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DAIKIN
Marine type
Container Refrigeration Unit

Service manual

Model
LKE8CD8

 **DAIKIN INDUSTRIES LTD**

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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 shut off.

CAUTION

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

NOTE

1. Confirm the function of the recorder and life of the battery when the chart paper is replaced with a new one.
2. Accurately tighten the covers for the control box not to make water leak in.
3. Confirm that the stop valves in the refrigeration circuits are opened before operation.
4. Be sure to check whether the cargos are cooled down to the temperature for transportation.
5. After operating the container refrigeration unit for service, wash the unit with fresh water, especially the external section of the unit carefully, because much salt sticks on the unit.

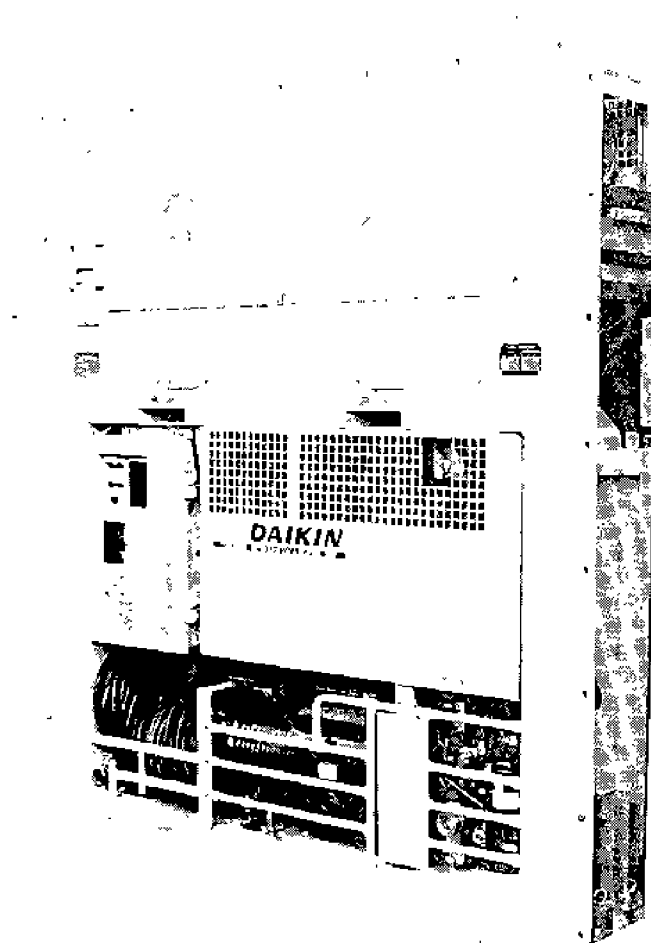
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1. Specification

1.1 General specification

Power supply	AC 200V 3 Phase 50/60Hz AC 220V 3 Phase 60 Hz AC 380 ~ 415V 3 Phase 50 Hz AC 440V 3 Phase 60 Hz (Dual voltage rating with voltage selector)
Compressor	Semi hermetic type (5.5kw)
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 Timer or manual switch. Sensing evaporator temperature by defrost thermistor
Refrigerant control	Thermostatic expansion valve
Capacity control	Hot gas bypass control with hot gas bypass valve
Protection devices	Circuit breaker, Over current relay, Dual pressure switch, Oil pressure switch, Fusible safety plug, Overheat thermistor, Compressor motor protection thermostat, Fan motor protection thermostat.
Refrigerant	R-12: (6.0 kg)
Lubricant	SUNISO 3GS-DI: (4.0ℓ)
Weight	Approx. 685 kg

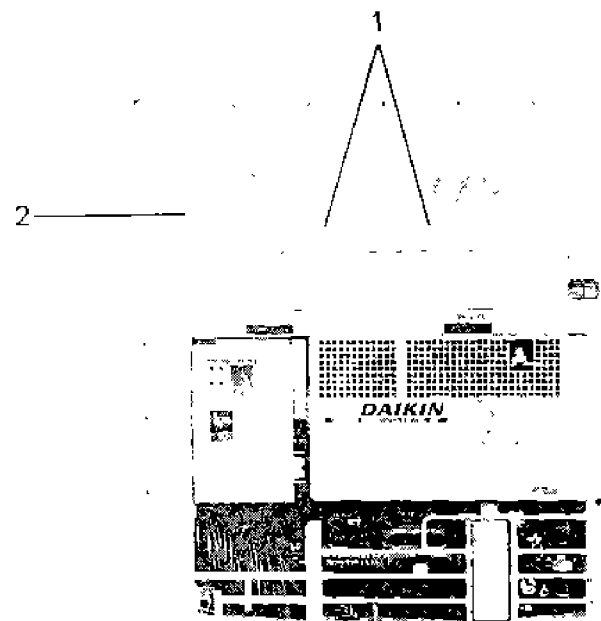
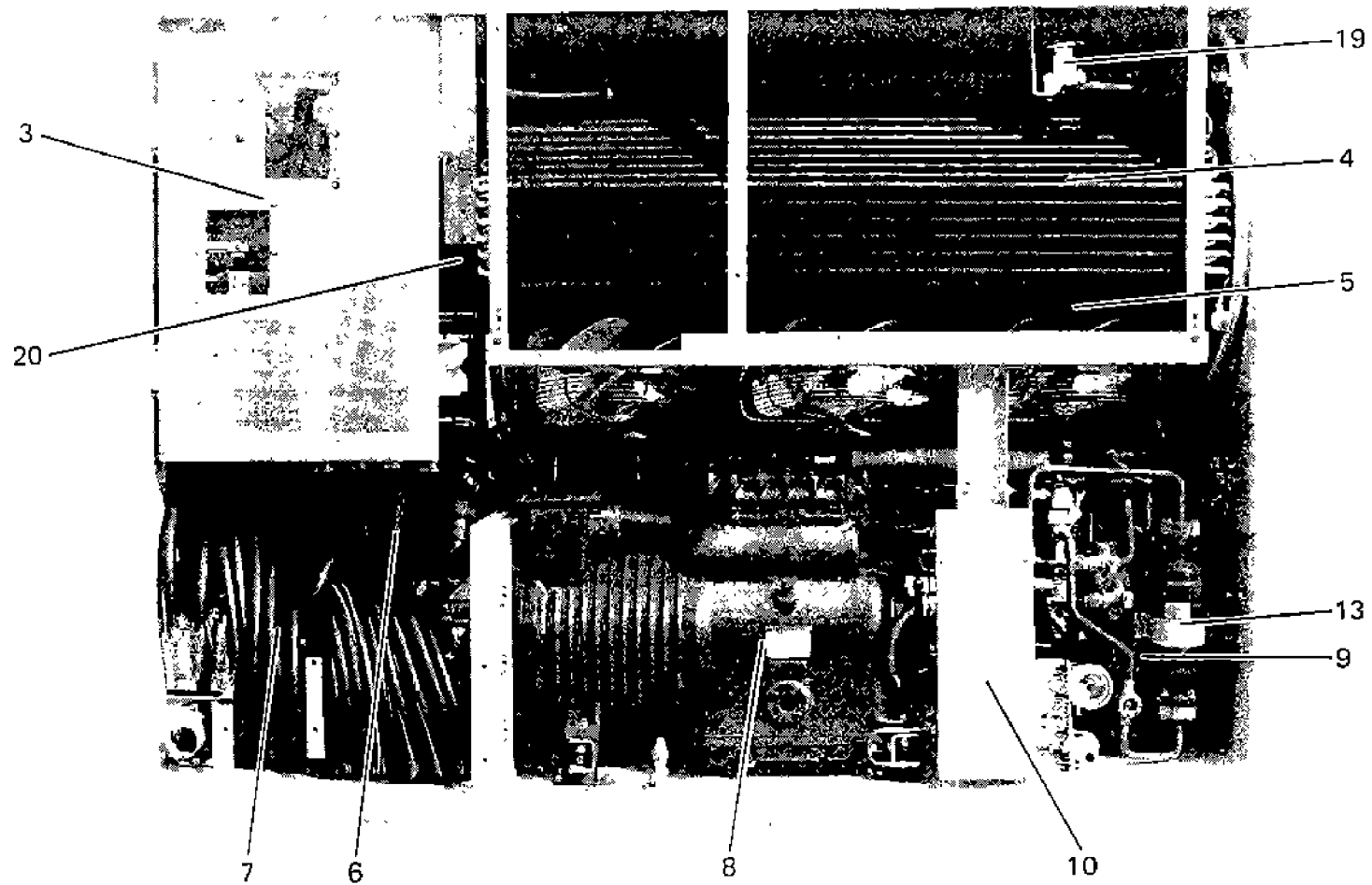


1.2 Set values of functional parts

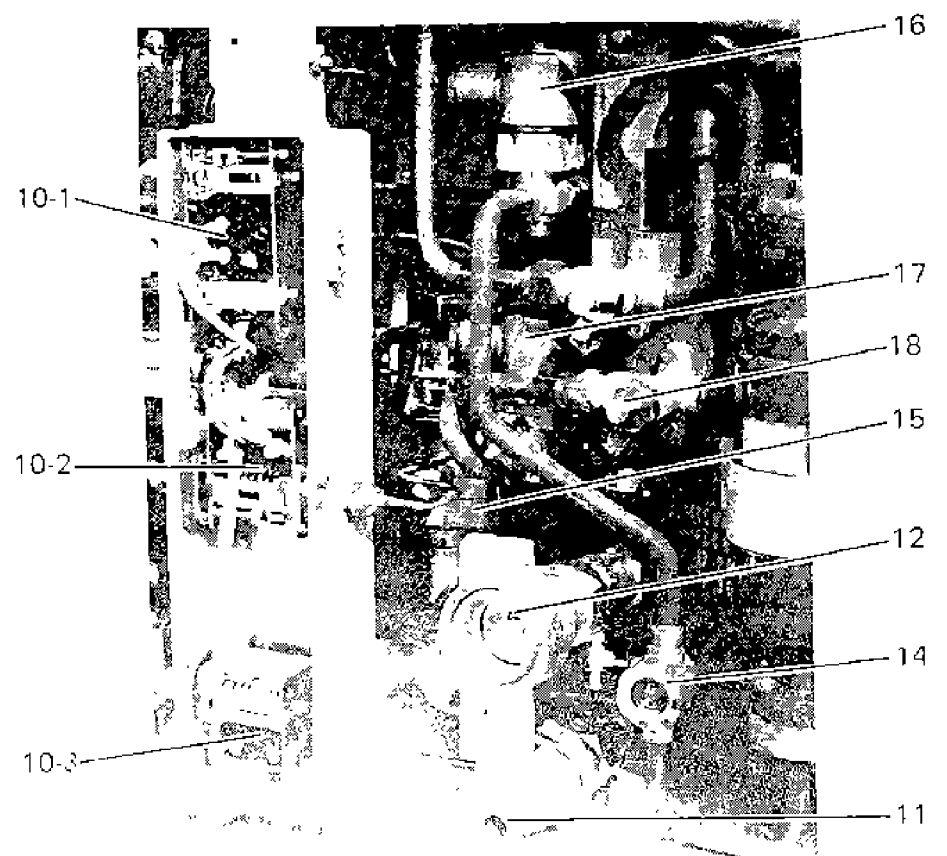
Part name	Mark	Function	Set value	
Oil pressure switch WNS-C106Q	63QL	OFF ON	1.0kg/cm ² 0.5kg/cm ²	
Dual pressure switch DNS-D306Q	63HL	Low pressure OFF ON High pressure OFF ON	40cmHgV 0.2kg/cm ² 20kg/cm ² 16.5kg/cm ²	
Water pressure switch SNS-C106Q6	63W	OFF ON	1.0kg/cm ² 0.4kg/cm ²	
Electronic controller	Overheat thermistor	TH2	OFF ON	71°C (160°F) 49°C (120°F)
	Defrost thermistor	TH1	OFF ON	40.6°C (105.1°F) 23.6°C (74.5°F)
	Defrost timer		ON	2 hr (out-range) 12 hr (in-range)
Overcurrent relay T-20-NP2S4	51C	OFF	10.0A	
Circuit breaker (main circuit) MK-53	52C1	OFF	50A	
Circuit breaker (control circuit) CP 31	52C2	OFF	7A	
Thermal protector KLIXON 9700L-01-11 (cond. fan motor) 9700K-01-11 (evap. fan motor)		OFF	120°C (248°F)	
Thermal protector KLIXON 7895 (compressor)	49	OFF	105°C (221°F)	

1.3 Construction

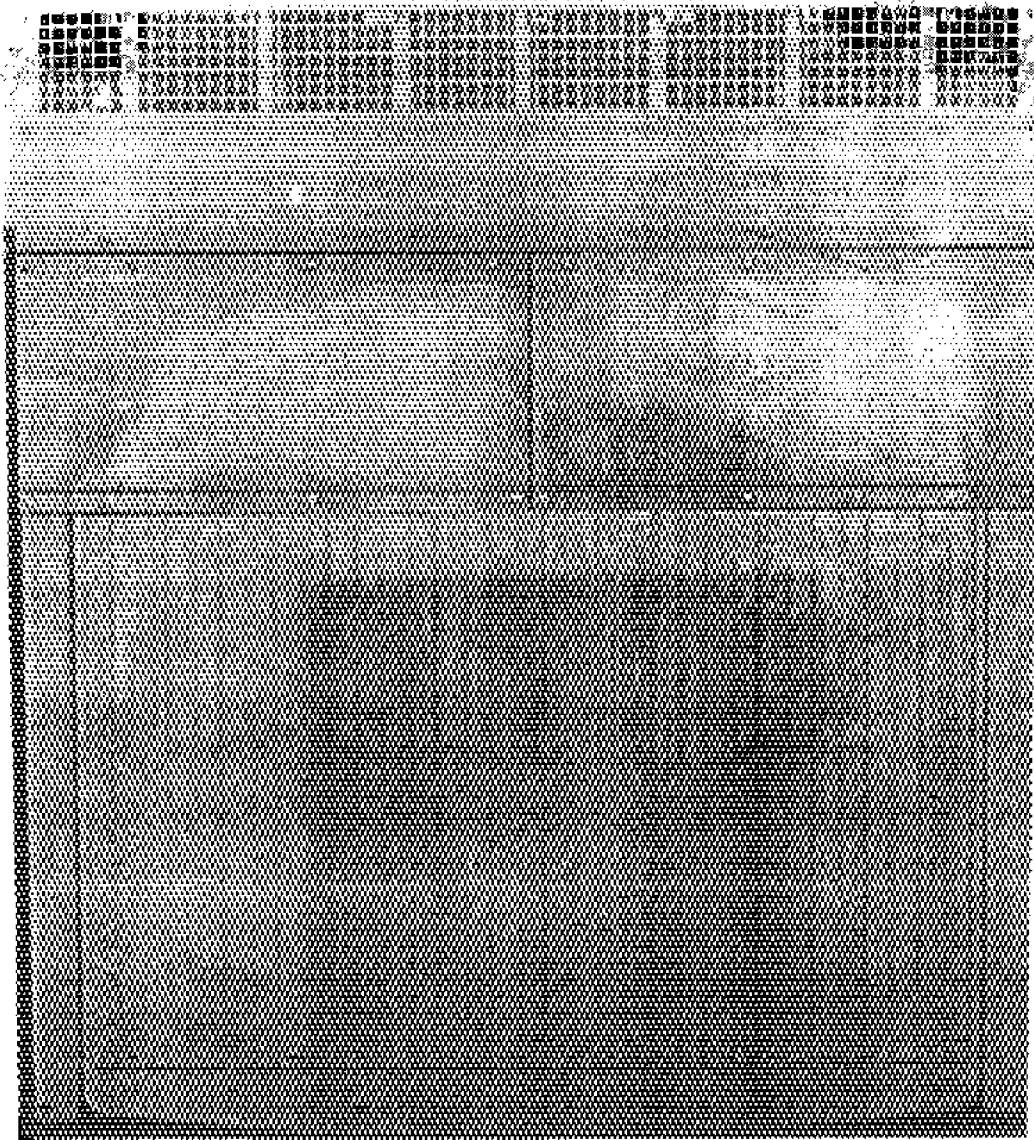
(1) Outside



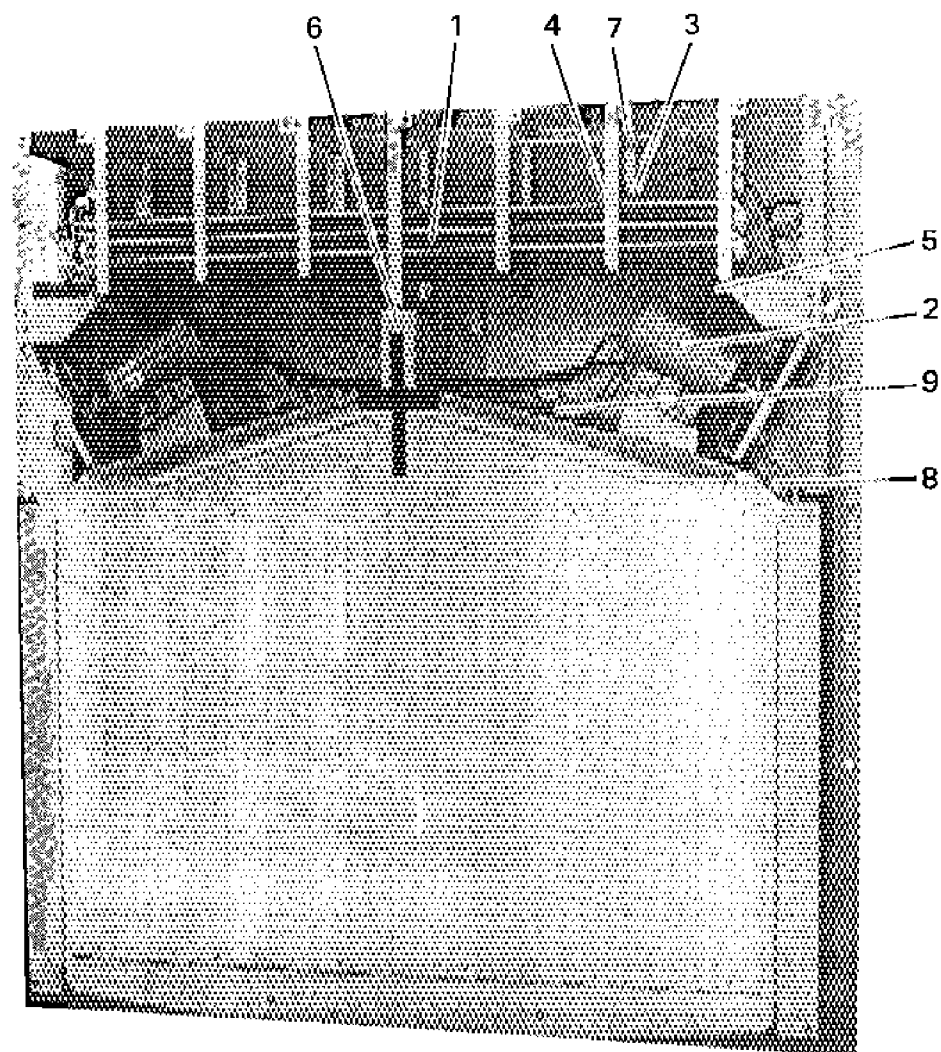
- 1 Access panel
- 2 Ventilator
- 3 Control box
- 4 Air cooled condenser
- 5 Condenser fan motor
- 6 Water cooled condenser
- 7 Cable stowage
- 8 Compressor
- 9 Accumulator-receiver with heat exchanger
- 10 Pressure switch box
 - 10 – 1 Dual pressure switch (63HL)
 - 10 – 2 Oil pressure switch (63QL)
 - 10 – 3 Water pressure switch (63W)
- 11 Water inlet coupling
- 12 Water outlet coupling
- 13 Dryer
- 14 Liquid/moisture indicator
- 15 Hot gas bypass valve
- 16 Liquid line solenoid valve (20S)
- 17 Hot gas line solenoid valve (20BS)
- 18 Stop valve for hot gas line
- 19 Expansion valve
- 20 Voltage selector switch



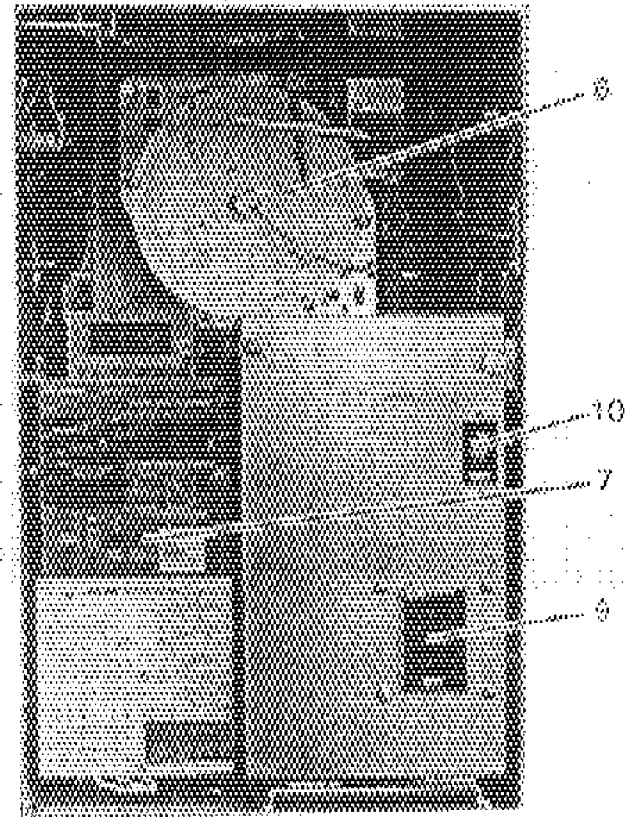
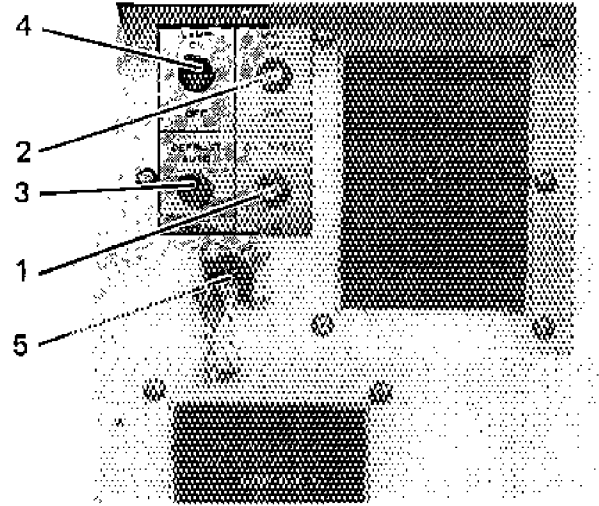
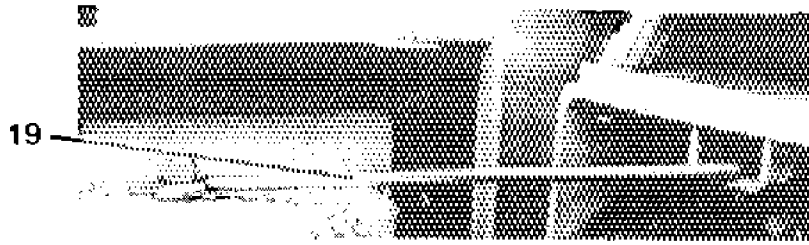
(2) Inside



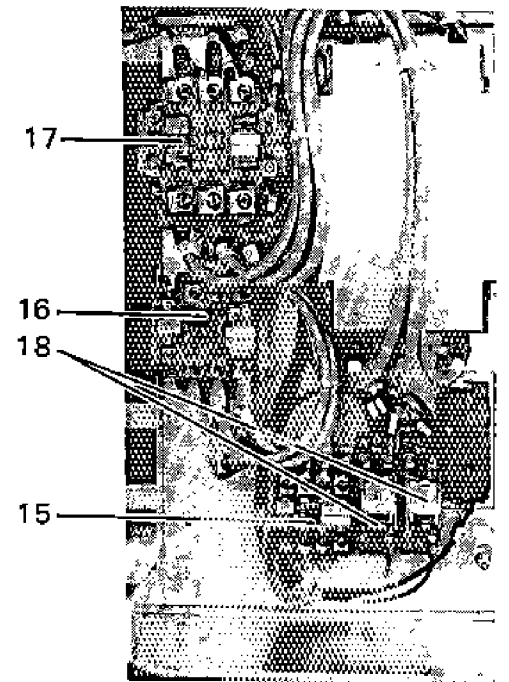
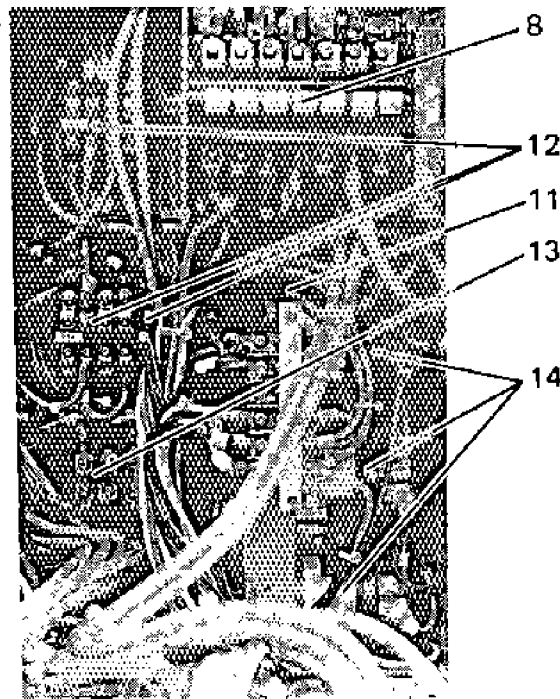
- 1 Evaporator
- 2 Evaporator fan motor
- 3 Defrost thermistor
- 4 Overheat thermistor
- 5 Defrost heater
- 6 Junction box
- 7 Return air sensor
- 8 Supply air sensor
- 9 Drain pan heater



(3) Control box

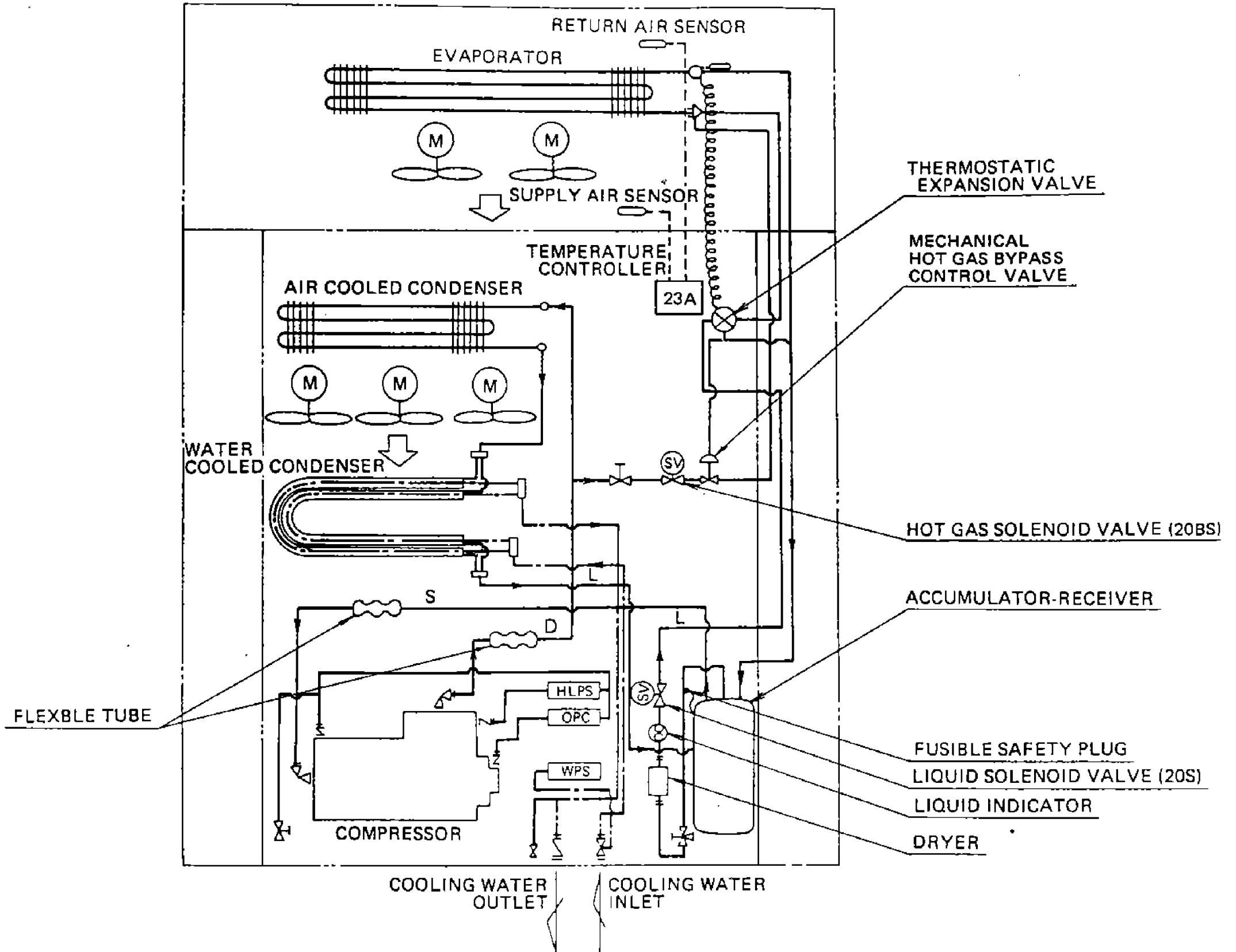


- 1 Oil pressure reset switch
- 2 Unit ON-OFF switch (3-88)
- 3 Manual defrost switch (3D)
- 4 Lamp switch (3-30L)
- 5 Cannon receptacle for pilot lamp
- 6 Recorder
- 7 Controller (23A)
- 8 Voltage selector
- 9 Circuit breaker (52C1)
- 10 Circuit breaker (52C2)
- 11 Transformer (Tr)
- 12 Voltage selector relay (2X1, 2, 3)
- 13 Over current relay (51C)
- 14 Capacitor (C, 1, 2, 3)
- 15 Evap fan motor relay (88F)
- 16 Heater relay (88H1)
- 17 Compressor relay (88C)
- 18 Auxilliary relay (2X4,5)
- 19 Stopper



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

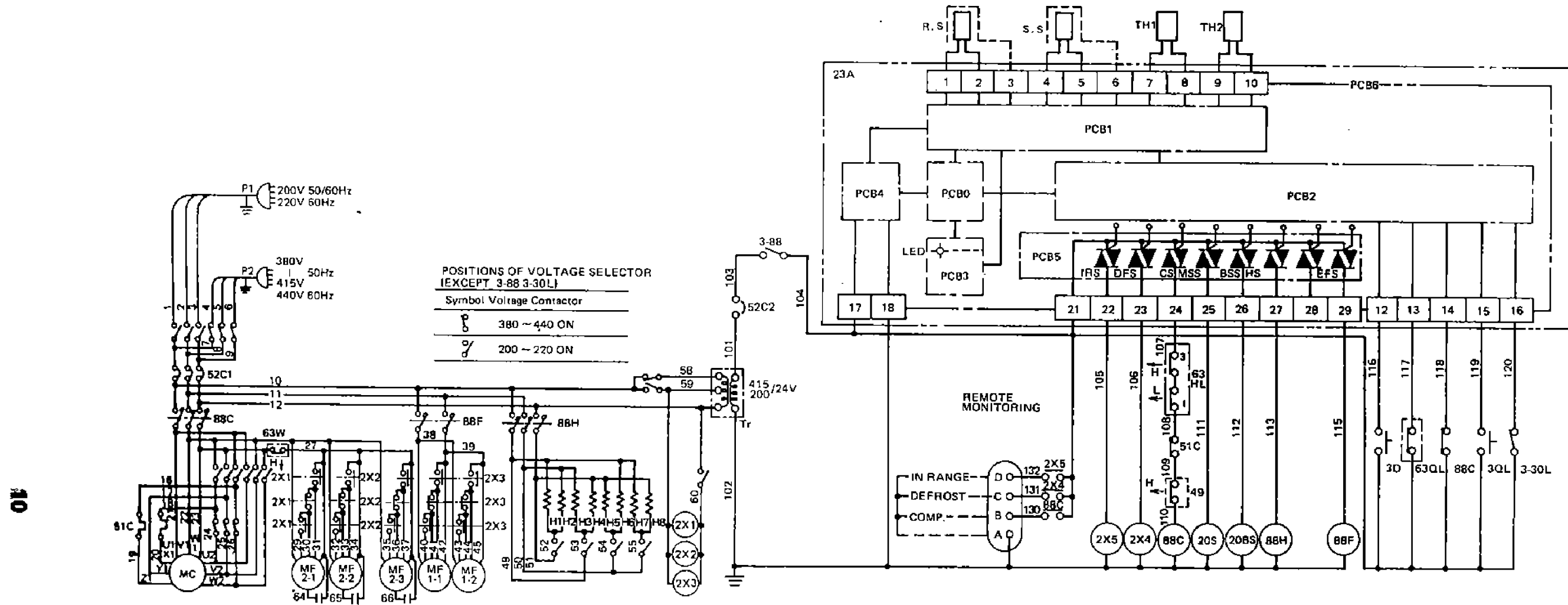
1.4 Piping diagram



- | | | | |
|---------|-------------------|------------|--------------------------------|
| — L — | LIQUID PIPE | HLPS(63HL) | DUAL PRESSURE SWITCH |
| — S — | SUCTION PIPE | OPS (63QL) | OIL PRESSURE PROTECTION SWITCH |
| — D — | DISCHARGE PIPE | WPS (63W) | WATER PRESSURE SWITCH |
| — II — | FLANGE CONNECTION | | |
| — I — | FLARE CONNECTION | | |
| — — — | REFRIGERANT PIPE | | |
| — - - - | WATER PIPE | | |

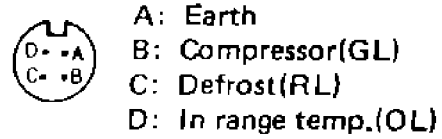
1.5 Wiring diagram

1.5.1. Sequence wiring



NOTES

1. Monitoring plug connected as follows.



2. Broken line shows external wiring

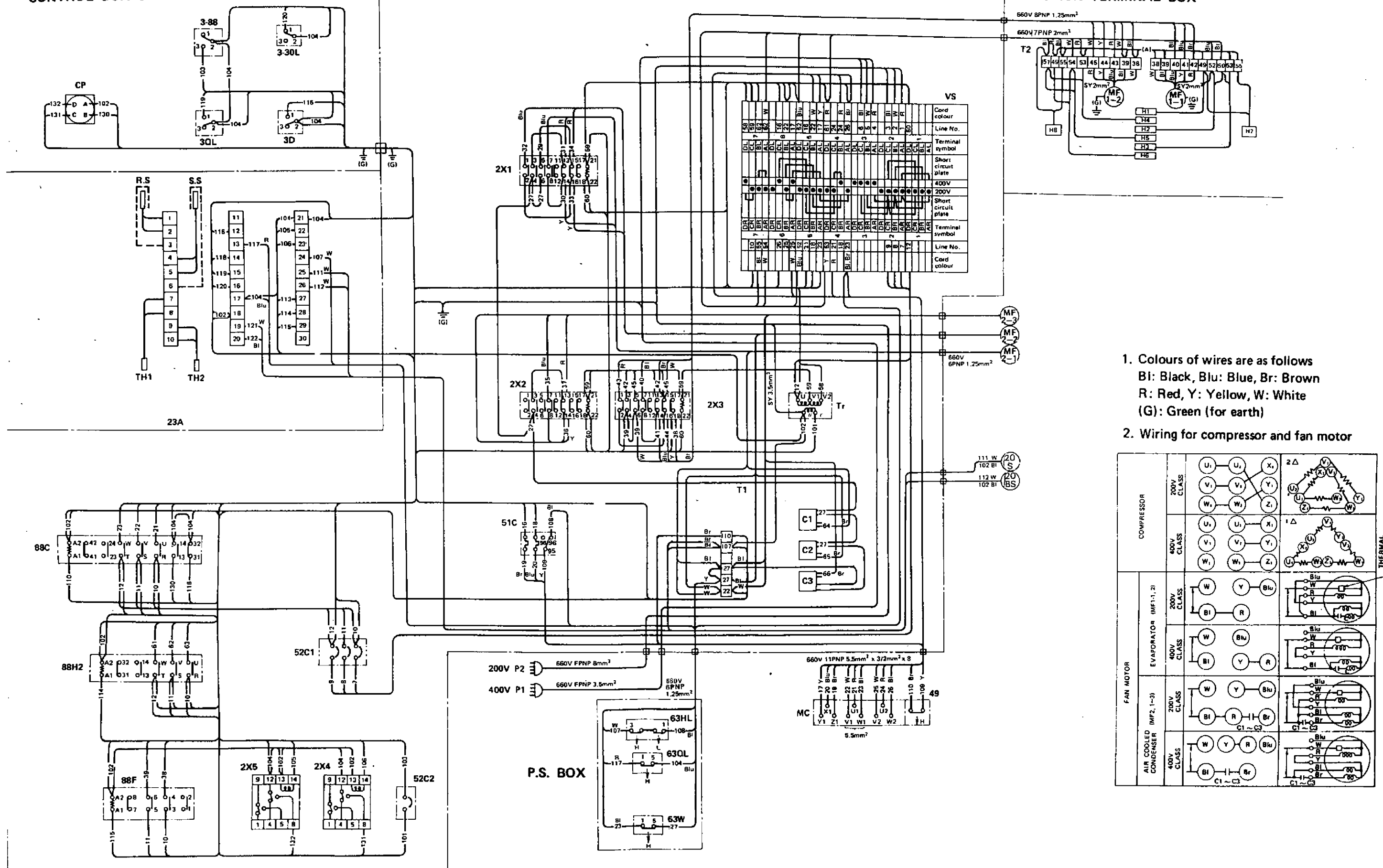
P	POWER PLUG	Tr	TRANSFORMER	23A	ELECTRONIC CONTROLLER
52C	CIRCUIT BREAKER	3-QL	OIL PRESSURE RESET SWITCH	PCB-O	CPU PCB
88C	MAGNETIC SWITCH FOR COMPRESSOR	3-88	ON-OFF SWITCH	PCB-1	ANALOG PCB
88F	MAGNETIC SWITCH FOR FAN MOTOR	3-30L	LAMP SWITCH	PCB-2	INPUT/OUTPUT PCB
88H	MAGNETIC SWITCH FOR HEATER	3D	MANUAL DEFROST SWITCH	PCB-3	DISPLAY PCB
2X	MAGNETIC RELAY	63W	WATER PRESSURE SWITCH	PCB-4	POWER SOURCE PCB
MC	COMPRESSOR MOTOR	63HL	DUAL PRESSURE SWITCH	PCB-5	SOLID STATE RELAY PCB
MF1	EVAPORATOR FAN MOTOR	63QL	OIL PRESSURE SWITCH	PCB-6	TERMINAL PCB
MF2	CONDENSER FAN MOTOR	51C	OVER CURRENT RELAY	R.S	RETURN AIR SENSOR
H1 ~ H6	EVAPORATOR COIL HEATER	49	COMPRESSOR PROTECTOR	S.S	SUPPLY AIR SENSOR
H7, H8	DRAIN PORT HEATER	20S	SOLENOID VALVE	TH1	DEFROST THERMISTOR
C	CAPACITOR	20BS	HOT GAS SOLENOID VALVE	TH2	OVER HEAT THERMISTOR

CAUTION
INSULATION TEST
SHOULDN'T BE
MADE TO
CONTROL CIRCUIT
(LINE NO.101~).

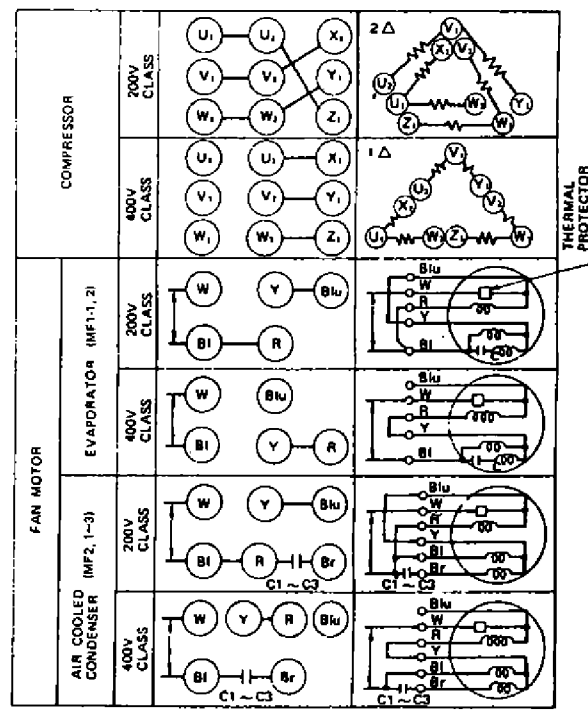
1.5.2 Actual wiring
CONTROL BOX COVER

CONTROL BOX

JUNCTION TERMINAL BOX



- Colours of wires are as follows
Bl: Black, Blu: Blue, Br: Brown
R: Red, Y: Yellow, W: White
(G): Green (for earth)
- Wiring for compressor and fan motor



2. Operation

Operate the unit by the procedures given below.

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

2.1 Preparation and operation

(1) Confirm that supply power is off.

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

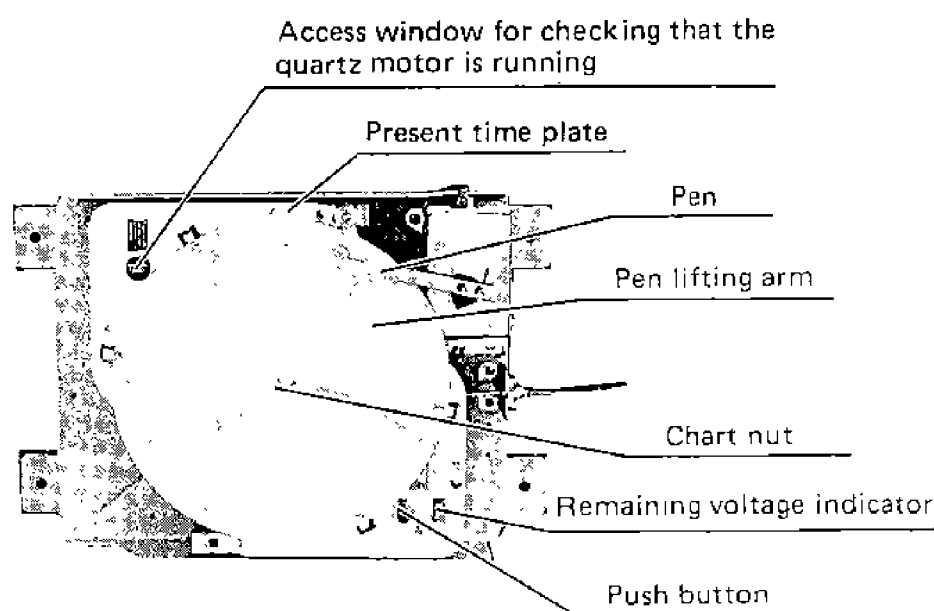
(2) Confirming the driving part of recording paper

- Confirming life of a dry element battery

Press the switch and confirm that the needle of the remaining voltage indicator remains in the blue zone. (The meter functions only when the switch is pressed down)

- Confirming the function of quartz motor

After confirming the life of dry element battery, check through the access window the fly wheel inside is rotating.

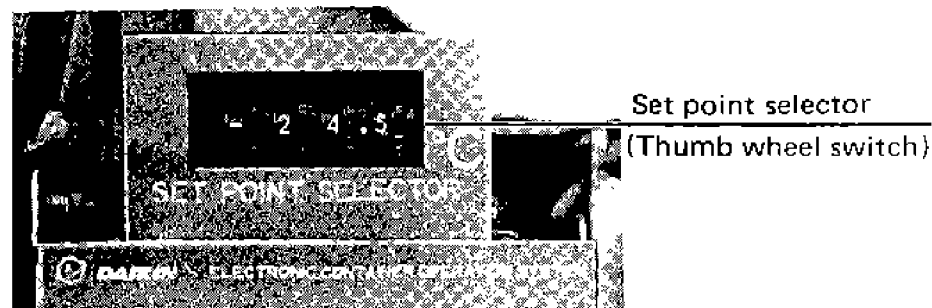


(3) Setting a piece of recording paper

- Raise the pen by the pen holder, loosen the chart nut, and set a new piece of recording paper.
- Set the date on the paper to an arrow of present time plate, then firmly tighten the chart nut and release the pen so that the recording can be accomplished.

(4) Temperature setting procedure (The electronic controller).

- Set the indication of the set point selector on the designated temperature.



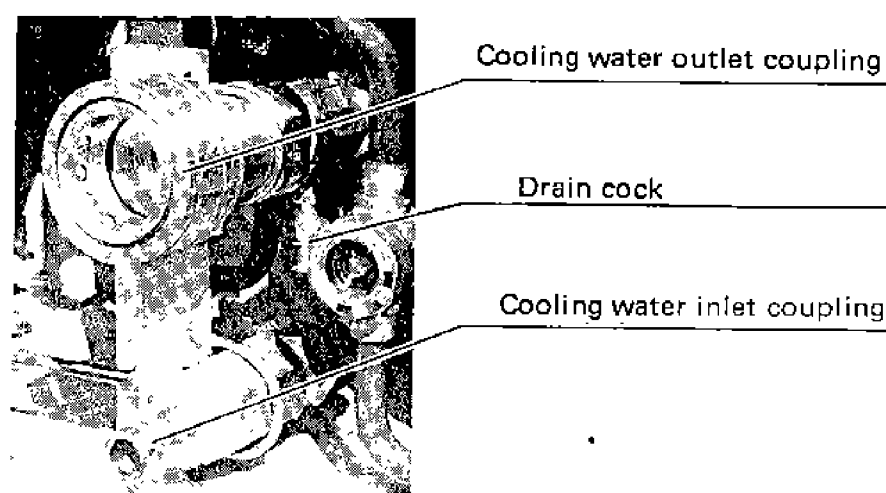
Notes 1. Do not touch the knob except when setting the temperature.

(5) Open or close the ventilator.

- Open or close the ventilator according to the cargo. (Be sure to keep it closed during transportation of frozen cargo.)

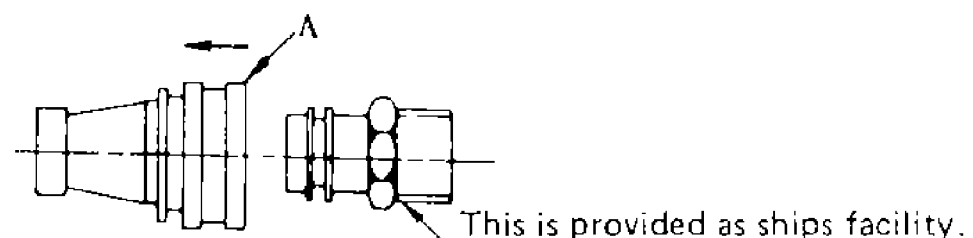
(6) Connect the cooling water piping.

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



When the cooling water couplings are connected, insert the coupling on the ship side into the coupling on the unit side until a "click" is heard.

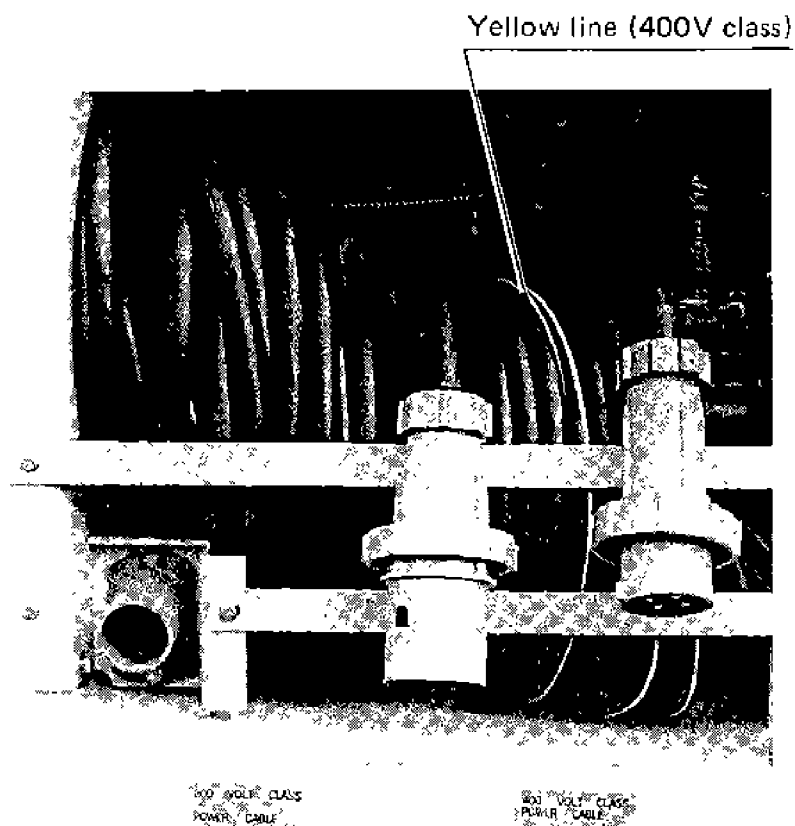
When disconnecting them, pull the coupling on the ship side toward you while pushing the A part of the female coupling in the direction pointed by an arrow mark.



Water joint at outlet side

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

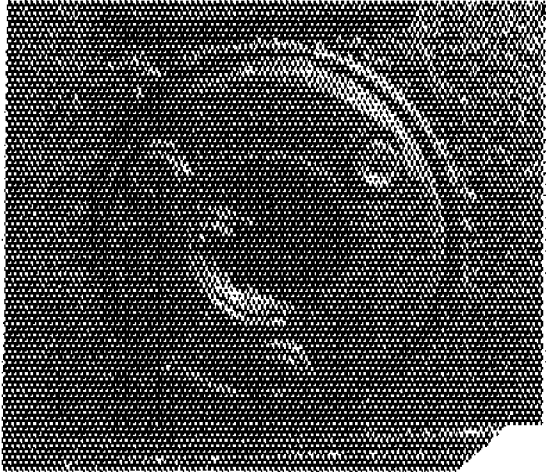
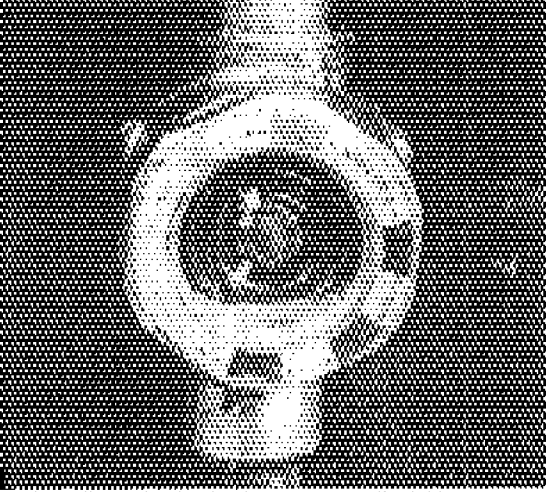
- (8) Set the voltage selector according to the supply voltage.
- (9) Plug in the power source which supplies the proper voltage and fasten the plug firmly.



- (10) Turn on the power switch of the facility (outside the unit).
- (11) Turn ON the circuit breakers.
- (12) Turn ON the operation switch provided at the front of the control box.
The controller outputs after 1 ~ 3 seconds delay, and the unit starts operation.
- (13) Close the cover of the control box.
If it is loose, water will leak. Check around the packing and tighten the cover securely.

Note: If the unit stops in about 2 minutes after starting, the oil pressure switch in many cases has been activated. At this time, electronic controller ALARM (OIL PRESS.) lights.
At this time, turn on the oil pressure reset switch (3-QL). The operation is automatically started within 2 minutes. (If the switch is turned on within 2 minutes after the oil pressure switch is energized, the ALARM lamp flickers.) If the unit stops again, repeat the above procedures.

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, sensuous and touching.
2. Check to ensure oil pressure protection switch functions, and the unit does not stop.	Visual (Controller Alarm Display)
3. Check suction and discharge pressures of the compressor. (For installation of a gauge, refer to "Section 9, page 49".)	Compare observed data with standard ones.
4. Check for proper oil level of compressor. Check to see the oil is clean. (Oil level may fall for a while after starting, but it rises gradually.)	 <p>Visual Oil level should be approx. ¼ to ¾ of its full scale.</p>
5. Check to see if refrigerant is sufficient. (The refrigerant bubbles immediately after starting, but this does not mean that refrigerant is lacking.)	 <p>Lack of refrigerant is indicated by bubbles in the moisture indicator.</p>
6. Check if any moisture is present in refrigerant circuit. (The color of moisture indicator may turn to orange if it has been exposed to gaseous refrigerant for a long time, but this is no indication of trouble.)	<p>Visual The moisture indicator should normally deep blue. Orange color is a sign of trouble.</p>
7. Check if the recorder operates according to the inside temperature.	Visual
8. Check operating conditions with the pilot lamps (LED).	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) After water-cooled operation.

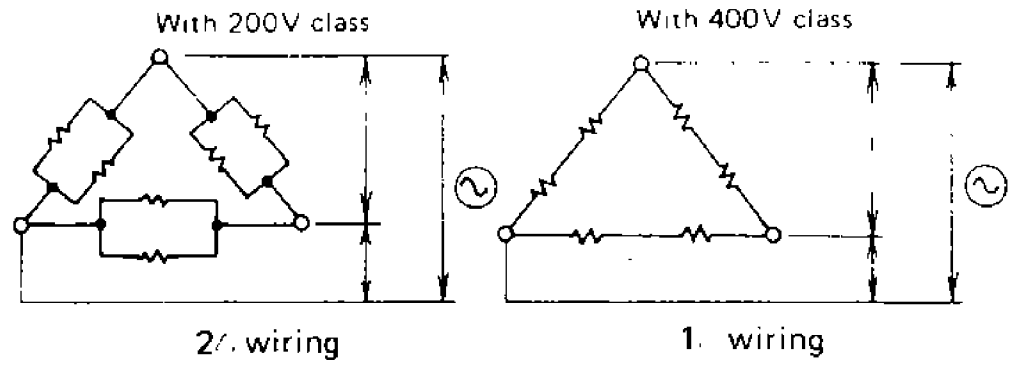
Remove the water piping.

(4) Close the cover of the control box.

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 (multi-contact cam switch) according to the supply voltage by hand. The voltage selector changes wiring of the motors, electric heaters, and the transformer of the control circuits to supply the relevant voltage. For example, the internal wiring of the compressor is changed as follows.

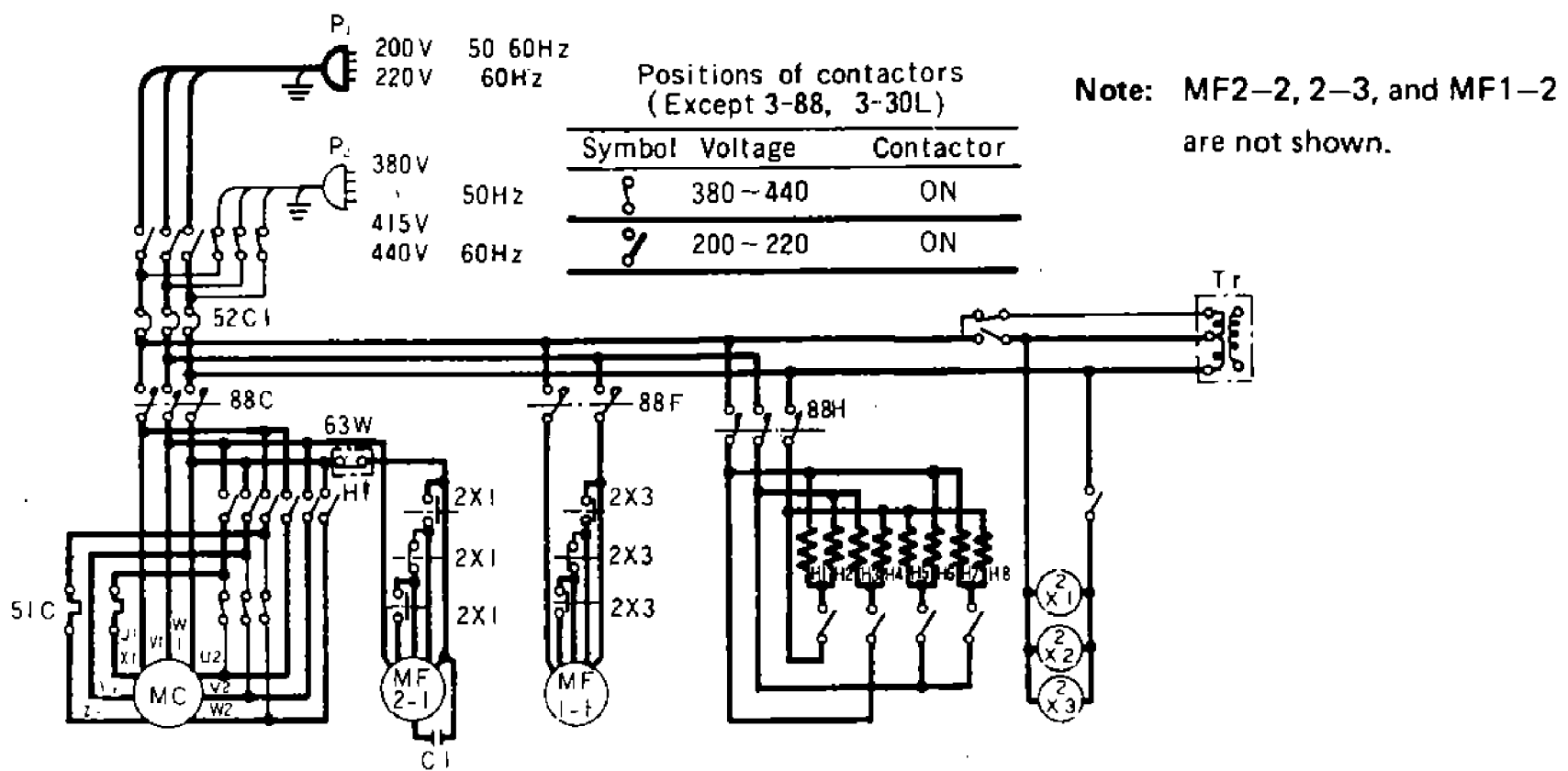


(2) Circuitry

- With 200V class (Set the selector lever to "200V CLASS".)

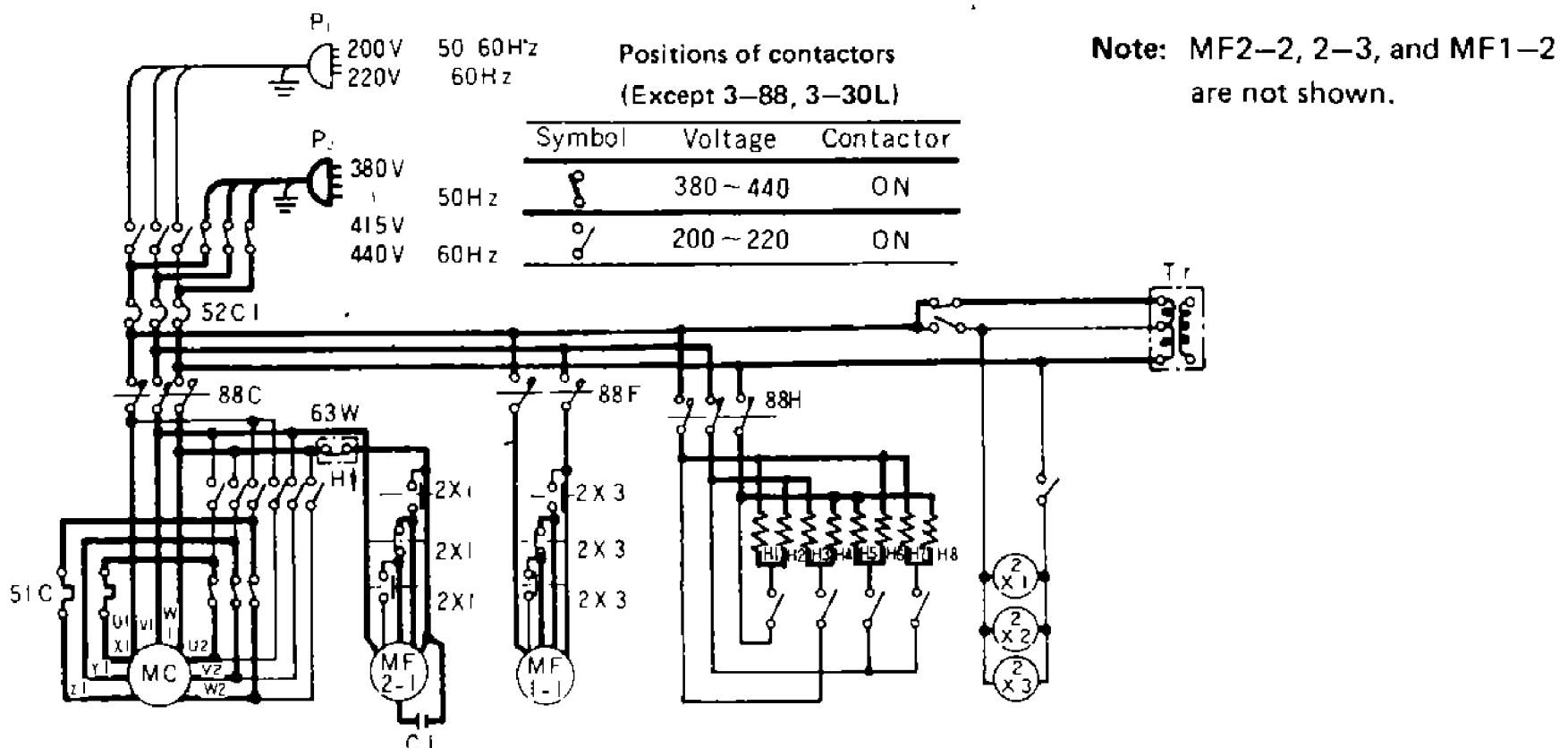
The contacts marked " " in the sequence chart (except 3-88 and 3-30L) are turned on.

The circuits for 200V class will be set up with the contacts and the voltage selector relay (2X1.2.3) are energized.



- 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).



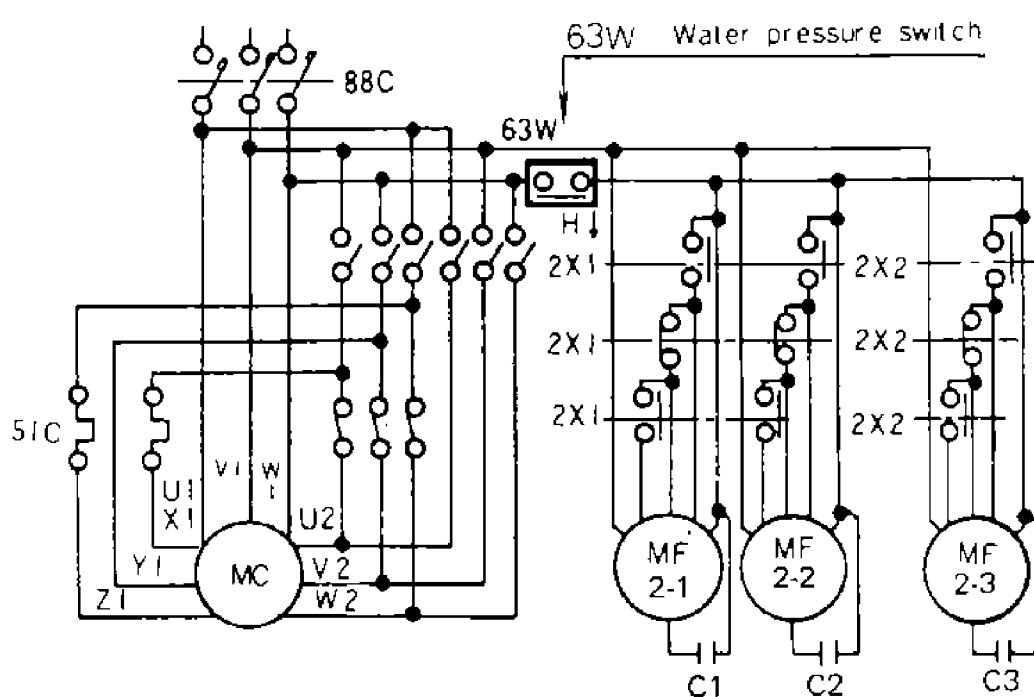
3.2 Air cooled and water cooled operation

The unit will operate on either air cooled or water cooled condenser operation.

During transit on land, in depot or on a vessegs deck, the air cooled operation will function, and the operation in ship holds is normally water cooled.

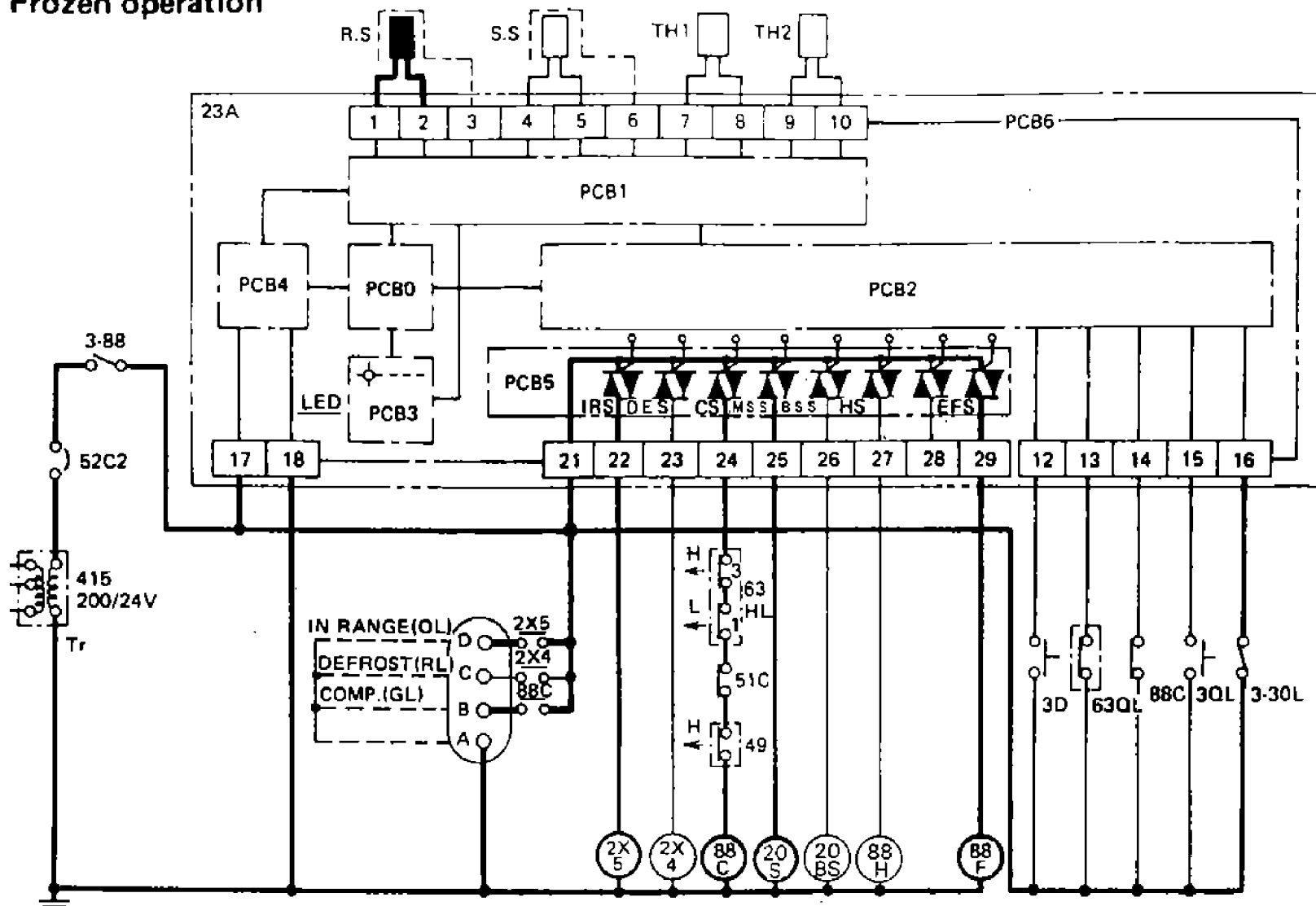
The operation will be changed from air cooled to water cooled automatically by the water pressure switch; i.e. when water pressure at the inlet of the water cooled condenser rises higher than the presetting value, the contact points of the water pressure switch are opened, so the condenser fan motors stop, and the water cooled operation starts.

When the water supply is disconnected. The contacts of the water pressure switch are made and the condenser fan motors rotate.



This diagram indicates air-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) stop, and water-cooled operation starts.

3.3 Frozen operation



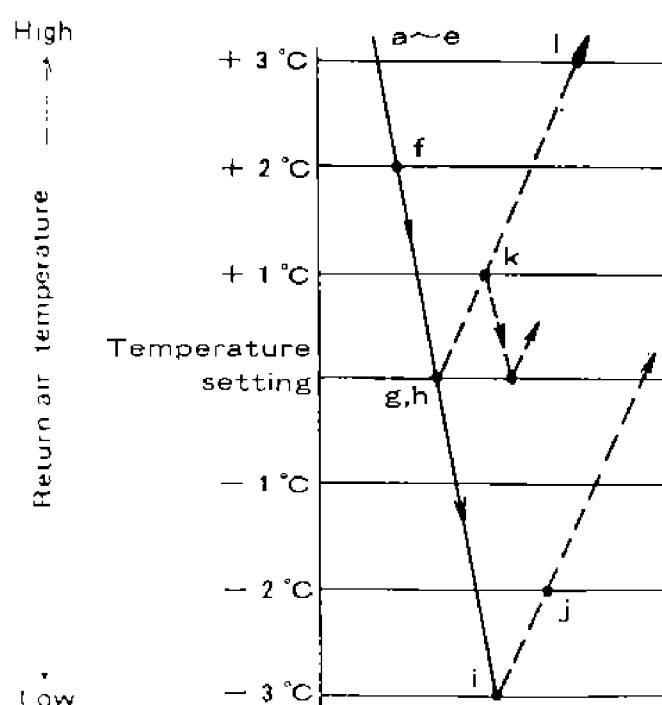
- (1) Switching over frozen and chilled modes

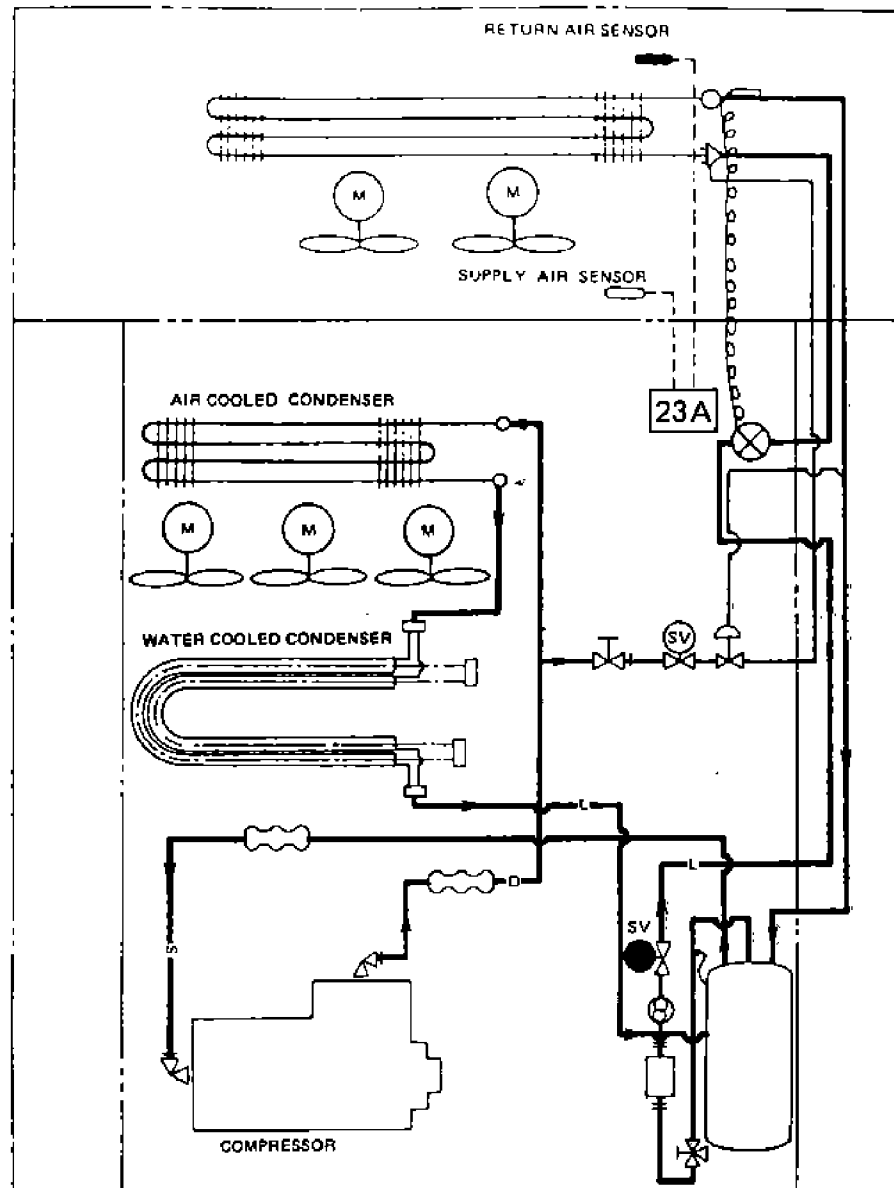
One of the modes will be automatically selected according to the setting of the setpoint selector.

 - When the setting is above -5°C : chilled mode
 - When the setting is less -5°C : frozen mode

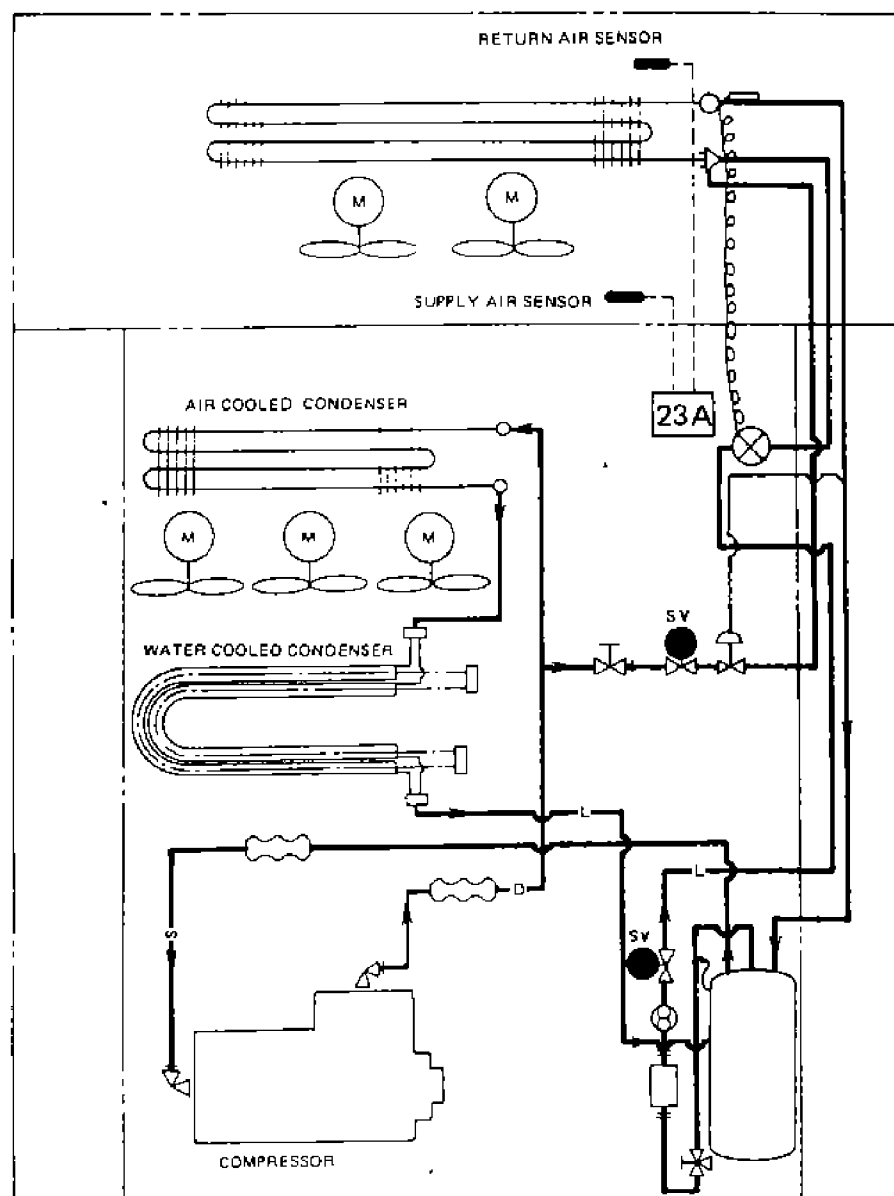
Note that in the frozen mode is operated without capacity control.
- (2) During frozen mode, the compressor will be automatically turned on and off, sensing return air temperature to the evaporator.
 - a. Turn on 3-88 (unit ON-OFF switch).
 - b. As relay EPS in 23A is turned on, 88F is energized to start MF1-1 and 1-2 (evaporator fan motors).
 - c. As relay MSS in 23A is turned on, solenoid valve 20S is opened. (BSS is turned off and 20BS is closed.)
 - d. When 20S is open, refrigerant flows and low pressure rises. LP of 63HL (dual pressure switch) are turned on.
 - e. With LP on, 88C (compressor relay) gets energized, MC (compressor) and MF2-1, 2 and 3 (air-cooled condenser fan motors) will start and GL (green lamp) will light up. --- The unit enters in the normal operation and inside temperature begins to fall. ---
 - f. When return air temperature to the evaporator falls to 1.0°C above the preset temperature, (preset temperature plus 2.0°C), IRS (23A) is turned on and OL lights up.
 - g. When the temperature falls lower than the preset temperature, MSS (23A) is turned off 20S closes, and "pump down" starts.
 - h. When the low pressure falls down to 40cmHgV , LP of 63HL is turned off; 88C becomes unenergized; MC, MF2-1, 2, and 3, etc. stop; and frozen operation stops.

- i. If 20S is closed but still MC does not stop "pump down," and the inside temperature drops 3°C below the preset temperature, CS, IRS (23A) are turned off to deenergize 88C. Then, the compressor is stopped and OL goes out.
- j. When the temperature rises to the preset temperature minus 2.0°C , IRS is turned on and OL lights up.
- k. When the temperature rises to the temperature setting plus 1°C , CS and MSS are turned on and frozen operation starts through the process of c \rightarrow d \rightarrow e described previously. The compressor is normally operated on and off repeatedly by operation of "g, h" \leftrightarrow "k" (ON/OFF of MSS \rightarrow OPEN/CLOSE of 20S)
- l. If the temperature rises further up to the preset temperature plus 3°C , IRS is turned off and OL will go out.



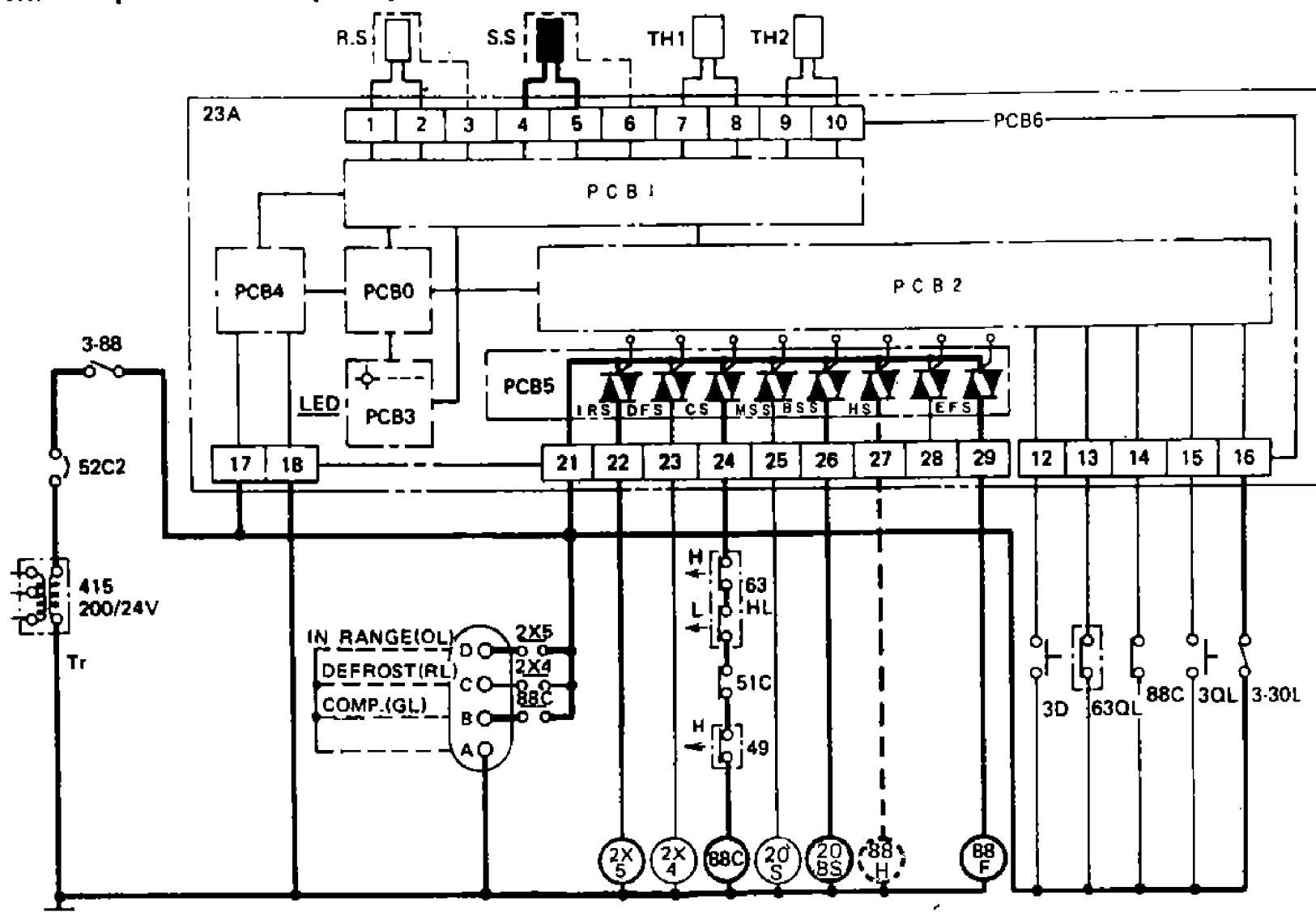


Flow of refrigerant during freezing operation



Flow of refrigerant during chilling operation

3.4 Chilled operation – capacity control

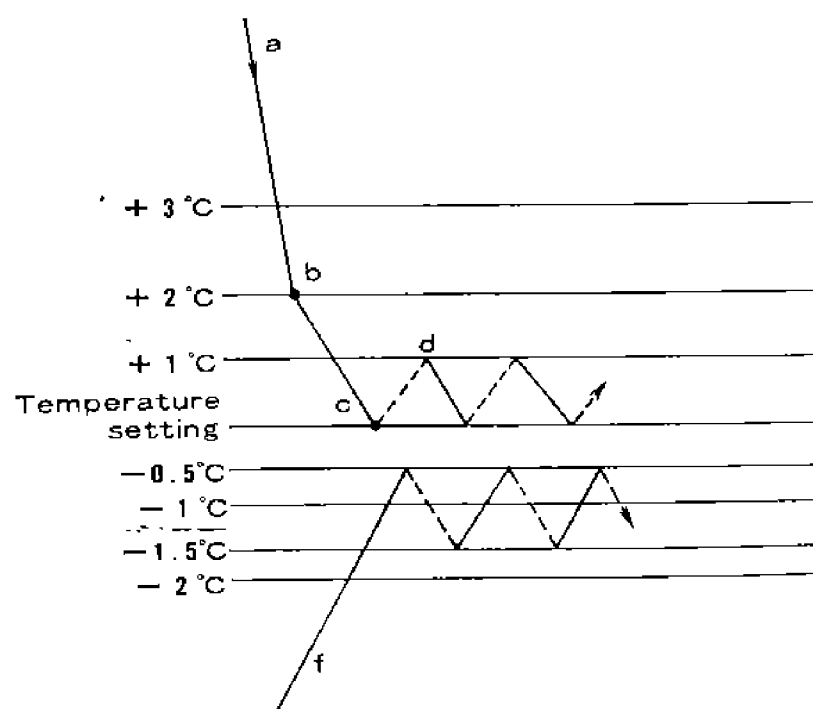


- (1) Chilled operation is performed when the setting temperature is above -5.0°C , and the circuit of the chilled mode is made by 23A automatically.
- (2) In case of the chilled mode, capacity control is achieved by hot gas depending on supply air temperature of the evaporator, and at the same time, over-cooling is prevented, sensing supply air temperature.
 - a. The operation is the same with that (step "a" ~ "e") of the frozen mode while supply air temperature falls to the preset temperature plus 2.0°C from the pull down period.
 - b. When the supply air temperature reaches the setting temperature plus 2.0°C , IRS is turned on (OL lights up), BSS is turned on, hot gas solenoid valve 20BS opens, through which hot gas is bypassed, and operation becomes capacity control mode. Hot gas flow is controlled by hot gas bypass valve.
 - c. When supply air temperature drops further and reaches to temperature setting, MSS and BSS of 23A are turned off, 20S and 20BS closes, and pump down will start. The compressor stops to prevent over-cool.
 - d. When supply air temperature rises and reaches to temperature setting plus 1°C after stopping the compressor, MSS and BSS are turned on, 20S and 20BS are open, and the compressor will start again. Since then, at step "c" and "d", hot gas is bypassed, and the compressor is operated on and off repeatedly.
 - e. On the other hand, the supply sensor for supply air temperature in to the storage is equipped to prevent over-cooling. When supply air temperature drops lower than temperature setting by -3°C , MSS and BSS are closed and pump down will start although return air temperature does not reaches to temperature setting of 23A, the compressor stops.

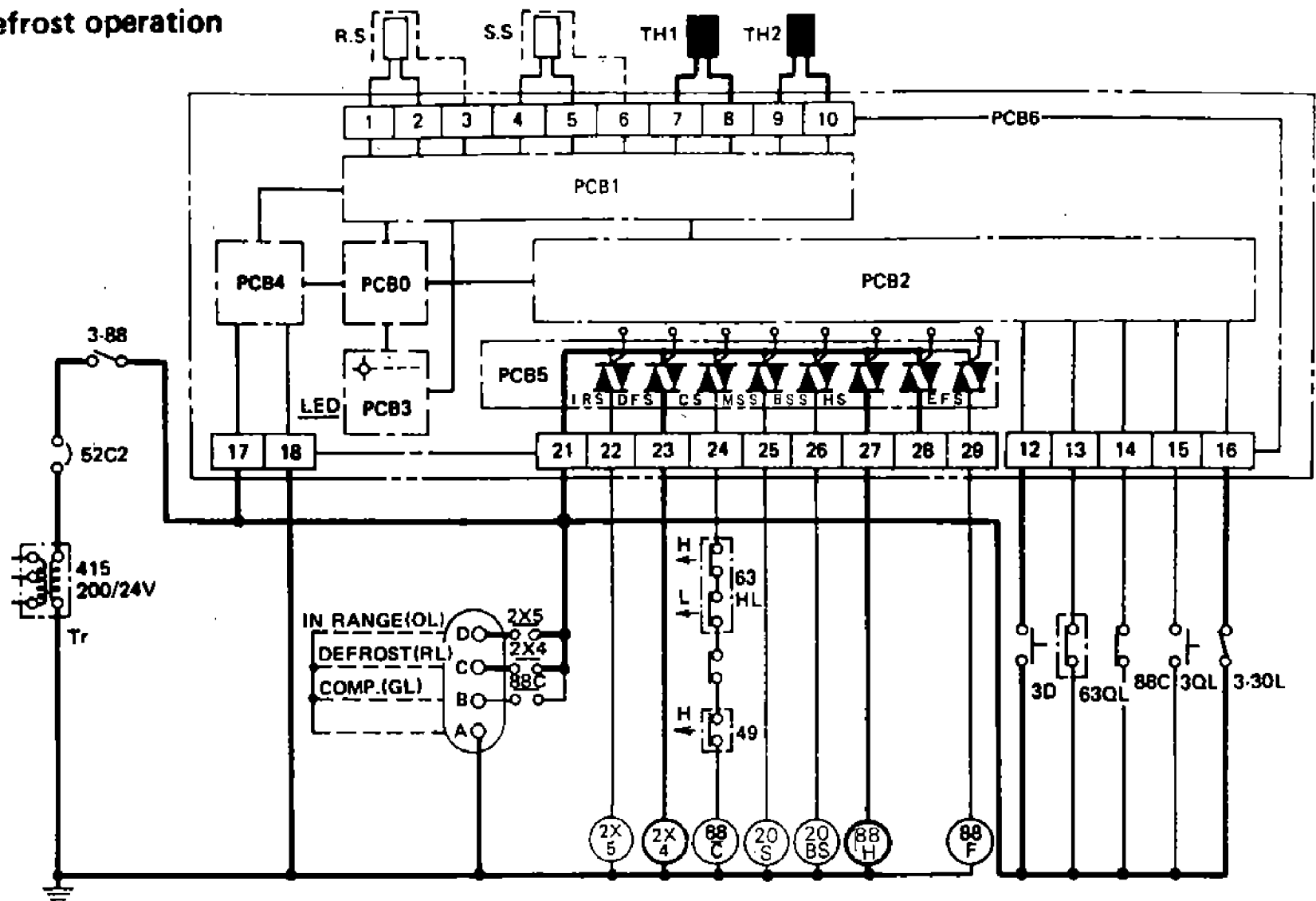
- f. Heating operation is performed by ON/OFF operation of the electric heater. When return air temperature in the storage is lower than temperature setting -1.5°C , HS of 23A is turned on, relay 88H is energized, and electric heater H1 ~ H8 are energized.

After that, temperature setting -0.5°C :	Heater OFF
-1.5°C :	Heater ON

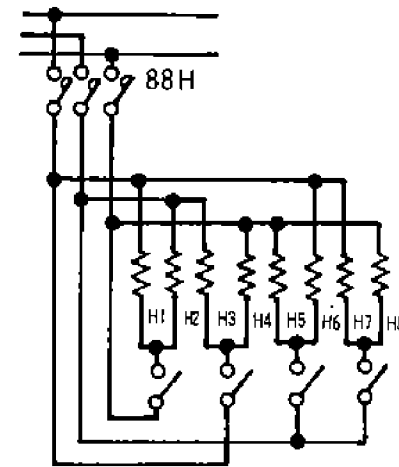
 As stated above, the heater is operated on and off.



3.5 Defrost operation



- (1) Defrosting operation starts based on the following two conditions.
- Timer (incorporated in controller) counts up; The defrost cycle time is as follows.
 - When inside temperature is above "preset temperature + 3°C" (IRS – OFF): 2 hours
 - When inside temperature is below "preset temperature + 2°C" (IRS – ON): 12 hours
 - Manual defrost switch (3D) is turned on. If one of those stated above is on, DFS is turned on and RL lights up.



The circuit shows 200V class circuit

- (2) Simultaneously as DFS is turned on:
- MSS, BSS are turned off, 20S, 20BS are closed, and "pump down" stops. When 88C is turned off, HS are turned on, 88H are energized, and the electric heaters are energized. Simultaneously, EFS is turned off, evaporator fan motors MF1-1, 2 stop, and defrost operation starts.
- (3) When the evaporator coil temperature rises to 7.5°C after having removed frost, (defrost temperature detects the coil temperature) DFS is turned off. Defrosting operation is terminated.

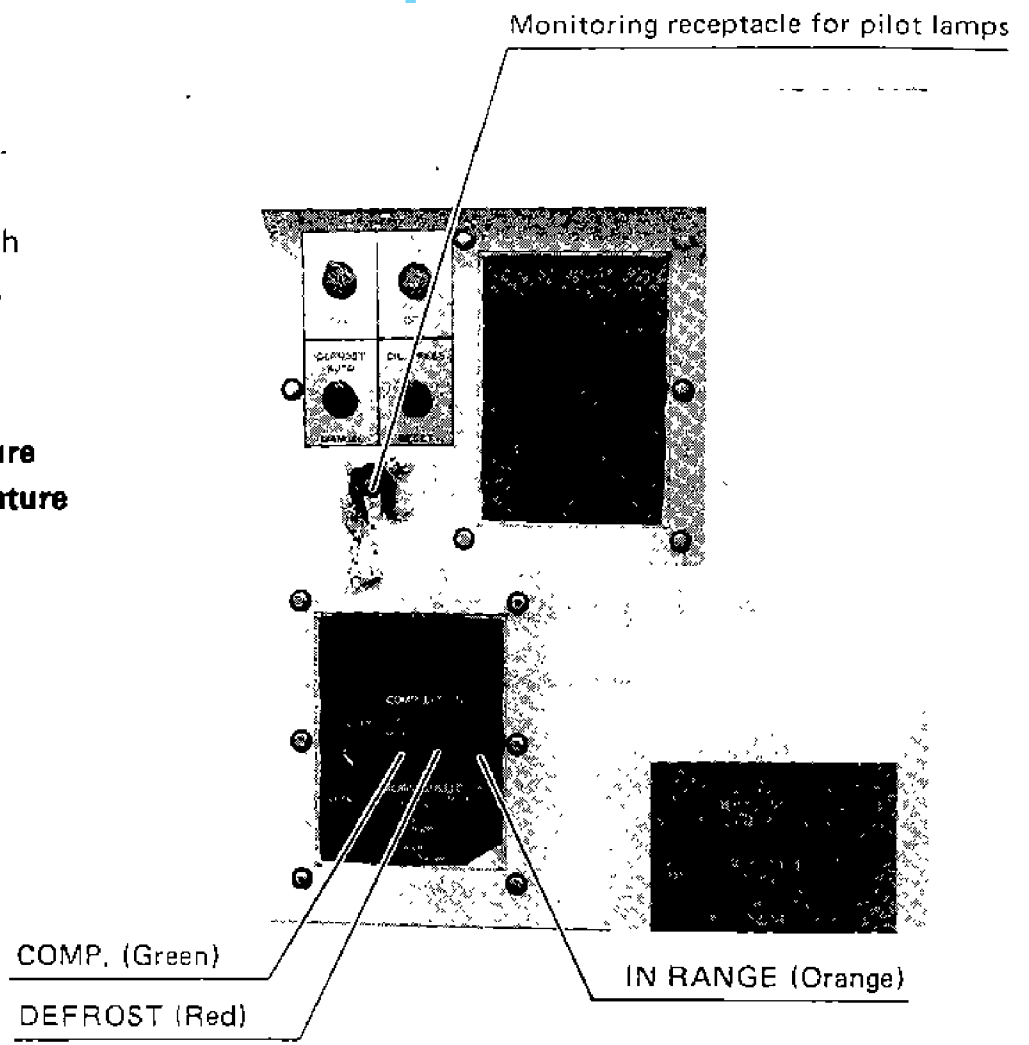
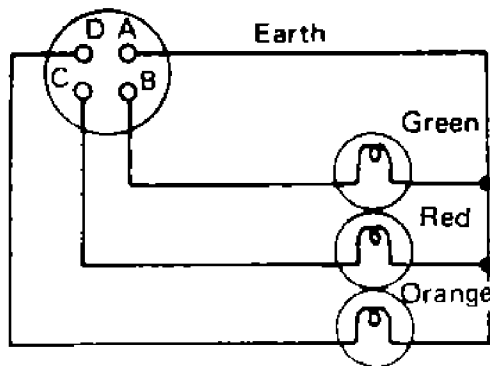
Note: If during defrost operation or heating operation, the temperature rises abnormally, (over 40.6°C, this is detected by the overheat thermistor) and HS are turned off, then the electric heaters are deenergized.

3.6 Pilot lamps and monitoring circuit

3 lamps (Light emitting diode) which indicate operating mode are mounted on the front panel of the controller in the control box and can be seen through the window if the cover of the control box is closed.

- **Comp. (Green)** . . .Compressor operating
- **Defrost (Red)** . . .Defrost operating (DFS: ON)
- **In range (Orange)** .IN RANGE (Inside temperature is in range . . . setting temperature $\pm 2^{\circ}\text{C}$)

Receptacles for monitoring pilot lamps are also equipped and its connections is shown at below.



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

NAME		TEMPERATURE SETTING ABOVE -5°C (+23°F) - AIR COOLED OPERATION					TEMPERATURE SETTING BELOW -5°C (+23°F) - AIR COOLED OPERATION			• WATER COOLED OPERATION
		COOLING		HEATING		DEFROST	COOLING		DEFROST	
		PULL DOWN	IN RANGE	PULL UP	IN RANGE		PULL DOWN	IN RANGE		
LIGHT	DEFROST - Red	X	X	X	X	○	X	X	○	WATER COOLED CONDITION IS THE SAME AS AIR COOLED EXCEPT WATER PRESS SWITCH (63W) OPEN CONDENSER FAN MOTOR DE-ENERGIZED
	COMP - Green	○	○	X	X	X	○	○	X	
	IN RANGE - Orange	X	○	X	○	X	X	○	X	
MAGNETIC SWITCH	COMPR COND. FAN MOTOR (88C)	○	○	X	X	X	○	○	X	
	EVAPORATOR FAN MOTOR (88F)	○	○	○	○	X	○	○	X	
	HEATER (88H)	X	X	○	○	○	X	X	○	
SOLENOID VALVE (20S)		○	○	X	X	X	○	○	X	
SOLENOID VALVE (20BS)		X	○	X	X	X	X	X	X	
COMPRESSOR		○	○	X	X	X	○	○	X	

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

4. Major components and maintenance

4.1 Components related with refrigeration circuit

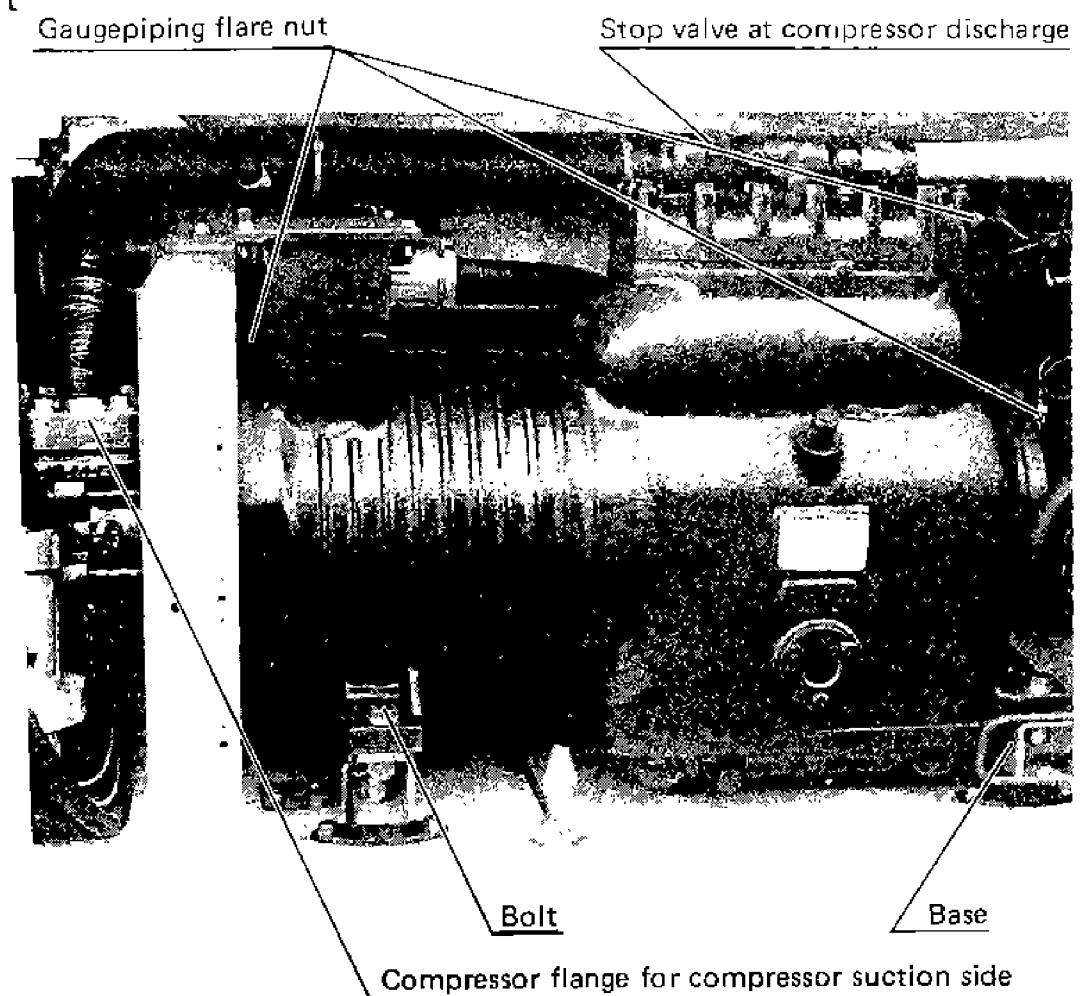
4.1.1 Compressor

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 and protective bar 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 and base.
- 4 Take out the compressor to the front of the unit.



(b) Installing procedure

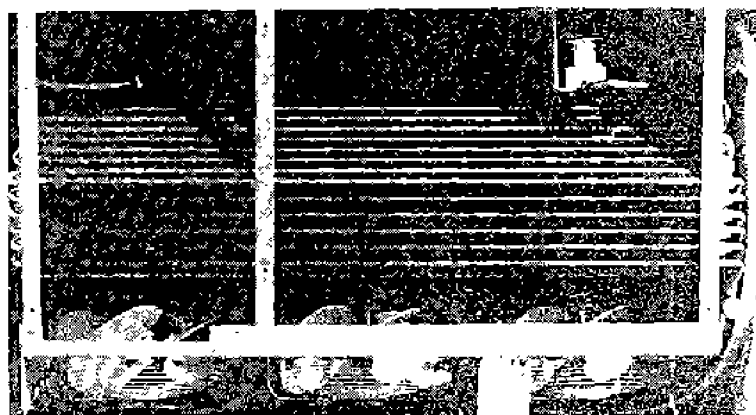
Install the compressor according to reverse procedure given above. When tightening the bolts, refer to the torque values listed.

4.1.2 Air-cooled condenser and evaporator

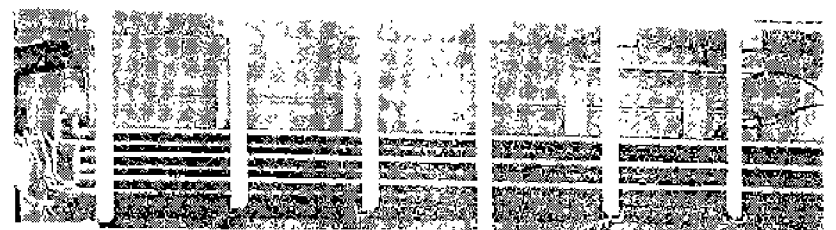
The "cross fin" coil has special corrugated fins. They are compact and very efficient in producing uniform heat exchange efficiency.

(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

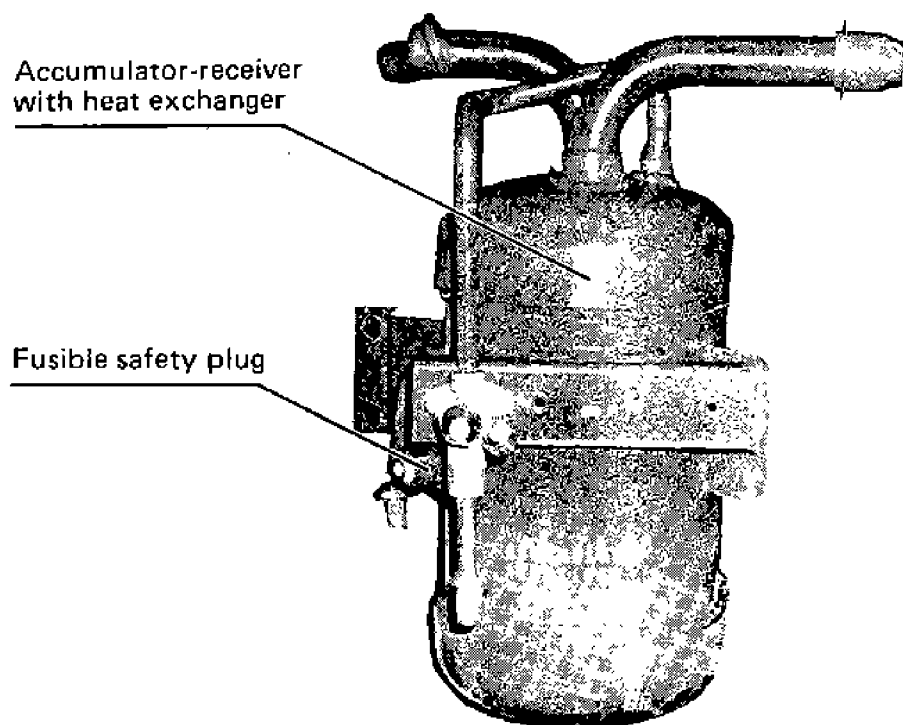
4.1.3 Water-cooled condenser

Of the tube-in-tube type in which cooling water flows in 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

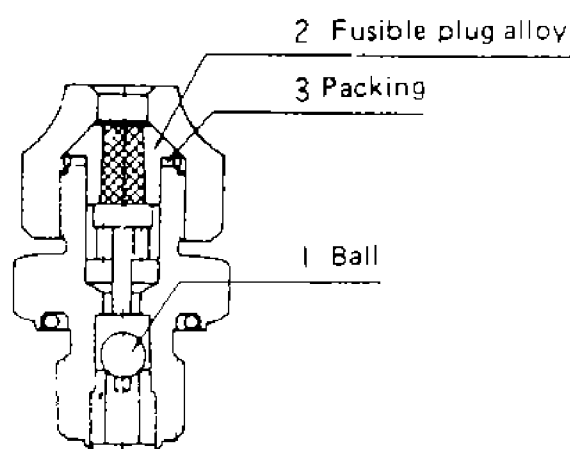
Consists of the accumulator, receiver, and heat exchanger, which are encased in a vertical cylindrical construction; i.e. the heat exchanger passes through the accumulator from its top to the bottom and reaches to the receiver.

This construction reduces heat loss. 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 is melted, check possible causes thoroughly. When fusible safety plug functions, the centre of the fusible safety plug alloy ② melts, 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 by means of ③, and tighten the flare nut.

4.1.5 Expansion valve

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



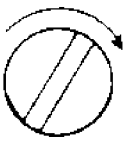

“CAUTION” Whenever adjusting and replacing the expansion valve, the unit should be isolated from the mains supply for safety.

(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.

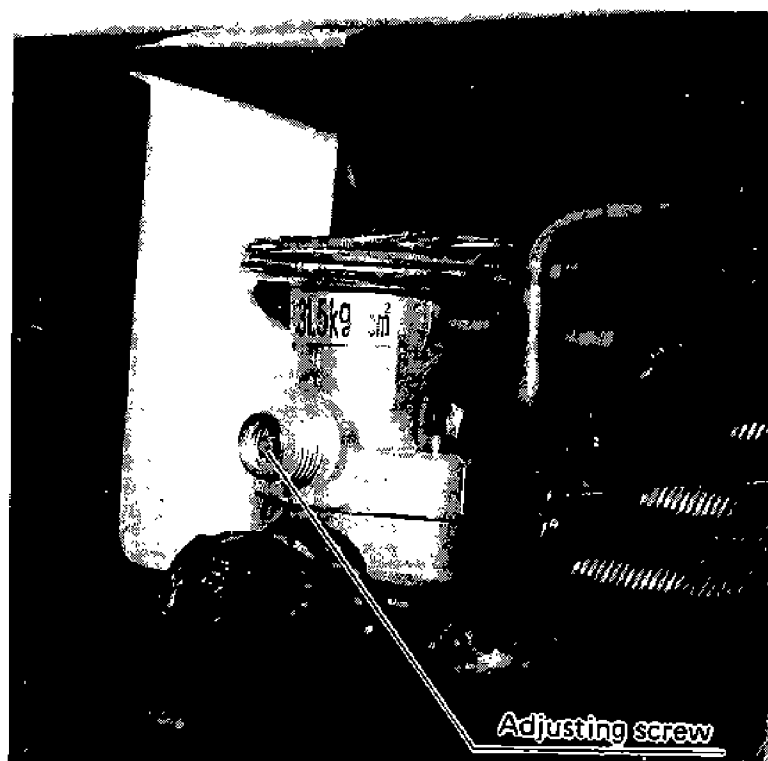
- (1) Adjustment based on the suction operation pressure
 - 1) Conform that the predesigned volume of the refrigerant has been charged.
 - 2) Attach a pressure gauge to each gauge port and operate the refrigeration unit, maintaining inside temperature at -18°C (-0.4°F). (See connecting of pressure gauge).
 - 3) When inside temperature comes to the preset temperature, compare the suction pressure reading with the standard pressure. (See Standard operation pressure curve)
 - 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)

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 found with the setting after adjustment of the expansion valve, return the adjusting screw to the original position, as trouble occurred 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 does not go down below $0\text{ kg/cm}^2\text{ G}$ (0 PSIG).



(b) Replacement

For replacement of the expansion valve, remove the access panel located on the front of the unit or by removing the evaporator bulkhead inside the container.

- 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

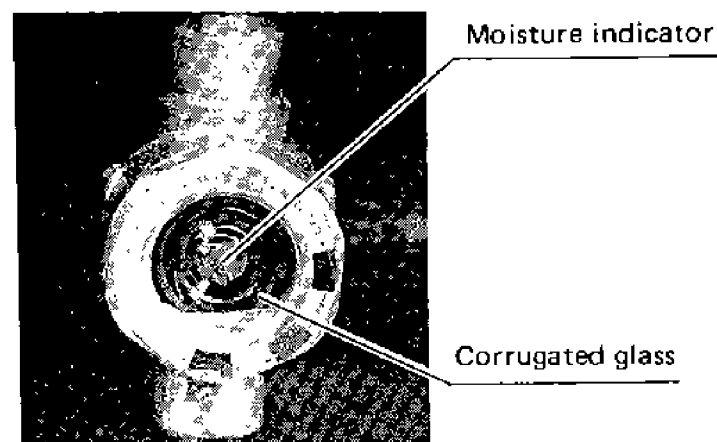
This indicator permits checking of flow of the refrigerant and moisture content in the refrigerant.

(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: The indicator may appear orange if it been exposed to gaseous refrigerant for a long time.



(b) Flow of the refrigerant

- When the liquid refrigerant is sealed, bubbles on the sight glass disappear.
- Check

Operation	Indicator state
At start	Bubbles appear but liquid refrigerant is sealed in 30 minutes to an hour after starting.
During operation	Bubbles may appear more or less. [particularly appear more during capacity control operation]

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

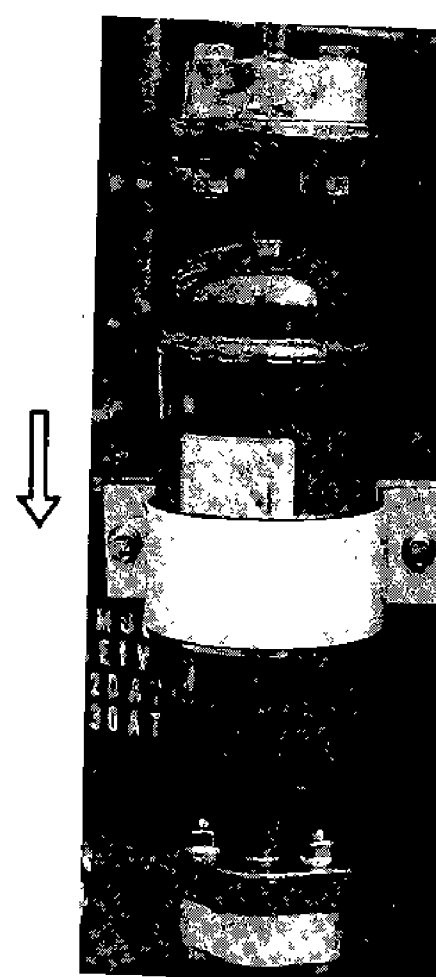
4.1.7 Dryer

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 vent 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 vent the air.
- 6) After completion of the work, restore the stop valve to its original state and then inspect the system for gas leakage. Confirm no gas leakage is found.



4.1.8 Solenoid valve (20S, 20BS)

- Two solenoid valve are installed respectively in the liquid line and hot gas line. They operate as follows according to operating mode.

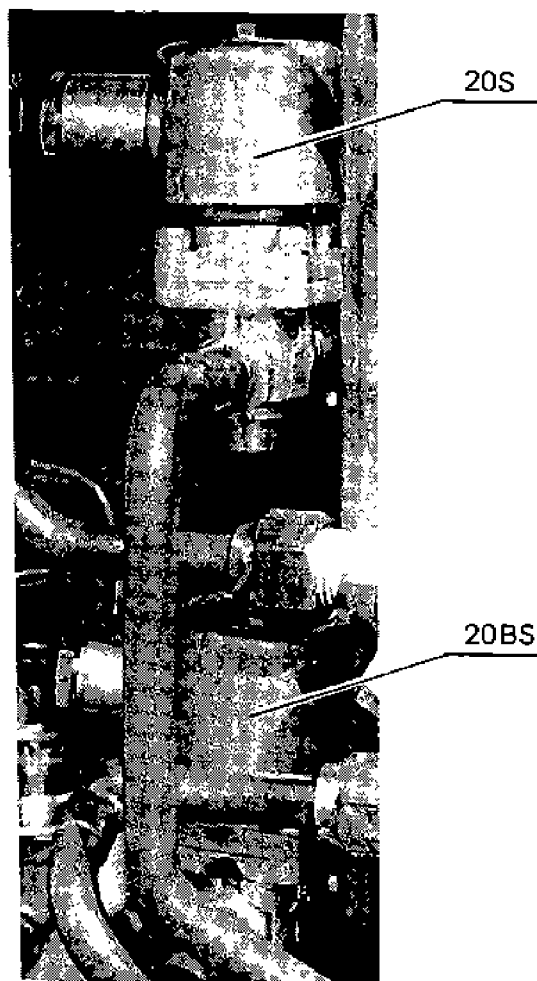
(a) During frozen mode

20S is open during operation.

When stopping the compressor by the controller, it is closed and stop flow of the refrigerant, performing "pump down".

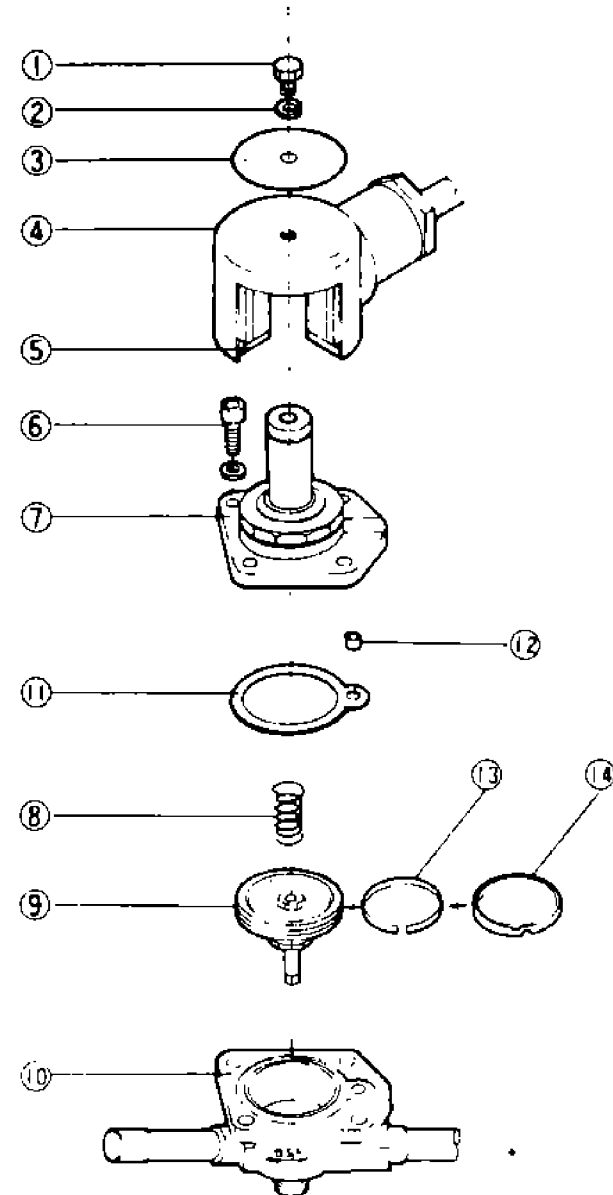
(b) During chilled mode

- During pull down period, 20S is open and 20BS is closed. When storage temperature becomes +2°C, 20BS is also open by the controller. Thereby, hot gas passes through 20BS and controls capacity.



(c) Disassembly

- The structure of the solenoid valve is shown at below. (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 70–80 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

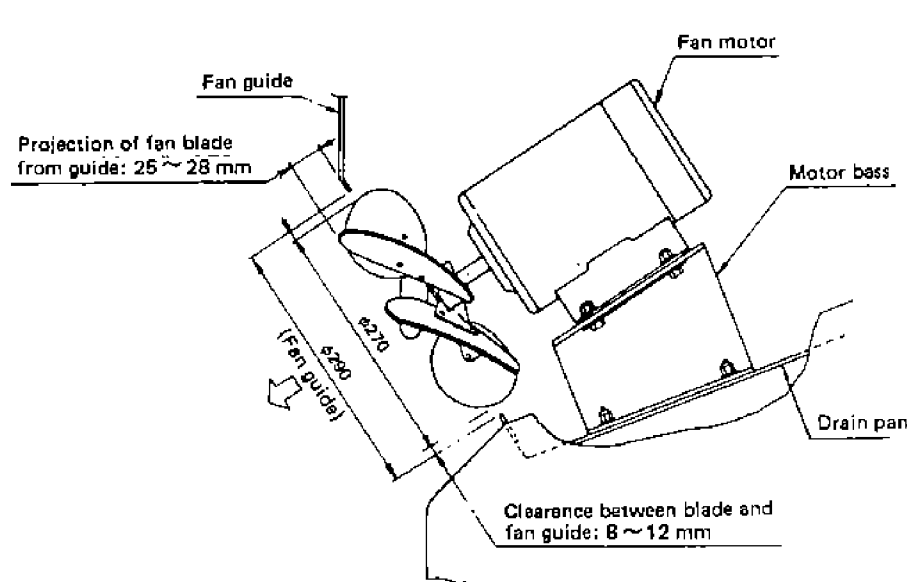
4.2 Components related with the air system

4.2.1 Fans and motors

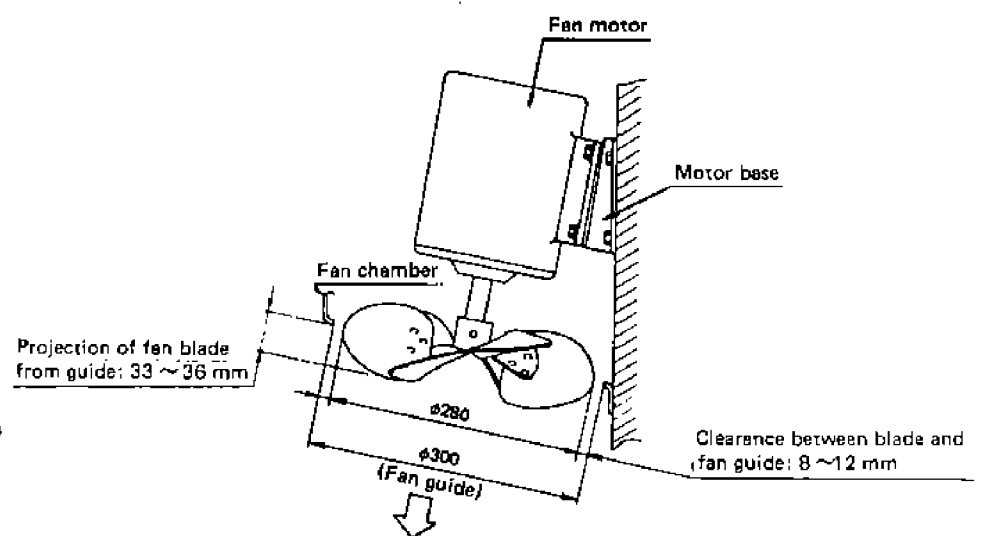
(a) Specifications

		Evaporator	Condenser
Fan	Type	propeller fan	propeller fan
	Number of blades	6 pcs.	6 pcs.
	Blade diameter	φ270	φ280
Motor	Type	Single-phase, squirrel-cage induction motor	
	Motor output (number of poles)	465W (2P)	125W (4P)
	Capacitor	Built-in	Separate
	Bearing	Ball bearing, 6203 contactless type, rubber shield	

(b) Installation procedure



Evaporator fan and motor

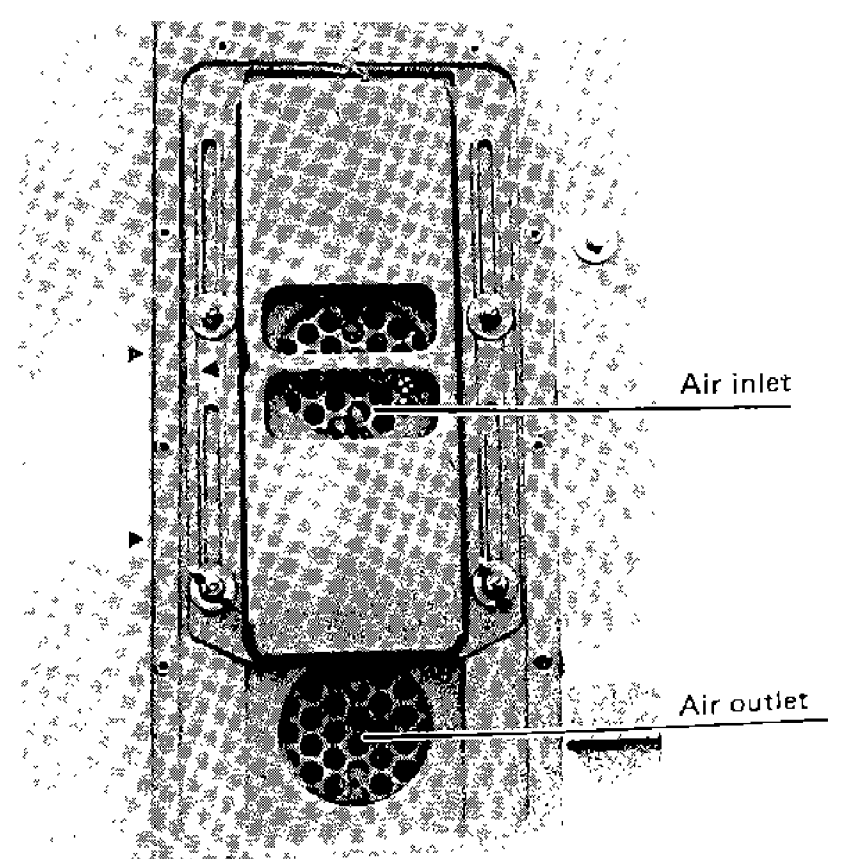
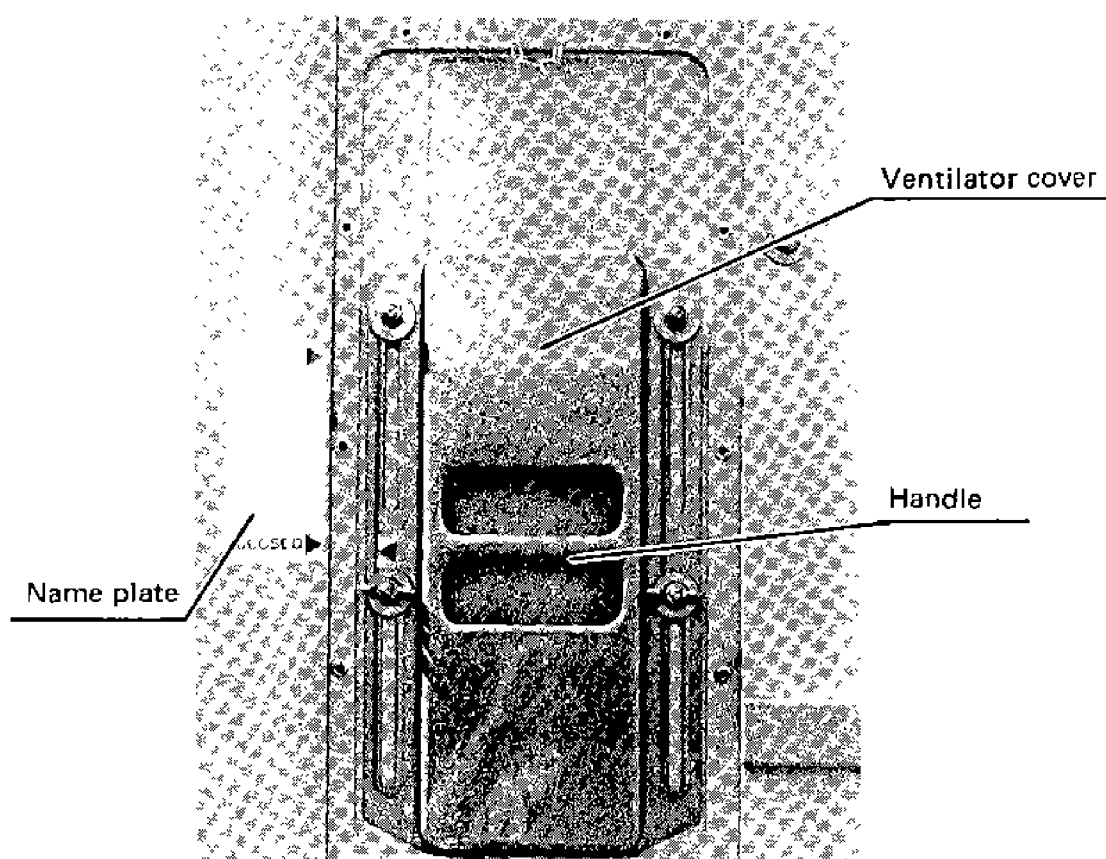


Condenser fan and motor

(a) Operation

- If ventilation is not needed:
Set the handle to CLOSED.

- If ventilation is needed:
Set the handle to OPEN.

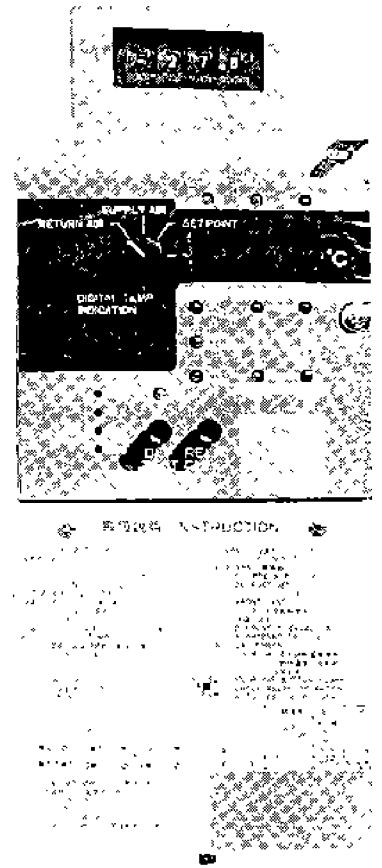


4.3. Temperature control system

4.3.1 Electronic controller (DUE-DK83-212-61)

1.1 Specification

- Power source AC24V, 50/60Hz
- Temperature range -29.9 ~ +25.0°C
- Sensor
 - SS: For supply air temperature control — Platinum resistance
 - RS: For return air temperature control — thermo-meter element
 - TH1: For defrost ter./detection — Thermistor element 0°C 100Ω
 - TH2: For prevention of overheat — Thermistor element
- Electronic Timer
 - Defrost timer (out-range) — 2 hr
 - Defrost timer (in-range) — 12 hr
 - Defrost back-up timer (for abnormal defrost completion sensor) 50 minutes
 - Oil Pressure — Alarm detection timer — 110 sec.
 - Restart delay timer — 120 sec.



- Output — Solidstate relay for ON/OFF
 - IRS (For in-range), MSS, BSS (For solenoid operated valves)
 - CS (For compressor), HS (For electric heater) — Step thermostat
 - DFS (For single defrost)
 - EFS (For evaporator for motor)

- Display — Digital temperature display
 - Supply air temp.
 - Return air temp.
 - Setting temp.

Change the digital temp. indication switch on the display panel.

- Light emitting diode Operation Displays — For each relay output (HS, EFS, MSS, BSS), operation mode/sensor (CHILLED — RETURN SUPPLY, FROZEN-RETURN) defrost test. (DEF. TEST)
- Alarm Displays — Supply air sensor, return air sensor, oil pressure alarm (ALARM-OIL PRESS.) and defrost thermistor (ALARM-DEF. SENSOR)

- Others
 - Defrost timer check function.
 - By delivery sensor in case of abnormal intake sensor.
 - Solenoid valve back up function
 - Defrost back up function
 - Relay check function
 - Over heat protecting function

1.2 Operation and display

1) Temperature setting

- Set the set point selector located in the upper part of the controller to the specified temperature.
Setting range: Variable range $-29.9 \sim +29.9^{\circ}\text{C}$
Note that the range $+25.1 \sim +29.9^{\circ}\text{C}$ is regarded as a set temperature of 25.0°C , and the digital temperature display will indicate 25.0°C .
- When the digital temperature display switch is set to the position for the set point, the value set by the switch is digitally displayed.

Note 1. Do not stop the switch unduly at intermediary positions. Allow digits to appear properly in the windows.

Note 2. The column for 10°C displays only 0,1 or 2.

Don't apply undue force.

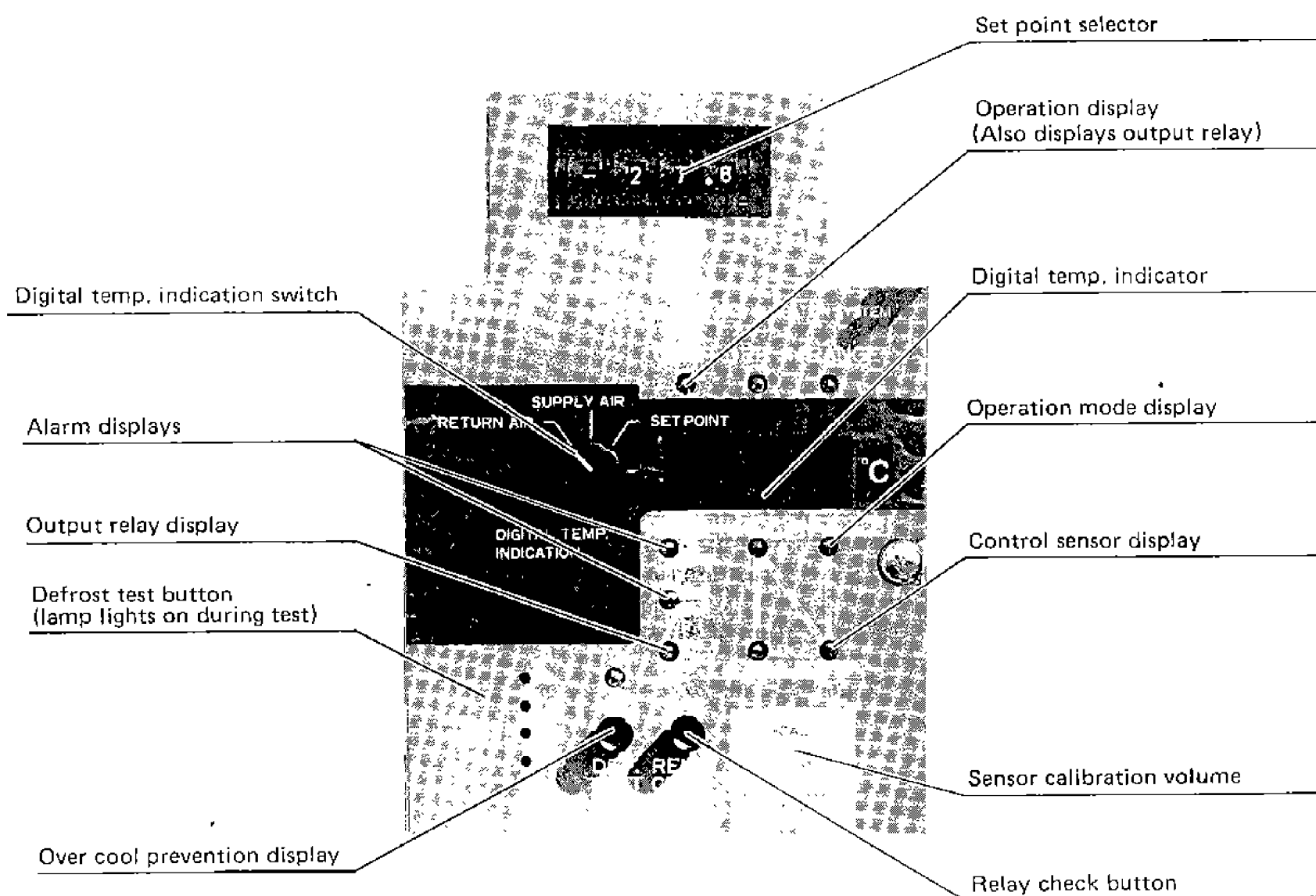
Note 3. Don't touch the set point selector unless this is required to set temperature!

2) Measurement of supply and return air temperatures

- Set the digital temp. indication switch ("DIGITAL TEMP. INDICATION SWITCH") to "SUPPLY". . . supply air temperature display. to "RETURN". . . return air temperature display.

NOTE: "E" is displayed when the control sensor is abnormal.

"E" is displayed at "SUPPLY" position when the supply air sensor (S.S) is abnormal. "E" is displayed at "RETURN" position when the return air sensor (R.S) is abnormal.

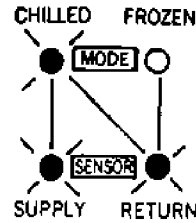


3) Operation Mode Confirmation

Operation modes are automatically switched at the preset temperature.

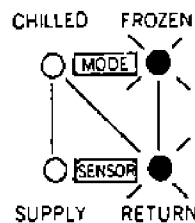
(a) Setting temperature above -5°C (CHILLED MODE)

- Lamps (green) for CHILLED MODE, SUPPLY AND RETURN AIR SENSORS go on.
- Performs the step thermometer operation by the supply sensor.
- When the operation proceeds from pull-down (MSS ON, BSS OFF) to in-range temperature (preset temperature $+1^{\circ}\text{C}$), BSS is turned ON to perform bypass control by hot gas.
- When the temperature inside the container is below the preset temperature, an heating operation is performed by the heater.



(b) Setting below -5.1°C (FROZEN MODE)

- Lamps (green) for FROZEN MODE and RETURN AIR SENSOR go on.
- Compressor is switched, ON/OFF at full capacity.



4) Display function

(a) Opening Display

- Comp. (Green) . . . Compressor operating
- Defrost (Red) . . . Defrost operating (DFS: ON)
- In range (Orange) . INRANGE (inside temperature is in range. . setting temperature $\pm 3^{\circ}\text{C}$.)

(b) Output Relay Operation Display (Red)

- SSR
 - HS88H: ON (heating operation or defrost operation)
 - EFSFor 88F-ON/OFF
 - MSSFor 20S-ON/OFF
 - BSSFor 20BS-ON/OFF

(c) Alarm Display

- ALARM
 - OIL PRESS.
 -When the reset switch is turned on within 120 seconds after oil pressure alarm display signalled abnormal oil pressure, the ALARM lamp flickers.
 - DEF. SENSOR
 -Displayed short circuit or broken wire of the defrost thermistor.

• Control Sensor (S.S, R.S) Alarm

	NORMAL	SUPPLY SENSOR ABNORMAL	RETURN SENSOR ABNORMAL	SUPPLY and RETURN SENSORS ABNORMAL
CHILLED MODE				
FROZEN MODE				

5) Defrost test

- Pushing the "DEF. TEST" button and the defrost test lamp (red) and will light up the defrost timer will start counting simultaneously.

NOTE; Do not hold the button pressed continuously.

- Defrost starting (after pushing the button)

- In-Range (when IRS is on) . .defrost starts (defrost lamp lights) after 43 sec. (12h/1000)
- In-Range (when IRS is on) . .defrost starts (defrost lamp lights) after 7 sec. (2H/1000)

- The defrost test lamp lights off ater defrosting.

NOTES 1. Defrost operation will not start even after the completion of time counting of the defrost timer when the temperature sensed by defrost completion thermostat is above 40.6°C . At this time, the defrost test lamp will go out also after the timer count up.

2. Press the defrost test button and the standard timer (2hr or 12 hr) is cleared.

6) Sensor Caliblration (S.S, R.S)

NOTE: DO NOT ADJUST EXCEPT DURING PERIODICAL INSPECTION!

- Adjust by turning the sensor calibration screw "CAL".
- Dip the sensor (S.S or R.S) in screw the ice water. Then adjust the digital temperature display valve of "SUPPLY" or "RETURN" air sensor to show 0°C .

7) Relay (step) check

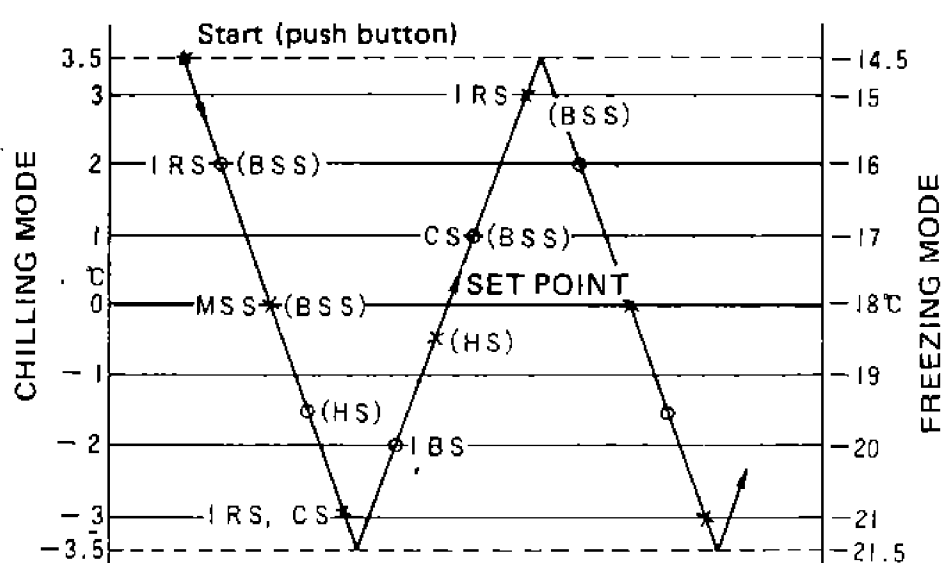
- a. Relay function point of the step thermostat can be easily checked. Refer to "Relay Function Pattern" regarding relay function points.
- b. Press the "relay check button", and S.S and R.S are disconnected automatically from the controller and the temperature setting is also changed forcedly changed follows.

Relay check: State before pushing the button	Relay check: During pushing the button		
	Digital temperature display value		
	SET POINT	SUPPLY AIR	RETURN AIR
In CHILLED MODE 	0°C	Storage temperature sensed by R.S is displayed.	Auto Swing temperature (see C) is displayed instead of temperature sensed by S.S.
In FROZEN MODE 	-18°C	Storage temperature sensed by S.S is displayed.	Auto Swing temperature (see C) is displayed instead of temperature sensed by R.S.

c. Checking methods

- Set the digital temperature display switch to "RETURN AIR".

Continue to push the relay check button, and digital temperature display swings as shown below centering on 0°C (-18°C), as false variation of inside temperature, and each output relay performs in step (which is confirmed by LED). The digital temperature display value at this time corresponds to the relay function point.



1. Symbol "0" represents the ON point and "X" the OFF point of the relay.
(BSS) and (HS) function during chilling only.
2. Auto Swing varies at the rate of 0.1°C/2 sec.
3. When the relay check button replaced, the unit is returned immediately to the normal control.

1.3 Defrost Function

1) Defrost Initiation

- Manual defrost switch (3D)
- Electronic timer
Out-range (setting temperature above +3°C) . . . 2 h
In-range (setting temperature below +1°C) . . . 12 h

2) Defrost Termination

- Temperature is detected by the defrost thermistor.
Defrost is terminated above +40.6°C OFF point (ON point is +23.6°C).

3) "Defrost" Thermistor Back-up Function

- When the thermistor is not operating well, the defrosting can almost operate normally.
Setting temperature $\geq 7.5^\circ\text{C}$ — Not defrosting.
Setting temperature $< 7.5^\circ\text{C}$ —
Defrosting is initiated to the defrost initiation signal (in accordance with (a)). Automatically terminated by the 50-minutes timer.

1.4 Overheat Protecting Function

Abnormal temperature rise during defrosting and heating is prevented by a overheat protecting thermister.

OFF: 71°C ON: 49°C

1.5 Delivery Safety Function

During chilled mode, the supply air temperature is monitored to prevent overcooling.

- When the return air temperature descends to the in-range (after hot gas bypass is started), the compressor stops once, and after it is restarted, switching is controlled by the temperature monitored by a supply sensor (SS).

- **Operation**

It is forced to stop by MSS, BSS, and the OVERCOOL lamp is turned on.

NOTE) If either of the control sensors RS and SS is faulty, overcooling prevention does not operate.

1.6 Control Sensor Back up Function

When the control sensors are broken or shorted, the following function automatically activates.

- **Chilled mode**

When RS is faulty: SS is automatically switched on to maintain operation.

When SS is faulty: Operation is kept on with RS, without the delivery safety function.

When both RS and SS are faulty: EFS only is on. Defrosting is not performed.

- **Frozen mode**

When RS is faulty: With CS, MSS and EFS on, frozen mode is maintained, but SS control is not performed, and defrosting is performed at 12 hour cycles.

1.7 Solenoid Valve Back-up Function (during FROZEN MODE)

- When the inside temperature is low than the in-range (-2°C below the setting temperature) without pump-down stop even though the solenoid valve (MSS, BSS, . . .OFF) is closed, the compressor is immediately stopped. (CS OFF \rightarrow 88C OFF)

- When this operation is continued, inside temperature is controlled in cycles of:
OFF setting temperature -3°C
ON setting temperature $+1^{\circ}\text{C}$

Note: When a b-contact of compressor magnetic switch (88C), which is connected to the controller terminal No. 14, is failed in contact, the following phenomena are shown.

1. In spite of the compressor stops, the "COMP" lamp (Green) of electronic controller lights on. In such a case, it also caused by the actuation of oil pressure protection system.
2. In spite of "DEF" lamp (Red) of electronic controller lights on "HS1" and "HS2" of SSR do not turn on, so that the electric heaters do not turn on. In above case, check the b-contact of 88C whether it is failed or not in contact, and if it is failed, replace "88C" with new one.

< Function pattern >

NAME	MODE	RS	SENSOR	Setting Temperature °C											
				-5	-4	-3	-2	-1	+1	+2	+3	+4	+5		
IRS	CHILLED	NORMAL	R.S		OFF				ON						OFF
		AB NORMAL	S.S	OFF				ON							OFF
	FROZEN	NORMAL	R.S		OFF				ON						OFF
		AB NORMAL	-						OFF						
MSS	CHILLED	NORMAL	R.S					OFF				ON			
		AB NORMAL	-					OFF				ON			
	FROZEN	NORMAL						OFF				ON			
		AB NORMAL							ON						
BSS	CHILLED	NORMAL						OFF				ON		OFF	
		AB NORMAL					OFF					ON		OFF	
	FROZEN							OFF							
HS	CHILLED	NORMAL	R.S					ON						OFF	
		AB NORMAL	S.S	ON										OFF	
	FROZEN	-	-										OFF		
CS	CHILLED	NORMAL	R.S					OFF					ON		
		AB NORMAL	S.S	OFF									ON		
	FROZEN	NORMAL	R.S					OFF					ON		
		AB NORMAL	-										ON		
DFS	DEFROST	-	-	Turned on only during defrost time											
EFS	-	-	-	Turned off only during defrost time											
DELIVERY SAFETY THERMISTOR	CHILLED	(DURING OPERATION NOMALLY)	S.S					OFF					ON		
DEFROST THERMISTOR	-	-	DEFROST SENSOR									ON	23.6°C	40.6°C	OFF
OVERHEAT THERMISTOR	-	-	OVERHEAT SENSOR									ON	49°C	71°C	OFF

• Supply and return air sensor are abnormal

	IRS	MSS	BSS	HS	CS	EFS
CHILLED	OFF	OFF	OFF	OFF	OFF	ON
FROZEN	OFF	ON	OFF	OFF	ON	ON

1.8 Printed Circuit Board (PCB)

1) PCB functions

a) CPU PCB (PCB-0)

- Consists of CPU, ROM, RAM, display controller, interval timer, and input/output controller.
- Processes all input/output signals.

b) Analog PCB (PCB-1)

- Consists of amplification circuit, fault sensing circuit, A/D converter circuit, and PID setting digital switch.
- Temperature input signals from all sensors are amplified by amplification circuit, enter as analog signals into A/D converter circuit to be converted into digital signals, and transmitted to CPU PCB.
- Analog signals from set point selector and phase control circuit etc. are also converted into digital signals by A/D converter circuit and transmitted to CPU PCB.

c) Input/output PCB (PCB-2)

- Consists of buffer circuit, and amplification circuit.
- Input signal from external contact is received by buffer circuit and transmitted to CPU PCB.

d) Display PCB (PCB-3)

- Consists of light emitting diode, digital display circuit, diode matrix circuit, temperature setting volume, and various switches.
- Receives display signal from CPU PCB to display by means of light emitting diode (LED) or digital display.
- Transmits switch signal on PCB to CPU PCB.
- Transmits analog signals from temperature setting volume and CAL volume to analog PCB.

e) Power source PCB (PCB-4)

- Consists of rectification circuit and constant voltage circuit and supplies power to electronic circuits.

f) SSR PCB (PCB-5)

- Consists of SSR (no contact relay) and photo coupler.
- Isolates output signal from CPU PCB by means of photo coupler and drives SSR.

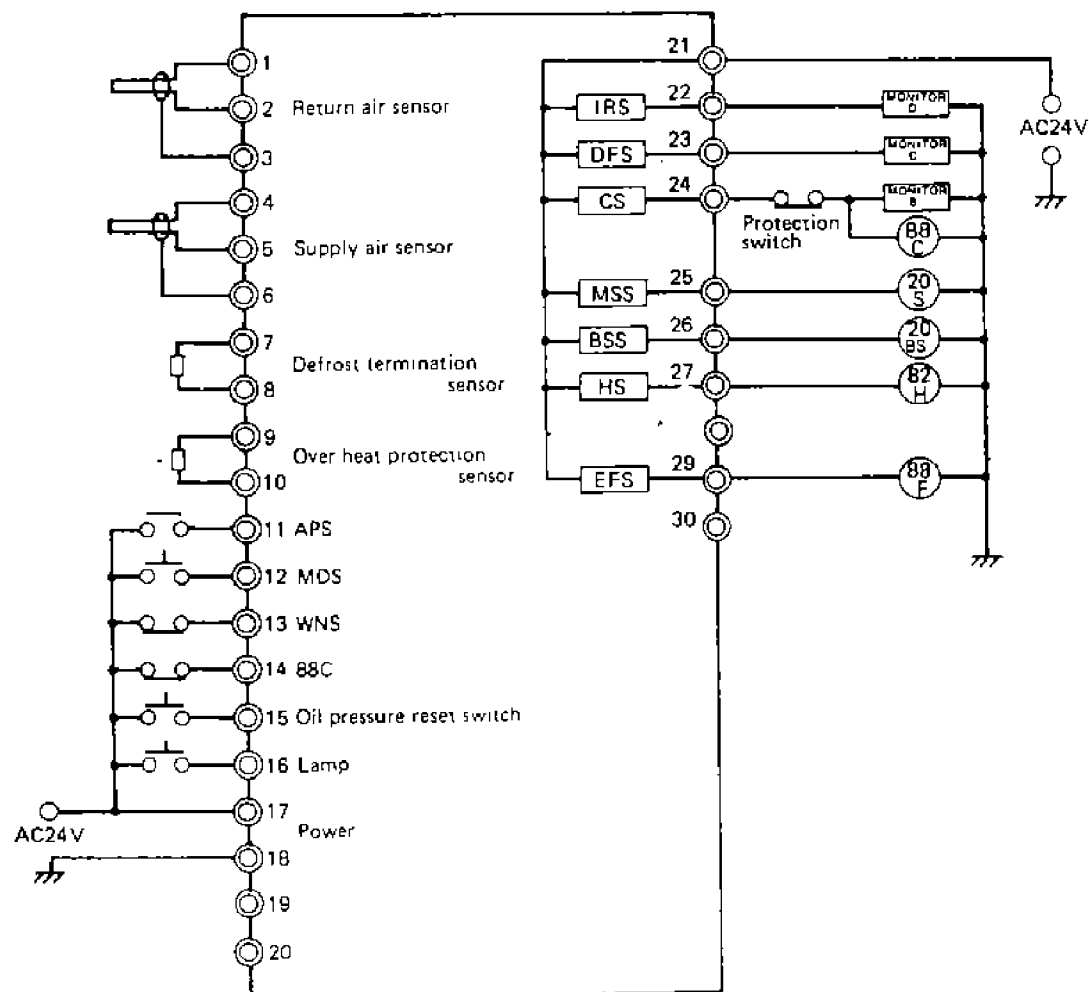
g) Terminal PCB (PCB-6)

- Consists of terminals to provide external wiring connections with this unit.

h) Thumb wheel board (PCB-7)

- Receives the temperature set value of the set point selector and transfers it to CPU board.

2) External wiring (wiring to terminal PCB, PCB-6)



IMPORTANT

1. Don't test the dielectric strength and insulation resistance of the controller and the operation circuit (24V AC circuit).
2. Don't short across terminals.
3. If above 1 and 2 are neglected, the controller will be damaged.

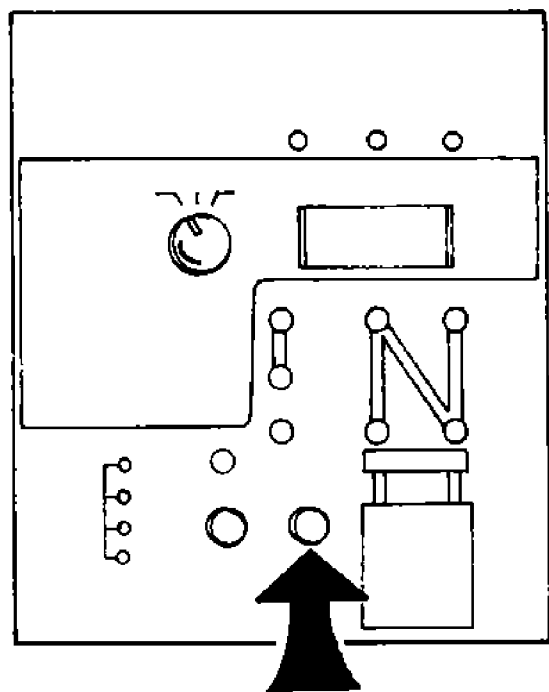
1.9 Inspection method

1) Checking thermostat step relay

Check the thermostat step relay while depressing the relay (step) check button. Refer to item 1.2-7).

a. Frozen mode

- Set the digital temperature display switch to "RETURN AIR"
- Keep the relay check button depressed.
- Temperature setting is fixed at -18°C and the inside temperature will falsely swing for $0.1^{\circ}\text{C}/2$ sec. from $-14.5^{\circ}\text{C} \rightarrow -21.5^{\circ}\text{C} \rightarrow -14.5^{\circ}\text{C} \rightarrow$, all of which are indicated on the digital display.
- With the temperature setting at -18°C the step relay of thermostat is turned on and off in accordance with such temperature fluctuation (which is confirmed by LED lamp). The temperature displayed digitally at this time is the function point of the relay.
- Release the relay check button, and the operation becomes normal.



b. Chilled mode

- Set the digital temperature indication switch to "SUPPLY AIR".
- Press the relay check button, and the temperature setting is fixed at 0°C causing the inside temperature to swing falsely from $+3.5^{\circ}\text{C} \rightarrow 0^{\circ}\text{C} \rightarrow -3.5^{\circ}\text{C} \rightarrow$
- Set the temperature at 0°C and check the relay function point in the same way as the FROZEN mode.
- c. Refer to the Function Pattern Table of item 6 for relay function points.

2) Defrost test

Press "DEF. TEST" button for testing. (Button should be pressed once. Do not keep it pressed down.)

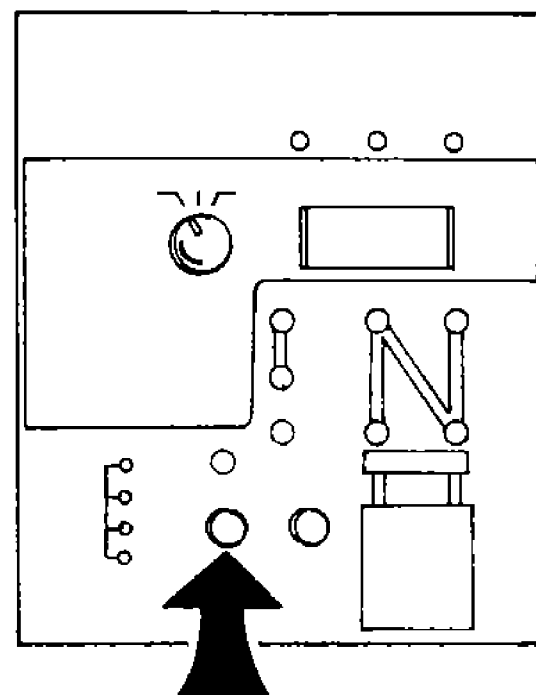
----- Refer to item 1.2-5.

- a. Pressing the button turns ON the test lamp (red) and the timer counter is started.

Within In-range (IRS : ON)	}	Defrost starts.
.. after 43 sec.		
Outside In-range (IRS : OFF)	}	
.. after 7 sec.		

b. Starting of defrost

After the timer finishes counting
 DEF. lamp (red) lights } Compressor
 MSS, BSS : OFF } → stops → HS are
 pumping-down. } turned ON.



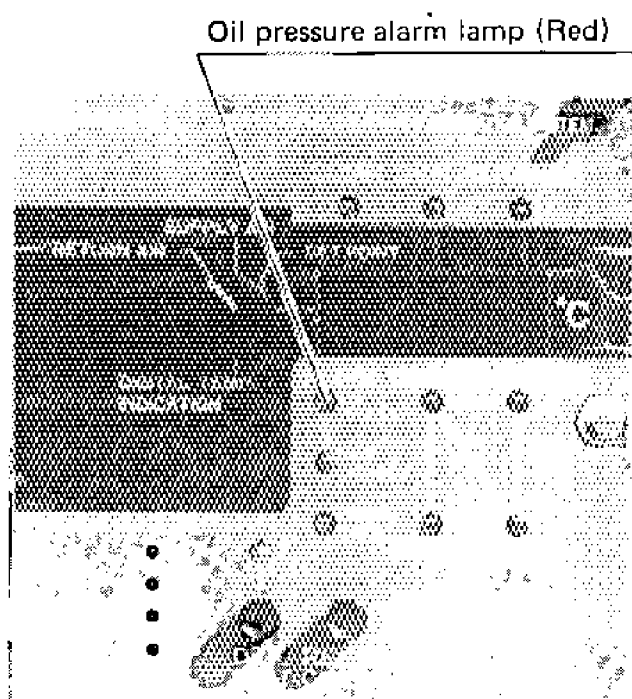
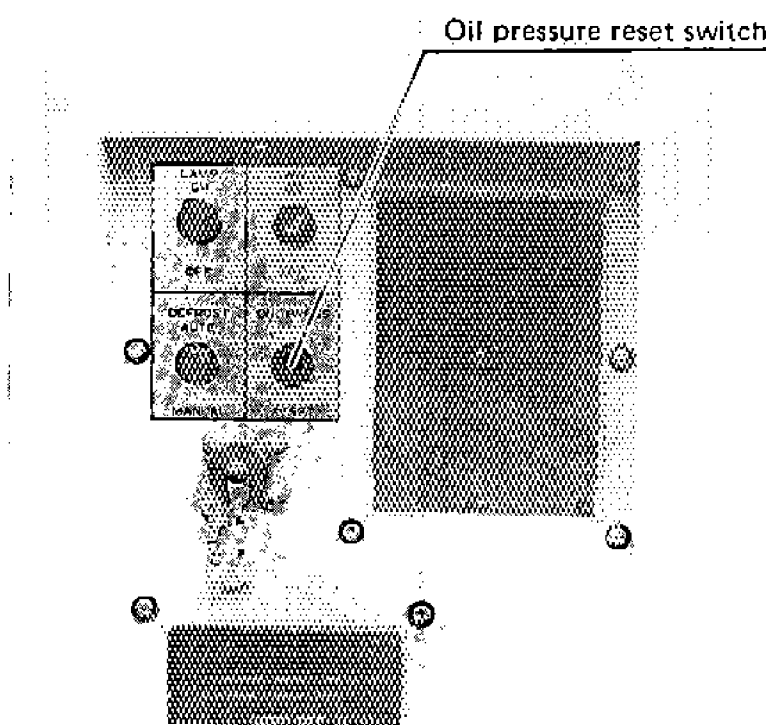
- Notes
1. This test cannot be effected during defrosting.
 2. Defrosting does not continue when the defrost thermistor is OFF (above $+40.6^{\circ}\text{C}$).
 3. When the defrost thermistor is faulty (short-circuit or disconnection)
 - Either connect between terminal No. 7 and 8 of the terminal PCB (PCB-6) or remove the wire connections for the terminal No. 7. or 8. This lights the ALARM pilot lamp (red) of DEF. SENSOR.
 - Press the test button under the above conditions to test defrosting according to the back up function (item 1.3-3)).

3) Back-up test of sensor (Pt)

- a. Either connect wirings of return air sensor or supply air sensor (between terminal No. 1 and 2 or No. 4 and 5 of the terminal PCB) or remove the wire connections for terminal No. 1 or 2 and No. 4 or 5.
- b. Checking faulty display
 - Confirm if the digital display shows, the faulty condition of the control sensor.
Refer to item 1.2-4)-(c).
 - Confirm if "E" is shown on the digital display.
Refer to item 1.2-2).

4) Checking of oil pressure protecting

- Connect between terminal No. 13 and 17 of the terminal PCB.
- Start the compressor. Oil pressure protecting functions after 110 seconds to stop the compressor (CS and COMP. LED : OFF) and the OIL PRESS. ALARM pilot lamp (red) goes on simultaneously.
- Reset check
Turn on the hydraulic reset switch (in the control box cover) within 120 seconds after the compressor stopped. The ALARM pilot lamp flickers.
— This restarts the compressor 120 seconds after it has stopped, and the ALARM pilot lamp goes off.



1.10 Troubles of Controller

1) Phenomena

When a controller is out of order, replace it with a new one.

Note) Confirm if the sensor (Pt) and thermister are functioning normally.

- Remove the wire connections from the controller terminal PCB and measure the resistance between the terminals. (Refer to the temperature vs. resistance characteristics table of item 11)

- a. Digital display and controller do not function when the power is on.
 - Check if the voltage (between terminal PCB No. 17 --18) is AC 24V.
 - Check if the external wiring (item 1.7-2) is normal.
 - Check if the connector wirings between each PCB are well fixed.
- b. LED does not light with the normal load (solenoid valve, relay, etc.) → Is lamp switch (3-30L : Control box cover) turned ON?
- c. Sensor (Pt) is normal, but output function is abnormal.
- d. Sensor (Pt) is normal, but "E" is displayed and LED display of the sensor goes out.
- e. DEF sensor ALARM is displayed when the defrost completion thermister is normal.
- f. The load does not function with LED displaying.
- g. The controller does not function according to external input (pressure switch, control switch).
- h. The preset temperature will not change by operating the set point selector.
- i. Controller's functions are not normal.

2) Replacement Procedures for Controller and Printed Circuit Board.

1) Steps

1. Shut off power supply
2. Remove terminal cover (set screws x 3)
3. Remove terminal board assembly (set screws x 4)

Pull-Out Connectors

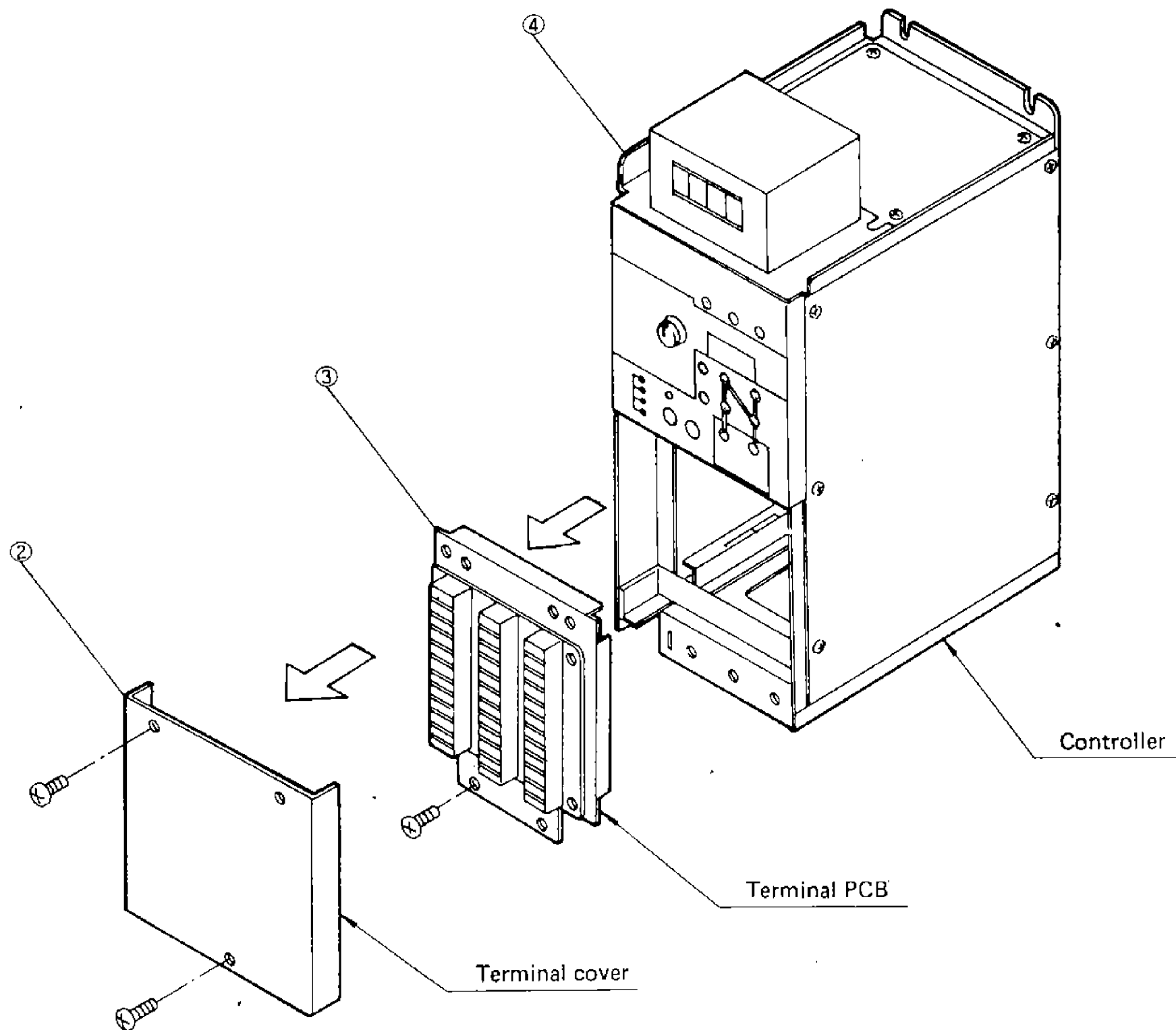
- Slowly pull out terminal board assembly.
- Remove connectors between printed circuit board and controller.

Note: Don't pull the lead wire itself.

4. Remove controller from control box.
 - fixed at two locations at bottom front
 - fixed at two locations at inside top
 - fixed at one location on right side top
5. Replace part in question by referring to the Figure below.

6. For reassembly reverses the above steps while confirming that no connector are fully inserted.

Note: When re-inserting connector, match guide direction, number of pins and connector numbers.



(10) Operation for emergency.

1) Procedures described below are for forced operation in an emergency when a new controller is not available although the controller has been found faulty. Since the defrost system oil pressure switch, etc. May not function properly sometimes depending on the nature of the controller fault controller problems.

The controller must be replaced immediately when new one is available.

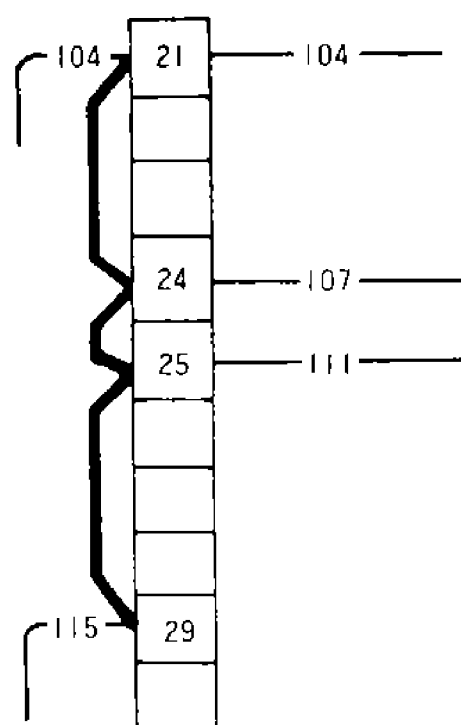
2) FROZEN mode operation (continuous operation of evaporator fan and compressor)

a. Remove the connectors (CN6B to E: 4pcs. in total) of the controller terminal PCB (reverse side). Refer to 2) in item 9 for the details.

b. Additionally connect short circuit lines (three block lines shown at right) to the terminal PCB.

c. Continuous operation is possible after the above procedures have been completed.

Note Protection switches (63HL, 51C, 49) may function to temporarily suspend compressor operation in this mode.



Terminal board on the terminal PCB

3) Heater operation

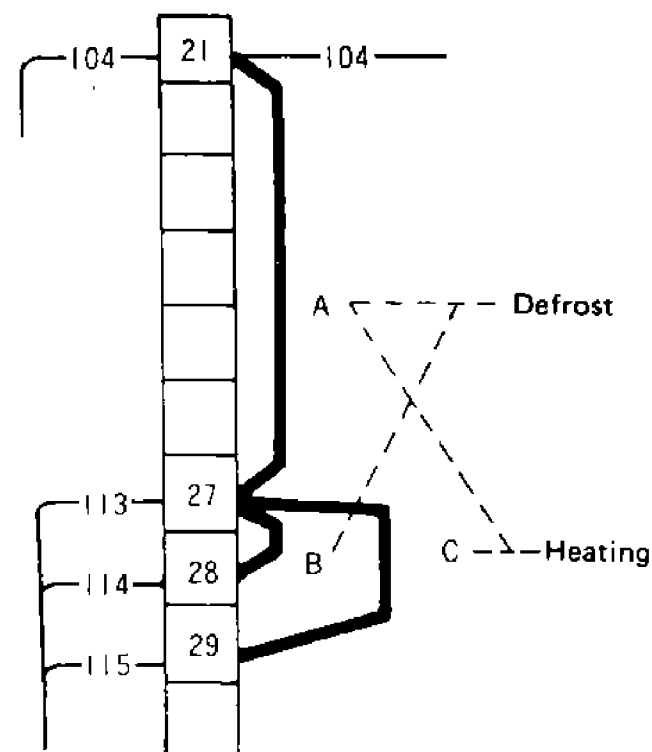
Note Overheat prevention thermostat may not function due to controller problems during heater operation, causing overheating.

Take care to prevent overheating.

a. Defrost operation

(Supply power to heaters H1 ~ H8.)

- Remove the connector from terminal PCB as described in item 2).
- Additionally connect short circuit lines (two block lines A and B shown at below) to the terminal PCB.



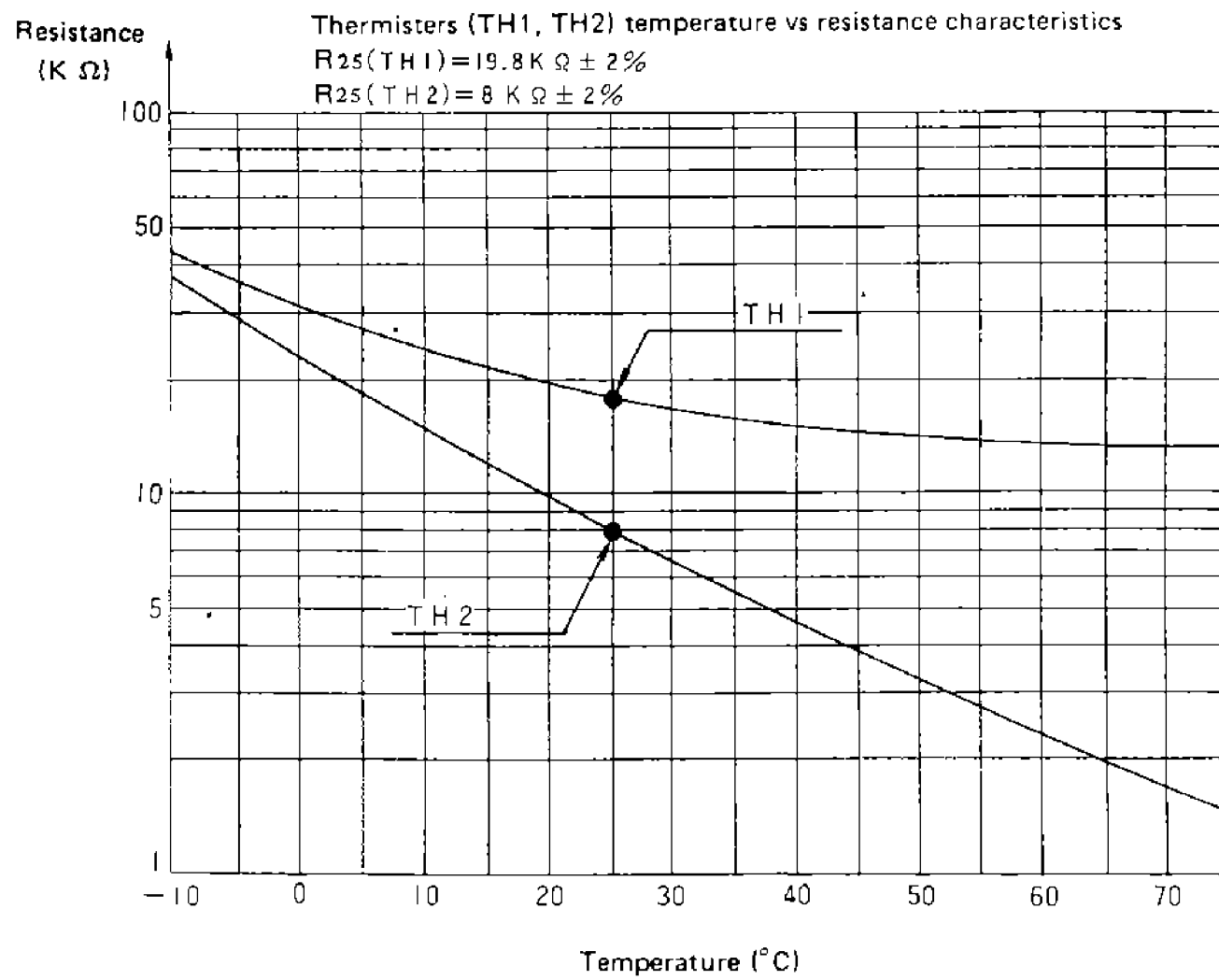
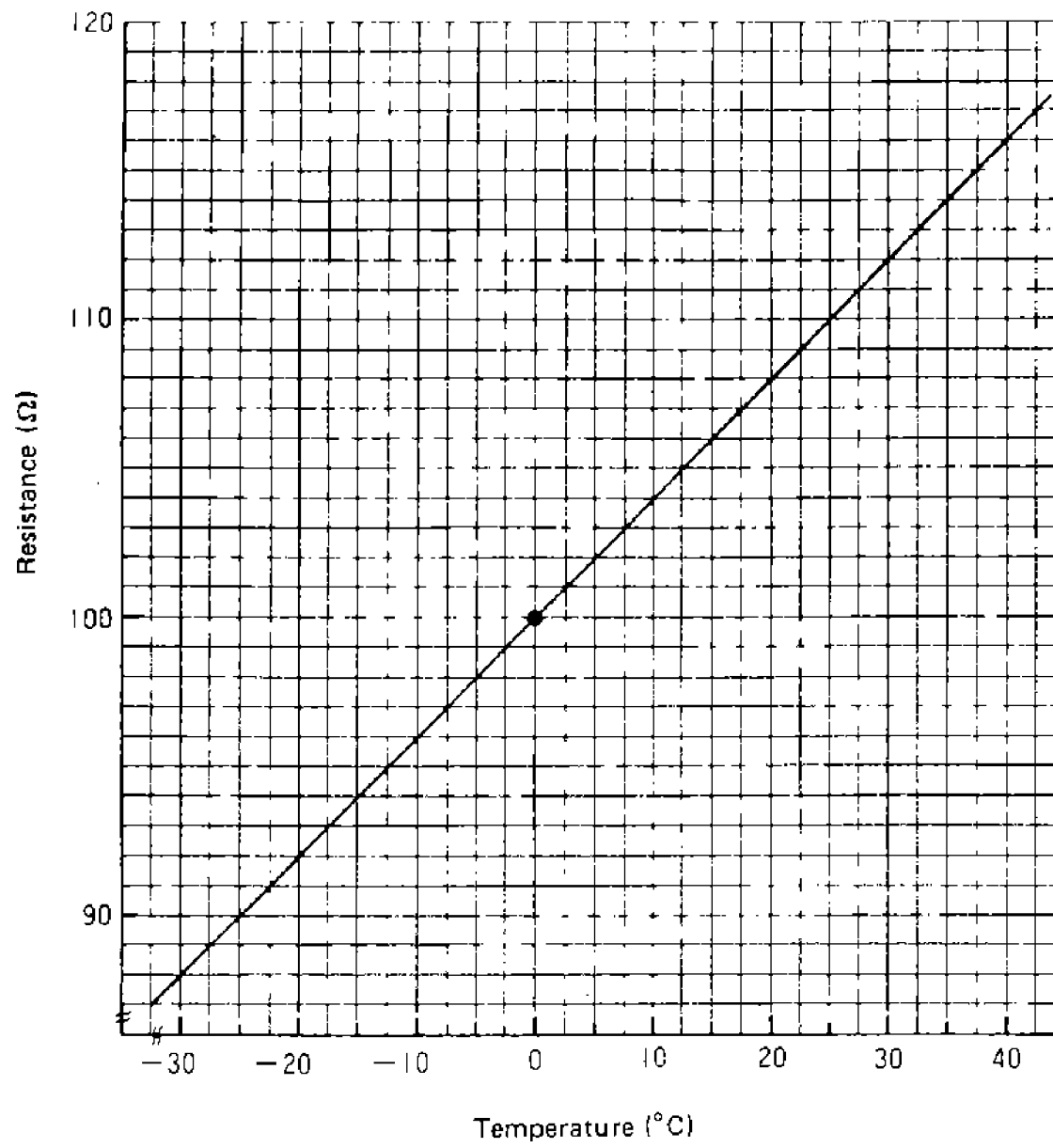
IMPORTANT:

To terminate defrosting, the power must be manually turned OFF or the short circuit lines removed.

- b. Heater operation (continuous operation of heaters H1, H2 and evaporator fan)
- Change the short circuit lines to A.B to A.C for the defrost operation in item a.
 - To stop heater operation, the power must be manually turned OFF or the short circuit lines removed.

1.12 Sensor characteristics (temperature vs resistance characteristics)

Control sensor (platinum resistance thermometer element: S.S, R.S)
Temperature vs resistance characteristics
Rating: 10 Ohm $\pm 0.3\%$ (0°C)



4.3.2 Capacity control system

The capacity control system using hot gas bypass, delivery safety thermostat and back up of refrigerant solenoid valve are provided in the unit to prevent the supply air from becoming extremely low and the cargoes from being freezeed when chilled cargoes are transported.

1) Capacity control operation

The capacity control operation by hot gas bypass system is explained in here. Switch-Over from normal operation (full load) and capacity control operation is done by the controller. In case temperature setting of the controller is higher than -5°C (23°F), the unit comes into capacity control operation by turning capacity control switch into "ON". The function will be described below in accordance with the wiring diagram.

In case the preset temperature exceeds -5°C (23°F), the inside temperature (return to evaporator) reaches a suitable temperature range, BSS of electronic controller 23A closes, and hot gas solenoid valve 20BS opens to allow hot gas to flow. The flow rate of the hot gas is controlled by the hot gas bypass valve. It then enters the evaporator, is mixed with the liquid refrigerant which passes through the expansion valve, and flows to the compressor. When the inside temperature further drops and reaches the preset temperature, MSS and BSS of 23A open to perform pump-down and the compressor stops.

On the other hand, a supply sensor to detect the temperature of the supply air from evaporator is provided to prevent over cooling.

When the temperature of the supply air drops below the preset temperature (-3°C), MSS and BSS are closed to perform pump-down to stop the compressor even before the return temperature reaches the preset on temperature of 23A.

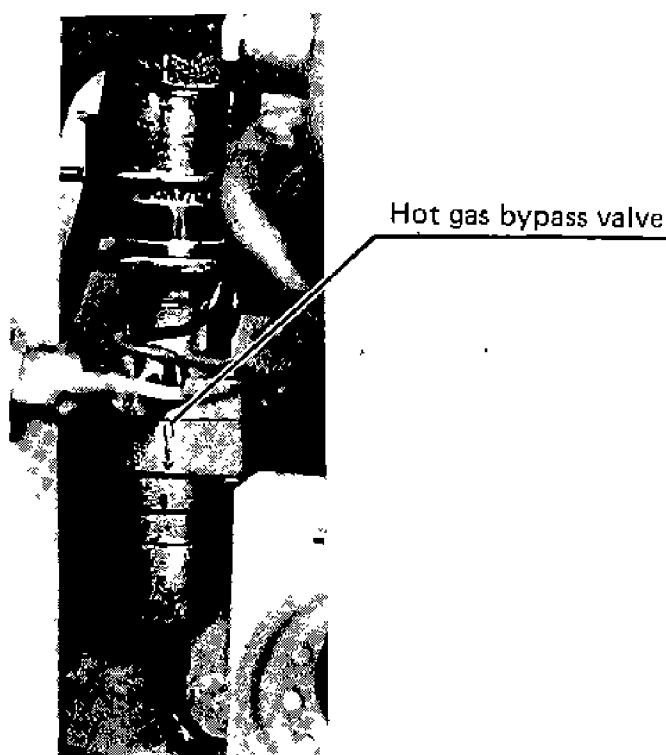
2) Precaution in the capacity control operation

When the preset temperature of the controller 23A is low during function control or when the ambient temperature is low, over cooling prevention actuates as described above and stops the compressor for the time being. But, this condition is not abnormal.

3) Hot gas bypass vale

The hot gas bypass valve controls the flow of hot gas. It has been precisely set at the factory. So do not change the setting.

- MODEL CPHE-4

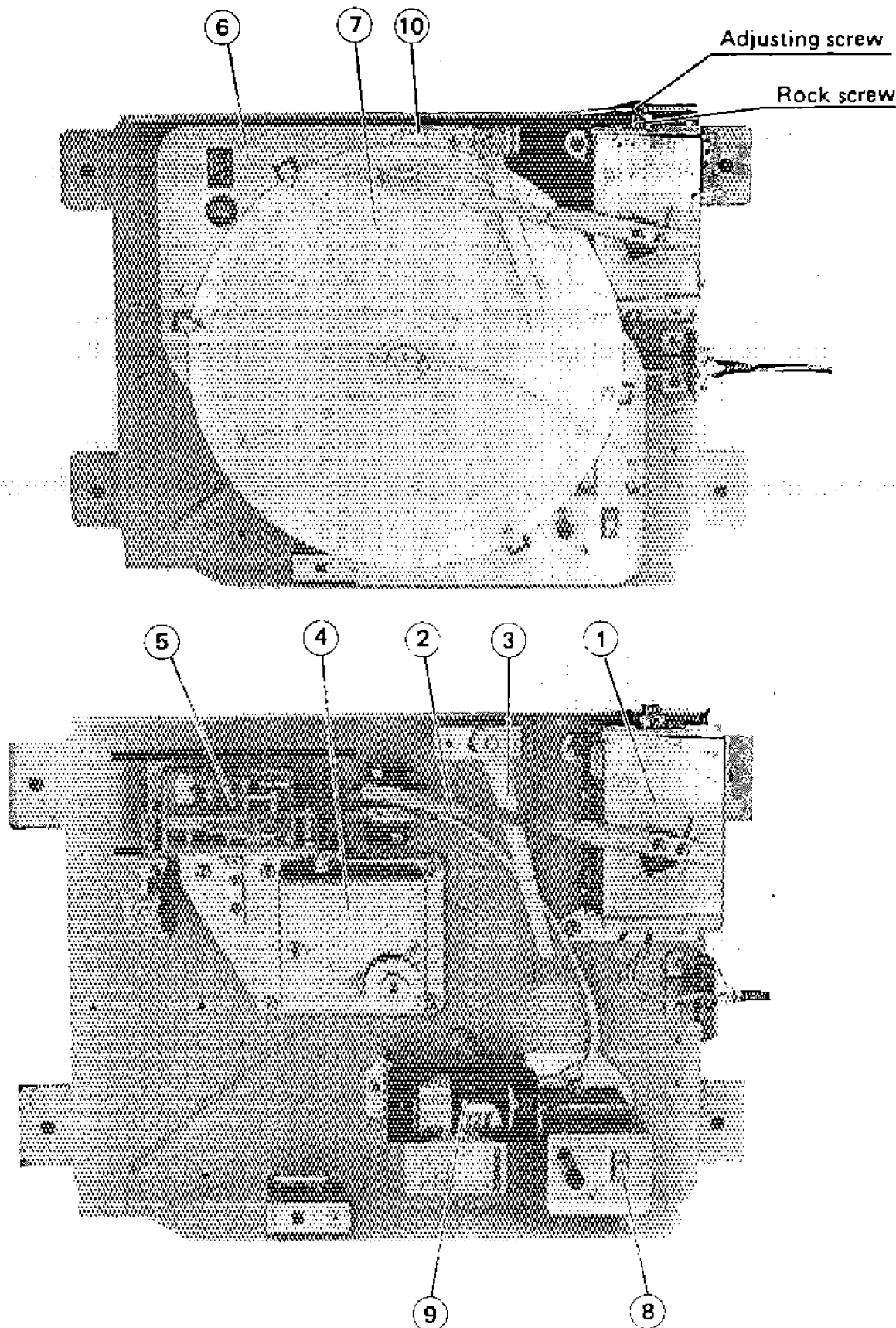


4.3.3 Recorder

1. Specifications

- Model SKM-2924
 - Feeler tube Gas sealed
 - Recording method Pressure sensing type
 - Recording temperature range $-29.9 \sim +25^{\circ}\text{C}$ ($-22 \sim 77^{\circ}\text{F}$)
 - Recording paper Dia. 203 Disk type pressure sensible paper (Graduation $1/1^{\circ}\text{C}$)
(Corresponding to PSD-217C (REV. A) made of PART LOW Co.)
 - Driving method for recording paper Timer (Quartz motor + reducing gears) a turn/31 days
- Goods corresponding to Dry battery
(DC 1.5V) JIS C 8501SUM2
IECR14
- Life is approx. 1 year (Remaining voltage indicator)

Quartz motor driving source:



- 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 controller in chilled mode at 0°C and confirm with the digital temperature display of the controller that the return air temperature has stabilized at 0°C and further move that the temperature indication of the recording pen is also 0°C .

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 or -18°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).

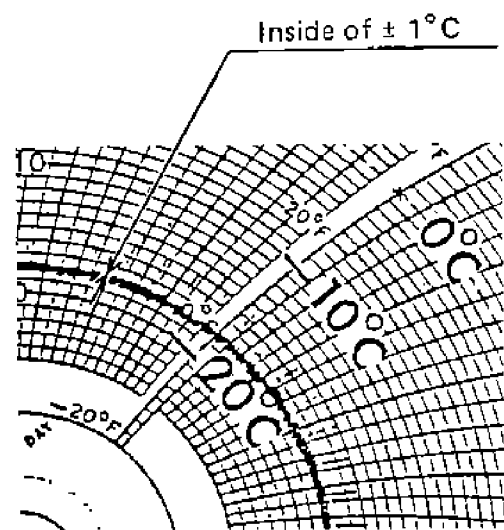
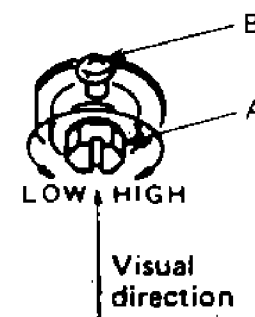
- 3) Generally a temperature recorder should be adjusted at 0°C, but the following method is available when the setting temperature is known.
 - Chilled mode (Setting temperature above -5°C) "Adjust at 0°C."
 - Frozen mode (Setting temperature below -5°C) "Adjust at 18°C."
- 4) Inspection and adjusting 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 phenomena 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 error.
5. When the pen is held by the pen lifter the pen may move unsmoothly, but it is no problem.

4. Replacement of parts

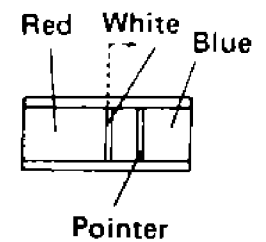
1) Battery

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 or IEC R14 of JIS C8501 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.



Residual voltage indicator

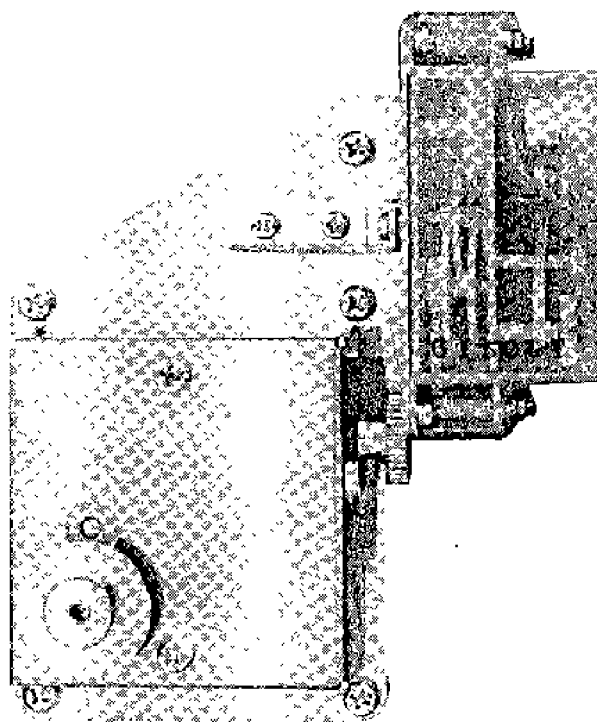
2) Residual voltage indicator battery

a) Replacement interval

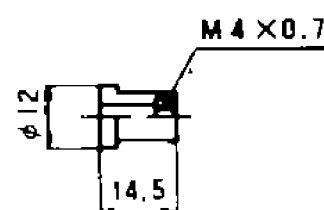
- In case oscillation of the needle is unstable when the push switch is pressed down for confirmation of remaining voltage.
- In case the remaining voltage indicator needle is within the white zone or in the red zone, although a new battery is set in.

b) Replacement method

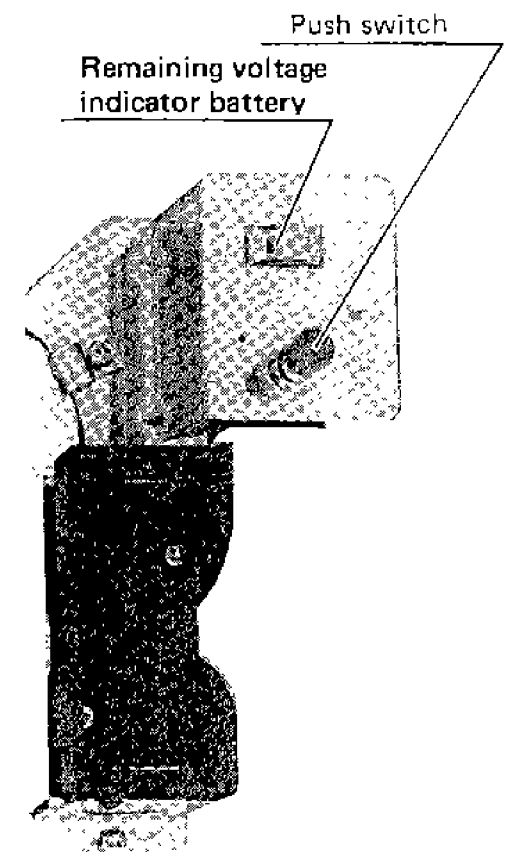
- Remove the recording panel by loosening the screw.
Remove the residual voltage indicator battery from the body, and replace it with a new one.
- When replacing the battery make certain that the terminal wirings are connected red to red and black to black.
- After replacement confirm that the pointer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



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 delays 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 anti-vibration 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 ~ 5 kg-cm.
- Confirm that the quartz motor functions correctly after replacement.

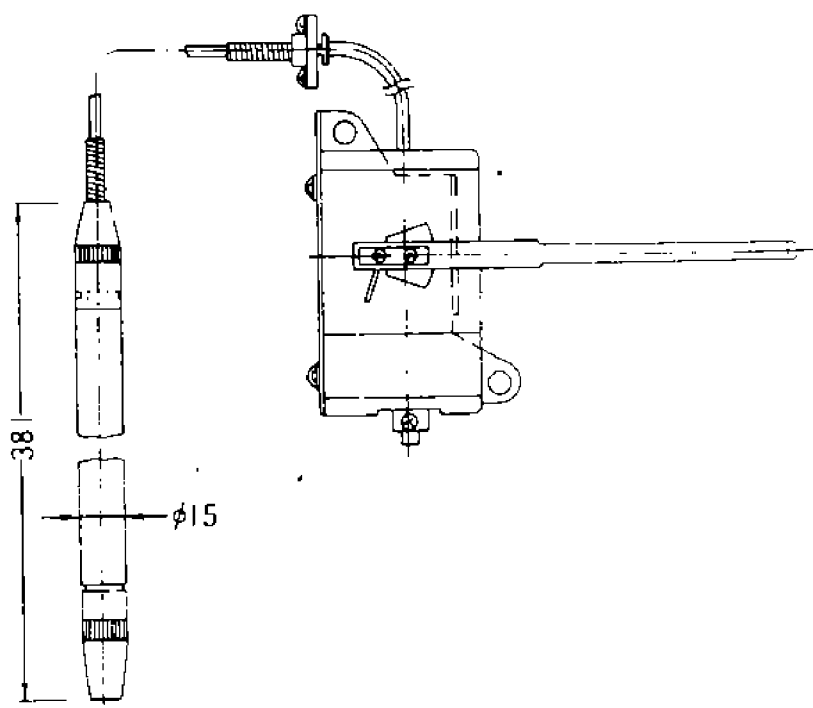
4) Thermal feeler bulb

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 — element DKM-AA001

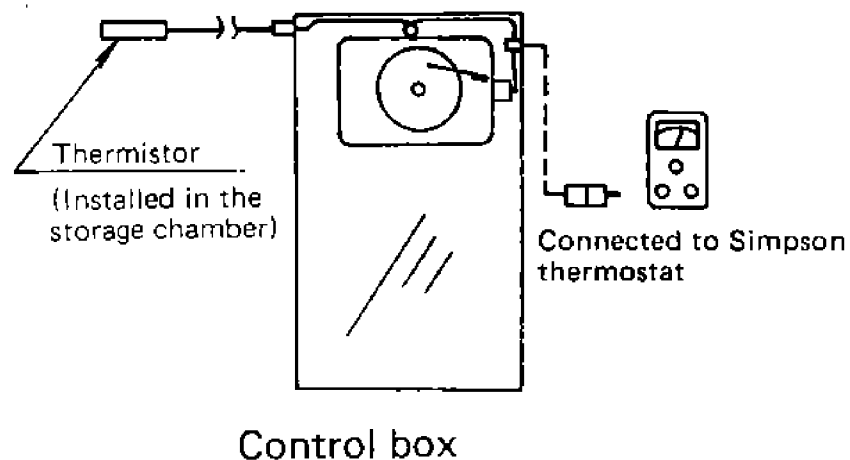
4.3.4 Thermistor for storage temperature

A thermistor is provided to measure the inside temperature of the refrigerator. The thermal sensing part is installed in the thermal sensing cylinder of the temperature recorder to detect the temperature at the same position.

The other end of the thermistor forms a connector with is located above the control box as shown on the under.

If it is connected to the thermometer, temperature at the feeler part of the thermistor can be measured.

The thermistor uses the following thermometer.



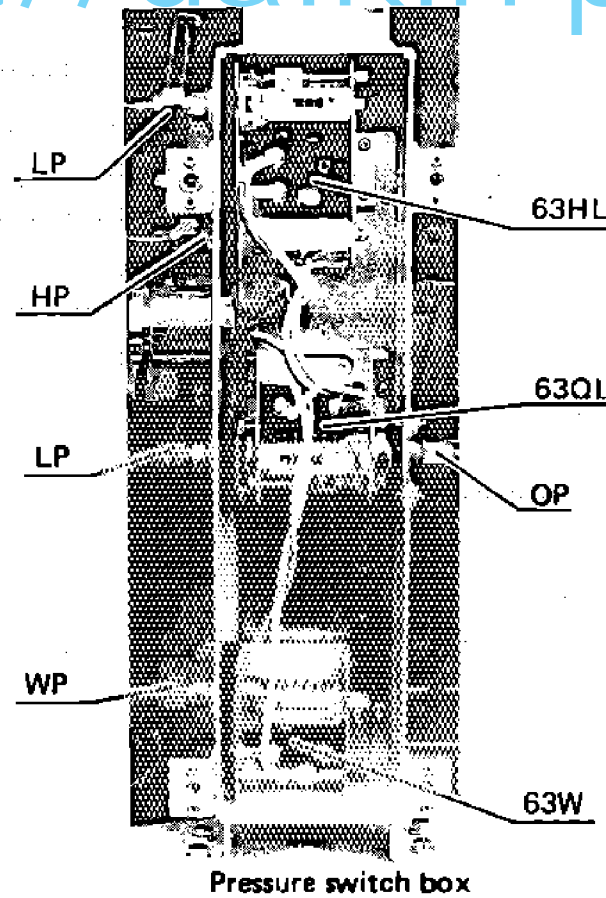
Maker	Type	Temperature range
Simpson Electric Company (U.S.A)	385-2	-50 ~ +70°F

Note: Adjustment of Simpson thermometer. Turn the adjusting screw so that the meter indicator points at 0°C. screw so that the meter indicator points at 0°C (32°F) when the change-over switch is set at READ in ice water whose temperature is stable at 0°C. Then set the change-over switch at ADJ and confirm that the indicator reading is 0°C (32°F). If it is not 32°F, remove the rear cover and adjust the adjusting screw located under the dry batteries to make the indicator point at 0°C (32°F).

4.4 Description on electrical and functional parts:

4.4.1 Dual pressure switch (63HL)

This stops the compressor when the pressure has risen or fallen excessively in the unit. The high pressure may rise above preset of HP if the condenser fan fails or cooling water does not circulate properly, etc. The low pressure may fall below preset of LP if "pump down" has been performed because the refrigeration circuit is blocked or the solenoid valves are closed. In these cases, the switch stops compressor.



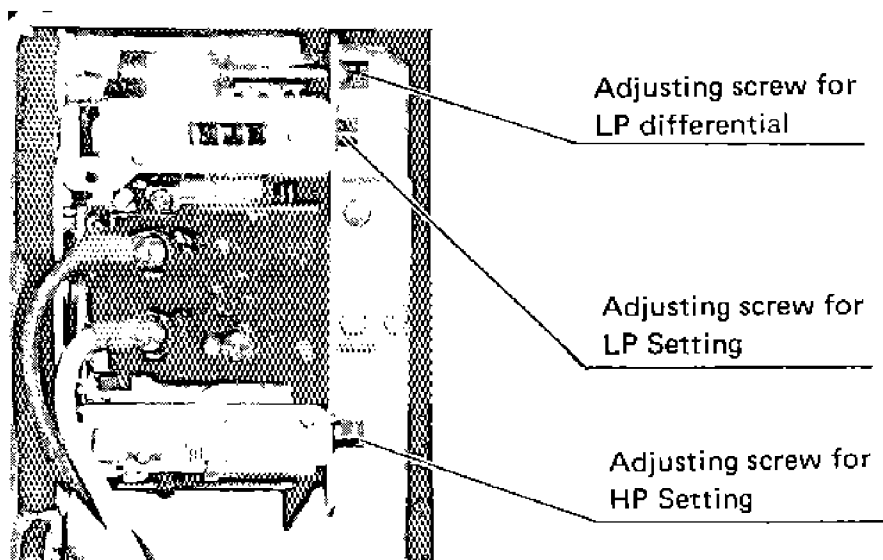
LP : Low pressure
 HP : High pressure
 OP : Oil pressure
 WP : Water pressure

(a) Adjustment method

Adjust the switch by turning the adjusting screw as described below;

Adjusting points of dual pressure switch

	Adjusting screw	Rotary direction		Function
High pressure side	Setting of adjusting screw	Clockwise		Setting (OFF value) becomes high, and pressure at the stopping of the refrigeration unit becomes high.
		Counter-clockwise		Setting (OFF value) becomes low, and pressure at the stopping of the refrigeration unit becomes low.
Low pressure side	Setting of adjusting screw	Clockwise		Setting (ON value) becomes low, and pressure at the starting of the refrigeration unit becomes low.
		Counter-clockwise		Setting (ON value) becomes high, and pressure at the starting of the refrigeration unit becomes high.
	Setting of adjusting screw for differential	Clockwise		Pressure difference between ON and OFF becomes large and difference between pressure on the starting and on the stopping becomes large.
		Counter-clockwise		Pressure difference between ON and OFF becomes closer and difference between pressure on the starting and on the stopping becomes closer.



- Notes:**
- 1) If it is necessary to adjust the adjusting screw for differential, be sure to adjust pressure setting first and then adjust differential.
 - 2) After adjusting the adjusting screw, apply chemical to the bolt head to prevent the bolt from being loosened vibration.

4.4.2 Oil pressure switch (63QL)

When oil pressure continues to drop, this switch sends a warning signal to the controller and stops the compressor automatically.

Oil pressure (difference between oil pressure and low pressure) falls due to oil pump failure, clogging and oil foaming.

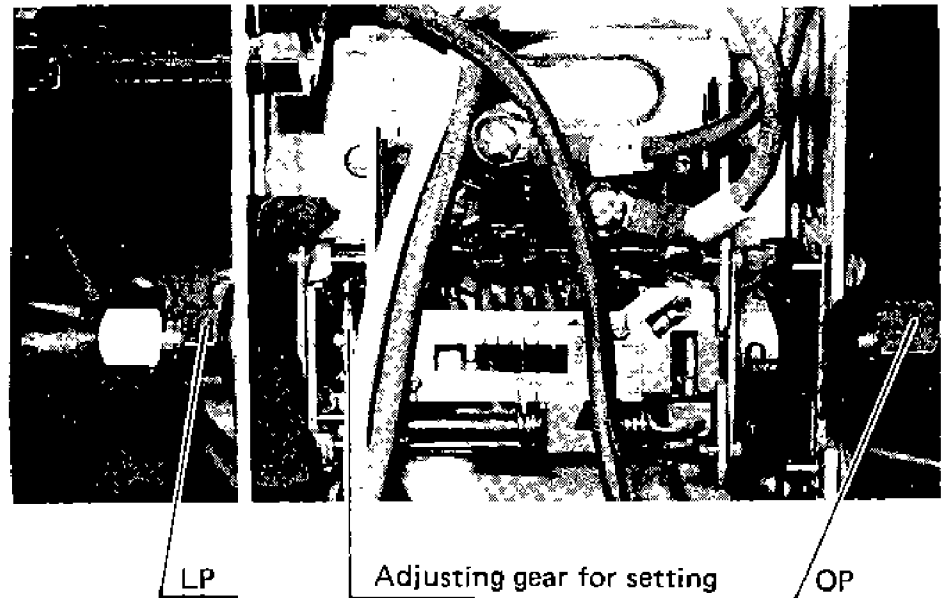
The compressor may be burnt because of oil shortage.

(a.) Operation

When the compressor is started, the oil pressure (differential pressure) rises, and the differential pressure contacts of 63QL are opened. However, if the oil pressure fails to rise for over 110 seconds after starting the compressor, the contacts are closed and the timer operates to stop the compressor.

(b.) Resetting

When the reset switch on the control box is turned on after 120 seconds from the stopping of the compressor, the compressor starts immediately. If the reset switch is turned on immediately after the stopping, the compressor will start after 120 seconds.

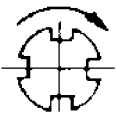
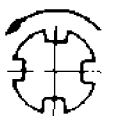


Oil pressure switch

(c) Adjustment method

- Adjust the oil pressure switch by turning the adjusting gear as described below.

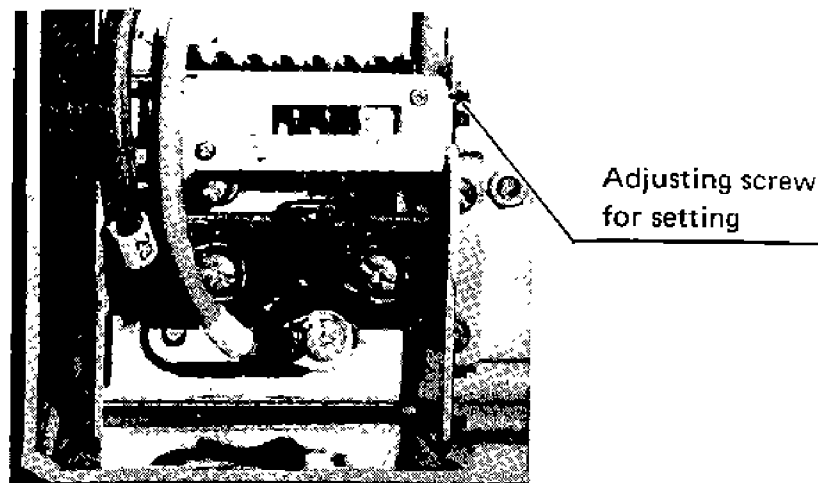
Adjusting points for oil pressure switch

Adjusting gear	Turning direction		Function
Adjusting gear for settings	Clockwise		Functional pressure (differential) becomes low and the differential pressure contacts of 63QL is connected with low pressure difference.
	Counter-clockwise		Functional pressure (differential) becomes high and the differential pressure contacts of 63QL is connected with high pressure difference.

Note: The following turning directions are viewed from the low pressure connection side.

4.4.3 Water pressure switch (63W)


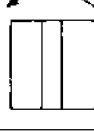
This switches over air and water cooled modes. If cooling water flows and water pressure rises above a preset water pressure at the inlet, the contact is turned off to stop the condenser fan motor and water cooled operation will start.



(a) Adjusting method

Turn the adjusting screw as stated below.

Adjusting points of water pressure switch

Adjusting screw	Turning direction		Function
Adjusting screw for setting	Clockwise		Setting (OFF value) becomes low, and fans stops quicker.
	Counter-clockwise		Setting (OFF value) becomes high, and fan is delayed in stopping.

Note: After the adjustment, be sure to apply loctite to the bolt head to prevent it from being loosened due to operation vibration.

4.4.4 Defrost thermistor (TH1)

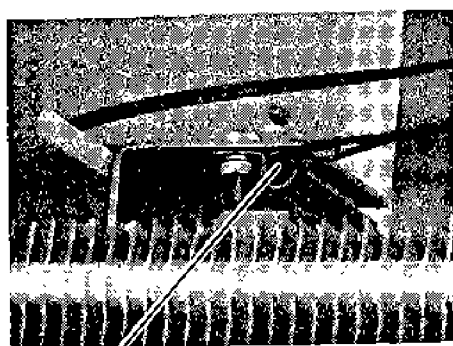
This senses ambient temperature around the thermistor and detects the defrost termination.

OFF: 40.6°C
ON : 23.6°C

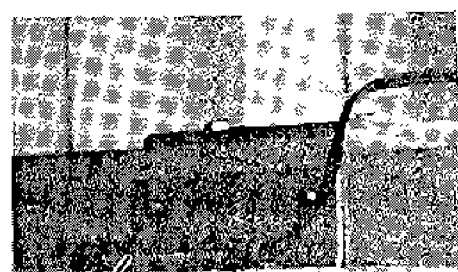
4.4.5 Over heat thermistor (TH2)

This prevents the electric heaters from overheating. If the heaters are overheating, the ambient temperature around the thermistor rises. It detects the overheat, and the controller cuts off the heaters.

OFF: 71°C
ON : 49°C



Defrost thermistor



Over-heat thermistor

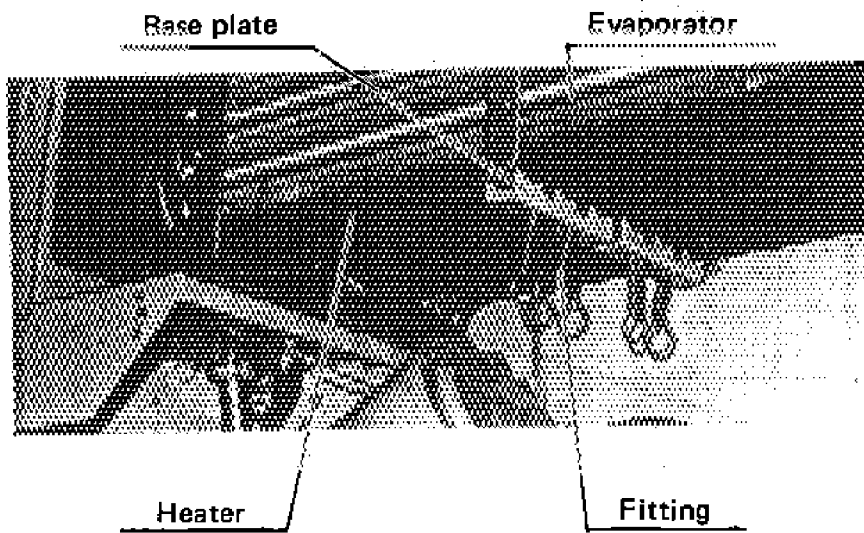
4.4.6 Electric heaters

Two kinds of electric heaters are used.

(a) Sheathed heaters (AC 220V, 1.0kw x 6)

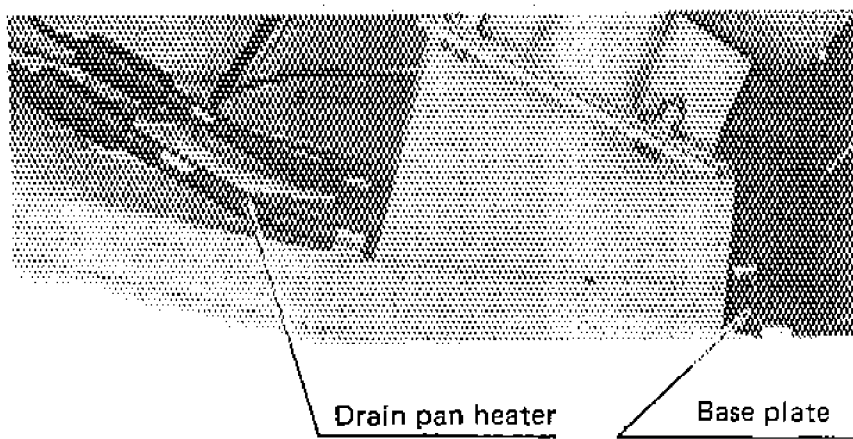
These are fitted at the bottom of the evaporator.
Used for defrosting and heating.

To replace them, lift the fittings up and remove them together with the base plate.

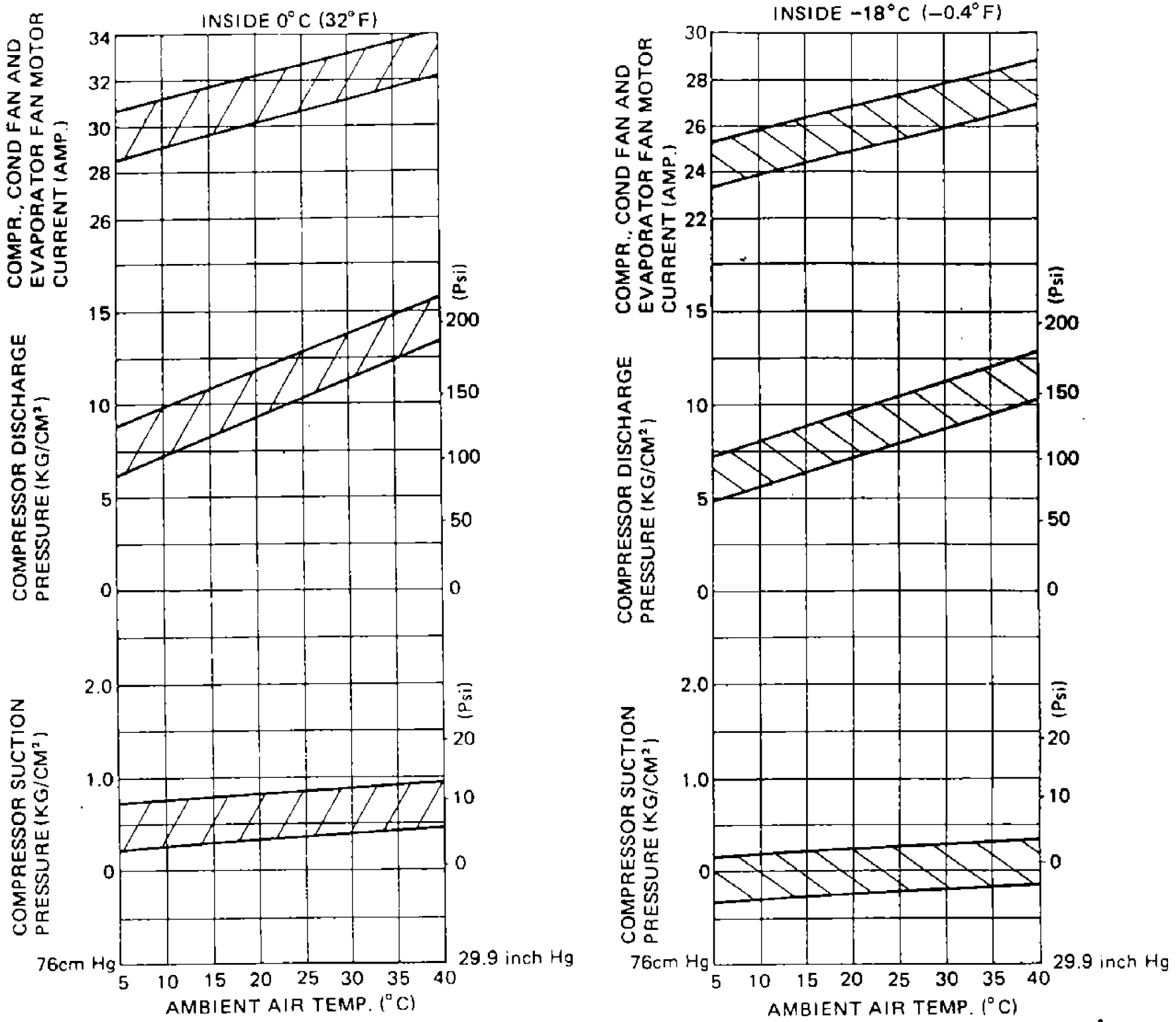


(b) Sheathed heaters (220V AC, 300W x 2)

These are fitted at the left and right of the drain pan to prevent the drain port from freezing (H7 and H8).



5. Operating pressure and running current



< For reference >

	Item	Unit	Value
1	Heater current – during defrosting Measure at primary side of 88H	A	17.0 (AC 220V)
2	Running current of condenser fan motor	A	1.2 (AC 220V)
3	Running current of evaporator fan motor	A	3.1 (AC 220V)
4	Compressor		240±20/17.3±1.4
	Compressor stop valve flange (Suction side/discharge side)		240±20/17.3±1.4 (Suction) 140±15/10.1±1.1 (discharge)
	Fan motor	kg·cm/lb·ft	70±7/5.0±0.5
	Solenoid valve		75±5/5.4±0.4
	Expansion valve		140±10/10.1±0.7
	Fan		30±1/2.2±0.1
	Bolt tightening torque		

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 are inoperative.	a. No trouble with unit	The unit halts by function of the temperature recording controller or in heating operation.	Setpoint selector is high	Readjust temp. setting as designed.
		b. Oil pressure control	It is not reset yet.		Repair trouble and turn reset switch to on.
		c. Solenoid valve does not function.	Coil is cut out.		Replace it.
		d. 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. Oil pressure switch is functioning.	Oil pressure will not rise. Oil is short or oil pump is out of order.	Additional oil charge, or repair oil pump.
			b. No trouble with unit	Controller functions and stops unit.	
		B: Condenser fans and compressor operate on and off repeatedly with evaporator fans in operation.	a. Pressure switch functions. High pressure side	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.					
Lower pressure side	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.			
b. Over-current relay or compressor protection thermostat has functioned.	Excessive large current due to over-load operation.	Trace causes.			

State	Phenomena	Functioning places	Cause	Countermeasures
III. Inside temp. is low than temperature setting	A: Compressor inoperative.	a. Soleroid 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.
III.	B: Hotgas bypass does not work	Modulating control valve does not open	Blocked with dust Controller is defective	Repair or replace Replace modulating valve or controller
		A: Inside temperature does not reach to preset temperature (Fans and compressor work)	a. Modulating control valve does not close. b. Capillary tube is defective c. No trouble with unit.	Blocked with dust In case the cargos which are not cooled down are loaded in the inside box of the container
IV. Inside temperature does not drop				
V. Inside temperature is not stable	A: Inside temperature is not stable during chilling and heating operations (Fans and compressor work properly)	a. Opening of modulating control valve (valve control voltage) is not stable	Controller is improperly adjusted	Adjust or replace
VI. Heating	A: Heater is inoperative.	a. No trouble with unit	Setting of set point selector is under -5.0°C	
		b. Overheat thermistor	Insufficient evaporator air volume	
VII. Defrosting operation	Defrosting and refrigerating operation are repeated in a short period of time.	a. Defrost timer incorrectly 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).

Container refrigeration unit inspection card

Installed ship name				Date of Inspection	
Container No.				Place of Inspection	
Loaded cargo		Loaded or none		Unit Model No.	
Customer's staff				Unit No.	
Service staff				Compressor No.	
Check	No.	Check point		Check method	Reference value
Check before operation	1	External appearance of important parts of container (doors, equipment mount, damaged points)		Visual	
	2	Cleaning interior and exterior of container		Visual	
	3	Checking the smudge of the unit (air-cooled condenser, evaporator)		Visual	
	4	Checking "through" points inside and outside unit		Visual	
	5	The refrigeration circuit for leakage of gas and oil (mainly at joints)		Halide torch, Visual	Flame reaction should be bluish purple
	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	Checking exterior of over heat thermistor		Visual	Shall have no damaged part
	10	Tightened condition of cable glands and monitoring receptacle		Retighten with tool	Make sure that they are firmly tightened
	11	Bolts for compressor, fans, and motors, etc. for fastening state		Retighten with tool	Make sure that they are firmly tightened
	12	Clearance between fan and fan guide		Visual	Evaporator fan : 5~9 mm Condenser fan : 3~7 mm
	13	Sealing at control box, and PS box, etc.		Visual	Packing and sealing should be intact
	14	Wire terminals for loosening correction		Visual, driver	
	15	Contact and/or coil of magnetic contactor for burning		Visual	
	16	Unit insulation resistance	Compressor circuit <input type="checkbox"/> MΩ Electric heater circuit <input type="checkbox"/> MΩ Evaporator fan circuit <input type="checkbox"/> MΩ	DC 500V megger	2MΩ or more
	17	Checking operation of oil pressure switch	CUT OUT <input type="checkbox"/> kg/cm ² CUT IN <input type="checkbox"/> kg/cm ²	Tension gauge Timer	1.0 kg/cm ² 0.5 kg/cm ²
	18	Supply voltage		Check line voltage at primary side of circuit breaker (main circuit)	Within ±10% of related voltage
Check during operation	19	Checking condenser and evaporator fan motors for vibration and noise		Touch and listen	
	20	Checking amount of circulating refrigerant		Check liquid indicator	Make sure that it is sealed
	21	Checking for water in refrigerant		Check liquid indicator	Deep blue
	22	Checking compressor oil level (operating condition)		Check compressor oil level gauge	⊖ (oil level 1/4 - 3/4)
	23	Confirm function of the recorder and the battery		Visual	
	24	Checking operation of controller and pilot lamps		Check pilot lamps (controller)	
	25	Checking manual defrosting operation		Manual defrost switch	
	26	Electric heater operation and current R <input type="checkbox"/> S <input type="checkbox"/> T <input type="checkbox"/>		Clamp meter	
	27	Checking operation of defrost thermistor thermostat (Completing temperature) <input type="checkbox"/> °C		Measuring temperature with controller	OFF 40.6±2° C
	28	Unit operating current R <input type="checkbox"/> S <input type="checkbox"/> T <input type="checkbox"/>		Clamp meter	-18° C <input type="checkbox"/> V <input type="checkbox"/> Hz

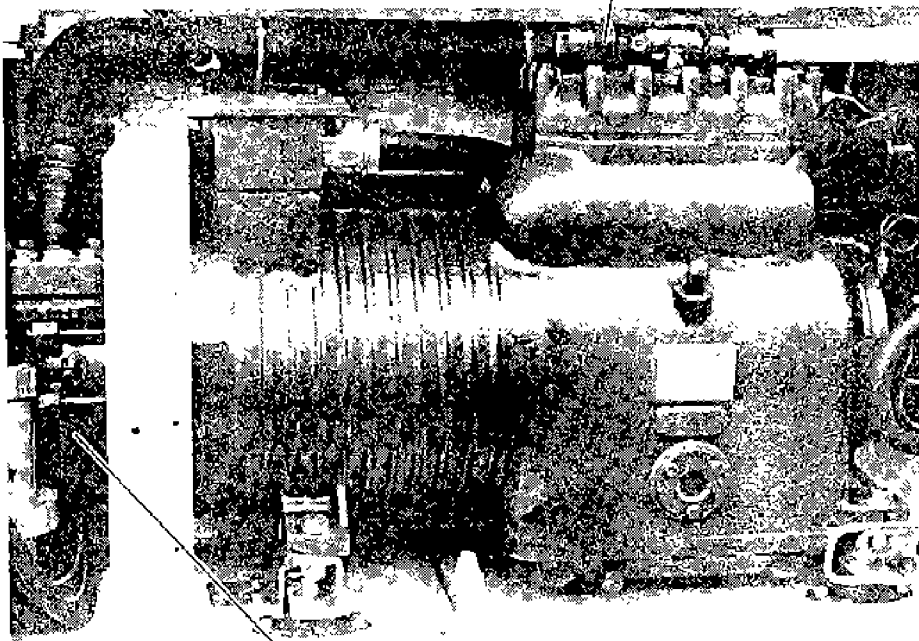
Check	No.	Check point	Check method	Reference value		
Check during operation	29	H-CUT OUT <input type="text"/> kg/cm ²	Blind air inlet	20 kg/cm ²		
		L-CUT OUT <input type="text"/> mm HgV	Accomplish pump down by use of the stop valve at the accumulator receiver outlet	400 mmHgV		
		L-CUT IN <input type="text"/> kg/cm ²		0.2 kg/cm ²		
	30	Checking switchover from water-cooled to air-cooled operation	Disconnect water coupling	Condenser fan motor shall operate		
		Checking switchover from air-cooled to water-cooled operation	Connect water coupling and supply water	Condenser fan motor shall stop		
	31	Checking voltage selector	Checking 200V class operation	Place voltage selector lever upward		
			Checking 400V class operation	Place voltage selector lever downward		
	32	Inside temperature °C	<input type="text"/>	0°C	-18°C	Automatic operation at -18°C
		Ambient temperature °C	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/> in one cycle
		LP kg/cm ²	<input type="text"/>	<input type="text"/>	<input type="text"/>	COMP OFF <input type="text"/> M
HP kg/cm ²		<input type="text"/>	<input type="text"/>	<input type="text"/>	COMP ON <input type="text"/> M	
Operating time		Immediately after operation	Operation starting 0°C <input type="text"/> Hr <input type="text"/> M	Operation starting -18°C <input type="text"/> Hr <input type="text"/> M	Automatic operation at -18°C <input type="text"/> Hr <input type="text"/> M	
Operation starting time		<input type="text"/>	<input type="text"/>			
33	Checking automatic defrosting	Defrost time <input type="text"/> M	Push the "DEFROST TEST" button	defrost starts after { out-range : 7 sec. in-range : 43 sec.		
Check after operation	34	Place new chart				
	35	Close caps for control box and PS box, etc.				
	36	Write down details of service on history cards				

8. How to maintenance

8.1 Handling method of the stop valve

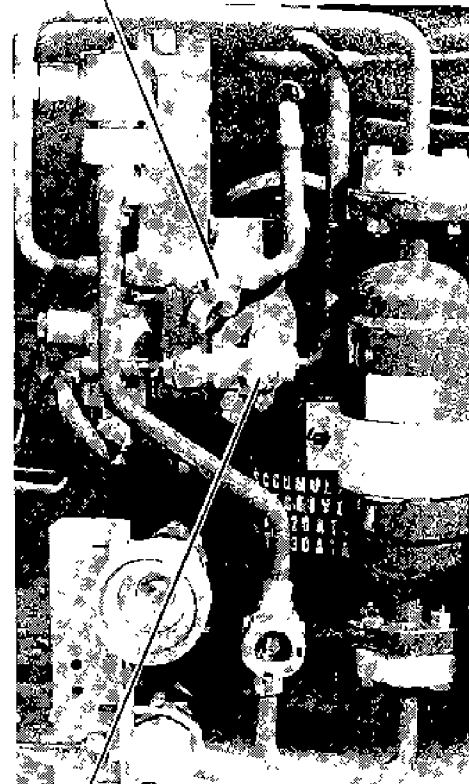
(1) Place of the stop valve and its kind

Stop valve at compressor discharge side



Stop valve at compressor suction side

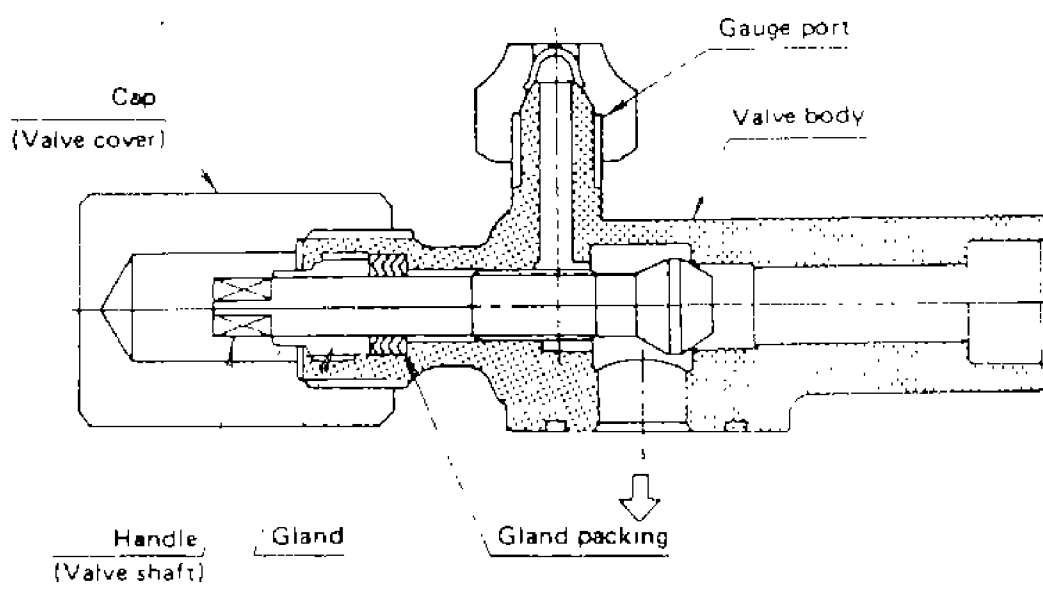
Stop valve at accumulator-receiver outlet side



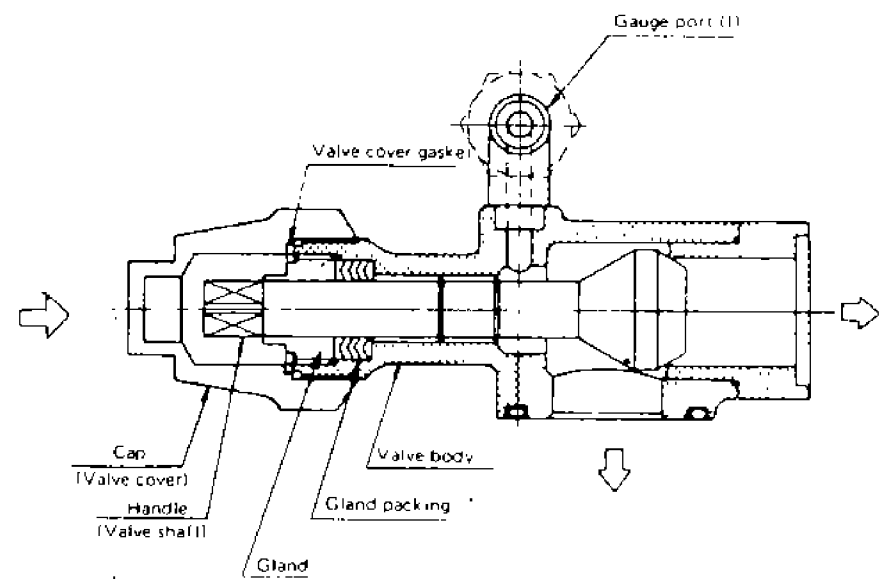
Stop valve at hot gas bypass

(2) Structure of stop valve

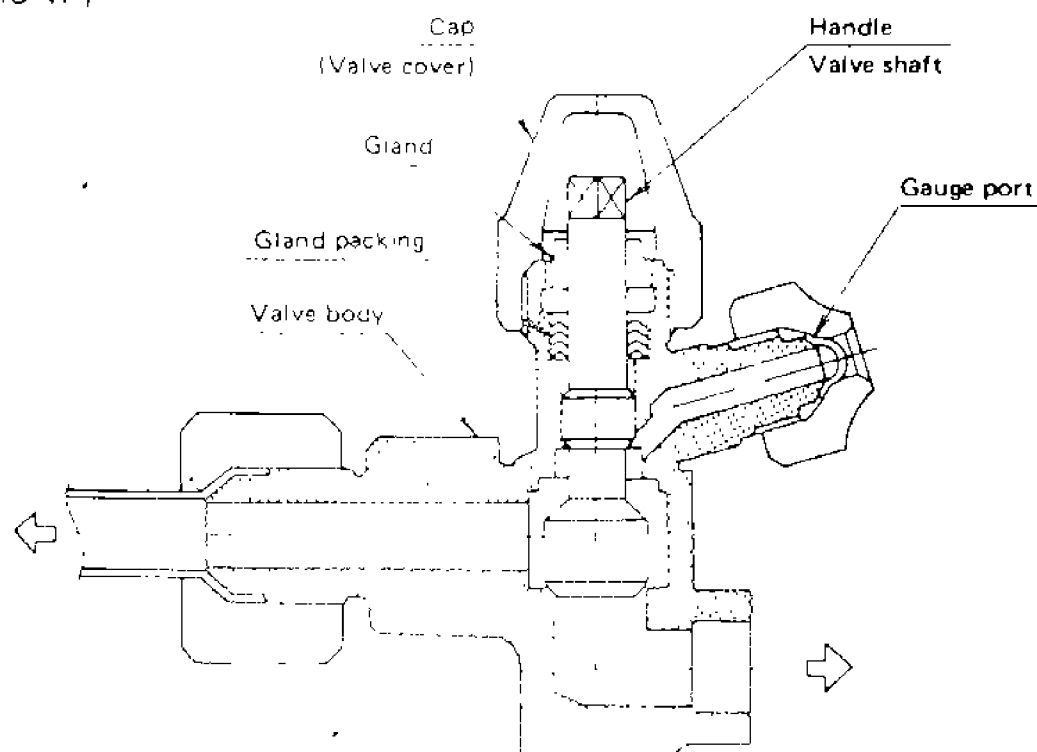
1 Stop valve at compressor discharge side (VSH10VAP-5S)



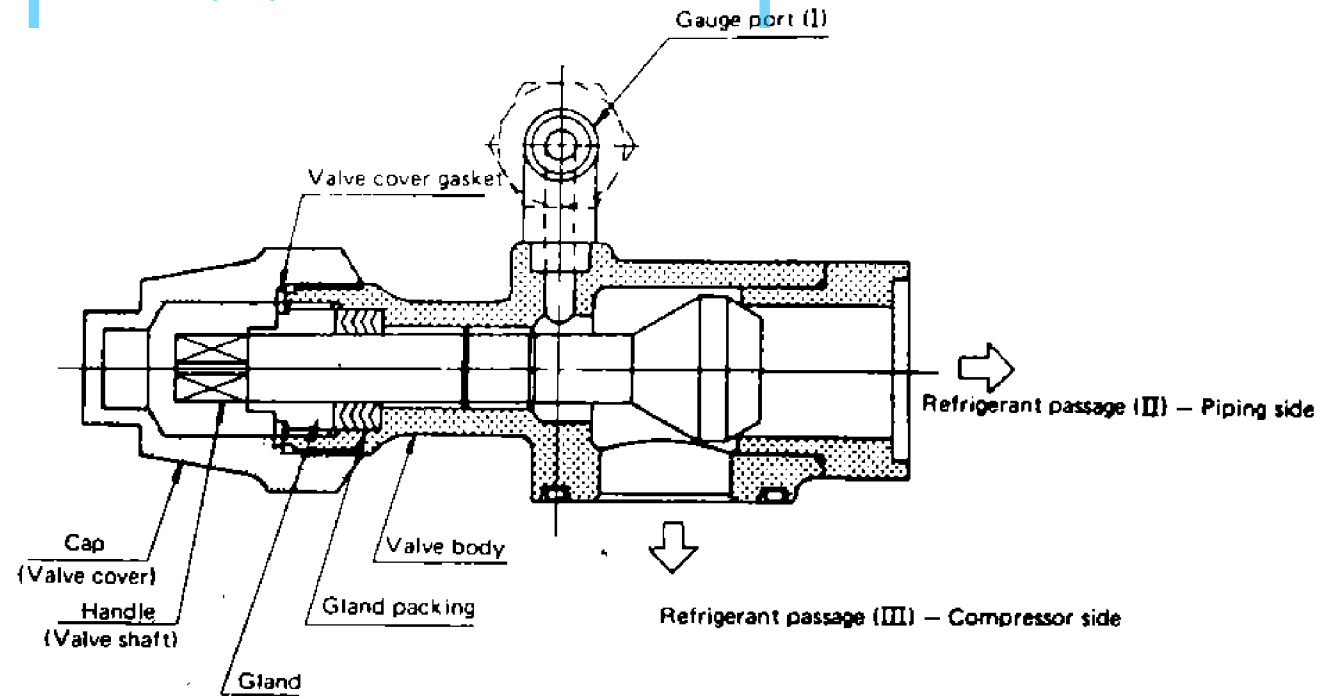
2 Stop valve at compressor suction side (VSH22XBP)



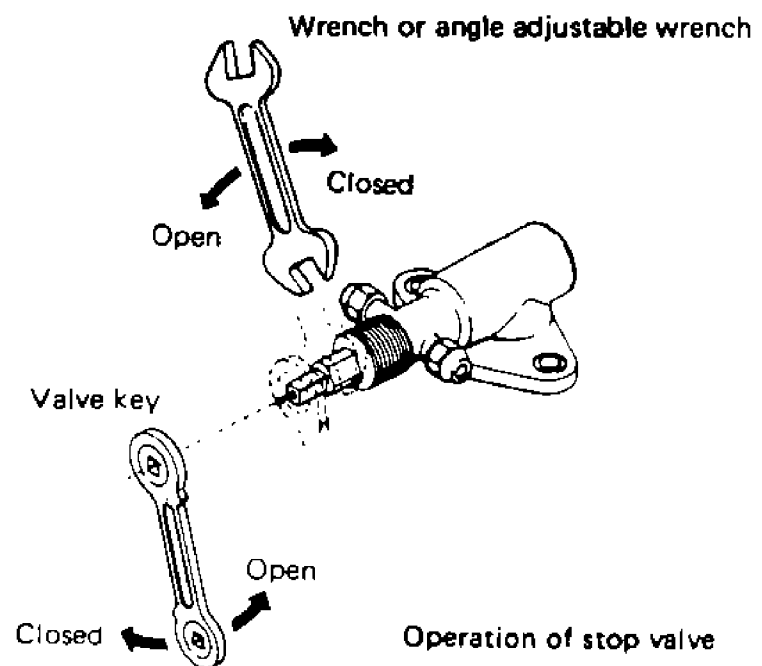
3 Stop valve at hot gas bypass (VSV10CBP-4S-4F)



(3) Handling method



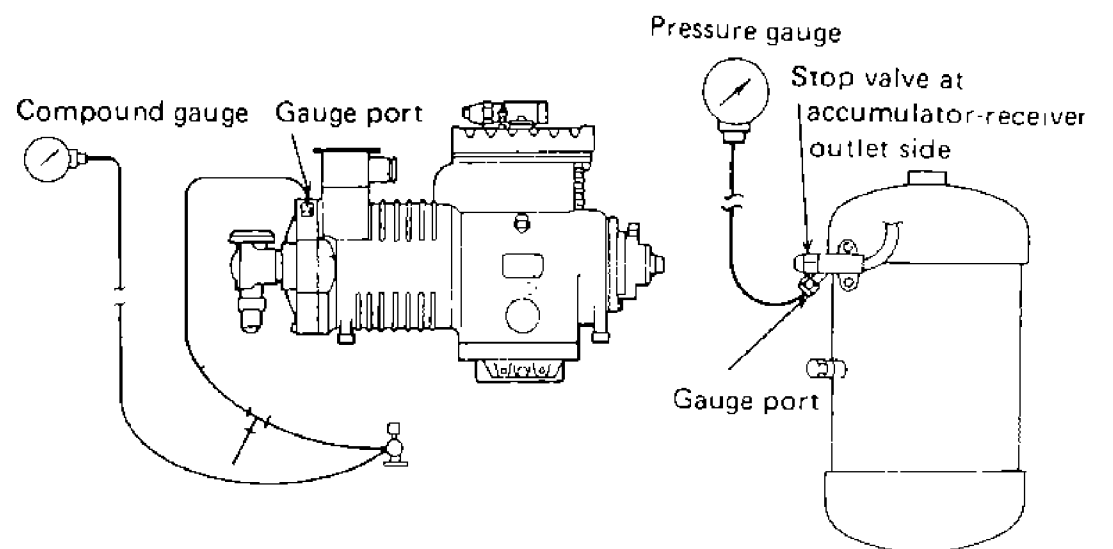
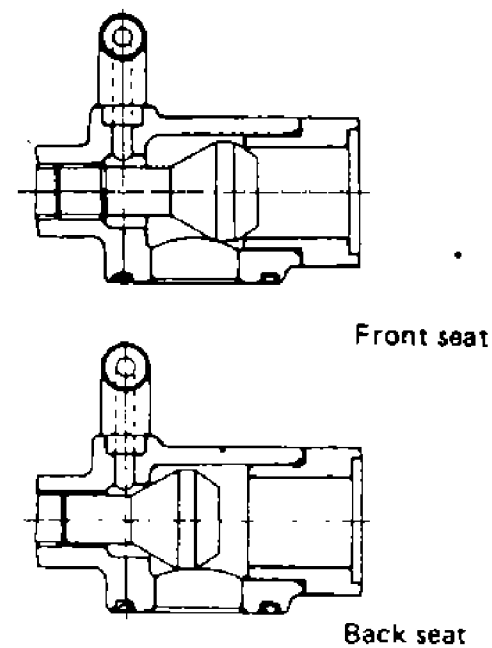
- 1) Remove the valve cap. At this time, be careful not to lose the gasket.
- 2) Loosen the gland in a way the refrigerant is not extracted.
- 3) Fully close the handleThe refrigerant passage I is connected to III (Front seat)
- 4) Fully release the handleThe refrigerant passage II is connected to III (Back seat)
- 5) Set the handle at the neutral positionThe 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.



8.2 Attaching or removing points of pressure gauge

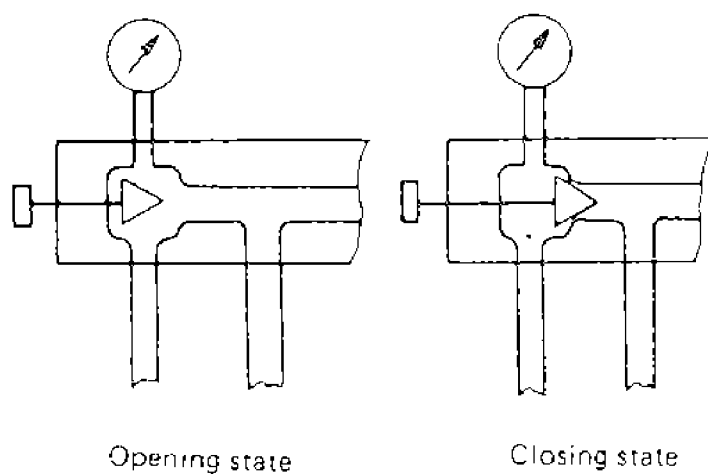
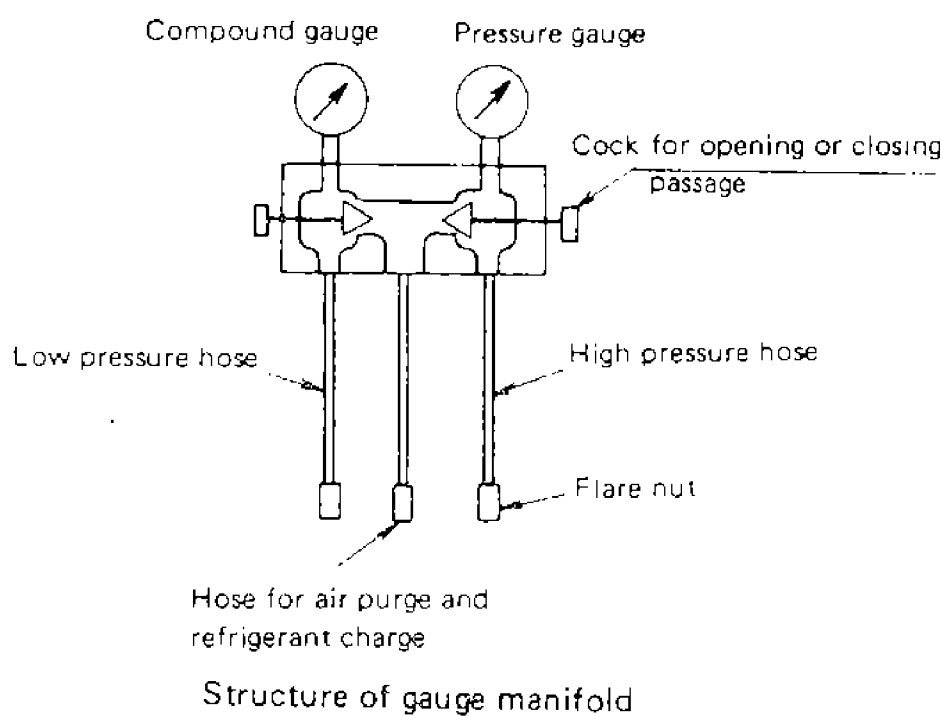
(1) Attaching a general pressure gauge

- 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 operation 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.



(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 the 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.



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 general pressure gauges) a little to extract the refrigerant from the hose.
At this time, do not open it suddenly so as not to joint 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 lose 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/cm² 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, which raise pressure in the accumulator-receiver with heat exchanger abnormally high and reduces heat transferring ratio of the condenser 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 in the following method.

- Stop the compressor, close the accumulator-receiver outlet 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

There 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 atmosphere.

(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 atmosphere

- 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 fire

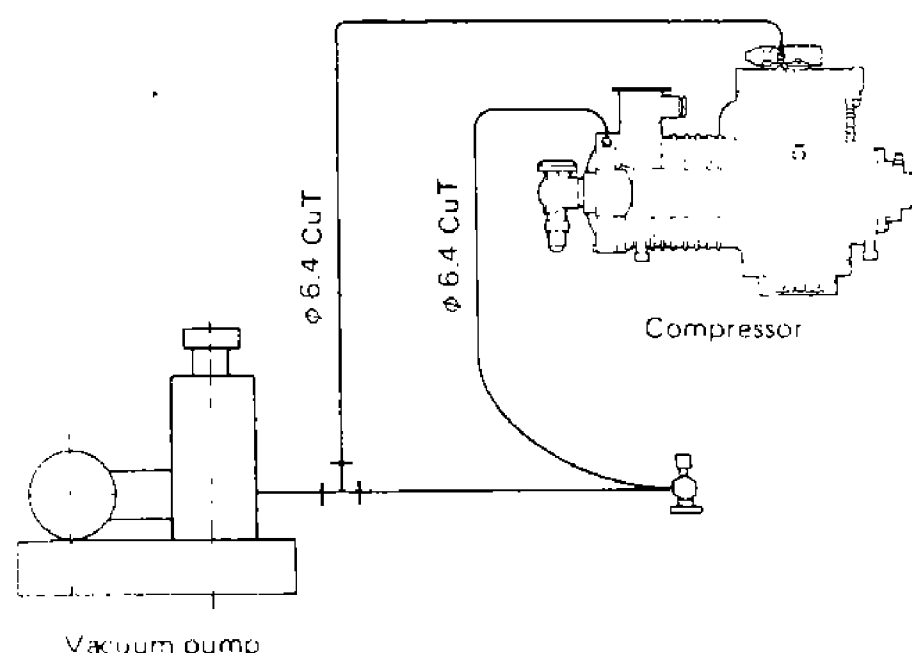
exchanger, otherwise the refrigerant oil and the liquid refrigerant are discharged, which may result in shortage of oil or getting chillblains.

- 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

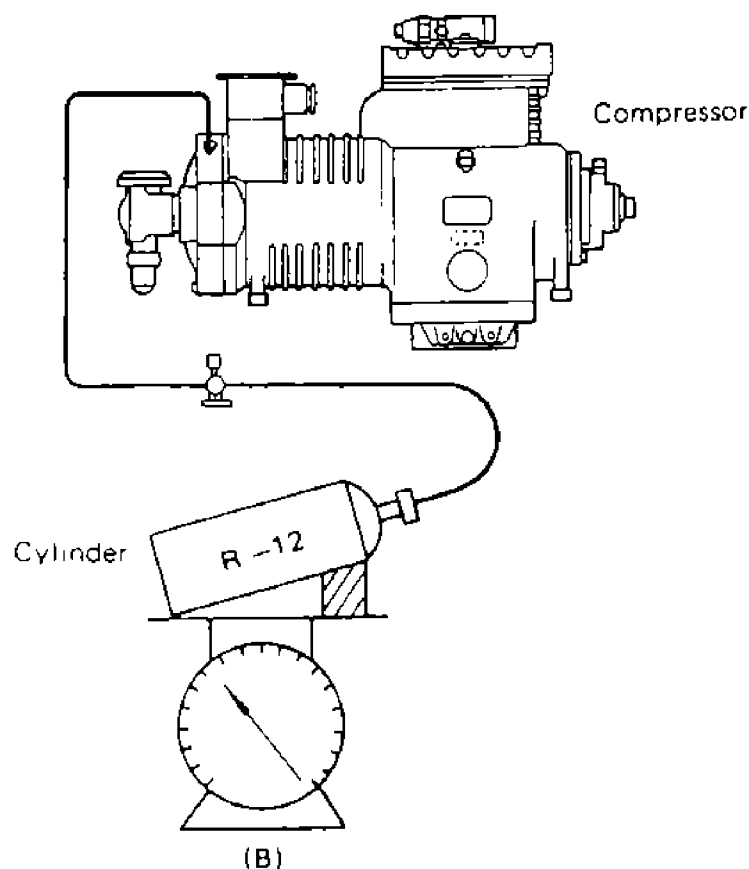
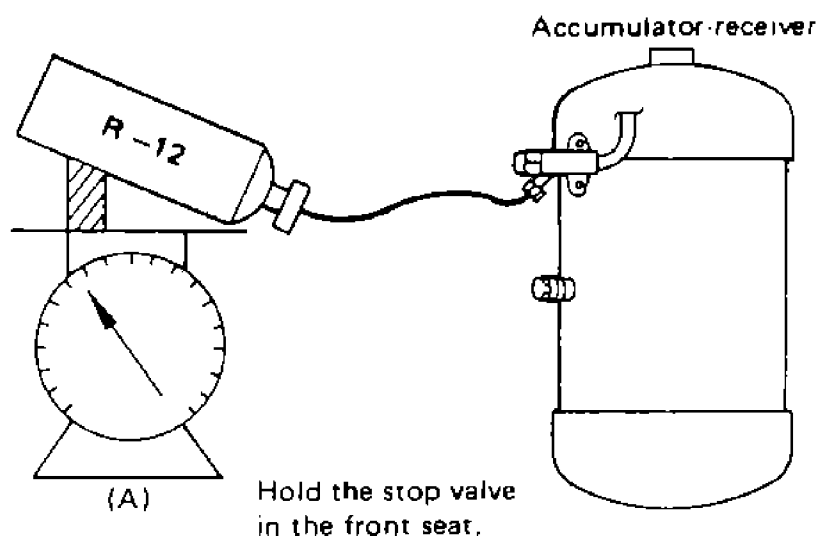
If all the refrigerant has leaked out and the air is intermixed in the refrigeration circuit, repair a cause of trouble and do vacuum drying. Then charge the predesigned volume of refrigerant. In case the refrigerant oil is replaced, do the same.

(Required tools)

1. Refrigerant cylinder (20 kg) for R-12 (CCl₂F₂) with mouth piece
 2. Refrigeration oil (20ℓ can) SUNISO 3GS-DI
 3. φ6.4 CuT (with two flare nuts)
 4. Pressure gauge (20 kg/cm²), compound gauge (10 kg/cm² x 75 cmHg) } 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 76 cmHg, 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).



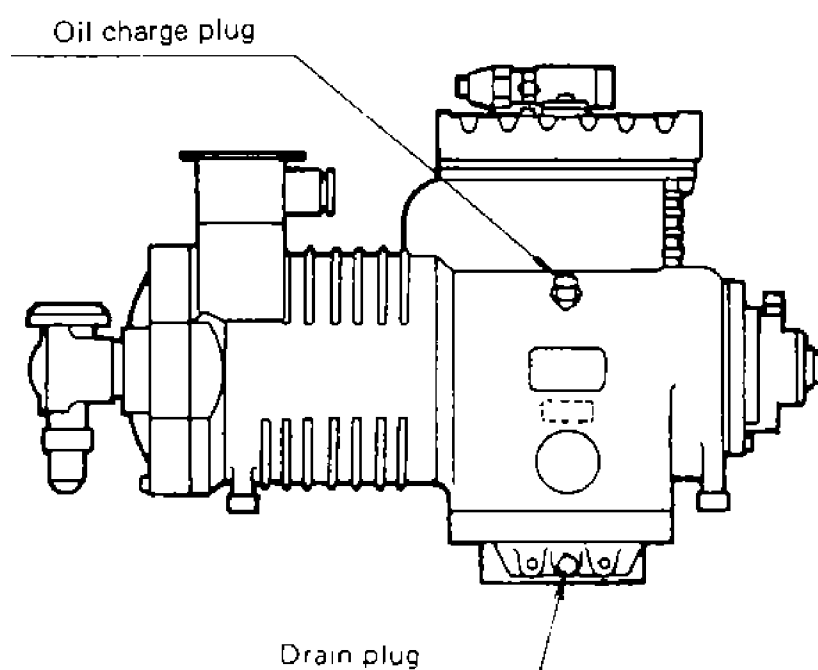
- 2) To evacuate the refrigeration circuit between the solenoid valve and expansion valve, reduce pressure of the circuit below the preset level of the low pressure switch lower the presetting level of the set point selector, operate the refrigeration unit, and open the solenoid valve for evacuation. 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 is 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 atmosphere 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 accum-receiver with heat exchanger and stop it when low pressure becomes 0.1 kg/cm^2 .
 - 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 vaccum gradually to hasten oil charge.
 - 5) Restore the stop valve to its original state.