INSTRUCTIONS

EM/SM-IP20/75/150

ION PUMP

No. IEM/SM-IP20/75/150

Serving Advanced Technology

JEOL 日本電子

8507001

CONTENTS

1. GENERAL

Ion pumps are widely used as clean ultra-high vacuum pumps that allow self-baking under vacuum at high temperatures.

If a high voltage is applied to the pump anode under high vacuum, the electrons emitted from the cathode will fly toward the anode. Because of the magnetic field, however, the electrons make a long stroke spiral motion. As a result, they frequently collide with gas molecules and produce ions and secondary electrons. The secondary electrons collide with other gas molecules, causing what is known as an avalanche. The ions collide with titanium plate cathode, and sputter titanium atoms. As a result, fresh titanium deposit layers form successively on the anode cell surface. Since fresh titanium deposit layers have strong gettering action, the active gas reacts with titanium and becomes a compound which is seized on the anode cell surface. The inactive gas is embedded in places on the cathode surface where there is less sputtering of titanium atoms.

As an index representing the "quality level" of an ion pump, an I/P value (I = ion current and P = the pressure in the pump) is used. The JEOL ion pumps have an I/P value about twice as high as that of other makers for the following reasons.

1) The mean magnetic field is as high as about 1.2 kGs.

2) The dimensions of the anode cylinder are optimized for the high magnetic field. As a result, the anode diameter is relatively small, allowing arrangement of many anode cells in a cathode area.

3) Penning discharge occurs in many enclosed spaces outside the four anode cylinders.

The JEOL ion pumps (20, 75, 150 lit./s) are bipolar type ion pumps with a pair of titanium plate cathodes. The pumps may be developed into a differential type pump capable of stable evacuation of inactive gases such as argon by replacing one side of the cathode pair with a tantalum plate.

After vacuum baking treatment and argon glow discharge treatment, the pump proper is checked as to the ultimate pressure and other capabilities and is charged with argon gas. With the blind flange attached, therefore, the pump cannot be started.

As control power supplies for the pumps, a power supply with a heat-resistant cable for 20 lit./s and a common power supply for 75 lit./s and 150 lit./s are available.

For adaptation to an automatic evacuation system, the control power supplies have the following built-in protective functions.

1) A protective function operates when an excessive ion current flows after a preset interval (0 to 5 minutes, normally preset to 5 minutes) after power on. In other words, if an excessive ion current flows 5 minutes after power on, the power supply will be automatically forced into an OFF state.

2) Has contact terminals in which the contacts open/close and close/open in synchronism with the ON/OFF of the power supply.

2. PUMP MODELS

An ion pump consists of the pump proper and control power supply. The designations of the four kinds of pumps, plus a pump element for 20 lit./s, are stated in Table 1, which also includes the respective pump configurations and control power supplies, each identified by a unit symbol. The unit symbols are symbols adopted for the sake of simpler instruction manual description.

Table 1 Pump Model Designations and Configurations

Model designation (Note)	Configuration (Unit Symbol)
EM-IP20	Pump proper (IP-20) and Power supply (C-20)
EM-IP75	Pump proper (IP-75) and power supply (C-75/150)
EM-IP150	Pump proper (IP-150) and power supply (C-75/150)
SM-IP20S	Pump proper (IP-20) and power supply (C-20S*)
SM-IP20E	Pump element (IP-20E**)

Note: The numbers in the model designations denote the nominal evacuation speed (lit./s).
* Equivalent to C-20 except the output cable (non-heat-resistant, 5 m)
** IP-20 without magnet

3. PREPARATIONS

3.1 Installing pump

Remove the bolts of the blank flange to detach the blank flange, and install the pump on the equipment to be evacuated.

1) Lightly wipe the edge of the flange with a piece of cloth dipped in a Freon 113 solution.

2) Use a new copper gasket when installing the pump.

3) If the flange portion is to be baked at a high temperature of over 250°C, apply a small amount of molybdenum bisulfide to the threaded portion of bolt.

4) Tighten each bolt evenly in the diagonal order, a little at a time to make sure that the bolts are not unevenly tightened. Finally, tighten the bolts with a torque of 250 kg-cm or more.

Notes: 1. Do not damage the edge of the flange.
2. Do not touch the pump's interior with bare hands.
3. For easier pump installation, remove the magnet before installing the pump.

3.2 Control Power Supply Connection

Connect the power cable to an AC outlet and connect the output cable to the high voltage terminal of the pump proper.

1) Verify that the AC power voltage matches the specified voltage of the power supply. The power supply transformer has terminals for input voltage selection. Normally the AC 200 V terminal is selected. If an adequate terminal is selected, the output voltage meter reading with no load will be 6.5 kV ± 10%.

2) Make sure that the three points, the AC outlet, control power supply and pump proper, have been adequately grounded.

3) Before connecting the output cable to the pump high voltage terminal, make sure that the power supply main switch is in the off position and that the power supply meter reading is zero volt.

4. OPERATION

1) Evacuate the ion pump to less than 0.1 Pa (about 1×10^{-3} Torr) with an auxiliary pump such as a turbo molecular pump or oil diffusion pump.

2) Verify that the meter selector switch of the control power supply is in the HV (High Voltage) position and then turn the control power supply on. Now penning discharge will occur in the pump, and the pump will start, while degassing itself. The anode voltage might not rise fully for a while, depending on conditions such as the history of the pump, effective evacuation speed of the auxiliary pump, etc.
   a) When the pressure in the pump seems very high, e.g., when the anode voltage does not increase to over 2 kV in more than a minute after power on, temporarily turn off the power supply. Turn it on again four or five minutes later.
   b) If the pump pressure is not low enough about 5 minutes after power on, the protection circuit will be activated to turn off the power supply. In this case, even if the pump pressure decreases to a sufficiently low level, power will not be automatically turned on. Four or five minutes after the power supply has been turned off, set the power supply switch to OFF and then to ON to restart the pump.

3) When the anode voltage (HV) increases to more than 6 kV, the ion current gradually decreases and the pump's operation returns to normal, close the valve of the auxiliary pump system.

4) If the anode voltage slowly decreases and the ion current increases, carry out sufficient rough pumping again before closing the volve of the auxiliary pump system.

Note: If the ion pump is used in a system with air leakage, the internal walls of the pump element and pump vessel will be oxidized, and the performance of the pump will drastically deteriorate. Check to ensure that there is no air leakage in the system.

5. VACUUM BAKING OF PUMP

When a pump long exposed to the atmosphere is to be started up or a chamber long exposed to the atmosphere is to be evacuated by pumping, the pump must be baked. If the pump is started up without baking, large current discharges will occur and raise the temperatures of both the pump element and pump vessel, and the pressure in the pump will increase, with the result that pump start-up will be difficult.

1) Turn the power supply off. While evacuating the ion pump with an auxiliary pump (a turbo molecular pump or oil diffusion pump), bake the pump vessel walls with a ribbon heater or similar heater. In this case, as a rule, remove the magnet and output cable plug from the pump proper. With proper heat insulation, by wrapping the pump heater with an aluminum foil, very high temperature baking can be done.

2) After an adequate period (preferably more than 10 hours) of baking, turn the heater off. After the pump wall surface has cooled down to less than 100°C, remount the magnet and output cable.

3) Verify that the pump wall temperature is below 100°C and then start up the pump in accordance with the procedure described under item 4, Operation.
   Notes: 1. For baking at a temperature below 200°C, the magnet need not be removed.
   2. The output cables of the power supplies C-20 and C-75/150 are heat-resistant cables. For baking at a temperature below 200°C, therefore, the output cable plugs need not be removed. The output cable of the C-20S, on the other hand, is a non-heat-resistant cable.
   3. The IP-150 pump has a 200 V, 400 W sheath heater wound around it.

6. CHARACTERISTICS

6.1 Evacuation Characteristics

(1) Performance

Table 2 Ion Pump Evacuation Performance

	IP-20	IP-75	IP-150
Ultimate pressure	1×10^{-7}Pa or less	As at left	As at left
Evacuation speed			
Nitrogen	20 lit./s	75 lit./s	150 lit./s
Air	22 lit./s	80 lit./s	160 lit./s
Argon	0.2 lit./s	0.8 lit./s	1.5 lit./s

(2) Pumping speed characteristics

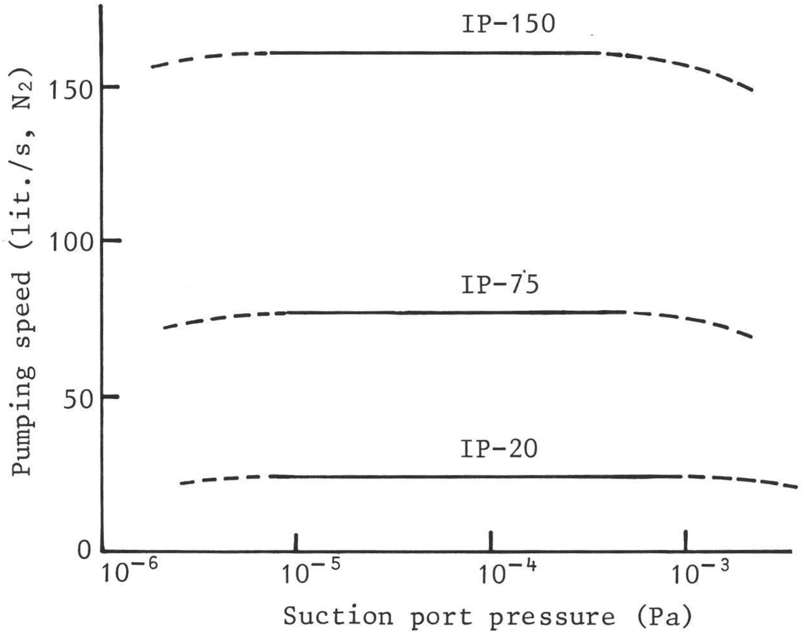

Fig. 1 Suction Port vs. Pumping Speed Characteristics (Nitrogen Gas)

(3) Pumping Speeds for Various Gases

Table 3 Ratios of Pumping Speeds for Various Gases
(The ratio for nitrogen is regarded as 100%.)

Gas	Ion pump
Nitrogen	100
Hydrogen	100 to 270*
Air	110
Hydrocarbon type gases	90 to 160**
Argon	1 (20***)

* Dependent on pressure
** Dependent on kind of gas
*** In the case of a differential type pump using tantalum for one side of the cathodes

6.2 Pump Current vs. Pressure Characteristics

The pressures in the pump and ion current are almost proportional to each other. Fig. 2 shows the pressure in the pump vs. ion current characteristics in nitrogen gas.

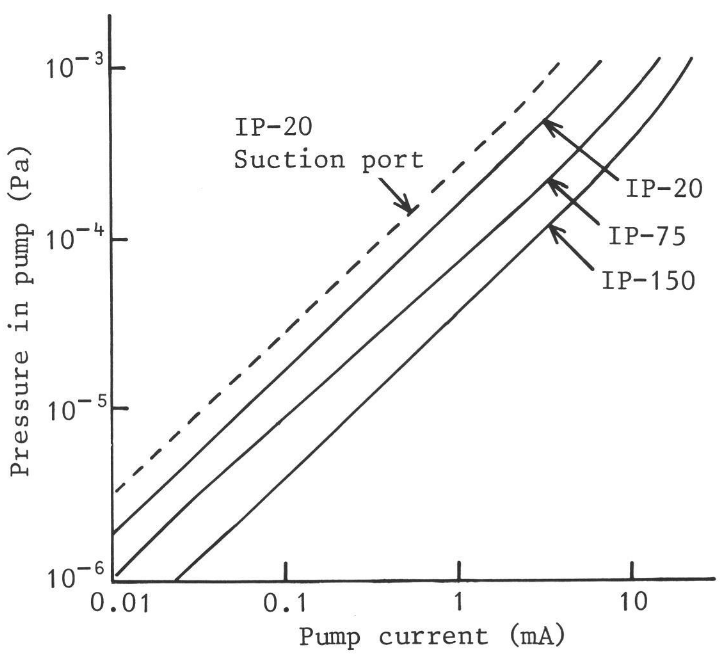

Fig. 2 Pump Current vs. Pressure Characteristicsp
(Nitrogen Gas)

Fig. 2 shows the suction port pressure vs. ion current characteristics of 20 lit./s SIP. Since the 20 lit./s SIP has a small calibre suction port flange, the pressure in the suction port is about 70% higher than the pressure in the pump. Since the calibre of suction port flange of larger pumps is sufficiently large, the suction port pressure is almost equivalent to the pressure in the large pump. The pressure (Pa) scale of the power supply indicates the pressure in the pump.

6.3 Leakage Flux Characteristics

In Fig. 3, the solid lines show the A-direction (upward above the flange port) characteristics, whereas the broken lines show the B-direction (see the illustration in the diagram) characteristics. The C-direction (rearward from the back of the magnet assembly) characteristics in IP-150 are shown with a dot chain line.

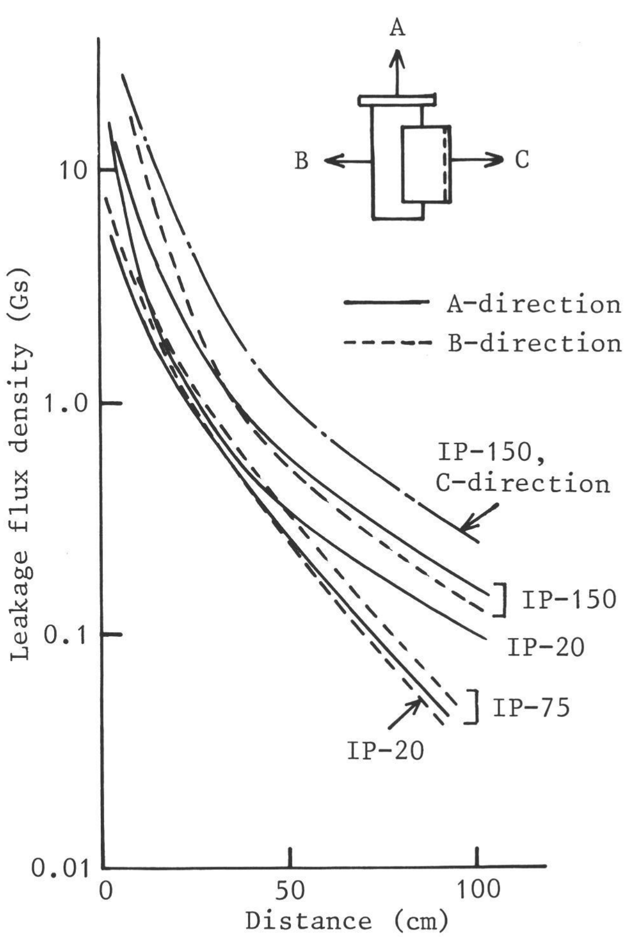

Fig. 3 Leakage Flux Characteristics

AC magnetic flux, though small in amount, will leak from the power supply. When the output current is 10 mA, AC leakage flux at a place very close to the power supply (0 to 2 cm away) will be as follows:

C-20;	0.3 Gs (p-p)
C-75/150;	0.8 Gs (p-p)

6.4 Power Supply Characteristics

Fig. 4 shows the output current vs. output voltage characteristics of power supply. Fig. 5 shows the pump current vs. time (time required before input is cut off) characteristics of the protection circuit of power supply.

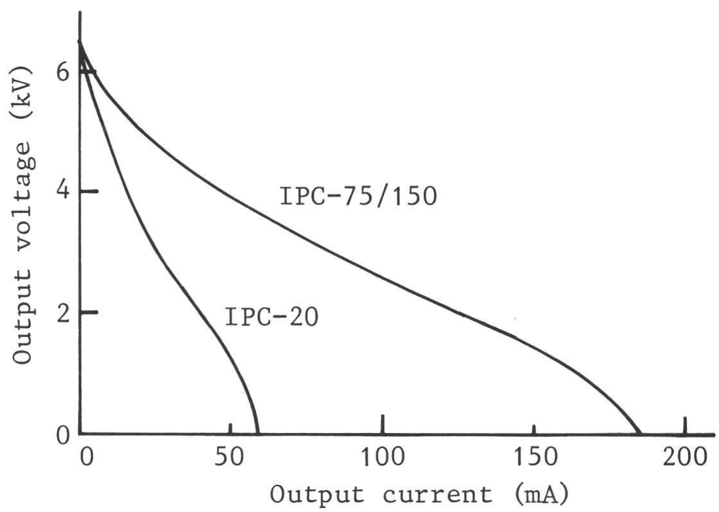

Fig. 4 Output Current vs. Output Voltage Characteristics

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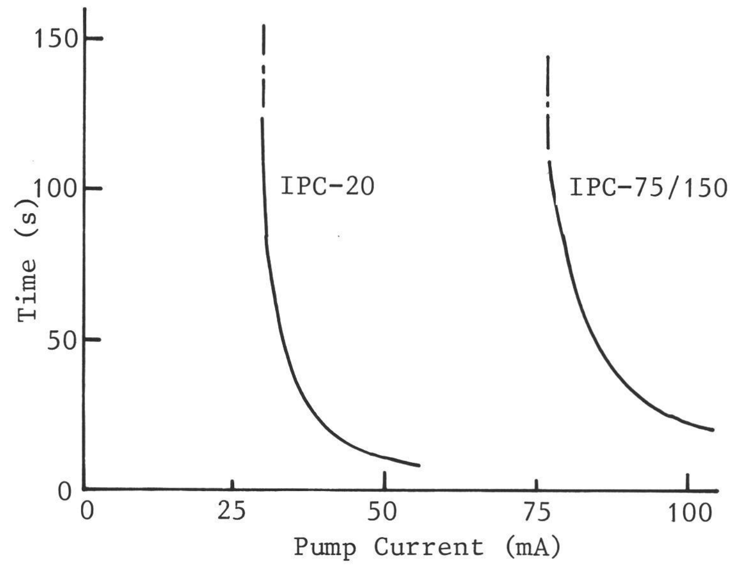

Fig. 5 Pump Current vs. Time Characteristics of Protection Circuit

The protection function of the power supply will be activated 5 minutes after power on (the interval may be changed to any value between 0 and 5 minutes with an internal timer which is normally set to 5 minutes).
If a pump current of about 30 mA (C-20) or about 80 mA or more (C-75/150) continues to flow for more than the specified period shown in Fig. 5, power will be turned off. To restart operation, temporarily set the input switch (located on the front panel of the control power supply) to OFF and then to ON.

7. PUMP CONFIGURATION

7.1 Pump Proper

Table 4 shows the configurations of the pumps.

Table 4 Configuration of Pump Proper

	IP-20	IP-75	IP-150
Suction port flange	70ϕ ICF	152ϕ ICF	203ϕ ICF
Gross weight	Approx. 14 kg	Approx. 23 kg	Approx. 40 kg
Weight of magnet	Approx. 10 kg	Approx. 14 kg	Approx. 23 kg
Baking heater	None	None	200 V, 400 W
Overall dimensions	Fig. 6 (a)	Fig. 6 (b)	Fig. 6 (c)

In addition, the IP-20E which is a magnet-less version of the IP-20 is available for maintenance and servicing.

7.2 Power Supplies

Table 5 shows the configurations of various types of power supplies.

Table 5 Configuration of Power Supply

	C-20(C-20S)	C-75/150
Input voltage	100, 115, 200, 220, 240 V	200, 220, 240 V
Maximum output voltage	6.5 kV ± 10%	As at left
Maximum output current	60 mA ± 10%	170 mA ± 10%
Protection function	Forces input to OFF when excessive output current flows.	As at left
Input cable	2 m, tap connection	As at left
Output cable	9 m, heat-resistant (5 m, non-heat-resistant)	9 m, heat-resistant
Weight	Approx. 13 kg	Approx. 26 kg
Overall dimensions	Fig. 7 (a)	Fig. 7 (b)

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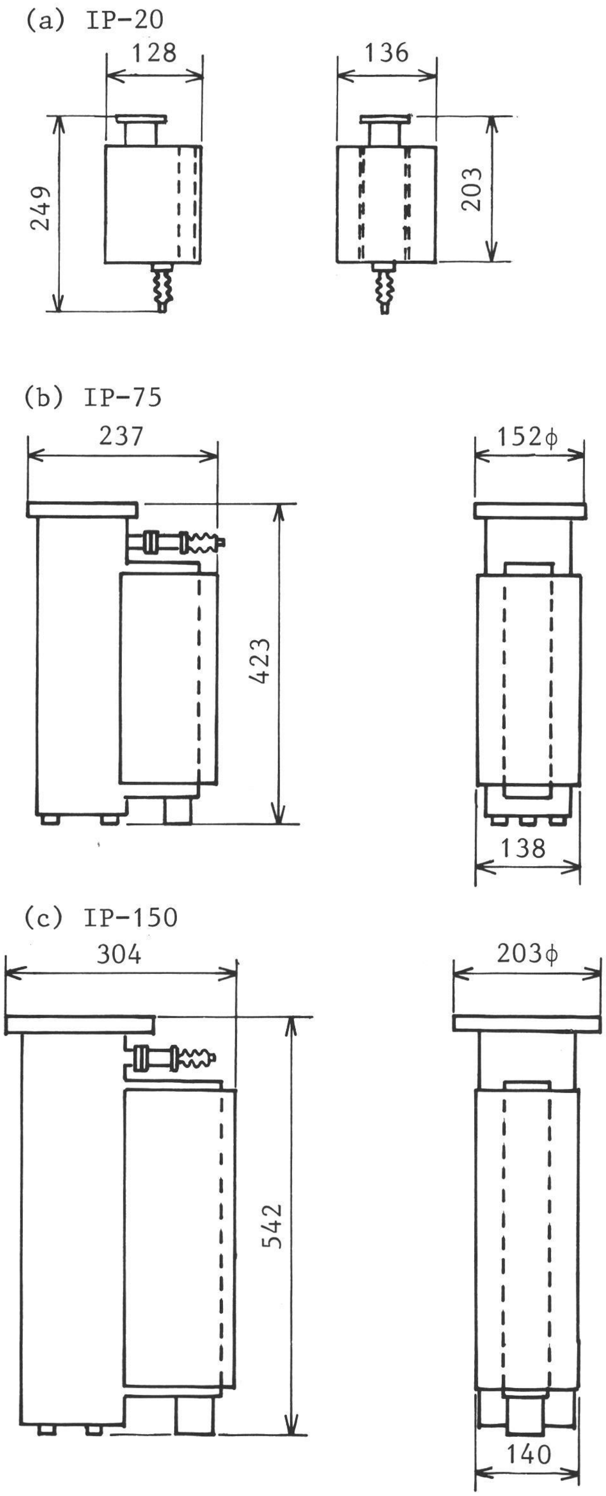


Fig. 6 Dimensions (pump proper, unit in mm)

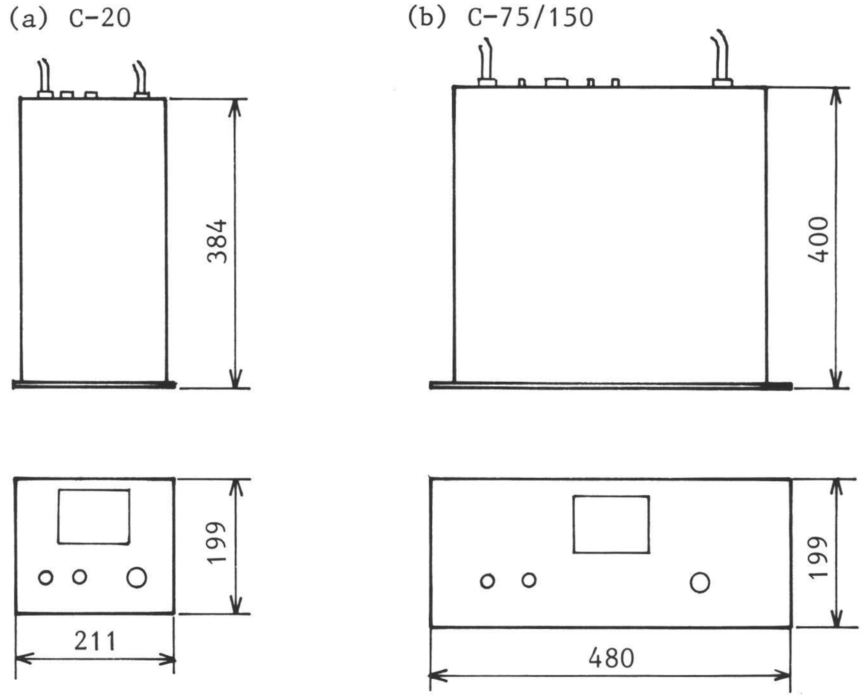
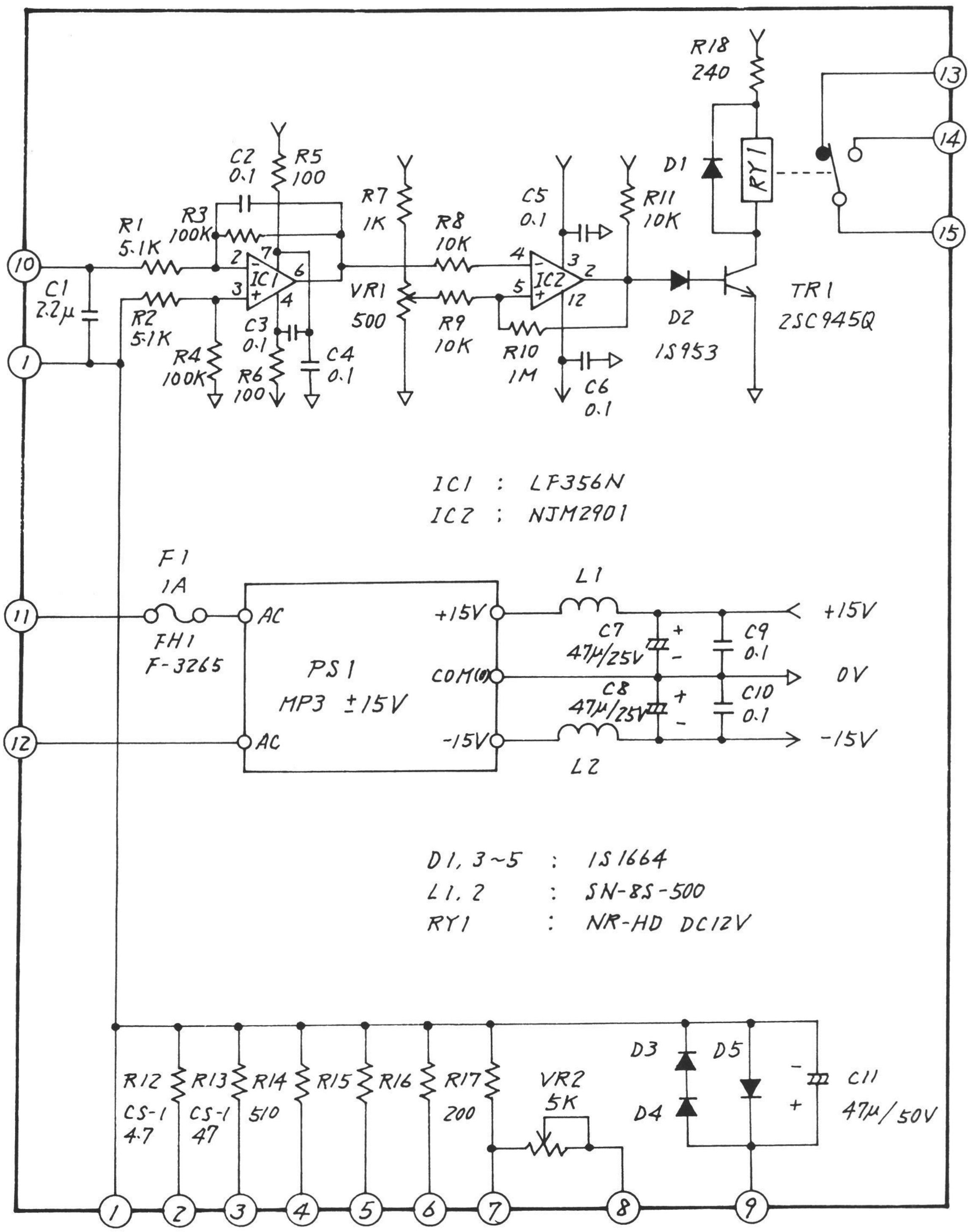
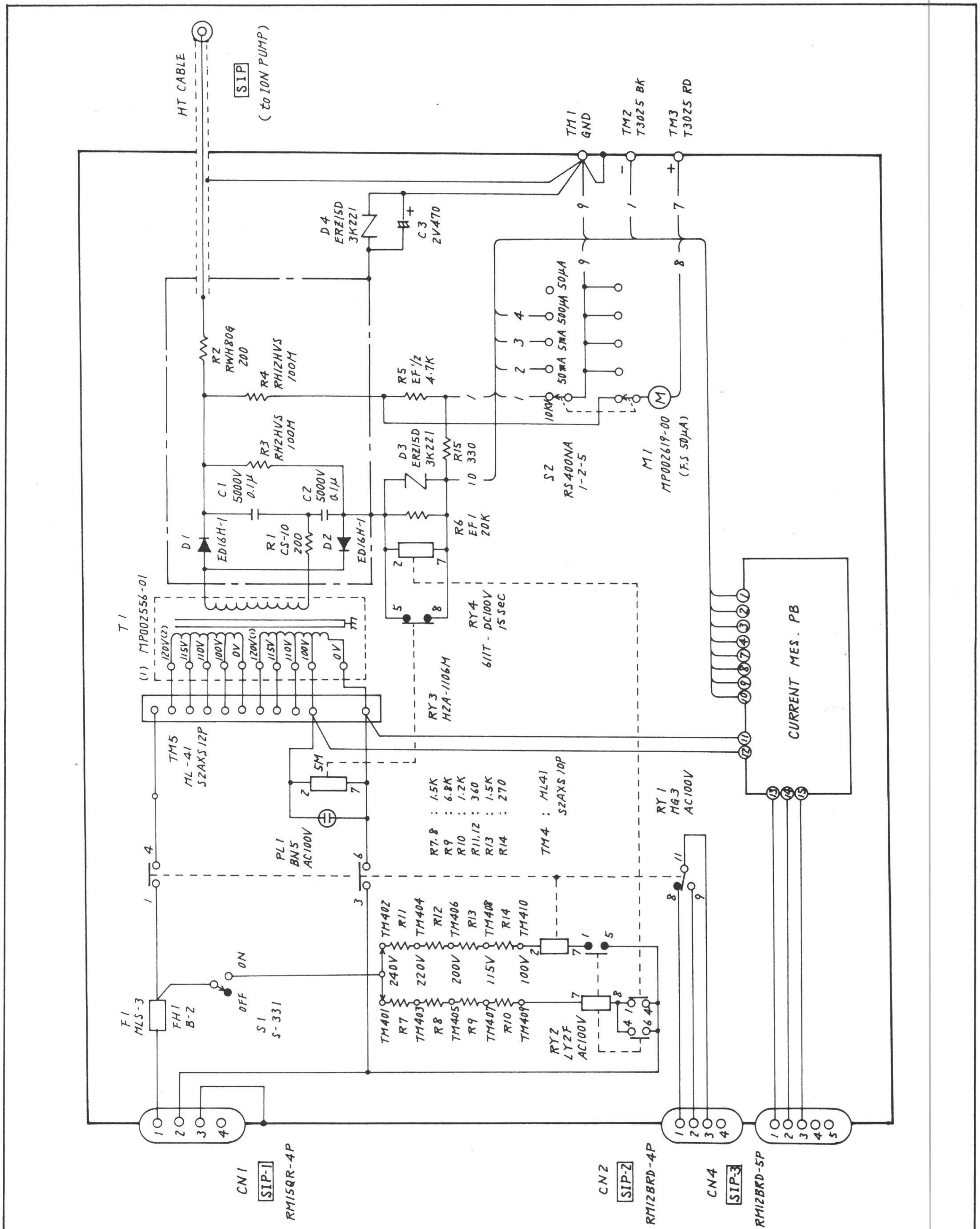


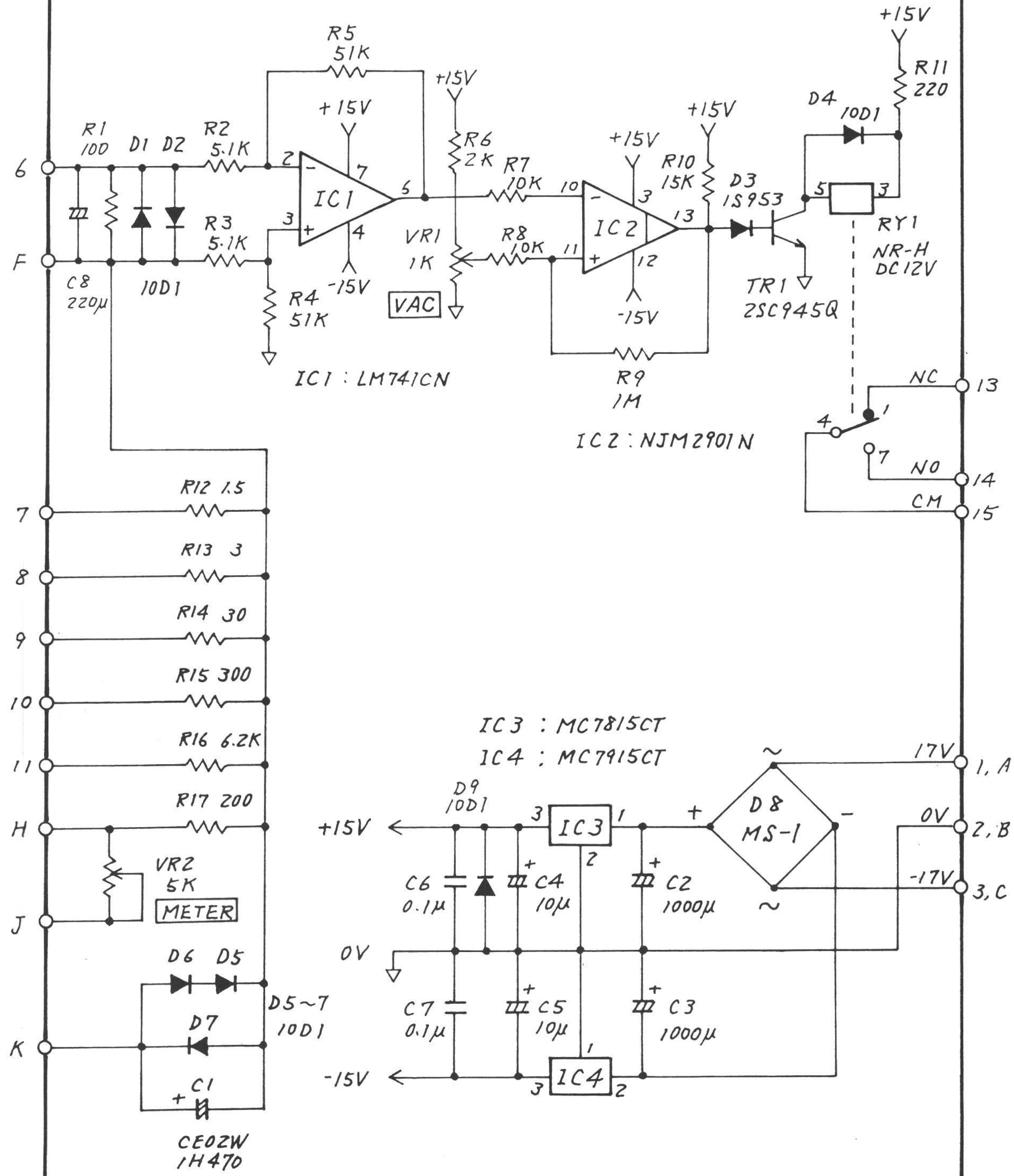
Fig. 7 Dimensions (pump proper, unit in mm)



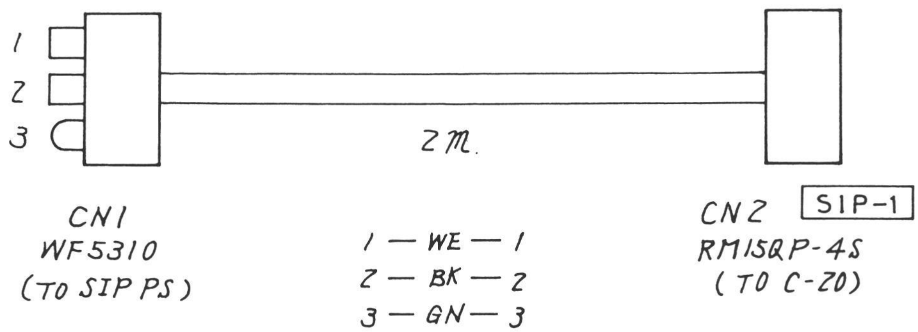
CURRENT MES. PB	606226087



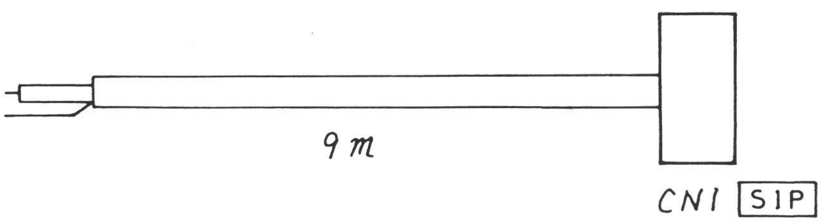
C-20	606148698



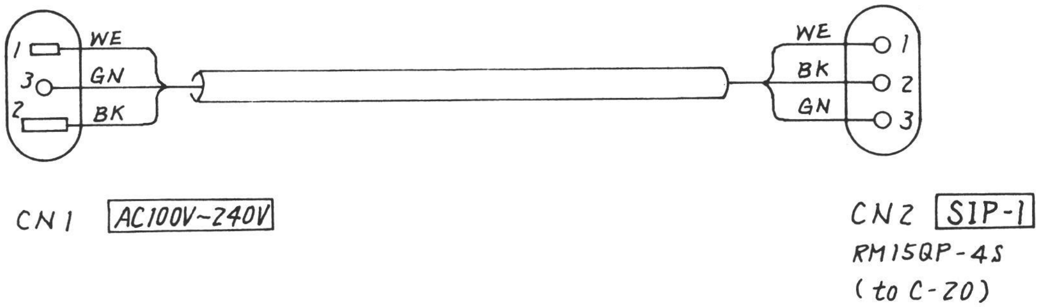
MEASURMENT PB	606120793



PS CABLES	606119710



HT CABLE	



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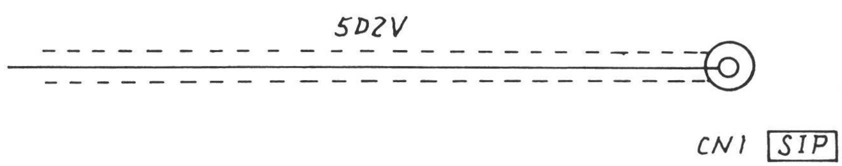
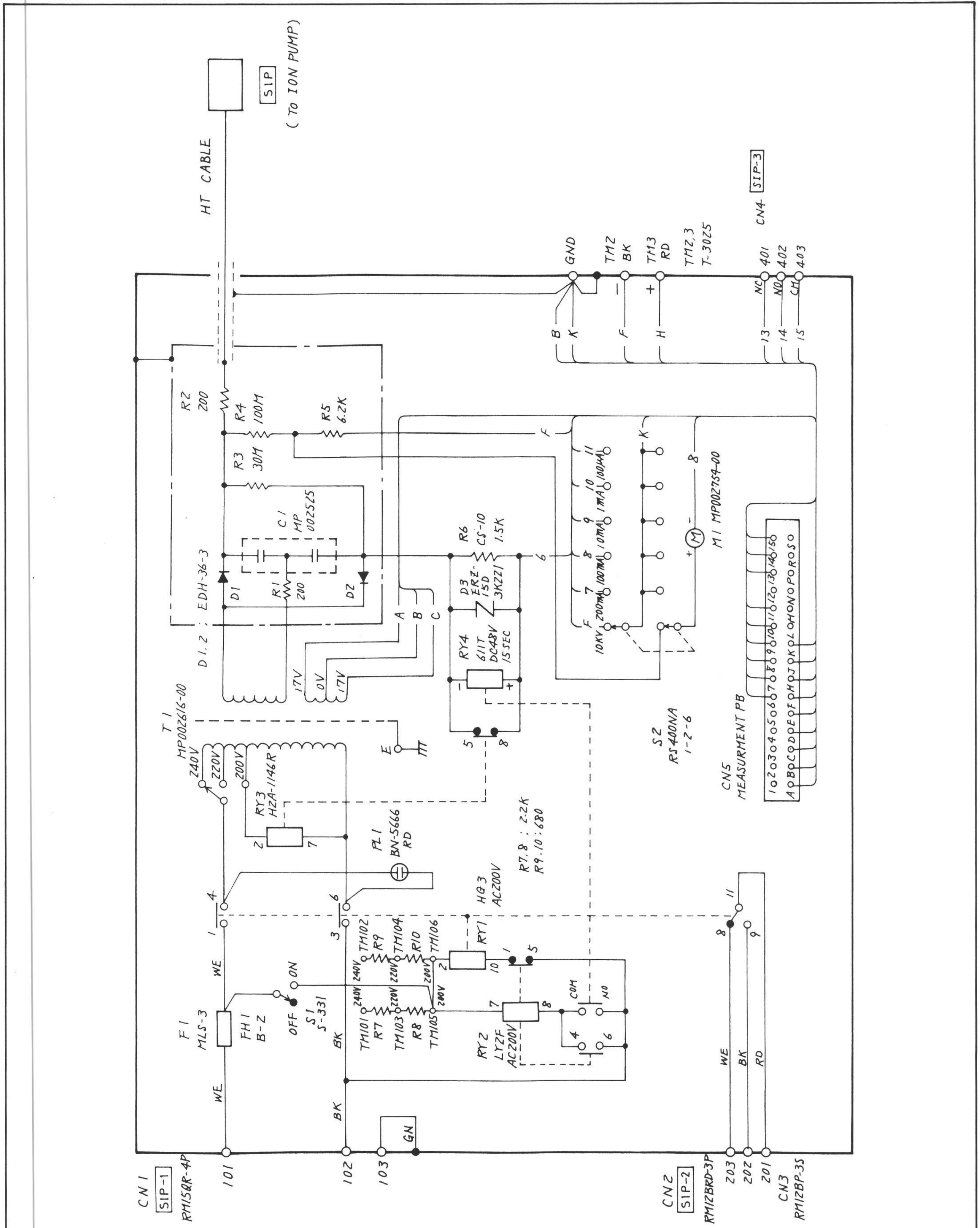


PS CABLE	606226079



C-75/150	606150374