Operator's Manual

ESH/V

5&7 INCH STROKE FRAME PORTPLATE CYLINDER

INGERSOLL-RAND®

AIR COMPRESSORS

Form AP-0136C
October 1980
Supersedes Nov. 1974

Approved For Release 2003/12/02 : CIA-RDP02-06298R000900030003-9

CONTENTS

STORAGE PRECAUTIONS

THE UNIT HAS BEEN PREPARED AT THE FACTORY WITH AN ANTI-CORROSIVE MATERIAL TO RETARD RUST FOR A SIX MONTH PERIOD. HOWEVER, IT IS IMPORTANT THAT THE UNIT BE STORED IN A WARM, DRY ENVIRONMENT.

UPON INSPECTION, IT MAY BE NOTED THAT THE CYLINDER IS PROTECTED BY VAPOR PHASE INHIBITOR (VPI) CRYSTALS. THOUGH SIMILAR TO SAND IN APPEARANCE, VPI IS NON-ABRASIVE AND WILL VAPORIZE WHEN THE MACHINE IS STARTED.

IF AFTER RECEIVING, IT IS NOTICED THAT THE PROTECTIVE SEALS ARE DAMAGED AND/OR COVERS OPENED, OR IF AFTER USE THE UNIT IS TO BE STORED, SHIPPED, OR OTHERWISE INOPERATIVE, YOUR LOCAL INGERSOLL-RAND OFFICE SHOULD BE CONTACTED FOR PROPER REPROCESSING PROCEDURES.

SAFETY PRECAUTIONS

READ CAREFULLY BEFORE INSTALLING THE COMPRESSOR

WHERE LUBRICATING OIL IS PRESENT IN THE COMPRESSOR DISCHARGE, AN AFTERCOOLER SHOULD BE INSTALLED IN THE FINAL COMPRESSOR DISCHARGE LINE; IT SHOULD BE MOUNTED AS CLOSE AS POSSIBLE TO THE COMPRESSOR.

WHEN INSTALLING A NEW COMPRESSOR IT IS ESSENTIAL TO REVIEW THE TOTAL PLANT AIR SYSTEM. THE USE OF PLASTIC OR CARBONIC BOWLS ON LINE FILTERS WITHOUT METAL GUARDS CAN BE HAZARDOUS.

A PRESSURE RELIEF VALVE MUST BE INSTALLED IN THE DISCHARGE PIPING BETWEEN THE COMPRESSOR AND ANY POSSIBLE RESTRICTION, SUCH AS A BLOCK VALVE, CHECK VALVE, AFTERCOOLER, OR AIR DRYER. FAILURE TO INSTALL A PRESSURE RELIEF VALVE COULD RESULT IN OVERPRESSURE, PIPE RUPTURE, DAMAGE TO THE COMPRESSOR AND PERSONAL INJURY. REFER TO INSTRUCTION BOOK FOR SPECIFIC INFORMATION.

ON BELT DRIVEN COMPRESSORS; A BELT GUARD, CONFORMING TO O.S.H.A., STATE AND LOCAL CODES, SHALL BE INSTALLED BY THE USER.

THOSE RESPONSIBLE FOR INSTALLATION OF THIS EQUIPMENT MUST PROVIDE SUITABLE GROUNDS, MAINTENANCE CLEARANCE AND LIGHTNING ARRESTORS FOR ALL ELECTRICAL COMPONENTS AS STIPULATED IN O.S.H.A. 1910.308 THROUGH 1910.329.

WHEN A RECEIVER IS INSTALLED, IT IS RECOMMENDED THAT OCCUPATIONAL SAFETY AND HEALTH STANDARDS AS COVERED IN THE FEDERAL REGISTER, VOLUME 36 NUMBER 105 PART II PARAGRAPH 1910.169 BE ADHERED TO IN THE INSTALLATION AND MAINTENANCE OF THIS RECEIVER.

ALL ELECTRICAL INSTALLATION MUST BE IN ACCORDANCE WITH RECOGNIZED ELECTRICAL CODES. BEFORE WORKING ON THE ELECTRICAL SYSTEM, BE SURE TO CUT OFF THE ELECTRICAL SUPPLY FROM THE SYSTEM BY USE OF A MANUAL DISCONNECT SWITCH. DO NOT RELY ON THE STARTER TO CUT OFF THE ELECTRICAL SUPPLY.

BEFORE STARTING THE COMPRESSOR, ITS MAINTENANCE INSTRUCTIONS MUST BE THOROUGHLY READ AND UNDERSTOOD.

DO NOT REMOVE THE COVERS FROM THE COMPRESSOR WHILE THE UNIT IS IN OPERATION. SEVERE INJURY FROM MOVING PARTS CAN RESULT.

COMPRESSED AIR AND ELECTRICITY CAN BE DANGEROUS, BEFORE DOING ANY MECHANICAL WORK ON THE COMPRESSOR:

A. SHUT THE MACHINE DOWN.
B. REMOVE POWER FROM THE MOTOR BY OPENING A MANUAL DISCONNECT SWITCH IN THE POWER LINE TO THE MOTOR. TAG AND LOCK THE DISCONNECT SWITCH SO NO ONE WILL CLOSE IT ACCIDENTALLY. DO NOT RELY ON THE MOTOR STARTER TO CUT OFF THE ELECTRICAL SUPPLY.
C. DO NOT ATTEMPT TO SERVICE ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
D. ENSURE THAT THE BELT WHEEL HAS BEEN LOCKED TO PREVENT ROTATION AND SUBSEQUENT PERSONAL INJURY.

PERIODICALLY ALL SAFETY DEVICES MUST BE CHECKED FOR PROPER OPERATION.
USE ONLY SAFETY SOLVENT FOR CLEANING THE COMPRESSOR AND AUXILIARY EQUIPMENT.

FAILURE TO HEED ANY OF THESE WARNINGS MAY RESULT IN AN ACCIDENT CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.

SECTION I - INSTALLATION

REFER TO INSTALLATION MANUAL AP-0250
FOR COMPRESSOR INSTALLATION INSTRUCTIONS

GENERAL

It is essential in installing a new compressor to review the total plant air system. This is to insure a safe and effective total system. One item which must be considered is liquid carryover into the plant air line. Installation of aftercoolers, air dryers and line separators is always good practice and these added safety features are recommended.

Water condensation can affect the operation of pneumatic devices. Aftercoolers and the addition of air dryers can eliminate this hazard.

Similarly, there can be bad effects if compressor coolants or lubricants are allowed to enter plant air systems.

Air line separators, properly selected and installed, can reduce any liquid carryover close to zero.

The use of plastic bowls on line filters *without metal guards* can be hazardous. Their safety can be affected by either synthetic lubricants or the additives used in mineral oils. From a safety standpoint, metal bowls should be used on any pressurized system. Review of your plant air line system is recommended.

IMPORTANT

It is extremely important that the compressor intake piping be thoroughly cleaned. Piping should be blown out with high pressure air after cleaning. The importance of starting any compressor with clean piping, particularly on the intake to any cylinder, cannot be over-emphasized.

COMPRESSOR PIPING

We cannot emphasize too strongly the necessity for thoroughly cleaning the inside of all piping before installing. If metal pieces, pipe scale, rust, welding spatter, dirt, and all foreign material are not carefully and thoroughly removed, they will be loosened by the flow of air and will cause serious damage.

All air piping and vessels supplied with the compressor have been internally cleaned and sprayed with rust preventative, and protective closures have been applied to all openings.

NOTE: Do not remove the protective coverings until you are ready to assemble the piping or vessels on the compressor.

RECOMMENDATIONS

This is particularly important with multi-stage high pressure compressors where special metallic packings are required and in "NL" (Nonlubricated) compressors where special carbon or Teflon rings and packagings are required. These parts are much more expensive than in a low pressure or lubricated cylinder compressor. Any dirt, rust, welding beads or scale carried into the compressor will cause scored packing rings, piston rods, and cylinder bores and pitted, leaking or broken valves.

NOTE: It is important that the piping be fabricated with sufficient flange joints so that it can be dismantled easily for cleaning and testing. It is far better to to clean and test the piping in sections before actual erection than after it is in place.

When piping is cleaned in sections before erection, it is possible to do a thorough job of eliminating all acid. This is difficult to do with piping erected and in position, as carry-over of acid into the cylinders is almost certain to occur when the machine is started. This has happened and can cause extensive damage.

If it is absolutely necessary to conduct the final hydrostatic test when the piping is in position, **care should be taken to provide vents at the high spots so that air will not be trapped in the piping.** Provision must be made for complete drainage after the test is completed. These connections should be planned in advance. Furthermore, **it is essential that all connections to the cylinders be broken and blanked off,** preferably with a spool piece removed between the piping and cylinder.

IMPORTANT

Complete drainage of the piping is essential if damage is to be prevented when starting.

The use of chill-rings for butt welds in piping is generally recommended in order to prevent welding beads from getting into the pipe and thus carrying through to the compressor on operation.

READ INSTALLATION MANUAL AP-0250 BEFORE INSTALLING COMPRESSOR

LOCATION OF MAJOR COMPONENTS

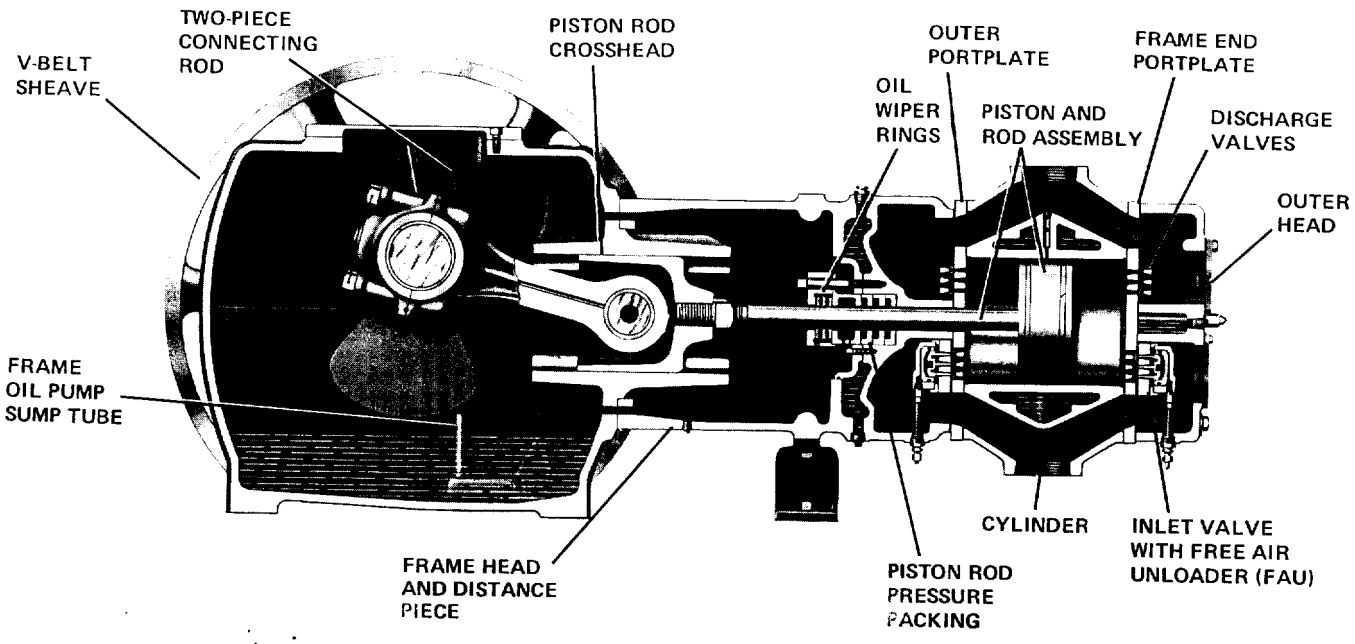


Figure 1. Cross Section View of Typical ESH Lubricated Compressor.

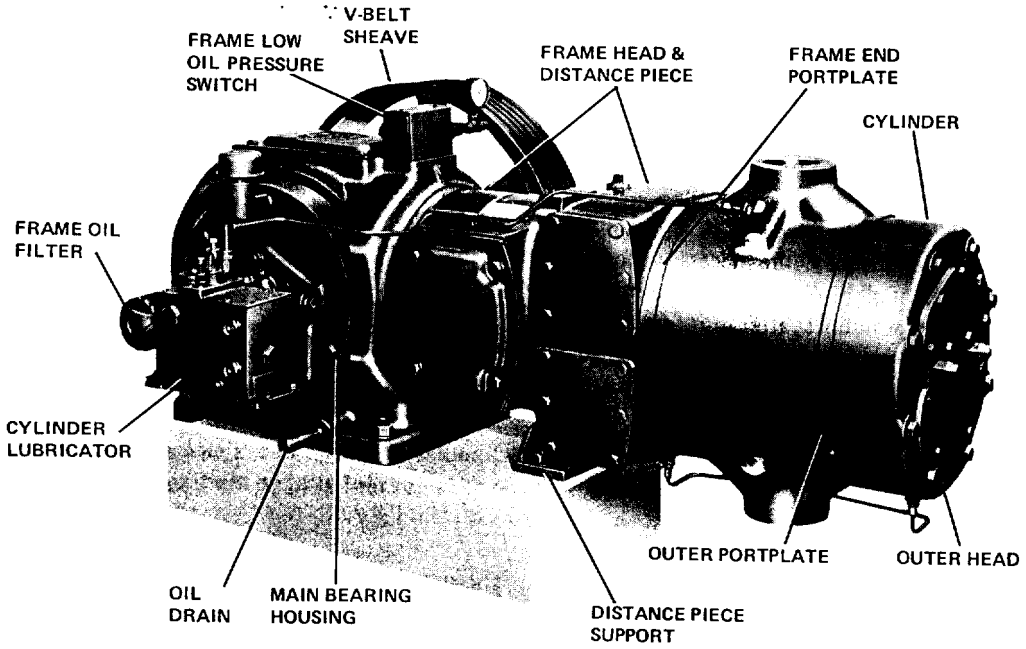


Figure 2. Horizontal Nonlubricated Compressor.

SECTION II - GENERAL OPERATION

The following instructions should be used by the operator as a guide for the general operation of the compressor. As the operator gains experience with the compressor under actual operating conditions, a set routine should be established.

After a general overhauling or installation of new parts, the operator should be guided by the instructions as though the compressor was new.

INITIAL START

IMPORTANT

It is very important that the intake piping be clean and properly installed. It is essential that this be done after installation or relocation of the compressor and after a long shutdown or new parts installation. See Form AP0250 Installation Manual for instructions.

Special Conditions for Nonlubricated Units – The successful operation of a compressor having a nonlubricated cylinder depends upon the lubricating qualities of the piston and wearing ring. The presence of dirt, scale of other abrasive material is injurious to any compressor cylinder. However, when a cylinder is run without lubrication the injury is much more serious. The importance of a really good filter and clean intake piping cannot be stressed too strongly.

For best operating conditions the cylinder should be free of moisture in the air and crankcase oil should not be allowed to enter the cylinder.

The oil wiper rings in the partition stuffing box will wipe the piston rod practically dry; however, there is a slight oil carryover past the wiper rings. An oil slinger, or oil stop plate is mounted on the rod, where it passes through the distance piece. Any oil which might seep past the wiper rings cannot work by this oil slinger and the cylinder is kept completely free of oil. With this arrangement the packing rings supply the only dry lubrication to the piston rod.

Preparation – When the installation of the compressor has been completed in accordance with instructions given in Section 1 of this book, carry out the following procedure before starting the machine.

1. Clean up the floor and foundation, and remove all cement, dirt and dust from the exterior of the compressor.
2. Remove the frame top cover and distance piece side covers and clean out with safety solvent every portion of the interior and the crankcase oil sump to insure a clean interior free from dust and dirt, which may have entered during shipping and installation. Use a cellulose sponge only, NEVER use waste or a linty cloth to clean the interior of the machine. You cannot get these portions too clean before putting in the oil. Clean the protective grease from the piston rods.

   The running and finished parts inside the crankcase are covered with a heavy anti-rust compound previous to shipment. It is not necessary to remove this coating before starting the compressor as it is soluble in the frame lubricating oil.
3. Fill the crankcase to the proper oil level on the oil sight glass with the recommended grade of crankcase lubricating oil. (Refer to Section 4, Frame Lubrication.) Pour oil over all the bearings which can be easily reached through the frame or openings. On lubricated units, fill the cylinder lubricator with the recommended grade of air cylinder lubricating oil. Refer to Section 6 for complete lubrication instructions and lubricating oil specifications.
4. Prime the frame lubricating oil pump. (Refer to Section 4 for Frame Lubrication.)
5. On lubricated units each cylinder force feed lubricator line must be disconnected at the point where it is attached to the oil inlet side of the check valve. The lubricator feeds must then be operated manually until all the air is forced out of the lines and oil appears. The lines should now be reconnected and the lubricator given several additional turns to assure proper lubrication of the cylinder as soon as the compressor is started. Once the compressor is started, the oil lines will remain full of oil and require no further attention.
6. Drain the air intake pipe of any moisture which may have accumulated. Be sure that the air intake filter is properly installed and protected (See AP-0250 for instructions in Section 5, page 26.
7. Install the packing in the stuffing boxes according to instructions in Section 5.
8. Replace the frame cover and turn the machine over BY HAND a few times in the direction shown by the arrow on the oil pump casing to make sure it works freely and everything is clear.

CAUTION

THIS IS IMPORTANT. ACCIDENTS HAVE RESULTED FROM STARTING A NEWLY ERECTED COMPRESSOR WITHOUT HAVING TURNED IT THROUGH AT LEAST ONE COMPLETE REVOLUTION.

NOTE: This compressor must rotate in one direction only due to the force feed lubricating pump. If specified, this lubricating system can be arranged for reverse rotation. The direction of standard rotation is counter-clock-wise when facing the belt wheel.

9. Before starting a new compressor be sure you are familiar with the starting and stopping controls, and with the regulation and regulator controlling the load and no-load operation. For details on regulator, regulation, and start-stop controls read Section 8 thoroughly.
10. Check the machine thoroughly to be sure there are not loose parts and that the machine has not been tampered with since its erection.

Initial Start – The machine may be started in accordance with the procedure outlined under "ROUTINE STARTING". A new compressor, or a compressor in which new parts have been installed, should always be allowed to run unloaded for an hour or more. Accomplish this either by making sure the Free-Air-Unloader unloads the cylinder–(Refer to Section 8 on Regulation), or by opening the discharge line to atmosphere so that no pressure will be built up.

When everything is working satisfactorily and the bearings remain cool, apply the load by exhausting the air from the free-air unloaders. Allow the pressure to build up in the receiver, and see that the regulator unloads the compressor at the desired receiver pressure. Make sure the safety valve on the receiver will start blowing at a pressure about 10 psi (0.69 bar) higher than the working pressure.

Routine Starting – After the initial starting procedure has been followed the compressor may be restarted as follows:

1. Check the lubricating oil level in the crankcase and in the cylinder lubricator if your unit is so equipped (lubricated units only).
2. Turn on a full supply of cooling water and check the actual circulation at the water discharge connection.
3. Drain the compressor intake of any accumulated moisture. (If starts are frequent, this need be done only as found necessary.)
4. Start the motor in accordance with instructions furnished with the electrical equipment. If oil pressure does not build up, the machine, with manual starting unloading will shut down automatically when the start button is released. On full auto start units, if the oil pressure does not build up the unit will shut down when the oil pressure shunt timer times out. The compressor is equipped with an oil pressure switch set at 5 psig (0.34 bar). The oil pressure is monitored at the drive side main bearing.

IMPORTANT

In the event that the compressor is started without first turning on the cooling water, shut down immediately.

DO NOT turn on the cooling water for some time, as it may crack the hot cylinder walls. After the heat has dissipated the water can be turned on and the compressor started.

5. As soon as the machine is started make sure that the oil pressure gauge indicates normal operating pressure of 15 to 40 psi (1.03 to 2.76 bar). If oil pressure is below 5 psi (0.34 bar) the unit will shut down automatically. On lubricated units also check the cylinder lubricator for feed.
6. Check the receiver pressure gauge to make sure the regulating device is operating properly and that it will unload the compressor at the maximum pressure for which the machine was built.

NOTE: Never leave the compressor until you are satisfied all controls are operating properly.

7. Adjust the flow of the cooling water so that the temperature of the water discharge is approximately 120°F. It is important that the cooling water discharge be checked, and adjusted, if necessary, to compensate for changes in the temperatures of the incoming water, the atmosphere and the compressor load. Insure correct operation of any automatic devices in the cooling water system.

Cold water may cause condensation and rust on the cylinder walls. This will result in rapid cylinder, piston and/or piston ring wear.

IMPORTANT

Do not leave water circulating through the water jackets of a compressor that is not running, as condensate will form on the cylinder walls, which may cause rust to form, destroying the polish of the cylinder bore.

OPERATIONAL MAINTENANCE

NOTE: For specific instructions on maintaining and inspecting nonlubricated compressor cylinders, refer to Section 5 of this manual.

ROUTINE OPERATIONAL MAINTENANCE

Required Maintenance	First Hours Of Operation			Daily Routine	Every 4000 [3] Hours
	2-3	50	200		
Check Frame Oil Level	X	X	X	X	X
Check Cylinder Lubricator Oil Level	X	X	X	X	X
Check and Adjust Lubricator Feed Rate If Required	X	X[2]	X[2]	X	X[2]
Check Safety Valves For Operation	X	X	X	X	X
Drain the Frame Oil and Check and Clean the Frame [1]		X			X
Check and Clean the Oil Pump and Oil Suction Screen [1]		X			X
Change the Frame Oil Filter		X		X	X
Change the Frame Oil		X			X
Drain the Condensate From the Receiver and/or Check the Operation of Automatic Drain Traps If So Equipped	X	X	X	X	X
Check the Cooling Water Temperature - 120°F at Discharge	X	X	X	X	X
Check the Oil Wiper Rings and Stuffing Box For Leakage		X	X		X
Check the Piston Rod For Abnormal Wear		X	X		X
Tighten All Exterior Bolts and Nuts	X	X	X		X
Tighten All Gasketed Joints		X	X		X
Tighten All Foundation Bolts		X	X		X
Compressor Ring Wear [5]		X	X		X
NL Piston Wear Ring (Rate of Wear)		X	X[4]		

1 Flush with safety solvent, drain and thoroughly dry before reassembly.
2 The condition of the valves and cylinder bore should influence lube rate - refer to Section 6.
3 Abnormal conditions will require more frequent maintenance.
4 Every 500 Hrs. thereafter until a rate of wear has been established.
5 First 500 Hrs. then as the piston wear rings are replaced.

Initial Break-In — After the compressor has run for the first two or three hours under load, and has thoroughly warmed up under operating conditions, it should be shut-down and checked out in compliance with the maintenance chart above.

CAUTION

BEFORE DOING ANY INSPECTION OR SERVICING ON THIS COMPRESSOR:

1. **SHUT THE MACHINE DOWN.**
2. **CUT OFF THE ELECTRICAL SUPPLY FROM THE MOTOR BY OPENING A MANUAL DISCONNECT SWITCH IN THE POWER LINE TO THE MOTOR. LOCK AND TAG THE DISCONNECT SWITCH SO NO ONE WILL CLOSE IT ACCIDENTALLY.**
3. **LOCK THE BELT WHEEL TO PREVENT ROTATION.**
4. **DO NOT ATTEMPT TO SERVICE ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.**

Regular Operation — The conditions under which the compressor must operate is a significant influence on the frequency of many maintenance checks. Therefore, consideration must be given to these factors when establishing the following routine:

1. Drain the receiver to remove water. This should be done regularly and as often as operating conditions require. An automatic ejector or trap makes an ideal way of draining the receiver; but, be sure to check its operation at least once a day.

CAUTION

ON LUBRICATED UNITS BOTH WATER AND OIL MAY ACCUMULATE IN THE RECEIVER. AN ACCUMULATION OF OIL IN THE RECEIVER MAY CAUSE AN OIL VAPOR EXPLOSION. THEREFORE OVERLOOKING OF THIS ROUTINE DRAINAGE, MAY BE HAZARDOUS.

2. Test all safety valves at least once each operating shift to make sure they are free and in operating condition. The operator should familiarize himself with these valves

and their location. Make sure that the safety valve will "blow-off" at a pressure a few pounds above working pressure. The safety valves must not be set higher than the maximum pressure stamped on the receiver, or rating of any component in the air system.

Safety valves are usually located on the receiver, intercooler and in the discharge piping.

CAUTION

DO NOT CHANGE THE BLOW-OFF PRESSURE OF A SAFETY VALVE, DO NOT REMOVE THE SAFETY VALVE AND REPLACE IT WITH A PLUG, SINCE THIS WILL ELIMINATE THE PROTECTION PROVIDED AND MAY RESULT IN SERIOUS INJURY TO PERSONNEL AND DAMAGE TO THE COMPRESSOR AND RECEIVER. SAFETY CODES REQUIRE A SAFETY VALVE TO PROTECT THE RECEIVER FROM OVER-PRESSURE.

CAUTION

IF A HAND VALVE IS INSTALLED BETWEEN THE COMPRESSOR AND RECEIVER, A SAFETY VALVE MUST BE INSTALLED BETWEEN THE COMPRESSOR AND HAND VALVE.

3. Set up a schedule and follow it regularly, for checking the frame lubrication system, inlet and discharge valves, stuffing boxes and packing and for cleaning the compressor and water jackets.
4. Clean the compressor intake filter as often as found necessary from operating experience. Dirty valves may indicate the filter is not functioning or the pipe is not tight.
5. Clean all breather and oil filters of dirt and sludge. The frequency of this operation will depend on operating conditions and location. In a dirty location, it may be necessary to check these items quite frequently.

   Frequently cleaning of the breather elements with safety solvent will allow the breathers to work properly and minimize the condensation of oil vapors on the outside of the compressor.

CAUTION

WE RECOMMEND THE USE OF SAFETY SOLVENT FOR CLEANING. NEVER USE GASOLINE, KEROSENE, OR SIMILAR FLUIDS TO CLEAN THE AIR INLET MUFFLER AND CLEANER.

SHUT-DOWNS

Routine – To shut-down the compressor during regular service push the stop button. Immediately, after the compressor has stopped, shut off the cooling water so that the cold water will not cause condensation to form within the cylinder.

All water passages, jackets, and piping must be drained if there is any danger of freezing.

Indefinite Periods – On lubricated units only; when a shut-down for a period of several weeks or longer is anticipated, run the unit at no-load for several minutes and pump extra cylinder oil into the cylinders by manually operating the lubricator. Then drain the cylinders, intercooler and all water piping.

NOTE: For compressor or cylinder storage instructions for non lubricated type compressors see Section 5.

For a shut-down of several weeks or longer, remove the piston-rod packing and wiper rings. (See Section 5.) If this is not done a ring of corrosion may develop on the rod and accelerate packing wear when the unit is put back into service.

When shutting down for extended periods, all the foregoing precautions should be taken, and every bit of moisture should be removed from the water and air passages. The piston rods should be coated with a protective grease.

IMPORTANT

In starting up after an extended shut-down, be sure to carefully follow the instructions for starting a new machine, particularly in regards to turning the machine over by hand for a few revolutions.

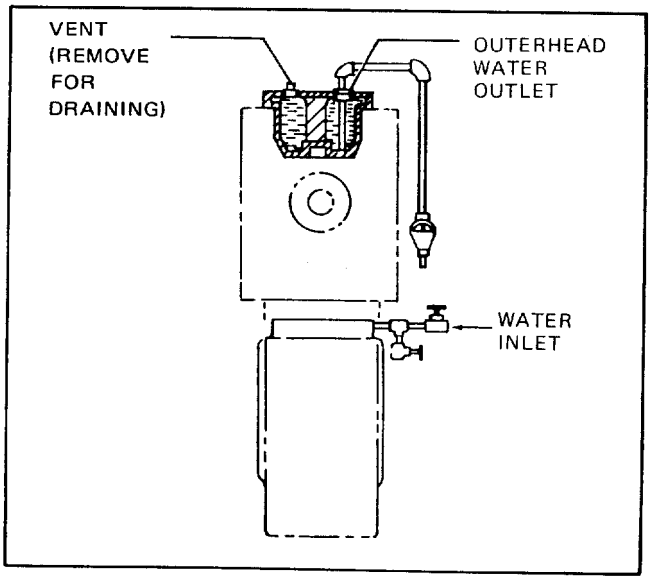


Figure 3. Draining the Outerhead.

WATER PIPING AND COLD WEATHER DRAINING

Special care must be taken in freezing weather to assure that the cylinder and heads are completely drained. On vertical (ESV) compressors the top head must be drained before the cylinder. It is drained by syphon action through the discharge pipe.

To drain the compressor water jackets proceed as follows. (See Figure 3.)

1. Open the water inlet valve until water flows out the open funnel on the discharge. This fills the syphon leg with water.
2. Close the inlet valve and remove the pipe plug vent in the outer head. This admits atmospheric air pressure to the water surface in the outer head, and starts the syphon operating.
3. Allow the discharge line to drain the outer-head.
4. Open the drain valve connected to the water inlet. This drains the compressor cylinder.
5. Remove two pipe plugs in the frame head. These plugs drain dead pockets in the frame head.

The above procedure must be followed when draining the unit in freezing weather to prevent bursting of the water jacket due to incomplete draining.

SECTION 3
FRAME AND RUNNING GEAR

3-1 GENERAL

Incorporated in the design of this unit are many features which make it economical, efficient, reliable, and easy to maintain. Some of the outstanding design features are:

1. **Sealed Frame** - Dust-and oil-tight frame with gasketed covers seals the frame from outside dust and dirt. The frame need be opened only at infrequent intervals for inspection.
2. **Full-Floating Bushings** - The full-floating bushings are force-feed lubricated and need no adjustment.
3. **Force-Feed lubrication** to all running parts.
4. **Non-adjustable crosshead.**

CAUTION

BEFORE DOING ANY INSPECTION OR SERVICING ON THIS COMPRESSOR:

1. SHUT THE MACHINE DOWN.
2. CUT OFF ELECTRICAL SUPPLY FROM THE MOTOR BY OPENING A MANUAL ISOLATOR SWITCH IN THE POWER LINE TO THE MOTOR. LOCK THE DISCONNECT SWITCH SO NO ONE WILL CLOSE IT ACCIDENTALLY.
3. LOCK THE BELT WHEEL TO PREVENT ROTATION.
4. DO NOT ATTEMPT TO SERVICE ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
5. WHEN SERVICING THE CYLINDER END, DRAIN THE WATER FROM THE CYLINDER JACKETS (REFER TO SECTION 2).

3-2 CROSSHEAD (Figure 3-1)

The crosshead is of one piece aluminum construction. No adjustment is necessary.

3-3 REMOVAL OF CROSSHEAD

1. On vertical units block the belt wheel to prevent rotation and block the crosshead prior to removal of the connecting rod. Remove connecting rod (refer to Section 3-6). Lower the crosshead to bottom of the stroke and reblock.
2. Loosen the piston rod crosshead lock nut and star washer.

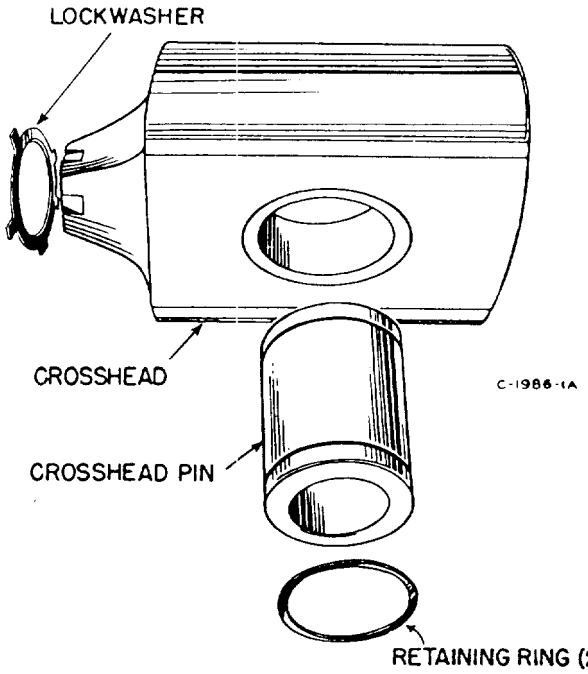


Figure 3-1. Crosshead, crosshead pin, and retaining rings.

3. Use a strap wrench to screw the piston rod out of the crosshead.
4. Remove the crosshead blocking and take the crosshead out through the frame opening.

Alternate Method

1. Block the belt wheel to prevent rotation.
2. Unscrew the piston rod from the crosshead (Refer to step 3 above.
3. Remove the complete cylinder end assembly.
   NOTE: This is accomplished by removing the hex nuts which secure the frame head and distance piece to the frame. Because of limited space, an extension wrench must be used to remove these nuts.
4. Remove one of the crosshead pin retaining rings.
5. Remove the crosshead pin.
6. Remove the crosshead.

IMPORTANT

During Steps Four and Five Above, Be Careful Not to Allow The Connecting Rod to Drop Forcibly on The Crosshead Guide.

3-4 CROSSHEAD PIN AND CROSSHEAD PIN BUSHING (Figures 3-1 and 3-2)

The crosshead pin is free to float in the crosshead and in the crosshead pin bushing. It is held in place by a flat spring-type retaining ring at each end of the pin.

To remove the crosshead pin, refer to the following procedure.

CAUTION

ON VERTICAL UNITS DO NOT REMOVE THE CROSSHEAD WITHOUT FIRST BLOCKING THE BELTWHEEL AND THE CROSSHEAD.

B. Before installing the spring-type retainers, inspect to be certain that the spring ends are angle cut and not square cut. Inadvertant use of square cut ring will make future disassembly extremely difficult.

C. One end of the crosshead pin contains a pipe plug. Should the pin become frozen into the crosshead, the pipe plug can be removed and a nipple and tee installed to allow pulling the pin with force. When installing the crosshead pin, be certain that the pipe plug end of the pin is accessible from the distance piece opening.

1. Unwind the retainer on the accessible side of the crosshead pin.

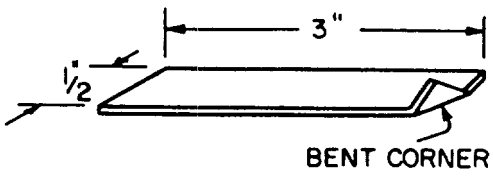
2. Push the pin back approximately ¼" (or not more than flush with the side of the crosshead). Refer to CAUTION note C. above.

3. Remove the frame cover.

4. Rotate the belt wheel to locate the crosshead at frame dead center.

5. Reach into the frame through the frame cover opening and, by feeling around the surface of the inner retainer ring, rotate the ring so that the ring split is accessible from the frame opening.

6. Using a short handled screw driver or a piece of thin metal (brass shim stock) shaped per the following sketch,



catch the end of the screw driver or tool edge in the retainer ring split and lift (or pry) an edge of the retainer ring out of the pin groove. The ring can now be unwound by hand.

NOTE

Removal will be simpler if the prying tool is held in the left hand while the right hand is used to prevent rotating of the ring while prying. The ring may be held by the right hand by reaching through the opening in the distance piece.

7. The crosshead pin is now free to be removed. Refer to CAUTION note A, B, and C.

8. To reassemole the crosshead pin, refer to the following procedure.

A. Locate the connecting rod and slide the crosshead pin into the crosshead until the pin is flush with the crosshead. Refer to CAUTION note C.

B. Wind a retainer into the groove on the back side of the pin and feel to be certain that the ring is seated into the groove. Refer to CAUTION note B. above.

C. Push the pin back to expose the ring groove on the exposed side of the pin and wind the retainer ring into the groove. Refer to CAUTION note C. above.

3-5 CONNECTING ROD (Figure 3-2)

The connecting rod has a solid eye at the crosshead end and a split eye at the crankpin end. A drilled oil passage connects the ends.

The connecting rod cap is held on by two bolts which are wired together at assembly. Two dowels are used at the joint where the rod and cap fit together. These dowels maintain alignment and must not be removed when removing the connecting rod cap from the connecting rod. When the rod is removed, one dowel remains in the cap and one dowel remains in the rod. This prevents mis-assembly when replacing the cap. The crankpin bushing is full floating and no adjustment is needed.

IMPORTANT

Never File The Joint or Use Shims Between The Cap and The Connecting Rod or in Any Other Way Disturb the Relationship Between These Two Precision Fitted Parts.

3-6 REMOVAL OF CONNECTING ROD (Figure 3-2)

1. Remove the crosshead pin. (Refer to Section 3-4.)

2. Place pieces of wood in the frame crosshead guide to protect it from the connecting rod. Observe blocking instructions in Section 3-3.

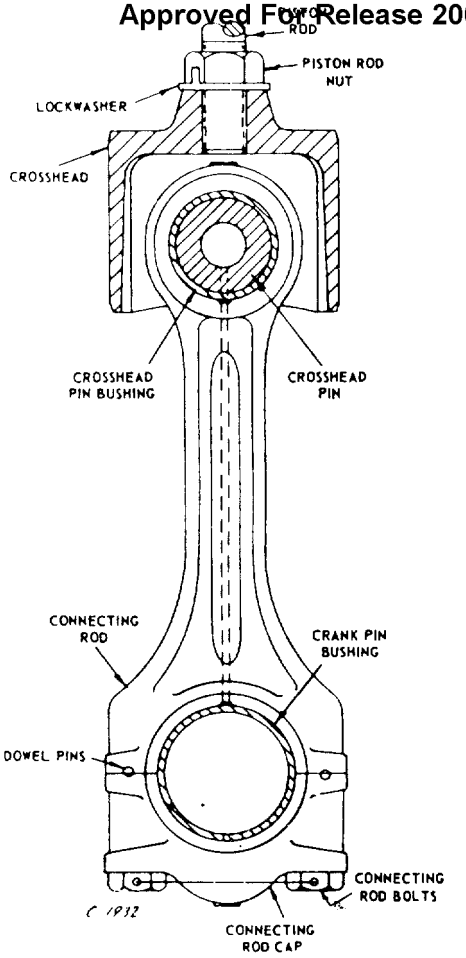


Fig. 3-2 - Connecting Rod

3. Rotate the crankshaft so that the connecting rod bolts are accessible thru the opening in the frame, and then remove the cap bolts.

4. Remove the connecting rod cap through the opening in the frame.

5. Rotate the crankshaft free of the connecting rod.

6. Remove the connecting rod through the frame opening.

7. To replace rod, reverse above procedure.

IMPORTANT

When Replacing The Connecting Rod Cap, Make Sure That The Retaining Bolts are Properly Secured Together with Locking Wire.

3-7 CRANKPIN BUSHINGS (Figure 3-3)

The crankpin bushing is aluminum of special bearing alloy and is made in two pieces to allow assembly on the crankshaft. It is full-floating and requires no adjustment.

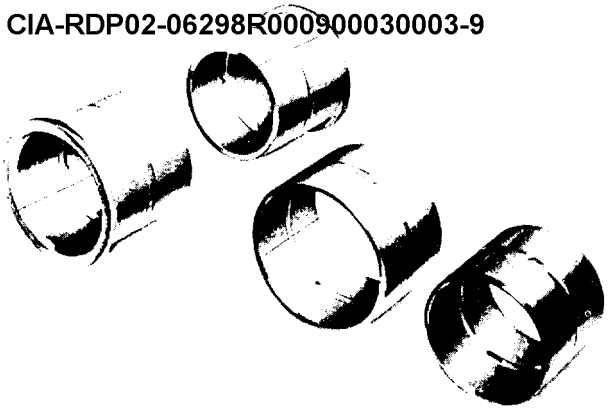


Fig. 3-3 - Crankpin Connecting Rod and Main Bearing Bushings

Both surfaces of the crankpin bushing are lubricated by oil which is forced through the drilled passages in the crankshaft under pressure by the frame oil pump.

If excess clearance causes the rod to become noisy, it is necessary to replace the bushing. The crankpin bushing can be replaced by removing the connecting rod cap and rotating the crankshaft free of the connecting rod.

CAUTION

THE BELT WHEEL AND THE CROSSHEAD MUST BE BLOCKED TO PREVENT ROTATION WHILE THE CRANKPIN BUSHING IS BEING REPLACED FAILURE TO DO SO CAN RESULT IN PERSONAL INJURY.

3-8 MAIN BEARING BUSHINGS (Figure 3-3 and 3-5)

Full-floating aluminum bushings are furnished capable of carrying both radial and thrust loads. Both the pump side and drive side main bearing bushings are identical and require no adjustment.

Both surfaces of each bushing are lubricated by oil which is forced through drilled passages in the crankshaft under pressure by the frame oil pump.

Should the bushings require replacement, use only duplicates of the original bushings. It is recommended that both bushings be replaced at the same time. These bushings must be free to float on the crankshaft and in the bearing housing Be certain that all parts are cleaned before assembly.

NOTE: If the main bearing housings are removed, the gaskets must be replaced with new ones. Only gaskets of the same type and size should be used. A gasket sealer should be used to ensure an oil tight joint.

It is necessary to remove the crankshaft when replacing the main bushing on the drive side. (Refer to Section 3-9 for instructions.)

An O-Ring is used to seal the joint between the main bearing housing and bedplate.

When the housing is removed, inspect this O-Ring and replace if necessary.

3-9 CRANKSHAFT (Figure 3-5)

The crankshaft is assembled in the bedplate by passing it through the opening on the bearing housing side of the bedplate. If it is necessary to remove the crankshaft, proceed as follows.

1. Remove the connecting rod and cap. (Refer to Section 3-6.)

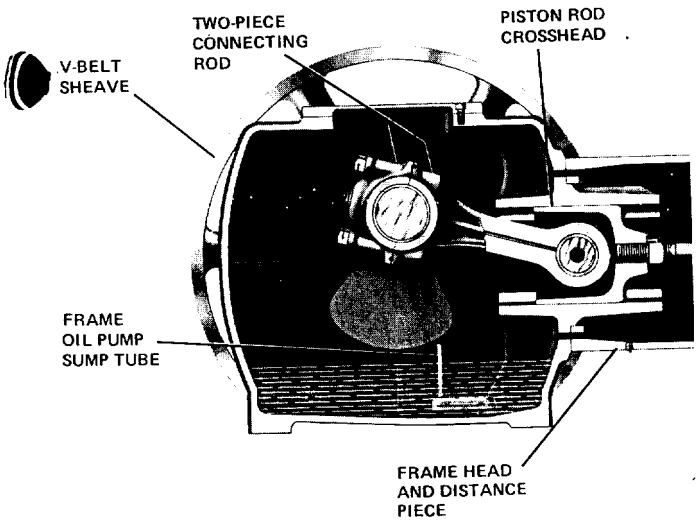


Fig. 3-4 - Cross-Section of Running Gear

2. Remove the V-belt sheave.

3. Remove the crankshaft oil seal. (Refer to Section 3-10.)

4. Remove the main bearing housing.

5. Support the crankshaft in a horizontal position and remove it from the frame by pulling straight out through the main bearing housing opening.

3-10 CRANKSHAFT OIL SEALS (Figure 3-6)

A double oil seal is provided on the drive side of the frame to prevent the escape of oil along the crankshaft. Each seal is of the lip type and is normally composed of a neoprene base material. A coil spring is mounted in the lip of each seal to maintain proper lip pressure on the crankshaft to insure sealing.

3-11 REMOVAL OF SEALS (Figure 3-7)

1. Remove the belt wheel.

2. Work a screw driver or similar tool along the joint between the outer surface of the seal and the bearing housing counterbore. Work the tool around the seal until the seal is completely removed from the counterbore. The seal will then slide off the crankshaft.

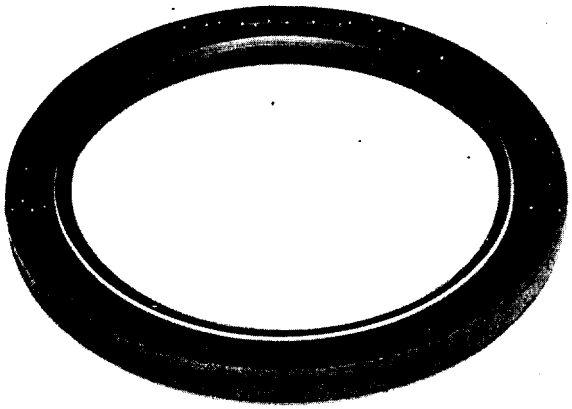


Fig. 3-6 - Crankshaft Oil Seal

NOTE: Since it is very probable that the seals will be damaged while being removed, be certain that new replacements are available.

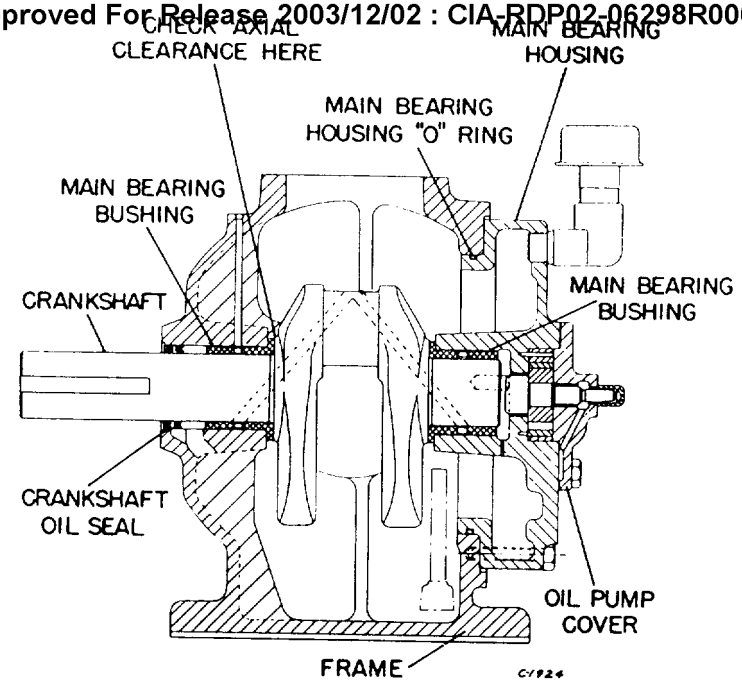


Fig. 3-5 - Crankshaft, Main Bushings and 5" Stroke Oil Seal

3-12 REPLACEMENT OF SEALS (Figure 3-7)

1. Thoroughly clean the crankshaft and bearing housing counterbore, and remove any nicks or sharp edges at the keyway. It is recommended that shim stock or tape be used over the keyway to protect the lip on the seals during assembly.

2. The lip section tends to distort if forced abruptly over the shaft. It is, therefore, recommended that the shaft and the lip of the seal be well coated with oil and a rotary screw motion be used while pushing it over the shaft.

5" Stroke Units

Force the inner seal into position such that there will be 1/4" (6.35 mm) to 5/16" (7.935 mm) between the inner seal and the outer seal when the outer seal is flush with the 1/8" (3.174 mm) counterbore.

7" Stroke Units

Force the inner seal into the bore as far as it will go using a block of wood and a hammer or an extremely blunt instrument. (Assembly at the factory is accomplished by using a metal tube over the shaft to force the seal evenly into its seat. Force the outer seal into the bore until the outer face of the seal comes flush with the counterbored face in the frame bearing housing.)

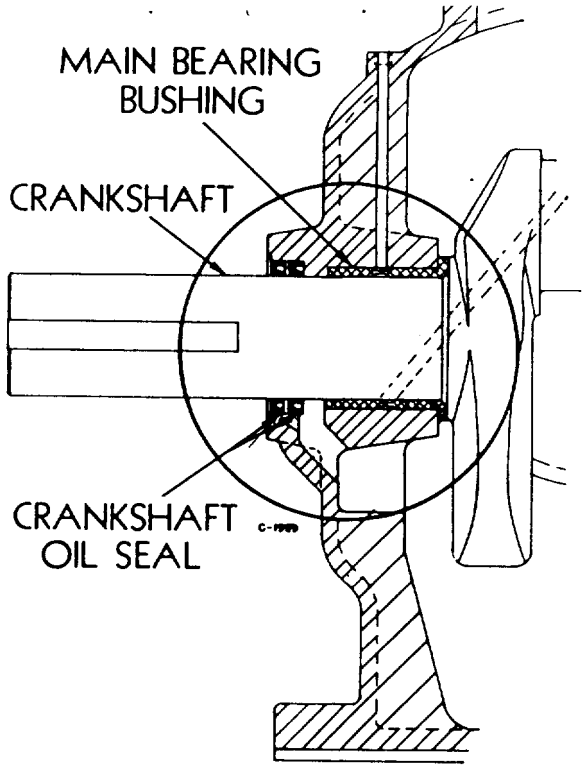


Fig. 3-7 - Cross-Section of 7" Stroke Oil Seal Assembly

SECTION IV - FRAME LUBRICATION

DESCRIPTION

General – A force feed lubrication system is used to supply oil to the main bearings, crankpin bushings, crosshead pin bushing and crosshead.

Operation – The frame lubrication system uses an internal gear type pump driven by the crankshaft. (Figure 9.) The pump draws oil from the sump through a coarse screen and forces the oil through a can type disposable filter. The oil then flows under pressure through drilled passages in the crankshaft to the main bearing bushings and crankpin bearing bushing. The connecting rod is rifle drilled for lubrication of the crosshead pin bushing. After passing through and lubricating the various parts the oil returns to the sump in the crankcase.

A spring loaded ball-check-type relief valve, protects the lubricating system from excessive oil pressure resulting from low ambient temperature at start-up or clogging of the oil filter.

When starting for the first time the oil pump must be primed. Remove the pipe plug in the pump cover (See Figure 10) and pour oil down the hole into the pump. Priming is necessary only before the initial start up or after the machine has been idle for several days.

Frame Oil Pump – The oil pump is an internal gear pump with two rotating gears. The pump drive shaft is driven directly off the compressor crankshaft. The internal gear is a press fit on the drive shaft and rotates at the same speed as the compressor crankshaft. The external gear is driven by the internal gear and rotates at reduced speed inside the pump locating ring. (Refer to Figure 11.)

Oil is trapped between the internal and external gear and is carried from the inlet to the discharge side of the pump. The oil then flows through the filter and into the compressor bearings.

The oil pump cover and the main bearing housing have drilled inlet and discharge passages. The suction strainer

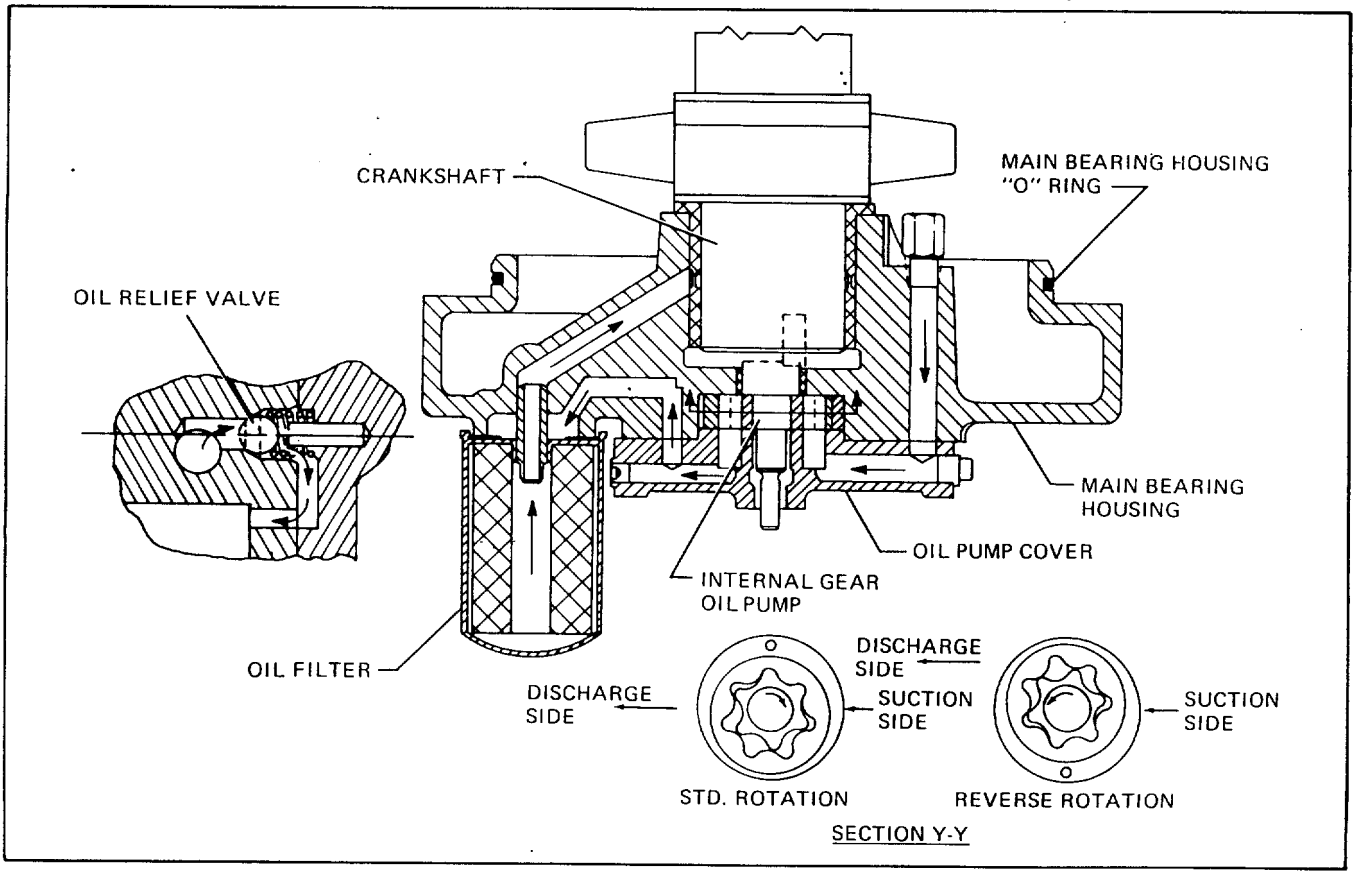


Figure 9. Frame Oil Pump and Filter Showing Oil Flow.

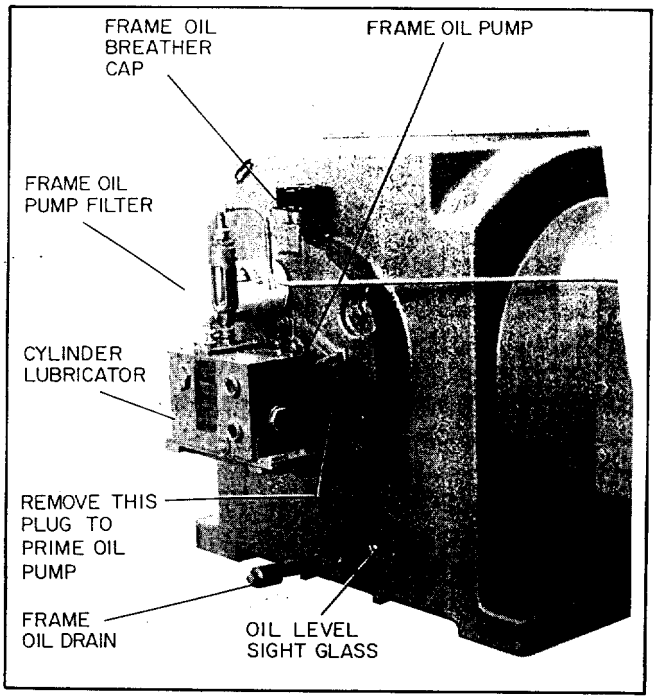


Figure 10. Priming Oil Pump.

located in the sump is connected to the pump by copper tubing. The pump shaft rotates in two bronze bushings which are lubricated by pump leakage. An oil seal prevents pump leakage from dripping on the floor. A built-in relief valve on the pump discharge prevents excessive pump pressure when starting with cold oil.

OIL PRESSURE AND TEMPERATURE

General – Oil pressure varies from unit to unit according to operating speed and lube oil viscosity. The compressor will operate satisfactory with 8 psig (0.55 bar) oil pressure measured at the pressure shut-down switch. (See Figure 10.) Normal Operating pressure is from 15 to 40 psig (1.03 to 2.76 bar).

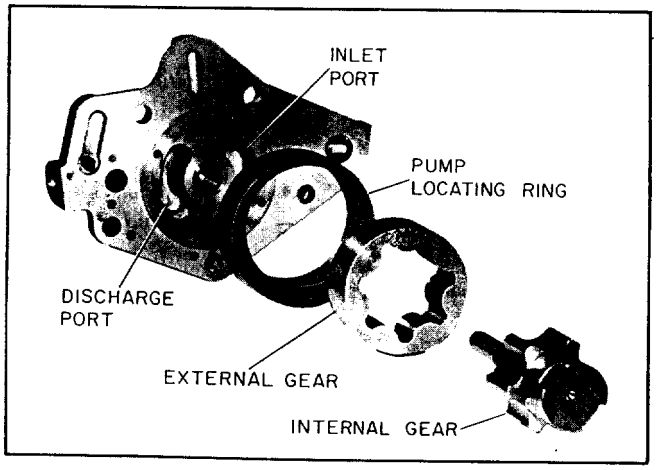


Figure 11. Frame Oil Pump.

Troubleshooting – A reduction in pressure will result from the following:

1. Plugged filter. Correct by replacing filter.
2. Plugged suction screen. Correct by cleaning.
3. Air leak in suction line. Correct by tightening all suction connections and pulling up on gasketed joints between oil pump casing and bearing housing.
4. Relief valve stuck open. To correct, remove relief valve, clean and replace.
5. Worn main bearings or crankpin bearing. Correct by replacing bearing.

The crankcase oil temperature will be approximately $50^{o}F$ ($10^{o}C$) above ambient temperature. Use of heavier viscosity oils will increase the crankcase temperature.

OIL FILTERING

General – A new machine always contains some dirt and foreign matter which is washed out by the flow of oil through the system. This is collected by the filter before it can get into bearings. When the filter becomes clogged, the pressure at the bearings will decrease until the oil pressure failure protection switch automatically shuts down the compressor at 5 psig (0.34 bar) oil pressure. The filter should be replaced before this happens.

Components – The frame lubricating oil filtering system consists of two units:

1. An 18 mesh wire screen is used on the intake of the lubricating oil pump. This screen will prevent coarse particles from entering the pump. This screen should be cleaned periodically.
2. A full flow replaceable cartridge type oil filter is used between the lube oil pump and the running parts. The cartridge is located on the main bearing housing (Figure 10). To replace the filter unscrew it from the housing and replace the entire unit with a new one, obtainable from Ingersoll-Rand branch stock.

OIL-PRESSURE FAILURE PROTECTION

General – The compressor is equipped with an automatic oil-pressure shut-down device which stops the machine in case of lubricating-oil-pressure failure. This oil pressure switch is set to operate at a rising pressure of 8 psig (0.55 bar) and at a decreasing pressure of 5 psig (0.34 bar). It is piped into the frame at the main bearing bushing on the drive side. An oil pressure gauge is mounted on the oil pressure shut-down switch.

Operation – It is necessary to keep this protective device inoperative during the starting period to permit oil pressure to build up and close the oil pressure switch. This is done by holding the Start button down for 10 to 20 seconds.

The normal oil pressure varies between 15 psig and 30 psig (1.03 to 2.07 bar) and is indicated on a dial pressure gauge which is piped into the drive side main bearing which is the end of the oil system and, therefore, insures oil being fed to all bearings resulting in assured lubrication and maximum heat removal.

If oil pressure drops below 15 psig (1.03 bar) the frame noise level may be higher.

FRAME OIL REQUIREMENTS

The capacity of the oil sump is approximately

2 GALLONS (7.6 liters) (1.7 Imp gal.)

Specifications – An exact oil specification which will include all oils suitable for this service and exclude all unsuitable oils, is impossible to write. The major oil companies have made exhaustive studies of air compressor lubrication and each has developed one or more oils which they can recommend, and we would suggest you show them these specifications and then follow their recommendations.

The oil must separate rapidly and produce little sludge. It must be a well refined petroleum product containing no fats or fixed oil compounding. Straight mineral oil containing a foam depressant is referred. It must be substantially non-corrosive to the common bearing metals. The pour point must be at least $10^{\circ}F$ ($-12^{\circ}C$) lower than ambient temperatures encountered to permit proper lubrication in the crankcase at starting.

The following recommended limits on laboratory test characteristics are generally satisfactory.

Flash Point (Open Cup)	$380^{\circ}F$ ($193^{\circ}C$) Min.
Viscosity at $100^{\circ}F$ ($38^{\circ}C$) (SSU)	780 Max.
Viscosity at $210^{\circ}F$ ($99^{\circ}C$) (SSU)	60 Min.
Carbon Residue (Conradson)	0.45% Max.
Strong Acid Number	0.00 Max.

All tests shall be conducted in accordance with the Standard Methods (latest Edition) of the American Society for Testing Material.

Servicing – Examine the oil at regular intervals to see that it does not discolor or become full of sludge. After the compressor has been in operation a while, it should not be necessary to change the oil more often than once every 4000 hours or once each year whichever occurs first. The oil may be drained from the crankcase through the drain plug located in the base of the sump. Check the oil level periodically and do not allow the oil to fall below the mark on the oil gauge level.

Add a small amount of oil periodically thru the breather tube to maintain the oil level while the unit is in operation.

When the unit is shut down the oil level will be well above the level on the oil level gauge.

Synthetic Lubricants – Synthetic lubricants are not normally used for frame lubrication due to their possible incompatability with paints and materials used in the frame and running gear components. Refer to Section 6, Cylinder Lubrication, for further information on the use of synthetic lubricants.

SECTION 5
COMPRESSOR CYLINDERS

(Non-vented Packing)

5-1 GENERAL

The compressor cylinder will be either lubricated or non-lubricated depending on application. The NL (non-lubricated) cylinder is used for applications that prohibit air or gas from being contaminated with oil, grease, gylcerine, or other lubricants. NL cylinders feature the TFE (tetrafluoroethylene) rider ring on the piston to prevent metal to metal contact of the piston with the cylinder bore, and TFE piston rings to maintain proper wall pressure. TFE is also used in NL cylinder pressure packing and through the use of wear strips and valve guide inserts in NL channel valves. In addition, an oil stop plate is used on the piston rod to prevent the travel of frame oil up the rod to the cylinder. The use of TFE components, wear strips, and an oil stop plate is not required with lubricated units. An NL compressor also requires a much finer cylinder bore than a lubricated model.

The cylinder end of the compressor consists of the cylinder with its valves, frame and outer heads, piston and rod, and the stuffing box and packing.

The following is a brief explanation of these major assemblies making up the cylinder end. Refer to the cross section (Figure 5-1) and become familiar with the parts and their functions.

A. The cylinder is the barrel type, free from all valve passages. Cast integral with the cylinder barrel are the cylinder barrel are the cylinder bore, air or gas passages, and an ample water jacket.

B. A valve port plate, with inlet and discharge valves attached is assembled between both the cylinder and outer head and between the cylinder and frame head distance piece.

C. To work on the port plate and valves, the outer head. which closes off the outer end of the cylinder, has two valve covers which can be removed.

D. The frame head and cylinder distance piece is one piece construction and separates the cylinder assembly from the frame. Four individual covers can be removed from the frame head distance piece to make the frame end port plate and valves accessible.

E. The pressure packing is make accessible by removal of the frame head distance piece cover.

F. The oil scraper rings are made accessible by removal of the frame head distance cover.

G. Ingersoll-Rand rectangular Type "A", Channel Valves with a reversible seat plate are used. (See Section 7 for complete description).

H. The port plates are held to the heads by two long studs with acorn nuts and a series of cap screws. A small gasket is used under each acorn nut.

I. The piston is cast iron. (Section 5-5)

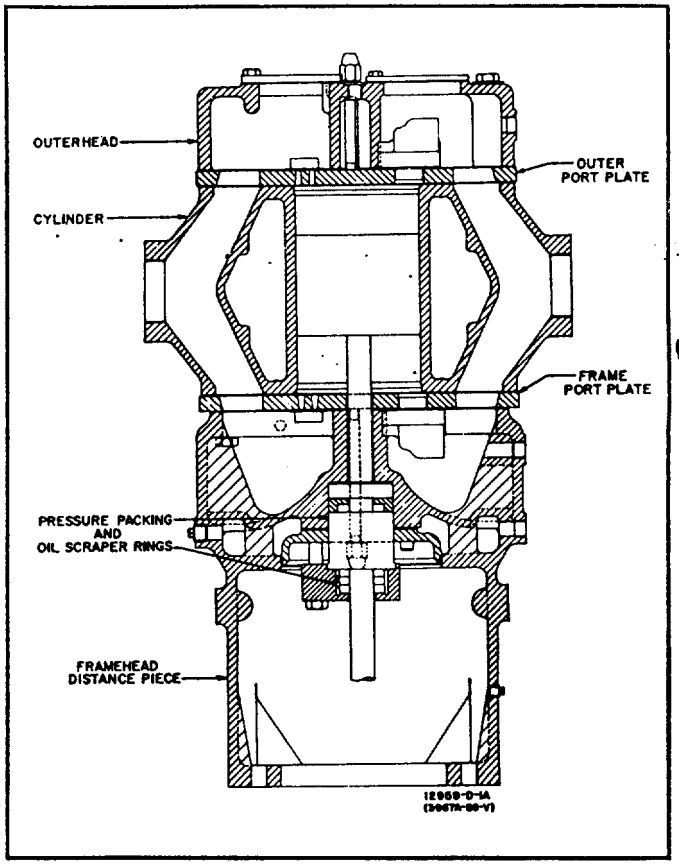


Figure 5-1. Cross-Section of ESV Compressor

5-2 CLEANING CYLINDER WATER JACKETS

If the circulating water is dirty, mud and silt will be deposited in the cylinder jackets and passages. These deposits will ultimately obstruct the flow of water entirely unless care is used to prevent such an accumulation. Clogged passages will interfere with proper cooling which will result in damage to the cylinders and pistons.

CAUTION

BEFORE DOING ANY INSPECTION OR SERVICING ON THIS COMPRESSOR:

1. SHUT THE MACHINE DOWN.
2. CUT OFF THE ELECTRICAL SUPPLY FROM THE MOTOR BY OPENING A MANUAL DISCONNECT SWITCH IN THE POWER LINE TO THE MOTOR. LOCK AND TAG THE DISCONNECT SWITCH SO NO ONE WILL CLOSE IT ACCIDENTALLY.
3. LOCK THE BELT WHEEL TO PREVENT ROTATION.
4. DO NOT ATTEMPT TO SERVICE ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
5. WHEN SERVICING THE CYLINDER END, DRAIN THE WATER FROM THE CYLINDER JACKETS (REFER TO SECTION 2).

The cylinder outer head should be removed occasionally and the water jackets and passages inspected. If deposits are found, they should be thoroughly cleaned out and the jackets completely flushed out with water.

If the cylinder water jackets are plugged, consideration should be given to raising water velocity to reduce scaling, to the possibility of water treatment, and to the installation of a screen or strainer in the water line to remove debris.

5-3 CLEANING CYLINDER AIR PASSAGES

The most satisfactory way to clean air passages is to take out the valves; then remove any hard carbon from the passage by light scraping. Any dirt or accumulation of foreign matter may then be cleaned with a safety solvent. Oil tends to collect in clearance pockets and they should be periodically cleaned and washed out with a safety solvent.

The valve may be soaked overnight in kerosene followed by a stiff brushing or light scraping to remove deposits. Make sure the valves are thoroughly dry before replacing. See Section 7 "Valves."

CAUTION

NEVER USE KEROSENE OR GASOLINE IN AN AIR CYLINDER TO CLEAN IT OUT. THIS IS A VERY DANGEROUS PRACTICE AND MUST BE ABSOLUTELY PROHIBITED.

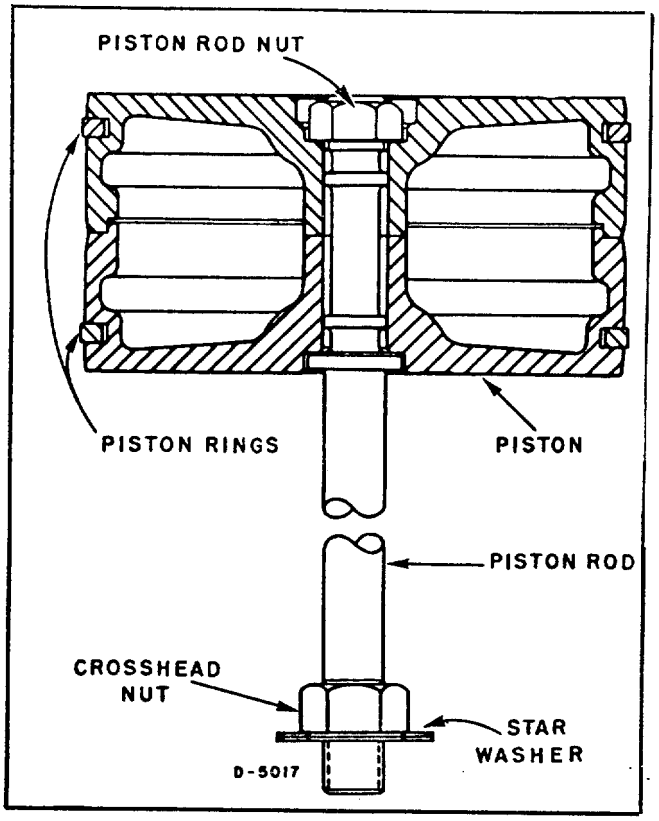


Figure 5-2. Piston, Rings, and Piston Rod

5-4 COLD WEATHER DRAINING

When the compressor is exposed to freezing temperatures while not in operation, drain the water from the cylinder jackets, the aftercooler if used, and the piping to prevent injury from freezing.

5-5 PISTON

The piston is a two piece iron casting with two or more piston rings (see Figure 5-2). It is held on the rod by a close sliding fit between the piston and the piston rod. The temperature expansion of the steel piston rod and the cast iron piston are the same. This assures a tight fit between the piston and rod under all temperature and pressure conditions.

PISTON RINGS

General – The two compression rings used on the piston are of single piece construction with an angle joint. On lubricated compressors the rings are of cast iron material, while non-lubricated (NL) rings require the use of TFE materials. In addition NL pistons use a TFE rider ring.

Lubricated-Rings – Lubricated piston rings ride in a film of oil, they maintain a tight seal between the piston and cylinder wall for long periods of constant service. If, after a relatively long period, a loss of capacity is suspected, it may be advisable to check the piston rings.

To inspect the piston ring, pull the piston out of the cylinder. (Refer to Page 2) Clean the rings and ring grooves and using the rings, measure the side clearance in the groove.

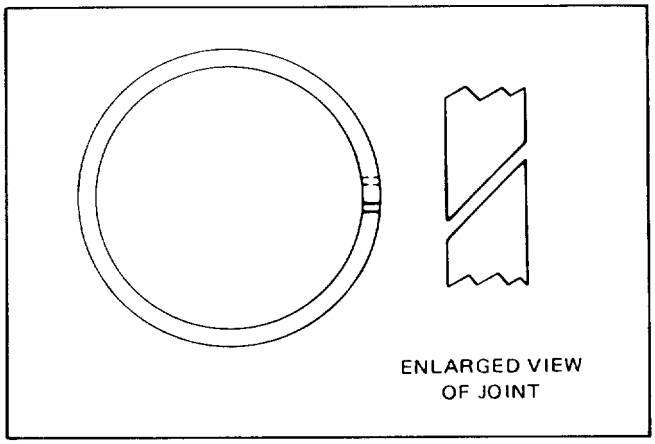


Figure 17. Piston Compression Ring.

Place each ring in the cylinder bore as square as possible with the bore and measure the end gap. With cast iron rings, it is important that the piston ring end gap be at least .002 inch (.051 mm) per inch of cylinder diameter. If the gap or side clearance appears to be excessive, new rings will be required. The dimensions of the cylinder bore and the piston grooves should be checked with a micrometer so that it can be determined whether standard or oversize rings are required. When ordering new rings, supply the factory with the micrometer readings.

For cylinder wear in excess of .003 inch (.076 mm) per inch of cylinder diameter, oversize rings should be used.

When installing new rings, it is important that each ring be checked for diameter and end gap at the smallest part of the cylinder bore. Before being installed in the piston, each ring should be rotated in the piston groove in which it is to be used to make sure that it does not bind at any point. Care must be taken in storing, handling, and installing rings to prevent burring the edges. Any burrs must be carefully removed before the rings are used.

Non-Lubricated-Rings – Non lubricated piston rings are made of TFE material. The compression rings are of single-piece construction with an angle joint. The TFE wearing ring is a single-piece ring with a step joint. This ring is not tight and so is free to turn. The turning results in practically even wear throughout and so no adjustment for ring wear is necessary.

NL PISTON RING WEAR

General – The importance of frequently checking the rings on "NL" cylinders for rate of wear cannot be over-emphasized. There are so many variables affecting the wear rate that it cannot be accurately predicted for any particular unit. Some of these variables are temperatures, pressure, piston weights, cleanliness of air and piping, and surface finish of the bore.

The piston rings should be replaced when worn approximately 1/4 to 1/2 of their original thickness.

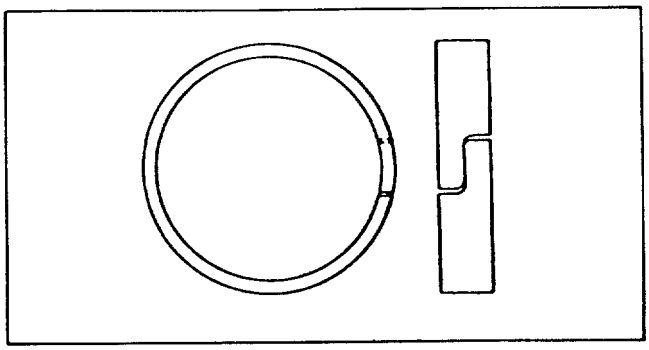


Figure 18. Piston Rider Ring.

Rider Ring Wear – The rider ring carries the weight of the piston on the cylinder. The cylinder bore has a fine honed surface and any foreign material or rusting will score or scuff this surface and cause the ring to wear more rapidly.

Wear Rate – The wear rate is ordinarily considerably higher during the first few hundred hours of operating and, therefore, the rate should be checked carefully as outlined and a wear rate established. Later the frequency of checking will have to be determined from experience.

The wearing ring should be replaced when the clearance between it and the cylinder decreases to .005 inch (.127 mm). See the instructions below for a procedure for establishing wear rate.

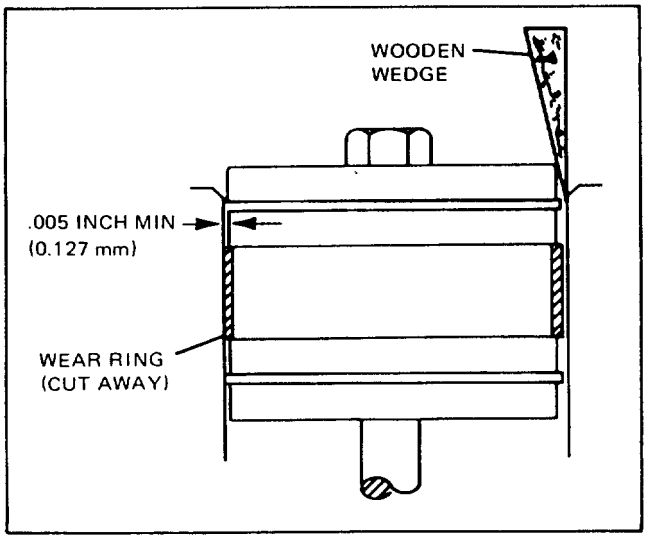


Figure 19. Checking the Rider Ring for Wear.

Establishing a Wear Rate – Remove the outer head (as described on Page 21) and turn the unit so that the piston is near the outer end of the cylinder. Place a wooden wedge between the piston and cylinder bore at the top to force the piston to the bottom of the cylinder. (See Figure 19.) Be careful that the piston ring is not damaged by the wedge. Measure the clearance between the piston and cylinder at the bottom with a feeler gauge. (Be sure that this is measured at the main bore, not the counterbore.)

Take measurements when the unit is about the same temperature; that is, do not measure it one time with the cylinder hot and the next time cold as the difference in temperature will affect the readings.

The clearance should be checked after 50, 200, and 500 hours operation and at least every 500 hours thereafter until an approximate rate of wear is established. This is very important as the wearing ring is the only means of carrying the piston on the cylinder bore and, if the piston touches this bore, immediate scoring will take place.

IMPORTANT

When the clearance between the bottom of the piston and the cylinder decreases to .005 inch (.127 mm) the wearing ring must be replaced.

Compression Ring Wear – The piston compression rings wear much faster than the wearing ring. However, they are initially thicker so do not have to be checked as frequently as the wearing rings. The ring thickness should be measured and recorded upon installation and at the end of the first 500 hours operation and then whenever the rider ring is replaced until a wear rate is established. To check the ring wear, it is necessary to remove the piston and rod from the cylinder.

Compression Ring Inspection – Remove the piston rings from the piston. Place each ring in the cylinder bore and measure the gap between the ends of the ring. Be sure that the ring is square in the bore. This can be done easily by placing the ring just inside the bore so that the edge lines up with the start of the counterbore. If the cylinder has not worn appreciably, the difference between the measured ring gap and the original gap at the time the unit was started divided by 6 will give the approximate reduction in thickness of the ring. The rings can be checked with a micrometer at several points to give the actual thickness. However, checking by placing in the cylinder gives a better indication of the size of ring gap. The larger this gap the more air will leak thru and thus reduce the capacity of the unit. Therefore, it is desirable to replace the rings with new ones after they have worn approximately 1/4 to 1/2 their original thickness.

5-6 DISASSEMBLY OF CYLINDER END

The heads and port plates are bolted together by two studs with acorn nuts. Always remove the outer head and port plate as an assembly. The two dowel pins, which protrude ½" (12.7 mm) on either side of the port plates, are for positioning.

A. Disassembly of Head

1. Stop the compressor, shut off the cooling water, and lock the electrical switch to prevent accidental start-up.

CAUTION

BEFORE DOING ANY INSPECTION OR SERVICING ON THIS COMPRESSOR:

1. **SHUT THE MACHINE DOWN.**
2. **CUT OFF THE ELECTRICAL SUPPLY FROM THE MOTOR BY OPENING A MANUAL DISCONNECT SWITCH IN THE POWER LINE TO THE MOTOR. LOCK AND TAG THE DISCONNECT SWITCH SO NO ONE WILL CLOSE IT ACCIDENTALLY.**
3. **LOCK THE BELT WHEEL TO PREVENT ROTATION.**
4. **DO NOT ATTEMPT TO SERVICE ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.**
5. **WHEN SERVICING THE CYLINDER END, DRAIN THE WATER FROM THE CYLINDER JACKETS (REFER TO SECTION 2).**

2. Shut off the air in the discharge and vent the pressure from within the cylinder.
3. Disconnect the free-air unloader piping and water piping to the port plate and head.
4. Drain the cylinder and head water jackets.
5. Remove piping connected to the cylinder and outer head.
6. Loosen the eight head bolts and back-off 1/4" (6.35 mm).
7. Place identifying marks on the cylinder, port plate, and head so these pieces can be replaced in their original positions.
8. Remove the 1/32" (.795 mm) gasket between the port plate and cylinder. If this is baked on, it should be loosened by driving a broad, flat wedge into the joint. Run a knife blade carefully between the gasket and faces. DO NOT USE A CHISEL AS THIS WILL INJURE THE FACES.

9. Remove the eight bolts and place the head and port plate assembly on a work bench.

CAUTION

Assembly is free with removal of these eight bolts.

B. Removal of Port Plate

1. Remove the two cap nuts which bolt the head and port plate together.
2. Repeat step seven (disassembly of head) to loosen the 1/32" (.795 mm) gasket between the head and port plate.

C. Removal of Piston and Rod from Cylinder

1. Remove the outer head and port plate.
2. Loosen the crosshead locknut and star lock washer.
3. Screw the piston rod out of the crosshead.
4. Remove packing and scraper rings from their boxes. Store in a clean place for re-use.
5. Remove piston and rod assembly from the cylinder.

IMPORTANT

When removing the piston and rod assembly from the cylinder, extreme care should be used to keep the assembly centered within the base of the cylinder and the packing gland.

To remove the piston from the rod, back off the piston nut approximately one turn and, using a brass rod small enough not to injure the threads on the nut, bump the end of this rod lightly. This could be sufficient to break the piston loose so that it can easily be pushed off the rod.

NOTE: When reassembling the piston and rod, tighten piston rod nut securely and prick-punch the threads to prevent the nut from working loose.

D. Removal of Cylinder

1. Remove the four head covers.
2. Take out the eight bolts which hold the cylinder to the frame head and port plate.

CAUTION

Assembly is free with removal of these eight bolts.

3. Loosen gasket joint between the port plate and cylinder.
4. Remove the cylinder barrel.

5-7 PISTON END CLEARANCE

Whenever the piston rod has been removed or even turned in or out of the crosshead, it is necessary to check the piston end clearance and make the necessary adjustment to restore it to the proper amount. If the piston is not removed from the rod, the original clearance can easily be maintained by center punching both the rod and the crosshead and making a suitable tram before removing the rod from the crosshead.

NOTE: Locate the piston rod tram mark such that, during operation, it will not enter the oil scraper rings and destroy the ring to rod seal.

To Adjust Piston End Clearance.

1. Lock the electrical switch to prevent accidental start-up of the unit.
2. Remove pressure from the cylinder and free air unloader piping.
3. Remove the outer head inlet valve cover (cover with small size bolts).
4. Disconnect the free air unloader line.
5. Remove inlet valve from the port plate.
6. Remove the frame head covers.
7. Remove the inlet valves from the frame head port plate.
8. Insert a wax taper or a piece of soft lead wire in the valve hole. Rotate the crankshaft by hand so that, when the piston has moved to the end of its stroke, the taper will flatten to the exact amount of clearance which exist between the piston and the port plate.
9. Adjust the clearance by screwing the piston rod into or out of the crosshead as is necessary to provide one third more clearance at the outer end than at the frame end.

   NOTE: The rod can be turned by using a socket wrench on the nut on the face of the piston. NEVER USE A PIPE WRENCH ON THE PISTON ROD.

10. Tighten the crosshead jam nut and bend star lock washer to prevent rod turning.
11. Replace valves, outer head inlet valve covers, and frame head covers.

5-8 PISTON ROD PACKING

A combination oil scraper and full floating pressure packing is assembled in the frame head distance piece.

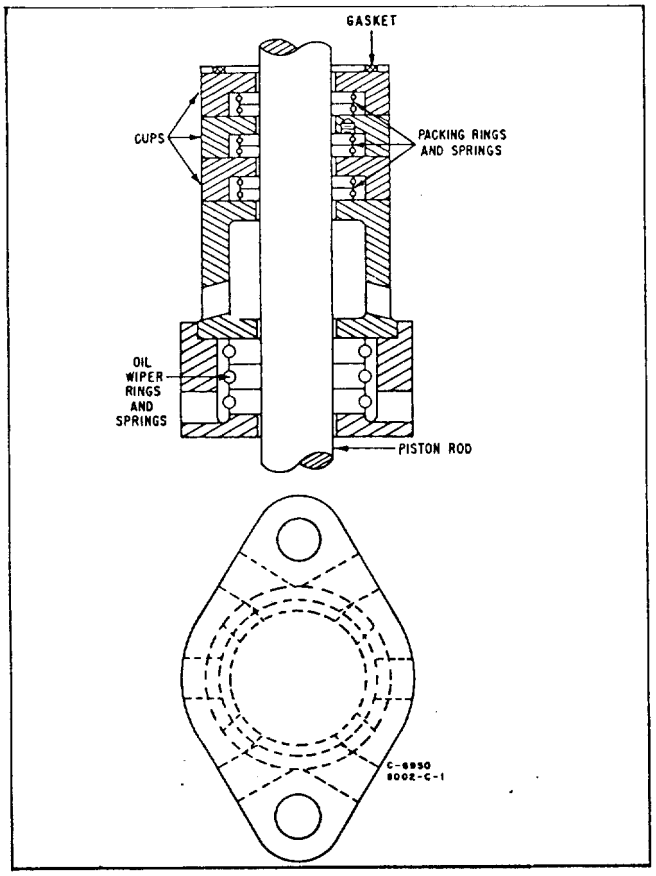


Figure 5-3. Piston Rod Packing and Oil Scraper Rings

A. Packing Rings

The packing rings are the very heart of the packing and should be handled carefully to prevent damaging before and during the time of installation. They are furnished in pairs and are usually cast iron.

Each matched pair is doweled together (as shown in Figure 5-4) so that the segmental joints of the two rings are staggered. Each ring consists of three segments. The end of each segment is marked and each segment must be assembled next to the one with the same marking (such as 1-1, 2-2, 3-3). Generally both rings of a pair are tangential cut and so can seal in either direction, either side may be placed nearest the pressure. When a radial cut ring and a tangential cut ring are used as a pair, the radial cut ring must be on the pressure side.

The packing rings are the only parts subject to wear under normal conditions. It is wise to always carry a spare set of rings in case of emergency. The packing case gasket is also a good spare to have on hand.

B. Packing Ring Materials

Packing rings are made of several materials depending on the service required of them but, in general, cast iron rings

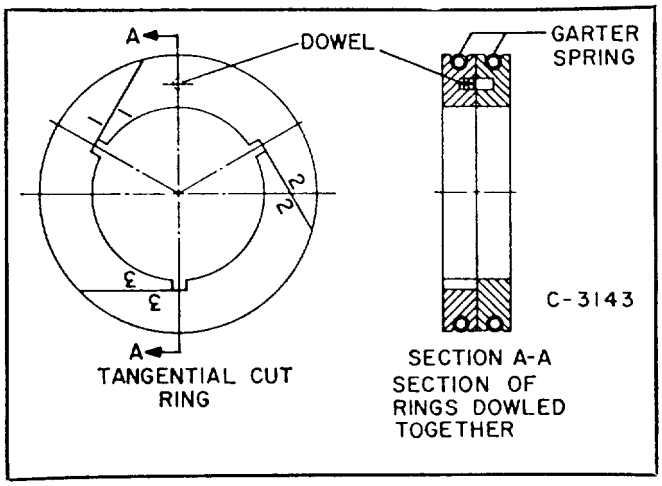


Figure 5-4. One Pair of Tangential Cut Packing Rings

are supplied for moderate pressures and temperatures where sufficient lubrication exists. Other ring materials are used for special conditions of pressure, temperature gas composition, or rod material. See Figure 5-3 for packing illustration.

C. Installation, Operation and Care of Packing

In the event the packing starts to leak after the unit has been in operation for a long period of time, the packing should be removed for cleaning and inspection. Carefully observe the order in which the rings come out of the case. It is necessary to replace the rings in the same order as they were removed to insure that the packing rings maintain their original sealing surface.

When Replacing the Packing Rings or Installation New Packing, Proceed as follows:

1. See that the rod, stuffing box packing case, and rings are thoroughly clean.
2. Install the rings on the rod as shown in Figure 5-3. Before the case is closed, pour oil over the rings.
3. Pull up on the bolts as you would on any gasketed joint. The rings are free to float in the cups irrespective of bolt pressure.
4. When the machine is started, oil the rod generously while rings are wearing in. They may leak slightly while forming a bearing surface, but should never blow.
   NOTE: Should the packing blow, check the gasket and the fit of the rings to the rod.

After installing a new packing or set of packing rings, the compressor should be started with no-load. Two or three times the usual amount of oil should be fed to the packing while it is wearing in, and the oil that works out along the rod and down over the flange should be watched to see that it remains clear. If the oil turns dark as the load and speed is

increased, this indicates premature wear is setting in. This may occur if too great a load is thrown on the rings before they have worn to a running fit.

D. "Breaking In" Packing

When the compressor is started up for the first time or after new packing has been installed, it is important to allow the packing rings to break in gradually. To do this, the machine should be run unloaded for a while and then gradually brought up to full load. In this process, the piston rod will heat up as a result of friction with the packing rings. When it appears that the rod is getting hot, the machine should be shut down. After the rod has cooled, repeat the same operation until the unit can be run under full load without the rod becoming too hot. It is difficult to say how long it takes to break in new packing. The time and effort spent in allowing packing rings to become properly seated before putting the compressor into full operation will help insure a good seal and longer packing ring life.

The procedure on breaking in packing on a steam driven unit is much the same. In addition to running at reduced pressure, the compressor can also be run at a slower speed until the breaking-in period is over.

E. Cleaning And Inspection

Periodically the packing should be removed for cleanin and inspection. The springs should be washed clean of ca. bon and sludge. The clearance between the end of the segments should be observed and if the rings are worn such that the segment ends butt, the rings must be replaced.

IN AN EMERGENCY, the clearance between the ends of the segments can be adjusted by cutting them off. The original opening was 1/8" (3.18 mm) at the step of the tangent joint. After making this emergency adjustment, it may be necessary to shorten the spring slightly to maintain sufficient tension to hold the ring segments to the rod.

In time the packing rings seating surfaces of the case wear as well as the rings. New rings will not seal against worn grooves. This can best be corrected by a complete factory overhaul.

5-9 OIL SCRAPER RINGS

Refer to Figure 5-3 and Figure 5-5.

The oil scraper rings are contained in the same stuffing box as the pressure rings. These prevent crankcase oil from being carried out of the crankcase along the piston rod.

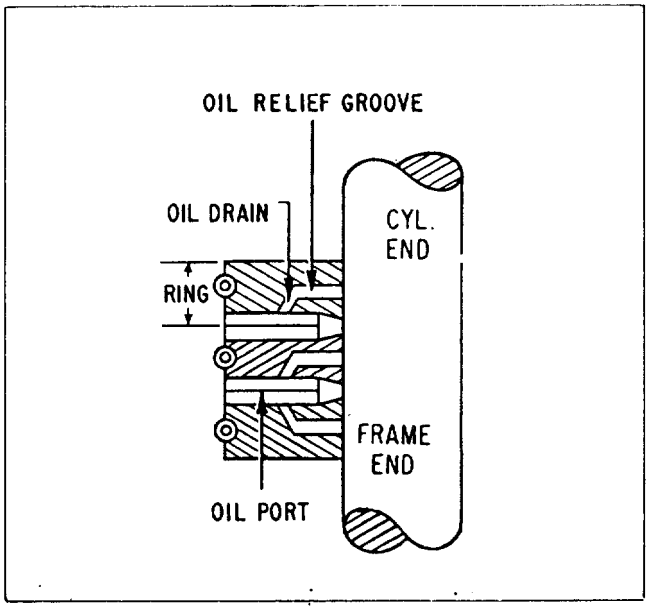


Figure 5-5. Oil Scraper Ring Arrangement

Renewal oil scraper rings are furnished in sets of three; each ring consisting of three segments. These segments are lettered or numbered and markings of adjacent segments MUST match. Before installing new rings, carefully clean the gland and assemble the rings on the rod as illustrated by Figure 5-3 and 5. The total side clearance of the scraper rings should not be more than .005" (.127 mm). Check this clearance with a straight edge before securing the gland in place. If clearance is insufficient for rings to float on the rod, they will not function properly. Too much clearance will cause the rings to act as a pump instead of wiping oil from the rod.

BOLT TORQUE VALUES — ESH/V Portplate Air Ends (Except 6 x 4, 7 x 4)

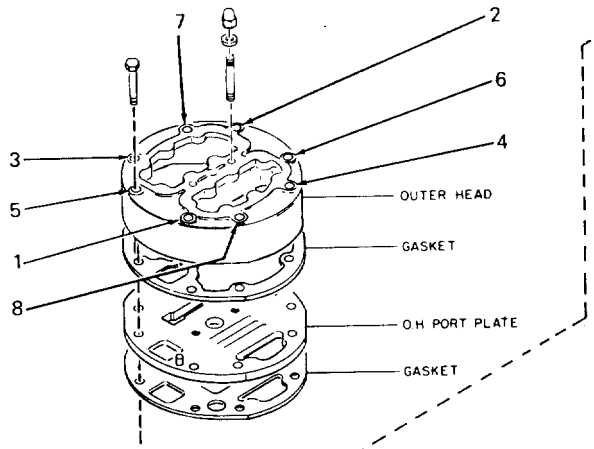
Part Reference	6x5, 7x5, 8x5, 8x7 Size	Torque	9-1/2x5, 9x7, 9-1/2x7 Size	Torque
Frame Head and Distance Piece				
Capscrew—Frame Head	5/8	160	3/4	280
Capscrew-Distance Piece Cover	1/2	45	1/2	45
Capscrew-Stuffing Box	7/16	70	7/16	70
Capscrew-Cover	1/2	85	1/2	85
Outer Head				
Capscrew-Outer Head	5/8	160	3/4	280
Capscrew-Inlet Valve Cover	3/8	35	3/8	35
Capscrew-Discharge Valve Cover	1/2	85	1/2	85
Frame End Portplate				
Stud-Frame End Portplate	1/2	85	1/2	85
Inlet Valves				
Capscrew-Inlet Valve Cover	5/16	17	5/16	17
Discharge Valves				
Capscrew-Discharge Valve	1/4	5	1/4	5

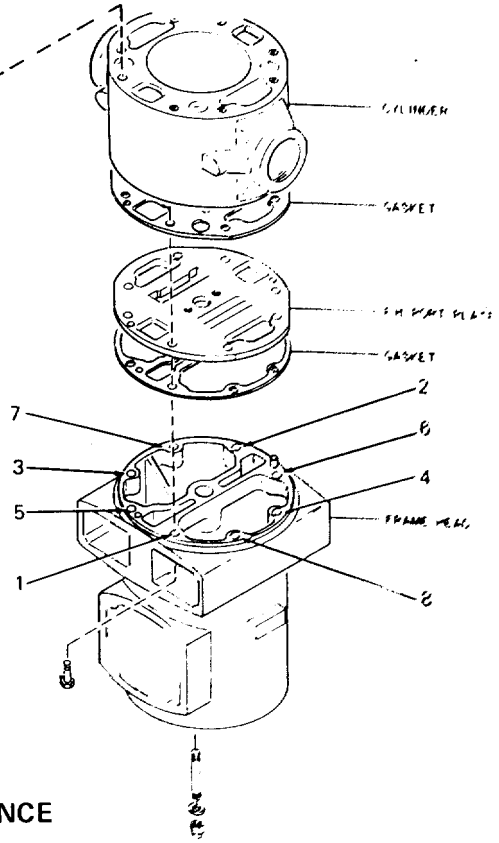
NOTE: All sizes in inches All torques in Ft-Lb.

PORTPLATE TO DISTANCE PIECE AND PORTPLATE TO HEAD ASSEMBLY TYPICAL FOR ESH/V & PHE PORTPLATE CYLINDERS

With the valves and studs assembled to the portplate:

1. Hand tighten the nuts and capscrews.
2. Torque the nuts to specification.
3. In the sequence shown below, torque the capscrews to specification.





TORQUE SEQUENCE

NOTES

SECTION VI - CYLINDER LUBRICATION

LUBRICATION REQUIREMENTS

General – On the ESH/ESV Type Compressors which are designed for lubricated service the compressor cylinder is lubricated by a force-feed lubricator which feeds oil, in the correct quantity, to the proper points. The lubricator is mounted on the pump side main bearing housing where it is driven by an extension of the frame oil pump drive shaft.

The ESH/ESV Type Compressors which are designed for non-lubricated service incorporate components which do not require oil lubrication. Therefore, this section does not apply to those compressors.

Safety Precautions – Most trouble experienced with compressor operation can be traced to poor cylinder lubrication and/or compressor maintenance. Improper maintenance of the compressor can produce abnormally high discharge temperatures resulting in the subsequent deterioration of the cylinder oil. This oil breakdown forms carbon deposits which collect on valves, head, discharge ports, and piping. In time, the buildup of carbon not only restricts air flow and valve operation; but, also presents conditions under which fire or detonation may occur.

CAUTION

CARBON BUILD-UP ON THE VALVES AND IN THE CYLINDER MAY CAUSE LEAKAGE AND EXCESSIVE HEAT. SUCH CONDITIONS CAN RESULT IN AN EXPLOSION.

Another problem which may be encounted is the intake or formation of water vapor in the cylinder. Even the types of oil which are most compatible with liquids cannot be expected to provide adequate lubrication under these circumstances. The continuous carry-over of liquid to the compressor cylinder requires the installation of efficient separators.

CAUTION

IN CASE OF WATER VAPOR, IT SHOULD BE NOTED THAT COMPRESSORS ARE NOT DESIGNED FOR HANDLING SUBSTANTIAL QUANTITIES OF CONDENSATE OR SUSPENDED LIQUID.

Inlet Air Filtering – The intake of dirty air into the compressor can be one of the major causes of lubrication trouble. If dust and dirt are found adhering to the sides of the inlet air passages, it is a good indication that the air inlet requires a filter or that the existing filter is malfunctioning. The intake piping should also be checked for leakage into the line. Long intake lines between the filter and the compressor cylinder can cause pipe scale to form; and therefore, they should be avoided. Instructions regarding air intake piping are given in Section 1 of this manual and Section 3 of your ESH/V Installation Manual (Ingersoll-Rand Form AP-0250).

CYLINDER OIL FEED RATES

Break-In – The initial break-in of a compressor cylinder must be made with an oil meeting the specifications of Ingersoll-Rand Type-3 Oil (refer to the chart on the following page). The break-in period should extend until the cylinder bore has taken on a glazed appearance. During the break-in period the cylinder lubricator should be adjusted to deliver the maximum amount of lubricant to the cylinder. This is necessary in order to flush out wear particles that might otherwise abrade the moving parts of the cylinder and valves. As the cylinder begins to take on a glazed appearance the lubricator feed rate can be gradually reduced until the desired lubrication is achieved.

Normal Operation – After the compressor has been properly broken-in, the lubricator should be adjusted to feed only the quantity required to maintain a thin film of oil on the cylinder walls and valves. This will assure proper lubrication and protection of the cylinders and valves as well as providing a tight piston seal.

It should be understood that it is impractical to specify the exact amount of oil to be fed to the cylinder. The amount of oil necessary to maintain proper lubrication will vary with load, operating conditions, and the quality of the oil being used. The best way to judge whether the cylinder is being properly lubricated is to periodically examine the condition of the valves and cylinder bore. If upon examination, the valves are found to be dry, dripping with oil, or carbonized then the cylinder is improperly lubricated and the feed rate must be corrected. The valves should be coated with a light film of oil which will give them a greasy appearance.

While the results of too little lubrication is understood, it should also be realized that excessive oil tends to carbonize the valves; causing them to leak. If the valves are found to be carbonized it is a good indication that they are receiving too much oil and/or the cylinder air intake is

dirty. The feed should be reduced and the air inlet filter checked. The valves and air passages should be cleaned before the compressor is put back into operation (refer to Page 37 for instructions).

CAUTION

NEVER USE KEROSENE OR GASOLINE IN THE AIR CYLINDER TO CLEAN IT OUT. KEROSENE AND GASOLINE VAPORIZES VERY QUICKLY AND IS EASILY EXPLODED. ITS USE THEREFORE, IS A VERY DANGEROUS PRACTICE AND SHOULD BE ABOLSUTELY PROHIBITED. USE SAFETY SOLVENT.

CYLINDER OIL SELECTION

General – The compressor cylinder should be lubricated with only the best grade of air cylinder oil, which is made special for air lubrication by the reputable oil companies. Selecting the proper type of air cylinder oil for your particular application will depend on cylinder size, discharge temperature, and the intake air quality with respect to wetness.

Actual operating experience indicates that a napthenic-base air cylinder oil does not form hard carbon deposits on valve parts as readily as other base oils and is therefore preferred for ESH/ESV service. This point and the following specifications should be thoroughly discussed with your industrial oil supplier so that he may select the correct lubricant for your operating conditions.

DESCRIPTION OF OIL TYPES

Type 1 – For cylinders less than 26 inches in diameter and discharge air temperatures under 350°F, handling dry gases; that is, gases which do not carry suspended liquid but may contain water vapor in the super-heated state throughout the compression cycle. Rust-and/or oxidation-inhibited oil or straight mineral oil is acceptable.

Type 2 – For applications identifcal to those where "Type 1" oil is normally recommended, and where for commercial reasons, the customer wishes to use internal-combustion engine lubrication oil. Internal combustion engine lubricating oil of the rust-and/or oxidation-inhibited or straight-mineral types is acceptable.

Type 2 X – For cylinders less than 26 inches in diameter and discharge air temperatures under 350°F, handling wet gases; that is, gases which may possibly carry *small quantities* of suspended liquid into the cylinder or occasionally may deposit some condensate in the cylinder. Compounded compressor cylinder oil or detergent engine oil is recommended. This oil must be capable of providing an improved state of boundary lubrication and must resist the washing effect of the condensate.

REQUIREMENTS	TYPE 1	TYPE 2	TYPE 2X	TYPE 3
Cylinder Diameter (in.)	26 Max.	26 Max.	26 Max.	Over 26
Cylinder Discharge Air Temp (°F)	350 Max.	350 Max.	350 Max.	Over 350
Condensaed Water Vapor Present (in Cylinder)	No	No	Yes or Possible	No
Suspended Liquid Present	No	No	Yes or Possible	No
Flash Point (Open Cup) °F	350 Min.	380 Min.	380 Min.	410 Min.
Viscosity @ 100°F (SSU)	420 Max.	780 Max.	780 Max.	Approx. 1100-1500
Viscosity @ 210°F (SSU)	50 Min.	54-65 Min.	60 Min.	105 Min.
Carbon Residue (Conradson)	.25 Max.	*.45 Max.	.45 Max.	.65 Max.
Sulfated Ash		.40 Max.		
Approx. SAE Number	20	20-30	30	60
Neutralization Valve (Color) Total Acid No.		**.15 Max.		
Strong Acid No. ASTM D-974-58T	0.00 Max.	0.00 Max.	0.00 Max.	0.00 Max.

* On Straight Mineral Or Additive Treated Non-Detergent Oils
** Ash Free Basis

Type 3 – For cylinders, 26 inches or more in diameter *or* discharge air in excess of 350°F, handling dry gases; that is, gases which do not carry suspended liquid but may contain water vapor which remains on the super-heated vapor throughout the compression cycle. Rust-and/or oxidation-inhibited oil or straight-mineral oil is acceptable.

SYNTHETIC LUBRICANTS

General – The synthetic lubricant field is quite large and is growing almost daily. It is difficult, if not impossible, to keep abreast of all the latest entries into this field. In general, our experience with synthetic lubricants indicates that they will normally do a commendable lubrication job when the compressor is properly prepared, the lubricant properly selected, and the lubricant supplied in sufficient quantity.

Cylinder Break-In – We have a large background of experience which indicates that it is difficult to properly break in new compressor cylinders, particularly many larger units on synthetic lubricants. Therefore, we recommend that cylinders be broken in (at least 150 hours of running time or until bore surfaces have taken on a glazed appearance) on a mineral oil. The mineral oil selected should have a viscosity at least equal to, or greater than, an SAE-60 oil. After the break-in period, the units may be switched back to a grade of synthetic lubricant per the lubricant manufacturer's recommendation. It is important that the quantity of synthetic lubricant fed to the cylinders be ample to wet the bore surface and that actual bore inspections be carried out within a few hours after starting on synthetic lubrication to determine that this is so.

In those few cases where it is absolutely impossible to break-in the compressor cylinders on a mineral oil due to system contaminations, it should be noted that the danger of cylinder scuffing does exist. Extreme cleanliness of suction piping is absolutely mandatory if scuffing is to be avoided since the film thickness of synthetic lubricant is generally less than with mineral oil.

Specifications – It is strongly recommended that the particular grade of synthetic lubricant selected must meet the following physical requirements:

Viscosity SSU @ 100°F (38°C)	500 maximum
Viscosity SSU @ 210°F (99°C)	57 minimum
Viscosity Index	60 minimum
Flash Point - °F (C°)	500 (260)
Fire Point - °F (C°)	550 (288)
Auto Ignition Point - °F (C°)	770 (410)
Pour Point - °F (C°)	- 30 (-34)

An acceptable synthetic lubricant for both initial break-in and normal operation is ANDEROL® 500. A product of Tenneco Chemicals Incorporated, it is a diester based lubricant that exhibits better temperature limits than mineral oil and subsequently results in minimum valve deposits while providing good lubrication.

It should be noted that although synthetic lubricants work fine in all types of lubricators it may be necessary to change the fluid in liquid sight feed lubricators to one more compatible with the synthetic being used.

ANDEROL® 500 is compatible with the paints and materials in the compressor frame and may be used as the frame and running gear lubricant.

NOTE: It must again be pointed out that many synthetic lubricants should not be used in the compressor cylinder or frame unless the compressor has been properly prepared.

CYLINDER LUBRICATOR

General – The compressor cylinder is lubricated during operation by oil force-fed from a liquid feed type lubricator which is mounted on the front of the compressor frame. The lubricator's drive shaft engages an extension of the frame oil pump drive shaft through a flexible coupling (See Figure 23). The lubricator will, when properly primed and maintained, deliver oil to the cylinder as soon as the compressor starts.

Description – The cylinder lubricator is the individual pump unit, liquid feed type with a standard reservoir capacity of 3-1/2 pints (1.7 liters). While horizontal (ESH) compressor lubricators have one pumping unit, the vertical (ESV) compressor lubricator is equipped with two. A pumping unit is provided with a single spindle (plunger)

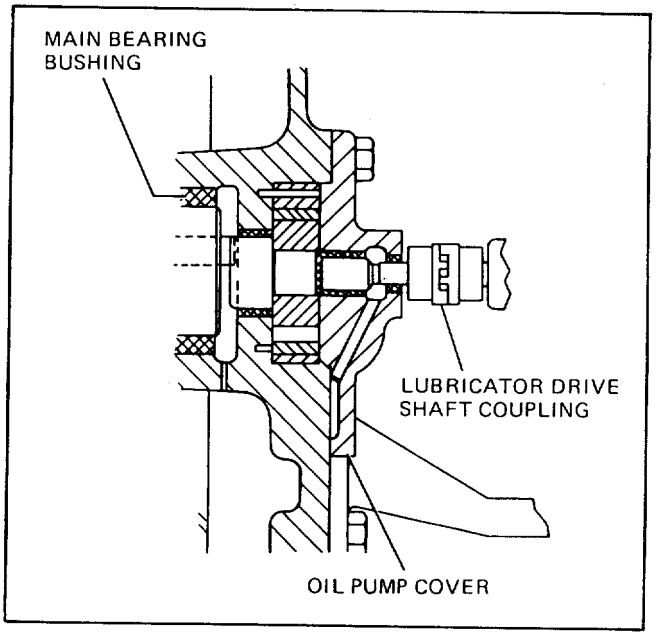


Figure 23. Typical Lubricator Drive.

which pumps the oil from the reservoir, through a pickup tube and vertically up through a sight feed which is filled with a transparent liquid. The oil is forced under system pressure to the compressor cylinder on each stroke of the lubricator spindle.

Adding Oil – To fill the lubricator, remove the filler cap in the top cover and pour in the proper grade of air cylinder lubricating oil. (See oil specifications on page 30.) Fill to the level indicated on the oil level sight glass on the side of the reservoir. Add oil slowly to prevent overflow.

Initial Start – In order for cylinder lubrication to start when the compressor is put into operation it will be necessary to prime the lubricator prior to initial start or whenever it stops feeding due to lack of oil in the reservoir. To prime the lubricator use the following procedure (refer to to Figure 24):

1. Loosen or remove the vent screw located below the glass in the sight feed body.
2. Adjust the feed to maximum delivery and then manually operate the pump spindle until clear oil is delivered. Replace and tighten the vent screw.
3. Each lube line connection should be loosened at the check valve. Manually operate the pump spindle until oil issues from the loosened fitting.
4. Retighten the lube line connection and for several minutes manually pump the unit to assure oil flow into the cylinder.

With the completion of the previous steps, the cylinder lubrication system is primed and ready for service.

IMPORTANT

Hand priming of the lubricator must be done prior to start-up to assure prelubrication of the cylinders. The length of time required for hand priming will be determined by experience.

Adjustment – To adjust the lubricator feed, the adjustment nut (refer to Figure 24) should be turned clockwise to decrease the flow rate and counter-clockwise to increase the flow. Brief, but complete instructions may be found on an instruction attached to the front of the lubricator reservoir.

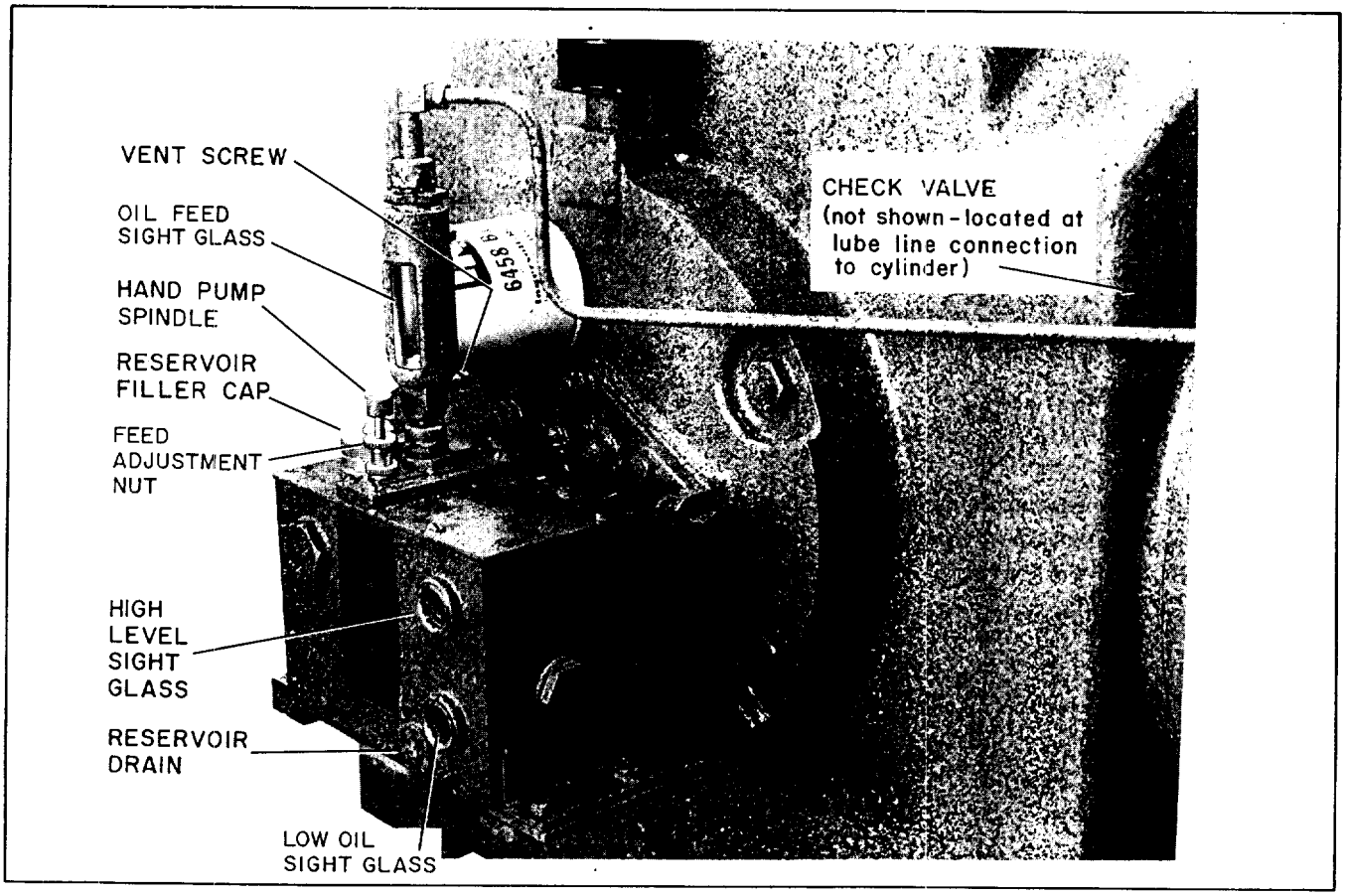


Figure 24. Cylinder Lubricator

Maintenance – The lubricator pumping unit is the ball valve type and it is important that these valves be kept clean and only clean oil be used. The reservoir should be periodically drained and flushed out and at the first indication of lack of uniformity in oil delivery, the pumping unit should be removed and cleaned.

On ESV units (which have two pumping units) care should be taken to remove and clean only one unit at a time. Each plunger is individually fitted to its pump body and therefore it must be returned to the same body from which it was removed.

In general, the following points should be attended to regularly:

1. Use only clean oil and keep the reservoir full.
2. See that all connections are tight and that the oil supply line is properly supported where vibration occurs.
3. Make sure that the lubricator is securely bolted to the main bearing housing and that the flexible coupling is in good condition.

In addition to the above, the check valve should be periodically inspected. The check valve is located at the end of the lubrication line at the cylinder where it is used to prevent air from blowing back into the lubricator. When the check valve leaks it usually gets hot. The leakage can usually be corrected by reseating the valve (see Figure 25).

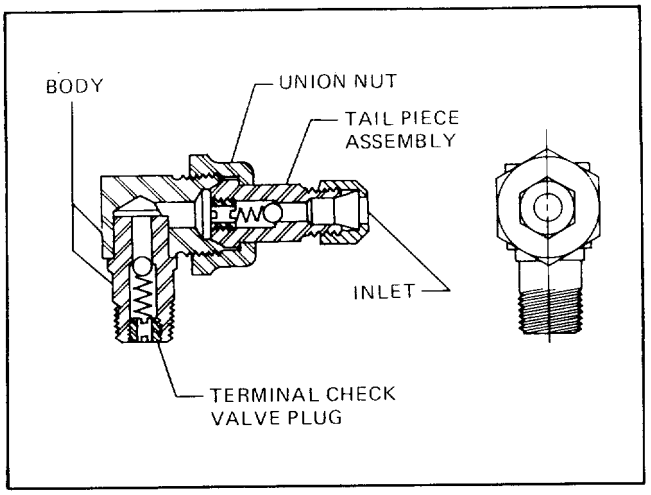


Figure 25. Typical Lubricator Line Check Valves.

Sight-Feed Liquid – The sight-feed should be kept full of liquid. A mixture of half glycerine and half distilled water is suggested; although, all glycerin or all distilled water may be used if desired.

To fill the sight glass, remove the upper coupling nut from the sight-feed and, using a small oil squirt can, fill the glass with the proper mixture. Synthetic or additive type oils will require a more suitable liquid which can be recommended by your local industrial oil supplier.

Should the sight glass become coated with oil, remove the lower coupling nut to disconnect the sight feed unit. The unit can be washed out or the glass can be removed for cleaning.

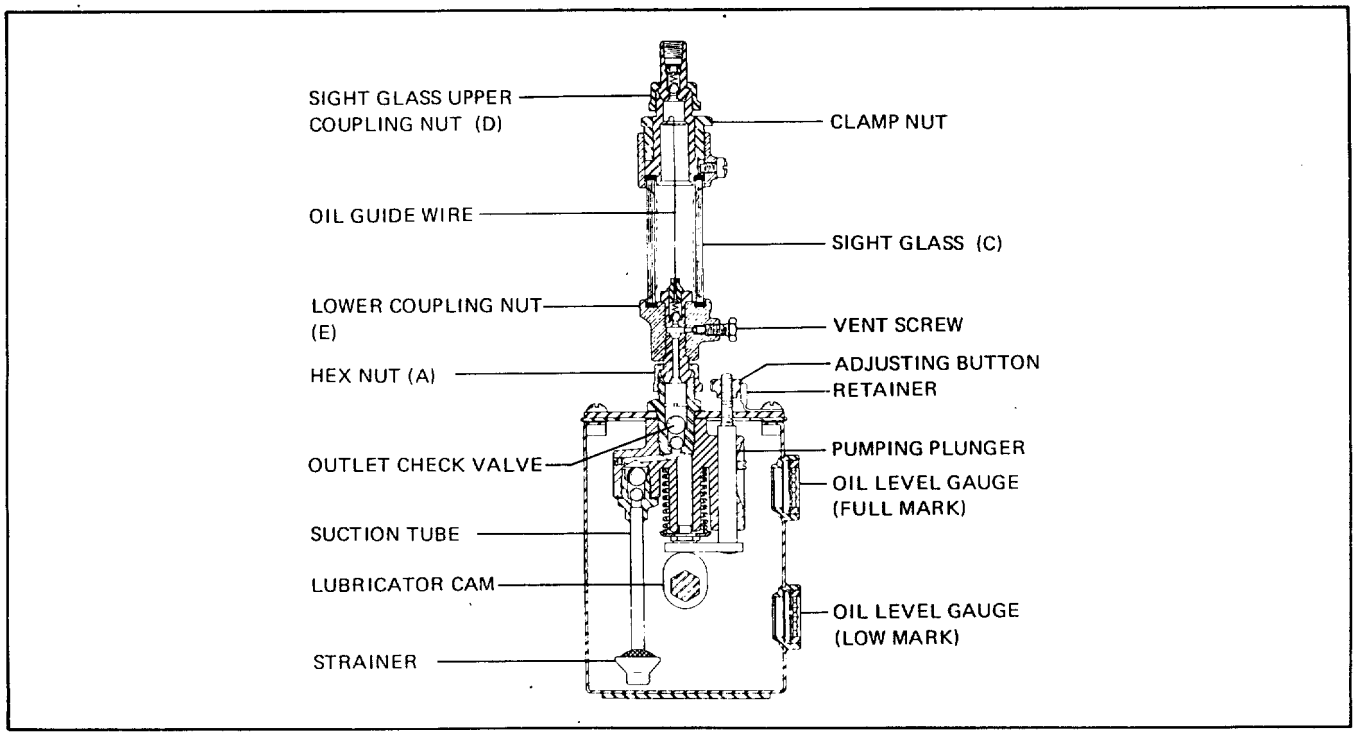


Figure 26. Force Feed Lubricator Assembly of Pumping Unit and Sight Dome.

SECTION 7R

Type "A" Rectangular Channel Valves

7R-1 GENERAL

The Type "A" rectangular channel valve (Fig. 7R-2) is an automatic compressor valve; that is, the valve is opened or closed by difference in pressure across the valve and not by mechanical linkage.

7R-2 DESCRIPTION (Fig. 7R-1)

1. The Type "A" rectangular inlet channel valve consists of an inlet valve seat, seat plate, valve guides, several channels which seat over and close a corresponding number of ports in the seat plate, an arched leaf spring for each channel, and an inlet stop plate which limits the lift of the channels. The Type "A" rectangular discharge channel valve consists of a seat plate, valve guides, channels, springs, and a discharge stop plate.

Figure 7R-1 is an exploded view of the Type "A" rectangular inlet and discharge channel valve and shows valve relationship to the port plate.

2. In the Type "A" rectangular channel valve, each spring has two functions. The first function is to return the channel to the seat plate after the gas has been pushed through the valve. As the secondary function, the spring fits within the back of its corresponding channel and, as the valve opens, a pocket of gas is trapped between the spring and the channel. This cushions the opening of the channel and prevents impact of the channel against the stop plate rib.

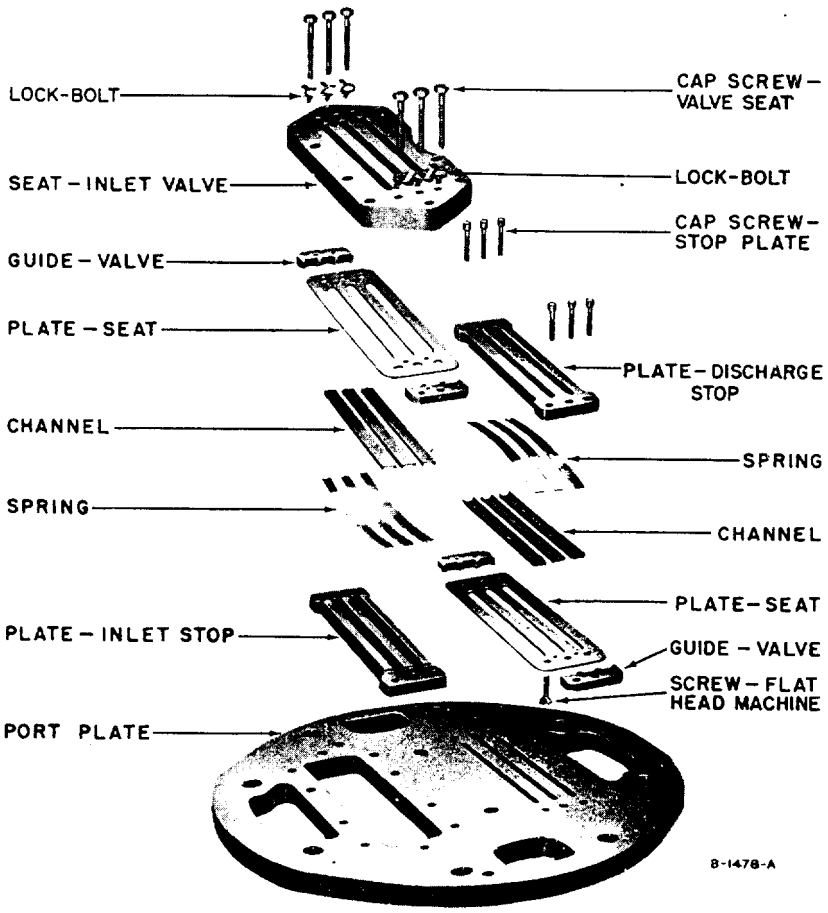


Fig. 7R-1—View showing typical Type "A" rectangular inlet and discharge channel valve.

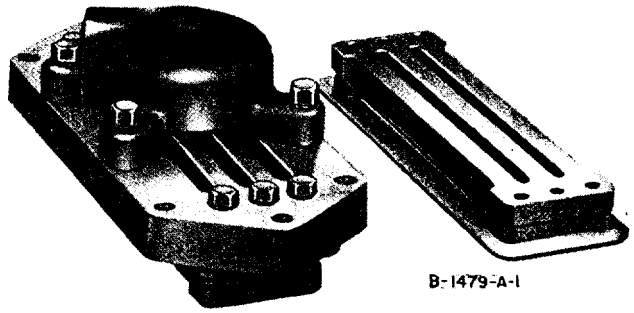


Fig. 7A-2—Type "A" rectangular channel valve Inlet with free-air unloader assembled at left, Discharge at right.

3. Since the cushion pocket is not closed until after the channel is in motion, the cushioning action is delayed in order that only a small differential pressure across the valve is required to open the valve. Thus, the channel lifts quickly and without impact to its full opening along the entire length of the channel. This channel and spring cushioning feature aids in making the valve quiet, highly efficient, and durable for long periods of operation.
4. When the seat plate becomes excessively worn on one side, it may be removed, inverted and reinstalled in the valve. This unique feature permits easy reconditioning of the channel seating surfaces in the valve at a nominal cost. Regrinding of the seat plate is not recommended. When both sides of the seat plate are sufficiently worn to impair proper sealing, a new seat plate must be installed.
5. Regrinding any part of a channel or spring is not recommended.

CAUTION

BEFORE DOING ANY INSPECTION OF SERVICING ON THIS COMPRESSOR:

1. SHUT THE COMPRESSOR DOWN.
2. REMOVE ALL ELECTRICAL POWER TO THE UNIT BY OPENING THE MANUAL DISCONNECT SWITCH WHICH HAS BEEN INSTALLED IN THE POWER LINE TO THE MOTOR.
3. DO NOT ATTEMPT TO SERVICE OR INSPECT ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
4. THE BELT WHEEL MUST BE BLOCKED TO PREVENT ROTATION.

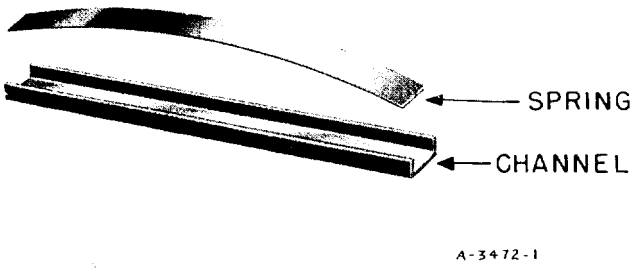


Fig. 7A-3—Channel and spring for Type "A" rectangular channel valve.

7R-3 REMOVAL AND REINSTALLATION OF VALVES

1. Shut down and block the compressor and lock the switch if possible so the unit cannot be started accidently before work is completed.
2. Be sure that all pressure is released from the compressor cylinder passages and piping. One cannot be too careful in this respect.
3. Remove the two outer head valve covers. Be sure appropriate gaskets for reassembly are available.
4. Remove the four frame head valve covers. Be sure appropriate gaskets for reassembly are available.
5. Obtain a marking pencil or tags and place corresponding marks or tags on the inlet valve, free-air unloader, and the discharge valve for reassembly reference.
   a. For Inlet Valve,
   Disconnect the free-air unloader piping and remove the valve seat cap screws. Remove the cage cap screws and lockwashers.
   b. Discharge Valve,
   Remove the stop plate cap screws.
6. Remove the valve being careful not to damage the sealing surface between the seat plate and the port plate.
7. If the discharge valves are carboned in place, break them loose by lightly striking edgewise on the end of the valve. Use a wooden block so as not to damage the valve.
8. During reinstallation of valves on the port plate the inlet valves must be returned to the inlet valve holes and the discharge valves must be returned to the discharge valve holes.
9. Prior to replacing the valves on the port plate, carefully inspect the seat plate and the port plate, around the valve openings,

as these surfaces form a metal to metal air tight joint and must be clean, flat, and free of scratches.

10. Replace each valve on the port plate in the same location from which it was removed. The valve should rest squarely on the port plate.
    a. Inlet Valve,
    Reinstall the cage cap screws and lockwashers and tighten. Reinstall the valve seat cap screws and tighten.
    b. Discharge Valve,
    Install the stop plate cap screws and tighten.
11. Connect the free-air unloader piping to the inlet valve free-air unloader assembly.
12. Replace the four valve covers.
13. Replace the two outer head valve covers.
14. Turn the compressor over by hand at least one complete revolution to make certain there is no interference with moving parts.
15. The compressor may now be started in the regular manner.

7R-4 DISASSEMBLY AND REASSEMBLY OF INLET VALVES

1. Remove the free-air unloader assembly.
2. Lay the valve assembly on a clean, flat surface with the inlet valve seat "up". Mark the inlet stop plate and valve guides for easy reference when reassembling the valve.
3. Remove the valve seat cap screws and bolt lock holding the valve assembly together.
4. Invert the valve assembly and remove the inlet stop plate.
5. Remove each spring and its corresponding channel separately. Clean all valve parts thoroughly. Replace each spring and its corresponding channel in the valve exactly as removed without turning end for end. By following this procedure, the original seating surfaces will be maintained.
6. In the event of an excessively worn or damaged seat plate, remove the valve guides and dowels by lightly tapping a sharp flat edge chisel under the valve guide. Mark the valve guides for correct replacement if they are to be used again. Remove and invert the seat plate or, if necessary, install a new seat plate. Reinstall the valve guides and dowels or, if required, install new valve guides and dowels.
7. If the seat plate is new or inverted, new channels and springs **must** be installed.

CAUTION

BEFORE DOING ANY INSPECTION OF SERVICING ON THIS COMPRESSOR:

1. SHUT THE COMPRESSOR DOWN.
2. REMOVE ALL ELECTRICAL POWER TO THE UNIT BY OPENING THE MANUAL DISCONNECT SWITCH WHICH HAS BEEN INSTALLED IN THE POWER LINE TO THE MOTOR.
3. DO NOT ATTEMPT TO SERVICE OR INSPECT ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
4. THE BELT WHEEL MUST BE BLOCKED TO PREVENT ROTATION.

The cost of new channels and springs is nominal and past experience has proven that this procedure increases valve life. Complete packaged sets of channels and springs for either an inlet or discharge valve are available to facilitate a valve rebuild. Spare parts should be stocked at all times.

8. Reinstall the inlet stop plate and invert the valve assembly.

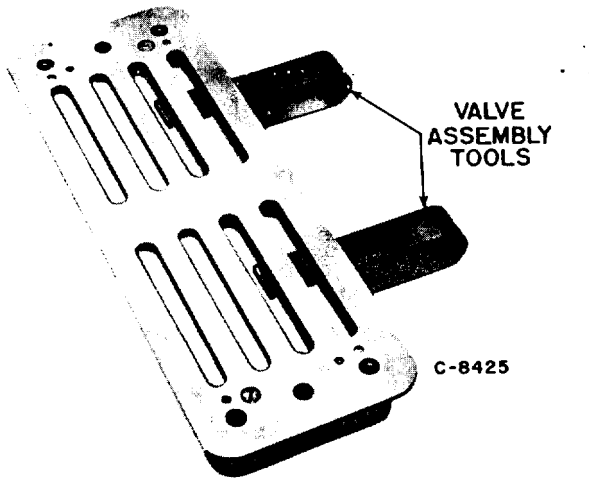


Fig. 7A-4—Use of assembly tool with eight port discharge valve.

9. Install the bolt lock, valve seat cap screws and tighten.
10. Press each channel separately back against the inlet stop plate rib to insure that each channel and spring system moves freely. The eraser end of a pencil or similar soft device is a satisfactory tool for this purpose.

11. When reassembly, care must be taken not to damage the seating surfaces which must always be clean and smooth to prevent leakage.
12. Replace the free-air unloader assembly.

IMPORTANT

It is important that inlet and discharge valve springs not be inadvertantly switched and that upon installation the channels and springs must be free to operate without binding. To do so will result in premature wear or breakage.

7R-5 DISCHARGE AND REASSEMBLY OF DISCHARGE VALVE

1. Lay the valve assembly on a clean, flat surface with the discharge stop plate "down". Mark the discharge stop plate, valve guides, and seat plate for easy reference when reassembling the valve.
2. Remove the flat head machine screws holding the valve assembly together.
3. Remove the seat plate.
4. Remove each spring and its corresponding channel separately. Clean all valve parts thoroughly. Replace each spring and its corresponding channel in the valve exactly as removed without turning end for end. By following this procedure, the original seating surfaces will be maintained.
5. In the event of excessively worn or damaged valve guides, remove the valve guides and dowels by lightly tapping a sharp flat chisel under the valve guide. Reinstall new valve guides and dowels.
6. In the event of an excessively worn or damaged seat plate, invert the seat plate or, if necessary, install a new seat plate.
7. If the seat plate is new or inverted, new channels and springs must be installed. The cost of new channels and springs is nominal and past experience has proven that this procedure increases valve life. Complete packaged sets of channels and springs for either an inlet or discharge valve are available to facilitate a valve rebuild. Spare parts should be stocked at all times.
8. Assembly tool, part number 1W72006, is available to aid in holding channels and springs in place prior to installing the seat plate. After a spring and channel are assembled and installed between the guides on the discharge stopplate, compress the channel and spring and slide the assembly tool into position to hold the channel and spring in the compressed position as shown in Fig. 7R-4. The remaining channels and springs can then be installed in an identical manner. With all channels and springs in place, replace the valve seat plate and remove the assembly tool. The eight port discharge valve will require two assembly tools; all other discharge valves require one assembly tool.
9. With the seat plate in position tighten the flat head machine screws. The flat head machine screws should not be more than "finger" tight to prevent seat plate bow.

CAUTION

BEFORE ANY ATTEMPT IS MADE TO INSTALL THE VALVES IT MUST BE ASSURED THAT EACH VALVE IS PROPERLY ASSEMBLED AND ATTACHED TO ITS RESPECTIVE CRAB OR CAGE. IF THE DISCHARGE VALVE IS MOUNTED UPSIDE DOWN OR IF THE VALVES ARE IMPROPERLY ASSEMBLED, EXTREME OVER PRESSURE CAN OCCUR. SUCH NEGLIGENCE CAN RESULT IN AN EXPLOSION, CAUSING DAMAGE TO THE COMPRESSOR AND PERSONAL INJURY.

CAUTION

INCORRECT PLACEMENT OF THE INLET AND DISCHARGE VALVES IN THE CYLINDER CAN CAUSE AN EXTREMELY HAZARDOUS CONDITION. INSTALLING AN INLET VALVE IN A DISCHARGE VALVE HOLE, OR INSTALLING A DISCHARGE VALVE UPSIDE DOWN, MAY CAUSE AN EXPLOSION. TAKE THE FOLLOWING PRECAUTIONS WHEN INSTALLING A VALVE:

CHANNEL VALVES – TO ENSURE THAT THIS TYPE VALVE IS RIGHT SIDE UP, ALWAYS FASTEN THE VALVE CRAB OR UNLOADER CAGE TO THE VALVE; THEN, MAKE CERTAIN THAT ONLY INLET VALVES ARE INSTALLED IN INLET HOLES AND ONLY DISCHARGE VALVES IN DISCHARGE HOLES.

IN MANY CASES, THE DISCHARGE VALVE HOLES ARE MADE SLIGHTLY SMALLER AT THE MINOR DIAMETER BELOW THE VALVE GASKET SEAT. WHEN AN INLET VALVE IS THEN INSTALLED IN A DISCHARGE HOLE BY MISTAKE, IT WILL NOT FIT DOWN INTO THE HOLE PROPERLY AND THE MECHANIC WILL BE ALERTED TO THE ERROR.

IF IN DOUBT AS TO WHETHER A VALVE IS INLET OR DISCHARGE OR AS TO WHICH CYLINDER HOLES RECEIVE INLET OR DISCHARGE VALVES, CHECK WITH YOUR SUPERVISOR.

10. Press each channel separately back against the discharge stop plate rib to insure that each channel and spring system moves freely. The eraser end of a pencil or similar soft device is a satisfactory tool for this purpose.
11. When handling the valve assembly, care must be taken not to damage the seating surfaces which must always be clean and smooth to prevent leakage.

7R-6 VALVE CLEANLINESS IS IMPORTANT

1. To obtain the maximum efficiency from a compressor cylinder, inlet and discharge valves must be clean and tight. Valves and cylinder gas passages must be inspected periodically and cleaned whenever dirt or carbon deposits are evident. Experience will dictate the time length of the valve maintenance cycle. When the compressor is first started, check the valves at least once a month and if found to be particularly dirty, locate and eliminate the cause.
2. Factors contributing to dirt or carbon found in compressor valves are as follows:

a. Dirty Intake Gas. Remedy: An intake filter or scrubber should be installed and properly maintained. Experience will dictate the time length of the filter or scrubber maintenance cycle.

CAUTION

CARBON BUILD-UP ON THE VALVES AND IN THE CYLINDER MAY CAUSE LEAKAGE AND EXCESSIVE HEAT. SUCH CONDITIONS CAN RESULT IN AN EXPLOSION.

b. Excess Oil. Remedy: Oil in excess of that amount required to properly lubricate the compressor cylinder bore and valves is detrimental to long valve life. The feed rate of the cylinder lubricator may be reduced to eliminate excess lubrication based on the condition of the compressor cylinder gas passages, valves, and cylinder bore: On inspection, the valve should have a greasy appearance but not have droplets of oil showing.

c. Improper Weight or Quality of Oil. Remedy: The compressor cylinder lubricant should be of the proper weight and of the highest quality in order to obtain maximum valve life. Consult your oil company for the correct compressor lubricant.

d. High Temperature of the Gas. Remedy: All compressor valves should be inspected for leakage which results in abnormally high gas temperatures and the formation of carbon deposits on the valves. In addition, the compressor cylinder cooling water system should be inspected for cleanliness and obstacles to determine if the proper quantity of water at the desired temperature is available. Periodic cleaning of the cooling water passages in the compressor cylinder may be required.

3. It will be necessary to disassemble the valve to thoroughly clean it. Brush valve parts carefully with a soft wire brush but use a bristle brush for all valve seating surfaces and the port plate. Care must be taken not to scratch or mark these ground seating surfaces. Rinse the metal valve parts thoroughly in safety solvent and blow away all loose particles with compressed air. Soaking valve parts overnight in safety solvent followed by a stiff brushing or light scraping will aid in the removal of carbon. The valve should be thoroughly dried prior to reinstallation on the port plate.

CAUTION

USE ONLY SAFETY SOLVENT TO CLEAN VALVES AND COMPRESSOR COMPONENTS. USE OF OTHER CHEMICALS CAN BE HAZARDOUS.

7R-8 SPARE PARTS

1. When spare or replacement valve parts are necessary, the parts must be obtained from our factory as the design of the valve parts requires special material and manufacturing methods. The spring and channel widths are held to very close manufacturing tolerances to provide the correct clearance and must not be changed. Channels and springs that are improperly manufactured will not have the cushioning feature which is essential to the quiet operation and durability of the Type "A" rectangular channel valve. Use only genuine Ingersoll-Rand parts.
2. Before ordering spare parts, the compressor serial number and size of the compressor cylinder valves must be determined. Each should always be presented when ordering spare parts. Further determination must then be made as to whether inlet or discharge valve parts are required. Channels have part numbers inscribed on each individual valve channel.

CAUTION

THE USE OF REPAIR PARTS OTHER THAN THOSE INCLUDED WITHIN THE INGERSOLL-RAND COMPANY APPROVED PARTS LIST MAY CREATE HAZARDOUS CONDITIONS OVER WHICH THE INGERSOLL-RAND COMPANY HAS NO CONTROL. SUCH HAZARDOUS CONDITIONS CAN LEAD TO ACCIDENTS THAT MAY BE LIFE-THREATENING, CAUSE SUBSTANTIAL BODILY INJURY, OR RESULT IN DAMAGE TO THE EQUIPMENT. THEREFORE, INGERSOLL-RAND COMPANY CAN BEAR NO RESPONSIBILITY FOR EQUIPMENT IN WHICH NONAPPROVED REPAIR PARTS ARE INSTALLED. USE OF REPAIR PARTS NOT APPROVED BY THE INGERSOLL-RAND COMPANY WILL VOID ALL OUTSTANDING EQUIPMENT WARRANTIES.

3. Spare parts in stock must be carefully handled to prevent mixup of similar parts for different valves. Compressor valves are designed for various services and pressure conditions. Many of the valve parts are similar in appearance but in actuality have many latent differences. Accidental use of incorrect valve parts may result in reduced compressor performance and short valve life. It therefore is advisable to maintain an easily recognizable and practical valve spare parts control system.

SECTION 7RN
TYPE "A" NL RECTANGULAR CHANNEL VALVES

7RN-1 GENERAL

The Type "A" NL rectangular channel valve (Fig. 7RN-1) is an automatic compressor valve; that is, the valve is opened or closed by difference in pressure across the valve and not by mechanical linkage. NL Channel Valves are designed to operate for long periods without oil or other lubricant by eliminating all moving metal to metal surfaces.

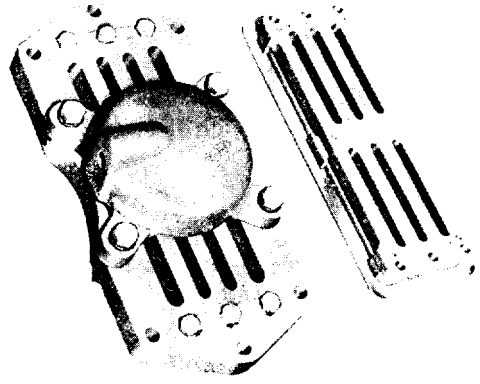


Fig. 7RN-1—Type "A" NL Rectangular Channel Valve Inlet With Free Air Unloader Assembled at Left, Discharge at Right.

7RN-2 DESCRIPTION

1. The Type "A" NL rectangular inlet channel valve consists of an inlet valve seat, seat plate, valve guide holders, guides, valve channels which seat over and close a corresponding number of ports in the seat plate, wear strips, an arched leaf spring for each channel, and an inlet stop plate which limits the lift of the channels. The Type "A" NL rectangular discharge channel valve consists of a seat plate, valve guide holders, guides, channels, wear strips, springs, and a discharge stop plate. Figure 7RN-2 is an exploded view of the Type "A" NL rectangular inlet and discharge channel valve and shows valve relationship to the port plate.

2. In the Type "A" NL rectangular channel valve, each spring has two functions. The first function is to return the channel to the seat plate after the gas has been pushed through the valve. As the secondary function, the spring fits within the back of its

corresponding channel and as the valve opens, a pocket of gas is trapped between the spring and the channel. This cushions the opening of the channel and prevents impact of the channel against the stop plate rib.

3. Since the cushion pocket is not closed until after the channel is in motion, the cushioning action is delayed in order that only a small differential pressure across the valve is required to open the valve. Thus, the channel lifts quickly and without impact to its full opening along the entire length of the channel. This channel and spring cushioning feature aids in making the valve quiet, highly efficient, and durable for long periods of operation.

4. When the seat plate becomes excessively worn on the one side, it may be removed, inverted, and reinstalled in the valve. This unique feature permits easy reconditioning of the channel seating surfaces in the valve at a nominal cost. Regrinding of the seat plate is not recommended. When both sides of the seat plate are sufficiently worn to impair proper sealing, a new seat plate **must** be installed.

5. Regrinding any part of a channel or spring **is not** recommended.

6. Valve guide holders are held on the inlet valve seat and discharge stop plate by Phillips button head screws. TFE material is used to manufacture valve guides and wear strips in the Type "A" NL rectangular channel valve. The wear strip fits inside the back of the channel between the channel and spring. (Fig. 7RN-3) Seat and stop plate are Parkerized to resist corrosion.

7RN-3 REMOVAL AND REINSTALLATION OF VALVES

1. Shut down and block the compressor, and lock the switch if possible, so the unit cannot be started accidentally before work is completed.

2. Be sure that all pressure is released from the compressor cylinder passages and piping. One cannot be too careful in this respect.

3. Remove the two outer head valve covers, following the instructions in Section 5. Be sure appropriate gaskets for reassembly are available.

CAUTION

BEFORE DOING ANY INSPECTION OR SERVICING ON THIS COMPRESSOR:

1. SHUT THE MACHINE DOWN.
2. CUT OFF THE ELECTRICAL SUPPLY FROM THE MOTOR BY OPENING A MANUAL DISCONNECT SWITCH IN THE POWER LINE TO THE MOTOR. LOCK AND TAG THE DISCONNECT SWITCH SO NO ONE WILL CLOSE IT ACCIDENTALLY.
3. LOCK THE BELT WHEEL TO PREVENT ROTATION.
4. DO NOT ATTEMPT TO SERVICE ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
5. WHEN SERVICING THE CYLINDER END, DRAIN THE WATER FROM THE CYLINDER JACKETS (REFER TO SECTION 2).

4. Remove the frame head valve covers. Be sure appropriate gaskets for reassembly are available.

5. Obtain a marking pencil or tags, and place corresponding marks or tags on the inlet valve, free-air unloader, and discharge valve for assembly reference.

5a. Inlet Valves.
Disconnect the free-air unloader piping and remove the valve seat cap screws. Remove the cage cap screws and lockwashers.

5b. Discharge Valves.
Remove the stop plate cap screws.

6. Remove the valve being careful not to damage the sealing surface between the seat plate and the port plate.

7. During reinstallation of valves on the port plate, inlet valves must be returned to inlet valve holes and discharge valves must be returned to discharge valve holes.

8. Prior to replacing the valves on the port plate, inspect the seat plate and the port plate around the valve openings carefully as these surfaces form a metal to metal air tight joint and must be clean, flat, and free of scratches.

9. Replace each valve on the port plate in the same location from which it was removed. The valve should rest squarely on the port plate.

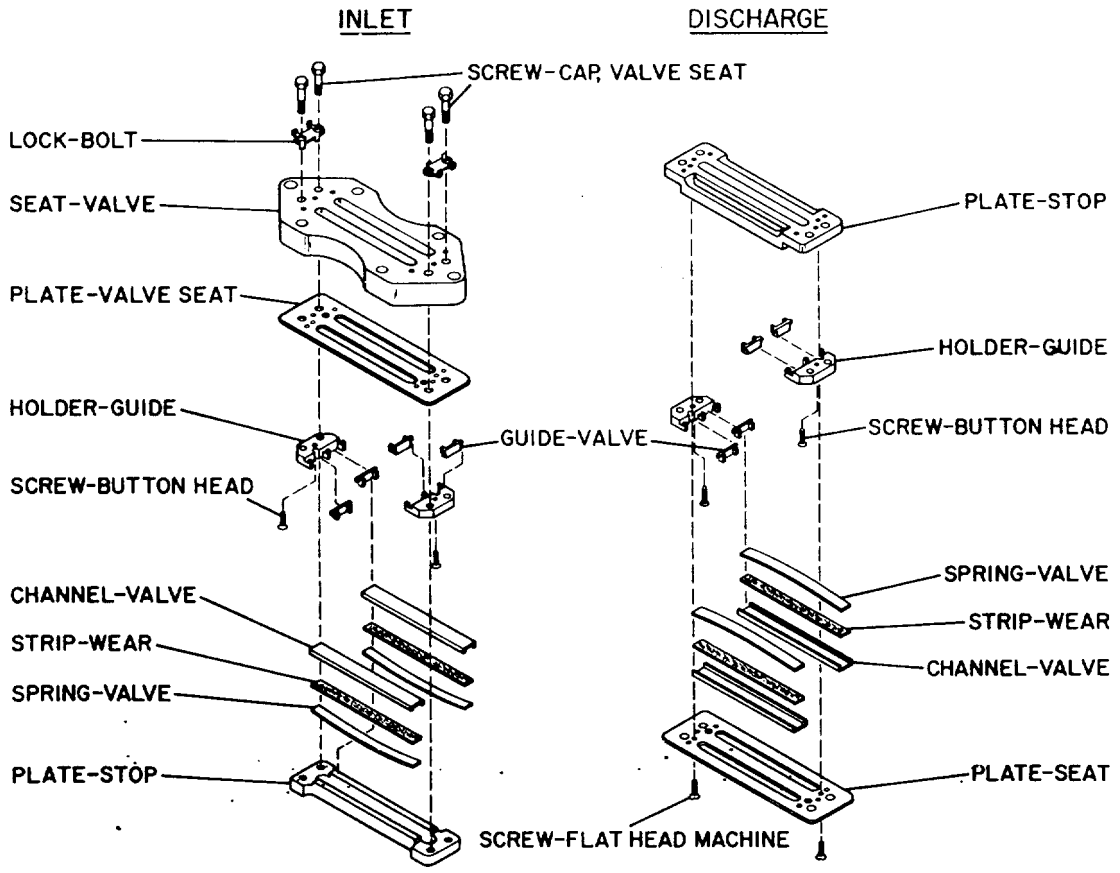


Fig. 7RN-2—Typical Type "A" NL Rectangular Inlet and Discharge Channel Valve.

9a. For an inlet valve.
Reinstall the cage cap screws and lockwashers and tighten. Reinstall the valve seat cap screws and tighten.

9b. Discharge Valve.
Install the stop plate cap screws and tighten.

10. Connect the free-air unloader piping to the inlet valve free-air unloader assembly.

11. Replace the four frame end valve covers.

CAUTION

BEFORE ANY ATTEMPT IS MADE TO INSTALL THE VALVES IT MUST BE ASSURED THAT EACH VALVE IS PROPERLY ASSEMBLED AND ATTACHED TO ITS RESPECTIVE CRAB OR CAGE. IF THE DISCHARGE VALVE IS MOUNTED UP-SIDE DOWN OR IF THE VALVES ARE IMPROPERLY ASSEMBLED, EXTREME OVER PRESSURE CAN OCCUR. SUCH NEGLIGENCE CAN RESULT IN AN EXPLOSION, CAUSING DAMAGE TO THE COMPRESSOR AND PERSONAL INJURY.

12. Replace the two outer head valve covers.

13. Turn the compressor over by hand at least one complete revolution to make certain there is no interference with moving parts.

14. The compressor may now be started in the regular manner.

7N-4 DISASSEMBLY AND REASSEMBLY OF INLET VALVES

1. Remove the free-air unloader assembly.

2. Lay the valve assembly on a clean, flat surface with the inlet valve seat "up". Mark the inlet stop plate and valve guides for easy reference when reassembling the valve.

3. Remove the valve seat cap screws and bolt lock holding the valve assembly together.

4. Invert the valve assembly and remove the inlet stop plate.

5. Remove each spring and its corresponding channel and wear strip separately. Clean all valve parts thoroughly. Replace each spring and its corresponding channel and wear strip in the valve exactly as removed without turning end for end. By following this procedure, the original seating surfaces will be maintained.

6. In the event of an excessively worn or damaged seat plate, remove the valve guide holder by removing the Phillips button head screws. Mark the valve guides for correct replacement if they are to be used again. Remove and invert the seat plate or, if necessary, install a new seat plate. Reinstall the valve guide holders and Phillips button head screws or, if appropriate, install new valve guides and Phillips button head screws.

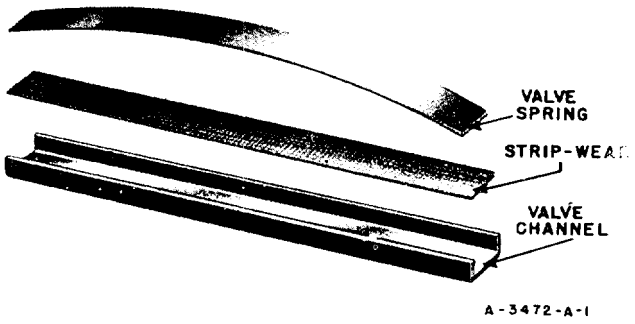


Fig. 7RN-3—Channel, Wear Strip, and Spring for Type "A" NL Rectangular Channel Valve.

The (TFE) valve guides are a slip fit into the guide holders and are securely held in position when the guide holders are assembled on the valve stop plate.

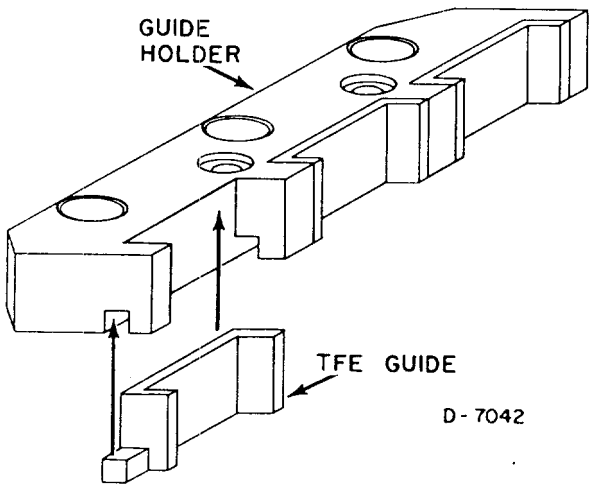


Fig. 7RN-4—Guide Holder and Insert.

7. If the seat plate is new or inverted, new channels, wear strips and spring **must** be installed. The cost of new channels, wear strips, and springs is nominal and past experience has proven that this procedure increases valve life. Complete packaged sets of channels, wear strips, and springs for either an inlet or discharge valve are available to facilitate a valve rebuild. Spare parts should be stocked at all times.

8. Tighten the Phillips button head screws one-half turn from snug tight and with the channels in place, adjust the valve guide holder to eliminate any side or end binding of the channels. Holding the valve guide holder in this position, tighten the Phillips button head screws.

9. Reinstall the inlet stop plate and invert the valve assembly.

10. Install the bolt lock and the valve seat cap screws and tighten.

11. Press each channel separately back against the inlet stop plate rib to insure that each channel, wear strip, and spring system moves freely. The eraser end of a pencil or similar soft device is a satisfactory tool for this purpose.

12. When handling the valve assembly, care must be taken not to damage the seating surfaces which **must** always be clean and smooth to prevent leakage.

13. Replace the free-air unloader assembly.

7RN-5 DISASSEMBLY AND REASSEMBLY OF DISCHARGE VALVES

1. Lay the valve assembly on a clean, flat surface with the discharge stop plate "down". Mark the discharge stop plate, valve guides, and seat plate for easy reference when reassembling the valve.

2. Remove the flat head machine screws holding the valve assembly together.

3. Remove the seat plate.

4. Remove each spring and its corresponding channel and wear strip separately. Clean all valve parts thoroughly. Replace each spring and its corresponding channel and wear strip in the valve exactly as removed without turning end for end. By following this procedure, the original setting surfaces will be maintained.

5. In the event of an excessively worn or damaged seat plate, invert the seat plate or, if necessary, install a new seat plate.

6. In the event of excessively worn or damaged valve guides, remove the valve guides by removing the Phillips button head screws. Insert new valve guides into the guide holders and fasten the guide holders in place with the Phillips button head screws.

7. If the seat plate is new or inverted, new channels, wear strips and springs **must** be installed. The cost of new channels, wear strips, and springs is nominal and past experience has proven that this procedure increases valve life. Complete packaged sets of channels, wear strips, and springs for either an inlet or discharge valve are available to facilitate a valve rebuild. Spare parts should be stocked at all times.

8. With the Phillips button head screws one-half turn from snug tight and with the channels in place, adjust the valve guide holders to eliminate any side or end binding of the channels. Holding the valve guide holders in this position, tighten the Phillips button head screws.

9. The two flat head machine screws should be tightened snugly. The only purpose of these screws is to hold the parts together until the valve is bolted to the port plate.

10. With all channels and springs in place, replace the seat plate. Hold the channels down with one hand and slide the seat plate into position from the end, over the channels, until it matches up with the holes in the guide holders. Install and carefully tighten the flat head screws making certain that the springs have not slipped under the seat plate to prevent it drawing down properly.

CAUTION

BEFORE ANY ATTEMPT IS MADE TO INSTALL THE VALVES IT MUST BE ASSURED THAT EACH VALVE IS PROPERLY ASSEMBLED AND ATTACHED TO ITS RESPECTIVE CRAB OR CAGE. IF THE DISCHARGE VALVE IS MOUNTED UPSIDE DOWN OR IF THE VALVES ARE IMPROPERLY ASSEMBLED, EXTREME OVER PRESSURE CAN OCCUR. SUCH NEGLIGENCE CAN RESULT IN AN EXPLOSION, CAUSING DAMAGE TO THE COMPRESSOR AND PERSONAL INJURY.

CAUTION

INCORRECT PLACEMENT OF THE INLET AND DISCHARGE VALVES IN THE CYLINDER CAN CAUSE AN EXTREMELY HAZARDOUS CONDITION. INSTALLING AN INLET VALVE IN A DISCHARGE VALVE HOLE, OR INSTALLING A DISCHARGE VALVE UPSIDE DOWN, MAY CAUSE AN EXPLOSION. TAKE THE FOLLOWING PRECAUTIONS WHEN INSTALLING A VALVE:

CHANNEL VALVES – TO ENSURE THAT THIS TYPE VALVE IS RIGHT SIDE UP, ALWAYS FASTEN THE VALVE CRAB OR UNLOADER CAGE TO THE VALVE; THEN, MAKE CERTAIN THAT ONLY INLET VALVES ARE INSTALLED IN INLET HOLES AND ONLY DISCHARGE VALVES IN DISCHARGE HOLES.

IN MANY CASES, THE DISCHARGE VALVE HOLES ARE MADE SLIGHTLY SMALLER AT THE MINOR DIAMETER BELOW THE VALVE GASKET SEAT. WHEN AN INLET VALVE IS THEN INSTALLED IN A DISCHARGE HOLE BY MISTAKE, IT WILL NOT FIT DOWN INTO THE HOLE PROPERLY AND THE MECHANIC WILL BE ALERTED TO THE ERROR.

IF IN DOUBT AS TO WHETHER A VALVE IS INLET OR DISCHARGE OR AS TO WHICH CYLINDER HOLES RECEIVE INLET OR DISCHARGE VALVES, CHECK WITH YOUR SUPERVISOR.

11. Press each channel separately back against the discharge stop plate rib to insure that each channel, wear strip, and spring system moves freely. The eraser end of a pencil or similar soft device is a satisfactory tool for this purpose.

12. When handling the valve assembly care must be taken not to damage the seating surfaces which **must** always be clean and smooth to prevent leakage.

7RN-6 VALVE CLEANLINESS IS IMPORTANT

1. To obtain the maximum efficiency from a compressor cylinder, inlet and discharge valves must be clean and tight. Valves and cylinder gas passages must be inspected periodically and cleaned whenever dirt is evident. Experience will dictate the time length of the valve maintenance cycle. When the compressor is first started, check the valves at least once a month and, if found to be particularly dirty, locate and eliminate the cause.

2. To eliminate dirt found in compressor valves, an intake filter or scrubber should be installed and properly maintained. Experience will dictate the time length of the filter or scrubber maintenance cycle.

3. All compressor valves should be inspected for leakage which results in abnormally high gas temperatures. In addition, the compressor cylinder cooling water system should be inspected for cleanliness and obstacles to determine if the proper quantity of water at the desired temperature is available. Periodic cleaning of the cooling water passages in the compressor cylinder may be required.

4. Complete disassembly is necessary to thoroughly clean the valve. Brush metal valve parts carefully with a soft wire brush but use a bristle brush for all valve seating surfaces and the port plate. Care must be taken not to scratch or mark these ground seating surfaces. Rinse metal valve parts thoroughly in safety solvent and blow away all loose particles with compressed air. The valve guides and wear strips may be wiped using a clean, dry cloth. Do not soak valve guides and wear strips in safety solvent. All valve components should be thoroughly dried prior to reassembly and reinstallation on the port plate.

CAUTION

USE ONLY SAFETY SOLVENT TO CLEAN VALVES AND COMPRESSOR COMPONENTS. USE OF OTHER CHEMICALS CAN BE HAZARDOUS.

7RN-7 SPARE PARTS

1. When spare or replacement valve parts are necessary, the parts must be obtained from our factory as the design of the valve parts requires special material and manufacturing methods. The spring and channel widths are held to very close manufacturing tolerances to provide the correct clearance and must not be changed. Channels and springs that are improperly made will not have the cushioning feature which is essential to the quiet operation and durability of the Type "A" NL rectangular channel valve. Use only genuine Ingersoll-Rand parts.

2. Before ordering spare parts, the compressor serial number and size of the compressor cylinder valves must be determined. Each should always be presented when ordering spare parts. Further determination must then be made as to whether inlet or discharge valve parts are required. Channels have part numbers inscribed on each individual valve channel.

CAUTION

BEFORE DOING ANY INSPECTION OF SERVICING ON THIS COMPRESSOR:

1. SHUT THE COMPRESSOR DOWN.
2. REMOVE ALL ELECTRICAL POWER TO THE UNIT BY OPENING THE MANUAL DISCONNECT SWITCH WHICH HAS BEEN INSTALLED IN THE POWER LINE TO THE MOTOR.
3. DO NOT ATTEMPT TO SERVICE OR INSPECT ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
4. THE BELT WHEEL MUST BE BLOCKED TO PREVENT ROTATION.

3. Spare parts in stock must be carefully handled to prevent mixup of similar parts for different valves. Compressor valves are designed for various services and pressure conditions. Many of the valve parts are similar in appearance but in actuality have many latent differences. Accidental use of incorrect valve parts may result in reduced compressor performance and short valve life. It, therefore, is advisable to maintain an easily recognizable and practical valve spare parts control system.

CAUTION

THE USE OF REPAIR PARTS OTHER THAN THOSE INCLUDED WITHIN THE INGERSOLL-RAND COMPANY APPROVED PARTS LIST MAY CREATE HAZARDOUS CONDITIONS OVER WHICH THE INGERSOLL-RAND COMPANY HAS NO CONTROL. SUCH HAZARDOUS CONDITIONS CAN LEAD TO ACCIDENTS THAT MAY BE LIFE-THREATENING, CAUSE SUBSTANTIAL BODILY INJURY, OR RESULT IN DAMAGE TO THE EQUIPMENT. THEREFORE, INGERSOLL-RAND COMPANY CAN BEAR NO RESPONSIBILITY FOR EQUIPMENT IN WHICH NONAPPROVED REPAIR PARTS ARE INSTALLED. USE OF REPAIR PARTS NOT APPROVED BY THE INGERSOLL-RAND COMPANY WILL VOID ALL OUTSTANDING EQUIPMENT WARRANTIES.

Free-Air Unloader

used with

Type "A" Rectangular Channel Valves

7A-9 . . . GENERAL

A free-air unloader is used on each inlet valve as a method of unloading the compressor cylinder either for starting or for capacity control during operation. The free-air unloader is actuated by pressure.

7A-10 . . . DESCRIPTION (Fig. 7A-4)

The free-air unloader is a combination piston plunger device which holds the inlet valve open when pressure is applied to the top of the unloader plunger. The hole in the side of the unloader cage is connected to a device which either admits or exhausts pressure from the top of the unloader plunger.

NOTE:—For the A357 and A465 valves, when the free-air unloader has been actuated, the unloader plunger seats against the inlet valve seat leaving the channels approximately .010" from full lift. In the A243 valve, the unloader plunger does not seat against the inlet valve seat but the channels are pushed to full lift against the inlet valve stop plate ribs by the fingers of the unloader plunger.

With zero pressure on the unloader plunger, the unloader spring holds the unloader plunger away from the channels. When pressure is applied, the unloader plunger travels to the inlet valve seat and sufficient force is available to keep each channel off its seat. A piston-ring and "O" ring on the unloader plunger prevents the escape of pressure past the unloader plunger.

CAUTION

BEFORE DOING ANY INSPECTION OR SERVICING ON THIS COMPRESSOR:

1. SHUT THE MACHINE DOWN.
2. CUT OFF THE ELECTRICAL SUPPLY FROM THE MOTOR BY OPENING A MANUAL DISCONNECT SWITCH IN THE POWER LINE TO THE MOTOR. LOCK AND TAG THE DISCONNECT SWITCH NO NO ONE WILL CLOSE IT ACCIDENTALLY.
3. LOCK THE BELT WHEEL TO PREVENT ROTATION.
4. DO NOT ATTEMPT TO SERVICE ANY COMPRESSOR PARTS WITHOUT FIRST RELIEVING THE ENTIRE SYSTEM OF AIR PRESSURE.
5. WHEN SERVICING THE CYLINDER END, DRAIN THE WATER FROM THE CYLINDER JACKETS (REFER TO SECTION 2).

7A-11 . . . REMOVAL AND REINSTALLATION OF INLET VALVE WITH FREE-AIR UNLOADER

Remove and reinstall an inlet valve with free-air unloader assembly as previously described for an inlet valve, paragraph 7A-3.

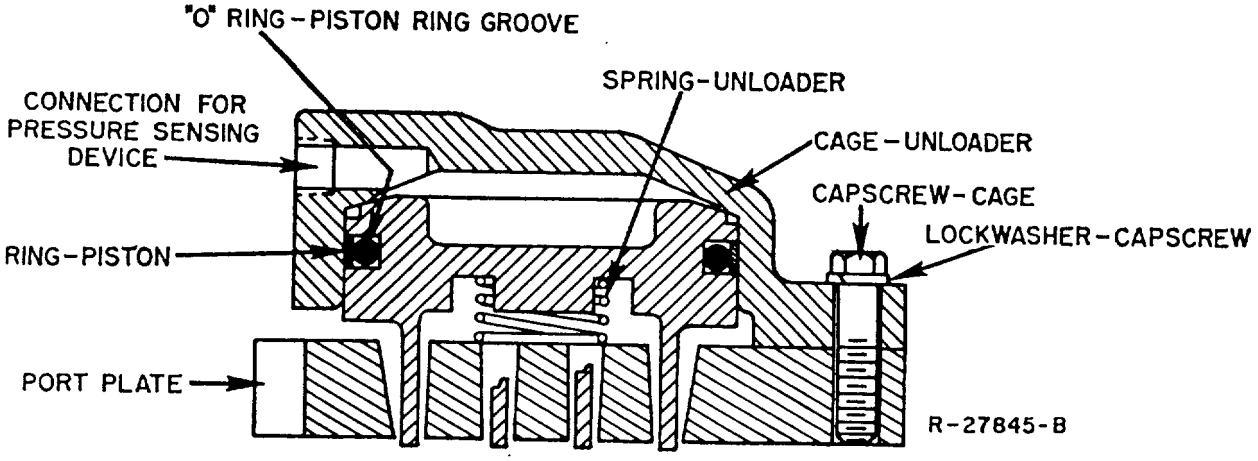


Fig. 7A-4 Type "A" Rectangular Channel Valve Free-Air Unloader.

7A-12 . . . DISASSEMBLY AND ASSEMBLY

1. Remove the four cage cap screws and lockwashers to separate the free-air unloader assembly from the inlet valve assembly.

2. The unloader plunger may then be pulled from the unloader cage.

3. Insert the unloader plunger into the unloader cage.

4. Reassemble free-air unloader assemby to the inlet valve assembly by inserting the four cage cap screws and lockwashers.

5. Make sure the unloader spring is in position and that all unloader plunger fingers work freely in the inlet valve seat ports.

7A-13 . . . FREE-AIR UNLOADER CLEANLINESS IS IMPORTANT

1. A free-air unloader assembly must be clean and tight to operate satisfactorily. The free-air unloader assembly must be inspected during the periodic valve maintenance inspection to determine the condition of the piston-ring and "O" ring. Experience will dictate the time-length of the free-air unloader maintenance cycle.

2. It will be necessary to disassemble the free-air unloader assembly to thoroughly clean all parts. Brush parts carefully with a soft wire brush. Rinse the free-air unloader parts thoroughly in safety solvent and blow away all loose particles with compressed air. Do not soak the piston ring or "O"-ring but wipe clean with a dry cloth. Soaking the free-air unloader parts in kerosene or safety solvent followed by a stiff brushing or light scraping will aid in the removal of foreign particles. All components should be thoroughly dried prior to reassembly.

CAUTION

USE ONLY SAFETY SOLVENT TO CLEAN VALVES AND COMPRESSOR COMPONENTS. USE OF OTHER CHEMICALS CAN BE HAZARDOUS.

SECTION VIII - REGULATION

MANUAL STARTING UNLOADING

General – This type of regulation is standard when the compressor is driven at constant speed and where the demand for air is fairly constant. Since the compressor runs at constant speed it is necessary to alter the output of the compressor cylinder when the demand for air changes. This is accomplished by using Free-Air Unloaders on the inlet valves so that the cylinder will operate either at full capacity or at no capacity. These Free-Air Unloaders are controlled by the Auxiliary Valve, which is mounted on the cylinder (as shown in Figure 35).

Installations – The Auxiliary Valve is used as a controlling valve for operating the free air unloaders. It operates automatically with the variations of receiver pressure. Therefore, it is important that the air for the Auxiliary Valve be supplied from the receiver and not from the discharge pipe of the compressor; as pulsations from the latter, even at some distance from the compressor, may cause the Auxiliary Valve to malfunction.

The Auxiliary Valve should be connected to the receiver with a 1/2 NPT minimum pipe size. The pipe must be free of dirt and scale and should therefore be thoroughly blown out before installation to the Auxiliary Valve. The connecting pipe should have as few turns as possible and should be free of low spots or pockets in which condensed water vapor or oil might collect.

Operation – When the receiver pressure rises to a value for which the Auxiliary Valve has been set, the latter functions to admit live air or gas to the Free-Air Unloaders. Immediately the Free-Air Unloaders push all the inlet valves off their seat, allowing air or gas to pass in and out through the inlet valves while the compressor piston continues to move back and forth. After a continued use of the air or gas reduces the receiver pressure to a predetermined value, the Auxiliary Valve exhausts the unloaders, thereby allowing the inlet valve to function normally and the compressor to operate at full capacity, Thus, the compressor unloads to maintain the receiver pressure within the pressure range for which the Auxiliary Valve has been set.

To unload the compressor for starting when there is pressure in the receiver, screw up on the wing nut at the bottom of the Auxiliary Valve. This action will admit air or gas to the Free-Air Unloaders and thereby vent the compressor cylinder to the intake passage. After the machine attains full speed, unscrew the wing nut and the compressor will operate in the normal manner.

Auxiliary Valve Adjustment – The pressure at which the Auxiliary Valve operates is adjusted by varying the tension

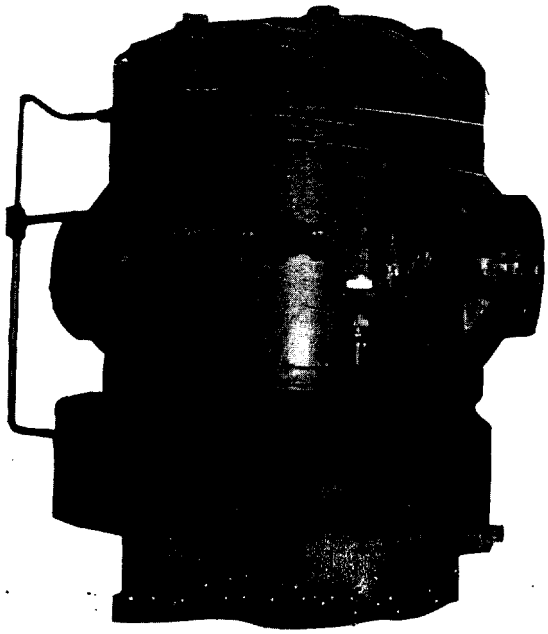


Figure 35. Auxiliary Valve.

of a spring by means of the spring adjuster. Turning the spring adjuster "in" (clockwise) raises the pressure at which the compressor unloads. Turning the spring adjuster "out" (counterclockwise) lowers the pressure. The range of pressure between unloading and reloading points is adjusted by giving the valve (A) more or less travel. Travel can be adjusted by removing or adding shims. Adding shims will decrease the range and removing shims will increase the range. The travel of the valve (A) should not exceed .035 in. (.89 mm) or be less than .012 in. (.30 mm) or the Auxiliary Valve will not function properly. The lower valve seat must be removed for this purpose. Turning the lower valve seat only a fraction of a complete revolution makes an appreciable change in range; consequently this adjustment must be made very carefully. When tested in the shop, the Auxiliary Valve, is usually adjusted for a range of about 10% of the pressure at which the Auxiliary Valve is set. It is not advisable to cut the range below this amount, unless required because of unusual conditions, as the pulsations in the receiver are liable to cause the valve to work with less certainty when the range is very short.

Manual Unloading – A hand unloading nut provides for unloading the compressor at will, as in starting the compressor when there is pressure on the line. Setting up the nut overcomes the resistance of the spring and admits

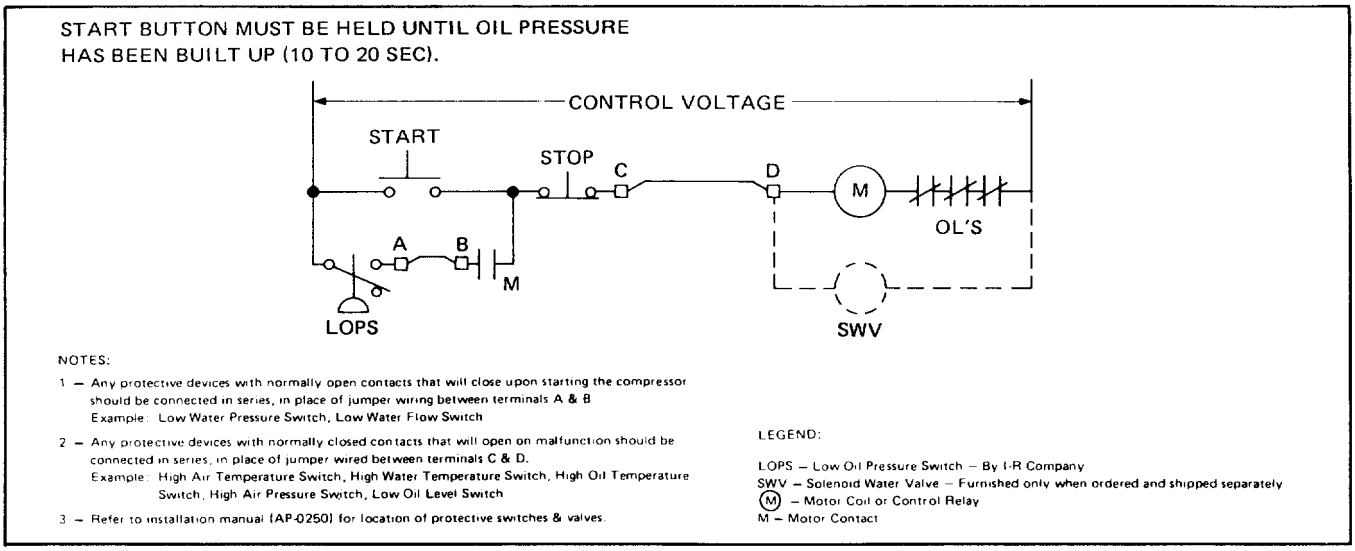


Figure 36. Wiring Diagram for Constant-Speed Control –Manual Starting Unloading.

pressure to the unloaders. When the nut is released the compressor takes up its load and the Auxiliary Valve will then automatically operate at the pressure for which it is set.

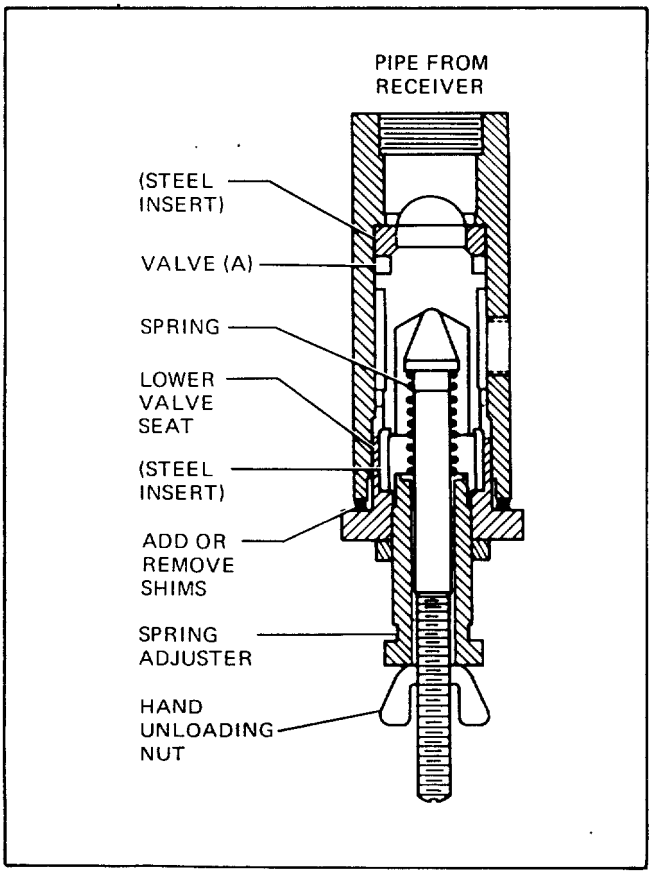


Figure 37. Secitonal View of Type XAA Auxiliary Valve.

Maintenance – The screen, which is above the upper valve seat, prevents any particles of dust or grit from being carried into the valve chamber. Should the Auxiliary Valve fail to work properly at any time, it should be disassembled and cleaned.

If the pipe from the receiver to the Axuiliary Valve is long, it may cause uncertain action and chatter. In this case enlarge the pipe. A small receiver placed in the regulator line close to the Auxiliary Valve will be an additional help. This receiver should be made of three-inch pipe and should be about 14 in. (36 mm) long.

FULL AUTOMATIC STARTING UNLOADING

General – This type of regulation is standard when the compressor is driven at constant speed, where the demand for air is fairly constant and where it is desired for the compressor to be automatically unloaded for starting. Since the compressor runs at constant speed, it is necessary to altar the output of the compressor cylinder to meet the demand for air. This is accomplished by the use of free air unloaders on the inlet valves. The cylinder can then be operated at either full capacity or no capacity. The free air unloaders are operated by a UL-58 diaphragm operated three-way valve, which is controlled by the solenoid operated three-way valve. The UL-58 and solenoid valve are mounted on the cylinder as shown in Figure 38. The piping and wiring diagram for the complete unit is shown in Figure 39.

Installation – The UL-58 three-way valve is supplied with tubing connecting it to the free air unloaders.

A separate pipe of 1/2 in. NPT minimum pipe size should be used by the customer to connect the UL-58 and the

solenoid valve to the receiver. This pipe should have no low spots or pockets in which condensed water or oil might collect and should have as few turns as possible. Pipe should be free from scale and should be blown out before connections are made. A settling chamber with a drain should be installed close the UL-58 to collect water, oil, and dirt.

A normally closed pressure switch is supplied with the compressor. This switch measures the discharge pressure and loads and unloads the compressor to meet the demand. It should be mounted by the customer as close to the receiver as possible. If tubing is used to pipe the switch it should be 5/16 in. (8 mm) diameter or larger.

Operation — When operating, the compressor will run continually after the start button is pushed and will be loaded and unloaded to meet the demand. The stop button must be pushed to stop the compressor. The compressor will be protected against oil pressure failure and will shut down automatically in the event of low oil pressure. The system will function as follows (Refer to Figure 39):

1. When the start button is pressed, the starter coil (M) and the time delay relay coil (TDR) will be energized. The motor will start and contact (M), across the start button, will close locking in the circuit. The time delay relay (TDR) will start timing when the start button is pushed and when its timing period expires the contact (TDR) will cross over. By this time, oil pressure will have built up and oil pressure switch (OPS) will be closed, holding in the circuit.
2. When the contact (TDR) crosses over, the solenoid operated three-way valve (UNL) will become energized, allowing the compressor to load. Pressure switch (PS) will now open and close as the discharge pressure rises and falls. This action will actuate the solenoid valve (UNL), loading and unloading the compressor.
3. The solenoid valve is normally connected through ports (A) to (C) when de-energized. Thus the compressor is unloaded by de-energizing the solenoid, allowing the solenoid valve to supply pressure from port (C) out port (A) to the top of the UL-58 three-way valve. When the solenoid is energized it will exhaust pressure from the top of the UL-58 through ports (A) to (B).
4. The UL-58 three-way valve is a direct acting diaphragm operated valve. It will apply pressure to the free air unloaders when pressure is applied to its diaphragm by the solenoid valve. It will exhaust pressure from the free air unloaders when pressure is exhausted from its diaphragm by the solenoid valve.
5. Application of pressure to the free air unloaders will unload the compressor and exhausting pressure from the free air unloaders will load the compressor.
6. In the event of low oil pressure, switch (OPS) will open, dropping out relay (M) and stopping the compressor.

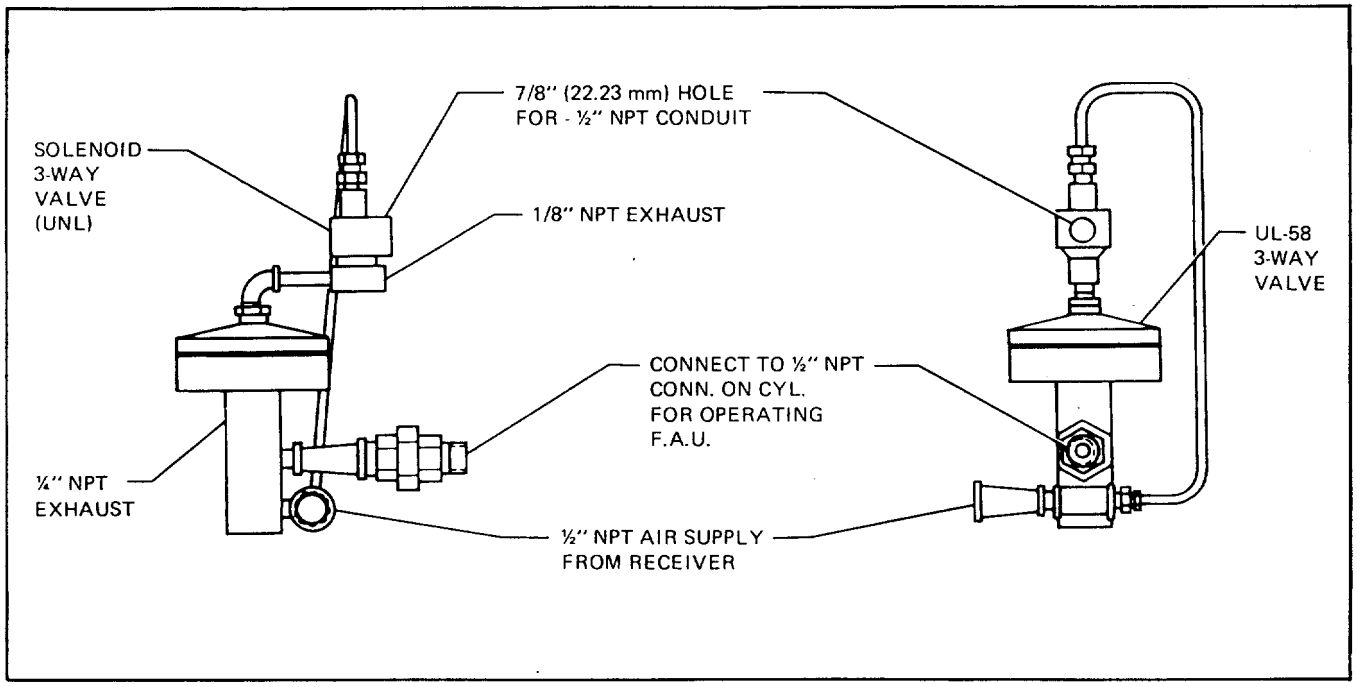
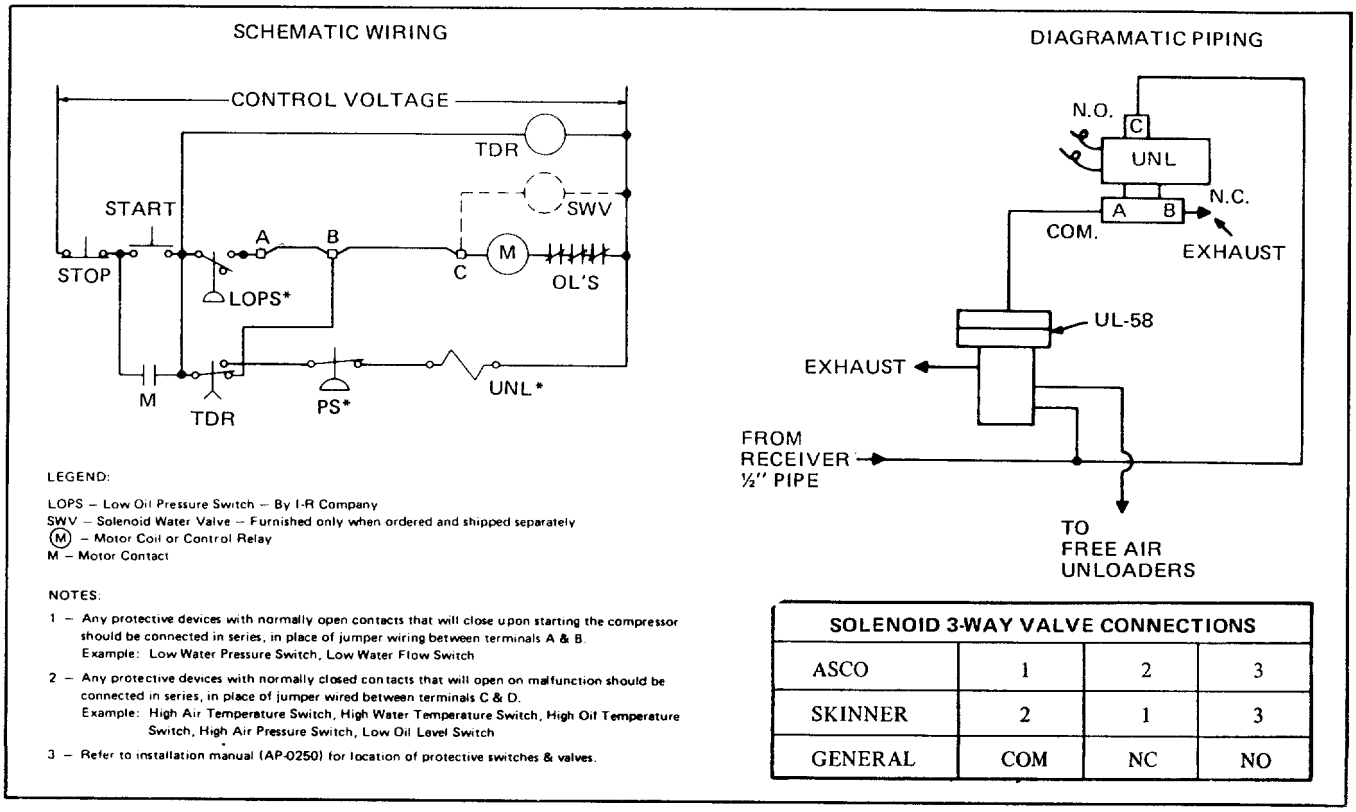


Figure 38. Mounting UL-58 Three-way Valve and Solenoid Valve on Cylinder.



SOLENOID 3-WAY VALVE CONNECTIONS			
ASCO	1	2	3
SKINNER	2	1	3
GENERAL	COM	NC	NO

Figure 39. Piping and wiring diagram for Constant-Speed Regulation-Full-Automatic starting unloading.

Solenoid Valve – The solenoid 3-way air valve is the packless type. There is only one moving part, which consists of a stainless steel core assembly, fitted with a resilient disc at each end. When the solenoid is de-energized, air passes from the compressor reciever to the unloader system. When the solneoid is energized, air from the receiver is shut off, and at the same time the unloader system exhausts to the atmosphere.

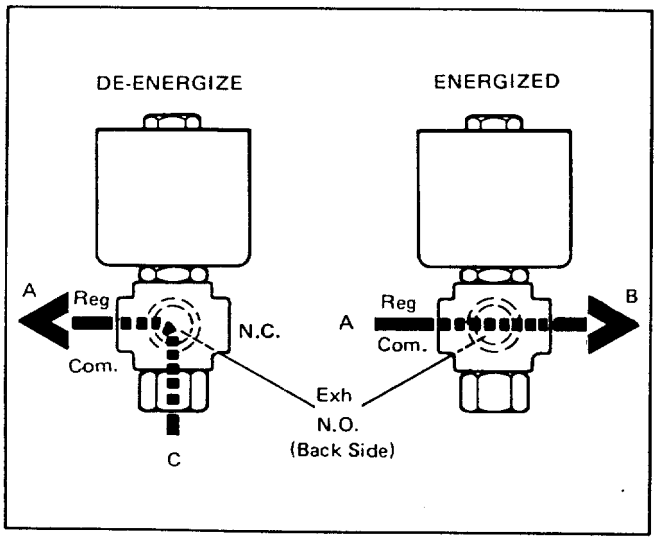


Figure 40. Solenoid Operated Three-way Valve.

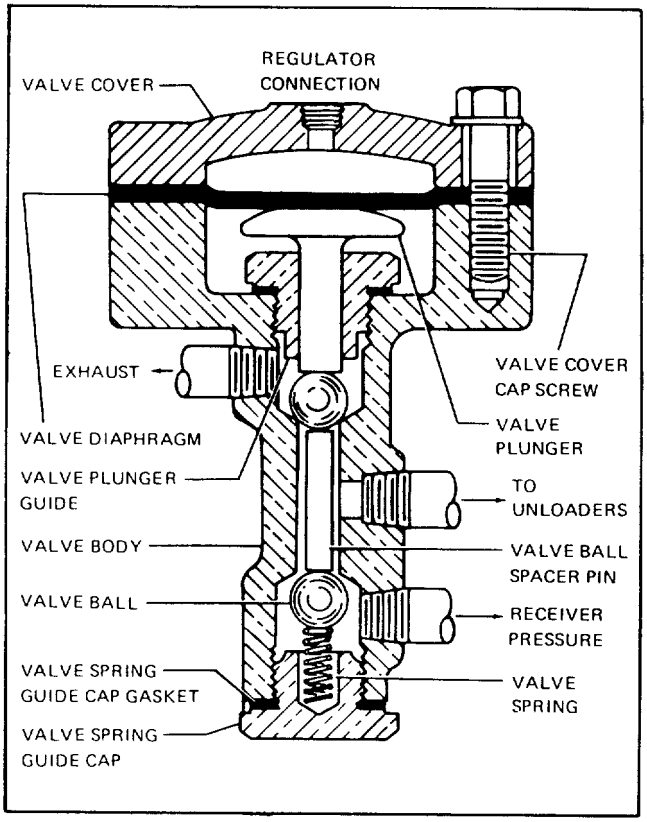


Figure 41. UL-58 Three-way Valve.

The UL-58 Three-way Valve (Figure 41) – The UL-58 three-way valve is a direct acting relay. When air from the solenoid is applied to the diaphragm, the lower ball will be forced off its seat allowing pressure to be applied to the unloading devices. When the solenoid exhausts air from the top of the diaphragm, the spring will return the lower ball to its seat and lift the upper ball. Pressure on the unloading devices will now be exhausted to atmosphere.

Should the UL-58C fail to operate the cause could be a hole in the diaphragm. In this event, the diaphragm must be replaced.

Should excessive air leaks occur around the ball seats, the balls and their seats should be cleaned. If this does not correct the trouble, new parts should be obtained from the factory.

SECTION IX - BELT DRIVE

BELT SHEAVE

General – The standard ESH/ESV is furnished with a single extended crankshaft, and a V-belt sheave. The belt sheave is constructed with a tapered, bushing type hub and is heavy enough to supply the necessary flywheel effect. In addition the sheave is statically balanced with small balance weights located around the inside of the sheave rim (see Figure 42).

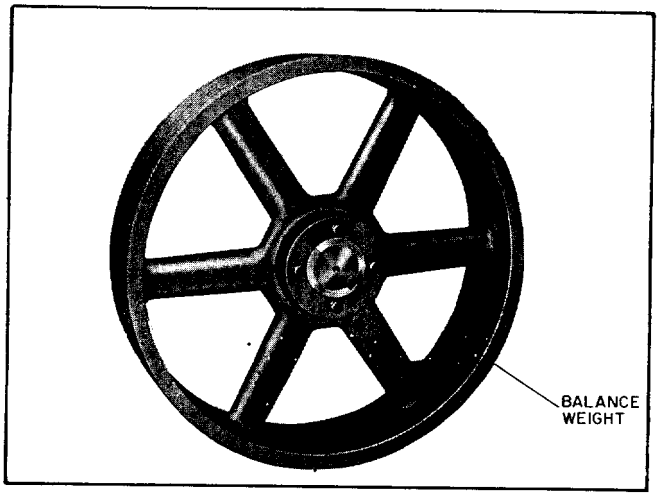


Figure 42. Belt Sheave Balance Weight.

Preinstallation – Prior to installation it should be assured that the bore and tapered cone surface of the bushing and sheave are free of all foreign substances such as paint and dirt. All burrs should be removed from these surfaces.

In addition, the outside of the tapered bushing, the inside diameter of the tapered sheave hub, and the area on the surface of the crankshaft where the sheave will be assembled should be coated with molybdenum sulfide (moly-kote) or white lead and oil. This is necessary if these parts are to be prevented from seizing. If these parts seize, belt wheel removal will be extremely difficult and the possibilities of breaking the tapered bushing as the jack bolts are tightened is greatly increased.

Installation – After the above preinstallation procedure is followed use the following method to install the sheave:

1. With the key in position, slide the sheave on to the crankshaft so that the face of the bushing is flush with the crankshaft, unless otherwise indicated on the foundation plan.
2. Line up the sheave and tighten each cap screw progressively. (See Tightening Instructions.) There should be a gap between the sheave hub and the bushing flange.

Tightening – When mounting a tapered bushing the tightening force on the screws is multiplied many times by the wedging of the tapered surface. This action compresses the bushing for a snug fit on the shaft.

If extreme screw tightening forces are applied in mounting the bushing, bursting pressures will be created in the hub of the mounted sheave or pulley which may cause it to crack. (See Tightening Information Chart on page 48.)

IMPORTANT

Tighten bushing screws evenly and progressively. Never allow the sheave to be drawn in contact with flange of bushing. This gap should be from 1/8" to 1/4" (3.2 to 6.4 mm)

Removal – To remove the V-belt sheave use the following procedure:

1. Loosen and remove cap screws.
2. Insert three cap screws in tapped removal holes and tighten evenly until sheave is loose on shaft.
3. Remove sheave using the bolts as jack bolts to loosen the tapered bushing and slide the wheel off the shaft.

Closely observe the instructions issued by the motor manufacturer for the motor driver to insure that the driver will perform satisfactorily. The standard direction of rotation is counterclockwise when looking at the compressor belt wheel, as indicated by the "arrow" on the oil pump casing or frame of the compressor. Refer to the foundation plan if rotation is not as indicated above.

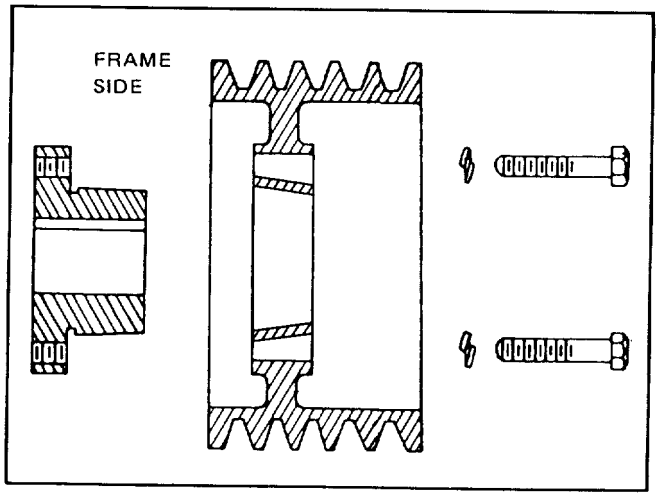


Figure 43. Tapered Bushing Assembly

Tapered Bushing	Size and Thread of Cap Screw	Ft. lbs (N·m) to Apply with Torque Wrench	Proper Wrench Pull with Open End or Socket Wrench	
			Wrench Length inches (mm)	Wrench Pull pounds (kg)
SH-SDS-SD	1/4 –20	6 (8.1)	4 (102)	18 (8.2)
SK	5/16–18	10 (14)	6 (152)	20 (9)
SF	3/8 –16	20 (27)	6 (152)	40 (18.1)
E	1/2 –13	40 (54)	12 (305)	40 (18.1)
F	9/16–12	50 (68)	12 (305)	50 (23)
J	5/8 –11	75 (102)	12 (305)	75 (34)
M	3/4 –10	100 (137)	15 (381)	80 (36)
N	7/8 – 9	125 (170)	15 (381)	100 (46)
P	1 – 8	175 (237)	18 (457)	117 (53)
W	1-1/8 – 7	225 (305)	24 (610)	113 (51)
S	1-1/4 – 7	275 (373)	30 (762)	110 (50)

Screw Tightening Information Chart

MOTOR INSTALLATION

General – Induction motors ordinarily used are comparatively easy to install. An adjustable base or set of slide rails must be provided under the motor to permit adjustment of the position of the motor for proper V-belt tension. The base must be properly levelled and grouted into the foundation in such a position that the motor sheave lines up with the compressor sheave and the shafts are parallel. It is also important that the base be located correctly with respect to distance from the compressor to insure maximum movement of the motor on the base for belt takeup.

NOTE: Motor location with respect to the base is such as to allow sufficient movement to slide the motor forward to put on the belts and to slide the motor away from the compressor to allow belt take-up.

Suitable screws are provided in the base or slide rails for adjustment of motor position, and care should be taken to insure that the grouting of the base does not interfere with the movement of the adjusting screws.

V-BELTS

Installation – When installing a multiple V-belt drive a check should first be made that the motor and compressor sheaves are properly aligned and that the shafts are parallel. MOVE the motor toward the compressor as far as the slide base will permit. Then put the belts on the sheave.

NOTE: Do not pry belts over sheave (pulley) grooves, as this will injure belts and greatly reduce belt life.

Adjustment – After the sheaves are properly installed and aligned the V-belts should be installed and adjusted as follows:

1. Measure the belt span (refer to Figure 44).
2. Using a spring scale, apply force to any one belt. This should be done at midpoint in the belt span.
3. Measure the force required to deflect the belt 1/64 inch (0.40 mm) for every inch (25 mm) or span length.

   Example: If the span length is 32 inches (813 mm) then the deflection should be 1/64 (0.40 mm) multiplied by 32 (813 mm/25mm) or 1/2 inch (13 mm).

4. Refer to the chart in Figure 44. for the correct "Force Required" if the belts are properly tensioned.

Prior to the initial break-in period, the belts should be adjusted to the upper range of valves listed in Figure 44. During this break-in period the belts will stretch somewhat as they seat themselves in the sheave grooves. After the first four hours of "run-in" the belts should be rechecked and if necessary, the tension should be readjusted to that value. This should again be checked after twenty-four hours to make sure they are still within this range.

COMPRESSOR STROKE	STANDARD DRIVES BELT SECTION	STANDARD DEFLECTION	FORCE REQ'D LBS INITIAL	AFTER BREAKIN
5"	3V	1/2 INCH	8-10	5-7
7"	3V	5/8 INCH	8-10	5-7

NOTE: DEFLECTION = 1/64 X BELT SPAN IN INCHES BELT SPAN IS MEASURED FROM POINT OF TANGENCY

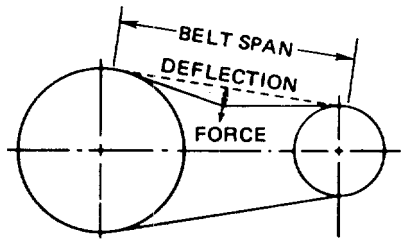


Figure 44. Checking V-Belt Tension By Deflection Force

Maintenance – Protect the V-belts against temperatures above 130°F (54°C). Avoid tight fitting guards or other abstructions which prevent free circulation of air.

Three elements especially hard on V-belts are: grit, oil and sunlight. Belts should be kept clean, free of oil and protected from sunlight as much as possible. Mineral oil is especially destructive, as it will penetrate deep into the belt and cause separation of the cover from the carcass. Oil is the greatest enemy of any rubber product because it causes swelling and rapid disintegration.

Do not use any belt dressing, resins or other adhesive substances of the running surfaces of the belts. Such materials may temporarily improve traction between the belts and the sheave grooves, but the belts surfaces will soon become glazed and the belts will slip more than before the application.

If it is necessary to renew the V-belts, install a complete new set. Otherwise, the new unstretched belts, being shorter than the old one, will have to carry most of the load until their initial stretch has taken place. This excessive uneven load will shorten the life of the new belts.

Keep any of the old belts that appear to be in serviceable condition for future emergency use.

Proper Fit – The V-belt should saddle in the sheave groove so that the top surface rides above the highest point of the sheave. Stresses are then distributed properly throughout the belt section and good contact is assured. A low-riding belt may 'bottom' on the sheave groove, relieving the wedging action on the sides. This causes slipping and burring. If a belt rides to high, it loses its contact area.

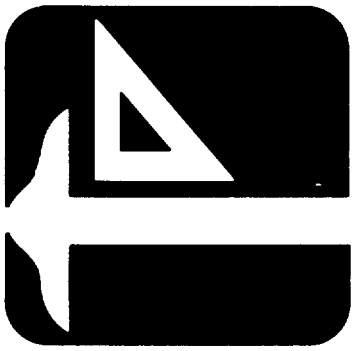
Belt Storage – Regardless of how much length variation results during storage period of V-belts, the belts will even out if properly adjusted during initial run-in. They will remain a matched set for balance of their service life. If machinery is to be idle for any sizable period of time, V-belts should be removed from sheaves and stored in a cool, dry, dark place, preferably uncoiled, and hung over pegs on a wall or rack. If left on equipment. V-belts acquire a permanent "set" which greatly increases possibility of failure.

Belts not in use should be stored in a cool, dark, dry place. If belts become water soaked, or are piled on a damp floor, undue shrinkage may occur.

Belt Guards – Belt guards are recommended and are furnished when specified. For normal operation an expanded metal guard is used to insure adequate ventilation. Proper ventilation will contribute to longer belt life; however, for weatherproof installation it may not always be possible to provide optimum ventilation.

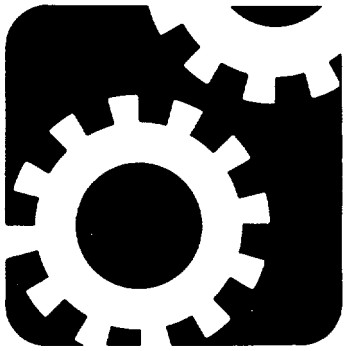
Special Engineering Service

We can help you with your compressed air problems by surveying your needs and recommending the proper compressor and air piping system for maximum efficiency.



Spare Parts

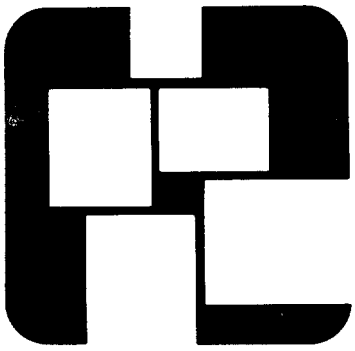
We stock genuine I-R spare parts for your I-R equipment, avoiding possible costly delays or the substitution of inferior parts. As a result, old machines are kept in good-as-new condition.



Fast Efficient Field Service

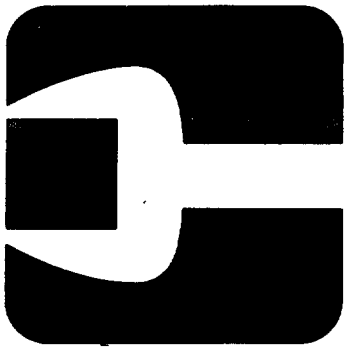
We maintain a staff of trained mechanics and service trucks to provide you with preventive maintenance or meet any emergencies you may have.

A world of experience... at your service!



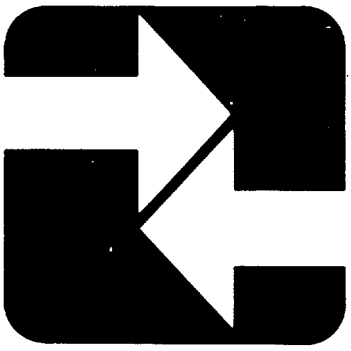
Complete Stock of Equipment

Our stock of complete machines, which can usually take care of any need, is backed up by Ingersoll-Rand prompt factory shipment to assure you on-time delivery.



Complete Repair Service

Trained mechanics will repair or overhaul compressors by factory recommedned methods, using only genuine parts.



Exchange Service Plan

We maintain stocks of compressors that can be substituted for your compressor while repairs are being made. This means no lost production time for you.

INGERSOLL-RAND®

AIR COMPRESSORS