DAIKIN

Marine type
Container Refrigeration Unit

Service manual

Model

LXE5-R

OCLU299111 TO OCLU299201
JSSU030354 TO JSSU030384

DAIKIN INDUSTRIES, LTD.

TR87-08

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

Please refer also to these manuals.

DANGER

1. Do not disconnect plug until power supply is shut off.
2. Do not touch the condenser fan during water cooled operation. (The condenser fan operates on and off to cool the control box.)

CAUTION

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

NOTE

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

Contents

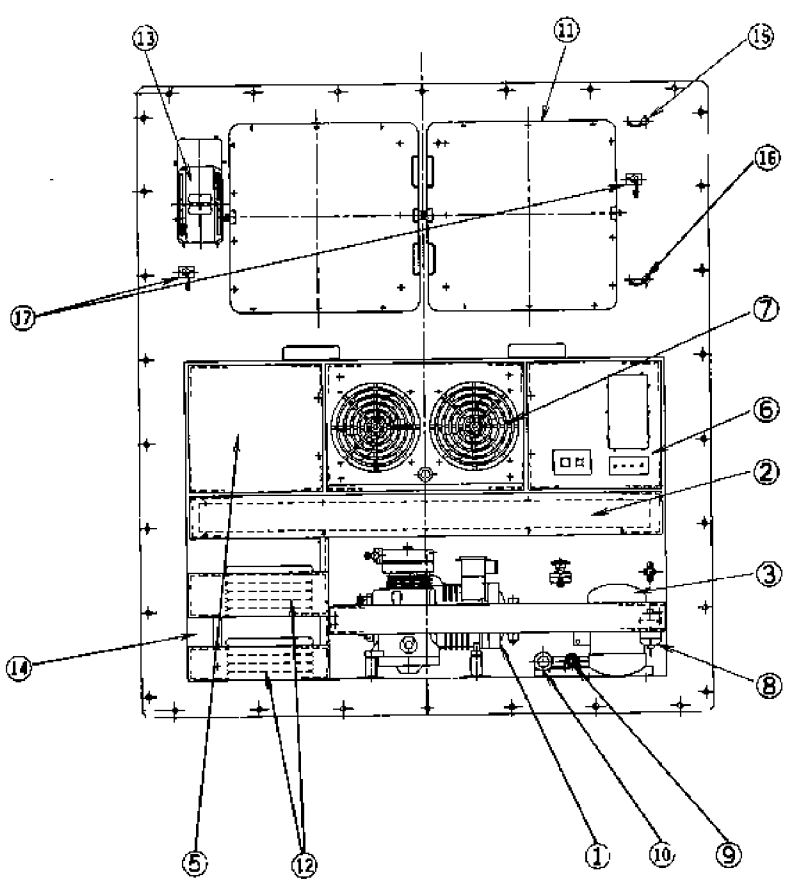
Chapter for operation

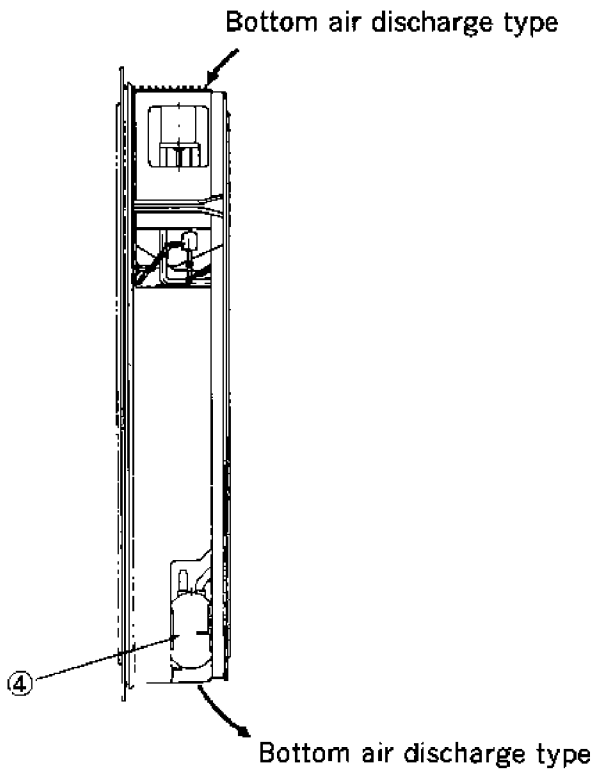
1. Operation ranges

Use the units within the following ranges

Item	Operation range	
Ambient temperature range	−15°C～+50°C (+5°F～+122°F)	
Cooling water	Quality of water	Fresh water
	Temperature	10°C～36°C (50°F～96.8°F)
	Water flow rate	20～46 ℓ /min.
	Pressure	2～5kg/cm²
Inside temperature range	−25°C～+25°C (−13°F～+77°F)	
Voltage	200V class 200V 50／60Hz、220V 60Hz 400V class 380V～415V 50Hz、400V・440V 60Hz Voltage fluctuation rate ±10%	
Vibration and shock	2G	

2. Names of parts



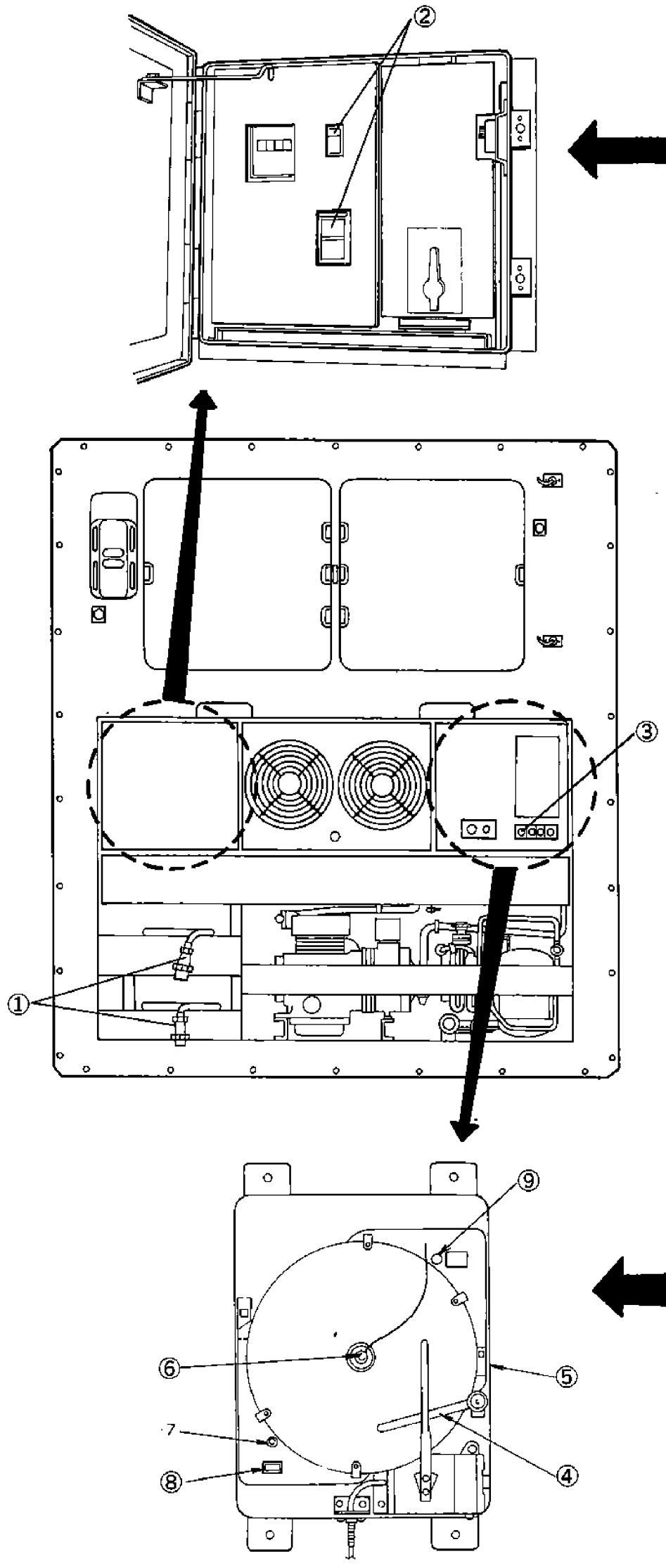


① Compressor
② Air cooled condenser
③ Water cooled condenser
④ Accumulator
⑤ Switch box
(Breaker for main circuit, breaker for control circuit voltage selector switch are installed in the box.)
⑥ Control box
(On the front, the operation switches are arranged, and controller and recorder are installed inside.)
⑦ Air cooled condenser fans
(Operate during air cooled operation. Note that they sometimes operate to cool the control box during water cooled operation.)
⑧ Dryer
⑨ Cooling water inlet coupling
⑩ Cooling water outlet coupling
(Connect the water piping to them before water cooled operation, and air cooled operation is automatically changed to water cooled operation.)
⑪ Access panel
⑫ Storage space for power cable
⑬ Ventilator
⑭ Transformer
⑮ Thermometer check point
(Use this port to measure inside temperature)
⑯ Gas sampling port
(Use this port to measure concentration of CO_2 in the storage.)
⑰ CO_2 control port

3. Operation

Operate the unit by the procedures given below.

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



3.1 Preparation and operation

Confirm that supply power is off.
Confirm that the power source ①, the circuit breaker ② and unit ON-OFF switch ③ are turned off before checking for safety's sake.

Confirming function of drive for the recording chart

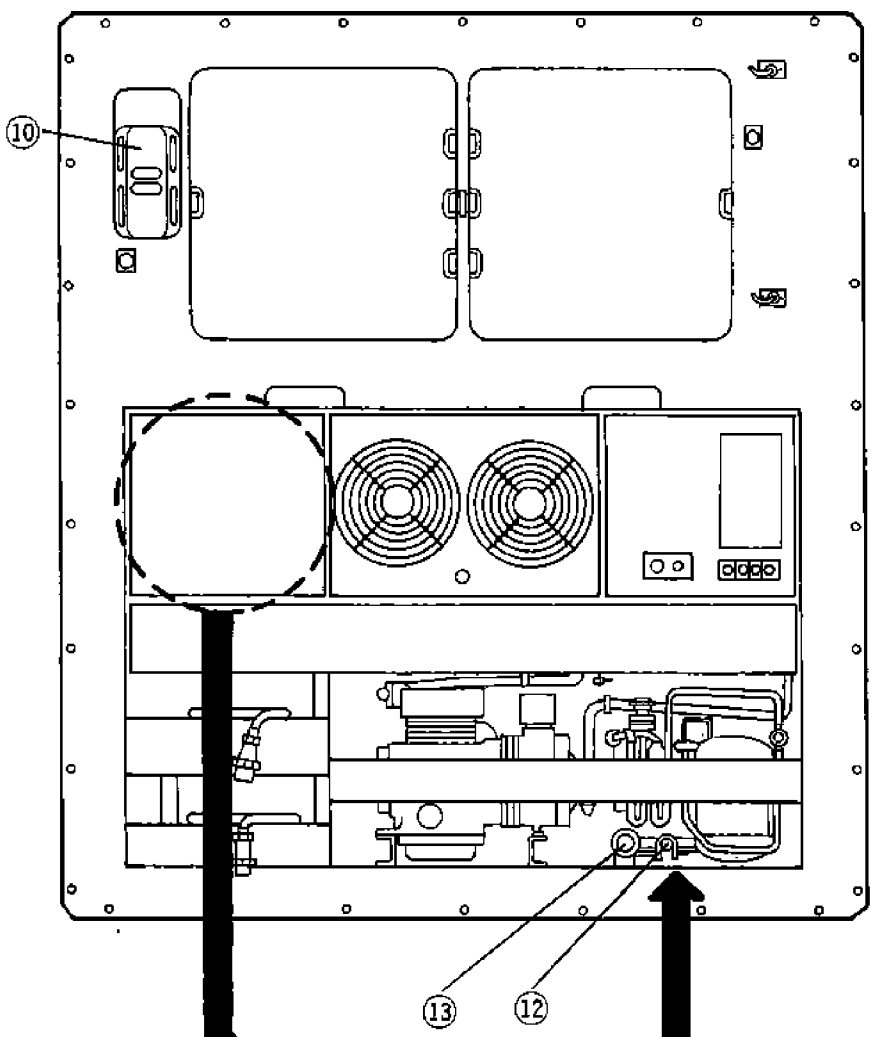
- Confirming life of a dry element battery
  Press the push button ⑦ and confirm that the needle of the remaining voltage indicator ⑧ remains in the blue zone. (The meter functions only when the push button ⑦ is pressed down)
- Confirming the function of quartz motor
  After confirming the life of dry element battery, check through the inspection window ⑨ the inside fly wheel is rotating.

Setting a sheet of recording paper

- Raise the pen by the pen holder ④, loosen the chart nut ⑥, and set a new sheet of recording paper.
- Set the date on the paper to an arrow of present time plate ⑤.
- Firmly tighten up the chart nut ⑥ and release the pen so that recording can be accomplished.

④ Pen lifting arm
⑤ Present time plate
⑥ Chart nut
⑦ Push button
⑧ Remaining voltage indicator
⑨ Inspection window for checking of quartz motor running

Open or close the ventilator.
Open or close the ventilator ⑩ according to the cargo. (Be sure to keep it closed during transportation of frozen cargo.)



Connect the cooling water piping.

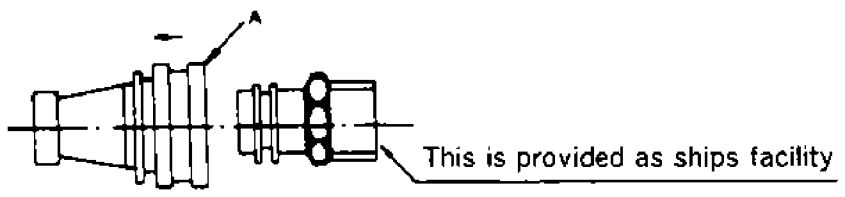
- In the case of water cooled operation, connect the water piping, and supply water through it.
- Connecting method

1. Connect the cooling water inlet coupling ⑫.
2. Connect the cooling water outlet coupling ⑬.

- Disconnecting method.

1. Disconnect the cooling water outlet coupling ⑬.
2. Disconnect the cooling water inlet coupling ⑫.

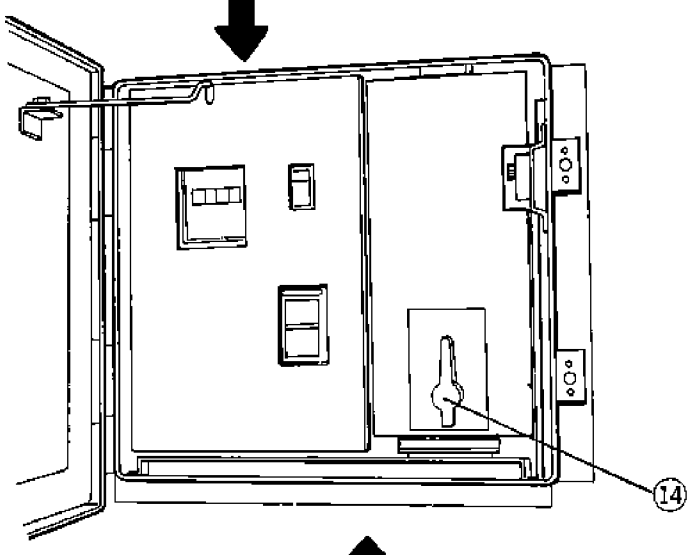
When the cooling water couplings are connected, insert the coupling on the ship side into the coupling on the unit side until a "click" is heard.

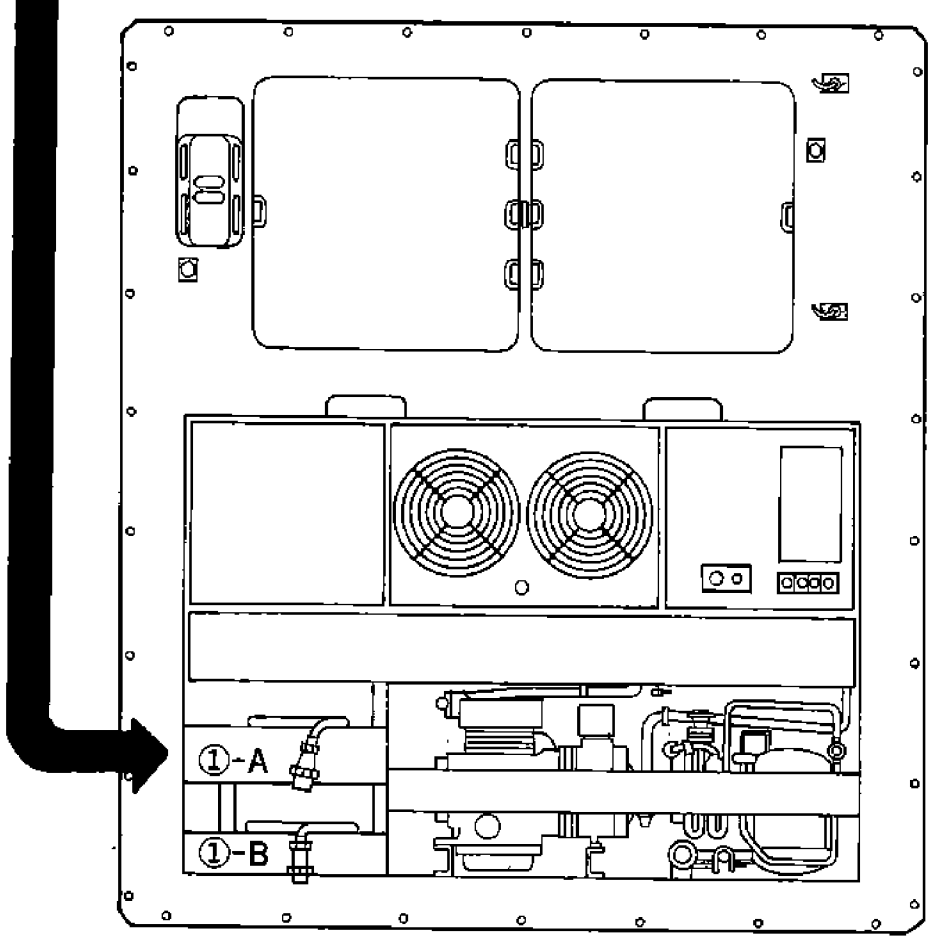


When disconnecting them, pull the coupling on the ship side toward you while pushing the "A" part of the female coupling in the direction pointed by an arrow mark.
Both at connecting and disconnecting, be careful for splash of cooling water.

Check that all refrigerant stop valves are opened.

Set the voltage selector ⑭ according to the supply voltage.





Plug ① in the power source which supplies the proper voltage, and fasten the plug ① firmly.

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

Turn ON the circuit breaker ② and unit ON-OFF switch ①.

Close the cover of the control box.
If it is loose, water will intrude. Check around the packing and tighten the cover securely

① power plug

①- A 200V class

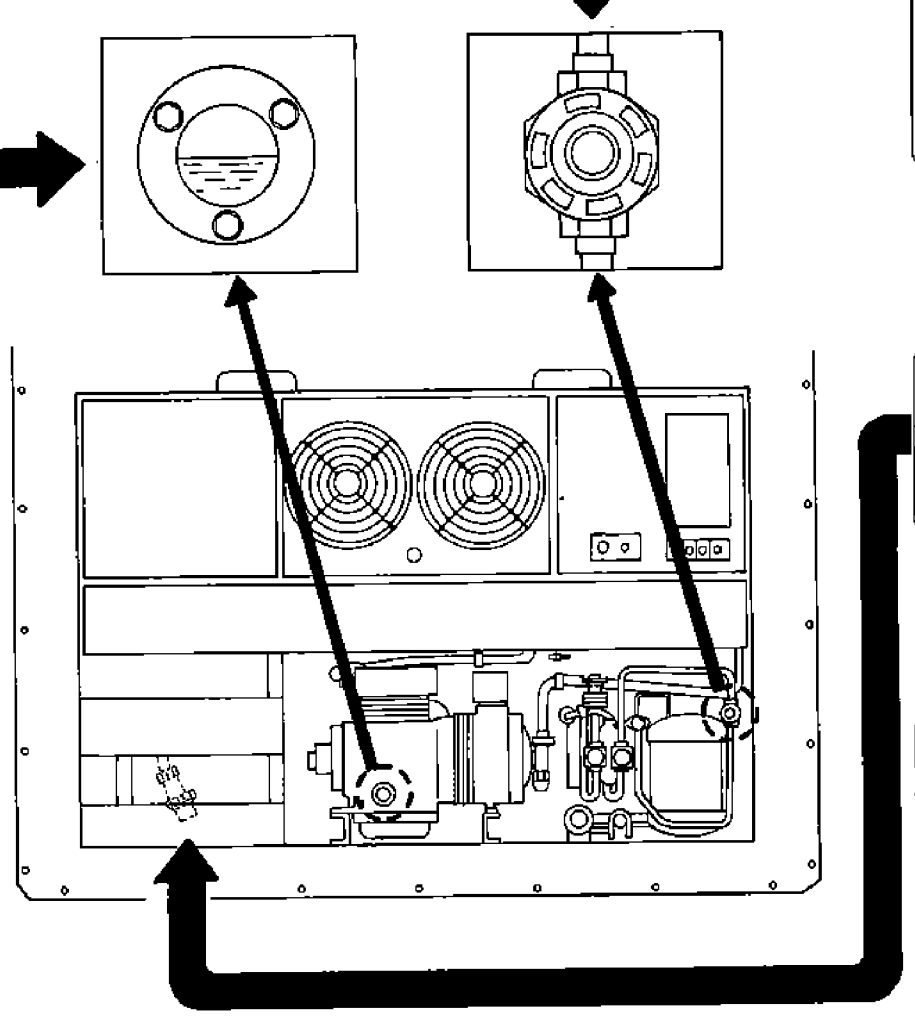
①- B 400V class

3.2 Checking during operation

Checking items (precautions)	Method of check
1. Check if unusual noise and vibration is not produced from compressor, fan and piping etc.	Visual, listening and touching.
2. Check to ensure oil pressure protection switch does not function, and the unit does not stop.	—
3. Check suction and discharge pressures of the compressor. (For installation of a gauge, refer to Section 6 "Maintenance".)	Compare observed data with standard ones.
4. Check for proper oil level of compressor. Check to see the oil is clean. (Oil level may fall for a while after starting, but it rises gradually.)	Visual Oil level should be approx. ¼ to ¾ of its full scale.
5. Check to see if refrigerant is sufficient. (The refrigerant bubbles immediately after starting, but this does not mean that refrigerant is lacking.)	Shortage of refrigerant is indicated by bubbles in the moisture indicator.
6. Check if any moisture is present in refrigerant circuit. (The color of moisture indicator may turn to orange if it has been exposed to gaseous refrigerant for a long time, but this is no indication of trouble.)	Visual The moisture indicator should normally appear deep blue. Orange color is a sign of trouble.
7. Check if the recorder operates according to the inside temperature.	Visual
8. Check operating conditions with the pilot lamps and check instrument	Visual

3.3 Maintenance after operation

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



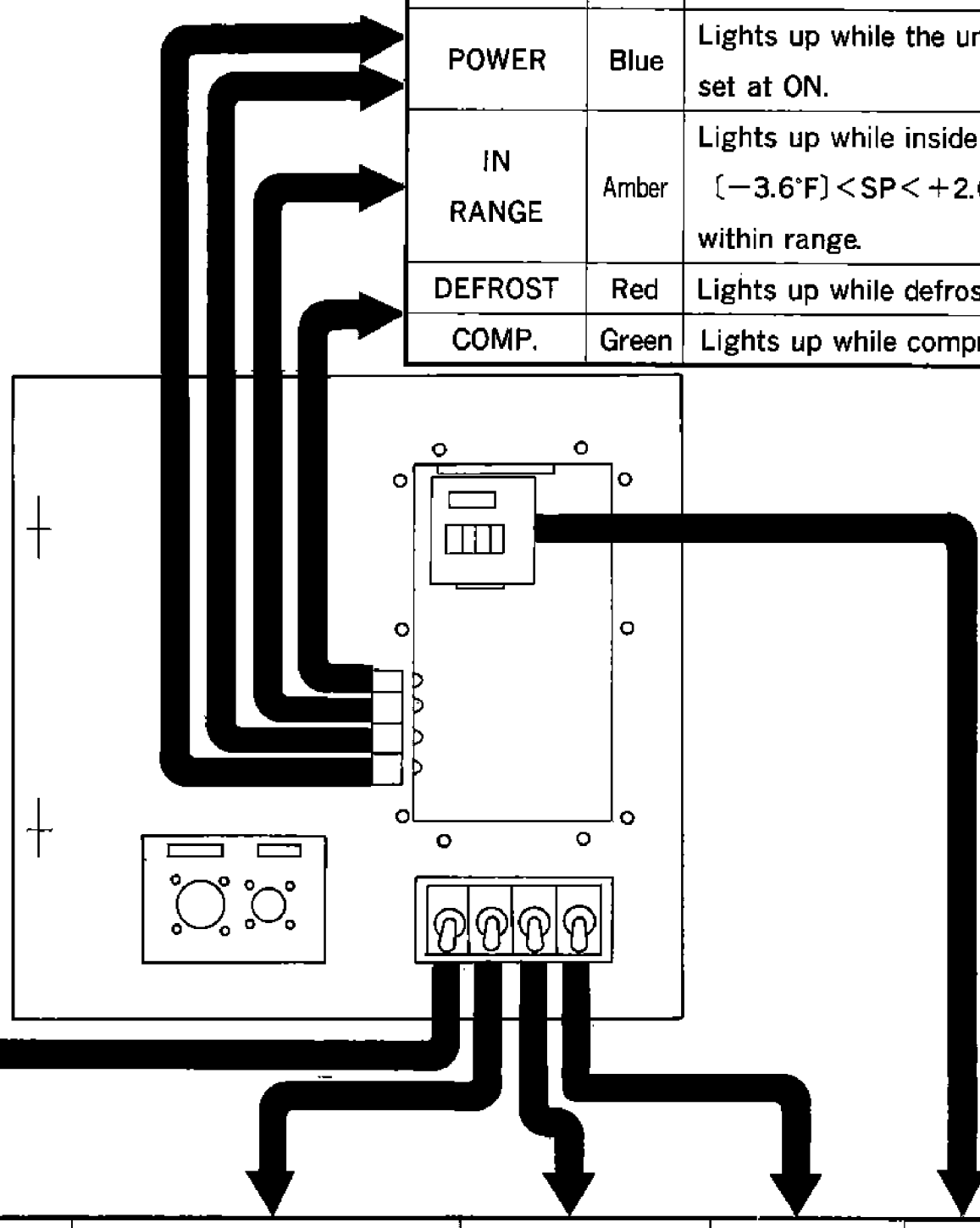
Stowing the power cable
Turn the plug's opening downward so that sea and rain water cannot enter the plug when stowing it.

Close the cover of the cotrol box.

After water cooled operation, remove the water piping.

3.4 Operation switches and pilot lamps

Pilot lamp	Color	Function
POWER	Blue	Lights up while the unit ON/OFF switch is set at ON.
IN RANGE	Amber	Lights up while inside temperature (−2.0°C 〔−3.6°F〕<SP<+2.0°C 〔+3.6°F〕) is within range.
DEFROST	Red	Lights up while defrosting
COMP.	Green	Lights up while compressor is running



Switches	Unit ON-OFF	Defrost AUTO-MANUAL		Heat-up ON-OFF	Lamp ON-OFF	Set point selector	
Operation mode	——	Defrost operation		Heat-up operation	——	Chilled operation	Frozen operation
Operation points	Turn on the switch	Automatic: Defrosting starts automatically by the timer S : 4Hr L : 12Hr	Manual: Turn on the switch	Turn on the switch (Only for chilled)	Turn on the switch.	Set the set point to −4.5°C～+25°C. (+23.9°F～+77°F)	Set the set point to −25°C～−6.5°C (−13°F～+20.3°F)
Functions	The unit is operated on and off. When the evaporator fan is running in low speed, the unit is delayed in starting by 10 seconds and then will run continuously.	Hot gas defrosting begins. When defrosting is terminated, chilled or frozen operation will begin automatically.		Heat up operation begins. After finishing heat-up operation, the unit is automatically put in chilled operation.	The pilot lamp lights up.	Chilled operation begins. Inside temperature is controlled in PID by the supply sensor.	Frozen operation begins. Inside temperature is controlled in ON/OFF operation by the return sensor.
						The evaporator fan speed is changed automatically from high to low and vice versa depending on return air temperature or supply air temperature.	

Chapter for maintenance and repair

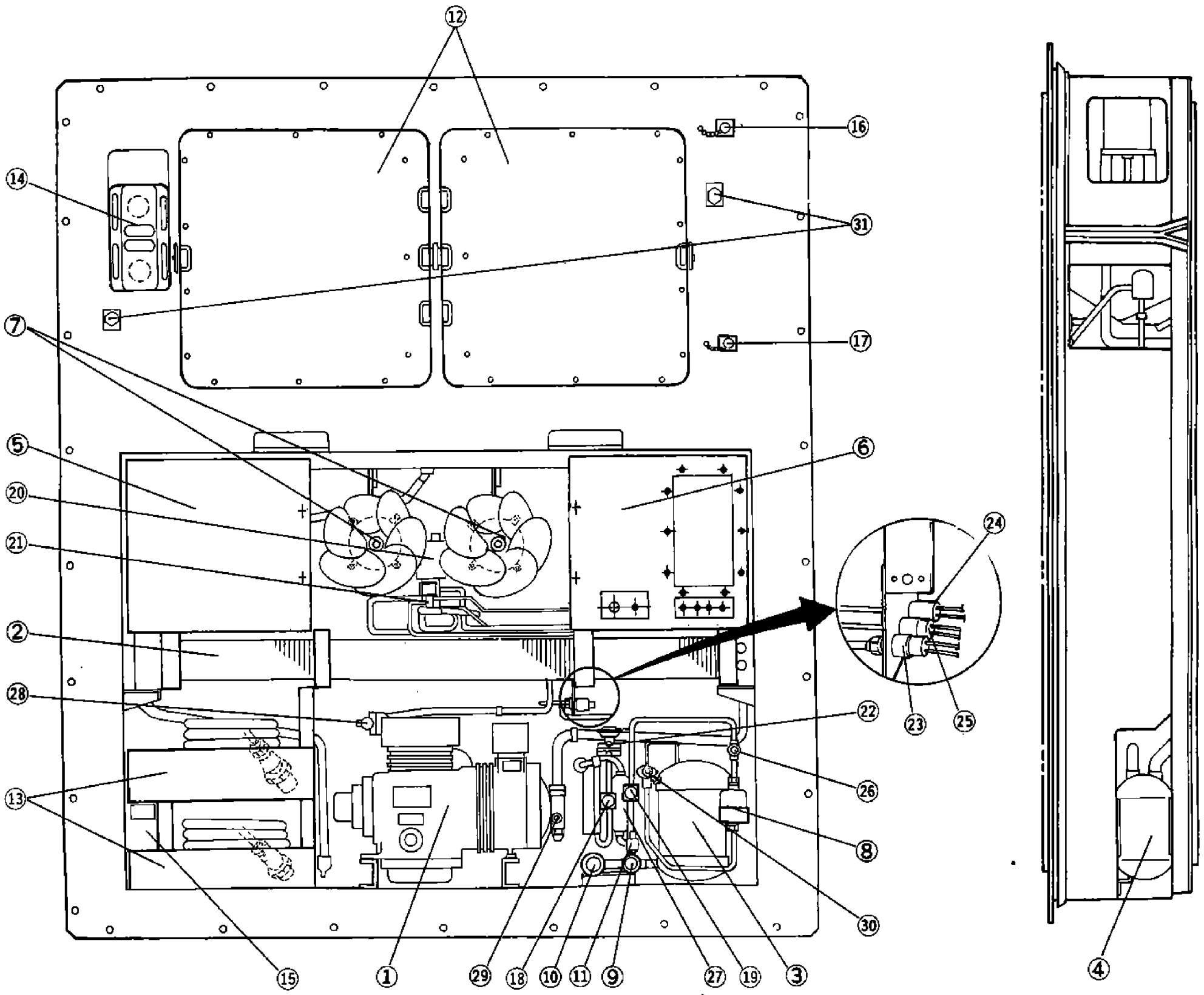
1. Data of the products

1.1 Main specifications

Item \ Model	L X E 5-R
Inside air discharge direction	Bottom air discharge type
Condenser cooling methods	Air/water cooled type
Power supply	AC 200V 3 Phase 50Hz AC 200V, 220V 3 Phase 60Hz AC 380~415V 3 Phase 50Hz AC 400V, 440V 3 Phase 60Hz (Dual-rating voltage system by voltage selector switch)
Compressor	Semi hermetic type (3.75 kW)
Evaporator	Cross finned coil type
Air cooled condenser	Cross finned coil type
Water cooled condenser	Vertical shell type
Fan	Motor direct driven propeller type
Fan motor	Three-phase squirrel-cage induction motor
Defrost Heating Initiation Termination	 Hot-gas defrost Timer or manual switch Sensing suction pipe temperature by the defrost termination thermostat
Refrigerant control	Thermostatic expansion valve
Capacity control	Hot gas bypass control with modulating control valve
Protection devices	Circuit breaker, over-current relay, compressor protective thermostat, fan motor protective thermostat, high pressure switch, low pressure switch, hight pressure control switch and fusible safety plug
Refrigerant (charged amount)	R12 : 5.0 (kg)/11 (lbs)
Lubricant (charged amount)	SUNISO 3GS-DI : 2.3 (ℓ)
Weight	Approx. 560 (kg)/1235 (lbs)

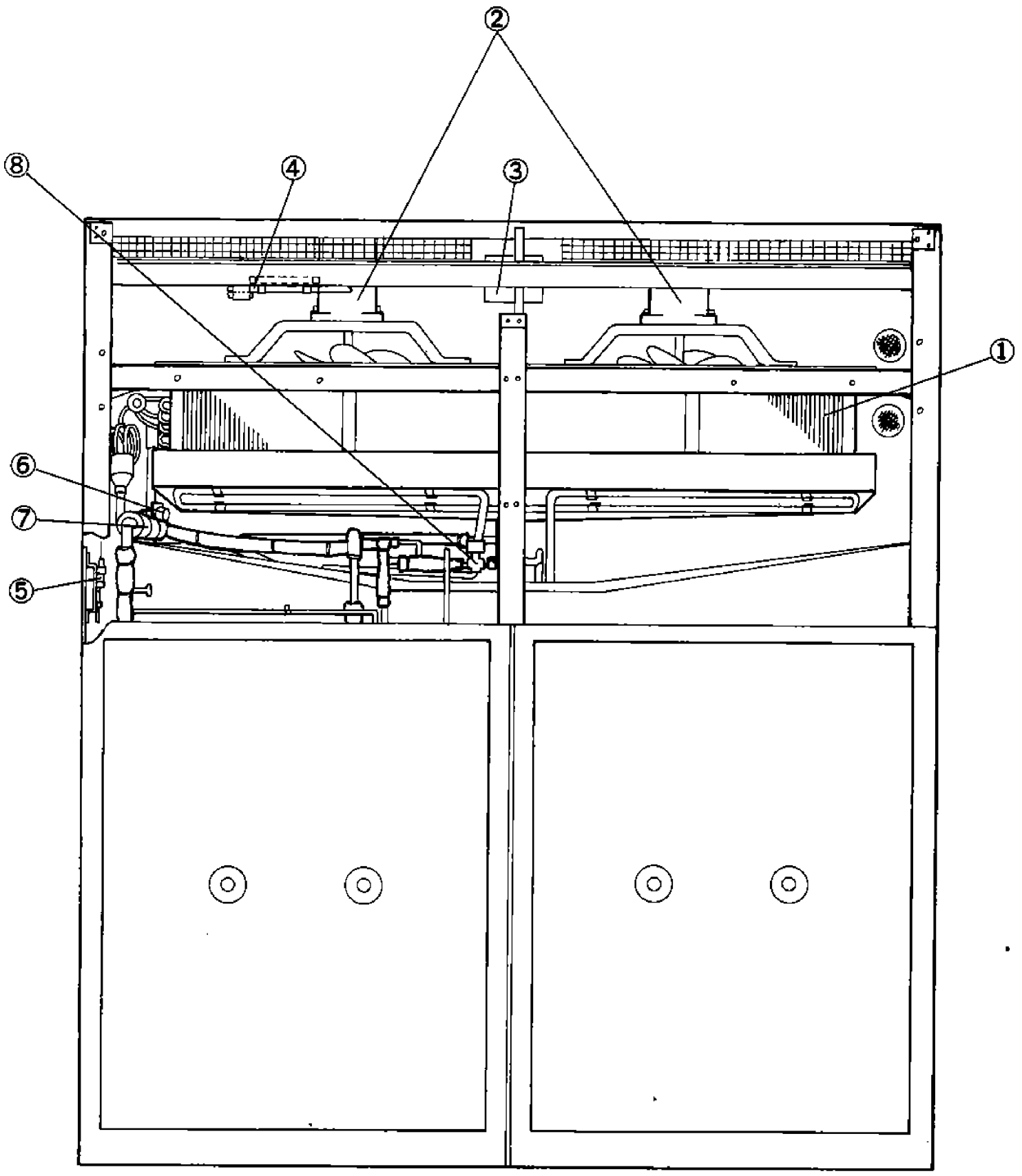
1.2 Names of parts

1.2.1 Outside



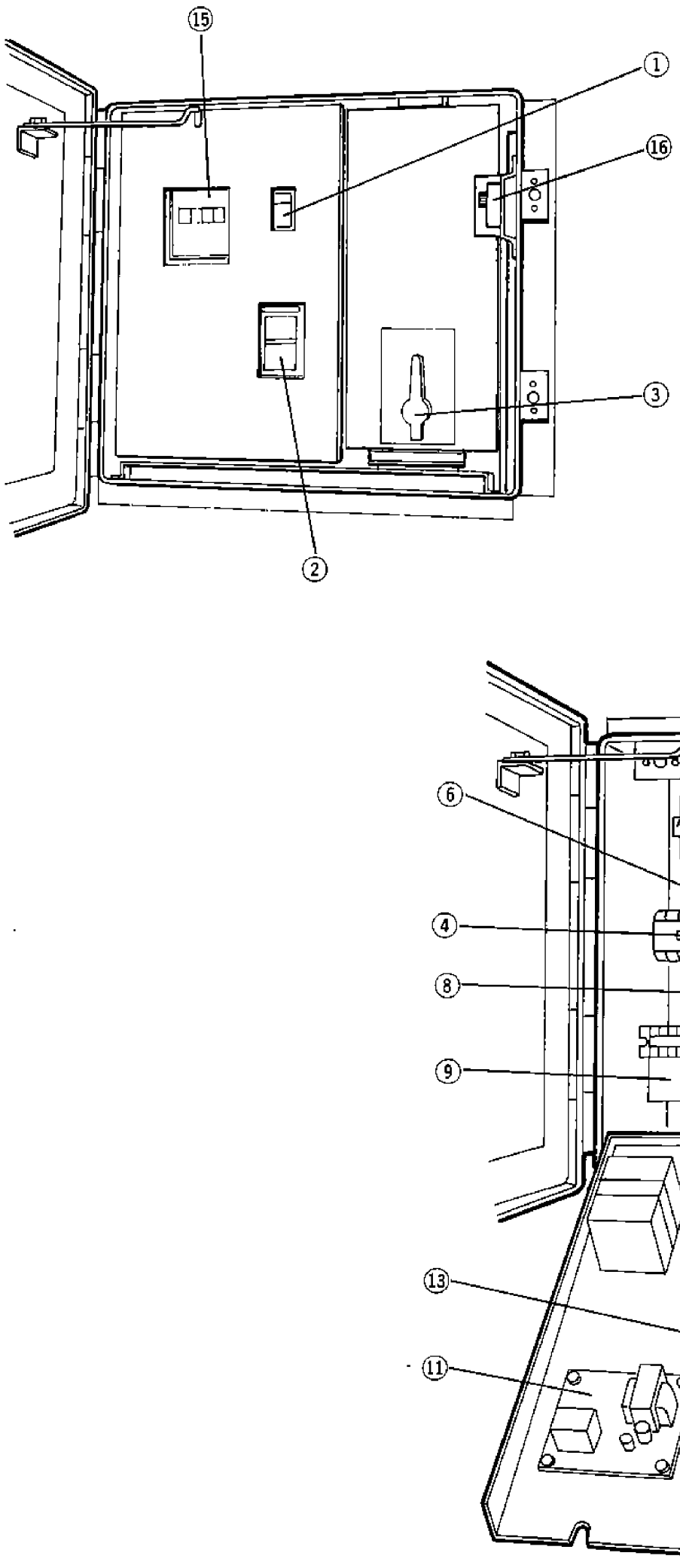
① Compressor
② Air cooled condenser
③ Water cooled condenser
④ Accumulator
⑤ Switch box
⑥ Control box
⑦ Air cooled condenser fan motor
⑧ Dryer
⑨ Cooling water inlet coupling
⑩ Cooling water outlet coupling
⑪ Water pressure switch(63W)
⑫ Access panel
⑬ Storage space for power cable
{Upper stage: 200V Class / Lower stage: 400V Class}
⑭ Ventilator
⑮ Transformer
⑯ Thermometer check point
⑰ Gas sampling port
⑱ Main liquid solenoid valve (20R1)
⑲ Measuring liquid solenoid valve (20R2)
⑳ Hot gas modulating control valve (20M)
㉑ Equalize 3-way solenoid valve (20R3)
㉒ Expansion valve
㉓ High pressure switch (63H1)
㉔ Low pressure switch (63L)
㉕ High pressure control switch (63H2)
㉖ Liquid/moisture indicator
㉗ Accumulator (for defrosting)
㉘ Stop valve at compressor discharge side
㉙ Stop valve at compressor suction side
㉚ Stop valve at water cooled condenser outlet side
㉛ CO_2 control port

1.2.2 Inside



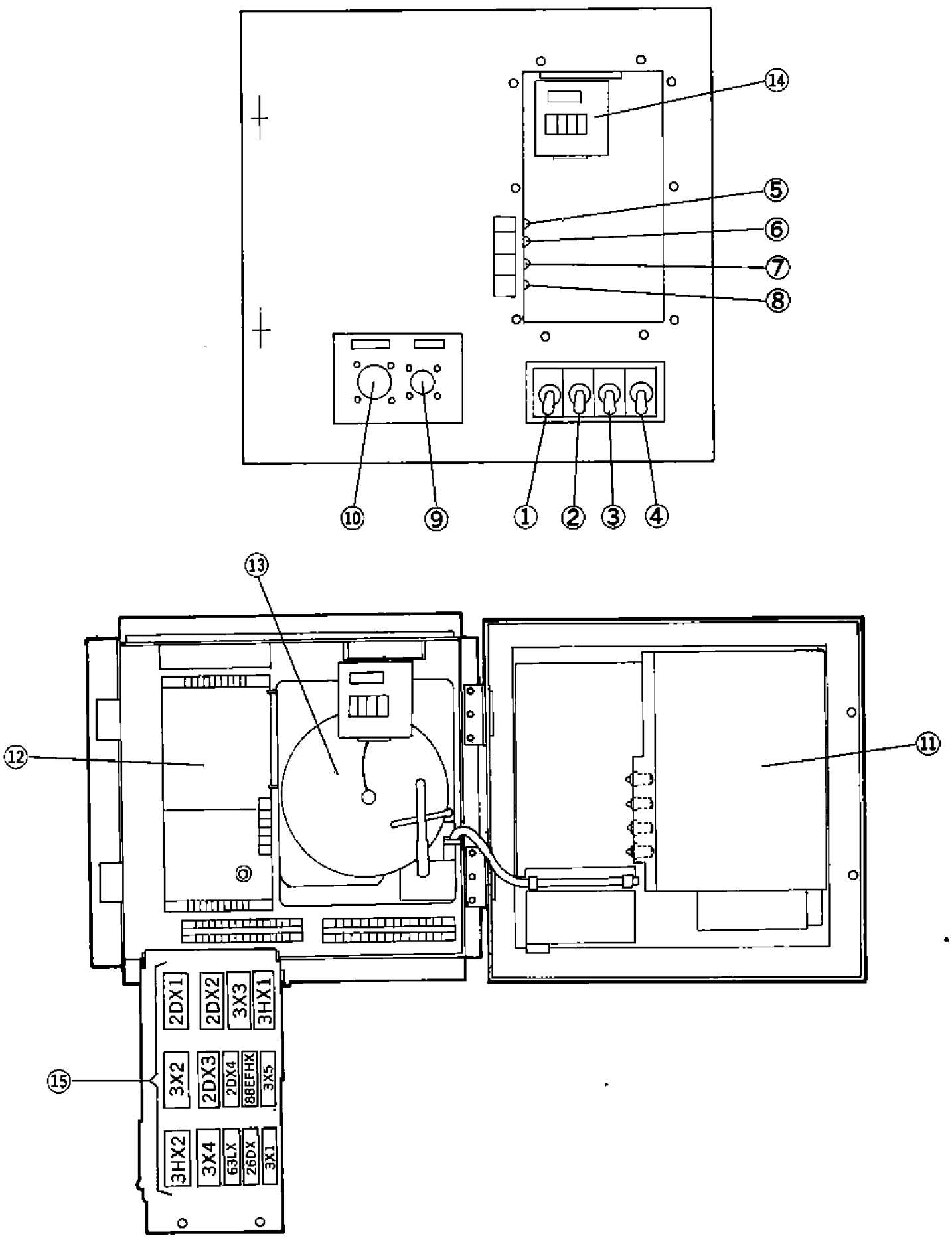
① Evaporator
② Evaporator fan motor
③ Junction terminal box
④ Return sensor (23A1), feeler tube (fan speed change-over thermostat), and feeler tube (recorder)
⑤ Supply sensor (23A1), supply sensor (23A2)
⑥ Defrost termination thermostat (26D) at the suction piping
⑦ Feeler tube (expansion valve)
⑧ Solenoid valve for drain pan heater (20R4)

1.2.3 Switch box



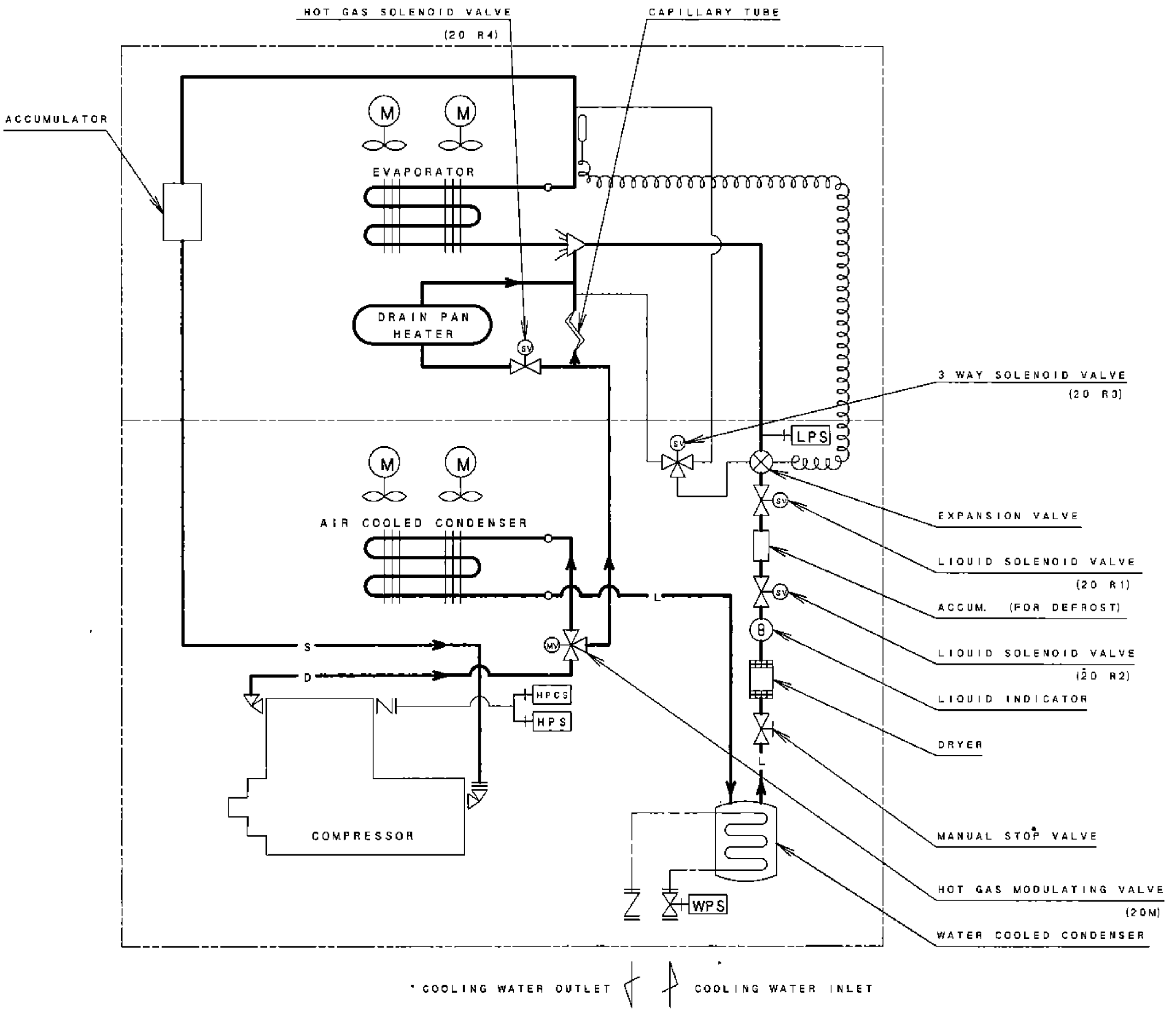
① Circuit breaker (52C2)
② Circuit breaker (52C1)
③ Voltage selector switch (83)
④ Magnetic contactor for compressor (88C)
⑤ Magnetic contactors for high speed evaporator fan motor (88EFH1 • 2 • 3)
⑥ Magnetic contactor for low speed evaporator fan motor (88EFL)
⑦ Magnetic contactors for air cooled condenser fan motor (88CF1 • 2)
⑧ Over-current relay (51C)
⑨ Transformer (Tr2)
⑩ Auxiliary relays (49EFX1 • 2)
⑪ Phase sequence controller (47)
⑫ Magnetic contactors (47X1 • 2)
⑬ Auxiliary relay (63WX)
⑭ Switch box thermostat (26BH)
⑮ Hour meter (HM)
⑯ Fan speed change-over thermostat (26F)

1.2.4 Control box



① Unit ON-OFF switch (3-88)
② Defrost AUTO-MANUAL switch (3D)
③ Heat up ON-OFF switch (3-H)
④ Pilot lamp ON-OFF switch (3-30L)
⑤ Pilot lamp (Green-COMP.) (GL)
⑥ Pilot lamp (Red-DEFROST) (RL)
⑦ Pilot lamp (Amber-IN RANGE) (AL)
⑧ Pilot lamp (Blue-POWER) (BL)
⑨ Receptacle for remote monitoring
⑩ Receptacle for ref. check
⑪ Electronic controller (23A1)
⑫ Electronic controller (23A2)
⑬ Recorder
⑭ Set point selector (SP)
⑮ Magnetic relays

1.3 Piping diagram



HPS (63H1)	HIGH PRESSURE SWITCH
LPS (63L)	LOW PRESSURE SWITCH
HPCS (63H2)	HIGH PRESSURE CONTROL SWITCH
WPS (63W)	WATER PRESSURE SWITCH

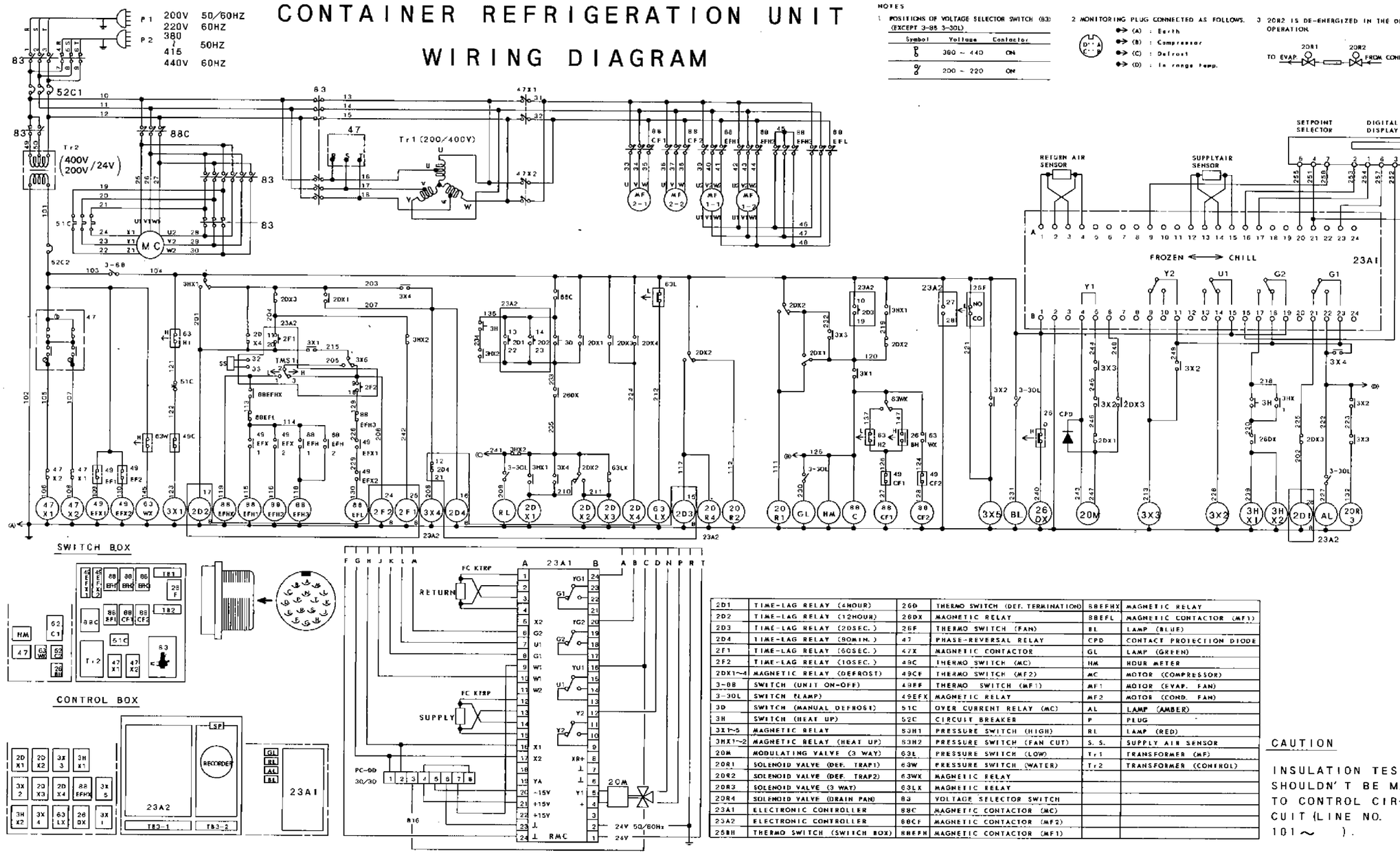
—L—	LIQUID PIPE
—S—	SUCTION PIPE
—D—	DISCHARGE PIPE
—||—	FLANGE CONNECTION
—|—	FLARE CONNECTION
- -	WATER PIPE

1.4 Electric wiring diagrams

1.4.1 Sequence

LXE5−R

CONTAINER REFRIGERATION UNIT
WIRING DIAGRAM



NOTES

1 POSITIONS OF VOLTAGE SELECTOR SWITCH (83) (EXCEPT 3-98 3-30L)

Symbol	Voltage	Contactor
P	380 ~ 440	ON
9	200 ~ 220	ON

2 MONITORING PLUG CONNECTED AS FOLLOWS.
(A) : Earth
(B) : Compressor
(C) : Defrost
(D) : In range temp.

3 20R2 IS DE-ENERGIZED IN THE DEFROST OPERATION.

SWITCH BOX

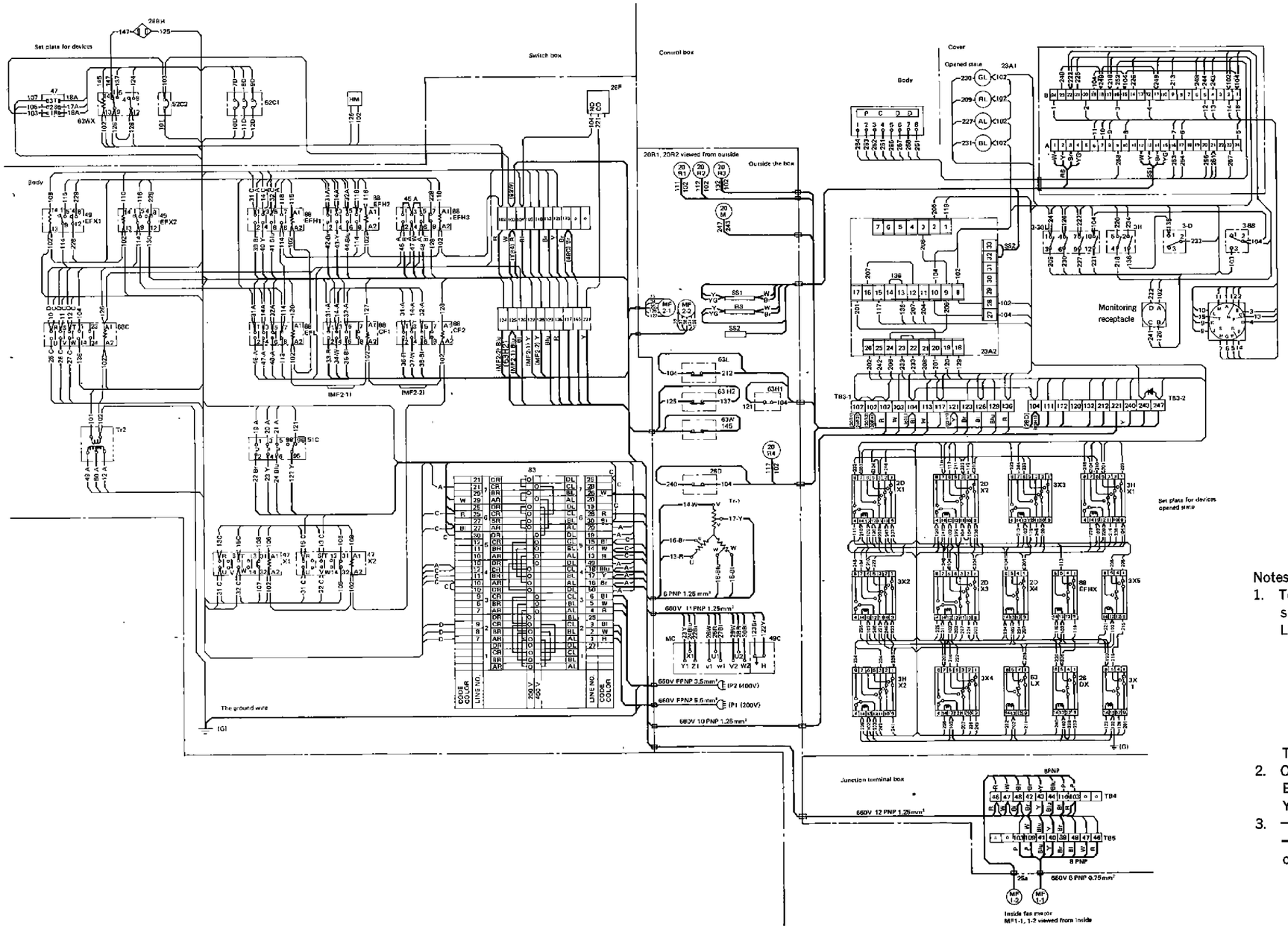
CONTROL BOX

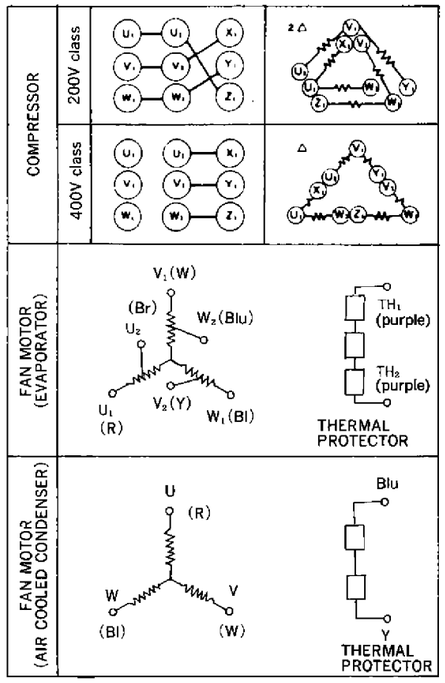
2D1	TIME-LAG RELAY (4HOUR)	26D	THERMO SWITCH (DEF. TERMINATION)	88EFHX	MAGNETIC RELAY
2D2	TIME-LAG RELAY (12HOUR)	26DX	MAGNETIC RELAY	88EFL	MAGNETIC CONTACTOR (MF1)
2D3	TIME-LAG RELAY (20SEC.)	26F	THERMO SWITCH (FAN)	BL	LAMP (BLUE)
2D4	TIME-LAG RELAY (90MIN.)	47	PHASE-REVERSAL RELAY	CPD	CONTACT PROTECTION DIODE
2F1	TIME-LAG RELAY (60SEC.)	47X	MAGNETIC CONTACTOR	GL	LAMP (GREEN)
2F2	TIME-LAG RELAY (10SEC.)	49C	THERMO SWITCH (MC)	HM	HOUR METER
2DX1~4	MAGNETIC RELAY (DEFROST)	49CF	THERMO SWITCH (MF2)	MC	MOTOR (COMPRESSOR)
3-88	SWITCH (UNIT ON-OFF)	49EF	THERMO SWITCH (MF1)	MF1	MOTOR (EVAP. FAN)
3-30L	SWITCH (LAMP)	49EFX	MAGNETIC RELAY	MF2	MOTOR (COND. FAN)
3D	SWITCH (MANUAL DEFROST)	51C	OVER CURRENT RELAY (MC)	AL	LAMP (AMBER)
3H	SWITCH (HEAT UP)	52C	CIRCUIT BREAKER	P	PLUG
3X1~5	MAGNETIC RELAY	63H1	PRESSURE SWITCH (HIGH)	RL	LAMP (RED)
3HX1~2	MAGNETIC RELAY (HEAT UP)	63H2	PRESSURE SWITCH (FAN CUT)	S. S.	SUPPLY AIR SENSOR
20M	MODULATING VALVE (3 WAY)	63L	PRESSURE SWITCH (LOW)	Tr1	TRANSFORMER (MF)
20R1	SOLENOID VALVE (DEF. TRAP1)	63W	PRESSURE SWITCH (WATER)	Tr2	TRANSFORMER (CONTROL)
20R2	SOLENOID VALVE (DEF. TRAP2)	63WX	MAGNETIC RELAY		
20R3	SOLENOID VALVE (3 WAY)	63LX	MAGNETIC RELAY		
20R4	SOLENOID VALVE (DRAIN PAN)	83	VOLTAGE SELECTOR SWITCH		
23A1	ELECTRONIC CONTROLLER	88C	MAGNETIC CONTACTOR (MC)		
23A2	ELECTRONIC CONTROLLER	88CF	MAGNETIC CONTACTOR (MF2)		
25BH	THERMO SWITCH (SWITCH BOX)	88EFH	MAGNETIC CONTACTOR (MF1)		

CAUTION

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

1.4.2 Actual wiring diagram (LXE5−R)





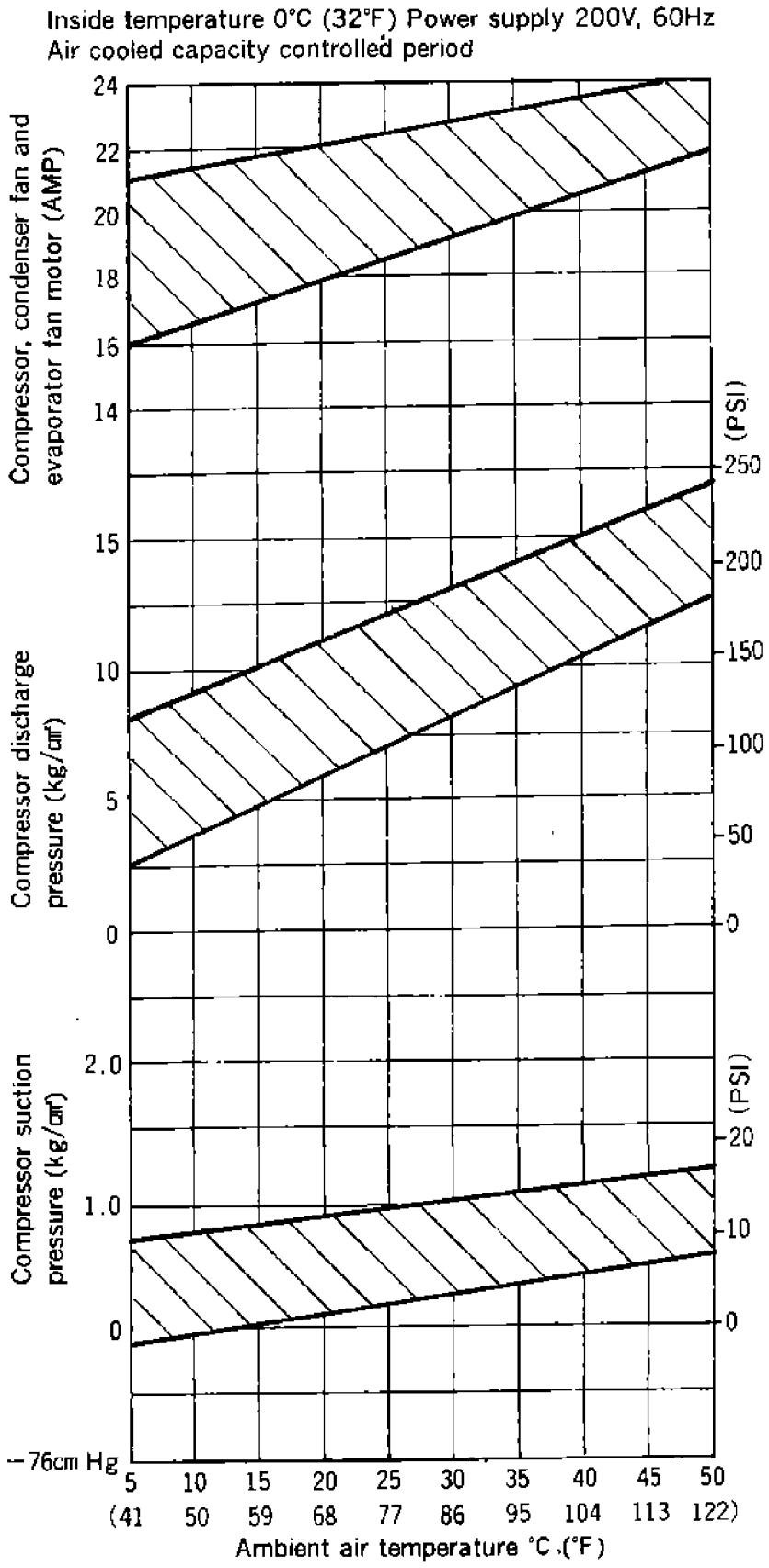
Notes :

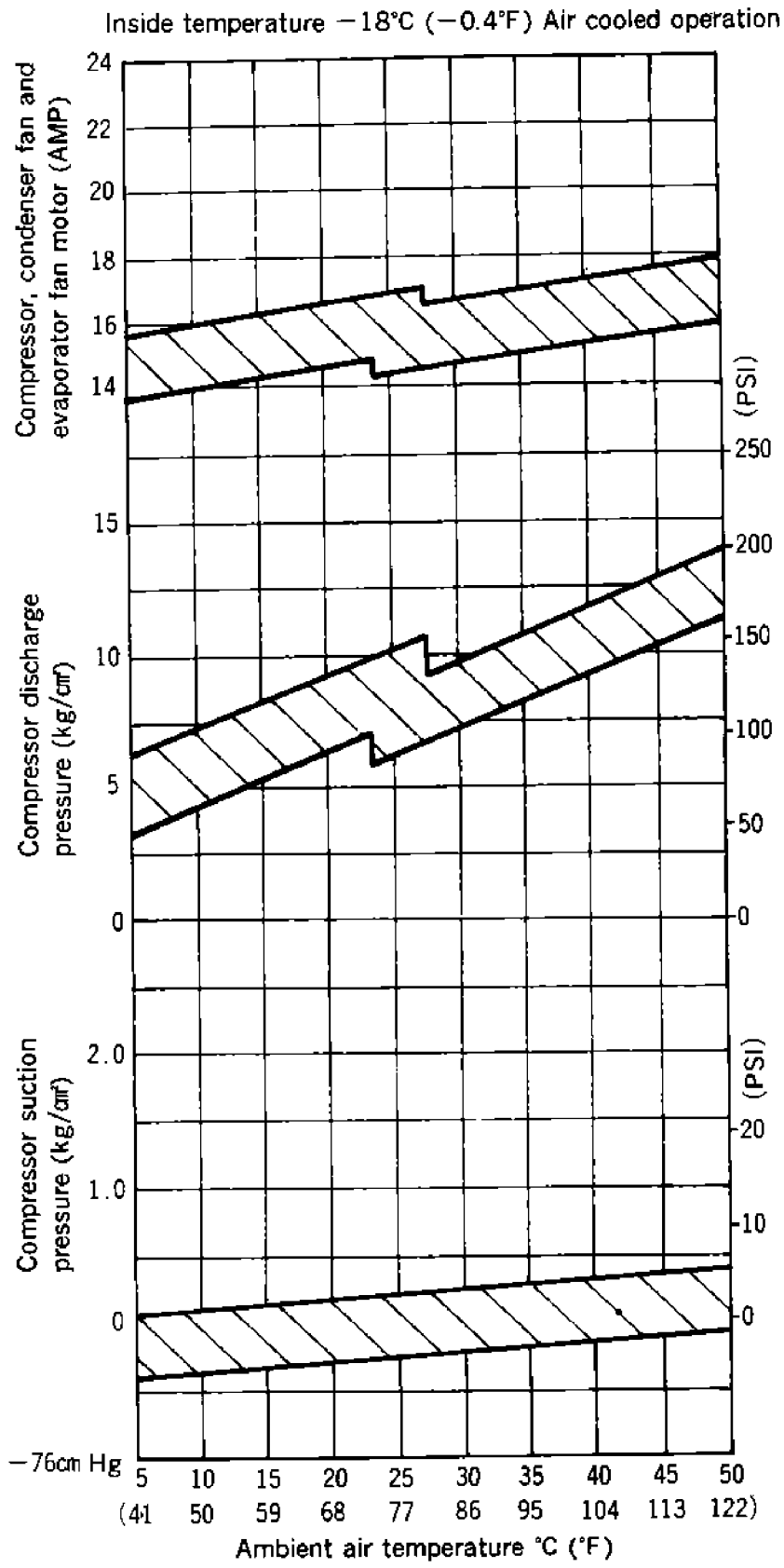
1. Terminal numbers of each device and wires used are as shown below.
   Line No.
   101～ : 100V KEX 0.75mm² : ——
   600V SCP 1.25mm² : —A—
   600V SCP 2.0mm² : —B—
   600V SCP 3.5mm² : —C—
   600V SCP 5.5mm² : —D—
   600V SCP 0.75mm² : ——
   The ground wire is VSF0.75mm²
2. Colors of wiring
   Bl : Black Blu : Blue Br : Brown R : Red
   Y : Yellow W : White (G) : Green (for earth)
3. —— shows the wiring in the board.
   —— shows the wiring for external devices and relay cables.

1.5 Set values of functional parts and protective devices

	Parts Name	Mark		Function		Set Value	Manufacture	Parts NO.
Pressure switch	High pressure switch 20PS−K200	63H1			OFF ON	20kg/cm² 16.5kg/cm²	Texas Instrument (JAPAN)	284060
	High pressure control switch ACB−BA26	63H2			OFF ON	7kg/cm² 11kg/cm²	Saginomiya Inc. (JAPAN)	630045
	Low pressure switch 20PS−K100	63L			OFF ON	40cmHgV 0.2kg/cm²	Texas Instrument (JAPAN)	284061
	Water pressure switch LCB−BB07	63W			OFF ON	1kg/cm² 0.4kg/cm²	Saginamiya Inc. (JAPAN)	284059
Thermostat and timer	Fan speed change-over thermostat	23A2	TMS1		ON(OFF) OFF(ON)	15°C (59°F) 20°C (68°F)	DAIKIN	698347
	Over-cooling protective thermostat		TMS2	29−30 Short-circuit (Option)	OFF ON	−1.5°C (29.3°F) +1.5°C (34.7°F)		
				29−30 Open (Factory set)	OFF ON	−3°C (26.6°F) 0°C (32°F)		
	Thermostat for solenoid valves		TMS3	Low temp. side	OFF ON	−10°C (14°F) −9°C (15.8°F)		
				High temp. side	ON OFF	9°C (48.2°F) 10°C (50°F)		
	Fan operation delay timer		2F1		ON	60 seconds		
	Fan Hi/Lo speed change-over timer		2F2		ON	10 seconds		
	Defrost timer: Short		2D1		ON	4 hours		
	Defrost timer: Long		2D2		ON	12 hours		
	Defrost timer: Compressor stop		2D3		ON	20 seconds		
	Defrost timer: Back-up		2D4		OFF	90 minutes		
Thermostat	Defrost thermistor ST−5B 30/20	26D			OFF ON	35°C (95°F) 20°C (68°F)	Wako Electric (JAPAN)	643004
	Switch box thermostat CS−7	26BH			OFF ON	35°C (95°F) 50°C (122°F)	Wako Electric (JAPAN)	643313
	Fan speed change-over thermostat	26F		CO−NO	OFF ON	−10°C (14°F) −7°C (+19.4°F)	Fuji Koki (JAPAN)	640031
Breaker OC	Over-current relay GT−20−NP2S4	51C			OFF	5.8A	Togami Electric (JAPAN)	612216
	Circuit breaker (Main circuit) MK53	52C1			OFF	32A	Niko Electric (JAPAN)	622703
	Circuit breaker (Control circuit) CP31/7−Z	52C2			OFF	7A	Fuji Electric (JAPAN)	674014
Motor	Condenser fan motor protective thermostat	49CF			OFF	125°C (257°F)	Built in motor	
	Evaporator fan motor protective thermostat	49EF			OFF	120°C (248°F)	Built in motor	
	Compressor protective thermostat	49C			OFF	105°C (221°F)	Built in motor	

1.6 Operation pressure and running current





〈For reference〉

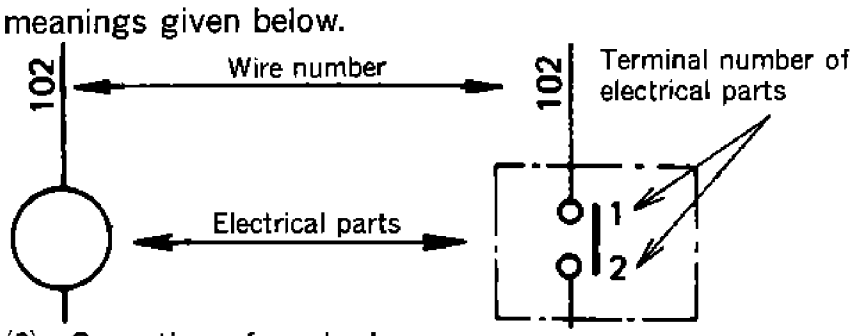
	Item		Unit	Value
1	'Condenser fan motor Running current (for 2 pcs.)		A	0.7 (AC400V)
2	Evaporator fan motor Running current (for 2 pcs.)		A	High speed 2.6 (AC400V)
				Low speed 0.7 (AC400V)
3	Tightening torque of bolts	Compressor	kg·cm/lb·ft	435/36
		Compressor stop valve flange		255/21
		Fan motor		125/10
		Solenoid valve		55/4.3
		Expansion valve		250/20.5
		Fan		55/4.3

Note : Allowable range of tightening torque ±10%

2. Operation modes and circuits

2.1 How to read wiring diagram

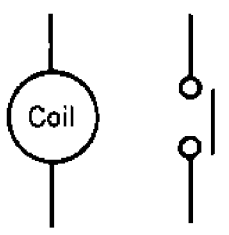
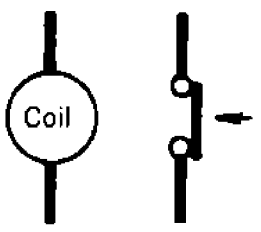
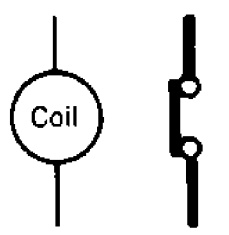
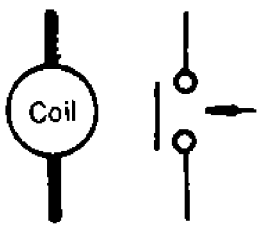
(1) In the wiring diagram, marks and numbers have the meanings given below.



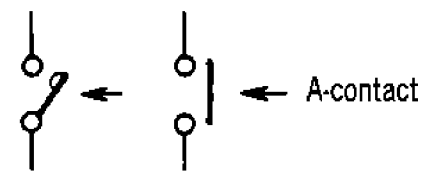
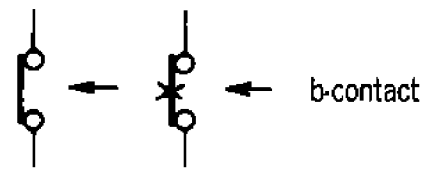
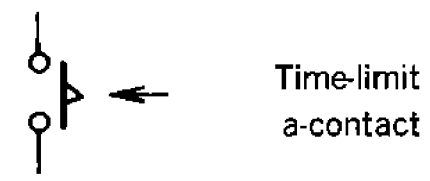
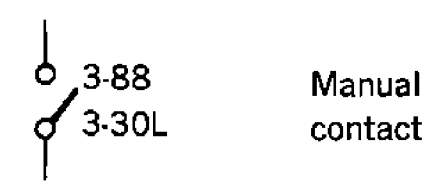
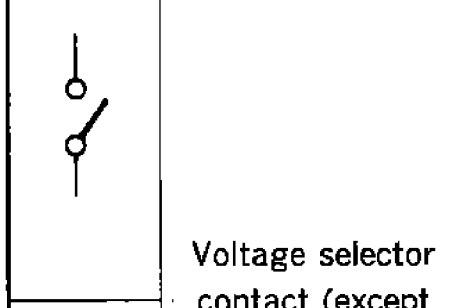
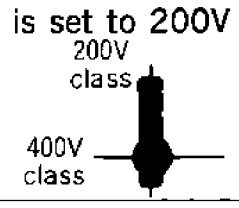
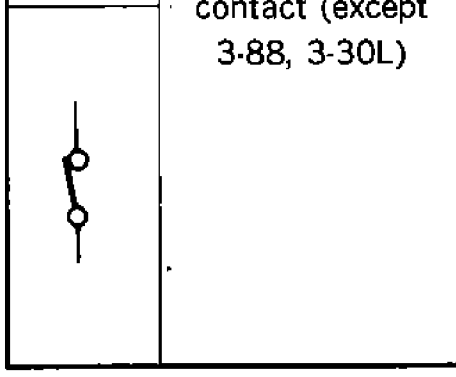
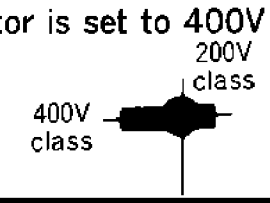
(2) Operation of contacts

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

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

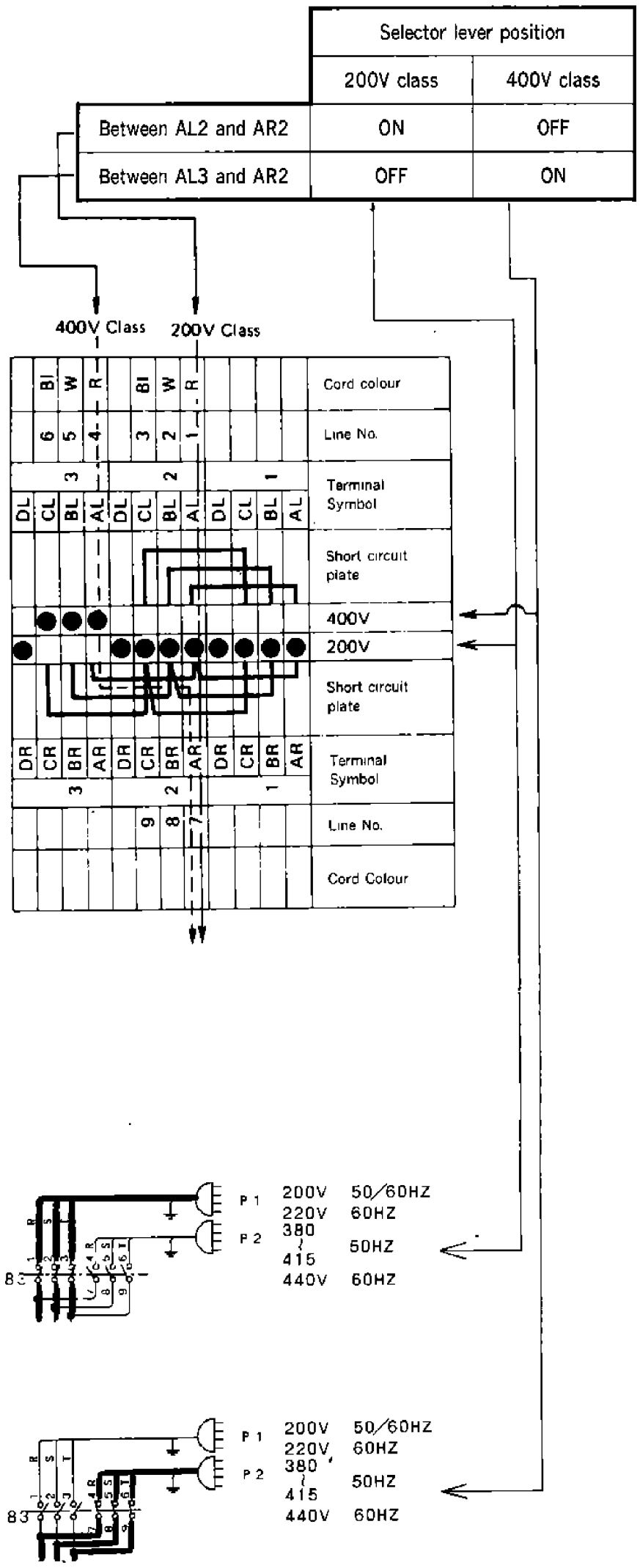
a-contact (normal open contact)	Contact is OFF when coil is not energized	
	Contact is ON when coil is energized	
b-contact (normal close contact)	Contact is ON when coil is not energized	
	Contact is OFF when coil is energized	

c. Kinds of contacts

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

d. How to read the wiring diagram of the voltage selector switch.
In the chart, "●" denotes that the contact is on.
The following example shows the states between terminals AL2 and AR2, and between AL3 and AR2.

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



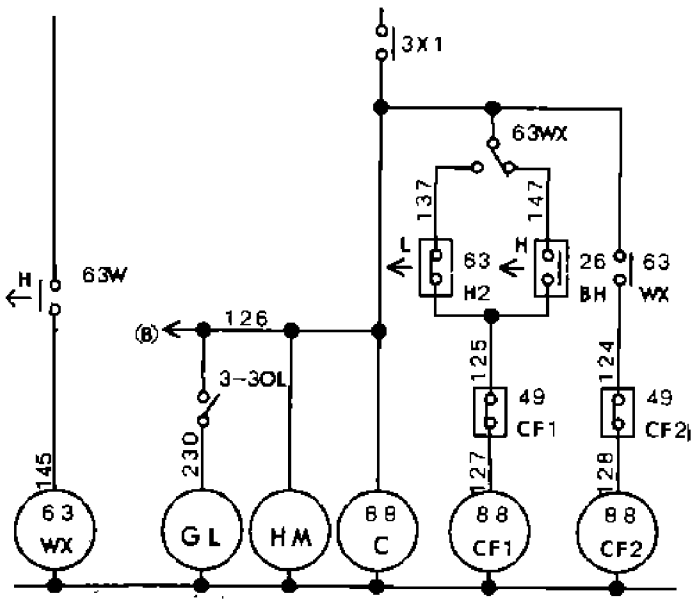
2.2 Air cooled and water cooled operation

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

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

● **Water cooled operation**

When cooling water is supplied to the water cooled condenser and water pressure higher than the predesigned one is put on the condenser inlet, the contact points of the water pressure switch (63W) are cut out, the magnetic contactors for condenser fans (88CF1, 88CF2) are turned off, the condenser fan motors stop, and water cooled operation starts.



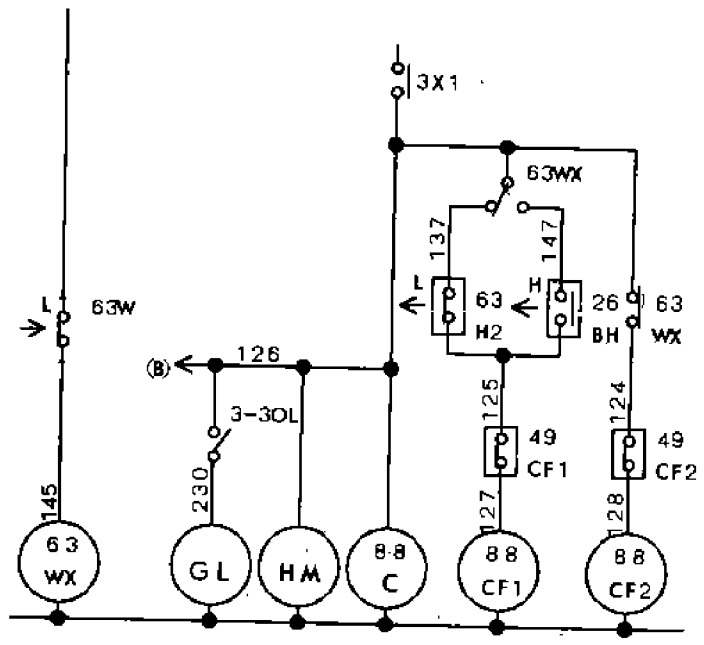
Note :

Note that the condenser fan on the left may sometimes operate to cool the control box during water cooled operation.

When temperature in the switch box rises, the thermostat (26BH) in the switch box is turned on, the magnetic contactor for condenser fan (88CF1) is turned on, and the condenser fan starts.

● **Air cooled operation**

When cooling water supply is suspended, the contact point of the water pressure switch (63W) come in contact, the magnetic contactors for condenser fans (88CF1, 88CF2) are turned on, the condenser fan motors rotate, and air cooled operation starts.



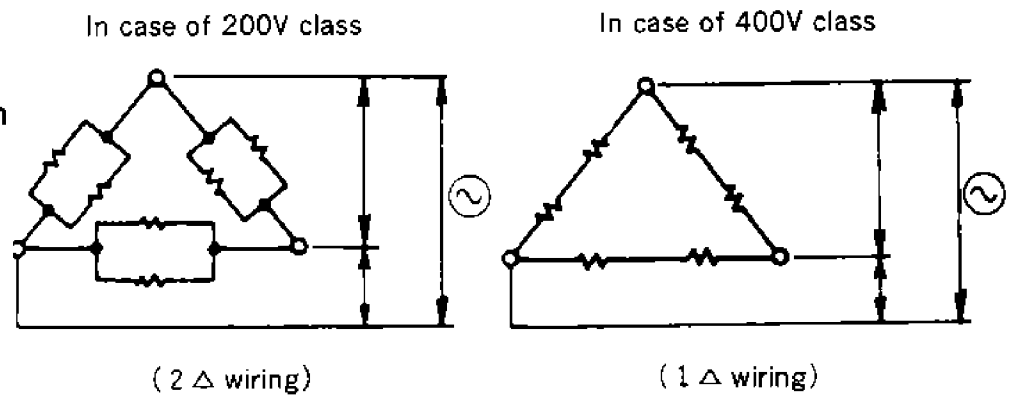
● **High pressure control**

When ambient temperature drops during air cooled operation, condensing pressure (high pressure) drops accordingly.

In addition, low pressure drops in accordance with condensing pressure drop and cooling capacity reduces. In order to prevent high pressure from dropping, the high pressure control pressure switch (63H2) is installed to turn off the magnetic switch (88CF1) for condenser fan when high pressure drops lower than 7 kg/cm². So one of the condenser fan (MF2-1) stops automatically, which prevents high pressure from dropping.

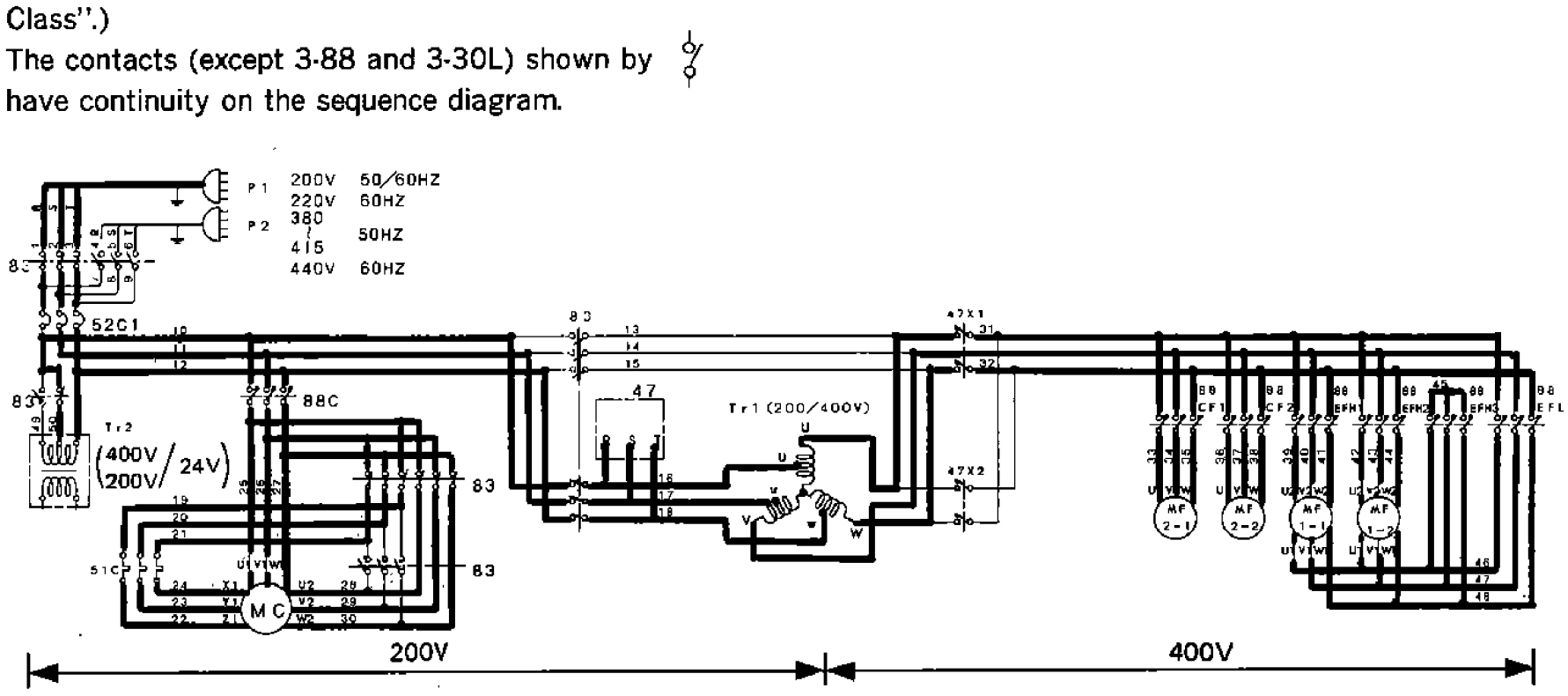
2.3 Voltage selection system (Change-over for 200V/400V class)

(1) The dual rating system is adopted to the compressor motor and the transformer method to the fan motor of the units. Turn the lever of the voltage selector switch (multi-contact cam switch) manually in accordance with the power supply available to change the wiring of the transformers of each motor and the control circuit suited for respective power supply. The internal wiring of the dual rating system in the compressor is as shown on the right.

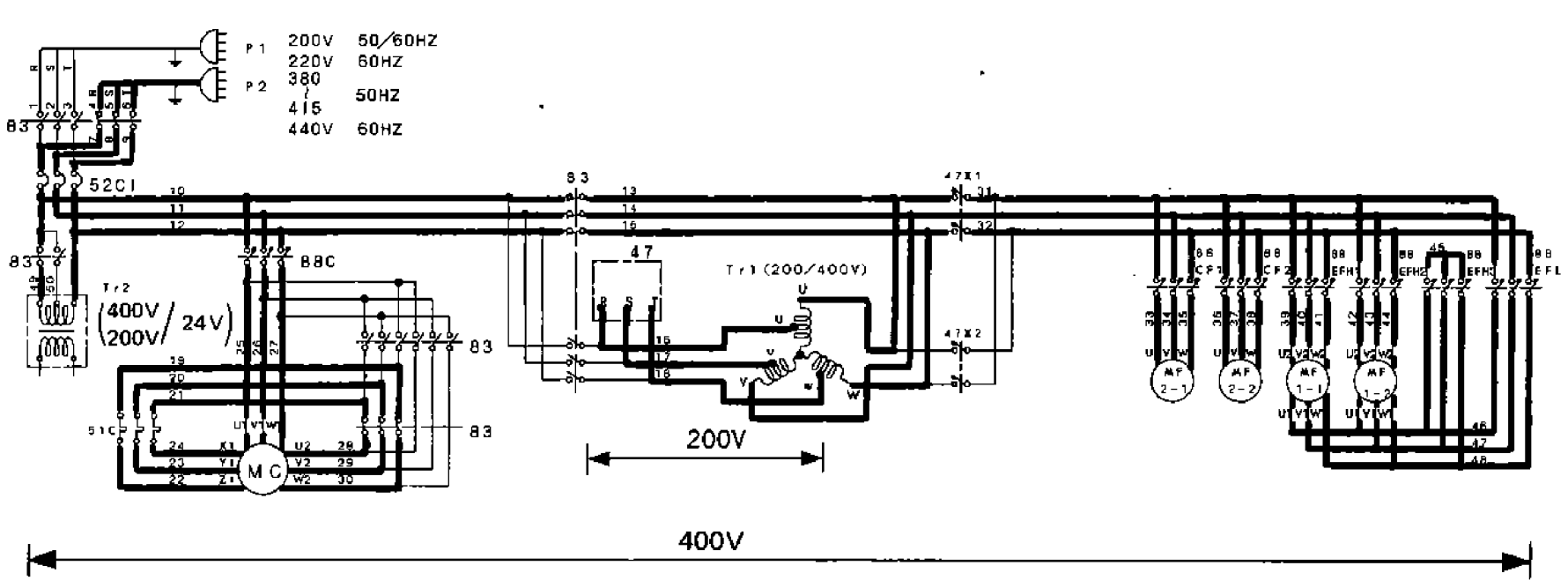


(2) Circuitry

○ In case of 200V class (Set the selector lever to "200V Class".)
The contacts (except 3-88 and 3-30L) shown by ⚲ have continuity on the sequence diagram.



○ In case of 400V Class (set the selector lever to "400V Class".)
The contacts shown by ⚲ have continuity on the sequence diagram and form the 400V class circuit.

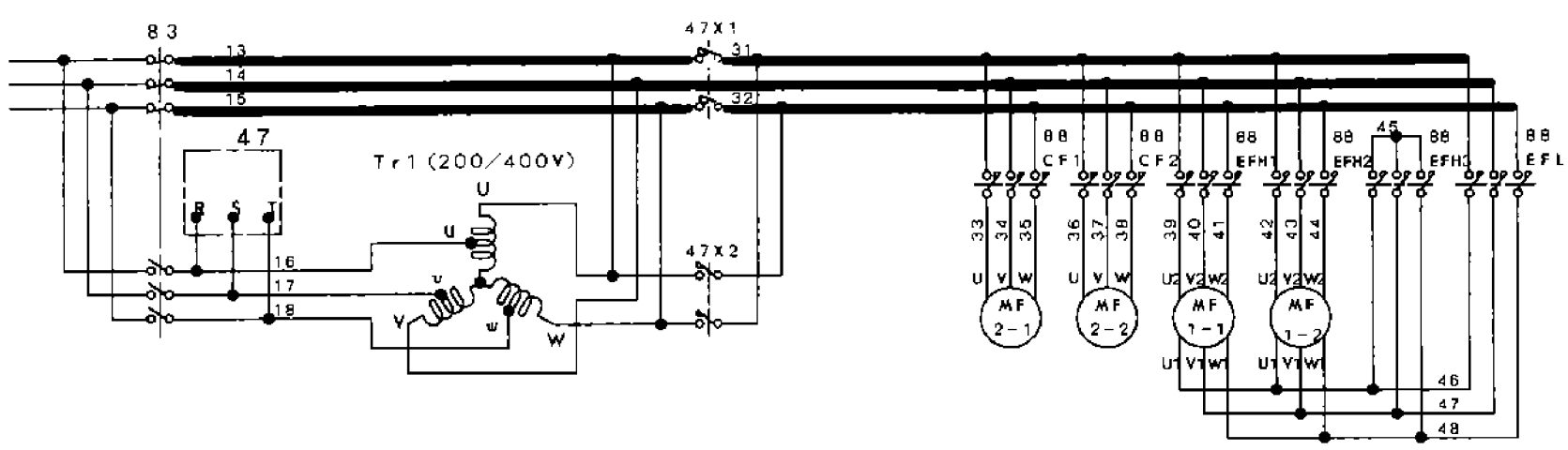


(3) Phase selection
The reversible method is adopted to the compressor and the proper phase selection method to the fan motor of the units.

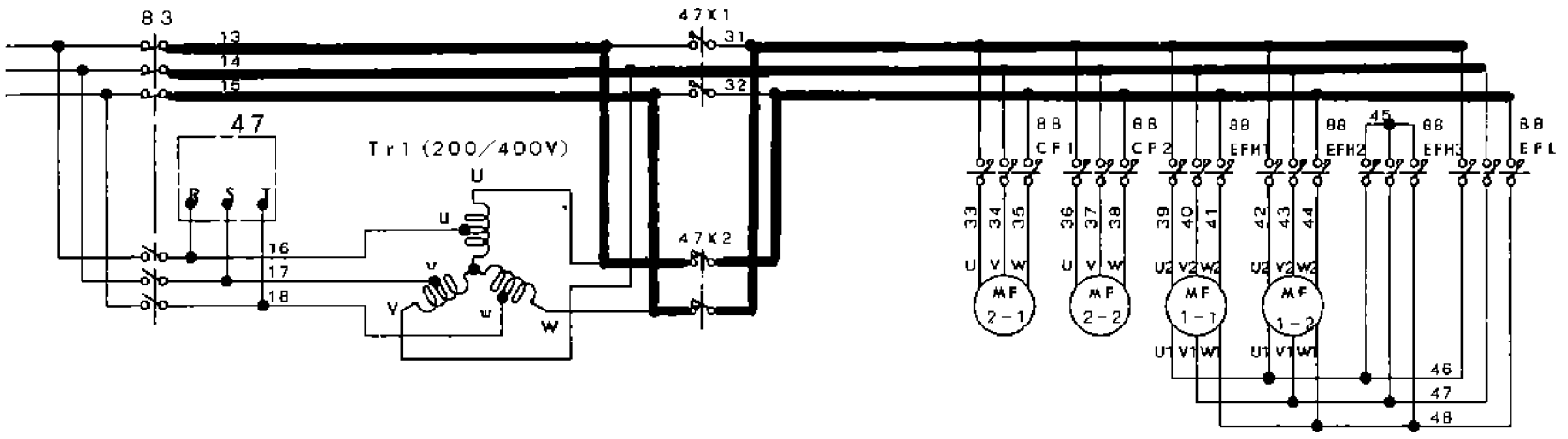
○ Compressor
The hydraulic pump adopted is a reversible trochoid pump, so the predesigned oil pressure can be obtained regardless of turning direction of the built-in motor.

○ Fan motor
The phase sequence controller adopted exchanges R phase with T phase automatically in case of wrong phase.
47: phase sequence controller
47X1・2: Magnetic switches for phase change-over

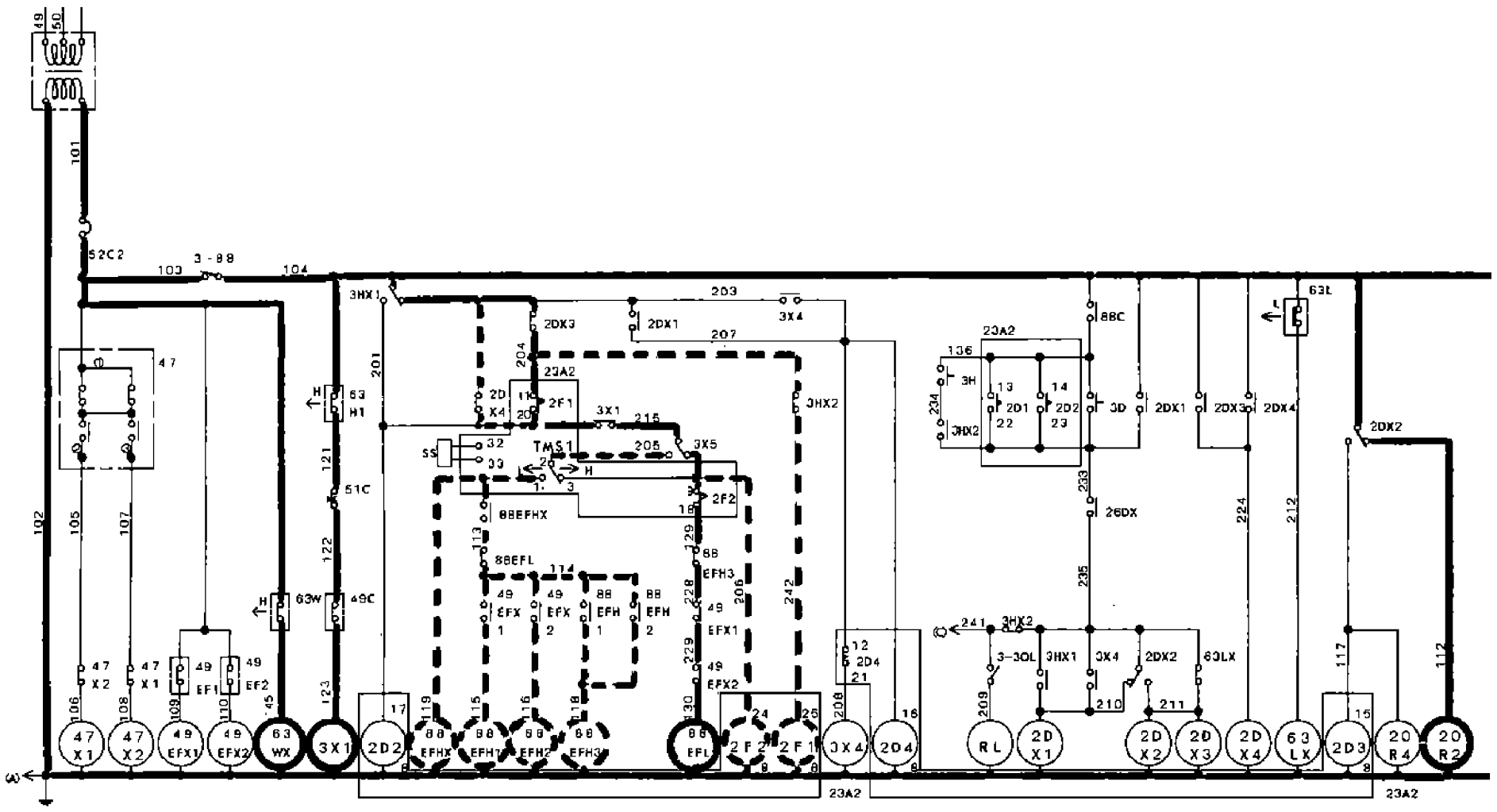
● Proper phase

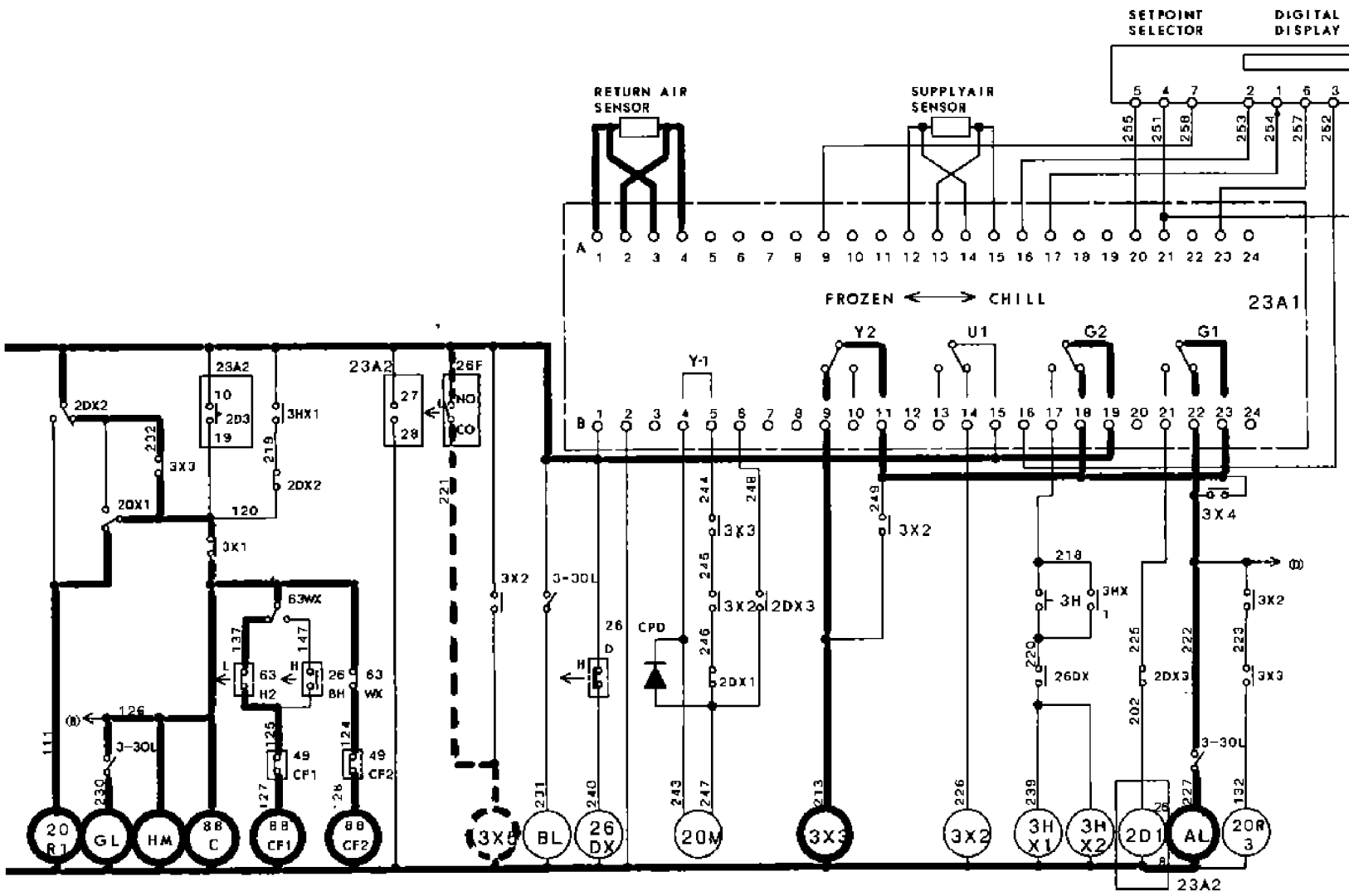


● Wrong phase



2.4 Frozen operation





In case temperature setting is below −5.1°C (+22.8°F), the frozen operation circuit is automatically formed by the function of the electronic controller (23A1). During frozen operation mode, the compressor operates on and off, sensing return air temperature of the evaporator.

(1) When the power supply switch (3-88) is turned on,

- The pilot lamp for power supply (BL, Blue) lights up.
- The fan will operate 10 seconds later by the function of the delay timer (2F2) (only during operation with low fan speed)
- In case return air temperature is higher than temperature setting, the compressor starts.
- At the same time as the compressor starts, the pilot lamp for compressor (GL, Green) lights up, condenser fans (MF2-1, MF2-2) start, liquid solenoid valves (20R1, 20R2) are open.

(2) As inside temperature drops, the electronic controllers (23A1, 23A2) control operation as stated below.

Ⓐpoint··· When supply air temperature of the evaporator reaches to +15°C (+59°F), speed of the evaporator fans (MF1-1, MF1-2) is changed from low to high by TMS1 of 23A2.

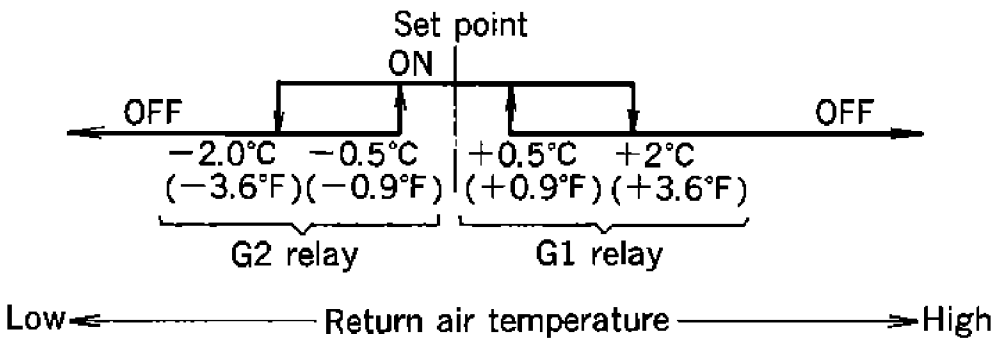
Ⓑpoint··· When return air temperature of the evaporator reaches to −10°C (+14°F), speed of the evaporator fans is changed from high to low by the fan speed change-over thermostat (26F).

Ⓒpoint··· When return air temperature reaches to temperature setting +0.5°C (+0.9°F), the lamp for in range (AL, Amber) lights up by G1 of 23A1.

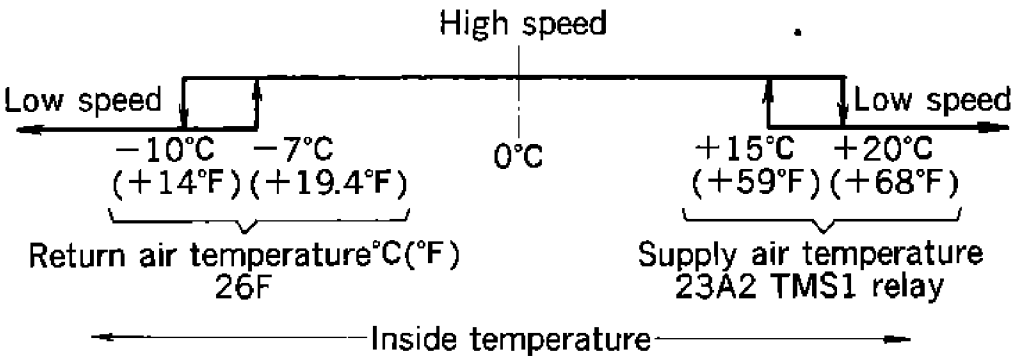
Ⓓpoint··· When return air temperature reaches to temperature setting $-t_2$°C, Y2 of 23A2 is turned off and the compressor stops.
At the same time as the compressor stops, the pilot lamp for compressor (GL, Green) goes off, condenser fans (MF2-1, MF2-2) stop, and the main liquid solenoid valve (20R1) is turned off.

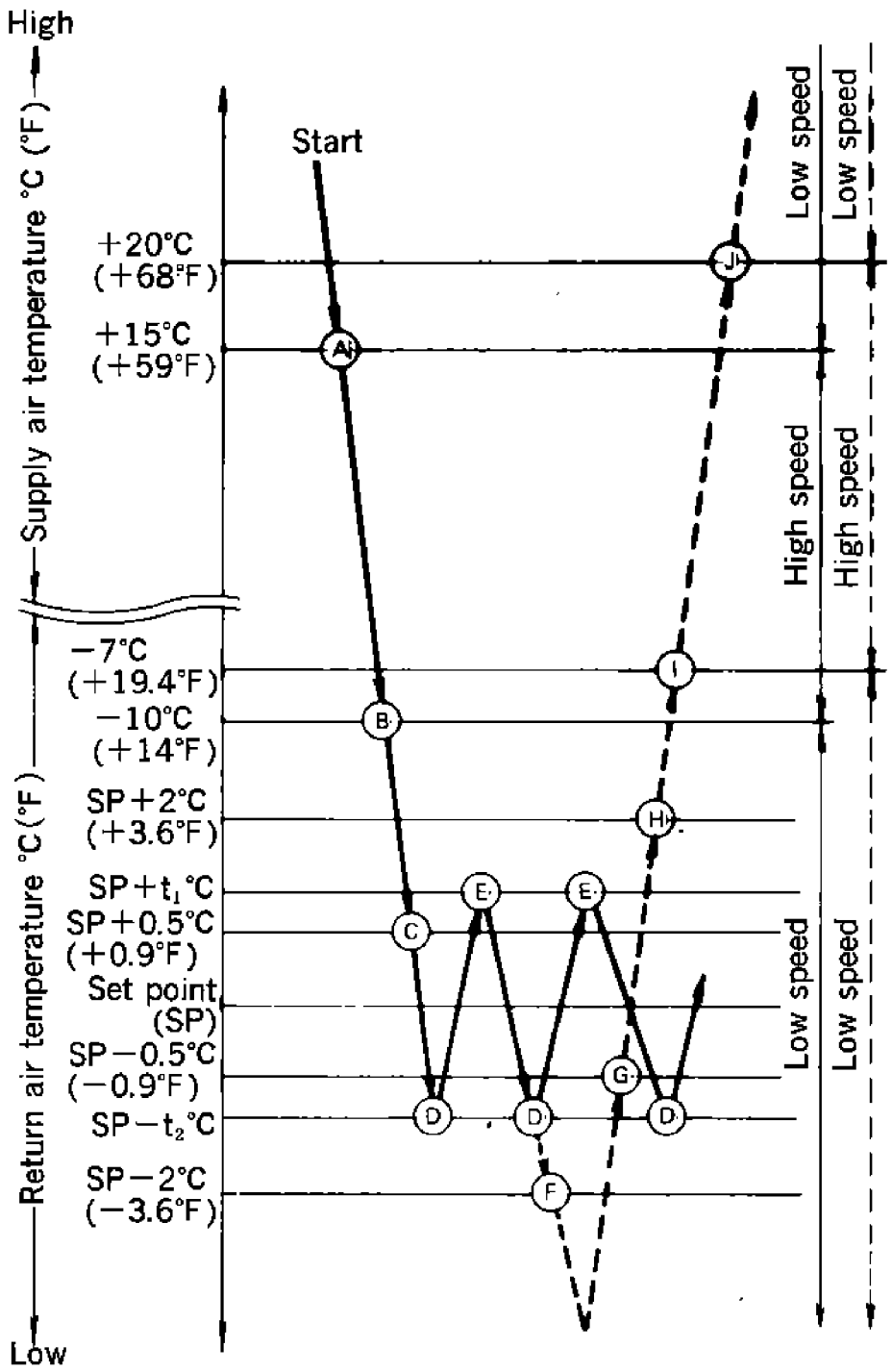
Ⓔpoint··· When return air temperature reaches to $+t_1$°C as inside temperature is rising, Y2 of 23A1 is turned on, the compressor and condenser fans operate, the pilot lamp for compressor (GL, Green) lights up, and the main liquid solenoid valve (20R1) is turned on.

(3) The lamp for in range lights up or off by G1 and G2 of 23A1, sensing return air temperature.



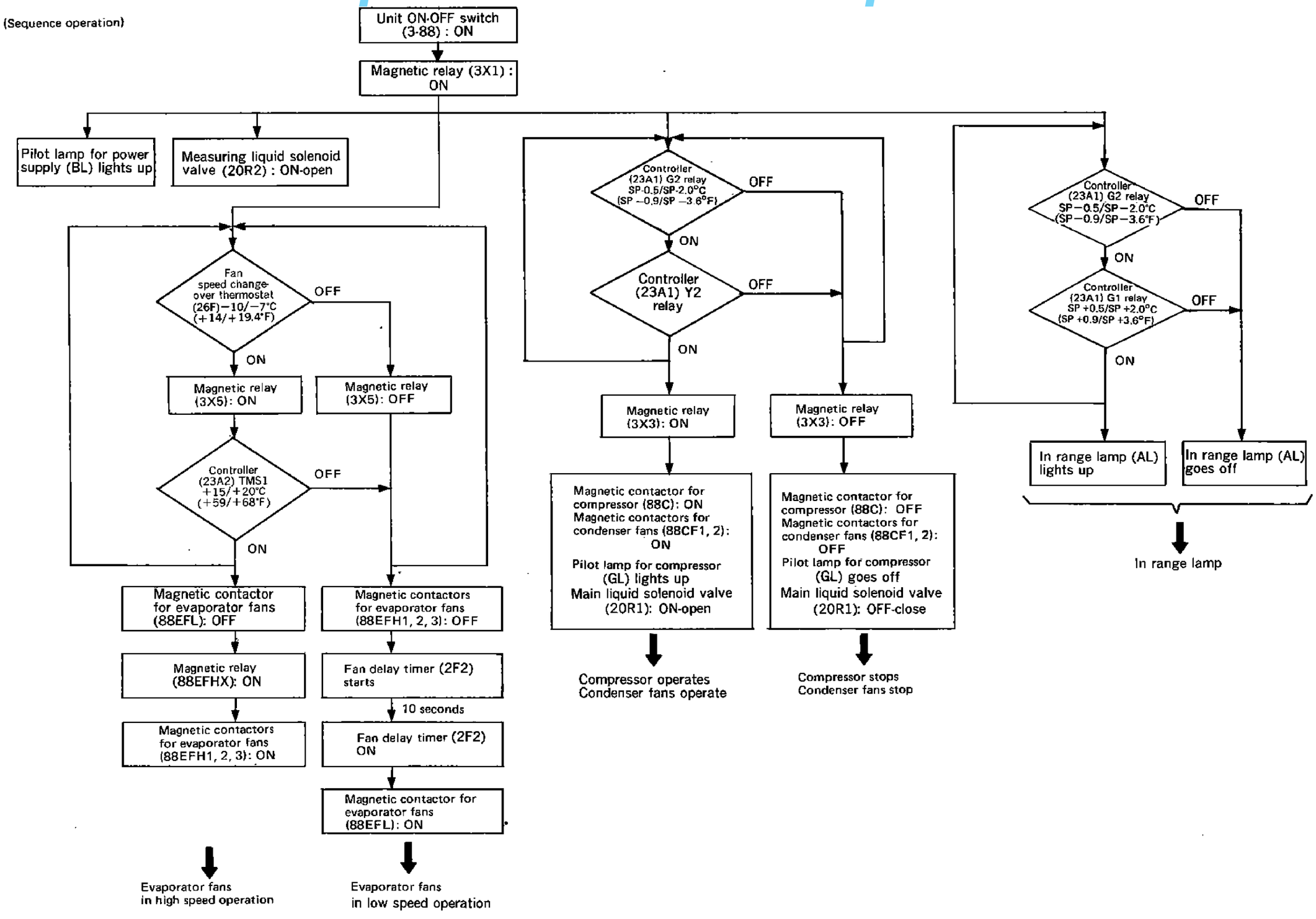
(4) Speed of the evaporator fans is changed from high to low and vice versa with the electronic controller (23A1) and fan speed change-over thermostat (26F).



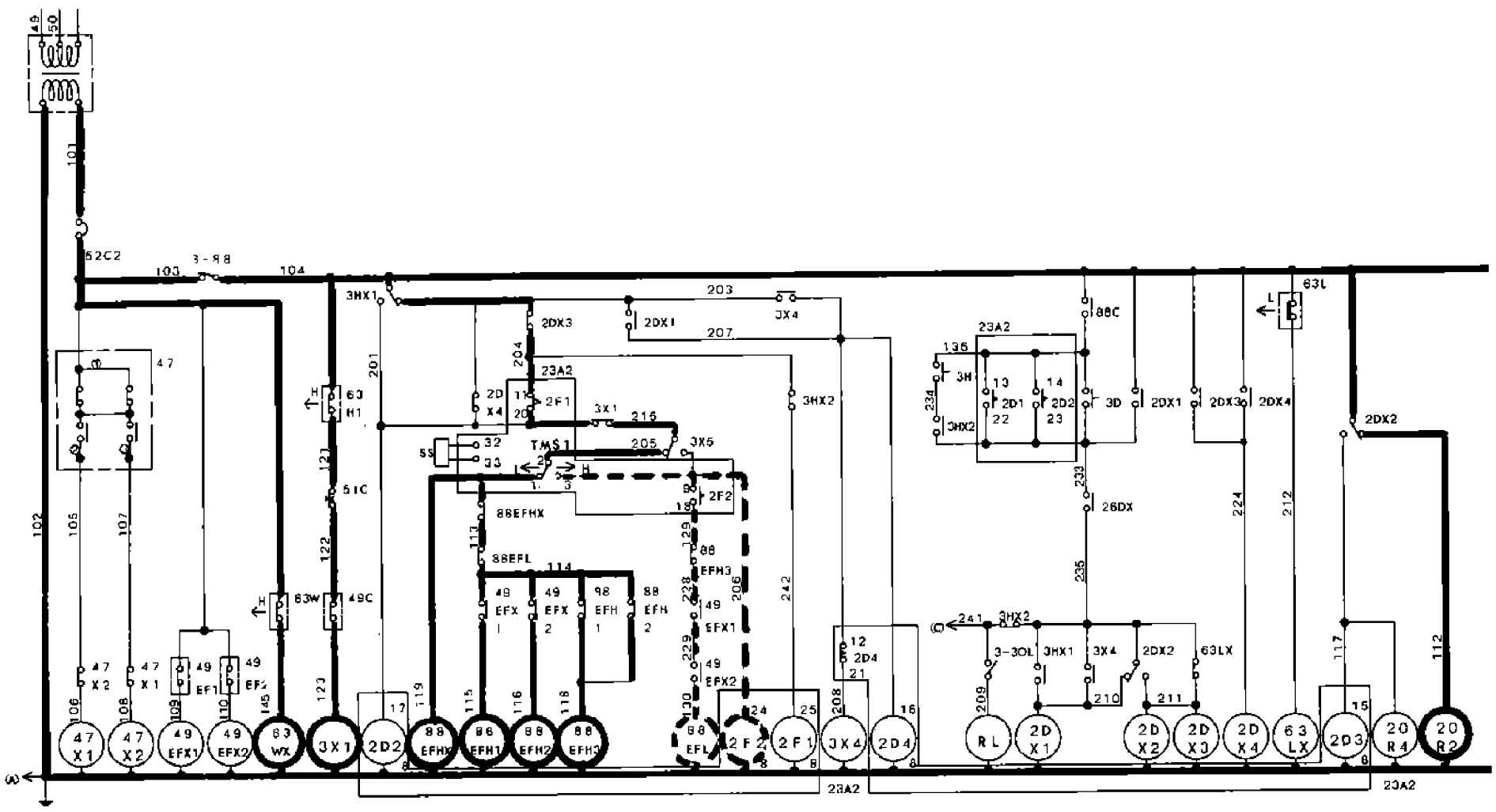


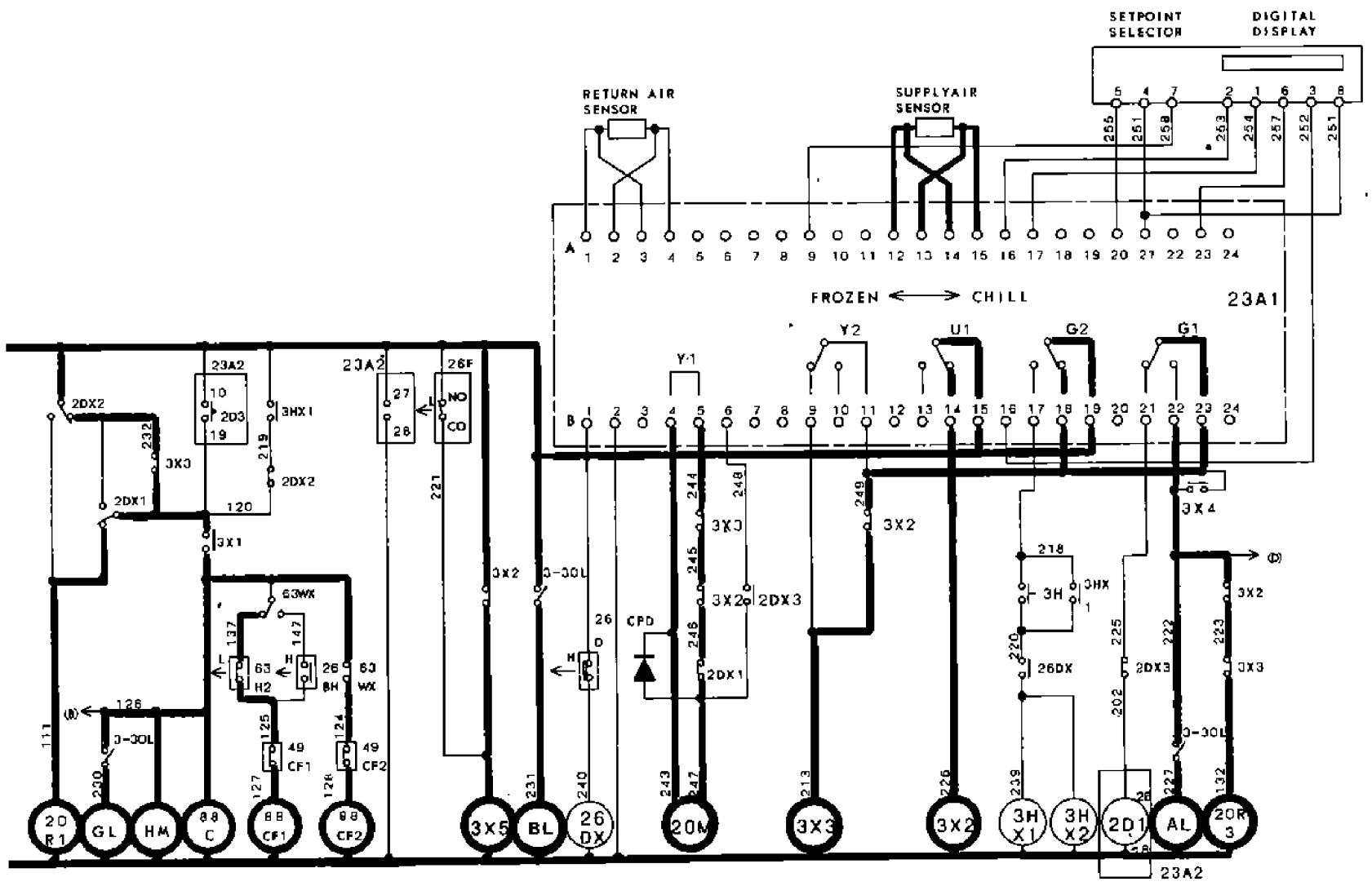
Note t_1 and t_2 °C (point of Y_2 relay function) are determined depending on temperature and time by means of P. I. D. (P: proportional action, I: integrl action, D: derivative action) of the controller

(Sequence operation)



2.5 Chilled operation-capacity control





When temperature setting is above −4.5°C (+23.9°F), the chilled operation circuit is automatically formed by electronic controller (23A1, 23A2).
During chilled operation mode, capacity control operation is performed by means of hot-gas bypass with the modulating valve (20M), sensing supply air temperature of the evaporator and liquid control with the equalize 3-way solenoid valve (20R3).

(1) When the power supply switch (3-88) is turned on,

- The pilot lamp for power supply (BL, Blue) lights up.
- The fan will start 10 seconds later by the function of the delay timer (2F2) (only during operation with low fan speed)
- In case return air temperature is higher than temperature setting, the compressor starts.
- At the same time as the compressor starts, the pilot lamp for compressor (GL, Green) and the condenser fans (MF2-1, MF2-2) start, and the main and measuring liquid solenoid valves (20R1 and 20R2) are open.

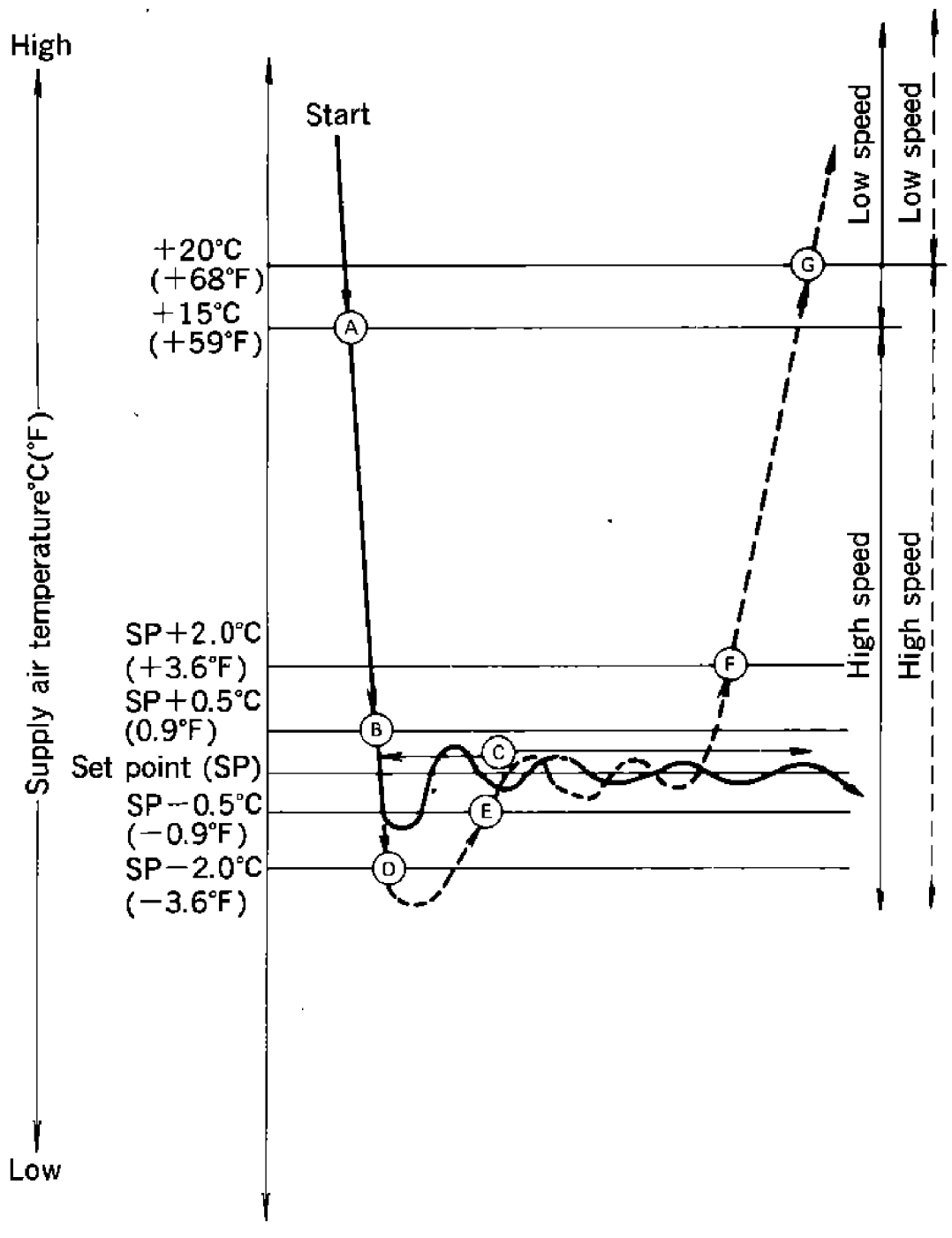
(2) As inside temperature drops, the electronic controllers (23A1, 23A2) control operation as stated below.

Ⓐpoint··· When supply air temperature of the evaporator reaches to +15°C (50°F), speed of the evaporator fans (MF1-1, MF1-2) is changed from low to high by TMS1 of 23A2.

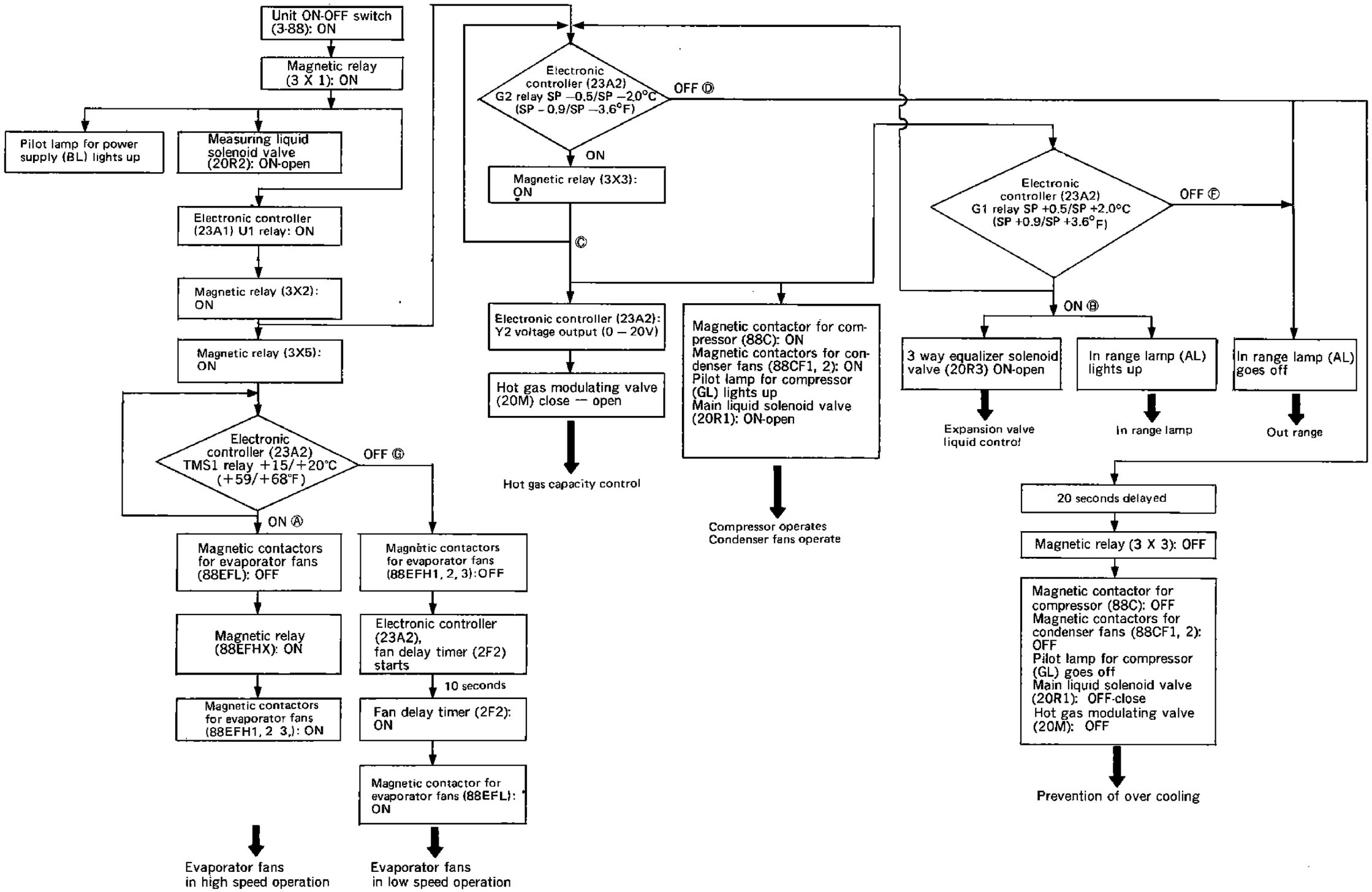
Ⓑpoint··· When return air temperature reaches to temperature setting +0.5°C (+0.9°F), the lamp for in range (AL, Amber) lights up with G1 of 23A1. At this temperature, the equalize 3-way solenoid valve (20R3) is turned on, and capacity control operation begins by means of liquid control by depressing hot-gas outlet pressure on the equalize port of the expansion valve.

Ⓒpoint··· As supply air temperature is approaching to temperature setting, Y1 voltage rises gradually from 0, the modulating valve (20M) starts opening, and capacity control of the hot-gas bypass begins.
It takes time to stabilize operation (opening of 20M; i.e. bypass amount becomes stable) since controlled air temperature has reached to temperature setting. (Such period differs more or less with temperature setting and ambient temperature.) During such period, the valve changes its opening degree (amount of hot gas) gradually and will stabilize operation.

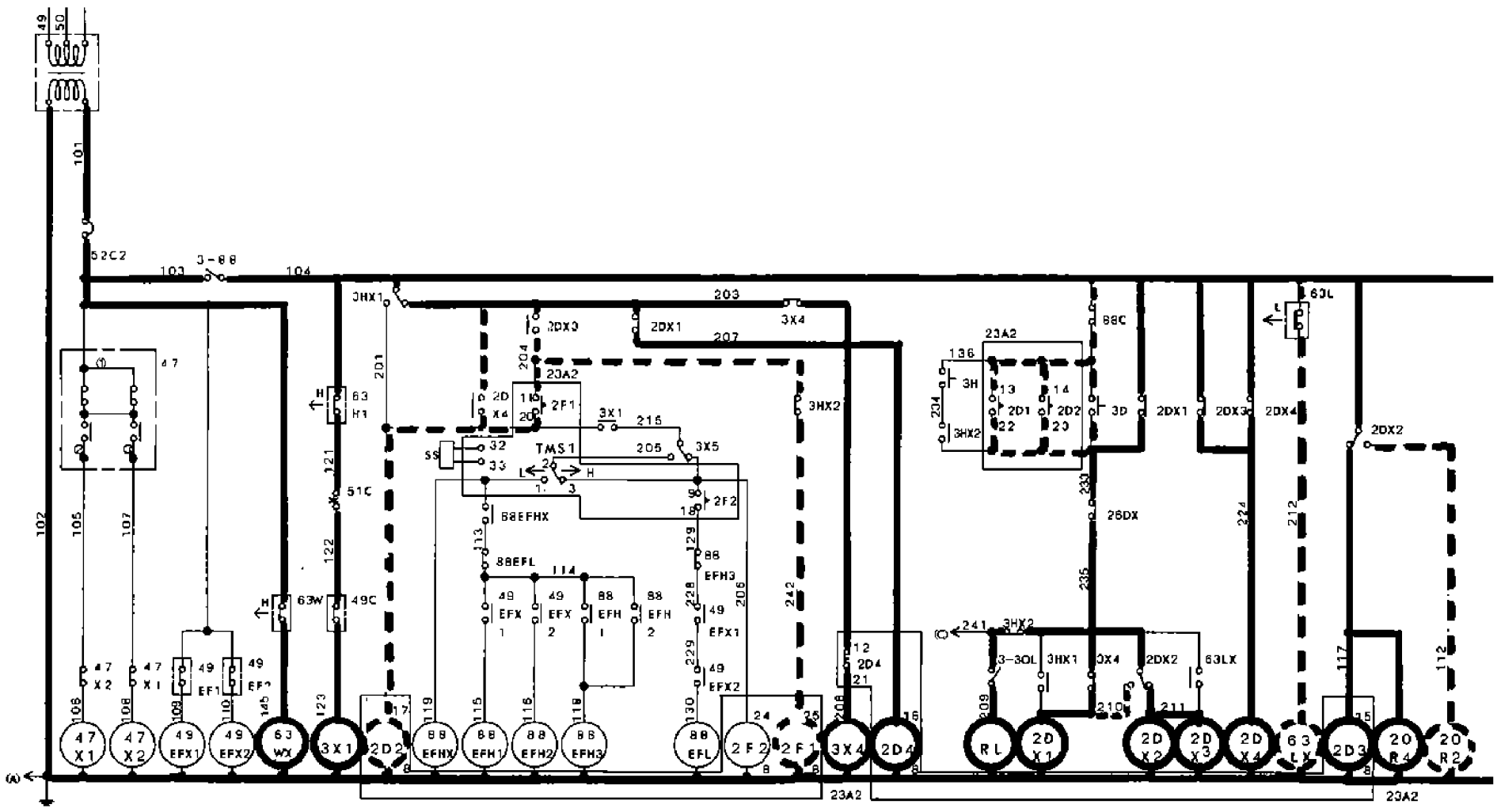
Ⓓpoint··· Depending on operating conditions (such as when the difference between the ambient and set point is small), G_2 relay is turned off and lamp AL goes out (after a delay of approximately 20 seconds) if the supply air temperature drops to 2°C(3.6°F) below set point before stabilizing (low limit alarm).
At the same time, 2X3 relay is turned off ; 20R1 and 20M are closed, the compressor stops to prevent over-cooling.

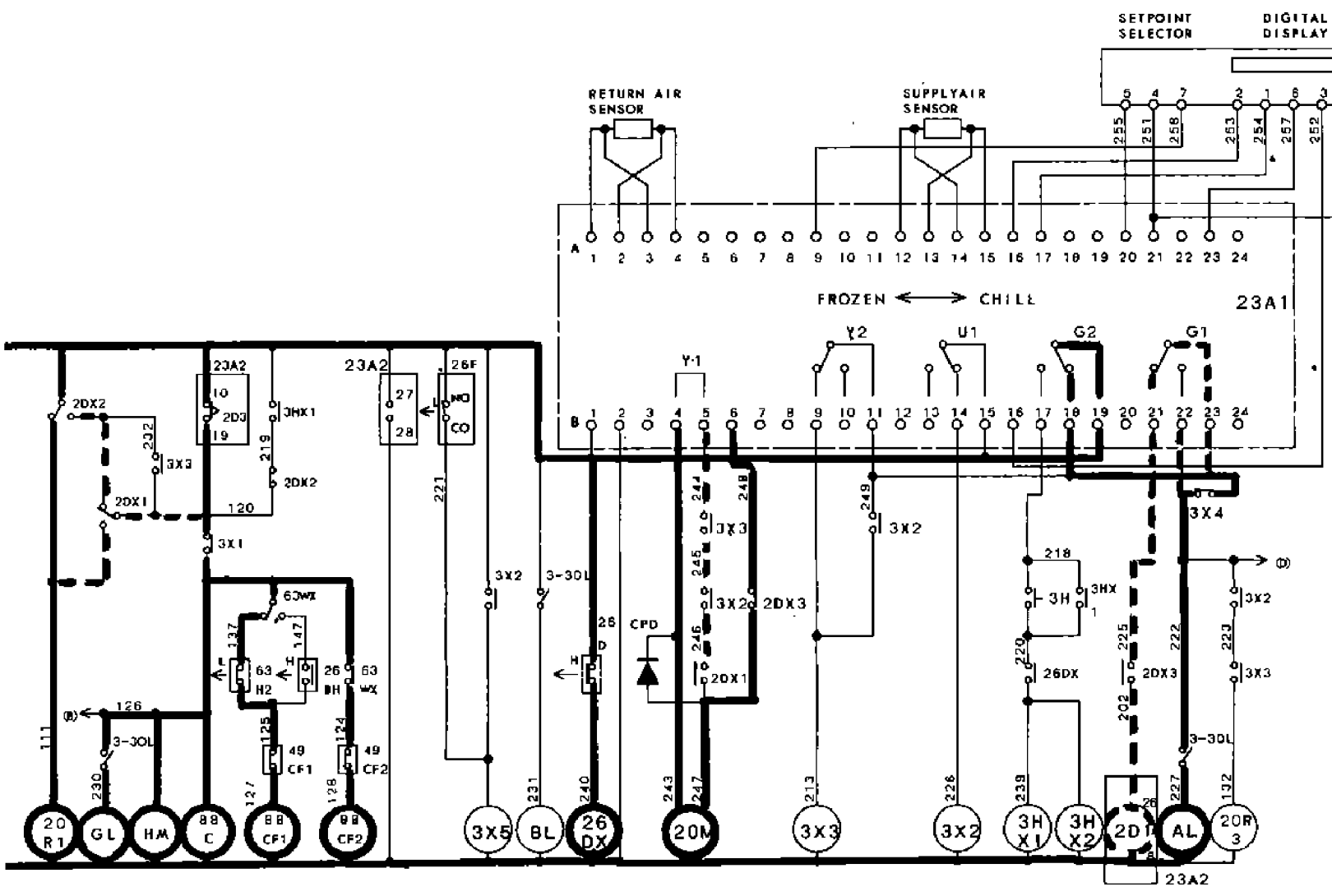


(Sequence operation)



2.6 Defrost operation





The hot-gas defrost system is adopted in the units; i.e. the high temperature and high pressure refrigerant (hot gas) from the compressor is sent to the evaporator and drain pan for defrosting. Since the evaporator is heated directly by the hot refrigerant in the evaporator, defrosting can be performed effectively.

(1) Defrosting starts
The dual timer method and manual switch method are adopted to start defrosting.

(a) Dual timer method

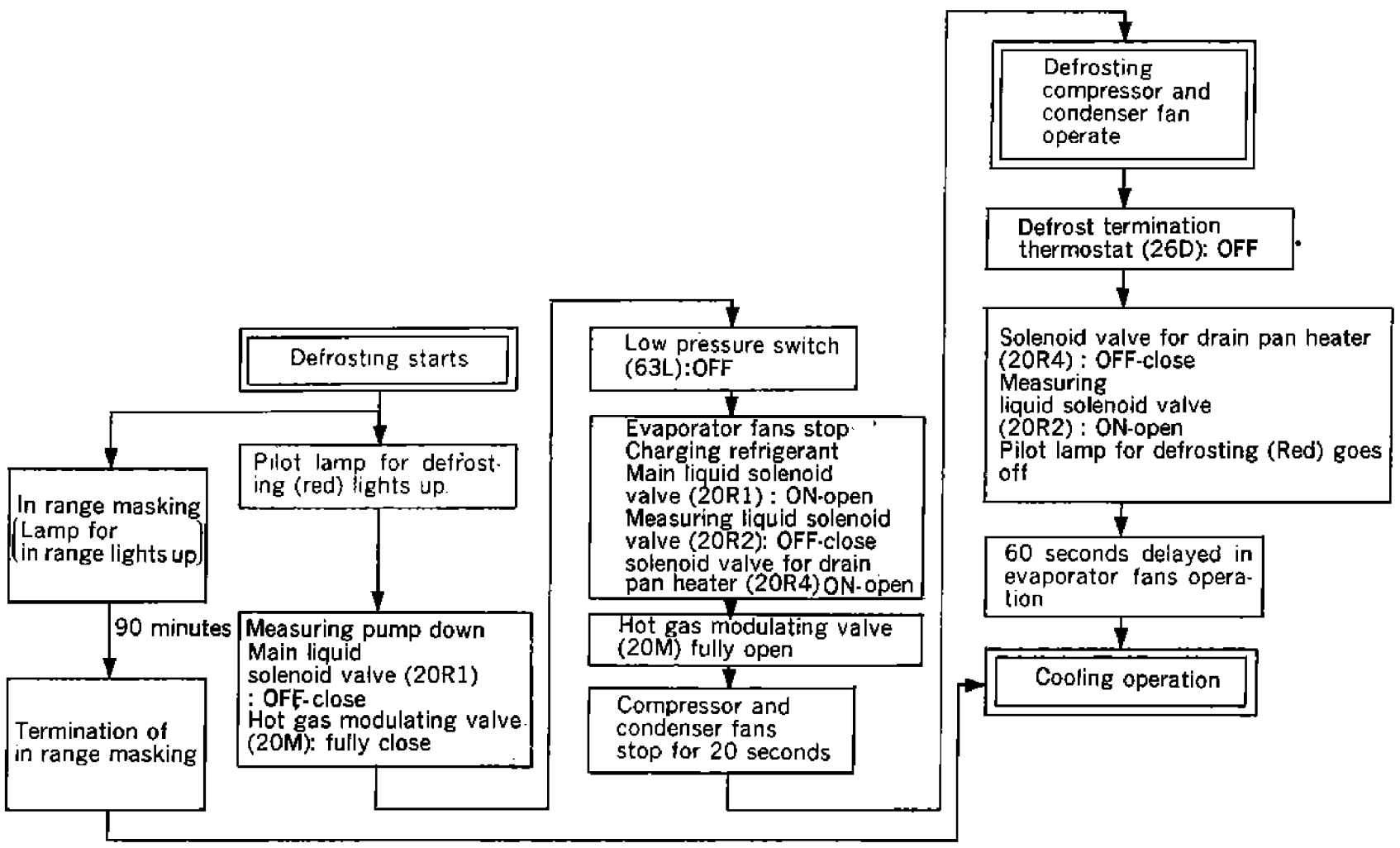
○ Short-cycle defrosting
During the time when return air temperature drops to in range temperature from pull down operation, defrosting starts every 4 hours by the short timer (2D1) of the electronic controller (23A2).

○ Long cycle defrosting
When return air temperature becomes within in range temperature (in range lamp lights up), defrosting starts every 12 hours by the long timer (2D2) of the electronic controller (23A2).

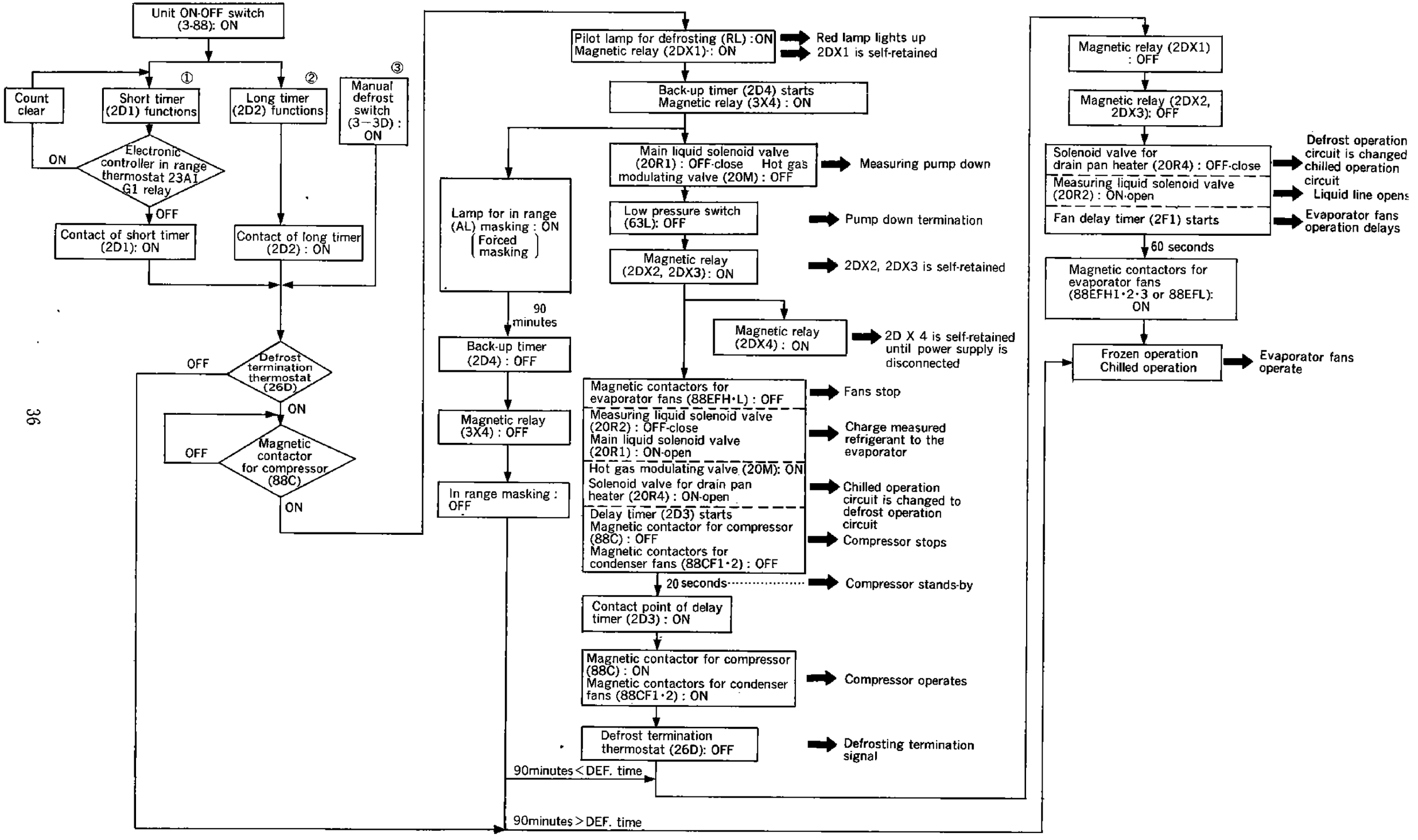
(b) Manual switch method
When the manual defrost switch (3D) is set to "MANUAL", defrosting starts.

(2) Defrost operation
The devices and components operate as shown below during defrost operation

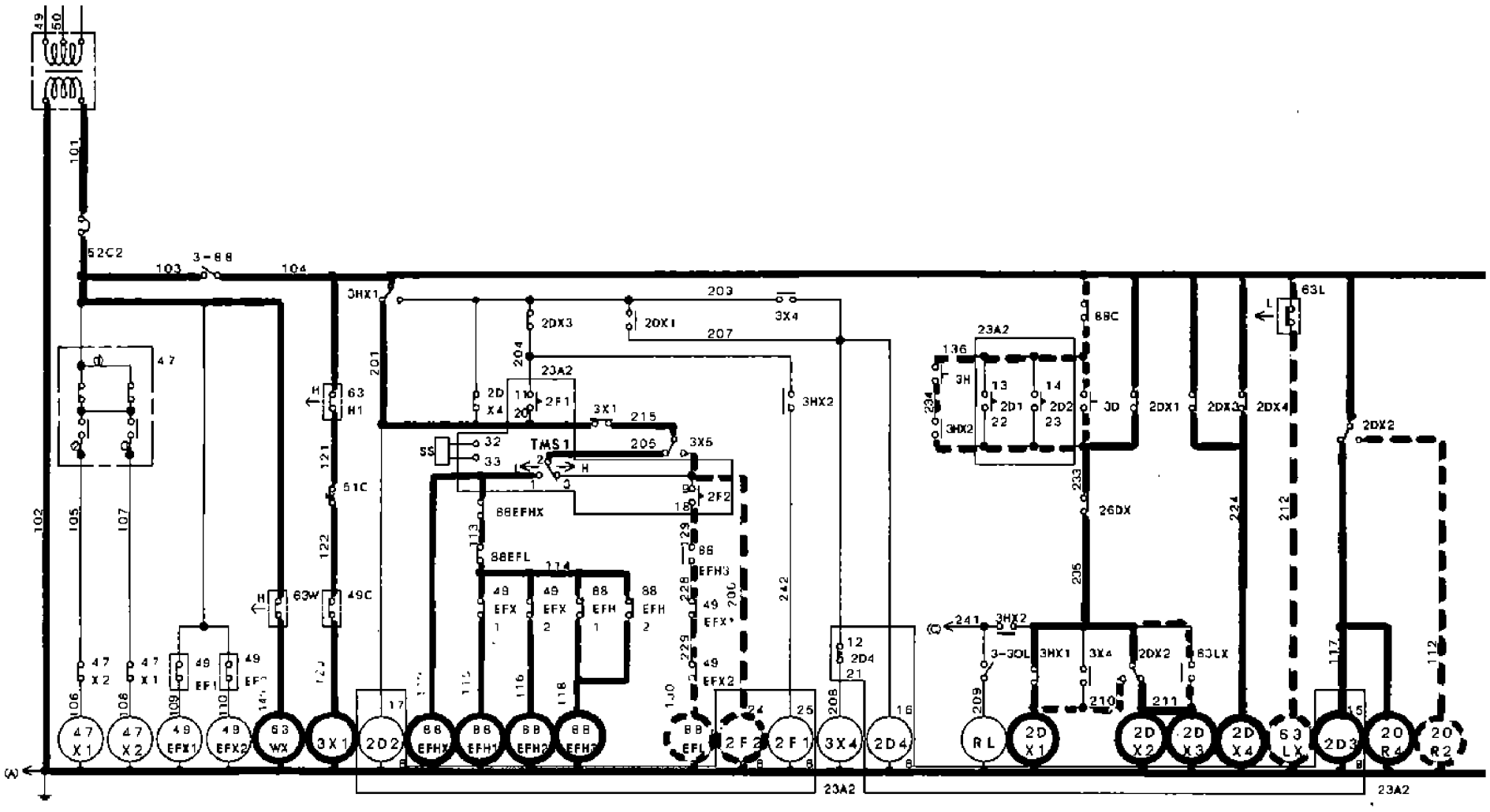
(3) The pilot lamp for in range (AL) lights up forcedly for 90 minutes with the timer since initiation of defrosting.

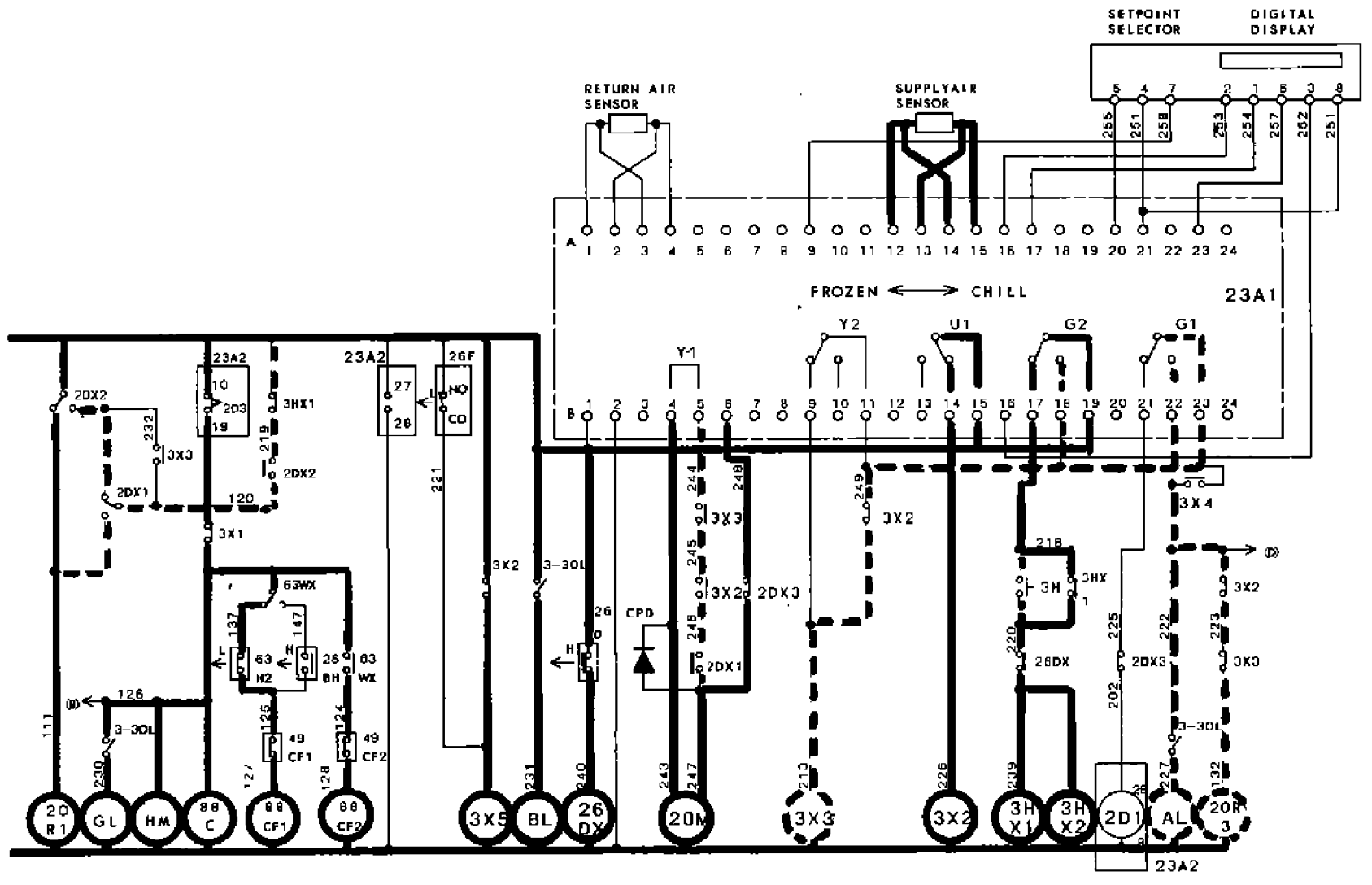


<Sequence operation>



2.7 Heat-up operation



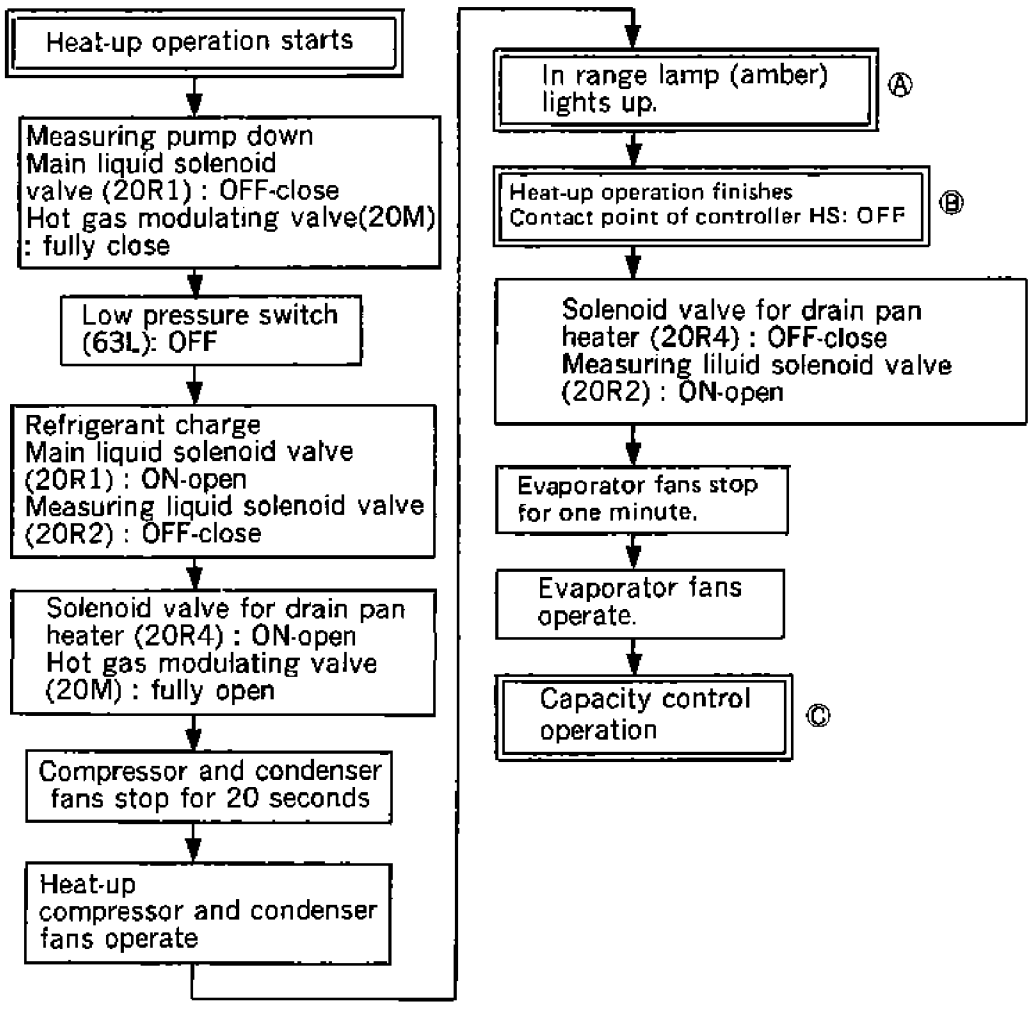


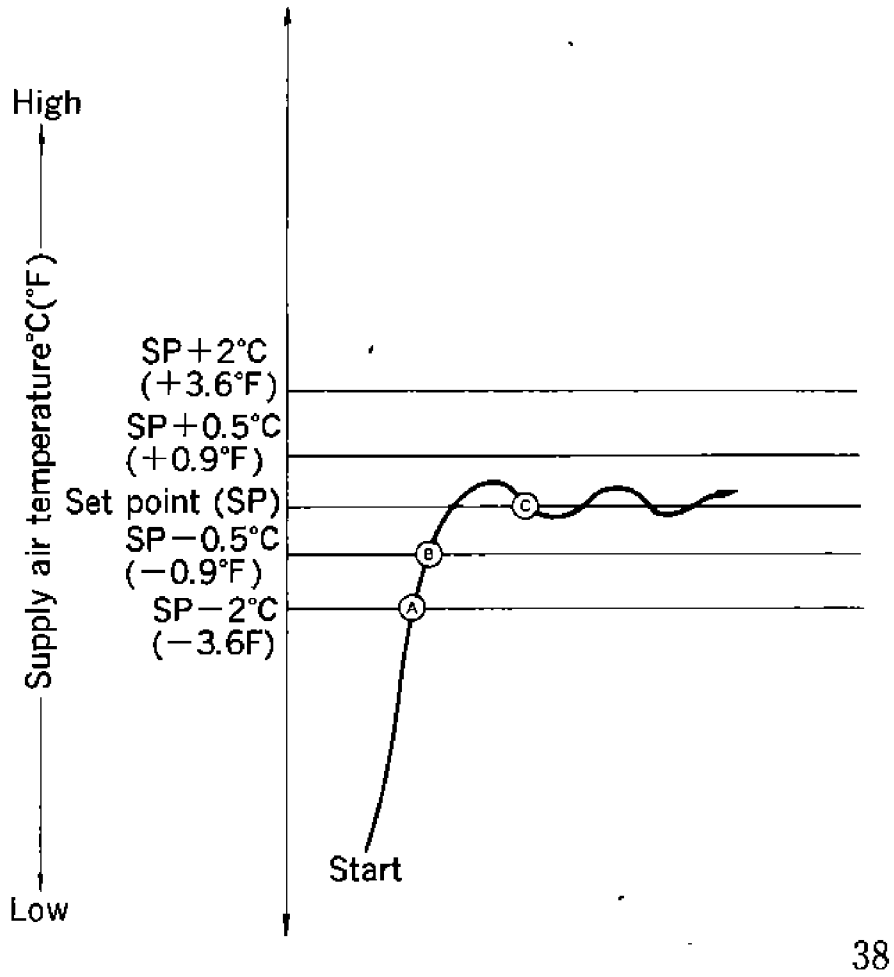
In case the compressor cannot be operated due to the function of the overcooling protector by means of G2 relay of the electronic controller (23A1) during chilled mode, it is possible to perform manual heat-up.
The hot gas heat-up system is adopted in the units; i. e. the high temperature and high pressure refrigerant (hot gas) from the compressor is sent to the evaporator to heat inside air.

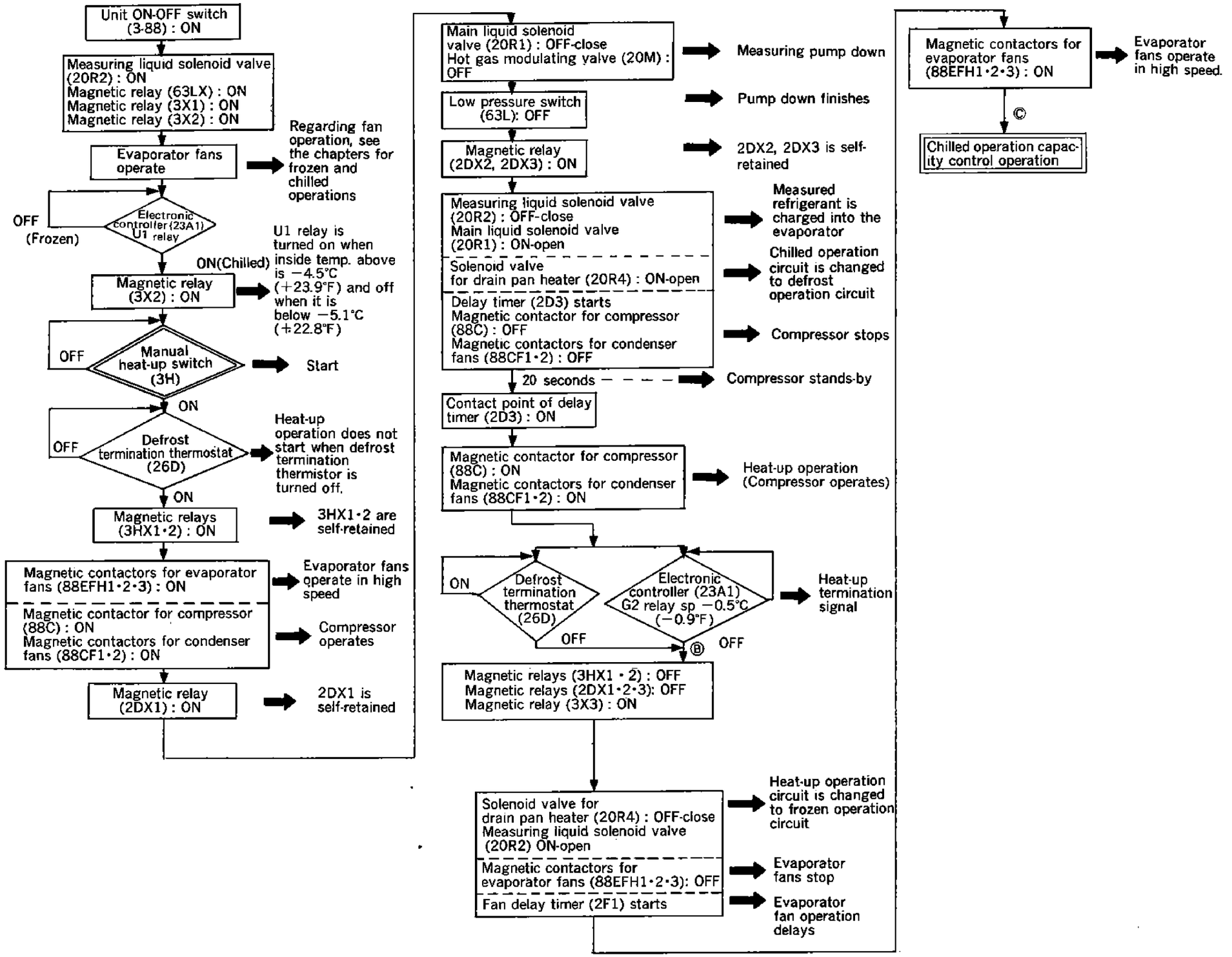
(1) Starting of heat-up
Heat-up is performed only when the controller is set to "chilled mode" (above −4.5°C (+23.9°F)). Heat-up operation starts when the heat-up switch (3H) is set to "ON".

(2) Heat-up operation
The devices and components operate as described on the right during heat-up operation.

(3) After termination of heat-up operation, hot gas capacity control is performed.

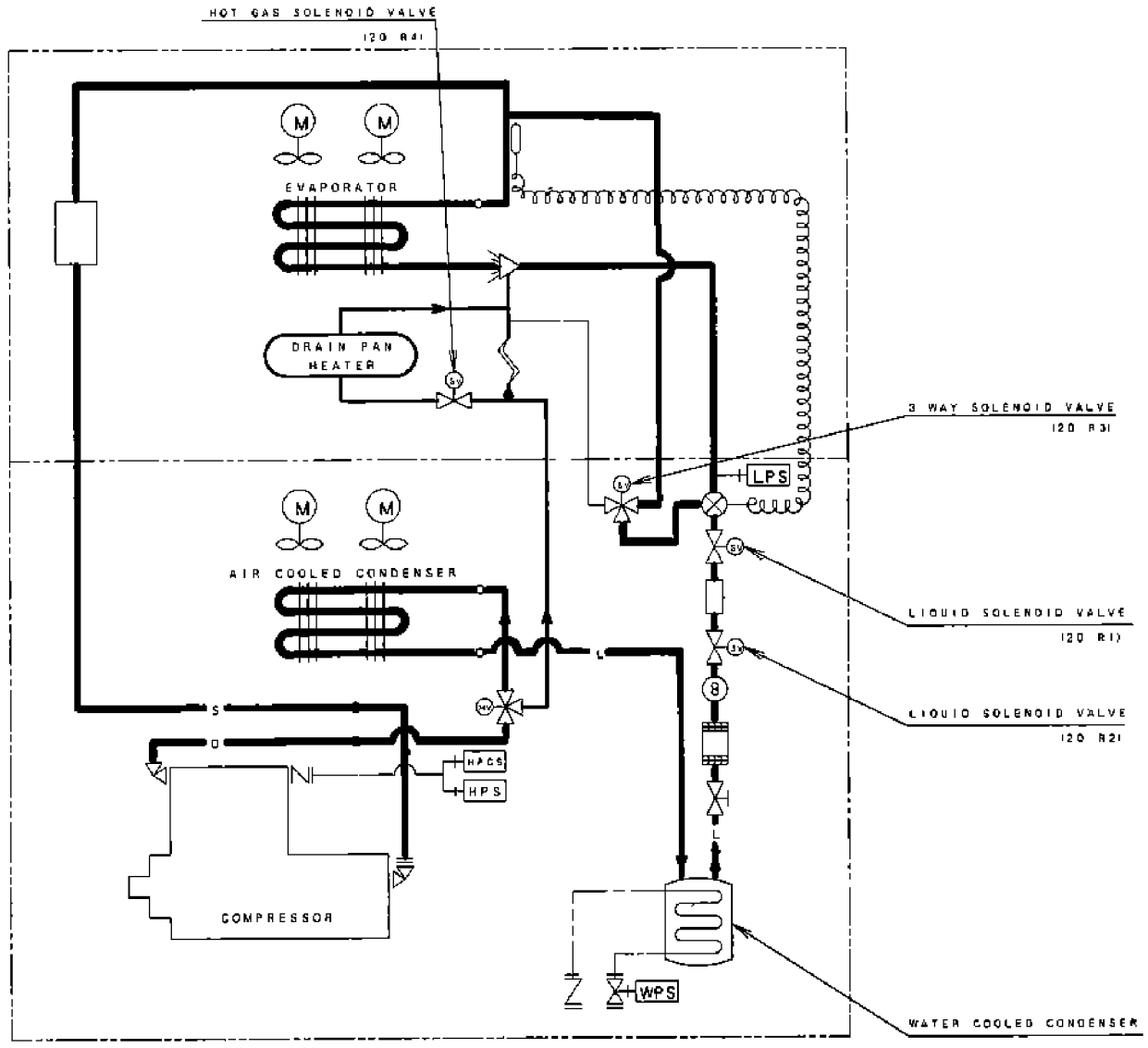




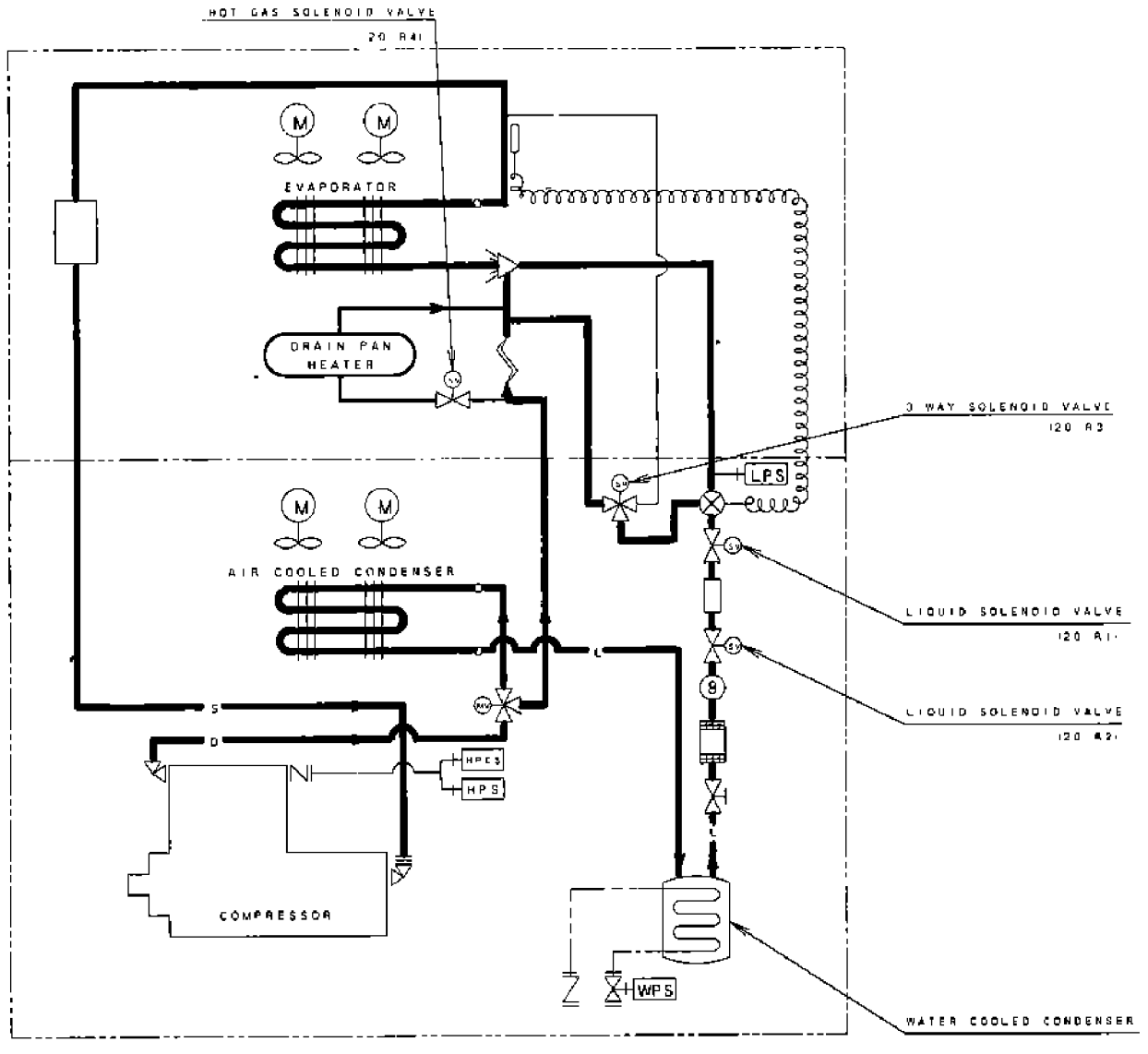


2.8 Refrigerant flow at each operation mode

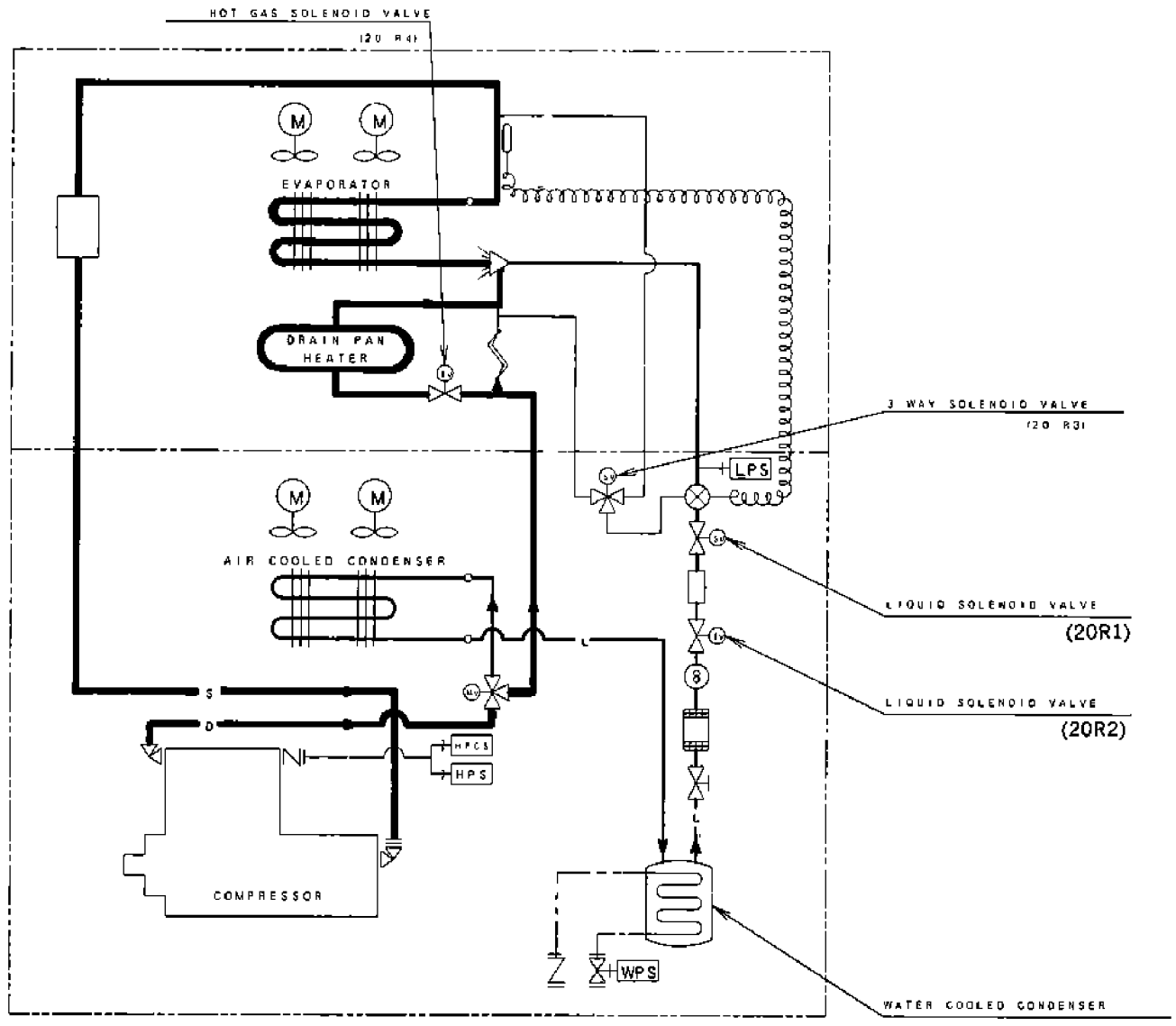
●Frozen operation



●Chilled operation



●Defrost • Heat-up operation

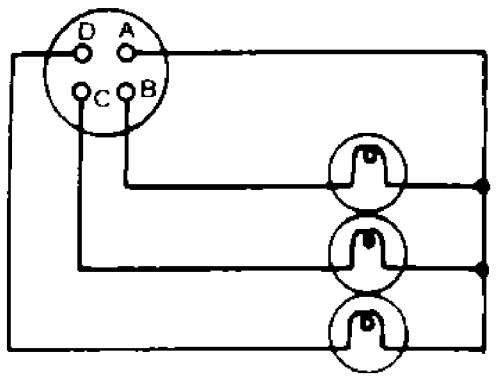


2.9 Pilot lamps and monitoring circuit

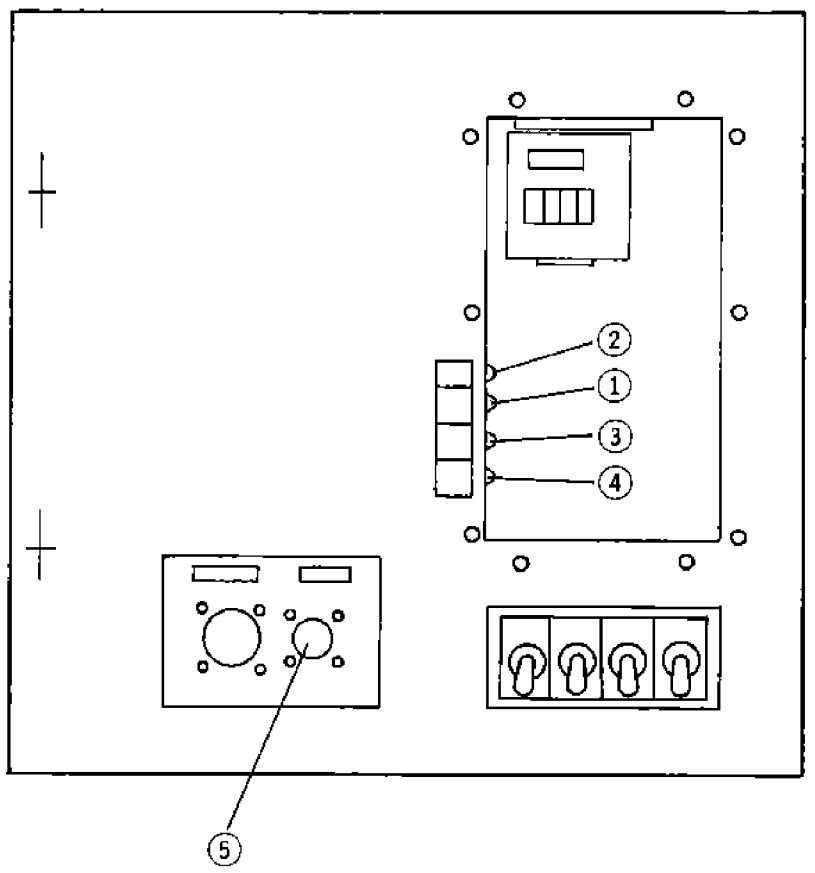
(1) Four lamps which indicate operating mode are mounted on the front panel of the control box.

Red : indicates defrost mode (RL)
Green : indicates that the compressor is running (GL)
Amber : indicates that inside temperature is within range (Within ±2.5°C (±4.5°F) of the preset temperature) (AL)
White : indicates that electrical source is supplied.

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



A : Earth
B : Compressor (Green)
C : Defrost (Red)
D : In range (Amber)



① Red
② Green
③ Amber
④ Blue
⑤ Monitoring receptacle for pilot lamp

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

Names of parts			Temperature setting of chilled mode Above −4.5°C(+23.9°F)			Temperature setting of frozen mode below −5.1°C(+22.8°F)		Defrost	Water cooled operation
			Pull down	In range	Heat-up	Pull down	In range	Operation	
Pilot lamps	Defrost-Red		×	×	×	×	×	○	Water cooled condition is the same as air cooled except ○ Water pressure switch(63W)-open ○ Condenser fan motor(MF2) De-energized ○ According to conditions, one of two condenser fan motors rotates even though water cooled operation
	Comp. ON-Green		○	○	○	○	○or×	○	
	In range-Amber		×	○	×	×	○	○	
Magnetic switches	Compressor capacitor, fan motor(88C)		○	○	○	○	○or×	○	
	Evaporator fan motor in low speed(88EFL)	Supply air temperature below 20°C(68°F) or Return air temperature −10°C(+14°F)	○ or ○	○ or ○	×	○ or ○	○	×	
	Evaporator fan motor in high speed(88EFH)	Return air temperature −7°C(+19.4°F) Supply air temperature 15°C(59°F)			○		×	×	
Solenoid valves	20R1		○	○	○	○	○or×	○	
	20R2		○	○	×	○	○	×	
	20R3		×	○	×	×	×	×	
	20R4		×	×	○	×	×	○	
	20M		×	○	○	×	×	○	
Compressor・MC			○	○	○	○	○or×	○	

Note ○ : **Energized or ON** × : **De-energized or OFF**

3. Trouble and countermeasures

If the unit does not work properly, inspect it in accordance with "Trouble and countermeasures" to find causes of trouble and provide appropriate countermeasures.

Trouble and countermeasures

State	Phenomena	Functioning places	Cause of trouble	Countermeasures
I. Unit does not operate.	A : Evaporator fans, condenser fans and compressor do not operate.	a. No trouble with unit	Electric interruption.	Trace causes of trouble.
			Power plug is not connected to power source receptacle.	Connect power plug to power source receptacle.
		b. Circuit breaker (main circuit) functions	It functions with large current due to short circuit.	Trace causes of trouble
		c. Circuit breaker (control circuit) functions	It functions with large current due to short circuit	Trace causes of trouble
		d. Controller malfunctions.	Sensor is damaged or other reasons.	Replace controller.
	B : Evaporator fans operate. Condenser fans and compressor do not operate.	No trouble with unit	Controller functions to stop the unit.	—
			Setting of set-point selector is high	Adjust setting appropriately.
	C : Compressor only operates, but evaporator and condenser fans do not operate	Phase sequence controller does not functions	Open phase power supply circuit.	Trace a cause of trouble.
			Phase sequence controller is faulty.	Replace faulty phase sequence controller.
II. Unit can operate but stops soon.	A : Condenser fans and compressor stop, keeping evaporator fans in operation.	No trouble with unit	Controller functions and stops unit.	—
	B : Condenser fans and compressor operate on and off. Evaporator fans continue operating.	a. High pressure switch functions.	Refrigerant is over-charged.	Discharge refrigerant.
			Air is intermixed in refrigeration system.	Purge air
			Cooling air volume is short during air cooled operation.	—
			● Condenser is clogged or air passages are blocked.	Clean condenser or remove obstacles
			● Fan blades are damaged.	Repair faulty fan blades or replace them.
			● Fan motor does not rotate.	Check electric wiring.
			Fan motor protective thermostat functions.	Trace causes of trouble.
			Cooling water is insufficent during water cooled operation.	—
			● Condenser is clogged with scale.	—
		b. Over-current relay and compressor protective thermostat function.	Current is excessively large due to over-load operation. Open phase power supply circuit.	Trace causes of trouble.
	C : Condenser fan and compressor operate. Evaporator fan operates on and off.	a. No trouble with unit.	One minute stopping of fan after defrosting.	—
		b. Protective thermostat is activated.	Coil temperature rise due to overcurrent to fan motor.	Trace causes of trouble.

State	Phenomena	Functioning places	Cause of trouble	Countermeasures
III. Inside temp. is low than tempea -ture setting	Compressor does not stop. (In frozen operation)	a. Controller does not function.	Sensor is disconnected	Replace sensor.
		b. Sensor is installed incorrectly.	—	Reattach sensor.
IV. Inside tempera -ture does not drop	Inside temperature does not reach to preset temperature. (Fans and compressor operate.)	a. Solenoid valve does not open.	Solenoid valve is clogged with dust.	Clean solenoid valve or remove obstacles.
		b. Suction pressure is low.	Charged refrigerant volume is short.	Additionally charge refrigerant, find leaking points or repair them.
			Dryer is clogged.	Replace dryer.
			Choked with water.	Replace dryer.
			Gas leaks from feeler tube of expansion valve.	Replace expansion valve.
			Loosening of screws for connection of sensor.	Additional tightening of screws.
V. Water cooled operation is not performed	Fans continue running although water couplings are connected.	Water pressure switch does not function.	Cooling water becomes insufficient. (Piping system is clogged or leaks.)	Trace causes of trouble
			Water leaks to switch	Repair leaking point.

● Trouble and countermeasures for defrosting and heating-up operation.

Read the sequence operation of each operation mode again. If operation does not accord with the sequence operation, take the necessary countermeasures in accordance with the following table.

The red and green pilot lamps light up during defrosting, and the green pilot lamp lights up during heating-up operation.

Phenomena	Functioning places	Causes of trouble	Countermeasures
Compressor stops soon after starting defrosting (heating-up).	No trouble with unit.	Unit stops for 20 seconds by timer.	—
Compressor operates on and off.	High pressure switch and over-current relay functions.	Measuring liquid solenoid valve (20R2) is not closed.	Clean solenoid valve or remove obstacles.
Compressor continues to evacuate for 90 minutes.	Main liquid solenoid valve (20R1) is not opened.	Low pressure switch is faulty.	Replace faulty low pressure switch.
		Wrong wiring for measuring liquid solenoid valve (20R2) and main liquid solenoid valve (20R1).	Check wiring.
It takes 90 minutes to defrost although frost collected is small.	No trouble with unit.	It takes time to defrost because of low ambient temp.	—
	Defrost termination thermistor does not open.	Defrost termination thermistor is faulty.	Replace defrost thermistor.
Frozen operation continues for 13 hours or more and defrosting will not start.	Controller does not function.	Controller is faulty.	Replace faulty controller.
Defrost and frozen operation repeat every 4 hours.	No trouble with unit.	Inside temperature is out of in range temperature.	—

4. PTI (Pretrip 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 — **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	Clamp meter	
	18	Checking operation of controller and pilot lamps	Check with changing temperature setting and check pilot lamps	
	19	Checking operation of defrost initiation air switch (option)	Check with U tube mmH_2O	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		

5. Major components and maintenance

5.1 Components related with refrigeration circuit

5.1.1 Compressor

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

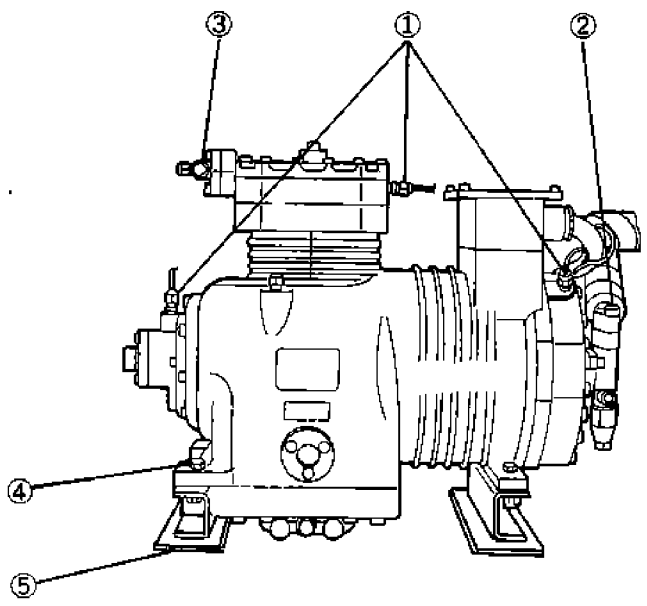
① **Replacement**

Remove the compressor by the following procedure.

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

② **Installing procedure**

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



① Gauge piping flare nut
② Companion flange for compressor suction side
③ Stop valve at compressor dischange side
④ Bolt
⑤ Base

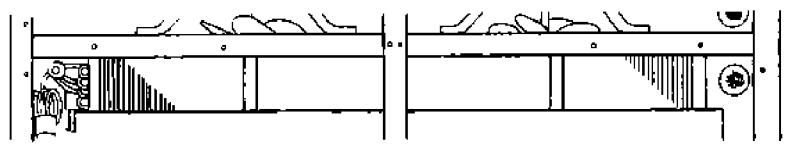
5.1.2 Air cooled condenser and evaporator

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

Maintenance

Service the air cooled condenser after removing the front panel. Service the evaporator after removing the access panels from outside.

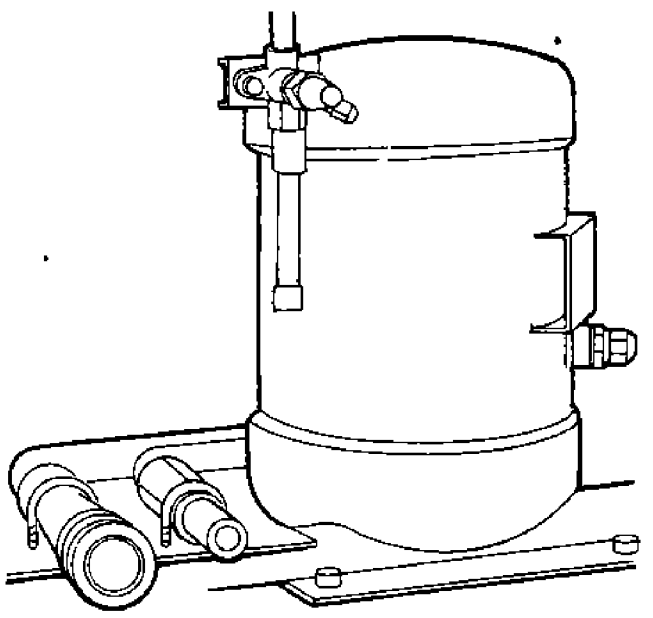
Air cooled condenser



Evaporator

5.1.3 Water cooled condenser

Since the condenser is of the shell and coil type, cooling water flows in the inner cooling tubing and the refrigerant flows in the condenser shell. The cooling tubing having special fins are used to make it light and compact.

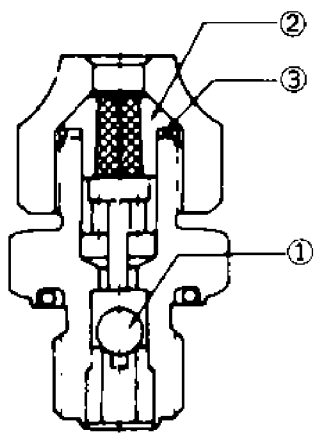


Replacement procedure of the fusible safety plug

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

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

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

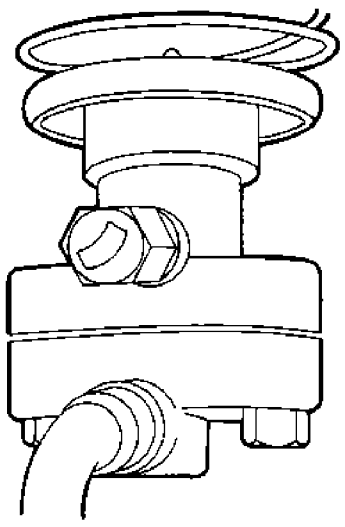


① Ball
② Fusible plug alloy
③ packing

Construction of fusible safety plug

5.1.4 Expansion valve

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



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

① **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.

a. **Adjustment based on the suction operation pressure**

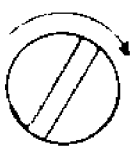
1) Confirm that the predesigned volume of the refrigerant has been charged.
2) Attach a pressure gauge to each gauge port and operate the refrigeration unit, maintaining inside temperature at −18°C(−0.4°F). (refer to "Maintenance").
3) When inside temperature comes to the preset temperature, compare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

b. **The adjustment based on frost stated on the compressor.**

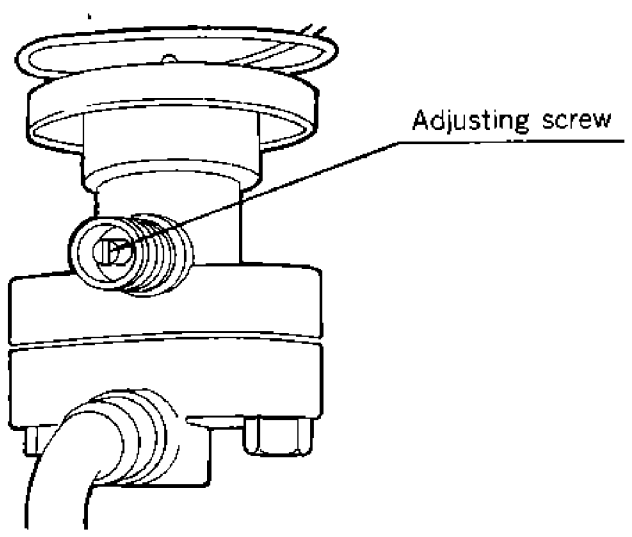
1) Refer to the caution for adjustment of expansion valve as above. At this time, inside temperature should be maintained to −18°C(−0.4°F).
2) Regulate the adjusting screw as stated below based on frost state on the suction pipe and the stop valve of the compressor.
3) Whether or not the adjustment required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

c. **Adjusting points for expansion valve**

- Suction pressure is higher than the standard pressure (Frost forms on the compressor side rather than the suction flange of the stop valve). Clockwise rotation of the adjusting screw decreases running pressure.



- Suction pressure is lower than the standard pressure (Frost forms on the suction pipe rather than the suction flange of the stop valve). Counterclockwise rotation of the adjusting screw increases running pressure.



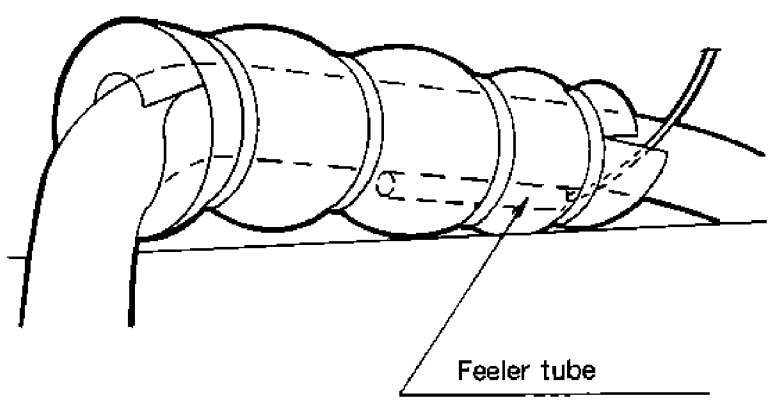
d. **Countermeasures after operation**

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

② **Replacement**

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

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.



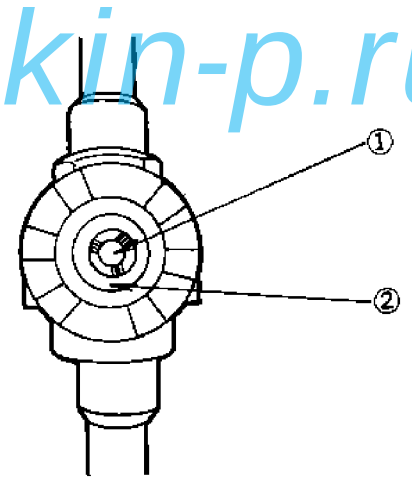
5.1.5 Liquid/moisture indicator

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

① **Moisture content**

- The indicator indicates moisture content by the color at the center of the window.
  Check this indicator during the unit is operating.

Color	State
Deep blue	Dry
Orange	Wet (moisture contained)



① Moisture indicator
② Corrugated glass

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.

② **Flow of the refrigerant**

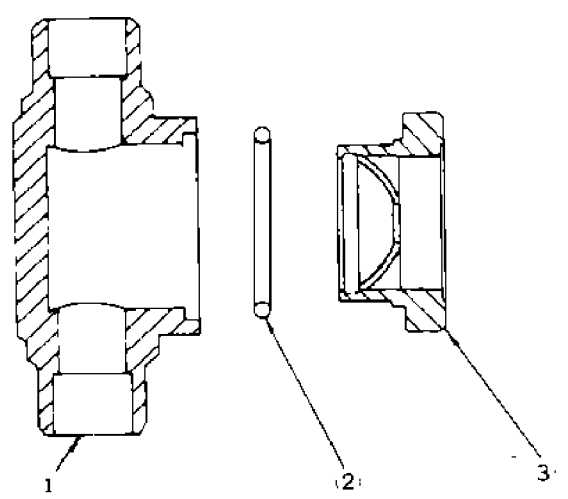
- When the liquid refrigerant is sealed, corrugation on the sight glass disappears.
- Check

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

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

③ **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.)



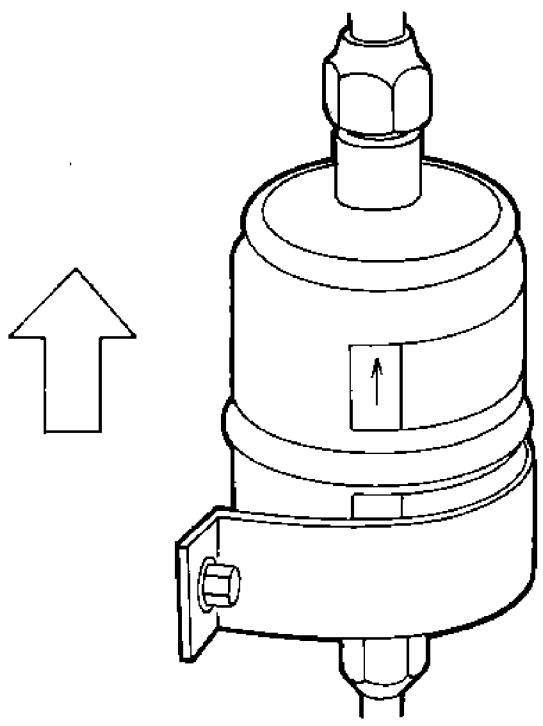
① Body
② O-ring
③ Sight glass

5.1.6 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.

Replacement

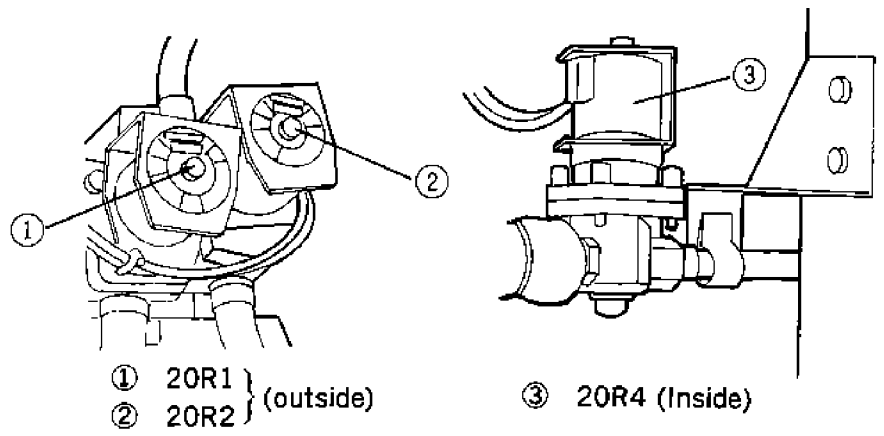
1) In "pump down" state (refer to "Maintenance"), close the compressor suction stop valve.
2) Then, loosen the flares at the both end of the dryer and replace the dryer quickly.
3) Be careful not to get air into the piping on the solenoid valve side while removing the dryer.
4) After reattachment of 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, turn on the unit ON/OFF switch instantly 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. Confirm no gas leakage is found.



5.1.7 Solenoid valves

- **Solenoid valves in the liquid line (20R1, 2)**
- **Solenoid valve for drain pan heater (20R4)**

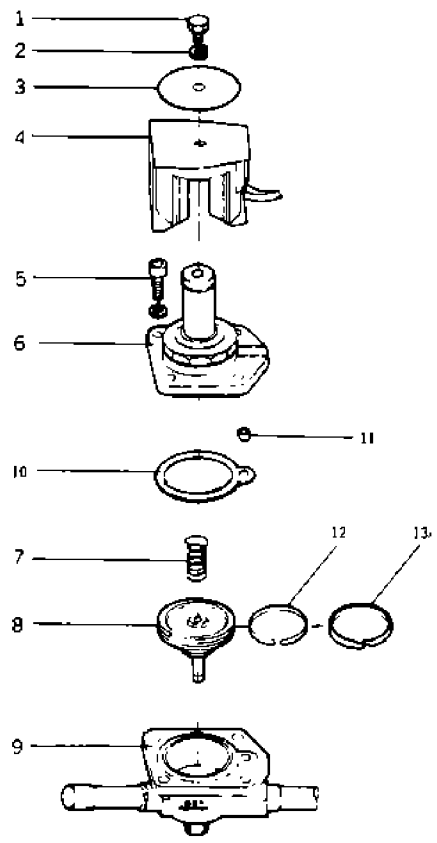
20R1, 2 are opened or closed by the signal of the controller.
When 20R1, 2 are closed, the refrigerant flow is blocked.



① 20R1
② 20R2 } (outside)
③ 20R4 (Inside)

Disassembly

1) The structure of the solenoid valve is shown at right. (For disassembly, checking, and reassembly, refer to this diagram.)
2) 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.)
3) During reassembly, tighten the four bolts×4 with torque of 50−60 kg-cm.



No.	Parts name
①	Set bolt (M5)
②	Spring lock washer (M5)
③	Name plate
④	Coil ass'y
⑤	Set bolt
⑥	Cover ass'y
⑦	Spring
⑧	Piston
⑨	Valve body
⑩	Packing
⑪	Sleeve
⑫	Inner ring
⑬	Piston ring

5.2 Components related with the air system

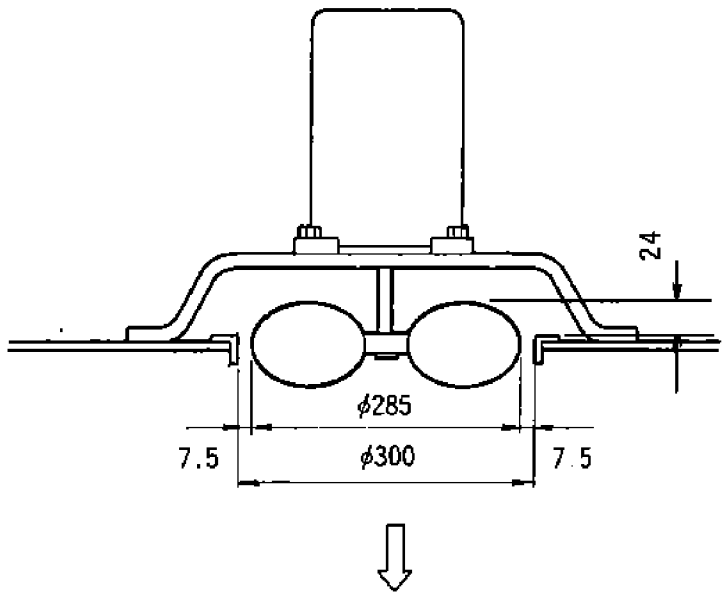
5.2.1 Fans and motors

① **Specifications**

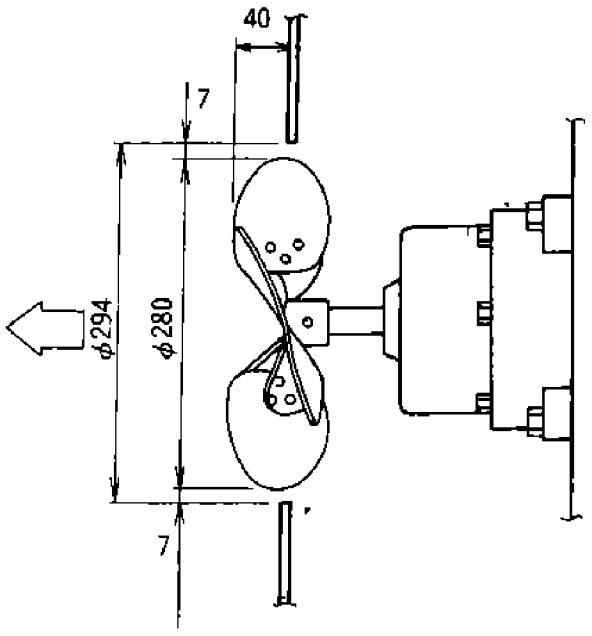
		Evaporator	Condenser
Fan	Type	Propeller fan	
	Numbers of blades	6 pcs.	
	Blade diameter	ϕ285	ϕ280
Motor	Type	3 phase squirrel-cage induction motor	
	Motor output (Pole numbers)	250/400W(2P)	75/110W(4P)
		30/50W(4P)	
	Bearing	Ball bearing, 6203 Non-contacting type Rubber seal	

② Installation procedure

a. Evaporator fan and motor

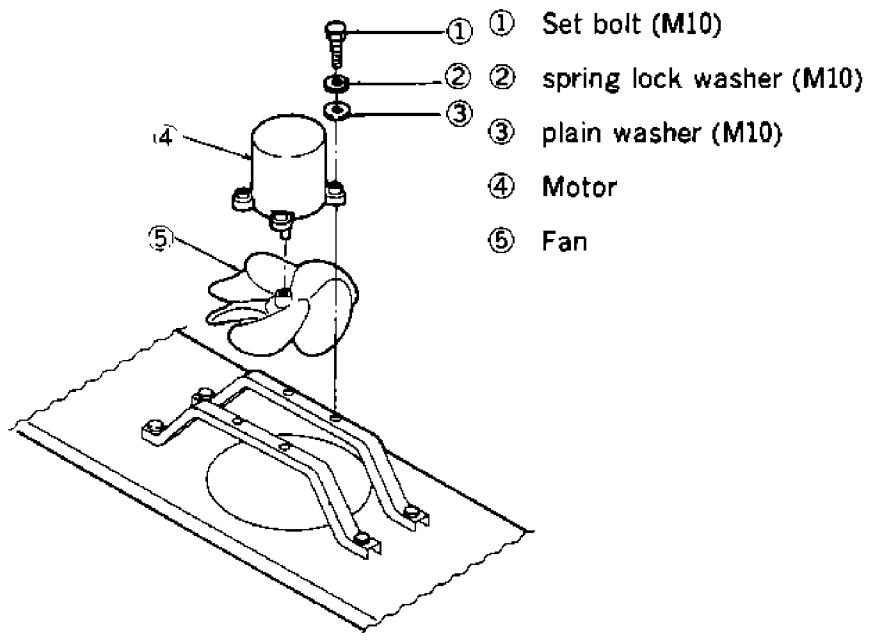


b. Condenser fan and motor



③ **Replacing method for evaporator fan**

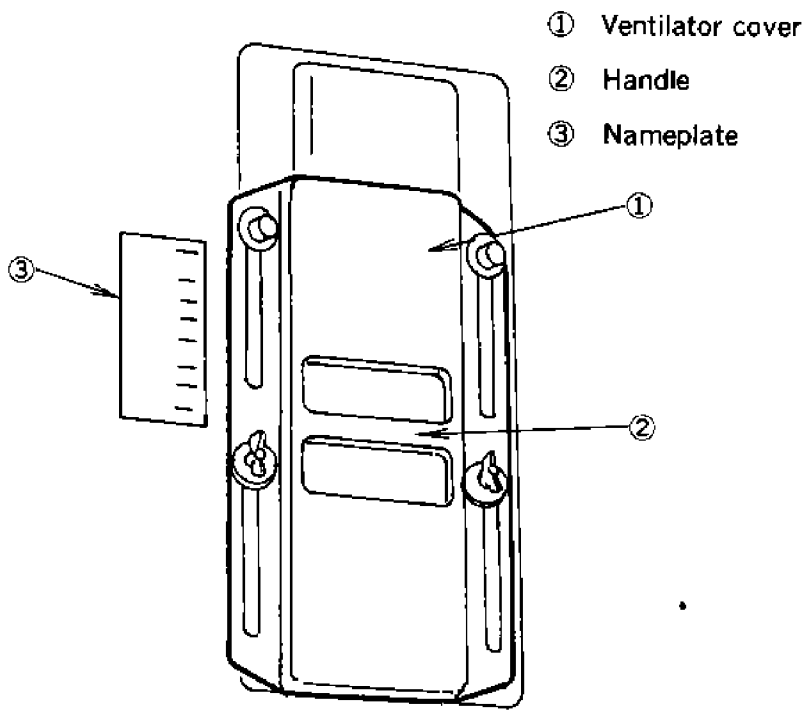
Before removing the evaporator fan, loosen the bolts on the fan motor and remove the motor.



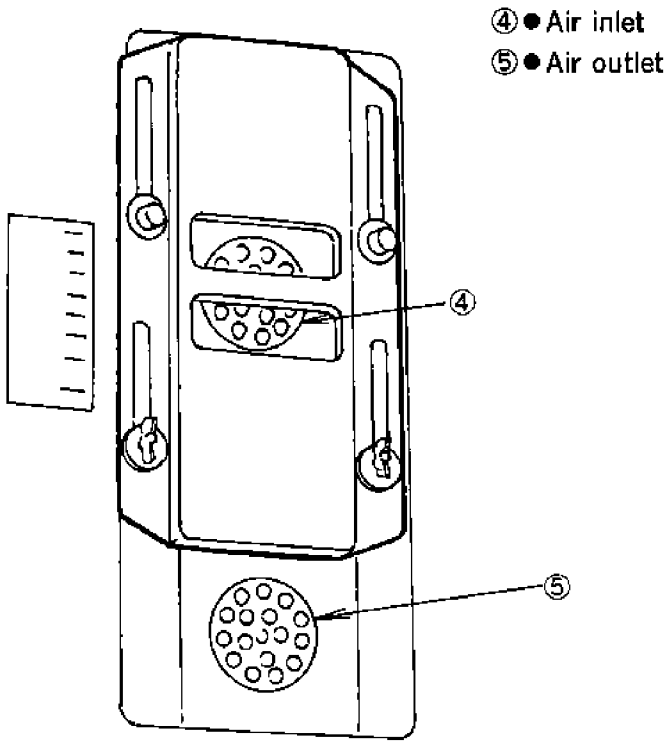
5.2.2 Ventilator

Handling method

1) In case ventilation is not needed:
Set the handle to "CLOSE".



2) In case ventilation is needed:
Set the handle to "FULL OPEN".



5.3 Functional electric parts

5.3.1 High pressure switch (63H1)

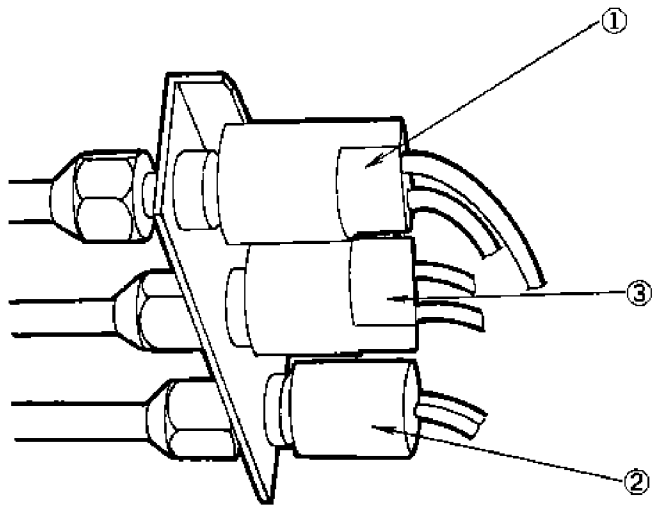
This switch causes compressor to stop, as the operation pressure of the unit has risen abnormally. Thus HPS is adapted to stop the compressor if the high pressure has gone up above its set value due to failure of condenser fan, obstructive passage to cooling water, etc.

5.3.2 Low pressure switch (63L)

When low pressure is lower than the predesigned value due to measured pump-down during defrosting or heat-up operation, this switch switches over the solenoid valve, detecting termination of measuring

5.3.3 High pressure control switch (63H2)

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



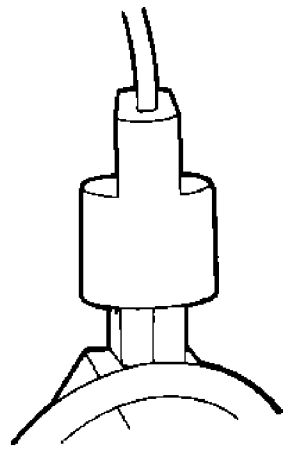
① High pressure switch (63H1)

② Low pressure switch (63L)

③ High pressure control switch (63H2)

5.3.4 Water pressure switch (63W)

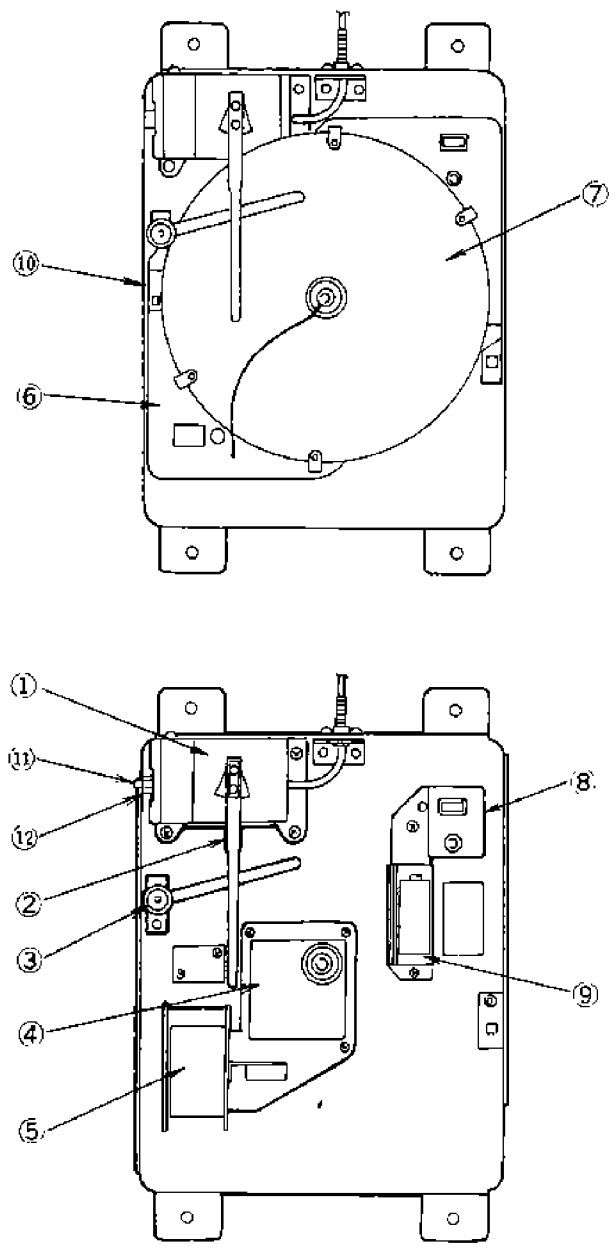
This switches over air and water cooled modes. If coolig water flows and water pressure rises above a preset water pressure at the inlet, the contact is turned off to stop the condenser fan motor and water cooled operation will start.



5.3.5 Recorder (SKM−2924A)

① **Specifications**

● Model	SKM-2924A
● Feeler tube	Gas sealed
● Recording method	Pressure sensing type
● Recording temperature range	−25～+25℃(−13～+77°F)
● Recording paper	Dia. 203 Disk type pressure sensible paper (Graduation 1/1℃) (Corresponding to PSD-217C (REV. A) made by 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
⑪ Adjusting screw
⑫ Lock screw

② **Inspection of recorded temperature**

Recording pen on chilled mode.

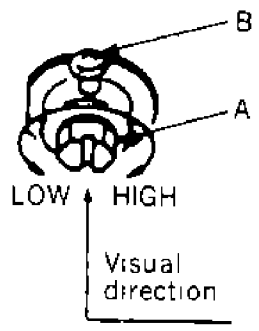
Operate the unit in chilled mode at 0℃ (32°F) setting and confirm with the digital temperature display of the controller that the supply air temperature has stabilized at 0℃(32°F). Then rotate the digital temp. indication switch to return air and calibrate the recording pen according to the return air temperature on digital display.

③ **Adjustments**

1) Make adjustments subsequent to the inspection in item.

2) 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℃ (9°F). Then turn the setting screw (A) counterclockwise to lower the temperature setting of the pen until the temperature is adjusted to the digital temperature. Tighten the lock screw (B) after the adjustment.

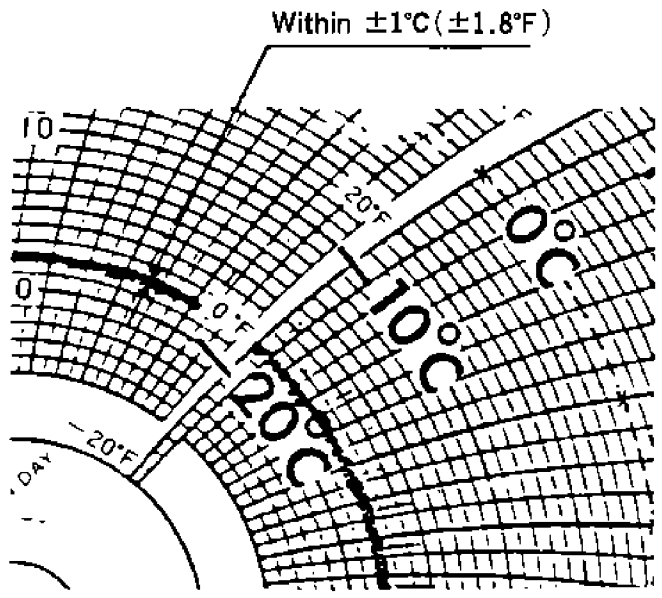
Note: 1 One turn of the setting screw (A) changes the temperature setting by approx. 5℃ (9°F).
2 Be careful that the temperature setting may be altered by tightening the lock screw (B).



3) Generally a temperature recorder should be adjusted at 0℃ (32°F), but the following method is available when the setting temperature is known.
- ● Chilled mode(Setting temperature : above −4.5℃ [+23.9°F])····· "Adjust at 0℃ (32°F)."
- ● Frozen mode (Setting temperature : below −5.1℃ [+22.8°F])····· "Adjust at −18℃ (−0.4°F)."

4) Inspection and adjusting method
- ● 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 becomes increasing.
  It is caused from its hysteresis that a pen sometimes shows the temperature lower from 1℃ (1.8°F) to 3℃ (5.4°F) when the temperature is increasing.
- ● It is a normal phenomena that the recording curves are a little influenced by the fluctuations of the ambient temperature. (Note : Basically the temperature recorder is designed for 25℃ [77°F] ambient, and 10℃ (18°F) fluctuations of the ambient temperature cause the error of ±0.2℃. [± 0.4°F])

- A temperature recorder adjusted at 0°C (32°F) sometimes shows the following curves at −18°C (−0.4°F) inside. It is a normal and allowable range.
  If the range exceeds the above, readjust it at 0°C (32°F) (or−18°C〔−0.4°F〕).
- Don't move the pen by hand, because it will cause an increase of error.
- When the pen is holded by the pen lifter the pen may move unsmoothly, but it is no problem.

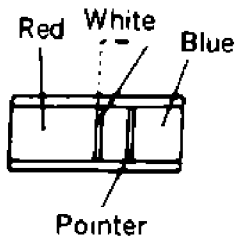


④ Replacement of parts

a. Battery

1) 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.)



Residual voltage indicator

2) Replacement method

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

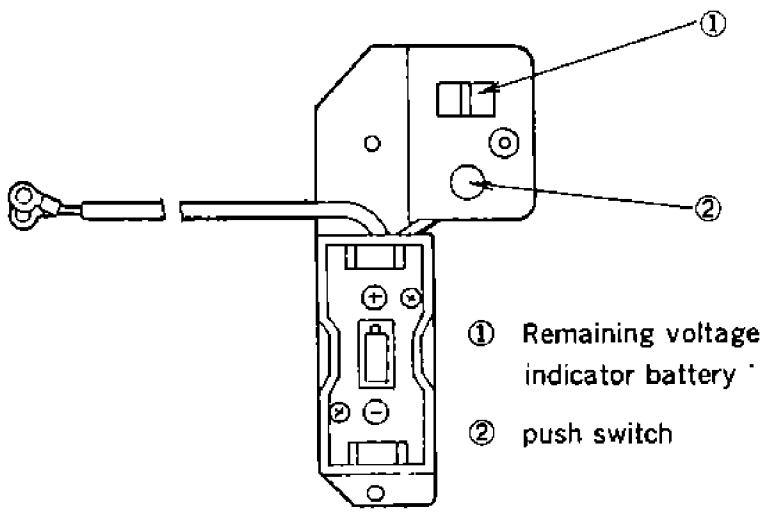
b. Residual voltage indicator battery

1) Replacement interval

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

2) 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.



(DKM-AA003)

Residual voltage indicator battery

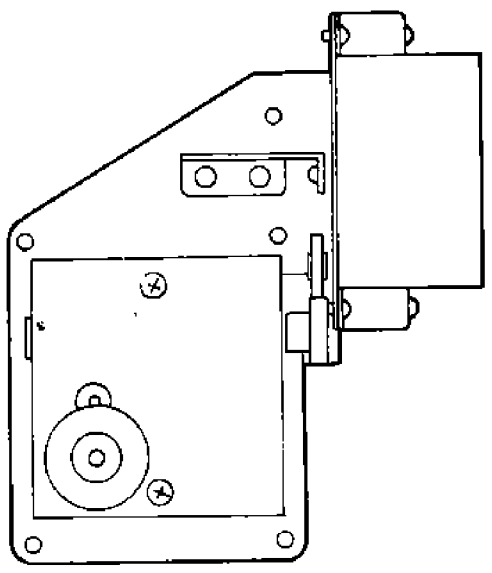
C. Timer (quartz motor speed reducing gear)

1) Replacement interval

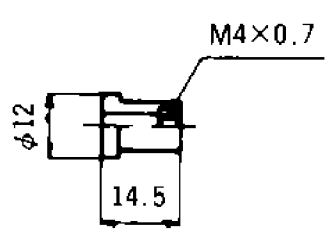
- When the quartz motor does not function even though residual voltage battery is normal.
- When the timer delays over three hours a day.

2) Replacement method

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



Timer (quartz motor speed reducer)



Accessory (anti-vibration rubber : 5 pcs)

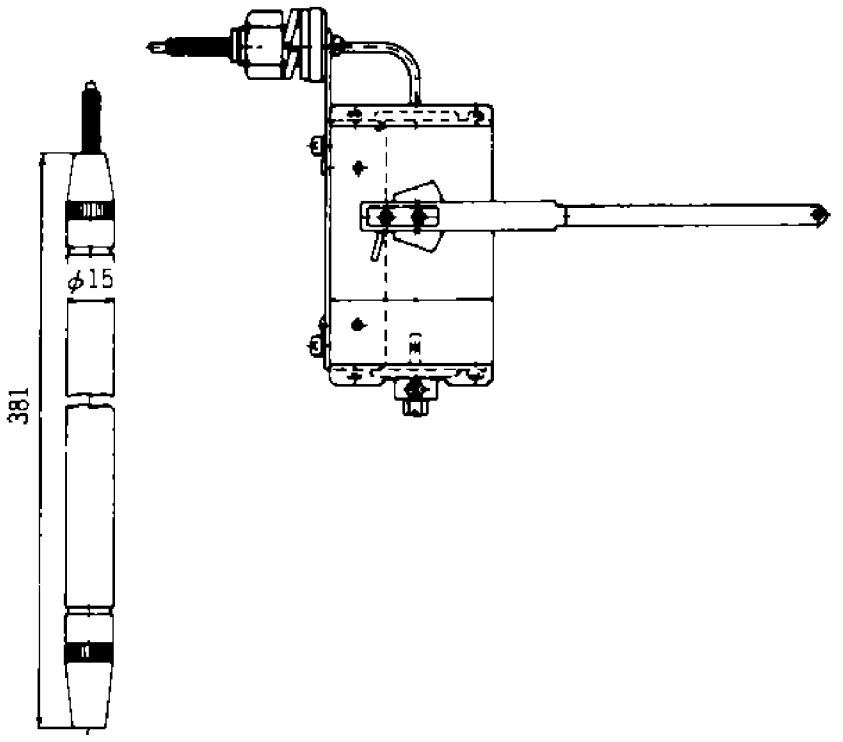
d. Thermal feeler tube

1) 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 tube, gas leakage may be suspected.)

2) Replacement method

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



Feeler tube—element ···SKM-AA001

5.3.6 Phase sequence controller (47)

① **Specifications**

- Type: PR8601
- Power supply: 190~200V 50Hz
  200~220V 60Hz

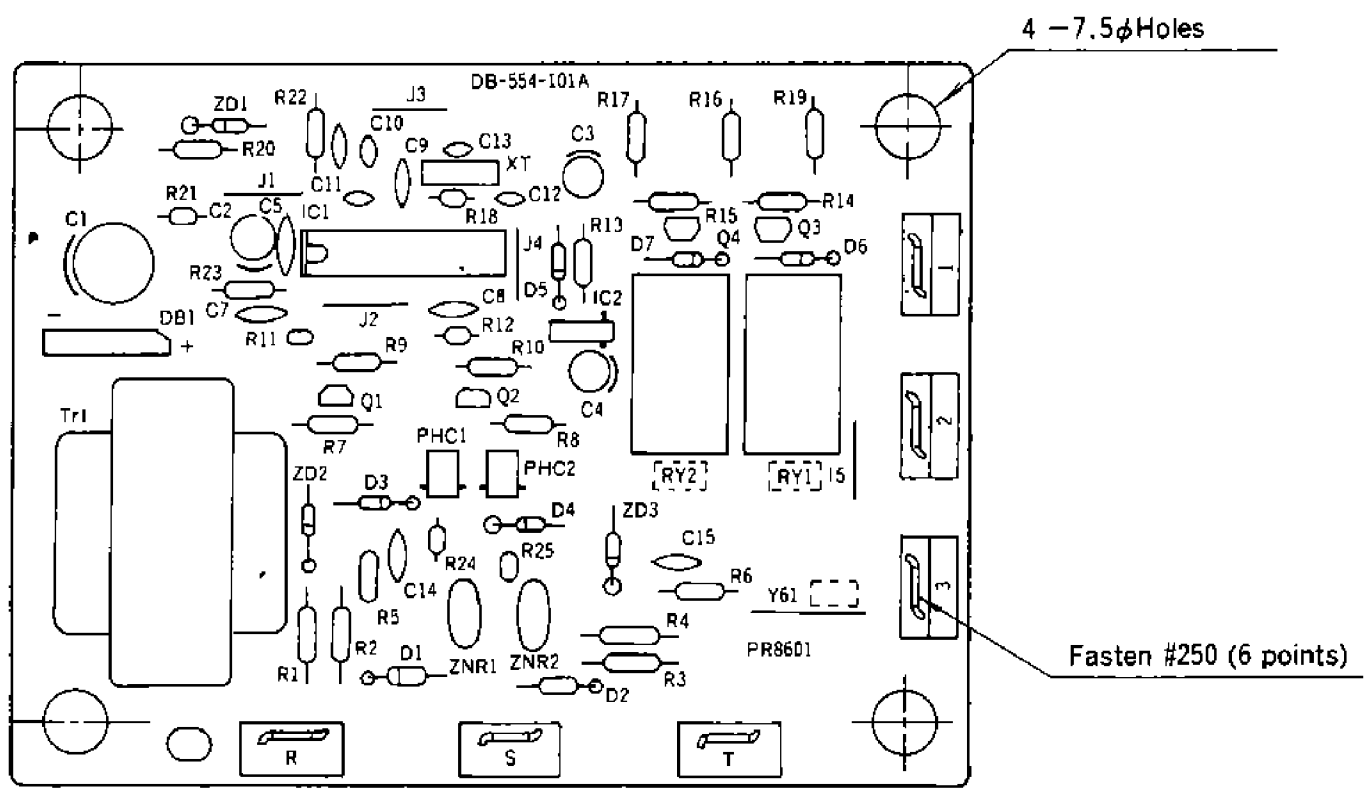
The phase sequence controller opens or closes the magnetic contactor for changing-over of phases, detecting phases, R. S. T. in the power supply to prevent the fan motor from reverse turning.
The integrated microcomputer detects voltage of each phase and phase order and operates as tabulated below.

State of power supply		Relay RY1	Relay RY2	Between terminals 1-2	Between terminals 1-3
De-energized period		OFF	OFF	No continuity	No continuity
Energized period	Proper phase	ON	OFF	Continuity	No continuity
	Wrong phase	OFF	ON	No continuity	Continuity
	Single phasing before supplying power	OFF	OFF	No continuity	No continuity
	Single phasing during energization	State before single phasing is retained.			

Note: Single phasing can be judged only on the power supplying side, but not on the load side.

② **Checking method for operation**
Exchange the power sources and check that the microcomputer operates as tabulated above. If not, replace the phase sequence controller.

③ **Cautions for replacing the switch**
Correctly connect each terminal in accordance with the wiring diagram. If not the switch may be burnt, or the microcomputer becomes erratic.



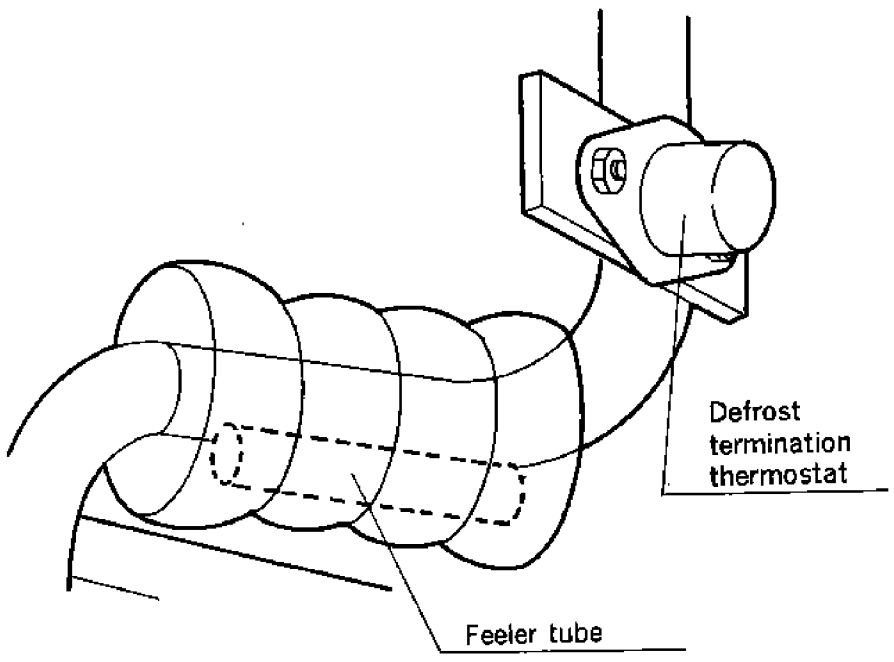
5.3.7 Defrost termination thermostat (26D)

The defrost termination thermostat is provided to terminate defrosting, sensing temperature of the suction piping in the storage.

OFF 35°C (95°F)

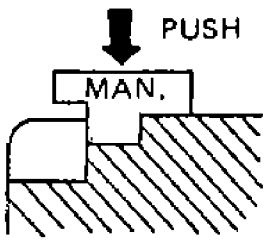
ON 20°C (68°F)

Since temperature of the suction piping rises quickly during actual defrosting, the thermostat is turned off at higher than 35°C (95°F)



5.3.8 Over current relay (51C)

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



5.3.9 Fan speed change-over thermostat (26F)

This thermostat is provided to change evaporator fan speed from high to low when return air temperature reaches to −10°C (+14°F) during frozen mode.

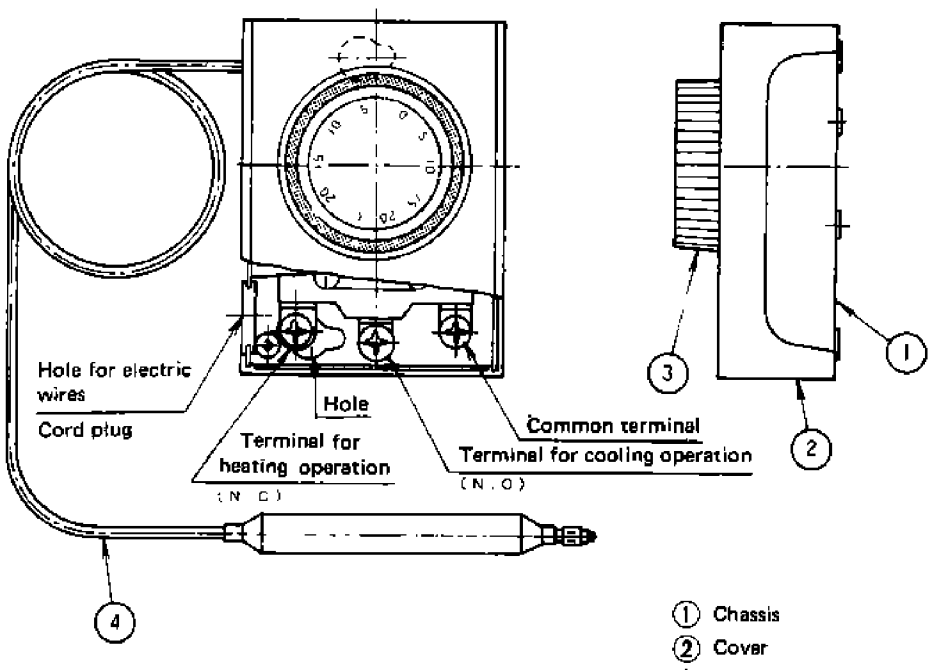
● Model E-IDM-4

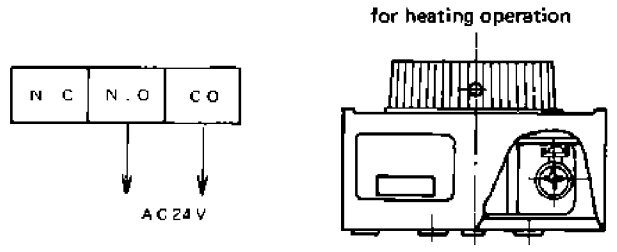
● Switch functional chart

Temp. / Switch	32°F −10 −9 −8 −7 −6 −5
−3°C (26.6°F)	(OFF) ← → (ON)

Note : Never manipulate the setting of 26F, which has been precisely adjusted at our factory before shipment.

● External wiring





● Insulation resistance 50MΩ or more with DC 500V megger

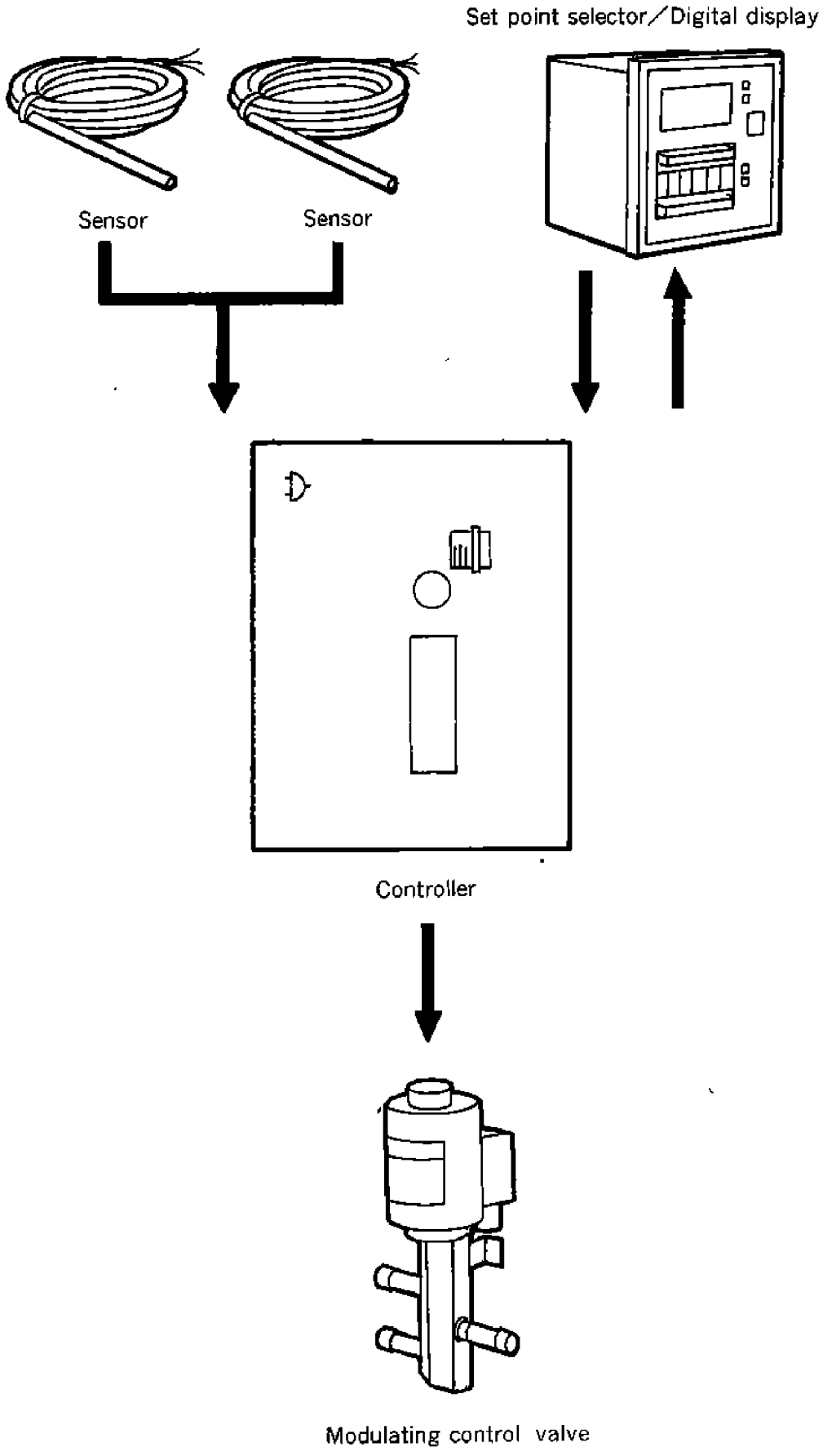
● Insulation strength for 1 minute with AC 500V

5.3.10 Electronic controller (23A1)

This unit performs temperature control in two modes.

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



Modulating control valve

① **Sensor (FC-KTRP)**

The supply air and return air sensors are identical.

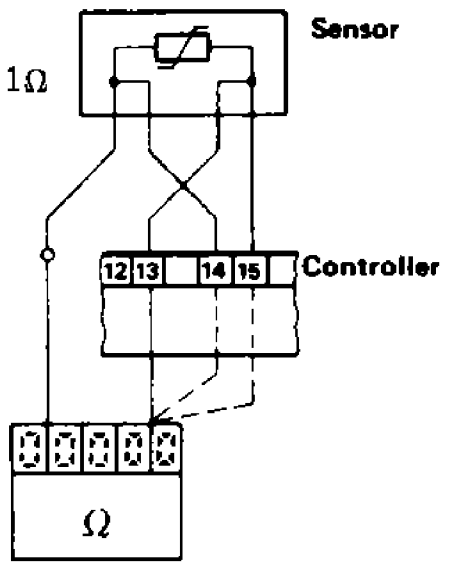
- Element———PT100Ω (0°C)
- Connection———with four leads

1) **Checking operation**

- Supply air sensor

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

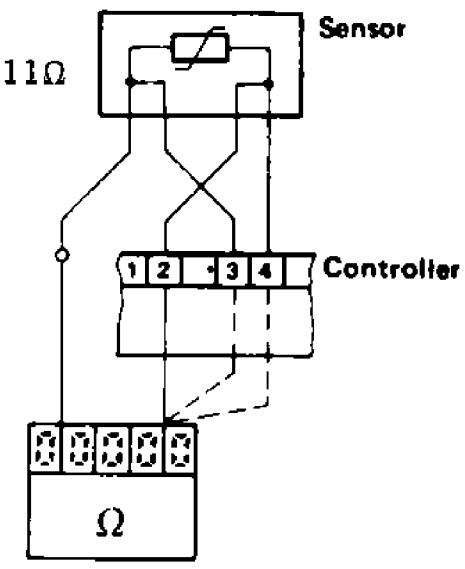
Terminal 13 : 88—111Ω
Terminal 14 : 0Ω
Terminal 15 : 88—111Ω



- Return air sensor

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

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



2) **Replacement of sensors**

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

3) **Temperature vs. resistance table**

Temperature °C (°F)	Resistance Ω	Temperature °C (°F)	Resistance Ω
−30(−22)	88.17	5(41)	101.95
−25(−13)	90.15	6(42.8)	102.34
−20(−4)	92.13	7(44.6)	102.73
−19(−2.2)	92.52	8(46.4)	103.12
−18(−0.4)	92.92	9(48.2)	103.51
−17(1.4)	93.31	10(50)	103.90
−16(3.2)	93.71	11(51.8)	104.29
−15(4.1)	94.10	12(53.6)	104.68
−14(6.8)	94.49	13(55.4)	105.07
−13(8.6)	94.89	14(57.2)	105.46
−12(10.4)	95.28	15(59)	105.85
−11(12.2)	95.68	16(60.8)	106.24
−10(14)	96.07	17(62.6)	106.63
− 9(15.8)	96.46	18(64.4)	107.02
− 8(17.6)	96.86	19(66.2)	107.40
− 7(19.4)	97.25	20(68)	107.79
− 6(21.2)	97.65	21(69.8)	108.18
− 5(23)	98.04	22(71.6)	108.57
− 4(24.8)	98.43	23(73.4)	108.96
− 3(26.6)	98.82	24(75.2)	109.35
− 2(28.4)	99.22	25(77)	109.73
− 1(30.2)	99.61	26(78.8)	110.12
0(32)	100.00	27(80.6)	110.51
1(33.8)	100.39	28(82.4)	110.90
2(35.6)	100.78	29(84.2)	111.28
3(37.4)	101.17	30(86)	111.67
4(39.2)	101.56		

② Setpoint selector/Digital display (PC-DD 30/30)

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

1) 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
(−21.8~+85.8°F)

- **Operating check**

1.Switch on controller (Unit ON-OFF switch)
2.Measure −15V DC ±0.5V, terminal 6 (⊻) −5
3.Measure +15V DC±0.5V, terminal 6(⊻) −4
If the measured values agree, the voltage supplied to the setpoint selector in correct.
4.Setpoint adjustment
−29.9°C(−21.8°F)=0.017V
0°C(32°F)=5.000V Terminal 6(⊻) −7
+29.9°C(+85.8°F)=9.983V
Tolerance ±0.017V

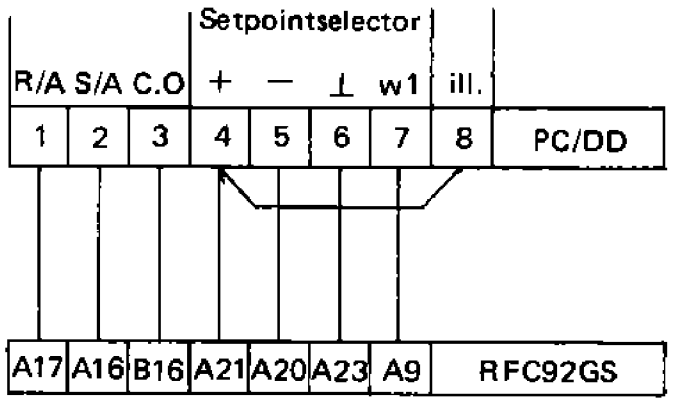
2) **Digital display**

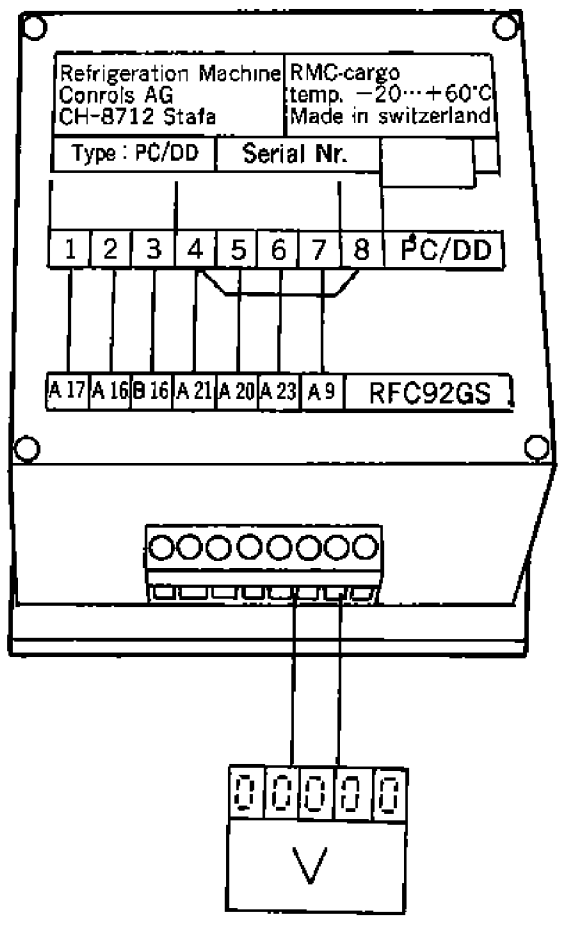
The supply or return air temperature, measured by the two sensors, is shown on the LCD display by the output voltage from controller.
In the chilled mode, the supply air temperature is shown. The return air temperature can be seen by pressing the button 〈push〉.
In the frozen mode, the return air temperature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

- **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

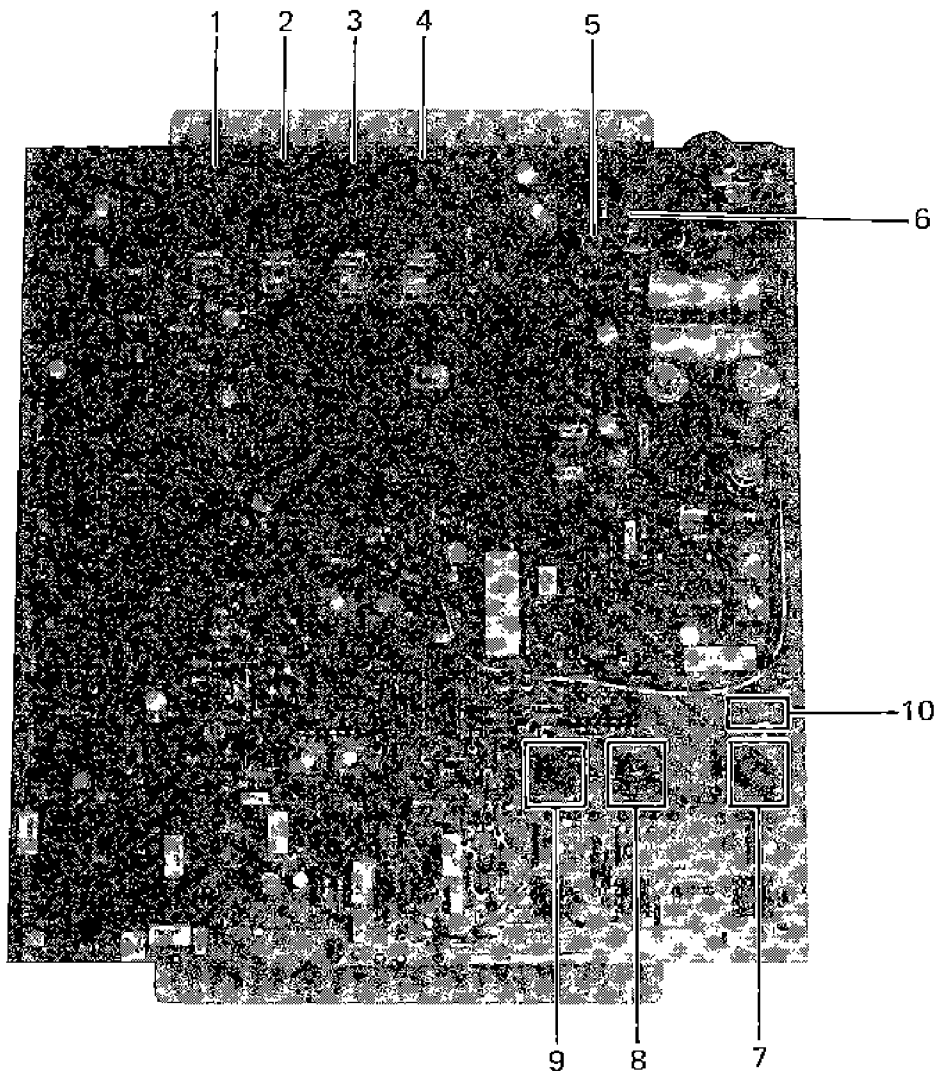




③ Controller (RFC-92GS-RMC-8302)

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.

1) **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	(+23.9/+23°F)
5	Spare transistor fuse (modulating valve for voltage output)	BC 107A	
6	Transistor fuse (modulating valve for voltage output)	BC 107A	
7	Derivative action preset time potentiometer	TV [s]	18 sec
8	Proportional band potentiometer (% of measuring range)	xp [%]	4 %
9	Integral action reset time potentiometer	TN [s]	90 sec
10	Jumper line (for TV × 10)		Cut

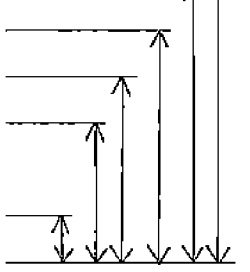
2) **Temperature-voltage conversion table**

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 (32°F) when voltage is 5V across A24-A16 of the terminal board (F-H of the receptacle).

2. The change-over point (U1) between chilled and frozen modes are switched over is −5°C (23°F) when voltage is 4.166V across A24-A7 of the terminal board (F-L of the receptacle).

Description		
Supply air temp. X1	H	A16
Return air temp. X2	G	A17
Setpoint w1	J	A10
High limit G1	K	A8
Low limit G2	M	A6
Change-over U1		
Chilled/Frozen	L	A7
Earth⏚	F	A24



Temperature/voltage conversion table

°C	(°F)	V	°C	(°F)	V	°C	(°F)	V
−30	(−22)	0	−10.0	(14)	3.3333	10.0	(50)	6.6666
−29.5	(−21.1)	0.0833	− 9.5	(14.9)	3.4166	10.5	(50.9)	6.750
−29	(−20.2)	0.1666	− 9	(15.8)	3.5	11	(51.8)	6.8333
−28.5	(−19.3)	0.250	− 8.5	(16.7)	3.5833	11.5	(52.7)	6.9166
−28	(−18.4)	0.3333	− 8	(17.6)	3.6666	12	(53.6)	7.0
−27.5	(−17.5)	0.4166	− 7.5	(18.5)	3.750	12.5	(54.5)	7.0833
−27	(−16.6)	0.5	− 7	(19.4)	3.8333	13	(55.4)	7.1666
−26.5	(−15.7)	0.5833	− 6.5	(20.3)	3.9166	13.5	(56.3)	7.25
−26	(−14.8)	0.6666	− 6	(21.2)	4.0	14	(57.2)	7.3333
−25.5	(−13.9)	0.750	− 5.5	(22.1)	4.0833	14.5	(58.1)	7.4166
−25	(−13)	0.8333	− 5	(23)	4.1666	15	(59)	7.5
−24.5	(−12.1)	0.9166	− 4.5	(23.9)	4.25	15.5	(59.9)	7.5833
−24	(−11.2)	1.0	− 4	(24.8)	4.3333	16	(60.8)	7.6666
−23.5	(−10.3)	1.0833	− 3.5	(25.7)	4.4166	16.5	(61.7)	7.75
−23	(−9.4)	1.1666	− 3	(26.6)	4.5	17	(62.6)	7.8333
−22.5	(−8.5)	1.25	− 2.5	(27.5)	4.5833	17.5	(63.5)	7.9166
−22	(−7.6)	1.3333	− 2	(28.4)	4.6666	18	(64.4)	8.0
−21.5	(−6.7)	1.4166	− 1.5	(29.3)	4.750	18.5	(65.3)	8.0833
−21	(−5.8)	1.50	− 1	(30.2)	4.8333	19	(66.2)	8.1666
−20.5	(−4.9)	1.5833	− 0.5	(31.1)	4.9166	19.5	(67.1)	8.25
−20	(−4)	1.6666	± 0	(32)	5.0	20	(68)	8.3333
−19.5	(−3.1)	1.750	0.5	(32.9)	5.0833	20.5	(68.9)	8.4166
−19	(−2.2)	1.8333	1	(33.8)	5.1666	21	(69.8)	8.5
−18.5	(−1.3)	1.9166	1.5	(34.7)	5.25	21.5	(70.7)	8.5833
−18	(−0.4)	2.0	2	(35.6)	5.3333	22	(71.6)	8.6666
−17.5	(0.5)	2.0833	2.5	(36.5)	5.4166	22.5	(72.5)	8.750
−17	(1.4)	2.1666	3	(37.4)	5.5	23	(73.4)	8.8333
−16.5	(2.3)	2.25	3.5	(38.3)	5.5833	23.5	(74.3)	8.9166
−16	(3.2)	2.3333	4	(39.2)	5.6666	24	(75.2)	9.0
−15.5	(4.1)	2.4166	4.5	(40.1)	5.75	24.5	(76.1)	9.0833
−15	(5)	2.5	5	(41)	5.8333	25	(77)	9.1666
−14.5	(5.9)	2.5833	5.5	(41.9)	5.9166	25.5	(77.9)	9.25
−14	(6.8)	2.6666	6	(42.8)	6.0	26	(78.8)	9.3333
−13.5	(7.7)	2.750	6.5	(43.7)	6.0833	26.5	(79.7)	9.4166
−13	(8.6)	2.8333	7	(44.6)	6.1666	27	(80.6)	9.5
−12.5	(9.5)	2.9166	7.5	(45.5)	6.25	27.5	(81.5)	9.5833
−12	(10.4)	3.0	8	(46.4)	6.3333	28	(82.4)	9.6666
−11.5	(11.3)	3.0833	8.5	(47.3)	6.4166	28.5	(83.3)	9.75
−11	(12.2)	3.1666	9	(48.2)	6.5	29	(84.2)	9.8333
−10.5	(13.1)	3.25	9.5	(49.1)	6.5833	29.5	(85.1)	9.9166
						30	(86)	10.0

[**Note**]

for temperature sensor output X1, X2 setpoint switch output w1, settings G1, G2, U1. $U/°C = \frac{10\ [V]}{60\ [°C]\ (140°F)} = 0.16667 V/°C$

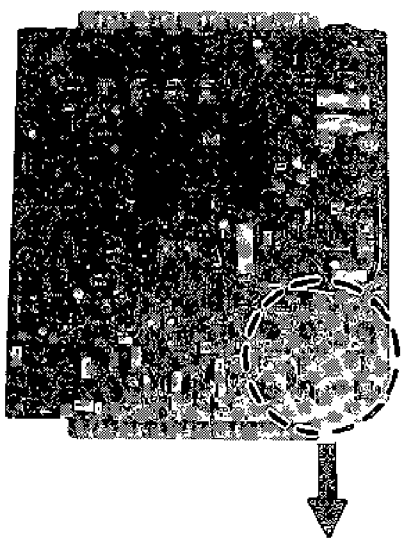
3) **Replacement of print substitute**

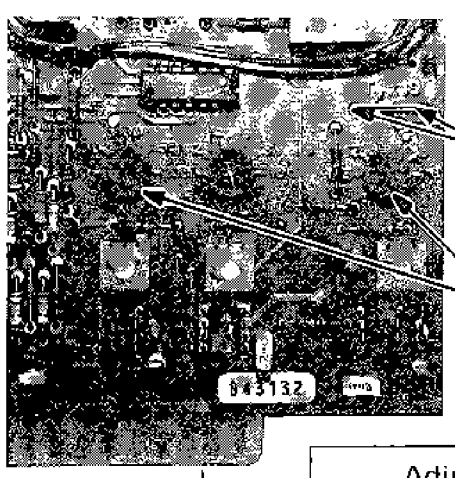
When replacing print substitute, adjustments of

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

are required.

Print substitute
RFC-92GS (RMC 8302)





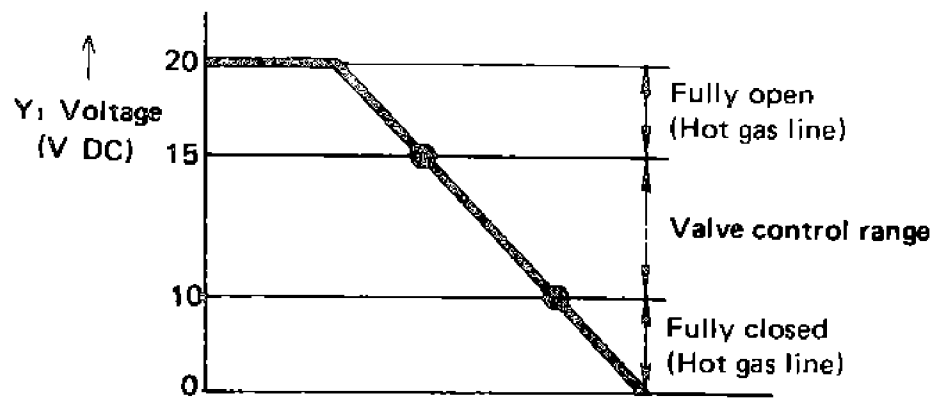
		Tv	(Jumper line for Tv)	Xp	Tn
Standard RMC factory setting		10sec	Remained	8%	60sec
For LXE5-R Revised setting		10sec	Remained	5%	50sec

Note:

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

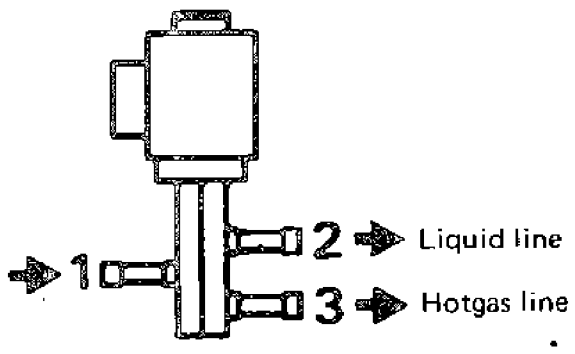
④ **Modulating control valve (M3F15L)**

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



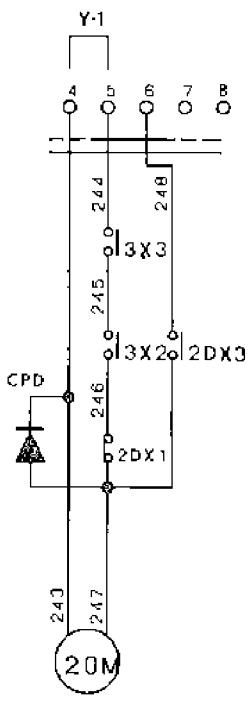
1) **Valve position**

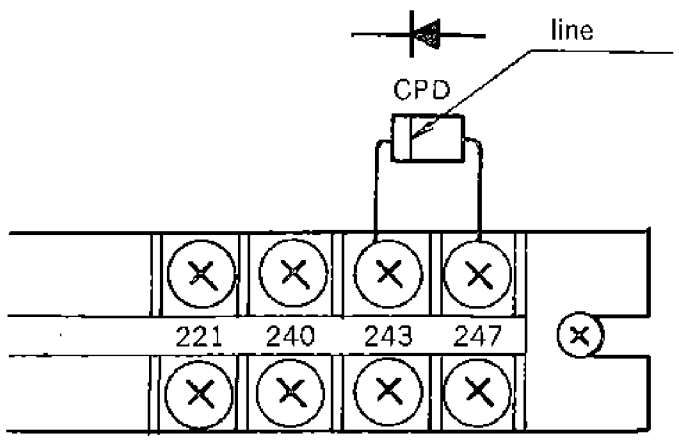
- De-energized period: 1.3 closed, 1-2 open
- The coil resistance of the valve is approximately 20Ω at 21°C (69.8°F).



2) **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.

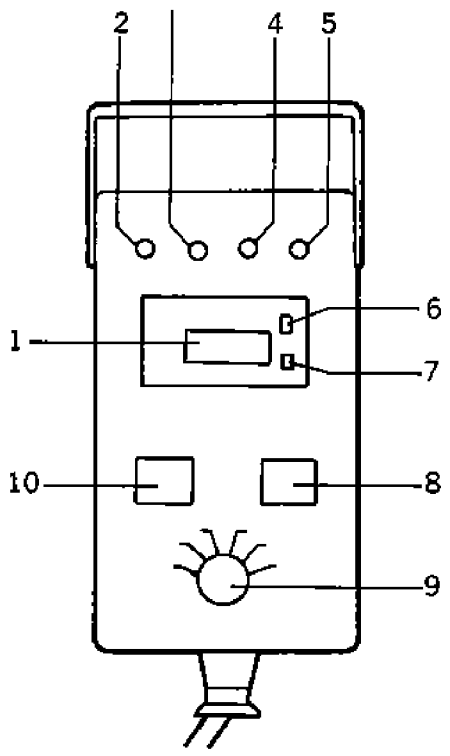




⑤ Check instrument

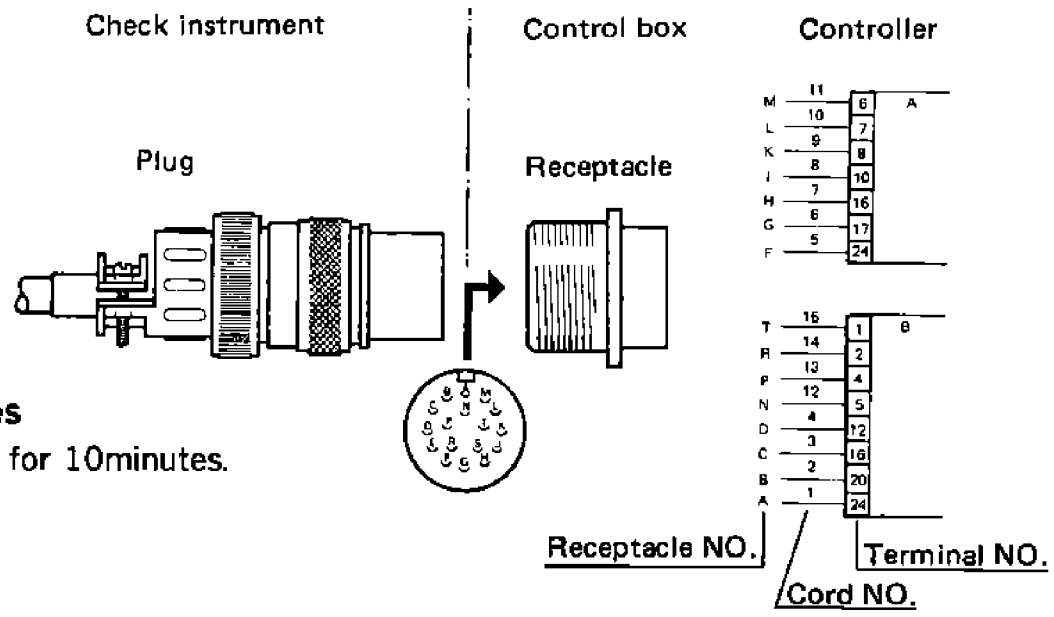
Connect the plug of the check instrument to the receptacle on the front panel of the control box, and check the following, operating the unit.

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 ——℃
7 Lamp for voltage indication
8 Modulating valve voltage button } $V(Y_1)$
9 Selector for.
—Setting upper limit
—Setting lower limit
—Setting operating mode change-over point
—Supply air temperature
—Return air temperature
—Setpoint
10 Scale illumination button

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



⑥ Checking operation of the controlling devices

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

Test procedure	Operating stage (Module)	Standard value		Measuring points			Possible causes of deviations from the standard value	Action
		Check instrument	Digital volt meter R: 10kΩ	Controller terminal	Set point selector terminal	Test socket		

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

Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min >10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
1	**A/C power supply**	Yellow "light" button depressed, display illumination ON					Controller and test socket disconnected	Check wires and connections
			24V $^{+15\%}_{-10\%}$ 50···60Hz	B1 B2			Mains switch off Control switch off Fuse defective	Check devices
2	**DC power supply** Power section	Indicator lamp Y_2, U_1, G_1, or G_2 illuminates					Controller and test socket disconnected	Check wires and connections
			22V $^{+15}_{-10}$ %	A24 B4			Rectifier defective	Replace controller board or rectifier
3	**DC power supply** Bridge	Selector on in "setpoint" position, indication same as selected setpoint Tolerance ±0.3°C (±0.54°F)					Controller and test socket disconnected	Check wires and connections Measure with digital voltmeter as per test procedure 3a
3a			−15V ±0.05V +15V ±0.05V		6(⅄) 5 6(⅄) 4		Controller and setpoint selector disconnected	Check wires and connections Measure with digital voltmeter as per test procedure 3b
3b			−15V ±0.05V +15V ±0.05V	A24 A20 A24 A22			DC supply defective Possible cause: short circuit with earth potential	Replace controller board Measure resistance between terminal A24 and Standard value: >600kΩ
4	Setpoint selector	Selector in "setpoint position Indication of same value as setpoint selector Tolerance ±0.3°C (±0.54°F)					Controller and test socket disconnected Controller and setpoint selector disconnected	Check wires and connections Measure with digital voltmeter as per test procedure 4a
4a			0.017V··· 9.983V DC see table "temperature/voltage convertion"		6(⅄) 7		Setpoint selector	Replace setpoint selector
4b			0.017V··· 9.983V DC see table "temperature/voltage convertion	A24 A10		F J	Controller and setpoint selector disconnected	Check wires and connections
5	**Supply air sensor** (sensor signal X_1)	Selector in "supply air" position Indication of same value as the temp. measured in the supply air (−30···+30°C) (−22···+86°F)					Disconnection	Measure with digital voltmeter as per test procedure 5a

Test procedure	Operating stage	Standard value Check instrument	Measuring points Digital voltmeter Ri min >10kΩ	Controller terminal	Setpoint selector terminal	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) (−22···+86°F)					Disconnection	Measure with digital voltmeter as per test procedure 6a
6a			0···10V DC see table "temperature/ voltage convertion"	A24 A5		F G	Controller and test socket disconnected	Check wires and connections
							Controller and sensor disconnected	Measure sensor resistance See table page" temperature VS. resistance" Replace defective sensor
								If the sensor is in order. replace controller board
7	**Controller output Y,** (to control valve) Set setpoint selector at −29°C (−20.2°F)	Depress blue button "Y, 〔V〕" Indication 0V					Connection between controller and test socket reversed	Check wires and connections
							Controller and test disconnected	Check wire and connections
	Set setpoint selector at +29°C (+84.2°F)	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) Set setpoint selector at +29°C (+84.2°F)	Lamp Y_2 illuminated					Controller and test socket disconnected	Check wires and Measure with digital voltmeter as per test procedure 8a
	Set setpoint selector at −29°C (−20.2°F)	Lamp Y_2 off					Connection between and test socket reversed	

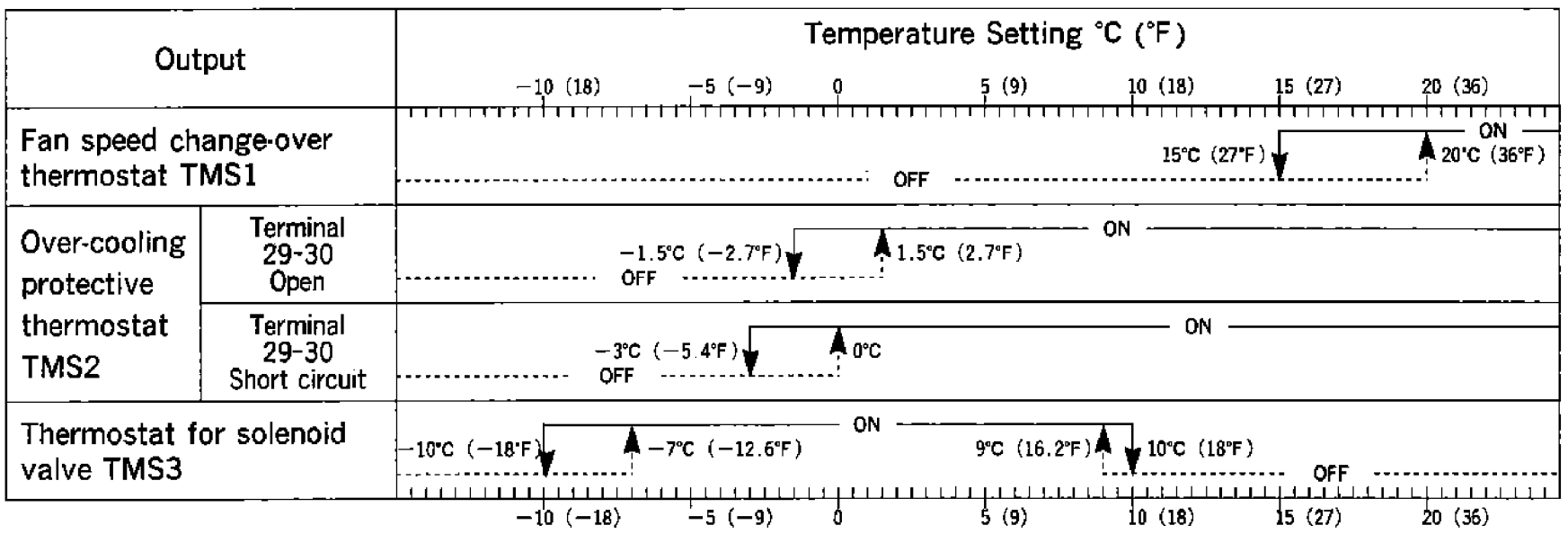
Test procedure	Operating stage	Standard value: Check instrument	Standard value: Digital voltmeter Ri min >10kΩ	Measuring points: Controller terminal	Measuring points: Setpoint selector terminal	Measuring points: Test socket	Possible causes of deviations from the standard value	Action
8a	Set sepoint selector at −29°C (−20.2°F)		0V			P D	Connection between controller and test socket reversed	Check relay Y_2 −29°C(−20.2°F)=B11−B9 (contact closed)
				B4 B12			Controller defective	+29°C(+84.2°F)=B11−B10 (contact closed)
	Set setpoint selector at +29°C (+84.2°F)		22V DC +15% −10%			P D	Controller and test socket disconnected	Check wires and connections
				B4 B12			Controller derfective	Replace controller board
9	**Alarm unit G_1** "temperature" too high	Selector in high limit position						
		Indication 2°C higher then setpoint Tolerance ±0.3°C (±0.54°F)					Controller and test socket disconnected	Check wires and connections
	Set setpoint selector at −29°C (−20.2°F)	Lamp G_1 illuminated after approx. 20_s					Controller and test socket disconnected	Check wires and connections
	Set setpoint selector at +29°C (+84.2°F)	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 (−20.2°F)		0V after approx 20_s			P A	Connection between controller and test socket reversed	Test relay G_1 "controller-b" −29°C(−20.2°F)=B23−B21 (contact close)
				B4 B24			Controller defective	+29°C(+84.2°F)=B23−B22 (contact closed) Check wises and connections
	Set setpoint selector +29°C (+84.2°F)		22V DC +15% −10%			P A	Controller and test socket disconncted	Replace controller board
				B4 B24			Controllem defective	
9b								
10	**Alarm unit G_2** "temperature "too low	Selector in "low linit" position						
		Indication 2°C (3.6°F) lower than setpoint Tolerance ±0.3°C (±0.54°F)						
	Set setpoint selector at +29°C (84.2°F)	Lamp G2 illuminated after approx 20_s					Controller and test socket disconnected	Measure with digital voltmeter as per test procedure 10_a
	Set setpoint selector at −29°C (−20.2°F)	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 (−20.2°F)		22V DC +15% −10%			P B	Controller and test socket disconnected	Check relay G2 "controller-b" −29.9°C(−21.8°F)=B19—B18 (contact closed) +29.9°C(+85.8°F)=B19—B17 (contact closed)
				B4 B20			Controller defective	Check wires and connections
	Set setpoint selector at +29°C (+84.2°F)		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 (+23.9°F) Tolerance ±0.3°C (±0.54°F)						
	Set setpoint selector at −29°C (−20.2°F)	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 (+84.2°F)	Lamp U_1 illuminated					Controller and test socket disconnected	Check wires and connections
11a	Set setpoint selector at +29°C (+84.2°F)		22V DC +15% −10%			P C	Controller and test socket disconnected	Check relay U_1 +29°C(+85.8°F)=B15—B14 (contact closed) −29°C(−21.8°F)=B15—B13 (contact closed)
				B4 B16			Controller defective	Check wires and connections
	Set setpoint selector at −29°C (−20.2°F)		0V			P C	Controller and test socket connections reversed	Replace controller board
				B4 B16			Controller defective	
11b								

5.3.11 Electronic controller (23A2)

① **Specifications**

- Model : P-TIMER
- Power supply : AC24V 50/60Hz
- Sensor : Thermistor
- Thermostat output



●Timer output

Output		Timer setting
Fan delay timer 2F1		60 seconds
Fan delay timer 2F2		10 seconds
Defrost initiation timer (Short) 2D1	Factory setting	4 hours
	Switch change-over	3 hours
Defrost initiation timer (Long) 2D2	Factory setting	12 hours
	Switch change-over	24 hours
Defrost delay timer 2D3		20 seconds
Defrost back-up timer 2D4		90 minutes

- Insulation resistance: DC500V megger 50MΩ or more
  Note: Do not impress the input terminals 32～33
- Dielectric pressure: AC500V for one minute
  Note: Do not impress the input terminals 32～33

② **Checking method for operation**

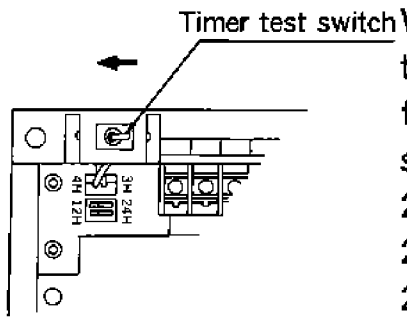
a. Checking thermostats for their outputs

- Set the set point selector to 0°C (32°F), and make pull-down start at supply air temperature above +25°C (+77°F). Compare output functioning point of each thermostat with supply air temperature to check the difference between them is within ±2°C (±3.6°F). Note that the thermistor does not follow speed of pull-down if it is very quick.
  In order to check the functioning point on the low temperature side of the solenoid valve thermostat (TMS3) at −10/−7°C (+14/+19.4°F), set the unit to −18°C (−0.4°F).
- When dial resistance is used for the check, refer to the conversion table for "Resistance vs. Temperature".

1) Connect the dial resistor to the thermistor terminals, 32 and 33 and check the printed circuit board.
2) Set the setter to 0°C (32°F).
3) Raise temperature of the dial resistor gradually from −50°C (−58°F) (77.5810kΩ) to 70°C (158°F) and then make it drop down to −50°C (−58°F) again. (Refe to table for thermistor resistance.)
4) Check that functioning points of the thermostat accord with the points are thermostat temperature setting.

b. Checking timers for their outputs

- 2D1, 2D2, 2D4
  Check the defrost initiation timers, 2D1, 2D2 and 2D4 by use of the test switch.



When the timer test switch is turned on continuously, the following timer countings are shortened.
2D1 4 hours→4 seconds
2D2 12 hours→12 seconds
2D4 90 minutes→9 seconds

- Set the set point selector to the temperature at which the unit starts and the lamp for IN RANGE goes off. When the timer test switch is turned on continuously, timer counting is shortened and defrosting starts. Defrosting will start by 2D1 4 seconds later after turning on the test switch, and the pilot lamps for DEFROST and IN RANGE will light up. So measure such a time lag. After initiation of defrosting, the lamp for IN RANGE will go off 9 seconds later by 2D4, so measure such a time lag.
- Regarding 2D2, operate the unit in the same manner and set the set point selector to the temperature at which the lamp for IN RANGE lights up. The lamp for DEFROST will light up 12 seconds later by 2D2 after turning on continuously the timer test switch.
- 2D3
  Operate the unit and turn on the manual defrost switch to start defrosting, and pump-down operation will start soon. When pump-down operation is finished, the compressor will stop for 20 seconds by 2D3 and then will restart.
- 2F1
  When the operation switch is turned on at inside temperature above 25°C (+77°F), the fan is delayed in starting by 10 seconds by 2F1, and then will run in low speed.
- 2F2
  After finishing defrosting (after the lamp for DEFROST going off), the fan is delayed in starting by one minute by 2F2, and will run.

c. Check points of thermistor

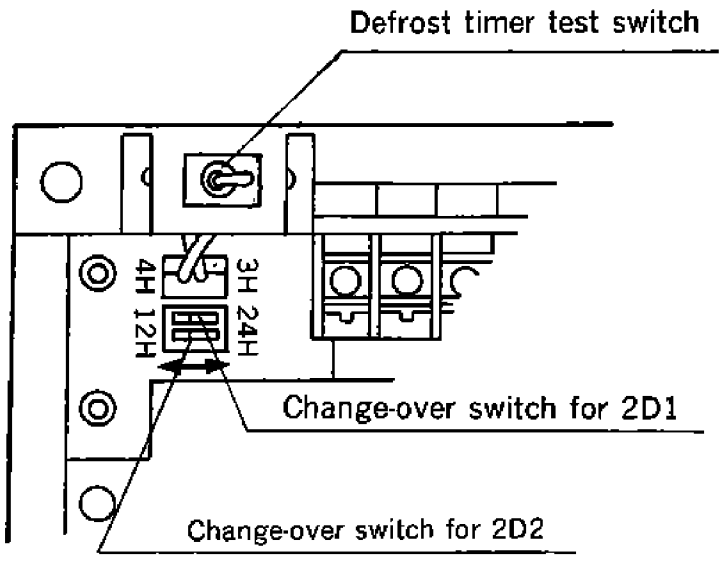
Remove the thermistor from the terminals, 32 and 33 and measure its resistance with a digital voltmeter, and at the same time measure inside temperature with a thermistor thermometer. Then, check that error is within ±1.0°C (±1.8°F) using the attached table for thermistor resistance.
In addition, prepare water, in which ice cubes are put and put a mercury thermometer and thermistor in it and check that error is within ±1.0°C (±1.8°F) by use of the table for thermistor resistance.
If such error differs largely with that in the table, replace the thermistor, as it must be faulty.

③ **Timer change-over switch**

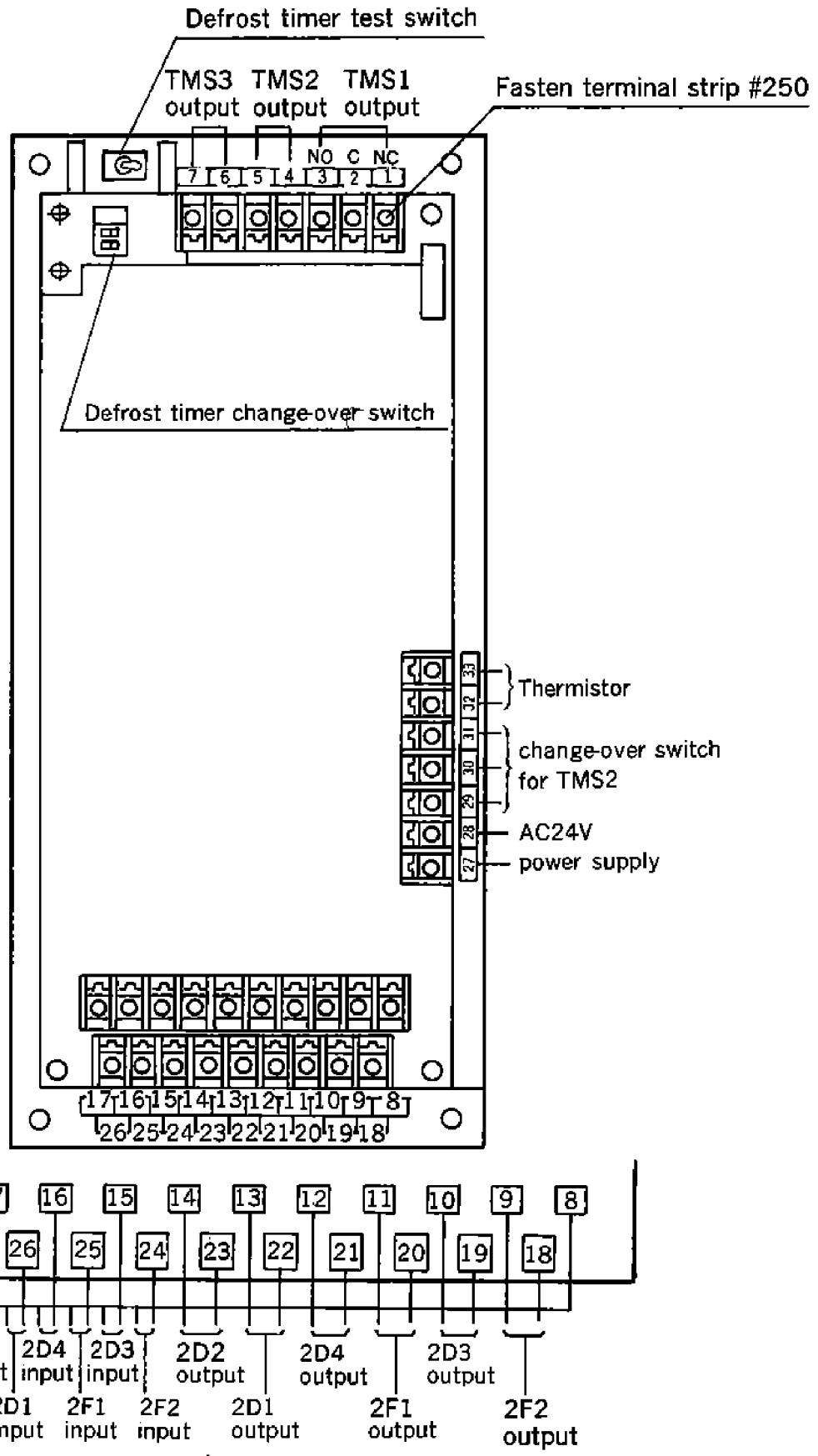
The defrost initiation timers, 2D1 and 2D2 can be changed in timer settings by the timer change-over switch.

Use a small screwdriver to change timer settings.

	Factory setting	Switch change-over
2D1	4H(hr)	3H(hr)
2D2	12H(hr)	24H(hr)



④ **External wiring**



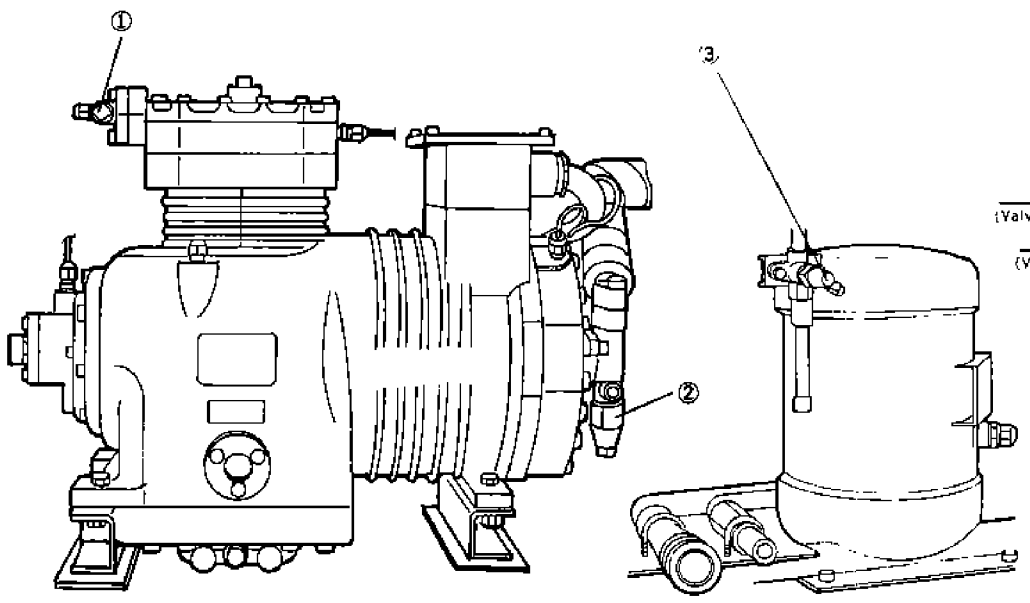
⑤ Sensor characteristics (Resistance-temperature conversion table)

Temperature °C (°F)	Resistance KΩ	Temperature °C (°F)	Resistance KΩ	Temperature °C (°F)	Resistance KΩ	Temperature °C (°F)	Resistance KΩ	Temperature °C (°F)	Resistance KΩ
−50 (−58)	77.5810	−27.5(−17.5)	22.0854	−5 (23)	7.4810	17.5(63.5)	2.9140	40 (104)	1.2740
−49.5(−57.1)	75.2718	−27 (−16.6)	21.5230	−4.5(23.9)	7.3151	18 (64.4)	2.8575	40.5(104.9)	1.2522
−49 (−56.2)	73.0412	−26.5(−15.7)	20.9770	−4 (24.8)	7.1534	18.5(65.3)	2.8023	41 (105.8)	1.2309
−48.5(−55.3)	70.8862	−26 (−14.8)	20.4471	−3.5(25.7)	6.9959	19 (66.2)	2.7483	41.5(106.7)	1.2100
−48 (−54.4)	68.8039	−25.5(−13.9)	19.9326	−3 (26.6)	6.8422	19.5(67.1)	2.6956	42 (107.6)	1.1896
−47.5(−53.5)	66.7917	−25 (−13)	19.4330	−2.5(27.5)	6.6929	20 (68)	2.6440	42.5(108.5)	1.1695
−47 (−52.6)	64.8468	−24.5(−12.1)	18.9443	−2 (28.4)	6.5471	20.5(68.9)	2.5934	43 (109.4)	1.1498
−46.5(−51.7)	62.9667	−24 (−11.2)	18.4698	−1.5(29.3)	6.4051	21 (69.8)	2.5440	43.5(110.3)	1.1306
−46 (−50.8)	61.1491	−23.5(−10.3)	18.0090	−1 (30.2)	6.2666	21.5(70.7)	2.4957	44 (111.2)	1.1117
−45.5(−49.9)	59.3916	−23 (− 9.4)	17.5615	−0.5(31.1)	6.1316	22 (71.6)	2.4484	44.5(112.1)	1.0932
−45 (−49)	57.6920	−22.5(− 8.5)	17.1268	0 (32)	6.0000	22.5(72.5)	2.4022	45 (113)	1.0750
−44.5(−48.1)	56.0336	−22 (− 7.6)	16.7045	0.5(32.9)	5.8709	23 (73.4)	2.3570	45.5(113.9)	1.0571
−44 (−47.2)	54.4298	−21.5(− 6.7)	16.2943	1.0(33.8)	5.7450	23.5(74.3)	2.3128	46 (114.8)	1.0396
−43.5(−46.3)	52.8785	−21 (− 5.8)	15.8957	1.5(34.7)	5.6223	24 (75.2)	2.2696	46.5(115.7)	1.0224
−43 (−45.4)	51.3779	−20.5(− 4.9)	15.5084	2 (35.6)	5.5026	24.5(76.1)	2.2273	47 (116.6)	1.0055
−42.5(−44.5)	49.9262	−20 (− 4)	15.1320	2.5(36.5)	5.3859	25 (77)	2.1860	47.5(117.5)	0.9890
−42 (−43.6)	48.5215	−19.5(− 3.1)	14.7634	3 (37.4)	5.2720	25.5(77.9)	2.1454	48 (118.4)	0.9728
−41.5(−42.7)	47.1621	−19 (− 2.2)	14.4052	3.5(38.3)	5.1610	26 (78.8)	2.1056	48.5(119.3)	0.9569
−41 (−41.8)	45.8465	−18.5(− 1.3)	14.0571	4 (39.2)	5.0527	26.5(79.7)	2.0667	49 (120.2)	0.9413
−40.5(−40.9)	44.5729	−18 (− 0.4)	13.7186	4.5(40.1)	4.9471	27 (80.6)	2.0287	49.5(121.1)	0.9260
−40 (−40)	43.3400	−17.5(0.5)	13.3896	5 (41)	4.8440	27.5(81.5)	1.9915	50 (122)	0.9110
−39.5(−39.1)	42.1361	−17 (1.4)	13.0698	5.5(41.9)	4.7428	28 (82.4)	1.9550	50.5(122.9)	0.8962
−39 (−38.2)	40.9705	−16.5(2.3)	12.7587	6 (42.8)	4.6440	28.5(83.3)	1.9194	51 (123.8)	0.8817
−38.5(−37.3)	39.8420	−16 (3.2)	12.4563	6.5(43.7)	4.5477	29 (84.2)	1.8845	51.5(124.7)	0.8674
−38 (−36.4)	38.7491	−15.5(4.1)	12.1621	7 (44.6)	4.4536	29.5(85.1)	1.8504	52 (125.6)	0.8534
−37.5(−35.5)	37.6907	−15 (5)	11.8760	7.5(45.5)	4.3619	30 (86)	1.8170	52.5(126.5)	0.8397
−37 (−34.6)	36.6654	−14.5(5.9)	11.5958	8 (46.4)	4.2723	30.5(86.9)	1.7842	53 (127.4)	0.8263
−36.5(−33.7)	35.6722	−14 (6.8)	11.3233	8.5(47.3)	4.1849	31 (87.8)	1.7520	53.5(128.3)	0.8131
−36 (−32.8)	34.7100	−13.5(7.7)	11.0582	9 (48.2)	4.0996	31.5(88.7)	1.7205	54 (129.2)	0.8002
−35.5(−31.9)	33.7776	−13 (8.6)	10.8003	9.5(49.1)	4.0163	32 (89.6)	1.6897	54.5(130.1)	0.7875
−35 (−31)	32.8740	−12.5(9.5)	10.5493	10 (50)	3.9350	32.5(90.5)	1.6596	55 (131)	0.7750
−34.5(−30.1)	31.9911	−12 (10.4)	10.3051	10.5(50.9)	3.8553	33 (91.4)	1.6300	55.5(131.9)	0.7627
−34 (−29.2)	31.1355	−11.5(11.3)	10.0675	11 (51.8)	3.7775	33.5(92.3)	1.6011	56 (132.8)	0.7507
−33.5(−28.3)	30.3063	−11 (12.2)	9.8363	11.5(52.7)	3.7015	34 (93.2)	1.5728	56.5(133.7)	0.7388
−33 (−27.4)	29.5024	−10.5(13.1)	9.6111	12 (53.6)	3.6273	34.5(94.1)	1.5451	57 (134.6)	0.7272
−32.5(−26.5)	28.7230	−10 (14)	9.3920	12.5(54.5)	3.5548	35 (95)	1.5180	57.5(135.5)	0.7158
−32 (−25.6)	27.9674	−9.5(14.9)	9.1772	13 (55.4)	3.4840	35.5(95.9)	1.4913	58 (136.4)	0.7047
−31.5(−24.7)	27.2346	−9 (15.8)	8.9681	13.5(56.3)	3.4149	36 (96.8)	1.4651	58.5(137.3)	0.6937
−31 (−23.8)	26.5239	−8.5(16.7)	8.7645	14 (57.2)	3.3474	36.5(97.7)	1.4394	59 (138.2)	0.6829
−30.5(−22.9)	25.8347	−8 (17.6)	8.5663	14.5(58.1)	3.2814	37 (98.6)	1.4143	59.5(139.1)	0.6724
−30 (−22)	25.1660	−7.5(18.5)	8.3732	15 (59)	3.2170	37.5(99.5)	1.3897	60 (140)	0.6620
−29.5(−21.1)	24.5121	−7 (19.4)	8.1853	15.5(59.9)	3.1536	38 (100.4)	1.3656		
−29 (−20.2)	23.8776	−6.5(20.3)	8.0022	16 (60.8)	3.0916	38.5(101.3)	1.3420		
−28.5(−19.3)	23.2621	−6 (21.2)	7.8239	16.5(61.7)	3.0310	39 (102.2)	1.3189		
−28 (−18.4)	22.6649	−5.5(22.1)	7.6502	17 (62.6)	2.9718	39.5(103.1)	1.2962		

6. Maintenance

6.1 Handling method of the stop valves

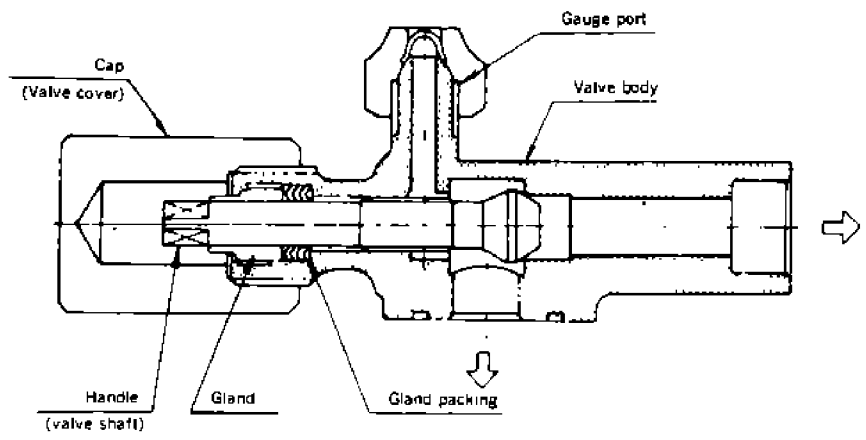
(1) Place of the stop valve and its kind



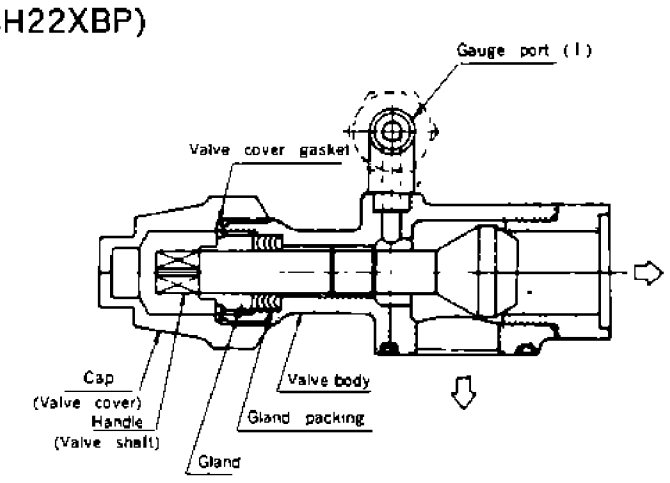
① Stop valve at compressor discharge side
② Stop valve at compressor suction side
③ Stop valve at water cooled condenser outlet side

(2) Structure of stop valve

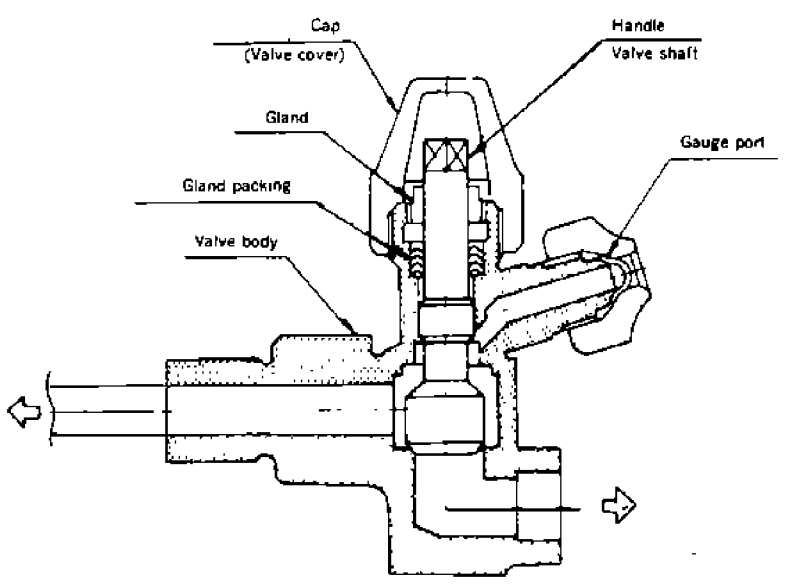
1 Stop valve at compressor discharge side (VSH10VAP-5S)



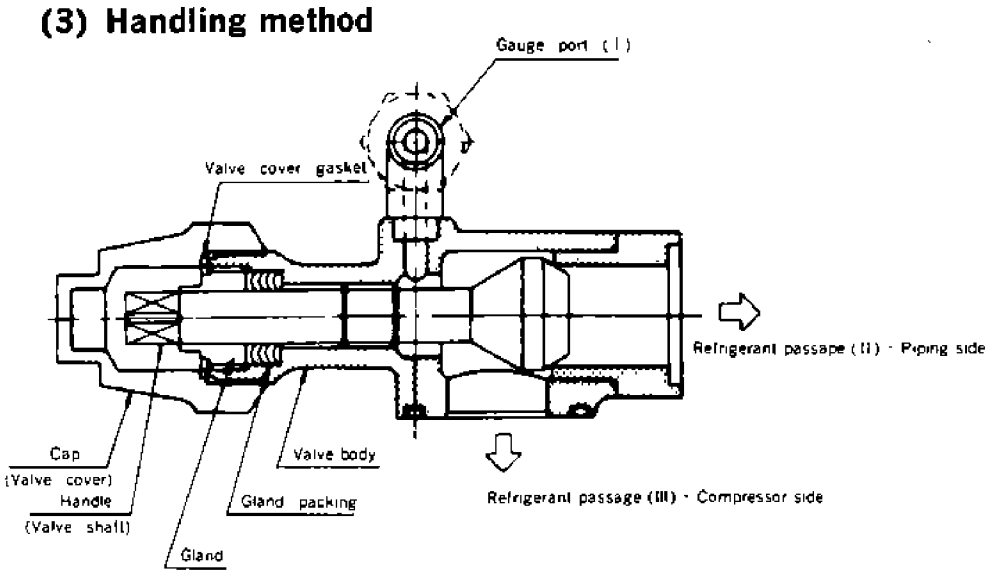
2 Stop valve at compressor suction side (VSH22XBP)



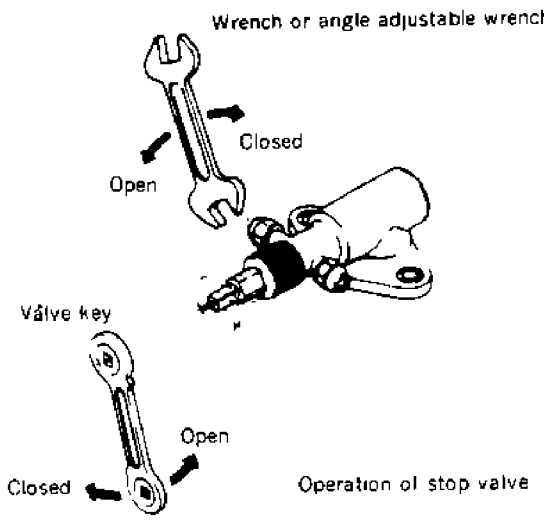
3 Stop valve at water cooled condenser outlet side (VSV10CBP-4S-4SR)



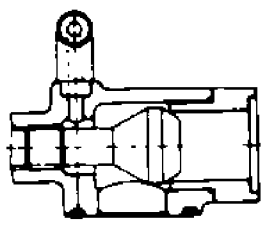
(3) Handling method



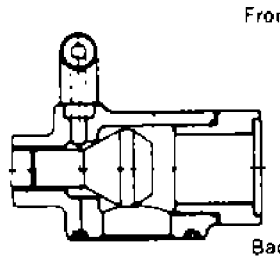
1) Remove the valve cap. At this time, be careful not to lose the gasket.
2) Loosen the gland in a way the refrigerant is not extracted.
3) Fully close the handle ·····The refrigerant passage I is connected to III (Front seat)
4) Fully release the handle·····The refrigerant passage II is connected to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



Front seat

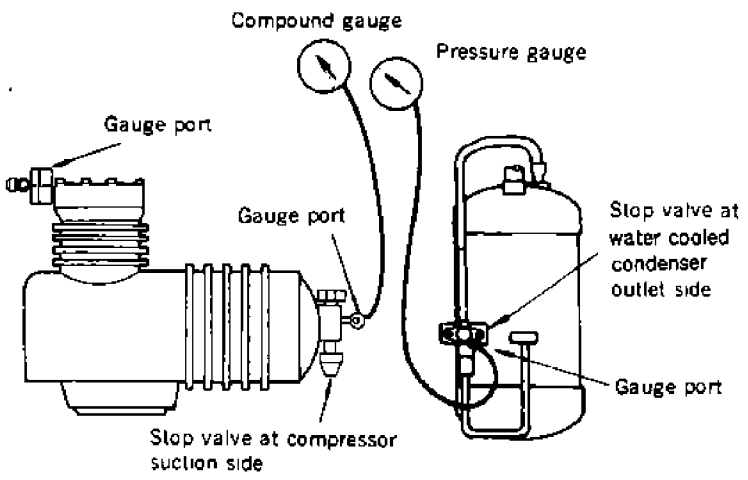


Back seat

6.2 Attaching or removing points of pressure gauges

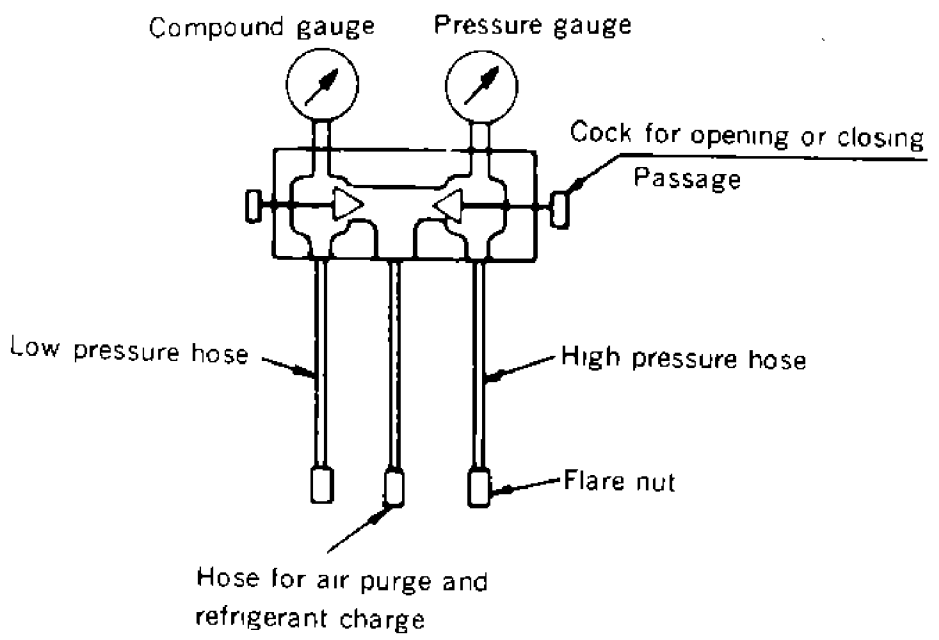
(1) Attaching a general pressure gauge

1) After opening the compressor suction valve and the water cooled condenser 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 unit is stopped without pump down.

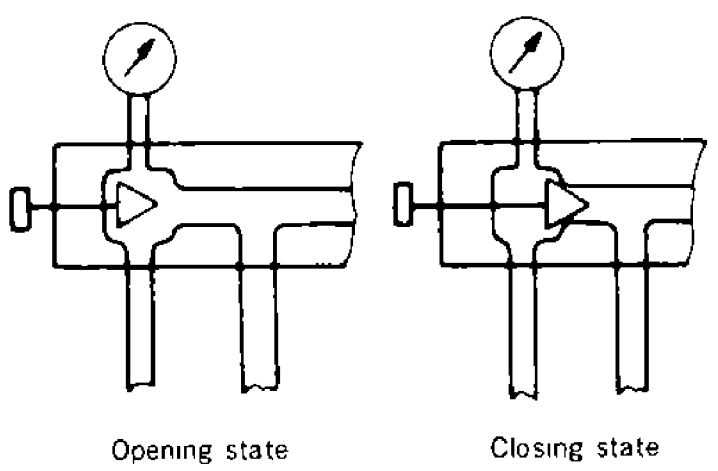


(2) Attaching the gauge manifold

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



Structure of gauge manifold



Opening and closing states of gauge manifold

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

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

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

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

6.3 Pump down

Pump down means that the refrigerant in the refrigeration circuit is liquidized and collected in the water cooled condenser. 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 water cooled condenser outlet valve.
4) Stop the operation when reading of the low pressure gauge becomes 0.1 kg/cm² and close the compressor discharge valve.
5) After a short while, read the low pressure gauge. If pressure rises, open the compressor discharge valve and repeat the same procedure.
6) Repeat the same procedure two or three times, and the refrigerant is collected in the water cooled condenser.

6.4 Charging and purging the refrigerant, refrigeration oil

(1) Purging non-condensable gas

If non-condensable gas such as air exsits in the refrigeration circuit, it is collected by the water cooled condenser, which raise pressure in the water cooled condenser abnormally high and reduces heat transferring ratio of the condenser surface. If 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 water cooled condenser 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 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 water cooled condenser 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 water cooled condenser 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 water cooled condenser, otherwise the refrigerant oil and the liquid refrigerant are discharged, which may result in shortage of oil or getting chillblains.
3) Do not extract the refrigerant in a closed room and also confirm there is no fire around it. Although the refrigerant is non-toxic, there may be fear of suffocation. In addition, if the refrigerant contacts with fire, it yields phosgene gas (toxic gas).

(3) Vacuum drying and charging refrigerant and refrigeration oil

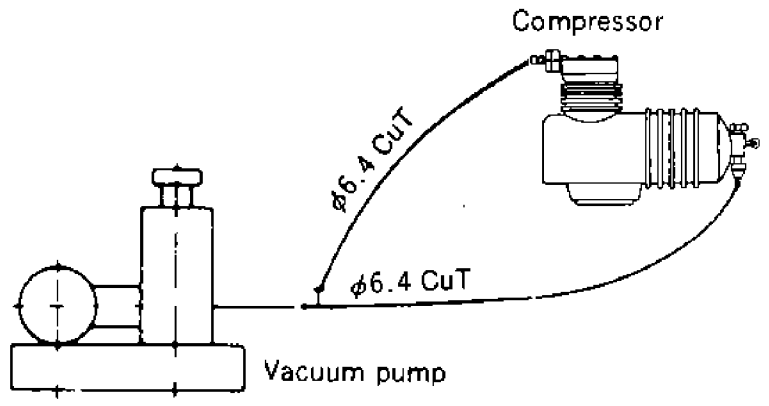
If all the refrigerant has leaked out and the air is intermixed in the refrigeration circuit, repair a cause of trouble and do vacuum drying. Then charge the predesigned volume of refrigerant. In case the refrigerant oil is replaced, do the same.

(Required tools)

1. Refrigerant cylinder (20 kg) for R12 (CC12F2) with mouth piece
2. Refrigeration oil (20 ℓ can) SUNISO 3GS-DI
3. ϕ6.4 CuT (with two flare nuts) } or gauge manifold
4. Pressure gauge (20 kg/cm²), compound gauge (10 kg/cm²×75 cmHg) } or gauge manifold
5. Weighing scale (Up to 50 kg)
6. Tools
7. Vaccum pump

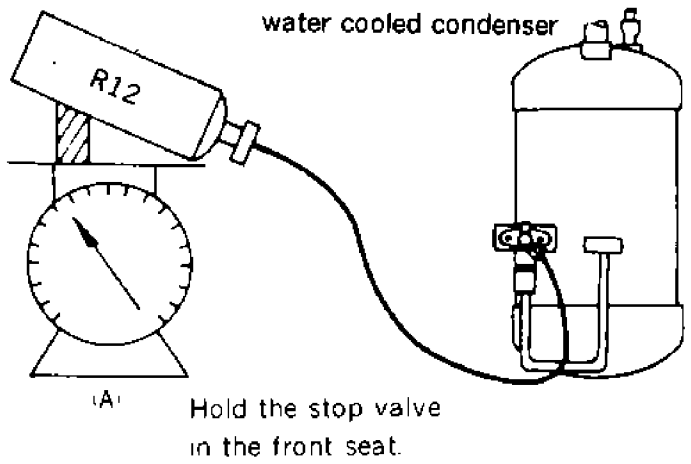
(a) In case the refrigerant is replenished without exchanging the refrigeration oil.

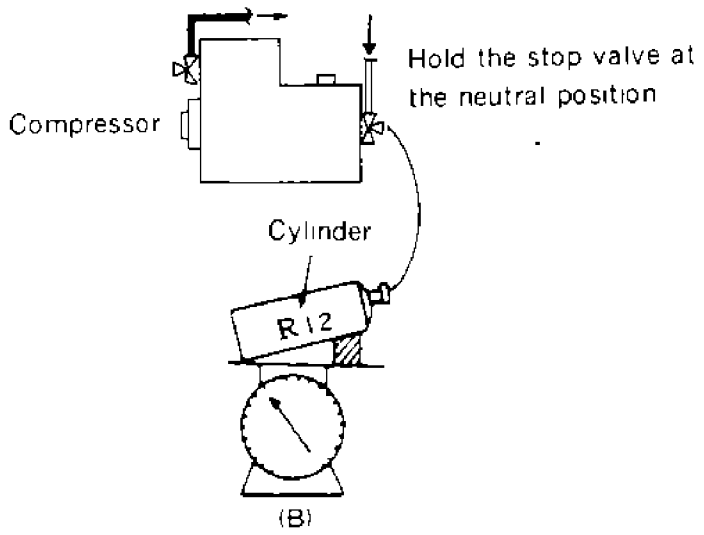
1) Connect the vacuum pump to the gauge ports of the compressor suction and discharge valves, form vacuum down to 76 cmHg, hold the stop valve in the back seat state and then remove the vacuum pump, leaving the vacuum state in the refrigeration circuit. However, when air enters in the refrigeration circuit,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



2) Place a refrigerant cylinder on the weighting scale, and record its weight.

3) In case the refrigerant is charged in the liquid state, do it as shown in the below figure (A). Prevent the liquid refrigerant collected in the water cooled condenser from flowing to the low pressure side. If the refrigerant is hardly charged, operate the compressor to charge it.





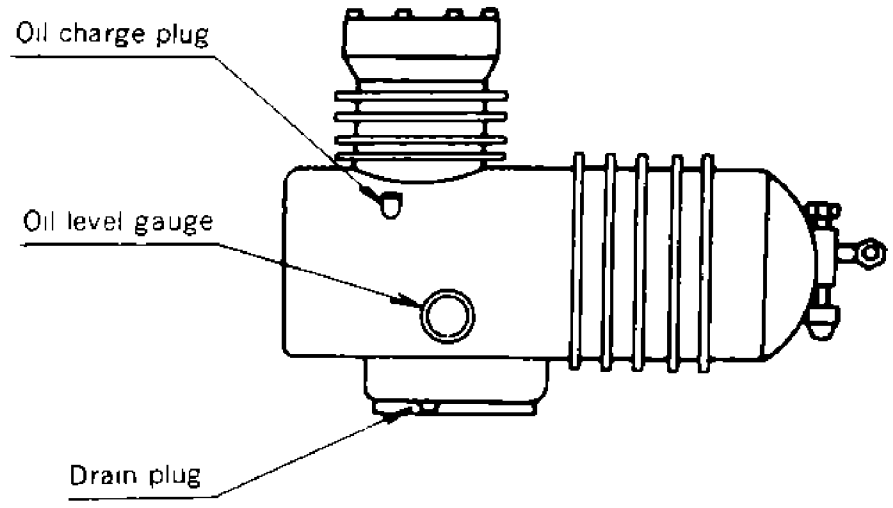
4) In case the refrigerant it charged in the gaseous state, do it as shown in above figure (B). If the refrigerant is hardly charged, operate the compressor to charge it.

5) Charge the predesigned volume of the refrigerant in the above stated methods either in 4 or 5.

6) 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 SUNINO 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 water cooled condenser and stop it when low pressure becomes 0.1 kg/cm².

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.

6.5 Check points for high pressure switch

Check the high pressure switch for functioning after stopping the condenser fans so as to raise discharge pressure. Remove the lead wire on the strip in the switch box to stop the condenser fans. After finishing the test, provide rewiring accurately as it was.