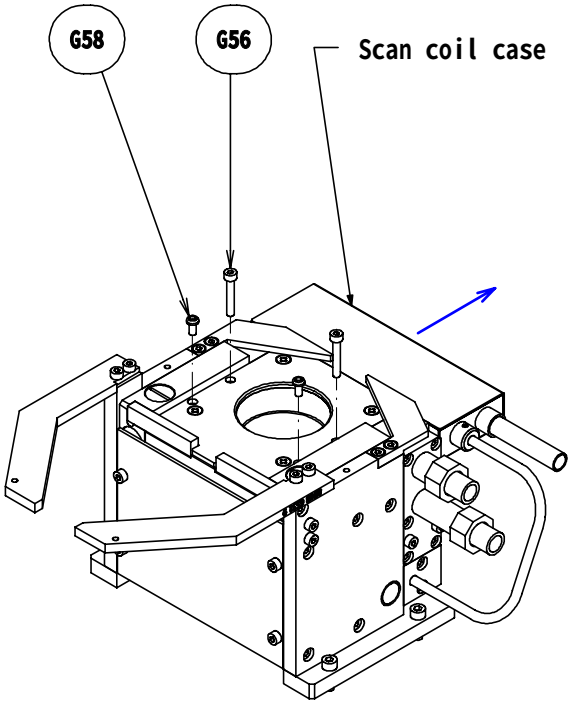


Fig.19

3. Remove the lead plate cover (G23) (**Fig. 20**).

4. Disconnect the lead plate (G43) and the high voltage wire.

5. Remove the bolt (G45), and then remove the lead plate (G43) (**Fig. 21**).

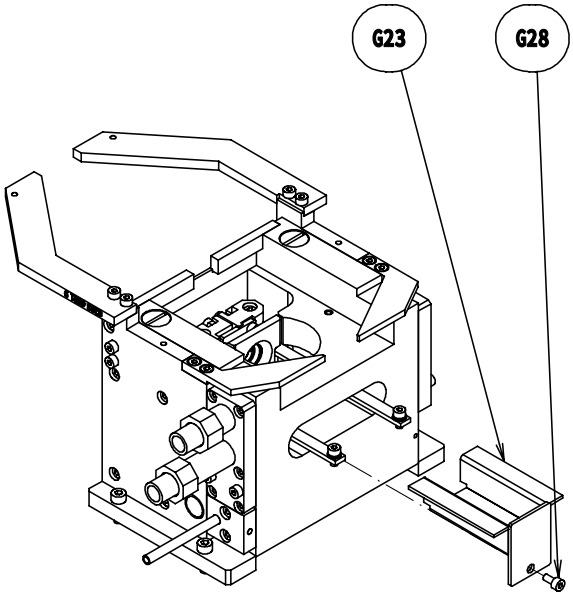


Fig. 20

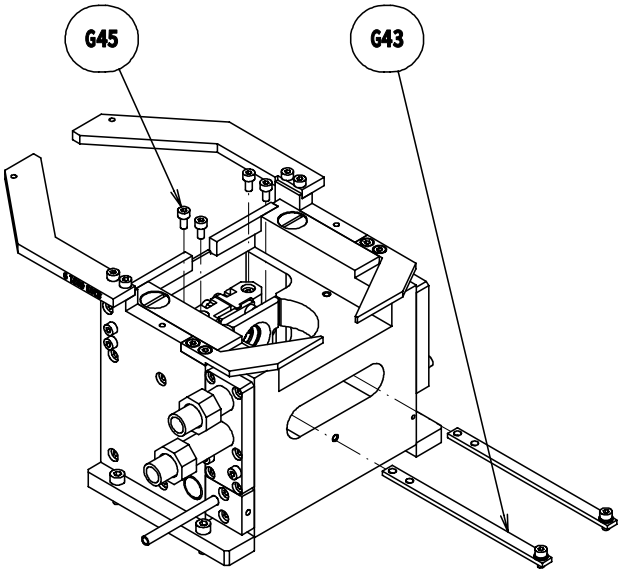


Fig. 21

6. Remove the two bolts (G45) and extract the entire grid assembly unit (**Fig. 22**).

7. Remove the grid assembly and the anode (G42) (**Fig. 23**).

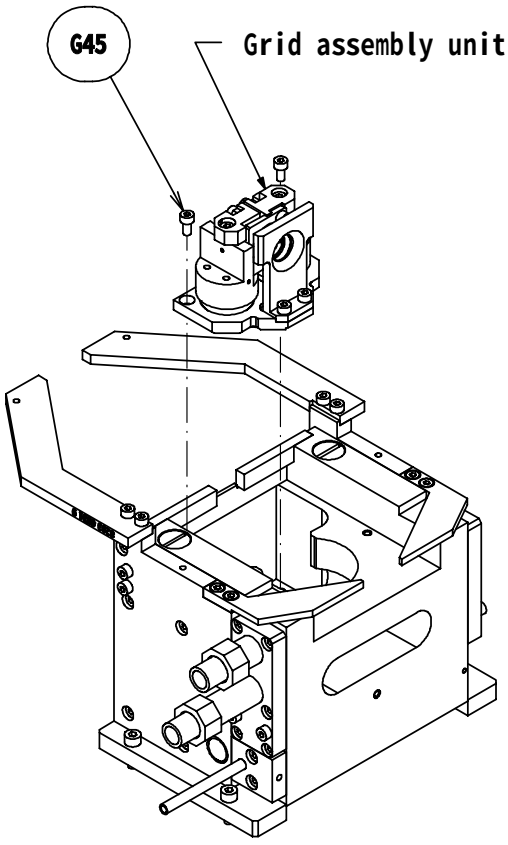


Fig. 22

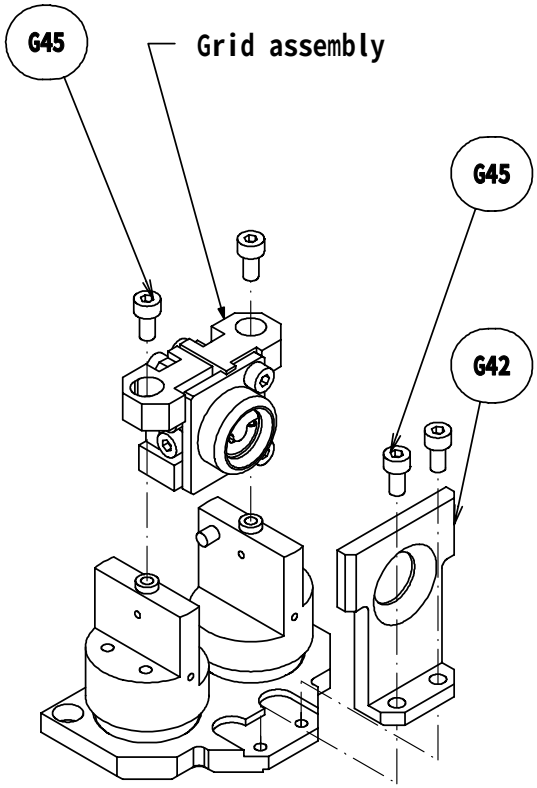


Fig. 23

8. Remove the bolts (G45) at the base (G32) side, and then remove the holders (G34, G35) (**Fig. 24**).
9. Remove the bolts (G45) at the insulator (G33) side, and separate the insulator (G33) from the base (G32) (**Fig. 24**).

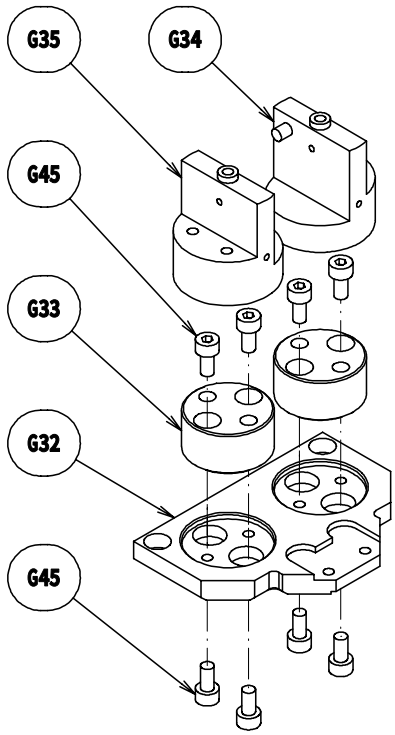


Fig. 24

When you clean the grid assembly unit, especially polish the following parts.

Lead plate (G43)

In particular, thoroughly polish the part that connects to the crimped terminal and the part that contacts the holder, so that a contact resistance does not increase. Also polish the part where the lead plate of the holder contacts.

Holder (G34,G35) cylindrical-part side surface

To prevent a discharge, especially polish the part near the anode.

Holder (G34, G35) upper part

Thoroughly polish the part where the grid assembly is mounted, so that a contact resistance does not increase.

Insulator (G33)

To prevent a discharge, polish it if it is badly contaminated.

When you assemble the grid assembly unit, use steps 1 to 9 in “(3) Other cleaning” in reverse. Restore all components to the original state. In particular, exercise extreme care as explained below.

⚠ Caution

To prevent the grid assembly from being mistakenly installed with its front and back reversed, a pin is attached to one holder (G34). After cleaning, when you fasten the holders (G34, G35) to the base, referring to **Fig. 25**, install the holder with the pin (G34) on the right seen from arrow A. Whereas, install the holder without a pin (G35) on the left as seen from arrow A.

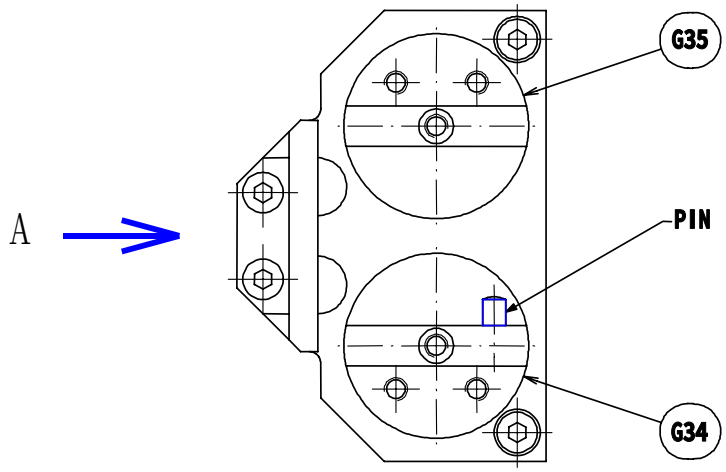


Fig. 25 Grid assembly unit (top view)

High-voltage feedthrough terminals

If the insulator and the aluminum cap of the high-voltage feedthrough terminals (BS-63050HV25GA) are contaminated, clean these parts. Note that, when you fasten or remove the bolts of the high-voltage feedthrough terminals, use two wrenches. If you use only one wrench, the insulator section of the feedthrough terminals might break.

Annealing

After cleaning, in advance of generating the electron beam, you have to degas the filament. Turn on only the filament switch on the operation panel, increase the current gradually to 200 mA using the emission current meter, and then keep this status for three minutes for degassing.

〔Ⅵ〕 Other

1) If you use the beam source at around the maximum beam output, it needs at least 5L/min of cooling water. Since the pressure difference between the faucet and the drain is about 0.15 MPa, when you want to run the water at this rate, use a cooling-water pipe with a sufficient diameter.

2) When you operate the heater for the evaporant, the electron beam source also becomes considerably hot. So, run the cooling water for the beam source simultaneously with the operation of the substrate heater. If you do not run the water, the deflector coils and the beam scan coils might burn.

3) When you replace the filament for the first time, pass the M4 tap through the screw where the filament-fastening bolt is screwed, and remove the burnt portion. If the filament-fastening bolt does not work smoothly after this removal, pass the tap again as soon as possible.

〔Ⅶ〕 Parts Configuration

The maintenance parts (consumable parts and replacement parts) for this electron beam source are as follows.

When you order maintenance parts, specify the part name, the standard (part number) and the quantity of each part.

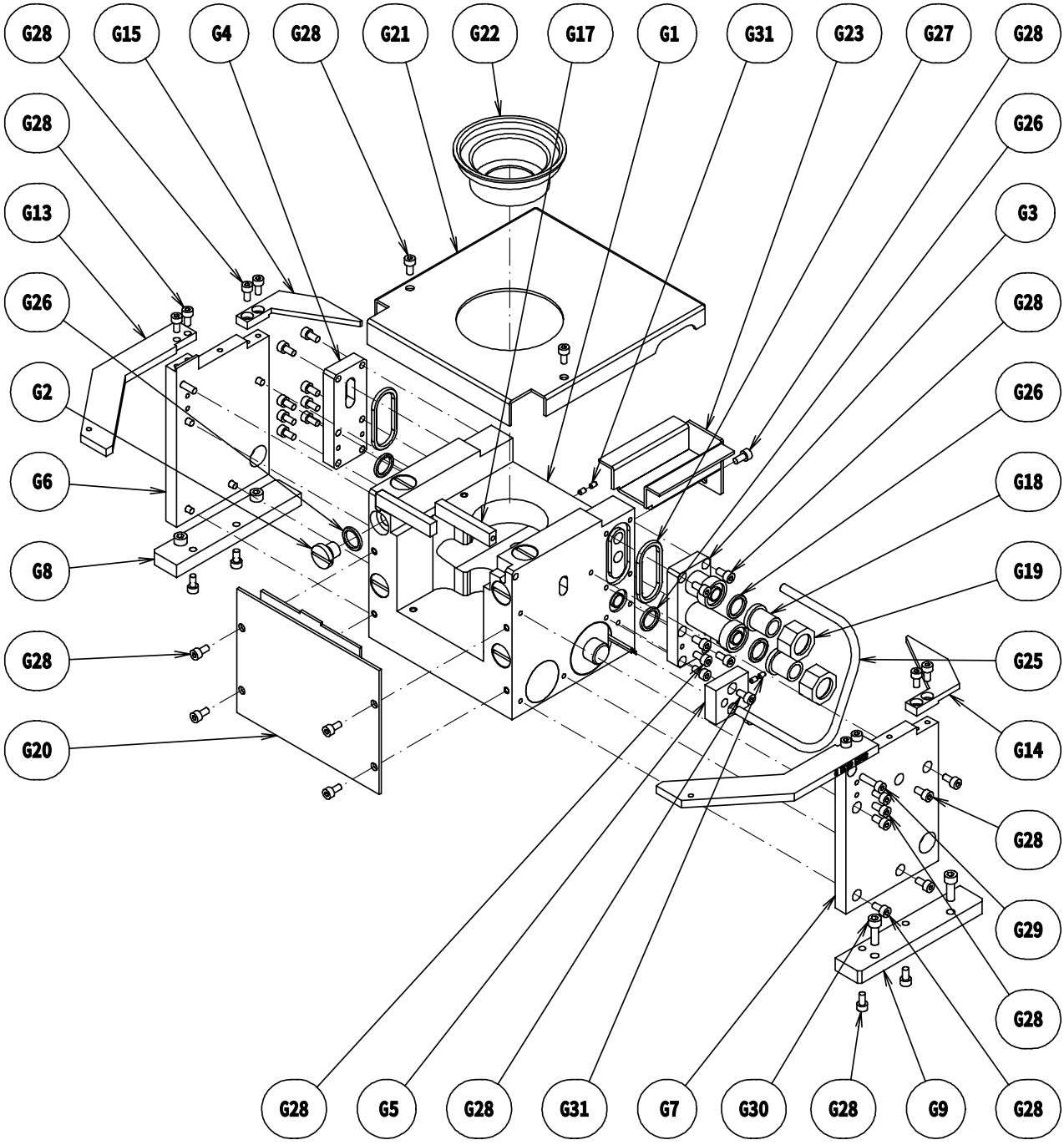
※ The replacement schedule is for reference only. Parts may require replacement at other times, depending on the conditions of operating the electron beam source.

The filament and the supporting electrode (G39 grid) are consumable parts. Also, replace the high-voltage wires inside the chamber (copper wires from the high-voltage feedthrough terminals to the electron beam source) once a year.

If you have to replace the deflector coils or the scan coils, or if you removed the permanent magnet from the copper block in the basic unit for cleaning, consult JEOL Ltd. or JEOL DATUM LTD.

For the parts other than the maintenance parts, consult with JEOL Ltd. or JEOL DATUM LTD.

BEAM SOURCE					
No.	Name	Quantity	Specifications	Remarks	Recommended Replacement
G1	Block	1	801829542		
G2	Plug	6	820372277		
G3	Pipe with Flange	1	812537475		
G4	Flange	1	820365262		
G5	Block	1	820365327		
G6	Yoke	1	812537505		
G7	Yoke	1	812537513		
G8	Base	1	820365297		
G9	Base	1	820365289		
G13	Pole Piece	2	820365319		3 years
G14	Pole Piece	1	820337145		
G15	Pole Piece	1	820337200		
G17	Pole Piece	2	820365271		
G18	Pipe Fitting	2	801313082		
G19	Nut	2	801242916		
G20	Cover	1	820365254		1 year
G21	Cover	1	812537521		1 year
G22	Cover	1	820375098		
G23	Cover	1	812538587		
G25	Tube	0.3m	430004818	Length Specified	
G26	O-ring	10	406017476	P12	2 years
G27	O-ring	2	406000387	P32	2 years
G28	Hexagon Socket Head Bolt	51	411002481	M4×8	
G29	Hexagon Socket Head Bolt	2	411002813	M4×15	
G30	Hexagon Socket Head Bolt	4	411000209	M5×15	
G31	Hexagon Socket Head Bolt	4	409005100	M3×5	


G28
G15
G4
G28
G21
G22
G17
G1
G31
G23
G27
G28
G28
G26
G13
G3
G26
G28
G2
G26
G6
G18
G8
G19
G28
G25
G20
G14
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G29
G28
G28
G5
G28
G31
G7
G30
G28
G9
G28

Fig.26

Grid Assembly Unit					
No.	Name	Quantity	Specifications	Remarks	Recommended Replacement
G32	Base	1	812537211		
G33	Insulator	2	812233182		2 years
G34	Holder	1	812537203		2 years
G35	Holder	1	812537220		2 years
G36	Holder	1	812537238		2 years
G37	Holder	1	812537246		2 years
G38	Grid	1	820336408		2 years
G39	Grid	1	820338443	Consumable Parts	
G40	Insulator	1	820364771		2 years
G41	Support	2	820364789		2 years
G42	Anode	1	820364797		2 years
G43	Lead Plate	2	820336441		3 years
G44	Filament	1	812180313	Consumable Parts	
G45	Hexagon Socket Head Bolt	30	411002481	M4×8	
G46	Spring Washer	2	412001683	M4	
G47	Washer	2	412003821	M4	

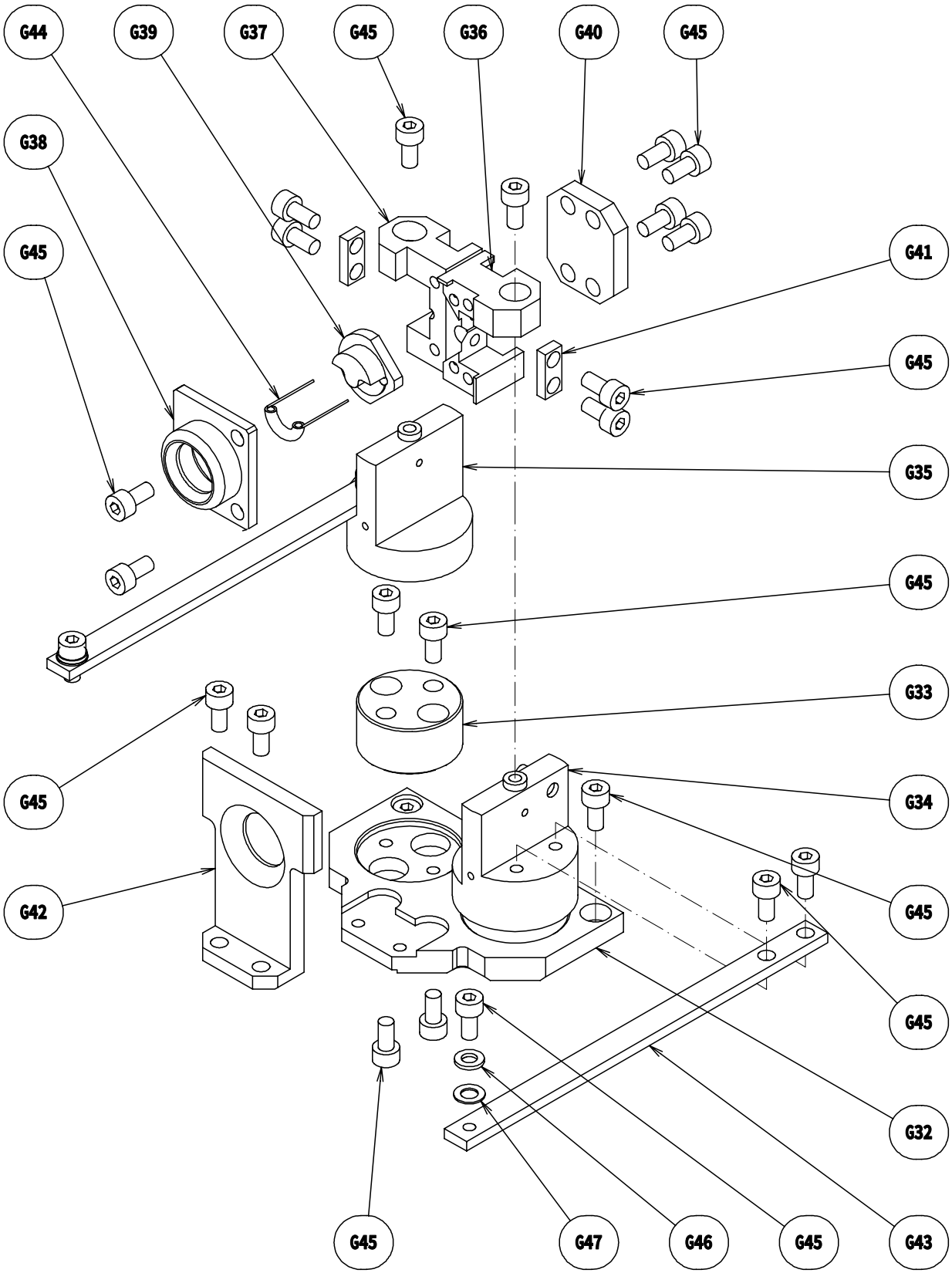
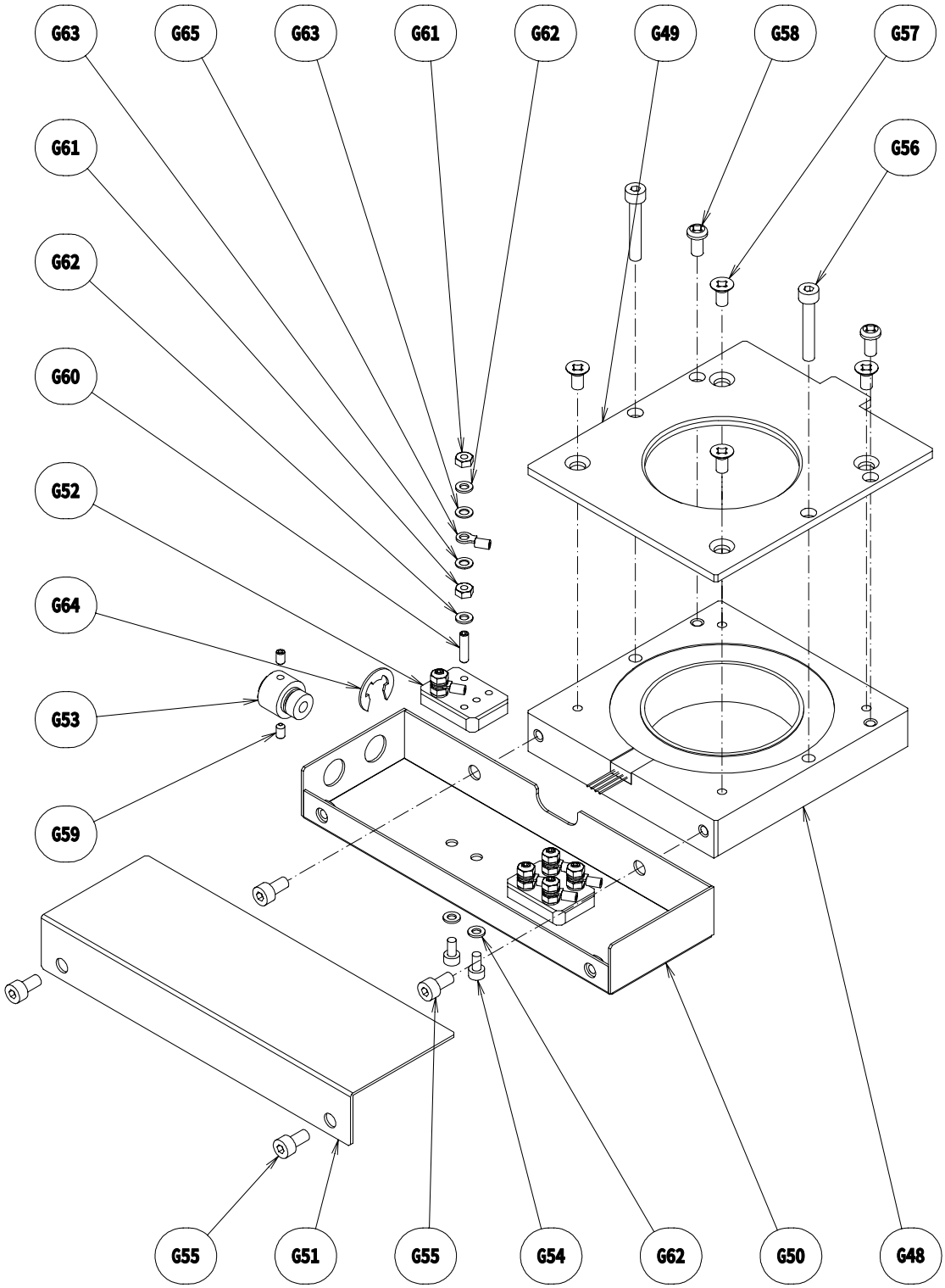

G44
G39
G37
G45
G36
G40
G45
G38
G45
G41
G45
G35
G45
G33
G45
G34
G42
G45
G45
G32
G45
G47
G46
G45
G43

Fig.27

SCANNING COIL					
No.	Name	Quantity	Specifications	Remarks	Recommended Replacement
G48	Coil	1	864967578		
G49	Cover	1	820364835		
G50	Case	1	812537301		
G51	Cover	1	820364843		
G52	Insulator	2	802164340		
G53	Connector	1	820254088		
G54	Hexagon Socket Head Bolt	4	411003666	M3×6	
G55	Hexagon Socket Head Bolt	4	411002481	M4×8	
G56	Hexagon Socket Head Bolt	2	411003640	M4×25	
G57	Phillips Flathead Screw	4	409008800	M4×8	
G58	Phillips Pan-Head Screw	2	409004251	M4×8	
G59	Hexagon Socket Set Bolt	2	409005100	M3×5	
G60	Hexagon Socket Set Bolt	6	409012777	M3×12	
G61	Hexagon nut	12	412001560	M3	
G62	Spring Washer	16	412001390	M3	
G63	Washer	12	412003813	M3	
G64	Snap Ring E-type	1	414001800	8 17.4PH	
G65	Crimping Terminal	6	416000266	R1.25-3	


G63
G65
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G48

Fig.28