DAIKIN

取扱説明書
Operation Manual

ダイキン 舶用小形冷凍機
Marine Type Small Size Condensing Units

このたびは、ダイキン舶用小形冷凍機をお買い上げいただき、まことにありがとうございます。

より長くご愛用いただくために、ご使用前には、必ずこの取扱説明書をお読みいただき、正しくご使用ください。

この取扱説明書には、安全についての注意事項を記載しております。
正しくお使いいただくために、ご使用前に、必ずお読みください。
お読みになった後、いつでもご覧になれるよう、お手元に保管してください。

本機には、各種の安全装置がついていますが、どんな据え付け、どんな取り扱いをしても大丈夫というわけではありません。
正しい据え付け、正しい取り扱いと手入れをするのが最大の安全装置です。
機内の点検、手入れをされる場合は、安全のため必ず運転スイッチを停止にし、電源スイッチを切ってください。

掲載機種
MODELS:

RKS2F
RKS3F
RKS5F
RKS8F
RKS10F

Carefully read this operation manual before using the air conditioner. It will tell you how to use the unit properly and help you if any trouble occurs.
After reading the manual, file it away for future reference.
This air conditioner is equipped with safety devices but they will not necessarily prevent all troubles caused by improper operation and inadequate maintenance. The best safety precaution is correct installation, proper operation and adequate maintenance.

この説明書はよくお読みになって心ず保管してください。
Carefully read this operation manual and file it away for future reference.

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Chapter 1 Safety Instructions...Be sure to follow them.

Read this section carefully before use and operate the unit properly.

- The cautions shown here are classified into the following two categories.
  Since these instructions are important for your safety, be sure to follow them.

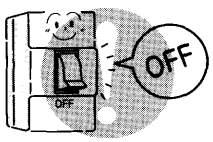
⚠WARNING	indicates a potentially hazardous situation which can result in death or serious injury if the unit is used improperly.
⚠ CAUTION	indicates a potentially hazardous situation which may result in injury or damage to property if the unit is used improperly. It may lead to serious results depending on the case.

- The pictographs with the following meanings are used in the text.

⃠	Never	❗	Follow the instructions.	⏚	Be sure to ground.

⚠WARNING

- **If abnormal conditions (a smell of burning, etc.) are encountered, turn off the power and contact your dealer.**
  If the unit is operated without eliminating the cause of them, failure, electric shock or fire may result.



- **Ask your dealer to install the unit.**
  If you install the unit yourself, water leakage, electric shock or fire may result due to improper installation.

- **When an improvement or repair is necessary, consult your dealer.**
  Improper improvements or repairs may cause water leakage, electric shock or fire.

- **Consult your dealer about the measures against refrigerant leakage.**
  When installing the unit in a small room, measures must be taken to prevent a leaked refrigerant (if any) from exceeding the threshold concentration. If the leaked refrigerant exceeds the threshold concentration, an oxygen deficiency accident will result.

⚠CAUTION

- ***Do not use the unit for purposes other than originally intended.***
  Do not use the unit for special purposes such as preservation of food, animals, plants, precision mechanical equipment or work of art. Their quality may deteriorate.

- ***When cleaning the unit, be sure to stop it and turn off the power.***
  The neglect of these measures may cause an electric shock or injury.

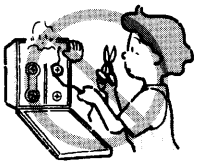
⚠ CAUTION

- **Do not put containers filled with water such as a vase on the unit.**
  Water may permeate the unit to degrade the electric insulation and cause an electric shock.

- **Do not set the unit in any place where combustible gas may leak.**
  If combustible gas leaks and gathers around the unit, it may catch fire.

- **Do not operate the unit with wet hands.**
  The operation with wet hands may cause an electric shock.

- **Use a fuse with the rated capacity only.**
  If a wire is used, failure or fire may result.



- **Do not put a combustible spray near the unit. Do not spray the unit.**
  A fire may result.

- **Install a circuit breaker.**
  If no circuit breaker is installed, an electric shock may result.

- **Do not let cold air blow directly to animals or plants.**
  A direct cold wind may exert adverse effects on them.

- **Do not wash the refrigerating machine in water.**
  An electric shock may result.

- **Ground.**
  Imperfect grounding may cause an electric shock.

- **Install drain pipes so as to ensure complete drainage.**
  Incomplete drainage may cause water leakage etc.

Chapter 2 Installation

⚠ WARNING

- **Ask your dealer to install the unit.**
  If you install the unit yourself, water leakage, electric shock or fire may result due to improper installation.

- **Consult your dealer about the measures against refrigerant leakage.**
  When installing the unit in a small room, measures must be taken to prevent a leaked refrigerant (if any) from exceeding the threshold concentration. If the leaked refrigerant exceeds the threshold concentration, an oxygen deficiency accident will result.

⚠ CAUTION

- **Do not set the unit in any place where combustible gas may leak.**
  If combustible gas leaks and gathers around the unit, it may catch fire.

- **Install a circuit breaker.**
  If no circuit breaker is installed, an electric shock may result.

- **Ground.**
  Imperfect grounding may cause an electric shock.

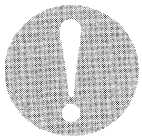
- **Install drain pipes so as to ensure complete drainage.**
  Imperfect drainage may cause water leakage etc.

In order to enjoy the full functions of the refrigerating machine for a long time, confirm the following points. If there is anything wrong with it, make any needed repairs before using it.

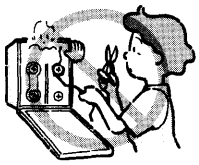
- **Ensure that an independent power source is provided for the refrigerating machine unit.**
  Without a separate power source, the circuit breaker may open or a fuse may blow.
- **Ensure that the wires and pipes will not be damaged.**
- **Be very careful not to allow water and foreign matters into the pipes.**
  In installing the system, keep the refrigerant pipe clean inside using a vacuum pump.

⚠CAUTION

- **When cleaning the unit, be sure to stop it and turn off the power.**
  The neglect of these measures may cause an electric shock or injury.



- **Use a fuse with the rated capacity only.**
  If a wire is used, failure or fire may result.

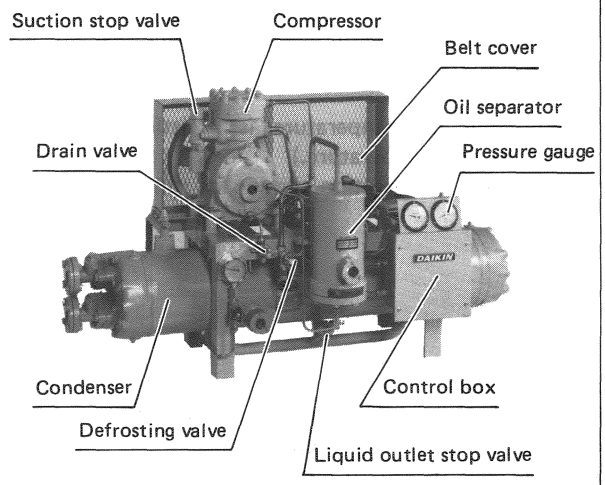


- **Do not wash the refrigerating machine in water.**
  An electric shock may result.

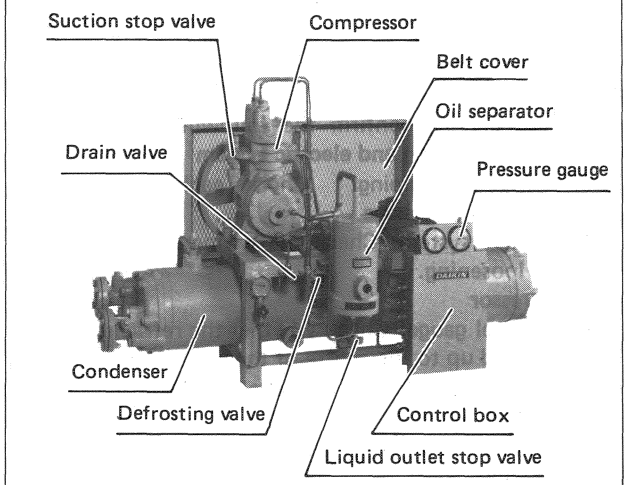
Chapter 4 Operation and Maintenance

1. Names and functions of parts

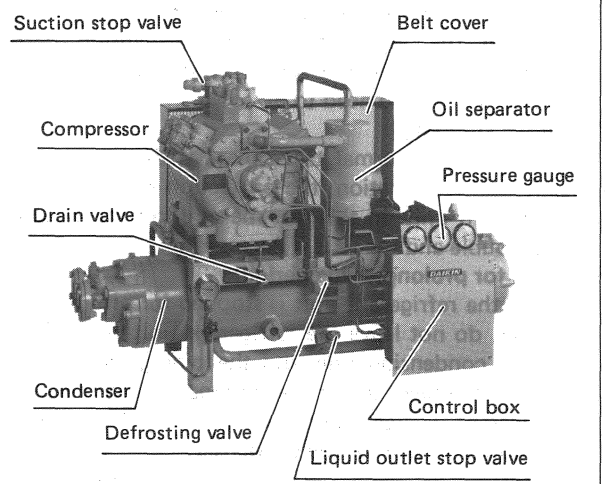
RKS 2F • 3F



RKS 5F



RKS 8F • 10F



Compressor . . . . . .Compresses the low temperature and low pressure gaseous refrigerant which was evaporated through the evaporator to such a degree that the refrigerant can be easily liquidized in the condenser.

Oil separator. . . . . .Separates the refrigeration oil from the gaseous refrigerant which was delivered by the compressor and returns the oil to the compressor automatically.

Condenser . . . . . .Liquidizes the high temperature and high pressure gaseous refrigerant which was delivered by the compressor with condenser water.

Control box . . . . . .Contains the safety devices such as dual pressure switch, oil pressure protection switch (RKS8F, 10F only), pressure switch for unloader, solenoid valve (RKS5F, 8F, 10F only), etc.

Defrosting valve . . .Allows the high temperature and high pressure gaseous refrigerant to pass to the evaporator to defrost the evaporator.

2. Operation and stopping

2-1. Inspection prior to operation

After completion of works for refrigerant piping, heating insulation, wiring, air tight test, vacuum drying and refrigerant charge, confirm the following.

- **Refrigerant piping and electric system**
  - Refrigerant piping: Check each pipe joint for refrigerant leakage.
  - Electric system: Check the wiring and the terminals for loosening.
- **Compressor**
  - Oil level gauge: Check whether the refrigeration oil is charged up to the centre of the oil level gauge.
  - V belt: Check the V belts for their tension and parallel degree.
  - Pulley: Check whether the pulley moves smoothly by hand.
- **Condenser**
  - Water pressure gauge: Check whether the gauge works correctly by supplying condenser water.
  - Air plugs on the head and the rear covers: Open the air plugs to vent the air.
  - Check whether water leaks.
  - Liquid level gauge: Check whether the refrigerant has been charged by this gauge.

2-2. Operation

Operate the condensing unit in the following order.

(1) Supply condenser water and operate the evaporator fan.

(2) Open the compressor suction valve half way.
Fully open the condenser inlet valve and the liquid outlet stop valve.

(3) Operate the compressor motor on and off.
- Operate the compressor on and off five or six times.
- Check whether the compressor motor rotates correctly (Clockwise viewed from the pully side).
- Check whether oil foaming is demolished by the oil level gauge.

(4) Operate the comprssor motor → Fully open the compressor suction stop valve for RKS8-10F.
In case of RKS2~5F, slightly close suction stop valve by 1 to 2 turns from full open.

(5) Check whether there is any trouble with pressure gauge, ammeter, thermometer, oil level gauge, etc.

(6) Check the oil return pipe of the oil separator for its temperature.
(Normally its temperature is a little warmer than atmospheric temperature.)

(7) Check the refrigeration system for refrigerant leakage.

2-3 Stopping

(Daily stopping)

(1) Turn off the power switch for compressor motor.

(2) Stop condenser water supply.

(3) If there is danger of water freezing up during suspension period of the condensing unit, remove the water drain plug to extract water from the condenser.
Note:
Close the manual stop valve attached before the expansion valve to prevent the liquid refrigerant from entering the evaporator during suspension period. However, if a solenoid valve is installed in the liquid piping, there is no need to do so.

(Abnormal stopping)

If anything abnormal takes place with the refrigerant unit during operation, the protection switch stops the refrigerant unit. In this case, be sure to trace a cause of the trouble and repair it if necessary.

(Stopping for prolonged idle period)

When the refrigerant unit is stopped for prolonged idle period, do not leave the refrigerant unit with pressure in the condensing unit and the piping, because they would be subject to unnecessary load, which may cause refrigerant leakage. Pump down the refrigerant into the liquid receiver or the condenser.
denser.
Note:
Regard the internal capacity of the condenser or the liquid receiver; if it cannot contain all refrigerant in it, remove the excess refrigerant into a refrigerant cylinder.

(Caution)

1. There would be a time delay when the expansion valve is adjusted once. So, once again adjust it approximately 15 minutes later.
2. If abnormal phenomena take place after the compressor is operated, trace a cause of trouble and repair it.
3. Regard the following during operation

Compressor

- Suction pressure and temperature. . . . Regard designed pressure and temperature as guides.
  If suction pressure and temperature are extremely low, discharge refrigerant temperature rises and refrigeration capacity reduces. If they are extremely high, the motor is over-loaded.
  Adjust over-heat degree within the allowable range of discharge gas temperature and oil temperature.
- Discharge pressure and temperature. . . . Regard designed pressure and temperature as guides.
  Be sure to operate the condensing unit with discharge gas temperature under 130°C. When condenser water temperature is low, adjust condenser water valve so that discharge pressure can be controlled over approx. 1 MPa. (When R-22 is used).

- Oil pressure, oil temperature and oil level. . . . In case of RKS 8F and 10F, suitable oil pressure is higher than suction gas pressure by 0.3~0.5 MPa.
  Suitable oil temperature is that you feel it warm when you touch the crankcase.
  Oil level should be the centre of the oil level gauge and oil should be clean.
- Noise and vibration. . . . Normal operation noise and vibration are so rhythmical that they do not get on one's nerve.
- V belt. . . . . Normal V belt should not roll and oscillate.

Oil separator

The oil separator is hot during operation. The return oil piping is a little warm. When the oil return piping gathers dew or frost, condensing temperature must be abnormally low. So it is necessary to control cooling water volume.

Condenser

To maintain appropriate condensing pressure (discharge pressure), check condenser water volume and water temperature. If cooling tubes are clogged with dust or non-condensable gas is intermixed, condensing pressure rises.
The suitable liquid level is at the centre of the level gauge.

3. Inspection

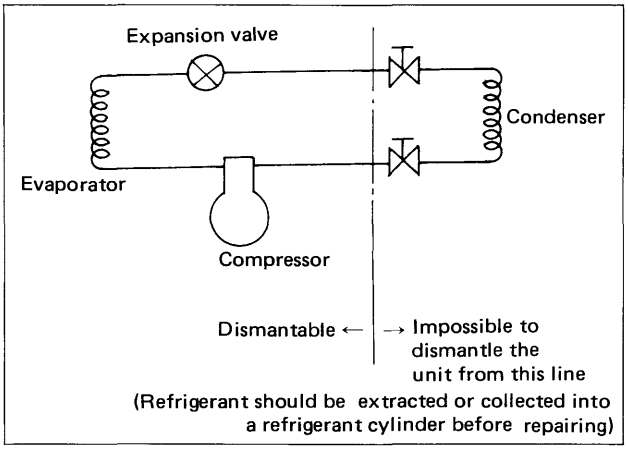
Inspect the following points regularly and adjust or repair the condensing unit if necessary.

Time of inspection	Inspection items	Points	Standards for judgment
Daily	• Lubrication oil in the compressor	Check it by oil level gauge	Oil level should be at the centre of the oil level gauge and oil should be clean.
	• Discharge pressure	Check it by discharge pressure gauge	Refer to the specifications (Temperature or pressure)
	• Suction pressure	Check it by suction pressure gauge	Refer to the specifications (Temperature or pressure)
	• Oil pressure	Check it by oil pressure gauge	Suction pressure +0.3~0.5 MPa
	• Condenser water temperature	Check it by thermometer	Range around 3 ~ 10°C
	• Vibration and noise	Auscultation and palpation	No abnormal vibration and noise
Every 3 months	• Refrigerant leakage from the refrigeration system	Check it with a gas detector or soapsuds	No reaction
	• Tension of V belt		Slack of approx. 10mm
	• Cleaning the condenser	Remove the head and rear covers and check and clean the condenser	Not stained nor clogged.
	• Corrosion-proof galvanized plate		Replace it if it was worn half.
Annually	• Check the dual pressure switch for its OFF pressure	High pressure side. . . Stop condenser water and check OFF pressure with pressure gauge	Pressure setting within $\pm^{0}_{0.15}$ MPa
		Low pressure side. . . Close the condenser outlet valve and OFF pressure with pressure gauge	Pressure setting within ±0.02 MPa
	• Compressor lubrication system	Check it with oil level gauge	Replace oil with new oil
	• Check the compressor opened	After opening the compressor, check it for clearance	Refer to the repairing standards (Page 16)

4. Maintenance work

4-1. Pump down

Pump down means that the refrigerant in the refrigeration system is collected temprorarily in the condenser (or the liquid receiver). After pumping down, the condensing unit can be dismantled within the limit shown below.



How to pump down the refrigerant:

1. Supply water into the condenser.
2. Open the compressor suction stop valve and condenser inlet stop valve.
3. Close the condenser liquid outlet stop valve. Open the solenoid valve in the liquid line by hand or electrically.
4. Short circuit the terminal so that the low pressure side of the dual pressure switch will not function.
5. Operate the compressor and draw the refrigerant on the low pressure side.
6. Stop the compressor when low pressure gauge reading becomes 0.02 MPa, and leave it for a while. When low pressure rises, once again operate the compressor until low pressure gauge reading becomes 0.02 MPa. Low pressure will not rise when this procedure is repeated two or three times.
7. Stop the compressor and close the condenser inlet stop valve quickly, and then close the suction stop valve.
8. After finishing pumping down, stop condenser water supply.

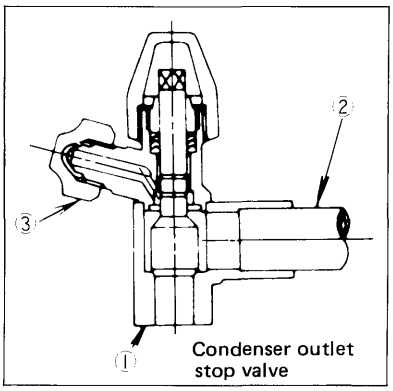
Caution:

1. If pump down continues for a long time, oil pressure may be lowered more or less, but do not short circuit the oil pressure protection switch circuit.
2. After finishing pump down, do not forget to restore the short circuit of the terminal on the low pressure side of the dual pressure switch.
3. It is unavoidable to extract a small amount of the refrigerant while dismantling after pumping down, so additionally charge the refrigerant appropriately after repair.
4. In case the refrigeration circuit is opened to the atmosphere for repair, be sure to repair it as quick as possible. If it is left opened for a long time, the refrigeration circuit may be rusted, which may cause a big trouble. If it takes time to repair, seal the opening, evacuate the circuit, and charge the dry nitogen gas in it.
5. Cover the opening with a clean cloth to prevent dust from entering the inside. Before assembling, clean each part completely, because the bearing and the rubbing parts are apt to be damaged by tiny dust.
6. When the compressor alone is dismantled, there is no need to pump down the refrigerant from the whole system, but pump down the refrigerant only from the compressor by closing the suction stop valve gradually.
7. Although the refrigerant is pumped down from the compressor, internal pressure on the high pressure side is considerably high. So do not remove the covers at once, but dismantle them after releasing internal pressure gradually.

4-2. Charging and extracting the refrigerant

■ **Charging the refrigerant**

(1) Supply condenser water.
(2) Tentatively connect the refrigerant cylinder to the refrigerant charge port and open the stop valve of the cylinder a little to purge the air from the connecting pipe. After that, connect the joints firmly.
(3) Open the condenser outlet stop valve half way.
(4) Close the solenoid valve in the liquid line to prevent the liquid refrigerant from entering the evaporator.
Note: Charge the liquid refrigerant only by tilting the refrigerant cylinder.
(5) Fully open the stop valve of the refrigerant cylinder.
In this state, the refrigerant can be changed until pressure in the cylinder is balanced with that in the system.



(1) Condenser outlet flange
(2) To expansion valve
(3) Joint for refrigerant charge
This figure shows when the stop valve is fully open.
When the valve is fully opened, (1) is connected to (2)
When the valve is half opened, (1) is connected to (2) and (3)

In case the refrigerant should be charged further,

(1) Fully open the condenser outlet stop valve.
(2) Operate the compressor with the solenoid valve in the liquid line opened, and charge the refrigerant by means of pump down.
(3) Stop the compressor when the predesigned volume of the refrigerant has been charged, and close the stop valve of the refrigerant cylinder. Then, disconnect the cylinder from the system.

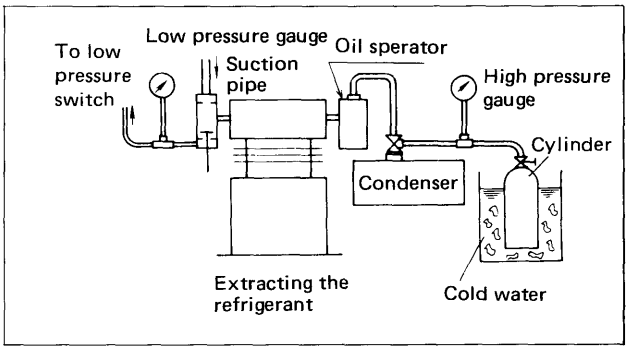
■ **Extracting the refrigerant**

When the refrigerant should be extracted due to over-charge or repairing work, extract it from the equalizing valve (used in common with air cock valve) in case extracting volume is only small. In case the refrigerant should be extracted in a large volume, extract the refrigerant into the refrigerant cylinder. The structure and capacities of cylinders are regulated by the law. Therefore, it is prohibited to over-charge the refrigerant into the cylinder by the law.

The work to recharge the refrigerant into the cylinder is as follows.

(1) Prepare an empty refrigerant cylinder. The cylinder should be guaranteed by the certificate issued by the relevant government and be within the guaranteed pressure limit (Approx. 3 years). In addition, the cylinder is thoroughly evacuated and its internal pressure should be under −0.099 Ma.

(2) Fully open the condenser inlet stop valve and close the service port. Connect the refrigerant cylinder with the service port with piping. Install a high pressure gauge in the way of the connecting piping.



(3) Submerge a cylinder into cold water by 3/4 of its height.

(4) Return the valve shaft of the condenser inlet stop valve a little and loosen the flare nut of the cylinder stop valve a little to extract the air from the connecting pipe. Firmly tighten up the flare nut when the air is extracted and open the cylinder stop valve.

(5) Leave all stop valves except the inlet stop valve in the refrigeration system as they were during operation, and operate the compressor. After operating the compressor, frequently stir water around the cylinder and add ice when the water becomes warm to keep its temperature as low as possible. Note the high pressure reading during extraction of the refrigerant, and stop the compressor when the pressure reading exceeds 1.15MPa and wait until the pressure drops.

(6) When compressor suction pressure becomes 0.01 MPa, stop the compressor. After awhile, pressure on the suction side rises, because the refrigerant in the oil evaporates. Repeat the compressor operation on and off until the suction pressure becomes stable to 0.01 MPa. If the compressor is automatically stopped before suction pressure becomes 0.01 MPa, lower the pressure setting on the low pressure side of the dual pressure switch to 0.01 − 0 MPa by the adjusting screw which is put out of the side of the dual pressure switch, or short circuit the contact points by hand.

(7) When suction pressure becomes stable to 0.01 MPa, close the valve of the refrigeration cylinder, remove the flare nut, and the connecting pipe.

4-3. Replenishing and extracting the refrigeration oil

■ **Replenishing oil**

Before replenishing the oil, pump down the refrigerant through the refrigeration unit. When suction pressure reaches to 0.01 MPa, stop the compressor and close the compressor suction stop valve and the condenser inlet stop valve. Then, gradually remove the flare nut for oil charge joint which is attached to the upper part of the crankcase. (In case of RKS2F, 3F, and 5F, remove the oil drain plug). When the plug is removed, charge the oil with care not to get air into it. (In case of RKS 8F and 10F, the oil charge joint is equipped with check valve.) Further, the charge hose should be inserted lower than the oil level in the oil container.

After charging the oil, tighten up the flare nut with blind cover (In case of RKS 2F, 3F, and 5F, restore the oil charge plug as it was), so oil doesn't leak. Restore the states of stop valves as they were.

■ **Extracting oil**

Pump down the refrigerant from the compressor and maintain pressure in the crankcase higher than atmospheric pressure. Then, loosen the drain oil valve and extract excess oil.

■ **Recommendable refrigeration oil**

The refrigeration oil should meet using temperature and operation conditions and should also be good quality.

The oil charged in the condensing unit is CRAVAS46 produced by Showa Shell. In case the refrigeration oil should be replaced, note the following:

- Do not intermix two different oils or do not use reclaimed oil.
- Replace with new oil and once again replace with new oil after more than 24 hours of operation.

Chose refrigeration oil from the following table.

Name of petroleum companies	Te < −30°C	Te ≧ −30°C
Nippon Sun Petroleum	SUNISO 3GSD (VG32)	SUNISO 4GS DID-K (VG56)
	SUNISO 3GS-D1 (VG32)	SUNISO 4GS-D1 (VG56)
		SUNISO 4GS (VG56)
Cosmo Petroleum	Cosmo super freeze 32	Cosmo super freeze 56
	Cosmo super freeze AB32	Cosmo super freeze AB46
Mobil Sekiyu	GARGOIL arctic oil 155	GARGOIL arctic oil 300 ID
General Oil	Polarol Super 32	Polarol Super 56
BRITISH PETOROLEUM	BP ENERGOL LPT-F 32	BP ENERGOL LPT-F 46
Showa Shell Petroleum	SHELL 32K	SHELL 68K
	CRAVAS OIL 32	CRAVAS OIL 46
Idemitsu Petrochemical	DAPHNY CR32A	DAPHNY LR46A, 68A
Kyodo Yushi	FLEOR F32	FLEOR F56
Nippon Petroleum Processing	Atomos 32	Atomos 46, 68
CALTEX TEXACO	CAPELLA WF32	CAPELLA WF68
Esso Standard Petroleum	ZELICE R32	ZELICE RS46, 68
	ZELICE S32	ZELICE S68
Mistubishi Oil	Diamond Freeze 32	Diamond Freeze 56
Matsumura Oil	Barrel freeze 32S	Barrel freeze 46SA
		Barrel freeze 46S

4-4. Detecting the refrigerant leakage

Whether or not the refrigerant leaks can be checked in various ways. In general, oil leaks together with the refrigerant, so you can find it easily. For a minute leak from the piping or around the unit, use a gas detector. When it is presumed that the refrigerant leaks inside the condenser, close the condenser water inlet and outlet valves and let water flow out of the condenser after removing the water plug in the bottom cover. Then bring a gas detector, close to the water plug hole. If any gas leaking is found, remove the condenser covers, check each cooling tube and the tube plates for refrigerant leakage.

4-5. Purging noncondensable gas

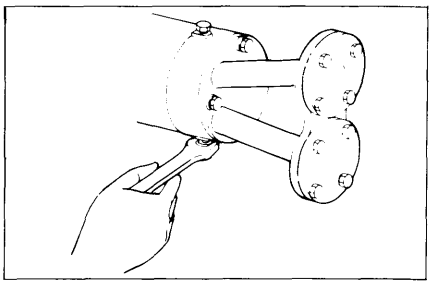
If discharge pressure is abnormally high and will not be restored to normal pressure although condenser water volume is increased, check whether noncondensable gas such as air is intermixed in the refrigeration circuit by the following method. Stop the compressor, close the condenser liquid outlet stop valve, and supply condenser water to the condenser until entering condenser water temperature becomes equal with leaving condenser water temperature. If there is any difference between condensing pressure and saturated pressure corresponding to condenser water temperature, there is noncondensable gas in the refrigeration circuit.

To extract noncondensable gas, pump down the refrigerant from the unit, stop the compressor, close the condenser inlet stop valve and leave the condenser for approx. 5 minutes. Thus the refrigerant vapor is condensed as much as possible. Then slightly open the purge plug (belongs to the equating valve for condenser) on the top of the condenser or the liquid receiver, from which the air is vented. Supply maximum condenser water volume to the condenser during air purging. When the air is purged, high pressure is lowered a little. When this pressure remains the same, air is vented completely. Since discharge gas is of very high pressure, do not get close to the discharge outlet while gas is extracted.

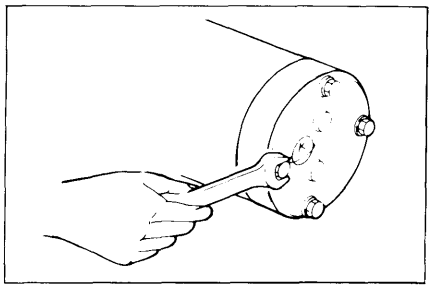
4-6. Cleaning the condenser cooling tubes

Although cleaning period differs more or less with water quality and running period, inspect the cooling tubes at least once every three months by opening the head and rear covers of the condenser and clean the cooling tubes if necessary. Before cleaning the cooling tubes, be sure to turn off the power source for pump.

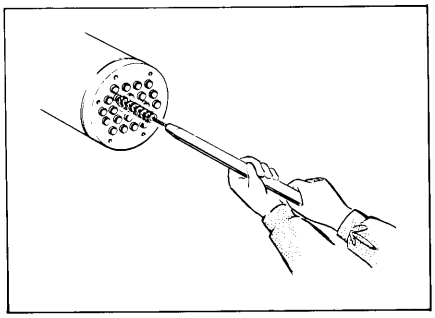
(1) Extract water in the system from the lowest position of the piping system. In addition, remove the upper and lower plugs on the condenser head and rear covers and vent water.



(2) Remove the head and rear covers on both ends (right or left)

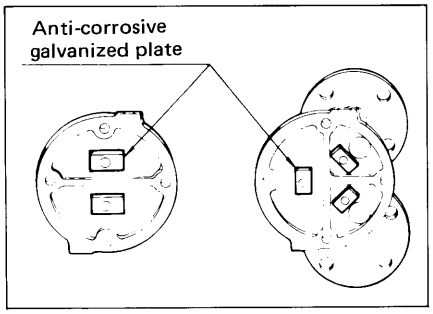


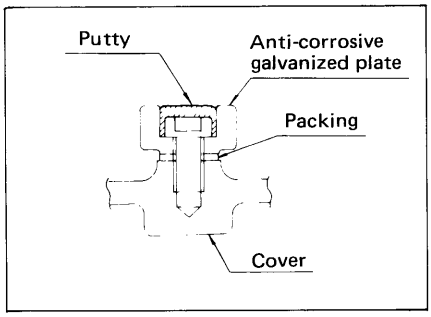
(3) Brush the cooling tube from the both ends as shown below and remove dust settled inside the cooling tube.



4-7. Replacing the anti-corrosive galvanized plate

The anti-corrosive galvanized plates attached to the condenser covers are very important to prevent the cooling tubes and the tube plates from being corroded. Check them at least once every three months for wear and replace them once every six months.



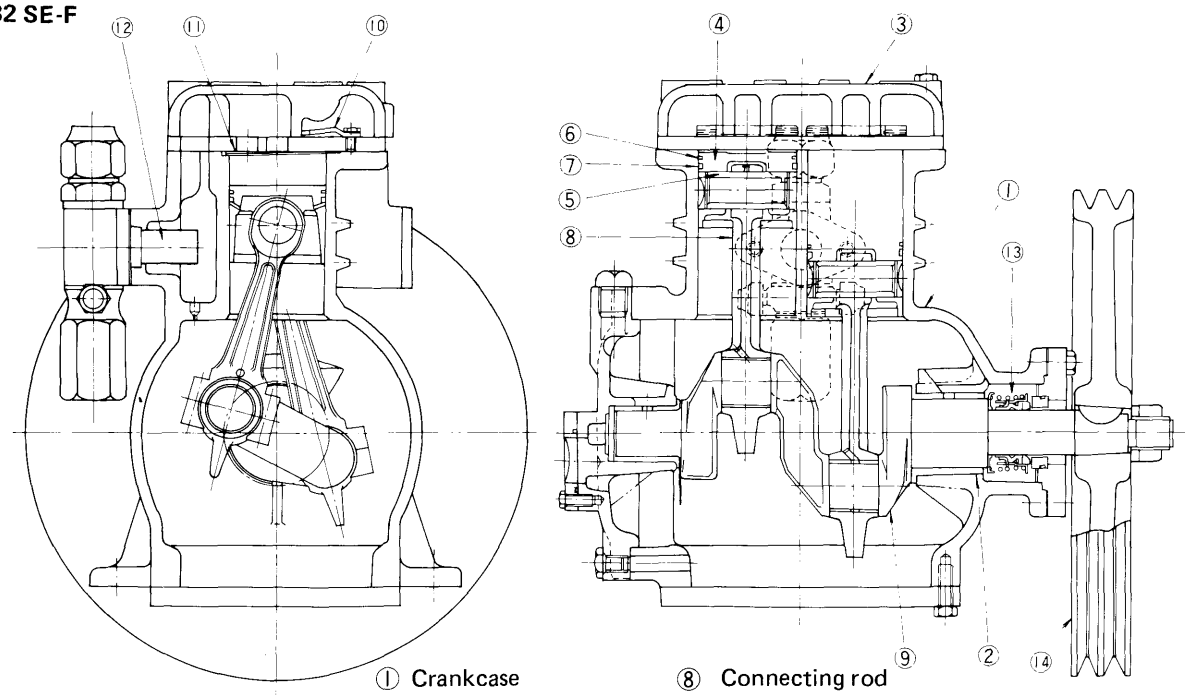


Install the anti-corrosive plate by means of packing as shown in the figure. Be sure to cover the bolt head with putty so that the bolt head does not contact water.

Chapter 5 Structure

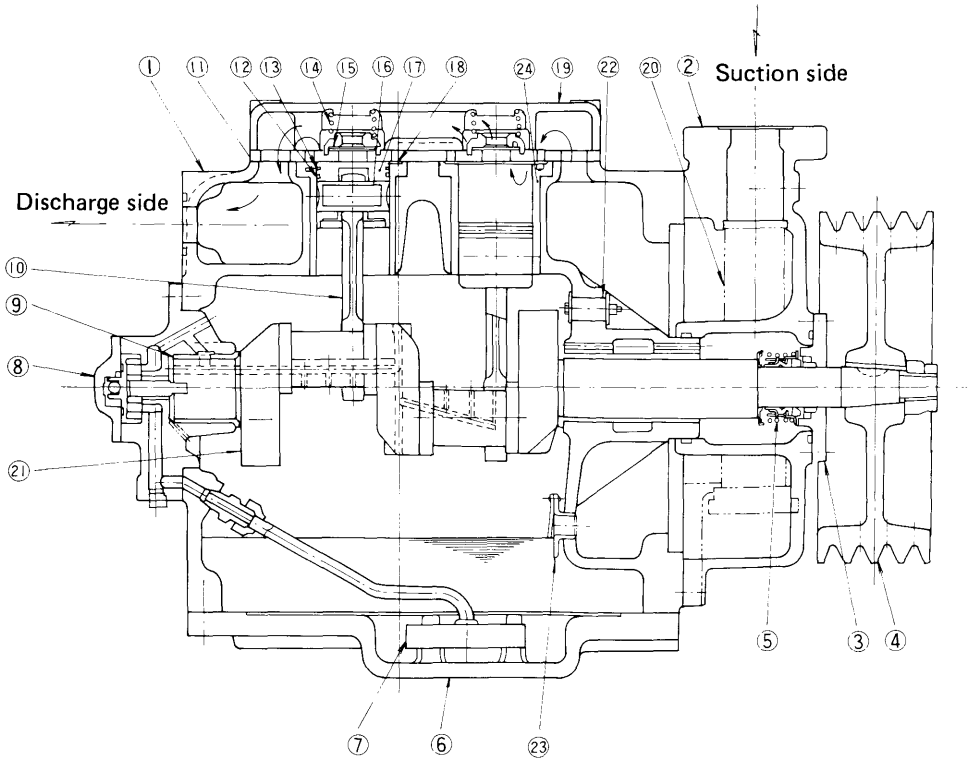
1. Compressor

2 C582 SE-F



① Crankcase
② Main bearing
③ Cylinder head cover
④ Piston
⑤ Piston pin
⑥ Piston ring
⑦ Oil ring
⑧ Connecting rod
⑨ Crankshaft
⑩ Discharge valve
⑪ Suction valve
⑫ Strainer
⑬ Shaft seal
⑭ Pulley

6 C552A-F



① Crankcase
② Strainer body
③ Side cover on the seal side
④ Pulley
⑤ Shaft seal
⑥ Bottom Cover
⑦ Oil suction strainer
⑧ Oil pump
⑨ Main bearing on oil pump side
⑩ Connecting rod
⑪ Valve seat
⑫ Oil ring
⑬ Piston ring
⑭ Safety spring
⑮ Discharge valve
⑯ Piston pin
⑰ Piston
⑱ Suction valve
⑲ Cylinder top cover
⑳ Strainer
㉑ Crank-shaft
㉒ Equalizing plate
㉓ Oil check valve
㉔ Cylinder liner

1-1. Caution for repairing compressor after dismantling it

- Handle the parts with care not to damage or not to make any scar when dismantling the compressor, particularly special care should be paid when handling the shaft seal.
- Use clean tools.
- After dismantling, place the parts in order on a clean place. If repairing work takes time, apply the refrigeration oil to each part to protect it from being rusted.
- Use absolute alcohol to wash the parts. After washing, wipe off alcohol completely.
- Do not use a fibre cloth to wipe alcohol, but use unwoven cloth such as moltoplain so as not to leave a thread on the surface of compressor parts.
- Carefully handle such parts which look alike or in pairs not to get them mixed up.
- Consider proper fitting clearance when the parts which are inlaid are mounted.
- Be sure to remove rust, water or foreign objects completely from the parts when assembled.
- Do not damage packings when the parts are removed. If a packing adheres to the metal surface, carefully peel it off so as not to impair metal surface. If it is hard to peel off, sacrifice the packing, but do not impair the metal surface.
- Apply clean oil to the machined surface and then place the packing on it.
- Remember location of bolts when they are removed. Although they look alike both in shape and size, their material and screw thread sometimes differ. Furthermore, do not forget to provide washers if they were attached originally.
- Insert the clamp bolts until their heads contact with the seat lightly and tighten the bolts arranged diagonally rather firmly first and then with predesigned torque. This method prevents one-sided tightening, refrigerant leakage, or bolt damage.

Tightening torque of bolts and nuts

Name		Thread size	Diagonal length	Tightening torque		Remark
				5T bolt	10T bolt	
Hexagonal head bolt		M6	10mm	5.1N·m	12.3N·m	
		M8	13	12.3	29.6	
		M10	17	25.2	60.8	
		M12	19	42.8	103	
		M16	24	101	243	
		M20	30	201	191	
Flare nut	F N S 2	U 7/16–20	17	15.7		Copper tube 1/4
	F N S 3	U 5/8–18	22	46.1		Copper tube 3/8
	F N S 4	U 3/4–16	24	63.7		Copper tube 1/2
	F N S 5	U 7/8–14	27	98.1		Copper tube 5/8
	F N S 6	U1 1/16–14	36	172		Copper tube 3/4

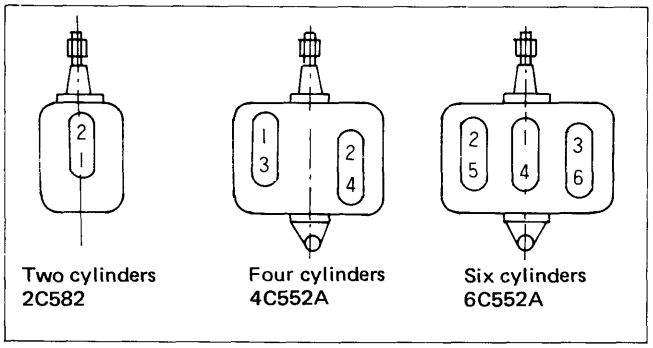
Notes:
1) In case of 10T bolts, 10 or 10T are embossed on the bolt head.
2) Tighten the bolts with relevant torque tabulated above. Overtightening of bolts is very dangerous and insufficient tightening may cause refrigerant leakage or loosening of bolts.

1-2. Crankcase

The casing is made of special cast iron and functions not only as a housing, but also as a cylinder liner (some of the compressors only), and has crankcase, suction chamber, discharge chamber, main bearing, working holes and other connecting holes.
The casings are available in two kinds; one with liner (C552A) and the other without liner (2C582). The bottom of the casing is used as refrigeration oil container. All the models are equipped with an oil level gauge to show oil volume in it.

1-3. Cylinder liner

As stated in the previous item, C552A is equipped with the cylinder liner made of special cast iron to resist abrasion. It can be easily replaced during overhaul.
The cylinder liner is pressed down by the valve seat. The liner can be dismantled or assembled easily, but do not run it with the cylinder heads opened. Furthermore, do not make any mistake with cylinder numbers when assembling or dismantling. The arrangement of the cylinders is as shown below.



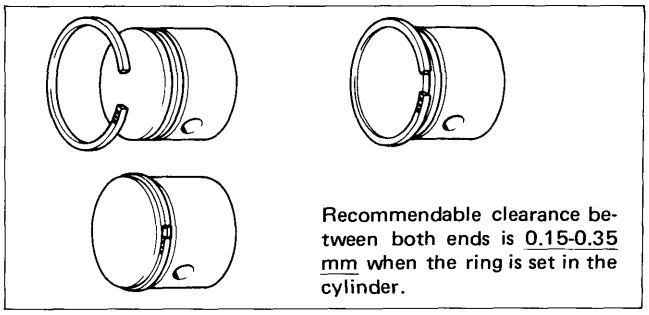
Two cylinders 2C582 | Four cylinders 4C552A | Six cylinders 6C552A

1-4. Cylinder head cover

The cylinder head cover is made of special cast iron. In the cylinder head cover, a safety spring is provided to prevent the valve seat, piston, cylinder from being damaged by liquid hammer or oil hammer, and raises the valve seat when difference between cylinder internal pressure and high pressure becomes over 0.3 MPa.
When the cylinder head cover is removed, it is advisable to make a mark on each cylinder head cover to discern them easily when assembling. When dismantling, loosen all hexagonal bolts evenly except two bolts arranged on both ends in the longitudinal direction to prevent the cover from jumping. When the cylinder cover is assembled, as stated above, tighten the hexagonal head bolts evenly.

1-5. Piston and connecting rod

The piston and connecting rod for 2C582 is made of high class cast iron, and that for C552A is of aluminum alloy. The piston is equipped with piston rings and oil ring to prevent compressed gas from leaking and oil from becoming short from a gap between the piston and the cylinder. The rings are made of fine cast iron and carefully selected to have predesigned clearance. So, they can move smoothly in the ring groove and yet fit in perfectly. Insert the rings in the order of oil ring, and then piston rings. Arrange those rings as that the joint part of the oil ring is away from those of the piston rings by 180°.
Note: Set the rings so that the NRP engraved on the ring end comes to the piston top side.

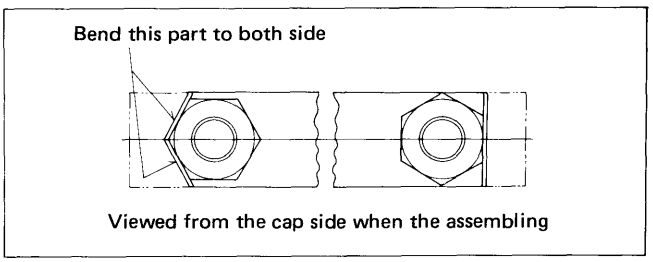


Recommendable clearance between both ends is 0.15-0.35 mm when the ring is set in the cylinder.

The connecting rod is connected with the piston pin at its small end and with the crank pin at its large end, and forms a bearing. The piston pin is of the full float type, and the stop rings are used to prevent the pins from coming off, which ensures accurate operation, and also ensures that the piston will never scratch the cylinder during operation. Material of the piston pin is carbon steel whose surface is quenched and ground, and the crank pin metal is white metal which goes well with the crank shaft. (In case of C552A, aluminum metal is used)
Reamer bolts and companion plugs are used to maintain the large end of the connecting rod perfectly round which is connected to the crankshaft with bolts. The stopper of the clamp bolts for the connecting rod is as shown below. Bend this part to both side. (Viewed from the cap-side when assembling)

How to bend the stopper for the clamp bolts for connecting rod

- C552A



- 2C582
  - The stopper is not provided.
  - U shape nut is used for prevention of loosening.
  - The U shape nut cannot reused.
  - Use new U shape nuts when reasembling.

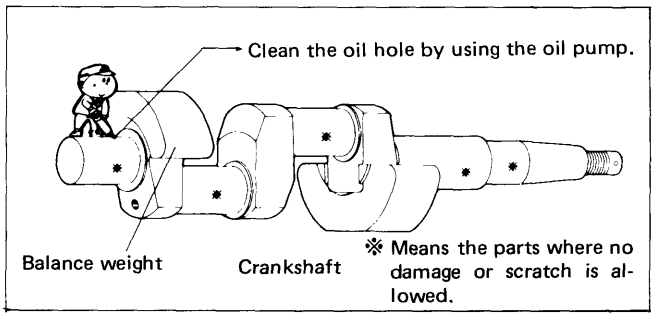
How to remove the connecting rod and the piston (2C582)

(1) Remove the cylinder head cover and valve seat assembly.
(2) After extracting the oil from the drain plug, remove the bottom cover and take out the U shaped nut for clamp bolts for connecting rod from that hole with a universal box spanner.
(3) Remove the cap from the large-end of the connecting rod and take out the piston connecting rod assembly in a downward direction.

(C552A)

(1) Remove the cylinder head cover, safety spring and valve seat assembly.
(2) After extracting the oil, remove the bottom cover, separate the stopper from the clamp bolts and remove the bolts by a universal box spanner.
(3) Remove the cap from the large-end of the connecting rod, and pull down the piston and connecting rod assembly.

1-6. Crankshaft



The crankshaft is a die forging made of carbon steel having high tension resistance, and the surface of its rubbing part is sintered by high-frequency wave. To prevent vibration and accompanying noise, the balance weight is attached so that the operation can be statically and dynamically balanced. Since the crankshaft is affected repeatedly by pressure of the compressed gas, inertia force of the piston and torque of the motor, carefully handle it so as not to impair the rubbing part, the notch, especially the part where stress is concentrated. Except the compressors whose lubrication method is of the splash type (2C582), there is an oil hole in the crankshaft, where the refrigeration oil delivered by the oil pump passes to the main bearing, the crank pin and the shaft seal chamber.

How to remove the crankshaft

C552A . . .Pull it toward the oil pump side.
2C582. . . .Pull it toward the counter-shaft seal side.

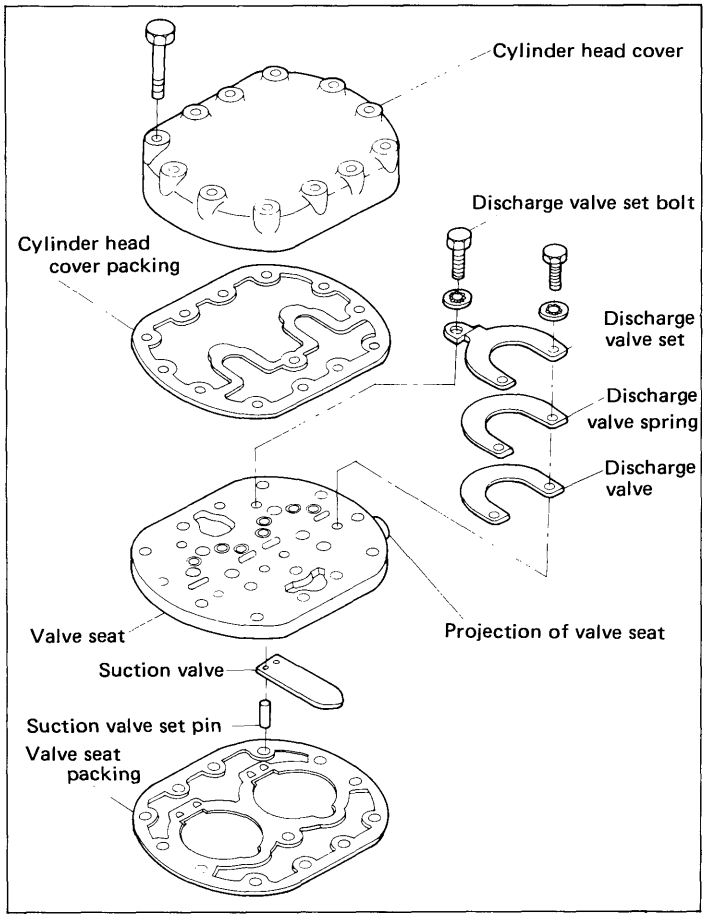
1-7. Main bearing

The main bearings are located on both sides of the crankshaft. They are kind of sliding bearings which support load on the crankshaft. The main bearing on the shaft seal side is made with the crankcase in a single body.

Main bearings
For 2C582. . .Phosphoric bronze
For C552A. . .Zinc bronze
are used as bearing alloys and are subject to fine boring after being pressed in the main bearing. So do not dismantle them unnecessarily except when the metal is replaced.

1-8. Valve mechanism

- **2C582SE · LE**



○ How to remove the valve mechanism

1. Remove the cylinder head cover.
2. Remove the valve seat by lifting it.
3. Remove the suction valve.

*4. Remove the caulked parts for bolts on the back side of the valve seat with a drill.

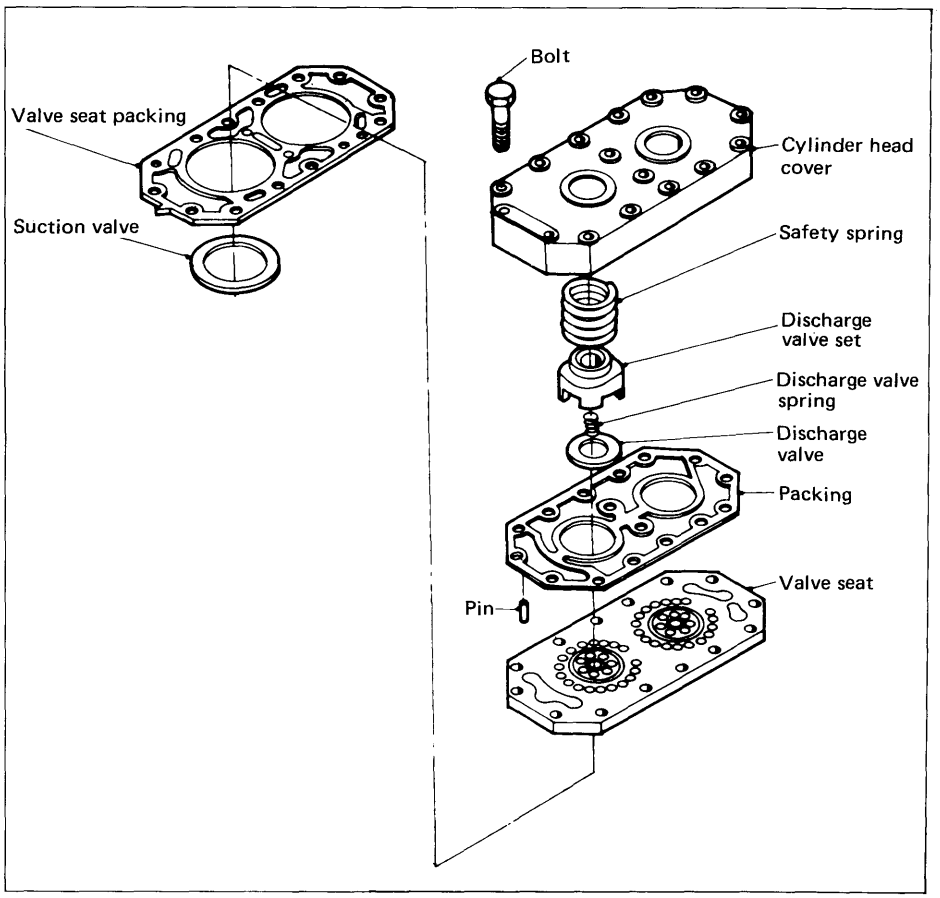
*5. Remove the discharge valve set bolts.

*6. Remove the discharge valve set, discharge valve spring and discharge valve.

Notes:

1. As a rule, the discharge valve and its related parts are replaced at the same time, as a discharge valve assembly. If it is unavoidable to dismantle them, remove them as as stated in from *4 to *6.
2. If the valve seat firmly adheres to the crankcase by means of the packing, lightly tap the projection of the valve seat (See the figure on the left) with a wood hammer. In this case do not tap it to the horizontal direction, but to the direction to remove it. The valve packing used between the valve seat and the crankcase is not only to prevent leak but also maintain ideal top clearance. So, handle it with care.

- **C552A**



○ How to dismantle the valve mechanism

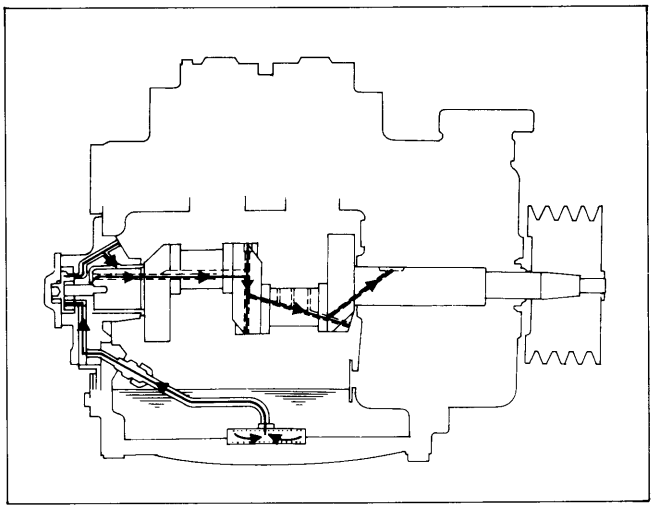
1. Remove the cylinder head cover.
2. Remove the safety spring.
3. Remove the valve set.
4. Remove the discharge valve spring.
5. Remove the discharge valve.
6. Lift up the valve seat and remove it.
7. Remove the suction valve.

1-9. Lubrication equipment

a. Lubrication system

Except the lubrication equipment for 2C582, lubrication method is of the forced lubrication type by oil pump; i.e. every rubbing surface is lubricated with pressurized oil delivered by the oil pump. In the lubrication system, an effective oil strainer and oil pressures regulating valve are installed.

Taking the lubrication system for C552A as an example, it will be explained below.



The lubrication oil in the bottom of the crankcase is drawn by the pump through the oil strainer made of metal net and then regulated in pressure. Oil pressure is regulated by the oil pressure regulating valve combined with the oil pump so that oil pressure throughout the lubrication system can be controlled properly and so that excessive oil is returned to the crankcase through the hole in the main bearing body on the pump side.

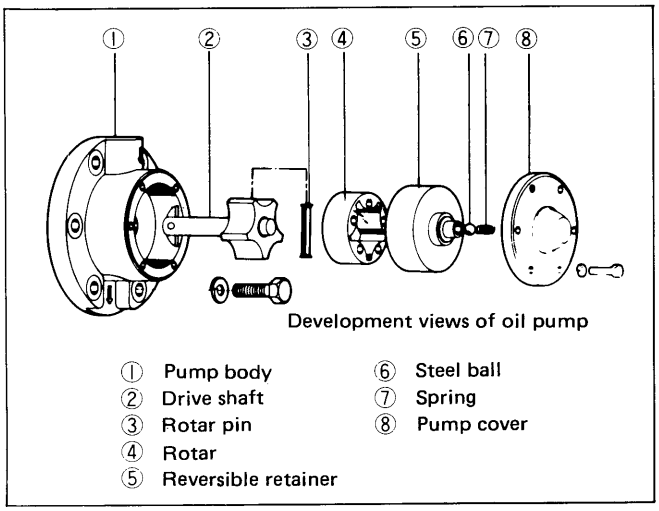
The lubrication oil having suitable pressure is delivered to the main bearing on the oil pump side, where it lubricates the main bearing metal and then each crank pin after having passed through the oil hole in the crank shaft and finally goes to the main bearing on the seal side or the seal box.

A part of the oil comes out of the side of the large end of the connecting rod and lubricates the cylinder liner and the piston by centrifugal force of the crankshaft and drops into the oil reservoir.

Lubrication method of 2C582 is of the splashing type; i.e. oil in the crankcase is splashed over the piston and the main bearings by the oil splasher attached to the large end of the connecting rod.

b. Oil pump

The oil pump is an automatic reversible trochoid pump driven directly by the crankshaft and is equipped with the automatic reversible mechanism which cannot reverse suction and discharge directions regardless of the crankshaft rotary direction. Namely, revolutional direction of the compressor is not limitted to oneway. This means there is no danger of burning the compressor if it is operated reversely.



Development views of oil pump

① Pump body
② Drive shaft
③ Rotar pin
④ Rotar
⑤ Reversible retainer
⑥ Steel ball
⑦ Spring
⑧ Pump cover

c. Oil strainer

The compressor (C552A) has an oil strainer on the oil pump suction side only. The oil strainer is made of fine mesh metal net. The oil strainer on the suction side is installed at the bottom of the crankcase, which makes it possible to suck the oil accurately even when the oil level becomes very low. In case oil pressure is gradually lowerd, although oil pressure differs more or less with oil temperature and its solubility into refrigerant, the strainer must be clogged in most cases. So, clean the strainer with a clean cloth.

d. Oil pressure control valve

During operation, oil pressure should be maintained higher than suction pressure by 0.3−0.5 MPa. Oil pressure is indicated by the oil pressure gauge. Oil pressure is regulated by adjusting thrust of the oil pressure control valve; i. e. displacement of the crankcase is reduced or increased by the oil pressure control valve. The oil pressure control valve is encased in the oil pump.

1-10. Unloader mechanism

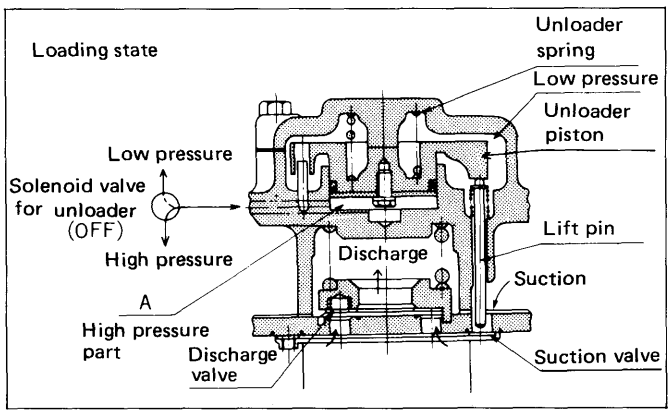
No unloader mechanism ..... RKS 2F, 3F
Suction blocked type unloader ..... RKS 5F
High pressure gas type unloader ..... RKS 8F, 10F

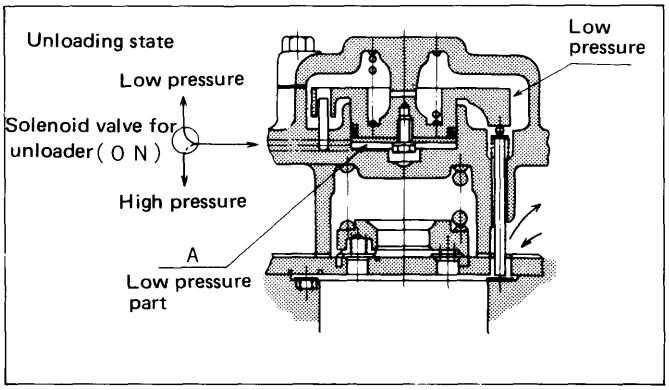
■ **High pressure gas type unloader mechanism**

The suction valve of the predesigned cylinder is opened by gas pressure to release load. The figure shows the unloader mechanism with no load. Since low pressure is loaded on the unloader piston, the piston is pressed down by thrust of the unloader spring, which makes the suction valve open.

The figure shows the unloader mechanism with load. When pressure activating the unloader piston is higher than low pressure by over 0.3 MPa, gas pressure exceeds thrust of the unloader spring and lift up the unloader piston, which made the suction valve close.

	Unloader cyliner internal pressure	Unloader piston	Lift pin	Suction valve
Unload	Low pressure	Down	Down	Open
Load	High pressure	Up	Up	Closed



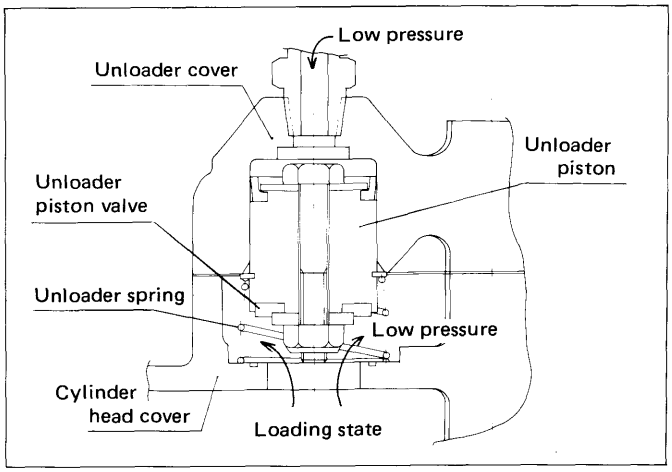


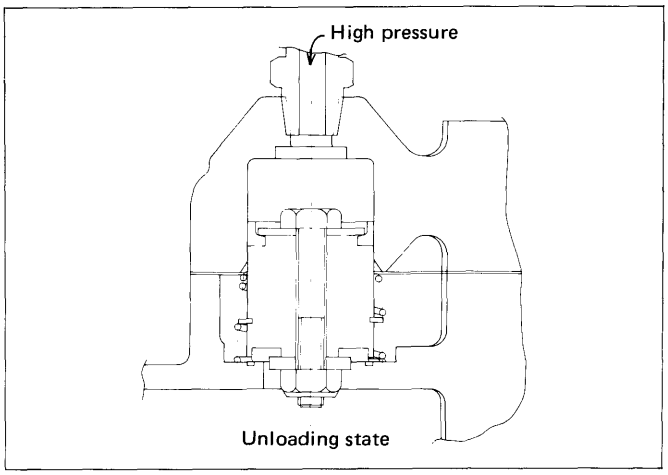
■ **Suction blocked type unloader mechanism**

The fig. shows unloading state. When pressure activating the unloader piston is higher than low pressure by over 3 kg/cm^2, gas pressure exceeds thrust of the unloader spring and raises the unloader piston, which closes the gas passage in the unloader.

The fig shows loading state. Low pressure is pressed on the unloader piston, the piston is raised by thrust of the unloader spring, which opens the gas passage in the unloader.

	Unloader cylinder internal pressure	Unloader piston	Suction passage
Unload	High pressure	Down	Closed
Load	Low pressure	Up	Open

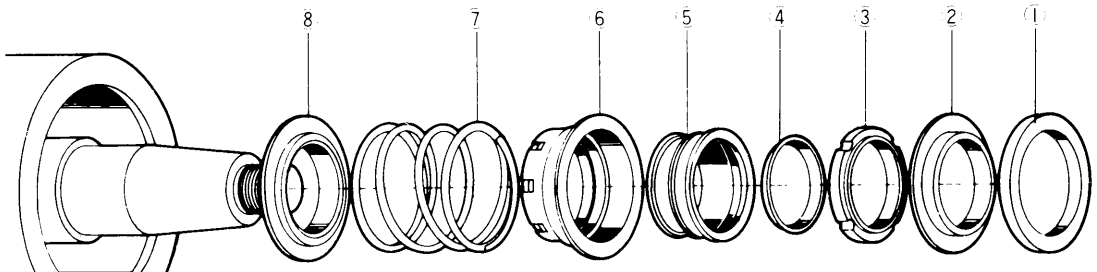




■ **The solenoid valve for unloader is turned on or off by the pressure switch for unloader.**

1-11 Shaft seal

Structure of shaft seal

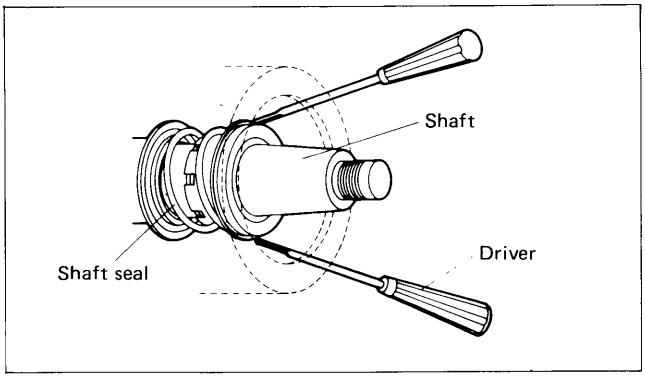


① O ring for seal ring
② Seal ring
③ Seal nose
④ Rubber bellows cylinder
⑤ Rubber bellows
⑥ Seal noise cylinder
⑦ Spring
⑧ Spring retainer

The shaft seal is of the rubber bellows system and consists of the rotor inward from the seal nose (main bearing side) and the stator outward from the seal ring (side-cover side), and prevents leakage by contacting two flat surfaces. Hydraulic oil delivered by the oil pump functions as seal by forming oil film as well as lubrication and cooling of the sealing surfaces.

■ **Dismantling**

1. Remove the V grooved pulley.
2. Gradually and equally loosen the bolts on the side cover on the shaft-seal side and then remove the side cover.
3. Remove the O-ring (which is attached to the side cover)
4. Since the assembly inward from the seal nose, cannot be pulled out by hand, slowly pull it out by using two — headed screw drivers from its top, bottom, right and left.

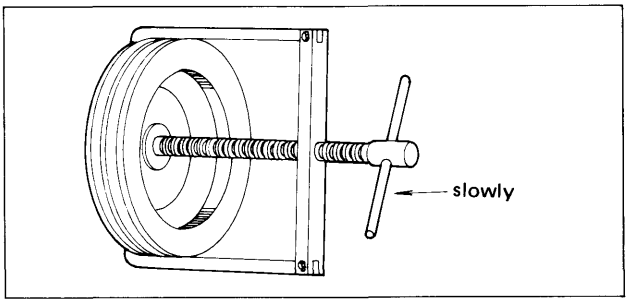


5. Clean the shaft seal assembly with clean refrigeration oil.
6. Carefully remove the seal nose and the rubber bellows. Be certain that sealing surface is kept perpendicular to the crankshaft. The sealing surface of the seal nose can be readjusted by using a surface plate.
   At this time, be sure to rub the surface so that it can be perpendicular precisely to the crankshaft.

■ **Mounting of shaft seal**

(1) Clean the whole shaft seal assembly with refrigeration oil.
(2) Sufficiently apply refrigeration oil to the crankshaft.
   Insert the shaft seal assembly inward from the seal nose, touching the periphery of the cylinder with your hands. Do not get the seal nose in contact with a hard metal. Insert the assembly to the far end of the cylinder and release it, and it will return a little with force of the spring.
(3) Apply clean refrigeration oil to the sealing surface of the seal nose and the seal ring in thin film state.
(4) Assemble the seal nose and the O-ring into the side cover.
(5) Insert the crankshaft into the side cover and tighten the bolts on the side cover in the correct order.
(6) Turn the crankshaft two or three times by hand before tightening up the bolts. Confirm that the gap between the side cover and the crankshaft is even.
(7) Attach the woodruff key and the pulley as they were.

- In case the V grooved pulley is removed, loosen the clamp nut and washer and take the pulley out as shown below by the puller. Since the boss hole for the V grooved pulley is tapered, do not tighten up the shaft-end nut to push the pulley into it.



1-12. Suction strainer

The suction strainer is inserted into the suction side and is made of fine stainless steel net. The strainer should be cleaned frequently at the onset of operation.
To remove the suction strainer, close the compressor suction stop valve and the condenser inlet stop valve, and then loosen the flare nut for gauge piping on the suction side to reduce internal pressure to the atmospheric pressure. Tighten up the flare nut as it was, remove the clamp bolt for suction stop valve, and take out the suction strainer.

1-13. Repairing standards for compressor parts

(Unit:mm)

Model	2 C582$^{S}_{L}$E–(C)F	$^{4}_{6}$C552A–F	Model	2 C582$^{S}_{Z}$E–(C)F	$^{4}_{6}$C552A–F
I.D. of cylinder	$\phi 58^{+0.020}_{0}$	$\phi 55^{+0.020}_{0}$	E.D. of crank pin	$\phi 28^{-0.007}_{-0.025}$	$\phi 42.5^{-0.035}_{-0.050}$
E.D of piston at its foot	$\phi 58^{-0.130}_{-0.150}$	$\phi 55^{-0.130}_{-0.150}$	I.D. of crank pin metal	$\phi 28^{+0.040}_{+0.005}$	$\phi 42.5^{+0.031}_{0}$
Standard clearance	0.130 ~ 0.170	0.130 ~ 0.170	Standard clearance	0.012 ~ 0.065	0.035 ~ 0.081
Upper limit of clearance for repairing	Over 0.35	Over 0.34	Upper limit of clearance	Over 0.18	Over 0.19
Lower limit of clearance for repairing	Under 0.45	Under 0.44	Lower limit of clearance	Under 0.23	Under 0.24
				Seal side / Counter seal side	
E.D. of piston pin	$\phi 23^{0}_{-0.010}$	$\phi 23^{0}_{-0.010}$	E.D. of crank shaft	$\phi 42^{-0.020}_{-0.040}$ / $\phi 28^{-0.015}_{-0.035}$	$\phi 46^{-0.055}_{-0.070}$
I.D. of piston pin	$\phi 23^{+0.013}_{0}$	$\phi 23^{+0.013}_{0}$	I.D. of main bearing metal	$\phi 42^{+0.040}_{+0.020}$ / $\phi 28^{+0.030}_{+0.010}$	$\phi 46^{+0.025}_{+0.005}$
Standard clearance	0 ~ 0.023	0 ~ 0.023	Standard clearance	0.040 ~ 0.080 / 0.025 ~ 0.065	0.060 ~ 0.095
Upper limit of clearance	Over 0.14	Over 0.14	Upper limit of clearance	Over 0.19 / Over 0.18	Over 0.20
Lower limit of clearance	Over 0.17	Over 0.17	Lower limit of clearance	Under 0.24 / Under 0.23	Under 0.25
				Pressure ring / Oil slinger ring	Pressure ring / Oil slinger ring
E.D. of piston pin	$\phi 23^{0}_{-0.010}$	$\phi 23^{0}_{-0.010}$	Width of piston ring	$2^{-0.01}_{-0.03}$ / $3.5^{-0.01}_{-0.03}$	$3^{-0.01}_{-0.03}$ / $4^{-0.01}_{-0.03}$
I.D. of small-end of connecting rod	$\phi 23^{+0.030}_{+0.015}$	$\phi 23^{+0.030}_{+0.015}$	Width of ring groove	$2^{+0.02}_{0}$ / $3.5^{+0.02}_{0}$	$3^{+0.02}_{0}$ / $4^{+0.02}_{0}$
Standard clearance	0.015 ~ 0.040	0.015 ~ 0.040	Standard clearance	0.010 ~ 0.050	0.010 ~ 0.050
Upper limit of clearance	Over 0.14	Over 0.14	Upper limit of clearance	Over 0.15	Over 0.15
Lower limit of clearance	Over 0.17	Over 0.17	Lower limit of clearance	Over 0.20	Over 0.20

- **Repairing period**

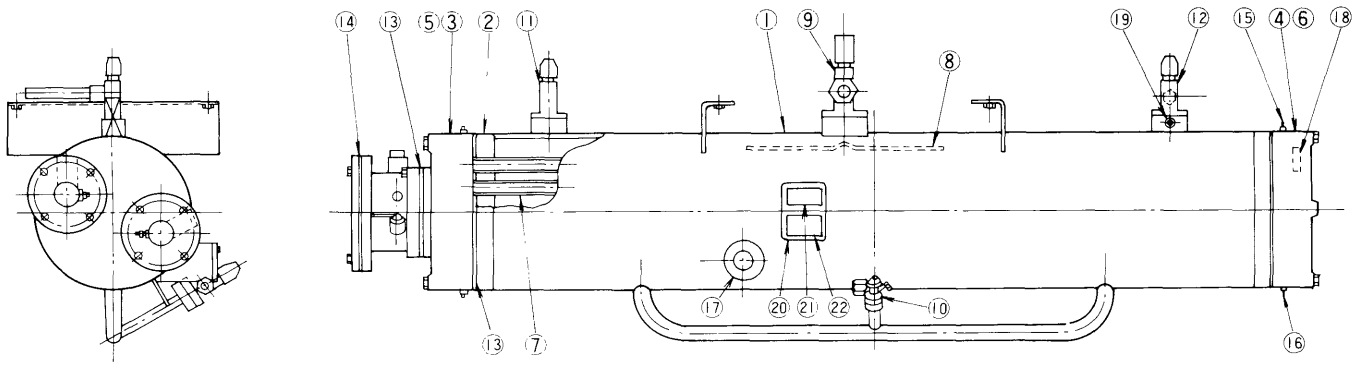
1. Upper limit of clearance means critical clearance, so if clearance becomes larger than that (in other words, if parts are worn out in such degree,) worn parts should be replaced with new ones.
2. Lower limit of clearance means the limit at which serious trouble such as insufficient refrigeration capacity, vibration or noise may occur.

2. Components

2-1. Condenser

The condenser is of the shell and bare tube type and anti-corrosive against sea water. The cooling tubes (Alblack tubes) with the tube plates (Naval crude steel) at their both ends are encased in the steel shell body, which is enclosed with the head and rear covers with the anti-corrosive zinc plates in them.

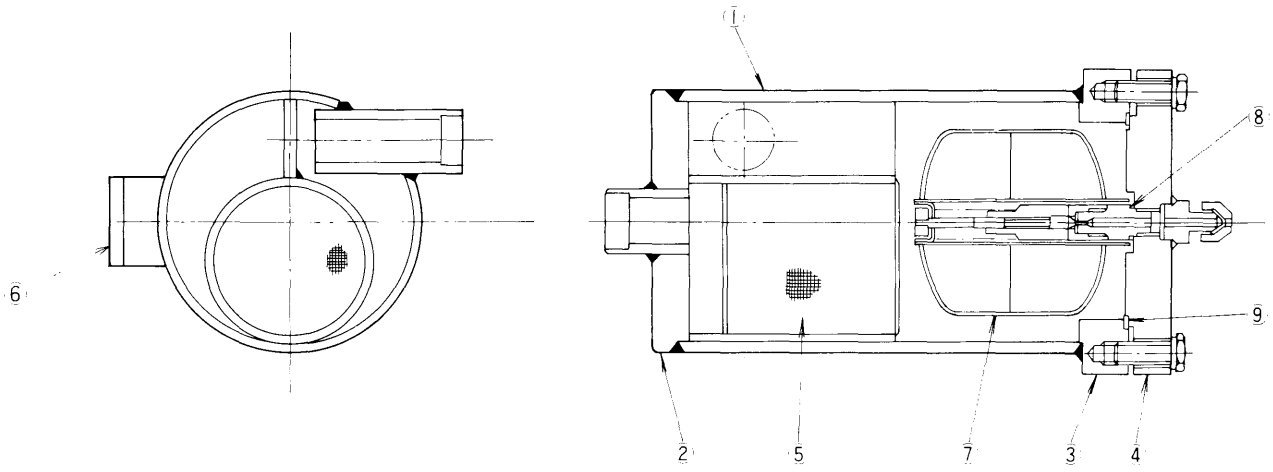
① Shell body
② Tube bundle
③ Front cover
④ Rear cover
⑤ Packing for head cover
⑥ Packing for rear cover
⑦ Cooling tubes
⑧ Distributing plate
⑨ Refrigerant inlet stop valve
⑩ Refrigerant outlet stop valve
⑪ Source valve for safety valve
⑫ Equalizing valve
⑬ Packing
⑭ Packing
⑮ Blind cock for purging air
⑯ Blind cock for purging water
⑰ Liquid level gauge
⑱ Anti-corrosive zinc plate
⑲ Gauge joint with check valve
⑳ Nameplate base
㉑ Nameplate for test pressure
㉒ Nameplate for shell body



2-2. Oil separator

The oil separator is designed to reduce velocity of the gaseous refrigerant and separate oil drops whose specific gravity is large from the gaseous refrigerant by gravity. The oil thus separated is further separated by the demistor, and the oil collected at the bottom of the separator is sent back to the crankcase automatically.
When the float valve is repaired, remove the flange at the bottom and inspect and clean the separator. Then pump down the refrigerant and evacuate the refrigeration system completely.

① Oil separator body
② Head cover
③ Flange
④ Rear cover
⑤ Demistor
⑥ Oil level gauge
⑦ Float
⑧ Copper packing for float valve seat
⑨ Flange packing



2-3. Controlling devices

■ Protective devices

(a) Dual pressure switch
This is activated when high pressure becomes abnormally high and low pressure becomes abnormally low, and stops the compressor. The high pressure side of the switch is of manual reset type. So press down the reset button when it is activated.

Standard settings				
High pressure:	ON	Manual	OFF	1.9 MPa
Low pressure:	ON	0.12 MPa	OFF	0.02 MPa

(b) Oil pressure protection switch (RKS8F • 10F)
This is activated when oil pressure cannot be raised to the predesigned pressure within 45 seconds from the starting or oil pressure drops under the predesigned pressure for more than 45 seconds during operation and stops the compressor. Since the switch is of the manual reset type, press down the reset button before restarting the unit.

Standard settings			
ON	0.1 MPa	OFF	0.15 MPa
Time limit	45 seconds		

■ Controlling devices

(a) Pressure switch for unloader
When low pressure drops lower than the predesigned pressure due to diminution of load, this activates the solenoid valve for compressor unloader to control capacity. When low pressure rises to the predesigned pressure, this is reset automatically.

Standard settings				
Set on the site				
Adjustable range	−0.066 ~ 0.6 MPa			
Range	0.06 ~ 0.4 MPa			
Factory set				
5F:	ON	0.2 MPa	OFF	0.12 MPa
8 • 10F:	ON	0.12 MPa	OFF	0.2 MPa

(b) Safety valve
When the high pressure switch is not activated, the safety valve attached to the condenser comes into operation to allow the refrigerant to escape outdoors. Thus, the safety valve prevents the system from abnormally high pressure.

Standard setting	Cracking pressure	Over 2.1 MPa

(Note) Be sure to pipe the safety valve to extract the refrigerant outside the ship.

Chapter 6 Materials

1. Trouble and countermeasures

Trouble	Cause	Countermeasures
(1) Discharge pressure is very high.	Air is intermixed in the refrigeration system.	Purge the air from the liquid receiver or the condenser.
	Condenser water temperature is very high or water flow is short.	Condenser water piping or the strainer is clogged, or water inlet and outlet valves are not fully opened. Check water pressure and control opening of water inlet and outlet valves.
	The stop valve on the high pressure side of the refrigeration system is closed.	Fully open the stop valve.
	Water fur is depositted in the condenser cooling tubing or the partition wall is corroded.	Clean the cooling tubing. If necessary, replace them or the cover.
	The cooling tubing are submerged in the liquid refrigerant due to overcharged refrigerant. Thus effective heat exchanging area is reduced.	Extract excessive refrigerant.
(2) Discharge pressure is very low.	Condenser water temperature is very low or water flow rate is excessive.	Adjust opening of the condenser water inlet valve or water regulating valve.
	Liquid refrigerant returns.	Firmly fix the feeler tube to the suction pipe and adjust the expansion valve.
	Clearance between the piston and the cylinder is large.	Wear of the piston and the cylinder is promoted.
	The refrigerant is short.	Additionally charge the refrigerant.
(3) Suction pressure is very high.	The discharge valve leaks.	Repair or replace the discharge valve.
	Opening of the expansion valve is excessive or setting of over-heat degree is very low.	Adjust the expansion valve or check whether the feeler bulb is correctly fixed.
	The suction valve, valve seat, piston etc. are damaged.	Remove each part for check and replace it if it is damaged.
	Capacity of the compressor is insufficient.	Check whether the compressor operate correctly. If it does, replace it with a larger compressor.
(4) Suction pressure is very low.	The liquid refrigerant flow rate is limited.	Open the valves in the liquid refrigerant line if they are closed. Make the solenoid valve activate correctly.
	The charged refrigerant volume is very short.	Additionally charge the refrigerant.
	The expansion valve is clogged with ice.	Wrap the expansion valve with warm cloth to melt ice. Activate desiccants of the dryer filter.
	The expansion valve is clogged with oil particles.	Check whether the oil level in the compressor and adjust it if necessary.
	Opening of the expansion valve is small or setting of over-heat degree is high.	Adjust the expansion valve.
	Capacity of cooling coil is lowered.	Check whether the fans operate correctly. Remove dust from the cooling coil. If the coil is frosted, remove frost.

Trouble	Cause	Countermeasures
(5) High pressure side of the dual pressure switch is activated, which operates the compressor on and off frequently.	Discharge pressure is very high.	See the previous item.
	Setting of the high pressure side of the dual pressure switch is wrong.	Adjust setting of the high pressure side of the dual pressure switch.
(6) Low pressure side of the dual pressure switch is activated, which operates the compressor on and off frequently.	The expansion valve is about to be clogged with dust.	Clean the expansion valve.
	The dryer filter is clogged.	Clean the dryer filter.
	The refrigerant leaks out of the feeler bulb of the expansion valve.	Replace the expansion valve with new one.
	Setting of the low pressure side of the dual pressure switch is very high.	Adjust setting of the low pressure side of the dual pressure switch.
(7) The cylinder head cover is over-heated.	Discharge pressure is very high.	See the previous item.
	Suction gas temperature is very high.	Adjust opening of the expansion valve.
	The discharge valve leaks.	After checking the discharge valve, repair or replace it with new one if necessary.
(8) The compressor does not start.	Voltage is lowered or the over-load relay is activated.	Reset the over-load relay.
	Trouble with the electric wiring.	Trace disconnecting part of the wiring and repair it.
	The switch is not turned on.	Turn on the switch.
	Electricity is interrupted.	Turn off the switch and wait until electricity is re-supplied.
	Contact points of the pressure switch are open.	Wait until pressure rises to close the contact points of the pressure switch.
	The condenser water pump and evaporator fan do not operate. (Contact points of the magnetic relay are open)	Operate the condenser water pump and evaporator fan.
	The high pressure side of the dual pressure switch is not reset.	Press the reset button.
	The refrigerant leaks out.	Trace a leaking point and repair it. Charge the predesigned volume of refrigerant.
	The contact points of thermostat are open.	Wait until the thermostat is activated.
(9) It smells odour.	The refrigerant leaks in a large volume.	Seal a leaking point and repair it.
	One of the electric devices are over-heated.	Turn off the power switch at once and trace cause of trouble.
	The belt is over-heated.	Adjust tension of the belt.
(10) Abnormal noise is heard during operation.	Anchor bolts or clamp bolts are loosened.	Tighten up achor bolts and clamp bolts.
	The belt or the pully are loosened.	Adjust tension of the belt. If the nut or key is damaged, replace it.
	The liquid refrigerant is drawn in, which may cause knocking.	Adjust opening of the expansion valve. Check whether the feeler bulb is attached correctly. If not, correct it.
	The oil is compressed.	Adjust oil charged volume.

Trouble	Cause	Countermeasures
	The suction valve, discharge valve, piston pin, connecting rod, bearing, etc. are damaged or worn.	Trace a place where noise is given out, and repair it.
	The refrigerant is throttled by the condenser inlet stop valve.	Fully open the valve shaft of the condenser inlet stop valve.
(11) Consumption of the refrigeration oil is excessive.	The liquid refrigerant returns.	Adjust the expansion valve.
	The refrigeration oil does not return to the crankcase.	Modify the piping and each device so that the oil returns easily to the crankcase.
	The piston ring is worn out.	Replace the piston ring with new one.
(12) Dew or frost gathers on the crankcase.	The expansion valve is opened excessively.	Adjust opening of the expansion valve.
	The charged refrigerant is excessive.	Extract unnecessary refrigerant.
(13) Refrigeration efficiency is insufficient.	Capacity of the unit is vary small.	Exchange the unit with a larger unit.
	The refrigerant leaks from the feeler bulb of the expansion valve.	Replace the faulty expansion valve with new one.
	The feeler bulb of the expansion valve is wrongly installed or installed in a wrong place.	Correctly attach the feeler bulb.
	The expansion valve is faulty or wrongly adjusted.	Repair the expansion valve.
	The expansion valve is clogged with dust.	Clean the expansion valve.
	The discharge valve and suction valve are faulty.	Repair or replace faulty discharge valve and suction valve with new ones.
	The expansion valve is frozen.	Warmth the expansion valve with warm cloth. Activate desiccants of the dryer.
	Air flow through the evaporator is insufficient.	Check the fans and their related parts.
	The evaporator is covered thickly with ice or frost.	Defrost the evaporator.
	The dryer filter is about to be clogged.	Clean the dryer filter.
	The stop valves which should have been opened are closed or throttled.	Open the stop valves.
	The charged refrigerant is short.	Additionally charge the refrigerant.
	The fan speed is reduced due to slipping of the belt.	Correct tension of the belt.
	Discharge pressure is vary high.	See the previous item.
	Suction pressure is very low.	See the previous item.

2. Comparison table of refrigerant temperature with refrigerant pressure

Temperature	Pressure		Temperature	Pressure	
°C	(Reference)(kgf/cm²abs)	MPa	°C	(Reference)(kgf/cm²abs)	MPa
−100	0.019957	0.10000	0	5.0774	0.4124
− 95	0.031561	0.09886	5	5.9556	0.5019
− 90	0.048412	0.09719	10	6.9434	0.6027
− 85	0.072238	0.09484	15	8.0488	0.7154
− 80	0.10512	0.09160	20	9.2804	0.8410
− 75	0.14951	0.08722	25	10.647	0.9804
− 70	0.20826	0.08142	30	12.156	1.1342
− 65	0.28464	0.07388	35	13.819	1.3038
− 60	0.38230	0.06424	40	15.643	1.4898
− 55	0.50533	0.05210	45	17.638	1.6932
− 50	0.65821	0.03701	50	19.815	1.9152
− 45	0.84582	0.01850	55	22.185	2.1569
− 40	1.07342	0.00410	60	24.758	2.4193
− 35	1.34665	0.03196	65	27.547	2.7037
− 30	1.6715	0.06509	70	30.566	3.0115
− 25	2.0542	0.1041	75	33.829	3.3443
− 20	2.5014	0.1497	80	37.356	3.7039
− 15	3.0201	0.2026	85	41.166	4.0924
− 10	3.6173	0.2635	90	42.289	4.5129
− 5	4.3005	0.3332	95	49.770	4.9698

Note: Gauge pressure is available by deducting 1.033 kg/cm^2.

3. Caution for newly installed units

In case a new unit is installed, note the following points, particularly in the first one month.

(a) A certain volume of the oil is circulated throughout the unit for awhile when the unit is operated for the first time. Therefore, oil volume in the crankcase is apt to be short. So carefully check the oil level gauge on the crankcase and replenish oil if it is short.

(b) The oil is deteriorated in the unit at the begining, so replace it with new oil five hours later after the test run. Furthermore, check the oil for its deterioration degree after one day, three days and a week, three weeks, and a month, and replace it with new oil if necessary. Be sure to use new oil, and do not use reclaimed oil. Before replacing oil, clean the crankcase where the oil was deposited with cleaner such as absolute alcohol. This delays deterioration speed of oil.

(c) Remove dust in the unit completely at the begining of operation. Whether or not dust is completely removed from the unit will affect operation conditions greatly.

(i) Strainer

If a piece of felt cloth is inserted inside the suction strainer during test run, fine objects can be removed. In this case, remove the felt cloth two hours later from the starting. At the same time, clean the strainer net with clean oil and once again insert a flet cloth. When the inside of unit becomes perfectly clean, remove the felt cloth. (Do not insert felt cloth other than test run.)

After that, check whether the suction strainer is dirty after 12 hours, and 24 hours from the starting, and clean it if necessary. At least, check the suction strainer continuously for the first one month and remove dust from the unit completely.

(ii) Oil suction strainer

When the oil is replaced, check whether the oil suction strainer set in the bottom of the crankcase is dirty by hand. If so, wipe off dust from the strainer with clean cloth. At the same time, clean up the crankcase bottom with sponge.

(d) In particular, check a new unit for refrigerant leakage, and additionally tighten the clamp bolts and pipe joint appropriately. In this case, however, not to tighten them one-sidedly. One-sided tightening may cause refrigerant leakage.

(e) The V belt is apt to be loosened, so adjust it after approximately 50 hours operation.

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