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Instruction & Service Manual

MODEL ES60
ELECTRA-SCREW®
STATIONARY COMPRESSOR

13-9-600

GARDNER-DENVER COMPANY
QUINCY, ILLINOIS

WARRANTY

Subject to the terms and conditions hereinafter set forth, Gardner-Denver Company (the Company) warrants products and parts sold by it, insofar as they are of its own manufacture, against defects of material and workmanship, under use and service in accordance with Company's written instructions, recommendations and ratings for installation, operating, maintenance and service of products, for a period of three months from the date of initial use, provided that such three month period shall in no case extend beyond one year from the date of shipment by Company. THIS WARRANTY IS LIMITED TO THE REPAIR OR REPLACEMENT, AS COMPANY MAY ELECT, OF ANY DEFECTIVE PARTS, REGARDING WHICH, UPON DISCOVERY OF THE DEFECTS, THE PURCHASER HAS GIVEN IMMEDIATE WRITTEN NOTICE. Installation and transportation costs are not included. Company shall have the option of requiring the return to it of the defective material, transportation prepaid, for inspection. Because of varying conditions of installation and operation, all guarantees of performance are subject to variation of 3%. COMPANY DOES NOT WARRANT THE MERCHANTABILITY OF ITS PRODUCTS AND DOES NOT MAKE ANY WARRANTY, EXPRESS OR IMPLIED, OTHER THAN THE WARRANTY CONTAINED HEREIN. Company has not authorized anybody to make any representation or warranty other than the warranty contained herein.

FOREWORD

Gardner-Denver ELECTRA-SCREW® compressors are the result of advanced engineering and skilled manufacturing. Thousands of satisfying, economical working hours are built into each machine.

To be assured of receiving maximum service from this machine, the owner must exercise care in its operation and maintenance. This book is written to give the operator and maintenance department essential information for day-to-day operation and maintenance. Careful adherence to these instructions will result in assured economy.

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COMPRESSOR – The Gardner-Denver Model "ES" ELECTRA-SCREW® compressor is a single stage, positive displacement rotary machine using meshing helical rotors to effect compression. Both rotors are supported between large capacity anti-friction bearings located outside the compression chamber. Single-width cylindrical roller bearings are used at the inlet end of the rotors. Two heavy-duty single row angular contact ball bearings at the discharge end locate each rotor axially and carry all thrust loads.

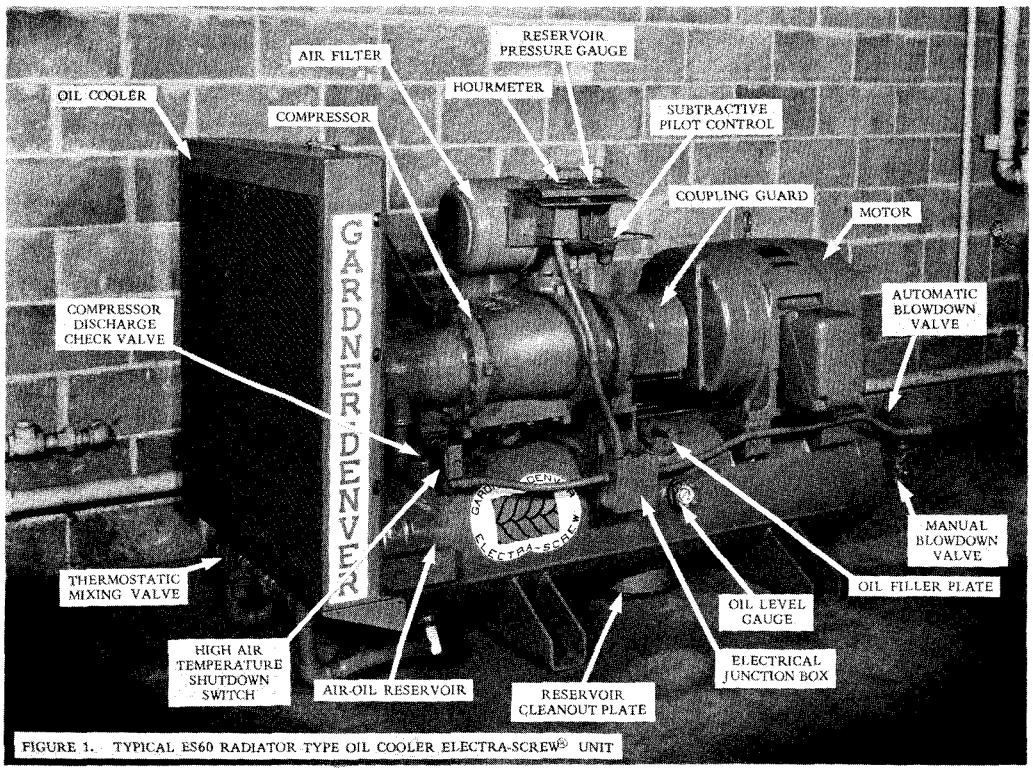

FIGURE 1. TYPICAL ES60 RADIATOR TYPE OIL COOLER ELECTRA-SCREW® UNIT

COMPRESSION PRINCIPLE (Figure 2) – Compression is accomplished by main and secondary rotors synchronously meshing in a one-piece cylinder. The main (driven) rotor has four helical lobes 90° apart. The secondary (idler) rotor has six matching helical grooves 60° apart to allow meshing with main rotor lobes.

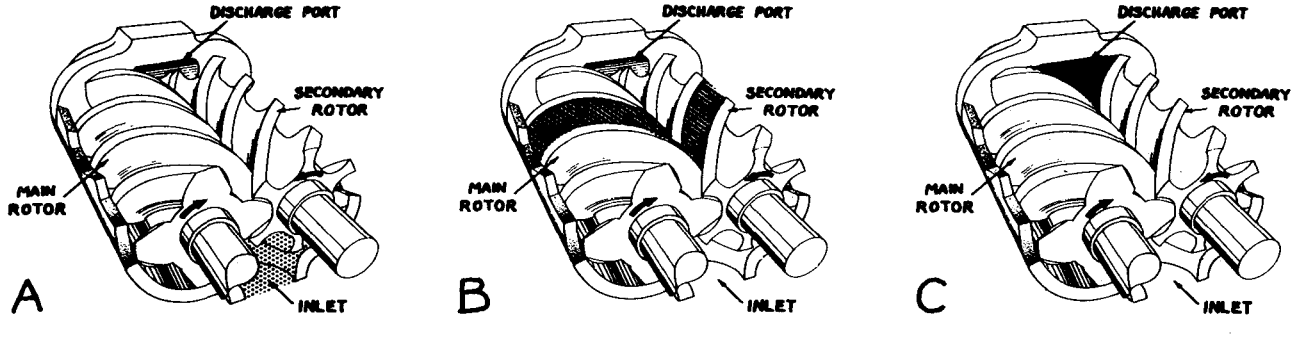

FIGURE 2. – COMPRESSION CYCLE

Air inlet port is located on top of compressor near the drive shaft end. Discharge port is near bottom at opposite end of compressor. (Figure 2 is inverted view to show inlet and discharge ports.) Compression cycle begins as rotors unmesh at the inlet port and air is drawn into cavity between main rotor lobes and secondary rotor grooves (A). When rotors pass inlet port cutoff, air is trapped in the interlobe cavity and flows axially with the meshing rotors (B). As meshing continues, more of the main rotor lobe enters the secondary rotor groove, normal volume is reduced and pressure increases. During the compression cycle, oil is injected into the cylinder to remove the heat of compression and seal internal clearances. Volume reduction and pressure increase continues until the air/oil mixture trapped in the interlobe cavity by the rotors passes the discharge port and is released to the oil reservoir (C).

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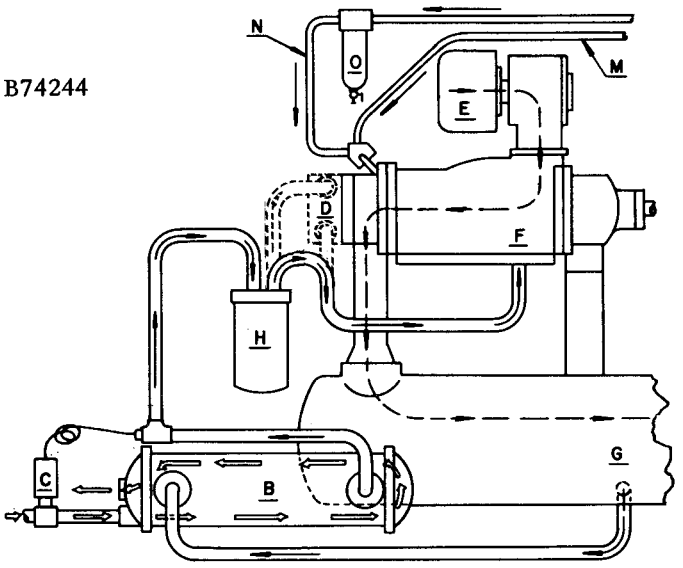


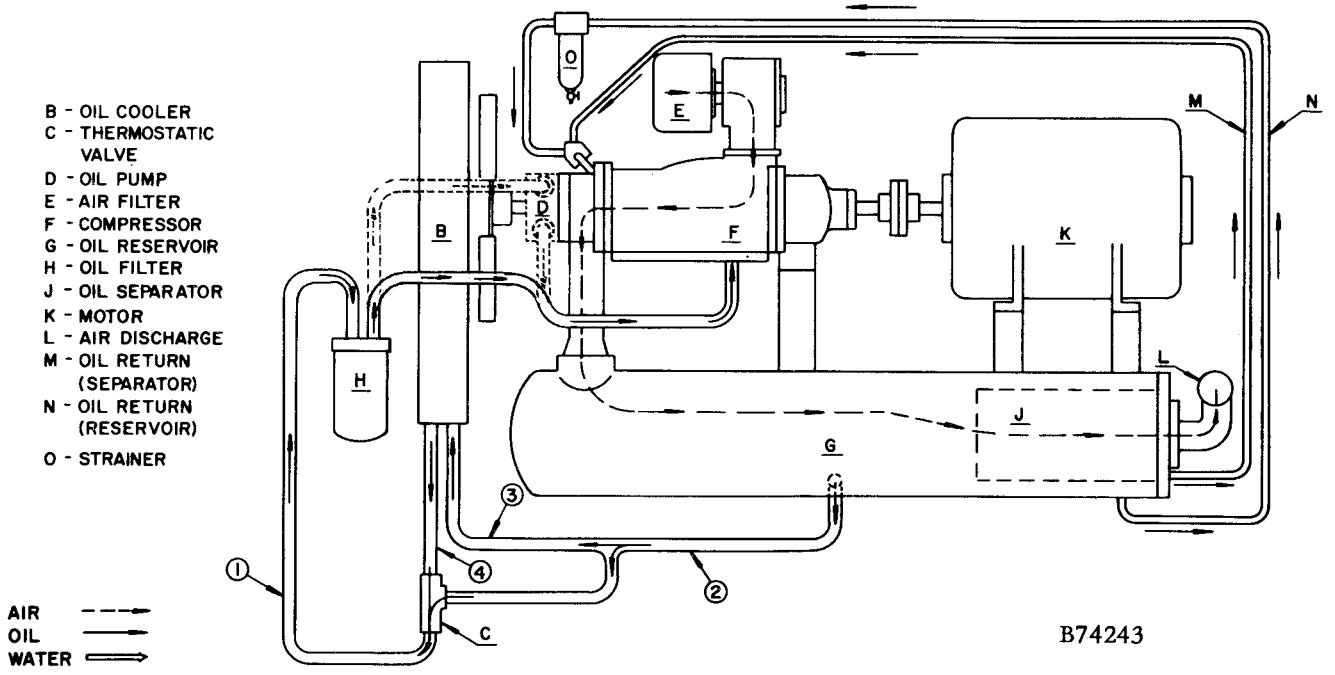
(Water Cooled Oil Cooler)

AIR FLOW (Figure 3) – The compressor air system uses the following components:

Air Filter
Inlet Valve
Compressor
Discharge Check Valve
Oil Reservoir-Separator
Discharge Manifold

Air is admitted through an air filter and passes through the antiblowback inlet unloader valve to the compressor. After compression, the air/oil mixture passes through the compressor discharge check valve into the oil reservoir.

In the oil reservoir more than 99% of the entrained oil is removed by velocity change and impingement and drops back into the reservoir. A multiple element final separator removes the balance of the oil and allows the air to pass through the discharge manifold to a service valve. Separated oil is returned to the system through tubing connecting the separator and the compressor.



(Radiator Type Oil Cooler)

FIGURE 3. – FLOW DIAGRAM – AIR-OIL SYSTEMS
(ES60A & ES60B Oil Pump Models – ES60E & ES60F Pumpless Models)

LUBRICATION, COOLING AND SEALING – On late models (ES60E and ES60F), air pressure in the oil reservoir forces oil through oil cooler, thermostatic mixing valve (mixing valve not used on water cooled oil cooler), and oil filter to supply compressor with lubricating oil. On early models (ES60A and ES60B), a positive displacement internal gear pump supplies compressor with oil.

A portion of the oil is directed through internal passages to all bearings to insure complete lubrication of moving parts. The balance of the oil is injected directly into cylinder to cool and lubricate rotors and seal internal clearances.

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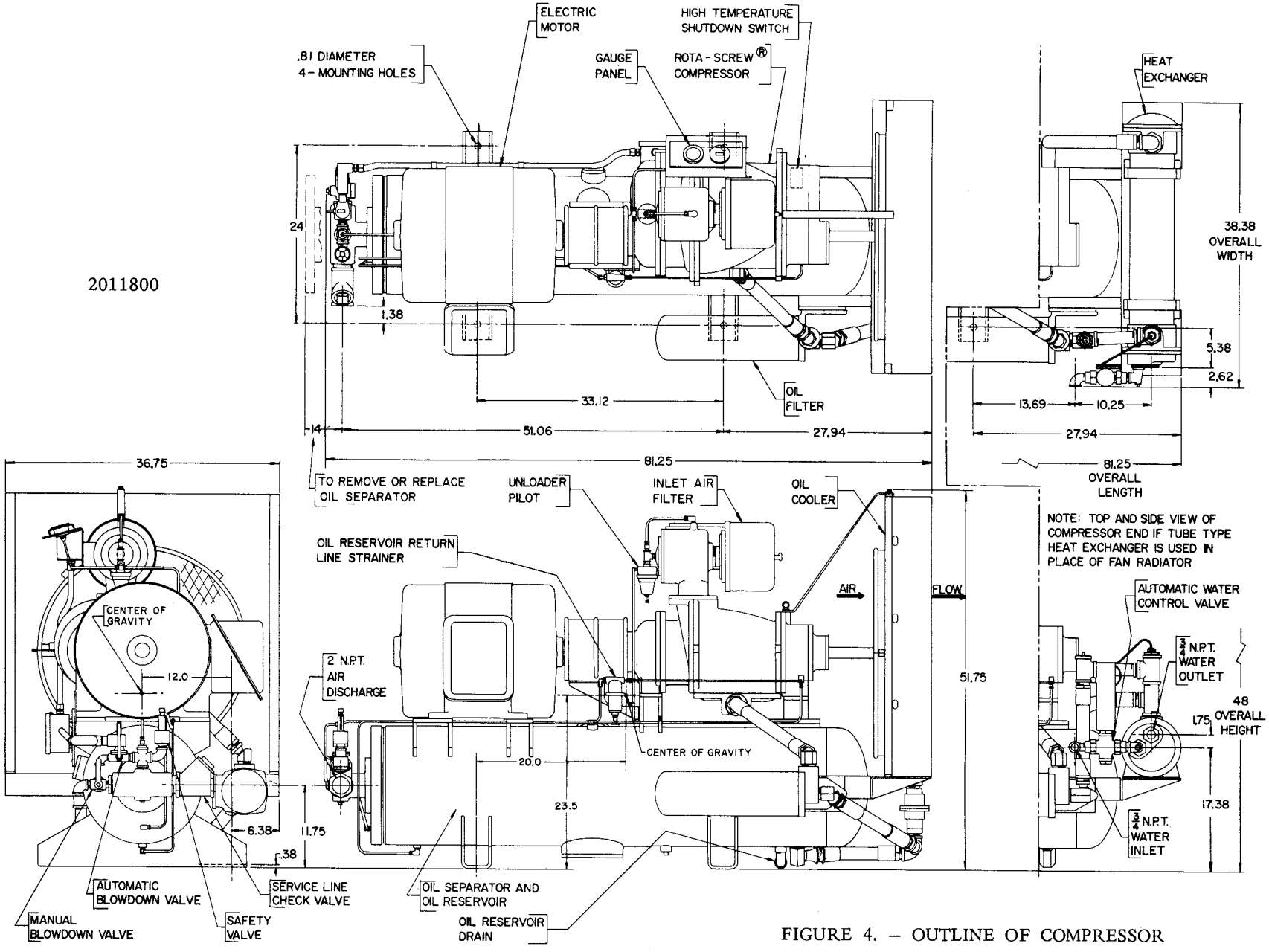


FIGURE 4. – OUTLINE OF COMPRESSOR

(Pumpless ES60E Fan Cooled and ES60F Water Cooled Models Shown. Models ES60A and ES60B with Oil Pump have Identical Dimensions.)

INSTALLATION

GENERAL – On receipt of unit, check for any damage that may have been incurred during transit. Report any damage or missing parts as soon as possible.

NOTE: Do not electric weld on compressor or base; bearings can be damaged by passage of current.

LOCATION – The compressor should be installed, whenever possible, in a clean, well-lighted, well-ventilated area with ample space all around for maintenance. Select a location that provides a cool, clean, dry source of air for the inlet filter. In some cases it may be necessary to install the air filter at some distance from the compressor to obtain proper air supply.

AIR COOLED UNIT (Figure 1) – If unit is to operate in an enclosure, provide the enclosure with adequate inlet and outlet for cooling air. Proper ventilation must be provided for adequate cooling; hot air must be exhausted from the enclosure. Do not block air flow through cooler. Allow two feet from cooler face to nearest obstruction. Refer to Figure 4 for direction of air flow through cooler.

WATER COOLED UNIT (Figure 6) – If unit is to operate in an enclosure, provide sufficient ventilation for electric motor.

FOUNDATION – The ELECTRA-SCREW® compressor requires no special foundation, but should be mounted on a smooth solid surface. Whenever possible, install unit near level. Temporary installation may be at 15° angle either lengthwise or sidewise.

Mounting bolts are not normally required, however, installation conditions such as piping rigidity, angle of tilt, or danger of shifting from outside vibration or moving vehicles may require the use of mounting bolts to the foundation. Coupling alignment must be checked after installation. Refer to Figure 4 for outline dimensions.

AUXILIARY AIR RECEIVER – Constant speed systems do not normally require an auxiliary air receiver. Automatic start-stop and dual control systems require an auxiliary air receiver for air storage and pressure switch location. Air receiver should be of adequate size, provided with a relief valve of proper setting, and a means of draining condensate. Refer to Figure 5.

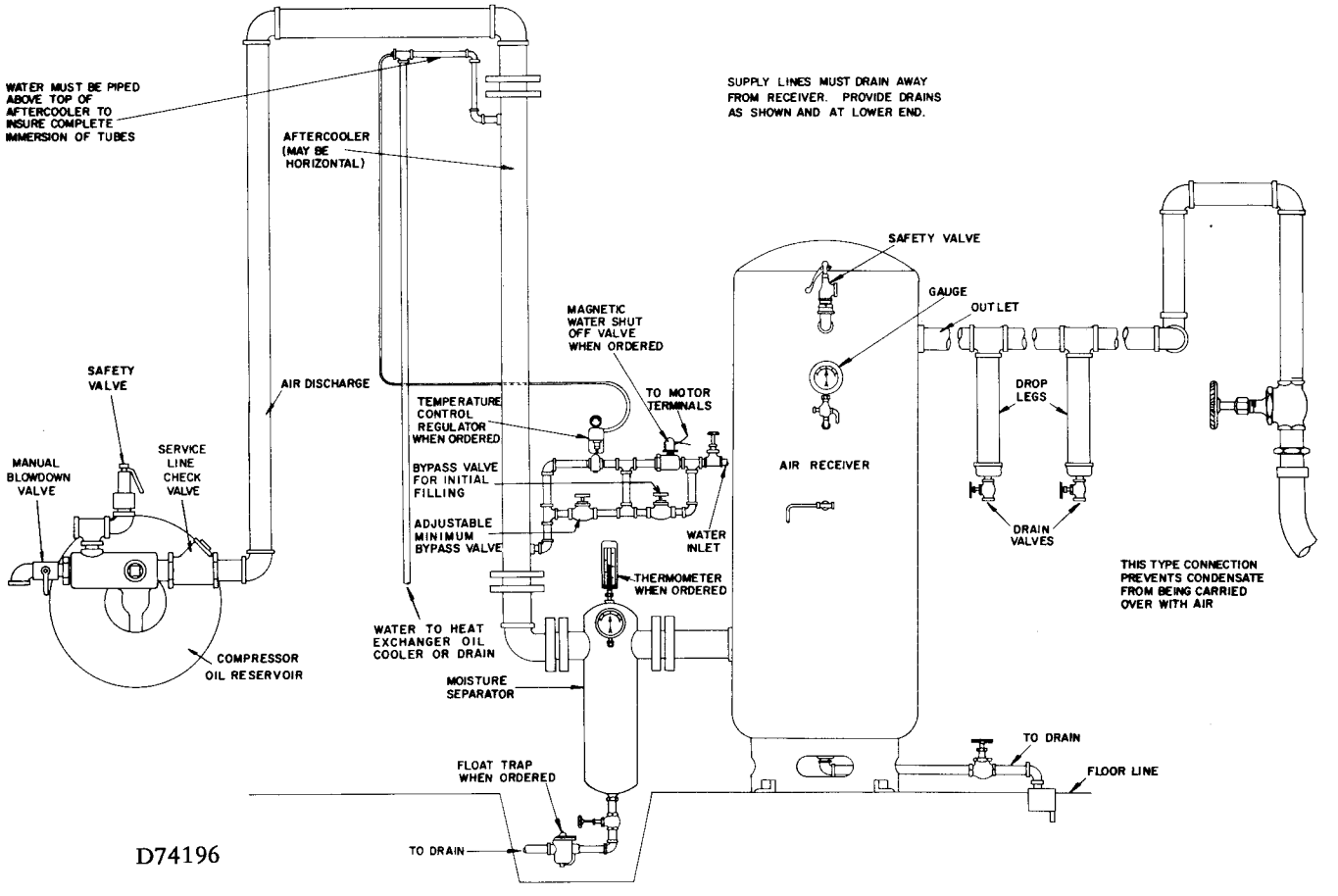


FIGURE 5. – AUXILIARY ACCESSORIES

AFTERCOOLER (Figure 5) – An aftercooler is generally not required with the ELECTRA-SCREW® unit since the normal discharge temperature is about 175° F. When an aftercooler is used, it is to be installed between the auxiliary air receiver and compressor discharge. A moisture separator is mounted between the aftercooler and auxiliary air receiver with a condensate drain provided at bottom. For complete installation and maintenance instructions, refer to manufacturer's bulletin.

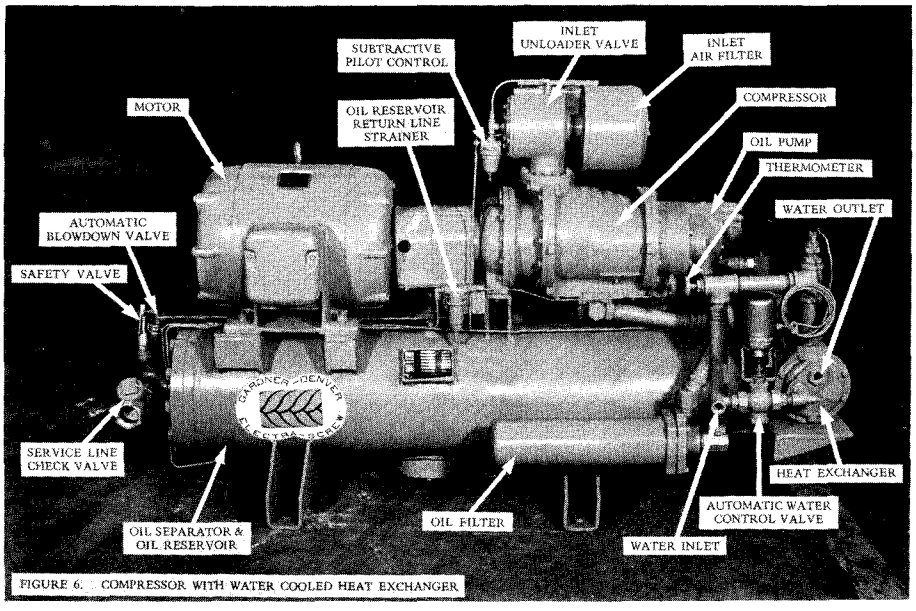


FIGURE 6. COMPRESSOR WITH WATER COOLED HEAT EXCHANGER

CONTROL PIPING – When a constant speed control system is provided, no further pneumatic control piping is required.

When a start-stop or dual control is furnished, the pneumatic pressure switch is mounted at the auxiliary air receiver and wired to motor junction box and (on dual control) the selector switch. A valve between receiver and pressure switch is recommended for shutting off control air when working on controls. Refer to control bulletin furnished with unit for wiring diagram.

INLET LINE – Where an inlet line is used between air filter and the compressor, it must be thoroughly cleaned on the inside to prevent dirt or scale from entering the compressor. **If welded construction is used, the line must be shot blasted and cleaned to remove welding scale.** In either case, the inlet line must be coated internally by galvanizing or painting with a moisture and oil-proof sealing lacquer. The inlet line should be the full size of inlet opening on the compressor. If an extra-long line is necessary, the pipe size should be increased accordingly. Following is the recommended size increase:

Length Of Inlet Line	Diameter Of Pipe Size
0 to 10 Ft.	Same As Compressor Inlet Opening
10 to 17 Ft.	One Size Larger Than Inlet Opening
17 to 38 Ft.	Two Sizes Larger Than Inlet Opening

Accessability for inlet air filter servicing must be considered when locating filters.

BLOWDOWN VALVE PIPING – For convenience, the automatic blowdown valve outlet should be piped to a drain or to the outside with pipe size the same as the blowdown valve outlet connection.

WATER PIPING (Water Cooled Heat Exchanger Models Only) (Figure 6) – When a water cooled heat exchanger is used in place of the radiator type oil cooler, pipe the inlet water to the automatic water control valve mounted on heat exchanger. Pipe outlet water from heat exchanger to a sump or drain.

The water source should be capable of supplying up to 20 gallon per minute at 40 PSIG minimum pressure; maximum water pressure should not exceed 150 PSIG. Maximum allowable water inlet temperature is 100° F.

The following water flow rates are approximate and a guide to sizing pipe, cooling towers or other water system equipment.

APPROXIMATE WATER FLOW (GPM)

Discharge Air Pressure PSIG	50° F. Water In 130° F. Oil Out	80° F. Water In 130° F. Oil Out	100° F. Water In 140° F. Oil Out
75	3	5	8
100	4	6	9
125	5	7	12
150	6	9	15

Water control valve is to be adjusted to maintain oil out of heat exchanger within the 130-140° F. range regardless of inlet water flow or temperature. See Maintenance Section for adjustment instructions.

STARTING AND OPERATING THE UNIT

A new unit as received from the factory has been prepared for shipping only. Do not attempt to operate unit until checked and serviced as follows:

1. **Compressor Oil** – Fill oil reservoir with proper amount and grade of oil recommended in Compressor Lubricants, Figure 7. Do not mix different type oils.

   Initial fill, or filling after complete draining of system, will show the oil level beyond the red "Excess Oil" range. After start-up, the oil will fall into green "Run" range as system components are filled. If necessary, add oil to bring the level into center of "Run" range when unit is operating (spread of "Run" range is approximately 5 gallons). ALWAYS STOP UNIT AND RELEASE AIR RECEIVER SECTION PRESSURE TO ADD OIL. During unloaded operation and after shutdown, system will partially drain back into the oil reservoir and oil level may read in "Excess Oil" range. DO NOT DRAIN OIL TO CORRECT; on the next loaded cycle or start, oil will again fill system and the gauge will indicate operating level.

SYSTEM CAPACITY: 21 U.S. Gallons	
Recommended Oils	Temperature Range
Automatic Transmission Fluid – -50° F. Pour Point – Meeting AQ-ATF, Type A, Suffix A, or GM Specification (Dexron), or Ford Specification (M2C33)	Year-round Operation – Except As Noted Below.
SAE 30 – Meeting Specification MIL-L-2104B, or MIL-L-45199 (Series 3)	+90° F. and Above – Where Periods Of Operation Exceed 8 Hours. **NEVER USE SAE 30 OIL BELOW +40° F.**

FIGURE 7. – COMPRESSOR LUBRICANTS

The recommended compressor lubricant is automatic transmission fluid meeting AQ-ATF, Dexron or Ford M2C33 specifications. On fan-cooled radiator models, automatic transmission fluid can be used for all operation up to +90° F. ambient temperature; when operating ambient exceeds +90° F. for 8 hours per day, SAE 30 oil meeting above specifications should be used. On water-cooled heat exchanger models, automatic transmission fluid can be used for all operation, provided oil temperature is held 130°-150° F. by adjustment of water flow control valve; if oil temperature will exceed 150° F., SAE 30 oil meeting above specifications should be used.

The oil must contain the following additives to be suitable for Electra-Screw® compressor use: (a) anticorrosion additive, (b) antioxidation additive, and (c) antifoam additive. Any other additives the above oils may contain as a standard of the refiner are acceptable.

Refer to "Compressor Oil System" in Maintenance Section for complete details of compressor oil system.

2. **Air Filter** – Inspect air filter to be sure it is clean and tightly assembled. Refer to "Air Filter" in Maintenance Section for complete servicing instructions. Be sure inlet line (if used) is tight and clean.

3. **Alignment** – Check all bolts and cap screws for tightness. Check coupling alignment. Refer to "Coupling" in Maintenance Section.

4. **Piping** – Refer to Installation Section and make sure all piping meets recommendations.

5. **Electrical** – Check wiring diagrams furnished with unit to be sure it is properly wired.

6. **Rotation** – Check motor rotation by momentarily starting motor. Compressor rotation is clockwise standing at motor end.

STARTING UNIT – COLD – If discharging into pressurized air system, close air service valve between main air system and unit discharge manifold and open oil reservoir manual blowdown valve. If unit is water cooled heat exchanger model, open manual water inlet valve fully. Start unit. Adjust manual blowdown valve to hold 65-70 PSIG oil reservoir pressure, and run unit for five minutes to warm up. Close manual blowdown valve and open service valve in discharge line. NOTE: If discharging into large system, refer to "Minimum Oil Reservoir Pressure" on the following page.

STARTING UNIT – HOT – No warm-up period is required. If unit is water cooled heat exchanger model, open manual water inlet valve fully. Start unit. NOTE: If discharging into large system, refer to "Minimum Oil Reservoir Pressure" on the following page.

MINIMUM OIL RESERVOIR PRESSURE, indicated by gauge on instrument panel, is 65 PSIG to avoid oil carry-over. When starting a large system, adjust service valve in discharge line to maintain 65 PSIG minimum pressure in oil reservoir; when system pressure reaches 65 PSIG, open service valve wide open. Long periods of operation at low pressure will cause noticeable oil carry-over.

AIR RECEIVER PRESSURE is controlled on constant speed units by adjustment of the inlet unloader pilot; on automatic start-stop units by pressure switch setting, and on dual control units by both pilot adjustment and pressure switch setting. Refer to control bulletin furnished with unit for details.

OIL TEMPERATURE – WATER COOLED HEAT EXCHANGER – A thermometer in the oil line (Figure 6) is furnished to monitor oil temperature on the water cooled heat exchanger models. Maintain 130-140° F. oil temperature into compressor. Refer to "Installation" section for water flow table and "Maintenance" section for water control valve adjustment.

DAILY CHECK – Refer to Service Check List on page 9.

STOPPING UNIT

Constant Speed Units – Bring the unit up to full unloaded pressure and press "STOP" button. Stopping unit at pressure below full unloaded pressure may cause oil carry-over. Oil reservoir will automatically blow down as motor stops. If unit is water cooled heat exchanger type, shut off water inlet valve.

Automatic Start/Stop Units – If unit is operating, allow it to build up to full receiver pressure and stop automatically, then turn "ON-OFF" line switch to "OFF". Stopping unit at pressure below full receiver pressure may cause oil carry-over. If unit has automatically stopped at full receiver pressure, turn "ON-OFF" line switch "OFF". On water cooled heat exchanger units shut off manual water inlet valve.

SERVICE CHECK LIST

Air Filter – Because operating conditions determine frequency of service, refer to "Air Filter" on page 10, and plan maintenance accordingly.

Every 8 Hours Operation

1. Check reservoir oil level – add oil if required. If oil consumption is high, refer to "Trouble Shooting" on page 15.
2. Observe if unit loads and unloads properly.
3. Drain moisture traps on air receiver and moisture separator (if used).
4. Drain strainer in oil return line (see Figure 6).

Every 125 Hours Operation

1. Check for dirt accumulation on radiator type oil cooler core faces. Blow off dirt if accumulation is excessive.

Every 200 Hours Operation

1. Lubricate coupling.

Every 1000 Hours Operation

1. Change oil filter cartridge. Change compressor oil if using SAE grade oil. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY (refer to "Oil Change Interval"). Flush oil system if required.
2. Clean strainer in oil return line. Clean magnetic plugs in oil reservoir.

Every 2000 Hours Operation

1. If using automatic transmission fluid, change oil and oil filter cartridge. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY (refer to "Oil Change Interval"). Flush oil system if required.
2. Clean strainer in oil return line. Clean magnetic plugs in oil reservoir.

Every 4000 Hours Operation

Replace oil separator agglomerator element. Clean and inspect separator screen element. NOTE: More frequent replacement of agglomerator may be required; refer to "Oil Separator" on page 12.

INSTRUMENTS – The instrument panel normally mounts the following items: (a) Hourmeter, (b) Air Pressure Gauge.

INLET UNLOADER VALVE (Figures 6 & 8) – The piston actuated inlet valve controls the compressor inlet and operates on air pressure from the control circuit on constant speed or dual control systems. Valve is closed when full pressure is on system and changes degree of opening in direct response to system pressure drop. On automatic start-stop system, valve closes automatically when compressor stops. Inlet valve contains piston spring "F" which returns piston and allows inlet valve to open as pressure decreases, and valve spring "G" which returns valve to closed position on shutdown of compressor to prevent blowback from compressor to air filter.

When the unit is unloaded or operating on reduced capacity, a small amount of air is introduced into the compressor through the bleed line to purge the oil through the unit.

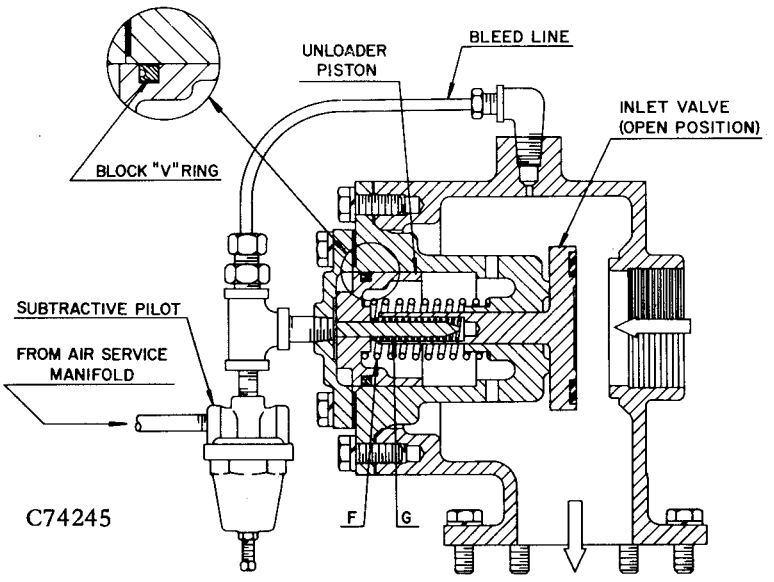


FIGURE 8. – INLET UNLOADER VALVE

COMPRESSOR CONTROLS – Compressor capacity control is obtained by one of the following systems supplied to the customer specifications:

(a) Constant Speed, (b) Start-Stop, (c) Dual Control.

These controls will be of suitable voltage and with suitable type enclosure to meet application requirements. REFER TO CONTROL BULLETIN FURNISHED WITH UNIT FOR WIRING AND ADJUSTMENT OF CONTROLS.

AUTOMATIC BLOWDOWN VALVE (Figure 4) – A solenoid valve, piped to the compressor discharge manifold ahead of the check valve and wired into the electrical system, will blow down the compressor air system on motor shutdown. See control bulletin for wiring diagram.

CHECK VALVE (Service Line) (Figure 4) – A renewable seat swing type check valve on the discharge manifold prevents back flow of air into compressor air system from the shop line when unit stops under automatic control or is shut down.

SAFETY DEVICES

Motor Protection Devices – Overload relays and other protective devices are to be furnished by the customer except when Gardner-Denver furnishes the starter on a factory-wired unit. "Guardistor", "Thermotector" or other heat-sensing shutdown devices in motor windings are furnished only when ordered.

High Air Temperature Shutdown (Figures 1 & 4) – The compressor is protected from lubrication failure by a high discharge temperature switch in the discharge line between the compressor discharge check valve housing and the oil reservoir. This switch is wired into the motor control circuit and will shut down the unit if discharge temperature exceeds 225° F. ± 5°. This switch will be in a suitable enclosure to meet application requirements. The switch has a maximum rating of 600 volts, is of the manual reset type, and must be reset any time unit is shut down due to high air discharge temperature. Refer to control bulletin for wiring diagram.

Safety Valve (Figure 4), installed on the discharge manifold, is set at the factory to the proper pressure for protection against overpressure of the oil reservoir. Periodic checks should be made to insure its proper operation. Never operate the unit without proper safety valve setting.

NEVER DISCONNECT SAFETY DEVICES THAT PROTECT THE UNIT.

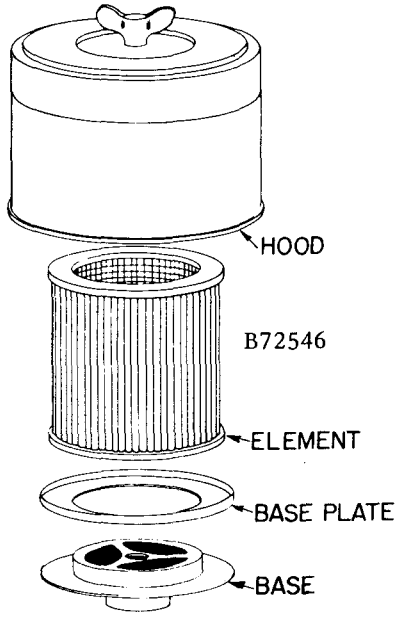


FIGURE 9. – DRY TYPE AIR FILTER

AIR FILTER (Figures 4 & 9) is dry type. Air filters must receive proper maintenance if maximum service is to be obtained from unit. Establishing adequate and timely filter service is MOST IMPORTANT. When outside surface of the element appears to be evenly coated with dirt, it should be cleaned as follows:

1. Remove wing bolt, lift off hood and filter media.
2. Vibrate or blow off heavy dirt accumulation.
3. If required, wash media with a household detergent and water. Allow to dry before reinstalling. DO NOT USE OIL, GASOLINE, SOLVENTS OR OILY WASTE TO CLEAN.

Replace element if filter media or seals at ends are damaged, or if element cannot be thoroughly cleaned.

Replace filter element with genuine replacement parts whenever needed. Good judgment should be used in establishing replacement interval. Do not attempt to overextend element life; the small savings involved do not justify the risk.

CAUTION: Do not run unit with damaged filter or filter parts. Always handle filter parts with care.

Causes of short element life are: severe dust conditions, infrequent servicing, improper cleaning, or contamination by oil or chemical fumes.

Severe dust conditions require the use of a heavy-duty two-stage dry type air filter. If your Electra-Screw® unit has been so equipped, refer to the filter manufacturer's instruction sheet for servicing.

COMPRESSOR OIL SYSTEM (Figure 3) cools the compressor, lubricates moving parts and seals internal clearances in the compression chamber.

The oil suction line is connected near bottom of oil reservoir. Oil is drawn by the oil pump or forced by air pressure, from reservoir through oil cooler, thermostatic mixing valve (on radiator type oil cooler units only), and oil filter into the compressor main oil gallery. Oil passes through internal passages for lubrication, cooling and sealing during the compression cycle. The air-oil mixture is then discharged to the oil reservoir where impingement and velocity change remove more than 99% of the oil from the air. The remaining oil is removed by the oil separator in the separator section of the reservoir.

OIL SPECIFICATIONS – Refer to "Compressor Lubricants" (Figure 7) under "Starting and Operating the Unit" for a listing of recommended oils. Automatic transmission fluid, with -50° F. pour point, is recommended for year-round use except where periods of operation exceeding eight (8) hours with ambient temperatures above +90° F. are encountered. In this case, SAE 30 oil meeting the specifications listed in Figure 7 is recommended. NEVER USE SAE 30 OIL BELOW +40° F. The SAE 30 motor oil must be corrosion, oxidation and foam inhibited. Mixing of different types, or the use of lubricants without sufficient oxidation inhibitor will result in formation of heavy varnish and sludge deposits throughout the system.

OIL QUALITY – There are many brands of lubricating oils which are represented by the suppliers as meeting one or more of the specifications listed under "Compressor Lubricants" (Figure 7). The ability of an oil to meet the minimum performance level of a specification is determined by the supplier. Therefore, the responsibility for the QUALITY of the oil and its PERFORMANCE IN SERVICE rests with the oil supplier.

COLD AMBIENT OPERATION – If an SAE grade oil is used, the oil should be changed to automatic transmission fluid when the ambient temperature drops to +40° F. in the space enclosing the compressor unit or if the unit operates out of doors. Experience clearly indicates that an oil with a pour point above the ambient temperature may chill in the oil cooler and block oil flow to the compressor. The loss of oil circulation causes excessive discharge air temperature and may result in compressor damage and/or a flash fire in the oil reservoir. This rise of discharge air temperature occurs very rapidly, and without oil as a wetting agent surrounding the sensing bulb of the high air temperature shutdown switch, damage generally results before the device can actuate to stop the unit.

ADDITION OF OIL BETWEEN CHANGES must be made when level of oil **in gauge is below "Run" range while unit is operating.** Stop unit and **be sure no air pressure is in oil reservoir.** Wipe away all dirt around oil filler plate or plug (Figure 1). Remove oil filler plate or plug and add oil as may be necessary to return oil level to center of the "Run" range when unit is operating (spread of "Run" range is approximately 5 gallons). Repeated addition of oil between oil changes may indicate excessive oil carry-over and should be investigated.

OIL CHANGE INTERVAL is determined by air filter maintenance, operating conditions and quality of oil. Good practice is to change oil often enough that drained oil is relatively clean. Under good operating conditions automatic transmission fluid can be used up to 2000 hours of operation and SAE 30 oil up to 1000 hours. When operating conditions are severe (very dusty, high humidity or high temperature) it may be necessary to change oil more frequently. Operating conditions and appearance of drained oil must be surveyed and oil change intervals planned accordingly by the user. Refer to "Compressor Oil Filter" for filter element replacement.

DRAINING AND CLEANING OIL SYSTEM – STOP UNIT. **Be sure no air pressure is in reservoir.** Always drain complete system. Drain when oil is hot to help prevent varnish deposits and to carry away impurities.

To drain system, use one of the following methods:

If unit is not elevated high enough to use oil reservoir drain openings to drain oil, a small hand-, electric- or air-operated pump should be used to drain reservoir. Remove compressor sump drain, oil cooler drain (2), oil filter, and oil return line strainer plugs. After oil reservoir is emptied, remove oil reservoir magnetic plug.

If unit is elevated so that oil reservoir drain openings can be used, remove following plugs: oil reservoir drain, oil reservoir magnetic, compressor sump drain, oil cooler drain (2), oil filter and oil return line strainer.

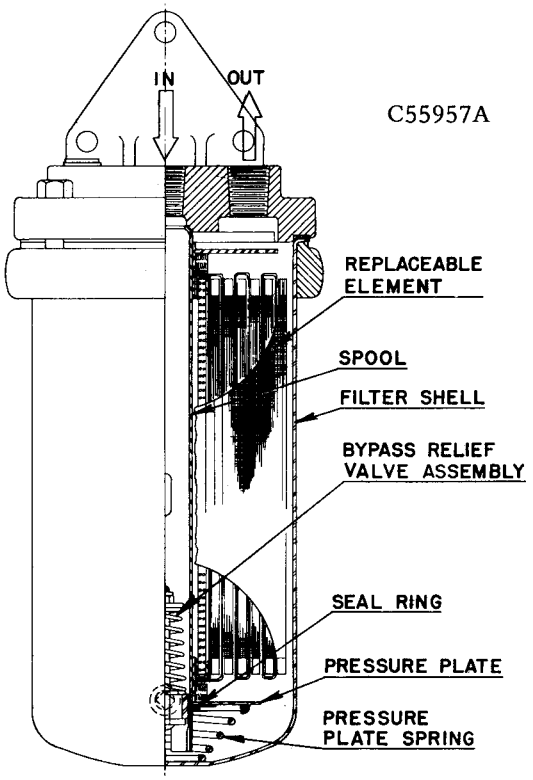


FIGURE 10. – COMPRESSOR OIL FILTER

Clean all magnetic plugs to maintain effectiveness. If drained oil and oil filter element are contaminated with dirt, flush entire oil system: reservoir, cooler, pump, mixing valve and lines. Inspect oil separator element for dirt accumulation; replace if necessary. If varnish deposit exists, contact oil supplier for recommendations for removal of deposit and prevention of recurrence.

FILLING OIL RESERVOIR – Wipe away all dirt before removing oil filler plate or plug in top of oil reservoir. Refer to "Compressor Lubricants" (Figure 7) for oil quantity required to fill compressor oil system. This amount brings pointer of oil level gauge into "Excess Oil" range. After a few minutes of operation, oil drops into "Run" range as oil fills other parts of system. Maintain operating oil level in "Run" range. After shutdown some oil will drain back to oil reservoir and oil level gauge may read in "Excess Oil" range. DO NOT DRAIN OIL TO CORRECT LEVEL; on next start, oil will again fill system and pointer indicate operating oil level. DO NOT OVERFILL as oil carry-over will result. With oil level at the centerline of the oil reservoir, the oil level gauge pointer will read approximately in the center of the "Run" range. Use only CLEAN containers and funnels so no dirt enters reservoir. Provide for clean storage of oils. Changing oil will be of little benefit if done in a slipshod manner.

COMPRESSOR OIL FILTER (Figure 10) is a vital part in maintaining a trouble-free compressor, since it removes dirt and abrasives from circulated oil. Filter is a replaceable cloth bag element type and is equipped with a relief valve that opens in event element becomes dirty enough to block flow of oil. **Element must be replaced each 1000 hours;** more frequent changes improve system reliability and are recommended.

Use only replacement element shown on filter tag, or refer to parts list for part number. Use following procedure to replace filter element. (Do not disturb piping.)

1. Dismantle filters, clean all parts and replace gasket on filter head.
2. Slide new element over spool and slip spring and plate assembly over end of tube.
3. Place reassembled element and spool into shell with relief valve and spring down (away from filter head).
4. Bolt assembly to filter head.

COMPRESSOR OIL COOLER – RADIATOR TYPE (Figure 4) – The fan is direct connected to the main rotor shaft and exhausts air through oil cooler away from the unit. Keep face of oil cooler core clean for efficient cooling of compressor oil. Oil cooler malfunction may be traced by checking oil pressure drop through the cooler; check by installing pressure gauges in each drain plug opening at bottom of cooler. At normal operating air service pressures (65 to 150 PSIG) with unit warm, a pressure drop of 5 to 18 PSIG can be expected between the inlet and outlet side of cooler.

THERMOSTATIC MIXING VALVE (Used With Radiator Type Oil Cooler) (Figure 11) is installed in the system as shown in the flow diagram, Figure 3. On start-up with unit cold, the thermostat in the valve is open to the bypass line, allowing oil to circulate directly from oil reservoir to compressor during warm-up period. As the oil warms up, the thermostat gradually opens to allow oil from the cooler to mix with oil from bypass line. After unit is warmed up, the mixing valve maintains oil injected into compressor at a minimum of 130° F. This system provides proper compressor warm-up and prevents moisture contamination of the oil.

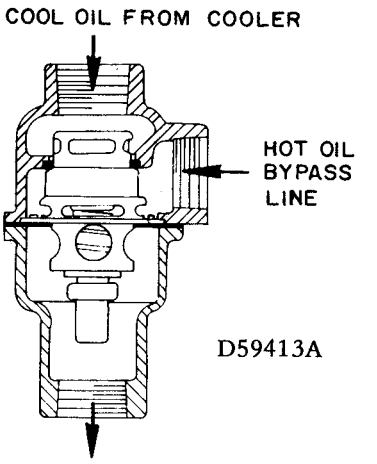


FIGURE 11. – THERMOSTATIC MIXING VALVE

To check thermostat, heat in oil – it should be wide open at 130° F. If unit shuts down due to high air discharge temperature, the cause may be that thermostat is stuck open in bypass position blocking cooler out of the system, in which case oil lines 1 and 2 (Figure 3) will be hot to the touch and lines 3 and 4 much cooler. When flushing oil system, remove mixing valve and clean all parts thoroughly.

COMPRESSOR OIL COOLER – WATER COOLED HEAT EXCHANGER (Figure 6) – The optional heat exchanger type cooler is the multiple pass type, with water in the tubes and oil in the shell. The water flow is controlled by a self-operated control valve (Figure 12) installed in the water inlet line to the cooler as shown in flow diagram (Figure 3), and is designed to maintain the oil injected into the compressor at 130° F. - 140° F. The valve's temperature sensing bulb is located in the oil discharge line of the cooler. A temperature change at the bulb operates the valve, increasing or decreasing the water flow. A thermometer in oil line at oil cooler outlet registers temperature of oil into compressor. A malfunction of the oil side of the oil cooler may be traced by checking pressure at oil inlet and outlet. Fittings at these locations are equipped with 1/4" pipe tap for gauge. At normal operating air service pressure (65 to 150 PSIG) with unit warm, a pressure drop of 2 to 6 PSI can be expected between oil inlet and oil outlet.

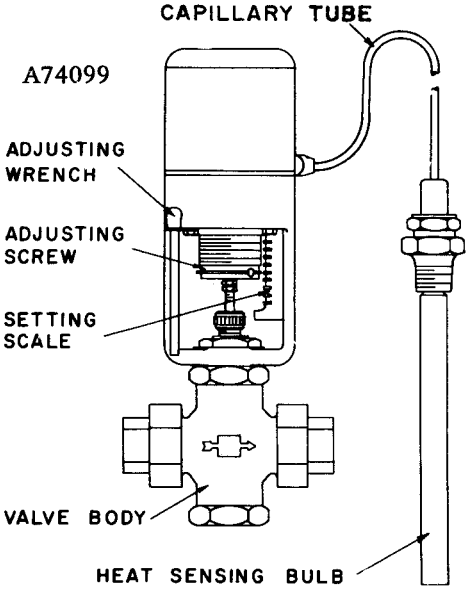


FIGURE 12. – WATER CONTROL VALVE

WATER CONTROL VALVE FOR HEAT EXCHANGER (Figure 12) – The water control valve is adjustable to compensate for varying inlet water temperatures. To decrease water flow (increase oil temperature) insert adjusting rod into one of the holes in the adjusting screw and move from left to right, increasing spring tension. To increase water flow (decrease oil temperature) turn screw in the opposite direction. The rib through the adjusting screw wrench holes is an index line for use with the index scale 0 to 8 in obtaining a desired setting.

Care must be used when handling the capillary tube; a kink or break in the tubing or connection will make the valve inoperative. Never attempt to change capillary length.

If a leak develops through the packing, tighten the packing gland nut firmly with a wrench to reseat packing around valve stem, then back off the nut until loose, and finally retighten nut finger tight. Tightening packing nut too tight may cause erratic operation. An occasional drop of oil on the valve stem at the packing nut will prolong packing life.

If valve malfunctions, check for foreign material in valve, erosion, or thermal system (capillary) failure.

AIR-OIL RESERVOIR (Figure 1) which supports the compressor, motor and auxiliary items, is divided internally by baffles into two sections. The section at compressor end acts as a primary separator of the air-oil mixture and as oil reservoir. The dry sump section, at motor end, acts as an air receiver and contains the final oil separator element. Excessive tilt of unit will allow oil to overflow the baffles into the separator section.

COMPRESSOR OIL SEPARATOR (Figure 13) located in the discharge manifold end of the oil reservoir consists of a renewable cartridge type agglomerator element (first stage) and screen element (second stage), and provides final removal of oil from stream. Oil from inside the separator, and from the dry sump section of the reservoir surrounding it, is returned through tubing to compressor bearing end plate.

Oil carry-over through service lines may be due to malfunction of oil separator caused by blown gaskets and/or ruptured elements. This in turn, may be due to using elements too long; heavy dirt or varnish deposit caused by inadequate air filter service, use of improper oil, or using oil too long for existing conditions. Collapsed agglomerator elements are usually due to heavy dirt and varnish build-up in the filtering material.

Oil carry-over may also be caused by oil that foams or oil return malfunction. When oil carry-over occurs, inspect the separator only after it is determined that the oil return lines are not the cause. Refer to "Oil Return" and Figure 14.

Under normal conditions the agglomerator should be replaced every 4000 hours of operation. If gauges are used to determine separator differential pressure and change interval, agglomerator should be changed when differential is 8 PSI.

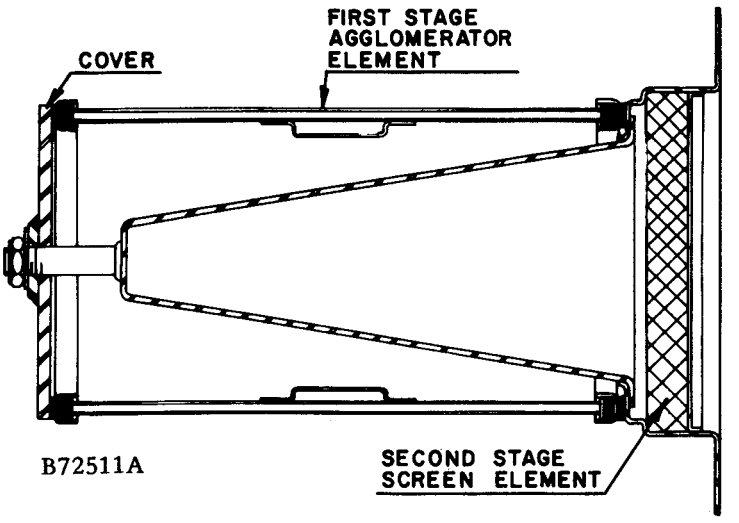


FIGURE 13. – OIL SEPARATOR

To remove separator for inspection or replacement:

1. Disconnect all tubing, remove discharge manifold, remove all separator flange screws and slide separator assembly from reservoir dry sump.
2. Clean oil return opening in separator flange.
3. Remove nut, separator cover and agglomerator element.
4. Inspect and clean second stage screen element and support assembly. Use nontoxic, nonflammable solvent. Replace element if necessary. Because the material and positioning of material in second stage screen element is important to efficient oil separation, it is made as an integral part of the flange and support bracket, and not supplied separately. Do not attempt to remove or repack second stage screen element. Screen element can be used for an indefinite period of time, provided it is cleaned at each agglomerator change. Usually, the only causes for replacement are physical damage or collection of large amounts of varnish so that it cannot be thoroughly cleaned.
5. Inspect the agglomerator element and gaskets bonded to each end. Replace if damaged or fouled with dirt. A drop light placed inside element will help show up any imperfections. Bonded gaskets may be replaced by using repair kit of two gaskets and adhesive, shown in parts list. Scrape all traces of old gaskets from ends of agglomerator element. Remove any gasket material adhering to end of screen element flange and separator cover. Stand agglomerator element on one end. Clean any oil from flange with solvent. Spread thin line of adhesive on end of agglomerator element. Place gasket on adhesive and press down all around. Wipe off any adhesive squeezed from between gasket and flange. Invert element and bond second gasket in place. Allow to dry for a few minutes before assembling agglomerator element to second stage screen element.
6. Reassemble separator, being careful to center element for effective gasket seal. Make certain nut, with copper washer, is pulled up tight.
7. Install separator assembly in oil reservoir. Note that one separator flange bolt hole is offset from equal spacing pattern and matches a similarly offset tapped hole in the reservoir flange. This orients the separator second stage screen element in proper position for best oil drain and efficient operation.

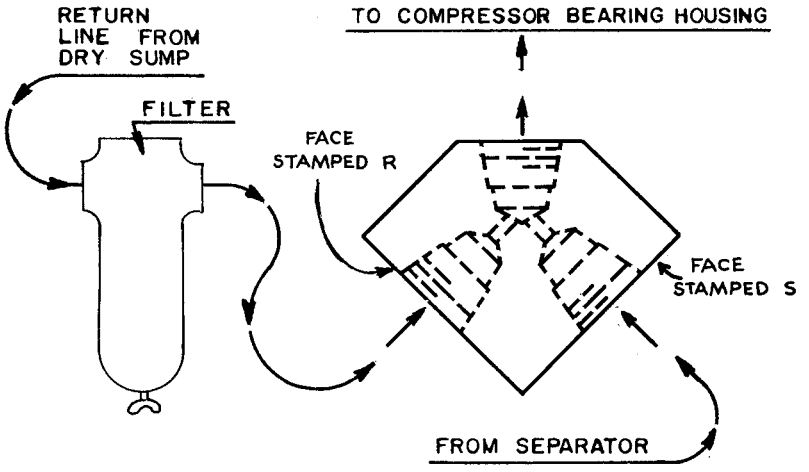


FIGURE 14. – OIL RETURN ORIFICE BLOCK

OIL RETURN (Figure 14) – Two lines return oil from the separator system to the compressor oil system through an orifice block which is piped to the compressor bearing housing. Orifice block face stamped "R" contains a 1/16" orifice and is connected to the return line from the dry sump portion of the oil reservoir. Orifice block face stamped "S" contains a 3/32" orifice and is connected to line from the oil separator. The line from the dry sump has a filter which should be drained daily and cleaned at each oil change.

Oil carry-over through air service line may be due to: plugged filter, plugged orifice, return line pinched shut or clogged, loose or broken connection, return line connected to wrong orifice in block. If a return line is replaced, use tubing of original line size.

OIL PUMP (ES60A & ES60B) is positive displacement internal gear type, direct driven by

compressor secondary rotor shaft. Pump is designed to deliver correct pressure and volume to compressor oil inlet. Pump discharge pressure will vary with oil viscosity and air discharge pressure.

OIL PRESSURE RELIEF VALVE – The relief valve is an integral part of the pump and bypassed oil merely circulates internally within the pump, protecting the system from overpressure caused by cold or heavy oil. The valve is set at 50 PSIG and will open when pressure on discharge side of the pump exceeds pressure on suction side by 50 PSI. This method provides lubrication while protecting system from overpressurization.

FAN is pinned and piloted to compressor rotor drive shaft extension and requires no maintenance.

COMPRESSOR OIL SYSTEM CHECK – The following readings are based on ambient temperature of 80° F. for air-cooled oil cooler and 80° F. inlet water on water-cooled oil cooler, with system in good condition. Compressor should be at operating temperature at time of checks. One-half hour operation at system pressure usually is sufficient to reach level-out temperature.

Air and Oil Discharge Temperature – 155° to 175° F. – check with thermometer in tapped opening on side of compressor discharge end plate.

Compressor Oil Inlet Temperature – 130° to 150° F. for fan-cooled radiator; 130° to 140° F. for water-cooled heat exchanger type – check at oil pump discharge.

Oil Pump Pressure – 80 to 90 PSI at 100 PSI air receiver pressure – check at oil pump discharge.

Oil Inlet Pressure (Pumpless Units) – 70 to 80 PSI at 100 PSI air receiver pressure – check at fitting in line from mixing valve discharge to compressor.

Oil Cooler Oil Pressure Drop (Air-Cooled Radiator Type) – 5 to 18 PSI – check with gauge in drain opening on each side of cooler bottom tank – inlet at right side, outlet at left side when facing cooler end.

Oil Cooler Oil Pressure Drop (Water-Cooled Heat Exchanger) – 2 to 6 PSI – check at heat exchanger inlet and outlet fittings – water pressure drop through heat exchanger depends on supply pressure and flow rate.

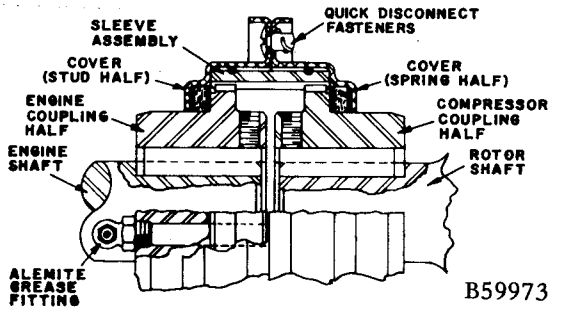


FIGURE 15. – DETAIL OF COUPLING

COUPLING (Figure 15) – The motor and compressor are direct connected by a gear-type flexible coupling. The coupling requires relubrication through the alemite fitting every 200 hours of operation with a light, separation resistant, nonhardening grease. Do not use cup grease.

The coupling is carefully aligned at the factory; however, if thermal expansion, settling, deflection of unit through shipment or handling, or maintenance on mating parts requires that coupling be realigned, proceed as follows:

1. Loosen quick disconnect fasteners on cover and separate cover halves.
2. Wipe coupling parts free of grease.
3. Position motor and compressor so that shaft ends are 1/8" apart. Coupling hub faces are approximately flush with shaft ends.

NOTE: It is recommended that a dial indicator be used to check angular and parallel alignment; however, Steps 4 and 5 give alternate method if indicator is not available.

4. Check angular alignment with feeler gauge by comparing the gap between hub faces at four points 90° apart. Shim and adjust motor and compressor so that gap measurements are uniform.
5. Check parallel alignment by placing a short straight edge across both hubs between gear teeth. Shim and adjust motor and compressor until straight edge lies flat on both hubs at two points 90° apart.
6. Recheck angular alignment to be sure it has not been disturbed.
7. Lubricate gear teeth and slide gear sleeve into engagement with teeth of both hubs.
8. Be sure gear sleeve "O" rings are not damaged. Slide cover halves over sleeve and engage quick disconnect fasteners.
9. Lubricate coupling with light, separation resistant, nonhardening grease through the alemite fitting.

TROUBLE SHOOTING

IF UNIT FAILS TO START check wiring system for wrong lead connections. Check manual reset on air temperature switch. Check for motor overload.

UNIT STARTS BUT STOPS AFTER SHORT RUN, check for: high air discharge temperature caused by low compressor oil level; clogged oil cooler or oil filter; thermostatic mixing valve stuck; dirt on oil cooler core face; unit operating in area with poor ventilation; defective oil pump; oil pump relief valve stuck open; water control valve inoperative; water not turned on; water tubes in cooler fouled; incorrect setting or malfunction of high air temperature shutdown switch.

COMPRESSOR DOES NOT UNLOAD, check for: control malfunction; control lines from air receiver or discharge manifold for restriction; air leaks in control system; inlet valve stuck; pilot or control adjustment; pilot for dirt, leaking diaphragm.

UNIT FAILS TO SHUT DOWN ON START-STOP SYSTEM, check for: control malfunction; control lines from air receiver for restriction or leaks; pressure switch for dirt, leaking diaphragm; wiring to switch. Refer to control bulletin.

SOLENOID BLOWDOWN VALVE CONTINUES TO PASS AIR, check for: loose leads. If wiring is correct, check for coil failure. Operation may continue by plugging valve outlet and blowing down reservoir with manual blowdown valve until solenoid valve can be replaced.

EXCESSIVE OIL CONSUMPTION, check for: oil carry-over through discharge line caused by overfilling reservoir; clogged, broken or loose oil return lines; oil return lines connected incorrectly to orifice block; ruptured agglomerator element or second stage screen element; defective separator gaskets or loose assembly; incorrect oil causing foam; all fittings and gaskets for oil leaks; operation below minimum pressure.

COMPRESSOR LOW ON DELIVERY AND PRESSURE, check for: clogged air filter; closed inlet valve caused by control not in adjustment; broken inlet valve spring; binding inlet valve piston; incorrect motor speed; compressor not large enough for air demand.

HEATING – Check items listed above under "Unit Starts But Stops After Short Run" and refer to "Compressor Oil System Check" on page 14.

DISASSEMBLY INSTRUCTIONS – COMPRESSOR UNIT

NOTE: The following illustrations show disassembly and assembly of the compressor for the water cooled oil cooler models. This model does not have shaft extension from main rotor which is used to drive the fan on radiator oil cooler models. During disassembly and assembly of radiator oil cooler models, this shaft extension must be taken into account.

Remove compressor unit from oil reservoir as follows: pull main breaker switch; disconnect all necessary tubing and oil lines; remove air filter, instrument panel, inlet valve, discharge manifold and coupling guard. Disconnect coupling, refer to "Coupling" in Maintenance Section. Unbolt compressor and lift from oil reservoir. Lifting device should be suitable for approximately 800 pounds. Cover all openings in oil reservoir and oil lines to keep out dirt. Pull coupling half from shaft extension, taking care not to damage shaft.

Disassembly of Compressor

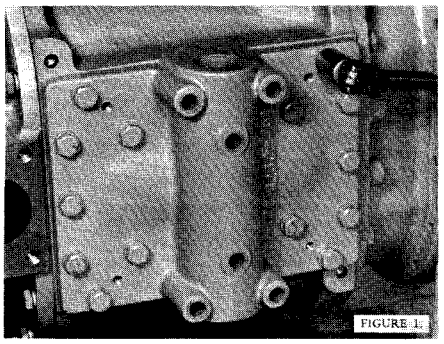


FIGURE 1.

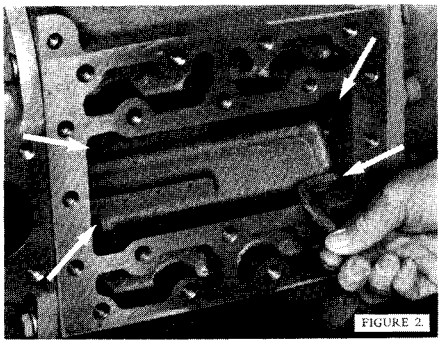


FIGURE 2.

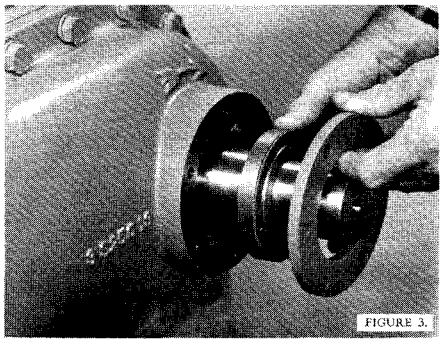


FIGURE 3.

1. Remove oil gallery plate at bottom of cylinder, Figure 1.

2. Remove internal cap screws in oil gallery (two at each end) holding cylinder to end plates, Figure 2.

3. Place compressor upright on solid work surface and blocked so inlet housing hangs free. Remove drive key from shaft. Remove shaft seal cover, back screws out evenly to avoid damaging carbon face of seal. Remove seal seat from bore, Figure 3. If stuck tight in bore by gasket, remove after end cover is removed in Step 4. Protect face of seal seat from damage.

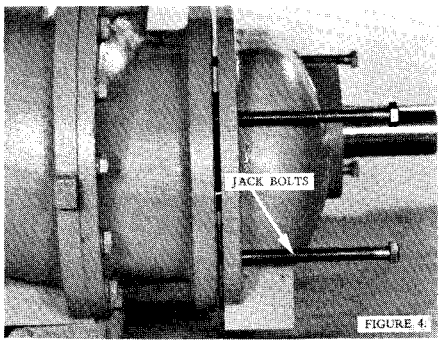


FIGURE 4.

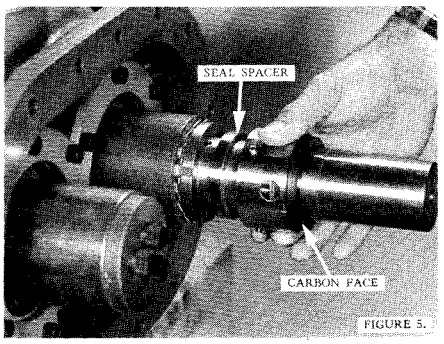


FIGURE 5.

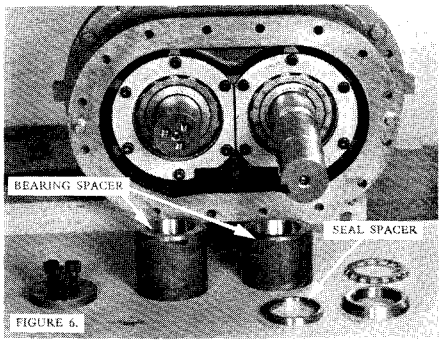


FIGURE 6.

4. Remove inlet end bearing cover cap screws and push bearing cover off with jack bolts, Figure 4. Lubricate jack bolts to prevent galling threads. All jack bolts should be hardened with round or flat ends. Pad seal body and shaft with rags to avoid damage to carbon face of seal.

5. Loosen set screws in seal body. Check shaft and keyway for burrs and dirt. Remove seal body from shaft, Figure 5. Protect seal carbon face from damage.

6. Remove seal spacer, locknut, washer, retainer plate and two bearing spacers, Figure 6.

7. Support inlet end plate with hoist. With four jack bolts, two at each side, jack end plate from housing and inlet end bearings from shaft, Figure 7. Lubricate jack bolts. Progressively tighten jack bolts evenly to prevent binding end plate on dowels and bearings on shaft. Remove with care to prevent damage to shaft and threads. When free of shaft, remove bearing inner race and roller assembly. If bearings are to be reused, tag to match.

8. Remove bearing outer race retainer plates. Pull outer race from housing, Figure 8; race is light press fit to slip fit. If bearings are to be reused, tag race to match respective roller assembly. Never reuse worn bearings.

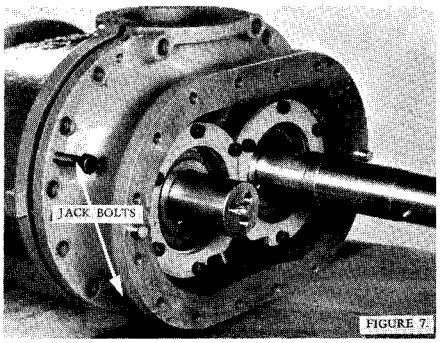


FIGURE 7.

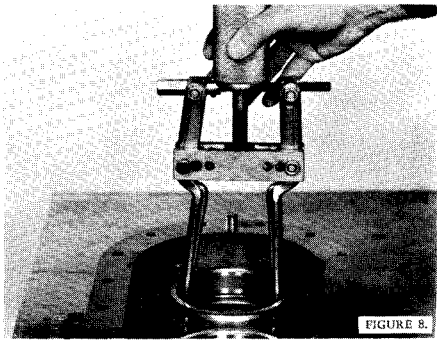


FIGURE 8.

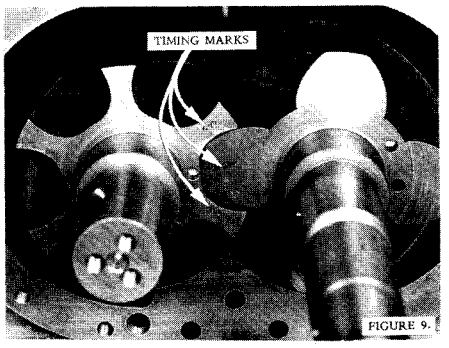


FIGURE 9.

9. As a safety measure, mark rotor as shown in case timing marks at other end have been destroyed, Figure 9.

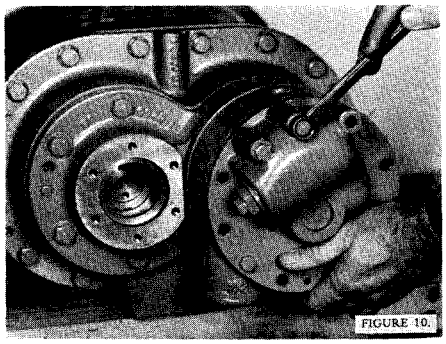


FIGURE 10.

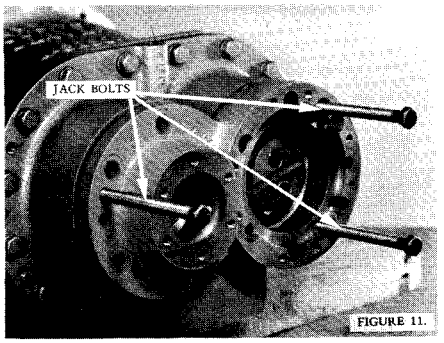


FIGURE 11.

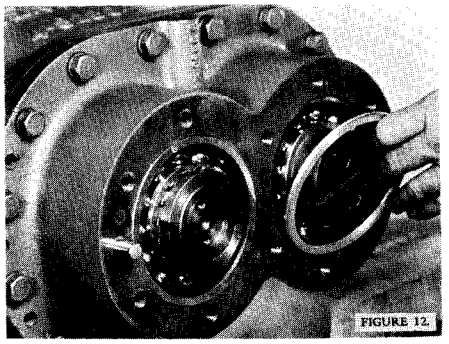


FIGURE 12.

10. **ES60A and ES60B Models Only** – Remove eight (8) pump to bearing cover plate bolts (those with lock washers under head) and slide pump away from mounting as an assembly (Figure 10). DO NOT remove the four (4) screws without lock washers, as these hold pump together. Remove cover plate on main rotor side. NOTE: On fan cooled units with extended shaft on main rotor side, remove the oil seal retainer plate and seal seat ring.

11. Remove bearing cover plate (Figure 11). Use jack bolts to pull cover from dowel pins evenly.

12. Remove bearing outer race shims (Figure 12). NOTE: On units with shaft extension on main rotor, remove the oil seal. Protect seal carbon face from damage.

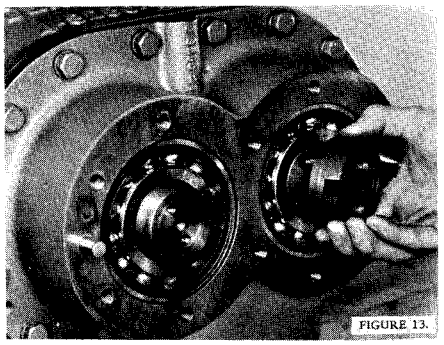


FIGURE 13.

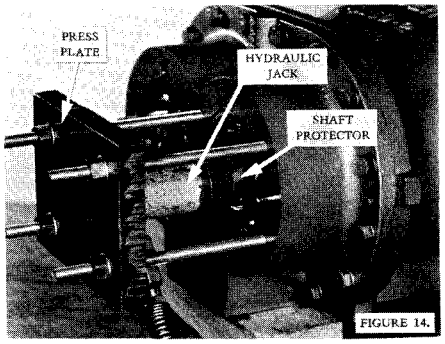


FIGURE 14.

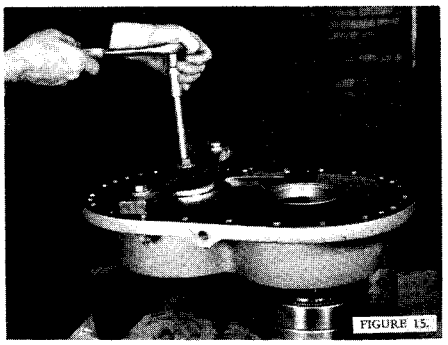
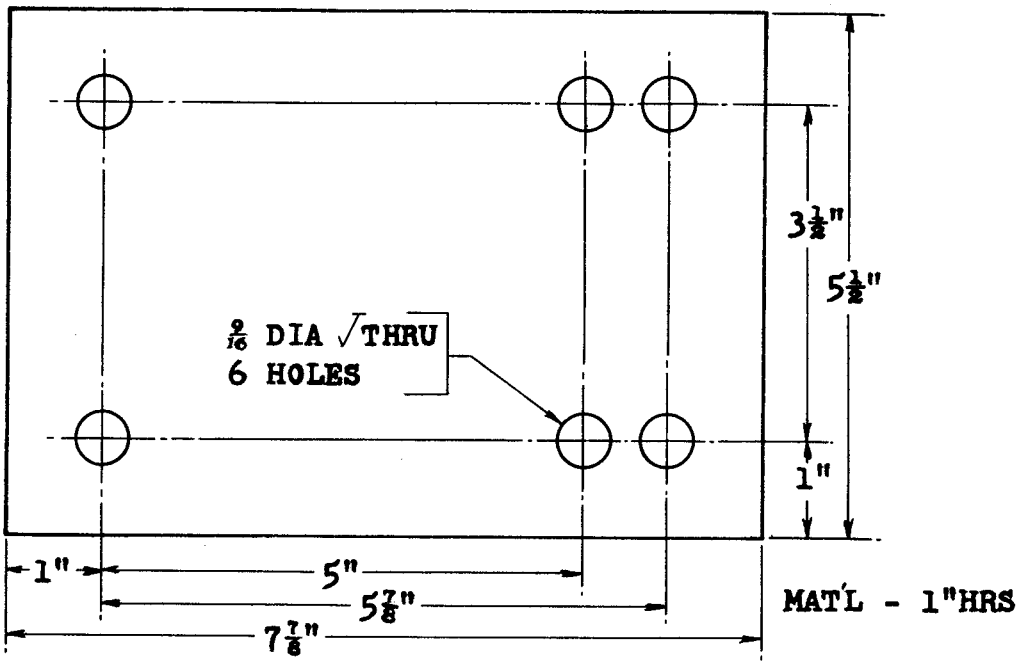


FIGURE 15.

13. Remove bearing retainer plate and bearing locknut from rotor shafts (Figure 13). Note that retainer plate has integral pump drive slot and pilots in rotor shaft.

14. Rig hydraulic jack and press plate as shown and press rotors through bearings at discharge end (Figure 14). Use shaft protector. When rotor extension is free of bearing remove rotor from cylinder. Remove with care to prevent burrs on rotor lobes and cylinder. Remove both rotors. NOTE: Sketch "A" gives dimensions of press plate. Bearing cover gasket may be used as template to lay out six holes required. This press plate is also used for installing discharge end bearings, Step 10, at assembly.

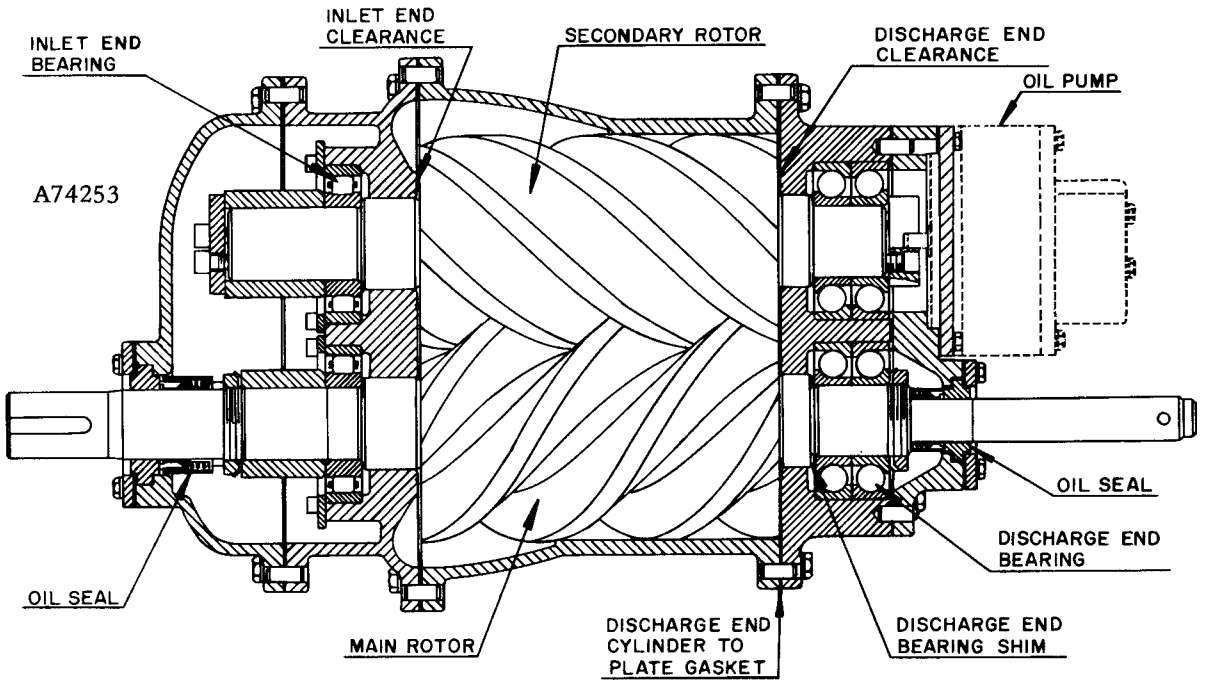
15. Remove discharge end plate from cylinder by use of jack bolts. Tighten jack bolts evenly to prevent binding of dowel pins. Discharge end bearings are slip fit in bore and may slide out by hand. Be careful they do not slide out when plate is turned over to push bearings out. Use padded surface and pushing tool to avoid damage (Figure 15). Tag bearings for reassembly in same position if to be reused. NEVER USE WORN BEARINGS.



SKETCH "A" – PRESS PLATE FOR REMOVING ROTORS FROM DISCHARGE END PLATE & FOR INSTALLATION OF DISCHARGE END BEARINGS

ASSEMBLY INSTRUCTIONS – COMPRESSOR UNIT

The ELECTRA-SCREW® compressor is manufactured with close tolerances for efficient operation. All parts must be handled carefully to prevent burrs which will give false tolerance readings and/or cause rapid wear. All parts and oil passages must be thoroughly cleaned of dirt which will cause galling of close running parts. Clean work area, washing tank, tools and wiping rags must be provided.



The ELECTRA-SCREW® operates without metal-to-metal contact of working parts. The measurements and procedures described in the following instructions must be done accurately for an efficient and quiet operating compressor. The measurements establish total rotor end clearance (inlet end plus discharge end) and fix the rotor in position to give correct discharge end clearance. Angular contact bearings and shims hold these close clearances when they are locked in position. Other clearances, such as rotor O.D. to cylinder, do not require measurement or setting since they are controlled by close manufacturing tolerances. As a general rule, if the assembled compressor turns freely, without drag or tight spots, proper clearances have been established within the machine.

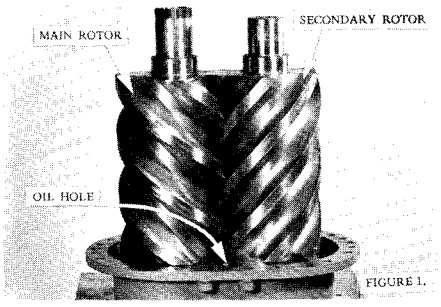


FIGURE 1.

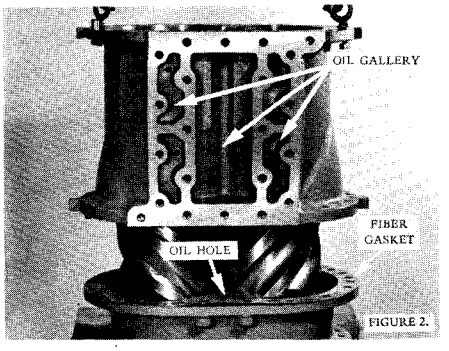


FIGURE 2.

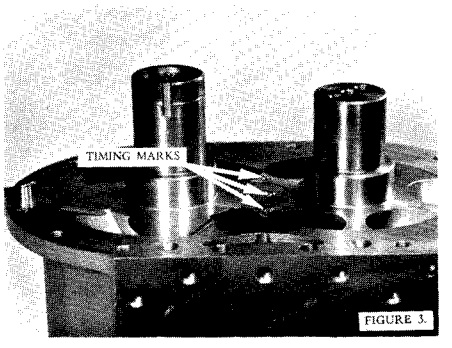


FIGURE 3.

1. (a) Place inlet end plate on suitable block with bearing bore side down. Coat both bores through end plate with oil.
   (b) Install rotors on end plate (Figure 1). The secondary rotor will be on the right and the main rotor on the left when viewed from oil hole side of plate. When last rotor is lowered in place, line up lobes to match timing marks (Figure 3). Use care in lowering the rotors through end plate to prevent burrs in end plate bore. NOTE: Each rotor carries pair identification marks. ROTORS MUST BE USED IN MATCHED PAIRS. Identification marks are also timing marks.

2. (a) Place fiber gasket on end plate; be sure to match holes in gasket with oil holes in plate, Figure 2. Lower cylinder in place. To avoid burring cylinder or rotors, take care to lower cylinder evenly and coat cylinder wall with oil.
   (b) Tighten all plate to cylinder cap screws including two screws inside oil gallery.
   (c) Cut out piece of gasket that bridges inlet opening.

3. With a bar through two bolts in end of rotor, rotate several times to be sure rotors are solid on the end plate. Check line-up of timing marks.

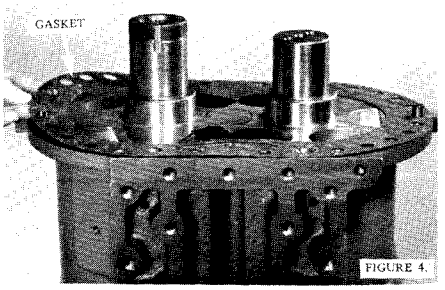


FIGURE 4.

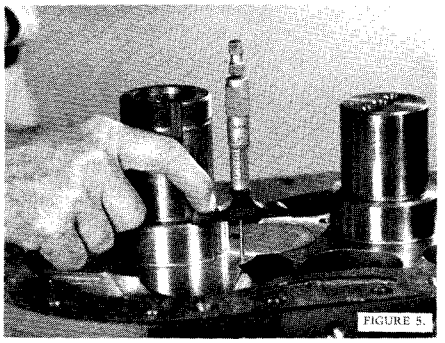


FIGURE 5.

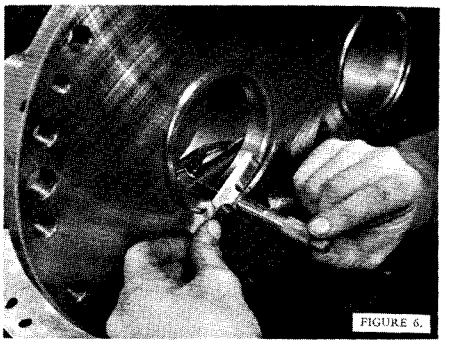


FIGURE 6.

4. Place gasket over dowel pins. Be sure gasket fits close to bore of cylinder to eliminate air slippage and does not block oil passages, Figure 4.

5. NOTE: Rotor end clearance at discharge end is most important and is established by use of shims between bearing and shaft shoulder to position end of rotor proper distance from end plate. Steps 5, 6, 8 and 9 must be performed carefully. With depth micrometer accurately measure the distance from bearing shoulder to face of rotor, Figure 5. Record measurement on each rotor for matching in Step 6. Be sure shoulder is free of burrs so bearing and shims will fit up tight.

6. With depth micrometer accurately measure distance from cylinder face of discharge end plate to flat stock placed across machined shoulder in bottom of bearing bore, Figure 6. (This shoulder supports the bearing outer race.) Be sure the flat stock used across shoulder is true to eliminate false readings. Record measurement of each bore in relationship to rotor measurements in Step 5. Inspect shoulder of bore for burrs to assure proper seating of bearing. If deep anvil outside micrometer is available, it may be used.

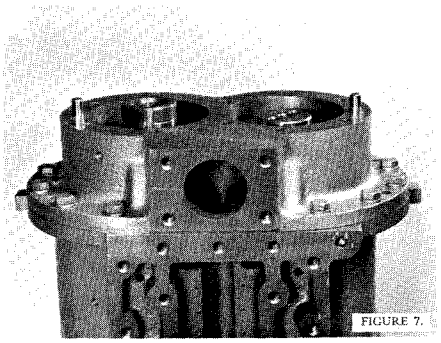


FIGURE 7.

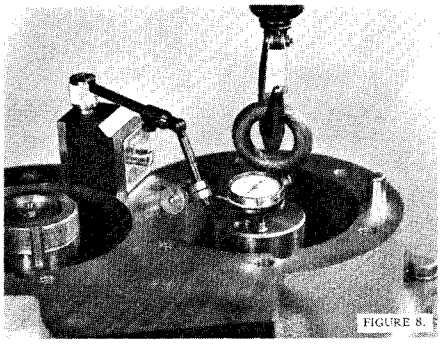


FIGURE 8.

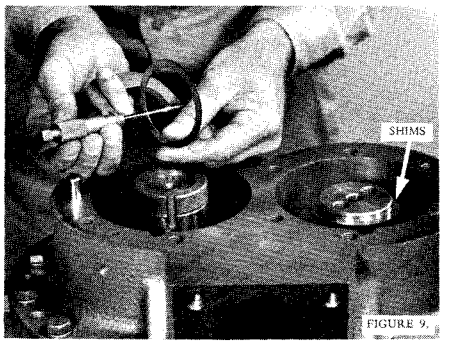


FIGURE 9.

7. Lower discharge end plate in place and tap over dowel pins evenly, Figure 7. Be sure plate to cylinder gasket stays in position. Install all cap screws, including two inside oil gallery, and pull up evenly to prevent binding of dowels. Tightening to proper torque rating will be done later in Step 15.

8. To check total end clearance, assemble dial indicator with button against end of shaft as shown in Figure 8. Set indicator on zero and lift rotor until end of rotor strikes face of discharge end plate. Reading of indicator will be total end clearance and should match range shown in Clearance Chart. Make this check on both rotors. If indicator reading is less than .020 (minimum) check for burrs between end of rotor and end plate. If reading is more than .036 (maximum) check for burrs between end plates and cylinder.

9. To determine the thickness of shims needed to give correct rotor discharge end clearance, subtract rotor shaft measurement, Step 5, from end plate measurement, Step 6. To this figure add discharge end clearance (refer to Clearance Chart). Add an additional .002" for crush fit. Be sure the rotor shoulder and end plate measurements are matched according to their related assembly positions. Check shim set thickness with outside micrometer, Figure 9. Install shims on respective shaft extension. NOTE: Installing end plate, Step 7, before performing Step 9 is recommended to prevent damage to shims as end plate slips over shaft.

CLEARANCE CHART – UNIT COLD

Total End Clearance (Inlet + Discharge)	.020 - .036
Inlet End Clearance	.018 - .032
Discharge End Clearance	.002 - .004

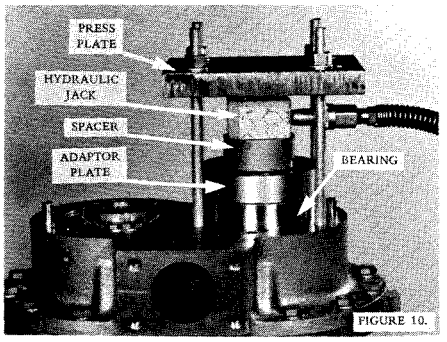
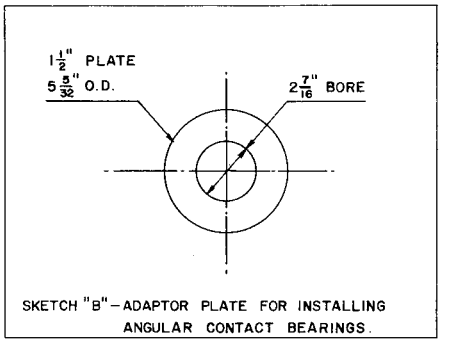
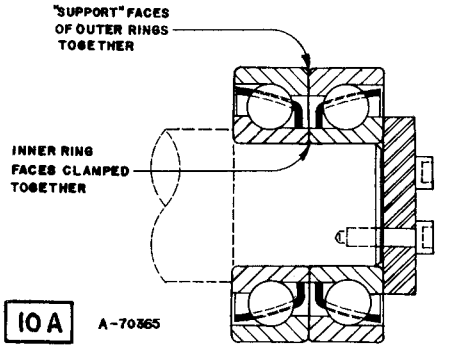


FIGURE 10.



SKETCH "B" – ADAPTOR PLATE FOR INSTALLING ANGULAR CONTACT BEARINGS.



10A A-70365

10. For ease of bearing assembly, lightly coat bearing bore and shaft extension with "Moly" type grease. NOTE: Do not drive bearings in with hammer and drift as damage to bearings may result, leading to early bearing failure. Figure 10 illustrates one method using press plate (see Sketch "A", Step 14 at Disassembly), hydraulic jack, adaptor plate and spacer (if required). Dimensions for adaptor plate is shown in Sketch "B". Be sure bearing is started in bore evenly and does not cock while being pressed into bore. ASSEMBLE BEARINGS IN END PLATE IN POSITION SHOWN IN FIGURE 10A. Faces marked "Support" go together. This gives a fixed bearing, holding rotors in a fixed position. Observe disassembly tags so bearings go back in same relation if original bearings are used. Never use worn bearings.

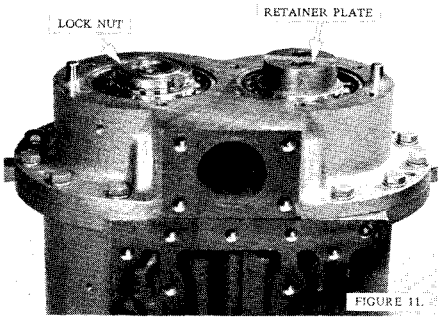


FIGURE 11.

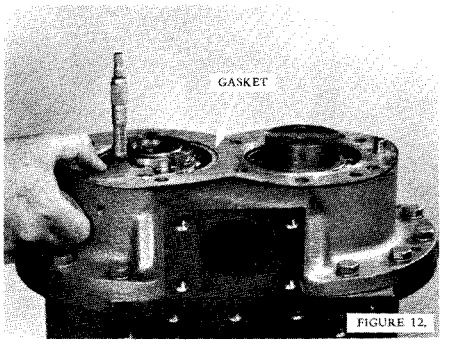


FIGURE 12.

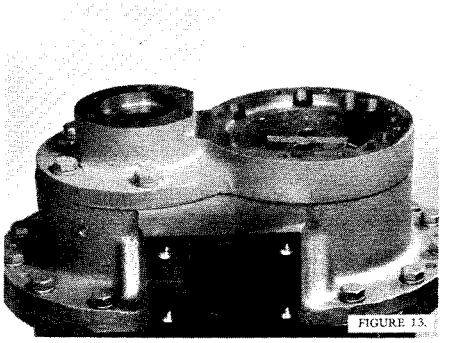


FIGURE 13.

11. Install bearing locknut and washer on main rotor and retainer plate on secondary rotor using Nylok type screws. Lubricate threads of nut and screws. Tighten the nut and retainer plate sufficiently to pull the rotor shaft through bearings until the shoulder of the shaft and shims, Figure 9, are jammed against bearing inner race. This provides proper rotor position from discharge end plate. Bend ear of washer into slot of nut.

12. Install bearing outer race shims and cover plate gasket. Shims are laminated and can be peeled to correct thickness. Shims must be .002" **below bearing cover plate gasket**. Check with depth micrometer, Figure 12. Shims must hold bearings in fixed position in bore. Be sure bearing outer race is seated in bore. NOTE: On fan cooled units with shaft extension on main rotor, install the shaft oil seal. Use care so teflon I.D. and carbon face are not damaged. Tighten Allen screws against shaft.

13. Oil bearings with oil to be used in unit. Make sure oil passage to bearing is not blocked by gasket. Install bearing cover plate and tighten evenly over dowel pins, Figure 13.

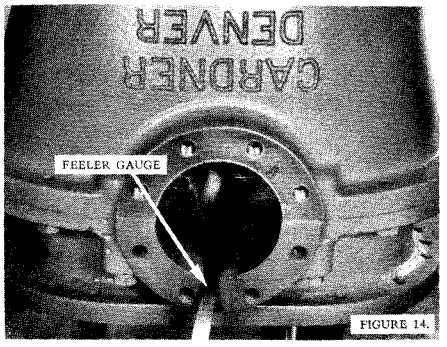


FIGURE 14.

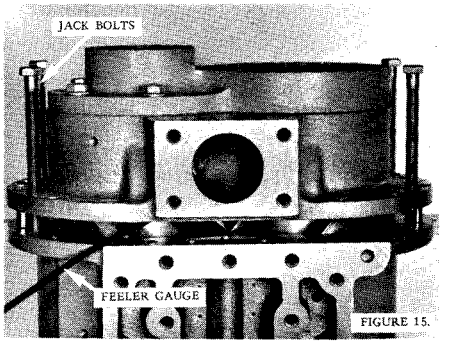


FIGURE 15.

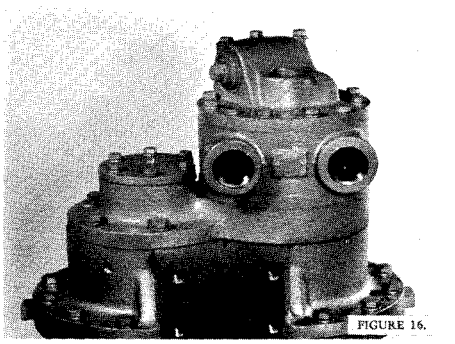
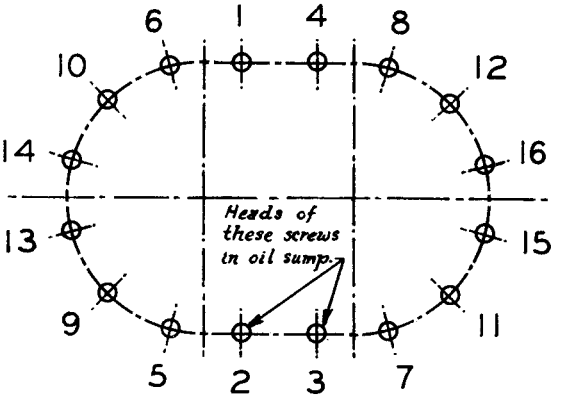


FIGURE 16.

14. Check inlet end clearance with feeler gauge through inlet opening, Figure 14. Rotate rotors and check each lobe of both rotors – refer to Clearance Chart.

15. Remove all discharge end plate to cylinder cap screws, including two inside oil gallery, and with four jack bolts, evenly

raise the end plate and rotor assembly about 1/2 inch to check discharge end clearance (between end of rotors and end plate), Figure 15. Refer to Clearance Chart for correct clearance. Check both rotors. If clearance is too small, it might be due to bearing outer race not seated against shoulder in bore. Remove bearing cover plate, jolt ends of rotor lightly – NOTE: Heavy blows may damage bearings. Repeat Steps 12 and 13 and recheck end clearance. If clearance is too great, it may be due to rotor shaft not being pulled through bearing far enough to jam shaft shoulder and shims (Figure 9) against bearing inner race. Check tightness of bearing retainers on end of shaft. If clearance is still not right, pull discharge end plate and recheck figures in Steps 5, 6, 8 and 9. Check for burrs on shoulders holding bearings from pulling up tight. Reassemble and again check clearances. When proper clearance is established, lower end plate and rotor assembly down on cylinder, install all screws and torque to 75-85 foot pounds and in sequence shown.



TORQUING SEQUENCE

16. **ES60A and ES60B Models Only** – Place gasket over pilot on oil pump face and lower pump into position as shown in Figure 16. Install bolts and pull up evenly. Plug openings of pump to keep out dirt. Install cover plate and gasket on main rotor side of bearing cover plate. NOTE: On fan-cooled units with shaft extension, install oil seal, seat ring gaskets, ring (polished face towards seal) and cover.

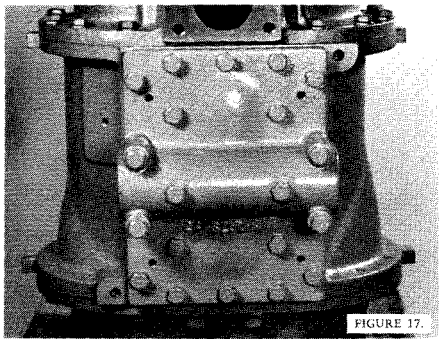


FIGURE 17.

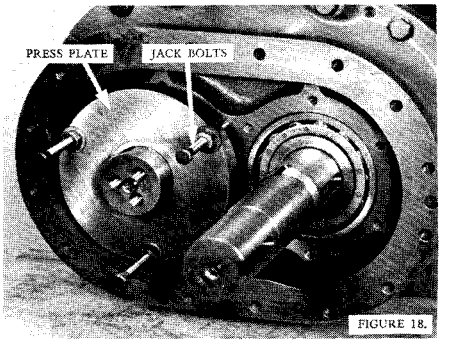
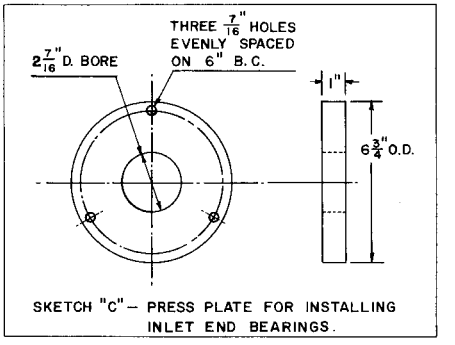


FIGURE 18.



SKETCH "C" – PRESS PLATE FOR INSTALLING INLET END BEARINGS.

17. Install oil gallery plate and gasket, Figure 17. Plug openings with clean rags to prevent entrance of dirt. Also protect inlet and discharge openings of unit.

18. Place assembly in horizontal position on substantial blocking. Lightly coat shaft and bearing bore with "Moly" type grease. Slide bearing over shaft extension. Assemble press plate as shown in Figure 18. Dimensions for press plate are shown in Sketch "C". Progressively tighten nuts on press plate screws and press bearing into place. Take care not to cock bearing or jam rollers as bearing enters bore. NEVER DRIVE BEARINGS IN PLACE.

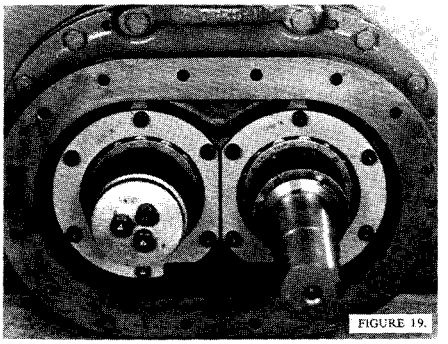


FIGURE 19.

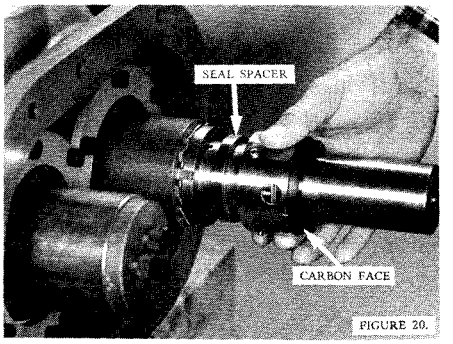


FIGURE 20.

19. Install bearing outer race retainers using Nylok type screws, Figure 19. Inspect shaft for burrs. Oil bearings with oil to be used in unit. Install bearing spacers (no keys used in shaft extension) with beveled end towards bearings. Install nut and lock washer on main rotor, and the retainer plate and three (3) Nylok screws on secondary rotor and pull up tight, Figure 19. Bend ear of washer into slot of nut.

20. Be sure face of nut is square and flat so seal spacer ring will run true. Slide seal spacer ring over shaft with counterbored side towards nut. Install seal with care so teflon I.D. and carbon face is not damaged. Tighten three (3) Allen screws in seal. Be sure seal is positioned solidly against spacer.

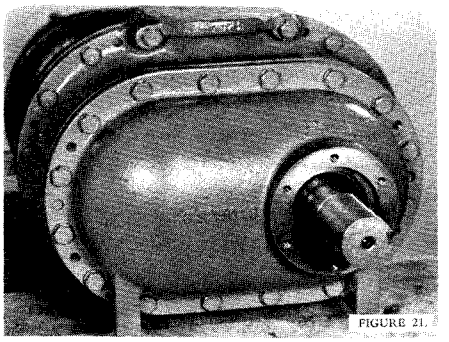


FIGURE 21.

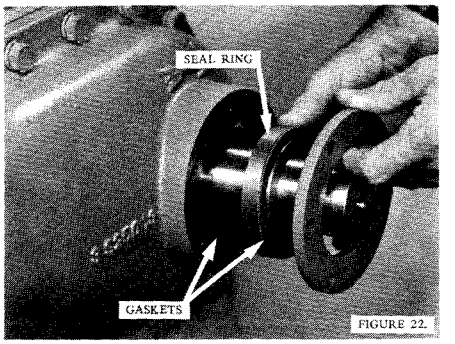


FIGURE 22.

21. Install bearing cover and gasket, Figure 21. Take care carbon face of seal is not damaged. Install all cap screws and tighten evenly to prevent binding of dowels.

22. Install seal ring gasket in counterbore of housing. Install seal ring in bore with polished face towards seal. Install outer gasket and cover, Figure 22. Tighten cap screws evenly so seal ring isn't cocked in bore.

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