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13-9-610
2nd Edition

Instruction & Service Manual

ELECTRA-SCREW ®

STATIONARY

BASE MOUNTED

COMPRESSOR

- 250 HP - MODEL ESQ
- 300 HP - MODEL ESR
- 350 HP - MODEL ESS
- 400 HP - MODEL EST

13-9-610

GARDNER-DENVER COMPANY

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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.

THIS BOOK COVERS THE FOLLOWING MODELS:

	AIR COOLED	WATER COOLED
250 HP	ESQAE (100 PSI) ESQBE (125 PSI)	ESQAF (100 PSI) ESQBF (125 PSI)
300 HP	ESRAE (100 PSI) ESRBE (125 PSI) ESRCE (150 PSI)	ESRAF (100 PSI) ESRBF (125 PSI) ESRCF (150 PSI)
350 HP	ESSAE (100 PSI) ESSBE (125 PSI) ESSCE (150 PSI)	ESSAF (100 PSI) ESSBF (125 PSI) ESSCF (150 PSI)
400 HP	ESTAE (100 PSI) ESTBE (125 PSI) ESTCE (150 PSI)	ESTAF (100 PSI) ESTBF (125 PSI) ESTCF (150 PSI)

FOREWORD

Gardner-Denver ELECTRA-SCREW® compressors are the result of advanced engineering and skilled manufacturing. 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 the maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

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SECTION 1

GENERAL INFORMATION

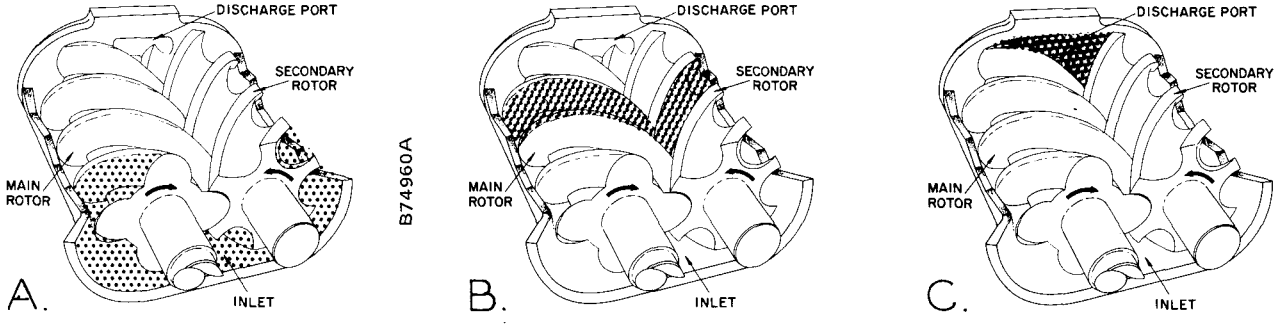


FIGURE 1-1. – COMPRESSION CYCLE

COMPRESSOR – The Gardner-Denver Model "ES" Electra-Screw® compressor is a single stage, positive displacement rotary machine using meshing helical rotors to effect compression. The input drive shaft and helical drive gear are supported in the gear case by high capacity ball and roller bearings; the drive gear meshes with a driven gear mounted on the main rotor shaft to drive the rotors. Both rotors are supported between large capacity antifriction 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.

COMPRESSION PRINCIPLE (Figure 1-1) – Compression is accomplished by the main and secondary rotors synchronously meshing in a one-piece cylinder. The main rotor has four helical lobes 90° apart. The secondary rotor has six matching helical grooves 60° apart to allow meshing with main rotor lobes.

The air inlet port is located on top of the compressor near the drive shaft end. The discharge port is near the bottom at the opposite end of the compressor cylinder. Figure 1-1 is an inverted view to show inlet and discharge ports. The compression cycle begins as rotors unmesh at the inlet port and air is drawn into the cavity between the main rotor lobes and secondary rotor grooves (A). When the rotors pass the 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. 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). Each rotor cavity follows the same "fill-compress-discharge" cycle in rapid succession to produce a discharge air flow that is continuous, smooth and shock-free.

AIR FLOW (Figure 1-3) – Air enters the air filter and passes through the inlet unloader valve to the compressor. After compression, the air/oil mixture passes into the oil reservoir where most of the entrained oil is removed by velocity change and impingement and drops back into the reservoir. The air and remaining oil then passes through the oil separator; the separated oil is returned to the system through tubing connecting the separator and compressor. The air passes through the reservoir discharge manifold, minimum pressure valve, discharge check valve and the unit shutoff globe valve to the plant air lines.

LUBRICATION, COOLING AND SEALING – Oil is forced by air pressure from the oil reservoir through the oil cooler, thermostatic mixing valve (mixing valve is not used with the water-cooled oil cooler), and oil filter and discharges into the compressor main oil gallery. A portion of the oil is directed through internal passages to the bearings, gears and shaft oil seal. The balance of the oil is injected directly into the compression chamber to remove heat of compression, seal internal clearances and lubricate the rotors.

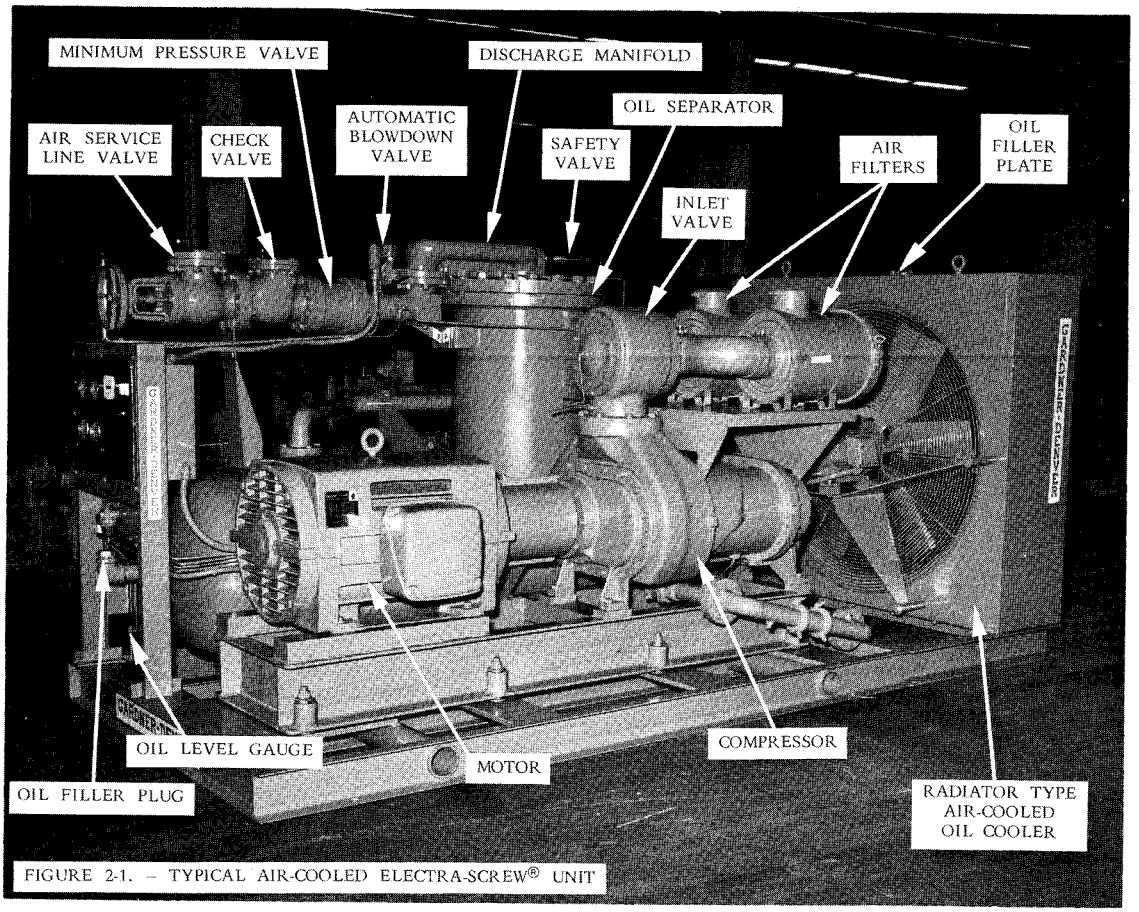


FIGURE 2-1. – TYPICAL AIR-COOLED ELECTRA-SCREW® UNIT

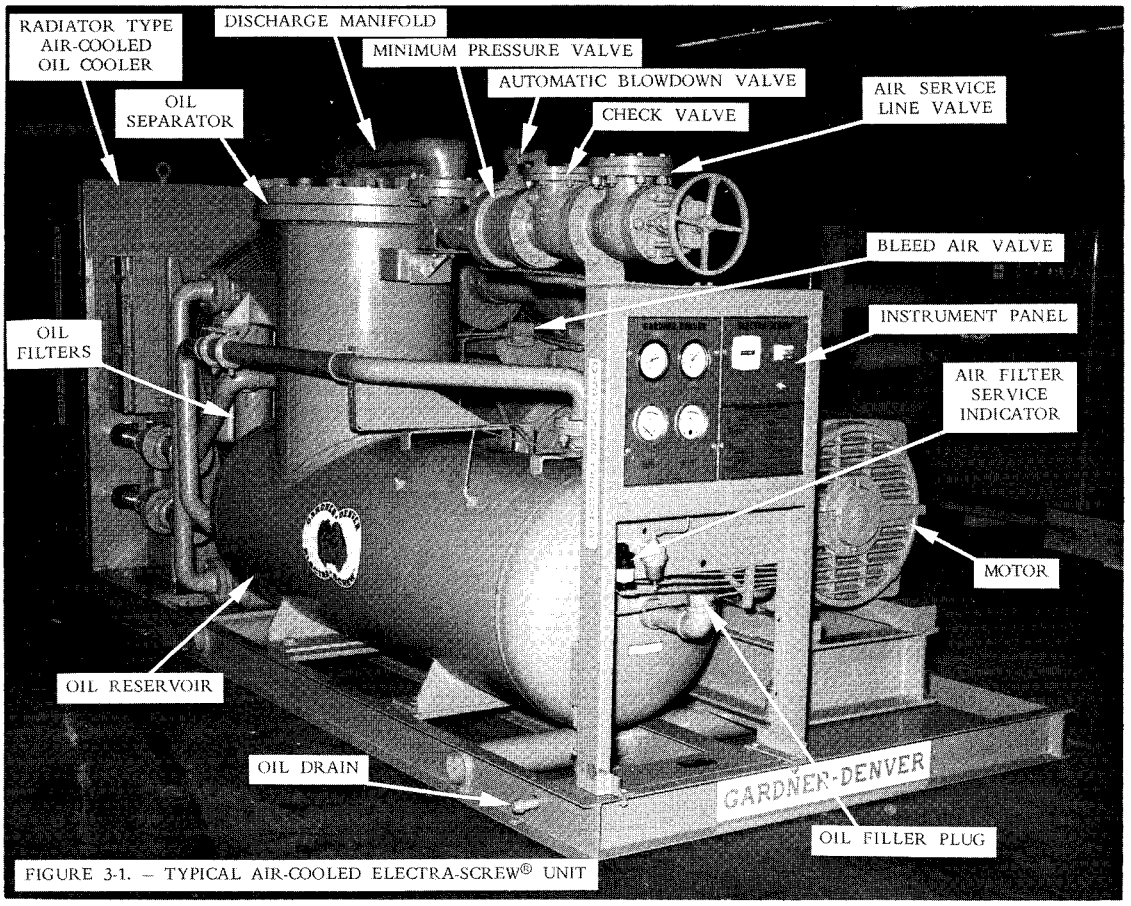


FIGURE 3-1. – TYPICAL AIR-COOLED ELECTRA-SCREW® UNIT

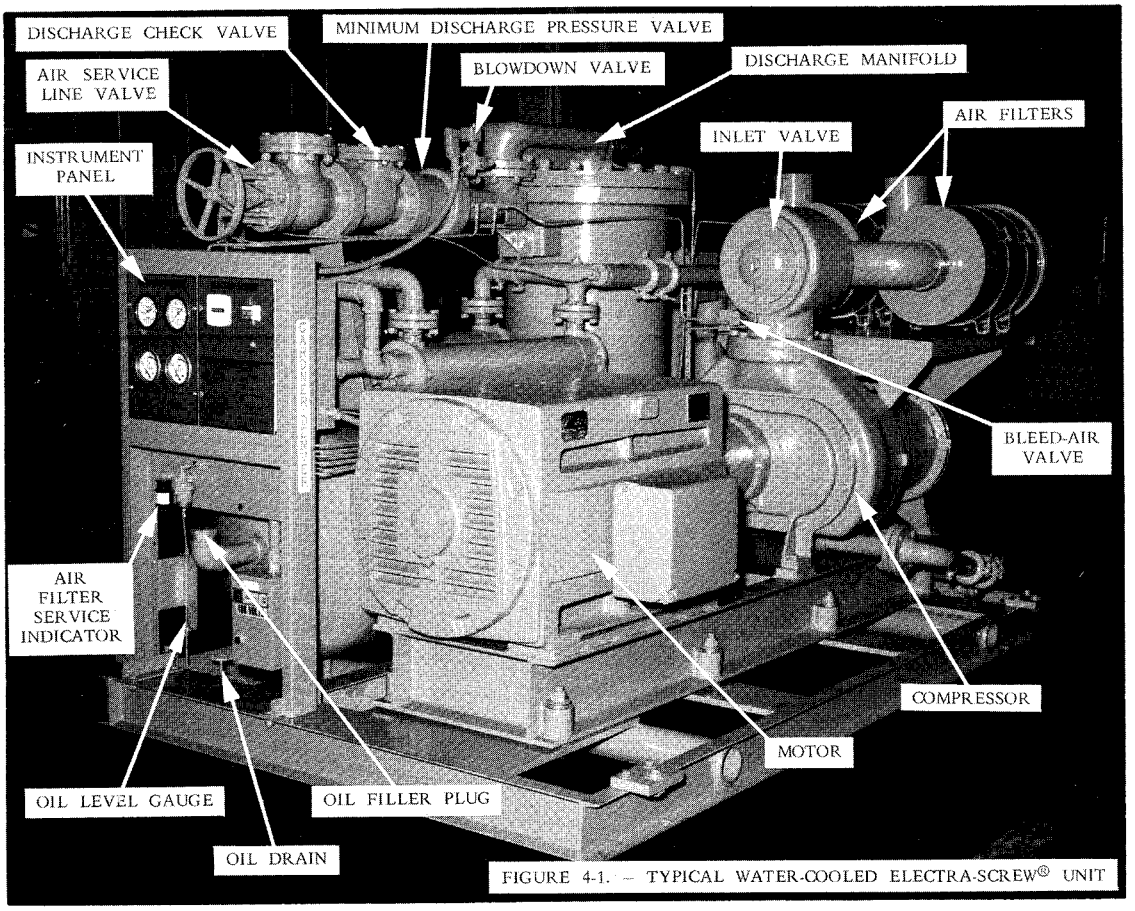


FIGURE 4-1. – TYPICAL WATER-COOLED ELECTRA-SCREW® UNIT

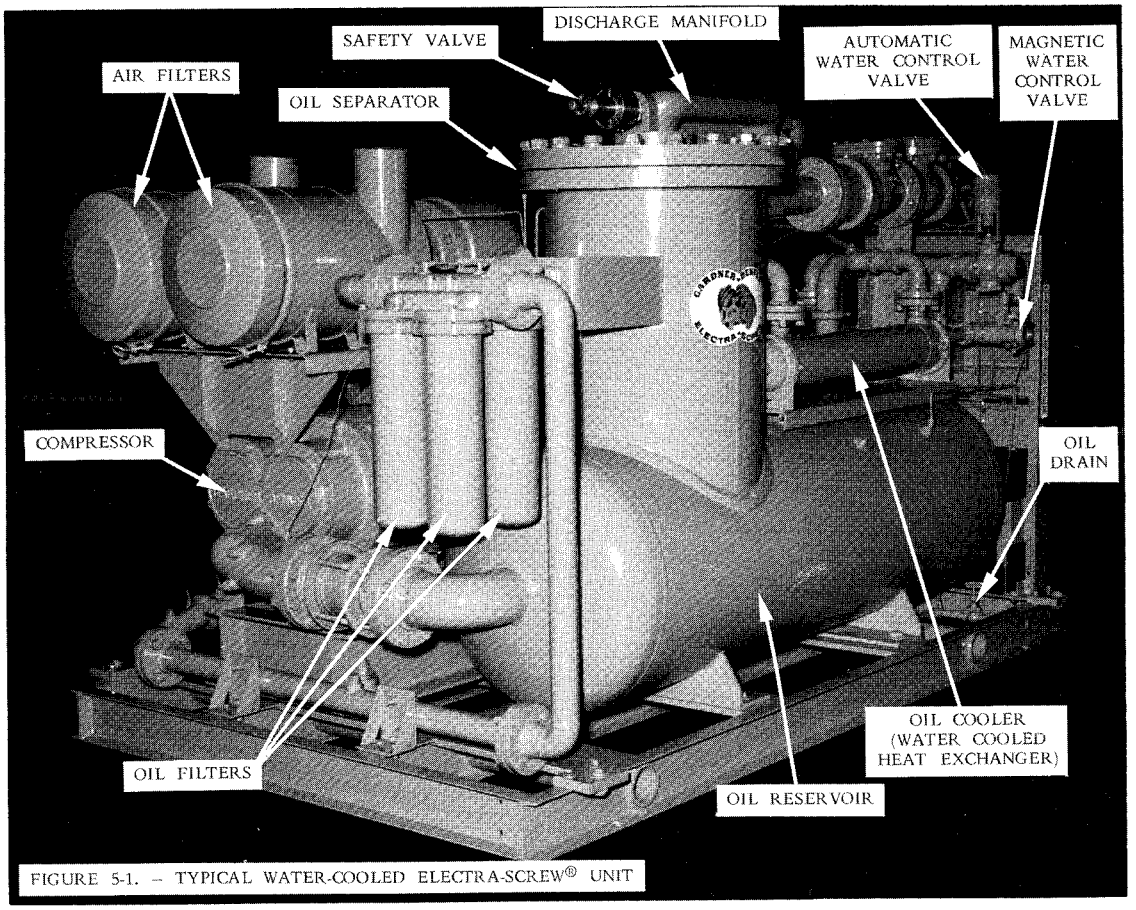


FIGURE 5-1. – TYPICAL WATER-COOLED ELECTRA-SCREW® UNIT

Notes

SECTION 2

INSTALLATION

GENERAL – On receipt of the 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 the compressor or base; bearings can be damaged by passage of current.

LIFTING BAIL – A lifting bail is provided to facilitate handling of the compressor unit. **Use the lifting bail only to lift the unit. Do not use other places such as the motor, compressor or discharge manifold piping as lifting points. Do not attempt to lift a connected compressor unit and air-cooled oil cooler module as one piece – lift the compressor unit and oil cooler module separately.** Acoustic enclosure top panel must be removed for access to the lifting bail. After use, the lifting bail may be removed.

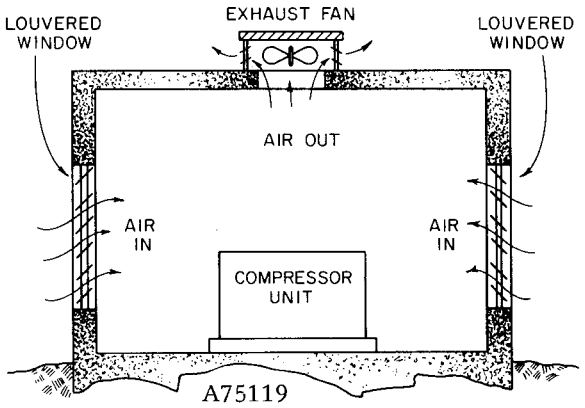


FIGURE 1-2. – TYPICAL COMPRESSOR ROOM

LOCATION – The compressor should be installed 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. In some cases it may be necessary to install the air filter at some distance from the compressor to obtain a proper air supply.

The compressor unit requires electric motor cooling air as well as air to the compressor inlet. Proper ventilation MUST be provided (Figure 2-2); hot air must be exhausted from the compressor operating area. A typical inlet-outlet air flow arrangement is shown in Figure 1-2.

If the air-cooled oil cooler module is to be installed at a location remote from the compressor unit, be sure that adequate ventilation is provided, Figure 2-2. Hot air must be exhausted from the oil cooler area.

VENTILATION – The unit, whether air or water cooled, with the standard acoustic enclosure requires sufficient air flow, Figure 2-2, for electric motor (main drive and enclosure vent fan) cooling. Air is drawn into the unit through ducts in the top and side of the enclosure and is exhausted vertically. Do not block air flow to and from the unit. Allow two (2) feet to the nearest obstruction on all sides and above the unit. When the unit is used without an acoustic enclosure, all of the ventilation and cooling air requirements also apply.

FOUNDATION – The Electra-Screw® compressor requires no special foundation but should be mounted on a smooth, solid surface of sufficient strength to support the weight of the unit. Whenever possible install the unit near level. Temporary installation may be made at a maximum of 10^{o} angle lengthwise or 30^{o} sidewise.

Mounting bolts are not normally required. However, installation conditions such as piping rigidity, angle of tilt, or danger of shifting from outside vibrations or moving vehicles may require the use of mounting bolts to the foundation. Coupling alignment must be checked AND MOTOR FEET DOWELED after installation. See Section 7 "Coupling".

OIL RESERVOIR DRAIN – The oil reservoir drain valve is located near the end of the oil reservoir just below the instrument panel. The drain valve is approximately 3 inches from the floor level. If this height is not sufficient to conveniently drain the oil, some other methods of providing oil drain are:

1. Elevate the compressor unit on the foundation to obtain the desired drain height.
2. Construct an oil sump or trough below the floor level and pump or bail the drained oil.
3. Pump oil from the reservoir filler opening or reservoir drain to a container.

MINIMUM AIR* FLOW FOR COMPRESSION AND COOLING
Cubic Feet/Minute

Model	Open Or Enclosed Compressor Unit	Oil Cooler Module	Open Unit With Connected Oil Cooler Module
ESQ	9300	26200	35500
ESR	9500	26500	36000
ESS	9800	26700	36500
EST	10000	27000	37000

* 80^{o} F. Inlet Air

FIGURE 2-2.

ACOUSTIC ENCLOSURE – The Electra-Screw® unit is furnished with an acoustic enclosure as standard equipment. The enclosure reduces the normal operating sound of the unit to 80 DBA or below in free field conditions.

In order to maintain the sound reduction ability of the cabinet, only the final discharge air line penetrates the enclosure. Other openings for electrical conduit, oil drain piping and water piping are to be cut into the enclosure during the time of installation at convenient positions for connection to external wiring and piping. All openings should be no larger than necessary for conduit or pipe diameter; the conduit or pipe should not touch the enclosure. When all conduit and pipes are in place, the open space between them and the enclosure panel should be sealed with a rubber grommet or elastic caulk. See "Electrical Wiring" below for precautions on wiring the starter to the compressor unit.

Service doors are provided for access to the instrument panel and controls and the oil and air filters. Be sure to allow enough space around the unit for doors to open completely as shown on outline drawing.

Access panel is provided on the top of the unit for servicing of the oil separator. Be sure to allow enough room above unit for panel and separator removal as shown on outline drawing.

The air for the compressor and for enclosure ventilation is drawn in through ducts in the top and side of the enclosure and is exhausted from the top of the enclosure. Do not block this air flow or allow the floor area near the enclosure to accumulate dirt.

AIR-COOLED OIL COOLER MODULE – The air-cooled oil cooler is a separate module and may be mounted remote to the enclosed compressor unit. If the compressor unit is not enclosed, the oil cooler module may be bolted and piped directly to the compressor unit base.

Ventilation – The oil cooler requires adequate cooling air flow. Proper ventilation MUST be provided, with hot air exhausted away from the cooler; take care that hot air is not recirculated from the exhaust to the inlet side of the cooler. Cooling air flow direction is from the motor side through the grille side of the oil cooler. Do not obstruct the air flow to or from the cooler. Allow two (2) feet clearance on all sides of the cooler module. See Figure 2-2 for cooling air flow requirements.

Low Oil Pressure Protection – The standard factory-installed low oil pressure shutdown switch on the compressor unit will prevent start-up or shut the unit down if oil pressure is not established or maintained due to malfunction in either a direct-connected or remote oil cooler system.

Direct-Connected Oil Cooler – Direct connection of the oil cooler module to the compressor unit main base should not be attempted with an enclosed compressor unit. Problems in piping, wiring, vibration isolation and maintaining the acoustic integrity of the compressor unit enclosure make such installations impractical. If the oil cooler module must be mounted near an enclosed compressor unit, consider a close-coupled arrangement using minimum lengths of pipe and conduit without an actual joining of the bases and modification of the compressor unit acoustic enclosure.

When the oil cooler module is specified for connection to the main base of an open compressor unit, all connecting parts, piping and wiring are supplied and where possible, in place on the compressor unit and the oil cooler module. The user is to join the bases, connect pipe unions or flanges and the electrical wiring. The compressor unit and oil cooler module should be set in place as separate units, then joined; DO NOT ATTEMPT TO USE THE COMPRESSOR UNIT LIFTING BAIL ONLY TO LIFT A JOINED COMPRESSOR UNIT AND OIL COOLER MODULE.

Remote-Mounted Oil Cooler – The oil cooler module can be mounted in any of several remote locations: close coupled, but not joined to the compressor unit; horizontal remote, located on the same level as the compressor unit, but some distance away; overhead remote, located above the level of the compressor unit, as on a roof. All piping and wiring between the compressor unit and the remote oil cooler is to be supplied by the user. THE DESIGN OF THE REMOTE OIL COOLER MODULE SYSTEM MUST BE APPROVED BY THE FACTORY BEFORE INSTALLATION. The design information to be submitted for approval includes:

1. Location of oil cooler module – inside or outdoors.
2. Range of operating ambient temperatures at the oil cooler location.
3. Elevation of the oil cooler above the compressor unit.
4. Pipe type and size(s) to be used to connect the oil cooler and the compressor unit. Minimum pipe size is 2-1/2" IPS.
5. Horizontal and vertical lengths of the pipe run. If more than one pipe size is used, list length of each size and total length.
6. Number and size of elbows, tees, unions, reducers and valves to be used in the pipe run.
7. A dimensioned sketch of the proposed piping system showing location of the compressor unit, oil cooler and pipe and fittings of 3 through 6 above.

All remote piping should be of adequate size to insure the minimum pressure loss. Design point 4 above lists the pipe size at the compressor unit oil inlet and outlet connections and is the minimum pipe size to be used. Long runs of pipe and the use of valves and fittings require larger than the minimum pipe sizes in the system to keep the pressure loss low. All pipe and fittings used in a remote oil cooler system should be galvanized or treated internally to prevent rust, and all valves are to be of a nonferrous construction to prevent corrosion and fouling.

The remote cooler should be placed so that the fan air flow through the cooler (air flow is from motor side through core) and the prevailing winds are in the same direction. A baffle should be provided on the exhaust side of the cooler for protection against occasional wind shifts.

For long runs of pipe or location of the oil cooler outdoors where the inlet oil temperature may be lowered due to heat radiation, the thermostatic mixing valve and bypass line should be removed from the oil cooler module and repiped into the oil system at the compressor unit. Thermal insulation of the pipe may be used in addition to the relocation of the thermostatic mixing valve/bypass line for reduced heat loss. Oil inlet temperature to the compressor must be maintained above 130° F.

When the oil cooler is mounted above the compressor unit, a check valve is furnished mounted on the compressor unit

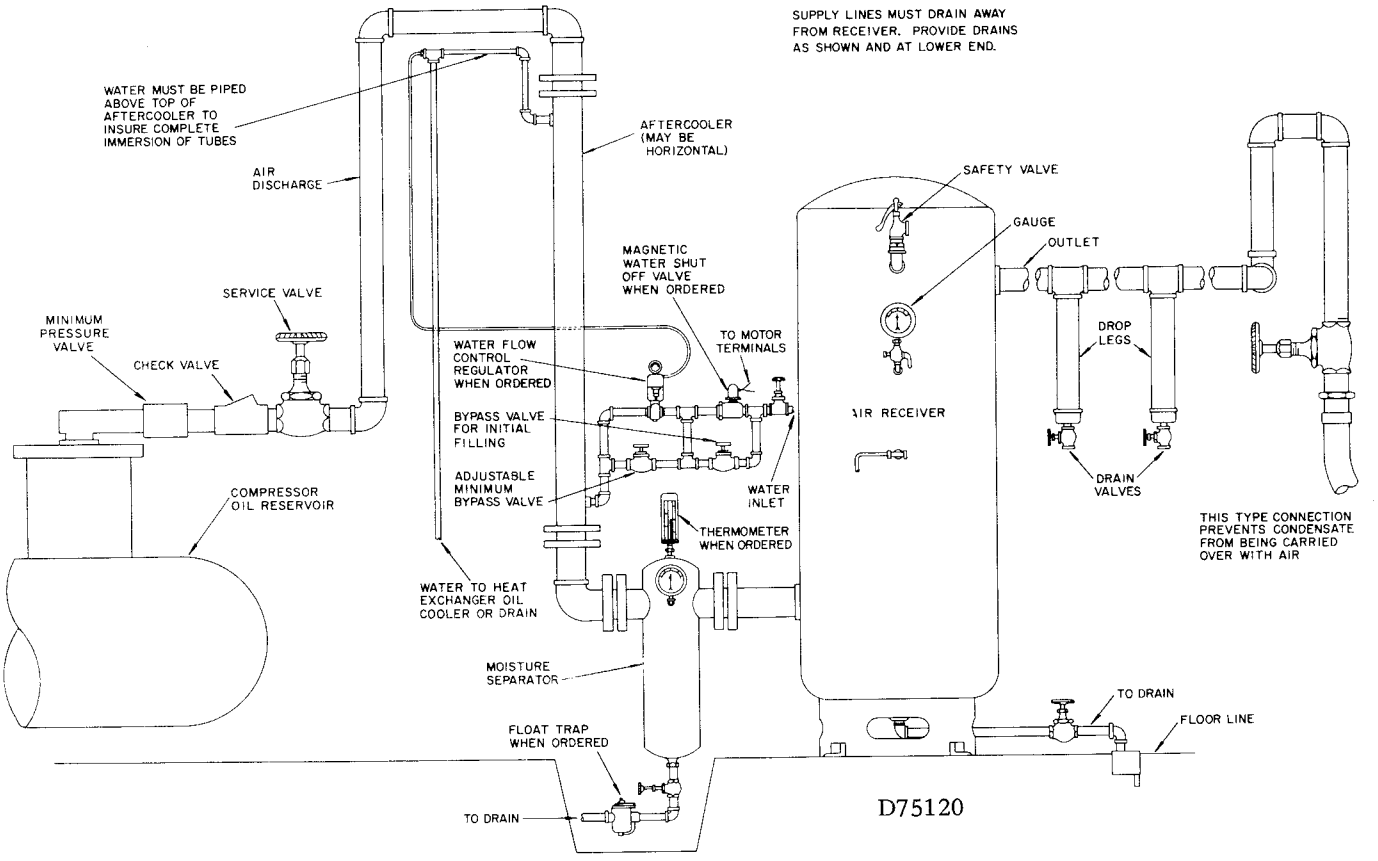


FIGURE 3-2. – AUXILIARY ACCESSORIES

in the line to the oil cooler; see Figure 2-5. A pneumatic pilot-operated normally-closed valve is furnished mounted at the oil filter inlet on the compressor unit line from the oil cooler; see Figure 2-5. The check valve permits oil flow to the oil cooler during operation, but prevents return oil flow from the cooler when the unit is shut down. The pilot valve is held open by air pressure from the unit oil reservoir during operation and closes under spring load when the unit is shut down to prevent return oil flow from the oil cooler.

An oil filler plate is located on top of the oil cooler for ease of filling of a remote oil cooler; see Figure 2-5.

A vent line as shown in Figure 2-5 is to be provided by the user to aid in filling the remote overhead oil cooler. The check valves and breather filter are furnished as part of the remote overhead oil cooler package.

AUXILIARY AIR RECEIVER – Constant speed control units do not normally use an auxiliary air receiver. Duomatic control units require an auxiliary air receiver unless the piping system is large and provides sufficient storage capacity to prevent rapid cycling. When used, an air receiver should be of adequate size, provided with a relief valve of proper setting, a pressure gauge and a means of draining condensate. Figure 3-2 shows a typical air receiver and auxiliary accessories.

AFTERCOOLER (Figure 3-2) – An aftercooler will provide control of moisture entering the shop air lines while reducing the normal low discharge temperature of about 170° F. at 100 PSIG discharge pressure to near inlet air temperatures.

When an aftercooler is used, it is to be installed between the compressor discharge and the auxiliary air receiver. A moisture separator is to be mounted between the aftercooler and the auxiliary air receiver with a condensate drain provided at the bottom.

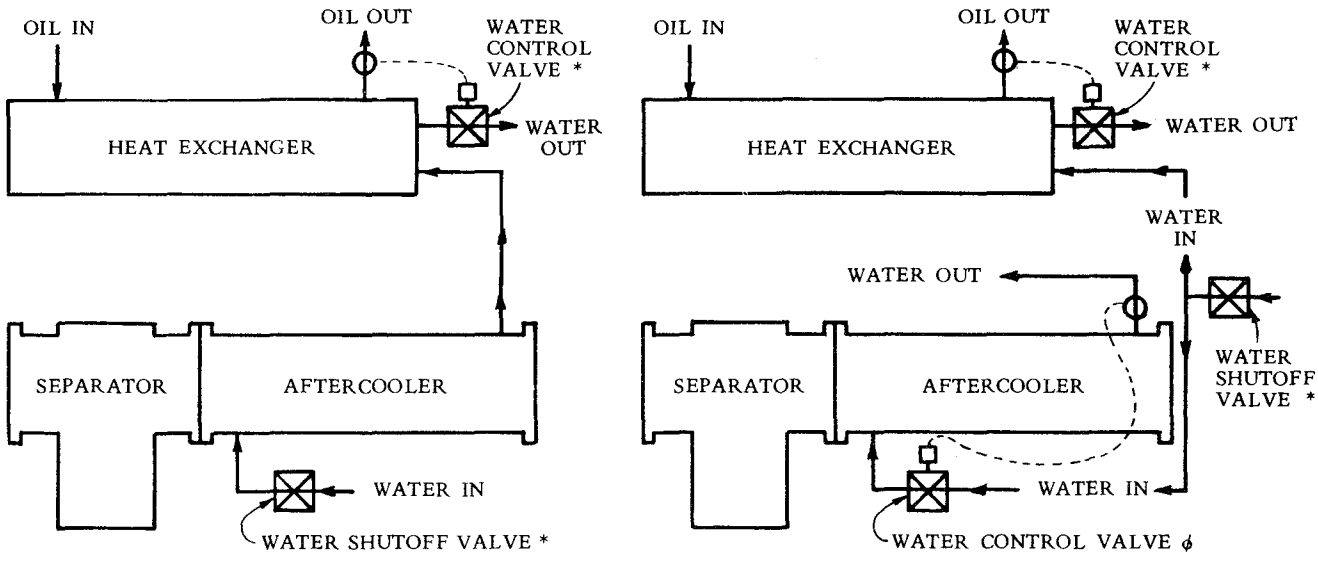
For complete installation and maintenance instructions on any accessory equipment, refer to the manufacturer's bulletin included in the unit data package.

CONTROL PIPING – Control piping is not necessary since the Electra-Screw® unit is factory wired and piped for the control system specified.

INLET LINE – Where an inlet line is used between the 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 the inlet opening on the compressor. If an extra-long line is necessary, the pipe size should be increased accordingly:

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 relocating the filters from the unit to a remote location.



SERIES PIPING – Water flow must be through aftercooler first for effective cooling of discharge air.

PARALLEL PIPING – Two water control valves required for temperature control of oil and discharge air temperature.

* FURNISHED BY GARDNER-DENVER COMPANY.
ϕ MUST BE ORDERED SEPARATELY.

FIGURE 4-2. – PIPING DIAGRAM FOR AFTERCOOLER AND HEAT EXCHANGER

DISCHARGE SERVICE LINE – The discharge service line connection is made at the globe valve located above the instrument panel of the unit. When manifolding two or more ES units on the same line, each ES unit is isolated by the check valve in the unit discharge line. If an ES unit is manifolded to another compressor, be sure the other compressor has a check valve in the line between the machine and the manifold.

BLOWDOWN VALVE PIPING – The blowdown valve is fitted with a muffler for operation indoors. If the installation requires, the muffler may be removed and the blowdown valve piped to the outside with pipe the same size as the blowdown valve outlet connection. See "Acoustic Enclosure" for precautions on piping which penetrates the enclosure.

WATER PIPING (Water-Cooled Heat Exchanger Models Only) – On machines equipped with a water-cooled heat exchanger, pipe water to the magnetic water shutoff valve mounted in the water inlet piping to the heat exchanger. Pipe outlet water from the water flow control valve to a sump or drain. See "Acoustic Enclosure" for precautions on piping which penetrates the enclosure.

The water source should be capable of supplying up to the maximum flow shown in Figure 5-2 below at a minimum

APPROXIMATE WATER FLOW – U.S. GALLONS/MINUTE						
Model	Rated Pressure PSIG	Water Temperature To Heat Exchangers				Maximum Water Flow
		60° F.	70° F.	80° F.	90° F.	
ESQAF	100	25.0	31.0	41.0	63.0	81.6
ESQBF	125	28.0	35.0	46.0	70.0	
ESRAF	100	29.0	37.0	50.0	73.0	121.2
ESRBF	125	31.0	39.0	53.0	78.0	
ESRCF	150	34.0	42.0	56.0	84.0	
ESSAF	100	33.0	41.0	55.0	82.0	121.2
ESSBF	125	37.0	47.0	61.0	93.0	
ESSCF	150	37.0	47.0	61.0	93.0	
ESTAF	100	36.0	45.0	59.0	89.0	121.2
ESTBF	125	41.0	51.0	67.0	103.0	
ESTCF	150	44.0	54.0	72.0	110.0	

The maximum water flow shown is that total flow allowable to the dual heat exchangers. The maximum allowable flow to each heat exchanger is one-half the total flow.

FIGURE 5-2.

pressure of 40 PSIG; maximum allowable water pressure is 150 PSIG.

The water flow rates shown in Figure 5-2 are approximate and a guide to sizing piping, cooling towers and other water system equipment. Water pipe size on unit is 2" NPT inlet and outlet.

The heat exchanger system is designed to operate with water inlet temperatures from 60° F. to 90° F. and a water outlet temperature not to exceed 110° F. If water cooler than 60° F. is used, high water outlet temperatures (over 110° F.) will be experienced along with shortened heat exchanger life caused by tube fouling and corrosion. If water warmer than 90° F. is used, higher compressor oil inlet temperatures and high water usage will result.

Most water systems will require control of impurities: filtration, softening or other treatment. See "Compressor Oil Cooler -- Water-Cooled Heat Exchanger" for more information on the water system.

Aftercooler – Heat Exchanger Water Piping (Figure 4-2) -- If an aftercooler is used and piped in series with the heat exchanger, remove the magnetic water shutoff valve from the compressor unit and relocate in the water inlet line upstream of the aftercooler. Pipe the aftercooler outlet water to the heat exchanger on the compressor unit. If the aftercooler is piped in parallel with the heat exchanger, provide a separate magnetic water control valve for the aftercooler and pipe separate inlet water lines to both the aftercooler and the heat exchanger. See "Acoustic Enclosure" for precautions on piping which penetrates the enclosure.

The water control valve is to be adjusted to maintain oil out of the heat exchanger within the 130°-140° F. range regardless of inlet water flow or temperature. See Section 5 for adjustment instructions and maximum allowable oil temperature.

ELECTRICAL WIRING – The Electra-Screw® unit is furnished with the compressor motor enclosure as specified by the user and a totally enclosed "air over" enclosure vent fan motor. If the unit has an air-cooled oil cooler, this fan motor is also a totally enclosed "air over" type and is complete with starter and enclosure as specified by the user.

It is necessary to connect the compressor unit (and oil cooler, if used) to a main starter of correct size, power characteristics and enclosure for the application. See Section 4 for typical wiring diagrams; however, use only the wiring diagrams supplied with the unit for final connection.

Starter – The main starter is to be mounted outside the enclosure at a location selected by the user at the time the unit is installed. A length of flexible conduit must be used from the motor conduit box to a point one (1) foot outside the enclosure (on units without an enclosure, to a point three (3) feet from the motor conduit box) to maintain effective sound and vibration isolation. Electrical connections to other parts of the unit (instrument panel, fan motor, etc.) from the starter do not require flexible conduit since the compressor and motor are already isolated from these parts. See "Acoustic Enclosure" for precautions on conduit which penetrates the enclosure.

Grounding – Equipment must be grounded in accordance with Table 250-95 of the National Electric Code.

WARNING: An equipment ground jumper, equal in size to the equipment ground conductor, must be used to connect the compressor-motor subbase to the main base, since the bases are isolated from each other by vibration mounts. The oil cooler fan and enclosure vent fan motor frame will be grounded to the base at the factory with a grounding conductor compatible with the fan short circuit protection.

SECTION 3

STARTING & OPERATING PROCEDURES

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

1. **Compressor Oil** – Check oil level in the oil reservoir. Add oil only if the oil level gauge reads in the red ADD OIL range. Do not mix different types of oils. The unit is shipped filled with G-M Specification "Dexron" automatic transmission fluid which is suitable for the first 2000 hours under normal operating conditions. For sustained operation above +90° F. ambient temperature, use SAE 30 engine oil meeting API Engine Service Classification "CC" or "CD"; see Figure 3-5 "Compressor Lubricants". **REPLACE OIL FILTER ELEMENT EVERY 1000 HOURS.**

   Initial fill, or filling after a complete draining of the system, may show the oil level beyond the red EXCESS OIL range. After start-up, the oil will fall into the operating range as system components are filled. If necessary, add oil to bring the level into the center of the RUN range when the unit is operating on load; see Figure 4-5 for quantity of oil required. ALWAYS STOP THE UNIT AND RELEASE AIR PRESSURE BEFORE REMOVING THE OIL FILLER PLUG TO ADD OIL. During unloaded operation and after shutdown, the system will partially drain back into the oil reservoir and the oil level will read higher than when operating on load. DO NOT DRAIN OIL TO CORRECT; on the next loaded cycle or start, oil will again fill the system and the gauge will indicate the operating level.

2. **Air Filters** – Inspect the air filters to be sure they are clean and tightly assembled. Refer to Section 6 "Air Filter" 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 Section 7 "Coupling" for procedure.

4. **Piping** – Refer to Section 2 "Installation" and make sure the piping meets all recommendations.

5. **Electrical** – Check the unit and user-installed wiring with the wiring diagrams furnished to be sure it is properly wired. See Section 4 "Controls and Instruments" for general wiring diagrams and Section 2 for installation instructions.

6. **Rotation** – Check the motor rotation by momentarily starting the motor. Compressor drive shaft rotation is counterclockwise standing at the motor end.

7. **Operating Light Test** – Observe the operating lights on the ON-OFF switch when jogging the motor in Step 6. Be sure all lamps are operative.

8. **System Pressure** – Set the constant speed pilot and/or operating air pressure switch to the desired unload pressure and differential. DO NOT EXCEED MAXIMUM OPERATING PRESSURE ON THE COMPRESSOR NAMEPLATE. See Section 4 "Controls and Instruments" for procedure.

9. **Operating Mode** – Refer to Section 4 for detailed information on the control system with which your unit is equipped – Constant Speed or Duomatic.

10. **Acoustic Enclosure** – Check for damaged panels or doors. Check all screws and latches for tightness. Be sure the intake ducts on the side and top of the enclosure, and the vent fan exhaust on top are not obstructed.

STARTING THE UNIT – The Constant Speed unit requires only pressing of the ON push button.

Duomatic control units require setting of the timer (constant speed, set in center of space between 30 and 0; automatic start-stop, set desired time, but not less than minimum time specified by the unit caution plate) and pressing of the ON push button.

OBSERVE UNIT COLD OR UNIT HOT STARTING PROCEDURES.

Unit Cold – Close the air service valve between the main air system and the unit check valve. If the unit is a water-cooled heat exchanger model, open any manual water inlet wide open. Start the unit and run for one minute. Open the air service valve. Since the unit is equipped with a minimum (65 PSIG) pressure discharge valve, no special procedure to maintain unit reservoir pressure is required.

Unit Hot – No warm-up period is required. Close the air service valve. If the unit is a water-cooled heat exchanger model, open any manual water inlet valves wide open. Start the unit. Open the air service valve.

DAILY CHECK – Refer to Section 8 "Maintenance Schedule".

STOPPING THE UNIT

Unit Operating On Constant Speed – Close the air service valve, allow the unit to build up to full unloaded pressure and press the OFF push button. Stopping the unit at a pressure below full receiver may cause oil carry-over. The oil reservoir will automatically blow down as the motor stops. If the unit is a water-cooled heat exchanger type, close any manual water inlet valves. Open the air service valve.

Unit Operating On Automatic Start-Stop – If the unit is operating, close the air service valve, allow the unit to build up to full receiver pressure and stop automatically, then press the OFF push button. Stopping the unit at a pressure below full receiver may cause oil carry-over. If the unit is stopped because of full receiver pressure or stopped on unloaded time cycle, press the OFF push button. On water-cooled heat exchanger units, close any manual water inlet valves. Open the air service valve.

SECTION 4

CONTROLS & INSTRUMENTS

GENERAL – The Gardner-Denver Model "ES" Electra-Screw® compressor units are available with two different control systems:

Constant Speed.

Duomatic (Selective – Constant Speed With Low Unloaded Horsepower Or Automatic Start-Timed Stop).

The standard Electra-Screw® unit consists of the compressor, oil reservoir and cooler, air and oil filters, the control system specified, an open drip-proof motor, and a dust resistant control enclosure/instrument panel all mounted on a steel base and enclosed in an acoustic cabinet with ventilating fan. The unit is factory wired for the voltage specified; electrical connection to a main starter, connection to the shop air line and to the shop water line (if the unit is water cooled) are to be made by the user.

CONTROL VOLTAGE – The control voltage for the start-stop push button, hourmeter, pressure switch, high discharge temperature shutdown switch, blowdown valve, and other electrical control devices is 115 volts regardless of power supply voltage. On standard units, the transformer in the control enclosure is connected to change the specified user's power supply voltage to 115 volt control voltage.

CIRCUIT BREAKER – On early models, the instrument panel incorporates separate push-to-reset type circuit breakers for the high temperature and low oil pressure shutdown switches (Figures 1-4, 2-4, 3-4, 4-4, 7-4 and 10-4). If a temperature or pressure failure occurs, a circuit breaker button will pop up indicating which safety device has stopped unit.

For circuit interruption on later models, see paragraph below relating to the specific safety device.

DO NOT CONTINUE TO RESET THE CIRCUIT BREAKER IF THE SAME MALFUNCTION OCCURS WITHIN A SHORT PERIOD OF TIME. FIND AND CORRECT THE TROUBLE BEFORE RESUMING OPERATION.

ON-OFF SWITCH – The Constant Speed unit has an ON-OFF push button with an amber lighted center section to indicate when the compressor is running.

The Duomatic Control unit has an ON-OFF push button with an amber lighted section to indicate ON (compressor running) and a green lighted section to indicate LOAD (compressor loaded). The black bar at the bottom of this switch has no function on early models; on later models it is the relay reset for the low oil pressure shutdown system.

To replace the bulb (Sylvania 120 PSB or equal) in any of the switches:

1. Turn the power off at the main breaker panel.
2. Open the control panel.
3. Turn the slotted locking screw on the upper side of the switch body counterclockwise 1/4 turn and remove the switch body from the switch operator.
4. Remove the old bulb located in the stem of the switch body and insert the new bulb.
5. Reassemble the switch body to the operator and lock in place by turning the locking screw 1/4 turn clockwise.

SAFETY DEVICES – Both control systems incorporate these safety devices:

Motor Protection Devices – Overload heaters are furnished for the acoustic enclosure vent fan motor and the air-cooled oil cooler fan motor starter in the voltage range specified. There are three (3) overloads of proper size for the starter and its enclosure. When replacing or changing overloads, be sure to select them from a 3-overload heater table, since the use of a third overload derates each overload for a given enclosure due to the extra heat. An overload from a 2-overload heater table would be undersize.

The overload heaters are in a common overload block in the starter and have a single common percentage adjustment knob with a 90 to 110% range. The knob is set at the factory on the 100% mark.

The main unit starter should be adequately fused and provided with overload heaters suitable for the application to provide protection for the unit drive motor.

High Air Temperature Shutdown – The compressor is protected from lubrication failure by a high discharge temperature switch located in the discharge pipe between the compressor discharge and the oil reservoir. This switch is wired into the motor control circuit and will shut the unit down if the discharge temperature exceeds 225° F. On early models the circuit breaker is located on the instrument panel and on later models on the switch itself and must be reset any time unit is shut down due to high air discharge temperature.

DO NOT CONTINUE TO RESET THE CIRCUIT BREAKER IF THE SAME MALFUNCTION OCCURS WITHIN A SHORT PERIOD OF TIME. FIND AND CORRECT THE TROUBLE BEFORE RESUMING OPERATION.

Automatic Blowdown Valve (Figure 3-1) – A solenoid valve, piped into the oil reservoir final discharge manifold ahead of the check valve and wired into the motor control circuit, will release pressure from the oil reservoir each time the unit is shut down on Constant Speed control. On the Duomatic control system, pressure will be released from the oil reservoir each time the compressor unloads or is shut down. A muffler terminates the blowdown line to reduce air discharge noise.

Safety Valve (Figures 2-1 & 5-1) – A pressure relief valve is installed in the final discharge manifold and set at the

(Continued on Section 4, Page 8)

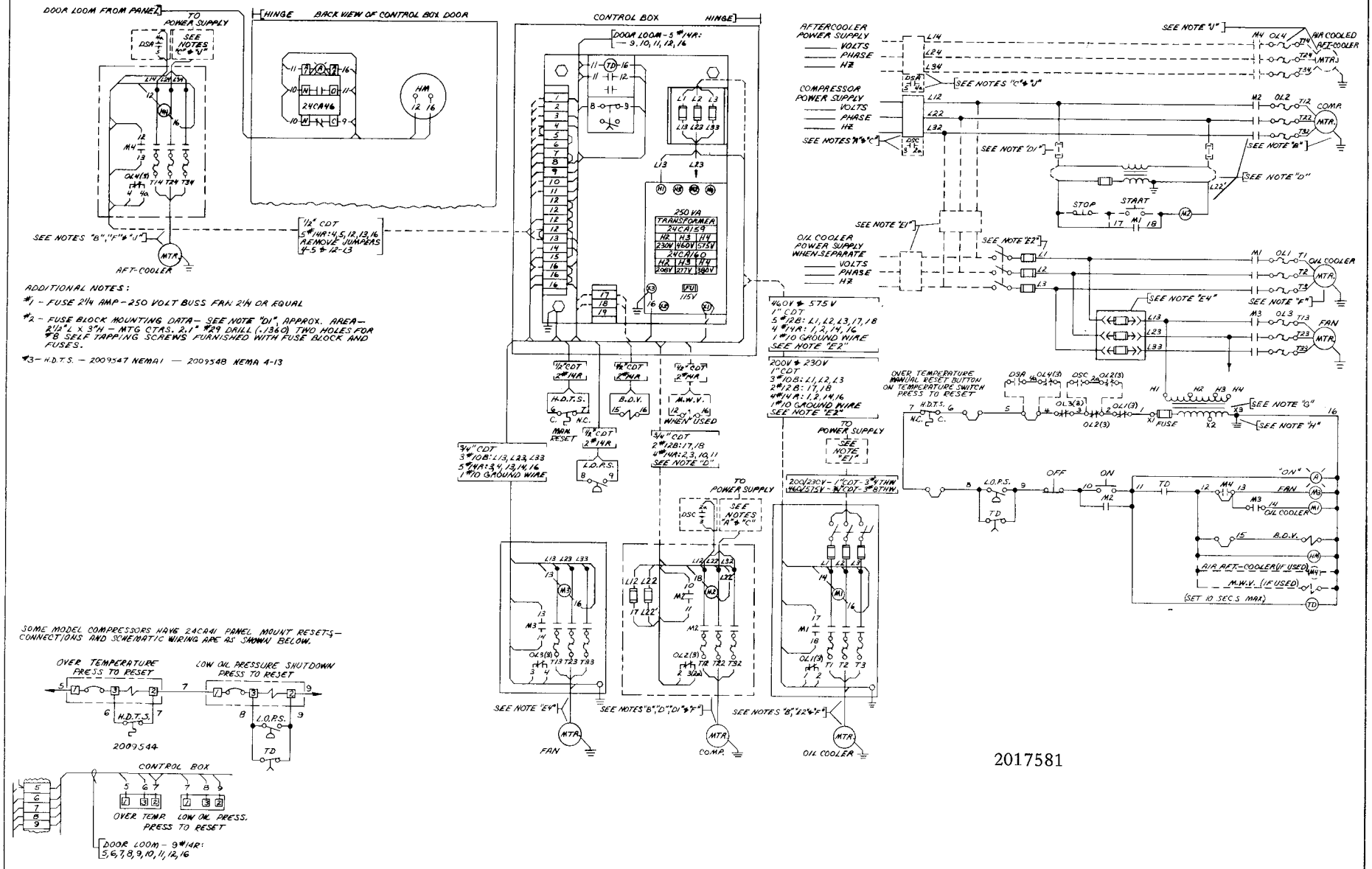


FIGURE 1-4. – WIRING DIAGRAM – AIR-COOLED UNITS – CONSTANT SPEED CONTROL

(FOR NOTES, SEE SECTION 4, PAGE 6)

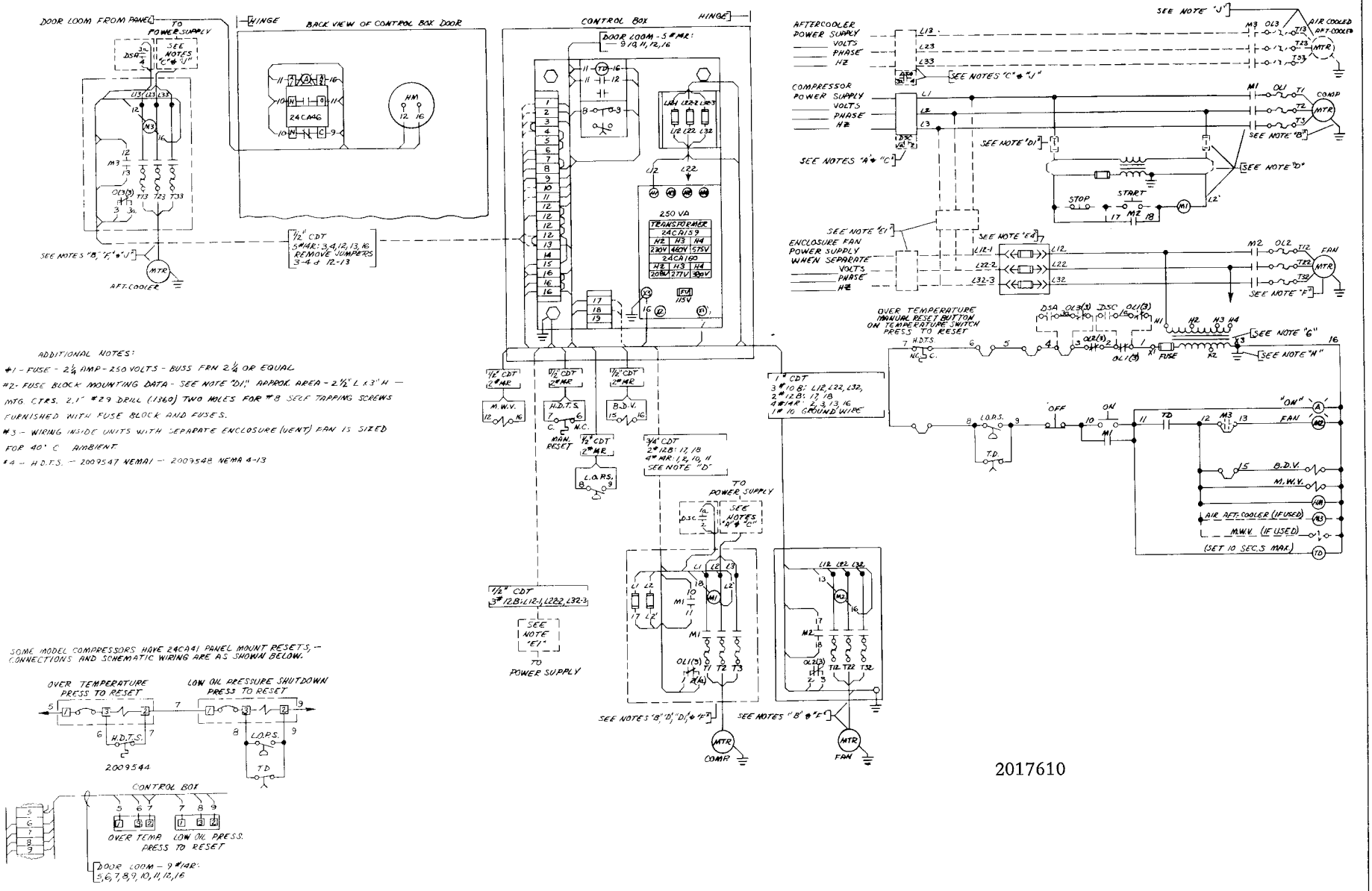


FIGURE 2-4. — WIRING DIAGRAM — WATER-COOLED UNITS — CONSTANT SPEED CONTROL

(FOR NOTES, SEE SECTION 4, PAGE 6)

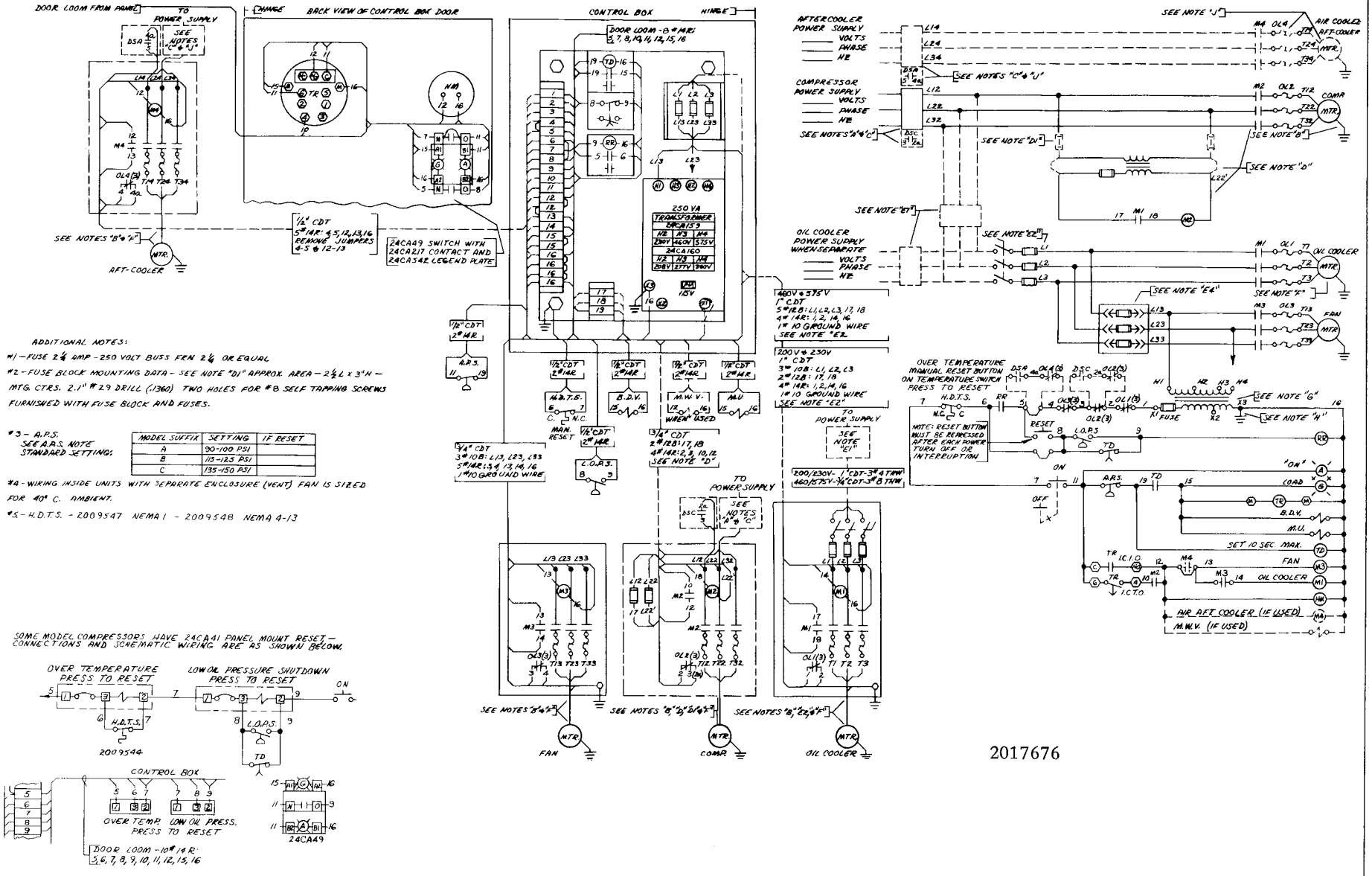


FIGURE 3-4. – WIRING DIAGRAM – AIR-COOLED UNITS – TIMED DUOMATIC CONTROL

(FOR NOTES, SEE SECTION 4, PAGE 6)

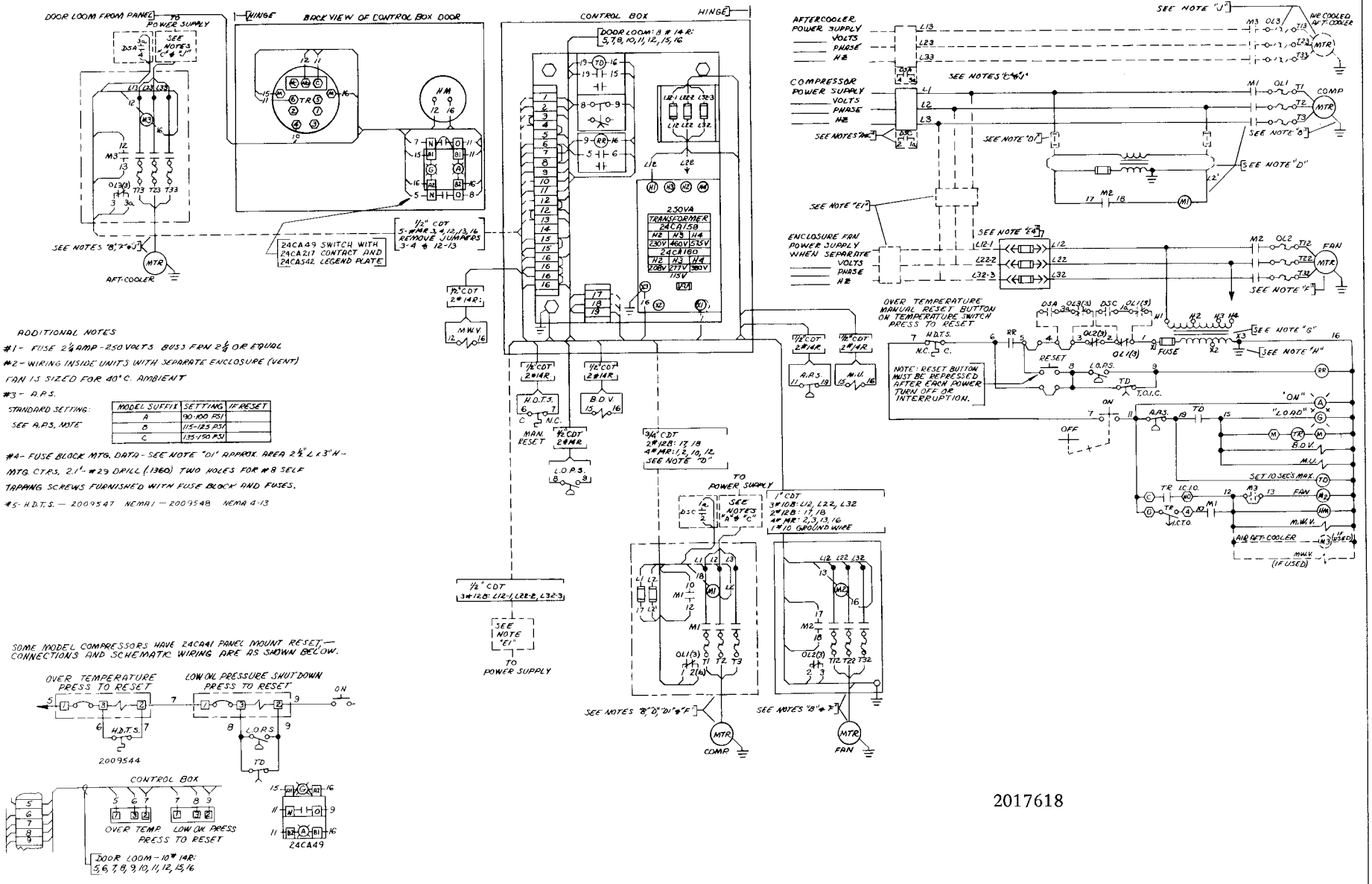


FIGURE 4-4. — WIRING DIAGRAM — WATER-COOLED UNITS — TIMED DUOMATIC CONTROL

(FOR NOTES, SEE SECTION 4, PAGE 6)

NOTES FOR WIRING DIAGRAMS

(FIGURES 1-4 THRU 4-4)

All equipment must be connected and phased exactly as shown. All piping, wiring and other equipment not specified on order is to be supplied by other than Gardner-Denver Company.

"A" – Compressor power supply disconnecting means – Fused Switch or Circuit Breaker (not furnished as a standard item – if ordered, it must be remote mounted and wired by customer).

"B" – Equipment must be grounded in accordance with Table 250-95 of the National Electrical Code. **WARNING** – An equipment ground jumper equal in size to the equipment ground conductor, must be used to connect the compressor motor base to the main base because the bases are isolated from each other by vibration mounts.

The enclosure fan and oil cooler motors (when used and factory wired) are grounded to the starter and/or main control panel as shown. The ground conductors for these motors are compatible to the motor short circuit protection.

"C" – When the control circuit voltage is from a separate power (voltage) source and is not controlled by the motor power supply disconnecting means, a disconnect switch (DS) interlock (not furnished) shall be mounted immediately adjacent to the motor power supply disconnecting means and wired by the customer as shown in the Schematic Wiring Diagram and per the data shown for that starter and its disconnecting means.

This interlocking device (DS) may be an Auxiliary (Aux.) or Electrical Interlock (E.I.) contact operated by the handle of the motor power supply disconnecting means.

When this disconnect switch (DS) interlock is a separate device, it shall be used to turn the control circuit "OFF" before operating the motor power supply disconnecting means. See Article 430-74 of the National Electrical Code.

"D" – The compressor motor starter on some units, depending on size, voltage, type or customer preference, is/must be remote mounted and wired by the customer.

All reduced voltage (current inrush) starters, manual and magnetic, are also remote mounted and wired by the customer.

When the compressor motor starter is remote mounted, the starter coil voltage shall be the same as the motor voltage, i.e., 200, 230, 460 volts, etc., unless the starter is ordered with its own fused control transformer. The contact (relay or fan-oil cooler starter interlock) from the compressor control panel to the remote mounted starter control circuit is rated 600 volts.

Normally, all remote mounted magnetic compressor starter control circuits are to be connected for TWO (2) WIRE control. A THREE (3) WIRE control variance is also shown on the constant speed control wiring diagrams.

The remote compressor starter control wiring shall be interlocked with the rest of the control wiring as shown in the Schematic Wiring Diagram and per the wiring data shown for the remote starter. The internal wiring shown is typical only. For exact wiring, see diagram on inside of starter or diagram supplied with starter.

"D1" – An ESG66459 Electrical Group with Buss Limitron KTK15 (600V-15A) Fuses will be furnished for all remote mounted compressor starters ordered by the Industrial Machinery Division (Quincy), Gardner-Denver Company, unless it is known that the starter ordered has its own control circuit fusing.

Customer is to mount and wire fuses using the mounting data shown on the wiring diagram for remote mounted starters.

Motor control circuits must be fused in accordance with Article 430-72 of the National Electrical Code.

"E1" – Oil Cooler power supply or enclosure fan feeder disconnecting means – Fused Switch or Circuit Breaker. NOT FURNISHED – and is remote mounted and wired by customer.

"E2" – Fused combination starter mounted on separate oil cooler module in NEMA 1 enclosure unless specified NEMA 4 for outdoor usage. When the separate oil cooler module is remote from the compressor, the interconnecting wiring is not furnished. This interconnecting wiring (by customer) is to be interlocked with the rest of the control wiring as shown in the Schematic Wiring Diagram and per the wiring data shown for oil cooler starter. The remote oil cooler equipment ground wire must be connected to the main control panel as shown. Fuses are sized for HP and voltage.

"E4" – 3 single pole fused pull-out blocks for 3 phase enclosure fan motors. These fuse blocks may be ganged together. Fuses are sized for HP and voltage.

"F" – Since most AC motors are wound for dual voltage, be certain leads are connected per the motor nameplate for the correct voltage.

"G" – Control transformers are sized for the components shown in the Schematic Wiring Diagram on 115 volts and not for any remote mounted compressor starter controls. Transformer part number with fusing data is shown on the wiring diagrams.

"H" – Control circuit ground. A green ground wire is

connected from the terminal shown on the wiring diagram to the control panel.

"J" – Air-cooled aftercooler with its starter and its power supply disconnecting means (Fused Switch or Circuit Breaker) with disconnect switch (DS) interlock – See Note "C" – (Not furnished as standard item – if ordered, it is remote mounted and wired by customer.)

The aftercooler (when sized for an individual compressor) starter coil is 120 volts and is wired and interlocked with the rest of the control wiring as shown in the Schematic Wiring Diagram and per the wiring data shown for the aftercooler starter with its disconnecting means. When the aftercooler is sized for more than one compressor, see instructions for aftercooler starter coil on the special wiring diagram or sketch.

THE FOLLOWING COMPONENTS ARE NOT USED ON ALL UNITS

(See Wiring Diagram For Usage)

B.D.V. – Blowdown Solenoid Valve – 110/120 V – 50/60 Hz – Two-Way Normally Open – 2W.N.O.

*	NEMA 1	NEMA 4 & 12
ESQ, R, S, T	91B15 – 1"	91B18 – 1"

*** B.D.V.'s are sized to blow down oil reservoir in approximately 45 seconds. If the compressor is started or loads up (low unloaded HP only) before the reservoir is blown down, the compressor may be starting under load which may cause motor failure, and/or oil mist will be carried over into the air lines.**

BOOT – 24CA281 – Transparent for PB's when NEMA 4.

C.R. – Control Relay – 24A494 – 110/120 V – 50/60 Hz Coil – 2S.P.N.O. Convertible 600 Volt Contacts.

D.S.A. – Disconnect Switch Interlock – Aftercooler.

D.S.C. – Disconnect Switch Interlock – Compressor.

H.D.T.S. – High Discharge Temperature Switch – Set 230° F.

	NEMA 1	NEMA 4 & 12
ESQ, R, S, T	† 2009547 ††	† 2009548 ††

† Bulb and Capillary Type – must be used with 200EST239 perforated thermal well.

†† Replaces 2009544 and 2009545 with Reset Switch.

H.M. – Hourmeter – 2009369 – 120 V – 60 Hz (Alternate 2009370 – 110 V – 50 Hz).

I.C.I.O. – Instant Closing – Instant Opening.

I.C.T.O. – Instant Closing – Timed Opening.

I.O.I.C. – Instant Opening – Instant Closing.

I.O.T.C. – Instant Opening – Timed Closing.

L.O.P.S. – Low Oil Pressure Switch – 88A302 – NEMA 1 (Alternate for NEMA 4 or 12 – 88A303) – Set 15-20 PSI. *NOTE: When starting unit for first time at final installation, loosen tube fitting on bottom of pressure switch.* After compressor is started and oil appears at the fitting, tighten fitting. If compressor shuts down on low oil pressure on the first start, wait until all the air has been bled off thru the blowdown valve before pressing reset button and restarting compressor.

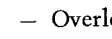
M. – Motor Starter Coil, Contacts, etc. Those starters furnished as standard equipment for low voltage control have 110/120 V – 50/60 Hz coils.

M.W.V. – Magnetic Water Valve – 110/120 V – 50/60 Hz – Two-Way Normally Closed – 2W.N.C.

WATER-COOLED OIL COOLER ϕ		
	NEMA 1	NEMA 4 & 12
ESQ, R, S, T	91B2 – 2"	91B23 – 2"

ϕ Valves have manual override.

M.W.V.'s are also shown on the Wiring Diagrams for Water-Cooled Aftercoolers (when used) and are to be sized for the aftercooler (if used).

O.L. – Overload – Heater  – Contacts  .

R.R.ϕϕ – Reset Relay – 24CA541 – 110/120 V – 50/60 Hz Coil – 2S.P.N.O. Convertible 300 Volt Contacts. Used with all automatic start controls which have low oil pressure shutdown. This relay gives LOW VOLTAGE PROTECTION which means a manual reset is required after every power turnoff or interruption. See the appropriate control wiring diagram for additional control switch components and resetting instructions.

ϕϕ Replaces 24CA41 Reset Switch (Circuit Breaker).

T.C.I.O. – Timed Closing – Instant Opening.

T.D. – Time Delay Relay – 24CA285 – 110/120 V – 50/60 Hz Coil – is set for a maximum of 10 seconds to establish oil pressure after each start-up. If TD timer coil fails, the unit will not start with magnetic starters and the latch (under voltage) coil on manual starters will not hold the starting handle in the RUN position when the handle is released if the control wiring is interlocked as shown on the wiring diagram. A low unloader HP control will unload the compressor if the TD timer coil fails after the unit is started.

T.O.I.C. – Timed Opening – Instant Closing.

V.R. – Voltage Relay – NEMA 1:

200 Volts – 60 Hz – 24CA286

230 Volts – 60 Hz – 24CA287

380/460 Volts – 50/60 Hz – 24CA288

575 Volts – 60 Hz – 24CA289

 – Terminals On Reset Button

 – Jumpers On Terminal Blocks (T.B.)

 – Indicating Light – 24CA40 (Sylvania 120 PSB or Equal)

ADDITIONAL COMPONENTS WHEN COMPRESSOR CONTROL IS OTHER THAN CONSTANT SPEED

A.P.S. – Air Pressure Switch – 2009353 – NEMA 1 (Alternate for NEMA 4, 12 – 88A303 Reset) – Set and/or Reset per order.

Excessive starting of motor can and will cause premature motor failure. Too frequent starting causes excessive heat which deteriorates the motor insulation. Excessive starting may be reduced by lowering the A.P.S. cut-in point (increasing differential) or by adding additional receivers to increase the system air storage capacity or both. The elimination of air leaks will also reduce the number of motor starts.

M.U. – Magnetic Unloader (Low Unloaded HP Only) – 90AC183 – NEMA 1 (Alternate for NEMA 4, 12 – 2009442) – 110/120 Volts – 50/60 Hz – Three-Way Normally Open – 3W.N.O. (Thru Door Mounting) – 110/120 V – 50/60 Hz Coil – 24A515 (Inside Panel Mounting) – 110/120 V – 50/60 Hz Coil.

DO NOT SET TIMER DIAL BETWEEN THE 0 AND 15 MINUTES.

See remarks following A.P.S. If compressor remains unloaded for time set on timer dial head (adjustable to 30 minutes), compressor will stop and then start up when air is needed. To make compressor run Constant Speed, set timer dial head in the 60° space midway between the 30 and 0 min. dial markings. When timer dial is set for Constant Speed operation and compressor is not running, compressor will not start until air is required (A.P.S. closes).

T.R. – Timing Relay (Timed Duomatic Only) – 24A482

 – Terminals On T.R. Timing Relay

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(Continued from Section 4, Page 1)

factory to 110% of the specified operating pressure for protection against overpressure. Periodic checks should be made to insure its proper operation. Never operate the unit without a proper safety valve setting.

Low Oil Pressure Shutdown – Units are provided with a pressure switch piped to the compressor oil sump and wired into the motor control circuit to protect the unit against operation at too low an oil pressure and against complete lubrication failure due to an oil line restriction or sudden loss of oil pressure. The pressure switch is set 15-20 PSIG and will stop the unit if the oil pressure falls below this pressure any time during operation, and will prevent the unit being started if the oil pressure does not rise to 15-20 PSIG within 10 seconds of starting.

The pressure switch is set 15-20 PSIG at the factory. If resetting is necessary:

1. Remove the pressure switch cover.
2. Adjust the upper limit pressure to 20 PSIG by turning the slotted screw (pressure) near the top of the switch. Clockwise movement of the screw raises the pressure; counterclockwise lowers the pressure. Note approximate pressure setting is indicated on the range scale on left face of switch.
3. Adjust the lower limit pressure to 15 PSIG by turning the slotted screw (differential) near the bottom of the switch until the cam-shaped calibrated dial under the pressure setting screw indicates about 1/4 of full scale reading from lowest setting. Clockwise movement of the screw reduces differential; counterclockwise increases differential. Note differential range (2-18 PSI) is indicated by marks on cam-shaped dial.

A timing relay, located in the control panel enclosure, is wired into the control circuit to provide the 10 second delay required for the compressor oil pressure to rise to 15-20 PSIG and energize the low oil pressure switch circuit.

To check the timing relay time delay setting:

1. Pull main breaker switch.
2. Move black timer tab located on upper half of relay block to the ON position and hold. Timer will begin to run for set time.
3. Observe the action of the upper set of contacts in the lower half of the relay block; the contacts will open when preset time runs out.
4. Adjustment of time delay setting is made by turning screw on lower left face of relay block to a faster (F) or slower (S) setting. Recheck setting of relay as in

No. 2 and No. 3 above each time screw is turned.

NEVER ATTEMPT TO ADJUST THE TIMING RELAY FOR MORE THAN 10 SECONDS DELAY – serious compressor damage may result from operation without lubrication for even a short period.

On early models, the low oil pressure circuit breaker is located on the instrument panel and must be reset any time a low oil pressure shutdown occurs.

On later models with **Constant Speed Control**, a circuit breaker is not used. The unit will not start automatically because the Start/Stop is a momentary contact type and no oil pressure will be present to complete the circuit. Therefore, a positive means to interrupt (or complete) the circuit is not needed. If the unit shuts down from low oil pressure, simply pressing the "Start" button will restart the unit.

On later models with **Duomatic Control** the reset for the control relay is the lower black bar on the Start/Stop switch. Since the duomatic control is an automatic starting type, a reset relay is used as a positive means to interrupt the circuit on a low oil pressure shutdown. If the unit shuts down from low oil pressure, press the black bar to energize the reset relay, and restart the unit.

CAUTION: Do not continue to restart the unit if the same malfunction occurs within a short period of time. Find and correct the trouble before resuming operation.

NEVER DISCONNECT SAFETY DEVICES THAT PROTECT THE UNIT.

INSTRUMENTS AND GAUGES (Figures 7-4 & 10-4) – Both control system instrument panels incorporate the following:

Hourmeter – A continuous reading (nonreset) type hourmeter displays the accumulated operating time of the unit and provides a convenient means for scheduling changes of oil supply and servicing of filters, separators and other devices.

Air Pressure Gauge – A direct reading air pressure gauge indicates final discharge air pressure at the discharge manifold.

Oil Temperature Gauge – A direct reading temperature gauge indicates compressor oil inlet temperature.

Pressure Differential Gauges – Two gauges, one reading the pressure differential across the oil filter, the other reading the pressure differential across the oil separators provide a continuous monitoring of the condition of these filters and indicate when changing of either element is required.

Air Filter Indicator – An air filter indicator is located just below the instrument panel and indicates when the air filters require servicing.

MINIMUM DISCHARGE PRESSURE VALVE (Figure 5-4) – An internal spring-loaded minimum pressure valve is used in the final discharge line to provide a positive pressure on the oil system of the compressor even when the air service valve is fully open.

The valve incorporates an orifice which, when air is flowing through it, maintains approximately 65 PSIG in the oil reservoir. A spring-loaded piston valve senses air pressure on the downstream (shop air line side) of the valve. When the system pressure rises above 65 PSIG, the spring is overridden and the valve opens to full porting.

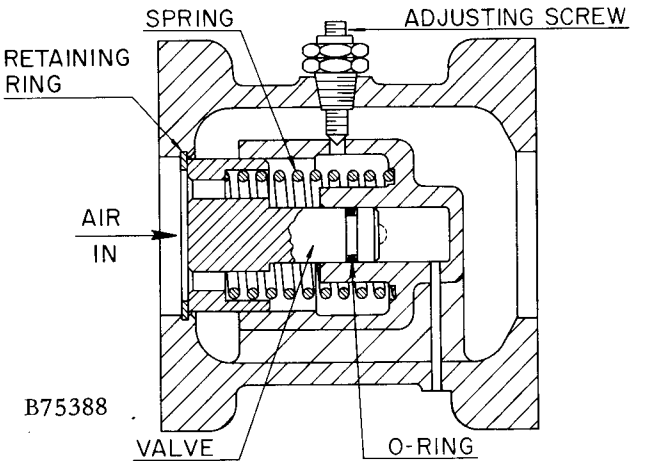


FIGURE 5-4. – MINIMUM DISCHARGE PRESSURE VALVE

The valve does not require maintenance or adjustment. If the valve fails to function, check the valve stem O-rings for sealing, valve orifices for restriction, or valve and valve seat for burrs and dirt.

Early valves are not adjustable; later valves are adjustable within a small range. Valves which can be adjusted have a set screw secured by a locknut on the side of the valve body. The minimum pressure can be adjusted as follows:

1. Start the compressor.
2. Reduce pressure downstream of minimum pressure valve below desired minimum pressure. DO NOT REDUCE DOWNSTREAM PRESSURE OR ADJUST VALVE BELOW 65 PSIG.
3. Loosen locknut on adjusting screw.
4. Turn set screw in to increase, or out to decrease minimum pressure to be held.
5. Hold set screw at desired point and tighten locknut.

CHECK VALVE (Oil Reservoir) (Figure 2-1) – A renewable seat swing type check valve in the final discharge manifold prevents backflow of air from the shop air line when the unit stops, unloads or is shut down.

CONSTANT SPEED CONTROL SYSTEM (Figures 1-4, 2-4, 6-4 & 7-4) – The Constant Speed Control System is used where requirements for air are high for long periods, causing the unit to remain loaded most of the time. The control is a stepless pneumatic system which regulates compressor inlet to match the air demand made on the compressor. Effective from 0 to 100% of the compressor capacity, the control opens the inlet valve as air is drawn from the service valve, maintains a constant valve opening as air demand levels off, or closes the valve when the demand ceases. The subtractive pilot and inlet valve are shown in Figure 6-4. The ON-OFF switch and instrument panel are shown in Figure 7-4.

Subtractive Pilot – The subtractive pilot is a spring-loaded diaphragm-actuated valve that regulates air pressure from the discharge manifold to the unloader piston. The pilot admits air to the inlet valve piston when a discharge manifold pressure equal to the pilot low setting is reached. The air begins to pass through pilot to the piston, and the inlet valve begins to close. As the discharge manifold pressure increases the pilot pressure also increases on the inlet valve piston, closing the inlet valve. At full manifold pressure (pilot unload setting) the pilot is exerting full differential pressure on the inlet valve piston and the inlet valve is fully closed. As the discharge manifold pressure falls, the pilot exerts proportionally less pressure on the inlet piston allowing the inlet piston spring to return the piston and the inlet valve to open. The pilot can be adjusted from 65 to 150 PSIG. The differential range of approximately 15 PSI cannot be changed. In order to obtain full capacity at the maximum operating pressure, the pilot should be set to unload *with the inlet valve fully closed* at approximately 8 PSIG above the maximum operating pressure.

Example with normal setting of 85–100 PSIG:

Discharge Manifold Pressure	Pressure In Control System	Inlet Valve	Compressor
80	0	Open	At full capacity
85	0	Open	At full capacity
90	5	Closing	Reduced capacity
95	10	Closing	Reduced capacity
100	15	Closed	Not compressing

Inlet Valve (Figure 6-4) – The inlet valve is a piston-actuated device whith controls the compressor inlet and operates on air pressure from the subtractive pilot. The valve is closed when full pressure is on the system and changes degree of opening in direct response to system pressure changes.

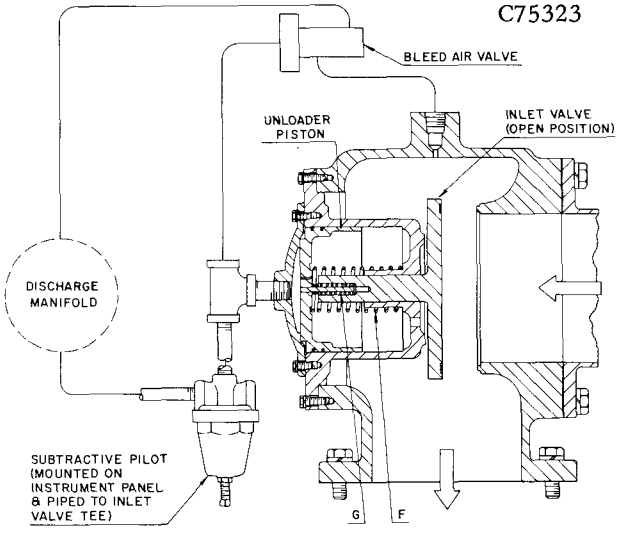


FIGURE 6-4. – INLET VALVE FOR CONSTANT SPEED CONTROL

The inlet valve contains piston spring "F" which returns the unloader piston and allows the inlet valve to open as pressure decreases, and valve spring "G" which returns the inlet valve to a closed position on shutdown of the compressor and prevents oil backflow from the compressor to the air filter.

Bleed Air Valve – A pilot-operated bleed air valve is provided in the inlet valve system to admit air to the compressor to scavange oil during the unloaded cycle. The subtractive pilot admits air to the bleed air valve piston at the same time as air is being admitted to the inlet valve piston at the beginning of the unloaded cycle. The bleed air valve piston shifts, allowing air to pass from the oil reservoir to the inlet valve behind the closed inlet valve, providing scavenging air as long as the compressor remains unloaded.

Operating Air Pressure Adjustment – Start the unit. Close the air service line valve, allow the unit to build to full pressure and unload, and proceed as follows:

PRESSURE TOO HIGH:

1. Loosen the subtractive pilot locknut. Back the adjusting screw out about one turn.
2. Open the air service line valve and bleed air from the unit so that the compressor loads again. Close the valve and allow the compressor to unload.
3. Repeat Steps 1 and 2 until the proper pressure is obtained. Tighten the locknut.

PRESSURE TOO LOW:

1. Loosen the subtractive pilot locknut.
2. Turn the adjusting screw in until the proper pressure is obtained.
3. Tighten the locknut.

DO NOT ADJUST THE FULL UNLOADED AIR PRESSURE TO MORE THAN 8 PSIG HIGHER THAN THE MAXIMUM STAMPED ON THE UNIT NAMEPLATE.

MINIMUM OPERATING PRESSURE IS 65 PSIG.

Electrical Wiring – Figures 1-4 and 2-4 are the wiring diagrams for the unit with Constant Speed Control.

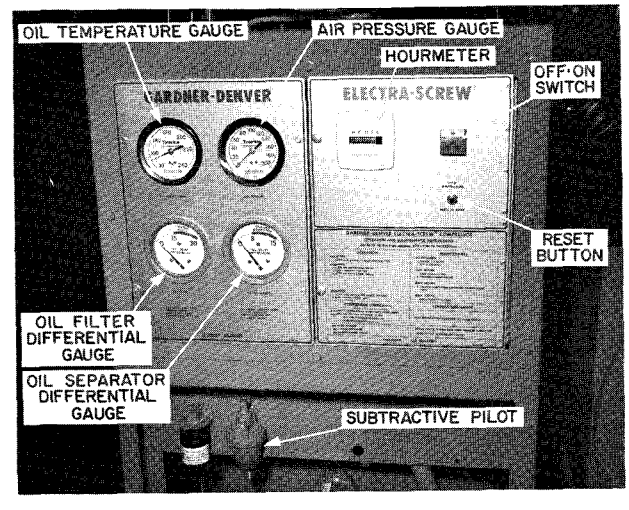


FIGURE 7-4. – INSTRUMENT PANEL CONSTANT SPEED CONTROL

DUOMATIC CONTROL SYSTEM (Figures 3-4, 4-4, 8-4, 9-4 & 10-4) – The Duomatic Control system is suitable for use only on water-cooled units or on air-cooled units which have the oil cooler module connected directly to the compressor unit main base.

The Duomatic Control system is used where air requirements vary widely, change in frequency of demand and where it is desirable to have some degree of control over the length of time the motor will run after the compressor unloads. During the time the compressor is unloaded with the motor running, the unit draws only about 20% of the power required on load at 100 PSIG.

An auxiliary air receiver with adequate volume must be used with the Duomatic Control system to prevent rapid cycling of the unit. Occasionally, shop air lines are of such a length as to provide adequate volume, but this should be carefully checked before using the unit without an auxiliary air receiver.

The Duomatic Control system offers two modes of operation controlled by the adjustable timer on the instrument panel (Figure 10-4).

Constant Speed – When the timer is set in the space between 30 and 0, the unit will run continuously. The inlet valve will open and allow the compressor to load when the pressure switch low setting is reached. When the pressure switch high setting (full receiver pressure) is reached, the inlet valve closes, unloading the compressor. Each time full pressure is reached, the oil reservoir blows down through the automatic blowdown valve to reduce the unloaded horsepower. The LOAD indicator light will signal whether unit is loaded (on) or unloaded (off). The ON indicator light will remain on as long as the On-Off switch ON push button is depressed.

Automatic Start-Timed Stop – When the timer is set between 0 and 30, the unit will start and the inlet valve open when the pressure in the receiver falls to the pressure switch low setting. When the pressure rises to the pressure switch high setting, the unit will unload (LOAD light off), the inlet valve will close, the motor will continue to run and the oil reservoir will blow down. If system pressure does not fall to the pressure switch low setting within the time set on the timer, the unit will stop. The ON indicator light will remain on as long as the On-Off switch ON push button is depressed. When air is again required, the unit will start, the timer will reset and the loaded-unloaded-stop cycle will repeat.

The timer must never be set at a time less than that indicated by the minimum run time caution plate on the instrument panel; see Figure 8-4. Use of less time of run interval will allow excessive motor starts and cause shortened motor life or failure.

MINIMUM RUN TIME SETTING FOR DUOMATIC CONTROL	
Model	Time (Minutes)
ESQ, ESR, ESS, EST	15

FIGURE 8-4.

The air pressure switch located under the unit control panel (Figure 10-4) controls the operating pressure of the system by opening and closing the inlet valve (Figure 9-4) as in Constant Speed and Timed Duomatic operation. The switch is piped from the final discharge line to the magnetic unloader valve and connected to the electrical circuit in the control box.

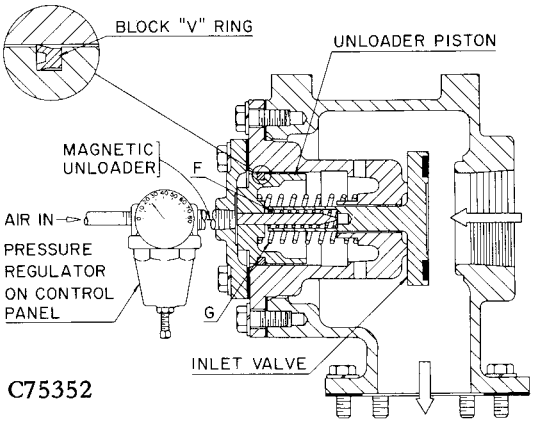


FIGURE 9-4. – INLET VALVE FOR DUOMATIC CONTROL

Inlet Valve (Figure 9-4) – The piston-actuated inlet valve controls the compressor inlet and operates on air pressure from the control circuit. The valve is closed when the preset full pressure is on the system, and open when the pressure in the system falls to a preset minimum. The inlet valve contains piston spring "G" which returns piston and allows the inlet valve to open when the pressure is removed, and valve spring "F" which returns the valve to a closed position on shutdown of the compressor to prevent oil blowback from the compressor through the air filter. The pressure regulator must be set 20–25 PSIG to prevent valve "slam".

Operating Air Pressure Adjustment – Set the timer for constant speed operation. Start the unit and close the shop air line valve sufficiently to hold an air pressure near the desired system pressure. Remove the operating air pressure switch cover and proceed as follows:

SET FULL RECEIVER PRESSURE (COMPRESSOR UNLOAD) POINT:

1. Turn the upper adjusting screw on the pressure switch until the pointer on the left edge indicates the desired pressure.

2. Close the shop air line valve and allow the air receiver pressure to build until the compressor unloads.

3. Note the air pressure shown in the instrument panel gauge. If it is not the pressure desired, bleed air from the air receiver until the compressor loads again. Repeat Steps 1 and 2 until the proper unloaded pressure is obtained.

SET LOW RECEIVER PRESSURE (COMPRESSOR LOAD) POINT:

1. With the unit running, air receiver at full pressure and shop air line valve closed, set the lower (differential) adjusting screw near the desired pressure. Full receiver pressure minus the differential is the low receiver (compressor load) point. The differential range

is approximately 2–18 PSIG on the circular scale above the adjusting screw.

2. Bleed air from the air receiver and note the pressure at which the compressor loads.

3. Repeat Steps 1 and 2 until the desired low receiver pressure point is obtained.

4. Replace the pressure switch cover.

DO NOT ADJUST THE OPERATING AIR PRESSURE HIGHER THAN THE MAXIMUM STAMPED ON THE UNIT NAMEPLATE.

MINIMUM OPERATING PRESSURE IS 65 PSIG.

Electrical Wiring – Figures 3-4 and 4-4 are the wiring diagrams for the unit with Duomatic Control system.

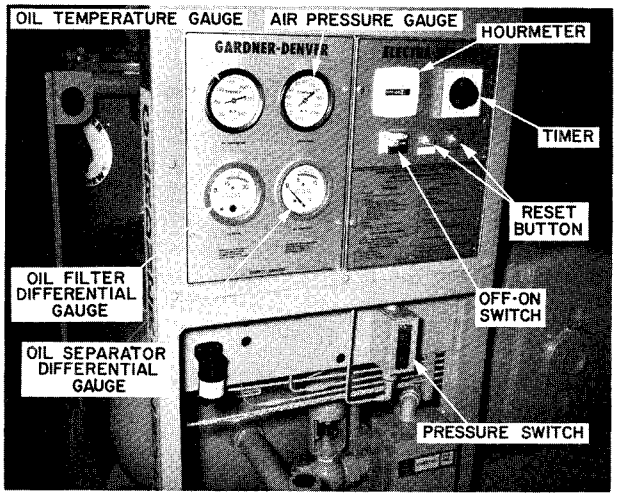
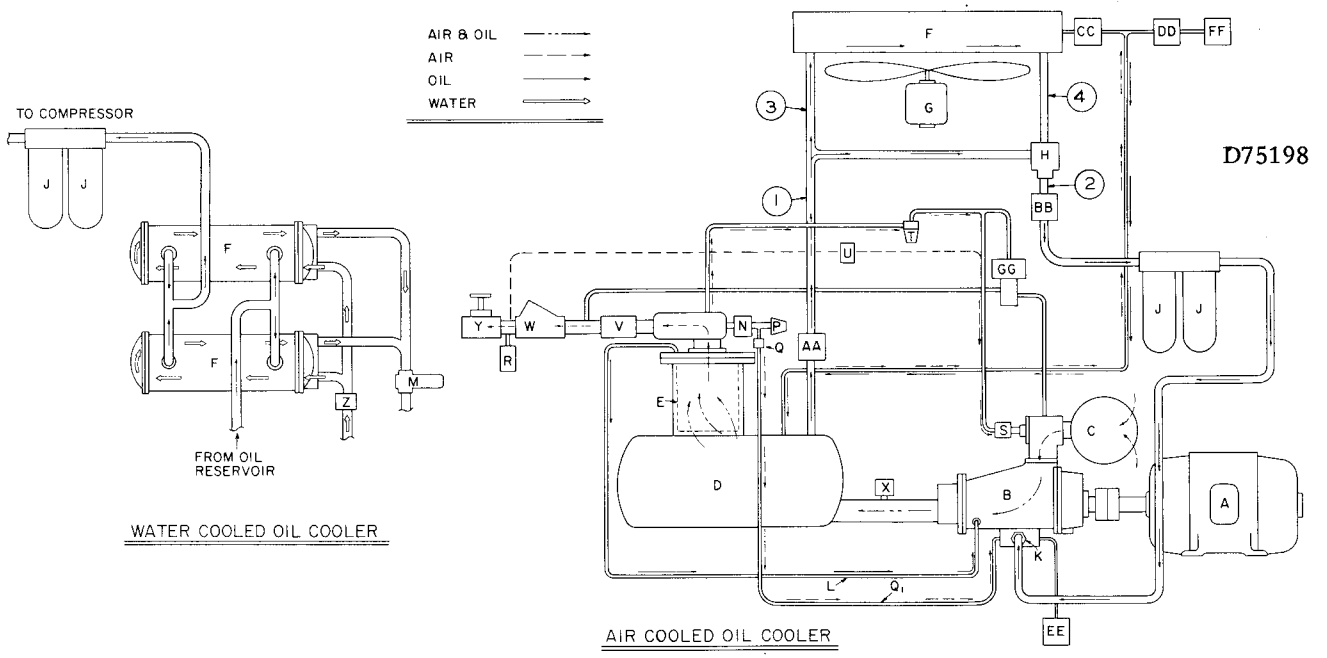


FIGURE 10-4. – INSTRUMENT PANEL TIMED DUOMATIC CONTROL

SECTION 5
LUBRICATION
OIL COOLER, OIL FILTER & SEPARATOR



A MOTOR
B COMPRESSOR
C AIR FILTER
D OIL RESERVOIR
E OIL SEPARATOR
F OIL COOLER
G FAN AND MOTOR
H THERMOSTATIC CONTROL VALVE
J OIL FILTERS
K OIL FLOW CONTROL VALVE (DUOMATIC ONLY)
L SEPARATOR TO CYLINDER OIL RETURN LINE
M WATER FLOW CONTROL VALVE
N MAGNETIC BLOWDOWN VALVE
P BLOWDOWN MUFFLER
Q BLOWDOWN LINE CHECK VALVE
Q1 BLOWDOWN LINE (DUOMATIC ONLY)
R OPERATING AIR PRESSURE SWITCH (DUOMATIC ONLY)
S MAGNETIC UNLOADER (DUOMATIC ONLY)
T PILOT (CONSTANT SPEED ONLY)
U PRESSURE REGULATOR (DUOMATIC ONLY)
V MINIMUM DISCHARGE PRESS. VALVE
W DISCHARGE CHECK VALVE
X HIGH DISCHARGE TEMPERATURE SHUTDOWN SWITCH
Y DISCHARGE SERVICE LINE VALVE
Z MAGNETIC WATER SHUTOFF VALVE
AA OIL LINE CHECK VALVE (REMOTE OVERHEAD OIL COOLER ONLY)
BB OIL STOP VALVE (REMOTE OVERHEAD OIL COOLER ONLY)
CC OIL PRESSURE RELIEVING CHECK VALVE (REMOTE OVERHEAD OIL COOLER ONLY)
DD VACUUM BREAK CHECK VALVE (REMOTE OVERHEAD OIL COOLER ONLY)
EE LOW OIL PRESSURE SWITCH
FF VENT BREATHER
GG BLEED AIR VALVE (CONSTANT SPEED ONLY)

FIGURE 1-5. – FLOW DIAGRAM – AIR-OIL SYSTEMS

COMPRESSOR OIL SYSTEM (Figures 1-5 & 2-5) cools the compressor, lubricates moving parts and seals internal clearance in the compression chamber.

The oil suction line is connected at the top of the oil reservoir with the pipe extending internally to near the bottom of the vessel. Air pressure in the oil reservoir forces oil through the oil cooler, thermostatic mixing valve (on radiator-type oil cooler units), oil filter, oil control valve (on duomatic units), and into the compressor main oil gallery.

The oil passes through internal passages for lubrication, cooling and sealing during the compression cycle. After compression the air-oil mixture is discharged to the oil reservoir where most of the entrained oil is removed by impingement and velocity change. The air and remaining oil then passes through the final oil separator. The separated oil is returned to the compressor oil system and the air passes to the final discharge line.

OIL SPECIFICATIONS – The recommended compressor lubricant is an automatic transmission fluid meeting General Motors "Dexron" specification. On air-cooled radiator models, automatic transmission fluid can be used for year-round operation except when operating ambient temperature exceeds +90° F. for 8 hours per day, then SAE 30 engine oil meeting API Engine Service Classifications "CC" or "CD" should be used. On water-cooled heat exchanger models, automatic transmission fluid can be used for all operation, provided the compressor oil inlet temperature is held 130°–160° F. by adjustment of the water flow control valve; if the oil inlet temperature will exceed 160° F. for more than 8 hours of operation, then SAE 30 engine oil meeting API Engine Service Classifications "CC" or "CD" should be used.

The oil must contain the following additives to be suitable for Electra-Screw® compressor use: (a) corrosion inhibitor, (b) oxidation inhibitor, and (c) foam inhibitor. Any other additives the above oil may contain as a standard of the refiner are acceptable. Mixing of different types, or use of lubricants without sufficient oxidation inhibitor will result in formation of heavy varnish and sludge deposits throughout the system.

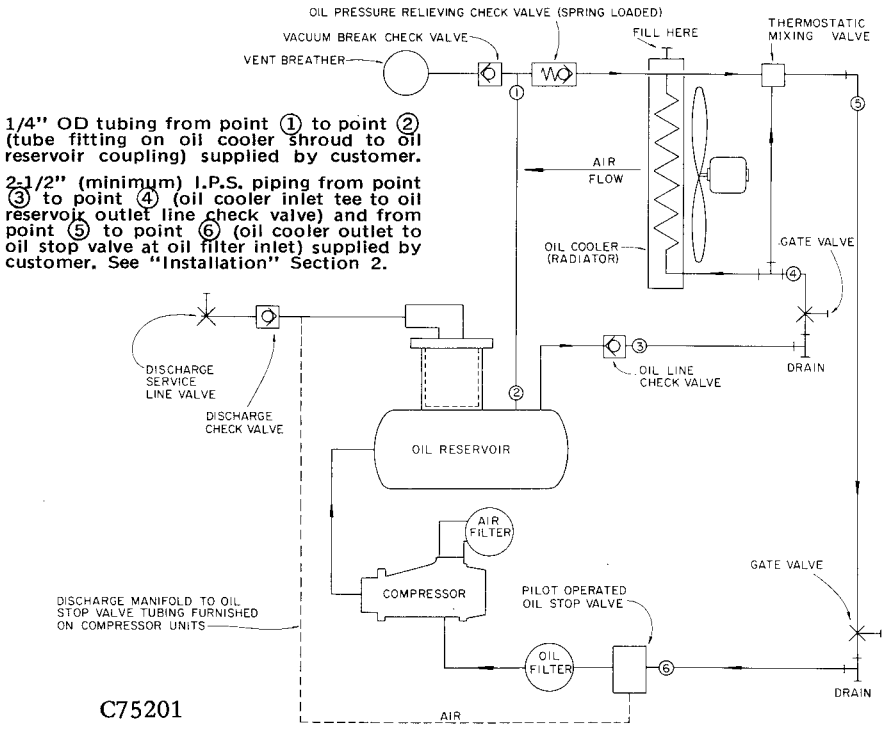


FIGURE 2-5. – OIL FLOW DIAGRAM – REMOTE, OVERHEAD MOUNTED OIL COOLER

Recommended Oils	Temperature Range
Automatic Transmission Fluid Meeting GM Specification "Dexron"	Year-Round Operation – Except As Noted Below
SAE 30 – Meeting Specification API Engine Service Classification "CC" Or API Engine Service Classification "CD" **NEVER USE SAE 30 OIL BELOW +40° F.**	8 Hours Or More During Operational Period: **Air-Cooled Unit** – Ambient Temperature Exceeds +90° F., **Water-Cooled Unit** – Oil Temperature Exceeds +160° F.

FIGURE 3-5. – COMPRESSOR LUBRICANTS

Model	System Capacity (Initial Fill)		Oil Reservoir Capacity ** (Refill)	Quantity – Top Of ADD To ℄ Of RUN
	Air Cooled *	Water Cooled		
ESQ	97	86	60	17
ESR	104	86	60	17
ESS	104	86	60	17
EST	104	86	60	17

* System capacity shown for the initial fill is for a unit with the oil cooler module connected directly to the compressor unit main base. Remotely mounted oil coolers will require additional oil to fill the piping between the compressor unit and the oil cooler.

** The oil reservoir refill quantity shown is measured at the centerline of the oil level gauge RUN range or approximately 5.5 inches below the centerline of the oil reservoir.

FIGURE 4-5. – OIL SYSTEM CAPACITIES (APPROXIMATE) – U.S. GALLONS

OIL QUALITY – There are many brands of lubricating oils and synthetic fluids which are represented by the suppliers as meeting one or more of the specifications listed under "Compressor Lubricants" (Figure 3-5) or as being satisfactory for screw compressor use. 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.

SYNTHETIC LUBRICANTS – Certain lubricants such as the synthetic hydrocarbon, synthetic diester or the polyether fluids are being marketed as suitable for screw compressor use. If such a fluid is to be used, care should be taken to insure that its viscosity, foam, oxidation and corrosion characteristics are equal or superior to those of the recommended automatic transmission fluid or the API specification oil.

Other synthetic fluids such as the phosphate esters (so called fireproof fluids) should not be used without changing of certain materials and coatings used in the unit, because of the rapid deterioration caused by this type of fluid. If fireproof fluids must be used, consult your Gardner-Denver representative for recommendations.

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^{o} F. in the space enclosing the compressor unit, and/or in the space enclosing the oil cooler module if it is remotely mounted. Experience clearly indicates that even though an oil has a pour point below the ambient temperature it may chill in the oil cooler and block oil flow to the compressor. The loss of 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. *Never use SAE 30 oil below +40^{o} F.*

ADDITION OF OIL BETWEEN CHANGES must be made when level of oil in the gauge is below the RUN range while the unit is operating. Stop unit and *be sure no air pressure is in the oil reservoir.* Wipe away all dirt around the oil filler plug. Remove the oil filler plug and add oil as necessary to return the oil level to the center of the RUN range when the unit is operating; the quantity required to raise the oil level from the top of the ADD range to the centerline of the RUN range is shown in Figure 4-5. Repeated addition of oil between oil changes may indicate excessive oil carry-over and should be investigated.

OIL LEVEL GAUGE indicates the amount of oil in the oil reservoir. When the unit is stopped the oil level will be higher in the RUN range than when operating on load. When the unit is operating the oil level should be near the center of the RUN range. In normal operation the oil level will fluctuate slightly as the compressor loads and unloads. Add oil only when the oil level gauge indicates in the ADD OIL range when the compressor is loaded. Drain oil only when the oil level gauge indicates EXCESS OIL when the compressor is loaded.

OIL CHANGE INTERVAL is determined by air filter maintenance, operating conditions and quality of oil. Good practice is to change oil often enough that the drained oil is relatively clean. Under good operating conditions automatic transmission fluid may 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 will be necessary to change the oil more frequently. Operating conditions and appearance of drained oil must be surveyed and the oil change intervals planned accordingly by the user. *Change the oil filter every 1000 hours.*

DRAINING AND CLEANING OIL SYSTEM – Stop unit *and be sure no air pressure is in the oil reservoir.* Always drain the complete system. Draining when the oil is hot will help to prevent varnish deposits and to carry away impurities. To drain the system, use one of the following methods:

If the unit is not elevated high enough to use the oil reservoir drain valve to drain oil, a small hand-, electric- or air-operated pump should be used to drain reservoir through the oil filler opening or from the drain valve. Remove compressor sump drain, oil cooler drain, and oil filter plugs. After the oil reservoir is emptied, remove the oil reservoir magnetic plug.

If the unit is elevated so that the oil reservoir drain valve can be used, empty the oil reservoir, then remove the following plugs: oil reservoir magnetic, compressor sump drain, oil cooler drain, and oil filter.

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

FILLING OIL RESERVOIR – Stop unit *and be sure no air pressure is in the oil reservoir.* Wipe away all dirt before removing the oil filler plug. Refer to "Oil System Capacities" Figure 4-5 for the oil quantity required to fill the compressor oil system. This amount may bring the oil level into the EXCESS OIL range on the gauge. After a short time of operation, the oil level will drop into the RUN range as oil fills other parts of the system. Maintain the oil level in the RUN range. On unloaded operation and after shutdown some oil will drain back into the oil reservoir and the oil level gauge may read in EXCESS OIL range. DO NOT DRAIN OIL TO CORRECT. On the next start, oil will again fill the system and the gauge will indicate the operating oil level. DO NOT OVERFILL as oil carry-over will result. Use only CLEAN containers and funnels so no dirt enters the reservoir. Provide for clean storage of oils. Changing oil will be of little benefit if done in a slipshod manner.

COMPRESSOR OIL FILTER (Figure 5-5) uses four single element filters connected in parallel and is a vital part in maintaining a trouble-free compressor, since it removes dirt and abrasives from the circulated oil. The filter is a replaceable cloth bag element type and is equipped with a relief valve that opens in the event the element becomes dirty enough to block the flow of oil. *Elements must be replaced every 1000 hours,* or when the pressure drop is 15 PSI. More frequent changes improve the system's reliability and are recommended.

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

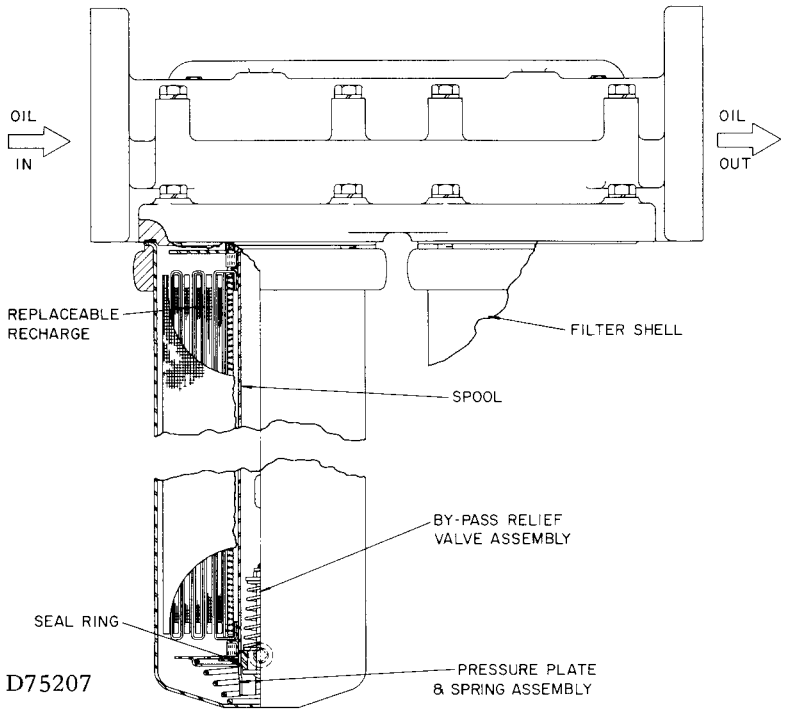


FIGURE 5-5. – COMPRESSOR OIL FILTER

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 the shell with relief valve and spring down (away from the filter head).

4. Bolt assembly to filter head.

COMPRESSOR OIL COOLER (RADIATOR TYPE) MODULE (Figures 2-1 & 3-1) – The air-cooled oil cooler module is designed for direct connection to an unenclosed compressor unit main base or mounted remote to an enclosed unit. The oil cooler fan is driven by an electric motor and moves cooling air from the motor side through the grille of the cooler. The fan motor starter is mounted on the cooler module.

The oil cooler requires pipe and electrical connection to the main compressor unit. Connecting piping and wiring are furnished when the module is direct connected to the unit main base. The user is to furnish all connecting piping and wiring when the oil cooler module is remotely mounted. See "Installation" Section 2.

Do not obstruct the air flow to and from the oil cooler. Allow two (2) feet clearance on all sides of the oil cooler. See Figure 2-2 for cooling air flow requirements. Keep both faces of the oil cooler core clean for efficient cooling of the compressor oil. Oil cooler malfunction may be traced by checking oil pressure drop through the cooler; check by installing pressure gauges at fittings in the inlet and outlet oil piping near the end of the cooler. At normal operating air service pressures (65 to 150 PSIG) with the unit warm, a pressure drop of 2 to 12 PSIG can be expected between the inlet and outlet side of the cooler. The instrument panel thermometer indicates the oil temperature to the compressor.

An oil filler plug is located in the piping on top of the oil cooler core for ease of filling the oil cooler especially when it is remote mounted.

When filling a remote mounted oil cooler, be sure all lines to and from the compressor unit are also filled to prevent excessive draw-down of oil supply in the oil reservoir. A vent line is installed between the oil cooler and the compressor oil reservoir as an aid in filling and to prevent siphoning. The oil cooler drain is located at the grille side of the oil cooler module to provide for complete draining of the oil system.

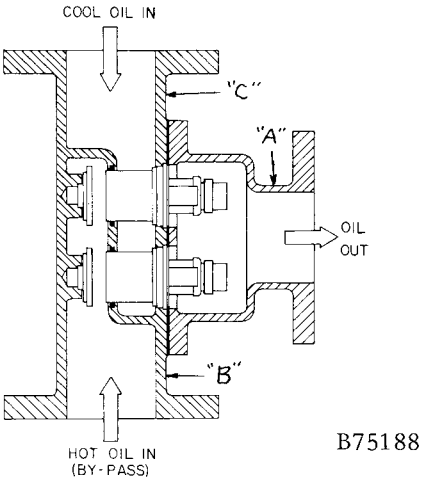


FIGURE 6-5. – THERMAL (THERMOSTATIC) MIXING VALVE

THERMAL (THERMOSTATIC) MIXING VALVE (Used With Radiator-Type Oil Cooler Only) (Figure 6-5) is installed in the system as shown in the flow diagram, Figure 1-5. On start-up with unit cold, the elements are closed to oil cooler allowing oil to circulate through bypass directly from oil reservoir to compressor during warm-up. As oil warms, elements gradually open to cooler and close to bypass to allow oil from cooler to mix with oil from bypass. After unit is warmed up, 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 oil.

To check elements, heat in oil – they should be fully extended at 130° F. If unit shuts down due to high air discharge temperature, the cause may be that one or both of the elements is stuck closed to the cooler thus blocking cooler out of the system, in which case lines 1 and 2 (Figure 1-5) will be hot to the touch and lines 3 and 4 much cooler. When flushing the oil system, remove the thermal elements and clean all parts thoroughly.

COMPRESSOR OIL COOLER – WATER-COOLED HEAT EXCHANGER (Figure 5-1) – The heat exchanger oil cooler is a multiple pass type, with water in the tubes and oil in the shell. The water flow is regulated by a self-operated flow control valve (Figure 7-5) installed in the water outlet line from the oil cooler as shown in the flow diagram (Figure 1-5) and designed to maintain the oil injected into the compressor at a minimum of 130° F.

See "Oil Specifications" on page 1, this section, for the maximum allowable oil inlet temperature. The valve's temperature sensing bulb is located in the oil outlet line of the oil cooler. An oil temperature change at the bulb operates the valve, increasing or decreasing the water flow, to maintain the oil temperature within the set range. The instrument panel thermometer indicates the oil temperature to the compressor.

Oil cooler malfunction may be traced by checking pressure at oil inlet and outlet. Fittings at these locations are equipped with a 1/4" pipe tap for a gauge. At normal operating air service pressure (65 to 150 PSIG) with the unit warm, a pressure drop of 3 to 12 PSI can be expected between the oil inlet and the oil outlet.

Water pressure drop from water inlet to outlet will vary with the inlet pressure and amount of water flowing. A normal pressure drop may range from 5 to 10 PSI. Any change in the pressure drop from that normally held may indicate tube leakage or fouling and should be investigated.

In many instances, the cooling water supply for the heat exchanger will contain impurities dissolved in solution and/or in suspension. These substances can cause scale formations, corrosion and fouling (plugging) of any water-cooled heat exchanger equipment. Disregarding the possibility that one or more of these conditions exists may result in increased maintenance and operation expense, reduced equipment life and emergency shutdown. It is strongly recommended that a reputable, local water treatment concern be engaged to establish the corrosion, scale-forming and fouling tendency of the cooling water and take steps necessary to remedy the situation if a problem does exist. The need for water treatment may only involve filtration (screening) to remove debris, sand and/or silt in the cooling water supply. However, chemical treatment methods may be necessary in certain instances to inhibit corrosion and/or remove suspended solids to alter the water's tendency to form scale deposits, or prevent growth of microorganisms. The normal maintenance program for the unit should include periodic cleaning on the tube side (water side) of the heat exchanger to remove deposits which enhance fouling and corrosion.

WATER FLOW CONTROL VALVE FOR HEAT EXCHANGER (Figure 7-5) – The water flow control valve is adjustable to compensate for varying inlet water temperatures. Use the oil temperature thermometer on the instrument panel in setting the flow control valve. **To decrease water flow** (increase oil inlet temperature) turn the adjusting screw from left to right, increasing spring tension. **To increase water flow** (decrease oil inlet temperature) turn the adjusting screw in the opposite direction. The groove at the lower edge of the adjusting screw is an index line for use with the index scale 0 to 8 in obtaining a desired setting.

These valves must be handled with care and proper tools and techniques must be used when working on the valve.

Care must be used when handling the capillary tube; a kink or break in the tubing or connections will make the valve inoperative. Never attempt to change capillary length. Excess capillary tube should be carefully coiled and placed so that damage will not occur in normal maintenance or traffic past unit.

If a leak develops through the packing, tighten the packing gland nut firmly with a wrench to reseat the packing around the valve stem, then back off the nut until loose, and finally retighten the nut finger tight. Tightening the 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.

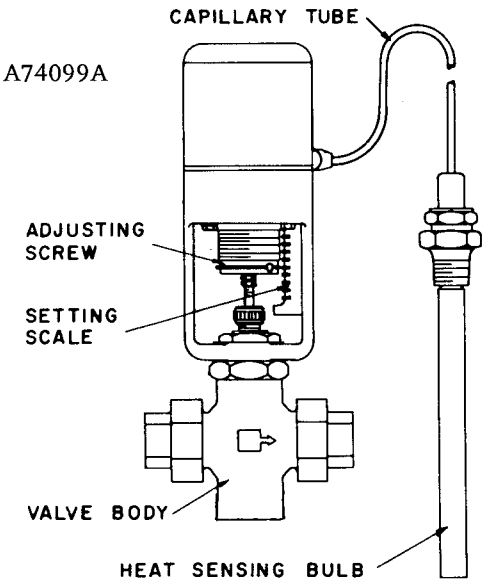


FIGURE 7-5. – WATER CONTROL VALVE

If the valve malfunctions, check for bent or binding (paint or corrosion, etc.) valve stem, foreign material in the valve, erosion, or thermal system (capillary) failure. If foreign material or scale is likely, the use of a strainer in the inlet water line is recommended.

WATER SHUTOFF VALVE – WATER-COOLED HEAT EXCHANGER (Figure 1-5) – A magnetic solenoid-operated water shutoff valve rated at 150 PSIG water pressure is supplied in the water inlet line ahead of the oil cooler. The valve is wired into the compressor control circuit and opens to allow water to flow any time the ON-OFF push button is ON and the compressor is running. When compressor stops under automatic control, or is shut off manually, the valve closes, stopping water flow through the system.

OIL RESERVOIR – The oil reservoir-separator combines two functions into one vessel. The horizontal section is the oil reservoir, providing oil storage capacity for the system and a primary oil separation means. The vertical section contains the final oil separator and has the discharge line mounted on the upper flange. The reservoir also provides limited air storage for control and gauge actuation.

COMPRESSOR OIL SEPARATOR (Figure 8-5) located in the vertical section of the oil reservoir consists of two renewable cartridge type oil separator elements and provides the final removal of oil from the air stream. Oil from inside the separators is returned through tubing to the compressor cylinder. Oil impinging on the outside of the first-stage separator drains directly back into the reservoir section.

Oil carry-over through the service lines may be caused by a faulty oil separator, operation at pressure below 65 PSIG, overfilling of the oil reservoir, oil that foams, or oil return line malfunction. If oil carry-over occurs, inspect the separators only after it is determined that the oil level is not too high, the oil is not foaming excessively, the oil return line from the discharge manifold to the compressor cylinder is not clogged or pinched off, the oil passage through the

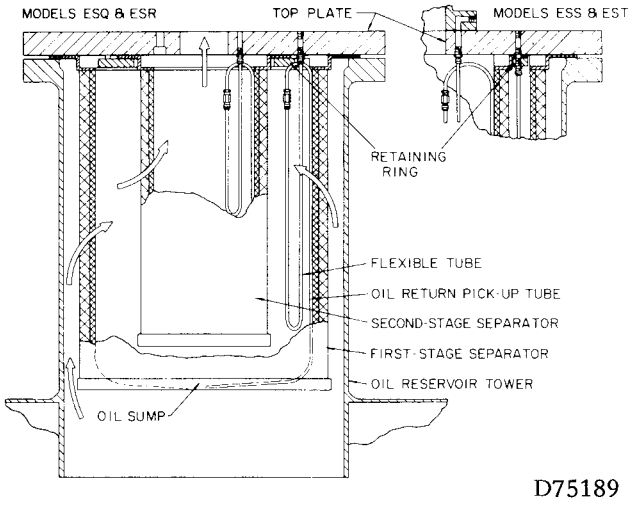


FIGURE 8-5. – COMPRESSOR OIL SEPARATOR

separator top plate is lined up with the discharge manifold return opening and gasket hole, and the return tube inside the separator is not loose or broken.

Oil carry-over malfunctions of the oil separators are usually due to using the 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. Ruptured or collapsed separator elements are usually due to heavy dirt and varnish buildup in the filtering material. Excessive tilt angle of the unit will also hamper separation and cause oil carry-over.

The oil separator pressure differential gauge will read differential across both separators of the dual separator system.

The first-stage separator and, depending on condition, the second-stage separator, should be changed when the oil separator gauge indicates 8 PSI differential with the unit on load at 100 PSIG. Usually, in a dual system, the first stage will contribute most of the pressure differential. It may be possible to reuse the second stage several times before an appreciable contribution to total pressure differential is noticed and the second stage changed.

To remove the separators for inspection or replacement:

1. Disconnect all tubing and the discharge manifold flange connection in the discharge line. Be sure the discharge line is adequately supported before removing the discharge flange cap screws.

2. Remove all cap screws holding the top plate to the oil reservoir tower. Lift top plate, manifold and attached second-stage separator just enough to disconnect the flexible oil return tube inside the first-stage separator. Lift the top plate, manifold and second-stage separator from the oil reservoir tower.

3. Invert the top plate, manifold and second-stage separator assembly. Remove the separator retaining ring and lift the separator from the top plate just enough to disconnect the flexible oil return tube inside the separator. Remove the second-stage separator.

4. Lift the first-stage separator from the oil reservoir tower.

5. Inspect both separators. Using a drop light inside the separators may reveal rupture or areas of heavy dirt or varnish deposits.

6. Replace the separators, if necessary, or reinstall the original separators. Be sure the gaskets bonded to the separators are not damaged.

7. Place the second-stage separator on the top plate so that the oil return holes in the separator flange and the top plate line up (Models ESS and EST). On Models ESQ and ESR, the oil return hole is outside the separator flange diameter. As the separator is being positioned, connect the flexible tube to the separator pickup tube. Make sure the connections on both ends of the flexible tube are tight.

8. Position the second-stage separator retaining ring so that the oil return hole lines up with the hole in the separator flange (Models ESS and EST). On Models ESQ and ESR, a notch in the retaining ring must be positioned over the oil return hole in the top plate. Install and tighten all retaining ring cap screws securely.

9. Place the first-stage separator into the oil reservoir tower.

10. Lower the assembled top plate, manifold and second-stage separator into the first-stage separator. As the assembly is lowered, connect the flexible oil return tubing to the first-stage separator pick-up tube. Make sure connections on both ends of the flexible tube are tight.

11. Reconnect the discharge manifold to the discharge line and tighten all cap screws securely. Reconnect tubing and tighten securely.

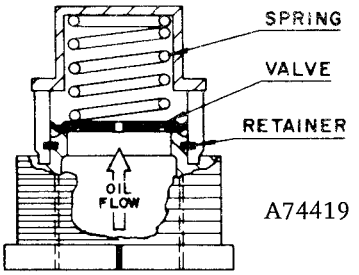


FIGURE 9-5. – OIL FLOW CONTROL VALVE

OIL FLOW CONTROL VALVE (Duomatic Control Unit Only) (Figures 1-5 & 9-5) – An oil flow control valve is located at the inlet to the compressor oil sump at the end of the oil piping from the oil filter. This valve functions as a metering and check valve during unloaded operation; release of the air pressure in the oil reservoir allows pressure to fall on the upstream side of the valve and the spring seats the disc. The vacuum developed in the compressor when unloaded is sufficient to cause a lubricating amount of oil to flow through the orifice hole in the seated disc. When air pressure is again applied in the oil reservoir on loaded operation, the spring force is overcome, and the full amount of oil flows into the compressor. The spring and disc are available for repair. If the valve seat is damaged, a complete new valve should be purchased to insure proper mating of seat and disc.

AUTOMATIC BLOWDOWN VALVE (Figure 1-5) – A solenoid-operated magnetic valve wired into the control circuit is used to relieve pressure in the oil reservoir section each time the unit unloads (Duomatic Control Only) or is shut down. On the Duomatic Control system only, a line from the pipe tee just downstream of the blowdown valve directs a portion of the blowdown air to the compressor sump to aid in scavenging oil for a smooth transition to unloaded operation; the in-line check valve at the compressor sump prevents flow to atmosphere during loaded operation. A muffler terminates the blowdown line to reduce air discharge noise.

PRESSURE DIFFERENTIAL GROUP – A set of gauges mounted on the instrument panel continuously monitors the pressure differential across the oil filter and the oil separators and indicates the condition of the filter and separators.

The oil filter elements should be changed when the gauge indicates a pressure differential of 15 PSI; the oil separators should be changed when the gauge indicates a pressure differential of 8 PSI with the unit on full load at 100 PSIG service pressure. See "Compressor Oil Separator" on page 5, this section.

COMPRESSOR OIL SYSTEM CHECK – The following readings are based on an ambient temperature of 80° F. for an air-cooled oil cooler and 80° F. inlet water temperature on a water-cooled oil cooler, with the system in good condition. Compressor should be at operating temperature at the time of checks. One-half hour of loaded operation is usually sufficient to reach level-out operating temperatures. When checking units with a remote mounted air-cooled oil cooler, some differences may be observed due to piping runs.

Air and Oil Discharge Temperature – 150° to 180° F. – Check with a thermometer in the tapped opening on top of the compressor discharge pipe to the oil reservoir.

Compressor Oil Inlet Temperature – 130° to 160° F. – Read at thermometer on the instrument panel or check with a thermometer at the compressor oil inlet line fitting.

Oil Inlet Pressure – 70 to 80 PSI at 100 PSI Air Receiver Pressure – Check at the fitting in the line near the compressor oil inlet.

Oil Cooler Oil Pressure Differential (Air-Cooled Radiator) – 2 to 12 PSI (65 to 150 PSIG Receiver Pressure) – Check at the fitting in the inlet and outlet lines of the oil cooler.

Oil Cooler Oil Pressure Differential (Water-Cooled Heat Exchanger) – 3 to 12 PSI (65 to 150 PSIG Receiver Pressure) – Check at the heat exchanger oil inlet and outlet fittings.

Oil Cooler Temperature Differential (Air-Cooled Radiator) – The oil temperature differential depends on the temperature of the air at the oil cooler fan and cleanliness of the core faces. As ambient temperatures and core restriction increase, the oil cooler outlet temperature will increase. The inlet oil temperature may be checked at the fitting in the oil inlet line on the oil cooler module. The outlet oil temperature may be checked at the fitting in the oil outlet line to the thermostatic mixing valve.

Oil Cooler Temperature Differential (Water-Cooled Heat Exchanger) – The oil temperature differential depends on the inlet water temperature and the water flow rate permitted by the water flow control valve setting. The oil inlet temperature may be checked at the fitting in the oil reservoir to heat exchanger line. The oil outlet temperature may be checked at the compressor oil inlet line fitting.

Oil Cooler Water Pressure Differential (Water-Cooled Heat Exchanger) – The water pressure differential through the heat exchanger will depend on supply pressure, flow rate, cooler tube cleanliness and outlet pressure. The inlet and outlet water pressures may be checked at the pipe plugs in the inlet bonnet of the heat exchanger.

SECTION 6
AIR FILTERS

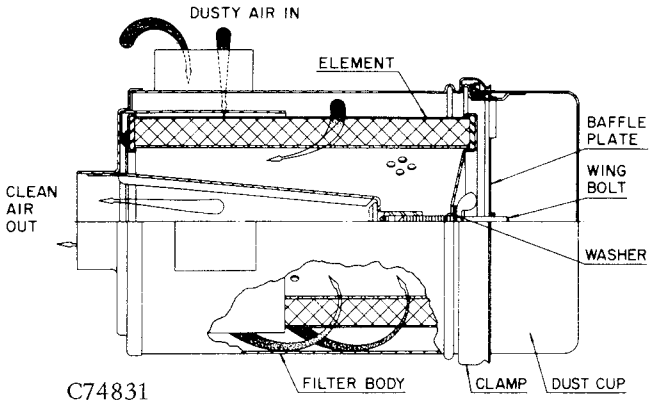


FIGURE 1-6. – AIR FILTER

AIR FILTER (Figure 1-6) furnished as standard equipment is a washable element two-stage dry type filter. The air filter must receive proper maintenance if maximum service is to be obtained from the unit. Establishing adequate and timely filter service is MOST IMPORTANT. To service the air filter, proceed as follows:

Dust Cup – Service every 4 to 120 hours depending on dust conditions. To service, loosen the retaining band clamp and remove the dust cup. Do not wash the dust cup – wipe clean with a clean dry cloth. Do not bend the edge of cup by striking on a hard surface. When installing the dust cup, make sure the clamp is securely tightened to prevent leakage.

Filter Element – The element should be serviced when the pressure drop through the filter reaches 20 inches of water or when inspection indicates a heavy accumulation of dirt on the outside of the element. Clean every 50 to 250 operating hours depending on dust conditions. Inspect every few days until experience determines the proper time for servicing. Higher than normal current use by the motor or loss of compressor capacity may indicate a need for servicing the filter element.

To service:

(a) Loosen the retaining band clamp and remove the dust cup from the body of the filter.

(b) Visually inspect the element in place. If cleaning is not necessary, reinstall the dust cup on the filter. If the element requires cleaning, unscrew the wing bolt and withdraw the element from the body.

(c) Wash the element by soaking in warm water with a mild detergent for about 15 minutes. Rinse the element thoroughly with clean water; a hose may be used if the water pressure does not exceed 40 PSIG.

(d) Inspect the element for ruptures or cracks in the pleated media; replace the element if any are found. Inspect the gasket on the bottom (outlet end) of the element; replace the entire element if the gasket is damaged.

(e) Allow the element to air dry COMPLETELY. Do not expose the element to heat over 150° F. Install the element in the filter body and fasten securely with the wing bolt. Reinstall the dust cup and retaining band clamp. Make sure the clamp is tightened securely to prevent leakage.

CAUTION: Do not oil this element. Do not wash in cleaning fluids. Never operate the unit without the element. Never use elements that are damaged, ruptured or wet. Never use gaskets that won't seal. Keep spare elements and gaskets on hand to reduce down time. Store elements in a protected area free from damage, dirt and moisture. Handle all filter parts with care.

Filter Element Life – The element should be replaced after six cleanings or if:

(a) Visual inspection indicates a rupture, crack or pin hole in the pleated media. Inspection should be done by placing a bright light inside the element.

(b) Pressure drop through a filter with a freshly cleaned element is below 3 inches of water with compressor running at full load – this would indicate a rupture or crack.

Inlet Screen and Tube – Inspect the inlet screen and tube for dirt accumulation each time the filter element is serviced. Clean the tube when required by ramming a clean dry cloth through the tube. Wipe the inside of the filter body to remove any dirt falling from the inlet tube before reinstalling the filter element.

AIR FILTER SERVICE INDICATOR (Figures 2-1 & 4-1) signals time to change or service the air filter. The flag in the window gradually rises as the filter element loads with dirt. When the pressure drop across the filter reaches the equivalent of 20 inches of water, the flag reaches the top and locks in position, indicating need for filter servicing. After servicing, reset the indicator by pushing the reset button all the way in, then release.

CAUTION: The air filter service indicator is an effective device only as long as the inlet system vacuum is maintained. If the vacuum is broken because of a defective filter gasket or ruptured element, the indicator WILL NOT function. It is wise, therefore, to periodically inspect the air filter for excessive dust buildup.

SECTION 7
COUPLING

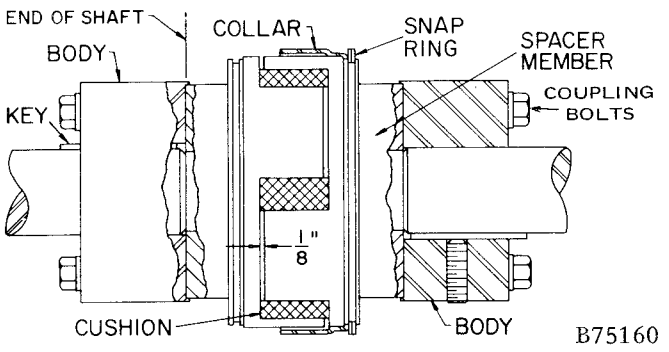


FIGURE 1-7. – COUPLING

COUPLING (Figure 1-7) – The motor and compressor are direct connected by a resilient cushion type flexible coupling. The coupling has a removable spacer center section with several individual cushions. The coupling does not require lubrication.

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

1. Tighten set screws over the keyways in each coupling body. Shaft ends are set flush to the inner face of the coupling body.

2. Remove the snap ring (or cap screws) from the spacer member and slide the collar back over coupling body.

3. Remove the individual load cushions.

4. Position the compressor and motor so that approximately 1/8" gap exists between the ends of the jaws of one spacer member and the flange of the opposite spacer member, Figure 1-7. This is important to prevent preloading the drive shaft bearing.

5. Check the angular alignment with a feeler gauge by comparing the 1/8" gap between the spacer jaw and the opposite flange at the three points of proximity. Shim and adjust the motor and compressor so that the gaps are uniform (Views "A" and "C", Figure 2-7). Maximum recommended gap variation is .015".

6. Check the parallel alignment by placing a straight edge across both spacer flanges. Shim and adjust the compressor and motor until the straight edge lies flat on both hubs measured at two (2) points 90^0 apart (Views "A" and "B", Figure 2-7). Maximum recommended difference in hub level is .015".

7. Recheck the angular alignment to be sure it has not been disturbed.

When the coupling alignment is complete, dowel two diagonally opposite motor feet with the tapered dowel pins supplied. Use a 13/32 diameter drill to drill the lead hole and ream to depth required with a number 8 tapered reamer.

8. Insert the individual cushions and slide the outer collar over the cushions, Figure 1-7, and secure snap ring or replace cap screws.

9. Tighten all motor and compressor screws securely.

Removal of Spacer Member – The coupling has a removable center spacer member for ease of maintenance on the compressor and the motor. If major maintenance requires access to the compressor gear case, or the removal of the compressor or the motor, the removable center spacer allows quick coupling disassembly without unbolting either the motor or compressor. To remove the center spacer, proceed as follows:

1. Remove the cap screws at each end of the coupling body.

2. Slightly compress the center spacer to disengage from the pilot in the coupling body and slide the completely disassembled spacer free.

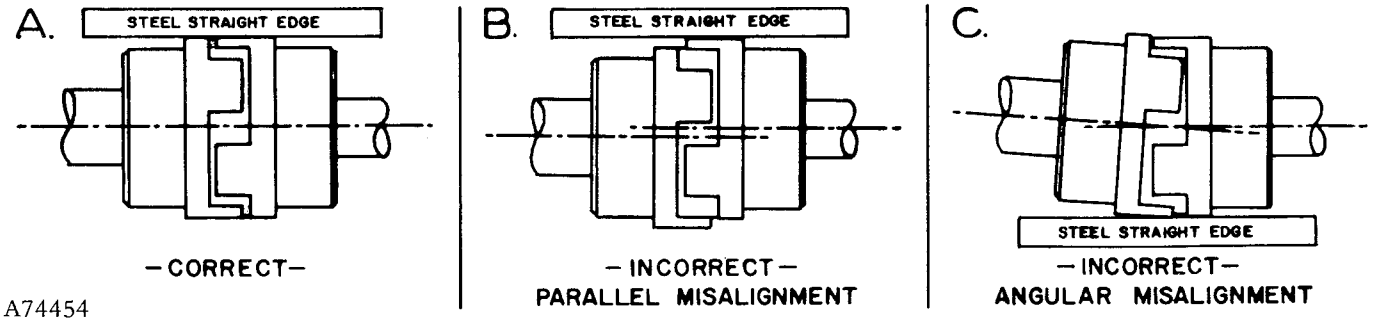


FIGURE 2-7. – COUPLING ALIGNMENT – MODELS ESQ, ESR, ESS & EST

Notes

SECTION 8
MAINTENANCE SCHEDULE

SERVICE CHECK LIST

Air Filter – Operating conditions determine frequency of service; refer to Section 6 "Air Filters" and plan maintenance accordingly.

Oil Separator – Change the oil separator elements when the pressure differential gauge indicates an 8 PSI differential. Refer to "Compressor Oil Separator" in Section 5 for further details.

Every 8 Hours Operation

1. Check the reservoir oil level – add oil if the oil level is in the ADD range with the compressor on load. If oil consumption is high, refer to "Compressor Oil Separator" in Section 5 and "Excessive Oil Consumption" in Section 9.
2. Observe if the unit loads and unloads properly.
3. Drain the moisture traps on separate air receiver and moisture separator, if used.

Every 125 Hours Operation

1. Check for dirt accumulation on radiator-type oil cooler core faces and on the enclosure ventilating fan and fan motor. Blow off dirt if accumulation is excessive.

Every 1000 Hours Operation

1. Change the oil filter element every 1000 hours or when the pressure differential gauge indicates a 15 PSI differential, whichever occurs first.
2. Change the compressor oil if using an SAE grade oil. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY (refer to "Oil Change Interval" in Section 5). Flush the system if required.

Every 2000 Hours Operation

1. If using automatic transmission fluid, change the compressor oil. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY (refer to "Oil Change Interval" in Section 5). Flush the system if required.
2. Clean the magnetic plug in the oil reservoir.

SECTION 9
TROUBLE SHOOTING

IF UNIT FAILS TO START, check:

1. Wiring system for wrong lead connections.
2. Temperature switch manual reset button, temperature and/or pressure shutdown circuit breaker on control panel.
3. Fuses in control enclosure or starter enclosure.
4. Compressor motor starter overload heaters and adjusting knob.
5. Oil cooler and/or enclosure vent fan motor overload heaters and adjusting knob.
6. Low oil pressure or faulty low oil pressure switch.
7. Contacts on timing relay for low oil pressure shutdown stuck open.
8. Faulty timing relay.

UNIT STARTS BUT STOPS AFTER A SHORT RUN, check:

1. High air discharge temperature caused by:
   (a) Low compressor oil level.
   (b) Clogged oil cooler or oil filters.
   (c) Thermostatic mixing valve inoperative.
   (d) Dirt on oil cooler core faces.
   (e) Poor ventilation of unit and/or oil cooler.
   (f) Oil control valve stuck (Duomatic control only).
   (g) Water control valve inoperative or water inlet temperature too high.
   (h) Magnetic water shutoff valve inoperative.
   (i) On remote oil cooler unit, pilot-operated valve or check valve in piping to oil cooler inoperative.
2. Temperature switch manual reset button, temperature and/or pressure shutdown circuit breaker on control panel.
3. Fuses in control panel enclosure or starter enclosure.
4. Compressor motor starter overloads and adjusting knob.
5. Oil cooler and/or enclosure vent fan motor overload heaters and adjusting knob.
6. Low oil pressure or faulty low oil pressure shutdown switch.
7. Time delay on timing relay for low oil pressure shutdown set for too short a time. MAXIMUM DELAY SETTING IS 10 SECONDS.
8. Faulty timing relay.

COMPRESSOR DOES NOT UNLOAD, check:

1. Magnetic unloader or pressure switch for malfunction (Duomatic control only).
2. Control lines for restriction.
3. Air leaks in control system.
4. Inlet valve stuck.
5. Pilot or pressure switch adjustment.
6. Pilot or pressure switch for dirt or leaking diaphragm.

SOLENOID BLOWDOWN VALVE CONTINUES TO PASS AIR, check for:

1. Loose wiring to the blowdown valve.
2. Coil failure on the blowdown valve.
3. Dirt or moisture in blowdown line check valve at compressor oil sump (Duomatic control only).

EXCESSIVE OIL CONSUMPTION, check for:

1. Oil carry-over through discharge line caused by:
   (a) Overfilling the reservoir.
   (b) Clogged, broken or loose oil return lines.
   (c) Ruptured oil separator element(s).
   (d) Loose assembly.
   (e) Incorrect oil causing foam.
   (f) Inoperative minimum pressure valve.
2. Oil leaks at all fittings and gaskets.

COMPRESSOR LOW ON DELIVERY AND PRESSURE, check for:

1. Clogged air filter.
2. Restricted inlet valve.
3. Broken inlet valve spring.
4. Binding inlet valve piston.
5. Incorrect motor speed.
6. Pilot adjustment and/or malfunction.
7. Automatic blowdown valve leaking (remove muffler to check).
8. "O" ring leaking on minimum pressure valve piston stem causing valve to be partly closed.

SECTION 10
COMPRESSOR OVERHAUL

ELECTRA-SCREW® COMPRESSOR DISASSEMBLY AND ASSEMBLY procedures are explained in the text. Some models may have a different or supplementary procedure which is listed following the general instructions for that step. Illustrations have been taken from various sizes of Electra-Screw® compressors. Minor variations in construction will be noted, but should not cause concern; all significant differences are covered by the text.

DISASSEMBLY INSTRUCTIONS – Pull main breaker switch. Remove oil lines, tubing and piping as required to clear compressor for removal from base. Air and oil filters are mounted differently according to models; remove filters and their brackets as required. Cover openings in oil lines, tubing, oil filter and air filter to keep out dirt. Remove inlet valve assembly and cover openings. Remove coupling guard and compressor feet to base bolts. With suitable lifting device (see chart below for weight), move compressor away from motor to disengage coupling. If shims are under compressor feet, tag for correct location for use at reassembly.

Compressor Model	Weight Of Compressor
ESQ, ESR, ESS, EST	2800 Lbs. (Approx.)

1. Place compressor on suitable blocking and remove oil sump housing. Tag so it can be reinstalled with oil inlet opening in proper direction for oil line connection.

2. Remove coupling half from drive shaft (use shaft protector to prevent damage to end of shaft), remove key. Remove seal retainer plate and seal seat, protect face of seal seat if it is to be reused. *NOTE: In the event seat is stuck in bore, it may be removed after removal of seal housing.*

   Remove two upper cap screws from seal housing and install two guide studs as shown to prevent housing from dropping and breaking carbon face of oil seal. Remove remaining cap screws and remove housing which has a pilot fit to bearing outer race.

3. Loosen the three set screws in seal body and slide seal from shaft. If it is to be reused, protect carbon face from damage and dirt.

4. Rig sling and eyebolts to support bearing housing and drive shaft assembly. Remove all housing cap screws. With four jack bolts, two either side, jack housing assembly from dowel pins of inlet housing. *NOTE: Jack bolts should be hardened with round or flat ends. Tighten jack bolts evenly to prevent binding of housing on dowel pins.*

   CAUTION: Be sure compressor is suitably blocked when housing is removed – feet will no longer support front of compressor.

   The assembly is heavier on the gear side (internal); therefore, firmly hold drive shaft to prevent overbalance and parts damage as assembly clears dowel pins.

5. Support housing and drive shaft assembly on blocking with coupling end of shaft down. Block under end of shaft to prevent bearing and shaft assembly from dropping out of gear housing as following steps are performed. Remove cap screws holding inner bearing housing to gear housing. With two jack bolts, jack inner housing from dowel pins. Tighten jack bolts evenly to prevent binding. Remove inner bearing housing and bearing split retainer plates. Remove inner roller bearing retainer ring from end of shaft. Rig puller and pull roller bearing, using shaft protector to prevent damage to shaft. It is not recommended to reuse bearings; however, if it must be reused, the bearing must be pulled with care to prevent damage – puller pressure must be applied to the inner race only.

6. With eyebolt in end of shaft, use hoist to lift gear, ball bearing and shaft assembly from gear housing. Bearing is a slip fit in housing. Remove retaining rings next to ball bearing and gear. The bearing must be pressed or pulled toward coupling end of shaft (with keyway) since there is a shoulder on shaft between ball bearing and gear. Pull or press gear towards the shaft extension (roller bearing end) of shaft. Gear removal is not necessary if it is to be reused. Handle with care to prevent damage to gear teeth.

7. Remove gear locknut and washer from main rotor shaft extension. With puller plate, made per Sketch "A", and hydraulic jack rigged as shown, pull gear. USE SHAFT PROTECTOR. Handle gear carefully to prevent damage to teeth if it is to be reused.

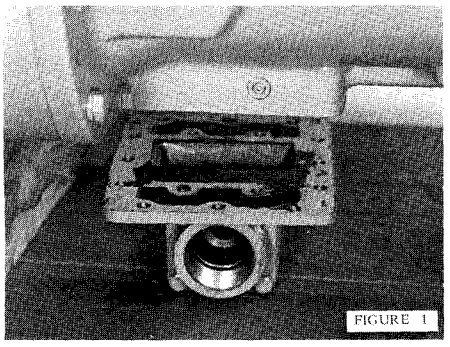


FIGURE 1

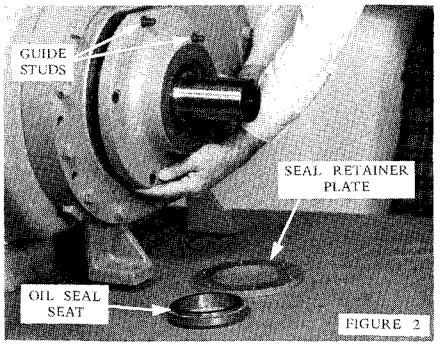


FIGURE 2

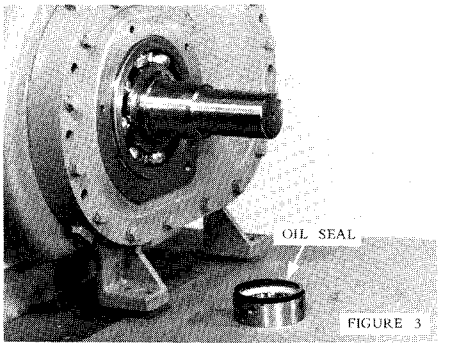


FIGURE 3

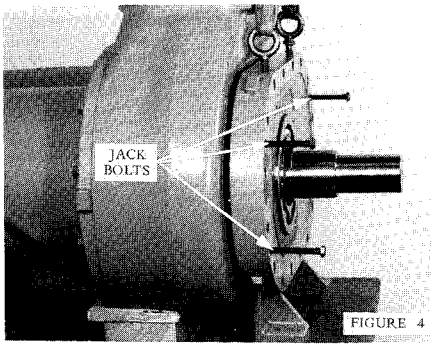


FIGURE 4

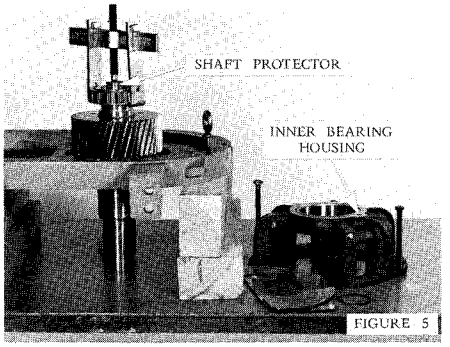


FIGURE 5

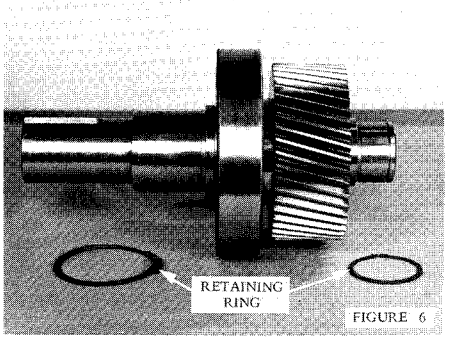


FIGURE 6

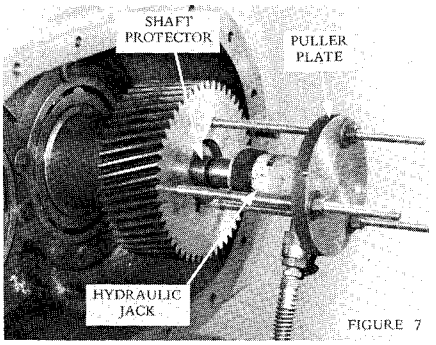
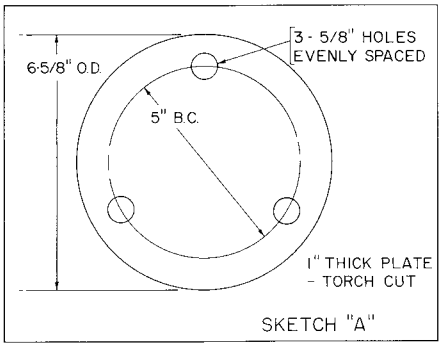


FIGURE 7



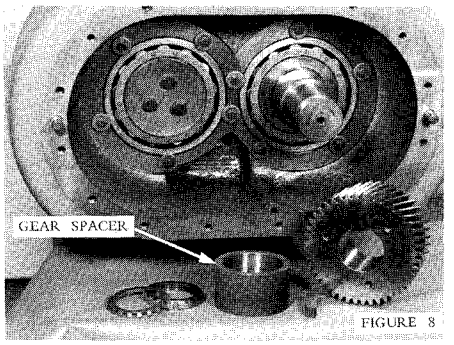


FIGURE 8

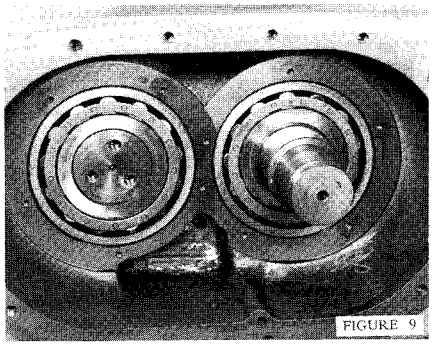


FIGURE 9

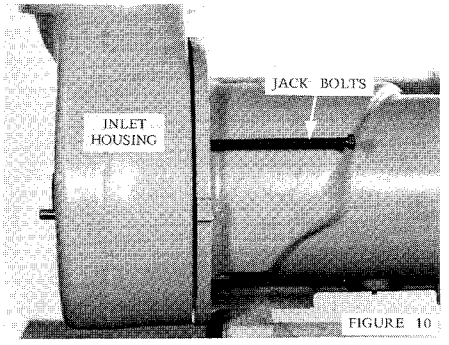


FIGURE 10

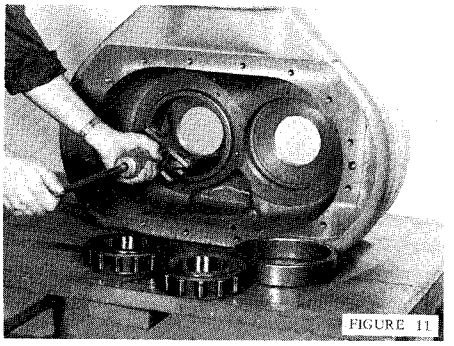


FIGURE 11

8. Remove gear spacer and key from shaft.

9. Remove three hex head cap screws and bearing retainer plate from end of secondary rotor shaft. Remove the ten (10) cap screws and washers holding bearing outer races in bore.

10. Remove all inlet housing to cylinder screws.

CAUTION: Be sure to remove the two screws at bottom center in recessed cavity of inlet housing; these screws are clearly shown in Assembly Figure 3.

With four jack bolts, two at each side, jack inlet housing from cylinder and bearings from shaft. Blocking may require adjustment so housing hangs free. Lubricate jack bolts. Progressively tighten jack bolts evenly to prevent binding housing on dowels and bearings on shaft. Use hoist to lift housing as bearings are jacked free of shaft. Remove inner race and roller assembly from housing. If bearings are to be reused, *which is not recommended,* tag to match inner race and rotor from which removed. As a safety measure mark ends of rotors so they can be matched at reassembly in case timing marks have been destroyed. Center punch rotor lobes as illustrated in Figure 4 of Assembly Instructions.

11. Remove bearing outer race from inlet housing. Race is light press fit to slip fit. If bearings are to be reused, tag outer race to match respective roller and inner race assembly.

12. Remove all bearing cover plate to discharge housing screws including the two long cap screws that enter through discharge manifold. With two jack bolts, one each side, jack housing from dowel pins. Use caution to prevent housing from binding on dowels.

NOTE: Make a plate according to Sketch "B" on following page. This plate is used in Step 13 of the Disassembly and Step 10 of Assembly. The discharge end cover plate gasket may be used to lay out the four holes at the corners of the plate.

13. Remove bearing retainer plates and outer race shims. With hydraulic jack and plate rigged as shown, press rotors through bearings. Use shaft protector to prevent

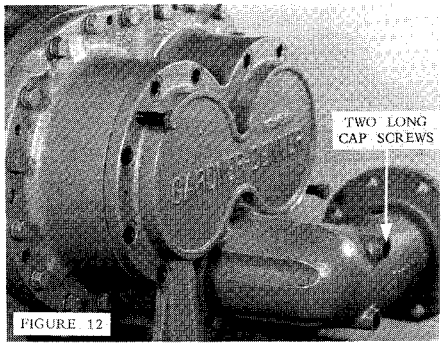
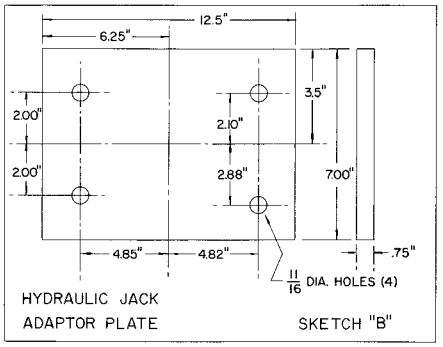


FIGURE 12



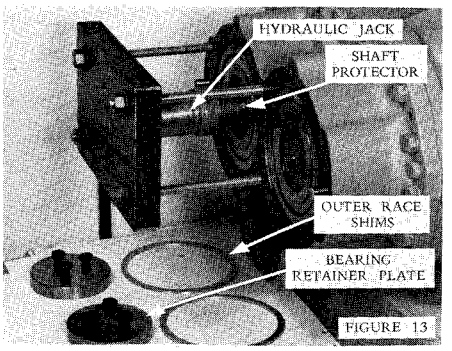


FIGURE 13

damage to end of rotor shaft. When rotor shaft is free of bearings, remove rotor from cylinder. Remove with care to prevent burrs on rotor lobes and cylinder. Remove both rotors.

14. Remove discharge housing from cylinder by use of jack bolts, using caution to prevent binding on dowel pins. Discharge end bearings are slip fit in bore and may slide out by hand. If they do not slide out freely, a pushing tool may be rigged as shown to press the bearing out. Be careful they do not fall out as plate is turned over in preparing to remove the bearings. Tag bearings for reassembly in same position if to be reused. NEVER REUSE WORN BEARINGS.

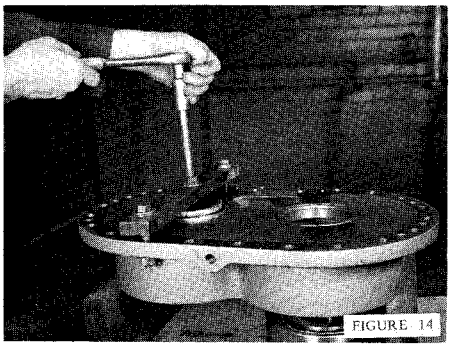
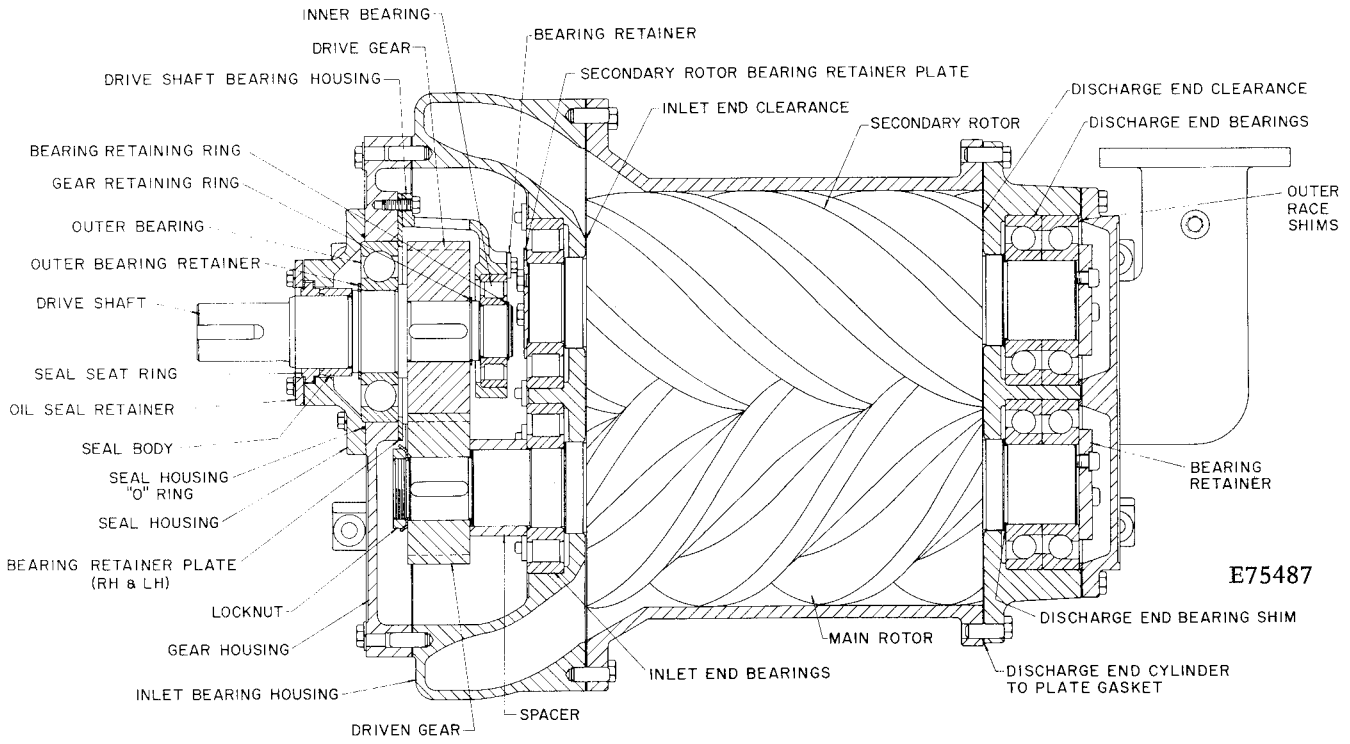


FIGURE 14



SECTIONAL VIEW OF COMPRESSOR

rotors. If the indicator reading does not match range in chart, check for burrs between housing and end of rotors.

CLEARANCE CHART – UNIT COLD

Total End Clearance (Inlet + Discharge)	.028–.043
Inlet End Clearance	.024–.037
Discharge End Clearance	.004–.006

9. To determine the thickness of shims needed to give correct rotor discharge end clearance, subtract the rotor shaft measurement, Step 5 from the discharge end housing measurement, Step 6. To this figure add the discharge end clearance (refer to clearance chart). Add an additional .002" for crush fit. Be sure the rotor shoulder (Step 5) and housing (Step 6) measurements are matched according to their related assembly positions. Check shim set thickness with outside micrometer. Install shims on respective shaft extension. Be sure shoulder of shaft is free of burrs. *NOTE: Housing should always be in place before these shims are installed to prevent damage to shims as housing slips over shaft.*

10. For ease of bearing assembly, lightly coat bearing bore and shaft extension with "Moly" type grease. Using bearing press plate (8-3/4" dia. x 5/8" thick) and hydraulic jack, assemble as shown and press discharge angular contact bearings in housing. *NOTE: Do NOT drive bearing in with hammer and drift as damage to bearings may result and lead to early bearing failure.* Be sure the bearing is started in bore evenly to prevent cocking of bearing. ASSEMBLE BEARINGS IN HOUSING IN POSITION AS 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.

11. Install bearing retainer plates using Nylok type screws. Tightening these screws pulls the rotor shaft through bearings until shoulder of shaft and shaft shims, Figure 9, are jammed against bearing inner race. This provides proper rotor position from discharge end plate.

12. Check discharge end clearance (end of rotor to housing) with feeler gauge through discharge opening – see clearance chart. Rotate rotors to check each lobe of both rotors. Since lower end of rotors are not yet held by bearings, there may be a slight out-of-square condition noticed in this check.

    If clearance is too small, it may be due to bearing outer race not seated against shoulder in bore. Jolt ends of rotors slightly. *NOTE: HEAVY BLOWS WITH A METAL HAMMER OR DRIFT MAY DAMAGE BEARINGS.*

    If clearance is too great, it may be due to shaft shoulder and shims not tight against bearing inner race. Refer to Step 11.

    If clearance is still not correct, it may be due to error in measurements or burrs. Remove discharge housing and bearings. Check for burrs on shaft shoulder, rotor ends, bearing bore and face of housing. Recheck figures in Steps 5, 6, 8 and 9. Reassemble and again check clearance.

13. Check inlet end clearance with feeler gauge through

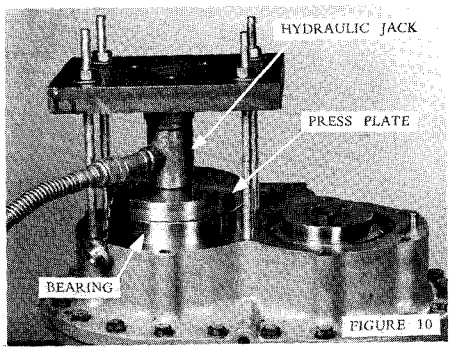


FIGURE 10

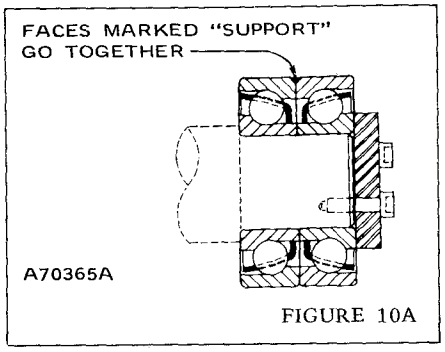


FIGURE 10A

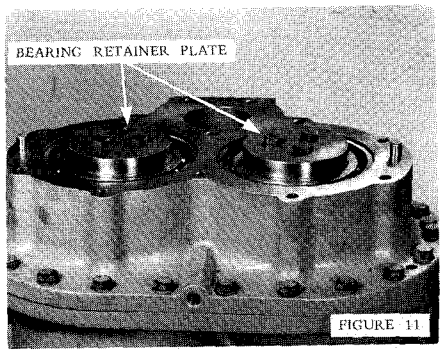


FIGURE 11

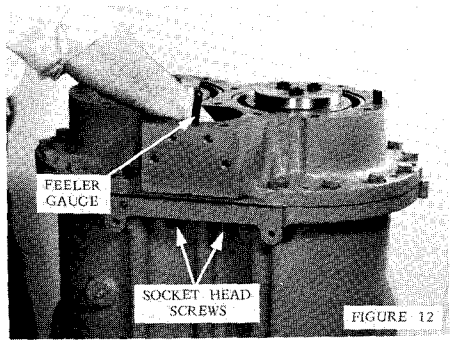


FIGURE 12

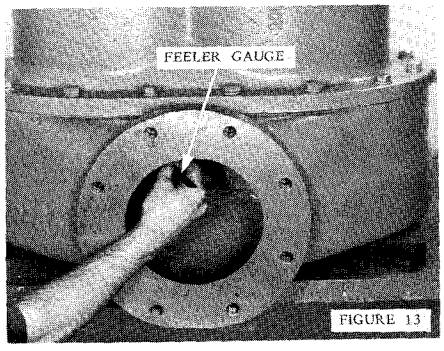


FIGURE 13

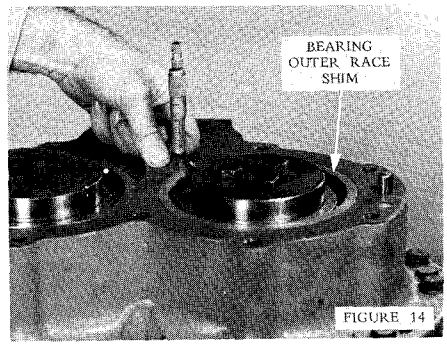


FIGURE 14

inlet opening. Rotate rotors and check each lobe of both rotors – refer to clearance chart.

14. 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. Shims must hold bearings in fixed position in bore. Be sure bearing outer race is seated in bore.

15. 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 pin.

16. Place assembly in horizontal position on substantial blocking. Lightly coat shafts and bearing bores with "Moly" type grease. NEVER DRIVE BEARINGS IN PLACE. Heat the inner race and roller assembly to 250° F. NEVER USE TORCH – HEAT IN OIL OR ELECTRIC OVEN. Allow heat to penetrate for 30 minutes. Slip bearing over shaft firmly against shoulder and allow to cool to room temperature. When thoroughly cool, tap outer race in bore using fiber or plastic hammer. Outer race is light press fit to slip fit in bore. NEVER USE WORN BEARINGS.

    Install bearing outer race retainer washers and Nylok screws. Install retainer plate, with pilot side towards shaft, and three (3) Nylok screws on secondary rotor and pull tight. Refer to torque chart. *NOTE: Due to close running clearance, DO NOT substitute cap screws with thicker heads.* Install gear spacer and gear key. Be sure shaft is free of burrs for installing gear. OIL BEARINGS.

17. Heat gear to 325-350° F. NEVER USE TORCH – HEAT IN OIL OR ELECTRIC OVEN. Allow heat to penetrate 30 minutes. Slip gear over shaft and key, firmly against gear spacer, with tapped puller holes out. Install lock washer and nut on shaft and pull tight. As gear cools, check nut for tightness. When cooling and tightening process is complete, bend ear of lock washer into slot in nut. OIL GEAR TEETH.

18. Heat ball bearing in oil or electric oven to 250° F. Stand drive shaft on end, coupling end up, and lower bearing in place. Install bearing retaining ring. DO NOT DRIVE BEARING ON SHAFT NOR HEAT WITH TORCH.

19. Install gear key in shaft. Support shaft and ball bearing on clean blocking. Heat gear in oil or electric oven to 325-350° F. Heat should penetrate for 30 minutes. Install gear, puller holes up, on shaft. Install gear retaining ring. Allow shaft and gear to cool before attempting to install roller bearing. Heat roller bearing inner race assembly in oil or electric oven to 250° F. Install bearing on shaft and install retaining ring. DO NOT DRIVE GEAR AND BEARING ON SHAFT NOR HEAT WITH TORCH.

20. Place gear housing (oil seal cover side down) on blocking high enough to clear drive shaft extension. Support gear, bearing and shaft assembly as shown (1/2-13 eyebolt) and lower bearing into housing bore until bearing is slightly below flush. Bearing is slip fit to very slight press fit in bore. The assembly may be "TAPPED" in place with FIBER faced hammer – be sure bearing is not cocked in bore. Place the split retainer plates on the housing, lining up cap screw holes and oil hole. Block under end of shaft so bearing will not slide through bore when hoist is removed.

21. Install roller bearing outer race (which is slip fit) in bore of inner bearing housing. Install roller bearing outer race retainers (two heavy flat washers and cap screws). Make sure oil passage plug is in place as shown. Lower inner bearing housing into place over gear housing dowel pins. Insert cap screws through bearing

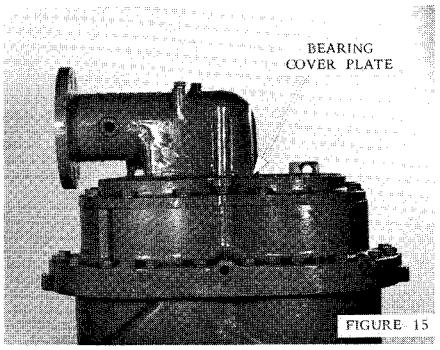


FIGURE 15

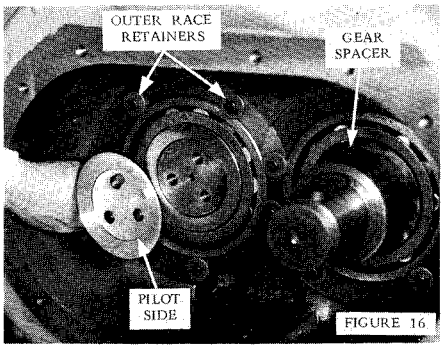


FIGURE 16

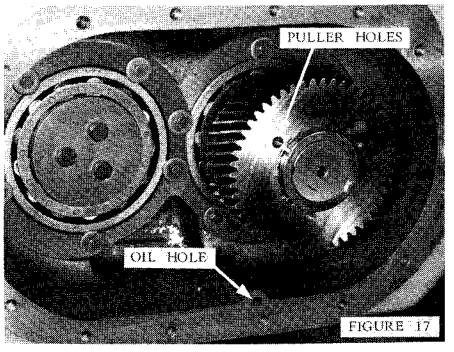


FIGURE 17

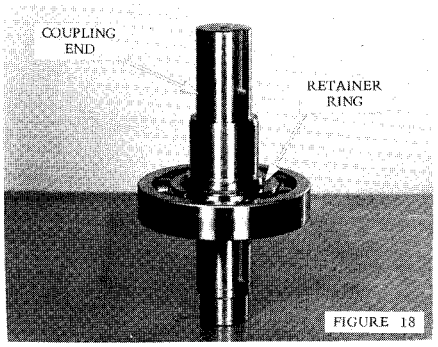


FIGURE 18

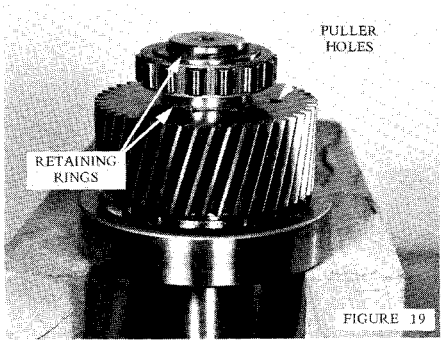


FIGURE 19

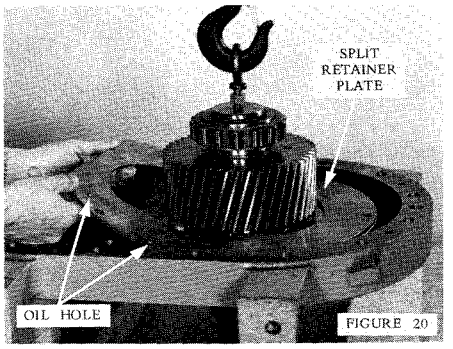


FIGURE 20

REBUILDING DATA FOR ESQ, ESR, ESS & EST GEAR-DRIVEN COMPRESSORS

DIMENSIONS

Center of Main Bore to Center of Secondary Bore	9.634/9.636
Cylinder Bore Diameter – Main	12.552/12.548
Secondary	11.576/11.572
Cylinder Length	20.665/20.661
Inlet End Bearing Bore Diameter	8.8580/8.8590
Inlet End Bearing Bore Depth	1.891/1.896
Inlet End Air Seal Bore Diameter	4.768/4.769
Discharge End Bearing Bore Diameter	8.8583/8.8588
Discharge End Bearing Bore Depth	3.950/3.952
Discharge End Air Seal Bore Diameter	4.763/4.764
Inlet and Discharge End Air Seal Bore Length, Rotor Side of Bore to Bearing Bore Shoulder	1.125/1.120
Rotor Body O.D. – Main	12.536/12.535
Secondary	11.560/11.559
Rotor Body Length	20.688/20.686
Rotor Shaft Air Seal Diameter – Inlet	4.750/4.749
Discharge	4.754/4.753
Rotor Shaft Air Seal Diameter Length * –	
Inlet	1.135/1.130
Discharge	1.100/1.095
Rotor Shaft Bearing Diameter	4.1346/4.1340
Rotor Shaft Bearing Diameter Length * –	
Inlet	1.88
Discharge (Main)	3.82
Main Rotor Shaft Gear Diameter	3.2505/3.2500
Main Rotor Shaft Gear Diameter Length *	3.24
Drive Shaft Seal Diameter	3.752/3.748
Drive Shaft Seal Diameter Length *	3.24
Drive Shaft Outer Bearing Diameter	4.3314/4.3308
Drive Shaft Outer Bearing Diameter Length	1.956/1.962
Drive Shaft Outer Bearing Shoulder Diameter	4.90
Drive Shaft Inner Bearing Diameter	2.7565/2.7560
Drive Shaft Inner Bearing Length	1.366/1.375
Drive Shaft Gear Diameter	3.1255/3.1250
Drive Shaft Gear Diameter Length *	3.239/3.249
Drive Shaft Coupling Diameter	3.000/2.999
Drive Shaft Coupling Diameter Length *	4.90

Dimensions in two (2) decimal places may vary ± .020.

* Includes any radii, chamfer or undercut.

DIMENSIONS (Continued)

Drive Shaft Inner Bearing Snap Ring Groove – Diameter	2.608/2.596
Width	.103/.108
Drive Shaft Gear Snap Ring Groove – Diameter	2.963/2.951
Width	.103/.108
Drive Shaft Outer Bearing Snap Ring Groove – Diameter	4.196/4.184
Width	.120/.125
Drive Gear Bore	3.1240/3.1245
Driven Gear Bore	3.2490/3.2495
Drive and Driven Gear Face Width *	3.250/3.245
Gear Center Distance	8.199/8.201
Gear Case Outer Bearing Bore	9.4488/9.4495
Gear Case Inner Bearing Bore	5.9055/5.9063
Gear Case Width, Flange to Face	2.402/2.398
Seal Housing Pilot Diameter	9.4488/9.4495
Seal Housing Pilot Diameter Depth *	.270/.272

FITS

Rotor Bearing Inner Race to Shaft –	
Inlet	.0005T/.0022T
Discharge	.0001T/.0015T
Rotor Bearing Outer Race to Bore –	
Inlet	.0003T/.0019L
Discharge	.0000/.0017L
Drive or Driven Gear to Shaft	.0005T/.0015T
Drive Shaft to Coupling	.000/.002L
Drive Shaft Outer Bearing –	
Inner Race to Shaft	.0001T/.0015T
Outer Race to Housing	.0000/.0019L
Drive Shaft Inner Bearing –	
Inner Race to Shaft	.0001T/.0012T
Outer Race to Housing	.0000/.0016L
Seal Housing Pilot to Outer Bearing	.0000/.0019L

RUNNING CLEARANCES

Rotor to Cylinder – Diametral – Main and Secondary	.012/.017
End Plate to Rotor – Axial – Inlet	.024/.037
Discharge	.004/.006
Air Seal – Diametral – Inlet	.018/.020
Discharge	.009/.011
Gear Backlash	.003/.005
Drive Shaft End Float (Cold)	.005/.025

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