SERVICE INSTRUCTIONS

of the

cryotherapy unit

kryotur 600

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ENCLOSURES

Fig. 1: Principle of operation of the ***kryotur 600***

Fig. 2: Bottom plate - fastening bolts

- Wiring diagram of ***kryotur 600***, edition 2 of 10. 12. 1996, no. 989.004 Sp 1 incl. Component list no. 989.004 SL, edition of 28. 08. 1996

- Wiring diagram of the rectifier PCB of the ***kryotur 600***, edition of 18. 06. 1996, no. 989.004-200:000 Sp and
  Component list no. 989.004-200:000 SL, edition of 18. 06. 1996

- Rectifier PCB of the ***kryotur 600*** equipped with components, edition of 18. 06. 1996, no. 063183-7.3-000-3

- Wiring diagram of the connecting cable to the ***stimutur 600***, edition of 11. 12. 1996, no. 989.009-000:000 Sp

- Spare parts list, edition of 18. 12. 1996

1 General Information

All service work, including opening the unit, shall only be performed by TUR or an after-sales/contract workshop authorized by us.

Separate the unit from the mains network before opening.

Use only those accessories and spare parts listed for the ***kryotur 600*** in the relevant documents (e.g. these Operating Instructions, spare parts list, price list).

Only in closed condition the unit shall be transported, stored and operated. With the coolant circuit filled up the unit shall not be submitted to any danger of frost.

Carefully read these Operating Instructions before commissioning the ***kryotur 600***.

This document has been mindfully established and the content precisely checked. Nevertheless, TUR cannot warrant the document is without any accidental error. For technical progress TUR reserves the right to change the products described in this document at any time. TUR will be not responsible for damages result from the improper use of the products described in this document.

2 Description of operation

(Cf. Fig. 1: Principle of operation of the ***kryotur 600***)

2.1 Generation of cold

2.1.1 The unit

The coldness is generated by means of a Peltier element (A02). This Peltier element is a semiconductor component used as heat pump. It consists of a lot of pn-semiconductor junctions soldered in series between two thin ceramic plates. When dc voltage is applied across the Peltier element the heat is transported from one side of the element to the other one by the current flow. Thus, one side becomes cold and the other one hot. The amount of heat pumped is directly proportional to the amount of current flow. The lower the temperature difference between the cold and hot sides the higher is the efficiency and, therefore, the cooling performance obtained.

About 120 W is the electric power consumption of the Peltier element used with the maximum operating voltage of 15.4 V and a maximum operating current of 14 A. Its inherent resistance is between 0.8 Ω and 1 Ω. The power consumption depends on the operating voltage. The cold side of the Peltier element is limited to a minimum temperature of about 2 °C (cf. subclause 2.3).

Between X4 (+) and X3 (-) of the distributor printed circuit board (PCB) the supply voltage can be measured. It is within 11 V to 15 V. For measuring the current X4 must be separated.

2.1.2 Applicators

- Cuff

The external coolant circuit (cf. subclause 2.2.2) extracts an amount of heat of maximum 30 W out of the cuff. Almost continuous cooling of the cuff's surface was obtained by our arranging the channels, through which the coolant is pumped, in labyrinthic way.

- Cooling head

Another Peltier element is provided in the cooling head. Its operation corresponds to that of the A2 element in the unit and is described in subclause 2.1.1.

The external coolant circuit decreases the temperature of the hot side of the Peltier element to the ambient temperature ± 8 °C.

The cold side is directly connected to the screwed-on attachment (cf. Operating Instructions, clause 16, Accessories) and can reach a minimum temperature of -10 °C.

Also the supply voltage corresponds to that of the element in the unit. 3.9 A is the maximum current, the inherent resistance is between 2.9 Ω and 3.5 Ω and the power consumption about 30 W to 40 W. The supply voltage can be measured at socket X037 (pins 1-7). Separate the line at X037 (pin 7) for measuring the current.

2.2 Coolant circuits

The Peltier element (A02) is mounted in a cooling module. Both sides of the element are connected to separate coolant circuits. The Peltier element extracts heat from the external coolant circuit (applicators) and delivers it to the internal coolant circuit.

2.2.1 Internal coolant circuit

In the internal coolant circuit, the heat of the Peltier element is taken by the coolant and pumped through the heat exchanger by Pump P01. This heat exchanger is mounted at the rear side of the unit and covered by a plug-in filter cassette. The filter mat inside the cassette shall reduce the ingress of particles (e.g. dust) into the unit. The cooling performance depends directly on the amount of penetrating air. Therefore, the filter mat should be regularly cleaned or replaced. By the fans M01 and M02 the ambient air is sucked through the heat exchanger and blown out of the unit at its right and left sides.

To obtain the optimum cooling performance the temperature difference between the sucked in and blown out air shall not exceed 14 °C with room temperatures of up to 25 °C and not exceed 20 °C with room temperatures of up to 30 °C.

In the operation, the pump is always switched on. Its operating voltage is 26 Va.c. non-stabilized.

2.2.2 External coolant circuit

The external coolant circuit is connected to the cold side of the Peltier element (A02). Coolant is pumped through the applicators by pump P02 which is switched on or of, when required, by relay (A2) mounted on the rectifier PCB. Its operating voltage is 26 Va.c. non-stabilized.

2.3 Temperature measurement and control

Temperature is measured by means of thermistors (high-temperature conductors). One side of all thermistors is connected to ground. The thermistors are cyclically scanned by the computer.

2.3.1 Temperature measurement at the cooling module (unit)

The temperature is measured by R_{Th02} at the cold side (marked blue) and R_{Th01} at the hot side (marked red).

R_{Th01} (KTY 10-6)	R_{Th02} (UUB 31J1)
About 2.6 kΩ at 15 °C	About 1.5 kΩ at 15 °C
2.3 kΩ at 20 °C	1.2 kΩ at 20 °C
2.0 kΩ at 25 °C	1.0 kΩ at 25 °C
1.7 kΩ at 30 °C	0.8 kΩ at 30 °C

Measuring points: X2, distributor PCB, (X038 not plugged in).

2.3.2 Temperature measurement at the applicators

- **Cuff**

The temperature is measured by the two thermistors R_{Th01} and R_{Th02}. In the cuff, the thermistors are mounted at the hose connection between inlet and outlet.

$R_{Th01/Th02}$ (UUB 31J1)

About 4.7 kΩ at 15 °C
3.7 kΩ at 20 °C
3.0 kΩ at 25 °C
2.4 kΩ at 30 °C

Measuring point: X037 (X030 not plugged in).

- **Cooling head**

At the cold side of the Peltier element the temperature is measured by R_{Th01}, type UUB 31J1 (values cf. subclause 2.3.1).

Measuring point: X037 (X030 not plugged in).

2.3.3 Temperature measurement by external temperature sensors

At the tip of the sensor the temperature is measured by thermistor R_{Th03}, type UUB 33J1 (cf. subclause 2.3.2).

Measuring point: X035 (X031 not plugged in).

The soldered connecting pins in the plug connector of the sensor are completely enclosed by silicon compound. This avoids any unintended short circuit by ingressing fluid during the sterilization.

2.3.4 Temperature control

- Cooling module in the unit

After switching on the ***kryotur 600*** and the automatic check the cold side of the Peltier element is cooled down to 2 °C (+0.4 °C hysteresis) (with no load). This value is controlled by switching on and off the current supply of the Peltier element by power transistor V_{T1} arranged on the rectifier PCB.

When the hot side of the Peltier element exceeds the temperature of 55 °C the current supply is interrupted by V_{T1}.

- Cuff

The treatment temperature adjusted is monitored by the thermistors in the cuff.

Cooling-down phase:

- Peltier element (cooling module) is switched on.
- Pump P02 (external coolant circuit) is switched on.

Control phase: Treatment temperature is reached and maintained constant at ± 2 °C

- The cold side of the Peltier element (cooling module) is kept constant at 2 °C + 0.4 °C (V_{T1} switching on and off).
- By the electronic relay A2 (rectifier PCB) the pump P02 is switched on or off as required.

- Cooling head

The treatment temperature adjusted is monitored by thermistor R_{Th1} in the cooling head. This thermistor is arranged at the cold side of the Peltier element mounted in the cooling head.

Cooling-down phase:

- Peltier element (cooling module) is switched on.
- Pump P02 is switched on.
- Peltier element (cooling head) is switched on.

Control phase: Treatment temperature is reached and maintained constant at ± 2 °C

- The cold side of the Peltier element (cooling module) is kept constant at 2 °C + 0.4 °C (cf. above subclause Cuff).
- As required the pump P02 is switched on or off (cf. above subclause Cuff).
- By power transistor V26 (computer PCB) the Peltier element (cooling head) is switched on or off as required.

Fan:

When the temperature of the hot side of the cooling module exceeds 40 °C the fan is switched to full performance; and then, when it falls below 35 °C, the fan is driven with half power again.

2.3.5 Overtemperature protection

In addition to the temperature control by the thermistors mentioned in subclause 2.3.4 a bimetallic cutoff (55 °C, switch-off hysteresis +6 °C) each is provided at the hot sides of the Peltier elements for interrupting the current supply of these elements in case of overtemperature - independent of the temperature control described in subclause 2.3.4.

Cooling module (unit): S02
Peltier element in the cooling head: S03

These bimetallic cutoffs are screwed on.

A temperature switch is wrapped in the primary winding of the mains toroidal transformer. It automatically switches off in case off an error at a temperature of 112 °C and on again after the transformer is sufficiently cooled down.

2.4 Power supply

The toroidal mains transformer generates two secondary voltages (12.5 Va.c. and 26 Va.c.).

12.5 Va.c.:

- Rectification by VD1 mounted on the rectifier PCB and C1.
- It is an uncontrolled supply voltage for the Peltier elements in cooling module (unit) and cooling head.
- Only the supply voltage of the Peltier element in the cooling head is secured by fuse F2 (4 A slow-acting) on the computer PCB.

26 Va.c.:

- Secured by fuse F1 (1 A slow-acting) on the rectifier PCB.
- It is an uncontrolled supply voltage for pumps P01 and P02 and computer PCB.
- From this, a circuit on the computer PCB generates controlled voltages:

  12 Vd.c.: For fans M01, M02, relay K1 on the computer PCB and triggering the electronic switch relay A2 on the rectifier PCB.

  5 Vd.c.: For computer, display and control signals (VT1, V26).

2.5 Automatic tests of the unit

(Cf. also subclause 5.2 Error diagnosis.)

- Watchdog test: It is checked whether the watchdog circuit responses within 1 s. If not, the error message appears:
„Error watchdog“.

- EPROM test: The checksum of the EPROM is calculated.
When not correct, the error message appears:
„Error EPROM checksum“.

- **EEPROM test:** Access to and checksum of the EEPROM are checked. The following messages appear in case of error:
  „Error EEPROM access" or
  „Error EEPROM checksum".

- **Analog inputs test:** All analog inputs are measured and checked for short circuits and conductor breaks.

  Measuring inputs:
  Thermistors, code resistances (when the accessories are connected) and reference resistances of the temperature measurement.

  Error messages cf. subclause 5.2, - Analog channels 1 to 8 (K 1-8).

- **Peltier element test: (unit)** The Peltier element is switched on and off. The message
  „Error test input of Peltier circuit 1 ON"
  is displayed when the test input shows HIGH with the element switched on.

  The message
  „Error test input of Peltier circuit 1 OFF"
  is displayed when the test input shows LOW with the element switched off.

- **Signalization/cooling test:** The horn, LED and fan outputs are activated. There is no error message.

2.6 STIM/KET combination mode

The combination mode can only be activated with the current stimulator connected and switched on. Following TTL level signals apply at socket X036:

- Selection of the STIM mode:
  X036 (pins 2-5): LOW otherwise: HIGH

- Start of stimulating current:
  X036 (pins 2-4): LOW otherwise: HIGH

The K1 relay on the computer PCB switches the stimulating current input X036 (pin 7) to X037 (pin 4) and, thus, directly to the cooling head.

At the end of treatment the Start output changes to HIGH.

stimutur 500 By the ***stimutur 500*** the stimulating current is automatically switched off after 60 minutes.

stimutur 600 When the accu-pack of the ***stimutur 600*** is flat (not charged) (accumulator voltage below 3 V) this is indicated by the ***kryotur 600*** by alternated beeps and flashing LCD displays. The combination mode cannot be started.

The same happens when only the connecting cable to the ***stimutur 600*** is plugged in the socket at the ***kryotur 600***.

2.7 Automatic recognition of the accessories connected

Due to the hardware coding of their plug connectors the accessories are correctly recognized.

- Cuff:	X037 (pins 5-6)	1.0 kΩ ± 1 %
- Cooling head:	X037 (pins 5-6)	3.9 kΩ ± 1 %
	In the measuring check X030 is not connected.	
- Temperature sensor:	X035 (pins 1-4)	short circuit.

2.8 EMC measures

The following external components are provided for reducing the radio interference voltage and radiation. They shall never be removed or replaced by ones of another type.

- Input mains filter A01,
- Capacitors C02 and C03,
- 4 foldable ferrite cores (around the cable harness),
- Screening plate on the computer PCB.

3 Mounting/dismounting

(Cf. Fig. 2: Bottom plate - fastening bolts.)

3.1 Opening the unit

Separate the unit from the mains network by drawing the plug connector. Turn the unit upside down, draw out the filter cassette and loosen the fastening bolts (item 1 in Fig. 2).

Turn the unit back to the normal work position so that the LCD display can be seen. Unscrew the screw cap of the external coolant circuit, carefully draw the upper case shell upwards and put it down to the right.

3.2 Replacing subassemblies

3.2.1 Computer PCB

Draw off the plug connectors of cable harness and fans and screw off the fan including the metallic grid. When mounting the unit the metallic grid prevents the cable harness is blocking or damaging the fan wheel.

Screw off the screening plate. Loosen the 6 fastening bolts of the computer PCB. Carefully lift the computer PCB. In doing, take care that the frame of the LCD display does not stick at the keyboard foil.

3.2.2 Rectifier PCB

Draw off the plug connectors of the cables and unlock the PCB in its guide. Draw off the PCP in upwards direction.

3.2.3 Mains transformer

Draw off the plug connectors of the mains transformer from mains switch and rectifier PCB. Loosen the fastening bolt (item 3 in Fig. 2). The mains transformer is additionally fastened at the bottom plate by double-side adhesive foil. Carefully loosen it from the bottom plate by means of a lever (e.g. screwdriver).

3.2.4 Pumps

Before replacing the pumps, drain off the corresponding coolant circuits according to the operating instructions. The operation principle of the pumps corresponds to that of a magnetically coupled impeller wheel. Thus, these subassemblies are very resistant to wear.

3.2.4.1 Pump of the internal coolant circuit

Disconnect the plug connectors of the cable from the rectifier PCB. Draw off the silicone hoses, screw off the cap of the inlet at the bottom plate, loosen the fastening bolts (item 4 in Fig. 2) and take out the pump upwards.

3.2.4.2 Pump of the external coolant circuit including reservoir

The pump of the external coolant circuit and the reservoir for the applicator coolant form a subassembly.

Draw off the plug connectors of the cable from the rectifier PCB and the silicone hoses. Loosen the fastening bolts (item 5 in Fig. 2). Now, the pump together with the reservoir can be taken out in upwards direction.

3.2.4.3 Opening the pumps

Opening the pumps is necessary when any contamination (particles which can impede the impeller wheel or clog the coolant pipes) entered during filling the coolant circuits must be removed.

The pump casing can be unlocked and pulled apart after turning the inlet connection (internal coolant circuit) or the reservoir to the left. The impeller wheel and its axle can be drawn out.

3.2.5 Peltier element (cooling module - unit)

Empty the internal and external coolant circuits according to the Operating Instructions. Open the unit as described in subclause 3.1. Draw off the plug connectors X038, X021, X019 and X020 and the silicone hoses of the cooling module and loosen the fastening bolts (item 2 in Fig. 2). Now, the cooling module including distributor PCB can be taken out.

At the hot side (marked red) of the cooling module there are the bimetal switch S02 and thermistor R_{Th01} the last one is screwed on by means of a bracket.

In a bore hole at the cold side (marked blue) of the cooling module the thermistor R_{Th01} is inserted and stuck by silicone compound.

When the Peltier element shall be replaced, loosen the 8 M2-bolts, provided at the hot side at the edge, and take out the aluminum heat exchanger. Only Peltier elements shall be inserted the circumferential edge of which is completely protected from ingressing fluid by means of silicone compound.

Before mounting the new Peltier element is to be electrically tested and it is to be checked which is the cold and hot side. For this purpose, connect it to a stabilized d.c. voltage source with current limitation (red connecting cable to +12 Vd.c., black one to ground). Hold the Peltier element between thumb and forefinger. Already after a short time the cold side can be distinguished from the hot one. The Peltier element shall never be heated to a temperature exceeding 70 °C.

3.2.6 Connecting sockets for temperature sensor and current stimulator

The soldered connections of X031 and X032 are completely enclosed by silicone compound so that no coolant can wet the contacts in case of an error. After any replacing the sockets the silicone protection must be reestablished.

3.3 Accessories

- Cuff/cooling head

Only the connector subassembly and its components (case, valves, electric plug connector) shall be replaced. For opening the connector case loosen the two bolts on the connecting surface. Now, the connector subassembly can be carefully pulled apart. The coolant hose is plugged onto the valves and fastened by a cable bracket.

In mounting the connector subassembly take care that the drain hole shows downwards in the plugged-in condition.

- Temperature sensor

Only the plug connector shall be replaced.
In mounting take care that the electric contacts soldered in the plug connector are completely covered by silicone compound.

3.4 Mounting the unit

In mounting the unit especially take care for the following:

- The about 2-cm high chamber, in which the mains input circuit is accommodated, must be completely sealed by silicone compound.
- When replacing the toroidal mains transformer the double adhesive foil below the transformer must be renewed.
- The soldered connections of the sockets X031 and X032 are to be completely covered by silicone compound.
- The coolant drain holes in the bottom plate of the unit must be open.
- Silicone hoses shall not show any tears.

- When mounting cooling module and pumps take care for the rubber gaskets are correctly seated.
- Take care for the joins of pumps and heat exchanger at the rear of the unit are tight.
- Take care for the cable harness when putting on the upper case shell. No part of it shall be between case and reservoir.
- Silicone hoses shall only be laid in bends and never creased even not partially.
- No fluid or wetness shall be on printed circuit boards or electric contacts.
- Contamination shall never ingress in the coolant circuits. Otherwise, the valves of the external coolant circuit could be clogged.
- At the end of the assembly, perform all safety checks according to clause 7 and the operation check according to clause 4.

4 Operation check

Check the operation with using the existing accessories and observing the Operating Instructions. The following cooling times (ambient temperatures up to 28 °C) must be obtained:

- „Constant temperature" mode:
  Kidney-shaped cuff: freely hanging, 12 °C, not more than 15 min.
- „Cooling head" mode:
  Cooling head: laying, cooling attachment to air, -8 °C, not more than 6 min.
- Temperature sensor:

  Kidney-shaped cuff, freely hanging, standard program:
  Put the temperature sensor in a separate container filled with water and check the temperature indication by means of a separate thermometer (± 2 °C).
- STIM mode:

  Connect cooling head and current stimulator:
  Connect a 500-Ω resistance between cooling head and stimulating current electrode. Measure the voltage across the resistance and compare the value with that given in the operating instructions of the current stimulator.

  With the ***stimutur 500*** the cooling head can be laid on the rubber electrode of the current stimulator. The ***stimutur 500*** shows the value of the current.

  With the ***stimutur 600*** the current can also be measured between cooling head and connector of the rubber electrode. Set the ***stimutur 600*** to the TENS mode. The slide switches on the rear are at central position. With maximum output power the a.c. current measured should be more than 0.4 mA.
- Automatic tests of the unit (cf. subclause 2.5)
  Visually and acoustically take care for the electronic horn, LED's and fan are operating well.
- During the operation draw off the accessory from the unit.
  The unit must recognize and display this condition. After reconnecting the accessory it must be possible to continue the treatment.
- Only in the STIM mode the ***kryotur 600*** can detect whether a current simulator is connected or not. When the current stimulator is disconnected during the treatment the ***kryotur 600*** does not recognize this changed condition. Only at the end of treatment and restarting the STIM mode again the ***kryotur 600*** detects the current stimulator is missing.

- In all modes check whether the unit indicates the end of treatment and switches off the cooling.

The operation check can be considerably simplified and shortened by using service adapters.

⇒ **Service adapter 2:**
(Simulation of cuff and temperature sensor)

The modes of operation „Constant temperature", Interval" and „Bio cycle" can be checked by means of this adapter.

Cooling time:	less than 5 min for down to 12 °C.
Temperature sensor:	Display of the constant value of 10 °C ± 1 °C.

⇒ **Service adapter 3:**
(Simulation of cooling head and a current stimulator)

The modes of operation „Cooling head" and „STIM" can be checked by means of this adapter.

Cooling time: less than 3 min for down to -8 °C.

In addition, the following conditions are automatically detected and optically displayed by the LED indicators:

- Yellow LED is lit: The operating voltage applies at the Peltier element of the adapter.
- 1st red LED is lit: The STIM mode is selected.
- 2nd red LED is lit: The treatment is started and the program activated.
- Green LED is lit: Relay K1 in the ***kryotur 600*** responded and stimulating current applies at the cooling head.

After the temperature adjusted is reached in the service adapter, the supply voltage of the Peltier element is switched off and on again, as required, according to subclause 2.3 so that the yellow LED is intermittently lit in the same rhythm.

5 Trouble shooting

5.1 Auxiliary means

	Order no.
Emptying set for the coolant circuits	73 1700
Service adapter 1 (cf. clause 7)	73 1710
Service adapter 2 (cf. clause 4)	73 1720
Service adapter 3 (cf. clause 4)	73 1730
Operating Instructions of the ***kryotur 600***	54 0276

Multimeter: Measuring ranges: 50 Vd.c., 14 Ad.c.
250 Va.c., 10 mAa.c., 4 Aa.c.
200 Ω to 1 MΩ

5.2 Error messages

Error messages are shown in case of any fault. Simultaneously a 2-Hz (0.5-s) beep is sounded. An error message cannot be acknowledged, but the unit must be switched off and on again (except: error messages of no. 1 to 3 below).

The following error messages are provided:

1. Applicator is not connected.
   The treatment is immediately interrupted when the applicator is disconnected during the treatment. After connecting the applicator again the treatment can be continued.
2. Wrong applicator connected.
3. The applicator temperature adjusted is not obtained.
   This error message is flashing and a beep sounds for 3 s, however, the treatment is continued. The error message disappears by pressing the START/STOP key.
4. Exceeding the temperature limits.
5. Short circuits, erroneous voltages, etc.
   Error messages are shown for all faults and a 2-Hz (0.5-s) beep sounds simultaneously.

For statistical purposes the last 10 errors that couldn't eliminated by the user are stored in the EEPROM. Every type of error is stored only once even it occurred several times. These errors stored can be displayed by invoking the corresponding service menu (cf. clause 6).

5.3 Error diagnosis

	Display	Trouble shooting / remedy
1.	„WATCHDOG ERROR"	Replace the computer PCB.
2.	„EPROM CHECKSUM ERROR"	Replace the EPROM, Replace the Computer PCB.
3.	„EEPROM CHECKSUM ERROR"	Replace the Computer PCB.
4.	„EEPROM ACCESS ERROR"	Replace the Computer PCB.

5.	TEST INPUT ERROR PELTIER CIRCUIT 1 OFF	– Trigger signal (TTL level) to V_{T1} is missing on rectifier PCB, – Power supply cable break, Peltier element, – Thermo-switch S02 is open (e.g. by temperature exceeding at the hot side), – Cf. subclause 2.1.1.
6.	„HOT SIDE OF CIRCUIT 1 55X EXCEEDS 550“ (X = 1 to 9)	– 550 = 55.0 °C 551 = 55.1 °C, etc. – Hot side of Peltier is too hot, – Replenish coolant, – Check R_{Th01} resistance on distributor PCB X4, – Check pump P01, – Replace the filter mat, – Check fans M01 and M02.
7.	TEST INPUT ERROR PELTIER COOLING HEAD OFF“	– Power supply of the Peltier element is interrupted in the cooling head, – V26 on the computer PCB did not switch, – F2 fuse (4 A slow) on computer PCB blown off, – Check the external coolant circuit, – Cf. subclause 2.1.2.
8.	„HOT SIDE OF CIRCUIT 1 IS TOO HOT“	Cf. error of no. 6.
9.	„ERRONEOUS MEASUREMENT BY SKIN SENSOR“	– Temperature difference between temperature sensor and cuff exceeds 28 °C, – Check thermistor R_{Th3}.
10.	„DIFFERENCE OF CUFF SENSORS“	– Temperature difference between thermistors R_{Th1} and R_{Th2} in the cuff exceeds 10 °C, – Check the thermistors.
11.	„ERROR VOLTAGE OF 12 V“	– Supply voltage of 12 Vd.c. does not apply at the computer PCB, – Cable break, – F2 fuse (4A slow) is blown off.
12.	„TEST INPUT ERROR STIMULATING CURRENT MODE IS ON“	– Connection X036, – Check by means of service adapter 3 (cf. error 15).
13.	„PLEASE, CONNECT CUFF“	– Check R_{code}, – Line break to X6 on the computer PCB.
14.	„PLEASE, CONNECT COOLING HEAD“	– Check R_{code}, – Line break to X6 on the computer PCB.

15.	„PLEASE, CONNECT CURRENT STIMULATOR“	– Check current stimulator connection X036 by means of service adapter 3: 1st red LED must lit = trigger signal applies at pin 5 of X036 or line break to X8 on the computer PCB, – Connecting cable to the current stimulator is defective, – Current stimulator is not switched on, – Stimulating current output at the current stimulator is defective (cf. service instructions of the current stimulator).
16.	„SETPOINT NOT OBTAINED“	– Temperature adjusted for the applicator is not obtained, – Check and replenish, if required, the coolant of the external and internal circuits, – Check the operation of fans M01 and M02, – Replace the filter mat, – Check the operation of pump P02 (external coolant circuit), – Check the operation of the valves of the external coolant circuit by means of the emptying set, – Rated power of the unit is not sufficient for this application - select a higher treatment temperature, – Cf. subclauses 2.1.1 and 2.1.2.
17.	„REFERENCE OF 1 KΩ IS TOO HIGH“	– Replace the computer PCB.
18.	„REFERENCE OF 1 KΩ IS TOO LOW“	– Replace the computer PCB.
19.	„REFERENCE OF 5 KΩ IS TOO HIGH“	– Replace the computer PCB.
20.	„REFERENCE OF 5 KΩ IS TOO LOW“	– Replace the computer PCB.
21.	„NO MEASURING CURRENT K0“ (from K0 to K7)	– Replace the computer PCB.
22.	„MULTIPLEXER ERROR 0“ (from 0 to 7)	– Replace the computer PCB.
23.	„LINE BREAK K0“ (from K0 to K7)	– Cf. subclause 5.3: Abbreviation key, – Check the lines of accessories and thermistors up to the plug connector of the computer PCB.
24.	„SHORT CIRCUIT K0“ (from K0 to K7)	– Cf. subclause 5.3: Abbreviation key, – Check the lines of accessories and thermistors up to the plug connector of the computer PCB.

25.	„TEMP XX °C EXT 0 °C“	– Line break R_{Th3} - external temperature sensor.
26.	Stimulating current does not flow to the cooling head	– Check the STIM mode by service adapter 3: • Relay K1 on the computer PCB does not switch - replace the computer PCB, • Line break between pin 6 of X036 and pin 6 of X8 or pin 8 of X6 and pin 4 of X037, – Cable break in the applicator or connecting cable to the current stimulator, – Current stimulator is defective (cf. service instructions of the current stimulator).
27.	STIM mode cannot be started	– Check the STIM mode by service adapter 3: • Line break between pin 4 of X036 and pin 5 of X8, • When the trigger signals for the current stimulator (red LED) and the signal for relay K1 (green LED) are missing check for cable break or replace the computer PCB, – Current stimulator connecting cable is defective, – Current stimulator is defective (cf. service instructions of the current stimulator).
28.	The LCD is flashing and a beep sounds when starting the STIM mode	– Connection pin 2 of X8 (+5 V) is loaded too heavily • e.g. by ***stimutur 600*** with the accumulator voltages below 3 V → charge the accumulator, • ***stimutur 600*** is not connected to the cable and switched on.
29.	After switching on the unit some LCD segments don't lit	– Fluid or wetness is on the computer PCB → • dry by means of a hair-dryer, or • dismount the PCB (conductive rubbers of the display are defective).
30.	The external temperature sensor is connected but no indication at the LCD display	– The code in the plug connector of the temperature sensor is not recognized by the computer, – Code: pins 1 to 4 of X035 short-circuit, – Line break between X035 and X11.

Abbreviation key:

- K (0-7): Analog channel (0 to 7), measuring value acquisition of thermistors, coding the accessories and reference resistances for temperature measurement

  K0 = Code resistance (pins 5 - 6 of X037)
  cuff = 1 kΩ, cooling head = 3.9 kΩ.

  K1 = Thermistor R_{Th3}, external temperature sensor (pins 2 - 3 of X035).

  K2 = Thermistor R_{Th1}, cuff or cooling head (pins 2 - 5 of X037)
  about: 4.7 kΩ at 15 °C,
  3.7 kΩ at 20 °C,
  3.0 kΩ at 25 °C,
  2.4 kΩ at 30 °C.

  K3 = Thermistor R_{Th2}, cuff (pins 3 - 5 of X037)
  about: 4.7 kΩ at 15 °C,
  3.7 kΩ at 20 °C,
  3.0 kΩ at 25 °C,
  2.4 kΩ at 30 °C.

  K4 = Thermistor R_{Th01}, cooling module, hot side (pins 1 - 3 of X2 on distributor PCB)
  about: 2.6 kΩ at 15 °C,
  2.3 kΩ at 20 °C,
  2.0 kΩ at 25 °C,
  1.7 kΩ at 30 °C.

  K5 = Thermistor R_{Th02}, cooling module, cold side (pins 2 - 3 of X2 on distributor PCB)
  about: 1.5 kΩ at 15 °C,
  1.2 kΩ at 20 °C,
  1.0 kΩ at 25 °C,
  0.8 kΩ at 30 °C.

  K6 = Reference resistance 1 kΩ (on computer PCB).

  K7 = Reference resistance 5 kΩ (on computer PCB).

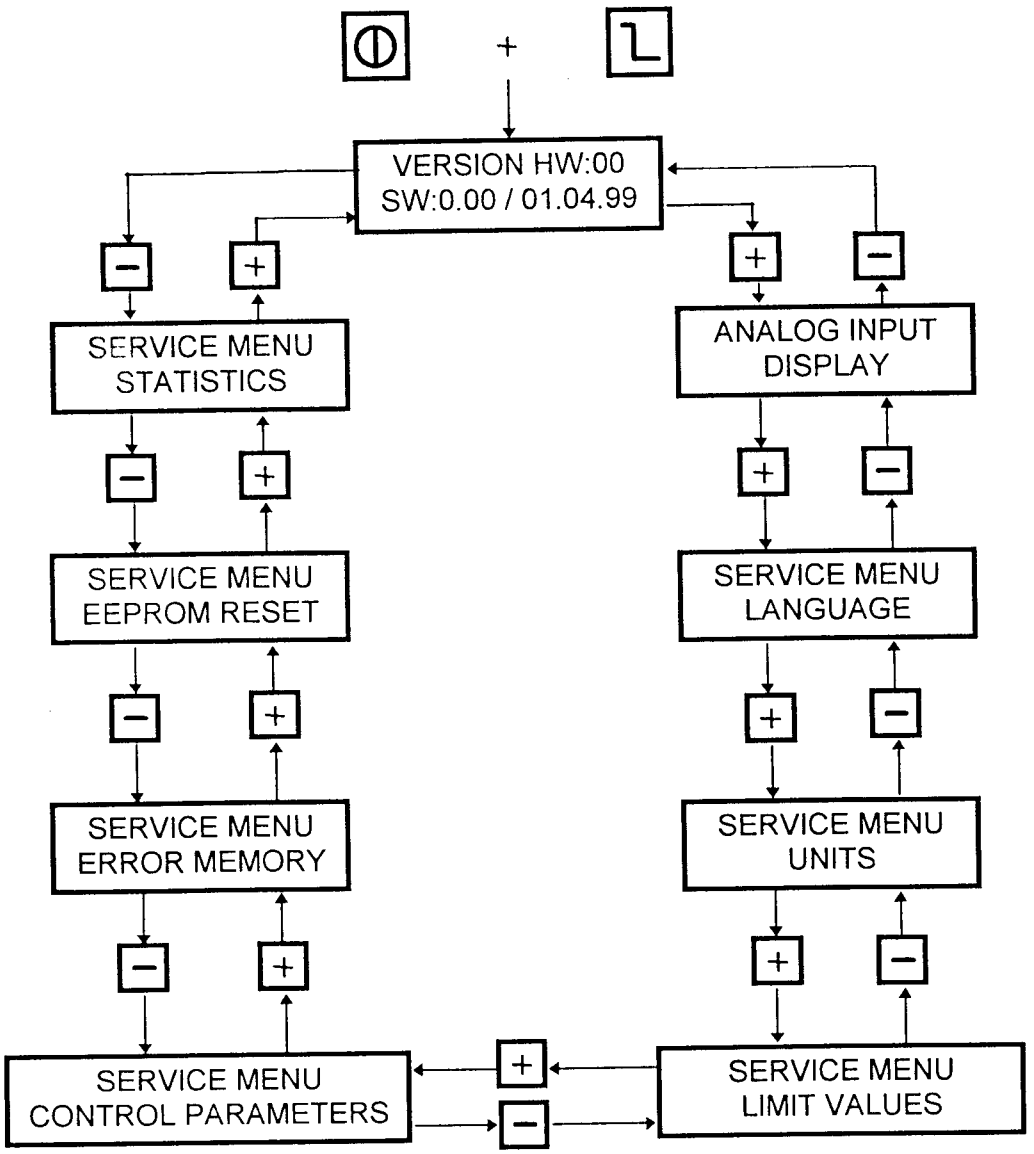
- Circuit 1: Internal coolant circuit.

- Circuit 2: External coolant circuit.

6 Service menus

The service menus can be invoked by simultaneously switching on the unit and pressing the „Constant temperature" mode key.

Toggling between the individual menus is done by pressing the „+" and „-„ keys and entering a special menu by pressing the Enter key „ ↵ " (cf. the figure below).



- **VERSION:**
  The actual hardware and software version is shown.

- **ANALOG INPUT DISPLAY:**
  Enter key: Measured values of the analog inputs (K0 to K7, cf. subclause 5.3) are displayed.
  „+" or „-„ keys: Toggling between the channels.
  Enter key: Back to the service menu.

- **LANGUAGE:**
  Enter key: Display of the actual language.
  „+" or „-„ keys: Toggling between the languages.
  Enter key: Selecting the language. Back to the service menu.

- **UNITS:**
  Enter key: Display of the actual unit.
  „+" or „-„ keys: Toggling between the units (°C, °F).
  Enter key: Selecting the unit. Back to the service menu.

- **LIMIT VALUES:**
  The limit values of the following individual modes of operation Temperature, Treatment time, Cooling and Pause shell never be changed. The limit values can be shown by pressing the following keys:
  - Enter key,
  - Mode of operation key,
  - Enter key several times until the SERVICE MENU - LIMIT VALUES appears again.

- **CONTROL PARAMETERS:**
  The control parameters are decisive for the operation of the unit and, thus, they shall not be changed. They perform the following functions:
  - Switch points of the Peltier element,
  - Sensor tolerances,
  - Cuff hysteresis,
  - Setpoint errors of the applicators,
  - Cooling head hysteresis.

- **EEPROM RESET:**
  Enter key: For resetting press this key twice.
  Enter key: Or pressing one time and then back to the SERVICE MENU by means of the „+" and „-" keys → results in no resetting.
  With respect to the LIMIT VALUES and CONTROL PARAMETERS the Reset EEPROM establishes the conditions adjusted by the manufacturer but the language selected is maintained. The UNIT is set to °C. The STATISTICS memories including the ERROR MEMORY are canceled except the operation hours counter.

- **STATISTICS:**
  Enter key: Display of the operation hours counter.
  „+" or „-„ keys: Toggling between the modes of operation counters.
  Enter key: Back to the service menu.

- **ERROR MEMORY:**
  Enter key: Display of the last error occurred.
  „+" or „-„ keys: Toggling between the last 10 errors. Every error type is shown only once.
  Enter key: Back to the service menu.

7 Safety tests

At least after 12 month each the ***kryotur 600*** shall be subjected to a safety test according to the MedGV, § 11. The individual checks have to correspond to the standards VDE 0750, Part 1, DIN ICE 601-1 and EN 60601-1.

The ***kryotur 600*** is designed according to protective system I, type BF, and corresponds to the MedGV Group 3. In the combination mode together with a current stimulator the whole connection corresponds to MedGV Group 1.

When the ***kryotur 600*** is used individually or together with a current stimulator on the instrument carrier ***combitur K*** the safety tests have to be performed at the instrument carrier completely equipped for the application.

The following electric characteristics have to be tested:

	Limit value
◆ **10-A resistance measurement of the protective conductor:** (to the metallic rim of the mains input filter)	
• including mains voltage supply line	< 0.1 Ω
• including instrument carrier	< 0.2 Ω
◆ **Alternative leakage current of the unit:**	
• ***kryotur 600*** separate (with the mains connector pins short-circuited and measured to parts of the unit that can be touched)	< 0.6 mA
• ***kryotur 600*** in the completely equipped instrument carrier (with the mains connector pins of the instrument carrier short-circuited and measured to parts of the unit that can be touched)	< 1 mA
◆ **Alternative leakage current of the patient:** Measure by means of service adapter 1. If the service adapter is not available connect all electric connector pins af the secondary socket connectors of the ***kryotur 600*** (X037, X035, X036) except pin 7 of X037 and pin 2 of X036. Measure the value between the short-circuited secondary connector pins (patient side) and metallic parts of the unit that can be contacted.	
• ***kryotur 600*** separate	< 2.5 mA
• ***kryotur 600*** in the completely equipped instrument carrier	< 5 mA
◆ **Insulation resistance (500 Vd.c.)**	
• Value between mains circuit and fastening bolts and metallic rim of the mains filter	> 2 MΩ
• Value between mains circuit and application part (by means of service adapter 1, cf. Alternative leakage current of the patient)	> 7 MΩ
• Value between application part (by means of service adapter 1, cf. Alternative leakage current of the patient) and fastening bolts and metallic rim of the mains filter	> 7 MΩ

At the end of the safety tests the operation test according to clause 4 must be performed. During this test take especially care for the coolant circuits are completely tight.

8 Maintenance

In addition to the yearly safety test prescribed by law (cf. clause 7) we recommend a maintenance check after six months each. To maintain the good cooling performance of the unit the following maintenance work should be done by our company or an after-sales service shop authorized by us:

- Replacing the coolant of the applicators (external coolant circuit after a half year) according to these Service Instructions.
  The emptying set is required for this work.
- Replacing the coolant of the unit (internal coolant circuit after a year) according to these Service Instructions.
- Checking both coolant circuits for being tight.
  (For this purpose, the unit must be opened).
- Replacing the filter mat at the rear of the ***kryotur 600***.
- Checking the mains switch covering for being tight.
- Checking the cooling performance of the applicators.
  (Cf. clause 4.)
- Checking the operation of the automatically closing valves of the external coolant circuit.
- Complete operation check of the unit including accessories.
  (Cf. clause 4.)

Replenishing the coolant in both circuits shall only be done by coolant delivered by the manufacturer.

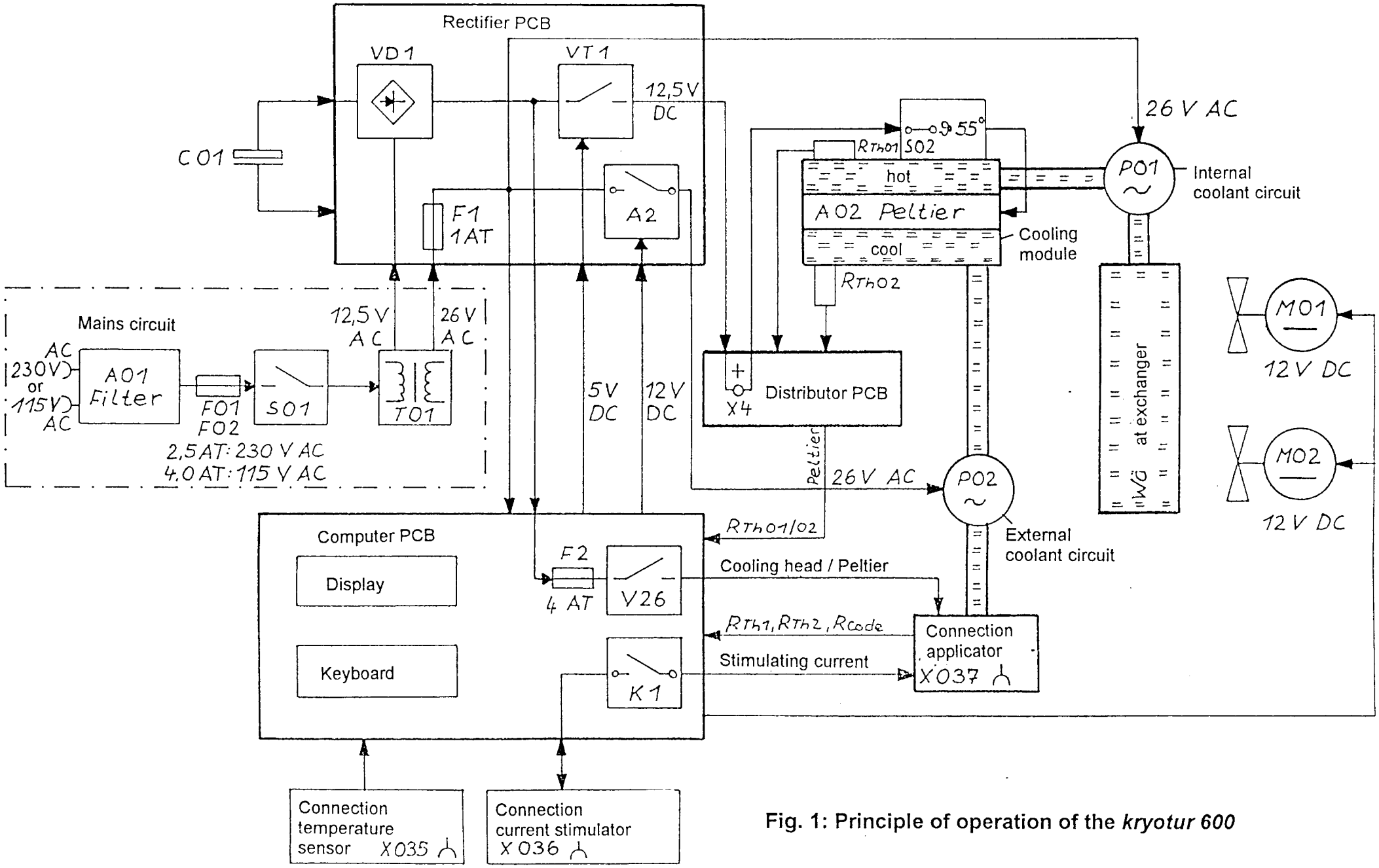
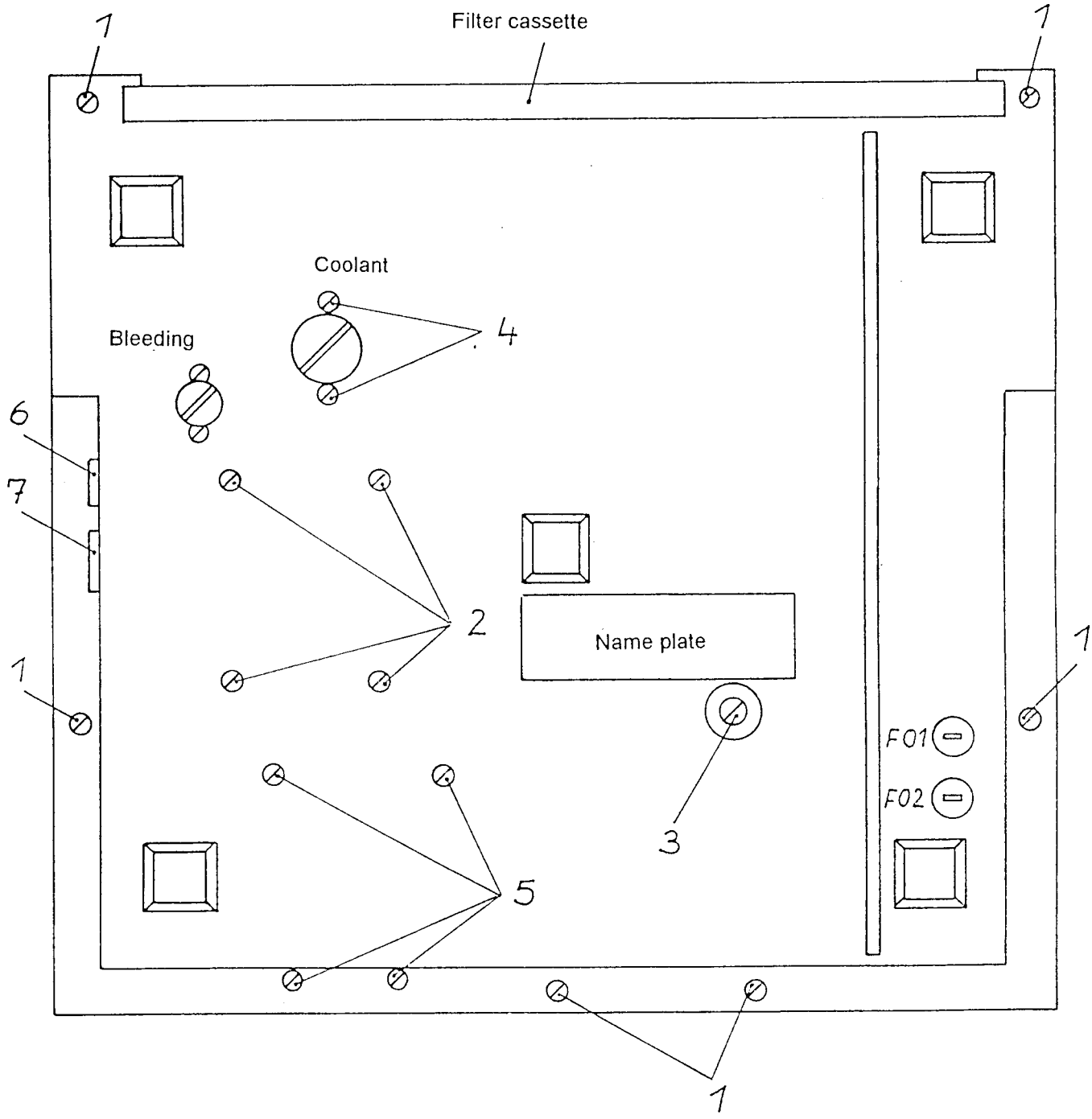
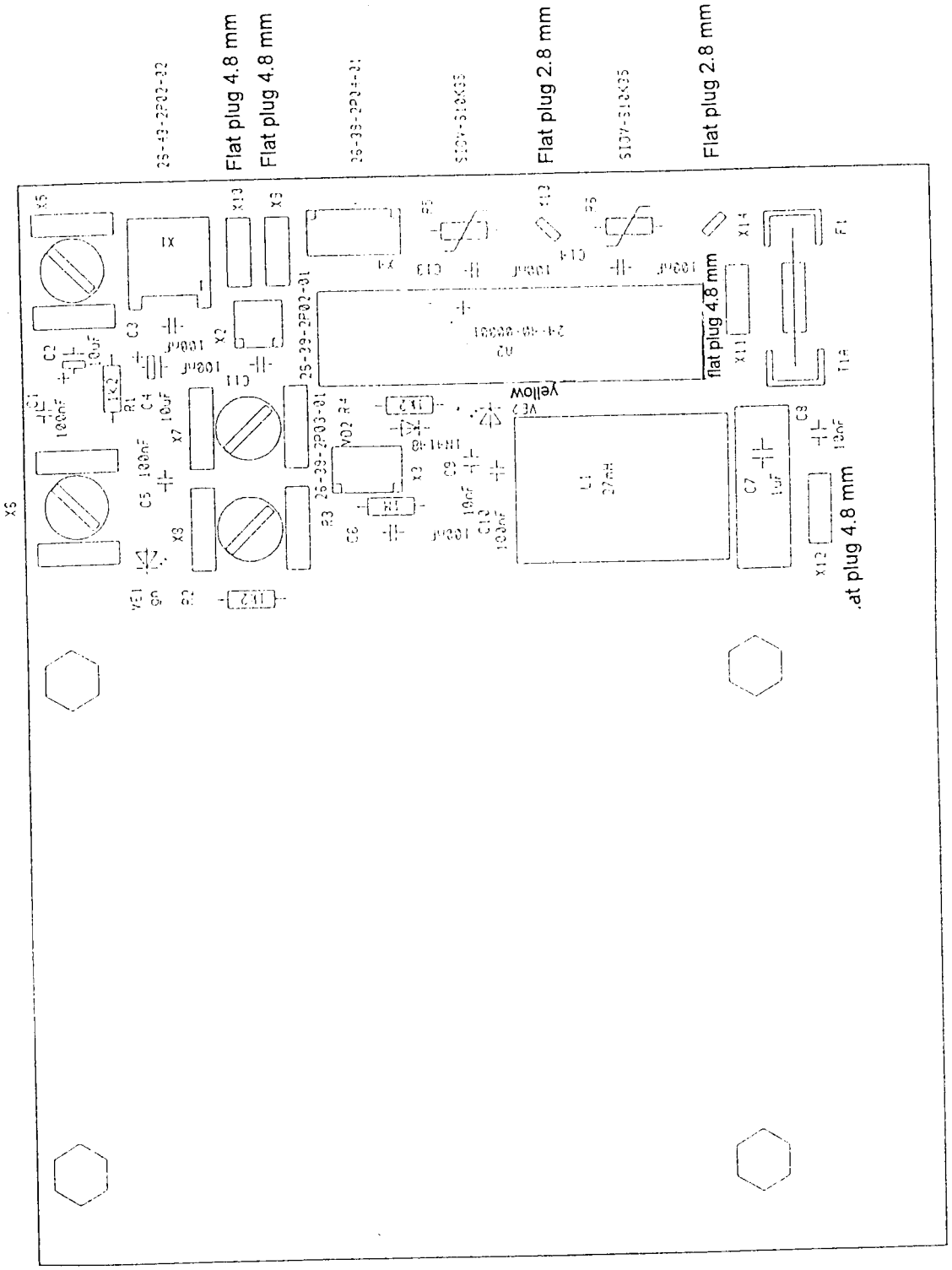


Fig. 1: Principle of operation of the *kryotur 600*



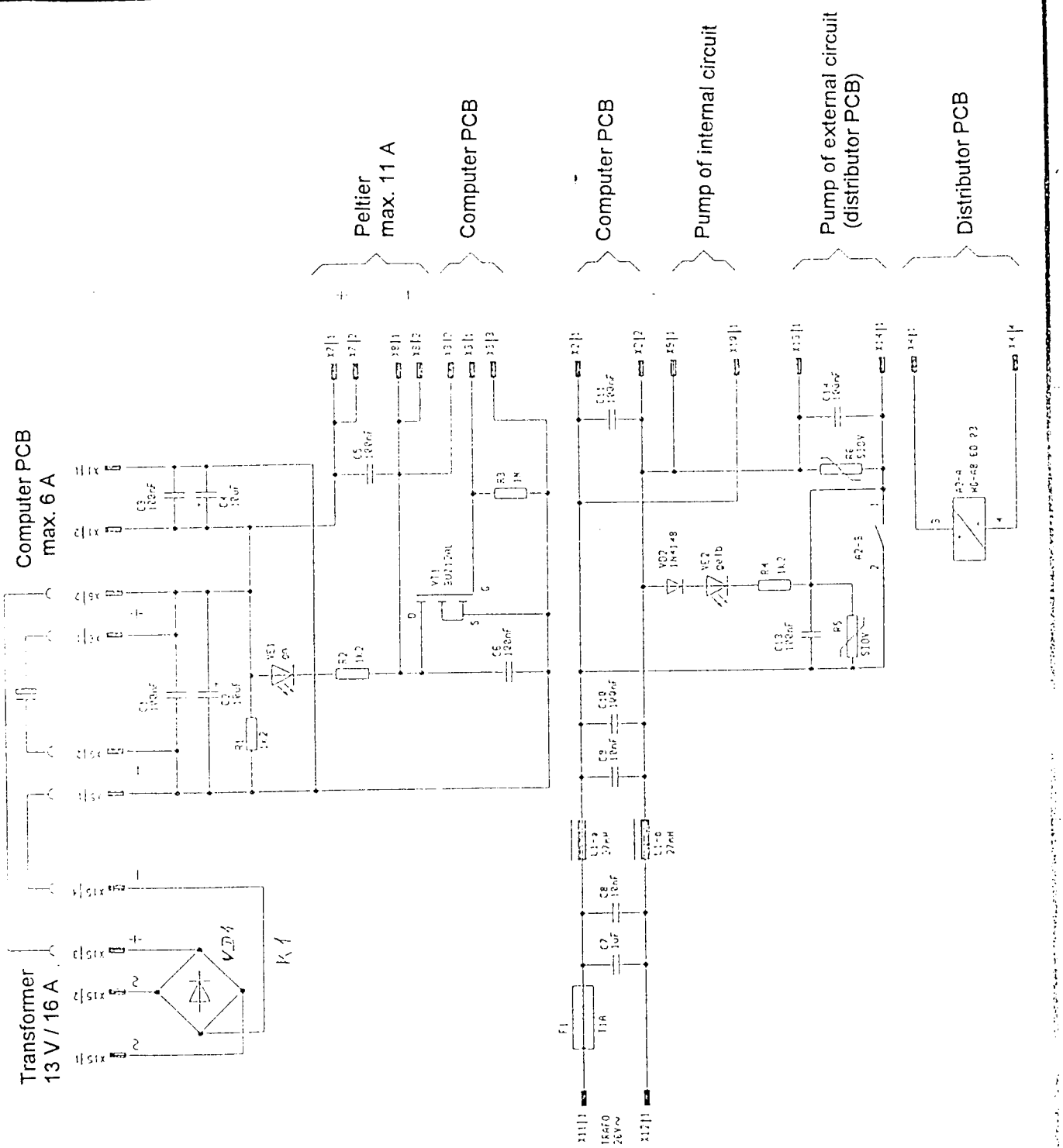
1 Casing
2 Cooling module
3 Pump of internal circuit
4 Pump of external circuit
6 Socket for temperature sensor
7 Socket for current stimulator

Fig. 2: Bottom plate - fastening bolts



See also Wiring diagram, rectifier PCB no. 989.004-200:000 Sp

				Halbzeug/Werkstoff	Allg. Abw. für Maße ohne Toleranzang.
				Designation **Rectifier PCB subassembly (*kryotur 600*)**	Maßstab / Bl. Anz. / Bl.Nr. / Masse
ÄZ	Mitteilung	Date	Name		
1996	Datum		Name	Drawing no. 063183-73-000-3 (4)	TUR elektromedizin
Drftm.	18.6.				Gesellschaft für Therapie- und Rehabilitationstechnik mbH
Konstr.					Berliner Str.60
Technol.					D-16540 Hohen Neuendorf
				Ers. für / Ers. durch	
Stand.					



See also Component list no. 989.004-200:000 SL

AZ	Mitteilung	Date	Name

Halbzeug/Werkstoff

Zul. Abw. für Maße ohne Toleranzang.

Maßstab

Bl. Anz. Bl. Nr.

Masse

Designation

Wiring diagram of rectifier PCB (*kryotur 600*)

1996	Datum	Name
Drftm.	18.6.	Rs
Konstr.		
Technol.		
Stand.		

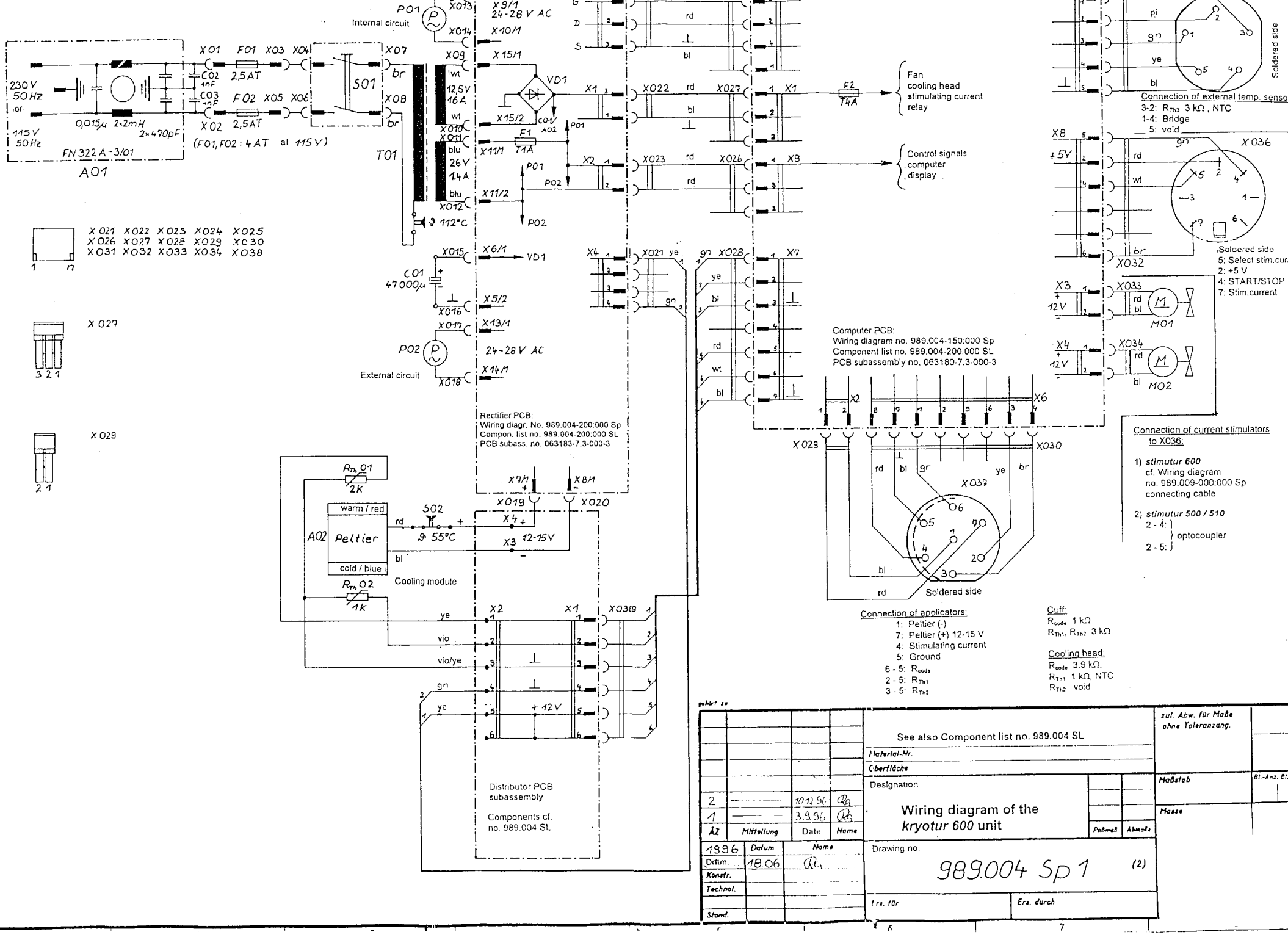
Drawing no.

989.004-200:000 Sp (4)

Ers. für

Ers. durch

TUR elektromedizin
Gesellschaft für Therapie- und Rehabilitationstechnik mbH
Berliner Str. 60
D-16540 Hohen Neuendorf



See also Component list no. 989.004 SL

2		10.12.96	Gä
1		3.9.96	Gä
Äz	Mitteilung	Date	Name

Material-Nr.

Oberfläche

Designation

Wiring diagram of the *kryotur 600* unit

Drawing no.

989.004 Sp 1 (2)

	Datum	Name
1996		
Drftm.	18.06.	Gä
Konstr.		
Technol.		
Stand.		

Ers. für

Ers. durch

zul. Abw. für Maße ohne Toleranzang.

Maßstab

Bl.-Anz. Bl.

Masse

Soldered side

6 7

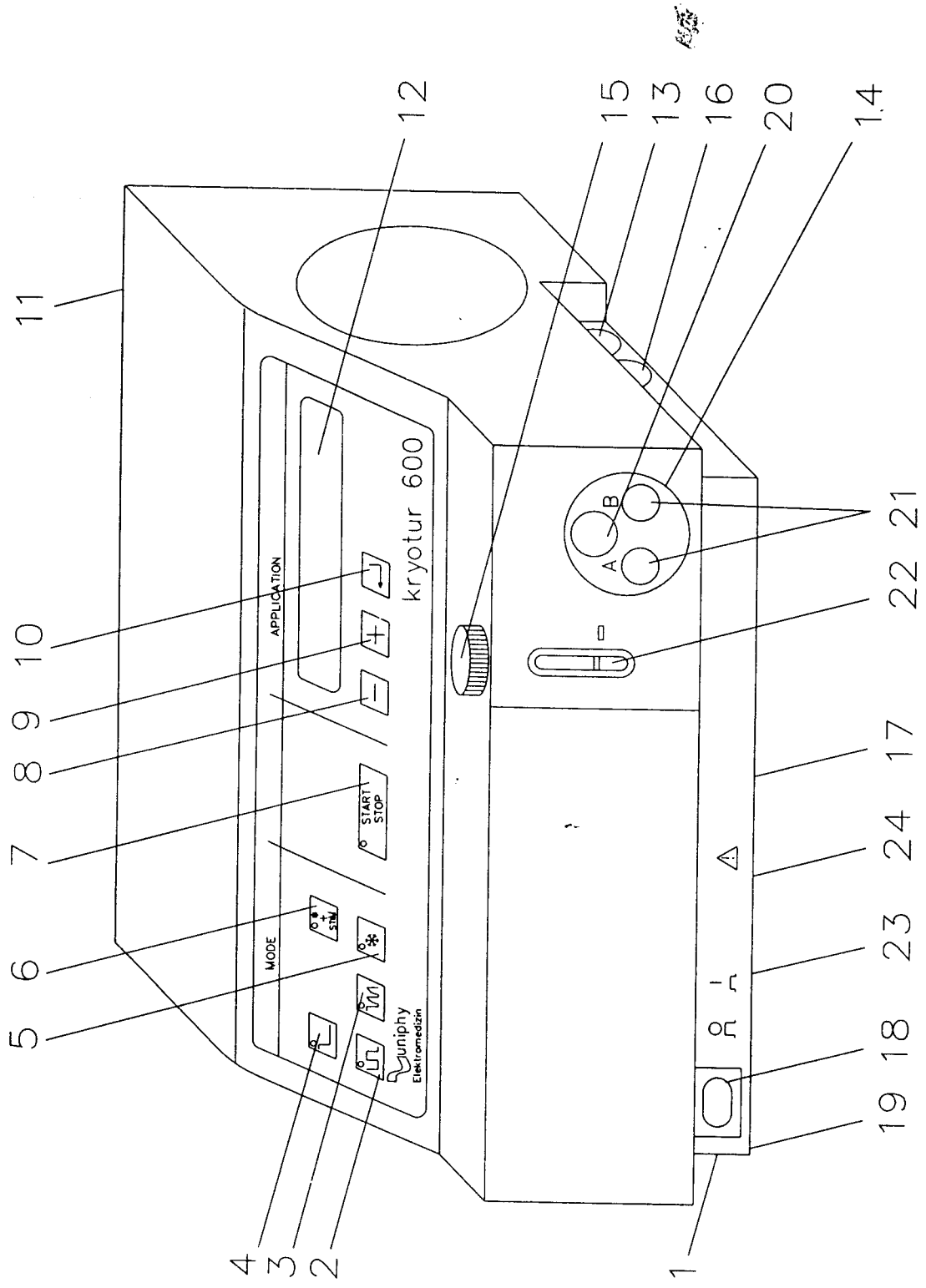


Fig. 1: Overall view of the *kryotur 600*

Operating and display elements

1	Mains connection socket (at the side)	
2	Operation key including LED indicator:	Mode of operation „Interval“
3	Operation key including LED indicator:	Mode of operation „Bio cycle“
4	Operation key including LED indicator:	Mode of operation „Constant temperature“
5	Operation key including LED indicator:	Mode of operation „Cooling head“
6	Operation key including LED indicator:	Mode of operation „STIM“ („KET“)
7	Operation key including LED indicator:	Switching ON and OFF the treatment
8	Operation key:	Setting the treatment parameters „-“
9	Operation key:	Setting the treatment parameters „+“
10	Operation key:	Jump to the next setting
11	Filter cassette with dust filter (rear wall)	
12	LCD display	
13	Socket for external temperature sensor	
14	Connector field for the applicator plugs	
15	Coolant inlet for external coolant circuit (screw cap 1)	
16	Socket for connecting a therapeutic current stimulator (at the side)	
17	Coolant inlet for internal coolant circuit (bottom, screw cap 2)	
18	Mains switch	
19	Mains fuses (bottom)	
20	Plug connector for the electric lines to the applicators	
21	Valves A and B for the external coolant circuit	
22	Level indicator of the external coolant circuit with minimum level marker, illuminated	
23	Bleeding screw of the internal coolant circuit (bottom, screw cap 3)	
24	Name plate (bottom)	

5 Coolant circuits

Fill or replenish only Aqua conservata SR in both (external and internal) coolant circuits.

5.1 Filling or replenishing coolant

5.1.1 External coolant circuit (applicators)

The capacity depends on shape and size of the applicator and is about 140 ml for the cooling head and about 190 ml for the kidney-shaped rubber cuff.

For replenishing connect the corresponding applicator to the unit (14). Arrange the applicator on the height level of the ***kryotur 600***. Switch on the mains switch (18) of the unit. After the automatic selftest simultaneously press the mode selector keys „Interval" (2) and „Cooling head" (5). Now, only the pump of the external coolant circuit is running and the message appears:

Simultaneously press the keys  and 

Display:

REPLENISH COOLANT IN THE APPLICATOR

Replenish coolant until the filling level is about 1 cm below the upper edge of inlet (15). There shall be no bubbles during the pumping and the pump runs without any noise. When within 5 minutes after replenishing the pump runs with „gurgling" noise the air bubbles collected in the pump are to be removed. For this purpose, switch off the mains switch (18), slowly shake the unit and switch on again. Restart the „Replenish water in the applicator" process and, if required, repeat again. After an applicator is correctly filled another one can be connected to the unit for checking the level or replenishing. At the end of replenishing tightly close the inlet (15) of the unit by screw cap 1. Leave this mode of operation by switching off the unit.

On level indicator (22), the coolant level of the external coolant circuit should be as high as possible during the cooling process. It shall never fall below the minimum level marker. Otherwise, optimum cooling of the applicators is not ensured. In such case, the cooling temperature selected is possibly not obtained (cf. clause 11).

Display:

SETPOINT NOT REACHED

Replenishing the coolant can also be done during the treatment.

ATTENTION: Weekly check the filling level of the applicators!
Avoid any coolant overflow. In case, the coolant is spilled immediately remove it from the unit by wiping dry (cf. clause 12).

15 Coolant inlet of the external coolant circuit

30 Coolant (500-ml plastic bottle)

31 Applicator
(cuff, cooling head or deep-freezing head)

45 Funnel (or plastic bottle with filling top)

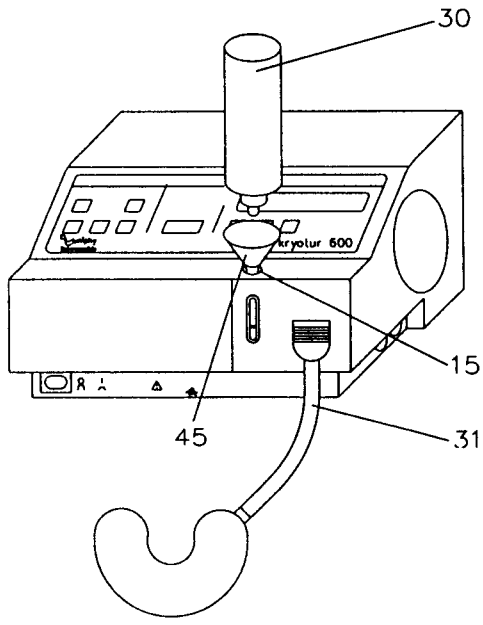
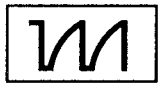


Fig. 2: Filling coolant into the applicator

5.1.2 Internal coolant circuit (unit)

Prior to filling up the internal coolant circuit replenish the external one according to subclause 5.1.1.

The capacity of the internal coolant circuit is about 370 ml. For filling or replenishing switch on the mains switch (18). An applicator shall not be connected. After the automatic selftest simultaneously press the mode selector keys „Constant temperature" (4) and „Bio cycle" (3). Now, only the pump of the internal coolant circuit is running and the message appears:

Simultaneously press the keys  and 

Display:

REPLENISH COOLANT IN THE UNIT

Now, turn the unit upside down. On the bottom of the unit there is a big screw cap 2 (17) on the inlet and a small screw cap 3 (23) on the air bleeding. Unscrew both screw caps by means of a coin. Fill coolant into the inlet until it becomes visible in the bleeding connection. Now, close the air bleed and continue filling up the coolant until its level is at least 5 mm below the horizontal bottom plate. Gently shake the unit. When the coolant level decreases replenish more coolant and carefully shake again. Repeat this until the coolant level is constant. No air bubbles shall be created by pumping, and the pump runs without any noise. If it begins running with a bubbling noise within 5 minutes after replenishing the coolant any air bubbles collected again in the pump. Switch off the unit by mains switch (18), shake it gently and switch on again. If required, repeat this process. Then switch off the unit by mains switch (18) and tightly close the fill-in connection. Turn the unit to its normal operating position.

ATTENTION: After first filling or replacing all coolant check the level after a week and then once per month each.
Optimum cooling performance is obtained with maximum filling height.
Avoid any coolant overflow. In case the coolant is spilled immediately remove it from the unit by wiping dry (cf. clause 12).

17 Coolant inlet of the internal coolant circuit

19 Mains fuses

23 Air bleed of the internal coolant circuit

24 Name plate

30 Coolant (500-ml plastic bottle)

45 Funnel (or plastic bottle with filling top)

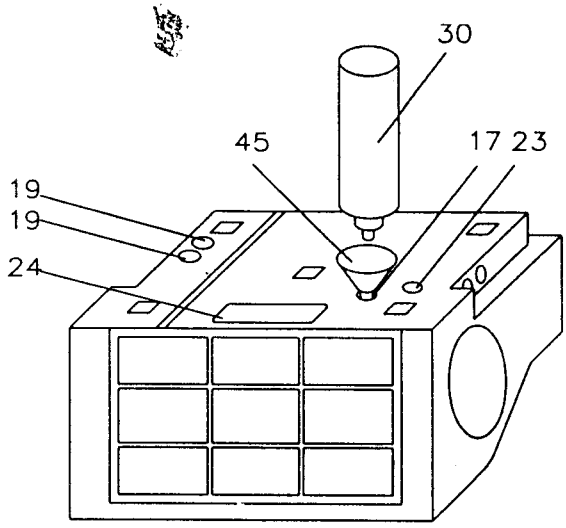


Fig. 3: Filling coolant into the unit

5.2 Emptying the coolant circuits

Emptying the coolant circuits is necessary for replacing the coolant (cf. clause 12), for repair or the unit is endangered to frost (cf. clauses 4 and 17). Replacing the coolant regularly ensures the optimum operation of the ***kryotur 600***. An emptying set (cf. clause 16 and subclause 5.2.1) is required for replacing the coolant of the external circuit.

5.2.1 External coolant circuit

The external coolant circuit can be separated by drawing off the connector of the applicator. Automatically closing valves avoid any coplant flow out of the unit connections (21A and 21B) and applicators.

The coolant in the applicators and the remaining coolant of the external coolant circuit in the unit must be separately removed.

5.2.1.1 Emptying the external coolant circuit of the unit

Connect emptying adapter 1 to the valve connector (21B) at the unit. Screw off screw cap 1 (15) and put the end of hose (33) in a deeper standing suitable container. By means of plastic syringe (32) pump air into inlet (15) until no coolant flows out of hose (33). Then connect the emptying adapter to valve connector (21A) at the unit and drain the coolant. Screw cap 1 on inlet (15) and draw off the emptying adapter 1 from the unit.

15 Coolant inlet of the external coolant circuit

21 Valves (A/B) of the external coolant circuit

32 100-ml plastic syringe

33 Emptying adapter 1

34 Container

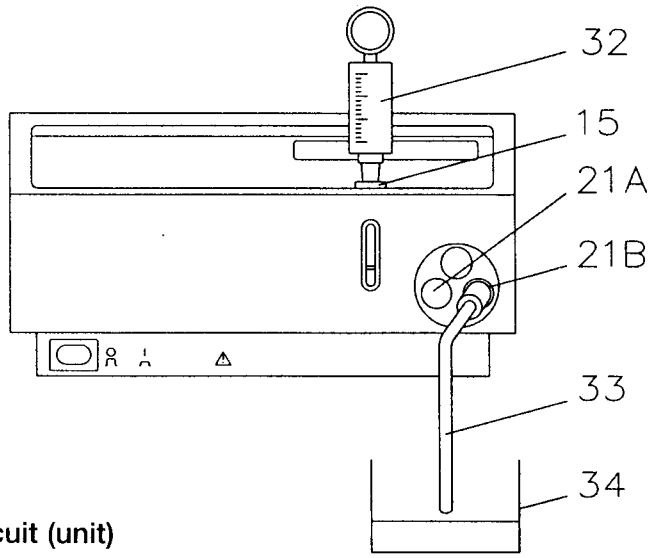


Fig. 4: Emptying the external coolant circuit (unit)