Electron beam gun ESQ 110

A product of BALZERS AG, Balzers

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Warning — High voltage

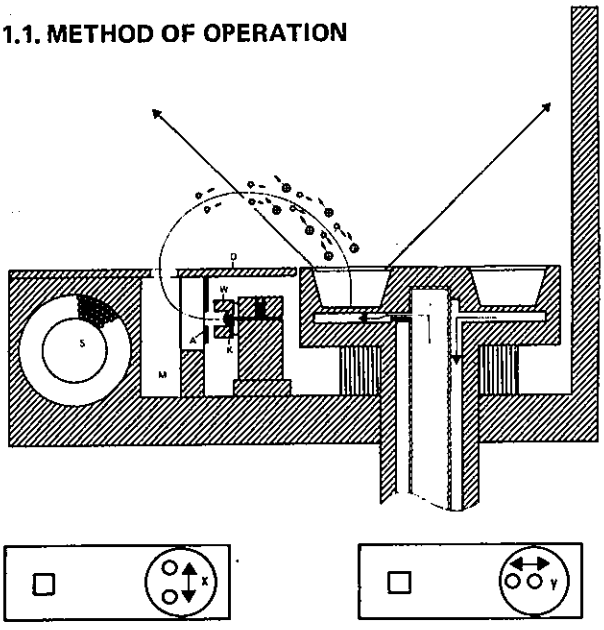
Service or repair work on components of the power supply or the high voltage lead-in may only be carried out by suitably qualified personnel. Contact with high voltage carrying components can be fatal.

Work on the high voltage lead-in for cleaning purposes, **after removing the power supply plug,** is the only exception to this rule.

1. APPLICATION

Constructed as an all-purpose evaporator, this system provides the best possible solution to any evaporation problem which can be overcome by the use of an electron beam evaporation source. At the same time, it is this quality of adaptability to the process which creates the necessity for accurate adjustment, in order to ensure that the optimum material evaporation characteristics are fully utilised. The electron beam evaporation system is a complete unit, with a power supply, controls and monitors.

1.1. METHOD OF OPERATION



X-sweep through an electromagnetic additional field (50 Hz)

Y-sweep through periodic variation (2 – 40 Hz) of the deflection field

Fig. 1

The electron beam evaporation source ESQ 110 consists of two main components (1) the electron beam gun, comprising the cathode K, Wehnelt shutter W and the anode A and (2) the water cooled evaporation crucible.

The electrons from the D.C. heated cathode (K), extracted through the electrical field, pass the anode (A), are deflected through approx. 270° by the magnetic field produced by the coil (S) and the pole shoes (M) and enter the crucible. The beam area is adjusted by the voltage connected to the Wehnelt shutter (W) (electrostatic focussing). There is another focussing effect in electrostatic focussing. The vapour atoms leaving the crucible are partially ionised by the electron beam. The electrons released by these vapour atoms travel at a much higher speed than the vapour ions, which have a speed distribution approximately corresponding to that of the neutral vapour atoms. Hence, high ion densities occur in the electron beam area, with a positive space charge capable of compensating for the negative space charge of the electrons. In fact, resulting from the vapour ions, a positive potential channel forms along the beam axis, which has a focussing effect on the beam electrons. Thus, with a 10 kV acceleration voltage, a density effect of the electron beam of approx. 40 kW/cm^2 is produced at the crucible surface.

Contrary to the evaporation of metal, a very much lower density effect of approx. 1 – 1.5 kW/cm^2 is desirable for the evaporation of dielectric materials. In this case the electron beam is de-focussed and "scanned" through an electro-magnetic A.C. field superimposed on the deflection field M. Another means of matching the evaporation source to the material to be evaporated and to the evaporation process is provided by a range of four interchangeable crucibles.

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2. TECHNICAL DATA

Max. power input for evaporation of	
Al with a) pot crucible b) other crucibles	12 kW 5.5 kW
X-Y deflection	variables
Coil current	0 – 2 A
Cooling water connection for evaporation source	3/8" Serto screw coupling
min. water pressure max. water pressure Throughput	3.5 bar 7 bar approx. 14 l/min at minimum 12 l/min
Intake temperature of the cooling water	4 - 50 °C
Beam spot, variable from	0.15 ÷ 10 cm^2
Work pressure	< 5 x 10^{-4} mbar
Bake-out, max.	100 °C
Weight	16 kg

2.1. Dimensions

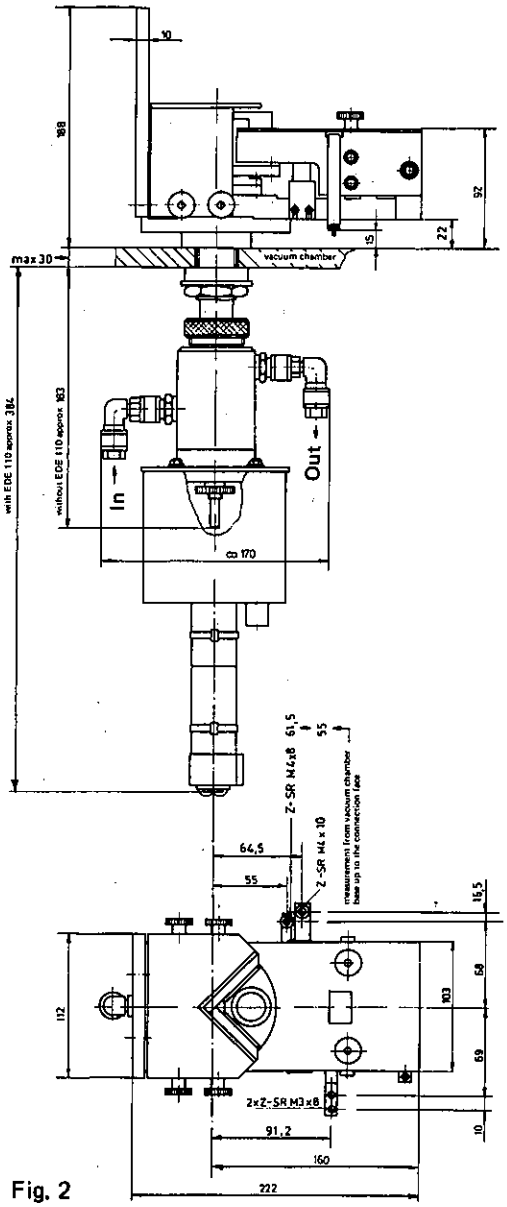


Fig. 2

3. DESCRIPTION

3.1. Evaporation source ESQ 110

The evaporation source is designed to ensure that apart from the material being evaporated, no hot surfaces of the gun can interfere with the evaporation process. The entire baseplate is thoroughly cooled by a special cooling line which is constructed as a bypass to the crucible cooling circuit. All masks, also the deflecting plate (secondary electrons) are made of solid copper and are in good thermal contact with the baseplate. The relevant screwed joints must therefore be firmly tightened.

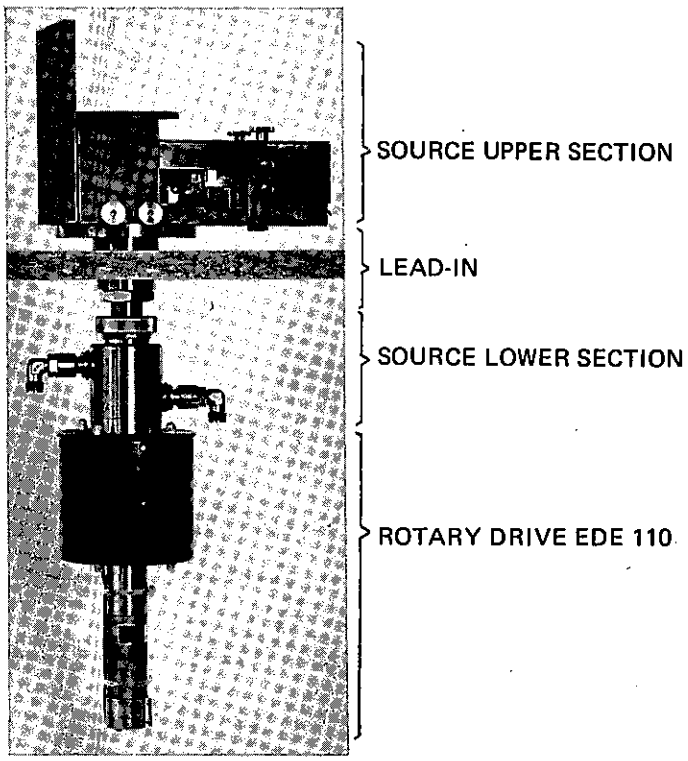


Fig. 3 270° Deflection gun with rotary drive

3.2. Major components of the ESQ 110

It is advisable to clean the crucible, crucible cap, deflection plate and gun mask regularly by means of sand-blasting. Crucible cleaning is particularly important for trouble-free, expedient evaporation. For this reason, simple crucible demounting is provided.

The pole shoes, which are not exposed to coating, should not be cleaned by sand-blasting, otherwise the nickle-plated surface (rust protection) will be worn away. Whilst sand-blasting the crucible and the baseplate, it is essential to make sure that all seal surfaces, also the mounting surfaces of the flat insulator and anode are masked. If these surfaces are damaged they must be restored, using a fine file or similar tool. A special plastic protection ring is supplied for crucible cleaning.

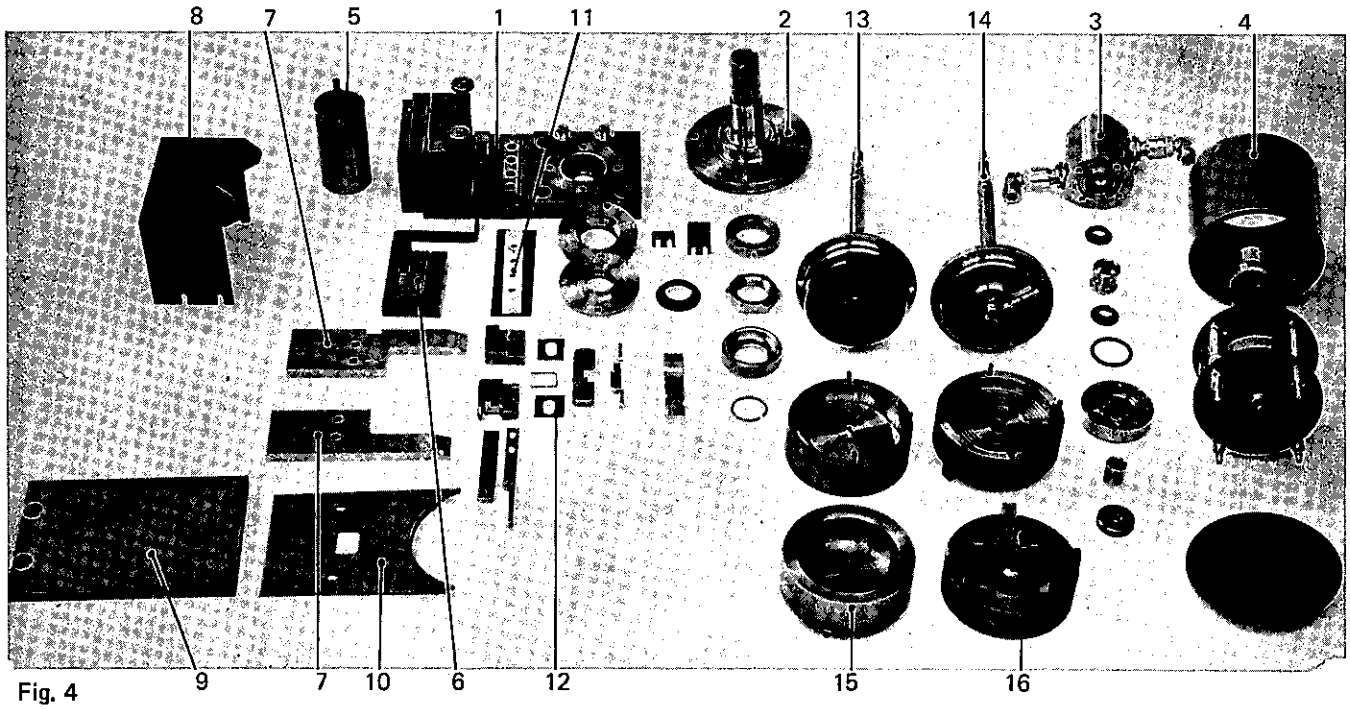


Fig. 4

1. Baseplate
2. Lead-in
3. Lower section (dismantled)
4. Rotary drive (dismantled)
5. Coil
6. Anode
7. Pole shoes
8. Crucible cap
9. Deflection plate
10. Copper mask
11. Flat insulator
12. Cathode system (dismantled)
13. Pot crucible (lower section)
14. Crucible lower section
15. Pot crucible
16. Oscillating crucible

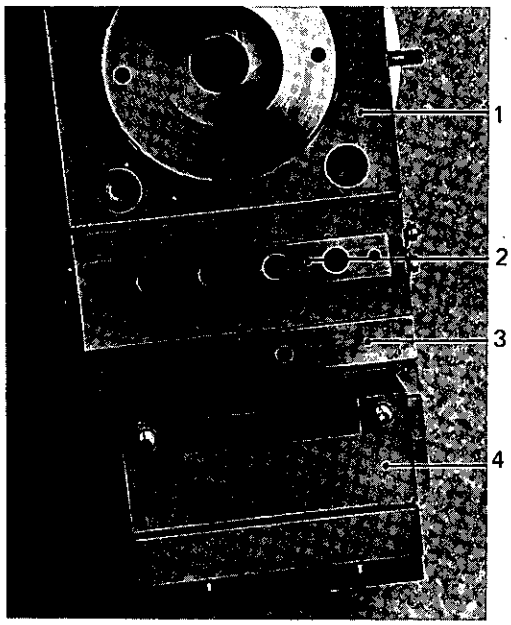


Fig. 5 Baseplate with coil holder

1. Baseplate
2. Mounting surface of the flat insulator
3. Mounting surface of the anode
4. Coil holder

4. INSTALLATION

4.1. Mounting the source ESQ 110

4.1.1. Mounting the source upper section

a. The bypass plate (Fig. 6) with the semi-circular milled slot is screwed over the appropriate outlet hole below the clean baseplate.

b. On the upper side, the Cr/Ni flange with the O-ring seal and the bronze flange with the gland seal are screwed in position with the four M4 screws. Before fastening the 4 setscrews, ensure the gap between the Cr/ni flange and the bronze flange is at least 0.2 mm (draw-in of gland seal). Finally attach the pole shoe to the coil holder with the M5 x 30 steel setscrews.

c. Mount the anode (Mo-parts facing the crucible)

4.1.2. Mounting the cathode holder

a Mount the two cathode holders on the flat insulator and screw in position with the two M3 cylindrical head screws.

b. Screw the Wehnelt section with the two round insulators to the cathode holder and tighten.

c. Tighten the cathode holder on the flat insulator.

d. Mount the cathode.

e. Adjust the lower Wehnelt plate (Ta) approx. 0.3 mm from the cathode

f. Screw the upper Wehnelt bar slacky in position with the two M2 vertical head screws (coat with Molykote).

g. Adjust the upper Ta plate approx. 0.3 mm from the cathode

h. Check the cathode, it should be located symmetrically in the gap b = 1.6 mm (Fig. 8).

i. Mount the two Cu-lead-ins on the cathode holder.

j. Tighten the Wehnelt wire firmly on the cathode holder (M2 cylindrical head screw).

k. Mount the cathode block on the baseplate.

l. Adjust the cathode: set back 2.7 ± 0.1 mm from the front face of the Wehnelt shutter.
(see section 5.2. and Fig. 20).

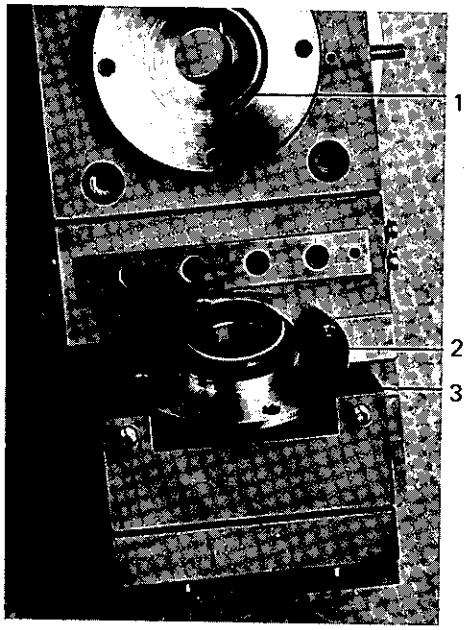


Fig. 6

1. Bypass plate
2. Gland seal
3. Bronze flange

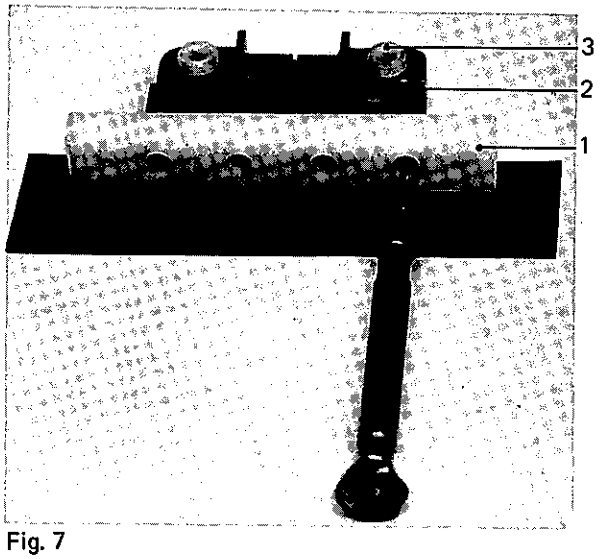


Fig. 7

1. Flat insulator
2. Cathode holder
3. Round insulator

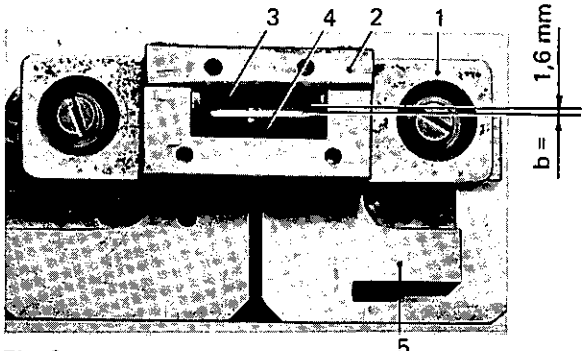


Fig. 8

1. Wehnelt section
2. Upper Wehnelt bar
3. Upper Wehnelt plate (Ta)
4. Lower Wehnelt plate (Ta)
5. Cathode holder

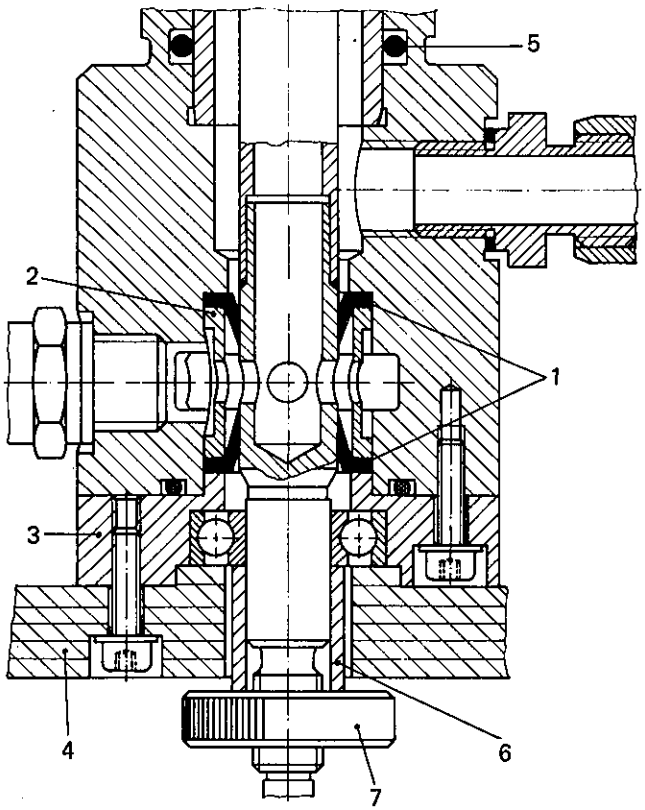


Fig. 9

1. Gland seal (14 x ~~27~~ 24 x 7 mm) — Misprint
2. Distance sleeve
3. Ballbearing flange
4. Ballbearing holder flange ϕ 60 mm (with rotary drive ϕ 115 mm)
5. O-Ring 27 x 4 mm
6. Intermediate piece
7. Milled nut with two M5 setscrews

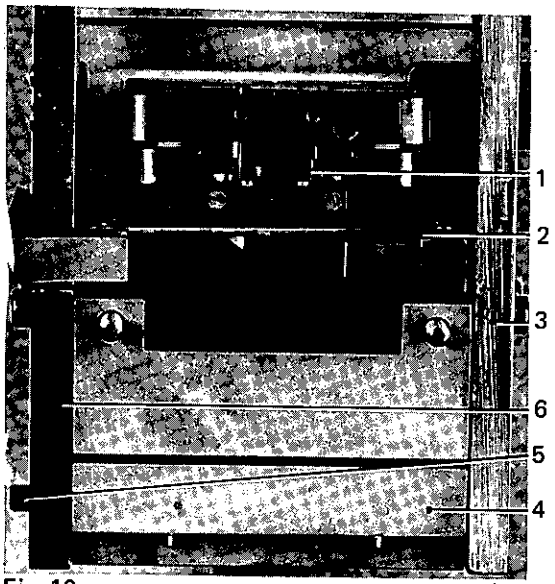


Fig. 10

1. Cathode system
2. Anode
3. Right hand pole shoe
4. Coil holder
5. Coil connection
6. Left hand pole shoe

m. Mount the deflection plate with two M5 setscrews.

o. Mount the complete cathode holder on the baseplate and adjust at a distance a = 3 mm from the anode, using a feeler gauge (two M3 screws) (see section 5.2.)

p. Insert the coil into the coil holder (note the connection side).

q. Mount the right hand pole shoe.

r. Clamp the coil firmly in position with the two M3 screws.

s. Mount the two coating protection plates for the flat insulator (small plate at the high voltage connection).

4.1.3. Mounting the source lower section

a. Attach the two water connections

b. Fit the gland seal (14/24 x 7 mm) with the seal lip facing downwards (Drawing!) Fig. 9, item 1)

c. Insert the distance sleeve

d. Fit the gland seal (14/24 x 7 mm) with the seal lip facing upwards (Fig. 9, item 1)

e. Mount the ballbearing flange with the ball bearing

f. Secure the cover flange and ballbearing flange in position with four M4 setscrews.

g. Lubricate and fit the 27 x 4 mm O-ring.

4.1.4. Mounting the source ESQ in the coating unit

a. Fit the lead-in with flange into the coating unit baseplate from above and fix in position with the washer (connect the earth line) and nut (M 30 x 1.5 mm). If the underside of the coating unit baseplate is coated with a protection film, then the gun and also the angle of the high current transformer (anode current) must be connected to the earth line (16 mm^2 Cu or Al strip 3 x 60 mm^2 which is provided with two 33 mm diameter holes and is firmly screwed to the gun and to the high current lead-in).

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 setscrews.

d. Mount the lock nut and the clamping ring on the lead-in from underneath.

e. Mount the source lower section on the lead-in 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 of the gland seals (see spare parts list BB 800 041 E/1, 2, items 19 and 20) on the crucible lower section as to finish traces; if necessary, re-polish them.
Lightly lubricate the cap-type gasket as well as the sealing surface with vacuum lubricant.

h. Slide-in the crucible lower section with the crucible from above (twist slightly to avoid damaging the gland seals).

i. With the milled nut M10 fasten the crucible lower section with intermediate piece manually towards the ball bearing

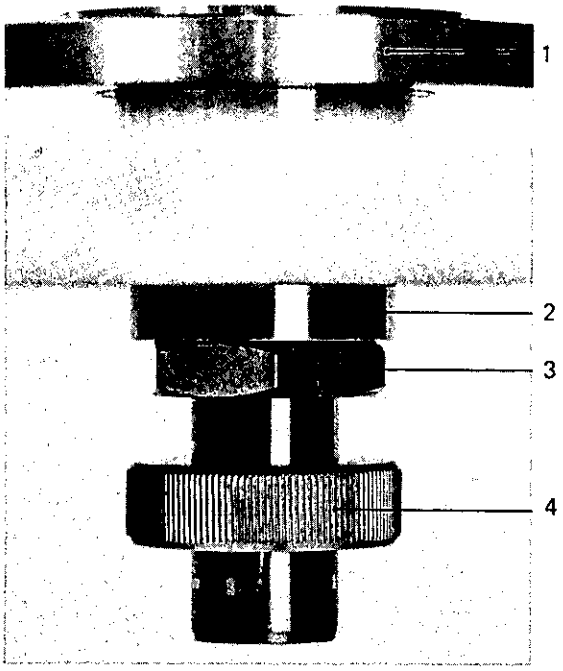


Fig. 11

1. Lead-in
2. Washer
3. Nut
4. Milled nut

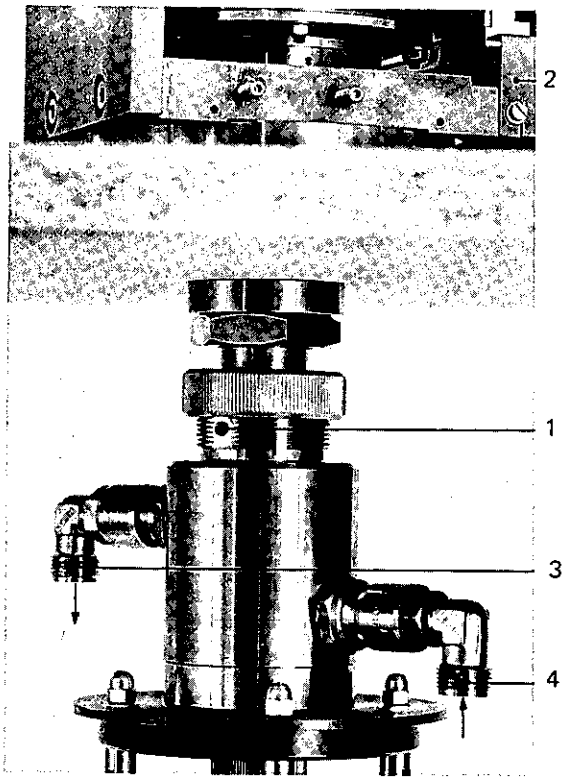


Fig. 12 Source lower section

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

(until the crucible does not move). Then turn the milled nut half a turn back and clamp it with the two M5 set-screws. The axial clearance for the crucible lower section in the gun should be approx. 0.5 mm.

j. Mount the crucible cap (required only for 4-way or oscillating crucible).

k. Secure the Cu-mask with the two M5 milled nuts.

l. The high voltage leads from the high voltage feedthrough to the source must be screened optically tight. The necessary sheet (Fig. 13, item 4) is supplied with the source. After installation, cut the sheet to exact size to avoid arc-overs during evaporation.

m. If there is sufficient space, bend the deflection (Fig. 13, item 1) about 90 ° backwards to crucible level. This will prolong the time intervalls between the cleanings, particularly when larger amounts of material are evaporated (e.g. with pot crucible).

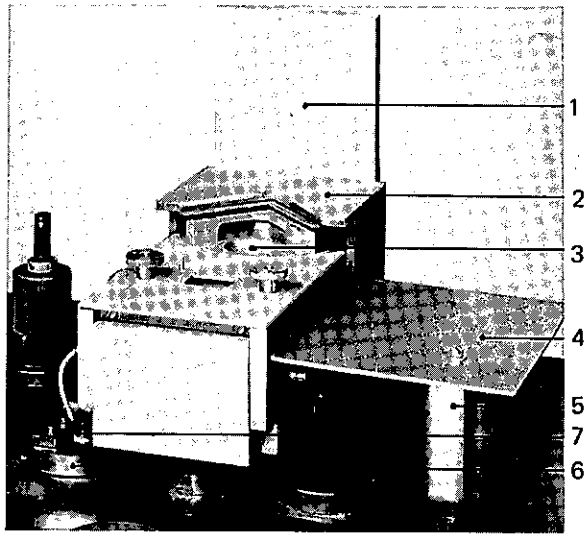


Fig. 13 Source complete with 4-way crucible

1. Deflection plate
2. Crucible cap
3. 4-way crucible
4. Screen for the cathode power supply
5. Screen for the high voltage lead-in
6. High current lead-in / Anode
7. Coil current lead-in

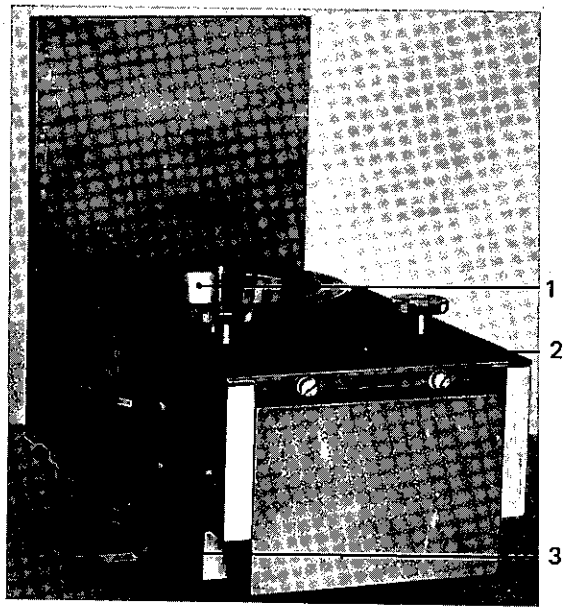


Fig. 14 Source with pot crucible

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

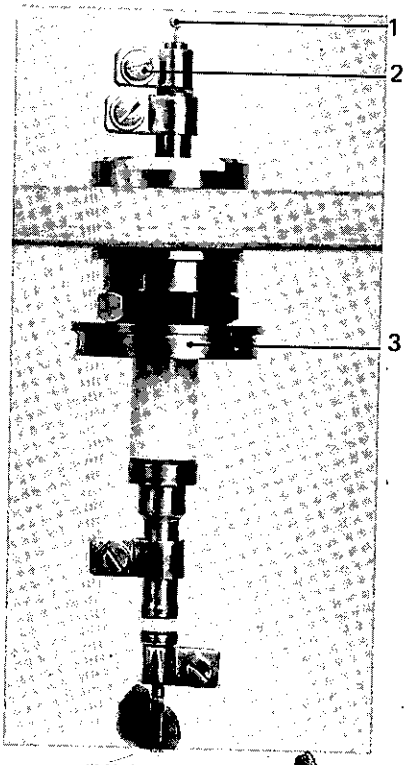


Fig. 15 High voltage lead-in

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

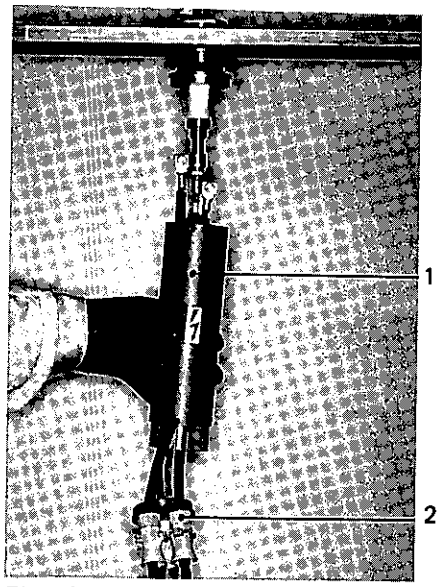


Fig. 16

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

4.2. Mounting the high voltage lead-in

a. If the high voltage lead-in 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 the high current cable (white) and the Wehnelt cable (red) through the appropriate cable connectors.

c. Fit the lead-in from above, taking care not to damage the seal and fix in place with the nut and washer (M 30 x 1.5). Push the insulation tube up into position.

d. Screw the protection tube holding plate with thread M 30 x 1.5 on the lead-in.

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

f. Screw the cable shoes of the high current cable to the appropriate clips on the lead-in.

g. Connect the Wehnelt cable.

h. Push the insulation tube and the protection tube up 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 with three M3 countersunk screws.

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

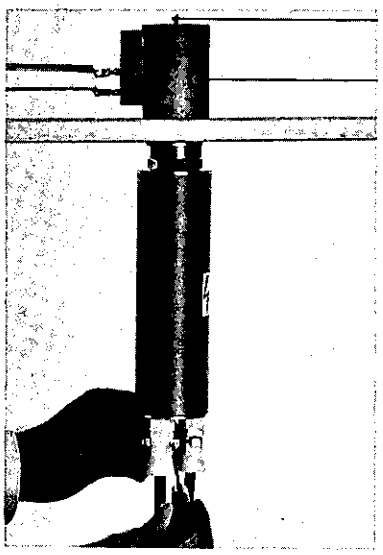


Fig. 17

1. Holder for the screen for the cathode power supply
2. Protection cover for the high voltage lead-in

4.3. Mounting the anode current lead-in and the anode current transformer

The high current lead-in (Fig. 13, item 6) acts as a current supply for the upper section of the anode (X-sweep). The lead-in must therefore be electrically insulated from the coating unit baseplate with 2 insulating plates, item 118 and 119 of the spare parts list BB 800 041 E / 6 and an insulating tube. If the underside of the coating unit baseplate is coated with an insulating protective film (anodised or brushed on), an earth line must be connected from the gun lead-in to the fixing angle 3 of the high current transformer. The connection from the lead-in to the anode is made with the installation material supplied, in accordance with the arrangement of the gun and high current lead-in. The coil current lead-in is mounted in the high current lead-in Fig. 13.

a. The anodised Al-high current lead-in is passed through the baseplate from above (ϕ 32.5 mm) and secured with the nut (M 30 x 1.5), simultaneously with the angle and insulation plate.

b. The nickel-plated copper angle is secured with the nut (M 20 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. The Cu-strip must be clamped between the Al-angle and the transformer.

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

e. Make the coil connection with the nut M3.

f. Connect the primary connection to the 240 V inlet. If the sweep amplitude is too small, or if it becomes too small after a long operating period, the 220 V connection can be used. A changeover can also be made in the control unit EKS on the Variac from connection 240 V to the 220 V connection).

5. MAINTENANCE

5.1. Maintenance of the source ESQ 110

The ESQ 110 electron beam gun requires very little maintenance. None of its components is exposed to coating. The crucible cap and the deflection plate are the only parts to be cleaned, the frequency of cleaning depending on the quantity of material evaporated. It should be considered that it is not the source which requires periodic cleaning but the cleanness of evaporation. Thick layers deposited on the deflection plate can be re-evaporated because of the thermal radiation which is due to poor conductivity, although the cooling may be perfect. Therefore, to ensure perfect evaporation, we recommend regular cleaning of the crucible cap and the deflection plate. Do not use the crucible cap when working with the pot or the grooved crucible. In special cases it may be possible to work without the deflection plate (low beam power or use of a short, angle plate that does not protrude over the crucible) if the contamination of the evaporation source by the evaporant is very little. However, periodic cleaning is essential in any case (sand-blast).

It is advisable to change the gland seals every 400 hours of operation. If the crucible lower section is changed frequently, it may become necessary to replace the gland seals at shorter intervals.

Check the sealing surfaces at the same time. The highly polished surfaces must show no scratches or grooves. If necessary, repolish the surfaces. Before reinstalling, the cap-type gasket and the sealing surfaces are to be lightly lubricated with an appropriate vacuum lubricant.

Every 100 evaporation hours, dismantle the flat insulator and the two round insulators of the cathode holder and clean either mechanically (emery cloth) or chemically. The insulators are made of high purity Al_2O_3.

Service life of the cathode:

30 hours of evaporation or 200 evaporation cycles.

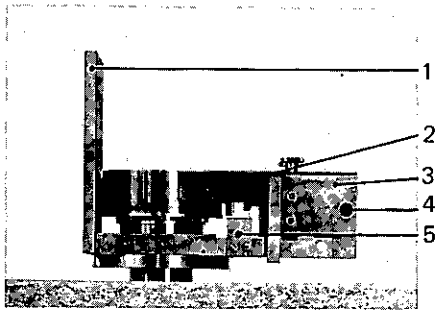


Fig. 18

1. Deflection plate
2. Cu-cap
3. Pole shoe
4. Coil connection
5. Coating shield for the flat insulator

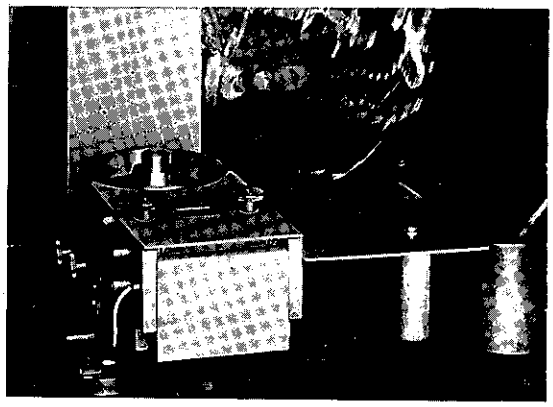


Fig. 19 Evaporation source complete with a grooved crucible

5.2. Changing the cathode

a. Remove the Cu-cap (two M5 milled nuts)
b. Remove the Wehnelt bar (two M2 countersunk screws)
c. Slacken the cathode holding screws (slotted screws M3)
d. Remove the old cathode
e. Insert the new cathode through the anode and into the hole in the holder
f. Insert the feeler gauge between the anode and Wehnelt
g. Press the cathode against the gauge and tighten the two cathode holder screws slackly
h. Mount the Wehnelt bar. Tighten the countersunk screws slackly. If new screws are being used it is advisable to give them a thin coating of Molykote beforehand.
i. Mount the Cu-mask.

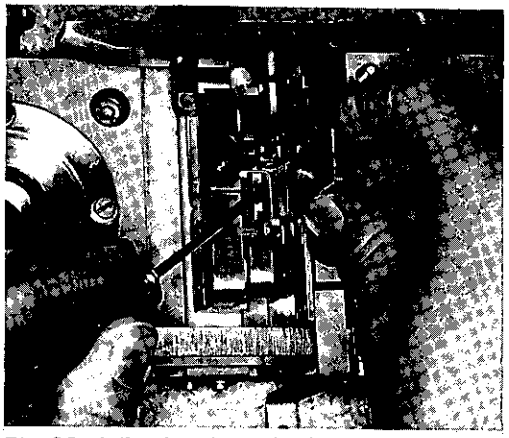


Fig. 20 Adjusting the cathode

5.3. Changing the crucible

In order to ensure that the evaporation source is ideal for the process, in addition to the electrical adjustments of the gun (beam power, acceleration voltage, focussing X-Y sweep) a range of interchangeable evaporation crucibles are provided. Three of these crucibles (4-way crucible No. 20-2751, oscillating crucible No. 20-2753 and the grooved crucible No. 20-2752) use the same crucible lower section 20-2673. Only the pot crucible 20-2737 has a special lower section. Therefore, it is only necessary to change the lower section if the pot crucible is to be changed for a different model or in reverse.

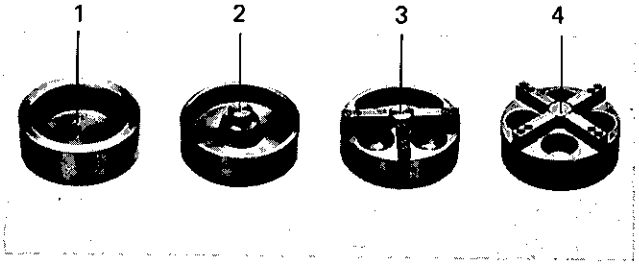


Fig. 21

1. Pot crucible
2. Grooved crucible
3. Oscillating crucible
4. 4 way crucible

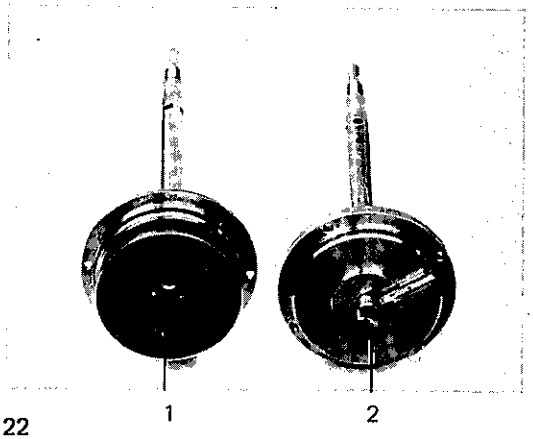


Fig. 22

1. Lower section for the pot crucible
2. Lower section for all the other crucibles

5.3.1. Changing the crucible without changing the lower section

The crucible is attached to the lower section by 4 steel bolts and nuts.

a. Switch off the gun water cooling. Connect the compressed air line to the water inlet and blow out the gun cooling system and the supply lines with compressed air.

b. Loosen the four M 3 nuts on the crucible lower section.

c. Using 2 screwdrivers as levers, lift the crucible off the lower section.

d. Mount a new crucible in the correct position (key-way) pressing it down with the hand. If necessary, apply a thin film of grease to the O-Ring beforehand.

e. Tighten the four M 3 nuts slackly.

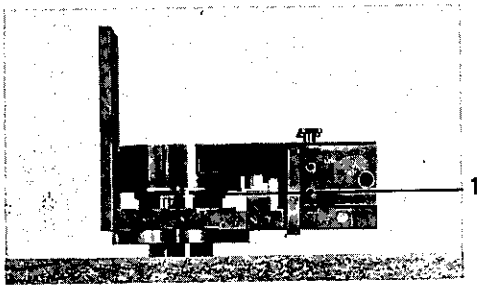


Fig. 23

1. Holding nuts (4 off on the periphery). When these nuts are loosened the crucible can be removed from the lower section.

9.3.2. Changing the crucible and the lower section

a. Switch off the gun water cooling. Connect the compressed air line to the water inlet and blow out the gun cooling water system and the supply lines with compressed air.

b. Remove the protection tube from the rotary drive EDE.

c. Remove the milled nut M 10 (rotary drive)

d. Lift the crucible with the lower section, upwards and out.

e. The new crucible lower section is pushed in from the top, downwards into the gun and rotated slightly (keyway) to bring it into position in the coupling. Fix in place with the milled nut M 10 and the distance sleeve (axial clearance 0.2 ÷ 0.5 mm).

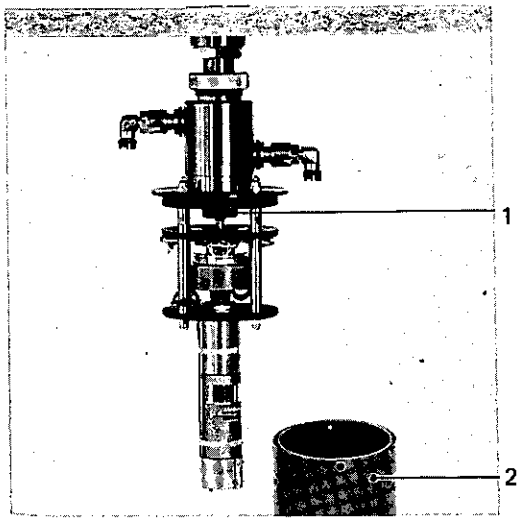


Fig. 24

1. Milled nut
2. Protection tube for the EDE

10. TROUBLESHOOTING

Fault	Cause	Correction
The crucible is destroyed by the evaporant (alloying)	Beam spot is not in crucible centre. For pot crucibles: distance of beam-spot to crucible edge is too short	Correct the beam spot position
	Beam power is too high	Reduce the beam power
	Insufficient cooling	If Al is being evaporated in 4-way or grooved crucible, set "power limit" on EKS to 5.5 kW.
Arcing at high evaporation rates	Poor coverage of the high voltage installation	Carefully screen
Arcing at high pressure. Pressure peaks	The evaporant is outgassing too strongly	De-gas at reduced power
The evaporant is spitting too much	The electron beam power density is too high	Sweep or reduce the power
	Crucible is contaminated (e.g. from material previously evaporated)	Clean the crucible (e.g. sand-blast)

Fault	Cause	Correction
Crucible movement is jammed	Stains of evaporant on the crucible / Mask	Clean
	Milled nut on the crucible lower section (No. 7. Fig. 31) is too tight	Set clearance with the milled nut at approx. 0.3 – 0.5 mm and secure with the two M 5 screws
Pressure rises if the rotation is switched on or off	Gland seal H 25 – 14 25/38 x 6.5 (Fig. 6 item 2) under the bronze flange is leaking	Replace the gland seal
Pressure rises if the cooling water is switched on	O-Ring 80 x 4 (Item 18 of the spare parts list BB 800 041 E/1) is leaking	Replace the O-Ring
	The draw-in of the gland seal is insufficient (see sect. 4.1.)	Turn off 0.2 mm from Cr/Ni flange (machining)
Pressure rises if the cooling water is switched off	Gland seal H25-14 25/ 38 x 6.5 (Fig. 6, item 2) under the bronze flange is leaking	Replace the gland seal
No beam spot in the crucible although the high voltage is switched on and the coil current indication is correct (6 kV ~ 0.85 A, 10 kV ~ 1.55 A)	Polarity of the coil is incorrect	Change the coil connection on the plug strip under the coating unit with the earth connection
The spot is too large	Cathode is pushed too far in the anode direction	Move the cathode back (using a gauge)
	No Wehnelt voltage	Check the contact EHS 110 to Wehnelt shutter

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.

Ordering Example

1 O-ring, Viton, ϕ 40 x 4 mm, Code No. B 4070 644 PV, as to spare parts list BB 800 041 E / 1a, Item 16.

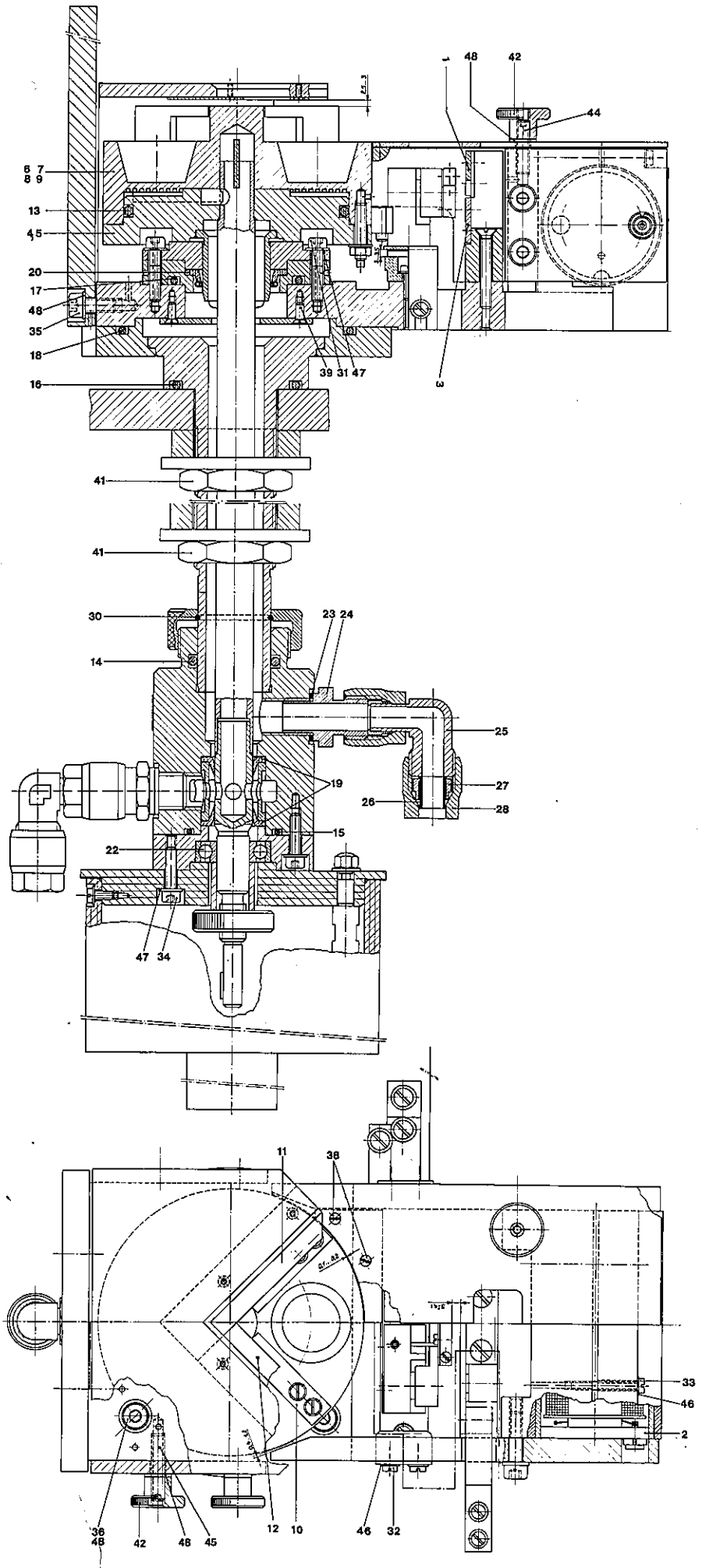
	Description Teil	Item Pos.	Code-No.	Bestell-Nr.	S	Remarks Bemerkungen
1	Anode 1	1	~~20-2688-R1~~	~~BK 202-688~~		
1	Coil/Spule komplett	2	BK 204 031 X			
1	Anode 2	3	~~20-2689-R1~~	BK 202-689		
1	Holder/Halter	4	20-2673 R1			to/zu Pos.6,7,8
1	Holder/Halter	5	20-2734 R1			to/zu Pos.9
1	4-way crucible/Vierlochtiegel	6	~~20-2751-R1~~	BK 204-202-T		
1	Oscillating crucible/Pendeltiegel	7	20-2753 R1			
1	Grooved crucible/Rinnentiegel	8	20-2752 R1			
1	Pot crucible/Einlochtiegel	9	20-2737 R1			
4	Bar/Steg	10	BK 202 669 A			to/zu Pos.6,7
1	Screening/Schirmblech	11	20-2695 P1			
1	Screening / Schirmblech	12	20-2696 P1			
1	O-Ring, Viton, ϕ 76 x 4	13	B 4071 063 PV			
1	O-Ring Neoprene, ϕ 27 x 4	14	B 4070 468 PN			
1	O-Ring, Neoprene, ϕ 29,2 x 3	15	B 4070 501 PN			
1	O-Ring, Viton, ϕ 40 x 4	16	B 4070 644 PV			
1	O-Ring, Viton, ϕ 42 x 4	17	B 4070 675 PV			
1	O-Ring, Viton, ϕ 80 x 4	18	B 4071 092 PV			
2	L-ring gasket/Hutmanschette H 14-4 14/24 x 7	19	B 4079 155 P			
1	L-ring gasket/Hutmanschette H 25-14 25/38 x 6,5	20	B 4079 309 VN			
		21				
1	Ball bearing/Rillenkugellager 6001 12/28 x 8	22	N 4001 318			
2	Seal ring/Dichtring SO 7-G 1/4, Cu	23	B 4119 532-K			
2	Nipple/Einschraubnuppel SO 1100-10-M 14	24	B 4101 537 MN			
2	Angle/Einstellwinkel SO 2600-10	25	B 4133 405 GN			
2	Sleeve/Stützhülse SO 18,3 - 10/8	26	B 4119 418 X			
4	Clamping ring/Klemmring SO 18,1 - 10	27	B 4119 367 X			
4	Socket joint /Anschlussmutter, SO 20-10-G3/8	28	B 4117 569 GN			
		29				
1	Spring ring/Federring	30	20-2666 P1			
4	Screw/Schraube M4 x 20	31	20-2733 P1			
4	Screw/Schraube M3 x 6	32	N 3052 189 X			Inox
2	Screw/Schraube M3 x 25	33	N 3052 203 X			Inox
8	Screw/Schraube M4 x 16	34	N 3059 259 X			Inox
2	Screw/Schraube M5 x 12	35	N 3059 292 X			Inox
4	Screw/Schraube M5 x 16	36	N 3059 296 X			Inox
		37				
8	Screw/Schraube M2 x 6	38	N 3111 114 X			
2	Screw/Schraube M3 x 8	39	N 3111 191 X			Inox
		40				
1	Nut/Mutter M30 x 1,5 Ms	41	BN 790 249			
1	Milled nut/Rändelmutter M5	42	N 3477 120 X			Inox
1	Threaded pin/Gewindestift M4 x 8	43	N 3211 251 X			Inox
2	Threaded pin/Gewindestift M5 x 20	44	N 3208 298 X			Inox
4	Threaded pin/Gewindestift M5 x 25	45	N 3208 301 X			Inox
6	Washer/Scheibe 3,2/7 x 0,5	46	N 3502 412 X			Inox
12	Washer/Scheibe 4,3/9 x 0,8	47	N 3502 414 X			Inox
12	Washer/Scheibe 5,3/10 x 1	48	N 3502 416 X			Inox

*not seen in the picture/nicht ersichtlich

Spare Parts for / Ersatzteile zu **20-2650 R1**

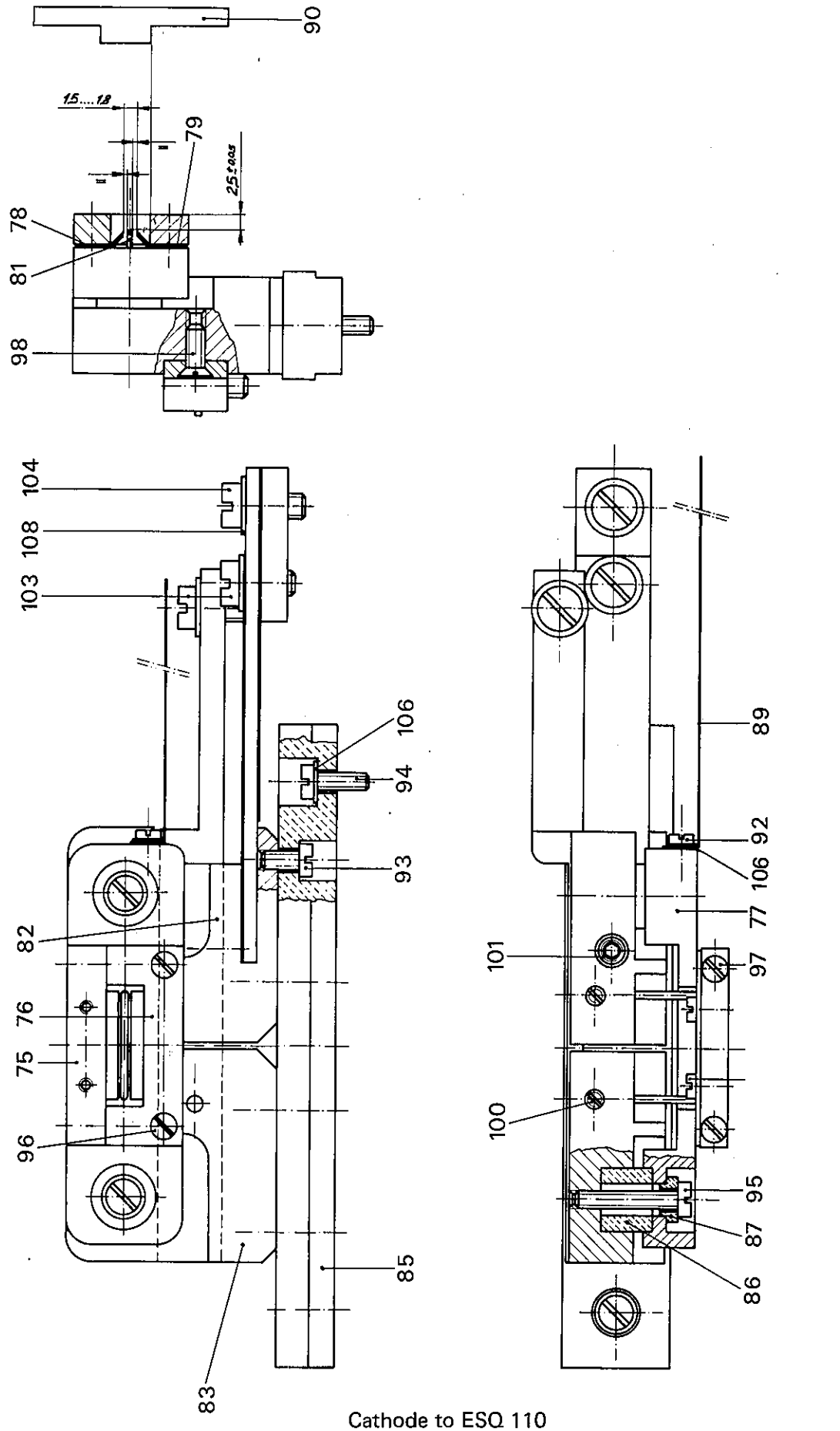
Electron beam evaporation source/Elektronenstrahl-Verdampfungsquelle ESQ 110

BB 800 041 E / 1a



Electron beam evaporation source / Elektronenstrahl-Verdampfungsquelle ESQ 110 20-2650 R1

	Description Teil	Item Pos.	Code-No. Bestell-Nr.		S	Remarks Bemerkungen
1	Beam/Balken	75	20-2697 P1			
1	Pile bents/Joch	76	20-2698 P1			
1	Wehnelt holder/Wehneltträger	77	20-2699 P1			
1	Wehnelt plate/Wehneltblech	78	BK 202 702			
1	Wehnelt plate/Wehneltblech	79	BK 202 703			
		80				
1	Cathode/Kathode	81	BK 202 704 A			
1	Cathode holder/Kathodenhalter	82	20-2718 P1			
1	Cathode holder/Kathodenhalter	83	20-2719 P1			
		84				
1	Insulator/Isolator	85	BK 202 700			
2	Insulator/Isolator	86	BK 202 701			
2	Ceramics part/Einzeltülle	87	B 4622 251 TN			
		88				
1	Wire/Draht, ϕ 1 x 500,Ni 99,8	89	B 2220 140-W			
1	Adjusting gauge/Einstellehre	90	20-3014 P1			
		91				
1	Screw/Schraube M3 x 4	92	N 3052 186 X			Inox
4	Screw/Schraube M3 x 6	93	N 3052 189 X			Inox
2	Screw/Schraube M3 x 10	94	N 3052 193 X			Inox
2	Screw/Schraube M3 x 16	95	N 3052 198 X			Inox
2	Screw/Schraube M2 x 6	96	N 3111 114 X			Inox
2	Screw/Schraube M2 x 8	97	N 3111 116 X			Inox
2	Screw/Schraube M3 x 8	98	N 3111 191 X			Inox
		99				
2	Threaded pin/Gewindestift M3 x 5	100	N 3204 188 X			Inox
1	Threaded pin/Gewindestift M4 x 8	101	N 3208 251 X			Inox
		102				
2	Screw/Schraube M4 x 8	103	N 3052 251 X			Inox
1	Screw/Schraube M4 x 10	104	N 3052 253 X			Inox
		105				
3	Washer/Scheibe 3,2/7 x 0,5	106	N 3502 412 X			Inox
3	Washer/Scheibe 4,3/9 x 0,8	108	N 3502 414 X			Inox



Cathode to ESQ 110

Kathode zu ESQ 110

20-2720 d R1

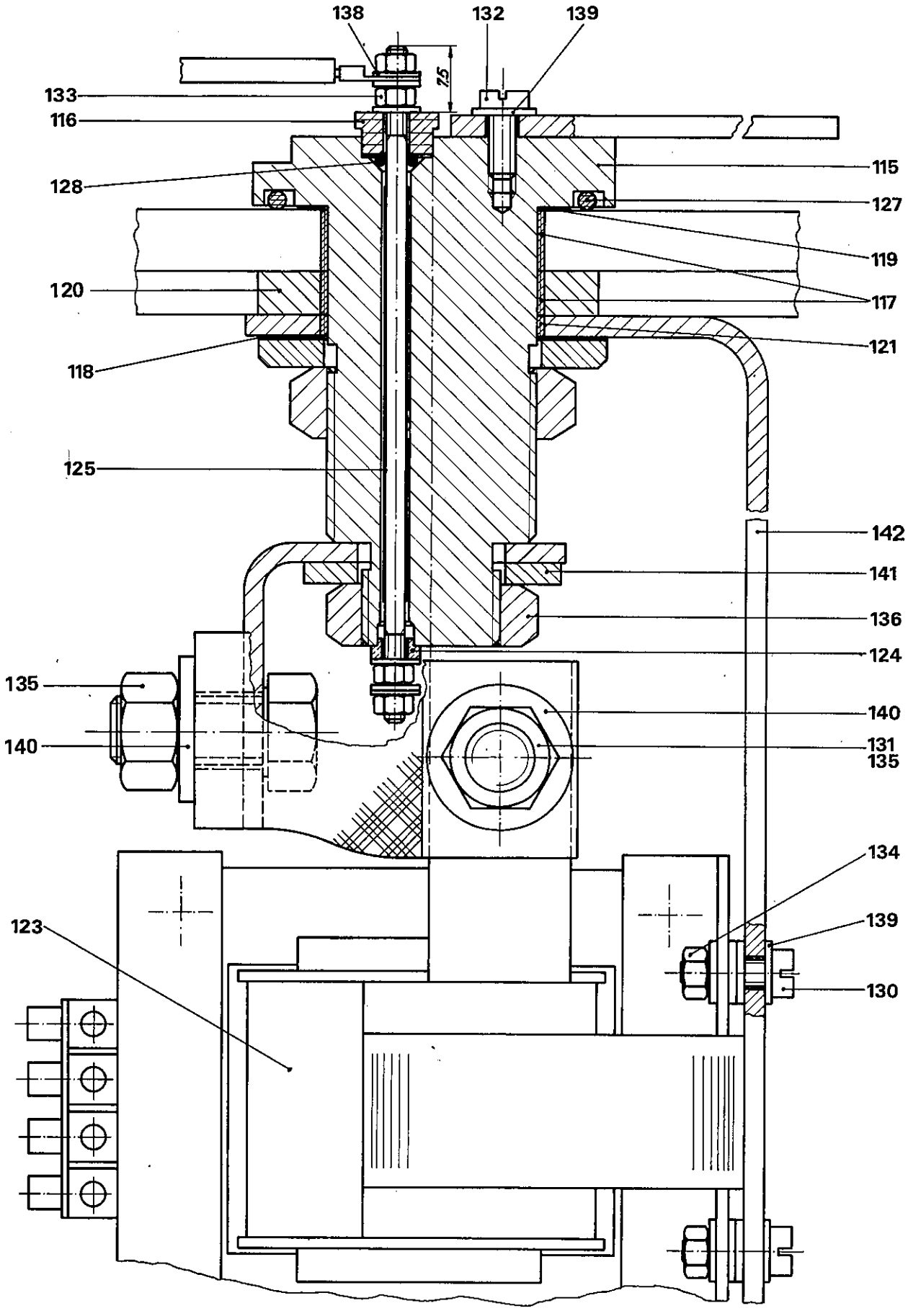
BB 800 041 E/5a

	Description Teil	Item Pos.	Code-No. Bestell-Nr.		S	Remarks Bemerkungen
1	Lead-in/Durchführung	115	20-2901 P1			
1	Connection ring/Abschlussring	116	20-2903 P1			
2	Sleeve/Hülse	117	20-2906 P1			
1	Washer/Scheibe	118	20-2907 P1			
1	Washer/Scheibe	119	20-2908 P1			
1	Ring	120	20-3301 P1			for/für BA510/
1	Insulating ring/Isolierring	121	20-3018 P1			710
		122				
1	High current transformer/Hochstromtransformator	123	BG 202 995			
1	Ceramics part/Einzeltülle	124	BO 326 031			
1	Hose/Schlauch RNF 100 Sw	125	B 4616 718 AA			
		126				
1	O-Ring, Viton, ϕ 40 x 4 mm	127	B 4070 644 PV			
1	O-Ring, Viton, ϕ 2,9 x 1,78 mm	128	B 4070 019 PV			
		129				
4	Screw/Schraube M4 x 12	130	N 3052 255 X			Inox
1	Screw/Schraube M10 x 20	131	N 3015 471 X			
1	Screw/Schraube M4 x 10	132	20-2905 P1			
4	Nut/Mutter M3	133	N 3415 037 X			Inox
4	Nut/Mutter M4	134	N 3415 039 X			"
2	Nut/Mutter M10	135	N 3415 051 X			"
1	Nut/Mutter M20 x 1,5	136	N 3410 124 MN			Ms
		137				
6	Washer/Scheibe 3,2/7 x 0,5	138	N 3502 412 X			Inox
18	Washer/Scheibe 4,3/9 x 0,8	139	N 3502 414 X			"
2	Washer/Scheibe 10,5/21 x 2	140	N 3502 424 X			"
1	Washer/Scheibe 21/37 x 3	141	N 3502 434 X			
1	Angle/Winkel	142	20-3016 P1			

Spare Parts for / Ersatzteile zu

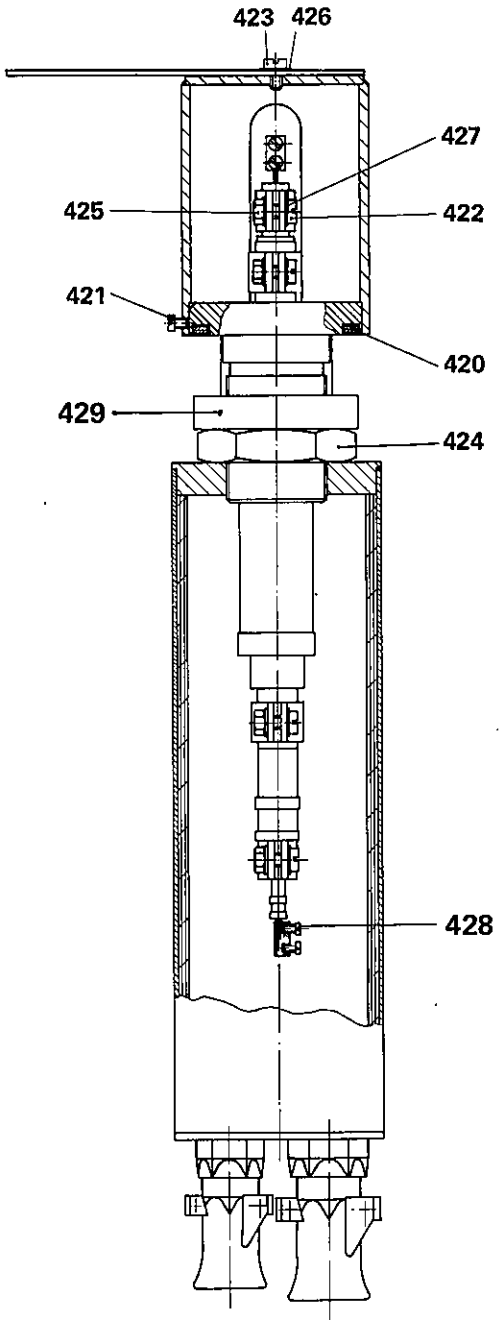
High current lead-in/Hochstromdurchführung 20-2900 c R1

BB 800 041 E/6a



High current lead-in / Hochstromdurchführung 20-2900 c R1 BB 800 041 E/7a

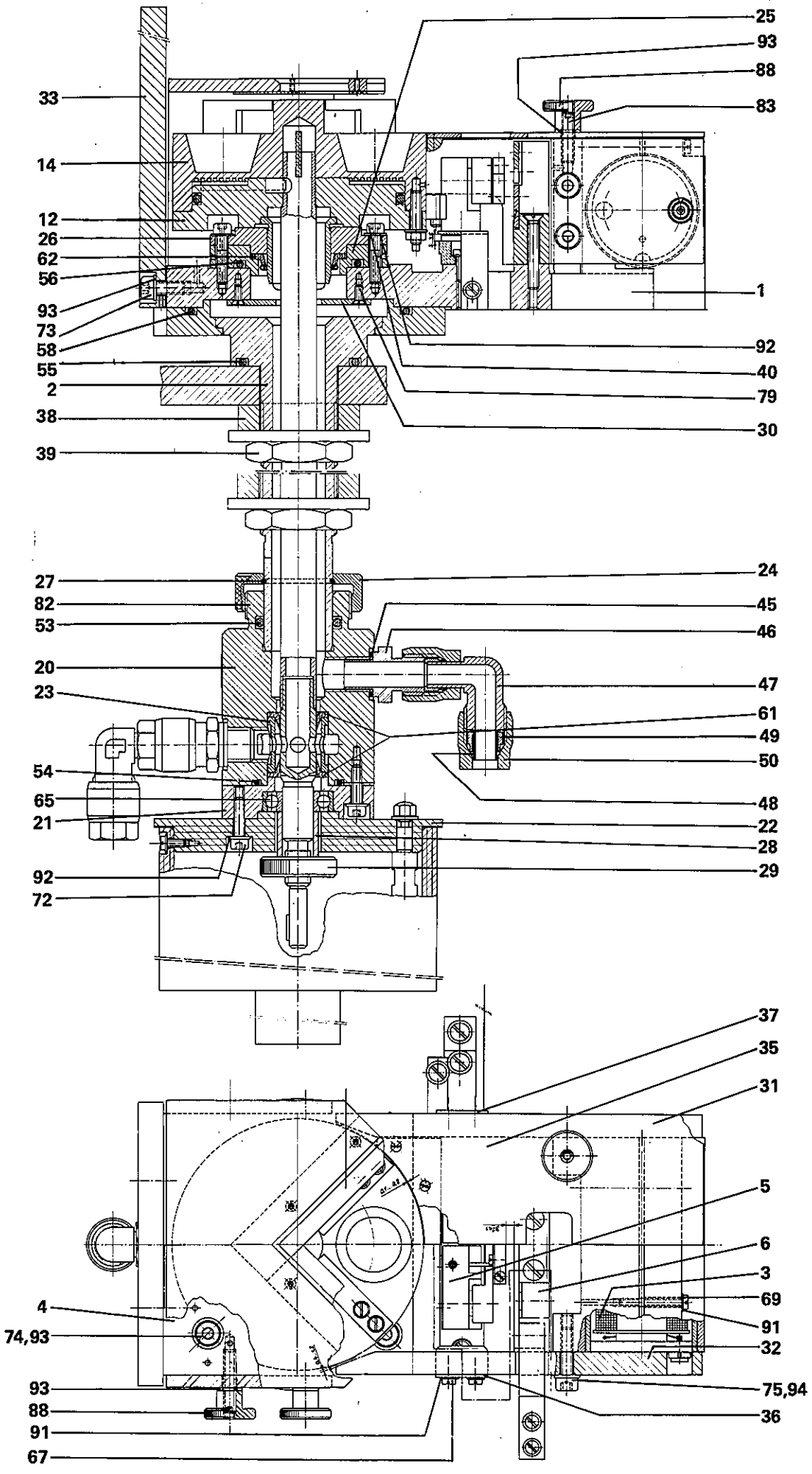
	Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
1	O-Ring, Viton ϕ 40 x 4	420	B 4070 644 PV		
1	Screw/Schraube M3 x 4	421	N 3052 186 X		
4	Screw/Schraube M5 x 12	422	N 3052 292 X		
1	Screw/Schraube M4 x 6	423	N 3052 249 X		
1	Nut/Mutter M30 x 1.5	424	BN 790 249		
4	Nut/Mutter M5	425	N 3415 041 X		
1	Washer/Scheibe 4,3/9 x 0,8	426	N 3502 414 X		
8	Washer/Scheibe 5,3/10 x 1	427	N 3502 416 X		
1	Terminal/Klemme	428	B 465510 701		
1	Washer / Scheibe	429	BN 790 250		



Spare Parts for / Ersatzteile zu 20-2880 b R1

High voltage lead-in / Hochspannungsdurchführung

BB 800 041 E / 20a

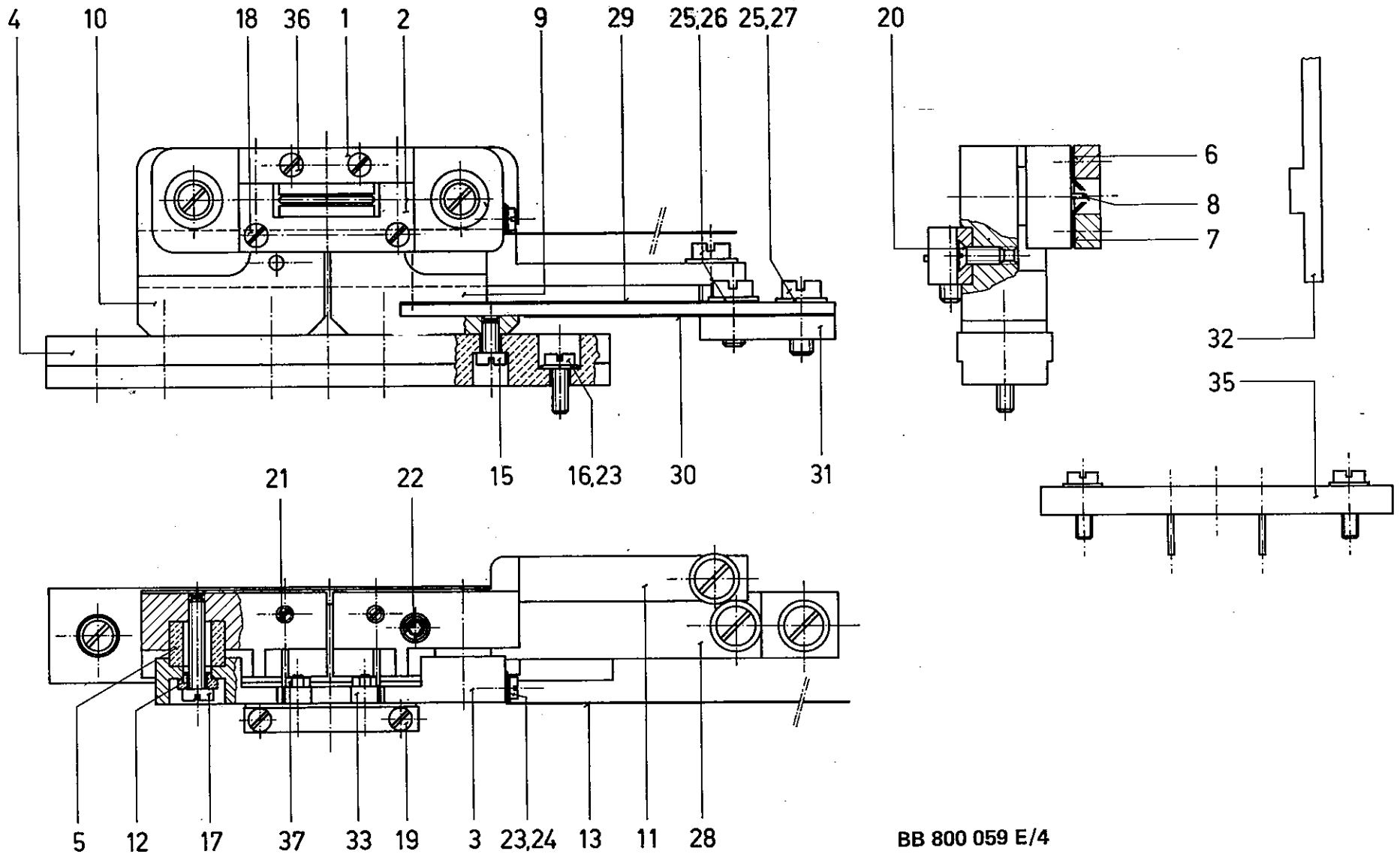


Electron beam evaporation source / Elektronenstrahl-Verdampfungsquelle ESQ 113 BB 800 059 E/1
BB 800 059 E/2

Order No. Bestell-Nr.	Quantity Stückzahl	Description Teil	Item Pos.	S / Reference S / Bemerkungen	
BK 204 841 -X	1	GRUNDPLATTE KPL. *Base plate*	1		
BK 204 749 -R	1	FLANSCH BK 604 026 *Flange*	2		
BK 202 685 -T	1	SPULE KPL. *Coil*	3		
BK 204 861 -T	1	TIEGELABDECKUNG *Cover*	4		
BK 204 129 -T	1	KATHODE KPL. *Cathode*	5	BB 800 059 E/3+4	1)
BK 204 126 -T	1	ANODE KPL. *Anode*	6	BB 800 059 E/5	1)
BK 204 851 -T	1	HALTER KPL *Holder*	12	BB 800 059 E/6	1)
BK 204 859 -T	1	4-LOCH-TIGEL 4 X 30 CCM *Crucible*	14		
BK 202 656	1	GEHAEUSE *Housing*	20		
BK 202 657	1	RING	21		
BK 202 658 -X	1	FLANSCH *Flange*	22		
BK 202 659	1	HUELSE *Bushing*	23		
BK 202 660	1	MUTTER *Nut*	24		
BK 202 661	1	FLANSCH *Flange*	25		
BK 202 662	1	FLANSCH *Flange*	26		
BK 202 666	1	FEDERRING *Spring ring*	27		
BK 202 675	1	HUELSE *Bushing*	28		
BK 203 115 -U	1	RAENDELMUTTER M10 KPL. *Nut*	29		
BK 202 678	1	RONDELLE *Washer*	30		
BK 204 847 -R	1	POLSCHUH RECHTS BK654039 *Pole shoe right*	31		
BK 204 848 -R	1	POLSCHUH LINKS BK654039 *Pole shoe left*	32		
BK 204 846	1	RUECKPLATTE *Back plate*	33		
BK 204 849	1	ABDECKPLATTE *Cover plate*	35		
BK 202 739	1	WINKEL *Angle*	36		
BK 202 740	1	SEITENBLECH *Side panel*	37		
BP 220 380	1	RING	38		
BN 790 249	1	6KT-MUTTER M30X1.5 *Nut*	39		
BK 202 733	4	Z-SR I-6KT *Screw*	40		

1) SPARE PARTS LIST

Order No. Bestell-Nr.	Quantity Stückzahl	Description Teil	Item Pos.	S / Reference S / Bemerkungen
B 4119 532 -K	2	DICHTRING, CU, SO 7- G 1/4 *Seal*	45	
B 4101 537 MN	2	E-NI,MS N,SO 1100-10-M14X1,5Z *Nipple*	46	
B 4133 405 GN	2	EINSTELLWI, MS VNI,SO 2600-10 *Angle*	47	
BN 809 552 D	2	SCHLAUCHTUELLE *Hose nipple*	48	
B 4119 367 -M	4	KLEMMRING, MS, SO 1-10 *Clamping ring*	49	
B 4117 569 GN	4	A-MU, MS-N, SO 20-10-G 3/8 *Nut*	50	
B 4070 468 PN	1	O-RING, NE, 27 X 4	53	
B 4070 501 PN	1	O-RING, NE, 29,2 X 3	54	
B 4070 644 PV	1	O-RING, VI, 40 X 4	55	
B 4070 675 PV	1	O-RING, VI, 42 X 4	56	
B 4071 092 PV	1	O-RING, VI, 80 X 4	58	
B 4079 155 P	2	HUTM, P, H 14- 4, 14/ 24X 7 *Shaft seal*	61	
B 4079 309 VN	1	HUTM, VI, 25/38X6,5 *BN915029* *Shaft seal*	62	
N 4001 318	1	RIL-K-LAGER 6001, 12/ 28X 8 *Ball bearing*	65	
N 3052 189 X	4	Z-SR, INOX, M 3 X 6 *Screw*	67	
N 3052 203 X	2	Z-SR, INOX, M 3 X 25 *Screw*	69	
N 3059 259 X	8	Z-SR I-6KT,INOX, M 4 X 16 *Screw*	72	
N 3015 298 X	3	6KT-SR, INOX, M 5 X 20 *Screw*	73	
N 3059 296 X	4	Z-SR I-6KT,INOX, M 5 X 16 *Screw*	74	
N 3059 298 8P	4	Z-SR I-6KT,8.9 VZNP, M 5 X 20 *Screw*	75	
N 3111 191 X	2	S-SR 90, INOX, M 3 X 8 *Screw*	79	
N 3211 251 X	1	GEW-STI I-6KT ZA;INOX; M 4X 9 *Threaded pin*	82	
N 3208 298 X	2	GEW-STI I-6KT K;INOX; M 5X20 *Threaded pin*	83	
N 3477 120 X	2	RAENDEL-MU HOCH, INOX, M 5 *Nut*	88	
N 3502 412 X	6	U-SR, INOX, 3,2/ 7 X 0,5 *Washer*	91	
N 3502 414 X	12	U-SR, INOX, 4,3/ 9 X 0,8 *Washer*	92	
N 3502 416 X	9	U-SR, INOX, 5,3/10 X 1 *Washer*	93	
N 3502 416 4P	4	U-SR, 4 VZNP, 5,3/10 X 1 *Washer*	94	



BB 800 059 E/4

Cathode / Kathode

BB 800 059 E/3

Order No. Bestell-Nr.	Quantity Stückzahl	Description Teil	Item Pos.	S / Reference S / Bemerkungen	
BK 204 737	1	BALKEN *Balk*	1		
BK 202 698	1	JOCH *Yoke*	2		
BK 202 699	1	WEHNELTTRAEGER *Wehnelt holder*	3		
BK 202 700	1	ISOLATOR *Insulator*	4		
BK 202 701	2	ISOLATOR *Insulator*	5		
BK 202 702	1	WEHNELTBLECH *Wehnelt panel*	6		
BK 202 703	1	WEHNELTBLECH *Wehnelt panel*	7		
BK 202 704 -R	1	KATHODE BK 604 018 A *Cathode*	8		
BK 202 718	1	KATHODENHALTER *Cathode holder*	9		
BK 202 719	1	KATHODENHALTER *Cathode holder*	10		
BK 202 745	1	ANSCHLUSSCHIENE *Connection bar*	11		
B 4622 251 TN	2	EINZELTUELLE 71-6115 *Sleeve*	12		
B 2220 140 -W	1	DRAHT, NI 99,8, Ø 1 *Wire*	13		500.00 MM
N 3052 189 X	4	Z-SR, INOX, M 3 X 6 *Screw*	15		
N 3052 193 X	2	Z-SR, INOX, M 3 X 10 *Screw*	16		
N 3052 198 X	2	Z-SR, INOX, M 3 X 16 *Screw*	17		
N 3111 114 X	2	S-SR 90, INOX, M 2 X 6 *Screw*	18		
N 3111 116 X	2	S-SR 90, INOX, M 2 X 8 *Screw*	19		
N 3111 191 X	2	S-SR 90, INOX, M 3 X 8 *Screw*	20		
N 3204 188 X	2	GEW-STI ZA;INOX, M 3 X 5 *Threaded pin*	21		
N 3208 251 X	1	GEW-STI I-6KT K;INOX; M 4X 8 *Threaded pin*	22		
N 3502 412 X	3	U-SB, INOX, 3,2/ 7 X 0,5 *Washer*	23		
N 3052 186 X	1	Z-SR, INOX, M 3 X 4 *Screw*	24		
N 3502 414 X	3	U-SB, INOX, 4,3/ 9 X 0,8 *Washer*	25		
N 3052 251 X	2	Z-SR, INOX, M 4 X 8 *Screw*	26		
N 3052 253 X	1	Z-SR, INOX, M 4 X 10 *Screw*	27		
BK 203 010	1	ANSCHLUSSCHIENE *Connection bar*	28		
BK 203 011	1	LEITBLECH *Deflector*	29		

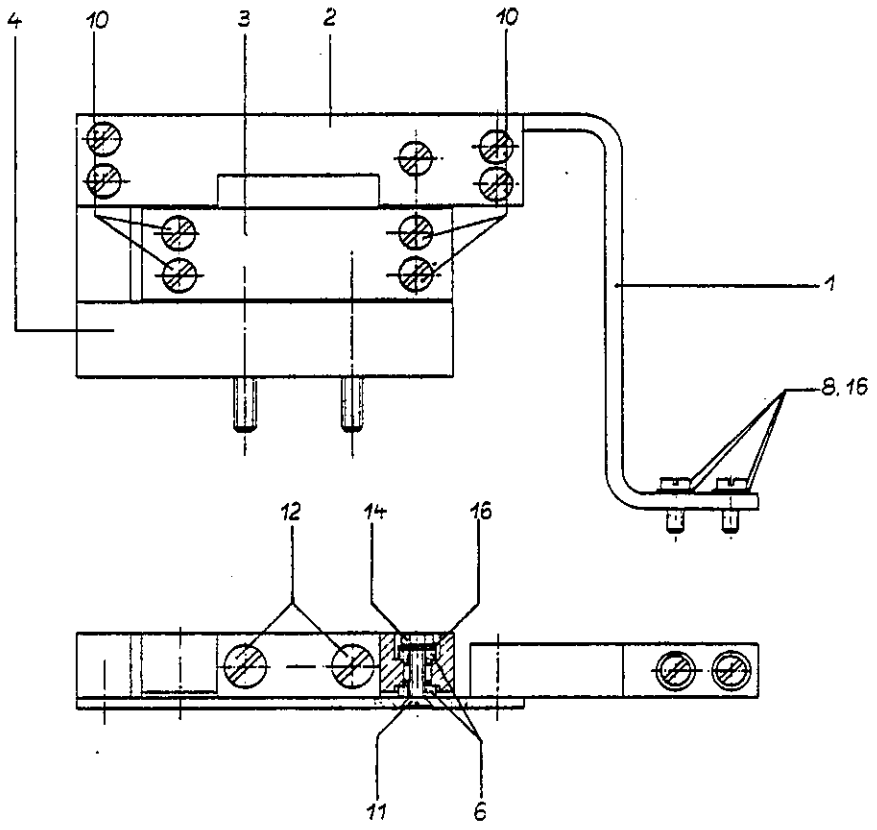
Order No. Bestell-Nr.	Quantity Stückzahl	Description Teil	Item Pos.	S / Reference S / Bemerkungen	
BK 203 012	1	LEITBLECH *Deflector*	30		
BK 203 013	1	VERSTEIFUNG *Stiffening*	31		
BK 203 014	1	EINSTELLEHRE *Feeler gauge*	32		
BK 202 735	2	DISTANZHUELSE *Sleeve*	33		
BK 204 739 U	1	JUSTIERBALKEN KPL. *Adjustment balk*	35		
N 3111 118 X	2	S-SR 90. INOX. M 2 X 10 *Screw*	36		
N 3415 027 X	2	6KT-MU 0.8D. INOX. M 2 *Nut*	37		
BK 202 720 EZ		KATHODE KPL.			
BK 204 740	1	MONTAGEHINWEIS			BEILEGEN
BK 850 197 -V	1	MONTAGEVORSCHRIFT			BEILEGEN

Spare parts for / Ersatzteile zu

Cathode / Kathode

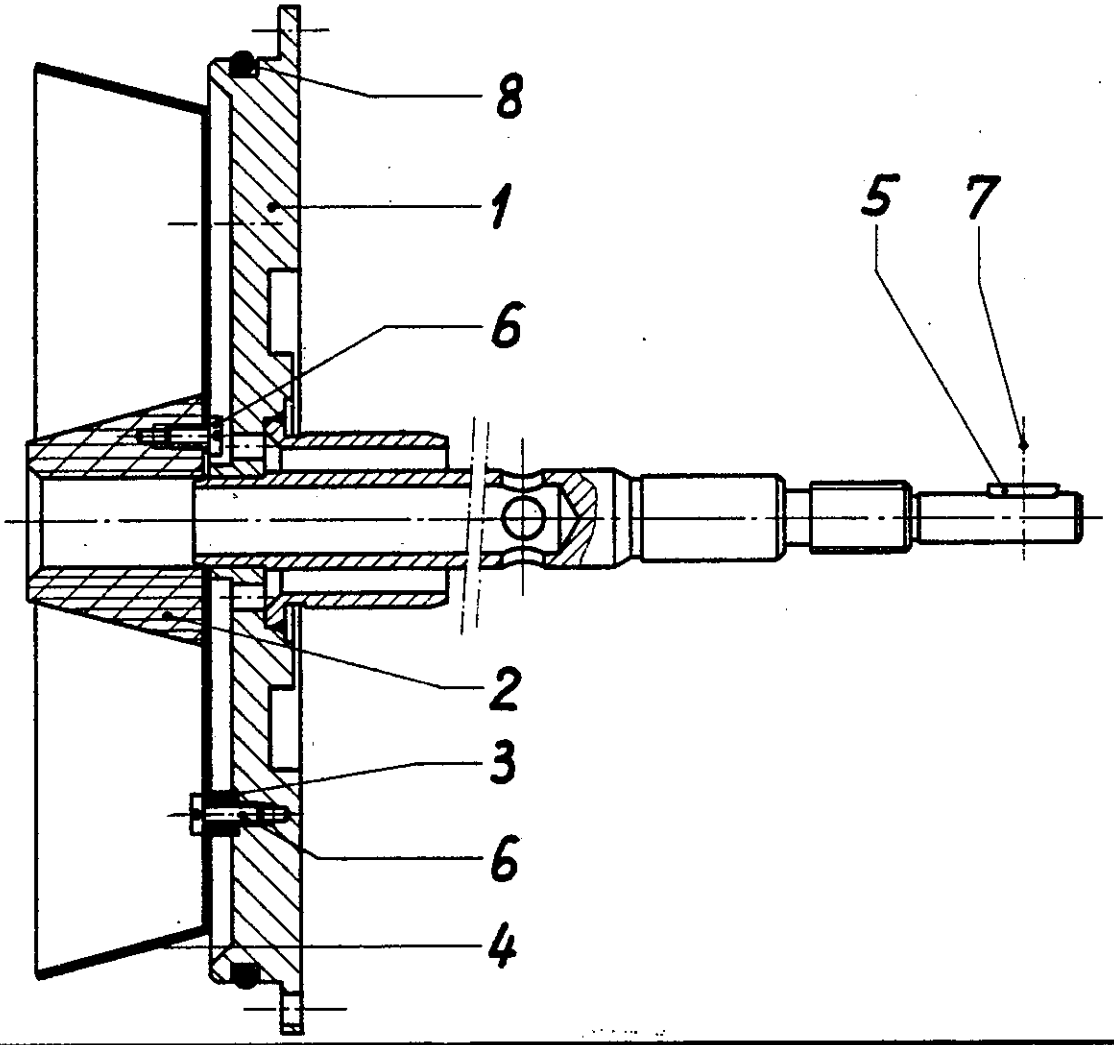
BB 800 059 E/3

Order No. Bestell-Nr.	Quantity Stückzahl	Description Teil	Item Pos.	S / Reference S / Bemerkungen	
BK 202 722 -X	1	ANSCHLUSSWINKEL,GELOETET *Angle*	1		
BK 202 688	1	ANODE 1	2		
BK 202 689	1	ANODE 2	3		
BK 202 723	1	ANODENHALTER *Holder*	4		
B 4622 251 TN	2	EINZELTUELLE 71-6115 *Sleeve*	6		
N 3052 191 X	2	Z-SR, INOX, M 3 X 8 *Screw*	8		
N 3111 191 X	8	S-SR 90, INOX, M 3 X 8 *Screw*	10		
N 3111 194 X	1	S-SR 90, INOX, M 3 X 12 *Screw*	11		
N 3111 267 X	2	S-SR 90, INOX, M 4 X 30 *Screw*	12		
N 3415 037 X	1	6KT-MU 0,8D, INOX, M 3 *Nut*	14		
N 3502 412 X	3	U-SB, INOX, 3,2/ 7 X 0,5 *Washer*	16		
BK 202 724 AZ		ANODE KPL.			



Spare parts for / Ersatzteile zu	
Anode	BB 800 059 E/5

Order No. Bestell-Nr.	Quantity Stückzahl	Description Teil	Item Pos.	S / Reference S / Bemerkungen
BK 204 853 -X	1	HALTER *Holder*	1	
BK 204 855	1	WASSERFUEHRUNG *Water-guide*	2	
BB 178 473	4	ROHR *Pipe*	3	
BK 204 857 -R	1	TOPF BB603159 *Pot*	4	
BK 202 674	1	KEIL *Key*	5	
N 3052 191 X	8	Z-SR, INOX, M 3 X 8 *Screw*	6	
N 3570 018 X	1	SCHW-SP-STI, INOX, S 1 X 5 *Pin*	7	
9 4071 376 PV	1	O-RING, VI, AN 250, 126,6 X 3,53	8	
BK 204 850 -Z		HALTER KPL *Holder*	20	



Spare parts for / Ersatzteile zu	BK 204 851 –T	
Halter		BB 800 059 E/6