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DAIKIN

Marine type

Container Refrigeration Unit

Service manual

Model

LKE8BD2

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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 plugs are connected and generator plant is operated.

NOTE

- 1 . Confirm the function of the watch of the electronic temperature controlling recorder and the life of battery when a chart paper is replaced.
- 2 . Accurately tighten the covers for the control box.
- 3 . Confirm that the stop valves in the refrigeration circuits are opened before operation.

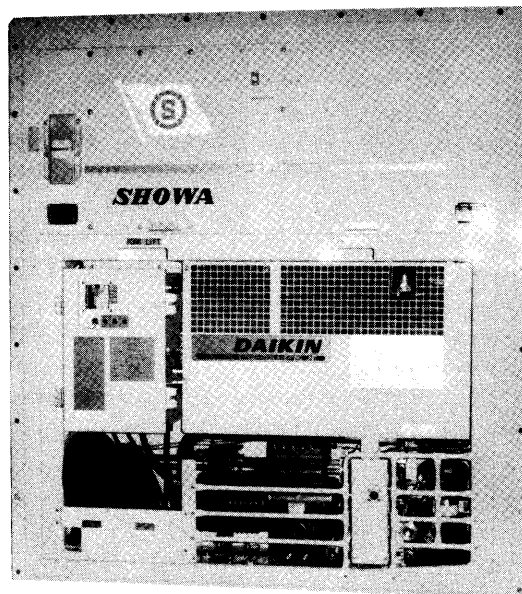
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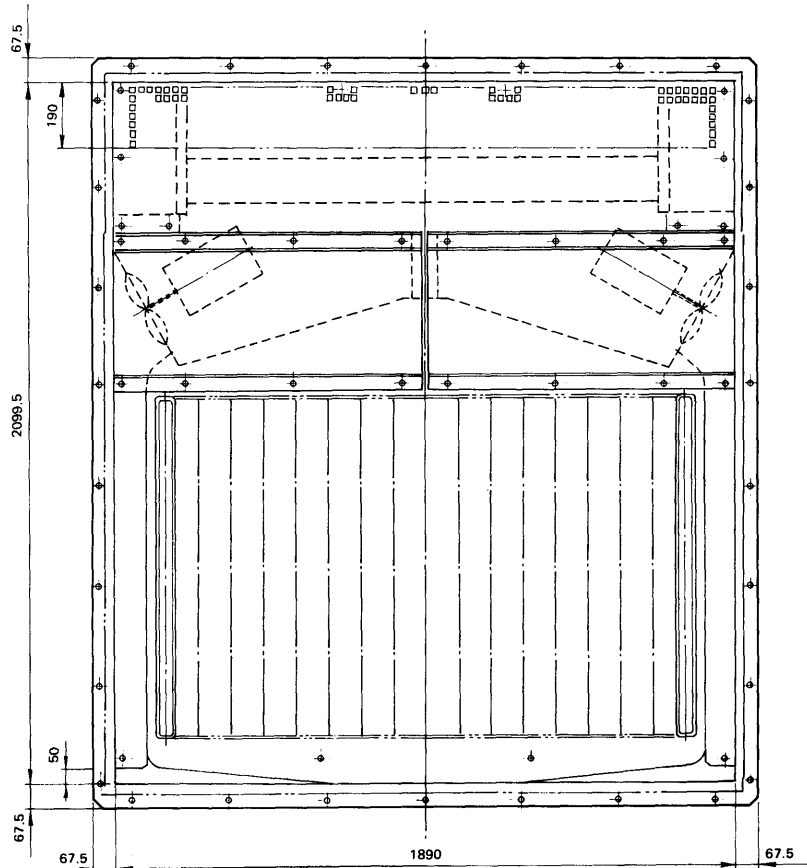
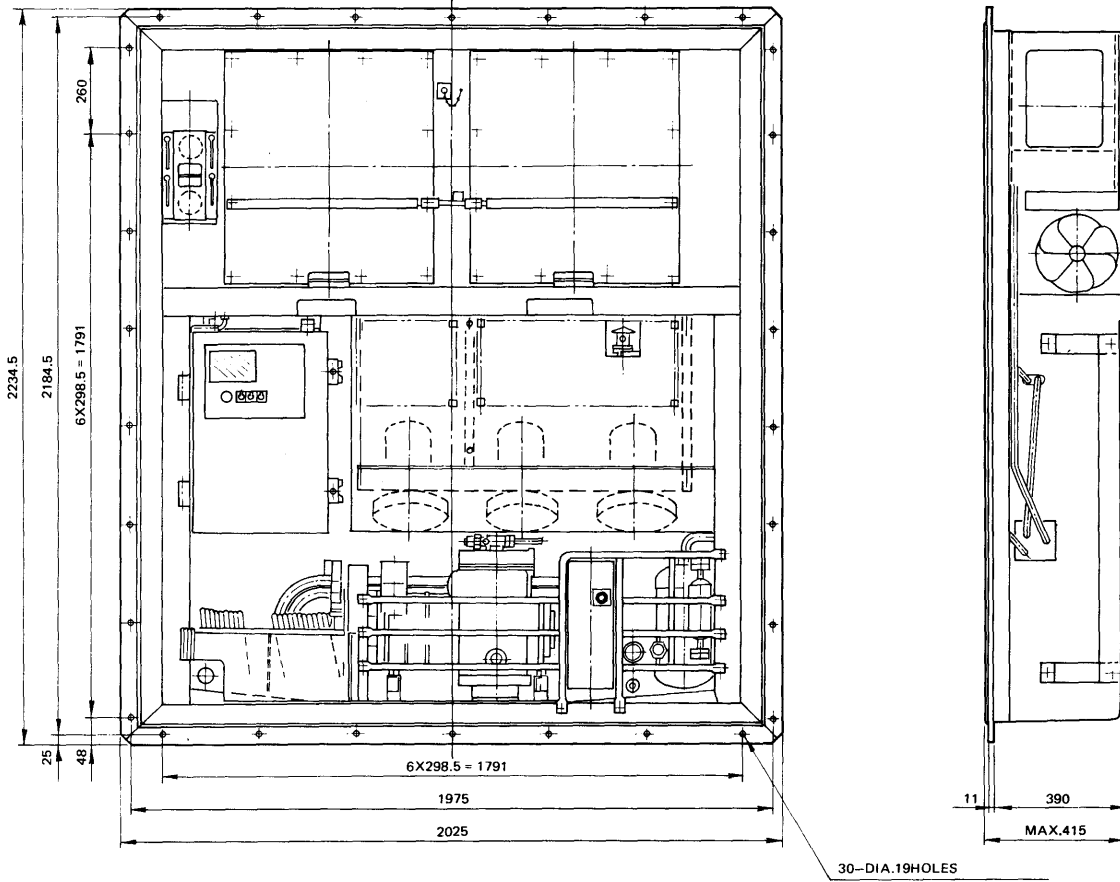
1. Specification

1.1 General specification

Power supply	AC 200V AC 220V AC 380~415V AC 440V (Dual voltage rating with voltage selector switch)	3 Phase 50/60Hz 3 Phase 60 Hz 3 Phase 50 Hz 3 Phase 60 Hz
Compressor	Semi hermetic type (5.5 kW)	
Evaporator	Cross finned coil type	
Air cooled condenser	Cross finned coil type	
Water cooled condenser	Hairpin-shaped tube-in-tube type	
Accumulator-receiver with heat exchanger	Vertical cylinder type	
Fan	Motor direct driven propeller type	
Fan motor	Single-phase squirrel-cage induction motor	
Defrost		
Heat source	Electric heater	
Initiation	Air pressure switch (detecting evaporator pressure difference), timer or manual switch.	
Termination	Sensing evaporator temperature by defrost termination thermostat	
Refrigerant control	Thermostatic expansion valve	
Capacity control	Hot gas bypass control (with delivery safety thermostat)	
Protection devices	Circuit breaker, Over current relay, Dual pressure switch, Oil pressure protection switch, Fusible plug, Firestat, Compressor motor protection thermostat, Fan motor protection thermostat.	
Refrigerant	R-12 (6.0 kg)	
Lubricant	SUNISO 3GS-DI (3.0 ℓ)	
Weight	Approx. 650 kg	

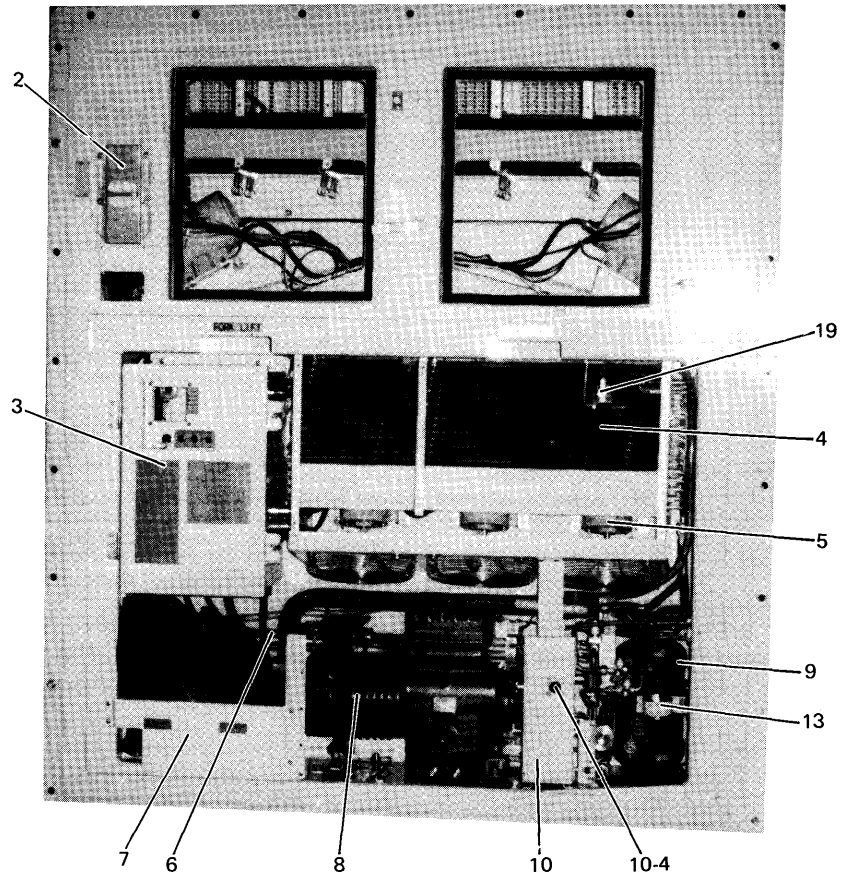
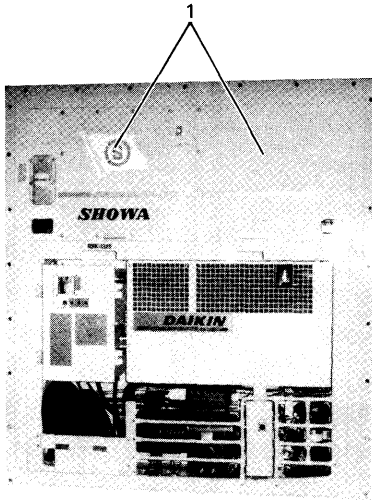


1.2 Outline

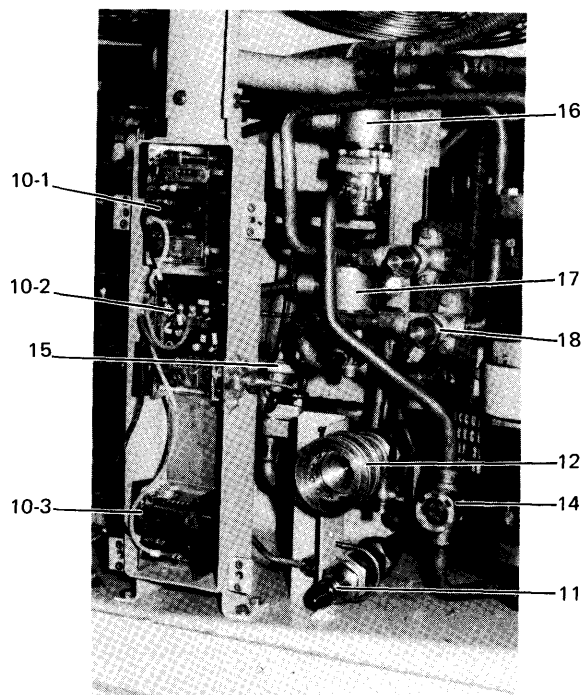


1.3 Construction

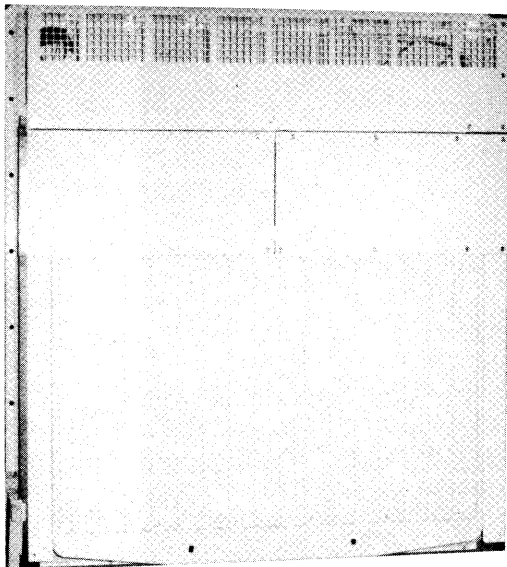
(1) Outside



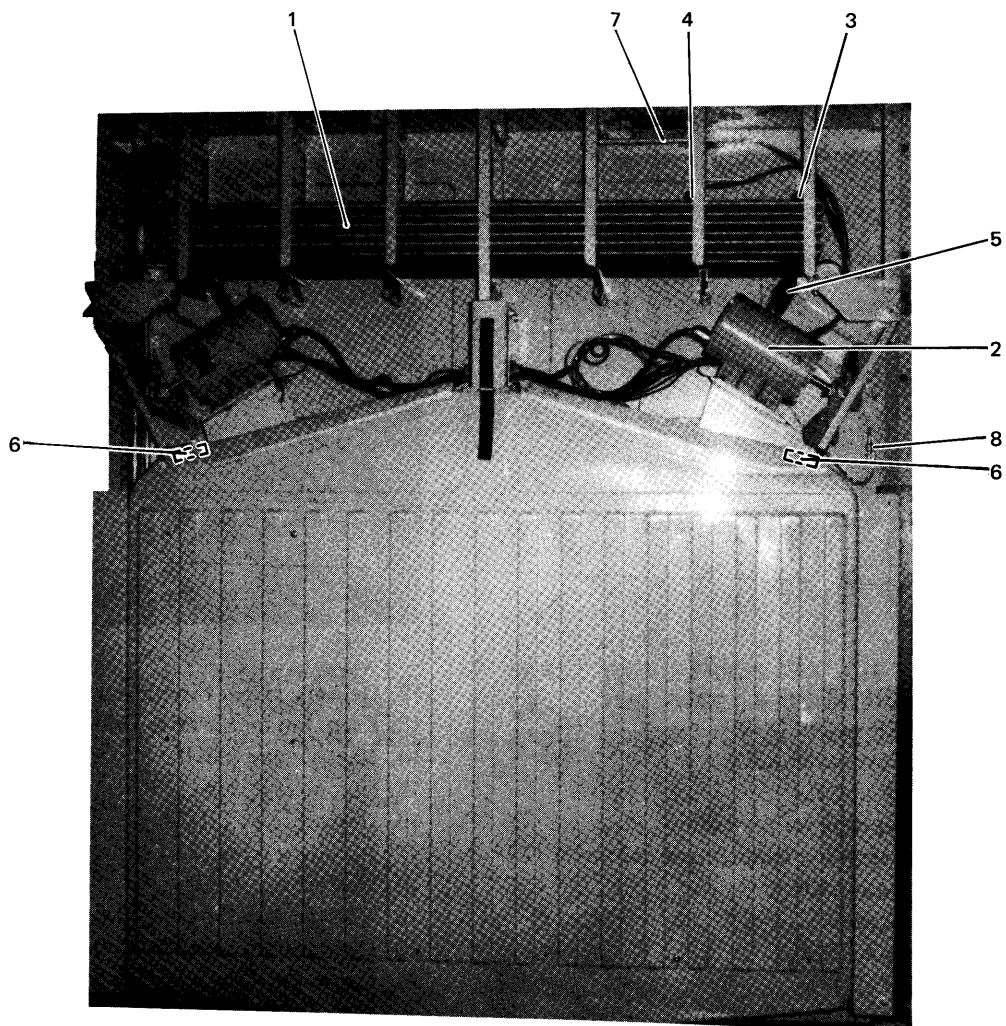
- 1 Access panel
- 2 Ventilator
- 3 Control box
- 4 Air cooled condenser
- 5 Condenser fan motor
- 6 Water cooled condenser
- 7 Cable stowage
- 8 Compressor
- 9 Accumulator-receiver with heat exchanger
- 10 Pressure switch box
 - 10 - 1 Dual pressure switch (63HL)
 - 10 - 2 Oil pressure protection switch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



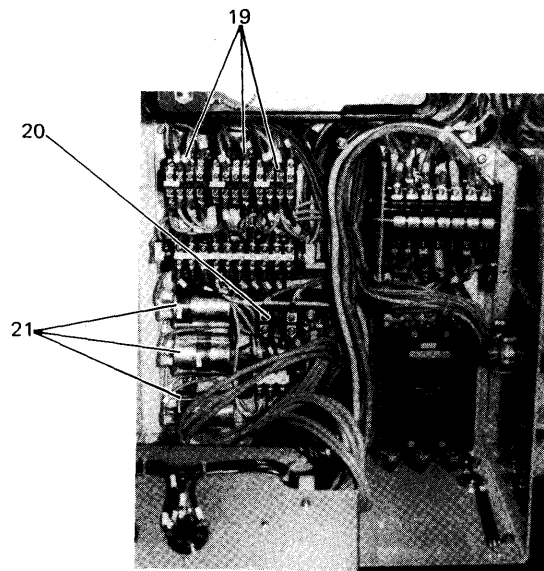
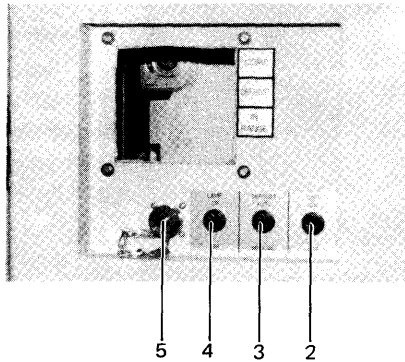
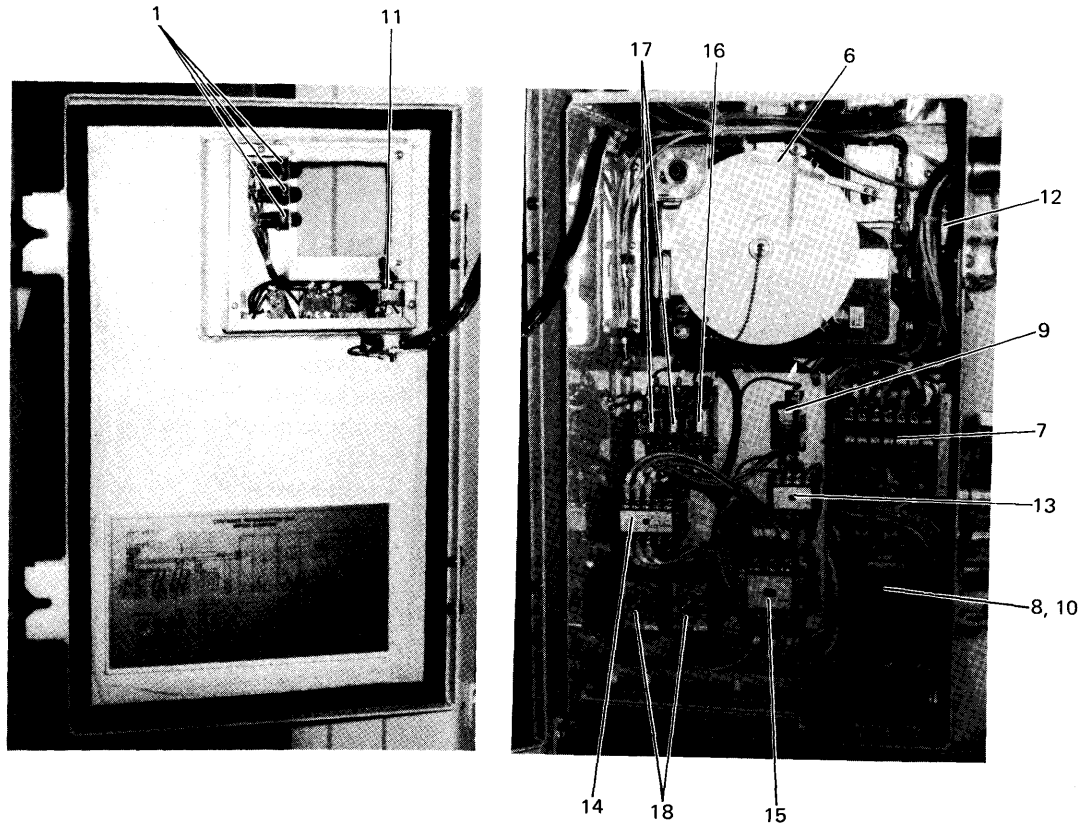
(2) Inside



- 1 Evaporator
- 2 Evaporator fan motor
- 3 Defrost termination thermostat
- 4 Firestat
- 5 Defrost heater
- 6 Drain port heater
- 7 Recording Temperature controller feeler tube
- 8 Delivery safety thermostat



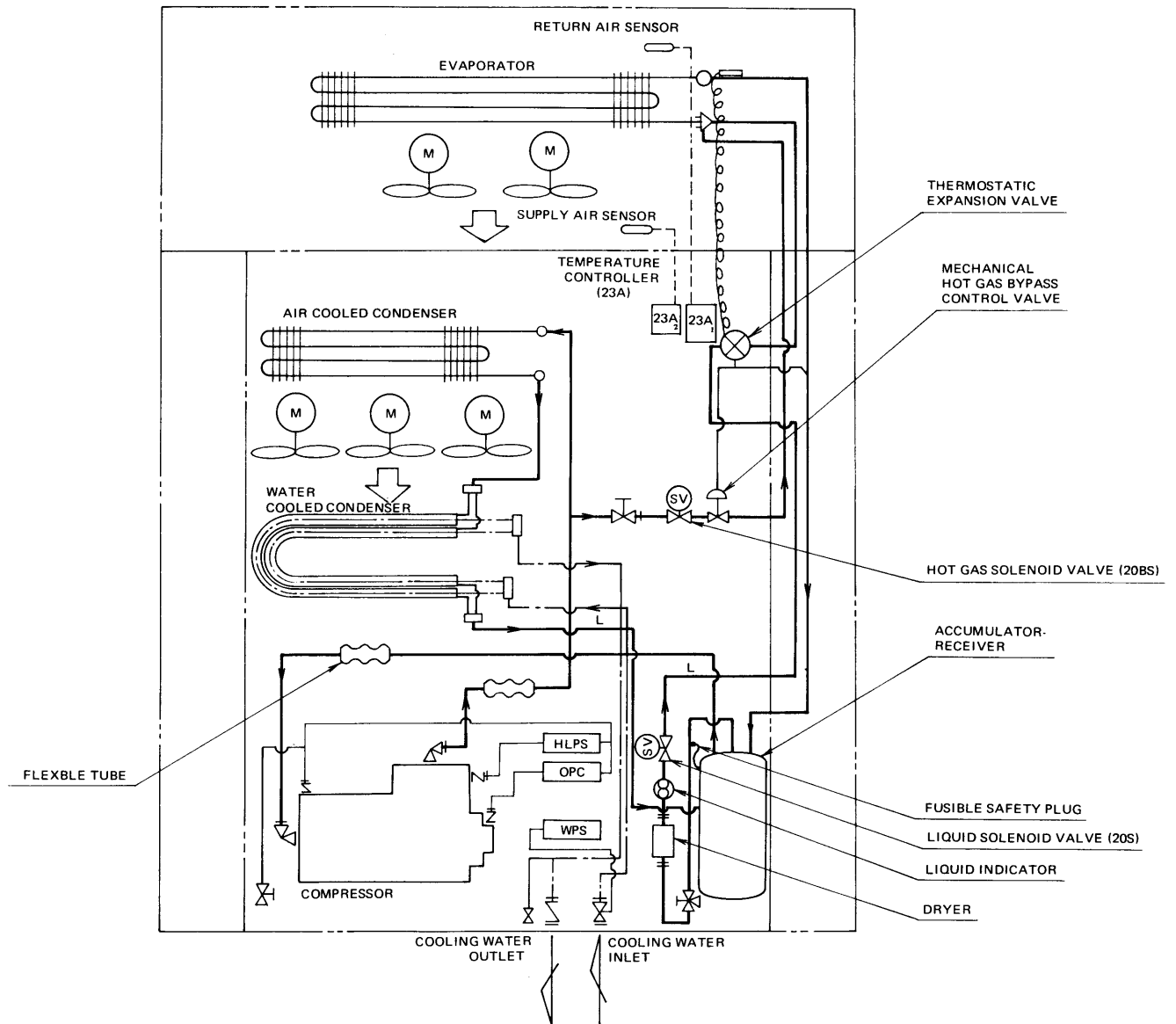
(3) Control box



- 1. Pilot lamp (RL, GL, OL)
- 2. Unit ON-OFF switch (3-88)
- 3. Manual defrost switch (3D)
- 4. Lamp switch (3-30L)
- 5. Cannon receptacle for pilot lamp
- 6. Electronic recording temperature controller (23A₁)
- 7. Voltage selector switch
- 8. Circuit breaker (52C₁)
- 9. Circuit breaker (52C₂)
- 10. Transformer (Tr)
- 11. Capacity control switch (3C)

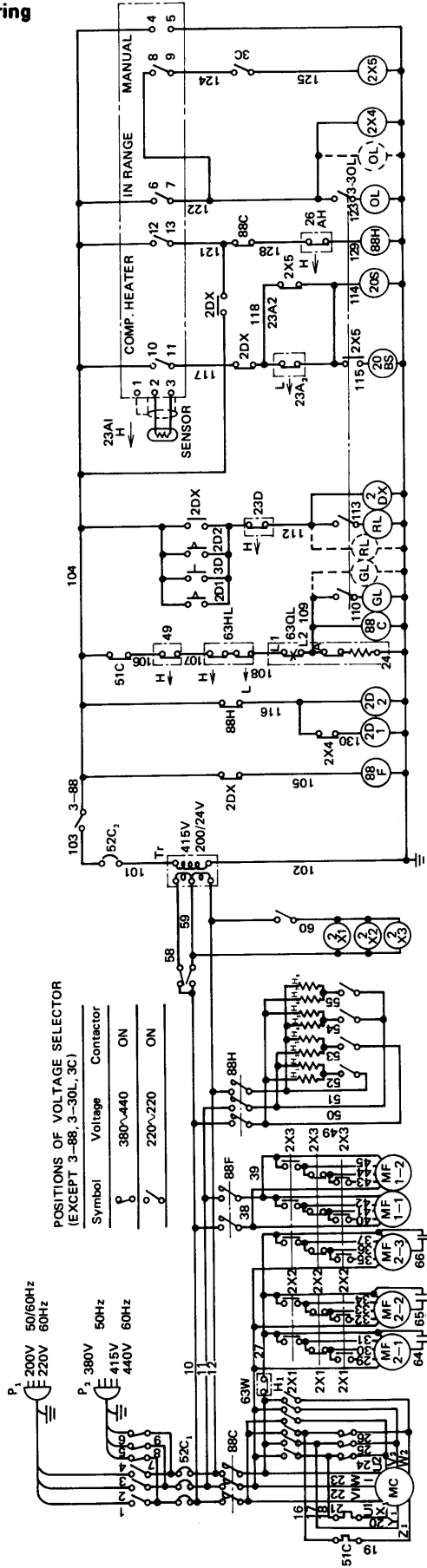
- 12. Delivery safety thermostat (23A₂)
- 13. Evap. fan motor relay (88F)
- 14. Heater relay (88H)
- 15. Compressor relay (88C)
- 16. Defrost relay (2DX)
- 17. Auxiliary relay (2X_{4,5})
- 18. Defrost timer (2D_{1,2})
- 19. Voltage selector relay (2X_{1,2,3})
- 20. Over current relay (51C)
- 21. Capacitor (C_{1,2,3})

1.4 Piping diagram



- | | | | |
|-----------|-----------------|------|--------------------------------|
| L | LIQUID PIPE | HLPS | : DUAL PRESS. SWITCH |
| S | SUCTION PIPE | OPS | : OIL PRESS. PROTECTION SWITCH |
| D | DISCHARGE PIPE | WPS | : WATER PRESS. SWITCH |
| — — | FLARE CONN. | | |
| — — | FLANGE CONN. | | |
| — — — | WATER PIPE | | |
| - - - - - | ELECTRIC WIRING | | |

1.5 Wiring diagram
1.5.1 Sequence wiring



POSITIONS OF VOLTAGE SELECTOR
(EXCEPT 3-88, 3-30L, 3C)

Symbol	Voltage	Contactor
	380~440	ON
	220~220	ON

P	POWER PLUG	Tr	TRANSFORMER	2DX	DEFROST RELAY
521.2	CIRCUIT BREAKER	3-88	ON-OFF SWITCH	2D	DEFROST TIMER
88C	COMPRESSOR RELAY	3-30L	LAMP SWITCH	63HL	DUAL PRESSURE SWITCH
88F	EVAP. FAN MOTOR RELAY	3D	MANUAL DEFROST SWITCH	63QL	OIL PRESSURE PROTECTION SWITCH
88H	HEATER RELAY	23D	DEFROST TERMINATION	63W	WATER PRESSURE SWITCH
2X	AUXILIARY RELAY	26AH	FIRESTAT	23A2	DELIVERY SAFETY THERMOSTAT
MC	COMPRESSOR MOTOR	23A1	ELECTRONIC RECORDING TEMPERATURE CONTROLLER	C	CAPACITOR
MF ₁	EVAPORATOR FAN MOTOR	GL.RL.OL.	LAMP	3C	CAPACITY CONTROL SWITCH
MF ₂	CONDENSER FAN MOTOR	51C	OVER CURRENT RELAY		
H ₁ ~ H ₆	EVAPORATOR COIL HEATER	49	COMPRESSOR PROTECTOR		
H _{7,8}	DRAIN PORT HEATER	20S	SOLENOID VALVE		
20BS	HOT GAS SOLENOID VALVE				

NOTES

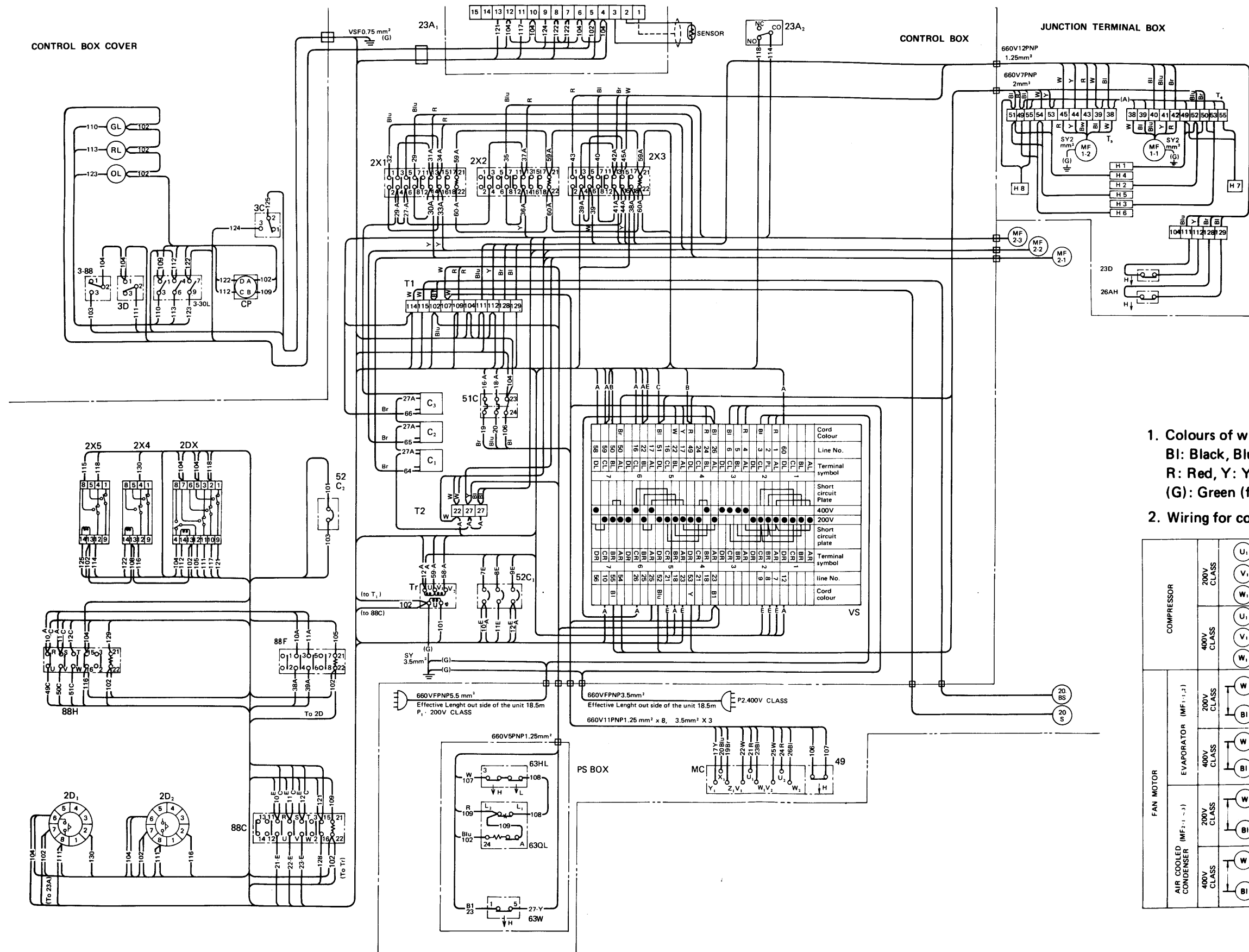
1. Monitoring plug connected as follows.

- A : Earth
- B : Compressor (GL)
- C : Defrost (RL)
- D : In range temp. (OL)

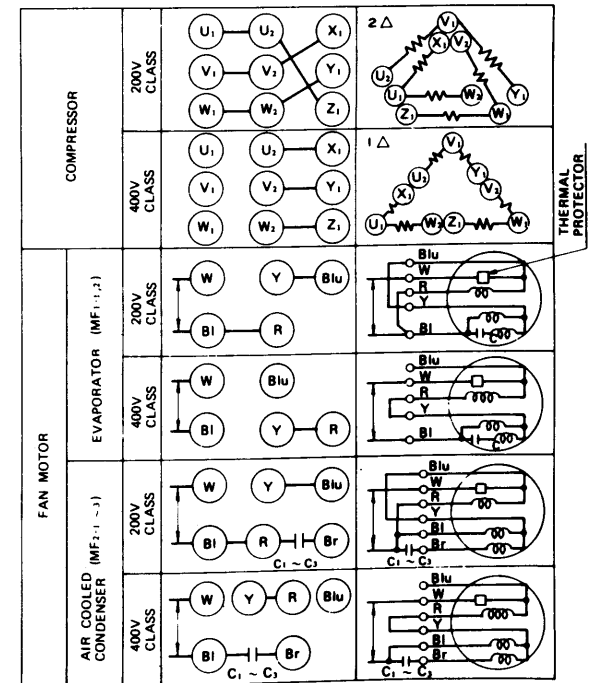


2. Broken line shows external wiring.

1.5.2 Actual wiring

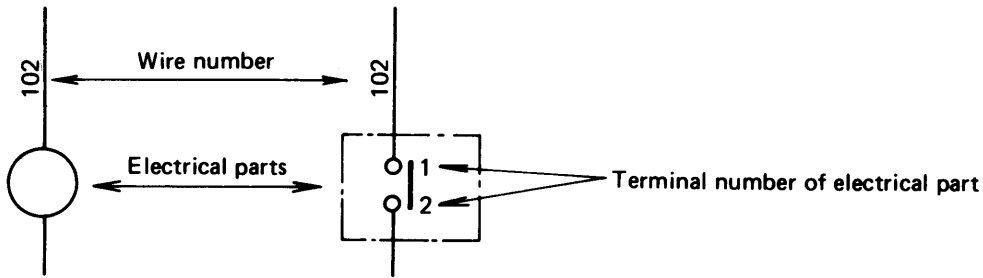


- Colours of wires are as follows
 Bl: Black, Blu: Blue, Br: Brown
 R: Red, Y: Yellow, W: White
 (G): Green (for earth)
- Wiring for compressor and fan motor



1.5.3 How to read wiring diagram

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



(2) Operation of contacts

- The wiring diagram indicates the stationary state in which the circuits are not activated.
- When a coil is energized (supplied with power), the associated contact changes its position.

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

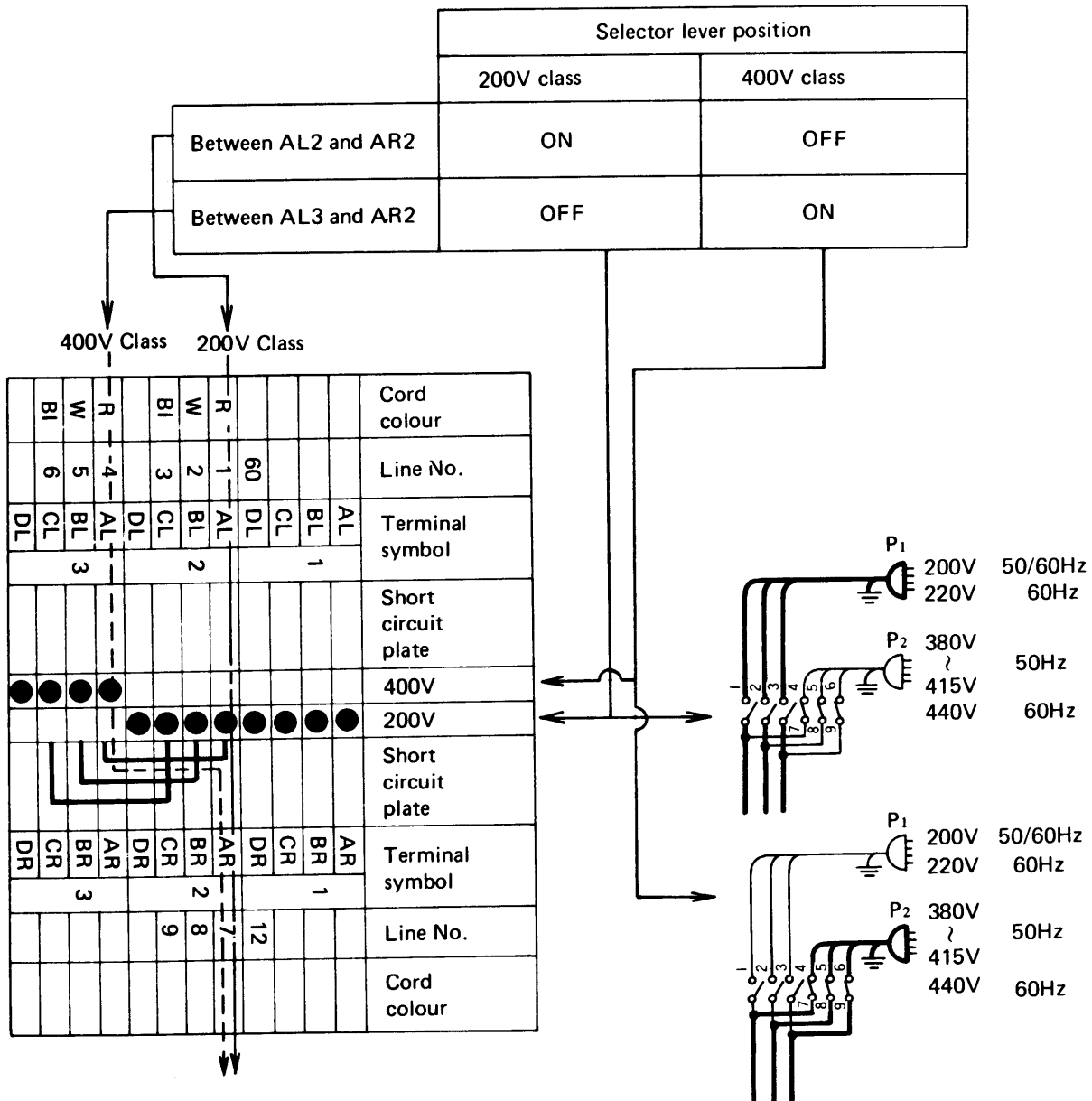
c. Kinds of contacts

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

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

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

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



2. Operation

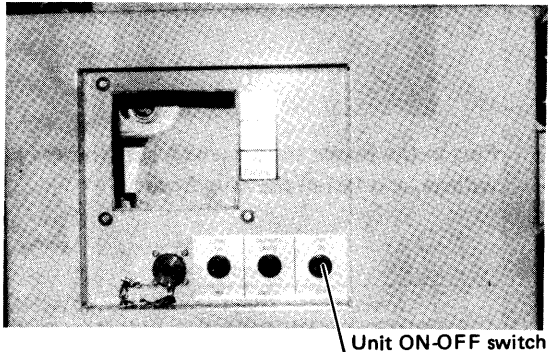
Operate the unit by the procedures given below.

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

2.1 Preparation and operation

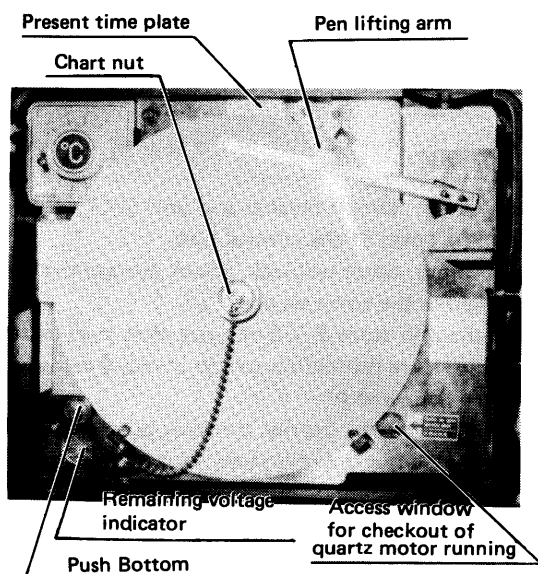
(1) Confirm that supply power is off.

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 from the access window the fly wheel inside is rotating.



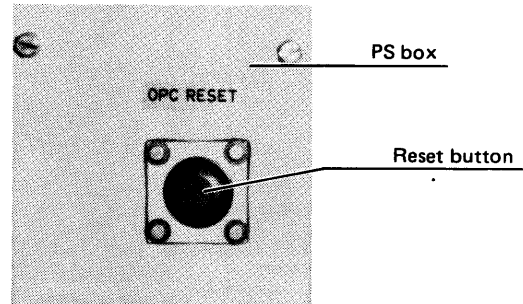
The cover of control box

(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 a graduation of present time and day on the graduations.
- Firmly tighten up the chart nut and release the pen so that recording can be accomplished.

(4) Reset the oil pressure protection switch.

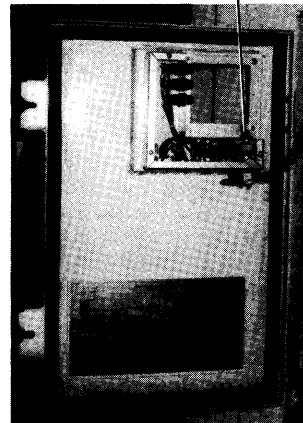
Reset by pressing the button on the front panel of the PS (Pressure switch) box. The unit does not start unless the switch is reset.



(5) Set the capacity control switch (3C).

- a. In case capacity control is required
- 3C . . .Set it to ON

Capacity control switch (3C)

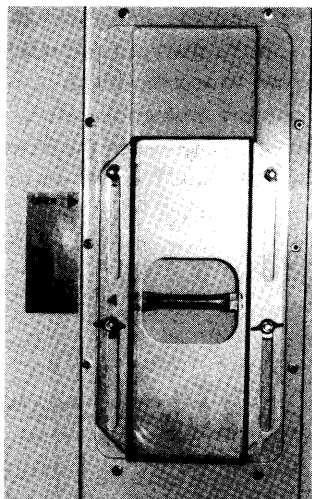


b. In case capacity control is not required

- 3C . . .Set it to OFF

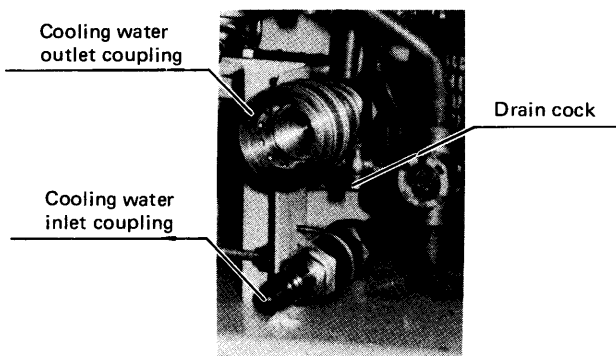
Notes:

- (6) Open or close the ventilator. See article (5)
 Open or close the ventilator according to the cargo.
 (Be sure to keep it closed during transportation of



Ventilator

- (7) Connect the cooling water piping.
 • In the case of water-cooled operation, connect the water piping, and supply water through it.



• Connecting method

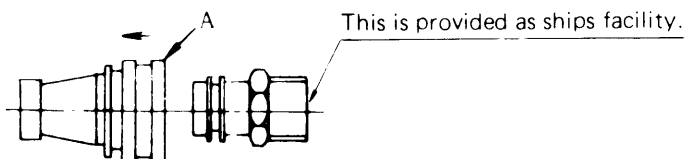
1. Close the drain cock.
2. Connect the cooling water inlet coupling.
3. Connect the cooling water outlet coupling.
4. Open the drain cock and purge the air.
5. After having completed air purge, close the cock.

• Disconnecting method

1. Disconnect the cooling water outlet coupling.
2. Disconnect the cooling water inlet coupling.
3. Open the cock and drain off.

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.

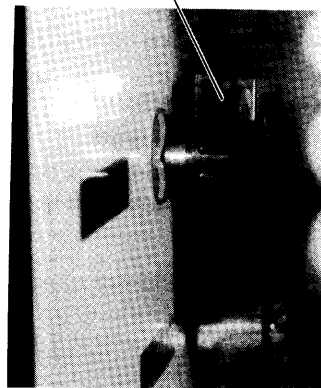
When disconnecting them, pull the coupling on the ship side toward you while pushing the A part of the female coupling in the direction pointed by an arrow mark.



Water connection at outlet side

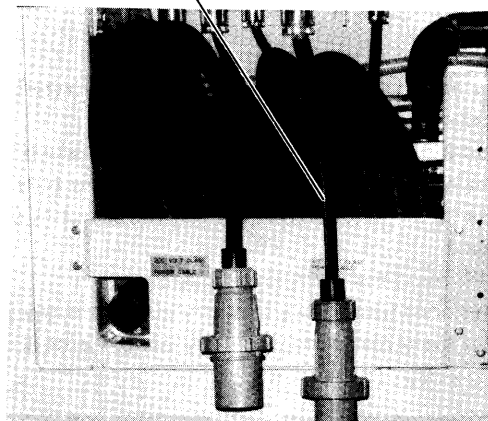
- (8) Check that all refrigerant stop valves are opened.
 (9) Set the voltage selector switch according to the supply voltage.

Selector lever



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

Yellow line
400V class



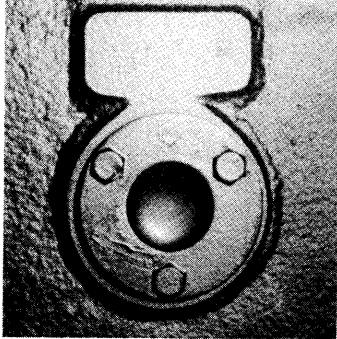
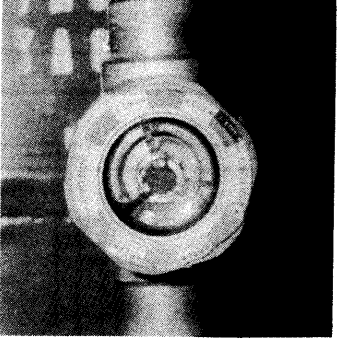
- (11) Turn on the power switch of the facility (outside the unit).
 (12) Turn ON the circuit breaker and unit ON-OFF switch.
 (13) Close the cover of the control box.

If it is loose, water will leak. Check around the packing and tighten the cover securely.

Note: If the unit stops 2 ~ 3 minutes after starting, the oil pressure protection switch in many cases has been activated.

If this happens, depress the reset button a few minutes after the unit stops. If it stops again, repeat the same action.

2.2 Checking during operation

Checking items (precautions)	Method of check	
1. Check if unusual noise and vibration is not 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.		
3. Check suction and discharge pressures of the compressor. (For installation of a gauge, refer to "Service".)	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.)		Visual Oil level should be approx. ¼ to ¾ of its full scale.
5. Check to see if refrigerant is sufficient. (The refrigerant bubbles immediately after starting, but this does not mean that refrigerant is lacking.)		Lack of refrigerant is indicated by bubbles in the moisture indicator.
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.)	Visual The moisture indicator should normally appear deep blue. Orange color is a sign of trouble.	
7. Check operating conditions with the pilot lamps	Visual	
8. Check if the recorder operates according to the inside temperature.	Visual	

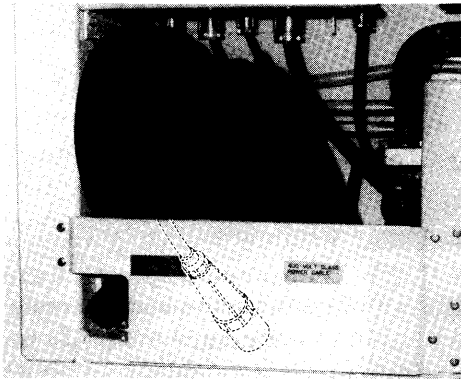
2.3 Maintenance after operation

(1) Stopping

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

(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

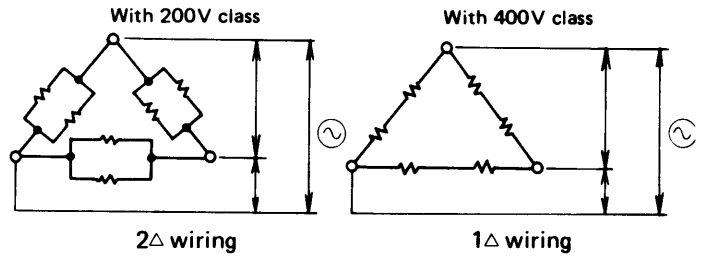
Remove the water piping, open cocks, and drain off.

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

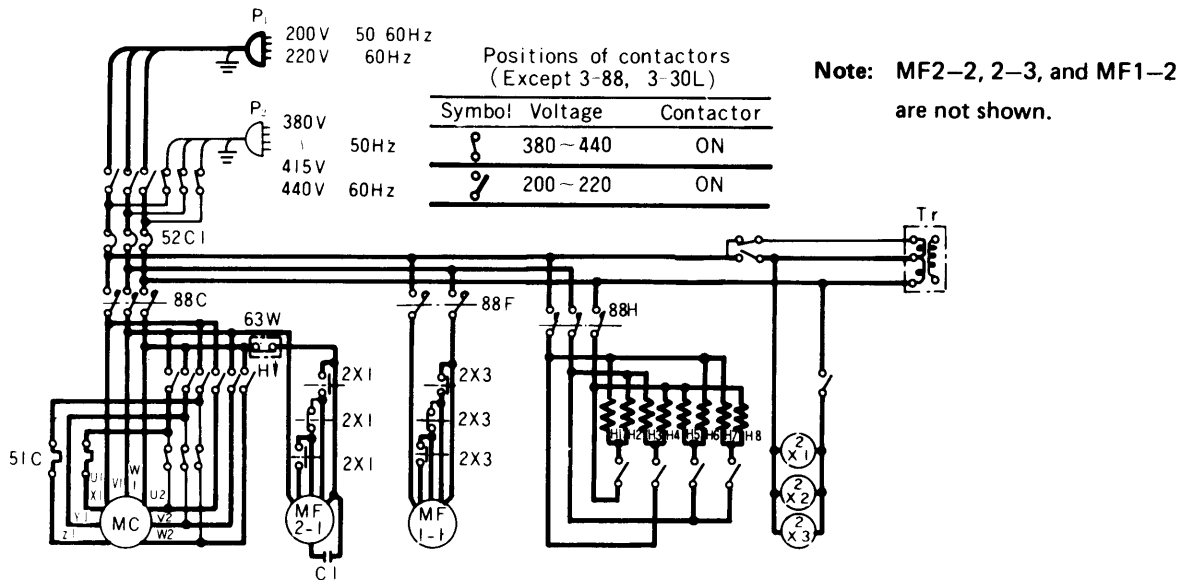


(2) Circuitry

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

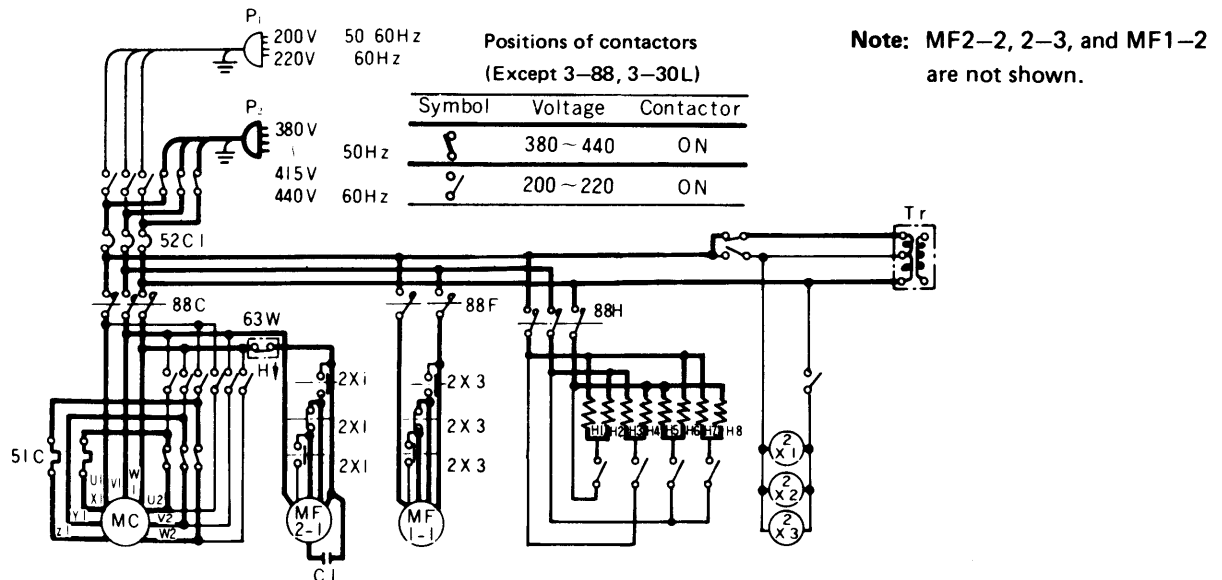
The contacts marked "⌘" in the sequence chart (except 3-88 and 3-30L) are turned on.

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).



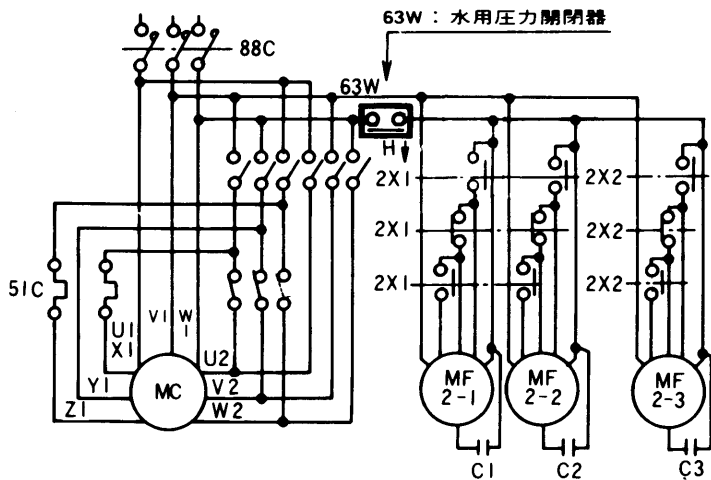
3.2 Air cooled and water cooled operation

The unit is possible to operate on either operations of air cooled or water cooled.

During the transit on the land, in the yard or on the deck, the air cooled operation is normal, and the operation in ship holds is normally water cooled.

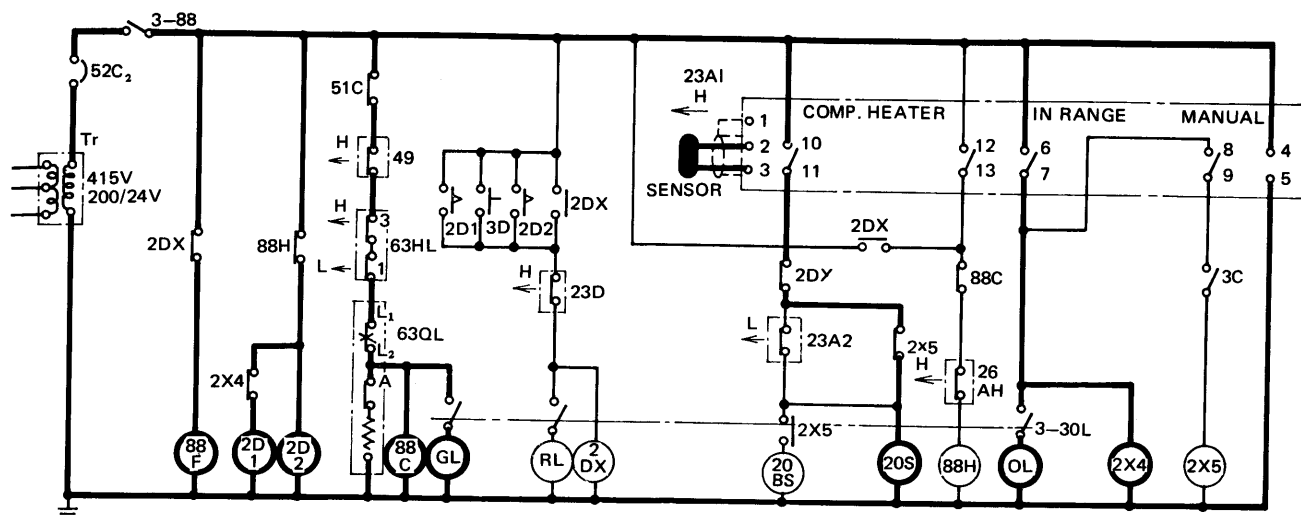
The operation can be changed from air cooled to water cooled and vice versa automatically by the water pressure switch; i.e. when water pressure at the inlet of the water cooled condenser rises higher than the presetting value, the contact points of the water pressure switch are cut out, so the condenser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

On the contrary, when water supply is suspended during the water cooled operation, the contact points of the water pressure switch come in contact and the condenser fan motors rotate. Thus, the air cooled operation starts.



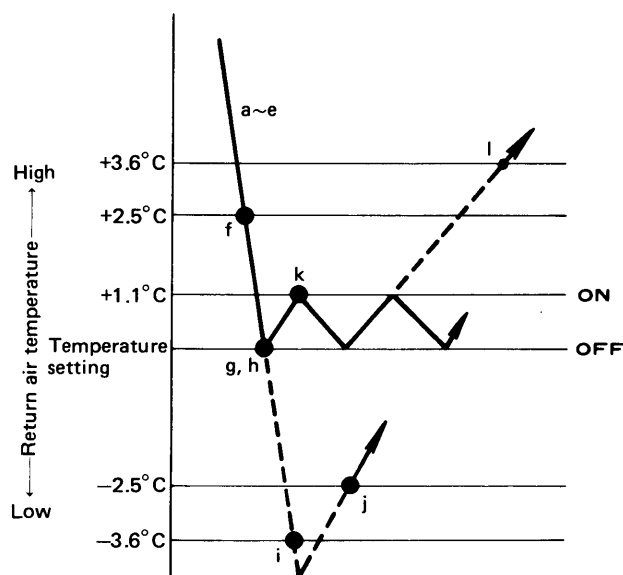
This diagram indicates air-cooled operation mode. When water pressure is applied to the switch, the switch mechanism moves in the direction of H ↓, so the condenser fan motors (MF2-1, 2, 3) stop, and water-cooled operation starts.

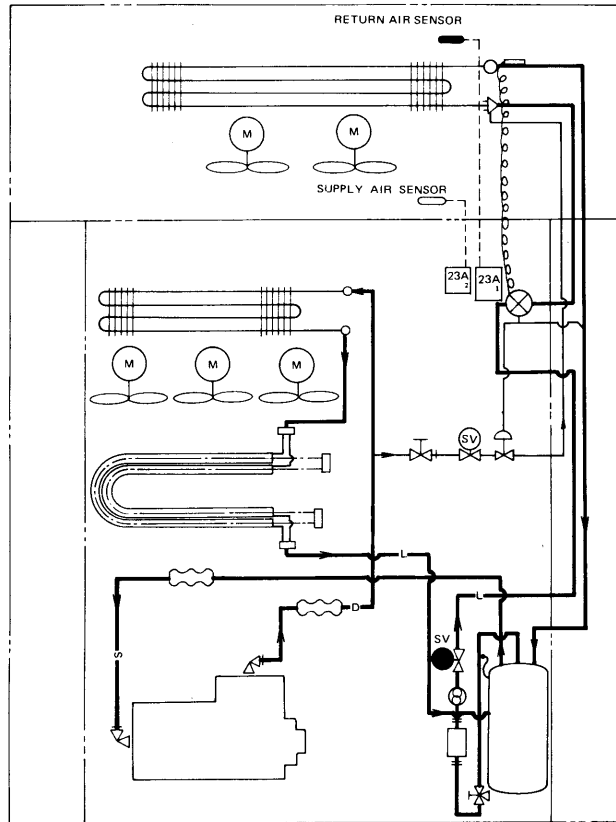
3.3 Freezing operation



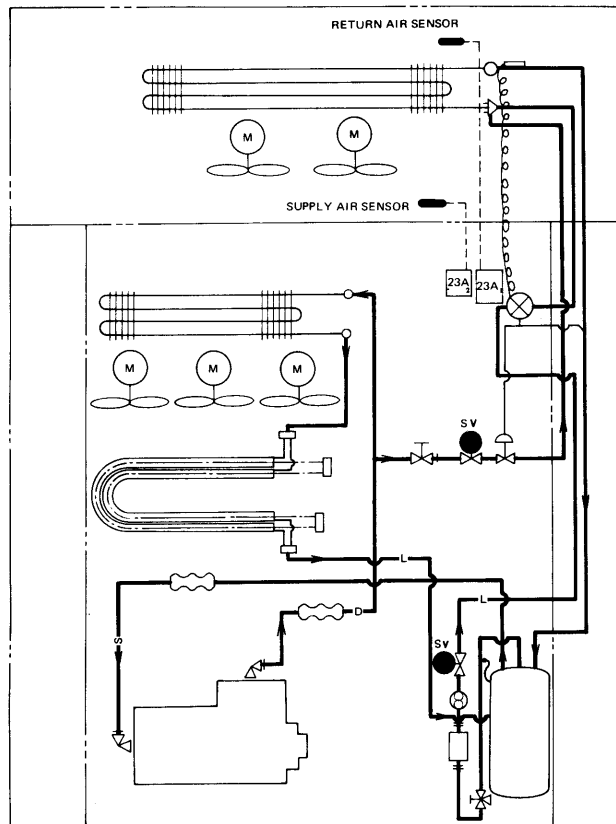
- (1) Change-over from cold storage to frozen storage or vice versa Change-over from cold storage to frozen storage can be automatically accomplished in accordance with setting of the electronic recording temperature controller (23A1)
 - When thermostat setting is over -4.5°C . . . Cold storage
 - When thermostat setting is under -6.5°C . . . Frozen storage

In case of cold storage, the manual relay of 23A1 is turned off.
Namely, capacity control is not accomplished.
- (2) During freezing 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. With 88F (evaporator fan relay) energized, MF1-1 and 1-2 (evaporator fan motors) start.
 - c. The solenoid valve is closed by means of the compressor relay in 23A1.
 - d. When 20S is open, refrigerant flow and low pressure rise. As it reaches 0.2 kg/cm^2 , 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 storage temperature drops to higher than thermostat setting by 2.5°C , the IN RANGE relay of 23A1 is turned on and OL (Orange lamp) lights up.
 - g. When storage temperature reaches thermostat setting, the compressor stops, 20S is open and pump down operation starts.
 - h. When the low pressure falls down to 40 cmHgV , LP of 63HL is turned off; 88C becomes unenergized; MC, MF2-1, 2, and 3, etc. stop; and freezing operation stops.
 - i. If storage temperature continues falling furthermore lower than thermostat setting by 3.6°C after stopping MC, the IN RANGE relay is turned off and the OL will go off (Low limit alarm).
 - j. When the temperature rises to the preset temperature minus 2.5°C , IN RANGE relay is turned on and OL lights up.
 - k. When storage temperature further rises and becomes higher than thermostat setting by $+1.1^{\circ}\text{C}$, the COMP. relay is turned on and the refrigeration unit is operated as stated in c \rightarrow d \rightarrow e.
 - l. When storage temperature rises higher than thermostat setting by $+3.6^{\circ}\text{C}$, the IN RANGE relay is turned OFF and OL will go off. (Upper limit alarm)



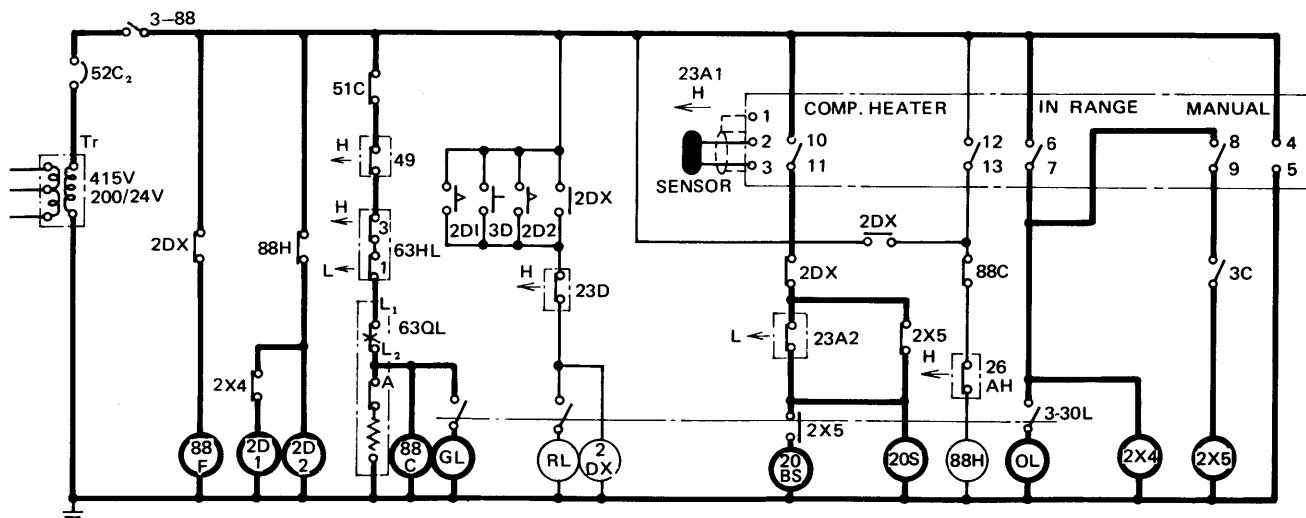


Flow of refrigerant during freezing operation

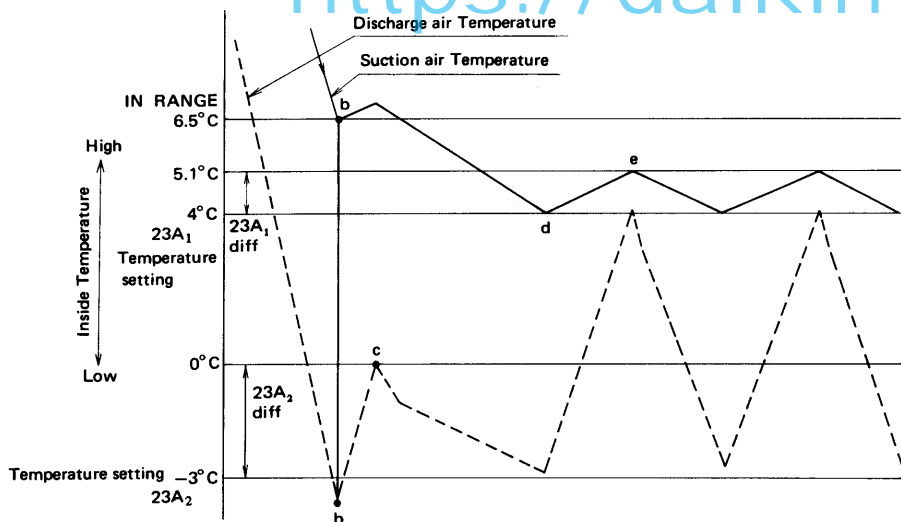


Flow of refrigerant during chilling operation

3.4 Chilling operation – capacity control



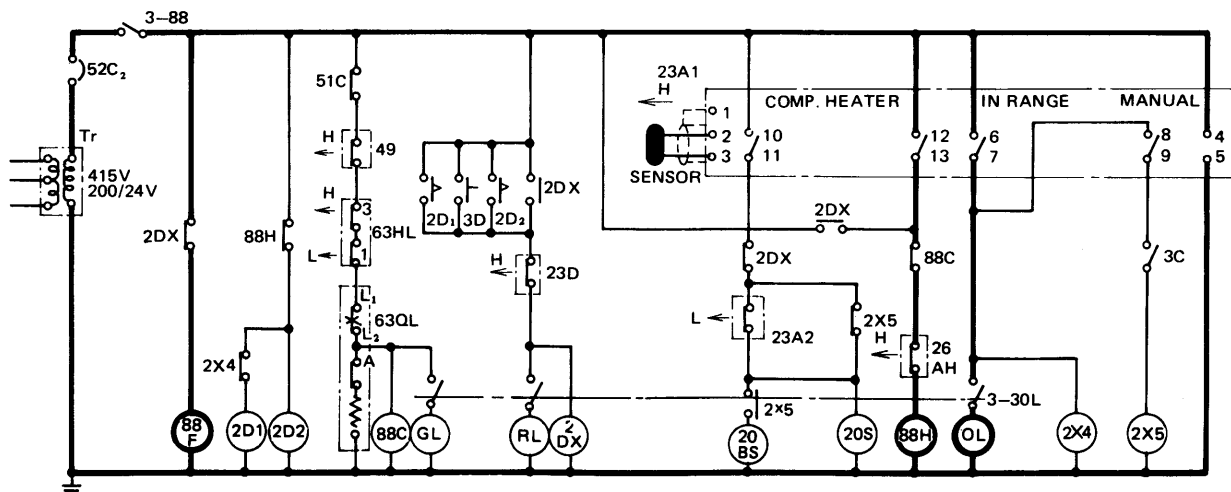
- (1) Chilling operation is performed when the preset temperature is -4.5°C or higher. MANUAL relay (which switches over freezing and chilling modes) of 23A1 is turned on, 2X₅ relay becomes energized and the circuit of the chilling operation is set up.
- (2) Frozen storage
 - a. In case capacity control is not required, set the switch (3C) for capacity control to OFF. The operation circuit becomes the same as that of cold storage. (Refer to "Cold storage").
 - b. In case capacity control is required, set the switch (3C) to ON.
- (3) Capacity control operation – Hot gas bypass method
 Hot gas is bypassed through the bypass valve to control suction air temperature. When discharge air temperature is lower than setting of discharge air thermostat (23A₂), pump down is accomplished, the compressor is stopped, and discharge air temperature is controlled so as not to over-cool.
 The operation sequence are explained hereunder.
 Never manipulate the setting of 23A₂, which has been precisely adjusted at our factory before shipment.
 - a. Operation for frozen storage is the same with that for cold storage described from a to e until storage temperature becomes higher than thermostat setting (23A₁) by 2.5°C from pull down operation. Hot gas will not be bypassed until entering storage temperature reaches the upper limit of suitable temperature. (In the above sequence, only 20S is opened through the line shown with ---)
 - b. When suction air temperature becomes higher than thermostat setting (23A₁) by 2.5°C , the IN RANGE relay (23A₂) is turned on (OL lamp lights up), 2X₅ relay is actuated, the hot gas bypass circuit and discharge air thermostat circuit are formed, and 20BS is open, which put the refrigeration unit in hot gas bypass operation. If discharge air temperature has reached -3°C (discharge air thermostat setting) in this time (the IN RANGE relay is turned on), 23A₂ is turned off and 20S and 20BS are closed. After pump down, the compressor stops not to over-cool.
 - c. In the next stage, when storage temperature rises and reaches ON point of 23A₂ (0°C), 20S and 20BS are open and let the hot gas bypass.
 - d. When storage temperature drops and entering storage air temperature reaches temperature setting of 23A₁ (0°C); i.e. before distributing air temperature reaches OFF point of 23A₂, 23A₁ and the COMP relay are turned off, 20S and 20BS are closed, and pump down starts. After pump down, operation is stopped.
 - e. When entering storage air temperature rises higher than thermostat setting of 23A₁ by $+1.1^{\circ}\text{C}$, the COMP relay is turned on and hot gas operation once again starts.
 – After that, 23A₁ controls suction air temperature by operating the compressor on and off.



Note:

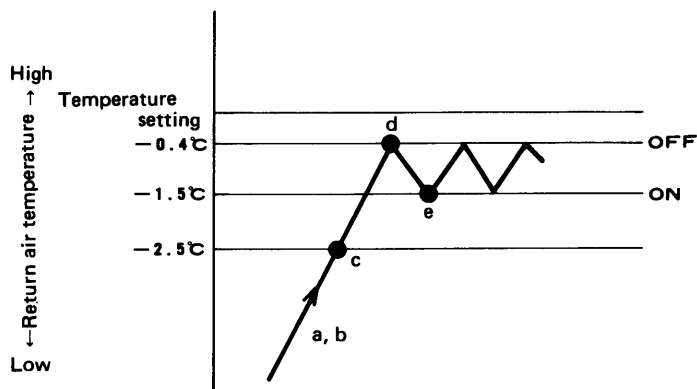
During capacity control operation, discharge air temperature is sometimes controlled by 23A₂ as shown in the following diagram. This is, however, not an abnormal state.

3.5 Heating operation

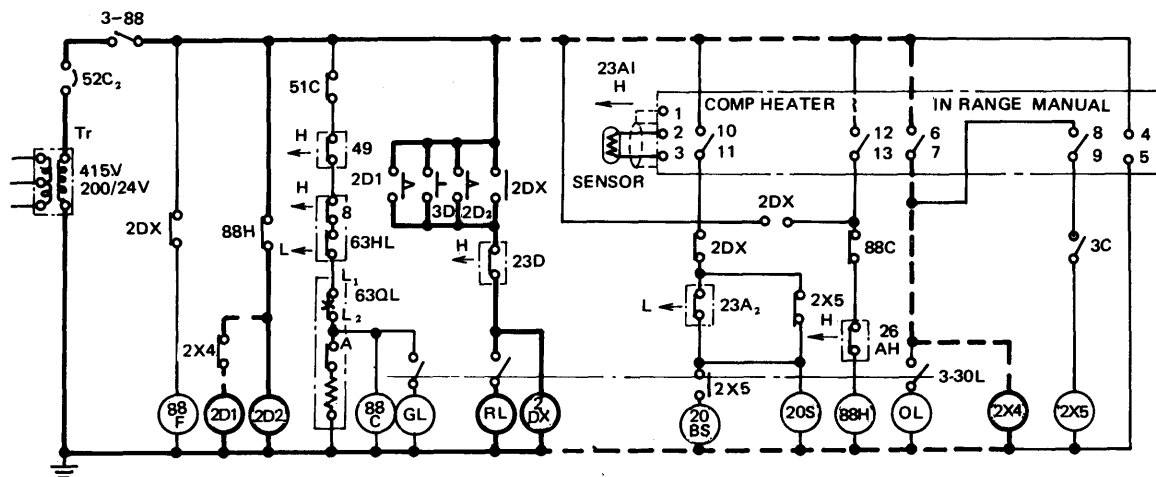


- 1) Heating is accomplished only when thermostat setting (23A₁) is over -4.5°C .
- 2) The heater relay of 23A₁ controls the electric heater on and off for heating.
 - a. When storage temperature is lower than thermostat setting, the COMP relay is turned off, 20S is closed, and MC, MF2-1, 2, 3 stop with pump down state.
 - b. When storage temperature is lower than thermostat setting by over 1.5°C , the heater relay is turned on, 88H is activated, and the electric heaters (H1-8) are energized. Then warm air is distributed to the storage space by the evaporator fan.
 - c. When storage temperature rises and reaches thermostat setting (-2.5°C), the IN RANGE relay is turned ON and OL will light up.
 - d. When storage temperature rises furthermore and reaches thermostat setting -0.4°C , the heater relay is turned off, 88H is deactivated and the electric heater is de-energized.

- e. When storage temperature falls to thermostat setting -1.5°C , the heater relay is turned on and heating will start again. If the heater is abnormally heated accidentally, the over-heat protection thermostat (26AH) is actuated to stop the heater.



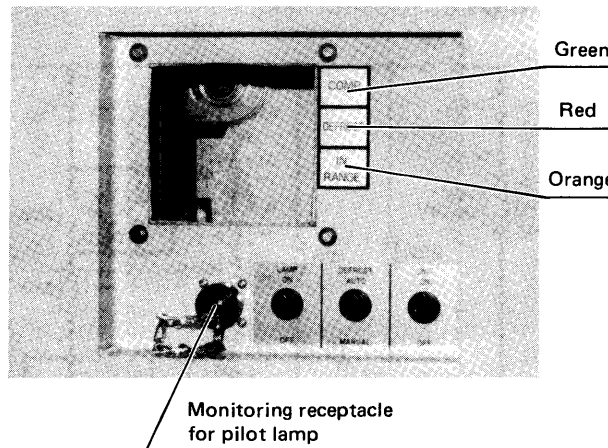
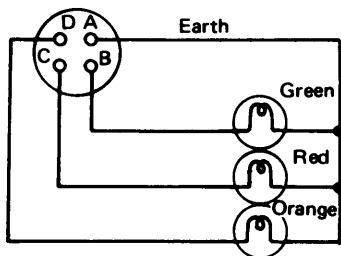
3.6 Defrost operation



- (1) Defrost operation can be started by the following two methods (three elements).
 - a. Auto defrost (dual timer method)
Defrost operation is carried out automatically by turning ON either of the two defrost timers (short timer: 2D₁ and long timer: 2D₂).
 - Short cycle defrost operation
Until the cooling temperature inside reaches the suitable temperature range from the pull down temperature, defrost operation is carried out in every two hours (on 60 Hz.) by 2D₁.
 - Long cycle defrost operation
When the cooling temperature inside reaches within the suitable temperature range, defrost operation is carried out in every 18 hours (on 60 Hz.) by 2D₂.
 - b. Manual defrost operation
Setting the manual defrost switch (3D) to "MANUAL" position turns on the switch and defrost operation starts.
If one of those stated above is on, defrost relay (2DX) becomes energized, and RL (red lamp) lights up.
- (2) When 2DX is energized:
 - 88F is deactuated and the evaporator fan stops.
 - 20S (20BS) is closed, GL will go off after pump down, 88C is deactuated and MC, MF2-1, 2,3 stop.
 - When 88C is deactuated, 88H is actuated, the electric heaters (H₁₋₈) are energized and defrosting starts.
- (3) When the evaporator coil temperature rises to 7.2°C after having removed frost, defrost termination thermostat (23D) is turned off and 2DX becomes unenergized. Now defrosting operation is completed.

3.7 Pilot lamps and monitoring circuit

- (1) Three lamps which indicate operating mode are mounted on the front panel of the control box.
- Red : indicates defrosting mode
 - Green : indicates that the compressor is running
 - Orange : indicates that storage temperature is with in range
- Receptacles for monitoring pilot lamp is also equipped and its connections is shown at below.



- (2) States of pilot lamps and operating modes
 (○ : lights, ★ : Goes off)

Be sure to check first that the pilot lamps are not blown out before check.

	Pilot lamps			Operation state	
	Orange	Red	Green	Normal	Abnormal
1	★	★	○	During refrigeration operation (Pull down)	
2	○	★	○	Temperature is proper for freezing, chilling or heating.	
3	○	★	★	Proper temperature (compressor stops)	
4	★	○	★	It is normal so long as operation becomes as stated in (1) during defrosting by approx one hour.	If this state continues for several hours, there must be trouble with defrosting termination thermostat or defrosting heater and its related parts.
5	○	○	○	Defrosting starts within proper temperature range. It is normal so long as the green pilot lamp goes out within 30 ~ 40 seconds.	If this state continues for more than a few minutes, it may be caused by (1) Clogging of solenoid valve (2) Low pressure setting is very low or malfunction of low pressure switch.
6	★	○	○	Defrosting starts during pull down. It is normal so long as the green pilot lamp goes out within 30 ~ 40 seconds.	
7	○	○	★	If orange pilot lamp goes off within few minutes during defrosting operation, operation is normal.	After a few minutes, orange and red pilot lamps light up or go off simultaneously. (Cause) Controller setting is wrong.
8	★	★	★	During heating operation (Pull up)	Function of safety devices: (1) Dual pressure switch (2) Oil pressure protection switch (3) Compressor protection thermostat (4) Power source and circuit breaker (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 the built-in motor so that there are few places where leakage of refrigerant may occur. The reversible trochoid pump used produces the required oil pressure regardless of the direction of rotation of the built-in motor.

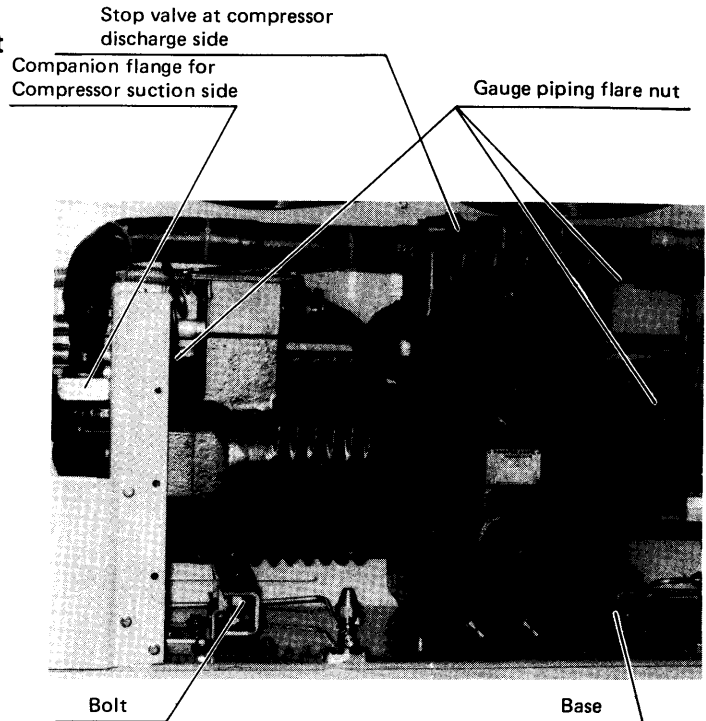
(a) Replacement

Remove the compressor in 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 the stopper
- 4 Remove the compressor and bolt nuts from the installation base (two each on left and right sides)
- 5 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 list for torque.

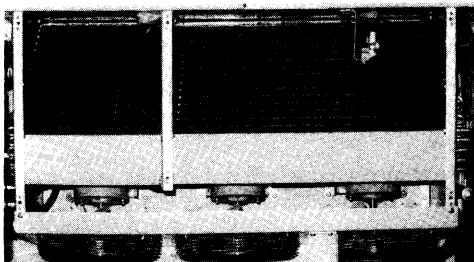


4.1.2 Air-cooled condenser and evaporator

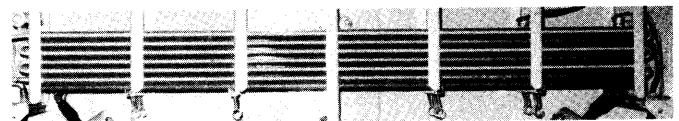
Of the "cross fin" coil type having special corrugated fins are compact and very efficient in producing uniform heat exchange efficiency.

(a) Maintenance

Service the air-cooled condenser after removing the air suction grille. Service the evaporator after removing the air suction grill from storage or the access panel from outside.



Air cooled condenser



Evaporator

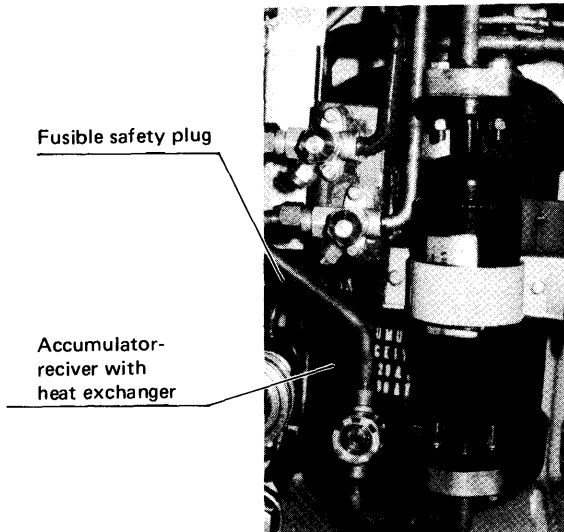
4.1.3 Water-cooled condenser

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

Consist 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 bottom to the top. reaches to the receiver.

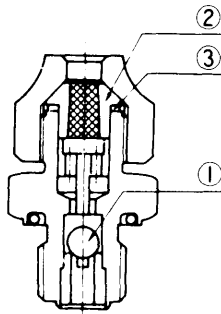
This construction reduces heat loss. A fusible safety plug is fitted to the receiver body.



(a) Replacement procedure of the fusible safety plug

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

When fusible plug functions, the centre of the fusible plug alloy ② melts, from which the refrigerant jets out. When the flare nut is removed, ① is apt to come out by pressure and clogs the passage of the refrigerant outlet, which prevents the refrigerant from jetting out and also the air from entering. Thus, refrigerant loss is extremely minimized.

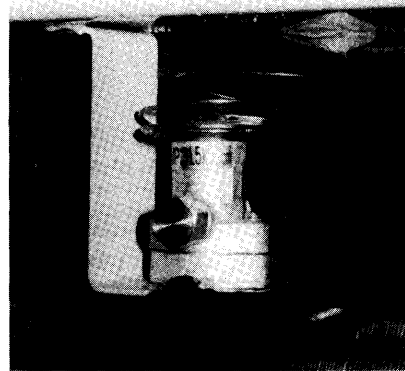


Construction of fusible plug

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 (motor overload protection) is adopted to protect the compressor motor from overload.





“CAUTION” Whenever adjusting and replacing the expansion valve, the unit should be stopped securely for safety sake.

(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.

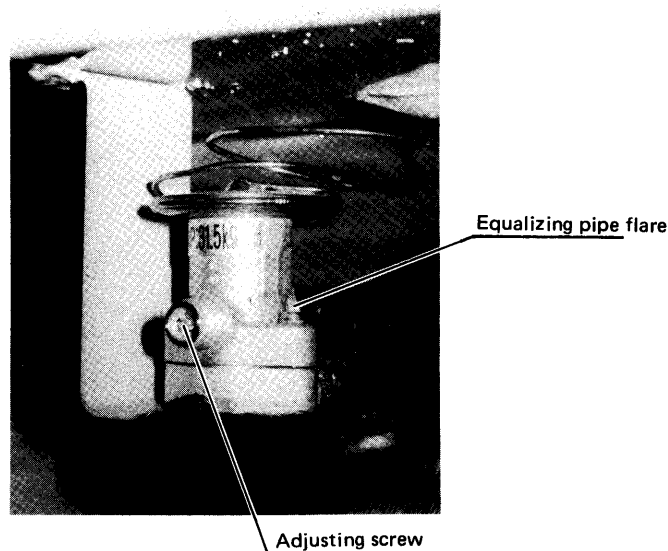
- (1) Adjustment based on the suction operation pressure
 - 1) Conform that the predesigned volume of the refrigerant has been charged.
 - 2) Attach a pressure gauge to each gauge port and operate the refrigeration unit, maintaining storage temperature at -18°C (-0.4°F). (See, Attaching or detaching points of pressure gauge).
 - 3) When temperature in the storage 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, storage 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 outdoor 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

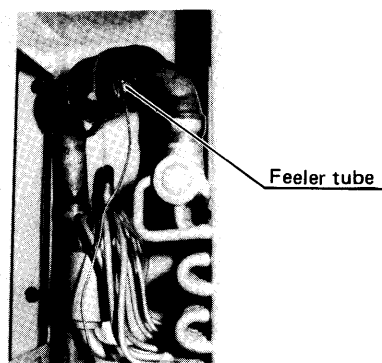
- Remember the original setting of the expansion valve. If any change is found with the setting after adjustment of the expansion valve, return the adjusting screw to the original position, as trouble occurred caused by other reasons.
- When the adjusting screw is returned to its original position, firstly turn it passing the original position and then return it to the original position.
- After adjustment, be sure to tighten up the clamp screw and cap it to prevent the refrigerant from leaking.
- After completion of the adjustment, operate the unit, keeping storage 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

Remove the access panel and the front panel of the air cooled condenser which are located outdoors, before undertaking the work.

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



4.1.6 Liquid/moisture indicator

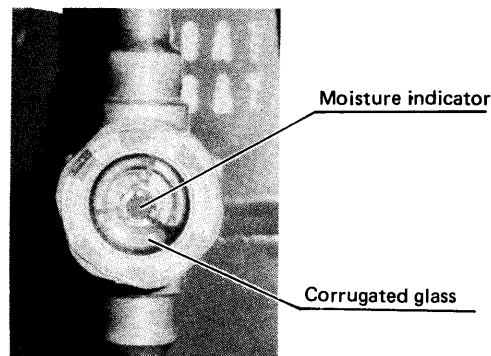
This indicator permits checking of flow of the refrigerant and moisture content in the refrigerant.

(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 has been exposed to gaseous refrigerant for a long time.



(b) Flow of the refrigerant

- When the liquid refrigerant is sealed, corrugation on the sight glass disappears.
- Check

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

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

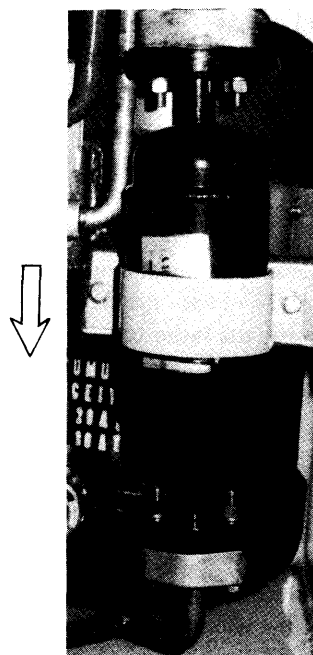
4.1.7 Dryer

This removes moisture and dust from the refrigerant while it is circulated. Replace the dryer if it does not remove moisture or is clogged.

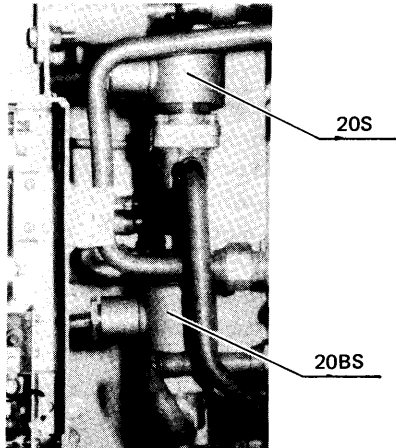
When installing the new dryer, follow the directions given on the nameplate and do not make any mistake about the direction of the dryer.

(a) Replacement

- 1) In "pump down" state (see Service), close the compressor suction stop valve.
- 2) Remove the flange bolts before and behind the dryer and replace the dryer with a new one as quick as possible. At this time, be careful not to lose the O-ring on the flange.
- 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 flange on the solenoid valve side and then close it at once.
- 5) Loosen the flange 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.



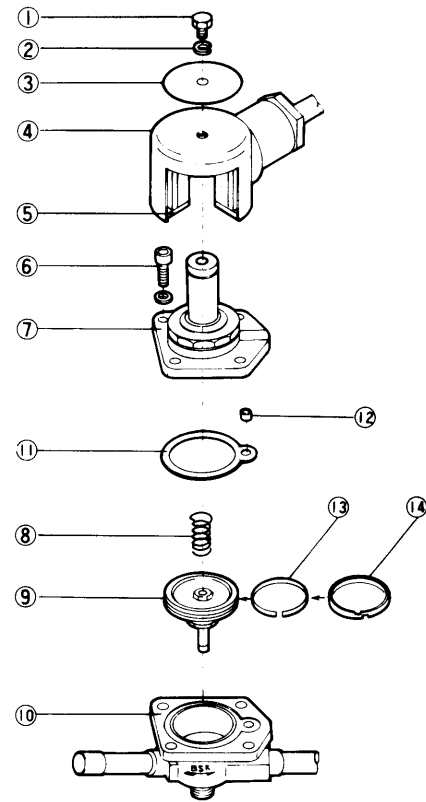
4.1.8 Solenoid valves



- a. Solenoid valve in the liquid line (20S)
20S is opened or closed by the signal of the controller.
When 20S is closed, the refrigerant flow is blocked.
(For pump down).
- b. Solenoid valve in the hot gas line (20BS)
The solenoid valve is opened to allow hot gas to pass when capacity is controlled or storage temperature becomes within suitable storage temperature range. (In case of pump down, this solenoid valve is also closed)
Both 20S and 20BS are open when the solenoid is energized and closed when not energized.

(c) Disassembly

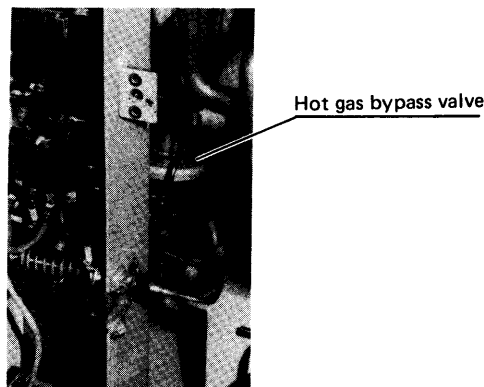
- The structure of the solenoid valve is shown at below.
(For disassembly, checking, and reassembly, refer to this diagram.)
- When brazing a pipe to the valve, cool the valve body with a wet cloth. (It is not required to disassemble the valve. Remove the coil ass'y from the body.)
- During reassembly, 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

4.1.9 Hot gas bypass control valve

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.



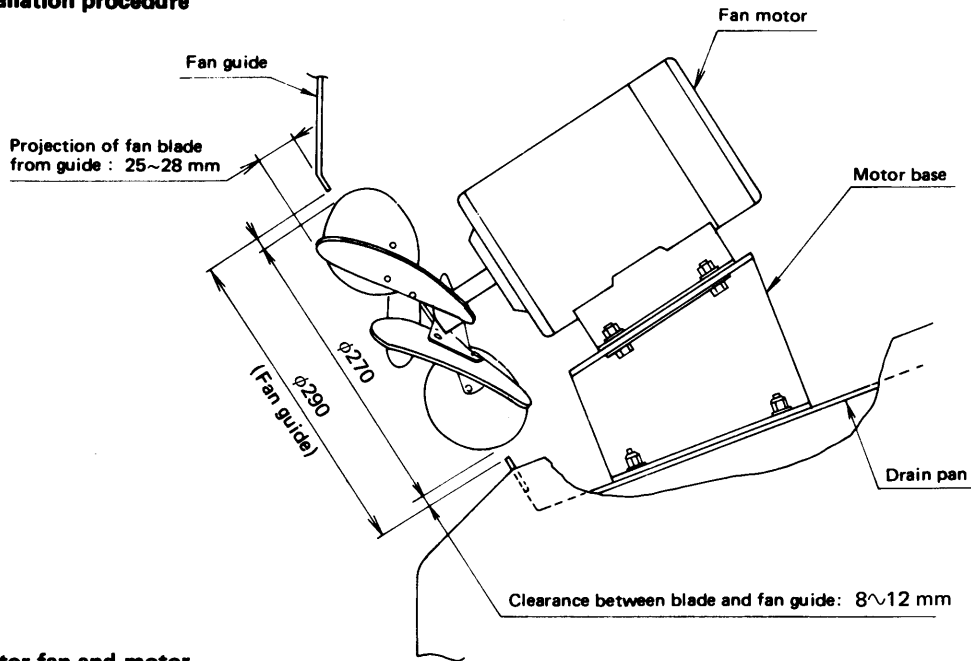
4.2. Components related with the air system

4.2.1 Fans and motors

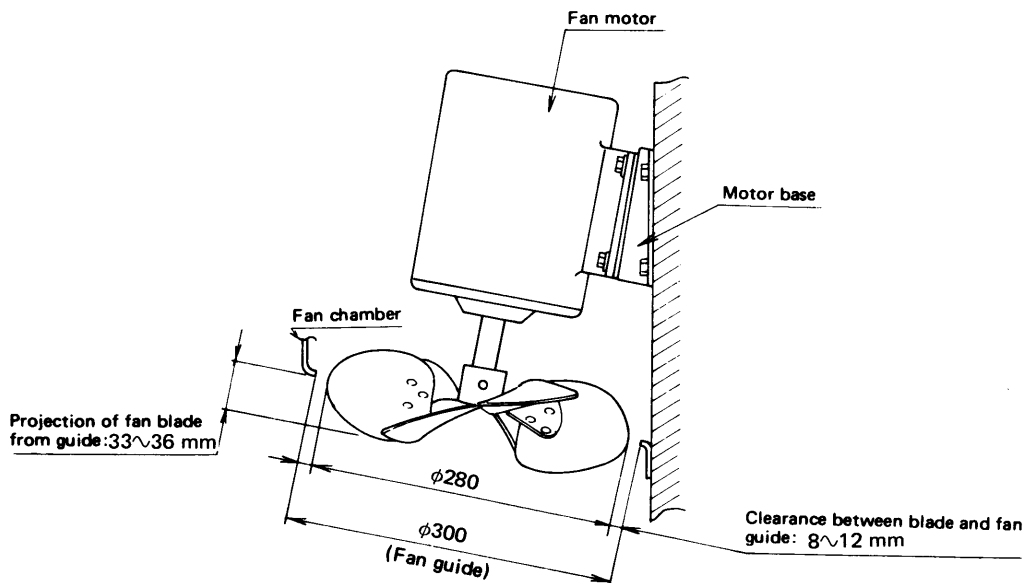
(a) Specifications

Fan	Type	Evaporator propeller fan	Condenser propeller fan
	Number of blades	6 pcs.	6 pcs.
	Blade diameter	$\phi 270$	$\phi 280$
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



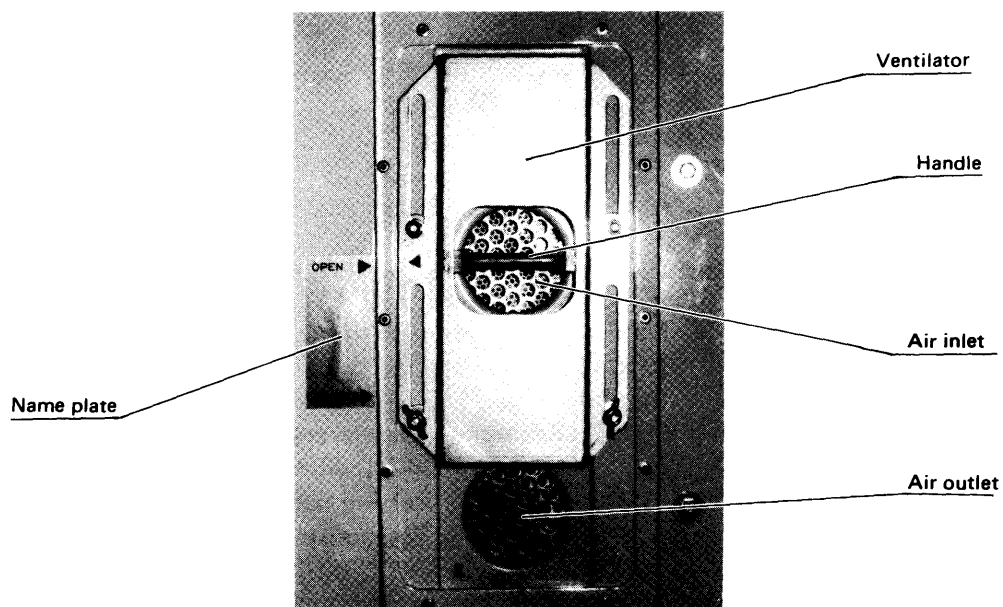
Evaporator fan and motor



Condenser fan and motor

4.2.2 Ventilator

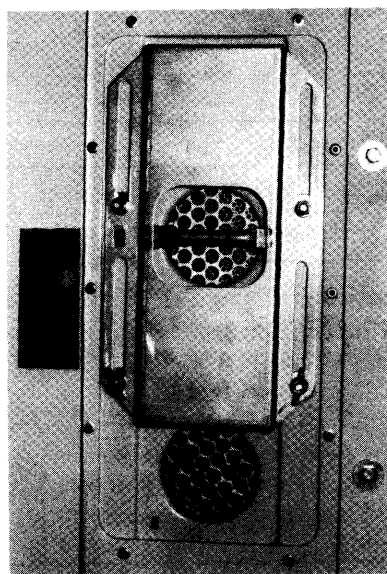
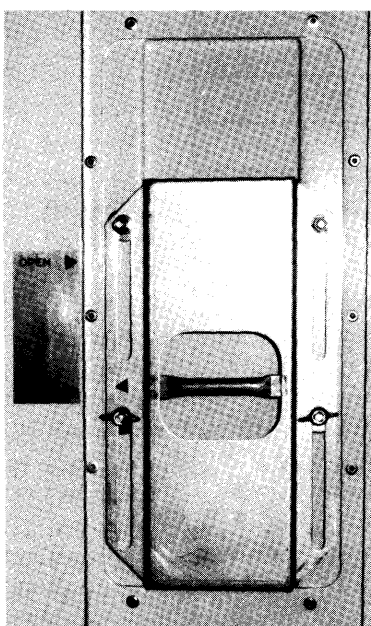
(a) View



(b) Operation

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

- If ventilation is needed:
 1. Loosen the lock nut
 2. Set the handle to FULL OPEN
 3. Tighten the lock nut



4.3 Temperature control components

4.3.1 Electronic recording temperature controller

Operation state of the unit and at the same time records the operation state.

This controller consists of electronic temperature controller and gas charged temperature recorder.

a. Specifications

Model : WKM-S424

(1) Electronic controlling parts

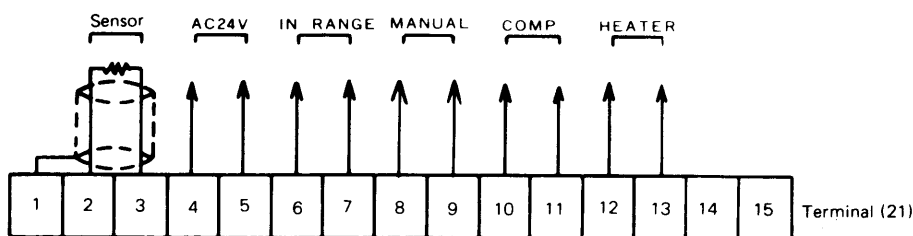
- Power source AC 24V 50/60Hz
- Temperature control range $-25 \sim +25^{\circ}\text{C}$ ($-13 \sim 77^{\circ}\text{F}$)
- Sensor Platinum rhodium resistance bulb (0°C (32°F) 100Ω)
- Number of output switches 4 ea
- Characteristics of switch function

Example: Temperature setting standards will be -2°C when sensing temperature and setting temperature are 0°C and 2°C respectively.

Temperature setting standards
(Sensor temp.) – (Temperature setting)

Temp.		Temp.														
		-7	-6	-5	-4	-3	-2	-1	0°F	1	2	3	4	5	6	7
Name		-4	-3	-2	-1	0°C	1	2	3	4						4
COMP	Setting Temperature	OFF							ON	OFF						
	Setting Temperature	OFF							ON	OFF						
IN RANGE	Setting Temperature	OFF			ON				OFF				ON			
	Setting Temperature	OFF			ON				OFF				ON			
HEATER	Setting Temperature	OFF							ON				OFF			
	Setting Temperature	OFF							ON				OFF			
MANUAL	Setting Temperature	ON														
	Setting Temperature	OFF														

- Difference between ON and OFF of switch (diff): 1.1°C (2°F)
- External wiring (Wiring from the devices in the control box to the unit to Terminal 21 in Fig. 1)



- Insulation resistance Over $50\text{ M}\Omega$ with DC 500V megger
 - Insulation strength for 1 minute with AC 500V
- Note:** Do not impress voltage on the sensor terminals 1, 2, and 3.

(2) Recording part

- Feeler tube
- Recording method
- Recording temperature range
- Recording paper

Gas sealed

Pressure sensing type

-25 ~ +25°C (-13 ~ 77°F)

Dia. 203 Disk type pressure sensible paper
(Graduation 1/1°C)

(Corresponding to PSD-217C (REV. A) made of PARTLOW 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 8501 SUM2

IEC R14

Quartz motor driving source:

Life is approx. 1 year (Remaining voltage indicator)

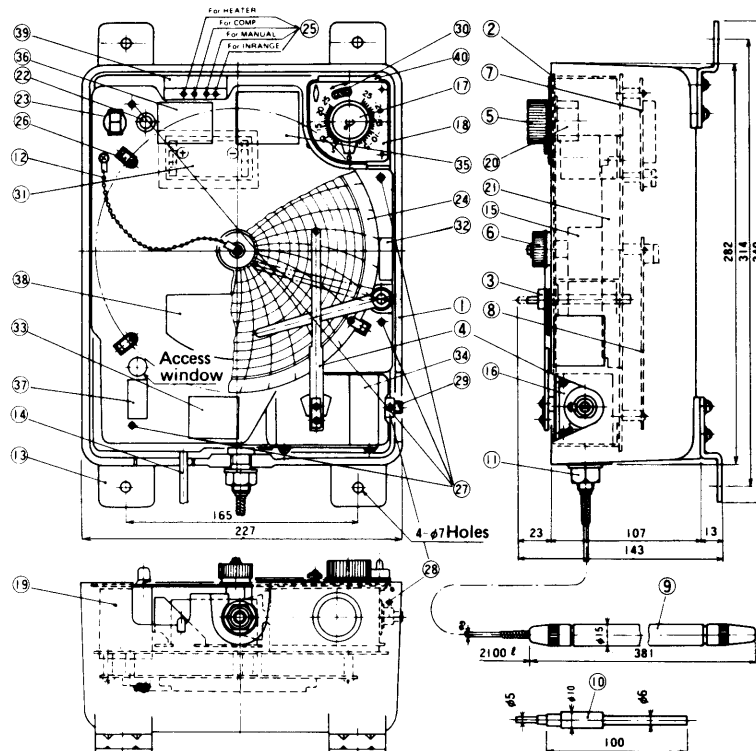


Fig. 1 Structure

- | | | |
|------------------------|--|--|
| (1) Case | (16) Element | (30) Fine adjusting screw for functioning temp. |
| (2) Recording board | (17) Name plate for setting knob | (31) Dry battery |
| (3) Pen lifting arm | (18) Setting name plate | (32) Present time plate |
| (4) Pen | (19) Quartz motor | (33) Instruction plate for pen operation |
| (5) Setting knob | (20) Volume | (34) Instruction plate for recording temperature adjustment |
| (6) Chart nut | (21) Terminal strip | (35) Instruction plate for controlled temperature adjustment |
| (7) Relay plate | (22) Push switch | (36) Instruction plate for battery checker |
| (8) Main base plate | (23) Remaining V indicator | (37) Instruction plate for starter |
| (9) Feeler tube | (24) Recording paper | (38) Wiring diagram |
| (10) Nickel sensor | (25) Function: | (39) Function indication plate |
| (11) Hexagonal nut | Pilot lamp for functioning temperature | (40) Set plate for volume setter |
| (12) Ball chain | (26) Claw for record paper | |
| (13) Mounting bracket | (27) Set screw for recording board | |
| (14) Sensor lead wires | (28) Rock screw | |
| (15) Mounting bracket | (29) Temperature indication screw | |

b. Operation points

(1) Electronic controlling parts

① Temperature setting

Turn the setting knob (5) to set its red line at desired temperature, at which the compressor is stopped by the compressor switch. The other switches will come into operation depending on difference between temperature setting and sensor temperature in accordance with the functional characteristics of Article a.(1).

② Confirmation of switch function

When the power source for the unit is turned on, the switch will function in accordance with Article a.(1) . For confirmation of switch function, see the pilot lamp (25) (Function temperature indication lamp).

The pilot lamps are arranged in the order from the under, lamp for HEATER lamp for COMP for MANUAL and lamp for IN RANGE.

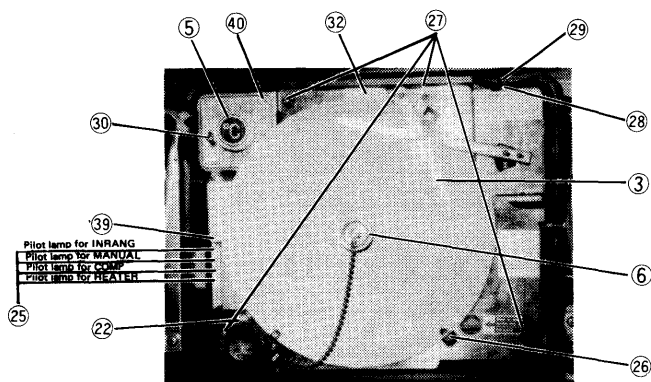
(2) Recording parts

① Removing the recording plate

(1) Turn the pen holding arm (3) by approximately 30° clockwise towards 5 O'clock by pressing it and release it, and the pen is suspended.

(The location of the arm is shown with dotted line in Fig. 2)

(2) Loosen four set screws (27) for recording board and the chart nuts (6), and remove the recording board to the A direction. The set screws (27) cannot be removed from the recording board to prevent them from being lost.



② Recording paper set

(1) Set the recording paper in the centre hole in such a way that it is inserted among three set claws (26), volume setting board (40) and the recording board. At this time, note that the periphery of the recording paper does not roll up.

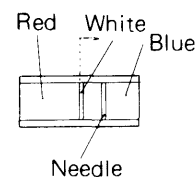
(2) Set a date on the recording paper (32) at the arrow mark on the present time plate. Firmly press the recording paper and tighten up the chart nut (6).

(3) Turn the pen holding arm (3) counterclockwise by pressing it. (The arm is located as shown with solid line in Fig. 2). At this time, confirm that the pen lifting arm is fixed.

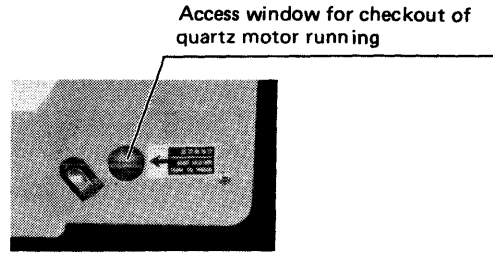
③ Driving part of recording paper

The recording paper is driven by the timer which is composed of a quartz motor and reducing gears. The quartz motor is driven by a dry battery.

(1) Checkout of remaining voltage of dry battery
Press down the push switch (22) to check life of a dry battery; i.e. check that the needle of the remaining voltage indicator is within blue zone. (The meter is functioning while the push button is pressed down)



- (2) Checkout of the quartz motor function
After having checked remaining voltage of the dry battery, check from the access window that flywheel inside is turning.



c. Inspection and adjusting method

(1) Electronic controlling part

① Inspection points

- (1) Set the temperature setting knob at 0°C (32°F) and put the unit into frozen operation.
- (2) Accomplish inspection after inside temperature becomes even after repeating compressor operation on and off more than three times.
- (3) When the compressor switch is turned off (Pilot lamp (25) goes off – see Article b.(2).②) or the solenoid valve is turned off, measure inside temperature with the thermistor and confirm that it is within 0 ± 1°C (32°F ± 2°F).
- (4) Confirmation of other switches
After having confirmed the compressor switch as stated in (3), operate the unit for a few minutes with its setting 0°C (32°F). When the compressor switch or the solenoid valve is turned off, confirm functioning temperature of each switch when the temperature setting knob (5) is turned by reading temperature indicated by the red line on the knob.
- (5) Confirm functioning temperature in the following order. Turn the temperature setting knob as stated below.
 - (a) Gradually raise temperature from -10°C (-14°F).
 - (b) Gradually decrease temperature from +10°C (+50°F).
- (6) Confirm that functioning temperature of each switch (by pilot lamp (25)) becomes as tabulated below by doing as stated in the above (a) and (b).

		Temperature setting														
		-7	-6	-5	-4	-3	-2	-1	0°F	1	2	3	4	5	6	7
Temp.																
Name		4	3	2	1	0°C	1	2	3	4	5	6	7			
(a)	COMP.			ON					OFF (0°C)			OFF				
	IN RANGE	OFF		ON (-2.5°C)			ON						OFF (3.6°C)			OFF
	HEATER					OFF					ON (1.5°C)				ON	
(b)	COMP.			ON			ON (-1.1°C)					OFF				
	IN RANGE	OFF	OFF (-3.6°C)				ON						ON (2.5°C)			OFF
	HEATER			OFF					OFF (0.4°C)				ON			

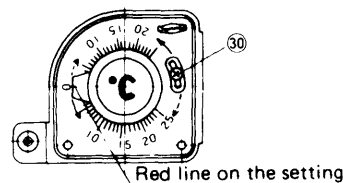
Notes:

1. Tolerance of switch function is $\pm 1^{\circ}\text{C}$ ($\pm 2^{\circ}\text{F}$) (Based on Comp. switch is turned OFF, and 0°C)
2. In case confirmation (b) is accomplished in succession of (a), wait until inside temperature becomes stable by operating the unit with inside temperature setting at 0°C (32°F), as inside temperature is raised in the process of confirmation (a).
3. For confirmation of function of the MANUAL switch and the fixed switch for HEATER, manipulate the temperature setting knob up and down when inside temperature is -10°C (14°F).
 - When the knob is pressed downward, the MANUAL switch and the switch for HEATER is turned OFF from ON at $-6.5 \pm 1^{\circ}\text{C}$ ($20 \pm 2^{\circ}\text{F}$).
 - When the knob is pressed up, the MANUAL switch and the switch for HEATER is turned ON from OFF at $-4.5 \pm 1^{\circ}\text{C}$ ($24 \pm 2^{\circ}\text{F}$)

② Adjusting method

If functioning temperature differs with temperature setting, adjust as stated below.

- (1) Set the setting knob at 0°C (32°F) and put the unit into frozen operation. After inside temperature becomes even, accurately measure inside temperature with the thermistor when the compressor switch or the solenoid valve is turned OFF.
- (2) Loosen the fine temperature control adjusting screw (30) and move the screw along the longitudinal hole as shown on the right, and then the red line on the setting knob moves accordingly. Set the red line at the temperature measured as in (1), and carefully tighten up the adjusting screw (30). (When the setting knob is tightened up, note it does not move) (Ex. When inside temperature setting is 0°C , if actual inside temperature is 0°C when the compressor switch (or the solenoid valve) is turned OFF, set the red line of the setting dial at 1°C .)
- (3) After completion of adjusting, inspect the unit in accordance with Article c.(1). ①



(2) Recording part

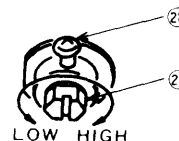
① Inspection points

Inspect the following recording part after having inspected and adjusted the electronic controller as stated in Article c.(1).

- (1) Set the knob to 0°C (32°F) and put the refrigeration unit into cooling. After confirming that the compressor was operated on and off several times since completion of pull down operation and that inside temperature became constant around 0°C (32°F), check whether temperature located by the pen is 0°C (32°F) when the switch or solenoid valve for compressor is turned off.

② Adjusting method

- (1) Accomplish adjustment in succession of the inspection described in Article c.(2). ①
- (2) Adjustment is accomplished by turning the temperature setting screw (29). Loosen the lock screw (28) and turn the setting screw (29) clockwise so that temperature setting is approximately under 5°C (41°F). Then, turn the setting screw (29) counterclockwise to reduce temperature indication of the pen to 0°C (32°F). Then, tighten up the lock screw (29) after adjustment.)



Notes:

1. A turn of the setting screw (29) changes temperature indication by approx. 5°C (9°F).
2. Temperature indication may be changed a little when the lock screw (28) is tightened up.

D. Replacement of parts

(Note: Replace parts after turning off the power source)

(1) Before replacing other parts, removing method of the internal device assembly is explained.

- (1) Remove the recording plate from the body (1) (See Article b. (2)●) When it is remove, it looks as shown in Fig. 3. In this state, sensor, timer, remaining voltage indicator and batter and dry battery are replaced.
- (2) Remove the internal device assembly. Loosen four hexagonal nuts (11) and screws (46) and remove the internal device assembly from the main body (1) and turn it back. Then it looks as shown in Fig. 4.

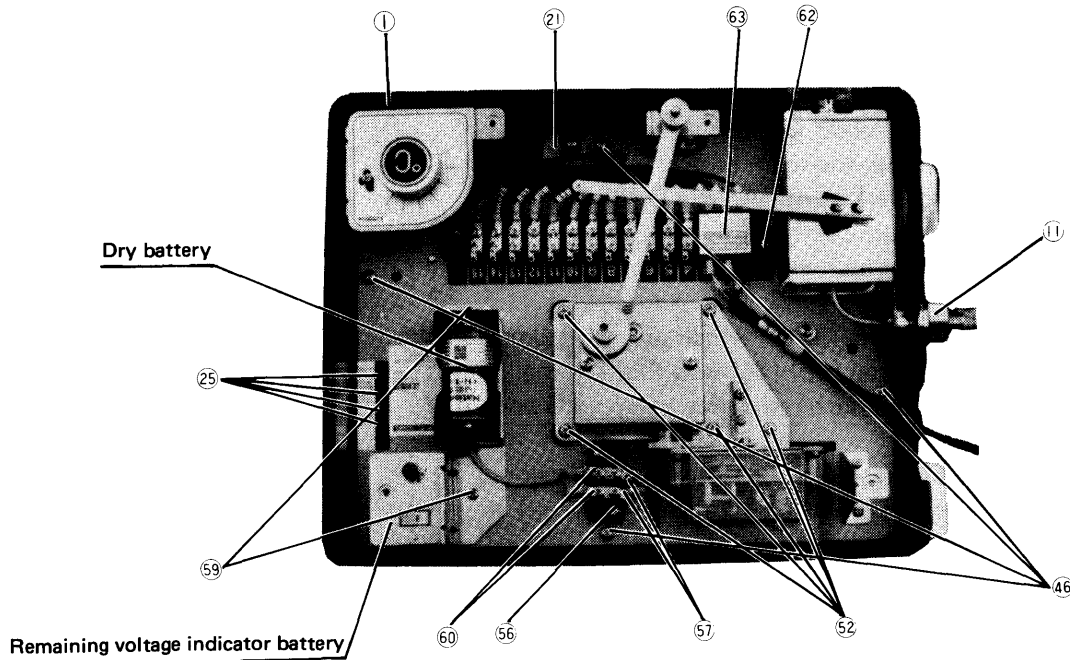


Fig. 3 Internal structure

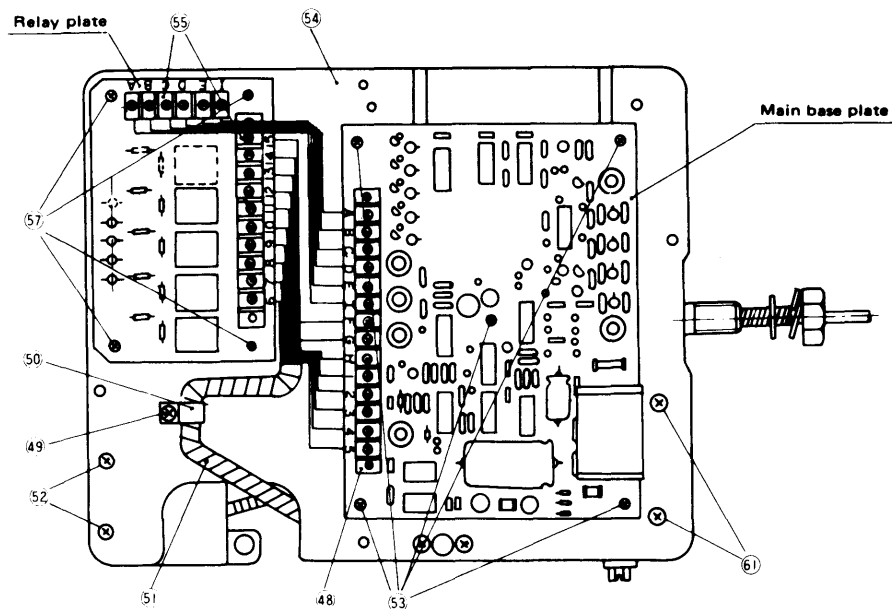


Fig. 4 Internal device assembly

(2) Electronic controlling parts

① Volume setter

(1) Replacing standards

- In case functioning volume of the compressor switch cannot be adjusted as stated in Article c. (1).②
- In case switches other than the compressor switch cannot be adjusted to function at the standard values.
- In case all the pilot lamps for functioning temperature do not light up although the power source switch is turned on. (If this phenomenon takes place, confirm the function of sensor in accordance with Article D.(2)④ and if no trouble is found with the sensor, apply this)
- In case switch function remains unchanged although setting of the volume setter is changed by the adjusting knob.

In the case of the above phenomena, measure resistance of the volume setter (in accordance with Article 2) and if it is out of the predesigned volume, replace the volume setter with a new one. If it is within the predesigned value, the main base plate must be out of order, so replace it in accordance with Article D,(3).②

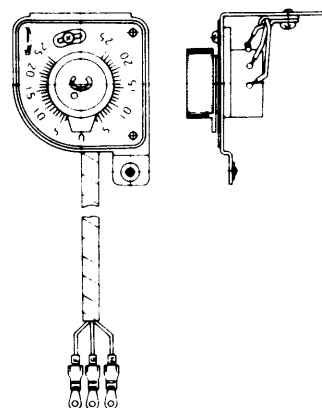


Fig. 5 Volume setter (WKM-AA005)

(2) Measuring resistance of the volume setter

- Adjust the volume setter as shown in Fig. 4 in accordance with Article D,(2).
- Remove the lead wires (3 pcs, F. G. H.) which are laid from the volume setter from the terminal (48) (14P) on the terminal strip of the main base plate and measure resistance between G and H of the lead wires.
- Confirm that resistance between G and H is within the values tabulated below at the predesigned temperature.

Temperature setting	Predesigned resistance
In case of -25°C	162 ~ 198 Ω
In case of 0°C	2250 ~ 2750 Ω
In case of 25°C	4132 ~ 5033 Ω

(3) Replacing points

- In case resistance is out of the predesigned value, replace the volume setter.
- From the state of the volume setter as shown in Fig. 4, loosen screw (49), remove power source plug (50), remove the spiral tube (51) from the wires. Then remove two screw bolts (52) and the volume setter can be removed from the base (54).
- After replacing the volume setter with a new one, inspect and adjust it in accordance with Articles c. (1).① and c. (1).②

② Main base plate

(1) Replacing standards

- In case the volume setter shows the phenomena as stated in Article D,(2). ● Replacing standards and yet it has no trouble or the same phenomena take place after replacing the volume setter.

(2) Replacing points

- Adjust the volume setter as shown in Fig. 4 in accordance with Article D,(1).
- Remove the wires (14 pcs Nos A ~ H, 1 ~ 5) from the terminal strip (48) on the main base plate.
- Remove 5 screws (53) to remove the base (54) from the main base plate, so replace it with new one.

After replacement, inspect and adjust it in accordance with Articles c. (1).● and c. (1).●

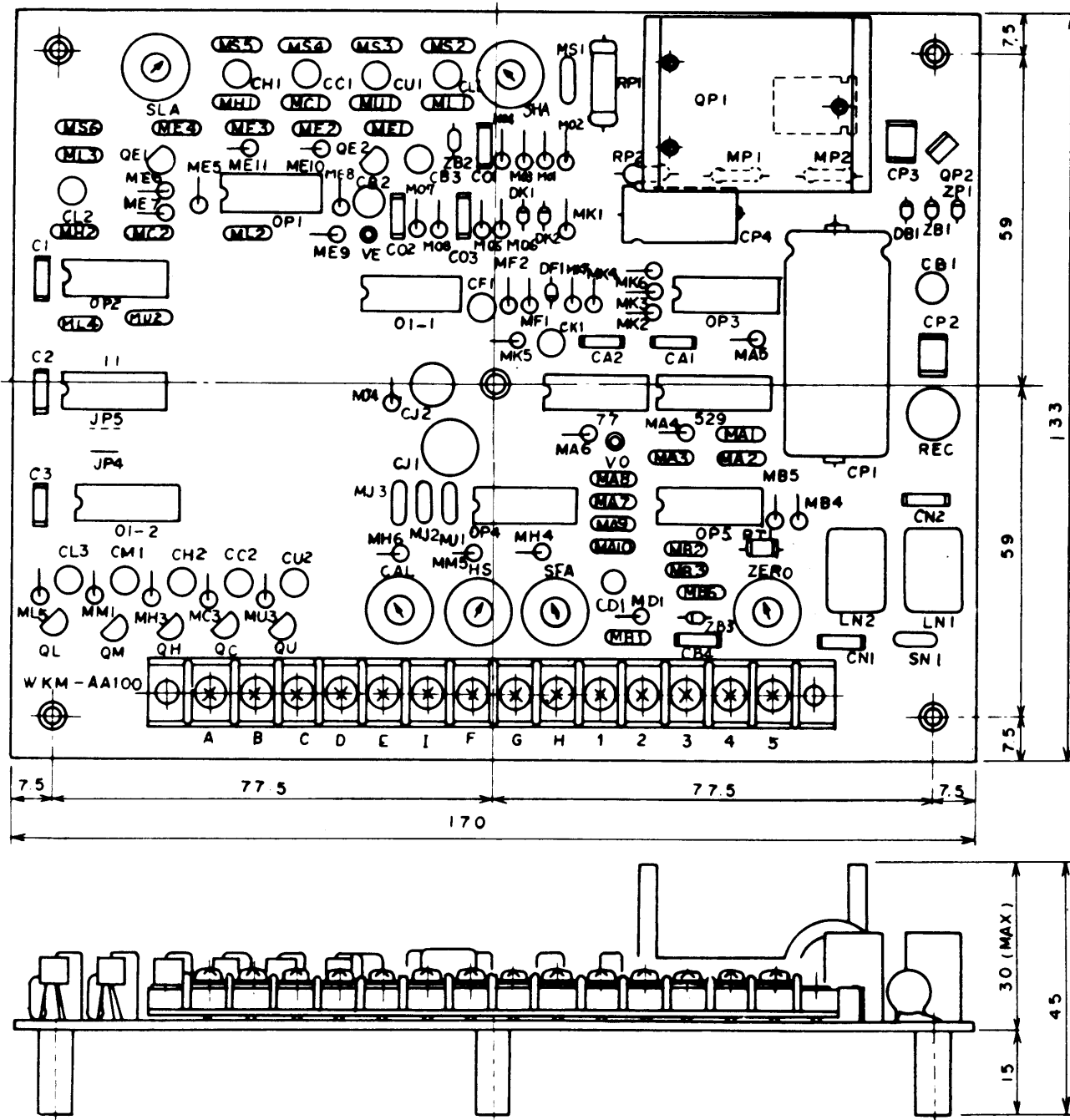


Fig. 6 Main base plate (WKM-AA100)

③ Relay base

(1) Replacing standards

- The pilot lamp for functioning temperature lights on and off, but the switch does not come into operation.

(2) Replacing points

- Adjust it as shown in Fig. 4 in accordance with Article D,(1).
- Remove the wires (14 pcs No. A ~ E, F ~ H, I, 1 ~ 5) from the terminal strip (55) on the relay base plate.
- Loosen four screws (57), and the relay base plate can be removed from the base (54). So replace the relay base plate with a new one.
- Check the pilot lamp and the switch for their functions after replacement.

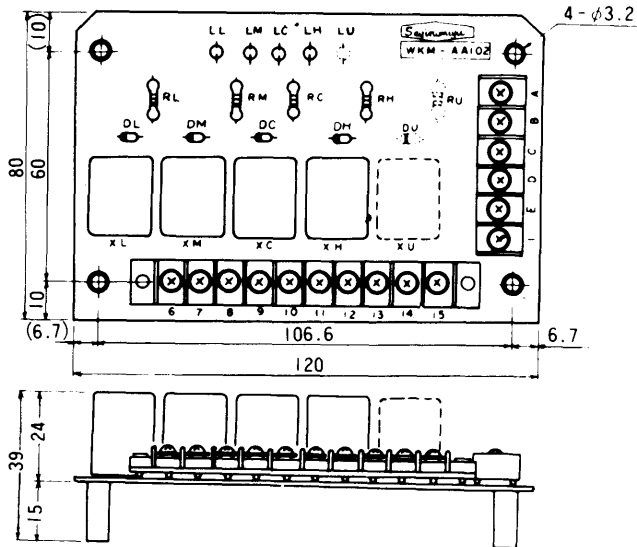


Fig. 7 Relay plate (WKM-AA102)

Note: Lay the wiring correctly in accordance with Fig. 8 when the main base plate and the relay plate are replaced.

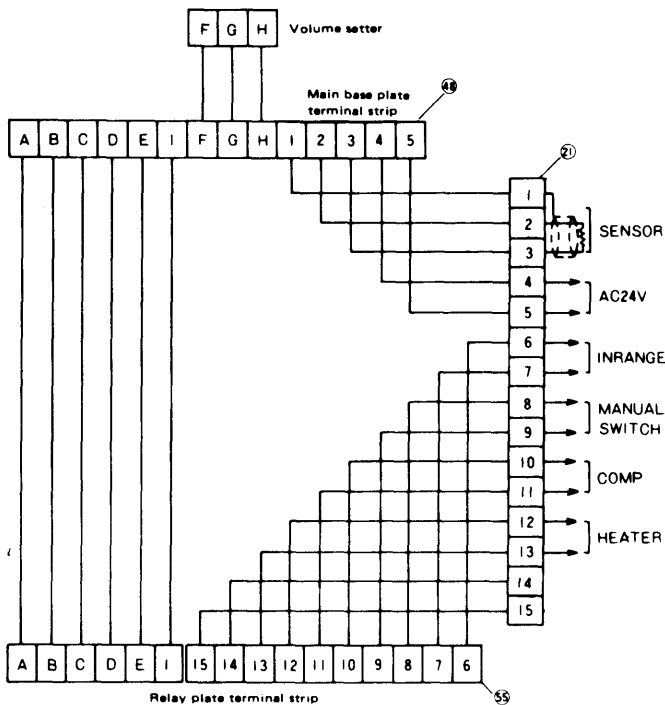


Fig. 8 Internal wiring diagram

④ Sensor

(1) Replacing standards

- In case the pilot lamps for functioning temperature (25) remain unlit although the power source is turned on.
- In this case, turn the temperature setting knob within $+25 \sim -25^{\circ}\text{C}$ and confirm that the pilot lamps light up. If one of the pilot lamps lights up, the sensor is correct. In case all the lamps remain unlit, measure resistance of the sensor as follows.
- Remove the recording board, (state shown in Fig. 3). Loosen the screws (62) to remove protection board for impressed voltage (63) loosen terminal screws (Nos. 1 to 3) on the terminal strip (21) and remove the wiring. Then, measure temperature of the feeler part and resistance of the sensor and compare them with the characteristics of temperature resistance shown in Fig. 10, and if they do not accord with them, replace the sensor. If they accord, the main base plate or the volume setter is out of order. So replace it in accordance with Articles D,(2).① and D,(2).②

(2) Replacing method

- Since numbers (1, 2, 3. . .) are described on the sensor lead wires, so connect them to the terminals having the same number on the terminal strip (21).
- After replacement, inspect and adjust the sensor in accordance with Articles C,(1).① and C,(1).②

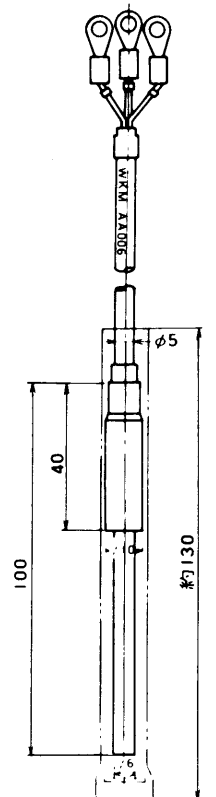
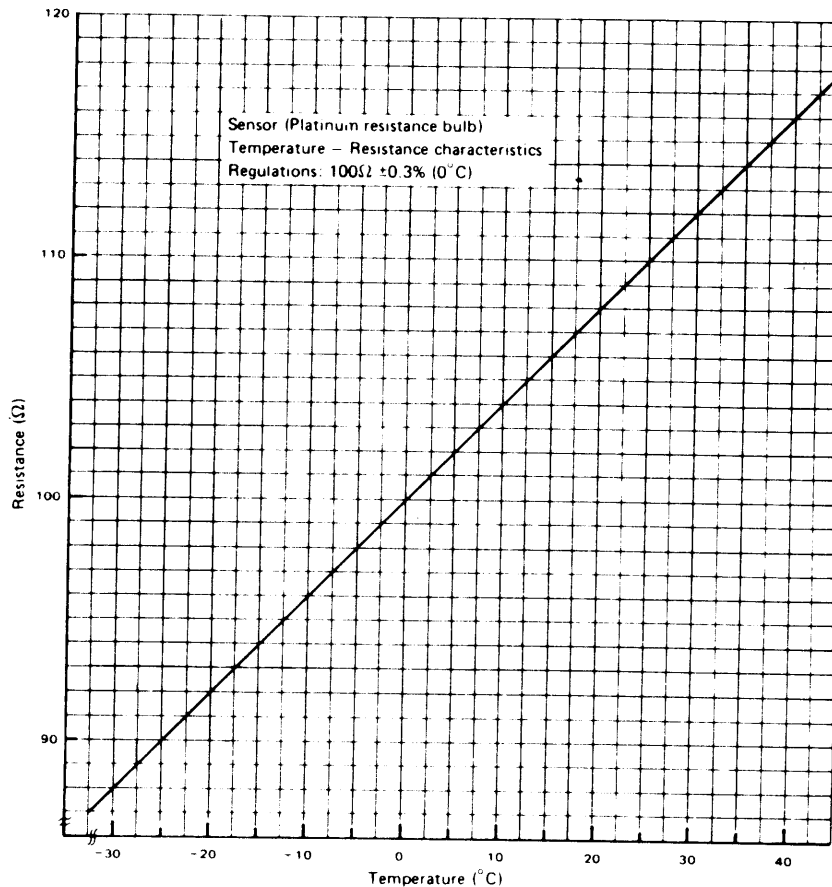


Fig. 9 Sensor (WKM-AA006)

Fig. 10

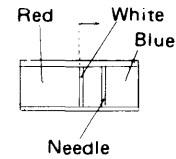


(3) Recording part

① Dry battery

(1) Replacing standards

- According to Articles b.(2). ㊦ confirm remaining voltage of a dry battery. If the needle of the indicator is out of the blue zone, replace the battery. (In case the indicator needle is within the white zone or above the dotted line in the figure on the right, life of battery may last approximately a month)



Remaining V indicator

(2) Replacing method

- Replace the recording board, and insert a battery so as not make a mistake in polarity as in the state of Fig. 3 (Fig. 3 shows polarity of a battery). It is advisable to use a battery similar to SUM-2 of JIS C8501 and R14 of IEC. (Dry battery DC1.5V)
- After replacement, confirm that the remaining voltage indicator is still within the blue zone and also confirm that the motor is running.

② Remaining voltage indicator battery

(1) Replacing standards

- 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.

(2) Replacing method

- Remove the recording board (state shown in Fig. 3). Loosen two screw bolts (59) and two screw bolts (60), and the remaining voltage indicator battery can be removed from the indicator body. So replace it with a new battery.
- When replacing, connect the wires to the terminal strip (56) in a way red wire to red and black wire to black.
- After replacing, insert a dry battery and then confirm that the needle of the remaining voltage indicator is within the blue zone and the quartz motor is running.

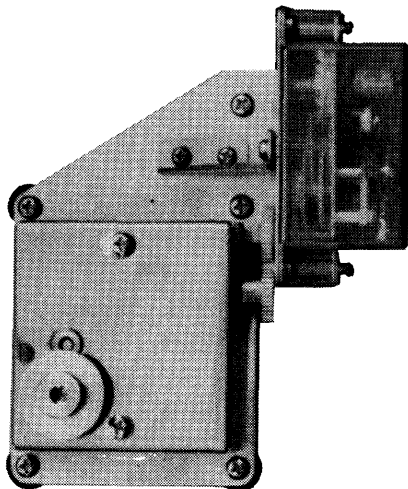
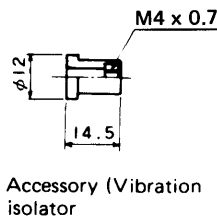


Fig. 12 Timer (Quartz motor reducing gears) (WKM-AA012)



Accessory (Vibration isolator)

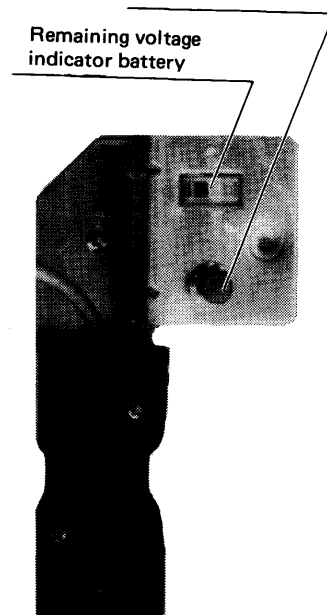


Fig. 11 Remaining voltage indicator - Battery (WKM-AA013)

③ Timer (Quartz motor reducing gears)

(1) Replacing standards

- Although remaining voltage of dry battery is correct (confirmed in accordance with Article b. (2). ③) the quartz motor does not start.
- In case time delay is over 3 hours per day.

(2) Replacing method

- Remove the recording board (state shown in Fig. 3). Loosen two screw bolts (57) from the terminal strip (56) to remove the wires. Then remove five screw bolts (58) to replace the timer with a new one.
- When replacing the timer, replace the attached vibration isolators (5 pcs) at the same time. The red wires are for + current and the black wires – current. Connect the wires to the terminal strip (56) in a way that red wires are connected to red and the black wires to black. Tightening torque for vibration rubber is 4 ~ 5 kg-cm.
- After replacement, confirm that the quartz motor is running.

④ Feeler tube – element

(1) Replacing standards

- After having adjusted the recording part in accordance with Article C.(2). ④, operate the unit with temperature setting within $-18 \sim +10^{\circ}\text{C}$ ($-0.4 \sim 50^{\circ}\text{F}$). If temperature indication differs from temperature setting by over 2°C (4°F) although inside temperature becomes stable to its temperature setting. (In case temperature indication is minus far from feeler tube temperature, gas may leak from the feeler tube)

(2) Replacing method

- Take out the internal assembly as stated in Article D,(1) and turn it inside out, which is shown in Fig. 4.
- Loosen two screw bolts (61) to remove the feeler tube – element and replace it with new one.
- After replacement, inspect and adjust it in accordance with Article C. (2)

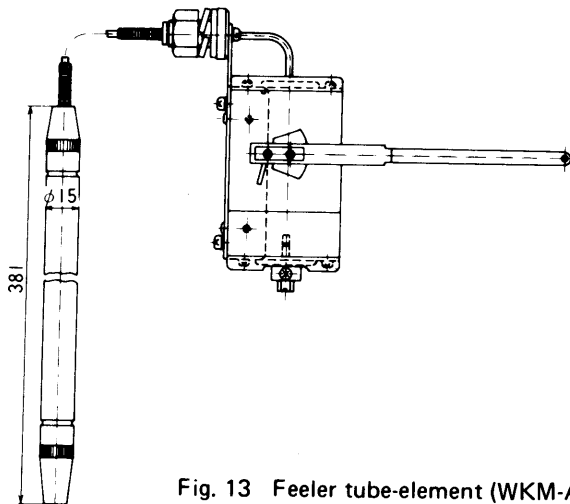


Fig. 13 Feeler tube-element (WKM-AA011)

E. Caution for handling

- (1) Be careful not to pull the sensor lead wires and capillary tube forcibly.
- (2) Do not bend the capillary tube with less than R50.
- (3) Do not give any impact to the sensing part of the sensor.
- (4) Do not give torque larger than 5 kg-cm onto the temperature setting knob.
- (5) Insulation test should be done with numbers from 4 to 15 on the terminal strip (21) (Fig. 3) Do not impress voltage on the sensor terminals of 1, 2 and 3.
- (6) After having replaced a recording paper, check that the pen holding arm is fixed (as shown with (3) located on the solid line on Fig. 1)
- (7) At the time of ex-factory, protection tube covers sensor as shown in Fig. 9 with dotted line to protect impact force.
Remove the protection tube in operation, otherwise the unit does not control container temperature accurately.

F. Trouble and countermeasures

If the unit is out of order, trace a cause of trouble and take appropriate countermeasures.

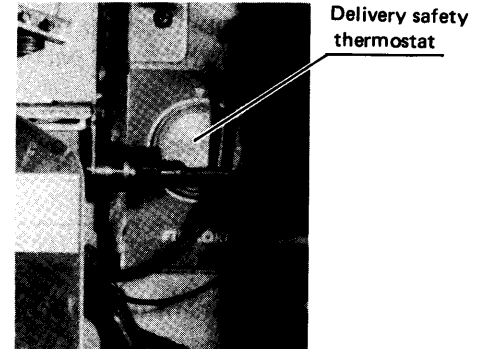
State of trouble	Phenomenon	Cause of trouble (Proceed with from top to bottom)	Inspection	Countermeasures
1. Unit is inoperative	Pilot lamps for switches remain unit.	Power source (AC 24V) is not input.	Inspect power source.	
		Inside temperature is already dropped to its temperature setting.	Turn temperature setting knob within $-25 \sim +25^{\circ}\text{C}$	If lamps and relay function, there is no trouble with unit.
		Sensor is disconnected or short-circuited.	Measure resistance of sensor.	Replace volume setter.
		Trouble with volume setter.	Measure resistance of volume setter.	Replace volume setter.
		Trouble with main base plate.		Replace main base plate.
	Pilot lamps for switches light up (For comp.)	Trouble with relay palte.		Replace relay plate.
2. Relay functioning temperature incorrect	Functioning point of compressor switch cannot be adjusted or if it can be adjusted, functioning points of other switches get out of their standards.	Trouble with volume setter.	Measure resistance of volume setter.	Replace volume setter.
		Trouble with main base plate.		Replace main base plate.
3. Record paper does not rotates	Quartz motor is in operation.	Chart nut is not tightened up.		Tighten up chart nut.
	Quartz motor stops.	Dry battery is used up.	Check dry battery for remaining voltage.	Replace dry battery.
		Trouble with timer.		Replace timer.
4. Remaining voltage indicator is faulty	<ul style="list-style-type: none"> ●When push switch is pressed down, oscillation of indication needle is unstable. ●Although new battery is mounted indication needle is within white or red zone. 	Trouble with remaining voltage indicator.		Replace remaining voltage indicator.
5. Time delay in recording paper	Time is delayed over 3 hours per day.	Trouble with timer.		Replace timer.
6. Recording temperature is wrong	Although recording temperature is adjusted at 0°C , indication temperature is wrong when rechecking.	Trouble with feeler tube-element.		Replace feeler tube – element.

4.3.2 Delivery safety thermostat

Delivery safety thermostat is installed inside of control box. When the discharge air temperature is desired to be held above -3°C according to the kind of cargo, turn on the capacity control switch (3C). Then, the discharge air thermostat ($23A_2$) senses the discharge air temperature thereby causes the compressor to turn on and off. When discharging air temperature reaches -3°C , discharge air thermostat functions to pump down the compressor until it stops. This prevents over-cooling of discharge air temperature.

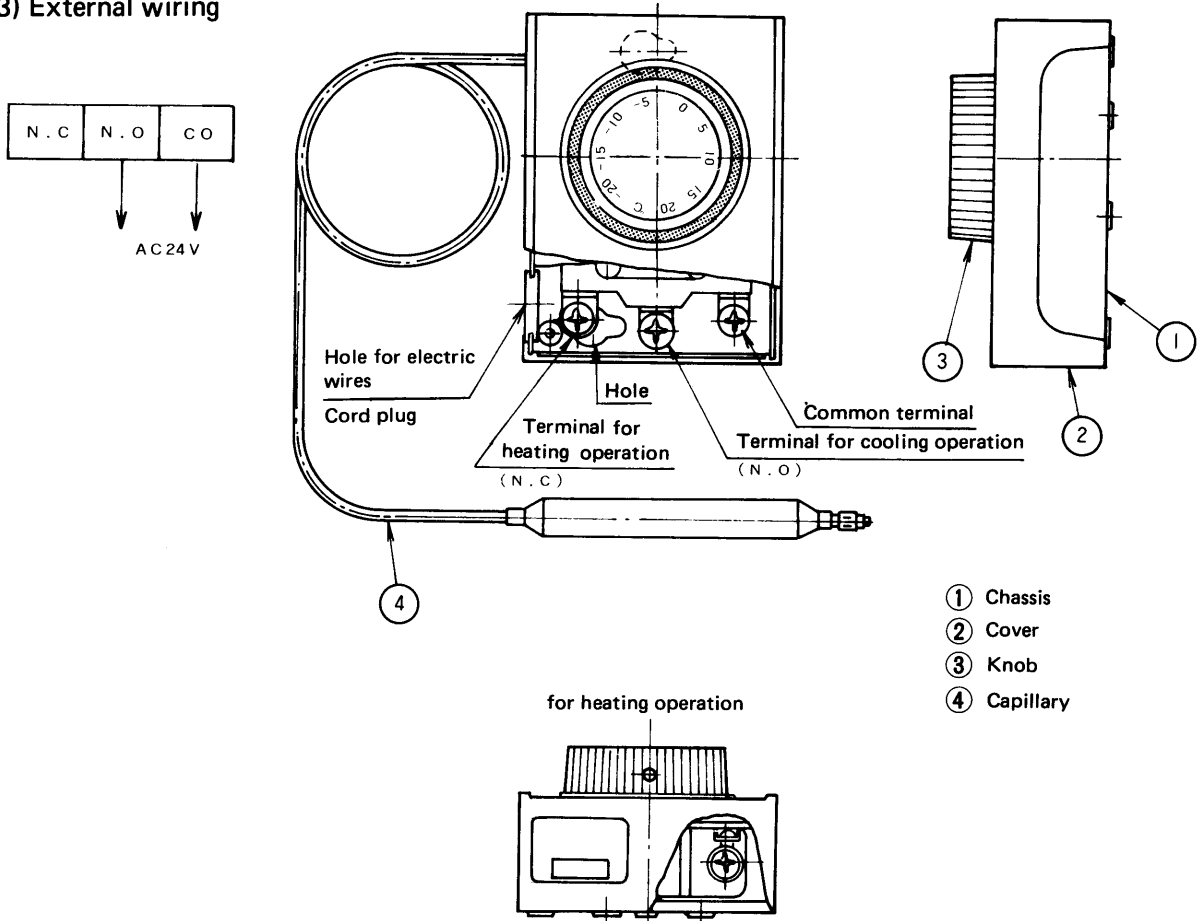
- 1) Model E-IDM-4
- 2) Switch functional chart

Temp.	32° F					
	-3	-2	-1	0 °C	1	2
Switch	(OFF) ←					
-3 °C	(ON) →					



Note: Never manipulate the setting of $23A_2$, which has been precisely adjusted at our factory before shipment.

3) External wiring

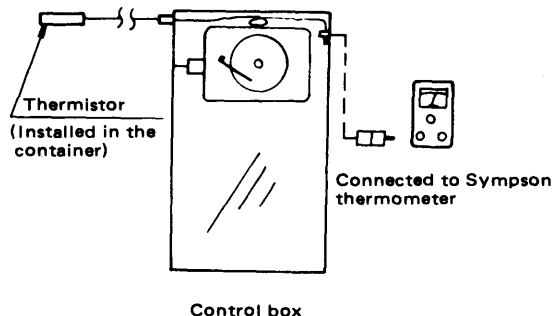


- 4) Insulation resistance
- 5) Insulation strength

50MΩ or more with DC 500V megger
for 1 minute with AC 500V

4. 3. 3 Thermistor for inside temperature

Two thermistors are installed for measuring inside temperature. One of their feeler parts is attached to the feeler tube of the recording temperature controller so that temperature of the same position can be detected. The other is attached to the feeler tube of the delivery safety thermostat. The other ends of the thermistors from connectors which are located above the control box as shown on the right. 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: 1) Adjustment of Simpson thermometer

Turn the adjusting screw so that the meter indicator points as 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).

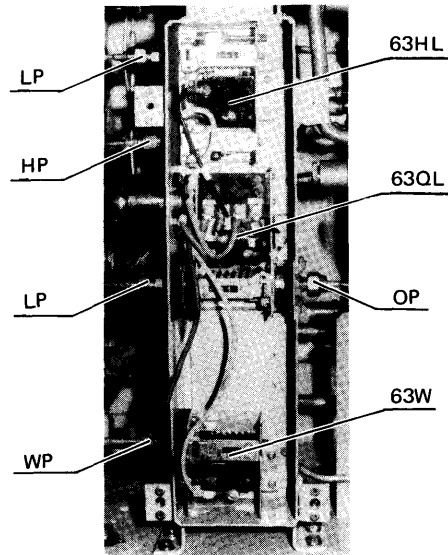
2) In case Simpson thermometer is not available

A thermister insertion hole is attached to center of the upper casing, so that a thermometer can be inserted in it to measure inside temperature.

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 clogged or the solenoid valves are closed. In these cases, the switch stops compressor.



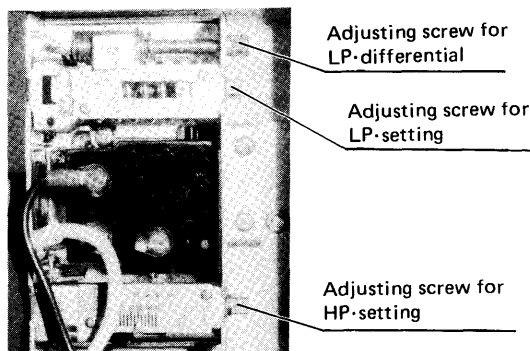
LP : Low pressure
 HP : High pressure
 OP : Oil pressure
 WP : Water pressure

(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.

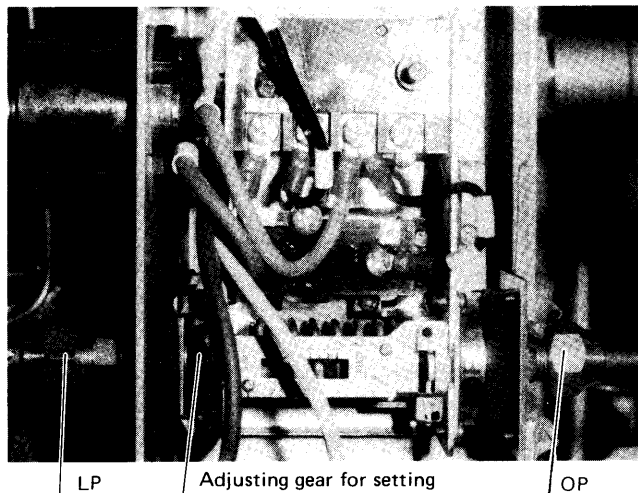


- Notes:**
- 1) If it is necessary to adjust the adjusting screw for differential, be sure to adjust pressure setting first and then adjust differential.
 - 2) After adjusting the adjusting screw, apply chemical to the bolt head to prevent the bolt from being loosened vibration.

4.4.2 Oil pressure protection switch (63QL)

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

This stops the compressor automatically when oil pressure continuously remains low, because the compressor may be burnt because of oil shortage.

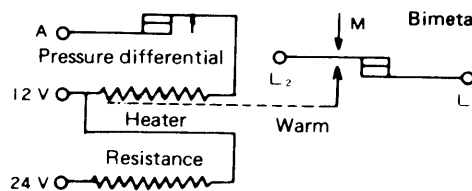


(a) Operation

The oil pressure (pressure difference) normally rises when the compressor has started. If the pressure does not rise, power will be supplied to the heater of a timer and a bimetal operate after a preset interval, thereby stopping the compressor will stop.

Note: Timing device is affected by ambient temperature and its set period differs with ambient temperature. (Standard temperature 25°C)

Ambient temperature	Set period
Higher	Shorter
Lower	Longer



Electric wiring in oil pressure protection switch

(b) Resetting

If 63QL has operated, depress the reset button several minutes after when the compressor stops. (The button will not be reset unless the bimetal is cold.)

(c) Adjustment method

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

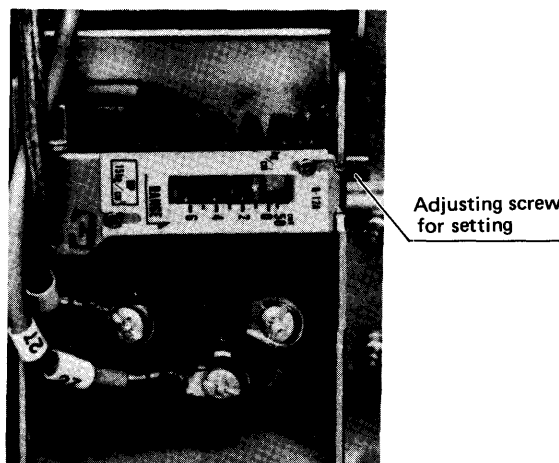
Adjusting points for oil pressure protection switch

Adjusting gear	Turning direction		Function
Adjusting gear for settings	Clockwise		Functional pressure (differential) becomes low and heater circuit is disconnected with low pressure difference.
	Counter-clockwise		Functional pressure (differential) becomes high and heater circuit is disconnected 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 the chemical to the bolt head to prevent it from being loosened due to operation vibration.

4.4.4 Defrost termination thermostat (23D)

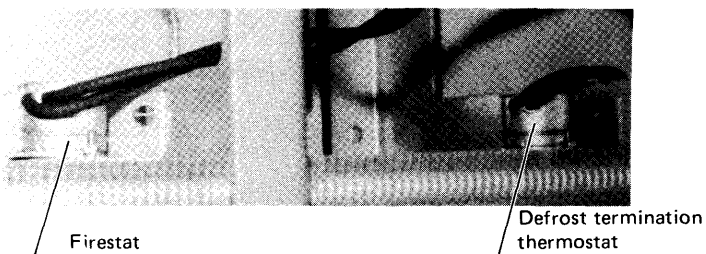
This senses ambient temperature around the thermostat and will terminate defrosting.

OFF: 7.2°C
ON : 1.7°C

4.4.5 Firestat (26AH)

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

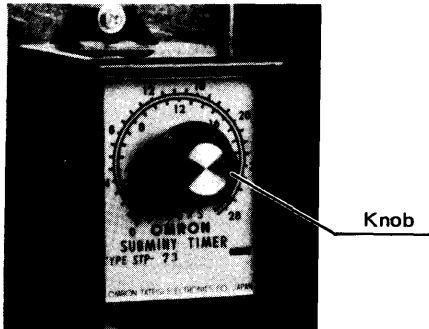
OFF: 71°C
ON : 49°C



4.4.6 Defrost timer (2D_{1,2})

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

- Adjustable range : 1~24 hours (60 Hz), 1~28½ hours (50 Hz).
- Once power has been turned off, the timer is reset to the initial state.



4.4.7 Electric heaters

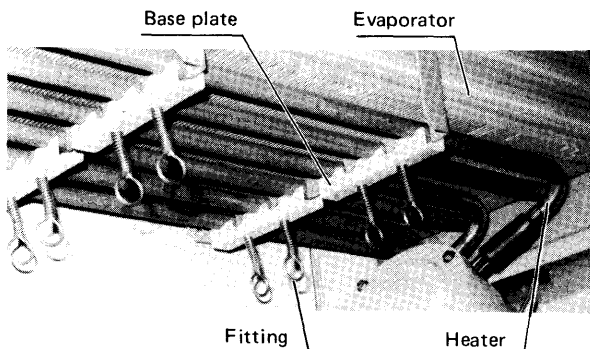
Two kinds of electric heaters are used.

(a) Sheathed heaters (220V AC, 0.65 kW x 6)

These are fitted at the bottom of the evaporator.

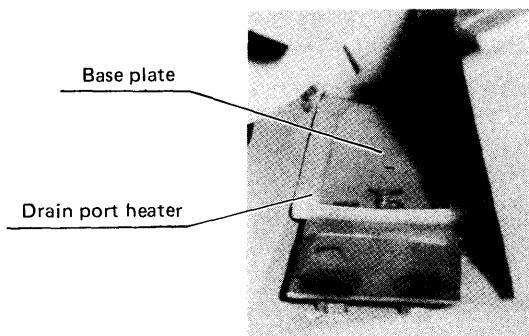
H₁ through H₆ are used for defrosting and heating

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



(b) Molded heaters (220V AC, 12W x 2)

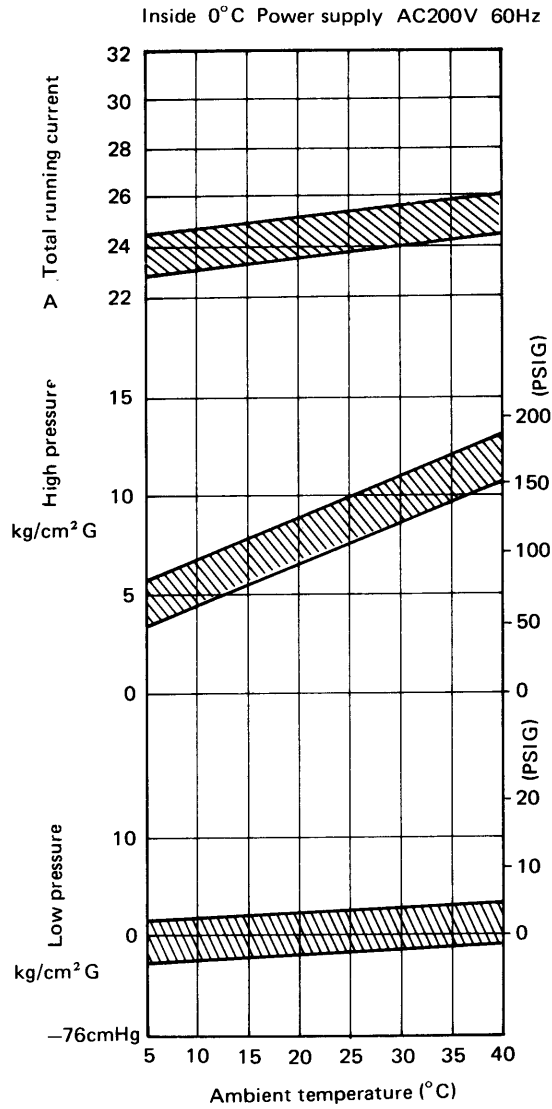
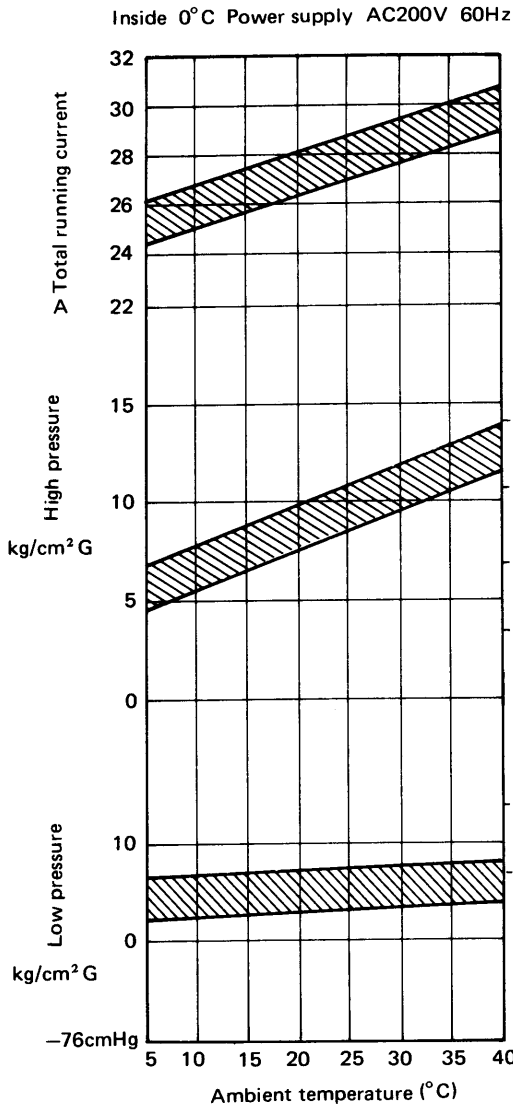
These are fitted at the left and right of the drain pan to prevent the drain port from freezing (H₇ and H₈).



5. Set values of functional parts

Part name		Function	Set value
Oil pressure protection switch ONS-C106Q	63QL	Heater circuit OFF ON Timer	1.0kg/cm ² 0.5kg/cm ² 110 seconds (ambient temperature 25°C) More than 5 seconds (ambient temperature 70°C)
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
Firestat KLIXON 20420L/L160-4	26AH	OFF ON	71°C (160°F) 49°C (120°F)
Defrost termination thermostat KLIXON 20420L/L45-1	23D	OFF ON	7.2°C (45°F) 1.67°C (35°F)
Defrost timer (short cycle)	2D ₁	ON	2 h (60 Hz) 2 $\frac{2}{5}$ (50Hz)
Defrost timer (long cycle) STP-73	2D ₂	ON	18h (60Hz) 21 $\frac{3}{5}$ (50Hz)
Overcurrent relay CR-20-NP ₂ S ₄	0C	OFF	10A
Circuit breaker (main circuit) MK-53	51C ₁	OFF	50A
Circuit breaker (control circuit) CP31	51C ₂	OFF	7A
Thermal protector (fan motor) KLIXON 9700L-01-11 (cond. fan motor) 9700K-01-11 (evap. fan motor)		OFF	120°C (248°F)
Thermal protector (comp. motor) KLIXON 7895		OFF	105°C (221°F)

6. Operating pressure and running current



< For reference >

	Item	Unit	Value
1	Heater current – during defrosting Measure at primary side of 88H ₂	A	16.0 (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	kg·cm/lb·ft	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		70±7/5.0±0.5
	Solenoid valve		75±5/5.4±0.4
	Expansion valve		140±10/10.1±0.7
	Dryer		70±7/5.0±0.5
	Bolt tightening torque		

7. 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. Cooling operation inoperative	A: Condenser evaporator fans and compressor are inoperative.	a. No trouble with unit	<ul style="list-style-type: none"> ● Current interruption ● Power source is disconnected. 	<ul style="list-style-type: none"> ● Trace cause ● Connect power source plug to power source. 	
		b. Circuit breaker functions (main circuit)	<ul style="list-style-type: none"> ● It functions due to over current. 	<ul style="list-style-type: none"> ● Trace causes and replace. 	
		c. Circuit breaker function (control circuit)	<ul style="list-style-type: none"> ● It functions due to over current. 	<ul style="list-style-type: none"> ● Trace causes and replace. 	
	B: Evaporator fans operative but condenser fans and compressor inoperative.	a. No trouble with unit	<ul style="list-style-type: none"> ● Thermostat functions and stops operation. ● Temperature setting is high. 	<ul style="list-style-type: none"> ● Trace causes and replace. 	<ul style="list-style-type: none"> ● Readjust temp. setting as designed.
		b. Oil pressure control	<ul style="list-style-type: none"> ● It is not reset yet. 	<ul style="list-style-type: none"> ● Trace causes and replace. 	<ul style="list-style-type: none"> ● Repair trouble and push down reset button.
		c. Solenoid valve does not function.	<ul style="list-style-type: none"> ● Coil is cut out. 	<ul style="list-style-type: none"> ● Trace causes and replace. 	<ul style="list-style-type: none"> ● Replace it.
		d. Malfunction of recording temperature controller.	<ul style="list-style-type: none"> ● Damage of capillary tube or mercury leaks out. 	<ul style="list-style-type: none"> ● Trace causes and replace. 	<ul style="list-style-type: none"> ● Replace it.
	II. Cooling operation stops soon	A: Condenser fans and compressor stop, keeping evaporator fans in operation.	a. Oil pressure protection switch is functioning.	<ul style="list-style-type: none"> ● Oil pressure will not rise. ● Oil is short or oil pump is out of order. 	<ul style="list-style-type: none"> ● Additional oil charge, or repair oil pump.
			b. No trouble with unit	<ul style="list-style-type: none"> ● Thermostat functions and stops unit 	<ul style="list-style-type: none"> ● Trace causes and replace.
		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.	<ul style="list-style-type: none"> ● Discharge refrigerant.
● Air in system				<ul style="list-style-type: none"> ● Air purge 	
● Insufficient air flow for air cooled operation.				<ul style="list-style-type: none"> ● Clean or remove obstacles. 	
● Condenser or passage clogged.				<ul style="list-style-type: none"> ● Clean or remove obstacles. 	
● Fan blade damaged.				<ul style="list-style-type: none"> ● Repair or replace. 	
● Fan motor does not rotate.				<ul style="list-style-type: none"> ● Repair or replace. 	
Capacitor inoperative.				<ul style="list-style-type: none"> ● Replace it. 	
Fan motor thermostat has functioned.				<ul style="list-style-type: none"> ● Trace causes. 	
● Lower pressure side	Insufficient water volume for cooling operation.	<ul style="list-style-type: none"> ● Condenser is clogged with scale. 	<ul style="list-style-type: none"> ● Additional charge, seek leaking positions and repair. 		
	Insufficient refrigerant charge	<ul style="list-style-type: none"> ● Additional charge, seek leaking positions and repair. 			
	Dryer clogging	<ul style="list-style-type: none"> ● Replace 			
	Moisture chokes.	<ul style="list-style-type: none"> ● Exchange dryer. 			
b. Over-current relay or compressor protection thermostat has functioned.	Gas leakage from feeler tube of expansions valve.	<ul style="list-style-type: none"> ● Exchange it. 			
	Excessive large current due to over-load operation.	<ul style="list-style-type: none"> ● Trace causes. 			

State	Phenomena	Functioning places	Cause	Countermeasures
III. Storage temp. is lower than temperature setting	A: Compressor inoperative.	a. Solenoid valve will not close.	Cloged with dust.	Replace it.
		b. Thermostat does not function.	Capillary gas shortage	Replace it.
		c. Wrong installation of feeler tube.	Wrong installation of feeler tube.	Reattach it.
IV. Water cooled operation inoperative	A: Fans run continuously after water joints have been connected.	a. Water pressure switch does not function.	Insufficient cooling water volume (clogging or leakage of piping system).	Trace causes.
			Water leakage from water piping to switch.	Repair leaking point.
V. Heating	A: Heater is inoperative.	a. No trouble with unit	Temp. setting of thermostat is lower than -6.7°C (20°F) Heating is not required, as load is small.	
		b. Firestat	Insufficient evaporator air volume	
VI. Defrosting operation	A: Defrosting and refrigerating operation are repeated in a short period of time.	a. Defrost timer makes an error.	Improper adjustment	Readjustment

8. 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

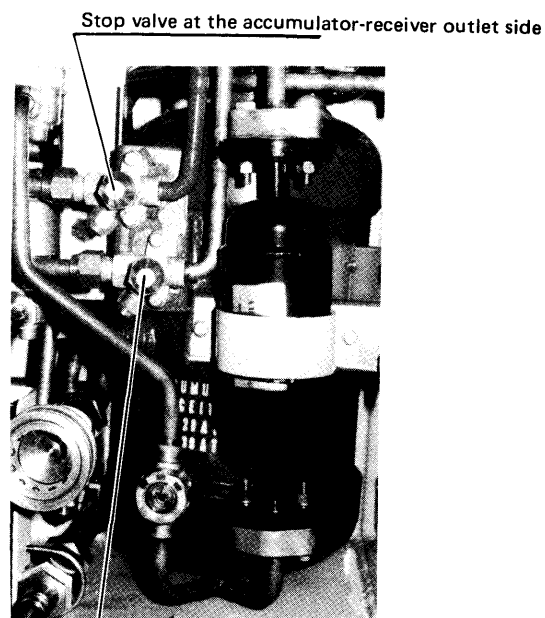
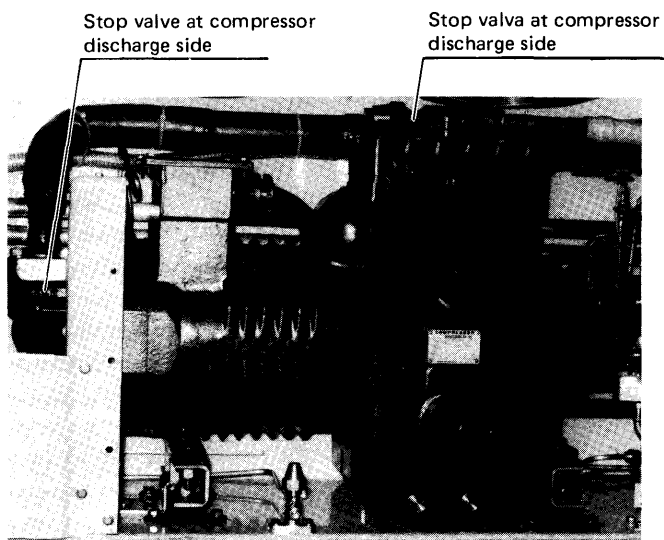
Installed ship name		Date of Inspection			
Container No.		Place of Inspection			
Loaded cargo		Loaded or none			
Customer's staff		Unit Model No.			
Service staff		Unit No.			
		Compressor No.			
Check	No.	Check point	Check method	Reference value	
Check before operation	1	External appearance of important 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 firestat	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 protection switch	CUT OUT <input type="checkbox"/> kg/cm ² CUT IN <input type="checkbox"/> kg/cm ²	Tension gauge Timer	1.0 kg/cm ² 110 seconds 0.5 kg/cm ² (25°C)	
18	Supply voltage		Check line voltage at primary side of circuit breaker	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	Visual, Pilot lamps		
	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 termination thermostat (Completing temperature) <input type="checkbox"/> °C		Mount thermistor to termination thermostat mounting position	OFF 7.2±1.7°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	Checking operation of dual pressure switch	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 operation of water pressure switch	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 power supply changeover switch	Checking 400V class operation	Place changeover switch lever upward		
			Checking 200V class operation	Place changeover switch lever downward		
	32	Storage 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"/>						
Check after operation	33	Checking automatic defrosting	Defrost time <input type="text"/> M			
	34	Place new chart				
	35	Close caps for control box and PS box, etc.				
	36	Write down details of service on history cards				

9. How to maintenance

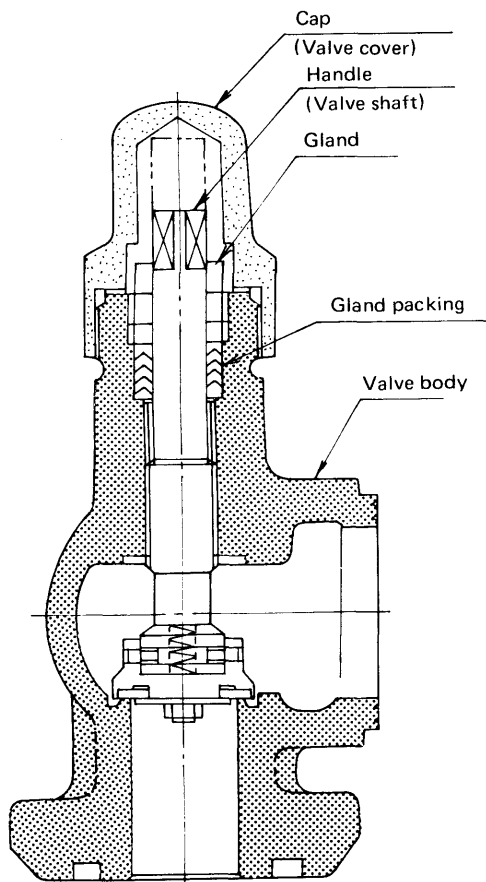
9.1 Handling method of the stop valve

(1) Place of the stop valve and its kind

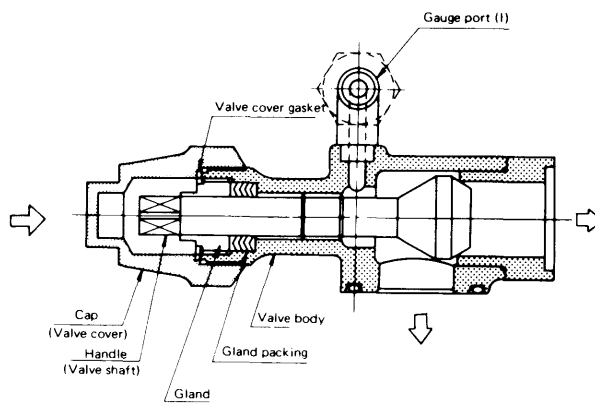


(2) Structure of stop valve

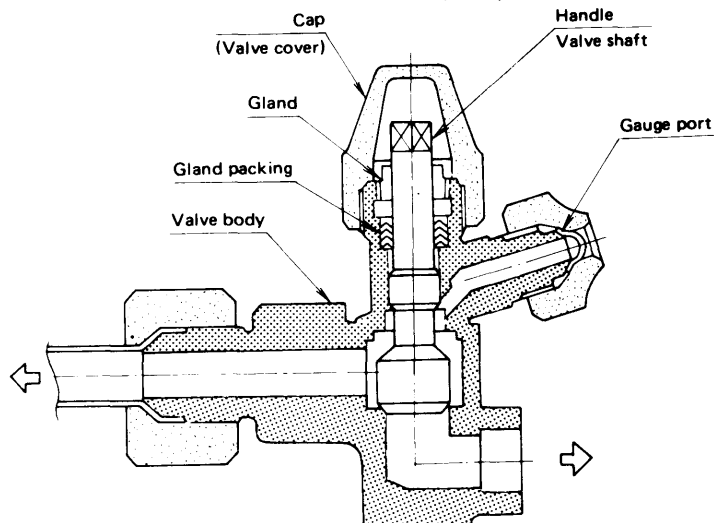
- 1 Stop valve at compressor suction side (VSL25E)



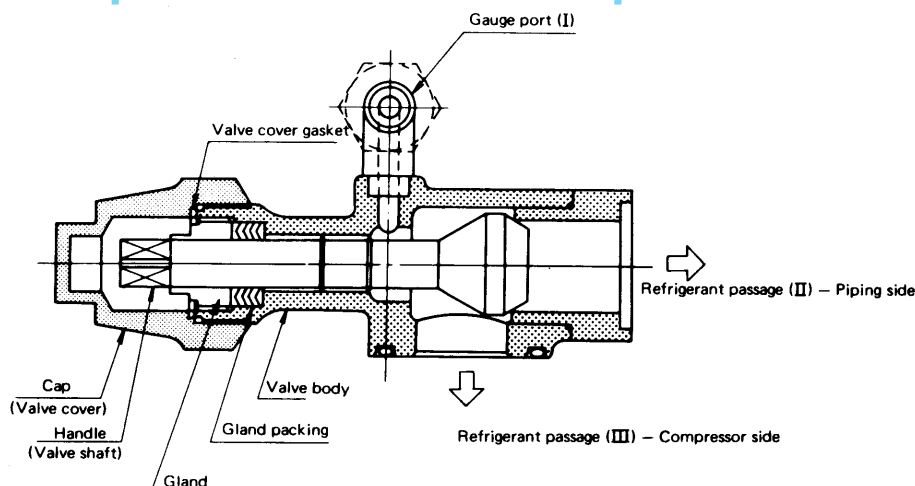
- 2 Stop valve at compressor discharge side (VSH22XBP)



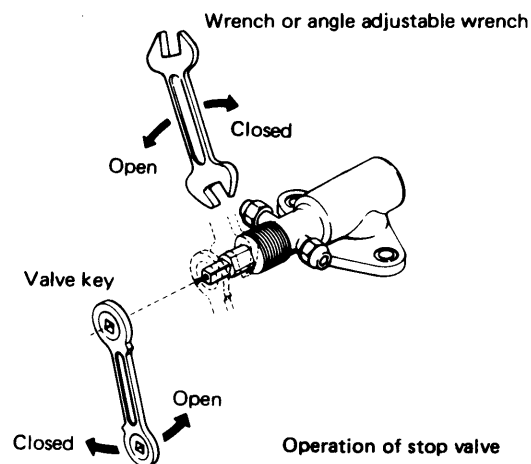
- 3 Stop valve at accumulator-receiver with heat exchanger outlet side
Stop valve at hot gas bypass (VSV10CBP-4S-4F)



(3) Handling method



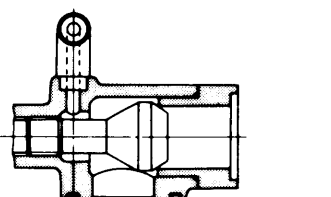
- 1) Remove the valve cap. At this time, be careful not to lose the gasket.
- 2) Loosen the gland in a way the refrigerant is not extracted.
- 3) Fully close the handleThe refrigerant passage I is connected to III (Front seat)
- 4) Fully release the handleThe refrigerant passage II is connected to III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



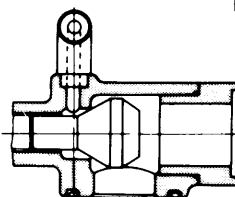
9.2 Attaching or removing points of pressure gauge

(1) Attaching a general pressure gauge

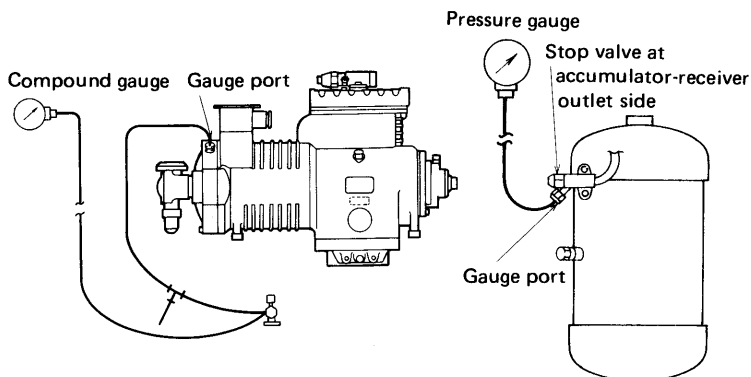
- 1) After opening the compressor suction valve and the accumulator-receiver valve fully (back seat), connect a pipe to the gauge port.
- 2) Loosen a little the flare nut on the pressure gauge side and tighten the handle of the stop valve a little (Middle seat) and return it at once. Thus the air is 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.



Front seat

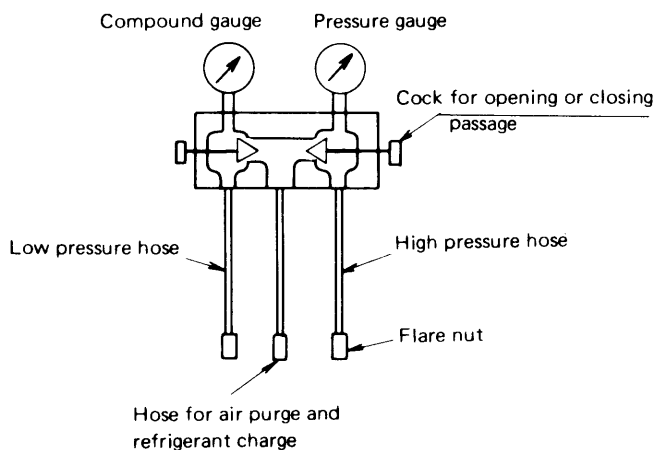


Back seat

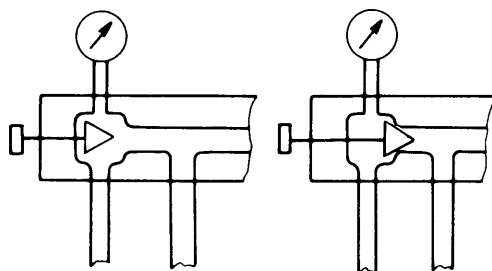


(2) Attaching the gauge manifold

- 1) With regard to mounting points, note the same caution as that for general pressure gauges.
- 2) Open the cocks which are attached to the both sides of the gauge manifold when mounting. Loosen the blind cover of the centre hose, and close the gauge port for the compressor suction valve and the accumulator-receiver outlet valve. (Back seat)
- 3) Attach the flare nut of the hose of the manifold on the high pressure side tightly and 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.



Structure of gauge manifold



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 loose it.

9.3 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.

Stop valve at the accumulator-receiver outlet side



9.4 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 heat

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

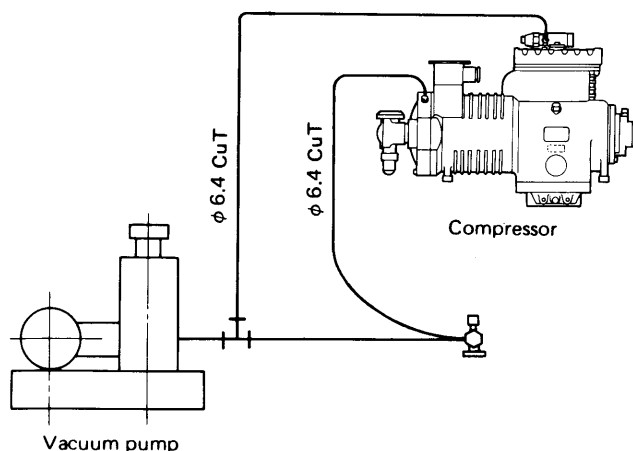
- 3) Do not extract the refrigerant in a closed room and also confirm there is no fire around it. Although the refrigerant is non-toxic, there may be fear of suffocation. In addition, if the refrigerant contacts with fire, it yields phosgene gas (toxic gas).

(3) Vacuum drying and charging refrigerant and refrigeration oil

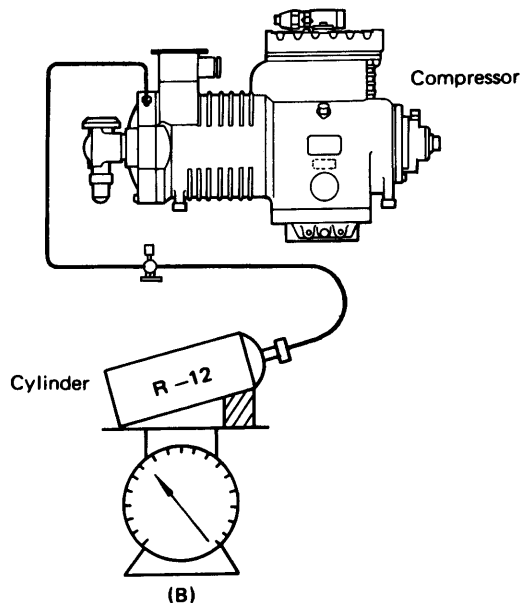
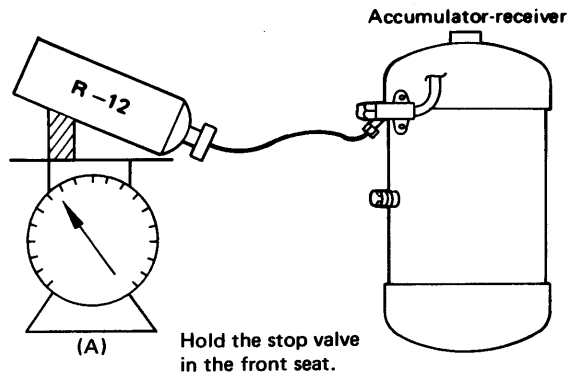
If all the refrigerant has leaked out and the air is intermixed in the refrigeration circuit, repair a cause of trouble and do vacuum drying. Then charge the predesigned volume of refrigerant. In case the refrigerant oil is replaced, do the same.

(Required tools)

1. Refrigerant cylinder (20 kg) for R-12 (CCl_2F_2) with mouth piece
 2. Refrigeration oil (20ℓ can) SUNISO 3GS-D1)
 3. $\phi 6.4$ CuT (with two flare nuts)
 4. Pressure gauge (20 kg/cm^2), compound gauge ($10 \text{ kg/cm}^2 \times 75 \text{ cmHg}$) } 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).



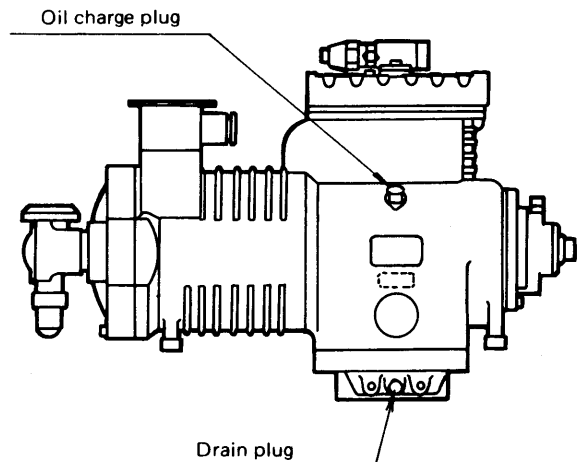
- 2) To evacuate the refrigeration circuit between the solenoid valve and expansion valve, reduce pressure of the circuit below the preset level of the low pressure switch lower the presetting level of the set point selector, operate the refrigeration unit, and open the solenoid valve for evacuation. 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 accume-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.

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