REVISED

DAIKIN

Marine type Container Refrigeration Unit

Service manual

Model

LKEN5BD17

DAIKIN INDUSTRIES LTD

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 recorder and life of the battery when the chart paper is replaced with a new one.

2 . Accurately tighten the covers for the control box not to make water leak in.

3 . Confirm that the stop valves in the refrigeration circuits are opened before operation.

4 . Be sure to check whether the cargos are cooled down to the temperature for transportation.

5 . After operating the container refrigeration unit for service, wash the unit with fresh water, especialy the external section of the unit carefully, because much salt sticks on the unit.

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1. Specification

1.1 General specification

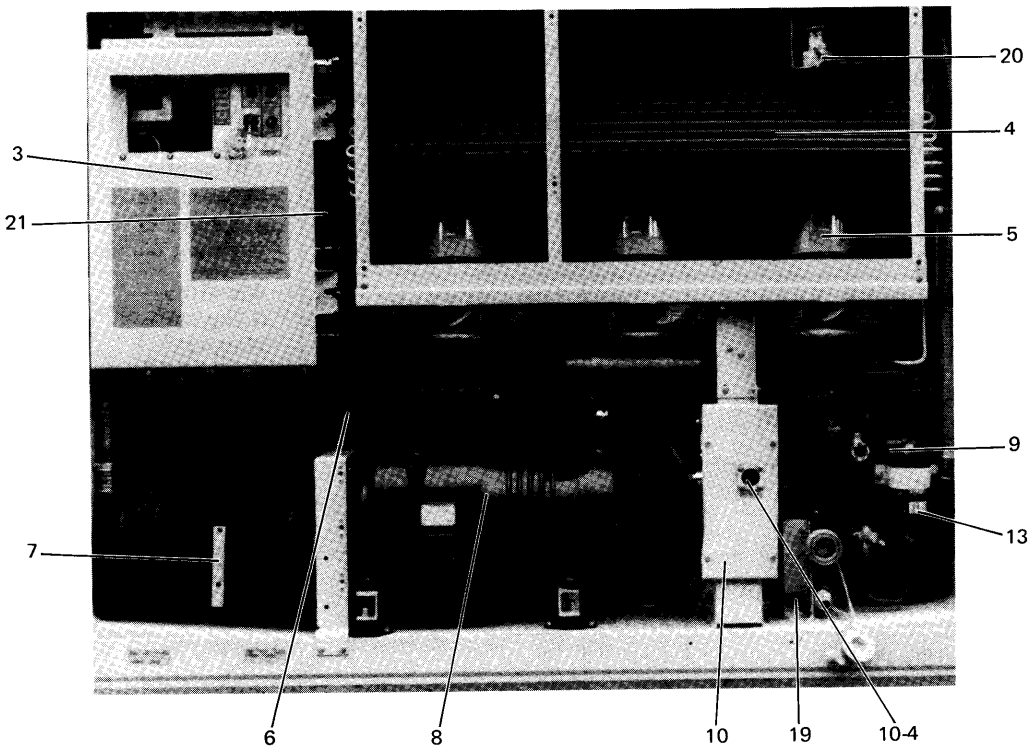
Power supply	AC 200V 3 Phase 50/60Hz AC 220V 3 Phase 60 Hz AC 380 ~ 415V 3 Phase 50 Hz AC 440V 3 Phase 60 Hz (Dual voltage rating with voltage selector)
Compressor	Semi hermetic type (3.75 kW)
Evaporator	Cross finned coil type
Air cooled condenser	Cross finned coil type
Water cooled condenser	Hairpin-shaped tube-in-tube type
Accumulator-receiver with heat exchanger	Vertical cylinder type
Fan	Motor direct driven propeller type
Fan motor	Single-phase squirrel-cage induction motor
Defrost Heat source Initiation Termination	 Electric heater Dual timer or manual switch. Sensing evaporator temperature by defrost termination thermostat
Refrigerant control	Thermostatic expansion valve
Capacity control	Hot gas bypass control with modulating control valve
Protection devices	Circuit breaker, Over current relay, Dual pressure switch, Oil pressure protection switch, Fusible plug, Firestat, Compressor motor protection thermostat, Fan motor protection thermostat.
Refrigerant	R-12 : 4.5 (kg) / 9.9 (lbs)
Lubricant	SUNISO 3GS-DI (2.3 ℓ)
Weight	Approx. 590 kg/1300 lbs

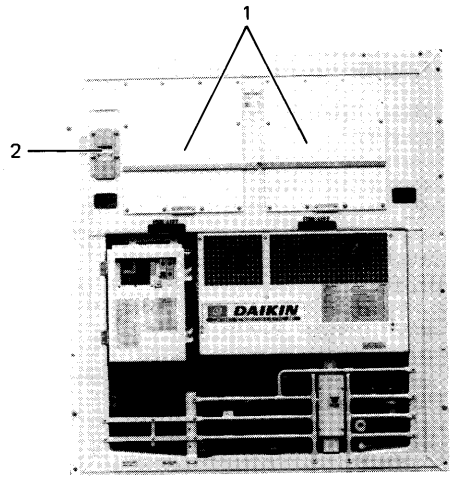
1.2 Set values of functional parts

Part name	Mark	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
High pressure control switch SNS-C130Q$_{11}$	63CL	OFF ON	7kg/cm^2 12.5kg/cm^2
Water pressure switch LCB-BB07	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 # 04-ES250A40T	23D	OFF ON	40°C (104°F) 20°C (68°F)
Defrost timer (short cycle) STP-D73	2D1	ON	2h (60Hz) 2 2/5h (50Hz)
Defrost timer (long cycle) STP-D73	2D2	ON	12h (60Hz) 14 2/5h (50Hz)
Overcurrent relay T-20-NP$_2$S$_4$	51C	OFF	5.5A
Circuit breaker MK-53	52C1	OFF	32A
Circuit breaker (control circuit) CP-31	52C2	OFF	7A
Thermal protector KLIXON 9700L-01-11 (cond. fan motor) 9700K-01-11 (evap. fan motor)		OFF	120°C (248°F)
KLIXON 7895 (compressor)	49	OFF	105°C (221°F)

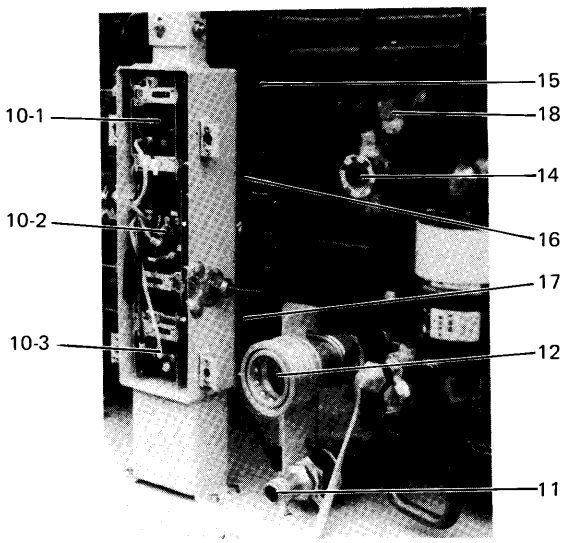
1.3 Construction

(1) Outside

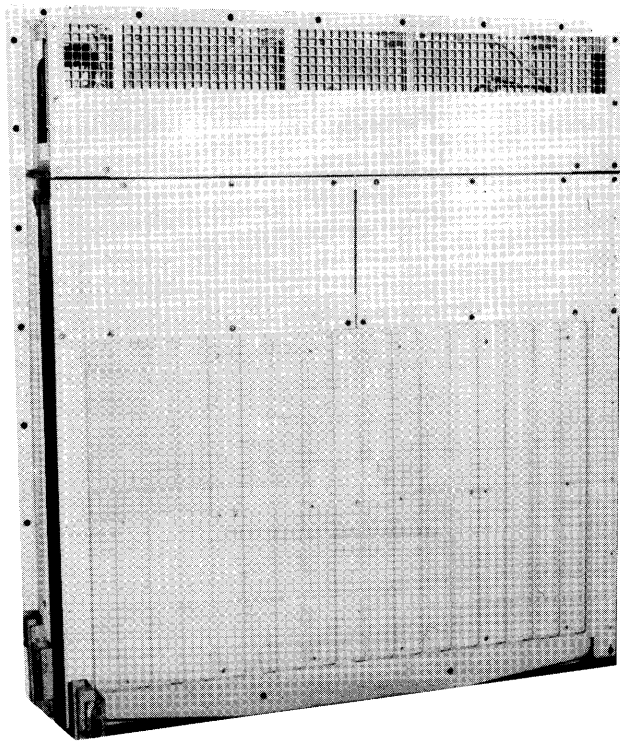




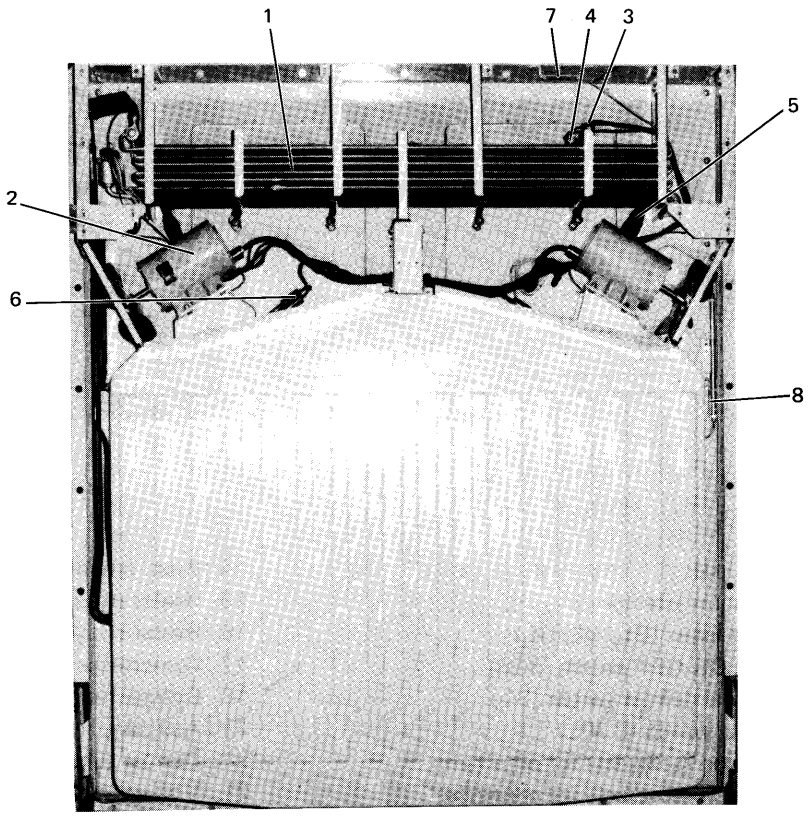
1 Access panel
2 Ventilator
3 Control box
4 Air cooled condenser
5 Condenser fan motor
6 Water cooled condenser
7 Cable stowage
8 Compressor
9 Accumulator-receiver with heat exchanger
10 Pressure switch box
10 – 1 Dual pressure switch (63HL)
10 – 2 Oil pressure protection switch (63QL)
10 – 3 High pressure control switch (63CL)
10 – 4 Reset button for oil pressure protection switch
11 Water inlet coupling
12 Water outlet coupling
13 Dryer
14 Liquid/moisture indicator
15 Modulating control valve (20M)
16 Solenoid valve
(20S1 for main line)
17 Solenoid valve
(20S2 for liquid control)
18 Stop valve for hot gas line
19 Water pressure switch (63W)
20 Expansion valve
21 Voltage selector switch



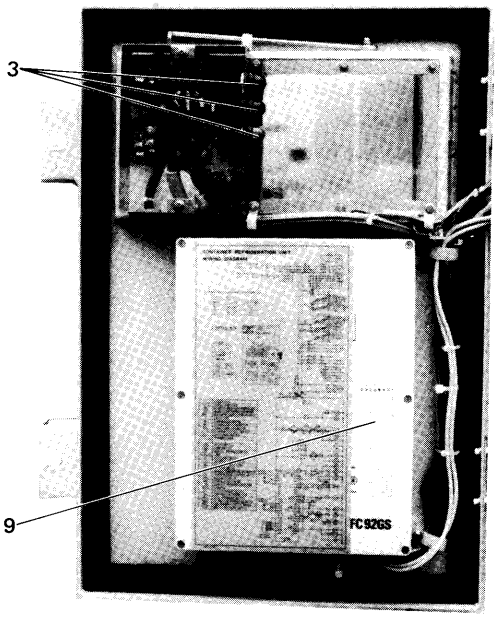
(2) Inside

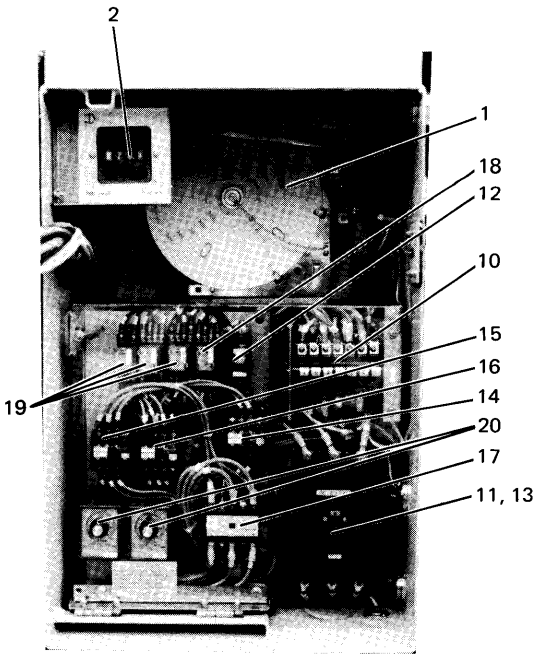


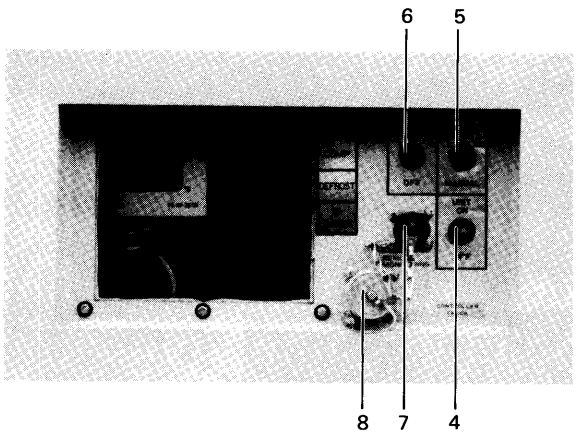
1 Evaporator
2 Evaporator fan motor
3 Defrost termination thermostat
4 Firestat
5 Defrost heater
6 Drain pan heater
7 Return air sensor
8 Supply air sensor

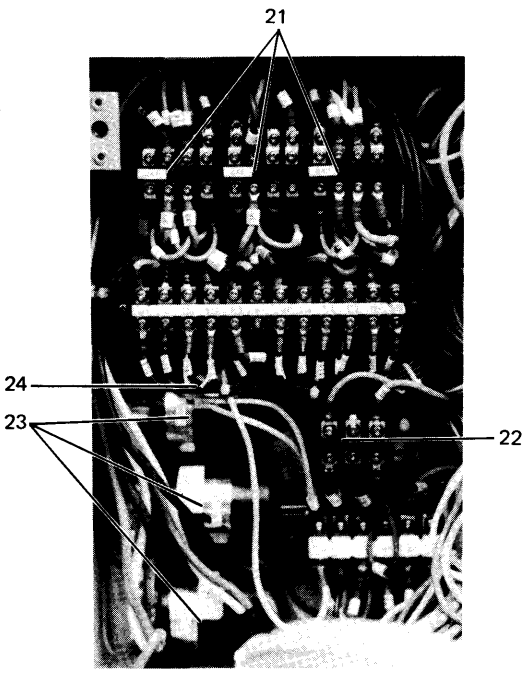


(3) Control box



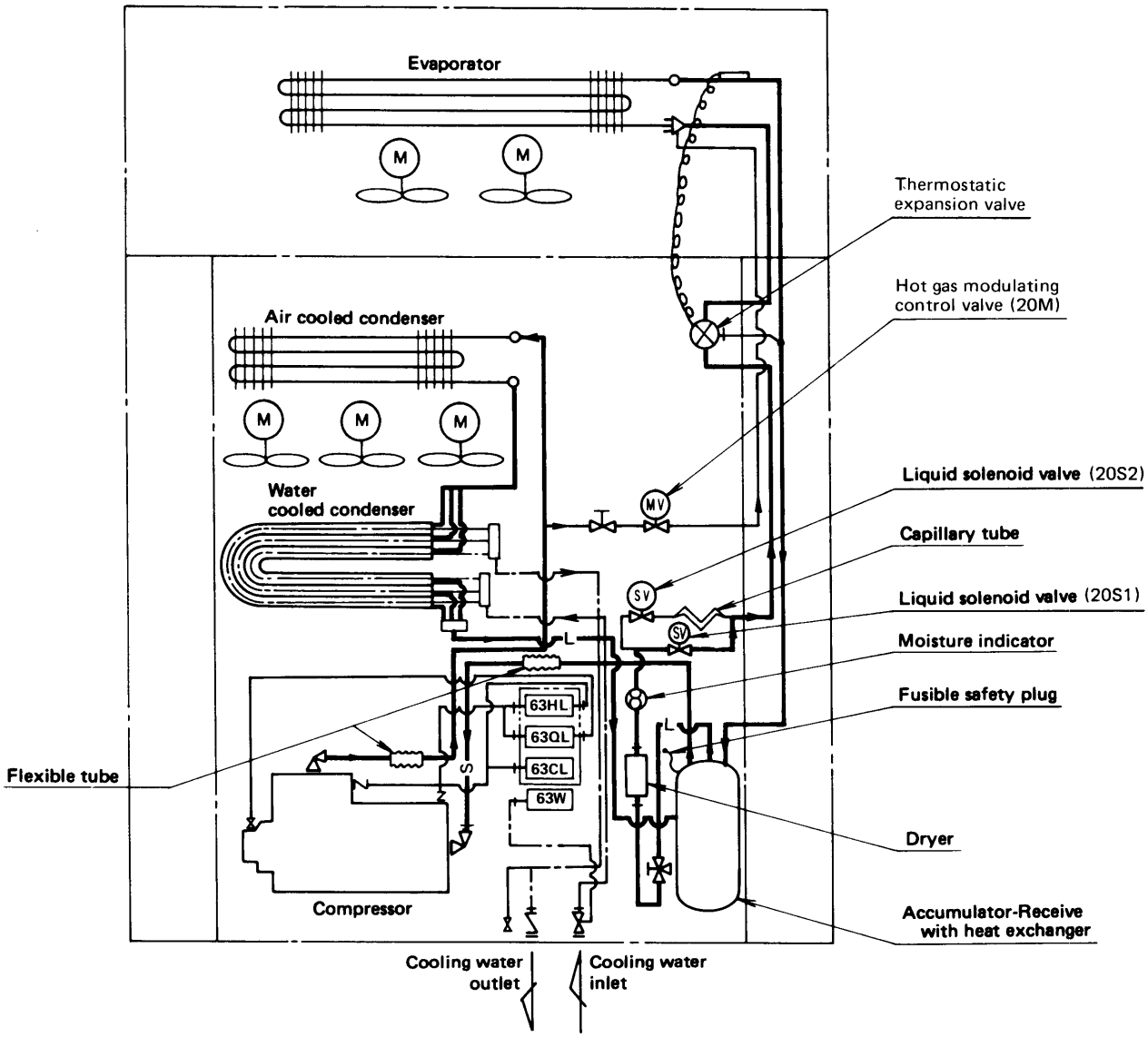






1 Recorder
2 Setpoint selector
3 Pilot lamp (GL, RL, OL)
4 Unit ON-OFF switch (3-88)
5 Manual defrost switch (3D)
6 Lamp switch (3-30L)
7 Cannon receptacle for pilot lamp
8 Cannon receptacle for controller
9 Controller (23A)
10 Voltage selector switch
11 Circuit breaker (52C1)
12 Circuit breaker (52C2)
13 Transformer (Tr)
14 Evap. fan motor relay (88F)
15 Heater relay (88H1)
16 Heater relay (88H2)
17 Compressor relay (88C)
18 Defrost relay (2DX)
19 Auxiliary relay (2X4, 5, 6)
20 Defrost timer (2D1, 2)
21 Voltage selector relay (2X1, 2, 3)
22 Over current relay (51C)
23 Capacitor (C1, 2, 3)
24 Diode (CPD)

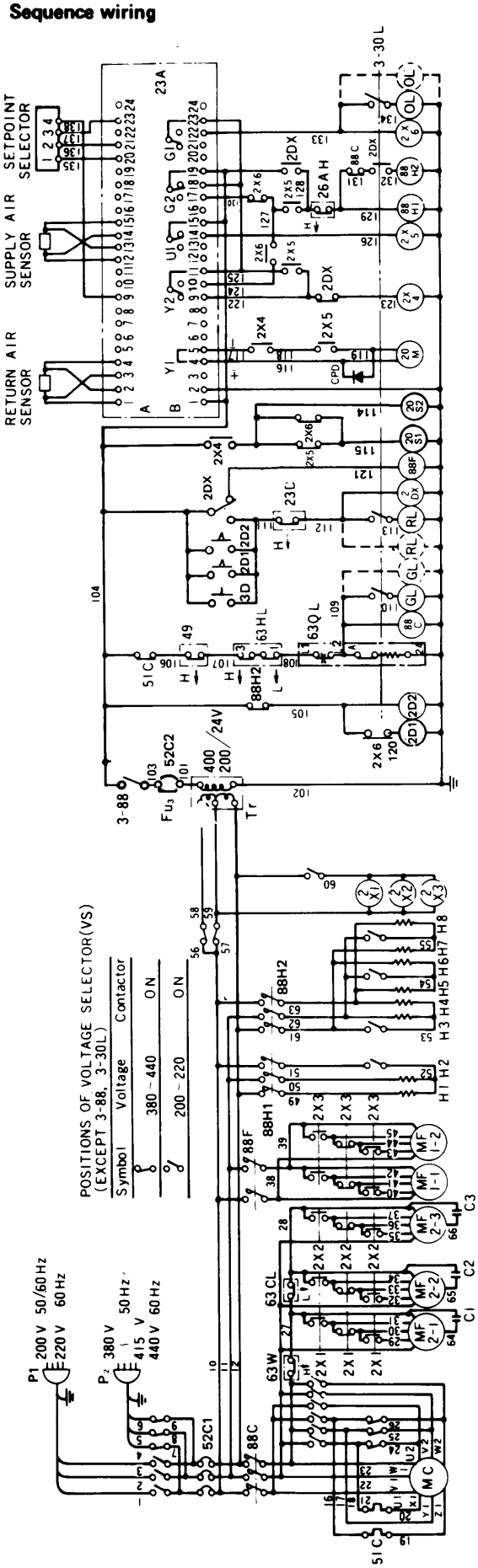
1.4 Piping diagram



—L— LIQUID PIPE	63HL : DUAL PRESS. SWITCH
—S— SUCTION PIPE	63QL : OIL PRESS. PROTECTION SWITCH
—D— DISCHARGE PIPE	63CL : HIGH PRESS. CONTROL SWITCH
—|— FLARE CONN.	63W : WATER PRESS. SWITCH
—||— FLANGE CONN.	
—- - — WATER PIPE	

1.5 Wiring diagram

1.5.1 Sequence wiring

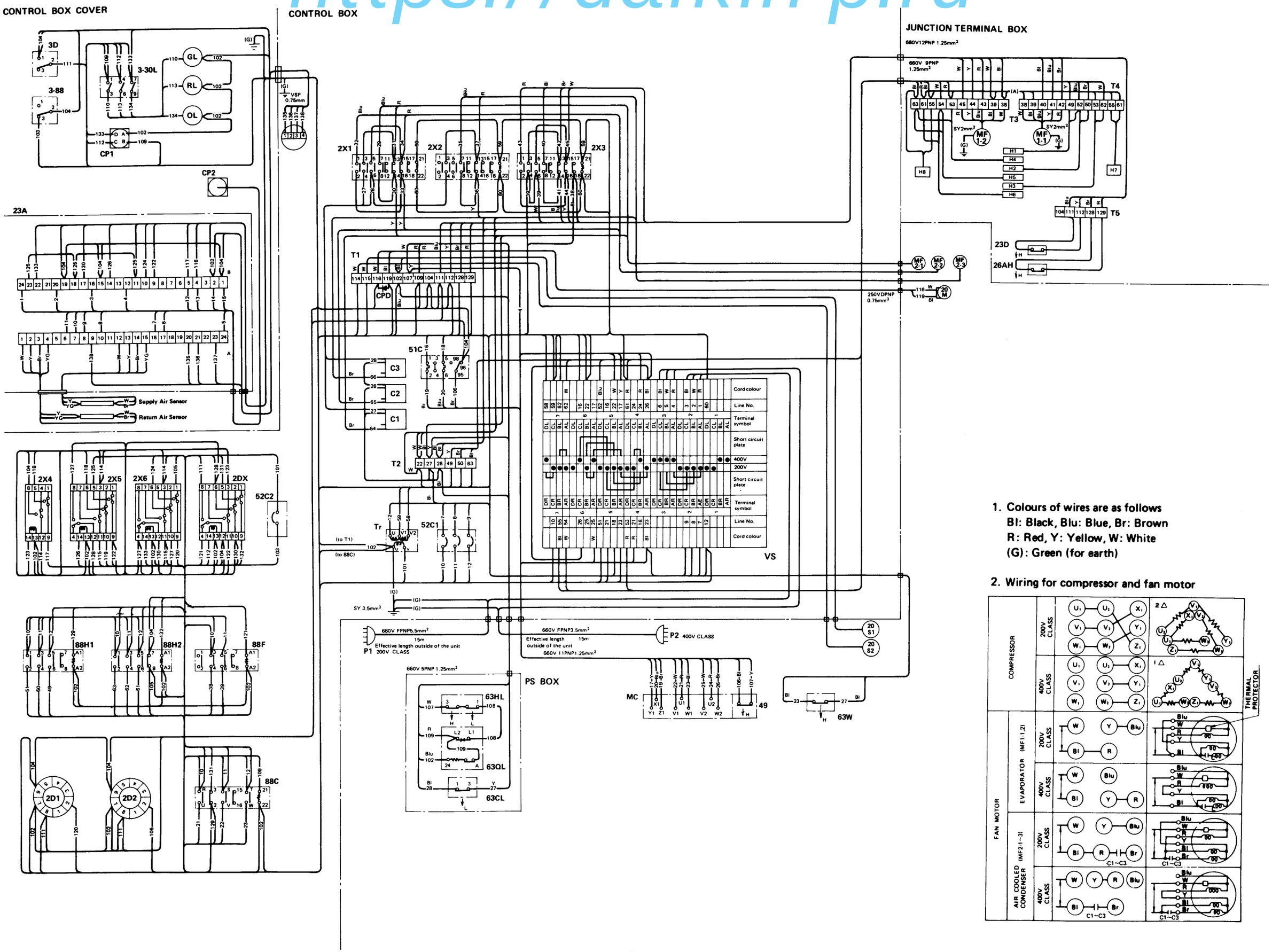


P	POWER PLUG	Tr	TRANSFORMER	2DX	DEFROST RELAY
52C1, 2	CIRCUIT BREAKER	3-88	ON-OFF SWITCH	2D1	DEFROST TIMER (SHORT)
88C	MAGNETIC SWITCH FOR COMPRESSOR	3-30L	LAMP SWITCH	2D2	DEFROST TIMER (LONG)
88F	MAGNETIC SWITCH FOR FAN MOTOR	3D	MANUAL DEFROST SWITCH	63HL	DUAL PRESSURE SWITCH
88H1, 2	MAGNETIC SWITCH FOR HEATER	23D	DEFROST TERMINATION THERMOSTAT	63QL	OIL PRESSURE PROTECTION SWITCH
2X	AUXILIARY RELAY	26AH	FIRESTAT	63W	WATER PRESSURE SWITCH
MC	COMPRESSOR MOTOR	23A	TEMPERATURE CONTROLLER	CPD	CONTACT PROTECTION DIODE
MF1	EVAPORATOR FAN MOTOR	GL, RL, LAMP OL		C	CAPACITOR
MF2	CONDENSER FAN MOTOR	51C	OVER CURRENT RELAY	63CL	HIGH PRESSURE CONTROL SWITCH
H1~H6	EVAPORATOR COIL HEATER	49	COMPRESSOR PROTECTOR		
H7, H8	DRAIN PAN HEATER	20S	SOLENOID VALVE		
20M	MODULATING CONTROL 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

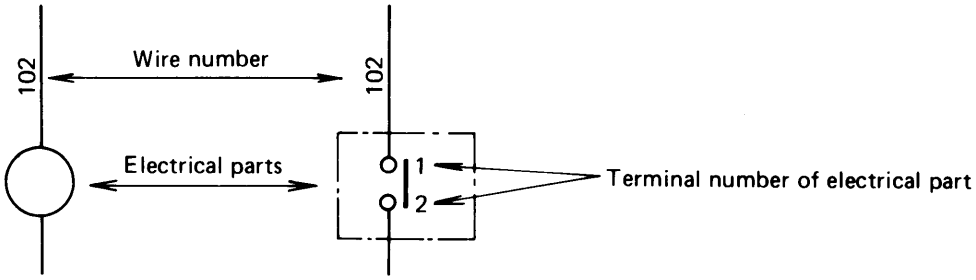


1. Colours of wires are as follows
   Bl: Black, Blu: Blue, Br: Brown
   R: Red, Y: Yellow, W: White
   (G): Green (for earth)

2. Wiring for compressor and fan motor

1.5.3 How to read wiring diagram

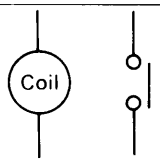
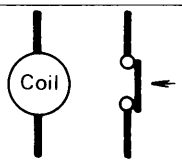
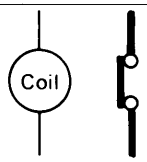
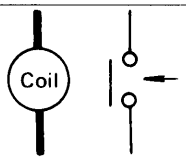
(1) In the wiring diagram, marks and numbers have the meanings given below.



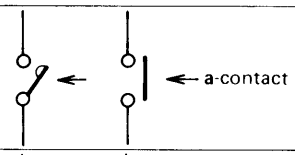
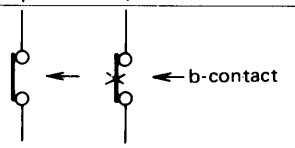
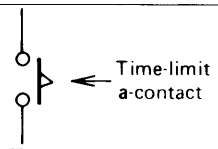
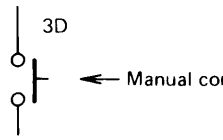
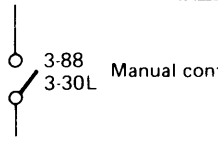
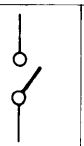
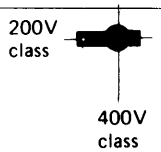
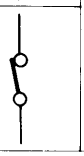
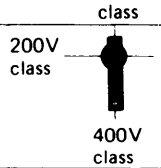
(2) Operation of contacts

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

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

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

c. Kinds of contacts

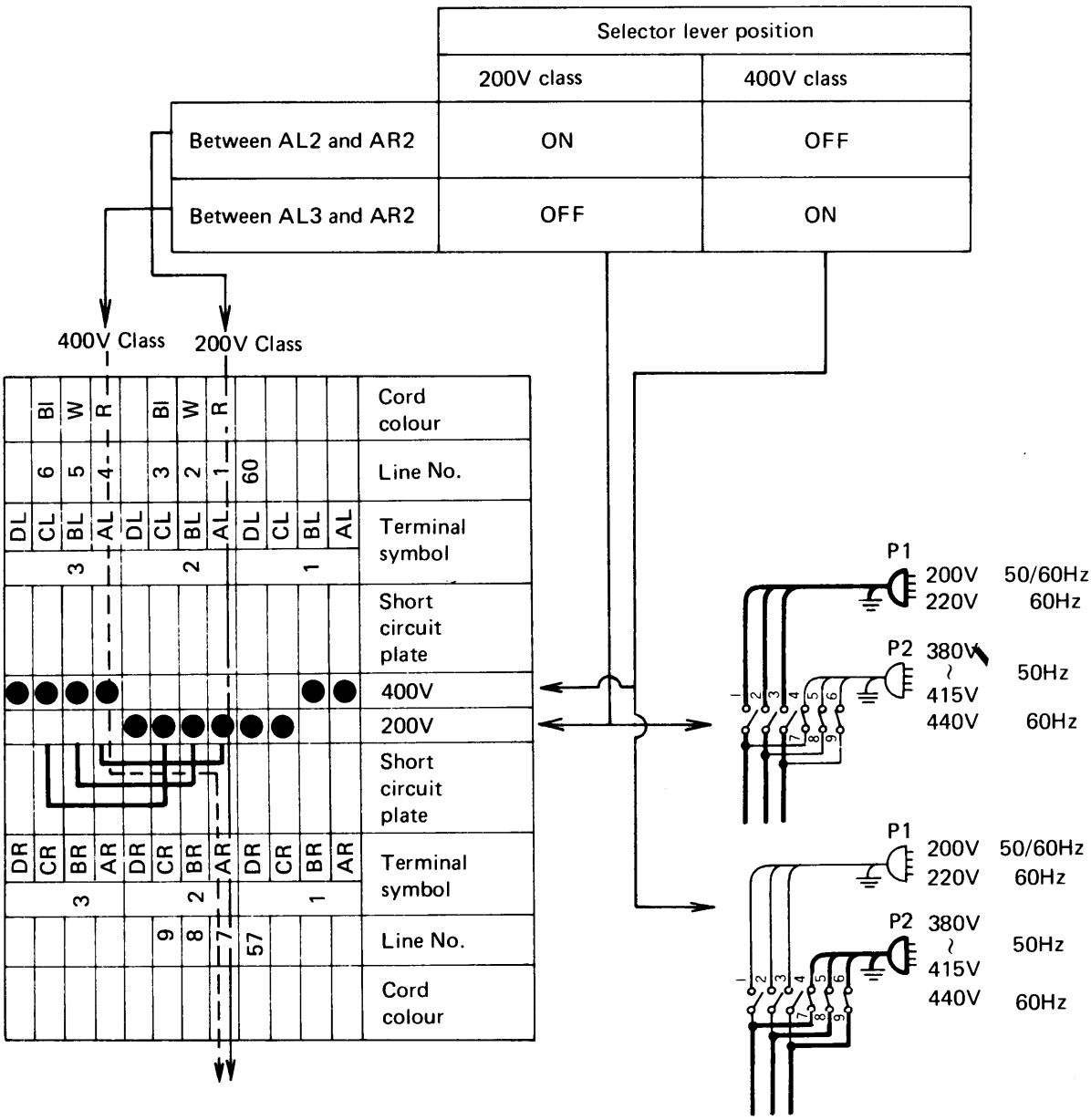
 a-contact	Operated by electromagnetic force, temperature, or pressure. ("x" denotes the reset button.)
 b-contact	
 Time-limit a-contact	Operates when the timer counting has completed.
 3D Manual contact	Contact of a snap switch. This turns on as long as the switch is kept pressed and turns off immediately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

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

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

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

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



2. Operation

Operate the unit by the procedures given below.

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

2.1 Preparation and operation

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

(2) Confirming the driving part of recording paper

- Confirming life of a dry element battery
Press the switch and confirm that the needle of the remaining voltage indicator remains in the blue zone. (The meter functions only when the switch is pressed down)
- Confirming the function of quartz motor
After confirming the life of dry element battery, check through the access window the fly wheel inside is rotating.

(3) Setting a piece of recording paper

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

(4) Set the setpoint selector.

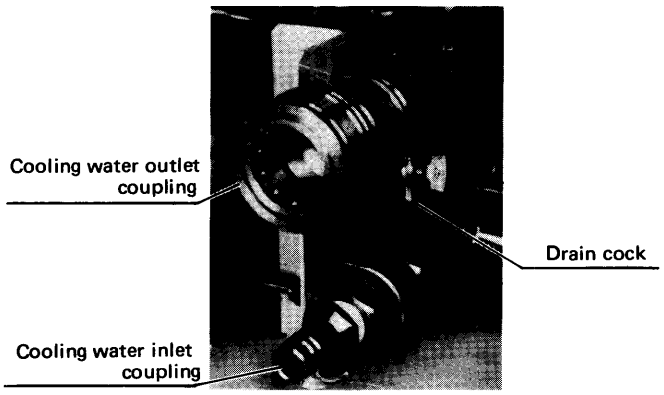
- Select a designated temperature by pressing the buttons.

Note: Do not touch the knob except when setting the temperature.

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

(6) Connect the cooling water piping.

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



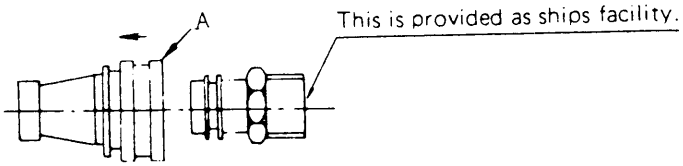
- Connecting method

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

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

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

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

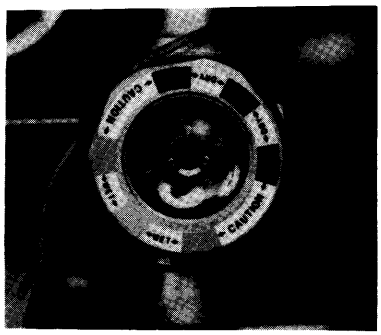
(10) Turn on the power switch of the facility (outside the unit).

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

(12) Close the cover of the control box.
If it is loose, water will leak in. 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 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 "Section 9, page 59".)	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 and check instrument (Stäfa).	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 breakers.

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

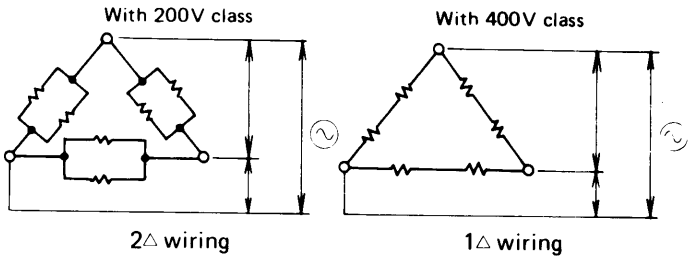
(3) After water-cooled operation
Remove the water piping, open cocks, and drain off.

(4) Close the cover of the control box.

3. Operating modes and circuits

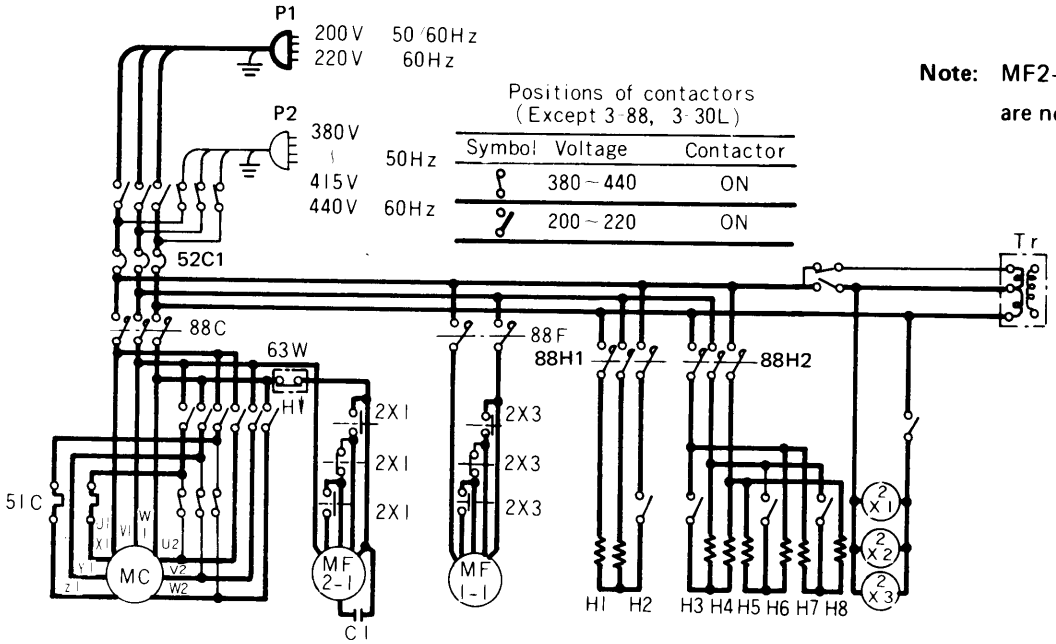
3.1 Voltage selection system (switching over 200V and 400V class)

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



(2) Circuitry

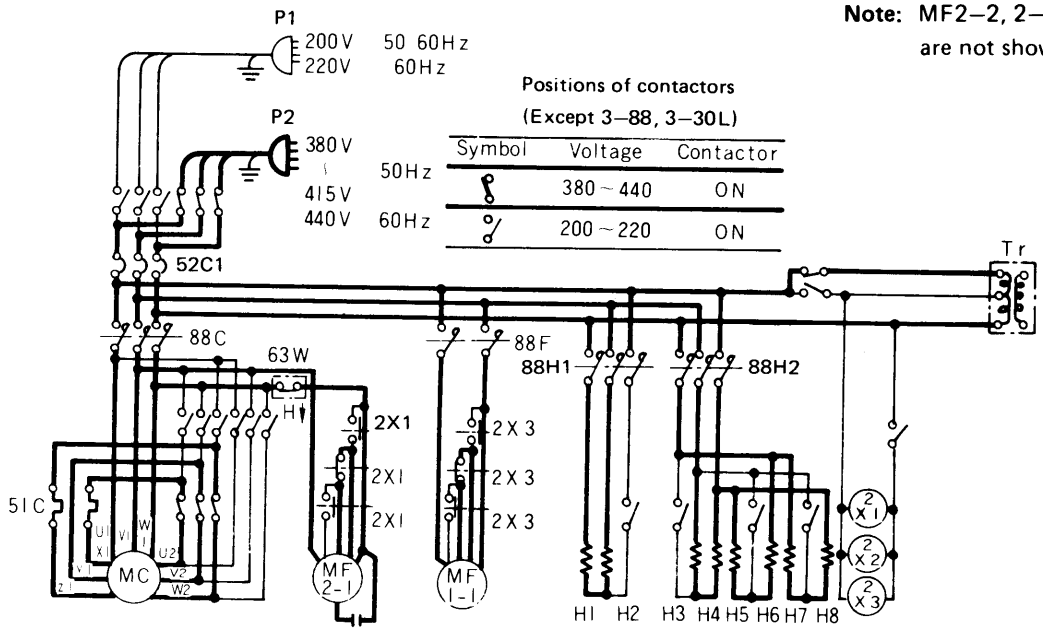
- With 200V class (Set the selector lever to "200V CLASS".)
The contacts marked "○/" in the sequence chart (except 3–88 and 3–30L) are turned on.
The circuits for 200V class will be set up with the contacts and the voltage selector relay (2X1.2.3) are energized.



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

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

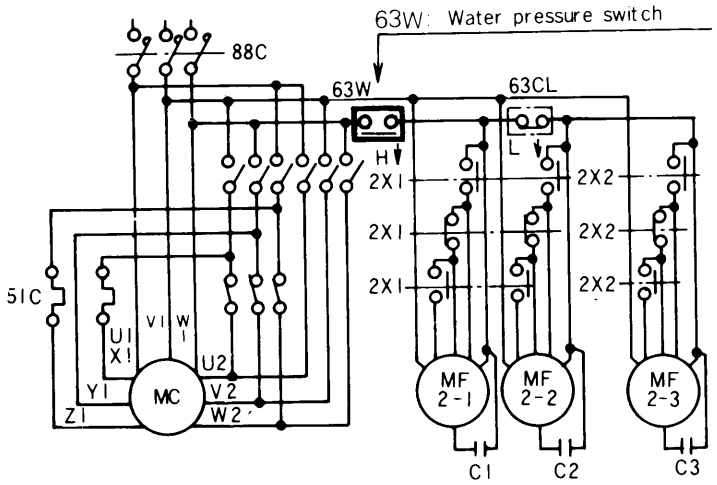
A. With main power supply



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

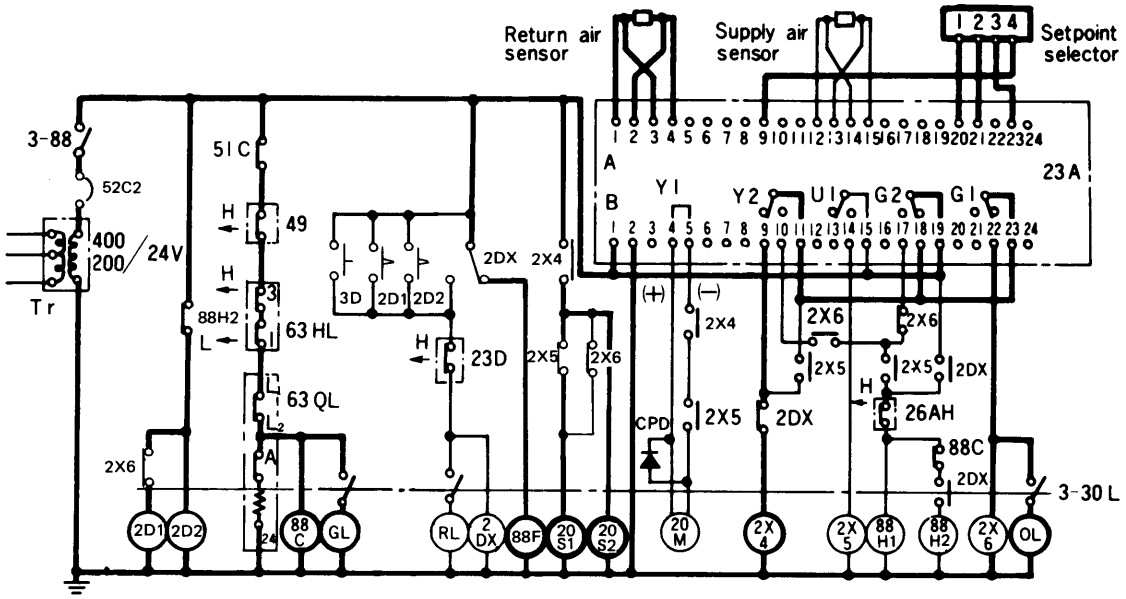
3.2 Air cooled and water cooled operation

The unit will operate on either air cooled or water cooled condenser operation.
During transit on land, in depot or on a vessegs deck, the air cooled operation will function, and the operation in ship holds is normally water cooled.
The operation will be changed from air cooled to water cooled automatically by the water pressure switch; i.e. when water pressure at the inlet of the water cooled condenser rises higher than the presetting value, the contact points of the water pressure switch are opened, so the condenser fan motors stop, and the water cooled operation starts.
When the water supply is disconnected. The contacts of the water pressure switch are made and the condenser fan motors rotate.



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

3.3 Frozen operation

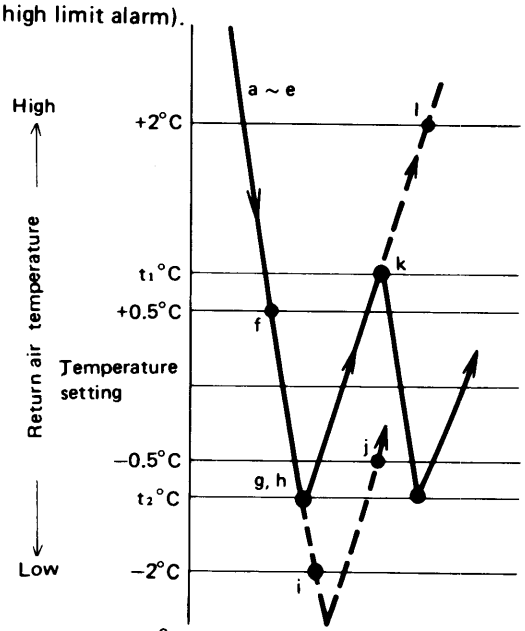


(1) Switching over frozen and chilled modes
One of the modes will be automatically selected according to the setting of the setpoint selector.

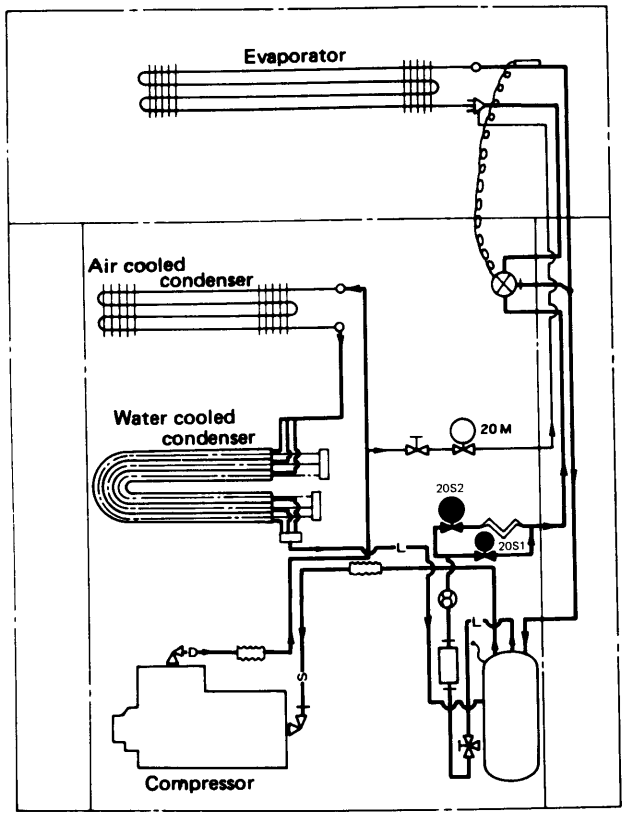
- When the setting is above −4.5°C : chilled mode
- When the setting is below −5.0°C : frozen mode

(2) During frozen mode, the compressor will be automatically turned on and off, sensing return air temperature to the evaporator.

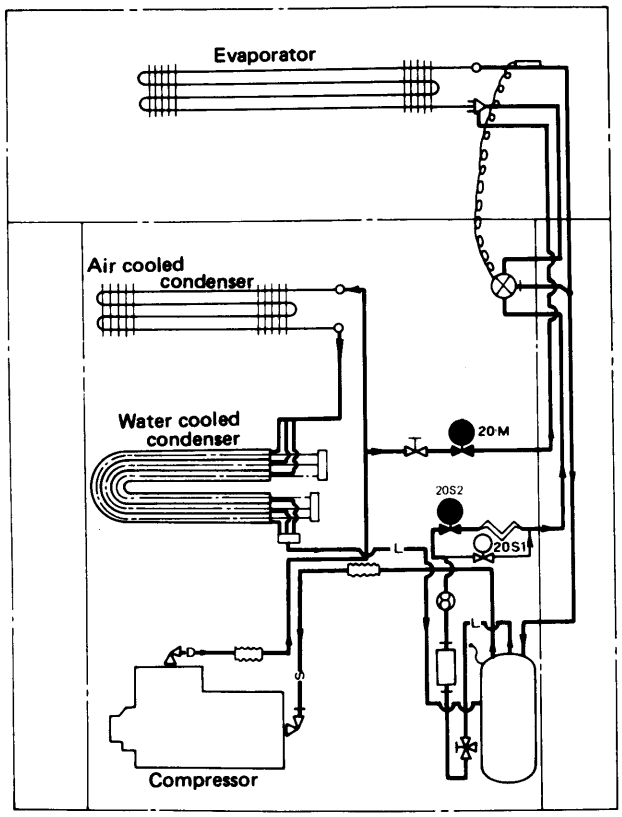
a. Turn on 3-88 (unit ON-OFF switch).
b. With 88F (evaporator fan relay) energized, MF1-1 and 1-2 (evaporator fan motors) start.
c. Solenoid valves (20S1 and 20S2) are open, with relay 2X4 energized by Y_2 relays (for compressor and heater) and G_2 (for low limit alarm) of 23A (controller).
d. When 20S1 and 20S2 are open, refrigerant flows and low pressure rises. 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 WL (white lamp) will light up. ——— The unit enters in the normal operation and container inside temperature begins to fall. ———
f. When return air temperature to the evaporator falls to 0.5°C above the preset temperature, (preset temperature plus 0.5°C), G_1 relay (high limit alarm) of 23A is turned on and GL (green lamp) lights up by $G_2 \rightarrow G_1$ (indicating that inside temperature is with in range).
g. When the temperature falls lower than the preset temperature, Y_2 relay is turned off (continuity between 9 and 11 of terminal B of 23A is lost); 2X4 becomes unenergized; 20S1 and 20S2 close; and "pump down" 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 frozen operation stops.
i If the temperature falls down to 2°C below the preset temperature after MC (compressor) has stopped, G_2 relay is turned off after a delay of approximately 20 seconds and GL goes out (low limit alarm).
j When the temperature rises to the preset temperature minus 0.5°C, G_2 relay is turned on and GL lights up.
k. When the temperature rises higher than the preset temperature. Y_2 relay is turned on and frozen operation starts by steps "c" through "e" described above.
l. If the temperature rises further up to the preset temperature plus 2°C, G_1 relay is turned off after a delay of approximately 20 seconds and GL will go out (high limit alarm).



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

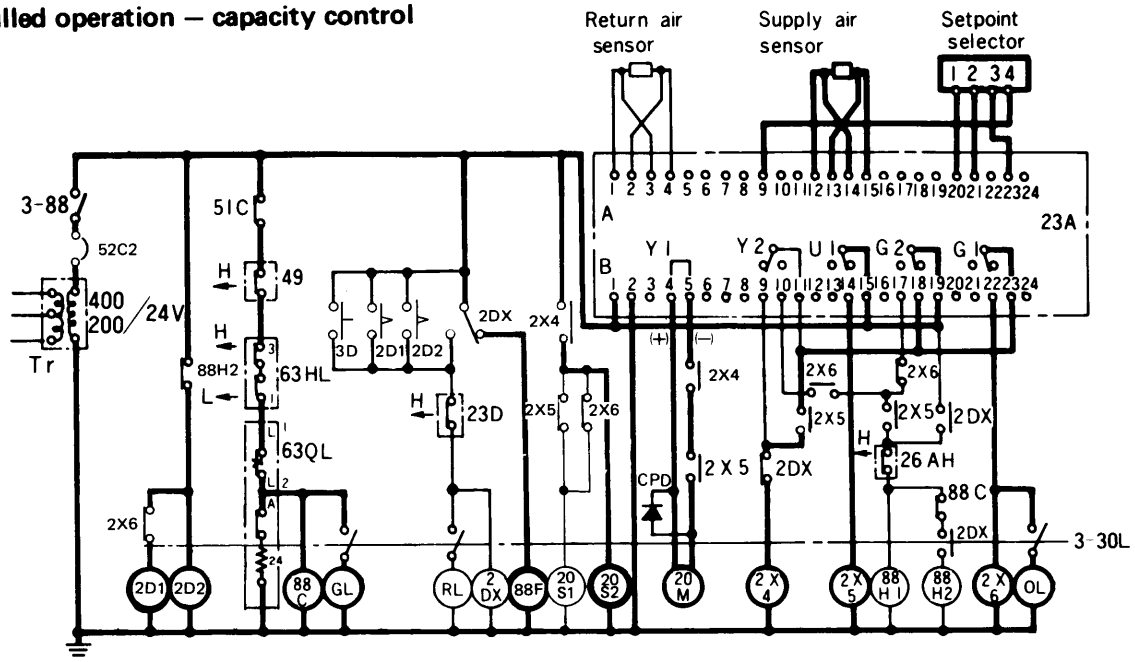


Flow of refrigerant during frozen operation



Flow of refrigerant during chilled operation

3.4 Chilled operation — capacity control



(1) Chilled operation is performed when the preset temperature is −4.5°C or higher. U_1 relay (which switches over frozen and chilled modes) of 23A is turned on, 2X5 relay becomes energized and the circuit of the chilled mode is made.

(2) Chilled operation is controlled sensing supply air temperature from the evaporator; i.e., the modulating control valve (20M) controls the amount of hot gas to be bypassed continuously while a capillary tube controls the liquid refrigerant.

a. The operation is the same with that (step "a" ~ "e") of the frozen mode while supply air temperature falls to the preset temperature plus 0.5°C from the pull down period.

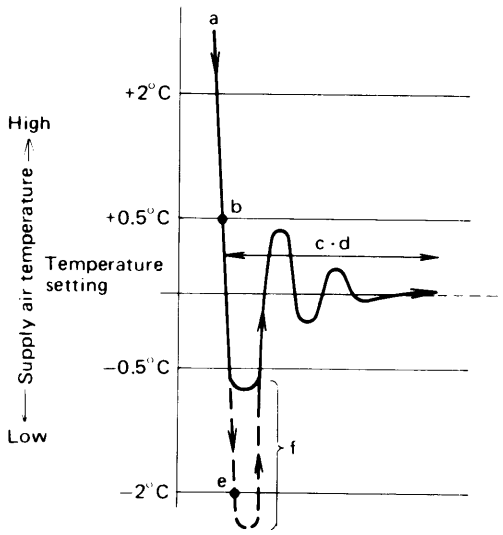
b. When the supply air temperature reaches the preset temperature plus 0.5°C, G_1 relay is turned on (GL lights), 2X6 relay gets energized, 20S1 closes; and, the capillary tube controls the liquid refrigerant.
(20S1 remains closed after that.)

c. As the supply air temperature rises to the preset value, Y_1 voltage rises slowly from zero, which opens the modulating control valve (20M) gradually, permitting hot gas to flow through.

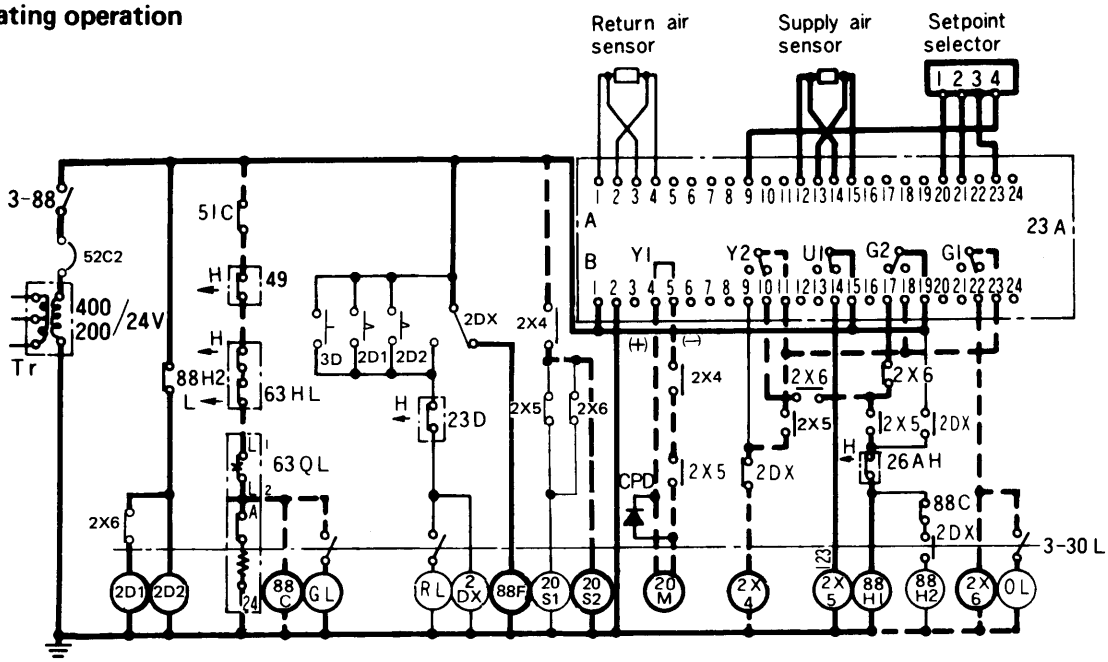
d. After the temperature has been reached the preset temperature, it takes about an hour for the unit to reach a steady state. (the opening of 20M is nearly fixed; i.e., the flow of bypassing hot gas is nearly constant.) (This interval varies somewhat with the preset and ambient temperatures.) During this time, the valve changes its openings to control the flow of hot gas until the supply air temperature becomes stable.

e. Depending on operating conditions (such as when the differece between the ambient and preset temperature is small), G_2 relay is turned off and lamp GL goes out (after a delay of approximately 20 seconds) if the supply air temperature becomes −2°C lower than the preset temperature before stabilizing hot gas bypass volume (low limit alarm).
At the same time, 2X4 relay is turned off; 20S2 and 20M are closed, after "pump down", the compressor stops to prevent over-cool.

f. If Y_2 relay has been turned off during step "e" above, the electric heaters (H1 and H2) may be turned on tentatively, but they will be turned off when the temperature rises.
(Refer to the section on Heating Operation for the details.)



3.5 Heating operation



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

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

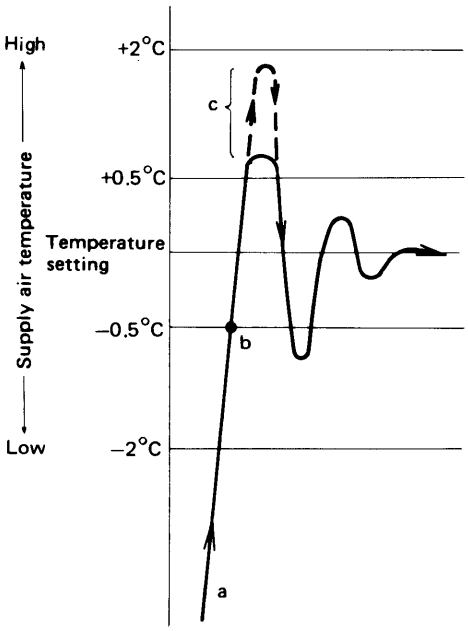
- Pull up – Heated only by electric heaters
- Steady state – Heated by hot gas bypass and electric heaters (when large heating capacity is needed)
  – Heated only by hot gas bypass (when small heating capacity is enough)

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

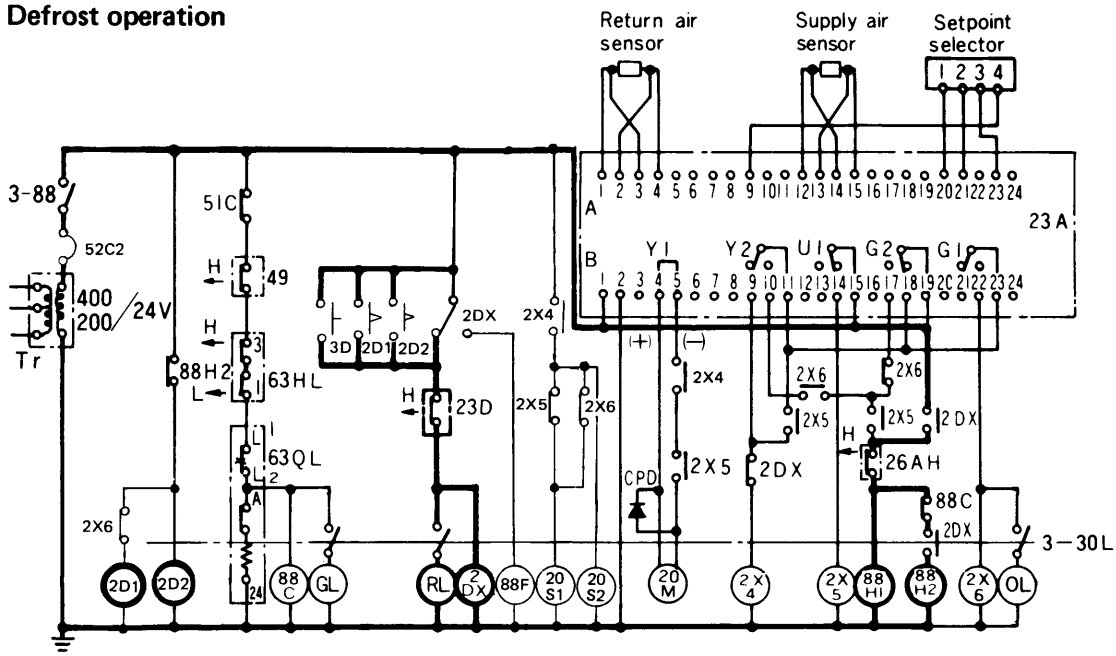
a. Pull up (The circuit indicated with bold lines in the sequence diagram functions)
Until the supply air temperature rises to the preset temperature minus –0.5°C, G_2 relay is turned off, which unenergizes 2X6, energizes the heater relay (88H1) and operates the electric heaters (H1 and H2). (compressor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

b. When the supply air temperature raises the preset temperature minus 0.5°C, G_2 relay is turned on and GL lamp light up. At the same time, 2X6 relay becomes energized,, so 88H1 is energized by Y_2 relay. Since G_2 relay is on, 2X4 relay is energized, 20S2 is open, and the compressor runs and heating starts with electric heaters and hot gas. (The circuit indicated by dotted lines in the sequence diagram functions.)
Afterwards, operation will become stable as time afterwards, elapses.

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



3.6 Defrost operation



(1) Defrosting operation starts based on the following two conditions.

- Timer (2D1 or 2D2) is turned on.
- Manual defrost switch (3D) is turned on.

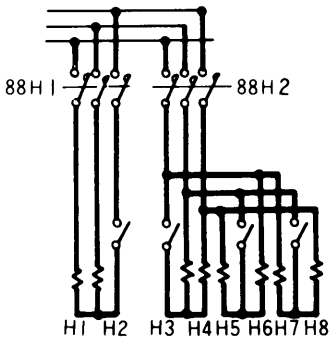
If one of those stated above is on, defrost relay (2DX) becomes energized, and RL (red lamp) lights up.

(2) When 2DX is energized:

- Electric heaters H1 and H2 are operated with 88H1 energized.
- 20S1 and 20M are closed with 2X4 relay unenergized. After "pump down", the compressor stops; 88H2 becomes energized and electric heaters H3 ~ 8 are operated. (Now all electric heaters H1 ~ H8 are turned on.)

(3) With 88H2 energized, the evaporator fan stops and defrosting operation starts.

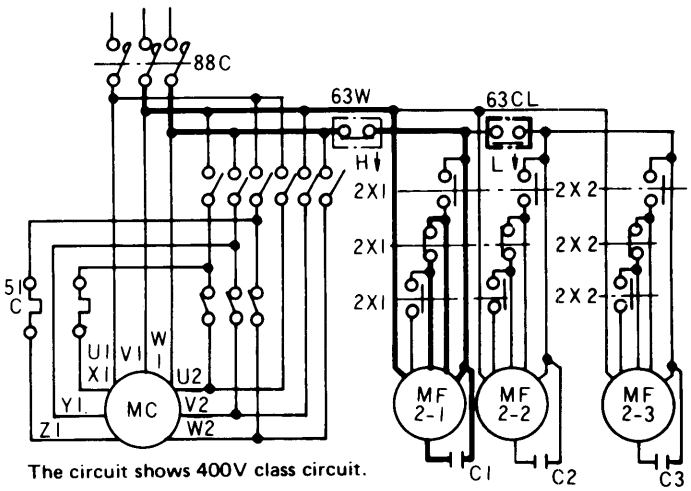
(4) After having removed frost, defrost termination thermostat (23D) is turned off and 2DX becomes unenergized. Now defrosting operation is completed.



The circuit shows 200V class circuit

3.7 High pressure control

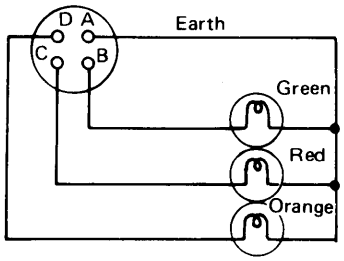
(1) The condensing pressure (high pressure) falls when the ambient temperature falls during air-cooled operation, and the lower pressure also falls accordingly. If operation is still continued in this condition, the low pressure switch will be turned off (LP of 63HL is turned off) and the compressor will stop so that the required refrigeration capacity is not available. To prevent the high pressure from falling, a pressure switch (63CL) (which controls the high pressure) stops two condenser fans (MF2-2 and 2-3) automatically when the high pressure falls to 7 kg/cm^2 (99.6 psi).



The circuit shows 400V class circuit.

3.8 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 (within +/−2°C of the preset temperature)
Receptacles for monitoring pilot lamp is also equipped and its connections is shown at below.



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

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

Part name		Set point selector set above −4.5°C (24°F) −Air cooled operation				
		Cooling		Heating		Defrost
		Pull down	In range	Pull up	In range	
Light	Defrost −Red	X	X	X	X	○
	Comp. −Green	○	○	X	○	X
	In range −Orange	X	○	X	○	※
Magnetic switch	Comp. cond. fan motor	○	○	X	○	X
	Evaporator fan motor	○	○	○	○	X
	Heater (88H1)	X	X	○	○	○
	Heater (88H2)	X	X	X	X	○
Solenoid valve (20S1)		○	X	X	X	X
Solenoid valve (20S2)		○	○	X	○	X
Modulating valve (20M)		X	○	X	○	X
Compressor		○	○	X	○	X

Part name		Set point selector set below −5.0°C (23°F) − Air cooled operation			Water cooled operation
		Cooling		Defrost	
		Pull down	In range		
Light	Defrost −Red	X	X	○	Water cooled condition is the same as air cooled except ○ Water press. switch (63W) open ○ Condenser fan motor (MF2) de-energized
	Comp. −Green	○	○	X	
	In range −Orange	X	○	※	
Magnetic switch	Comp. cond. fan motor	○	○	X	
	Evaporator fan motor	○	○	X	
	Heater (88H1)	X	X	○	
	Heater (88H2)	X	X	○	
Solenoid valve (20S1)		○	○	X	
Solenoid valve (20S2)		○	○	X	
Modulating valve (20M)		X	X	X	
Compressor		○	○	X	

Notes 1. ○: Energized or ON, X: De-energized or OFF
2. ※: According to 23A

4. Major components and maintenance

4.1 Components related with refrigeration circuit

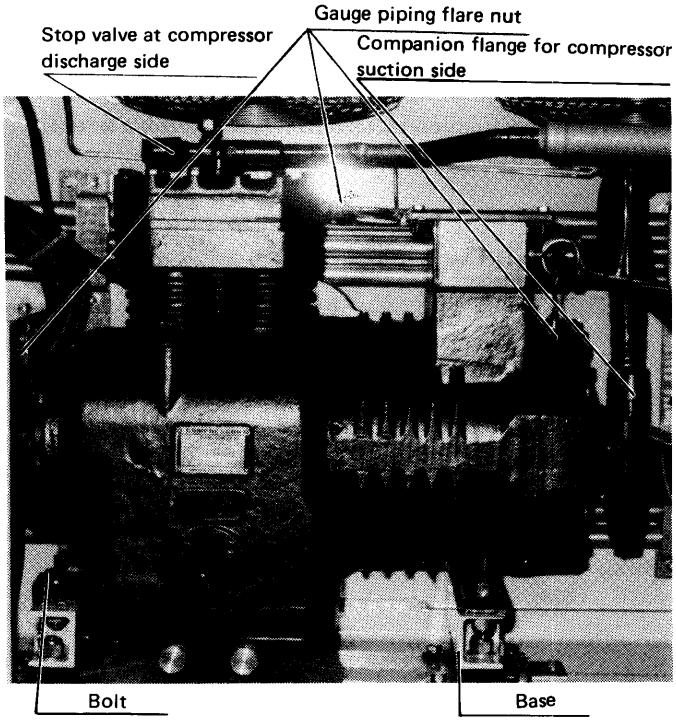
4.1.1 Compressor

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

(a) Replacement

Remove the compressor by the following procedure.

1 Remove the front and base plates and protective bar of the cable stowage.
2 Remove the discharge stop valve, suction stop valve gauge piping flare nut (compressor side) and cable.
3 Remove four bolts (two on each side) ' tening the compressor and base.
4 Take out the compressor to the fror nit.



(b) Installing procedure

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

4.1.2 Air-cooled condenser and evaporator

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

(a) Maintenance

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

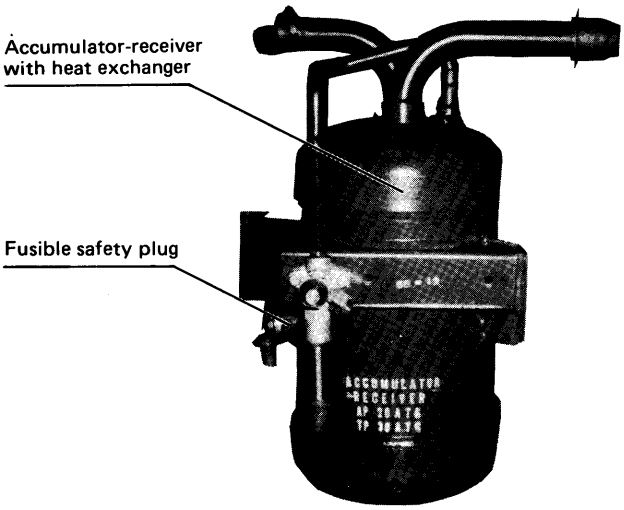
4.1.3 Water-cooled condenser

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

4.1.4 Accumulator-receiver with heat exchanger

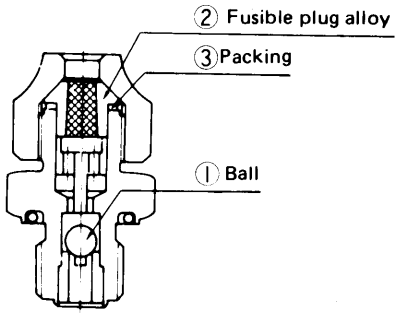
Consists of the accumulator, receiver, and heat exchanger, which are encased in a vertical cylindrical construction; i.e. the heat exchanger passes through the accumulator from its top to the bottom and reaches to the receiver.

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



(a) Replacement procedure of the fusible safety plug

When pressure rises abnormally in the system, the fusible safety plug melts itself, so if the fusible safety plug is melted, check possible causes thoroughly. When fusible safety plug functions, the centre of the fusible safey plug alloy ② melts, from which the refrigerant escapes. When the flare nut is removed, ① (ball) will come out under pressure and block the passage of the refrigerant outlet, which prevents the refrigerant from escaping and also the air from entering. Thus, refrigerant loss is extremely minimized.

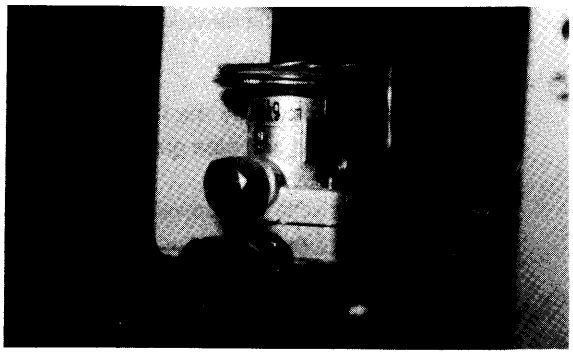


Construction of fusible safety plug

Insert a new ② by means of ③, and tighten the flare nut.

4.1.5 Expansion valve

The externally equalized 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 isolated from the mains supply for safety.

(a) Adjusting the expansion valve

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

(1) Adjustment based on the suction operation pressure

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

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

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

Adjusting points for expansion valve

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

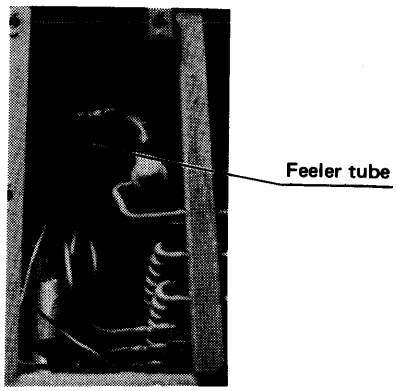
(3) Countermeasures after operation

1) Remember the original setting of the expansion valve. If any change is found with the setting after adjustment of the expansion valve, return the adjusting screw to the original position, as trouble occured caused by other reasons.
2) When the adjusting screw is returned to its original position, firstly turn it passing the original position and then return it to the original position.
3) After adjustment, be sure to tighten up the clamp screw and cap it to prevent the refrigerant from leaking.
4) After completion of the adjustment, operate the unit, keeping inside temperature at −18°C (−0.4°F) and confirm that low pressure does not go down below 0 kg/cm² G (0 PSIG).

(b) Replacement

For replacement of the expansion valve, remove the access panel located on the front of the unit or by removing the evaporator bulkhead inside the container, and the drain pan back plate located at the left side.

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



4.1.6 Liquid/moisture indicator

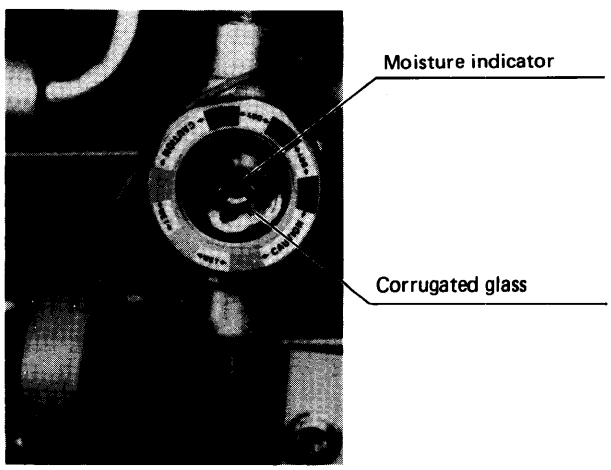
This indicator permits checking of flow of the refrigerant and moisture content in the refrigerant.

(a) Moisture content

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

Color	State
Deep blue	Dry
Orange	Wet (moisture contained)

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



(b) Flow of the refrigerant

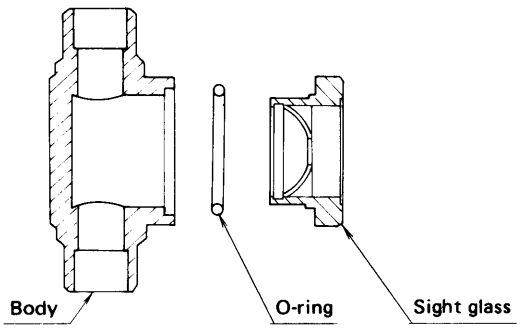
- When the liquid refrigerant is sealed, corrugation on the sight glass disappears.
- Check

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. [particularly appear more during capacity control operation]

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

(c) Replacement

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

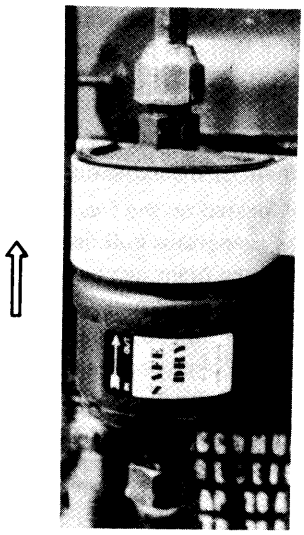


4.1.7 Dryer

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

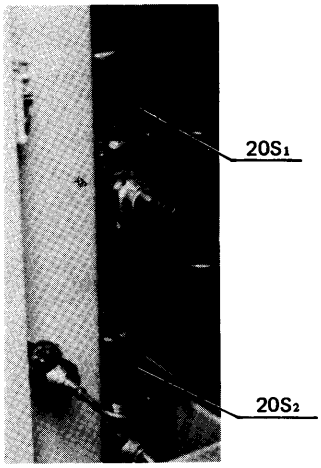
(a) Replacement

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



4.1.8 Solenoid valves

There are two solenoid valves (20S1 and 20S2) in the liquid line. They operate as follows according to operating mode.



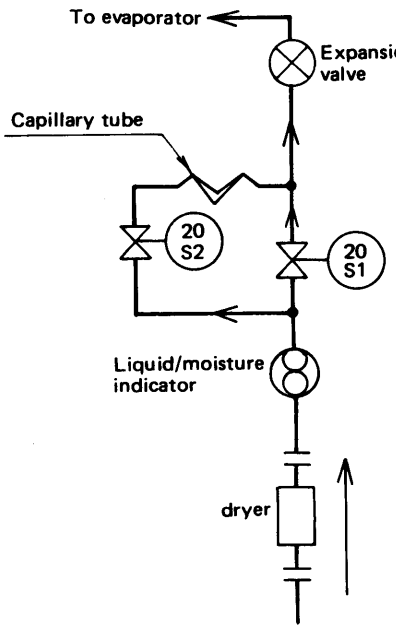
(a) During freezing mode

Both 20S1 and 20S2 are open during operation. When stopping the compressor by the controller, they are closed and stop flow of the refrigerant, performing "pump down".

(b) During chilling mode

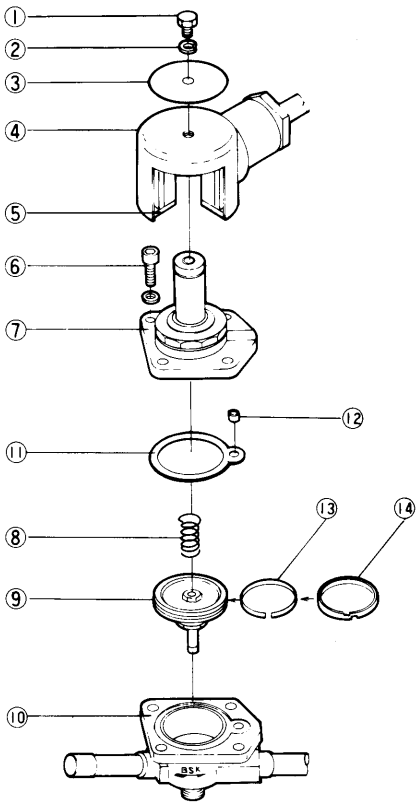
The two valves are open during "pull down". When the supply air temperature falls to the preset temperature plus 0.5°C, 20S1 alone is closed by directions of the controller. The refrigerant then flows through the capillary tube via 20S2 (liquid control).

Both 20S1 and 20S2 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

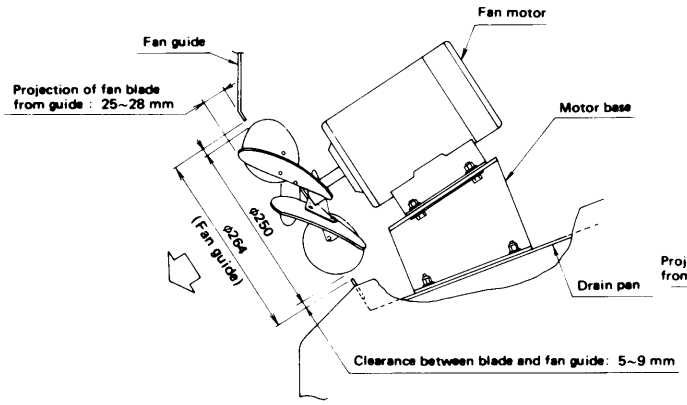
4.2. Components related with the air system

4.2.1 Fans and motors

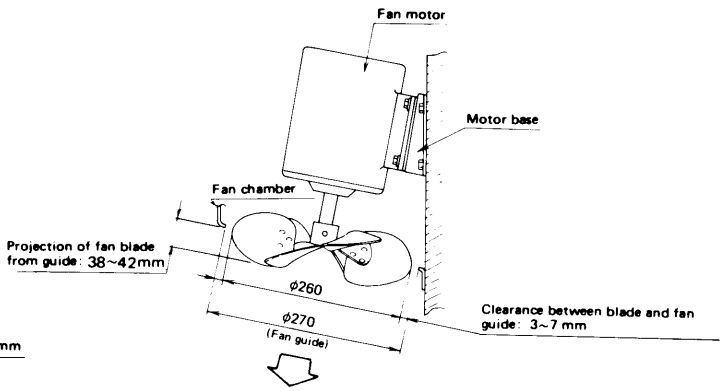
(a) Specifications

		Evaporator	Condenser
Fan	Type	propeller fan	propeller fan
	Number of blades	6 pcs.	6 pcs.
	Blade diameter	ϕ250	ϕ260
Motor	Type	Single-phase, squirrel-cage induction motor	
	Motor output (number of poles)	465W (2P)	60W (4P)
	Capacitor	Built-in	Separate
	Bearing	Ball bearing, 6203 contactless type, rubber shield	

(b) Installation procedure



Evaporator fan and motor

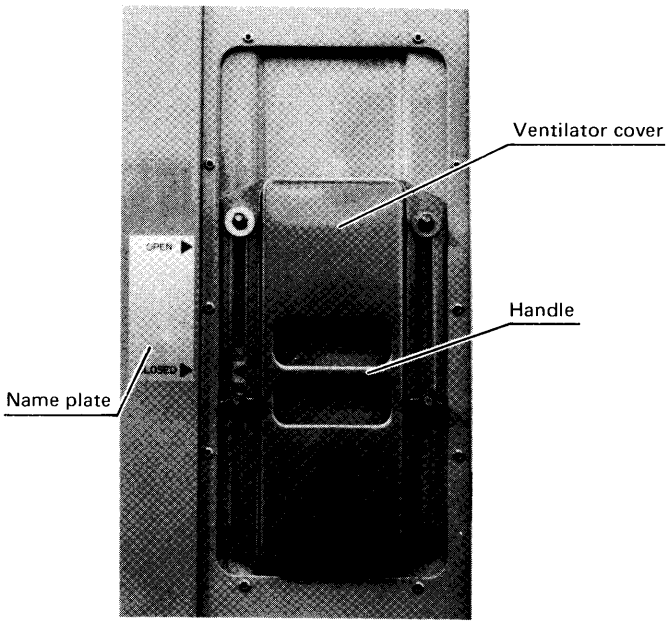


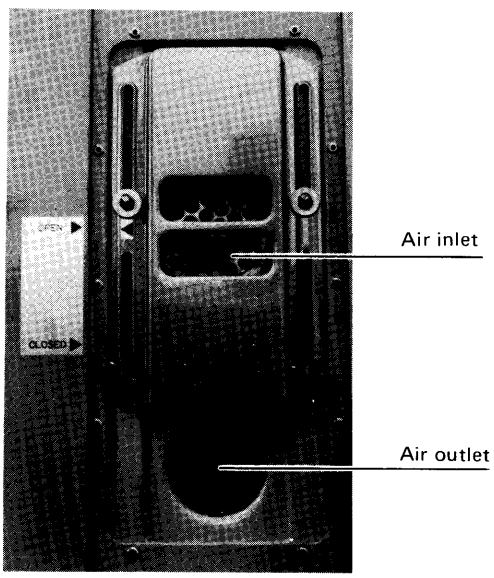
Condenser fan and motor

4.2.2 Ventilator

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

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





4.3 Temperature control system

This unit performs temperature control in three modes.

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

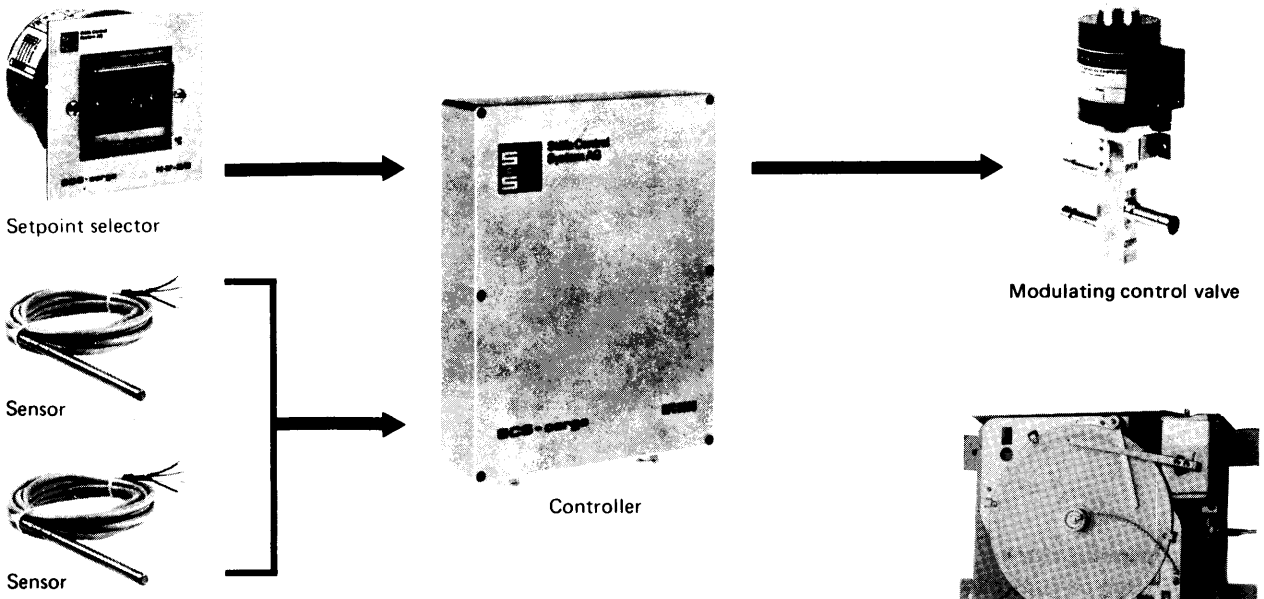
II Chilled-operation: capacity control by hot gas bypass

III Heating operation: capacity control by hot gas bypass and electric heater control.

} Supply air temperature is controlled (supply air sensor).

Selecting one of these operating modes automatically, the temperature control system controls the inside temperature according to the preset temperature.

- The supply and return sensors will be automatically switched according to the preset temperature.
- Adoption of a check instrument makes it possible to know the control state easily.
- Recorder continuously records the delivery air temperature inside the container, and the chart is driven by the spring-wound clock.



4.3.1 Sensor FC-KTRP

The supply air and return air sensors are identical.

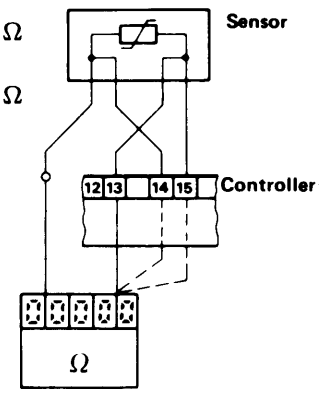
- Element ——— PT100 Ω (0°C)
- Connection ——— with four leads

(a) Checking operation

- Supply air sensor

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

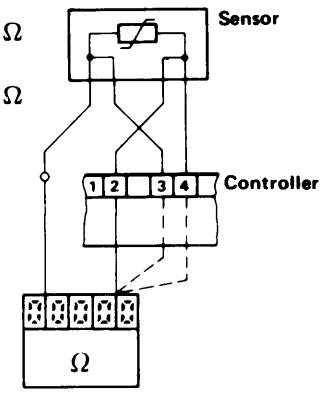
Terminal 13:	88 – 111 Ω
Terminal 14:	0 Ω
Terminal 15:	88 – 111 Ω



- Return air sensor

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

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

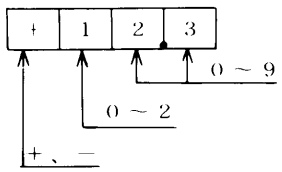


- Temperature vs. resistance table

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

4.3.2 Setpoint selector PC-RP30/30

Temperature setting is of digital indication. Press the buttons arranged both upper and lower of each indication for setting.
Temperature range . . . . −29.9 ~ +29.9°C

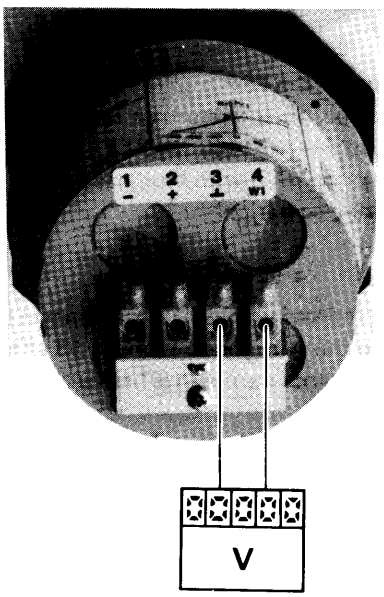


a. Operating check

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

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

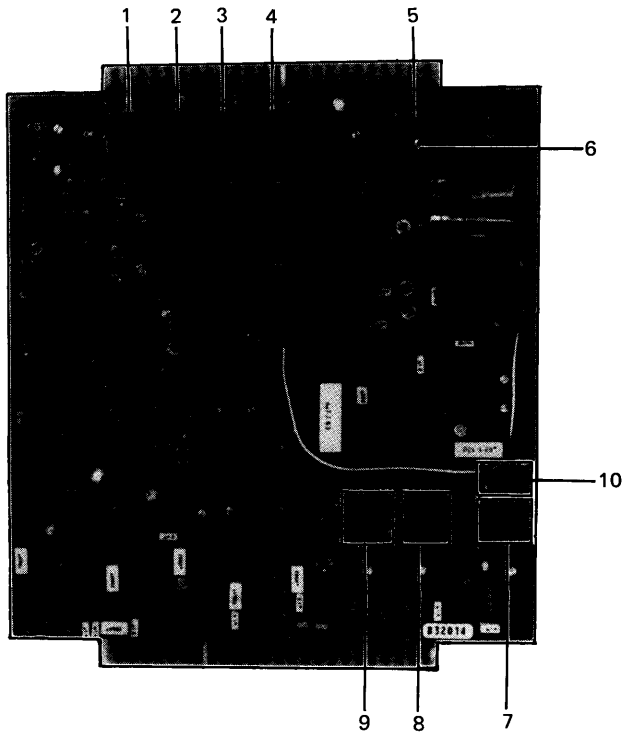
4. Setpoint adjustment
   −29.9 °C = 0.017 V
   0 °C = 5.000 V Terminal 3 (⊥) −4
   +29.9 °C = 9.983 V
   Tolerance ± 0.017 V



4.3.3 Controller RFC-92GS

According to the preset temperature, one of two sensors (supply or return) is selected to control the modulating control valve, compressor, and electric heaters and gives alarm at high and low limits of the inside temperature. In addition, according to controlled temperature, output is delivered to the recorder.

(a) Parts name



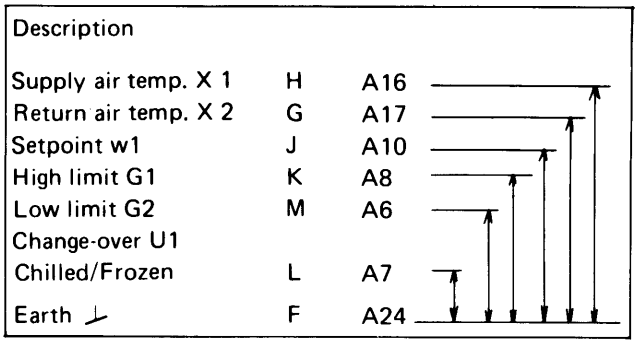
Item	Description		RMC Factor setting
1	High limit relay (In range)	G1	
2	Low limit relay (In range)	G2	
3	Mode change-over relay	U1	−4.5/−5°C
4	Y2 output relay	Y2	
5	Spare transistor fuse } (modulating valve for voltage output)	BC 107A	
6	Transistor fuse }		
7	Derivative action preset time potentiometer	TV [s]	10
8	Proportional band potentiometer (% of measuring range)	xp [%]	8
9	Integral action reset time potentiometer	TN [s]	60
10	Jumper line (for TV x 10)		

(b) Temperature-voltage conversion table

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

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

2. The change-over point (U1) between chilled and frozen modes are switched over is −4.5/−5°C when voltage is 4.25/4.1666V across A24-A7 of the terminal board (F-L of the receptacle).



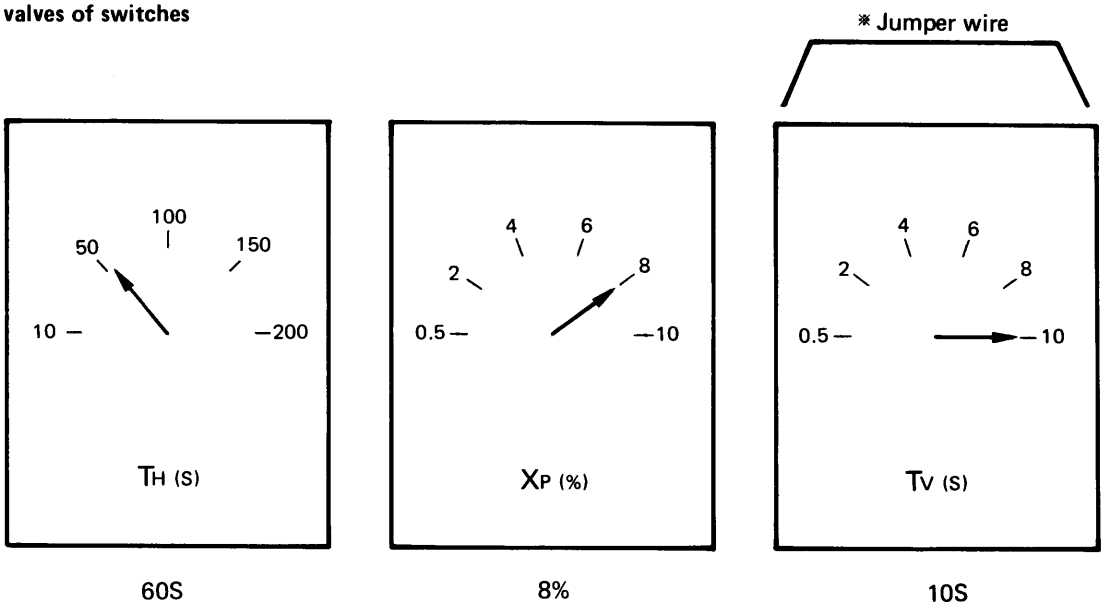
Temperature/voltage conversion table

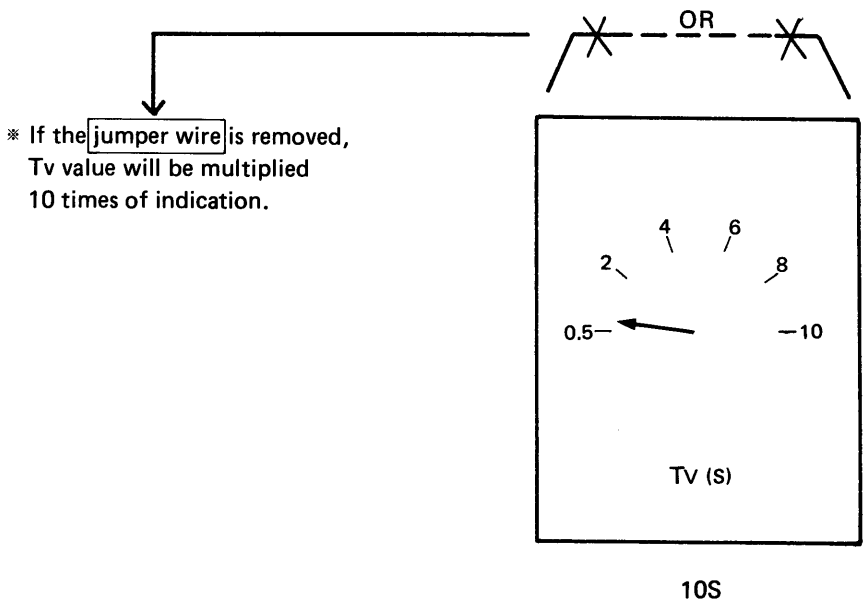
°C	V	°C	V	°C	V
−30	0	−10.0	3.3333	10.0	6.6666
−29.5	0.0833	− 9.5	3.4166	10.5	6.750
−29	0.1666	− 9	3.5	11	6.8333
−28.5	0.250	− 8.5	3.5833	11.5	6.9166
−28	0.3333	− 8	3.6666	12	7.0
−27.5	0.4166	− 7.5	3.750	12.5	7.0833
−27	0.5	− 7	3.8333	13	7.1666
−26.5	0.5833	− 6.5	3.9166	13.5	7.25
−26	0.6666	− 6	4.0	14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

[Note]

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

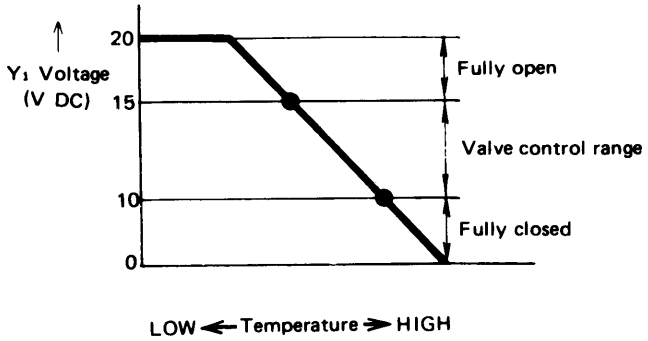
(c) Setting valves of switches





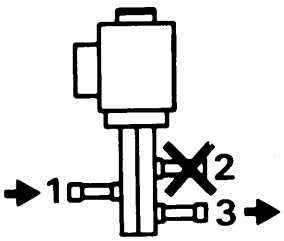
4.3.4 Modulating control valve M3F15L

Output (Voltage Y_1) of the controller drives this valve. As a two-way valve, this controls the flow of hot gas bypass continuously. The valve opening may be read from voltage Y_1 with a checker.



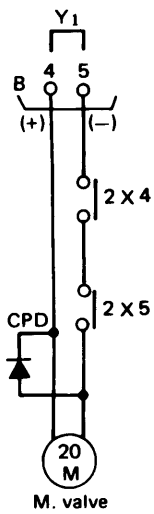
(a) Valve position

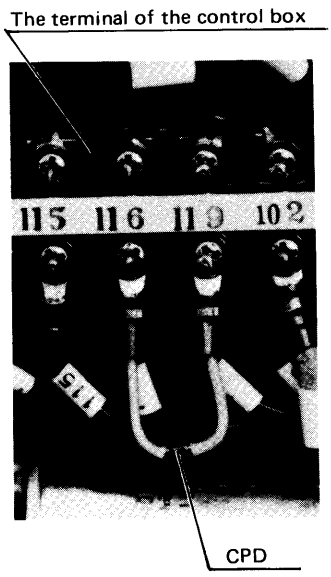
- De-energized period: 1–3 closed
- The coil resistance of the valve is approximately 20Ω at 21°C.



(b) CPD (contact protective diode)

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

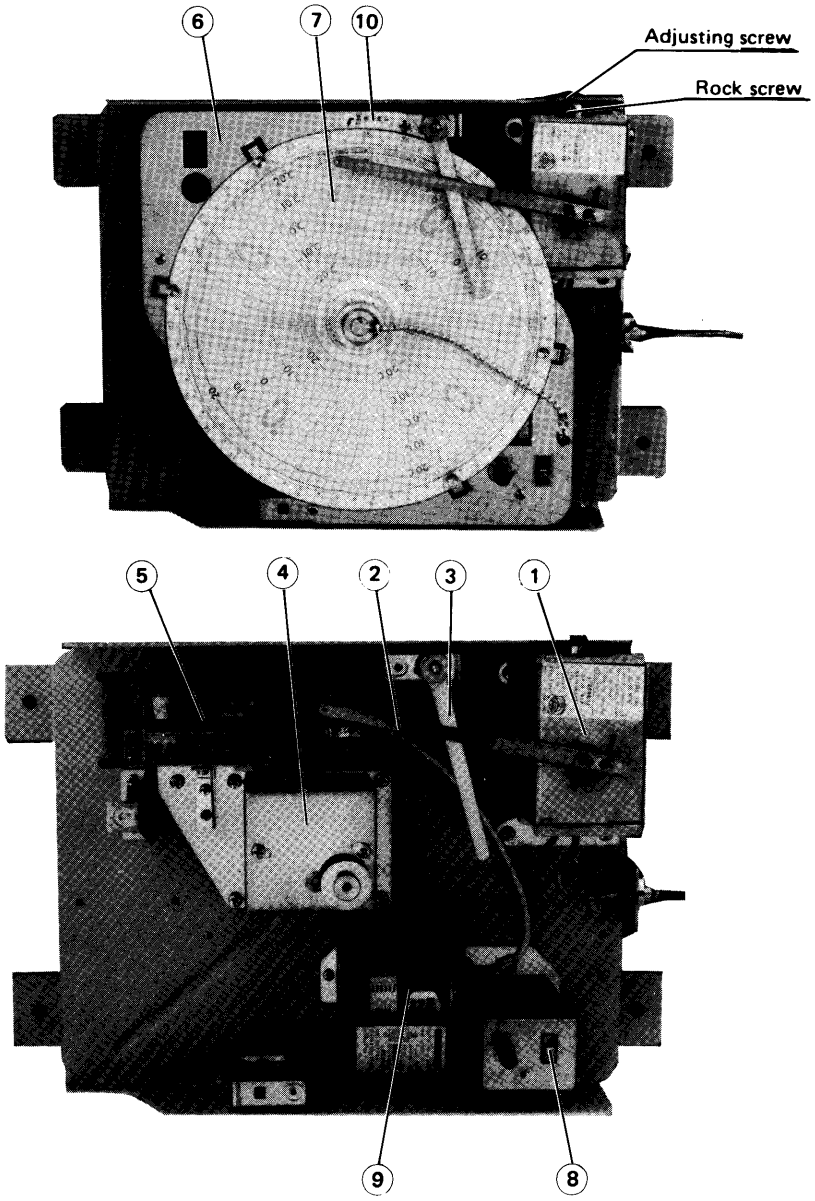




4.3.5. Recorder

1. Specifications

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



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

2. Inspection of recorded temperature

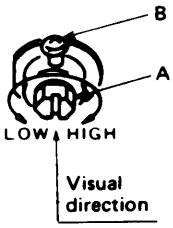
1) Recording pen on chilled mode

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

3. Adjustments

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

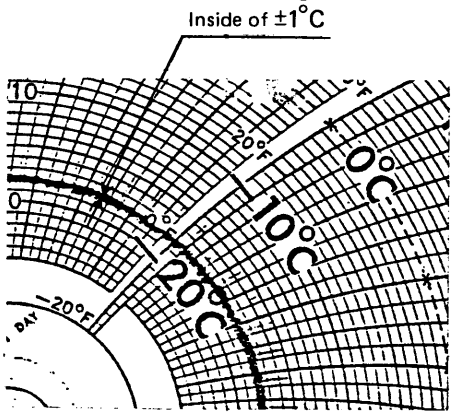
2) Turn the temperature setting screw (A) to adjust the temperature. Loosen the lock screw (B) and turn the setting screw (A) clockwise to temporarily raise the temperature setting by approximately 5°C.
Then turn the setting screw (A) counterclockwise to lower the temperature setting of the pen until the temperature is adjusted to 0°C or −18°C.
Tighten the lock screw (B) after the adjustment.



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

3) Generally a temperature recorder should be adjusted at 0°C, but the following method is avairable when the setting temperature is known.
- Chilled mode (Setting temperature above −5°C) . . . . . "Adjust at 0° C."
- Frozen mode (Setting temperature below −5°C) . . . . . "Adjust at − 18° C."

4) Inspection and adjusting method
1. Adjust a temperature recorder when the container inside temperature becomes decreasing.
Temperature recorder's pen shows the temperature correctly when it is decreasing. Don't adjust it when the temperature become increasing.
It is caused from its hysteresis that a pen sometimes shows the temperature lower from 1°C to 3°C when the temperature is increasing.
2. It is a normal phenomina that the recording curves are a little influenced by the fluctuations of the ambient temperature. (Note: Basically the temperature recorder is designed for 25°C ambient, and 10°C fluctuations of the ambient temperature cause the error of ±0.2°C.)
3. A temperature recorder adjusted at 0°C sometimes shows the following curves at −18°C inside. It is a normal and allowable range.



If the range exceeds the above, readjust it at 0°C (or −18°C)

4. Don't move the pen by hand, because it will cause an increase of error.
5. When the pen is holded by the pen lifter the pen may move unsmoothly, but it is no problem.

4. Replacement of parts

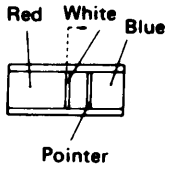
1) Battery

a) Replacement interval

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

b) Replacement method

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



Residual voltage indicator

2) Residual voltage indicator battery

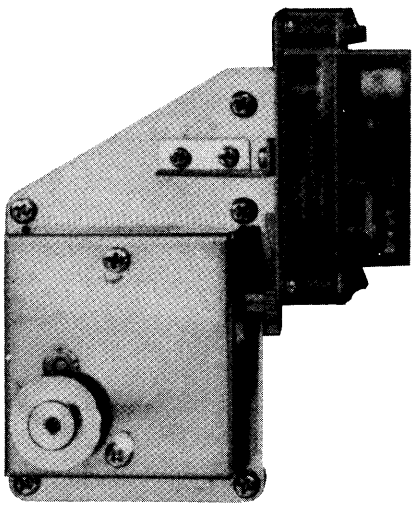
a) Replacement interval

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

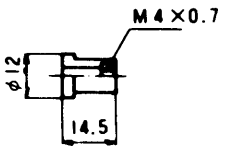
b) Replacement method

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

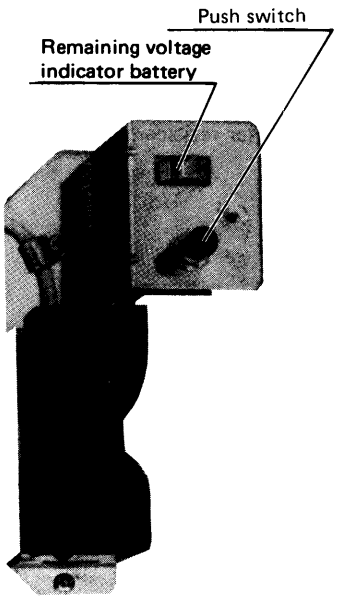
- Battery is to be replaced every 12 months.



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



Accessory (anti-vibration rubber : 5 pcs)



Residual voltage indicator battery (DKM-AA003)

3) Timer (quartz motor speed reducing gear)

a) Replacement interval

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

b) Replacement method

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

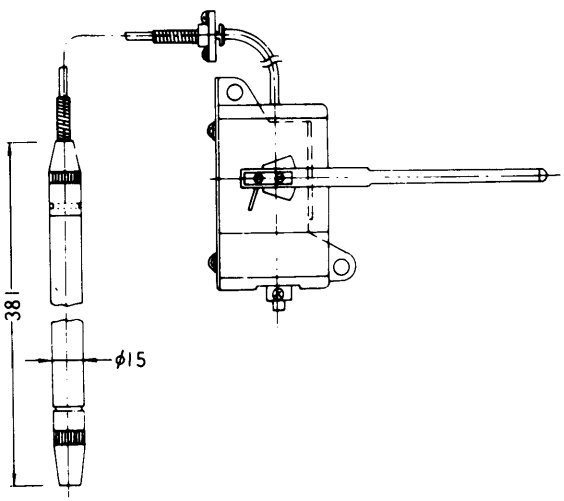
4) Thermal feeler bulb

a) Replacement interval

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

b) Replacement method

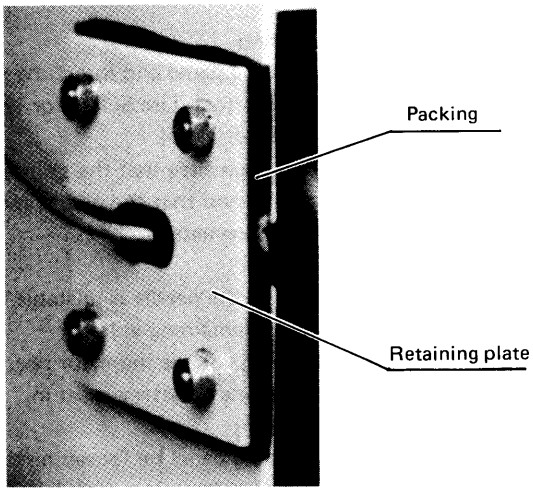
- Loosen the screw and remove the thermal feeler bulb − element. Replace it with a new one.
- After replacement, inspect and adjust.



Thermal feeler bulb − element (DKM-AA001)

- **Note**

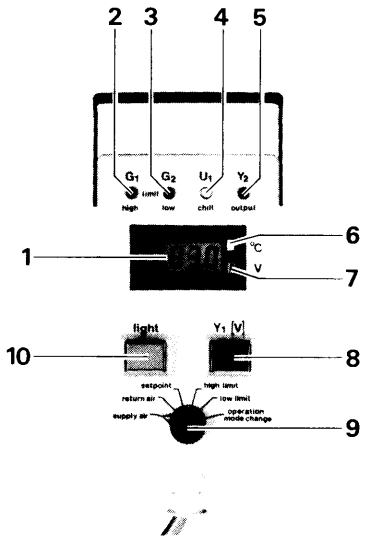
  In case of fitting a capillary set plate and a packing, be sure not to stand out them from the edge of a control box.



4.3.6 Check instrument

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

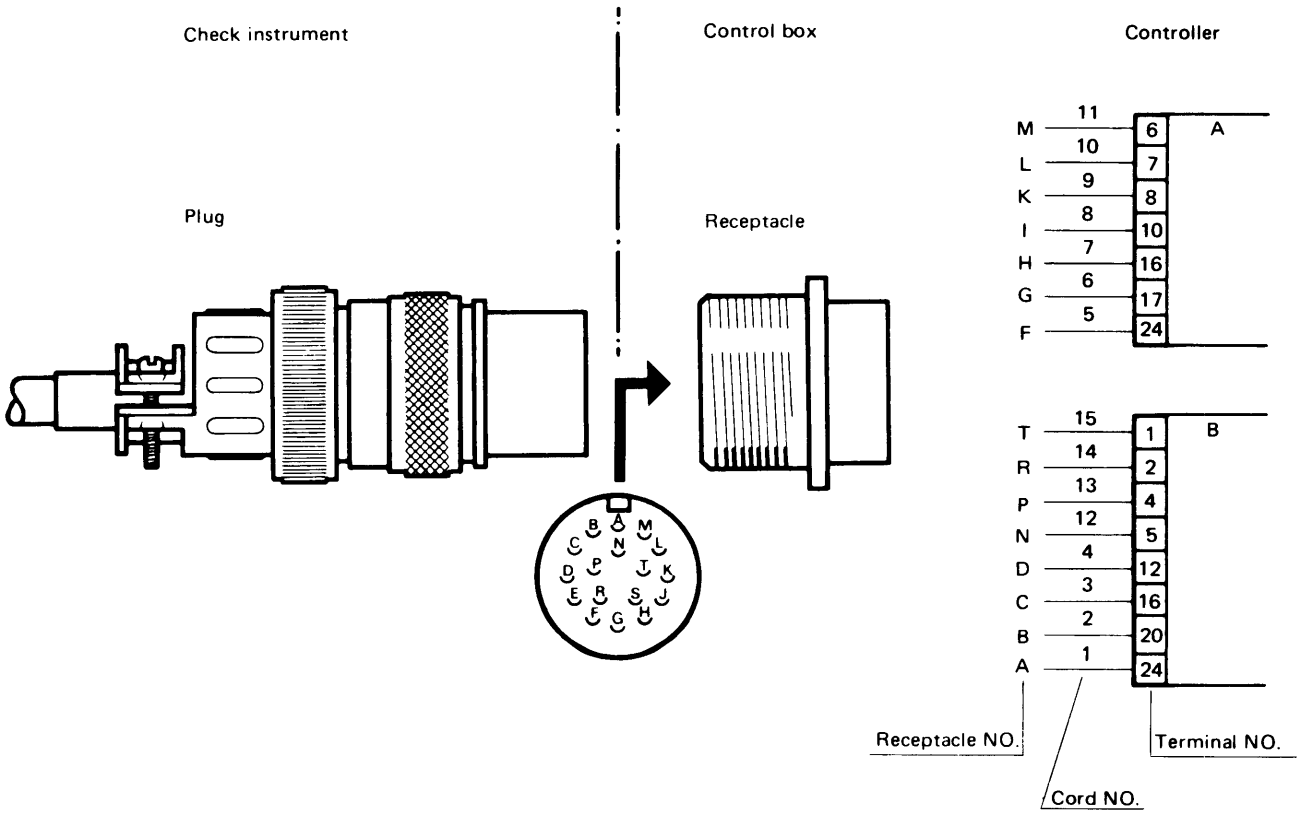
Note: When the check instrument is used do not subject it to direct sun light. Further, each inspection and adjustment should be done after 10 ~ 20 minutes energization.



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

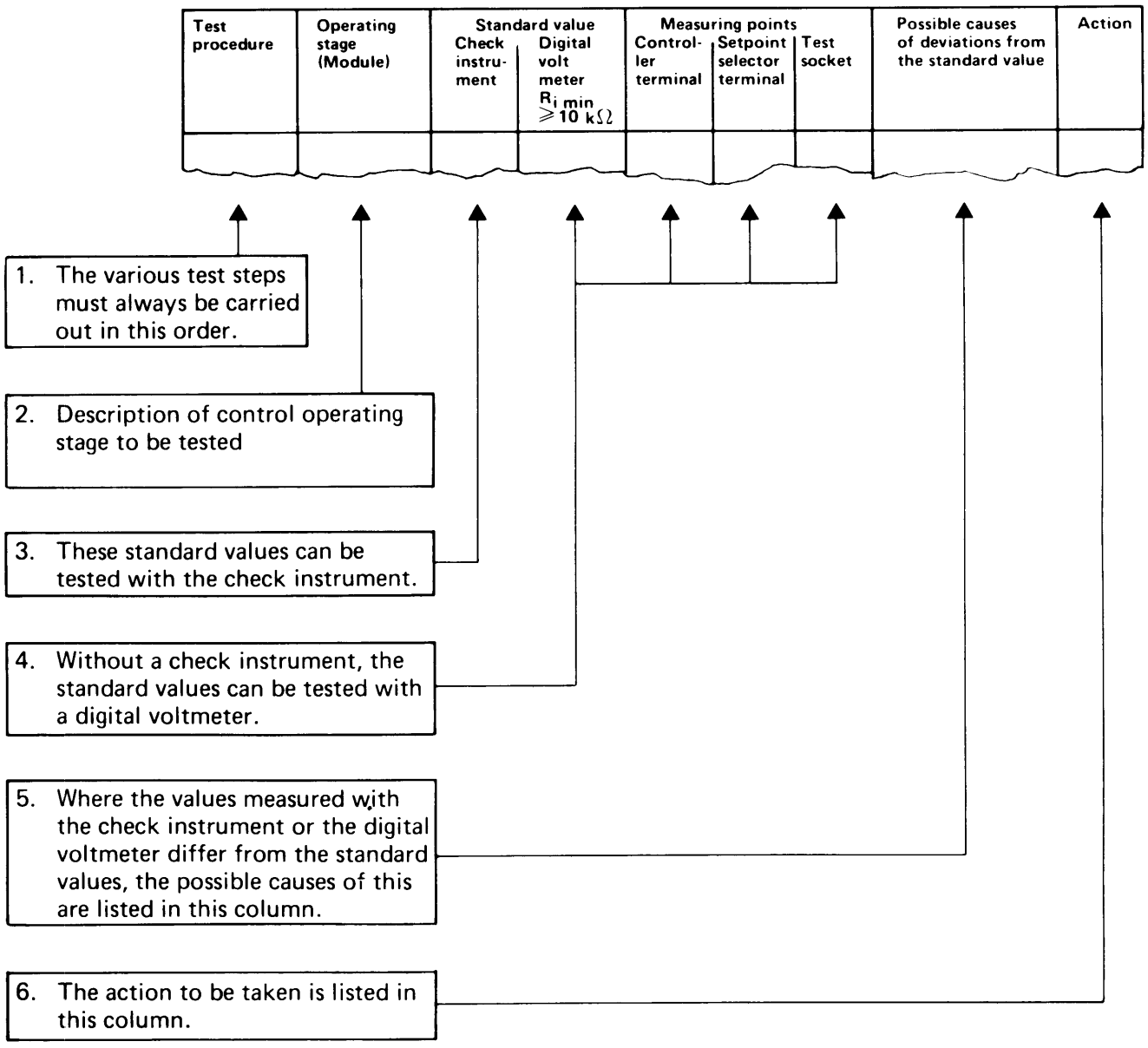
10 Scale illumination button

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



4.3.7 Checking operation of the controlling devices

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



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

Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min ⩾ 10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
5a			0...10V DC see table "temperature/voltage convertion"	A24 A16		F H	Controller and test socket disconnected	Check wires and connections
							Controller and sensor disconnected	Measure sensor resistance. See table page "temperature VS. resistance" Replace defective sensor
								If the sensor is in order, replace controller board
6	**Return air sensor** (sensor signal X_2)	Selector in "return air" position. Indication of same value as the temp. measured in the return air (−30...+30°C)					Disconnection	Measure with digital voltmeter as per test procedure 6a
6a			0...10V DC see table "temperature/voltage convertion"	A24 A5		F G	Controller and test socket disconnected	Check wires and connections
							Controller and sensor disconnected	Measure sensor resistance See table page "temperature VS. resistance" Replace defective sensor
								If the sensor is in order, replace controller board
7	**Controller output Y_1** (to control valve)	Depress blue button "Y_1 [v]"					Connection between controller and test socket reversed	Check wires and connections
	Set setpoint selector at −29°C	Indication 0V					Controller and test disconnected	Check wire and connections
	Set setpoint selector at +29°C	Indication 15...20V DC						Measure with digital voltmeter as per test procedure 7a
7a			0...20V DC	B4(+) B5		P (+) N	External short circuit between terminals B4 and B5 on controller	Rectify short circuit (protective diode (CPD), see "MC valve"
							Transistor fuse defective	Replace transistor fuse see "controller-b"
8	**Controller output Y_2** (on/off)							Check wires and
	Set setpoint selector at +29°C	Lamp Y_2 illuminated					Controller and test socket disconnected	Measure with digital voltmeter as per test procedure 8a
	Set setpoint selector at −29°C	Lamp Y_2 off					Connection between and test socket reversed	

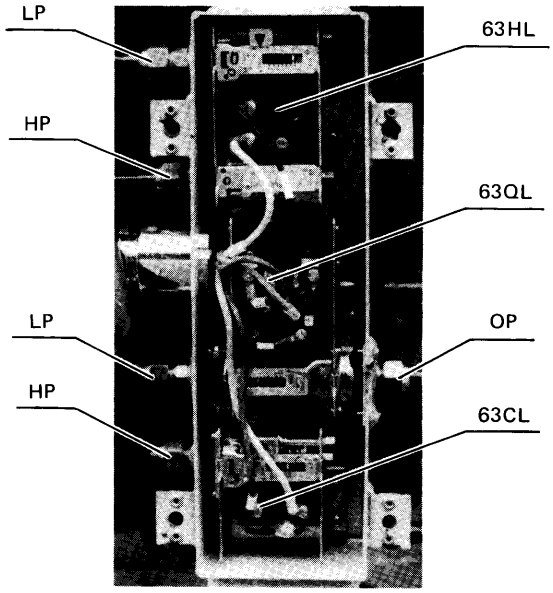
Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min ⩾ 10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
8a	Set sepoint selector at −29° C		0V			P D	Connection between controller and test socket reversed	Check relay Y_2 −29° C = B11–B9 (contact closed) +29° C = B11–B10 (contact closed)
				B4 B12			Controller defective	
	Set setpoint selector at +29° C		22V DC +15 % −10 %			P D	Controller and test socket disconnected	Check wires and connections
				B4 B12			Controller defective	Replace controller board
9	**Alarm unit G_1** "temperature" too high	Selector in high limit position Indication 2° C higher then setpoint Tolerance ±0.3° C					Controller and test socket disconnected	Check wires and connections
	Set setpoint selector at −29° C	Lamp G_1 illuminated after approx. 20 s					Controller and test socket disconnected	Check wires and connections
	Set setpoint selector at +29° C	Lamp G_1 off					Connection between controller and test socket reversed	Measure with digital voltmeter as per test procedure 9a
9a	Set setpoint selector at −29° C		0 V after approx 20s			P A	Connection between controller and test socket reversed	Test relay G1 "controller-b" −29° C = B23–B21 (contact close) +29° C = B23–B22 (contact closed)
				B4 B24			Controller defective	Check wises and connections
	Set setpoint selector +29° C		22V DC +15 % −10 %			P A	Controller and test socket disconnected	Replace controller board
				B4 B24			Controller defective	
9b								
10	**Alarm unit G_2** "temperature" too low	Selector in "low limit" position Indication 2° C lower then setpoint Tolerance ±0.3° C						
	Set setpoint selector at +29° C	Lamp G2 illuminated after approx. 20 s					Controller and test socket disconnected	Measure with digital voltmeter as per test procedure 10a
	Set setpoint selector at −29° C	Lamp G2 off					Connection between controller and test socket reversed	Check wires and connections

Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min ⩾ 10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
10a	Set setpoint selector at −29°C		22V DC +15% −10%			P B	Controller and test socket disconnected	Check relay G2 "controller-b" −29.9°C = B19−B18 (contact closed) +29.9°C = B19−B17 (contact closed)
				B4 B20			Controller defective	Check wires and connections
	Set setpoint selector at +29°C		0V after approx. 20s			P B	Connection between controller and test socket reversed	Replace controller board
				B4 B20			Controller defective	
10b								
11	Operating mode change over U_1	Selector switch in operation mode change position Indication −4.5°C Tolerance ±0.3°C						
	Set setpoint selector at −29°C	Lamp U_1 off					Connecting between controller and test socket reversed	Measure with digital voltmeter as per test procedure 11a
	Set setpoint selector at +29°C	Lamp U_1 illuminated					Controller and test socket disconnected	Check wires and connections
11a	Set setpoint selector at +29°C		22V DC +15% −10%			P C	Controller and test socket disconnected	Check relay U1 +29°C = B15−B14 (contact closed) −29°C = B15−B13 (contact closed)
				B4 B16			Controller defective	Check wires and connections
	Set setpoint selector at −29°C		0V			P C	Controller and test socket connections reversed	Replace controller board
				B4 B16			Controller defective	
11b								

4.4 Description on electrical and functional parts.

4.4.1 Dual pressure switch (63HL)

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

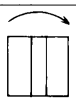
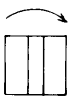
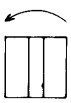


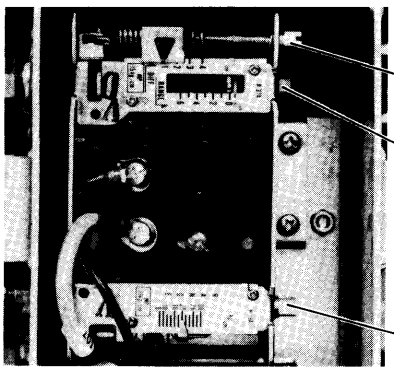
LP : Low pressure
HP : High pressure
OP : Oil pressure

(a) Adjustment method

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

Adjusting points of dual pressure switch

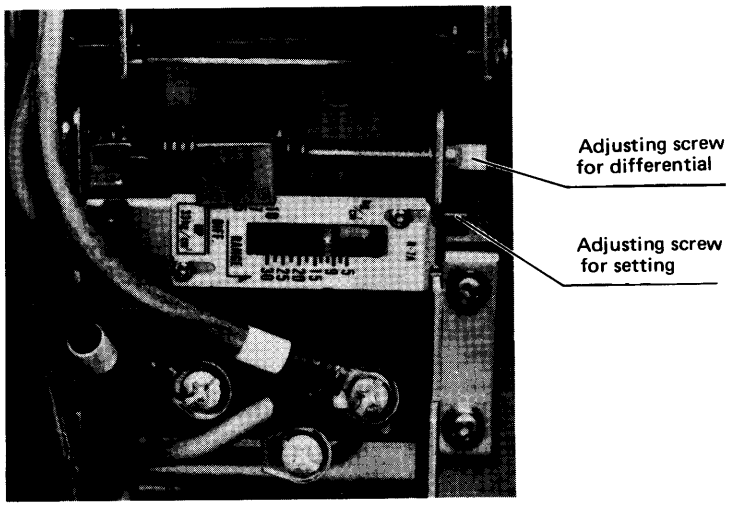
	Adjusting screw	Rotary direction		Function
High pressure side	Setting of adjusting screw	Clockwise		Setting (OFF value) becomes high, and pressure at the stopping of the refrigeration unit becomes high.
		Counter-clockwise		Setting (OFF value) becomes low, and pressure at the stopping of the refrigeration 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 High pressure control pressure switch (63CL)

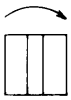
If the ambient temperature is low during air cooled operation, two out of three condenser fans are turned off so that the high pressure should not fall. (As for more details, refer to "high pressure control")



(a) Adjusting method

Adjust the adjusting screw as staged below.

Adjusting points for high pressure control switch

Adjusting screw	Turning direction		Function
Adjusting screw for setting	Clockwise		Setting value (ON value) becomes low and fan speed increases
	Counter-clockwise		Setting value (ON value) becomes high and fan speed decreases
Adjusting screw for differential	Clockwise		Pressure difference between ON and OFF becomes large and stopping period of certain fans is prolonged.
	Counter-clockwise		Pressure difference between ON and OFF becomes small, and stopping period of certain fans is shortened.

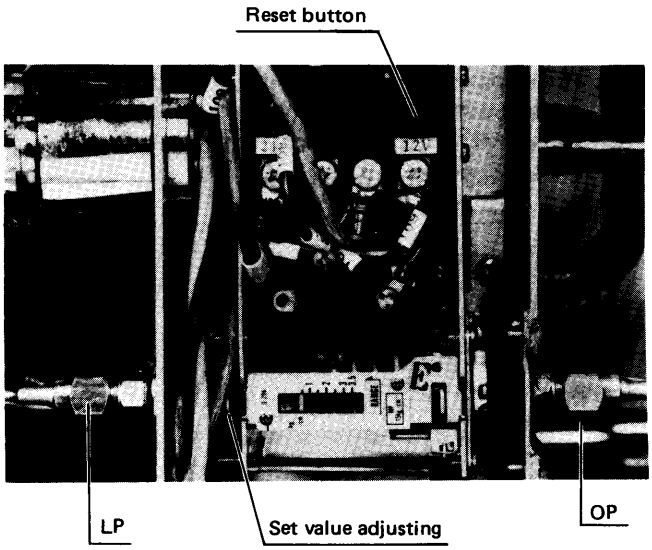
Notes: 1) In case it is necessary to adjust the adjusting screw for differential, be sure to adjust setting first and then differential.

2) After adjustment of the adjusting screws, be sure to apply the following chemical to the bolt heads to prevent them from loosening by vibration.

4.4.3 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.

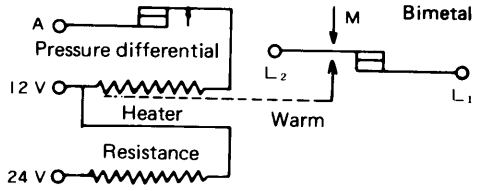


(a) Operation

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.

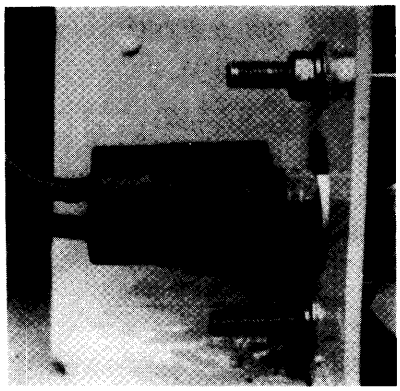
Adjusting points for oil pressure protection switch

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.

4.4.4 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.



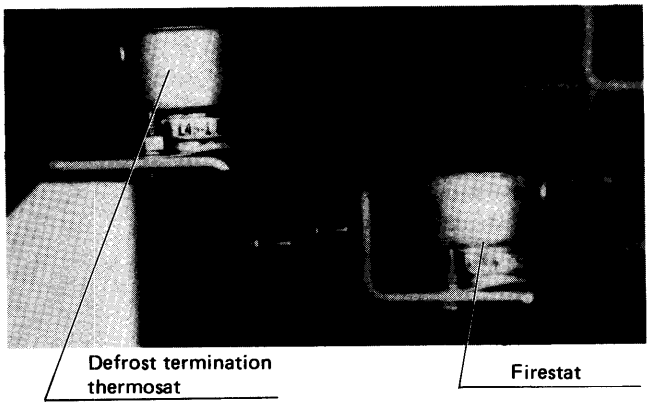
4.4.5 Defrost termination thermostat (23D)

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

OFF: 40°C
ON : 20°C

4.4.6 Firestat (26AH)

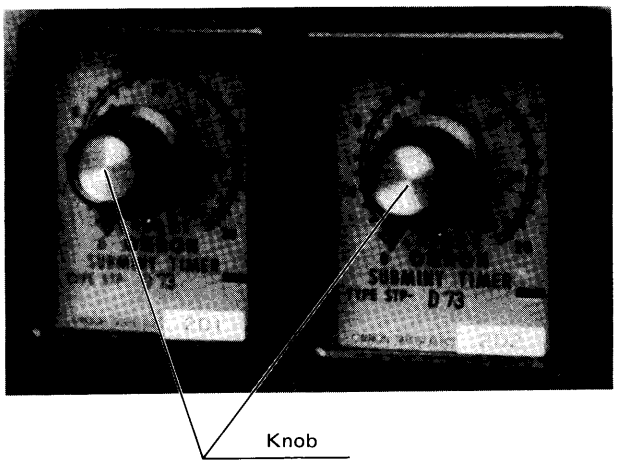
This prevents the electric heaters from overheating.
If the heaters is overheated, the ambient temperature around the thermostat rises and the thermostat cuts off the heaters.
OFF: 71°C
ON : 49°C



4.4.7 Defrost timer (2D1, 2)

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

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

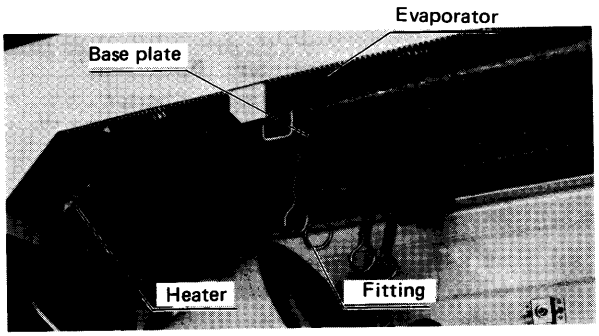


4.4.8 Electric heaters

Two kinds of electric heaters are used.

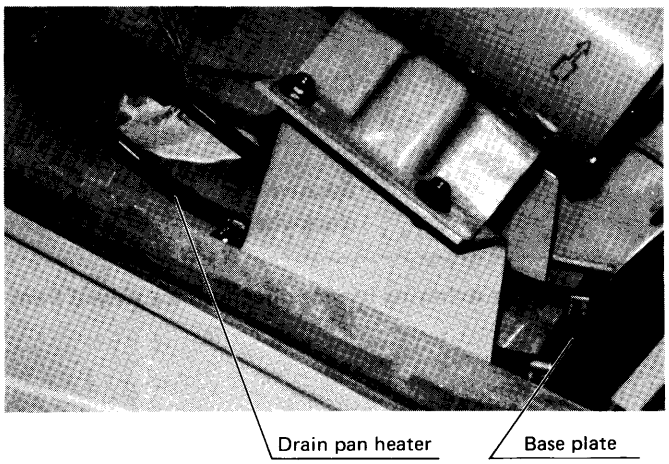
(a) Defrost heaters (220V AC, 0.65 kW x 6)

These are fitted at the bottom of the evaporator.
H1 through H6 are used for defrosting. H1 and H2 are used as auxiliary heaters during heating operation.
To replace them, lift the fittings up and remove them together with the base plate.

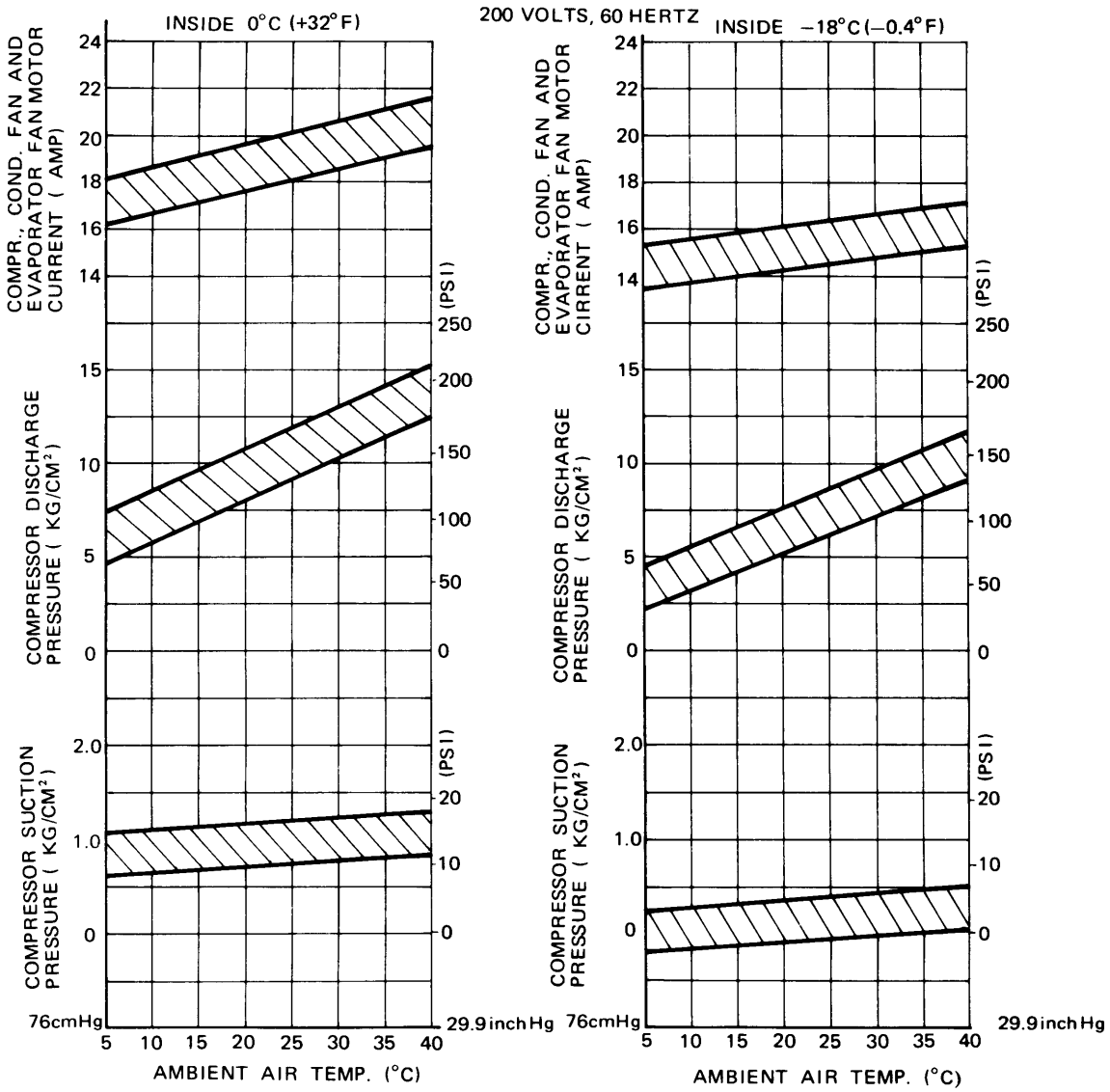


(b) Drain pan heaters (220V AC, 0.3kW x 2)

These are fitted on the drain pan to prevent the drain port from freezing (H7 and H8).



5. Operating pressure and running current



< For reference >

	Item		Unit	Value
1	Heater current – during defrosting Measure at primary side of 88H		A	11.5 (AC 220V)
2	Running current of condenser fan motor		A	0.7 (AC 220V)
3	Running current of evaporator fan motor		A	3.0 (AC 220V)
4	Bolt tightening torque	Compressor	kg·cm/lb·Ft	240 ± 20/17.3 ± 1.4
		Compressor stop valve flange		140 ± 15/10.1 ± 1.1
		Fan motor		70 ± 7/5.0 ± 0.5
		Solenoid valve		75 ± 5/5.4 ± 0.4
		Expansion valve		140 ± 10/10.1 ± 0.7

6. Troubles and countermeasures

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

Troubles and countermeasures

State	Phenomena	Functioning places	Cause	Countermeasures
I. Cooling operation inoperative	A: Condenser evaporator fans and compressor are inoperative.	a. No trouble with unit	● Current interruption	● Trace cause
			● Power source is disconnected.	● Connect power source plug to power source.
		b. Circuit breaker functions	● It functions due to over current.	● Trace causes and replace.
	B: Evaporator fans operative but condenser fans and compressor inoperative.	a. No trouble with unit	● Thermostat functions and stops operation.	
			● Temperature setting is high.	Readjust temp. setting as designed.
		b. Oil pressure control	● It is not reset yet.	Repair trouble and push down reset button.
		c. Solenoid valve does not function.	● Coil is cut out.	Replace it.
		d. Malfunction of controller.	●Sensor is damaged or other reasons.	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.	● Oil pressure will not rise. ● Oil is short or oil pump is out of order.	Additional oil charge, or repair oil pump.
		b. No trouble with unit	● Thermostat functions and stops unit	
	B: Condenser fans and compressor operate on and off repeatedly with evaporator fans in operation.	a. Pressure switch functions. ● High pressure side	● Excessive charge of refrigerant.	Discharge refrigerant.
			● Air in system	Air purge
			● Insufficient air flow for air cooled operation.	
			● Condenser or passage clogged.	Clean or remove obstacles.
			● Fan blade damaged.	Repair or replace.
			● Fan motor does not rotate.	
			Capacitor inoperative.	Replace it.
			Fan motor thermostat has functioned.	Trace causes.
			Insufficient water volume for cooling operation.	
			● Condenser is clogged with scale.	
		● Lower pressure side	Insufficient refrigerant charge	Additional charge, seek leaking positions and repair.
			Dryer clogging	Replace
			Moisture chokes.	Exchange dryer.
			Gas leakage from feeler tube of expansions valve.	Exchange it.
		b. Over-current relay or compressor protection thermostat has functioned.	Excessive large current due to over-load operation.	Trace causes.

State	Phenomena	Functioning places	Cause	Countermeasures
III. Inside temp. is lower than temperature setting	A: Compressor inoperative.	a. Solenoid valve will not close.	Clogged with dust.	Replace it.
		b. Controller does not function.	Sensor is disconnected	Replace it.
		c. Sensor is installed wrongly.		Reattach it.
	B: Hotgas bypass does not work	Modulating control valve does not open	Clogged with dust	Repair or replace
			Controller is defective	Replace transistor or controller
IV. Inside temperature does not drop	A: Inside temperature does not reach to preset temperature (Fans and compressor work)	a. Modulating control valve does not close.	Stuffing of duct, etc.	Repair or replace valves.
		b. Capillary tube is defective	Clogged with dust	Repair or replace
V. Inside temperature is not stable	A: Inside Temperature is not stable during chilling and heating operations (Fans and compressor work properly)	a. Opening of modulating control valve (valve control valtage Y_1) is not stalbe	Controller is improperly adjusted	Adjust or replace
VI. Heating	A: Heater is inoperative.	a. No trouble with unit	Setting of set point selector is under −5.0°C.	
		b. Firestat	Insufficient evaporator air volume	
VII. Defrosting operation	A: Defrosting and refrigerating operation are repeated in a short period of time.	a. Defrost timer makes an error.	Improper adjustment	Readjustment.

7. PTI (Pre Trip Inspection)

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

Example of container refrigeration unit inspection card

Installed ship name		Date of inspection	
Container No.		Place of inspection	
Loaded cargo		Unit Model No.	
Customer's staff		Unit No.	
Service staff		Compressor No.	

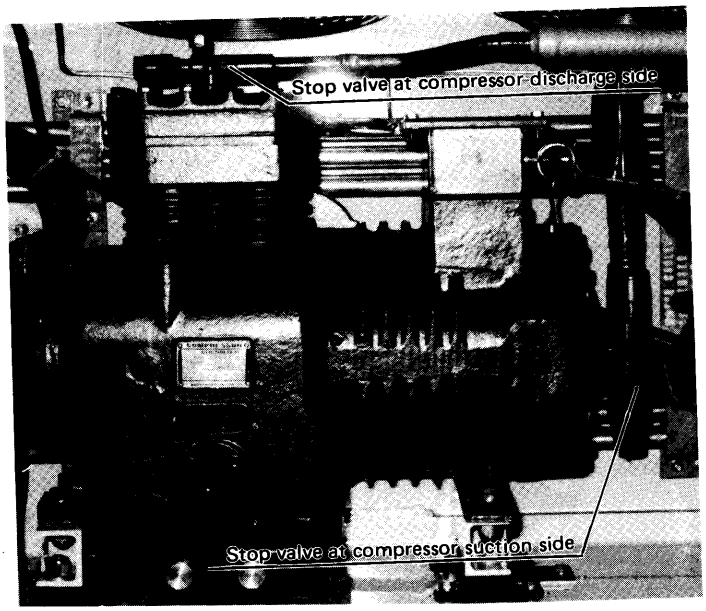
Chek	No.	Check point		Check mathod	Reference value
	1	External appearance of importants parts of container (doors, equipment mount, damaged points)		Visual	
	2	Cleaning interior and exterior of container		Visual	
	3	Checking the smudge of the unit (air-cooled condenser, evaporator)		Visual	
	4	Checking "through" points inside and outside unit		Visual	
	5	Checking for leakage from refrigerant system (joints)		Halide torch	
	6	Checking external appearance of power cable and plug		Visual	
	7	Cleaning drain hose		Visual	Shall be free from clogging
	8	Cleaning defrost air hose and checking to ensure that there is no trap		Visual	Shall be free from clogging
	9	Mounted condition of electric heaters		Visual	Make sure that leads are not in contact with heaters
	10	Checking exterior of firestat		Visual	Shall have no damaged part
	11	Tightened condition of cable glands and monitoring receptacle		Retighten with tool	Make sure that they are firmly tightened
	12	Checking condenser and evaporator fan motors for vibration and noise		Touch and listen	
	13	Checking amount of circulating refrigerant		Check liquid indicator	Make sure that it is sealed
	14	Checking for water in refrigerant		Check liquid indicator	Deep blue
	15	Checking compressor oil level (operating condition)		Check compressor oil level gauge	⊖ (oil level 1/4～3/4)
	16	Checking operation and battery of recorder		Visual	
	17				
	18	Checking operation of controller and pilot lamps		Reefer check instrument	
	19	Checking operation of defrost initiation air switch		Check with U tube	20mmH$_2$O CUTIN
	20	Unit operating current R[ ] S[ ] T[ ]		Clamp meter	−18°C [ ] V [ ] Hz
	21	Unit insulation resistance	Compressor circuit [ ] MΩ	DC 500V megger	2MΩ or more
			Electric heater circuit [ ] MΩ		
			Evaporator fan circuit [ ] MΩ		
	22	Checking manual defrosting operation		Manual defrost switch	
	23	Checking operation of defrost termination thermostat (Completing temperature) [ ] °C		Mount thermistor to completion thermostat mounting position	OFF 40°C
	24	Electric heater operation and current R[ ] S[ ] T[ ]		Clamp meter	
	25	Checking operation of dual pressure swich	H-CUT OUT [ ] kg/cm²	Operate the air cooled condenser without fan operation	20 kg/cm²
			L-CUT OUT [ ] mmHgV	Accomplish pump down by use of the stop valve at the water cooled condenser outlet	400 mmHgV
			L-CUT IN [ ] kg/cm²		0.2 kg/cm²
	26	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
	27	Checking power supply changeover switch	Checking 400V class operation	Place changeover switch lever upward	
			Checking 200V class operation	Place changeover switch lever downward	

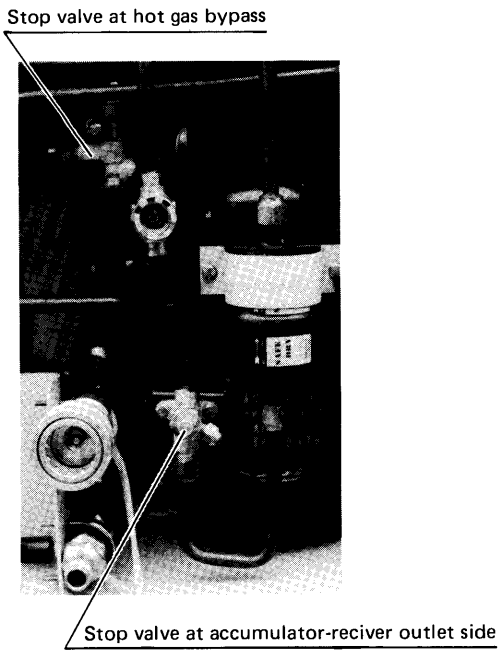
Chek	No.	Check point			Check mathod	Reference value	
	28	Storage temperature °C		0°C	−18°C	Automatic operation at −18°C	
		Ambient temperature °C					in one cycle
		LP kg/cm²					COMP OFF M
		HP kg/cm²					COMP ON M
		Operating time	Immediately after operation	Operation starting 0°C Hr M	Operation starting −18°C Hr M	Automatic operation at −18°C	Hr M
		Operation starting time					
	29	Checking automatic defrosting operation	Defrost time M				

8. How to maintenance

8.1 Handling method of the stop valve

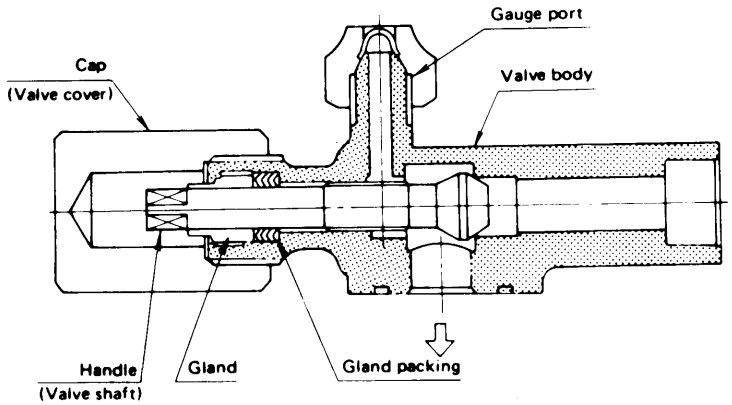
(1) Place of the stop valve and its kind



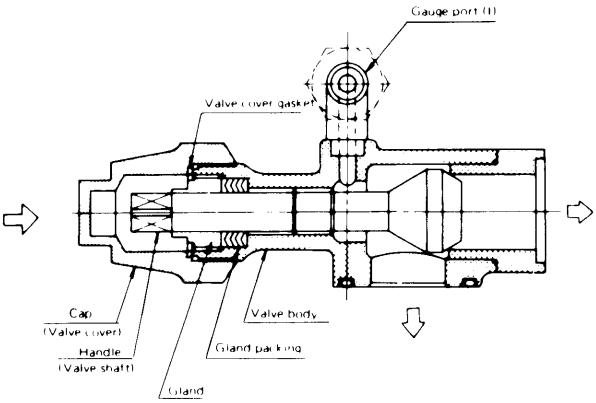


(2) Structure of stop valve

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

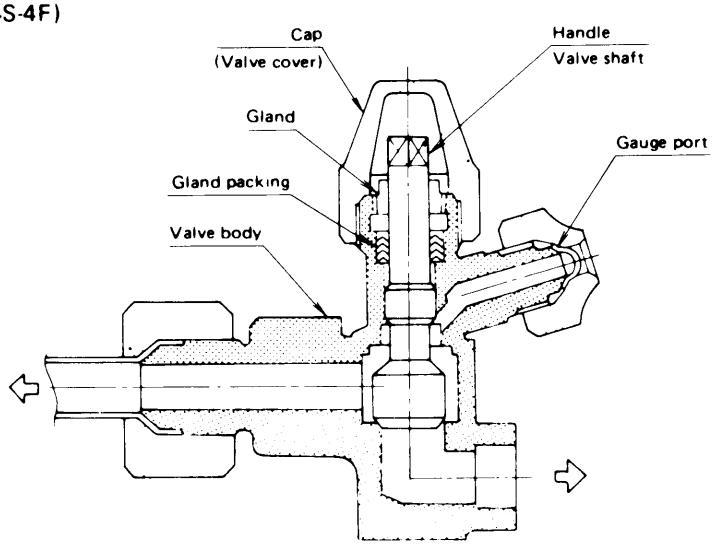


2 Stop valve at compressor suction side
(VSH22XBP)

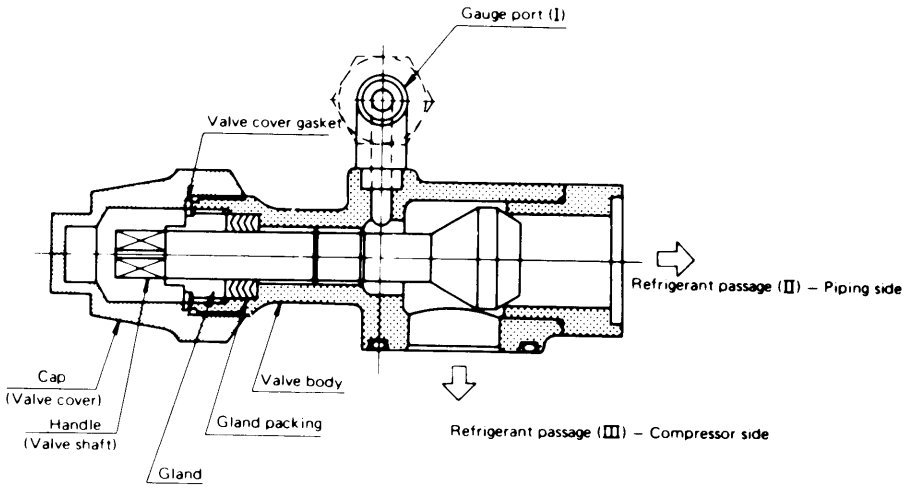


3. Stop valve at accumulator-receiver with heat exchanger outlet side

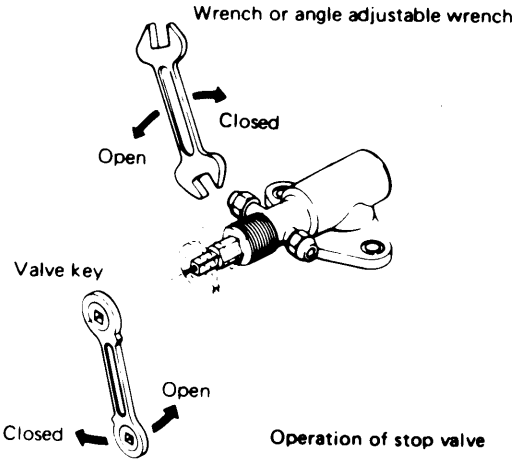
Stop valve at hot gas bypass
(VSV10CBP-4S-4F)



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

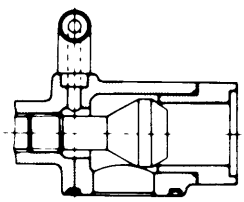


Operation of stop valve

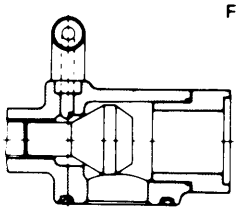
8.2 Attaching or removing points of pressure gauge

(1) Attaching a general pressure gauge

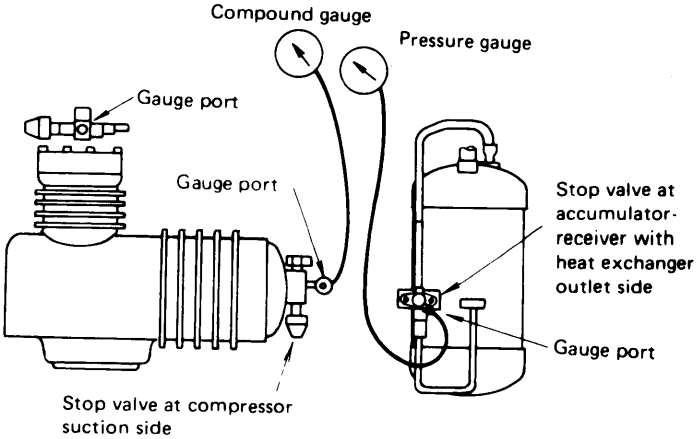
1) After opening the compressor suction valve and the accumulator-receiver valve fully (back seat), connect a pipe to the gauge port.
2) Loosen a little the flare nut on the pressure gauge side and tighten the handle of the stop valve a little (Middle seat) and return it at once. Thus the air is purged.
3) After purging the air, accurately tighten up the flare nut on the pressure gauge side.
4) Close the handle of the stop valve a little, and confirm that the needle of the gauge rises.
5) Be certain that the needle of the pressure gauge does not oscillate during the 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

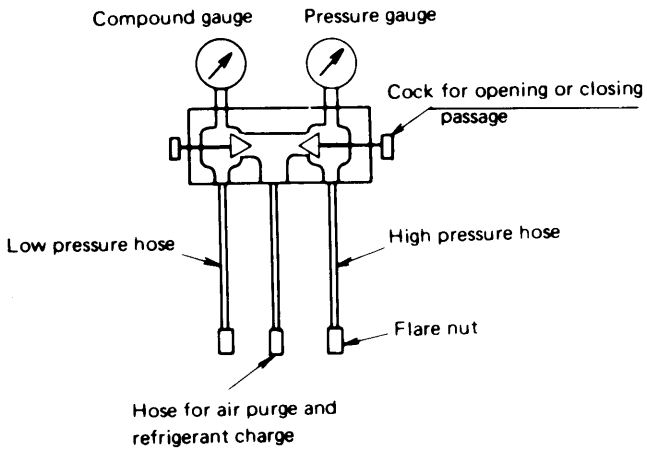


Back seat

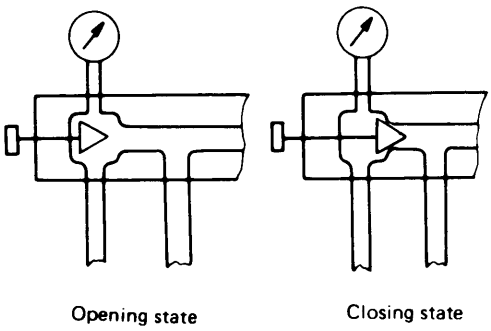


(2) Attaching the gauge manifold

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 care 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.

8.3 Pump down

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

< Working procedure >

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

8.4 Charging and purging the refrigerant

(1) Purging non-condensable gas

If non-condensable gas such as air exsits 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 exsists in the following method.

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

In this case, purge non-condensable gas as stated below.

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

(2) Refrigerant purge

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 atomosphere.

(a) Collecting the refrigerant in a cylinder

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

(b) Extracting the refrigerant to the atomosphere

1) Open the gauge port on the suction side of the compressor to extract the gaseous refrigerant to the atmosphere.
2) Do not open the compressor discharge valve or the gauge port of the accumulator-receiver with heat exchanger, otherwise the refrigerant oil and the liquid refrigerant are discharged, which may result in shortage of oil or getting 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

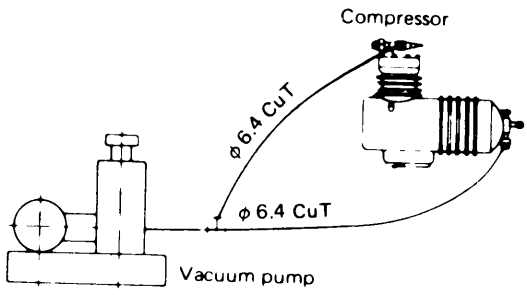
If all the refrigerant has leaked out and the air is intermixed in the refrigeration circuit, repair a cause of trouble and do vacuum drying. Then charge the predesigned volume of refrigerant. In case the refrigerant oil is replaced, do the same.

(Required tools)

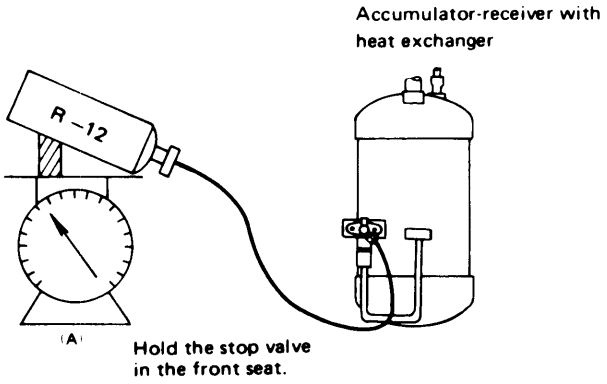
1. Refrigerant cylinder (20 kg) for R-12 (CCl_2F_2) with mouth piece
2. Refrigeration oil (20ℓ can) SUNISO 3GS-DI)
3. ϕ6.4 CuT (with two flare nuts)
4. Pressure gauge (20 kg/cm^2), compound gauge (10 kg/cm^2 x 75 cmHg) } or gauge manifold
5. Weighing scale (Up to 50 kg)
6. Tools
7. Vaccum pump

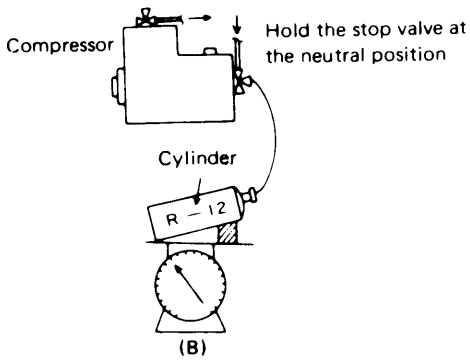
(a) In case the refrigerant is replenished without exchanging the refrigeration oil.

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 vaccum pump, leaving the vacuum state in the refrigeration circuit. However, when air enters in the refrigeration circuit, form the vaccum in the circuit down to 76 cmHg and leave it for more than 2 hours (vaccum 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.

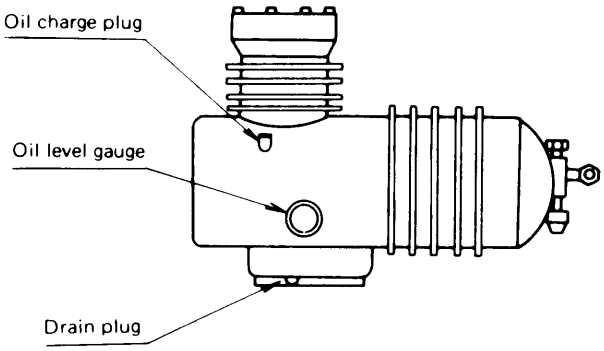




3) Place a refrigerant cylinder on the weighting scale, and record its weight.
4) In case the refrigerant is charged in the liquid state, do it as shown in the above figure (A). Prevent the liquid refrigerant collected in the accumulator-receiver with heat exchanger from flowing to the low pressure side. 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 atomosphere for a long time, as it may contain water. In case oil still remains in the oil can after charging, be sure to cap it.

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

1) Operate the refrigeration unit to pump down the refrigerant by use of the stop valve at the outlet of the 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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