TRANE™

Maintenance HCOM-M-8

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Product Section	**Refrigeration**
Product	**Reciprocating Compressor -Condenser Units**
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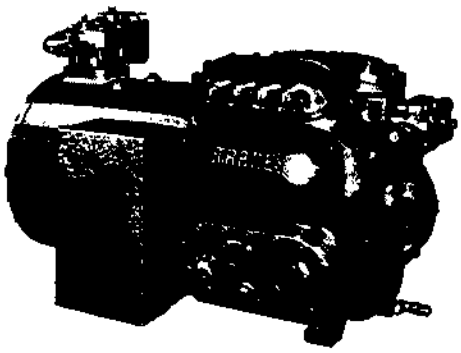
SEMI-HERMETIC RECIPROCATING COMPRESSORS

Compressor Service And Overhaul
MODEL E, 4-5-6 AND 8 CYLINDERS



The Trane Company
La Crosse, Wisconsin 54601-7599
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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.

The Model E Hermetic Reciprocating Compressor may be serviced without being removed from its base or foundation. Handhole covers are provided for inspection, cleaning and repair without tearing down the entire compressor. However, it may be advantageous to set the compressor on a work bench or table when performing a complete overhaul.

Preselective fit is not required with Trane compressor parts. All parts may be replaced with standard stock items.

As parts are removed, do the following:

1. Clean each part with a refrigeration parts cleaner.

2. Inspect each part for evidence of wear, breakage or copperplating. As a guide for replacement, Table 1 lists tolerances and wear limits.

3. Coat each part with clean compressor oil.

When reinstalling parts, do the following:

1. Use new gaskets and "O" rings.

2. Use a torque wrench when tightening bolts or nut and bolt combinations. Improper tightening can cause premature wear, stripping of threads or even failure of a part. Table 2 lists the torques to be followed.

3. Lubricate all bearing surfaces before placing in the machine. This will enable the compressor to run without seizing when it is first started up and before oil pressure is built up.

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. Open the system disconnect switch and lock in that position or remove the fuses from the switch. If the compressor is being removed from its base or foundation, support the suction and hot gas lines to prevent undue strain on the piping and joints. Plug the compressor control lines to prevent entry of foreign matter. Tag or mark the motor electrical leads as they are removed for ease of assembly.

The following procedures detail methods of removing, inspecting and reinstalling each compressor part. The sequence also is correct for complete compressor teardown.

Table 1 — Recommended Wear Limits and Tolerances

Part Name	Original Spec.	Recommended Limit	Maximum Recommended Diametral Clearance
Main Bearings Crankshaft - Mains	2.8765 - 2.8785 2.8735 - 2.8745	2.8805 2.8720	.006
Conrod - Crank Pin Crankshaft - Crank Pin	2.7520 - 2.7530 2.7485 - 2.7495	2.7560 2.7450	.008
Piston Pin Conrod - Pin Bore	1.1248 - 1.1250 1.1253 - 1.1256	1.1244 1.1258	.0011
Cylinder Liner Piston	3.6600 - 3.6610 3.6520 - 3.6530		
Piston Rings (Gap in 3.6660 Ga.)	.005 - .015	.035	
Valves (All)	Valves are .038"-.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 side to side.		
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.

Table 2 — Bolt Torques

Item	Torque Foot-Pounds	Item	Torque Foot-Pounds
Cylinder Head Bolts	76	Connecting Rod Bolts	23
Discharge Valve Bolt	50	Connecting Rod Bolt - Offset Rod	24
Handhole Cover Bolts	76	Oil Pump Mounting Bolts	14
Sight Glass Mounting Bolts (B Design)	6	Oil Pump Cover Bolts	43
Distributor Cover Bolts	23	Suction Cover Bolts	115
Capacity Control Bolts	23	Motor Bearing Bolts	69
Suction Service Valve Mounting Bolts	195	Motor Terminal Nuts	25-30
Suction Service Valve Flange Screws	195	Motor Terminal Lugs	25-30
Discharge Service Valve Mounting Bolts	115	Motor Terminal Lug Set Screws	25-30
Discharge Service Valve Flange Screws	115	Motor Terminal Board Retaining Ring Bolts	51*
Motor Rotor Bolts	195	Stator Bolt	176

*"M" Design Sequence and later 42 ft. lbs.

Table 3 — Operating Data

No. Cylinders	Bore	Stroke	R.P.M.	Norm. Tonnage R-12	Norm. Tonnage R-22	Valve Connections Suction	Valve Connections Discharge	Weight R-12	Weight R-22	Oil Pressure	Oil Capacity
4	3.66"	2.75"	1750	30	50	3-⅛"	2-¼"	1350	1350	50-60	32 PTS.
5	3.66"	2.75"	1750	40	60	4-⅛"	2-¼"	1500	1500	50-60	34 PTS.
6	3.66"	2.75"	1750	50	75	4-⅛"	2-⅝"	1570	1570	50-60	34 PTS.
8	3.66"	2.75"	1750	60	100	4-⅛"	3-⅛"	1765	1765	50-60	36 PTS.

Note:

See Service Bulletin HCOM-SB-4 "Recommended Oils and Oils Charges for Reciprocating and Scroll Compressors".

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 at opposite ends of the cylinder head. Back off the remaining two bolts two or three turns. If the cylinder head is not following the bolts, jar the head with a rawhide hammer. Loosen the last two bolts alternately to relieve the tension of the safety head springs. When the bolts have been removed, lift off the cylinder head and safety head springs (Figure 1).

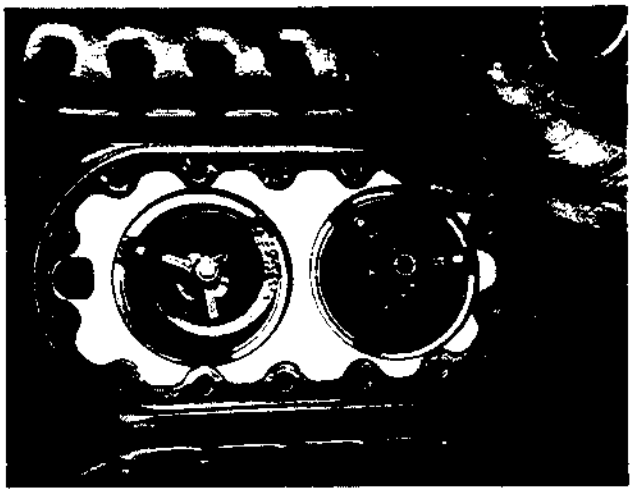

Figure 1 — Removing Safety Head Spring

Inspection:
The cylinder head and housing sealing surfaces should be smooth and level. Nicks or grooves will not provide the proper seal.

To Install:
Center the safety head springs on the discharge valve cage assemblies (Figure 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 tightening the two bolts alternately. Insert the remaining bolts and tighten all bolts to a final torque.

Torque — 76 Foot-Pounds

Discharge Valve

"G" design sequence and later cpmpressors do not use the valve cushion or retainer. See Parts List HCOM-UP-2 for parts availability and part substitution for design sequences "A" through "F".

To Remove:
Remove cylinder head (see "To Remove Cylinder Head"). Lift off safety head springs. Lift off discharge valve cage (Figure 2).

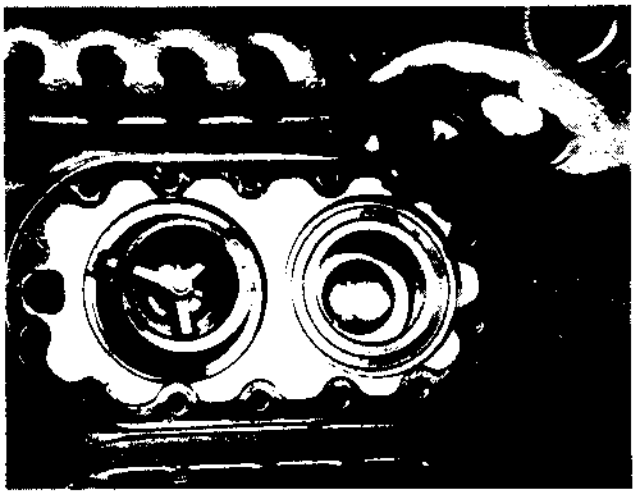

Figure 2 — Removing Discharge Valve Cage

To Disassemble Discharge Valve:
Loosen locknut on discharge valve bolt. Remove valve bolt and seat. Remove valve ring, springs, cushion retainer and cushion (Figure 3).

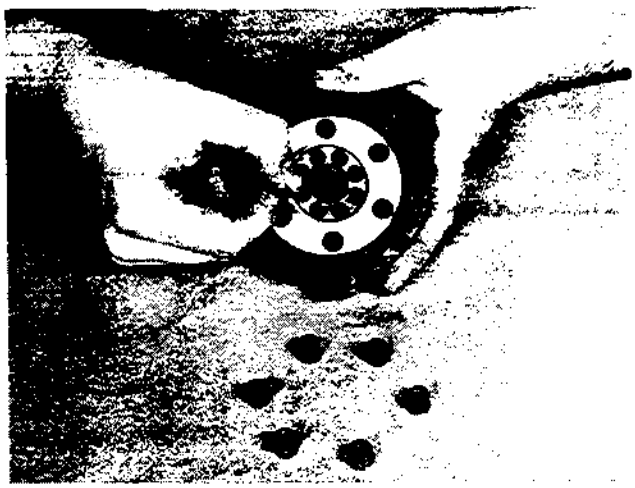

Figure 3 — Inserting Discharge Valve Cushion Retainer

Inspection:
Inspect all discharge valve parts for evidence of copperplating, liquid slugging or wear. See Table 1 for valve and valve spring replacement data.

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. Press valve cushion retainer into place (Figure 3). Place valve springs into the spring

pockets in valve cage. Lay the valve ring over the springs (Figure 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 (Figure 5). Attach locknut and tighten. Recheck valve ring movement to make sure that it is not restricted (Figure 5. Tighten to final torque.

Torque — 50 Foot-Pounds

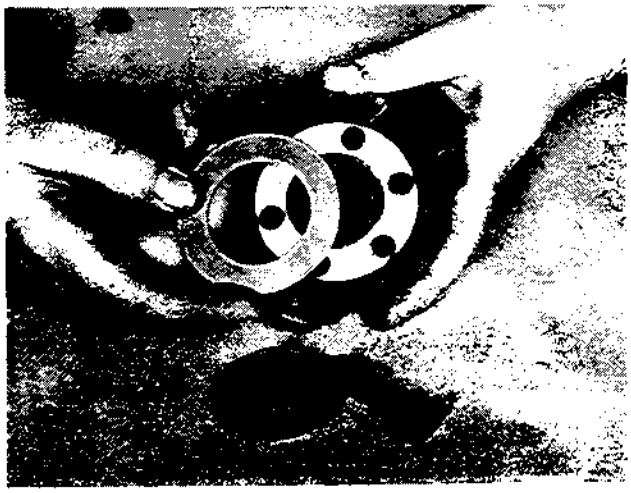

Figure 4 — Inserting Discharge Valve

Figure 5 — Checking Valve Movement

To Install:
Set the valve assembly in place, making sure that it seats properly.

Suction Strainer Assembly

Design sequence "M" and later compressors do not utilize the suction strainer assembly but instead use a strainer basket in the suction inlet of the compressor. Inspect and clean or replace the strainer basket as required.

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. Remove the top screw while supporting the weight of the cover. The strainer pan is attached to the cover and is removed with the cover (Figure 6).

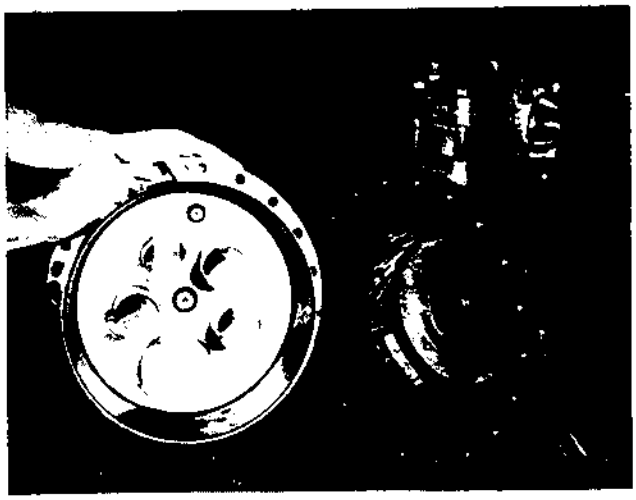

Figure 6 — Removing Suction Strainer Assembly

Inspection:
Inspect the suction strainers for dirt or damage to the wire mesh. If necessary, clean or replace.

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.

To Install:
With the suction strainer assembly attached to the cover, place two screws in the cover (opposite sides). Lubricate the cover gasket and place on the cover using the screws as a guide. Set the assembly against the housing making sure the roll pin registers in the cover and draw the screws up hand tight. Insert and tighten the remaining screws. Tighten all screws to final torque.

Torque — 115 Foot-Pounds

Cylinder Liners

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

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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:
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 (Figure 7).

Figure 7 — Liner Puller Block

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 (Figure 8) it can be withdrawn by hand.

Support the piston to prevent it from falling against the housing as the liner is pulled out of the housing.

On cylinder liners equipped with unloaders, the unloader mechanism may come out with the cylinder liner.

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.

Figure 8 — Pulling Cylinder Liner

Inspection:
Replace the liner if there is evidence of excessive wear or scoring on the inside wall. Wear limits are listed in Table 1.

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 gap 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 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 down firmly against the rings. The rocking and rotating motion will guide the rings 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. Be sure it is seated in the housing.

To Install:

(Cylinder Liner Assembly With Unloader)
The only difference between the installation of the liner and the liner with unloader is in the proper positioning of the unloader 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 degrees 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: Damage to the oil connector or register pin may result if the unloader is forced into position while placed improperly in the housing.

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.

Cylinder Unloader Assembly

If high heat or dirty crankcase oil is encountered, the unloader mechanism should be disassembled and the "O" rings replaced. Figure 9 illustrates the unloader "O" rings.

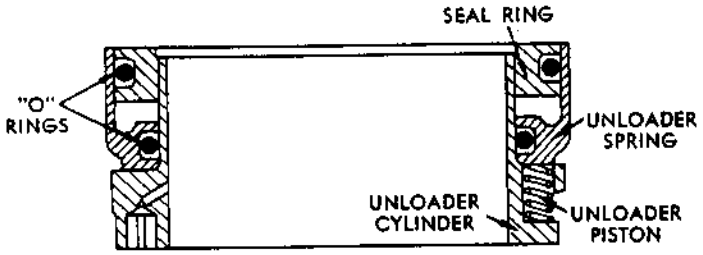


Figure 9 — Cross Section View of Unloader

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 (Figure 10).

Figure 10 — Removing Unloader From Liner

To Disassemble Unloader:
Work the unloader piston and seal ring off the unloader cylinder (Figure 11). A screwdriver may be used for this purpose. When the top section is free, remove the seal ring from the piston (Figure 12).

Figure 11 — Disassembling Unloader

Figure 12 — Removing Seal Ring

Inspection:
Inspect the "O" rings for damage or deterioration and replace if necessary. The seal ring and unloader piston are not available as separate parts. If damage is noted on either part, replace the complete unloader assembly.

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

Place the seal ring on top of the unloader piston. Drive the seal ring into position as shown in Figure 13. The face of the seal ring should be approximately ¼" below the upper edge of the unloader piston. Be sure the "O" rings do not become damaged as this may cause excessive oil leakage into the refrigeration system.

Figure 13 — Positioning Seal Ring

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".

Suction Valve Assembly

To Remove:
Invert the cylinder liner and valve assembly. Remove the three retainers (Figure 14). Do not move the liner around on top of the valve assembly.

Lift the liner assembly away from the valve assembly (Figure 15). With the cylinder liner separated from the valve assembly, the valve ring, springs and "O" ring can be removed (Figure 16).

Figure 14 — Removing Suction Valve Retaining Rings

Figure 15 — Lifting Off Liner

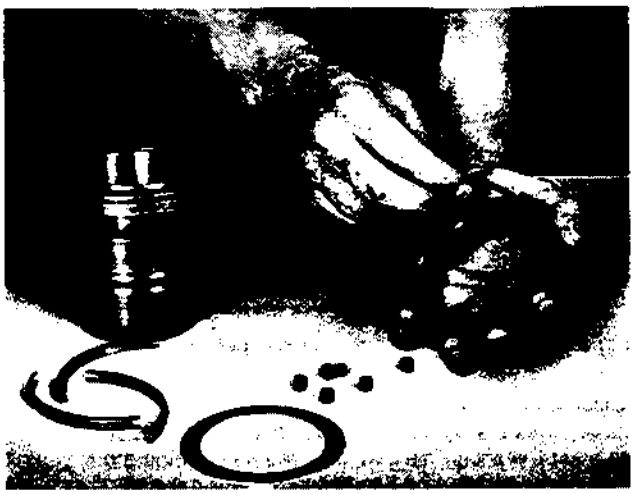


Figure 16 — Removing "O" Ring

Figure 17 — Removing Suction Valve Ring

Inspection:
Inspect the valve ring for copperplating or wear. See Table 1 for tolerances and wear limits.

Replace the valve springs if the compressor has operated in excess of those hours listed in Table 1.

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 (Figure 17). Set the valve plate assembly in an inverted position and place the cylinder liner on the valve plate (Figure 15). Fasten the suction valve assembly to the liner by installing the three retainers. One edge of these rings is wider than the other and fits into the cylinder liner (see Figure 18). Check the movement of the suction valve to see that it is not restricted within the assembly (Figure 19).

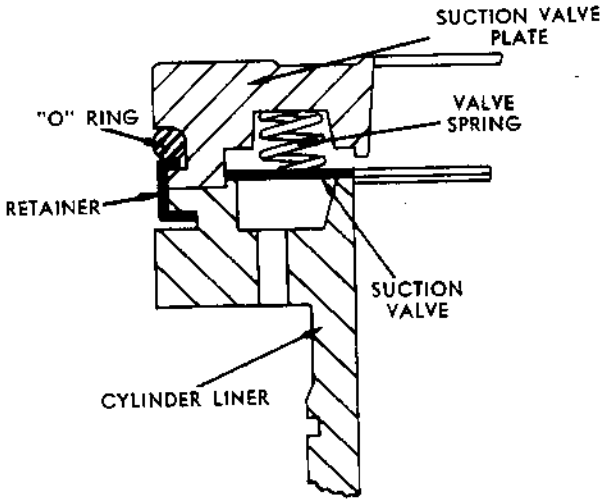


Figure 18 — Illustration of Suction Valve Retainer

Figure 19 — Checking Suction Valve Movement

Take-Up Ring and Lift Pins

To Disassemble:
Place cylinder liner in an inverted position. Release retaining ring (Figure 20) and slide off cylinder liner. Slide take-up ring off the cylinder liner. Remove lift pins and lift pin springs.

Figure 20 — Removing Retaining Ring

Inspection:
Inspect the take-up ring, lift pins and springs for damage.

To Assemble:
Place cylinder liner in an inverted position. Place springs on lift pins and insert lift pins into holes on underside of cylinder liner (Figure 21). Push take-up ring down over the cylinder liner and slide retaining ring into the ring groove on the cylinder liner (Figure 20). With retaining ring in position, work the take-up ring up and down to make sure the lift pins move freely and can raise and lower the suction valve ring.

Figure 21 — Inserting Springs and Lift Pins

Crankcase Handhole Covers

The handhole cover at the front of the compressor contains the oil level sight glass, a cleanable oil strainer and the compressor capacity control actuator when external electric capacity control is not used. A capacity control actuator adjustment screw is located on the front side of the cover. The handhole cover at the back of the compressor is fitted with a crankcase heater and a tapping for a crankcase oil equalizing line.

To Remove Actuator Bevel Spring:
Remove the adjusting screw plug and gasket on the face of the handhole cover. Using a screwdriver, remove the adjusting screw and slotted plug inside the cover. Pull the bevel spring and spring plug out of the cover. See Figure 22.

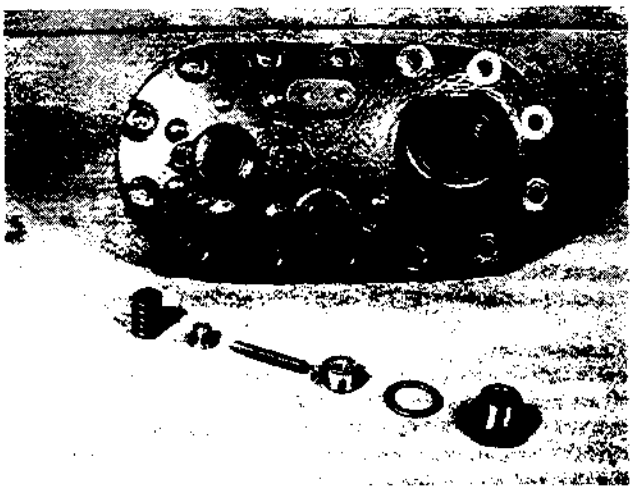


Figure 22 — Bevel Spring and Adjusting Screw Assembly

Inspection:
Check the spring for damage and color coding. The color coding is as follows R-12 Black, R-22 Green.

To Install Bevel Spring:
Insert the bevel spring and spring plug into the handhole cover. Install the slotted plug, turning until it bottoms. Replace the adjusting screw in the slotted plug. Replace the gasket and adjusting screw plug turning hand tight.

When the system is again started, the compressor loading and unloading sequence must be reset by the adjusting screw. See "Operation and Maintenance, Hermetic Reciprocating Compressors".

To Remove Handhole Covers:
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 and remove the remaining screw.

Inspection:
Inspect the handhole cover and housing sealing surfaces for nicks or large grooves.

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. Insert the remaining bolts, pull them up hand tight and then tighten all bolts to final torque.

Torque — 76 Foot-Pounds

To Remove Oil Strainer:
Remove the plug on the face of the handhole cover. Withdraw the "O" ring, spring and oil strainer.

Inspection:
Clean or replace the oil strainer 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.

Capacity Control Actuator

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

Remove the bellows assembly "O" ring 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 (Figure 23).

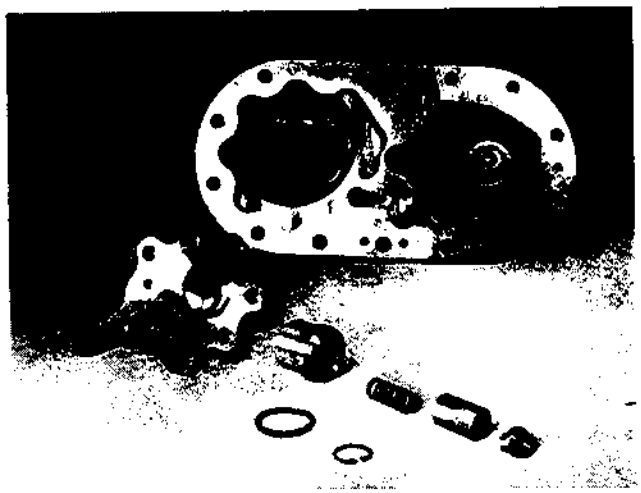


Figure 23 — Bellows Assembly

Remove the retaining ring from the fulcrum pin that 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 (Figure 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.

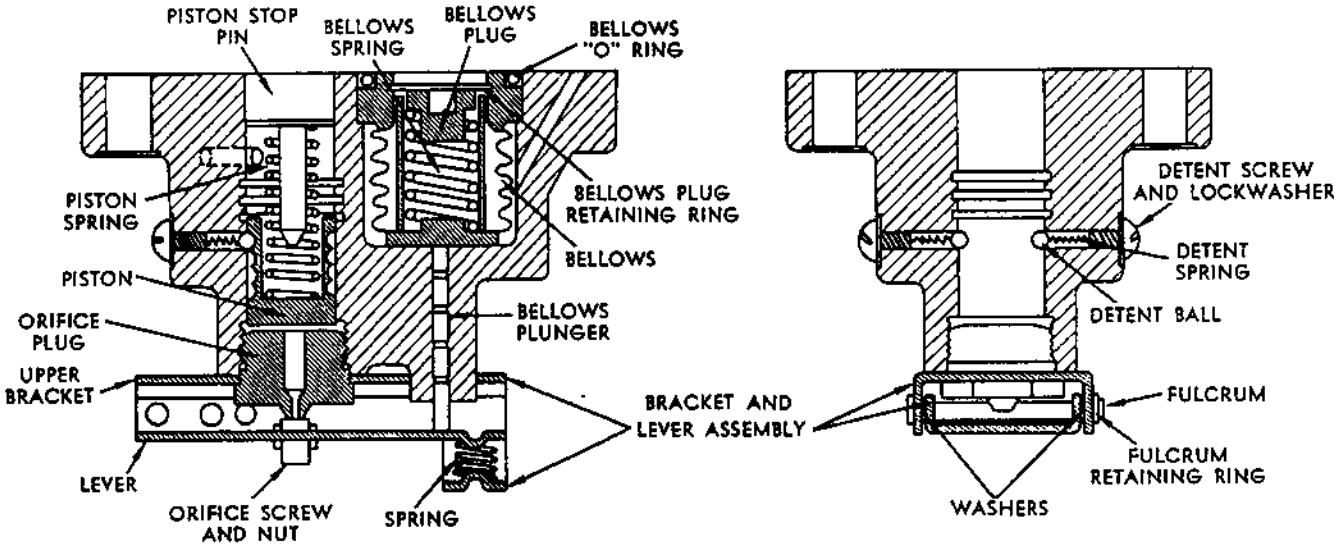


Figure 24 — Cross Section Views of Capacity Control Actuator

CAUTION: Do not attempt to adjust or otherwise turn or remove the orifice screw and nut that 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.

To Assemble Capacity Control Actuator:
Set the piston spring down over the piston stop pin inside the actuator housing. Slide the piston into position. Insert the detent balls, springs, washers and retaining screws. Install the orifice plug and upper bracket.

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.

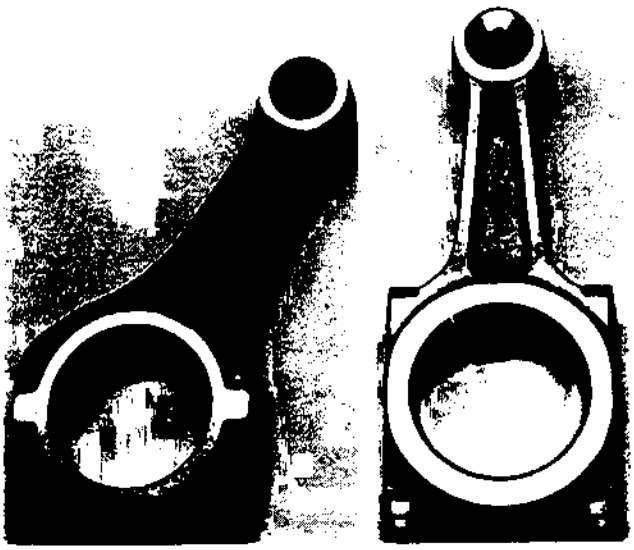
Place the sleeve, spring and spring stop into the bellows assembly. Fasten in place with the retaining ring. Set the bellows assembly into the actuator and replace the bellows assembly "O" ring.

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

Torque — 23 Foot-Pounds

Connecting Rod and Piston Assembly

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.



NEW OLD

Figure 25 — New and Old Style Connecting Rods

To Remove:
Remove cylinder head (see "To Remove Cylinder Head," Page 4). Remove discharge valve cage (see "To Remove Discharge Valve Cage," Page 4). Remove suction strainer assembly (see "To Remove Suction Strainer," Page 5). Remove cylinder liner (see "To Remove Cylinder Liner," Page 6). Remove handhole covers (see "To Remove Handhole Covers," Page 10). Rotate the crankshaft until the connecting rod nuts are accessible through the handhole cover. Remove the two nuts from the connecting rod bolts.

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

Inspection:
Follow the wear limits listed in Table 1 for the connecting rods and crankpins. Check for evidence of copperplating and make sure the oil control holes are open in the piston head.

To Install:
Lubricate the bearing surfaces on the rod and shaft with clean compressor oil. Because connecting rod bolts are body-bound, they must be driven into the connecting rod with a lightweight mallet or hammer (see Figure 26). Be sure that the beveled side of the head of the connecting rod bolt is turned toward the shank of the connecting rod.

All connecting rods have two matched marks which identify the rod and cap as a unit. THESE TWO MATCH MARKS MUST BE ASSEMBLED SO THAT THEY ARE ON THE SAME SIDE OF THE ROD. Each connecting rod and rod cap has a chamfer which matches a fillet on the crankshaft rod journal. When installing the rod and cap, make sure the chamfer and fillets match. On compressors which have four rods to a journal, the two inside chamfers should face each other. If there are three rods on a journal, the middle rod chamfer should face the pump end of the compressor.

Figure 26 — Inserting Connecting Rod Bolts

Invert cylinder liner on clean work surface using care not to mar the valve seat on the top side of the liner assembly. Rotate the piston rings on the piston to stagger the gap in the piston rings. Start the head of the piston down into the cylinder liner. The cylinder liner skirt is tapered to assist the entry of the piston and ring into the liner. With the piston started into the liner, rotate and rock the piston and at the same time press down firmly on the skirt of the piston (see Figure 29). After all rings have passed the bottom of the liner skirt, push the piston down into the liner until the bottom of the piston is even with the bottom of the cylinder liner.

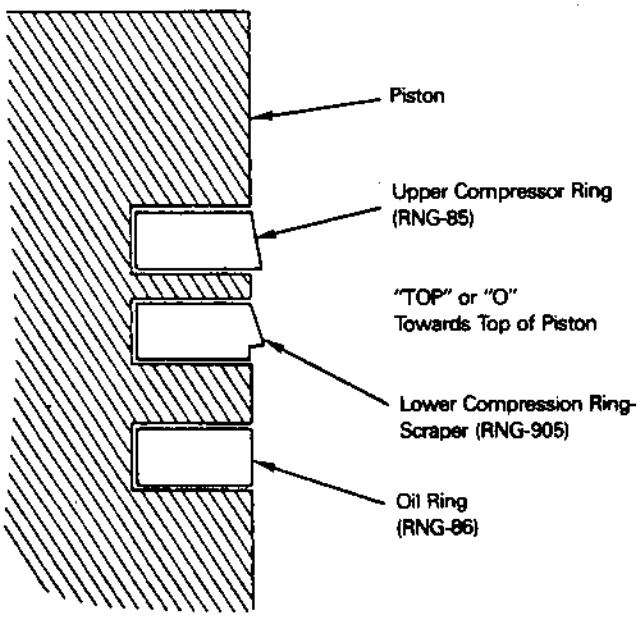


Figure 27 — Replacement Piston Ring Set (RNG-77) for 3-Ring Pistons

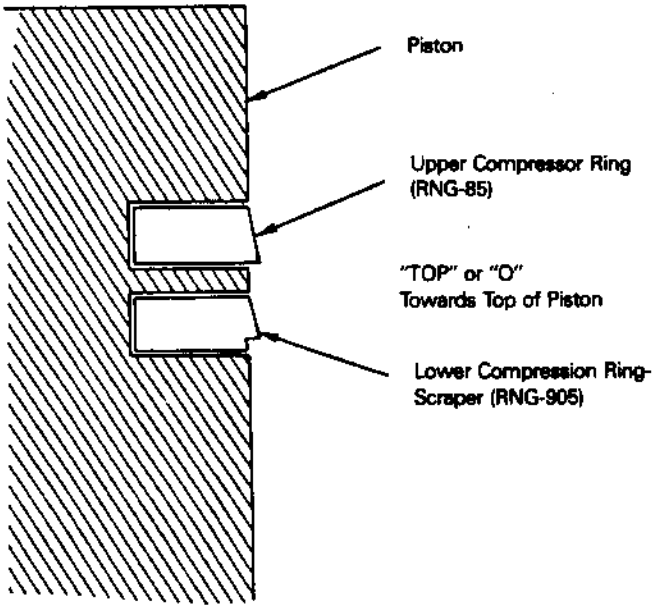


Figure 28 — Replacement Piston Ring Set (RNG-77) for 2-Ring Pistons

Figure 29 — 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 (Figure 30). Press the liner into final position (see "To Install Cylinder Liner With Unloader," Page 4). With the rod in position against the shaft, place the cap on the connecting rod bolts. Be sure that the match marks are correct.

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 all connecting rod nuts be drawn tight with a torque wrench. Improper tension will cause distortion of the rod and result in premature wear or failure of the connecting rod bearings.

Torque — 23 Foot-Pounds

> 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.

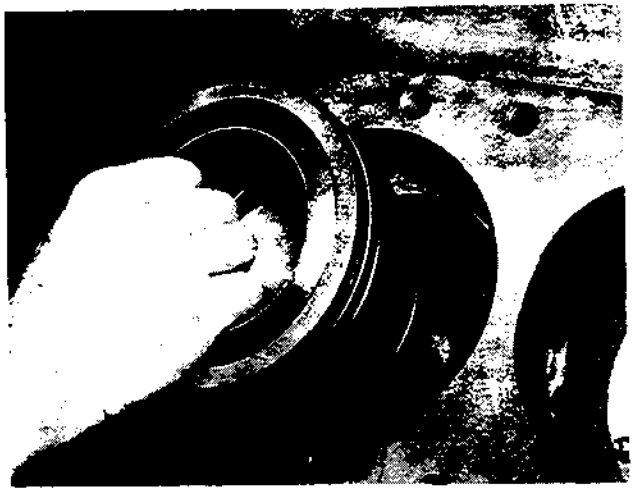


Figure 30 — Installing Liner and Piston Assembly In Crankcase

Piston and Wrist Pin Assembly

Prior to design sequence "K" a three ring groove piston was used. The "K" design sequence and later compressors use a two ring groove piston. The pistons are interchangeable in the same compressor.

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.

Inspection:
Check the piston pin and pin bore tolerances as listed in Table 1. Replace the pin and/or piston if grooves are found on the bearing surfaces. Check the oil control holes in the piston to be sure they are open.

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

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 "K" 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.

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.

Inspection:
The ring grooves must be clean and must not contain burrs. Roll the back edge of the rings in the grooves to make sure they fit freely. Table 1 contains wear limits and tolerances.

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.

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 27 for the three groove piston ring installation.

Two Groove Piston:
The scraper ring goes in the bottom groove and the compression ring goes in the top groove. See Figure 28 for the two groove piston ring installation.

Oil Pump Assembly

The oil pump is a complete assembly and cannot be repaired in the field. If it becomes inoperative, the complete pump must be replaced.

To Remove:
Loosen and remove the screws which hold the oil pump cover and "O" ring to the housing (Figure 31).

The oil pump assembly is bolted to the pump end bearing. Remove the four screws and lockwashers and rock the pump up and down to break the gasket seal. Do not strike the pump with a hammer.

Figure 31 — Removing Oil Pump Cover

Inspection:
The oil pump may be disassembled for inspection and cleaning if necessary. If wear or breakage is found, replace the entire pump.

Figure 32 — Removing the Rotor

To Install:
Clean the face of the bearing head and oil pump. Place two screws through the flange of the oil pump, lubricate the oil pump gasket and place on the face of the oil pump using the screws as a guide. Be sure the holes in the gasket match the holes in the oil pump and bearing head. The drain slot in the oil pump must be at the bottom.

Turn the oil pump key to match the slot in the end of the crankshaft. Attach the pump and gasket to the bearing and draw the screws up hand tight. Tighten all screws to final torque.

Torque — 14 Foot-Pounds

Lubricate the oil pump cover "O" ring and place in the slot between the bearing head and the housing. Set the cover over the oil pump, insert and tighten the mounting screws hand tight. Tighten all screws to final torque.

Torque — 43 Foot-Pounds

Motor Rotor and Stator

To Remove Rotor:
Remove the suction strainer pan assembly (see "To Remove Suction Strainer Assembly") and a handhole cover (see "To Remove Handhole Cover"). On "M" design sequence and later compressors remove the suction cover and a handhole cover.

Place a soft block of wood against one of the crankshaft counterweights to prevent the crankshaft from turning. Remove the rotor retaining bolt and washer. Ease the rotor off the end of the crankshaft. The rotor-crankshaft key will slide with the rotor as it is removed.

> CAUTION: When removing the rotor from the compressor insure that the rotor does not hit the motor stator end turns. This could cause damage to the motor windings and result in a motor electrical failure. See Figure 32.

To Remove Stator:
Remove the Motor Terminal box cover and junction box from the compressor.

Design Sequence "A" through "K"
Figure 33 illustrates the motor terminal board and terminals for "A" through "K" design sequence compressors. Disassemble the terminal lugs, lock nuts, buss bars and sealing spacers. Remove the terminal board mounting ring and pull the assembly out of the housing. Work the "O" rings off the terminals and push the terminals out of the terminal board and locating plate. Disconnect the motor thermostat leads.

Design Sequence "M" and Later
Figure 34 illustrates the motor terminal board and terminals for "M" design sequence and later compressors. Disassemble the terminal lugs, lock nuts, buss bars. Pull the upper terminal insulator off the terminal studs. Remove the terminal plate mounting bolts. Lift the plate and gasket. Disconnect the motor thermostat leads. Remove the terminal plate and gasket, working the terminal studs and terminal seals out of the plate carefully to avoid damaging the studs.

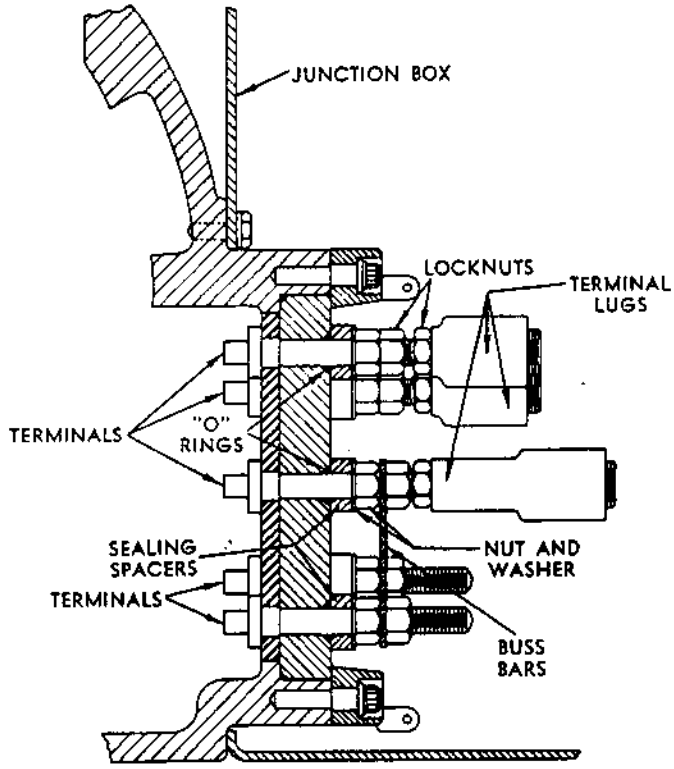


Figure 33 — Motor Terminal Assembly - "A" through "K"

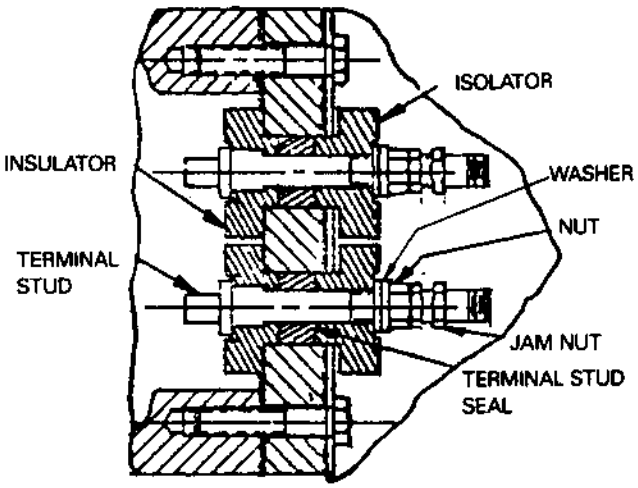


Figure 34 — Motor Terminal Assembly - "M" and Later

At the top of the compressor motor barrel, remove the stator bolt. To support the weight of the stator, provide cribbing next to the housing. Grasp the stator with both hands and pull the stator out of the housing. See Figure 35. Guide the motor leads to prevent damage as the stator is pulled outward. A sharp rap on the side of the motor barrel with a plastic hammer may be necessary to start the stator moving.

> CAUTION: When removing the motor stator be careful not to damage the motor windings. Damaging the motor windings could result in a motor electrical failure.

Set the rotor and stator in a clean, dry area where the windings will be protected from damage.

Figure 35 — Removing the Stator

Installing Stator:
As an aid in positioning the stator in the housing, scribe a guideline from the center of the stator bolt hole, across the stator laminates in the direction opposite the motor leads. A similar line should be scribed on the outside of the housing from the center of the stator bolt hole to the suction cover end of the housing. With these guide marks aligned, the mounting bolt hole will match when the stator is in position.

Tie a string around the stator leads and pull them back inside the stator. To help support the weight of the stator during installation install cribbing next to the compressor. Push the stator into the housing using the guidelines scribed earlier to align the stator mounting hole with the stator bolt hole in the compressor housing. Install the stator mounting bolt and "O" ring. Torque to 176 foot-lbs.

Attach the thermostats leads to the spade connections inside the housing. (Design sequences "A" through "K" only).

Reassemble the terminal plate, terminal studs, "O" rings, and nuts as shown in Figure 33 for "A" through "K" design sequence. Torque nuts to 25 foot-lbs.

For Design Sequence "M" and later reassemble the terminal plate, terminal studs, insulators and terminal seals, and nuts as shown in Figure 34. Attach the motor thermostat leads to the terminal plate. Torque the nuts to 10-25 foot-lbs.

Place the assembled terminal board in the housing and install. Tighten all bolts to the required torque. Design sequence "A" through "K" with terminal ring, 51 foot-lbs. Design sequence "M" and later, 42 foot-lbs.

Installing Rotor:
Place the rotor on the crankshaft and push it into position, lining up the key way in the rotor and crankshaft. Insert the key and tap into position.

Insert the rotor retaining bolt and washer and draw the bolt up hand tight. Block the crankshaft so that it will not turn by placing a block of wood against one of the crankshaft counterweights. Tighten the rotor retaining bolt to the required torque.

Torque — 195 Foot-Pounds

Check the rotor-stator air gap with a feeler gauge. The maximum allowable air gap variation is 0.008"-0.010" side to side.

Main Bearings and Crankshaft

The pump-end and motor-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 must be replaced. An arbor press is required to prevent damage to the bearing.

Design sequence "A" through "K"
The pumpend bearing head contains a spring loaded ball type oil relief valve and the motorend bearing has a foam breaker and check valves. Both the oil relief valve and foam breaker may be removed for inspection, cleaning or replacement.

Design sequence "M" and later
The pumpend bearing head contains a spring loaded ball type oil relief valve, but 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 "M" design sequence and later compressors.

> NOTE: The "M" design sequence bearing head has a tapered tail piece, see Figure 36 and is drilled for the check valves used in the "A" through "K" design sequences. By installing the check valves and foam breaker in the bearing head it can be used in an "A" through "K" compressor. BUT the "A" through "K" design sequence bearing head cannot be used in a "M" design sequence or later compressor because the tail piece of the bearing head is not tapered and the motor rotor will interfere with the bearing head.

Whenever the crankshaft or either main bearing is removed from the compressor, crankshaft end play must be adjusted. Adjustment is made by using .005, .010 or .020 metal shims between the pump-end bearing and the crankshaft.

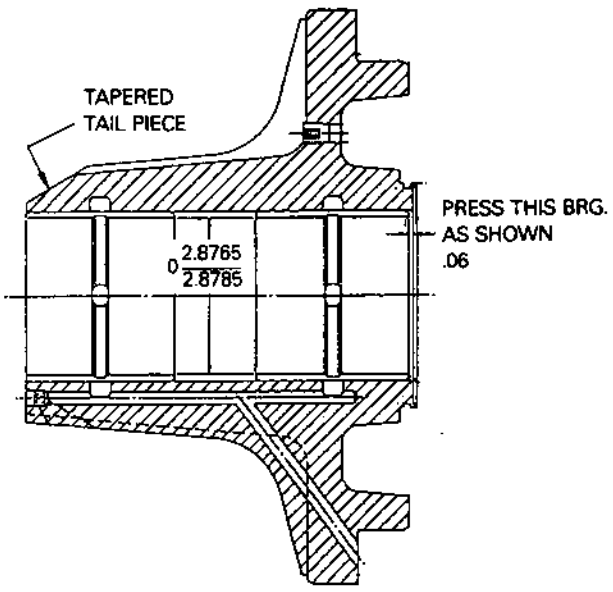


Figure 36 — Pumpend Bearing Head - "M" and Later

To Remove Motor End Bearing:
Remove the motor rotor (see "To Remove Rotor") and handhole cover (see "To Remove Handhole Cover").

Loosen and remove all of the bearing head screws. Pull the bearing off the end of the crankshaft and, at the same time, hold the crankshaft to prevent it from following the bearing. Do not bump the bearing head on the motor stator.

The crankshaft will balance in the pump-end bearing and does not need to be blocked.

If the crankshaft is frozen in the bearing head, remove the connecting rod assemblies (see "To Remove Connecting Rods") and pull the bearing head-crankshaft assembly as a unit.

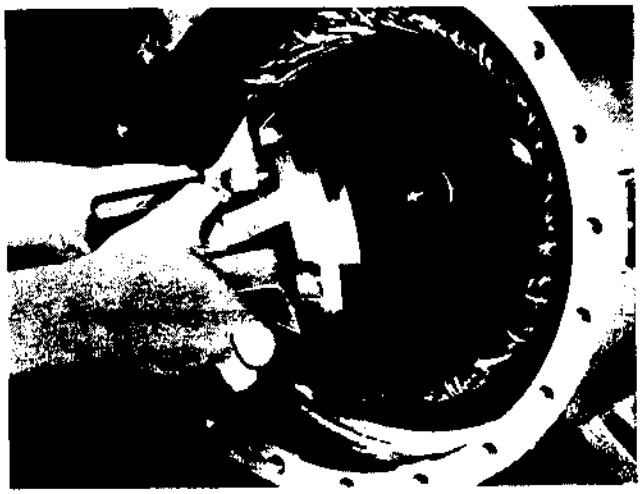


Figure 37 — Removing Motor End Bearing

Inspection:
Examine the bearing surfaces for damage or copperplating. Check the oil passages and clean them if necessary. Wear limits are given in Table 1.

To Remove Crankshaft:
The crankshaft is removed from the compressor through the motor-end of the compressor. Remove the connecting rods and piston assemblies (see "Connecting Rod and Piston Assembly," "To Remove," Page 11). Remove the motor-end bearing (see "To Remove Motor End Bearing").

Grip the crankshaft at the center and at the motor-end of the shaft. Place one hand through the handhole opening and the other at the end of the shaft. Carefully draw shaft out of pump-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 38). Be careful not to drop the crankshaft on the stator.

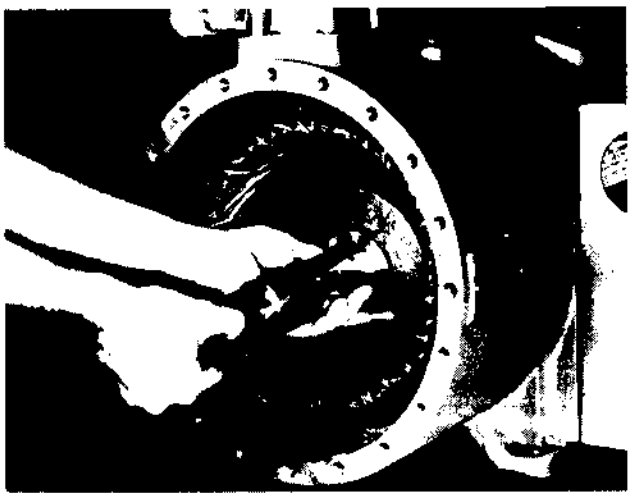


Figure 38 — Removing Crankshaft

Inspection:
Examine the crankshaft journals and bearing surfaces for damage or copperplating. Check the oil passages and clean them if necessary. Wear limits are given in Table 1.

To Remove Pump-End Bearing:
Remove the oil pump (see "To Remove Oil Pump"). Pull the bearing head (Figure 39) out of the housing. This bearing is not bolted in place but is held by the oil pump cover. An "O" ring seals the inner bearing surface to the housing and it may be necessary to force the bearing out of the housing.

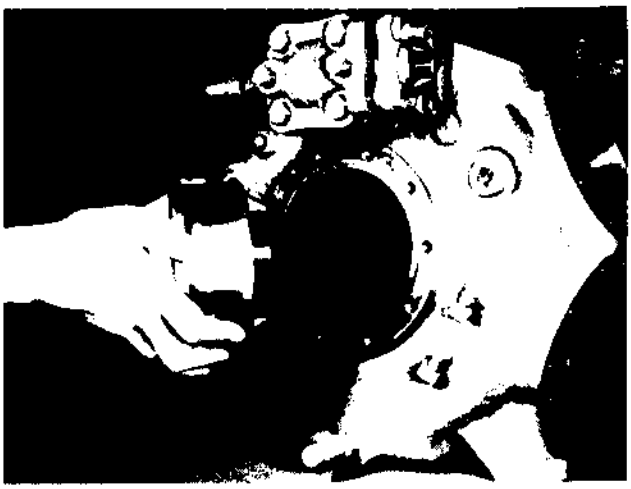


Figure 39 — Removing Pump End Bearing

Inspection:
Examine the pump-end bearing for damage or copperplating and clean the oil passages if necessary. Wear limits are given in Table 1.

To Install Main Bearings and Crankshaft:
Lubricate the pump-end bearing "O" ring and place in the groove in the housing (Figure 40).

Clean the pump-end bearing and lubricate all bearing surfaces. Guide the bearing into the housing with the roll pin in the housing fitting into the hole in the bearing flange. Attach the oil pump cover but do not install the oil pump. Tighten all bolts to the required torque.

Torque — 43 Foot-Pounds

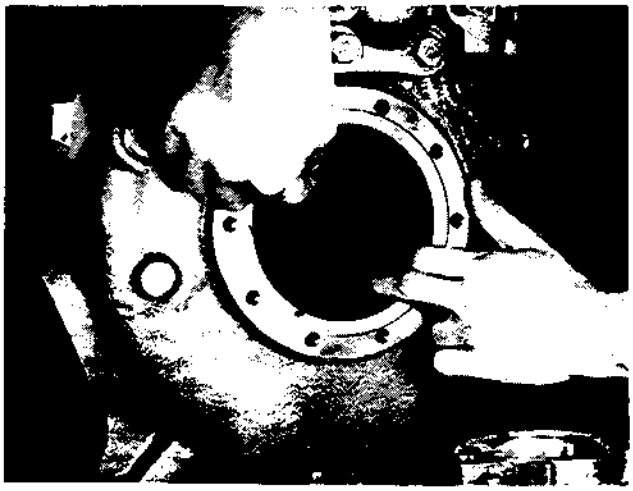


Figure 40 — Installing Pump End Bearing "O" Ring

Lubricate the thrust washer and place on the pump-end of the crankshaft. Place a .010" shim on the same end of the crankshaft and lubricate all bearing surfaces of the crankshaft. Place the crankshaft in the housing and into the pump-end bearing. Be sure the thrust washer and shim are in position

When the crankshaft is in position, it can be released and does not need to be supported.

Lubricate the other thrust washer and place it over the motor-end of the crankshaft.

The motor-end bearing has a small "O" ring near the bottom of the flange which rests against the housing. Lubricate the "O" ring and place it on the bearing. Push the bearing into position against the housing making sure the thrust washer is positioned correctly. Insert and tighten the bearing mounting screws to the required torque.

Torque — 69 Foot-Pounds

Crankshaft end-play adjustment is determined by the number and thickness of the shims placed between the pump-end bearing and the housing. These shims are .005", .010" and .020" thick.

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

Crankshaft end-play clearance should be .017" to .026". 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 made, remove the oil pump cover and install the oil pump (see "To Install Oil Pump"). Tighten oil pump screws to final torque.

Torque — 14 Foot-Pounds

Install the oil pump cover and tighten all screws to final torque.

Torque — 43 Foot-Pounds

Recheck crankshaft end play.

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 (Figure 41).

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 refrigerant compressor parts cleaner.

To Install:
Roll the foam-breaker screen into approximate shape and insert into bearing head (Figure 41). Replace end ring and retaining ring. Replace magnetic plug and relief valve.

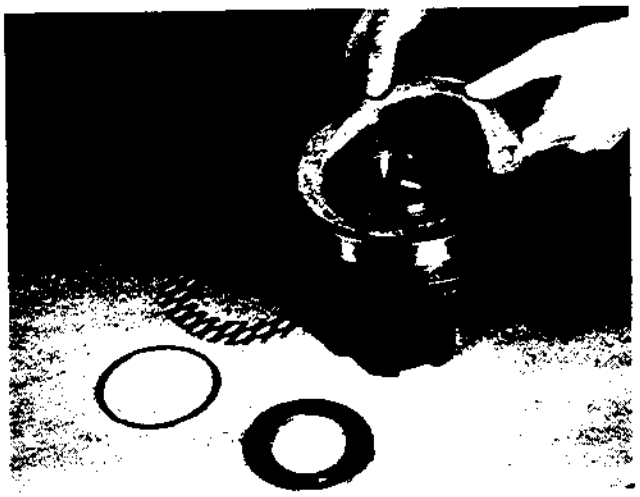


Figure 41 — Removing Foam Breaker

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. If the relief valve has 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.

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 42 shows the location of the round strainer and the magnets in the crankcase.

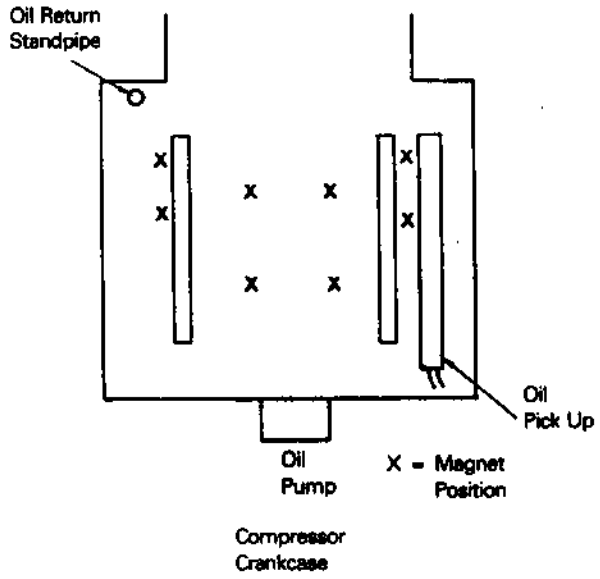


Figure 42 — Magnet Mounting Locations

To Remove:
Remove handhole covers (see "To Remove Handhole Covers"). The flat strainer screen assembly is held 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.

To Install:
Place the strainer assembly in position and connect the flarenut 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.

Oil Check Valves

Design sequence compressors "A" through "G" 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.

When rebuilding Design Sequence compressors "A" through "G" the upper cylinder check valves should be replaced with oil drain orifices (see parts list HCOM-UP-2). 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 HCOM-UP-2). The "J" design sequence compressor also uses the same street elbow and pipe assembly. These changes were made to improve the oil return to the crankcase by 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.

The design sequence "M" compressors relocated the position of the oil drain orifices and also relocated the street elbow and tube assembly into the motor barrel and increased its size for better oil return.

Oil Pressure Sensing:
Compressors prior to Design Sequence "H" 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.