HIGH VACUUM COATING UNIT
BA 510 AUTOMATIC

Operation Manual No. A 11-3918 e

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für Hochvakuumtechnik und Dünne Schichten
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1. APPLICATIONS

The BA 510 Automatic is a compact high vacuum coater of large capacity. Like the other coaters BA 710 and BA 360 of the BALZERS standard line, the BA 510 Automatic has the same versatile basic design. With a large number of accessories and auxiliary equipment available, it is easy to adapt the BA 510 Automatic for various applications, such as:

Micro circuits	Interference filters
Semi conductors	Anti-reflection coating
Magnetic films	Surface mirrors
Multi layer systems	Metallising, etc.

The BA 510 Automatic is a general production unit of large capacity. Having the same basic design as the other units of the BALZERS standard line, a large number of the same accessories may also be used. The pumping system with a pumping speed of 1900 l/sec. allows short working cycles and low ultimate pressures. In the coolable and heatable double walled bell jar pressures below 1×10^{-6} Torr can be obtained without using liquid nitrogen cooling. With multi-coolant baffle and Meissner trap ultimates below 1×10^{-7} Torr can be obtained.

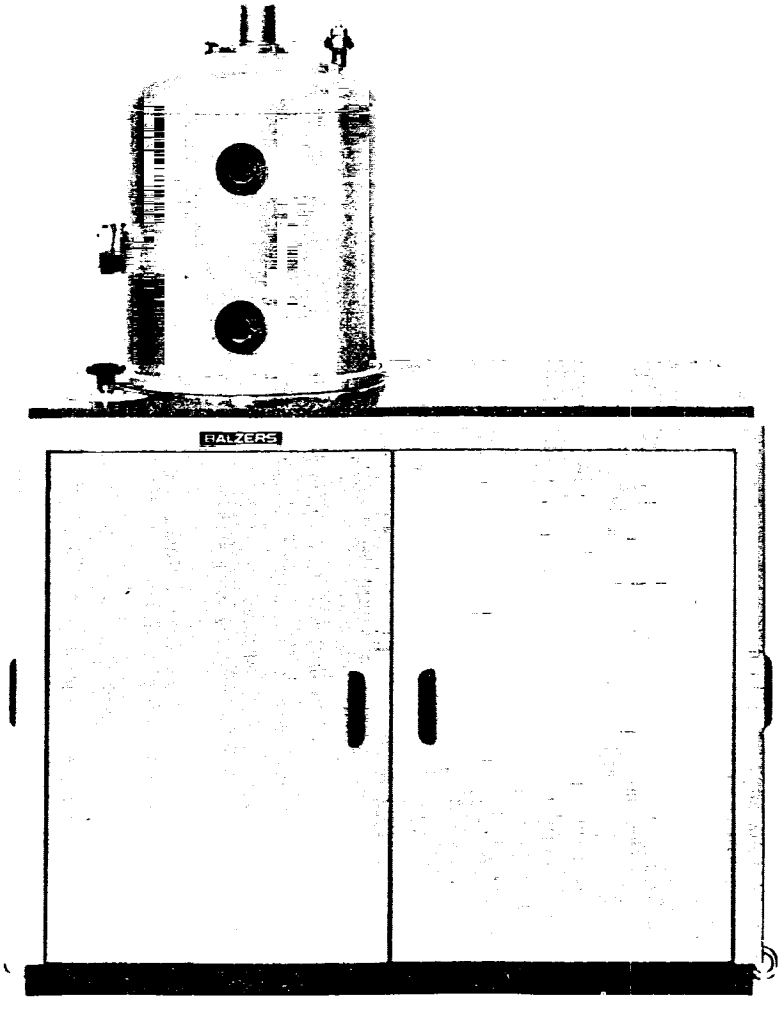


Fig.1

2. TECHNICAL DATA

2.1. Dimensions

Complete unit see installation drawing Fig.2

Bell jar:	Inner diameter	505 mm
	Cylindrical height	520 mm
	Overall height	650 mm

2.2. Weight

Weight of the unit	approx.750 kg

2.3. Pumping system

Fully automatic PST 1900 with diffusion pump DIFF 1900 and fore vacuum pump DUO 35

Pumping speed of the diffusion pump DIFF 1900 without baffle for air at 10^{-4} Torr	1800 l/sec
Pumping speed of the fore vacuum pump DUO 35 at 760 Torr	35 m^3/h

Multi-coolant baffle

2.4. Valves

High vacuum plate valve (pneumatic)	PV 205 P
Fore vacuum and bypass valve (pneumatic)	V 36 P
Vent valve (electro-magnetic)	FV 27 M

2.5. Operational data

Nett pumping speed for air at the base plate at 10^{-4} Torr	600 l/sec

2.6. Connection data

2.6.1. Electrical (see also 4.11.)

Power max.	approx. 4 kVA
Voltage	3x380/220 V (3P+N+E)
Frequency	50 cycles

2.6.2. Compressed air

Pressure min./max.	5 - 8 atm.
Connection:	⌀ 6 mm

2.6.3. Cooling water

Pressure min./max.(dynamics)	1 - 4 atm.

Optimal input temperature (20° C should not be exceeded)	< 10° C
Flow through quantity at 1 atm. (including bell jar and base plate cooling)	approx. 400 l/h
Connections	⌀ 13 mm
Output	without pressure

2.6.4. Hot water

(For accelerated de-gassing of the chamber) Pressure min./max.	1 - 4 atm.
Max. input temperature (with neoprene seals)	80°C
Flow through quantity at 1 atm.	approx. 150 l/h
Output	without pressure
Connection	⌀ 13 mm

2.6.5. Exhaust of fore pump

Connection	⌀ 26 mm

2.6.6. Foundations

Special foundations are not needed. The unit may be placed without fixation on a level floor.

2.7. Data for checking tightness of the unit (pressure rise check)

Volume of chamber until plate valve	approx. 134 l
Volume of the pumping system from plate valve to fore line valve	approx. 20 l
Volume between base plate and plate valve	approx. 10 l
Nett pumping speed at the base plate	approx. 600 l/sec
Obtainable ultimate pressure in the chamber	approx. 1×10^{-6} Torr
Maximum tolerable leak rate of the clean bell jar	approx. 2×10^{-4} Torr l/sec
Maximum tolerable leak rate of the plate valve seal	approx. 1×10^{-5} Torr l/sec
Maximum tolerable leak rate of the pumping system between plate valve and fore line valve	approx. 1×10^{-4} Torr l/sec

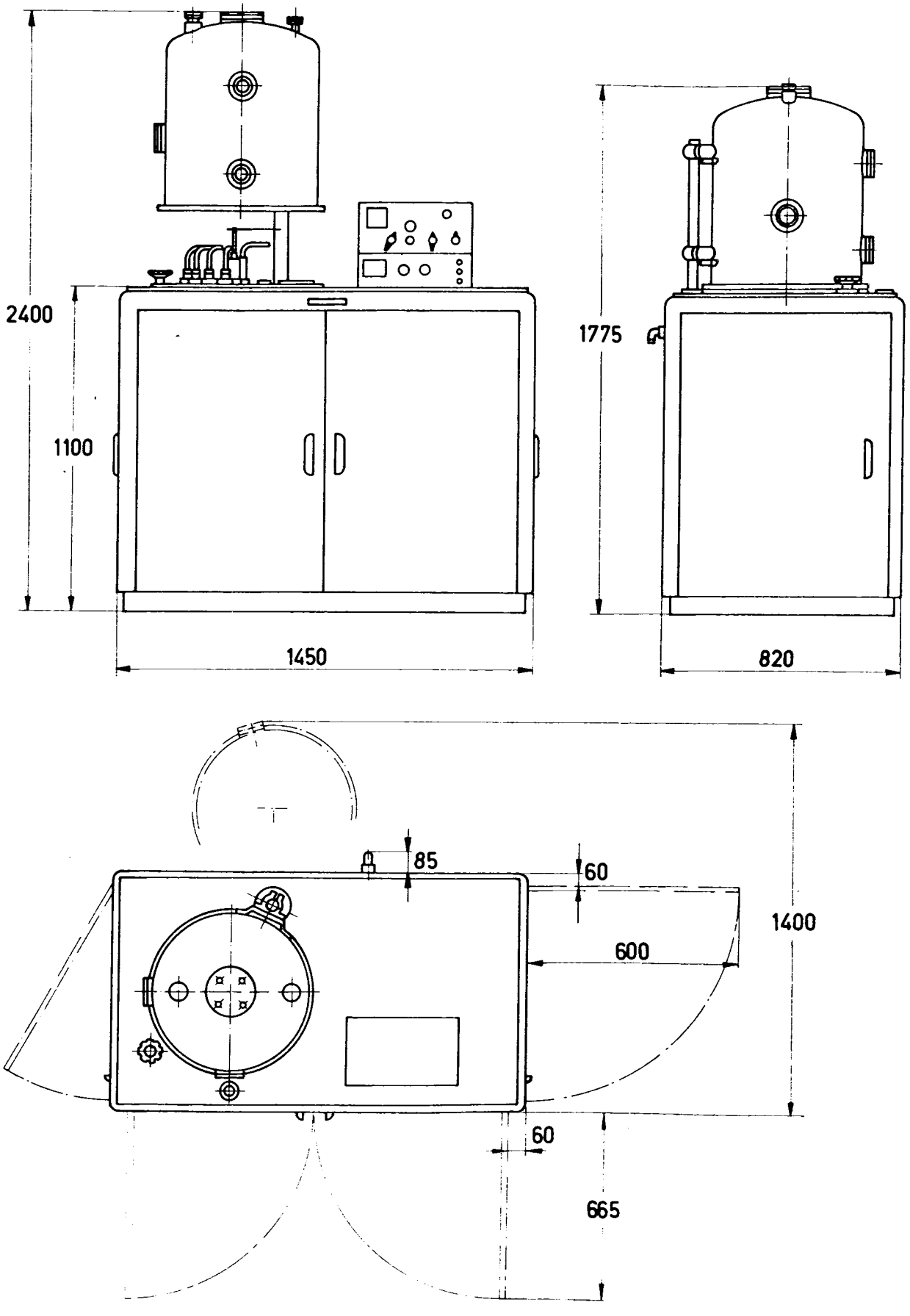


Fig.2 Installation dimensional drawing to BA 510 Automatic

3. DESCRIPTION

3.1. The cabinet

of the BA 510 Automatic is a steel construction with front and side doors. The rear wall is easily removable.

3.2. The Bell Jar

is a double-walled construction of stainless steel. It can be cooled and/or heated. The inner surface is polished. The sight glasses fitted at the double wall allow for the supervision of the coating process. Additional devices can be mounted at four blanked-off flanges.

3.3. The Polished and Hard-chromium Plated Bell Baseplate

is provided with 17 bores which are blanked off. Various components e.g. high current feedthroughs and rotary seals can be installed in these bores. Two easily replaceeable sight glasses for the photometric film thickness measuring equipped are fitted in the baseplate.

3.4. The Pumping System

The generously dimensioned, fully automatic pumping system with a 1800 l/sec diffusion pump warrants short, trouble-free working cycles. The diffusion pump is equipped with a highly efficient multi-coolant baffle (coolable with water or liquid nitrogen) which practically eliminates oil backstreaming. All valves (exception vent valve) are electro-pneumatically actuated and close automatically in the event of power failure. The pneumatically actuated valves open and close smoothly i.e. without hard shocks or vibrations which could interfere with or even damage sensitive setups in the bell jar.

The pressure in the bell jar is measured by means of a cold cathode gauge head (measuring range 5×10^{-3} to 5×10^{-8} Torr) and a Pirani gauge head (measuring range 50 Torr to 2×10^{-3} Torr). A further Pirani gauge head is built-in at the backing side of the diffusion pump. The vacuum gauge is fitted in a rack panel together with the pumping system control unit. The Pirani gauge heads are also used as sensors for the pressure-dependant automatic control.

3.5. The Evaporation Device

is an accessory to BALZERS coating units (refer to separate operating instruction) and is, therefore, not included in the basic unit BA 510 Automatic. However, the wiring of the unit is prepared for the installation of up to four high current transformers. The bell baseplate is provided with 17 bores allowing for the installation of at least four evaporation sources.

3.6. The Glow Discharge Equipment

is an accessory to BALZERS coating units (refer to separate operating instruction) and is, therefore, not included in the basic unit BA 510 Automatic. However, all connection lines required for hooking up the appro-

priate components such as vacuum relay, gas inlet valve etc. are provided in the wiring system of the basic unit. Thus, the glow discharge equipmen can be added at any time and without undue expense.

3.7. Evaporation and Glow Discharge Control

The controls for the high current and the glow discharge equipment are placed in a rack panel (see separate manual). By using additional control panels, it is possible to achieve semi or fully automatic glow discharge and evaporation control.

3.8. The Vacuum Measuring Equipment

consists of two medium-vacuum Pirani gauge heads NV 4 and of one high vac· uum gauge head HV 5.

The measuring range is between 50 Torr and 5 x 10^{-8} Torr. The power supply for the gauge heads, the pressure indicator instrument and the gauge head commutator switch are - together with other control equipment - installed in a rack panel (refer to separate operating instruction).

4. INSTALLATION

When unpacking the plant keep in mind that - as a transport safety measure - the bell is evacuated. It may not be vented or liftet by force.

Refer to the separate operating instructions for the connection of the pumps, valves etc.

4.1. Environment

This should be free of dust and draughts, and dry.

4.2. Space required

See installation drawing Fig.2

4.3. Transporting the Plant to the Place of Installation

Four crane eyes are attached to the lower base frame of the plant in order to facilitate moving.

The BA 510 Automatic should be transported to the final place on installation making use of the crane eyes mentioned above. Hemp ropes should be used while the points of contact must be protected with cardboard or similar. It is of utmost importance that four ropes of exactly the same length are used, which - when loaded - do not alter in length. They must be led to one common suspension point (crane hook). These pracautions are necessary in order to prevent that the plant tips over when it is lifted off the ground. It is also possible to push metal rods through the ring screws. Take care to avoid lateral slipping of the metal bars when the plant is lifted.

4.4. Installation of the Fore-pump

The fore-pump is screwed to a frame and on the other hand the frame is fixed to a cabinet. When the coating unit is in its definite position, the frame should be loosened from the cabinet (remove the distancing tubes) and the frame with the pump is placed directly on the floor to avoid transmission of vibrations to the cabinet.

4.5. Cooling Water Supply

Connect the 13 mm ⌀ hose nipple to the water mains through a shutoff cock. The cooling water pressure may not exceed 4 atmosphere pressure. If necessary, a pressure reducing valve must be incorporated.
Connect this hose nipple to the one on the plant (KE). Refer also to the cooling water diagram Fig.3 and picture Fig.4.

4.6. Hot Water Supply

Connection to boiler or continuous flow heater through hose nipple 13 mm ⌀. A pressure reducing valve must be installed if the pressure exceeds 4 atmospheres above atmospheric pressure.

The hot water supply line is connected to the plant through the hose nipple HE as shown in the cooling water diagram Fig.3 and picture Fig.4.

4.7. Cooling Water Drain

Connect the hose nipple 13 mm ⌀ without shutoff cock to the drain pipe. The cooling water must flow away freely i.e. unthrottled. Connect the draining hose to the hose nipple GA as shown in the cooling water diagram Fig.3 and in picture Fig.4.

4.8. Deep Coolants

For plants equipped with Meissner trap (accessory) or if deep-cooling with the multi-coolant baffle is planned, the customer has to prepare the following parts:

Dewar vessel for liquid nitrogen

Copper tube ⌀ 6 x 1 mm or plastic hose of the same dimension

Asbestos hose for the heat insulation of the copper tubes etc.

Armaflex hose 3/8" x 1/2" (sponge rubber hose with smooth skin)

4.9. Compressed Air Connection

Connect the compressed air hose ⌀ 6 mm to the compressed air supply and to the hose nipple P of the plant as shown in picture Fig.4.

4.10. Exhaust Gas Line Connection

The exhaust nipple of the backing pump has an O.D. of 26 mm.
The exhaust line (rubber hose or fixed installation) should be led out to the open air. It should be led out in such a way that condensates can not flow back into the pump. This means that the exhaust line should lie

lower than the exhaust port of the pump. If it cannot be avoided that the exhaust line rises above the level of the exhaust port of the pump, a condensate draining cock or, better, a condensate siphon must be installed at the lowest point of the exhaust line.

It is not advisable to connect the backing pump exhaust line to a water drain as any obstruction in the latter my cause contamination not only of the pump but of the whole unit.

Cooling water diagram to the
BA 510 Automatic

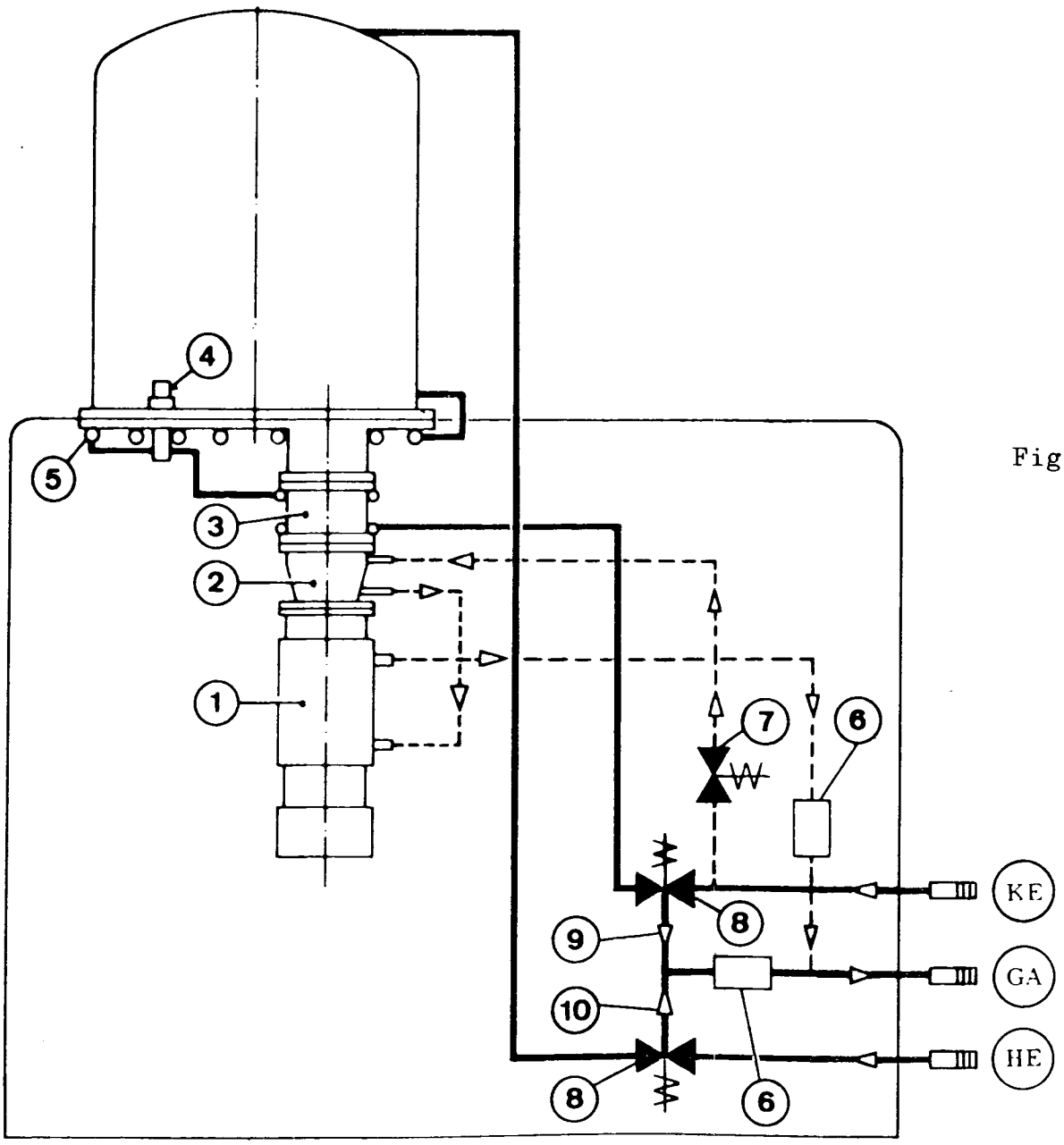


Fig.3

— — — — — Cooling water to baffle and diffusion pump

——————— Hot and cold water (alternative) to the bell jar, the bell baseplate and the plate valve

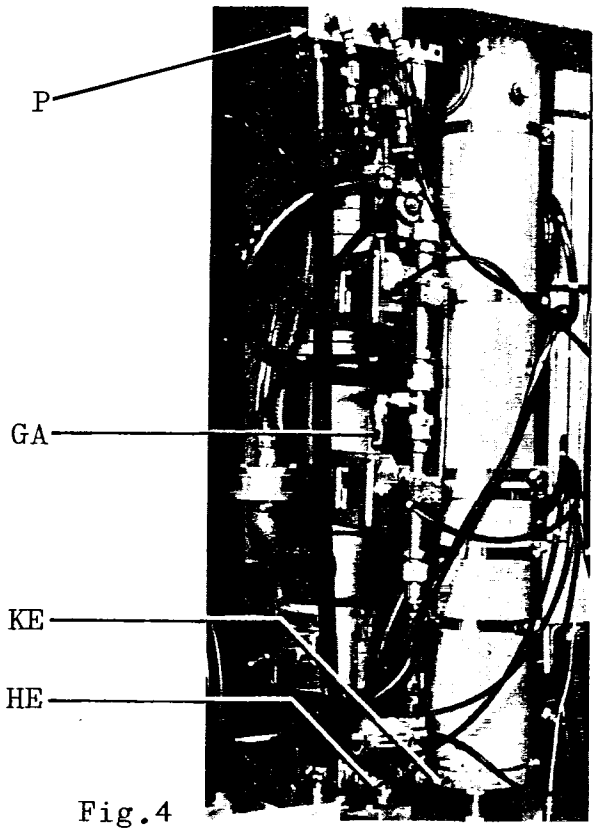


Fig.4

1 Diffusion pump
2 Multi-coolant baffle
3 Plate valve
4 High current feedthrough (accessory
5 Baseplate cooling
6 Flow relay
7 Two-way valve (solenoid-actuated)
8 Three-way valve (solenoid-actuated)
KE Cooling water inlet
HE Hot water inlet
GA Common drain (hot and cold water)
P Compressed air connection

4.11. Electrical Connection

On the rear of the unit there are two cables with multi-contact plugs. One cable is connected to the pumping system and has to be plugged into the pumping system control panel. The other cable is connected with the high current supply, high voltage supply, rotary cage drive etc. and has to be plugged into the evaporation glow discharge panel. The mains are connected directly to the control panels. The mains connection is made over a main switch and fuses (installed by customer) to the control panels.

Normally our units leave the works already wired according to the client requirements. Should, as an exception, this not be the case, the backing pump motor and the control voltage transformer (in the pumping system control panel) must be adapted to the actual mains voltage in accordance with the wiring diagram. The control voltage transformer in the control panel must be adapted under reference to the appropriate operating instruction. The wiring diagram to the pumping system control panel shows which voltages reach the backing pump motor and the diffusion pump. The motor and the diffusion pump heater must be reconnected accordingly, if necessary.

The mains connection of the various control panels must be made as per wiring diagram by an electrician.

4.12. Pumping Oils

The pumps already contain the necessary quantity of pumping fluid.

5. DESIGN AND FUNCTIONING OF THE PUMPING SYSTEM

5.1. Main Parts of the Pumping System

See also schematic diagram Fig.5 and photograph Fig.6

DUO Two-stage rotary vane pump with gas ballast valve for pumping condensable vapours.

DIFF Three-stage water cooled oil diffusion pump.

BFL Multi-coolant baffle for further suppression of the innately low oil backstreaming of the diffusion pump. The multi-coolant baffle can be cooled with water or liquid nitrogen.

BV Bypass-valve, pneumatically operated flap valve with electrical control. The valve is open and stays open when control voltage is switched on. In case of power failure the valve closes automatically (spring operated).
In the closed and open positions, terminal switches are used for interlocking and signalisation.

VV Fore line valve. Same as bypass valve.

PV High vacuum valve. Pneumatically actuated valve with electric control of the two-way air cylinder. In the event of compressed air failure two or three more actuating cycles are made possible by the pressure reserve in the air tank. The valve closes automatically in the event of power failure. In open and closed positions terminal switches are used for interlocking and signalisation.

FV Vent valve. Like BV and VV but solenoid actuated

2 Pirani gauge head Type NV 4 for measuring the fore vacuum in the fore line. (This gauge is at the same time a sensor for the automatic control). Measuring range 50 - 2 x 10^{-3} Torr.

1 Pirani gauge head Type NV 4 for measuring the fore vacuum in the chamber. Sensor for the automatic control.
Measuring range 50 - 2 x 10^{-3} Torr (cannot be seen in Fig.7.)

3 Penning gauge head Type HV 5 for measuring high vacuum in the chamber. Measuring range 1 x 10^{-3} - 5 x 10^{-8} Torr.

5.2. Functioning of the Pumping System

(Refer also to the vacuum diagram Fig.5 and photograph Fig.6)

As atmospheric air may not be pumped through the operational (hot) diffusion pump and in order to obtain short pumping cycles, the unit is provid ed with a bypass line. During roughing of the bell the diffusion pump is isolated by closing the plate valve and the backing line valve. Thus, any irruption of air into the diffusion pump is avoided. The diffusion pump is cut-in into the pumping process by opening the plate valve and the backing line valve only after the bell has been evacuated by the backing pump to the permissible working pressure of the diffusion pump. During bypass pumping i.e. when the backing line valve is closed, the diffusion pump works against the fore-vacuum reserve in the backing line. The bell can be vented through the vent valve FV when the process is finished.

5.3. Pumping System Safeties

The pumping process is fully automatically controlled by means of vacuum sensors. Therefore, errors are not possible. The most important interloc are:

5.3.1. None of the valves can open when the fore vacuum pump is not running.

2. The fore-line valve VV cannot open if the bypass valve BV is open and vice-versa.

3. The plate valve cannot open if the bell jar is at atmospheric pressure and/or if the diffusion pump is cold.

4. The vent valve cannot open when the high vacuum valve is open.

5. The bypass valve cannot open when the high vacuum valve and the fore line valve are open.

6. The diffusion pump heater cannot be switched on if the backing pump is not running.

7. All valves close in the event of power and/or air failure.

8. After switching off the pumping system the water cooling continues until the diffusion pump is cold.

9. Reverse running of the backing pump would pump oil into the fore-vacuum line and, thus, cause contamination of the fore-line valve VV and of the Pirani gauge head. This danger is avoided by an anti-return device.

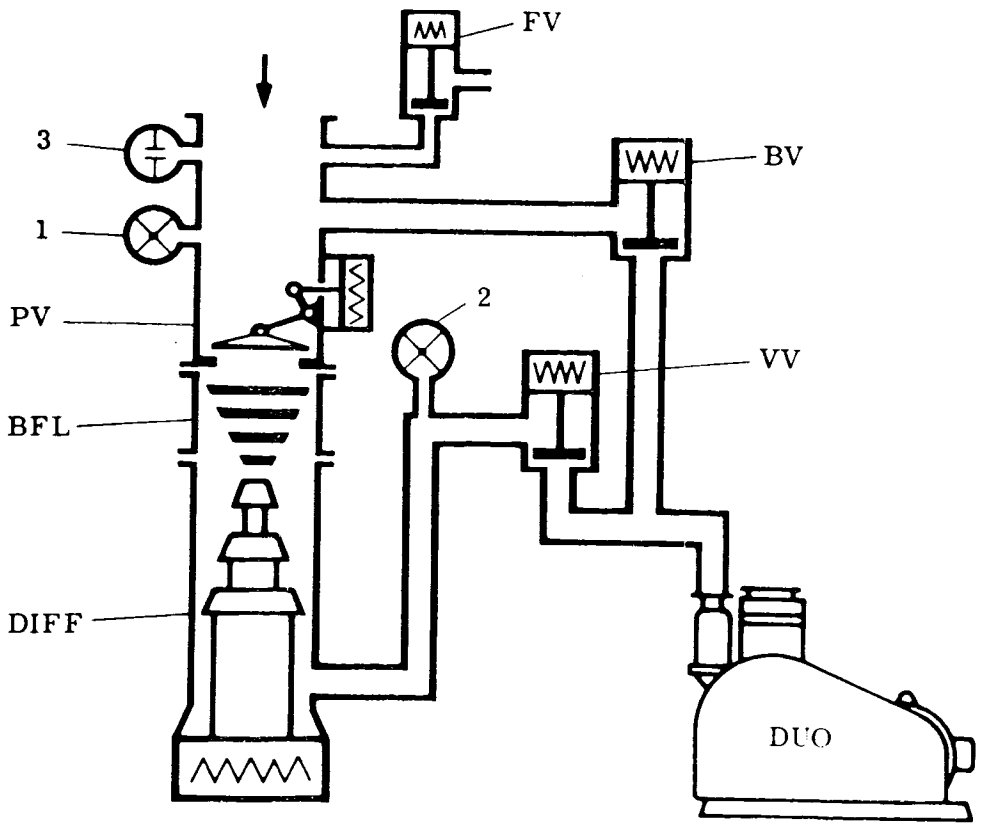


Fig.5 Schematic diagram of pumping system

5.3.10. Two flow relays mounted in the cooling system monitor the cooling water circulation of the diffusion pump as well as that of the bell jar and to the feedthroughs (refer to Fig.3). The diffusion pump heater cannot be switched on if the cooling water circulation is insufficient.

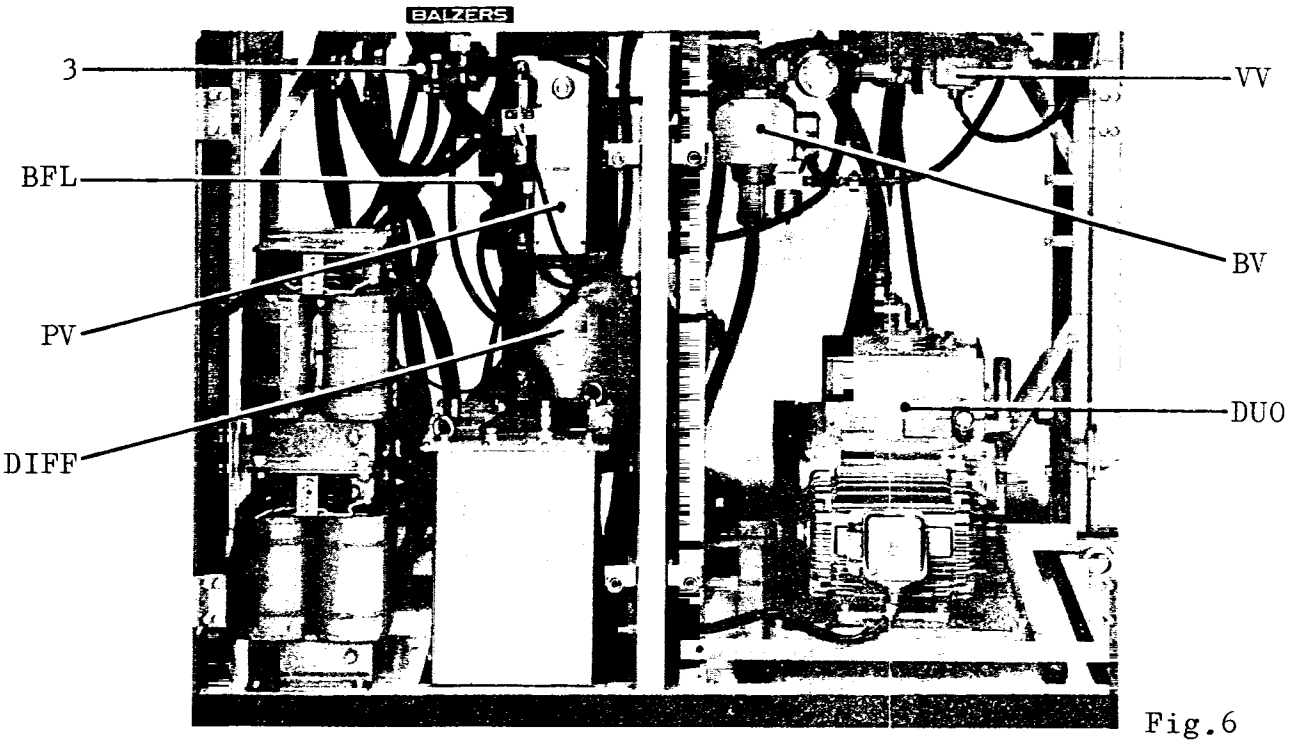


Fig.6

6. OPERATION

The unit is sturdy and works for years maintaining the good operational data if it is treated as a high vacuum unit should be. Therefore, the directions for operation and maintenance must always be carefully observed.

6.1. General Directions

6.1.1. Keep the bell clean

Keep off oil, grease and water. Even very small quantities which cannot be visually detected may strongly influence pumping times and ultimate vacuum. Therefore, only use absolutely clean and dry cloths and do not touch the inside of the bell jar, the base plate or the jigs with sweaty hands. In the event of the chamber becoming contaminated, if necessary, clean all parts contaminated according to Paragraph 7.8. Keep off threads, hairs, etc. A single hair on the main seal is sufficient to deteriorate functioning.

6.1.2. Use of gas inlet valves, e.g. needle valve

Ensure that when using such a valve for glow discharge, the pressure in the chamber does not rise above approximately 5×10^{-2} Torr.

6.1.3. Evacuate the bell before breaks in operation

The bell must be evacuated to 0,1 Torr or better before longer breaks in operation, especially before putting the unit out of operation, in order to avoid longer than necessary exposure to the atmospheric humidity.

6.2. Putting pumping system into operation

This is done by means of the main switch on the control panel (see separate manual).

6.3. Putting pumping system out of operation

This is done by means of the main switch. After switching off the cooling water runs on until the diffusion pump is cold. Therefore, the unit should not be switched off by switching off at the mains, as long as the diffusion pump is hot (see also separate manual).

6.4. Bell Jar Hoist

The bell jar of the BA 510 Automatic is lifted and lowered by hydro-pneumatic action. The hydraulic cylinder is placed within the cabinet. The control switch is on the pumping system control panel.

In order to avoid undue wear, the bell jar is to be swung away only if it is in its uppermost position. Thus, always lift the bell jar to the stop and swing it away only then.

For cleaning and other work the bell jar can also be lowered in the completely swung back position. Set the mode of operation selector switch to "STANDBY".

7. MAINTENANCE

For components such as pumps, valves, gauges etc. refer also to separate manuals.

7.1. Backing pump

Check the oil level periodically e.g. once per week and re-fill if necessary.

7.2. Diffusion pump

A diffusion pump always looses oil slowly when in operation. Oil vapours are pumped away by the backing pump. The oil loss is proportional to the gas flow through the pump.

In correct operation, the oil level in the diffusion pump must be checked at the sight glass every 6 months. The oil is to be replaced or filled up if necessary. This check must be done while the pump is in operation in order to permit ascertaining whether the pump oil must be replaced or replenished. Pay attention to the following:

The pump is fit for operation if the oil is clean, i.e. clear and transparent and if the oil level is not lower than the top third of the sight glass. If the oil filling is normal the level is above the sight glass during operation and, thus, not visible. Replenishing can be done through the backing port without dismounting the cold diffusion pump. Fill up such a quantity of oil that the level is visible approximately 2 mm below the upper edge of the sight glass when the diffusion pump is cold.

Be aware of the slow equalization of the levels inside and outside the jet system.

If the oil level check indicates that the pump oil is contaminated (dark brown discolouring of the oil), the diffusion pump and the jet system must be dismantled, the oil replaced as described in the separate instruction. Proceed as follows:

7.2.1. Remove cooling water input connections at the diffusion pump.

2. Blow out remaining water with pressured air.

3. Remove cooling water outlet and electrical connections.

4. Vent the bell jar. The diffusion pump must not be vented while the bell jar is evacuated in order to avoid damaging the plate valve.

5. Disconnect the hose with spiral spring by removing the jubilee clip. The sealing surface of the hose nipple must not be scratched.

6. Dismount jet system of diffusion pump according to separate manual.

7. Remove the oil by tilting the diffusion pump.

8. Clean the diffusion pump and the jet system. Fill in fresh oil.

9. Reassemble and mount pump into the unit again in reverse sequency.

7.3. High vacuum plate valve

Lubricate moving mechanism every six months with molycot oil or paste.

7.4. Flap valves

Lubricate moving mechanism every six months with molycot oil or paste.

7.5. High vacuum gauge heads HV 5

See separate manual.

7.6. Fore vacuum gauge heads NV 4

See separate manual.

7.7. Protection of the Bell Jar against Coating

For the protection of the bell jar walls and of the bell baseplate against coating the use of a protective cylinder and a protective shield is recommended. They are cleaned much easier than the bell jar and the bell baseplate. Both are available as accessories. The bell jar, the baseplate

and the installed components can also be protected with aluminium foil lining and wrapping which are replaced when heavily coated.

7.8. Cleaning the Bell Jar

The deposits formed on the bell jar walls and on the baseplate by coating must be removed from time to time as they cause increased pumping time. Most simple cleaning is effected with emery cloth. Thicker coats peel off when they are loosened with a screw driver or scraper without sharp edges. Subsequently, wash with alcohol and dry.

7.9. Cleaning of sight glasses

The protective glasses and if necessary the sight glasses themselves can easily be cleaned in acid. They have to be rinsed in water afterwards and dried.

7.10 Overhaul of the Unit

After approximately 3500-4500 operating hours the complete coating unit should be overhauled.

IT IS ADVISABLE TO HAVE THE OVERHAUL DONE BY A BALZERS SERVICE ENGINEER.

Overhaul:

7.10.1. Clean thoroughly the bell jar, pumps, valves, vacuum gauges, lead-ins, fore vacuum line pressure, pressure line and water lines.

2. Exchange the main base plate seal, the valve seals and pump seals according to separate manuals.

3. Change the oil of the fore-pump and of the diffusion pump.

4. Overhaul and cleaning of the hydraulic cylinder. Replace cup seal in case of heavy oil loss. Check the oil level in the reserve cylinder and replenish, if necessary, up to the filler screw with Aircraft Hydraulic Fluid Type A-A (Caltex). Refer also to the spare parts list Z11-219, Bl.7, Pos.91).

   If you want to use another hydraulic fluid, make <u>absolutely sure</u> that it has the following properties:

Setting point	approx.	$-60^{\circ}C$	Viscosity	at $-20^{\circ}C$	approx. $9^{\circ}E$
Flash point	approx.	$100^{\circ}C$		at $20^{\circ}C$	approx. $3^{\circ}E$
				at $50^{\circ}C$	approx. $2^{\circ}E$

   The oil must contain additives which with certainty prevent that it picks up air.

   Check the hydraulic lines and connections and replace if necessary the seals.

5. Leak test and check of pumpdown time. Please, refer to the separate instruction TESTING FOR LEAK TIGHTNESS, LEAK DETECTION AND SEALING HIGH VACUUM EQUIPMENT.

8. POSSIBLE DEFECTS AND THEIR RECTIFICATION

8.1. Dissatisfactory pump down in bypass operation

(Measuring point 1, ROUGH)

Possible reasons:

Bell jar not completely closed.

Bell jar seal damaged or contaminated.

Servo gas inlet valve of needle valve (accessory) not closed.

Excessive leak.

Defective fore vacuum pump.

Bypass valve does not operate correctly.

8.2. Dissatisfactory pump down in stand by operation

(Measuring point 2, BACK)

Possible reasons:

Seal of plate valve and/or fore line valve and/or bypass valve damaged or contaminated.

Fore vacuum pump defective.

Leak in the fore line system.

8.3. Dissatisfactory pump down in high vacuum operation

(Measuring point 3, HIGH VAC)

Possible reasons:

Base plate main seal damaged or contaminated.

Servo gas inlet valve or needle valve (accessory) not completely closed.

Diffusion pump heating interrupted because of insufficient water cooling.

Diffusion pump heater defective.

Not enough oil in the diffusion pump.

Diffusion pump oil burnt.

Leak in high vacuum system.

8.4. Defect on diffusion pump because of burnt oil or lack of oil

In cases of defects according to point 8.3. a method to check if lack of diff-oil or burning of pump oil is the reason can easily be done in the following way by checking pressure rise in the chamber with cold diffusion pump. If this pressure rise is normal the above-mentioned reason are probable. In this case proceed according to point 7.2.

If the colour of the pump oil is very dark and if the jet system and the inside walls of the diffusion pump is covered with a black film, the oil is burnt and has to be exchanged after cleaning of the pump. (See separate manual). In this case it has also to be checked whether the baffle and the plate valve are contaminated with burnt oil. Clean with a brush, water and a sand-free cleaning agent. If necessary, use a very fine emery cloth. Afterwards wash with alcohol and dry thoroughly.

9. SPARE PARTS

All essential spare parts are mentioned on the spare parts list and usually are available ex stock.

Mechanical spare parts	Z 11-219 p. 2 - 9
Electrical spare parts	Z 11-219 p. 10

Sheet 4 contains for instance indications concerning pumps, valves etc. (items 15 - 22). In this case a separate spare parts list is supplied according to which spare parts orders may be made.

Spare parts lists which are also used for the other BALZERS units, e.g. Z 11-107, are attached to this manual after the section Z 11-219.

Sample Order

1 Sight glass dia. 75 x 8, Code No. 431 689, according to spare parts list Z 11-219, p. 9, item 132.

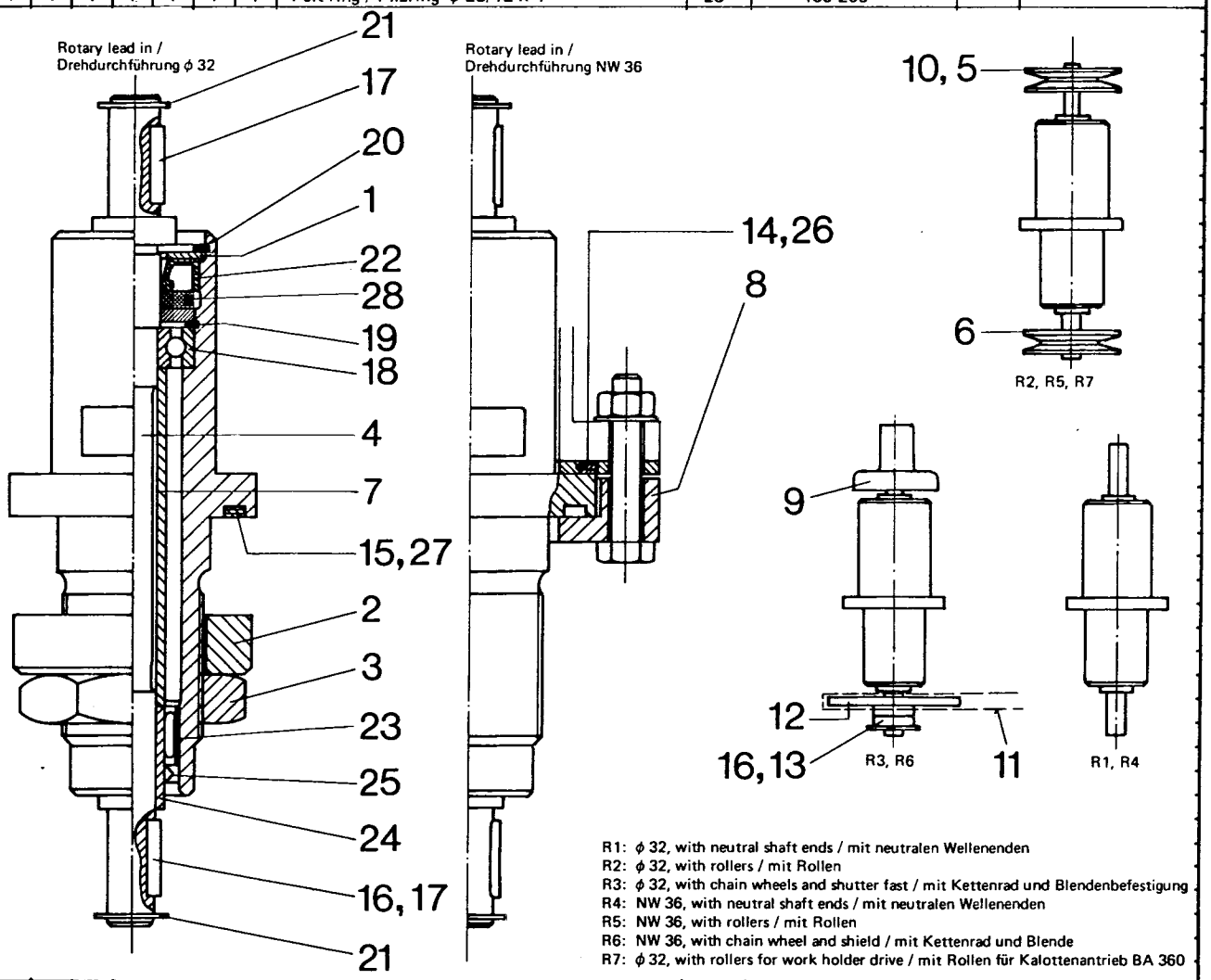
COMPLETE DATA FACILITATES THE WORK OF OUR SERVICE DEPARTMENT,

AND EVEN MORE IMPORTANT:

ENSURES PROMPT SERVICE AND DESPATCH OF

THE CORRECT COMPONENTS.

							Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
1	1	1	1	1	1	1	Washer / Scheibe	1	511-5241 P1		
1	–	–	–	1	1	1	Washer / Scheibe	2	511-5218 P1		
1	–	–	–	1	1	1	Nut / Sechskantmutter M 30 x 1,5	3	590 249		
1	1	1	1	1	1	1	Shaft / Welle	4	11-5243 P1		
–	–	1	–	–	1	–	Roller / Rolle	5	511-5956 P1		
1	–	1	–	–	1	–	V-belt pulley / Keilriemenscheibe	6	511-5244 P1		
1	1	1	1	1	1	1	Bushing / Hülse	7	11-5245 P1		
–	1	1	1	–	–	–	Flange / Flansch	8	511-5022 P1		
–	1	–	–	1	–	–	Extension / Verlängerung	9	511-5180 P1		
1	–	–	–	–	–	–	Roller / Rolle	10	11-3214 P1		
–	1	–	–	1	–	–	Chain / Präz. Rollenkette L = 850	11	435 064		
–	1	–	–	1	–	–	Chain wheel / Kettenrad	12	511-5954 P1		
–	1	–	–	1	–	–	Spacer / Distanzring	13	511-1955 P1		
–	1	1	1	–	–	–	O-Ring 42 x 4 Neoprene	14	406 412		
1	–	–	–	1	1	1	O-Ring 40 x 4 Neoprene	15	406 694		
–	1	–	–	1	–	–	Key / Einlegfederkeil 3 x 3 x 12	16	461 523		
2	1	2	2	1	2	2	Key / Einlegfederkeil 3 x 3 x 16	17	461 487		
1	1	1	1	1	1	1	Ball bearing / Kugellager ϕ 10/26 x 8	18	411 008		
1	1	1	1	1	1	1	Retaining ring / Sicherungsring ϕ 26 x 1,2	19	442 151		
1	1	1	1	1	1	1	Retaining ring / Sicherungsring ϕ 30 x 1,2	20	441 846		
2	1	2	2	1	2	2	Lock washer / Sicherungsscheibe ϕ 10 x 0,9	21	441 858		
1	1	1	1	1	1	1	Shaft seal / Gaco-Ring	22	406 868		
1	1	1	1	1	1	1	Needle bearing / Nadelhülse ϕ 14/20 x 12	23	411 132		
1	1	1	1	1	1	1	Inner ring / Innenring ϕ 10/14 x 20	24	411 133		
1	1	1	1	1	1	1	Seal / Dichtung ϕ 14/20 x 3	25	411 134		
–	1	1	1	–	–	–	O-Ring 42 x 4 Viton	26	406 816		
1	–	–	–	1	1	1	O-Ring 40 x 4 Viton	27	406 815		
1	1	1	1	1	1	1	Felt ring / Filzring ϕ 28/12 x 4	28	406 206		



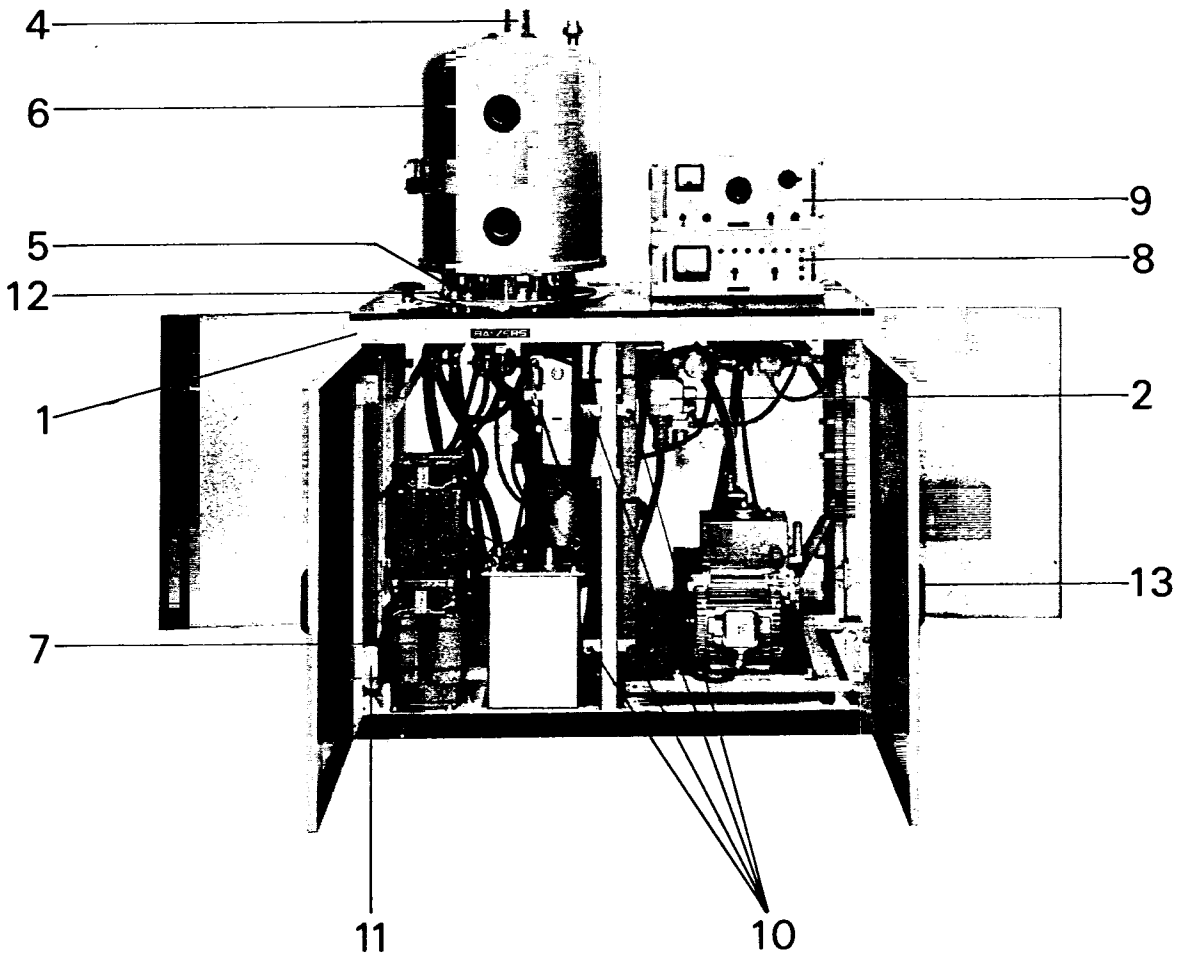
R1: ϕ 32, with neutral shaft ends / mit neutralen Wellenenden
R2: ϕ 32, with rollers / mit Rollen
R3: ϕ 32, with chain wheels and shutter fast / mit Kettenrad und Blendenbefestigung
R4: NW 36, with neutral shaft ends / mit neutralen Wellenenden
R5: NW 36, with rollers / mit Rollen
R6: NW 36, with chain wheel and shield / mit Kettenrad und Blende
R7: ϕ 32, with rollers for work holder drive / mit Rollen für Kalottenantrieb BA 360

Spare Parts for / Ersatzteile zu

Rotary lead in / Drehdurchführung **11-5207** **Z 11 – 107**

1170/Bee

		Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
1		Housing / Gestell	1			incl.item Pos. 10-13
1		Pumping unit / Pumpstand	2			Z 11-219/3-4
1		Water battery / Wasserbatterie	3		*	Z11-219/5; Z11-277
1		Bell jar hoist / Glockenhebevorrichtung	4			Z11-304/3-4
1		Base plate / Glockenteller	5			Z11-219/8
1		Bell jar / Glocke	6			Z11-219/9
1		Electr. equipment / Elektro. Ausrüstung	7			Z11-219/10
1		Pumping unit control / Pumpstand-Steuereinheit	8		**	
1		Evaporation control / Verdampfungs-Steuerung	9		**	
8		Permanent magnet / Dauermagnet	10	361 028		
8		Hinge / Scharnier	11	11-6046 R1		
1		Mirror / Spiegel, ϕ 80 x 2	12	431 787		
1		Handle / Muschelgriff	13	401 104		



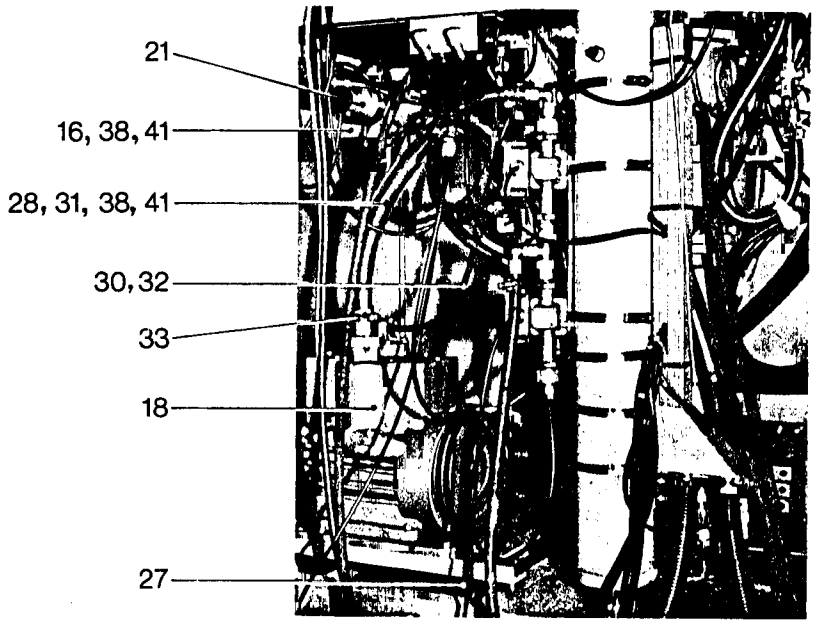
* not shown in this picture / im Bild nicht ersichtlich ** see sep. instruction / siehe sep. Anleitung

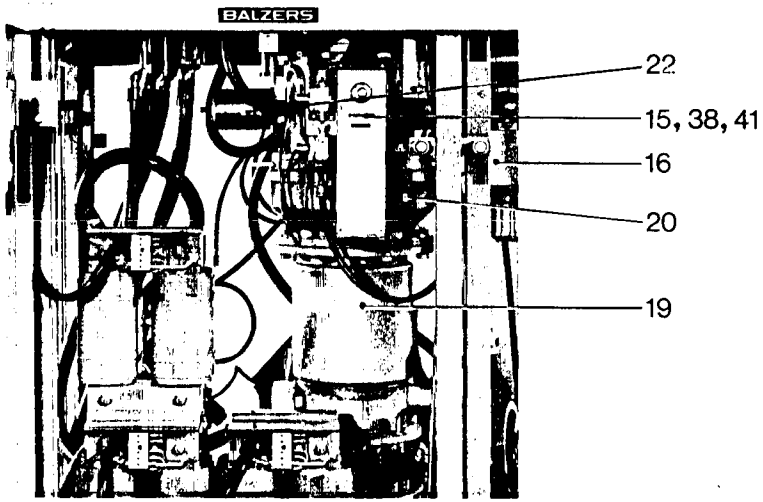
Spare Parts for / Ersatzteile zu

BA 510 AUTOMATIC

Z11–219/1a

Valid for serial Nos. / Gültig für Fabr. Nrn. 1101-2000





Z 11-219 Bl. 3

		Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
1		PV 205 P	15			*
2		V 36 P	16			*
1		FV 27 ML	17			*
1		DUO 35	18			*
1		DIFF 1900	19			*
1		MCB 1900	20			*
2		NV 4	21			*
1		HV 5	22			*
			23			
			24			
			25			
			26			
4		Anti-vibration mount / Schwingelement V 7/40	27	456 033		
2		PVC-hose / PVC-Schlauch LW 30 x 5 x 510	28	415 096		
1		PVC-hose / PVC-Schlauch LW 25 x 3,5 x L	28	415 035		
1		Hose / Gummischlauch LW 6 x 3 x 1400	30	415 089		
2		Spring / Federspirale L = 200	31	480-4052 P1		
6		Hose clamp / Schlauchbinder (M6)	32	415 001		
4		Hose clamp / Schlauchbinder (M20)	33	415 004		
			34			
			35			
			36			
4		O-Ring, Neoprene, ϕ 34 x 4	37	406 410		
12		O-Ring, Neoprene, ϕ 42 x 4	38	406 412		
1		O-Ring, Neoprene, ϕ 60 x 4	39	406 415		
4		O-Ring, Viton, ϕ 34 x 4	40	406 813		
12		O-Ring, Viton, ϕ 42 x 4	41	406 816		
1		O-Ring, Viton, ϕ 60 x 4	42	406 819		

* see sep. Instruction / siehe sep. Anleitung

Spare Parts for / Ersatzteile zu

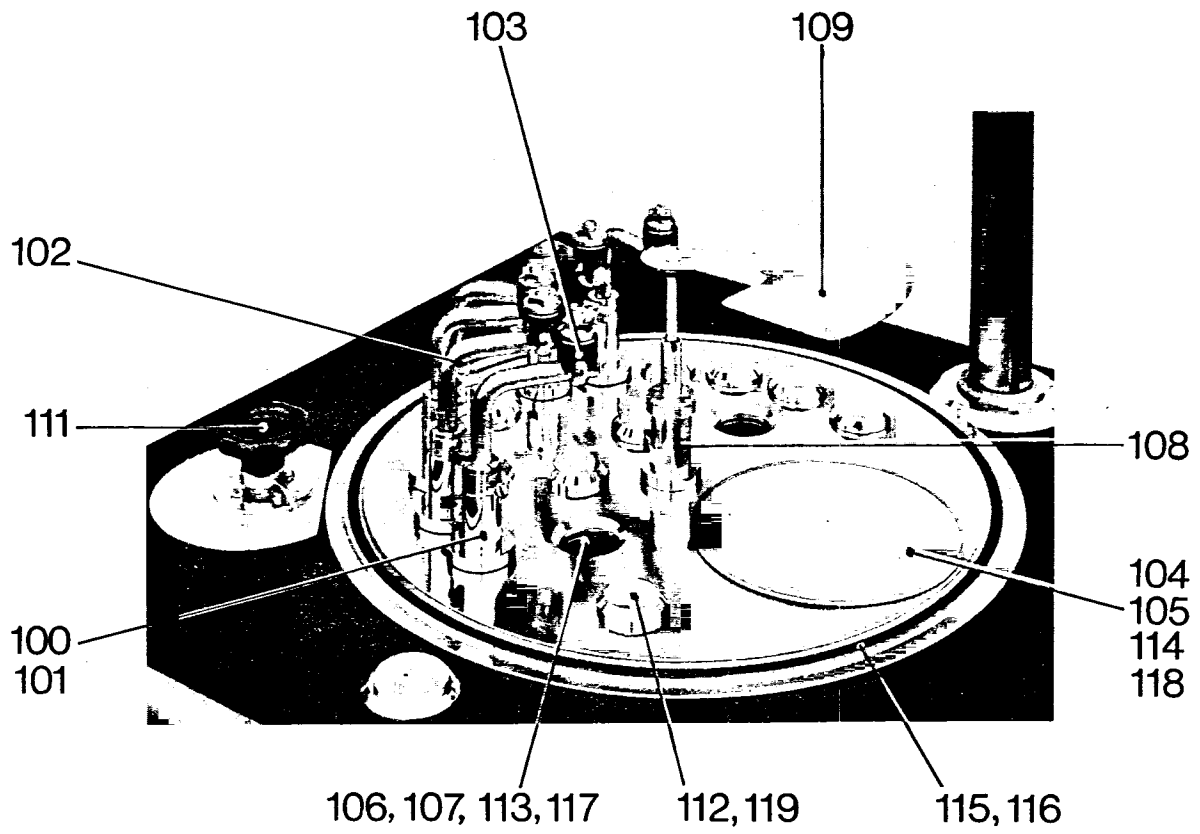
Pumping unit / Pumpstand

Z 11 – 219/4

1170/Bee

	Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
3	High current feedthrough / Hochstromdurchführung	100	11-5024 R2		Accessories/Zubehör
3	Ground feedthrough / Massedurchführung	101	11-5024 R2		Accessories/Zubehör
6	Electrode / Elektrode	102	11-5048 P1		Accessories/Zubehör
6	Clamp compl. / Klemmkopf	103	11-3175 R1		Accessories/Zubehör
1	Test blanking plate / Prüfblindflansch	104	11-5069 R1		*
1	Protection mesh / Schutzsieb	105	11-5781 R1		
2	Sight glass / Schauglas, ϕ 62 x 6,5	106	431 782		
2	Seal / Unterlage, ϕ 52/62 x 1	107	406 505		
1	Rotary lead in / Drehdurchführung (Accessories/Zubehör)	108	11-5207		Z 11-107
1	Deflector plate / Blendenblech	109	11-5182 R1		Accessories/Zubehör
		110			
1	Star knob / Sternrad	111	401 045		Accessories/Zubehör
8	O-Ring, Neoprene, ϕ 40 x 4	112	406 694		
2	O-Ring, Neoprene, ϕ 54 x 4	113	406 414		
2	O-Ring, Neoprene, ϕ 200 x 6	114	406 432		
1	O-Ring, Neoprene, ϕ 500 x 10	115	406 717		
1	O-Ring, Viton, ϕ 500 x 10	116	406 866		
2	O-Ring, Viton, ϕ 54 x 4	117	406 818		
2	O-Ring, Viton, ϕ 200 x 6	118	406 867		
8	O-Ring, Viton, ϕ 40 x 4	119	406 815		

* not visible / nicht ersichtlich



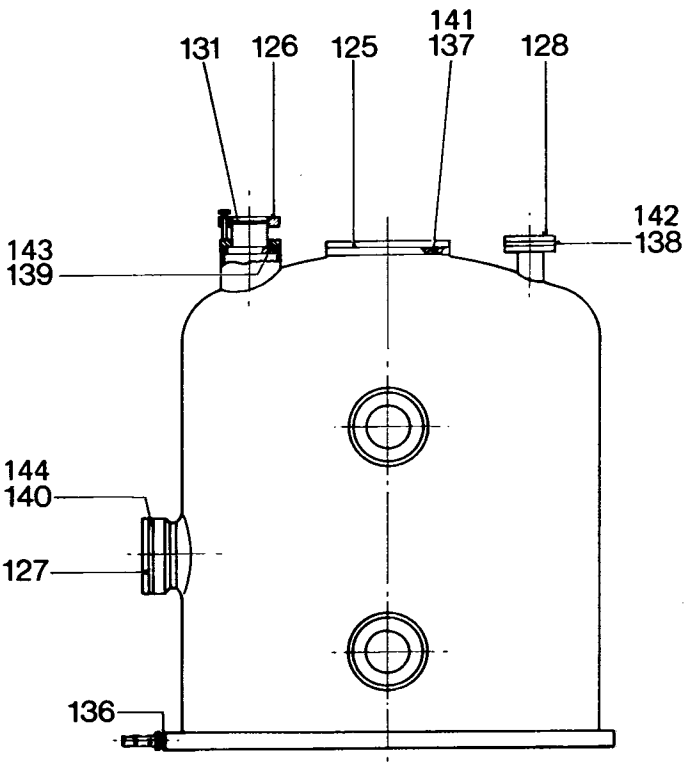
Spare Parts for / Ersatzteile zu

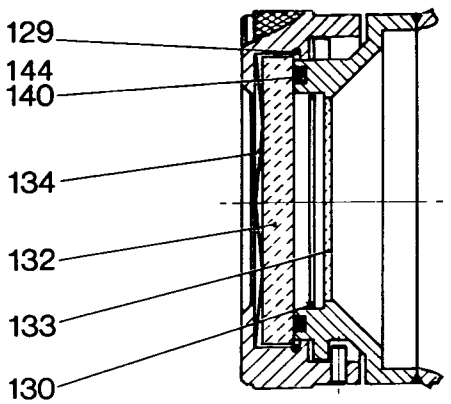
Base plate / Glockenteller

Z 11-219/8a

	Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
1	Blanking plate / Blindflansch	125	11-5149 P1		
1	Flange ring loose / loser Flansch	126	11-0092 P1		
1	Blanking plate / Blindflansch NW 52	127	540 141		
1	Blanking plate / Blindflansch NW 27	128	540 108		
2	Spring ring / Sprengring	129	80-4053 P2		
2	Spring ring / Sprengring	130	80-4053 P1		
1	Spring ring / Sprengring	131	520 092		
2	Sight glass / Schauglas, ϕ 75 x 8	132	431 689		
2	Protectiv glass / Schutzglas, ϕ 55 x 2	133	431 754		
2	Spring washer / Federscheibe	134	11-2762 P1		
		135			
1	Seal / Dichtung, Firefly, ϕ 18/13 x 2	136	406 640		
1	O-Ring / Neoprene, ϕ 114 x 6	137	406 419		
1	O-Ring, Neoprene,ϕ 34 x 4	138	66018		
1	O-Ring, Neoprene, ϕ 54 x 4	139	406 414		
3	O-Ring, Neoprene, ϕ 60 x 4	140	66023		
1	O-Ring, Viton, ϕ 114 x 6	141	406 826		
1	O-Ring, Viton, ϕ 34 x 4	142	66202		
1	O-Ring, Viton, ϕ 54 x 4	143	406 818		
3	O-Ring, Viton, ϕ 60 x 4	144	66204		
1	Temperature control / Temperaturregler	145	54-0078 R1		*

* not visible / nicht ersichtlich



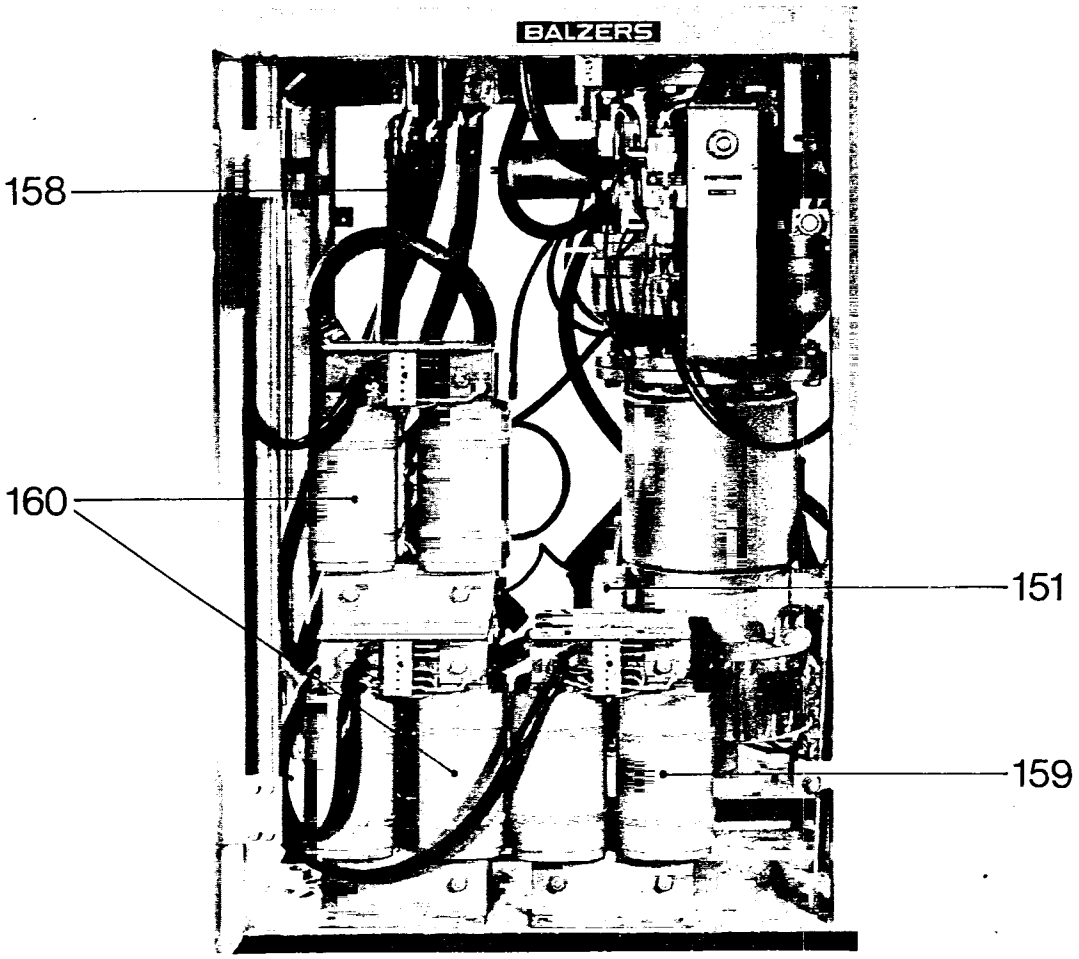


Spare Parts for / Ersatzteile zu

Bell jar / Glocke

Z 11 – 219/9a

	Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
1	Temperature control / Temperaturregler	151	54-0077 R1		DIFF
1	Temperature control / Temperaturregler	152	54-0078 R1		Chamber/Glocke
1	Delay circuit / Verzögerungsprint	153	51-8024 R1		
1	Plug / Amphenolstecker 7 P	154	335 092		
1	Cable clamp / Kabelklemme	155	335 117		to/zu Pos. 154
1	Socket / Kupplung	156	335 121		to/zu RV 27 E
		157			
4	High current cable / Hochstromkabel	158			Accessories/Zubehör
1	High current transformer / Hochstromtrafo 2 x 6 V	159			Accessories/Zubehör
2	High current transformer / Hochstromtrafo 2 x 4 V	160			Accessories/Zubehör



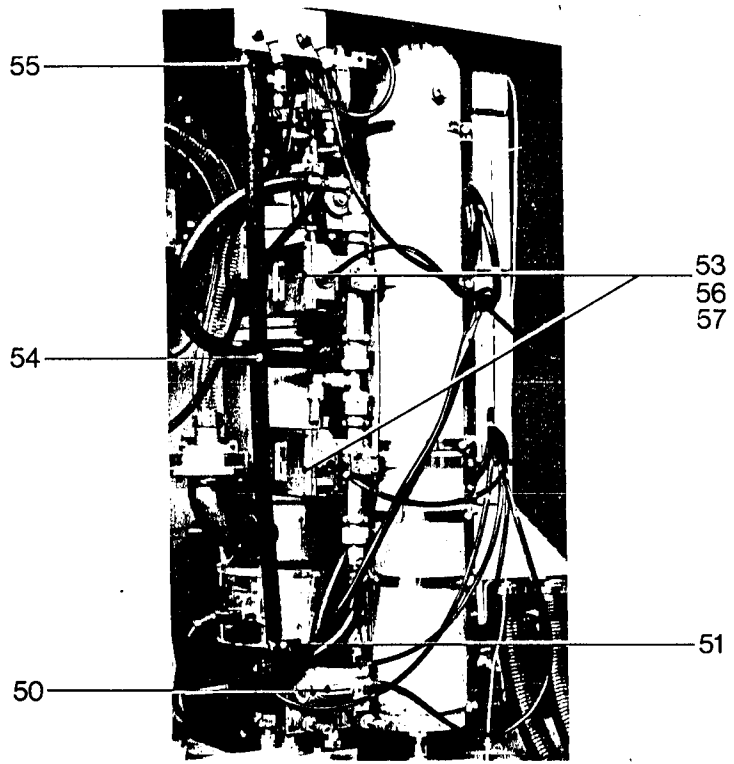
Spare Parts for / Ersatzteile zu

Electr. equipment / Elektr. Ausrüstung

Z 11 – 219 Bl. 10

	Description / Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
1	Valve / Zwei-Weg-Ventil 115/60 Hz	50	421 571		
2	Valve / Drei-Weg-Ventil	51	421 596		
		52			
2	Water flow switch / Strömungswächter	53	331 214		
1	Hose / Gummischlauch 13 LW x 3 x L	54	415 056		
25	Hose clamp / Schlauchbinder M 10	55	415 068		
1	Diaphragm / Blende 2-4 l/min.	56	331 220		*
1	Diaphragm / Blende 1-2 l/min.	57	331 248		to/zu DIFF
	Coil / Spule, 115 V / 60 Hz	58	362 030		**
	Armature / Magnetanker	59	362 035		**
	Micro-switch / Mikro-Schalter	60	331 477		***
	Seal set / Dichtungssatz	61	407 163		***

* to chamber / zu Glocke ** to item / zu Pos. 50, 51 *** to item / zu Pos. 53



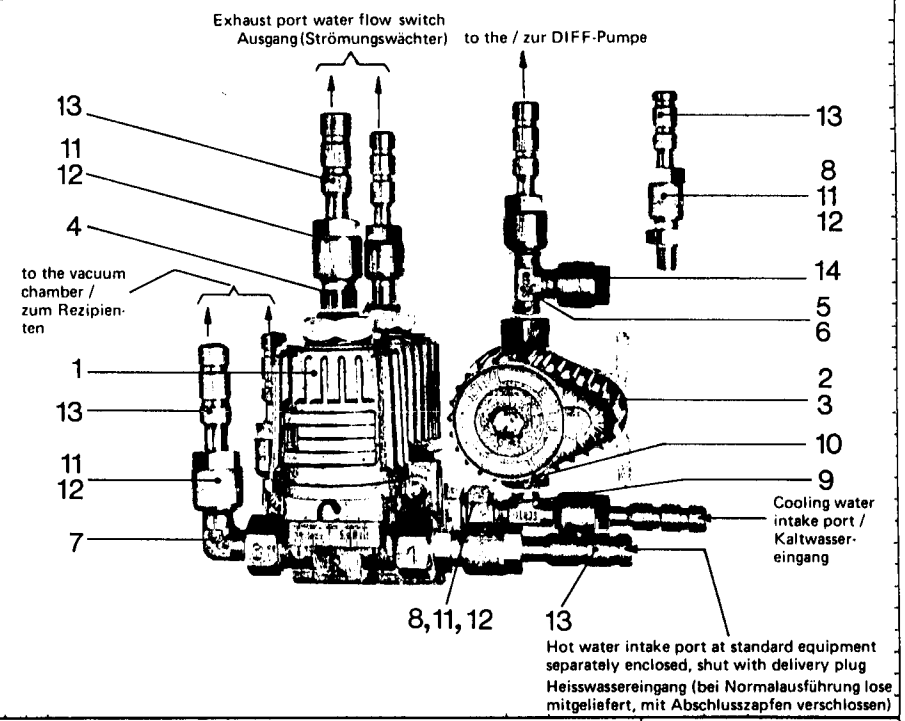
Spare Parts for / Ersatzteile zu

Water battery / Wasserbatterie — **Z 11 – 219/5**

1170 / Bee

	Description / Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
2	Solenoid valve / Dreiwegventil, 430 / C6B	1	363 012		115 V / 60 Hz
3	Coil to solenoid valve / Spule zu Magnetventil	2	362 030		to item/zu Pos. 1 u. 3
1	Solenoid valve / Zweiwegventil, 490/J4B	3	421 571		115 V / 60 Hz
2	Nipple / Einschraubnippel	4	11-5594 P1		
1	Fitting / Regulier-T-Stück	5	11-5597 P1		
1	Adjusting screw / Regulierschraube	6	11-5523 P1		
2	Nipple / Einschraubnippel, SO 2400-10-1/4"	7	421 642		
2	Nipple / Einschraubnippel, SO 1100-10-1/4"	8	421 643		
1	Fitting / Einstell-T-Stück SO 3600 A-10-10	9	421 721		
1	Fitting / Übergangsnippel, SO 40-10-1/4"	10	421 616		
9	Connection nut / Anschlussmutter, SO 20-10-3/8"	11	421 314		
9	Clamping ring / Klemmring SO 1-10	12	421 411		
7	Hose nipple / Schlauchnippel, ϕ 13	13	80-9552 P1		
2	Delivery plug / Abschlusszapfen, SO 2-10	14	421 613		
2	Armature / Magnetanker	15	362 034		to item/zu Pos. 1
1	Armature / Magnetanker	16	362 035		to item/zu Pos. 3
1	Water flow switch / Strömungswächter, V1 G15	17	331 214		*
	Diaphragm / Blende, 2-4 lt/min	18	331 220		**
	Diaphragm / Blende, 1-2 lt/min	19	331 248		to/zu DIFF
	Micro-switch / Mikroschalter	20	331 477		to item/zu Pos. 17
	Seal-set / Dichtungssatz	21	407 163		to item/zu Pos. 17

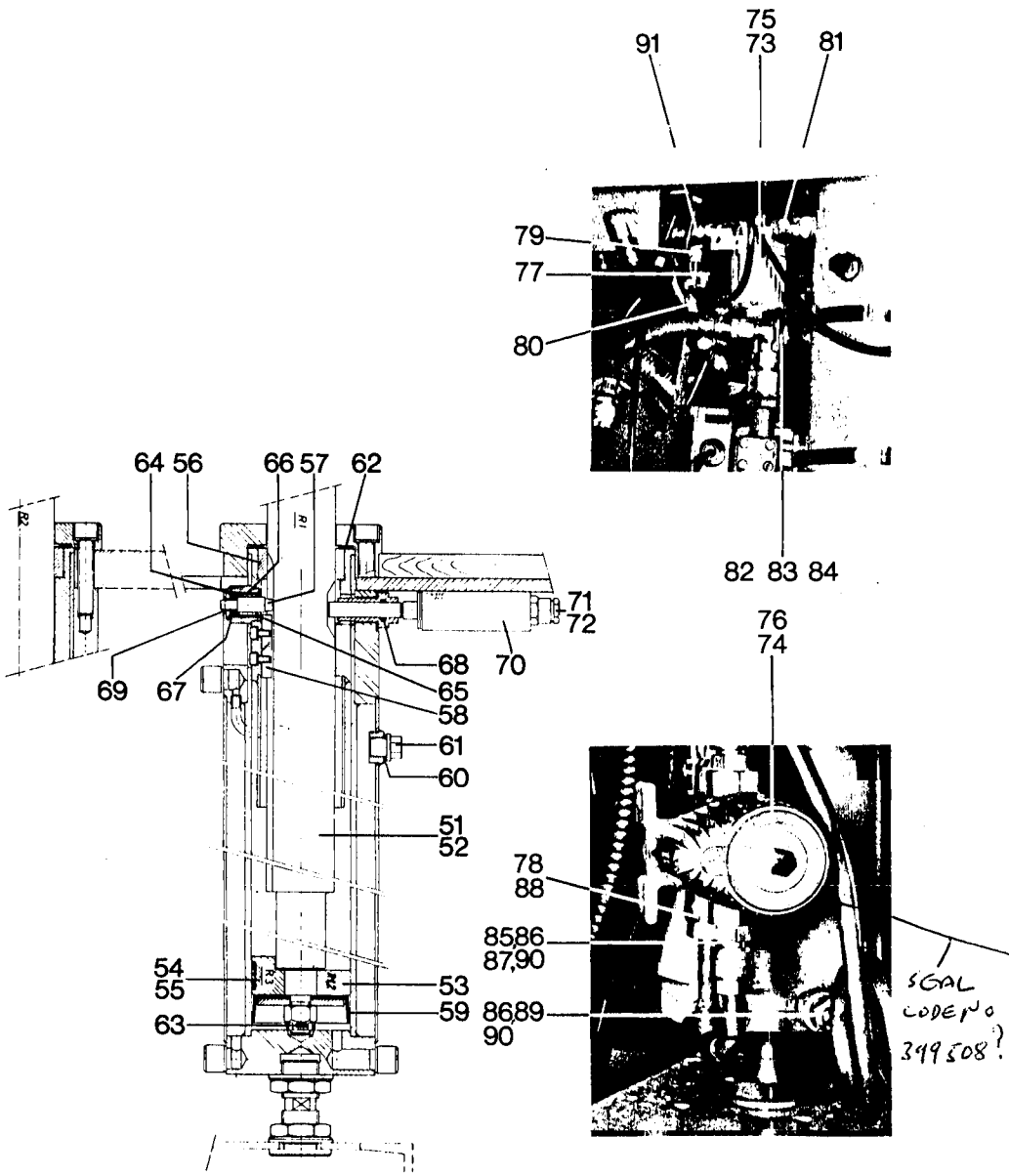
* not visible / nicht ersichtlich ** to chamber / zu Glocke



Spare Parts for / Ersatzteile zu

Water battery / Wasserbatterie 11-5999
(pressure range 2 - 3,5 atm / Druckbereich 2 - 3,5 atü) — **Z 11 – 277/a**

1170 / Bee



			Description Teil	Item Pos.	Code-No. Bestell-Nr.	S	Remarks Bemerkungen
–	1	1	Support / Säule	51	11-5922 P1		
1	–	–	Support / Säule	52	11-12959 P1		
–	1	1	Piston / Kolben	53	11-5923 P1		
1	–	–	Piston / Kolben	54	11-8058 P1		
1	–	–	Piston guide / Kolbenführung	55	11-8059 P1		
1	1	1	Slipring / Gleitring	56	11-5926 P1		
1	1	1	Axle / Achse	57	11-8060 P1		
1	1	1	Key / Einlegfederkeil	58	11-5930 P1		
1	1	1	Shaft seal / Topfmanschette	59	11-7624 P1		
1	1	1	Seal / Dichtung, Firefly, ϕ 16/20	60	406 641		
1	1	1	Delivery screw / Verschlussschraube, G 3/8"	61	421 064		
2	2	2	Cup spring / Tellerfeder, 89-0661 P1	62	442 989		
1	1	1	Split pin / Splint, ϕ 4 x 30	63	461 451		
1	1	1	Retaining ring / Sicherungsring, J19 x 1	64	442 691		
1	1	1	Spring ring / Sprengring, BR 19	65	442 885		
1	1	1	Needle bearing / Nadellager, NK 12/16	66	411 182		
1	1	1	Ball bearing / Rillenkugellager, EL 7	67	411 183		
1	–	–	Felt ring / Filzring, ϕ 12/18 x 4	68	406 224		
1	1	1	Pin / Spannstift, ϕ 2 x 12	69	461 390		
1	–	–	Switch / Sicherheitsschalter	70	331 476		
1	–	–	Cable clamp / Kabelverschraubung, PG 9	71	E 305 023		
1	–	–	Counter nut / Gegenmutter, PG 9	72	E 305 123		
1	1	1	Solenoid valve / 3-Weg-Ventil, 115 V, 60 Hz	73	363 003		
1	1	1	Solenoid valve / 2-Weg-Ventil, 115 V, 60 Hz	74	421 560		
1	1	1	Coil / Spule, 115 V, 60 Hz	75	362 030		to item/zu Pos. 73
1	1	1	Coil / Spule, 115 V, 60 Hz	76	362 016		to item/zu Pos. 74
1	1	1	Non return valve / Rückschlagventil, SO 7300-6-1/8"	77	421 656		
1	1	1	Non return valve / Rückschlagventil, SO 7300-10-1/2"	78	421 677		
2	2	2	Nipple / Übergangsnippel, SO 40-6-1/8"	79	421 447		
2	2	2	Nipple / Einschraubnippel, SO 1100-6-1/4"	80	421 626		
1	1	1	Nipple / Einschraubnippel, SO 1100-10-1/4"	81	421 634		
2	2	2	Connection nut / Anschlussmutter, SO 20-6-1/8"	82	421 643		
2	2	2	Clamping ring / Klemmring, SO 1-6	83	421 449		
2	2	2	Sleeve / Stützhülse, SO 3-6-4	84	421 452		
2	2	2	Connection nut / Anschlussmutter, SO 20-10-3/8"	85	421 314		
6	6	6	Sleeve / Stützhülse, SO 3-10-8	86	421 307		
2	2	2	Nipple / Einschraubnippel, SO 1100-10-1/4"	87	421 634		
2	2	2	Connection nut / Anschlussmutter, SO 20-10-1/2"	88	421 530		
2	2	2	Fitting / Einschraubstutzen, SO 1000-10-3/8"	89	421 521		
6	6	6	Clamping ring / Klemmring, SO 1-10	90	421 411		
1	1	1	Filter	91	11-5334 R1		
			Hydraulik oil / Hydrauliköl Aircraft, Typ A-A	92	480 130		4 Liter

Spare Parts for / Ersatzteile zu

Bell jar hoist / Glockenhebevorrichtung 11-5910

Z 11–304/4

Bell jar hoist
Glockenhebevorrichtung

Z11-304/3

1170/Bee