# Example for installation and initial operation of an evaporation equipment with EHV 110 A

Issued: July 1980 / DN 9228

## DANGER HIGH VOLTAGE

Touching parts under high voltage is absolutely FATAL.
Service work on the high voltage supply and the high voltage feedthroughs may only be carried out by qualified personnel. Service work on the high voltage system may only be carried out when the high voltage has been turned off.
The system is considered turned off when the master switch (MAIN SWITCH) on the EHV 110 A has been turned off or when the mains plug has been disconnected.
As a safety precaution a screw coupling connection is to be made from the grounding bar in the high voltage supply to the high voltage output (capacitator discharge).
The various terminals in the interlock circuit must not be considered as safety elements.
Caution:
When the cabinet doors are open and the high voltage supply is on there is **FATAL DANGER.**
The cabinet door of the EHV 110 A is only to be opened with a specially marked key (high voltage lightening streak). This key may only be carried by a qualified electrical expert.
The doors to the system frame must be provided with a lock. For service purposes the doors to the system frame may only be opened by a qualified electrical expert. Interlock switches on the frame doors do not qualify as safety elements. Before installing the EHS, therefore, be sure that the master switch is off or that the mains plug has been pulled.

**1. EVAPORATION EQUIPMENT** (one source in one evaporation system):

consisting of EHV 110 A, EKS 110 A, ETS 110, EHS 110, 111 and ESQ 110 ( single chamber operation).

### 1.1.1. Mounting the source ESQ 110 in the evaporation system

a. Fit the feedthrough with flange into the coating unit base plate above and fix in position with the washer (connect ground line) and nut (M30 x 1.5 mm). If the underside of the coating unit base plate is covered with a protective film, then the gun and also the angle of the high current transformer (anode current) must be connected to the ground line (16 $mm^2$ Cu or Al strip 3 x 60 mm which is provided with two 33 mm diameter holes and is firmly screwed to the gun and to the high current feedthrough).

b. Fit the 80 x 4 mm O-ring.

c. Fix the completely assembled source upper section (without the crucible or the crucible lower section) in position with four M5 inner hex screws.

d. Mount the lock nut and the clamping ring on the feedthrough from underneath

e. Mount the source lower section on the feedthrough and with the positioning screw (inner hexagon screw M4) slackly tighten in the key way.

f. Tighten the lock nut firmly.

g. Check the sealing surfaces for the L-ring gaskets (refer to spare parts list BB 800 041 E/1, 2, item 19 and 20) on the crucible lower section and repolish, if necessary. There should be no grooves resulting from the machining operation.

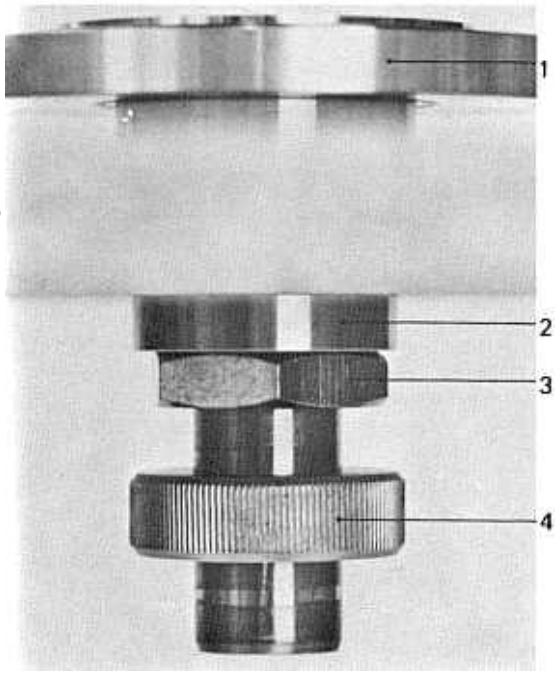


Fig. 1

1. Feedthrough
2. Washer
3. Nut
4. Knurled nut

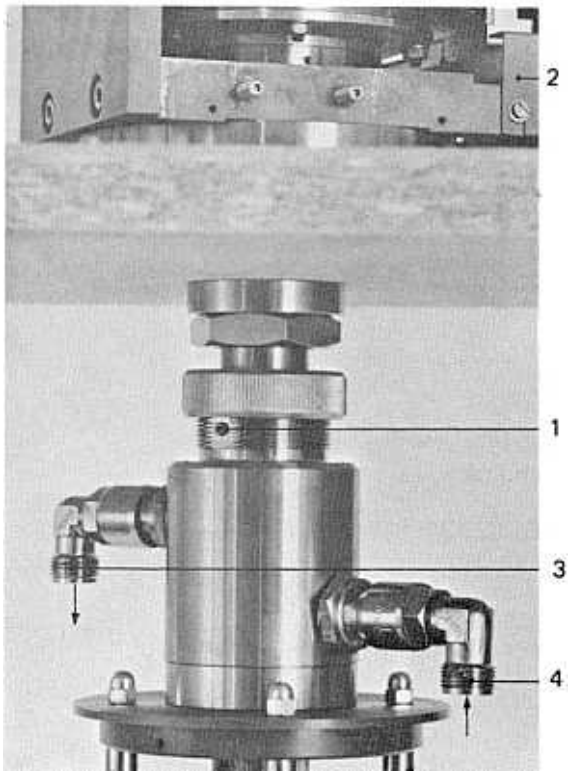


Fig. 2 Source lower section

1. Inner hex screw M4
2. Evaporation protection for the flat insulator
3. Water outlet
4. Water inlet

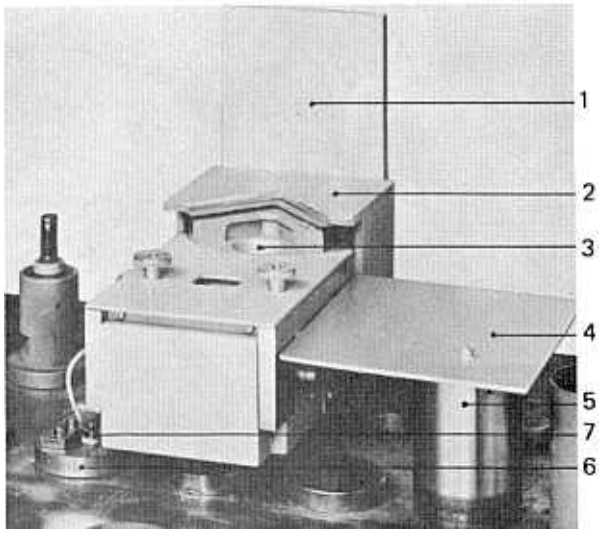


Fig. 3 Source complete with 4-way crucible

1. Deflection plate
2. Crucible cap
3. 4-way crucible
4. Screen for the cathode power supply
5. Screen for the high voltage feedthrough
6. High current feedthrough (anode)
7. Coil current feedthrough

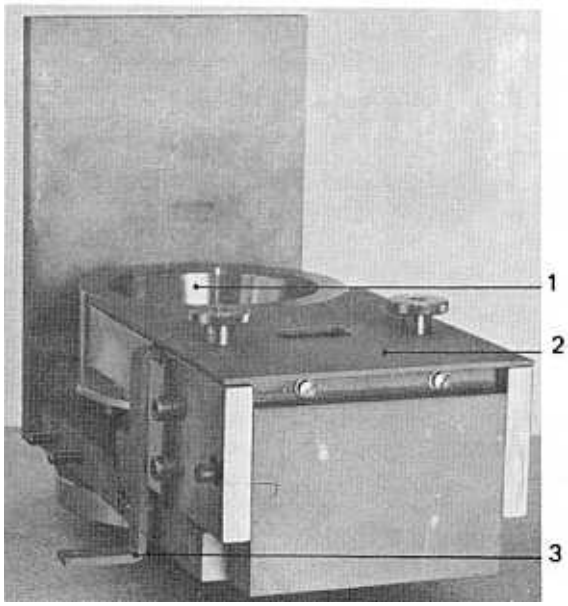


Fig. 4 Source with pot crucible

1. Pot crucible
2. Cu-mask
3. High current connection of the anode current.

h. Push-in the crucible lower section with the crucible assembled from above in downward direction (turn slightly to avoid damaging the various L-ring gaskets).

i. Tighten the crucible lower section with the knurled nut M10 and the intermediate pipe towards the ball bearing manually. (Crucible cannot be turned). Following this, reset the knurled nut by turning back half a rotation and secure with two set screws M5. The axial clearance of the crucible lower section in the gun must be approx. 0,3 ÷ 0,5 mm.

j. Screw the crucible cap (on 4-way crucible or oscillating crucible only).

k. Tighten the Cu-mask with two knurled nuts M5.

l. Optically, the high voltage supply lines must be adequately screened from the high voltage feedthrough up to the source. The pertinent screening plate (fig. 3, item 4.), included in the source, must be cut accurately after installation to avoid frequent arcing during evaporation.

m. If enough space is available, the deflection plate (fig. 3, item 1) may be bent backwards by 90° to crucible level. In this way, the cleaning periods can be extended considerably if larger batches of material are evaporated (pot crucible).

n. A shutter on top of the source must always be grounded. If the shutter has been insulated by means of ceramic parts, this ground line has to be provided between the shutter plate and the evaporation system (naked metal wire, Cu, Al, Ni).

### 1.1.2. Cooling water connection

Providing for the water lines:

a. From the water valve outlet (currentless, open) to the water inlet of the source (refer to fig. 2, item 4).

b. From the water outlet of the source (refer to fig. 2, item 3) to the inlet of the water flow control switch (note direction of flow).

c. From the outlet of the water flow control switch to the water outlet (no pressure).

d. From the water supply to the inlet of the water valve.

e. From the inlet of the water flow control switch (mind the direction of flow!) to the WATER OUT connection on the rear panel of the rack cabinet of the EHV 110 A.

f. From the outlet of the water flow control switch to the water outlet (no pressure).

g. From the water supply to the WATER IN connection on the rear panel of the rack cabinet.

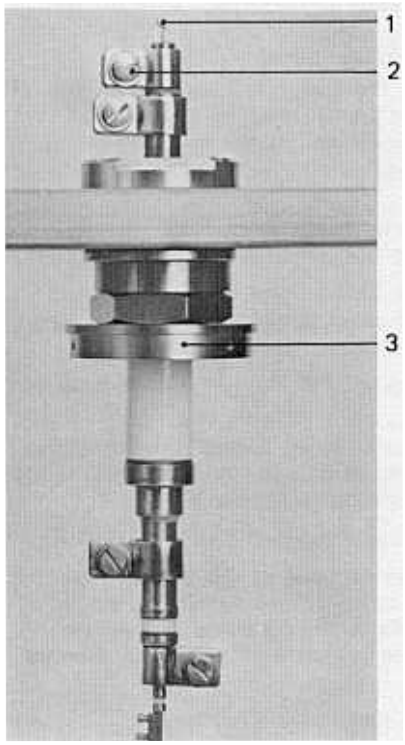


Fig. 5 High voltage feedthrough

1. Wehnelt connection
2. Heater current connection
3. Protection tube holding plate

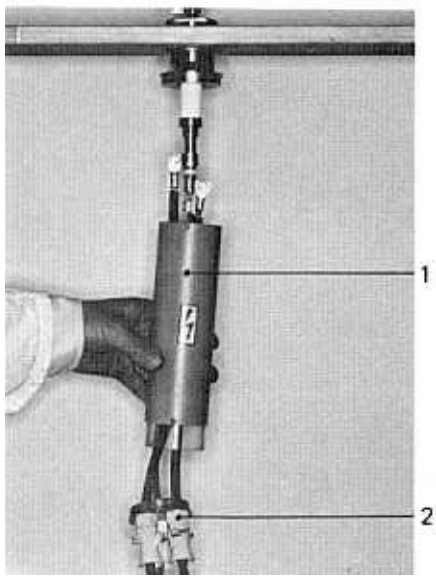


Fig. 6

1. Protection tube (with the insulation tube pushed into position)
2. Cable union plate

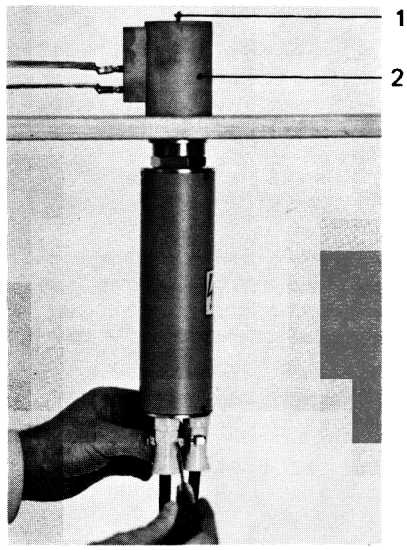


Fig. 7

1. Holder of the screen for the cathode power supply
2. Protection cover for the high voltage feedthrough

**1.2 Mounting the high voltage feedthrough**

a. If the high voltage feedthrough has not been completely dismantled, the following components must be removed: the protection tube, insulation tube, nut (M30 x 1.5) and connection plate to which the external cable is attached.

b. Thread in the high current cable (white) as well as the Wehnelt cable (red) through the pertinent cable union.

c. Fit the feedthrough from avove (be sure not do damage the seal) and secure in place with the nut and washer (M30 x 1.5).
Push up insulation tube.

d. Screw the protection tube holding plate with thread M30 x 1.5 on the feedthrough.

e. Push the insulation tube and the protection tube over the high current and Wehnelt cable.

f. Screw the cable shoes of the high current cable to the appropriate clips on the feedthrough.

g. Connect the Wehnelt cable.

h. Push up the insulation tube and the protection tube to the protection tube holding plate and secure the protection tube with three M3 countersunk screws.

i Push up the cable union plate and screw it to the protection tube by means of three M3 countersunk screws.

j. Tighten the cable union so that the high current and Wehnelt cables are stress-free.

**1.3. Mounting the anode current feedthrough and the anode current transformer** (low voltage feedthrough)

The high current feedthrough (fig. 3, item 6) acts as a current supply for the upper section of the anode (X-sweep). The feedthrough must therefore be electrically insulated from the coating unit base plate by means of two insulating plates, Items 118 and 119 of the spare parts list BB 800 041 E/6 and an insulating tube. If the underside of the coating unit base plate is covered with an insulating protective film (anodized or brushed on), a ground line must be connected from the gun feedthrough to the fixed angle of the high current transformer.
The connection from the feedthrough to the anode is made with the installation material furnished in accordance

with the lay-out of the gun and high current feedthrough. The coil current feedthrough is mounted in the high current feedthrough (Fig. 3, Item 6).

a. The anodized Al-high current feedthrough must be inserted through the base plate (32,5 mm diam.) from above and secured with the nut (M30 x 1,5) simultaneously with the attachment of the angle and insulation plate.

b. The nickel-plated copper angle is secured with the nut (M20 x 1,5).

c. Attach the high current transformer to the angle item 142 of the spare parts list BB 800 041 E/6 so that the high current contact can be made. In this step, the Cu-strip must be clamped between the Al-angle and the transformer.

d. Make the high current contact using the screw (M8), nut and washer.

f. Connect the primary line to the inlet with 240 V. If the sweep amplitude is too small, or it becomes too small after an extended operating period, the 220 V connection may be used. A change-over may also be made in the control unit EKS on the variable transformer from connection 240 V to the connection of 220 V!

### 1.4. Installation of the heater current power supply EHS

#### 1.4.1. EHS 110

a. Mount the terminal box underneath the gun and connect the appropriate control cable to socket SOURCE 1 – J1 of the EHV 110 A.

b. The EHS 110 is to be mounted into the frame of the coating unit, underneath the electron beam gun, and fastened with 4 screws at the feet of the filament current transformer.

The doors of the system frame must be provided with a lock. The doors of the system may only be opened for service purposes by a qualified electrician. Interlock switches on the frame doors do not qualify as safety elements. Before installing the EHS it must be assured, therefore, that the master switch is turned off or that the mains plug has been pulled.

c. Loosen the 4 fastening screws for the red cover hood and lift the hood about 10 cm.

d. Connect the high cable:

Inner conductor to the centre tapping (secondary) of the filament current transformer T1 (screw M5); outer conductor (sheathing) to the earth screw (Fig. 3, item 3 of the operating instructions BB 800 062 BE).

e. Lower the hood again and fasten it with the 4 screws.

f. Fit the angle with traction relief for the high voltage cable to the bottom of the stand frame.

g. Carefully fasten the return conductor (16 mm$^2$, black) which is parallel to the high voltage cable to the base plate of the coating chamber (near the gun).

h. Remove the cable guard from the red cover hood.

i. Pass the two high voltage cables and the Wehnelt cable through the rubber cuffs and the screw connections and plug them in.

j. Re-tighten the cable guard (traction relief) (mind the rubber cuffs!)

k. Connect the primary terminals of the two transformers in the terminal box below the gun (the connections inside the EHS were made in the factory). Make sure to follow the correct connection diagram e.g. S 5219 a.

#### 1.4.2. EHS 111

a. Mount the terminal box underneath the gun and connect the appropriate control cable to socket SOURCE 1 – J1 of the EHV 110 A.

b. The EHS 111 has to be mounted into the frame of the coating unit, beneath the electron beam gun.

The doors of the system frame must be provided with a lock. The doors of the system may only be opened for service purposes by a qualified electrician. Interlock switches on the frame doors do not qualify as safety elements. Before installing the EHS must be assured, therefore, that the master switch is turned off or that the mains plug has been pulled.

c. Loosen 8 screws and remove the front panel.

d. Insert the high voltage cable without the return conductor (16 mm$^2$, black) through the cable connector on the metal housing.

e. Connect the high voltage cable:

Inner conductor to the centre tapping (secondary) of the filament current transformer T1 (screw M5); outer conductor (sheathing) to the earth screw (Fig. 3, item 3 of the operating instructions BB 800 062 BE).

f. Attach the angle with traction relief for the high voltage cable to the bottom of the metal box.

g. Carefully fasten the high voltage cable, which is parallel to the return conductor (16 mm$^2$), to the base plate of the coating chamber (near the gun).

h. Remove the cable guard for the two filament current cables.

i. Pass the two filament current cables through rubber cuffs and screw connectors and connect them to the filament current transformer (screw M5).

j. Re-tighten the cable guards (mind the rubber cuffs!).

k. Connect the primary winding of the filament current transformer in the terminal box below the gun (the connection inside the EHS was made in the factory). Make sure to follow the correct connection diagram, e.g. S 5219 a.

l. Remount the front panel with 8 screws.

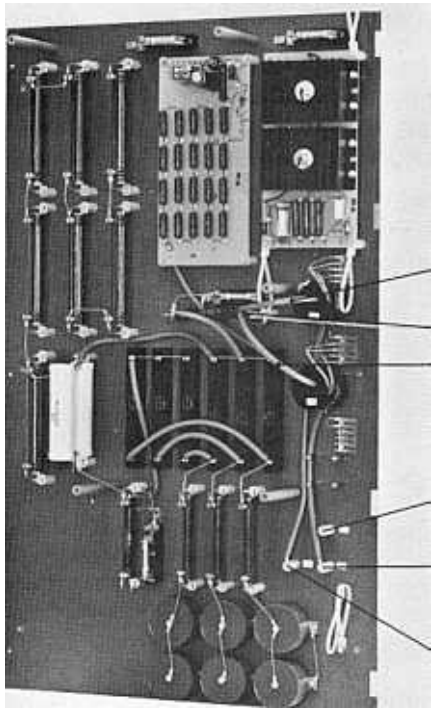


Fig. 8

### 1.4.3. Installation of the HV-cable from EHS to EHV 110 A

a. Insert the HV-cable and the return conductor (16 mm$^2$, black) through the cable connector on the rear panel of the EHV 110 A (HIGH VOLTAGE CABLES).

b. Fasten the external conductor of the HV-cable and the return conductor (16 mm$^2$, black) to 2 separate ground terminals on the Cu ground-bar.

c. The fully insulated center conductor of the HV-cable has to be attached to the high voltage outlet 1 on the high voltage plate (see Fig. 8, item 1).

### 1.5. Connections of the control and interlock circuits in the terminal box (refer to pertinent connection diagram, e.g. S 5219 a)

Before the connections are made, the limit switches, vacuum switches and valves must be mounted, if necessary.

a. Door switches of the cabinet doors

b. Disconnect plug of the coating unit or bell respectively.

c. Vacuum switch

d. Water flow control switch of the gun and the tube (EHV 110 A)

e. Water valve of the gun

f. Anode current transformer

g. Coil

### 1.6. Connections between the EHV 110 A and EKS 110 A

| Sockets on the EHV | | Sockets on the EKS 110 A |
|---|---|---|
| a. J3 | control cable | J7 |
| b. J4 | control cable | J6 |
| c. J5 | motor cable | J5 |

d. Transducer cable No. 1 into socket J8 on the EKS 110 A.

e. Control cable EKS No. 1 into socket J3 on the EKS 110 A.

f. Connect the internal connection cables of the cabinet with the sockets J1 and J2 of the EHV 110 A, U3.

g. Connect the blind plugs J7 and J10 with the EHV 110 A, U3.

h. The shorting plug "MULTI CHAMB. OPER." on the EHV 110, U3 must be removed.

i. When an external interlock circuit is used for monitoring the phases of the mains, the shorting plug "AUXIL." on the EHV 110, U3 must be removed.

### 1.7. Other connectors

a. If a substrate heater is used in the evaporation system, it must be interlocked via the socket J9 of the EKS 110 A.

b. If the gun control is triggered by an external rate measuring device for rate regulation (0 – 10 V, DC), the corresponding control voltage is supplied to the EKS 110 A via the socket J1.

c. Connect the rotary drive EDE 110 to the socket J2 on the EKS 110 A.

d. For manual operation: Connect the Coat-O-Matic blind plug to the socket J4 of the EKS 110 A and insert the blind plug-in printed circuit board in the interior of the EKS 110 A.

e. For automatic operation: Connect the control cable of the Coat-O-Matic or of the regulating unit ADU 100 to the socket J4 and insert the relay plate E5 (Coat-O-Maticprint) in the EKS 110 A.

All control and measuring lines must be conducted upwards through the ventilator slits or through the left opening of the connection plate of the EHV 110, U2 (see separate operating instructions EHV 110 A), on the rear of the rack cabinet.

### 1.8. Control measurement

Using an ohmmeter, the resistance between the ground terminal on the EHV 110 A and the evaporation system must be measured. The resistance must be smaller than 0.1 Ω.

### 1.9. Inserting the tube

When fastening the water connections, make sure the plastic hose is not twisted.

### 1.10. Power supply

a. The supply voltage must coincide with the data on the name plate of the EHV 110 A. If this is not the case, refer to the specifications for "Voltage change" BG 241 267 in the operating instructions of the EHV 110 A.

b. Preliminary fuse according to the data in the diagram of the EHV 110 A.

c. Remove the left (view from the rear) side panel of the rack cabinet.

d. Connect the power cable through the "POWER INPUT" connector to the mains terminals as specified in the diagram.

e. Provide stress-relief for the power cable (cable connector).

f. Affix the high voltage labels furnished to the doors of the evaporation system.

## 2. EVAPORATION EQUIPMENT (two sources in one evaporation system)

consisting of: one EHV 110 A, two EKS 110 A, two ETS 110, two EHS 110/111 and two ESQ 110.

### 2.1. Installation

Both sources, high voltage and anode current feedthroughs as well as the heater current power supply units EHS have to be mounted according to sections 1.1. to 1.4.

The control cable of the EHS No. 2 has to be connected to the socket SOURCE 2 – J2 on the rear panel of the EHV 110 A.

### 2.2. Installation of the HV cables from the EHS units to the EHV 110 A

a. Each of the HV-cables, together with its return conductor (16 mm$^2$, black) has to be conducted through a cable connector on the rear panel of the EHV 110 A (HIGH VOLTAGE CABLES).

b. The external conductors (sheathings) of the HV-cables and their return conductors (16 mm$^2$, black) must connected to 4 separate ground terminals on the Cu ground bar.

c. The fully insulated center conductor of the HV-cable of source 1 is to be connected to the high voltage outlet 1 (see Fig. 8, item 1); and the one of source 2 has to be conducted to the high voltage outlet 2 (see Fig. 8, item 2) on the high voltage plate.

### 2.3. Connections of the control and interlock circuits in the terminal box (refer to pertinent connection diagram, e.g. S 5219 a).

The interlock circuits for the second source (refer to section 1.5, items a – c) are bypassed in the terminal box for the second source.

The remaining connections are made in the terminal box as specified in section 1.5. (Single chamber operation).

### 2.4. Connections between the EHV 110 A and EKS 110 A

| Sockets on the EHV 110 A | Sockets on the EKS 110 A |
|---|---|
| a. J3 control cable | EKS 110 A, No. 1 J7 |
| b. J4 control cable | EKS 110 A, No. 1 J6 |
| c. J5 control cable | EKS 110 A, No. 1 J5 |
| d. J6 control cable | EKS 110 A, No. 2 J7 |
| e. J7 control cable | EKS 110 A, No. 2 J6 |
| f. J8 control cable | EKS 110 A, No. 2 J5 |

g. Transducer cable No. 1 into socket J8 on the EKS 110 A No. 1

h. Control cable EKS No. 1 into socket J3 on EKS 110 A No. 1

i. Transducer cable No. 2 into socket J8 on the EKS 110 A, No. 2

j. Control cable EKS No. 2 into socket J3 on the EKS 110 A, No. 2

k. Blind plug J10 into EHV 110 A

l. Shorting plug "MULTI CHAMB.OPER." on the EHV 110 A must be removed.

m. When an external interlock circuit is used for monitoring the phases of the mains, the shorting plug "AUXIL." on the EHV 110 A must be removed.

### 2.5. Other connectors

a. If a substrate heater is used in the evaporation system, must it be interlocked via the female sockets J9 of both EKS 110 A units (series connection).

b. If a gun control is triggered by an external rate measuring device for rate regulation (0 – 10 V, DC), the corresponding control voltage is supplied to the EKS 110 A, being part of the system, via the socket J1.

c. Connect both rotary drives EDE 110 to the sockets J2 of the pertinent EKS 110 A units.

d. For manual operation of the source: connect the Coat-O-Matic blind plug to the socket J4 of the EKS 110 A, being part of the source, and insert the blind plug-in printed circuit board in the interior of the EKS 110 A.

e. For automatic operation of a source: connect the control cable of the Coat-O-Matic or of the Automatic Deposition unit ADU 100 to the socket J4 of the EKS 110 A, being part of the source, and insert the relay plate E5 – Coat-O-Maticprint.

### 2.6. Control measurement

Refer to section 1.8.

### 2.7. Mounting the tube

Refer to section 1.9.

### 2.8. Power supply

Refer to section 1.10.

## 3. EVAPORATION EQUIPMENT (three sources in three evaporation systems)

consisting of: one EHV 110 A, three EKS 110 A, three ETS 110, three EHS 110/111, three ESQ 110 and one EHU 103.

The EHU 102 has to be connected carefully to the ground terminal of the EHV 110 A via a 10 $mm^2$ ground line at the ground terminal provided.

The EHU 103 has to be mounted directly above the mains distributor. Do not mount any other unit between mains distributor and EHU 103.

### 3.1. Installation

All sources, high voltage and anode current feedthroughs as well as the heater current power supply units EHS have to be mounted according to sections 1.1. to 1.4. The control cable of the EHS No. 2 has to be connected to the socket SOURCE 2 – J2 and SOURCE 3 – J3 on the rear panel of the EHV 110 A.

### 3.2. Installation of the HV-cables from the EHS units to the unit as well as to the EHU 103

a. Refer to section 2.2. a.

b. The external conductors (sheatings) of the HV-cables and their return conductors (16 $mm^2$, black) must connected to 6 separate ground terminals on the Cu-ground bar.

c. Mount the 3rd transducer, comprised in the consignment, and connect the control lines analogue to the other transducers to the terminal strip (see section 7, Trouble-shooting).

d. Disconnect the connection lines (see Fig. 8, Items 5 and 6) from the HV connection (see Fig. 8, Item 4) through the transducers to the HV-connections 1 and 2.

e. Mount the auxiliary instrument into the EHU 103 (see separate operating instructions EHU 103).

f. By means of the three special high voltage cables which are included in the EHU 103, the following connections are made:

   1. from the high voltage point, on the 50 Ω resistor (Fig. 8, item 6) to the common high voltage outlet HVO on the EHU 103.
   2. From the high voltage outlet HV1 on the EHU 103 through the transducer T5 to the high voltage connection 1 (Fig. 8, item 1). From the high voltage outlets HV2 and HV3, resp., on the EHU 103 through the transducers.T6 and T7, resp., to the high voltage connections 2 and 3, resp. (see Fig. 8, items 1.2 and 3).

g. Conduct the fully insulated center conductors of the HV-cables to the high voltage connectors and connect them to the corresponding sources (see Fig. 8, items 1,2 and 3).

h. Provide the HV-connections on the EHU 103 with plastic covers.

### 3.3. Connections between the EHU 103 and EKS 110 A

| Sockets on the EHU 103 | | Sockets on the EKS 110 A |
|---|---|---|
| a. J1 | control cable | EKS 110 A, No. 1, J6 |
| b. J2 | control cable | EKS 110 A, No. 2, J6 |
| c. J3 | control cable | EKS 110 A, No. 3, J6 |

For interlocks over the sockets J4, J5, J6 on the EHU 103, refer to the separate operating instructions EHU 103.

### 3.4. Connections between EHV 110 A and EKS 110 A

a. Provide all connections mentioned under section 2.4.a, c, d, f, g, h, i, and j.

| Sockets on EHV 110 A | | Sockets on EKS 110 A |
|---|---|---|
| b. J9 | control cable | EKS 110 A, No. 3, J7 |
| c. J11 | control cable | EKS 110 A, No. 3, J5 |

d. Transducer cable No. 3 into socket J8 on the EKS 110 A, No. 3

e. Control cable EKS No. 3 into socket J3 on the EKS 110 A, No. 3

f. Blind plugs J4, J7, and J10 into EHV 110 A

g. Insert shorting plug "MULTI CHAMB.OPER."

h. Refer to section 2.4. m.

### 3.5. Connections of the control and interlock circuits in the terminal boxes of all sources

All terminal boxes are to be connected, as described in section 1.5.

### 3.6. Other connectors

a. If a substrate heater is used in the evaporation system, this has to be interlocked via the socket J9 of the EKS 110 A being part of the system.

b. If a gun control is triggered by an external rate measuring device for rate regulation (0 – 10 V, DC), the corresponding control voltage is supplied to the EKS 110 A, being part of the system, via the socket 1.

c. Connect all rotary drivers EDE 110 to the sockets J2 of the pertinent EKS 110 A units.

d. For manual operation of a system: Connect the Coat-O-Matic blind plug to the socket J4 of the EKS 110 A, being part of the system, and insert the blind plug-in printed circuit in the interior of the EKS 110 A.

e. For automatic operation of a system: Connect the control cable of the Coat-O-Matic or of the Automatic Deposition unit ADU 100 to the socket J4 of the EKS 110 A, which is part of the system, and insert the relay plate E5 (Coat-O-Maticprint).

f. Make the ground line from EHV 110 A with a min. of 6 $mm^2$ Cu to the rack cabinet.

### 3.7. Control measurements with an ohmmeter

a. The resistance between the ground terminal of the EHV 110 A and the evaporation systems

b. between the ground terminal of the EHV 110 A and the EHU 103, as well as

c. between the rack cabinet and the evaporation system must be smaller than 0,1 Ω in each case.

### 3.8. Mounting the tube

refer to section 1.9.

### 3.9. Power supply

Refer to section 1.10.

## 4. INITIAL OPERATION (single chamber process)

(refer to section 1)

4.1. Switch on the power supply (the ground leakage circuit breaker and the automatic circuit breaker). The "POWER" lamp lights.

2. Turn on the cooling water for the high voltage tube. The "TUBE WATER" lamp on the EHV 110 A, U2 lights.

3. Turn on the cooling water for the ESQ 110 electron beam gun. The "GUN WATER" lamp on the EKS 110A.

4. Close the rack cabinet doors and the side panels. The "DOOR" lamp on the EHV 110 A lights. Check all safety switches (S5, S6, S7) by opening the rear door about 30°. The signal lamp must go out every time the rear door is opened.

5. With the shorting plug "AUXIL." inserted, the pilot lamp "AUXIL." on the EHV 110 A, U2 lights. If an interlocking contact has been connected (shorting plug pulled out), this interlock circuit must be checked.

6. Check the coil current on the EKS 110 A (approx. 0.7 A with the high voltage 6 kV acceleration voltage approx. 1.3 A with 10 kV acceleration voltage).

7. In order to test the function of the electron beam gun, it is advisable to place some copper in the crucible. Due to its low melting temperature, this material is not too bright during evaporation, allowing a simple spot control.

   After filling the pockets of the crucible, run the rotary drive through the various positions to test the rotary movement is functioning correctly (if too much material is charged, the crucible can be blocked).

8. The correct functioning of the monitoring switches of the first interlock circuit is indicated on the EKS 110 A by the three lamps "DOOR" (cabinet doors), "VAC" (vacuum switch) and "GUN WATER" (cooling water of the source).

9. Check the monitoring switches of the first safety circuit,

   a. open and close each cabinet door of the evaporation system. Each time the lamp "DOOR" on the EKS 110 A must go out and light again, (if switch is present)

   b. close the cabinet doors, pump down the system, the pilot lamp "VAC." must light at approx. 50 mbar Following this, the system must be vented. The lamp must go out.

10. Evacuate the system, pressure $< 5 \cdot 10^{-4}$ mbar.

11. Release the high voltage on the EKS 110 A and on the EHV 110 A by means of the key switch. The lamps HIGH VOLTAGE-OFF on the EHV 110 A and on the EKS 110 A will light.

12. The second interlock circuit acts on the release relay of the automatic circuit breaker F9. In the event that the connector K2 is still switched on (e.g. relay is still attracted), the primary voltage of the HV-transformer will be switched off by the automatic circuit breaker F9 when the second safety switch on the door of the coating unit or bell, respectively, is actuated. In this event, the automatic circuit breaker F9 will be dropped out over the release relay.

13. Switch on the high voltage on the EKS 110 A or on the EHV 110 A.

    Vent the system without emission current, but with the high voltage switched on. After the maximum current of approx. 900 mA has been indicated on the emission current meter of the EHV for approx. 1,5 sec., the high voltage must switch off automatically (time relay).

4.14. Pump down the system, pressure $< 5 \cdot 10^{-4}$ mbar, switch on the high voltage. Switch on the cathode heater (FILAMENT ON) and wait for the turn-on time (approx. 3 sec.) of the heater current at position "0" of the emission current potentiometer. Check the cathode heating current. When using the heater current power supply units EHS 110, a heater current of 25 A must be available and a heater current of 18 A on the EHS 111. (In case of a break down, refer to the operating instructions EKS 110 A).

15. When the second heating stage has been switched on, increase the emission current slowly to approx. 100 mA. (If a crucible control unit ETS is used, a possible blocking of the emission current after the crucible position has been obtained must be unlocked by resetting the emission current potentiometer "EMISSION CONTROL" at 0 position). Observe the spot.

16. If, at a coil current of 700 mA no spot in the crucible area is visible, the polarity of the coil must be reversed on the terminal strip 1J2 (in the terminal box underneath the gun).

    Underneath the potentiometer "BEAM POSITION", there are two adjustment potentiometers. 6 kV and 10 kV for changing the positions of the beam spot in the crucible (potentiometer "BEAM POSITION" in "O" position).

17. When the cathode is correctly mounted, an emission current of 700 mA can be obtained at a heater current of 40 – 45 A. For the adjustment it is advisable to enlarge the spot to approx. position "6" with the potentiometer AMPL. LAT in order to avoid a possibly contaminated evaporant splashing. If the heater current necessary to obtain 700 mA is greater than 50 A, the cathode must be shifted towards the anode (in steps of approx. 0,2 mm). If the heater current at 700 mA emission current is less than 40 A, the cathode must be moved in the opposite direction.

18. The correct Wehnelt voltage is set on the rotary switch of the EHS in such a way (need only be checked after changing the cathode) that at 10 kV acceleration voltage, an emission current of 700 mA can also be obtained at a heater current of 40 – 45 A.

19. Any smaller emission current can now be adjusted as a maximum value with the potentiometer "POWER" LIMIT" on the EKS 110 A. With simultaneous operation of two guns, it is essential to observe this setting (distribution of the total emission current of 1.35 A to all guns).

20. If the crucible is used, the permissible beam power will be $L_{max}$ = 12 kW, i.e. there will be a max. emission current of 1.1 A at 11 kV accelerating voltage.

    It may be advantageous to adjust the emission current meter on the EKS 110 A with the potentiometer R8 (see Fig. 5, Item 3 of the operating instructions of the EKS 110 A) in a way that an indication of 900 mA on the EKS 110 A results in an emission current of 1 A on the EHV 110 A, U2.

21 With a beam power of 10 kW, the optimum spot size will be approx. 1 $cm^2$ for aluminium. For this it will

be necessary to reduce the Wehnelt voltage to 200 V or perhaps 0 V on the EHS heater current supply unit.

4.22. The distance between the edge of the spot and the inner wall of the crucible has to be at least 15 mm. Further, during evaporation the crucible should always rotate continuously.

23. For all crucibles excepting the pot crucible, the maximum power is $L_{max}$ = 5.5 kW for the evaporation of aluminum.

The corresponding Wehnelt voltage is 250 V or 300 V.

24. High voltage test of the system under operating conditions. At a beam current of approx. 0,5 A all doors of the cabinet will be opened one after the other. Every time a door opens, the high voltage must switch of immediately. (as long as a switch is present on the frame)

25. Test of the crucible control units ETS

During the evaporation, a new position is selected on the ETS 110. As a result, the emission current is blocked (lamp EMISS. BLOCKED lights) and can be switched on in the new position only after the potentiometer EMISSION CONTROL is reset at 0.

## 5. INITIAL OPERATION WITH TWO SOURCES IN ONE EVAPORATION SYSTEM (refer to section 2).

5.1 The operation of the two sources is started as described in Section 4. The power limitation (POWER LIMIT) must be set on each EKS 110 A in such a way that the total beam current does not exceed a value of 1.35 A.

2. If the distance between the two sources is less than 50 mm, it will be noted that both magnetic fields are interfering with each other to a slight extent. For this reason it will be advisable to space the sources more than 50 mm apart.

## 6. INITIAL OPERATION WITH TWO SOURCES IN TWO EVAPORATION SYSTEMS (refer to section 3)

6.1. Check the ground connection on each source with the high voltage switched on.

2. Switch on the power supply (switch on the automatic circuit breaker and the ground leakage circuit breaker), the lamp "POWER" will light.

3. Turn on the cooling water for the electron beam gun ESQ 110 No. 1, lamp "GUN WATER" on the EKS 110 A, No. 1.

4. Turn on the cooling water for the high voltage tube, lamp "TUBE WATER" on the EHV 110 A, U2, lights.

6.5. With the rack cabinet doors and side walls closed, the lamp "AUXIL." on the EHV 110 A, U2 will light. In order to check this interlock circuit, the side walls and the rear door must now be opened slightly one after the other (approx. 30° opening angle) and the lamp "AUXIL" must go out each time.

6. With the shorting plug "AUXIL." inserted, the pilot lamp "AUXIL." on the EHV 110 A, U2 lights. If an interlocking contact has been connected (shorting plug pulled out), this interlock circuit must be checked.

7. Check the coil current on each EKS 110 A (approx. 0.7 A with 6 kV acceleration voltage, approx. 1.3 A with 10 kV acceleration high voltage).

8. In order to test the function of the electron beam gun, it is advisable to place some copper in the crucible. Due to its low melting temperature, this material is not too bright during evaporation allowing a simple spot control.

9. After filling the pockets of the crucible run the rotary drive through the various positions to test that the rotary movement is functioning correctly (if too much material is charged, the crucible can be blocked).

10. The correct functioning of the monitoring switches of the first interlock circuit is indicated for each evaporation system on the relevant EKS 110 A by the three lamps "DOOR" (cabinet doors),"VAC" (vacuum switch) and "GUN WATER" (cooling water of the source).

Check the monitoring switches of the first interlock circuit.

a. Open and close each cabinet door of the evaporation system No. 1. Each time the lamp "DOOR" on the EKS 110 A, No. 1 must go out again. (if switch is present)

b. Close the cabinet doors.

Pump down the system, the pilot lamp "VAC." must light at approx. 50 Torr. Following this, the system must be vented. The lamp must go out.

c. Evacuate the system, pressure $< 5 \cdot 10^{-4}$ mbar.

12. Release the high voltage on the EHV 110 A by means of the key switch. The lamp HIGH VOLTAGE-OFF on the EHV 110 A will light.

13. The second interlock circuit acts on the release relay of the automatic circuit breaker. In the event that the contactor K2 is still switched on (e.g. relay is still attracted), the primary voltage of the HV-transformer will be switched off by the automatic circuit breaker F9 when the second limit switch on the rear door of the EHV 108 is actuated. In this event, the automatic circuit breaker F9 will be dropped out over the release relay.

If this error occurs, or if the second interlock circuit is incorrectly wired, the high voltage cannot be switched on even though the lamps "HIGH VOLTAGE OFF" lights

14. Pump down all systems, pressure $< 5 \cdot 10^{-4}$ mbar.

15. Switch on the high voltage on the EHV 110 A VOLTAGE-ON).

16. Release the high voltage on the EKS 110 A, No. 1 by means of the key switch and switch on the high voltage (HV-ON).

17. Vent the system No. 1 without emission current, but with the high voltage switch on. After the maximum current of approx. 1.4 A has been indicated on the emission current meter of the EHV 110 A 0.6 sec., the high voltage must switch off automatically (time relay). If the vent valve is interlocked over the EHU 103, this test cannot be conducted. In this

event, the system can be vented only after the high voltage on the EKS 110 A of the relevant system has been switched off (third safety circuit).

6.18. Pump down the system No. 1 again, pressure $< 5 \cdot 10^{-4}$ mbar and switch on the high voltage on the EHV 110 A and on the EKS 110 A.

19. Switch on the cathode heater (FILAMENT ON) and wait for the turn-on time (approx. 3 sec.) of the heater current at position "0" of the emission current potentiometer.

20. Check the cathode heating current. When using the heater current power supply unit EHS 110, a current of 25 A must be available and a current of 18 A on the EHS 111.

21. When the second heating stage has been switched on, increase the emission current slowly to approx. 100 mA (if a crucible control unit ETS is used, a possible blocking of the emission current after the crucible position has been obtained must be unlocked by resetting the emission current potentiometer "EMISSION CONTROL" at 0 position). Observe the spot.

If at a coil current of 700 mA no spot in the crucible area is visible, the polarity of the coil must be reserved on the terminal strip 1J2 (in the terminal box underneath the gun).

Underneath the potentiometer "BEAM POSITION", two adjustment potentiometers are located with 6 kV and 10 kV, resp.

22. When the cathode is mounted correctly, an emission current of 700 mA can be obtained at a heater current of 40 – 45 A. For the adjustment it is advisable to enlarge the spot to approx. position "6" with the potentiometer AMPL. LAT in order to avoid a possibly contaminated evaporant splashing. If the heater current necessary to obtain 700 mA is greater than 50 A, the cathode must be shifted towards the anode (in steps of approx. 0,2 mm). If the heater current at 700 mA is less than 40 A, the cathode must be moved in the opposite direction.

23. The correct Wehnelt voltage is set on the rotary switch of the EHS in such a way (need only be checked after changing the cathode) that at 10 kV acceleration voltage, an emission current of 700 mA can also be obtained at a heater current of 40 – 45 A.

24. Any small emission current can now be adjusted as a maximum value with the potentiometer "POWER LIMIT" on the EKS 110 A, No. 1. With simultaneous operation of several guns, it is essential to observe this setting (distribution of the total emission current of 1.35 A to all guns).

25. If the pot crucible is used, the permissible beam power will be $L_{max}$ = 12 kW, i.e. there will be a max. emission current of 1.1 A at 11 kV accelerating voltage.

It may be advantageous to adjust the emission current meter on the EKS 110 A with the potentiometer R8 (see Fig. 5, item 3 of the operating instructions of the EKS 110 A) in a way that an indication of 900 mA on the EKS 110 A results in an emission current of 1 A on the EHV 110 A, U2.
With simultaneous operation of several guns it must be ensured that the emission current of 1.35 A is distributed to all guns.

26. With a beam power of 10 kW, the optimum spot size will be approx. 1 $cm^2$ for aluminium. For this it is necessary to reduce the Wehnelt voltage to 200 V or perhaps 0 V on the EHS heater current supply unit.

6.27. The distance between the edge of the spot and the inner wall of the crucible has to be at least 15 mm. Further, during evaporation the crucible should always rotate continuously.

28. For all crucibles excepting the pot crucible, the maximum power is $L_{max}$ = 5.5 kW for the evaporation of aluminum.

The corresponding Wehnelt voltage is 250 V or 300 V.

29. Test of the crucible unit ETS.

During the evaporation, a new position is selected on the ETS 110, No. 1. As a result, the emission current is blocked (lamp EMISS. BLOCKED lights) and can be switched on in the new position only after the potentiometer EMISSION CONTROL is reset at 0.

30. The second limit switch of the evaporator door of bell is switched automatically in series with the first interlock circuit in multi-chamber operation (by changing the cable connections on the EHU 103).

31 High voltage test of the system under operating conditions, when the system frame has been provided with a terminal switch. At a beam current of approx. 0,5 A (6 kV or 10 kV acceleration voltage) all doors of the cabinet will be opened one after the ofher. Every time a door opens, the high voltage on the source 1 must switch off (lamp SOURCE 1 on the EHU 103 and lamp HV-ON on the EKS 110 A, No 1 must go out). For each test the high voltage on the EKS 110 A, No. 1 must be on agin.

32. Switch off the high voltage on the EKS 110 A, No. 1 and vent the vacuum chamber. The high voltage on the EHV 110 A must remain in ON position, however. If the high voltage shuts off due to excess current, it will be mandatory to check the installation of the EHU 103.

33. Refer to sections 6.4., 6.8. – 6.11. and 6.32. on an analogous procedure to be followed for the other systems.

34. Adjust 10 kV or perhaps 11 kV on the EHV 110 A, U2.

## 7. TROUBLE SHOOTING

Under operating conditions, i.e. when the high voltage is switched on, there are large metallic surfaces at high voltage potential in the control cabinet EHV 110. Contact with these high voltage carrying components is fatal. For this reason, although the rear door has a safety switch, it may only be opened when the high voltage is switched off (the action of opening the door switches off the voltage).
It is only necessary to open the rear door for service or installation work, which may only be undertaken by suitably qualified personnel. The key should be kept by a properly trained electrician who is responsible for it.

When tracing faults, it may sometimes be necessary to make measurements with the power supply open. Measurements of this type or the re-adjustment of adjustment potentiometers may only be carried out by personnel with the necessary qualifications. In no circumstances may measurement connections be either made or disconnected whilst the high voltage is switched on, neither may the various measuring instruments be touched during measurement.

Measuring lines must always be laid so that they are a few centimeters away from the high voltage carrying components. For measurements on high voltage carrying parts, make sure that the measuring instrument is always placed outside the rack cabinet and the back side doors are closed.

Ensure that high voltage measurements are done only when two persons are present.

All safety elements must function correctly before the guns can be operated. A light will then show up in all the square white lamps on the EHV 110 A, U3 and on the EKS 110 A. If one safety device is not functioning correctly, the corresponding lamp and all the following indicating lamps will go out.

| Fault | Cause | Correction |
|---|---|---|
| High voltage ON is not operating (The OFF lamp does not light) (on the EHV 110 A, U3) | The automatic breaker HIGH VOLTAGE CIRCUIT is not switched on | Switch on the automatic breaker |
| | Break in the control circuit (signal lamps do not light) | Check the control circuit as to diagram |
| Automatic breaker F 9 switches off (high voltage off) (on the EHV 110 A, U2) | Short circuit in the high voltage transformer | Change the high voltage transformer. |
| | Break in 2nd interlock circuit | Trace the fault as to diagram and repair. |
| | Time relay K4 responds (step 1 remains on, relay K2 does not respond) | |
| High voltage switches off under load after a short time and can be switched on only after 30 sec. | Thermo relay switches off during turn-on time, due to overload. | |
| | Break in time relay K4 | Change time relay K4 |
| | Contactor K2 does not switch all | (see spare parts list) |
| Fuse F6 on the EHV 110 A is blown. | Water valve 1K1 for the gun is defective. | Change the coil or the water valve (see operating instructions of the watering plant). |
| High voltage cannot be adjusted to 6 kV (on the EHV 110 A, U2) | Water resistance (elec.) for tube cooling too low (R = 2 M Ohms at least) | Use clean water |
| | Z-diode on cathode bias unit E3 | Change Z-diode or p.c. board |
| Earth leakage circuit breaker F20 switches off, all safety circuit lights go out (on the EHV 110 A, U2). | Faulty insulation (earth contact) in control circuit 115 V, 97 V or in cathode heater circuit 220 V. | Repair insulation |
| High voltage not adjustable, remains at 11 kV (on the EHV 110 A, U2). | Output transistor on high voltage regulator E 1 defective (see next item) | Change the high voltage p.c. board, or replace transistor |
| Output transistor on high voltage regulator E 1 faulty (on the EHV 110 A, U2) | Arcing on the high voltage tube between anode and grid due to condensed water because of faulty or missing cap-type gasket | Dry the tube, mount or change the cap-type gasket. |

| Fault | Cause | Correction |
|---|---|---|
| Cathode heater current lamp FILAMENT ON does not light | The COAT-O-MATIC blind plug has not been connected to the EKS (J4) | Connect the blind plug |
| | The blind printed circuit connector (fig. 8, item 1) is missing (refer to operating instructions BB 800 064 BE) | Connect the blind printed circuit connector |
| | No coil current,or the coil current is set too low (< 0,4 A) (refer to operating instructions BB 800 064 BE) | Set the correct coil current on the adjustment potentiometer (alt. trimpot) (below BEAM POS.) |
| The coil current is not influenced by the adjustment potentiometer (on the EKS 110 A) | The input transistor on the coil circuit board E4 is defective | Exchange the printed circuit board or replace transistor |
| No coil current | The fuse F2 is burned out (refer to BB 800 064 BE) | Replace |
| | The coil connection is defective either outside or in the evaporation system | Make the contact |
| The coil current is instable | The transistor T7, BC 261 B at the input 4/6 on the coil circuit board E4 is defective (refer to BB 800 064 BE) | Replace the printed circuit board or the transistor |
| The coil current 2 A cannot be influenced | The transistor T4, BSX 46 – 16 on the coil circuit board E4 is defective | Replace the transistor or the printed circuit board |
| With a slight turn of the emission current potentiometer the heater current is over 70 A, no emission | The thyristor (fig. 3, item 1) is defective (refer to BB 800 064 BE) | Replace the thvristor or thvristor set |
| | The relay K1 on the printed circuit board E4 in the EHV 110 A is defective | Replace the relav |
| No heater current after depressing the push button FILAMENT ON (on the EKS 110 A) | Break in the cathode | Change the cathode |
| | Poor contact in the cathode heater circuit | Check the contact points on the HV-lead-in and EHS |
| | The MIN setting on the potentiometer R12 on the thyristor driver circuit board is incorrectly adjusted | Set the potentiometer in fig. 4, item 2 at the heating current acc. to operating instructions BB 800 064 BE |
| | The pulse-transformer on the thyristor driver circuit board is defective | Exchange the printed circuit board |
| After a slight turn of the emission current potentiometer the emission increases immediately to the set limit | The transducer outlet (J7, J8) has been confused (refer to BB 800 064 BE) | Connect the correct cable to the EKS socket J8 according to the source assigned |
| | The measuring outlets of the transducer have been confused | Change the polarity of the measuring outlets |
| | The potentiometer R1 is defective (fig. 1, item 5) | Replace the potentiometer (refer to BB 800 064 BE) |
| No emission with the high voltage switched on, the heater current remains at minimum setting | The toggle switch is at CONST. RATE (fig. 1, item 6) (refer to BB 800 064 BE) | Change |
| | POWER LIMIT (fig. 1, item 4) is set too low (refer to BB 800 064 BE) | Turn potentiometer clockwise |

| Fault | Cause | Correction |
|---|---|---|
| The instruction push-buttons on the ETS 110 are operative. The drive cannot be switched on by the ETS | The fuse F2 is defective (built in the interior of the unit) | Exchange fuse F2 (refer to BB 800 061 BE) |
| The crucible is destroyed by the contents of the crucible (alloy the crucible) | The spot is not in the center of the crucible | |
| | For the spot crucible the distance between the spot and the wall of the crucible is too small | Correct the position of the spot |
| | The beam power is too high<br>Cooling is inadequate | Reduce the beam power, If aluminium is evaporated in the 4-way crucible or in the oscillating or grooved type of crucible, then set "POWER LIMIT" on the EKS at 5,5 kW |
| Arcing at high evaporation rates | Poor screen of the high voltage installation | Screen carefullv |
| Arcing at increased pressure, pressure peaks | The evaporant degasses too strongly | Degas at reduced pressure |
| The evaporant splashes too much | The electron beam power density is too high | Sweep or reduce the power |
| | The crucible is contaminated (e.g. from material previously evaporated) | Clean the crucible (e.g. sand-blast) |
| The crucible movement is jammed | Material splashes on the crucible/ mask | Clean |
| | Knurled nut on the crucible lower section (fig. 9, item 7) is too tight (refer to BB 800 059 BE) | Set the clearance with the knurled nut at approx. 0,3 to 0,5 mm and secure with the two M5 screws |
| The pressure rises if the rotation is switched on or off | The L-ring gasket H 25 – 14 25/38 x 6,5 (fig. 6, item 2) under the bronze flange leaks | Replace the L-ring gasket |
| The pressure rises if the cooling water is turned on | The O-ring 80 x 4 (item 18 of the spare parts list BB 800 041 E/1) leaks | |
| | Tapper of L-ring gasket too small (refer to section 4.1. BB 800 059 BE) | Machine the Cr/Ni flange by turning down 0,2 mm |
| The pressure rises if the cooling water is turned off | The L-ring gasket H25 –1425 / 38 x 6,5 (fig. 6, item 2) under the bronze flange leaks (refer to BB 800 059 BD) | Replace the L-ring gasket |
| No spot in the crucible though the high voltage has been turned on and the coil current read-out is correct J = approx. 1,6 A | Incorrect polarity of the coil | Interchange the coil connection on terminal strip underneath the coating unit with ground connection. |
| The spot is too large | The cathode is pushed too far in the direction of the anode | Move the cathode back (use a gauge) |
| | No Wehnelt voltage | Check the contact EHS to Wehnelt shutter |
| Irregular movement of the spot in the crucible | Electrostatic charge of the shutter above the source | Ground the shutter plate with a naked metal wire. |

| Fault | Cause | Correction |
|---|---|---|
| High voltage arcing when pressure in the vac. chamber is $p < 5 \times 10^{-5}$ mbar | High voltage feedthrough is contaminated | Remove connections from high voltage feedthrough to the gun and switch on the high voltage. If arcing continues, dismantle and clean the high voltage feedthrough |
| | Flat insulator is contaminated | Clean the insulator |
| | High voltage installation in the vac, chamber is faulty (high voltage carrying components too close to earthed surfaces) | Correct the installation |