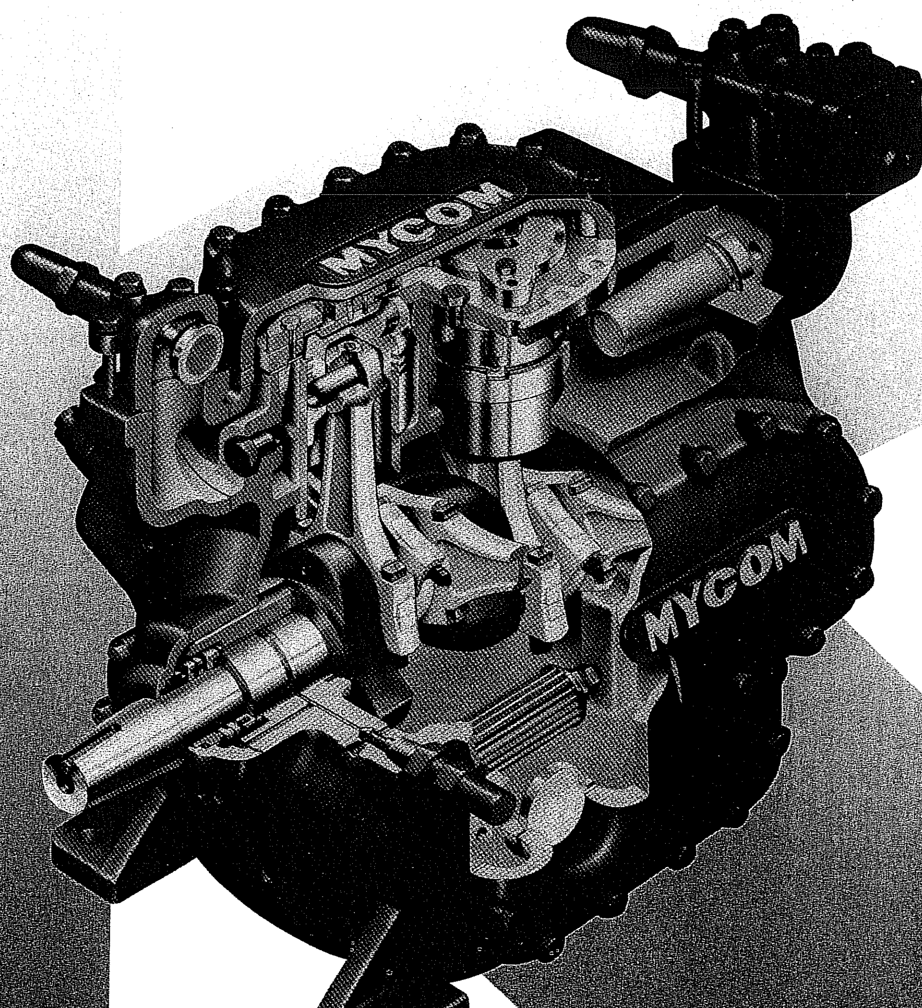
# MYCOM

## K SERIES

## Instruction Manual Reciprocating Compressor

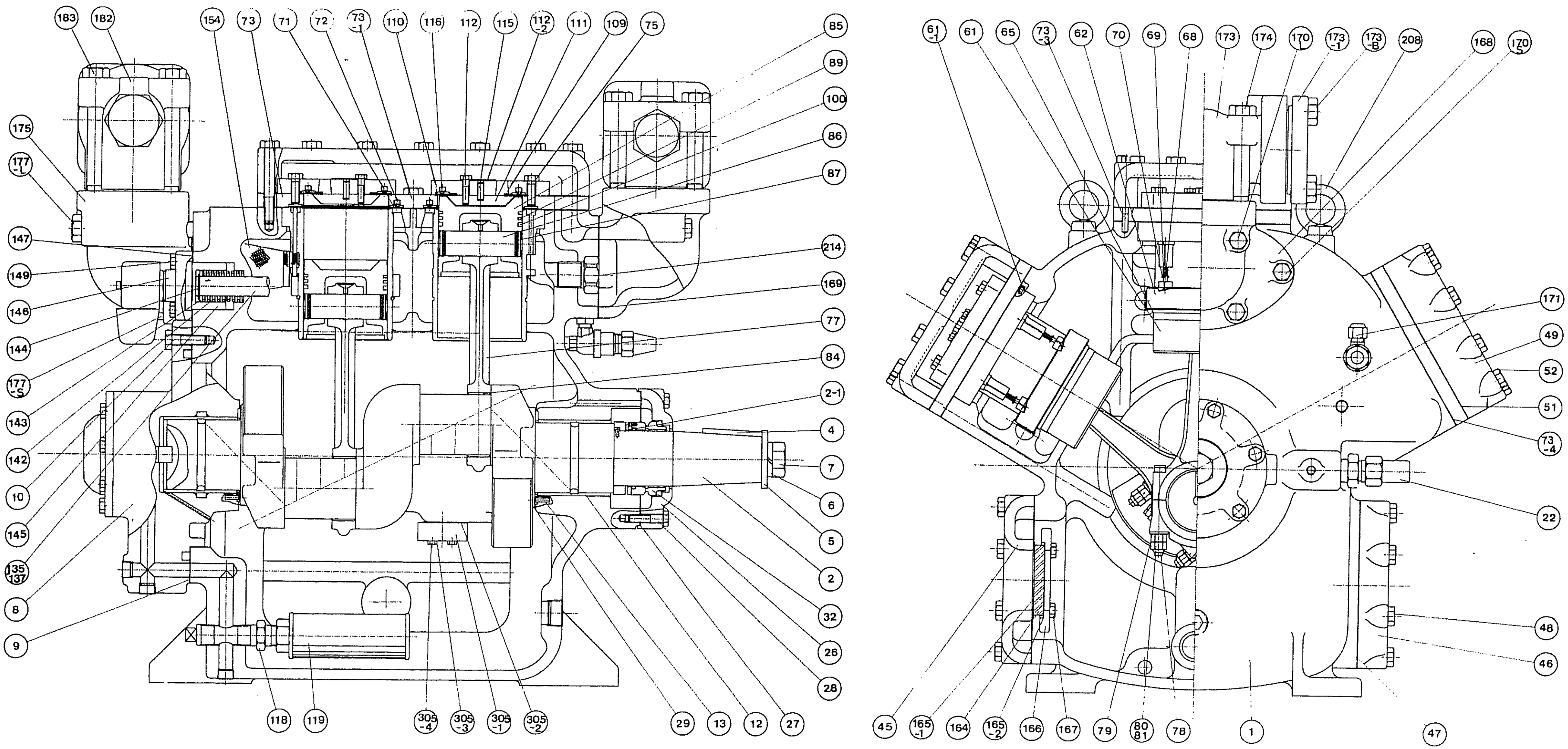



**MAYEKAWA MFG. CO., LTD.**

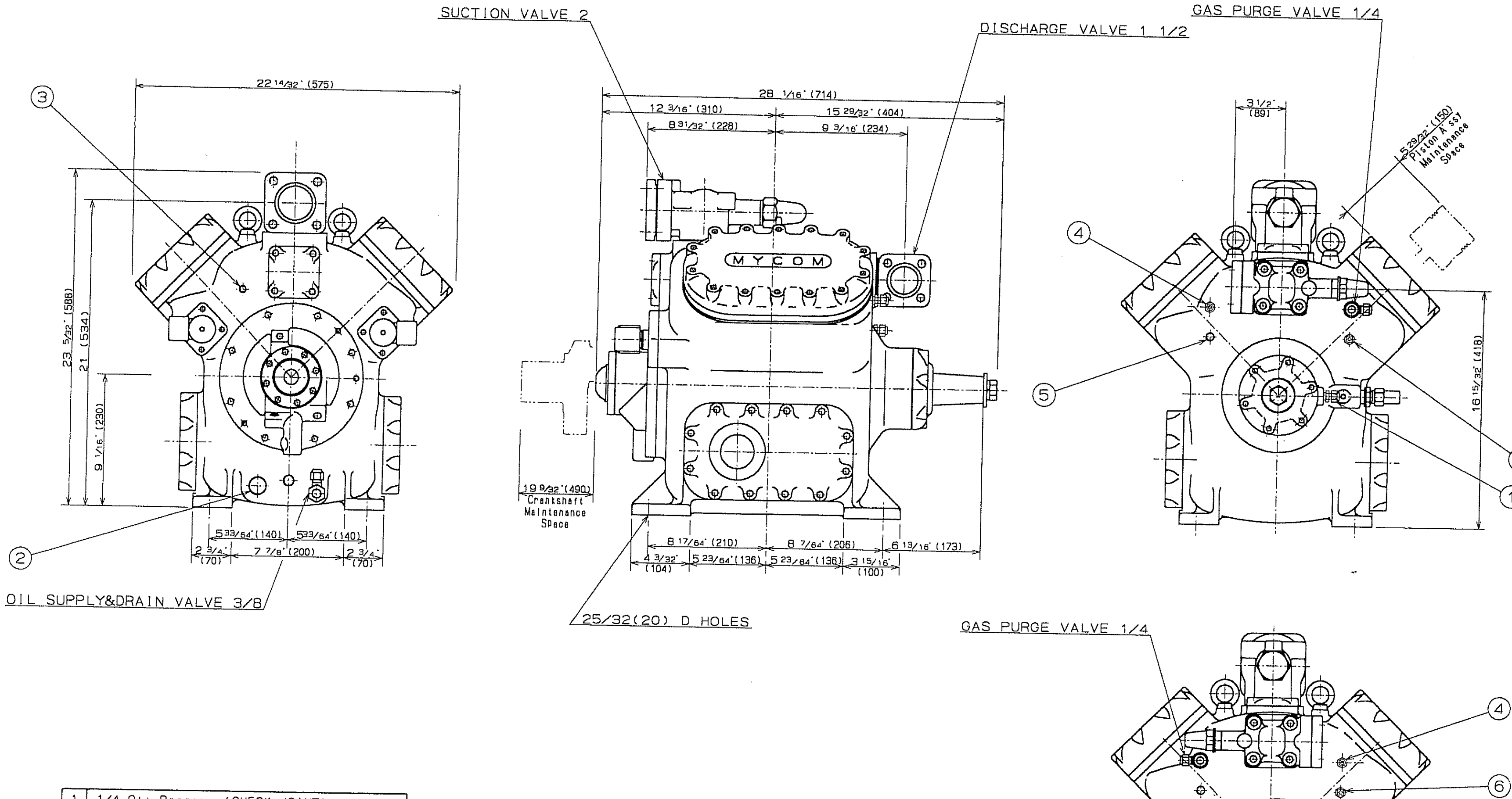
Tokyo-Japan

# Index

Fig. 1 K Series Compressor, Cross-sectional View



## Fig. 2 K Series Compressor, External Dimensions




| | |
|---|---|
| 1 | 1/4 Oil Pressur (CHECK JOINT) |
| 2 | 1" Crankcase Oil Heater PLUG |
| 3 | 1/4 Suction Pressur PLUG |
| 4 | 1/4 Discharge (CHECK JOINT) |
| 5 | 3/8 PLUG -Suction |
| 6 | 1/4 Suction (CHECK JOINT) |
| | |
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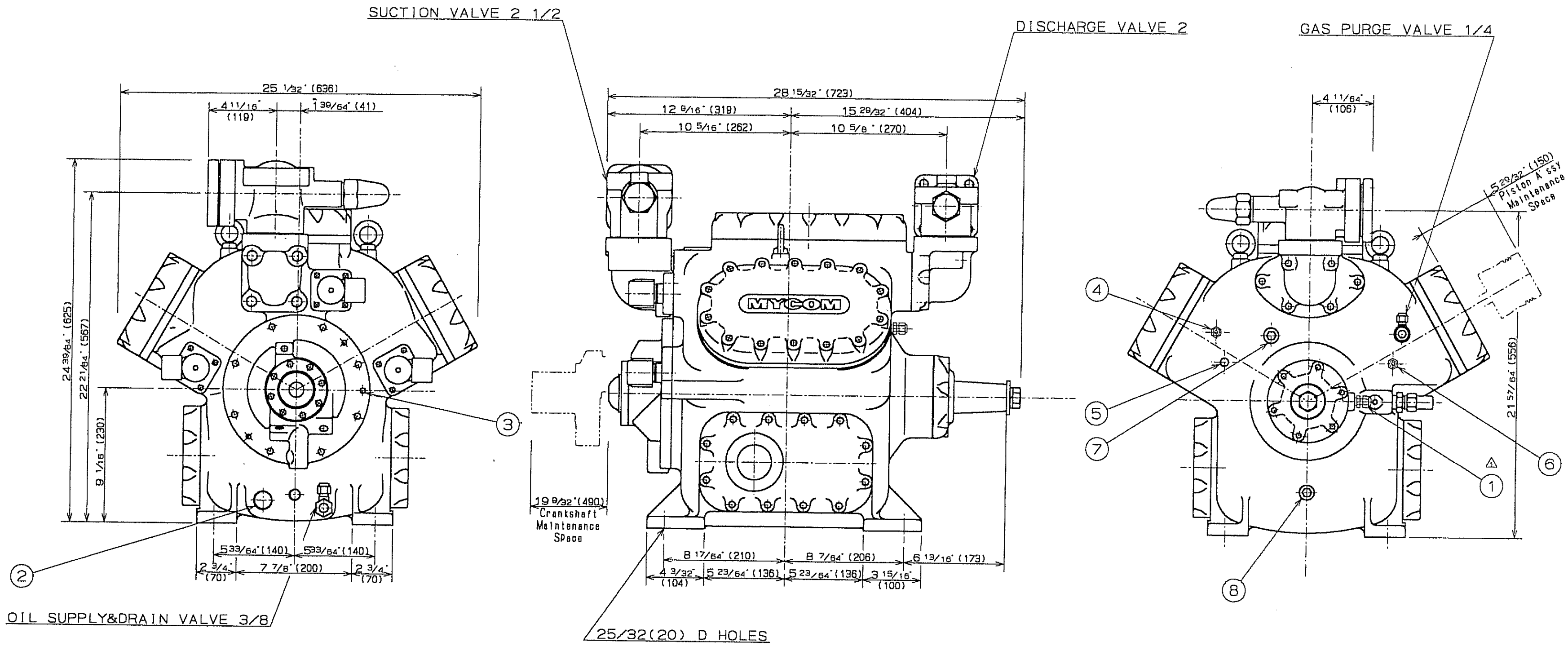
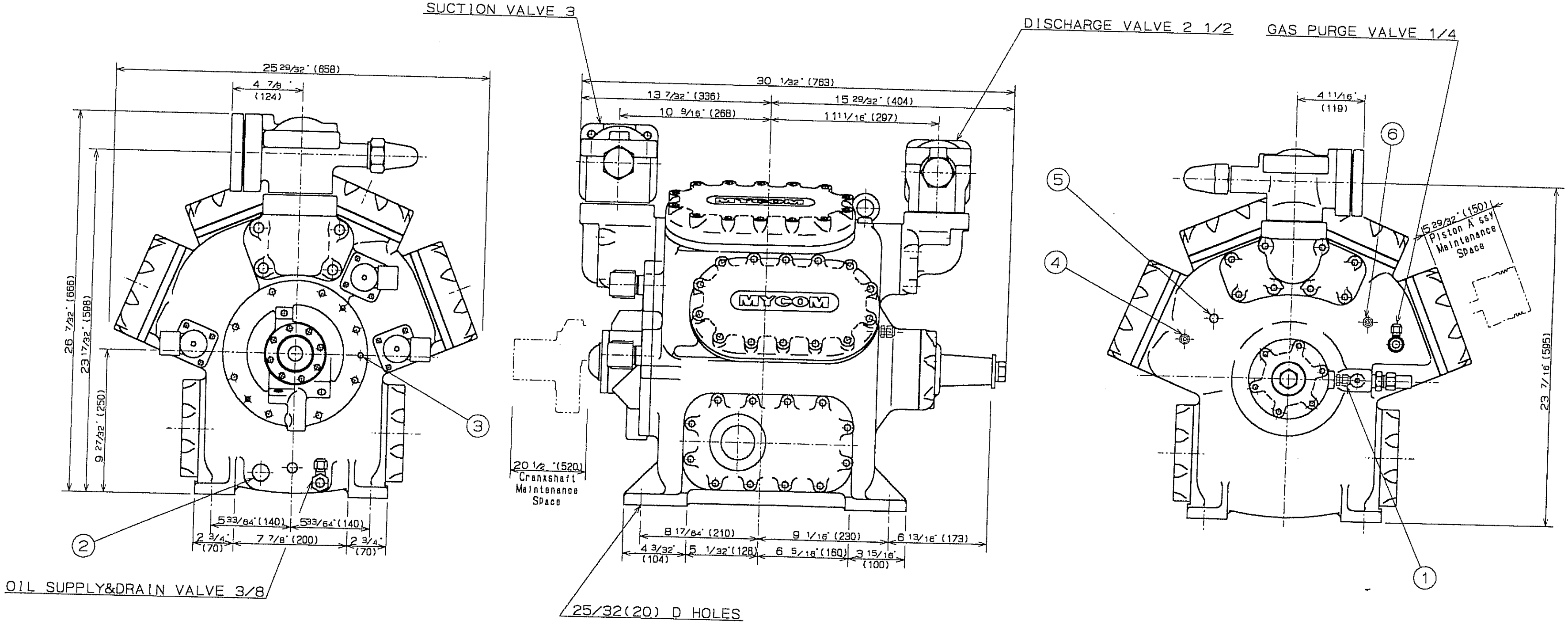
| | |




| | |
|---|---|
| 1 | 1/4 Oil Pressur (CHECK JOINT) |
| 2 | 1" Crankcase Oil Heater PLUG |
| 3 | 1/4 Suction Pressur PLUG |
| 4 | 1/4 Discharge (CHECK JOINT) |
| 5 | 3/8 PLUG -Suction |
| 6 | 1/4 Suction (CHECK JOINT) |
| 7 | 3/4 Gas Equalizing PLUG |
| 8 | 3/4 Oil Equalizing PLUG |
| | |
| | |




| | |
|---|---|
| 1 | 1/4 Oil Pressur (CHECK JOINT) |
| 2 | 1" Crankcase Oil Heater PLUG |
| 3 | 1/4 Suction Pressur PLUG |
| 4 | 1/4 Discharge (CHECK JOINT) |
| 5 | 3/8 PLUG -Suction |
| 6 | 1/4 Suction (CHECK JOINT) |
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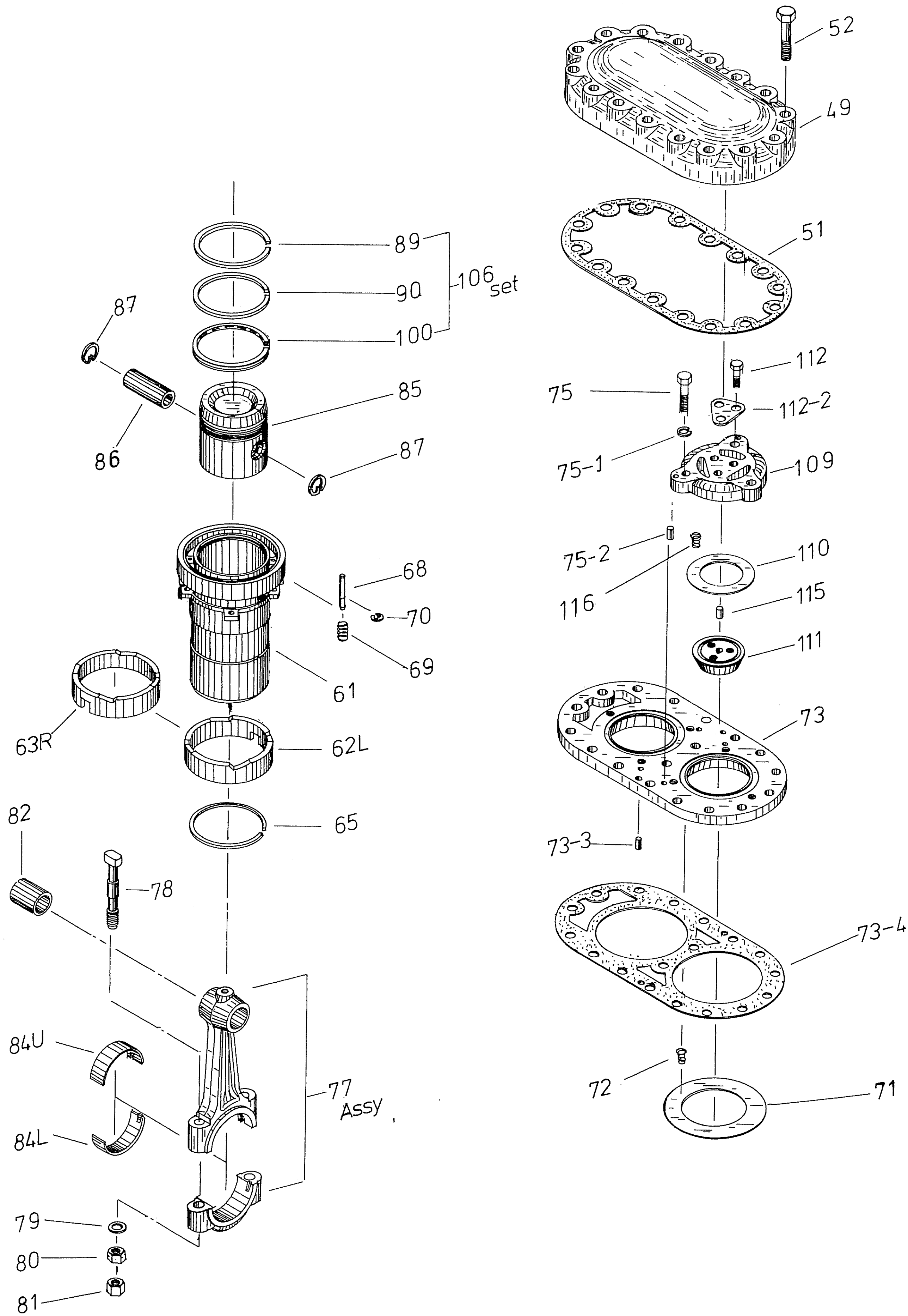
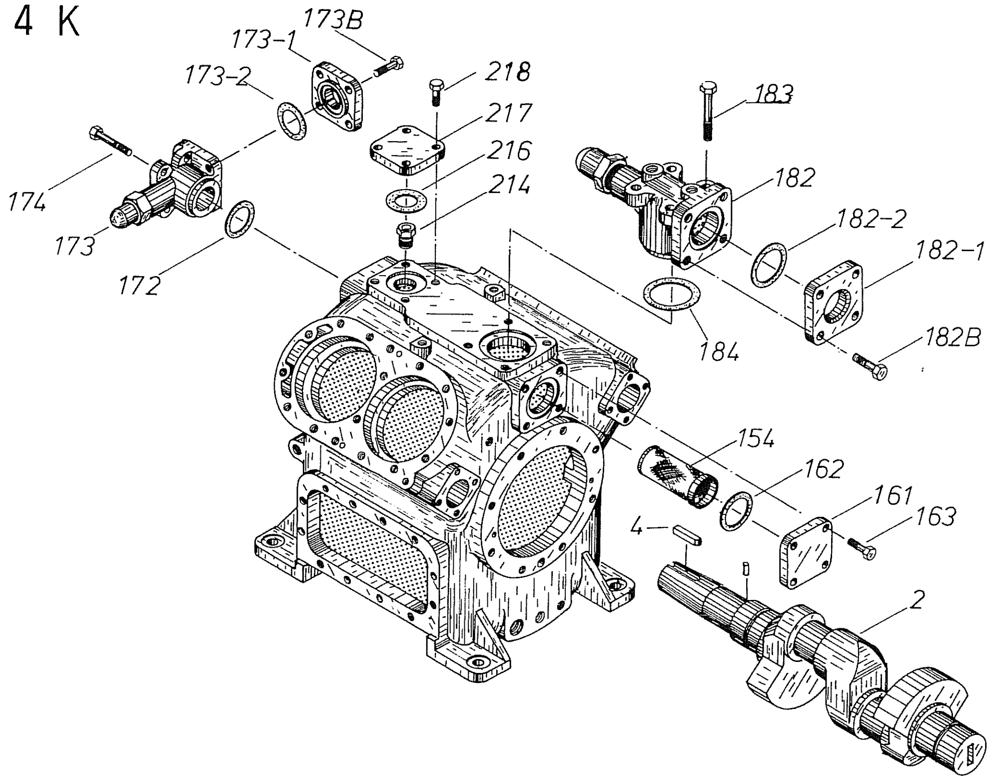
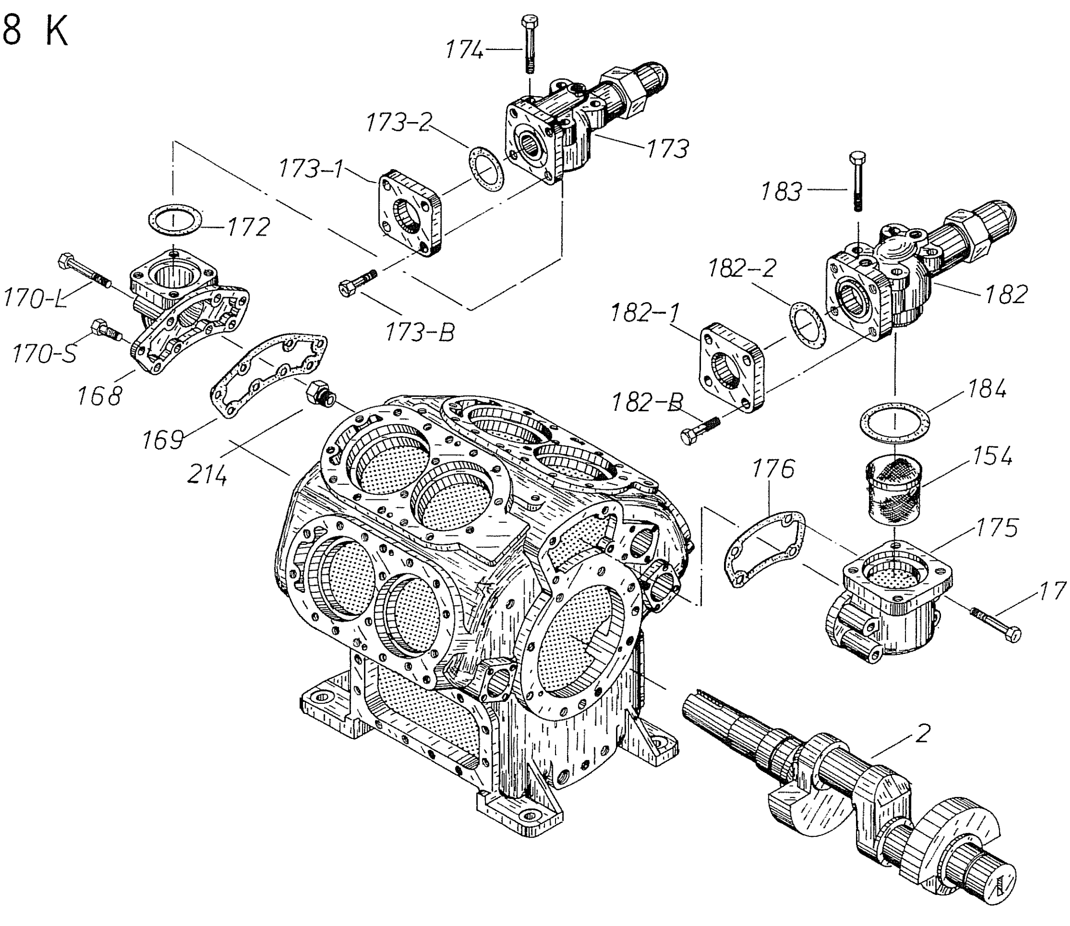
Fig. 3 K Series Compressor, Exploded View

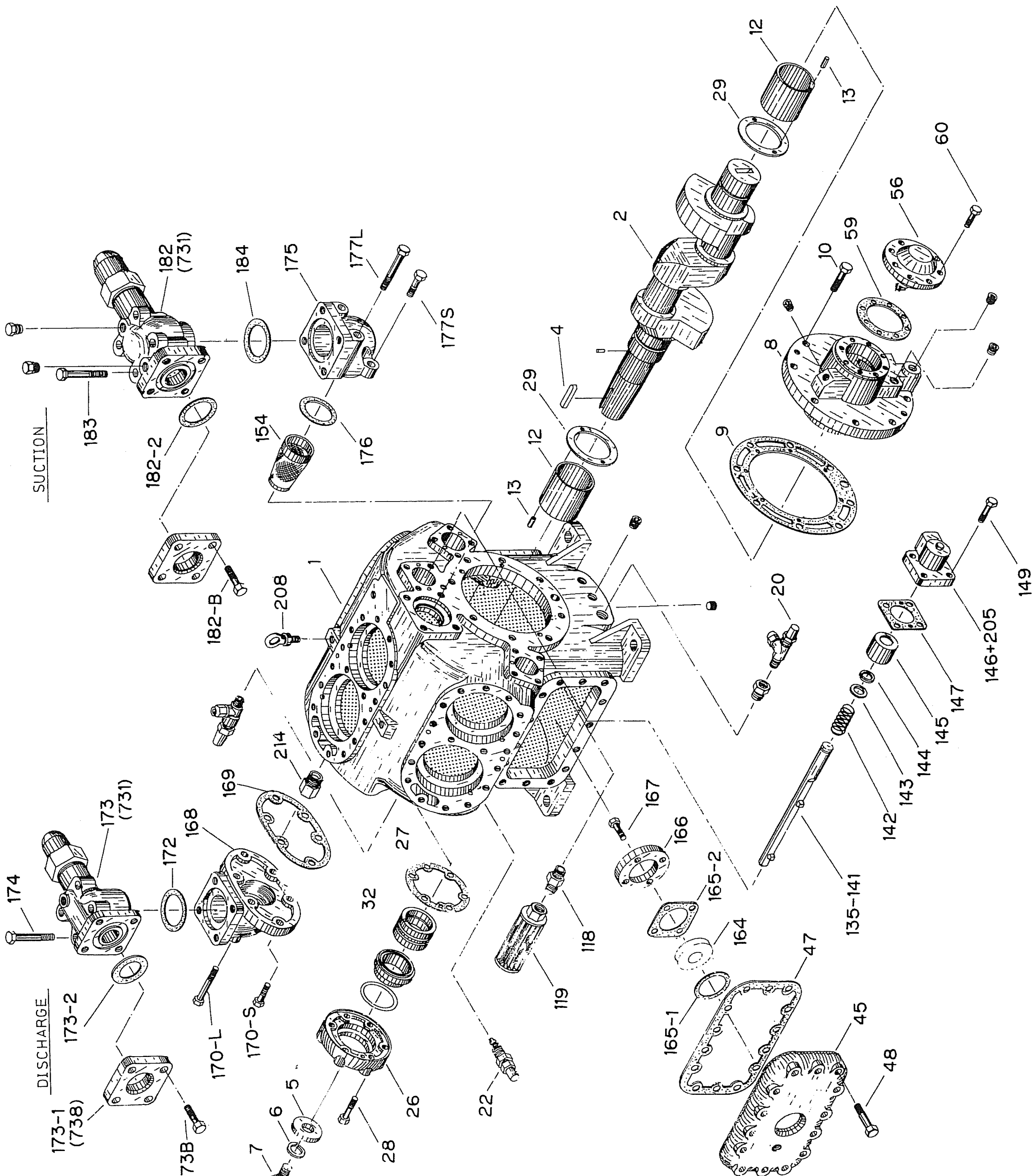


4 K


173B
173-1
173-2
218
217
216
214
174
173
172
183
182
182-2
182-1
184
182B
154
162
161
163
4
2

8 K


174
173-2
173
173-1
172
170-L
170-S
168
169
214
173-B
183
182-2
182
182-1
182-B
184
154
176
175
177
2


SUCTION
DISCHARGE
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118
119
135-141
142
143
144
145
146+205
147
149
154
164
165-1
165-2
166
167
168
169
170-L
170-S
172
173
(731)
173-1
(738)
173-2
173B
174
175
176
177L
177S
182
(731)
182-2
182-B
183
184
208
214

| No. | Part No. | Name of Parts | Material | Q' ty 4K | 6K | 8K | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 1 | Crank case | FC25 | 1 | 1 | 1 | |
| 2 | 2 | Crankshaft | FCD60 | 1 | 1 | 1 | |
| 3 | 2-1 | Retainer drive pin | SK5 | 1 | 1 | 1 | |
| 4 | 4 | Pulley key | S45C | 1 | 1 | 1 | ø3 × L8 (Spring pin) |
| 5 | 7 | Pulley set bolt | SCM435 | 1 | 1 | 1 | M20 × L50 |
| 6 | 5 | Pulley flat washer | SS41 | 1 | 1 | 1 | |
| 7 | 6 | Spring washer, pulley set bolt | SWRH62 (B) | 1 | 1 | 1 | For M20 |
| 8 | 8 | Housing, bearing | FC25 | 1 | 1 | 1 | Combined to oil pump |
| 9 | 9 | Gasket, bearing housing | V6405 | 1 | 1 | 1 | |
| 10 | 10 | Bolt, bearing housing | SCM435 | 8 | 8 | 8 | M10 × L35 |
| 11 | 12 | Min bushing | WJI (F1) | 2 | 2 | 2 | |
| 12 | 29 | Thrust washer | LBC3 (F100) | 2 | 2 | 2 | |
| 13 | 13 | Looking pin, thrust washer | SK5 | 4 | 4 | 4 | ø4 × L8 |
| 14 | 22 | Oil pressure regulating valve | ~ | 1 | 1 | 1 | Substitute Model C |
| 15 | 26 | Shaft seal cover | FC25 | 1 | 1 | 1 | |
| 16 | 27 | Gasket, shaft seal cover | V6405 | 1 | 1 | 1 | |
| 17 | 28 | Bolt, shaft seal cover | SCM435 | 6 | 6 | 6 | M8 × L35 |
| 18 | 32 | Mechanical seal assembly | ~ | 1 | 1 | 1 | |
| 19 | 49 | Head cover | FC25 | 2 | 3 | 4 | |
| 20 | 51 | Gasket, head ccver | V6405 | 2 | 3 | 4 | |
| 21 | 52 | Bolt, head cover | SCM435 | 28 | 42 | 56 | M10 × L75 |
| 22 | 109 | Cage, discharge valve | FC25 | 4 | 6 | 8 | |
| 23 | 75 | Bolt, discharge valve cage | SCM435 | 12 | 18 | 24 | M8 × L25 |
| 24 | 75-1 | Position pin, discharge valve cage | S45C | 8 | 12 | 16 | ø6 × L18 (Panel pin) |
| 25 | 110 | Discharge plate valve | SUS 403 VA | 4 | 6 | 8 | |
| 26 | 111 | Seat, discharge valve | SNC631 | 4 | 6 | 8 | |
| 27 | 112 | Bolt, discharge valve seat | SCM435 | 12 | 18 | 24 | M6 × L25 |
| 28 | 112-2 | Retainer, discharge valve seat bolt | SPCC | 4 | 6 | 8 | t = 0.8 |
| 29 | 115 | Positioning pin, discharge valve seat | S45C | 4 | 6 | 8 | ø6 × L18 (Panel pin) |
| 30 | 116 | Spring, discharge valve | SK5 | 24 | 36 | 48 | Substitute Model C |
| 31 | 73 | Vlve plate | FCD45 | 2 | 3 | 4 | |
| 32 | 73-4 | Gasket, valve plate | V6405 | 2 | 3 | 4 | |
| 33 | 73-1 | Bolt, valve plate | SCM435 | 4 | 6 | 8 | M10 × L25 |
| 34 | 73-3 | Positioning pin, valve plate | S45C | 4 | 6 | 8 | ø6 × L18 (Panel pin) |
| 35 | 71 | Suction plate valve | SUS403 VA | 4 | 6 | 8 | |
| 36 | 72 | Spring, suction valve | SK5 | 16 | 24 | 32 | Substitute Model C |
| 37 | 61 | Cylinder sleeve | FC25 | 4 | 6 | 8 | |
| 38 | 61-1 | Positioning pin, cylinder sleeve | SK5 | 4 | 6 | 8 | ø3 × L8 (Spring pin) |
| 39 | 62L | Cam ring (Keftward slanted) | FC25 | 1 | 3 | 4 | |
| 40 | 63R | Cam ring (Rightward slanted) | FC25 | 2 | 2 | 2 | |
| 41 | 65 | Retaining ring, unloader | SK5 | 3 | 5 | 6 | |
| 42 | 68 | Lift pin, unloader | S50C-D | 12 | 20 | 24 | ø5 × L69.3 |
| 43 | 69 | Spring, unloader lift pin | SWC | 12 | 20 | 24 | Substitute Model C |
| 44 | 70 | Stop ring, lift pin | S60CM | 12 | 20 | 24 | E4 |
| 45 | 85 | Piston | AC8 A or B | 4 | 6 | 8 | |
| 46 | 86 | Pin, piston | SCM415 | 4 | 6 | 8 | øwt × L73 |
| 47 | 87 | Lock spring, piston pin | SK5 | 8 | 12 | 16 | H25, Substitute Model C |
| 48 | 89 | Piston ring | FC25 | 8 | 12 | 16 | 1st & 2nd |
| 49 | 100 | Oil ring | FC25 | 4 | 6 | 8 | 3rd |
| 50 | 77 | Connecting rod | T31-T6 | 4 | 6 | 8 | |
| 51 | 78 | Bolt, connecting rod | SCM435 | 8 | 12 | 16 | Special bolt M10 × L81 |
| 52 | 80 & 81 | Nut, connecting rod | S45C | 16 | 24 | 32 | M10 |
| 53 | 79 | Washer, connecting rod | S45C | 8 | 12 | 16 | |
| 54 | 84 | Bearing halves, connecting rod | WJI (F1) | 8 | 12 | 16 | 2PCS / EACH |
| 55 | 45 | Hand fole cover (Blind) | FC25 | 1 | 1 | 1 | |
| – | 46 | Hand hole cover (with window) | FC25 | 2 or 1 | 2 or 1 | 2 or 1 | |
| 56 | 47 | Gasket, hand hole cover | V6405 | 2 | 2 | 2 | |
| 57 | 48 | Bolt, hand hole cover | SCM435 | 24 | 24 | 24 | M10 × L45 |

| No. | Part No. | Name of Parts | Material | Q' ty 4K | 6K | 8K | Remarks |
|---|---|---|---|---|---|---|---|
| 58 | 164 | Oil sight glass | BH54 | 2 or 1 | 2 or 1 | 2 or 1 | Substitute Model A |
| 59 | 166 | Gland, oil sight glass | SS41 | 2 or 1 | 2 or 1 | 2 or 1 | |
| 60 | 167 | Bolt, oil sight glass gland | SCM435 | 8 or 4 | 8 or 4 | 8 or 4 | M8 × L25 |
| 61 | 165-1 | Gasket, oil sight glass | V6405 | 2 or 1 | 2 or 1 | 2 or 1 | t = 1.5 |
| 62 | 165-2 | Gasket, oil sight glass | V6405 | 2 or 1 | 2 or 1 | 2 or 1 | t = 1.5 |
| 63 | 146 | Unloader cover | ~ | 2 | 3 | 3 | Built in sol. valve |
| 64 | 147 | Gasket, unloader cover | V6405 | 2 | 3 | 3 | |
| 65 | 149 | Bolt, unloader cover | SCM435 | 8 | 12 | 12 | M8 × L135 |
| 66 | 145 | Unloader piston | S25C | 2 | 3 | 3 | Substitute Model A |
| 67 | 135 | Push rod, unloader (1) | AC2B-F | 1 | 1 | 1 | |
| 68 | 136 | Push rod, unloader (2) | AC2B-F | 1 | 1 | 1 | |
| 69 | 137 | Push rod, unloader (3) | AC2B-F | – | 1 | 1 | |
| 70 | 143 | Washer, unloader push rod | S25C | 2 | 3 | 3 | Substitute Model C |
| 71 | 144 | Stop ring, unloader push rod | S45 | 2 | 3 | 3 | Substitute S20 Model C |
| 72 | 142 | Spring, unloader device | SWC | 2 | 3 | 3 | Substitute Model A |
| 73 | 154 | Filter, suction | SUS316 | 1 | 1 | 1 | |
| 74 | 175 | Elbow, suction | FC25 | – | 1 | 1 | |
| 75 | 176 | Gasket, suction elbow | V6405 | – | 1 | 1 | Sub. 65A Valve gasket |
| 76 | 177L | Bolt, suction slbow (1) | SCM435 | – | 2 | Δ4 | M16 × 140 Δ × 120 |
| 77 | 177S | Bolt, suction elbow (2) | SCM435 | – | 2 | – | M16 × 150 |
| 78 | 168 | Cover, sicdharge gas passway | FC25 | – | 1 | 1 | |
| 79 | 169 | Gasket, discharge gas passway cover | V6405 | – | 1 | 1 | |
| 80 | 170L | Bolt, discharge gas passway cover (1) | SCM435 | – | 2 | 2 | M10 × L100 |
| 81 | 170S | Bolt, discharge gas passway cover (2) | SCM435 | – | 4 | 6 | M10 × L45 |
| 82 | 119 | Filter, oil | SUS316 | 1 | 1 | 1 | Substitute Model C (#20) |
| 83 | 118 | Hexhead nipple, PT 1/2 × PT /12 | S25 | 1 | 1 | 1 | |
| 84~87 | | (Discontinued numbers) | | | | | |
| – | 305 | Pressure equalizing pipe assembly | – | 2 | 2 | 2 | |
| 88 | 214 | Built-in safety valve | ~ | 1 | 1 | 1 | PT 1" |
| 89 | 182-1 | Companion flange, suction | S25C | 1 | 1 | 1 | |
| 90 | 182-2 | Gasket, companion flange | V6405 | 1 | 1 | 1 | |
| 91 | 182B | Bolt, companion flange | SCM435 | 4 | 4 | Δ4 | Δ M20 × L50 M16 × L45 |
| 92 | 173-1 | Companion flange, discharge | S25C | 1 | 1 | 1 | |
| 93 | 173-2 | Gaasket, discharge flamge | V6405 | 1 | 1 | 1 | |
| 94 | 173B | Bolt, discharge flange | SCM435 | Δ4 | 4 | 4 | Δ M 12 × L40 M16 × L45 |
| 95 | 182 | Service valve, suction | ~ | 1 | 1 | 1 | |
| 96 | 184 | Gasket, suction service valve | V6405 | 1 | 1 | 1 | |
| 97 | 183 | Bolt, suction service valve | SCM435 | Δ4 | 4 | 4 | Δ × L110 M16 × L140 |
| 98 | 173 | Service valve, discharge | ~ | 1 | 1 | 1 | |
| 99 | 172 | Gasket, discharge service valve | V6405 | 1 | 1 | 1 | |
| 100 | 174 | Bolt, discharge service valve | SMC435 | ×4 | 4 | Δ4 | M16 × 130 M16 × L110 × × L120 |
| 101~106 | | (Discontinued numbers) | | | | | |
| 107 | 20 | Oil feeding valve, PT 3/8 Angle | ~ | 1 | 1 | 1 | MR-3FR |
| 108 | 171 | Valve, age purge PT 1/4 | ~ | 1 | 1 | 1 | MR-2FR |
| 109 | 208 | Eye bolt, hanger | SF40 | 2 | 2 | 2 | M12 |
| 110 | ~ | Check joint | ~ | 3 | 3 | 3 | HP, LP, OP |

Notes:

* "Substitute Model C" means "Interchangeable with the service parts for Model C Mycom compressor.
* On order of the parts, do not forget to designate respective No. and part No.

## 1. General Design

MYCOM K Series compressors represent the newest design among the A, B, C, JW, WA and WB series of multi-cylinder compressors. This series fills the capacity gap between the C and A series of compressors.
The special design of the K Series allows direct coupling with 4-pole motors or diesel engines, making it ideal for applications requiring small size, light weight and high speed.
Applied to every portion of the compressor is MYCOM's extensive technical know-how resulting from a long history of working with R22 and R502 refrigerant systems. For example, it has been found that an oil cooler is unnecessary for standard cooling applications. K Series compressors have built-in piping for lubrication and unloader operation so there is no external piping at all. This results in a neat design and easy maintenance.

All parts of the compressor are manufactured using modern numerically controlled machines, inspected according to rigid quality control standards and assembled and tested before shipment by highly skilled engineers.
With all the care that has been put into the design and construction of MYCOM's K Series compressors, you can be confident that the machine you buy will live up to your expectations. It is important to remember, however, that function and performance depend on appropriate maintenance. For long life and optimum performance, be sure to carry out all required periodic maintenance.

### Specifications

| Item \ Model | F4K | | | F6K | | | F8K | | |
|---|---|---|---|---|---|---|---|---|---|
| Refrigerant type | R22, Open type | | | | | | | | |
| No. of cylinders | 4 | | | 6 | | | 8 | | |
| Cylinder bore | 85 | | | | | | | | |
| Cylinder stroke | 65 | | | | | | | | |
| Revolution Speed (RPM) | 900 | 1,450 | 1,750 | 900, | 1,450 | 1,750 | 900 | 1,450 | 1,750 |
| Displacement ($M^3$/Hr) | 79.6 | 128.3 | 154.8 | 119.4 | 192.4 | 232.3 | 159.3 | 256.6 | 309.6 |
| Driving method | Direct Drive or Belt | | | | | | | | |
| Capacity control system | Hydraulic control solenoid valve | | | | | | | | |
| Compressor lubrication oil | ISO-VG46 or higher viscosity oil | | | | | | | | |
| Oil quantity (Litres) | 9.0 | | | 9.0 | | | 10.0 | | |
| High side design pressure | 24 kg/cm G | | | | | | | | |
| Low side design pressure | 7 kg/cm G | | | | | | | | |
| Discharge valve size | 40A | | | 50A | | | 65A | | |
| Suction valve size | 50A | | | 65A | | | 80A | | |
| Dimensions of unit (mm) | 850L × 575W × 588H | | | 723L × 636W × 625H | | | 763L × 658W × 666H | | |
| Net weight (kg.) | 223 | | | 272 | | | 317 | | |

## 2. Mechanisms

### 2.1 Gas Compression Mechanism and Gas Flow

Suction and discharge stop valve are provided respectively on the gas inlet and outlet if the compressor.
Refrigerant vaporized in the evaporator flows ti the compressor through the refrigerant piping, The gasses through the suction service valve (182), the suction elbow (175) and is filterd by the suction filter (154) at the crankcase inlet before entering the suction gas chamber in the crankcase.
A suction gas chamber and crankshaft chamber are provided in the crankcase.
The compressor cylinders are located in the suction gas chamber and the pistons are jointed to the crankshaft by connecting rods which reciprocate the pistons.
Suction and discharge valves, which operate based on the pressure difference before and after the valves, are mounted on the top of each cylinder.
When the piston descendd in the cylinder, the internal pressure drops and gas in the suction chamber pushes up on the suction valve and flows into the cylinder.
Gas flows into the cylinder until the piston reaches the bottom dead center point, at which time the suction valve is pressed against the valve seat by a spring and the cylinder is tighty sealed.
When the piston begins to ascend, the volume inside the cylinder decreases, pressuring the gas. this is termed the compression phase.
When the pressure inside the cylinder exceeds the discharge pressure, the gas pushes up on the discharge valve and escapes from the cylinder to the high pressure side of the system. The pressurized gas leaving the cylinder flows to the condenser through the discharge elbow and discharge service valve where it is cooled and liquified before passing to the evaporator.
In essence, this high speed, multi-cylinder compressor acts like a pump transferring heat from a low point to a high point.

### 2.2 Suction and Discharge Valve Mechanosm

The design of the suction and discharge valve mechanism used on K Series compressors differs somewhat from the mechanism used on other MYCOM high speed, multi-cylinder compressors.
The head spring is eliminated while the valve seats for two sets of cylinders are paired together as a single sheet and bolted to the unit.
Other aspects of the design such as the following are designed based on experience with other models:

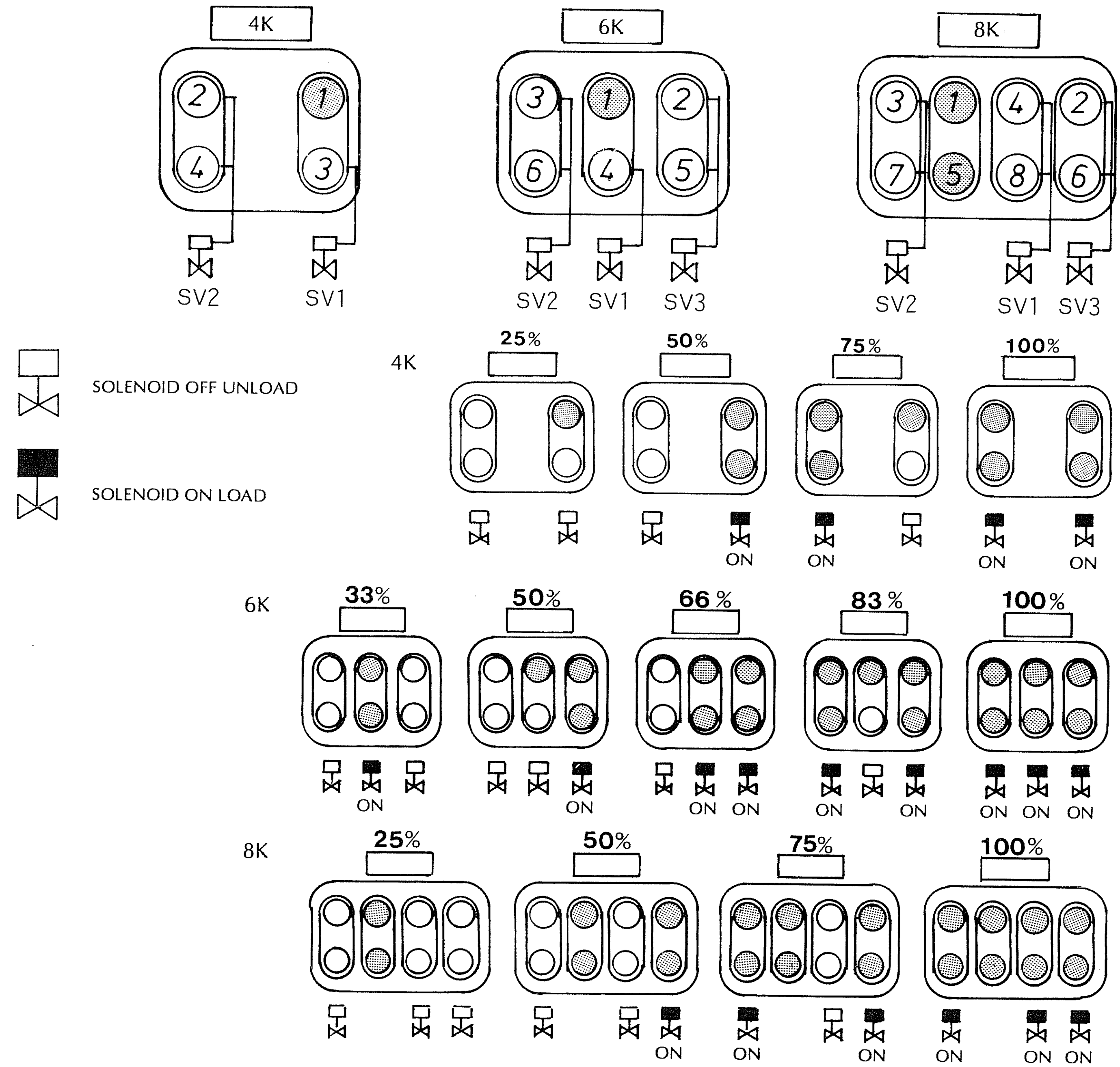
- Minimum clearance between the discharge valve seat and the crown of the piston
- Return shock acsorption by gas damping using the ring valve.
- Variable spring force using a volute spring.

### 2.3 Capacity Control Mechanism

Compressor capacity is controlled by regulating operation of the suction valve using an oil pressure-driven unloader piston for actuation. This is a standard system used on all MYCOM high speed, multi-cylinder compressors to change the number of gas compression cylinders operating at any particular time.
The suction valve seat of each cylinder is provided with a flanged portion on the top of the cylinder sleeve. Gas flowing to a cylinder passes through an intermediate space and a vertically operating lift pin is fitted in the center of the seat. The top of the pin contacts the suction valve while the bottom contacts the slant face of the cylinder cam turning around the cylinder circumference. The cylinder cam (cam ring) is rotated by an oil pressure-driven push rod, moving the lift pin up and down as the cam ring rotates.
When the pin descends and reduces seat level, the suction valve operaters freely according to the pressure difference on the seat. When the pin pushes up on the suction valve as the cam is rotated, the suction valve cannot operate despite the pressure difference. In other words, gas enterng the suction port is not compressed even though the piston moves up and down, and no gas is discharged. Under this condition the cylinder is said to be in an "unload" state.
Capacity of the compressor controlled by changeing the number of loaded cylinders.
The cam activating the lift pins is activated by push rod, unloader piston and a spring. When no oil pressure is applied to the unloader piston, spring force positions the system in the "unload" state. Capacity control is therefore performed by cutting off oil pressure to the unloader piston using a three-way solenoid valve.
Compressor start-up is accomplished in the unloaded condition and compression is commenced only after the oil pump running by the rotation of the crankshaft to raise oil pressure sufficiently to operate the unloader mechanism.
Using a three-way solenoid valve to reduce oil pressure during operation provides the additional merit of reduced oil pump load compared to the usual system which requires oil pressure even during "unload" operation. This system also provides multi-step capacity control.

**Table 1 MYCOM K Compressor Capacity Control Steps**

* 16.6% load is for start-up only.
○ Inside number is loaded cylinder nomber



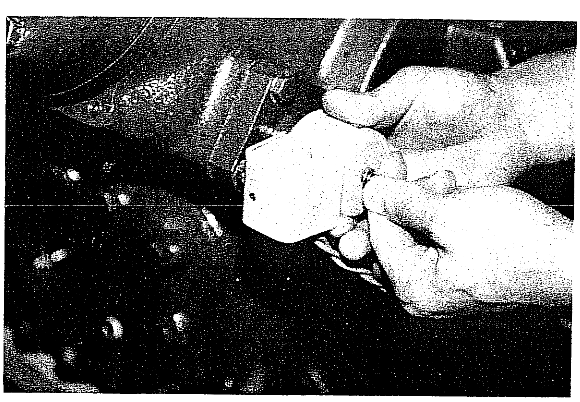



**Fig. 4 Unloader Device & Solenoid Valve**

## 2.4 Lubrication Mechanism

K Series models with standard specifications use no piping apart from the controller pressure transmission line.
The only joint used in the lubrication system is a fitting for the pump suction side oil filter. All other oil flow paths are internally cast or drilled.
A single oil filter with a fine mesh is used on the suction side to assure adequate oil filtration. Since a reversible trochoid gear oil pump is used, the discharge direction is fixed, irrespective of the direction of rotation of the compressor crankshaft.
An oil pressure regulating valve is fitted to a seat with a spring. This valve maintains specified pressure automatically and relieves abnormal high pressure in the same manner as a safety valve.

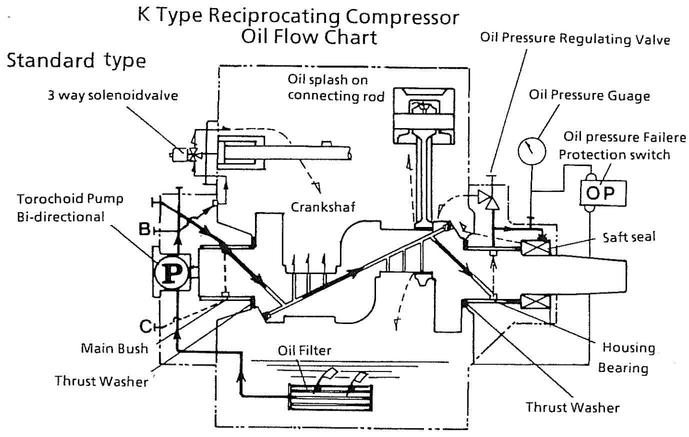



**Fig. 5A Lubricating Oil Flow Diagram (Standard)**
**(Without Oil Cooler)**

## 2.4.1 Oil Flow of Model K

The bottom of the crankshaft chamber in the crankcase serves as an oil reservoir.
Oil passes through the oil filter (119) and is sucked into the oil pump driven off the crankshaft and pressurized.
The pump is a reversible trochoid type which discharges the oil in one direction only irrespective of the direction of shaft rotation.
Oil discharged from the pump asses through a drilled hole and branches along two routes, one leading to the main bearing oil lubrication hole and the other leading to the unloader via a channel on the flange face.
The oil lubricating the main bearing enters an oil hole in the crankshaft after passing through the crankshaft oil channel. A portion of the passing through th crankshaft lubricates the crank pins while another portion of the oil sprays on the inner walls of the cylinders, the connecting rod small ends and the pistons to achieve lubrication and cooling.
Oil passing through the shaft lubricates the seal side bearing, then flows through the oil pressure regulating valve and finally branches to the shaft seal and the oil reservoir.
Oil entering the shaft seal returns to the oil reservoir via a hole in the top of the seal.
Oil flowing via the channel of the main bearing flange face enters the unloader cover solenoid valve through a hole in the crankcase.
When the three-way solenoid valve is activated, oil enters the unloader cylinder, pushing on the piston and initiating loaded operation. Under this condition, the position of the piston is maintained by the oil pressure.
When the three-way solenoid valve is deactivated, no oil is supplied from the pump and cylinder pressure is equalized with crankcase pressure.
Oil in the cylinder is pushed out by spring force and the system returns to an unload condition.

## 2.4.2 When Oil Cooler Installed

In this case, oil flow to the main bearing head is altered. An internal blind plug and intake and discharge ports for the oil cooler are necessary, as shown in Fig. 6.
With an oil cooler is installed, oil supplied to the main bearing is returned to the oil cooler, where temperature is reduced. Oil from the cooler is supplied to the main bearing through another hole. All other flow lines remain unchanged.
When modifying the compressor for use with an oil cooler an internal blind plug must always be fitted.

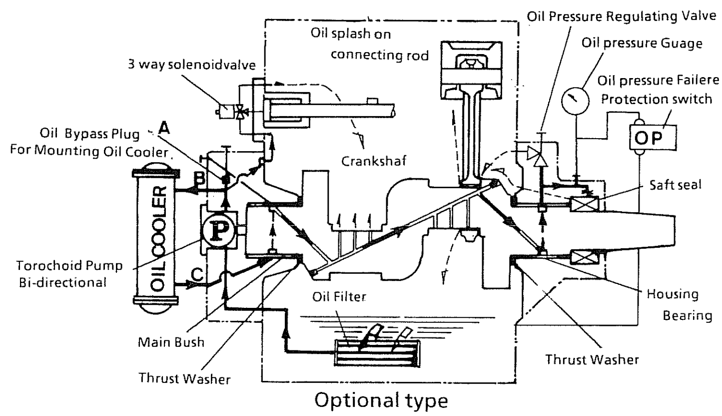
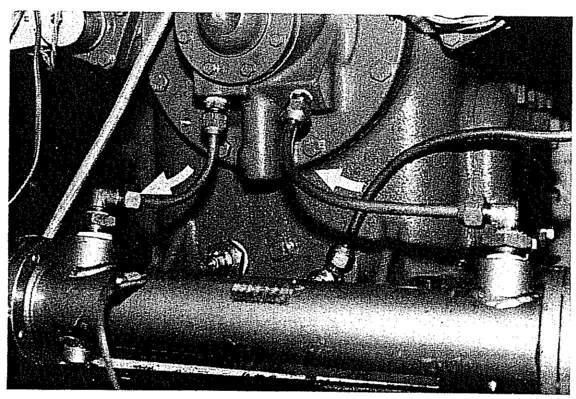



**Fig. 5B Lubricating Oil Flow Diagram**
**(With Oil Cooler)**



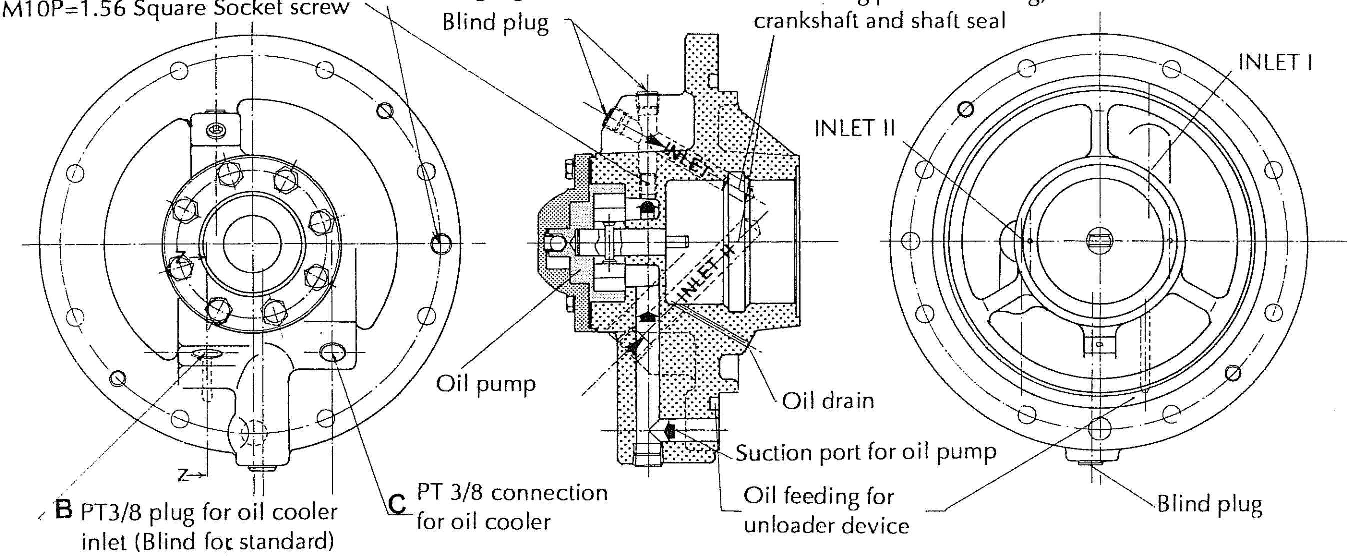
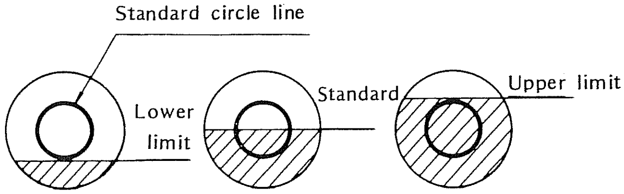



**Fig. 6 Oil Passages in Bearing Housing**

### 2.4.3 Oil Level

The oil level in the crankcase is monitored by means of an oil sight glass.

| | 4 K | 6 K | 8 K |
|---|---|---|---|
| Upper limit | 10.7 | 10.7 | 12.0 |
| Normal | 9.0 | 9.0 | 10.0 |
| Lower limit | 7.3 | 7.3 | 7.0 |



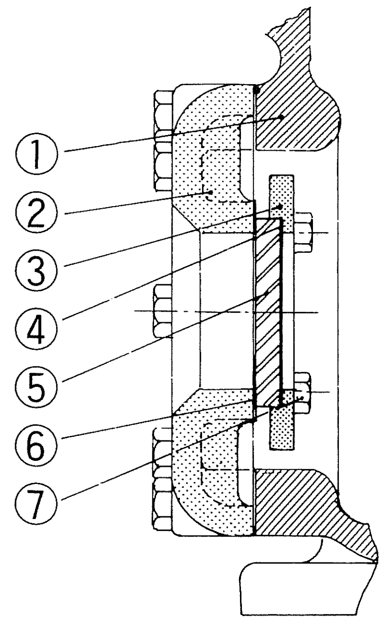
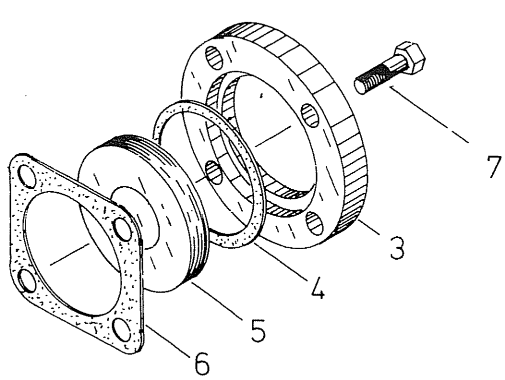




**Fig. 7A Oil Sight Glass, Sectional View**




① CRANK CASE
② HAND HOLE COVER
③ OIL SIGHT GLAND
④ OIL SIGHT GLAND GASKET
⑤ OIL SIGHT GLASS
⑥ OIL SIGHT GLASS GASKET
⑦ OIL SIGHT GLAND BOLT

**Fig. 7B Oil Sight Glass, Exploded View**

## 2.5 Mechanical Shaft Seal

The mechanical shaft seal used is a simple but reliable mechanism of proven design used on many MYCOM high speed, multi-cylinder compressors.
A combination of Stellite and carbon is used for the friction surface of the seal and an O-ring is used as packing.
The shaft seal is an unbalanced type single sealing system.
The seal rotates in an oil reservoir and pressure-fed oil adequately lubricates and cools the seal.

## 2.7.1 Oil Cooler

Operation of the compressor under conditions other than those specified as standard may require installation of an oil cooler.
For details, please refer to your nearest MYCOM dealer.
When installing the oil cooler, oil passage to the main bearing must be changed. Refer to Paragraph 2.4.2, Section 2.4, Lubrication mechanisms for details.
Either an air-, water- or refrigerant cooled oil cooler may be used, provided that it meets heat exchange requirements.

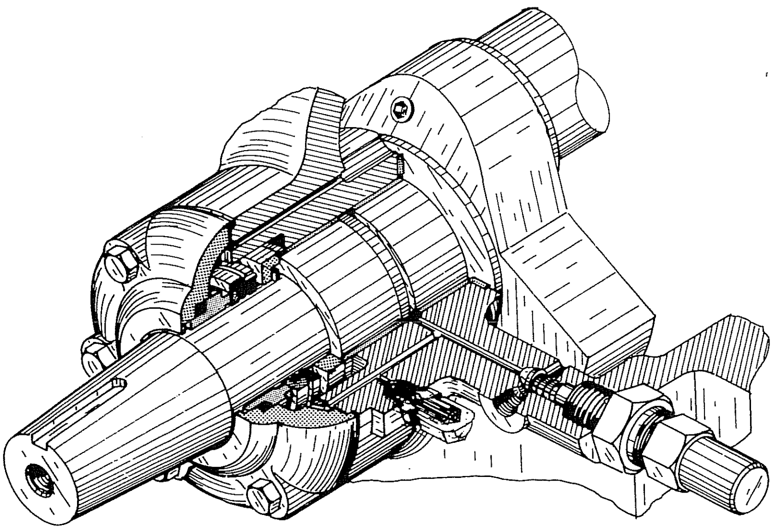


Fig. 8 Mechanical Shaft Seal Portion, Oblique Sectional View

## 2.6 Built-in Safety Valve

A safety valve is installed as standard equipment.
This valve is mounted between the discharge elbow and the suction chamber to connect the two with each other.
The safety valve actuates when differential pressure between high pressure and suction pressure reaches 24 Kg/cm².

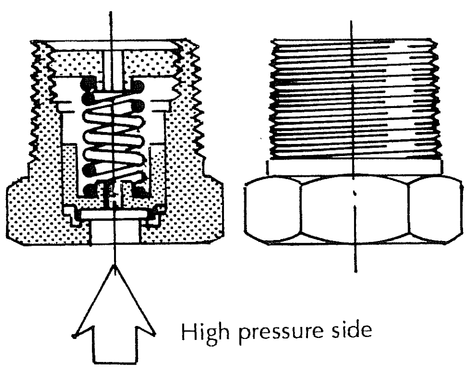



**Fig. 9 Internal Built-in Safety Valve**

## 2.6.1 Optional Accessories

If local laws or regulations prohibit use of an internal safety valve, an external safety valve can be mounted by processing the flange on the discharge elbow.

## 2.7.2 Model "MYPRO-K1" Microprocessor panel (Optional)

MYCOM K Series compressors may be equipped with an optional MYPRO-K1 Automatic Control Panel. With the pressure sensors provided, this panel monitors discharge pressure, suction pressure and oil pressure. In addition, capacity control based on suction pressure, abnormal pressure alarm and automatic operation stop functions are available. Sequential control of multiple compressor units is possible simply by connecting the control panels with each other. For details concerning the components and function of the "MYPRO-K1", consult with the adjacent MYCOM sabsidiory office or distibutor.

## 2.8 Accessories

(The type of accessories changes according to specifications for the packaged unit)

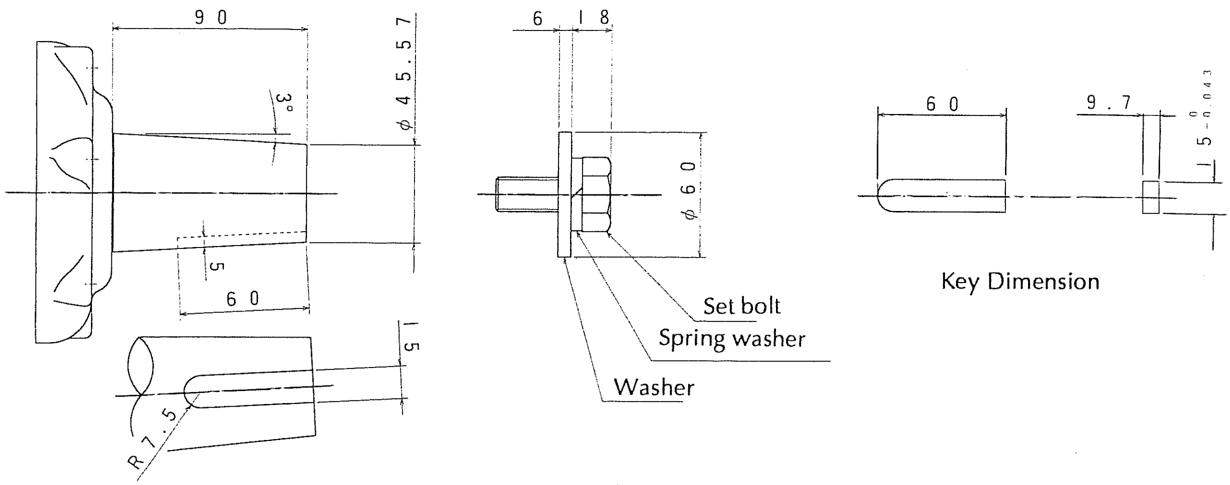



**Fig. 10 Shaft End**

### 2.8.1 Coupling for Direct Drive (Form Flex Type)

As shown in Fig. 11, the form flex type double flexing coupling consists of hubs, spacers and a laminated flexible disk referred to as the "element."

Since the function of the coupling is to transmit motive power, the performance of the element is extremely important. In this couple the element is composed of three thin stainless steel plates laminated together. It exhibits excellent flexibility and power transmission characteristics. Having no frictional or rubber parts subject to wear, the coupling has an extremely long service life.

Use of the double flexing type of coupler allows form inspection of the compressor shaft seal without removing the motor.

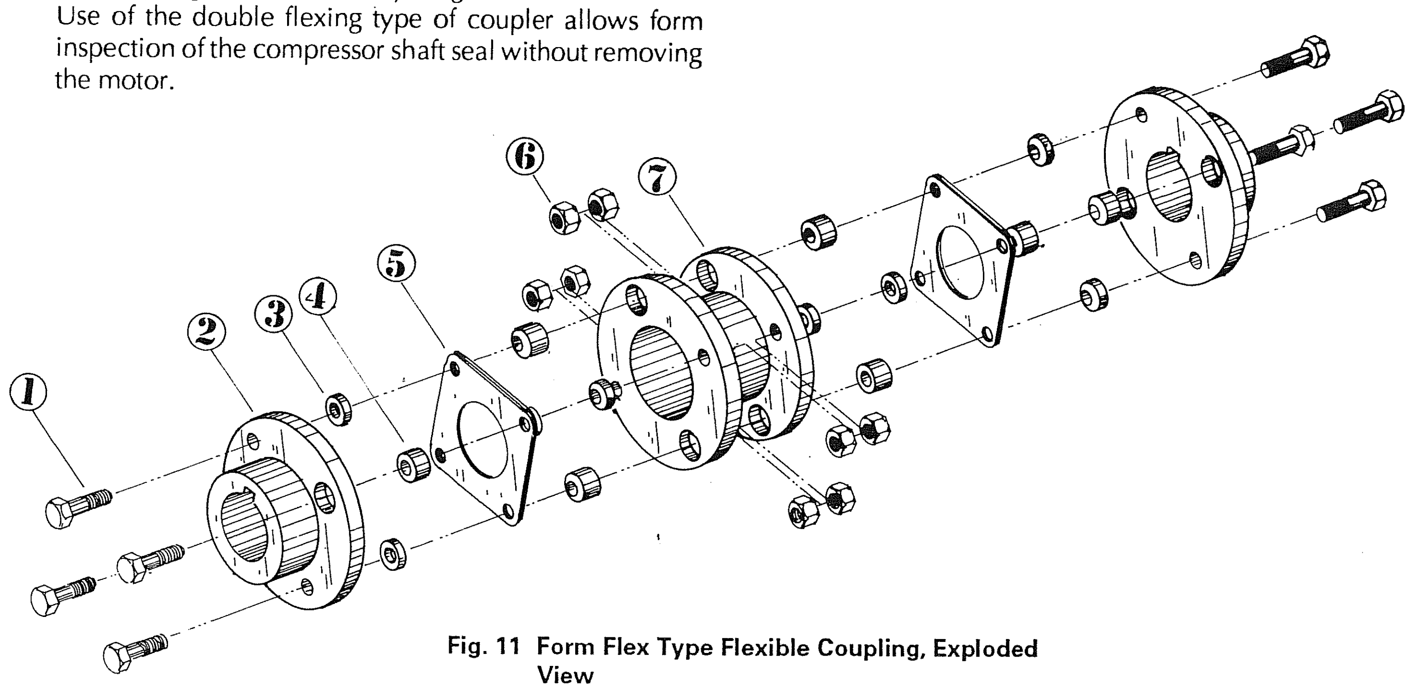



**Fig. 11 Form Flex Type Flexible Coupling, Exploded View**

### 2.8.2 Center flex type coupling

A center flex coupling is used when the compressor is driven by an engine.

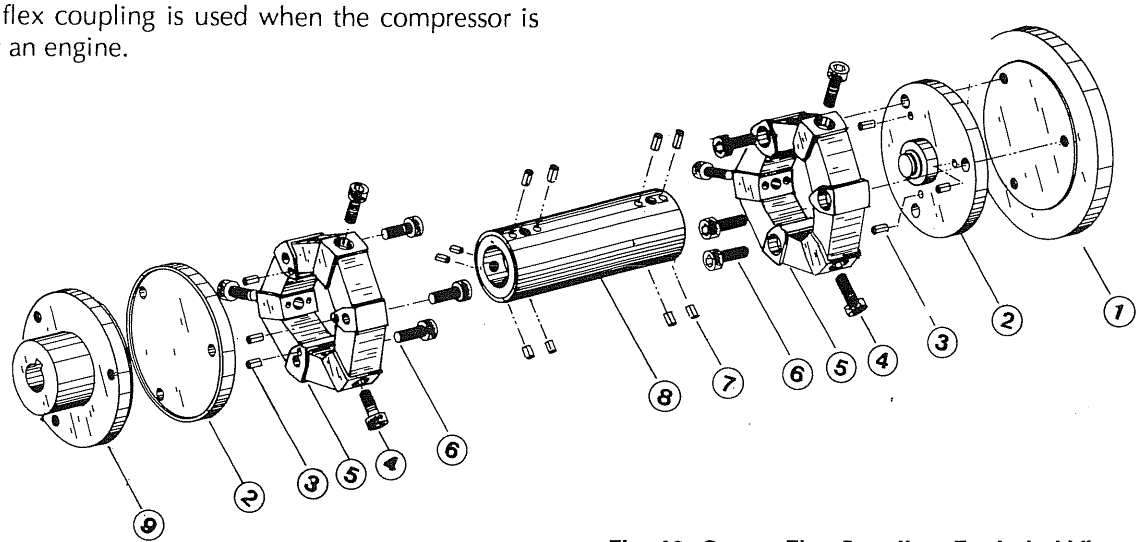



**Fig. 12 Center Flex Coupling, Exploded View**

① Compressor side coupling hub
② Flange hub plate
③ Spring pin
④ Clamping bolt
⑤ Center flex coupling (rubber or plastic)
⑥ Clamping bolt
⑦ Spring pin
⑧ Cylinder hub for spacer
⑨ Motor side coupling hub

**Table 2**

| Size | A2±0.1 | ød | t2 max | Spring pin specifications |
|---|---|---|---|---|
| CF-A-8 | 12 | 4 | 2 | 3-ø4×8 |
| CF-A-16 | 18 | 5 | 4 | 3-ø5×10 |
| CF-A-25 | 18 | 5 | 4 | 3-ø5×10 |
| CF-A-30 | 20 | 5 | 4 | 3-ø5×10 |
| CF-A-50 | 20 | 4 | 2 | 3-ø5×10 |
| CF-A-90 | 25 | 8 | 4 | 3-ø8×16 |
| CF-A-140 | 25 | 8 | 4 | 3-ø8×16 |
| CF-A-250 | 20 | 10 | 6 | 3-ø10×18 |

(1) When rubber parts are fitted to the spacer cylinder hub and flange hub, wipe off any oil which may have accumulated on the fitting face of the cylinder hub and flange hub and secure the bolts to the specified torque using a torque wrench. In this case, it is advisable to apply a small amount of grease to the bolt bearing face to aid in tightening the bolts securely.

(2) When the flange hub fitted with rubber parts is mated with the spacer cylinder, it may possibly become deformed due to friction contact with the bolt bearing faces. The bolts should be screwed in while protecting the hub from deformation.

(3) The bolts are coated with a special locking agent (blue) so that once a bolt has been secured to the specified torque it will not become loose due to vibration. Bolts with this locking agent may be reused two more times. If a bolt has been used more than three times it must be replaced (contact Mayekawa Mfg. Co., Ltd. or Miki Pulley Co., Ltd.). Do not apply a liquid anaerobic locking agent on the coupling bolts and nuts.

(4) Bolts should be used only after confirming that they meet coupling specifications. Especially, the nominal length of bolts should be confirmed.

(5) When the center flex rubber parts are fitted to the cylinder hub, first screw in each bolt to a depth of two threads, then tighten the bolts to the specified torque.

(6) After completing assembly, confirm that all rubber parts are fitted correctly and there is no deformation.

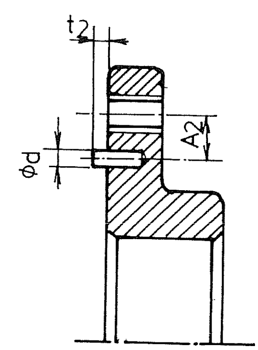



**Fig. 13 Spring Pin, Flexible Coupling**

### 2.8.3 Flywheel for V-belt Drive (Optional for some countries)

The flywheels for V-belt drive are P.C.D. 250 (external form 261) for belts numbered 5V with a B section. These belts are used on the 4K, 6K, 8K and, respectively.

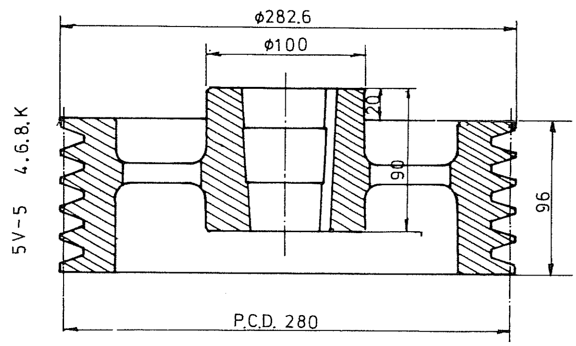



**Fig. 14 Flywheel, Sectional View**

When a belt other than the standard specified V-belt is to be used, consult with your local MYCOM dealer.
Belts requiring high tension may not be suitable for use with K Series compressors because of the high bearing load.

### 2.8.4 Pressure Gauges and Thermometers

When the MYPRO-K1 Control Panel (micro processor) is installed, monitoring processor is done by the Mypeo's standard pressure sensor.
Mount a tee coupling with a branch pipe for the pressure gauge at the midway point on the piping between the control panel and the pressure sensor element.
If the MYPRO-K1 Control Panel is not installed, connect the piping from the pressure tap to the necessary components (ref. Fig. 15).

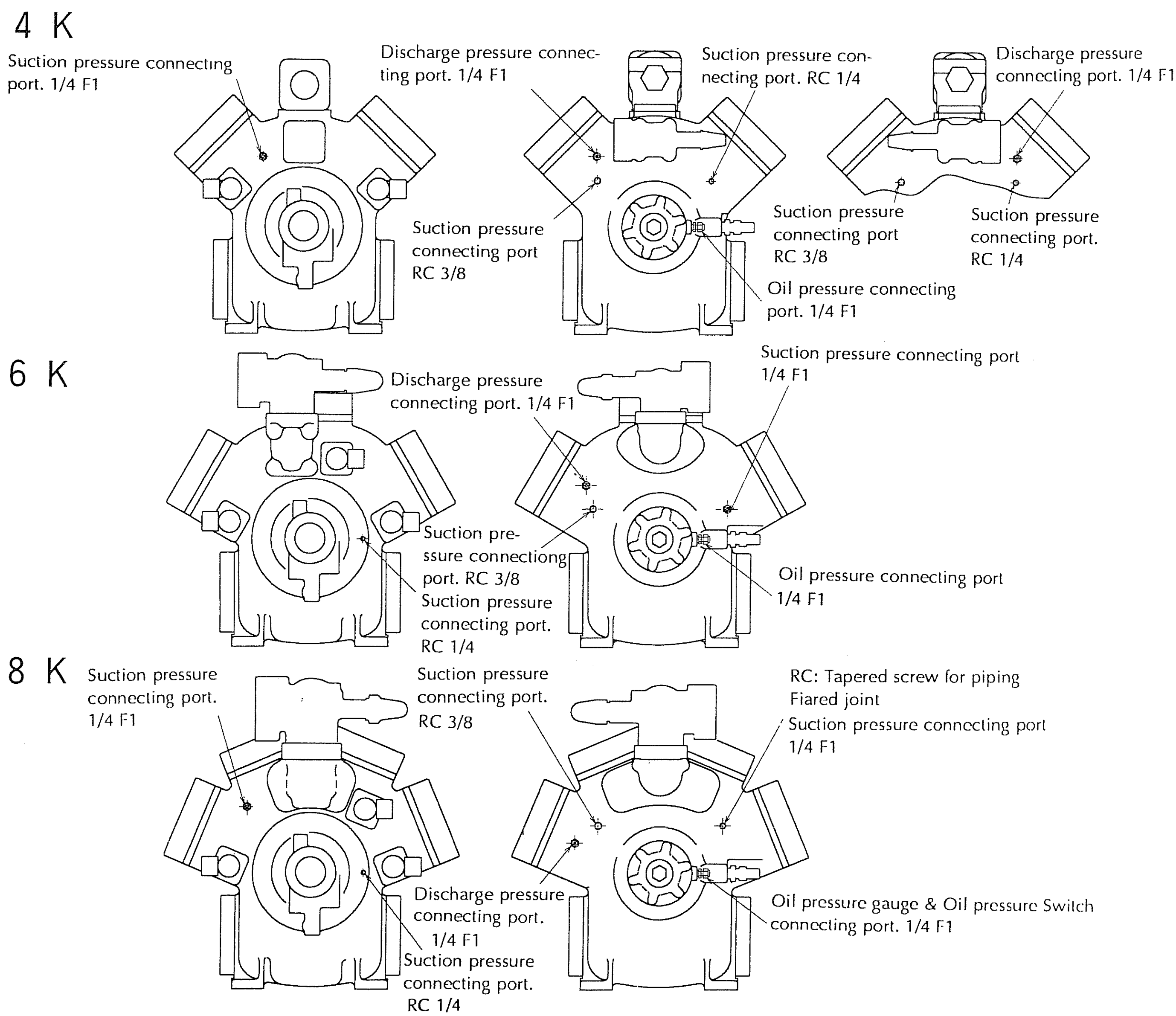



**Fig. 15 Piping Connection Indications**

## 3. Installation and Operation

Compactly constructed K Series compressors are designed for compatibility with a wide range of applications. Service conditions and operation therefore differ according to the respective application. This manual does not cover specific compressor packages, of which there are many. Instead, it focuses only on the major components and general requirements of the K Series compressor.

### 3.1 Alignment Work for Compressor Unit

For applications where the refrigeration unit is combined with various components at the site, the following alignment work is required.

#### 3.1.1 V-Belt Drive

**A. Fitting Compressor Flywheel**

a) Clean the compressor crankshaft extension, the bore of the flywheel, and the keyways in the crankshaft and flywheel; remove any rust, burrs, oil, point or dirt.

b) Fit the key into the crankshaft keyway and seat it home.

c) The compressor flywheel is a heavy component and must be carefully supported with a sling and crane is order to safely fit it to the crankshaft.
Check the key is side fitting in the keyway with ample top clearance, otherwise the flywheel will not tighten onto the shaft.

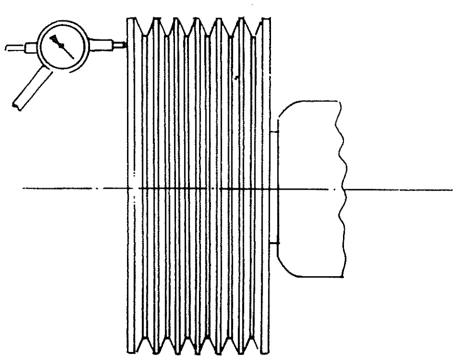


**Fig. 16 Flywheel Alignment**

d) Having satisfactorily fitted the key, press the flywheel onto the shaft by fitting the retaining plate and tightening the bolt firmly.

**B. Biting Motor Pulley**

a) Clean the motor shaft extension, the bore of the motor pulley and the keyways in the shaft and pulley; remove any rust, burrs, oil, paint or dirt.

b) Fit the key into the shaft keyway and seat it home.

c) The motor pulley is a very heavy component and must be adequately supported with a sling and crane in order to safely fit it to the shaft. Use the crane to guide the pulley over the shaft.
Check the key is side fitting in the keyway with ample top clearance, otherwise the motor pulley will not tighten onto the shaft.

**C. Removing Compressor Flywheel**

a) Remove the belt guard. Slacken off the belts by moving the motor towards the compressor and then carefully remove the belts from their grooves.

b) Remove the flywheel using the puller supplied in the compressor tool kit.

c) Unscrew and remove the large bolt securing the flywheel on the shaft.
Fit the puller onto the flywheel as shown in Fig. 17.
Position a wood block or metal plate behind the puller so that the jacking screw does not damage the threaded hole in the end of the crankshaft/motor shaft. Tighten the jacking screw to pull the flywheel/motor pulley off the shaft.

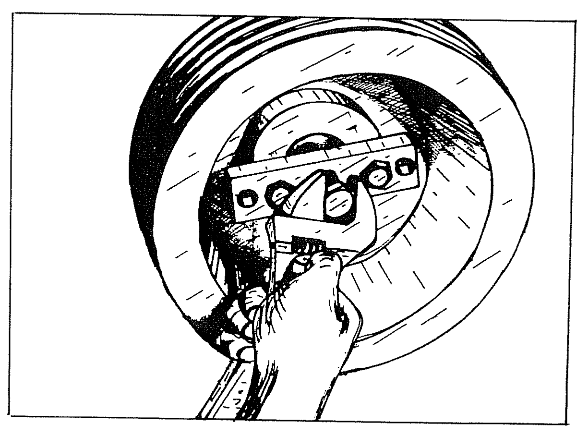


**Fig. 17 Removing Compressor Flywheel**

### D. V-Belt Alignment and Tensioning

A matched set of V-belts should always be used. Belts of different brands or types must not be mixed. Any difference in the cross-section or internal composition will seriously reduce running life. New and used belts should never be used together in the same set for similar reasons.

The belts are installed and the drive tensioned as follows:

a) If the compressor and motor are assembled on a baseplate, thus must be accurately leveled prior to installing and aligning the drive.

b) Clean any oil, grease, rust or burrs from the compressor flywheel and motor pulley belt grooves.
Move the motor towards the compressor to reduce the center distance of the drive. Use the adjusting screws fitted to the motor rails (if supplied) or, alternatively, position the motor by hand. It should be possible to slip the V-belts into their grooves without any undue force being applied.

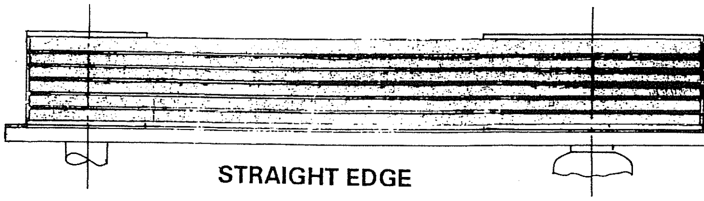
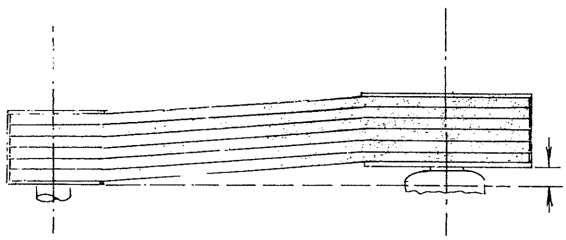


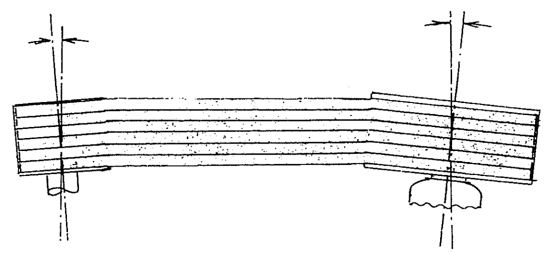

**Fig. 18 Method of Aligning Flywheel and Motor Pulley**

c) It is important to correctly align the compressor flywheel and motor pulley. This is accomplished by placing a metal straight edge across the back faces of the flywheel and pulley as illustrated in Fig. 18. Alternatively, a wire may also be stretched across.
Confirm that the compressor crankshaft and motor driveshaft axes are parallel. If any adjustments are necessary, place metal shims under the compressor and/or motor mount feet to correct.

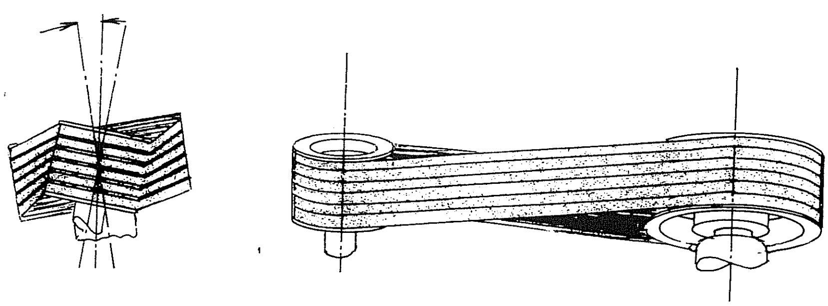
Fig. 19 Illustrates the various types of V-belt misalignment which may be encountered. Please note that the diagrams have been deliberately exaggerated.



Alignment of shaft are parallel, but the mounting place of the pulleys are inadequate.



Alignment of shafts are not parallel with each other.



Shafts are parallel with each other but the shaft core lines are twisted, resulting in quicker abrasion on the belts.

**Fig. 19 Types of V-belt Misalignment**

d) After the drive has been aligned, the belts must be accurately tensioned.
Measure the length of the span in millimeters. At the center of the span, use a spring balance to apply force in a direction perpendicular to the span until the belt is deflected from the normal by an amount equal to 0.016 mm for every millimetre of length, e.g., the deflection for a span of 1000 mm is $1000 \times 0.016 = 16$ mm.
Rotate the flywheel at least four times before taking the measurement. Repeat this procedure for each belt, taking an average value of these forces and comparing the value with those shown in Fig. 20.
If the average measured force falls within the values given in the figure, the drive tension is satisfactory. A measured force below the lower value indicates insufficient tensioning, however, a newly installed belt drive should be tensioned to the higher value to allow for the normal drop in tension during the running-in period. After the drive has been running for a few drays, the belts will have stretched by a small amount and seated in the grooves. Recheck belt tension to determine if adjustment is necessary.

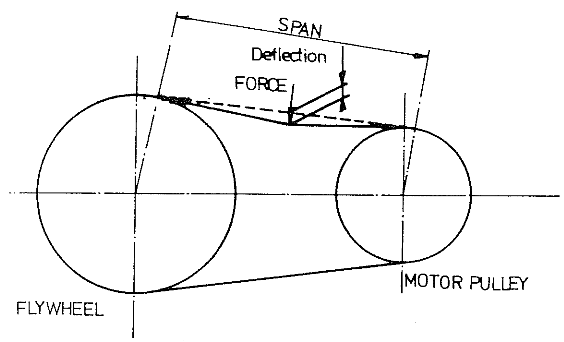



**Fig. 20 V-belt Tensioning**

e) After the drive has been tensioned, recheck the compressor flywheel and motor pulley alignment. If this is acceptable, secure the flywheel and motor pulley in position with the bolts or studs provided.

f) Place the belt guard over the belts and secure in place.

### 3.1.2 Direct-coupled Drive

The drive coupling is a flywheel spacer type composed of two half-couplings separated by a spacer. Small inaccuracies in drive alignment are accommodated by a number of thin sheets of stainless steel sandwiched between the bolts holding the coupling halves to the spacer. The compressor half-coupling incorporates a flywheel which absorbs any torque fluctuations and assures the best dynamic balance.

### A. Fitting Half-couplings

a) If the drive has been pre-aligned, the half-couplings will already be fitted to the compressor and motor shafts. The spacer is removed and shipped separately to prevent rough handling during transit from distorting the drive alignment or damaging the coupling.

**Note**

The coupling alignment must be checked before fitting the spacer. If the compressor and/or motor were transported to the site separately, place them in position on the baseplate. A pre-aligned drive will include any shims required. Insert these shims (if necessary) under the compressor and/or motor mounting feet.

b) If the half-couplings are not already fitted, indicating that the drive has not been pre-aligned, fit them to the compressor and motor shafts. Begin with the compressor half-coupling.

c) Clean the compressor crankshaft extension, the bore of the compressor half-coupling and the keyways in the crankshaft and half-coupling. Remove any rust, burrs, oil, paint or dirt.

d) Fit the key into the crankshaft keyway and set it home.

e) The compressor half-coupling is a very heavy component and must be adequately supported with a sling and crane in order to safely fit it onto the crankshaft. Use the crane to guide the half-coupling over the crankshaft taper.
Check the key is side fitting in the keyway with ample top clearance, otherwise the half-coupling will not tighten onto the shaft.

f) Having satisfactorily fitted the key, lock the half-coupling onto the shaft.
For all compressors secure the half-coupling by fitting the retaining plate and tightening the bolt securely.
Check the half-coupling alignment on the shaft by noting the dial indicator deflection through 360° around the rim face of the half-coupling, as shown in Fig. 21. The deflection should be within ±0.05 mm. If the alignment is out, inspect all mating surfaces for dirt or burrs.

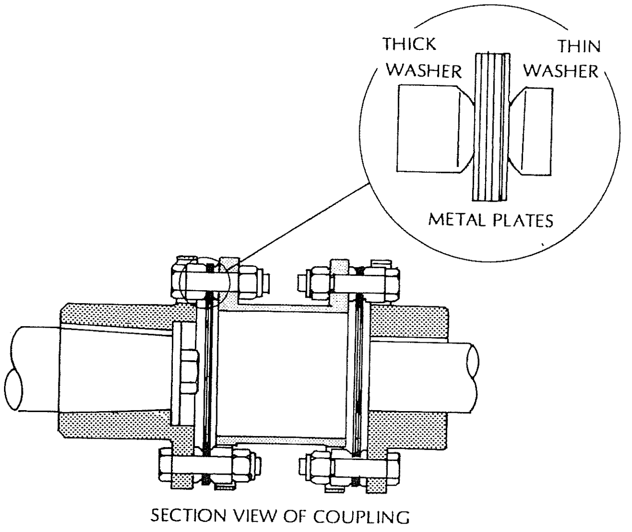



**Fig. 21 Coupling Assembly Half-Coupling**

g) Now fit the motor half-coupling. Clean the motor shaft extension, the bore of the motor half-coupling and the keyways in the motor shaft and half-coupling. Remove any rust, burrs, oil, paint or dirt.

h) The motor half-coupling is a light interference fit on the motor shaft. When making this interference fit, the half-coupling bore must be expanded by heating in a warm oven or by immersion in a bath of hot oil. An oil temperature of approx. 90~120°C is usually adequate for this purpose.

Having heated the motor half-coupling as explained above, assemble the half-coupling and the shaft key over the motor shaft. The key must be a side fit in the keyway with sufficient top clearance. Align the inner face of the coupling flush with the end of the motor shaft.

i) Check the half-coupling alignment on the motor shaft as described for the compressor half-coupling.

## B. Drive Alignment

a) Before attempting to align the drive, the baseplate must be installed on the foundation and accurately levelled.

b) If the drive motor is fitted with sleeve bearings, determine the motor's magnetic center from the manufacturer's instructions or, alternatively, switch on the motor and scribe the running position at a suitable place on the motor shaft extension, measuring from the motor casing. The motor must remain on its magnetic center.

c) Adjust the position of the motor so that the distance between shaft ends (DBSE) equals the value shown in Table 4 for the particular size of compressor.

| COMPRESSOR | K | WA and WJ | WB | C |
|---|---|---|---|---|
| DISTANCE BETWEEN SHAFT ENDS | 164.2 mm | 159.7 mm | 205.5 mm | 108.8 mm |
| DISTANCE BETWEEN FACES | 139.7 mm ±0.25 mm | 139.7 mm ±0.25 mm | 190.5 mm ± 0.25 mm | 110 mm ± 0.25 mm |
| MAXIMUM ANGULAR ERROR | 0.05°/ 100 mm DBSE | 0.05°/ 100 mm DBSE | 0.05°/ 100 mm DBSE | 0.05°/ 100 mm DBSE |
| BOLT FASTENING TORQUE | 116 lbf ft 16.0 kg/m 157 Nm | 68 lbf ft 9.4 kg/m 92 Nm | 68 lbf ft 13.4 kg/m 132 Nm | 68 lbf ft 7.3 kg/m 72 Nm |

**Table 3 Coupling specification**

d) In practice, the total drive misalignment is usually found to be a combination of three different types, i.e., axial, lateral and angular. For this reason a methodical approach is best, correcting one type of misalignment at one time. Deal first with any axial misalignment, the correct angular alignment and finally lateral misalignment.

Provided steps a~c above have been carried out correctly, the axial alignment should be correctly set. Confirm that lateral and angular alignment of the half-couplings is within the dimensions given in Table 4 using a dial indicator on each face and around the circumference. Testing for angular and lateral misalignment is illustrated in Fig. 22.

As far as possible, adjust the alignment by placing shims under the motor feet only. For example, if there is angular misalignment of the motor half-coupling, shims of the correct thickness are required under the front or rear pair of motor feet. In the case of lateral misalignment, shims are required under all four motor feet.

A drive coupling which has already been aligned by the maker should require little if any additional shimming.

e) When the half-couplings are correctly aligned, recheck the DBSE and ensure the motor has remained on its magnetic center. When all is satisfactory, secure the compressor and motor in position with the bolts and nuts provided.

After tightening the fastenings, recheck drive alignment.

f) Confirm that the pipe lines, particularly the suction and discharge lines, are well supported where they connect to the compressor. If any undue strains is placed on the compressor, it may be impossible to maintain drive alignment during operation. Recheck the alignment after making these connections.

Also, remember that any appreciable movement of the baseplate after the drive has been aligned may affect compressor/motor alignment.

g) Locate the spacer between the half-couplings. Insert the metal plates, using an equal number at each location. Fit the special washers, nuts and bolts. Note in Fig. 21 how the curved faces of the washers must be positioned facing the flexible metal plates, with the thicker washer in the clearance hole in the half-coupling. Tighten to the torque value specified in Table 3.

h) Place the guard over the coupling and secure in place.

## C. Removal of Half-couplings

a) Remove the coupling guard.

b) Undo and remove the bolts and washers securing the spacer. Remove the spacer and metal plates.

c) Remove the compressor half-coupling from the crankshaft.

d) Using a suitable pulley extractor, remove the motor half-coupling. Impact hammering must not be used to achieve removal as this may damage the motor shaft bearings.

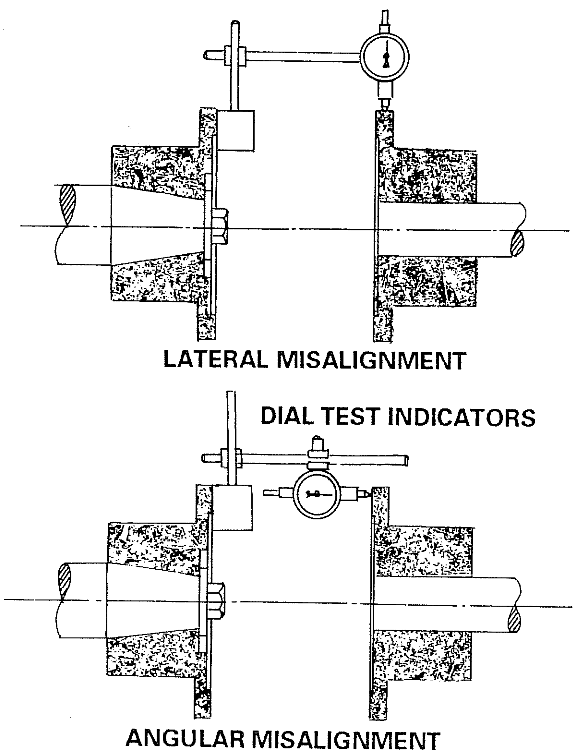



**Fig. 22 Half-Coupling Aligning Method**

## D. Angular Alignment

a) Clamp two dial indicators at diametrically opposite points on one half-coupling, with the sensing probes resting on the other half-coupling.

b) Rotate the motor half-coupling until the indicators are in line vertically, set the dials to zero.

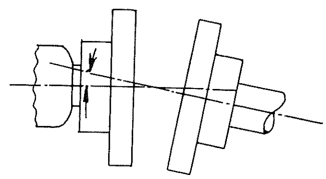
c) Rotate the motor half-coupling through half a revolution (180°C). A variation between readings indicates a deviation from alignment. If the gap between the two coupling faces is wider at one side, this can be corrected by moving the motor. A wider gap at the bottom or top is corrected by adding shims under the front or rear pair of motor feet, respectively. Adjust the position of the motor until the readings are identical or within the required tolerance.

## E. Lateral Alignment

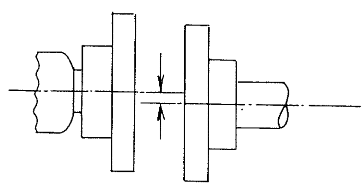
a) Clamp a dial indicator to one half-coupling with the sensing probe resting on the rim of the other half-coupling. Set the dial to zero.

b) Rotate the motor half-coupling and note the dial reading at each quarter revolution (90°). Add or subtract shims under all four motor feet until the readings are identical or within the required tolerance.

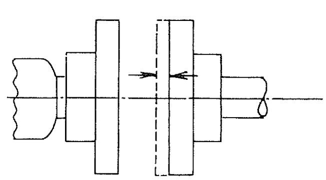
Remember that the gap between the coupling halves must be set with the compressor crankshaft on it's front thrust face and the motor shaft on it's magnetice center.



ANGULAR MISALIGNMENT
In this condition the shaft center lines meet at a point midway between the shaft ends.



LATERAL MIAALIGNMENT
In this condition the shaft center lines are parallel but laterally displaced.



AXIAL MISALIGNMENT
In this case the shaft center lines are parallel and coincident but there is axial displacement of one or both shafts.

**Fig 23 Types of Coupling Misalignment**

### 3.2 Piping

#### 3.2.1. Refrigerant Piping

a. The compressor is one of the few components in any freezing refrigeration or cooling system which has moving parts. It must therefore be protected from contamination by foreign matter. Use the utmost care when installing refrigerant piping to prevent scale from entering the pipes. As piping work proceeds, systematically remove all rust, dust and welding chips.

b. Nitrogen gas is usually sealed in the compressor as an anti-corrosion measure prior to shipment from the factory. Do not open either the suction or discharge valve until the compressor is connected with the piping and all other necessary conditions have been met.

c. The utmost care must be exercised to prevent moisture from entering the refrigerant piping and the compressor. Moisture contamination will cause serious problems during operation such as frozen valve. For this reason, any piping connection work needed should be performed with due consideration to maintaining dryness in the system.

d. When connecting piping, be sure to remove the dust guard blind plates on pipe fittings. Cases have been reported of failure to remove these plates prior to operation, resulting in serious problems taking considerable time to trace and remedy.

e. The suction gas piping should be mounted at a suitable angle to assure smooth return of oil into the oil reservoir of the compressor. Piping equipped with an intermediate trap and riser piping should display gas flow rates which allow smooth return of oil based on Freon refrigerant piping principles.

#### 3.2.2 Piping to Pressure Gauges and Protection Devices

(When "Mypro-K1" control panel not installed)

For piping connections to the pressure gauges and switches, refer to Fig. 2. Pressure gauges and thermometers, unlike the protection switches, have no direct effect on continuous operation or stopping of the compressor but installation is necessary in order to allow the system operator to monitor the status of the equipment during operation.

The following pressure gauges and thermometers are used to judge operational status:

- Oil pressure gauge
- Suction pressure gauge
- Discharge pressure gauge
- Suction gas thermometer
- Discharge gas thermometer

When arranging the piping to the oil pressure gauge, gas pressure gauges and other components, work should be carried out referring to Fig. 2.
When 6 mm OD pipe must be welded, care should be taken to prevent weld slag from blocking the pipe.

#### 3.2.3 Protection Switches (Pressure and Temperature)

The temperature of respective portions of the compressor stabilize within a specified temperature range during normal operation. Continuous monitoring of the temperature at various points thus allows the operator to determine the location of any problem which may be developing.
Usually, controlling discharge gas temperature and oil temperature to prevent abnormal high temperature serves as protection against mechanical failure of the compressor.
Oil temperature and the discharge gas temperature are closely related so any abnormal change in discharge gas temperature, which becomes evident at a comparatively early stage, can usually be recognized as an indication of increasing oil temperature. The pressure of respective portions of the compressor stabilizes in a specified range during normal operation, much like the temperature.
If pressure is abnormal, the compressor should be stopped immediately to prevent development of a serious problem.
The following switches are used for the above purposes:

- Abnormal high temperature protection switch (discharge temperature thermo-switch)
- Oil pressure failure protection switch (OP)
- Abnormal high pressure protection switch (HP)
- Low pressure control switch (LP)

#### 3.2.4 Oil Heater and Thermo-switch

The oil heater is a cartridge type sheathed heater. It is a hermetic model designed to provide maximum heat radiation. The heating wire is wrapped with insulation and sealed within a stainless steel tube. This oil heater is mounted on the compressor.
For the locations of the oil heater and the thermo sensor of the oil heater thermo-switch (control bulb), refer to Table 3, "Accessory Connection Ports," in Section 2.8.4.
Halocarbon refrigerant easily dissolves in oil so oil in the crankcase is liable to foam at start-up or during times when a small pressure change occurs. Consequently, insufficient pressure or lubrication failure may result. The compressor is therefore equipped with a heater and thermo-switch to maintain oil temperature at a specified level (standard temp.: 30°C)

**Table 4 Safety (Protection) Device Setting Values**

| Protection device | Control method | Setting Value |
|---|---|---|
| (1) Oil pressure failure protection switch (OP) | OFF<br>ON<br>Manual reset | Low pressure + 1.2 kg/cm²<br>Low pressure + 0.7 ± 0.2 kg/cm² |
| (2) Abnormal high pressure cutout switch (HP) | OFF<br>ON<br>Manual reset | 15.5 ± 0.5 kg/cm² |
| (3) Built-in safety valve | High/low pressure difference | 22 kg/cm² |
| (4) Low pressure control switch (LP) SNS-C106Q | OFF<br>ON | 2.5 ± 0.2 kg/cm²<br>1.5 ± 0.2 kg/cm² |
| (5) High temperature protection switch | OFF<br>ON<br>Manual reset | 125 ± 3°C |
| (6) Oil heater thermo-switch | OFF<br>ON | 34 ± 2°C<br>30 ± 2°C |

Performance testing of the protection devices should be carried out during trial running at the site and, except for the built-in safety valve, all setting values should be reset if necessary according to operating conditions and the refrigerant used.

**Caution: HP Performance Test**

When carrying out performance testing, the HP should be adjusted to the working pressure of the compressor. When the switch operates at a pressure equal to the reading of the high pressure gauge, the HP is regarded as properly functioning. HP activation performance should never be tested at the preset pressure level.

### 3.2.5 Oil Separator

Gas discharged from the compressor contains atomized oil entrained in the refrigerant. Consequently, an oil separator is required to remove the oil from the refrigerant gas.
The structure of the oil separator is shown in Fig. 23.
Refrigerant discharged from the compressor flows into the oil separator through the gas inlet near the top, circulating around the inner wall of the separator. Oil particles entrained in the gas are separated out by centrifugal force, clinging to the wall of the separator and falling into the bottom reservoir due to gravity. When sufficient oil accumulates in the oil reservoir, a float valve opens to automatically return the oil to the compressor crankcase.

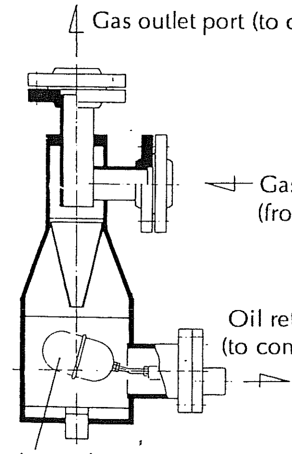



**Fig. 24 Oil Separator**

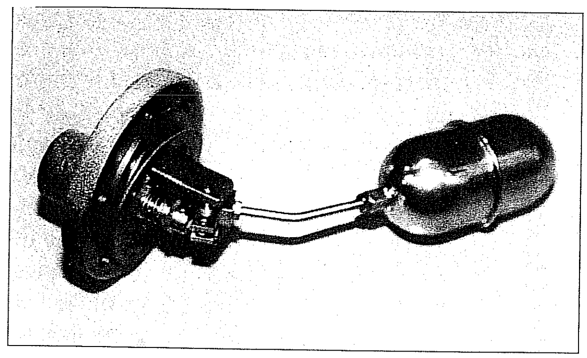


**Fig. 25 Float Valve**

### 3.3 Airtight Testing

(Only when carried out at installation site)

After completing all piping and wiring work, an airtight test of the piping system must be carried out.
In this case, the standard pressure gauge should not be used but should be sealed off by closing the root valve to the gauge.
Two sets of ø100 or larger pressure gauges with graduations 1.5 to 2 times the test pressure should be made available. These pressure gauges should be equipped with root valves to facilitate gauge reading.

1) Air should not be compressed to raise the pressure of the system as moisture in the air will condense and later cause trouble with the system. Instead, dry nitrogen gas or carbon dioxide should be used.

- Refrigeration compressors are not designed to compress air. If air is compressed, the discharge temperature will rise sharply, exceeding the flashpoint of the lubricant, and equipment seizure and even explosion may occur.

(Reference)
The flash point of the lubrication oil is 180~200°C. When room temperature air is compressed to 10 $kg/cm^2$, the temperature will rise to 250~300°C and if compressed to 20 $kg/cm^2$, it will reach ignition temperature.

2) All compressórs shipped from the factory have passed pressure proof testing at 30 $kg/cm^2$ and airtight testing at 20 $kg/cm^2$. Airtight testing of the compressor itself is not required at the installation site unless it has been disassembled.

3) Close the suction and discharge valves to isolate the compressor from the piping being tested. If this is not done, without oil charging, the friction face of the oil seal may leak if pressure exceeds 10 $kg/cm^2$.

4) Be sure that the root valves of all safety devices with bellows such as the OP and LP switches are closed. If left open, the bellows and operating components of the switches will be damaged by the pressure.

5) When automatic devices such as solenoid valves, thermal expansion valves, etc. are installed on the liquid piping, the system must be operated manually or a bypass around the valves set up so that pressure is distributed uniformity to all components in the system.

6) Care should be taken when raising pressure to avoid sudden pressure increases. Raise pressure to the required level gradually, checking all main components in the system for airtightness.

7) After completing airtight testing of the system open the compressor suction valve slightly to raise pressure to 5~8 $kg/cm^2$ and confirm airtightness on the pressure gauge and pressure switch mounted at the installation site. Pressure in the low pressure side may not readily rise due to actuation of the plate valves.
An excessively quick rise in pressure may cause the safety valve to actuate.

### 3.3.1 Vacuum Testing

After completing airtight testing, the system should be vacuum tested.

1) Discharge the gas used during airtight testing by opening the purge valve. Dust and other foreign matter will also be ejected from the piping with the gas.

2) Vacuum testing has the additional function of removing moisture from the system piping.
Using a vacuum pump, evacuate the inside of the system to remove moisture.

   - In system using R22 refrigerant, the presence of 100PPM or more of moisture may cause hydrolysis at 135~145°C, resulting in deterioration of the lubricating oil and corrosion of the system.

3) After evacuating the system, allow to stand for at least twelve hours under vacuum conditions. Check periodically for loss of vacuum. If the change in vacuum after twelve hours is less than 5 mmHG, the system can be considered sufficiently airtight. If vacuum loss exceeds 5 mmHG, airtight testing should be carried out once again.

### 3.3.2 Charging Oil

Before initial start-up, charge the compressor with lubricating oil. Usually, the compressor is not charged with lubricating oil prior to shipment from the factory in order to avoid possible mixture of different brands of oil.

1) All frictional parts are, however, given an oil coating which should last for two to three months. If six months or more have passed since the compressor was shipped from the factory, the oil film on these parts may have disappeared. In this case, open the handhole cover and lubricate all moving parts.

2) If the compressor is still under vacuum, fit a hose to the lubricant charging/drain valve and charge oil from the oil can using the negative pressure of the compressor. Fill the compressor with oil to the upper level of the oil sight glass. Care should be taken when carrying out oil charging to prevent moisture and foreign matter entry into the compressor.

3) If the compressor is not under vacuum, remove the P.T. 3/4 blind plug and charge or fill the compressor through the lubricant charging/drain valve using a pump.

4) After completing oil charging, evacuate the compressor again using a vacuum pump.

### 3.3.3 Charging Refrigerant

1) Confirm that the refrigeration system is evacuated and that all components are normal.

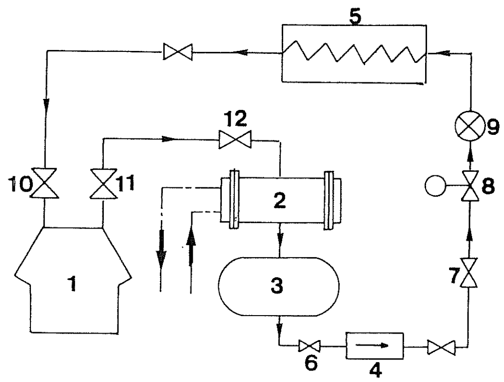
2) As the system has been evacuated, first charge refrigerant into the receiver using the pressure difference between the receiver and the gas cylinder. When refrigerant no longer flows into the receiver due to the increase in pressure, the charging method must be changed. Close the receiver outlet valve and charge through the evaporator.

3) Before charging, incline the gas cylinder at an angle of approx. 30° with the valve end down. Open the valve gradually. When evaporator pressure reaches 2 kg/cm², start the compressor.

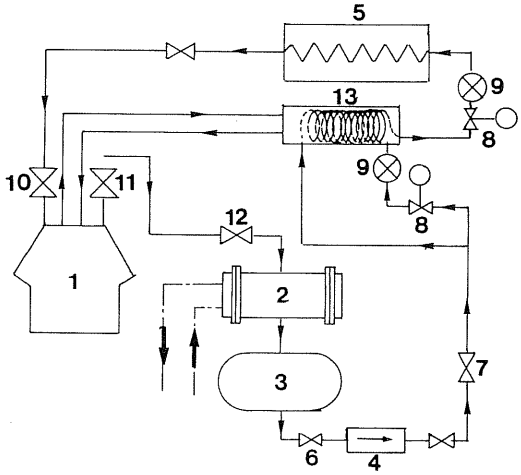
4) The amount of refrigerant remaining in the gas cylinder may be judged by tapping the cylinder or by weighing it.
When the specified quantity of refrigerant has been charged into the system, remove the cylinder after first closing the charging port valve. Finally, open the receiver outlet valve in preparation for regular operation.

## 3.4 Start-up (Ref. Fig. 26)

The quality, hence the value, of cooled or frozen products, depends enormously on effective operation of the cooling system. Likewise with air conditioning systems, effective operation of the cooling plant has a direct effect on the morale and efficiency of workers.
It is therefore obvious that refrigeration system operating engineers thoroughly understand the structure of the entire system, the principles of operation, the function of the compressor and other plant components, as well as refrigeration theory. With regard to the piping system, the location of all valves and the effect they have on operation should be fully mastered.
Every refrigeration system incorporates unique construction features, which must be recognized. In the case of newly constructed factories or ships, the operating engineer should ask the engineer in charge of installation of the cooling system for an explanation of the working principles and should participate in all trial operations together with the supplier.
Even if it means a delay in start-up or sailing of several days, a system should not be accepted if it does not fully meet the expectations of the purchaser's engineer in charge.
An error in operation of the refrigeration system can result in major damage to the system and even injury-inducing accident. Today's multi-cylinder compressors are designed for semi- or full-automatic operation. Such systems are very reliable but not completely so. Because refrigerant and lubricating oil are mixed in the freezing cycle, operating conditions are much more difficult than they are for a pure liquid or gas system such as is found in, for example, a petrochemical plant. Consequently, even during normal operation of a fully automatic cooling system, when there is a large change in freezing load, the judgement of a competent operating engineer is much more reliable than simply depending on the automatic system controls.




**Single-stage Compressor Flow Sheet**




**Two-stage Compressor Flow Sheet**

1. Compressor
2. Condenser
3. Receiver
4. Dryer
5. Evaporator
6. Receiver outlet stop valve
7. Manual stop valve before expansion valve
8. Solenoid valve before expansion valve
9. Expansion valve
10. Suction stop valve
11. Discharge stop valve
12. Condenser inlet stop valve
13. Gas/liquid intercooler

——— Refrigerant piping
– – – Cooling water piping

**Fig. 26 Representative Piping Diagram for Refrigeration Installation**

### 3.4.1 Preparation for Start-up

(1) Daily preparations prior to start-up

a) Check all components, piping and wiring carefully.

b) Start the cooling water pump and confirm that water is flowing smoothly to the condenser.
Starting the system without cooling water flow is extremely dangerous. Always confirm adequate flow before continuing.

In the case of air conditioning systems which do not use cooling water, confirm that the fan is rotating in the proper direction.

c) Check the oil level in the compressor.

d) Confirm the quantity of refrigerant in the receiver (3) by observing the level gauge.

e) Confirm that all stop valves are adjusted correctly for start-up.

* Manual devices:
Fully open all manual stop valves on the refrigerant pipe line except for the compressor suction stop valve (10) and the manual stop valve (7) just in front of the expansion valve.

Caution:
After long term stopping and/or trial operation, the receiver stop valve (6) should be opened instead of the stop valve (7) just before the expansion valve.

* Fully automatic devices:
Fully open all manual stop valves except for the solenoid valves and other automatic valves.

(2) Preparations required especially for trial operation

Caution:
The following preparations for trial operation are required in addition to the regular daily preparations noted above.

a) Fully open the manual valves on the refrigerant pipe line except for the compressor suction stop valve (10) and the receiver outlet stop valve (6).

b) Manual operation
Manually turn the flywheel (direct drive coupling) several times in the proper direction of rotation before starting.
If the system has not been operated for a long period of time (at initial startup after installation or after long-term shutdown of one month or more), immediate start-up may cause damage to the compressor due to the absence of a proper oil film on the bearings and pistons.

c) Confirming rotating direction
Start the compressor motor several times to confirm that the compressor shaft rotates normally.

d) If a solenoid valve is installed, proper functioning of the valve should be confirmed.

### 3.4.2 Operation (Ref. Fig. 26)

(1) Confirm that the compressor discharge stop valve (11) is fully open.

(2) Confirm that the receiver outlet stop valve (6) is fully closed and the compressor suction stop valve (10) slightly open.

(3) Start the compressor and confirm that oil pressure is rising smoothly. Also check the ammeter.

(4) Gradually open the compressor suction stop valve (10) immediately after starting up the compressor. Keep opening the valve until the pressure indicated on the suction pressure gauge drops to a level slightly lower than normal suction pressure, then open the valve fully after confirming that refrigerant liquid is not being returned to the crankcase.

**Caution:**
If the suction stop valve (10) is opened suddenly, any refrigerant liquid in the piping flows to the crankcase and compressor liquid back may result. Consequently, care should be taken to prevent insufficient lubrication and seizure due to the mixing of oil in the liquid. Such a problem may be caused by a considerable amount of liquid remaining in the piping due to inadequate handling when the system was previously stopped.

(5) Next, carefully open the receiver outlet stop valve (6).

(6) When suction pressure is significantly higher than regular pressure, regulate the suction gas using the suction stop valve (10) or unload capacity to operate at the rated horsepower of the motor.

(7) Adjust the opening of the expansion valve (9) while monitoring frosting on the compressor suction pipe (a thin layer of frost forms on the suction filter) to prevent liquid back.

(8) It will take some time for the expansion valve (9) to have an effect on operation after adjustment. For this reason, adjustment should be done little by little.

(9) Confirm proper functioning of all measuring instruments such as pressure gauges, thermometers and the ammeter.

Caution:
(3.4.2 Operation) is a representative example of initial start-up procedures for a manual device after installation. The specifications of a fully automatic system may differ, as may operation of the various stop valves. Precautions during operation are mentioned below. For further details consult the engineer in charge of installation.

(A) Trial Operation (applicable to all systems)
Operate the system based on the procedures given in 3.4.2 Operation.

(B) Daily Operation of Manual Device (device manually started and stopped)
The stop valves which should be closed for recovering refrigerant in the system before stopping must be opened when starting up. If adjustment of the manual stop valve (7) just before the expansion valve is to be carried out, before manipulating the valve, adjust the receiver outlet stop valve (6) first and confirm the results.

(C) Daily Operation of Fully Automatic Device (device started and stopped automatically)
The stop valve which should be closed for refrigerant recovery operation before stopping is the solenoid valve (8) just before the expansion valve. The solenoid valve (8) is also automatically actuated at start-up to regulate the compressor to no-load for starting. With a fully automatic device, adjustment of the receiver outlet valve (6) and the compressor suction stop valve (10) is not needed.

### 3.4.3 Precautions During Operation

#### (1) Initial Operation

The cooling system should function for a long period of time at maximum performance. Proper initial operation is, therefore, extremely important in assuring this goal.
The initial operation period is considered to be approx. 10~24 hours after initial start-up. During this time, any dust, scale, rust or other foreign matter in the piping is carried by the gas into the compressor. Any sludge which cannot be removed by the suction filter will become mixed with the oil and may cause failure or accident at some later date.
While the inflow of foreign matter to the compressor lasts for a considerable period of time, most is during initial operation. Check the filter and the condition of the oil periodically during initial operation.
The appearance of the oil in the crankcase indicates the condition of refrigerant in the cooling system and the level of oil contamination. If the oil remains clear for a long period of time, it can be assumed that the system is relatively clean. If the oil becomes dark or turbid brown, foreign matter exists in the system. Replace the oil as soon as possible to prevent the foreign matter from causing abnormal wear of the moving parts of the compressor.

**Table 5 Service Schedule**

| Frequency | Oil replacement & filter cleaning | Frequency | Suction filter cleaning |
|---|---|---|---|
| 1st | After charging refrigerant | | – |
| 2nd | After initial operation period | 1nd | Soon after initial operation period |
| 3rd | 100 hours after initial start-up | 2rd | 100 hours after initial start-up |
| 4th | 300 hours after initial start-up | 3th | 300 hours after start-up |
| 5th | 700 hours after initial start-up | 4th | 700 hours after initial start-up |
| 6th~ | Every 1,000 hours | 5th~ | Every 1,000 hours |

Note: In addition to the above, oil replacement and suction filter inspection and cleaning should be carried out whenever the compressor oil becomes contaminated or the filter becomes clogged.

Special attention should be paid to the following points:
a) Inspection and cleaning of filter and replacement of oil
b) Confirm that there is no overheating or abnormal sound from the compressor.

#### (2) Operation Log and Inspection

The operational status of the cooling system should be monitored and recorded in a logbook.
Conscientious record keeping promotes safe and efficient operation of the cooling system and is an important diagnostic tool for detecting and remedying potential problems developing in the system. While the operating engineer should be prepared to deal with any problem that occur, it is far more important to prevent a problem before it happens.
The operator should keep the machine room clean at all times and store tools and spare parts in a location readily accessible if equipment problems are encountered.

a) **Suction Pressure and Temperature**

It is recommended that suction pressure be maintained at saturation pressure corresponding to evaporative temperature. In actuality, there will be a slight pressure loss due to piping resistance.

If the pressure loss is excessive, the suction filter may be clogged, in which case it should be cleaned.

Suction pressure and evaporative pressure (temperature) are determined when the system is designed. If the system is operated at a suction pressure lower than the specified value, a considerable drop in refrigeration capacity will result. On the contrary, if suction pressure is higher than the specified value, refrigeration capacity will be improved but power consumption will increase and motor overload may result.

In any case, maintaining the proper suction pressure is essential to long-term, economic operation.

Under normal conditions the best suction temperature is:

Saturation temperature corresponding to suction pressure +5~10°C (this means that the degree of superheat is 5~10°C). If superheat of this level is secured, liquid back will not occur.

Operation with a much higher degree of superheat will result in an abnormal rise in discharge temperature, which will exert a harmful influence on operation. [Ref. (3.5 Design Parameters)].

b) **Discharge Pressure and Temperature**

"Condensing pressure + piping resistance" is the standard level of discharge pressure.

When the discharge pressure rises excessively, problems such as reduced refrigeration capacity and low efficiency due to increased power consumption result and the motor may be overloaded.

Abnormally high pressure may result from insufficient cooling water supply, contamination of the refrigerant gas with a noncondensable gas (air) or low heat exchange efficiency. Symptoms such as these may change from momentarily so a careful record of operating conditions is essential.

Conversely, if there is an abnormal drop in discharge pressure (condensing pressure) problems such as increased refrigeration capacity and reduced power consumption may result. Operation will be unprofitable taking power consumption for the cooling water pump and the flow rate of the cooling water into consideration. Discharge temperature will show some variations depending on the kind of refrigerant and the degree of suction gas super heat but do not allow the discharge temperature to increase higher than 120°C as a rule.

If the discharge temperature is abnormally high, problems such as excessive super-heating of the suction gas and recompression super heat resulting from damaged discharge/suction plate valves are possible.

c) **Lubricant pressure**

Proper oil pressure is: Suction pressure + 2.0~3.0 kg/$cm^2$

A drop in oil pressure may be due to clogging of the oil filter or foaming of the oil in the crankcase (which often happens if a large quantity of liquid refrigerant is returned to the crankcase).

Abnormal wear or abrasion of the compressor moving parts may also cause a drop in pressure.

In such case, pressure falls gradually and is apt not to be noticed immediately. For this reason, studying the system logbook regularly is essential for diagnosing potential abnormalities before serious trouble and damage are encountered.

d) **Oil Quantity (oil level)**

Check the oil quantity using the oil level gauge to confirm that it is within the specified range. Usually, the oil level will gradually decline during initial operation. In this case, when oil cannot be seen in the gauge, charge oil to the specified level.

If refrigerant is mixed with the oil flowing into the crankcase, oil foaming will occur, resulting in an apparent increase in the oil level gauge reading. Take this into account during operation.

e) **Oil Temperature**

The oil temperature will of course differ according to operating conditions but it should remain within the range of ambient temperature up to 70°C as a rule. Operation which raises the temperature of the hand hole cover on the crankcase to over 70°C should be avoided.

f) **Contaminated Oil**

Under normal operating conditions the oil should remain transparent and clear. If the oil turns from brown to black, the quality has deteriorated or become contaminated and should be replaced.

Muddy oil indicates the presence of solid foreign matter. In this case, replace the oil as soon as possible. Consider the case of oil used in the engine of an automobile. Assuming that the engine oil must be replaced after every 10,000 km of driving at 50 km/hr., it would have to be replaced every nine days if the automobile were driven 24 hours a day. In comparison, taking the operating conditions of a refrigeration compressor into consideration, compressor lubrication oil is utilized for a relatively long period of time. For this reason careful oil management is vital for extended durability of the machinery. Frequent oil replacement is essential for stable, long-term operation.

**g) Shaft Seal Oil Leakage**

Evaluate according to the amount of oil leaking from the seal. When shipped from the factory, oil leakage of 3cc per hour is considered acceptable. Under normal operating conditions, several drops of oil per minute is considered acceptable.

**h) Power Transfer Components**

In the case of a V-belt driven type, check belt tension carefully. Excessively tensioned belts may overload the bearings of the compressor and motor as well as cause premature belt wear.
Conversely, if the belts are too loose, heat and abrasion may result due to belt slippage. Improper tensioning will result in premature belt wear and abnormal vibration.
Periodic adjustment of the V-belts is necessary (ref. 3.1 Alignment Work for Compressor Unit).
In the case of a direct drive coupling type, check for abnormal sounds due to loose bolts (ref. 3.1 Alignment Work for Compressor Unit).
Under normal operating conditions the sound generated by the compressor should be rhythmical.

**i) Electric Motor**

The electric current and voltage should be within the specified range and the bearing casing should remain at normal operating temperature.
Confirm the above based on the electric motor manufacturer's recommendations.

**j) Others**

- Temperature of Refrigerant Liquid Piping (During Normal Operation)
  Under normal conditions, the refrigerant liquid pipe (from the receiver to the expansion valve) should be warm to the touch.
  If the liquid pipe is hot, a considerable amount of gas is flowing through the pipe instead of liquid refrigerant due either to a malfunction of the condenser or insufficient refrigerant.
  Conversely, if the liquid pipe is too cold, the liquid has expanded in the piping due to an abnormal pressure drop resulting from a clogged dryer, improperly sized or twisted pipe or partial closure of a valve.
  In either case, investigate the cause of the malfunction, remedy and readjust the refrigerant flow rate to achieve normal operation.

- Liquid Hammer and Oil Hammer
  When a significant quantity of liquid refrigerant is sucked into a cylinder, the compressor will produce a clanking sound and the discharge pipe will become cold (because the discharge temperature is suddenly reduced).
  This symptom is called "liquid hammer" or "oil hammer" and is very harmful to the compressor. The strong impact of the cylinder on the uncompressable liquid can possibly lead to serious damage or an accident.
  If this system is encountered during operation, throttle or close the suction stop valve to stop the flow of liquid into the compressor and then adjust the expansion valve.
  When the liquid hammer stops and the discharge pipe temperature rises, open the suction stop valve gradually to return to normal operation.
  "Oil hammer" is a similar symptom in which the oil level in the crankcase is excessively high. In this case, excess oil in the crankcase should be removed.

  **Cautions:**
  Liquid hammer at start-up should be controlled by adjusting the suction stop valve. This problem occurs when the liquid refrigerant remaining in the evaporator is sucked into the compressor under unsatisfactory evaporation conditions. If the expansion valve is adjusted at start-up, the valve opening may be insufficient during subsequent normal operating conditions and will require readjustment.

- Refrigerant Leakage
  Many flareless, flared and packing type joints are used throughout the cooling system. These parts of the compressor subject to high pressure, high temperature or vibration may become loose and leak refrigerant. For this reason, periodic confirmation of the integrity of joints is necessary. Regularly inspect joints and retighten to the required torque if necessary.

**(3) Drop in Compressor Performance**

The compressor provides optimum capacity when operating at high suction pressure and low discharge pressure. If there is a drop in compressor performance, however, a similar condition of high suction and low discharge pressure may gradually develop. This tends to develop gradually over a long period of time, pointing to the very important need for careful monitoring of compressor performance. As well, changes in pressure gauge readings do not always warn of such a problem. For example, a pressure drop may also be caused by leakage from or damage to a discharge or suction plate valve or leakage from around the piston rings.

Apart from the compressor, a similar decline in performance may be traceable to a leak in the built-in safety valve or the oil separator return oil float valve.

**(4) Oil Consumption**

Some of the oil used to lubricate the moving parts of the compressor mixes with the refrigerant gas compressed in the cylinders and enters the condenser and receiver through the oil separator.

Most Halocarbon refrigeration systems utilize an oil separator equipped with an automatic oil return device. Oil is also returned from the evaporator.
While a considerable amount of oil is apparently consumed during initial operation of the system, this symptom decreases in time, that is to say, the quantity of oil returned from the evaporator and the actual consumption of oil tend to balance out closely and there is less need charging additional oil.
If the compressor is frequently started and stopped or operated under abnormal conditions which contribute to liquid back, oil foaming in the crankcase or abnormal oil consumption will occur. Care must be taken to prevent such problems from developing.

### 3.4.4 Operation Stop and Shutdown (ref. Fig. 26)

#### (1) Daily Operation Stop

a) Close the manual stop valve (7) in front of the expansion vâlve.

b) Confirm the gradual decline in suction pressure (maintain the suction pressure above 0 kg/cm²).

c) Stop the electric motor and close the compressor suction valve (10) and discharge stop valve (11).

d) Stop the cooling water supply or stop the cooler fan. If the ambient air temperature is expected to drop below 0°C, drain all water from the condenser (2) to prevent it from freezing up.

e) Turn off the main power switch.

**Caution:**
The above instructions are representative for a manual system. The specifications of fully automatic systems as well as cooling systems vary considerably and operation of the stop valve may differ. Operating precautions are noted below but ask the engineer in charge of installation of the refrigeration equipment to outline the particular procedures for your system.

1) When a solenoid valve (8) is mounted on the refrigerant liquid piping between the receiver (3) and the expansion valve (9), operation of the manual valve (7) mentioned in (1)-a) above is not required but the solenoid valve (8) should be closed.

2) With a fully automatic refrigeration system or when automatic valves (check valves) are mounted on the compressor suction and discharge ports, operation of the suction and discharge stop valves (10 & 11) mentioned in (1)-c) above is not required.

3) In the case of a fully automatic system, manual operation of the valves mentioned in (1)-a) ~ d) above is not required.

**Caution:**
<u>The most dangerous problem that can be encountered with a refrigeration system is liquid sealing.</u>
In this case, refrigerant liquid is sealed in the pipes between valves. The valves can be seriously damaged as the liquid expands and in the worst case, the pipe or the valves may explode, posing a serious threat of physical injury The refrigerant piping from the receiver to the evaporator should therefore be handled with special care.

**(Liquid Sealing Prevention Measures)**

1) Close all stop valves (solenoid valves, check valves and manual valves) successively following procedures, making sure that no refrigerant liquid remains in the piping.
In principle, first close the receiver outlet side stop valve, then withdraw refrigerant until frost on the liquid piping melts.

2) When closing all stop valves on the piping, one of the valve must be opened to release pressure in the pipe to the appropriate pressure vessel in the system.

3) Any portion of the refrigerant piping located between valves which poses a potential for liquid sealing, should be provided with a relief valve to the appropriate pressure vessel in the system.

#### (2) Extended Shutdown

1) Close the receiver outlet stop valve (6)
(The solenoid valve and manual valve on the refrigerant liquid piping connected to the evaporator should be open.)

2) Start the compressor and operate for some time to recover refrigerant in the piping into the receiver. Continue this operation until the frost which appears on the refrigerant liquid pipe (the piping from the receiver outlet stop valve [6] to the evaporator [5] begins to melt.).

3) Confirm that the suction pressure gradually declines. Maintain the suction pressure above 0 kg/cm².

4) When the suction pressure reaches 0.1~0.5 kg/cm²G, stop the electric motor, close the compressor suction stop valve (10) and the discharge stop valve (11), then close the condenser inlet stop valve (12) to store the recovered refrigerant in the receiver and condenser.

5) Stop the flow of cooling water (or the cooling fan). At this time, open the drain valve on the cooling water system to fully drain all water from the system as a precaution against freezing of the pipes, valves and condenser tubes in the event of below zero temperatures.

6) Turn off the main power switch.

**Caution:**
During refrigerant recovery operations, always pay attention to the receiver as it has limited capacity. Recover refrigerant into the receiver while carefully monitoring the receiver level gauge. Do not recover refrigerant exceeding three-quarters (3/4) of the capacity of the receiver. Collect any remaining refrigerant in a spare gas cylinder

### 3.5 Design Parameters

**Table 6 Design Parameters**

| No. | Item | | Single-stage | |
|---|---|---|---|---|
| 1 | Refrigerant | | R-22 | R-502 |
| 2 | Evaporative Temperature (°C) | Max.<br>Min. | 10<br>–30 | 14<br>–30 |
| 3 | Condensing Temperature (°C) | Max. | 55 | 60 |
| 4 | Discharge gas temperature (°C) | | Under 135 | |
| 5 | Oil temperature (°C)** | | Under 70 | |
| 6 | Degree of superheat (°C)*** | | Less than 15 | Less than 30 |
| 7 | Revolution speed (RPM) | Max.<br>Min. | 1800<br>900 | |
| 8 | Oil pressure (Low pressure + ~) $kg/cm^2$ | | 2 ~ 3 | |

Note:

* No.4 Single-stage machine compression ratio = $\frac{\text{Condensing pressure (Abs. pressure)}}{\text{Evaporative pressure (Abs. pressure)}}$

** No.6 Oil temperature (°C)
Minimum oil temperature is set to 30°C by adjusting oil heater thermo-switch.

*** No.7 Degree of superheat (°C)
Discharge temperature rises as the degree of suction gas superheat rises.
Since oil temperature also rises, a critical value must be carefully maintained.

## 4. Inspection and Maintenance

It is commonly recognized that the majority of problems and accidents encountered in operating refrigeration systems are caused by insufficient monitoring of performance or insufficient maintenance.
Daily checks, monitoring and maintenance are vital to assuring maximum performance, long service life and prevention of accidents.

### 4.1 Daily Checks

The following should be checked every two to three hours and values and subjective observations recorded in the system logbook.

a) Suction pressure
b) Discharge pressure
c) Oil pressure
d) Suction temperature
e) Discharge temperature
f) Liquid level in receiver and oil level in crankcase
g) Abnormal sound and vibration
h) Others
- Electric motor power consumption
- Cooling water supply to condenser
- Presence of moisture in the system
- Ambient temperature in the machine room

The following should also be recorded:

1) Date and quantity of oil charged into the compressor
2) Date and quantity of refrigerant charged into the compressor
3) Date of filter cleaning
4) All measures carried out during inspection and maintenance of the system
5) Running total of system operating hours

### 4.2 Monthly Inspection

a) Check V-belt tension
V-belt tension is correct when pressed at the midway point, the belt can be flexed a distance equal to the thickness of the belt.

b) Check the security of the flywheel (or coupling) and the running strain.

c) Check the performance of all protection devices such as the pressure gauges and pressure sensors.
Regarding pressure sensors, activation pressure should be tested.

d) Confirm that oil leakage from the shaft seal portion is within allowable limits.

e) Check for gas and oil leaks from flareless joints, flared joints and packed joints both visually and using a Haloid torch.

f) Inspect and clean the cooling water system. Depending upon the water quality, deposits may accumulate in the cooling water tank and piping. If there is considerable contamination the condenser cooling pipes may also have to be cleaned.

### 4.3 Periodic Inspection

In principle, periodic inspection should be carried out every twelve months or 6,000 hours of operation, whichever is comes first.

#### a. First Periodic Inspection (Overhaul)

The first periodic inspection should be carried out twelve months or 6,000 hours after the system is commissioned. Remove the shaft seal cover, head cover, handhole cover and disassemble the pistons and connecting rods. In this inspection it is not necessary to remove the shaft and bearing head.

(1) Replace the plate valves and plate valve springs.
(2) Replace the connecting rod bearing metals.
(3) Replace the mechanical seal assembly.
(4) Replace the piston rings and oil rings.
(5) Replace the gaskets and O-rings.
(6) Inspect the connecting rods for abnormal wear or damage and replace if necessary.
(7) Inspect the piston pins and replace if they are not within service limits.
(8) Inspect the cylinder sleeves and pistons for abnormal wear or damage and replace if necessary.
(9) Inspect the connecting rods for abnormal wear or damage and replace if necessary.
(10) Inspect the crankshaft pin for abnormal wear or damage and replace if necessary.
(11) Inspect and clean the filter.
(ref. [3.4.3 Precautions during Operation])
(12) Clean the interior of the crankcase.
(13) Replace the lubricating oil.
(ref. [3.4.3 Precaution during Operation])
(14) Inspect the V-belts for abrasion or abnormal wear and replace if necessary.
(15) Others
- Grease the fittings of the electric motor (preferably every 1,000 hours).
- Replace the built-in safety valve if it has been actuated.

#### b. Second and Every Two Years Periodic Maintenance (Overhaul)

The second periodic inspection (and every two years thereafter or 12,000 hours) should be carried out two years or 12,000 hours after the system is commissioned. In addition to those items covered in the first periodic inspection, the following should be carried out. Unlike in the first periodic inspection, the shaft and main bearing head must be removed and inspected.

(1) Inspect the main bearing and thrust bearing for abnormal wear or damage and replace if necessary.
(2) Inspect the thrust pad and replace if it does not meet standards.
(3) Inspect the crankshaft for abnormal wear or damage and replace if it does not meet standards.
(4) Inspect all other portions of the system and repair or replace if necessary.

#### c. Inspection of Filter

(1) Refer to [a) Inspection and Cleaning of Filter and Replacement of Oil] in (3.4.3 Precautions during Operation).
(2) Cleaning of the dryer-filter and the water piping system filter is required.

#### d. Pressure Gauges (or Pressure Sensors)

Calibrate all pressure gauges every six months using a standard pressure gauge. Replace any gauge showing an error exceeding the minimum unit of graduation.

**Cautions:**

(1) The time mentioned in paragraphs "a" and "b" above may vary according to the model, refrigerant, RPM, pressure conditions, service conditions, system situation and kind of oil used. MYCOM does not guarantee the replacement to any parts free of charge.

(2) Normally, all expendable parts of MYCOM Model K Series compressors are replaced during periodic inspection (overhaul).

## 5. Lubricating Oil

### 5.1 Function and Characteristics of Lubricating Oil

Lubricating oil must be capable of lubricating all moving parts and contributing to smooth operation of the compressor for a long period of time by preventing abrasion or seizure. In order to assure this, the lubricating oil used should have the following characteristics:

1) Proper viscosity which can be maintained at the specified operating temperature.

2) Adequate fluidity at low temperature (working temperature range of freezing system).

3) Chemical stability, no corrosion effect on metal parts or affect on rubber parts used in the system.

4) Should not experience wax decomposition or degradation at low temperature.

5) Should not generate sludge or carbon under high temperature conditions.

6) Should be free of moisture.

7) Should provide sufficient lubrication efficiency.

### 5.2 Selection of Lubricating Oil

a) The lubricating oil should be of the proper viscosity and fluidity to feed automatically into the respective moving components of the compressor.

b) Taking oil circulation throughout the refrigeration system into consideration, a lower viscosity is desirable in the evaporator but a higher viscosity is desirable in the compressor crankcase. The oil selected should satisfy as much as possible these different requirement.

c) In the case of Halocarbon refrigeration systems, the viscosity of the lubricating oil drops when refrigerant is entrained in the oil, regardless of the original viscosity of the oil before operation. Lubricating oil classified as or corresponding to ISO-VG32 exhibits a lower viscosity, resulting in comparatively earlier abrasion of moving parts. It is recommended that users select an oil classified as or corresponding to ISO-VG46 or one with higher viscosity.

### 5.3 Changing Lubricating Oil Brand

When the oil normally used is to be replaced by oil of another brand, unexpected problems may be encountered due to the incompatibility of the old and the new oil when they are mixed together. Special care should be taken when changing oil brands.

a) When the oils are manufactured by different firms, consult with each company to confirm that no harm will result. The same goes even if the two different oils are manufactured by the same firm.

b) Changing the viscosity grade of the oil is acceptable if the new oil is manufactured by the same firm as the old oil.

Example: SUNISO4GS → SUNISO5GS

### 5.4 Lubricating Oil Supply

The oil level will gradually decline under continuous operation of the compressor. Supply oil according to the following procedures when the oil level is within the yellow circle of the oil sight glass.

a) Close the compressor suction stop valve gradually to evacuate suction pressure to approx. 120 cmHg.

b) Supply oil gradually from the compressor lubricant charging/drain valve using an oil charging hose.

c) After supplying the necessary quantity of oil, close the charging/drain valve securely.

d) Open the suction stop valve gradually and return to normal operation.

**Cautions:**

- When supplying oil, special care should be taken to prevent air and water from entering the crankcase.
- The lubricating oil supplied to the compressor should be fresh and free of any contamination by foreign matter.
- Supply oil gradually, taking care to prevent oil foaming in the crankcase.
- Unused lubricating oil should be stored in an airtight container to prevent moisture contamination.

### 5.5 Brand of Lubricating Oil

Recommended brand: ISO-VG46 or equivalent
Note: ISO viscosity grade: ISO-VG46cst (40°C)

| Maker | Brand | | Remarks |
|---|---|---|---|
| Idemitsu Kosan | Daphne | CR46A | Often utilized |
| Nippon Sun Sekiyu | SUNISO | 4GS | |
| Nippon Sekiyu | ATMOS | 46 | |
| Shell Sekiyu | CLABUS | 46 | |
| Mitsubishi Sekiyu | DIAMOND FREEZE | 46 | |
| Kosmo Sekiyu | SUPPER FREEZE | 56 | |
| Kyodo Sekiyu | FREOL | U46 | |
| Esso Standard | ZERICE | R46 | |
| Showa Sekiyu | CRABUS | 46 | |
| Mobile Oil | GAGOIL ARCHTIC | 300ID | |

**Table 7 Lubricating Oil**

# 6 Disassembly, Inspection and Reassembly

## 6.1 Disassembly

There are only two reasons for disassembling the compressor; one is for periodic inspection and the other is for repair. Before starting disassembly work, the refrigerant gas in the compressor must be evacuated to another system component or purged according to the following procedures.

### 6.1.1 Refrigerant Purging

**(1) when Compressor is Operative**

a) Close the compressor suction valve and the oil return valve on the oil separator.

b) Prepare the discharge valve so that it can be closed immediately when necessary.

c) If provided, release the low pressure cut-off switch so that it does not activate when pressure is reduced. In the case of an automatically controlled system, other devices such as the temperature controller must be short circuited or the compressor cannot be operated. Check the status of all control devices carefully and switch over to manual operation.

d) Run the compressor until the suction pressure drops to 0 $kg/cm^2$ G, then stop operation.

e) Allow the compressor to sit for some time so that any refrigerant mixed in the lubricating oil evaporates. During this time the suction pressure will rise gradually. Operate the compressor again to bring suction pressure back to 0 $kg/cm^2G$.

f) Repeat the above operation cycle several times until suction pressure does not rise higher than 0.2 $kg/cm^2$ after the machine is shut down, then close the discharge stop valve and open the gas release valve gradually to equalize the internal pressure of the compressor with atmospheric pressure.
Confirm that the compressor internal pressure is not lower than atmospheric pressure, otherwise air and moisture will enter the system.
Further discharging of Freon gas into the atmosphere is harmful to the ozone layer and should be strictly avoided.

g) Turn off the main power source to isolate the system.

**(2) When Compressor is Inoperative**

a) Close all valves such as the suction stop valve, discharge stop valve and oil return valve of the oil separator to isolate the compressor.

b) Gradually open the gas release valve or suction stop valve and compressor side blind plug of the discharge stop valve to release the refrigerant gas contained in the compressor into the atmosphere.
If another compressor is available, operate to recover as much refrigerant as possible from the compressor being purged.

### 6.1.2 Cautions During Disassembly

a) Use only standard hand tools.

b) When removing parts from the compressor, take all possible care to protect them from damage.

c) Place all disassembled parts on a clean workbench in good order.

d) Clean all parts in alcohol, gasoline or kerosene.

e) When cleaning parts use compressed air, a sponge or a clean white cloth. Always apply a coating of fresh lubricating oil after cleaning a part.

f) When disassembling the cylinders, always group the parts carefully according to the respective cylinder. Particularly care should be taken regarding connecting rod components as the rod and cap combinations are unique and the parts are not interchangeable.

g) Confirm that all Allen bolts are tightened to the specified torque. At their respective portion.

h) Always coat the gaskets and all parts with fresh lubricant before reassembly.

## 6.2 Disassembly

### 6.2.1 Draining Lubricating Oil

After recovering and purging all refrigerant gas from the compressor, the lubricating oil must be drained from the crankcase.
Connect an oil charging hose to the oil feeding valve located on the right side of the compressor below the oil pump and draining the lubricating oil into a container (Fig. 27).

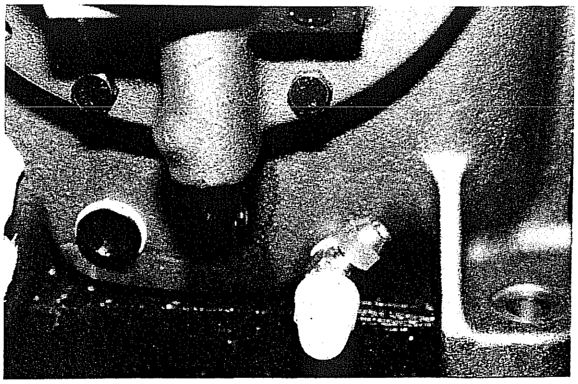


**Fig. 27 Oil Feeding Valve**

### 6.2.2 Motor Attachment Disassembly

Remove the V-belt or coupling and pull the flywheel or coupling hub off the driveshaft using a puller.
The shaft end is tapered to ease removal so care should be taken once the flywheel or coupling is loosened lest if fall down and cause damage.

### 6.2.3 Head Cover Disassembly (Head cover weight: 7.8 kg/piece)

a) Remove the top head covers before removing the bottom ones in order to prevent dislodged foreign matter and dirt from contaminating the lower cylinder valves (Fig. 28~29).

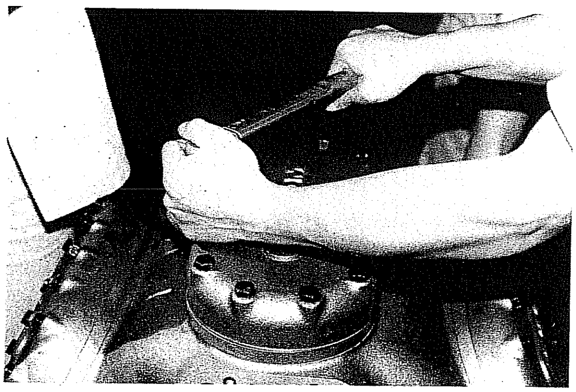


**Fig. 28 Removing Head Cover**

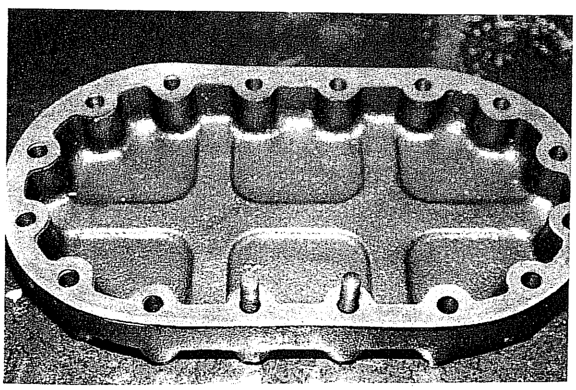


**Fig. 29 Head Cover**

b) When removing a head cover, remove all bolts except for one at the top. Finally, holding the head cover securely by hand, unfasten the final bolt and lift the cover free (Fig. 28~30).

c) If the head cover gasket sticks, lightly tap the side of the cover with a hammer to free the gasket. Do not attempt to pry the cover off with a sharp instrument.

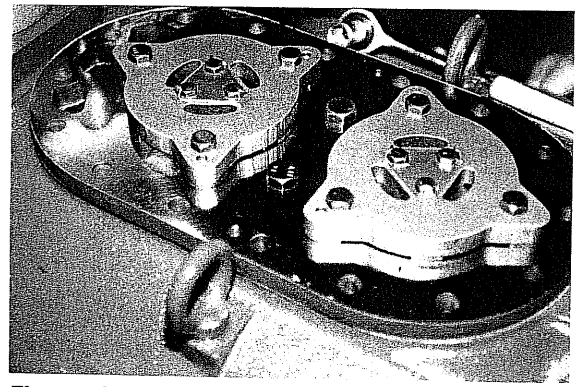


**Fig. 30 Head Cover Removed**

d) The head cover bolts also secure the valve plate under the cover. The valve plate is, however, well fixed to the crank case by a positioning pin and two bolts and will not come free when the head cover is lifted off.

e) Unlike with A, B, C, J, WA, WB and SF series compressors, no head springs are used.

### 6.2.4 Valve Plate and Discharge Valve Assembly Removal

#### A. Discharge Valve Assembly (Weight: 1.0 kg/set)

a) The discharge valve is incorporated in the discharge cage assembly and affixed to the valve plate by two positioning pins and three bolts (Fig. 31).

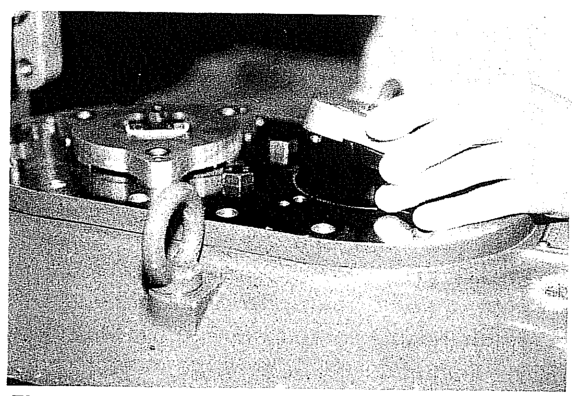


**Fig. 31 Removing Discharge Valve Cage**

b) Remove the cage retainer bolts and lift off the cage. The pins fit tightly so the cage should be raised vertically taking care not to bend the pins (Fig. 32).

c) After removing the cage, the upper face of the valve plate is exposed. Take care to prevent damage (Fig. 33).

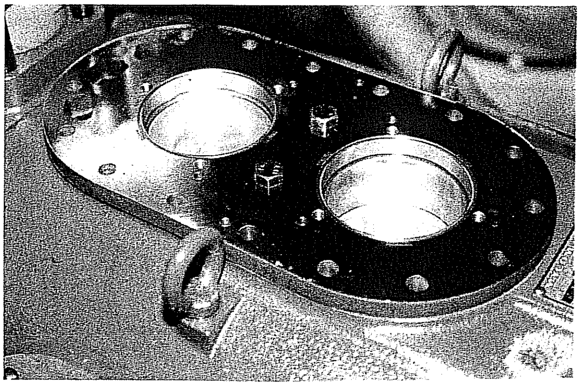


**Fig. 32 Valve Plate**

d) The discharge valve cage and seat are secured together by three bolts. Straighten the bolt locking washers and remove the bolts.
The seat is affixed with one positioning pin.
When the seat is removed, the discharge valve can be detached.
The discharge valve spring should be fitted into the spring hole in the cage to prevent loss (Fig. 34).

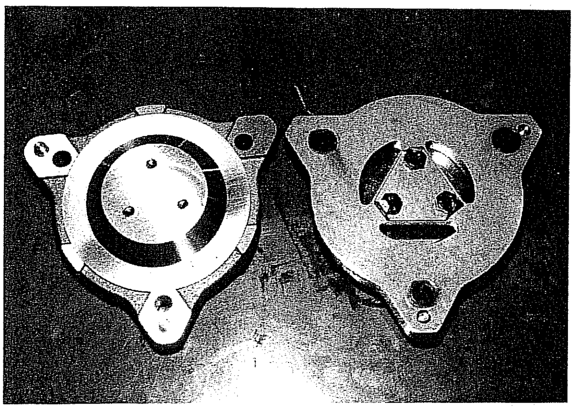


**Fig. 33 Discharge Valve Cage**

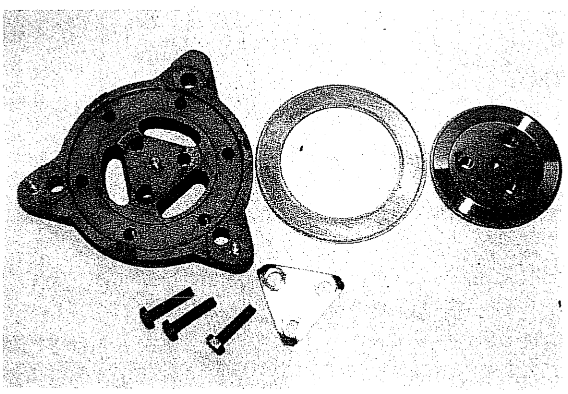


**Fig. 34 Discharge Valve Cage Disassembled**

**B. Valve Plate Disassembly (Weight: 3.5 kg/piece)**

a) Apart from the head cover retainer bolts, which have already been removed, the valve plate is secured to the crankcase by two bolts at the center. Remove these bolts.

b) Lift off the valve plate vertical to the head face. To facilitate removal, screw in slightly one of the bolts already removed for use as a handle (Fig. 35).

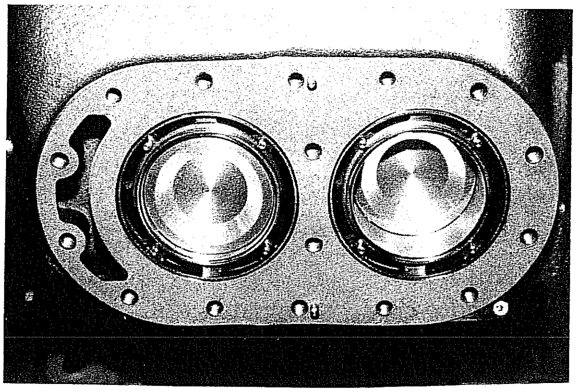


**Fig. 35 View after Valve Plate Removed**

### 6.2.5 Hand Hole Cover Disassembly (Weight: 7.8 kg/piece)

a) Remove all bolts securing the hand hole cover except for one bolt at the top. Loosen the remaining bolt slightly and free the cover from the crankcase if the gasket is stuck (Fig. 36).

b) Remove the final bolt while supporting the hand hole cover by hand.

c) The oil sight glass mounted on the hand hole cover is held by a gasket from the inside. Disassembly of the sight glass is not required (Fig. 37).

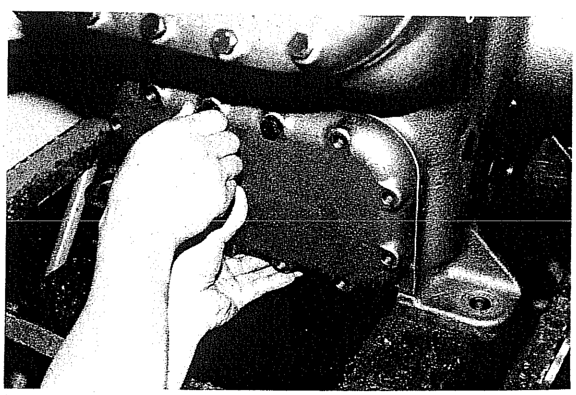


**Fig. 36 Removing Hand Hole Cover**

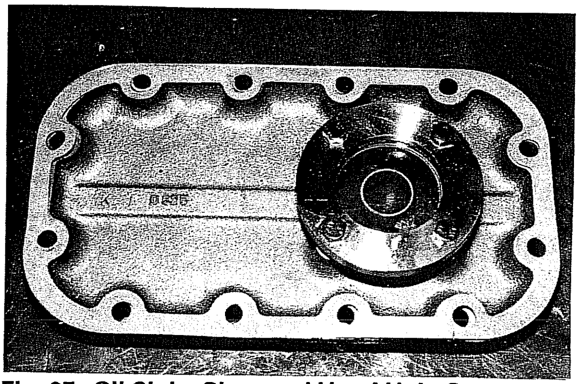


Fig. 37 Oil Sight Glass and Hand Hole Cover

### 6.2.6 Cylinder Assembly Disassembly (Cylinder Sleeve, Piston, Connecting Rod and Related Parts) (Weight: 3.4 kg/set)

**A. Drawing Out Cylinder**

a) As the width of the connecting rod big end is greater than the diameter of the cylinder, the cylinder must be removed from the crankcase together with the piston and rod assembly.

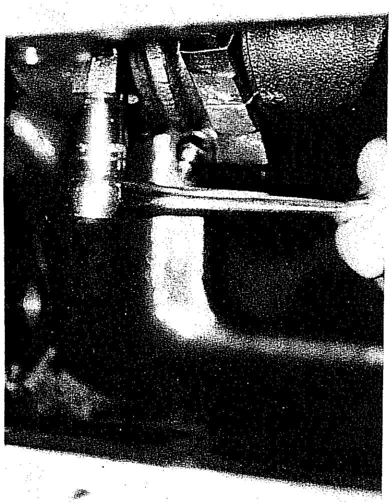


Fig. 38 Loosening Connecting Rod Retainer Bolt

b) Remove the cylinder from the assembly. First turn the crankshaft so that the piston is positioned at the bottom dead center point.

c) Remove the No.1 and No.2 nuts securing the rod big end. Be careful not to drop the washers into the crankcase when performing this work (Fig. 38).

d) Remove the rod cap. Turn the crankshaft slowly so that the next piston is positioned at the bottom dead center point. The cylinder which has been freed from the crankshaft will rise. While holding the rod with one hand inserted through the hand hole to prevent the rod from striking the crankcase, grasp the flanged portion of the cylinder and lift out (Fig. 39~40).

e) Free and draw out each cylinder in a like manner and arrange each assembly together in a manner which will allow proper installation in the correct order during reassembly. All rod caps, bolts and nuts should be grouped with their respective cylinder assemblies.

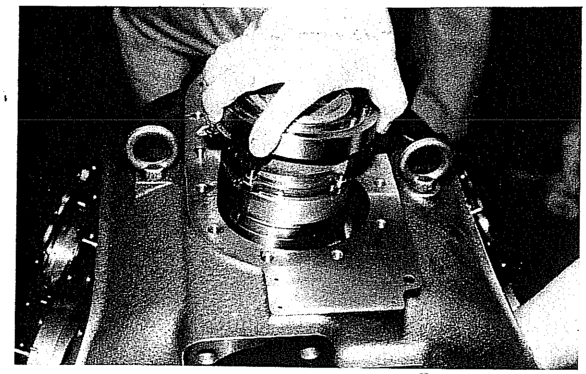


Fig. 39 Removing Cylinder Assembly

**B. Piston and Connecting Rod Removal**

a) After removing the bolts from the big end, place the cylinder assembly on a wood or plastic plate with the cylinder seat (flanged end) facing down.

b) Holding the cylinder with one hand, draw out the piston and connecting rod by the big end.

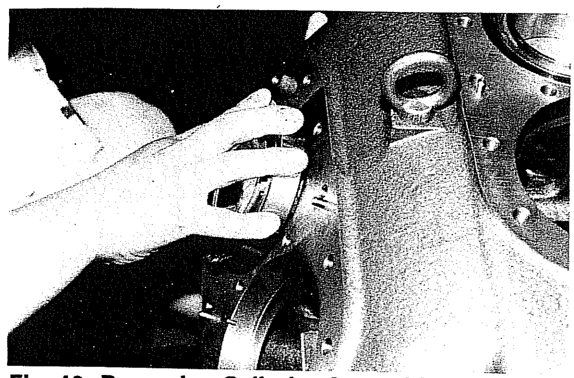


Fig. 40 Removing Cylinder Assembly

**C. Cylinder Sleeve Disassembly (Weight: 3/4 kg/set)**

a) It is usually unnecessary to disassemble the cylinder sleeve unless the sleeve itself must be replaced.
If the retaining ring fitted in the lower groove on the sleeve is removed, the cam ring will drop.

b) Two types of cam ring are used, i.e., one with a leftward facing upward slant and one with a rightward facing upward slant.
Careful attention should be paid to fitting each cam ring in the proper position.

c) Remove the spring lock E ring from the lift pin and remove the lift pin from the cylinder. Be careful not to lose the spring (Fig. 41~42).

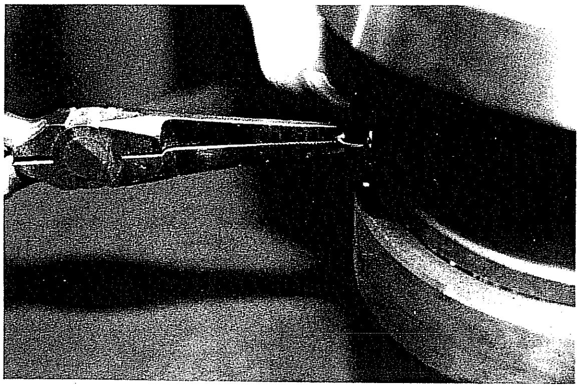


**Fig. 41 Removing "E" Ring for Lift Pin**

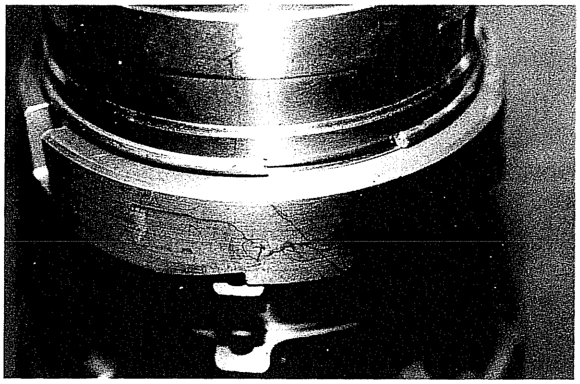


**Fig. 42 Retaining Ring**

## D. Piston and Connecting Rod Disassembly

a) Position the piston with the crown facing down and the rod end facing up. Remove the piston snap ring using pair of snap ring pliers.

b) Holding the piston and connecting rod securely, push the piston pin out with your fingers to separate the piston and connecting rod.

c) It is usually unnecessary to remove the connecting rod large end bearing metal unless it must be replaced. Regarding the small end, the rod body material itself acts as the bearing so, unlike on other models, no bushing is fitted (Fig. 43~44).

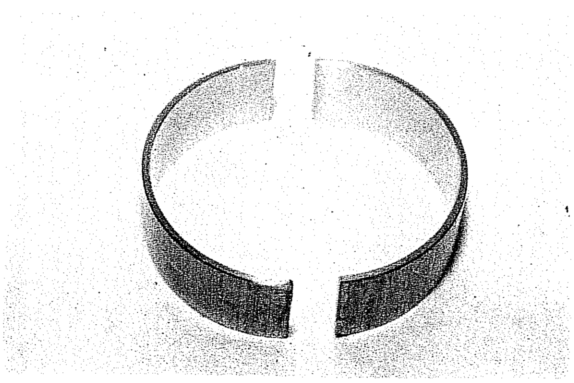


**Fig. 43 Bearing Halves for Connecting Rod Big End**

d) Each set of connecting rods and caps is engraved with mating marks. Be sure to keep the rod and cap pairs together.

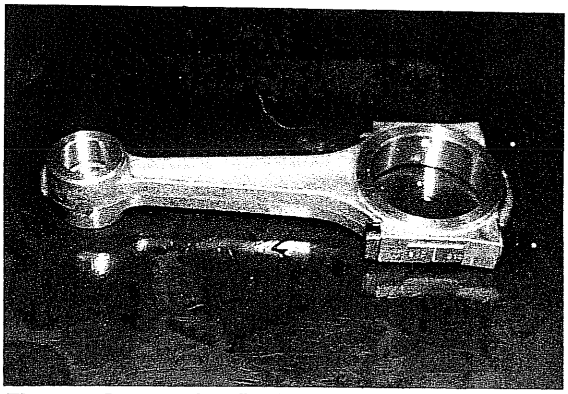


**Fig. 44 Connecting Rod**

## E. Piston Ring Removal

a) Do not remove the piston rings unless replacement is necessary (Fig. 45).

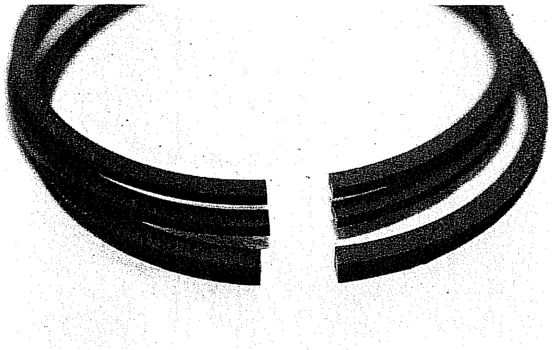


**Fig. 45 Piston Rings and Oil Ring**

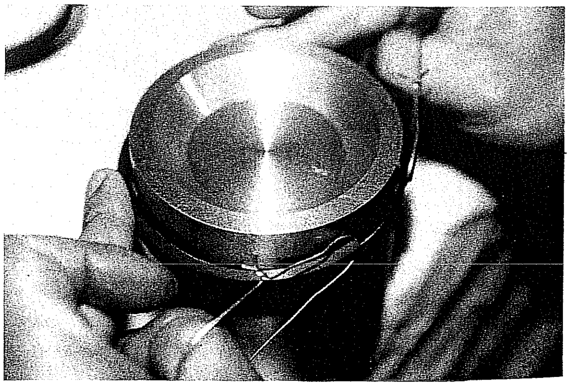


**Fig. 46 Removing Piston Ring**

b) Utilize hooks or a pair of piston ring pliers to expand the ring end gap and allow removal of the ring. Always expand the ring end gap in the same plane and the ring. A thick copper loop can also be used for expanding the ring (ref. Fig. 46).

c) Torsional expansion of the ring will deform the ring and result in oil leakage later.

### 6.2.7 Unloader Mechanism Disassembly

a) It is usually unnecessary to disassemble the unloader mechanism unless a component part has failed.

b) Remove the coil portion of the unloader solenoid valve (remove the nut which secures the coil) and remove the unloader cover bolt (Fig. 47).
Since the cover will move outward due to pressure from the unloader spring, be sure to keep a grip on the cover.

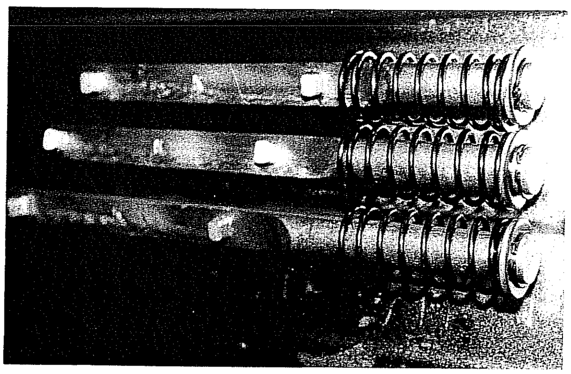


**Fig. 47 Unloader Push Rod**

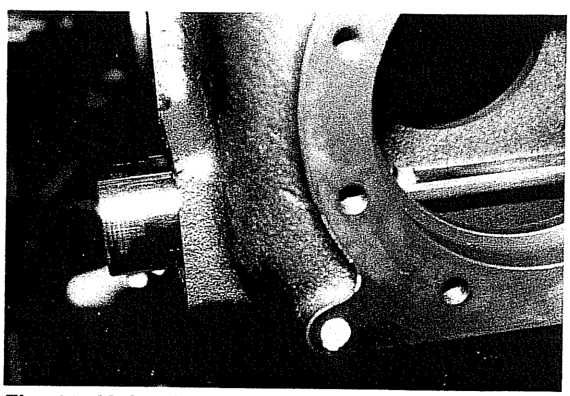


**Fig. 48 Unloader Piston**

c) Remove the cover. The unloader piston, push rod and spring can now be easily removed (Fig. 48~50). The length of the push rod will differ according to the position of the related cylinder.
The mounting position of the cylinder and cover should be recorded (Fig. 51).

d) Leave the retaining ring and washer for the push rod as they are.

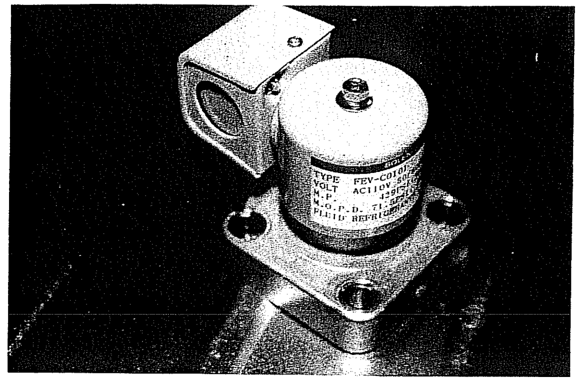


**Fig. 49 Unloader Solenoid Valve**

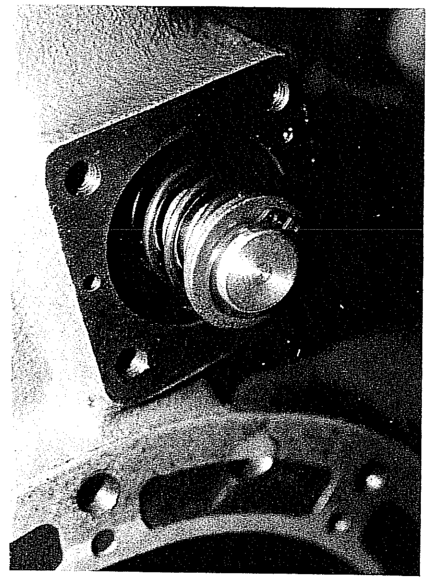


**Fig. 50 Unloader Push rod**

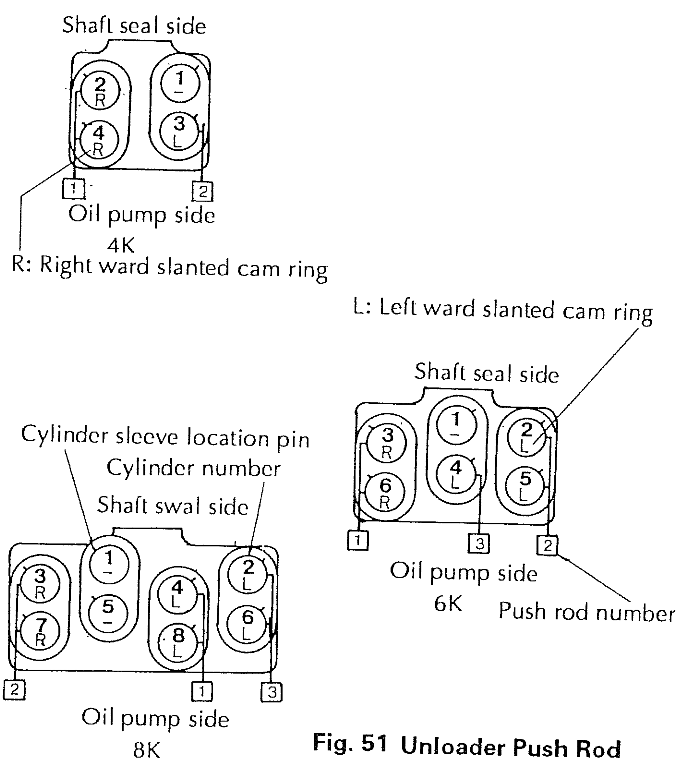



**Fig. 51 Unloader Push Rod and Cam Ring**

### 6.2.8 Shaft Seal Cover Removal

a) Position an oil pan under the shaft seal cover to catch any oil remaining in the seal.

b) Loosen all seal cover retainer bolts.
If the gasket is not stuck, a gap will open between the cover and the case due to the pressure of the seal spring. Remove all except two bolts on opposite sides (Fig. 52). Loosen the two bolts alternately and remove while holding the cover.

c) Remove the cover perpendicular to the crankshaft.

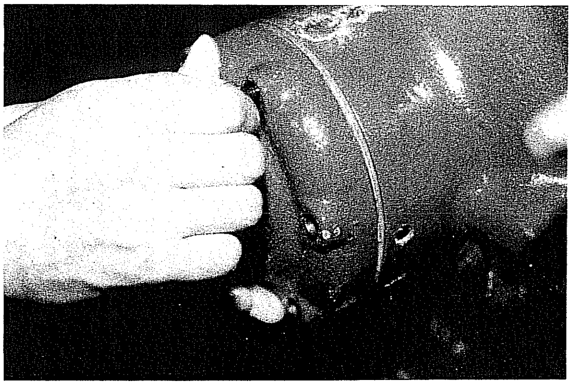


**Fig. 52 Shaft Seal Cover**

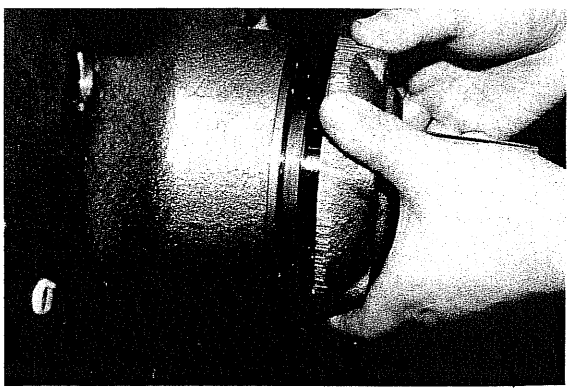


**Fig. 53 Removing Shaft Seal Cover**

d) If the gasket has adhered to the cover, loose the bolts and rotate the cover right and left to free the gasket (Fig. 53).

e) The seal carbon is secured in the seal cover by an O-ring. Remove the seal carbon by pushing from the outside of the cover (Fig. 54).
Since the seal carbon is easily damaged, handle with care (Fig. 55).

### 6.2.9 Mechanical Shaft Seal Disassembly

a) Remove the shaft seal cover to reveal the mechanical seal assembly.
The mechanical shaft seal assembly is connected to the shaft by a shaft seal collar position by a knock pin. It consists of the seal ring, O-ring, O-ring retainer, seal drive pin, O-ring retainer drive bolt and seal spring.

b) Grasp the shaft seal assembly with both hands and draw out. The entire assembly will come free from the shaft.

c) Dismantle the seal assembly, arrange in an orderly fashion and store with care.
The seal ring frictional face should be protected to prevent damage (Fig. 56).

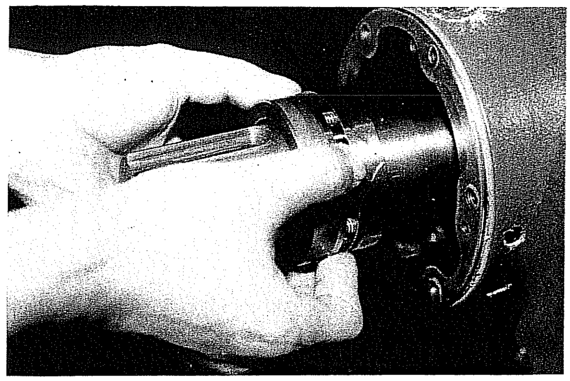


**Fig. 54 Removing Shaft Seal**

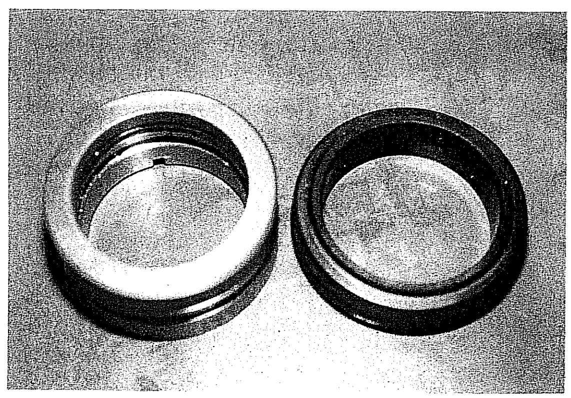


**Fig. 55 Mechanical Shaft Seal**

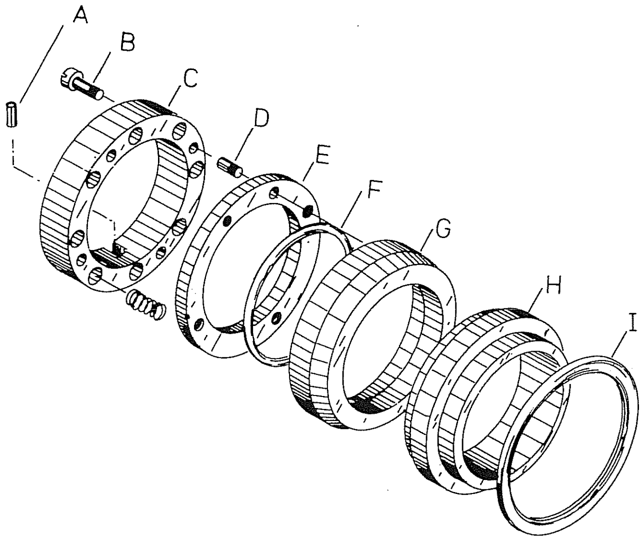



**Fig. 56 Mechanical Shaft Seal Assembly, Exploded View**

### 6.2.10 Main Bearing Head Disassembly

* The clearance of the crankshaft in the thrust direction should be measured before removing the main bearing head. Push the shaft in the crankcase close to the seal side or the pump side and measure the clearance with a thickness gauge inserted between the opposite shaft end face and the metal. Alternately, push the shaft to the pump side and measure the distance moved in the thrust direction using a dial gauge mounted on the end of the crankshaft.

a) Remove all main bearing head retainer bolts.
A blind hole has been taped in the bearing head flange. Screw one of the bolt removed into the blind hole to force off the bearing head.
The gasket should remain adhered to the crankcase side (Fig. 75~58).

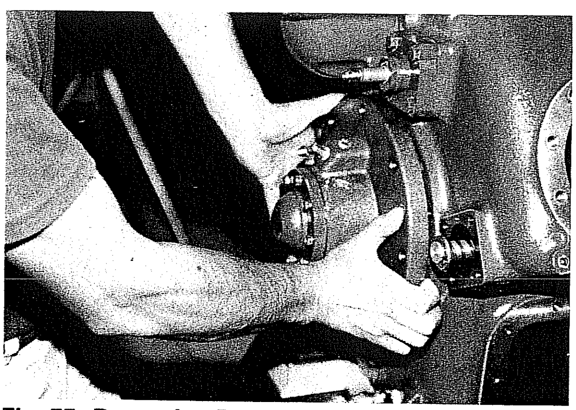


**Fig. 57 Removing Bearing Housing**

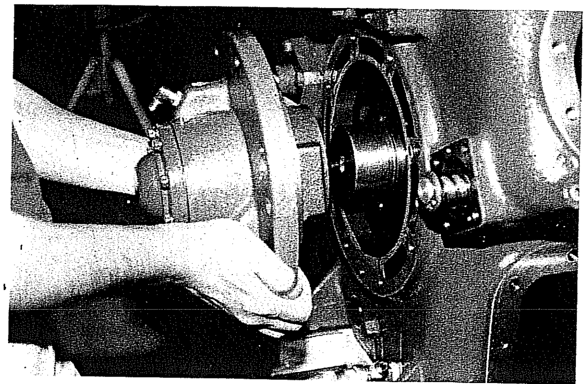


**Fig. 58 Removing Bearing Housing**

b. After pushing the bearing head off somewhat with the blind hole bolt, grasp with both hands and pull off.
The shaft fitting for the bearing in the main bearing head may sometimes come out together with the main bearing head.
Secure the crankshaft by hand through the hand hole or from the seal side to prevent the crankshaft being pulled out together with the main bearing head (Fig. 59).

### 6.2.11 Main Bearing Thrust Metal Disassembly

a) The main bearing is press fitted into the hole on the main bearing head.
In appearance it resembles a thin coiled bushing (Fig. 60).
It is usually unnecessary to remove the bearing unless replacement is required.

b) The thrust bearing is a circular-shaped metal plate with a backing sheet. It is fitted to the thrust face of the main bearing head by a faucet and lock pin (Fig. 61).

c) When replacing the thrust bearing, push out the metal with an "L"-shaped pry bar.

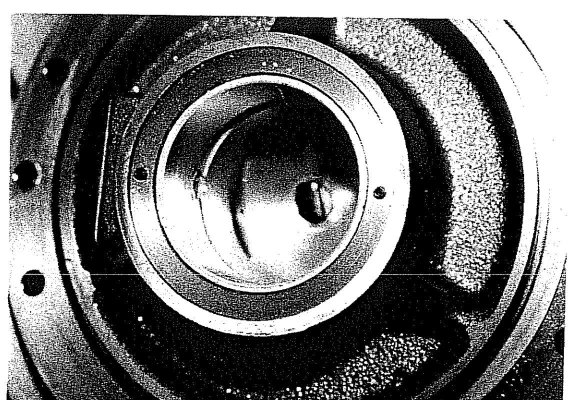


**Fig. 59 Bearing Housing and Thrust Washer**

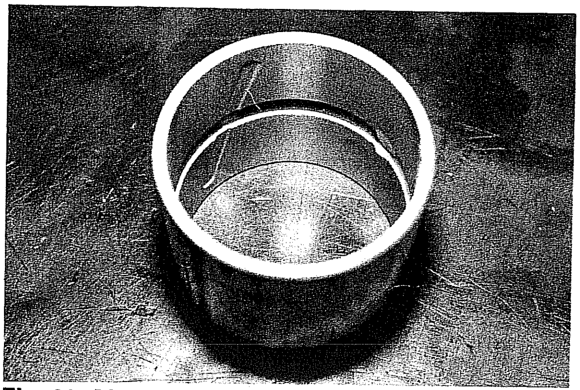


Fig. 60 Main Bushing

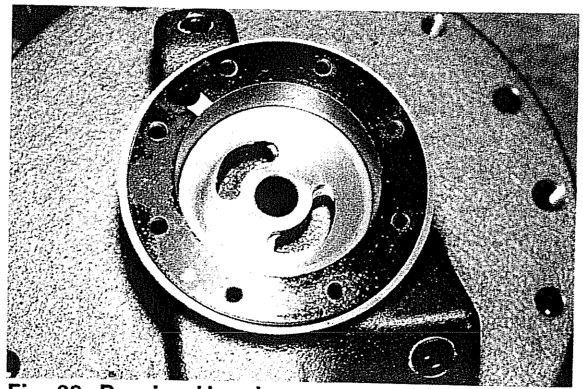


Fig. 62 Bearing Housing

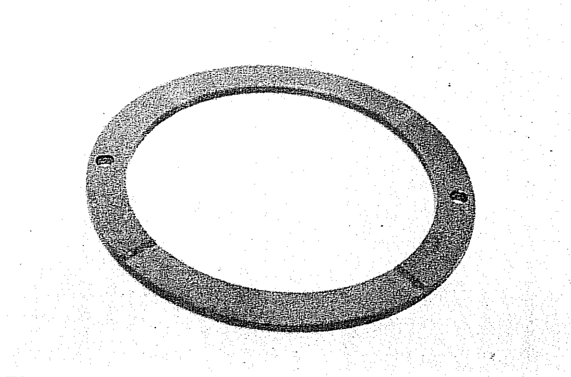


Fig. 61 Thrust Washer

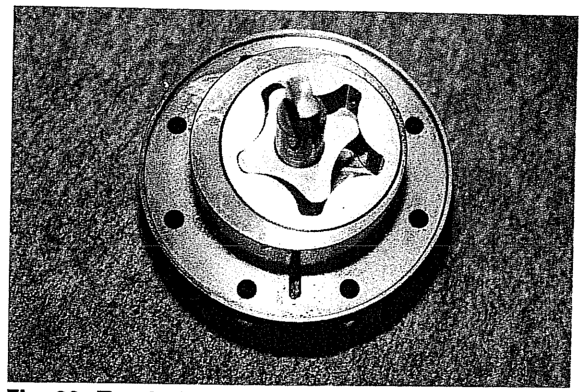


Fig. 63 Trochoid Oil Pump

### 6.2.12 Oil Pump /disassembly

The oil pump assembly is mounted on the main bearing head. Part of the main bearing head serves as a bearing for the pump.
Remove the pump retainer bolts and detach the pump cover, casing, inner gear and outer gear. If the oil pump has experienced a failure, replace as an assembly. In case of journal abrasion, replace the main bearing head assembly. (Fig. 63~64)

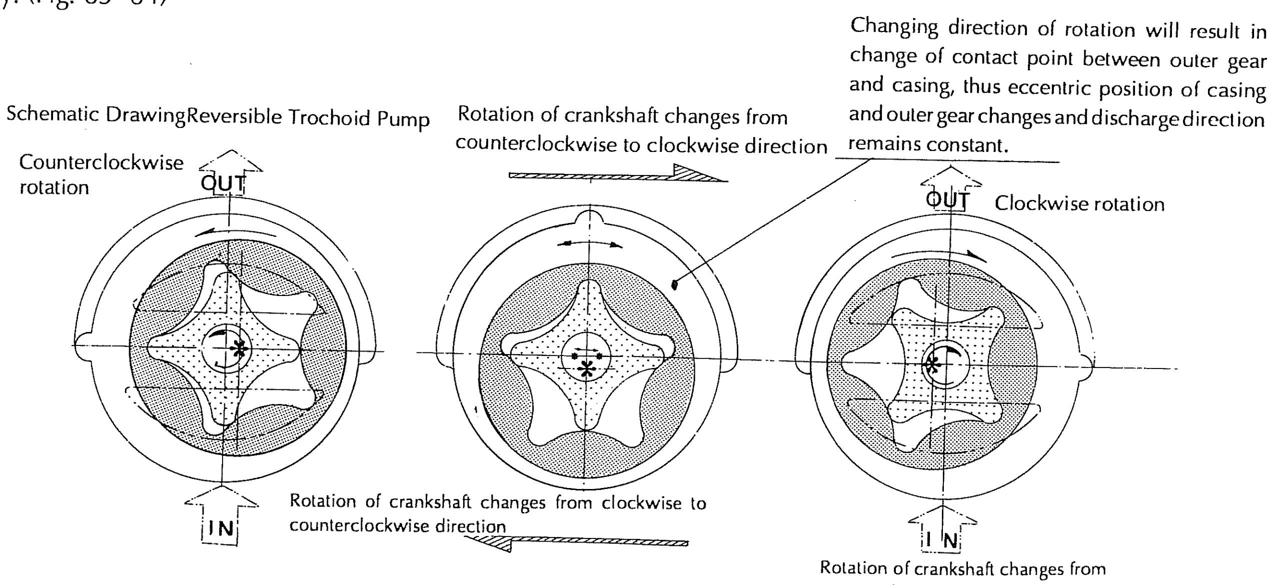



Fig. 64 Reversible Pump Mechanism

### 6.2.13 Crankshaft Disassembly (Weight: 22.4 kg/ piece)

a) After removing the main bearing head, the crankshaft is held in place only by the seal side metal.
With an assistant to support one end of the crankshaft, lift and draw out the shaft until the main bearing side balance weight can be rested on the main bearing flange (Fig. 65).

b) The crankshaft can now be drawn out fully as shown in the photo (Fig. 66)(Fig. 67).

c) After the crankshaft has been removed, support on wood V-blocks to prevent damage to the journals

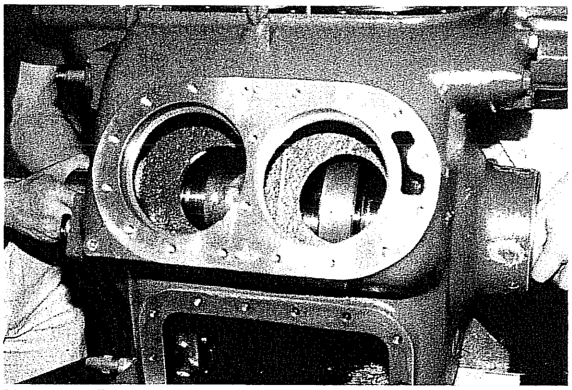


Fig. 65 Removing Crankshaft

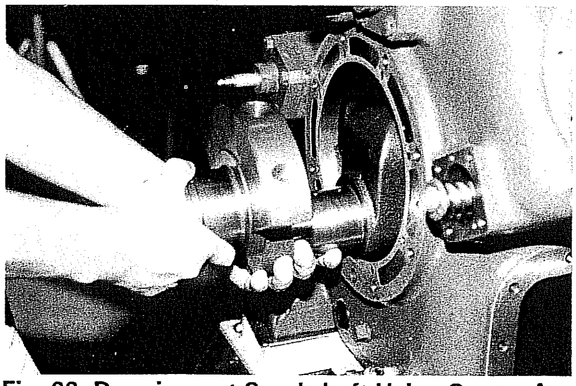


Fig. 66 Drawing out Crankshaft Using Center Arm

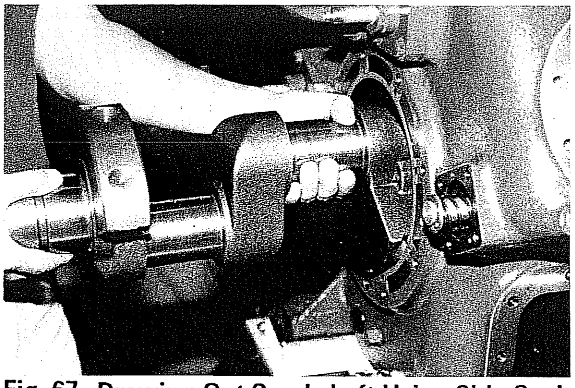


Fig. 67 Drawing Out Crankshaft Using Side Seal Balance Portion

### 6.2.14 Seal Side Bearing Disassembly

a) The seal side bearing of Model K compressors is mounted in the crankcase.
It is usually unnecessary to remove the seal side bearing unless replacement is required (Fig. 68).

b) The thrust bearing, which is identical to the one mounted in the main bearing head, is secured to the crankcase by a lock pin.

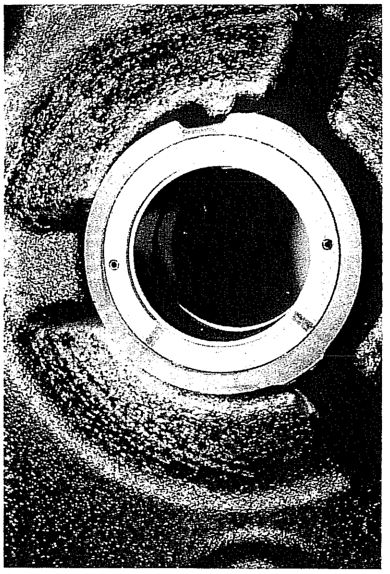


Fig. 68 Shaft seal Side Thrust Washer and Main Bushing

### 6.2.15 Oil Filter Disassembly

The oil filter is mounted on the crankcase by a hexhead nipple. Remove the oil filter together with the nipple. Since the wire mesh of the filter element is rather weak, unnecessary force should not be applied (Fig. 69).

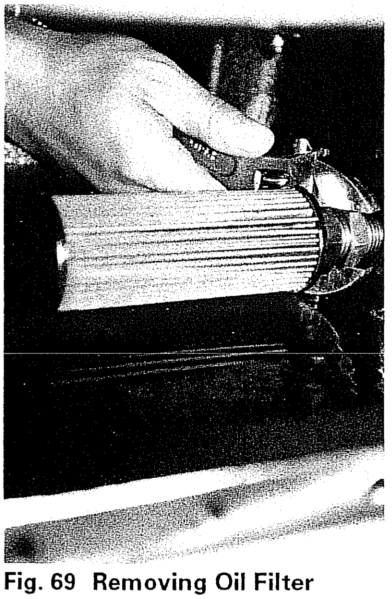


Fig. 69 Removing Oil Filter

### 6.2.16 Suction Gas Filter Disassembly

The suction gas filter is mounted inside the suction elbow. The suction gas filter should always be cleaned during each periodic inspection (Fig. 70).

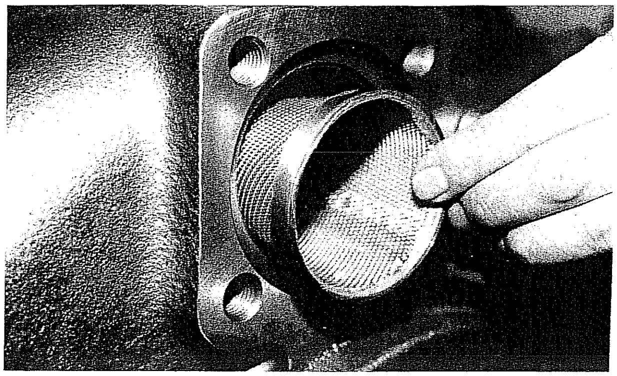


**Fig. 70 Removing Suction Filter**

### 6.2.17 Built-in Safety Valve Disassembly

The plug-like safety valve is screwed into the boundary wall between the high and low pressure sides inside the discharge side elbow.
If the safety valve has once been activated during operation, it should be removed and replaced as activation pressure may drop due to deformation of the Teflon component.
Confirm that the preset activation pressure is accurate (Fig. 71~72).

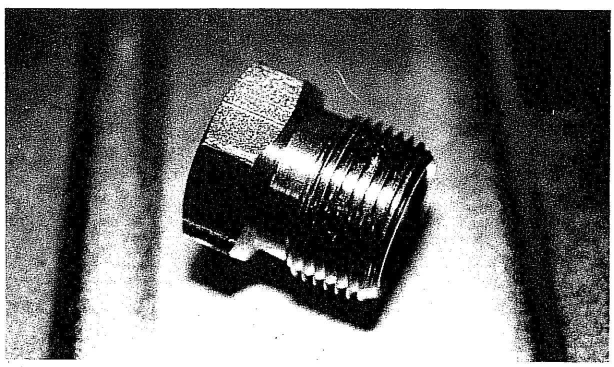


**Fig. 71 Built-in Safety Valve**

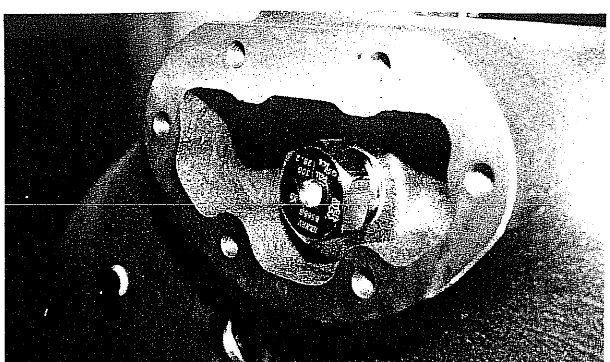


**Fig. 72 Mounting Position of Built-in Safety Valve**

### 6.2.18 Oil Pressure Regulating Valve Disassembly

The oil pressure regulating valve is screwed into the right side of the crankcase facing the crankshaft.
It is usually unnecessary to disassemble the oil pressure regulating valve unless a problem has been encountered in oil pressure adjustment.

### 6.2.19 Pressure Equalizer and Oil Failure Protection Device Disassembly

Holes are provided between the crankcase suction chamber and the crankshaft chamber to equalize pressure. The oil failure protection device is mounted here to prevent oil entering the crankshaft chamber from entering the suction chamber (Fig. 73).
It is usually unnecessary to disassemble the oil failure protection device (Fig. 74).

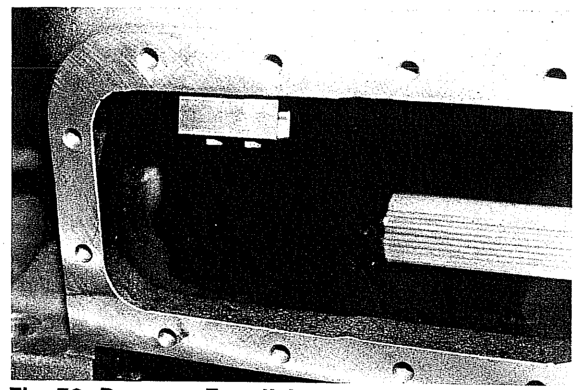


**Fig. 73 Pressure Equalizing**

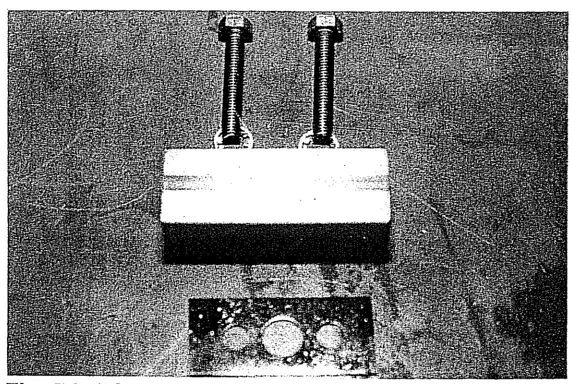


**Fig. 74 Disassembly of Pressure Equalizing Devices**

### 6.3 Reassembly

* All parts disassembled from the compressor should be repaired or replaced according to the inspection and replacement standards.
Reassembly work is essentially carried out in the reverse order of disassembly.
When ordering spare and replacement parts, specify the number of the part in the exploded view (Fig. 3) or parts list, the part name and the model and serial number of the compressor.

#### 6.3.1 Cautions During Reassembly

a) When replacing parts, before reassembly confirm that they are in fact the correct parts.

b) Clean all parts in kerosene, remove any visible rust with fine emery paper and finally coat with lubricating oil before reassembling.

c) Have an oiler available with fresh lubricating oil for application to friction surfaces just before assembly.

d) Dry all parts clean with compressed air, cotton cloth or nonwoven fabric. Other materials such as wool and synthetic fibers do not absorb oil well and may leave fibers on the parts, causing later problems.

e) The gaskets used between mated surfaces should be coated with lubricating oil on both sides before installation. Also scrape clean all mating surfaces of gasket residue before mounting a new gasket.

f) All hand tools used during disassembly should be cleaned before commencing assembly work.

g) When mounting a cover, care should be taken to assure that the gasket is properly positioned. Be particularly careful when mounting gaskets to avoid blocking oil ports.

h) Fasten all bolts lightly then tighten to the specified torque in a criss-cross pattern.

#### 6.3.2 Crankcase Reassembly

a) Supply lubricating oil to all portions of the compressor shaft seal, bearings, etc.

b) When replacing the bearing, be sure to press fit in the correct direction, positioning the oil holes of the bearing metal on the right side of the oil regulating valve. In this case the oil groove should face upward.

c) The bearing should be press fitted using a bolt and washer. Do not strike with a hammer.

d) Mount the oil filter.
Do not push on the filter element. Seat using the screw on the filter.

#### 6.3.3 Crankshaft Reassembly

a) Apply a generous coating of lubricating oil to the crankcase journals.
Support the crankshaft balance weight on the main bearing head flange (ref. Fig.75).

b) Side the crankshaft into the crankcase until the center arm is balanced on the main bearing head flange. When carrying out this work be careful not to damage the bearing with the shaft end.

c) When the balance weight of the crankshaft on the oil pump side passes the flange portion, the crankshaft bearing portion is ready to accept the bearing. The crankshaft end is visible at the shaft seal side. Insert the shaft into the bearing while supporting both ends of the crankshaft. Move the crankshaft parallel to the shaft core.

d) Push the shaft in until it contacts the thrust face. Vertically position the groove for driving the oil pump.

#### 6.3.4 Oil Pump, Main Bushing and Main Bearing Housing Reassembly

a) If the main bushing must be replaced, pry out the metal with an "L"-shaped lever wedged against the pump side wall.
The thrust bearing metal may also come out. Even if the bearing metal remains, use emery paper to polish.

b) When press fitting the new metal, remove the pump and insert a bolt in the pump bearing hole.
The metal should not be tapped in as repeated strong shocks may deform the bearing.

c) Fit the thrust washer to mate with the locking pin.

d) Mount the oil pump.
Mount the oil pump after fitting the gasket with the stamp (flange portion) facing down (oil suction side). Improperly positioning the gasket will affect the performance of the oil pump. The pump shaft must be secured precisely with the crankshaft in the vertical direction.

e) Apply a generous coating of lubricating oil to the journal and fit the gasket. Be careful not to block the oil port by improperly positioning the gasket. Fit the bearing over the crankshaft and then raise the main bearing head slightly and push the crankshaft into the crankcase.

f) The pump shaft fits into crankshaft groove during the final 20 mm of travel. Turn the main bearing head left and right to ensure a tight fit.

g) When the shaft fits into the groove properly the shaft can easily be pushed into the crankcase.
Fasten the bolts lightly and move the crankshaft to confirm a good fit, then tighten the bolts to the specified torque.

h) Move the shaft in the axial direction and measure the thrust gap.

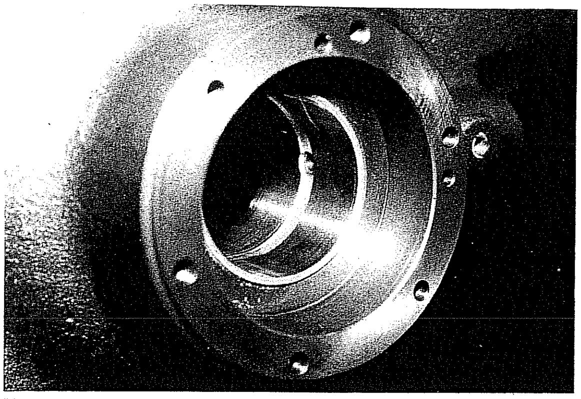


**Fig. 75 Shaft Seal Housing**

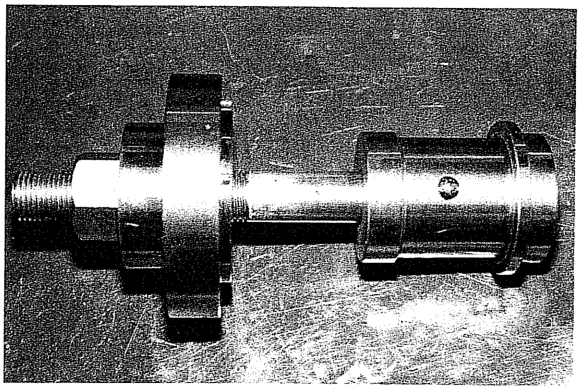


**Fig. 76 Main Bushing Mounting Tool**

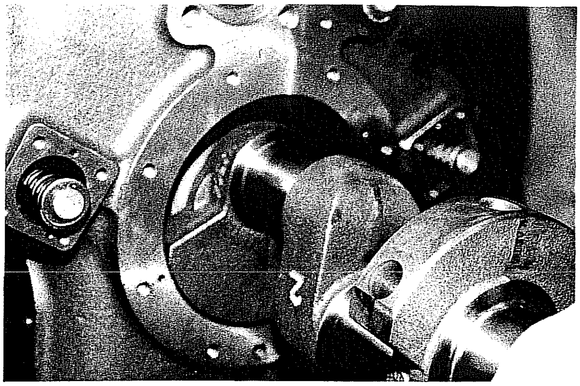


**Fig. 77 Mounting Crankshaft**

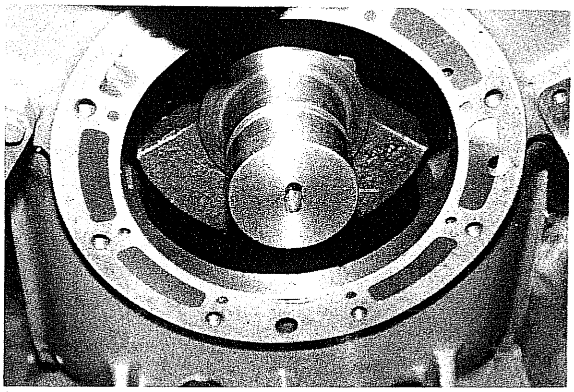


**Fig. 78 Preparations for Mounting Oil Pump**

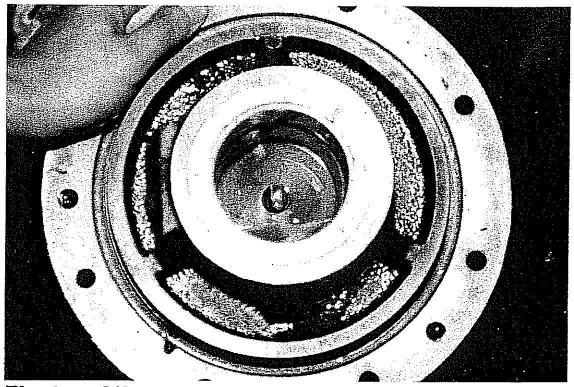


**Fig. 79 Oil Pump Shaft**

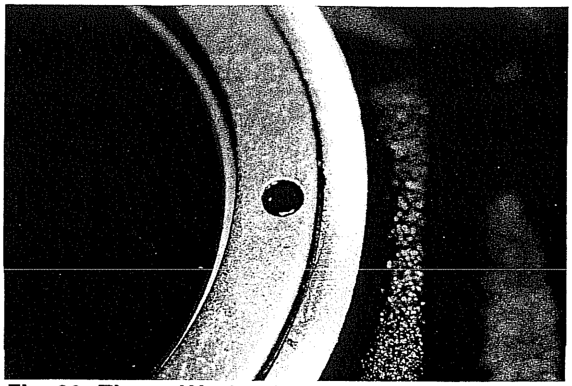


**Fig. 80 Thrust Washer Retainer**

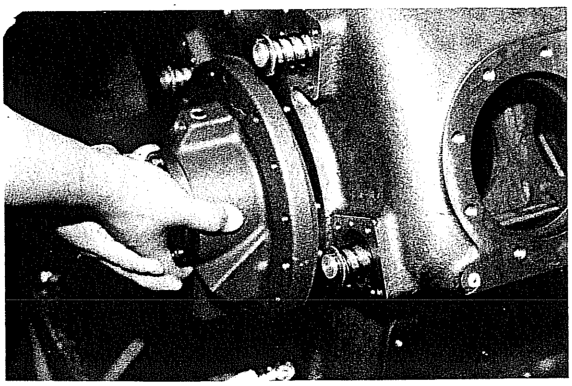


**Fig. 81 Setting Pump Shaft on Crankshaft**

### 6.3.5 Mechanical Shaft Seal Reassembly

a) Lightly fit the oil coated O-ring and press down evenly to seat it. Care must be taken to prevent the friction surface of the ring from being scratched.

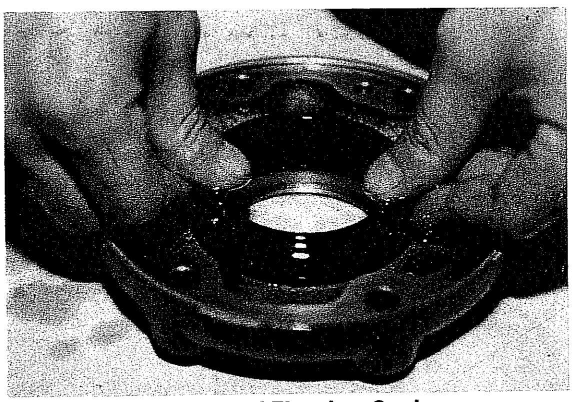


**Fig. 82 Reassembly of Floating Seal**

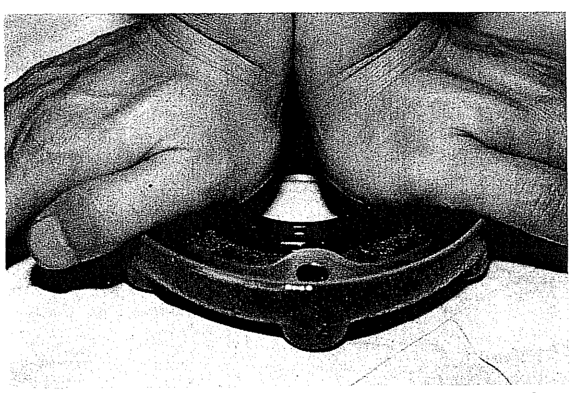


**Fig .83 Reassembly of Floating Seat (Seal Carbon)**

b) When installing the shaft seal retainer, position the locking pin upward and push in the shaft with the notch of the seal retainer of the assembly pointing upward. Confirm that the locking pin engages with the notch.

c) Attach the gasket to the seal cover, being sure to orient it correctly so that the oil port is not blocked.

d) Apply oil to the seal, position the seal cover perpendicularly in front of the shaft and slide it over the shaft carefully.

e) Install the shaft seal cover on the crankcase with the bolts and tighten to the specified torque.
Turn the crankshaft to confirm that the seal is correctly positioned and the shaft turns smoothly.

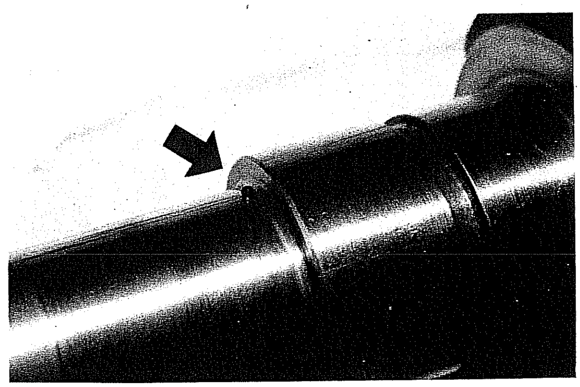


**Fig. 84 Shaft Seal Retainer**

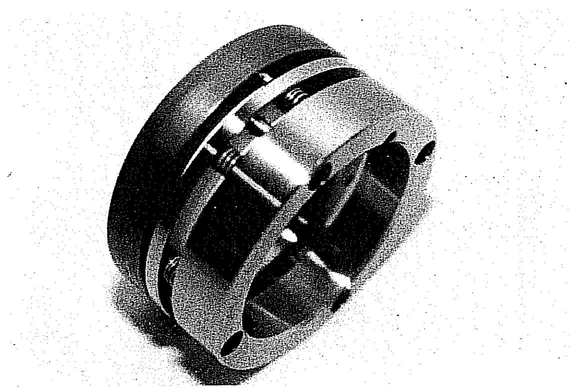


**Fig. 85 Mechanical Shaft Seal Assembly**

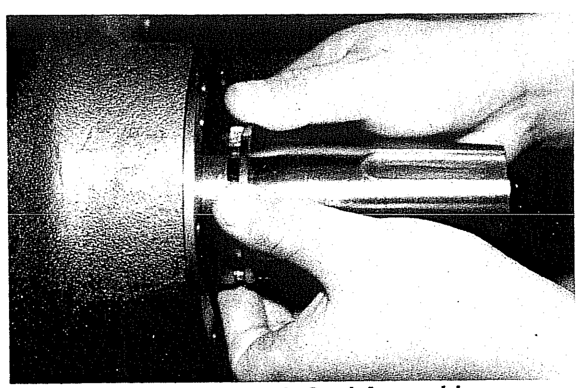


**Fig. 86 Mechanical Shaft Seal Assembly**

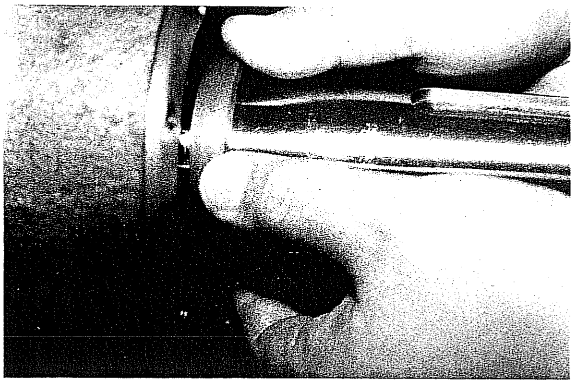


Fig. 87 Setting Mechanical Shaft Seal Assembly

### 6.3.6 Cylinder Assembly Reassembly

#### A. Piston and Piston Rings

a) Mounting the piston rings of the pistons.
The rings consist of:
- 1st piston ring (top)
- 2nd piston ring (second)
- Oil ring (bottom)

Mount the rings in order starting with the oil ring.

b) The ring end gap should not be excessive when reassembled, nor should a ring be distorted in any way. After installing each ring, confirm that it moves smoothly in the groove.

c) The ring end gaps of the three rings should be offset from each other by 180°.

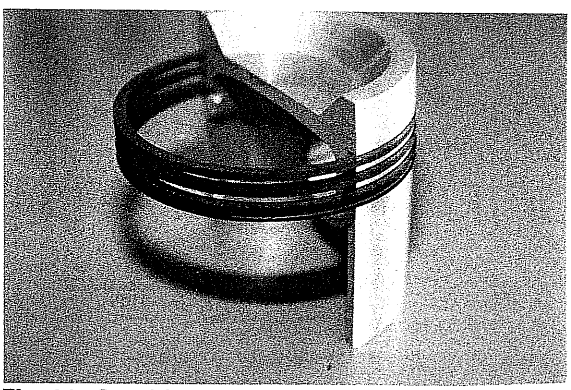


Fig. 88 Combination of Piston Rings


Fig. 89 Mounting Piston Rings


Fig. 90 Improper Arrangement of Piston Rings


Fig. 91 Proper Arrangement of Piston Rings

#### B. Piston and Connecting Rod Reassembly

a) Stand the piston on its crown and attach the connecting rod to the piston with the piston pin. Should fit snugly.

b) Install the piston pin circlip in the groove of the piston.

c) If the plain bearing metal for the big end of a connecting rod is to be replaced, it may be necessary to file the protrusion on the metal to assure a proper fit with the notch in the rod.
Be sure to clean the rod big end and the back of the plain bearing metal carefully before installing the metal. If necessary, polish the metal with fine emery paper.
The top and bottom plain bearing metals for the big end are identical.
Care must be taken during reassembly to ensure that the gap between the rod and the bearing metal remains free of dust or other foreign matter.

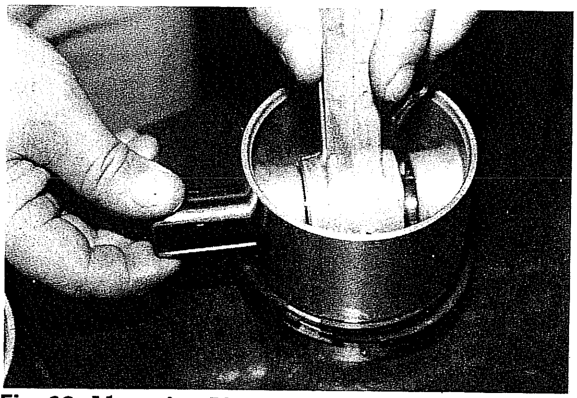


**Fig. 92 Mounting Piston Pin**

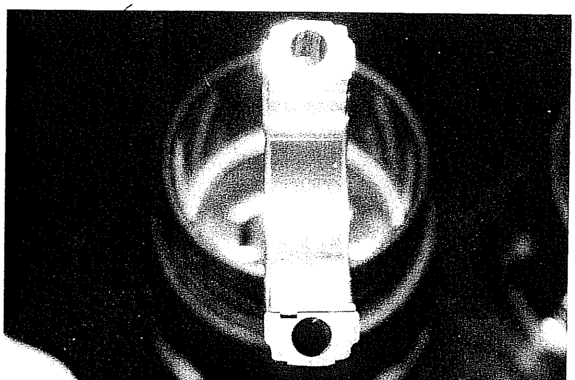


**Fig. 93 Bearing Metal, Connecting Rod Big End**

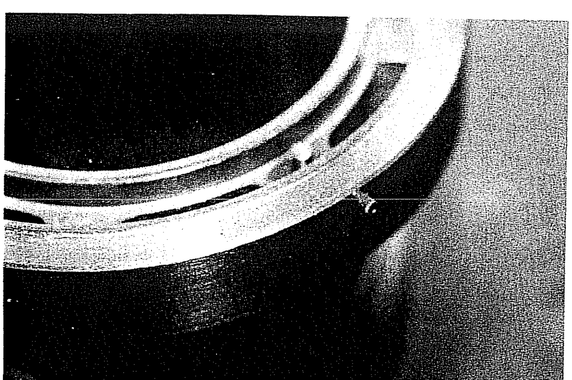


**Fig. 94 Positioning Pin, Cylinder Sleeve**

**Fig. 95 Retaining Ring**

### C. Cylinder Sleeve Reassembly

a) If the cylinder sleeve is to be replaced, first drive the lock pin into the flange, then mount the cam ring and secure with the retaining ring. Be sure that the direction of the cam ring slant is correct.

b) Mount the lift pins and lift pin springs and then install the "E" locking ring.

c) Turn the cam ring to adjust the notch on the cam ring and the lock. The correct relationship between the notch position and the pin is as follows:
Model 6K:
Cam ring rightward slanted down: 2 pcs.
Cam ring leftward slanted down: 3 pcs.

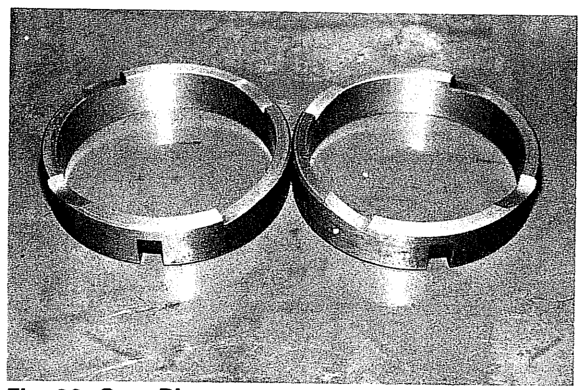


**Fig. 96 Cam Rings**

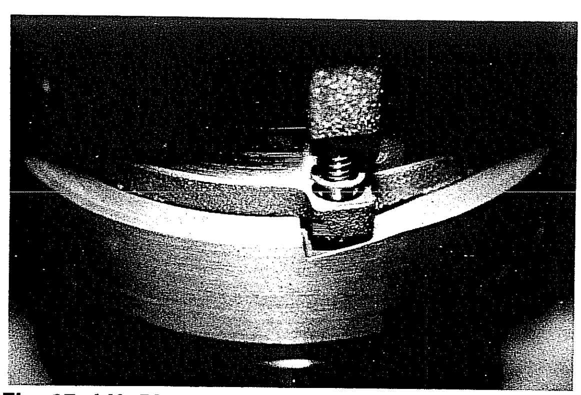


**Fig. 97 Lift Pin, Spring and "E" Locking Ring**

Regarding the mounting position, refer to Figs. 98 and 99.
In the case of the rightward facing slant cam ring, the notch on the cam ring should be positioned 45° in a clockwise direction from the positioning pin.
For leftward facing cam rings it should be 45° counterclockwise from the positioning pin.
Four lift pins offset by 90° each are installed for each cam ring. The notch of the cam ring is therefore positioned at the center between two lift pins.

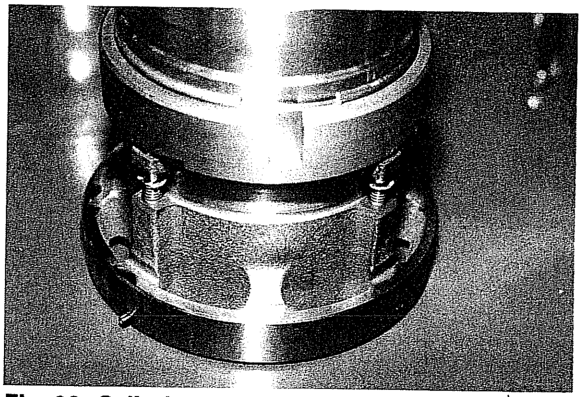


**Fig. 98 Cylinder Sleeve, Cam Ring and Lift Pin**

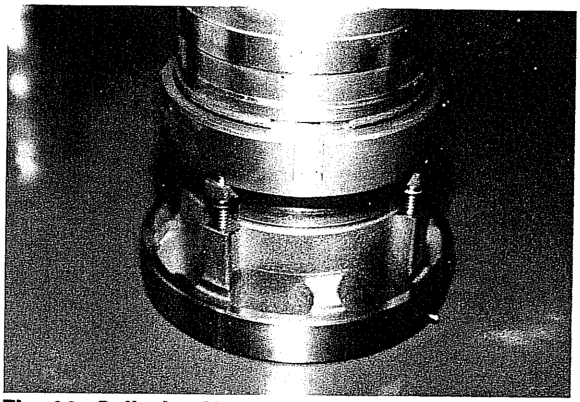


**Fig. 99 Cylinder Sleeve, Cam Ring and Lift Pin**

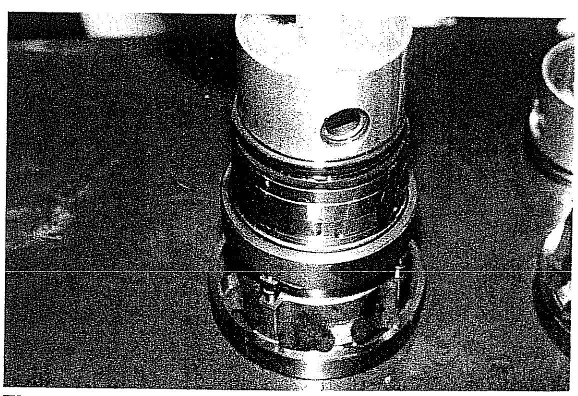


**Fig. 100 Installing Piston into Cylinder Sleeve**

**D. Cylinder Sleeve and Piston/Rod Assembly Reassembly**

a) Turn the cam ring to raise the lift pins out of the seat and position the sleeve with the seat side facing down.

b) Apply lubricating oil to the piston, then, holding the piston rod in one hand, insert the piston approximately half-way into the cylinder.

c) The piston ring section of the piston is inserted into the cylinder from the tapered portion of the cylinder while squeezing the rings. The cam ring is positioned in the same location as before disassembly.

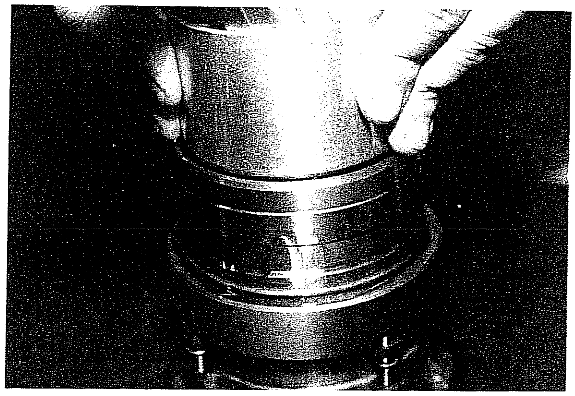


**Fig. 101 Installing Piston into Cylinder Sleeve**

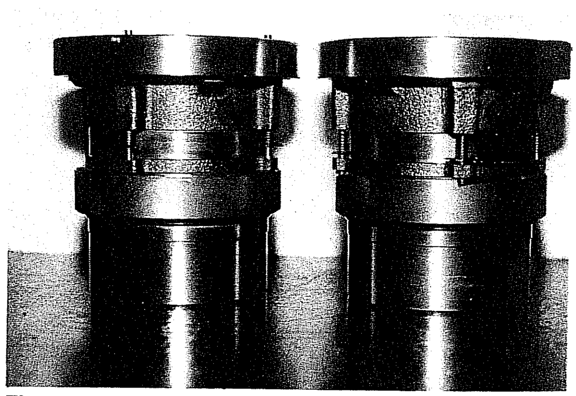


**Fig. 102 Movement of Lift Pin**

d) After fitting all of the cylinders with pistons, arrange in order of assembly grouped by type of cam ring.

### 6.3.7 Mounting Cylinder Assembly in Crankcase

a) The cylinders are mounted in the crankcase from the top, confirming that the cam ring, the position of the notch and the direction of the sleeve lock are correct.
Fit the piston retaining bolt to the connecting rod.

b) Adjust the unloader piston by fitting the cover temporarily so that the unloader push rod comes out the center of the pin hole of the cylinder, as shown in the photo (Fig. 103). Secure temporarily. Care must be taken during the final stage of mounting because the piston may protrude into the piston cover.

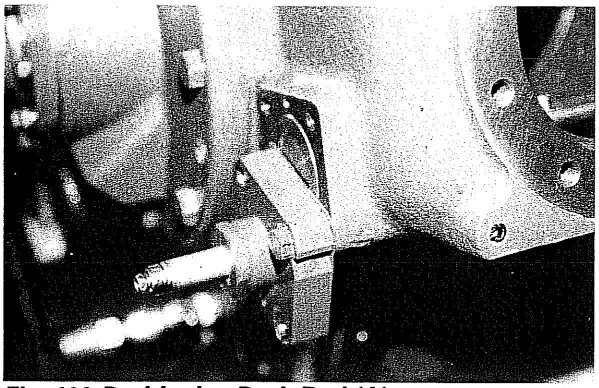


**Fig. 103 Positioning Push Rod (A)**

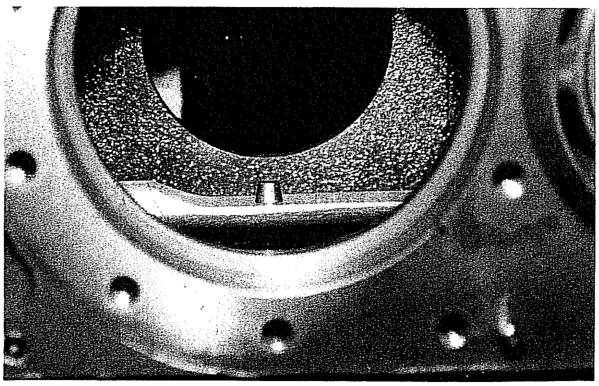


**Fig. 104 Positioning Push Rod (B)**

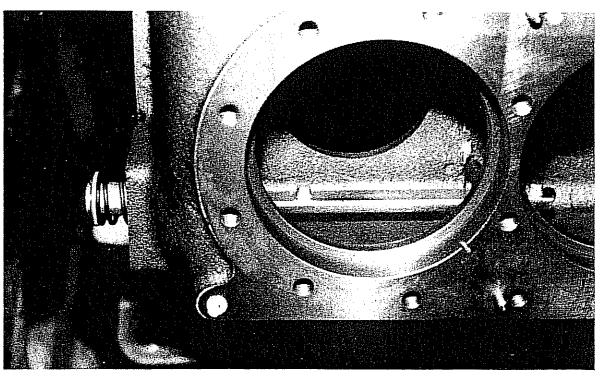


**Fig. 105 Push Rod, Free Position**

c) Position the crank pin of the cylinder to be mounted at the bottom dead center point. Position the piston in the center of the cylinder and insert the entire assembly into the crankcase.
When the notch on the cam ring matches the push rod pin, push the cylinder deep into the crankcase, aligning the sleeve lock and the groove in the crankcase.

d) Lift up the piston and move the big end of the connecting rod to position the bearing metal on the crank pin.

e) Confirm the rod cap fitting direction, mount, and install the washers and nuts. Tighten the bolts alternately to the specified torque.

f) Rotate the crankshaft after installing the assembly to confirm smooth movement. At this time hold the cylinder by hand, otherwise, not being yet secured, it will move with the piston. As an alternative, install a bolt and washer temporarily in one of the valve plate holes to hold down the cylinder.
When turning the crankshaft, do so slowly and carefully, holding the cylinder firmly.

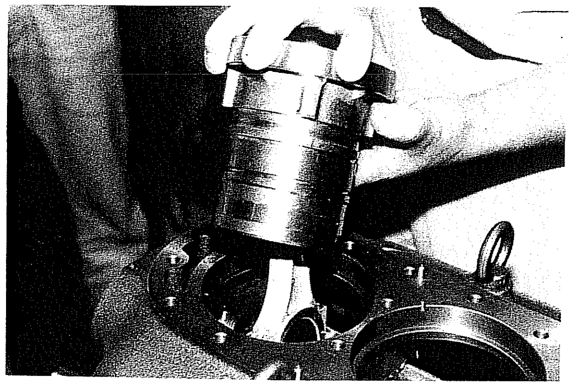


**Fig. 106 Mounting Cylinder**

**Fig. 107 Mounting Cylinder**


Fig. 108 Pushing Down Piston

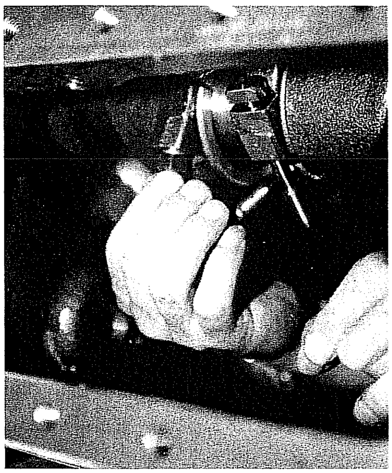


Fig. 109 Mounting Connecting Rod on Crankshaft

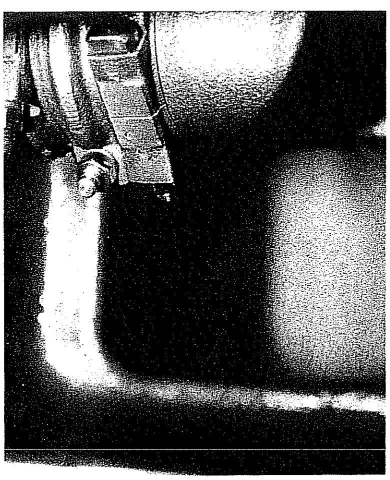


Fig. 110 Mounting Rod Cap

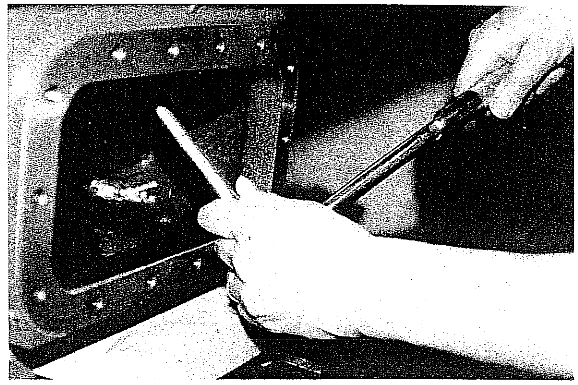


Fig. 111 Tightening Rod Cap

### 6.3.8 Valve Assembly Reassembly

#### A. Valve Plate Reassembly

a) Mount the suction valve springs on the suction valve side of the valve plate. As the outer diameter of the spring is large, it must be twisted into the hole.

b) Mount the suction valve on the valve plate and fix to the plate using the valve retainer provided (Fig.113). Carry out this work on two cylinders at a time.

c) Lubricate the gasket and position on the crankcase. Confirm the correct location of the valve plate positioning pin.

d) Confirm that the lift pins are lower than the cylinder sleeve face.
(If the lift pins are higher than the face, reposition the unloader cover and press on the unloader piston to lower the pins.)

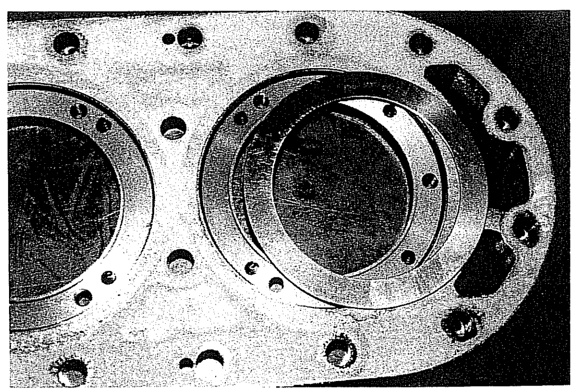


Fig. 112 Valve Plate and Suction Valve

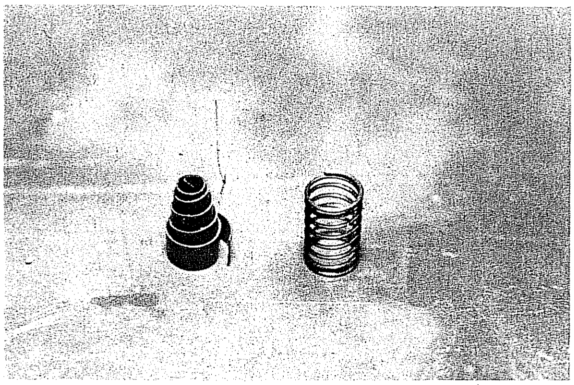


**Fig. 113 Spring and Coil Spring**

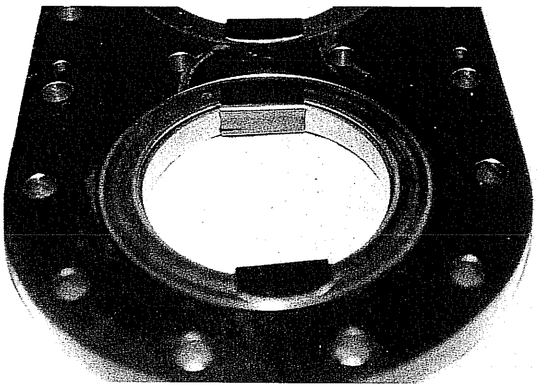


**Fig. 114 Retainer Tool, Suction Valve**

e) Mount the valve plate, aligning the positioning pin correctly.
Lightly secure the two central bolts and remove the valve retainer.
Confirm that the valve position is correct.

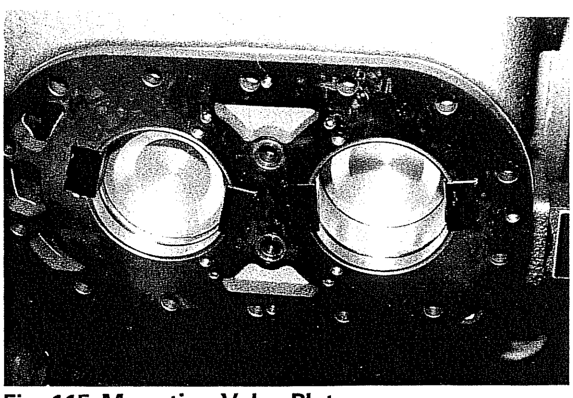


**Fig. 115 Mounting Valve Plate**

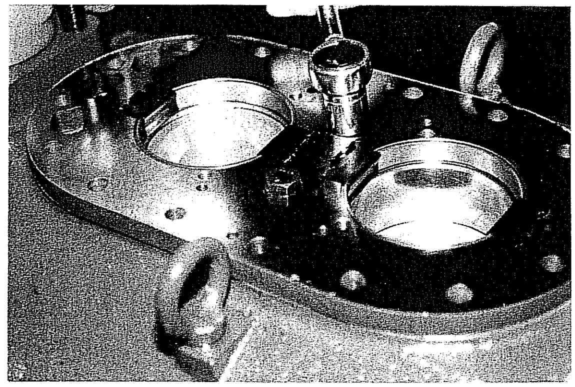


**Fig. 116 Tightning Valve Plate**

## B Discharge Valve Cage Reassembly

a) Mount the discharge valve springs on the discharge valve cage. Twist the spring into the hole.

b) Position the discharge valve on the discharge valve cage and secure with the discharge valve seat.
The seat should be aligned with the central positioning pin.

c) Fasten the seat with the bolts. Be sure to install the triangular retaining washer with the valve plate positioning pin.

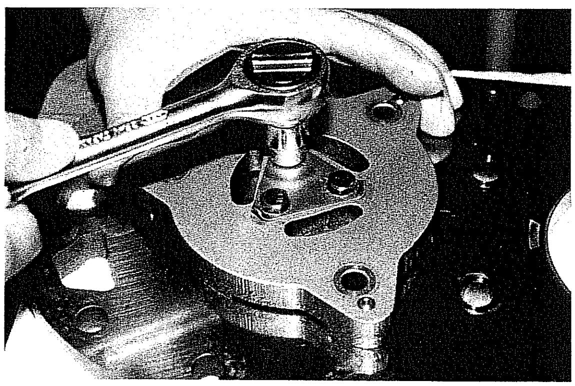


**Fig. 117 Mounting Discharge Valve Cage**

d) Tighten the bolts to the specified torque, then remove the valve cage to confirm that the valve actuates. Also confirm that the bolt heads are approximately level with the seat face. If they are significantly lower than the face, the wrong bolts may have been used. If, on the other hand, the bolt heads are protrude from the seat face, they may interfere with the piston.
After confirming the above, bend the corners of the lock washers.

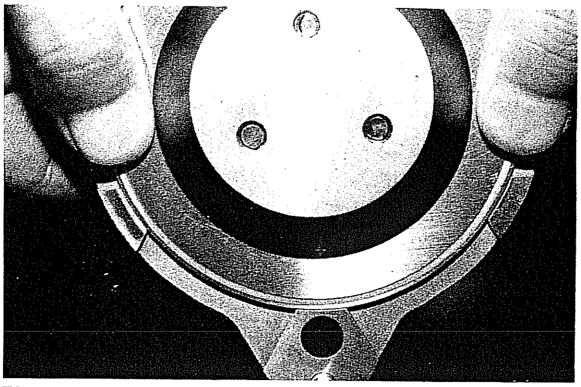


Fig. 118 Checking Activation of Discharge Plate Valve

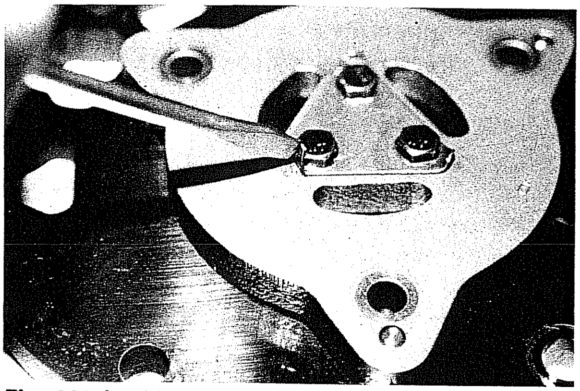


Fig. 119 Locking Bolt Retainer, Discharge Valve Seat

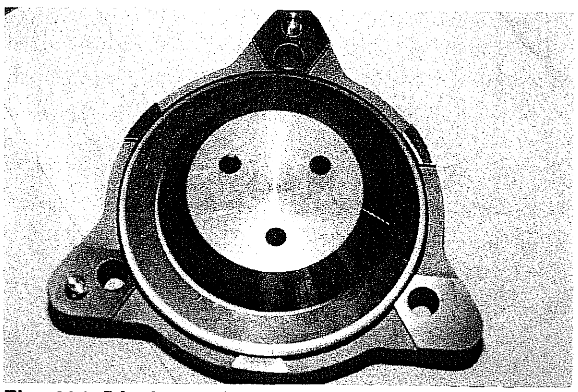


Fig. 120 Discharge Valve Cage Properly Assembled

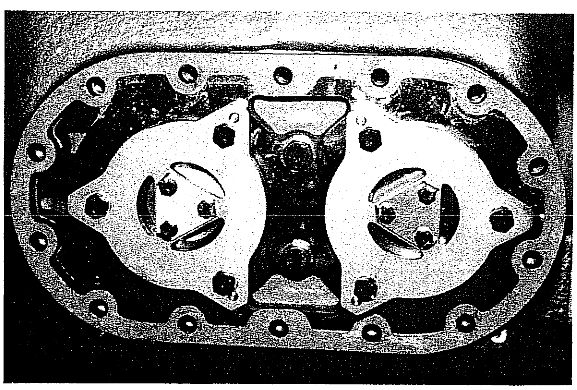


Fig. 121 Mounting Head Cover

e) Remount the valve cage in the specified position on the valve plate.
Be particularly careful about the length of the bolts. If the bolt is too short it will reduce upper clearance, resulting in reduced volumetric efficiency. On the other hand, if the bolt is too long it will press against the suction valve and inhibit compression. Bolts of the same length as previously installed should always be used.

### 6.3.9 Head Cover Reassembly

a) Attach the gasket to the valve plate and mount the head cover.

b) Tighten the bolts alternately in a criss-cross pattern to the specified torque.

c) Turn the crankshaft by hand to confirm smooth movement.

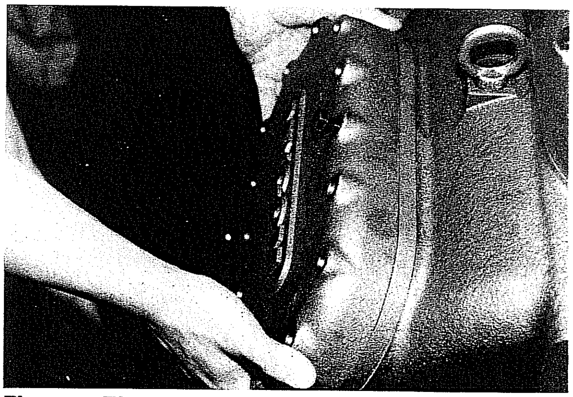


Fig. 122 Tightening Head Cover Bolts

### 6.3.10 Hand Hole Cover Reassembly

a) Confirm that the cover with the sight glass is to be mounted on the correct side.
Attach the gasket to the cover and secure the cover with the bolts.

b) Tighten the hand hole cover bolts to the specified torque.

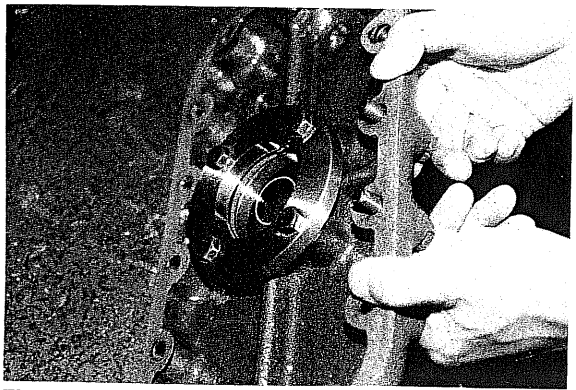


Fig. 123 Hand Hole Cover

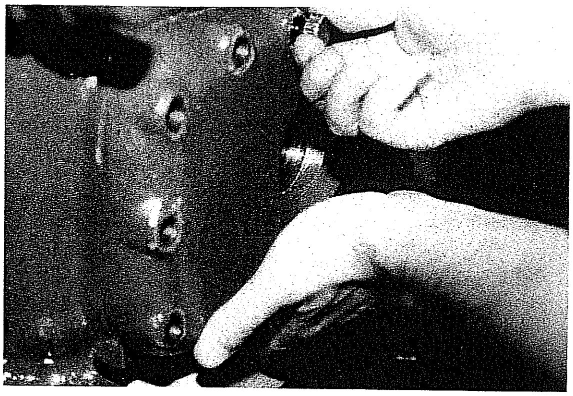


Fig. 124 Installing Hand Hole Cover Bolt

### 6.3.11 Unloader Cover Reassembly

a) Push on the unloader piston by hand to confirm actuation.

b) Fix the unloader cover after confirming that the gasket hole, the crankcase hole and the solenoid valve oil passage in the unloader cover are properly aligned. Tighten the unloader cover.

c) Mount the solenoid valve coil.

### 6.3.12 Suction Elbow and Discharge Elbow Reassembly

a) Mount the suction strainer.

b) Mount the suction elbow and tighten the bolts to the specified torque.

c) Screw in the built-in safety valve.

d) Mount the discharge elbow and tighten the bolts to the specified torque.

## 6.4 Inspection and Replacement Standards for Parts

### 6.4.1 Replacement of Lubricating Oil

a) In addition to daily checks of quantity, contamination level, color, etc., an oil sample should be extracted every six months for analysis by the oil maker.

b) If the lubricating oil becomes extremely dirty, do not hesitate to replace it. If the oil has a light coffee brown hue (ASTM-6 or more), replace.

c) Check the oil trap in the bottom of the crankcase periodically for metallic residue. If any metal particles are found, trace the source.
The residue found in the trap may include dirt from the suction piping or particles of frictional parts of the compressor.

d) If foreign matter finds its way into the compressor, the moving parts of the system may be subject to premature wear or damage. It is therefore vital that all precautions be taken to prevent contamination.

e) When submitting lubricating oil samples to the oil manufacturer, have them check the following:

(1) Oil Analysis

In general, analysis should be carried out to evaluate the characteristics indicated below. Normally, a one litre sample in a clear plastic or glass container is sufficient for analysis.

❶ Hue (ASTM)
❷ Kinematic viscosity (40°C sct)
❸ Total oxidation (mgKOH/g)
❹ Moisture (ppm or Vol/s)
❺ Milli-pore filter

Note: Items 1 through 5 represent routine analysis.

❻ Fluidity (°C)
❼ Wax fog point (°C)
❽ Metallic content (WC, ppm)

(2) Oil Replacement Standard

The oil should be replaced based on the following values:

| | | |
|---|---|---|
| ❶ Hue | : | ASTM 6 or over |
| ❷ Kinematic viscosity | : | New oil ± 15% |
| ❸ Total oxidation | : | 0.5 mgKOH/g or over |
| ❹ Moisture | : | 100 ppm or over |
| ❺ Milli-pore filter | : | 25 or over |

Deterioration of the oil can generally be determined by items ❶ through ❸ above.
If the moisture content or contamination by foreign matter is high, however, the oil should be replaced immediately and the source of the moisture or foreign matter traced.

Abnormal moisture:

- The system is not properly sealed and moisture and/ or air is leaking into the system.
- The original oil contains an excessive amount of moisture or the oil has not been properly stored.

Abnormal milli-bore:

- The interior of the system has not been adequately cleaned and residue in the piping has been flushed through to the system with the refrigerant and mixed with the oil.
- Abnormal abrasion of moving parts.

### 6.4.2 Suction Filter and Oil Filter

a) After cleaning the wire mesh, check for damage of failure of the welds.
Any defective parts should be repaired or replaced. Note that a special flux is required for stainless steel welding.

b) Any dirt remaining in the fine mesh after cleaning should be blown out with compressed air. Aim the air blast in the opposite direction to fluid flow.

c) The oil filter is a corrugated cylindrical filter. If the filter is clogged, blow out with compressed air from the inside.

### 6.4.3 Crankshaft

a) Check for abrasion of the crankshaft journals. This can be initially be done manually as abnormal abrasion can be recognized as a difference in the height of the friction and non-friction areas.
Check each journal for wear using a micrometer. If measurements exceed service limits replace the crankshaft.

b/ The frictional parts of the crankshaft may be damaged during disassembly work. If any scratches or scoring are found, polish using fine emery paper or a whetstone.

| Measuring point | Standard Dimensions | Service Limit |
|---|---|---|
| Diameter of Main Bearing | 70 mm | 69.88 mm |
| Diameter of Thrust Bearing | | |
| Diameter of Crank Pin | 60 mm | 59.88 mm |

c) Remove all plugs from the crankshaft and clean the oil ports thoroughly.
Especially, the plugs themselves are liable to become dirty. Wash the plugs thoroughly in kerosene and lubricate with oil before reinstalling.
If the plugs are not reinstalled, oil pressure failure and compressor seizure will result.

d) Check the mechanical seal mounting face of the crankshaft for scratches or scoring and repair using fine emery paper or a whetstone.

### 6.4.4 Mechanical Seal

a) Check the frictional face of the shaft seal cover side floating seat and the crankshaft side seal ring.
The frictional face should exhibit a lustrous finish. If not, replace the mechanical seal assembly.

b) Check the frictional face of the floating seat for cracks or other damage and replace the mechanical seal assembly with a new one if necessary.

c) Two O-rings are used. If the O-rings are deformed or have lost resiliency, replace them.

### 6.4.5 Piston, Piston Pin and Piston Rings

a) Each piston should be inspected carefully for damage to the circumference. If any damage is found, polish with a whetstone, moving the stone perpendicular to the direction of movement during operation.

b) If the outer diameter of the piston exceeds the service limit given below, replace it.

| Measuring point | Standard Dimensions | Service Limit |
|---|---|---|
| Piston Diameter | 85 mm | 84.80 mm |

c) Regarding piston pin hole to piston pin clearance, if the measured value exceeds the service limit given below, replace the part showing the greater degree of wear.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Clearance between piston pin hole & piston pin | 0.007 ~ 0.026 mm | 0.15 mm |

d) If the outer diameter of the piston pin exceeds the service limit given below, replace it.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Piston Diameter | 25 mm | 24.85 mm |

e) Piston ring wear can be determined by measuring the ring end gap.
Insert the piston ring into the cylinder sleeve approx. 3 mm from the bottom and measure the ring end gap. If the gap exceeds the service limit given below, replace the ring.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Piston ring (top, 2nd, bottom) | 0.15 ~ 0.35 mm | 1.2 mm |

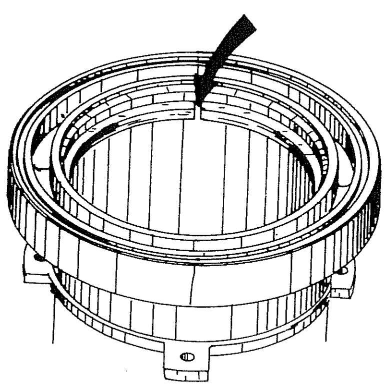


**Fig. 125 Measuring Piston Rings**

f) If the clearance between the piston ring groove and the piston ring exceeds the service limit given below, replace the piston ring or the piston.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Clearance between piston ring groove and piston ring | 0.02 ~ 0.06 mm | 0.15 mm |

### 6.4.6 Connecting Rod

a) Check the surface of the bearing metal fitted in the big end. If the metal shows signs of pitting, the shaft pin portion of the rod may become worn. Replace the metal.

b) If clearance between the crank pin and the metal exceeds the service limit given below, replace the metal.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Clearance between crank pin and bearing metal | 0.020 ~ 0.079 mm | 0.20 mm |

c) If the clearance between the piston pin and the small end pin hole of the connecting rod exceeds the following service limit, replace the pin.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Clearance between piston pin and piston pin hole | 0.027 ~ 0.054 mm | 0.15 mm |

### 6.4.7 Cylinder Sleeve

a) Check the suction valve seat on the suction on the cylinder sleeve.
If scratches or scoring are found, repair by lapping the seat.

b) If the height of the seat exceeds the service limit given below, replace the cylinder sleeve.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Height of valve seat portion of cylinder sleeve | 0.5mm | 0.20 mm |

c) Check the inner wall of the cylinder sleeve and repair any scratches with a fine whetstone.

d) If the clearance between the inside diameter of the cylinder sleeve and the piston skirt exceeds the service limit given below, replace the sleeve.

| Measuring point | Standard Dimensions | Service Limit |
| --- | --- | --- |
| Clearance between cylinder inner surface and piston skirt portion | 0.080 ~ 0.132 mm | 0.3 mm |

e) If the inner diameter of the cylinder sleeve exceeds the service limit given below, replace the sleeve. Measure the diameter at a point 10~20mm from the top of the cylinder, the point which is subject to the greatest wear.

| Measuring point | Standard Dimensions | Service Limit |
|---|---|---|
| Cylinder inner diameter | 85 mm | 85.2 mm |

### 6.4.8 Discharge Valve (Assembly) and Suction Valve (Assembly)

a) The discharge plate valve, suction plate valve and valve springs must be replaced every 6,000 hours. Durability of these components varies according to operating conditions but the wear limit for the valve seat portion should be less than 0.15mm from the standard thickness.

| Valve | Standard Thickness |
|---|---|
| Discharge plate valve | 1.0 mm |
| Suction plate valve | 1.0 mm |

b) Even if abrasion of the plate valve seat is within the service limit, if scratches, scoring or other damage is found on the circumference, replace.

c) When repairing the discharge valve seat portion of the valve plate, the polishing allowance should be within the service limit.
Excessive polishing will result in the piston head striking the valve seat.

### 6.4.9 Oil Pump

When oil pressure cannot be increased during operation even if the oil pressure regulating valve is closed and no clogging of the oil filter is evident, the most likely problem is abrasion of the pump gears, bearing or shaft. To inspect the pump, remove from the compressor and manipulate the shaft axially and radially to check for excessive free play.
If the shaft is loose, replace the pump as an assembly. The geared bearing functions as the body of the main bearing head. If the bearing is found to be excessively worn, replace the entire bearing head.

### 6.4.10 Main Bushing and Thrust Washer

a) Measure the clearance between the main bushing and the crankshaft.
If clearance exceeds the service limit given below replace the main bushing.

| Measuring point | Standard Dimensions | Service Limit |
|---|---|---|
| Clearance between main bushing and crankshaft | 0.040 ~ 0.139 mm | 0.3 mm |

b) If the inside diameter of the main bushing exceeds the service limit given below, replace the replace the main bushing.

| Measuring point | Standard Dimensions | Service Limit |
|---|---|---|
| Main bushing inside diameter | 70 mm | 70.15 mm |

c) Measure the thickness of the thrust washer and replace if the inside diameter exceeds the service limit given below.

| Measuring point | Standard Dimensions | Service Limit |
|---|---|---|
| Thrust washer inside diameter | 2.95 ~ 3.05 mm | 2.8 mm |

### 6.4.11 Springs

a) Measure the free length of each spring.
If the free length is 10% or more shorter than the appropriate value given in the table below, replace the spring with a new one.

| Name of Spring | Standard Dimensions (mm) (Free length × coil dia. × outer dia.) |
|---|---|
| Discharge valve spring | 10 × ø0.2 × MAX. ø6 |
| Suction valve spring | |
| Lift spring | 10 × ø0.4 × ø5.2 |
| Unloader device spring | 72 × ø2.8 × ø32.3 |

### 6.4.12 Built-in Safety Valve

If the built-in safety valve has actuated, the seat is liable to be clogged with foreign matter, resulting in subsequent refrigerant leakage.
If any leakage is found, replace the safety valve as an assembly.

### 6.4.13 Gaskets and O-rings

a) After removing a gasket, inspect it carefully for cuts, tears or other abnormality.
If a gasket shows signs of hardening, replace it.

| O-ring Name | Standard | Nominal No. | Outer Dimensions (mm) (Outer dia. × Inner Dia. × Thicknes) |
|---|---|---|---|
| O-ring, Mechanical Seal (for shaft seal ring) | JIS.B.2401 | G55 | 60.6 × 54.4 × 3.1 |
| O-ring, Mechanical Seal (for floating seat) | JIS.B.2401 | P65 | 76 × 64.6 × 5.7 |

b) Although the O-rings used are made of synthetic rubber, they may deteriorate due to exposure to the refrigerant and oil over a period of time.
Check all O-rings for signs of hardening, softening and deformation. Periodic replacement is recommended.
When ordering, specify the refrigerant used.

## 6.4.14 Gaskets

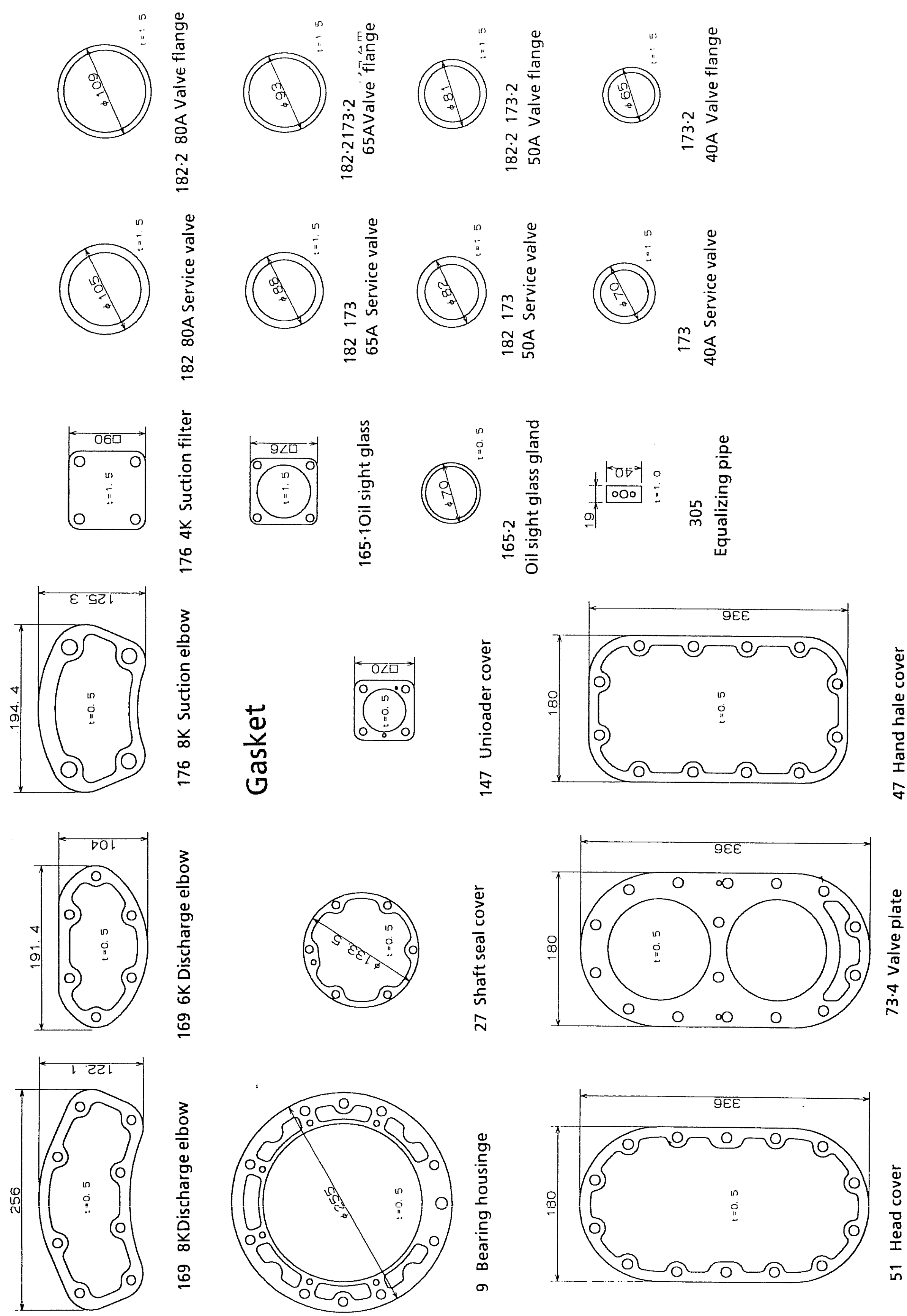



Fig. 126 Gaskets

## 6.4.15 Standard Clearances

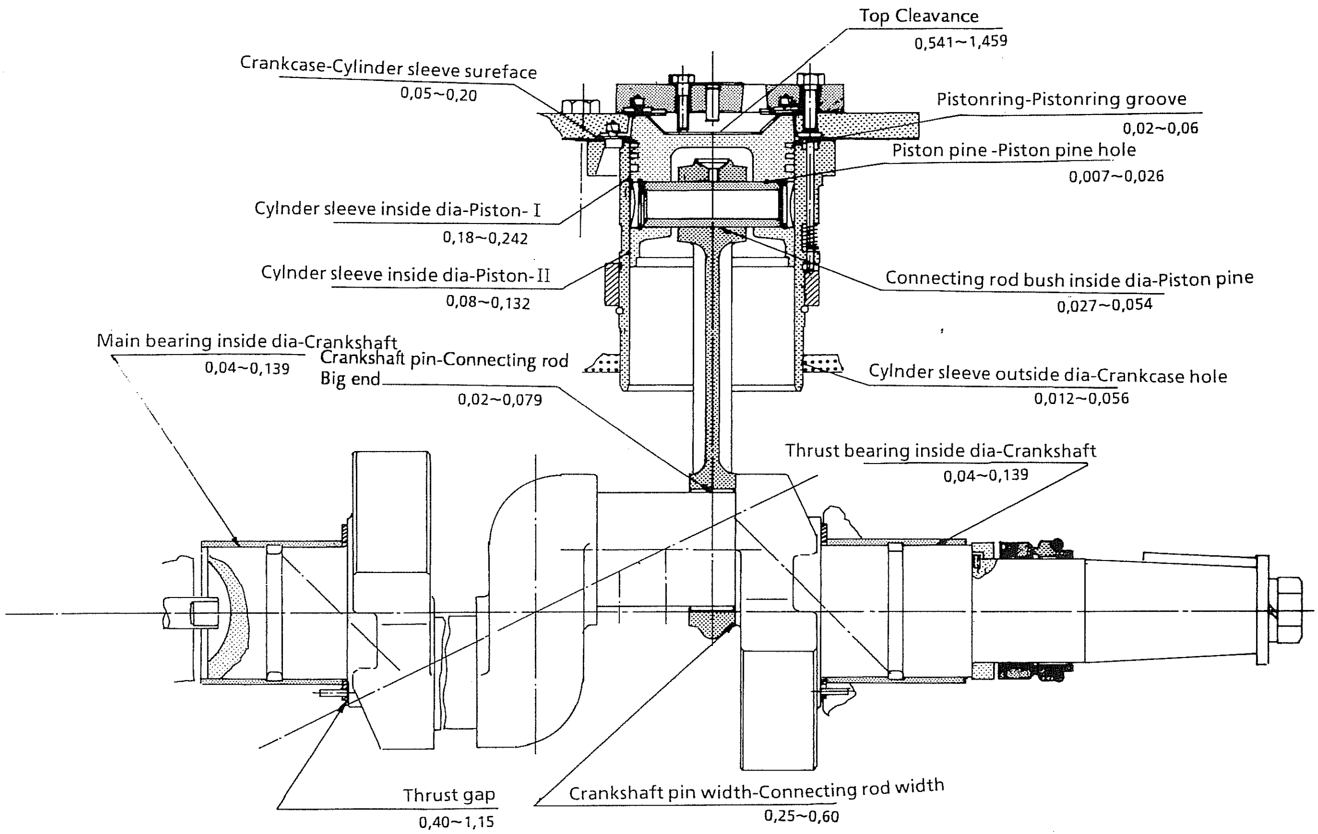



**Fig. 127 Standard Clearances**