

# *MYCOM 400V Series Screw Compressor*

*Instruction Manual Vol. 2*

MAYEKAWA MFG.CO.,LTD.

## **Section Locator**

<b>1. Outline of Compressor</b>	<b>P1</b>
<b>1-1 General Introduction to 400V Series Compressor</b>	<b>P1</b>
1-1-1 Suction Stage	P2
1-1-2 Compression Stage	P2
1-1-3 Discharge Stage	P3
<b>1-2 Outline of Compressor Structure</b>	<b>P3</b>
1-2-1 Bearing	P3
1-2-2 Mechanical Shaft Seal	P3
1-2-3 Unloader Slide Valve Indicator	P3
1-2-4 Compressor Oil Flow	P3
<b>2. Component Parts</b>	<b>P6</b>
<b>2-1 Exploded View of Parts</b>	<b>P6</b>
<b>2-2 Cross Sectional View</b>	<b>P7</b>
<b>2-3 Parts List</b>	<b>P9</b>
<b>2-4 Outer View</b>	<b>P10</b>
<b>3. Disassembly</b>	<b>P11</b>
<b>3-1 Preparations for Assembly</b>	<b>P11</b>
<b>3-2 Removing Compressor from Skid</b>	<b>P11</b>
3-2-1 Refrigerant (or Gas) Evacuation	P11
3-2-2 Disconnecting Auxiliary Equipment	P12
3-2-3 Lifting and Removing Compressor	P12
<b>3-3 Overhaul</b>	<b>P12</b>
3-3-1 Mechanical Shaft Seal	P13
3-3-2 Unloader Cylinder Assembly	P16
3-3-3 Bearing Cover	P17
3-3-4 Thrust Bearing Gland	P18
3-3-5 Thrust Bearing Assembly	P18
3-3-6 Domed Cap Nut and Nut	P20
3-3-7 Balance Piston Cover	P20
3-3-8 Vi Adjusting Rod	P20
3-3-9 Balance Piston Assembly	P21
3-3-10 Suction Cover	P21
3-3-11 Rotor Assembly	P22
3-3-12 Vi Slider	P22
3-3-13 Guide Block Stem and Guide Block	P22
3-3-14 Slide Valve	P22
3-3-15 O-ring Gland	P23
3-3-16 Main Bearing and Side Bearing	P23
<b>3-4 Parts Inspection</b>	<b>P23</b>
3-4-1 Mechanical Shaft Seal	P23
3-4-2 Unloader Cover Assembly	P23
3-4-3 Unloader Cylinder Assembly	P23
3-4-4 Bearing Cover	P24
3-4-5 Thrust Bearing Gland	P24
3-4-6 Thrust Bearing Assembly	P24
3-4-7 Balance Piston Cover	P24
3-4-8 Vi Adjusting Rod	P24
3-4-9 Balance Piston Assembly	P24
3-4-10 Suction Cover	P25
3-4-11 Rotor Assembly	P25

# **MYCOM 400V SERIES SCREW COMPRESSOR**

## **Instruction Manual, Vol. 2**

---

3-4-12 Vi slider	P25
3-4-13 Guide Block Stem and Guide Block	P25
3-4-14 Slide Valve	P25
3-4-15 Rotor Assembly	P26
3-4-16 O-ring Gland	P26
3-4-17 Bearing Head	P26
3-4-18 Main Bearing and Side Bearing	P26

---

### **4. Re-Assembly P27**

---

<b>4-1 Preparation for Re-Assembly</b>	<b>P27</b>
<b>4-2 Re-Assembly and Adjustment of Parts</b>	<b>P27</b>
4-2-1 Slide Valve	P27
4-2-2 Guide Block Stem and Guide Block	P28
4-2-3 Vi Slider	P28
4-2-4 Rotor Assembly	P28
4-2-5 Suction Cover	P28
4-2-6 Vi Adjusting Rod	P29
4-2-7 Balance Piston Assembly	P30
4-2-8 Thrust Bearing Assembly and Adjustment for End Clearance	P30
4-2-9 Bearing Cover	P34
4-2-10 Unloader Cover Assembly	P34
4-2-11 Unloader Cylinder Assembly	P34
4-2-12 Balance Piston Cover	P36
4-2-13 Mechanical Shaft seal	P36

---

### **5. Unloader Indicator Assembly and Unloader Indicator Fixture Assembly P39**

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<b>5-1 Exploded View of Unloader Indicator Assembly and Unloader Indicator Fixture Assembly</b>	<b>P39</b>
<b>5-2 Disassembly and Re-Assembly for Unloader Indicator Fixture Assembly</b>	<b>P40</b>
<b>5-3 Disassembly and Adjustment of Unloader Indicator</b>	<b>P41</b>
5-3-1 Disassembly and Adjustment of Unloader Indicator	P41
<b>5-4 Inspection</b>	<b>P42</b>
<b>5-5 Assembly and Adjustment</b>	

---

### **6. Standards of Components P44**

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<b>6-1 Hand Tool Kit</b>	<b>P44</b>
<b>6-2 O-ring Kit for Compressor</b>	<b>P45</b>
<b>6-3 O-ring for Mechanical Shaft Seal</b>	<b>P45</b>
<b>6-4 Gasket Kit</b>	<b>P45</b>
<b>6-5 Lock washer and Lock Nut</b>	<b>P45</b>
<b>6-6 Bolt Fastening Torque</b>	<b>P45</b>

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# **MYCOM 400V SERIES SCREW COMPRESSOR**

## **Instruction Manual, Vol. 2**

### **1. Outline of Compressor**

MYCOM 400V Series screw compressor has been developed with the latest technology.

A variable Vi function allows this compressor to be adjusted readily for various operating conditions and a new profile (O-profile) has brought farther better performance.

The basic construction of the 400V Series is same as the standard MYCOM V-Series compressors.

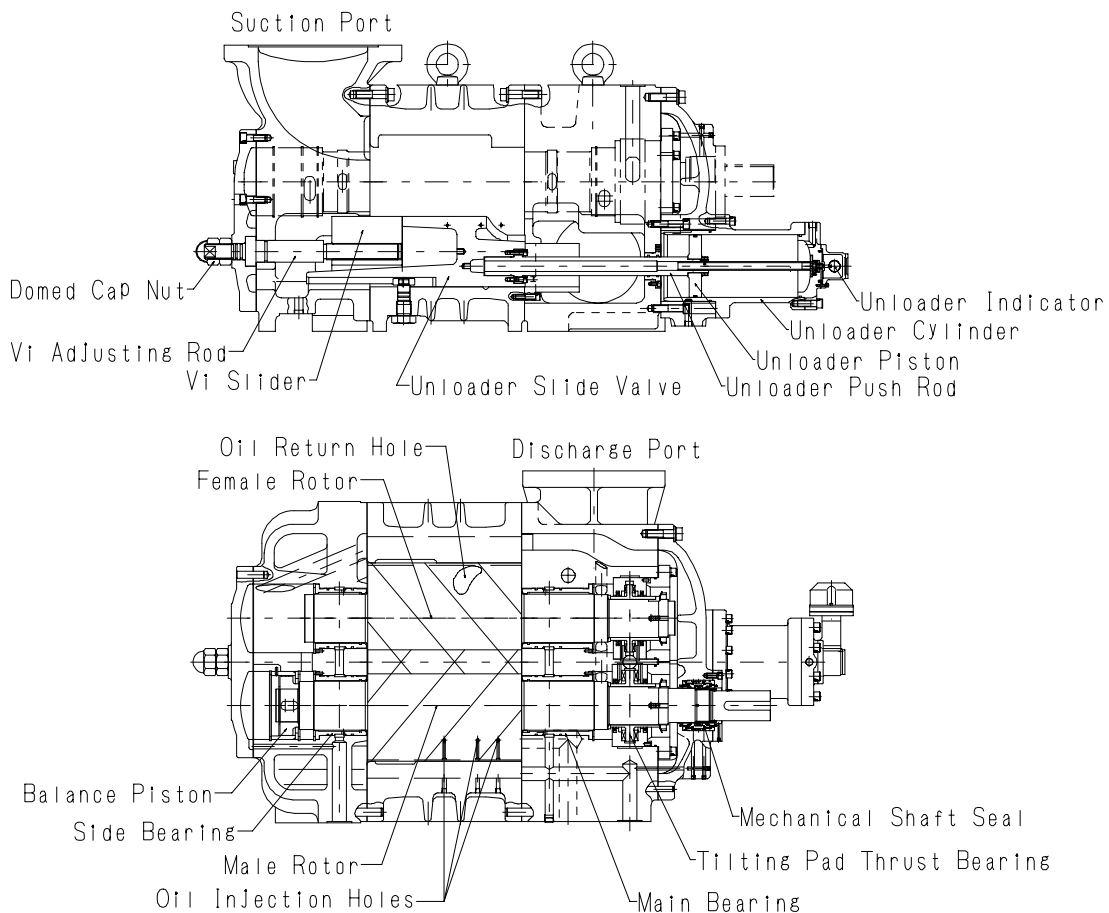


Fig. 1-1 General Structure of 400V

### **1-1 General Introduction to 400V Series Compressor.**

This screw compressor is classified as a positive displacement rotary type compressor.

Suction gas is trapped in the clearance between the two mated rotors and pressure increased by decreasing volume. The compressed gas is then discharged as a high pressure gas.

# **MYCOM 400V SERIES SCREW COMPRESSOR**

## **Instruction Manual, Vol. 2**

As shown in Fig. 1-1, male and female screw rotors which have different profiles are mounted in a casing. This is the main portion of the compressor which compresses the gas. The rotor having four (4) convex lobes is called the "male" or "M" rotor while the rotor with six (6) concave lobes is called the "female" or "F" rotor.

The M rotor is turned by a driver connected to the M rotor shaft. Compressor efficiency is related directly to the shape of the rotor lobes. In the case of 400V Series, the rotors have unsymmetrical profiles which improves efficiency significantly. The new profile successfully reduces the size of the triangular blow-hole located between the compressor side casing and the two rotors by 60%, minimizing leakage due to the pressure difference.

The clearance between the leading edges of the rotor lobes and the casing is sealed by an oil film. With the V series, however, a change has been incorporated to raise the pressure of the oil film and the clearance between the casing and the lobe leading edges is wedge shaped.

### **1-1-1 Suction Stage**

As shown in Fig. 1-2 and Fig. 1-3, the rotors of different lobe shape mesh and the clearance between the M rotor lobe, F rotor groove and compressor casing increases gradually from the suction side as the rotors turn. When the clearance reaches the maximum as the rotors rotate further, this is sealed by the walls at both ends of the rotor and becomes independent.

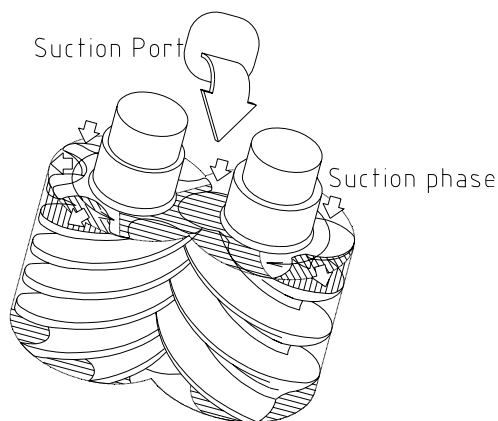


Fig. 1-2 Suction stage

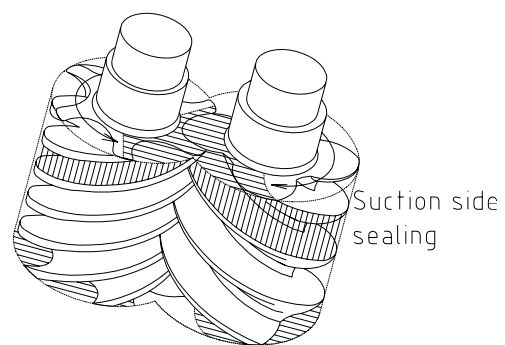


Fig. 1-3 Suction side sealing

### **1-1-2 Compression Stage**

As the rotors turn further, the volume between the lobes is decreased, compressing the trapped gas, while the sealing line moves toward the discharge side.

# MYCOM 400V SERIES SCREW COMPRESSOR

## Instruction Manual, Vol. 2

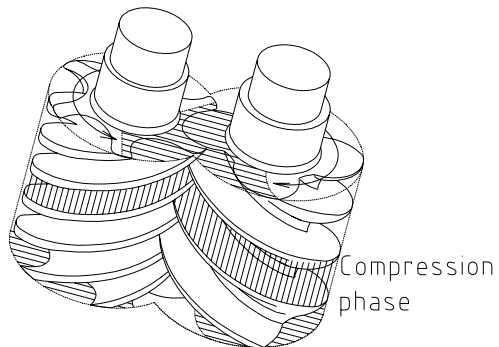


Fig. 1-4 Compression stage

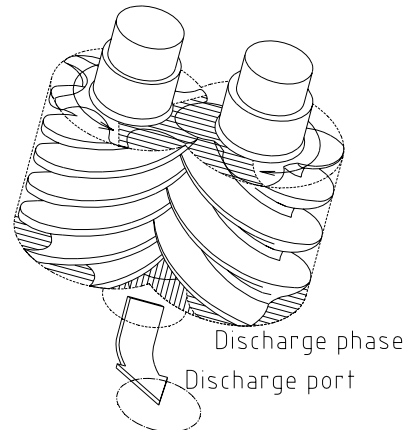


Fig. 1-5 Discharge stage

### **1-1-3 Discharge Stage**

The volume between the lobes is decreased to the designated  $V_i$ , the clearance between the discharge port and rotors is linked and the gas is pushed out to the discharge side.

## **1-2 Outline of the Compressor Structure**

### **1-2-1 Bearings**

The radial load of the compressor is absorbed by white metal-lined bearings while the axial thrust load on the rotor is absorbed by tilting pad thrust bearing.

### **1-2-2 Mechanical Shaft Seal**

A new, double balanced type mechanical shaft seal is used on the drive shaft. The mechanical seal utilizes O-ring packing to allow service with various kinds of gases.

A combination of carbon and metals is chosen to assure the durability of the frictional parts and sealing effect.

### **1-2-3 Unloader Slide Valve Indicator**

A cylinder indicator cam is provided to indicate position of the variable  $V_i$  slide valve and unloader slide valve. The capacity ratio is shown on the dial indicator.

The capacity ratio can be output by a potentiometer for remote indication.

### **1-2-4 Compressor Oil Flow**

Lubrication oil for journal bearings is required a forced lubrication which needs oil pump pressure. Injection oil is allowed pressure differential flow system under the condition of more than 70 psi pressure differential between

# MYCOM 400V SERIES SCREW COMPRESSOR

## Instruction Manual, Vol. 2

suction and discharge. The oil injection ports are located on the male rotor side of the rotor casing.

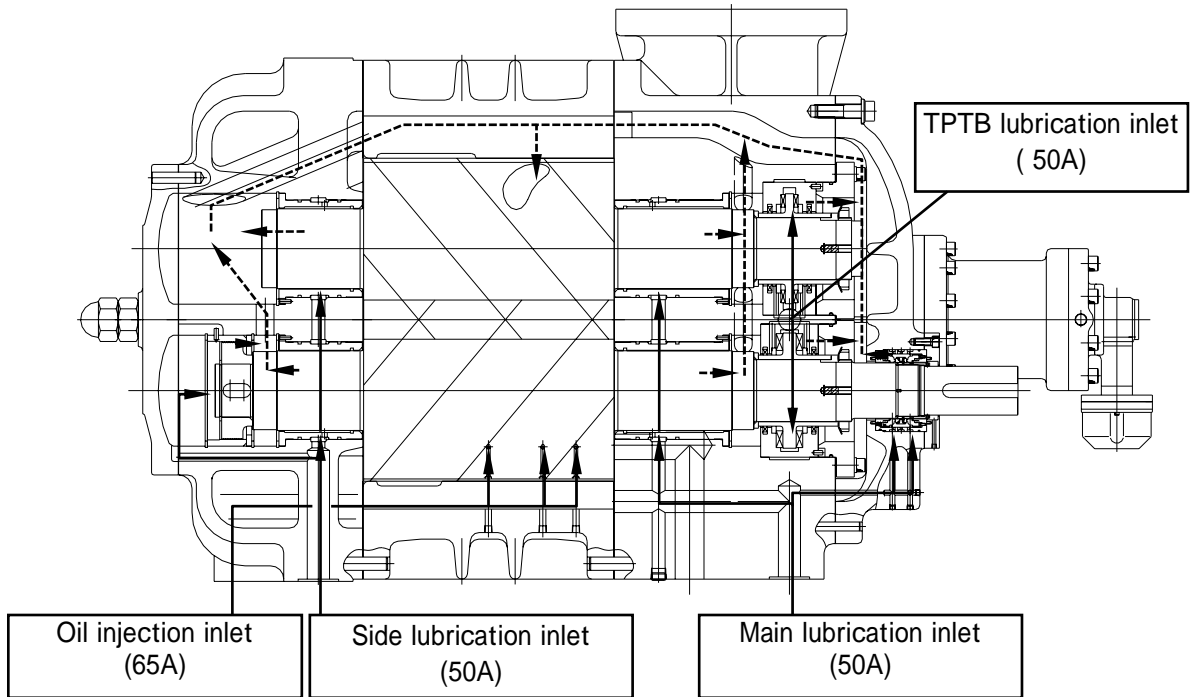


Fig. 1-6 Lubricating Oil Flow, Inside of Compressor

To move the slide valve it is necessary to have an independent oil pressure unit which provides 75~113 psi oil pressure above the discharge pressure. (Fig.1 -7)

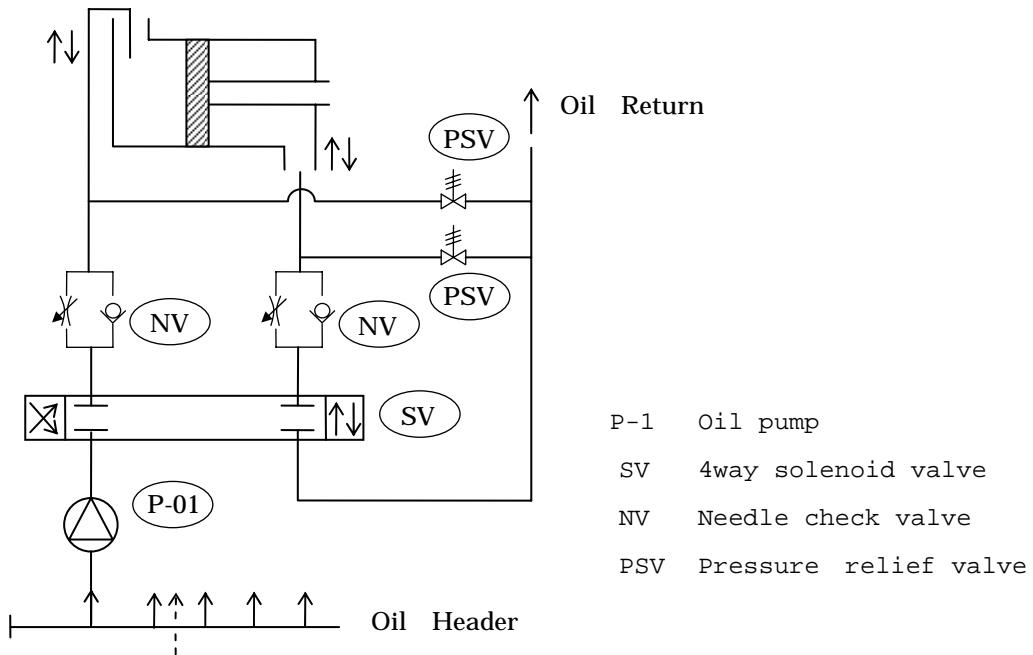


Fig. 1-7 Unloader System Oil Flow Diagram

**MYCOM 400V SERIES SCREW COMPRESSOR**

**Instruction Manual, Vol. 2**

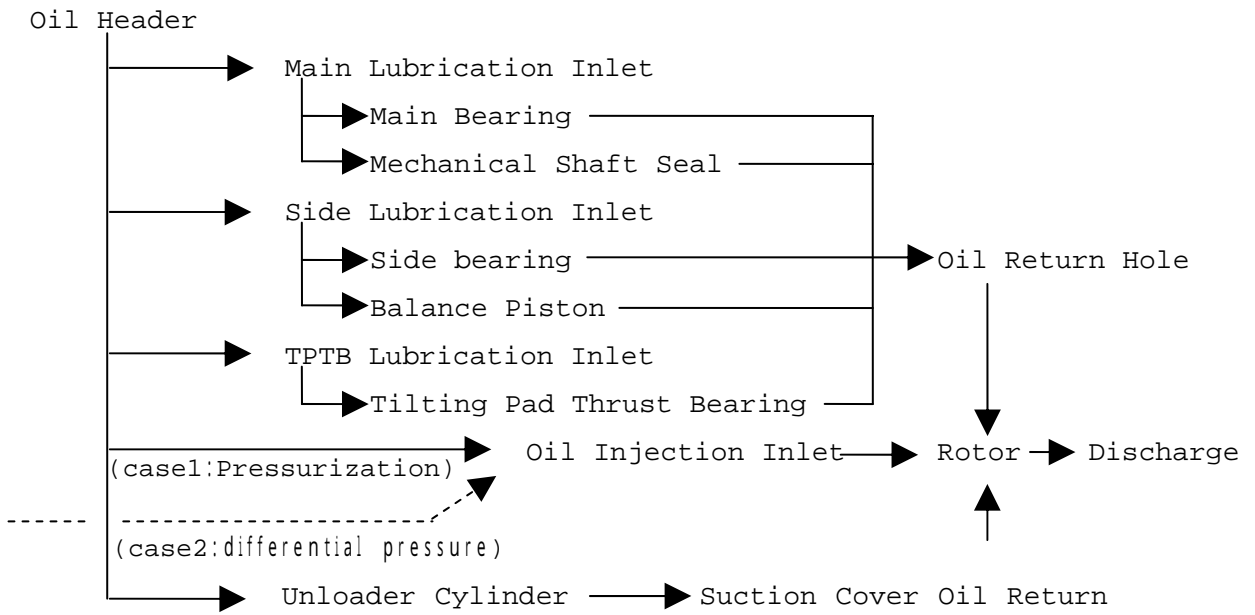


Fig. 1-8 Lubrication Oil Flow Diagram



# MYCOM 400V SERIES SCREW COMPRESSOR

## Instruction Manual, Vol. 2

### 2. Component Parts

#### 2-1 Exploded View of Parts

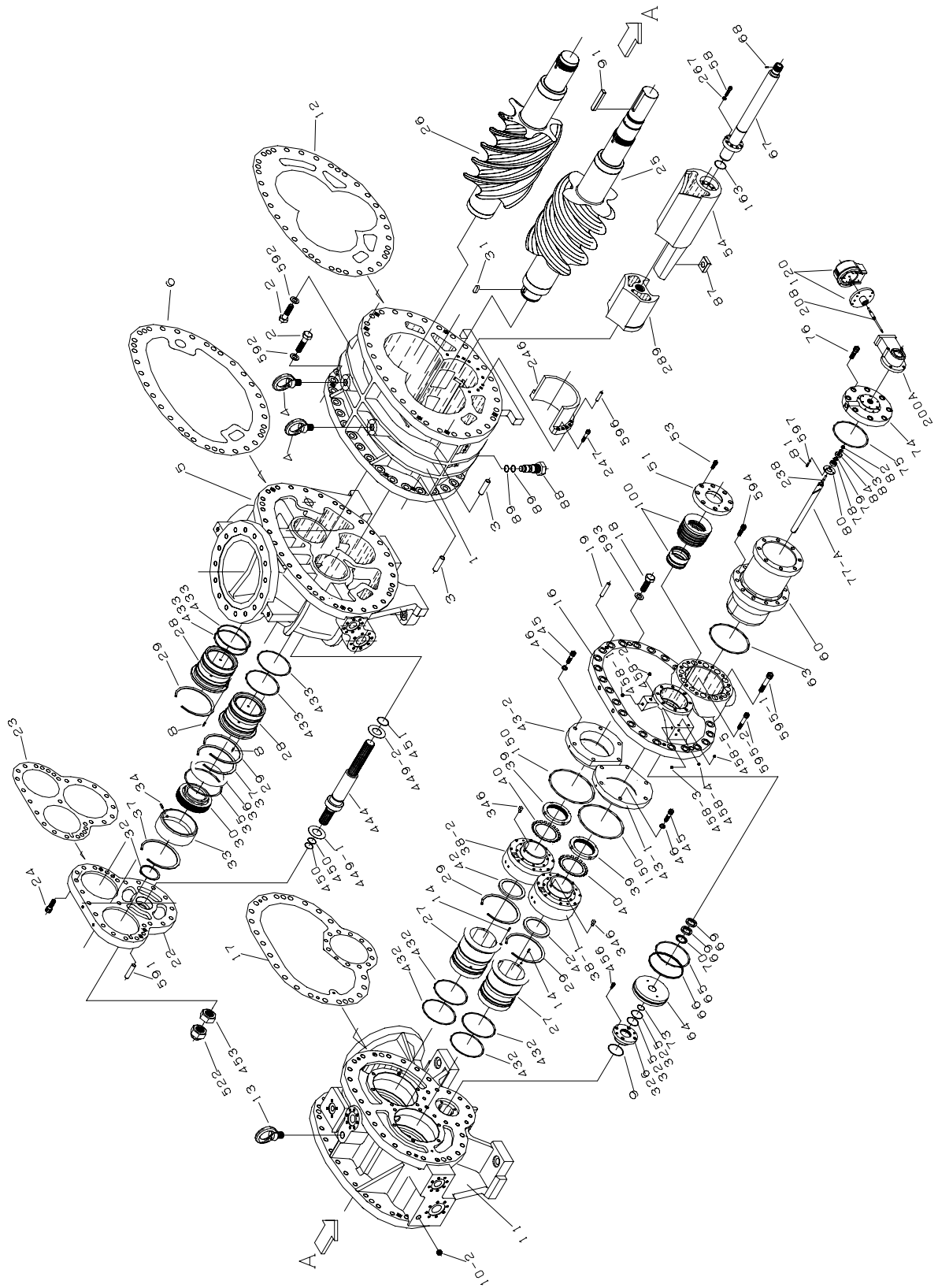


Fig. 2-1 Exploded View of Compressor, Model 400VMD

**MYCOM 400V SERIES SCREW COMPRESSOR**

**Instruction Manual, Vol. 2**

**2-2 Cross Sectional View**

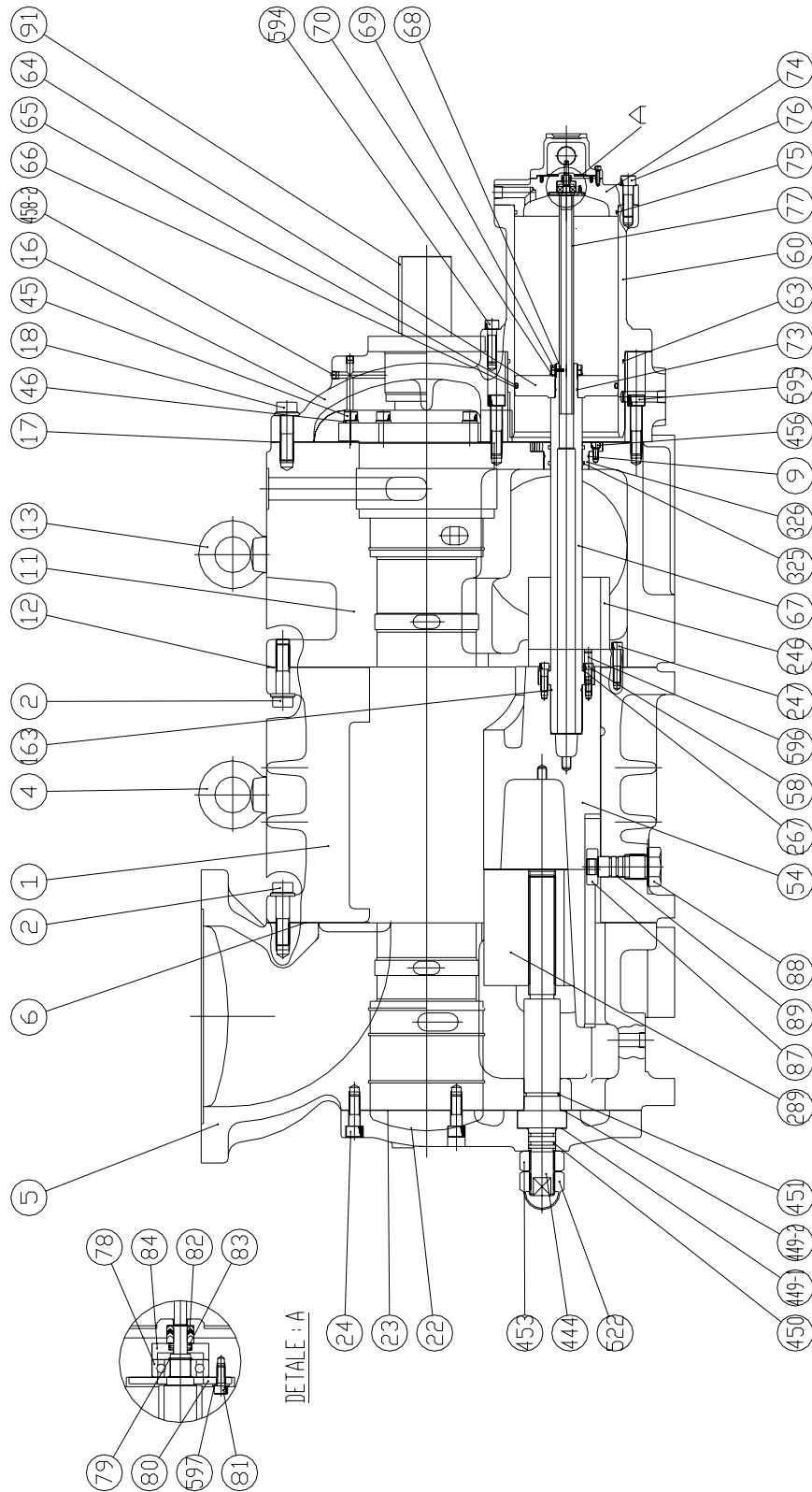


Fig. 2-2 Cross Section View(1)

**MYCOM 400V SERIES SCREW COMPRESSOR**

**Instruction Manual, Vol. 2**

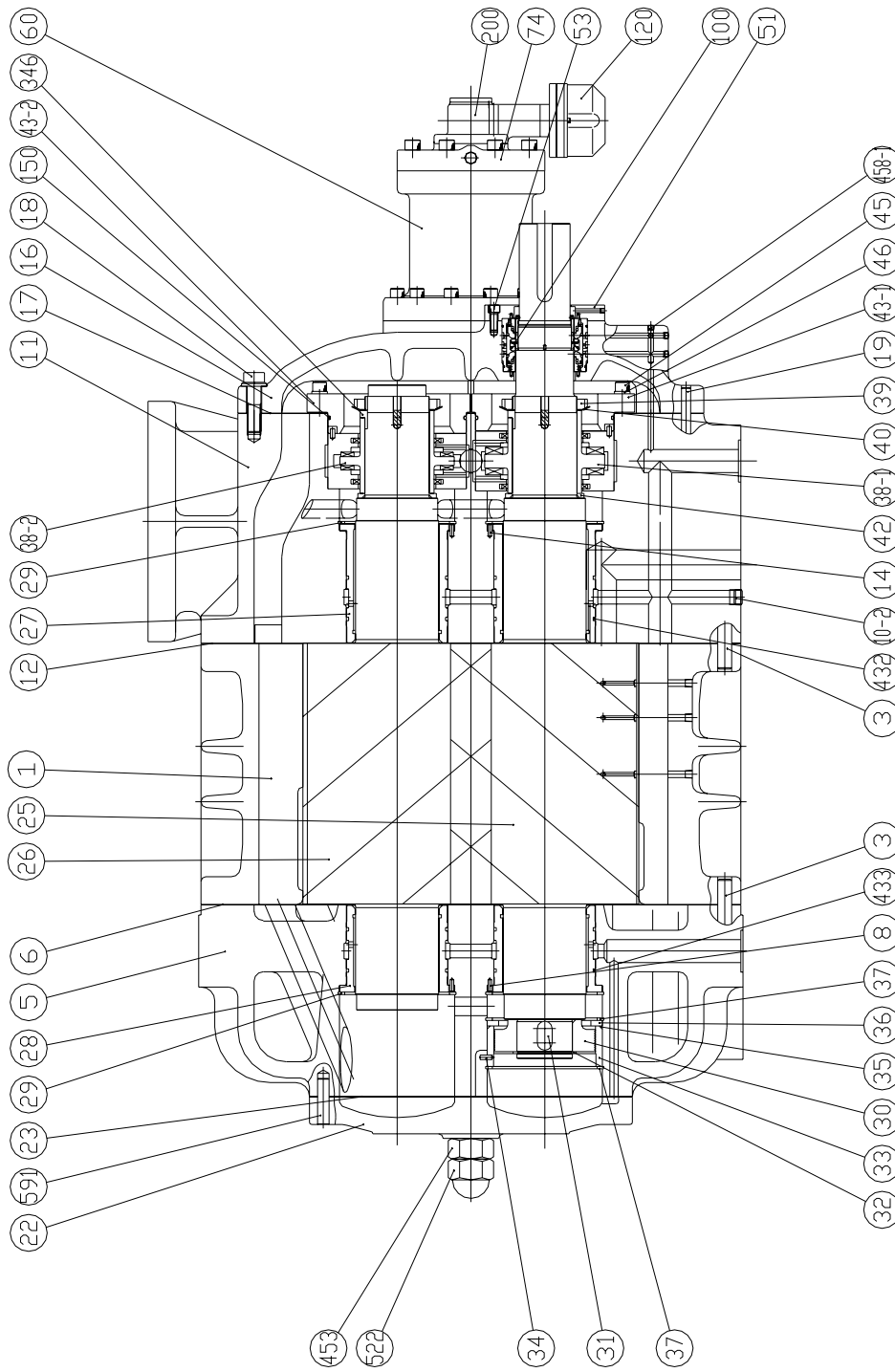


Fig. 2-3 Cross Section View(2)

# **MYCOM 400V SERIES SCREW COMPRESSOR**

## **Instruction Manual, Vol. 2**

### **2-3 Parts List**

Table 2-1 Parts List

No.	Parts Name	Qty	No.	Parts Name	Qty
1	Rotor casing	1	67	Push Rod, Unloader Slide Valve	1
2	Hexagon Socket Head Cap Screw	60	68	Guide Pin	1
3	Parallel Pin	4	69	Locknut	2
4	Eyebolt	2	70	Lockwasher	1
5	Suction Cover	1	73	O Ring	1
6	Gasket, Suction Cover	1	74	Unloader Cover	1
8	Spring Pin	2	75	O Ring	1
9	O Ring	1	76	Hexagon Head Cap Screw	8
10-2	Plug	1	77	Unloader Indicator Cam	1
11	Bearing Head	1	78	Ball Bearing	1
12	Gasket, Bearing Head	1	79	C Type Retaining Ring	1
13	Eyebolt	1	80	Bearing Gland	1
14	Spring Pin	2	81	Hexagon Head Cap Screw	3
16	Bearing Cover	1	82	V Ring	1
17	Gasket, Bearing Cover	1	83	Spring	1
18	Hexagon Socket Head Cap Screw	22	84	Retainer	1
19	Parallel Pin	2	87	Guide Block	1
22	Balance Piston Cover	1	88	Guide Block Stem	1
23	Gasket, Balance Piston Cover	1	89	O Ring	2
24	Hexagon Socket Head Cap Screw	24	91	Shaft Key	1
25	Male Rotor	1	100	Mechanical Shaft Seal Assembly	1
26	Female Rotor	1	120	Unloader Indicator Assembly	1
27	Main Bearing	2	150	O Ring	2
28	Side Bearing	2	163	O Ring	1
29	C Type Retaining Ring	4	200	<b>Unloader Indicator Fixture Assy.</b>	1
30	Balance Piston	1	246	Unloader Slide Valve Guide	1
31	Key, Balance Piston	1	247	Hexagon Head Cap Screw	8
32	C Type Retaining Ring	1	267	Spring Washer	8
33	Sleeve, Balance Piston	1	289	Vi Slider	1
34	Spring Pin	1	325	O Ring	2
35	O Ring	1	326	Gland, O Ring	1
36	Spacer	1	346	TPTB Key	2
37	C Type Retaining Ring	2	432	O Ring	4
38-1	Thrust Bearing Assembly	1	433	O Ring	4
38-2	Thrust Bearing Assembly	1	444	Vi Adjusting Rod	1
39	Locknut	2	449-1	Thrust Washer	1
40	Lockwasher	2	449-2	Thrust Washer	1
42	Spacer, Thrust Bearing Alignment	2	450	O Ring	2
43-1	Thrust Bearing Gland	1	451	O Ring	1
43-2	Thrust Bearing Gland	1	453	Hexagon Nut	1
45	Hexagon Socket Cap Screw	12	456	Hexagon Head Cap Screw	4
46	Spring Lockwasher	12	458-1	Plug	4
51	Seal Cover	1	458-2	Plug	2
53	Hexagon Socket Cap Screw	8	522	Domed Cap Nut	1
54	Slide Valve	1	591	Parallel Pin	2
58	Hexagon Socket Cap Screw	8	594	Hexagon Head Cap Screw	12
60	Unloader Cylinder	1	595-1	Hexagon Head Cap Screw	10
63	O Ring	1	595-2	Hexagon Head Cap Screw	2
64	Unloader Piston	1	596	Parallel Pin	2
65	O Ring	1	597	Spring Washer	3
66	Cap Seal	1			

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

**2-4 Outer View**

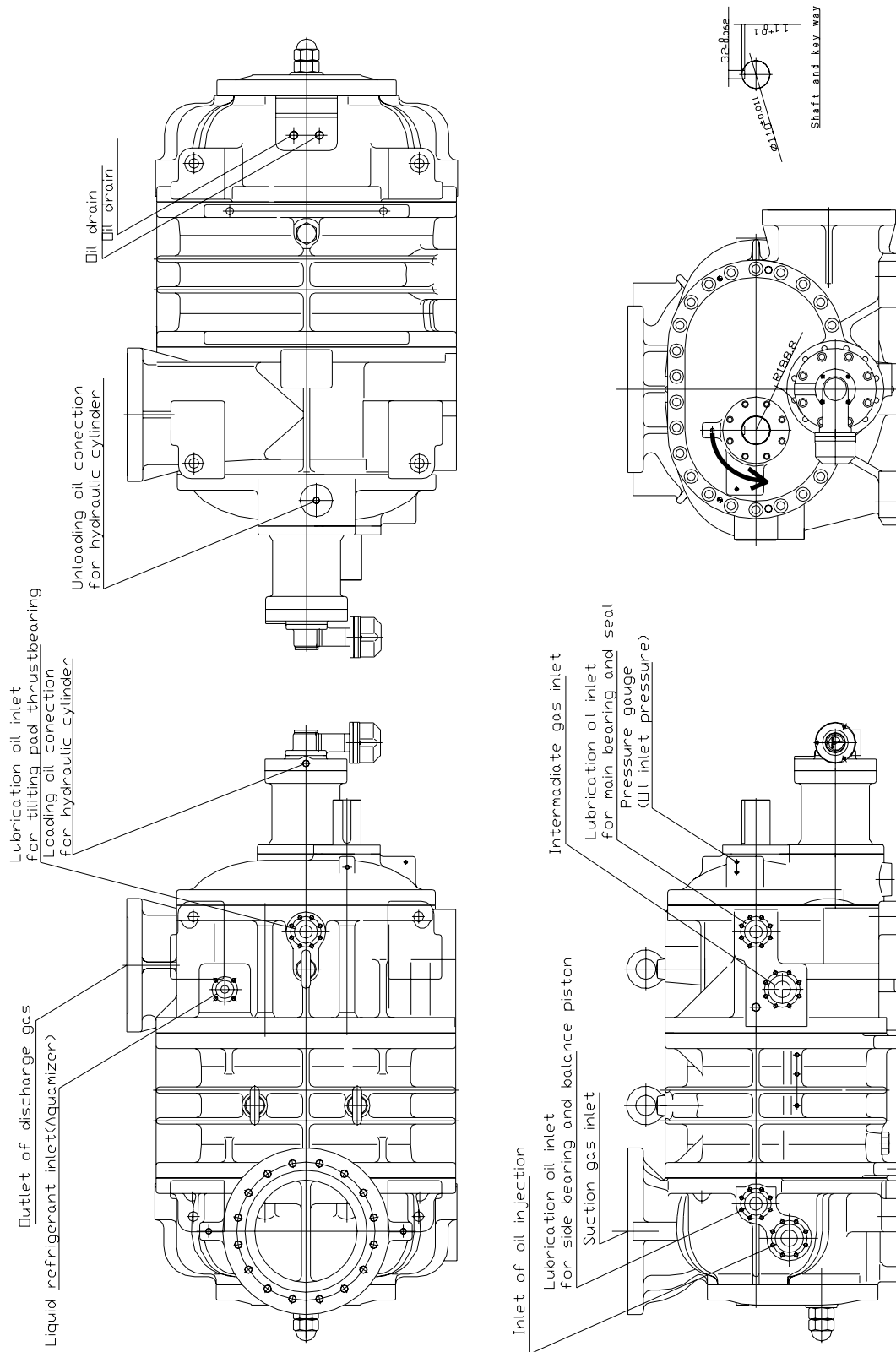


Fig. 2-4 Outer View, Model 400VMD

### **3. Disassembly**

Disassembly work at the job site should be limited only for replacing the shaft seal and checking unload mechanism. It is recommendable to remove the compressor from the skid for major overhaul due to the large size of components. Disassembly, inspection and handling of the parts should be done only with a full understanding of the construction of the compressor and the instruction manual should be referred to frequently at the work proceeds.

#### **3-1 Preparations for assembly**

All workers engaged in disassembly work should be trained in advance and should be provided with appropriate safety apparel such as safety goggles, helmet, steel-toed shoes and coveralls.

#### **3-2 Removing Compressor from Skid**

The pressure in the compressor is higher than the ambient air pressure in most system. Be sure to remove all the gas from the compressor before commencing work.

##### **3-2-1 Refrigerant(or Gas) Evacuation**

Compressor internal pressure should be reduced to the ambient air pressure level.

The compressor internal pressure should not be a vacuum when being removed. If the compressor is removed when internal pressure is in a vacuum condition, its internal casing surface may get rust due to dew formation.

There are several different ways to remove the pressure in the compressor, depending on the type of gases.

If the system uses Freon refrigerant, the following methods should be used to ensure that no gas is released into the atmosphere.

- a) Transfer all refrigerant in the unit to the low pressure side through the bypass valve.
- b) If the plant has two compressors, extract the refrigerant from one unit by operating the other compressor.
- c) Recover the refrigerant using a small portable compressor.

### **3-2-2 Disconnecting Auxiliary Equipment**

Disconnect parts such as the drive couplings, suction/discharge piping, lubrication piping and other pipes such as those for liquid injection and the economizer as well as all control wiring and mounting bolts.

When remove piping, a drain pan should be positioned under the joint being loosened to catch the oil.

### **3-2-3 Lifting and Removing Compressor**

When the compressor is lifted from the skid, three eyebolts on the compressor must be used. (Fig.3-1)

Wooden block should be placed on the work bench underneath the compressor to cushion and stabilize the compressor.

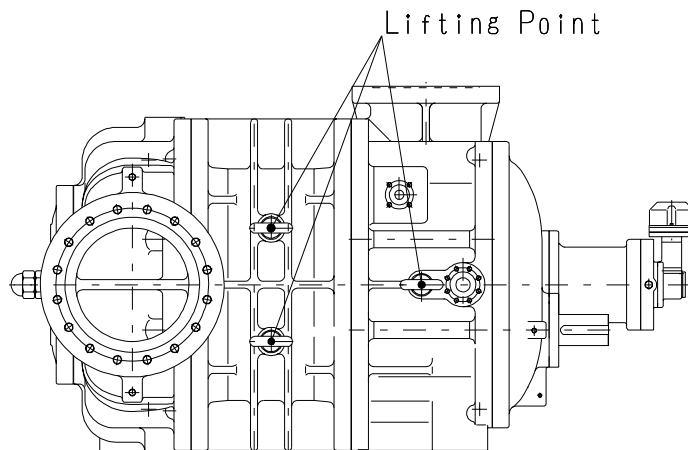


Fig. 3-1 Lifting Point of 400V Series

### **3-3 Overhaul**

Overhaul procedure is shown as follows. The following steps are recommendable.

- 1) Mechanical shaft seal
- 2) Unloader cylinder
- 3) Bearing cover
- 4) Thrust bearing gland
- 5) Thrust bearing assembly
- 6) Domed cap nut and nut
- 7) Balance piston cover
- 8) Vi adjusting rod
- 9) Balance piston assembly
- 10) Suction cover

# MYCOM 400V SERIES SCREW COMPRESSOR

## Instruction Manual, Vol. 2

- 11) Rotor assembly
- 12) Vi slider
- 13) Guide block stem and guide block
- 14) Slide valve
- 15) O-ring gland
- 16) Main bearing and side bearing

### 3-3-1 Mechanical Shaft Seal

1. Remove hexagon socket cap screws on the seal cover and remove the seal cover.

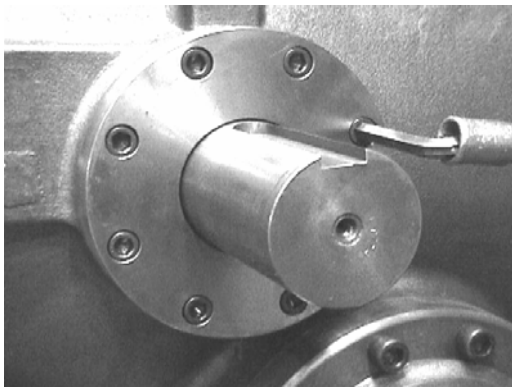


Fig. 3-2 Remove seal cover (1)

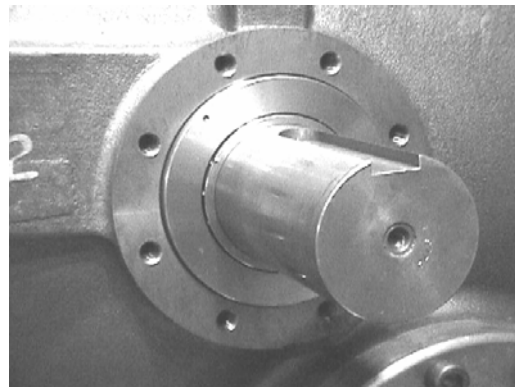


Fig. 3-3 Remove seal cover (2)

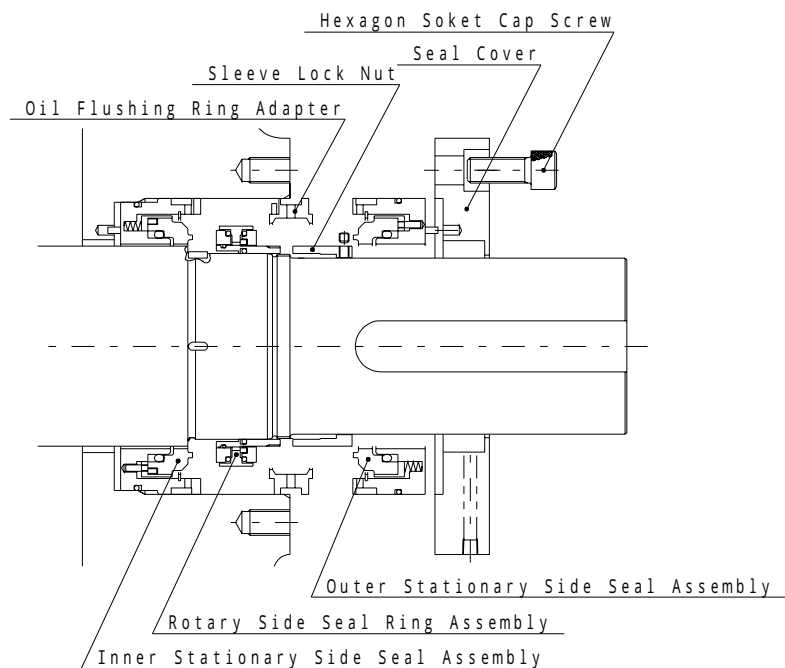


Fig. 3-4 Cross sectional view of mechanical shaft seal

2. Install two eyebolts into bolt holes on the outer stationary side seal



## MYCOM 400V SERIES SCREW COMPRESSOR

### Instruction Manual, Vol. 2

assembly and pull out the outer stationary side seal assembly carefully.

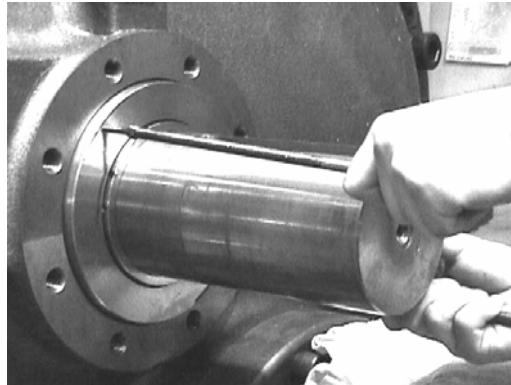


Fig. 3-5 Outer stationary side seal assembly

3. Loosen set screws on the sleeve lock nut and then turn the sleeve lock nut by the wrench. Remove the sleeve lock nut from the shaft.

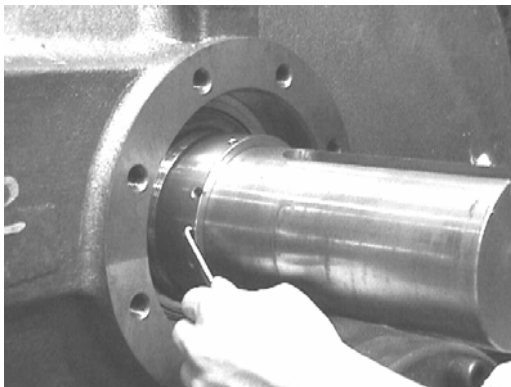


Fig. 3-6 Set screw

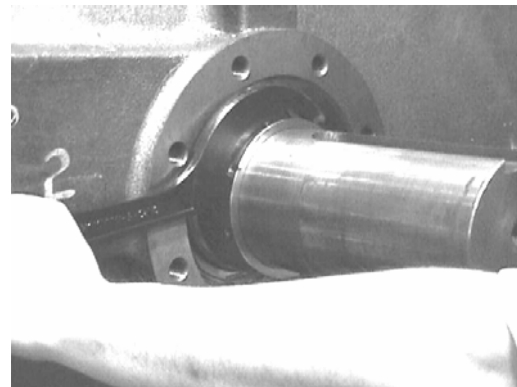


Fig. 3-7 Lock nut sleeve(1)



Fig. 3-8 Lock nut sleeve(2)

4. Attach the threaded ring jig to the rotary side seal ring assembly and pull out the rotary side seal ring assembly with the threaded ring jig from the stuffing box.

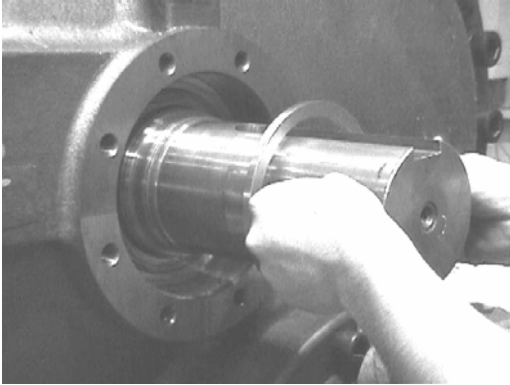


Fig. 3-9 Threaded ring jig

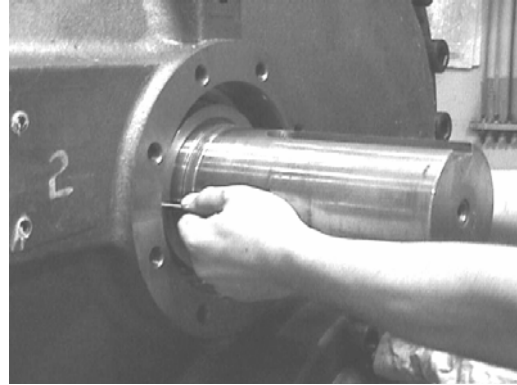


Fig. 3-10 Rotary side seal ring assembly.

5. Remove the oil flushing ring adapter from the stuffing box.

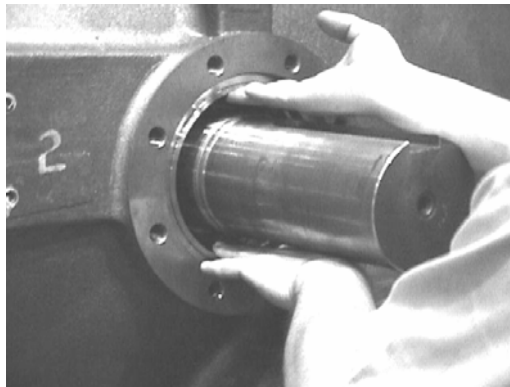


Fig. 3-11 Oil flushing ring adapter

6. Remove the small key on the top of the male rotor. Keep small key so as not to lose it.

7. Install two eyebolts to bolt holes on the inner stationary side seal assembly and pull it out horizontally from the stuffing box.

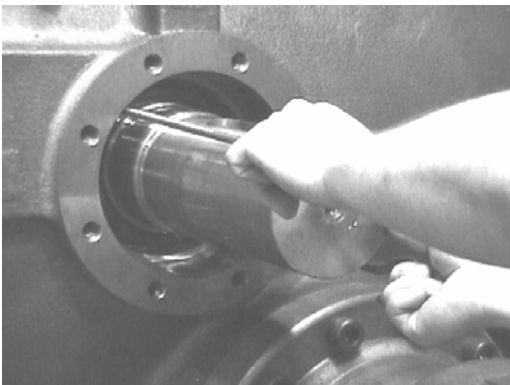


Fig. 3-12 Inner stationary side seal

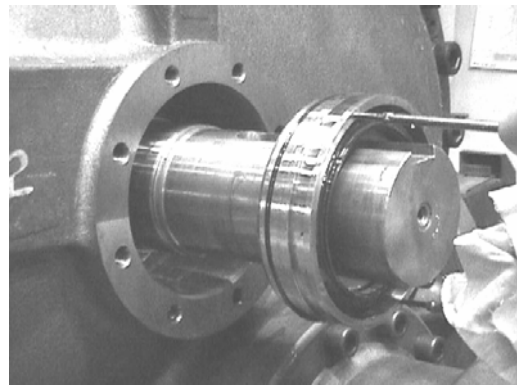


Fig. 3-13 Inner stationary side seal

**3-3-2 Unloader Cylinder Assembly**

1. Remove hexagon cap screws on the unloader cover and remove the unloader cover. Prepare an oil pan to receive the spilt oil from the unloader cylinder in the process of the unloader cover removing.

2. Screw two eyebolts into bolt holes on the unloader piston and pull out the unloader piston with the eyebolts towards the end of the unloader cylinder.

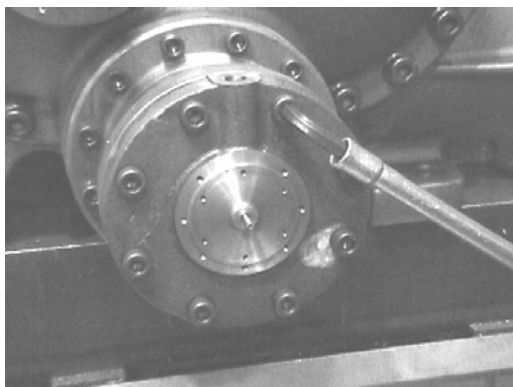


Fig. 3-14 Unloader cover(1)

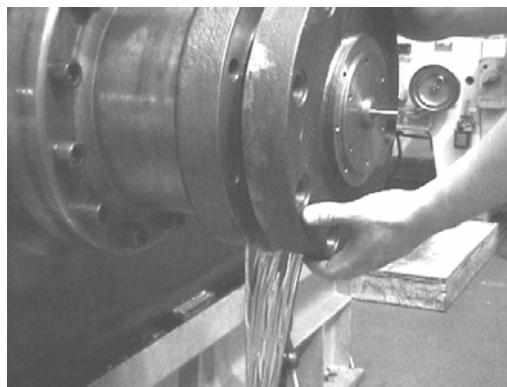


Fig. 3-15 Unloader cover(2)

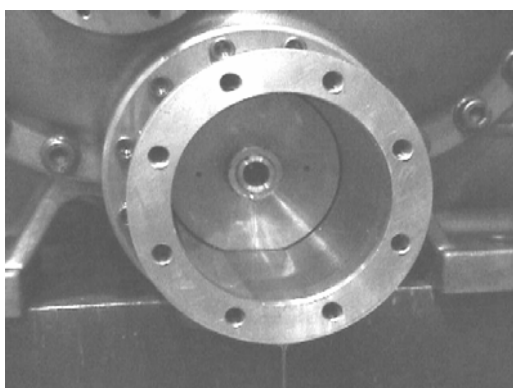


Fig. 3-16 Unloader piston(1)

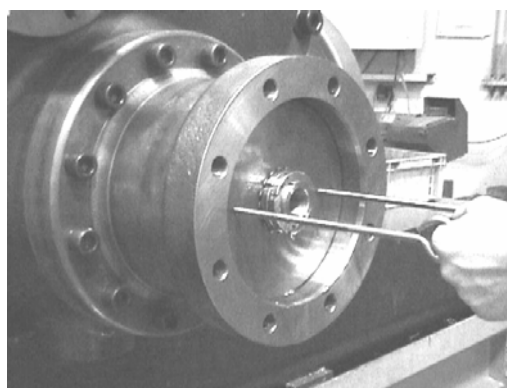


Fig. 3-17 Unloader piston(2)

3. Loosen two lock nuts and remove lock nuts and lock washer.

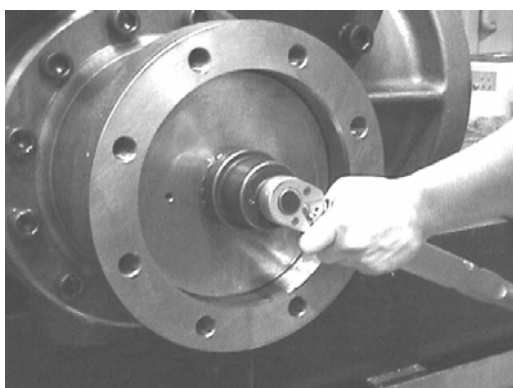


Fig. 3-18 Lock nut and washer(1)

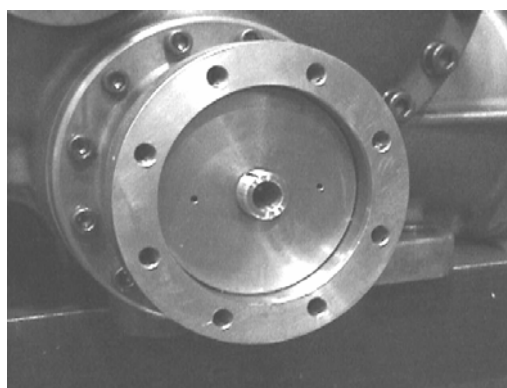


Fig. 3-19 Lock nut and washer(2)

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

4. Remove hexagon cap screws on the unloader cylinder flange. Pull out the unloader cylinder by 25mm.

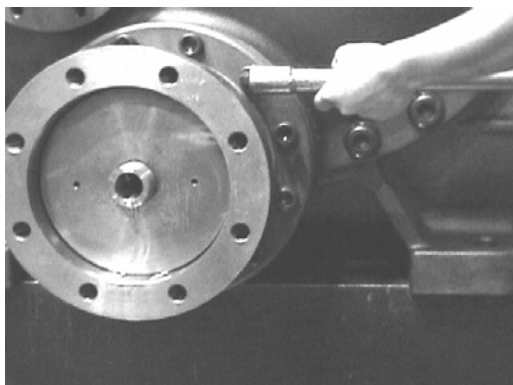


Fig. 3-20 Unloader cylinder(1)

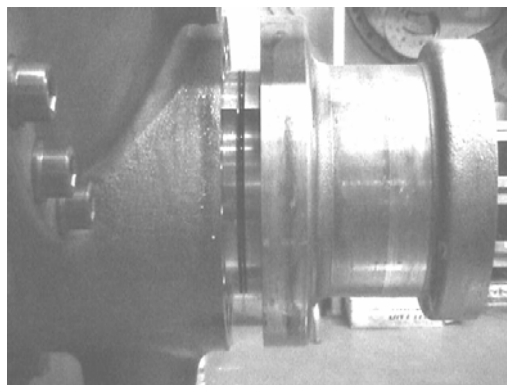


Fig. 3-21 Unloader cylinder(2)

5. Lift up the unloader cylinder by using the crane. Pull out the unloader cylinder horizontally. Prepare an oil pan to recover the spilt oil from the unloader cylinder when removing the unloader cylinder.

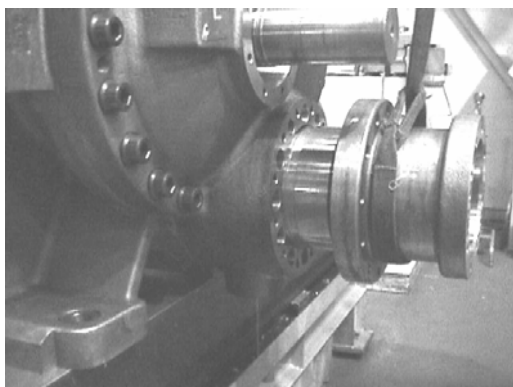


Fig. 3-22 Unloader cylinder(3)

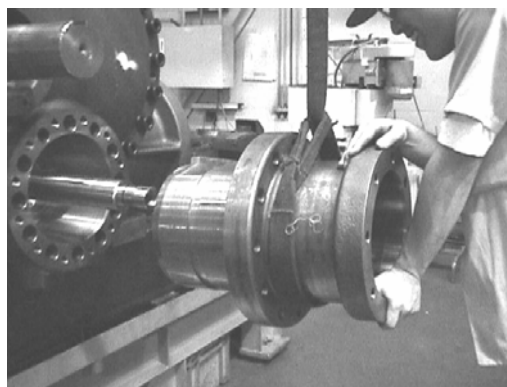


Fig. 3-23 Unloader cylinder(4)

### **3-3-3 Bearing Cover**

1. Loosen hexagon cap screws on the bearing cover. Install two lifting lugs into bolt holes at the top of the bearing cover. Pull out two parallel pins.

2. Remove two bolts at the top and insert safety bolts. Lift up the bearing cover by using the crane. Remove all the remaining bolts, and pull out the bearing cover. Prepare an oil pan for the spilt oil from the bearing head when removing the bearing cover.

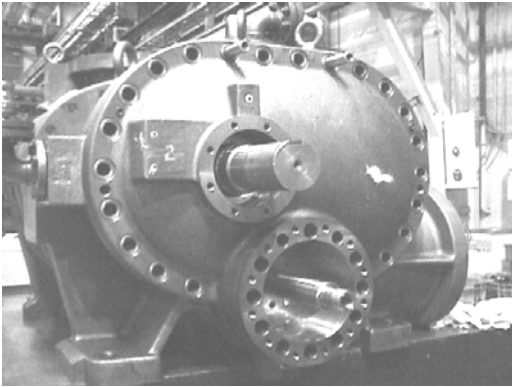


Fig. 3-24 Bearing cover(1)

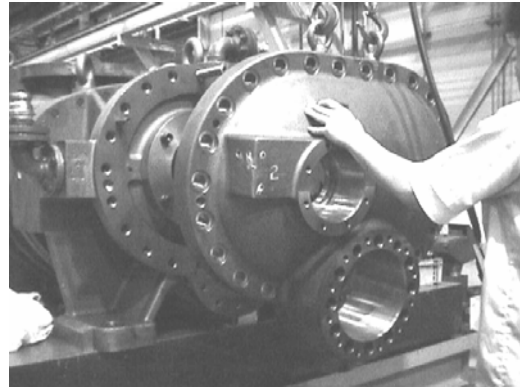


Fig. 3-25 Bearing cover(2)

#### **3-3-4 Thrust Bearing Gland**

1. Loosen hexagon cap screws and install the lifting eyebolt into the bolt hole at the top of the thrust bearing gland.
2. Lift up the thrust bearing gland and remove bolts and insert safety bolt at the top of the thrust bearing gland. Pull out the thrust bearing gland by using minus drivers. Remove the thrust bearing gland and another side thrust bearing gland as same.

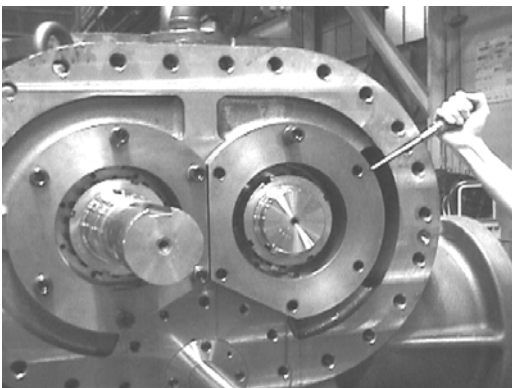


Fig. 3-26 Thrust bearing gland(1)

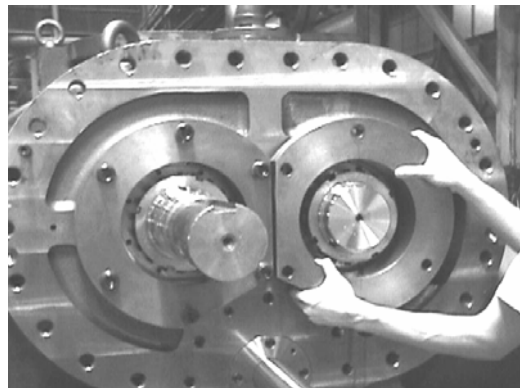


Fig. 3-27 Thrust bearing gland(2)

#### **3-3-5 Thrust Bearing assembly**

1. Loosen the lock nut by using the lock nut wrench and remove the lock nut and lock nut washer.

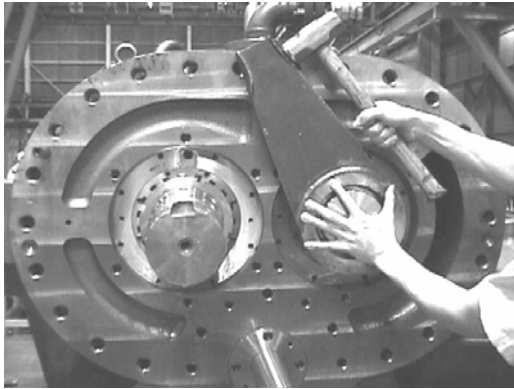


Fig. 3-27 Lock nut(1)

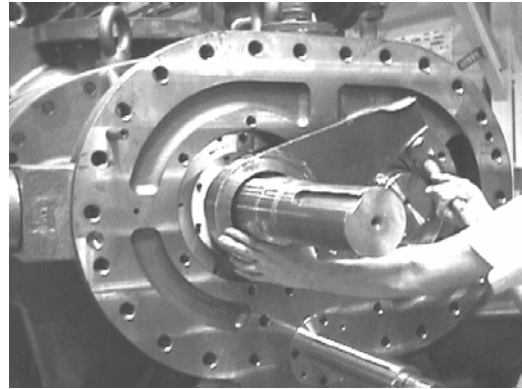


Fig. 3-28 Lock nut(2)

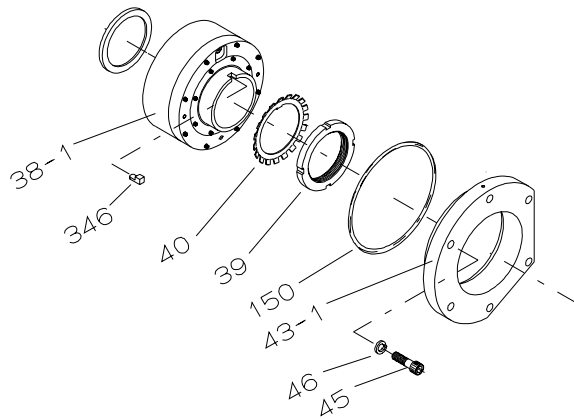


Fig. 3-29 Exploded view of thrust bearing

2. Remove the key on the shaft. Keep small key so as not to miss it.
  
3. Install two eyebolts into bolt holes on the tilting pad thrust bearing and pull it out until a bolt hole on the top of the bearing shows up towards axial direction.
  
4. Install the lifting eyebolt into the hole on the top of the tilting pad thrust bearing and lift it up. Pull out the tilting pad thrust bearing from the bearing box.

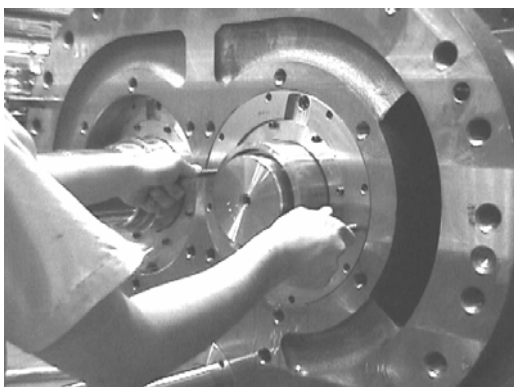


Fig. 3-30 Thrust bearing(1)

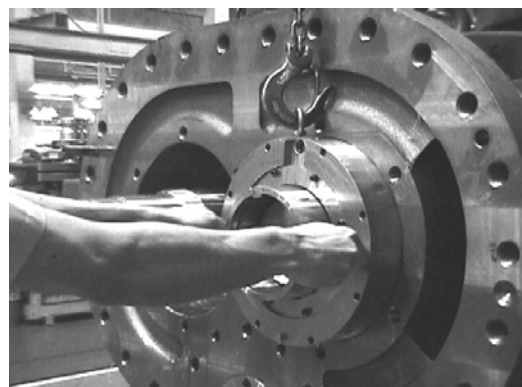


Fig. 3-31 Thrust bearing(2)

5. Remove thrust bearing alignment spacer from the shaft.

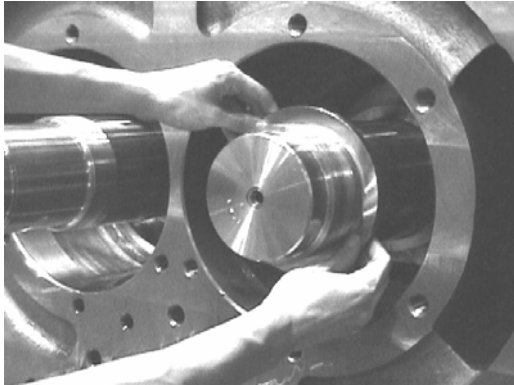


Fig. 3-32 Alignment spacer(1)

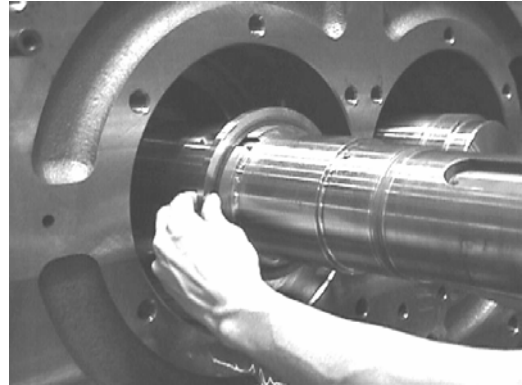


Fig. 3-33 Alignment spacer(2)

### **3-3-6 Domed Cap Nut and Nut**

Loosen the domed cap nut by using the cooper hammer and remove it. Loosen the nut and remove it next time.

### **3-3-7 Balance Piston Cover**

1. Loose and remove two bolts at the top of the balance piston cover. Install two safety bolts into bolt holes at the top of the balance piston cover.

2. Pull out two parallel pins and loosen all remaining hexagon cap screws on the balance piston cover. Install two lifting lugs into bolt holes on the top of the balance piston cover and lift up the balance piston cover by using the crane. Remove all remaining bolts, and pull out the balance piston cover. Prepare an oil pan to recover the spilt oil from the suction cover when removing the balance piston cover.

### **3-3-8 Vi adjusting rod**

Catch flat surfaces of the Vi adjusting rod by the adjustable angle wrench and turn the Vi adjusting rod counterclockwise. Pull out the Vi adjusting rod horizontally.

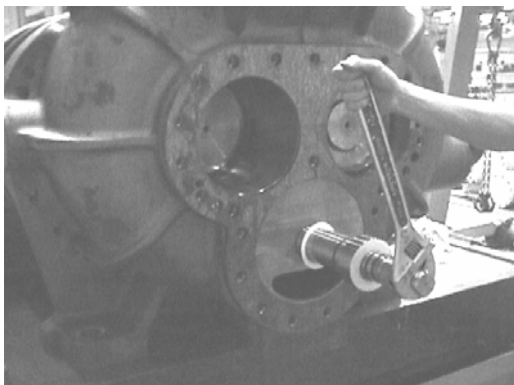


Fig. 3-34 Vi adjusting rod(1)

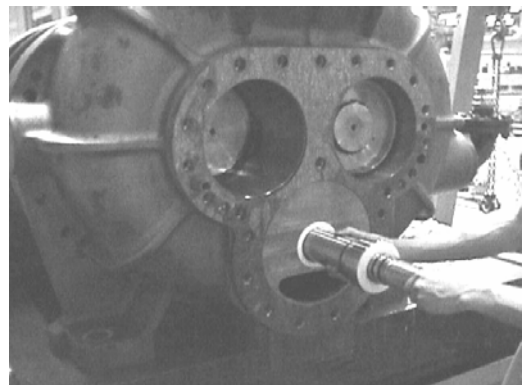


Fig. 3-35 Vi adjusting rod(2)

**3-3-9 Balance Piston Assembly**

1. Remove the retaining ring by using the snap ring pliers.
2. Install two eyebolts into bolt holes on the balance piston and pull out the balance piston.
3. Remove the balance piston sleeve, O-ring and the spacer ring. Remove the retaining ring by using the snap ring pliers.

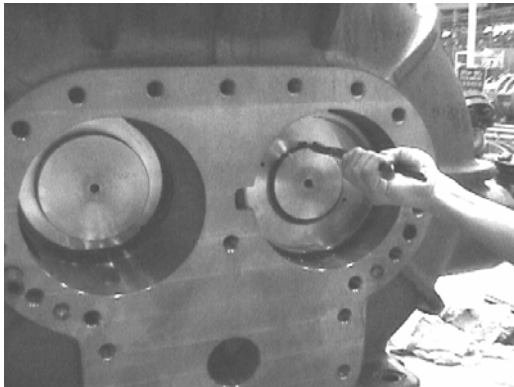


Fig. 3-36 Retaining ring

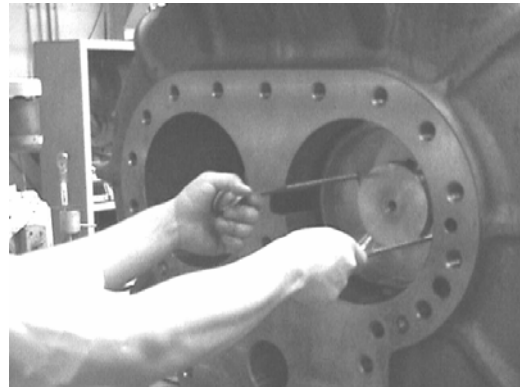


Fig. 3-37 Balance piston(2)

**3-3-10 Suction Cover**

1. Loosen bolts connecting the rotor casing to the suction cover without removing the two parallel pins.
2. Set the compressor as the following fig. 3-38. Install two lifting lugs into bolt holes on the top of the suction cover and lift up the suction cover by using the crane.
3. Pull out two parallel pins and loosen and remove all the bolts.
4. Lift the suction cover by using crane and pull out the suction cover horizontally.

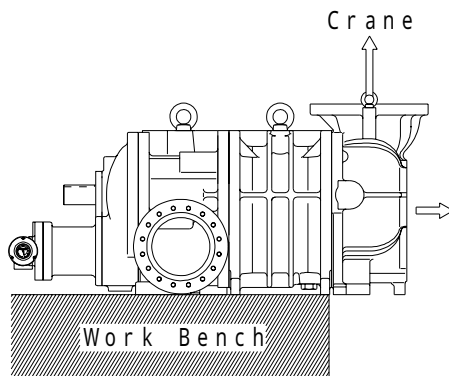


Fig. 3-38 Setting of compressor

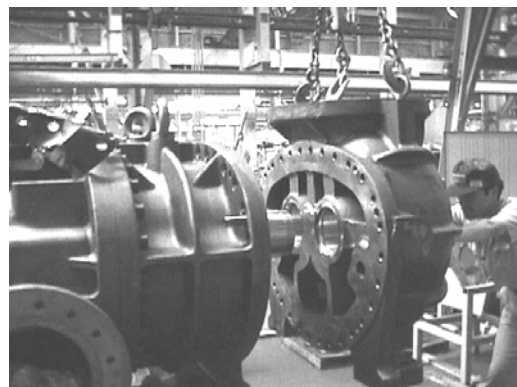


Fig. 3-39 Suction cover

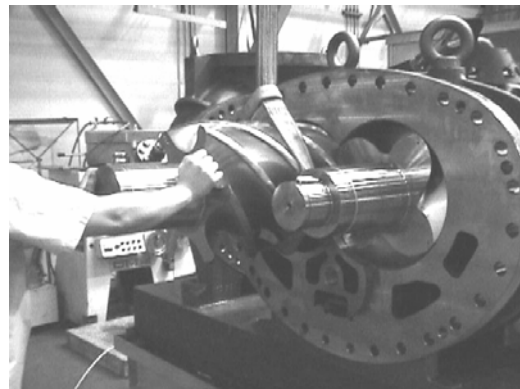
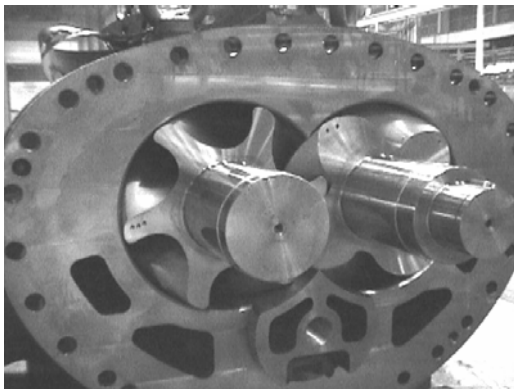


## **MYCOM 400V SERIES SCREW COMPRESSOR**

### **Instruction Manual, Vol. 2**

#### **3-3-11 Rotor Assembly**

1. Push out half of female rotor by turning the drive shaft of male rotor clockwise.
2. Fasten female rotor to the lifting belt and lift up it by using crane carefully.
3. Pull out female rotor horizontally by turning drive shaft of male rotor clockwise.
4. Push out shaft end of male rotor and fasten male rotor to the lifting belt.
5. Lift up male rotor carefully and pull it out horizontally.



#### **3-3-12 Vi Slider**

Pull out Vi slider horizontally.

#### **3-3-13 Guide Block Stem and Guide Block**

Push out the slide valve to the direction of bearing head. Remove the guide block on the guide block stem. Lift up the assembly of the bearing head and rotor casing by using crane. Loosen the guide block stem at the bottom of the rotor casing and remove it. Put the assembly on the working bench.

#### **3-3-14 Slide Valve**

Pull out half of the slide valve. Fasten the slide valve to the lifting belt. Lift up the slide valve and pull it out.

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

**3-3-15 O-ring Gland**

Loosen the hexagon cap screws and remove the bolts. Install two bolts to bolt holes and pull out the O-ring gland.

**3-3-16 Main Bearing and Side Bearing**

Take a look at the surface of the main bearing and the side bearing. If any damages on the bearings are found, remove the retaining ring from the bearing head casing or suction cover casing by using the snap ring pliers and push the main bearing or side bearing out of the rotor casing. When the bearing sits tight on the bearing housing, tap it out using a soft hammer with a plastic or wooden block. Do not strike the bearing directly with a hard hammer.

**3-4 Parts Inspection**

**3-4-1 Mechanical Shaft Seal**

1. Inspect the frictional surface of the carbon and seal ring. If any signs of damage or peeling on the surfaces are found, replace both of the carbon and seal ring.

2. Inspect the O-rings. O-rings may have some swelling or deformation. If any abnormality is observed in an O-ring, replace it with new one.

**3-4-2 Unloader Cover Assembly**

The indicator cam, shaft bearing and V-ring seal are mounted in the unloader cover provided at the end of the unloader cylinder. It is not necessary to disassemble these parts unless they have some damages on them.

**3-4-3 Unloader Cylinder Assembly**

1. Inspect the cap seal and O-ring on the unloader piston and replace if any damage or abnormality is found.

2. The inner surface of the unloader cylinder may sometimes be coated with oil residue or scored.

Finish the inner surface with fine emery paper to remove them.

3. Inspect the push rod and O-ring on the unloader piston and O-ring on the cylinder. If the O-rings show signs of deformation or swelling, replace them with new ones.

**3-4-4 Bearing Cover**

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

Inspect the inner surface of the unloader cylinder box and the stuffing box. The inner surface of the unloader cylinder box or the stuffing box may sometimes be coated with oil residue or scored.

Finish the inner surface with fine emery paper.

**3-4-5 Thrust Bearing Gland**

Inspect the O-ring on the thrust bearing gland. If the O-rings show signs of deformation or swelling, replace with new ones.

**3-4-6 Thrust Bearing Assembly**

1. Disassemble the tilting pad thrust bearing. Inspect the frictional surface of the tilting pads and the thrust collar. If there are any signs of damage or peeling on the tilting pads, replace all tilting pads. If the thrust collar is slightly damaged, finish the thrust surface with fine emery paper after cleaning. If the thrust collar and tilting pad are heavily damaged, it is recommendable to replace them to new ones.

2. Inspect the friction surface of the floating seal and the thrust collar. If the thrust collar and the floating seal are slightly damaged, finish the frictional surface with fine emery paper after cleaning. If the thrust collar and the floating seal are heavily damaged, MYCOM recommend the thrust bearing assembly to replace them to new ones.

**3-4-7 Balance Piston Cover**

Inspect the contact surface with the O-ring. If any damage are founded on the contact surface, finish the surface with fine emery paper after cleaning.

**3-4-8 Vi Adjusting Rod**

Inspect the Vi adjusting rod and O-rings. If the O-rings show signs of deformation or have swelling, replace them with new ones.

**3-4-9 Balance Piston Assembly**

Since the clearance between the balance piston and the balance piston sleeve is smaller than the clearance between the rotor shaft and the bearing, the sleeve may experience wear.

If the inner diameter of the sleeve exceed the service tolerance, indicated at the bottom of the manual, replace it to new one. The clearance provided on the periphery of the balance piston is designed so as to be adjusted by

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

the peripheral clearance and elasticity of the O-ring but sleeve wear is not unusual. Inspect the O-ring and replace if any deformation is founded.

**3-4-10 Suction Cover**

Inspect the contact surface with the O-ring. If any damage are founded on the contact surface, finish the surface with fine emery paper after cleaning.

**3-4-11 Rotor Assembly**

1. Inspect the rotor journals for damage. The mechanical shaft seal mounting portions must be inspected.

2. Inspect the rotor lobes, especially the edges, for damage or abnormal wear. If the compressor has been operating normally, there should be no damage found. If, however, scoring or scratches, etc. are found, it points to a problem with the suction strainer as such damage can only be made by foreign matter entering the system.

**3-4-12 Vi slider**

Inspect the Vi slider and the frictional surfaces and clearance between the Vi slider and the rotor casing. If any damage are founded on the frictional surface, finish the surface with fine emery paper after cleaning.

**3-4-13 Guide Block Stem and Guide Block**

Inspect the guide block stem and the guide block. If any damage are found on the frictional surface, smooth the surface with fine emery paper. If the O-rings show signs of deformation or swelling, replace them with new ones.

**3-4-14 Slide Valve**

Inspect the slide valve and the frictional surfaces and clearance between the slide valve and the rotor casing. If any damage is found on the frictional surface, smooth the surface with fine emery paper.

**3-4-15 Rotor Casing**

Inspect the inner surface of rotor casing. If traces of scratch are visible on the inner surface of the rotor casing, most possible cause is on the bearings problem. Performance will remain unchanged despite wear up to 0.3% of the rotor diameter, excessive wear of the leading edges of the rotors will result in performance decrease.

## **MYCOM 400V SERIES SCREW COMPRESSOR**

### **Instruction Manual, Vol. 2**

#### **3-4-16 O-ring Gland**

Inspect the O-rings. If the O-rings show signs of deformation or swelling, replace them with new ones.

#### **3-4-17 Bearing Head**

Inspect the rotor end surface. If any scratches are visible on the rotor end surface of the bearing head, smooth the surface with fine emery paper and whetstone flatly after cleaning.

#### **3-4-18 Main Bearing and Side Bearing**

1. Inspect the inner surface of the bearing if any foreign matters are imbedded in the white metal. Also measure the inner dimensions of the bearing.
2. Inspect the O-rings. If the O-rings show signs of deformation or swelling, replace them with new ones.

#### **4. Re-Assembly**

##### **4-1 Preparation for Re-Assembly**

Start re-assembling of the compressor immediately after completion of inspection and repair work.

Reconfirm which parts must be replaced and prepare the replacement parts referring to paragraph 3-4.

Re-assembly is essentially carried out in the reverse order of disassembly. All tools necessary for re-assembly should be cleaned and all compressor parts cleaned thoroughly and coated with lubricating oil just before starting work.

##### **4-2 Re-Assembly and Adjustment of Parts**

Use torque wrench for tightening up bolts and nuts in accordance with the torque values specified. During re-assembling, make frequent reference to the cross-sectional drawing, exploded view and parts list provided in order to assure that the compressor is being assembled properly.

Genuine replacement parts should always be used and modification should be strictly avoided.

Recommended order of re-assembly is shown as the following.

Order of Re-assembly

- 1) Slide valve
- 2) Guide block stem and guide block
- 3) Vi slider
- 4) Rotor assembly
- 5) Suction cover
- 6) Vi adjusting rod
- 7) Balance piston assembly
- 8) Thrust bearing assembly
- 9) Bearing cover
- 10) Unloader cylinder assembly
- 11) Unloader cover assembly
- 12) Balance piston assembly
- 13) Mechanical shaft seal

##### **4-2-1 Slide Valve**

Lift up the slide valve by using the crane and insert the slide valve into rotor casing. Check if it moves smoothly in the housing.

**4-2-2 Guide Block Stem and Guide Block**

Lift up the assembly of the bearing head and the rotor casing by using crane. Install the guide block stem with the O ring to the bottom of the rotor casing and tighten up the guide block stem. Put the assembly on the working bench. Push out the slide valve for the direction of bearing head. Install the guide block to the top of the guide block stem. Pull out the slide valve and fit the groove of the slide valve into the guide block stem.

**4-2-3 Vi slider**

Install the Vi slider to the rotor casing.

**4-2-4 Rotor Assembly**

1. Lift up the female rotor by using crane and install it to the rotor casing until the journal shaft of the female rotor fit into the journal bearing. Female rotor jut out the rotor casing about 100 mm.

2. Lift up the male rotor by using the crane and install it into the rotor casing. When the male rotor is installed into the rotor casing, fit the lobe marked the "1" on the male rotor into space between the "1" and the "2" on the female rotor.

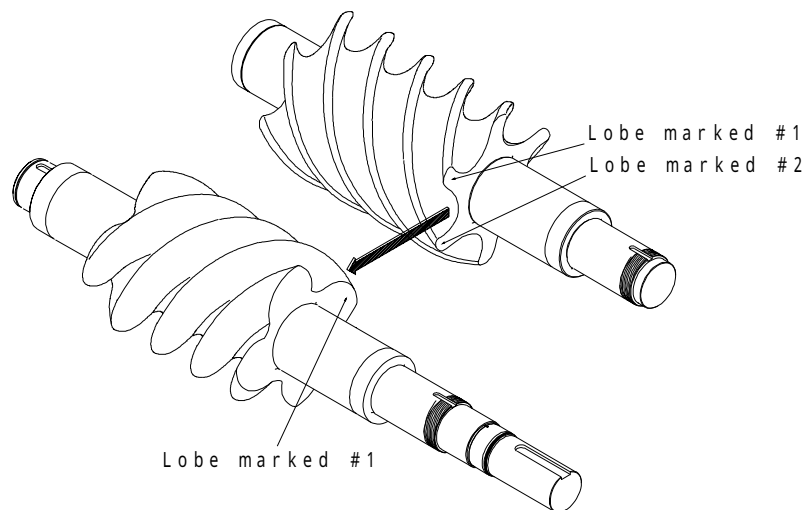


Fig. 4-1 Fitting male rotor and female rotor

3. Push out male and female rotor in the rotor casing completely.

**4-2-5 Suction Cover**

1. Install two lifting lugs on the top of the suction cover and lift up the

suction cover by using crane.

2. Adjust the height of the suction cover to the height of the center of rotors and push out the suction cover into the rotor journal shaft.

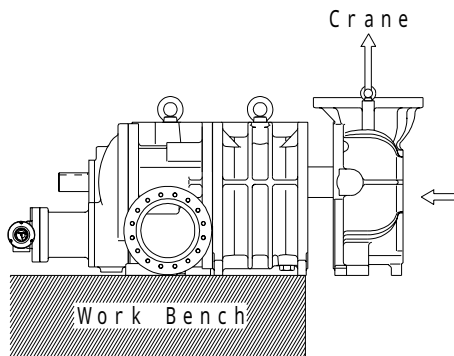


Fig. 4-2 Setting of compressor

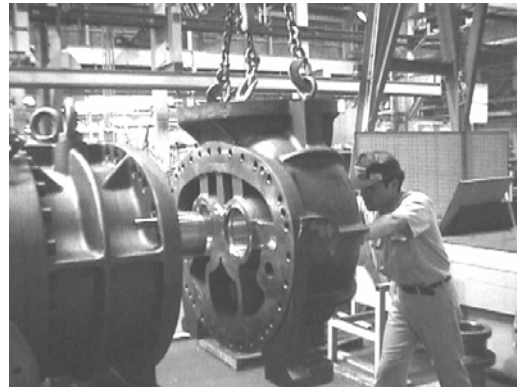


Fig. 4-3 Suction cover

3. Tighten up four hexagon cap screws in balance except sides of holes of the parallel pins.

4. Drive two parallel pins into holes and check the movement of the slide valve.

5. Tighten up all the bolts.

#### **4-2-6 Vi Adjusting Rod**

Insert the Vi adjusting rod with the teflon thrust washer. Catch the flat surfaces of Vi adjusting rod by the adjustable angle wrench and turn the Vi adjustable rod clockwise and connect Vi adjusting rod and Vi slider.

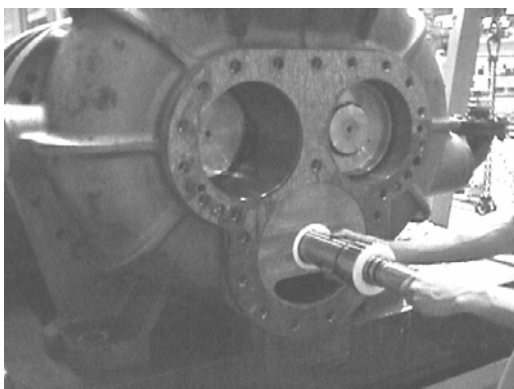


Fig. 4-4 Vi adjusting rod(1)

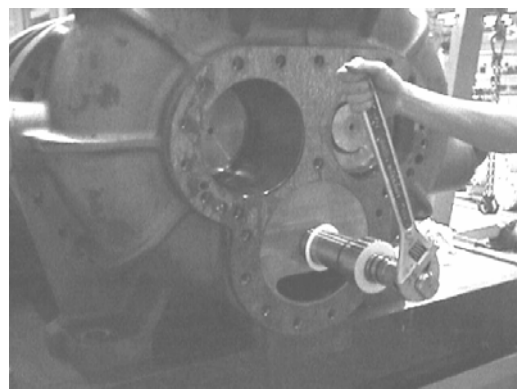


Fig. 4-5 Vi adjusting rod(2)



#### 4-2-7 Balance Piston Assembly

Insert spacer ring, O-ring and balance piston sleeve in turn. Insert a retainer ring by using the snap ring pliers.

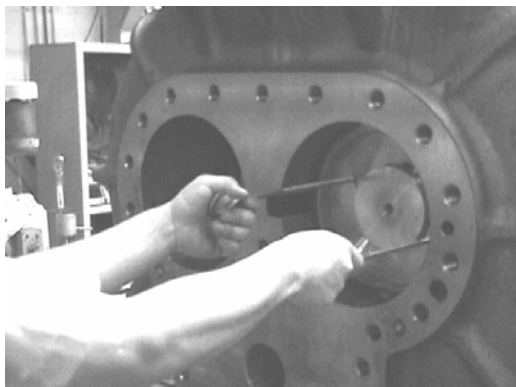


Fig. 4-6 Balance piston(1)

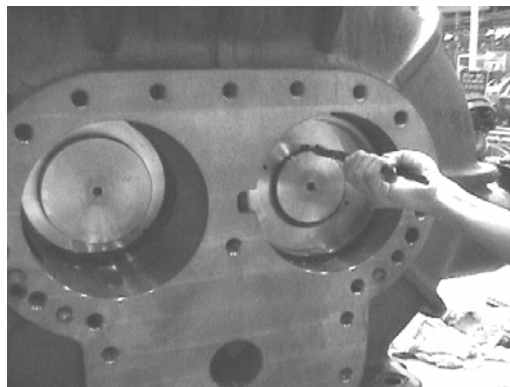


Fig. 4-7 Retainer ring

#### 4-2-8 Thrust Bearing Assembly and Adjustment for End Clearance

1. Install the spacer to adjust the end clearance.

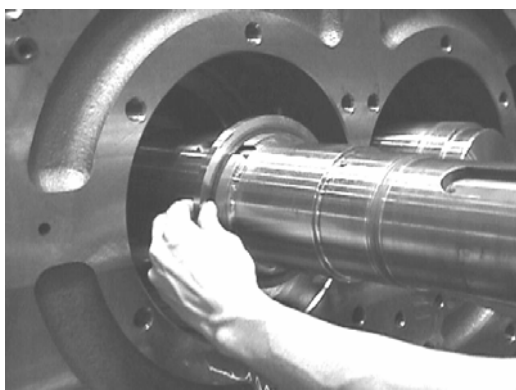


Fig. 4-8 Alignment spacer(1)

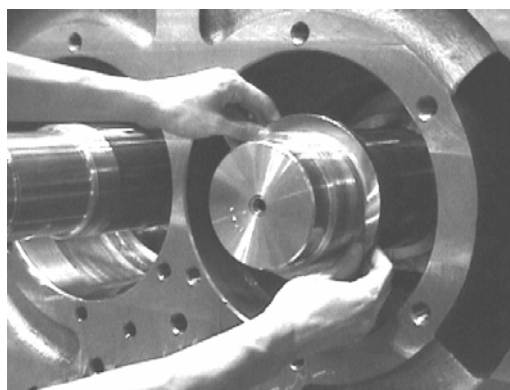


Fig. 4-9 Alignment spacer(2)

2. Install two eyebolts to the tilting pad thrust bearing and lift it up by using crane.

3. Install the thrust collar of the tilting pad thrust bearing to the shaft and push out tilting pad thrust bearing.

4. Insert the key on the key way.

5. Install lock washer and lock nut and tighten up the lock nut by using lock nut wrench.

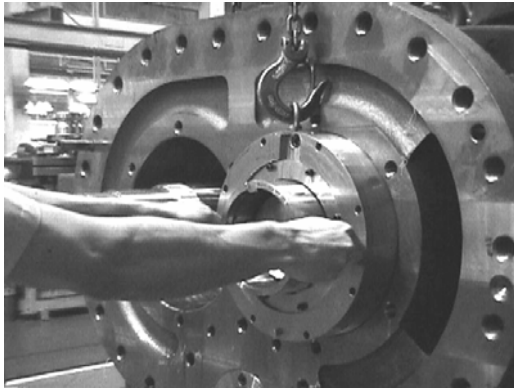


Fig. 4-10 Thrust bearing(1)

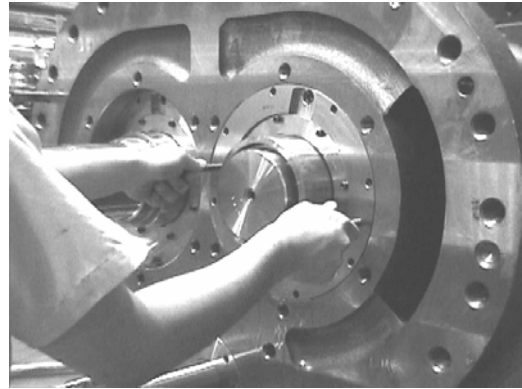


Fig. 4-11 Thrust bearing(2)

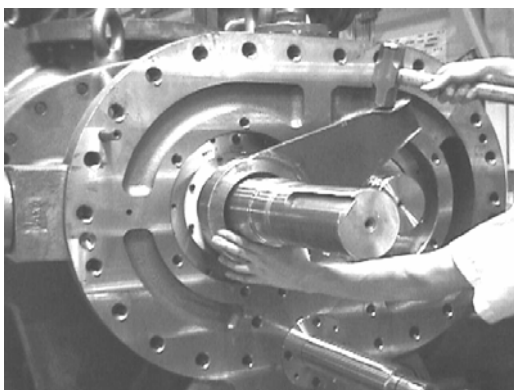


Fig. 4-12 Lock nut(1)

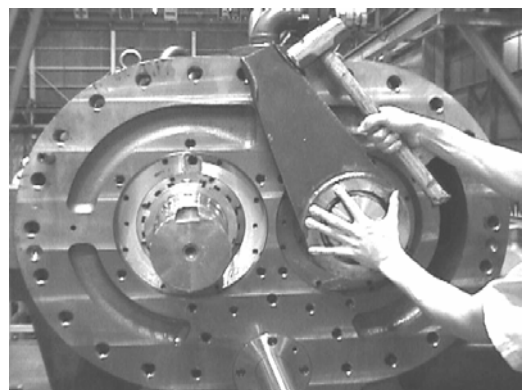


Fig. 4-13 Lock nut(2)

6. Install the thrust bearing gland and hexagon socket cap screws. Do not tighten up the hexagon socket cap screw.

7. To set the end clearance of the male rotor side, turn the drive shaft clockwise and push out the male rotor from the suction side until the rotor hit the surface of the bearing head casing.

For female rotor side, turn the drive shaft counterclockwise and push out female rotor in the same manner.

8. Mount the dial indicator on the suction side end surface, set the indicator to the zero position.

9. Tighten the hexagon cap screws on the thrust bearing gland by the torque value of 100 N·m. When tightening the hexagon cap screws, rotor is moved to the suction side and the end clearance forms between the rotor end surface and the bearing head end surface.

# MYCOM 400V SERIES SCREW COMPRESSOR

## Instruction Manual, Vol. 2

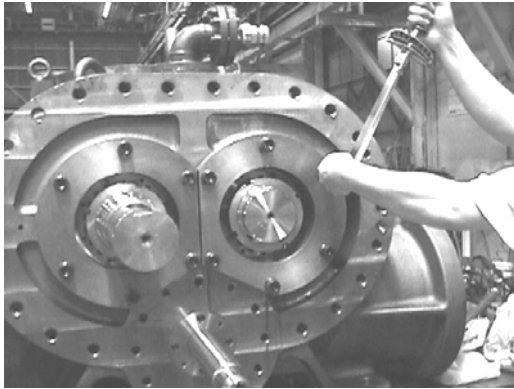


Fig. 4-14 Adjusting clearance(1)

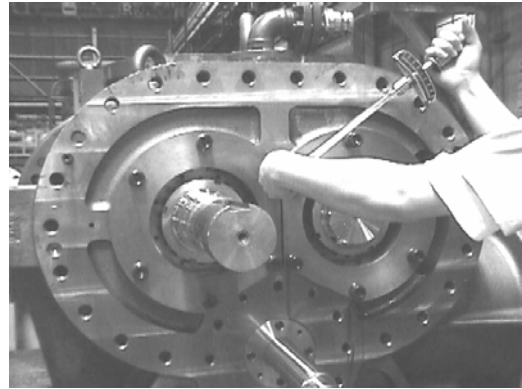


Fig. 4-15 Adjusting clearance(2)

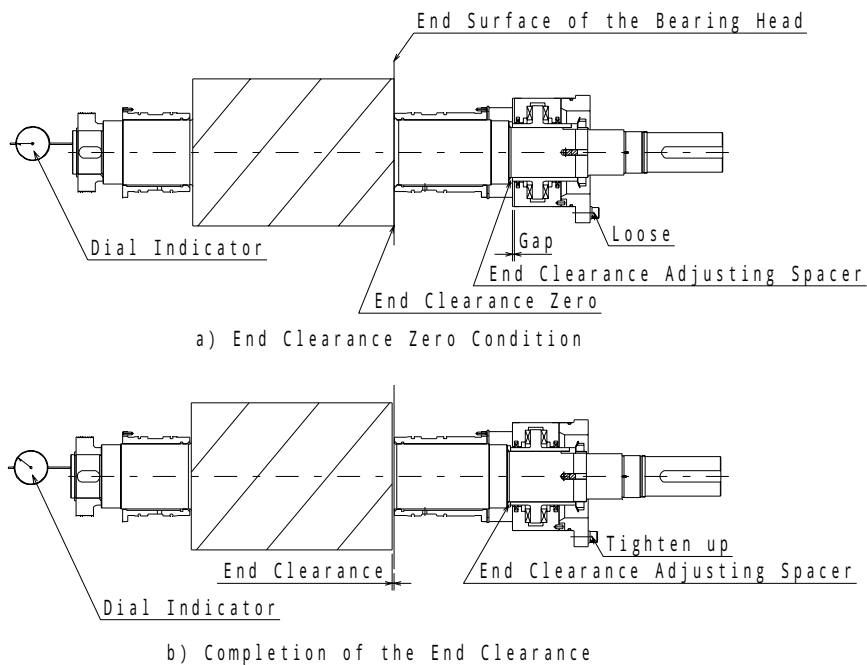


Fig. 4-16 Adjusting end clearance

10. If the end clearance is not within the appropriate range shown below, adjust the end clearance in accordance with one of the methods explained later.

If the end clearance is within the appropriate range, adjust another side end clearance.

Table 4-1 End clearance of 400V series

Unit(mm)

Model	Single stage(high-stage)	Booster(low-stage)
400VSD	0.24-0.30	0.70-0.80
400VMD	0.24-0.30	0.75-0.85

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

11. Adjust the end clearance as follows.

(1)When the end clearance is larger than the specified value.

This means that the end clearance between the rotor end surface and bearing head end surface is too large when the thrust bearing is secured with the gland.

Remove the thrust bearing and the end clearance adjusting spacer. The surface of the end clearance adjusting spacer must be ground down by the amount of the difference between the measured value and the specified value because the end clearance adjusting spacer is too thick. To accomplish this, a high precision grind must be used to ensure that both surfaces of the end clearance adjusting spacer are parallel. After the machining, measure the thickness of the end clearance adjusting spacer using a micrometer. And insert the end clearance adjusting spacer to the shaft and assemble the thrust bearing. For assembling the thrust bearing, take a look at the dial indicator and measure several times and confirm that the proper end clearance is achieved.

(2)When the end clearance is smaller than the specified value.

This means that the end clearance between the rotor end and bearing head end is too small when the thrust bearing is secured with the gland.

Remove the thrust bearing and the end clearance adjusting spacer. Insert the shim between the end clearance adjusting spacer and thrust bearing collar end surface by the amount of the difference between the measured value and the specified value because the end clearance adjusting spacer is too thin. And assemble the thrust bearing. For assembling the thrust bearing, take a look at the dial indicator and measure several times and confirm that the proper end clearance is achieved.

12. After the adjustment for one side end clearance, adjust the end clearance for the other side as same.

13. Rotate the male rotor by hands to confirm a smooth rotation.

14. Check the axial deflection of the shaft rotation with dial indicator positioned on the mechanical shaft seal fitting portion. Maximum run-out of 0.05mm is acceptable. Excessive run-out may be caused by nonuniformity of the thrust bearing adjusting spacer or mismatching of the lock nut and the lock washer. When the runout is larger than the specified value, remove thrust bearing assembly and check the flatness of the spacer and the nut and washer.

And re-assemble again. Check the run-out of shaft rotation again and confirm

that the proper run-out is achieved.

15. After completing the end clearance set up and the run-out check, tighten up the lock nut securely and bend the claw of the lock washer.

**4-2-9 Bearing Cover**

1. Insert two safety bolts at the top of the bearing cover and fit the bearing cover gasket put some oil on the bearing head surface.

2. Lift up the bearing cover by using crane and fit the bearing cover with a care of no damage on the mechanical shaft seal portion.

3. Drive two parallel pins into holes by copper hammer and tighten up the hexagon cap screws. Be careful not to mistake three kinds of bolts.

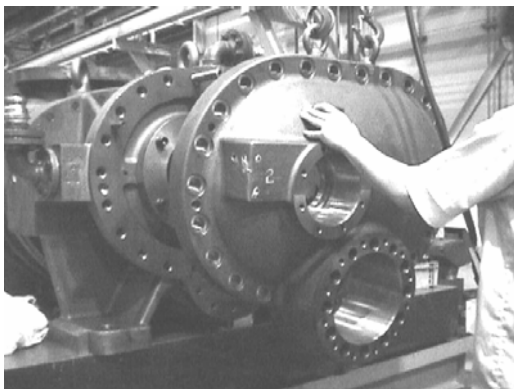


Fig. 4-17 Bearing cover(1)

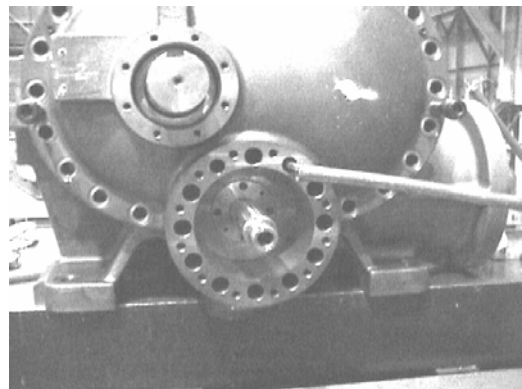


Fig. 4-18 Bearing cover(2)

**4-2-10 Unloader Cover Assembly**

Assemble parts in accordance with Fig. 4-19. Confirm the smooth rotation of the cam shaft.

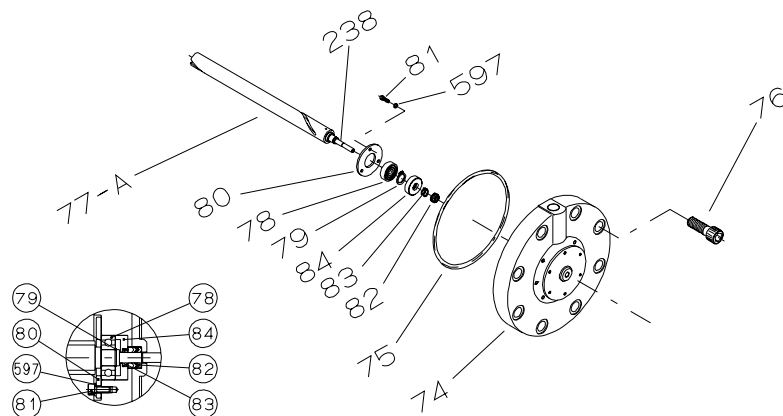


Fig.4-19 Exploded view of the unloader cover assembly

**4-2-11 Unloader Cylinder Assembly**

## **MYCOM 400V SERIES SCREW COMPRESSOR**

### **Instruction Manual, Vol. 2**

1. Fit the O-ring on the unloader piston groove and cover with cap seal. Insert the unloader piston in the unloader cylinder from the beveled side. Fit the O-ring on the unloader cylinder.

2. Lift up the unloader cylinder assembly using crane and insert the unloader cylinder assembly into the bearing cover. The flat surface is located at the top of the cylinder.

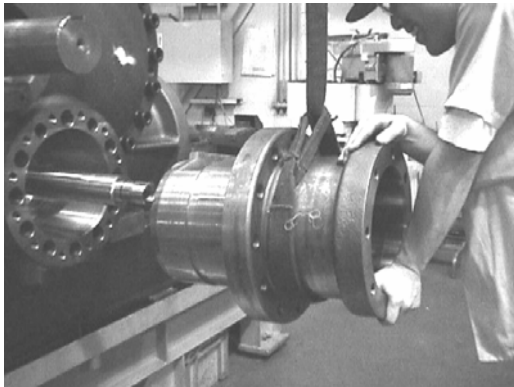


Fig. 4-20 Unloader cylinder(1)

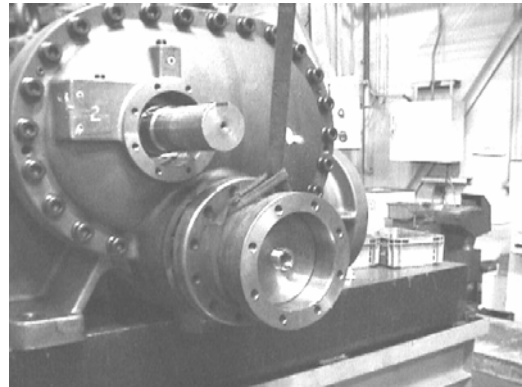


Fig. 4-21 Unloaser cylinder(2)

3. Tighten up all the bolts.

4. Mount the lock nut on threaded portion at the end of the push rod. Install two eyebolts into unloader piston threaded holes. Pull out the unloader piston towards the end of the unloader cylinder.

5. Install the lock washer and the lock nut and tighten up the lock nut using lock nut wrench. Tighten up the other lock nut securely and bend the claw of the lock washer.

6. Install two eyebolts into threaded holes and confirm that the movement of the unloader piston is manually smooth.

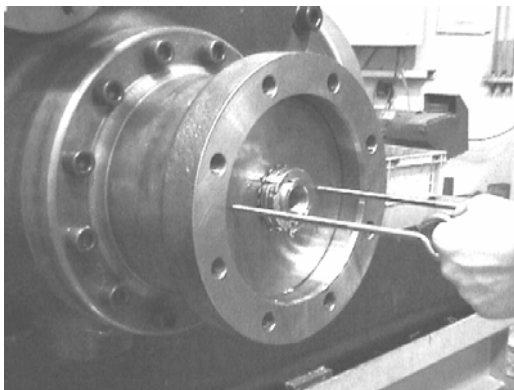


Fig. 4-22 Unloader piston(1)

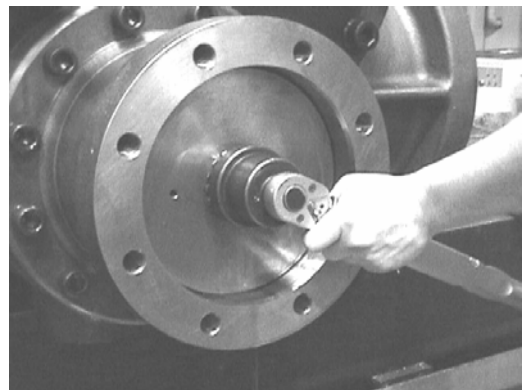


Fig. 4-23 Unloader piston(2)

7. Fit the O-ring on the groove of the unloader cover assembly and push in

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

the unloader cover assembly while mating the groove on the cam with the pin on the push rod.

8. Tighten up hexagon cap screws with the outlet of the unloader piston hydraulic piping facing up.

**4-2-12 Balance Piston cover**

1. Insert two safety bolts at the top of the balance piston cover and fit the bearing cover gasket applied oil on the suction cover surface.

2. Lift up the balance piston cover by using crane and fit the balance piston cover.

3. Drive two parallel pins into holes by copper hammer and tighten up the hexagon cap screws.

4. Catch flat surface of the Vi adjusting rod by the adjustable angle wrench and turn the Vi adjusting rod clockwise and counterclockwise. Confirm the smooth rotation of Vi adjusting rod.

**4-2-13 Mechanical Shaft Seal**

Many seal failures can be caused from installation errors. Careful installation is a major factor in the life of a seal. The installation procedure is shown as follows.

1. Install two eyebolts into threaded holes on inner stationary side seal assembly. Insert inner stationary side seal assembly into the stuffing box while mating the pin hole on the bearing cover with the pin on the carbon assembly.

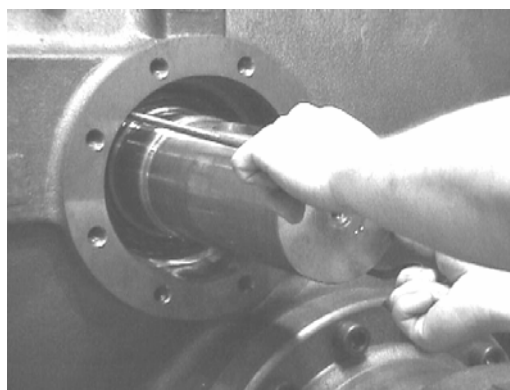
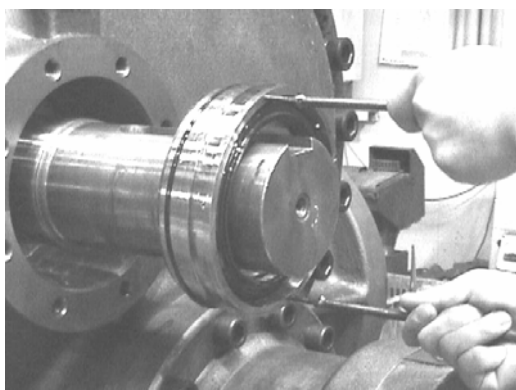


Fig. 4-24 Inner stationary side seal(1)      Fig. 4-25 Inner stationary side seal(2)

2. Insert the oil flushing ring adapter into the stuffing box while mating

## MYCOM 400V SERIES SCREW COMPRESSOR

### Instruction Manual, Vol. 2

the pin groove on the stationary side seal assembly with the pin on the oil flushing ring adapter.

3. Mount the threaded ring jig on the rotary side seal ring assembly. Fit the key to the key way on the shaft. Insert the rotary side seal ring assembly while mating the key groove on the rotary side seal ring assembly with the key on the shaft.

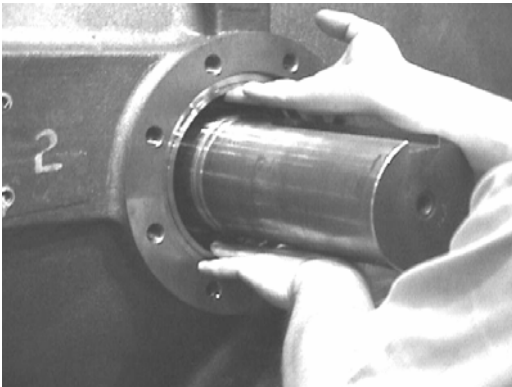


Fig. 4-26 Oil flushing ring adapter(left photo)

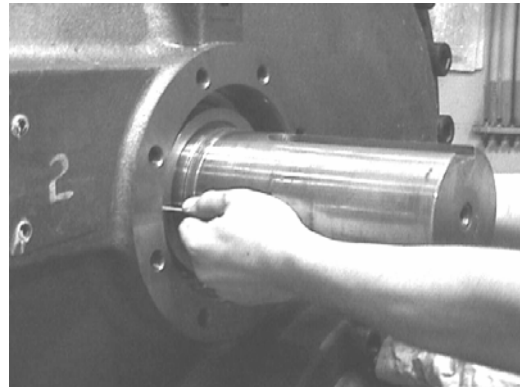


Fig. 4-27 Rotary side seal ring assembly with threaded jig(right photo)

4. Remove the threaded ring jig from the rotary side seal ring assembly. Mount the sleeve lock nut on the shaft and tighten up the sleeve lock nut. Tighten up two set screws on the sleeve lock nut so as not to get loose.

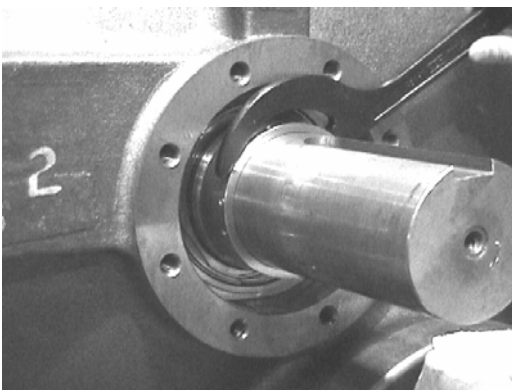


Fig. 4-28 Sleeve lock nut

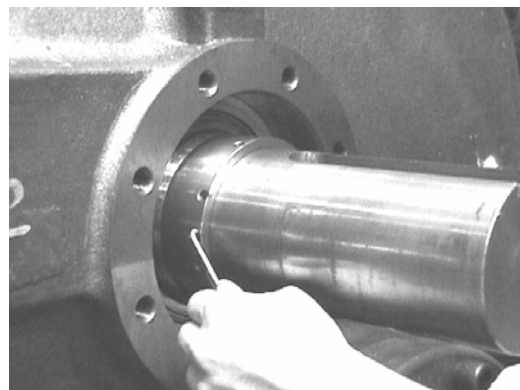


Fig. 4-29 Set screw

5. Install two eyebolts into threaded holes on the outer stationary side seal assembly. Insert outer stationary side seal assembly into the stuffing box.

6. Fit the seal cover on the bearing cover while mating the pin hole on the



**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

seal cover with the pin on the outer stationary side seal assembly. Tighten up hexagon cap screws evenly in diagonal sequence.

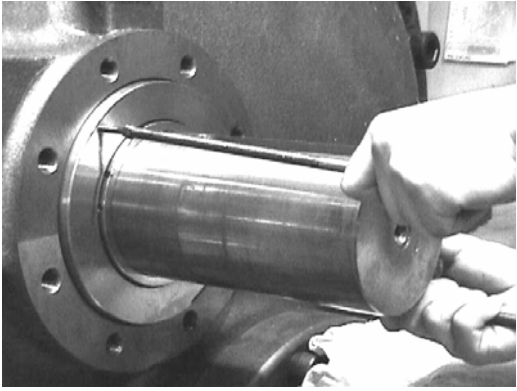


Fig. 4-30 Outer stationary side seal

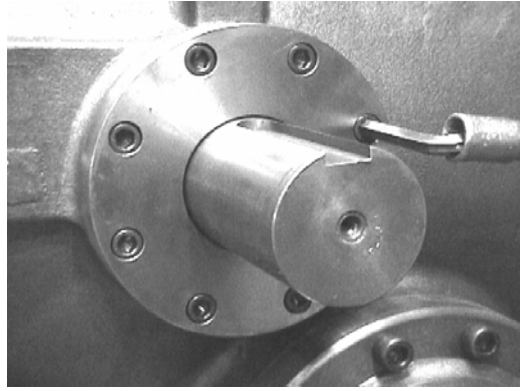


Fig. 4-31 Seal cover

# MYCOM 400V SERIES SCREW COMPRESSOR

## Instruction Manual, Vol. 2

### 5. Unloader Indicator Assembly and Unloader Indicator Fixture Assembly

#### 5-1 Explode View of Unloader Indicator Assembly and Unloader Indicator Fixture Assembly

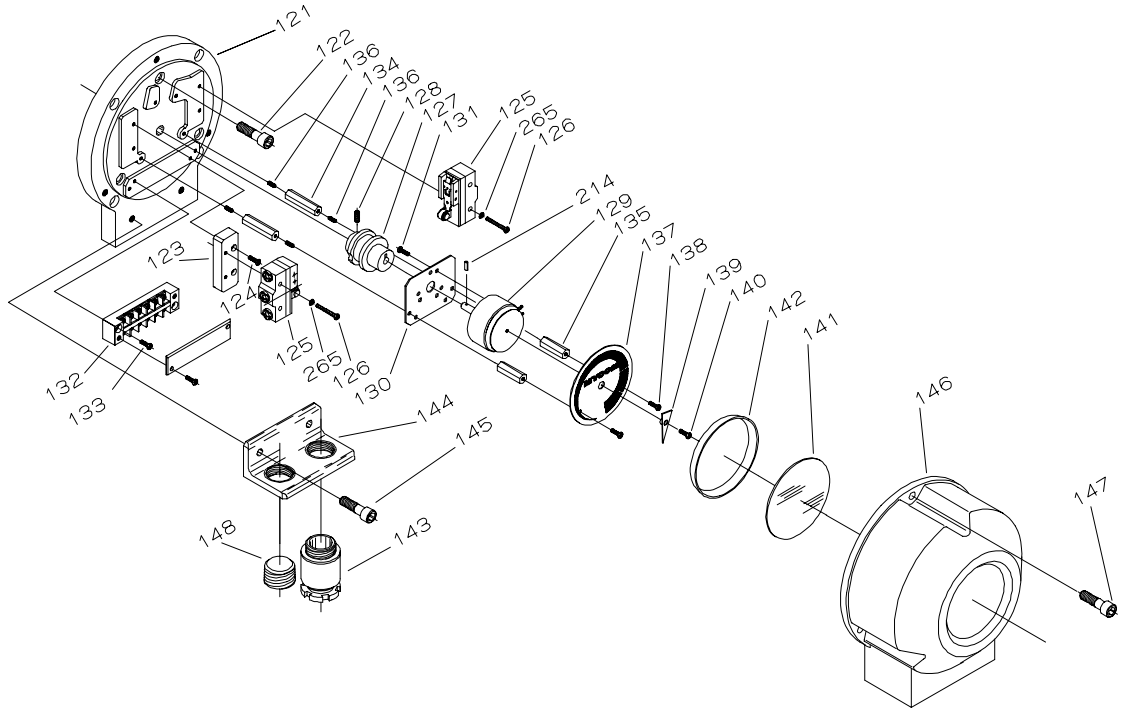


Fig. 5-1 Unloader indicator assembly

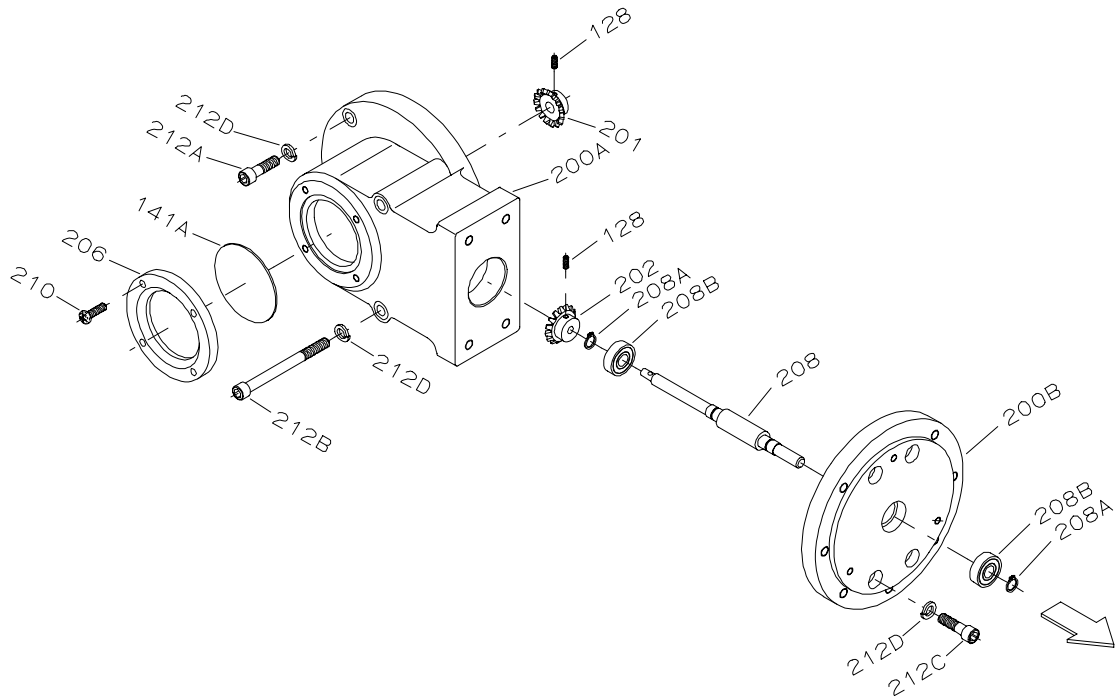


Fig. 5-2 Unloader indicator fixture assembly

# **MYCOM 400V SERIES SCREW COMPRESSOR**

## **Instruction Manual, Vol. 2**

Table 5-1 Unloader indicator and fixture assembly parts list

No.	Parts	Qty.	No.	Parts	Qty.
121	Micro-switch base plate	1	142	Indicator glass spacer ring	1
122	Hexagon socket cap screw	3	143	Electric wiring connector	1
123	Micro-switch set plate	1	144	Connector support	1
124	Machine screw	2	145	Hexagon socket cap screw	2
125	Micro-switch	2	146	Indicator cover	1
126	Machine screw	4	147	Hexagon socket cap screw	3
127	Micro-switch cam	1	148	Plug	1
128	Hex-head socket set screw	4	200A	Indicator fixture casing	1
129	Potentiometer	1	200B	Indicator fixture plate	1
130	Potentiometer mounting plate	1	201	Bevel gear(1)	1
131	Machine screw	3	202	Bevel gear(2)	1
132	Terminal block	1	206	Glass support	1
133	Machine screw	2	208	Shaft	1
134	Dial plate support(1)	2	208A	Snap ring	2
135	Dial plate support(2)	2	208B	Ball bearing	2
136	Hexagon socket cap screw	4	210	Machine screw	4
137	Dial plate	1	212A	Hexagon socket cap screw	2
138	Machine screw	2	212B	Hexagon socket cap screw	2
139	Indicator pointer	1	212C	Hexagon socket cap screw	4
140	Machine screw	1	212D	Spring washer	8
141	Indicator glass	1	214	Spring pin	1
141A	Indicator glass	1	265	Spring washer	4

### **5-2 Disassemble and Re-assemble for Unloader Indicator Fixture Assembly**

Unloader Indicator Fixture Assembly is mounted on the unloader cover. Unloader indicator assembly is attached to the unloader indicator fixture assembly. When disassembling and re-assembling, handling parts should be done only with a full understanding of the construction of the unloader indicator assembly.

### **5-3 Disassembly and Adjustment of Unloader Indicator**

The potentiometer(129), micro-switch(125) and micro-switch cam(127) are mounted in the shaft(208) of the unloader indicator fixture assembly.

## **MYCOM 400V SERIES SCREW COMPRESSOR**

### **Instruction Manual, Vol. 2**

#### **5-3-1 Disassembly and Adjustment of Unloader Indicator**

a) Remove the machine screw(140) securing the indicator pointer(139).

b) Remove the machine screw(138) securing the dial plate(137)

c) The potentiometer mounting plate(130) is fitted between the dial plate support(1)(134) and dial plate support(2)(135).

Loosen and remove support(2) by turning counterclockwise while holding support(1) securely.

d) When the right and left support are removed, the potentiometer(129) can be removed together with the mounting plate(130).

e) The potentiometer is secured to the mounting plate with three machine screws(131).

f) The micro-switch(125) is secured with two long machine screws(126).

Loosen these screws to remove the micro-switch.

The micro-switch component on the right side is for the no-load position signal and the one on the left side is for the full-load position signal.

The micro-switch set plate(123), secured by other screws(124), is mounted under the left side micro-switch component. The micro-switch component on the right side is for the no-load position signal while the one on the left side is for the full-load position signal.

Adjustment of the micro-switch is accomplished using with micro-switch cam(127).

g) The terminal block(132) and other parts can be removed by removing the screws(133) securing them.

#### **5-4 Inspection**

a) Only actuation of the electrical components needs to be inspected.

Since a full rotation type potentiometer is used, test to confirm smooth resistance throughout the full rotation of the device.

Operation in an atmosphere containing moisture or corrosive gas will lead to rusting of the components and resistance may change, resulting in faulty operation indication.

**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**

b) Check the actuation of the contact points of the micro-switch components using a tester (for details contact Electric Department of MYCOM).

**5-5 Assembly and Adjustment**

The procedures for re-assembling the unloader indicator are the reverse of disassembly.

Adjustment after assembly is, of course, very important. There are basically two aspects of adjustment.

(1) The physical relationship between the micro-switch cam (127) and the slide valve (54).

(2) The relationship between the no-load position and the resistance value of the potentiometer.

Adjustment of these factors should be carried out after the micro-switch baseplate (121) has been mounted on the unloader indicator fixture plate (200B).

a) The unloader cover is fitted to re-assembled on the compressor with the unloader piston (64) in the no-load position so secure the micro-switch cam with the hexagon head cap screw (128) to bring it into line with the countersunk hole in the shaft (208) of the unloader indicator fixture assembly. Rotation of the micro-switch cam is transmitted by rotation of the unloader indicator cylinder cam through the unloader indicator fixture assembly. Micro-switch cam is then in the no-load position.

Align the concave point of the micro-switch cam (127) facing the unloader indicator fixture plate (200B) with the actuation arm point of the micro-switch.

b) When mounting the potentiometer (129), fit the spring pin (214) of the potentiometer shaft in the groove of the micro-switch cam.

c) Correct positioning of the potentiometer is established by the work indicated in the above paragraph b.

d) Fit the dial plate and mount the indicator pointer (139), aligning it to the no-load position.

If a full load micro-switch (125) is provided, adjust the micro-switch setting screw (126) so that it is actuated by the cam.

## **MYCOM 400V SERIES SCREW COMPRESSOR**

### **Instruction Manual, Vol. 2**

Actuation of the micro-switch(125) is confirmed by moving the unloader slide valve(54) to the full load position with oil pressure when the hydraulic pump can be operated or by supplying low pressure air to the unloader piston(64).

If the machine screw(126) of the micro-switch are loose, the micro-switch may slip out of the position, resulting in irregular or faulty actuation. Secure the micro-switch tightly after confirming actuation.

e) After confirming proper actuation, connect the control wiring as before and mount the unloader indicator cover(146). Be careful not to pinch the wires with the cover.

Disassembly, inspection and re-assembly of V series unit is now completed.

# **MYCOM 400V SERIES SCREW COMPRESSOR**

## **Instruction Manual, Vol. 2**

### **6. Standards of Components**

#### **6-1 Hand Tool Kit**

Hand tool name	Location
Ratchet wrench (1/4")	Needle valve
Crescent wrench (375mm)	Vi adjusting rod
Screwdriver (+)	Load indicator
Screwdriver (-)	Lock washer
Offset wrench (46mm)	M30 Hexagon head bolt (Suction flange)
Offset wrench (36mm)	M24 Hexagon head bolt (Discharge flange)
Offset wrench (24mm)	M16 Hexagon head bolt (Other flanges)
Hexagon bar wrench (22mm)	M30 Hexagon socket head cap screw
Hexagon bar wrench (19mm)	M24 Hexagon socket head cap screw
Hexagon bar wrench (17mm)	M22, M20 Hexagon socket head cap screw
Hexagon bar wrench (14mm)	M16 Hexagon socket head cap screw
Hexagon bar wrench (12mm)	M14 Hexagon socket head cap screw
Hexagon bar wrench (10mm)	M12 Hexagon socket head cap screw
Hexagon bar wrench (5mm)	M6 Hexagon socket head cap screw
Hexagon bar wrench (4mm)	M5 Hexagon socket head cap screw
Hexagon bar wrench (2mm)	M2.5 Hexagon socket head cap screw
Eyebolt (M8 X 2)	Balance piston, unloader piston, thrust bearing gland
Eyebolt (M10 X 2)	Tilting pad thrust bearing
Eyebolt (M5 X 2)	Mechanical shaft seal
Lock nut wrench (AN28)	Lock nut (thrust bearing)
Lock nut wrench (AN10)	Lock nut (unloader piston)
Torque wrench (130N)	M20 Hexagon socket head cap screw
Hexagon head socket (17mm)	M20 Hexagon socket head cap screw
Snap ring pliers (H-6)	Retaining ring (hole 250mm)
Snap ring pliers (S-4)	Retaining ring (shaft 120mm)
Copper hammer	M56 Hexagon nut, M56 Domed cap nut
Plastic hammer	
Iron hammer	Lock nut
Sponge (160mmX160mmXt30mm)	
Jig for mechanical shaft seal	Mechanical shaft seal

# **MYCOM 400V SERIES SCREW COMPRESSOR**

## **Instruction Manual, Vol. 2**

### **6-2 O-ring Kit for compressor**

No.	Size	Qty.	No.	Size	Qty.
9	JIS B 2401 G95	1	150	JIS B 2401 G290	2
35	JIS B 2401 G240	1	163	JIS B 2401 G65	1
63	JIS B 2401 G250	1	325	JIS B 2401 P70	2
65	JIS B 2401 P215	1	432	JIS B 2401 G210	4
66	CAP-3BE-215	1	433	JIS B 2401 G210	4
73	JIS B 2401 G45	1	450	JIS B 2401 P50A	2
75	JIS B 2401 G220	1	451	JIS B 2401 P70	1
89	JIS B 2401 P39	2			

### **6-3 O-ring List for Mechanical Shaft Seal**

No.	Size	Qty.	No.	Size	Qty.
P1-2	JIS W 1516 G33	2	P4A	JIS B 2401 P135	2
P1-4	AS568 158	2	P52-1	JIS W 1516 G39	1
P2A	JIS B 2401 G120	1	P52-2	JIS W 1516 G40	1

AS568 : Aerospace size standard for O-ring

### **6-4 Gasket Kit**

No.	Location	Qty.	No.	Location	Qty.
6	Suction cover	1	17	Bearing cover	1
12	Bearing head	1	23	Balance piston cover	1

### **6-5 Lock Washer and Lock Nut**

No.	Lock nut size	Qty.	No.	Lock washer size	Qty.
39	AN28	1	40	AW28X	1
69	AN10	1	70	AW10	1

### **6-6 Bolt Fastening Torque**

Size	kgf-cm	N-m	Size	kgf-cm	N-m
M4	28	2.8	M14	1400	140.0
M5	60	6.0	M16	2400	240.0
M6	100	10.0	M20	4500	450.0
M8	250	25.0	M22	6000	600.0
M10	500	50.0	M24	7500	750.0
M12	900	90.0	M30	16000	1600.0



**MYCOM 400V SERIES SCREW COMPRESSOR**  
**Instruction Manual, Vol. 2**