DAIKIN

Marine type Container Refrigeration Unit

Service manual

Model

LKE8CD10 LKE8CD11

CSSU296000 TO CSSU296163
OCLU295800 TO OCLU295965

OCLU490150 TO OCLU490203

DAIKIN INDUSTRIES, LTD.

TR85—08

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

- Parts list
- Compressor disassembly & reassembly manual.

Please refer also to these manuals.

DANGER

Do not disconnect plug until power supply is switched off.

CAUTION

Do not start the unit until plugs are connected and generator plant is operating.

NOTE

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

WARNING

DEFROST OPERATION

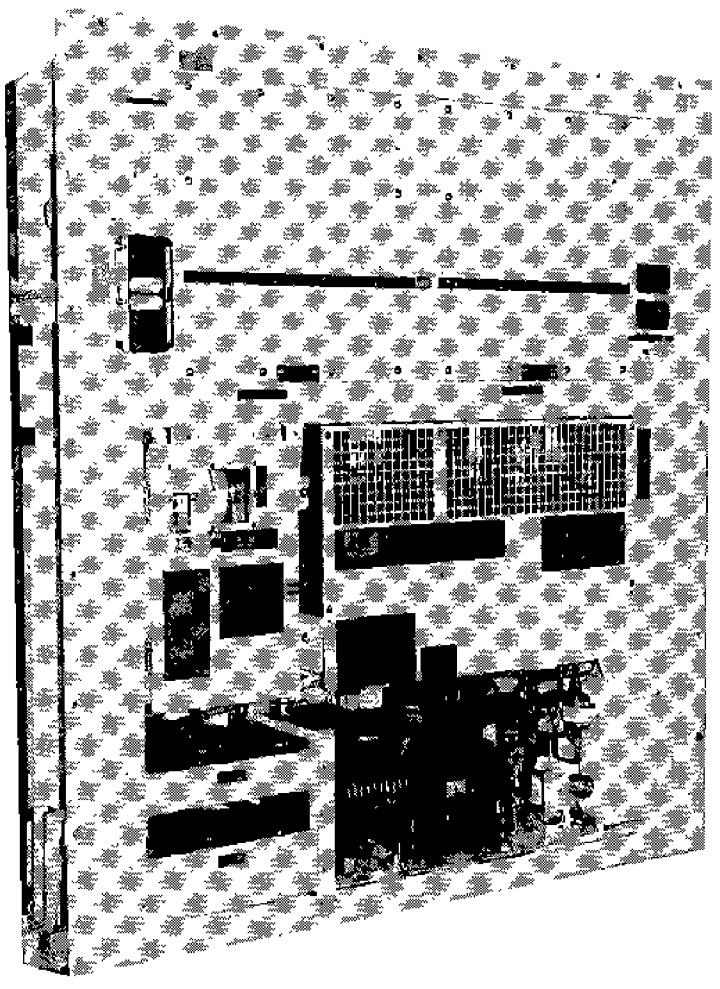
1 . Defrosting of the evaporator section is achieved by utilizing hot gas from the compressor. There are no electric elements fitted.
2 . Please note that it may take several minutes after the compressor pumps down then stops before the L. P. switch resets depending upon the evaporator temperature.

Index

1. Specification

1.1 General specification

Power supply	AC 200V 3 Phase 50Hz AC 200, 220V 3 Phase 60 Hz AC 380 ~ 415V 3 Phase 50 Hz AC 400, 440V 3 Phase 60 Hz (Dual voltage rating with voltage selector)
Compressor	Semi hermetic type (5.5 kW)
Evaporator	Cross finned coil type
Air cooled condenser	Cross finned coil type
Water cooled condenser	Hairpin-shaped tube-in-tube type
Accumulator-receiver with heat exchanger	Vertical cylinder type
Fan	Motor direct driven propeller type
Fan motor	Single-phase squirrel-cage induction motor
Defrost	
Heat source	Hot gas from the compressor.
Initiation	Air pressure switch, timer or manual switch.
Termination	Sensing suction line temperature by defrost termination thermostat or timer.
Refrigerant control	Thermostatic expansion valve
Capacity control	Hot gas bypass control with modulating control valve
Protection devices	Circuit breaker, Over current relay with single phase protection, High pressure switch, Low pressure switch, Oil pressure protection switch, Fusible safty plug, Compressor motor protection thermostat, Fan motor protection thermostat.
Refrigerant	R-12: 6.0 (kg)/13.3 (lbs)
Lubricant	SUNISO 3GS-DI : 4.0 (ℓ)
Weight	Approx. 670(kg)/1477(lbs) [LKE8CD10] Approx. 680(kg)/1499(lbs) [LKE8CD11]

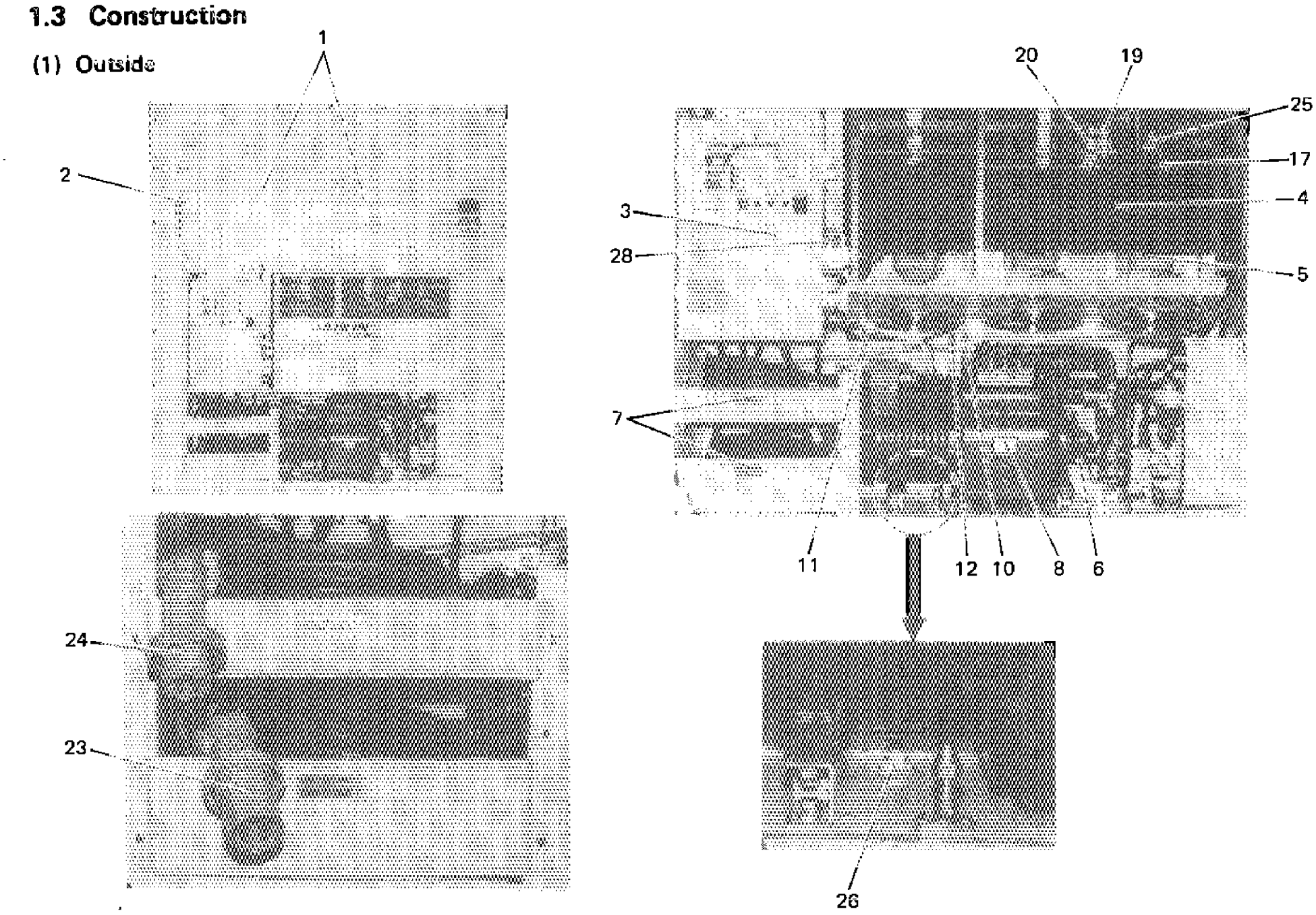


1.2 Set values of functional parts

Part name	Mark	Function	Set value	Manufacturer	Parts No.
Low pressure switch 20PS-K110	LPS	Low pressure OFF ON	40cmHgV 0.2kg/cm²	Texas inst (JAPAN)	284057A
High pressure switch 20PS-K210	HPS	High pressure OFF ON	20kg/cm² 16.5kg/cm²	Ditto	284056A
High pressure control switch ACB-BA22	HPCS	OFF ON	7kg/cm² 11kg/cm²	Saginomiya (JAPAN)	284058
Water pressure switch LCB-BB07	WPS	OFF ON	1.0kg/cm² 0.4kg/cm²	Ditto	284059
Defrost termination thermostat BIMETAL TYPE ST-5B40/20	23D1,2	OFF ON	40°C 20°C	Takachiho (JAPAN)	643001A
Defrost timer STP-D73-4	2D1	ON	12h (60Hz) (14½h (50Hz))	Tateishi (JAPAN)	621094
Defrost termination timer STP-D73-3	2D2	ON	90min. (60Hz) (108min. (50Hz)	Ditto.	621093
Evaporator fan motor delay timer STP-D73-2	2F	ON	1min (50Hz)	Ditto	621077
Compressor capacity protection E-1DM-2 thermostat	23A2	OFF	−5°C	Fuji koki (JAPAN)	640880
Air pressure switch SDS-K104	APS	ON	25mmH_2O (LKE8CD10)	Saginomiya (JAPAN)	642408
Air pressure switch SDS-K105	APS	ON	31mmH_2O (LKE8CD11)	Saginomiya (JAPAN)	632370
Over current relay GT-20-NP_2S_4	51C	OFF	10.0A	Togami (JAPAN)	622381
Circuit breaker (main circuit) MK-53	52C1	OFF	50A	Nikko electric (JAPAN)	622702
Circuit breaker (control circuit) CP-31	52C2	OFF	7A	Fuji electric (JAPAN)	622706
Thermal protector (Fan motor)		OFF	120°C (248°F)		
Thermal protector (compressor)	49	OFF	105°C (221°F)		

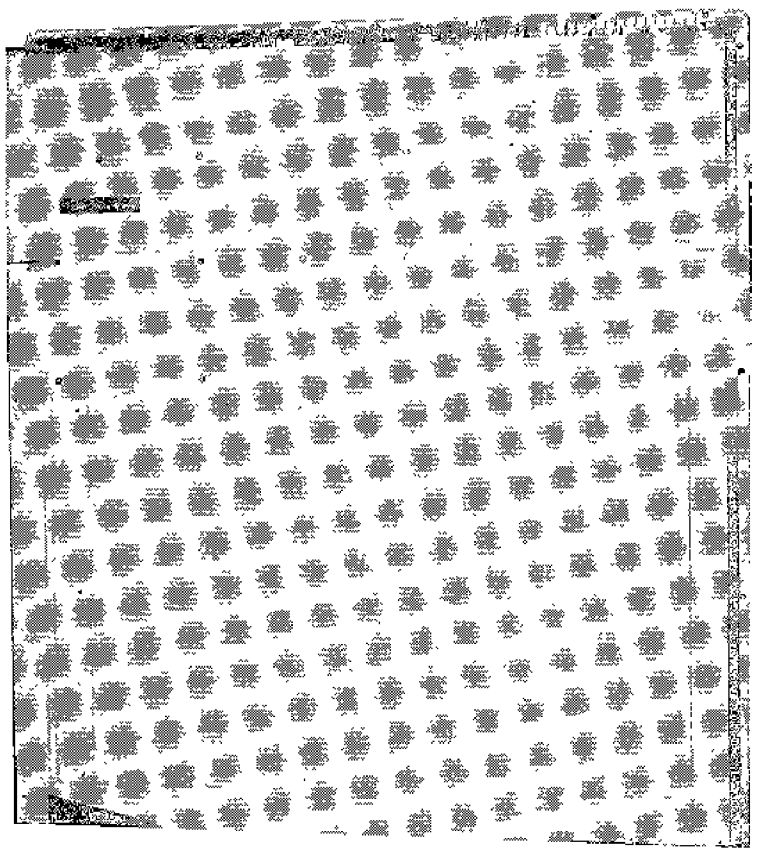
1.3 Construction

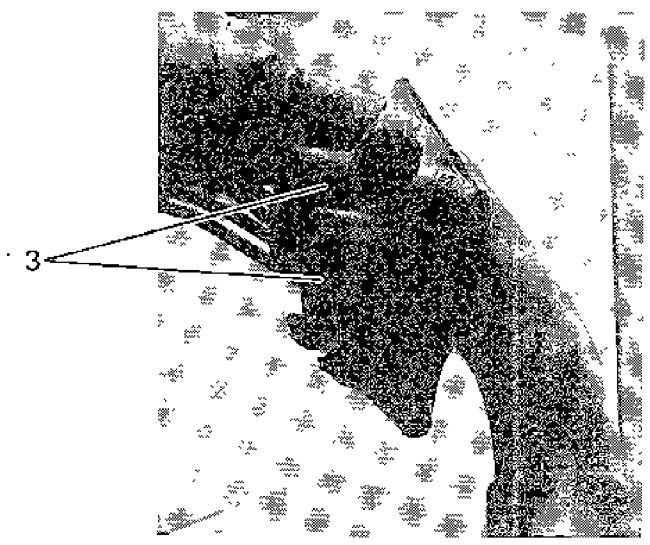
(1) Outside



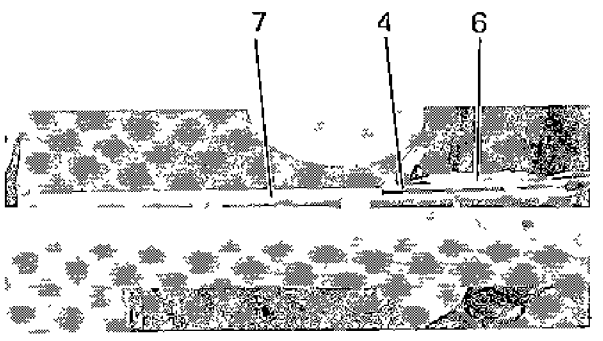
1. Access panel
2. Ventilator
3. Control box
4. Air cooled condenser
5. Condenser fan motor
6. Water cooled condenser
7. Cable stowage
8. Compressor
9. Accumulator-receiver with heat exchanger
10. High pressure switch
11. Low pressure switch
12. High pressure fan control switch
13. Water pressure switch
14. Water inlet coupling
15. Water outlet coupling
16. Dryer
17. Liquid/moisture indicator
18. Modulating control valve (20M)
19. Solenoid valve (20LS1 for main line)
20. Solenoid valve (20LS2 for main line)
21. Suction line solenoid valve (20SS)
22. Stop valve (liquid line)
23. Power plug (200V ~ 220V)
24. Power plug (380V ~ 440V)
25. Expansion valve
26. Gland for supply air sensor
27. Discharge filter
28. Voltage selector switch

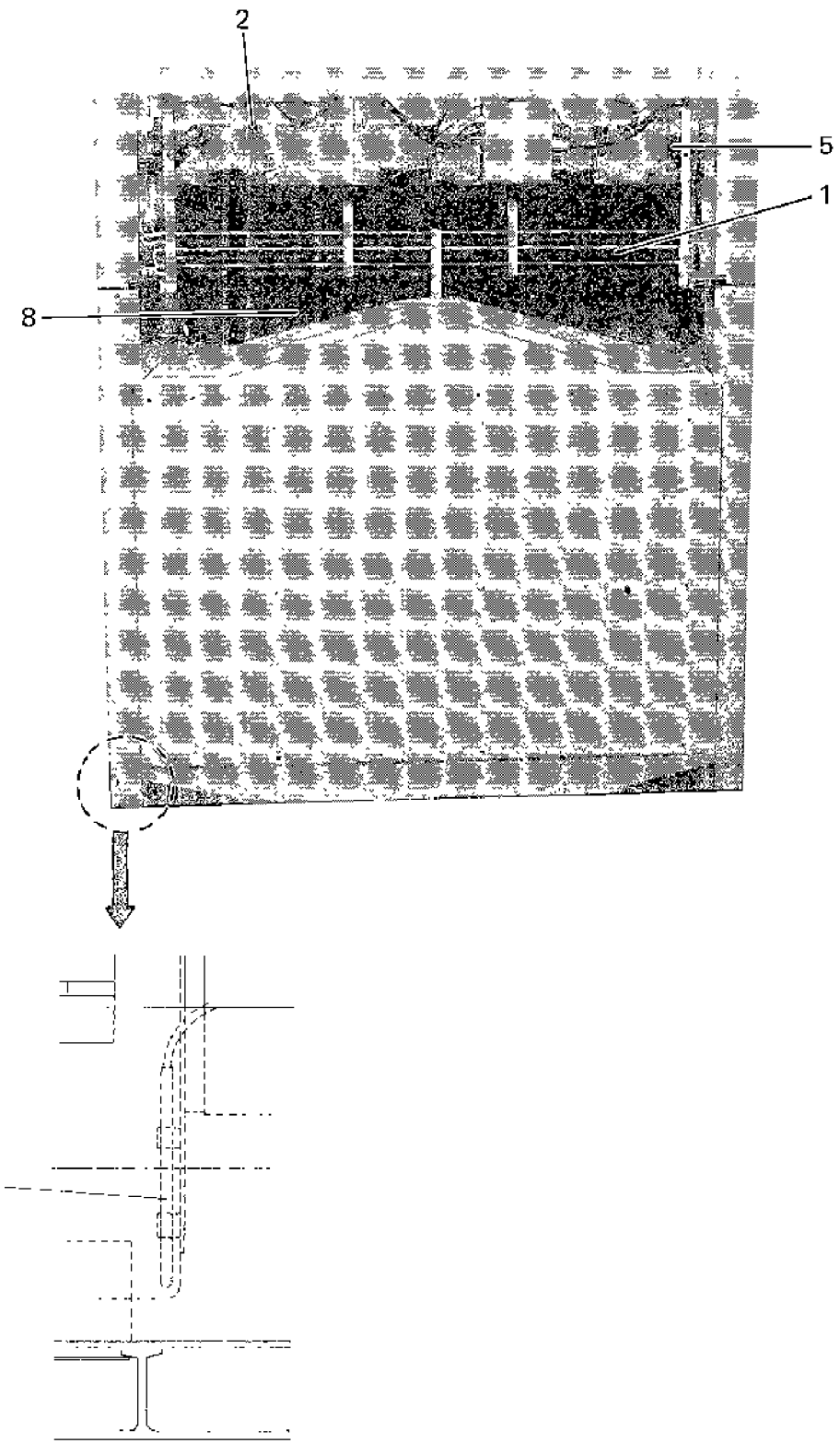
(2) Inside



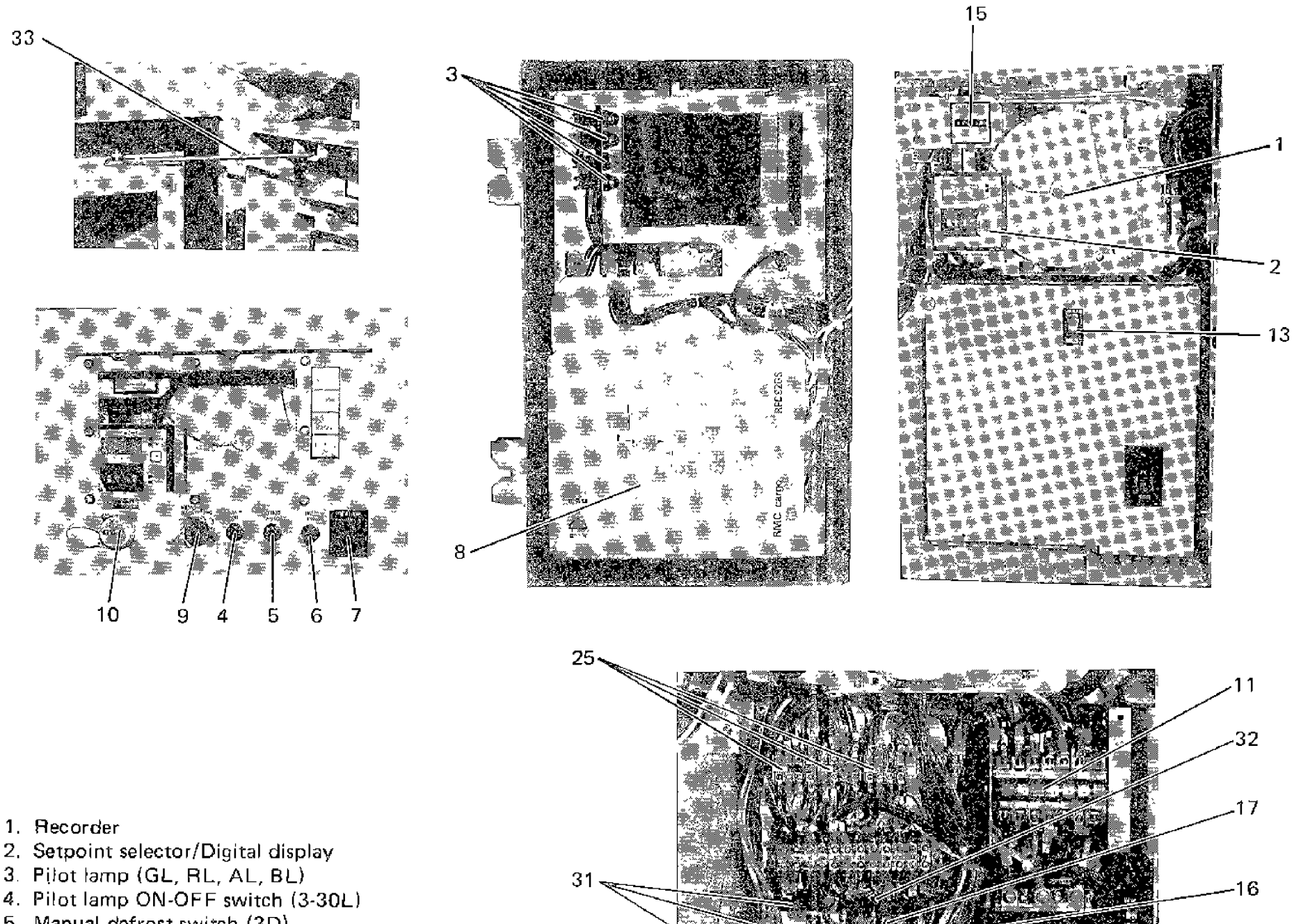


1. Evaporator
2. Evaporator fan motor
3. Defrost termination thermostat
4. Return air sensor
5. Air pressure switch
6. Feeler tube of compressor capacity protection thermostat.
7. Recorder sensor
8. Solenoid valve (20DPS)
9. Supply air sensor





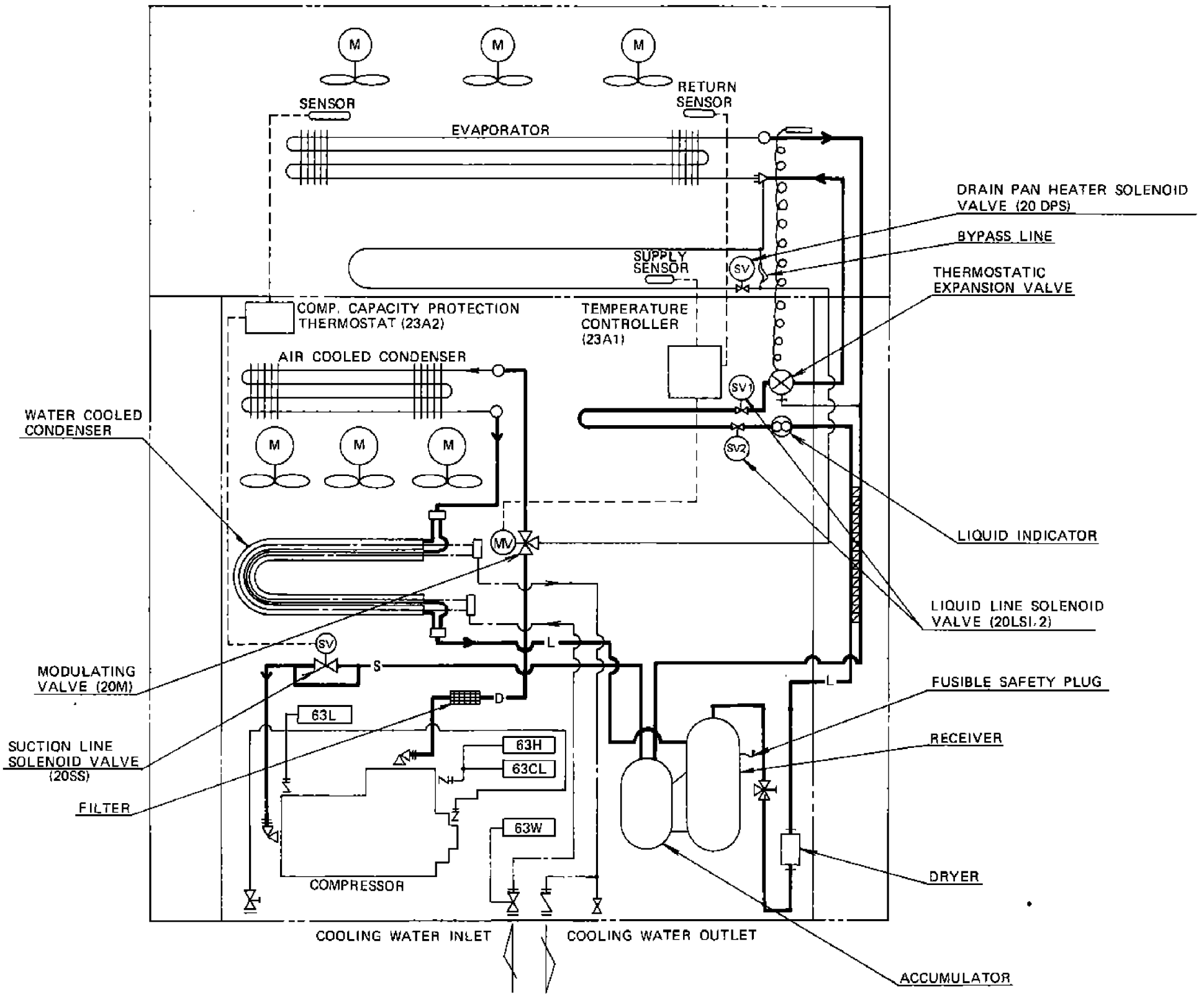
(3) Control box



1. Recorder
2. Setpoint selector/Digital display
3. Pilot lamp (GL, RL, AL, BL)
4. Pilot lamp ON-OFF switch (3-30L)
5. Manual defrost switch (3D)
6. Unit ON-OFF switch (3-88)
7. Heat up switch (3-HU)
8. Controller (23A1)
9. Cannon receptacle for remote monitoring
10. Cannon receptacle for ref. check
11. Voltage selector
12. Circuit breaker (52C1)
13. Circuit breaker (52C2)
14. Transformer (Tr)
15. Hour meter (HM)
16. Compressor capacity protection thermostat
17. Over current relay (51C)
18. Compressor relay (88C)
19. Evap. fan motor relay (88F)
20. Defrost timer (2D1)
21. Evaporator fan motor delay timer (2F)
22. Defrost termination timer (2D2)
23. Defrost initiation relay (2DX1)
24. Defrost auxiliary relay (2DX2, 3)
25. Voltage selector relay (2X1,2,3)
26. Solenoid valve ON-OFF relay (2X4)
27. Chill/Frozen change over relay (2X5)
28. Digital display ON-OFF relay (2X6)
29. Heat up relay (2X7)
30. In range timer auxiliary relay (2X8)
31. Capacitor (C)
32. Diode (CPD)
33. Stopper

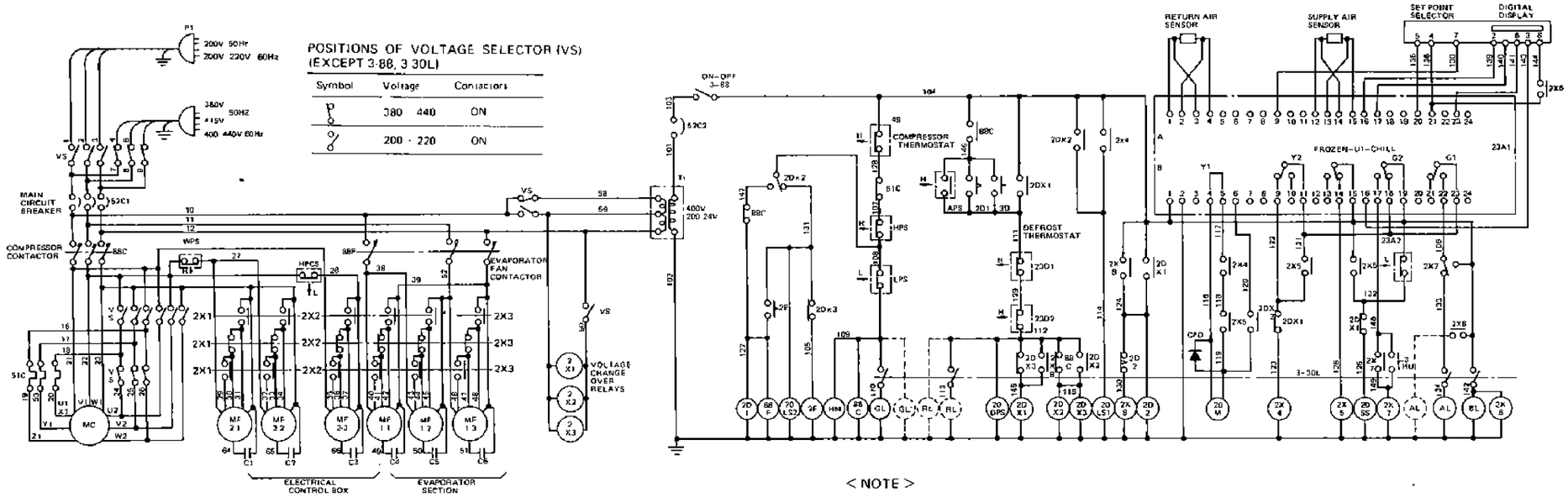
- Be sure to use "Stopper" when operate or maintenance the components in the control box.

1. 4 Piping diagram



—L— LIQUID PIPE
—S— SUCTION PIPE
—D— DISCHARGE PIPE
—+— FLARE CONNECTION
—‖— FLANGE CONNECTION
— — — WATER PIPE
----- ELECTRIC LINE

HPS : HIGH PRESSURE SWITCH
HPCS : HIGH PRESSURE CONTROL SWITCH
LPS : LOW PRESSURE SWITCH
WPS : WATER PRESSURE SWITCH



< NOTE >

TIMER

OVER CURRENT RELAY

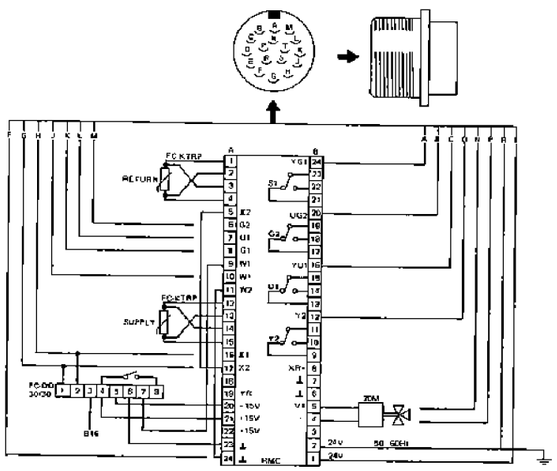
CIRCUIT BREAKER

H OPERATES ON INCREASE IN TEMPERATURE OR PRESSURE

L OPERATES ON DECREASE IN TEMPERATURE OR PRESSURE

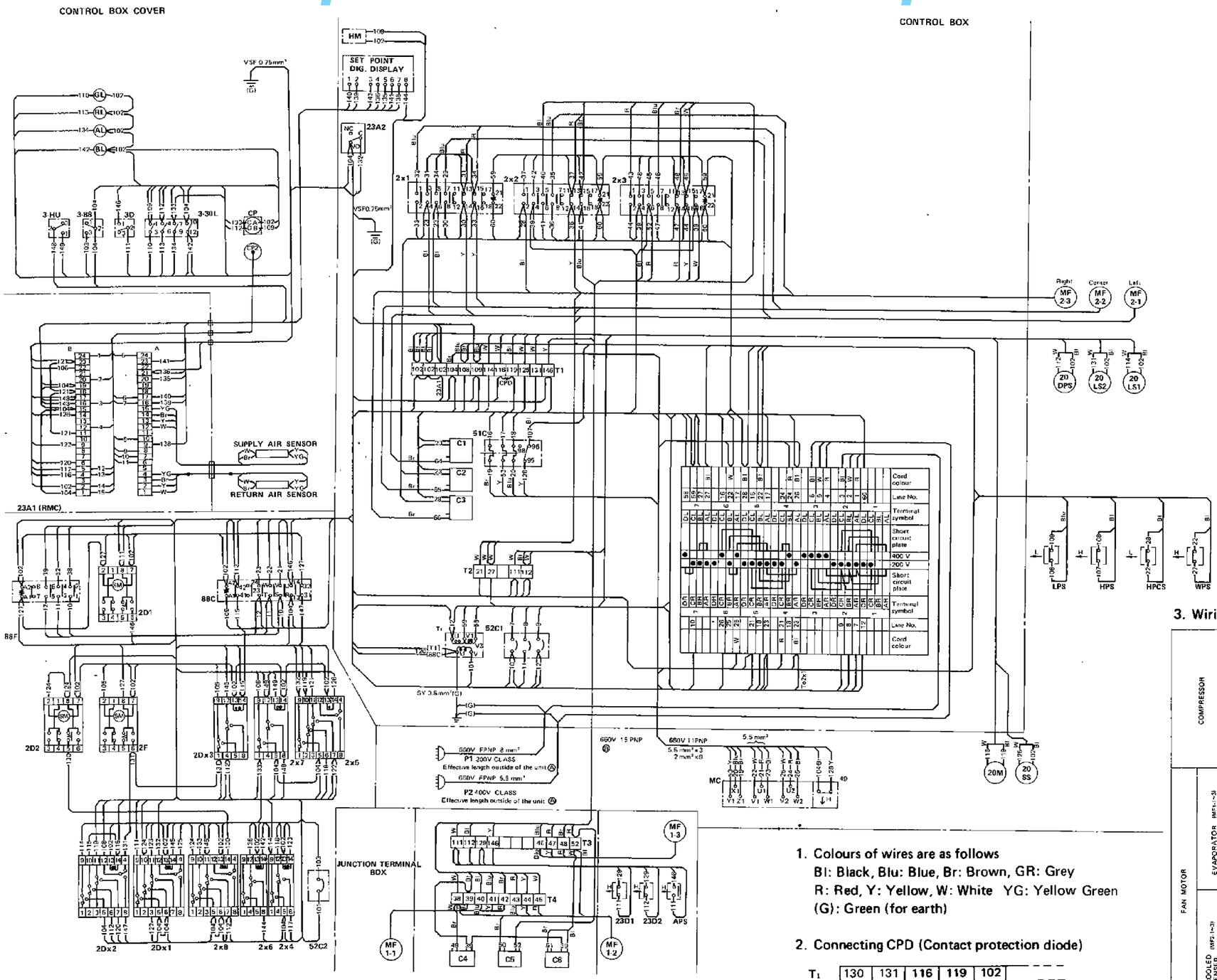
A : Earth
B : Compressor (GL)
C : Defrost (RL)
D : In range temp. (AL)

(Broken line shows external wiring)

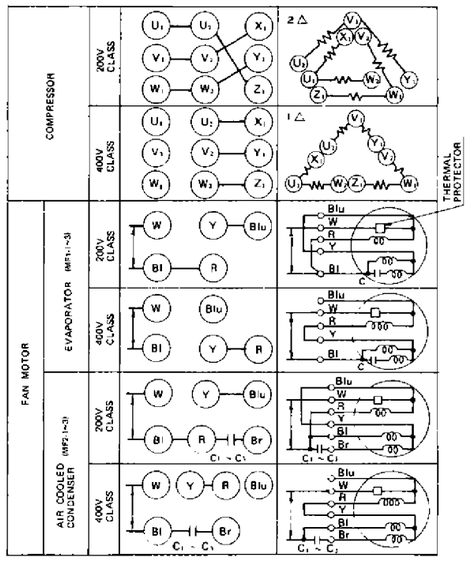


2D1	DEFROST TIMER	3-HU	HEAT UP SWITCH	HPCS	HIGH PRESSURE CONTROL SWITCH
2D2	DEFROST TERMINATION TIMER	20DPS	DRAIN PAN HEATER SOLENOID VALVE	LPS	LOW PRESSURE SWITCH
2F	EVAPORATOR FAN MOTOR DELAY TIMER	20M	MODULATING VALVE	WPS	WATER PRESSURE SWITCH
2DX1	DEFROST INITIATION RELAY	20LS1,2	LIQUID LINE SOLENOID VALVES	C	CAPACITOR
2DX2,3	DEFROST AUXILIARY RELAYS	23A1	RMC TEMPERATURE CONTROLLER	CPD	CONTACT PROTECTION DIODE
2X1 ~ 3	VOLTAGE CHANGE OVER RELAYS FOR FAN MOTOR	23A2	COMPRESSOR CAPACITY PROTECTION THERMOSTAT	MC	COMPRESSOR MOTOR
2X4	COMPRESSOR CONTROL RELAY	23D1,2	DEFROST TERMINATION THERMOSTATS	MF1	EVAPORATOR FAN MOTOR
2X5	CHILL/FROZEN CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	MF2	CONDENSER FAN MOTOR
2X6	DIGITAL DISPLAY ON-OFF RELAY	51C	OVER CURRENT RELAY	HM	HOUR METER
2X7	HEAT UP RELAY	52C1,2	CIRCUIT BREAKERS	P1,2	POWER PLUGS
2X8	IN RANGE TIMER AUXILIARY RELAY	88C	COMPRESSOR CONTACTOR	Tr	TRANSFORMER
3-30L	LAMP SWITCH	88F	EVAPORATOR FAN MOTOR CONTACTOR	VS	VOLTAGE SELECTOR SWITCH
3-88	UNIT ON-OFF SWITCH	APS	AIR PRESSURE SWITCH	GL, RL, AL, BL	LAMPS
3D	MANUAL DEFROST SWITCH	HPS	HIGH PRESSURE SWITCH	20SS	SUCTION LINE SOLENOID VALVE

1.5.2 Actual wiring

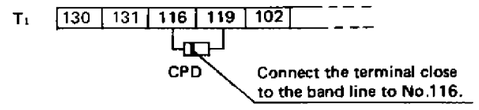


3. Wiring for compressor and fan motor



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

2. Connecting CPD (Contact protection diode)

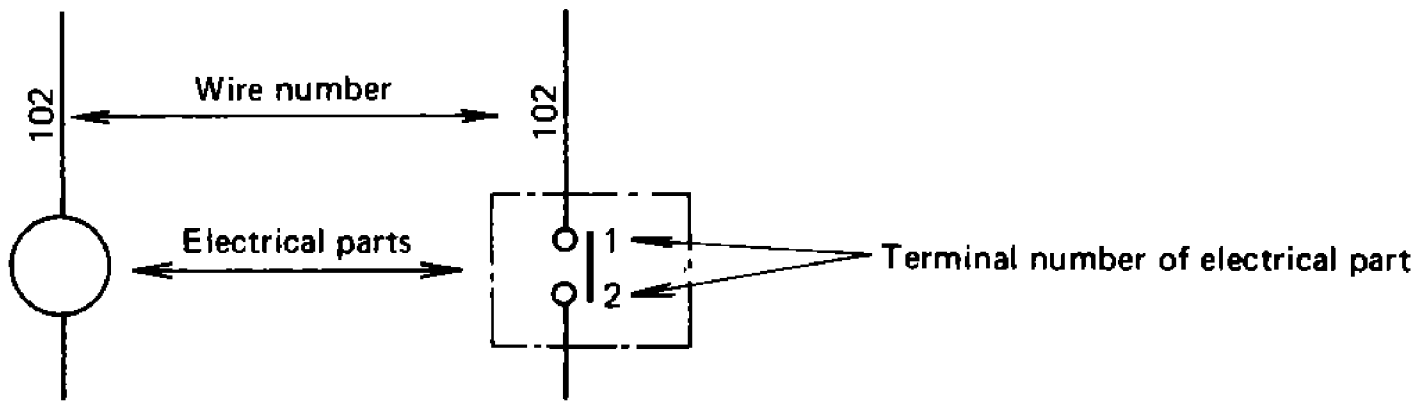


NOTE)

Ⓐ	Ⓑ	Model
15m	2mm×2(No.38,39) 0.75mm×13	LKE8CD10
18.5m	2mm×3(No.38, 39, 52)0.75mm×12	LKE8CD11

1.5.3 How to read wiring diagram

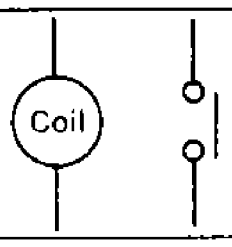
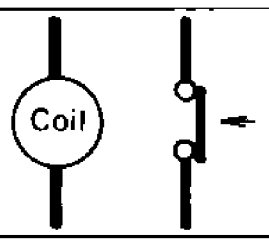
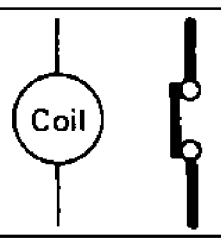
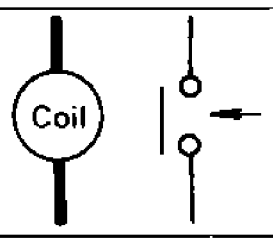
(1) In the wiring diagram, marks and numbers have the meanings given below.



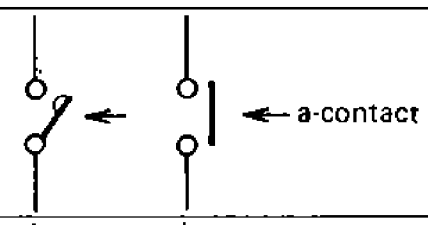
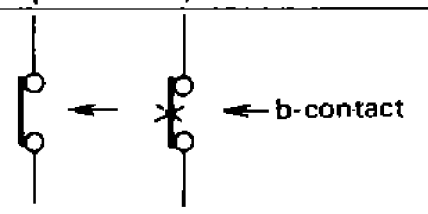
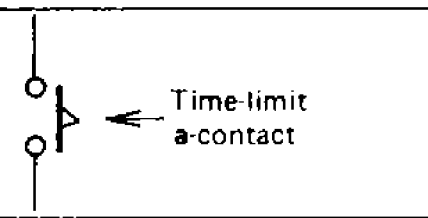
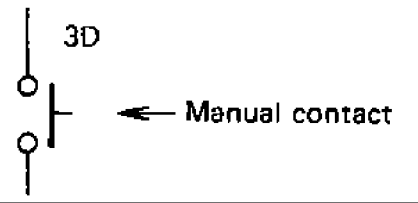
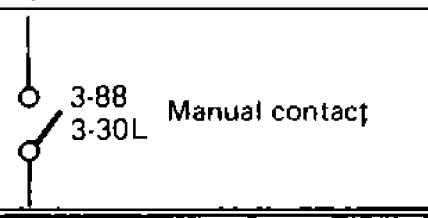
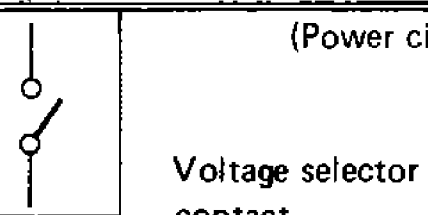
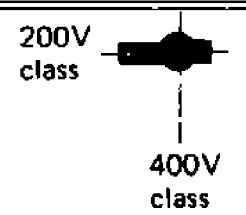
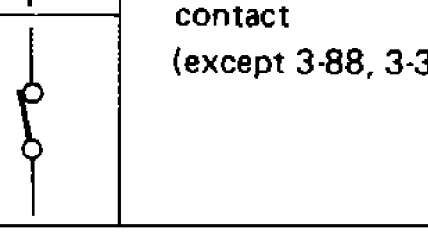
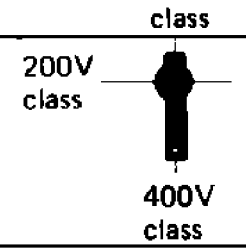
(2) Operation of contacts

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

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

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

c. Kinds of contacts

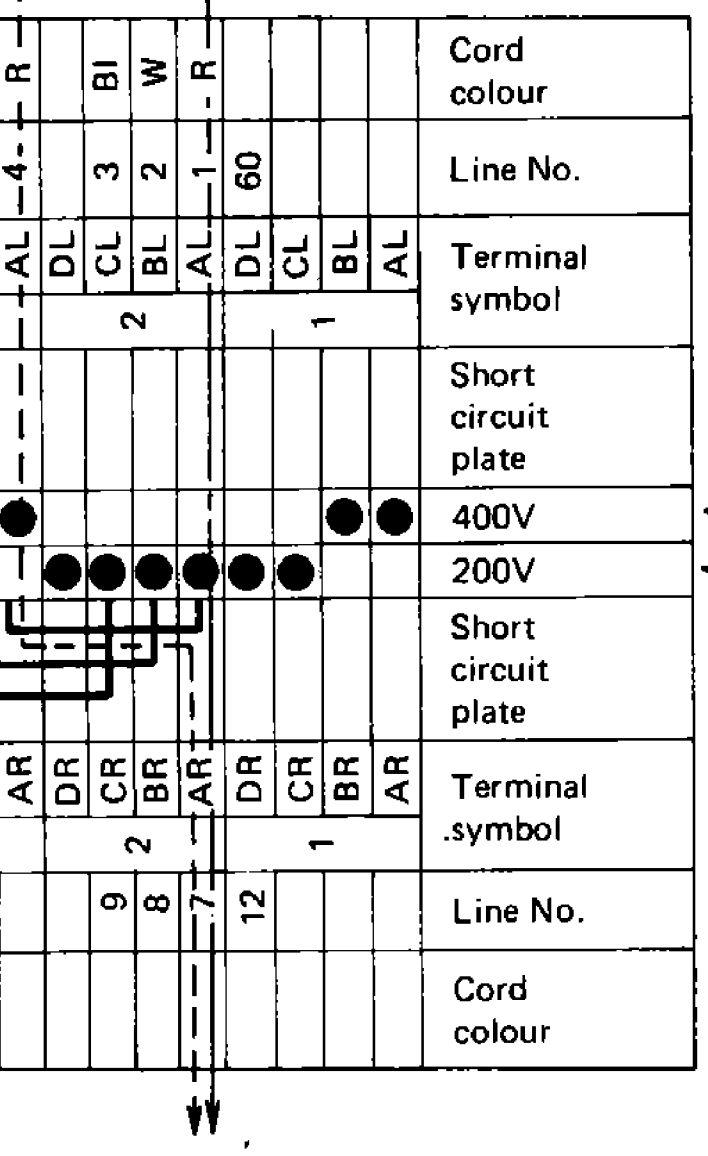
		Operated by electromagnetic force, temperature, or pressure. ("x" denotes the reset button.)
		
		Operates when the timer counting has completed.
		Contact of a snap switch. This turns on as long as the switch is kept pressed and turns off immediately when released.
		Contact of a snap switch. This turns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

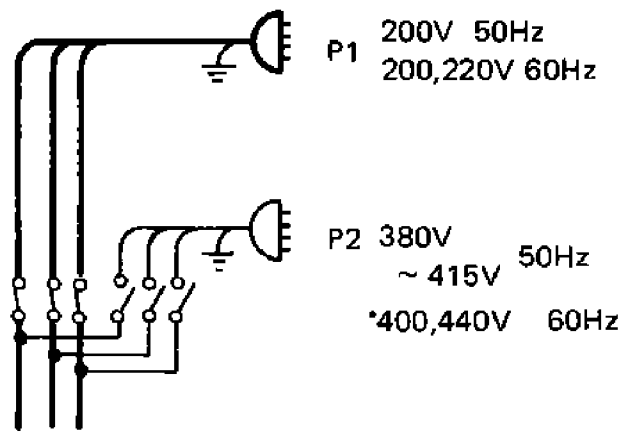
d. How to read the wiring diagram of the voltage selector switch.

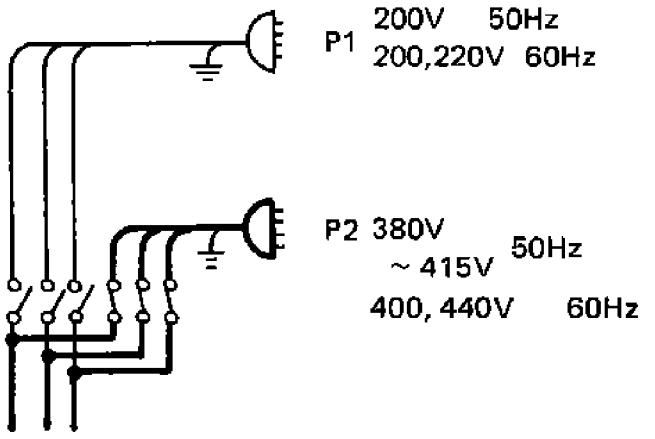
In the chart, "●" denotes that the contact is on.

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

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







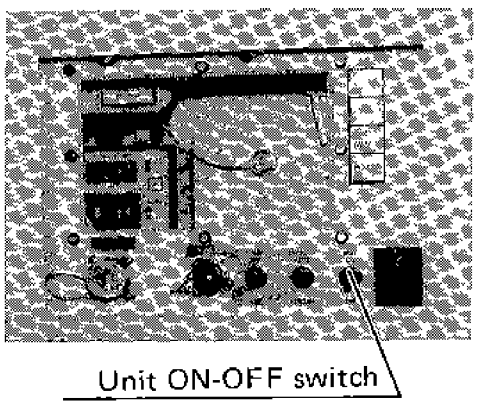
2. Operation

Operate the unit by using the procedures given below.

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

2.1 Preparation and operation

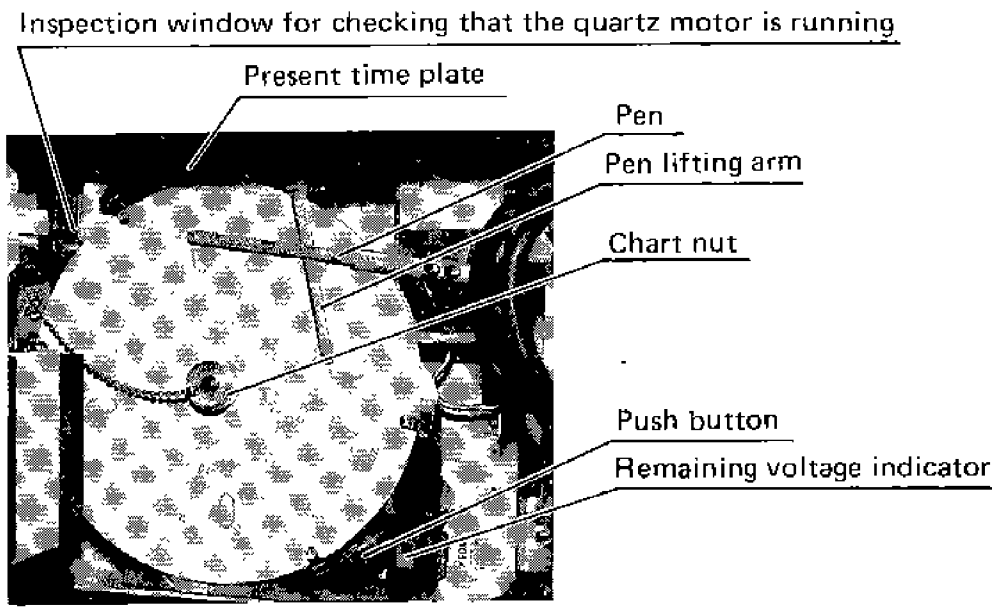
(1) Confirm that power supply is off.
Confirm that the power source, the circuit breaker and unit ON-OFF switch are turned off before checking for safety's sake.



The cover of control box

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

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

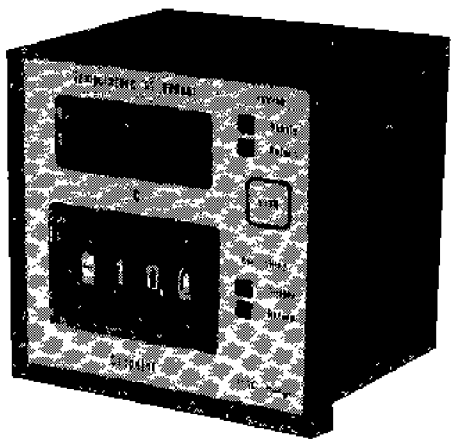


(3) Setting a sheet of recording paper

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

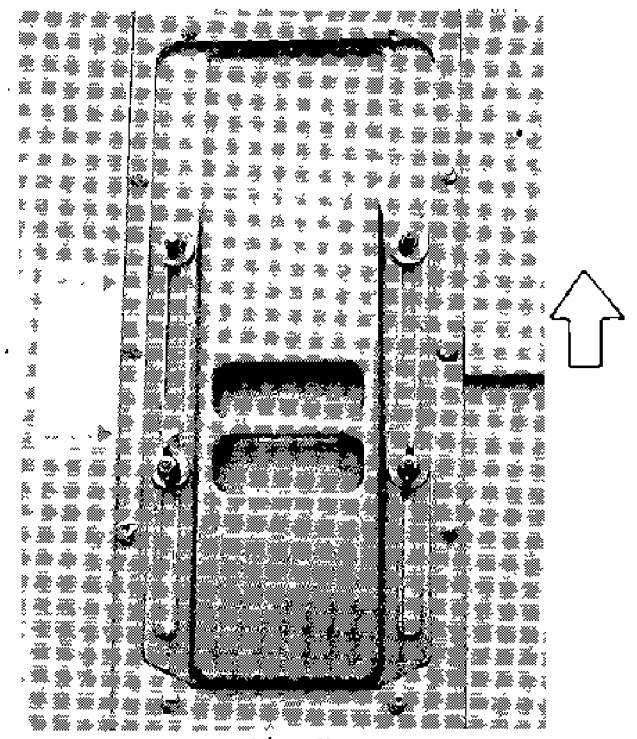
(4) Set the setpoint selector.

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



Setpoint selector/Digital display

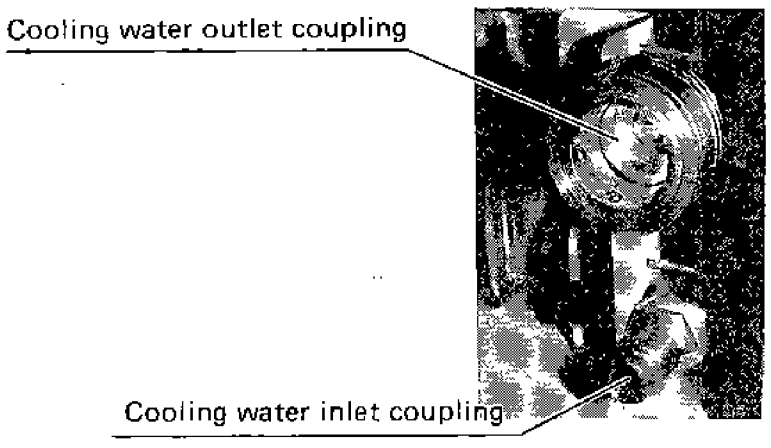
(5) Open or close air refreshening ventilator.
Open or close the ventilator depending upon to the cargo. (Be sure to keep it closed during transportation of frozen cargo.)



Ventilator

(6) Connect the cooling water piping.

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

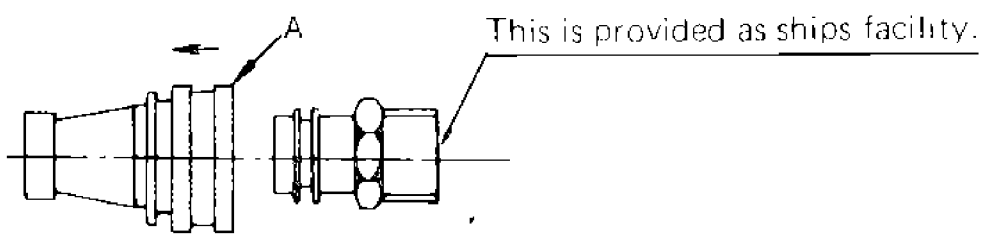


● Connecting method.

1. Connect water supply line to the water inlet coupling.
   Note:
   (1) Air is automatically released from water cooled condenser.
   Ensure the water drains out of water outlet coupling.
2. Connect water discharge line to the water outlet coupling.

● Disconnecting method.

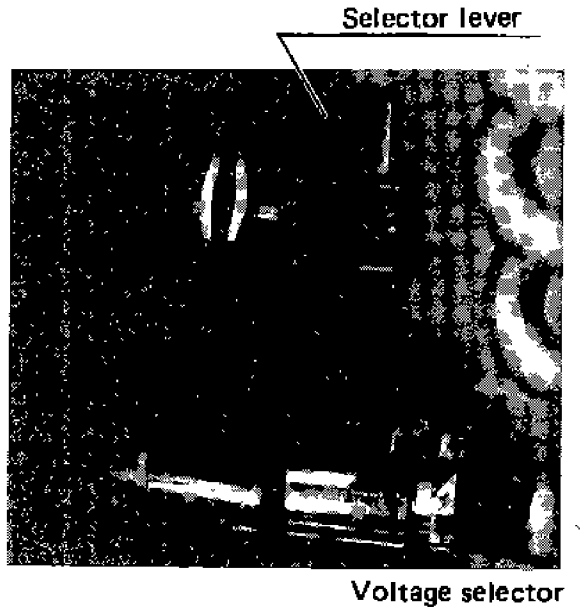
1. Disconnect water supply line from the water inlet coupling.
2. Disconnect water discharge line from the water outlet coupling.
   Note:
   (1) It is not necessary to open drain cock after disconnecting couplings because self draining is applied in cooling water outlet coupling.
   (2) When connecting the cooling water couplings insert the coupling on ship side into the coupling on the unit side until a "click" is heard.
   When disconnecting them, pull the coupling on the ship side toward you while pushing the A part of the female coupling in the direction pointed by an arrow mark.



Water connection at outlet side

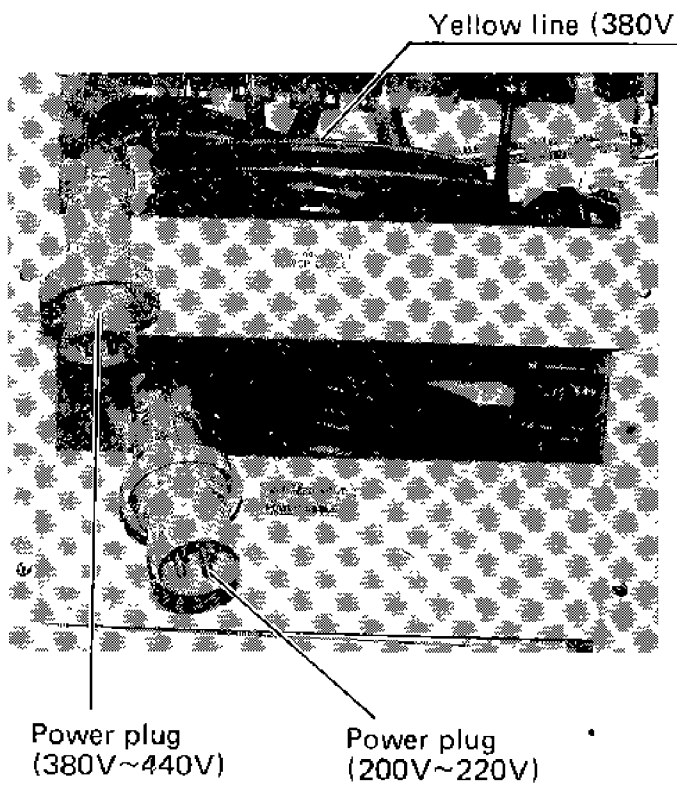
(7) Check that all refrigerant stop valves are opened.

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



Voltage selector

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

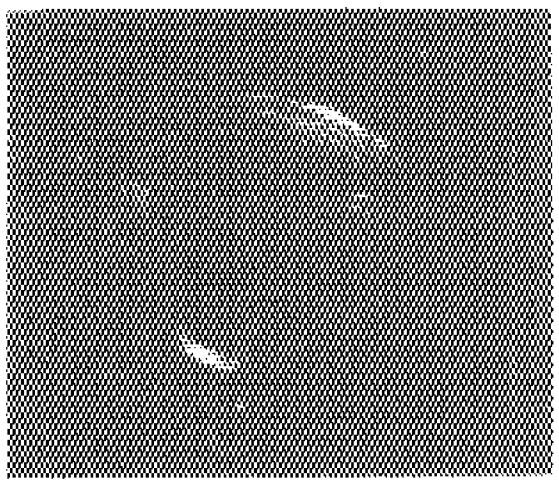
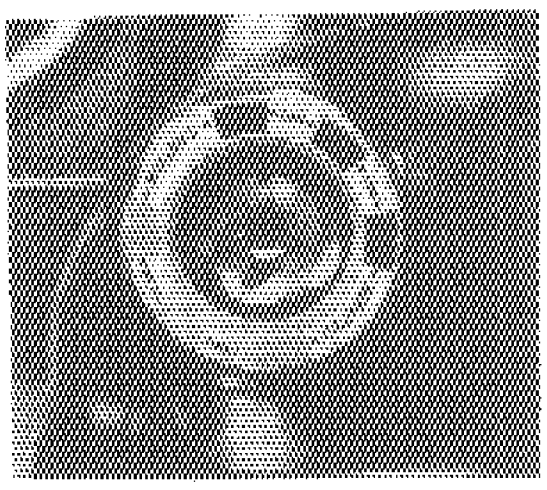


(10) Turn on the power switch of the facility (outside the unit).

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

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

2.2 Checking during operation

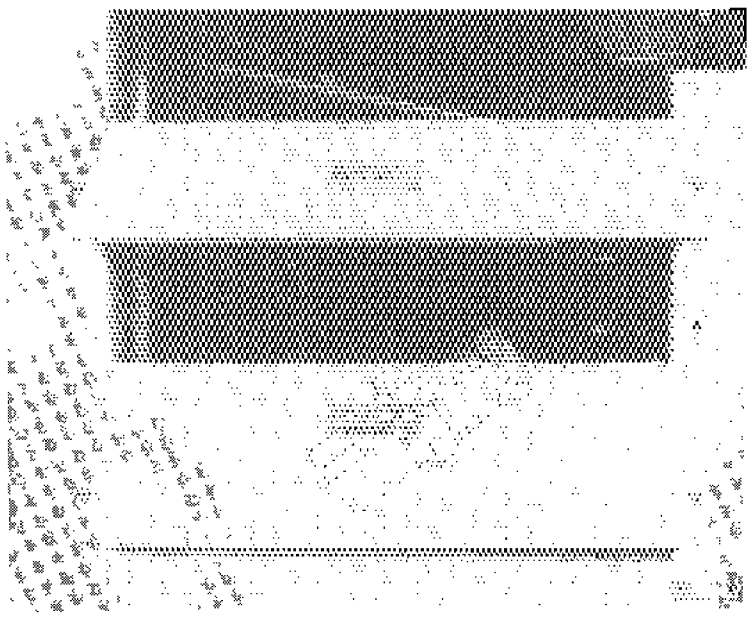
Checking items (precautions)	Method of check
1. Check if unusual noise and vibration is produced from compressor, fan and piping etc.	Visual, touch and listen.
2. Check suction and discharge pressures of the compressor. (For installation of a gauge, refer to "Section 9".)	Compare observed data with standard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

2.3 Maintenance after operation

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

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

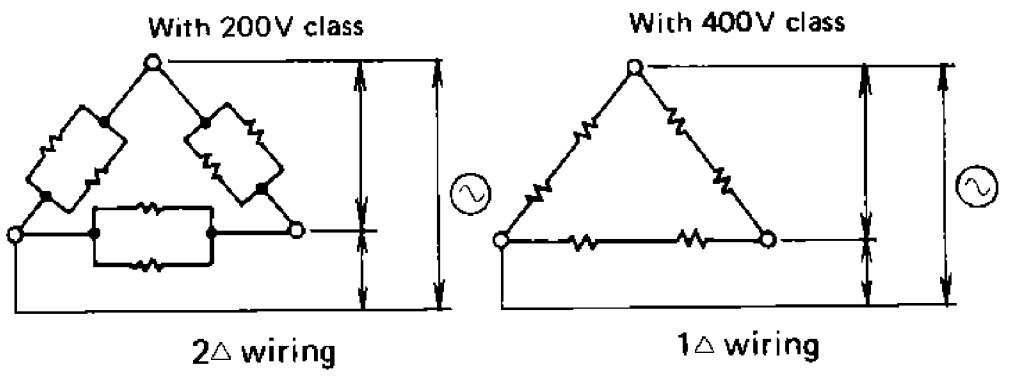
(3) Close the cover of the control box tightly.



3. Operating modes and circuits

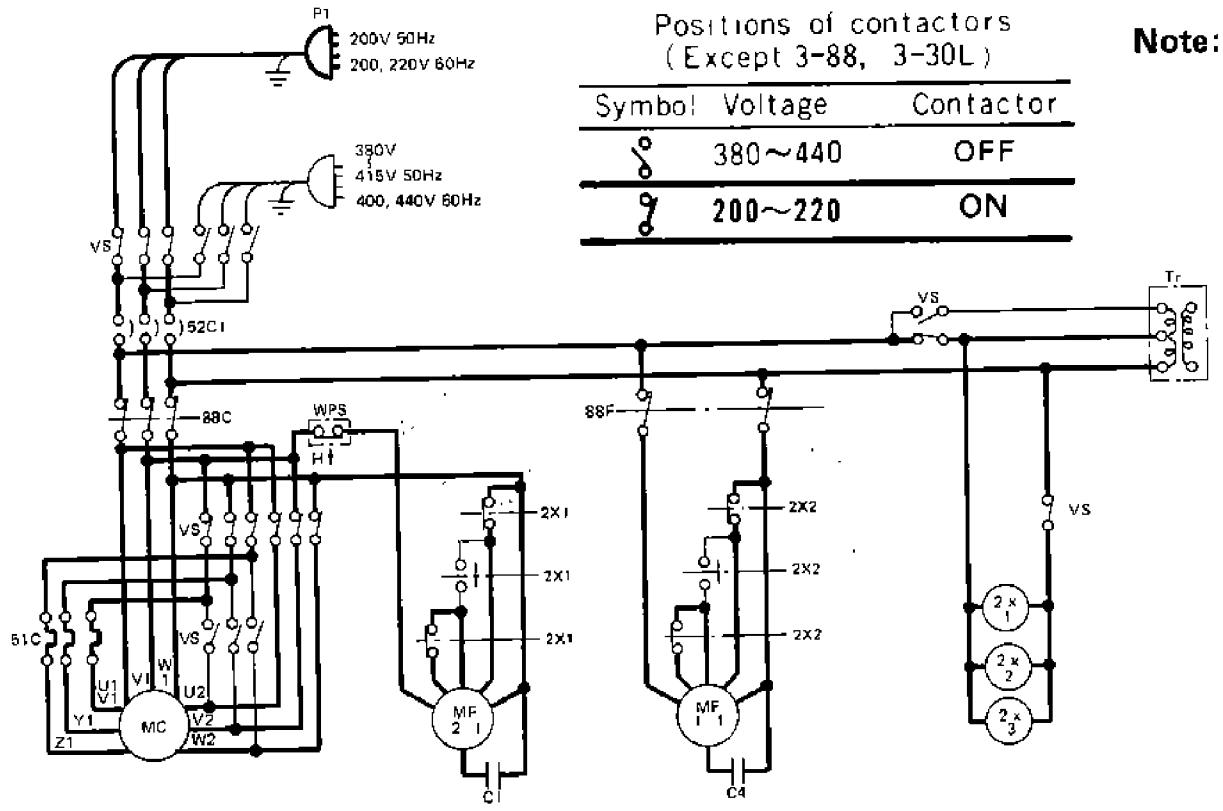
3.1 Voltage selection system (switching over 200V and 400V class)

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



(2) Circuitry

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



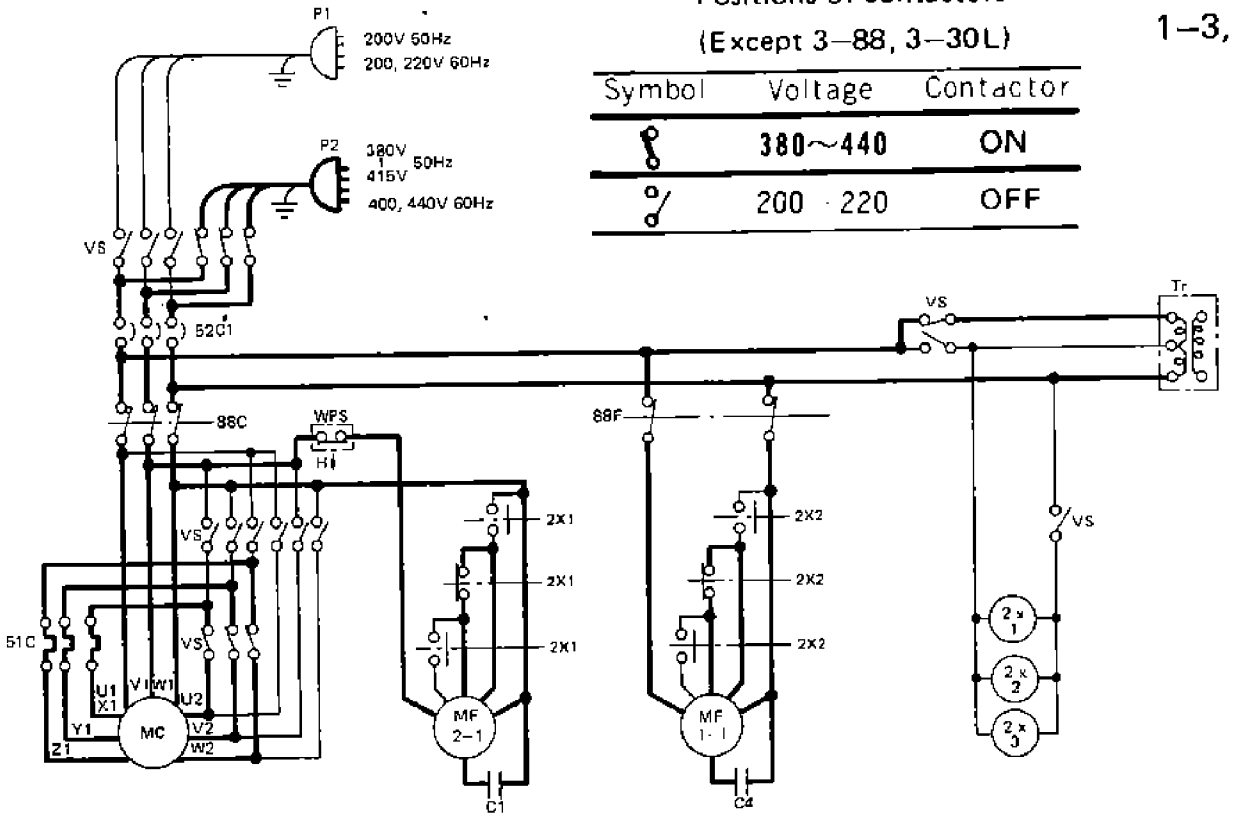
Positions of contactors
(Except 3-88, 3-30L)

Symbol	Voltage	Contactor
	380~440	OFF
	200~220	ON

Note: MF2–2, 2–3, and MF1–2, 1–3, 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



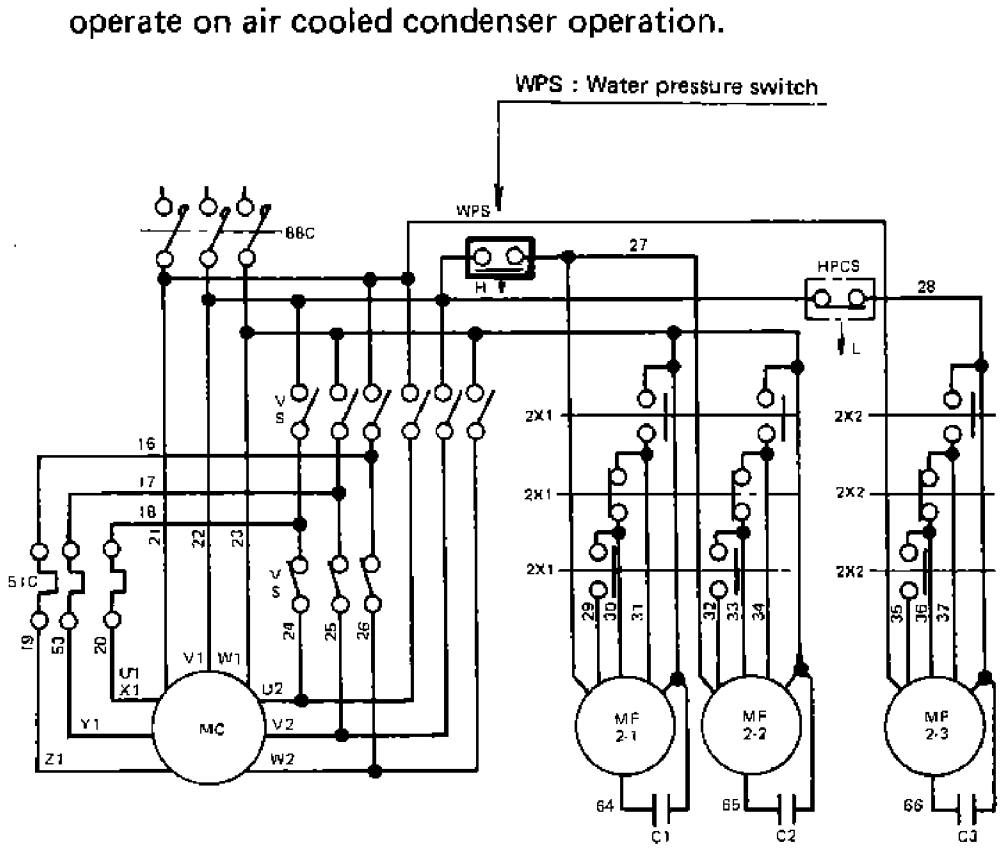
Positions of contactors
(Except 3–88, 3–30L)

Symbol	Voltage	Contactor
	380~440	ON
	200 · 220	OFF

Note: MF2–2, 2–3, and MF1–2, 1–3, are not shown.

3.2 Air cooled and water cooled operation

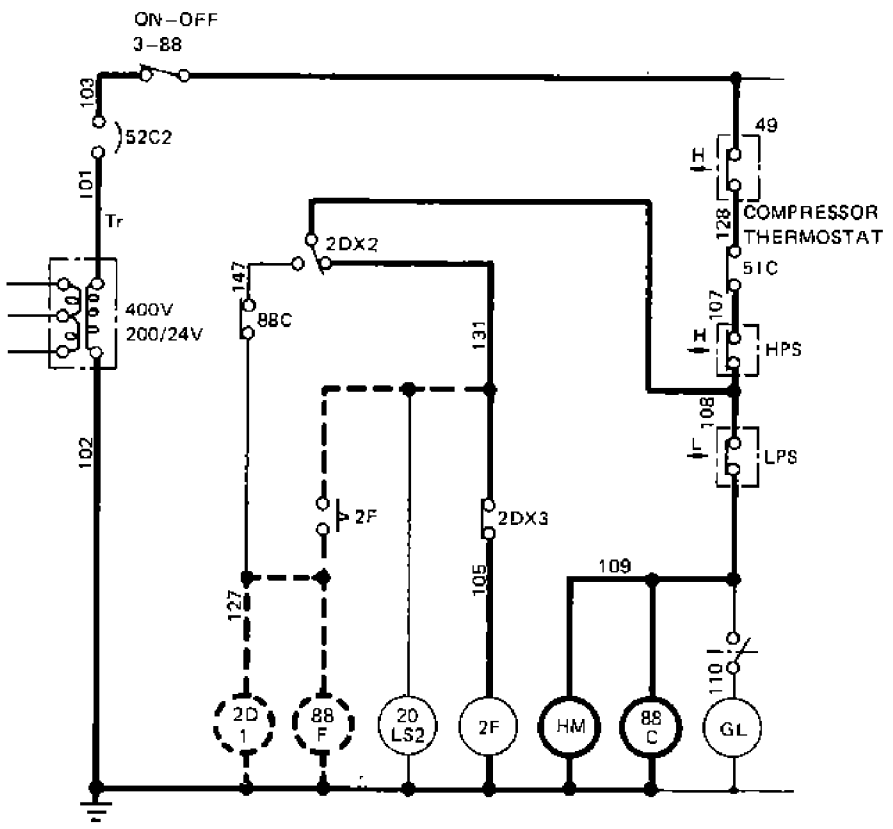
The unit will operate on either air cooled or water cooled condenser operation.
The water cooled condenser is used when cooling water is available such as in a ship's hold.
The operation will be changed from air cooled to water cooled automatically by the water pressure switch; i.e. when water pressure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



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

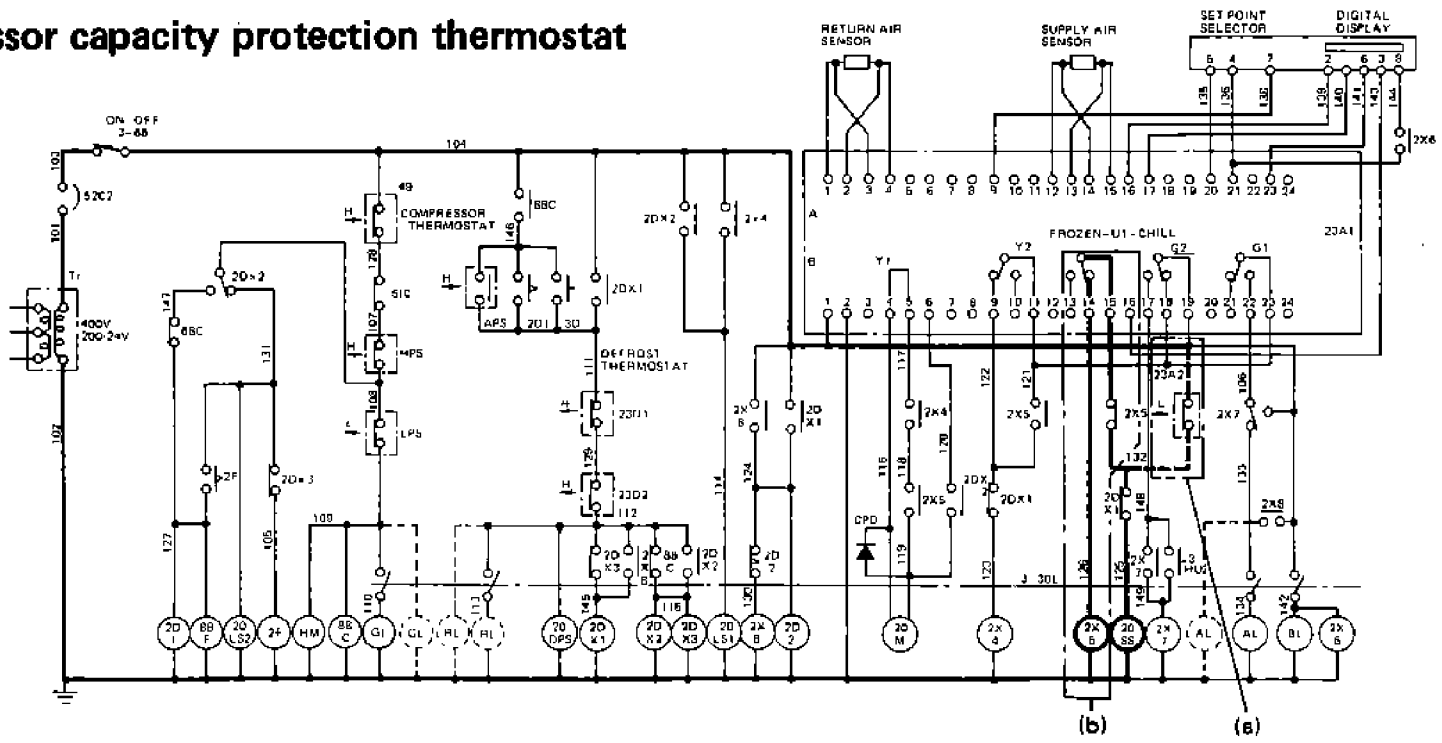
Note:
During the water cooled operation and depending upon the compressor discharge pressure, the left hand condensor fan (MF2-3) may operate.

3.3 Evaporator fan motor delay timer



A delay timer (2F) has been fitted into the circuit controlling the evaporator fan starting contactor (88F) which delays the starting of the evaporator fans for one minute in the following circumstances.
1) When first switching on the unit.
2) When restoring an interrupted power supply
3) After defrosting has been accomplished
This ensures a reduced electrical starting load and for any free water to be frozen before the evaporator fans circulate air to the cargo.

3.4 Compressor capacity protection thermostat

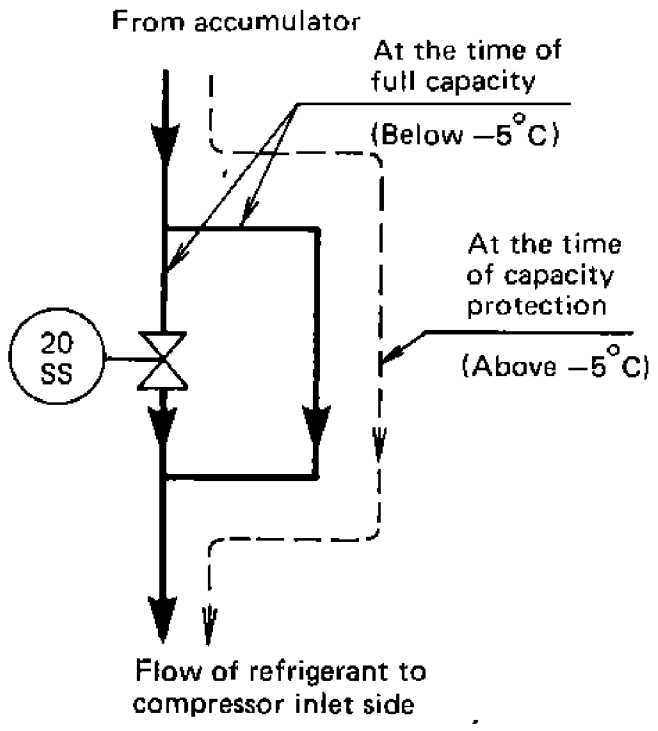


2D1	DEFROST TIMER	3-HU	HEAT UP SWITCH	HPCS	HIGH PRESSURE CONTROL SWITCH
2D2	DEFROST TERMINATION TIMER	20DPS	DRAIN PAN HEATER SOLENOID VALVE	LPS	LOW PRESSURE SWITCH
2F	EVAPORATOR FAN MOTOR DELAY TIMER	20M	MODULATING VALVE	WPS	WATER PRESSURE SWITCH
2DX1	DEFROST INITIATION RELAY	20LS1,2	LIQUID LINE SOLENOID VALVES	C	CAPACITOR
2DX2,3	DEFROST AUXILIARY RELAYS	23A1	RMC TEMPERATURE CONTROLLER	CPD	CONTACT PROTECTION DIODE
2X1~3	VOLTAGE CHANGE OVER RELAYS FOR FAN MOTOR	23A2	COMPRESSOR CAPACITY PROTECTION THERMOSTAT	MC	COMPRESSOR MOTOR
2X4	COMPRESSOR CONTROL RELAY	23D1,2	DEFROST TERMINATION THERMOSTATS	MF1	EVAPORATOR FAN MOTOR
2X5	CHILL/FROZEN CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	MF2	CONDENSER FAN MOTOR
2X6	DIGITAL DISPLAY ON-OFF RELAY	51C	OVER CURRENT RELAY	HM	HOUR METER
2X7	HEAT UP RELAY	52C1,2	CIRCUIT BREAKERS	P1,2	POWER PLUGS
2X8	IN RANGE TIMER AUXILIARY RELAY	88C	COMPRESSOR CONTACTOR	Tr	TRANSFORMER
3-30L	LAMP SWITCH	88F	EVAPORATOR FAN MOTOR CONTACTOR	VS	VOLTAGE SELECTOR SWITCH
3-88	UNIT ON-OFF SWITCH	APS	AIR PRESSURE SWITCH	GL,RL,AL,BL	LAMPS
3D	MANUAL DEFROST SWITCH	HPS	HIGH PRESSURE SWITCH	20SS	SUCTION LINE SOLENOID VALVE

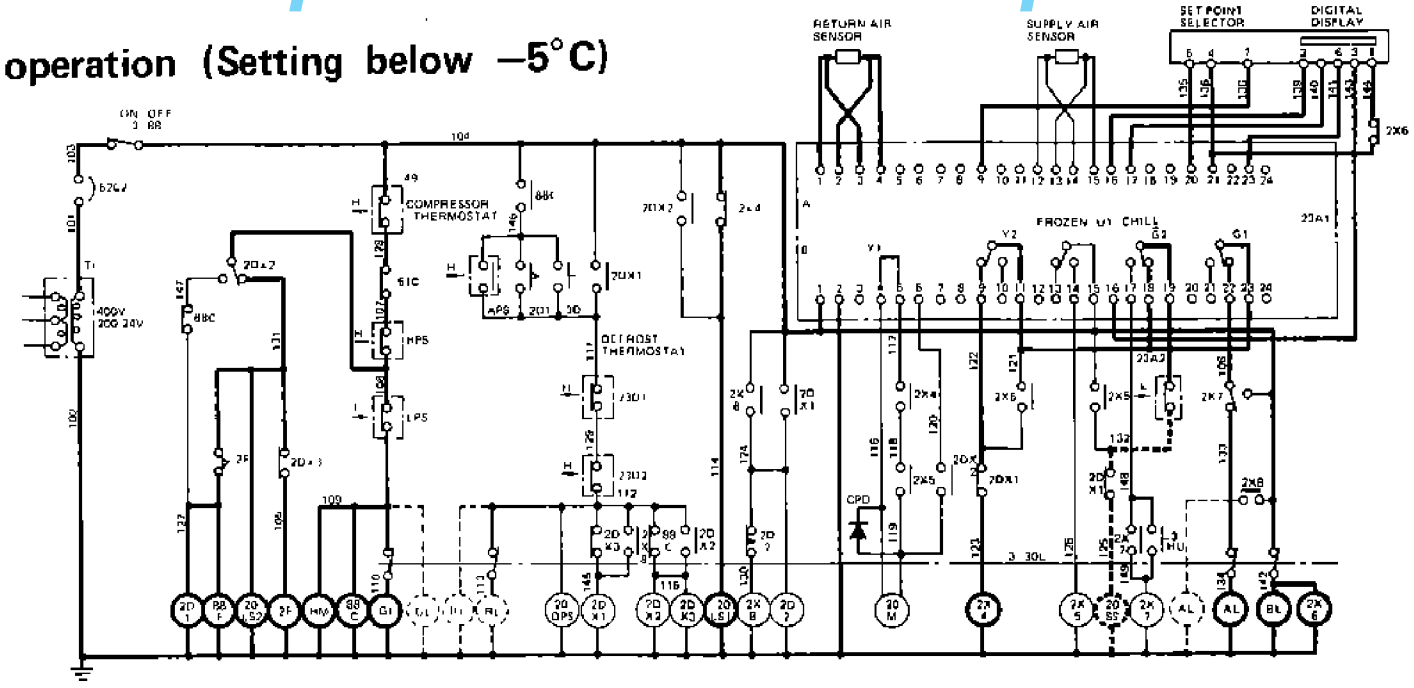
In order to protect compressor from overload and perform reduced load operation under suction gas control, the suction line is fitted with a solenoid valve 20SS (this valve will close when energized) closed.

a. While in frozen mode
Thermostat 23A2 will close resulting in energizing suction line solenoid valve 20SS until return air temperature drops to $-5^{\circ}C$ and compressor capacity protection will be performed. As return air temperature has fallen below $-5^{\circ}C$, contact of thermostat 23A2 for overload protection will be opened and 20SS will open allowing normal full capacity operation. (indicated by thick broken lines in the wiring diagram (a)).

b. While in chilled mode
Normally, reduced load operation is run. Thus 2X5, being energized at all times by U_1 relay (23A1 controller), independent of 23A2, brings 20SS into closed state (as indicated by thick lines in the wiring diagram (b)).



3.5 Frozen operation (Setting below –5°C)



2D1	DEFROST TIMER	3-HU	HEAT UP SWITCH	HPCS	HIGH PRESSURE CONTROL SWITCH
2D2	DEFROST TERMINATION TIMER	20DPS	DRAIN PAN HEATER SOLENOID VALVE	LPS	LOW PRESSURE SWITCH
2F	EVAPORATOR FAN MOTOR DELAY TIMER	20M	MODULATING VALVE	WPS	WATER PRESSURE SWITCH
2DX1	DEFROST INITIATION RELAY	20LS1,2	LIQUID LINE SOLENOID VALVES	C	CAPACITOR
2DX2,3	DEFROST AUXILIARY RELAYS	23A1	RMC TEMPERATURE CONTROLLER	CPD	CONTACT PROTECTION DIODE
2X1~3	VOLTAGE CHANGE OVER RELAYS FOR FAN MOTOR	23A2	COMPRESSOR CAPACITY PROTECTION THERMOSTAT	MC	COMPRESSOR MOTOR
2X4	COMPRESSOR CONTROL RELAY	23D1,2	DEFROST TERMINATION THERMOSTATS	MF1	EVAPORATOR FAN MOTOR
2X5	CHILL/FROZEN CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	MF2	CONDENSER FAN MOTOR
2X6	DIGITAL DISPLAY ON–OFF RELAY	51C	OVER CURRENT RELAY	HM	HOUR METER
2X7	HEAT UP RELAY	52C1,2	CIRCUIT BREAKERS	P1,2	POWER PLUGS
2X8	IN RANGE TIMER AUXILIARY RELAY	88C	COMPRESSOR CONTACTOR	Tr	TRANSFORMER
3–30L	LAMP SWITCH	88F	EVAPORATOR FAN MOTOR CONTACTOR	VS	VOLTAGE SELECTOR SWITCH
3–88	UNIT ON–OFF SWITCH	APS	AIR PRESSURE SWITCH	GL,RL,AL,BL	LAMPS
3D	MANUAL DEFROST SWITCH	HPS	HIGH PRESSURE SWITCH	20SS	SUCTION LINE SOLENOID VALVE

(1) Switching over frozen and chilled modes
One of the modes will be automatically selected according to the setting of the set point selector.
- When the setting is above –4.5°C : chilled mode
- When the setting is below – 5°C : frozen mode

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

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

b. 20LS1 and 20LS2 are open, with relay 2X4 energized by Y_2 relays (for compressor) and G_2 (for low limit alarm) of 23A1.

c. When 20LS1 and 20LS2 are open, refrigerant flows and low pressure rises. LPS are turned on.

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

e. Upon timer count-up for 2F, 88F will be energized, and evaporator fan motors will start.
- - - The unit enters in the normal operation and container inside temperature begins to fall. - - -
Until return air temperature drops to -5°C, compressor should be operated in the way of overload protection (as indicated by broken lines in the wiring diagram).

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

g. When the temperature falls lower than set point, Y_2 relay is turned off (continuity between 9 and 11 of terminal B of 23A is lost); 2X4 becomes de-energized 20LS1 close; and "pump down" starts.

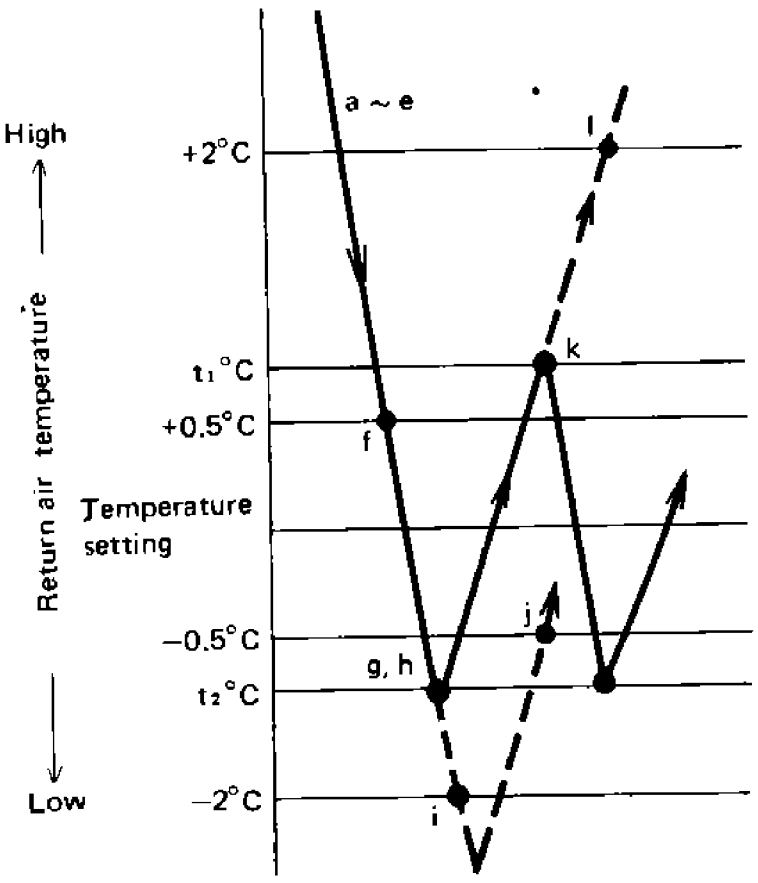
h. When the low pressure falls down, LPS is turned off; 88C becomes de-energized; compressor, condenser fan motors, etc., stop; and frozen operation stops.

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

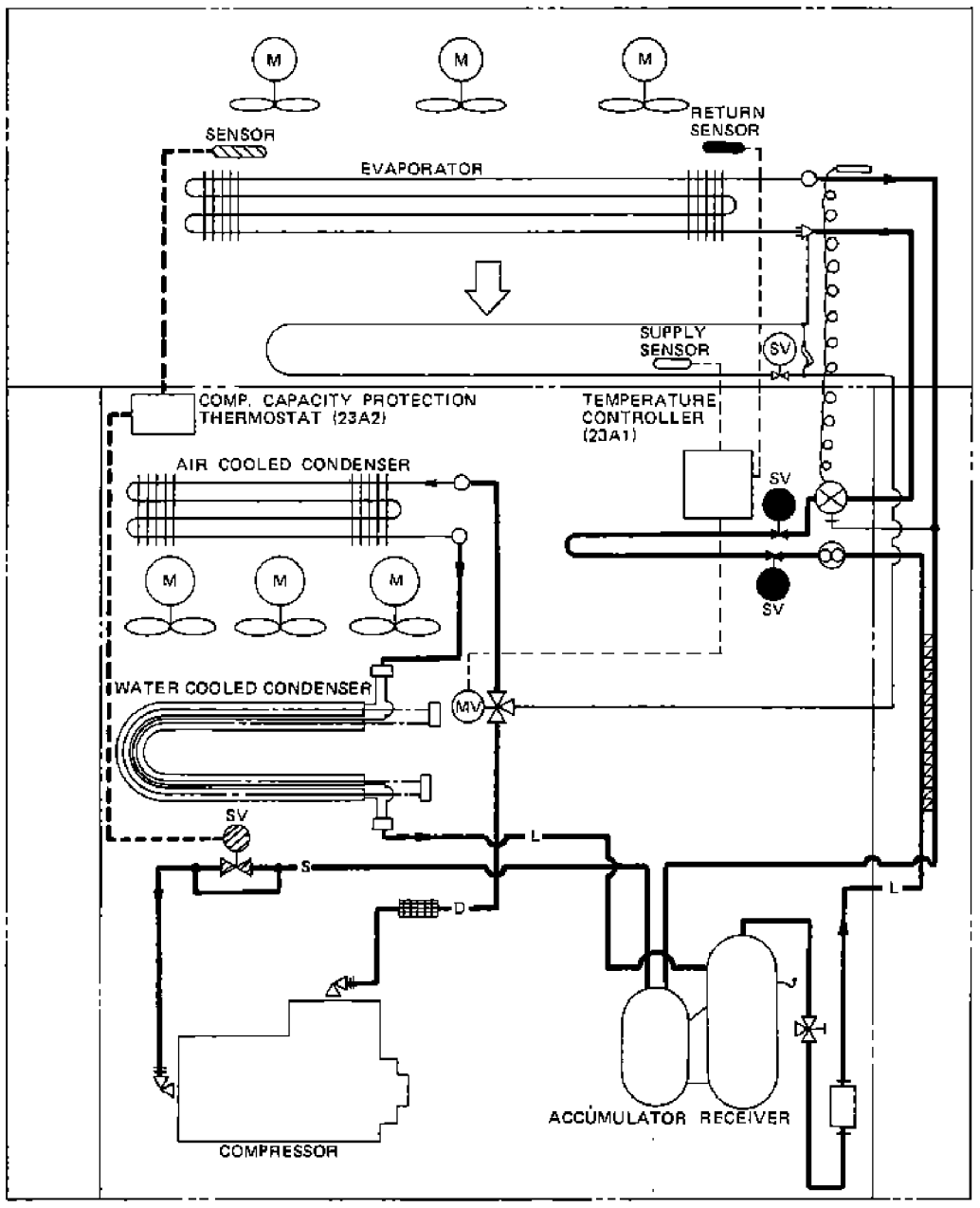
j. When the temperature rises to 0.5°C below set point G_2 relay is turned on and AL illuminates.

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

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

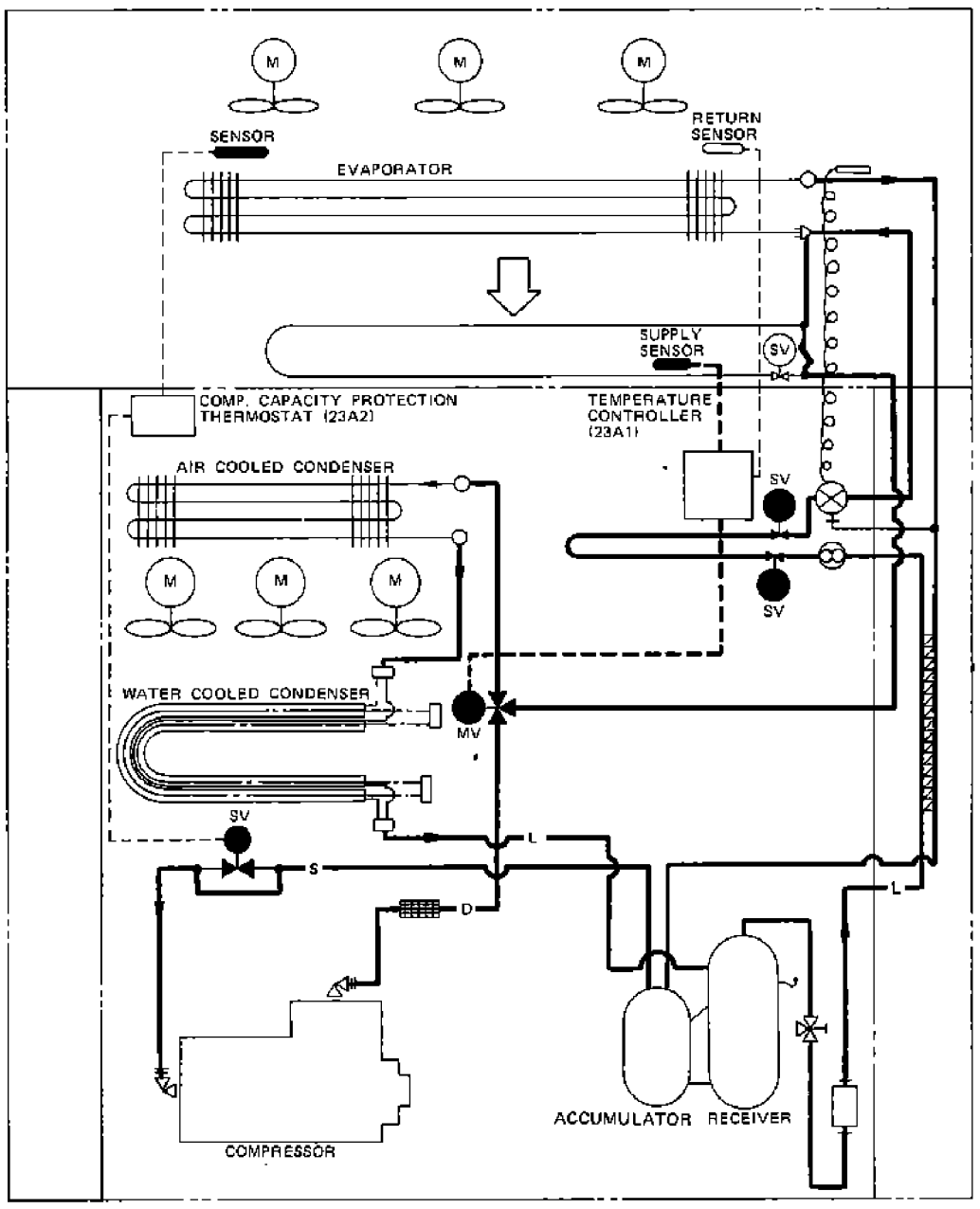


Note: t_1 and t_2°C (point of Y_2 relay function) are determined depending on temperature and time by means of P.I.D. (P: proportional action, I: integral action, D: derivative action) of the controller.



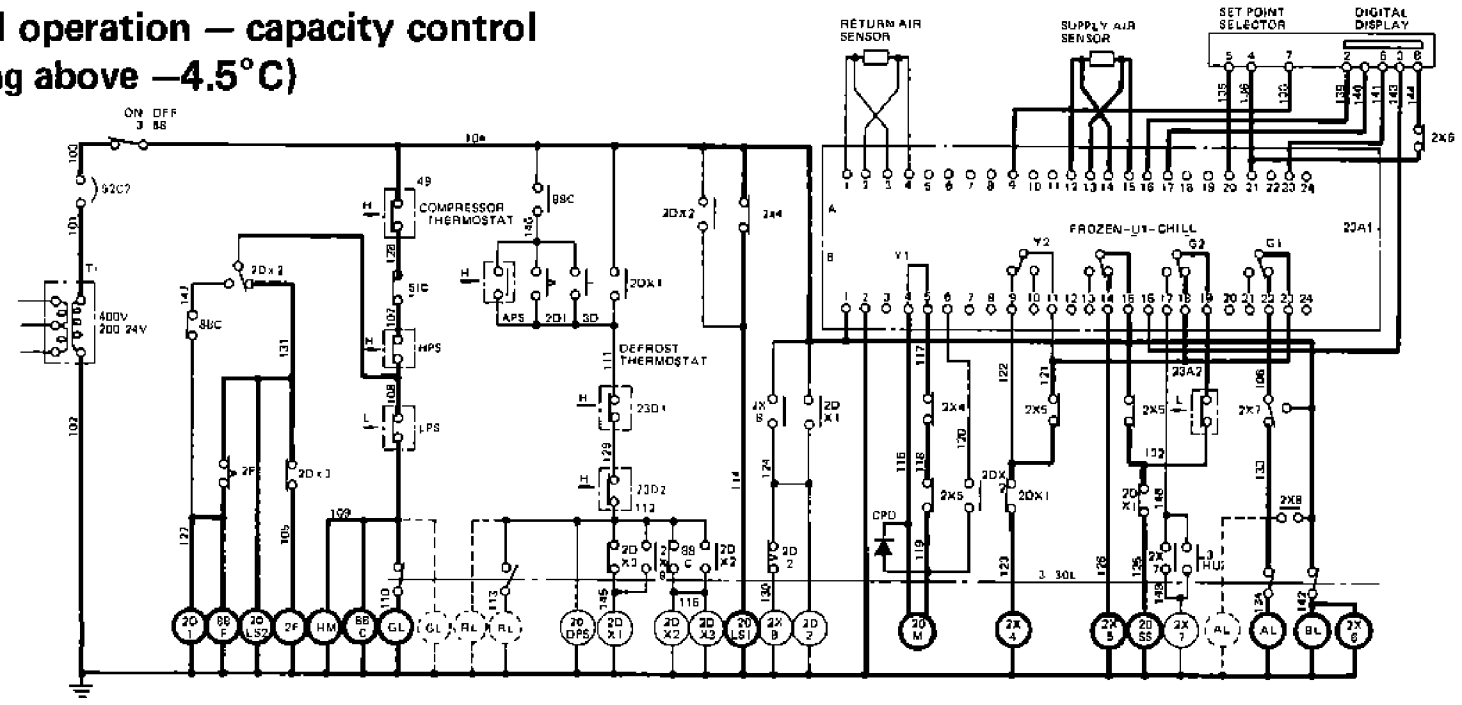
Note: The modulating valve diverges all the gas to the condenser section allowing full flow through the evaporator via the expansion valve.

Flow of refrigerant during frozen operation



Flow of refrigerant during chilled operation

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



2D1	DEFROST TIMER	3-HU	HEAT UP SWITCH	HPCS	HIGH PRESSURE CONTROL SWITCH
2D2	DEFROST TERMINATION TIMER	20DPS	DRAIN PAN HEATER SOLENOID VALVE	LPS	LOW PRESSURE SWITCH
2F	EVAPORATOR FAN MOTOR DELAY TIMER	20M	MODULATING VALVE	WPS	WATER PRESSURE SWITCH
2DX1	DEFROST INITIATION RELAY	20LS1,2	LIQUID LINE SOLENOID VALVES	C	CAPACITOR
2DX2,3	DEFROST AUXILIARY RELAYS	23A1	RMC TEMPERATURE CONTROLLER	CPD	CONTACT PROTECTION DIODE
2X1~3	VOLTAGE CHANGE OVER RELAYS FOR FAN MOTOR	23A2	COMPRESSOR CAPACITY PROTECTION THERMOSTAT	MC	COMPRESSOR MOTOR
2X4	COMPRESSOR CONTROL RELAY	23D1,2	DEFROST TERMINATION THERMOSTATS	MF1	EVAPORATOR FAN MOTOR
2X5	CHILL/FROZEN CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	MF2	CONDENSER FAN MOTOR
2X6	DIGITAL DISPLAY ON-OFF RELAY	51C	OVER CURRENT RELAY	HM	HOUR METER
2X7	HEAT UP RELAY	52C1,2	CIRCUIT BREAKERS	P1,2	POWER PLUGS
2X8	IN RANGE TIMER AUXILIARY RELAY	88C	COMPRESSOR CONTACTOR	Tr	TRANSFORMER
3-30L	LAMP SWITCH	88F	EVAPORATOR FAN MOTOR CONTACTOR	VS	VOLTAGE SELECTOR SWITCH
3-88	UNIT ON-OFF SWITCH	APS	AIR PRESSURE SWITCH	GL,RL,AL,BL	LAMPS
3D	MANUAL DEFROST SWITCH	HPS	HIGH PRESSURE SWITCH	20SS	SUCTION LINE SOLENOID VALVE

(1) Chilled operation is performed when the preset temperature is above −4.5°C and the unit is controlled by the supply air sensor. U_1 relay (which switches over frozen and chilled modes) of 23A1 is turned on, 2X5 relay is energized and the circuit of the chilled mode is made.
In this mode, suction solenoid valve is kept closed effeitively protecting the compressor.

(2) The controller subsequently positions the modulating valve (20M) so that the correct proportion of gas is distributed between the flow through the expansion valve and the flow direct to the evaporator coil through the bypass line of the drain pan heater.

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

b. When the supply air temperature reaches 0.5°C above set point, G_1 relay will turn on and AL lamp illuminates, indicating that the temperature is appropriate.

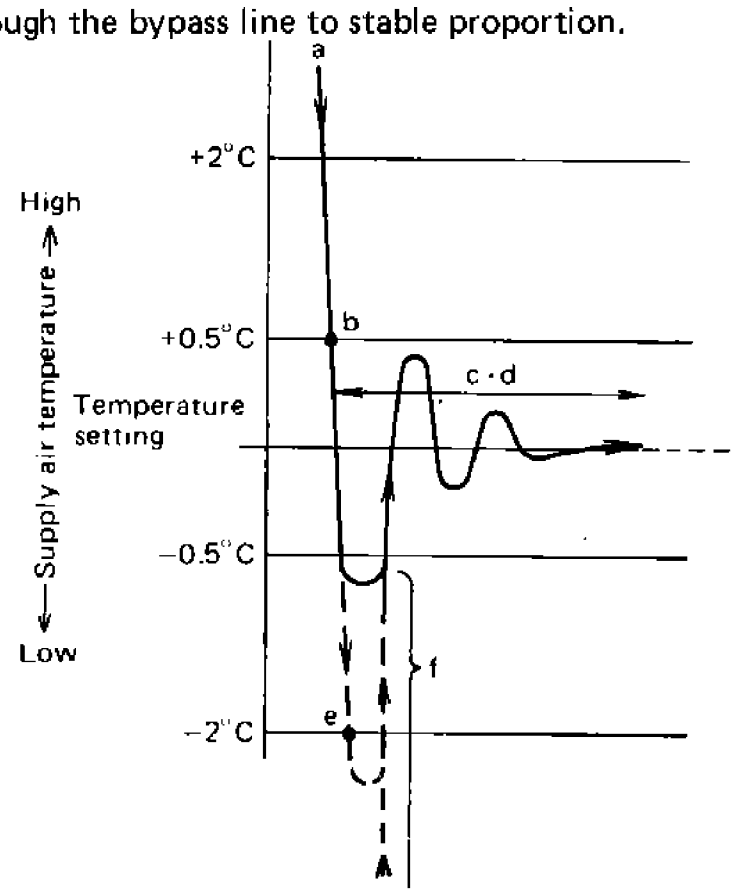
c. As the supply air temperature reaches set point , Y_1 voltage rises slowly from zero, which opens the modulating control valve (20M) gradually, permitting hot gas to distribute.

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

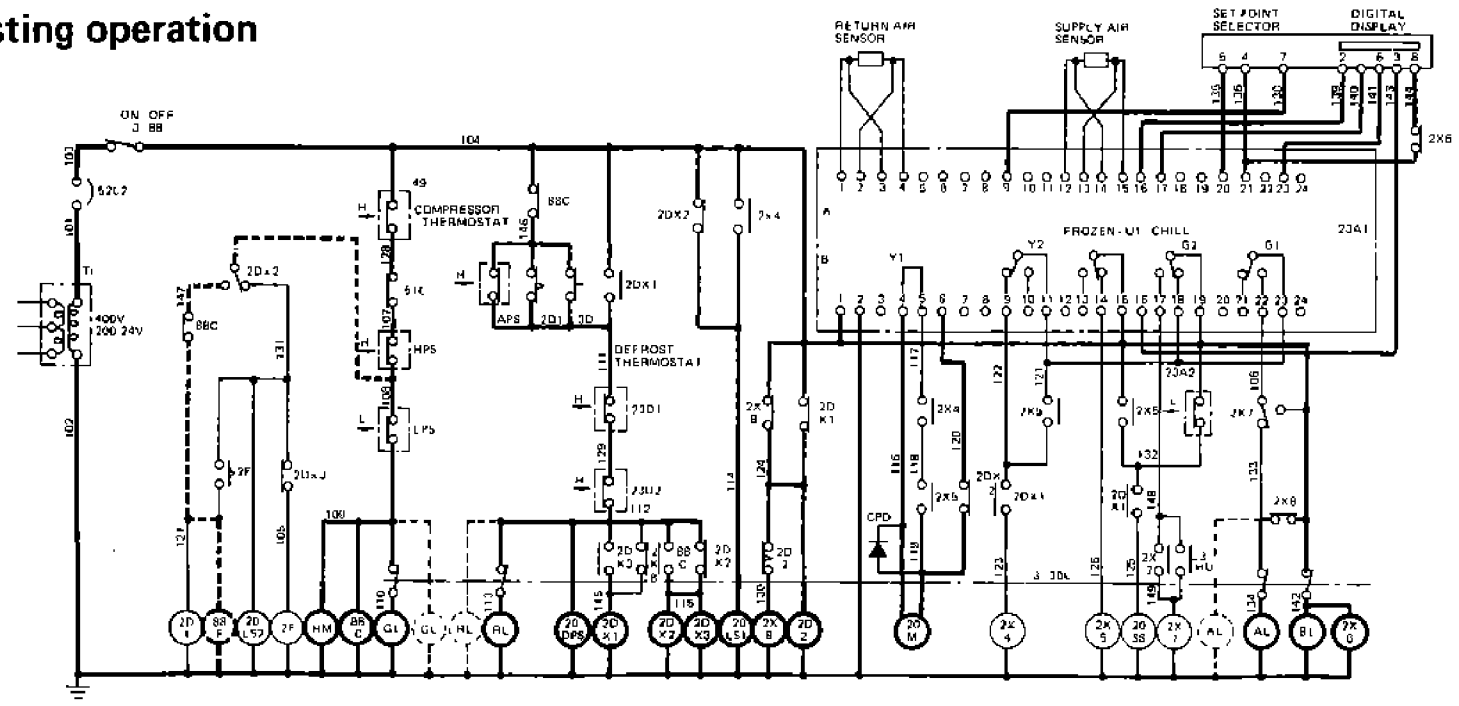
e. Depending on operating conditions (such as when the differece between the ambient and set point is small), G_2 relay is turned off and lamp AL goes out (after a delay of approximately 20 seconds) if the supply air temperature drops to 2°C below set point before stabilizing (low limit alarm).
At the same time, 2X4 relay is turned off; 20LS1 and 20M are closed, after "pump down", the compressor stops to prevent over-cooling.

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

Compressor will come to a "pump-down" stop, leaving only evaporator fan motor operating. Then as supply air temperature reaches to 0.5°C below set point, the compressor will start and the position of 20M will gradually move from full flow of hot gas into evaporator coil through the bypass line to stable proportion.



3.7 Defrosting operation



2D1	DEFROST TIMER	3-HU	HEAT UP SWITCH	HPCS	HIGH PRESSURE CONTROL SWITCH
2D2	DEFROST TERMINATION TIMER	20DPS	DRAIN PAN HEATER SOLENOID VALVE	LPS	LOW PRESSURE SWITCH
2F	EVAPORATOR FAN MOTOR DELAY TIMER	20M	MODULATING VALVE	WPS	WATER PRESSURE SWITCH
2DX1	DEFROST INITIATION RELAY	20LS1,2	LIQUID LINE SOLENOID VALVES	C	CAPACITOR
2DX2,3	DEFROST AUXILIARY RELAYS	23A1	RMC TEMPERATURE CONTROLLER	CPD	CONTACT PROTECTION DIODE
2X1~3	VOLTAGE CHANGE OVER RELAYS FOR FAN MOTOR	23A2	COMPRESSOR CAPACITY PROTECTION THERMOSTAT	MC	COMPRESSOR MOTOR
2X4	COMPRESSOR CONTROL RELAY	23D1,2	DEFROST TERMINATION THERMOSTATS	MF1	EVAPORATOR FAN MOTOR
2X5	CHILL/FROZEN CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	MF2	CONDENSER FAN MOTOR
2X6	DIGITAL DISPLAY ON-OFF RELAY	51C	OVER CURRENT RELAY	HM	HOUR METER
2X7	HEAT UP RELAY	52C1,2	CIRCUIT BREAKERS	P1,2	POWER PLUGS
2X8	IN RANGE TIMER AUXILIARY RELAY	88C	COMPRESSOR CONTACTOR	Tr	TRANSFORMER
3-30L	LAMP SWITCH	88F	EVAPORATOR FAN MOTOR CONTACTOR	VS	VOLTAGE SELECTOR SWITCH
3-88	UNIT ON-OFF SWITCH	APS	AIR PRESSURE SWITCH	GL, RL, AL, BL	LAMPS
3D	MANUAL DEFROST SWITCH	HPS	HIGH PRESSURE SWITCH	20SS	SUCTION LINE SOLENOID VALVE

(1) Defrosting is achieved by utilizing hot gas from the compressor.
Defrosting can be initiated from three sources.

- By manual defrost switch (3D).
- By a defrost timer (2D).
(Every 12 hours at 60Hz or every 14½ hours at 50Hz).
- By the action of an air pressure switch (APS) which is activated when the pressure across the evaporator coil is 25mmH_2O (LKE8CD10) or 31mmH_2O (LKE8CD11).

Signal by a defrost timer or an air pressure switch is effective for defrost initiation only at compressor running. Defrosting initiates at next compressor running when above signals occur in the halt of compressor.

Upon receiving a signal from any of the above, defrost initiation relay (2DX1) is energized which is self held and red lamp (RL) will be illuminated and causing the solenoid valve (20DPS) to open.

(2) At the time 2DX1 is energized, the 2X4 relay is de-energized causing the compressor to pump down the system and the 2X8 relay is energized causing defrost termination timer (2D2) to start.

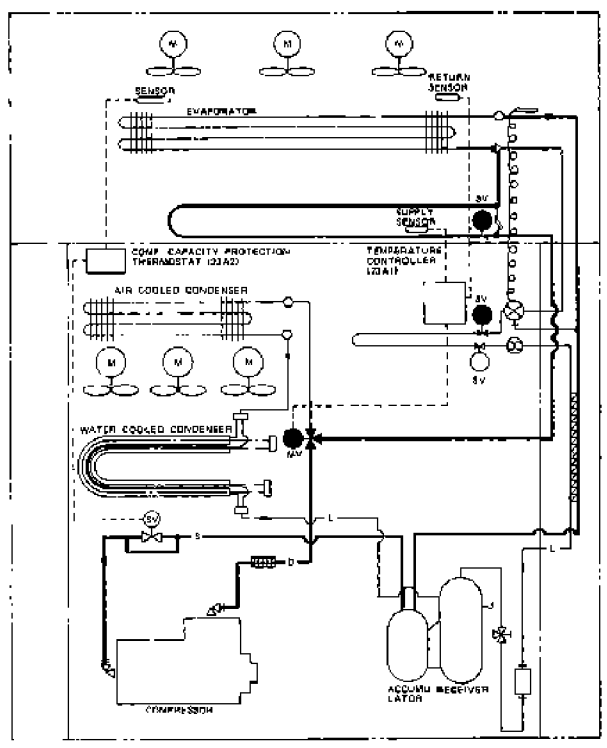
(3) After the compressor has pumped down the system and stop on low pressure switch (LPS), 2DX2 relay will be energized causing.

- The evaporator fans to keep running up to re-start of compressor for defrosting.
- The solenoid valve (20LS1) to open and the solenoid valve (20LS2) to close which release a measured amount of liquid into the evaporator coil which will reset the low pressure switch (LPS) causing the compressor to restart.
- Modulating valve (20M) will diverge all hot gas from the compressor to enter the evaporator coil through the drain pan heater to effect the defrost resulting in energizing drain pan solenoid valve (20DPS).

(4) The termination of the defrost is caused by the opening of the termination thermostats (23D1, 2).
These thermostats are located on the suction pipe leaving the evaporator coil and either of or both thermostats should be operated at approximately 40 deg.C and further more the termination of defrost is made back up by defrost termination timer (2D2).
The defrost termination timer (2D2) stops defrosting forcedly after taking 90 min. at 60 Hz from initiation and illuminates in range lamp (AL) for 90 min. at 60 Hz regardless inside temperature during defrosting.
Notes:

(1) Depending upon the operating conditions, the time taken for the compressor to restart after solenoid (20LS1) reopens may take up to approximately 5 minutes.

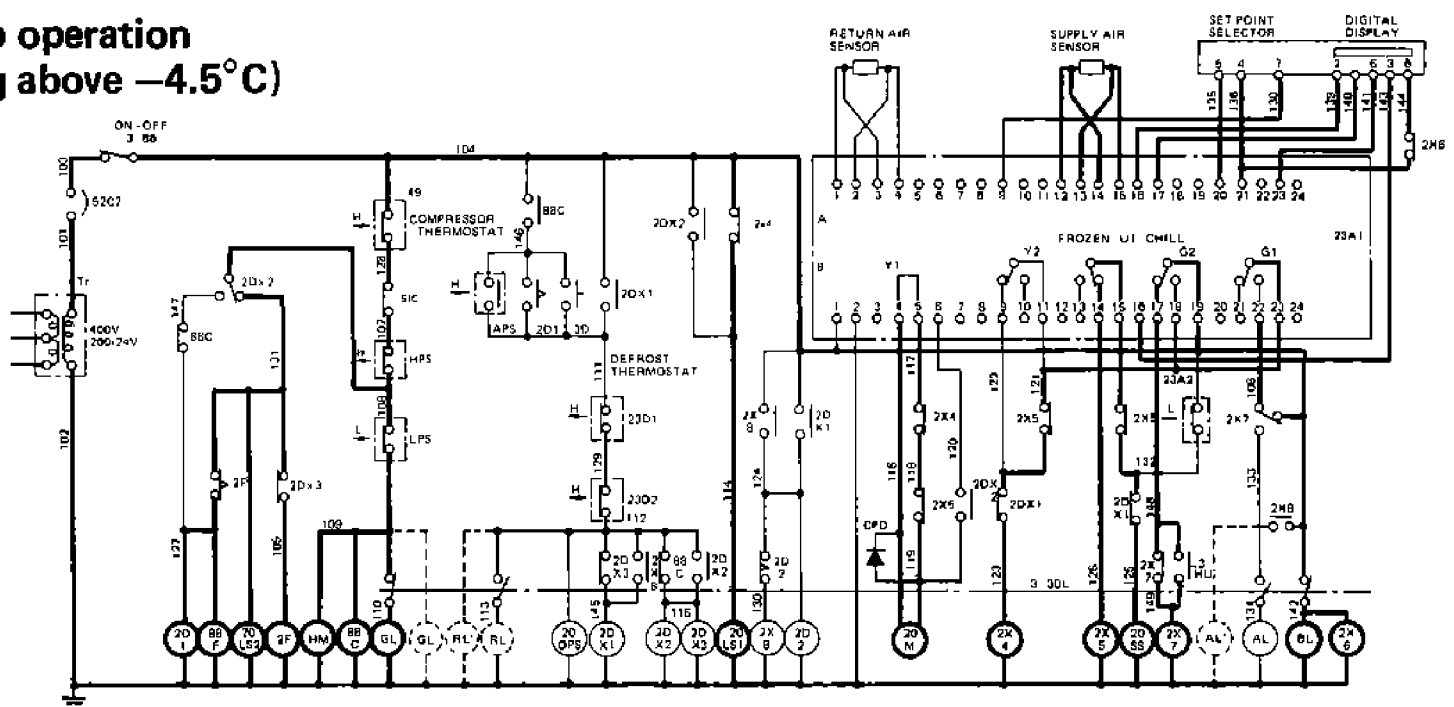
(2) The time taken to fully defrost the evaporator coil will vary between 15 to 50 minutes.



Flow of refrigerant during defrosting operation.

(3) When defrosting operation is changed to frozen operation at completion of defrosting, it is possible to have the frost on compressor temporarily at low ambient.

3.8 Heat up operation (Setting above –4.5°C)



2D1	DEFROST TIMER	3-HU	HEAT UP SWITCH	HPCS	HIGH PRESSURE CONTROL SWITCH
2D2	DEFROST TERMINATION TIMER	20DPS	DRAIN PAN HEATER SOLENOID VALVE	LPS	LOW PRESSURE SWITCH
2F	EVAPORATOR FAN MOTOR DELAY TIMER	20M	MODULATING VALVE	WPS	WATER PRESSURE SWITCH
2DX1	DEFROST INITIATION RELAY	20LS1,2	LIQUID LINE SOLENOID VALVES	C	CAPACITOR
2DX2,3	DEFROST AUXILIARY RELAYS	23A1	RMC TEMPERATURE CONTROLLER	CPD	CONTACT PROTECTION DIODE
2X1~3	VOLTAGE CHANGE OVER RELAYS FOR FAN MOTOR	23A2	COMPRESSOR CAPACITY PROTECTION THERMOSTAT	MC	COMPRESSOR MOTOR
2X4	COMPRESSOR CONTROL RELAY	23D1,2	DEFROST TERMINATION THERMOSTATS	MF1	EVAPORATOR FAN MOTOR
2X5	CHILL/FROZEN CHANGE OVER RELAY	49	COMPRESSOR PROTECTOR	MF2	CONDENSER FAN MOTOR
2X6	DIGITAL DISPLAY ON–OFF RELAY	51C	OVER CURRENT RELAY	HM	HOUR METER
2X7	HEAT UP RELAY	52C1,2	CIRCUIT BREAKERS	P1,2	POWER PLUGS
2X8	IN RANGE TIMER AUXILIARY RELAY	88C	COMPRESSOR CONTACTOR	Tr	TRANSFORMER
3–3OL	LAMP SWITCH	99F	EVAPORATOR FAN MOTOR CONTACTOR	VS	VOLTAGE SELECTOR SWITCH
3–88	UNIT ON–OFF SWITCH	APS	AIR PRESSURE SWITCH	GL,RL,AL,BL	LAMPS
3D	MANUAL DEFROST SWITCH	HPS	HIGH PRESSURE SWITCH	20SS	SUCTION LINE SOLENOID VALVE

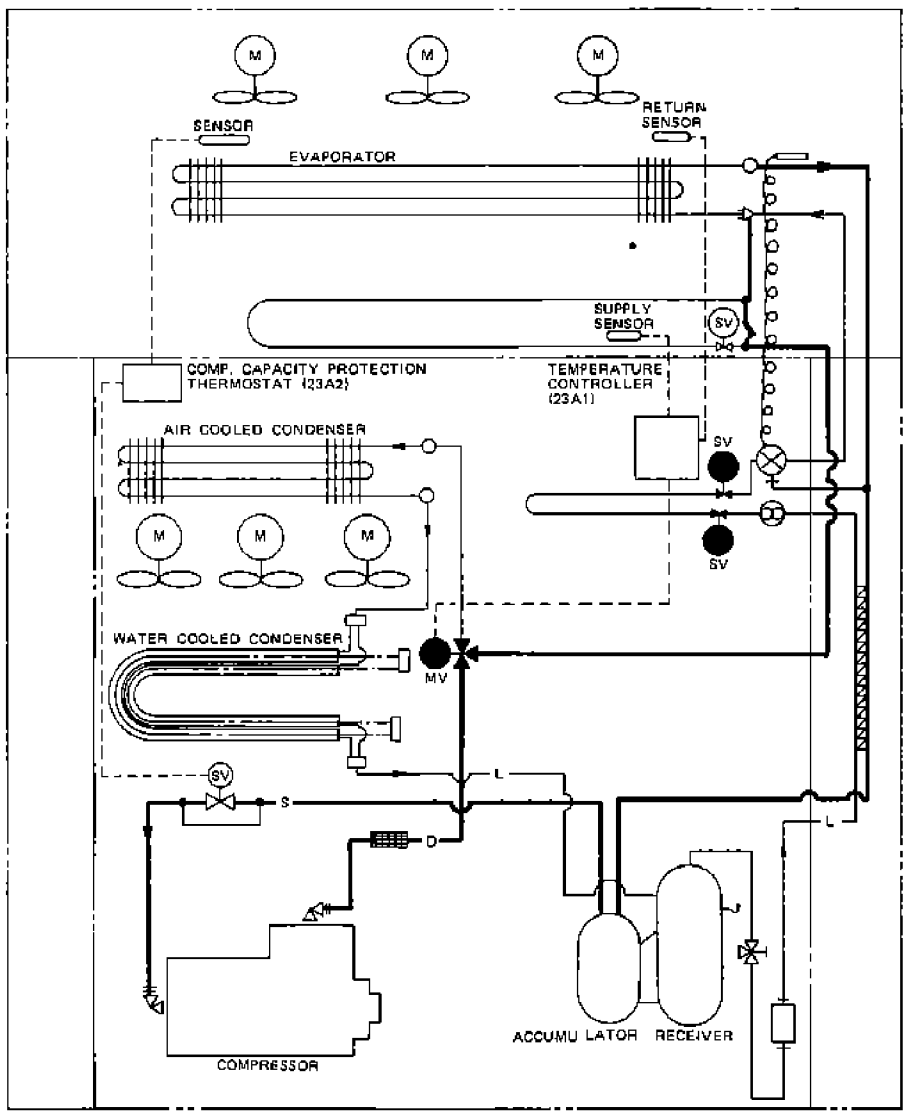
When the inside temperature is lower than the setting temperature in chilled mode at starting, heating operation is available by manual switch up to in range temperature and changes to chilled operation automatically.

(1) Only evaporator fans rotates after switching on when inside temperature is lower than the setting temperature.

(2) The 2X7 relay is energized by heat up switch (3-Hu) causing the 2X4 relay to be energized.

(3) Operation of the 2X4 relay causes the solenoid valves (20LS1,2) to open and the modulating valve (20M) to diverge all hot gas to the evaporator coil through the bypass line of the drain pan heater when the low pressure switch is reset.

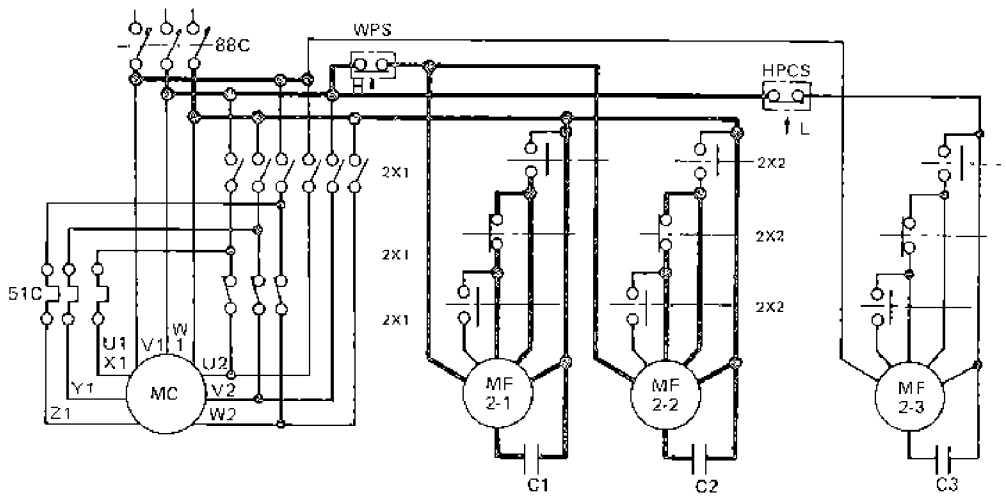
(4) When inside temperature is raised up to in range temperature, the 2X7 relay is de-energized by G2 relay and heat up operation changes to chilled operation automatically.
After the inside temperature is raised up to in range temperature, heat up operation never occurs without switching on the heat up switch (3-Hu) by manual, even if inside temperature is cooled down less than low limit temperature.



Flow of refrigerant during heat of operation.

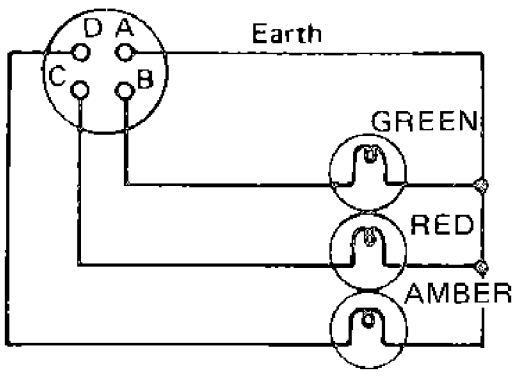
3.9 Condenser fan control

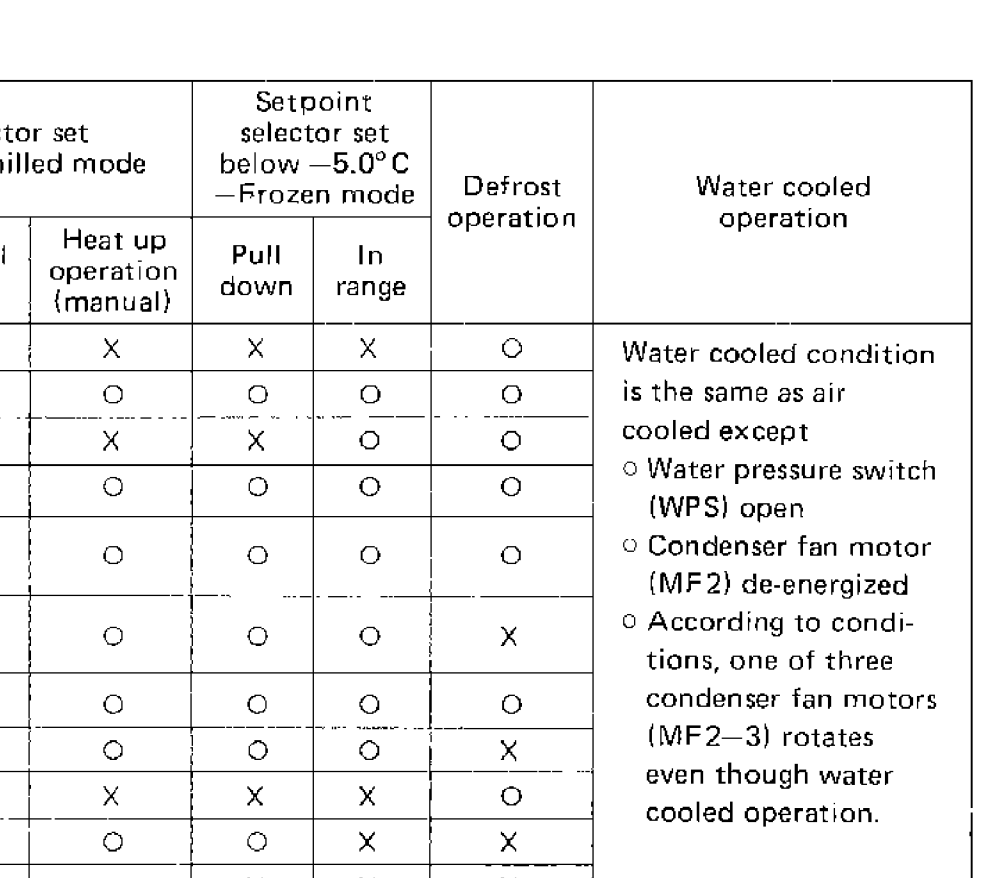
(1) When the compressor discharge pressure falls to 7kg/cm^2 (99.6 psi) one of the three condensor fan is stopped by the action of HPCS.



3.10 Pilot lamps and monitoring circuit

(1) Four lamps which indicate operating mode are mounted on the front panel of the control box.
Red : indicates defrosting mode (RL)
Green : indicates that the compressor is running (GL)
Amber : indicates that inside temperature is with in range (within +/−2°C of the preset temperature) (AL)
Blue : indicates that electrical source is supplied.
Receptacle for monitoring is fitted and its connections is shown at below.





(2) Amber lamp is lighting for 90 min. on 60 Hz from initiation of defrosting by the defrost termination timer (2D2).

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

Parts name				Setpoint selector set above −4.5°C −Chilled mode				Setpoint selector set below −5.0°C −Frozen mode		Defrost operation	Water cooled operation
				Pull down	In range	Pull up	Heat up operation (manual)	Pull down	In range		
Light	Defrost −Red			X	X	X	X	X	X	O	Water cooled condition is the same as air cooled except ○ Water pressure switch (WPS) open ○ Condenser fan motor (MF2) de-energized ○ According to conditions, one of three condenser fan motors (MF2−3) rotates even though water cooled operation.
	Comp −Green			O	O	X	O	O	O	O	
	In range −Amber			X	O	X	X	X	O	O	
	Power −Blue			O	O	O	O	O	O	O	
Magnetic switch	Comp., cond. fan motor (88C)			O	O	X	O	O	O	O	
	Evaporator fan motor (88F)			O	O	O	O	O	O	X	
Solenoid valve	20LS1			O	O	X	O	O	O	O	
	20LS2			O	O	O	O	O	O	X	
	20DPS			X	X	X	X	X	X	O	
	20SS	Inside temperature	Above −5°C	O	O	O	O	O	X	X	
			Below −5°C	—	—	—	—	X	X	X	
Modulating valve (20M)				X	O	X	O	X	X	O	
Compressor				O	O	X	O	O	O	O	

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

4. Major components and maintenance

4.1 Components related with refrigeration circuit

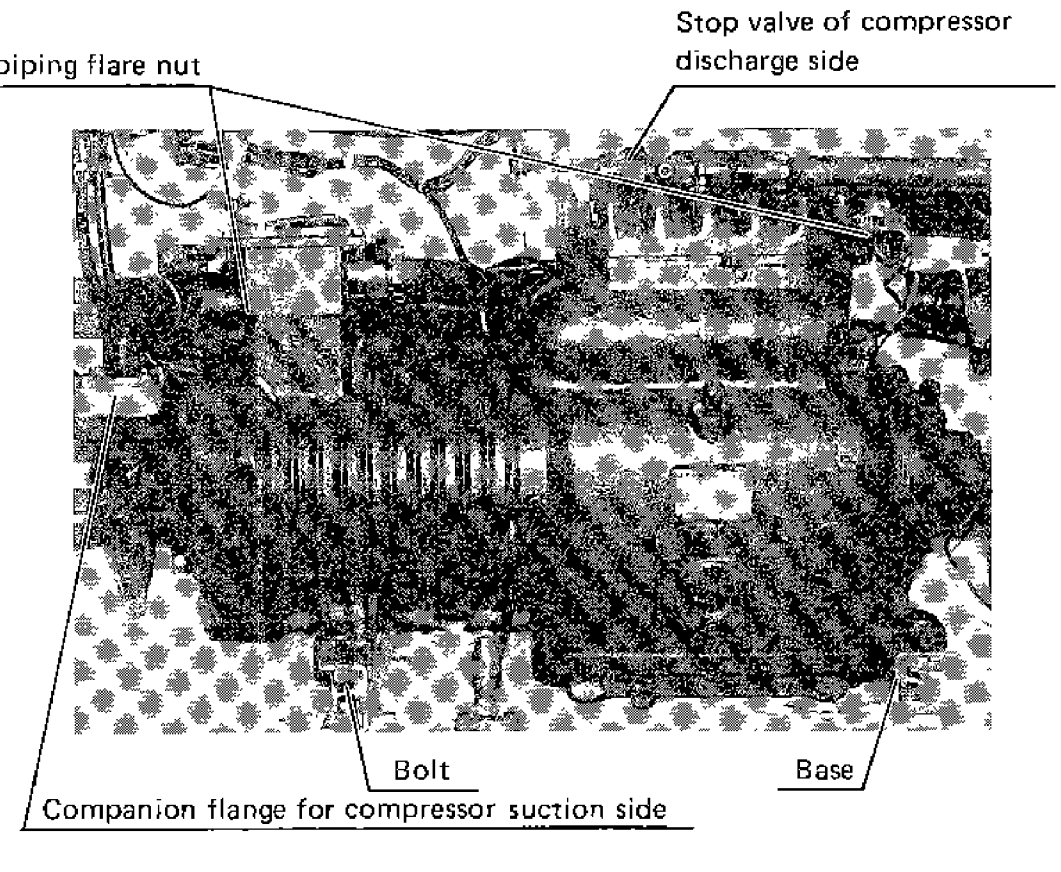
4.1.1 Compressor

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

(a) Replacement

Remove the compressor by the following procedure.

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



(b) Installing procedure

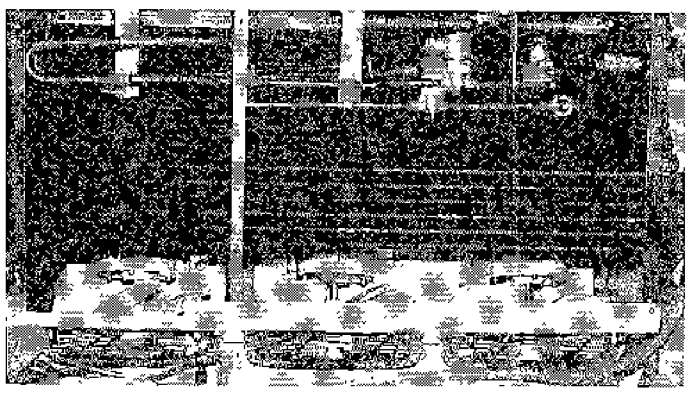
Install the compressor reversing the procedure given above. When tightening the bolts, refer to the torque values listed.

4.1.2 Air-cooled condenser and evaporator

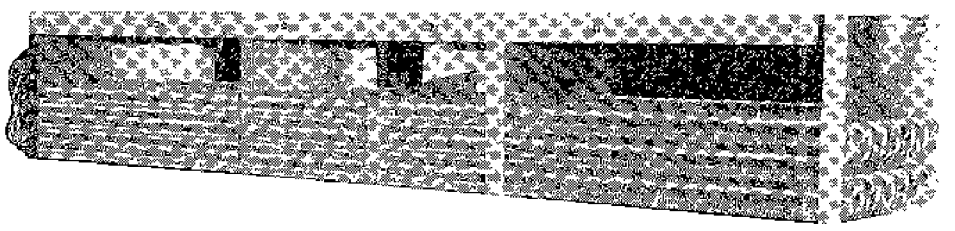
The "cross fin" coil has special corrugated fins. They are compact and very efficient in producing uniform heat exchange efficiency.

(a) Maintenance

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



Air cooled condenser



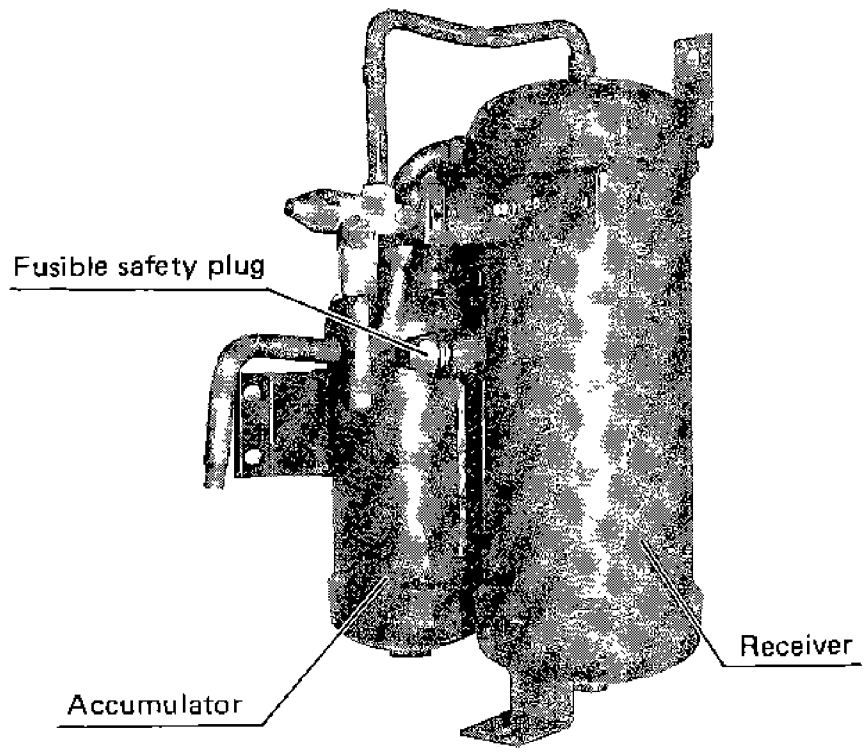
Evaporator

4.1.3 Water-cooled condenser

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

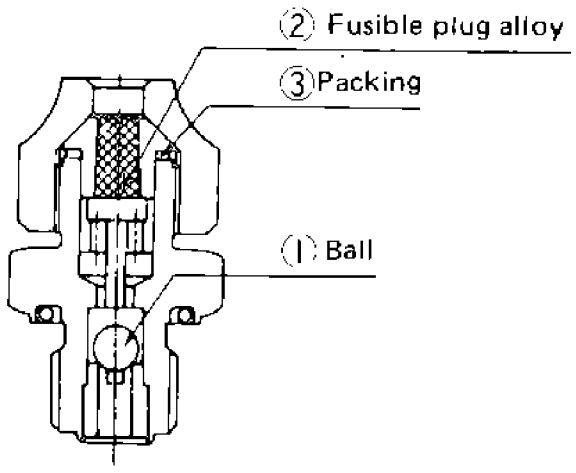
4.1.4 Accumulator-receiver with heat exchanger

Consists of the accumulator, receiver and heat exchanger, which are covered with insulator. A fusible safety plug is fitted to the receiver body.



(a) Replacement procedure of the fusible safety plug

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

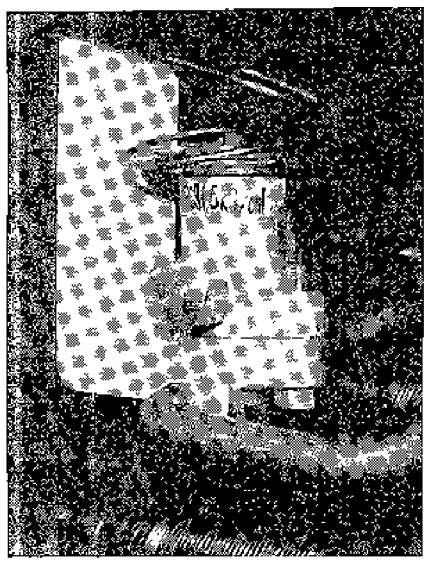


Construction of fusible safety plug

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

4.1.5 Expansion valve

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



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

(a) Adjusting the expansion valve

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

(1) Adjustment based on the suction operation pressure

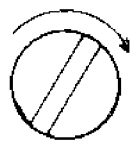
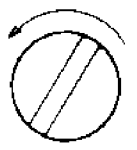
1) Conform that the predesigned volume of the refrigerant has been charged.
2) Attach a pressure gauge to each gauge port and operate the refrigeration unit, maintaining inside temperature at −18°C (−0.4°F). (See connecting of pressure gauge).
3) When inside temperature comes to the preset temperature, compare the suction pressure reading with the standard pressure. (See Standard operation pressure curve on page 54)
4) If suction pressure reading differs with the standard pressure, adjust the expansion valve as stated below.
5) After loosening the clamp screw, turn the adjusting screw.
6) Note that pressure will not change after a certain lapse of time.

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

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

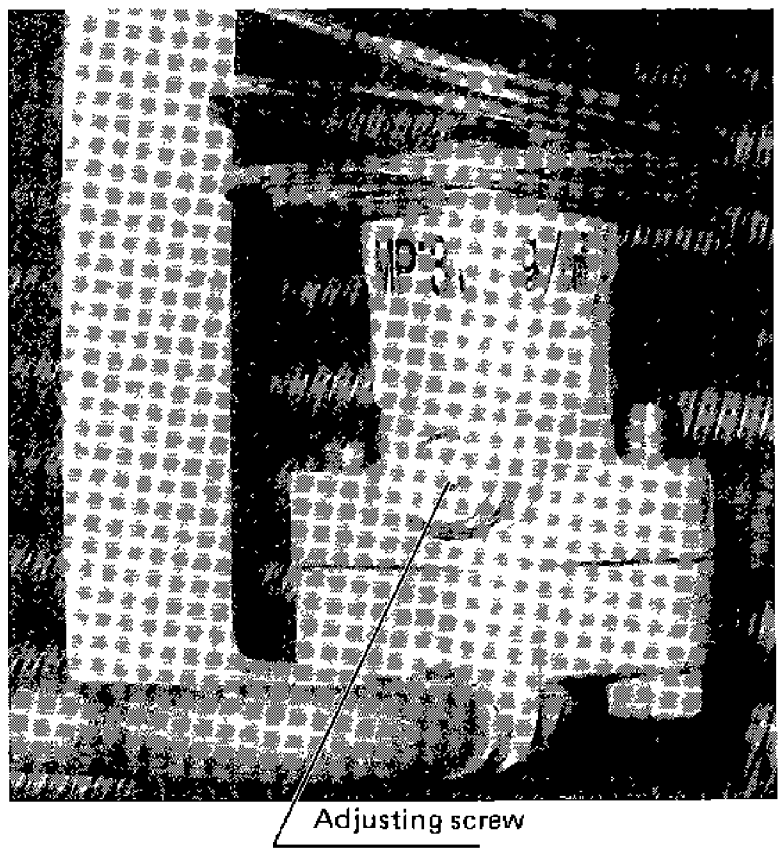
Note: Check the position of the feeler tube fitted to the suction pipe from the evaporator before making any adjustments.

Adjusting points for expansion valve

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

(3) Countermeasures after operation

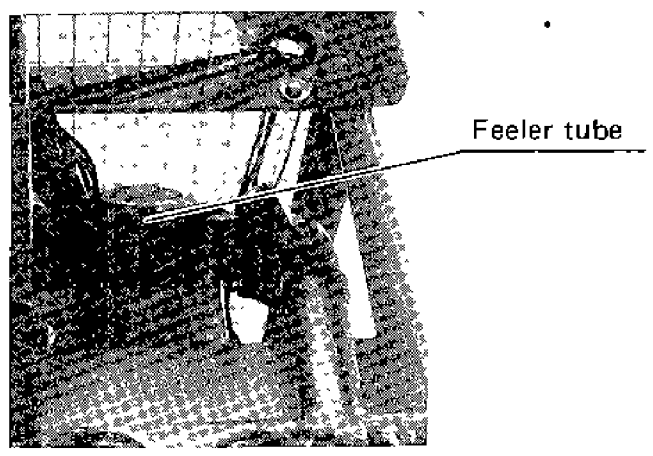
1) Remember the original setting of the expansion valve. If any change is not found with the setting after adjustment of the expansion valve, return the adjusting screw to the original position, as trouble occured caused by other reasons.
2) When the adjusting screw is returned to its original position,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



(b) Replacement

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

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



4.1.6 Liquid/moisture indicator

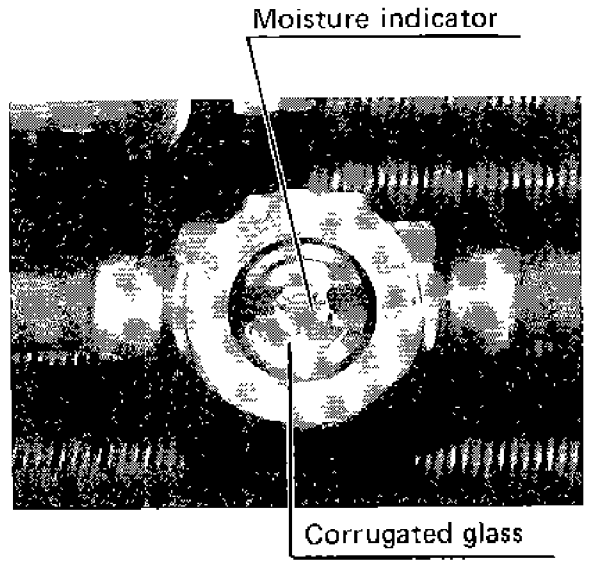
This indicator permits checking of flow of the refrigerant and moisture content in the refrigerant. Check this indicator during the unit is operating.

(a) Moisture content

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

Color	State
Deep blue	Dry
Orange	Wet (moisture contained)

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



4. To shorten the time for change of indicator, raise up the temperature of liquid refrigerant.

(b) Flow of the refrigerant-frozen mode only

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

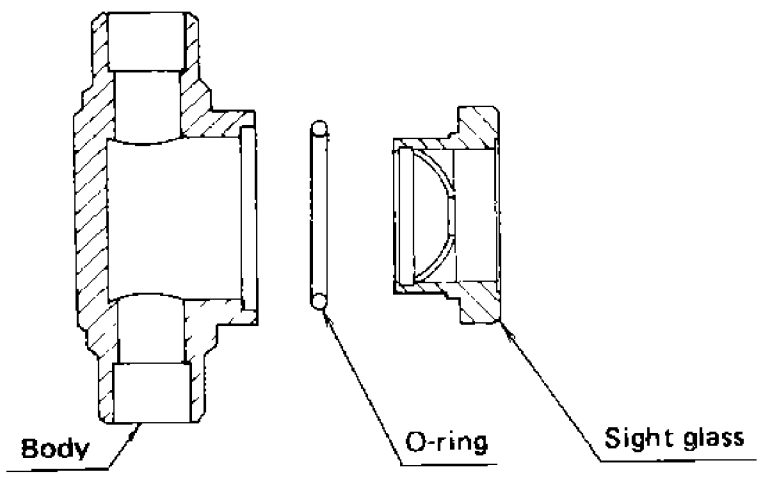
● Check

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

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.)

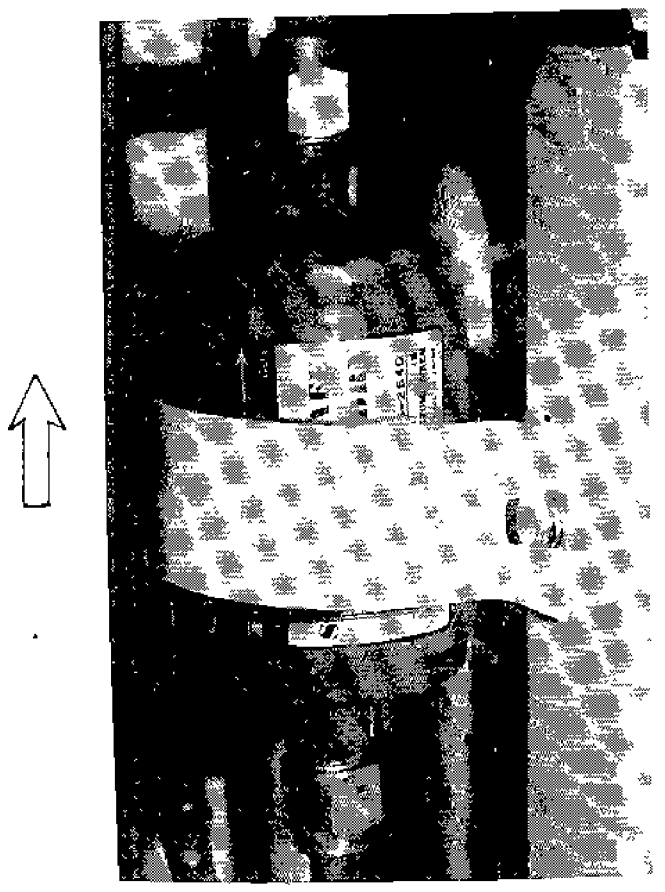


4.1.7 Dryer

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.

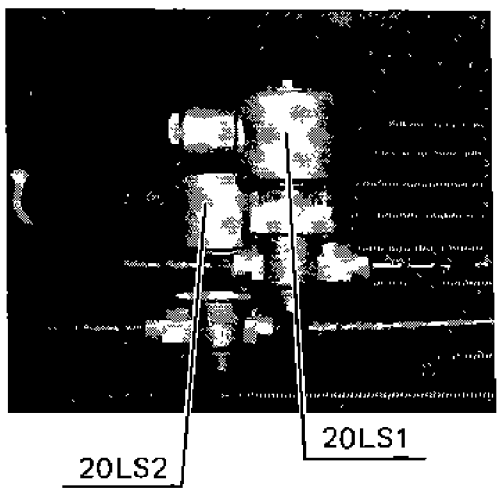
(a) Replacement

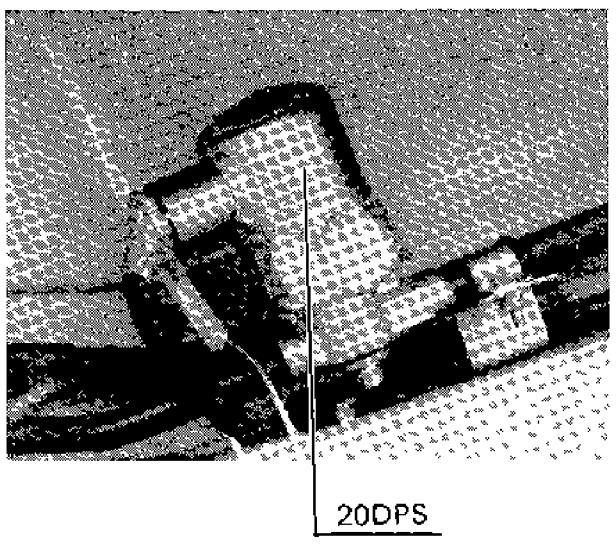
1) In "pump down" state (see Service), close the compressor suction stop valve.
2) Then, loosen the flares at the both end of the dryer and replace the dryer quickly.
3) Be careful not to get air into the piping on the solenoid valve side while removing the dryer.
4) After reattachment of the dryer,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

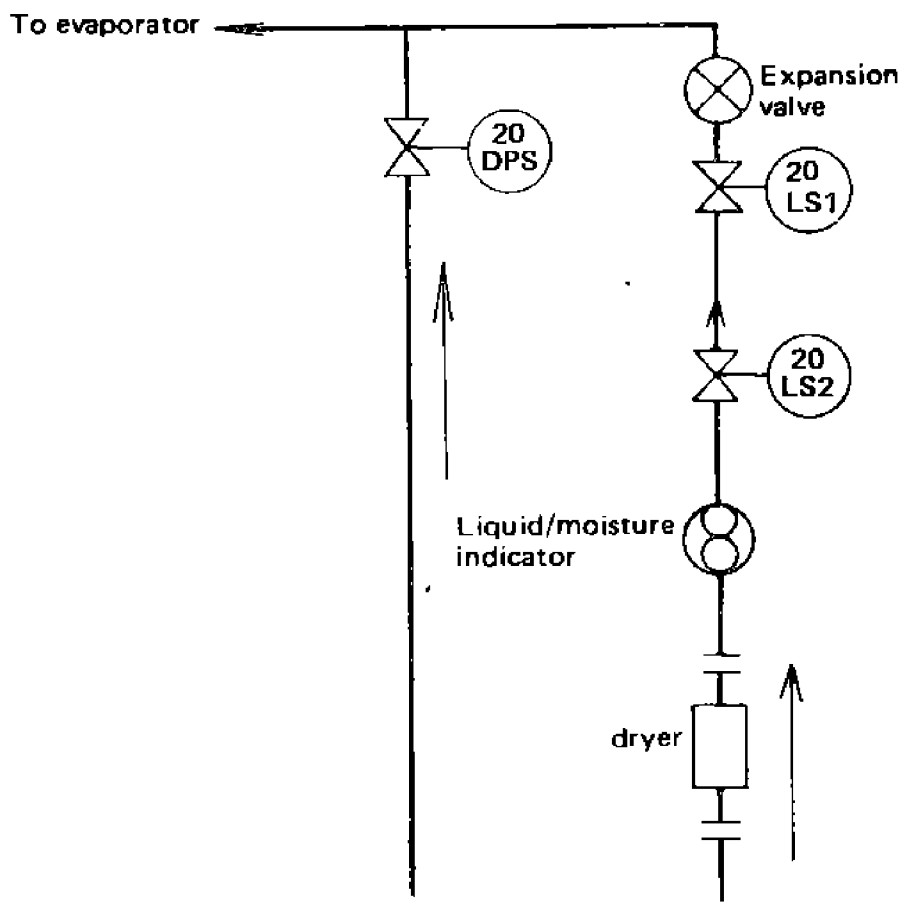


4.1.8 Solenoid valves in the liquid line (20LS1, 20LS2) and in the hot gas line (20DPS)

There are two solenoid valves in the liquid line and one solenoid valve in the hot gas line. They function according to operating mode.

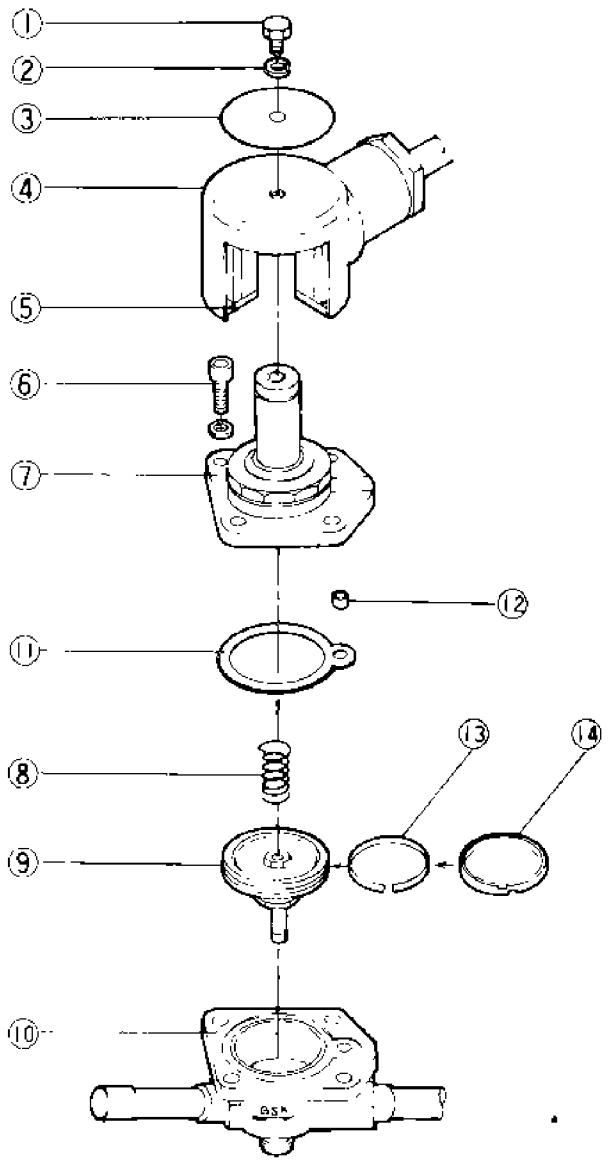






<Disassembly>

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

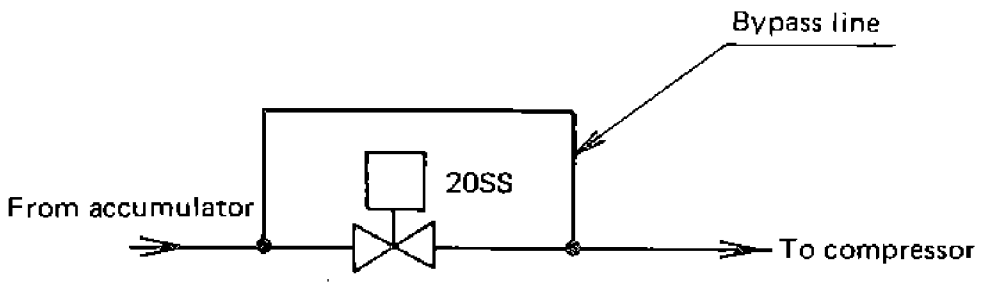


No.	Parts name
1	Set bolt
2	Spring lock washer
3	Name plate
4	Coil ass'y
5	Retaining plate
6	Set bolt
7	Cover ass'y
8	Spring
9	Piston
10	Valve body
11	Packing
12	Sleeve
13	Inner ring
14	Piston ring

4.1.9 Suction line solenoid valve (20SS)

a. 〈Actuation description〉

This valve is located on suction line to compressor.
It operates in accordance with return air temperature.

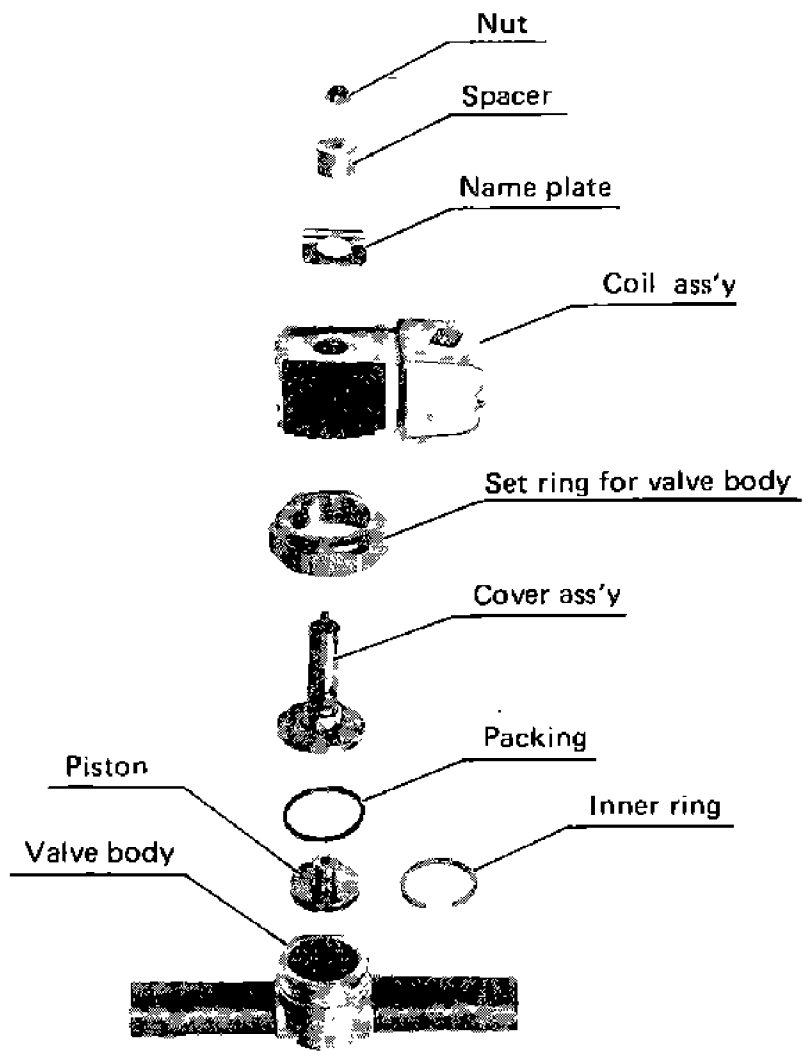


Close when the solenoid is energized and open when de-energized.

b. <Disassembling>

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

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



4.1.10 Discharge filter

This filter is located on discharge line from compressor.

<Disassembling>

- Loosen the cap of filter to inspect the inside with two spanners.
- At reassembling, tighten the cap with torque of 900kg·cm.
- At loosening or tightening the cap of filter, be careful not to privide the strong force to the connected pipes with two spanners.
- At replacement, the body of discharge filter is to be cooled well for brazing.

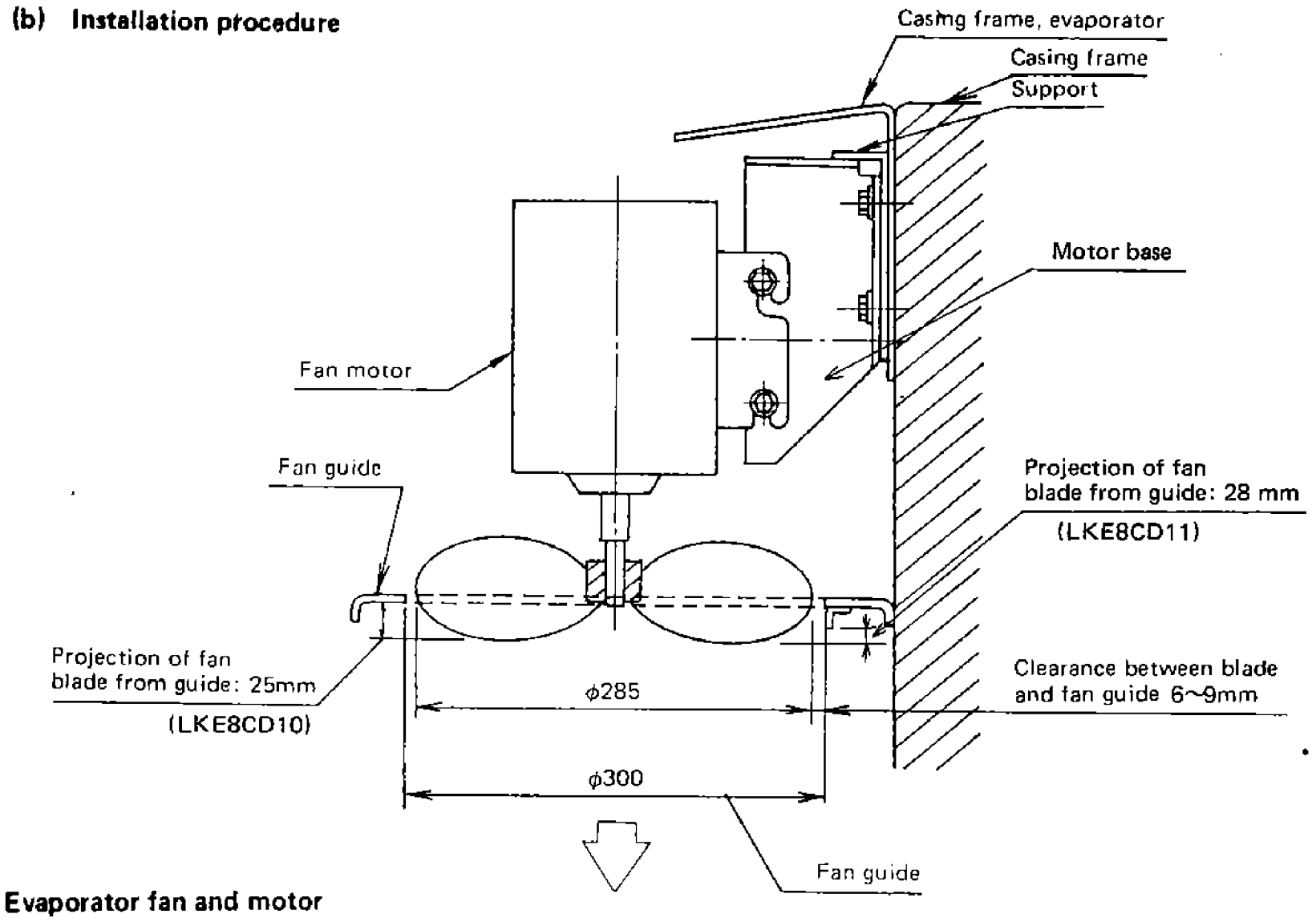
4.2. Components related with the air system

4.2.1 Fans and motors

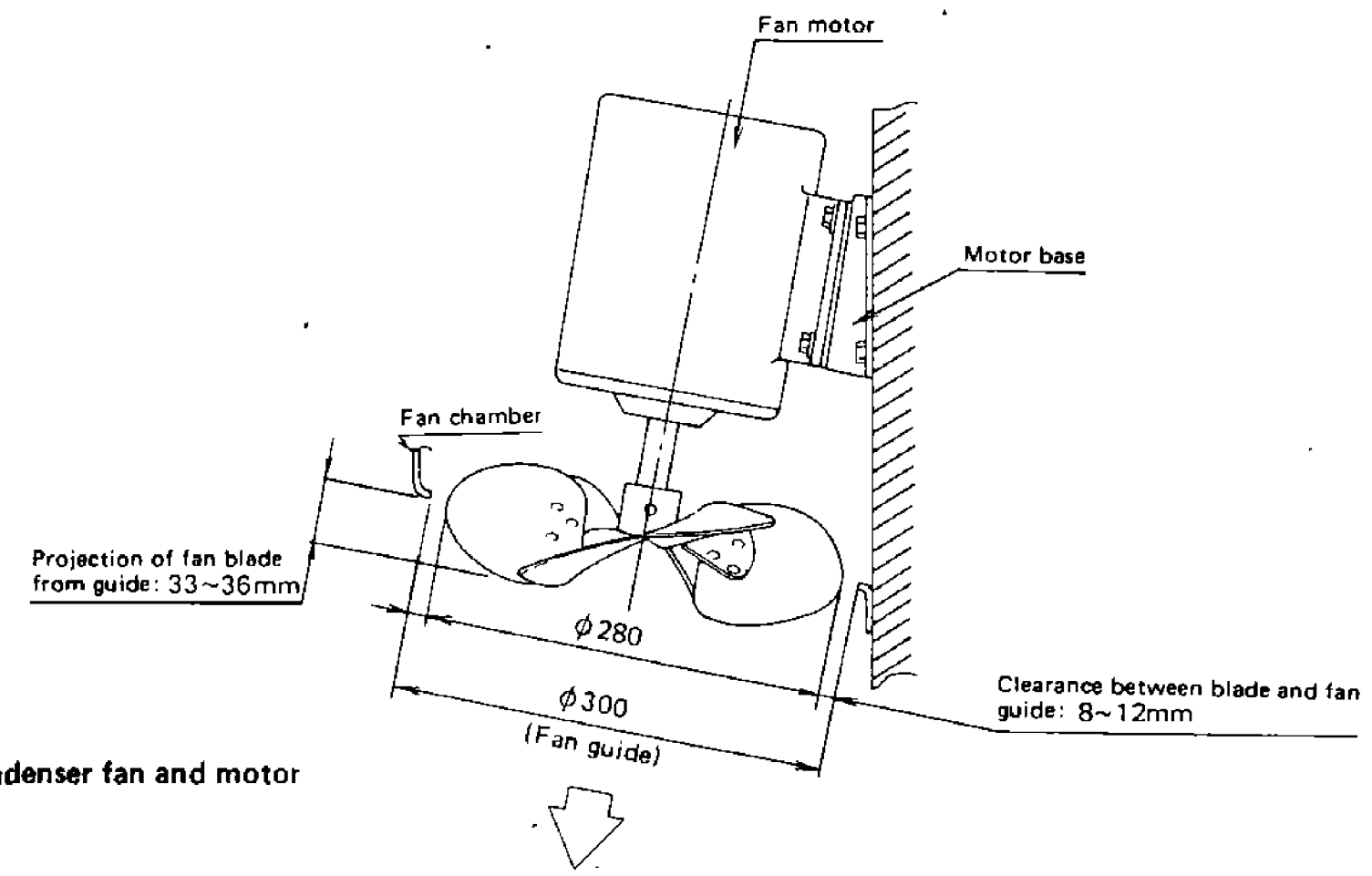
(a) Specifications

		Evaporator		Condenser
		LKE8CD10	LKE8CD11	
Fan	Type	Propeller fan		
	Number of blades	6 pcs.	6 pcs.	6 pcs.
	Blade diameter	ϕ285	ϕ285	ϕ280
Motor	Type	Single phase, squirrel-cage induction motor		
	Motor output (number of poles)	380W (2P)	490W (2P)	125W (4P)
	Capacitor	Separate	Separate	Separate
	Bearing	Ball bearing, 6203 contactless type, rubber shield		

(b) Installation procedure



Evaporator fan and motor

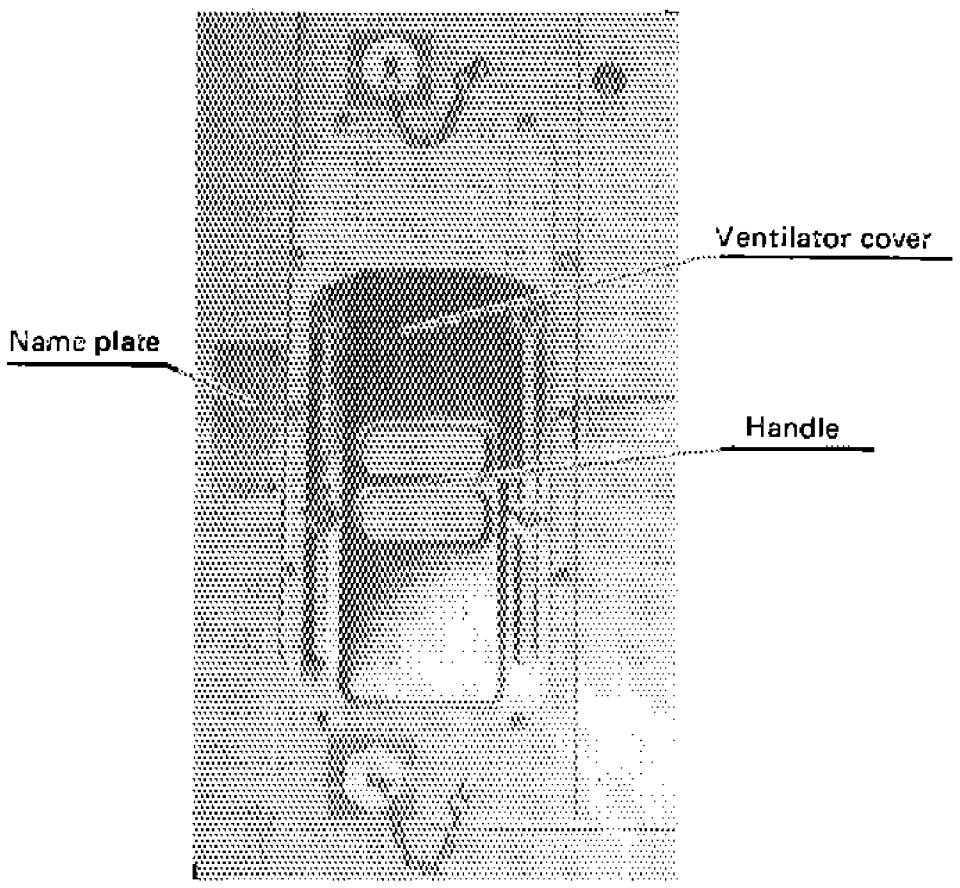


Condenser fan and motor

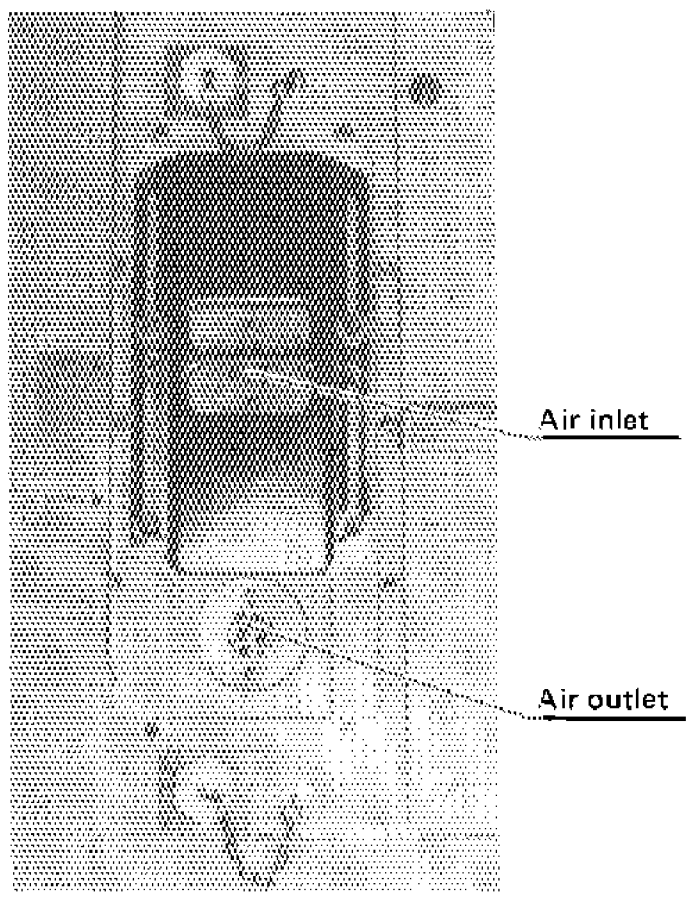
4.2.2 Ventilator

Operation

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



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



4.3 Temperature control system

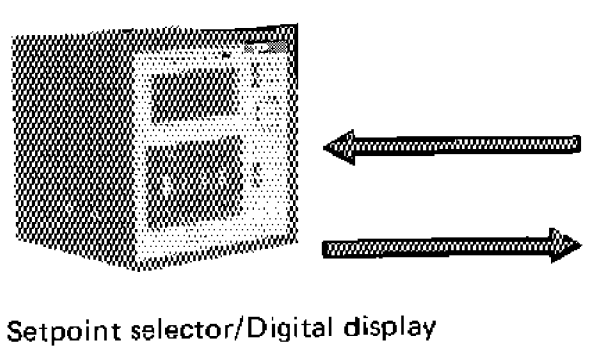
This unit performs temperature control in two modes.

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

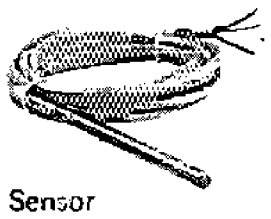
II Chilled-operation: capacity control by hot gas bypass: Supply air temperature is controlled (supply air sensor).

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

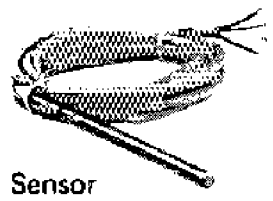
- **The supply and return sensors will be automatically switched according to the preset temperature.**
- **Adoption of a check instrument makes it possible to know the control state easily.**
- The digital display enables the switching between the suction and the supply temperature to be made by push-button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



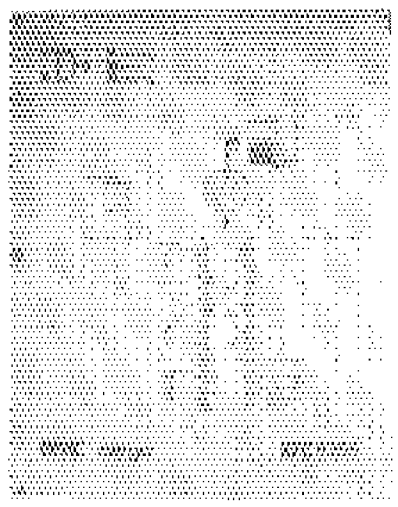
Setpoint selector/Digital display



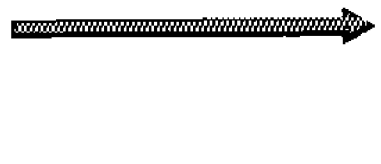
Sensor



Sensor



Controller



Modulating control valve

4.3.1 Sensor (FC-KTRP)

The supply air and return air sensors are identical.

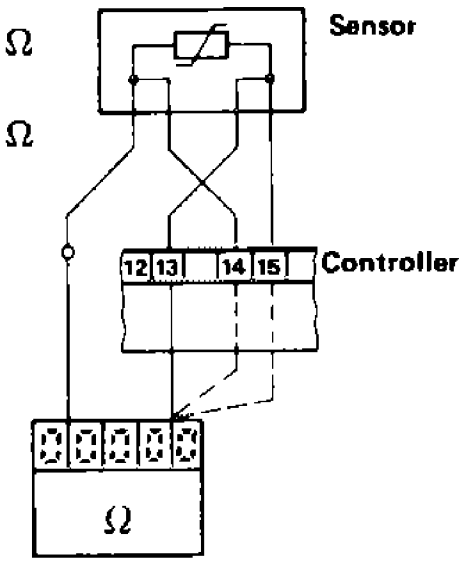
- Element ——— PT100 Ω (0°C)
- Connection ——— with four leads

(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.

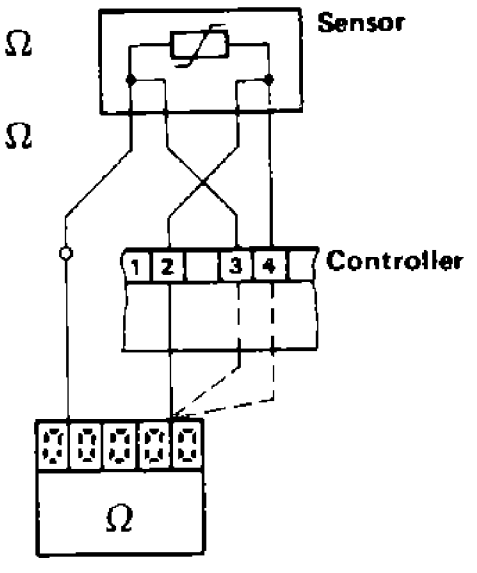
Terminal 13:	88 – 111 Ω
Terminal 14:	0 Ω
Terminal 15:	88 – 111 Ω



- 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/Digital display (PC-DD 30/30)

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

- Setpoint selector

Temperature setting is of digital indication. Press the 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 6 (⊥) −5
3. Measure +15 V DC ± 0.5 V, terminal 6 (⊥) −4

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

4. Set point adjustment
   −29.9 °C = 0.017 V
   0 °C = 5.000 V Terminal 6 (⊥) −7
   +29.9 °C = 9.983 V
   Tolerance ± 0.017 V

- Digital display

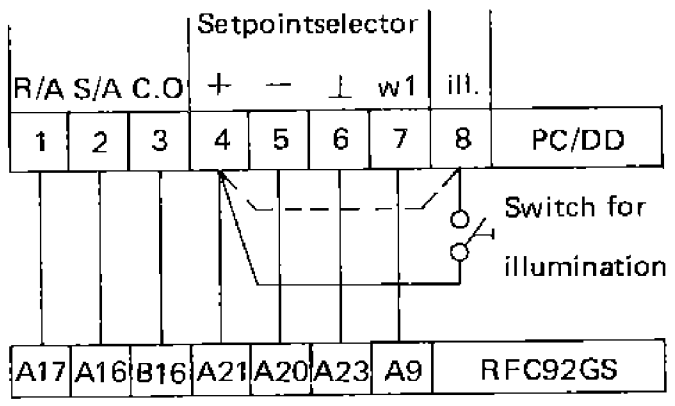
The supply or return air temperature, measured by the two sensors, is shown on the LCD display by the output voltage from controller.
In the chilled mode, the supply air temperature is shown. The return air temperature can be seen by pressing the button 《 push 》.
In the frozen mode, the return air temperature is shown. The supply air temperature can be seen by pressing the button 《 push 》.
The according modes are indicated by light emitting diodes (LED).

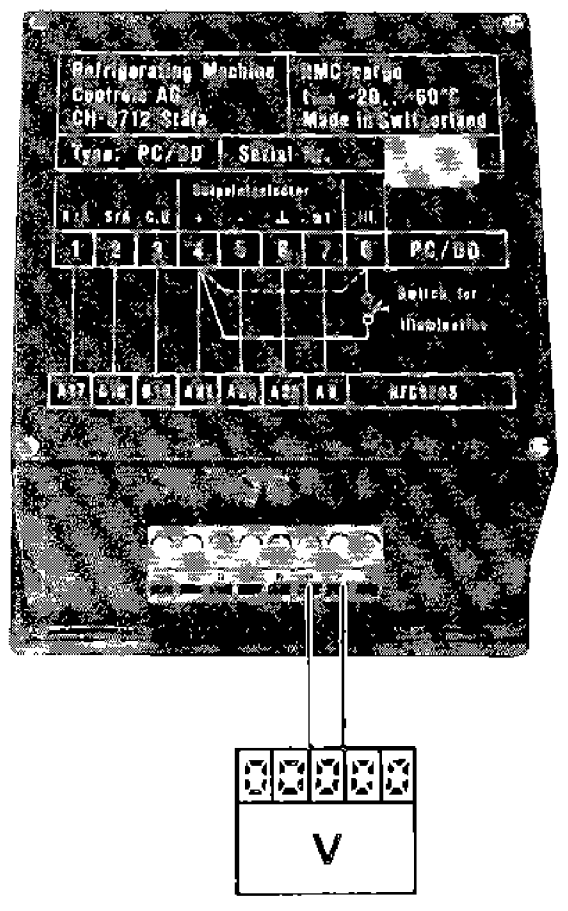
a. Operating check

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

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

Connection diagramm

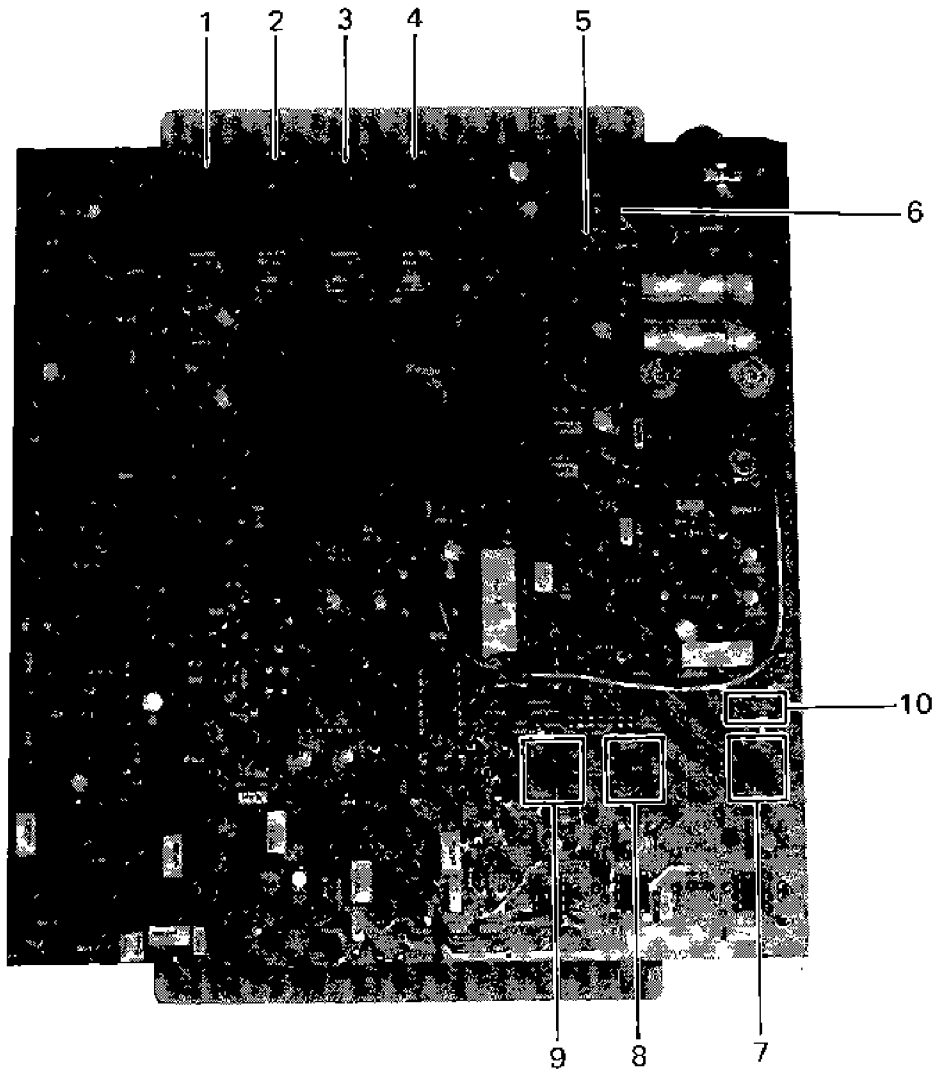




4.3.3 Controller (RFC-92GS·RMC-8302)

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

(a) Parts name



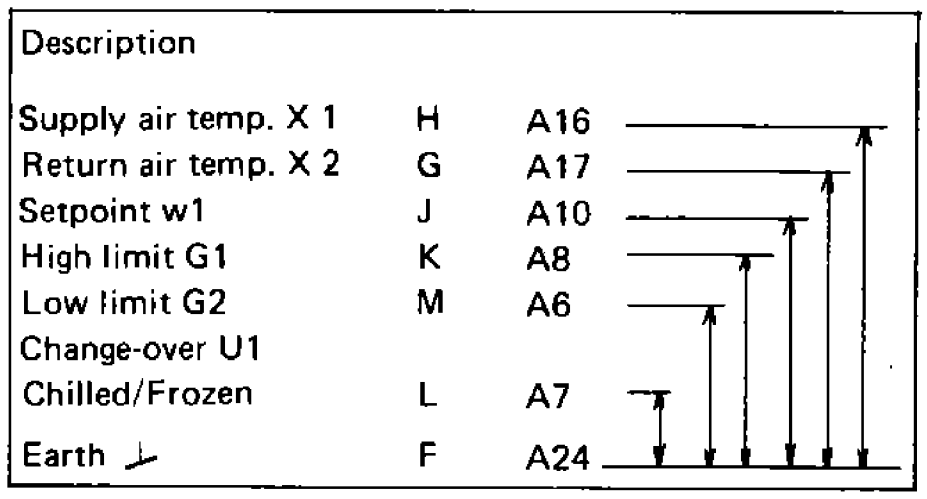
Item	Description		RMC Factor setting	
1	High limit relay (In range)	G1		
2	Low limit relay (In range)	G2		
3	Mode change-over relay	U1	−4.5/−5°C	
4	Y2 output relay	Y2		
5	Spare transistor fuse } (modulating valve for voltage output)	BC 107A		
6	Transistor fuse }			
–			LKE8CD10	LKE8CD11
7	Derivative action preset time potentiometer	Tv [s]	5	10
8	Proportional band potentiometer (% of measuring range)	Xp [%]	4	4
9	Integral action reset time potentiometer	Tn [s]	30	50
10	Jumper line (for TV x 10)		Remained	

(b) Temperature-voltage conversion table

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

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

2. The change-over point (U1) between chilled and frozen modes are switched over is −5.0°C when voltage is 4.166V across A24-A7 of the terminal board (F-L of the receptacle).



Temperature/voltage conversion table

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

[Note]

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

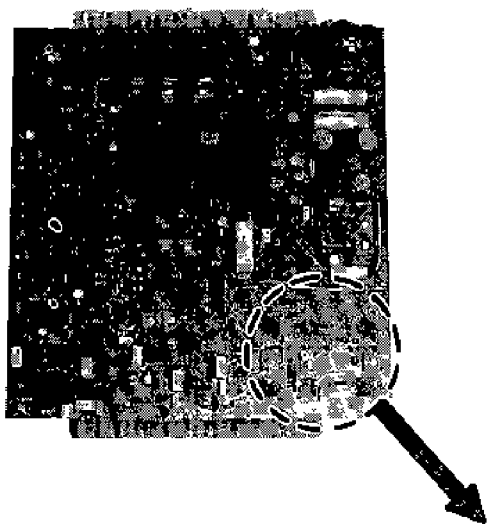
(c) Replacement of print substitute

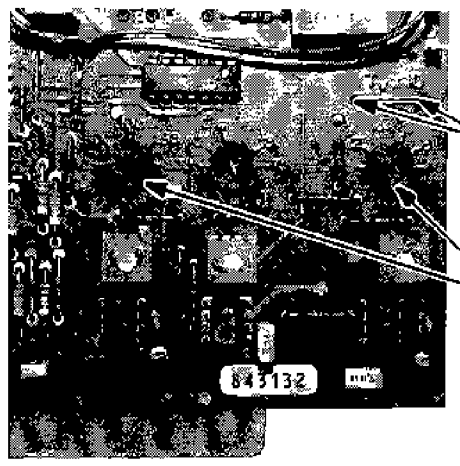
When replacing print substitute, adjustments of

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

are required.

Print substitute
RFC-92GS (RMC 8302)





Jumper line for multiplication of Tv x 10

Remained

Adjustments are to be made by turning potentiometers.

	Value set at RMC factory	Altered value	
		LKE8CD10 LKE8CD3	LKE8CD11
Tv	10 sec →	5 sec	10 sec
(Jumper line for Tv	Remained	Remained)	
Xp	8% →	4%	4 %
Tn	60 sec →	30 sec	50 sec

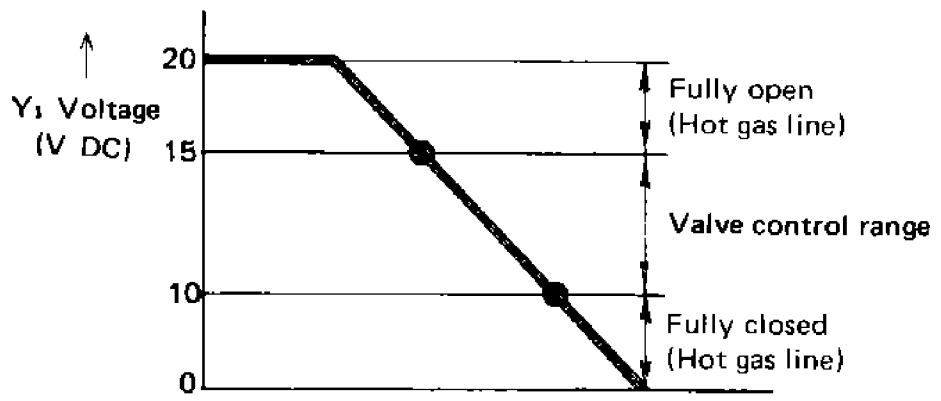
Adjustments are to be made by turning potentiometers.

Note:

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

4.3.4 Modulating control valve (M3F15L)

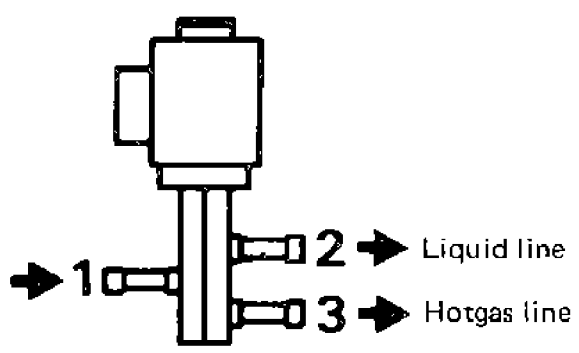
- This valve is operated by controller output (Y_1 volt). Having three way function, it provides continuous control of flow of hot gas bypass and that of liquid refrigerant. The degree of opening of the valve under control may be determined from the voltage value of Y_1 as measured with RMC check instrument.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



LOW ← Temperature → HIGH

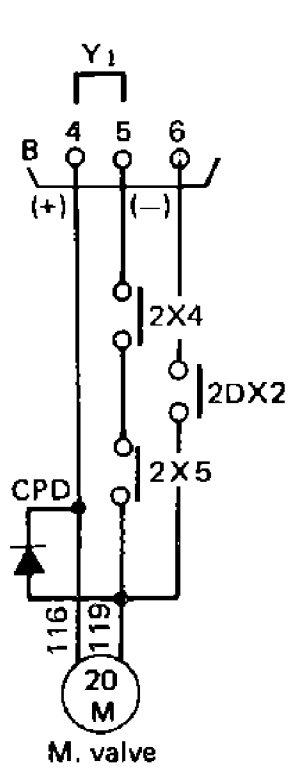
(a) Valve position

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



(b) CPD (contact protective diode)

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

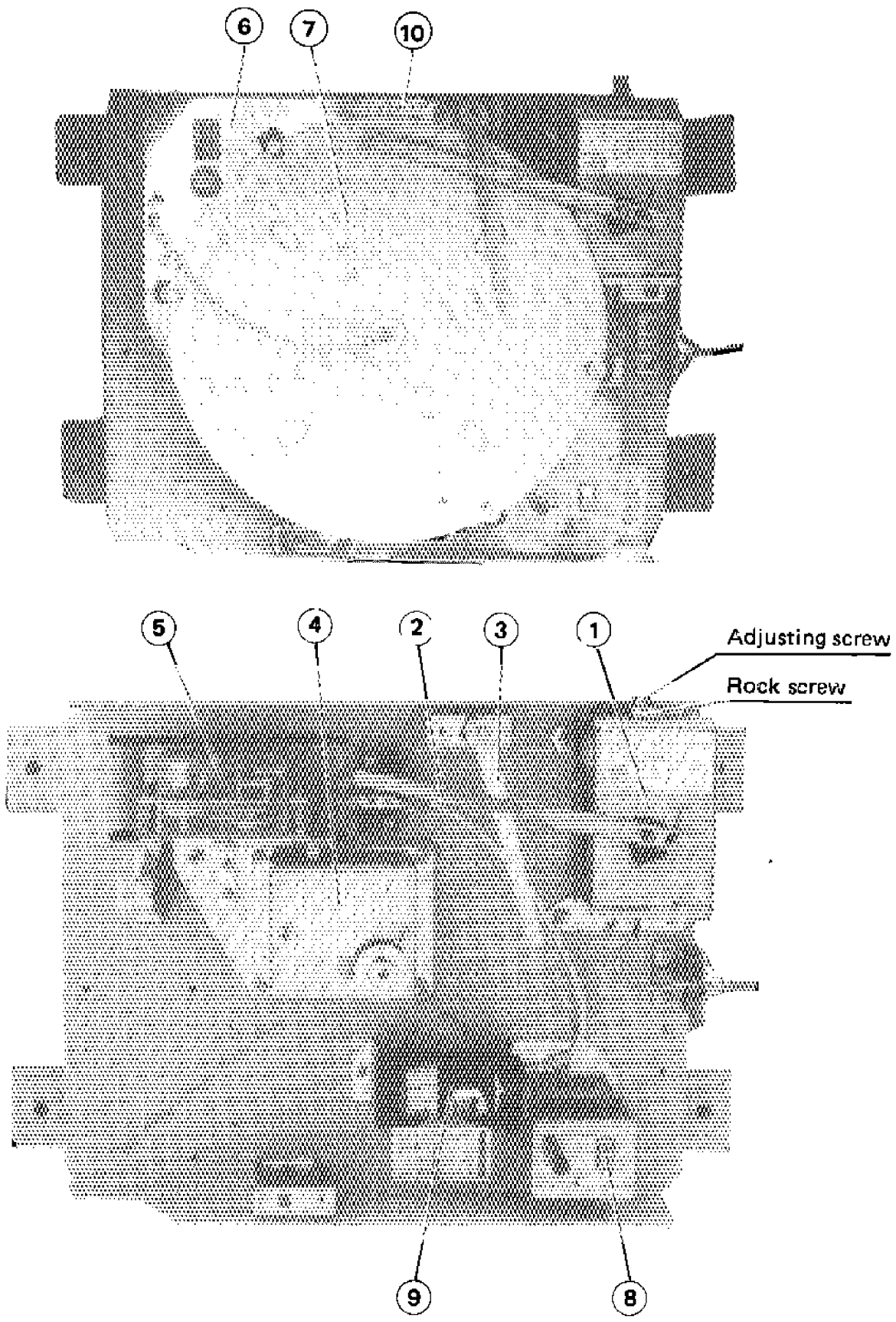


4.3.5 Recorder

1. Specifications

- Model — SKM-2924A
- 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 PARTLOW 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 voltage indicator)



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

2. Inspection of recorded temperature

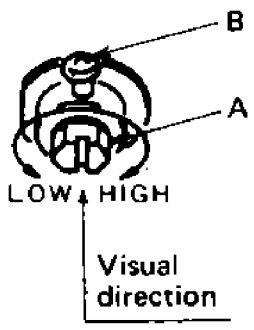
1) Recording pen on chilled mode

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

3. Adjustments

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

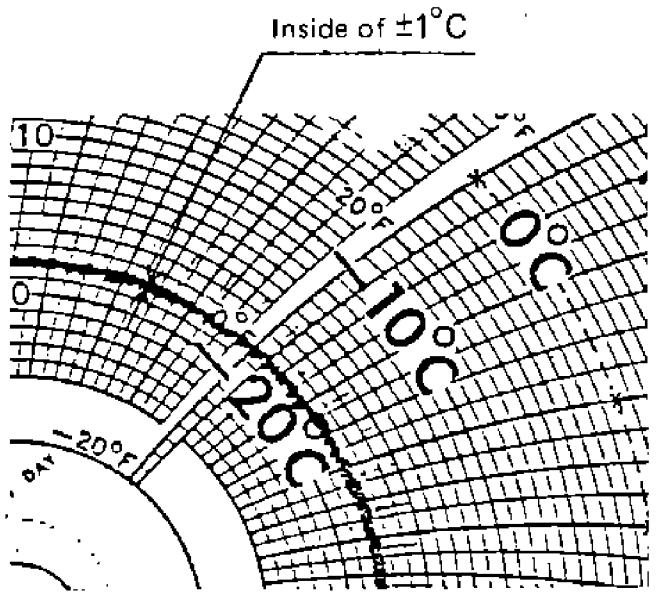
2) Turn the temperature setting screw (A) to adjust the temperature. Loosen the lock screw (B) and turn the setting screw (A) clockwise to temporarily raise the temperature setting by approximately 5°C.
Then turn the setting screw (A) counterclockwise to lower the temperature setting of the pen until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



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

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

4) Inspection and adjusting method
1. Adjust a temperature recorder when the container inside temperature becomes decreasing.
Temperature recorder's pen shows the temperature correctly when it is decreasing. Don't adjust it when the temperature become increasing.
It is caused from its hysteresis that a pen sometimes shows the temperature lower from 1°C to 3°C when the temperature is increasing.
2. It is a normal phenomenon 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 **deviation of ±0.2°C.)**
3. A temperature recorder adjusted at 0°C sometimes shows the following curves at −18°C inside. It is a normal and allowable range.



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

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

4. Replacement of parts

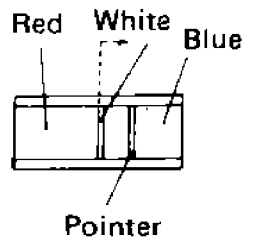
1) Battery

a) Replacement interval

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

b) Replacement method

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



Residual voltage indicator

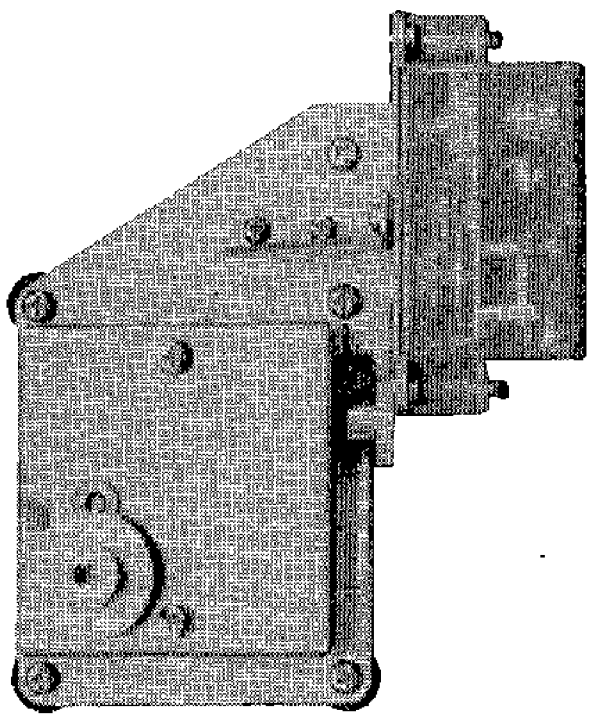
2) Residual voltage indicator battery

a) Replacement interval

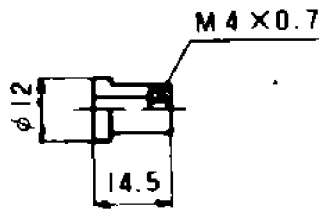
- In case oscillation of the needle is unstable when the push switch is pressed down for confirmation of remaining voltage.
- In case the remaining voltage indicator needle is within the white zone or in the red zone, although a new battery has been fitted.

b) Replacement method

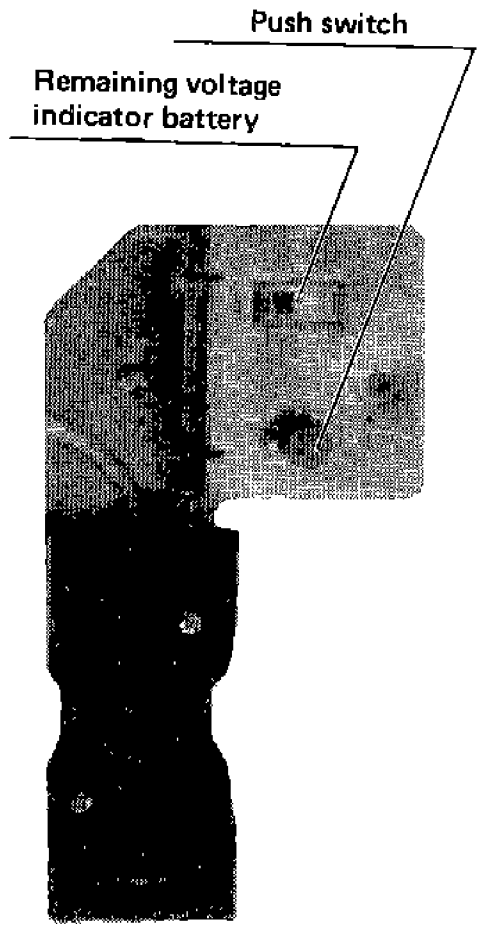
- Remove the recording panel by loosening the screw.
  Remove the residual voltage indicator battery from the body, and replace it with a new one.
- When replacing the battery make certain that the terminal wirings are connected red to red and black to black.
- After replacement confirm that the pointer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



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



Accessory (anti-vibration rubber : 5 pcs)



Residual voltage indicator battery (DKM-AA003)

3) Timer (quartz motor speed reducing gear)

a) Replacement interval

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

b) Replacement method

- Remove the recording panel to remove the wiring. Loosen the screws (5 pcs) to remove the timer, and replace the timer with a new one.
- When replacing the timer, also replace the 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.
- Ensure that the quartz motor functions correctly after replacement.

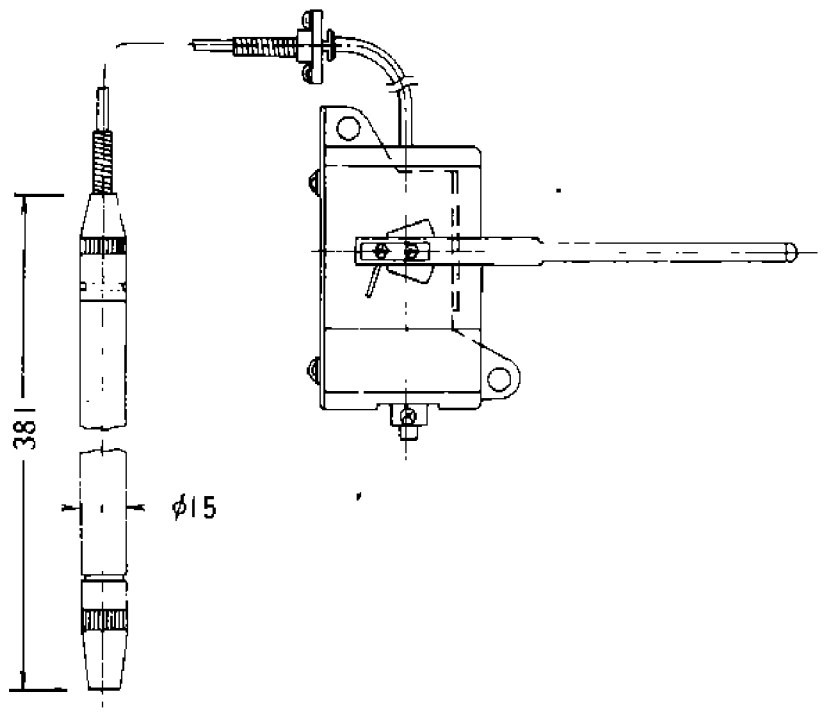
4) Thermal feeler bulb

a) Replacement interval

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

b) Replacement method

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

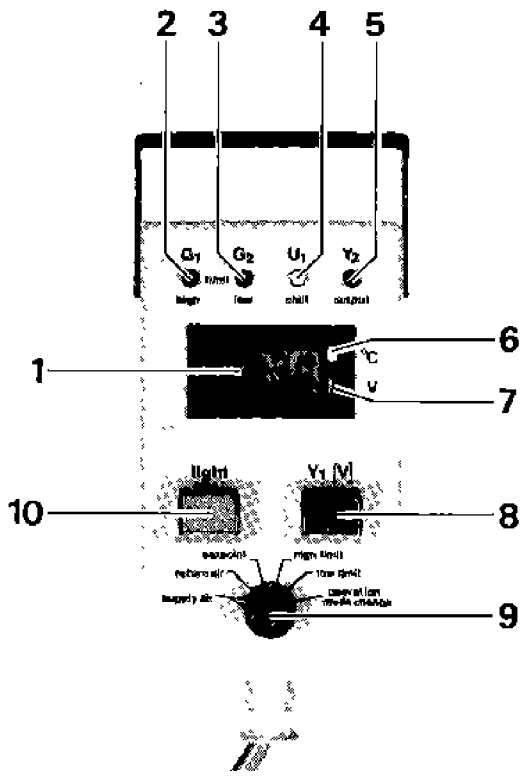


Thermal feeler bulb − element (SKM-AA001)

4.3.6 Check instrument

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

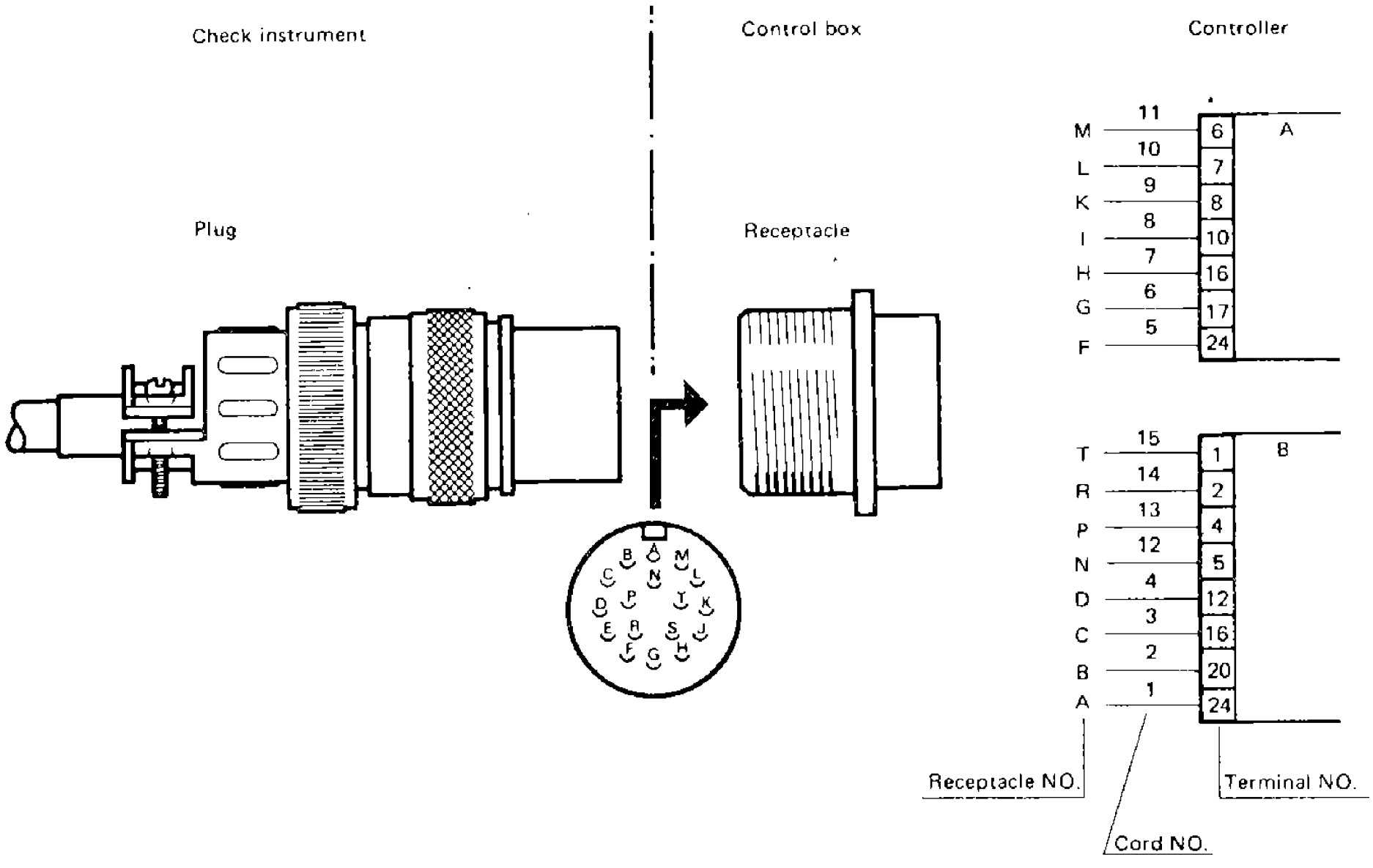
Note: When the check instrument is used do not subject it to direct sun light. Further, each inspection and adjustment should be done after 10 ~ 20 minutes energization.



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

10 Scale illumination button

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



4.3.7 Checking operation of the controlling devices

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

Test procedure	Operating stage (Module)	Standard value: Check instrument	Standard value: Digital volt meter $R_{i\ min} \geqslant 10\ k\Omega$	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action

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

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

Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min ≥ 10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
5a			0...10V DC see table "temperature/voltage convertion"	A24 A16		F H	Controller and test socket disconnected	Check wires and connections
							Controller and sensor disconnected	Measure sensor resistance. See table page "temperature VS. resistance" Replace defective sensor
								If the sensor is in order, replace controller board
6	**Return air sensor** (sensor signal X_2)	Selector in "return air" position. Indication of same value as the temp. measured in the return air (−30...+30° C)					Disconnection	Measure with digital voltmeter as per test procedure 6a
6a			0...10V DC see table "temperature/voltage convertion"	A24 A5		F G	Controller and test socket disconnected	Check wires and connections
							Controller and sensor disconnected	Measure sensor resistance See table page "temperature VS. resistance" Replace defective sensor
								If the sensor is in order, replace controller board
7	**Controller output Y_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	

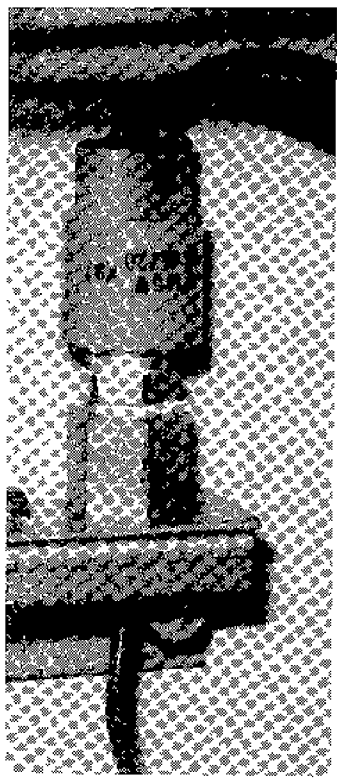
Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min ⩾ 10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
8a	Set sepoint 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					Out of cablibration	Cabibrate according procedure 11b
	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 of electrical function parts

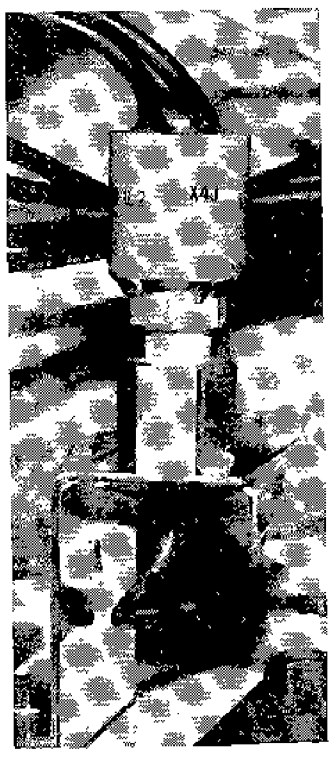
4.4.1 High pressure switch (HPS)

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



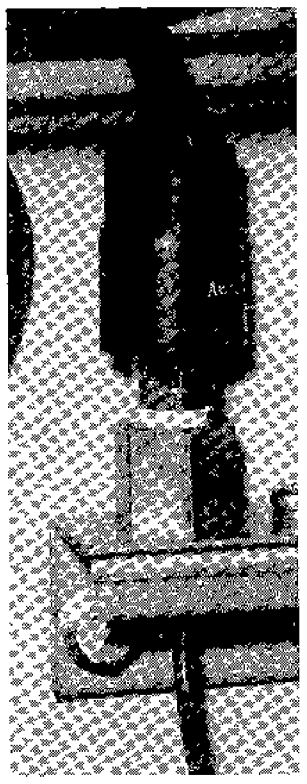
4.4.2 Low pressure switch (LPS)

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



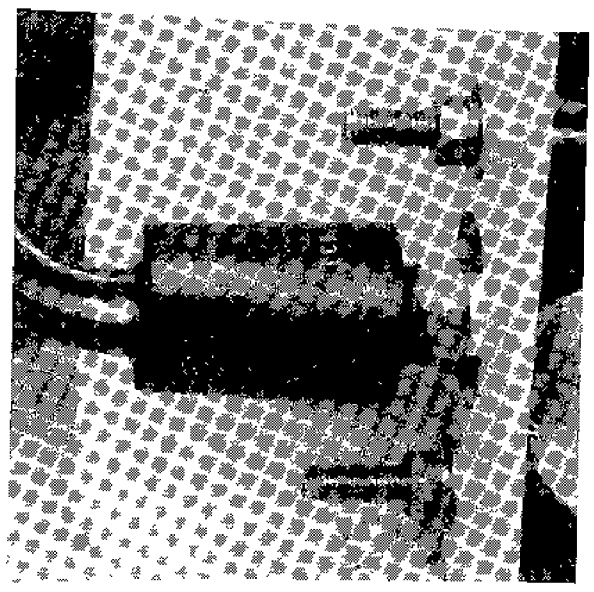
4.4.3 High pressure control switch (HPCS)

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



4.4.4 Water pressure switch (WPS)

This switches over air and water cooled modes. If 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.



Low pressure switch

4.4.5 Air pressure switch (APS)

If the evaporator is frosted, difference of the air pressures at the inlet and outlet of the evaporator becomes large. If the pressure difference rises above a preset value, the air pressure switch operates and defrosting will start.

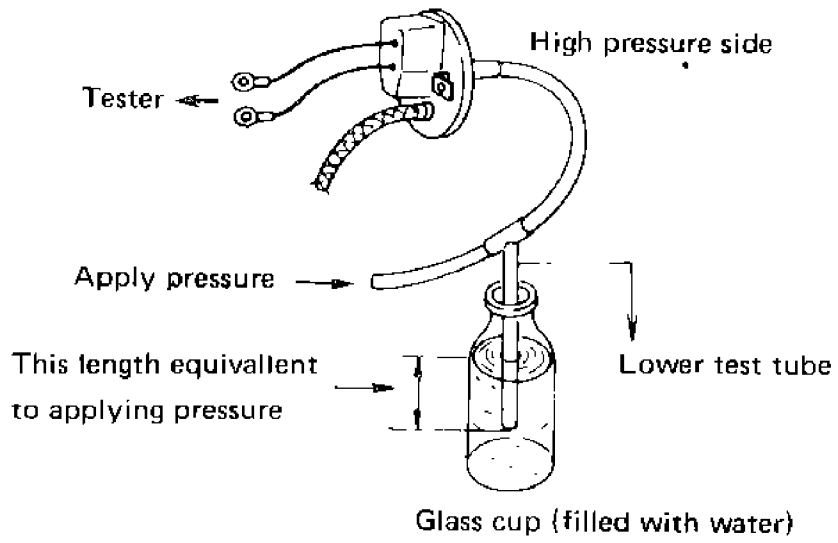
(a) Checking operating value

- Set the checker device as shown on the right.
- Applying pressure to the high pressure side, lower the test tube slowly. (At this time, small bubbles must come out at the bottom of the tube.)
- Read the length of H (length of the tube which is below the water surface) when the tester indicates continuity. The operating point of the air pressure switch is the value of H plus 5 mmH_2O. Check this value a few times.
- To apply pressure, you may blow air into the tube. Alternative methods use a pump, APS tester, or manometer.

Note:

This air pressure switch is factory set to 25mmH_2O for LKE8CD10 or 31 mmH_2O for LKE8CD11 and is not adjustable.

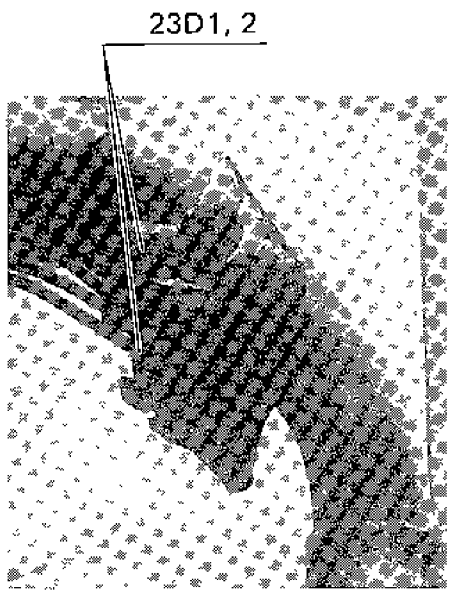
High pressure switch



4.4.6 Defrost termination thermostat (23D1,2)

These senses suction gas temperature in the suction pipe to the compressor and will terminate defrosting.

OFF : 40°C
ON : 20°C

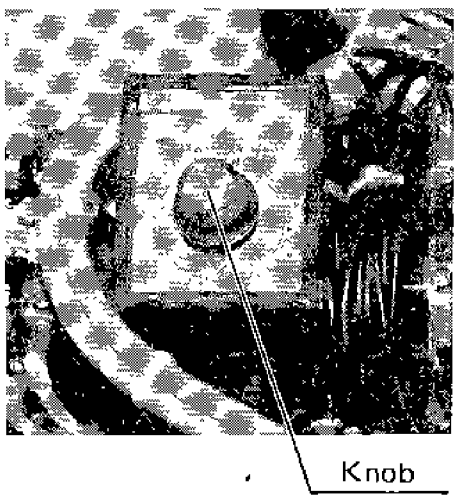


4.4.7 Defrost timer (2D1)

The defrost timer activates defrosting operation automatically at preset intervals. Set the timer at a correct interval by turning a knob on its front face. Do not adjust it while operating.

- Setting value: 12 hours (60 Hz)
- Once power has been turned off, the timer is reset to the initial state.

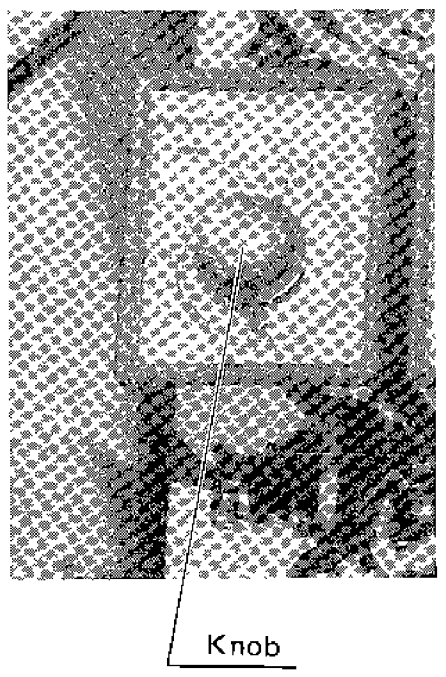
NOTE) The refrigeration unit should not be used for pulling down the temperature of cargoes or freezing them. The unit has insufficient capacity for such purpose. All cargoes should be loaded into container pre-cooled.



4.4.8 Defrost termination timer (2D2)

This timer makes back up the defrost termination and stops the defrosting forcedly and illuminate in range lamp (AL) for 90 min. (60 Hz) including defrosting period.

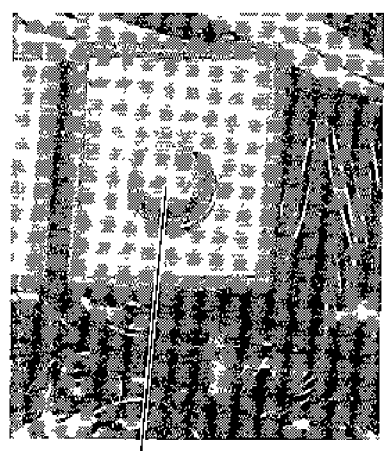
- Setting value: 90 min. (60 Hz)
- Once power has been turned off, the timer is reset to the initial state.
- When this timer has failure and there is no spare parts, provide a wire between terminal (6) on 2DX2 and terminal (12) on 2DX3 provisionally, after taking out the timer from the socket.



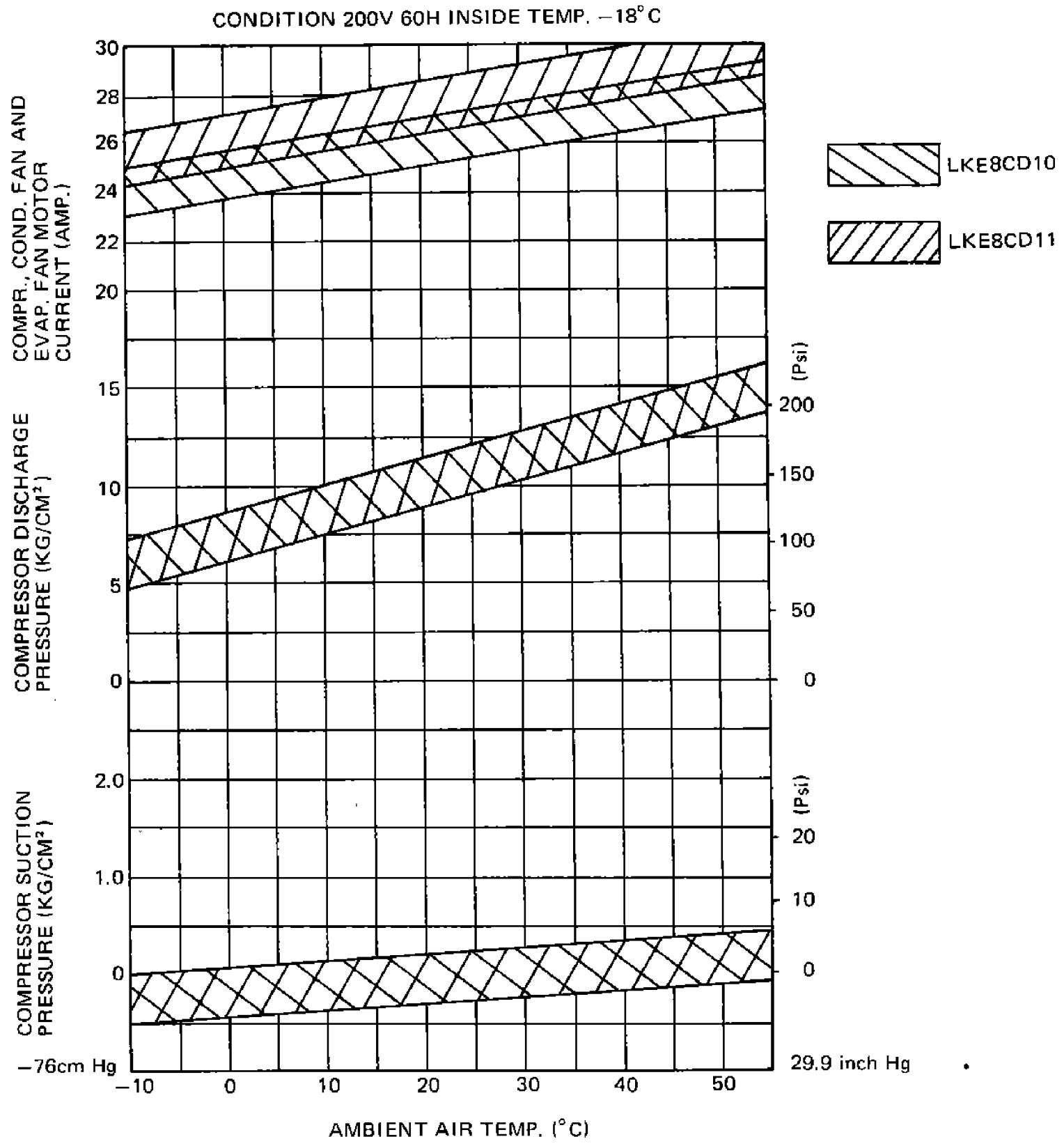
4.4.9 Evaporator fan delay timer (2F)

This timer delays the start of evaporator fan motors for 1 minutes from unit start or termination of defrosting.

- Setting value: 1 min. (50Hz)
- Once power has been turned off, the timer is reset to the initial state.



5. Operating pressure and running current



< For reference >

	Item		Unit	Value	
				LKE8CD10	LKE8CD11
1	Running current of each of condenser fan motors		A	1.2 (AC 220V)	
2	Running current of each of evaporator fan motors		A	2.6 (AC 220V)	3.1A (AC 220V)
3	Bolt tightening torque	Compressor	kg·cm/lb·ft	435/36	
		Fan motor		255/21	
		Solenoid valve		55/4.3	
		Expansion valve		250/20.5	
		Fan		55/4.3	

Note) Allowable range of tightening torque: ±10%

6. Troubles and countermeasures

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

Troubles and countermeasures

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

State	Phenomena	Functioning places	Cause	Countermeasures
		c. Over-current relay or compressor protection thermostat has functioned.	Excessive large current due to over-load operation.	Trace causes.
		d. Over current relay or high pressure switch has functioned	Inlet line solenoid valve does not close due to stuffing of dust. Compressor capacity protection thermo. does not function.	Adjust or replace thermo.
III. Inside temp. is lower than temperature setting	A: Compressor inoperative.	a. Solenoid valve will not close.	Blocked with dust.	Replace it.
		b. Controller does not function.	Sensor is disconnected	Replace it.
		c. Sensor is installed wrongly.		Reattach it.
	B: Hotgas bypass does not work	Modulating control valve does not open	Blocked with dust Controller is defective	Repair or replace Replace transistor or controller
IV. Inside temperature does not drop	A: It does not reach the set temperature. (Fan and compressor are in normal state.)	a. Modulating control valve does not close.	Stuffing of dust, etc.	Repair or replace valves.
		b. Suction line solenoid valve does not open at a temperature below the inside return air temperature of −5°C.	Stuffing of dust, etc. Compressor capacity protection thermo. does not function.	Clean, repair or replace suction line solenoid valves. Adjust or replace thermo.
V. Inside temperature is not stable	A: Inside temperature is not stable during chilled and heating operations (Fans and compressor work properly)	a. Opening of modulating control valve (valve control voltage Y_1) is not stable	Controller is improperly adjusted	Adjust or replace
VI. Water cooled operation inoperative	A: Fans run continuously after water joints have been connected.	a. Water pressure switch does not function.	Insufficient cooling water volume (clogging or leakage of piping system).	Trace causes. Repair leaking point.
VII Defrosting operation	A: Defrosting and refrigerating operation are repeated in a short period of time.	a. Defrost timer incorrectry set or faulty.	Improper adjustment	Readjustment
	B: Defrosting does not start	a. Air pressure switch does not function	Bad connection, damage or cologging of connecting hose	Repair or replace.

7. PTI (Pre Trip Inspection)

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

Container refrigeration unit inspection card

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

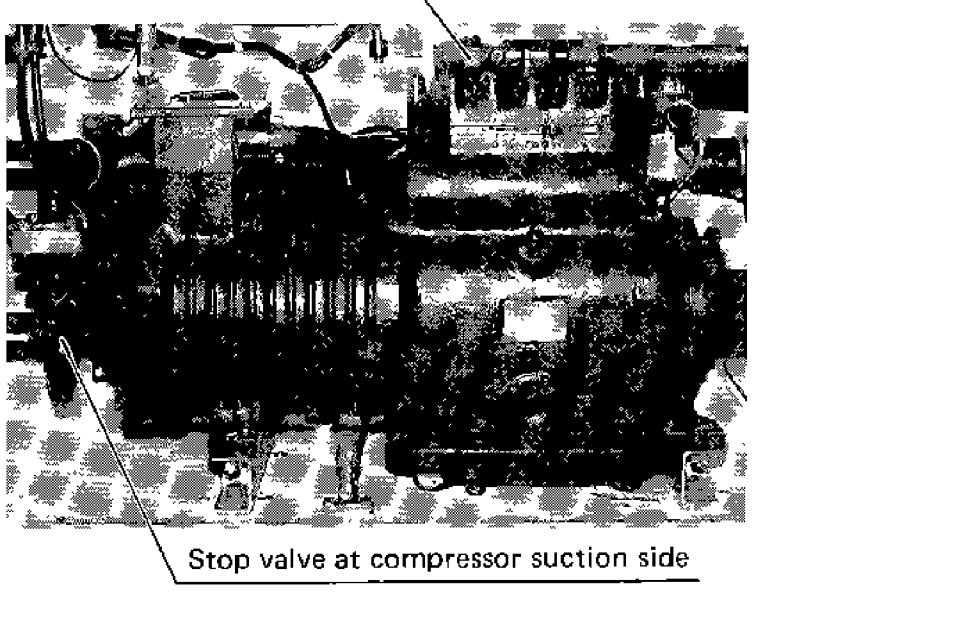
Installed ship name		Date of inspection	
Container No.		Place of inspection	
Loaded cargo		Unit Model No.	
Customer's staff		Unit No.	
Service staff		Compressor No.	

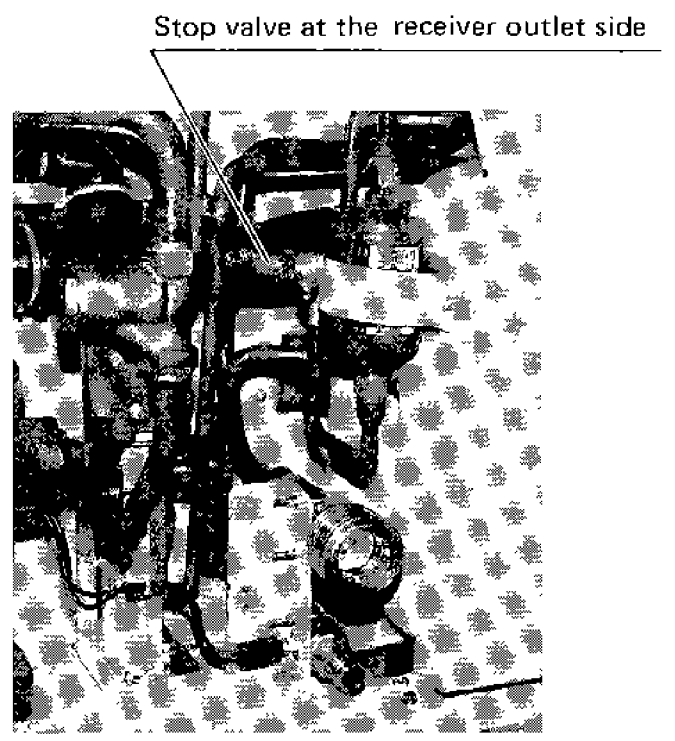
Check	No.	Check point	Check method	Reference value
	1	External appearance of importants parts of container (doors, equipment mount, damaged points)	Visual	
	2	Cleaning interior and exterior of container	Visual	
	3	Checking the smudge of the unit (air-cooled condenser, evaporator)	Visual	
	4	Checking penetration between inside and outside of unit	Visual	
	5	Checking leakage of gas and oil on refrigerant circuit (mainly at 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 that there is no trap on it	Visual	Shall be free from clogging
	9	Checking operation of heat-up function	Check operation	
	10	Checking appearance of defrost termination thermostat	Visual	
	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 seal of liquid indicator	Check liquid indicator	Make sure that it is sealed
	14	Checking for water in refrigerant	Check liquid indicator	Dark 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	Checking operation of each solenoid valve	Listen or touch each tube	
	18	Checking operation of controller and pilot lamps	Reefer check instrument	
	19	Checking operation of defrost initiation air switch	Check with U tube: 25 mmH₂O (LKE8CD10) / 31 mmH₂O (LKE8CD11)	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
		Unit insulation resistance — Evaporator fan circuit ☐ MΩ	DC 500V megger	2MΩ or more
	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 ~ 60°C
	24	Checking operation of high pressure control switch	Visual left side air cooled condenser fan to be stopped	
	25	Checking operation of high pressure switch — H-CUT OUT ☐ / IN ☐ kg/cm²	Operate the air cooled condenser without fan operation	20 Kg/cm² / 16.5 Kg/cm²
		Checking operation of low pressure switch — L-CUT OUT ☐ mmHgV	Accomplish pump down by use of the stop valve at the water cooled condenser outlet	400 mmHgV
		Checking operation of low pressure switch — L-CUT IN ☐ kg/cm²	Accomplish pump down by use of the stop valve at the water cooled condenser outlet	0.2 Kg/cm²
	26	Checking operation of water pressure switch — Checking switchover from air cooled to water cooled operation	Disconnect water coupling	Condenser fan motor shall operate
		Checking operation of water pressure switch — 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 200V class operation	Place changeover switch lever upward	
		Checking power supply changeover switch — Checking 400V class operation	Place changeover switch lever downward	
	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 0°C → −18°C ☐ Hr ☐ M — Automatic operation at −18°C ☐ Hr ☐ M
		Operation starting time ☐ ☐		
	29	Checking automatic defrosting operation — Defrost time ☐ M and checking back-up timer		

8. Maintenance procedures

8.1 Handling method of the stop valve

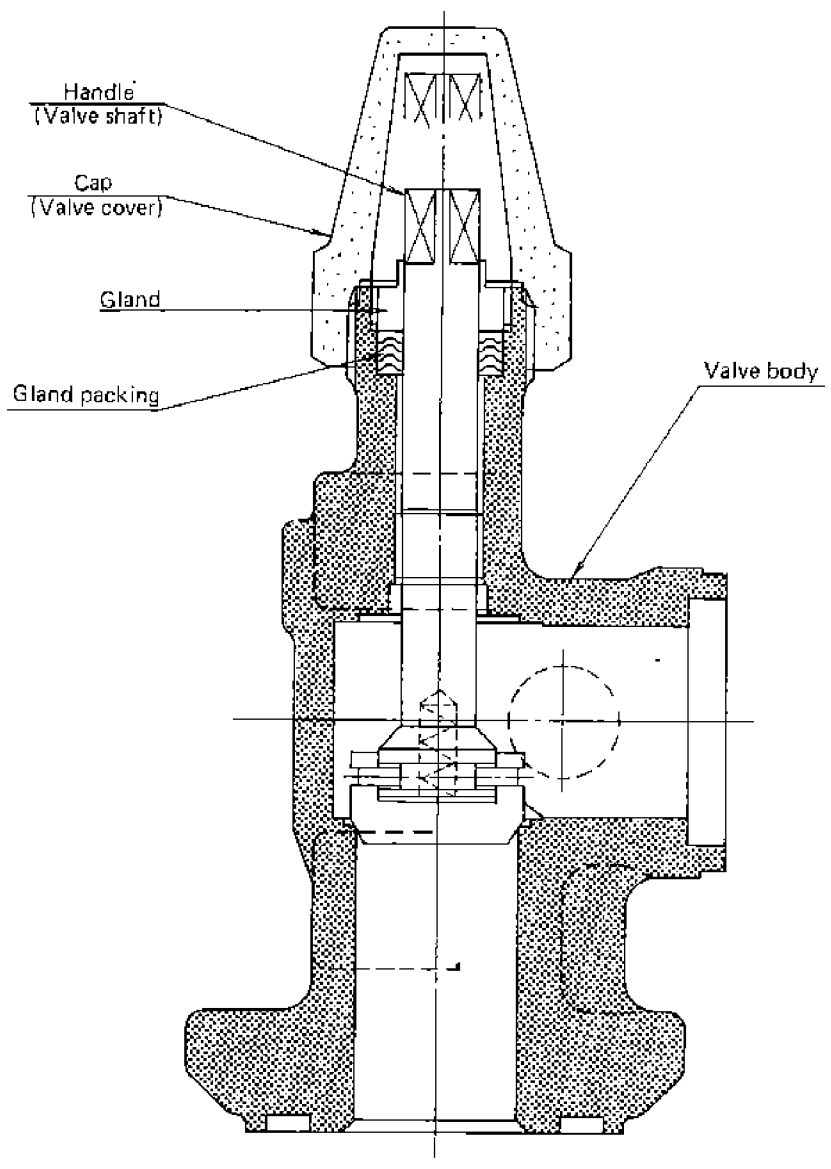
(1) Position of shut off valves



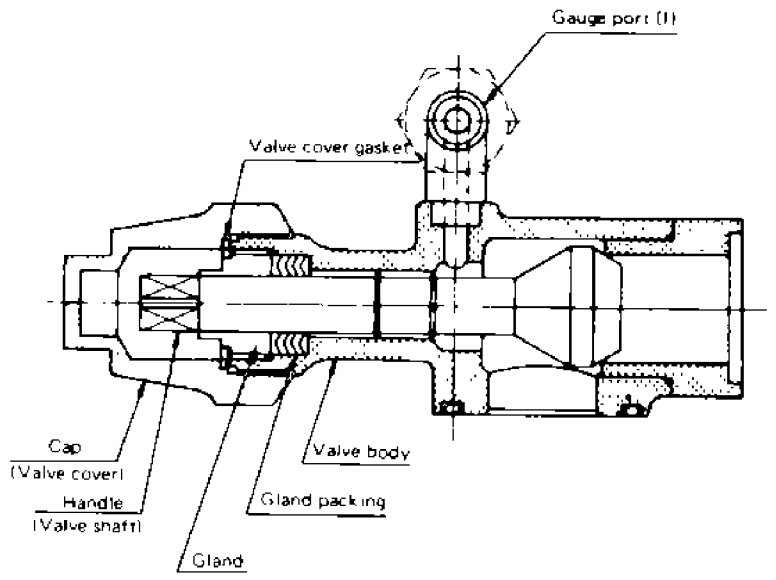


(2) Structure of stop valve

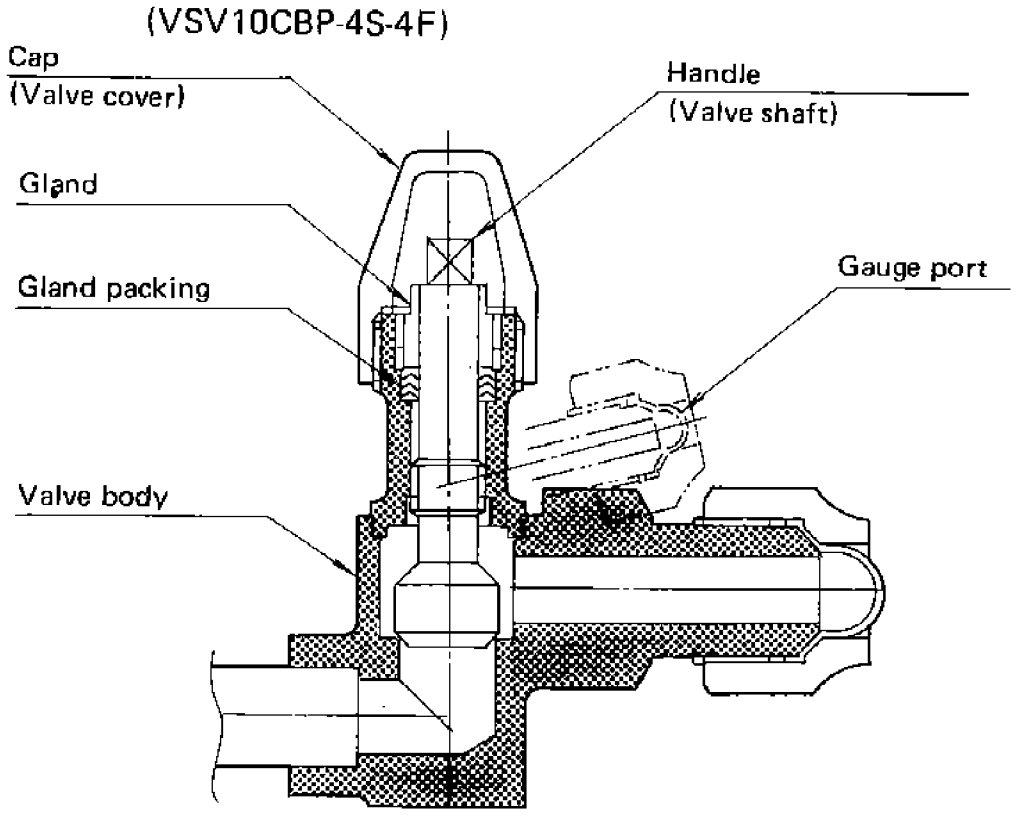
1. Stop valve at compressor suction side (VSH26HL)



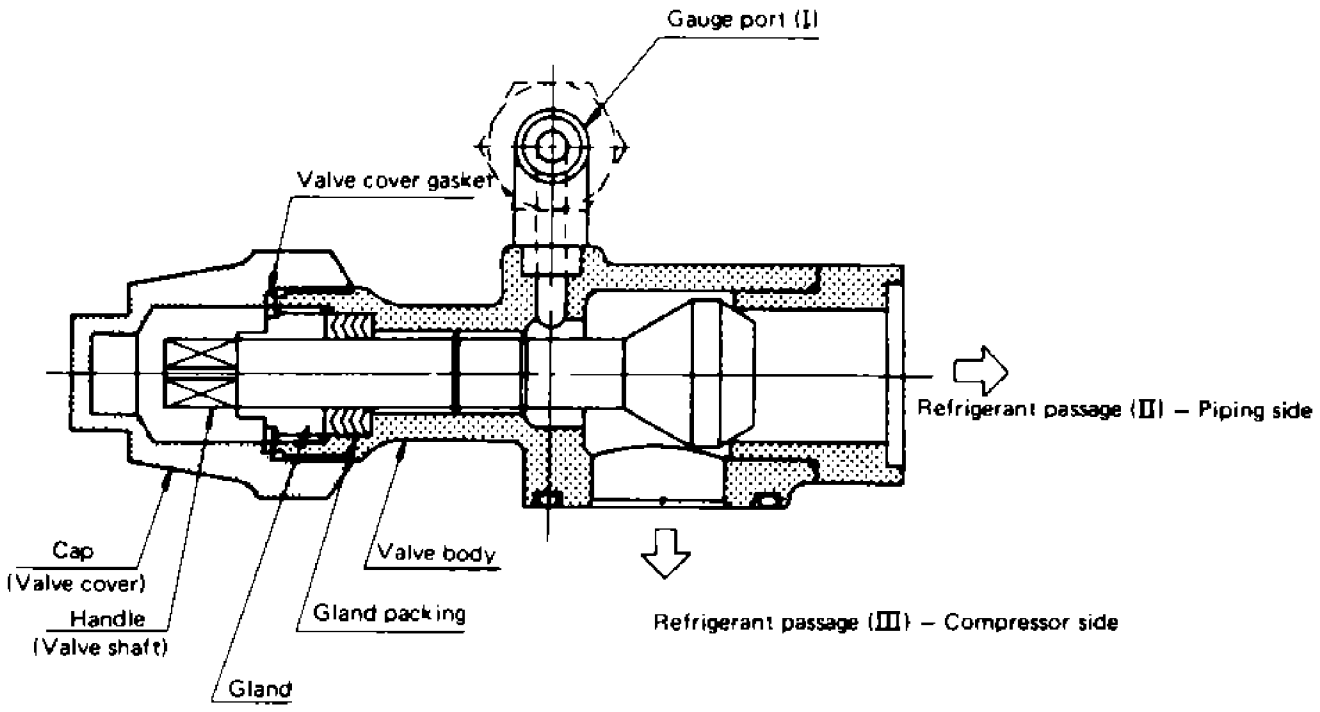
2. Stop valve at compressor discharge side (VSH22XBP)



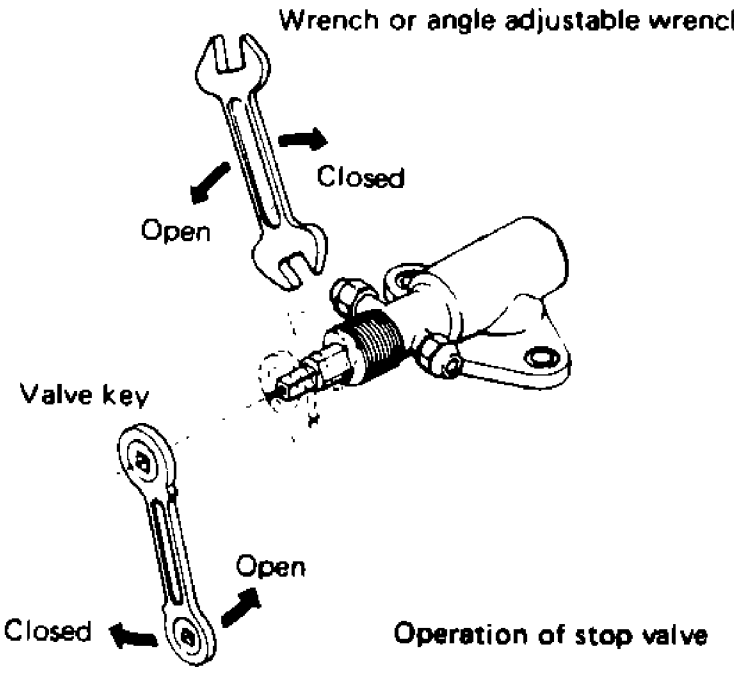
3. Stop valve at the receiver outlet side (VSV10CBP-4S-4F)



(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.

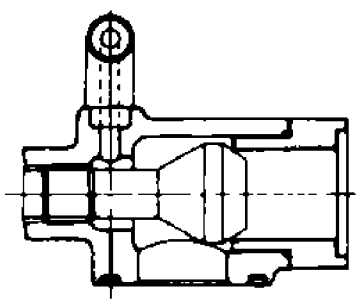


Operation of stop valve

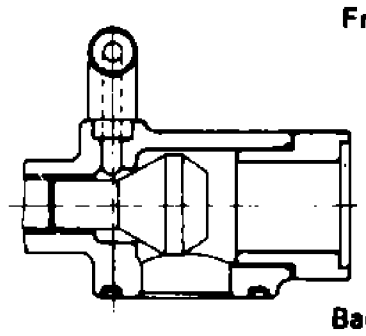
8.2 Attaching or removing points of pressure gauge

(1) Attaching a general pressure gauge

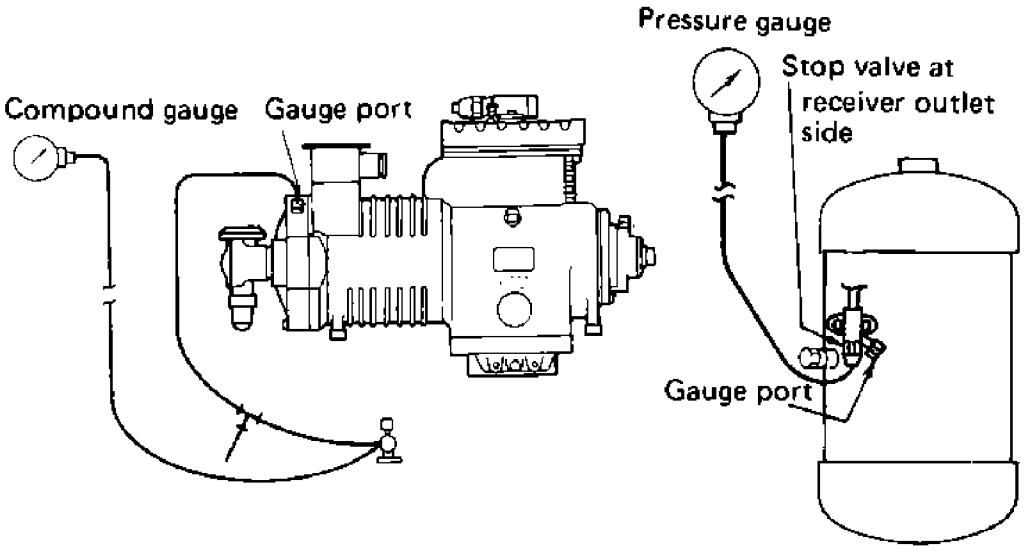
1) After opening the compressor suction valve and the receiver valve fully (back seat), connect a pipe to the gauge port.
2) Loosen a little the flare nut on the pressure gauge side and tighten the handle of the stop valve a little (Middle seat) and return it at once. Thus the air is purged.
3) After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

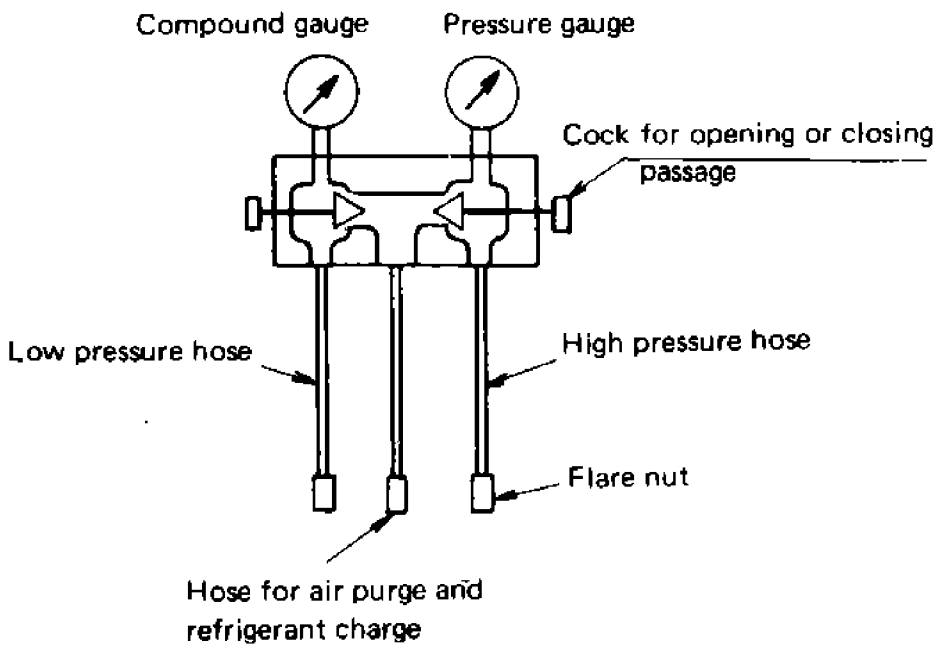


Back seat

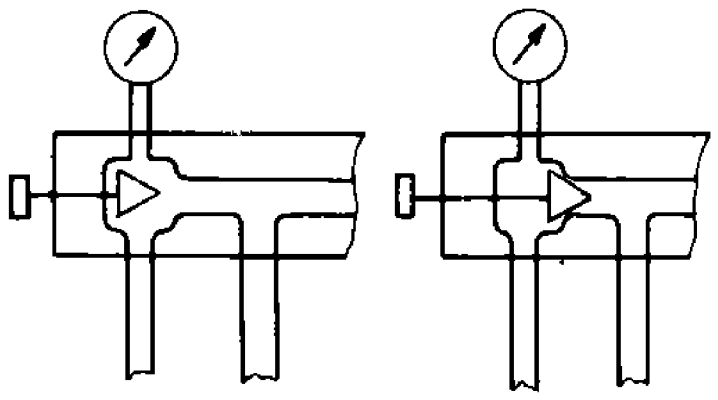


(2) Attaching the gauge manifold

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 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 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 receiver outlet valve at the neutral seat and measure pressure.



Structure of gauge manifold



Opening state Closing state

Opening and closing states of gauge manifold

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

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

1) Hold the handle of the stop valve in the back seat state, and close the gauge port.
2) Open the cock (in 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 jet out liquid refrigerant.

3) After extracting the refrigerant from the hose, remove the pipe connection for the gauge piping.
4) Place the blind cover on the gauge port of the stop valve, accurately tighten up the flare nut and ensure no refrigerant leaks.

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

8.3 Pump down

Pump down means that the refrigerant in the refrigeration circuit is liquidized and collected in the receiver with haeat exhcanger. 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 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 receiver with heat exchanger. If no pressure gauge is attached, the unit is stopped by the low pressure setting.

8.4 Charging and purging the refrigerant

(1) Purging non-condensable gas

If non-condensable gas such as air exists in the refrigeration circuit, it is collected by the receiver with heat exchanger, which raise pressure in the 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 receiver outlet valve and wait until leaving and entering cooling air (or water) of the air (water) cooled condenser become equal. If there is any difference between saturated pressure corresponding to cooling air (water) and condensing pressure, non-condensable gas exists. In this case, purge non-condensable gas as stated below.

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

(2) Refrigerant purge

There are two methods of refrigerant purge; i.e. one is for collecting the refrigerant extracted in a cylinder and the other is for discharging it to the 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 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 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 receiver with heat exchanger, otherwise the refrigerant oil and the liquid refrigerant are discharged, which may result in shortage of oil.
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 danger 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

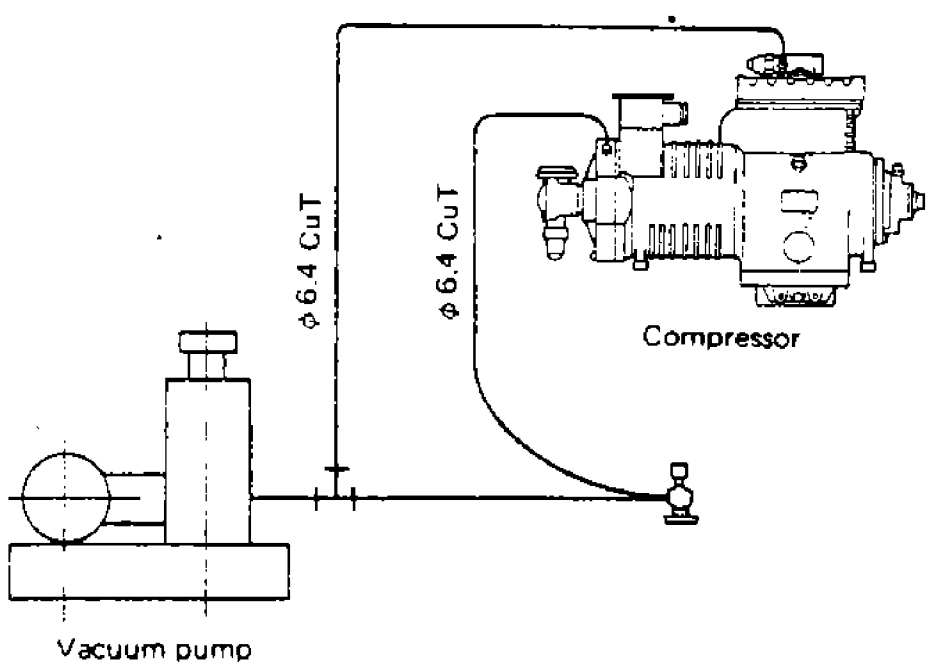
If all the refrigerant has escaped and the air is intermixed in the refrigeration circuit, repair the cause of the trouble and undertake vacuum drying. Then charge the predesigned volume of refrigerant. In case the refrigerant oil is replaced, do the same.

(Required tools)

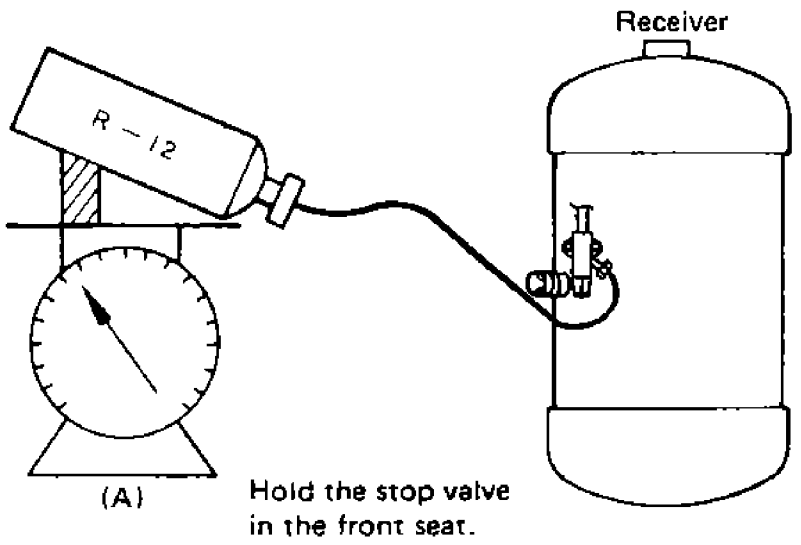
1. Refrigerant cylinder (20 kg) for R-12 (CCl_2F_2) with mouth piece
2. Refrigeration oil (20ℓ can) SUNISO 3GS-DI)
3. φ6.4 CuT (with two flare nuts)
4. Pressure gauge (20 kg/cm^2), compound gauge (10 kg/cm^2 x 75 cmHg) } or gauge manifold
5. Weighing scale (Up to 50 kg)
6. Tools
7. Vaccum pump

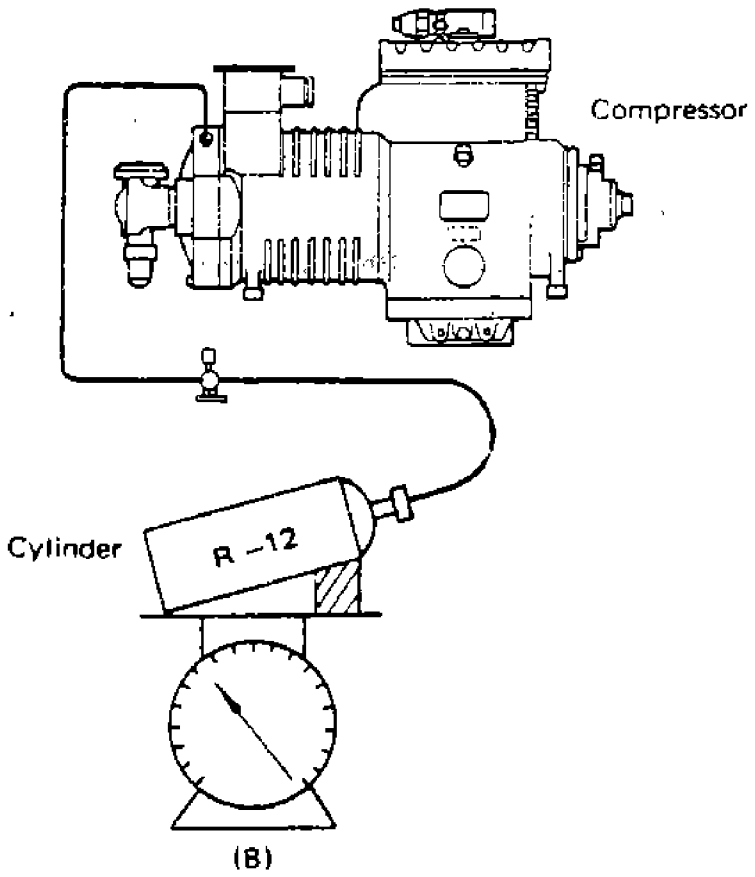
(a) In case the refrigerant is replenished without exchanging the refrigeration oil.

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.

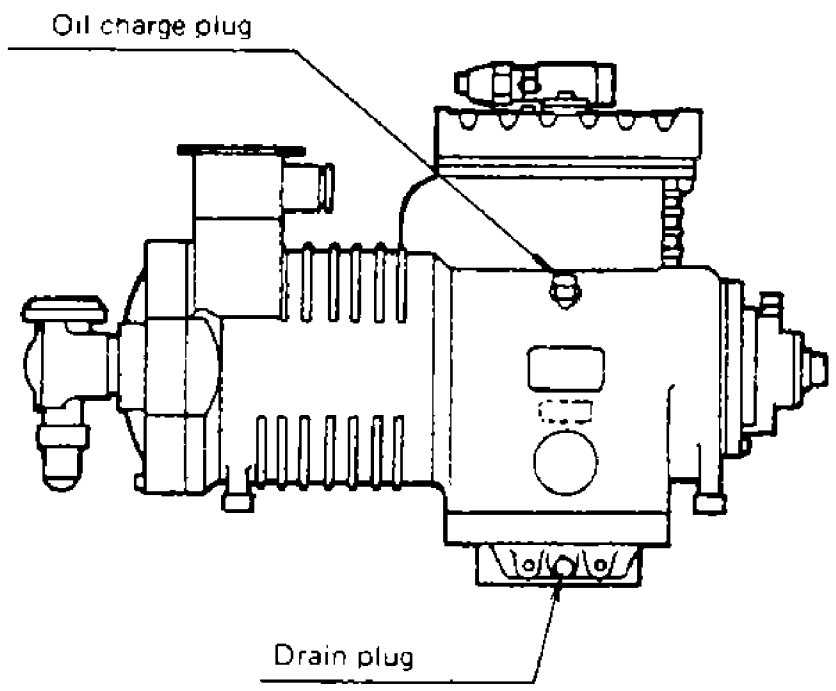




3) Place a refrigerant cylinder on the weighing scale, and record its weight.
4) In case the refrigerant is charged in the liquid state, do it as shown in the above figure (A). Prevent the liquid refrigerant collected in the receiver with heat exchanger from flowing to the low pressure side. If the refrigerant 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 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.

9. Electric operating table

DEVICES \ MODE	AIR COOLED OPERATION									WATER COOLED OPERATION
	SETPOINT SELECTOR									
	ABOVE −4.5°C (CHILLED MODE)						BELOW −5°C (FROZEN MODE)			
	COOLING		HEATING		MANUAL HEAT UP	DEFROST	COOLING		DEFROST	
	PULL DOWN	IN RANGE	PULL UP	IN RANGE			PULL DOWN	IN RANGE		
MAGNETIC SWITCH										* WATER COOLED CONDITION IS THE SAME AS AIR COOLED EXCEPT WATER PRESS. SWITCH OPEN AND COND. FAN MOTOR DE-ENERGIZED. * ONE CONDENSER FAN MOTOR OUT OF THREE ROTATES ACCORDING TO CONDITION EVEN THOUGH WATER COOLED OPERATION.
COMP. CONTACTOR (88C)	E	E	DE	E	E	E	E	E	E	
EVAP. FAN MOTOR CONTACTOR (88F)	E	E	E	E	E	DE	E	E	DE	
DEFROST TIMER (2D1)	E	E	E	E	E	DE	E	E	DE	
DEFROST TERM. TIMER (2D2)	DE	DE	DE	DE	DE	E	DE	DE	E	
DEFROST INIT. RELAY (2DX1)	DE	DE	DE	DE	DE	E	DE	DE	E	
DEFROST AUX. RELAY (2DX2, 3)	DE	DE	DE	DE	DE	E	DE	DE	E	
COMP. CONTROL RELAY (2X4)	E	E	DE	E	E	DE	E	E	DE	
CHILL/FROZEN CHANGE OVER RELAY (2X5)	E	E	E	E	E	E	DE	DE	DE	
DIGITAL DISPLAY ON-OFF RELAY (2X6)	E	E	E	E	E	E	E	E	E	
HEAT UP RELAY (2X7)	DE	DE	DE	DE	E	DE	DE	DE	DE	
IN RANGE TIMER AUX. RELAY (2X8)	DE	DE	DE	DE	DE	E	DE	DE	E	
LIQUID LINE SOLENOID VALVE										NOTE: 1. E: ENERGIZED DE: DE-ENERGIZED $\bar{O}$: OPEN C: CLOSE 2. 2F: EVAP. FAN DELAY TIMER AT START OR AFTER DEFROST, EVAP. FAN START IS DELAYED FOR ONE MINUTE. 3. 2D2: DEFROST TERMINATION TIMER IN RANGE LAMP LIGHTS ON FOR 90 MINUTES FORCEDLY FROM DEFROST INITIATION BY THIS TIMER.
20LS1	$\bar{O}$	$\bar{O}$	C	$\bar{O}$	$\bar{O}$	$\bar{O}$	$\bar{O}$	$\bar{O}$	$\bar{O}$	
20LS2	$\bar{O}$	$\bar{O}$	$\bar{O}$	$\bar{O}$	$\bar{O}$	C	$\bar{O}$	$\bar{O}$	C	
DRAIN PAN HEATER SOLENOID VALVE										
20DPS	C	C	C	C	C	$\bar{O}$	C	C	$\bar{O}$	
SUCTION SOLENOID VALVE										
20SS — INSIDE TEMP. — ABOVE −5°C	C	C	C	C	C	$\bar{O}$	C	C	$\bar{O}$	
20SS — INSIDE TEMP. — BELOW −5°C	C	C	C	C	C	$\bar{O}$	$\bar{O}$	$\bar{O}$	$\bar{O}$	
MODULATING VALVE (20M)	C	$\bar{O}$	C	$\bar{O}$	$\bar{O}$	$\bar{O}$	C	C	$\bar{O}$	
COMPRESSOR	ON	ON	OFF	ON	ON	ON	ON	ON	ON	
COND. FAN MOTOR	ON	ON	OFF	ON	ON	ON	ON	ON	ON	
EVAP. FAN MOTOR	ON	ON	ON	ON	ON	OFF	ON	ON	OFF	
LAMPS										
COMP. (GREEN)	ON	ON	OFF	ON	ON	ON	ON	ON	ON	
DEFROST (RED)	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	ON	
IN RANGE (AMBER)	OFF	ON	OFF	ON	OFF	ON	OFF	ON	ON	
POWER (BLUE)	ON	ON	ON	ON	ON	ON	ON	ON	ON	