



TRANE™

Maintenance

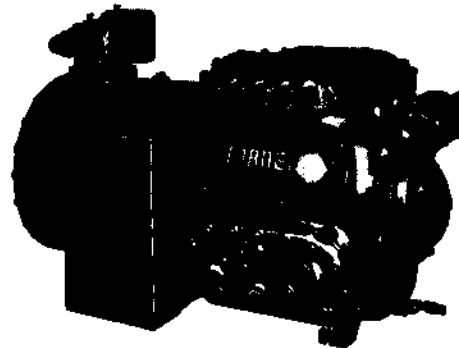
HCOM-M-2

Library	Service Literature
Product Section	Refrigeration
Product	Reciprocating Compressor - Condenser Units
Model	Hermetic F
Literature Type	Maintenance
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HERMETIC RECIPROCATING COMPRESSORS

COMPRESSOR SERVICE AND OVERHAUL

Model F, 4-5-6 and 8 Cylinders
Design Sequence C, D, and E



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 F 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 parts 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 Oil Clearance
Main Bearings	2.1265 - 2.1280	2.1305	
Crankshaft - Mains	2.1245 - 2.1250	2.1230	.0055
Conrod - Crank Pin (Vert.)	2.0022 - 2.0030	2.006	
Crankshaft - Crank Pin	1.9995 - 2.0000	1.997	.007
Piston Pin	.8748 - .8750	.8744	
Conrod - Pin Bore (Vert.)	.87505 - .87530	.8755	.0011
Cylinder Liner	2.7500 - 2.7505	2.7520	
Piston (Perpendicular to Centerline of Pin Bore)	2.7480 - 2.7487	2.7470	.0035
Piston Rings (Gap in 2.7500 Ga.)	.007 - .017	.040 Compression Rings .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	Refrigerant 22	
	Black	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.

Table 2 — Bolt Torques

Item	Torque Foot-Pounds	Item	Torque Foot-Pounds
Cylinder Head Bolts	43	Oil Pump Mounting Bolts (C Design)	14
Discharge Valve Bolt	30	Oil Pump Mounting Bolts (D Design)	6
Handhole Cover Bolts	43	Oil Pump Cover Bolts (C design)	43
Sight Glass Mounting Bolts	6	Oil Pump Cover Bolts (D design)	43
Distributor Cover Bolts	23	Suction Cover Bolts (C Design)	43
Capacity Control Bolts	23	Suction Cover Bolts (D Design)	43
Suction Service Valve Mounting Bolts	115	Pump End Bearing Mounting Bolt (D Design)	43
Suction Service Valve Flange Screws	115	Motor Bearing Bolts	23
Discharge Service Valve Mounting Bolts	58	Motor Terminal Nuts	2½
Discharge Service Valve Flange Screws	58*	Motor Terminal Lugs	2½
Motor Rotor Bolts	135	Motor Terminal Lug Set Screws	14
Connecting Rod Bolt Offset Design	12	Motor Terminal Board Retaining Ring Bolts	6
Connecting Rod Bolts	14		

* Except 4-cylinder discharge flange screws 1½ - 12 foot pounds.

Table 3 — Operating Data

No. Cylinders	Bore	Stroke	R.P.M.	Nom. Tonnage		Valve Connections		Design Seq. C Weight		Design Seq. D Weight		Oil Pressure	Oil Capacity
				R-12	R-22	Suct.	Disch.	R-12	R-22	R-12	R-22		
4	2-¾"	2"	1750	13	20	2½"	1½"	770	810	575	605	50-80	18 PTS.
5	2-¾"	2"	1750	15	25	2½"	1½"	800	850	580	615	50-80	19 PTS.
6	2-¾"	2"	1750	20	30	2½"	1½"	830	880	600	630	50-80	19 PTS.
8	2-¾"	2"	1750	25	40	2½"	1½"	880	950	625	670	50-80	20 PTS.

Note:

See Service Bulletin HCOM-SB-4 "Recommended Oils and Oil Changes 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).

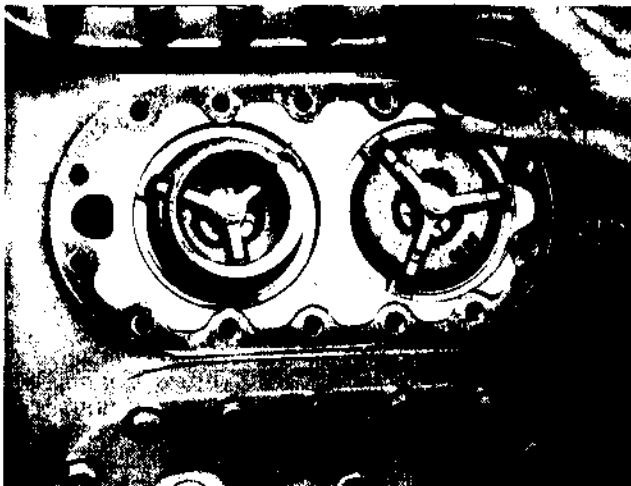


Figure 1 — Removing Safety Head Spring

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 — 43 Foot-Pounds

Discharge Valve

"C" design sequence and later compressors do not use the valve cushion or retainer. See Parts List HCOM-UP-1 for parts availability and part substitution for design sequences "A" and "B".

To Remove:

Remove cylinder head (see "To Remove Cylinder Head"). Lift off safety head springs (Figure 1). Lift off discharge valve cage (Figure 2).

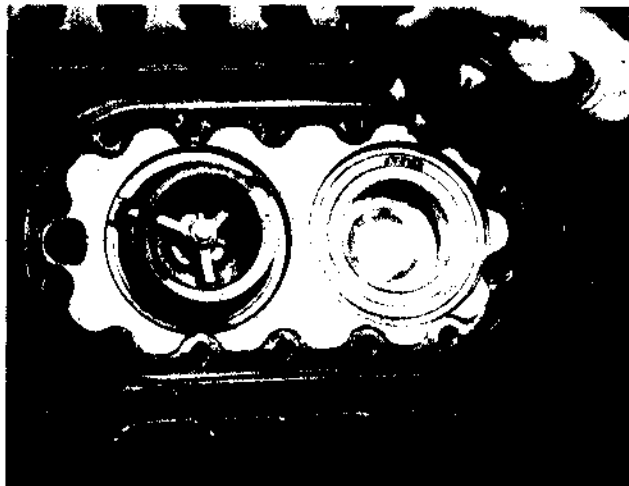


Figure 2 — Removing Discharge Valve Cage

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 a final torque.

Torque — 30 Foot-Pounds.

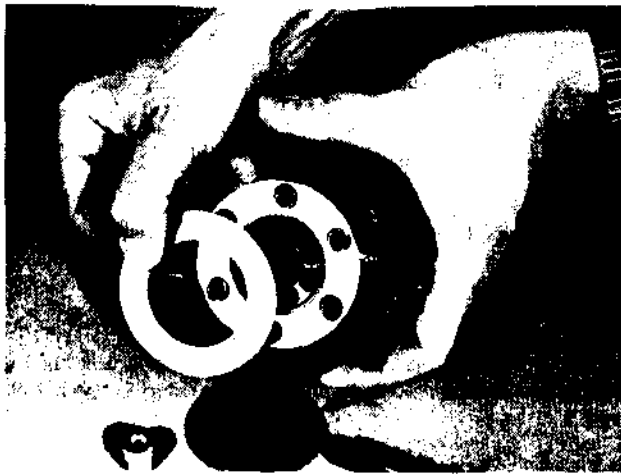


Figure 4 — Inserting Discharge Valve

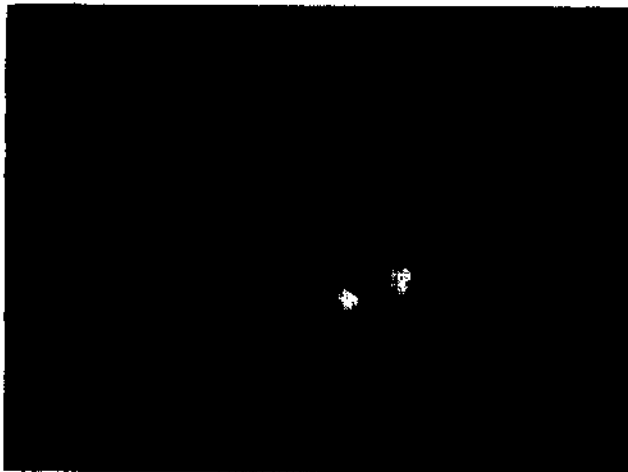


Figure 5 — Checking Valve Movement

To Install:

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

Suction Strainer Assembly

To Remove:

Remove all of the suction cover screws with the exception of the top screw (Figure 14). Back out the top screw 1 or 2 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). Detach strainer pan from cover (Figure 7).

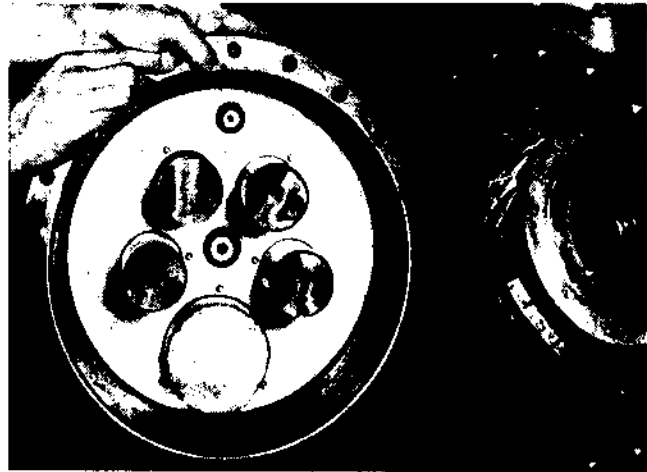


Figure 6 — Removing Suction Strainer Assembly



Figure 7 — Suction Strainer Pan Removed from Cover

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:

Install suction cover "O" ring (Figure 7).

With the suction strainer assembly attached to the cover, place two screws in the cover (opposite sides). Set the assembly against the housing and draw the screws up hand tight. Insert and tighten the remaining screws. Tighten all screws to a final torque.

Torque — 43 Foot-Pounds.

Cylinder Liners

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

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:

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 8). This special tool's part number is Blk-11.

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.

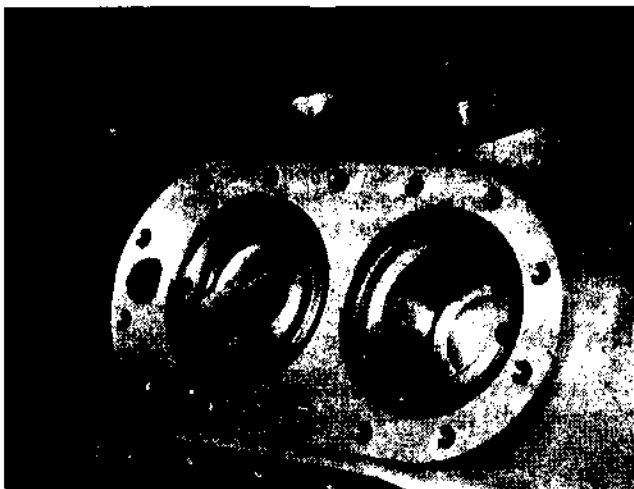


Figure 8 — Liner Puller Block



Figure 9 — 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, Page 3.

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. Lubricate walls of cylinder hole with compressor oil. This will allow liner to slip into cylinder hole easily.

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 down firmly against the rings. The rocking and rotating motion will guide the rings into the tapered liner.

CAUTION: Do not hammer or attempt to force the liner over the rings. 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 with its two unloader-to-liner "O" rings (Figure 10) down into the housing and over the piston as described previously.



Figure 10 — Unloader-to-Liner "O" Ring

Cylinder Unloader Assembly

If high heat or dirty crankcase oil is encountered, the unloader mechanism should be disassembled and the "O" rings replaced. Figure 11 illustrates the unloader "O" rings.

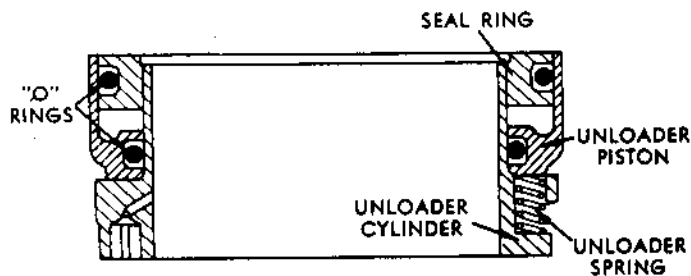


Figure 11 — Cross Section View of Unloader

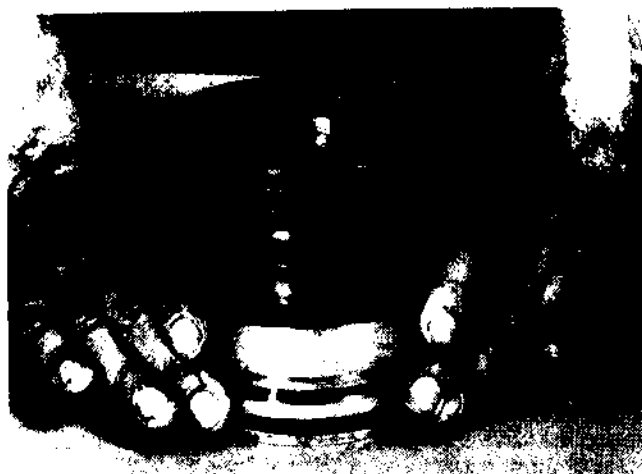


Figure 12 — Removing Unloader From Liner

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 12).

To Disassemble Unloader:

Work the unloader piston and seal ring off the unloader cylinder (Figure 13). A screwdriver may be used for this purpose. When the top section is free, remove the seal ring from the piston (Figure 14).

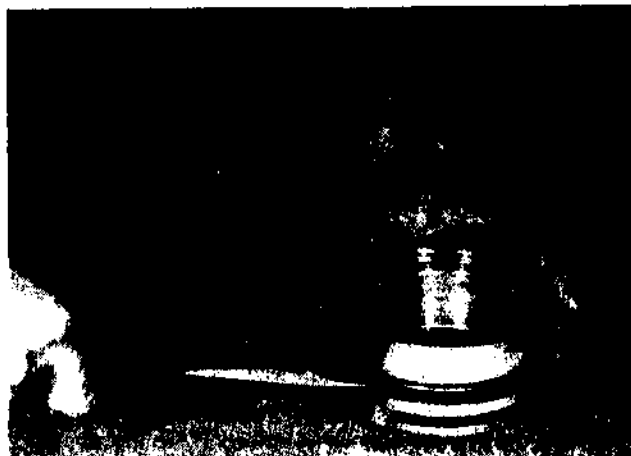


Figure 13 — Disassembling Unloader



Figure 14 — 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 15. The face of the seal ring should be approximately $\frac{1}{4}$ " 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 15 — 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" Page 6.

Suction Valve Assembly

To Remove:

Invert the cylinder liner and valve assembly. Remove the three retainers (Figure 16). Do not move the liner around on top of the valve assembly.

Lift the liner assembly away from the valve assembly (Figure 17). With the cylinder liner separated from the valve assembly, the valve ring, springs and "O" ring can be removed (Figure 18).



Figure 16 — Removing Suction Valve Retaining Rings



Figure 17 — Lifting Off Liner



Figure 18 — Removing "O" Ring



Figure 19 — Removing Suction Valve Ring

Inspection:

Inspect the valve ring for copperplating or wear. See Table 1, Page 3 for tolerances and wear limits.

Replace the valve springs if the compressor has operated in excess of those hours listed in Table 1, Page 3.

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 19). Place the cylinder liner on the valve plate (Figure 17). 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 20). Check the movement of the suction valve to see that it is not restricted within the assembly (Figure 21).

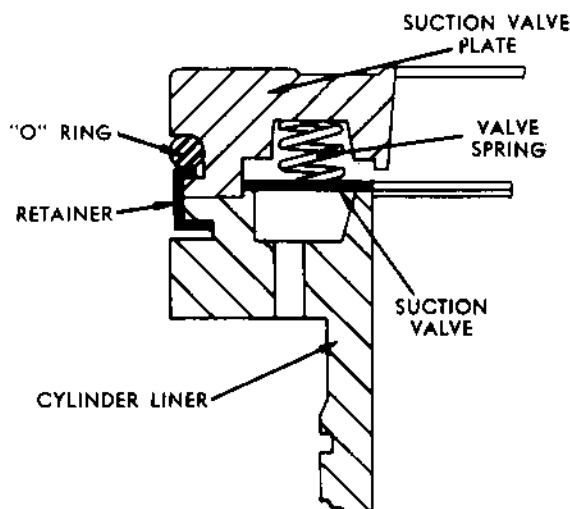


Figure 20 — Illustration of Suction Valve Retainer



Figure 21 — Checking Suction Valve Movement

Take-Up Ring and Lift Pins**To Disassemble:**

Place cylinder liner in an inverted position. Remove unloader-to-liner "O" rings. Release retaining ring (Figure 22) and slide off cylinder liner. Slide take-up ring off the cylinder liner. Remove lift pins and lift pin springs.

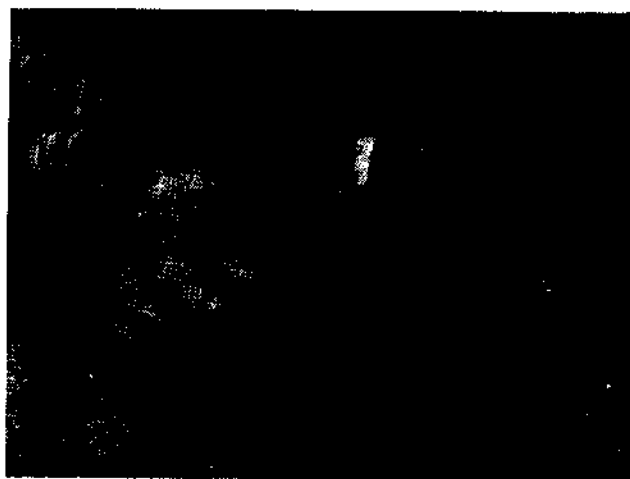


Figure 22 — Removing Retaining Ring

Inspection:

Inspect the "O" rings, 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 23). Push take-up ring down over the cylinder liner and slide retaining ring into the ring groove on the cylinder liner (Figure 22). 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. Replace "O" rings.



Figure 23 — 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 Bellows 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 bellows spring and spring plug out of the cover. See Figure 24.

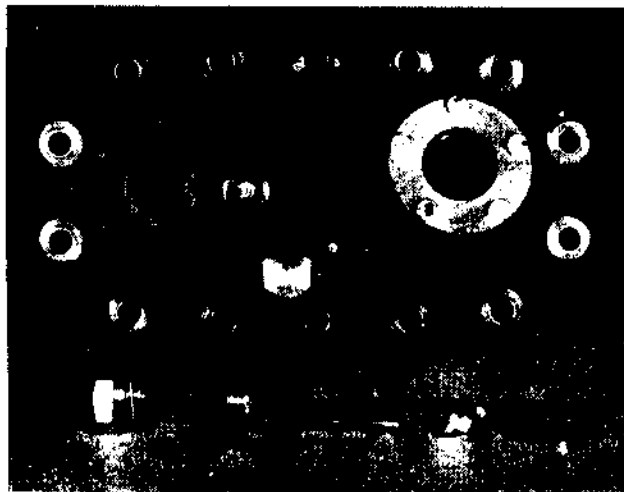


Figure 24 — Bellows Spring and Adjusting Screw Assembly

Inspection:

Check the spring for damage and color coding. See Table 1, Page 3.

To Install Bellows Spring:

Insert the bellows 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 two of the top center screws on the handhole cover. The top screws should then be backed out approximately 4 to 5 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 screws. Do not disturb capacity control.

Inspection:

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

To Install Handhole Cover:

Insert two screws through the cover (opposite each other), oil the gasket with clean compressor oil and place the gasket down over the cover using the two screws as a guide. Insert the screws and pull them up hand tight. Insert the remaining screws, pull them up hand tight and then tighten all screws to a final torque.

Torque — 43 Foot-Pounds

To Remove Finger Oil Screen:

Remove the plug on the face of the handhole cover. Withdraw the "O" ring, spring and finger oil screen.

Inspection:

Clean or replace the finger oil screen as necessary.

To Install Finger Oil Screen:

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 25).

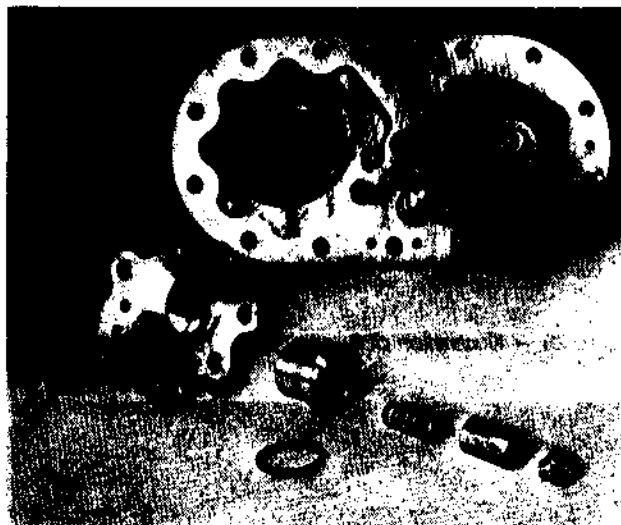


Figure 25 — Bellows Assembly

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 26).

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.

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.

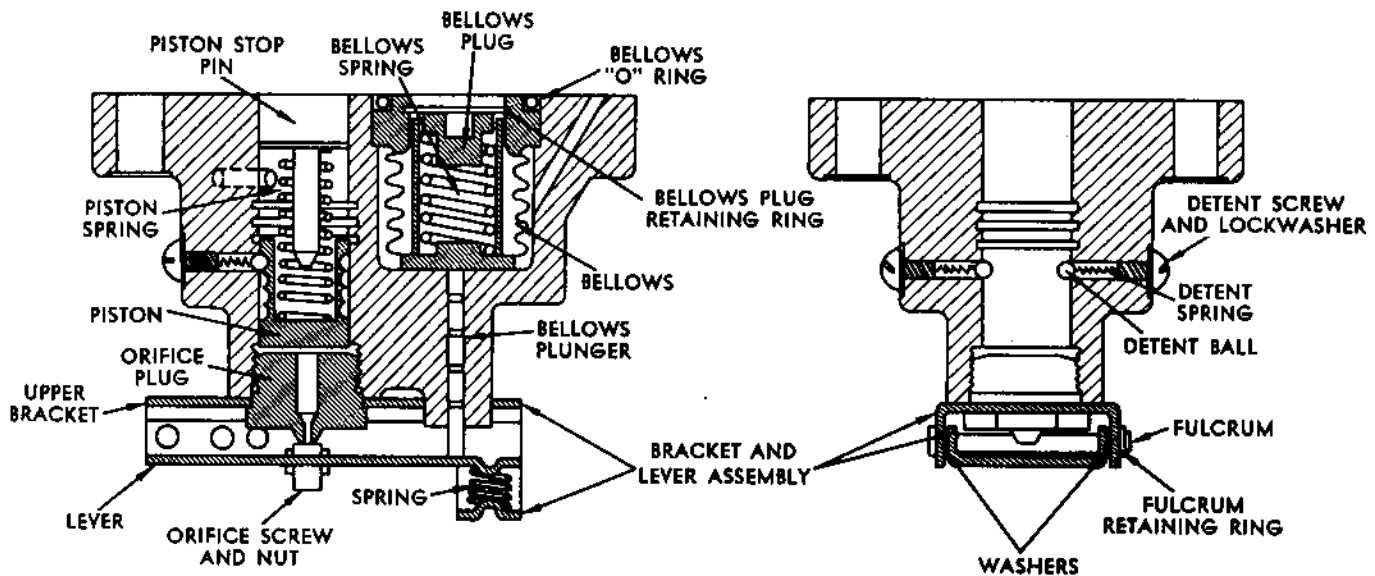


Figure 26 — Cross Section Views of Capacity Control Actuator

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. 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 a final torque.

Torque — 23 Foot-Pounds.

Connecting Rod and Piston Assembly

The rod design used on "E" design sequence compressor use an offset rod with capscrews instead of rod bolts. See Figure 27. 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.

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.

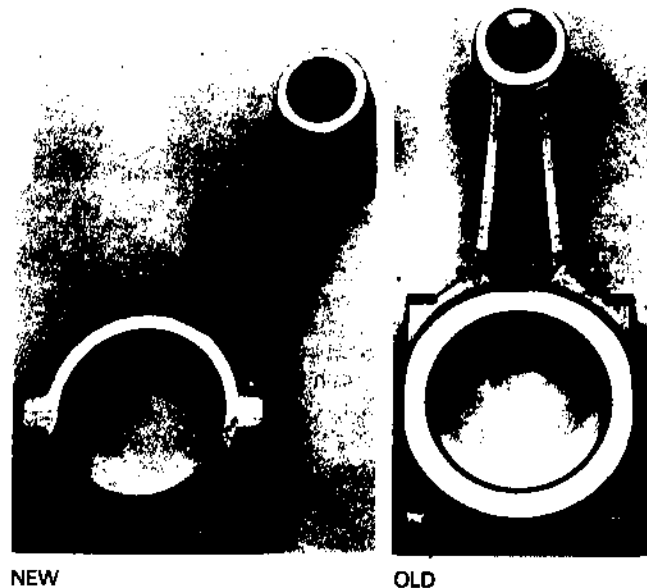


Figure 27 — New and Old Style Connecting Rods

With a block of wood or lightweight mallet, slowly and alternately drive the connecting rod bolts up through 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, Page 3 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 28). 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.** On the crankshaft, the **MATCHED MARKS MUST FACE THE DISCHARGE END OF THE COMPRESSOR.**

Invert cylinder liner on clean work surface using care not to mar the valve plate 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



Figure 28 — Inserting Connecting Rod Bolts

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 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 5). 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 — 14 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

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 two compression rings and one oil ring.

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 burns. 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 oil control ring goes in the bottom groove on the piston and the two compression rings go in the upper two grooves with the chamfer on the inside diameter of the ring facing the top of the piston. When the rings are in final position, be sure they move freely in their grooves.

Oil Pump Assembly (Design Sequence C)

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.

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 a 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 a final torque.

Torque — 43 Foot-Pounds.

Oil Pump and Bearing Head Assembly (Design Sequence D)

The oil pump is an integral part of the bearing head assembly and cannot be repaired in the field (Fig. 32).

It may, however, be disassembled, cleaned and reassembled without changing parts.

To Remove:

Loosen and remove the eight mounting screws which hold the oil pump cover in the bearing head assembly. Remove pump gears.

Inspection:

The oil pump and its parts should be inspected. If found defective, replace complete oil pump and bearing head assembly.

To Install:

Clean parts. Lubricate with clean compressor oil. Replace oil pump in bearing assembly, tightening cover bolts finger tight.

Torque — 6 Foot-Pounds

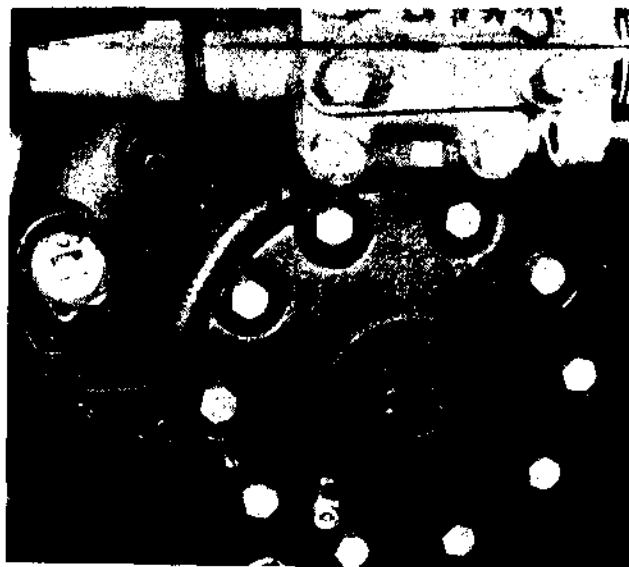


Figure 32 — Oil Pump and Bearing Head Assembly

Motor Rotor and Stator

The stator may be eased out of the housing without using a motor puller after the rotor has been removed.

To Remove Rotor:

Remove the suction strainer pan assembly (see "To Remove Suction Strainer Assembly" Page 5) and a handhole cover (see "To Remove Handhole Cover" Page 10).

Place a soft block of wood or plastic mallet between one of the crankshaft counterweights and crankcase land area of housing to prevent the crankshaft from turning (Figure 33). Remove the rotor retaining bolt and washers. Ease the rotor off the end of the crankshaft. A rotor-crankshaft key will slide with the rotor as it is removed (Figure 34).



Figure 33 — Mallet Wedged Between Counterweight and Compressor Housing



Figure 34 — Removing the Rotor

To Remove Stator:

Figure 35 illustrates the motor terminal board and terminals. Disassemble the terminal lugs, lock nut, 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.

Remove the stator locating bolt on top of the housing (Figure 36).

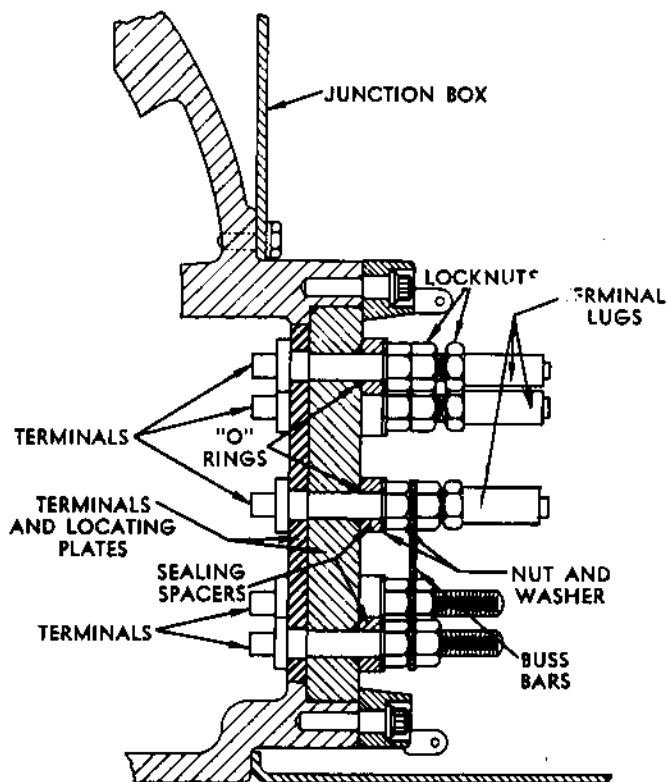


Figure 35 — Motor Terminal Assembly

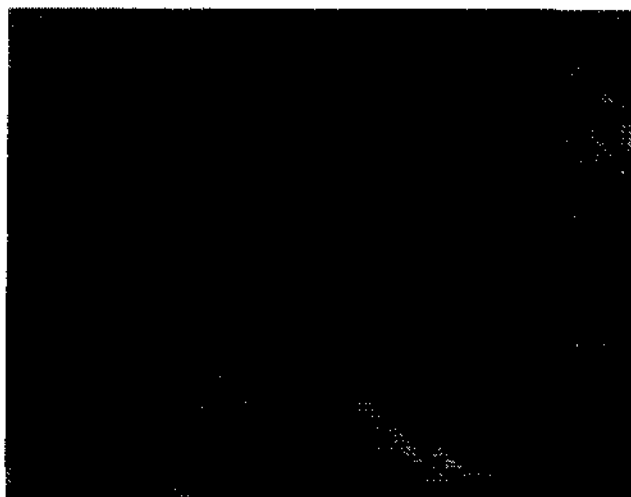


Figure 36 — Removing the Stator

Place soft cloth over palm and lower arm and grasp opposite end of stator. Pull stator out of housing three or four inches. At this point disconnect the three thermostat leads from the terminal connectors inside the housing (Figure 37). Then continue removing stator, placing opposite hand under stator as it moves beyond suction end of housing. If rotor does not move out easily, strike side of housing with rawhide or plastic mallet, pulling stator outward at the same time. Be sure terminal leads do not catch housing during the removal procedure.

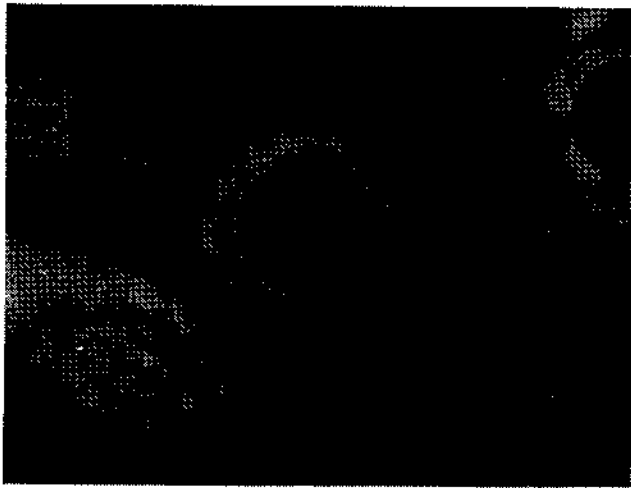


Figure 37 — Terminal Connectors Removed From Housing

Installing Stator:

Scribe a guide line across the stator iron through the center of the bolt mounting hole (Figure 38). A similar line should be scribed on the housing from the center of the bolt hole to the suction end opening. With these guide marks aligned, the locating bolt holes will match when stator is in position.

Tie a string or "O" ring around the stator leads and pull them back inside the stator.

With a soft cloth over right hand and lower arm, grasp motor leads, support weight of stator on arm. Align guide lines and start stator into housing.

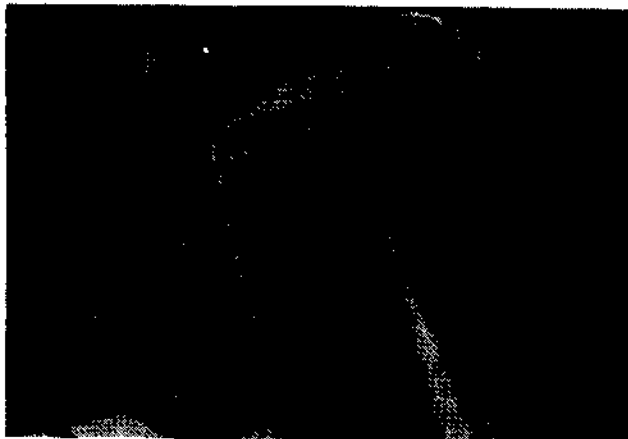


Figure 38 — Guide Line Scribed on Stator

CAUTION: Do not bump exposed windings against housing. To do so may cause a motor failure.

As soon as housing will support stator, pull leads by means of string or "O" ring through junction box opening (Figure 39). Attach the motor thermostat leads to the terminal connection inside the housing. Be sure all leads come through junction box opening. Then move stator into housing until stator bolts will register in locating hole.

Install stator locating bolt and "O" ring.

Torque — 69 Foot-Pounds

Reassemble the terminal and locating boards, studs, "O" rings and nuts (Figures 35 and 40). Tighten to the required torque.

Torque — 2½ Foot-Pounds

Install new terminal block "O" ring.

Place the assembled terminal board in the housing and install the retaining ring and mounting bolts. Tighten all bolts to the required torque.

Torque — 6 Foot-Pounds

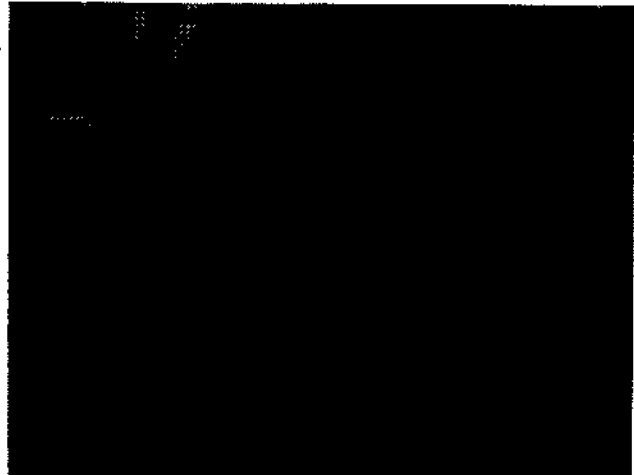


Figure 39 — Pulling Leads Through Junction Box Opening



Figure 40 — Terminal Block Assembly Parts

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 final position.

Insert the rotor retaining bolt and washers and draw the screw up hand tight. Block the crankshaft so that it will not turn by placing a block of wood or plastic mallet between one of the crankshaft counterweights and the land area of the housing (Figure 32, Page 13). Tighten the rotor retaining screw to the required torque.

Torque — 135 Foot-Pounds

Check the rotor-stator air gap with a feeler gage.
ALLOWABLE AIR GAP — .008"-.010" SIDE TO SIDE.

Main Bearings and Crankshaft

The pump-end and motor-end main bearings (Figure 41) 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, except in the pump end bearing head of Design Sequence D. If it becomes necessary to replace this bearing, the entire pump end bearing head assembly must be replaced.

The pump-end bearing contains a spring loaded ball bearing type oil regulating valve, factory set to regulate oil pressure between 55 to 65 psi. The oil regulating valve (Figures 42 and 43) may be removed for inspection, cleaning or replacement.

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 pump end bearing thrust collar (Figure 44).

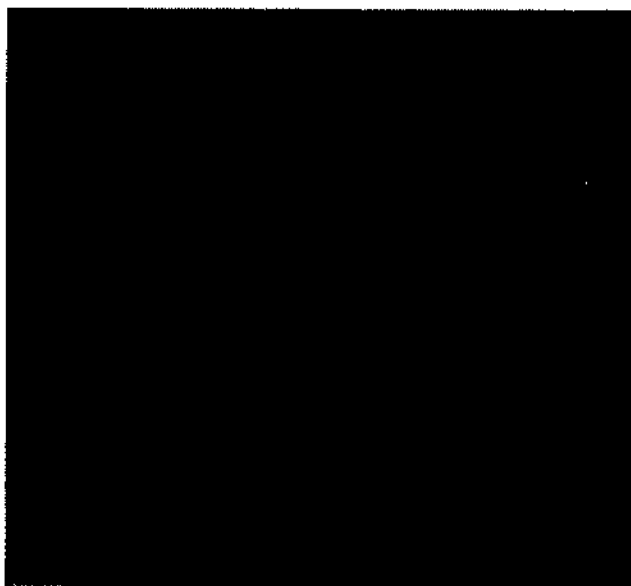


Figure 41 — Motor End Bearing Disassembled for Cleaning

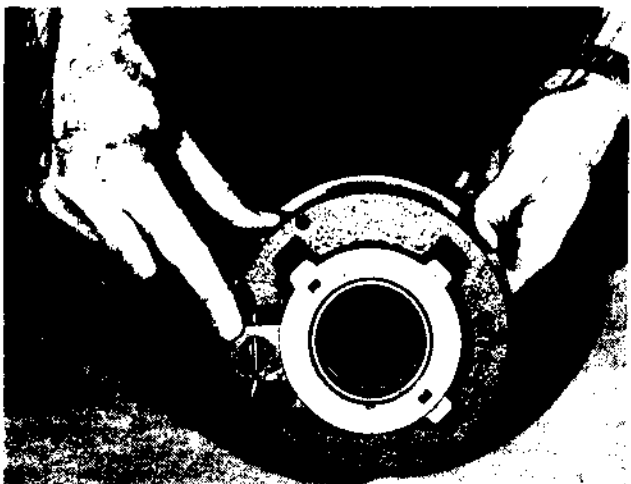


Figure 42 — Oil Regulating Valve Installed in Design Sequence C.



Figure 43 — Oil Regulating Valve Removed, Design Sequence D



Figure 44 — Pump End Bearing Head Assembly With Thrust Collar and Shims Removed

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 windings.

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," Page 11) and pull the bearing head-crankshaft assembly as a unit.

Inspection:

Examine the bearing surfaces for damage or copperplating. Check the oil passages and clean them if necessary (Figure 41). Wear limits are given in Table 1, Page 3.

To Remove Crankshaft:

(Design Sequence C)

The crankshaft of Design Sequence C 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").

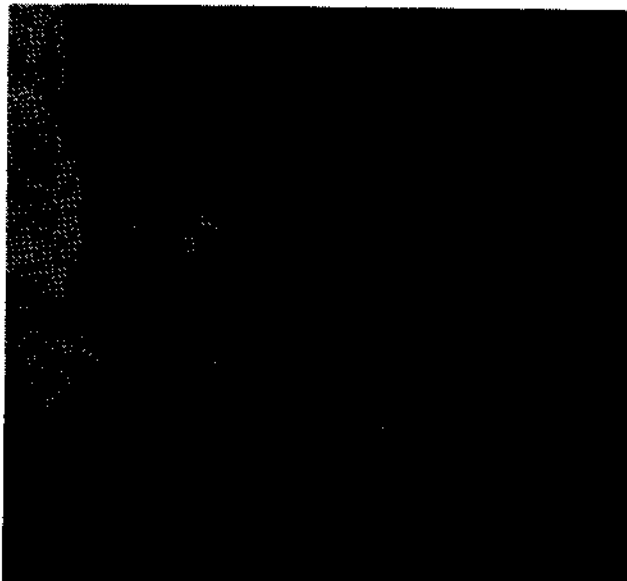
Grip the crankshaft at the center and at the motor-end of the shaft. Place one hand through the handhole opening and the other at the end of the shaft. Carefully draw shaft out of pump-end bearing. When shaft end is clear of bearing, remove hand from handhole cover opening and grasp shaft with both hands through suction end of compressor. Draw shaft out of compressor housing (Figure 45). Be careful not to drop the crankshaft on the stator.



Figure 45 — Removing Crankshaft

(Design Sequence D)

The crankshaft of Design Sequence D is removed from the compressor through the pump end. Remove the connecting rods and piston assemblies (see "Connecting Rod and Piston Assembly," "To Remove," Page 11). Remove the pump end bearing (see "To Remove Pump End Bearing Head Assembly," Page 13).



With one hand through the handhole cover opening, grip the crankshaft at the center. With the other hand, grip the pump end of the shaft. Carefully draw shaft out of the motor end bearing. After shaft is clear of bearing, continue guiding outward until the second counterbalance can be rested on the pump end opening. Remove hand from handhole cover opening and grasp protruding shaft with both hands to complete removal (Figure 46).

Inspection:

Examine the crankshaft journals and bearing surfaces for damage or copperplating. Remove magnetic plugs, check the oil passages and clean if necessary (Figure 47). Wear limits are given in Table 1, Page 3.

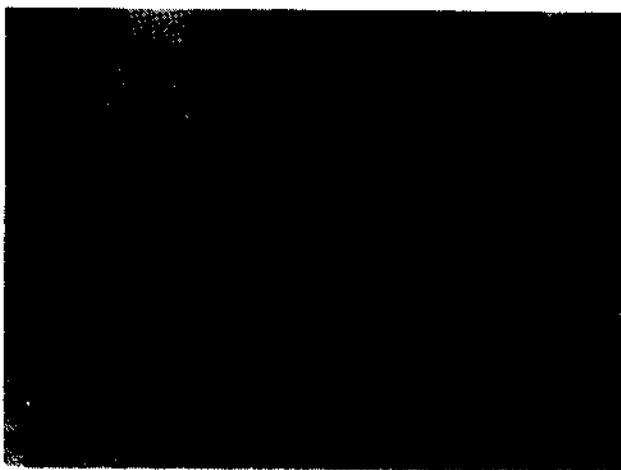


Figure 47 — Crankshaft With Magnetic Plugs Removed

To Remove Pump-End Bearing:

(Design Sequence C)

Remove the oil pump of Design Sequence C (see "To Remove Oil Pump"). Pull the bearing head out of the housing (Figure 48). 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.

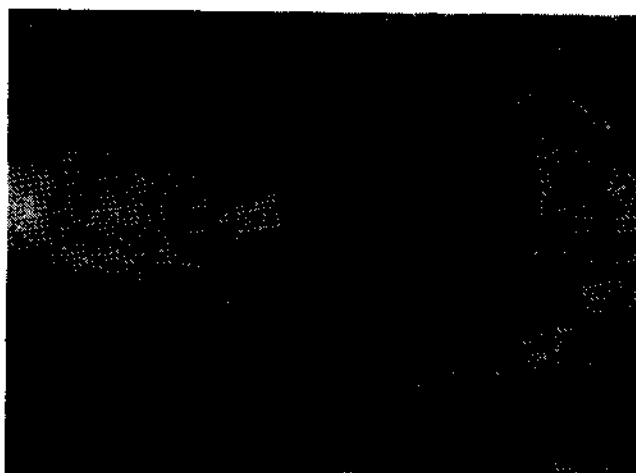


Figure 48 — Removing Pump End Bearings, Design Sequence C

Figure 46 — Removing Crankshaft, Design Sequence D

(Design Sequence D)

Remove the pump and bearing head assembly of Design Sequence D by removing mounting bolts. Insert two of the mounting bolts in the puller holes of the bearing head housing, drawing them in alternately, three or four turns at a time. This will move the assembly away from the housing so the entire pump end bearing head assembly can be easily removed.

Inspection:

Examine the pump-end bearing for damage or copperplating and clean the oil passages if necessary. At the same time the oil regulating valve referred to earlier in this section and bearing surface. Clean and repair if necessary. Wear limits are given in Table 1, Page 3.

To Install Main Bearings and Crankshaft:

(Design Sequence C)

Lubricate the pump-end bearing "O" ring and place in the groove in the housing (Figure 49).

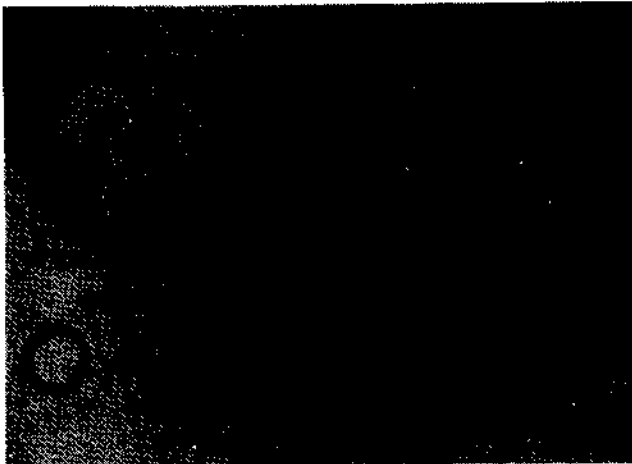


Figure 49 — Installing Pump End Bearings "O" Ring

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

Lubricate the thrust collar and a .010 shim. Place shim and bearing on the pump-end bearing of the crankshaft. Lubricate all bearing surfaces of the crankshaft. Place the crankshaft in the housing and into the pump-end bearing. Be sure the thrust collar 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 collar and place it in position on the motor end of the bearing head assembly.

Next lubricate the small "O" ring and place it in position in the "O" ring recess located on the flange of the bearing head assembly.

A locating groove is adjacent to the "O" ring recess (Figure 50).



Figure 50 — Motor End Bearing Head Assembly.

Start the bearing head assembly with all of its components on the crankshaft, gradually working into position so that the roll pin in the housing registers into the locating groove. Insert and tighten the bearing mounting screws to the required torque.

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

Crankshaft end play clearance should be .015" to .025".

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. If measurement is not the same on both ends of the shaft, check position of the thrust collar.

When final selection of shims has been made, remove the oil pump cover and install the oil pump (see "To Install Oil Pump" Page 13). Tighten oil pump screws to final torque.

Torque — 14 Foot-Pounds

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

Torque — 43 Foot-Pounds

Recheck crankshaft end play.

(Design Sequence D)

Lubricate the thrust collar and place it in position on the motor-end bearing head assembly.

Next, lubricate the small "O" ring and place it in position on the "O" ring recess located on the flange of the bearing head assembly.

A locating groove is adjacent to the "O" ring recess (Figure 50).

Install the bearing head assembly with all of its components into the housing so that the roll pin in the housing registers into the locating groove. Insert and tighten the bearing mounting screws to the required torque.

Torque — 23 Foot-Pounds

Lubricate all bearing surfaces of the crankshaft and place the crankshaft in the housing and into the motor end bearing.

Be sure the thrust collar remains in position.

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

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

Lubricate the pump-end bearing "O" ring (Figure 51) and place in the groove of the housing.

Clean the pump-end bearing head assembly and lubricate all bearing surfaces. Lubricate gasket and install on flange of pump-end bearing head assembly so notches are properly aligned.

Lubricate the thrust collar and a .010" shim. Place shim and thrust collar on the pump-end bearing head assembly.

Line up pump drive with slot on end of crankshaft. Guide the pump-end bearing head assembly into the housing. Insert and tighten the mounting screws to the required torque.

Torque — 43 Foot-Pounds

Crankshaft end-play clearance should be .015" to .025".

Push the crankshaft against the pump-end bearing head thrust collar. With a feeler gauge, 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. If measurement is not the same on both ends of the shaft, check position of thrust collars.

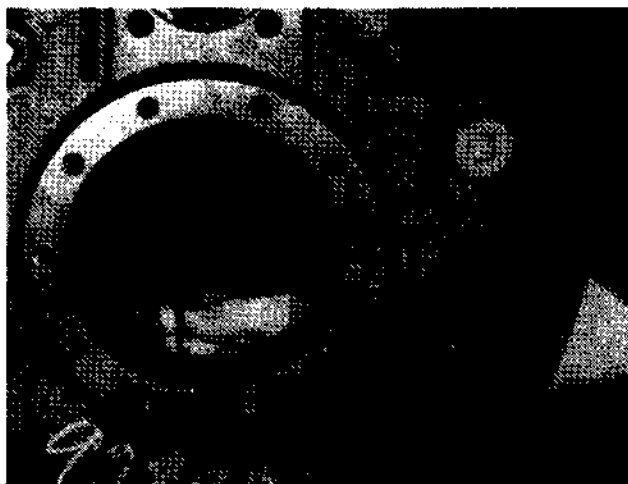


Figure 51 — Installing Pump End Bearing "O" Ring

Foam-Breaker

To Remove:

See "To Remove Handhole Covers," Page 10. The two foam breakers are mounted on the wall of the housing, separating the crankcase and motor sections. They are located left and right of the crankshaft. Unscrew from housing, clean and inspect as necessary. Foam breaker consists of returning ring, ball, seat and non-replaceable screen (Figure 52).

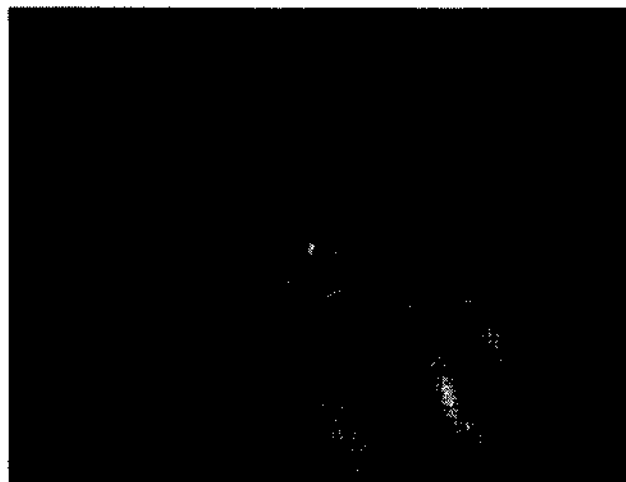


Figure 52 — Foam Breakers

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 (Figure 51). 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.



Figure 53 — Oil Strainer with Hold-Down Strap, Connection and Elbow

To Remove:

Remove handhole covers (see "To Remove Handhole Covers," Page 10). The strainer screen assembly is held in position by a steel spring hold-down strap. Grip the hold-down strap and pull out and up to release. Disconnect the flare nut and remove the oil strainer screen assembly (Figure 53).

To Install:

Place strainer assembly in position and connect flare nut to crankcase elbow. Do not tighten. Snap the hold-down strap 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.