Electron gun control EKS 110 A

Products of BALZERS AG, Balzers

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1. APPLICATION

Whilst the EHV, High Voltage Supply, provides the regulated high voltage for the evaporation source, the EKS 110 A, Electron Gun Control Unit, is used as power supply for the cathode (to control the electron beam output), as control for the beam spot on the evaporant, and as power supply for the crucible drive motor. The ETS, Crucible Control Unit, for various automatic movements of the crucible, can be mounted into the EKS 110 A as a plug-in module.

2. TECHNICAL DATA

2.1. Dimensions

Width: 483 mm
Height: 221.5 mm
Depth: 530 mm

2.2. Electrical connection

The electric power is fed over the respective EHV, High Voltage Supply Unit. See the separate operating instructions and the block diagram.

3. DESCRIPTION

3.1. The front panel contains:

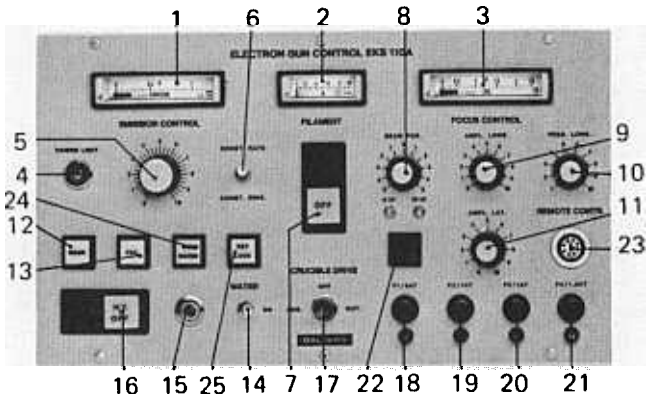

Fig. 1 Front panel EKS 110 A

1. Instrument for emission current MJ1 (emission current via the transducer T5 and the measurement amplifier A 1)
2. Instrument for the cathode heater current MJ2
3. Instrument for the coil current MJ3
4. Emission current limitation (POWER LIMIT) R 2
5. Emission current potentiometer R 1
6. Toggle switch with 2 positions, S 6
   a. CONST. RATE, for use when the evaporisation rate is stabilised via film thickness measuring instrument and a rate-meter.
   b. CONST. EMIS., used without rate regulation
7. Cathode heater ON/OFF (FILAMENT ON/OFF) S 1/ S 2
8. Spot positioning (BEAM POSITION) with adjustment potentiometers R 6 and R 7 below it for adjusting the beam position at 6 kV or 10 kV operating voltage, resp.
9. Sweep Y-direction (APML. LONG) R 4
10. Frequency for Y-direction sweep (FREQU. LONG) R 5
11. Sweep X-direction (AMPL. LAT.) T 4
12. Signal lamp for coating unit door, vacuum bell etc. (DOOR) LA 1
13. Signal lamp, vacuum (VAC.) LA 2
14. Toggle switch cooling water for the gun (GUN WATER)
15. Key switch for the high voltage (KEYLOCK)
16. High voltage ON/OFF (HIGH VOLT.) S 3/S 4 ON/ OFF
17. Crucible drive. Toggle switch with 3 positions:
    left: Crucible rotation towards the left (switch position with release) (anti-clockwise)
    centre: The crucible does not rotate, the crucible control ETS 110 can be operated normally
    right: Crucible rotation towards the right (clockwise) (permanent contact).
18. Fuse F 1 cathode heater circuit
19. Fuse F 2 emission current regulation and power supply to the coil
20. Fuse F 3 sweep X-direction
21. Fuse F 4 power supply to the motor (crucible drive)
22. Signal lamp automatic control
23. Receptacle for remote control EFS
24. Signal lamp for gun cooling water (GUN WATER)
25. Signal lamp for high voltage (KEYLOCK) LA 3

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3.2. The rear panel contains:

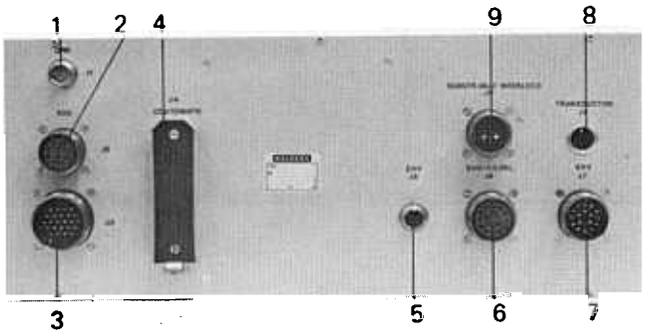


Fig. 2 Rear panel EKS 110 A

1. J 1 Connection for automatic rate regulation 0 - 10 V.
2. J 2 Crucible drive EDE
3. J 3
4. J 4
5. J 5
6. J 6
7. J 7
8. J 8
9. J 9

refer to the separate operating instructions "Installation example and block diagram".

3.3. The EKS 110 A contains the following components:

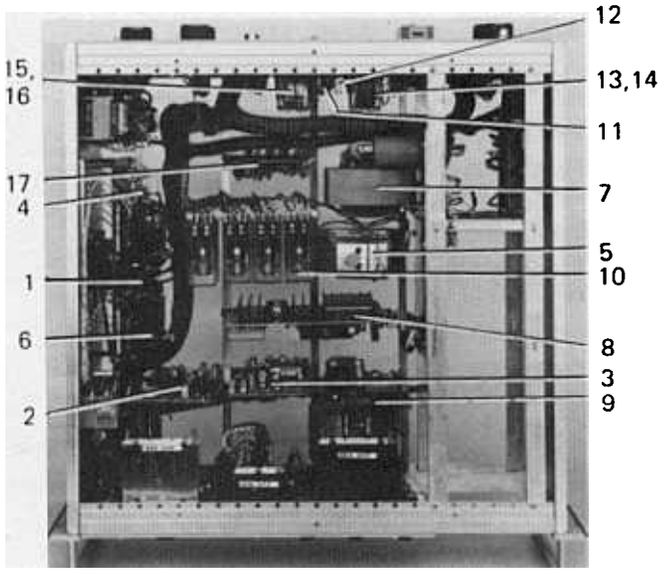


Fig. 3

Cathode heater current circuit, comprising:

1. Thyristor set
2. Thyristor drive printed circuit (see Fig. 4)
3. Measurement and control amplifier A 1 (see Fig. 5)
4. Series resistor R 1, 2, for switching on the cathode heater current in stepped switching.
5. Time relay K 13 for stepped switching of the cathode heater current (setting time, approx. 3 sec).
6. Rectifier D 3 for heater current measurement and potentiometer R 6 for calibrating the heater current measuring instrument MJ 2

Power supply to the coil, comprising:

7. Power supply transformer T 3 for the current stabilised coil printed circuit E 4
8. Coil printed circuit E 4 (see Fig. 7).
9. Sweep printed circuit E 3 (see Fig. 6)
10. Relay K 11 for monitoring the current of the power supply
11. Adjustment potentiometer R 11 for monitoring the current supply to the coil (on E 1)
12. Relay plate E 1
13. Relay K 3, Coat-O-Matic power supply failure
14. Relay K 4, Change-over to remote control of the emission current
15. Relay K 5, Change-over to remote control BEM. POS. and crucible drive
16. Relay K 6, Change-over to remote control FILAMENT OFF
17. Relay plate E 5 COAT-O-MATIC (see Fig. 8, item 2)

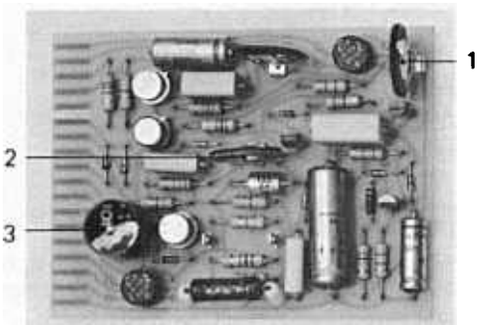


Fig. 4 Thyristor driver

1. Current limitation (current converter)
2. Minimum current (cathode pre-heating
3. Impulse transformer

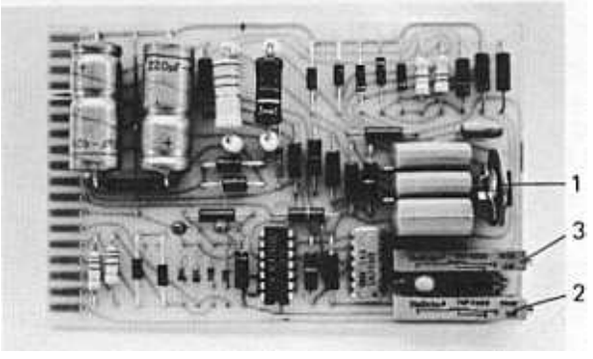


Fig. 5 Measurement and control amplifier A 1

1. Emission current damping
2. Amplification
3. Zero point emission current on the instrument

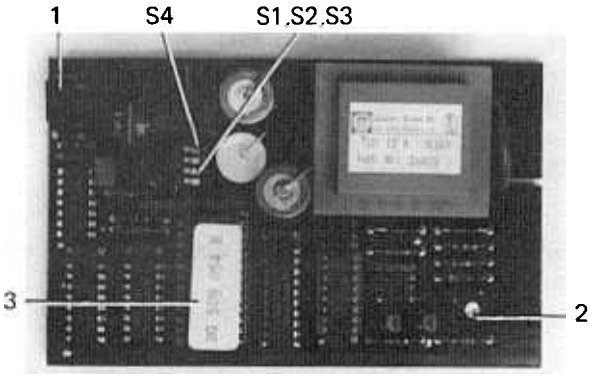


Fig. 6 Sweep printed circuit E 3

S1, S2, S3	Selection of the deflection curve shape
S4	Selection of the sweep speed
1, 2	Potentiometers R4 and R12
3	Program memory

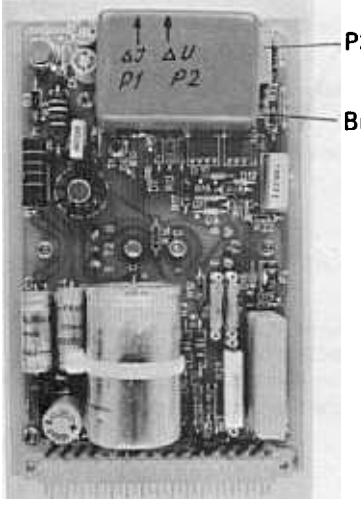


Fig. 7 Coil printed circuit E 4

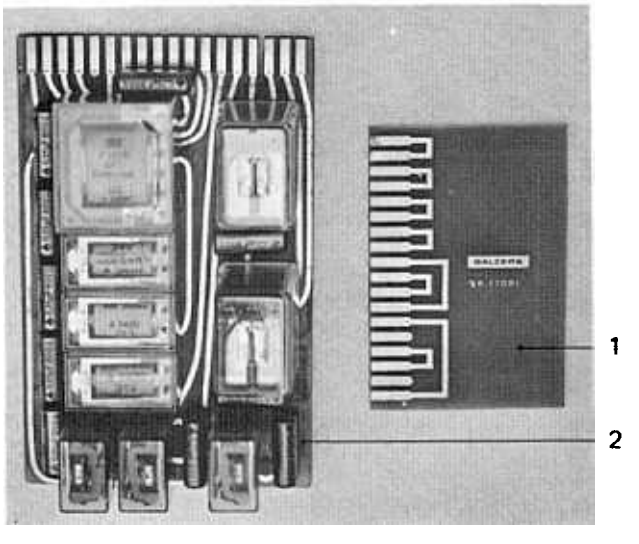


Fig. 8

1.	Blind plug	COAT-O-MATIC
2.	Relay plate E 5 (S 5221)	COAT-O-MATIC

4. FUNCTION

When the cooling water for the gun is switched on and the necessary throughput is signalled by the water flow control, the heater current (FILAMENT ON) can be switched on. This heater current is interlocked by the relay K 11 of the coil monitor. This means that the heater current is switched off if the current supply to the coil falls below a minimum value (0.4 A) set on the potentiometer R 11. When the high voltage is switched on, a control signal is transmitted by the control amplifier A 1 (Fig. 5) via the EHV, to the thyristor driver printed circuit. By this cathode overheating is avoided if the high voltage supply fails. The cathode heater is switched on in two stages by pressing the push-button FILAMENT ON (time relay K approx. sec.). Hence, to a large extent, the cathode can be protected from distortion.

If the EHV 110 A, high voltage supply, is used, the beam spot can be positioned accurately with the two potentiometers (6 kV and 10 kV) below the "BEAM POSITION" knob, for both high voltage values 6 kV and 10 kV. If another high voltage supply like EHV 108 is used, balancing will be necessary when the high voltage is switched from 10 kV to 6 kV (see the separate operating instructions for EHV 108). Beam spot positioning is then accomplished only with the 10 kV potentiometer.

The AMPL.LONG and FREQUENCY potentiometers belong to sweep pc board E3. From it the deflection function set on the AMPL.LONG (R4) potentiometer is conducted over the potentiometer's middle pick-up to the current programming path of the coil power supply E4.

The a.c. voltage 0 - 220 V from the variable transformer T 4 is connected to the high current transformer of the evaporation gun, via the rotary knob AMPL. LAT. The secondary winding of this high current transformer produces the anode current necessary for beam sweep (lateral).

With regard to the Wehnelt voltage feed for the cathode when the coating plant is open, it is essential to ensure the that the Wehnelt voltage is not connected to the operational evaporation gun (cathode change). For this reason, the Wehnelt voltage is interlocked on the primary side via the 'VAC'. signal (output at plug J 7 contact A).

4.1. Adjusting the cathode heating current

(see Fig. 4., thyristor driver)

The cathode heating current is adjusted with the potentiometer R 12 (Fig. 4, item 2), the high voltage being switched off. With the cathode heating current units EHS 110 and EHS 110 U, it will be approx. 25 A, with the EHS 111 it will be approx. 18 A.

With the high voltage on the EHV 110 A (6 kV) switched on, the cathode heating current is adjusted with the potentiometer R 7 (Fig. 4, item 1) so that with an emission current of 700 mA or more there will be less than 60 A.

With the EHV 108, the limitation of the cathode heating current will only be possible if the cathode inputs between high voltage lead-in and cathode block are shorted.

Adjusting: Switch-on the high voltage and turn on the emission current slowly with the "EMISSION CONTROL" potentiometer (because the cathode heating current rises quickly). Then, adjust the cathode heating current to 65 A with the potentiometer R 7 (Fig. 4, item 1).

4.2. Adjusting the emission current
(see Fig. 5 measuring and control amplifier A 1)

4.2.1. Damping the emission current control circuit, with "ERROR VOLTAGE" (signal on an external control unit) switched off.

a. Adjust the emission current to approx. 500 mA; toggle switch in "CONST. EMISS." position

b. Set toggle switch S 6 (Fig. 1, item 6) to "CONST. RATE" position

c. Switch back the toggle switch S 6 to "CONST. EMISS." position

The emission current should now rise to 500 mA without overshooting; otherwise the damping must be increased with the potentiometer R 9 (Fig. 5, item 1)

4.2.2. Amplifying the emission current control circuit.

Adjust the emission current to 500 mA with the "EMISSION CONTROL" potentiometer (Fig. 1, item 5). Then tune the emission current with the potentiometer R 6 (Fig. 5, item 2) until the EHV, high voltage supply, also reads a current of 500 mA (calibrating the emission current control circuit).

4.2.3. Zero adjustment

Without the high voltage, the emission current meter MJ 1 on the EKS 110 A should read about 1/2 to 1 scale division. Adjust this value with the potentiometer R 8 (Fig. 5, item 3).

4.3. Coil printed circuit E 4

Potentiometer P 1, for adjusting the current programming resistance of 1.8 kΩ/V

Potentiometer P 2, for adjusting the voltage programming resistance of 1 kΩ/V

Potentiometer P 3, for adjusting the voltage

Bridge Br 3; open in case of current programming (normally in EKS 110 A)

4.3.1. Pin bar connection

Pins:

12/-14/15, Main voltage, min 30 V / 2.5 A a.c.

26/27 - 28/29 = Auxilliary voltage, approx. 40 V / 100 mA a.c.

4/4 - 6/7 = Connections for current programming

2/3 30/31 = Connections for voltage programming

8/9/10/11 = Terminal, plus voltage

24/25 = Sensitive line plus

18/19/20/21 = Terminal, minus voltage

30/31 = Sensitive line minus

The charts are factory adjusted to 30 V. Current regulation starts at 2.1 A (3.6 k)

4.4 Sweep pc board E3

(see Fig. 6)

The control signal for the beam deflection coil current supply comes from a digital memory (EPROM) and is converted by a D/A converter. By varying the positions of switches S1, S2, and S3 different curves can be recalled from the digital memory.

Adjustment:

- Selection of the sweep speed with S4 ON = 1 + 10 s.
  S4 OFF = 0.1 + 1 s
- Selection of the desired deflection curve using S1, S2 and S3 (refer to enclosed PROGRAM TABLE)
- Potentiometers R4 and R12 are adjusted at the factory and must not be changed

4.5. Controlling the EKS 110 A with the EFS, remote control unit

When the EFS, remote control unit, is used, the emission current interlock will remain inactive for changing the crucible position, i.e. the emission current is not switched-off automatically for selecting another crucible position.

5. START-UP

See the separate installing and starting examples, e.g. BB 800 066 BE

If none of the separate operating instructions corresponds with the delivered system, follow the instructions given in the special instructions for each unit.

6. TROUBLESHOOTING

Fault	Cause	Correction
Cathode heater current lamp FILAMENT OFF does not light	COAT-O-MATIC blind plug is not plugged in to the EKS (J4)	Insert the plug
	The blind plug-in printed circuit (Fig. 8 No. 1) is missing	Plug-in the blind printed circuit board
	No coil current, or adjusted coil current is too low (< 0.4 A).	Adjust the coil current with tuning potentiometer (below BEAM pos.)
No coil current	Fuse F 2 is burnt out	Replace
	Coil connection is faulty, either outside or in the coating unit	Make the contact
The coil current is not influenced by the tuning potentiometer	Input transistor on coil circuit board is defective	Replace transistor, or change board
Coil current is instable	Transistor T 7 BC 261 B at the input 4/6 on coil circuit board faulty	Replace transistor, or change boar

No heater current after pressing the push-button FILAMENT ON	MIN. setting on the potentiometer R 12 on Thyristor driver printed circuit is incorrect	Set the potentiometer (in Fig. 4 No. 2) at pre-heating current acc. to paragr. 4.1
	The pulse transformer on the thyristor driver printed circuit is faulty	Change the driver printed circuit board
Coil current 2A cannot be influenced	Transistor T 4, BSX 46 - 16 on coil pc-board E 4 is faulty.	Change transistor or pc-board
HV-OFF lamp does not light, high voltage can't be switched on	2nd safety circuit is faulty.	Check 2nd safety circuit as to schematic, repair fault
With a slight turn of the emission current potentiometer the heater current is over 70 A, no emission	Thyristor (Fig. 3, item 1) is faulty	Change the thyristor or thyristor set
After slightly turning the emission current potentiometer the emission rises immediately to the limit.	Transducer cable is wrongly connected. Potentiometer EMISSION R 1 is faulty (Fig. 1, item 5)	Insert the correct cable into EKS (socket J8) Change the potentiometer
The high voltage is on, there is no emission, the heater current remains at minimum setting	Toggle switch at CONST. RATE (Fig. 1, item 6)	Switch over
	POWER LIMIT (Fig. 1, item 4) is too low	Adjust the potentiometer clockwise

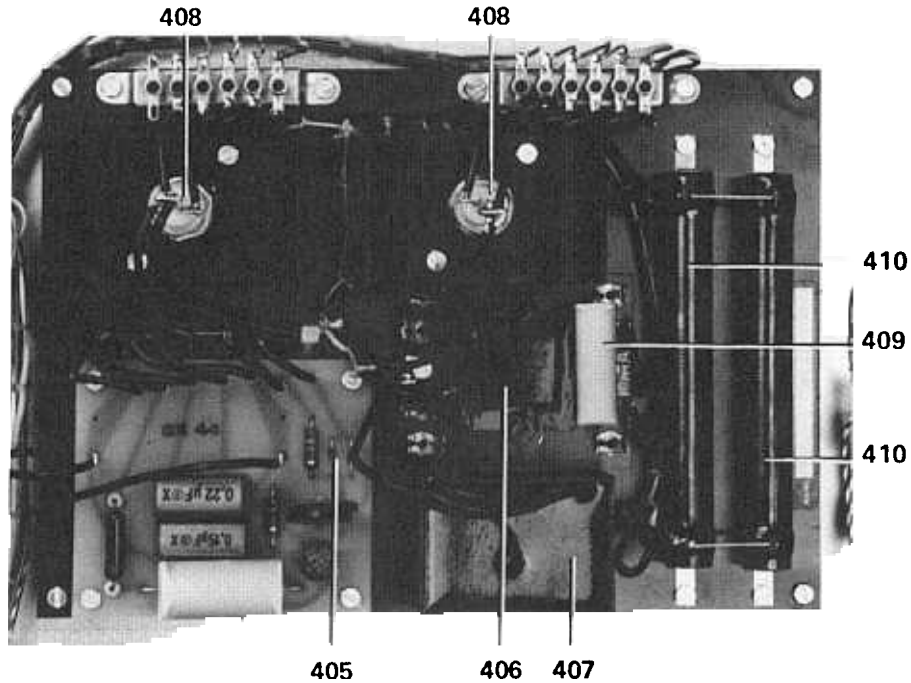
7. SPARE PARTS

Please order your spare parts according to the enclosed spare parts list.

Always state type and serial number as indicated on the name plate of the unit.

Order example:

1 potentiometer, 100 ohms, 0.25 W, Code No.
B 4870 210 LA as to spare parts list BB 800 041 E / item 352



A. Calibrating the EKS 110 A to emission current

(See the diagrams: for EKS 110 A:
BG 005 261-S, BG 005 262-S (formerly S 5206 and S 5207 or S 5235 and S 5236 resp.)
for the emission current of the measuring and regulating amplifier: S 5220).

If an EKS 110 A is installed later (e.g. subsequent to delivery or exchange), renewed calibration of the unit as to emission current measurement and of the high voltage supply (EHV 110, EHV 110 A, EHV 108) will be necessary.

Reason: The operating curve of the transducer which is used for measuring the emission current and which is always integrated into the high voltage supply, reveals considerable scattering.

Calibration procedure

Preparations: The EKS 110 A is readily connected; evaporation source and high voltage supply are ready for operation; main switch is "On".

1. **Adjusting the ZERO point** on the "EMISSION" meter of the EKS 110 A (see diagram S 5220):
   Turn the trimmpot R8 (minimum) on the measuring and regulating amplifier (see operating instructions EKS 110 A, Fig. 5, item 2) until the indicator display half a scale division positiv.
2. **Adjusting the operation current:**
   2.1. Set the "EMISSION CONTROL" potentiometer of the EKS 110 A to zero.
   2.2. Switch on the HIGH VOLTAGE and FILAMENT; set the beam to "Sweep".
   2.3. Adjust the emission current on the "EMISSION CONTROL" potentiometer to 0.8 A; check on the "EMISSION" meter of the EKS 110 A. (If there is a EHV 108 high voltage supply, adjust 0.5 A).
   2.4. The "EMISSION" meter of the **high voltage control unit** will now indicate a value different from that displayed on the meter of the EKS 110 A. With the trimmpot R6 (max.) on the measuring and regulating amplifier this value can now be balanced with the value indicated on the EKS 110 A.

B. Calibration of the EKS 110 A in conjunction with the EHS 111, heating current supply

In conjunction with the EHS 110, the "FILAMENT" base current for the EKS 110 A will be standard adjusted at the factory to about 25 A; the emission current being null. In conjunction with the EHS 111, however, the "FILAMENT" base current for the EHS 110 A has to be decreased.

Procedure:

1. Adjust the "EMISSION CONTROL" potentiometer for "0" scale divisions.
2. Switch-on the "FILAMENT". Adjust the base current on the "FILAMENT" meter for about 18 A with the trimmpot "R 12" (diagram BG 522 228 AS) on the "thyristor driver" board (see the operating instructions for EKS 110 A, Fig. 4, item 2).
3. Switch-on the "HIGH VOLTAGE". Slowly adjust the "EMISSION CONTROL"potentiometer from "0" to "2" scale divisions; this produces the emission current. Make sure the beam spot in the crucible is in corrrect position.
4. Reduce the emission current to approx. 50 mA with the trimmpot "R 12" on the "thyristor driver" board (1 scale division on the "EMISSION" meter). The "FILAMENT" meter should now read about 18 A.
5. Switch-off "HIGH VOLTAGE" and "FILAMENT". Adjust the "EMISSION CONTROL" potentiometer back to "0".

All calibration adjustments described above are made at the factory if the EHS is part of a complete coating unit. If the EHS 111 is delivered as a single unit together with other gun controls, this adjustment has to be carried out at the customer's premises.