DAIKIN

Marine type Container Refrigeration Unit

Service manual

Model

LKEN5BD20

OCLU2990035 TO OCLU2991108

DAIKIN INDUSTRIES LTD

TR86－6

This manual describes the features, functions, operation, and maintenance of the container refrigeration unit. In addition, the manuals listed below are also available.

- Parts list
- Compressor disassembly & reassembly manual.

Please refer also to these manuals.

DANGER

Do not disconnect plug until power supply is switched off.

CAUTION

Do not start the unit until a plug is connected and generator plant is operated.

NOTE

1. Ensure that the recorder is working correctly when a new chart is fitted.
2. Ensure that the control box covers are correctly tightened.
3. Ensure that the stop valves in the refrigeration circuits are opened before operation.

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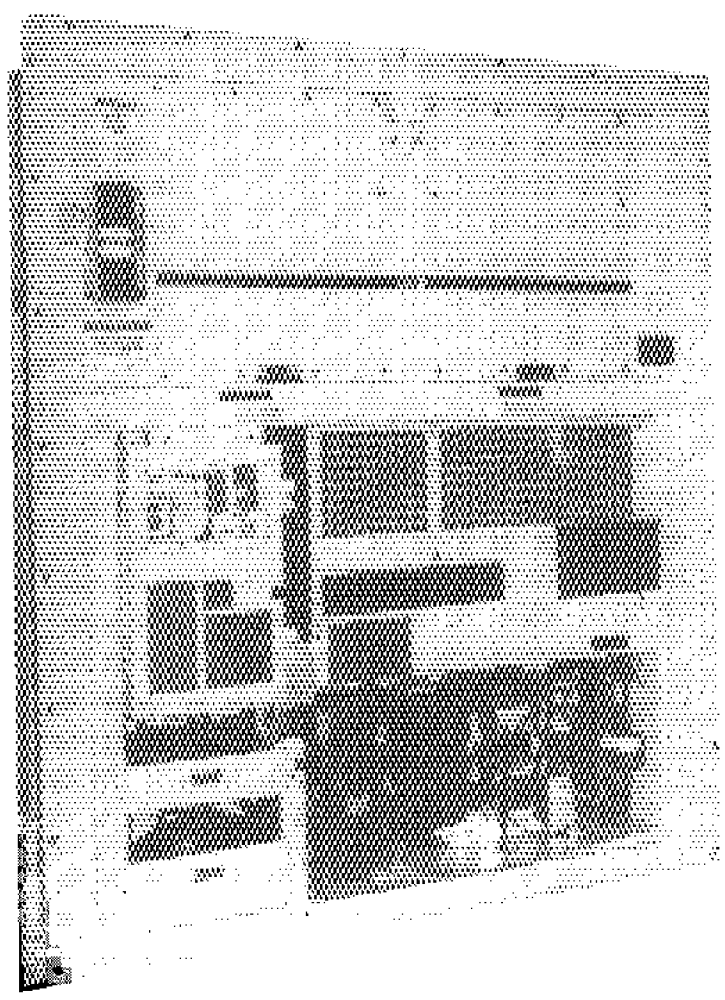
1. Specification

1.1 General specification

Power supply	AC 200V 3 Phase 50 Hz AC 200, 220V 3 Phase 60 Hz AC 380~415V 3 Phase 50 Hz AC 400, 440V 3 Phase 60 Hz (Dual voltage rating with voltage selector)
Compressor	Semi hermetic type (3.75 kW)
Evaporator	Cross finned coil type
Air cooled condenser	Cross finned coil type
Water cooled condenser	Hairpin-shaped tube-in-tube type
Accumulator-receiver with heat exchanger	Vertical cylinder type
Fan	Motor direct driven propeller type
Fan motor	Single-phase squirrel-cage induction motor
Defrost Heat source Initiation Termination	 Electric heater Air pressure switch, timer or manual switch Sensing evaporator temperature by defrost termination thermostat
Refrigerant control	Thermostatic expansion valve
Capacity control	Hot gas bypass control with modulating control valve
Protection devices	Circuit breaker, Over current relay with single phase protection, High pressure switch, Low pressure switch, Firestat, Fusible safety plug, Compressor motor protection thermostat, Fan motor protection thermostat
Refrigerant	R12 : 4.5 (kg)/9.9 (lbs)
Lubricant	SUNISO 3GS-DI (2.3 ℓ)
Weight	Approx. 590 (kg)/1301 (lbs)

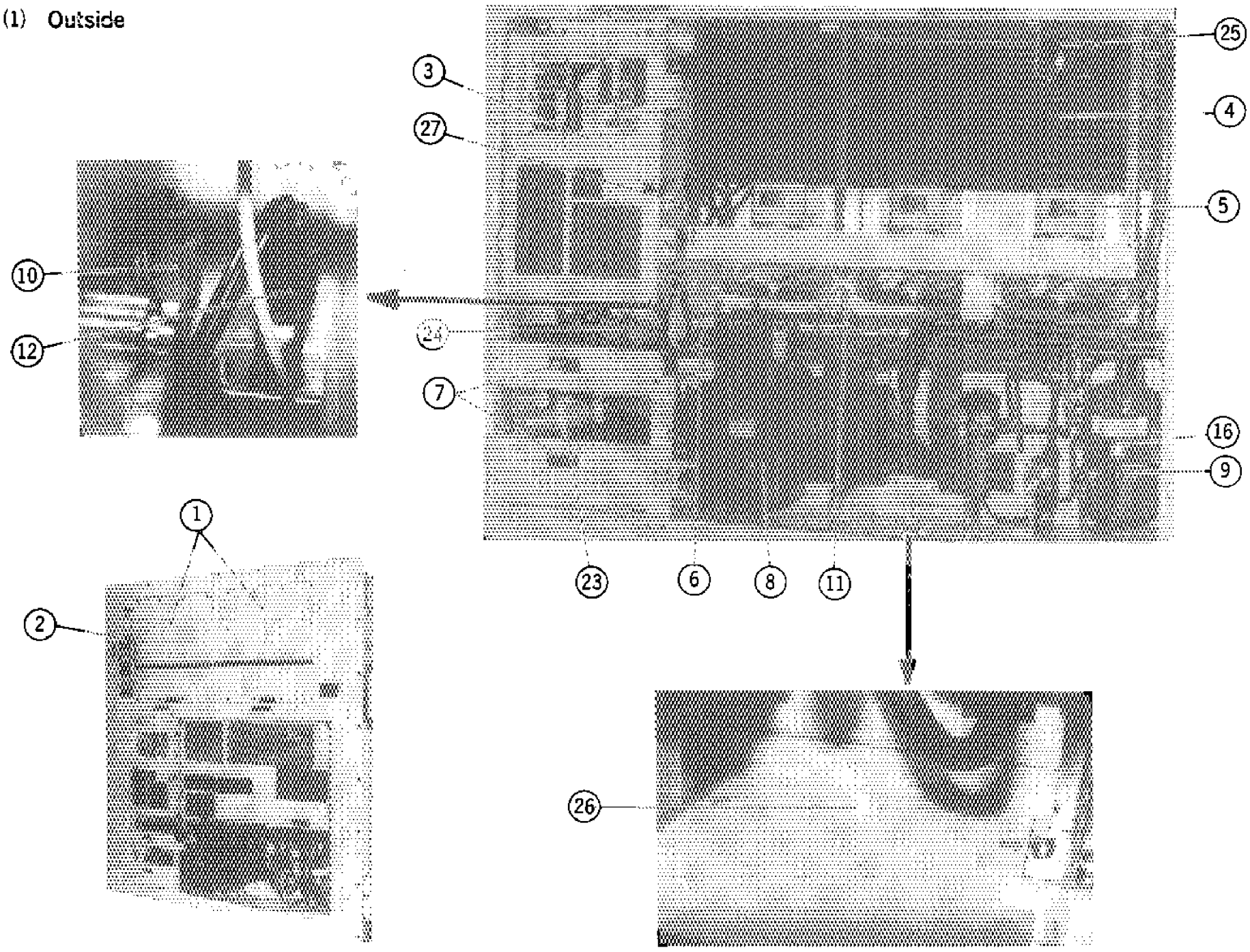


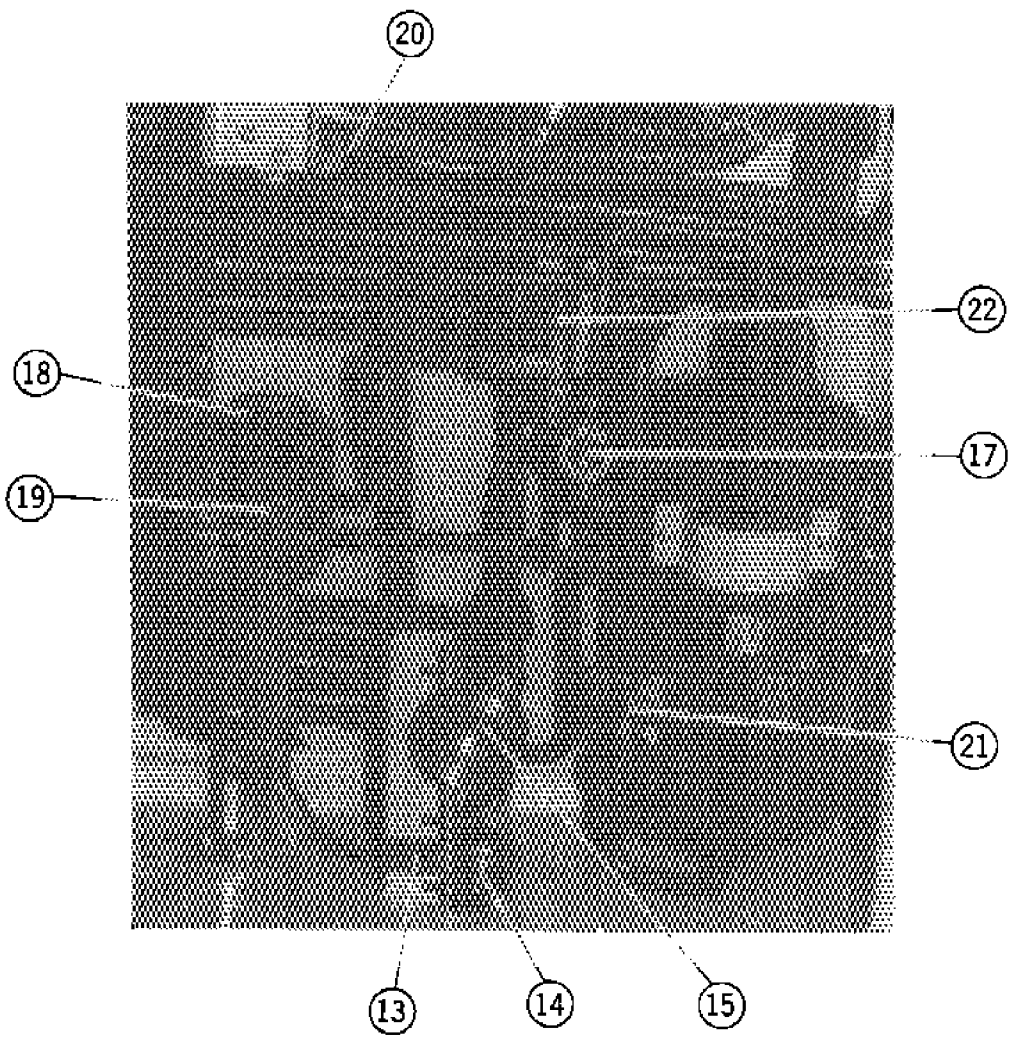
1.2 Set values of functional parts

Part name	Mark	Function		Set value	Manufacturer	Parts No.
Low pressure switch 20PS-K110	LPS	Low pressure	OFF ON	40cmHgV 0.2kg/cm²	Texas inst (JAPAN)	284057A
High pressure switch 20PS-K210	HPS	High pressure	OFF ON	20kg/cm² 16.5kg/cm²	Ditto	284056A
High pressure control switch ACB-BA22	HPCS		OFF ON	7kg/cm² 11kg/cm²	Saginomiya (JAPAN)	284058
Water pressure switch LCB-BB07	WPS		OFF ON	1.0kg/cm² 0.4kg/cm²	Ditto	284059
Defrost termination thermostat BIMETAL TYPE ST-5B40/20	23D		OFF ON	40°C 20°C	Takachiho (JAPAN)	643001A
Firestat BIMETAL TYPE ST-5B71/49	26AH		OFF ON	71°C 49°C	Ditto	643109A
Defrost timer (outside range) STP-D73-4	2D1		ON	2hr (60Hz) (2⅔hr (50Hz))	Tateishi (JAPAN)	621094
Defrost timer (in range) STP-D73-4	2D2		ON	12hr (60Hz) (14⅔hr (50Hz))	Ditto	621094
Over current relay GT-20-NP_2S_4 (Manual reset)	51C		OFF	5.5A	Togami (JAPAN)	612008
Circuit breaker (main circuit) MK-53	52C1		OFF	32A	Nikko electric (JAPAN)	622703
Circuit breaker (control circuit) CP-31	52C2		OFF	7A	Fuji electric (JAPAN)	622706
Thermal protector (Fan motor)			OFF	120°C (248°F)		
Thermal protector (compressor)	49		OFF	105°C (221°F)		

1.3 Construction

(1) Outside

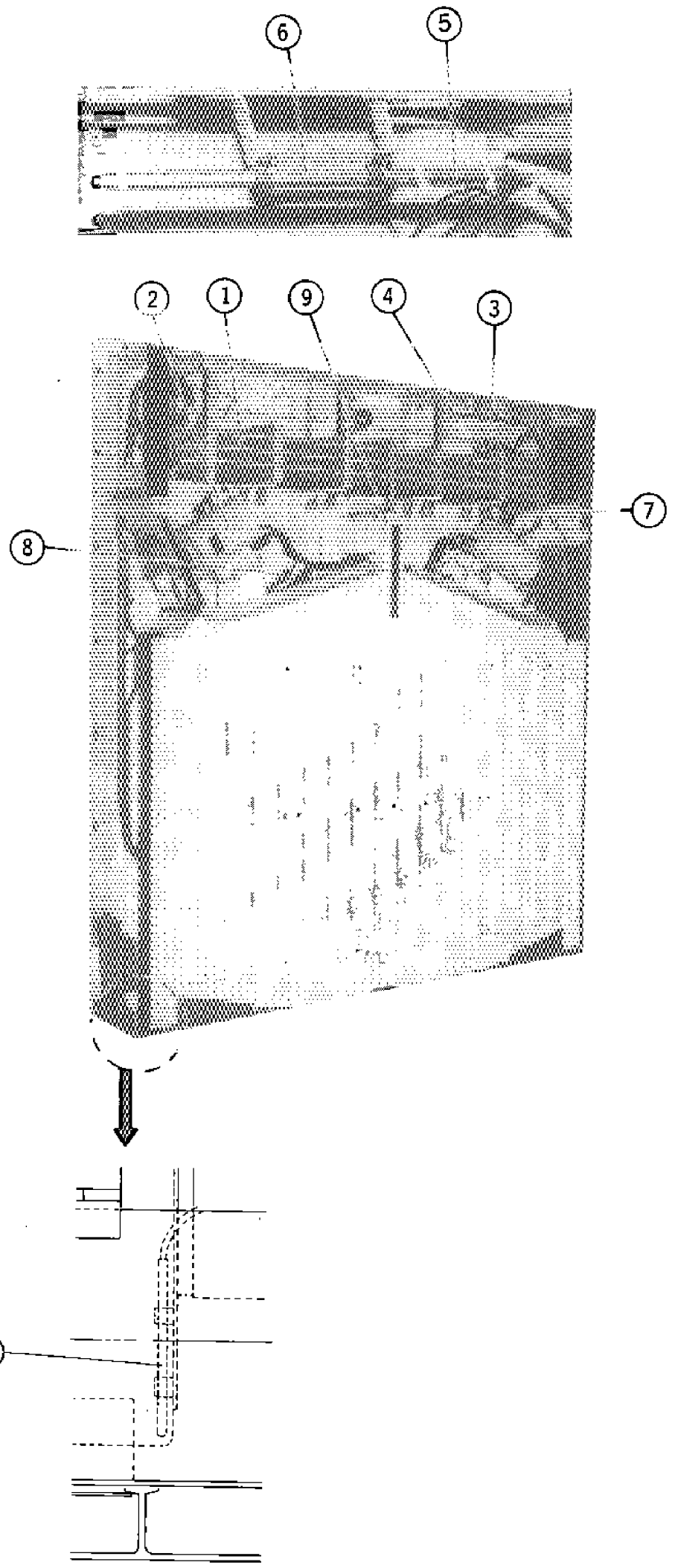




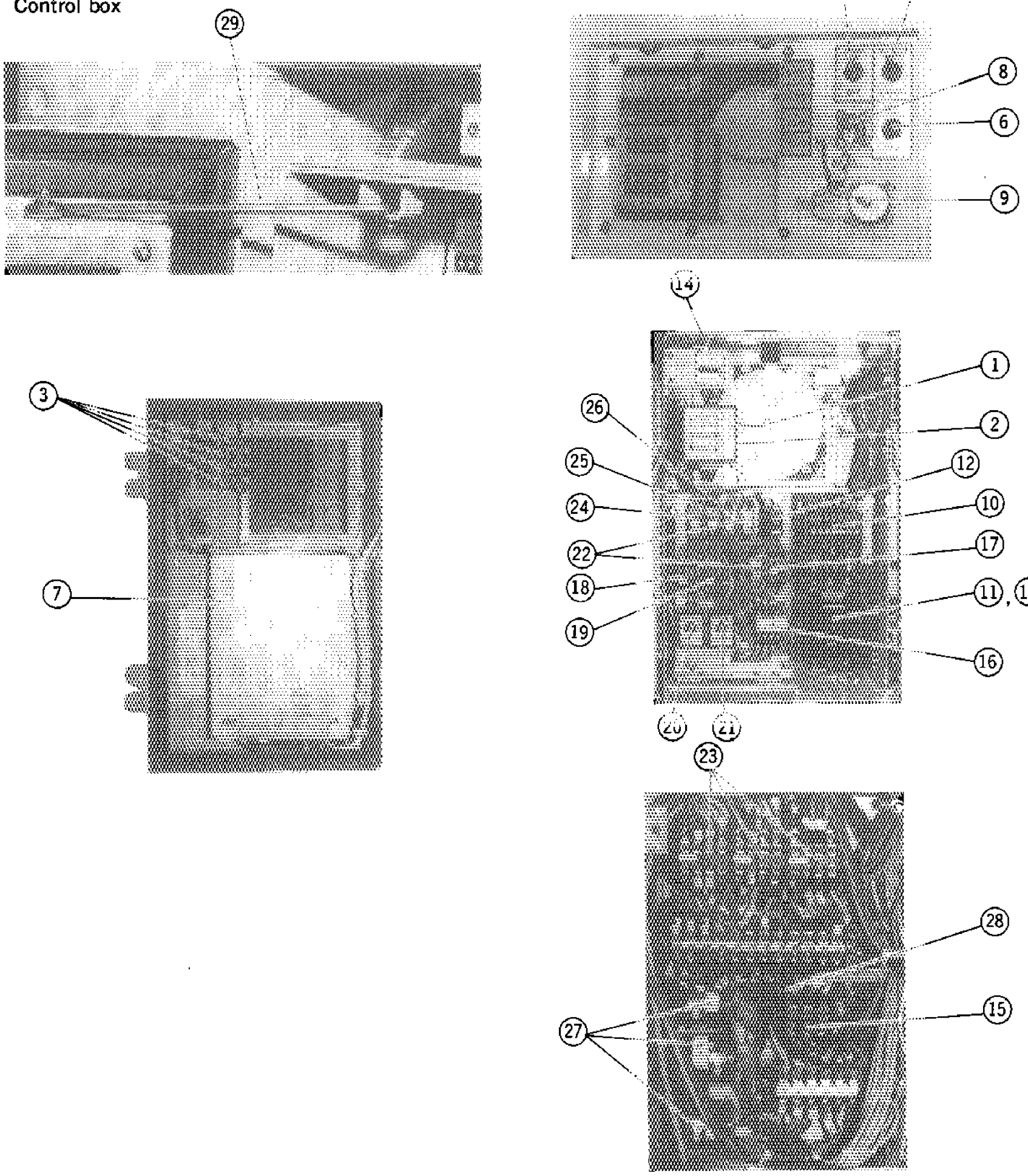
1 Access panel
2 Ventilator
3 Control box
4 Air cooled condenser
5 Condenser fan motor
6 Water cooled condenser
7 Cable stowage
8 Compressor
9 Accumulator-receiver with heat exchanger
10 High pressure switch
11 Low pressure switch
12 High pressure fan control switch
13 Water pressure switch
14 Water inlet coupling
15 Water outlet coupling
16 Dryer
17 Liquid/moisture indicator
18 Modulating control valve (20M)
19 Solenoid valve (20R for main line)
20 Suction line solenoid valve (20SS)
21 Stop valve (liquid line)
22 Stop valve (hot gas line)
23 Power plug (200V~220V)
24 Power plug (380V~440V)
25 Expansion valve
26 Gland for supply air sensor
27 Voltage selector switch

(2) Inside

1 Evaporator
2 Evaporator fan motor
3 Defrost termination thermostat
4 Firestat
5 Return air sensor
6 Recorder sensor
7 Defrost heater
8 Drain pan heater
9 Junction box
10 Supply air sensor



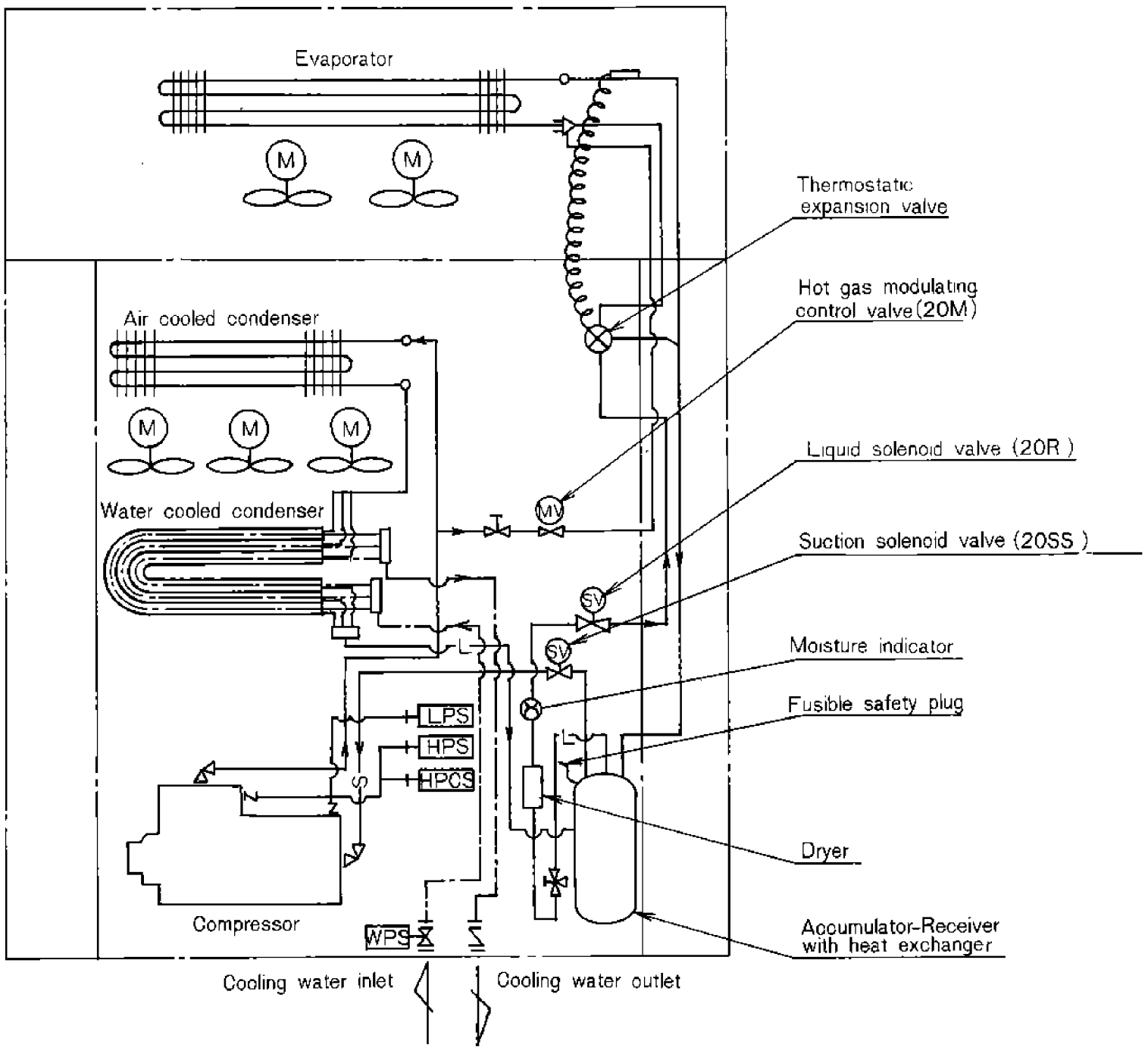
(3) Control box



1 Recorder
2 Setpoint selector/Digital display
3 Pilot lamp (GL, RL, AL, BL)
4 Pilot lamp ON-OFF switch (3-30L)
5 Manual defrost switch (3D)
6 Unit ON-OFF switch (3-88)
7 Controller (23A1)
8 Cannon receptacle for remote monitoring
9 Cannon receptacle for ref. check
10 Voltage selector
11 Circuit breaker (52C1)
12 Circuit breaker (52C2)
13 Transformer (Tr)
14 Hour meter (HM)
15 Over current relay (51C)
16 Compressor relay (88C)
17 Evap. fan motor relay (88F)
18 Heater relay (88H1)
19 Heater relay (88H2)
20 Defrost timer (2D1)
21 Defrost timer (2D2)
22 Defrost relay (2DX1, 2)
23 Voltage selector relay (2X1, 2, 3)
24 Compressor control relay (2X4)
25 Chill/Frozen change over relay (2X5)
26 In range auxiliary relay (2X6)
27 Capacitor (C)
28 Diode (CPD)
29 Stopper

● Be sure to use "Stopper"when operate or maintenance the components in the control box.

1.4 Piping diagram



——L——	LIQUID PIPE	LPS : LOW PRESS. SWITCH
——S——	SUCTION PIPE	HPS : HIGH PRESS. SWITCH
——D——	DISCHARGE PIPE	HPCS : HIGH PRESS. CONTROL SWITCH
——|——	FLARE CONN.	WPS : WATER PRESS. SWITCH
——‖——	FLANGE CONN.	
—— - ——	WATER PIPE	

1.5 Wiring diagram

1.5.1 Sequence wiring

POSITIONS VOLTAGE SELECTER (83VS) (EXCEPT 3-88, 3-30L)

SYMBOL	VOLTAGE	CONTACTOR
	380~440	ON
	200~220	ON

200V	50/60Hz	
220V	60Hz	
380~415V	50Hz	
440V	60Hz	

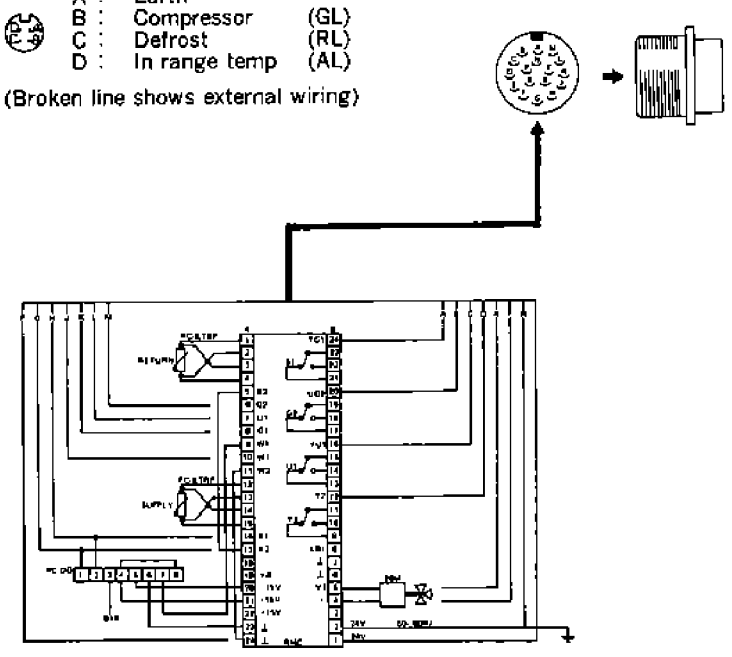
<NOTE>

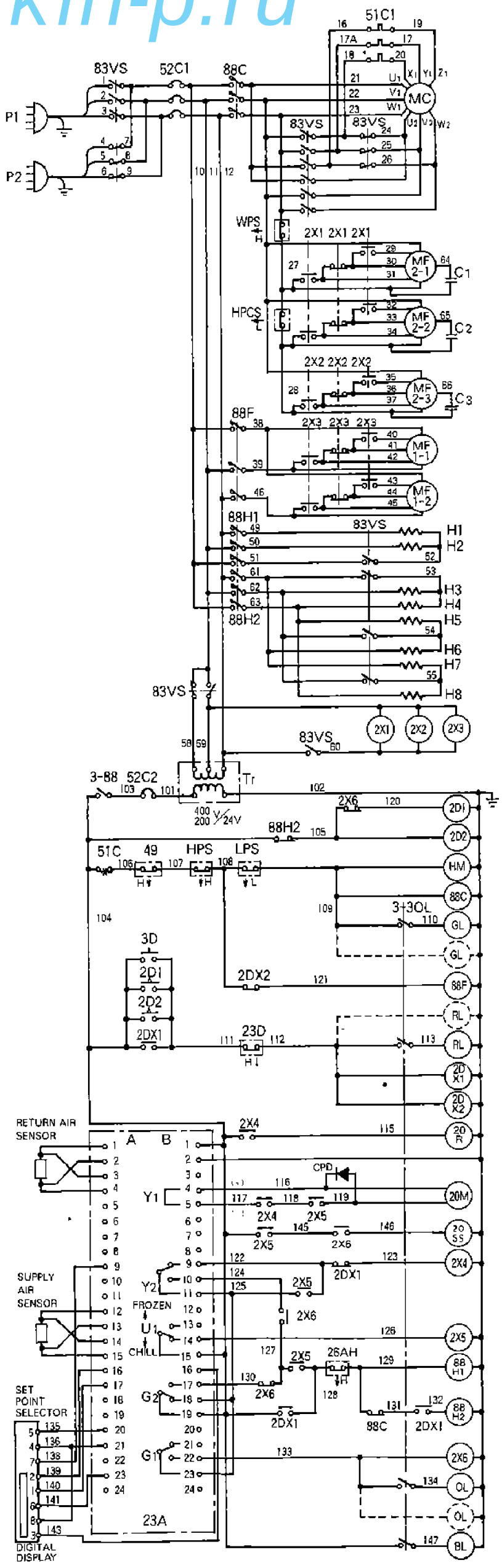
- TIMER
- OVER CURRENT RELAY
- CIRCUIT BREAKER
- A : Earth
- B : Compressor (GL)
- C : Defrost (RL)
- D : In range temp (AL)

(Broken line shows external wiring)

H OPERATES ON INCREASE IN TEMPERATURE OR PRESSURE

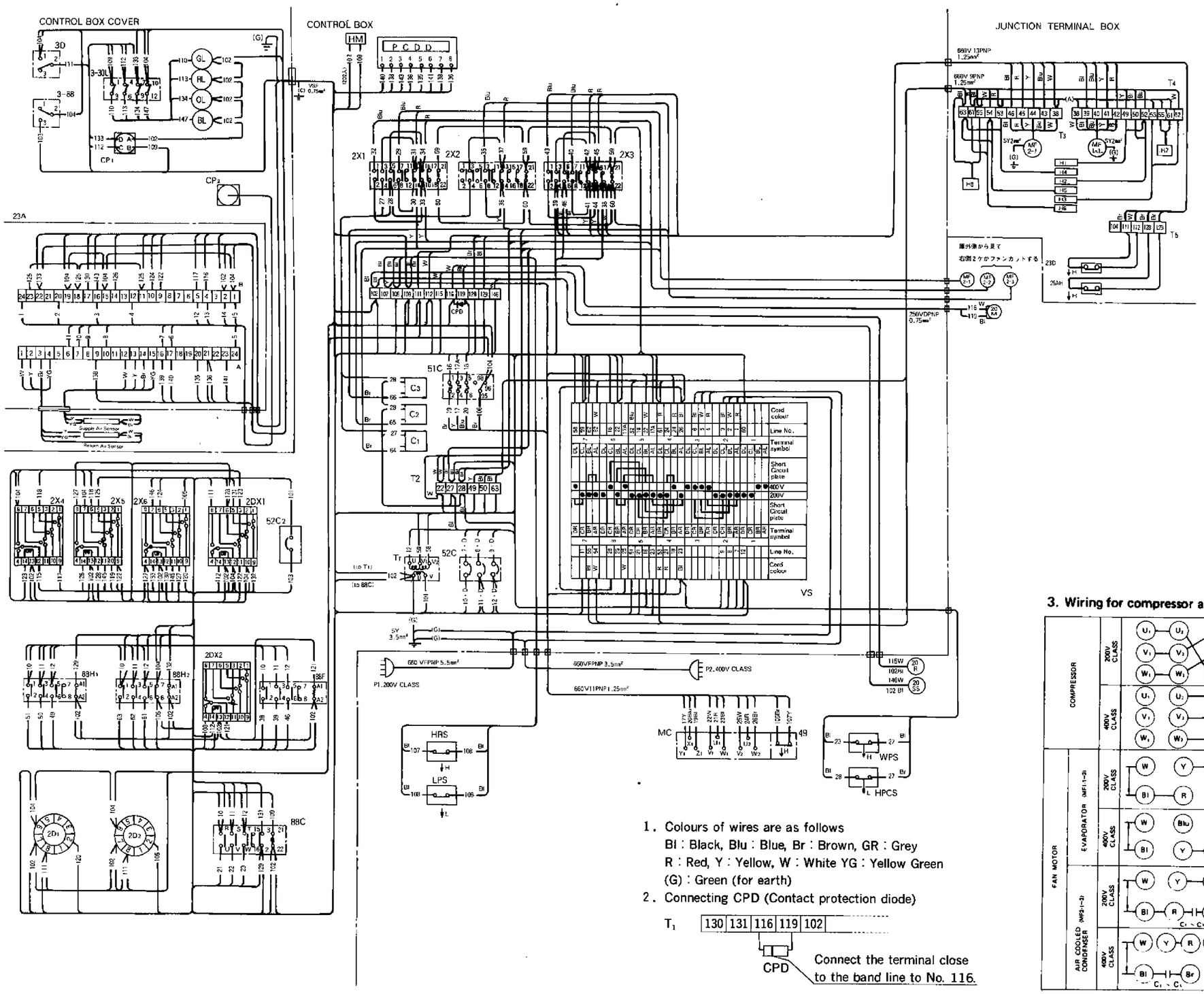
L OPERATES ON DECREASE IN TEMPERATURE OR PRESSURE





2D1	DEFROST TIMER (OUTSIDE RANGE)
2D2	DEFROST TIMER (IN RANGE)
2DX1, 2	DEFROST RELAY
2X1~3	VOLTAGE CHANGE OVER RELAY
2X4	COMPRESSOR CONTROL RELAY
2X5	CHILL/FROZEN CHANGE OVER RELAY
2X6	IN RANGE AUXILIARY RELAY
20M	MODULATING VALVE
20R	LIQUID LINE SOLENOID VALVE
20SS	SUCTION LINE SOLENOID VALVE
23A	RMC TEMPERATURE CONTROLLER
23D	DEFROST TERMINATION THERMOSTAT
26AH	FIRESTAT
3D	MANUAL DEFROST SWITCH
3-30L	LAMP SWITCH
3-88	UNIT ON-OFF SWITCH
49	COMPRESSOR PROTECTOR
51C	OVER CURRENT RELAY
52C1, 2	CIRCUIT BREAKER
83VS	VOLTAGE SELECTOR SWITCH
88C	COMPRESSOR CONTACTOR
88F	EVAPORATOR FAN MOTOR CONTACTOR
88H1, 2	HEATER CONTACTOR
BL, GL, RL, OL	LAMP
C	CAPACITOR
CPD	CONTACT PROTECTION DIODE
H1~H6	EVAPORATOR COIL HEATER
H7, 8	DRAIN PAN HEATER
HM	HOUR METER
HPCS	HIGH PRESSURE CONTROL SWITCH
HPS	HIGH PRESSURE SWITCH
LPS	LOW PRESSURE SWITCH
MC	COMPRESSOR MOTOR
MF1	EVAPORATOR FAN MOTOR
MF2	CONDENSER FAN MOTOR
PJ, 2	POWER PLUG
Tr	TRANSFORMER
WPS	WATER PRESSURE SWITCH

1.5.2 Actual wiring

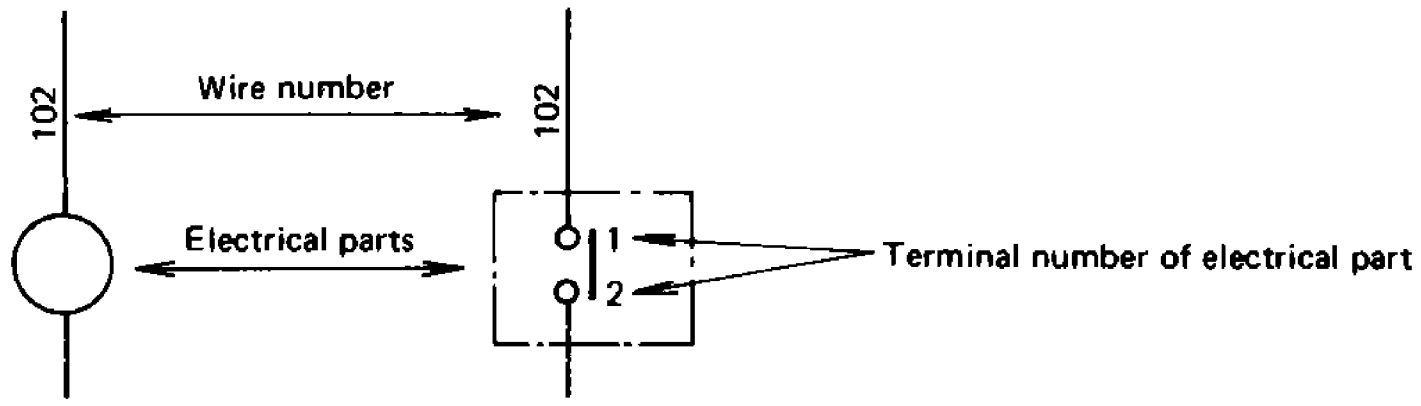


1. Colours of wires are as follows
   Bl : Black, Blu : Blue, Br : Brown, GR : Grey
   R : Red, Y : Yellow, W : White YG : Yellow Green
   (G) : Green (for earth)
2. Connecting CPD (Contact protection diode)

3. Wiring for compressor and fan motor

1.5.3 How to read wiring diagram

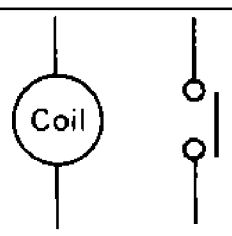
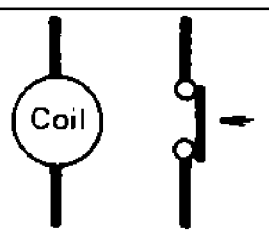
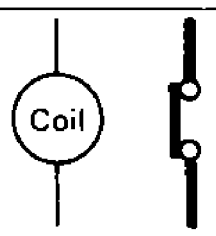
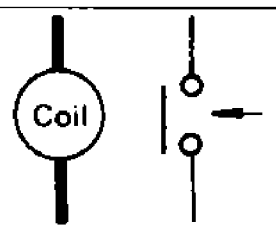
(1) In the wiring diagram, marks and numbers have the meanings given below.



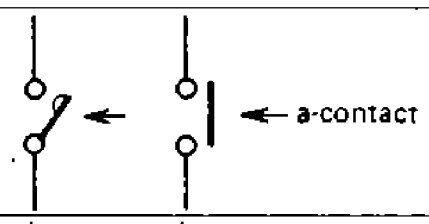
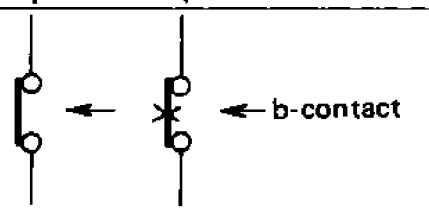
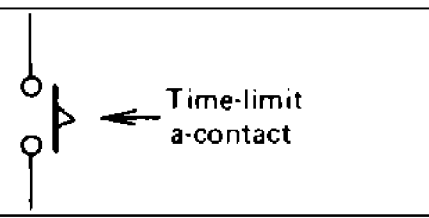
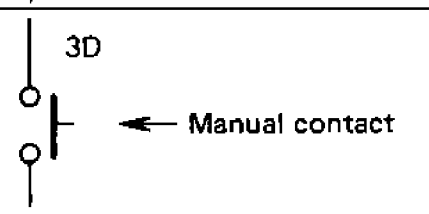
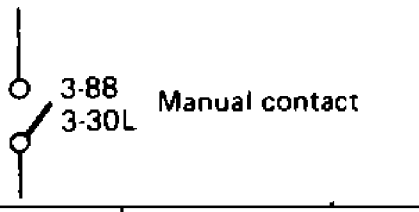
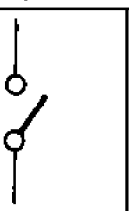
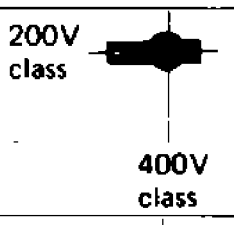
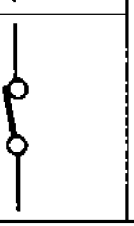
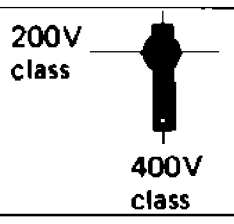
(2) Operation of contacts

a . The wiring diagram indicates the stationary state in which the circuits are not activated.

b . When a coil is energized (supplied with power), the associated contact changes its position.

a-contact (normal contact)		b-contact (reverse contact)	
Contact is OFF when coil is not energized	Contact is ON when coil is energized	Contact is ON when coil is not energized	Contact is OFF when coil is energized
			

c . Kinds of contacts

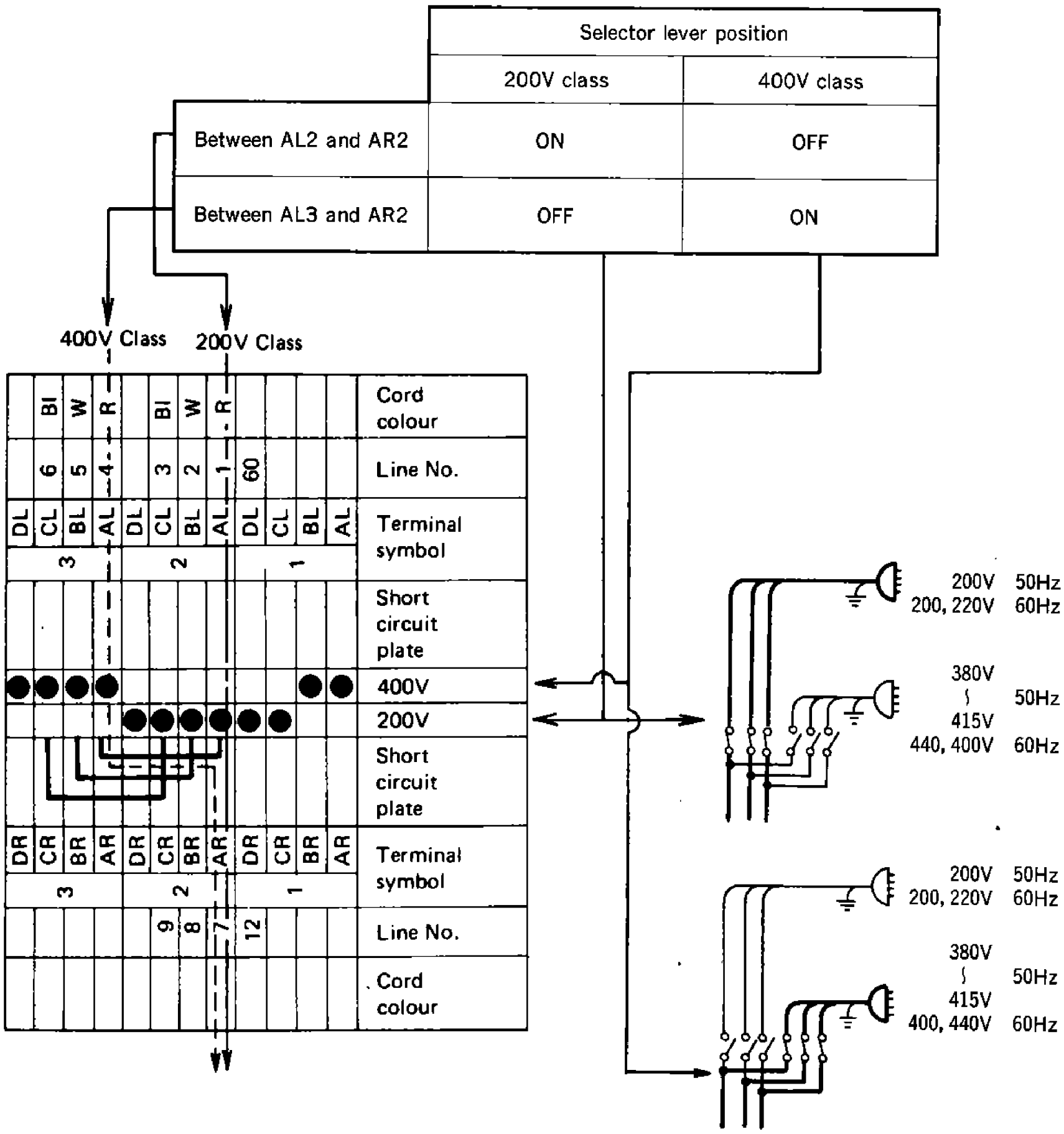
	Operated by electromagnetic force, temperature, or pressure. ("x" denotes the reset button.)
	
	Operates when the timer counting has completed.
	Contact of a snap switch. This turns on as long as the switch is kept pressed and turns off immediately when released.
	Contact of a snap switch. This turns on and holds the on state once the switch is turned on.
 Voltage selector contact (except 3-88, 3-30L)	This turns on when the selector is set to 200V class 
	This turns on when the selector is set to 400V class 

d .How to read the wiring diagram of the voltage selector switch.

In the chart, "●" denotes that the contact is on.

The following example shows the states between terminals AL2 and AR2, and between AL3 and AR2.

	Selector lever position	
	200V class	400V class
Between AL2 and AR2	ON	OFF
Between AL3 and AR2	OFF	ON



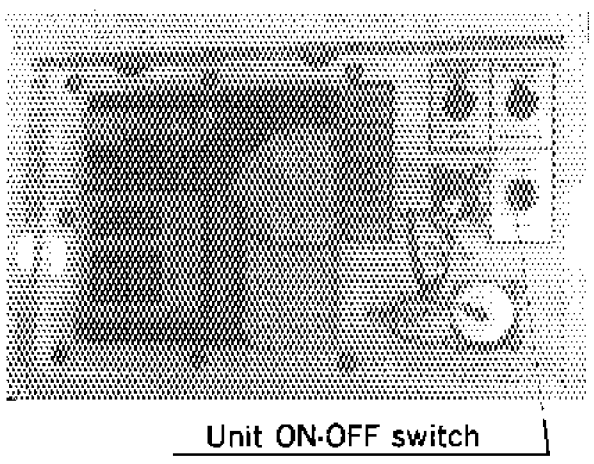
2. Operation

Operate the unit by using the procedures given below.

- Preparation and operation
- Checking during operation
- Maintenance after operation

2.1 Preparation and operation

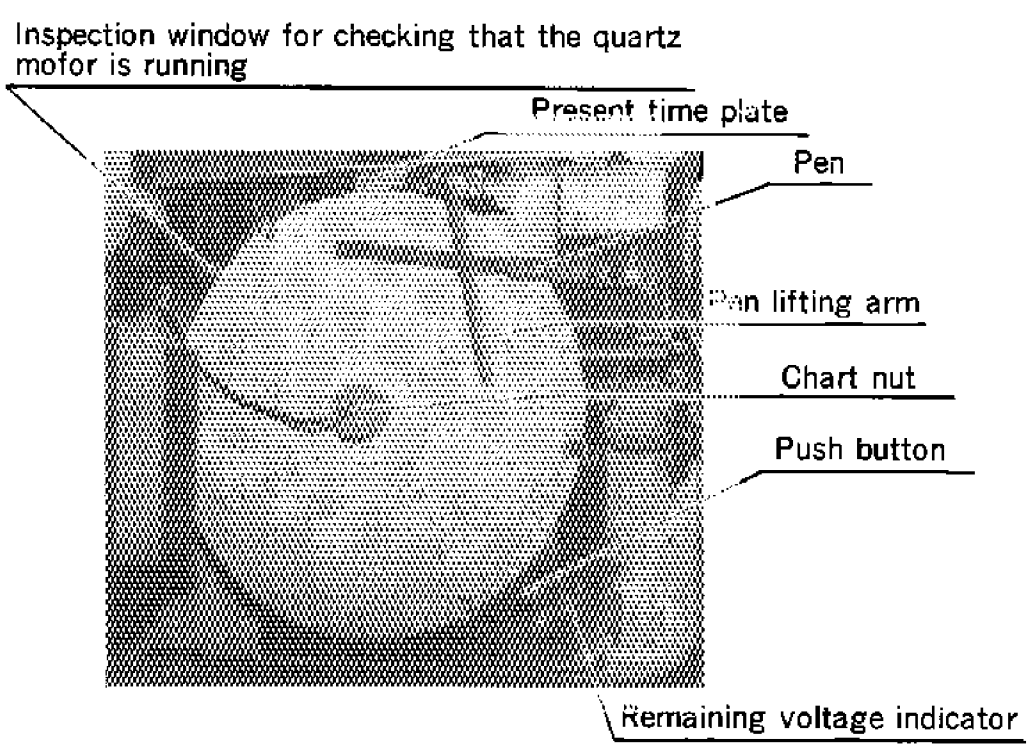
(1) Confirm that power supply is off.
Confirm that the power source, the circuit breaker and unit ON-OFF switch are turned off before checking for safety's sake.



The cover of control box

(2) Ensuring the function of drive for the recording chart

- Ensuring the life of a dry element battery
Press the switch and ensure that the needle of the remaining voltage indicator remains in the blue zone. (The meter functions only when the switch is pressed)
- Confirming the function of quartz motor
After confirming the life of dry element battery, check that the flywheel is rotating in the inspection window.

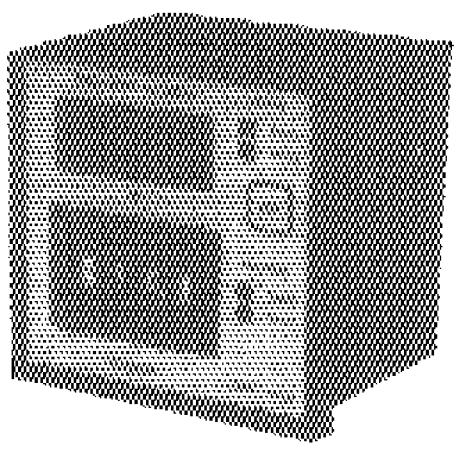


(3) Setting a sheet of recording paper

- Raise the pen by the pen holder, loosen the chart nut. and place a new recording chart.
- Position the chart under the pen so that it corresponds to the correct time and day number.
- Firmly tighten up the chart nut and release the pen so that recording can be accomplished.

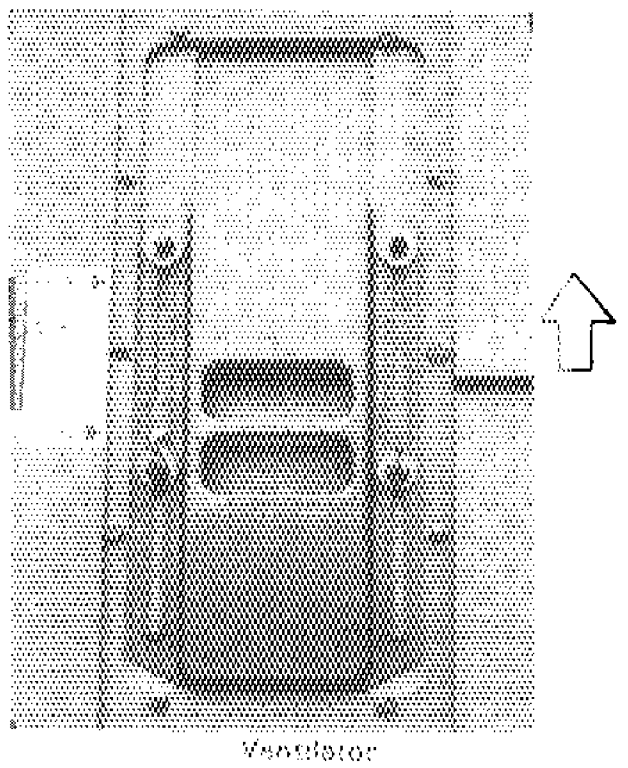
(4) Set the setpoint selector.

- Select a designated temperature by pressing the buttons arranged above and beneath the digital selector displays.



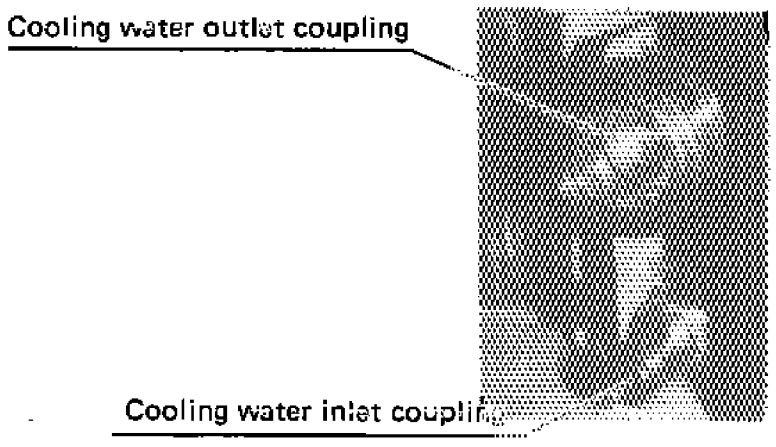
Setpoint selector/Digital display

(5) Open or close air refreshening ventilator.
Open or close the ventilator depending upon to the cargo. (Be sure to keep it closed during transportation of frozen cargo.)



(6) Connect the cooling water piping.

● In the case of water-cooled operation, connect the water piping, and supply water through it.



● Connecting method.

1. Connect water supply line to the water inlet coupling.

Note :

(1) Air is automatically released from water cooled condenser.
Ensure the water drains out of water outlet coupling.

2. Connect water discharge line to the water outlet coupling.

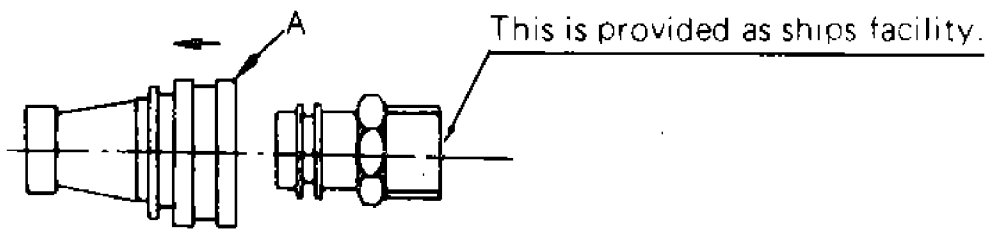
● Disconnecting method.

1. Disconnect water supply line from the water inlet coupling.
2. Disconnect water discharge line from the water outlet coupling.

Note :

(1) It is not necessary to open drain cock after disconnecting couplings because self draining is applied in cooling water outlet coupling.

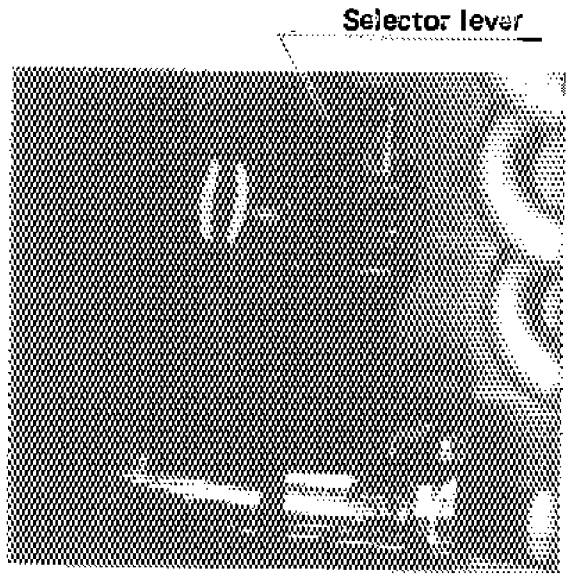
(2) When connecting the cooling water couplings insert the coupling on ship side into the coupling on the unit side until a "click" is heard.
When disconnecting them, pull the coupling on the ship side toward you while pushing the "A" part of the female coupling in the direction pointed by an arrow mark.



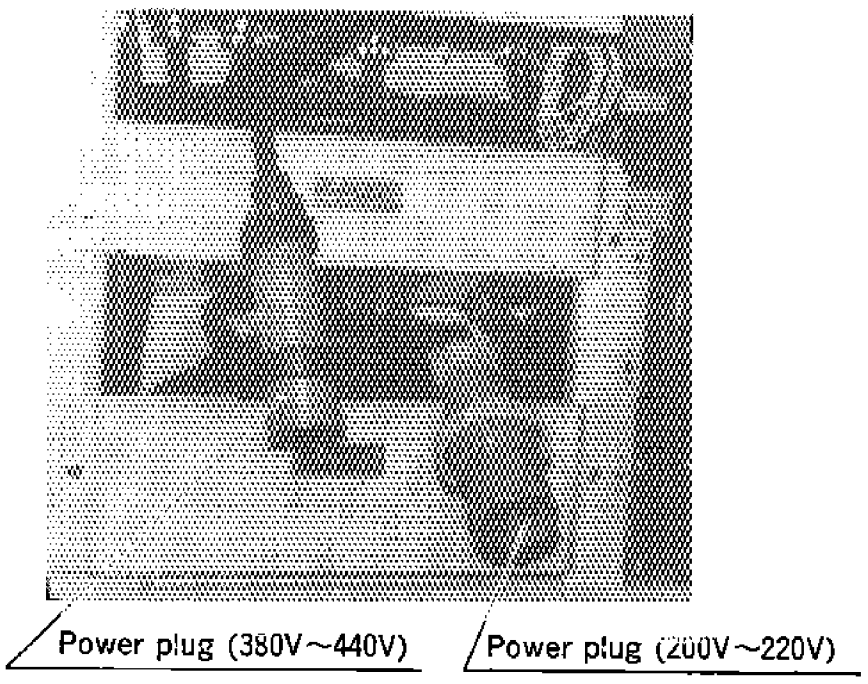
Water connection at outlet side

(7) Check that all refrigerant stop valves are opened.

(8) Set the voltage selector and power selector according to the supply voltage.



(9) Plug in the power source which supplies the proper voltage, and fasten the plug firmly.

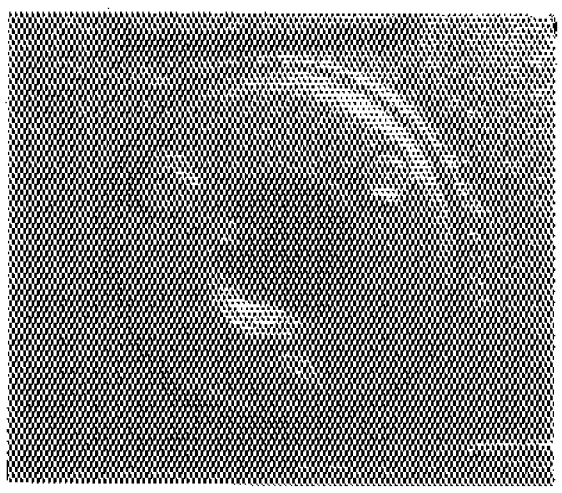
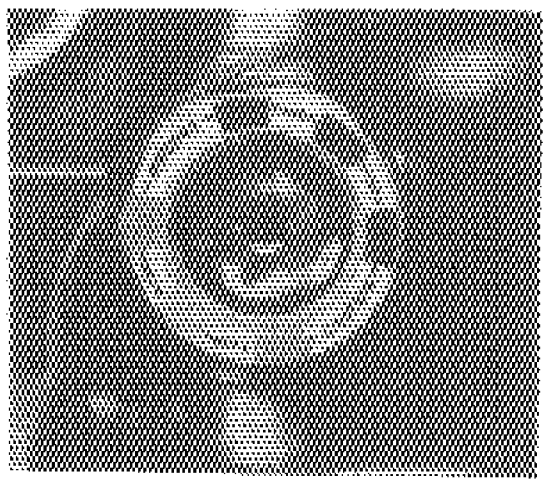


(10) Turn on the power switch of the facility (outside the unit) .

(11) Turn ON the circuit breakers and unit ON-OFF switch.

(12) Close the cover of the control box.
If it is loose, water will ingress. Check the seal and tighten the cover securely.

2.2 Checking during operation

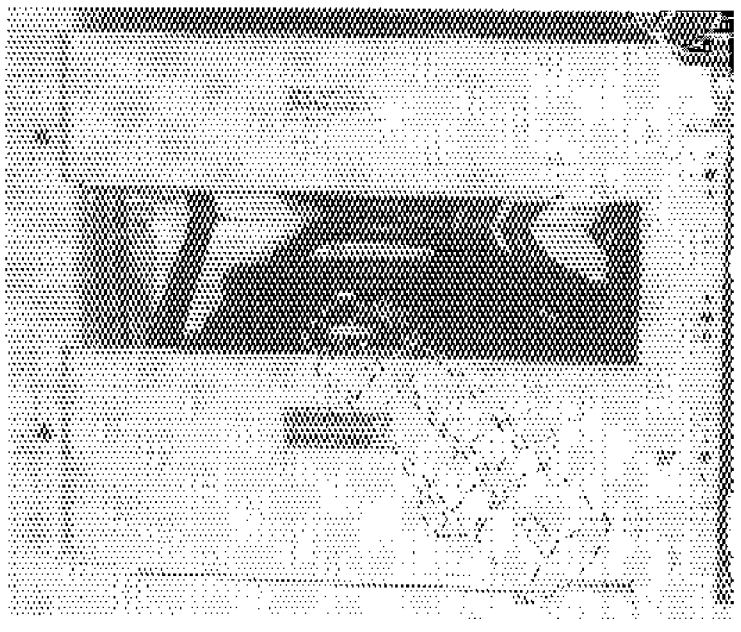
Checking items (precautions)	Method of check
1 . Check if unusual noise and vibration is produced from compressor, fan and piping etc.	Visual, touch and listen.
2 . Check suction and discharge pressures of the compressor. (For installation of a gauge, refer to "Section 9".)	Compare observed data with standard ones.
3 . Check that the oil level is correct. Check to see the oil is clean. (Oil level may fall for a while after starting, but it rises gradually.) 	Visual Oil level should be approx. ¼ to ¾ of its full scale.
4 . Check to see if refrigerant is sufficient. (The refrigerant bubbles immediately after starting, but this does not mean that refrigerant is lacking.) 	Shortage of refrigerant is indicated by bubbles in the moisture indicator. When in the frozen mode only.
5 . Check to see if any moisture is present in refrigerant circuit. (Note that the color of moisture indicator may turn to orange due to exposure to gaseous refrigerant for a long time, but this is no trouble of indication or due to ageing as against moisture ingress.)	Visual The moisture indicator should normally appear deep blue. Orange color is a sign of trouble.
6 . Check operating conditions with the pilot lamps and RMC check instrument.	Visual
7 . Check if the recorder operates according to the inside temperature.	Visual

2.3 Maintenance after operation

(1) Stopping
To stop the unit, perform defrosting operation with the manual defrost switch and immediately turn off the unit ON-OFF switch after the compressor has stopped, (stop the unit with "pump-down" state.) After pump down, turn off the circuit breakers.

(2) Stowing the power cable
Turn the plug's opening downward so that sea and rain water cannot enter the plug when stowing it.

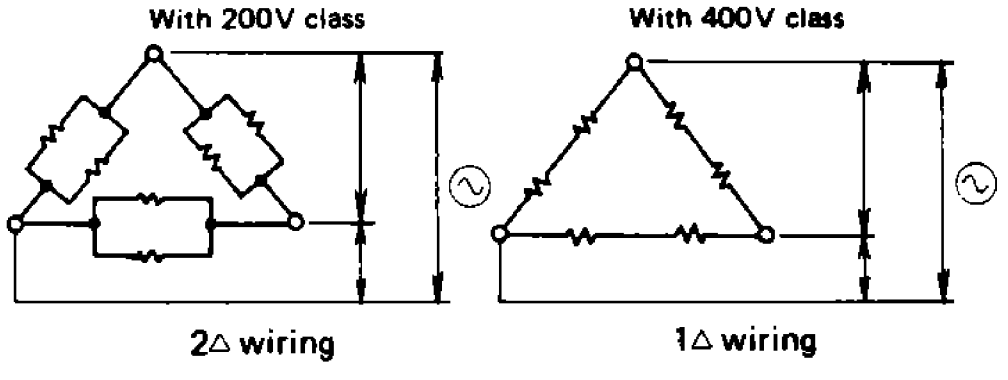
(3) Close the cover of the control box tightly.



3. Operating modes and circuits

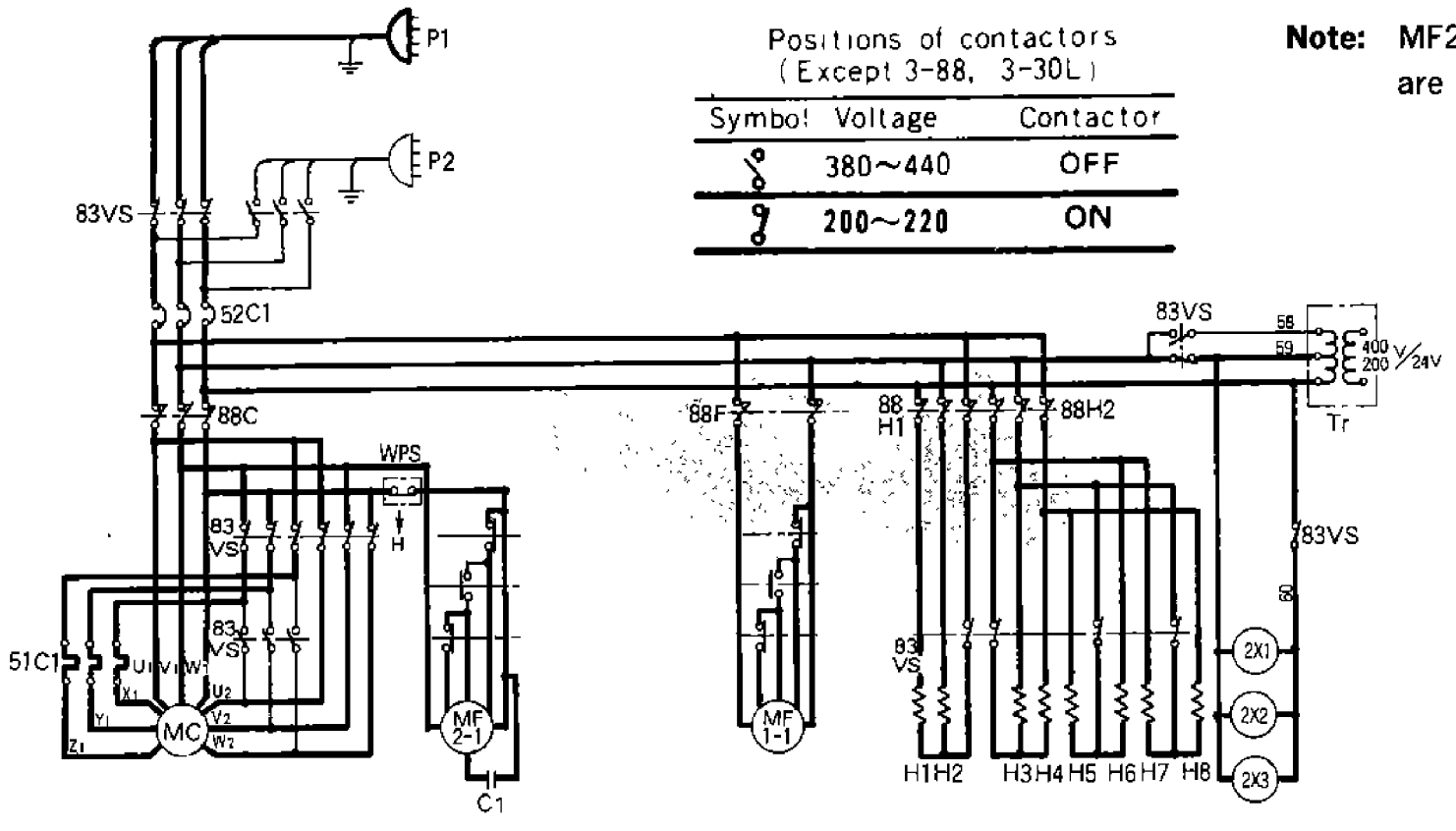
3.1 Voltage selection system (switching over 200V and 400V class)

(1) This unit is adaptable to either of two supply voltages (dual rated voltage). Set the voltage selector (multicontact cam switch) according to the supply voltage by hand. The voltage selector changes wiring of the motors, and the transformer of the control circuits to supply the relevant voltage.
For example, the internal wiring of the compressor is changed as follows.



(2) Circuitry

● With 200V class (Set the selector lever to "200V CLASS".)
The contacts marked " " in the sequence chart (except 3—88 and 3—30L) are turned on.
The circuits for 200V class will be set up when the contacts and the voltage selector relay (2X1.2.3) are energized.

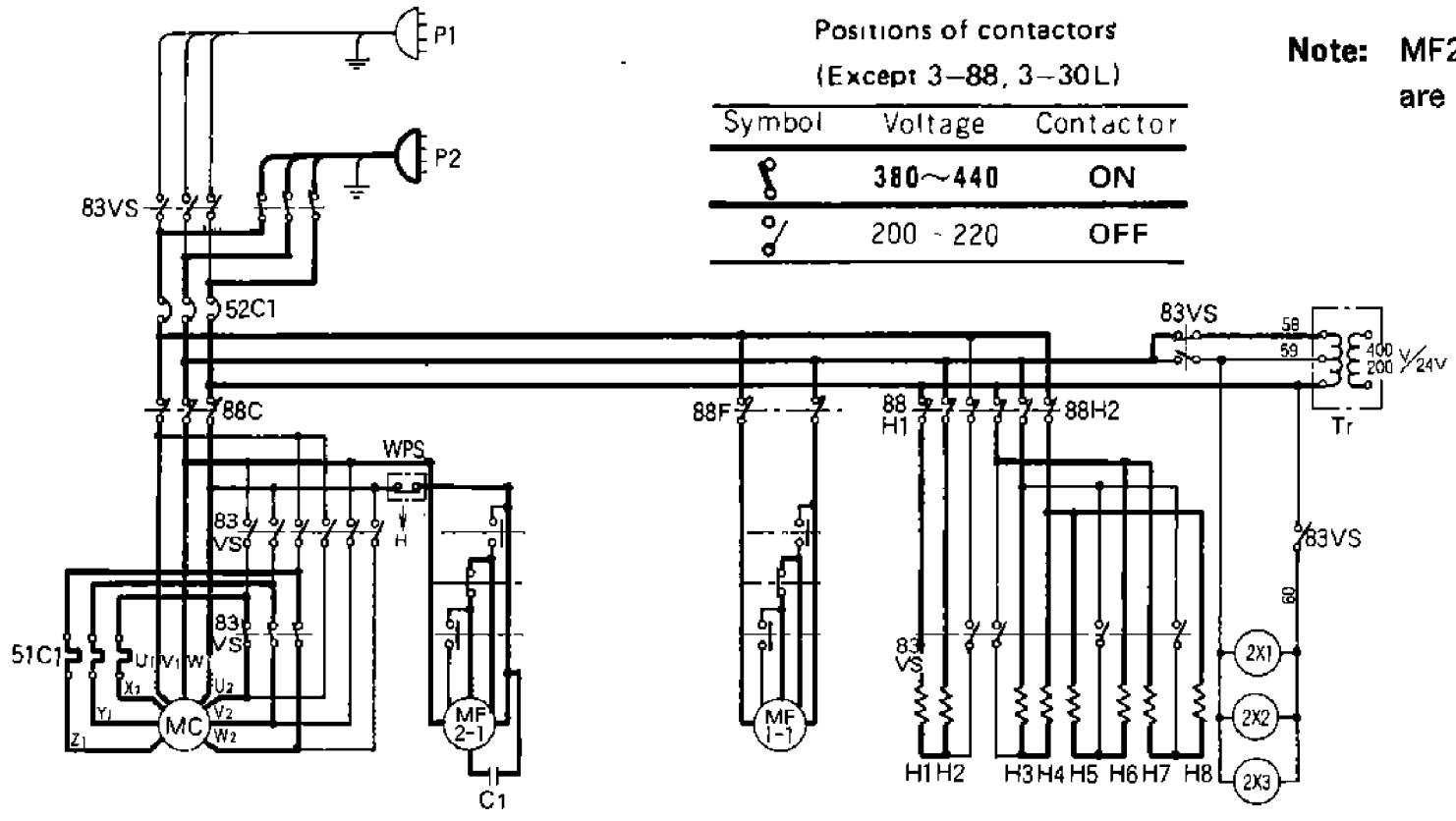


Positions of contactors (Except 3-88, 3-30L)

Symbol	Voltage	Contactor
	380~440	OFF
	200~220	ON

Note: MF2—2, 2—3, and MF1—2 are not shown.

● With 400V class (Set the selector lever to "400V CLASS".)
The contacts marked " " in the sequence diagram are turned on and the circuits for 400V class will be set up (2X1.2.3 are off).



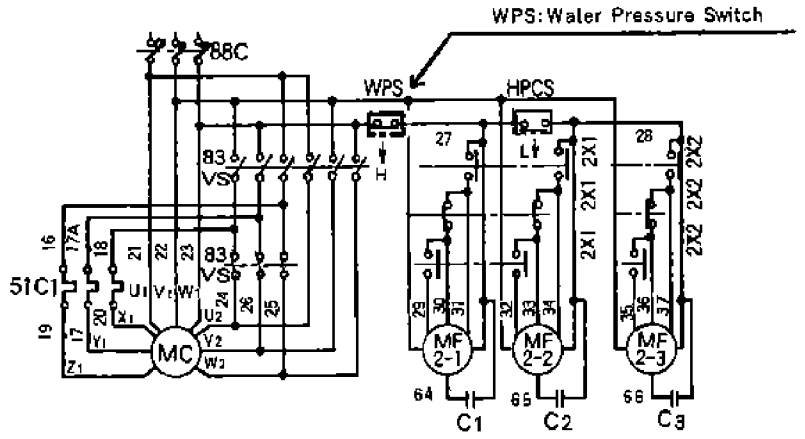
Positions of contactors (Except 3-88, 3-30L)

Symbol	Voltage	Contactor
	380~440	ON
	200~220	OFF

Note: MF2—2, 2—3, and MF1—2 are not shown.

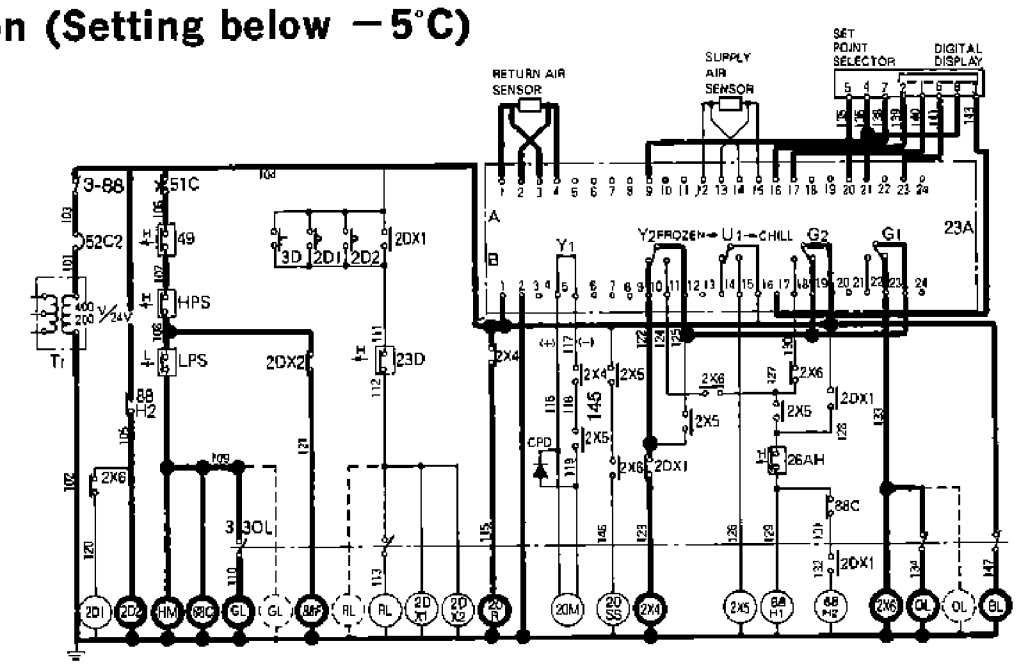
3.2 Air cooled and water cooled operation

The unit will operate on either air cooled or water cooled condenser operation.
The water cooled condenser is used when cooling water is available such as in a ship's hold.
The operation will be changed from air cooled to water cooled automatically by the water pressure switch; i.e. when water pressure at the inlet of the water cooled condenser rises higher than the presetting value, the water pressure switch will open resulting in de-energizing the condenser fan motors, the unit will operate on water cooled condenser operation.
When the water supply is disconnected. The contacts of the water pressure switch will close and the unit will operate on air cooled condenser operation.



This diagram indicates water-cooled operation mode. When water pressure is applied to the switch, the switch mechanism moves in the direction of H ↓, so the condenser fan motors (MF2—1, 2, 3) will be de-energized and water-cooled operation starts.

3.3 Frozen operation (Setting below −5°C)



2D1	DEFROST TIMER (OUTSIDE RANGE)	3D	MANUAL DEFROST SWITCH	H1~H6	EVAPORATOR COIL HEATER
2D2	DEFROST TIMER (IN RANGE)	3-30L	LAMP SWITCH	H7,8	DRAIN PAN HEATER
2DX1,2	DEFROST RELAY	3-88	UNIT ON-OFF SWITCH	HM	HOUR METER
2X1~3	VOLTAGE CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	HPCS	HIGH PRESSURE CONTROL SWITCH
2X4	COMPRESSOR CONTROL RELAY	51C	OVER CURRENT RELAY	HPS	HIGH PRESSURE SWITCH
2X5	CHILL/FROZEN CHANGE OVER RELAY	52C1,2	CIRCUIT BREAKER	LPS	LOW PRESSURE SWITCH
2X6	IN RANGE AUXILIARY RELAY	83VS	VOLTAGE SELECTOR SWITCH	MC	COMPRESSOR MOTOR
20M	MODULATING VALVE	88C	COMPRESSOR CONTACTOR	MF1	EVAPORATOR FAN MOTOR
20R	LIQUID LINE SOLENOID VALVE	88F	EVAPORATOR FAN MOTOR CONTACTOR	MF2	CONDENSER FAN MOTOR
20SS	SUCTION LINE SOLENOID VALVE	88H1,2	HEATER CONTACTOR	P1,2	POWER PLUG
23A	RMC TEMPERATURE CONTROLLER	BL,GL RL,OL	LAMP	Tr	TRANSFORMER
23D	DEFROST TERMINATION THERMOSTAT	C	CAPACITOR	WPS	WATER PRESSURE SWITCH
26AH	FIRESTAT	CPD	CONTACT PROTECTION DIODE		

(1) Switching over frozen and chilled modes
One of the modes will be automatically selected according to the setting of the set point selector.

- When the setting is above −4.5°C : chilled mode
- When the setting is below − 5°C : frozen mode

(2) During frozen mode, the compressor will be automatically switched off and on controlled by the rerurn air sensor.

a. Turn on 3-88.
Power lamp BL (Blue) will illuminate.

b. 20R is open, with relay 2X4 energized by Y_2 relays (for compressor) and G_2 (for low limit alarm) of 23A1.

c. When 20R is open, refrigerant flows and low pressure rises. LPS are turned on.

d. With LPS on, 88C is energized. Compressor, condenser fan motors and evaporator fan motors will start and GL (Green lamp) will illuminate.

e. The unit commences to refrigerate automatically and the temperature inside the container begins to fall. Note that during the "pull down"period, the defrost timer 2D1 operates a frequent defrost sequence.

f. When return air temperature to the evaporator falls to 0.5°C above set point, (preset temperature plus 0.5°C), G_1 relay (high limit alarm) of 23A1 is turned on and AL (amber lamp) illuminates by $G_2 \rightarrow G_1$ (indicating that inside temperature is with in range).

g. When the temperature falls lower than set point, Y_2 relay is turned off (continuity between 9 and 11 of terminal B of 23A is lost); 2X4 becomes de-energized 20R close; and "pump down" starts.

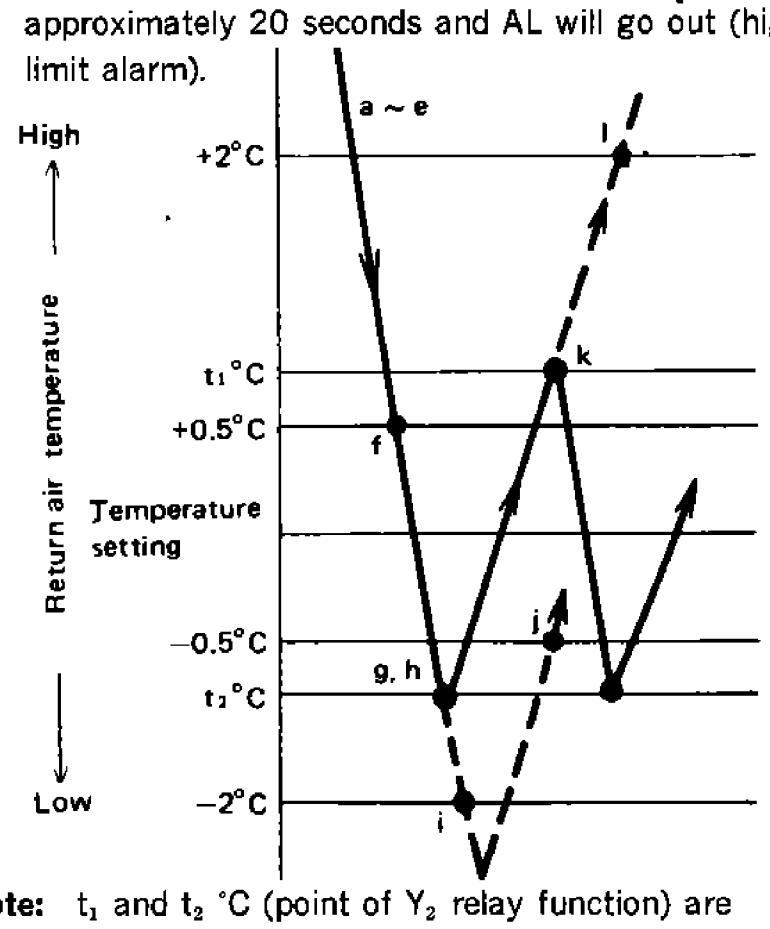
h. When the low pressure falls down, LPS is turned off; 88C becomes de-energized; compressor, condenser fan motors, etc., stop; and frozen operation stops.

i. If the temperature falls down to 2°C below set point G_2 relay is turned off after a delay of apporoximately 20 seconds and AL goes out (low limit alarm).

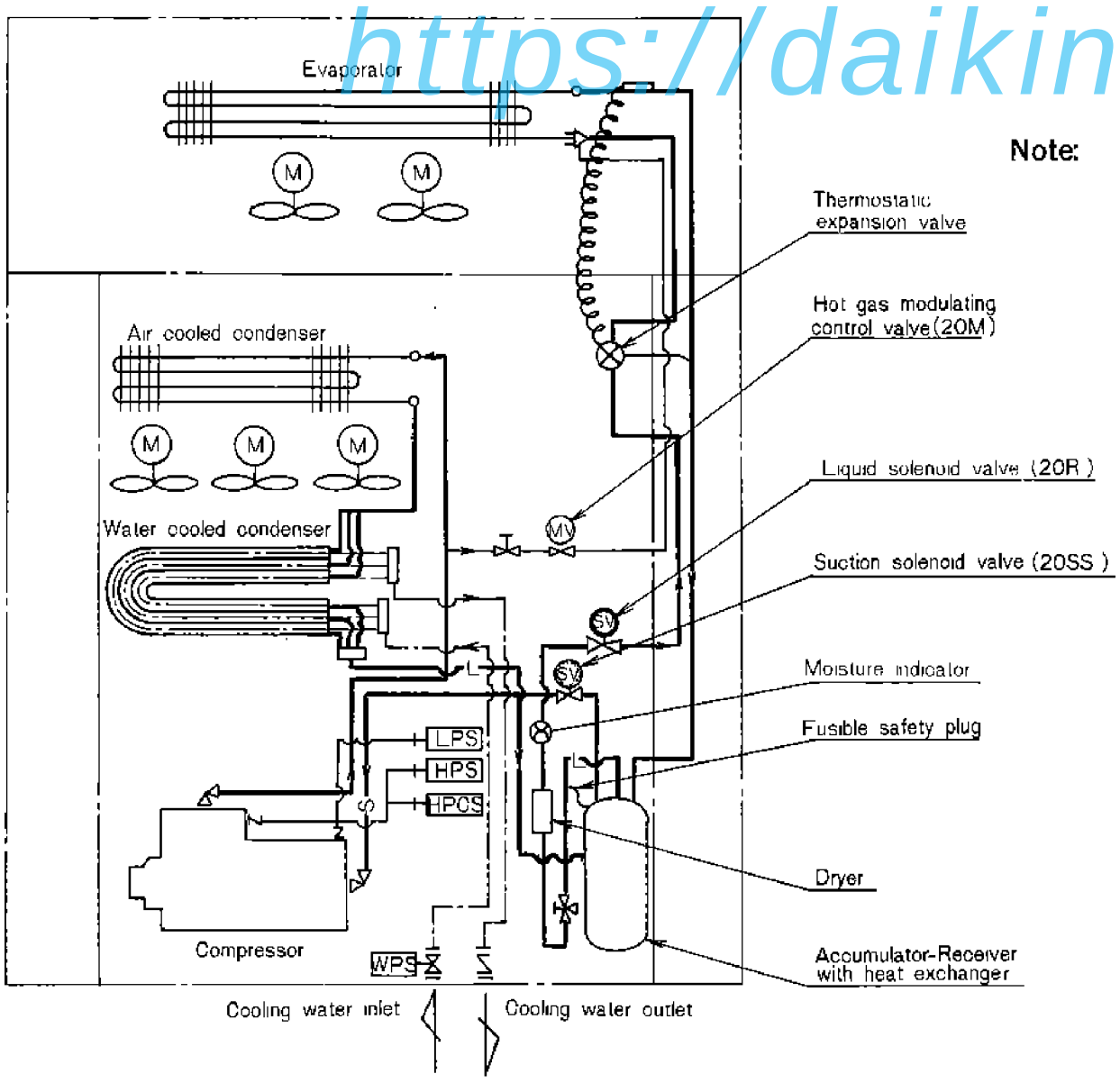
j. When the temperature rises to 0.5°C below set point G_2 relay is turned on and AL illuminates.

k. When the temperature rises higher than set point, Y_2 relay is turned on and frozen operation starts by steps "c" through "e" described above.

l. If the temperature rises further up to the 2°C above set point, G_1 relay is turned off after a delay of approximately 20 seconds and AL will go out (high limit alarm).

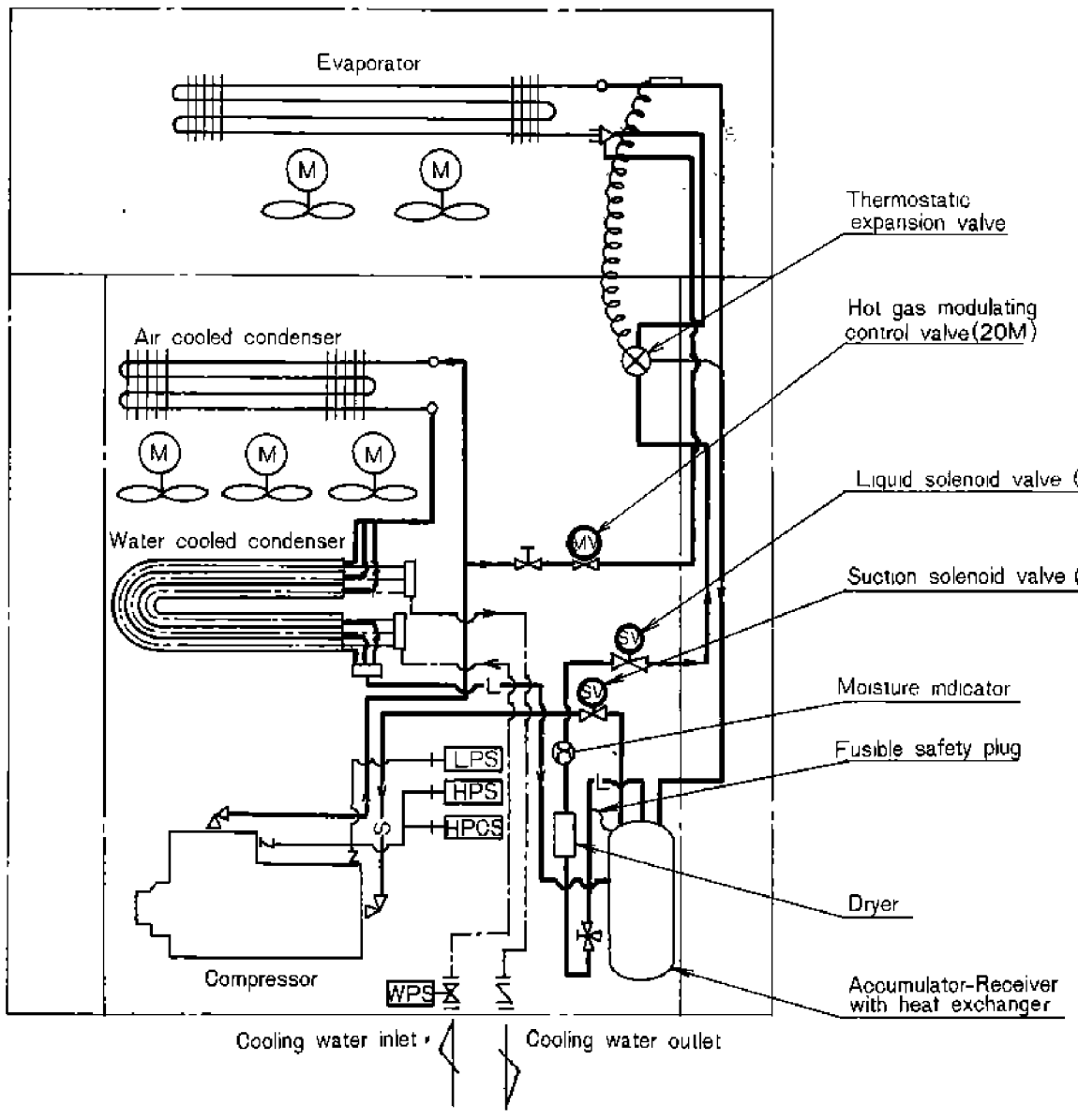


Note: t_1 and t_2 °C (point of Y_2 relay function) are determined depending on temperature and time by means of P.I.D. (P: proportional action, I: integral action, D: derivative action) of the controller.



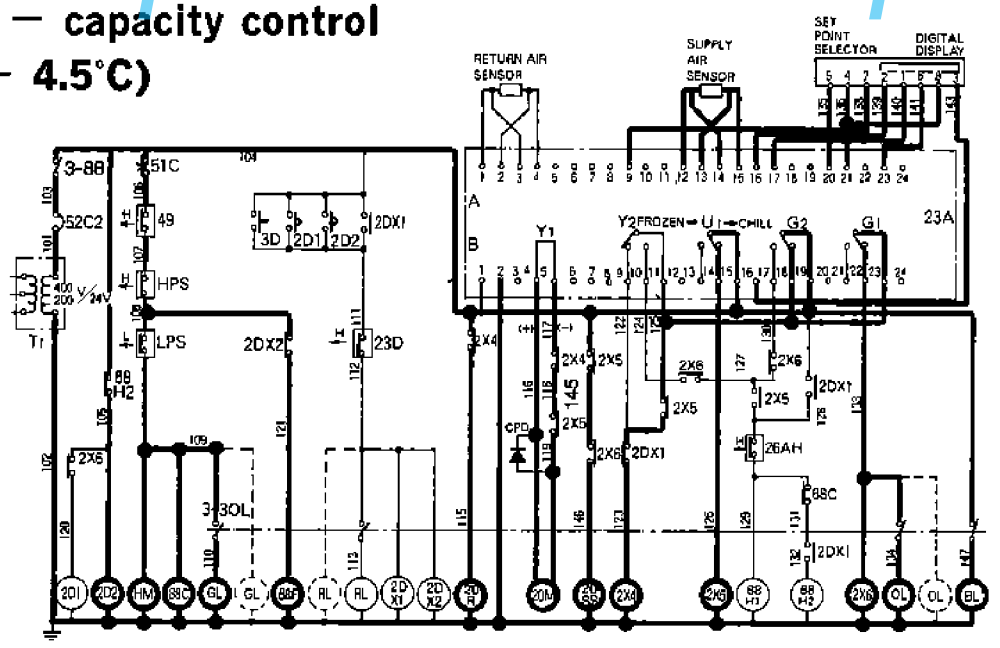
Note: The modulating valve diverges all the gas to the condenser section allowing full flow through the evaporator via the expansion valve.

Flow of refrigerant during frozen operation



Flow of refrigerant during chilled operation

3.4 Chilled operation — capacity control (Setting above — 4.5°C)



2D1	DEFROST TIMER (OUTSIDE RANGE)	3D	MANUAL DEFROST SWITCH	H1~H6	EVAPORATOR COIL HEATER
2D2	DEFROST TIMER (IN RANGE)	3-30L	LAMP SWITCH	H7,8	DRAIN PAN HEATER
2DX1,2	DEFROST RELAY	3-88	UNIT ON-OFF SWITCH	HM	HOUR METER
2X1~3	VOLTAGE CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	HPCS	HIGH PRESSURE CONTROL SWITCH
2X4	COMPRESSOR CONTROL RELAY	51C	OVER CURRENT RELAY	HPS	HIGH PRESSURE SWITCH
2X5	CHILL/FROZEN CHANGE OVER RELAY	52C1,2	CIRCUIT BREAKER	LPS	LOW PRESSURE SWITCH
2X6	IN RANGE AUXILIARY RELAY	63VS	VOLTAGE SELECTOR SWITCH	MC	COMPRESSOR MOTOR
20M	MODULATING VALVE	88C	COMPRESSOR CONTACTOR	MF1	EVAPORATOR FAN MOTOR
20R	LIQUID LINE SOLENOID VALVE	88F	EVAPORATOR FAN MOTOR CONTACTOR	MF2	CONDENSER FAN MOTOR
20SS	SUCTION LINE SOLENOID VALVE	88H1,2	HEATER CONTACTOR	P1,2	POWER PLUG
23A	RMC TEMPERATURE CONTROLLER	BL,GL, RL,OL	LAMP	Tr	TRANSFORMER
23D	DEFROST TERMINATION THERMOSTAT	C	CAPACITOR	WPS	WATER PRESSURE SWITCH
26AH	FIRESTAT	CPD	CONTACT PROTECTION DIODE		

(1) Chilled operation is performed when the preset temperature is above — 4.5°C and the unit is controlled by the supply air sensor. U_1 relay (which switches over frozen and chilled modes) of 23A1 is turned on, 2X5 relay is energized and the circuit of the chilled mode is made.

(2) The RMC equipment automatically positions the hot gas control valve to balance the quantity of the hot gas flow to that of the liquid flow through the expansion valve to give the required delivery air temperature to the cargo.

a. The operation is the same with that (step"a"~"e") of the frozen mode while supply air temperature falls to 0.5°C above set point.

b. When the supply air temperature reaches 0.5°C above the set point, the G 1 relay on the RMC board will switch the relay 2X6 which amongst other things will cause the suction valve 20SS to throttle the suction to the compressor and AL lamp to illuminate. (ie) During the pull down sequence, the compressor will provide full refrigeration capacity however in order to achieve a saving in the electrical power consumption, the capacity of the compressor is restricted.

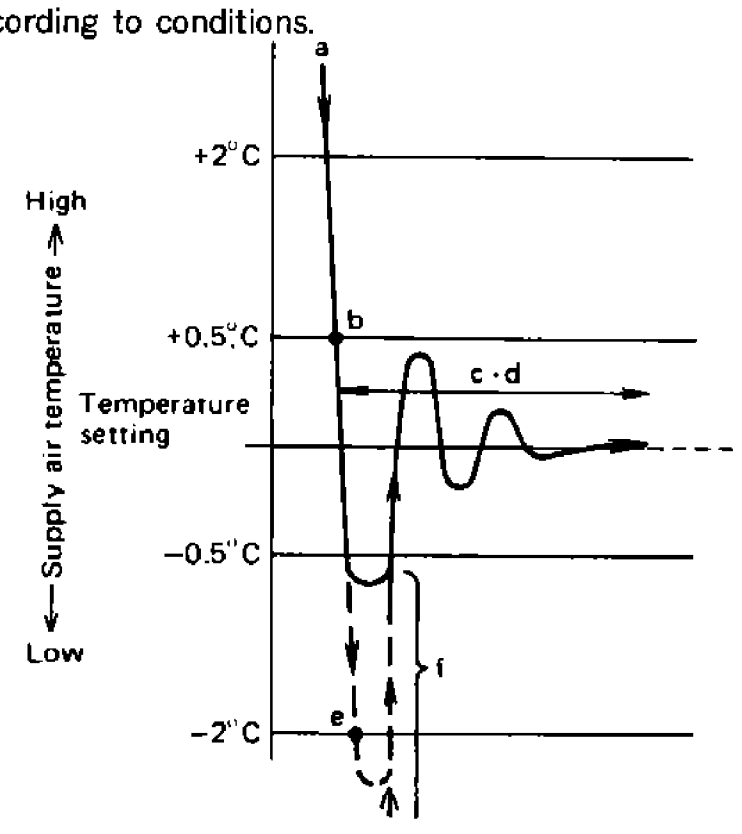
c. As the supply air temperature reaches set point, Y_1 voltage rises slowly from zero, which opens the modulating control valve (20M) gradually, permitting hot gas to distribute.

d. After the temperature has reached set point, it takes about an hour for the unit to reach a steady state. (the position of 20M is nearly fixed; i, e., the proportion of hot gas is nearly constant.) (This period varies somewhat with set point and ambient temperatures.) During this period, the valve changes its position to control the portion of hot gas until the supply air temperature becomes stable.

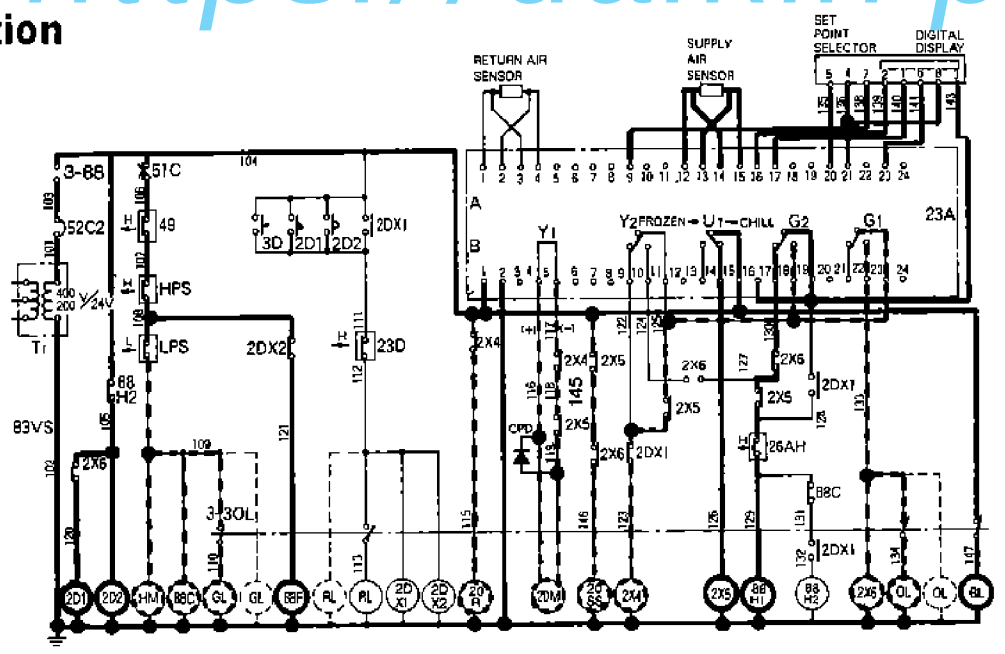
e. Depending on operating conditions (such as when the differece between the ambient and set point is small), G_2 relay is turned off and lamp AL goes out (after a delay of approximately 20 seconds) if the supply air temperature drops to 2°C below set point before stabilizing (low limit alarm).
At the same time, 2X4 relay is turned off; 20R and 20M are closed, after "pump down", the compressor stops to prevent over-cooling.

f. Heating operation.
- When Y_2 relay turns off during the step"e" above mentioned or.
- When inside temperature is lower (by more than 2°C) than set point.——

Compressor will come to a "pump-down" stop, leaving only evaporator fan motor operating and the electric heaters (H_1 and H_2) will turn on. Then as supply air temperature reaches to 0.5°C below set point, the compressor will start and the position of 20M will gradually move from full flow of hot gas into evaporator coil and the electric heaters will turn off according to conditions.



3.5 Heating operation



2D1	DEFROST TIMER (OUTSIDE RANGE)	3D	MANUAL DEFROST SWITCH	H1~H6	EVAPORATOR COIL HEATER
2D2	DEFROST TIMER (IN RANGE)	3-30L	LAMP SWITCH	H7,8	DRAIN PAN HEATER
2DX1,2	DEFROST RELAY	3-88	UNIT ON-OFF SWITCH	HM	HOUR METER
2X1~3	VOLTAGE CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	HPCS	HIGH PRESSURE CONTROL SWITCH
2X4	COMPRESSOR CONTROL RELAY	51C	OVER CURRENT RELAY	HPS	HIGH PRESSURE SWITCH
2X5	CHILL/FROZEN CHANGE OVER RELAY	52C1,2	CIRCUIT BREAKER	LPS	LOW PRESSURE SWITCH
2X6	IN RANGE AUXILIARY RELAY	83VS	VOLTAGE SELECTOR SWITCH	MC	COMPRESSOR MOTOR
20M	MODULATING VALVE	88C	COMPRESSOR CONTACTOR	MF1	EVAPORATOR FAN MOTOR
20R	LIQUID LINE SOLENOID VALVE	88F	EVAPORATOR FAN MOTOR CONTACTOR	MF2	CONDENSER FAN MOTOR
20SS	SUCTION LINE SOLENOID VALVE	88H1,2	HEATER CONTACTOR	P1,2	POWER PLUG
23A	RMC TEMPERATURE CONTROLLER	BL,GL RL,OL	LAMP	Tr	TRANSFORMER
23D	DEFROST TERMINATION THERMOSTAT	C	CAPACITOR	WPS	WATER PRESSURE SWITCH
26AH	FIRESTAT	CPD	CONTACT PROTECTION DIODE		

(1) Heating operation will be performed only when the preset temperature is −4.5°C or higher as in the chilled mode. Inside temperature will be controlled, sensing the supply air temperature.

(2) There are three modes in the heating operation.

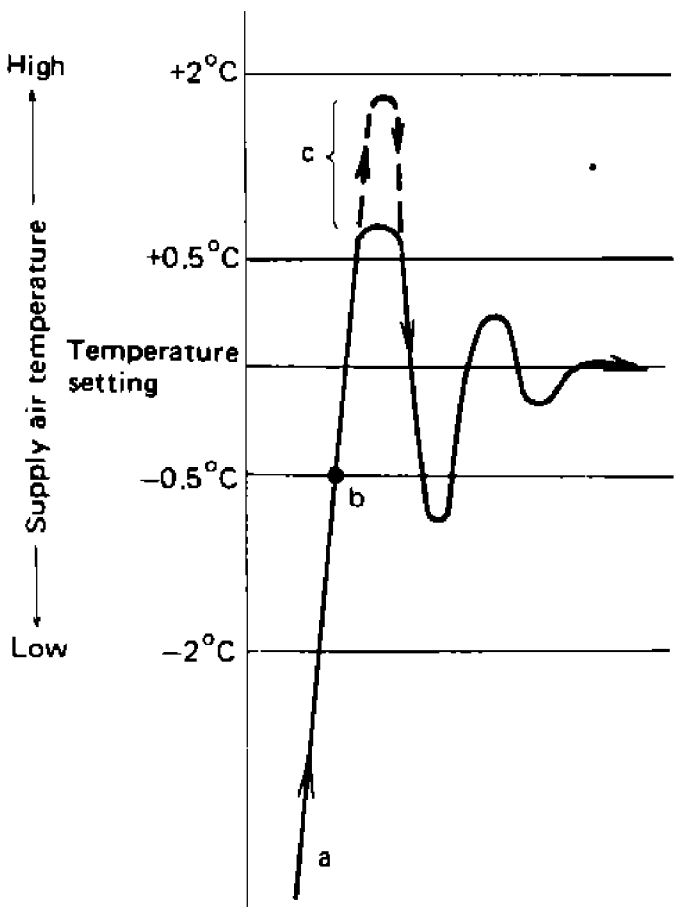
- Pull up − Heated only by electric heaters
- Steady state − Heated by hot gas bypass and electric heaters (when large heating capacity is needed)
  − Heated only by hot gas bypass (when small heating capacity is enough)

One of these three modes will be automatically selected according to load conditions.

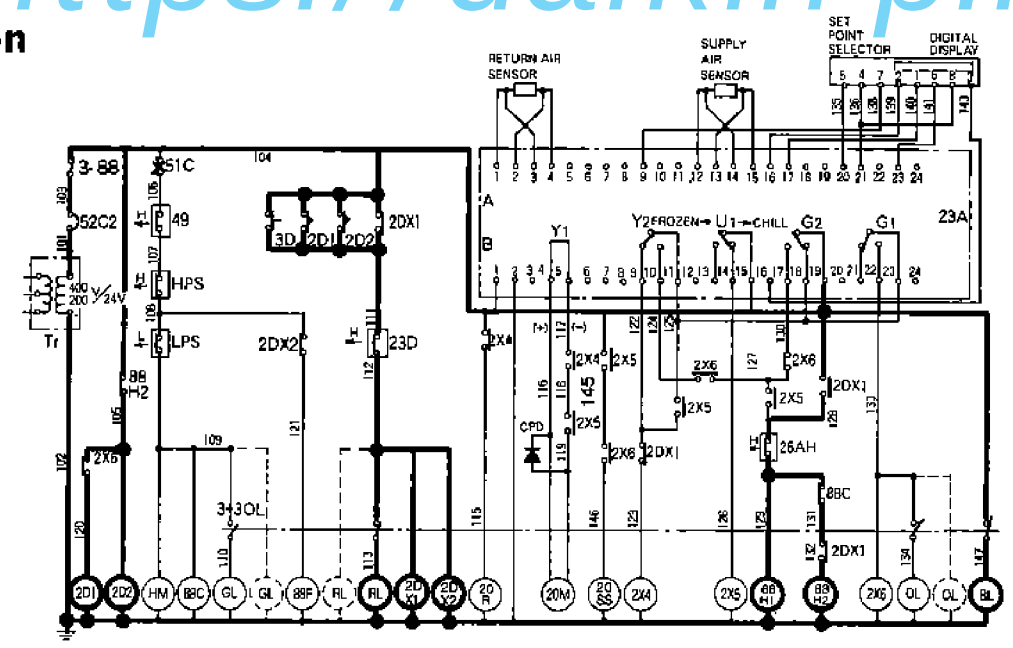
a . Pull up (The circuit indicated with bold lines in the sequence diagram functions)
Until the supply air temperature rises to the preset temperature minus −0.5°C, G_2 relay is turned off, which de-energizes 2X6, energizes the heater relay (88H1) and operates the electric heaters (H1 and H2). (compressor stops.)

b . When the supply air temperature raises the preset temperature minus 0.5°C, G_2 relay is turned on and GL lamp light up. At the same time, 2X6 relay becomes energized, so 88H1 is energized by Y_2 relay. Since G_2 relay is on, 2X4 relay is energized, 20R is open, and the compressor runs and heating starts with electric heaters and hot gas. (The circuit indicated by dotted lines in the sequence diagram functions.)
Afterwards, operation will become stable as time afterwards, elapses.

c . If heating load is small as stated in step "b", the inside temperature will rise: Y_2 relay is operated (the function point varies depending on PID operation): 88H1 becomes de-energized: and the heaters (H1 and H2) are turned off, and heating operation only with hot gas bypass is performed. (The circuit is the same as that of chilled operation in the sequence diagram.)



3.6 Defrost operation



2D1	DEFROST TIMER (OUTSIDE RANGE)	3D	MANUAL DEFROST SWITCH	H1~H6	EVAPORATOR COIL HEATER
2D2	DEFROST TIMER (IN RANGE)	3-3OL	LAMP SWITCH	H7,8	DRAIN PAN HEATER
2DX1,2	DEFROST RELAY	3-88	UNIT ON-OFF SWITCH	HM	HOUR METER
2X1~3	VOLTAGE CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	HPCS	HIGH PRESSURE CONTROL SWITCH
2X4	COMPRESSOR CONTROL RELAY	51C	OVER CURRENT RELAY	HPS	HIGH PRESSURE SWITCH
2X5	CHILL/FROZEN CHANGE OVER RELAY	52C1,2	CIRCUIT BREAKER	LPS	LOW PRESSURE SWITCH
2X6	IN RANGE AUXILIARY RELAY	63VS	VOLTAGE SELECTOR SWITCH	MC	COMPRESSOR MOTOR
20M	MODULATING VALVE	88C	COMPRESSOR CONTACTOR	MF1	EVAPORATOR FAN MOTOR
20R	LIQUID LINE SOLENOID VALVE	88F	EVAPORATOR FAN MOTOR CONTACTOR	MF2	CONDENSER FAN MOTOR
20SS	SUCTION LINE SOLENOID VALVE	88H1,2	HEATER CONTACTOR	P1,2	POWER PLUG
23A	RMC TEMPERATURE CONTROLLER	SL,GL RL,OL	LAMP	Tr	TRANSFORMER
23D	DEFROST TERMINATION THERMOSTAT	C	CAPACITOR	WPS	WATER PRESSURE SWITCH
26AH	FIRESTAT	CPD	CONTACT PROTECTION DIODE		

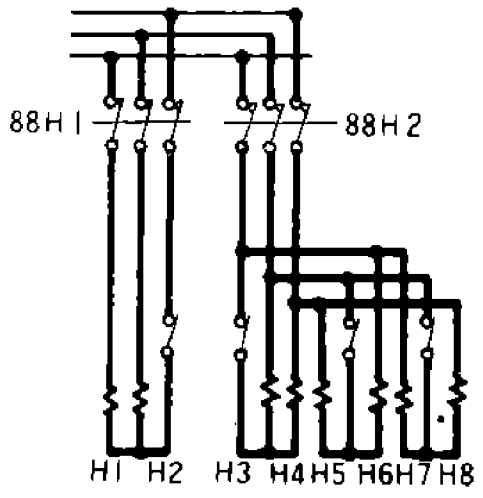
(1) Timer 2D1 introduces a defrost every 2 hours (60HZ) during the pull down sequence until the within range temperature light illuminates.
At this time the defrost interval is extended to every 12 hours (60HZ) by the action of the timer 2D2.

- Manual defrost switch (3D) is turned on.
If one of those stated above is on, defrost relay (2DX) becomes energized and RL (red lamp) lights up.

(2) When 2DX is energized :

- Electric heaters H1 and H2 are operated with 88H1 energized and evaporator fans stop.
- 20R and 20M are closed with 2X4 relay de-energized. After "pump down", the compressor stops ; 88H2 becomes energized and electric heaters H3~8 are operated. (Now all electric heaters H1~H8 are turned on.)

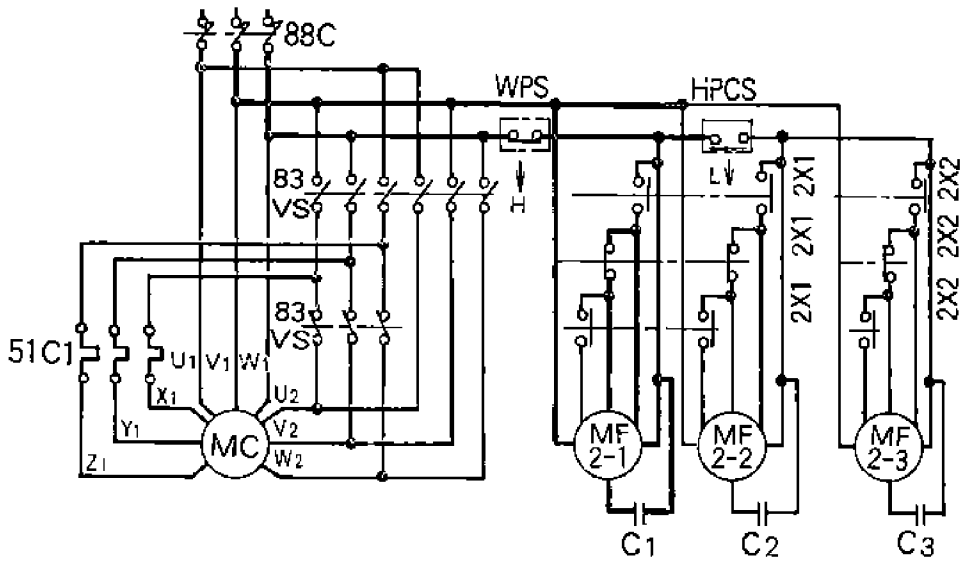
(3) After having removed frost, defrost termination thermostat (23D) is turned off and 2DX becomes de-energized. Now defrosting operation is completed.



The circuit shows 200V class circuit

3.7 High pressure control

The condensing pressure is dependant upon the ambient temperature and if not controlled could result in the compressor being stopped by the action of the LP switch. To ensure that this does not happen, a pressure switch fitted to the discharge line (HPCS) which stops two of the three condensor fans when the discharge gas pressure falls to 7Kg/cm² (99.6 psi).

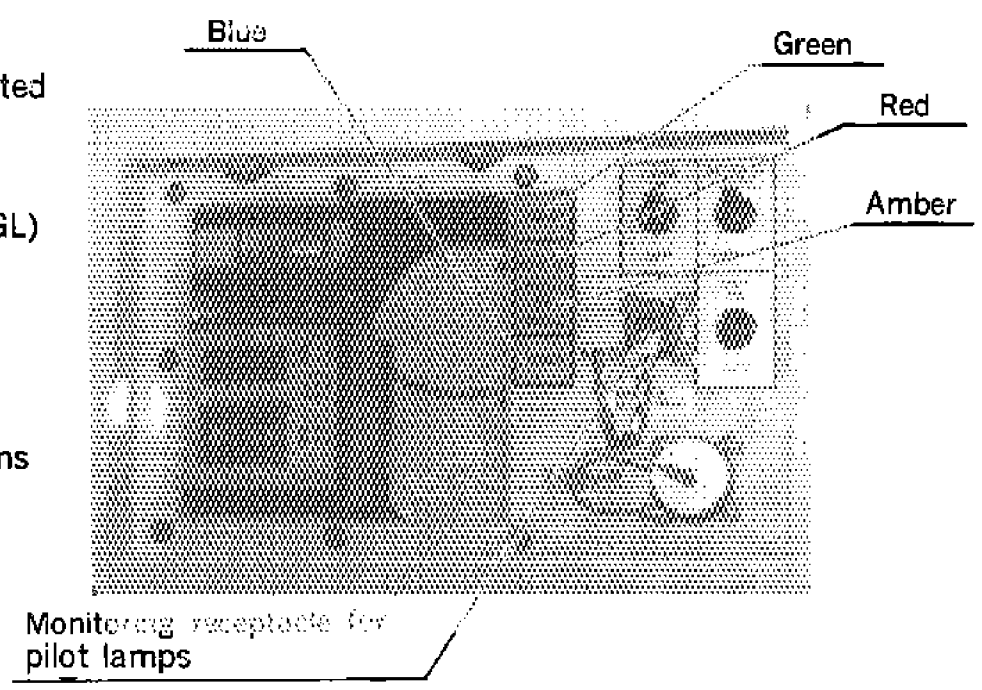


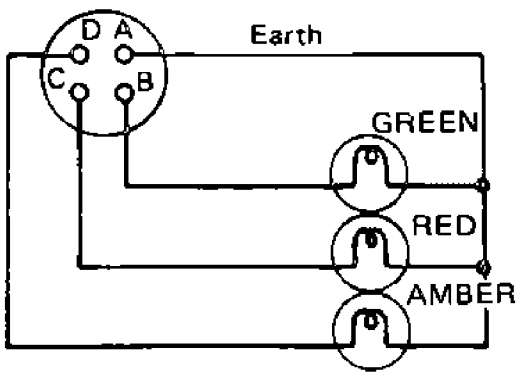
3.8 Pilot lamps and monitoring circuit

(1) Four lamps which indicate operating mode are mounted on the front panel of the control box.

Red : indicates defrosting mode (RL)
Green : indicates that the compressor is running (GL)
Amber : indicates that inside temperature is with in range (within +/−2°C of the preset temperature) (AL)
Blue : indicates that electrical source is supplied.

Receptacle for monitoring is fitted and its connections is shown at below.





(2) How to judge operation state by pilot lamps and action of the components.

Parts name		Setpoint selector set above −4.5°C −Chilled mode			Setpoint selector set below −5.0°C −Frozen mode		Defrost operation	Water cooled operation
		Pull down	In range	Pull up	Pull down	In range		
Light	Defrost −Red	×	×	×	×	×	○	Water cooled condition is the same as air cooled except ○ Water pressure switch (WPS) open ○ Condenser fan moter (MF2) de-energized
	Comp. −Green	○	○	×	○	○	×	
	In range −Amber	×	○	×	×	○	×	
	Power −Blue	○	○	○	○	○	○	
Magnetic switch	Comp., cond. fan motor (88C)	○	○	×	○	○	×	
	Evaporator fan motor (88F)	○	○	○	○	○	×	
Solenoid valve	20R	○	○	×	○	○	×	
	20SS	×	○	×	×	×	×	
Modulating valve (20M)		×	○	×	×	×	×	
Compressor		○	○	×	○	○	×	

Notes 1 ○ : Energized or ON, × : De-energized or OFF

4. Major components and maintenance

4.1 Components related with refrigeration circuit

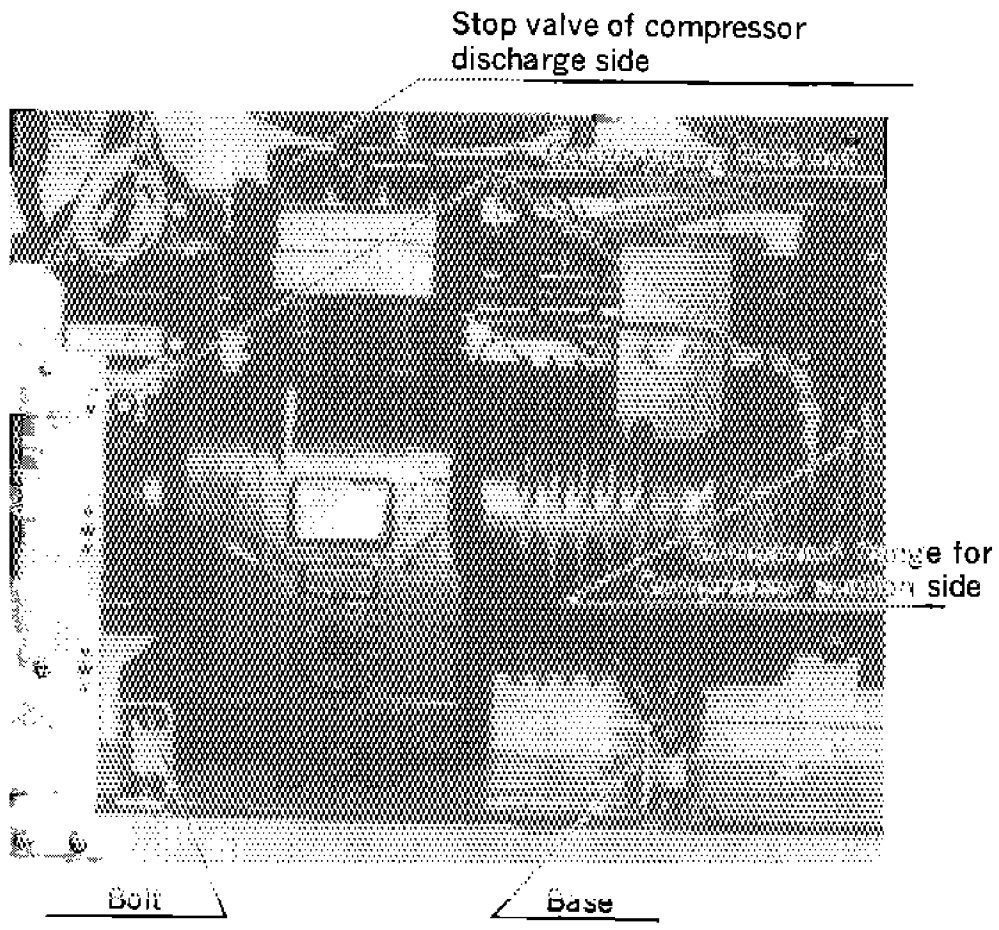
4.1.1 Compressor

The compressor is of a semi-hermetic type with built-in motor so that there are few places where leakage of refrigerant may occur. The reversible lubricating oil pump used produces the required oil pressure regardless of the direction of rotation of the built-in motor.

(a) Replacement

Remove the compressor by the following procedure.

1 Remove the front and base plates of the cable stowage.
2 Remove the discharge stop valve, suction stop valve gauge piping flare nut (compressor side) and cable.
3 Remove four bolts (two on each side) fastening the compressor base and casing frame.
4 Take out the compressor and base to the front of the unit.



(b) Installing procedure

Install the compressor reversing the procedure given above. When tightening the bolts, refer to the torque values listed.

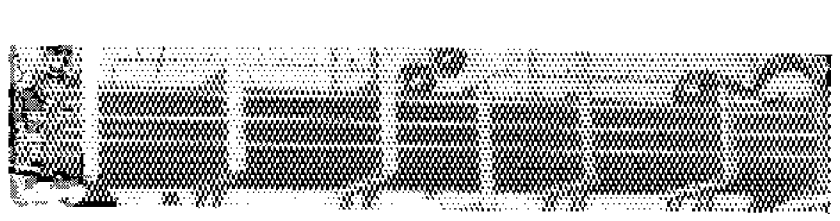
4.1.2 Air cooled condenser and evaporator

The "cross fin" coil has special corrugated fins. They are compact and very efficient in producing uniform heat exchange efficiency.

(a) Maintenance

Service the air-cooled condenser after removing the air suction grille. Service the evaporator after removing the air return grille or the access panels from outside.

Air cooled condenser



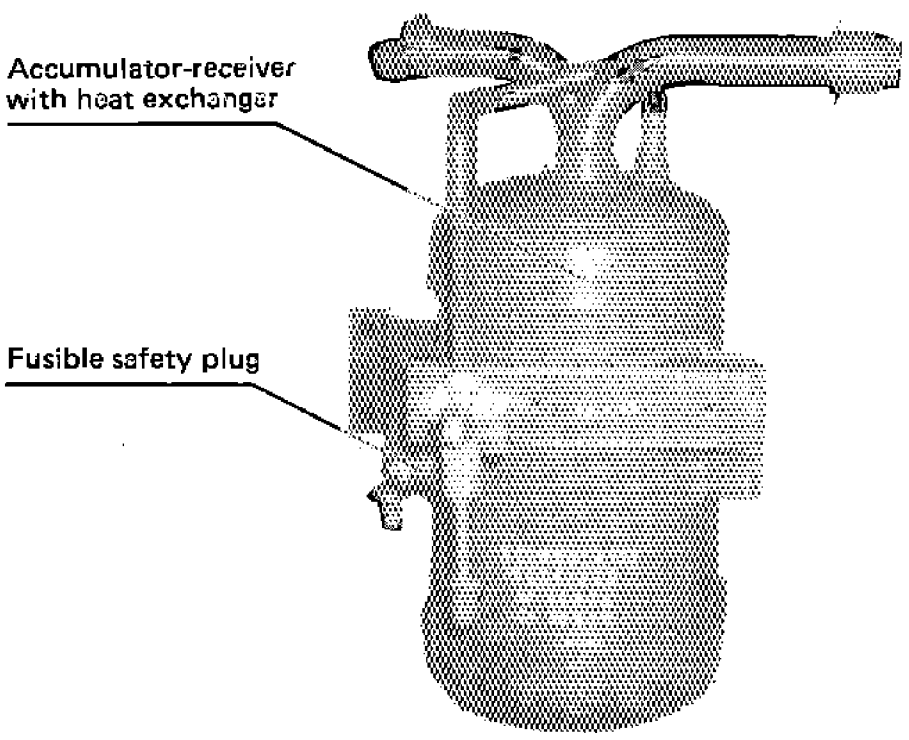
Evaporator

4.1.3 Water-cooled condenser

Of the tube-in-tube type in which cooling water flows through the inner tube while the refrigerant flows between the outside wall and the wall of the inner tube. Since special fins are fitted, the condenser is compact and light.

4.1.4 Accumulator-receiver with heat exchanger

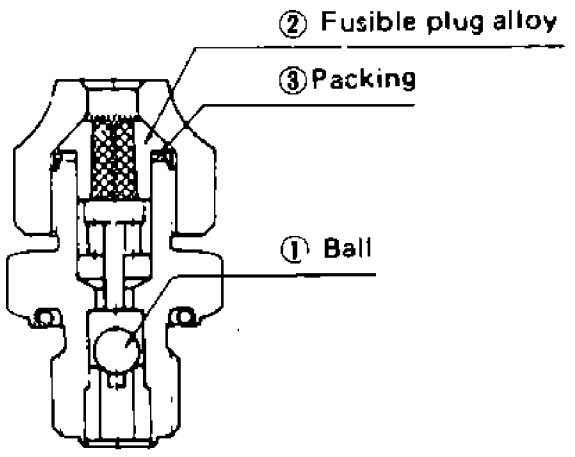
Consists of the accumulator, receiver, and heat exchanger. A fusible safety plug is fitted to the receiver body.



(a) Replacement procedure of the fusible safety plug

When pressure rises abnormally in the system, the fusible safety plug melts itself, so if the fusible safety plug has melted, check all the possible causes thoroughly.

When fusible safety plug functions, the centre of the fusible safey plug alloy②melts, from which the refrigerant escapes. When the flare nut is removed,① (ball) will come out under pressure and block the passage of the refrigerant outlet, which prevents the refrigerant from escaping and also the air from entering. Thus, refrigerant loss is extremely minimized.

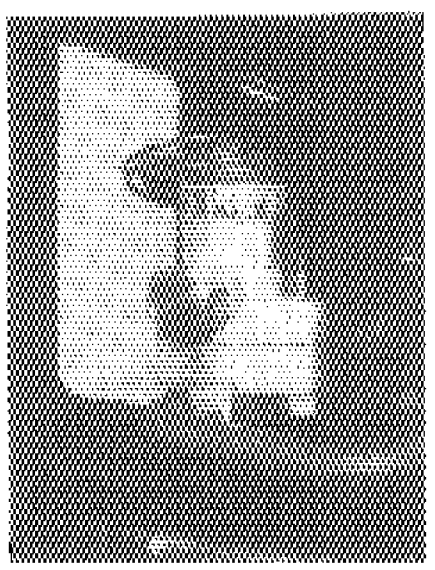


Construction of fusible safety plug

Insert a new ② with ③, and tighten the flare nut.

4.1.5 Expansion valve

The externally equalized expansion valve which is fitted before the evaporator and senses the super-heat degree refrigerant leaving evaporator and controls flow of the refrigerant automatically to the evaporator according to operating conditions. The expansion valve with MOP (MAXIMUM OPERATING PRESSURE) is adopted to protect the compressor motor from overload.



"CAUTION" Whenever adjusting and replacing the expansion valve, the unit should be isolated from the mains supply for safety.

(a) Adjusting the expansion valve

There are two methods to adjust the expansion valve ; i.e. one is the adjustment based on the suction operation standard and the other is that based on the frost conditions on the compressor.

(1) Adjustment based on the suction operation pressure

1) Confirm that the predesigned volume of the refrigerant has been charged.
2) Attach a pressure gauge to each gauge port and operate the refrigeration unit, maintaining inside temperature at −18°C (−0.4°F). (See connecting of pressure gauge).
3) When inside temperature comes to the preset temperature, compare the suction pressure reading with the standard pressure. (See standard operation pressure curve on page 51)
4) If suction pressure reading differs with the standard pressure, adjust the expansion valve as stated below.
5) After loosening the clamp screw, turn the adjusting screw.
6) Note that pressure will not change after a certain lapse of time.

(2) The adjustment based on frost stated on the compressor.

1) Refer to the caution for adjustment of expansion valve as above. At this time, inside temperature should be maintained to−18°C (−0.4°F).
2) Regulate the adjusting screw as stated below based on frost state on the suction pipe and the stop valve of the compressor.
3) Whether or not the adjustment required is judged by frost state of the flange on the suction side of the suction valve.
4) However note that frost state differs with ambient air conditions (temperature and humidity).

Note : Check the position of the feeler tube fitted to the suction pipe from the evaporator before making any adjustments.

Adjusting points for expansion valve

Adjusting screw	Turning direction		Operation state
Adjusting screw of expansion valve	Clockwise		Suction pressure is higher than the standard pressure (Frost forms on the suction pipe rather than the suction flange of the stop valve), Clockwise rotation of the adjusting screw decreases running pressure.
	Counter-clockwise		Suction pressure is lower than the standard pressure (frost forms on the compressor side rather than the suction flange of the stop valve). Counterclockwise rotation of the adjusting screw increases running pressure.

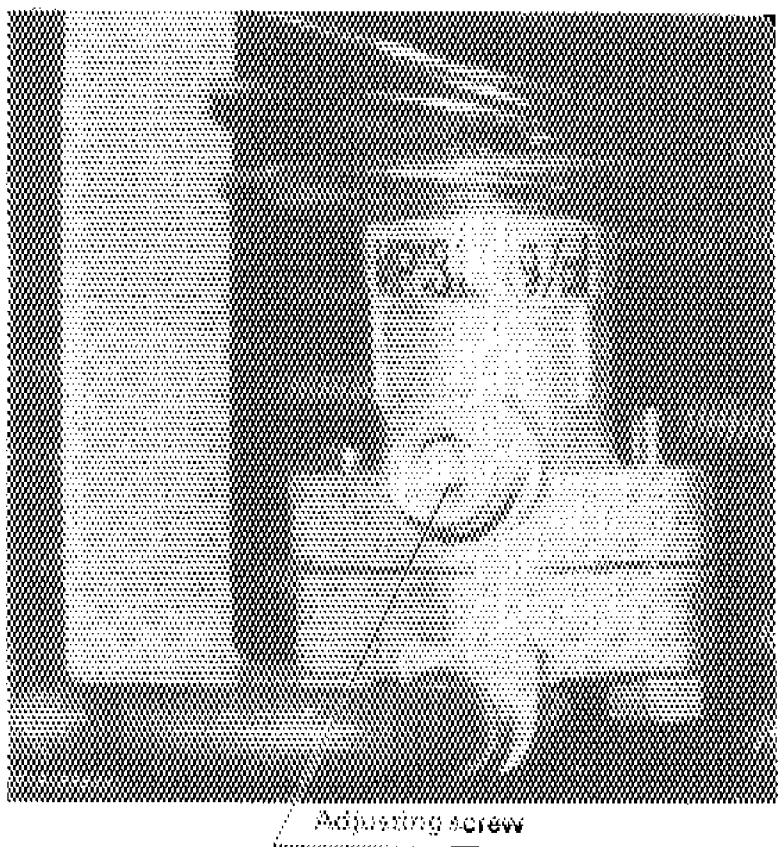
(3) Countermeasures after operation

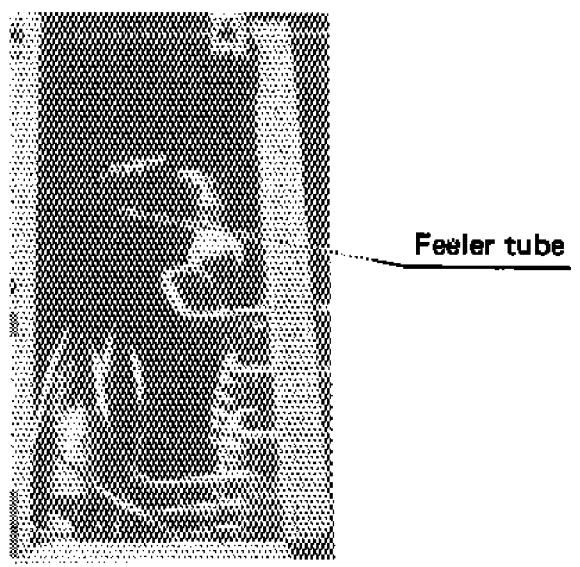
1) Remember the original setting of the expansion valve. If any change is not found with the setting after adjustment of the expansion valve, return the adjusting screw to the original position, as trouble occured caused by other reasons.
2) When the adjusting screw is returned to its original position, firstly turn it passing the original position and then return it to the original position.
3) After adjustment, be sure to tighten up the clamp screw and cap it to prevent the refrigerant from leaking.
4) After completion of the adjustment, operate the unit, keeping inside temperature at −18°C (−0.4°F) and confirm that low pressure is within the range of operating pressure at item 6.

(b) Replacement

In replacing this valve, the work should be done after removing access panel and air-cooled condenser front plate located outside the container and evaporator fan motor section back plate and drain pan back plate placed inside the container. (If only cage is to be replaced. only air-cooled condenser front panel shall be removed.)

1) Remove the feeler tube, equalizing pipe flare, and fastening bolts. (To replace the cage alone, there is no need to remove the feeler tube.)
2) Remove the power assembly, cage, and packing.
3) Be sure to install a new packing when replacing it.





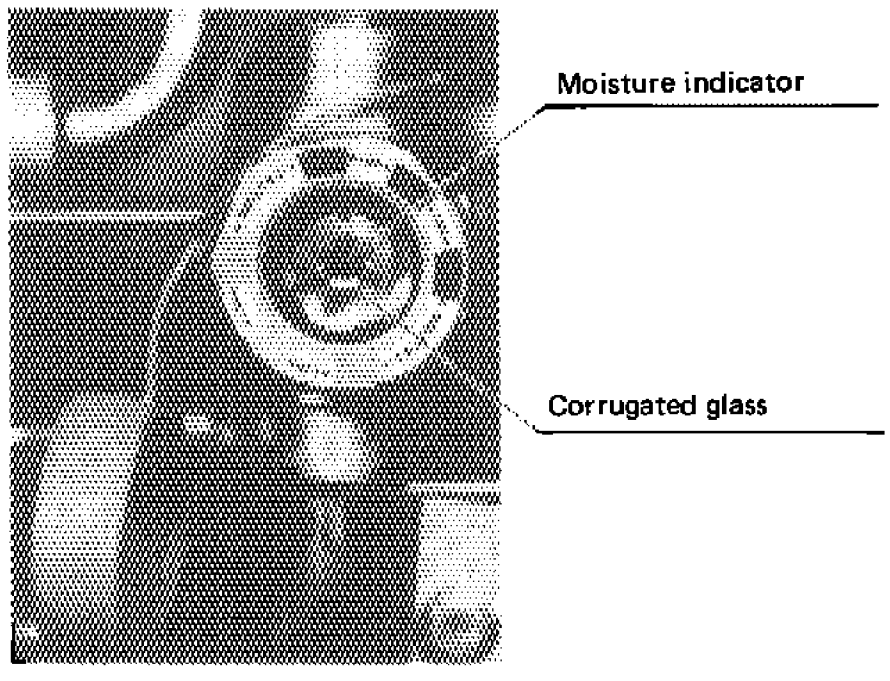
4.1.6 Liquid/moisture indicator

This indicator permits checking of flow of the refrigerant and moisture content in the refrigerant. Check this indicator during the unit is operating.

(a) Moisture content

The indicator indicates moisture content by the color at the center of the window.

Color	State
Deep blue	Dry
Orange	Wet (moisture contained)



Note : 1. The indicator may appear yellow if it has been exposed to gaseous refrigerant for a long time.
2. The indicator is to be checked at being sealed with liquid refrigerant after operating for a few hours.
3. Change of the indicator is influenced by the temperature of liquid refrigerant. The lower temperature cause the change of indicator to take the longer time.
4. To shorten the time for change of indicator, raise up the temperature of liquid refrigerant.

(b) **Flow of the refrigerant**

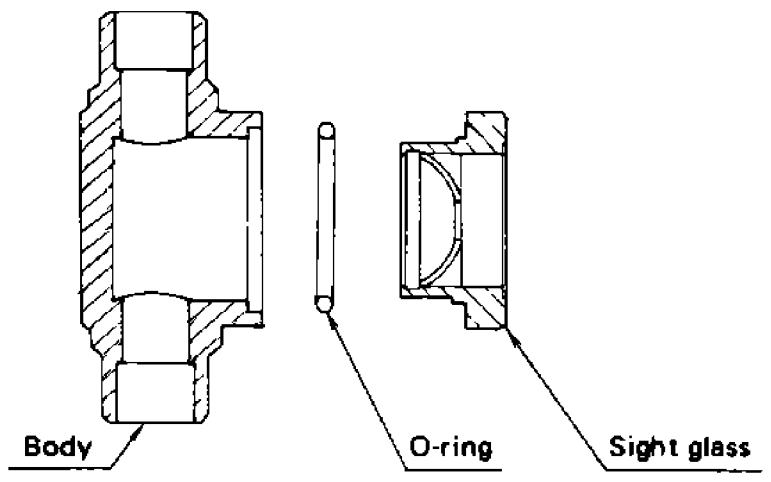
- When indicator is filled with liquid refrigerant, pattern of wave on glass disappears.
- Check

Operation	Indicator state
At start	Bubbles appear but liquid refrigerant is sealed in 30 minutes to an hour after starting.
During operation	Occassional bubbles may appear more or less. {Particularly appear more during capacity control operation}

It bubbles develop continuously, the refrigerant is possibly running short.

(c) Replacement

1) Put the system in "pump down" state.
2) Turn the sight glass counterclockwise, and remove it together with the O-ring.
3) Apply refrigeration oil to the new O-ring, and fasten the sight glass with torque of 70±5kg-cm.
(Do not apply excessive torque, or the O-ring will break.)

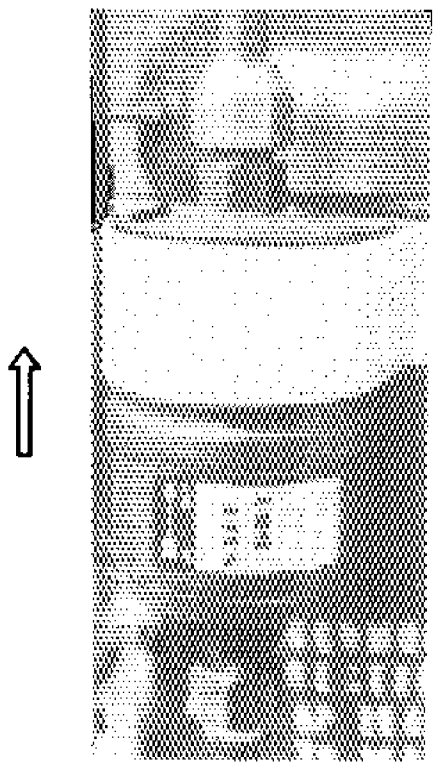


4.1.7 Dryer

This removes moisture and dust from the refrigerant while it is circulated. Replace the dryer if it does not remove moisture or is clogged.
When installing the new dryer, follow the directions given on the nameplate and do not make any mistake about the direction of the dryer.

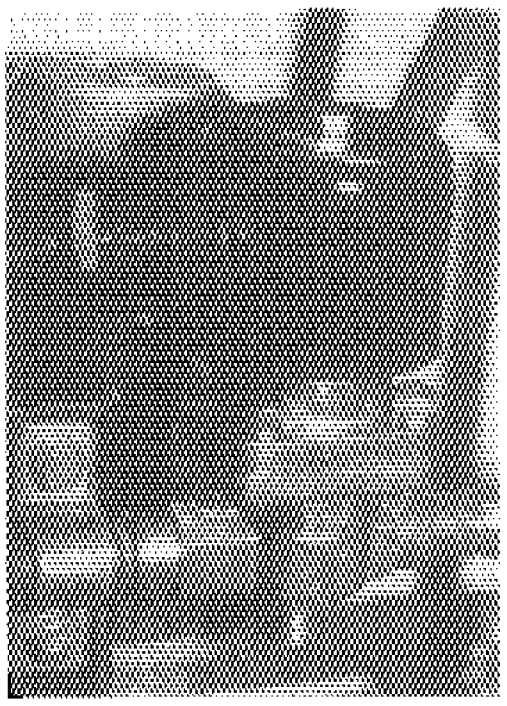
(a) Replacement

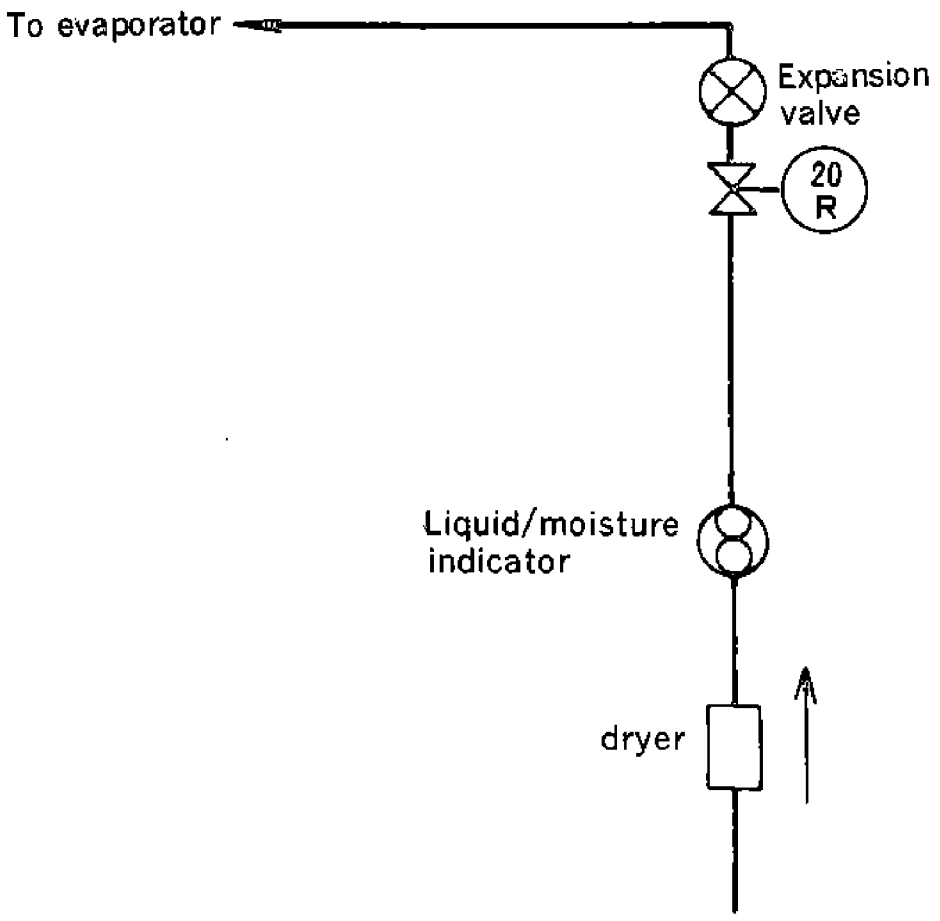
1) In "pump down" state (see Service), close the compressor suction stop valve.
2) Then, loosen the flares in front of and behind the dryer and replace the dryer quickly.
3) Be careful not to get air into the piping on the solenoid valve side while removing the dryer.
4) After reattachment of the dryer, open the stop valve a little to purge the air in the dryer from the flare on the solenoid valve side and then close it at once.
5) Loosen the flare on the other side, forcedly turn off the low pressure of the dual pressure switch, turn on the master control switch and open the solenoid valve only to purge the air.
6) After completion of the work, open the stop valves to its original state and then inspect the system for gas leakage. Ensure no gas leakage is found.



4.1.8 Solenoid valves in the liquid line

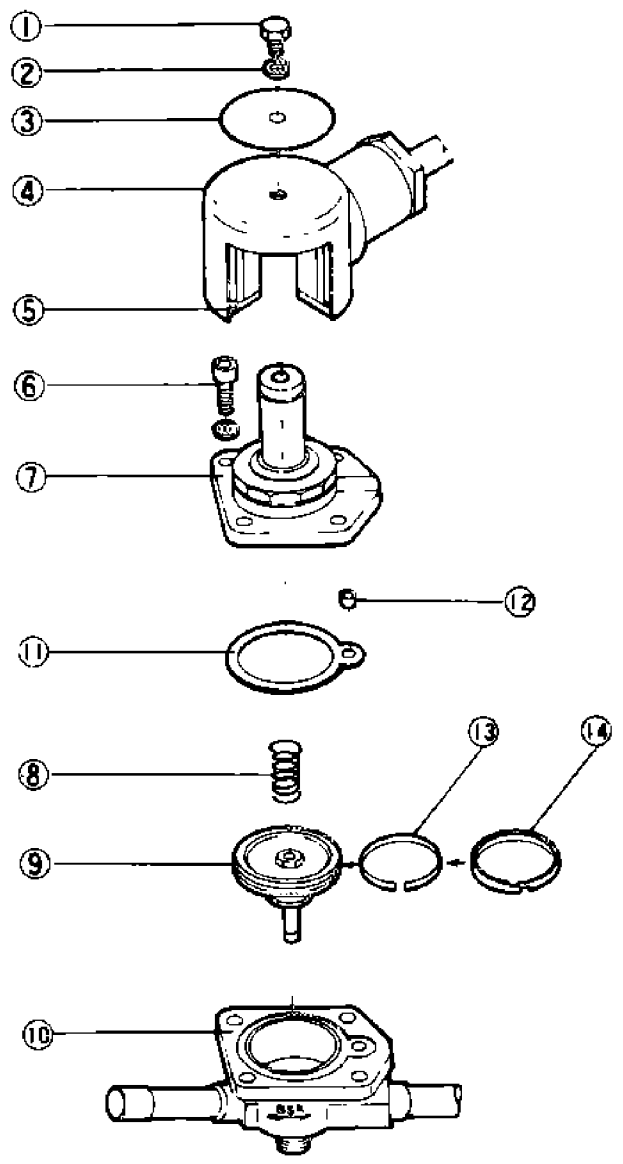
There is a solenoid valve in the liquid line and it controls flow of liquid refrigerant.





<Disassembly>

- The structure of the solenoid valve should be detached (For disassembly, checking, and reassembly, refer to this diagram.)
- When brazing a pipe to the valve, cool the valve body with a wet cloth. (It is not required to disassemble the valve. Remove the coil ass'y from the body.)
- During reassembly, tighten the four bolts x4 with torque of 50−60 kg-cm.



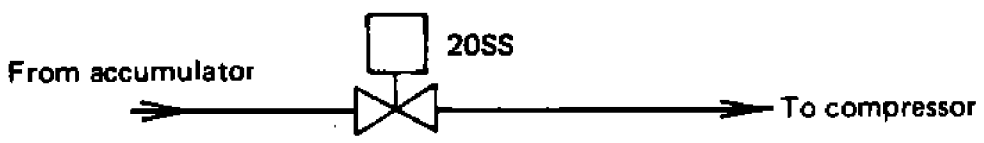
No.	Parts name
①	Set bolt
②	Spring lock washer
③	Name plate
④	Coil ass'y
⑤	Retaining plate
⑥	Set bolt
⑦	Cover ass'y
⑧	Spring
⑨	Piston
⑩	Valve body
⑪	Packing
⑫	Sleeve
⑬	Inner ring
⑭	Piston ring

4.1.9 Suction line solenoid valve (20SS)

a. <Actuation description>

This valve is located on suction line to compressor.

It operates in accordance with supply air temperature.

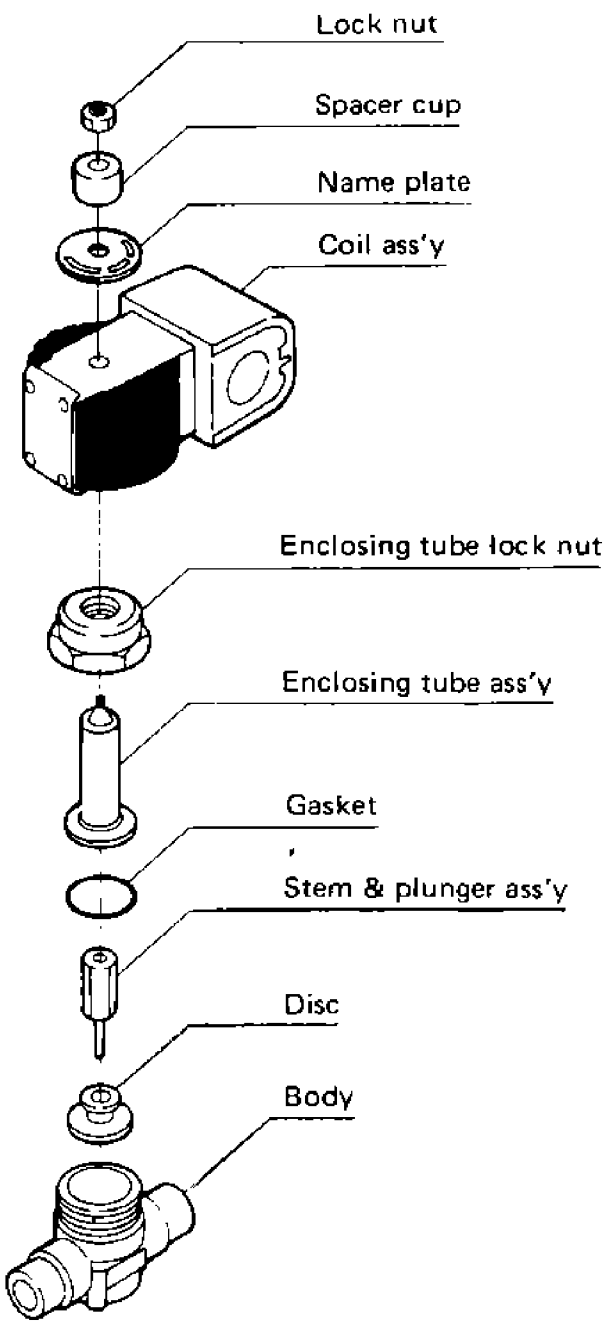


Close when the solenoid is energized and open when de-energized.

b. <Disassembling>

- The structure of the interior of solenoid valve is as shown in the figure below (this figure shall be referred to in disassembling and assembling or overhauling).

- When soldering piping, the valve body should be cooled by applying wet cloth thereon. (Coil should detached from the valve body, but it need not be disassembled.)



4.2. Components related with the air system

4.2.1 Fans and motors

(a) Specifications

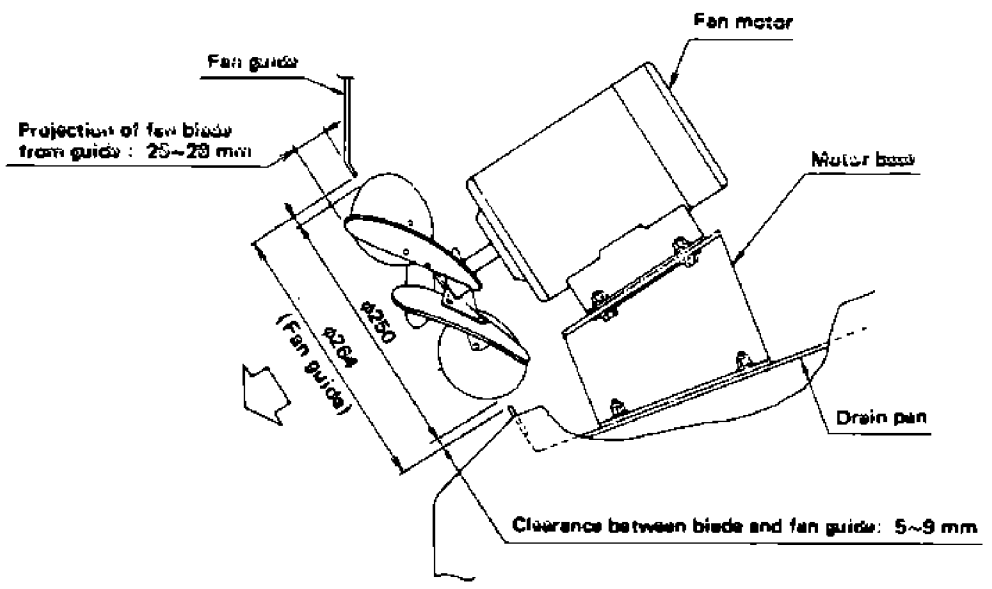
<Fan>

	Evaporator	Condenser
Type	propeller fan	propeller fan
Number of blades	6 pcs.	6 pcs.
Blade diameter	ϕ250	ϕ260

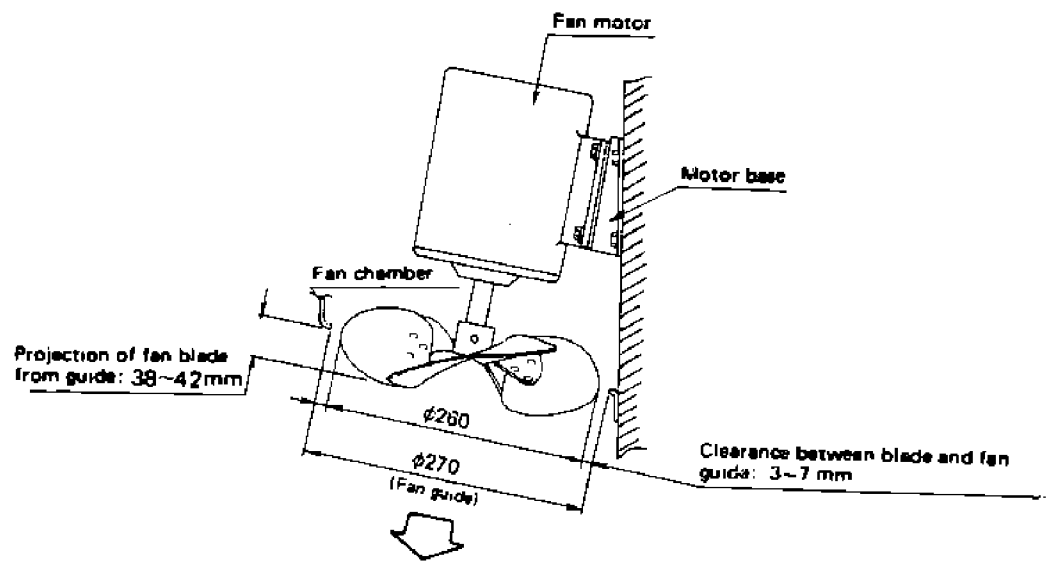
<Motor>

Type	Single-phase, squirrel-cage induction motor	
Motor output (number of poles)	465W (2P)	60W (4P)
Capacitor	Built-in	Separate
Bearing	Ball bearing, 6203 contactless type, rubber shield	

(b) Installation procedure



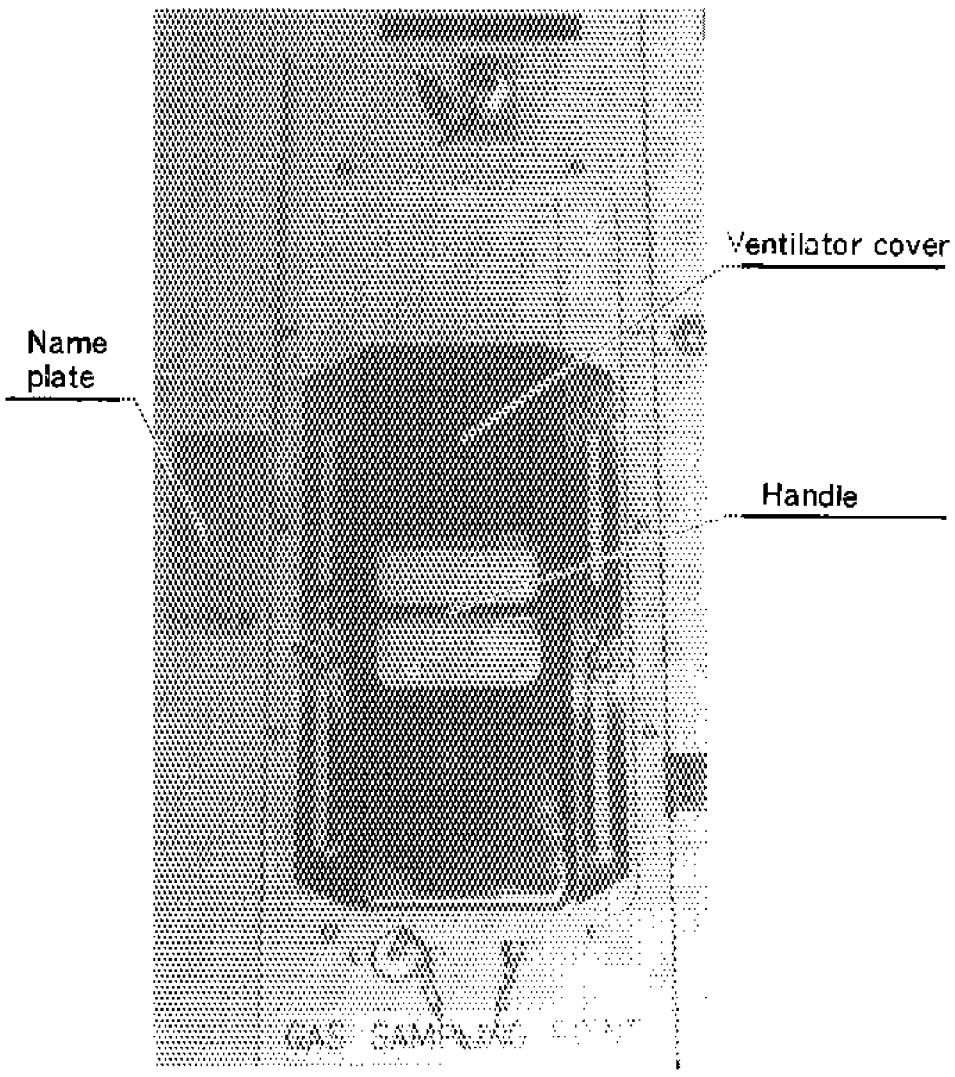
Evaporator fan and motor



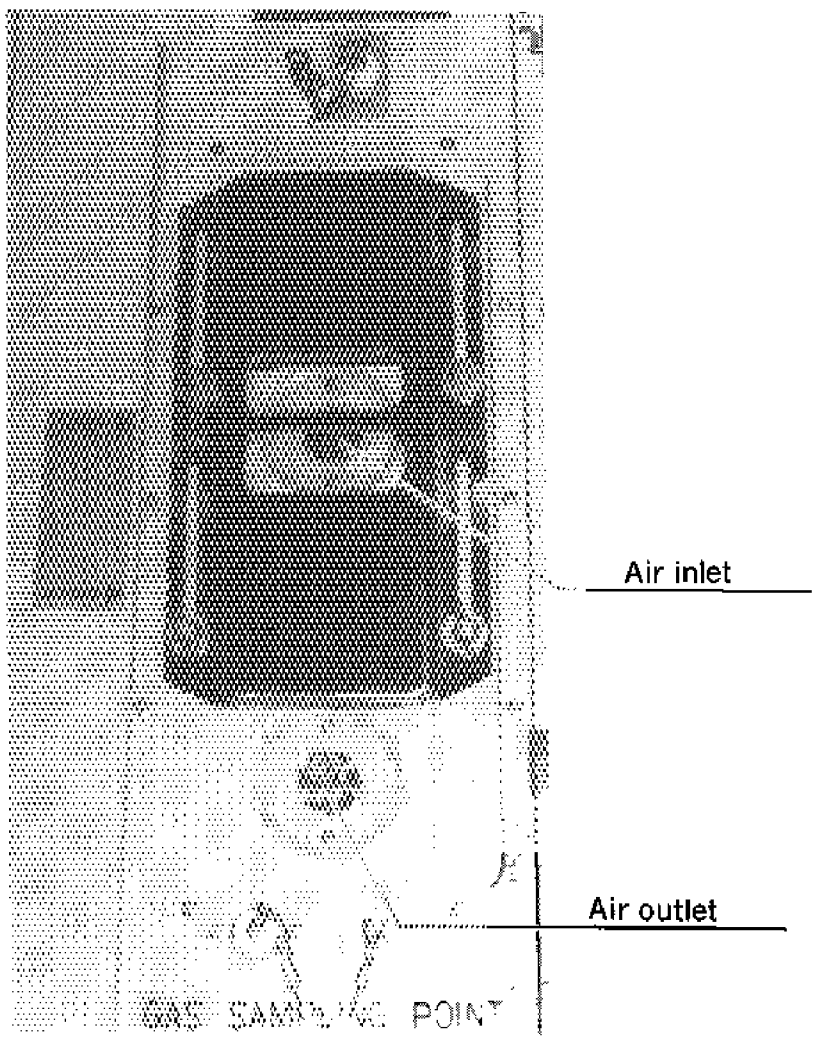
Condenser fan and motor

4.2.2 Ventilator

(a) If ventilation is not needed :
Set the handle to CLOSED.



(b) If ventilation is needed :
Set the handle to OPEN.



4.3 Temperature control system

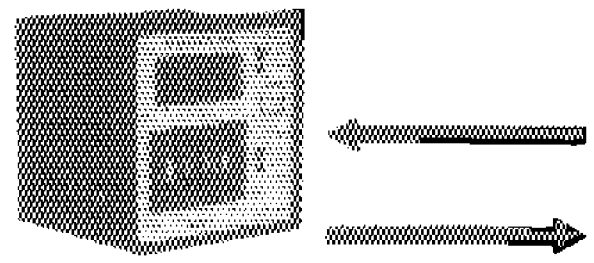
This unit performs temperature control in two modes.

I Frozen operation : compressor on-off control : Return air temperature is controlled (return air sensor).

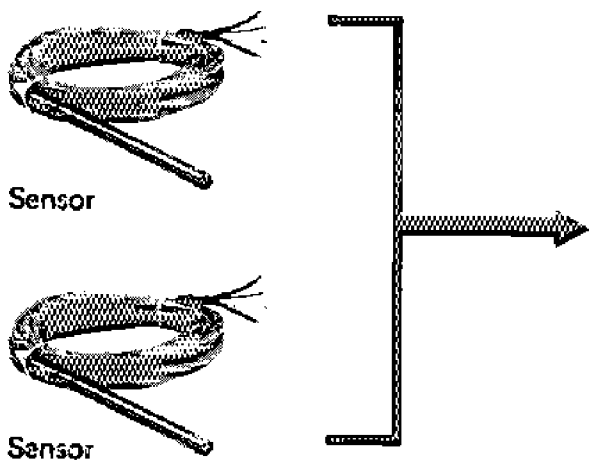
II Chilled operation : capacity control by hot gas bypass : supply air temperature is controlled (supply air sensor)

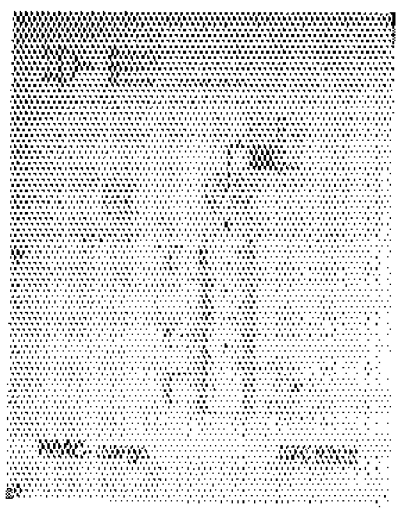
This system makes automatic choice between two modes, conducts control of inside temperature in reference to the set temperature and also provides a digital indication.

- The supply and return sensors will be automatically switched according to the preset temperature.
- Adoption of a check instrument makes it possible to know the control state easily.
- The digital display enables the switching between the suction and the supply temperature to be made by pushbotton operation.

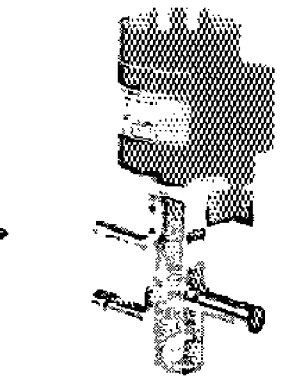


Setpoint selector/Digital display





Controller



Modulating control valve

4.3.1 Sensor (FC-KTRP)

The supply air and return air sensors are identical.

- Element ———PT100Ω (0°C)
- Connection ———with four leads

(a) Checking operation

- Supply air sensor

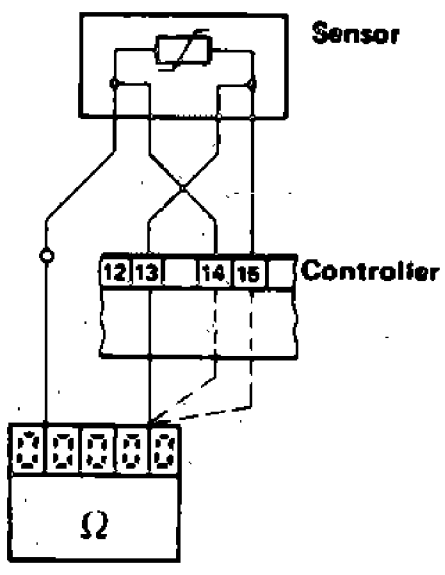
Remove wire from terminal 12 and connect measuring instrument to this wire and to terminal 13 of terminal block A. If the resistance measured is between 88 and 111Ω, the sensor is in order.

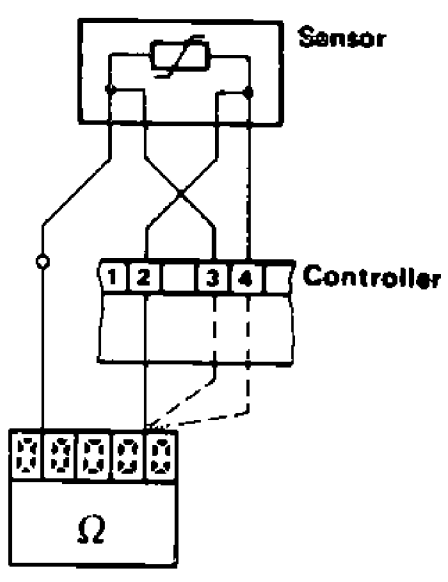
Terminal 13 : 88 — 111Ω
Terminal 14 : 0Ω
Terminal 15 : 88 — 111Ω

- Return air sensor

Remove wire from terminal 1 and connect the measuring instrument to this wire and to terminal 2 on terminal block A. If the resistance measured is between 88 and 111Ω the sensor is in order.

Terminal 2 : 88 — 111Ω
Terminal 3 : 0Ω
Terminal 4 : 88 — 111Ω





(b) Replacement of Sensors

When replacing defective sensors, ensure that the sensor bulb is insulated from the machinery metalwork.

● **Temperature vs. resistance table**

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
−30	88.17	− 9	96.46	5	101.95	18	107.02
−25	90.15	− 8	96.86	6	102.34	19	107.40
−20	92.13	− 7	97.25	7	102.73	20	107.79
−19	92.52	− 6	97.65	8	103.12	21	108.18
−18	92.92	− 5	98.04	9	103.51	22	108.57
−17	93.31	− 4	98.43	10	103.90	23	108.96
−16	93.71	− 3	98.82	11	104.29	24	109.35
−15	94.10	− 2	99.22	12	104.68	25	109.73
−14	94.49	− 1	99.61	13	105.07	26	110.12
−13	94.89	0	100.00	14	105.46	27	110.51
−12	95.28	1	100.39	15	105.85	28	110.90
−11	95.68	2	100.78	16	106.24	29	111.28
−10	96.07	3	101.17	17	106.63	30	111.67
		4	101.56				

4.3.2 Setpoint selector/Digital display (PC-DD 30/30)

The PC-DD combines the setpoint selector and the digital display in a single housing.

● Setpoint selector

Temperature setting is of digital indication. Press the bottons arranged both upper and lower of each indication for setting.

Temperature range……−29.9～+29.9°C

a. Operating check

1. Switch on controller (Unit ON-OFF switch)
2. Measure −15V DC ±0.5V, terminal 6 (⏚) −5
3. Measure +15V DC±0.5V,terminal 6 (⏚) −4

If the measured values agree, the voltage supplied to the setpoint selector is correct.

4. Setpoint adjustment

−29.9°C=0.017V
0 °C=5.000V Terminal 6 (⏚) −7
+29.9°C=9.983V
Tolerance ±0.017V

● **Digital display**

The supply or return air temperature, measured by the two sensors, is shown on the LCD display by the output voltage from controller.

In the chilled mode, the supply air temperature is shown. The return air temperature can be seen by pressing the button 《push》.

In the frozen mode, the return air temperature is shown. The supply air temperature can be seen by pressing the button 《push》.

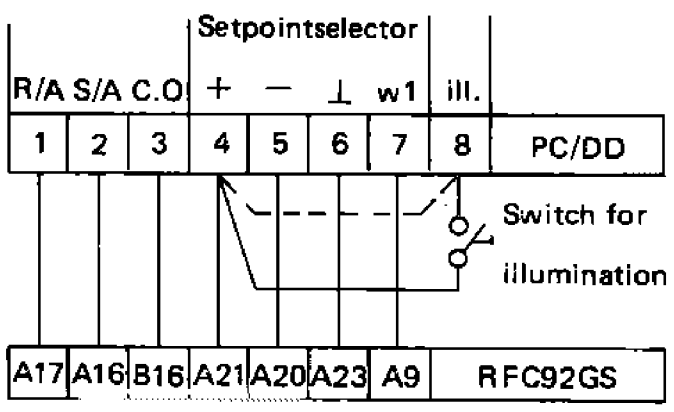
The according modes are indicated by light emitting diodes (LED).

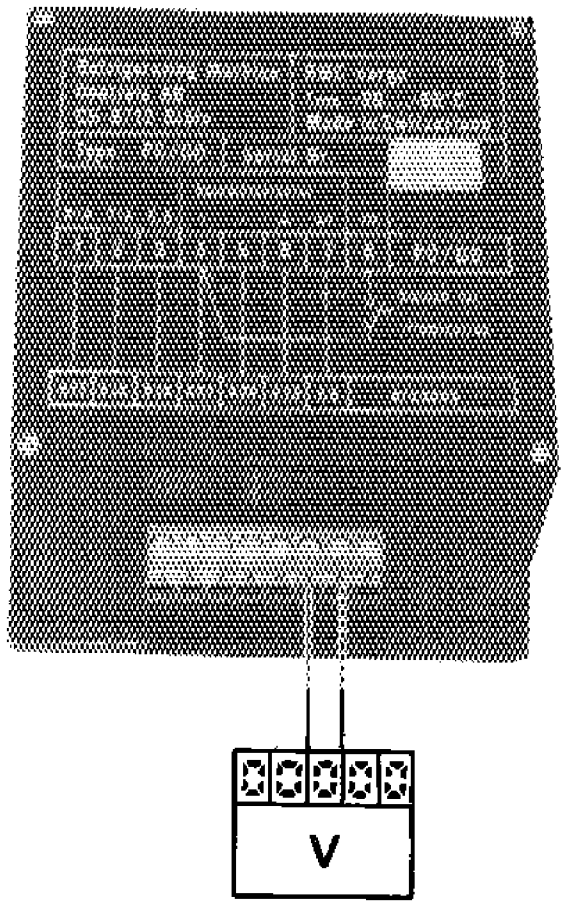
a. Operating check

1. Switch on controller (Unit ON-OFF switch)
2. Measure output voltage 0—10 VDC, terminal 1—6, 2—6

(Determined by the aid of a temperature/voltage conversion table.)

Connection diagramm

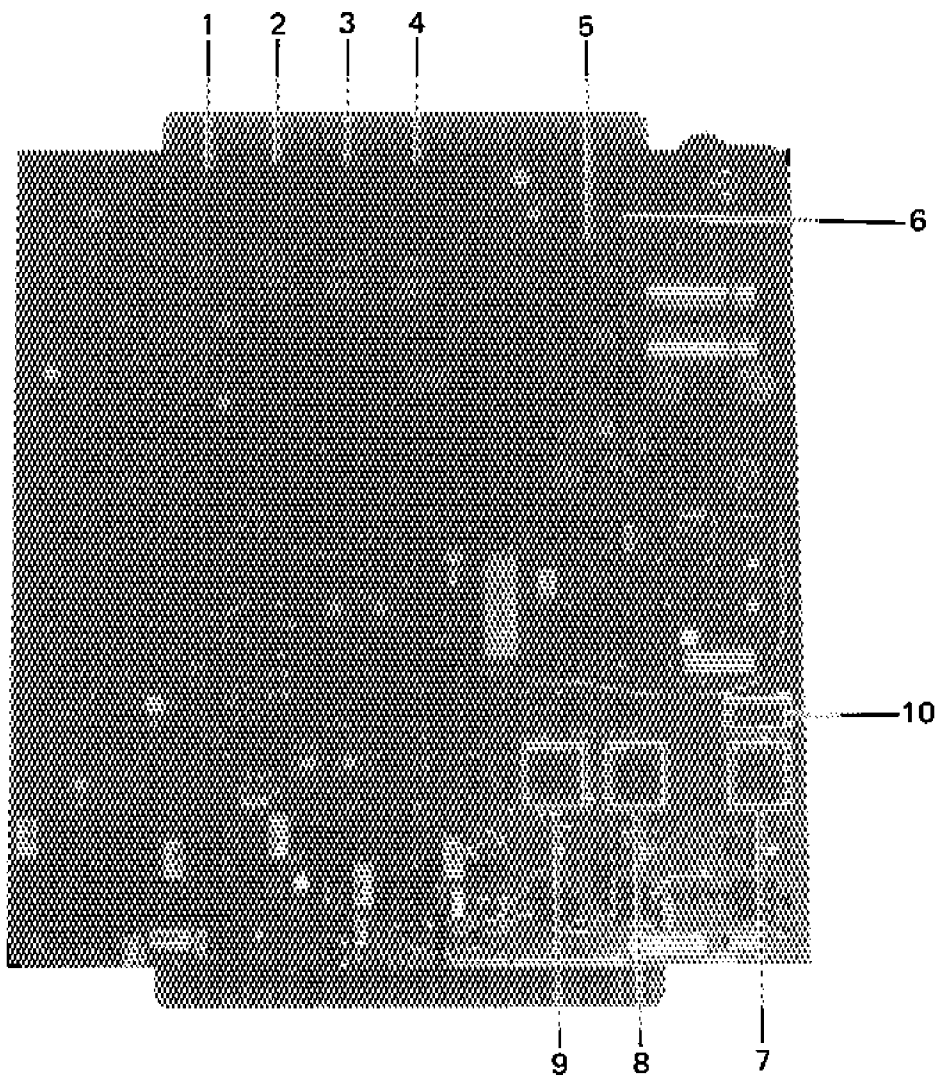




4.3.3 Controller (RFC-92GS-RMC-8302)

According to the preset temperature, one of two sensors (supply or return) is selected to control the modulating control valve, compressor, and gives alarm at high and low limits of the inside temperature. It delivers to the digital display its output corresponding to the control temperature.

(a) Parts name



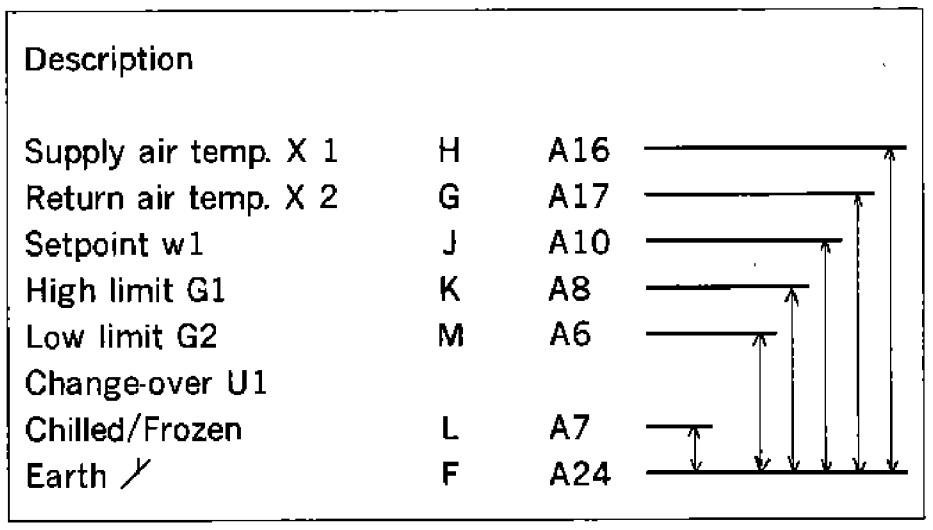
Item	Description		RMC Factor setting
1	High limit relay (In range)	G1	
2	Low limit relay (In range)	G2	
3	Mode change-over relay	U1	−4.5/−5°C
4	Y2 output relay	Y2	
5	Spare transistor fuse } (modulating valve for voltage output)	BC 107A	
6	Transistor fuse } (modulating valve for voltage output)		
7	Derivative action preset time potentiometer	TV [s]	18 sec
8	Proportional band potentiometer (% of measuring range)	xp [%]	4 %
9	Integral action reset time potentiometer	TN [s]	90 sec
10	Jumper line (for TV × 10)		Cut

(b) Temperature-voltage conversion table

The temperature on the right and preset temperature can be converted to voltage with the terminal board of the controller or the receptacle of the checker.

Examples : 1. Supply air temperature (X1) is 0°C when voltage is 5V across A24-A16 of the terminal board (F-H of the receptacle).

2. The change-over point (U1) between chilled and frozen modes are switched over is −5°C when voltage is 4.166V across A24-A7 of the terminal board (F-L of the receptacle).



Temperature/voltage conversion table

°C	V	°C	V	°C	V
−30	0	−10.0	3.3333	10.0	6.6666
−29.5	0.0833	− 9.5	3.4166	10.5	6.750
−29	0.1666	− 9	3.5	11	6.8333
−28.5	0.250	− 8.5	3.5833	11.5	6.9166
−28	0.3333	− 8	3.6666	12	7.0
−27.5	0.4166	− 7.5	3.750	12.5	7.0833
−27	0.5	− 7	3.8333	13	7.1666
−26.5	0.5833	− 6.5	3.9166	13.5	7.25
−26	0.6666	− 6	4.0	14	7.3333
−25.5	0.750	− 5.5	4.0833	14.5	7.4166
−25	0.8333	− 5	4.1666	15	7.5
−24.5	0.9166	− 4.5	4.25	15.5	7.5833
−24	1.0	− 4	4.3333	16	7.6666
−23.5	1.0833	− 3.5	4.4166	16.5	7.75
−23	1.1666	− 3	4.5	17	7.8333
−22.5	1.25	− 2.5	4.5833	17.5	7.9166
−22	1.3333	− 2	4.6666	18	8.0
−21.5	1.4166	− 1.5	4.750	18.5	8.0833
−21	1.50	− 1	4.8333	19	8.1666
−20.5	1.5833	− 0.5	4.9166	19.5	8.25
−20	1.6666	± 0	5.0	20	8.3333
−19.5	1.750	0.5	5.0833	20.5	8.4166
−19	1.8333	1	5.1666	21	8.5
−18.5	1.9166	1.5	5.25	21.5	8.5833
−18	2.0	2	5.3333	22	8.6666
−17.5	2.0833	2.5	5.4166	22.5	8.750
−17	2.1666	3	5.5	23	8.8333
−16.5	2.25	3.5	5.5833	23.5	8.9166
−16	2.3333	4	5.6666	24	9.0
−15.5	2.4166	4.5	5.75	24.5	9.0833
−15	2.5	5	5.8333	25	9.1666
−14.5	2.5833	5.5	5.9166	25.5	9.25
−14	2.6666	6	6.0	26	9.3333
−13.5	2.750	6.5	6.0833	26.5	9.4166
−13	2.8333	7	6.1666	27	9.5
−12.5	2.9166	7.5	6.25	27.5	9.5833
−12	3.0	8	6.3333	28	9.6666
−11.5	3.0833	8.5	6.4166	28.5	9.75
−11	3.1666	9	6.5	29	9.8333
−10.5	3.25	9.5	6.5833	29.5	9.9166
				30	10.0

[Note]

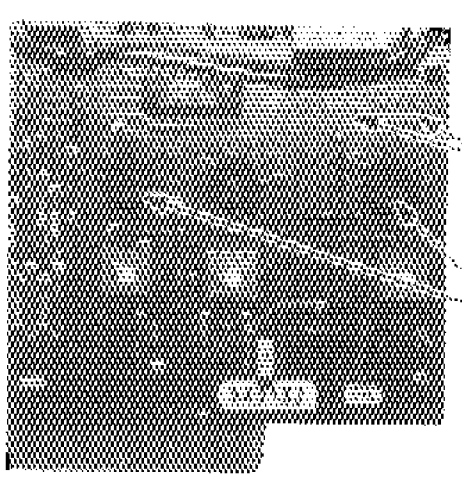
for temperature sensor output X1, X2 setpoint switch output w1, settings G1, G2, U1. $U/°C = \frac{10\ [V]}{60\ [°C]} = 0.16667V/°C$

(c) Replacement of print substitute

When replacing print substitute, adjustments of

- Proportional band Xp (%) and
- Integral action time Tv (s) and
- Derivative action time Tn (s)

are required.



	Standard RMC factory setting		For LKEN5BD20 Revised setting
Tv	10sec	→	18sec
(Jumper line for Tv)	Remained		Cut
Xp	8%	→	4%
Tn	60sec	→	90sec

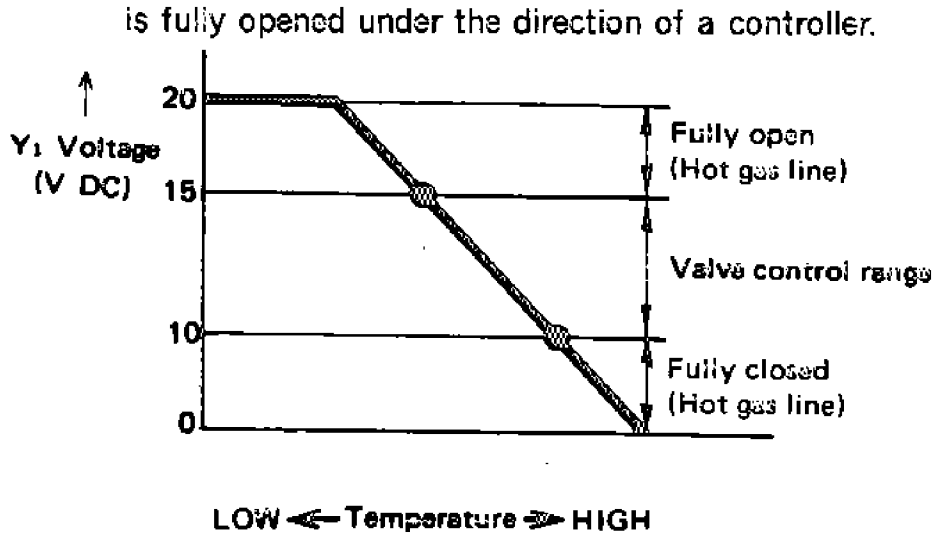
Adjustments are to be made by turning potentiometers.

Note:

If the replacement board has a wire between Tv×10, then readings shown on scale are singular. If wire is removed, then scale readings are to be multiplied by 10.

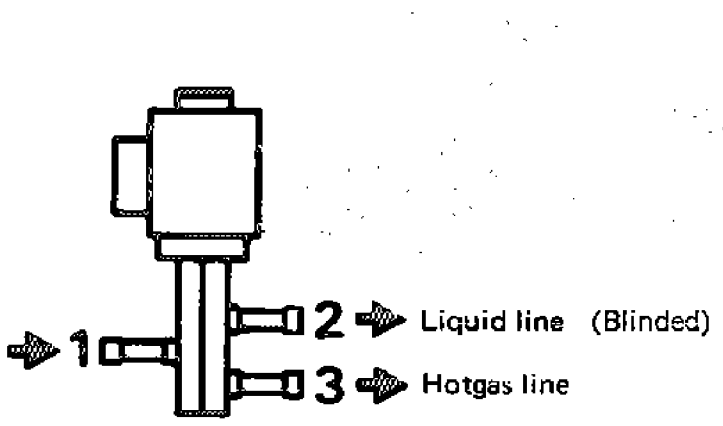
4.3.4 Modulating control valve (M3F15L)

- This valve is operated by controller output (Y_1 volt). Having two way function, it provides continuous control of flow of hot gas. The degree of opening of the valve under control may be determined from the voltage value of Y_1 as measured with RMC check instrument.
- When the defrosting is conducted, the hot gas line is fully opened under the direction of a controller.



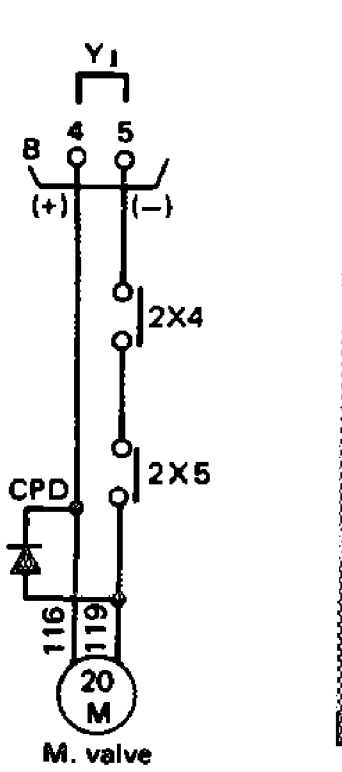
(a) Valve position

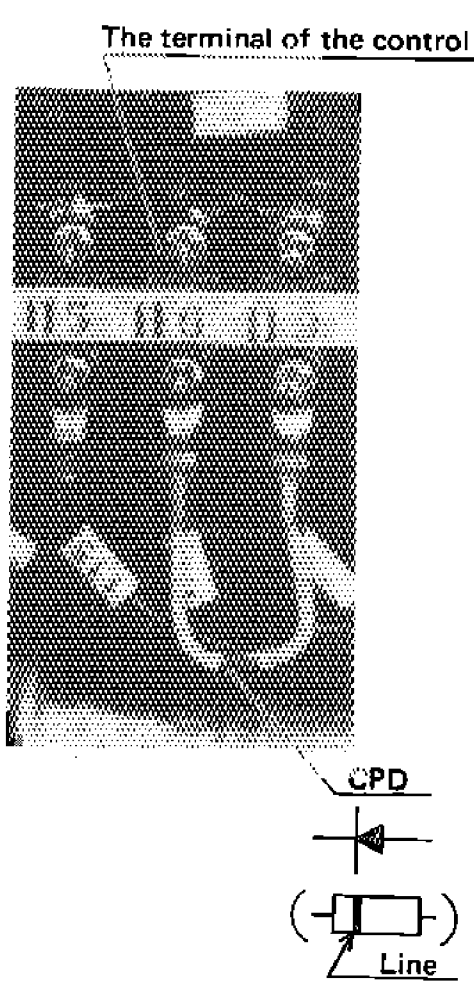
- De-energized period: 1-3 closed, 1-2 open
- The coil resistance of the valve is approximately 20Ω at 21°C.



(b) CPD (contact protective diode)

A CPD is inserted in the valve circuit. This protects the relay contacts from surge current which flows when the circuit is opened and closed. The CPD is fitted to the terminal of the control box.

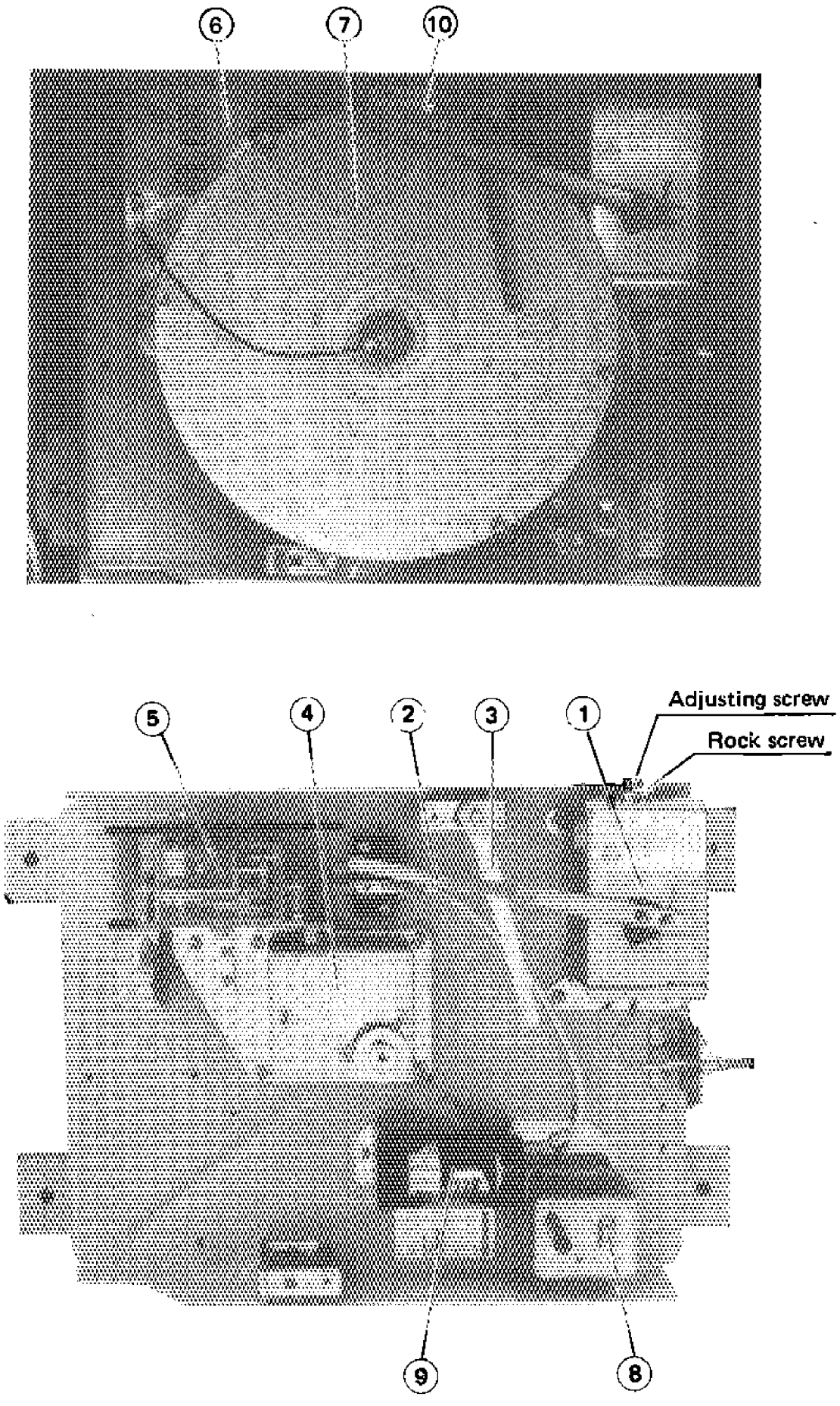




4.3.5 Recorder

1. Specifications

⓪	Model	SKM-2924A
⓪	Feeler tube	Gas sealed
⓪	Recording method	Pressure sensing type
⓪	Recording temperature range	−29.9～+25℃ (−22～77°F)
⓪	Recording paper	Dia. 203 Disk type pressure sensible paper (Graduation 1/1℃) (Corresponding to PSD-217C (REV. A) made of PARTLOW Co.)
⓪	Driving method for recording paper	Timer (Quartz motor + reducing gears) a turn/31 days
	Quartz motor driving source:	Goods corresponding to Dry battery (DC 1.5V) JIS C 8501 ·····SUM2 IEC ·····R14 Life is approx. 1 year (Remaining voltage indicator)



1 Element
2 Pen
3 Pen lifting arm
4 Reducer
5 Quartz motor
6 Recording board
7 Recording paper
8 Remaining V indicator
9 Battery
10 Present time plate

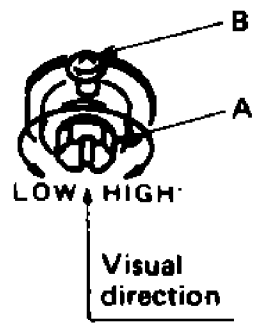
2. Inspection of recorded temperature

1) Recording pen on chilled mode
Operate the unit in chilled mode at 0°C setting and confirm with the digital temperature display of the controller that the supply air temperature has stabilized at 0°C. Then push the digital temp. indication switch to return air and calibrate the recording pen according to the return air temperature on digital display.

3. Adjustments

1) Make adjustments subsequent to the inspection in item (2).

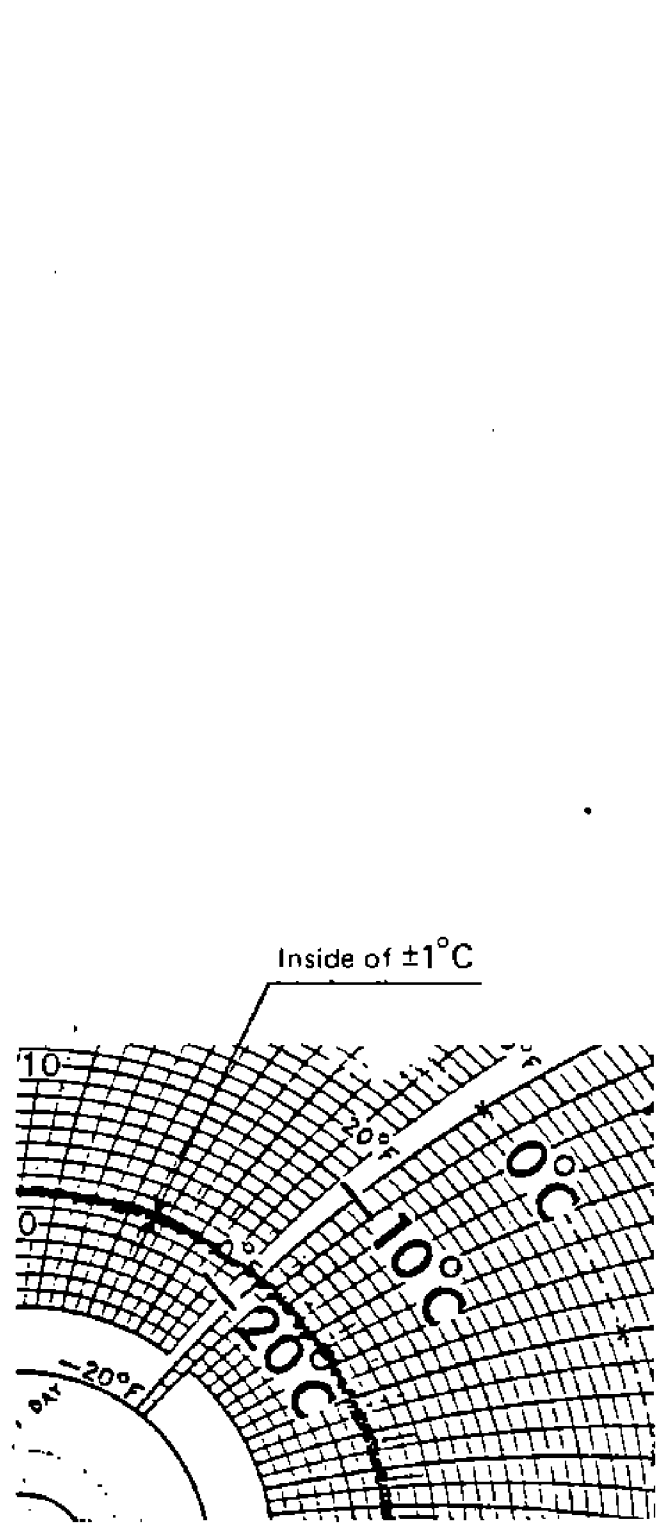
2) Turn the temperature setting screw (A) to adjust the temperature. Loosen the lock screw (B) and turn the setting screw (A) clockwise to temporarily raise the temperature setting by approximately 5°C.
Then turn the setting screw (A) counterclockwise to lower the temperature setting of the pen until the temperature is adjusted to 0°C.
Tighten the lock screw (B) after the adjustment.



Note 1 One turn of the setting screw (A) changes the temperature setting by approx. 5°C (9°F).
2 Be careful that the temperature setting may be altered by tightening the lock screw (B).

3) A temperature recorder should be adjusted at 0°C.

4) Inspection and adjusting method
1. Adjust a temperature recorder when the container inside temperature becomes decreasing.
Temperature recorder's pen shows the temperature correctly when it is decreasing.
Don't adjust it when the temperature become increasing.
It is caused from its hysteresis that a pen sometimes shows the temperature lower from 1°C to 3°C when the temperature is increasing.
2. It is a normal phenomina that the recording curves are a little influenced by the fluctuations of the ambient temperature. (Note : Basically the temperature recorder is designed for 25°C ambient, and 10°C fluctuations of the ambient temperature cause the error of ±0.2°C.)
3. A temperature recorder adjusted at 0°C sometimes shows the following curves at −18°C inside. It is a normal and allowable range.
If the range exceeds the above, readjust it at 0 °C (or−18°C).
4. Don't move the pen by hand, because it will cause an increase of fluctuation.
5. When the pen is holded by the pen lifter the pen may move unsmoothly, but it is no problem.



4. Replacement of parts

1) Battery

a) Replacement interval

- When the indicator is out side the blue zone after checking the residual voltage of the battery. (When the indicator is above the dotted lines, i.e., within the white zone shown in the right figure, the battery has approximately one-month life.)

b) Replacement method

- Remove the recording panel and insert the new battery making certain that the battery polarity is correct. Use SUM-2 of JIS C8501 or IEC R14 battery or the equivalent (DC1.5V dry cell).
- After replacement, confirm that the pointer of the residual voltage indicator is within the blue zone and that the quartz motor functions properly.

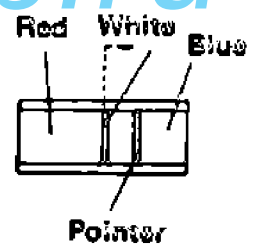
2) Residual voltage indicator battery

a) Replacement interval

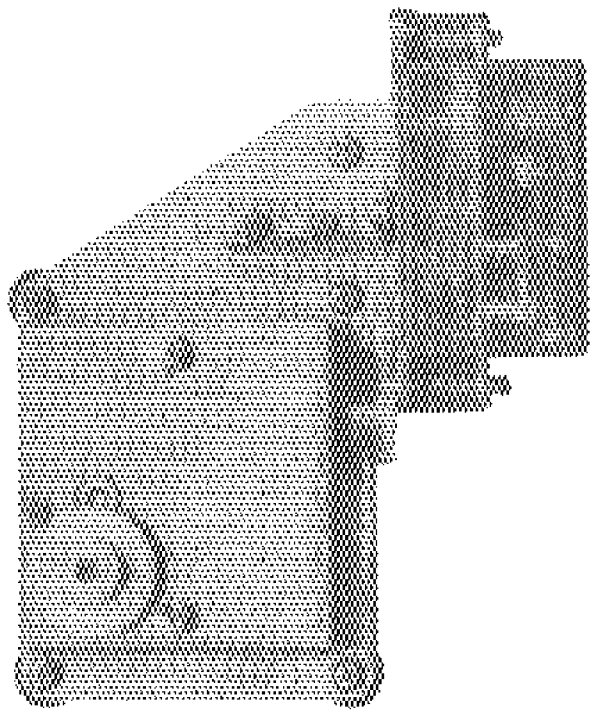
- In case oscillation of the needle is unstable when the push switch is pressed down for confirmation of remaining voltage.
- In case the remaining voltage indicator needle is within the white zone or in the red zone, although a new battery has been fitted.

b) Replacement method

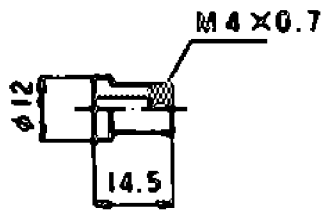
- Remove the recording panel by loosening the screw.
  Remove the residual voltage indicator battery from the body, and replace it with a new one.
- When replacing the battery make certain that the terminal wirings are connected red to red and black to black.
- After replacement confirm that the pointer is within the blue zone and that the quartz motor functions properly.
- Battery is to be replaced every 12 months.



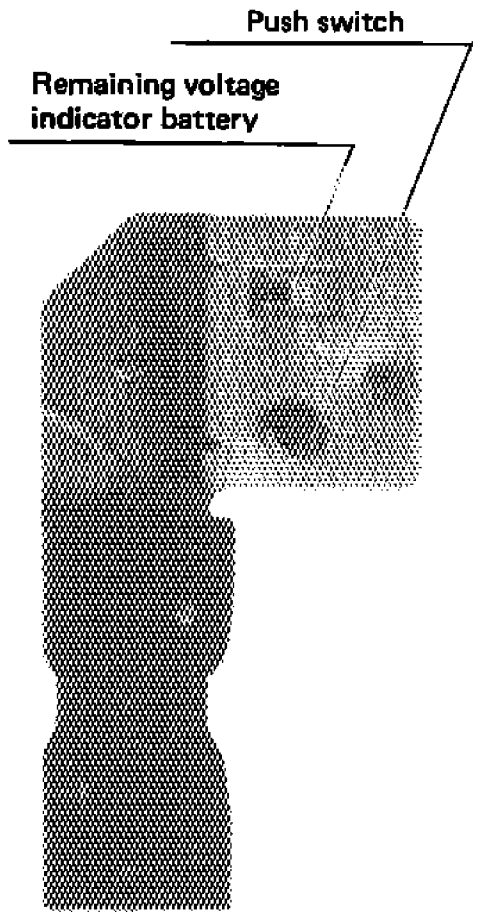
Residual voltage indicator



Timer (quartz motor speed reducer) (WKM-AA012)



Accessory (anti-vibration rubber : 5 pcs)



Residual voltage indicator battery (DKM-AA003)

3) Timer (quartz motor speed reducing gear)

a) Replacement interval

- When the quartz motor does not function even though residual voltage battery is normal.
- When the timer loses over three hours a day.

b) Replacement method

- Remove the recording panel to remove the wiring. Loosen the screws (5 pcs) to remove the timer, and replace the timer with a new one.
- When replacing the timer, also replace the antivibration rubbers (5 pcs). The red wire is for (+) and the black wire for (−), therefore, connect the red terminal with red and the black with black. Tighten the anti-vibration rubbers with torque of 4 ~5kg-cm.
- Ensure that the quartz motor functions correctly after replacement.

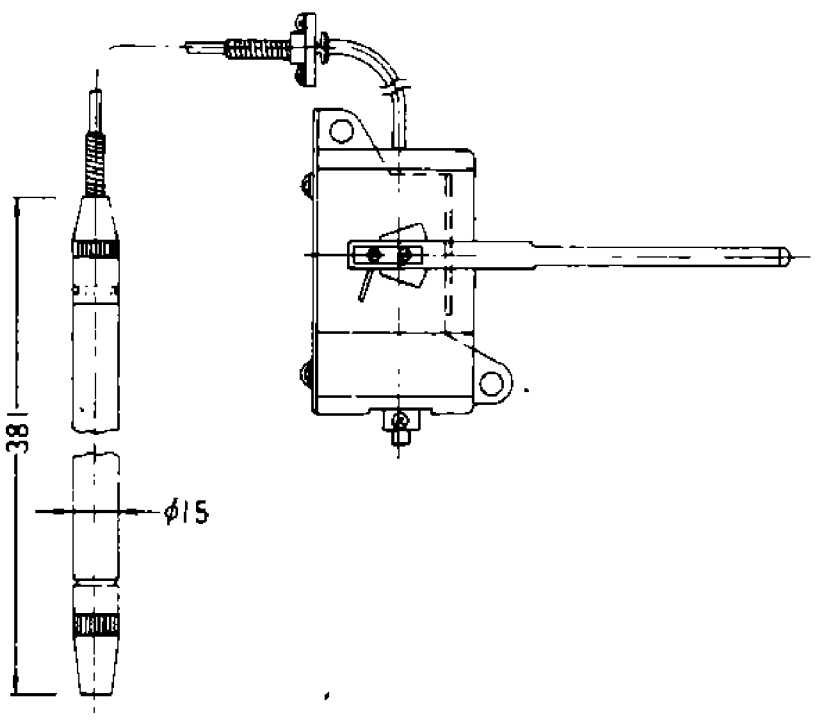
4) Thermal feeler bulb

a) Replacement interval

- After the pen has been adjusted and the controller has been operated within the temperature range of −18 to +10°C (−0.4 to 50°F), with the inside temperature stabilized at the temperature setting: When the temperature indication under the above conditions deviates by more than 2°C (4°F) against the temperature setting. (When the temperature indication is substantially less than the temperature of the thermal feeler bulb, gas leakage may be suspected.)

b) Replacement method

- Loosen the screw and remove the thermal feeler bulb − element. Replace it with a new one.
- After replacement, inspect and adjust.

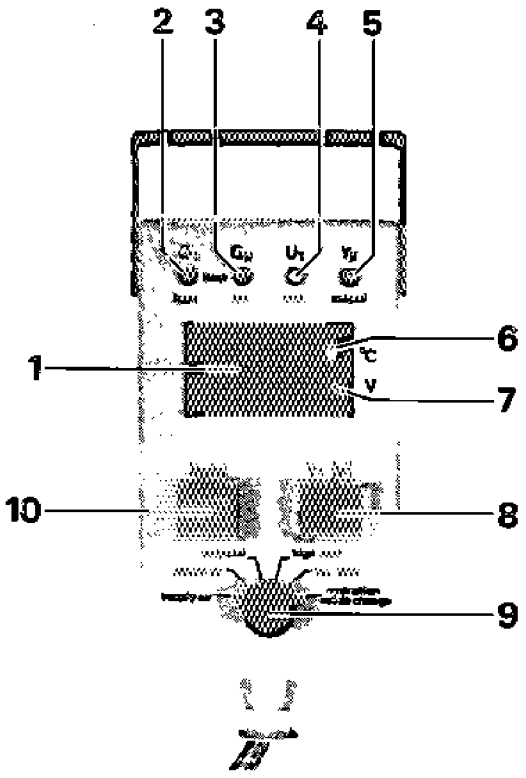


Thermal feeler bulb SKM-AA001

4.3.6 Check instrument

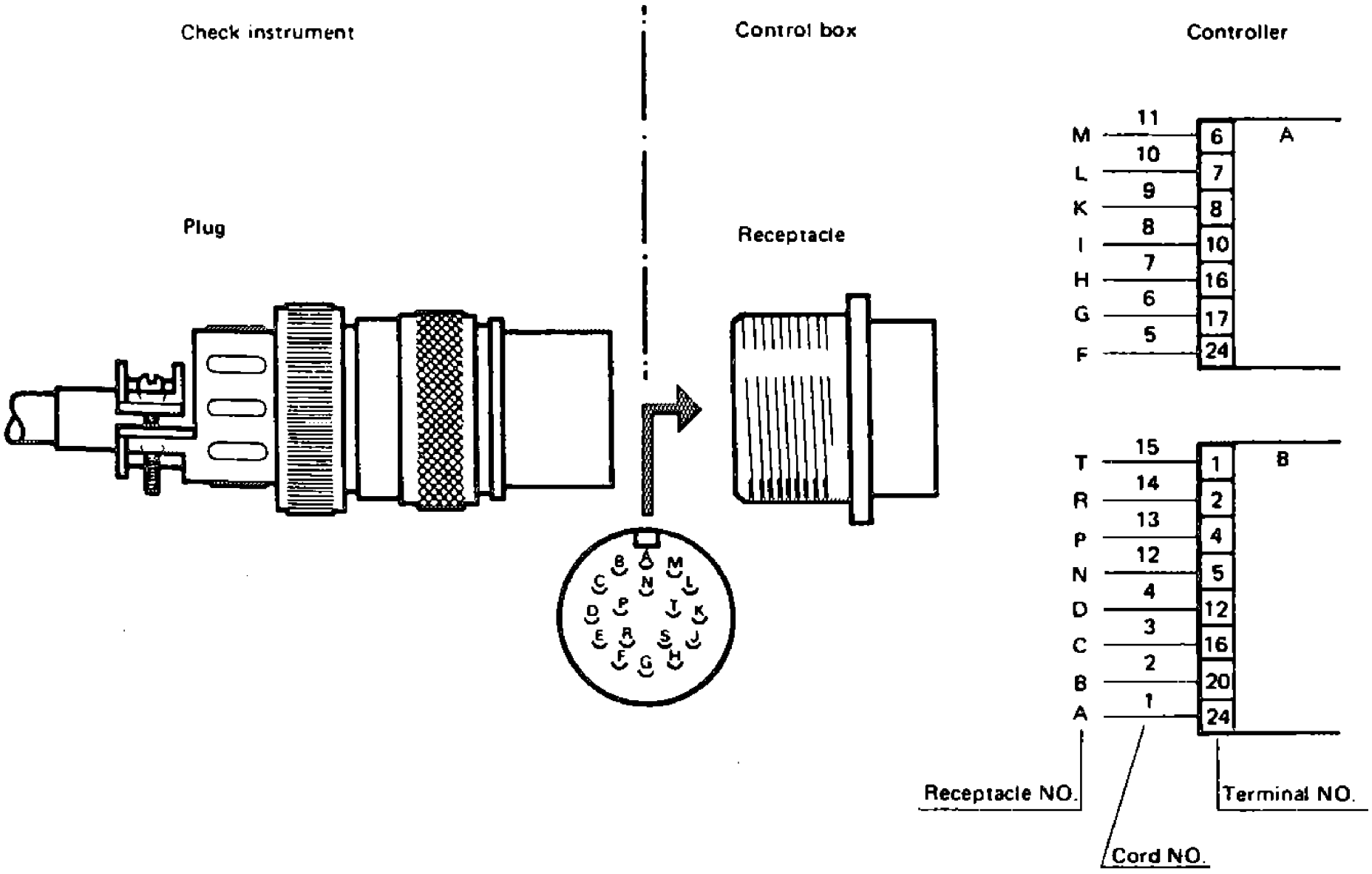
Connect the plug of the check instrument to the receptacle on the front panel of the control box, and check the following, operating the unit.

Note: when the check instrument is used do not subject it to direct sun light. Further, each inspection and adjustment should be done after 10~20 minutes energization.



1 Liquid crystal indication
2 Alarm temperature too high ——G_1
3 Alarm temperature too low ——G_2
4 Chilled operation ————U_1
5 Electrical heating "on" with chilled operation
compressor "stop" with frozen operation } Y_2
6 Lamp for temperature indication —·—C°
7 Lamp for voltage indication
8 Modulating valve voltage button } V(Y_1)
9 Selector for:
—Setting upper limit
—Setting lower limit
—Setting operating mode change-over point
—Supply air temperature
—Return air temperature
—Setpoint
10 Scale illumination button

Note: 2 ~ 5 signify the state when the lamp lights up



4.3.7 Checking operation of the controlling devices

Note : Before checking, operate the compressor for 10 minutes.

Test procedure	Operating stage (Module)	Standard value		Measuring points			Possible causes of deviations from the standard value	Action
		Check instrument	Digital volt meter $R_i \geq 10k\Omega$	Controller terminal	Set point selector terminal	Test socket		

1. The various test steps must always be carried out in this order.
2. Description of control operating stage to be tested
3. These standard values can be tested with the check instrument.
4. Without a check instrument, the standard values can be tested with a digital voltmeter.
5. Where the values measured with the check instrument or the digital voltmeter differ from the standard values, the possible causes of this are listed in this column.
6. The action to be taken is listed in this column.

Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min >10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
1	**A/C power supply**	Yellow "light" button depressed, display illumination ON					Controller and test socket disconnected	Check wires and connections
			24V $^{+15}_{-10}$% 50···60Hz	B1 B2			Mains switch off Control switch off Fuse defective	Check devices
2	**DC power supply** Power section	Indicator lamp Y_2,U_1,G_1,or G_2 illuminates					Controller and test socket disconnected	Check wires and connections
			22V $^{+15}_{-10}$ %	A24 B4			Rectifier defective	Replace controller board or rectifier
3	**DC power supply** Bridge	Selector on in "setpoint" position, indication same as selected setpoint Tolerance ±0.3°C					Controller and test socket disconnected	Check wires and connections Measure with digital voltmeter as per test procedure 3a
3a			−15V ±0.05V +15V ±0.05V		6(⅄) 5 6(⅄) 4		Controller and setpoint selector disconnected	Check wires and connections Measure with digital voltmeter as per test procedure 3b
3b			−15V ±0.05V +15V ±0.05V	A24 A20 A24 A22			DC supply defective Possible cause: short circuit with earth potential	Replace controller board Measure resistance between terminal A24 and Standard value: >600kΩ
4	Setpoint selector	Selector in "setpoint position Indication of same value as setpoint selector Tolerance ±0.3°C					Controller and test socket disconnected Controller and setpoint selector disconnected	Check wires and connections Measure with digital voltmeter as per test procedure 4a
4a			0.017V··· 9.983V DC see table "temperature/voltage convertion"		6(⅄) 7		Setpoint selector	Replace setpoint selector
4b			0.017V··· 9.983V DC see table "temperature/voltage convertion	A24 A10		F J	Controller and setpoint selector disconnected	Check wires and connections
5	**Supply air sensor** (sensor signal X_1)	Selector in "supply air" position Indication of same value as the temp. measured in the supply air (−30···+30°C)					Disconnection	Measure with digital voltmeter as per test procedure 5a

Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min >10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
5a			0···10V DC see table "temperature/ voltage convertion"	A24 A16		F H	Controller and test socket disconnected	Check wires and connections
							Controller and sensor disconnected	Measure sensor resistance. See table page "temperature VS. resistance" Replace defective sensor
								If the sensor is in order. replace controller board
6	**Return air sensor** (sensor signal X_2)	Selector in "return air" position Indication of same value as the temp. measured in the return air (−30···+30°C)					Disconnection	Measure with digital voltmeter as per test procedure 6a
6a			0···10V DC see table "temperature/ voltage convertion"	A24 A5		F G	Controller and test socket disconnected	Check wires and connections
							Controller and sensor disconnected	Measure sensor resistance See table page" temperature VS. resistance" Replace defective sensor
								If the sensor is in order. replace controller board
7	**Controller output Y,** (to control valve)	Depress blue button "Y, (V) "					Connection between controller and test socket reversed	Check wires and connections
	Set setpoint selector at −29°C	Indication 0V					Controller and test disconnected	Check wire and connections
	Set setpoint selector at +29°C	Indication 15···20V DC						Measure with digital voltmeter as per test procedure 7a
7a			0···20V DC	B4(+) B5		P(+) N	External short circuit between terminals B4 and B5 on controller	Rectify short circuit (protective diode (CPD), see "MC valve"
							Transistor fuse defective	Replace transistor fuse see "controller-b"
8	**Controller output Y_2** (on/off)							Check wires and Measure with digital voltmeter as per test procedure 8a
	Set setpoint selector at +29°C	Lamp Y_2 illuminated					Controller and test socket disconnected	
	Set setpoint selector at −29°C	Lamp Y_2 off					Connection between and test socket reversed	

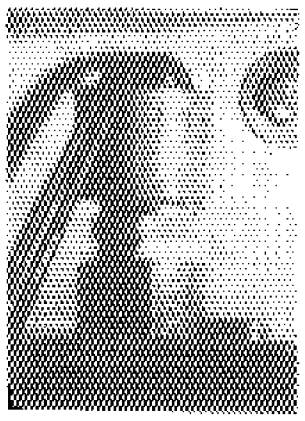
Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min >10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
8a	Set sepoint selector at −29°C		0V			P D	Connection between controller and test socket reversed	Check relay Y_2 −29°C=B11—B9 (contact closed)
				B4 B12			Controller defective	+29°C=B11—B10 (contact closed)
	Set setpoint selector at +29°C		22V DC +15% −10%			P D	Controller and test socket disconnected	Check wires and connections
				B4 B12			Controller derfective,	Replace controller board
9	**Alarm unit G_1** "tempera-ture" too high	Selector in high limit position						
		Indication 2°C higher then setpoint Tolerance ±0.3°C					Controller and test socket disconnected	Check wires and connections
	Set setpoint selector at −29°C	Lamp G_1 illuminated after approx. 20_s					Controller and test socket disconnected	Check wires and connections
	Set setpoint selector at +29°C	Lamp G_1 off					Connection between Controller and test socket reversed	Measure with digital voltmeter as per test procedure 9a
9a	Set setpoint selector at −29°C		0V after approx 20_s			P A	Connection between controller and test socket reversed	Test relay G_1 "controller-b" −29°C=B23—B21 (contact close)
				B4 B24			Controller defective	+29°C=B23—B22 (contact closed) Check wises and connections
	Set setpoint selector +29°C		22V DC +15% −10%			P A	Controller and test socket disconnncted	Replace controller board
				B4 B24			Controllem defective	
9b								
10	**Alarm unit G_2** "tempera-ture "too low	Selector in "low linit" position						
		Indication 2°C lower than setpoinrt Tolerance ±0.3°C						
	Set setpoint selector at +29°C	Lamp G2 illuminated after approx 20_s					Controller and test socket disconnected	Measure with digital voltmeter as per test procedure 10_a
	Set setpoint selector at −29°C	Lamp G2 off					Connection between controller and test socket reversed	Check wires and connections

Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min >10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
10a	Set setpoint selector at −29°C		22V DC +15% −10%			P B	Controller and test socket disconnected	Check relay G2 "controller-b" −29.9°C=B19—B18 (contact closed) +29.9°C=B19—B17 (contact closed)
				B4 B20			Controller defective	Check wires and connections
	Set setpoint selector at +29°C		0V after approx. 20_s			P B	Connection between controller and test socket reversed	Replace controller board
				B4 B20			controller defective	
10b								
11	Operating mode change over U_1	Selector switch in operation mode change position Indication −4.5°C Tolerance ±0.3°C						
	Set setpoint selector at −29°C	Lamp U_1 off					Connecting between controller and test socket reversed	Measure with digital voltmeter as per test procedure 11a
	Set setpoint selector at +29°C	Lamp U_1 illuminated					Controller and test socket disconnected	Check wires and connections
11a	Set setpoint selector at +29°C		22V DC +15% −10%			P C	Controller and test socket disconnected	Check relay U_1 +29°C=B15—B14 (contact closed) −29°C=B15—B13 (contact closed)
				B4 B16			Controller defective	Check wires and connections
	Set setpoint selector at −29°C		0V			P C	Controller and test socket connections reversed	Replace controller board
				B4 B16			Controller defective	
11b								

4.4 Description of electrical function parts.

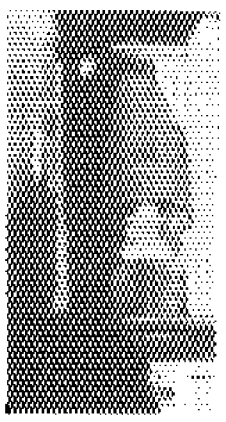
4.4.1 High pressure switch (HPS)

This switch causes compressor to stop, as the operation pressure of the unit has risen abnormally. Thus HPS is adapted to stop the compressor if the high pressure has gone up above its set value due to failure of condenser fan, obstructive passage to cooling water, etc.



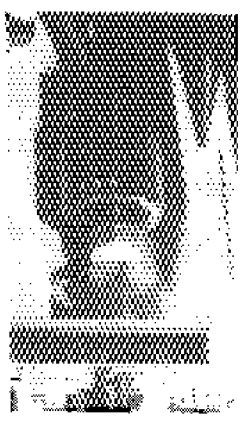
4.4.2 Low pressure switch (LPS)

This switch causes the compressor to stop when the operation pressure of the unit has dropped abnormally or when "pump down" operation has been conducted. Thus LPS is adapted to stop the compressor, if the low pressure has gone down below its set value if a result of "pump-down" due to stuffed cooling system or closed liquid line solenoid valve.



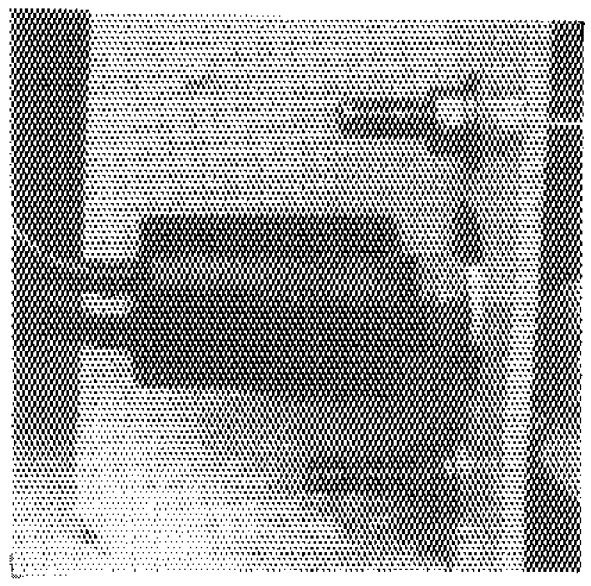
4.4.3 High pressure control switch (HPCS)

If the ambient temperature is low during air cooled operation, two out of three condenser fans are turned off so that the high pressure should not fall. (As for more details, refer to "high pressure control")



4.4.4 Water pressure switch (WPS)

This switches over air and water cooled modes. If coolig water flows and water pressure rises above a preset water pressure at the inlet, the contact is turned off to stop the condenser fan motor and water cooled operation will start



4.4.5 Defrost termination thermostat (23D)

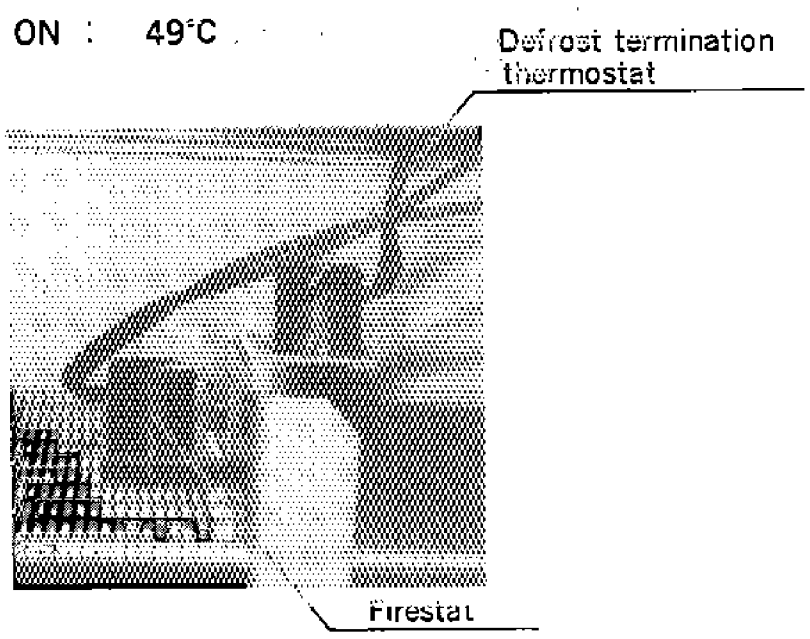
This senses surrounded temperature around the thermostat and will terminate defrosting.

OFF : 40°C
ON : 20°C

4.4.6 Firestat (26AH)

This prevents the electric heaters from overheating. If the heaters is overheated, the ambient temperatur around the thermostat rises and the thermostat cuts off the heaters.

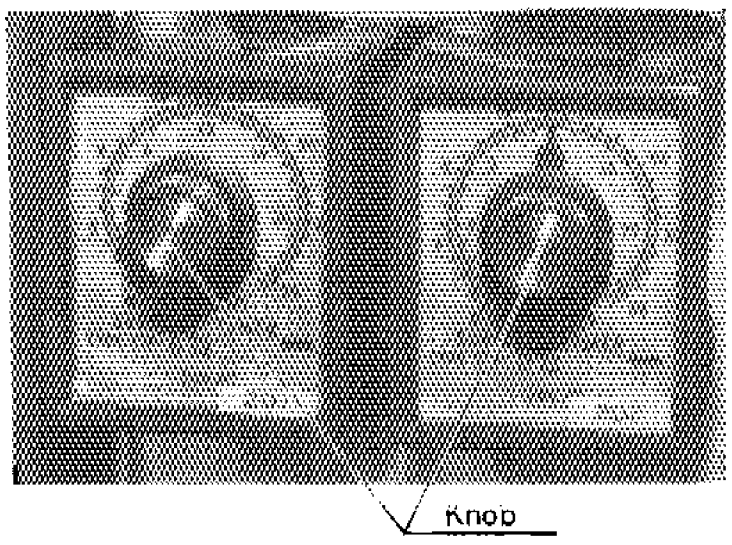
OFF : 71°C
ON : 49°C



4.4.7 Defrost timer (2D1, 2)

The defrost timer activates defrosting operation forcedly in preset intervals. The timer setting is determined freely with a knob. However, do not adjust it while operating, or do not set to "0" (hr) it may cause trouble or erratic operation.

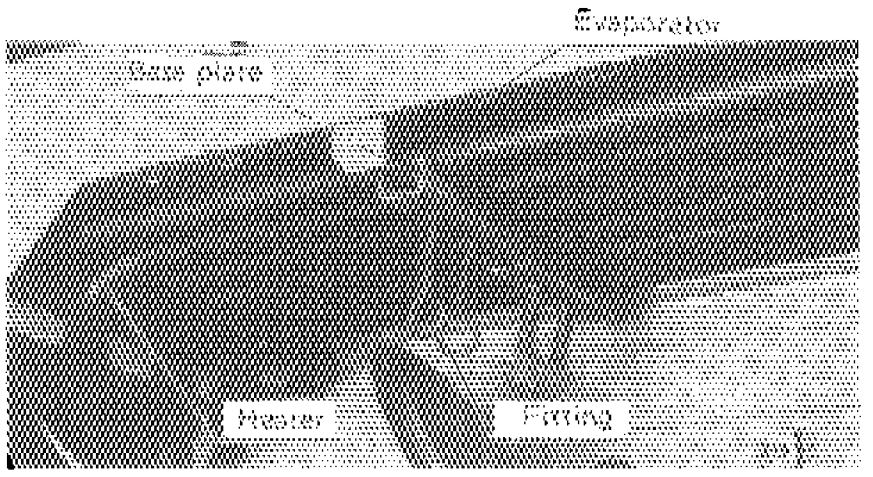
- Once power has been turned off, the timer is reset to the initial state.



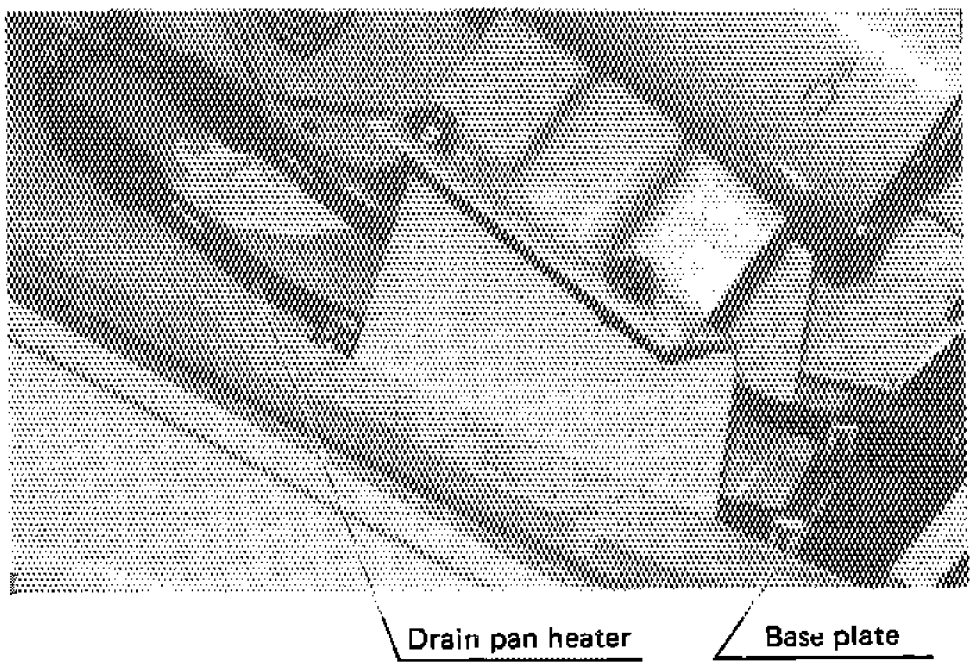
4.4.8 Electric heaters

Two kinds of electric heaters are used.

(a) Defrost heaters (220V AC, 0.65 kW × 6)
These are fitted at the bottom of the evaporator. H1 through H6 are used for defrosting. H1 and H2 are used as auxiliary heaters during heating operation. To replace them, lift the fittings up and remove them together with the base plate.

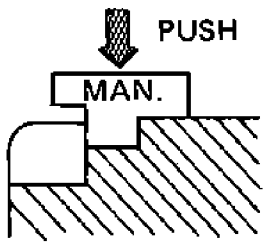


(b) Drain pan heaters (220V AC, 0.3kW × 2)
These are fitted on the drain pan to prevent the drain port from freezing (H7 and H8)

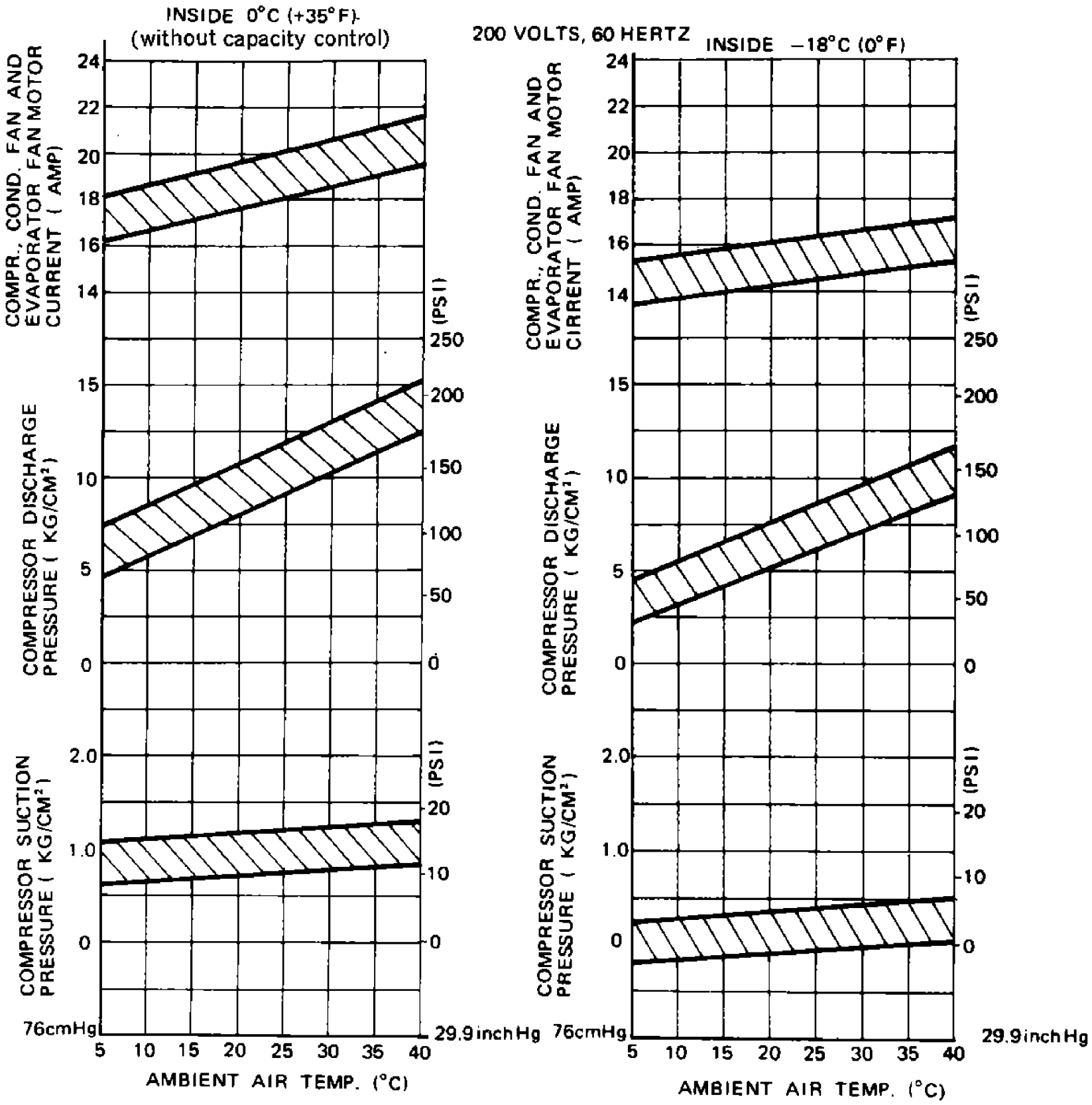


4.4.9 Over current relay (51C)

Over current relay in the electric cotrol box is manual reset type. Push green button to reset when over current relay works for over current protection to the compressor.



5. Operating pressure and running current



〈For reference〉

	Item		Unit	Value
1	Heater current−during defrosting measure at primary side of 88H		A	11.5 (AC220V)
2	Running current of condenser fan motor		A	0.7 (AC220V)
3	Running current of evaporator fan motor		A	3.0 (AC220V)
4	Bolt tightening torque	Compressor	Kg-cm/lb-ft	435/36
		Compressor stop valve flange		255/21
		Fan motor		125/10
		Solenoid valve		55/4.3
		Expansion valve		250/20.5
		Fan		55

Note) Allowable range of tightening torque; ±10%.

6. Troubles and countermeasures

If the unit does not work properly, inspect it in accordance with "Troubles and countermeasures" to find cause of trouble and repair it.

Troubles and countermeasures

State	Phenomena	Functioning places	Cause	Countermeasures
I. Operation inoperative	A : Condenser evaporator fans and compressor are inoperative.	a. No trouble with unit	Current interruption Power source is disconnected.	Trace cause Connect power source plug to power source.
		b. Circuit breaker function (main circuit)	It functions due to over current.	Trace causes and replace.
		c. Circuit breaker function (control circuit)	It functions due to over current.	Trace causes and replace.
	B : Evaporator fans operate but condenser fans and compressor inoperative.	a. No trouble with unit	The unit halts by function of the temperature controller	
			Setpoint selector is high	Readjust temp. setting as designed.
		b. Solenoid valve does not function. (Liquid line)	Coil is cut out.	Replace it.
		c. Controller malfunctions.	Sensor is damaged or other reasons.	Replace it.
II. Operation stops soon	A : Condenser fans and compressor stop, keeping evaporator fans in operation.	a. No trouble with unit.	Controller functions and stops unit.	
	B : Condenser fans and compressor operate on and off repeatedly with evaporator fans.	a. High pressure Switch functions	Excessive charge of refrigerant.	Discharge refrigerant.
			Air in system	Air purge
			Insufficient air flow for air cooled operation.	
			Condenser or passage clogged.	Clean or remove obstacles
			Fan blade damaged.	Repair or replace.
			Fan motor does not rotate.	
			Capacitor inoperative.	Replace it.
			Fan motor thermostat has functioned.	Trace causes.
			Insufficient water volume for cooling operation.	
			Condenser is clogged with scale.	
		b. Lower pressure Switch functions	Insufficient refrigerant charge.	Additional charge, seek leaking positions and repair.
			Dryer clogging	Replace
			Moisture chokes	Exchange dryer.
			Gas leakage from feeler tube of expansions valve.	Exchange it.

State	Phenomena	Functioning places	Cause	Countermeasures
III. Inside temp. is lower than temperature setting		c. Over-current relay or compressor protection thermostat has functioned.	Excessive large current due to over-load operation.	Trace causes.
		d. Over current relay or high pressure switch has functioned	Inlet line solenoid valve does not close due to stuffing of dust. Compressor capacity protection thermo. does not function.	Adjust or replace thermo.
	A : Compressor inoperative.	a. Solenoid valve will not close.	Blocked with dust.	Replace it.
		b. Controller does not function.	Sensor is disconnected	Replace it.
		c. Sensor is installed wrongly.		Reattach it.
	B : Hot gas bypass does not work	Modulating control valve does not open	Blocked with dust Controller is defective	Repair or replace Replace transistor or controller
IV. Inside temperature does not drop	A : It does not reach the set temperature. (Fan and compressor are in normal state.)	a. Modulating control valve does not close.	Stuffing of duct, etc	Repair or replace valves.
		b. Suction line solenoid valve does not open at pull down or frozen mode.	Stuffing of dust, etc. Suction solenoid valve does not function.	Clean, repair or replace suction line solenoid valves.
V. Inside temperature is not stable	A : Inside temperature is not stable during chilled and heating operations (Fans and compressor work properly)	a. Opening of modulating control valve (valve control voltage Y_1) is not stable	Controller is improperly adjusted	Adjust or replace
VI. Water cooled operation inoperative	A : Fans run continuously after water joints have been connected.	a. Water pressure switch does not function.	Insufficient cooling water volume (clogging or leakage of piping system).	Trace causes. Repair leaking point.
VII. Defrosting operation	A : Defrosting and refrigerating operation are repeated in a short period of time.	a. Defrost timer incorrectry set or faulty.	Improper adjustment	Readjustment

7. PTI (Pre Trip Inspection)

To keep the unit in good operating condition, check adjust or repair the unit when necessary. The following is the checking items of PTI (an example of container refrigeration unit checklist).

Example of container refrigeration unit inspection card

Container refrigeration unit inspection card — **DAIKIN INDUSTRIES, LTD.**

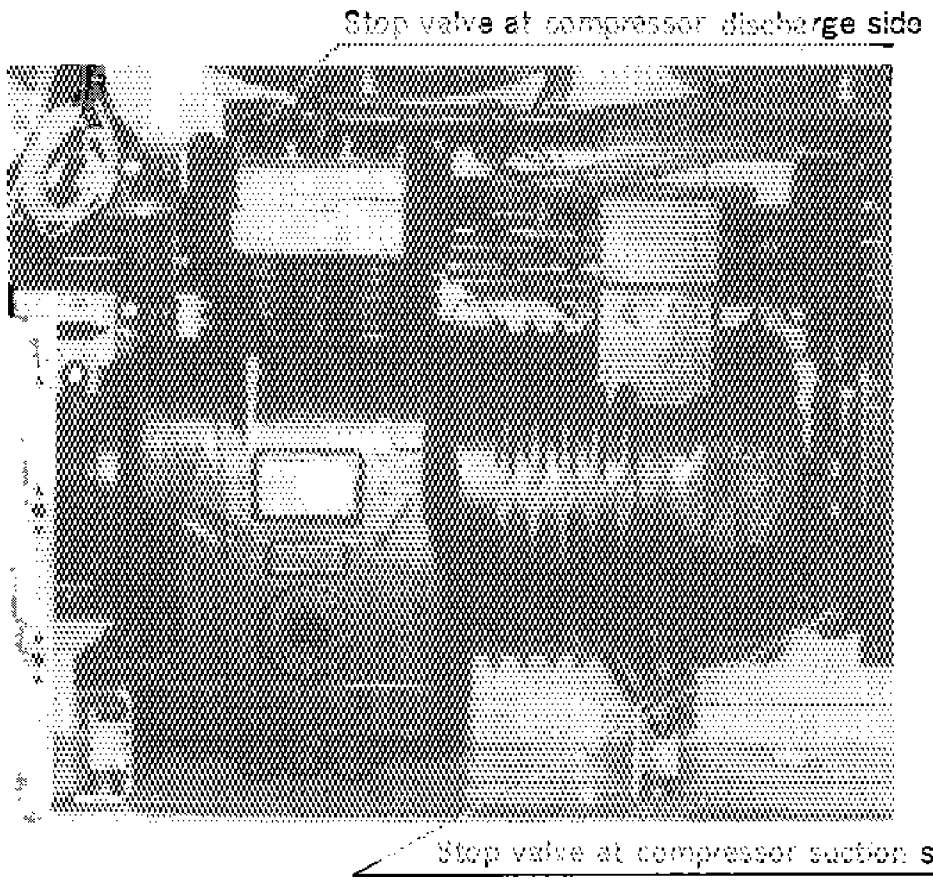
Ship's name		Unit Model		Date of Inspection	
Container No.		Unit No.		Place of Inspection	
Loaded or empty	Loaded cargo	Compressor No.		Customer's staff	
				Service staff	

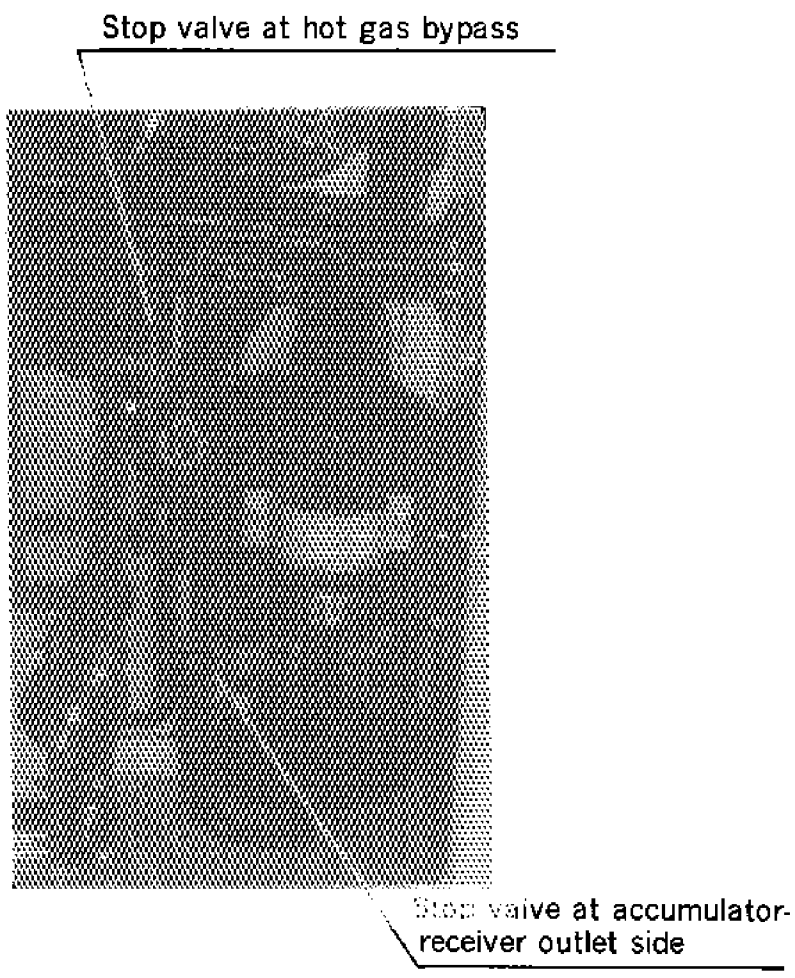
	No	Result DECOS	WKM	RMC	Check point	Check method	Reference valve
Check before operation	1				External appearance and installation of unit (doors, equipment mount, damaged points)	Visual	
	2				Cleaning interior and exterior of unit	Visual	
	3				Checking smudge of unit (air cooled condenser, evaporator)	Visual	
	4				Checking penetration between inside and outside of unit	Visual	
	5				Checking leakage of gas and oil on refrigerant circuit (mainly at joints)	Gas detector Visual	
	6				Checking external appearance of power cable and plug	Visual	
	7				Cleaning drain hose	Visual	Shall be free from clogging
	8				Mounted condition of electric heaters	Visual	Make sure that leads are not in contact with heaters
	9				Cleaning defrost air hose and checking that there is no trap on it	Visual	Shall be free from clogging
	10	/			Checking appearance of firestat	Visual	Shall have no damaged part
	11		/	/	Checking appearance of over heat thermistor	Visual	Shall have no damaged part
	12				Tightened condition of cable glands and monitoring receptacle	Retighten	Make sure that they are firmly tightened
	13				Checking installation bolt of compressor, fan and fan motors	Retighten with tool	Make sure that they are firmly tightened
	14				Clearance between fan and fan guide	Visual	Shall be kept suitable clearance
	15				Sealing at control box, and PS box, etc	Visual	Packing and sealing Shall have sufficient contact
	16				Slackness of electric terminals and appliance installation	Visual, driver	
	17				Thermal injury of contactors, relays, and coils	Visual	
	18				Insulation resistance: Compressor circuit ☐ MΩ; Electric heater circuit ☐ MΩ; Evaporator fan motor circuit ☐ MΩ	DC 500V megger	2MΩ or more
	19				Checking operation of defrost initiation air switch	Check with manometer	5HP 20 mm H_2O CUT IN 7 ½HP 25 mm H_2O CUT IN
Check during operation	20				Checking operation of oil pressure switch	Confirm normal function during running	1.0 kg/cm² (110Sec. at 25°C) 0.5 kg/cm²
	21				Checking noise and vibration of compressor, fans and fan motors	Touch and listen	
	22				Checking circulating refrigerant	Check liquid indicator	Make sure that it is filled
	23				Checking water ingress in refrigerant	Check liquid indicator	Green···sporlan/Deep blue···Alco
	24				Checking compressor oil level (operating condition)	Check at compressor oil level gauge	⊖ (Oil level 1/4 ~ 3/4)
	25				Checking operation of controller and pilot lamps	Check with changing temperature setting and check pilot lamps	
	26				Checking accuracy of recorder (at inside temperature 0°C)	Measuring temperature with controller or thermometer	
					Confirming function of recorder and battery	Visual or check with battery checker	
	27				Checking manual defrosting operation	Manual defrost switch or test switch on controller	
	28				Electric heater Operation and current R ☐ S ☐ T ☐	Clamp meter	
	29				Checking function of defrost thermination	Visual (lamp or controller)	
	30				Unit operation current R ☐ S ☐ T ☐	Clamp meter 18 C ☐ V ☐ Hz	
	31				Checking operation of dual pressure switch: H-CUT OUT ☐ kg/cm²	Blind air inlet	20 kg/cm²
					L-CUT OUT ☐ mm Hgv	Accomplish pump down by use of the stop valve at the accumulator receiver or water cooled condenser	40 mm Hgv
					L-CUT IN ☐ kg/cm²		0.2 kg/cm²
	32				Checking operation of water pressure swith: Checking switch over from water-cooled to air-cooled operation	Disconnect water coupling	Condenser fan motor shall operate
					Checking switch over from air-cooled to water-cooled operation	Connect water coupling and supply water	Condenser fan motor shall stop
	33				Checking voltage change over: Checking 200V class operation	Turn voltage selector lever upward (LKE TYPE) downward (LK TYPE)	
					Checking 400V class operation	Turn voltage selector lever downward (LKE TYPE) upward (LK TYPE)	
	34				Inside temperature °C	0°C / -18°C	Automatic operation at 18°C
					Ambient temperature °C		in one cycle
					LP kg/cm²		COMP, OFF ☐ M
					HP kg/cm²		COMP, ON ☐ M
					Operating time — Immediately after operation: Operation ☐ Hr; Starting 0°C ☐ M	Operation ☐ Hr; Starting 18°C ☐ M	Automatic ☐ Hr; Operation ☐ M
					Operation Starting time ☐ ☐		
	35				Checking automatic defrosting — Defrost time ☐ M	Push the "DEFROST TEST" → defrost starts after taking (DECOS ONLY)	out-range : 14sec in-range : 43sec.
Check after operation	36				Place new chart		
	37				Close control box and PS. box, etc.		
	38				Record details of service on history cards		

8. Maintenance Procedures

8.1 Handling method of the stop valve

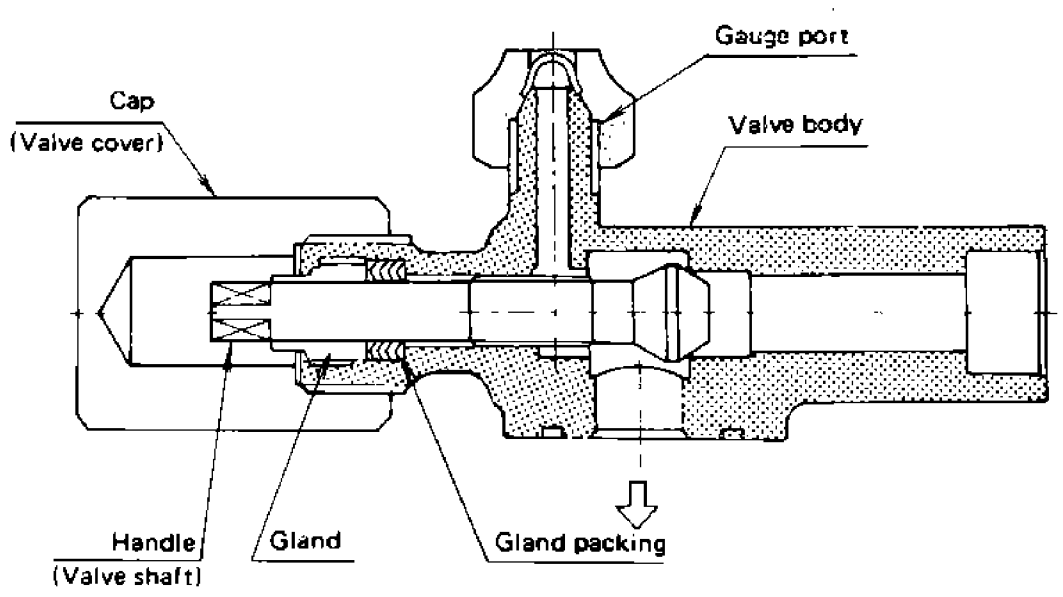
(1) Position of shut off valves



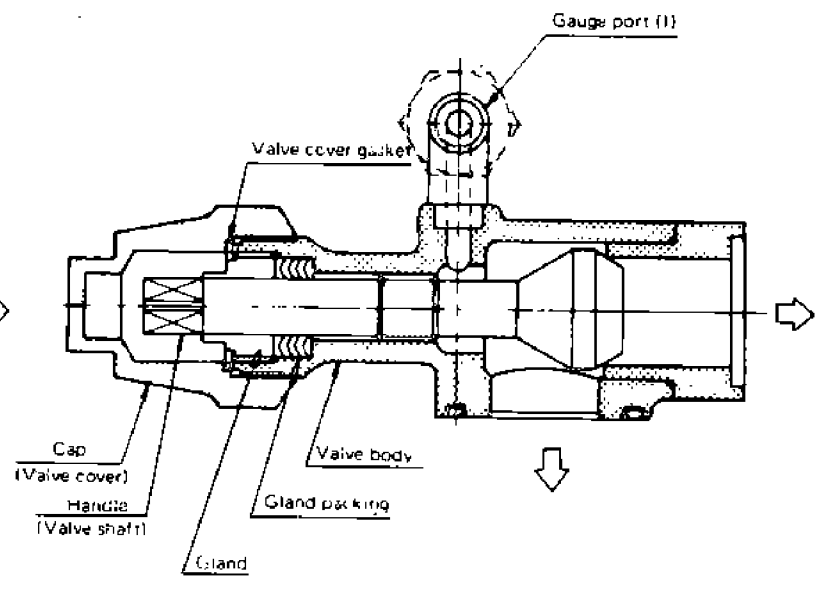


(2) Structure of stop valve

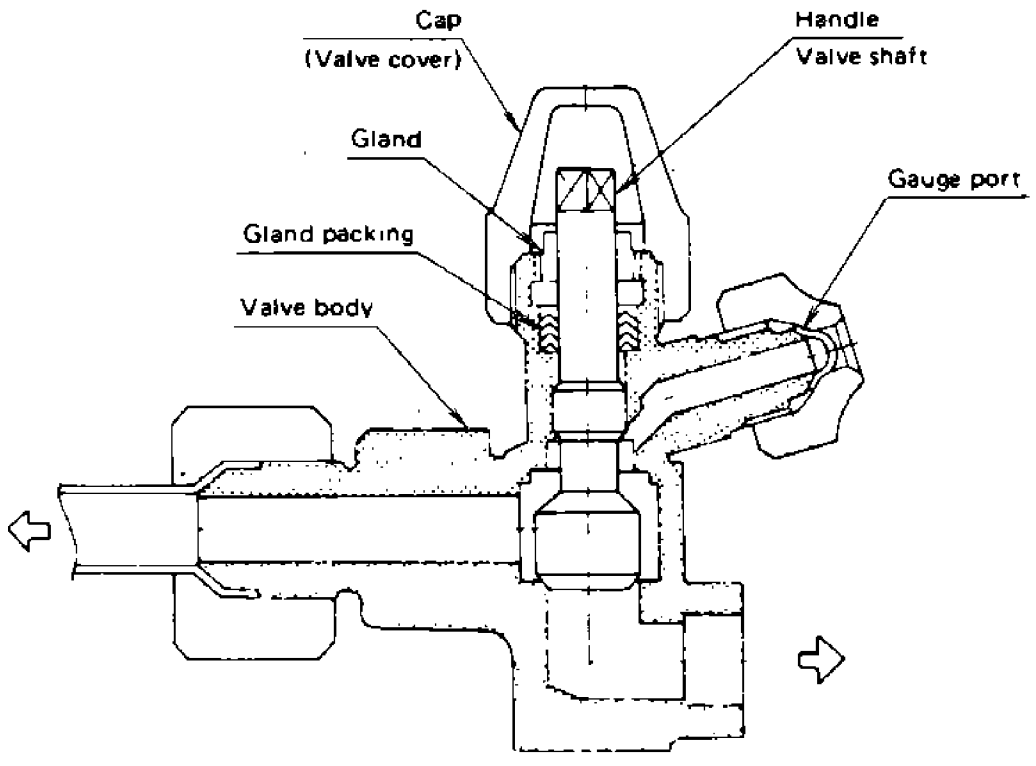
1 Stop valve at compressor discharge side
(VSH10VAP-5S)



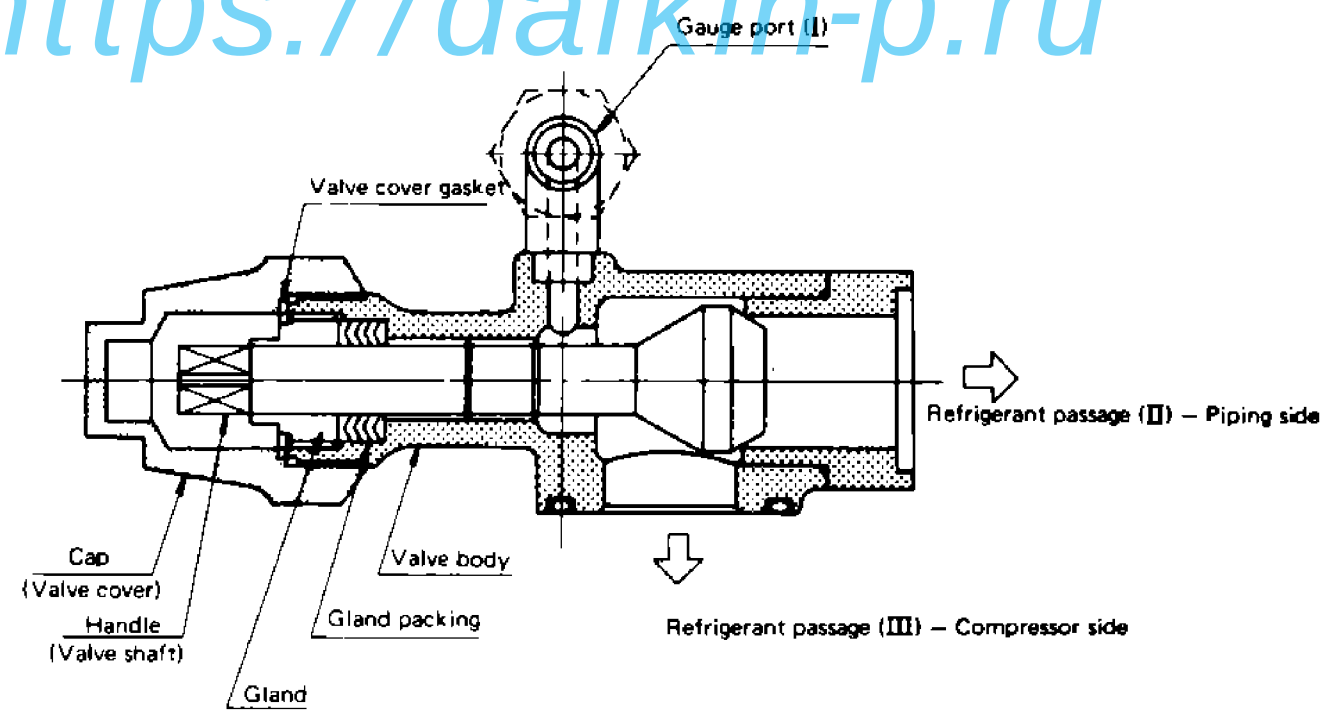
2 Stop valve at compressor suction side
(VSH22XBP)



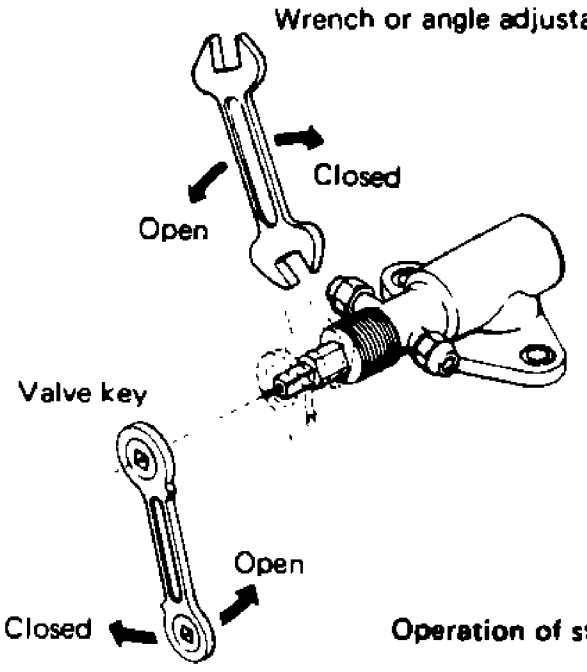
3 Stop valve at accumulator-receiver with heat exchanger outlet side
Stop valve at hot gas bypass
(VSH10CBP-4S-4F)



(3) Handling method



1) Remove the valve cap. At this time, be careful not to lose the gasket.
2) Loosen the gland in a way the refrigerant is not extracted.
3) Fully close the handle ·····The refrigerant passage I is connected to III (Front seat)
4) Fully release the handle·····The refrigerant passage II is connected to III (Back seat)
5) Set the handle at the neutral position
·····The refrigerant passage I is connected to II and III.
6) The refrigerant passage differs with the procedure mentioned in 3,4, or 5. So select the best passage by necessity.
7) Operate the handle, tighten the gland and place the valve cap as it was after completion of the work. At this time, do not forget to attach the gasket.

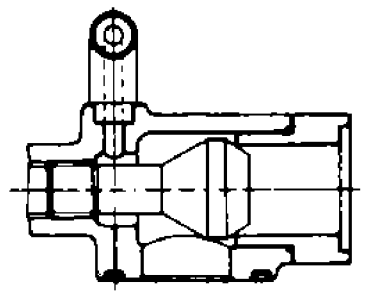


Operation of stop valve

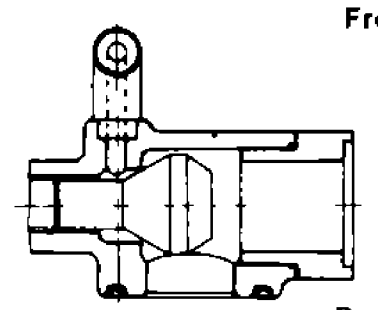
8.2 Attaching or removing points of pressure gauge

(1) Attaching a general pressure gauge

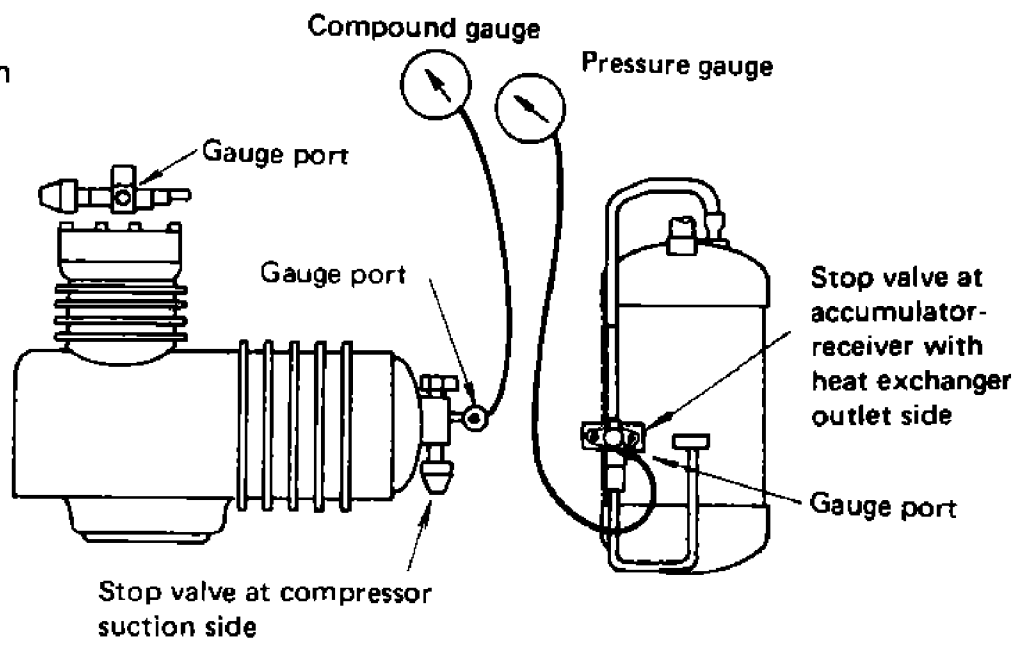
1) After opening the compressor suction valve and the accumulator-receiver valve fully (back seat),connect a pipe to the gauge port.
2) Loosen a little the flare nut on the pressure gauge side and tighten the handle of the stop valve a little (Middle seat) and return it at once. Thus the air is purged.
3) After purging the air, accurately tighten up the flare nut on the pressure gauge side.
4) Close the handle of the stop valve a little, and confirm that the needle of the gauge rises.
5) Be certain that the needle of the pressure gauge does not oscillate during the opération of the unit. If it oscillates, do not close the gauge port fully and open the handle of the stop valve a little.
6) In case the pressure gauge is attached to the low pressure side, if the low pressure is lower than the atmospheric pressure, the air is drawn in the piping during the air purging. So install the pressure gauge after confirming that low pressure is higher than the atmospheric pressure.
7) Operate the unit and confirm that the unit is stopped without pump down.



Front seat

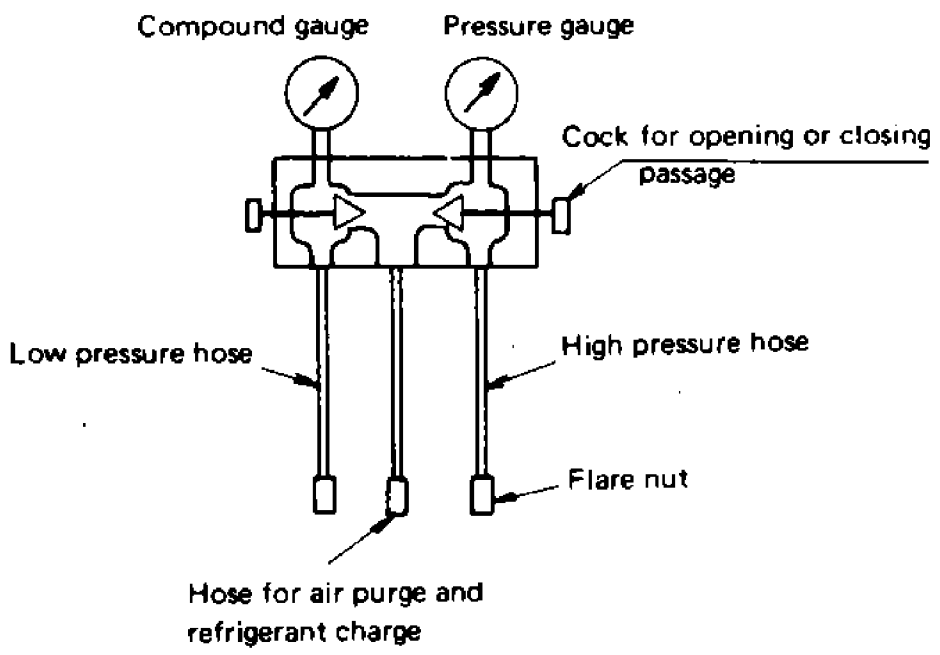


Back seat

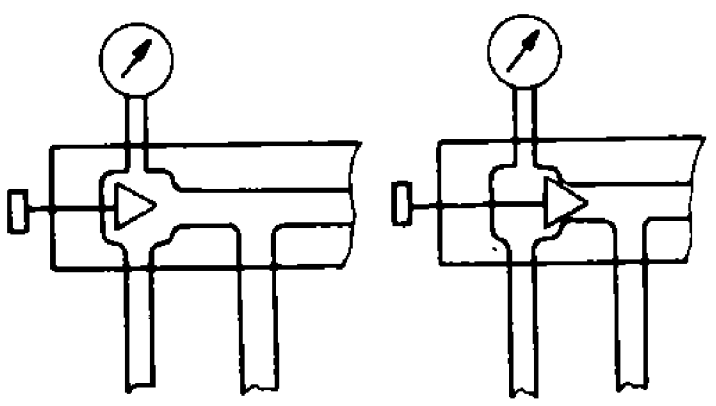


(2) Attaching the gauge manifold

1) With regard to mounting points, note the same caution as that for general pressure gauges.
2) Open the cocks which are attached to the both sides of the gauge manifold when mounting, Loosen the blind cover of the centre hose, and close the gauge port for the compressor suction valve and the accumulator-receiver outlet valve. (Back seat)
3) Attach the flare nut of the hose of the manifold on the high pressure side tightly and on the low pressure side loosely.
4) Loosen the accumulator-receiver outlet valve and vent the air from the hose on the low pressure side and the centre hose and then once again keep the stop valve in the back seat state. After that, tighten up the flare nut on the low pressure side.
5) After closing the cocks of the gauge manifold, keep the cock of the compressor suction valve and accumulator-receiver outlet valve at the neutral seat and measure pressure.



Structure of gauge manifold



Opening state Closing state

Opening and closing states of gauge manifold

(3) Removing the pressure gauge and the gauge manifold, as stated below.

When the high pressure hose is removed, note that the liquid refrigerant in the hose may jet out, which is very dangerous.

1) Hold the handle of the stop valve in the back seat state, and close the gauge port.
2) Open the cock (in case of gauge manifolds) or the flare nuts (in case of genral pressure gauges) a little to extract the refrigerant from the hose. At this time, do not open it suddenly so as not to jet out liquid refrigerant.
3) After extracting the refrigerant from the hose, remove the pipe connection for the gauge piping.
4) Place the blind cover on the gauge port of the stop valve, accurately tighten up the flare nut and confirm no refrigerant leaks.

Note: Since the blind cover is very small, be careful not to loose it.

8.3 Pump down

Pump down means that the refrigerant in the refrigeration circuit is liquidized and collected in the Accumulator-receiver with heat exchanger, This work is required to repair the refrigeration circuit for minimizing leaking volume of the refrigerant and risks due to pressure rising.

〈Working procedure〉

1) Install pressure gauges to the high pressure side the low pressure side.
2) Operate the refrigeration unit (either on water cooled or air cooled operation)
3) Close the accumulator-receiver outlet valve.
4) Stop the operation when reading of the low pressure gauge becomes 0.1 kg/㎠ and close the compressor discharge valve.
5) After a short while, read the low pressure gauge. If pressure rises, open the compressor discharge valve and repeat the same procedure.
6) Repeat the same procedure two or three times, and the refrigerant is collected in the accumulator-receiver with heat exchanger. If no pressure gauge is attached, the unit is stopped by the low pressure setting of the dual pressure switch.

8.4 Charging and purging the refrigerant

(1) Purging non-condensable gas

If non-condensable gas such as air exists in the refrigeration circuit, it is collected by the accumulator-receiver with heat exchanger,wich raise pressure in the accumulator-receiver with heat exchanger abnormally high and reduces heat transferring ratio of the condeser surface. It is, therefore, very important to extract non-condensable gas.

If discharge pressure is abnormally high (even though cooling water volume is increased, in case of water cooled operation) and will not return to the normal pressure, inspect if non-condensable gas such as air exists with the following method.

● Stop the compressor, close the accumulator-receiver oultet valve and wait until leaving and entering cooling air (or water) of the air (water)cooled condenser. become equal. If there is any difference between saturated pressure corresponding to cooling air (water) and condensing pressure, non-condensable gas exists. In this case , purge non-condensable gas as stated below.

1) Accomplish pump down
2) Condense the refrigerant as much as possible, and then discharge it from the gauge port of the compressor discharge valve.
3) Discharge the condensed refrigerant repeatedly reading the pressure gauge until condensing pressure becomes saturated pressure.

(2) Refrigerant purge

Ther are two methods of refrigerant purge;i.e. one is for collecting the refrigerant extracted in a cylinder and the other is for discharging it to the atomosphere.

(a) Collecting the refrigerant in a cylinder

1) Prepare an empty cylinder which has been dried by forming vacuum inside and weigh it.
2) The cylinder is connected to the gauge port of the Accumu-receiver with heat exchanger by piping with the cylinder cock closed, and then loosen the flare nut on the cylinder side a little to vent the air from the piping.
3) Operate the refrigeration unit to pump down the refrigerant.
4) After completion of pump down, open the gauge port of the accumulator receiver with heat exchanger and then open the cock of the cylinder to collect the liquid refrigerant into the cylinder.
5) After collecting the refrigerant, close the gauge port and the cock and then remove the piping.
6) Be certain that the refrigerant has been collected in the cylinder by weighing it.
7) As for the refrigerant remaining in the refrigeration circuit, extract it to the atmosphere.

(b) Extracting the refrigerant to the atomosphere

1) Open the gauge port on the suction side of the compressor to extract the gaseous refrigerant to the atmosphere.
2) Do not open the compressor discharge valve or the gauge port of the accumulator-receiver with heat exchanger, otherwise the refrigerant oil and the liquid refrigerant are discharged, which may result in shortage of oil or getting chilblain.
3) Do not extract the refrigerant in a closed room and also confirm there is no fire around it. Although the refrigerant is non-toxic, there may be fear of suffocation. In addition, if the refrigerant contacts with fire, it yields phosgene gas (toxic gas).

(3) Vacuum drying and charging refrigerant and refrigeration oil

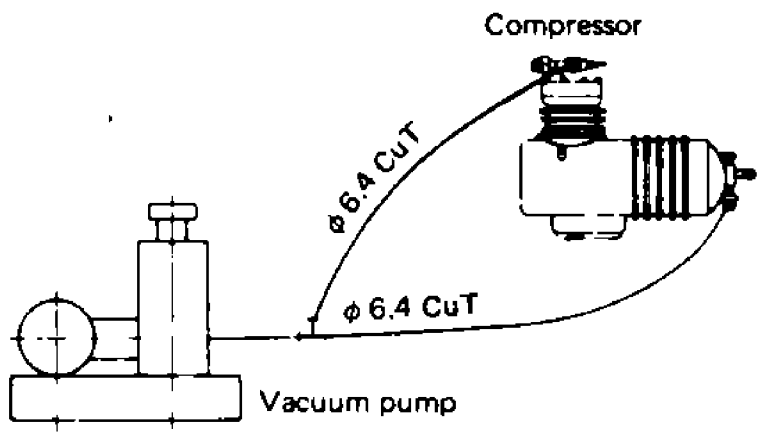
If all the refrigerant has leaked out and the air is intermixed in the refrigeration circuit, repair a cause of trouble and do vacuum drying. Then charge the predesigned volume of refrigerant. In case the refrigerant oil is replaced, do the same.

(Required tools)

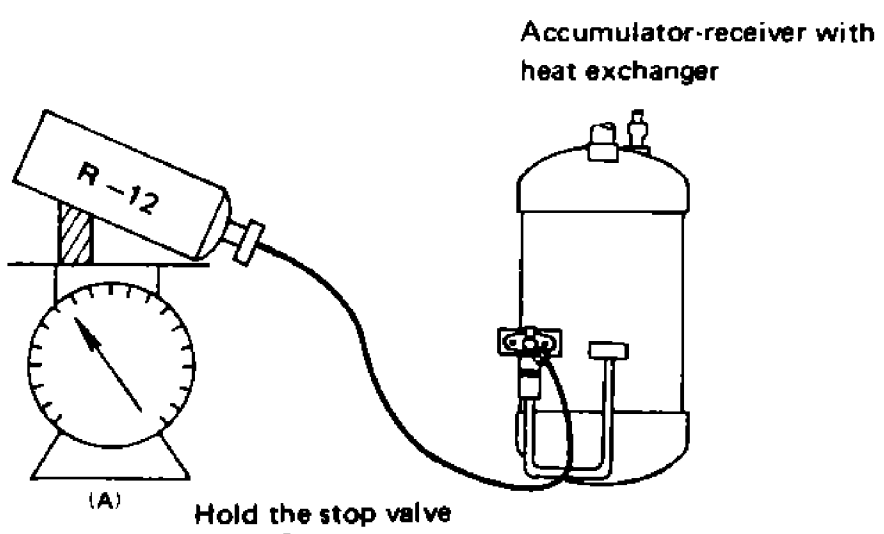
1. Refrigerant cylinder (20kg) for R-12 (CC12F2) with mouth piece
2. Refrigeration oil (20 ℓ can) SUNISO 3GS-DI)
3. ∅6.4CuT (with two flare nuts)
4. Pressure gauge (20kg/㎠), compound gaguge (10kg/㎠×75cmHg) } or gauge manifold
5. Weighing scale (Up to 50 kg)
6. Tools
7. Vacuum pump

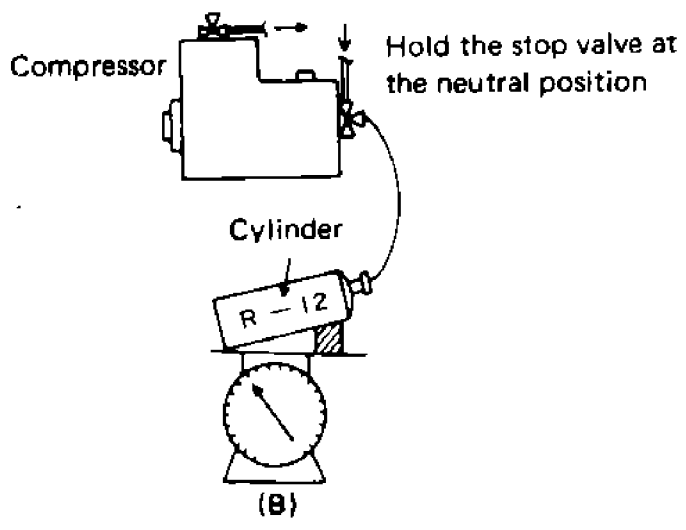
(a) In case the refrigerant is replenished without exchanging the refrigeration oil.

1) Connect the vacuum pump to the gauge ports of the compressor suction and discharge valves, form vacuum down to 76cmHg, hold the stop valve in the back seat state and then remove the vacuum pump, leaving the vacuum state in the refrigeration circuit. However, when air enters in the refrigeration circuit, form the vacuum in the circuit down to 76 cmHg and leave it for more than 2 hours (vacuum drying).



2) To evacuate the refrigeration circuit between the solenoid valve and expansion valve, reduce pressure of the circuit below the preset level of the low pressure switch lower the presetting level of the set point selector, operate the refrigeration unit, and open the solenoid valve for evacuation. At this time (vacuum drying), the compressor remains idle since the low pressure switch is off, and the solenoid valve alone open.

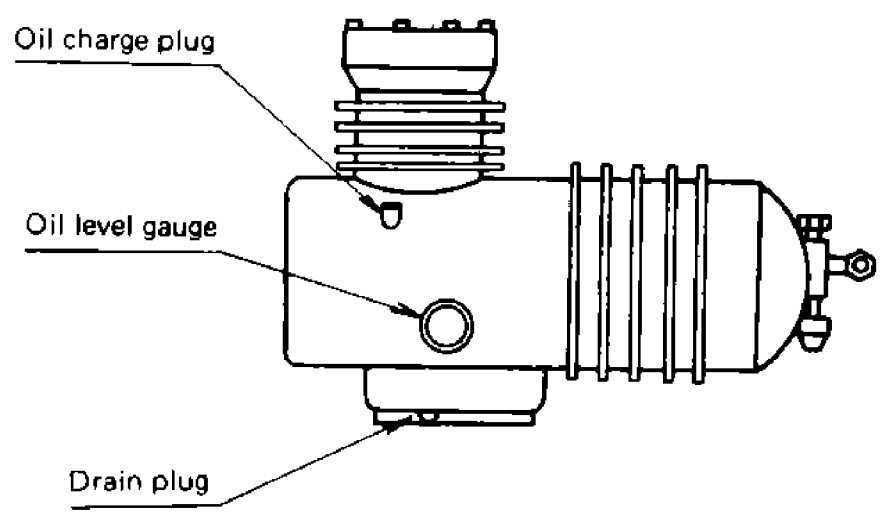




3) Place a refrigerant cylinder on the weighting scale, and record its weight.
4) In case the refrigerant is charged in the liquid state, do it as shown in the above figure (A). Prevent the liquid refrigerant collected in the accumulator-receiver with heat exchanger from flowing to the low pressure side. If the refrigerant is hardly charged, operate the compressor to charge it.
5) In case the refrigerant it charged in the gaseous state, do it as shown in the above figure (B). If the refrigerant is hardly charged, operate the compressor to charge it.
6) Charge the predesigned volume of the refrigerant in the above stated methods either in 4 or 5.
7) After completion of refrigerant charge, hold the stop valve in the back seat state and confirm that if the predesigned volume of the refrigerant has been charged by operating the refrigeration unit.

(b) Charging the refrigerant as well after replenishment of refrigerant oil

1) Extract the refrigerant oil.→Firstly discard all the gas so that pressure in the refrigerant circuit becomes 0. Then loosen the drain plug at the bottom of the compressor to extract all the oil. At this time, firstly open the oil charge plug and then the drain plug to prevent the oil from jetting out.



2) Tighten up the drain plug.
3) Charge the predesigned volume of the oil from the charge plug of the compressor.
4) Accomplish vacuum drying and refrigerant charge stated in (1).
5) Be sure to stop the compressor while this work is accomplished.
6) When the refrigeration oil is discarded, be sure to remove the oil level gauge for cleaning.
7) Recommendable refrigeration oil is SUNISO 3GS-DI. SUNISO 3GS-DI is superior to SUNISO 3GS in heat resistance.
   Maker of SUNISO 3GS—DI is SUN OIL CO., LTD. (U.S. A)
8) Do not mix two refrigeration oils.
9) Do not use oil which is left opened to the atomosphere for a long time, as it may contain water. In case oil still remains in the oil can after charging, be sure to cap it.

(c) In case only the refrigeration oil is exchanged.

1) Operate the refrigeration unit to pump down the refrigerant by use of the stop valve at the outlet of the accumu-receiver with heat exchanger and stop it when low pressure becomes 0.1Kg/㎠.
2) Tighten up the discharge valve of the compressor.
3) Open the gauge port on the suction side to extract the refrigerant on the low pressure side.
4) Charge the oil from the oil charge plug.At this time, form the vacuum gradually to hasten oil charge.
5) Restore the stop valve to its original state.

MODE / DEVICES	AIR COOLED OPERATION								WATER COOLED OPERATION
	SETPOINT SELECTOR								
	ABOVE −4.5°C (CHILLED MODE)					BELOW −5°C (FROZEN MODE)			
	COOLING		HEATING		DEFROST	COOLING		DEFROST	
	PULL DOWN	IN RANGE	PULL UP	IN RANGE		PULL DOWN	IN RANGE		
MAGNETIC SWITCH									●WATER COOLED CONDITION IS THE SAME AS AIR COOLED EXCEPT WATER PRESS-SWITCH OPEN AND COND-FAN MOTOR DE-ENERGIZED
COMP. CONTACTOR (88C)	E	E	DE	E	DE	E	E	DE	
EVAP. FAN MOTOR CONTACTOR (88F)	E	E	E	E	DE	E	E	DE	
HEATER CONTACTOR (88H1)	DE	PID	E	PID	E	DE	DE	E	
HEATER CONTACTOR (88H2)	DE	DE	DE	DE	E	DE	DE	E	
SHORT DEFROST TIMER (2D1)	E	DE	E	DE	DE	E	DE	DE	
LONG DEFROST TIMER (2D2)	E	E	E	E	DE	E	E	DE	
DEFROST AUX. RELAY(23D×1.2)	DE	DE	DE	DE	E	DE	DE	E	
COMP. CONTROL RELAY (2×4)	E	E	DE	E	DE	E	E	DE	
CHILL/FROZEN CHANGE OVER RELAY (2×5)	E	E	E	E	E	DE	DE	DE	
IN RANGE AUXILIARY RELAY (2×6)	DE	E	DE	E	DE	DE	E	DE	
LIQUID LINE SOLENOID VALVE (20R)	Ō	Ō	C	Ō	C	Ō	Ō	C	NOTE 1. E : ENERGIZED DE : DE-ENERGIZED Ō : OPEN C : CLOSE PID : OPERATED BY PID CONTROL
SUCTION SOLENOID VALVE (20SS)	Ō	C	Ō	C	Ō	Ō	Ō	Ō	
MODULATING VALVE (20M)	C	Ō	C	Ō	C	C	C	C	
COMPRESSOR	ON	ON	OFF	ON	OFF	ON	ON	OFF	
COND. FAN MOTOR	ON	ON	OFF	ON	OFF	ON	ON	OFF	
EVAP. FAN MOTOR	ON	ON	ON	ON	OFF	ON	ON	OFF	
LAMPS									
COMP (GREEN)	ON	ON	OFF	ON	OFF	ON	ON	OFF	
DEFROST (RED)	OFF	OFF	OFF	OFF	ON	OFF	OFF	ON	
IN RANGE (AMBER)	OFF	ON	OFF	ON	OFF	OFF	ON	OFF	
POWER (BLUE)	ON	ON	ON	ON	ON	ON	ON	ON	