BALZERS

OPERATING INSTRUCTIONS

Control unit ERE 101

1. Application

The ERE 101 control unit is used in conjunction with the BPU 100 E or BPU 100 M evaporation control systems and the pumping system control PC 101 to control evaporation coating systems (BA 510, BA 710, BAK 550).

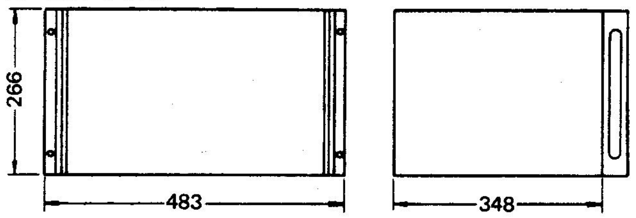
It has the following functions:

- Amplification or conversion of the output and input signals to 24 V AC (max. 6 A)
- Control of the secondary functions: Glow discharge, LN_2 supply, substrate holder rotation, Meissner trap cooling
- Production of the +5 V and ± 15 V stabilized DC voltages
- 2 terminal strips which are used as the central connection points for all the control voltage signals as well as for testing and measurement points in the case of malfunctions

2. Technical data

Mains voltage:	220 V, 50 Hz convertible 208 – 240 V, 50 – 60 Hz
Rating:	120 VA
Control voltages:	24 V AC – distributed to 5 control circuits (6 A each) 24 V AC – distributed to 2 control circuits (4 A each) ± 15 V stabilized 1 A + 5 V stabilized 6 A
Output signals:	36 output channels 24 V AC, 6 A max. – Ohmic load per control circuit
Input signals:	36 input channels 24 V AC, potential free contact required
Analog signals:	4 analog channels looped across terminals
Connections:	Terminals 4 mm^2

19" rack module



3. Description

3.1 Signal adaptation

3.1.1 Design

The input and output signals from the sub-modules of digital control unit ECU 101 or QSR 101 C pass from it via 32-pole plug connectors and multi-polar cable directly to the adapter pc board in the power distributor ERE 101. The plug plug connectors of the cables and those for the power distributor are coded.

3.1.2 Function

Commands and acknowledgement are transmitted between digital control unit ECU 101 and the ERE 101 by DC-energized relay circuits. This makes it possible to isolate these two pieces of equipment consistently in order to obtain a high degree of operating reliability. The isolation of the analog signals is provided for the A/D and D/A converters in the ECU by opto-electronic signal couplers. All control elements of the energy distribution system, as well as the pneumatic and hydraulic control elements, are operated with 24 V. The analog signals from and to the control unit are in a voltage range from 0 to 10 VDC.

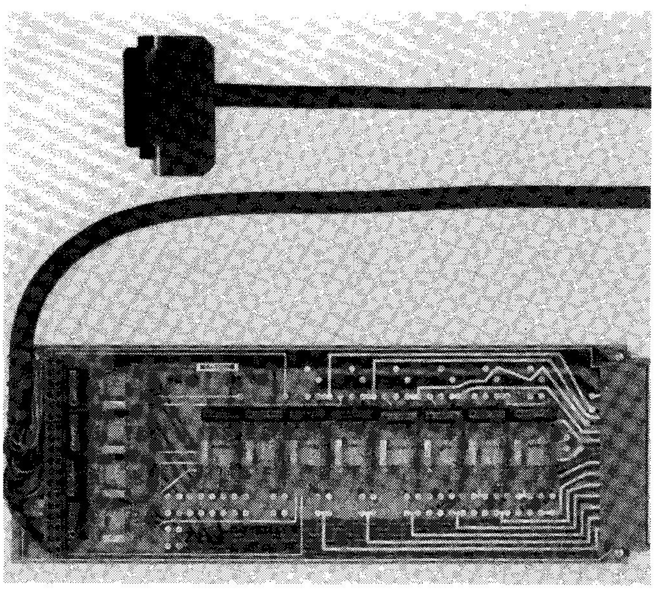


Fig. 1 Adapter pc board with cable

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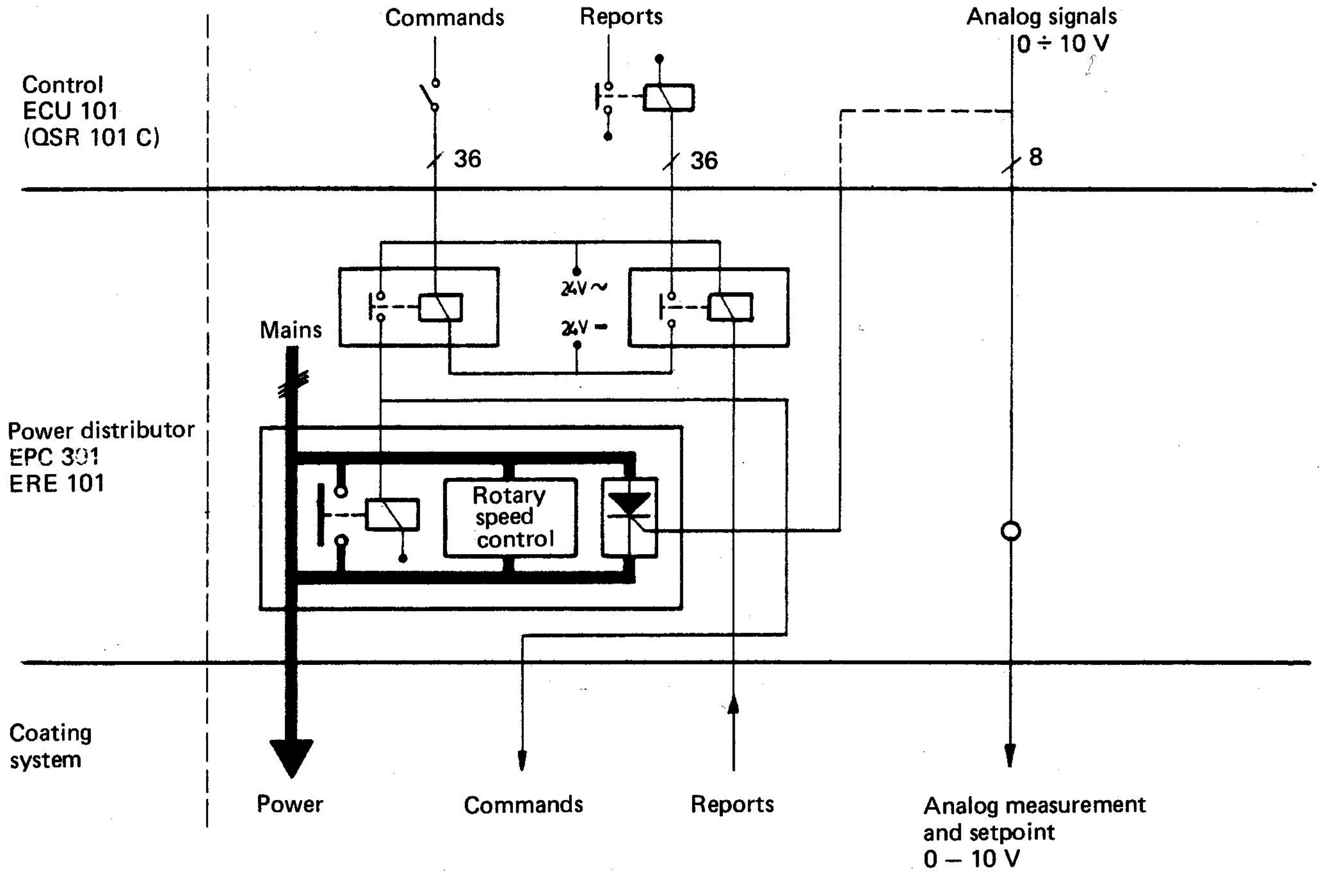


Fig. 2 Schematic circuit diagram of the command transmission

Commands and reports are accepted by 2 different adapter pc boards.

– Adapter pc board input
– Adapter pc board output

3.2 Adapter plug-in pc board input

The pc board accepts the transmission of 12 report signals from the coating system to the digital control unit. A maximum of 3 such units can fit into the magazine of the ERE 201

The signal diagram input depends on the configuration of the coating system.

The valid circuit diagram is enclosed with the system.

3.2.1 Technical data:

Dimensions	100 x 280
Number of control circuits	12
Relay control voltage	24 V ~
Relay control current	approx. 12 mA

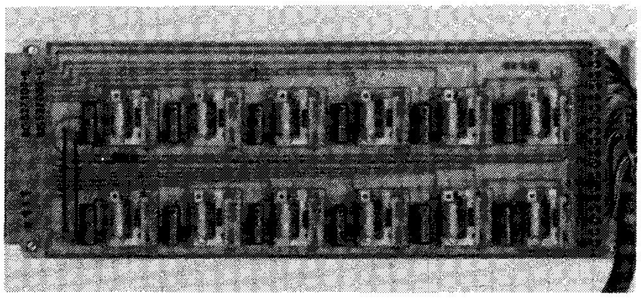


Fig. 3 Adapter pc board input

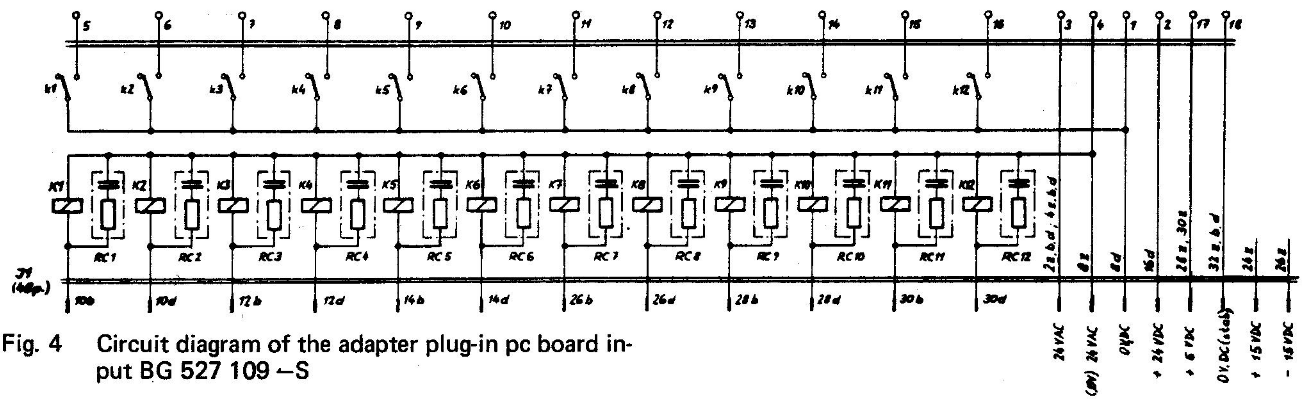


Fig. 4 Circuit diagram of the adapter plug-in pc board input BG 527 109 –S

3.3 Adapter plug-in pc board output

This unit transmits 12 command signals from the digital control unit to the coating system. The magazine in the power distributor has space for a maximum of three such units.

The basic model does not have the connections from the pc board connectors to the switching contacts of the 12 relays. These are made with jumpers which are fitted according to the configuration of the coating system.

The signal diagram output depends on the configuration of the coating system. The valid circuit diagram is enclosed with the system.

Technical data

Dimensions	100 x 280 mm
Number of control circuits	12
Coil resistance in the direct current relays	720 Ω
Max. load on the switching contacts	6 A ~

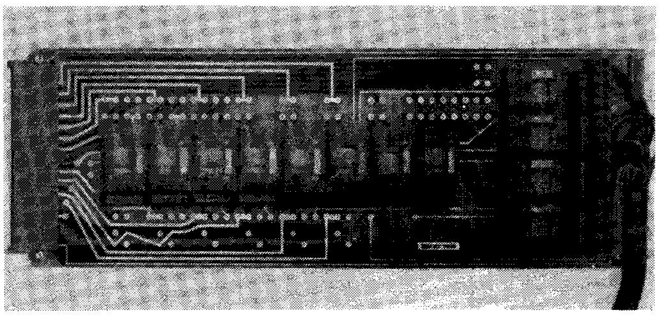


Fig. 5 Adapter plug-in board

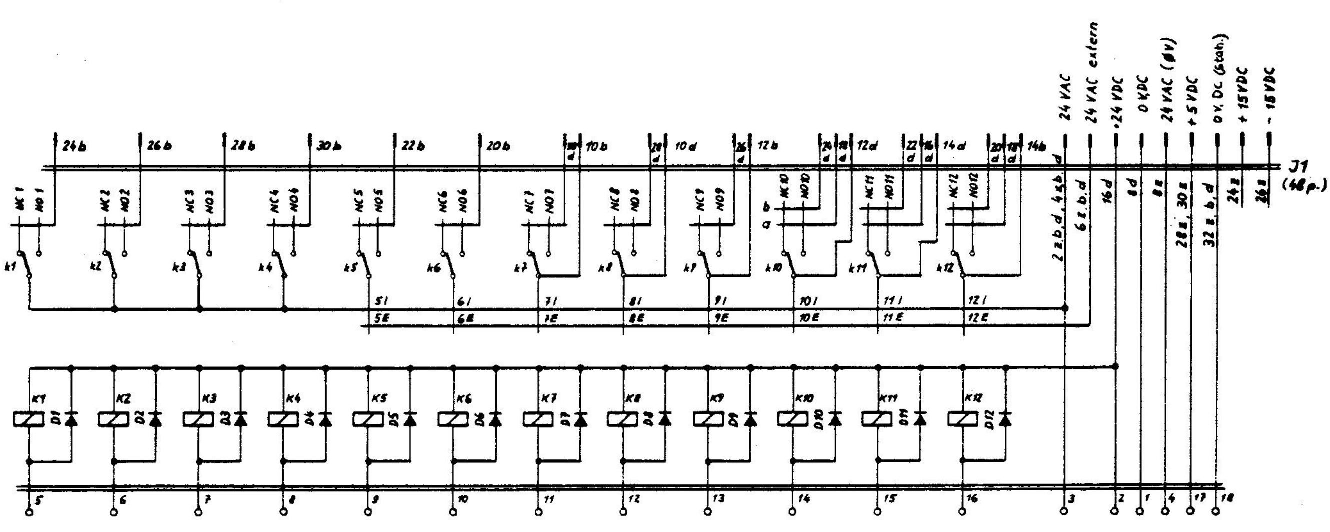


Fig. 6 Circuit diagram of the adapter plug-in pc board output BG 527 108 –S

3.4 Auxiliary controllers

Purpose

These control circuits are required for maintaining the desired basic conditions for the actual coating process. These functions can be switched on and off by the process computer. The control procedure with set-point input takes place in the auxiliary controller or using the control elements on the front panel of the ERE 101.

Design

The auxiliary controllers are constructed on pc boards in the same way as the adapter circuits. These pc boards are slid along the guide tracks into the ERE 101 from the back of the instrument.

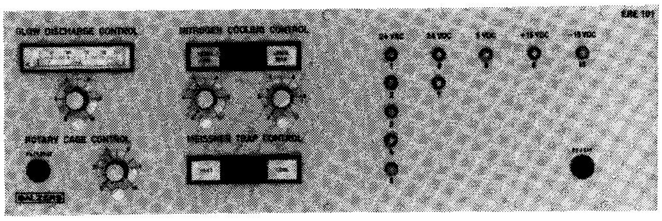


Fig. 7 Control elements for the auxiliary controllers

The controllers are operated from the front panel where the various statuses are also displayed (see Fig. 7)

The system can be expanded to a maximum of

1 rotary speed control unit

1 nitrogen level controller

1 supply unit for the Meissner trap

1 glow discharge controller

3.5 Rotary speed control unit

Purpose:

The motor control pc board controls the speed of the smaller shunt commutator DC motors necessary for the coating process.

They include, for example

- Substrate holder rotary drive
- Drive for feeding coating material

3.5.1 Function

The stator winding of the shunt commutator motor is supplied with a pulsating direct current from the full-wave rectifier G1. The rotor is supplied with the same DC voltage via the thyristor as control element. The electromagnetic force generated in the rotor by the rotation is compared each time just prior to ignition with the set point for the desired speed. The resulting difference causes a shift of the ignition timing and therefore a change in the energy fed to the rotor equivalent to the necessary speed correction. This makes it possible to maintain a constant motor speed independenty of the motor load and the mains voltage. The RC element at the set point input of the control amplifier results in a gradual running-up to the preset speed. A filter consisting of a double choke and two capacitors located at the circuit input prevents excessively high interference voltage peaks from reaching the mains.

3.5.2 Operation

All that is required is the setting of the desired speed at the respective knob on the front panel. The switching on and off of the desired direction at the right moment is initiated by the process computer by energizing the control input 16 b for right hand rotation and control input 8 b for left-hand rotation with a 24 V AC voltage.

Fuse F1 must be properly selected to suit the particular motor model.

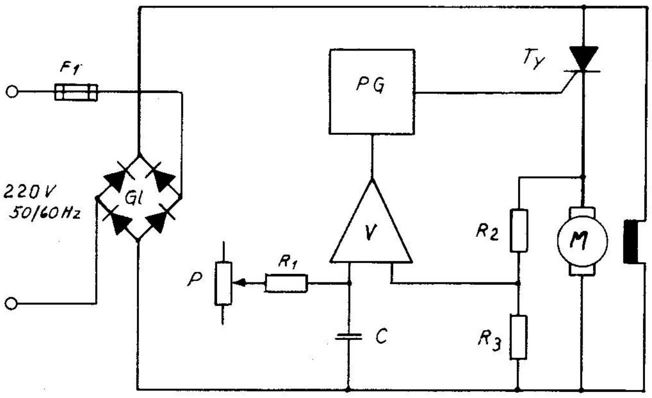


Fig. 8 Principle circuit diagram of the rotary speed controller unit

Legend:

F_1	Fuse
Gl	Rectifier
P	Set point potentiometer
R_1, C	RC element for smooth starting
V	Control amplifier
PG	Pulse generator
R_2, R_3	Actual value voltage divider
M	DC motor
Ty	Thyristor

Technical data, rotational speed control unit

Power supply	220 V 50/60 Hz
Power	max. 600 W
Motor field voltage	180 (220) *V DC
Motor field current	max. 0.25 Amp.
Motor armature voltage, adjustable	approx. 20 ... 160 (190) *V

*figures in brackets = actual values

Motor armature current	max. 600 W
Time constant for smooth starting	0.5 sec.
Fuse protection (miniature fuse on pc board)	
Motor model AFV 35	0.63 Amp. slow
DFV 48	2.5 Amp. slow
EFV 65	2.5 Amp. slow
MFV	3.0 Amp. slow

The minimum and maximum rotational speed, as well as the speed stabilities can be adjusted on the trimmer potentiometers on the pc board.

3.5.3 Gear motor

The DC gear motors given preference are those manufactured by Zürrer & Co. in Zurich. The speed at the gear unit output depends on the rotary drive used and the particular coating system.

The following motors are used:

Model	AFV	20 Watt
	DVF	75 Watt
	EFV	185 Watt
	MFV	320 Watt

The motors have:

Field voltage	190 V DC
Armature voltage	190 V DC
max. speed	5000 rpm
min. speed	500 rpm

When using other DC motors care should be taken that the continuously drawn total amperage with the motor under load never exceeds 2.7 A. Overloading or blockage of the motor can result in destruction of the semiconductors in the motor control pc board. The fuse can only protect the circuitry reliably if it is rated 1.6 A or less.

3.5.4 Settings

The minimum and maximum speeds can be set on the two trimmer potentiometers R3 and R4 respectively. Turning the trimmer potentiometer clockwise raises the speed. The desired speeds are : min = 500 rpm and max. 5000 rpm. The motor should not be run at less than the minimum speed, because the motor cooling would then be insufficient.

The speed stability can be adjusted with trimmer potentiometer R12. Turning this trimmer potentiometer counterclockwise (ccw) smooths out load-related speed fluctuations but it also reduces the speed, which can then be readjusted with trimmer potentiometers R3 and R4.

Connection: The connection assignments can be taken from diagram BG 527 472 -S.

3.6 Nitrogen level control

3.6.1 Purpose

This plug-in unit employs sensor MLS 102 to provide automatic nitrogen level control in nitrogen cooled components (e.g. nitrogen baffle, nitrogen balloon, etc.)

3.6.2 Function

The rod-shaped resistance temperature sensor NLS 102 (see illustration) is installed immersed in the liquid nitrogen being controlled. The sensor is heated slightly, and this heat is dissipated to the medium surrounding it. This means that its resistance changes depending on the depth to which it is immersed in the liquid nitrogen, which has a temperature of -190 °C. The current through the probe is measured, and this signal is amplified in the amplifier A1. Its output signal is fed to the inputs of the four adjustable threshold switches. The maximum nitrogen level is set on P1, the minimum level on P2. These switching commands are transmitted via a control logic to the switching amplifier for the nitrogen valve in such a way that the valve opens when the level drops below the minimum and recloses when the maximum level is exceeded.

The third threshold switch controls the emergency cooling system. This prevents the baffle temperature from rising too sharply in the event of a nitrogen supply failure. It consists of a small compressor refrigerator, whose evaporator is mounted in the cooling baffle in order to remove heat. Should the nitrogen supply fail, the temperature in the baffle would rise sharply. When the sensor reaches about +5 °C, the threshold switch turns on the refrigerator. If the specifications for final vacuum and purity of the residual gas are not particularly demanding, it is possible only to work with the emergency cooling system. In this case the nitrogen supply should be shut off with a manual check valve. Should both cooling systems fail, a standard safety thermostat switches off the diffusion pump heater.

The fourth threshold switch monitors the operability of the sensor itself. If it becomes defective, the nitrogen supply is cut off in order to avoid flooding, the cooling unit is switched on at the same time, and the lamp "defect" lights on the front panel.

Sensor NLS 102	
Temperature range	+50 ° – -200 °C
Resistance range*	500 (+20 °C) 100 (-190 °C)

*These figures refer to the disconnected (unheated) sensor

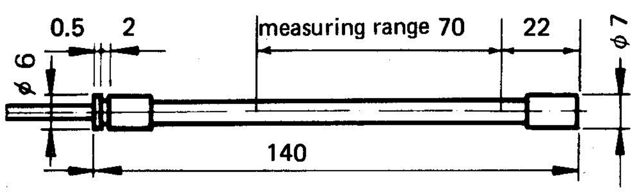


Fig. 9 Dimension drawing of NLS 102

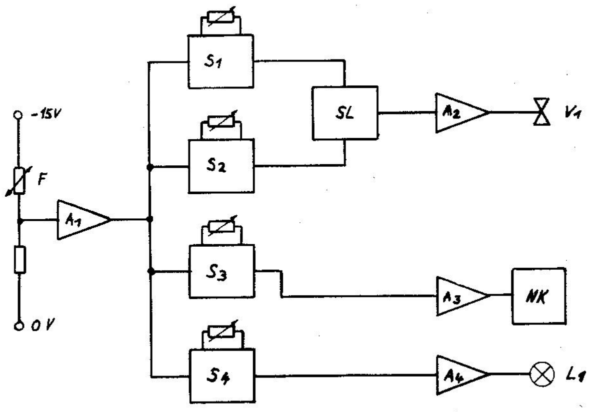


Fig. 10 Schematic diagram of nitrogen level control system

Legend:

F	Sensor
A1	Measuring amplifier
S1 – S4	Threshold switches
SL	Control logic
t	Time circuit
A2 – A4	Switching amplifiers
V1	Nitrogen valve
NK	Emergency cooling system
L1	Warning lamp for sensor defect

3.6.3 Operation

The level control system receives command signals from the digital pump station control unit PC 101. Normally all that is required is to make the adjustments at initial start-up.

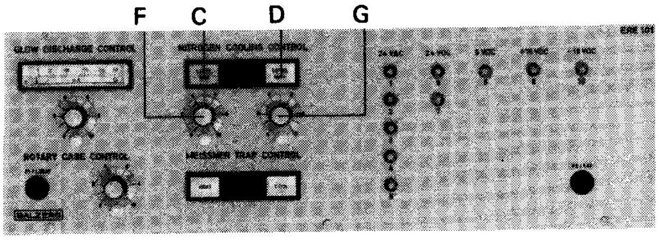


Fig. 11 Operating controls for the nitrogen level control system

Indicator Lamps

C (LN_2-LEVEL MIN) This lamp lights at the lower LN_2 level and goes out as soon as MAX level is reached.

D (LN_2-LEVEL MAX) This lamp lights at the MAX level and goes out as soon as MIN level is reached

Potentiometers

F This potentiometer is used to adjust the lower nitrogen level.

G This potentiometer is used to adjust the upper nitrogen level.

3.6.4 Start-up with LN_2 cooling

1. Set potentiometer for upper level switch point (G) to 10
2. Set potentiometer for lower level switch point (F) to 10
3. Switch BPU 100 controller on ECU submodule BL 101 to manual operation. Then switch on nitrogen cooling with the respective switch of the particular output unit OU 101 of the digital control unit. The LN_2 valve opens, the indicator lamp (C) "LEVEL MIN" lights.
4. Supply of LN_2 is maintained until liquid nitrogen emerges at the LN_2 outlet of the consumer.
5. Slowly turn potentiometer (G) towards 0 until LN_2 valve closes ("LEVEL MAX" lamp (D) lights). Fix upper level switch point by turning the knob half a step back.
6. Set potentiometer (F) one scale graduation below potentiometer (G). Continue cooling consumer at this setting until LN_2 consumption levels off at minimum, i.e. consumer has reached the final temperature. Then make final adjustment of lower level switching point (F), proceeding as follows. Wait for switching interval from "LEVEL MIN" to "LEVEL MAX", then immediately set potentiometer (F) to zero stop. As soon as nitrogen vapour ceases to emerge from nitrogen outlet of consumer, turn potentiometer until the LN_2 valve opens. To prevent the LN_2 level from repeatedly dropping to zero, set potentiometer (F) one scale graduation higher (i.e., clockwise). Now the LN_2 supply is operable.
7. Make sure the lower switching point setting gives a maximum level difference (minimum LN_2-consumption).

Important: Once these switching points are set, do not make any further changes in the potentiometer settings (make record or mark them!)

A readjustment is necessary whenever the NLS 102 sensor or the controller pc board is replaced.

Important: The pressure in the LN_2 Dewar should be less than 2 bar, optimum 1.3 – 1.5 bar.

Connection: The connection assignment of the plug-in pc boards can be taken from diagram BG 527 472 -S

3.7 Supply unit for Meissner trap

3.7.1 Description

The control system comprises:

Servo control system

Meissner trap pc board
(board in power distributor EPC 201)

Temperature sensor BKF 103 with cable

With the supply device a Meissner trap can be cooled with liquid nitrogen as well as heated with hot air.

3.7.2 Servo control system

The servo control system consists of the following components:

1. Tank in which the compressed air is heated up by a heating resistor.
2. 2 solenoid valves for shutting off the nitrogen and compressed-air lines.
3. Pressure reducing valve for regulating the compressed-air flow rate.
4. Connections of the nitrogen and compressed-air lines.

3.7.3 Meissner trap pc board

This is designed as a printed circuit board to be slid into the control unit. It consists essentially of an electronic thermostat with permanently adjusted switching point and switching differential. The sensor is monitored for breakage by a second threshold switch. Whenever the sensor is defective, the warning lamp "sensor defect" lights, and the nitrogen supply is cut off.

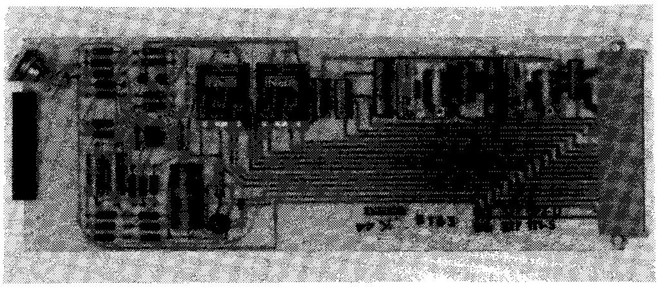
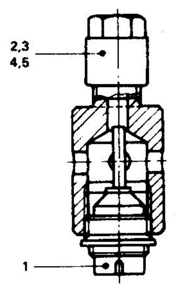


Fig. 12 Meissner trap pc board

3.7.4 Sensor

Resistance temperature sensor with positive thermal coefficient R = 1000 Ω at 25 °C. The sensor measures the temperature at the nitrogen outlet of the Meissner trap. The sensor line is run via a 4-pole Tuchel plug connector directly to the Meissner trap pc board.

R1	R2	Description / Teil	Item / Pos.	Code-No.	Bestell-Nr.	S	Remarks / Bemerkungen
1	1	Sensor / Fuhler	1	BB 186 090 -T			
1	–	Nut / A-Mutter	2	B 4117 563 GM			
1	–	Clamping ring / Klemmring SO 1 – 8	3	B 4119 363 -M			
–	1	Nut / A-Mutter 20 – 8 G 1/4"	4	B 4117 557 GM			
–	1	Clamping ring / Klemmring SO 1 – 6	5	B 4119 359 -M			



Temperature sensor / Temp.-Fühler BKF 103   Rohr ϕ 6 mm BB 192 177 –T
Rohr ϕ 8 mm BB 192 176 –T

Fig. 13 Sensor

3.7.5 Function

Signals reaching the two control inputs "COOL" (26b) or "HEAT" (18d) can provide the following operating conditions.

Cryogenic cooling of Meissner trap.

Connection 26b is energized with 24 V~: Liquid nitrogen is forced into the Meissner trap until nitrogen in liquid form starts emerging at the outlet of the Meissner trap. The temperature sensor responds to this and switches the nitrogen supply off with a valve. Then the sensor heats up again gradually and switches the nitrogen supply back on.

Heating the Meissner trap.

In order to avoid long waiting times for the thawing of the Meissner trap, it can be heated. A control signal reaching connection 18d starts the heating operation, and compressed air is fed via a pressure reducing valve and through a tank into the Meissner trap. A heating resistor for heating up the air is incorporated in this tank. The air flow should be adjusted at the pressure reducing valve in such a way that the air temperature is approx. 80 °C when the air leaves the tank after being heated for 10 minutes. This effectively prevents the formation of condensate when the coater is vented, and other deposits such as oil, grease, etc., are discharged, i.e. the Meissner trap is cleaned.

When this operation is carried out, however, steps must be taken to prevent any interruption of the compressed-air supply; otherwise the heating resistor would overheat.

3.7.6 Connection

The arrangement of connections is shown in the schematic "control prints BG 527 472 -S".

3.8 Glow discharge control

As a rule, this control circuit is used to stabilize the discharge current for the glow discharge substrate cleaning operation by means of the gas pressure. The control element is a small solenoid valve at the gas inlet, control valve RVE 016. But this controller can also be used to control other pressure regulation processes.

3.8.1 Design

The controller is designed as a plug-in pc board to be inserted in the control unit. Its receptacle is coded, so that it can only be inserted in the proper position. Set-point adjustment and glow amperage display are both on the partial front panel "auxiliary controllers". (See Fig. 4.17)

3.8.2 Function

The control voltage U_S drawn from the glow discharge current is balanced with the adjustable reference voltage U_R in a bridge circuit as shown in diagram Fig. 4.20. In the balanced condition $U_S = U_R$ and thus the effective voltage at the amplifier input is approximately nil. If this balance is upset by a change in the control voltage, the input voltage U_E will change corresponding to the difference $U_R - U_S$. The voltage U_E is amplified by the amplifier to a value which is sufficient to actuate the valve, which will open and shut at a frequency of 5 – 10 Hz., and thus provide a pulsating gas flow. Experience shows that only mean pressures are significant in glow discharge processes. As the control voltage is automatically compensated, the current drawn is virtually zero

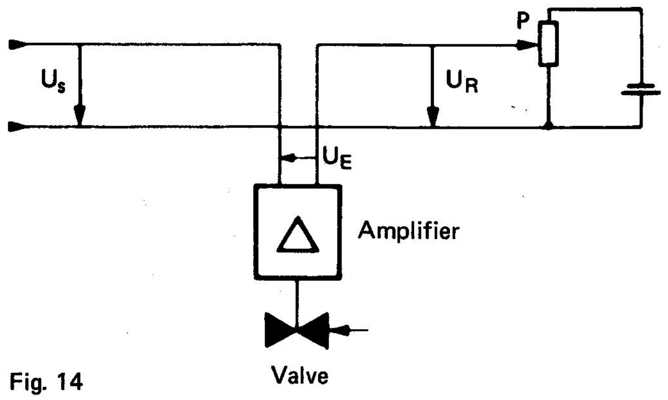


Fig. 14

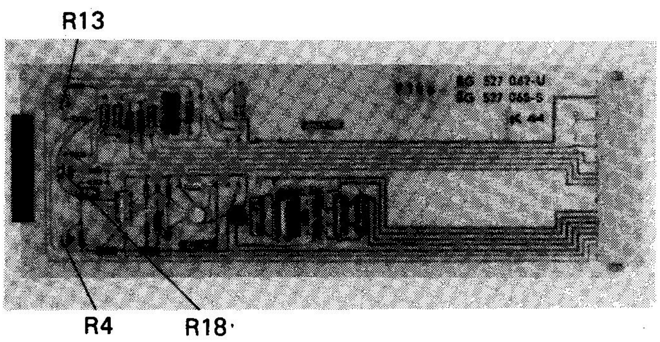


Fig. 15

3.8.3 Technical data

Power supply	from auxiliary voltage sources of the EPC 201
Controlled by	process computer control voltage 24 V
Measuring range of instrument	0 to 250 mA
Control range	10^{-2} to 7 mbar l/sec
Control signal	max. 150 mV, DC. µA
Valve voltage at the moment of actuation	approx. 3 V DC (average value)
Leak rate of the valve when closed	10^{-8} mbar l/sec

Connection: The connection assignment can be taken from diagram BG 527 472 -S.

3.8.4 Signal circuit monitoring

Display lamps for the individual control circuits are located on the front panel. The fuses allocated to them are located in the power distributor.