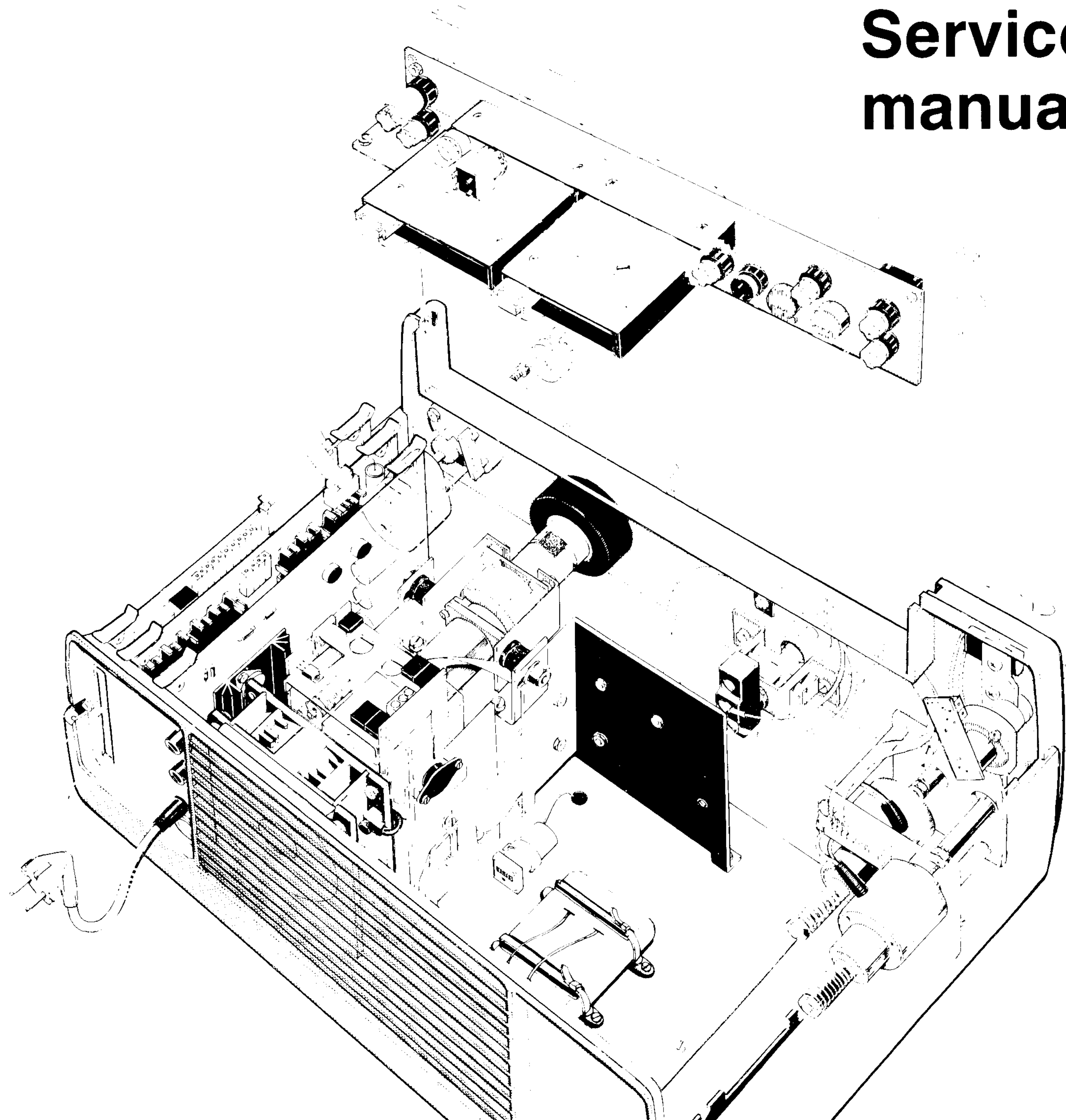
AK-10 System

Blood monitor BMM 10-1

Service manual



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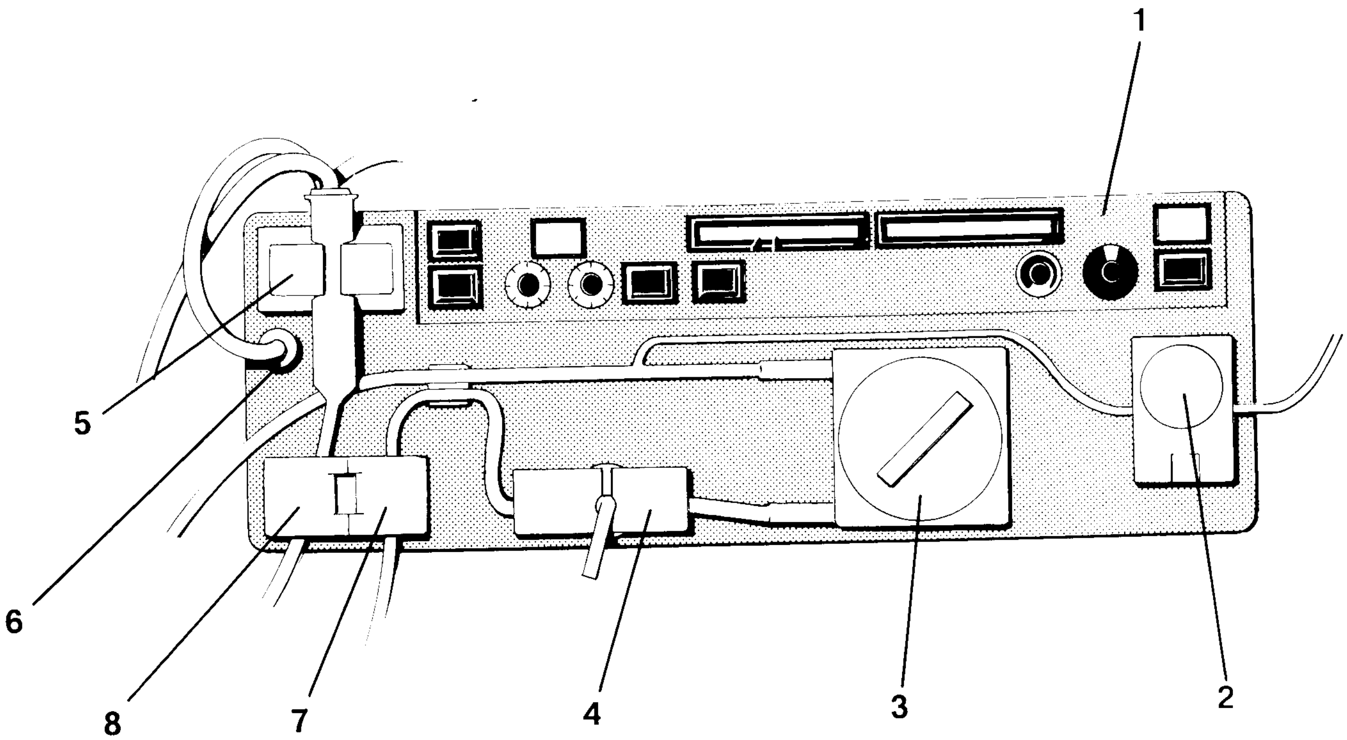
Contents

Introduction

General

The function of the blood unit is to control and monitor the blood flow through the dialyser and to control the addition of heparin to the blood, if applicable, before the dialyser. It contains a venous pressure instrument with adjustable alarm limits, arterial pressure monitor, and circuits for buzzer alarm common to the blood and fluid units, and also a mains alarm. An alarm box can be connected to the unit. Disposable lines are used for the blood flow.

The operating function is made clear in the operator's manual.



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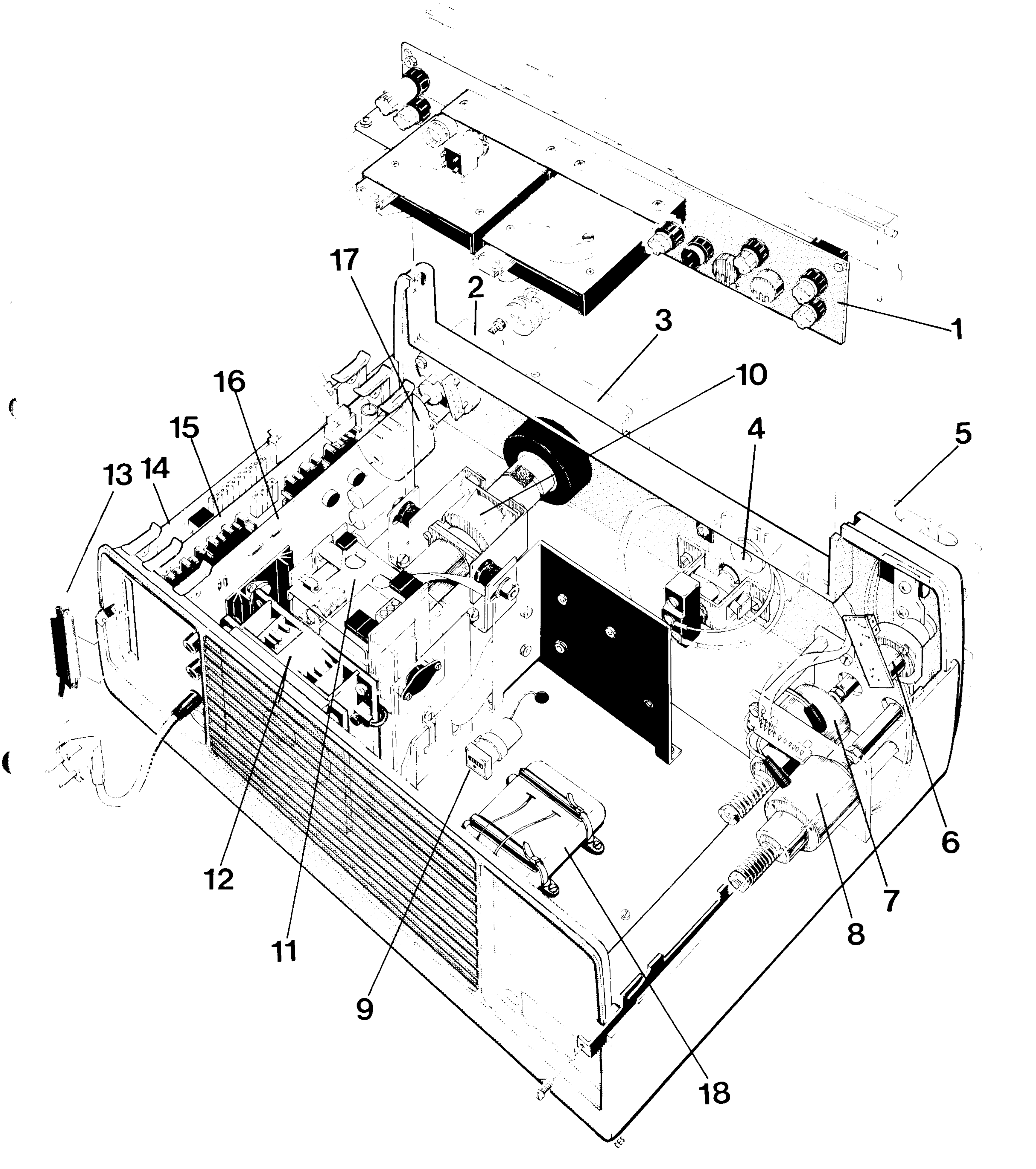
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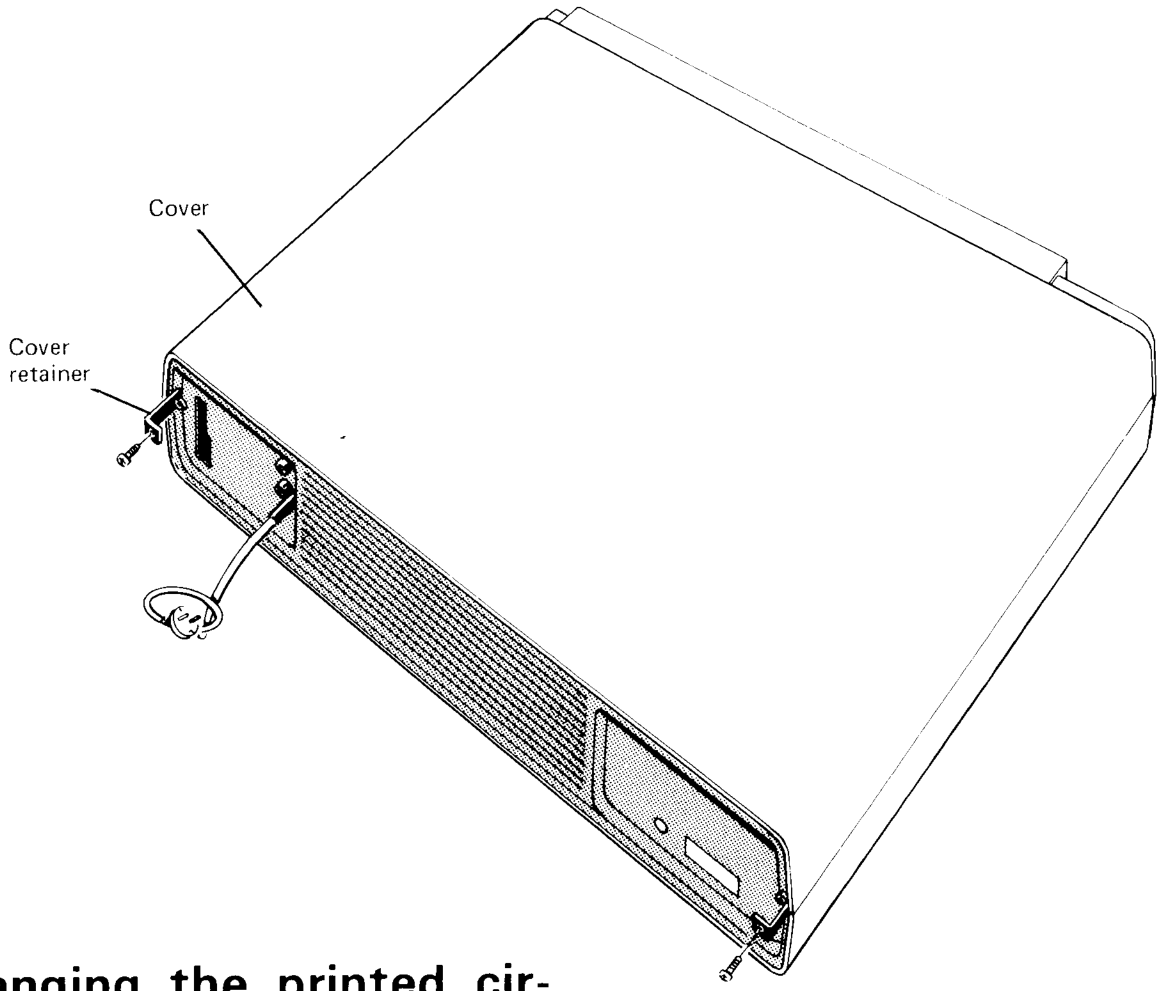
Removing the cover

Disconnect the machine from the mains.

Undo the locking screws and withdraw the cover retainers. Lift the cover straight up.

Before replacing the cover, see that the cover retainers are pulled out and that cables are not going to be pinched. Insert the cover retainers carefully at the same time depressing the cover.



Changing the printed circuit boards

Fold the lifting arms outwards.

When replacing the boards, note that there is a key arrangement whereby each board only fits one position. Board 3 is furthest out.

Board 3: control logic board
Board 2: motor control board
Board 1: power supply board

Removing the rear section

First remove the printed circuit boards. The rear section with the fan can then be lifted away.

Changing the fan

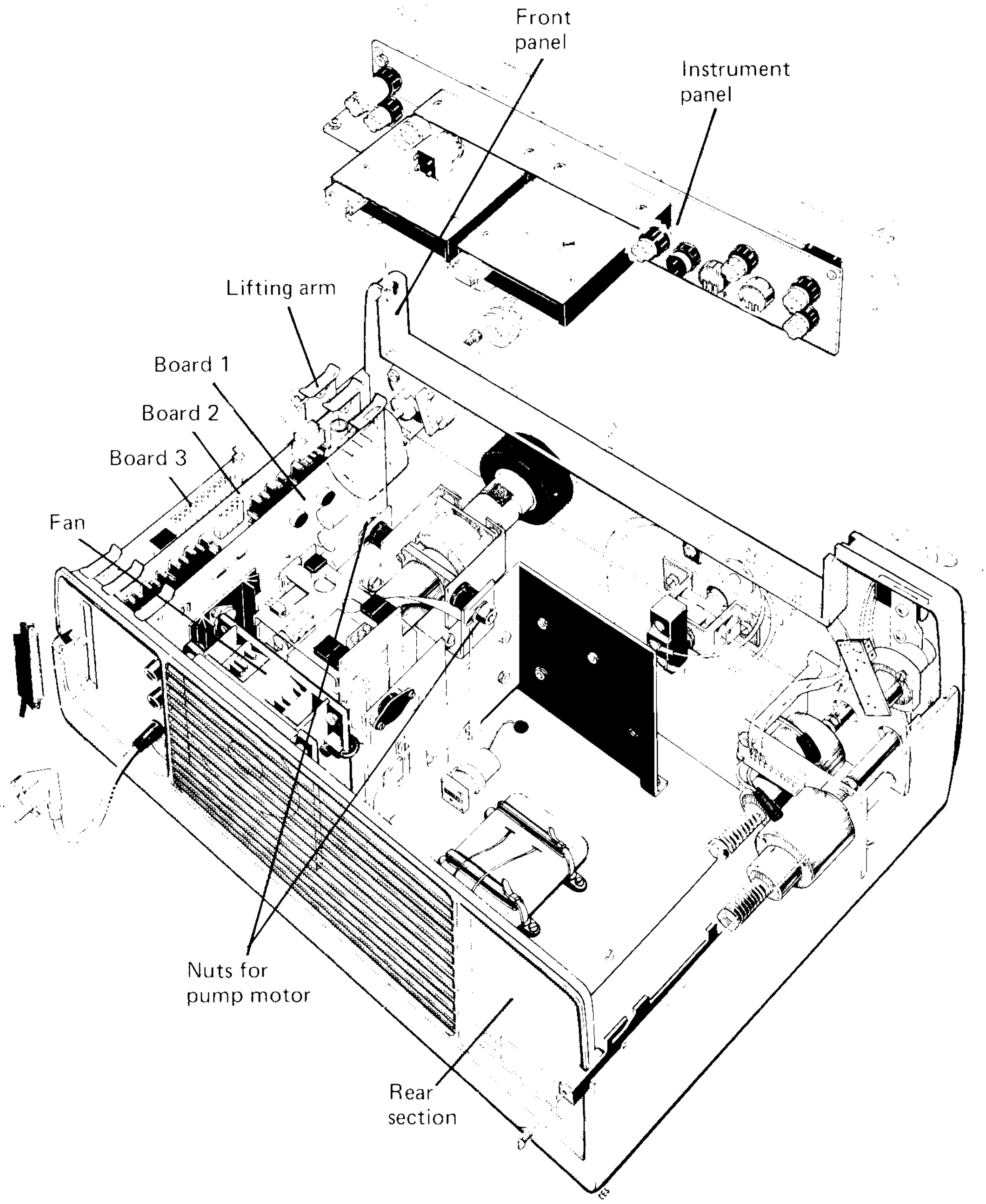
Remove the rear section to expose the fan.

Removing the instrument panel

The instrument panel can be lifted up with all connections intact. First disconnect the machine from the mains.

Removing the front panel

1. Undo the outer nuts on the pump motor mounting.
2. Push the motor back so that the clutch disengages.
3. Unplug the connectors and lift up the front panel.



Changing signal lamps

Remove the text cap with the special tool or by inserting a screwdriver in the slot on the top and twisting. Remove the lamp by pulling it straight out with the removing tool.

The lamp for MUTE is 14 V, 80 mA. The other lamps are 36 V, 30 mA.

Blood flow regulation

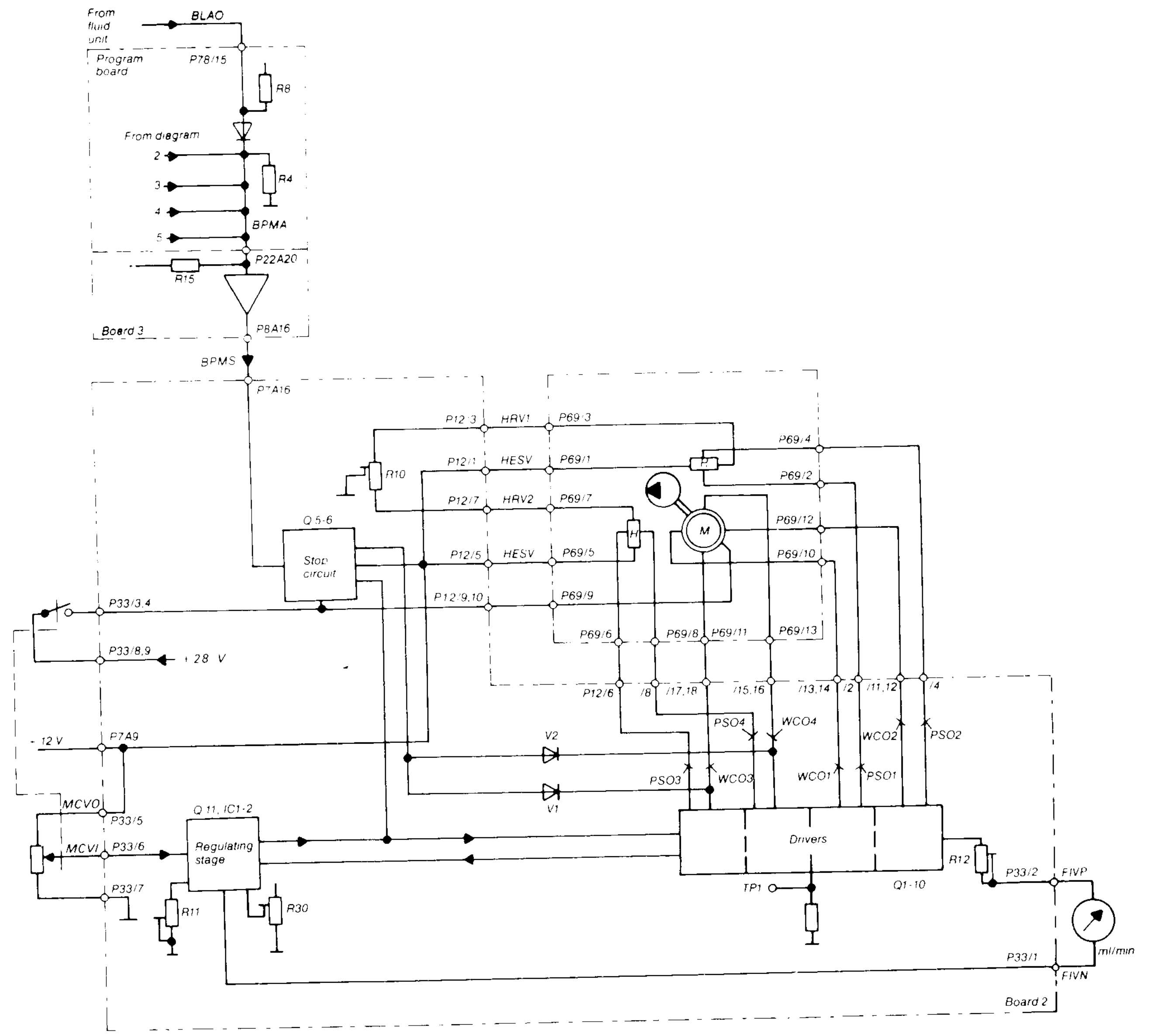


Diagram 1

Description

When the blood flow potentiometer is turned from the zero position, a switch connects + 28 V to one end of the four windings of the blood pump motor. The other ends of the windings are each connected to their own driver.

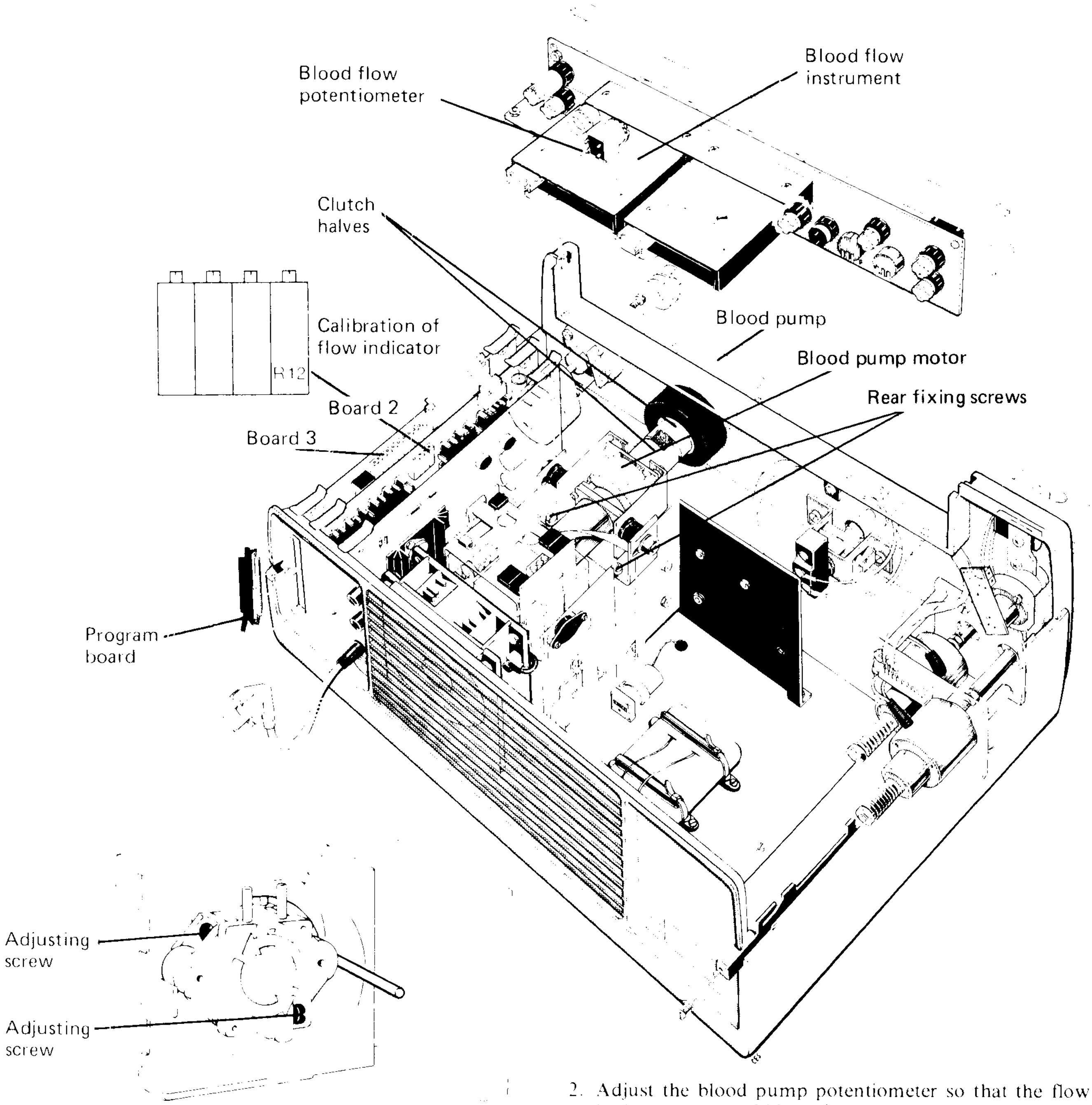
The motor has no commutator. It is controlled instead by Hall elements which sense the position of the rotor. The Hall elements are fed with + 12 V (HESV) and balanced with R10. PS01—04 from the Hall elements control the drivers.

The motor can be stopped at any time by BPMS signal, which is received as BPMA from the circuits for either air detection, arterial or venous pressure monitoring (possibly also from the circuits for arterial and venous line clamping at SN ON) or at BLAO from the blood leak detector in the fluid unit. (If another type of fluid unit is used, BLAO comes in via an optocoupler.) The signal enters a stop circuit which acts on the drivers. For a quick stop this results in short-circuiting of two of the motor windings through the diodes V1 and V2. When BPMS ceases, the stop circuit causes a current limitation in the drivers so that the motor does not start in a rush.

The speed of the motor — i.e. indirectly the flow — is regulated by the signal MCVI from the flow potentiometer to a regulating stage, which acts on the drivers. The regulating stage also senses the current through the drivers. In case of momentary overloading it limits the current. In case of prolonged overloading it stops the motor but automatically makes repeated attempts at starting.

The number of revolutions — i.e., indirectly the flow — is indicated on an instrument with the aid of FIVP—FIVN. The instrument is calibrated with R12.

As long as the blood leak detector does not give an alarm, BLAO from the fluid unit is low. If the plug on the cable between the fluid and blood units is withdrawn from the fluid unit, R8 gives a high signal so that the motor is stopped. If the plug is withdrawn from the blood unit, the voltage division between R15 and R4 is interrupted, which also gives a high signal so that the motor is stopped.



Adjusting the blood pump

Insert the gauge pin between one of the pressure rollers and the pump path without using force. Check that the holder of the roller just starts to move inwards. If it does not, rotate the rotor through 180°, turn the adjusting screw and check again.

Note. If the blood pump is adjusted for a different tube dimension the flow indicator must be re-calibrated.

Calibrating the flow indicator

1. Insert the pump segment being used at present in the blood pump. Connect the inflow end to a vessel of water and the outflow end to a measuring glass graduated in ml.
2. Adjust the blood pump potentiometer so that the flow indicator shows 200 ml/min.
3. Measure the fluid transference for 1 minute.
4. Adjust R12 on Board 2 so that the flow indicator shows the value measured.
5. Readjust the blood pump potentiometer so that the flow indicator shows 200 ml/min and repeat the calibration.

Changing the blood pump motor

1. Remove the two rear screws in the bottom plate of the motor and loosen the front screws.
2. Unplug the cable.
3. Pull the motor to the rear so that the two halves of the clutch slide apart and lift out the motor.

Air detection

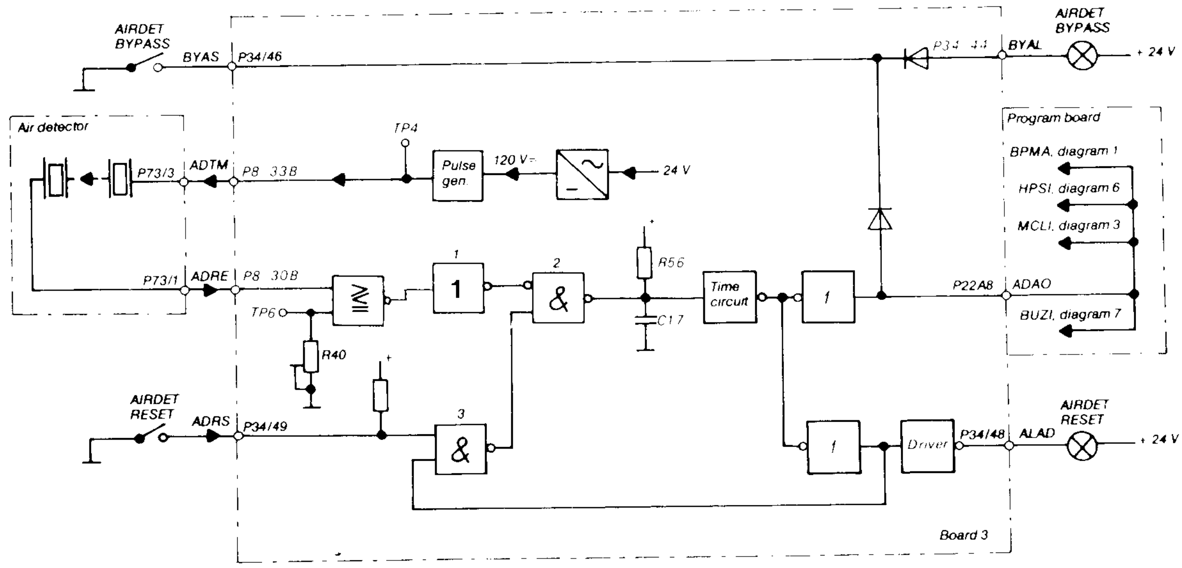


Diagram 2

Description

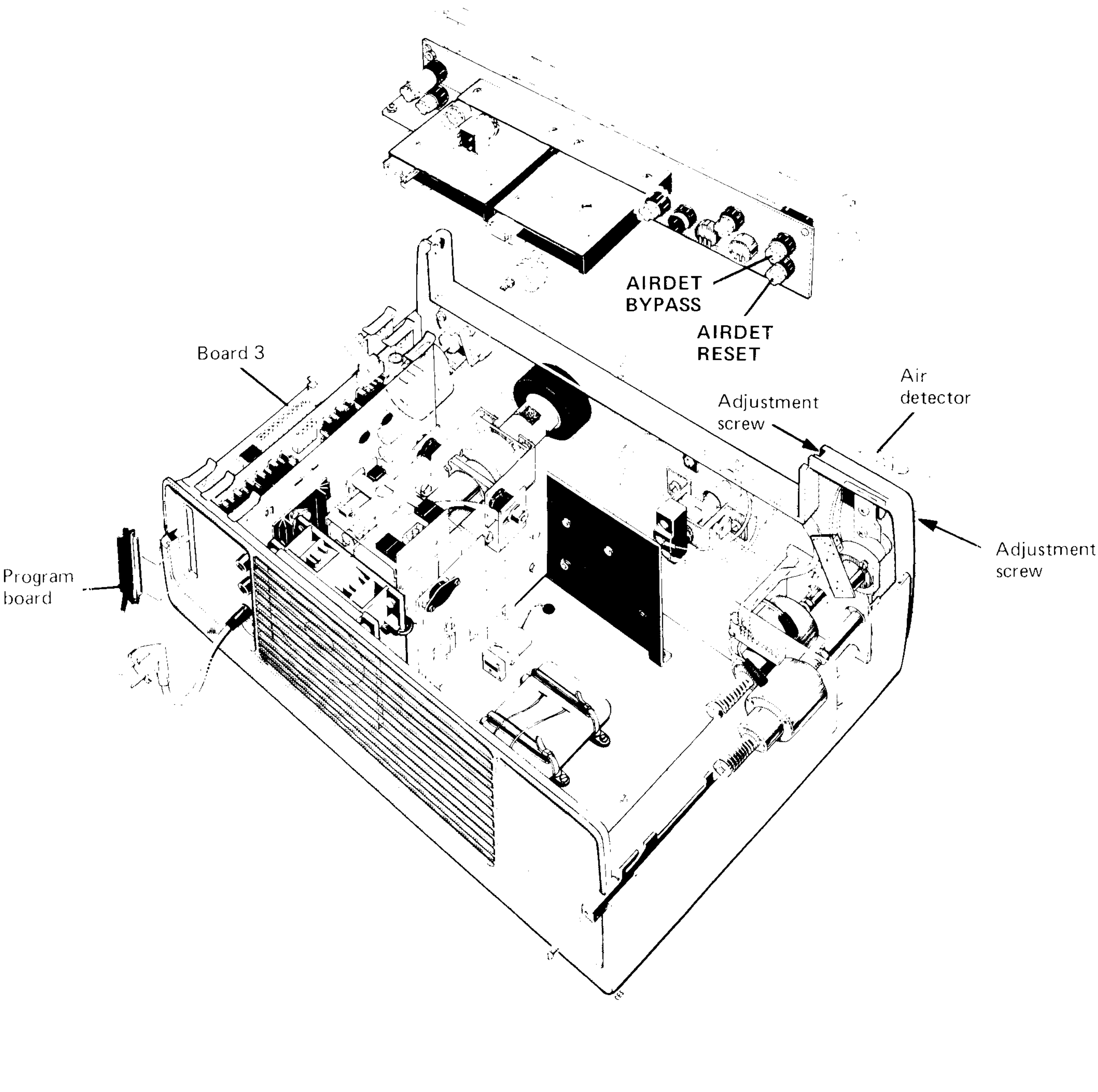
A pulse generator is fed with 120 V from a rectifier with voltage doublers in several stages. From the pulse generator, ADTM pulses are fed to the transmitter crystal of the air detector, which during the pulse period oscillates at ultrasonic frequency.

The ultrasonic signal is picked up by the receiving crystal and fed as ADRE to a comparator. The sensitivity of the air detector is regulated by R40. A 'zero' is issued by the comparator for every ultrasonic oscillation ADRE. This 'zero' and ADTM, which is also low, are fed to an AND gate 1, which in cases of coincidence gives a 'zero' to a second AND gate 2.

From AND gate 2, a 'zero' is issued which discharges a capacitor. After the end of the pulse the capacitor is charged until the next pulse arrives. If air appears between the crystals in the air detector the signal to be received ceases, i.e. coincidence is no longer obtained. Therefore the charging of the capacitor continues. If the capacitor is not discharged within 0.8 sec, i.e. voltage is fed to the time circuit for a longer period than normal, the time circuit gives a 'zero', resulting in the signal ADAO being sent out, the lamp AIRDET RESET lighting up and AND gate 2 being locked in the one-position. The locking of AND gate 2 is cancelled by AND gate 3 when AIRDET RESET is put in the on-position.

The signal ADAO results in BUZI for buzzer alarm, MCLI for arterial and venous line clamping, HPSI for heparin pump stop and BPMA/BPMS for blood pump stop.

If AIRDET BYPASS is put in the on-position, the alarm signal is grounded together with AIRDET BYPASS, which lights up.



Adjusting the air detector

The air detector is intended for drip chambers of 18—30 mm diameter. It is adjusted at the factory for the drip chamber specified by the customer.

When adjusting to a larger diameter: Insert the new drip chamber, and screw in the screws on the side until the drip chamber can be moved sideways about 1 mm.

When adjusting to a smaller diameter: Place the new drip chamber in the middle of the detector and undo the screws until the drip chamber can be moved about 1 mm.

Clamping of arterial and venous lines

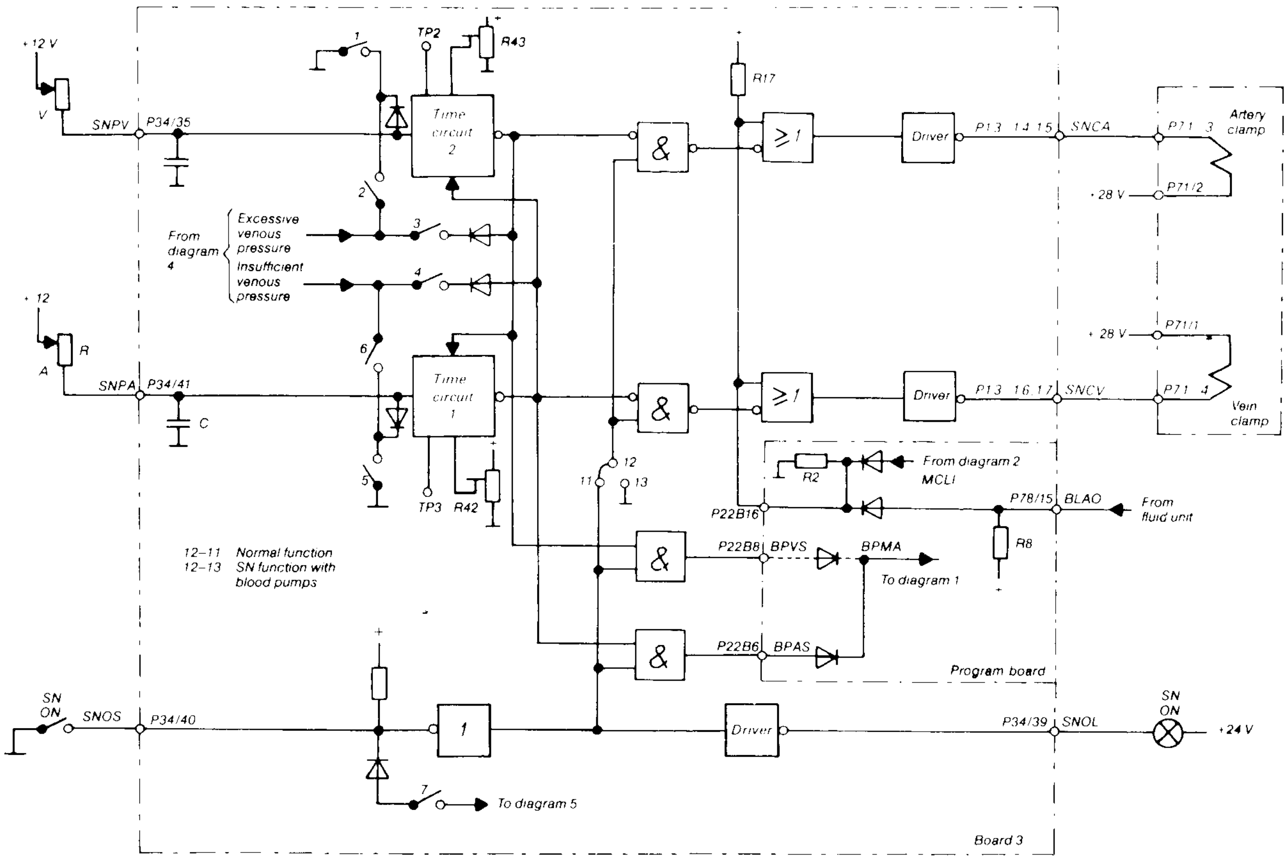


Diagram 3

Description

If SN ON is put in the on-position, the SN ON light will come on and all AND gates will open so that they can be controlled from two time circuits. The times are set by RC circuits which include the potentiometers on the front panel.

The time circuits issue zeros during the timing period. When a time circuit output reverts to one, it starts the timing period for the other time circuit.

Let us assume that time circuit 2 reverts to one, starting time circuit 1. As long as the output from time circuit 2 was low, the artery clamp was activated, i.e. closed. It now opens.

When the time set on potentiometer A (for the *artery* clamp) has run out, the output of time circuit 1 reverts to one, starting time circuit 2. The output from time circuit 2 will now close the artery clamp.

Note that time circuit 1 thus controls the opening time of the artery clamp, which is connected to time circuit 2. In the same way time circuit 2, with the V potentiometer, controls the opening time of the vein clamp, which is connected to time circuit 1.

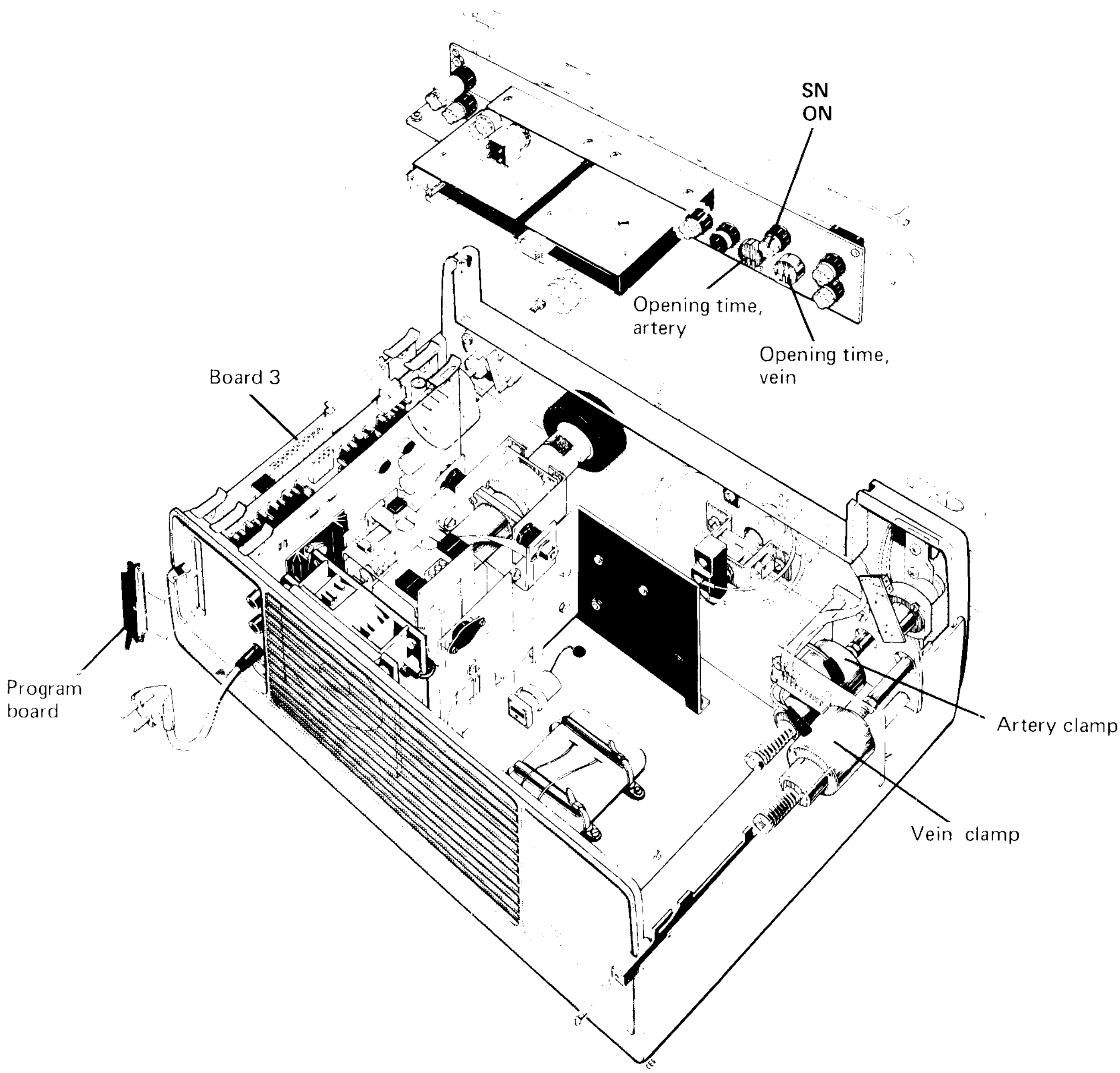
The potentiometers are graduated 1—15 secs.

Independently of the time circuits and the position of the SN switch, the clamps are closed at alarm by MCLI, from the air detector, or BLAO, from the blood leak detector in the fluid unit. (If another make of fluid unit is being used, BLAO comes in via an optocoupler.)

Normally a diode is fitted to stop the blood pump motor when the artery clamp is closed at SN ON.

Normally the wire-wrap pins 12—11 are connected. If the connection is moved to 12—13, SN function is obtained with the blood pump in the blood unit and an external blood pump, both running intermittently.

If switch 7 is put in the on-position, the arterial pressure alarm is disconnected when SN is switched on. This is because the arterial pressure varies within wide limits during SN so that false alarms might occur.



As long as the blood leak detector gives no alarm, BLAO from the fluid unit is low. If the plug on the cable between the fluid and blood units is withdrawn from the fluid unit, R8 gives a high signal so that artery and vein clamps are closed. If the plug is withdrawn from the blood unit, the voltage division between R17 and R2 is interrupted, which also gives a high signal so that the clamps are closed.

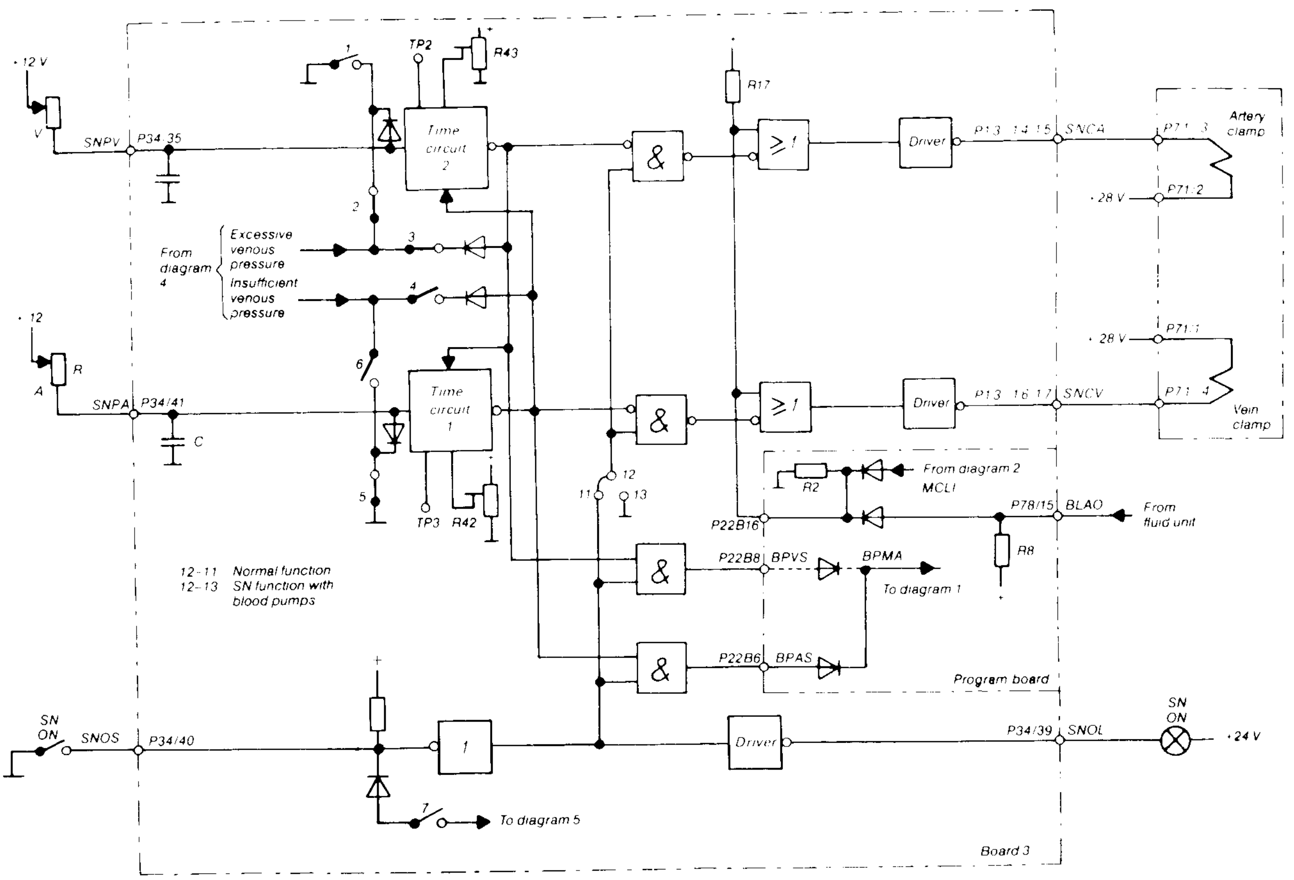


Diagram 3 (switches 2, 3, 5 closed)

The clamps and the blood pump can alternatively be controlled by the maximum and minimum alarm limits for the venous pressure (zeros) if certain manual switches are put in the on-position.

Artery clamp	Vein clamp	Switches in on-position
Max. alarm limit	Time	2, 3, 5
Time	Min. alarm limit	1, 4, 6
Max. alarm limit	Min. alarm limit	1, 5, 3, 4
Max. alarm limit (time)	Min. alarm limit (time)	2, 3, 4, 6

In the last of these alternatives the corresponding time circuit takes over control if the set time has expired before the alarm limit has been reached.

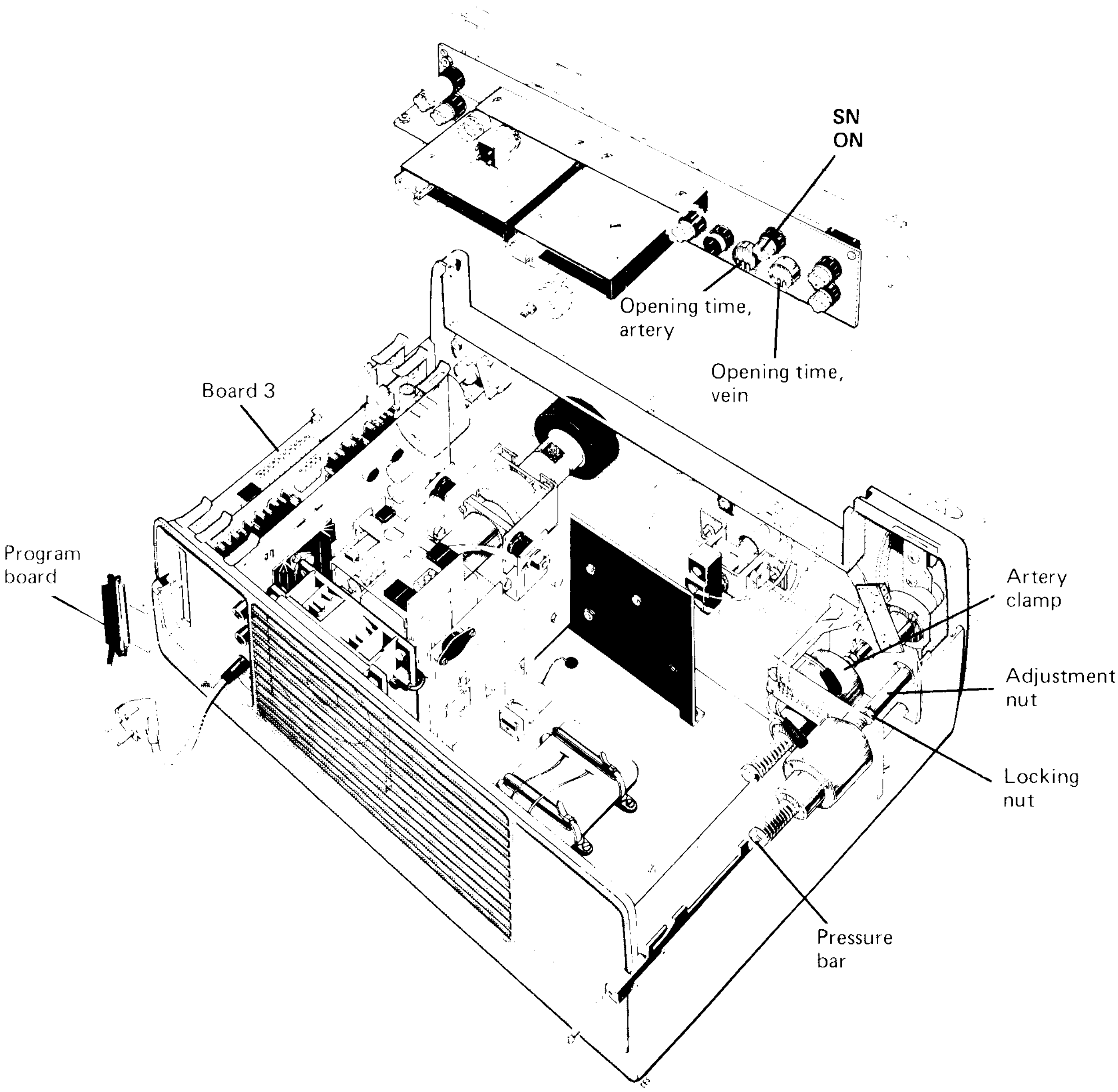
As an example, let us consider the first alternative (see the waveform diagram), starting when the vein clamp is closed.

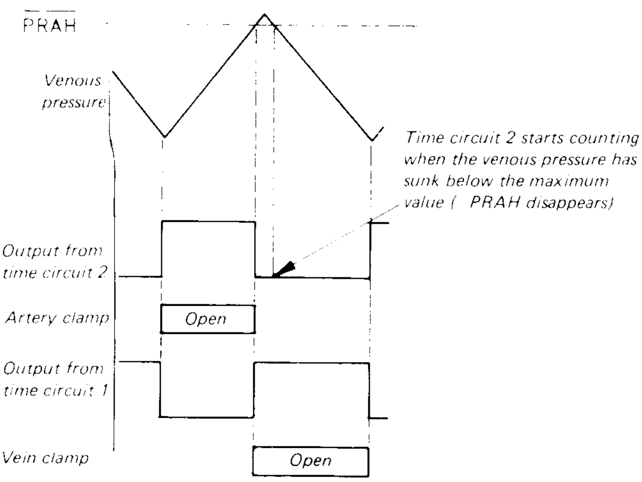
The venous pressure will then be rising. When the pressure reaches the set maximum level, —PRAH will be fed through switch 3 to the control input of time circuit 1. The output of this circuit will then revert to one, i.e. the vein clamp is opened. At the same time, —PRAH will close the artery clamp.

Because switch 2 is closed, time circuit 2 will not start counting until the venous pressure is again below the maximum limit. The output will then go low, taking over the closing of the artery clamp from —PRAH.

When the time set on the V potentiometer has run out, the output of time circuit 2 will revert to one, opening the artery clamp and switching time circuit 1 over to issue a zero output. The vein clamp will close, the venous pressure rises and the described sequence will be repeated.

Note that time circuit 1 follows the control input at all times as the RC input is disabled by switch 5.





Adjusting the magnetic clamps

1. Insert a tube in the magnetic clamp. Connect a manometer and a pressure-producing device such as a rubber squeezer.

2. Loosen the locking nut.

3. Hold the pressure bar to prevent it revolving. Turn the adjustment nut until tightness is obtained; to check this, raise the pressure to 600 mm Hg (80 kPa): the pressure should then not fall by more than 30 mm Hg (4 kPa) in 15 seconds.

4. Tighten the locking nut and safety the nuts with locking fluid.

Venous pressure monitoring

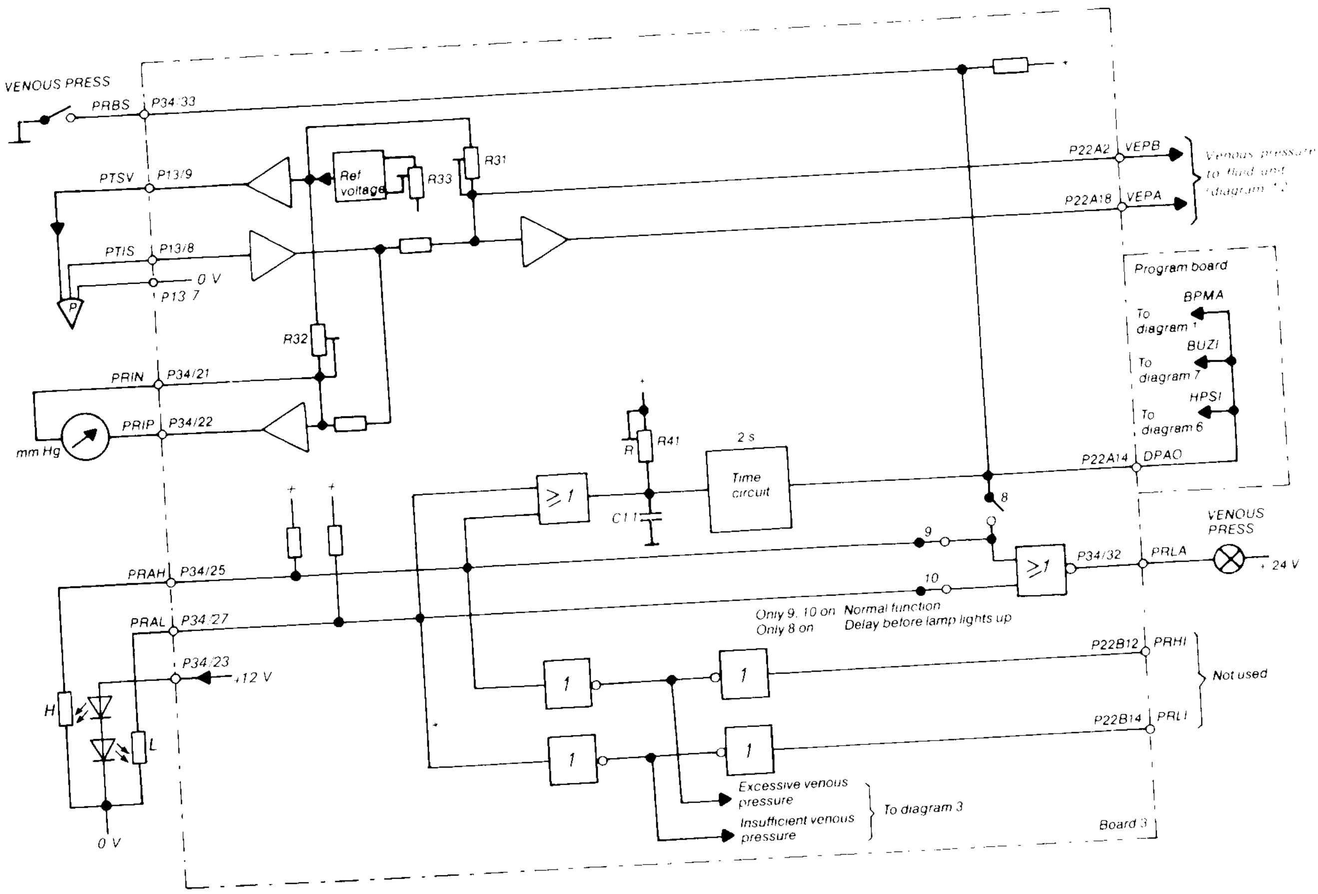


Diagram 4

Description

The signal PTIS is fed from the venous pressure transducer to an instrument on the front panel. The instrument is zeroed with R32.

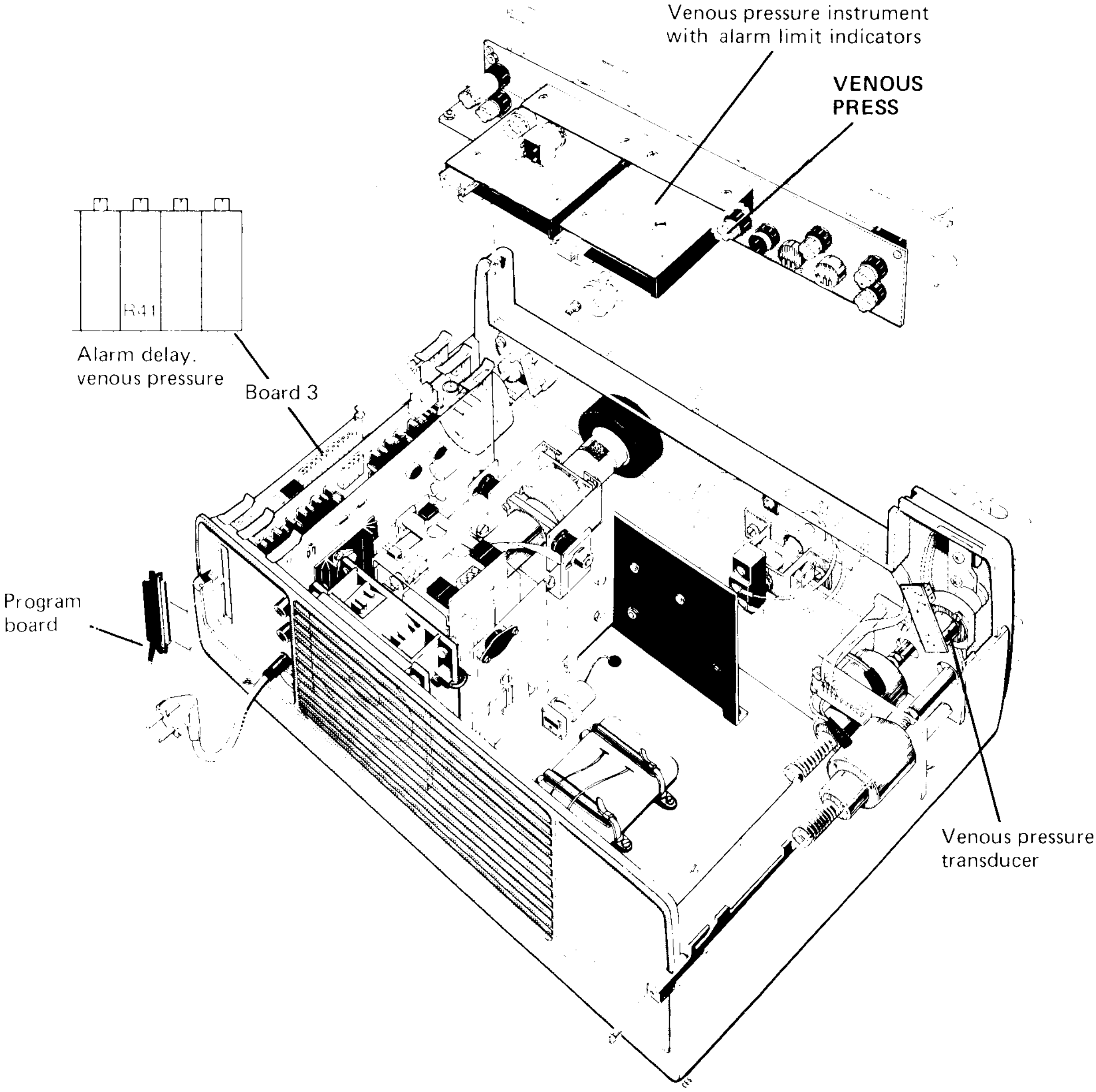
The pressure transducer signal is also fed as VEPA and VEPB to the circuits for pressure regulation in the fluid unit at TMP. The zero level is set with R31.

On the instrument there are two alarm limit indicators with opto-electronic sensors, one giving PRAH when pressure is too high, the other PRAL when pressure is too low. The switches 9 and 10 are normally closed so that the signals cause the VENOUS PRESS lamp to light up immediately.

The signals are also fed to a time circuit, which after 2 seconds (adjustable from 1 to 8 seconds) gives DPAO. This signal results in BPMA for blood pump stop, BUZI for buzzer alarm and HPSI for heparin pump stop. The signal DPAO can, however, be cancelled by holding VENOUS PRESS pressed in. This results in forced running of the blood pump so that the operator can examine the cause of the alarm, except for max. pressure alarm.

If switches 9 and 10 are opened and 8 closed there will also be a delay before the lamp lights up.

The signals PRAH and PRAL are in addition inverted and fed to the circuits for arterial and venous line clamping.



Adjusting the alarm delay, venous pressure

The unit is delivered with the alarm delay for venous pressure set at 2 seconds. This can be altered to a maximum of 8 seconds by means of R41 on Board 3 and a stop watch.

Arterial pressure monitoring

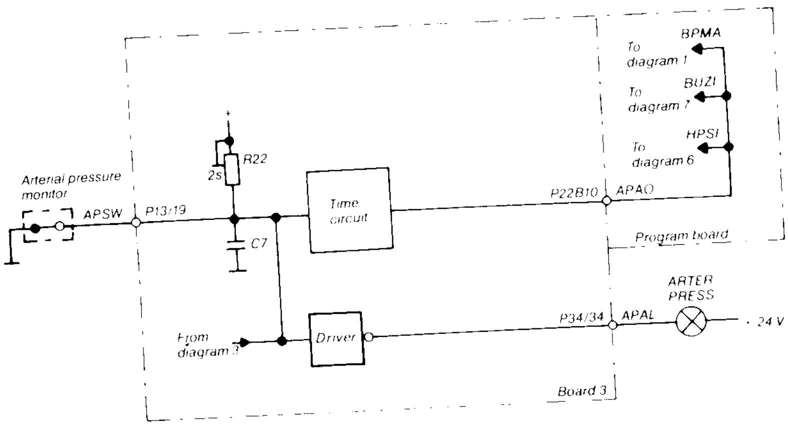


Diagram 5

Description

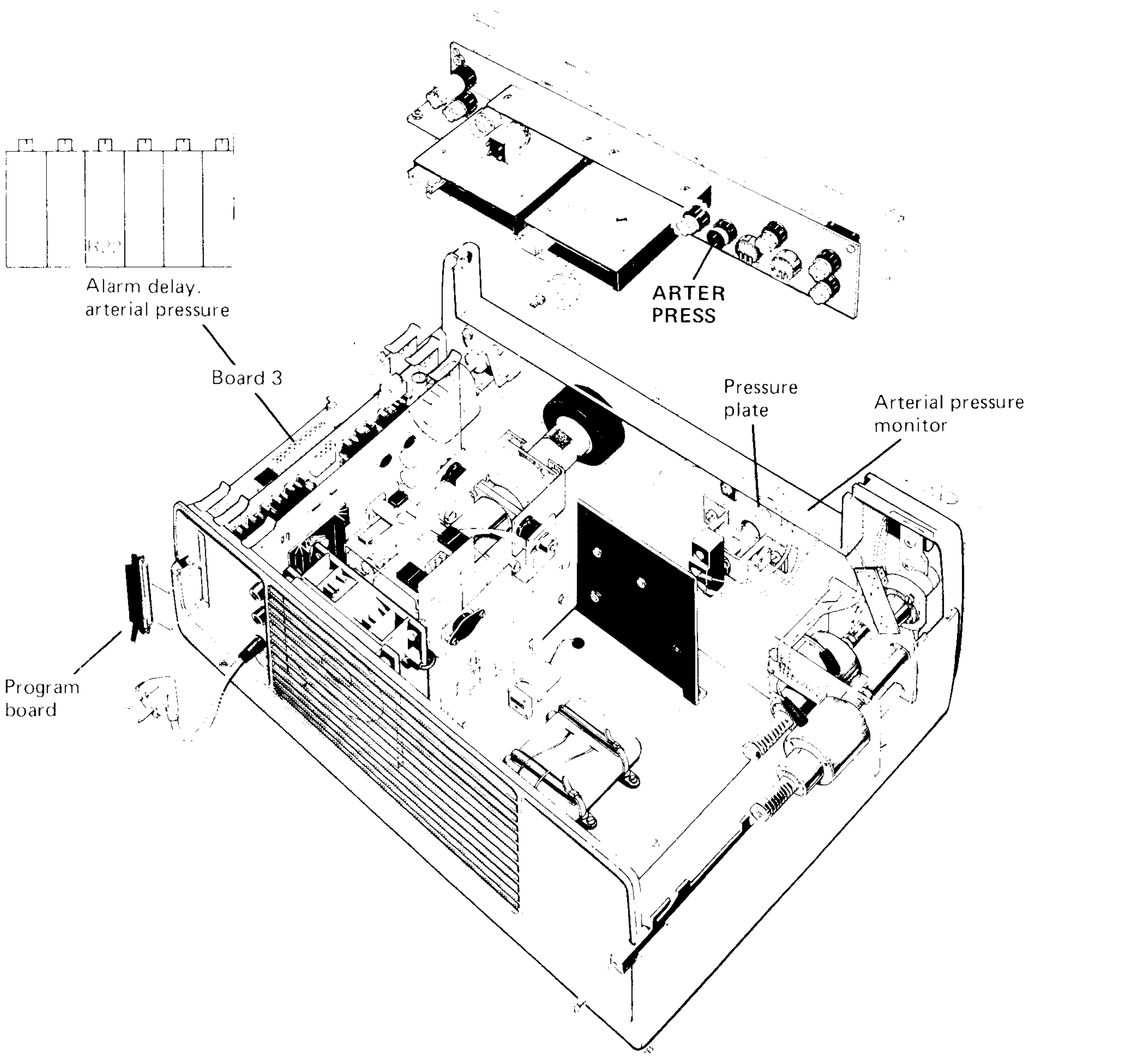
If the microswitch in the arterial pressure monitor opens due to insufficient arterial pressure, the ARTER PRESS lamp lights up.

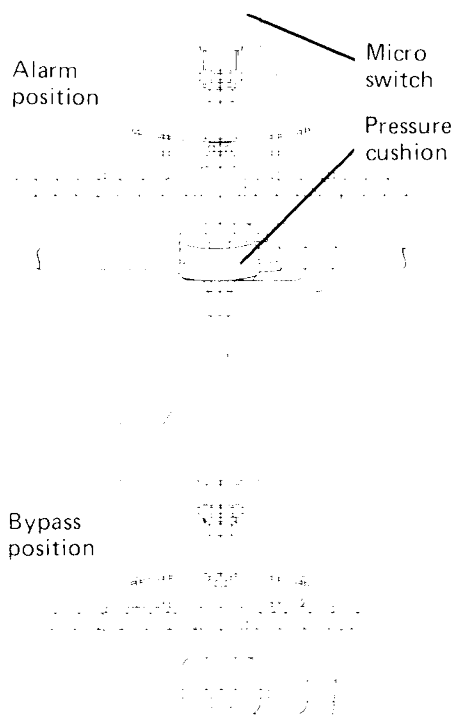
When the capacitor in the RC circuit has been charged after 2 seconds, the time circuit gives the signal APAO, which results in BPMA for blood pump stop, BUZI for buzzer alarm and HPSI for heparin pump stop.

The delay time is adjustable with R22.

If a 'zero' comes in from the circuits for arterial and venous line clamping (SN ON in on-position), the arterial pressure monitoring is deactivated.

With the pressure plate in the by-pass position, the artery alarm function is by-passed.





Adjusting the arterial pressure monitor

1. Insert a tube set and let the pump suck water at 37°C.

2. Connect a reference manometer for negative pressure between the water container and the monitor.

3. Throttle the tube between the manometer and the water container. Check that the alarm lamp lights up at 150—200 mm Hg (20—27 kPa). Adjust if necessary by turning the pressure plate (clockwise for alarm at lower pressure, counterclockwise for higher).

4. The machine is delivered with the alarm delay for arterial pressure set at 2 seconds. This can be altered to a maximum of 8 seconds by means of R22 on Board 3 and a stop watch.

Heparin flow regulation

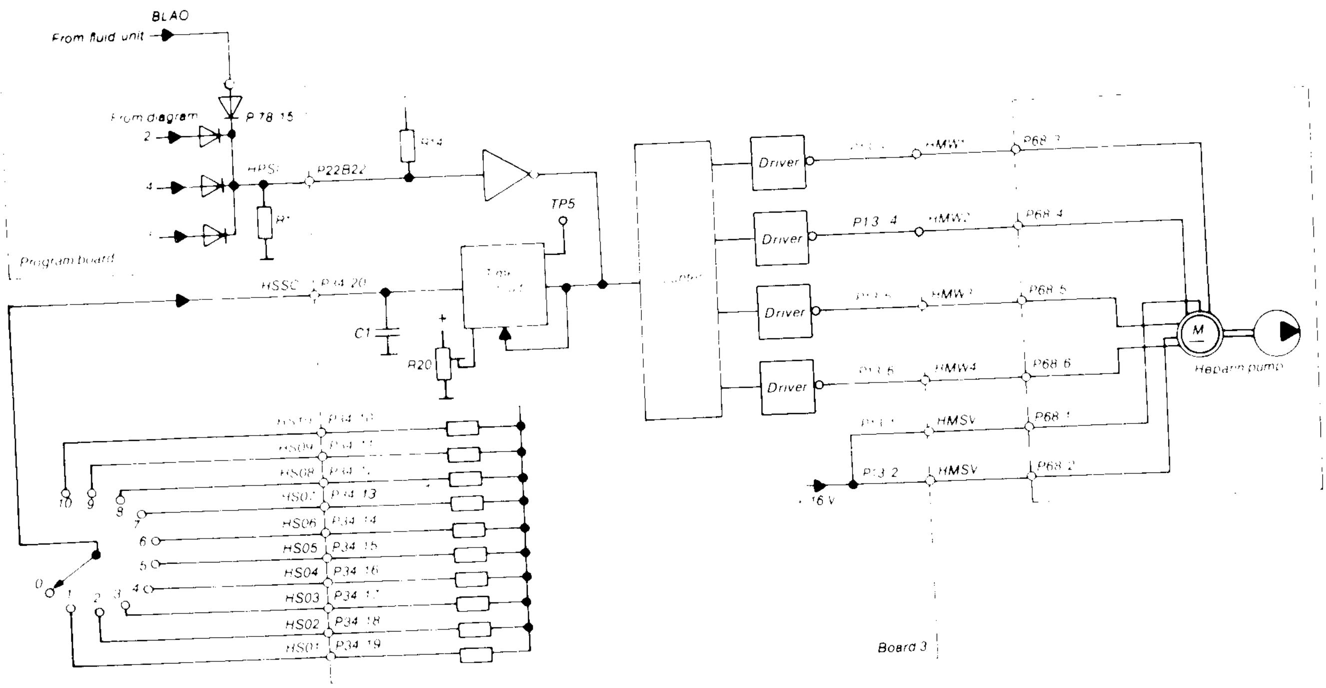


Diagram 6

Description

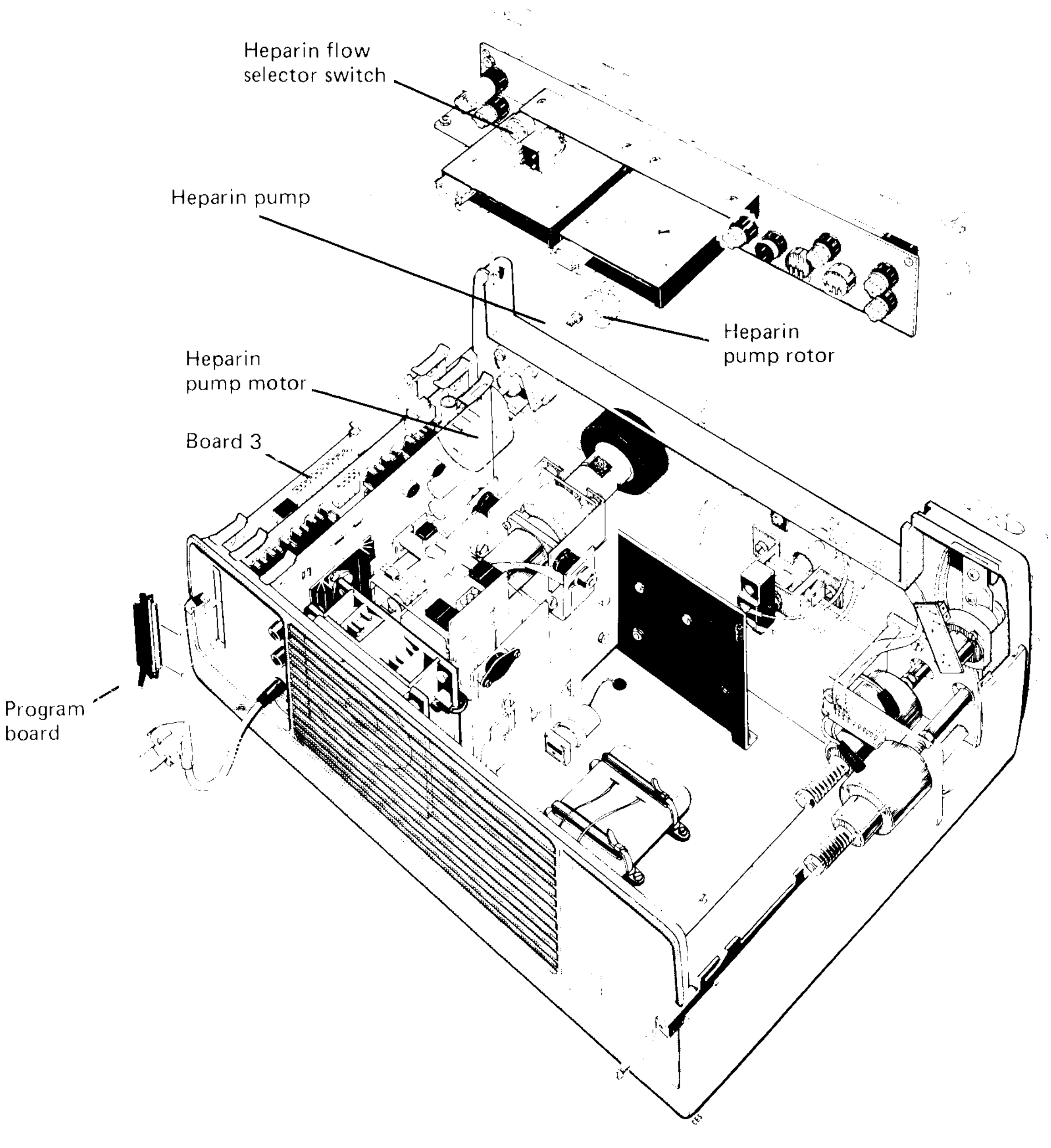
A switch on the front panel is used to select a resistor so that different RC circuits are formed together with a capacitor on the entry to a time circuit. According to the switch position, the time circuit gives 'ones' at different intervals (127 x RC). The time circuit resets itself so that it is immediately restarted at each 'one'.

The time circuit controls a counter, which in turn controls a stepping motor.

The counter is stopped if HPSI is received from the circuits for air detection or for venous or arterial pressure monitoring or BLAO is received from blood leak detector.

If the plug on the cable between the fluid and blood units is withdrawn from the blood unit, the voltage division between R14 and R1 is interrupted so that a high signal is obtained on P22B22, i.e. the heparin pump stops.

The speed of the motor — i.e. indirectly the flow — is regulated by R20.



Changing the heparin pump

Remove the rotor and loosen the four screws that then become accessible.

Buzzer alarm

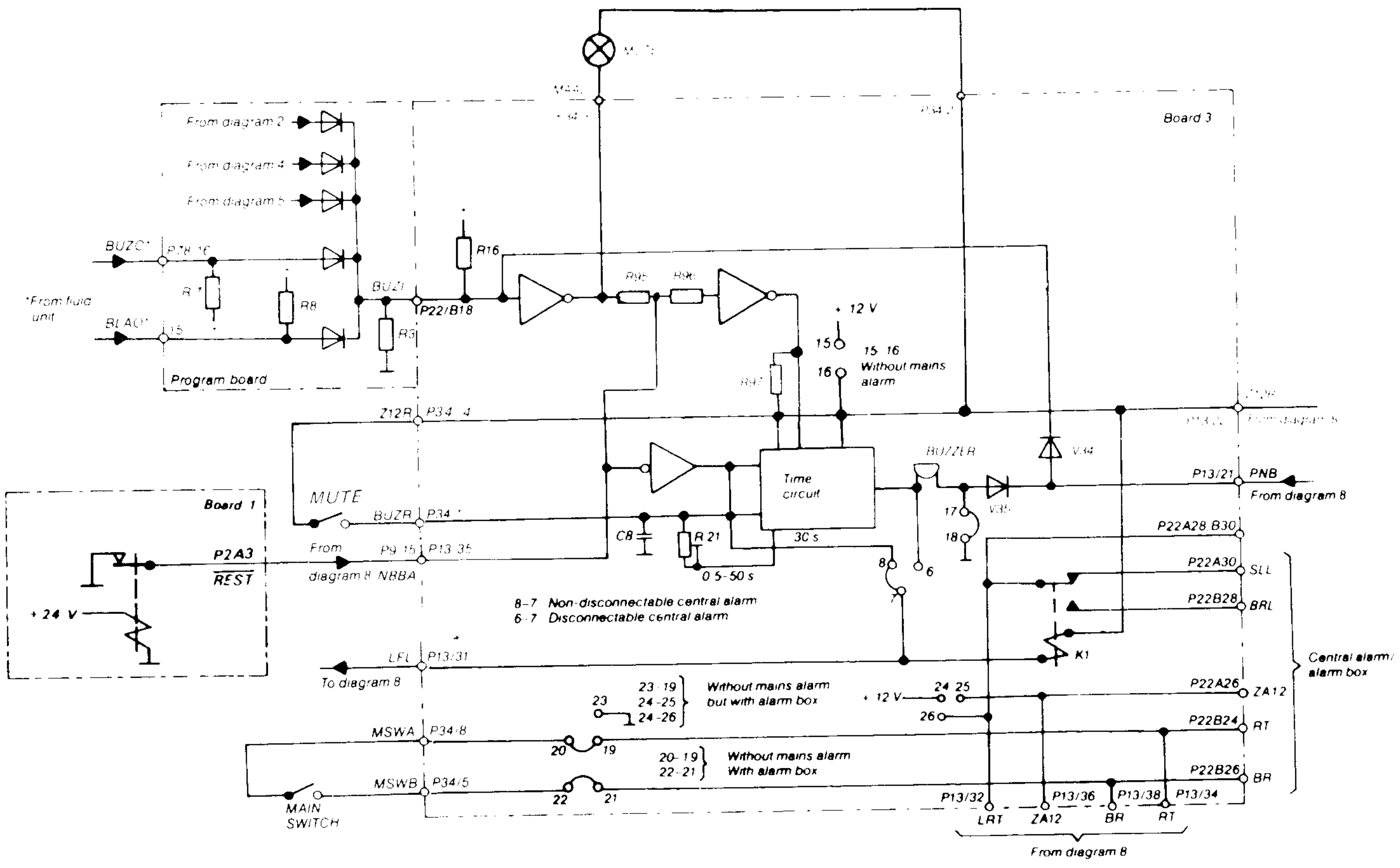


Diagram 7

Description

When BUZI comes from the circuits for air detection or venous or arterial pressure monitoring, the MUTE lamp lights up, the buzzer sounds and a relay for central alarm is released (since the relay receives plus on both sides). BUZI is also obtained at BUZO, from the fluid unit circuits for pressure regulation, temperature monitoring, conductivity monitoring, water level monitoring, disinfection control and blood leak detection. (The blood leak detection circuits also issue BLAO, which also gives rise to BUZI). If another make of fluid unit is being used, BUZO and BLAO come in via an optocoupler. If the machine has a mains alarm, a low signal is received on P13/35 in case of mains failure.

An alarm is also initiated if a 24 V relay on power supply board 1 is released due to +24 V failure.

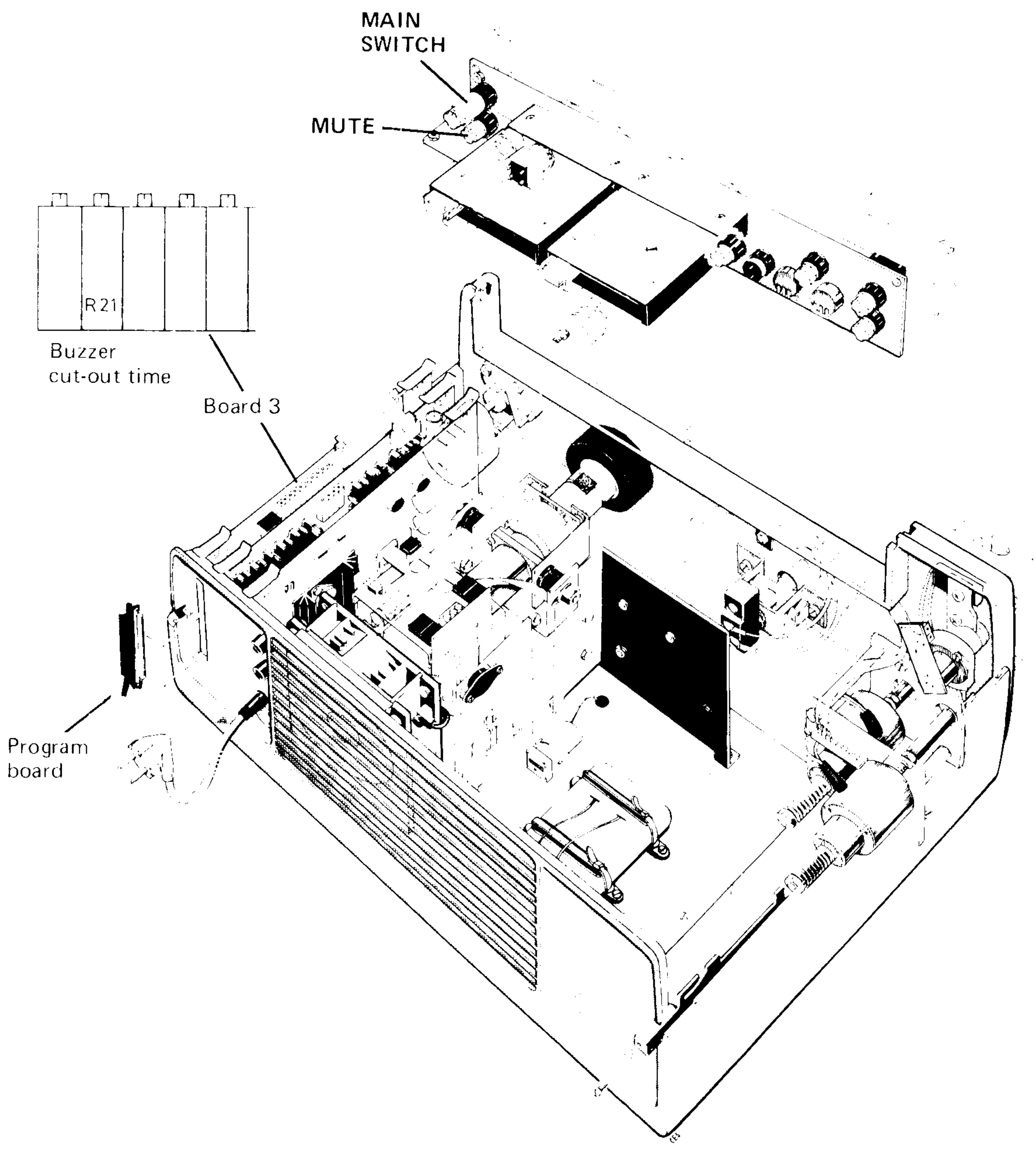
If MUTE is pressed in, 12 V is fed as BUZR to a time circuit, which silences the buzzer, normally for 30 seconds (adjustable from 0.5 to 50 sec with R21).

If the wire-wrap pins 6—7 are connected, the central alarm also ceases for the set time. Normally, however, pins 8—7 are connected. In both cases a high signal LFL is fed out (see "Mains alarm").

If the machine is not provided with a mains alarm, the pins 17-18 are connected. If the machine has mains alarm, the buzzer is earthed instead with PNB for an intermittent buzzer and MUTE facility.

Note that if there is no BUZI, the entry to the inverter before the time circuit is kept high by the voltage through the MUTE lamp. If the lamp fails the voltage disappears and an alarm is issued.

Since central alarm goes out from the relay if the machine is turned off, RT/BR is fed to the central alarm unit for indication of the position of the mains switch. If the machine is equipped with mains alarm, the wire-wrap connections 20—19 and 22—21 are absent. RT/BR will then come as an intermittent signal from the mains alarm circuits in case of a power failure.



As long as no alarm is initiated from the fluid unit, both BUZO and BLAO are low. If the plug on the cable between fluid and blood units is withdrawn from the fluid unit, R7 and R8 give high signals so that alarm is issued. If the plug is withdrawn from the blood unit, the voltage division between R16 and R3 is interrupted, which also gives a high signal so that alarm is issued.

Adjusting the buzzer cut-out time

The machine is delivered with the buzzer cut-out time, when MUTE is pressed in, set at 30 seconds. This can be altered to a minimum of 0.5 seconds and a maximum of 50 seconds by means of R21 on Board 3 and a stop watch.

Mains alarm

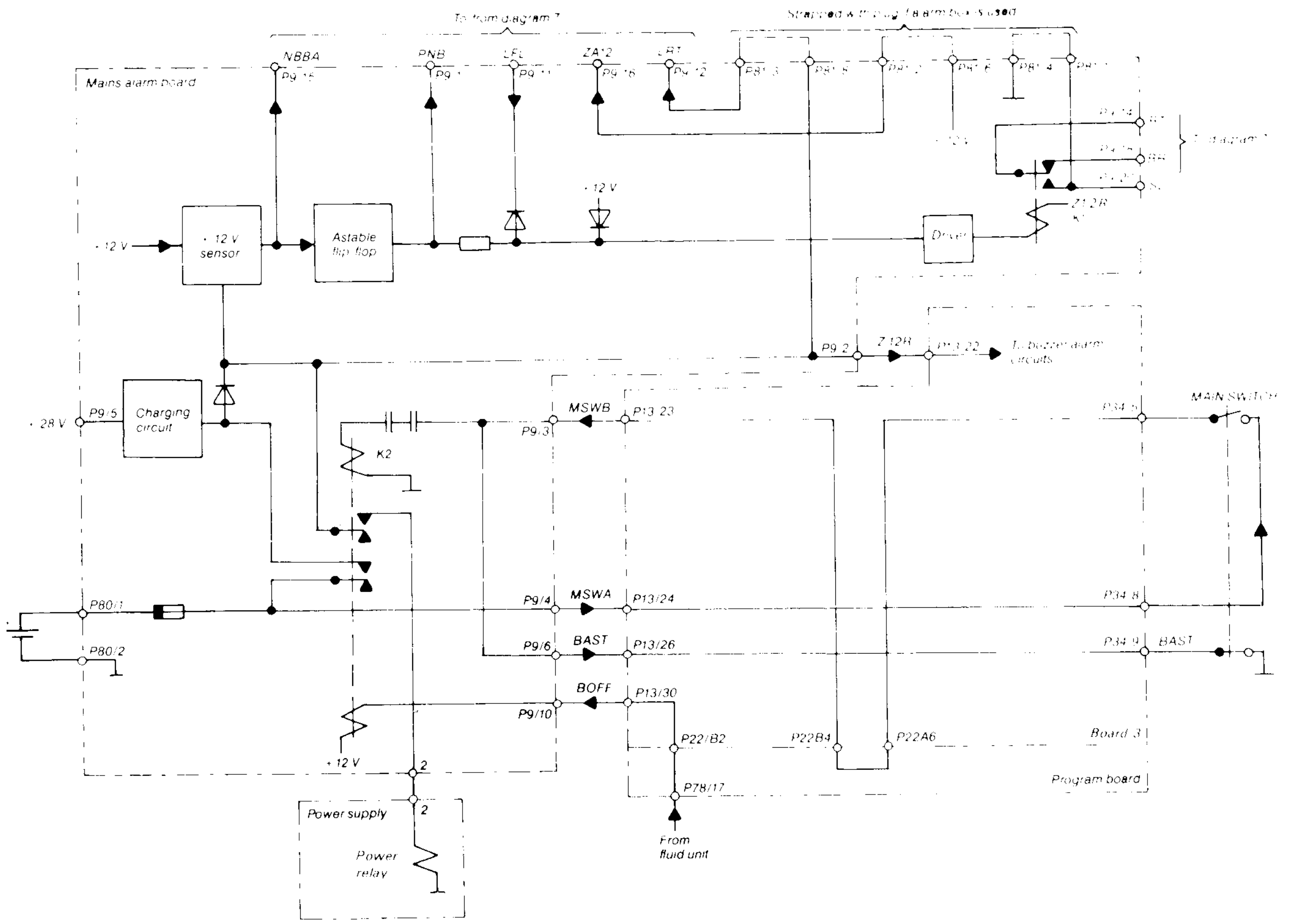


Diagram 8

Description

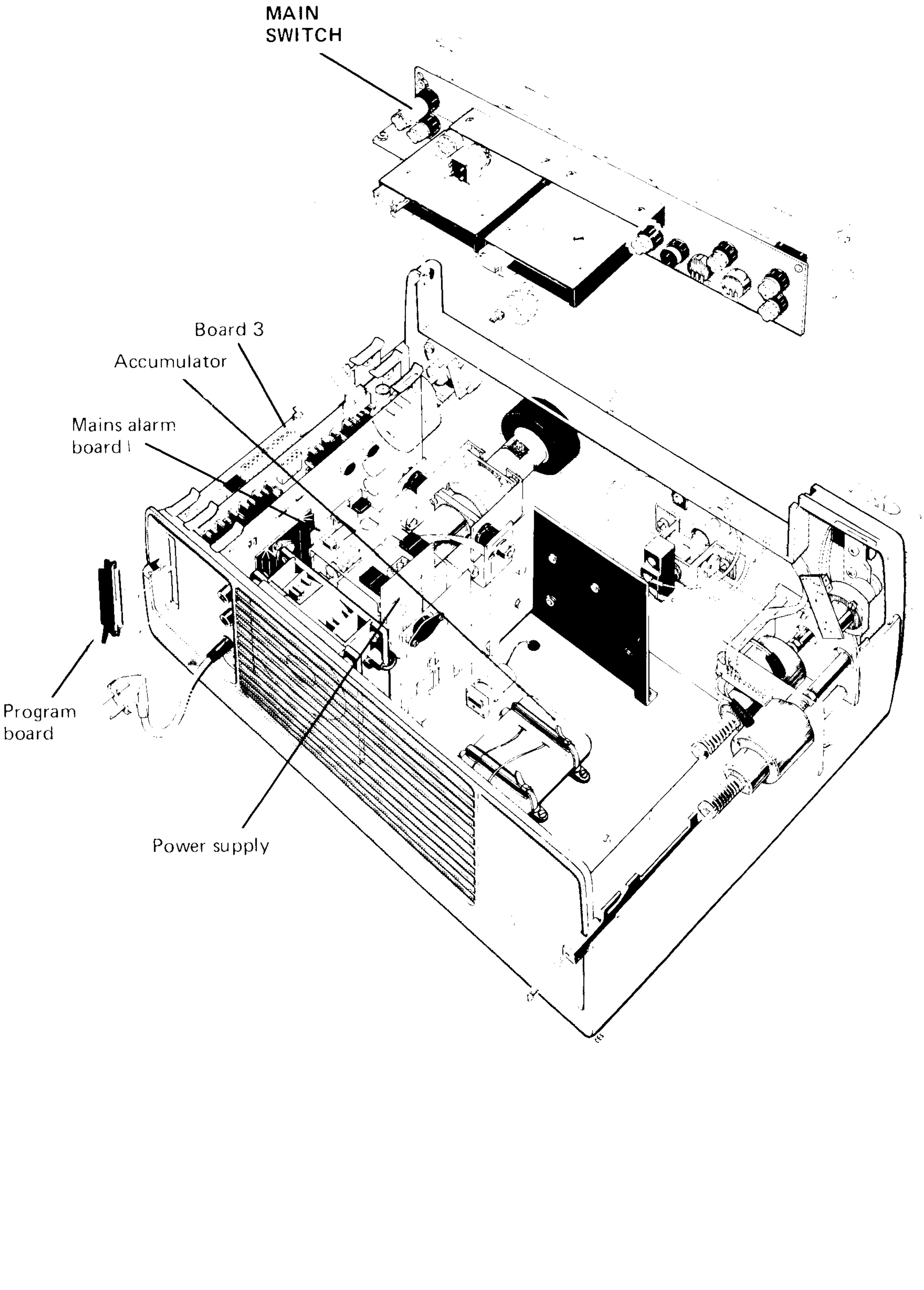
If the monitor is equipped with mains alarm it is always started with the aid of an accumulator. When the MAIN SWITCH is placed in the on-position, a polarised relay K2 is given an activating pulse by two capacitors and then feeds the power relay with voltage from the accumulator. This is then charged from a charging circuit via one of the contacts in K2.

In the event of a power failure the accumulator supplies both the buzzer alarm circuits on Board 3 and a + 12 V sensor. When the + 12 V voltage disappears in the event of power failure, the sensor gives a signal to the buzzer alarm circuits via P9/15. This also activates an astable flip-flop, which pulses a relay K1 for RT/BR to the buzzer alarm circuits and gives a pulsing signal PNB (for pulsed buzzer alarm) to the buzzer alarm circuits. When buzzer alarm occurs, LFL comes in from the buzzer alarm circuits for activating K1.

The capacitors are discharged through the earth signal BAST when the MAIN SWITCH is put in the off-position. The polarised relay is then released.

The second coil in the polarised relay is intended for mains switch-off from the fluid unit when the emptying programme is finished (not standard).

If alarm box is being used, certain pins are strapped in connector P81.



Recharging the accumulator

See under "Power supply".

Alarm box

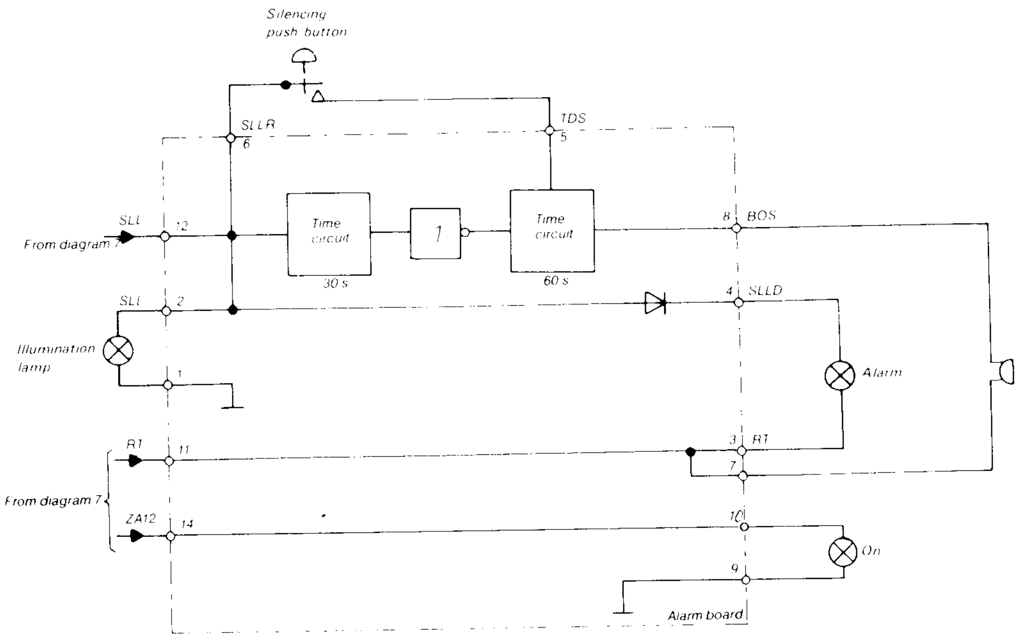


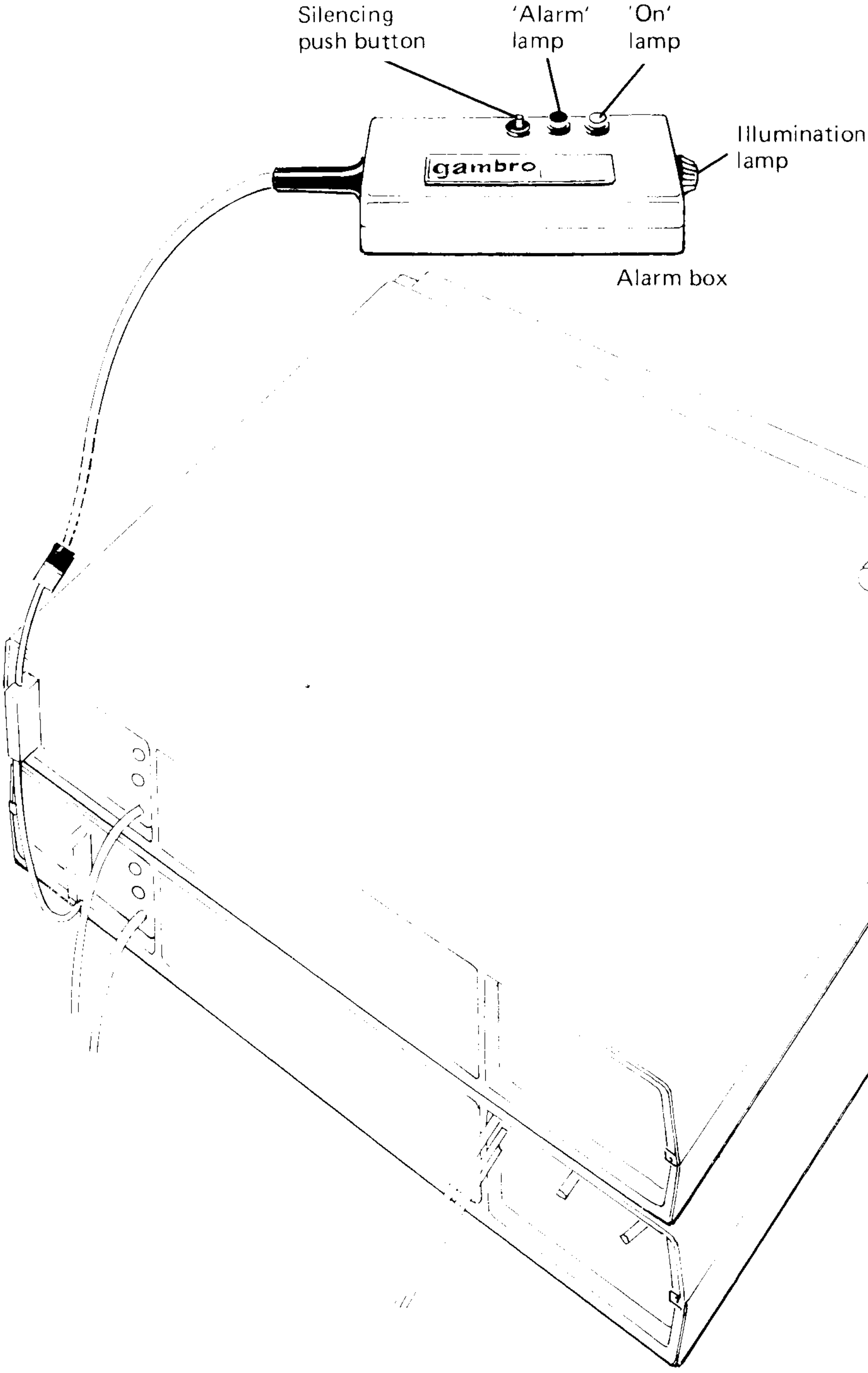
Diagram 9

Description

If alarm box is used an 'on' lamp is kept lit by ZA12 when the blood unit is in operation.

When alarm is given, SLL is received from the buzzer alarm circuits. This causes a lamp to come on for illumination and another lamp for alarm. In addition, a time circuit gives BOS to a buzzer after 30 sec. The buzzer can be silenced for 60 sec by feeding TDS from a push button switch to a second time circuit.

If the apparatus is equipped with mains alarm the alarm box will give intermittent alarm at mains failure.


Silencing
push button
'Alarm'
lamp
'On'
lamp
Illumination
lamp
gambro
Alarm box

Power supply

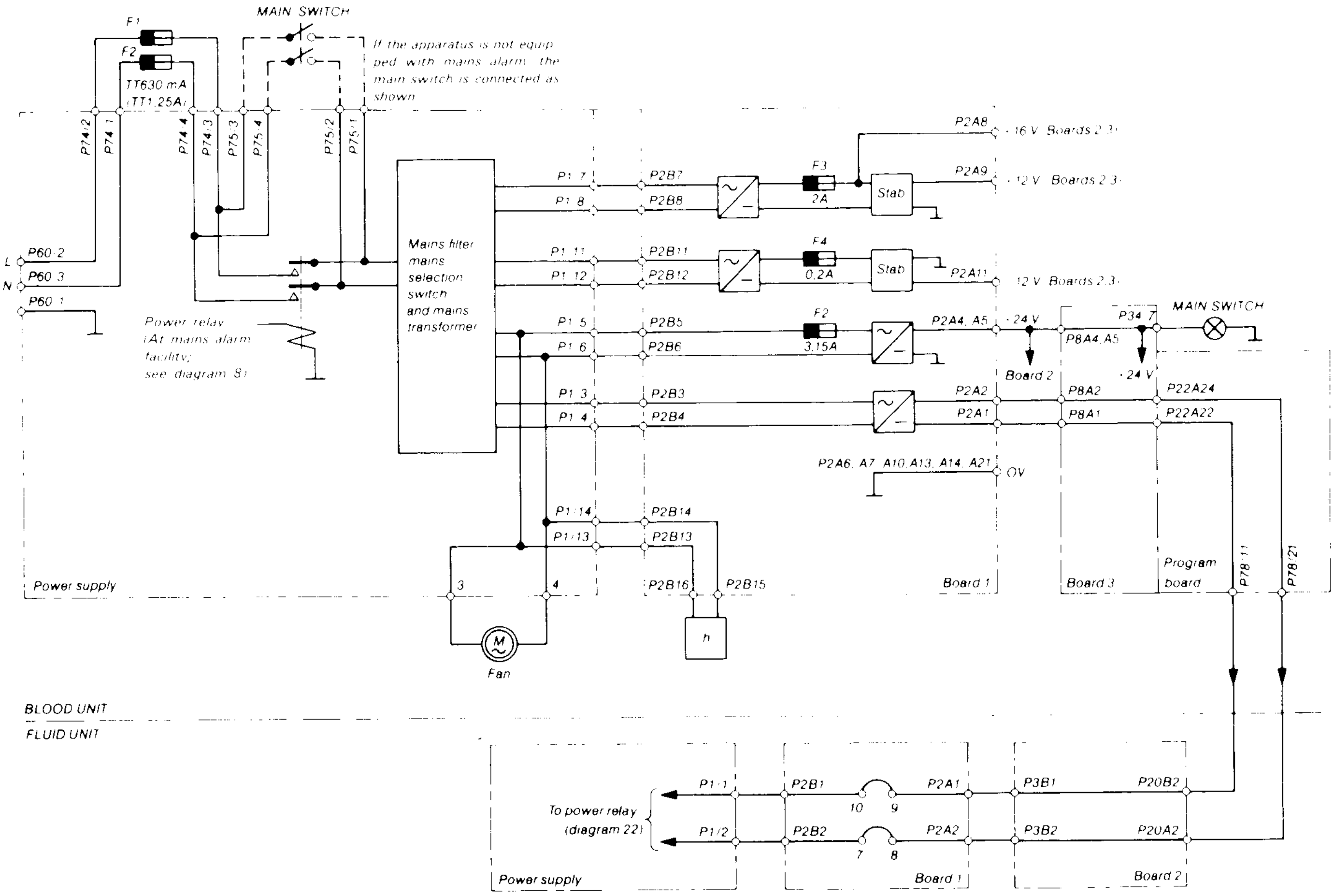


Diagram 10

Description

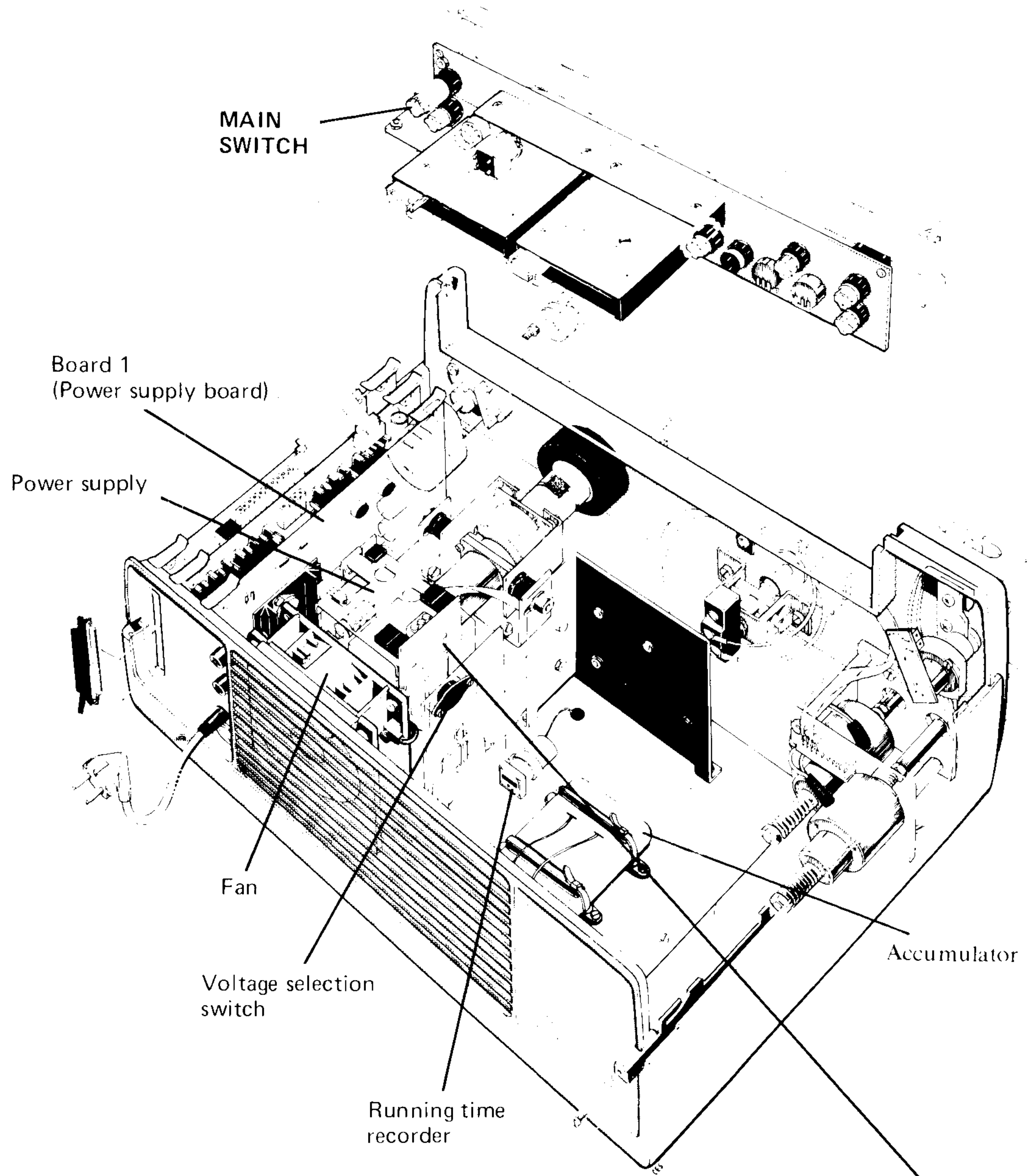
The blood unit receives its electrical supply from a power supply without mains alarm, or a power supply with mains alarm, and Board 1.

The power supplies are connected directly to the mains. In the power supply without mains alarm, the mains voltage is connected with the MAIN SWITCH. The power supply contains mains filter, voltage selection for 110, 130, 220 and 240 V, as well as ± 10 V and mains transformer. A fan, a running time recorder and Board 1 are connected to the mains transformer.

In the power supply with mains alarm, the mains voltage is connected by the MAIN SWITCH connecting the voltage from an accumulator to a power relay (see "Mains alarm"). Apart from the power relay, this power supply contains mains filter, voltage selection for 110, 130, 220 and 240 V, as well as ± 10 V, mains transformer and mains alarm board.

Board 1 contains rectifiers with stabilisers for + 12 V and —12 V, one rectifier for + 24 V and one rectifier for operating the mains relay in the fluid unit.

Board 2 contains a filter, which is fed with + 24 V. The voltage from the filter, approx. + 28 V, is used for the blood pump motor and the magnetic clamps.

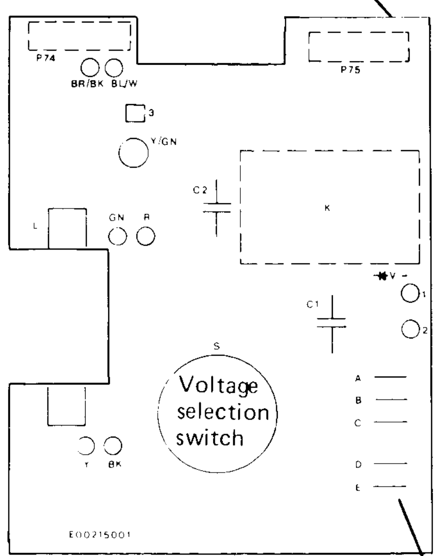


Recharging the accumulator

Short-circuit P75/3—1 and P75/4—2 (main switch connector) to recharge the accumulator in an apparatus with mains alarm, if the accumulator has been fully discharged.

Changing the voltage

The switch can be set for 110, 130, 220 and 240 V. By means of strapping it is also possible to select ± 0 V, + 10 V or —10 V deviation from these values.



Power supply board

Strap A for +/-0 V
Strap B, D for -10 V
Strap C, E for +10 V

Signal list

ADAO	Air	Detector	Alarm	Output
ADRE	Air	Detector	Receiver	
ADRS	Air	Detector	Reset	Switch
ADTM	Air	Detector	Transmitter	
ALAD	Alarm	Lamp	Air	Detector
APAL	Arterial	Pressure	Alarm	Lamp
APAO	Arterial	Pressure	Alarm	Output
APSW	Arterial	Pressure	Switch	
BAST	Battery	Start		
BLAO	Blood	Leak	Alarm	Out
BOFF	Battery	Off		
BPAS	Blood	Pump	Arterial	Stop
BPMA	Blood	Pump	Motor	Alarm
BPMS	Blood	Pump	Motor	Stop
BPTS	Blood	Pump	Tacho	Signal
BPVS	Blood	Pump	Venous	Stop
BPWC	Blood	Pump	Winding	Current
BRL	Break	Alarm		
BUZI	Buzzer	Input		
BUZR	Buzzer	Reset		
BYAL	Bypass	Air	Detector	Lamp
BYAS	Bypass	Air	Detector	Switch
DPAO	Delayed	Pressure	Alarm	Output
FIVN	Flow	Indicator	Voltage	Negative
FIVP	Flow	Indicator	Voltage	Positive
HESV	Hall	Element	Supply	Voltage
HMSV	Heparin	Motor	Supply	Voltage
HMW1-4	Heparin	Motor	Winding	1-4
HPSI	Heparin	Pump	Stop	Input
HRV1	Hall	Return	Voltage	1
HRV2	Hall	Return	Voltage	2
HS01-10	Heparin	Speed	1-10	
HSSC	Heparin	Speed	Select	Common
LRT	Alarm	Relay		
MAAL	Main	Alarm	Lamp	(MUTE)
MCLI	Magnetic	Clamp	Input	
MCVO	Motor	Control	Voltage	Output
MCVI	Motor	Control	Voltage	Input
MSWA	Main	Switch	A	
MSWB	Main	Switch	B	
NBBA	Mains	Break	Buzzer	Alarm
PNB	Pulse	Mains	Break	
PRAH	Pressure	Alarm	High	
PRAL	Pressure	Alarm	Low	
PRBS	Pressure	Bypass	Switch	
PRHI	Pressure	High	Information	
PRIP	Pressure	Instrument	Positive	
PRIN	Pressure	Instrument	Negative	
PRLA	Pressure	Lamp	Alarm	
PRLI	Pressure	Low	Information	
PS01-04	Positive	Switch	1-4	
PTIS	Pressure	Transducer	Input	Signal
PTSV	Pressure	Transducer	Supply	Voltage
REST	Reset			
RSTN	Restart	Negative		
RSTP	Restart	Positive		
SLL	Signalling	Alarm		
SNCA	Single	Needle	Clamp	Arterial
SNCV	Single	Needle	Clamp	Venous
SNOL	Single	Needle	On	Lamp
SNOS	Single	Needle	On	Switch
SNPA	Singel	Needle	Potentiometer	Arterial
SNPV	Single	Needle	Potentiometer	Venous
VEPA	Venous	Pressure	A	
VEPB	Venous	Pressure	B	
WC01-04	Winding	Contact	1-4	

Technical data

Type designation	BMM 10-1
Blood pump	
Design	Selfthreading pump
Flow regulation	Approx 50-500 ml/min with tube 8 × 2 mm dia. (pump speed 0-50 r/m)
Flow indicator	0-500 ml/min
Heparin pump	
Design	Tube pump for two tubes (heparin and, when suitable, protamin) 1 × 2 mm dia.
Flow regulation	0-10 ml/h
Venous pressure instrument	-200 to +400 mm Hg +/-10 mm Hg
Air detector	
Design	Ultrasonic sensing of blood in the drip chamber.
Alarm level	With Gambro vein chamber: max 0.2 ml air/min at blood flows below 300 ml/min.
Arterial pressure monitor	
Design	Microswitch with bypass position
Alarm level	Adjustable -50 to -500 mm Hg with Gambro arterial pressure cushion.
Power supply	
Mains voltages	240, 220, 130, 110 V +/-10%, 50 or 60 Hz (mains frequency must be specified for runningtime meter).
Power	Max. 100 W
Cable length	Approx 3 m
Mains socket	Standard earthed socket, DIN specifications for 220 V, ASA for 110 V
Fuses	220 V: 2* × 0.63 ATT, DIN 5 × 20 110 V: 2* × 1.25 ATT, ASA 6.3 × 22 *For some countries 1 × 0.63 ATT, 1.25 ATT
Leakage current	$<30\ \mu A$
Ambient temperature	15-35°C
Dimensions	Depth 400 mm (with front components 450 mm) Widht 510 mm, height 190 mm
Weight	13 kg

Special adjustments

Supply voltages

Check that the voltage at "Z12P" on Board 1 is +12 V +/-0.5 V and that the voltage at "Z12N" has the same value as "Z12P" (but negative). If necessary, adjust R47.

Venous pressure instrument

Calibrating the venous pressure transducer

1. Connect a DMM to pin A (Z0VL) and pin C (PTSV) on the press. transducer board.
2. Adjust R33 on Board 3 to -5 V +/-20mV om the DMM.
3. Connect a reference gauge and a rubber squeezer to the nipple on the front panel.
4. Connect the DMM to pin A (Z0VL) and pin B (PTIS) on the pressure transducer board.
5. Adjust R1 to -3.500 V +/-8mV NOTE! Zero pressure.
6. Apply a positive pressure of +400 mm Hg with the rubber squeezer and adjust R4 to -3.900 V +/-8mV.
7. Repeat points 5 and 6 until voltages at both 0 and +400 mm Hg are correct.

Pressure and corresponding voltages:

mm Hg	V
-200	-3.300
-100	-3.400
0	-3.500 Adjust point (R1)
+100	-3.600
+200	-3.700
+300	-3.800
+400	-3.900 Adjust point (R4)

Tolerances: +/-5 mm Hg and +/-8 mV

Venous pressure amplifier

8. Disconnect plug P40. Zero the instrument mechanically with the zeroing screw before switching on the mains supply.
9. Connect plug P40. Zero the instrument electrically with potentiometer R32 on Board 3.
10. Apply a positive pressure of +400 mm Hg with the rubber squeezer. Adjust if necessary with R33 to read +400 mm Hg on the venous pressure instrument.

Venous pressure alarm delay.

1. Simulate an venous pressure alarm situation.
2. Adjust R41 to get 2 sec. delay time.

Output VEPA/VEPB

After the venous pressure instrument has been calibrated:

1. Connect a mA-meter to contacts a18 (+) and a2 (-) in P22. To make it easier a modified interface connector (K0 6226) can be used (See Service Information no 054, 1981).
2. If the fluid unit is connected,the TMP button must be depressed.
3. Adjust R31 on Board 3 to zero-reading.
4. Apply a positive pressure of +400 mm Hg with the rubber squeezer and adjust R4 to -3.900 V +/-8 mV.
5. Check that the value is 666 µA.

BMM 10 +	Compensation	VEPA VEPB
DFM / UDM 10	Non	0 µA
1 extra module*	+25mmHg	+42 µA
2 extra modules*	+33mmHg	+55 µA

* Compensation is necessary only when the extra module(s) is placed between the BMM 10-1 and DFM / UDM 10-1.

Clamp times

1. Set the program switches 1-6 on Board 3 in "OFF" position.

Coarse adjustment

2. Turn the arterial and venous time setting knobs on the front panel fully counterclockwise (min position).
3. Connect a pulse counter or an oscilloscope to TP2 w.r.t TP1 on Board 3.

   NOTE! If no pulses occurs preadjust R43 and R42 (Board 3) to obtain +8 V on the slides of the potentiometers. Restart the BMM.
4. Adjust R43 to 5.3 ms +/-0.2 ms = 88.68 Hz +/-7 Hz.
5. Connect the pulse counter or the oscilloscope to TP3 on Board 3.
6. Adjust R42 to 5.3 ms +/-0.2 ms = 188.68 Hz +/-7 Hz.

Fine adjustment

7. Turn the arterial and venous time setting knobs on the front panel fully clockwise (max position).
8. Adjust R43 to 80 ms +/-1 ms on TP2.
9. Adjust R42 to 80 ms +/-1 ms on TP3

Calibration of the time knobs

10. Turn the arterial and venous time setting potentiometers to read 48 ms on TP2 and TP3. Fasten the knobs to correspond 10 sec on the scales.

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Heparin selector switch

1. Check the mechanical limits of the knob (0 and 10.)

2. Turn the switch fully clockwise. That will correspond to "10" on the knob.

3. Connect a pulse counter or an oscilloscope to TP5 w.r.t. TP1 on Board 3. Measurement gives the following pulse:

4. Adjust R20 on Board 3 so that the pulse counter or the oscilloscope shows 88 µs at PVC tube = 11.363 kHz.

5. To check the internal timer on Board 3 connect the pulse counter or the oscilloscope to TP9 (Board 3), the time will be 44.7 ms +/-0.2 ms = 22.37 Hz.

6. Check that the pump head speed now is app. 2.25 RPM. **NOTE!** This is only a check point.

Arterial pressure alarm delay

1. Simulate an arterial pressure alarm situation.

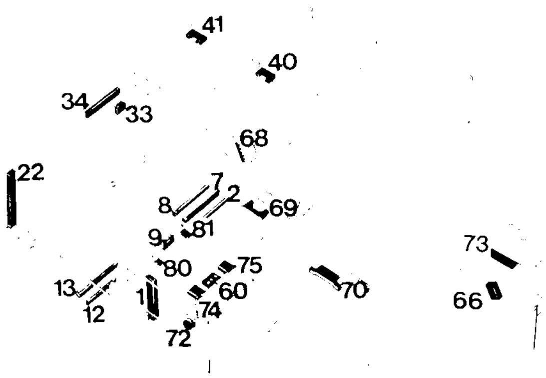
2. Adjust R22 to get 2 sec. delay time.

Air detector sensitivity

1. Remove P73 from the air detector.

2. Connect an mV-meter to TP6 w.r.t. TP1 on Board 3.

3. Adjust R40 on Board 3 to obtain 200 mV +/-10mV DC on the mV-meter



Buzzer bypass time

1. Simulate an alarm situation.

2. Press MUTE.

3. Adjust R21 to get 30 sec. buzzer bypass time.

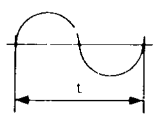
Blood pump motor circuits

1. Adjust R30 to read +1.5 V on TP5 w.r.t. TP2 on Board 2.

2. Turn the flow control knob on the frontpanel fully clockwise (maximum pump speed).

3. Connect an oscilloscope to the anode side on one of the diodes V3, V5, V7, V9.

4. Adjust R11 on Board 2 to read 20 ms for silicone segment or 17.85 ms for PVC segment = 56 R.P.M.



5. Adjust R12 on Board 2 to read 500 ml/min on the blood flow meter.

6. Make sure that SN button is released.

7. Connect the oscilloscope to TP1 on Board 2 and adjust the sweep rate so that at least four pulses are shown on the oscilloscope.

8. Balance the Hall elements by adjusting R10 on Board 2 for as equal pulse wide as possible.

9. Run the blood pump slowly, stop it by grasping the pump handle, check that driving stops after 3-5 seconds (stopping time) and that restart is obtained after about 20 seconds.

10. Cause an alarm by moving the alarm limits for the venous pressure instrument. The pump should now stop almost immediately.

Mains alarm charging circuit

1. Set R10 on the mains alarm board in the power supply to +16 V at Tp1 w.r.t. TP2.

Trouble shooting

Blood unit

1. The machine does not start and the MUTE lamp is blinking.

   No mains voltage:
   Check the mains voltage. Check the mains fuses at the rear of blood unit.

2. The machine does not start, but the buzzer reset lamp is not blinking.

   a. *Accumulators for the mains alarm discharged:*
   Attach the power relay bypassing connector to connector P75. Switch on the main switch. Charging time is approx. 24 hours.

   b. *Charging circuit for the accumulators defective:*
   Change the power supply.

3. The actual venous value does not correspond to the shown value.

   Venous pressure transducer board or venous pressure amplifier need adjusting:
   Adjust on the pressure transducer board or on control logic board 3 as described in service manual under "Special adjustments".

4. Venous pressure alarm, which cannot be removed by moving the alarm limit indicators on the instrument.

   a. *Venous pressure instrument defect:*
   Change the venous pressure instrument.

   b. *Control logic board 3 defect:*
   Change the control logic board.

5. The VENOUS PRESS lamp is not lit during alarm.

   a. ***Lamp blown:***
   Change the lamp.

   b. *Control logic board 3 not correctly programmed:*
   Reprogram the control logic board. If the venous pressure lamp should light up at once, only switches 9 and 10 should be closed. If the venous pressure lamp should be activated with delay, only switch 8 should be closed.

6. Venous pressure is constantly at positive maximum.

   Fuse F4 on power supply blown:
   Change the fuse.

7. The air detector makes false alarms.

   a. *Bad fitting between the drip chamber and the detector head:*
   Change the position of the drip chamber.

   b. *The sensitivity of the air detector needs adjusting:*
   Adjust the sensitivity as described in service manual under "Special adjustments".

   c. *Air detector head needs adjusting:*
   Adjust the air detector head with the plastic screws on the side of the detector head.

8. The air detector is not working.

   a. *Air detector head defect:*
   Change the air detector head.

   b. *Control logic board 3 defect:*
   Change the control logic board.

9. The actual flow of the blood pump lower than the shown value.

   a. *The rollers of the pump head need adjusting:*
   Adjust the pump rollers for the dimension of the blood line in use.

   b. *The blood pump motor control circuits need adjusting:*
   Adjust on motor control board 2.

10. The actual flow of the blood pump is higher than the shown value.

    The blood pump motor control circuits need adjusting:
    Adjust on motor control board 2.

11. The arterial pressure alarm is not working.

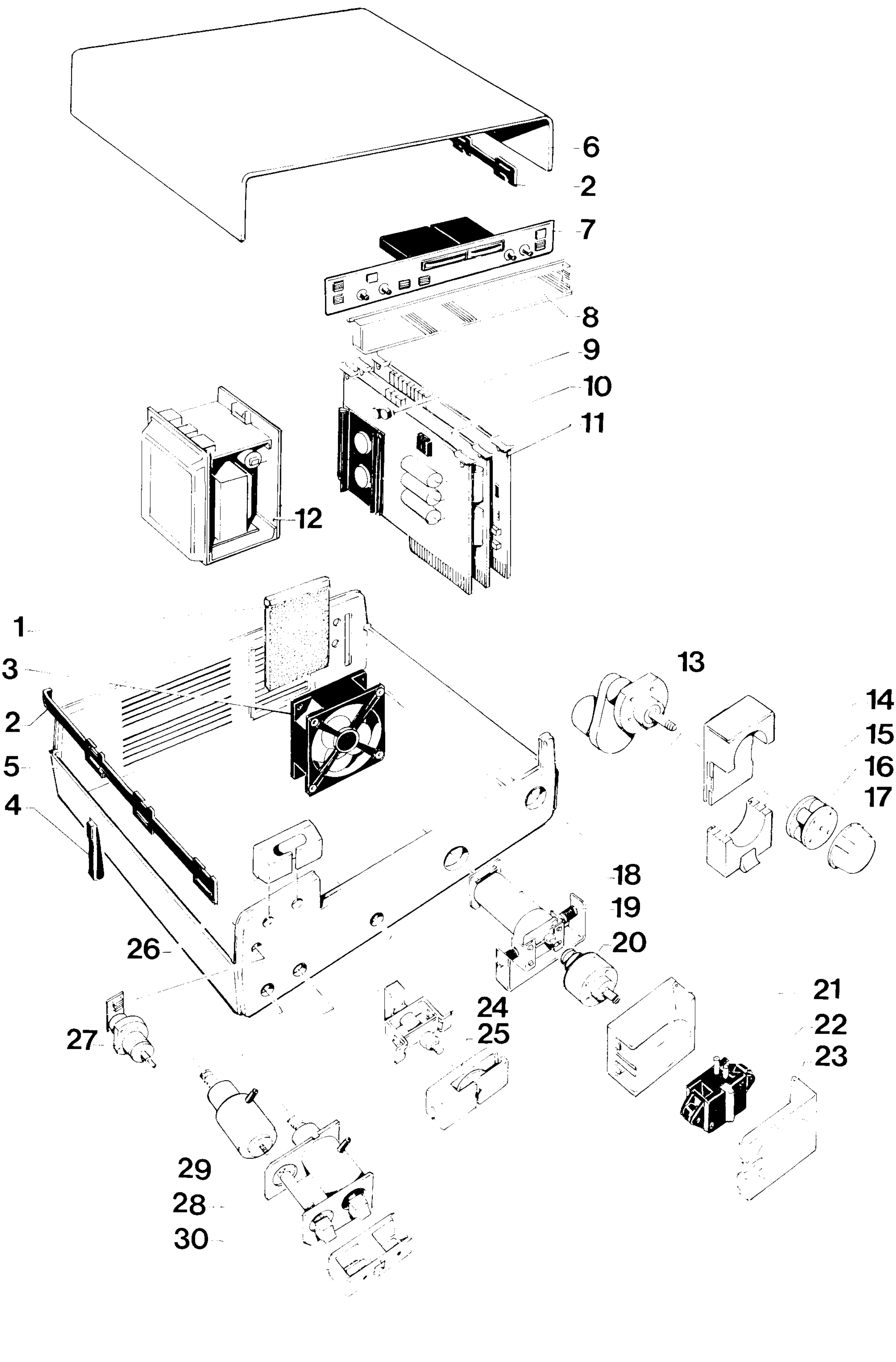
    a. *Microswitch at the rear of the arterial pressure monitor defective:*
    Change the microswitch.

    b. *Control logic board 3 defect:*
    Change the control logic board.

12.	The arterial pressure monitor alarming at a wrong value.	*Arterial pressure monitor needs adjusting:* Adjust the arterial pressure monitor by turning the pressure plate.
13.	The buzzer is sounding but the MUTE lamp is not lit.	*MUTE lamp is blown:* Change the lamp (14 V, 80 mA).
14.	The heparin pump is not working.	*a.* *Heparin pump motor defect:* Change the heparin pump motor. *b.* *Control logic board 3 defect:* Change the control logic board.
15.	The flow from the heparin pump not as set on the selector switch.	*Control logic board 3 needs adjusting:* Adjust R20 on the control logic board as described in "Special adjustments".
16.	The single needle function is not working.	*Control logic board 3 not correctly programmed or defect:* Check the programming. Change the control logic board if necessary.
17.	The single needle intervals not as set on the potentiometers.	*The clamp times need adjusting:* Adjust on the control logic board 3 as described in "Special adjustments".
18.	The heparin pump works irregularly.	*a.* *Gear-box defect:* Change the motor assembly. *b.* *Motor defect:* Change the motor assembly. *c.* *Control logic board 3 defect:* Change the board.

Spare parts list, modules

Item	Denomination	Order no.	Remarks
1	Filter	K1 1118 001	
2	Locking slide	K0 4387 A	
3	Fan	K1 2578 001	
4	Retaining catch	K0 6200 001	
5	Cover upper	K1 2540 001	
6	Cover lower	K1 2540 003	
7	Instrument panel	K0 4568 C	
8	Transparent panel cover	K0 4274 001	
9	Power supply board	K0 4538 H	
10	Motor control board	K0 4475 004	
11	Control logic board	K0 4471 C	
12	Power supply	K0 8042 002	
13	Bearing axis incl. motor	K0 4562 A	
14	Pump housing	K0 4560 B	
15	Tube holder	K0 4558 A	
16	Rotor	K0 4561 A	
17	Knob	K0 4557 A	
18	Motor	K0 4721 A	
19	Rubber mounting	K0 4817 001	
20	Bearing axis	B0 0224 A	
21	Pump housing	B0 0255 001	
22	Roter	B0 0248 A	
23	Cover	B0 0251 A	
24	Arterial pressure monitor switch	K0 4511 A	
25	Arterial pressure monitor head	K0 4510 A	
26	Air detector head	K1 2185 001	
27	Venous pressure unit	K0 6513 004	
28	Magnetic clamp unit	K0 4508 A	
29	Magnetic coil	K0 4507 A	
30	Magnetic clamp housing	K0 4509 A	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