TRANE® AIR CONDITIONING	FILE INFORMATION: DIVISION TAB:TRANE REFRIGERATION PRODUCTS PRODUCT TAB:RECIPROCATING COMPRESSOR-CONDENSER UNITS MODEL TAB:HERMETIC E-F LITERATURE ITEM- GENERAL SERVICE BULLETIN	LITERATURE FILE NO. **HCOM-SB-39A** **GENERAL SERVICE BULLETIN**

7/1/81
Supersedes HCOM-SB-39
Dated 11/5/80

SUBJECT: DIAGNOSIS OF MODEL "E" AND "F" COMPRESSOR LOW OIL PRESSURE AND OIL LOSS PROBLEMS

INTRODUCTION:

The purpose of this Service Bulletin is to discuss the lubrication system and diagnostic techniques to determine the cause of low oil pressure and oil loss in Model "E" and "F" compressors.

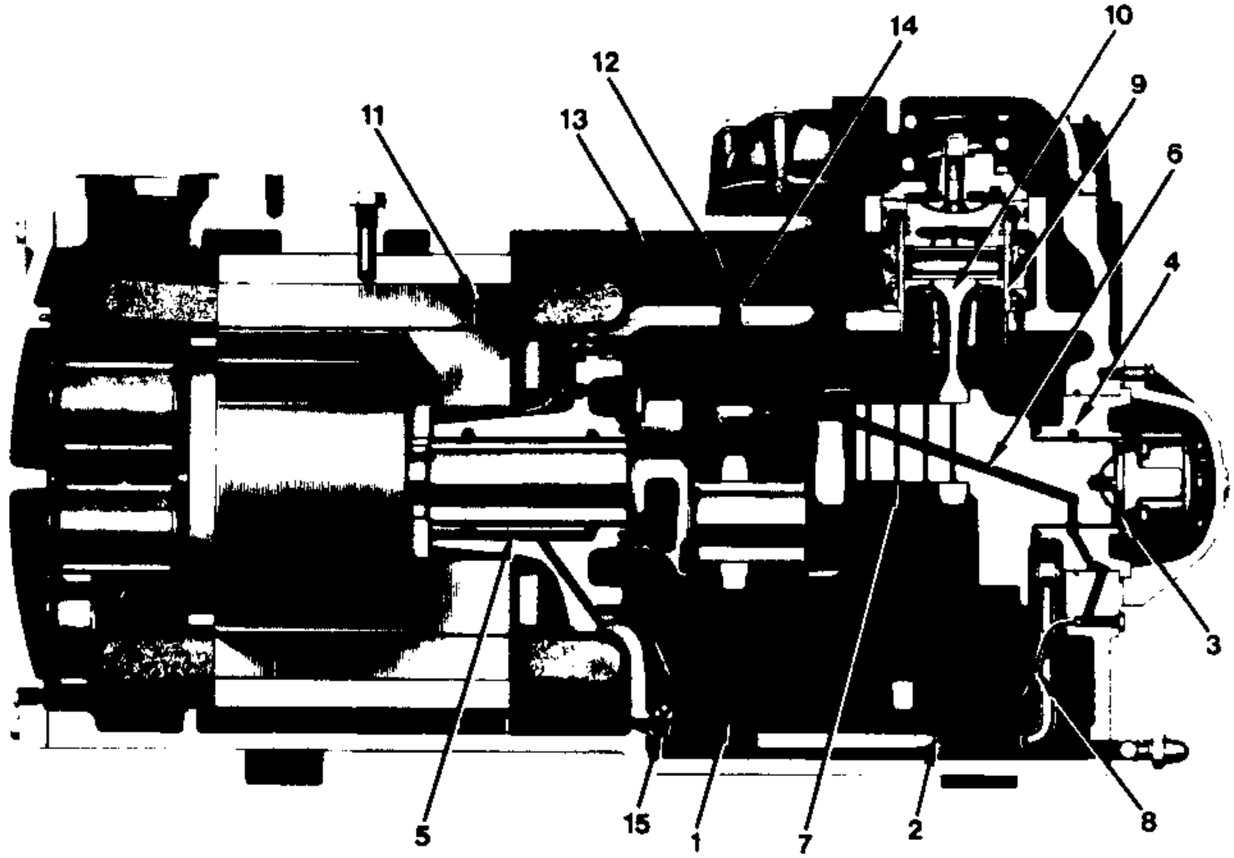
DISCUSSION:

The Lubrication System

The lubrication system in the Model "E" and "F" compressors is a force feed oil system. The oil is pumped by a reversible positive displacement pump. Refer to Figure 1 for part identification. The oil in the compressor crankcase (1) is drawn through the inlet of the oil screen (2), located in the bottom of the crankcase, into the suction of the pump (3), the pump increases the pressure and feeds the oil pump end main bearing (4), the motor end main bearing (5) and the center of the crankshaft which feeds the connecting rods through holes (7) drilled in the crankshaft journals. The oil is also fed to the capacity control hand hole cover through an oil line (8) which is swedged into the compressor housing. After the oil is fed into the hand hole cover, it is channeled through the finger strainer into either the suction actuated unloader control or the electric unloader solenoid valves by passages in the distributor plate. The oil is either directed to the cylinder unloader mechanism or bled back to the crankcase.

The cylinder liners (9) are lubricated by oil that is thrown off the crankshaft as it rotates. The wrist pin (10) is lubricated in the same manner, but requires a load reversal during the suction and compression strokes in order to obtain adequate lubrication.

Normally, the circulated refrigerant contains 3-5 percent oil. On a 100 ton system, this amounts to 12 gallons/hour that is normally circulated

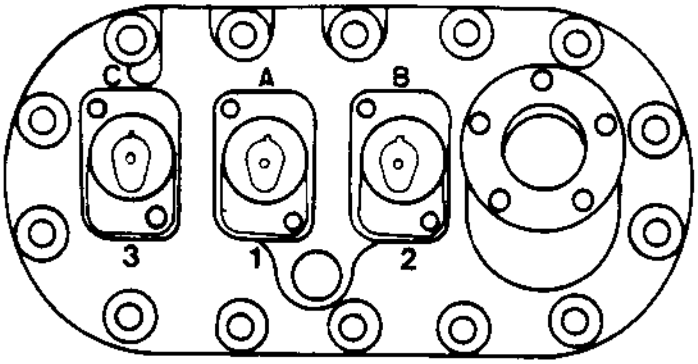


LEGEND

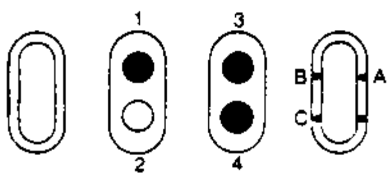
1 Compressor Crankcase
2 Oil Screen Inlet
3 Pump Suction
4 Main Bearing - Oil Pump End
5 Main Bearing - Motor End
6 Crankshaft Journal Oil Supply
7 Crankshaft Journals
8 Oil Line
9 Cylinder Liners
10 Wrist Pin
11 Motor Barrel
12 Suction Chamber
13 Housing
14 Orifices
15 Stand Pipe

FIGURE 1 - Lubrication System Part Identification

throughout the system and must be returned to the compressor crankcase. The oil return system depends on a pressure differential between the motor barrel (11) and the compressor crankcase (1). As the suction gas passes from the motor barrel (11) to the suction chamber (12) the pressure is reduced because of the restriction in the housing (13). The crankcase is vented to the suction chamber by orifices (14), causing the crankcase to be at a lower pressure than the motor barrel. This pressure differential causes the oil in the motor barrel to be pulled up through the stand pipe (15) into the crankcase. The stand pipe prevents oil from migrating to the motor barrel during the off cycle. This insures that the oil level in the crankcase will be sufficient to provide adequate lubrication during start-up of the compressor.



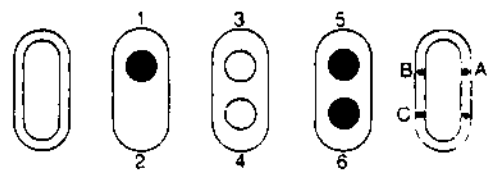
4 CYL. COMPRESSOR



MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CA-PAC-ITY
LOADING				
UNLOADED	—	2	1, 3 & 4	25
1st	A	2 & 1	3 & 4	50
2nd	A & B	2, 1 & 3	4	75
LOADED	A, B & C	2, 1, 3 & 4	—	100
UNLOADING				
LOADED	A, B & C	2, 1, 3 & 4	—	100
1st	A & B	2, 1 & 3	4	75
2nd	A	2 & 1	4 & 3	50
UNLOADED	—	2	4, 3 & 1	25

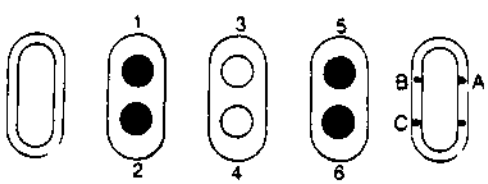
5 CYL. COMPRESSOR



MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CA-PAC-ITY
LOADING				
UNLOADING	—	3 & 4	1, 5 & 6	40
1st	A	3, 4 & 5	1 & 6	60
2nd	A & B	3, 4, 5 & 6	1	80
LOADED	A, B & C	3, 4, 5, 6 & 1	—	100
UNLOADING				
LOADED	A, B & C	3, 4, 5, 6 & 1	—	100
1st	A & B	3, 4, 5 & 6	[illegible]	80
2nd	A	3, 4 & 5	1 & 6	60
UNLOADED	—	3 & 4	1, 5 & 5	40

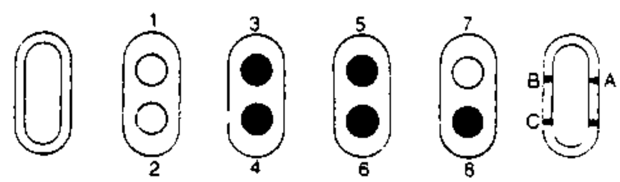
6 CYL. COMPRESSOR



MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO.	UNLOADED CYLINDER CYLINDER NO	% CA-PAC-ITY
LOADING				
UNLOADED	—	3 & 4	1, 2, 6 & 5	33
1st	A	3, 4 & 5	1, 2 & 6	50
2nd	A & B	3, 4, 5 & 6	1 & 2	66
LOADED	A, B & C	3, 4, 5, 6, 1 & 2	—	100
UNLOADING				
LOADED	A, B & C	3, 4, 5, 6, 1 & 2	—	100
1st	A & B	3, 4, 5 & 6	1 & 2	66
2nd	A	3, 4 & 5	1, 2 & 6	50
UNLOADED	—	3 & 4	1, 2, 6 & 5	33

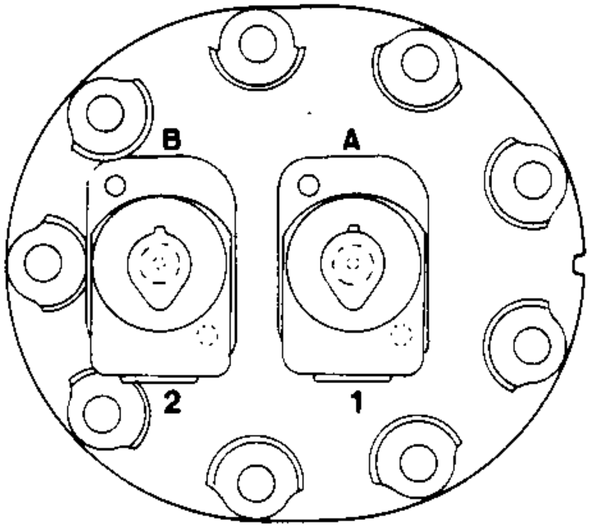
8 CYL. COMPRESSOR



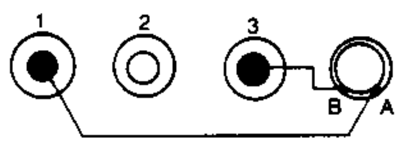
MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CA-PAC-ITY
LOADING				
UNLOADED	—	1, 2 & 7	3, 4, 5, 6 & 8	[illegible]
1st	A	1, 2, 7 & 8	3, 4, 5 & 6	[illegible]
2nd	A & B	1, 2, 5, 6, 7 & 8	3 & 4	[illegible]
LOADED	A, B & C	1, 2, 3, 4, 5, 6, 7 & 8	—	[illegible]
UNLOADING				
LOADED	A, B & C	1, 2, 3, 4, 5, 6, 7 & 8	—	[illegible]
1st	A & B	1, 2, 5, 6, 7 & 8	3 & 4	[illegible]
2nd	A	1, 2, 7 & 8	3, 4, 5 & 6	[illegible]
UNLOADED	—	1, 2 & 7	3, 4, 5, 6 & 8	[illegible]

FIGURE 2 - Model E Compressor Capacity Control Sequence and Cylinder Loading and Unloading



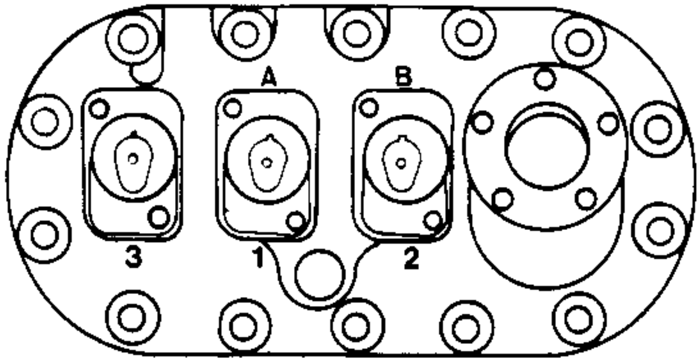
3 CYL. COMPRESSOR



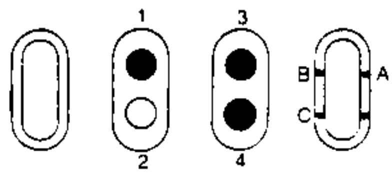
MOTOR END
OR
SUCTION END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CA-PAC-ITY
		LOADING		
UNLOADED	—	2	1 & 3	33
1st	A	1 & 2	3	66
LOADED	A & B	1, 2 & 3	—	100
		UNLOADING		
LOADED	A & B	1, 2 & 3	—	100
1st	A	1 & 2	1 & 2	66
UNLOADED	—	2	1, 2 & 3	33

FIGURE 3 - Model F, 3 Cylinder Compressor, Capacity Control Sequence and Cylinder Loading and Unloading



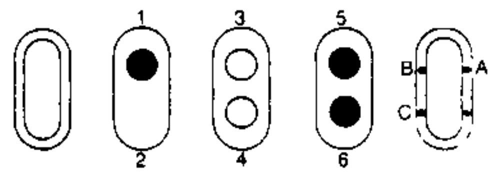
4 CYL. COMPRESSOR



MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CAPACITY
		LOADING		
UNLOADED	—	2	1 3 & 4	25
1st	A	2 & 1	3 & 4	50
2nd	A & B	2 1 & 3	4	75
LOADED	A. B & C	2 1 3 & 4	—	100
		UNLOADING		
LOADED	A B & C	2. 1 3 & 4	—	100
1st	A & B	2 1 & 3	4	75
2nd	A	2 & 1	4 & 3	50
UNLOADED	—	2	4 3 & 1	25

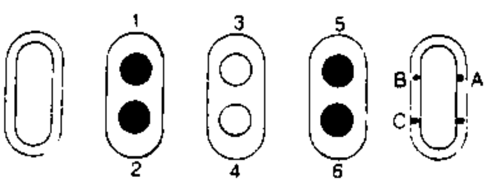
5 CYL. COMPRESSOR



MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CAPACITY
		LOADING		
UNLOADING	—	3 & 4	1 5 & 6	40
1st	A	3 4 & 5	1 & 6	60
2nd	A & B	3. 4 5 & 6	1	80
LOADED	A B & C	3. 4. 5. 6 & 1	—	100
		UNLOADING		
LOADED	A B & C	3 4 5 5 & 1	—	100
1st	A & B	3 4 5 & 6	1	80
2nd	A	3 4 & 5	1 & 6	60
UNLOADED	—	3 & 4	1 5 & 6	40

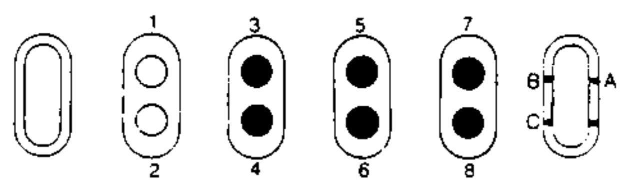
6 CYL. COMPRESSOR



MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CAPACITY
		LOADING		
UNLOADED	—	3 & 4	1 2. 6 & 5	33
1st	A	3 4 & 5	1 2 & 6	50
2nd	A & B	3 4 5 & 6	1 & 2	66
LOADED	A B & C	3. 4 5 6 1 & 2	—	100
		UNLOADING		
LOADED	A B & C	3. 4 5 6 1 & 2	—	100
1st	A & B	3 4 5 & 6	1 & 2	66
2nd	A	3 4 & 5	1 2 & 6	50
UNLOADED	—	3 & 4	1 2 6 & 5	33

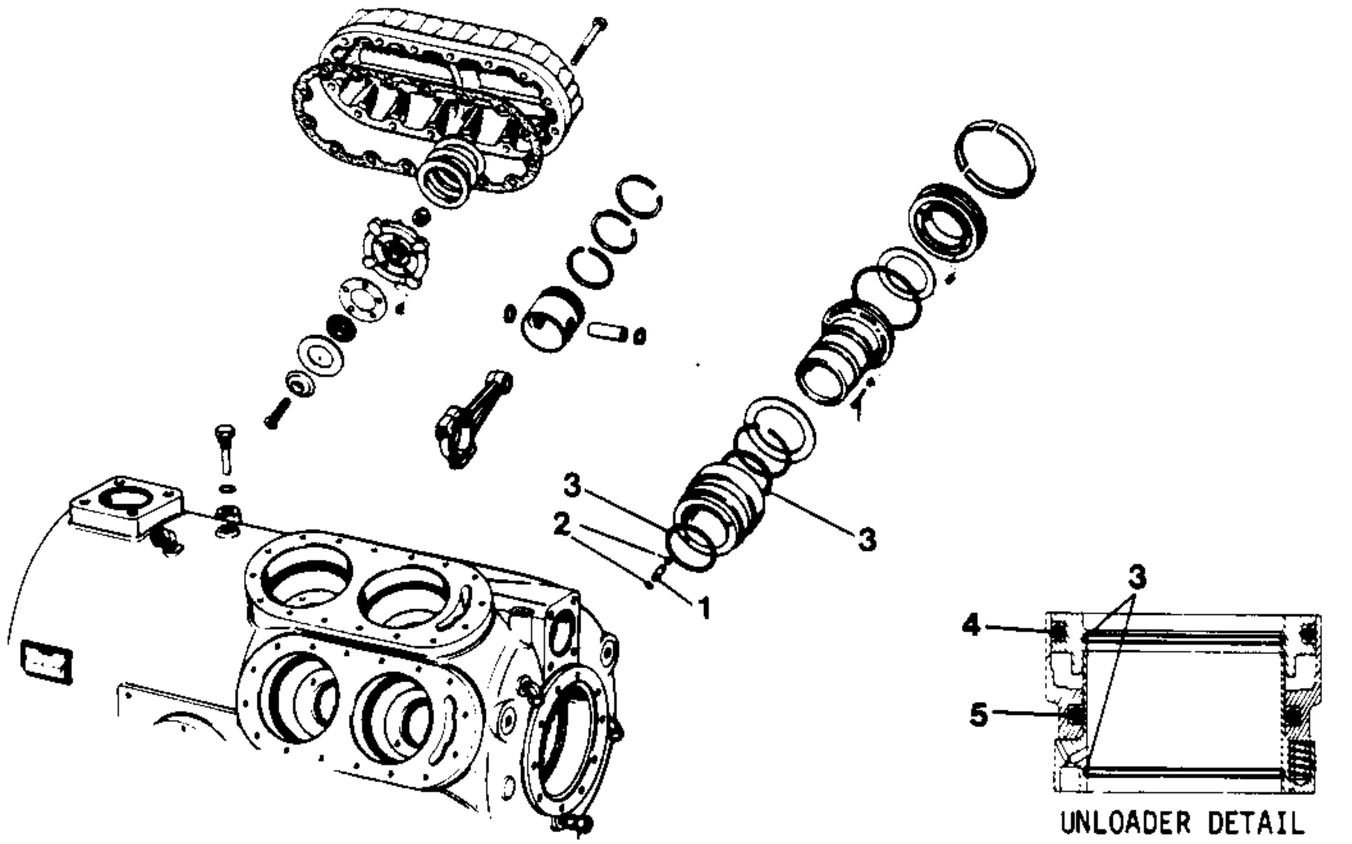
8 CYL. COMPRESSOR



MOTOR END

STAGE OF LOADING OR UNLOADING	CONTROL LINE	LOADED CYLINDER CYLINDER NO	UNLOADED CYLINDER CYLINDER NO	% CAPACITY
		LOADING		
UNLOADED	—	1 & 2	3 4 7 8 5 & 6	25
1st	A	1 2 5 & 6	3. 4 7 & 8	50
2nd	A & B	1 2. 5 6. 7 & 8	3 & 4	75
LOADED	A B & C	1 2. 5 6 7 8. 3 & 4	—	100
		UNLOADING		
LOADED	A. B & C	1. 2. 5. 6. 7 8. 3 & 4	—	100
1st	A & B	1. 2. 5. 6. 7 & 8	3 & 4	75
2nd	A	1 2 5 & 6	3 4 7 & 8	50
UNLOADED	—	1 & 2	3 4 7 8 5 & 6	[illegible]

FIGURE 4 - Model F, 4, 5, 6 and 8 Cylinder Compressor, Capacity Control Sequence and Cylinder Loading and Unloading



LEGEND

1 Connector - Oil
2 "O" Ring - Oil Connector
3 "O" Ring - Cylinder Liner to Unloader
4 "O" Ring - Unloader Seal Ring
5 "O" Ring - Unloader Piston

FIGURE 5 - Unloader "O" Rings

DIAGNOSIS:

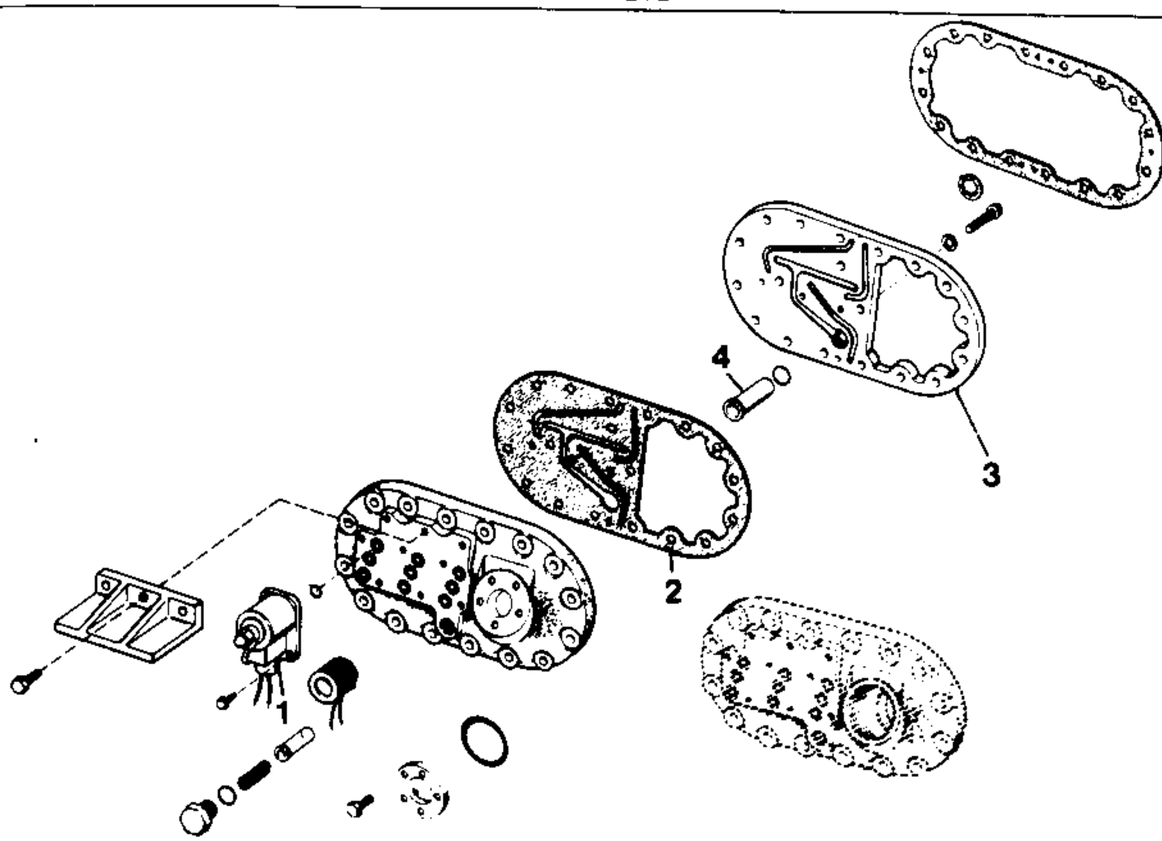
Low Oil Pressure:

1. Unloader System

The first and easiest thing to check when an oil pressure problem exists is the unloading system. This can be done by systematically loading and unloading the compressor while observing the oil pressure and operation of the unloaders. This will indicate if the low oil pressure problem is due to the unloader system while identifying which cylinders are contributing to oil pressure problems. For example, if the unloader solenoid is defective, the oil pressure will drop approximately 10-15 psi when the solenoid is energized. Figures 2 through 4 give the loading sequence for both electric and suction actuated unloading.

Once it has been determined that the problem is with the unloading system, the hand hole cover should be removed and the proper oil control line pressurized with oil to approximately 30 psi. If the control line does not hold pressure, check the following:

(1) Cracked oil control line.



LEGEND

1 Unloader Solenoid Valve
2 Gasket - Distributor
3 Oil Distributor Plate
4 Finger Strainer Cover

FIGURE 6 - Unloader Hand Hole Cover

(2) Missing unloader connector. See Figure 5, Item 1.

(3) Missing or deteriorated unloader connector "O" ring. See Figure 5, Item 2.

(4) Defective unloader "O" rings. See Figure 5, Items 3,4 and 5.

NOTE: This problem manifests itself by oil loss during "loaded" operation with a corresponding oil return during "unloaded" operation.

If the control line holds pressure, check the following:

(1) Defective unloader solenoid valve. See Figure 6, Item 1.

(2) Broken Disc Holder Assembly - ASCO unloader solenoid valve. See Figure 7. Repair kits (Kit #170-177) are available from authorized ASCO stocking distributors. Call 212-344-3765 or 201-966-2000 to obtain the name of the nearest ASCO distributor.

(3) Incorrect or defective gasket between hand hole cover and oil distribution plate. See Figure 6, Item 2.

(4) Incorrect or defective oil distribution plate. See Figure 6, Item 3.

(3) Broken finger strainer cover. See Figure 5, Item 4.

NOTE: This problem may manifest itself by both low oil pressure <u>and</u> oil loss, regardless of compressor loading.

2. Oil Pump

A defective oil pump can cause low or no oil pressure. The pump may be worn or stuck or the oil pump drive tang may be broken. A stuck oil pump or broken drive tang are most often caused by copper plating which indicates excessive moisture in the system.

3. Excessive Main Bearing and Connecting Rod Clearance

Excessive main and rod bearing clearances can cause low oil pressure. Poor lubrication and/or oil dilution can cause excessive wear of bearing surfaces. See the "Compressor Diagnosis" Service Training Manual for a description of these two types of failures and how to distinguish between them.

Another cause for excessive clearance on the connecting rods is loose rod cap nuts. It is very important to properly torque the connecting rod nuts to assure that the correct clearances are maintained.

4. Plugged Oil Strainer

Restriction of the oil inlet strainer will cause an insufficient amount of oil for lubrication and result in excessive bearing wear and low oil pressure. Several sources of contamination which may enter the crankcase and plug the oil inlet screen are discussed below:

(1) Residue from a motor burn can plug the oil inlet screen if the correct service clean-up procedure is not used. Using the correct service procedures for system clean-up will eliminate this source.

(2) Excessive moisture in the system may freeze the oil inlet screen. Static crankcase temperatures below 32F will cause the water to freeze and restrict the oil inlet screen. This amount of moisture typically results from a frozen water chiller. An oil analysis will confirm the presence of excessive water in the oil. The maximum acceptable water content of new oil is 30 ppm.

(3) Aluminum and babbit material restricting the oil inlet screen indicate that there is severe main and rod bearing wear. The compressor should be dismantled and the worn parts replaced.

(4) Occasionally a dark, rubbery, sticky substance is found in the crankcase which can restrict the oil inlet screen. The substance is polymethylmethacrylate. It is a pour point depressant which is an additive in Standard Oil 32P. Model E and F compressors require a parafinic base oil in order to control unloader "O" ring swell. One of the characteristics of this type of oil is that it has relatively high pour and floc points. These properties are important because they determine how well the oil will flow at low temperatures and what temperature wax will precipitate out of the oil. Polymethylmethacrylate is an additive that lowers the pour point of the oil. It does this by changing the nature of the wax, which in turn, affects the ability of the oil to flow.

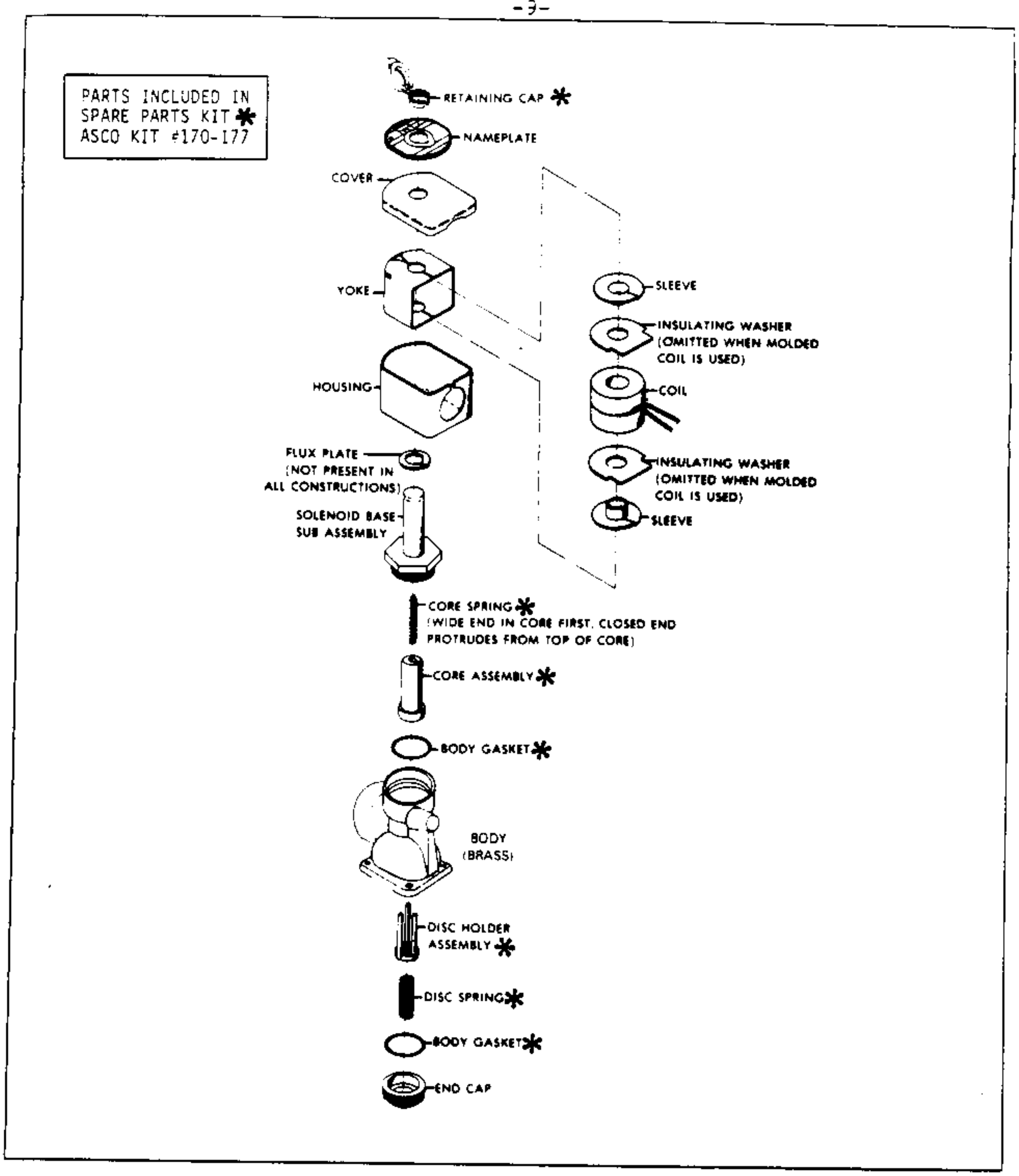


FIGURE 7 - ASCO Unloader Solenoid Valve Part Identification

If polymethylmethacrylate is found in the compressor crankcase, thoroughly clean the compressor crankcase and inlet oil strainer and change the system filter drier and the compressor oil.

(5) Miscellaneous

The following items may also contribute to low oil pressure and can be checked by pressurizing the oil system with the hand hole cover removed and observing excess oil flow.

(1) Magnetic plug left out of the crankshaft. See Figure 8.

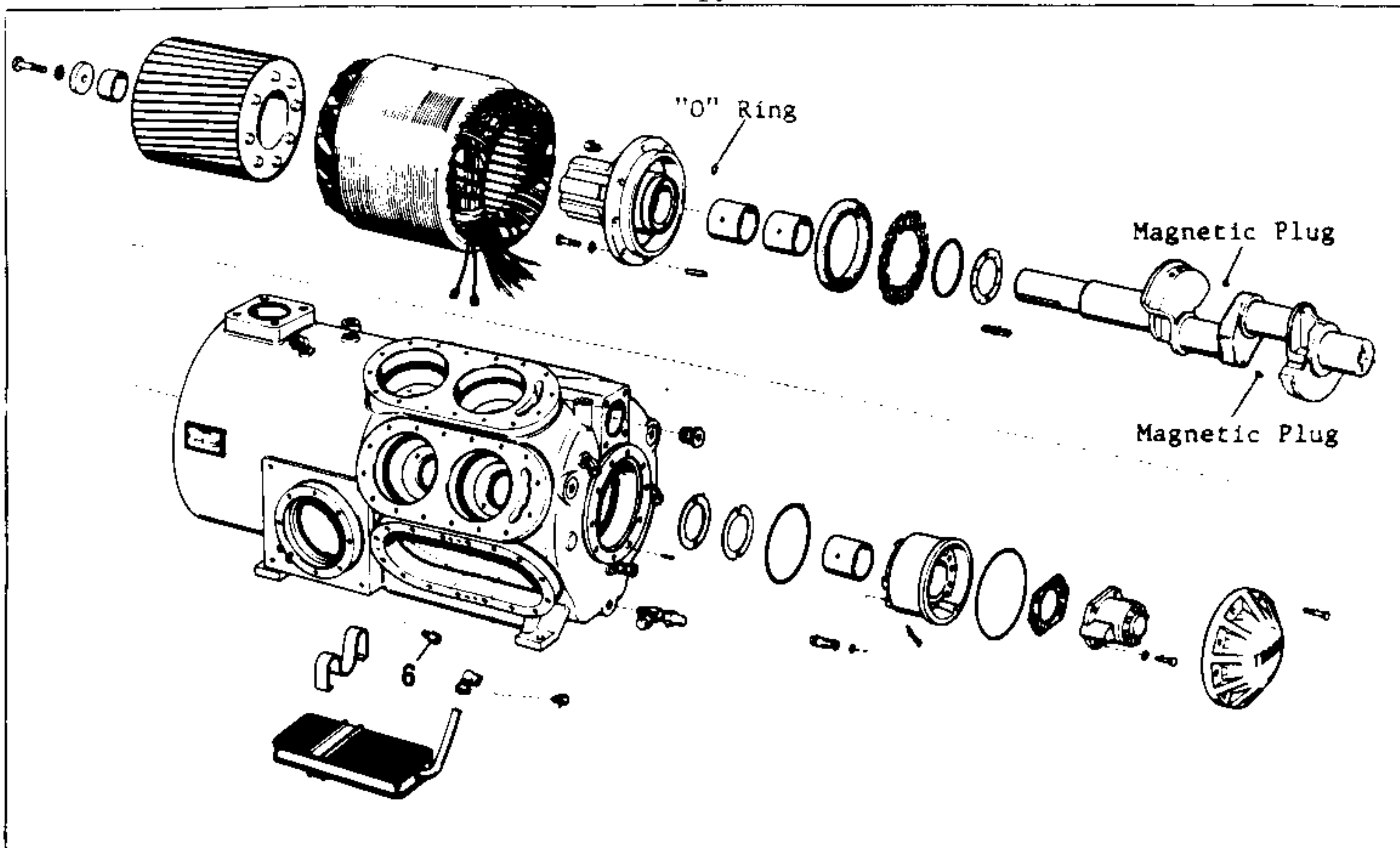


FIGURE 8 - Motor Bearing End, "O" Ring and Crankshaft Magnetic Plugs

(2) Plug left out of motor end bearing head. The suction cover must be removed to observe excess oil flow. See Figure 9.

(3) "O" ring left out between motor end bearing head and housing. The suction cover must be removed to observe excess oil flow. See Figure 8.

(4) Orifice plug left out of seal end bearing head (open compressor). Seal cover must be removed to observe excess oil flow and to visually inspect if orifice plug is installed. See Figure 10.

(5) The unloader solenoid valves may have leaky "O" rings. This results in an oil leak which is visible externally to the compressor at the unloader handhole cover. The Trane Company uses two manufacturers for the unloader solenoid valves, ASCO and Product Engineering Corporation. See Figures 11 and 12 for identification and proper orientation looking at the handhole cover.

Oil Loss

Oil loss is generally associated with the compressor pumping a greater amount of oil than can be returned to the crankcase. The cause for this may be insufficient pressure differential between the motor barrel and the crankcase, excess oil being pumped by the compressor, incorrect field piping or a restriction in the oil return port between the motor barrel and the crankcase.

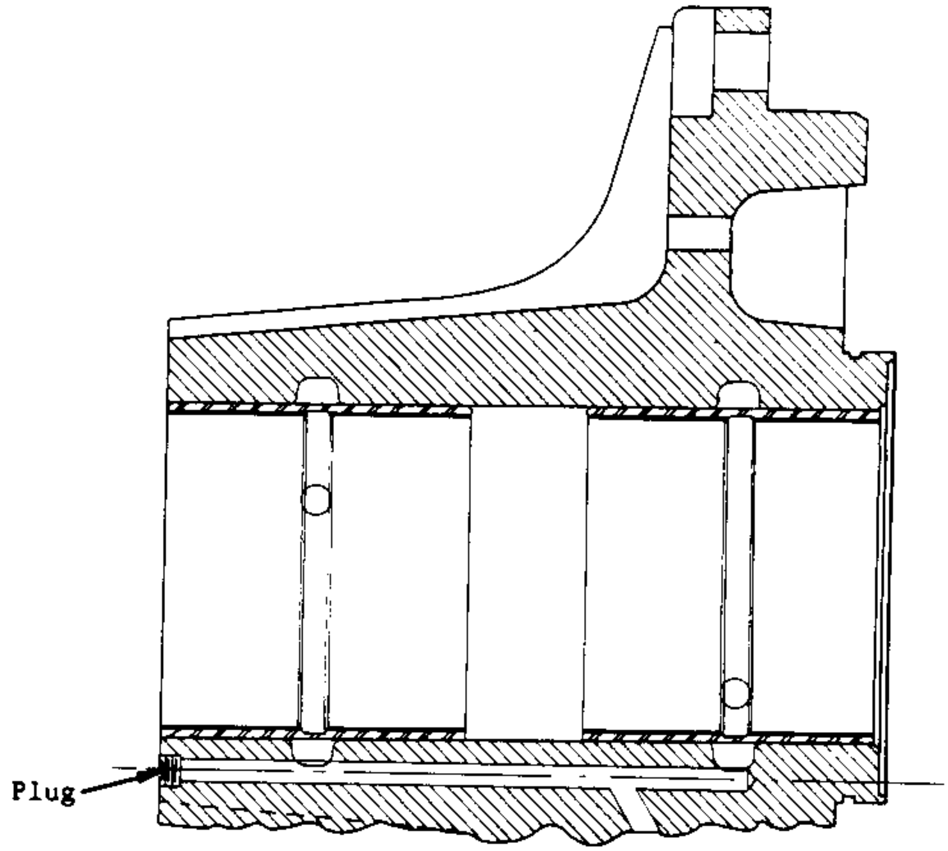


FIGURE 9 - Motor End Bearing Head Plug

1. Insufficient Pressure Differential

Insufficient pressure differential between the crankcase and the suction chamber may be caused by excessive blow-by resulting from worn or broken rings, stuck rings, rings not properly installed or seated and worn or broken suction valve(s). Also, any part of the system which restricts the mass gas flow below a minimum gas flow, as determined by minimum compressor loading, such as a defective TXV valve, or plugged suction gas strainer, may reduce the pressure differential required to insure proper oil return.

A discharge to the suction leak in the compressor housing, caused by either a crack in the housing or a leaking internal relief valve, will also cause insufficient pressure differential. Check this, by building blank-off plates to cover the housing discharge ports, pressurizing the high side and checking for leaks around the internal relief valve.

NOTE: A large leak may pressurize the crankcase to the point where, because the compressor will not unload, the oil in the unloaders can not bleed back to the crankcase. This phenomenon results because of the "reverse" pressure condition that occurs between the suction chamber around the unloaders and the crankcase.

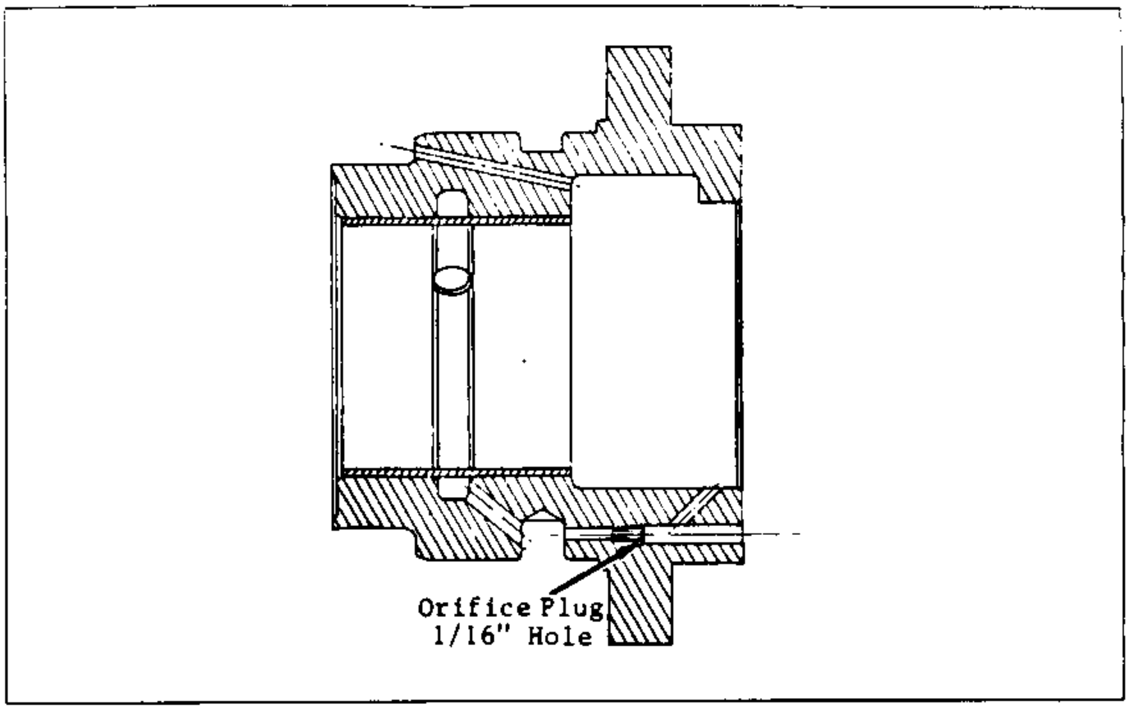


FIGURE 10 - Seal End Bearing Head Plug

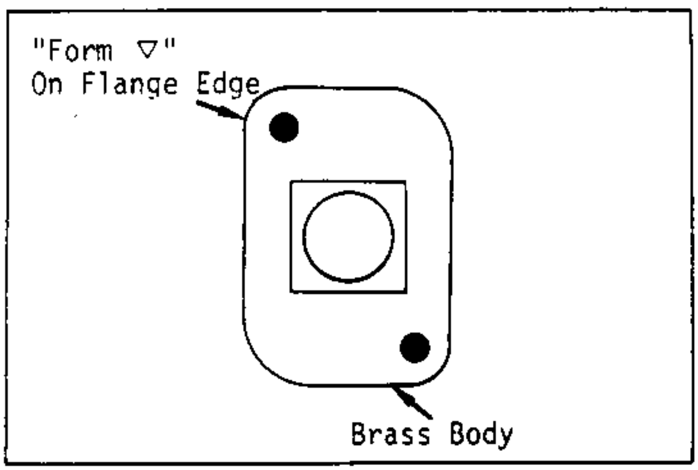


FIGURE 11 - ASCO Unloader Solenoid Valve

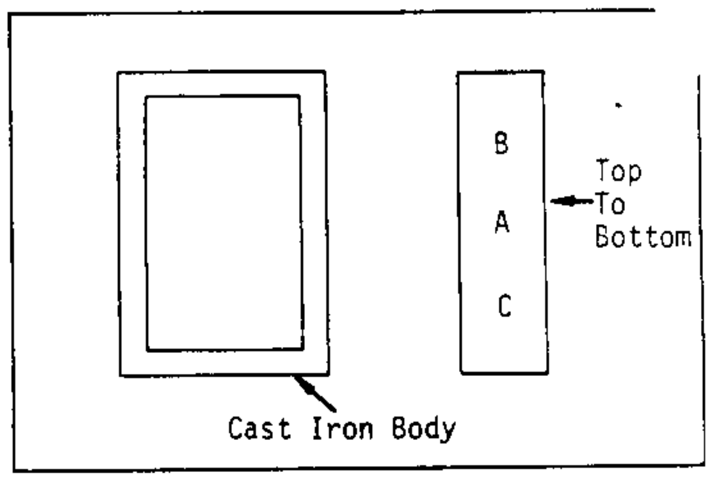


FIGURE 12 - Product Engineering Corporation

If the compressor does not have an orifice to vent the crankcase to the suction chamber, the check valves should be removed and replaced with the orifice plug. The orifice aids the necessary pressure equalization between the suction chamber and the crankcase. At the same time, the stand pipe should be installed to prevent oil migration to the motor barrel during the off cycle. See Service Bulletin HCOM-SB-28.

2. Excess Oil Pumping

   Excessive compressor oil pumping can be attributed to several conditions: bad compressor "O" rings, worn, stuck or broken rings, and oil spraying on the cylinder liners from broken oil lines or cracked finger strainer. These conditions have been previously discussed and the same diagnostic procedures can be used.

3. One of the main reasons for poor oil return is poorly designed field piping. If this problem exists, it will manifest itself during unloaded operation of the compressor. If this is suspected, the trapping and pipe sizing should be checked. Refer to the "Trane Reciprocating Refrigeration Manual" to check the design of field piping. The main items to check are the size of oil traps and refrigerant velocities in the discharge lines at both full and minimum load.