DAIKIN

Marine type
Container Refrigeration Unit

Service manual

Model

LKN5AD3

DAIKIN KOGYO CO., LTD.

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.

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1. General specifications

1.1 Specifications

Model	LKN5AD3
Power supply	AC 200V 3 Phase 50/60Hz AC 220V 3 Phase 60Hz AC 380 ~ 415V 3 Phase 50Hz AC 440V 3 Phase 60Hz
Compressor	Semi hermetic type (3.75 kW)
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
Defrost	
Heat source	Electric heater
Initiation	Air pressure switch (detecting evaporator pressure difference), timer or manual switch.
Termination	Thermostat mounted on evaporator
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.
Refrigerant	R-12 (5.5 kg)
Lubricant	SUNISO 3GS-D1 (2.3 ℓ)
Weight	Approx. 545 kg

1.2 Electric characteristics

Power supply			AC200V 50Hz	AC220V 60Hz	AC415V 50Hz	AC440V 60Hz
Power consumption	Refrigeration operation	kW	5.8	5.8	5.8	5.8
	Heating operation	kW	4.7	4.7	4.7	4.7
Starting current		A	121	121	60	60
Total running current		A	19 (MAX)	19 (MAX)	10 (MAX)	10 (MAX)
Running current	Cooling operation	A	12.9	13.0	6.1	6.7
	Defrosting	A	9.3	10.2	4.8	5.1
	Heating operation	A	11.6	13.3	6.0	6.8

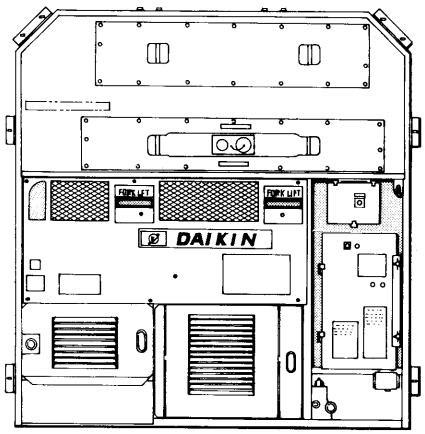
Note; Running current for refrigeration operation is based on ambient temp. 38°C, storage temp. —18°C.

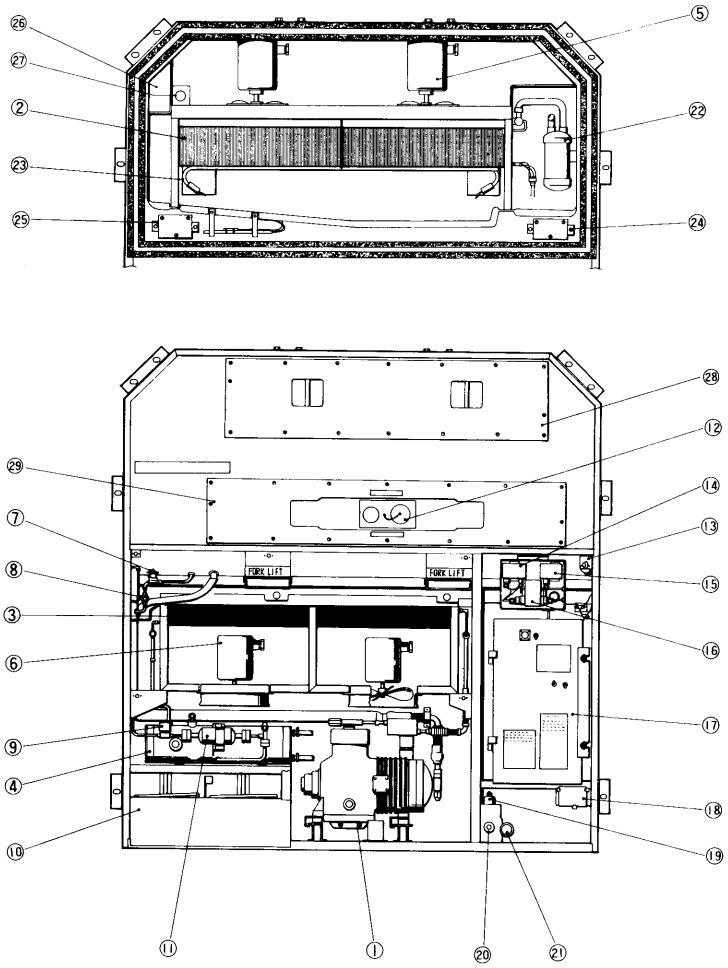
1.3 Set values of functional parts

Part name	Function	Set value
Oil pressure control switch ONS–C106Q	Heater circuit OFF ON Timer	1.0 kg/cm² 0.5 kg/cm² 110 seconds (ambient temperature 25°C) More than 5 seconds (ambient temperature 70°C)
Dual pressure switch DNS–D306Q	Low pressure OFF ON High pressure OFF ON	40 cmHgV 0.2 kg/cm² 20 kg/cm² 16.5 kg/cm²
High pressure switch	OFF ON	7 kg/cm² 11 kg/cm²
Water pressure switch SNS–C106WQ	OFF ON	1.0 kg/cm² 0.4 kg/cm²
Firestat KLIXON 20420L/L160–4	OFF ON	71°C (160°F) 49°C (120°F)
Defrost termination switch KLIXON 20420L/L45–1	OFF ON	7.2°C (45°F) 1.67°C (35°F)
Air pressure switch for defrost BEC No. 19–R70–B20–A2.5	ON	20mmH_2O
Defrost timer STP–73	ON	24h (60 Hz) 28½h (50 Hz)
Overcurrent relay CR–20–NP_2S_4	OFF	5.5A

2. Construction

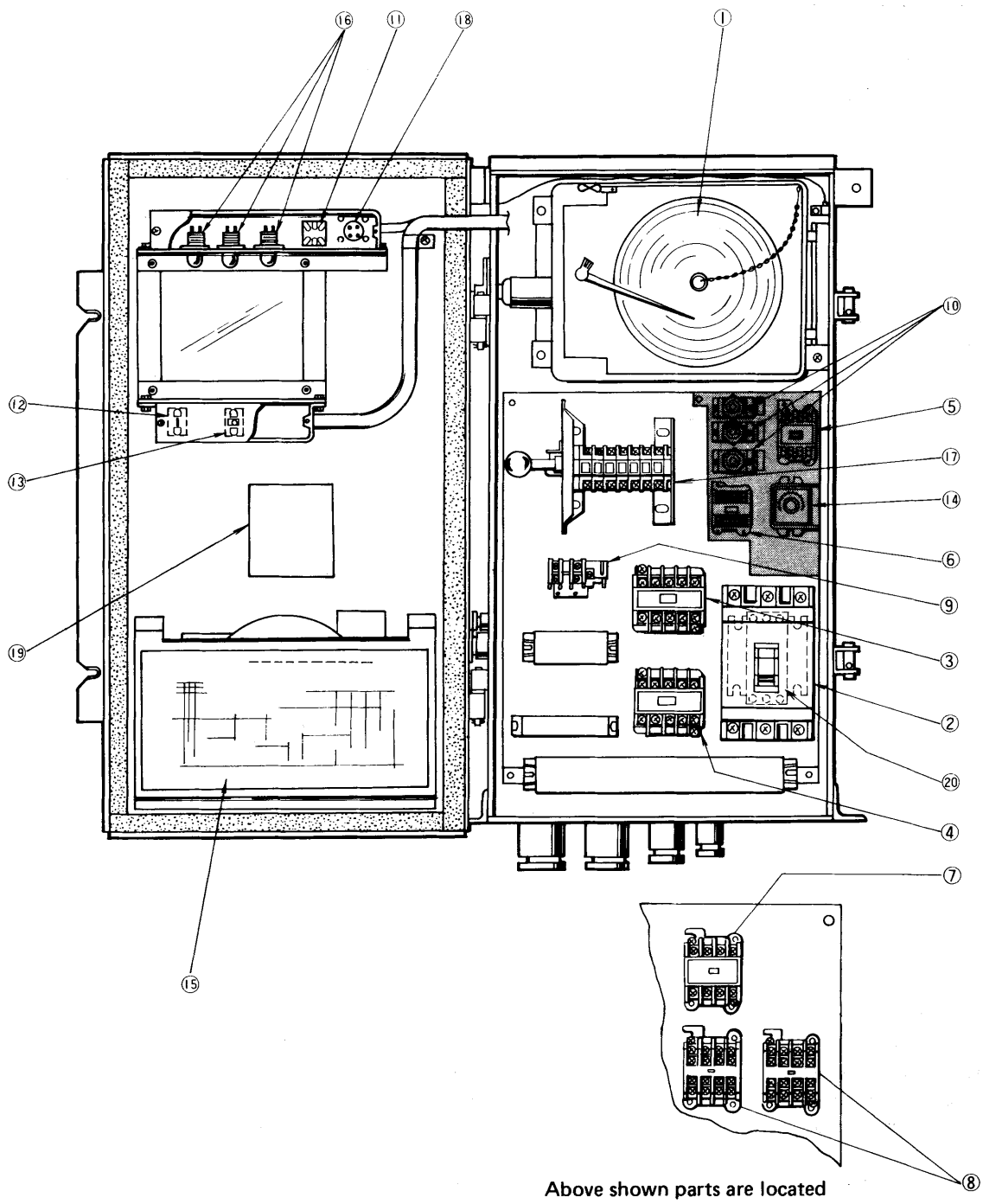
2.1 External appearance of unit





① Compressor
② Evaporator
③ Air cooled condenser
④ Water cooled condenser
⑤ Evaporator fan motor
⑥ Condenser fan motor
⑦ Expansion valve
⑧ Moisture indicator
⑨ Solenoid valve
⑩ Cable storage
⑪ Dryer
⑫ Fresh air intake
⑬ Air pressure switch for defrosting
⑭ Dual pressure switch
⑮ High pressure control switch
⑯ Oil pressure control switch
⑰ Control box
⑱ Water pressure switch
⑲ Water regulator
⑳ Water inlet coupling
㉑ Water outlet coupling
㉒ Accumulator
㉓ Defrost heater
㉔ Junction terminal box, lower (A)
㉕ Junction terminal box, lower (B)
㉖ Junction terminal box, upper
㉗ Receptacle
㉘ Service panel, upper
㉙ Service panel, lower

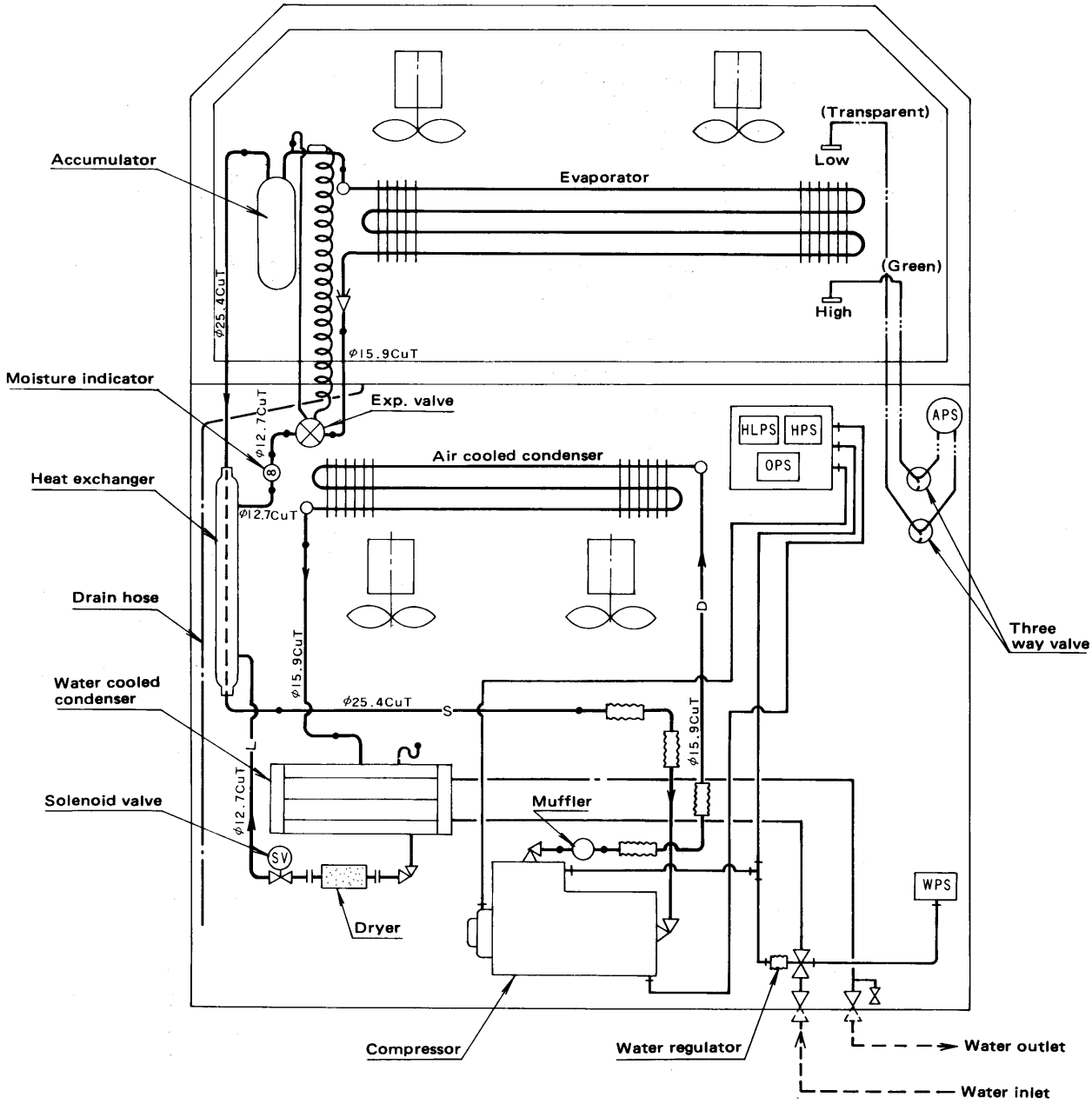
2.2 Control box



Above shown parts are located under the ▒ area.

① Recording temperature controller
② Circuit breaker
③ Magnetic switch for compressor
④ Magnetic switch for heater
⑤ Magnetic switch for fan motor
⑥ Magnetic relay for defrosting
⑦ Magnetic switch for crankcase heater
⑧ Magnetic relay for power supply exchange
⑨ Over current relay
⑩ Fuse
⑪ Snap switch for lamp
⑫ Snap switch for operating
⑬ Snap switch for defrosting
⑭ Timer
⑮ Wiring diagram
⑯ Pilot lamp
⑰ Cam switch
⑱ Cannon receptacle for pilot lamp
⑲ Name plate for arrangement of components
⑳ Transformer

3 . Piping diagram

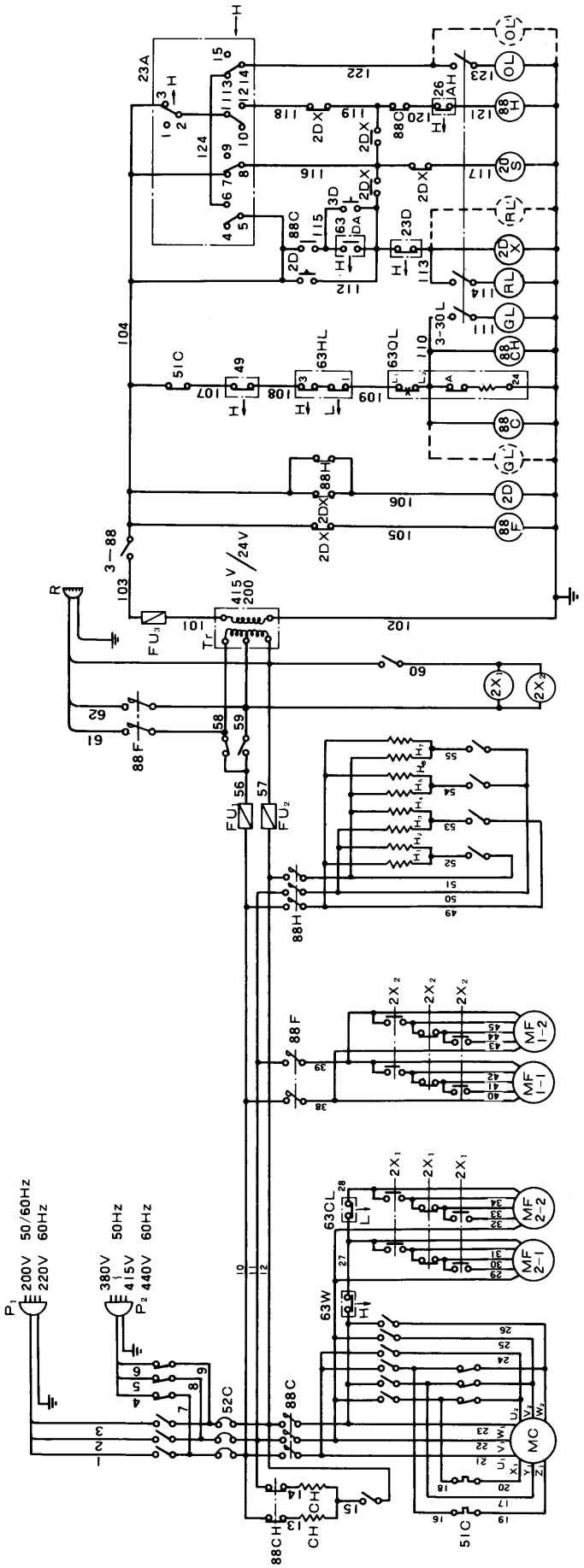


— L — Liquid pipe
— S — Suction pipe
— D — Discharge pipe
—●— Brazing
—|— Flare conn.
—||— Flange conn.
— · — Water pipe
— ·· — Air pipe

HLPS: Dual press. switch
OPS : Oil press. control switch
HPS : High press. control switch
APS : Air press. switch
WPS : Water press. switch

4 . Wiring diagram

4.1 Sequence wiring



Mark	Name	Mark	Name	Mark	Name
$P_{1,2}$	Power plug	MF_1	Evaporator fan motor	63HL	Dual pressure switch
52C	Circuit breaker	MF_2	Condenser fan motor	63QL	Oil pressure control switch
88C	Magnetic switch for compressor	$H_1 \sim H_6$	Evaporator coil heater	3-30L	Lamp switch
88F	Magnetic switch for fan motor	H_7	Drain heater	63DA	Defrost intiation switch
88H	Magnetic switch for heater	CH	Crankcase heater	3D	Manual defrost switch
$2X_{1,2}$	Magnetic switch	88CH	Magnetic switch for crankcase heater	23D	Defrost termination thermostat
63W	Water pressure switch	3-88	ON-OFF switch	26AH	Firestat
63CL	High pressure control switch	2DX	Magnetic relay	23A	Temperature control
$Fu_{1,2,3}$	Fuse	2D	Defrost timer	GL, RL, OL	Lamp
Tr	Transformer	51C	Over current relay	20S	Solenoid valve
MC	Compressor motor	49	Compressor motor protector	R	Receptacle

NOTES

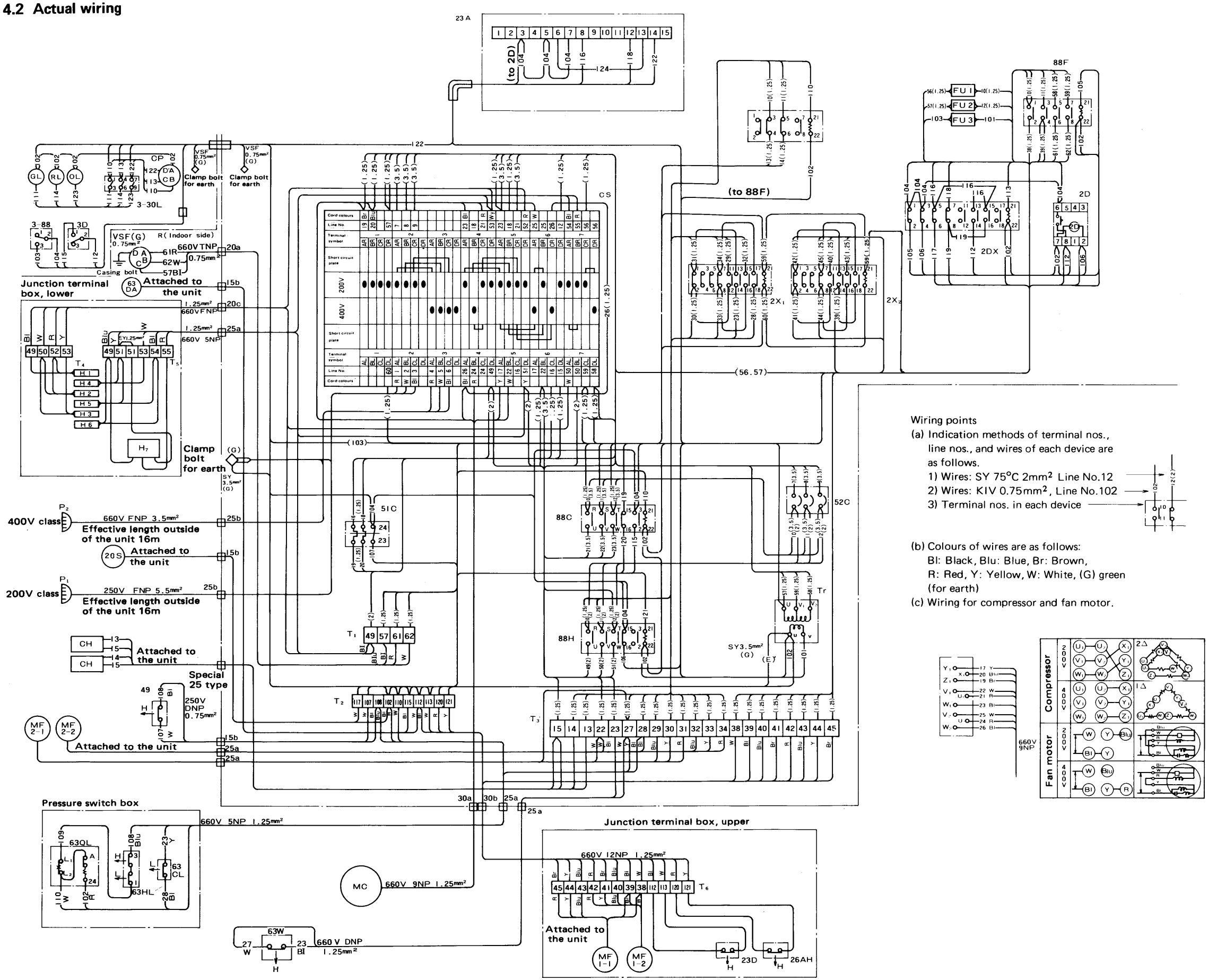
1. Monitoring plug connected as follows.
   A : Earth
   B : Operation (GL)
   C : Defrost (RL)
   D : In range temp. (OL)

2. Broken line shows external wiring.
3. Positions of contactors.
   (Except 3-88, 3-30L)

Symbol	Voltage	Contactor
∮	380 ~ 440	ON
∮	200 ~ 220	ON

4. Receptacle (R) is connected as follows.
   A : 400V
   B : 200V
   C : Common
   D : Earth

4.2 Actual wiring



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.
(h) Checking the refrigerant system for leakage.

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

(3) Set the lever of the manual change-over switch to power source voltage.

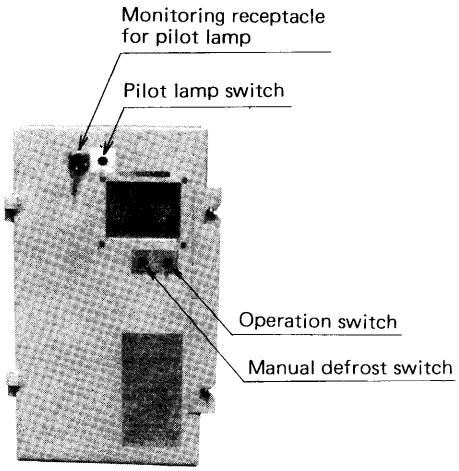
(4) Connect the power plug to the power source.

(5) Wind the spring of the recording temperature controller (replacement of recording papers)

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

(7) When the ambient temperature is low, turn "ON" the power switch at least one hour before operation for crankcase heater "ON".

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



Each switches on the cover of control box

(9) 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.
(c) Confirm lighting and turning off of pilot lamps.
(d) Be certain of operation of control and protection devices.
(e) Be certain that there is no unusual noise and vibration.
(f) Be certain that voltage and current are correct.

(g) Be certain the moisture indication is green. Check if refrigerant flashing is observed.
Notes: 1. When outdoor temperature is high during air cooled operation, air bubbles may be contained.
2. Check colour of the indicator when it is exposed to the liquid refrigerant.
3. In case the indicator was exposed to the gaseous refrigerant for a long time, put the unit in refrigeration operation for approximately 12 hours (exposed to the liquid refrigerant) and then check colour of the indicator.

(h) Be certain that no oil leakage is found.
(i) Be certain that no liquid back and liquid hammer occur.
Note: Discharge pressure can be kept constantly and not subjected to the ambient temperature during water cooled operation.

5.2 Cooling and heating operation

This unit is capable of both cooling and heating.
The recording temperature controller is capable of switching from the cooling operation to the heating operation and vice versa automatically and maintains storage temperature constant retardless of ambient temperature.
Heating is accomplished by the electric heaters. All the heaters, i.e. heating and defrosting heater installed at the bottom of the evaporator and the heater installed at the drain outlet function.
A manual switch which is turned off when temperature setting is under −6.7°C (20°F) is installed in the heating circuit of the recording temperature controller; i.e. when storage temperature is low, invaded heat becomes large. So there is no need to heat forcedly. If the storage chamber is wrongly heated, stored goods may be damaged. That is the reason why the electric heater does not come into operation when storage temperature is under −6.7°C (20°F).
The compressor and the heater do not come into operation simultaneously. An over-heat protective thermostat is installed on the top of the evaporator to turn off the electric heater in case of abnormal heating.

5.3 Air cooled and water cooled operation

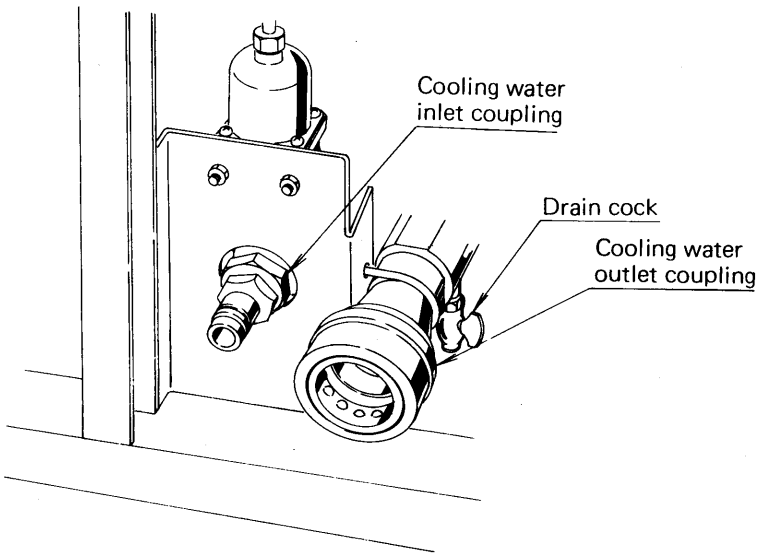
(1) Change-over of operation between air cooled and water cooled
The unit is possible to operate on either operations of air cooled or water cooled.
During the transit on the land, in the yard or on the deck, the air cooled operation is normal, and the operation in ship holds is normally water cooled.
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.

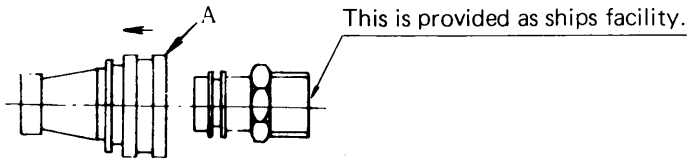
○ Before the water cooled operation:
1. Close the drain cock.
2. Connect the cooling water inlet coupling.
3. Connect the cooling water outlet coupling.
4. Open the drain cock and purge the air.
5. After having completed air purge, close the cock.

○ After the water cooled operation:
1. Disconnect the cooling water outlet couping.
2. Disconnect the cooling water inlet couping.
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

5.4 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 3D 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 defrosting operation will be explained hereunder, so please read to refer the attached wiring diagram.
The automatic defrosting is initiated by the air pressure switch for defrosting and the defrost timer. By this, the defrosting operation can be accurately accomplished even when one of them is out of order.
In case the air pressure switch for defrosting 63DA functions, pressure difference before and behind the evaporator becomes large and the contact points of 63DA are closed. Since the 2DX coil is energized, the 88F coil is de-energized, the contact points are opened, the evaporator fan motor MF1 stops, pressure difference before and behind the evaporator is eliminated, the contact points of 63DA are open and the 2DX coil is self retained by means of the circuit from 23A and remains energized.
On the other hand, the 20S circuit is de-energized as the contact points of 2DX are open, so 20S is closed and pump down is started. Then the contact points of 63HL are open, the contact points of 88C are open, and the condenser fan motor MF2 and the compressor MC stop. When the 88C coil is de-energized, the contact points of 88C in the 88H circuit are closed, 88H is energized, and the electric heater H comes into operation. Thus, defrosting starts.
The defrost timer 2D functions as follows.
2D is energized at the same time when the cooling operation is started (3-88 is turned on) and counts times. If the defrosting operation starts by means of 63DA or 3D during time counting, 2D is de-energized and returned to the original state.
On completion of the defrosting operation, 2D starts counting times. If the defrosting operation will not start by 63DA or 3D within the preset period of 2D during the cooling operation, 2D starts it.
Once the defrosting operation has started, 2D is returned to its original state and is ready to start counting times on completion of the defrosting operation; i.e. 2D functions counting times after completion of the defrosting operation (Function by 63DA, 2D, 3D) as stated before.
In case the manual defrosting switch 3D is set at "MANUAL" the operation is the same as mentioned in the function of 63DA.

When defrosting is terminated, the evaporator temperature rises, and the contact points of defrost termination thermostat 23D are open. So, the 2DX coil is de-energized and the contact points of 2DX are reset as shown below, so 88H is de-energized, and the heater operation is completed. At the same time, 20S is energized, the solenoid valve is open, pump down is released, the contact points of 63HL are closed, and the unit will come into the refrigeration operation again. In case 63DA, 2D or 3D is turned on when the compressor is stopped by 23A, 2DX is not self-retained, so defrosting will not start. Namely the defrosting operation starts after the 20S circuit is closed by 23A.
The firestat 26AH 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 23A.

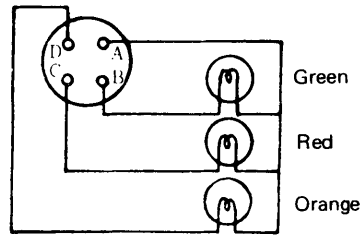
5.5 Pilot lamps and remote monitoring lamps

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

Green . . . . . .lights up while compressor is running.
Orange . . . . .lights up while storage temp. is within the preset range.
Red . . . . . .lights up during the defrosting operation.

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 monitering receptacle is located at the front of the electric kit box. Cap it when it is unused. The wiring connections to the monitering receptacle are shown below, so provide the wiring correctly.

Monitering 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 importants parts of container (doors, equipment mount, damaged points)	Visual	
	2	Cleaning interior and exterior of container	Visual	
	3	Checking the smudge of the unit (air-cooled condenser, evaporator)	Visual	
	4	Checking "through" points inside and outside unit	Visual	
	5	Checking for leakage from refrigerant system (joints)	Halide torch	
	6	Checking external appearance of power cable and plug	Visual	
	7	Cleaning drain hose	Visual	Shall be free from clogging
	8	Cleaning defrost air hose and checking to ensure that there is no trap	Visual	Shall be free from clogging
	9	Mounted condition of electric heaters	Visual	Make sure that leads are not in contact with heaters
	10	Checking exterior of firestat	Visual	Shall have no damaged part
	11	Tightened condition of cable glands and monitoring receptacle	Retighten with tool	Make sure that they are firmly tightened
	12	Checking condenser and evaporator fan motors for vibration and noise	Touch and listen	
	13	Checking amount of circulating refrigerant	Check liquid indicator	Make sure that it is sealed
	14	Checking for water in refrigerant	Check liquid indicator	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)	Measuring temperature with a thermistor	
	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 20 ± 2 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
		Electric heater circuit ☐ MΩ		
		Evaporator fan circuit ☐ MΩ		
	22	Checking manual defrosting operation	Manual defrost switch	
	23	Checking operation of defrost termination thermostat (Completing temperature) ☐ °C	Mount thermistor to completion thermostat mounting position	OFF 7.2±1.7°C
	24	Electric heater operation and current R ☐ S ☐ T ☐	Clamp meter	
	25	Checking operation of dual pressure swich: H–CUT OUT ☐ kg/cm²	Operate the air cooled condenser without fan operation	20 kg/cm²
		L–CUT OUT ☐ mmHgV	Accomplish pump down by use of the stop valve at the water cooled condenser outlet	400 mmHgV
		L–CUT IN ☐ kg/cm²		0.2 kg/cm²
	26	Checking operation of water pressure switch: Checking switchover from water-cooled to air-cooled operation	Disconnect water coupling	condenser fan motor shall operate
		Checking switchover from air-cooled to water-cooled operation	Connect water coupling and supply water	Condenser fan motor shall stop
	27	Checking power supply changeover switch: Checking 400V class operation	Place changeover switch fever upward	
		Checking 200V 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 starting –18°C ☐ Hr ☐ M	Automatic operation at –18°C ☐ Hr ☐ M
		Operation starting time ☐ ☐			
	29	Checking automatic defrosting operation Defrost time ☐ M			

7. Inspection and adjusting method.

7.1 Recording temperature controller

(1) Components

The recording thermostat consists of five microswitches. The switches th_2, th_1, th_4 and th_3 are arranged in the order from your side and th_5 on the right side.

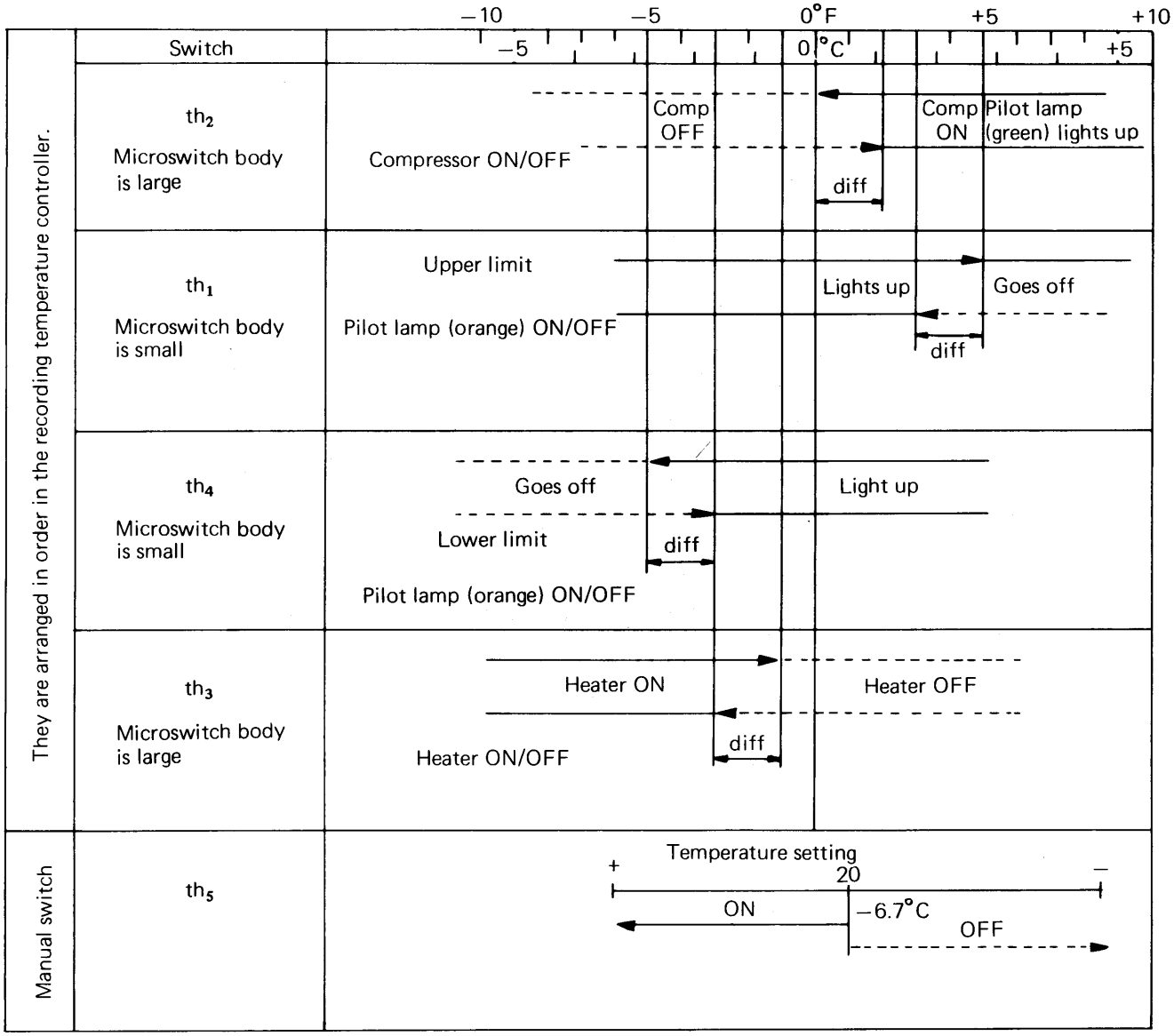
th_2 → Controls "ON" – "OFF" of cooling.
th_1 → Indicates upper limit of WL (orange) (Set temp. +5°F or more .....OFF)
th_4 → Indicates lower limit of WL (orange) (Set temp. –5°C or less .....OFF)
th_3 → Controls "ON" – "OFF" of heating.
th_5 → Interlocked with set temperature. "ON" when set temperature is more than 20°F (–6.7°C), and "OFF" when set temperature is lower than 20°F.

(2) Function

Functions of the five microswitches stated previouslly will be explained below with differece between temperature setting and feeler tube temperature.

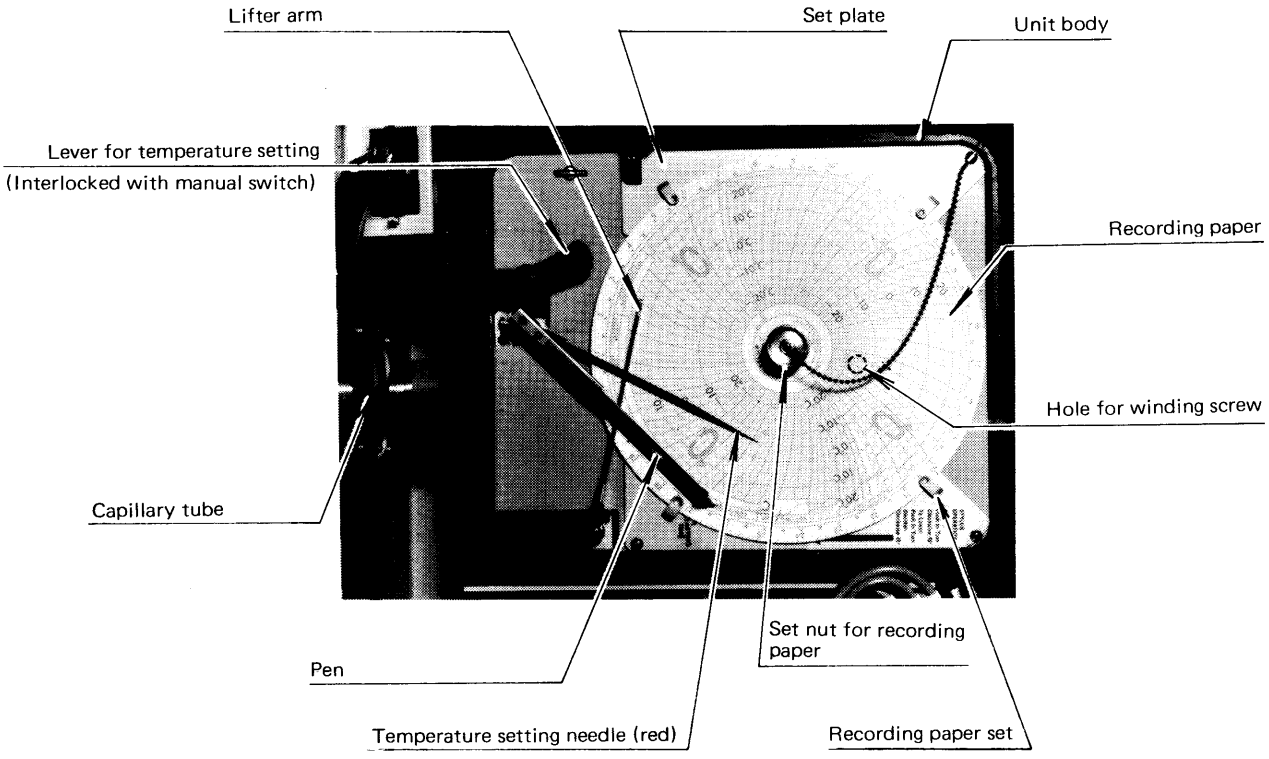
(Feeler tube temperature – Temperature setting)

Solid line (———) shows ON
Dotten line (---------) shows OFF



(3) Setting procedure of the recording chart

1) Hold the shaft of the lifter arm and turn it clockwise by 45° from the horizontal position. Release the shaft and the lifter arm goes up to raise the pen upward, making a gap between the retaining plate and pen.
2) Pull out the spring winder provided at the right corner, insert it into the spring winding hole in the center of the retaining plate, and turn it clockwise until the spring is wound up. The spring drives the chart for 31 days.
3) Remove the knob by turning it counterclockwise, insert the chart under the red temperature indicator, fit the center hole with the position where the knob fits, and tighten up the knob.
4) The retaining plate has four chart fixtures. Insert the chart under the fixtures to prevent the chart periphery from curling up.
5) Rotating of the temperature setting lever moves the temperature indicator. Set the indicator to a desired temperature on the scale of the chart. Clockwise rotation of the lever moves the indicator toward the center. (low temperature)
6) Unfasten the knob slightly and rotate the chart until the date on the chart is aligned with the start mark.
7) Hold the shaft of the lifter arm and turn it counterclockwise until the arm is brought to the level position. The pen comes down and presses down the chart and starts recording.
In this position, the arm is locked. If the lifter arm is turned clockwise by 45° from the horizontal position, the pen is brought up and stops recording. Before the start of recording, be certain that the lifter arm is locked in the horizontal position.



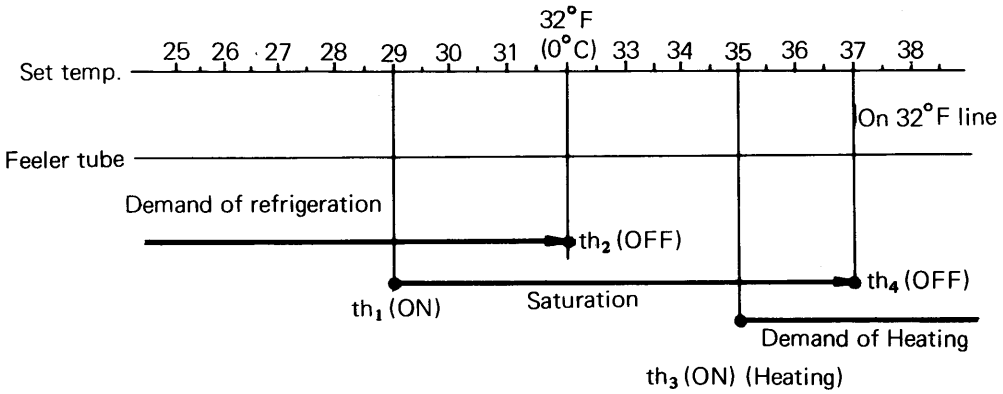
(4) Adjustment

When the recording thermostat deviates from its set values over a long period of services, adjust it as follows;

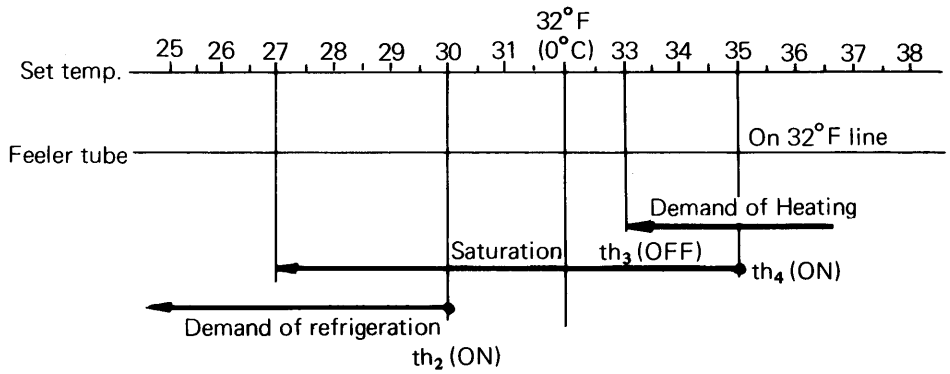
With the feeler tube at a fixed temperature, increase or reduce the set temperature, read the functioning temperature of each microswitch, and check the temp. difference between the switches and the differential values of the switches thermselves. In this case, maintain the feeler tube temperature at 32°F (0°C) by soaking the feeler tube in a water tank.

Note: If the function is out of order frequently, check if mercury leaks out of the feeler tube.

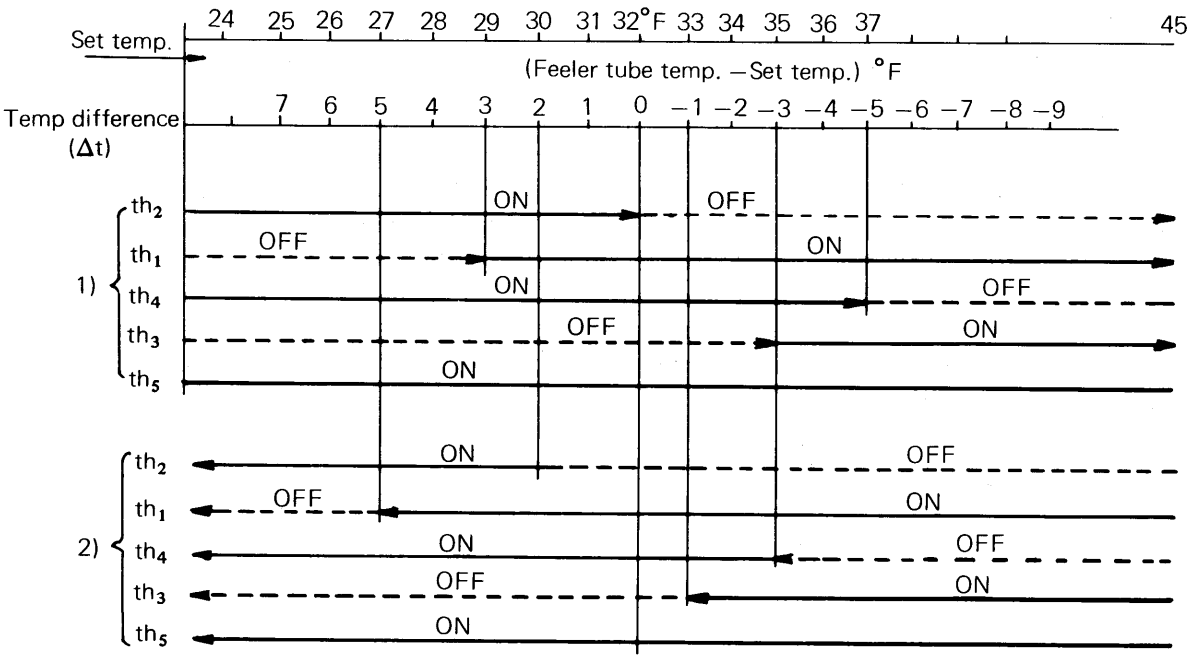
1) Increase the set temperature gradually from 20°F (−6.7°C) to 45°F (+7.2°C).
This means transfer from the refrigerating demand through the saturated state (where the feeler tube and set temperature are equal) to the heating state.



2) Reducing the set temperature gradually from 45°F (7.2°C) to 20°F (−6.7°C).
This means transfer from the heating demand through the saturated state to the refrigerating state.



Through the experiments of the items (1) and (2), you can find the functioning temperature of each microswitch. The microswitches, if normal, should function as follows.



Differential of each microswitch is difference between functioning temperature when the set temperature is increased and when it is reduced.
Deviation from the true values of the microswitches as a whole can be found from the experiments of the above items (1) and (2).
Experiment of item (1)

Deviation of

th_2 32°F − Actual functioning temp. = Δt_1
th_1 29°F − " = Δt_2
th_4 37°F − " = Δt_3
th_3 35°F − " = Δt_4

Experiment of item (2)

Deviation of

th_2 30°F − Actual functioning temp. = $\Delta t_1'$
th_1 27°F − " = $\Delta t_2'$
th_4 35°F − " = $\Delta t_3'$
th_3 33°F − " = $\Delta t_4'$

Thus, average deviation is given by:

$$\Delta t = 1/8\ (\Delta t_1 + \Delta t_2 + \Delta t_3 + \Delta t_4 + \Delta t_1' + \Delta t_2' + \Delta t_3' + \Delta t_4')$$

After calculating Δt, open the cover of the control box and rotate and adjust the adjusting screw of thermostat provided under the diaphragm.
If there is any of the four switches that shows a considerably greater deviation than the others with respect to $\Delta t_1 \sim \Delta t_4$ and $\Delta t_1' \sim \Delta t_4'$, it means a large departure from the specified value. (The deviation values of Δt_1 through Δt_4 should be about equal under normal condition.)

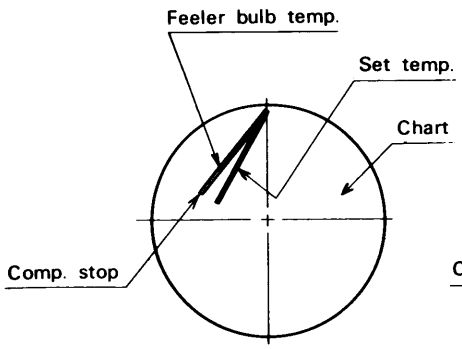
In such a case, the projection of each pin that controls the function of a microswitch must be adjusted. For adjustment, change the position of the adjusting bolt inward or outward by using the special spanner.
If the microswitches have no errors $\Delta t_1'$ through $\Delta t_4'$ and yet the feeler tube temperature (inside temperature) and set temperature do not coincide, make calibration by the following procedures.

1) Maintain the feeler tube temperature at 0°C.
2) Move the temperature indicator of the recorder toward the low temperature side (Example: +5°F→0°F), and make adjustments so that the feeler tube temperature and temperature indicator will coinside.

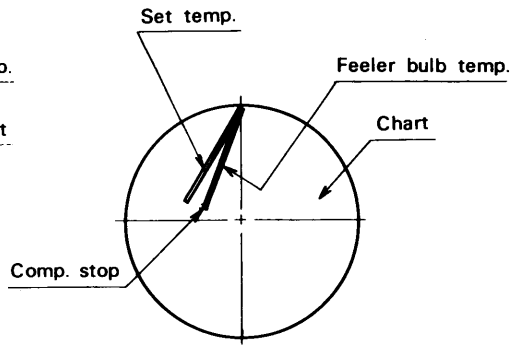
(5) Adjustment

When (feeler tube temp. −set temp.) is positive . . . . . Loosen lock screw and turn adjusting screw counter-clockwise

When (feeler tube temp. −set temp.) is negative. . . . . Loosen lock screw and turn adjusting screw clockwise.



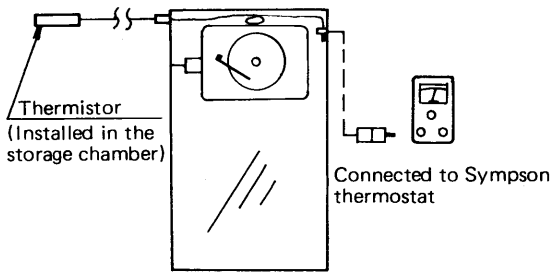
(Feeler bulb temp.−Set temp.) is positive



(Feeler bulb temp.−Set temp.) is negative

(6) Thermistor for storage temperature

A thermistor is installed for measuring storage temperature. Its feeler part is attached to the feeler tube of the recording temperature controller so that temperature of the same position can be detected. The other end of the termistor forms a connector which is located above the electric kit box as shown on the right. If it is connected to the thermometer, temperature at the feeler part of the thermistor can be measured. The thermistor uses the following thermometer



Electric kit box

Maker	Type	Temperature range
Simpson Electric Company (U.S.A.)	385-2	−50 ~ +70° F

Note: 1) Adjustment of Simpson thermometer

Turn the adjusting screw so that the meter indicator points at 0° C (32° F) when the change-over switch is set at READ in ice water whose temperature is stable at 0° C. Then set the change-over switch at ADJ and confirm that the indicator reading is 0° C (32° F). If it is not 32° F, remove the rear cover and adjust the adjusting screw located under the dry batteries to make the indicator point at 0° C (32° F).

2) In case Sympson thermometer is not available.

When the cap is removed from the fresh air intake attached to the lower access door (On the left side viewed from the front), a hole can be seen. Insert a thermometer into the hole to measure storage temperature.

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.

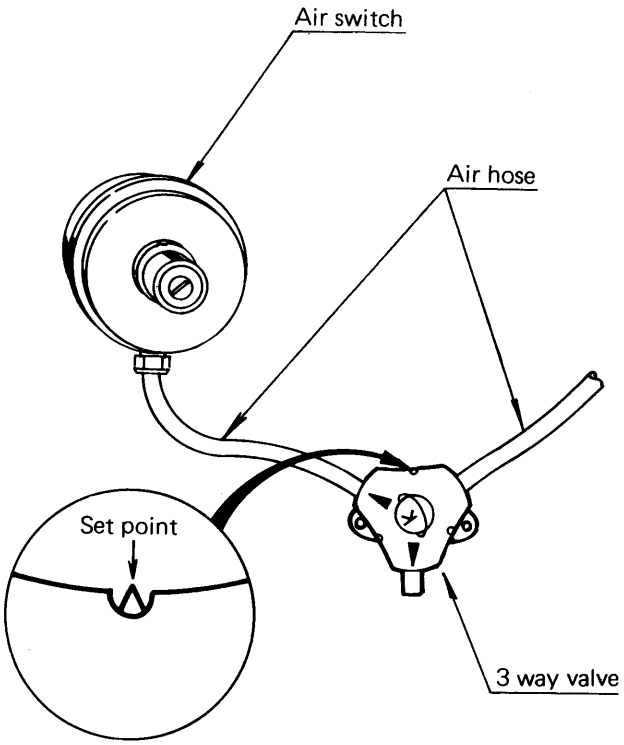
(2) When the operation value is larger than the set value, turn the adjusting screw counterclockwise.

(3) When the operating value is smaller than the set value, turn the adjusting screw clockwise.

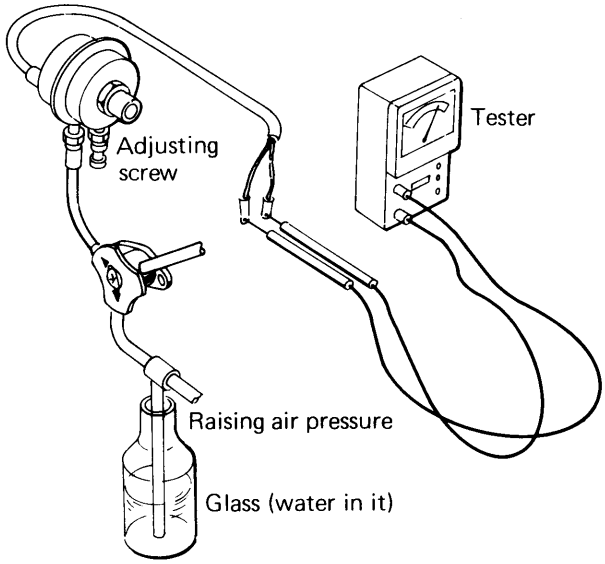
Adjusting method

(a) Set the three way valve for high and low pressure of the air switch as follows.

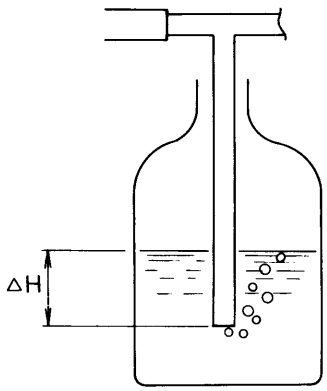
Note: Be sure to put together to the set point when the three way valve (directional control valve) is set.



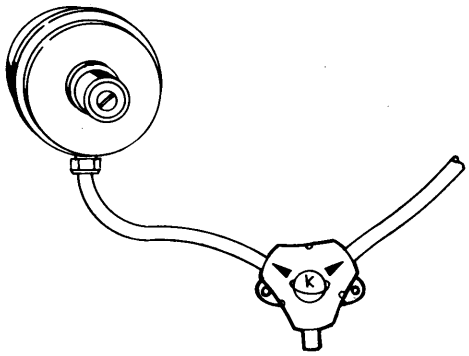
(b) Remove two lead wires from the electric kit box and connect them to a test lamp or a tester.
(c) Connect the air switch adjustor shown below to the three way valve (on high pressure side).



(d) Place a test tube in a container containing water, and gradually raise pressure in a way that air bubbles are generated in it.
(e) Read △H (following fig.) when the lamp lights up or the tester is energized, and confirm that value added 5mmH_2O to the reading is within the allowance of the setting.



(f) When ΔH is out of the setting allowance, adjust the adjusting screw so that ΔH is within the setting allowance, repeating the process from (d) to (e).
(g) After completion of the adjustment, set the three way valves (both high and low pressure sides) to the positions indicated by the arrow marks shown below.



(h) Remove the adjustor and connect the lead wires to the original terminals.

7.3 Dual pressure switch

(1) Attach a pressure and a compound gauge.
(See 9. Maintenance – attaching pressure gauge)
(2) High pressure side
(a) Raise high pressure by covering the air suction inlet or the air discharge outlet of the air cooled condenser with a blind plate. When high pressure cannot be raised because of low outdoor temperature, forcedly make the pressure switch for water function so as to stop the fan, or remove the wiring for fan motor and put the unit in the air cooled operation without fan 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. Cooling operation inoperative	A: Condenser evaporator fans and compressor are inoperative.	a. No trouble with unit	● Current interruption	● Trace cause
			● Power source is disconnected.	● Connect power source plug to power source.
		b. Circuit breaker functions	● It functions due to over current.	● Trace causes and replace.
		c. Fuse is burnt out.	—do—	—do—
	B: Evaporator fans operative but condenser fans and compressor inoperative.	a. No trouble with unit	● Thermostat functions and stops operation.	
			● Temperature setting is high.	Readjust temp. setting as designed.
		b. Oil pressure control	● It is not reset yet.	Repair trouble and push down reset button.
		c. Solenoid valve does not function.	● Coil is cut out.	Replace it.
		d. Malfunction of recording temperature controller.	● Damage of capillary tube or mercury leaks out.	Replace it.
II. Cooling operation stops soon	A: Condenser fans and compressor stop, keeping evaporator fans in operation.	a. Oil pressure protection switch is functioning.	● Oil pressure will not rise. ● Oil is short or oil pump is out of order.	Additional oil charge, or repair oil pump.
		b. No trouble with unit	● Thermostat functions and stops unit	
	B: Condenser fans and compressor operate on and off repeatedly with evaporator fans in operation.	a. Pressure switch functions. ● High pressure side	● Excessive charge of refrigerant.	Discharge refrigerant.
			● Air in system	Air purge
			● Insufficient air flow for air cooled operation.	
			● Condenser or passage clogged.	Clean or remove obstacles.
			● Fan blade damaged.	Repair or replace.
			● Fan motor does not rotate.	
			Capacitor inoperative.	Replace it.
			Fan motor thermostat has functioned.	Trace causes.
			Insufficient water volume for cooling operation.	
			● Condenser is clogged with scale.	
		● Lower pressure side	Insufficient refrigerant charge	Additional charge, seek leaking positions and repair.
			Dryer clogging	Replace
			Moisture chokes.	Exchange dryer.
			Gas leakage from feeler tube of expansions valve.	Exchange it.
		b. Over-current relay or compressor protection thermostat has functioned.	Excessive large current due to over-load operation.	Trace causes.

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

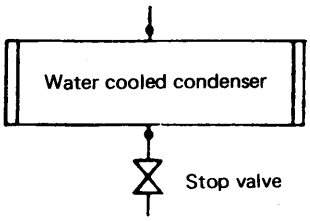
9 . Maintenance

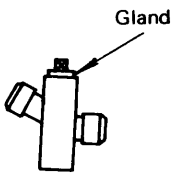
It is important to study thoroughly how to maintain the equipment properly reading the following items before the unit is operated.

○ **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 water cooled condenser. In case the pressure gauge is not attached, the operation is stopped by the dual pressure switch on the low pressure side.



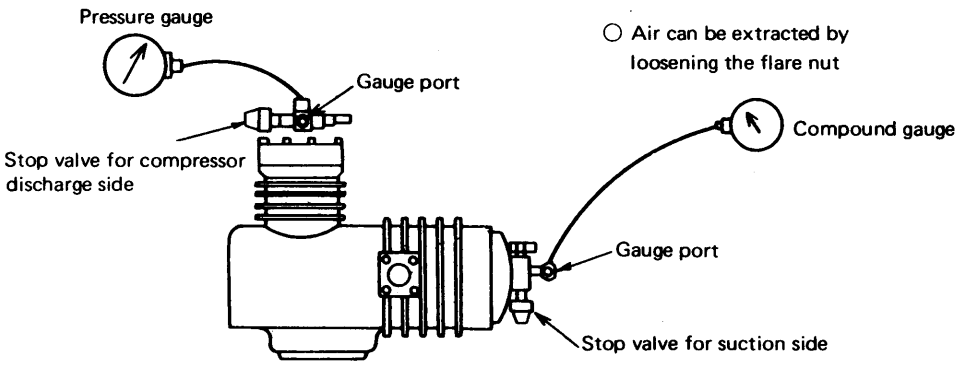


Stop valve on the water cooled condenser

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).

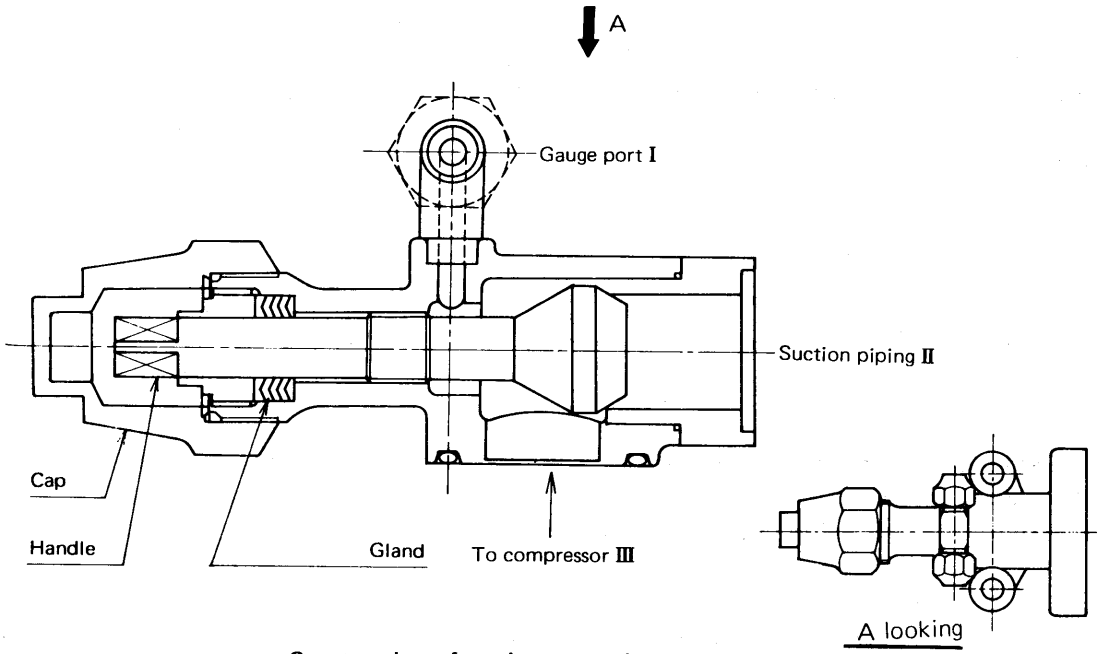


Piping connection for pressure gauge

(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.

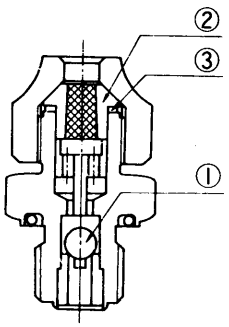


Construction of suction stop valve

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.

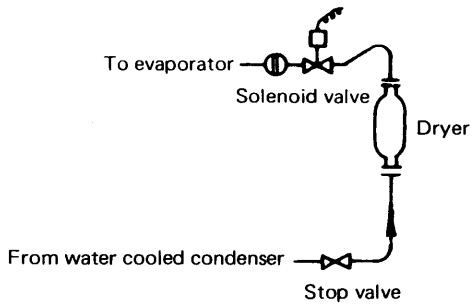


Construction of fusible plug

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) Vent the air which invaded in from the gauge port of the stop valve at the outlet of the water cooled condenser while replacing the dryer with a new one.

9.3 Purging of non-condensable gas

If non-condensable gas such as air exsists in the refrigeration circuit, it is collected in the condenser which rises pressure in the condenser abnormaly high, and at the same time heat transferring ration of the condenser surface is reduced, resulted in lowering of refrigeration capacity. It is therefore very important to extract non-condensable gas.
In case discharge pressure is abnormally high and cannot be reduced to the normal (although cooling water volume is increased in case of water cooled operation), check if non-condensable gas exsists in the following method.

*Stop the compressor, close the stop valve of the condenser or the liquid receiver and wait until entering and leaving condenser cooling water (or air) temperatures become equal. If there is any difference between condensing pressure and saturated pressure corresponding to cooling water (air) temperature, non-condensable gas must exsist in the refrigeration circuit. Extract non-condensable gas as stated below.

(1) Pump down
(2) Condense the refigerant 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

• 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 used the following method except at the time of emergency.

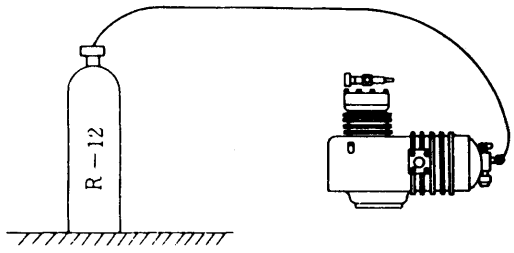
[Work order]

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) In case the refrigerant is charged, attach a dual pressure gauge, and pump down the refrigerant with the stop valve at the outlet of water cooled condenser closed, and charge the refrigerant until liquid level reaches to approximately half of the liquid level gauge.



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 vaccum 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) ϕ6.4 copper tube (with 2 ea of flare nuts)

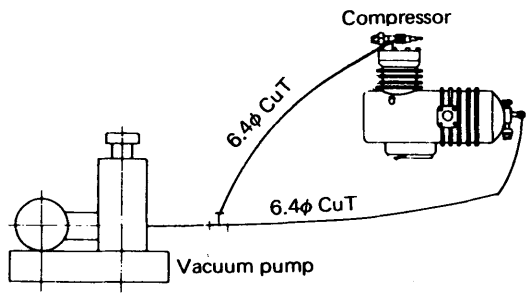
(3) Scale (50 kg)

(4) Machine tools

(5) Vacuum pump

[Work order]

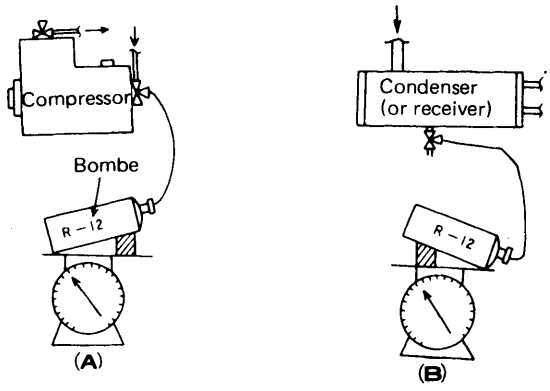
(1) Connect the vacuum pump to the gauge fittings of the stop valve on the suction and delivery sides of the compressor and form vaccum of approx. 76 cmHg in the refrigerant system for about 4 hours and disconnect the vacuum pump, maintaining the vacuum in it.



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 (or 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.

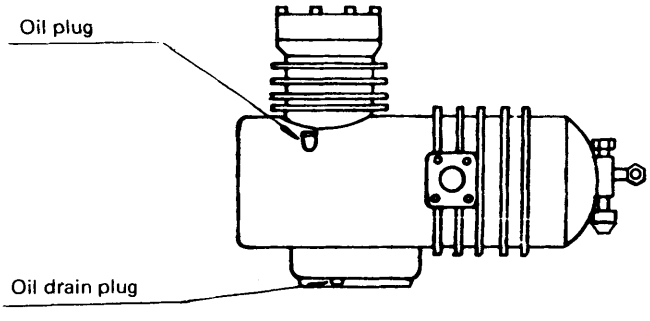
- **Both the refrigerant and the lubricant are replaced**

(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

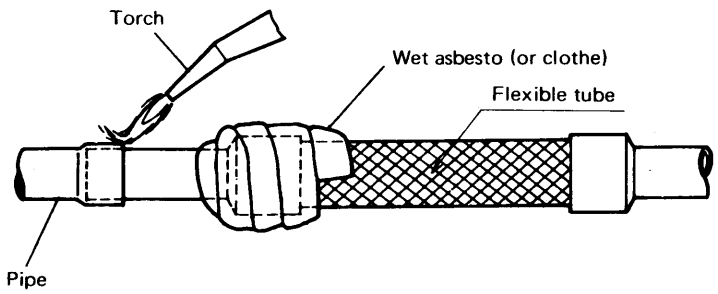
After all the procedures as mentioned before are completed, be sure to test the entire system for gas leakage with a halide torch gas detector carefully.

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 wraping wet asbestos. If the welded part of the blade fixture is heated excessively, air tighteness is damaged which may cause leakage.



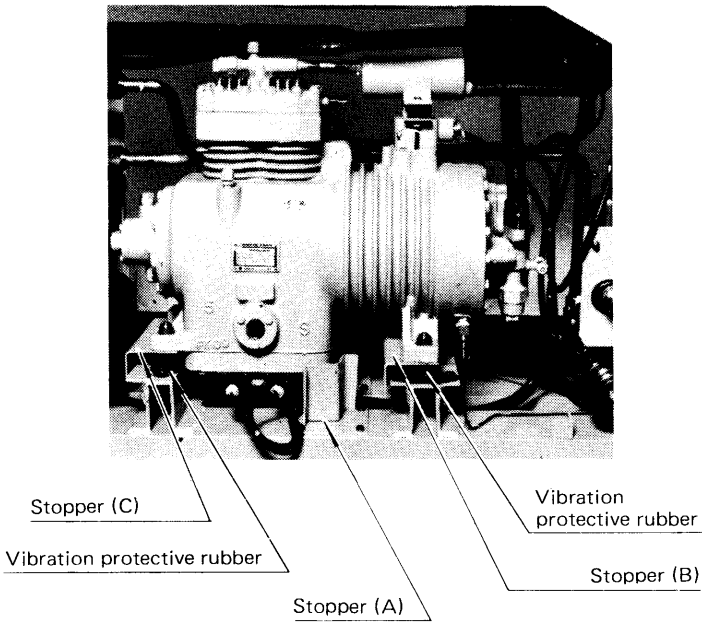
Flexible tube soldering

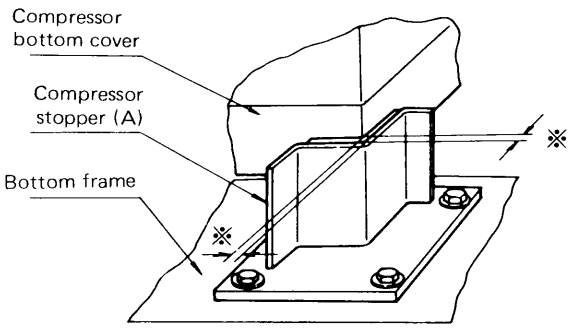
Caution for the work after flexible tube was connected

The flexible tube on the suction side should be thoroughly dried on its surface and provided with the thermal contractive tube. In addition, the flexible tube on the discharge side should be wound precisely (more than duplex winding) with silicon tape. If there is any gap in the insulation, water freezes up on it, which may cause corrosion or damage.

9.8 Caution for replacement of compressor

Vibration protective rubbers are attached to the bottom of the compressor.In addition stoppers are provided to protect the compressor from abnormal movement caused by impace. The stoppers attached are available in three kinds, (A) (B) and (C) and totally four stoppers are attached. When the stoppers (A) are attached (two points at front and rear), take a gap smaller than 3 mm (shown with※in the figure) between the compressor and the stopper (A).





When power cable are put back,
be sure to the plug to be downward.

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