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DAIKIN

Marine type

Container Refrigeration Unit

Service manual

Model

LKS502 TYKR1

DANGER

Do not disconnect plug until power supply is shut off.

CAUTION

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

NOTE

- 1 . Wind drive spring of recording temperature controller whenever chart is renewed.
- 2 . Tighten control box cover securely.

Index

	Page
1. General specifications	1
1.1 Specifications	1
1.2 Capacity and electrical characteristics	2
1.3 Set values of functional parts	3
2. Construction	4
2.1 Condenser section and power transformer	4
2.2 Control box	5
2.3 Evaporator section	6
3. Piping diagram	7
4. Wiring diagram	8
5. Operating instructions	11
5.1 Operating instructions	11
5.2 Refrigeration and heating operation	12
5.3 Usage of power transformer	13
5.4 Air cooled and water cooled operation	14
5.5 Defrosting operation	15
5.6 Pilot lamps and remote monitoring lamps	16
6. Periodical inspection	17
7. Inspection and adjusting methods	18
7.1 Recording temperature controller	18
7.2 Air pressure switch for defrost initiation	23
7.3 Dual pressure switch	23
8. Trouble and countermeasures	24
9. Maintenance	26
9.1 Replacement of fusible plug	27
9.2 Replacement of dryer	28
9.3 Purging of non-condensable gas	28
9.4 Additional charge of refrigerant and lubricant	28
9.5 Vacuum drying and charging refrigerant and lubricant	29
9.6 Gas leakage test	30
9.7 Caution for replacement of flexible tube	31

1. General specifications

1.1 Specifications

Model	LKS502TYKR1	
Type	Air and water cooled separate type	
Power supply	AC 200V 3 Phase 50/60Hz AC 220V 3 Phase 60Hz AC 415V 3 Phase 50Hz AC 440V 3 Phase 60Hz	
Compressor	Type	Semi hermetic type
	Model	2HC58LB 2 cyl. x 58 bore x 60 stroke (mm)
	Rated output	3.75 kW 1450/1725 rpm (50/60 Hz)
	Crankcase heater	45 W x 2
Air cooled condenser	Cross finned coil type	
Water cooled condenser	Shell and finned tube type	
Evaporator	Cross finned coil type	
Fan	Motor direct driven propeller type	
Cond. fan motor	0.2 kW x 2	
Evap. fan motor	0.2 kW x 2	
Defrost		
Heat source	Electric heater	
Initiation	Air pressure switch (detecting evaporator pressure difference), timer or manual switch.	
Termination	Thermostat mounted on evaporator	
Electric heater		
Defrost heater	0.5 kW x 6	
Drain pan heater	0.5 kW x 2	
Drain pipe heater	0.25 kW x 2	
Recording temperature controller	Temp. range $-25^{\circ}\text{C} \sim +25^{\circ}\text{C}$ 31 days clock type	
Refrigerant control	Thermostatic expansion valve	
Protection devices	Circuit breaker, Over current relay, Fuse, Dual pressure switch, Oil pressure protection switch, Fusible plug, Firestat, Compressor motor protection thermostat, Fan motor protection thermostat.	
Pilot lamp	Green : Compressor running Red : Defrosting operation Orange : Within temperature White : Power supply	
Cooling water	Fresh water	
Refrigerant	R-12 (5.5 kg)	
Lubricant	SUNISO 3GS-DI (2.3 l)	
Weight	Approx. 585 kg (Including power transformer)	

1.2 Capacity and electrical characteristics

Item		Model	LKS502TYKR1		
Refrigerating capacity		kcal/h	2,700	5,200	
Operating conditions	Storage temperature	°C	−18 (0° F)	4 (40° F)	
	Ambient temperature for air-cooled operation	°C	35 (95° F)		
	Cooling water rate for water-cooled operation	ℓ/min.	Max. 27		
	Entering cooling water temperature	°C	Max. 36 (96.8° F)		
Heating capacity		kW	5.1 (Including fan motor input)		
Power	Refrigeration	kW	5.8	5.8	
	Heating	kW	5.3	5.3	
Electrical characteristics	Power supply		AC 220V 3 phase 60Hz	AC 440V 3 phase 60Hz	
	Running current		A	Max. 19	
	Overall starting current		A	121	
	Overall current	Defrosting	A	12.5	6.3
		Heating	A	15	7.5
		Refrigeration	A	15	7.5
Conditions for refrigeration operation		Ambient temperature 35°C at storage temperature −18°C			

Note; Refrigerating capacity is based on 60 Hz operation.

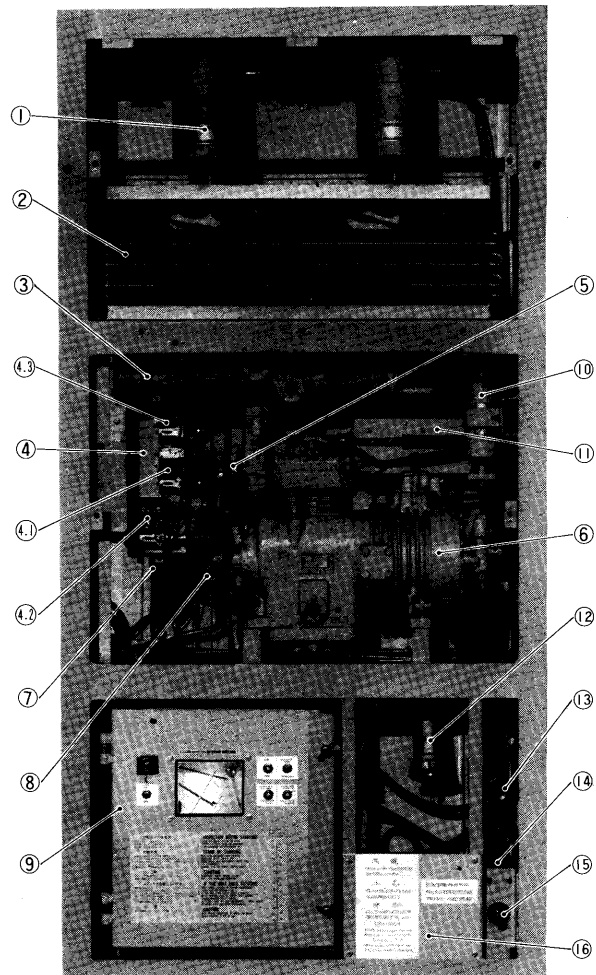
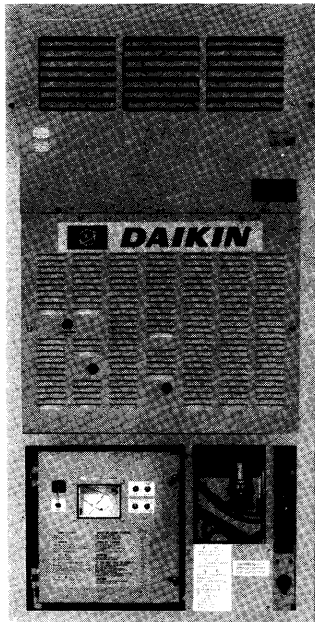
1.3 Set values of functional parts

Part name	Function	Set value
1. Oil pressure control switch ONS-C106Q	Heater circuit OFF	1.0±0.2 kg/cm ²
	ON	0.5±0.2 kg/cm ²
	Timer	110±20 seconds (ambient temperature 20°C) More than 5 seconds (ambient temperature 70°C)
2. Dual pressure switch DNS-D306Q	Low pressure OFF	40±14 cmHgV
	ON	0.2 ^{+0.3} _{-0.2} kg/cm ²
	High pressure OFF	20±0.75 kg/cm ²
	ON	16.5±1.25 kg/cm ²
3. Water pressure switch SNS-C106WQ	OFF	1.0±0.2 kg/cm ²
	ON	0.4±0.2 kg/cm ²
4. Compressor thermal protector KLIXON-No. 7895	OFF	90°C (194°F)
	ON	68°C (154°F)
5. Firestat KLIXON 20420L/L160-4	OFF	71°C (160°F)
	ON	49°C (120°F)
6. Defrost termination switch KLIXON 20420L/L45-1	OFF	7.2°C (45°F)
	ON	1.67°C (35°F)
7. Air switch for defrost BEC No. 19-R70-B	ON	44±2mmH ₂ O
8. Defrost timer STP-73	ON	12h (60 Hz)
		14¼h (50 Hz)
9. Fan motor protection thermostat	OFF	120°C (248°F)
10. Overcurrent relay CR-20-NP ₂ S ₄	OFF	19A

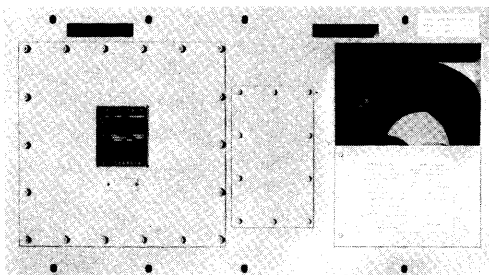
2. Construction

2.1 Condenser section and power transformer

Condenser section

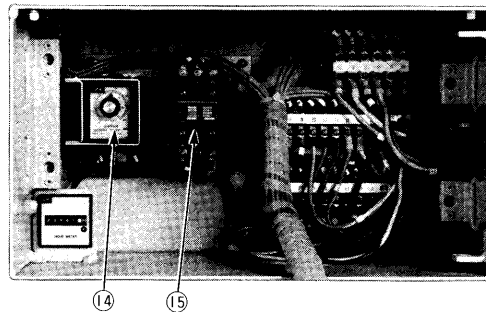
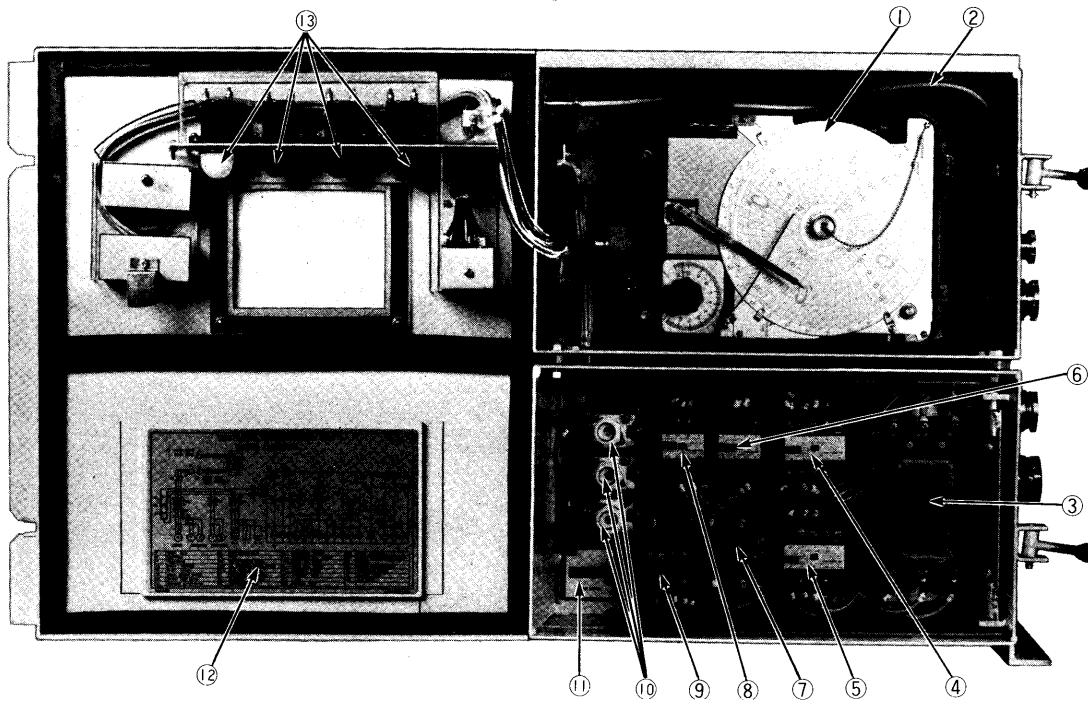


Power transformer



- | | |
|--|----------------------------------|
| ① Condenser fan motor | ⑧ Liquid indicator |
| ② Air cooled condenser | ⑨ Control box |
| ③ Water cooled condenser | ⑩ Dryer |
| ④ Pressure switch box | ⑪ Junction box |
| ④.1 Dual pressure switch | ⑫ Receptacle |
| ④.2 Oil pressure protection switch | ⑬ Cooling water outlet coupling |
| ④.3 Water pressure switch | ⑭ Water regulating valve |
| ⑤ Solenoid valve | ⑮ Cooling water inlet coupling |
| ⑥ Compressor | ⑯ 200V class power cable storage |
| ⑦ Air pressure switch for defrost initiation | ⑰ 400V class power cable storage |

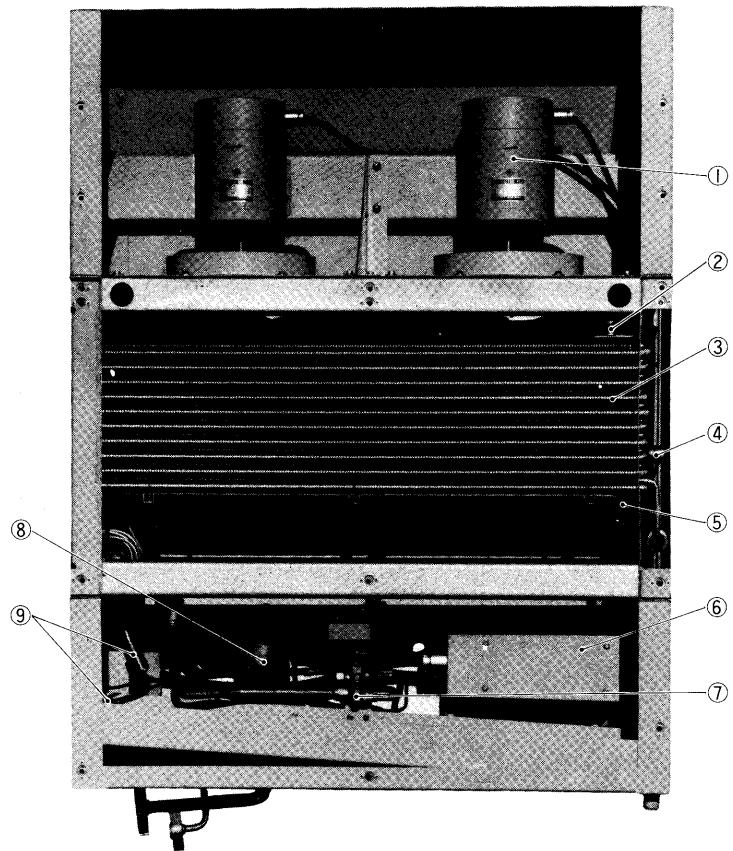
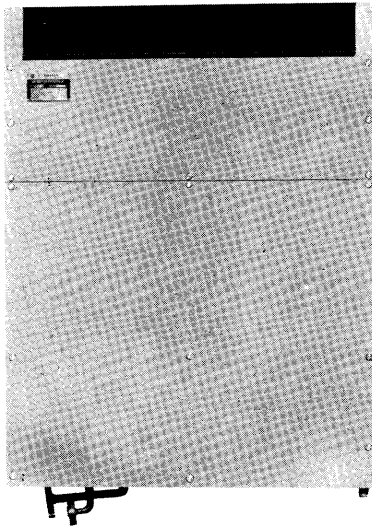
2.2 Control box



The bottom of control box (lower)

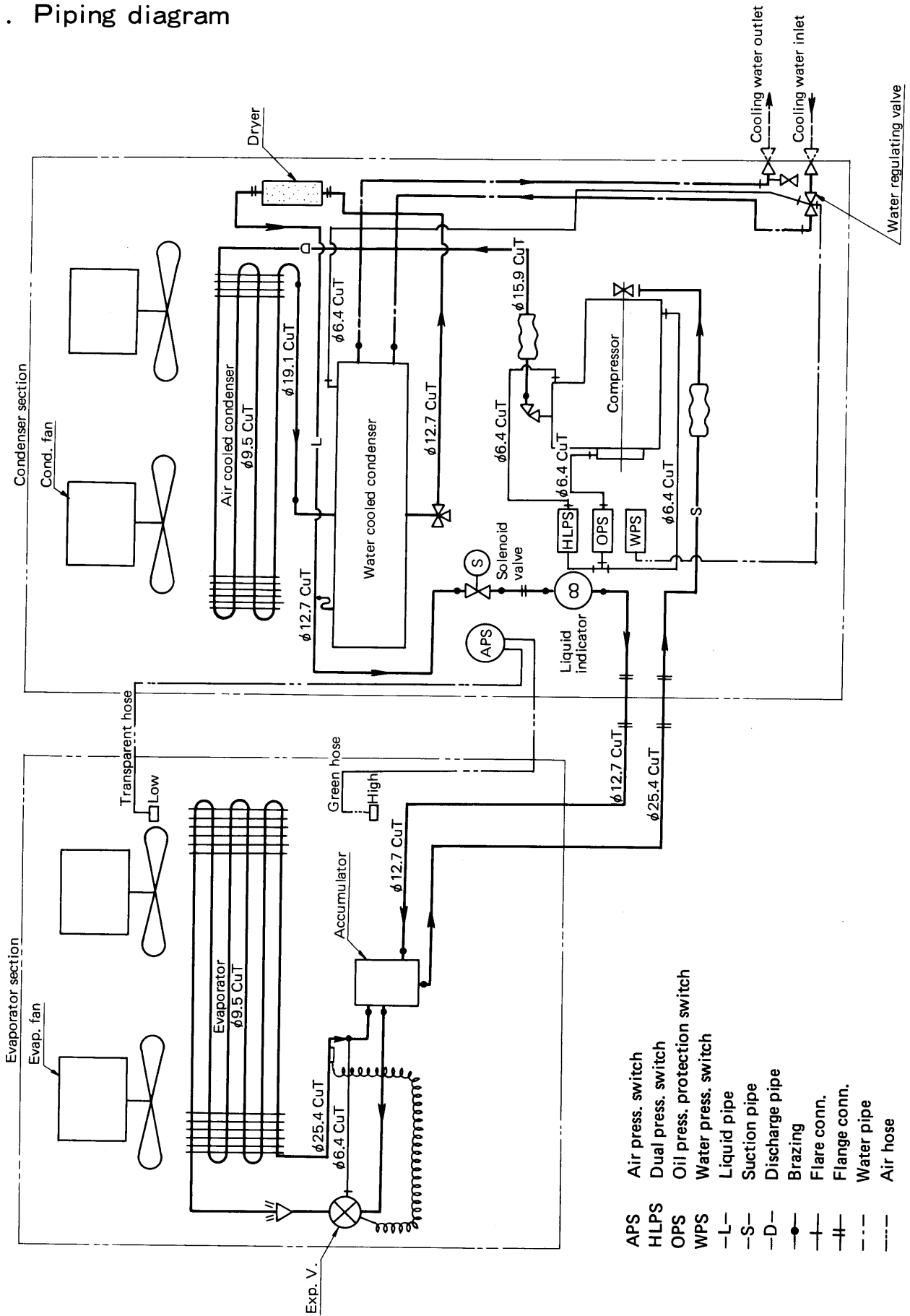
- ① Recording temperature controller
- ② Connector for inside temperature sensor leads
- ③ Circuit breaker
- ④ Magnetic switch for compressor
- ⑤ Magnetic switch for heater
- ⑥ Magnetic switch for evaporator fan motor
- ⑦ Over current relay
- ⑧ Magnetic relay for crankcase heater
- ⑨ Magnetic relay for defrosting
- ⑩ Fuse
- ⑪ Hour Meter
- ⑫ Wiring diagram
- ⑬ Pilot lamp
- ⑭ Defrost timer
- ⑮ Transformer for control circuit

2.3 Evaporator section

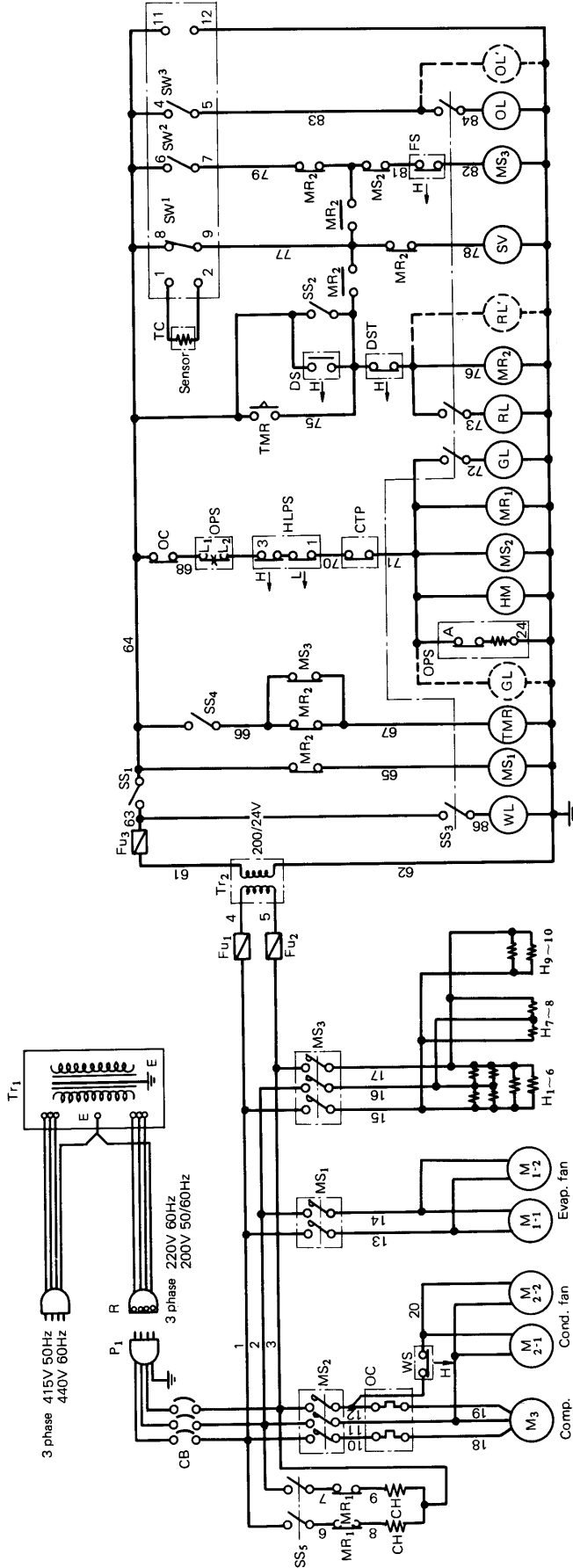


- ① Evaporator fan motor
- ② firestat
- ③ Evaporator
- ④ Defrost termination thermostat
- ⑤ Evaporator coil heater
- ⑥ Junction box
- ⑦ Expansion valve
- ⑧ Accumulator with heat exchanger
- ⑨ Drain pan heater

3. Piping diagram



4. Wiring diagram



Mark	Name	Mark	Name	Mark	Name
P1,2	Power plug	H7~8	Drain pan heater	TMR	Defrost timer
CB	Circuit breaker	H9~10	Drain pipe heater	CTP	Motor protector
OC	Over current relay	Fu1,2,3	Fuse	DST	Defrost termination thermostat
M1	Evaporator fan motor	SS1	ON - OFF switch	FS	Firestat
M2	Condenser fan motor	SS2	Manual defrost switch	DS	Defrost initiation switch
M3	Compressor motor	SS3	Lamp switch	TC	Temperature controller
WS	Water pressure switch	SS4	Defrost timer switch	SV	Solenoid valve
HLP5	Dual pressure switch	SS5	Crank case heater switch	GL,RL,OL,WL	Lamp
OPS	Oil pressure protection switch	MS1	Magnetic switch for fan motor	R	Receptacle
Tr1,2	Transformer	MS2	Magnetic switch for compressor	HM	Hour meter
CH	Crankcase heater	MS3	Magnetic switch for heater		
H1~6	Evaporator coil heater	MR1,2	Magnetic relay		

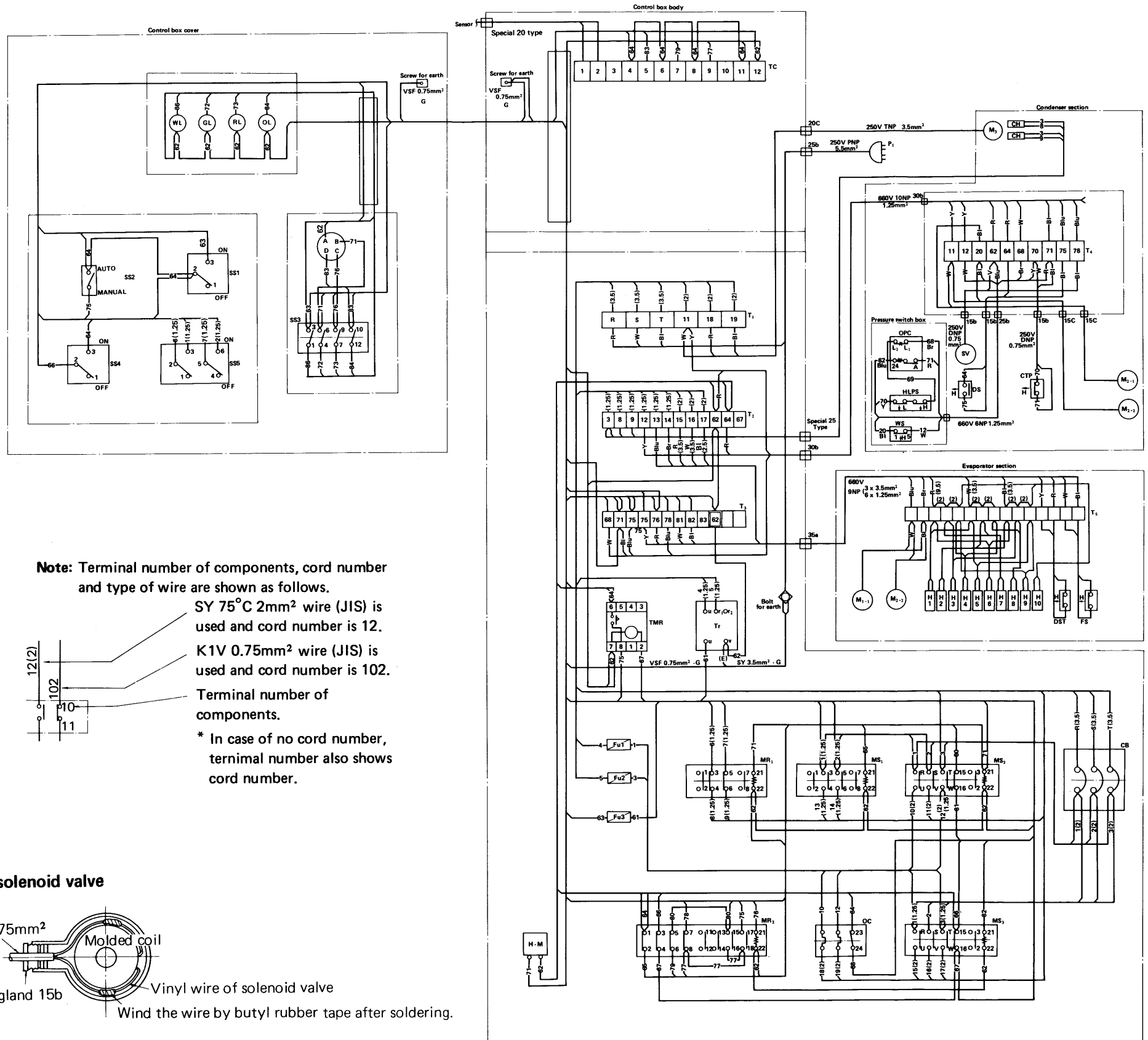
NOTE

- Monitoring plug connected as follows.

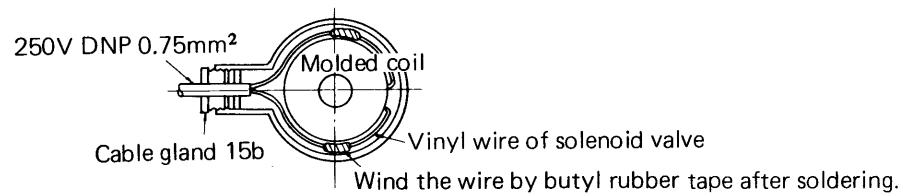


- Broken line shows external wiring.

Actual wiring diagram



Wiring in the solenoid valve



5 . Operating instructions

5.1 Operating instructions

Operate the unit according to the following instructions.

(1) Inspection before operation

- (a) Checking of external appearance.
- (b) Fastening of bolts, nuts, magnetic switches, magnetic relays and plugs.
- (c) Checking breakage of wiring in control box and entire system, electrical insulation, clogging of contact points of magnetic switches and magnetic relays.
- (d) Checking oil level of compressor oil level gauge and purity of oil (the oil level should be at the middle of the round window of the gauge)
- (e) Checking the oil pressure protection switch for reset.
- (f) Checking drain cock of water cooled condenser for opening during air cooled operation. (to prevent water freezing)
- (g) Checking that refrigerant stop valves on the compressor discharging and suction sides, and outlet side of the water cooled condenser are opened.

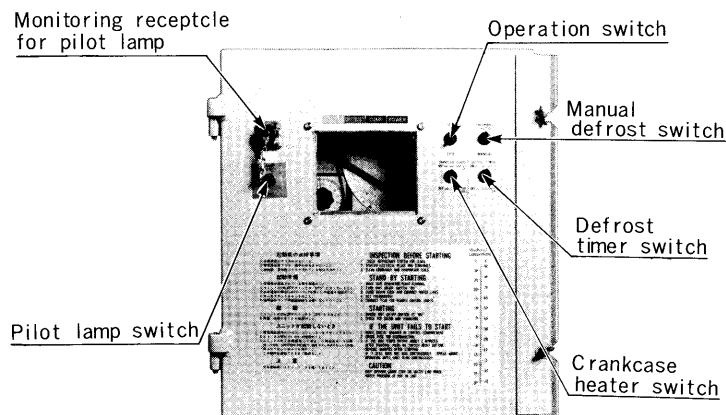
(2) Connect the cooling water couplings. (In case of water cooling operation)

(3) Connect the power plug to the power source.

(4) Wind the drive spring of recording temperature controller and adjust the setting knob to the inside temperature to be maintained.

(5) Operate the generator set, if it is used.

(6) Turn "ON" the operation switch on the control box cover.



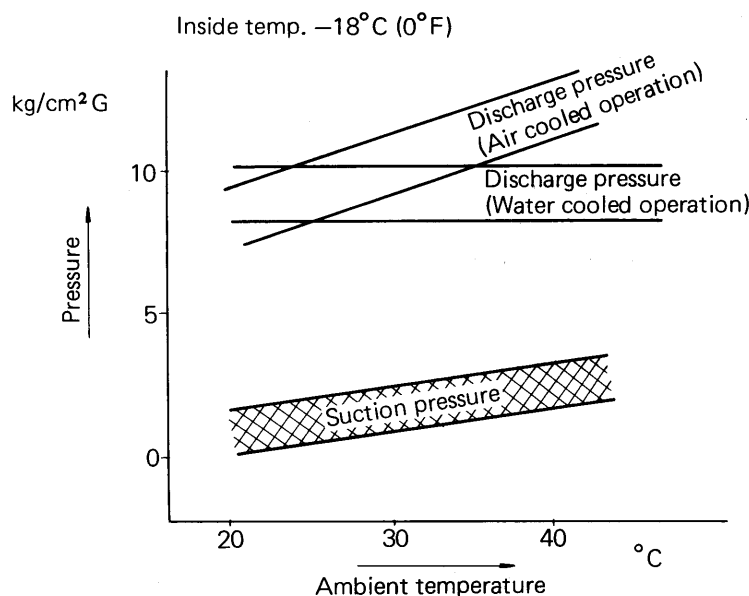
Each switches on the cover of control box

(7) Inspection during operation

- (a) Inspect suction and discharge pressure of the compressor. With regard to attaching gauges, refer to Item 9.
- (b) Check the oil level gauge of the compressor. Oil level during the operation is approx. half the oil level gauge, and oil level during an idle period is a little higher than half. For a while after start up, the oil level may be invisible, but it will gradually rise. If the oil level is invisible for a long time, it is necessary to discover the cause. Do not add oil.
- (c) Be certain that no refrigerant leakage is found from the refrigerant system with the gas detector.
- (d) Confirm lighting and turning off of pilot lamps.
- (e) Be certain of operation of control and protection devices.
- (f) Be certain that there is no unusual noise and vibration.
- (g) Be certain that voltage and current are correct.

- (h) Be certain the liquid indication is green. Check if refrigerant flashing is observed. In case of ambient temperature is high during air cooled operation, air cells may be found, or at the beginning or the water cooled operation air cells may be visible in the refrigerant.
- (i) Be certain that no oil leakage is found.
- (j) Be certain that no liquid back and liquid hammer occur.

Outline of the operating pressure to the ambient temperature



Note: Discharge pressure can be kept constantly and not subjected to the ambient temperature during water cooled operation.

5.2 Refrigeration and heating operation

The unit is possible to operate either ways refrigeration or heating operations.

Changeover of the operations between refrigeration and heating is realized automatically by the recording temperature controller, and the inside temperature of the container can be maintained constantly without affected by the variation of ambient temperature.

Heating is accomplished by electric heaters. During the heating operation, the heaters located on the lower part of the evaporator and that attached to the drain pan and drain pipe function. In addition, the evaporator fan motors function as heaters.

The relay for heater in the recording temperature controller has a electrical circuit which comes to "OFF" when the temperature setting is lower than -6.7°C (20°F). In case the inside temperature is low, heating load is large, so there is no need to heat forcedly. If heated wrongly, there is a fear of imparing the quality of the cargo.

Therefore, the heater has been set so as not to operate under -6.7°C (20°F).

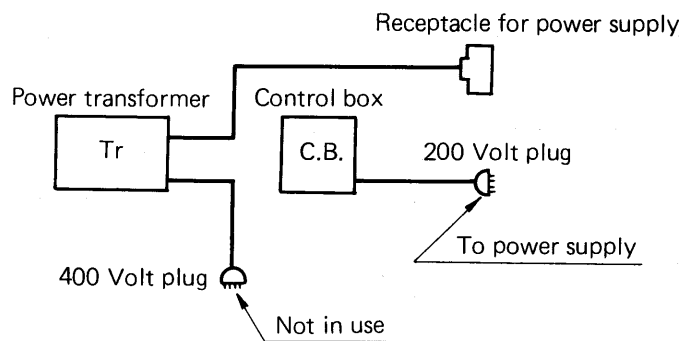
The compressor and the electric heaters are controlled to prevent from coming into operation simultaneously. To the upper part of the evaporator, the firestat is attached to stop the electric heater when heat rises abnormally.

5.3 Usage of power transformer

The unit is possible to operate on either ways 200V class or 400V class power supply by means of power transformer.

■ **In case of 200V class power supply.**

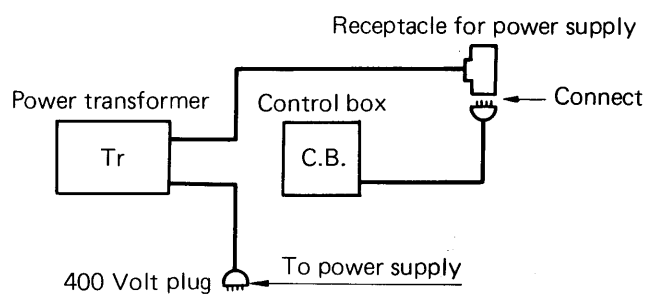
- (1) Connect 200V class power plug in the unit to power source



Connection diagram of power cables under 200V class operation

■ **In case of 400V class power supply.**

- (1) Connect 200V class power plug to receptacle in the unit for power source.
- (2) Connect 400V class power plug in the power transformer to power source.



Connection diagram of power cables under 400V class operation

5.4 Air cooled and water cooled operation

(1) Change-over of operation between air cooled and water cooled

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

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

The operation can be changed from air cooled to water cooled and vice verce automatically by the water pressure switch; i.e. when water pressure at the inlet of the water cooled condenser rises higher than the presetting value, the contact points of the water pressure switch are cut out, so the condenser fan motors stop, and the water cooled operation starts. On the contrary, when water supply is suspended during the water cooled operation, the contact points of the water pressure switch come in contact and the condenser fan motors are rotated. Thus, the air cooled operation starts.

(2) Connecting method of the couplings for cooling water.

The cooling water pipes are connected to the inlet and outlet of the water cooled condenser with the quick coupling so that they can be connected or disconnected easily.

To accomplish the water cooled operation, the cooling water inlet and the outlet are piped and air in the water cooled condenser and the piping should be purged, and after that it is necessary to drain off all the water, according to the following instruction.

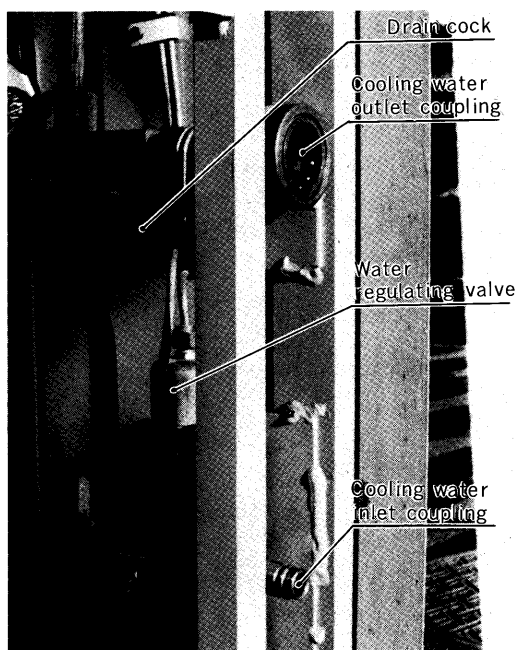
Note; During water cooled operation, fresh water shall be used as cooling water.

○ Before the water cooled operation:

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

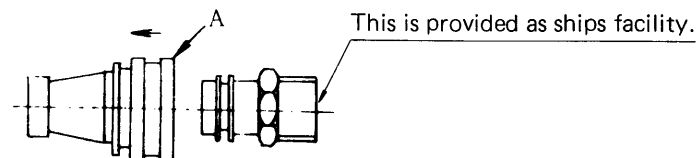
○ After the water cooled operation:

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



Water and drain connections

The water outlet coupling is designed to be open when connected with the other coupling but closed when separated from the other coupling so water flows when the outlet is connected, but does not flow when separated. The couplings should be connected in the order from the inlet to the outlet, coupling. When the cooling water couplings are connected, insert the coupling on the ship side into the coupling on the unit side until a "click" is heard. When disconnecting them, pull the coupling on the ship side toward you while pushing the A part of the female coupling in the direction pointed by an arrow mark.



Water connection at outlet side

5.5 Defrosting operation

The defrosting operation is accomplished by the electric heater used for heating either manually or automatically.

When the manual defrost switch on the front of the control box is turned towards "MANUAL", the manual defrosting is carried out.

However, when the manual defrosting switch SS_2 is released, it springs back from "MANUAL" to "AUTO" and the automatic operation is recovered. Further, manual defrosting is not accomplished unless temperature on the evaporator surface is 1.6°C (35°F) or less while the compressor is in operation.

The automatic defrosting is initiated by the defrosting air pressure switch DS and the defrost timer TMR. By this, the defrosting operation can be accurately accomplished even when one of them is out of order.

In case the defrosting air pressure switch DS functions, pressure difference before and behind the evaporator becomes large and the contact points of DS are closed. Since the MR_2 coil is energized, the MS_1 coil is de-energized, the contact points are opened, the evaporator fan motor M_1 stops, pressure difference before and behind the evaporator is eliminated, the contact points of DS are open and the MR_2 coil is self retained by means of the circuit from TC and remains energized. On the other hand, the SV circuit is de-energized as the contact points of MR_2 are open, so SV is closed and pump down is started. Then the contact points of HLPS are open, the contact points of MS_2 are open, and the condenser fan motor M_2 and the compressor M_3 stop. When the MS_2 coil is de-energized, the contact points of MS_2 in the MS_3 circuit are closed, MS_3 is energized, and the electric heater H comes into operation. Thus, defrosting starts.

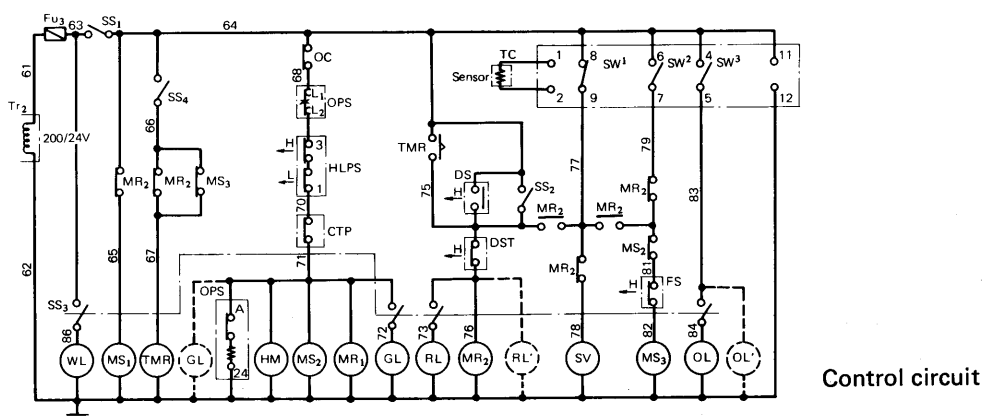
The defrost timer TMR functions as follows.

TMR is energized at the same time when the cooling operation is started (SS_1 is turned on) and counts times. If the defrosting operation starts by means of DS or SS_2 during time counting, TMR is de-energized and returned to the original state.

On completion of the defrosting operation, TMR starts counting times. If the defrosting operation will not start by DS or SS_2 within the preset period of TMR during the cooling operation, TMR starts it. Once the defrosting operation has started, TMR is returned to its original state and is ready to start counting times on completion of the defrosting operation; i.e. TMR functions counting times after completion of the defrosting operation (Function by DS, TMR, SS_2) as stated before.

In case the manual defrosting switch SS_2 is set at "MANUAL" the operation is the same as mentioned in the function of DS.

When defrosting is terminated, the evaporator temperature rises, and the contact points of defrost termination thermostat DST are open. So, the MR₂ coil is de-energized and the contact points of MR₂ are reset as shown below, so MS₃ is de-energized, and the heater operation is completed. At the same time, SV is energized, the solenoid valve is open, pump down is released, the contact points of HLPS are closed, and the unit will come into the refrigeration operation again. In case DS, TMR or SS₂ is turned on when the compressor is stopped by TC, MR₂ is not self-retained, so defrosting will not start. Namely, the defrosting operation starts after the SV circuit is closed by TC. The firestat FS protects against unusual high heat as mentioned before in the heating operation. However, it is different from the heating operation, defrosting is carried out regardless of the temperature setting of TC.



5.6 Pilot lamps and remote monitoring lamps

In the control box, the following four pilot lamps are mounted, and which are shown running conditions as follows.

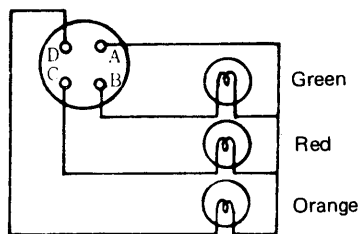
- Greenlights up while compressor is running.
- Orangelights up while storage temp. is within the preset range.
- Redlights up during the defrosting operation.
- Whitelights up while unit is operated.

These lamps are attached on the upper part of the access window so that they cannot be seen from the front, which means these lights are mistaken for other guard lights from the bridge.

Further, they are also used for lighting the recording chart.

In addition, the receptacle for pilot lamp is equipped to guard the operation remotely in the ship. The monitoring receptacle is located at the front of the control box. Cap it when it is unused. The wiring connection method of the socket panel is shown below, so provide the wiring without a mistake.

Monitoring receptacle for pilot lamp



6. Periodical inspection

Inspect the each components in the unit periodically as it works in good condition, and adjust or repair them if it is necessary.

Container refrigeration unit inspection card

Installed ship name				Date of inspection			
Container No.				Place of inspection			
Loaded cargo		Loaded or none		Unit Model No.			
Customer's staff				Unit No.			
Service staff				Compressor No.			
Check	No.	Check point		Check method		Reference value	
	1	External appearance of important parts of container (doors, equipment mount, damaged points)		Visual			
	2	Cleaning interior and exterior of container		Visual			
	3	Checking the smudge of the unit (air-cooled condenser, evaporator)		Visual			
	4	Checking "through" points inside and outside unit		Visual			
	5	Checking for leakage from refrigerant system (joints)		Halide torch			
	6	Checking external appearance of power cable and plug		Visual			
	7	Cleaning drain hose		Visual		Shall be free from clogging	
	8	Cleaning defrost air hose and checking to ensure that there is no trap		Visual		Shall be free from clogging	
	9	Mounted condition of electric heaters		Visual		Make sure that leads are not in contact with heaters	
	10	Checking exterior of firestat		Visual		Shall have no damaged part	
	11	Tightened condition of cable glands and monitoring receptacle		Retighten with tool		Make sure that they are firmly tightened	
	12	Checking condenser and evaporator fan motors for vibration and noise		Touch and listen			
	13	Checking amount of circulating refrigerant		Check liquid indicator		Make sure that it is sealed	
	14	Checking for water in refrigerant		Check liquid indicator		Green	
	15	Checking compressor oil level (operating condition)		Check compressor oil level gauge		⊖ (oil level 1/4 - 3/4)	
	16	Checking to ensure that clock spring of temperature recording thermostat has been fully wound		Confirm with spring winding tool			
	17	Checking to ensure that recording thermostat has been calibrated (at storage temperature of -18°C)		Mount thermistor to feeler tube sensor			
	18	Checking operation of recording thermostat and pilot lamps		Move temperature setting indicator (red) and check			
	19	Checking operation of defrost initiation air switch		Check with U tube		44±2 mmH ₂ O CUTIN	
	20	Unit operating current TR <input type="checkbox"/> IS <input type="checkbox"/> IT <input type="checkbox"/>		Clamp meter		-18°C <input type="checkbox"/> V <input type="checkbox"/> Hz	
	21	Unit insulation resistance		Compressor circuit <input type="checkbox"/> MΩ		DC 500V megger	
				Electric heater circuit <input type="checkbox"/> MΩ			
				Evaporator fan circuit <input type="checkbox"/> MΩ			
	22	Checking manual defrosting operation		Manual defrost switch			
	23	Checking operation of defrost termination thermostat (Completing temperature) <input type="checkbox"/> °C		Mount thermistor to completion thermostat mounting position		OFF 7.2±1.7°C	
	24	Electric heater operation and current IR <input type="checkbox"/> IS <input type="checkbox"/> IT <input type="checkbox"/>		Clamp meter			
	25	Checking operation of dual pressure switch		H-CUT OUT <input type="checkbox"/> kg/cm ²		Operate the air cooled condenser without fan operation	
				L-CUT OUT <input type="checkbox"/> mmHgV		Accomplish pump down by use of the stop valve at the water cooled condenser outlet	
				L-CUT IN <input type="checkbox"/> kg/cm ²		20 kg/cm ² 400 mmHgV 0.2 kg/cm ²	
	26	Checking operation of water pressure switch		Checking switchover from water-cooled to air-cooled operation		Disconnect water coupling	
				Checking switchover from air-cooled to water-cooled operation		Connect water coupling and supply water	
	27	Checking power supply changeover switch		Checking 400V class operation		Place changeover switch lever upward	
				Checking 200V class operation		Place changeover switch lever downward	
	28	Storage temperature °C <input type="text"/>		0°C		-18°C	
		Ambient temperature °C <input type="text"/>		<input type="text"/>		<input type="text"/>	
		LP kg/cm ² <input type="text"/>		<input type="text"/>		<input type="text"/>	
		HP kg/cm ² <input type="text"/>		<input type="text"/>		<input type="text"/>	
		Operating time		Immediately after operation		Operation starting 0°C <input type="text"/> Hr <input type="text"/> M	
					Operation starting -18°C <input type="text"/> Hr <input type="text"/> M		
					Automatic operation at -18°C <input type="text"/> Hr <input type="text"/> M		
					Operation starting time <input type="text"/> <input type="text"/>		
	29	Checking automatic defrosting operation		Defrost time <input type="text"/> M			

7. Inspection and adjusting method.

7.1 Recording temperature controller

This apparatus is functioned with a combination of electronic temperature control system and mechanical recording thermometer.

The recording system is consisted of the feeler tube assembly and a chart drive spring timer. The electronic control system operates electro-mechanical relays in response to signals from a sensor.

(1) Relay components

This apparatus consists of three relays. The relays SW#1, SW#2 and SW#3 are arranged in the order from the bottom.

SW#1 → Controls "ON" – "OFF" for cooling.

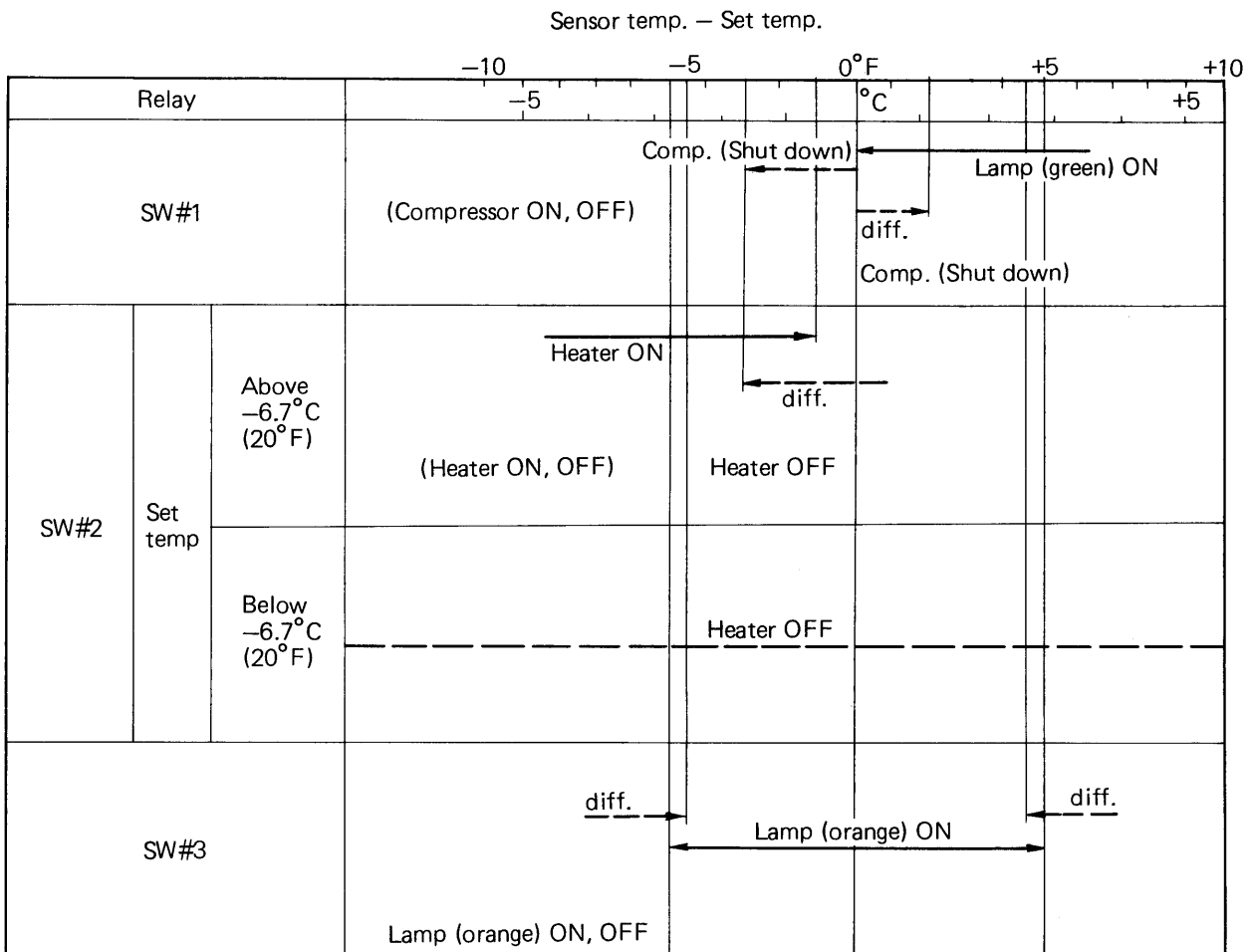
SW#2 → Controls "ON" – "OFF" for heating. And this relay comes "OFF" when set temperature is lower than -6.7°C ($+20^{\circ}\text{F}$)

SW#3 → Indicates in range lamp (OL).

(Set temp. $+2.8^{\circ}\text{C}$ ($+5^{\circ}\text{F}$) or more ---- "OFF")
 (Set temp. -2.8°C (-5°F) or less ---- "OFF")

(2) Function

Each relays as described in (1) are functioned in accordance with difference between temperature setting and temperature at the sensor as following;

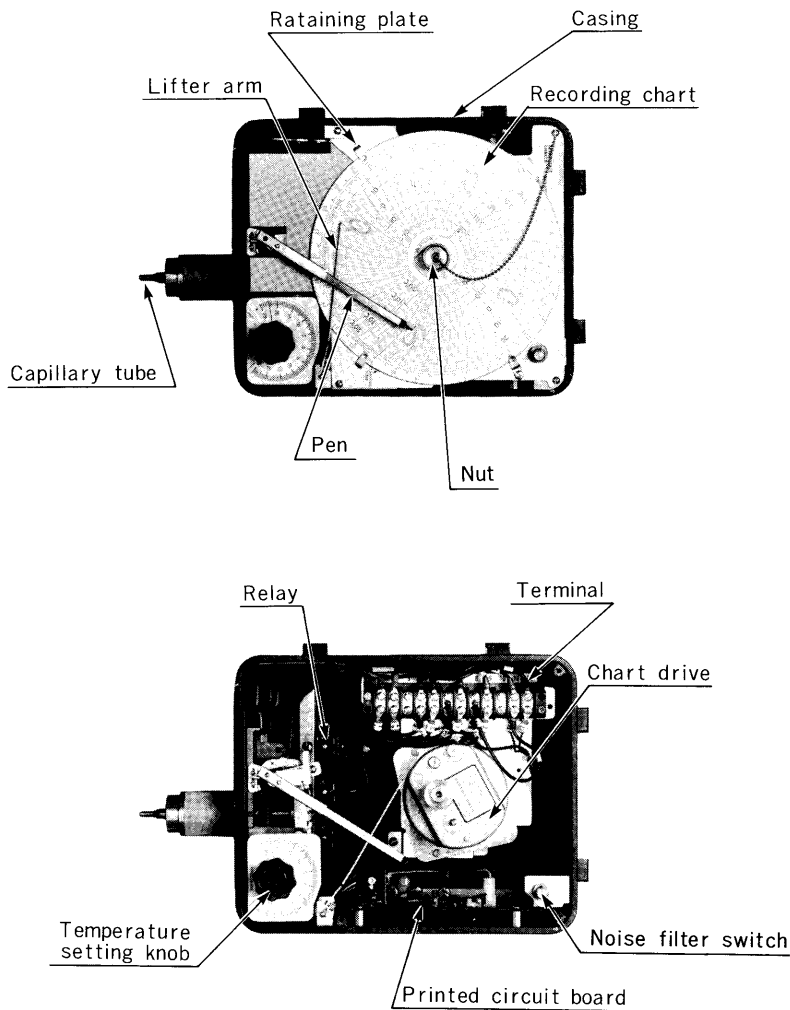


(3) Wiring

Electrical connections in the controller are wired as follows.

<u>TERMINAL</u>	<u>CONNECTION</u>
1	Sensor
2	
3	
4	SW#3
5	
6	SW#2
7	
8	SW#1
9	
10	
11	AC 24V electric source
12	

Recording temperature controller

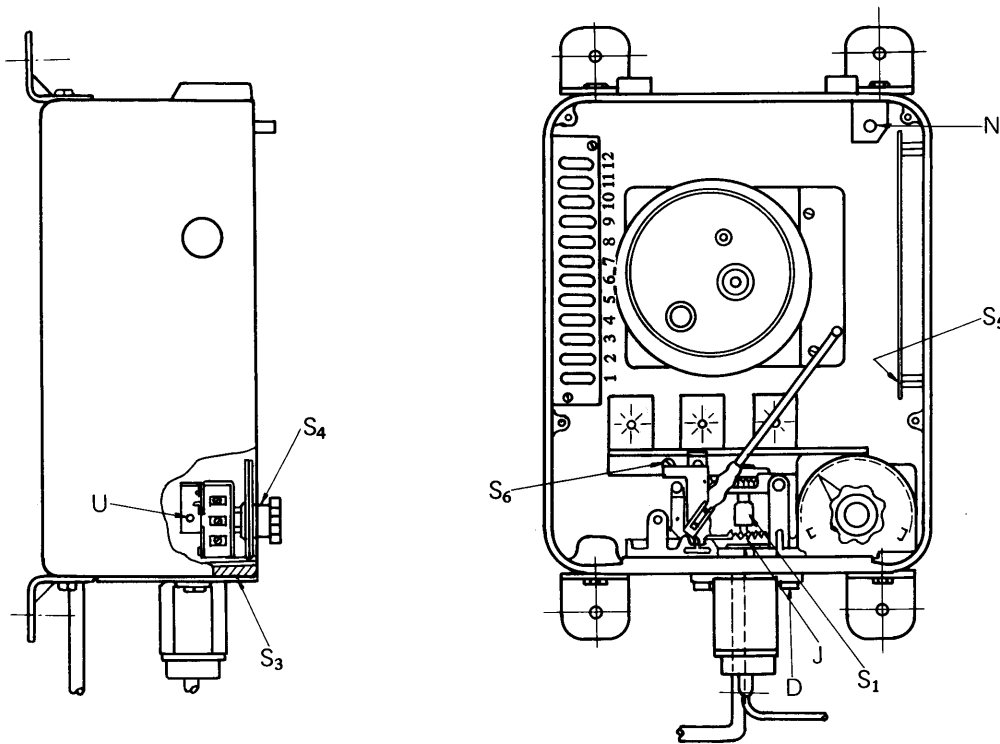


(4) Inspection and adjusting method

(a) Recording system

After temperature at the feeler tube for recording system has been stabilized at 0°C (32°F), this temperature shall be compared with the temperature indicated on the chart. If the temperature difference was found in above comparison, indication temperature on the chart shall be calibrated in accordance with following procedure.

- 1) Keep the feeler tube in the ice bath to maintain 0°C.
- 2) Loosen the set screw "S₁". Then adjust pen-indicated temperature by turning the hex shaft "J" with a standard wrench to get 0°C.
Pen – indicated temperature more than 0°C Turn clockwise.
Pen – indicated temperature less than 0°C Turn counterclockwise.
Retighten the set screw "S₁".



Construction of recording temperature controller

(b) Electronic control system

[Inspection method]

After temperature at the sensor has been stabilized at 0°C (32°F), check the temp. difference between the relays and the differential values of the relays themselves by means of increasing and decreasing of the set temperature, and reading the functioning temperature of each relays.

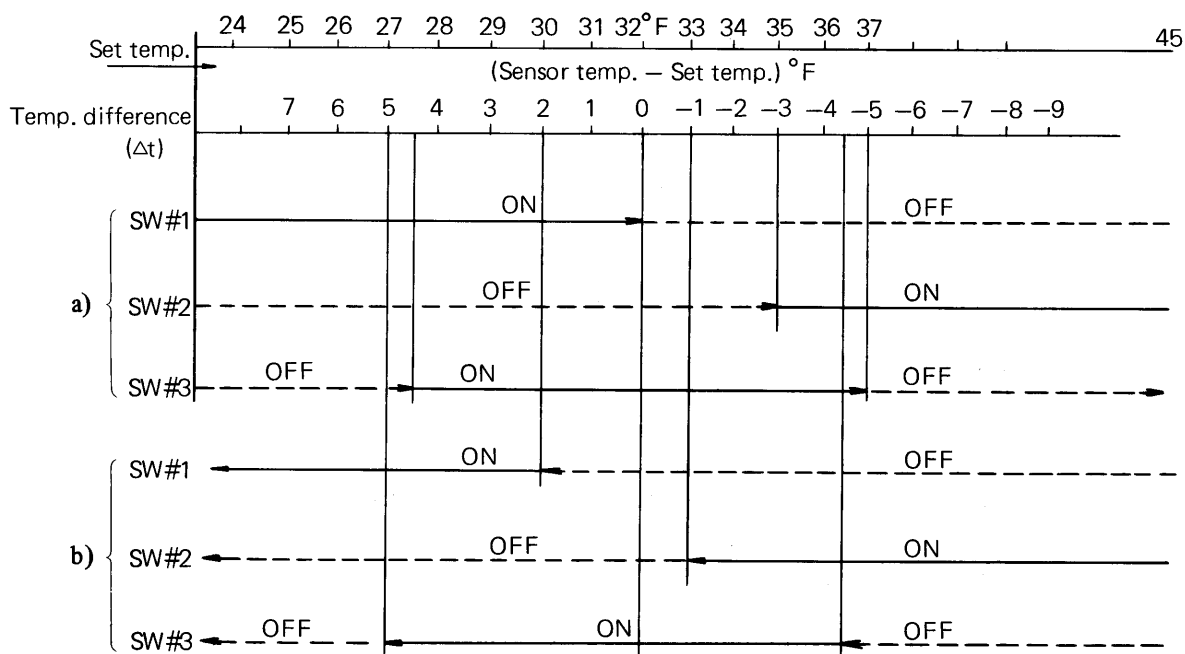
- 1) Keep the sensor in the ice bath to maintain 0°C (32°F)
- 2) Turn "ON" the operation switch.
- 3) Pull up "OFF" the noise filter switch "N".
(Be certain to turn "ON" this switch after checking or adjusting.)
- 4) Check the functioning temperature in accordance with following procedure.
Turn the temp. setting knob as follows.
 - a) Increase the set temperature gradually from -6.7°C (+20°F) to +7.2°C (+45°F).
 - b) Decrease the set temperature gradually from +7.2°C to -6.7°C.

Through the experiments the intems a) and b), you can find the functioning temperature of each relays.

(Check the function of the relays by means of on-and-off of lamps on each relays.)

And, as the relays functions with a ten seconds or less time delay, check the functioning temperature of the relays by turning the setting knob gradually.

The relays, if normal, will function as follows.



Functions of each switches in the recording temperature controller

As a result of check, if the relays are shown with a large deviation entirely, the setting knob shall be positioned to zero in accordance with following procedure.

[Adjusting method]

- 1) Keep the sensor temperature at 0°C.
- 2) Turn the setting knob gradually from the low temperature and stop turning the setting knob at the functioning position of the relay SW#1 (ON → OFF : the position of the lamp goes off.)
- 3) In this position, loosen the knob for setting screw "S₄" with a hexagon wrench carefully and reset the setting temperature at 0°C. And retighten the knob for setting screw "S₄" carefully. (In this time setting shaft shall not be moved)
- 4) Check its function in accordance with the inspection method as described before. And if the setting knob is loosened, tighten a hex-head screw "U", located behind the knob with a spanner.
- 5) Replacement of the parts
After each parts have been replaced, calibrate its function in accordance with the inspection method as described before.
 - a) Replacement of the printed circuit board
 - Remove the four black wires from terminal board (No. 1, 2, 11 and 12)
 - Remove the two screws "S₅" which hold the circuit board.
 - Draw out the circuit board carefully from the plastic holder in the bottom of the case. (In this case, circuit board shall be removed by sliding to the knob for setting temperature side to avoid damage of the noise filter.)
 - Unplug carefully two connectors (for relays and for setting – potentiometer) from the circuit board.
 - Install new circuit board in accordance with reverse procedure as described above.
 - b) Replacement of the relay assembly
 - Remove the two set screws "S₆", and make relay assembly free. (In this case, it is necessary to remove assembly of the setting – potentiometer from the case temporarily.)
 - Remove carefully the six wires from terminal board (No. 4, 5, 6, 7, 8 and 9) and unplug connector from the circuit board.
 - Install new relay assembly in accordance with reverse procedure as described above.
 - c) Replacement of the temperature setting – potentiometer
 - Unplug carefully potentiometer connector from the circuit board.
 - Remove the two mounting screws "S₃", then remove assembly of the setting – potentiometer from the case.
 - Loosen the knob for setting screw "S₄" then remove the knob.
 - Remove the two screws, then remove the dial.
 - Separate the potentiometer from its mounting plate by loosening the nut at center of the plate.
 - Install new potentiometer to the plate in accordance with reverse procedure as described above.

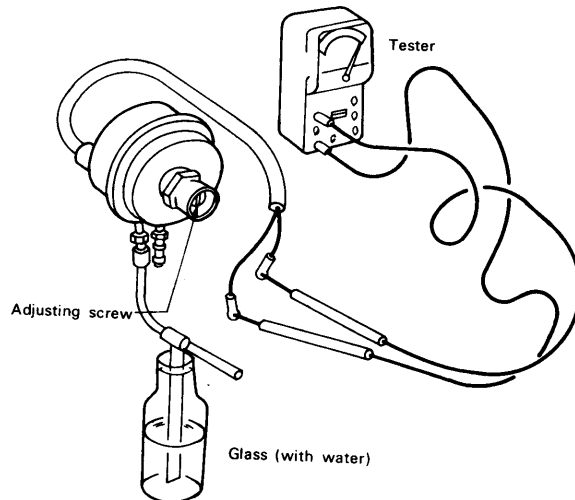
7.2 Air pressure switch for defrost initiation

The air pressure switch has been precisely set at the factory. So do not change the setting unnecessarily. As for resetting, do it as follows.

- (1) Before checking the set value, be certain that the high and low pressure hoses are not broken, damaged or clogged.
- (2) When the operation value is larger than the set value, turn the adjusting screw counterclockwise.
- (3) When the operating value is smaller than the set value, turn the adjusting screw clockwise.

Adjusting method

- (a) Remove the flare joints from the high and low pressure hose couplings of the air pressure switch. However, do not disconnect the air hose from flare joint.
- (b) Disconnect the two leads in the control box and connect the leads to test lamp or tester.
- (c) Prepare the air switch adjuster shown below.
- (d) Place the test tube in the container containing water and blow into the tube to produce air bubbles in the water.



Calibration of air pressure switch for defrost initiation

7.3 Dual pressure switch

- (1) Attach a pressure and a compound gauge.
(See 9. Maintenance – attaching pressure gauge)
- (2) High pressure side
 - (a) Remove the wiring from the air cooled condenser fan and put the unit into the air cooled operation.
 - (b) Read pressure indication when the unit is stopped. This is value of pressure at OFF.
 - (c) Leave the unit in the state of (b) and read pressure indication. This is value of pressure at ON.
 - (d) Provide the wiring again, which has been removed as in (a).
- (3) Low pressure side
 - (a) Accomplish the pump down with the stop valve at the water cooled condenser closed.
 - (b) Read pressure indication when the unit is stopped. This is value of pressure at OFF.
 - (c) Gradually open the stop valve at the outlet of the water cooled condenser to release the pump down and read pressure indication when the unit is restarted. This is value of pressure at ON.

Note: During the confirmation work stated in (c), if sudden pressure fluctuation occurs, the pressure switch may be delayed in function from the predesigned value. In this case reconfirm the values, accomplishing the work stated in from (a) to (c). Further, the function on the low pressure side can be confirmed by the thermostat but for confirmation of precise setting, do it as stated in (a) – (c).

8. Troubles and countermeasures

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

Troubles and countermeasures

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

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

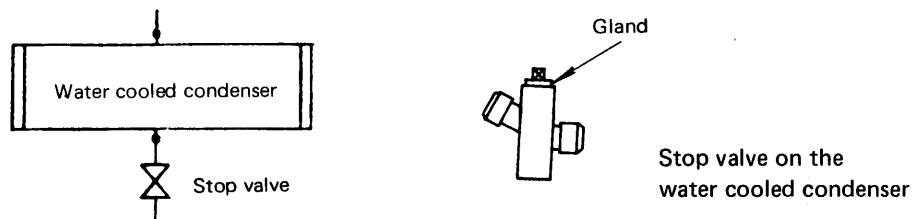
9 . Maintenance

It is important to study thoroughly how to maintain the equipment properly reading the following items before the unit is operated.

○ Pump down

What we call “pump down” is to collect the refrigerant in the refrigeration system in the condenser, and its purpose is to prevent the refrigerant from leaking when the refrigerant system is repaired. Accomplish pump down in the following order.

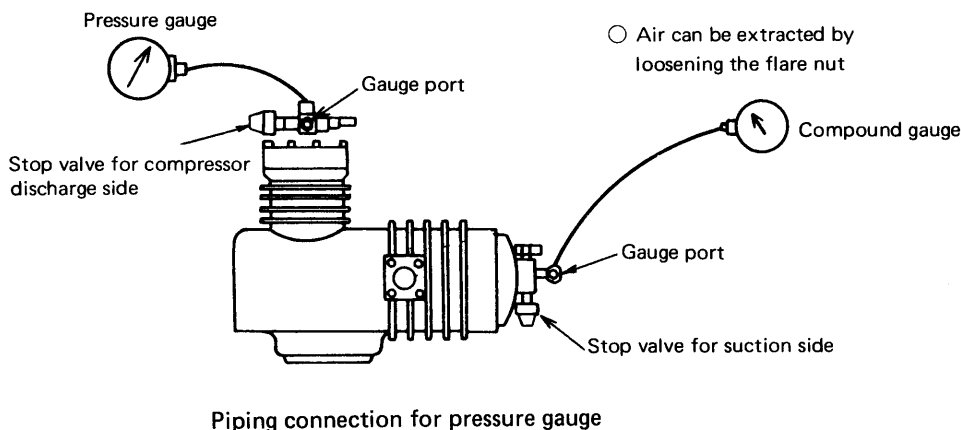
- (1) Attach pressure gauges both to the high and the low pressure sides of the compressor.
- (2) Operate the compressor. (Either water or air cooled)
- (3) Close the stop valve at the outlet of the water cooled condenser.
- (4) When a vacuum is created on the low pressure side, watching the low pressure gauge, stop the operation and close the stop valve at the outlet of the compressor. Repeat the procedure two or three times, and the refrigerant is collected in the condenser. In case the pressure gauge is not attached, the operation is stopped by the dual pressure switch on the low pressure side.



When the stop valve is closed, remove the cap, and then loosen the gland to a degree that the gas is not discharged, and then tighten the handle fully. Finally, tighten the gland. When opening it, do the above in the reverse order.

○ Attaching pressure gauge

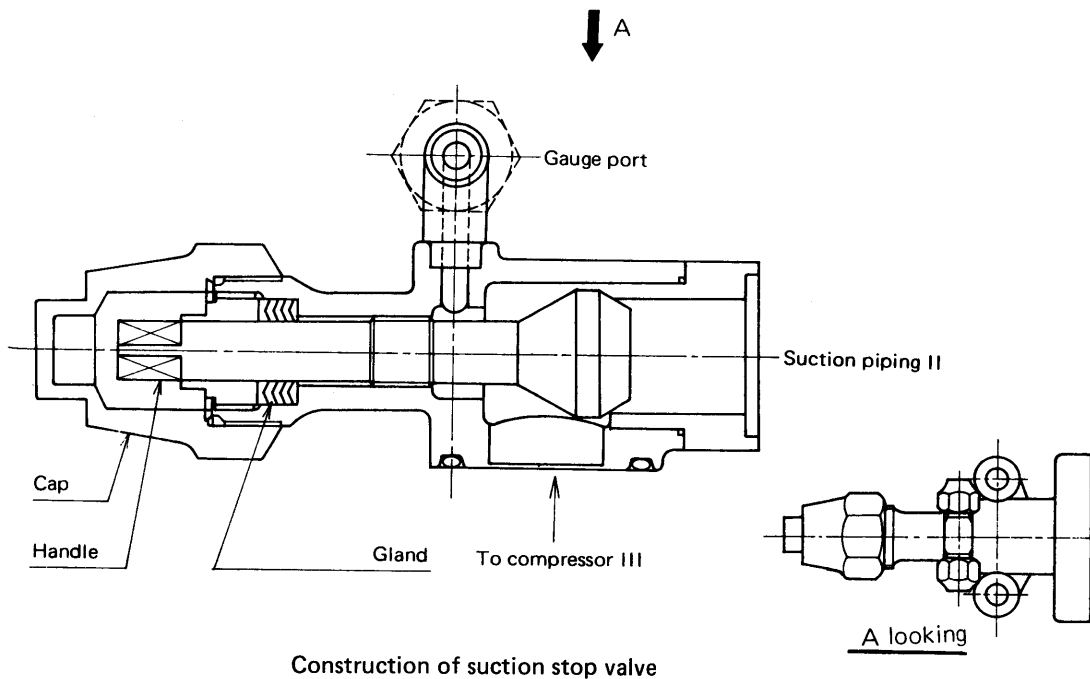
It is recommendable to attach the pressure gauge, because the operation state is easily confirmed and adjusted. Therefore, attach it as much as possible in the following manners. (When attaching it, the operation should be stopped).



- (1) Fully open the stop valves on the suction and discharge sides of the compressor and connect the gauge piping to the gauge port.
- (2) Set the handle of the stop valve at the neutral position. (The needle of the gauge rises up).
- (3) Vent the air through the gauge piping.

The following are the handle methods of the stop valves attached to the compressor.

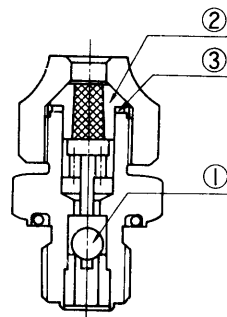
- (1) Remove the cap.
- (2) Loosen the gland to a degree that no gas is discharged.
- (3) Fully tighten the handle, and the refrigerant passage forms between I and III.
- (4) Fully turn back the handle, and the refrigerant passage forms between II and III.
- (5) Set the handle at the neutral position, and the refrigerant passage forms among I—II—III.
- (6) As mentioned in 3, 4, 5, the refrigerant passage is formed differently, attach it properly to suit your respective conditions.
- (7) After having manipulated the handle, be certain that the gland is closed and capped.



9.1 Replacement of fusible plug

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

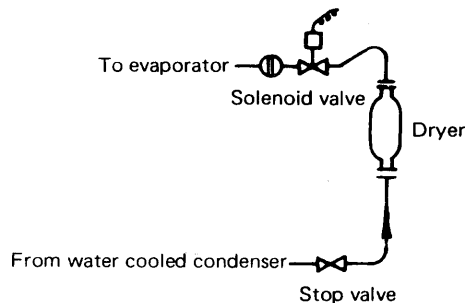
When fusible plug functions, the centre of the fusible plug alloy ② melts, from which the refrigerant jets out. When the flare nut is removed, ① is apt to come out by pressure and clogs the passage of the refrigerant outlet, which prevents the refrigerant from jetting out and also the air from entering.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



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

9.2 Replacement of dryer

In case water in the system cannot be removed or the dryer is clogged, replace the dryer with a new one.



Piping diagram around the dryer

The dryer is located at the outlet side of the water cooled condenser, and can be replaced in the following way.

- (1) Attach the pressure gauge to the stop valve at the outlet of the water cooled condenser.
- (2) Close the stop valve at the outlet of the water cooled condenser and accomplish pump down.
- (3) When the reading of the pressure gauge becomes approx. 1 kg/cm^2 , set it at OFF. At this moment, the solenoid valve is closed.
- (4) Close the stop valve on suction side of the compressor.
- (5) Remove the band for fixing the dryer.
- (6) Then, remove the flange bolts before and after the dryer and attach a new dryer. When the dryer is removed, be careful not to let the O rings at the upper and the lower flange parts fall off.
- (7) Purge the air which has entered while the gauge port of the stop valve was replaced.

9.3 Purging of non-condensable gas

If non-condensable gas such as air exists in the refrigeration system, it gathers in the condenser and raises pressure abnormally high. In addition, it lowers heat transferring efficiency on the condensing surface. Therefore, non-condensable gas should be vented. In case delivery pressure is abnormally high and pressure cannot be lowered by increasing cooling water volume. Check if non-condensable gas exists as follows.

* Stop the compressor and close the stop valve at the outlet of the condenser until water temperature is equal at the inlet and the outlet of the condenser. At this time, if there is a difference between saturated pressure corresponding to cooling water temperature and condensing pressure, it proves presence of non-condensable gas. In this case, purge it as follows.

- (1) Pump down
- (2) Condense the refrigerant as much as possible, and then purge non-condensable gas from the stop valve at the discharging side of the compressor.
- (3) Check the pressure gauge, and repeat the above stated procedure until condensing pressure is equal to saturated pressure.

9.4 Additional charge of refrigerant and lubricant

● Charging the refrigerant

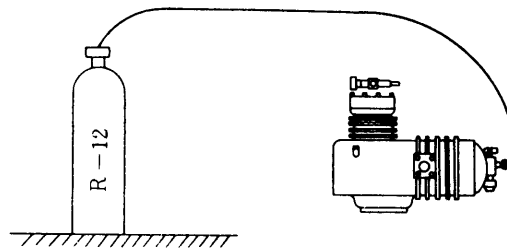
In case the refrigerant becomes short because of refrigerant leakage during the operation or refrigerant purge for repair, charge it additionally after thorough check of gas leaking points. However, the charging amount of the refrigerant has already been fixed, so do not use the following method except at the time of emergency.

[Work order]

Connect the refrigerant cylinder to gauge port of the stop valve at the suction side of the compressor temporarily, and open the stop valve of the cylinder a little to purge the air in the connecting pipe. Then, charge the refrigerant, keeping the compressor in operation.

At this time, keep the following items strictly.

- (1) Pressure in the cylinder should be higher than pressure on the low pressure side.
- (2) Attach pressure gauge and compound gauge, and refrigerant level rises to approx. 1/2 of the level gauge on the water cooled condenser.



Piping connection for refrigerant charging

9.5 Vacuum drying and charging refrigerant and lubricant

In case the refrigerant becomes short and the air is intermixed, it is necessary to charge the predesigned amount of the refrigerant additionally after repairing and the vacuum drying. Further, when the lubricant is replenished, the same procedures as mentioned above are also required.

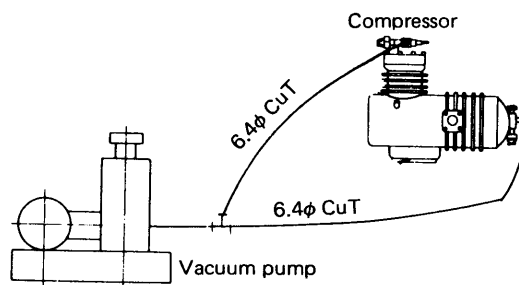
● In case the refrigerant alone is replaced

[Necessary parts]

- (1) Cylinder of R-12 (contains 20 kg)
- (2) $\phi 6.4$ copper tube (with 2 ea of flare nuts)
- (3) Scale (50 kg)
- (4) Machine tools
- (5) Vacuum pump

[Work order]

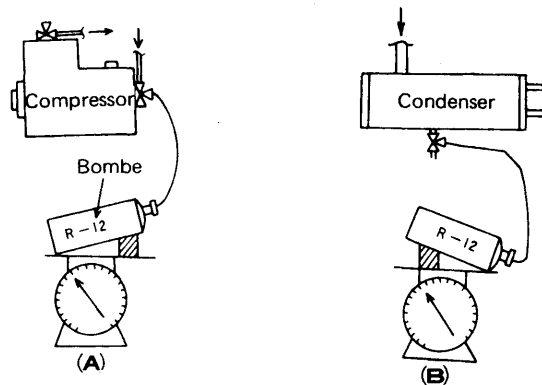
- (1) Connect the vacuum pump to the gauge fittings of the stop valve on the suction and delivery sides of the compressor and form vacuum of approx. 76 cmHg in the refrigerant system for about 4 hours and disconnect the vacuum pump, maintaining the vacuum in it.



Piping connection for vacuum drying

- (2) Connect the cylinder to the stop valve on the suction side of the compressor and purge the air in the connecting pipe.

(3) Place the cylinder on the scale and record its weight.

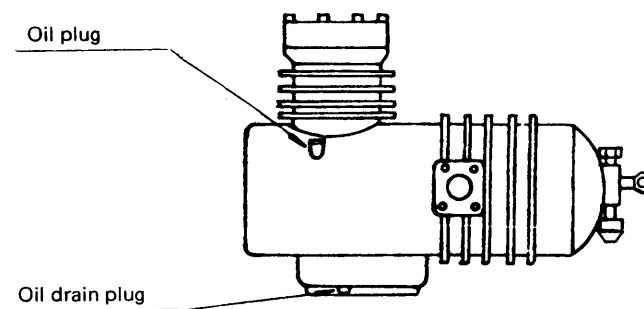


Weighing method of refrigerant

- (4) In case the refrigerant is charged in the gaseous state, do it as shown in (A) in the above figure. If the refrigerant becomes difficult to be charged, operate the compressor.
- (5) In case the refrigerant is charged in the liquid state, do it as shown in (B) in the above figure. Accomplish pump down so as not to allow the liquid collected in the water cooled condenser to pass. If the refrigerant becomes difficult to be charged, operate the compressor.
- (6) Charge the predesigned volume of the refrigerant as stated in (4) or (5).
- (7) After completion of the refrigerant charge, adjust the stop valve to the original state and operate the compressor.

● **Both the refrigerant and the lubricant are replaced**

- (1) Purge all the refrigerant gas so that refrigerant pressure becomes zero, and then drain all the lubricant by loosening the oil drain plug at the bottom of the compressor.
- (2) Close the oil drain plug.
- (3) Fill the compressor with the lubricant in the predesigned amount from the oil plug of the compressor.
- (4) Charge the refrigerant.



Oil charging

9.6 Gas leakage test

After all the procedures as mentioned before are completed, be sure to test the entire system for gas leakage with a halide torch gas detector carefully.

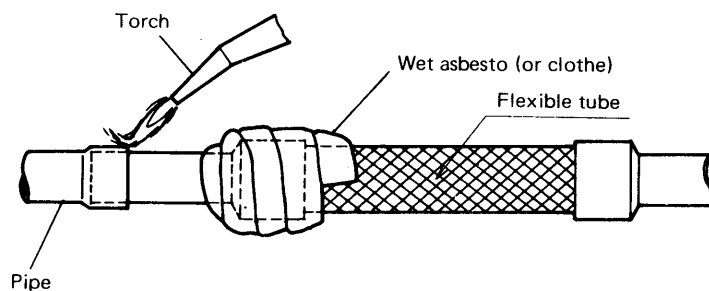
9.7 Caution for replacement of flexible tube

Although the flexible tubes used are carefully selected, if any of them is damaged, replace it with a new one.

Two flexible tubes are attached; i.e. one is attached to the suction line and the other to the discharge line. When they are replaced, carefully do as follows.

Caution for welding

When the flexible tube is connected to the pipe by welding, heat the inlet metal with flame of the torch as shown in the figure below and do not heat the welded part of the blade fixture by wrapping wet asbestos. If the welded part of the blade fixture is heated excessively, air tightness is damaged which may cause leakage.



Flexible tube soldering

Caution after flexible tube was connected

After surface of the flexible tube on the suction line has been dried adequately, be certain that is wound by the butyl rubber tape to avoid water in the air (Double covered). If there is any gap, it may cause damage due to freeze-up of water or corrosion.

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