TRANE™

# Maintenance OCOM-M-5

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|---|---|
| Library | **Service Literature** |
| Product Section | **Refrigeration** |
| Product | **Reciprocating Compressor - Condenser Units** |
| Model | **Open E & F** |
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| Supersedes | **2C1C 1284** |

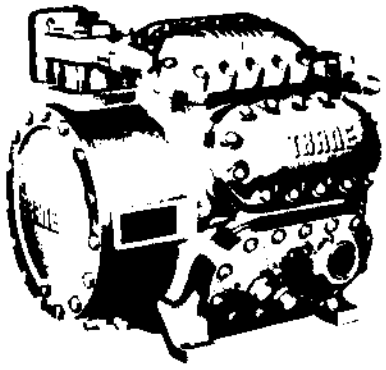
# OPEN RECIPROCATING COMPRESSORS

MODEL E-4, 5, 6 AND 8 CYLINDER
DESIGN SEQUENCE A THRU K

MODEL F-4, 5, 6 AND 8 CYLINDER
DESIGN SEQUENCE A, B AND C

MODEL F-3
DESIGN SEQUENCE A THRU E

*THIS SECTION COMBINES 2C1C, 2C2C AND 2C3C DATED NOV., 1959



The Trane Company
La Crosse, Wisconsin 54601-7599
Printed in U.S.A.

**The Trane Company urges that when servicing Trane equipment, or any other manufacturer's equipment, every effort should be made to eliminate the emissions of CFC,HCFC and HFC refrigerants to the atmosphere resulting from installation, operation, routine maintenance or major repair of the equipment. Conservation of refrigerants is important even when working with acceptable alternative refrigerants.**

Conservation and emission reduction can be accomplished by following recommended Trane operation, maintenance, and service procedures with specific attention to the following:

1. Refrigerant used in any type of air-conditioning or refrigerating equipment should be recovered for reuse, recovered and/or recycled for reuse, reprocessed (reclaimed), or properly destroyed, whenever it is removed from the equipment.
2. Always determine possible recycle or reclaim requirements of the recovered refrigerant before beginning recovery by any method. (Questions about recovered refrigerants and acceptable refrigerant quality standards are addressed in ARI Standard 700.)
3. Use approved containment vessels and safety standards for the storage or transporting of new or used refrigerant. Comply with all applicable transportation standards when shipping refrigerant containers.
4. To minimize refrigerant emissions use recycling equipment when recovering refrigerant. Use methods which will pull the lowest possible system vacuum while recovering and condensing refrigerant into containment.
5. When leak checking with trace refrigerant and nitrogen, use HCFC-22 (R-22) rather than CFC-12 (R-12) or any other fully halogenated refrigerants. Remain aware of any new leak test methods which eliminate refrigerants as a trace gas.
6. When cleaning system components avoid using chemicals that have ozone depletion capability. Properly dispose of used materials in accordance with the manufacturers recommendations.
7. Take extra care to properly maintain all service equipment directly supporting refrigerant service work such as gages, hoses, vacuum pumps, and recycling equipment.
8. Remain aware of unit enhancements, conversion refrigerants, compatible parts and manufacturer's recommendations which will reduce refrigerant emissions and increase equipment operating efficiencies. Follow specific manufacturers guidelines for conversion of existing systems.
9. In order to assist in reducing power generation emissions, always attempt to improve equipment performance with improved maintenance and operations which will help conserve energy resources.

**Table 1 — Recommended Wear Limits and Tolerances - Model "F" Compressors**

| Part Name | Original Spec. | Recommended Limit | Maximum Recommended Oil Clearance |
|---|---|---|---|
| Main Bearings<br>Crankshaft - Mains | 2.1265 - 2.1280<br>2.1245 - 2.1250 | 2.1305<br>2.1230 | .0055 |
| Conrod - Crank Pin (Vert.)<br>Crankshaft - Crank Pin | 2.0022 - 2.0030<br>1.9995 - 2.0000 | 2.006<br>1.997 | .007 |
| Piston Rod<br>Conrod - Pin Bore (Vert.) | .8748 - .8750<br>.87505 - .87530 | .8744<br>.8755 | .0011 |
| Cylinder Liner<br>Piston (Perpendicular To Centerline Of Pin Bore) | 2.7500 - 2.7505<br>2.7480 - 2.7487 | 2.7520<br>2.7470 | .0035 |
| Piston Rings (Gap In 2.7500 Ga.) | .007 - .017 | .040 Compression Rings<br>.060 Oil Rings | |
| Valves (All) | Valves are .033" thick - should be replaced when seat groove wear depth exceeds .010" (.023" thinnest section). | | |
| Valve Springs (All) | Whenever compressor is disassembled for servicing. Valve springs should be replaced where they have operated in excess of 5000 hours on R-12 or 3000 hours on R-22. | | |
| Bellows Springs | Refrigerant 12<br>Black | Refrigerant 22<br>Green | |
| Allowable Air Gap, Rotor and Stator - .008 - .010 Side to Side. | | | |
| End Play (Crankshaft) - .015" - .025" | | | |

Notes:

1. The above recommended wear rates are for individual parts. For mating parts, the maximum recommended oil clearance should predominate. In most cases this means that both mating parts should not each be at the recommended limit dimension.
2. These recommended limits are listed as good practice for normal service rebuilding of compressors which will be reliable when put back into service. It is not necessary to rebuild a compressor when these limits are anticipated.

* Due to the many design changes over the years and the different combinations of parts that may have been used during rebuilding, it is impractical to give the tolerances by design sequence. Therefore the part dimensions given are for the latest design compressors.

**Table 1 — Recommended Wear Limits and Tolerances - Model "E" Compressors**

| Part Name | Original Spec. | Recommended Limit | Maximum Recommended Diametral Clearance |
|---|---|---|---|
| Main Bearings<br>Crankshaft - Mains | 2.8765 - 2.8785<br>2.8735 - 2.8745 | 2.8805<br>2.8720 | .006 |
| Conrod - Crank Pin<br>Crankshaft - Crank Pin | 2.7520 - 2.7530<br>2.7485 - 2.7495 | 2.7560<br>2.7450 | .008 |
| Piston Pin<br>Conrod - Pin Bore | 1.1248 - 1.1250<br>1.1253 - 1.1256 | 1.1244<br>1.1258 | .0011 |
| Cylinder Liner<br>Piston | 3.6600 -3.6610<br>3.6520 - 3.6530 | | |
| Piston Rings (Gap In 3.6660 Ga.) | .005 - .015 | .035 | |
| Valves (All) | Valves are .036" - .040" thick - If not broken. Valves should be replaced when seat groove wear depth exceeds .010" (.028" thinnest section). | | |
| Valve Springs (All) | Whenever compressor is disassembled for servicing, valve springs should be replaced where they have operated in excess of 5000 hours on R-12 or 3000 hours on R-22. | | |
| Motor Air Gap (Max. Variation) | .010 | | |
| End Play (Crankshaft) — .017 - .026 | | | |

Notes:

1. The above recommended wear rates are for individual parts. For mating parts, the maximum recommended oil clearance should predominate. In most cases this means that both mating parts should not each be at the recommended limit dimension.
2. These recommended limits are listed as good practice for normal service rebuilding of compressors which will be reliable when put back into service. It is not necessary to rebuild a compressor when these limits are anticipated.

* Due to the many design changes over the years and the different combinations of parts that may have been used during rebuilding, it is impractical to give the tolerances by design sequence. Therefore the part dimensions given are for the latest design compressors.

**Operating Table**

| Model | No. Cylinders | Bore | Stroke | RPM* | Nom. Tonnage R-12 | Nom. Tonnage R-22 | Valve Connections Suction | Valve Connections Discharge | Weight | Minimum Oil Press. | Oil Gap |
|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 4 | 3.66 | 2.75 | 1750 | 30 | 50 | 3⅛ | 2⅛ | 760 | 40-45 | 32 |
| E | 5 | 3.66 | 2.75 | 1750 | 40 | 60 | 4⅛ | 2⅛ | 830 | 40-45 | 34 |
| E | 6 | 3.66 | 2.75 | 1750 | 50 | 75 | 4⅛ | 2⅝ | 855 | 40-45 | 34 |
| E | 8 | 3.66 | 2.75 | 1750 | 60 | 100 | 4⅛ | 3⅛ | 960 | 40-45 | 36 |
| F | 3 | 2.75 | 2.00 | 1750 | 10 | 15 | 1⅝ | 1½ | 375 | 40-60 | 13.5 |
| F | 4 | 2.75 | 2.00 | 1750 | 13 | 20 | 2⅛ | 1⅝ | 450 | 40-60 | 18 |
| F | 5 | 2.75 | 2.00 | 1750 | 15 | 25 | 2⅛ | 1⅝ | 500 | 40-60 | 19 |
| F | 6 | 2.75 | 2.00 | 1750 | 20 | 30 | 2⅝ | 1⅝ | 510 | 40-60 | 19 |
| F | 8 | 2.75 | 2.00 | 1750 | 25 | 40 | 2⅝ | 1⅝ | 570 | 40-60 | 33 |

*Minimum 1000 rpm.
**For recommended oil see Service Bulletin HCOM-SB-4 "Recommended Oils For Reciprocating and Scroll Compressors."

The compressor illustrated is an eight cylinder Model F machine which is typical of the E and F compressor design. Assembly and disassembly procedures for the various size units is essentially the same. The few differences that do exist are noted in the instructions.

Pre-selective fit is not required with Trane compressor parts. All parts may be replaced with standard stock items. This means, for instance, that a new connecting rod may be installed without special fitting of inserts or shims.

Wherever bolts, or nut and bolt combinations are drawn up, a torque wrench should be used to assure proper fit. Some assemblies, such as connecting rod, can become distorted and cause premature wear or even complete failure if not tightened correctly. Proper torques are listed throughout the following pages.

Before opening the compressor for service, operate the system to pumpdown the compressor and then close the service valves. If the compressor cannot be operated, close the service valves. After the compressor has been isolated with the service valves, remove the refrigerant with a refrigerant recovery device. Do not relieve the refrigerant to the atmosphere. Follow the refrigerant recovery device manufacturer's operating instruction for proper operation. If repairs require the removal of the suction or handhole covers, the crankcase oil must be drained.

As each part is removed, oil with new, clean compressor oil. When reinstalling, clean each part thoroughly with refrigeration parts cleaner and re-oil with new, clean compressor oil.

CAUTION: Lubricate all bearing surfaces as parts are being reinstalled. This will enable the compressor to run without seizure when it is started up and before oil pressure is built up.

## Cylinder Head

**WARNING**
**To prevent injury or death due to compressor cylinder heads being propelled by the compressor internal pressure and striking persons working on or observing the work insure that the service valves are tightly closed and that the internal compressor pressure as measured at the service valve(s) back seat port is at atmospheric pressure.**

**WARNING**
**To prevent injury or death due to the compressor cylinder heads being propelled by the compressor safety head springs and striking persons working on or observing the work never remove all the head bolts and then jar the head with a hammer to loosen it. Always leave two bolts at opposite ends of the head and back them off two or three turns then use a mallet to loosen the head. Once the head is loose alternately loosen the remaining bolts to relieve the tension on the springs.**

**To Remove:**
Loosen and remove all but two cylinder head bolts. Back off the remaining two bolts two or three full turns. Examine the cylinder head to see if it is following the bolts. If it is not, jar the head with a lead or rawhide hammer until the gasket breaks loose. Alternately loosen the two bolts to relieve the tension of the safety head springs. When the bolts have been removed, lift off the cylinder head and safety head springs (Fig. 1).

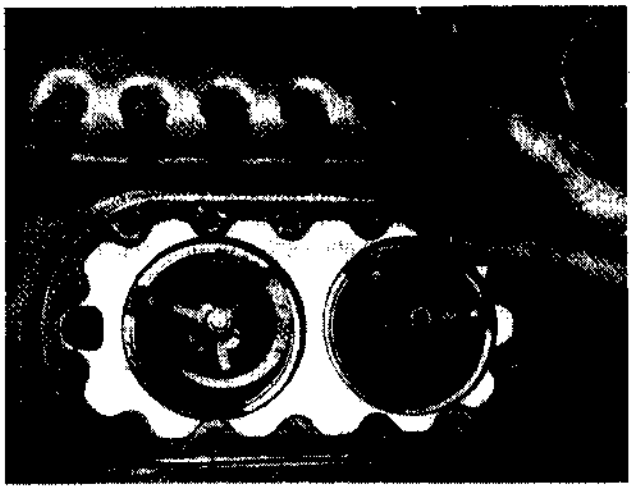


Figure 1 — Removing Safety Head Spring

**To Install:**
Center the safety head springs on the discharge valve cage assemblies (Fig. 1). Insert two bolts (on opposite sides) through the cylinder head, oil the cylinder head gasket with clean compressor oil and place on the cylinder head using the two bolts as a guide. Turn the two bolts two or three full turns and check the safety head springs to be sure they are still in proper position. Draw the head down evenly by alternately tightening the two bolts. Insert and tighten remaining bolts. Tighten all bolts to final torque. NOTE: Each cylinder head of the 3 cylinder Model F compressor is marked with a notch. The notched side of the cover is to be installed toward the seal end of the compressor.

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 76 |
| F | 43 |

## Discharge Valve

**To Remove:**
Remove cylinder head (see "TO REMOVE CYLINDER HEAD." Lift off safety head springs (Fig. 1). Lift off discharge valve cage (Fig. 2).

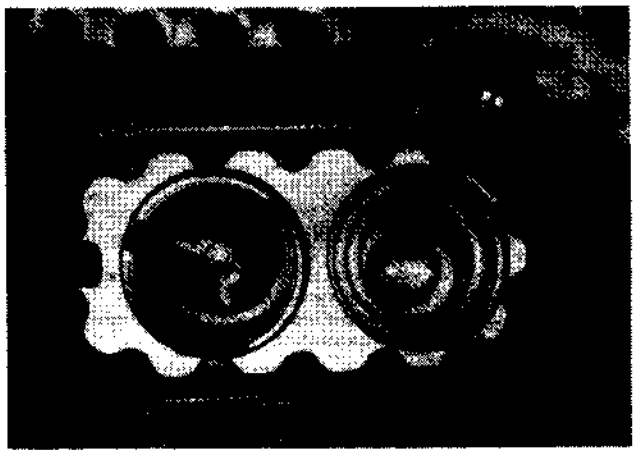


Figure 2 — Removing Discharge Valve Cage

**To Install:**
Press valve assembly into place, making sure that it seats properly.

**To Disassemble Discharge Valve:**

**Model "E" Compressor**
"G" design sequence and later compressors do not use the valve cushion or retainer. See Parts List OCOM-UP-1 for parts availability and part substitution for design sequences "A" through "F."

**Model "F" Compressor**
The model "F" compressor started to use a gas cushion beginning "E" design sequence for 3 cylinder compressors and "C" design compressors for the 4,5,6, and 8 cylinder compressors. See Parts list OCOM-UP-2 and OCOM-UP-3 for parts availability and part substitution for earlier design sequences.

Loosen locknut on discharge valve bolt. Remove valve bolt and seat. Remove valve ring, springs, cushion retainer and cushion.

**To Assemble Discharge Valve:**
Place valve cushion into the discharge valve cage making sure that the outer edge of the cushion is tucked into the undercut slot in the valve cage (Fig. 3). Press valve cushion retainer into place (Fig. 3). Place valve springs into the spring pockets in valve cage (Fig. 4). Lay the valve ring in place over springs (Fig. 4) and insert valve seat and cage bolt into the cage assembly. Before tightening locknut, make sure the valve ring registers in the valve guide (Fig. 5). Attach locknut and tighten. Recheck valve ring movement to make sure that its movement is not restricted by the valve guide (Fig. 5). Tighten to final torque.

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 50 |
| F | 40 |

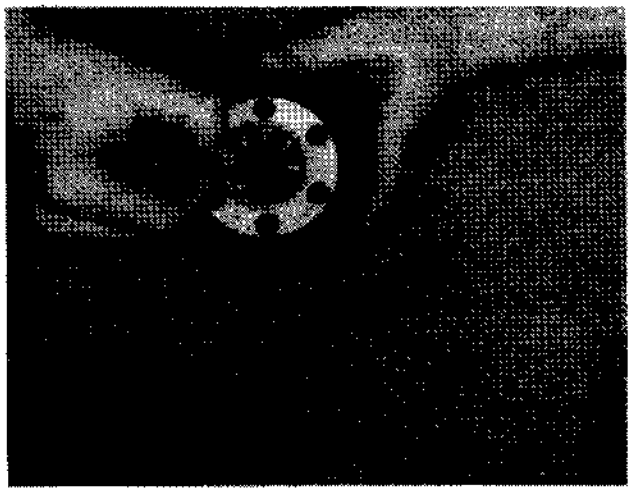


Figure 3 — Inserting Discharge Valve Cushion Retainer

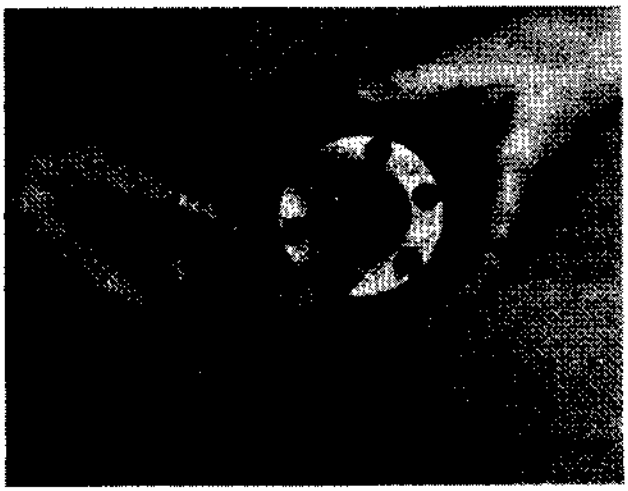


Figure 4 — Inserting Discharge Valve

Figure 5 — Checking Valve Movement

## Cylinder Liners

**WARNING**
**To prevent injury or death due to compressor cylinder heads being propelled by the compressor internal pressure and striking persons working on or observing the work insure that the service valves are tightly closed and that the internal compressor pressure as measured at the service valve(s) back seat port is at atmospheric pressure.**

**WARNING**
**To prevent injury or death due to the compressor cylinder heads being propelled by the compressor safety head springs and striking persons working on or observing the work never remove all the head bolts and then jar the head with a hammer to loosen it. Always leave two bolts at opposite ends of the head and back them off two or three turns then use a mallet to loosen the head. Once the head is loose alternately loosen the remaining bolts to relieve the tension on the springs.**

Cylinder liners can be removed and replaced without removal of the piston and connecting rod assemblies.

**To Remove:**
Remove cylinder head, safety head spring and discharge valve cage assembly from above the cylinder liner to be removed (see "To Remove Discharge Valve"). The suction valve plate which is mounted on the top of the cylinder liner is tapered in toward the top. A metal liner puller block is available which fits this taper (Fig. 6).

Rotate the crankshaft until piston head is down about two inches from the top surface of the valve plate. Place liner puller block in cylinder so that tapered ends fit inside of valve plate and hold in position. Rotate the crankshaft until piston head contacts puller block and continue to rotate shaft, forcing cylinder liner out of housing. After cylinder assembly is forced out beyond the "O" ring seal (Fig. 6) it can be withdrawn by hand.

Figure 6 — Pulling Cylinder Liner

On cylinder liners equipped with unloaders, the unloader mechanism may come out with the cylinder liner. While the liner is being withdrawn, support the piston through the liner so that it does not strike the compressor housing when the liner is removed.

In some cases it may be impossible to rotate the crankshaft. In such cases it will be necessary to remove the handhole covers and drive the cylinder liners out by hand. This is done by placing a small block of hard wood against the skirt of the cylinder liner and by tapping against the block with a light hammer. In this fashion, drive the cylinder liner up until the "O" ring clears the top of the cylinder.

**To Install:**

**(Cylinder Liner Assembly Without Unloader)**
The bottom of the cylinder liner assembly is tapered for entry of the piston and piston rings. Before placing the liner over the piston, rotate the piston rings on the piston to stagger the tap of the rings.

Rotate the crankshaft so that the piston is near the top of its stroke. While rotating the shaft, guide the piston so that it does not become wedged in the cylinder hole.

Insert the liner into the hole in the housing until the liner is against the top of the piston. Center the head of the piston in the bottom of the liner. Rock and rotate the liner on the piston, and at the same time press it down firmly against the rings. The rocking and rotating motion will guide the ring into the tapered cylinder liner.

> CAUTION: Do not hammer or attempt to force the liner over the ring. Sudden shock can cause ring breakage.

When all rings are in the liner, push the liner all the way down into the cylinder housing.

**To Install:**

**(Cylinder Liner Assembly With Unloader)**
The installation of the cylinder liner assembly with unloader is the same as the installation of the plain liner as far as entry of the piston and rings is concerned. The main difference, however, is in the proper positioning of the unloader assembly in the housing.

The unloader cylinder housing is fitted with a register pin and an oil connector. The underside of the unloader assembly has two holes which correspond to the above. These holes are 180 apart. The register pin protrudes further from the face of the housing than the oil connector and serves as a guide for the unloader assembly. It also permits proper registration of the oil connector.

Insert the unloader assembly into the housing, making sure the holes in the unloader are aligned properly with the register pin and oil connector.

> CAUTION: The register pin hole in the unloader assembly is smaller than the oil connector hole. The oil connector hole will pass over the register pin but the register pin hole will not go over the oil connector. Forcing the unloader assembly down when unloader assembly is improperly positioned by 180 may cause excessive damage to the oil connector or the register pin.

When the unloader is in position in the housing cylinder hole, push the liner down into the housing and over the piston as described previously (Fig. 7).

Figure 7 — Installing Cylinder Liner

## Cylinder Unloader Assembly

If high heat or dirty crankcase oil is encountered, the unloader mechanism should be disassembled and the "O" rings replaced. Figure 8 illustrates the unloader "O" rings.

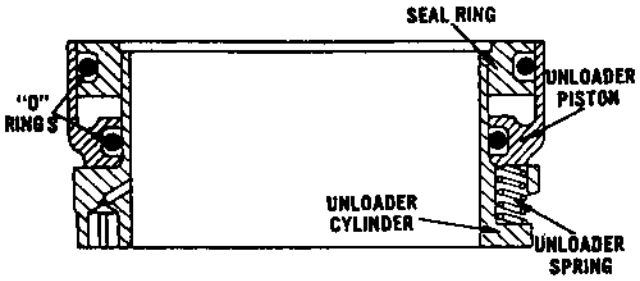



Figure 8 — Cross Section View of Unloader

**To Remove:**
In some cases it may be necessary to jar the unloader loose from the liner. This may be done by gripping the unloader assembly in the hands and striking the skirt or bottom of the cylinder liner against a soft wood surface (Fig. 9).

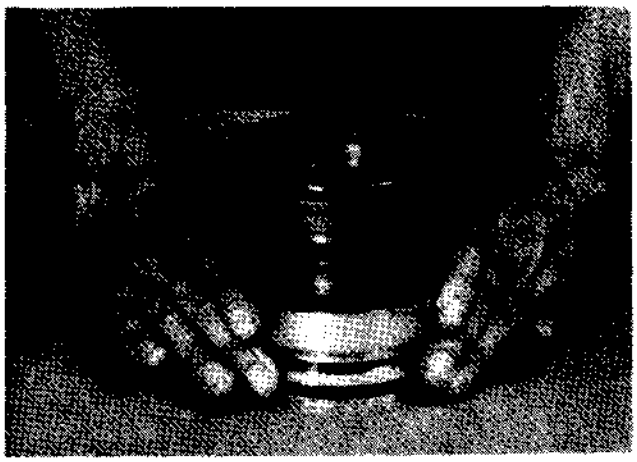


Figure 9 — Removing Unloader From Liner

**To Install:**
The unloader mechanism should be installed in the housing followed by the cylinder liner as described in "To Install Cylinder Liner Assembly Without Unloader."

**To Disassemble Unloader:**
Using a wide-bladed screw driver, work the unloader piston and seal ring off the unloader cylinder (Fig. 10). When the top section is free, remove the seal ring from the piston (Fig. 11).

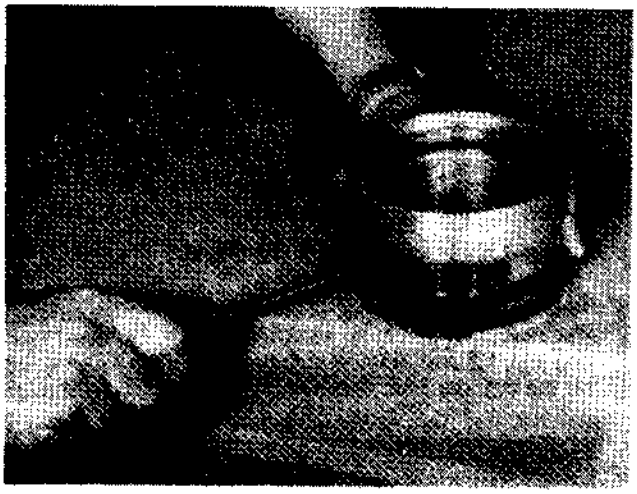


Figure 10 — Disassembling Unloader

Figure 11 — Removing Seal Ring

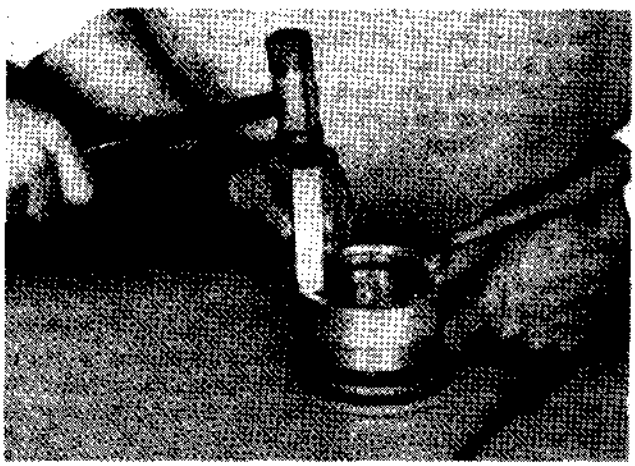


Figure 12 — Positioning Seal Ring

**To Assemble Unloader:**
Wet all surfaces, including "O" rings, with new, clean compressor oil. With "O" rings in place, force the unloader piston down over the unloader cylinder.

Place the seal ring on top of the unloader piston and with a small block of wood, drive the seal ring into position (Fig. 12). Drive the seal ring down into the piston until the face of the seal ring is approximately 1/4" below the upper edge of the unloader piston.

## Suction Valve Assembly

**To Remove:**
Invert the cylinder liner and valve assembly. Remove the three retainers (Fig. 13). Do not move the liner around on top of the valve assembly.

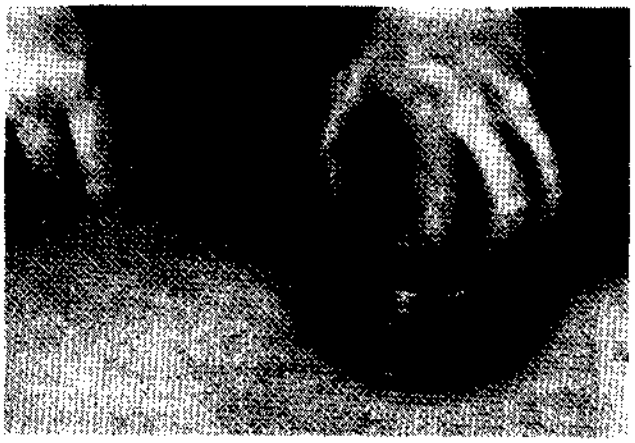


Figure 13 — Removing Suction Valve Retaining Rings

Lift the liner assembly away from the valve assembly (Fig. 14). With the cylinder liner separated from the valve assembly, the valve ring, springs and "O" ring can be removed (Fig. 16).

Figure 14 — Lifting Off Liner

**To Assemble:**
Set the suction valve plate in an inverted position and place the "O" ring on the valve plate. Place the springs in their pockets and the valve ring in the valve plate (Fig. 15). Set the valve plate assembly in an inverted position and place the cylinder liner on the valve plate (Fig. 14). Fasten the suction valve assembly to the liner by installing the three retainers. One edge of these rings is wider than the other

Figure 15 — Removing Suction Valve Ring

Figure 16 — Removing "O" Ring

and fits into the cylinder liner (see Fig. 17). Check the movement of the suction valve to see that it is not restricted within the assembly (Fig. 18).

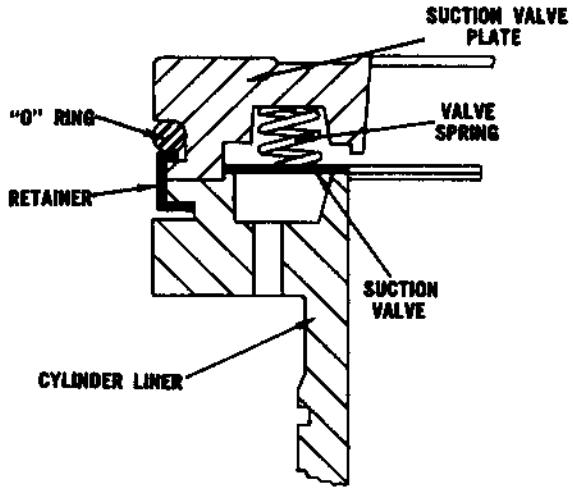



Figure 17 — Illustration Of Suction Valve Retainer

Figure 18 — Checking Suction Valve Movement

## Take-Up Ring and Lift Pins

**To Disassemble:**
Place cylinder liner in an inverted position. Release retaining ring (Fig. 19) and slide off cylinder liner. Slide take-up ring off the cylinder liner. Remove lift pins and lift pin springs.

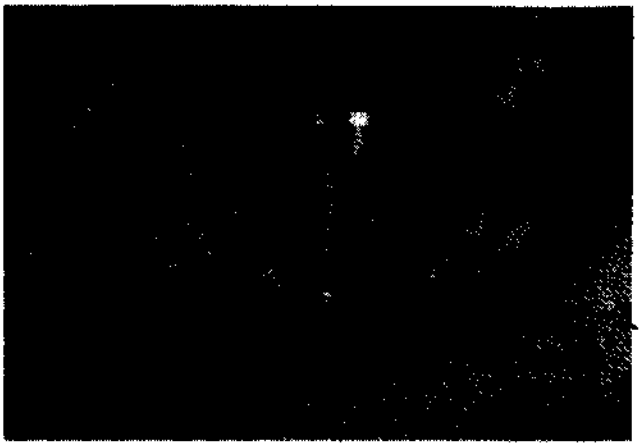


Figure 19 — Removing Retaining Ring

**To Assemble:**
Place cylinder liner in an inverted position. Place springs on lift pins and insert lift pins in holes on underside of cylinder liner (Fig. 20). Push take-up ring down over the cylinder liner and slide retaining ring into the ring groove on the cylinder liner (Fig. 19). With retaining ring in position, work the take-up ring up and down to see that the lift pins move freely and can raise and lower the suction valve ring. The cylinder liner is now ready for the assembly of the unloader mechanism to the cylinder liner (see "To Install Unloader Assembly," Page 7).

## Crankcase Handhole Covers

The handhole cover on the front side of the compressor contains the oil level sight glass and the compressor capacity control actuator and cleanable oil strainer.

Figure 21 shows the reverse side of the control handhole cover assembly with the capacity control mechanism. The capacity control mechanism can be removed as a unit and disassembled for repair.

Figure 20 — Inserting Spring and Lift Pins

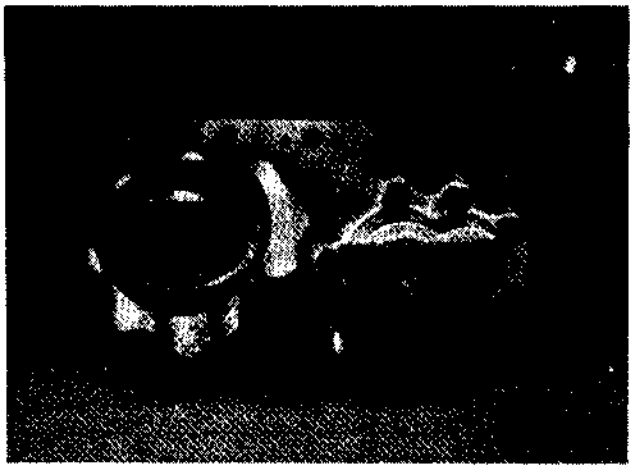


Figure 21 — Back Side of Control Handhole Cover

**To Remove Handhole Cover:**
Before removing handhole covers, crankcase oil must be drained from the compressor.

Remove all but the top center bolt on the handhole cover. The top screw should then be backed out approximately 8 to 10 turns. Tap lightly around the rim of the handhole cover to break it loose from the gasket. When the seal is broken, support the cover with the hand at the bottom and remove the remaining screw.

**To Install Handhole Cover:**
Insert two bolts through the cover (opposite each other), oil the gasket with clean compressor oil and place the gasket down over the cover using the two bolts as a guide. Insert the bolts and pull them up hand tight. Tighten all bolts to final torque.

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 76 |
| F | 43 |

## Capacity Control Oil Strainer

**Model E or F, 4, 5, 6 and 8 Cylinder Design**

**To Remove Oil Strainer:**
Remove the plug on the face of the handhole cover. Withdraw the "O" ring, spring and oil strainer. Clean or replace as necessary.

**To Install Oil Strainer:**
Insert the oil strainer into the handhole cover and place the spring over the top of the oil strainer. Place the "O" ring and plug on the handhole cover and tighten the plug hand tight.

**Model F, 3 Cylinder Design:**

**To Remove Oil Strainer:**
The oil strainer is pressed into the steel back plate of the control handhole cover. Remove the steel back plate by loosening and removing the seven screws which secure the capacity control and back plate to the handhole cover. Force the strainer screen out of the back plate.

**To Remove Oil Strainer:**
Press the oil strainer into the steel back plate. The metal ferrule should be flush with the face of the steel back plate as illustrated in Figure 22. Reinstall back plate, capacity control and gaskets. Tighten screws to final torque. TORQUE — 23 foot pounds.

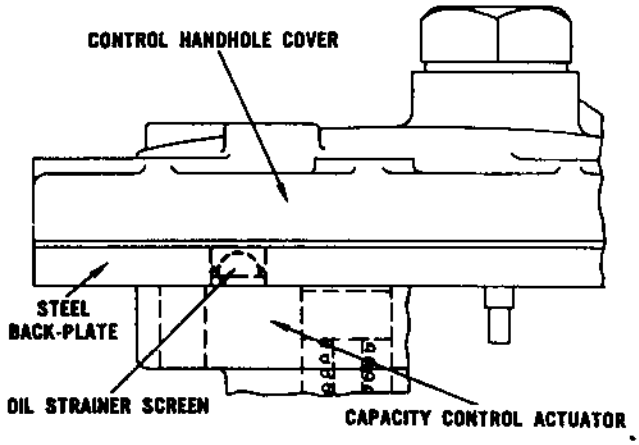



Figure 22 — Oil Strainer Installed in Steel Back Plate

## Capacity Control Actuator

**To Disassemble Capacity Control Actuator:**
Remove the bolts which hold the capacity and control actuator to the handhole cover.

Remove the bellows assembly "O" rings and remove the bellows assembly from the actuator. To disassemble the bellows, remove the retaining ring and pull the spring, spring plug and sleeve out of the bellows (Fig. 23).

Figure 23 — Bellows Assembly

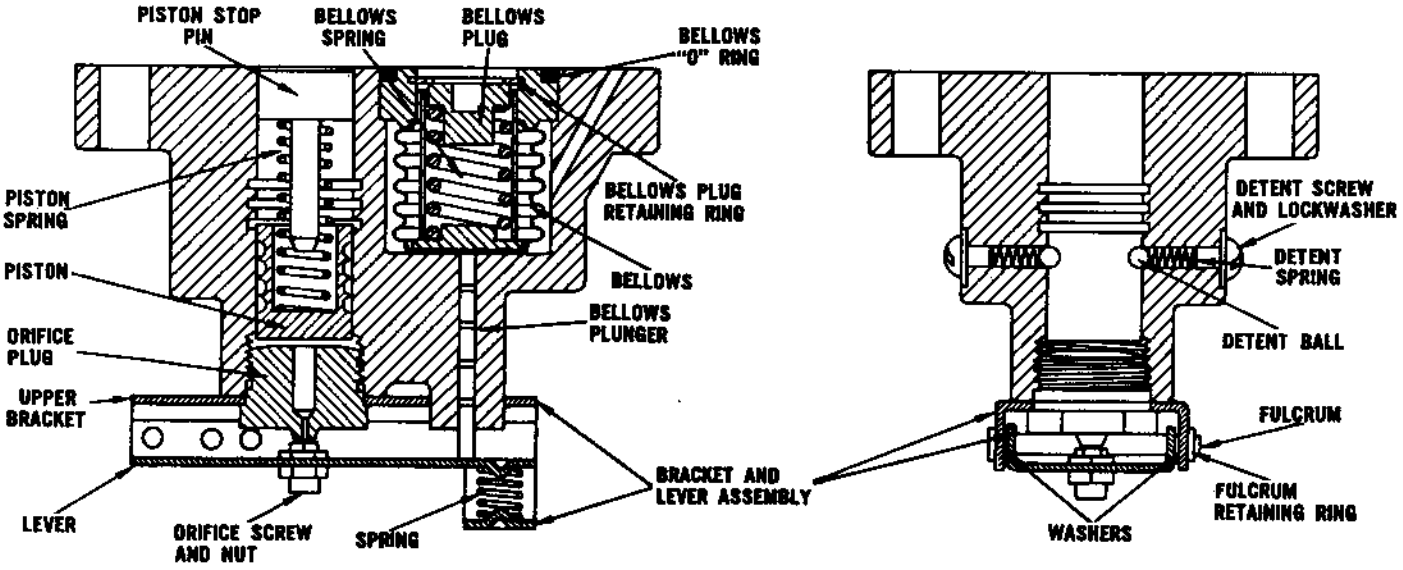



Figure 24 — Cross Section Views of Capacity Control Actuator

Remove the retaining ring from the fulcrum pin which holds the lever of the bracket assembly. Remove the fulcrum pin, lever and two small washers. Loosen the orifice plug and remove it from the actuator housing (Fig. 24).

To remove the internal piston and piston spring, remove the two detent screws, washers, springs and balls at the sides of the actuator housing. After they have been removed, the piston and piston spring will drop out of the actuator housing. All parts can now be cleaned. Parts of the bellows assembly may be replaced if necessary. However, parts are not available for the piston, spring, orifice plug and detent assembly. If they become worn or broken, a new capacity control actuator must be installed.

**To Assemble Capacity Control Actuator:**
Set the piston spring down over the piston stop pin inside the actuator housing. Slide the piston into position and hold while inserting the two detent balls, springs, washers and screws at the side of the actuator. Insert and tighten the orifice plug.

Replace the lever of the bracket assembly and fasten in place with the fulcrum pin and retaining ring. The two small washers should be placed between the upper channel and lever to act as bearing surfaces. Insert the spring.

Place the sleeve, spring and spring stop into the bellows assembly. Fasten in place with the retaining ring. Set the bellows assembly into the actuator and replace the bellows assembly "O" ring.

> CAUTION: Do not attempt to adjust or otherwise turn or remove the orifice screw and nut which are attached to the lever of the bracket assembly. They have been factory set to control the orifice opening of the capacity control. If this setting is changed, it will be necessary to replace the entire capacity control actuator.

Set the complete control actuator assembly and gasket on the handhole cover and attach with the seven bolts. Tighten to final torque with a torque wrench.

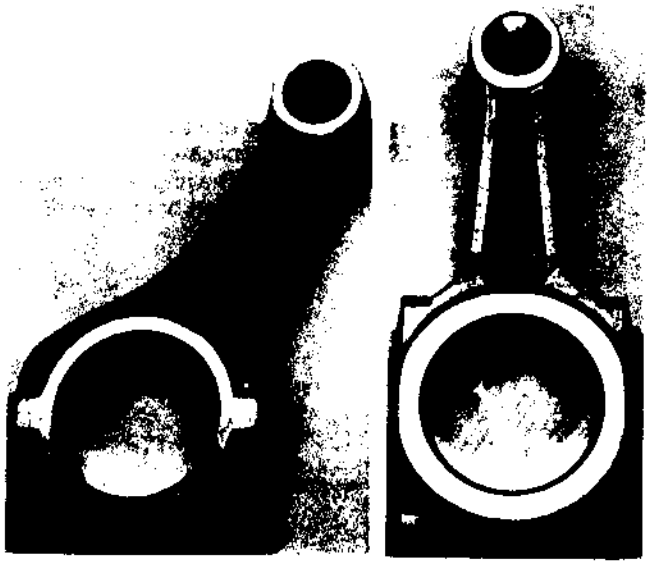
The unloader spring should be checked that the correct spring is installed in the compressor. The spring color coding is as follows: GREEN R-22 BLACK R-12

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 23 |
| F | 23 |

## Connecting Rod and Piston Assembly

**Model "E"**
The rod design used on "J" design sequence with a serial number designator of "A" and all subsequent design sequence compressor use an offset rod with capscrews instead of rod bolts. See Figure 25. This rod is used as a direct replacement for all design sequences. The offset rod may be mixed with the straightrod on the same crankshaft rod journal. The match marks need to be on the same side of the rod and the direction of the chamfers are installed in the same manner as described in the TO INSTALL section. The rod bolt torque is 24 foot-lbs.

**Model "F"**
The rod design used on 4,5,6 and 8 cylinder "C" design sequence with a serial number designator of "C" and 3 cylinder compressors with a "E" design sequence with a "D" serial number designator use an offset rod with capscrews instead of rod bolts. See Figure 25. This rod is used as a direct replacement for all design sequences. The offset rod may be mixed with the straightrod on the same crankshaft rod journal. The match marks need to be on the same side of the rod and the direction of the chamfers are installed in the same manner as described in the To Install section. The rod bolt torque is 12 foot-lbs.



NEW OLD

Figure 25 — New and Old Style Connection Rods

**To Remove:**
Remove cylinder head (see Page 4). Remove discharge valve cage and cylinder liner (see Page 4). Remove handhole covers (see Page 9). Rotate the crankshaft until the connecting rod nuts are accessible through the handhole cover and remove the two nuts.

With a block of wood or mallet, slowly and alternately drive the connecting rod bolts up through the connecting rod. When the body-bound section of the bolt is free of the connecting rod cap, the cap may be removed. Then the piston and connecting rod assembly may be drawn out through the top of the cylinder.

**To Install:**
Lubricate bearing surfaces on the rod and shaft with clean compressor oil. Drive the connecting rod bolts into the connecting rod with a mallet or hammer (see Figure 26). Be sure the beveled side of the connecting rod bolt head is turned toward the shank of the connecting rod. On all models, connecting rods and rod caps have two matched marks. WHEN ASSEMBLING, THESE TWO MATCH MARKS MUST BE ON THE SAME SIDE OF THE ROD.

**Model "E" Design Sequence "B" and Later**
Each connecting rod and rod cap has a chamfer on one edge of the bearing surface which rides on the crankshaft rod journal. This chamfer matches a fillet where the crankshaft rod journal and sidewall meet. When assembling the rod and cap to the crankshaft, make sure the chamfer matches the fillet. On a four rod journal, the two inside chamfers should face each other. On a three rod journal, the middle rod matched marks should face the seal end of the compressor.

**Model "E" Design Sequence "A": Model "F" Design Sequence "A" Through "C"**
THE MATCH MARKS MUST FACE THE SEAL END OF THE COMPRESSOR.

Figure 26 — Inserting Connecting Rod Bolts

Invert cylinder liner on clean work surface. Do not mar the valve seat on the top side of the liner assembly. Rotate the piston rings to stagger the ring gap. Start the piston head down into the cylinder liner. With the piston started into the liner, rotate and rock the piston and press down firmly on the piston skirt (see Figure 27). After all rings have passed the bottom of the liner skirt, push the piston down until its bottom is even with the bottom of the cylinder liner.

Figure 27 — Inserting Piston And Connecting Rod Assembly Into Liner

Rotate the crankshaft until the shaft journal is in position to accept the connecting rod. Lower the entire assembly down into the cylinder (Fig. 28). Press the liner into final position (see "To Install Cylinder Liner With Unloader," Page 7). With the rod in position against the shaft, place the cap on the connecting rod bolts. Be sure that the match marks on the cap face the seal end of the compressor.

Figure 28 — Installing Liner And Piston Assembly In Crankcase

Place the connecting washers and nuts in place and tighten the connecting rod nuts on the bolts. When drawing up the connecting rod nuts, do so alternately to pull the cap up against the rod evenly. It is essential that these nuts be finally drawn up with a torque wrench because improper tension on these rods will cause distortion of the rod and will result in premature wear and possibly complete failure of the connecting rod bearing.

| Comp. Model | Torque (Foot Pounds) | Offset Rod Torque (Foot Pounds) |
|---|---|---|
| E | 23 | 24 |
| F | 14 | 12 |

CAUTION: After connecting rod bolts and nuts have been tightened to proper torque, rotate the crankshaft to make sure that the rod turns freely. Repeat as each rod is installed.

## Piston and Wrist Pin Assembly

**Model "E" Compressor Only**
Prior to model design sequence "J" serial number design designator "C" a three ring groove piston was used. The "J" model design sequence, serial number "C" design designator and later compressors use a two ring groove piston. The pistons are interchangeable in the same compressor and only the two ring groove piston is available as a part replacement.

**To Remove:**
Remove the two snap rings that hold the wrist pin in the piston. Drive the pin out through the wrist pin hole, using a wood block or a brass driving rod. Use care not to nick the surface of the piston or distort the shape of the hole.

**To Install:**
Place the connecting rod in the piston and drive the wrist pin through the connecting rod by tapping lightly with a rawhide mallet and brass driving rod. When the wrist pin is in position, insert the two wrist pin locking rings.

## Piston Rings

**Model "E" Compressor Only**
Always replace piston rings as a set. A set consists of one compression ring, one oil ring and one scraper ring. Prior to design sequence "J" the ring set consisted of two compression rings and an oil ring. The ring set can be used with either the three ring groove piston or the two ring groove piston.

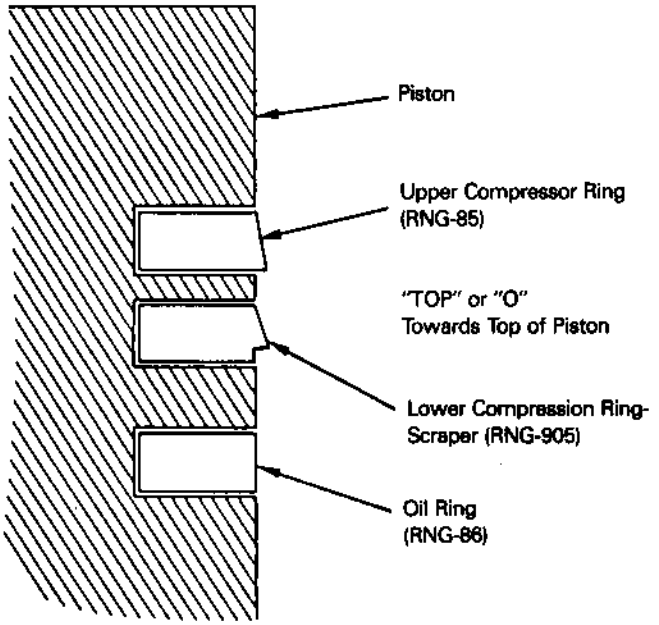



Figure 29 — Replacement Piston Ring Set (RNG-77) for 3-Ring Pistons

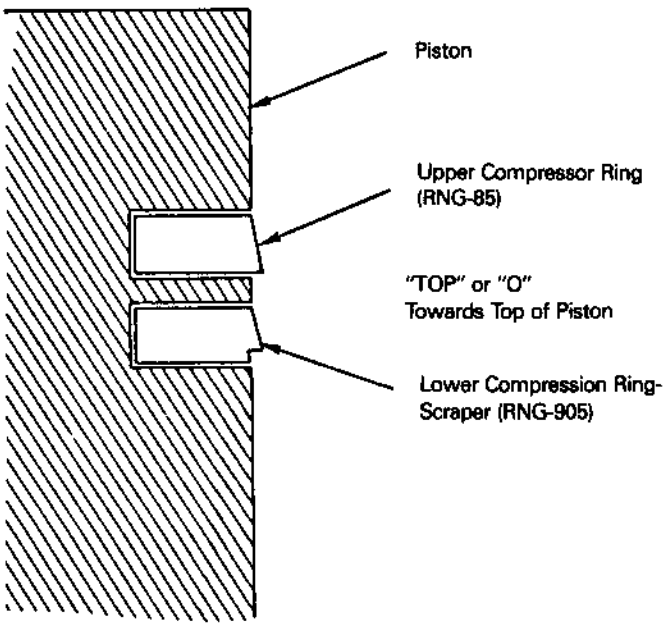



Figure 30 — Replacement Piston Ring Set (RNG-77) for 2-Ring Pistons

**To Remove:**
The piston rings can be removed from the piston by using shim stock between the rings and the piston. Carefully work the rings out of the groove and slide them over the shim stock and off the piston.

**To Install:**
To install the rings work them carefully down over the piston to their proper groove, using shim stock to slide the rings into position. The rings are marked with "TOP" or "O" and this mark must face the top of the piston.

**Model "E" Only**

**Three Groove piston:**
The oil ring goes in the bottom groove, the scraper ring goes in the middle groove, and the compression ring in the top groove. See Figure 29 for the three groove piston ring installation.

**Two Groove Pistons:**
The scraper ring goes in the bottom groove and the compression ring goes in the top groove. See Figure 30 for the two groove piston ring installation.

When the rings are in their final position, check to see that they move freely in their grooves. Also check to insure that the ring gaps are not lined up, if they are, stagger them to prevent oil bypass and blow by.

When installing new rings on a piston, be sure the that the grooves in the piston are clean and do not contain burrs.

## Compressor Shaft Seal

**Model "E" Only**
Design sequence "H" and later Model "E" compressors use a different style seal and bearing head assembly than previous design sequence compressors see Figure 31. Refer to parts list OCOM-UP-1 for parts availability and parts substitution. Torque values for the seal cover for "H" design sequence type seals is 32 foot-lbs. Installation instruction ship with the replacement seal. The installation procedure is the same as the earlier design sequence seal

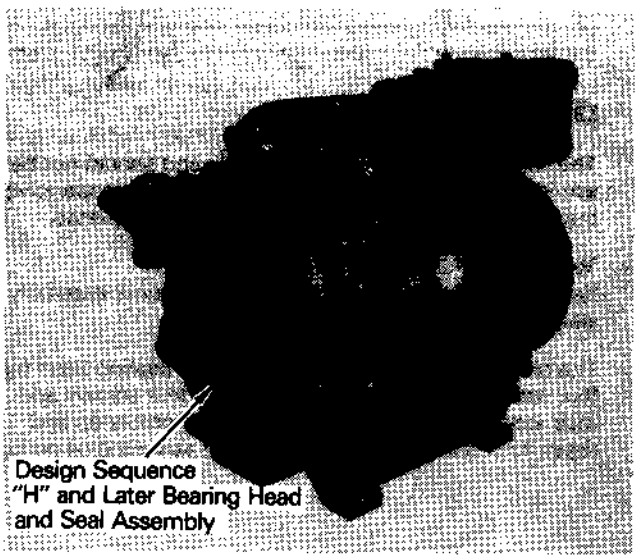



Figure 31 — Design Sequence "H" and Later Seal and Bearing Head Assembly

**To Remove:**
Loosen and remove all but two (on opposite sides) of the bolts which hold the seal cover to the compressor housing. Alternately loosen the two remaining bolts. If the cover does not follow the two bolts as they are loosened, tap around the outer rim of the seal cover to help break it loose. Back out the two screws carefully and remove the seal cover plate (Fig. 32). This plate must be removed evenly to prevent damage or breakage to the carbon nose ring within the seal.

Figure 32 — Seal Cover Removed

A seal seat fits into the seal cover and is held tightly by and "O" ring. The seat may be forced out of the cover by placing a soft-faced object against the seat and driving it out of the seal cover (Fig. 33).

Figure 33 — Removing Seal Seat

**To Install:**
Oil the seal seat "O" ring and place over the seat. Push the seal seat and "O" ring into the seal cover.

If the seal assembly has been damaged or shows excessive wear, replace with a complete new seal assembly. Never attempt to reuse any parts of this assembly.

Place the seal spring, neoprene bellows and retaining ring onto the crankshaft (Fig. 34). Slide onto shaft as far as they will go. Thoroughly clean the carbon nose ring with refrigeration parts cleaner and examine to be sure it is not damaged. Wet the carbon nose ring with clean compressor oil and place over the crankshaft into the ring retainer (Fig. 35). The notches in the retainer ring should be aligned with the notches in the carbon nose ring.

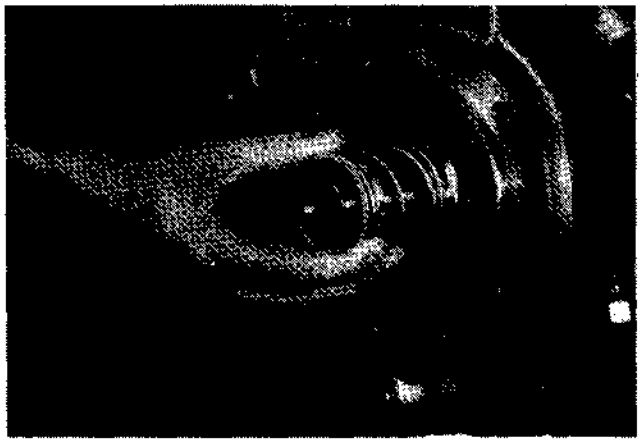


Figure 34 — Removing Crankshaft Seal

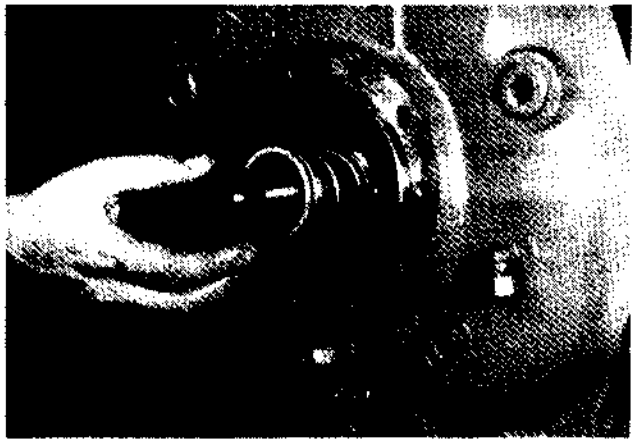


Figure 35 — Installing Seal Carbon Nose Ring

Clean the face of the seal end bearing, the housing where the seal cover rests and the face area of the seal end cover. Insert two bolts into the seal cover (at opposite sides) and place the cover in position over the crankshaft. Push the seal cover against the housing to engage the two bolts. Draw up both bolts slowly and evenly to prevent damage to the carbon nose ring.

Insert and tighten remaining bolts. Tighten bolts to final tension with a torque wrench.

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 43 |
| F | 43 |

## Suction Strainer Assembly

**To Remove:**
Remove all of the suction cover screws with the exception of the top screw. Back out the top screw 10 or 12 full turns. The cover plate is provided with jackscrew holes and two of the cap screws should be inserted into these jackscrew holes to assist in breaking the seal.

After the cover plate has been removed, the strainer pan can be removed from the suction chamber (Fig.36). The suction strainer screens can be cleaned if necessary. The oil filter at the bottom of the strainer assembly cannot be cleaned. It is recommended that when the compressor is disassembled for service that the oil filter be replaced.

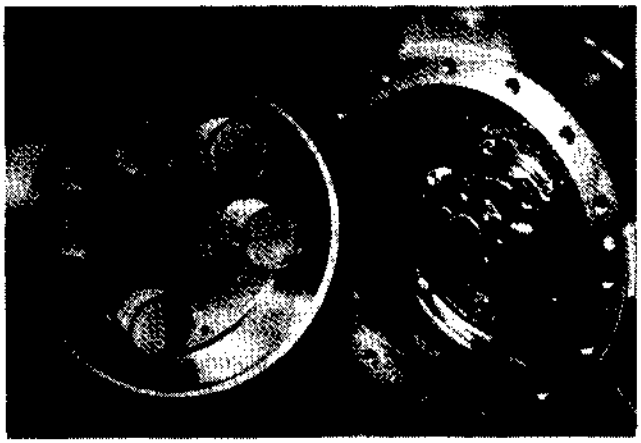


Figure 36 — Removing Suction Strainer Pan

**To Install:**
When the strainer pan is inserted into the suction chamber, the guide post must register in the slot at the bottom of the bearing head (Fig. 36).

Place the cover plate and gasket against the face of the suction chamber and tighten the cap screws.

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 115 |
| F | 58 |

## Oil Pump Assembly

The oil pump is a complete assembly and should not be serviced in the field. If the oil pump becomes inoperative, the complete oil pump assembly should be replaced.

**To Remove:**
Remove the suction cover and suction strainer assembly (see "To Remove Suction Strainer").

The oil pump is bolted to the pump end bearing head by four screws. Loosen and remove these four screws and their lockwashers. Rock the oil pump assembly up and down to break the gasket seal. Do not strike the oil pump.

**To Install:**
The oil pump key (Fig. 37) must be turned to fit the slot in the end of the crankshaft. After all screws have been drawn up hand tight, tighten to the required torque.

Figure 37 — Installing Oil Pump

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 14 |
| F | 14 |

## Main Bearings and Crankshaft

The pump end and seal end main bearings contain sleeve type, steel-backed babbitt bearing inserts which are pressed into the bearing head. If either bearing insert becomes damaged or worn, it may be replaced.

**To Remove Pump End Bearing (Fig. 38):**
Remove shaft seal assembly (see "To Remove Shaft Seal Assembly," Page 13). Remove suction cover (see "To Remove Suction Strainer," Page 14). Remove handhole covers (see "To Remove Handhole Covers," Page 9). Remove piston and connecting rod assemblies (see "To Remove Piston and Connecting Rod Assemblies," Page 11).

Remove bearing head screws and lockwashers from pump end bearing. Insert screws in jackscrew holes and break gasket seal between face of bearing and compressor housing (Fig. 39).

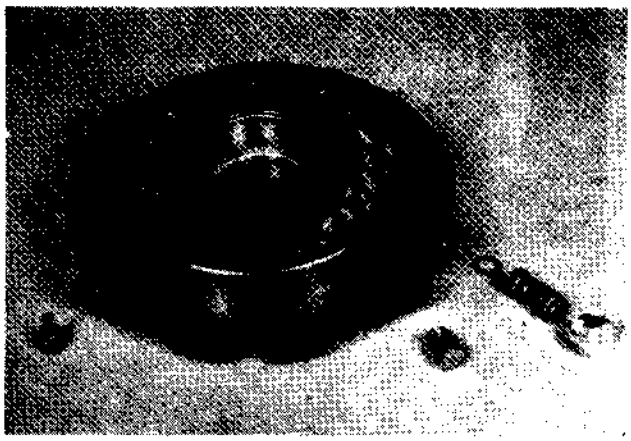


Figure 38 — Magnetic Plug and Relief Valve

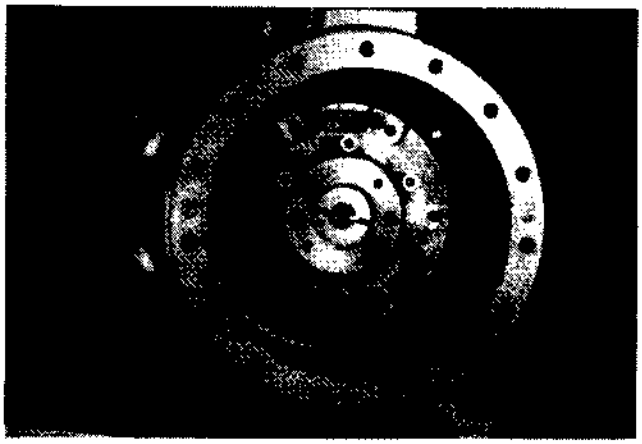


Figure 39 — Pulling Pump End Bearing Head

The bearing head has a lip which fits into the compressor housing. When the lip of the bearing head is free of the housing, it can be removed from the end of the shaft. The shaft does not require support.

**To Remove Crankshaft:**
The crankshaft is removed from the compressor through the suction end of the compressor. Before removing the crankshaft, remove the connecting rods and piston assemblies (see Connecting Rod and Piston Assembly, "To Remove," Page 11). Remove the shaft seal (see Shaft Seal, "To Remove," Page 13) and the pump end bearing (see "To Remove Pump End Bearing," Page 14).

Grip the crankshaft at the center and at the pump end of the shaft. One hand is through the handhole opening and the other at the end of the shaft (Fig. 40). Carefully draw shaft out of seal end bearing. When shaft end is clear of bearing, shift hands so that shaft is gripped through suction end of compressor. Draw shaft out of compressor housing.

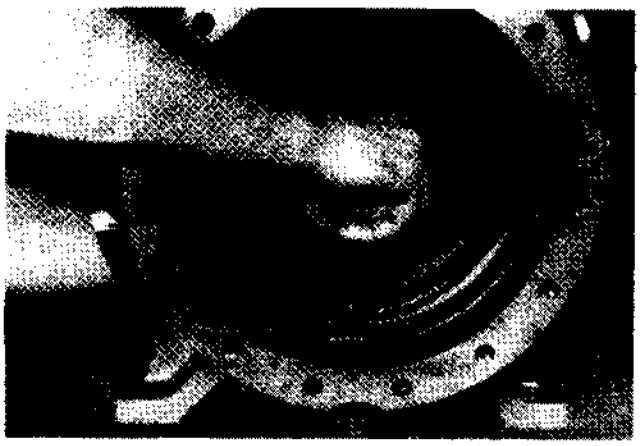


Figure 40 — Removing Crankshaft

**To Remove Seal End Bearing:**
If the seal end bearing is to be removed, the pump end bearing and the crankshaft must first be removed (see "To Remove Pump End Bearing" and "To Remove Crankshaft," Page 15).

Remove seal end bearing by pulling straight out (Fig. 41). This bearing is not bolted to the housing, but is held in position by the seal cover.

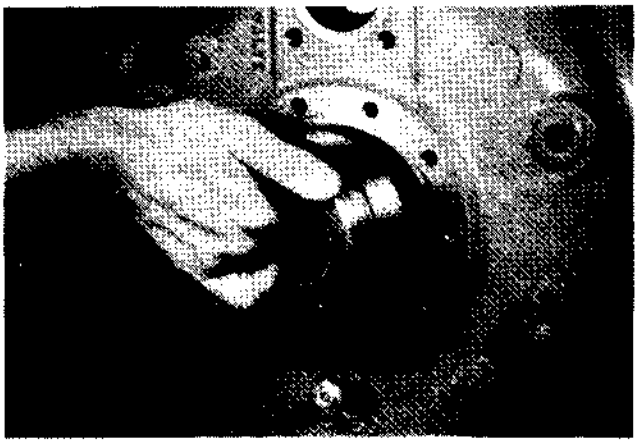


Figure 41 — Removing Seal End Bearing Head

**To Install Main Bearings and Crankshaft:**
Lubricate the seal end bearing "O" ring with clean compressor oil and place in the "O" ring groove in the compressor housing (Fig. 42). Slide the bearing assembly into the compressor housing. Install seal cover but do not install seal at this time.

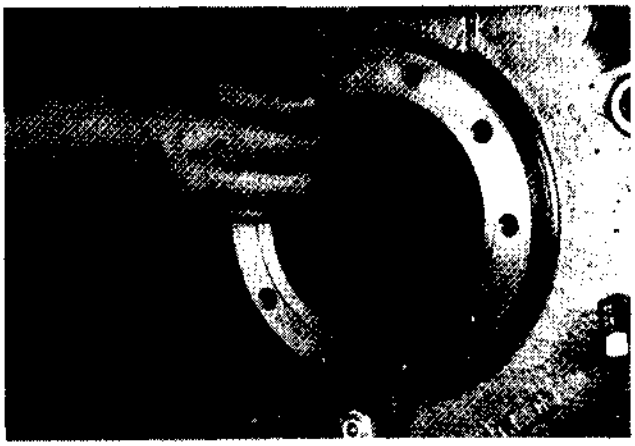


Figure 42 — Installing Seal End Bearing "O" Ring

Cover the smooth face of the bearing thrust collar with clean compressor oil. Place thrust collar on crankshaft (smooth face against bearing head and groove side toward crankshaft).

Lubricate all bearing surfaces on crankshaft. Carefully guide the seal end of the shaft into the main bearing on the seal end of the compressor. Check the thrust collar to be sure the register tabs fit into the seal end bearing properly. Carefully push the shaft all the way into the bearing until the shoulder of the shaft is against the thrust collar.

When the shaft has been positioned as above, it can be released and does not need to be supported or blocked from the underside.

Cover smooth face of pump end bearing and smooth face of thrust collar with clean compressor oil and place thrust collar on bearing head. Smooth face of thrust collar is toward the bearing head and the grooved side of the thrust collar is toward the shaft.

**Pump End Bearing Head and End Play Adjustment:**
Crankshaft end play adjustment is determined by the number and thickness of the shims placed between the pump end bearing head and the housing. These shims are .005", .010" and .020" thick.

Insert two bearing head screws (opposite each other) into the bearing head and place two .020" paper shims over the screws against the flange of the bearing head. Do not lubricate shims, the flange of the bearing head or the face of the crankcase. With the shims in place, and the thrust collar properly located on the bearing head, place the bearing head assembly on the end of the crankshaft. Turn the "TOP" mark on the bearing head to the proper position. Tighten the two screws hand tight. Install remaining screws and tighten all screws to proper torque.

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 69 |
| F | 23 |

Crankshaft end play measurement and adjustment must be made without the shaft seal or connecting rods installed.

Push crankshaft against pump end bearing thrust collar. With feeler gage, measure distance between shoulder of shaft and face of seal end thrust collar. Push shaft against seal end bearing thrust collar and with a feeler gage measure distance between shaft and pump end thrust collar. This measurement should be the same on both ends of the shaft.

A second method of measuring end play uses the dial indicator as illustrated in Figure 43. The dial indicator is placed against the shaft. Push the shaft against the sealed end and then back against the pump end. The difference in dial readings gives total end play clearance.

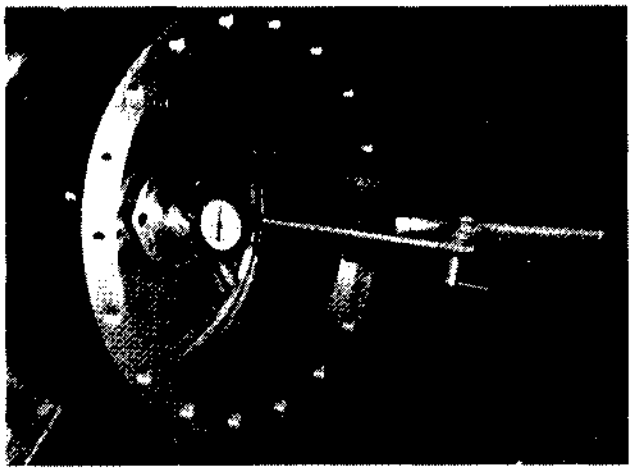


Figure 43 — Checking Crankshaft End Play

Crankshaft end play clearance should be .015" to .025". End play may be adjusted by the number and thickness of gaskets installed between the pump end bearing flange and the housing.

When final selection of shims has been placed between pump end bearing and crankcase housing, tighten screws to proper torque.

| Comp. Model | Torque (Foot Pounds) |
|---|---|
| E | 69 |
| F | 23 |

Recheck end play measurements with feeler gage.

Remove seal cover, install seal and seal cover (see "To Install Seal").

## Foam-Breaker

**To Remove:**
If it becomes necessary to clean the foam-breaker assembly within the pump end bearing head, remove the retaining ring and end ring. With the end ring removed, the foam-breaker screen can be removed for cleaning (Fig. 40).

It may be necessary to remove the magnetic plug and the pressure relief from the bearing head to clean the passages within the bearing head assembly. The entire assembly may be washed with a suitable refrigeration compressor parts cleaner (see Fig. 38).

**To Install:**

**Model "E" Compressor Only**

**Design sequence "K" and later**
The motor end bearing head does not contain a foam breaker or check valves. This is due to the different crankcase venting system used on the "K" design sequence and later compressors

Roll the foam-breaker screen into approximate shape and insert into bearing head (Fig. 44). Replace end ring and retaining ring. Replace magnetic plug and relief valve.

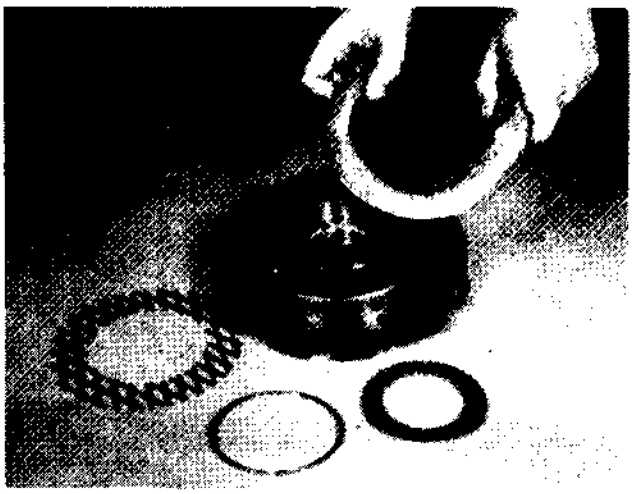


Figure 44 — Removing Foam Breaker

## Relief Valve

If compressor discharge pressure becomes excessive and other safety devices fail to function, a pressure relief valve within the compressor will open. When this happens, hot gas is directed back to the suction side of the compressor.

The compressor pressure relief valve is located inside the housing directly behind the discharge service valve. Remove the discharge service valve to inspect or replace. If the relief valve was opened, check the compressor for internal damage.

## Crankcase Oil Strainer Assembly

Whenever a compressor is opened for repairs, the oil strainer assembly should be removed and replaced with a new strainer.

**Model "E" Compressor Only**
The flat design oil strainer has been replaced with a round design strainer. The round design strainer is a direct replacement for the flat design. It does not use the metal retainer clip as does the flat design. It is also recommended that eight magnets be positioned in the crankcase to help attract and hold metal filings in the crankcase and out of the lubrication system. Figure 46 shows the location of the round strainer and the magnets in the crankcase.

**To Remove:**
Remove hand hole covers (see "To Remove Handhole Covers"). The flat strainer screen assembly is hold-down by a steel spring hold down clip. Grip the hold-down clip and pull out and up to release. Disconnect the flarenut and remove the strainer.

If removing a round strainer assembly, it is necessary to only disconnect the flarenut and remove the strainer.

Figure 45 — Removing Spring Retainer

**To Install:**
Place the strainer assembly in position and connect the flare- nut to the fitting in the housing. If the round screen assembly is being installed the flarenut can be tightened while holding the strainer in place. If the flat strainer screen is being installed, snap the hold-down clip into position (fits into the channel on top of the strainer assembly) then tighten the flarenut with the flat strainer screen in position.

**To Install:**
Place strainer assembly in position and connect flare nut to crankcase. Do not tighten. Snap the hold-down strip into position (fits into channel on top of strainer assembly). With the strainer assembly in position, tighten flare nut connection to crankcase.

## Oil Check Valves

Two oil check valves are located in the two lower banks of cylinders at each side of the compressor. Their function is to return oil to the compressor crankcase which has collected in the upper suction chamber. Oil which may collect in the suction strainer pan assembly is returned to the compressor crankcase through an oil check valve located in the suction chamber wall.

These valves are ball-seating type valves. If necessary, they may be removed and cleaned with a refrigerant parts cleaner.

**Model "E" Compressor Only**
Design sequence compressors "A" thru "G" and "H" model design sequence with a serial number designator of "L" and prior used two check valves located in the lower banks of cylinders at each side of the compressor. Their function was to return oil to the compressor crankcase which collects in the upper suction chamber. Oil which may collect in the suction strainer pan assembly and motor barrel was returned through an oil check valve located in the suction chamber wall between the motor barrel and the crankcase.

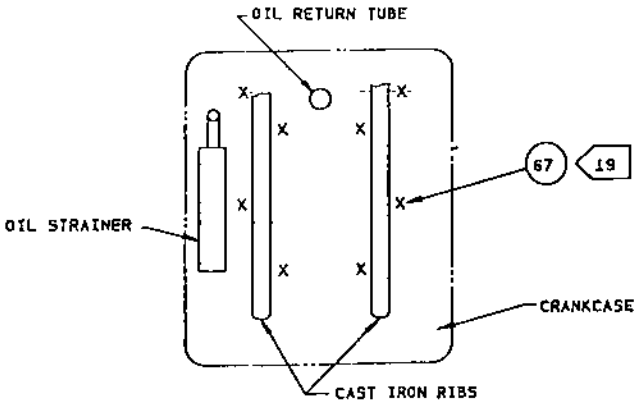



Figure 46 — Magnet Placement

When rebuilding Design Sequence compressors "A" through "H" and "H" model design sequence with a serial number designator of "L" and prior, they should be updated using the oil drain orifices and street elbow and pipe used in later designs. The upper cylinder check valves should be replaced with oil drain orifices (see parts list OCOM-UP-1). Also the oil check valve located in the suction chamber wall between the motor barrel and the crankcase should be replaced with a Street elbow and Tube Assembly (see parts list OCOM-UP-1). These changes were made to improve the oil return to the crankcase be improving the venting of the crankcase and preventing the oil from migrating from the crankcase to the motor barrel during the off cycle.

The design sequence "K" compressors used a larger size street elbow and tube assembly and it is not interchangeable with previous design sequence compressors.

**Oil Pressure Sensing:**

**Model "E" Compressors Only**
Compressors prior to Design Sequence "F" with a serial number design designator or "F" sensed the oil pressure at the oil discharge port at the pump end of the compressor. It is recommended that when compressors of these design sequences are rebuilt that the oil sensing location be moved to the oil sightglass handhole cover. This will require a kit, part number KIT-454 to make the conversion. The oil pressure control cutout setting will be required to be increased to 30 psid. The kit includes direction for making the conversion and adjusting the oil pressure control.