13-9-606
7th Edition

ELECTRA-SCREW ®

STATIONARY

BASE MOUNTED

COMPRESSOR

- 30 HP - MODEL ESG
- 40 HP - MODEL ESH
- 50 HP - MODEL ESJ

Service Manual

13-9-606

COOPER INDUSTRIES

GARDNER-DENVER
INDUSTRIAL MACHINERY DIVISION

COOPER INDUSTRIES

GARDNER-DENVER

ELECTRA-SCREW® AND ELECTRA-SAVER® COMPRESSORS

WARRANTY

Gardner-Denver (the "Company") warrants its products only as follows:

GENERAL PROVISIONS AND LIMITATIONS

The Company warrants to each original retail purchaser ("Purchaser") of its new products from the Company or its authorized distributor that such products are, at the time of delivery to the Purchaser, made with good material and workmanship, provided that no warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment, been subject to negligence, accident, improper storage, or improper installation or application.
3. Any product which has not been operated or maintained in accordance with normal practice and with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others, except as separately rated.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted directly to the manufacturer.

The Company's obligation under this warranty is limited to furnishing repaired part or, at its option, replacement part, during normal business hours at an authorized service facility of the Company, for any part which in its judgment proved not to be as warranted within the applicable Warranty Period. During the first 90 days from initial use, not to exceed 120 days from date of shipment to first Purchaser, labor for installation of such a part will be provided without charge to the user during normal working hours at an authorized service facility of the Company. All costs of transportation of parts claimed not to be as warranted and of repaired or replacement parts and service personnel from such service facility shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by Company, transportation prepaid by Purchaser, to establish a claim under this warranty.

Replacement parts provided under the terms of this warranty are warranted for the remainder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components thereof.

WARRANTY PERIOD

Basic compressor air ends, consisting of all parts within and including the compressor cylinder and gear housing, are warranted for 24 months from date of initial use or 27 months from date of shipment to the first Purchaser, whichever occurs first.

Electric motors and oil coolers are warranted for 12 months from date of initial use or 15 months from date of shipment to first Purchaser, whichever occurs first.

All other components are warranted for 6 months from date of initial use or 9 months from date of shipment to first Purchaser, whichever occurs first.

DISCLAIMER

THE COMPANY MAKES NO OTHER WARRANTY OF ANY KIND WHATSOEVER EXPRESSED OR IMPLIED AND ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED BY THE COMPANY. THE COMPANY SHALL IN NO CASE BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES WHATSOEVER WITH RESPECT TO PRODUCTS OR SERVICES MANUFACTURED OR FURNISHED BY IT OR ANY ACTS OR OMISSIONS RELATING THERETO. THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO PURCHASER. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

No statement, representation, agreement, or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented within 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which the cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

THIS BOOK COVERS THE FOLLOWING MODELS:

	AIR COOLED	WATER COOLED
30 HP	ESGAE (100 PSI) ESGBE (125 PSI)	ESGAF (100 PSI) ESGBF (125 PSI)
40 HP	ESHAE (100 PSI) ESHBE (125 PSI) ESHCE (150 PSI)	ESHAF (100 PSI) ESHBF (125 PSI) ESHCF (150 PSI)
50 HP	ESJAE (100 PSI) ESJBE (125 PSI) ESJCE (150 PSI)	ESJAF (100 PSI) ESJBF (125 PSI) ESJCF (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

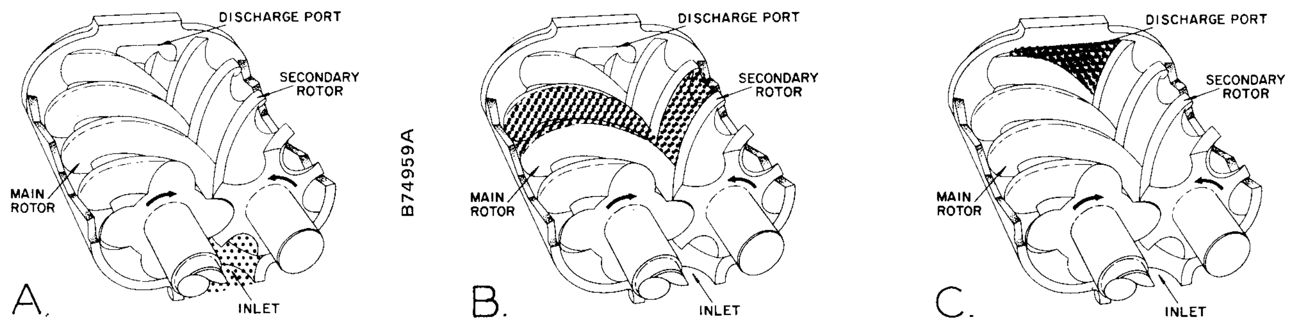


FIGURE 1-1. – COMPRESSION CYCLE

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 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.

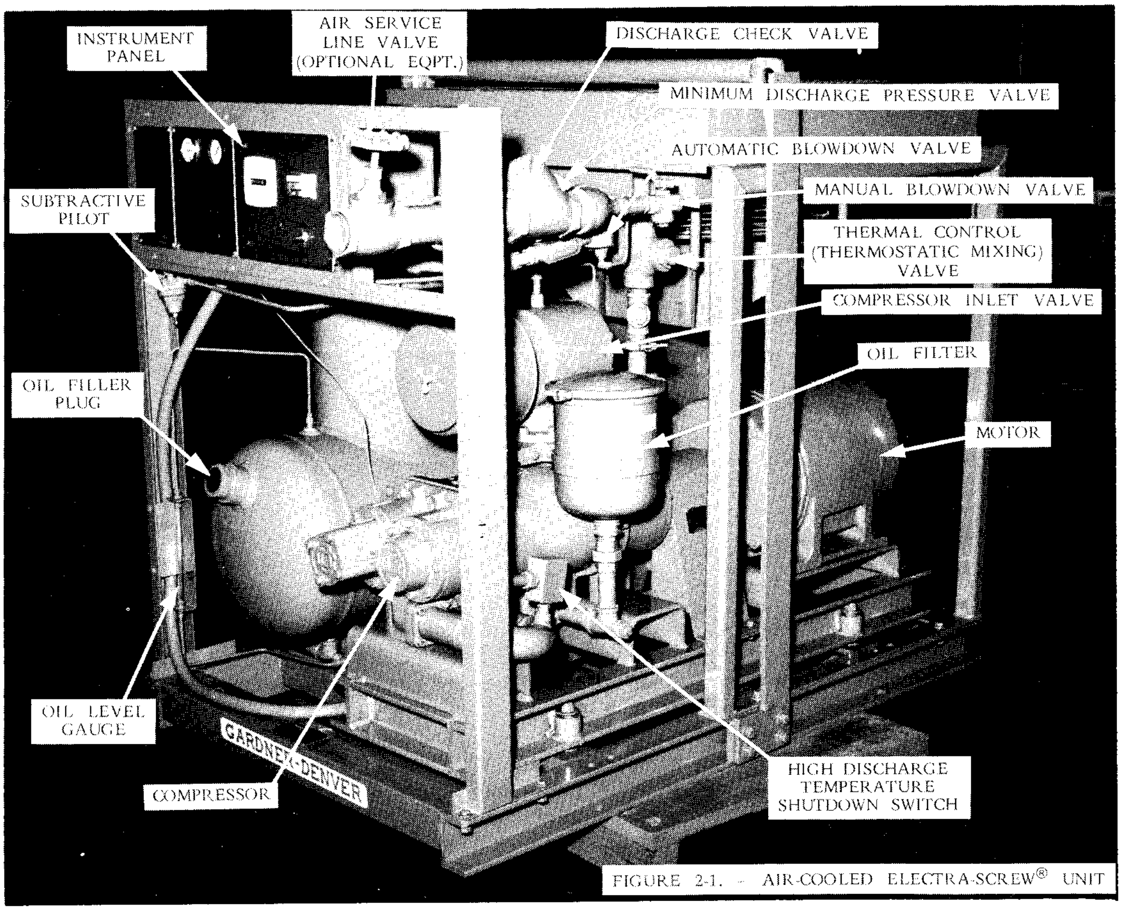


FIGURE 2-1. — AIR-COOLED ELECTRA-SCREW® UNIT

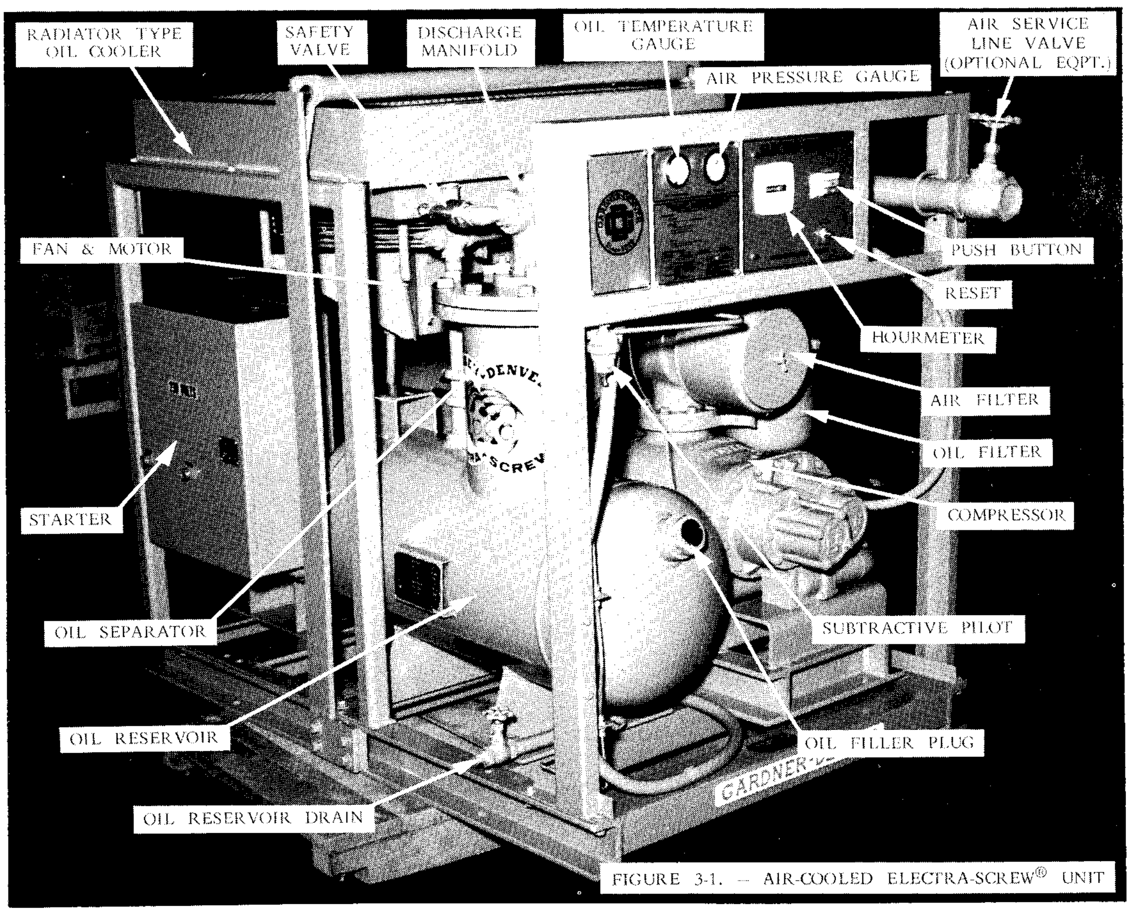


FIGURE 3-1. — AIR-COOLED ELECTRA-SCREW® UNIT

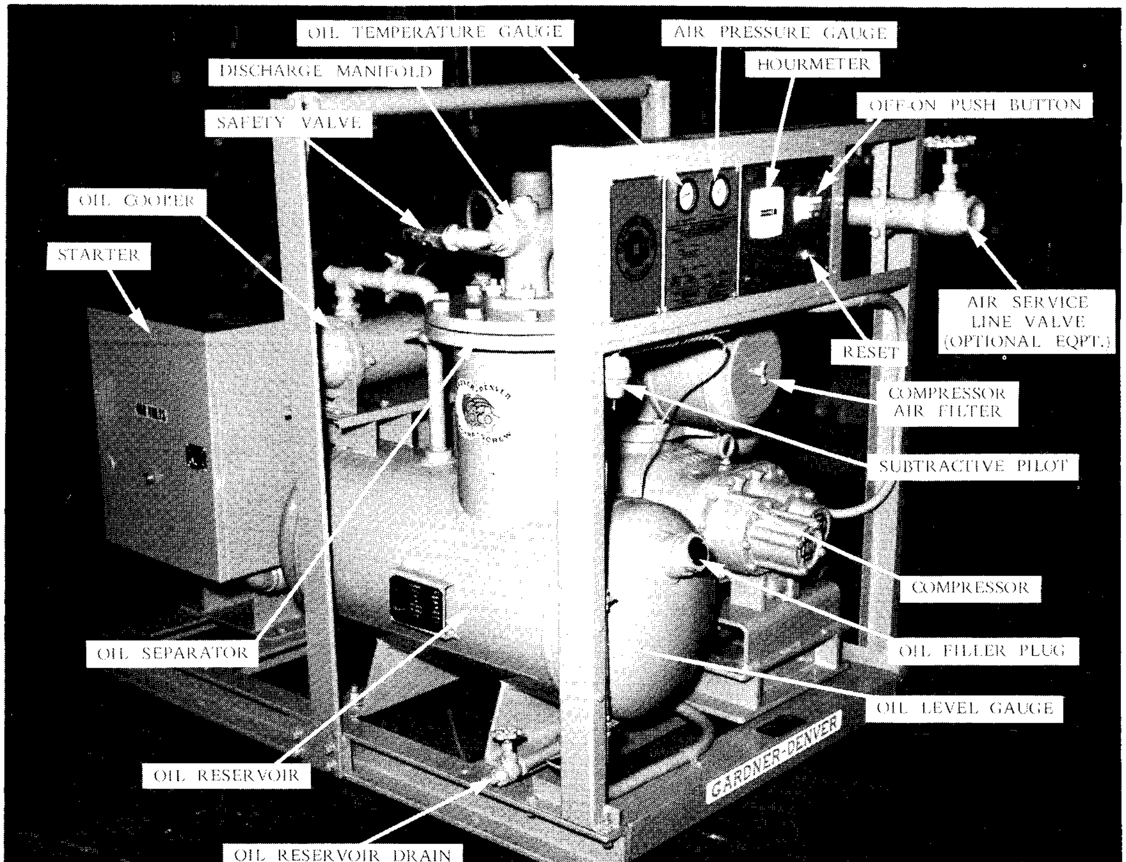


FIGURE 4-1. – WATER-COOLED ELECTRA-SCREW® UNIT

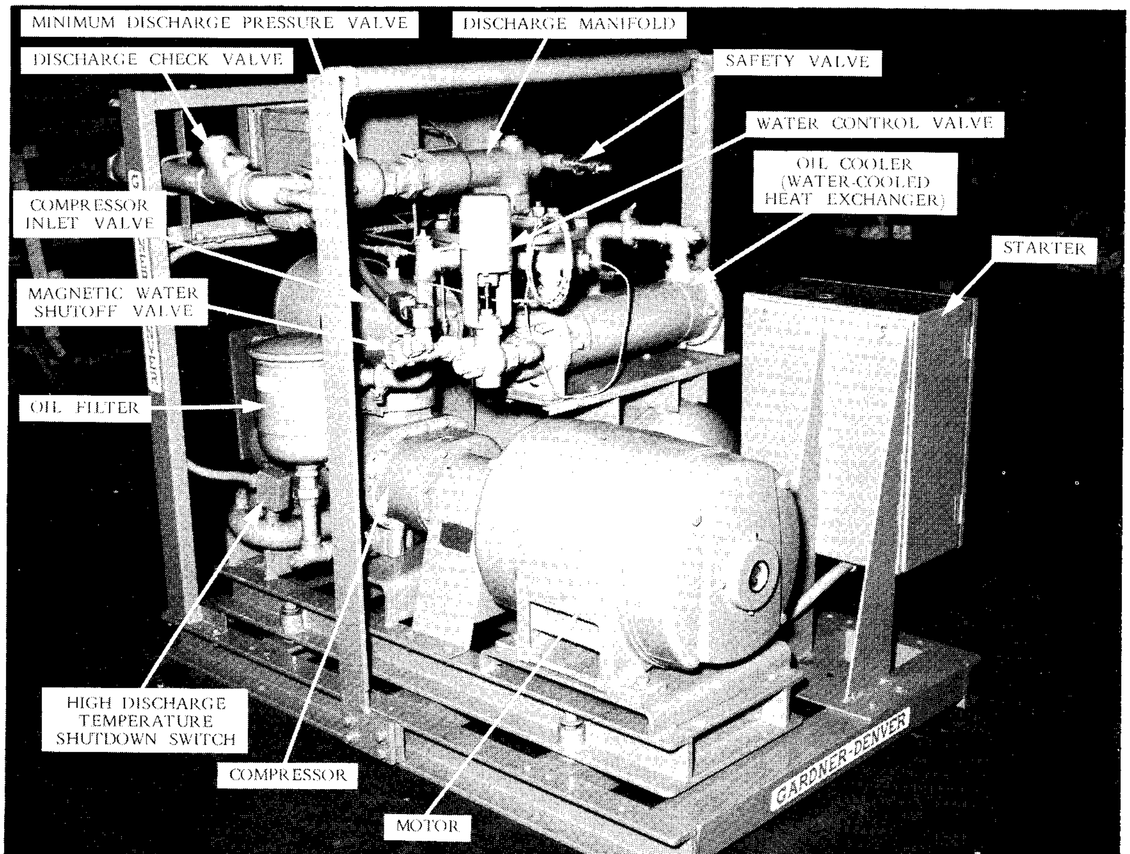


FIGURE 5-1. – WATER-COOLED ELECTRA-SCREW® UNIT

Notes

SECTION 2
INSTALLATION

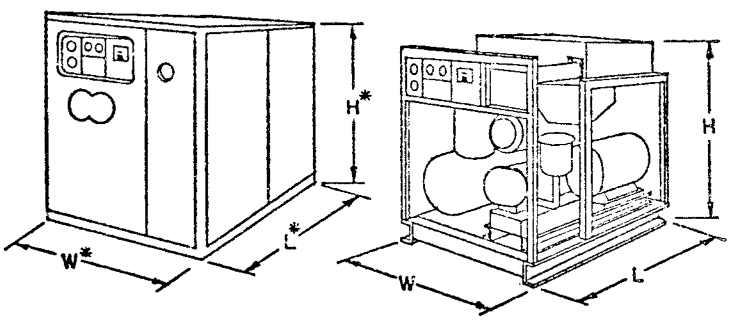
GENERAL – On receipt of the unit, check for any damage that may have been incurred during transit. Report any damage or missing parts as soon as possible.

NOTE: DO NOT electric weld on the compressor or base; bearings can be damaged by passage of current.

LIFTING UNIT – Early models were furnished with lifting bails; later models are not so equipped. Proper lifting and/or transporting methods must be used to prevent damage.

Where lifting bail is not supplied, lift compressor unit by base only. Do not use other places such as enclosure, motor, compressor oil discharge manifold and piping as lifting points.

Physical size and weight of unit, Figure 1-2, may allow use of tow motors. Unit may also be moved into location by rolling on bars. Acoustic enclosure, if supplied, may easily be removed if deemed necessary for weight or size reduction.



Model	HP	Approx. Weight	Dimensions					
			H*	H	L*	L	W*	W
ESG	30	2800	54.5	49	74	60	54	40
ESH	40	2900	54.5	49	74	60	54	40
ESJ	50	3100	54.5	49	74	60	54	40

FIGURE 1-2.

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

Both the air-cooled and water-cooled units require cooling air as well as air to the compressor inlet. Proper ventilation MUST be provided; hot air must be exhausted from the compressor operating area. A typical inlet-outlet air flow arrangement is shown in Figure 2-2.

Air-Cooled Unit – The air-cooled unit with the standard

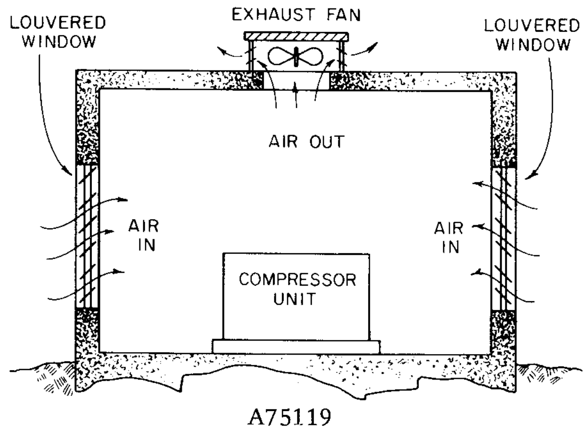


FIGURE 2-2. – TYPICAL COMPRESSOR ROOM

acoustic enclosure requires sufficient air flow, Figure 3-2, for the compressor oil cooling system and for electric motor cooling. Air is drawn into the unit around the base of the enclosure and is exhausted vertically. Do not block the air flow to and from the unit. Allow two (2) feet to the nearest obstruction on all sides and above the unit. When the air-cooled unit is used without an enclosure all of the above ventilating and cooling air requirements also apply.

Minimum Air Flow* For Compression And Cooling (Cubic Feet/Minute)		
Model	Air Cooled	Water Cooled
ESG, ESH, ESJ Without Aftercooler	6000 cfm	4000 cfm
ESG, ESH, ESJ With Aftercooler	6600 cfm	4000 cfm

* 80° F. Inlet Air

FIGURE 3-2.

Water-Cooled Unit – The water-cooled unit with the standard acoustic enclosure requires sufficient air flow, Figure 3-2, for electric motor (main drive and enclosure vent fan) cooling. Air is drawn into the unit around the base 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. Lubricate the vent fan motor every 8000 hours of operation with two (2) drops of SAE 20 oil. When the water-cooled unit is used without an acoustic enclosure, all of the above 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. Whenever possible install the unit near level. Temporary installation may be made at a maximum 10° angle lengthwise or 30° sidewise.

Mounting bolts are not normally required. However, in-

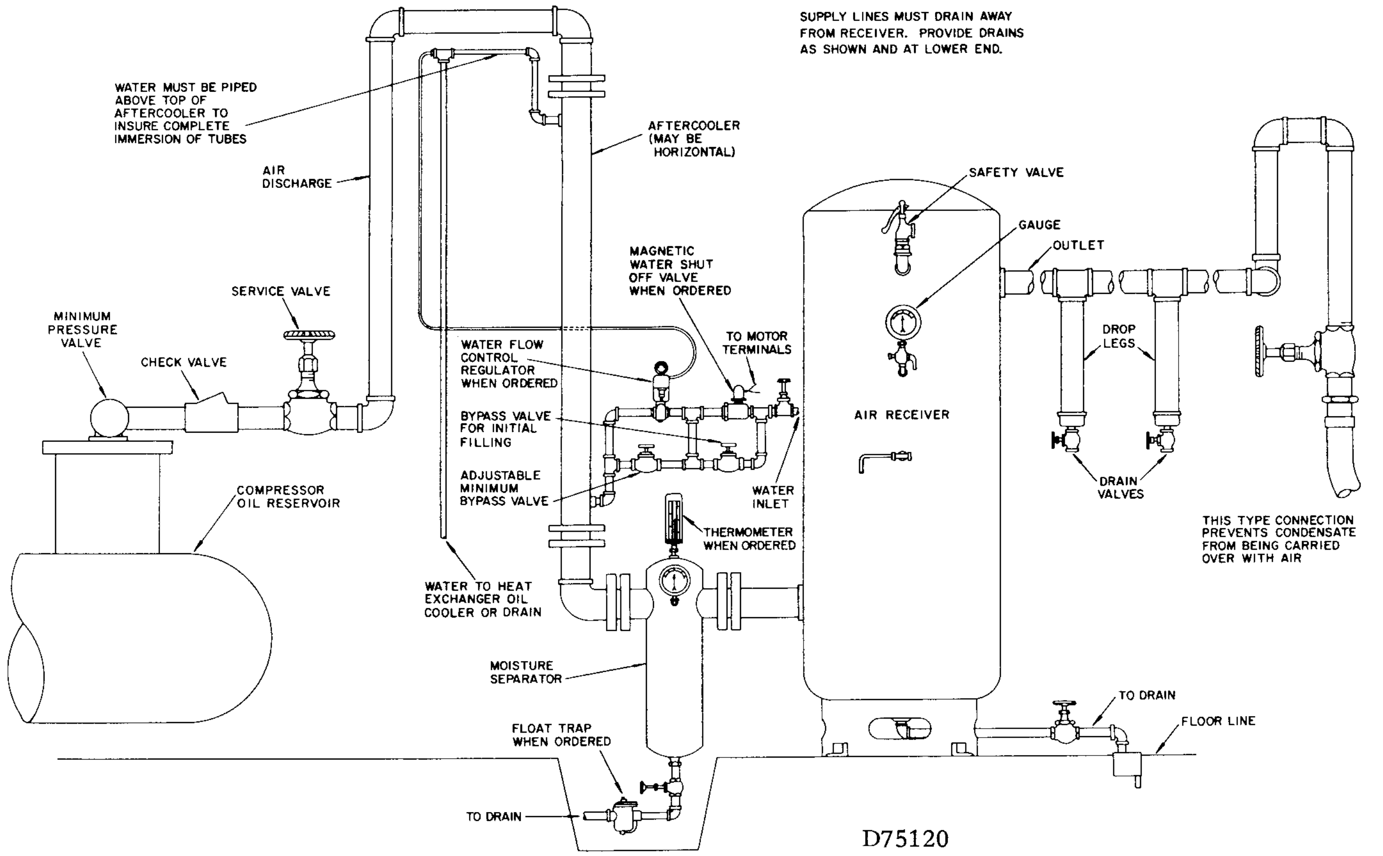


FIGURE 4-2. – AUXILIARY ACCESSORIES

stallation conditions such as piping rigidity, angle of tilt, or danger of shifting from outside vibration or moving vehicles may require the use of mounting bolts to the foundation. Coupling alignment must be checked after installation.

OIL RESERVOIR DRAIN – The oil reservoir drain valve is located near the end of the oil reservoir just below the instrument panel. On all models, the drain valve is approximately 6 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 raising blocks 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 drain to a container.

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 a level below 80 DBA in free field conditions.

In order to maintain the sound reduction ability of the cabinet, only the final discharge air line penetrates the enclosure. At the time of installation, other openings for electrical conduit, oil drain piping and water piping are to be cut into the enclosure 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.

Service doors are provided for access to the instrument panel and controls, the oil and air filters and the starter enclosure. Be sure to allow enough space around the unit for the doors to open completely.

An access panel is provided on the top of the unit for servicing of the oil separator. Be sure to allow enough room above the unit for panel and separator removal.

The air for the compressor and for enclosure is drawn in around the base 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.

AUXILIARY AIR RECEIVER – Constant speed control units do not normally use an auxiliary air receiver. Automatic start-stop, dual and 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 4-2 shows a typical air receiver and auxiliary accessories.

AFTERCOOLER (Figure 4-2) – 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 temperature.

Aftercoolers are available in these classifications:

1. Factory-installed built-in air-cooled radiator type.
2. Factory-installed built-in water-cooled shell and tube type.
3. Externally-mounted aftercoolers supplied by user.

Built-In Air-Cooled Aftercooler – This radiator-type aftercooler is mounted at the factory in the same supporting structure as, and adjacent to, the unit radiator-type oil cooler. The unit cooling fan forces air through the aftercooler and oil cooler. The compressed air is taken from the oil reservoir manifold, passes through the aftercooler and moisture separator to the final discharge outlet. A moisture

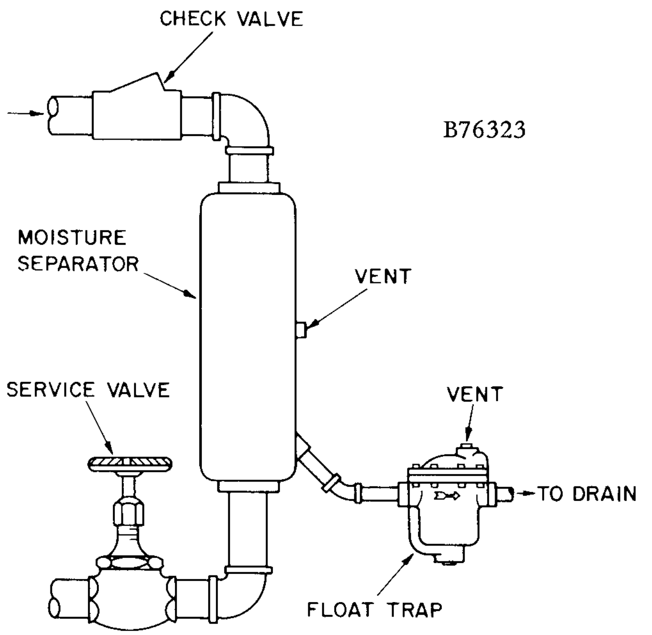


FIGURE 5-2. – BUILT-IN AFTERCOOLER UNITS – INSTALLATION OF SEPARATOR AND TRAP

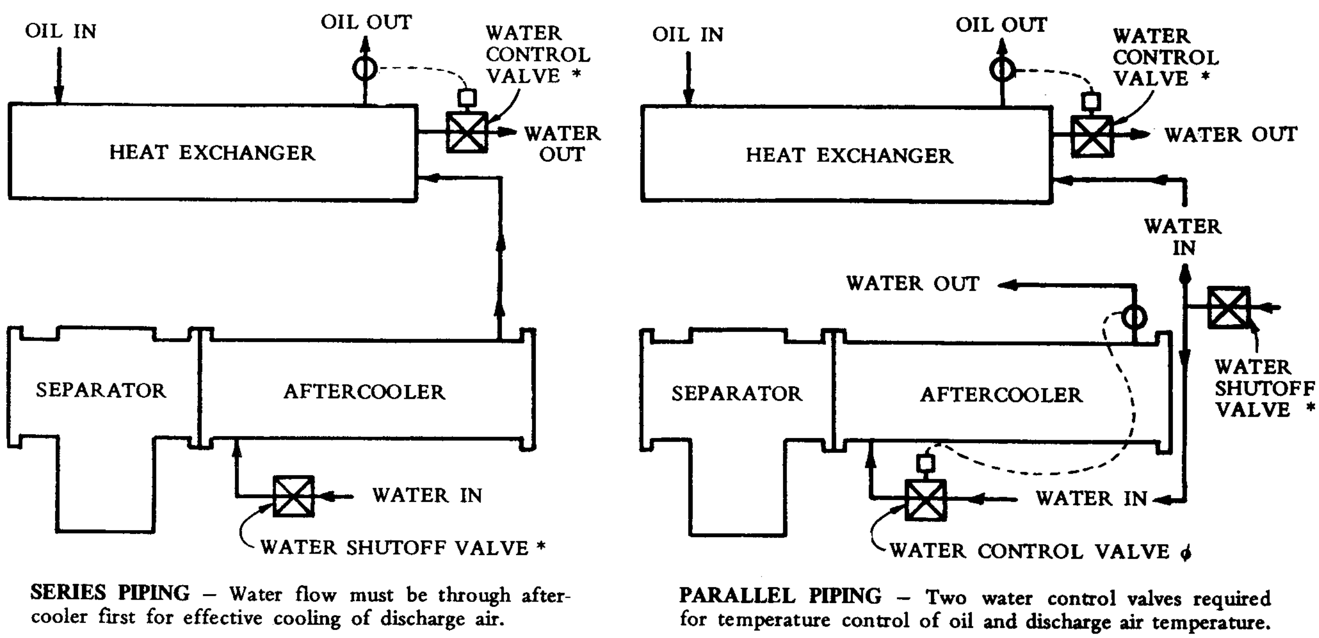
trap is supplied to remove separated moisture; mounting of the trap is at user-selected location for convenience of draining. See Figure 5-2 for moisture trap connection to separator. Later models of steel air-cooled aftercoolers are coated internally to resist corrosion. Coated aftercoolers have a tag attached to one header with identification and date.

Built-In Water-Cooled Aftercooler – This shell and tube-type aftercooler is mounted at the factory adjacent to the unit oil cooling shell and tube-type heat exchanger. The aftercooler is piped in series with the heat exchanger. Water is admitted through a magnetic water shutoff valve to the aftercooler and passes through the aftercooler, then the heat exchanger, and finally exits through the water flow control valve. See Section 5 for a discussion of the functions and setting of the water shutoff and flow control valves. The compressed air is taken from the oil reservoir manifold, passes through the aftercooler and moisture separator to the final discharge outlet. A moisture trap is supplied to remove separated moisture; mounting of the trap is at user-selected location for convenience of draining. See Figure 5-2 for moisture trap connection to separator.

Externally-Mounted Aftercooler – When the aftercooler is mounted outside the compressor unit, it is to be installed between the final discharge outlet and any auxiliary air receiver. Figure 4-2 shows a water-cooled aftercooler, but the piping arrangement shown also applies to an air-cooled type. A moisture separator is to be mounted directly downstream from the aftercooler and before any auxiliary air receiver. A suitable moisture trap should be provided at the separator to insure adequate draining.

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 com-



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

FIGURE 6-2. – PIPING DIAGRAM FOR AFTERCOOLER AND HEAT EXCHANGER pressor. **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.

DISCHARGE SERVICE LINE – The discharge service line connection is made at the nipple located at the upper right instrument panel side 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 size the same as 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 below at a minimum pressure of 40 PSIG; maximum allowable water pressure is 150 PSIG.

The following water flow rates are approximate and a guide to sizing piping, cooling tower and other water system equipment.

APPROXIMATE WATER FLOW
U.S. Gallons/Minute

Model	Water Temperature To Heat Exchanger				Maximum Water Flow
	60° F.	70° F.	80° F.	90° F.	
ESG	3.1	4.0	5.5	8.0	17.0
ESH	4.4	5.5	7.3	11.0	17.0
ESJ	5.5	6.5	8.5	13.0	40.8

The maximum water flow shown is that allowable through the heat exchanger.

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 sytems 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.

Externally-Mounted Aftercooler – Heat Exchanger Water Piping (Figure 6-2) – If an aftercooler is used and piped in series with the heat exchanger, remove the magnetic water shutoff valve from the heat exchanger 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. Maximum allowable oil temperature is 160° F. See Section 5 for adjustment instructions.

ELECTRICAL WIRING – Standard Units – The Electra-Screw® is factory wired for all starter to motor and control connections for the voltage specified on the order. It is necessary only to connect the unit starter to the correct power supply. See Section 4 for wiring diagrams of the control system on your unit. The standard unit is supplied with an open drip-proof motor, a NEMA I starter enclosure and a dust resistant control enclosure.

Remote Starter – Some low voltage and special application starters are too large to be mounted within the unit enclosure and must 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 Electrical 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 main base with a grounding conductor compatible with the fan short circuit protection at the factory.

MOTOR LUBRICATION – Long time satisfactory operation of an electric motor depends in large measure on the bearings and timely lubrication. The following charts show recommended grease qualities and regreasing intervals for motor supplied with ball bearings. For additional information refer to the motor manufacturer's instructions.

GREASE RECOMMENDATIONS

	Standard Service	High Temperature
Worked Penetration	265–296	220–240
Oil Viscosity, SSU At 100 F .	400–550	475–525
Soap Type	Lithium	Lithium
N-H Bomb, Minimum Hours For 20 PSI Drop At 210 F .	750	1000
Bleeding, Maximum Weight % In 500 Hours 212 F	10	3
Rust Inhibiting	Yes	Yes

The following procedure should be used in regreasing:

1. Stop the unit.
2. Disconnect the unit from the power supply.
3. Remove the relief plug and free the hole of hardened grease.
4. Wipe the lubrication fitting clean and add grease with a hand-operated grease gun.
5. Leave the relief plug temporarily off. Reconnect the unit and run for about 20 minutes to expell the excess grease.
6. Stop the unit. Replace the relief plug.
7. Restart the unit.

REGREASING INTERVAL

Type Of Service	Typical Examples	Rating	Relubrication Interval
Standard	One- Or Two-Shift Operation	150 HP and Below	18 Months
		Over 150 HP	12 Months
Severe	Continuous Operation	150 HP and Below	9 Months
		Over 150 HP	6 Months
Very Severe	Dirty Locations, High Ambient Temperature	150 HP and Below	4 Months
		Over 150 HP	2 Months

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 reservoir. Add oil only if the oil level gauge reads in the red ADD OIL range. Do not mix different type oils. Unit is shipped filled with automatic transmission fluid which is suitable for the first 2000 hours under normal operating conditions. For sustained operation where the oil inlet temperature will exceed 170° F. for more than four hours per day, refer to "High Temperature Operation" in Section 5. **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 (spread of the RUN range is shown in Figure 3-5). ALWAYS STOP THE UNIT AND RELEASE AIR PRESSURE BEFORE REMOVING 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 Filter** – Inspect the air filter to be sure it is clean and tightly assembled. Refer to Section 6 "Air Filter" for complete servicing instructions. Be sure the 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. **Moisture Separator Trap** – The moisture separator trap must be primed by filling with clean water prior to initial start-up of unit.

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

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

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

9. **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 COMPRESSOR NAMEPLATE. See Section 4 "Controls and Instruments" for procedure.

10. **Operating Mode** – Refer to Section 4 for detailed information on the control system with which your unit is equipped (Constant Speed, Automatic Start-Stop, Dual or Duomatic).

11. **Acoustic Enclosure** – Check for damaged panels or doors. Check all screws and latches for tightness.

STARTING UNIT – Constant Speed and Automatic Start-Stop units require only pressing of ON push button. Dual control units require pressing of constant speed (CON) push button or automatic start-stop (AUTO) push button as desired. 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 between 2 and 30) and pressing of ON push button. **OBSERVE UNIT COLD OR UNIT HOT STARTING PROCEDURES.**

Unit Cold – If discharging into a pressurized air system, 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 valves wide open. Start the unit and allow to reach full pressure and unload. Open the air service valve. Since the unit is equipped with a minimum (55-65 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 water-cooled heat exchanger model, open any manual water inlet valves wide open. Start unit. Open the air service valve.

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

STOPPING 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 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 OFF push button. On water-cooled heat exchanger units, close any manual water inlet valves. Open air service valve.

SECTION 4
CONTROLS & INSTRUMENTS

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

Constant Speed

Automatic Start-Stop

Dual (Selective – Constant Speed or Automatic Start-Stop)

Duomatic (Selective – Constant Speed With Low Unloaded Horsepower or Automatic Start – Timed Stop)

Unless voltage and starter enclosure size do not permit mounting of the starter or customer specifications instruct otherwise, the Electra-Screw® unit is prewired with the starter mounted and all starter to motor and control connections for the voltage specified on the order. It is necessary only to connect the unit to the correct power supply, to the shop air line and to the shop water line, if the unit is the heat exchanger type. The standard unit consists of the compressor, oil reservoir and cooler, air and oil filters, the control system specified, an open drip-proof motor, NEMA I starter enclosure and a dust resistant control enclosure/instrument panel all mounted on a steel base and enclosed in an acoustic cabinet.

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. A transformer in the control enclosure is connected to change the power supply voltage to 115 volt control voltage.

ON-OFF SWITCH – The Constant Speed and the Automatic Start-Stop units have an ON-OFF push button with an amber lighted section to indicate when compressor is running.

The Dual control unit has a push button switch with CON-OFF and AUTO-OFF sections for the two modes of operation and an amber lighted center section to indicate when 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.

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

1. Turn power off at main breaker panel.

2. Open control panel.

3. Turn slotted locking screw on upper side of switch body counterclockwise 1/4 turn and remove switch body from switch operator.

4. Remove old bulb located in stem of switch body and insert new bulb.

5. Reassemble switch body to operator and lock in place by turning locking screw 1/4 turn clockwise.

SAFETY DEVICES – All four control systems incorporate these safety devices:

Motor Protection Devices – Overload heaters are furnished for the starter in the voltage range specified. There are three (3) overloads in the starter 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.

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 discharge temperature exceeds 225° F. The manual reset is located on the switch and must be reset any time unit is shut down due to high air discharge temperature.

Circuit Breaker – Some early units have a separate push-to-reset type circuit breaker for the high discharge temperature shutdown switch located on the instrument panel (Figures 1-4, 2-4, 3-4, 4-4, 7-4, 8-4, 10-4 and 11-4). If a temperature failure occurs, the circuit breaker button will pop up indicating that the safety device has stopped the unit.

DO NOT CONTINUE TO RESET THE MANUAL RESET (OR 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 (Figures 2-1, 5-1 & 1-5) – A solenoid valve piped into the oil reservoir final discharge manifold between the minimum pressure valve and the check valve and wired into the motor control circuit, will release pressure from the oil reservoir each time the motor stops on constant speed, automatic start-stop or dual control systems. On the duomatic 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 3-1 & 4-1) – A pressure relief valve is installed in the final discharge manifold and set at the 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.

NEVER DISCONNECT SAFETY DEVICES THAT PROTECT THE UNIT.

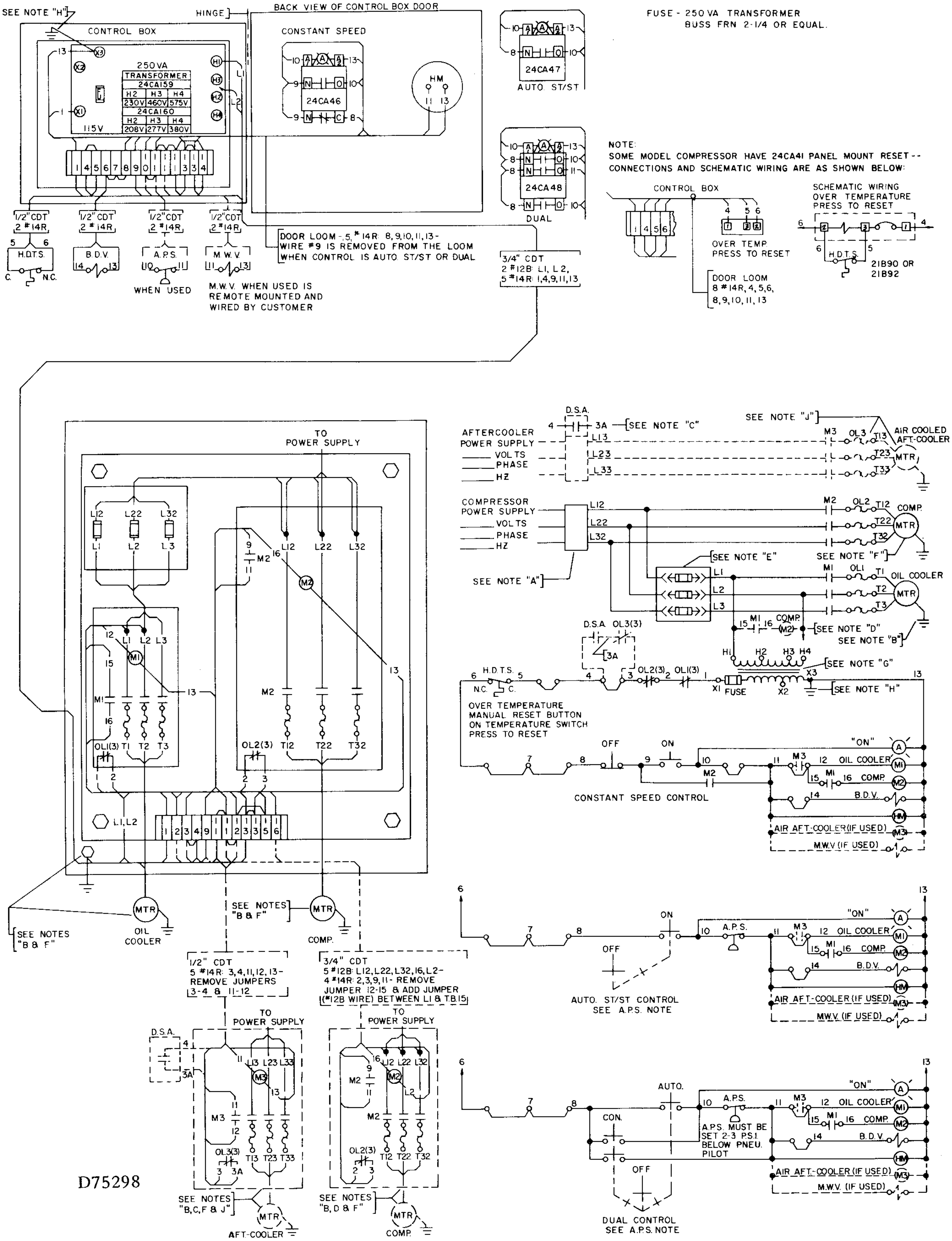


FIGURE 1-4. – WIRING DIAGRAM – AIR-COOLED UNITS –
CONSTANT SPEED, AUTOMATIC START-STOP & DUAL CONTROL
(For Notes See Section 4, Pages 6 & 7)

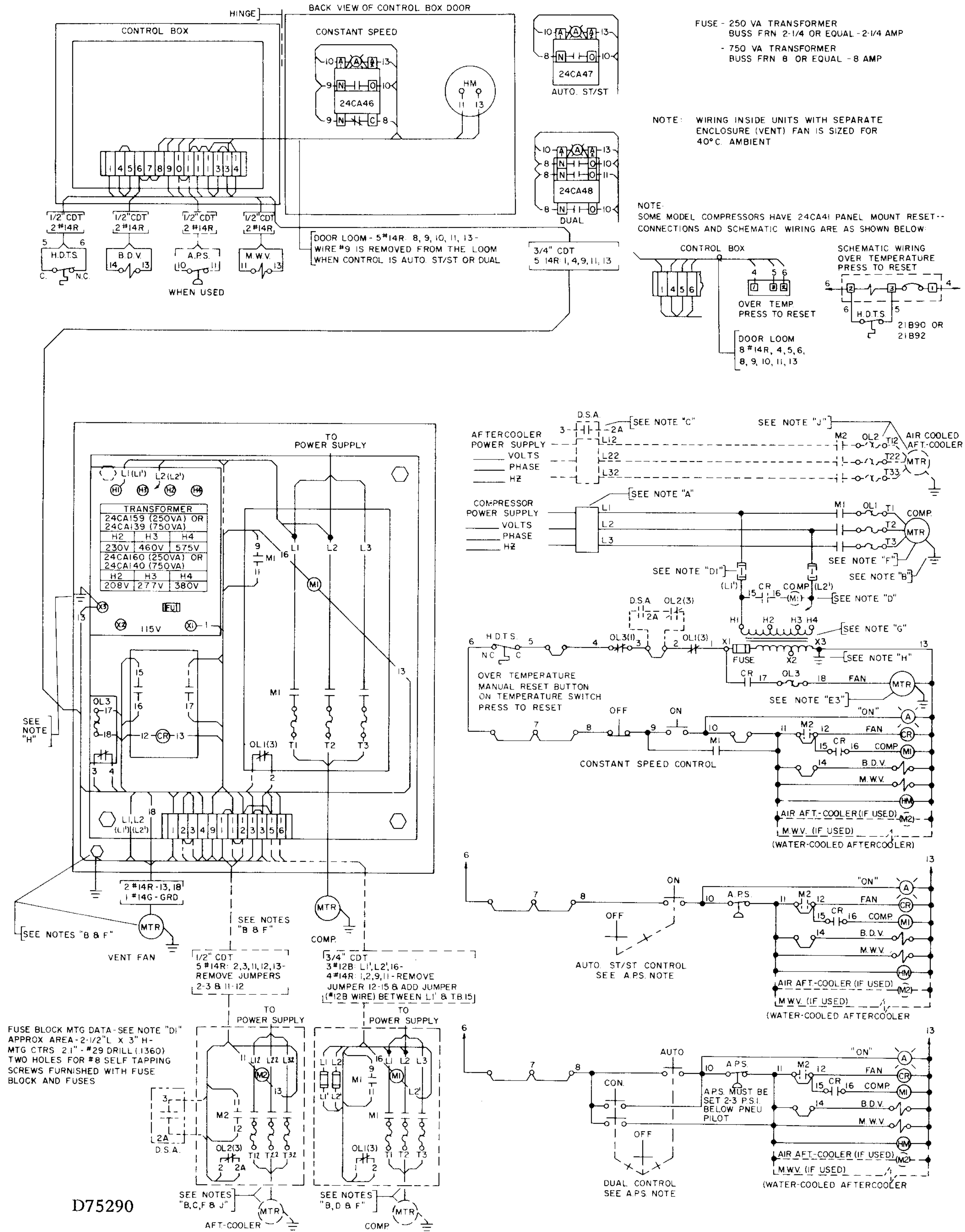


FIGURE 2-4. – WIRING DIAGRAM – WATER-COOLED UNITS – CONSTANT SPEED, AUTOMATIC START-STOP & DUAL CONTROL
(For Notes See Section 4, Pages 6 & 7)

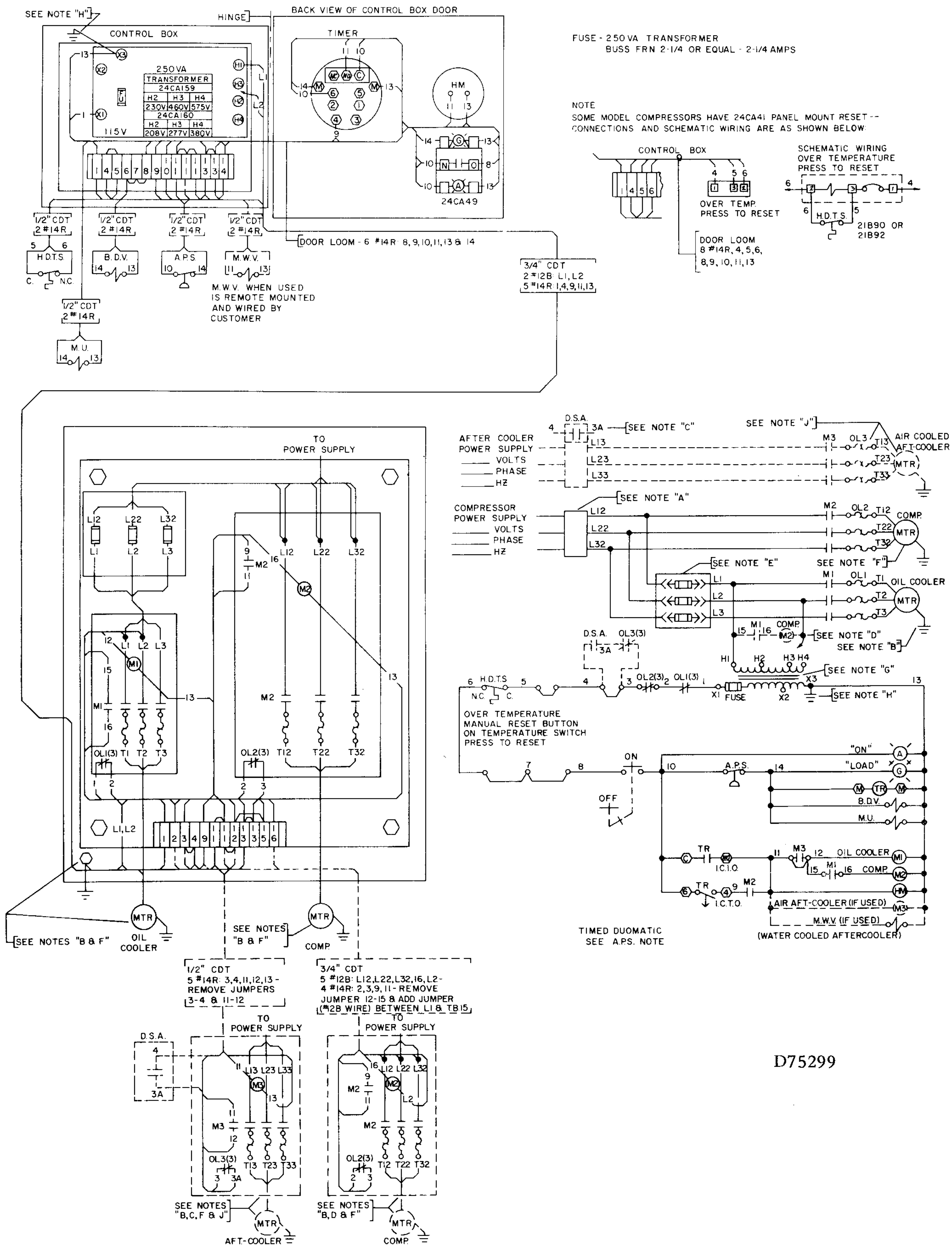


FIGURE 3-4. – WIRING DIAGRAM – AIR-COOLED UNITS – TIMED DUOMATIC CONTROL

(For Notes See Section 4, Pages 6 & 7)

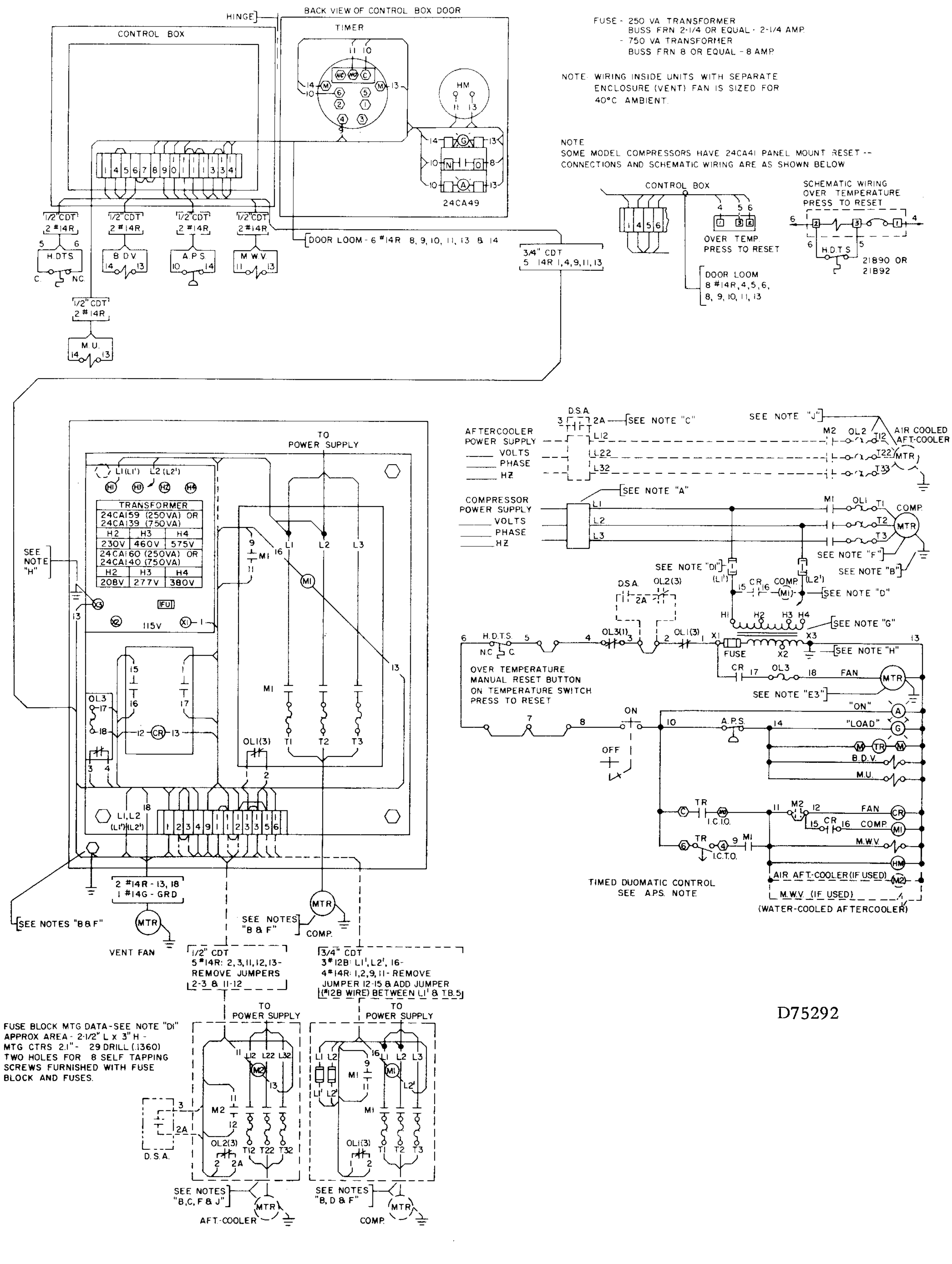


FIGURE 4-4. – WIRING DIAGRAM – WATER-COOLED UNITS – TIMED DUOMATIC CONTROL

(For Notes See Section 4, Pages 6 & 7)

NOTES FOR WIRING DIAGRAMS

(FIGURES 1-4, 2-4, 3-4 & 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.

All remote mounted magnetic compressor starter control circuits are to be connected for TWO (2)-WIRE control.

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 Quincy Division, 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.

"E" – 3 pole fused pull out block for mounted air-cooled oil cooler motor short circuit protection. Fuses are Class J-600 volts.

"E3" – 115 volt control circuit fusing provides short circuit protection for single phase enclosure fan motors.

"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.

B.D.V. – Blowdown Solenoid Valve – 110/120 V – 50/60 Hz – Two-Way Normally Open – 2W.N.O. – Part No. 90AC162 (1/2") for NEMA 1 – Part No. 90AC163 (1/2") for NEMA 4 & 12.

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.

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.

H.D.T.S. – High Discharge Temperature Switch – Set 230° F. – 21D9 (Replaces Part No. 21B90 for NEMA 1, Part No. 21B92 for NEMA 4 & 12).

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

M. – Motor Starter Coil, Contacts, etc. These 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 (Valves have Manual Override) – Part No. 90AC118 (3/4") for NEMA 1 – Part No. 90AC103 (3/4") for NEMA 4 & 12.

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.

RESET – 24CA41 – Reset Button Seal 24CA42. The 1/2 inch extension of the reset button red plunger (1/4 inch normal) gives visual indication of the shutdown trouble point.

Press button to reset after checking and correcting cause of shutdown.

– Terminals On Reset Button.

– Jumpers On Terminal Blocks (T.B.).

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

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.

Port A (1) – Inlet Valve
Port B (2) – Exhaust
Port C (3) – Pressure Regulator

Service valve must be opened as soon as compressor reaches full pressure and unloads. If it isn't, the compressor will cycle (load-unload) rapidly.

I.C.I.O. – Instantaneous Closing On Energization – Instantaneous Opening On De-energization.

I.C.T.O. – Instantaneous Closing On Energization – Time Opening On De-energization.

T.R. – Timing Relay – 24A482 – 110/120 V – 50/60 Hz.

DO NOT SET TIMER DIAL BETWEEN THE 0 AND 3 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).

– Terminals On T.R. Timing Relay.

INSTRUMENTS AND GAUGES (Figures 7-4, 8-4, 10-4 & 11-4) – All four 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, separator(s) 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.

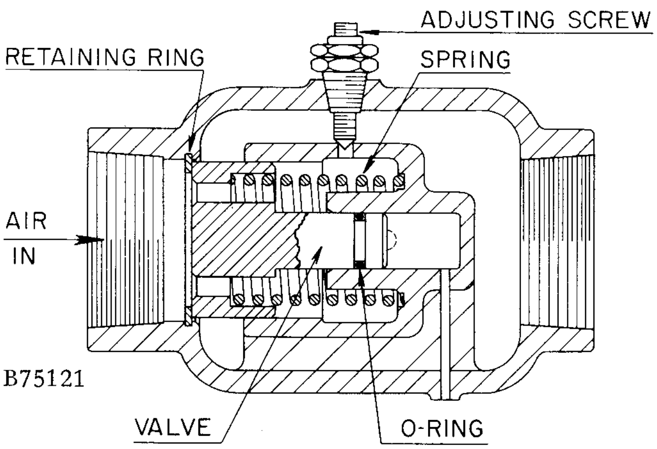


FIGURE 5-4. – MINIMUM DISCHARGE PRESSURE VALVE

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 55-65 PSIG in the oil reservoir. When the system pressure rises above the minimum, the spring-loaded piston is overridden and the valve opens to full porting.

The valve does not require maintenance. 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 compressor unit.
2. Reduce pressure downstream of minimum pressure valve below desired minimum pressure. DO NOT REDUCE DOWNSTREAM PRESSURE OR ADJUST VALVE BELOW 40 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 air demand made on the compressor. Effective from 0 to 100% of 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 valve when the demand ceases. The subtractive pilot and inlet valve are shown in Figure 2-1. 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 PSI above the maximum operating pressure. Example with normal setting of 80–100 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

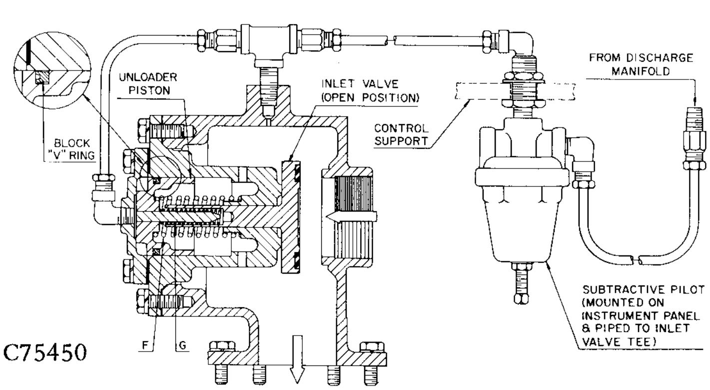


FIGURE 6-4. – INLET VALVE FOR CONSTANT SPEED CONTROL

Inlet Valve (Figure 6-4) – The inlet valve is a piston-actuated device which 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.

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 closed position on shutdown of the compressor and prevents oil backflow from the compressor to the air filter.

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 proper pressure is obtained. Tighten the locknut.

PRESSURE TOO LOW:

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

DO NOT ADJUST THE FULL CAPACITY OPERATING AIR PRESSURE HIGHER THAN THE MAXIMUM STAMPED ON THE UNIT NAMEPLATE. MINIMUM OPERATING PRESSURE IS 65 PSIG.

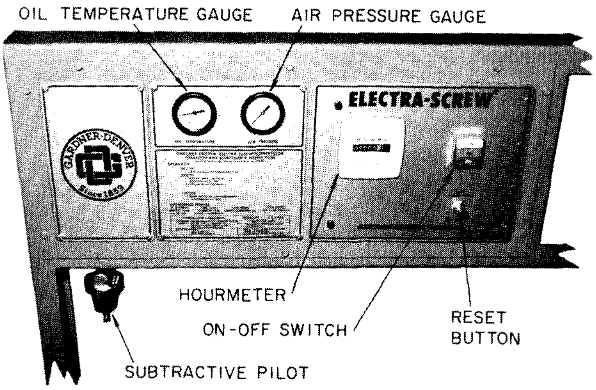


FIGURE 7-4. – INSTRUMENT PANEL CONSTANT SPEED CONTROL

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

AUTOMATIC START-STOP CONTROL SYSTEM (Figures 1-4, 2-4, 8-4 & 9-4) – The Automatic Start-Stop Control System is used where requirements for air are for short and/or intermittent periods. The system automatically starts the motor when the discharge manifold pressure falls to a predetermined point and stops the motor when the discharge manifold pressure rises to a predetermined point.

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

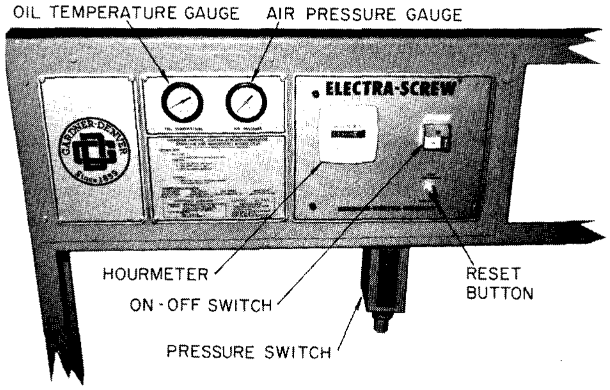


FIGURE 8-4. – INSTRUMENT PANEL AUTO START-STOP CONTROL

The operating pressure of the system is controlled by the air pressure switch located under the control panel, Figure 8-4. The switch is piped to the final discharge manifold between the check valve and the air service line valve and connected to the electrical circuit in the control box.

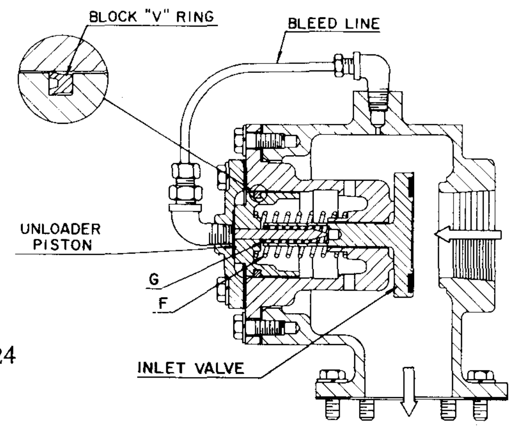


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FIGURE 9-4. – INLET VALVE FOR AUTO START-STOP CONTROL

The inlet valve with control orifice shown in Figure 9-4 closes automatically when the unit stops to prevent oil backflow from the compressor through the air filter.

Operating Air Pressure Adjustment – Start the unit. Close the air service line valve sufficiently to hold the discharge manifold pressure near the system pressure desired. Remove pressure switch cover.

SET FULL PRESSURE (MOTOR STOP) POINT:

1. Turn the upper adjusting screw on the pressure switch

until the pointer on left edge indicates the desired pressure; turn clockwise to raise pressure, counterclockwise to lower.

2. Close the air service line valve, allow pressure to build until the unit stops and observe pressure.

3. Open the air service line valve, bleed air from the system until the unit starts, then repeat Steps 1 and 2 until the proper pressure is obtained.

4. Repeat Steps 1, 2 and 3 until the proper full receiver pressure point is obtained.

SET LOW PRESSURE (MOTOR START) POINT:

1. With power on, the unit air pressure gauge showing full pressure and air service line valve closed, set lower (differential) adjusting screw near desired pressure; Turn counterclockwise to increase differential, clockwise to decrease. Full receiver pressure minus differential is the low receiver pressure (motor start) point. Differential range is approximately 2-18 PSIG on the circular scale above the adjusting screw.

2. Open the air service line valve, bleed air from the system so that the motor starts and observe pressure at that point.

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

4. Replace the pressure switch cover.

DO NOT SET THE FULL PRESSURE (MOTOR STOP) POINT 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 Automatic Start-Stop Control system.

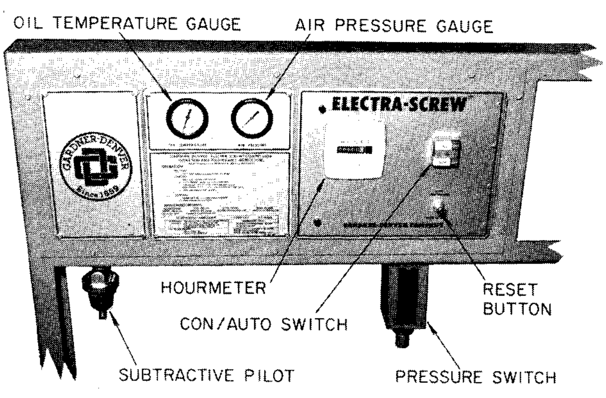


FIGURE 10-4. – INSTRUMENT PANEL DUAL CONTROL

DUAL CONTROL SYSTEM (Figures 1-4, 2-4 & 10-4) – The Dual Control system incorporates both the Constant Speed Control and the Automatic Start-Stop Controls systems for use where air requirements vary from high usage for long periods to short and intermittent periods of use. When the air use is high, operate the unit at constant speed to eliminate excessive starting and stopping of the unit. When the air use is low, operate the unit on automatic start-stop to eliminate long unloaded periods and wasted power. The unit control panel (Figure 10-4) incorporates both CON and AUTO sections in the On-Off push button. These buttons are interlocked so that the unit cannot be changed from one mode of operation to the other unless the unit is first stopped.

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

Operating Air Pressure Adjustment – With the unit operating on CON section of the On-Off push button, follow the procedure for Constant Speed system adjustment on Page 9 of this section.

With the unit operating on the AUTO section of the On-Off push button, follow the procedure for Automatic Start-Stop system pressure adjustment on Page 9 of this section.

The pressure switch unload point must be set approximately 3 PSI lower than the subtractive pilot unload point to prevent overriding and closing of the inlet valve by the pilot on Automatic Start-Stop operation.

DO NOT ADJUST THE OPERATING AIR PRESSURE AND/OR FULL PRESSURE (MOTOR STOP) POINT HIGHER THAN THE MAXIMUM STAMPED ON THE UNIT NAMEPLATE. MINIMUM OPERATING PRESSURE IS 65 PSIG.

Electrical Wiring – Figures 1-4 and 2-4 show the wiring diagrams for the unit with Dual Control System.

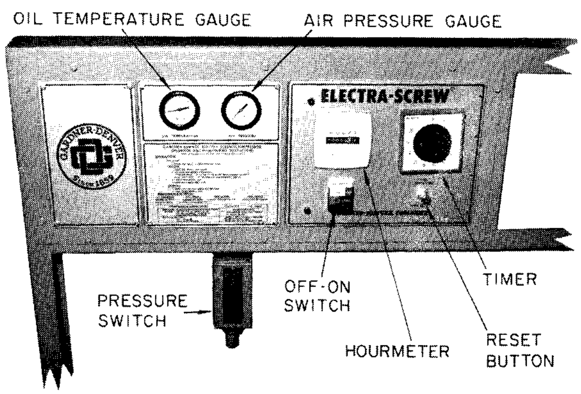


FIGURE 11-4. – INSTRUMENT PANEL TIMED DUOMATIC CONTROL

DUOMATIC CONTROL SYSTEM (Figures 3-4, 4-4, 11-4 & 12-4) – 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 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 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 three modes of operation controlled by the adjustable timer on the instrument panel (Figure 11-4).

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-Stop – When the timer is set at 0, the unit will start and inlet valve will open each time 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 stop, the inlet valve will close, and the oil reservoir will blow down. The LOAD indicator light will remain on only when the compressor is running. The ON indicator light will remain on as long as the On-Off switch ON push button is depressed.

Timed Automatic Start-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), and 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 should be set beyond the three (3) minute mark since the repeat accuracy of the timer between zero (0) and three (3) minute marks is not reliable. Second, the blowdown valve requires about 45 seconds to completely blow down the oil reservoir. If the compressor restarts before the reservoir is blown down, oil mist is carried over into the air lines. Finally, repeated compressor starting under loaded conditions can cause motor failure.

The air pressure switch located under the unit control panel (Figure 11-4) controls the operating pressure of the system by opening and closing the inlet valve (Figure 12-4) as in Constant Speed and Timed Duomatic operation, or by starting and stopping the unit as in Automatic Start-Stop 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.

Inlet Valve (Figure 12-4) – The piston-actuated inlet valve controls the compressor inlet and operates on air pressure from the control circuit. The valve is closed when preset full pressure is on the system, and opens 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 closed position on shutdown of the compressor to prevent oil blowback from

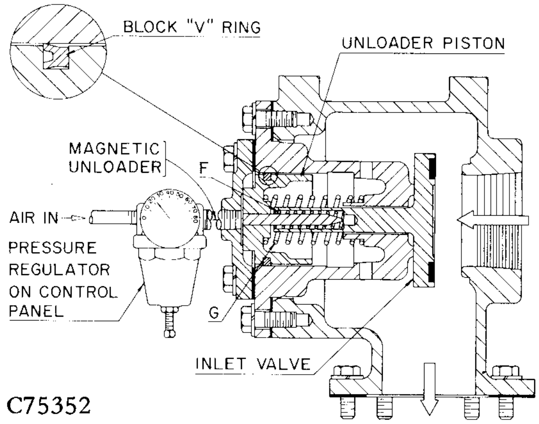


FIGURE 12-4. – INLET VALVE FOR DUOMATIC CONTROL

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.

SET FULL RECEIVER PRESSURE (COMPRESSOR UNLOAD) POINT:

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

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

3. Note air receiver pressure shown on the instrument panel gauge. If 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 power on, air receiver at full pressure and shop air line valve closed, set lower (differential) adjusting screw near desired pressure. Full receiver pressure minus differential is the low receiver (compressor load) point. Differential range is approximately 2–18 PSIG on the circular scale above the adjusting screw.

2. Bleed air from the air receiver so that the compressor loads and note pressure obtained.

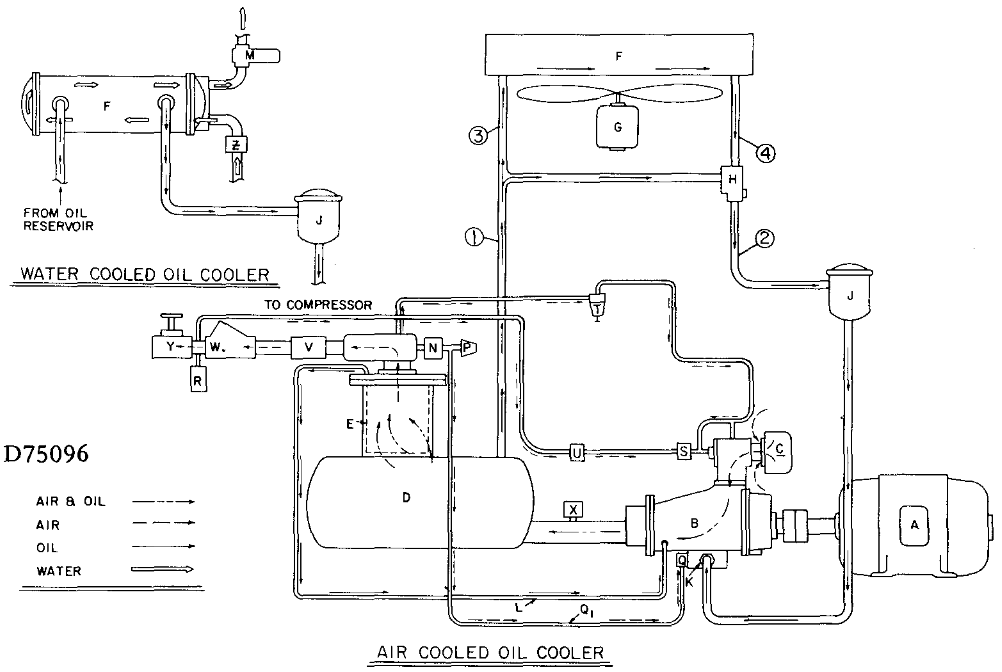
3. Repeat Steps 1 and 2 until desired low receiver pressure point is obtained.

4. Replace 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 show the wiring diagrams for the unit with Duomatic Control system.

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 & Motor
H Thermal Control (Thermostatic Mixing) Valve
J Oil Filter
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
Q_1 Blowdown Line (Duomatic Only)
R Operating Air Pressure Switch (Auto S/S, Dual & Duomatic Only)
S Magnetic Unloader (Duomatic Only)
T Pilot (Constant Speed & Dual Control)
U Pressure Regulator (Duomatic Only)
V Minimum Discharge Pressure Valve
W Discharge Check Valve
X High Discharge Temperature Shutdown Switch)
Y Discharge Service Line Valve — Customer Furnished
Z Magnetic Water Shutoff Valve

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

COMPRESSOR OIL SYSTEM (Figure 1-5) cools the compressor, lubricates moving parts and seals internal clearances in the compression chamber.

The oil suction line is connected at the top of the oil reservoir with the tube extended 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. The air-oil mixture is then 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 and the air passes to the final discharge line.

OIL SPECIFICATIONS – The recommended compressor lubricant is an automatic transmission fluid meeting General Motors "Dexron II" specifications. On air-cooled radiator models, automatic transmission fluid can be used for year-round operation except when oil inlet temperature exceeds 170° F. for 4 hours per day – see "High Temperature Operation". On water-cooled heat exchanger models, automatic transmission can be used for all operation provided the compressor oil inlet temperature is held 150-170° F. by adjustment of the water flow control valve; if the oil inlet temperature will exceed 170° F. for more than 4 hours see "High Temperature Operation".

Recommended Oils	Temperature Range
Automatic Transmission Fluid Meeting GM Specification "Dexron II"	Year-Round Operation – Except As Noted Below.

FIGURE 2-5. – COMPRESSOR LUBRICANTS

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 the use of lubricants without sufficient oxidation inhibitor will result in formation of heavy varnish and sludge deposits throughout the system.

OIL QUALITY – There are many brands of lubricating oils and synthetic fluids which are represented by the suppliers as meeting one or more of the specifications listed under "Compressor Lubricants" (Figure 2-5) or as being satisfactory for rotary 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 polyol ester fluids are being marketed as suitable for rotary 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.

Regardless of the synthetic change interval used, the oil filter and oil separator change intervals remain the same as those recommended for automatic transmission fluid.

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° F. in the space enclosing the compressor unit. 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 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° F.**

HIGH TEMPERATURE OPERATION – Short periods of up to 4 hours of sustained oil inlet temperatures over 170° F. do not require a change from the recommended lubricant of Figure 2-5. If the oil inlet temperature is sustained over 170° F. for a period of more than 4 hours, one of the following types of lubricant or its equal should be used:

Type	Manufacturer & Designation
Synthesized Hydrocarbon	Mobil SHC626
Diester	Anderol 497
Polyol ester	Emery 2990A

Any type or brand of synthetic lubricant chosen must have a foam depressant, oxidation and corrosion inhibiting characteristics equal to those of Dexron II automatic transmission fluid, and must meet these minimum specifications:

Viscosity SUS at 100° F.	300
Viscosity SUS at 210° F.	50
Pour Point	-35° F.

When installing the synthetic lubricant, the original lubricant should be drained completely and the system flushed before filling with the synthetic. Complete draining will involve removal of all plugs in the compressor, oil reservoir and oil lines; in some cases, piping will require removal for complete draining. Although automatic transmission fluid is compatible with most synthetic lubricants, residual automatic transmission fluid can dilute and reduce the life of the synthetic. In no case should the high discharge air temperature switch be set above +225° F. to compensate for high temperature operation.

Use caution when selecting a synthetic lubricant, some downstream air system components, such as air line lubricator bowls, gaskets and valve trim, are not compatible with some synthetics. All materials used in Gardner-Denver Electra-Screw® compressor units are compatible with the types of synthetic lubricants listed above. See "Synthetic Lubricants" paragraph.

If seasonal temperature variations are wide, the use of a lighter viscosity synthetic lubricant may be necessary in cold weather. Note the pour point of the synthetic being used; in general, the lubricant should not be used in ambient temperatures nearer than 30° F. to its' pour point. Always observe cautions described in "Cold Ambient Operation" paragraph. Lighter viscosity synthetic lubricants must have foam depressant, oxidation and corrosion inhibiting characteristics equal to those of Dexron II automatic transmission fluid and meet these minimum specifications:

Viscosity SUS at 100° F.	140
Viscosity SUS at 210° F.	44.0
Pour Point	-60° 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 spread of the RUN range is shown in Figure 3-5. 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 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

Model	System Capacity (Initial Fill)	Oil Reservoir (Refill) Capacity *	"ADD" Line To Centerline Of Run Range
ESG, ESH, ESJ	13 Gallons – Water Cooled 15 Gallons – Air Cooled	10 Gallons	4 Gallons

* Measured at center of oil level gauge RUN range or approximately 2" below reservoir centerline.

FIGURE 3-5. – OIL SYSTEM CAPACITIES (U.S. GALLONS) 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. Remove compressor sump drain, oil cooler drain (2), 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 (2) 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 oil separator element(s) 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 3-5) 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 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 4-5) 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 paper element type and is equipped with an 18-21 PSI relief valve that opens in the event the element becomes dirty enough to block the flow of oil. Element 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.

1. Loosen the clamp screws, remove clamp ring and filter cover. Remove the element retainer and lift the element from the filter body. Clean all parts and replace the gasket in the filter cover.

2. Slide the new element over the center tube. Screw the element retainer and relief valve assembly into the end of the center tube hand tight.

3. Replace the cover and clamp ring. Tighten both clamp screws securely.

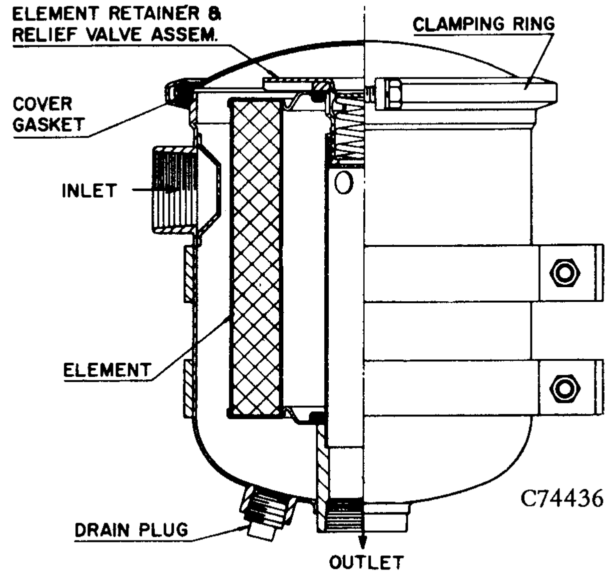


FIGURE 4-5. – COMPRESSOR OIL FILTER

COMPRESSOR OIL COOLER – RADIATOR TYPE (Figure 3-1) – The oil cooler fan is driven by a separate electric motor and exhausts air upward through the oil cooler away from the unit. Do not obstruct air flow to and from the cooler. Allow two (2) feet clearance above the cooler. On acoustically enclosed units do not obstruct the air inlets around the lower edge of the enclosure. 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 in each drain plug opening at the end of the

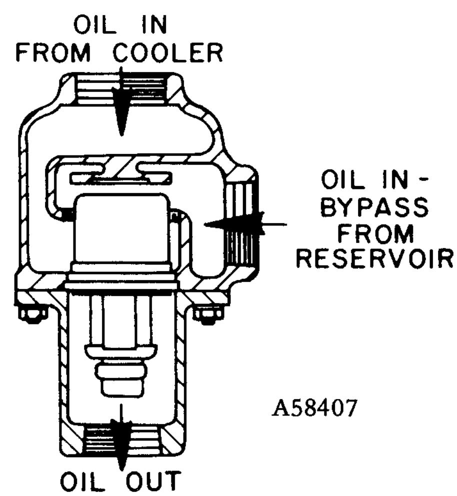


FIGURE 5-5A. – THERMOSTATIC MIXING VALVE cooler. At normal operating air service pressures (65 to 150 PSIG) with the unit warm, a pressure drop of 2 to 12 PSIG can be expected between the inlet and outlet side of the cooler. The instrument panel thermometer indicates the oil temperature to the compressor.

THERMAL CONTROL (THERMOSTATIC MIXING) VALVE (Used With Radiator-Type Oil Cooler Only) (Figure 5-5A) is installed in the system as shown in the flow diagram, Figure 1-5. On start-up, with the unit cold, the thermal element in the valve is open to the bypass line, allowing oil to circulate directly from the oil reservoir to the compressor during the warm-up period. As the oil warms up, the thermal element gradually opens to allow oil from the cooler to mix with oil from the bypass line. After the unit is warmed up, the control valve is to maintain oil injected into compressor at a minimum of the valve set temperature.

If unit shuts down due to high air discharge temperature, the thermal element may be stuck open to the bypass position blocking the 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. To check the thermal element, heat in oil and check that valve is wide open at ± 5° F. of rating stamped on element.

Operation of the compressor in high humidity conditions may require adjustment of the valve to raise the discharge temperature to prevent condensation in the oil reservoir. At 80° F. ambient temperature, the following minimum discharge temperature (measured at the compressor discharge elbow) must be held for the listed relative humidity (RH) and discharge pressure:

	66% RH	83% RH	100% RH
100 PSIG	141° F.	149° F.	158° F.
125 PSIG	149° F.	158° F.	167° F.

The minimum discharge temperature changes in direct proportion to the ambient temperature; i.e., if the ambient temperature is 90° F., all the listed discharge temperatures are increased 10° F. Generally, when the valve is set at one ambient temperature, the oil cooler capacity is such that the discharge temperature rises and falls with the ambient and is maintained within satisfactory limits.

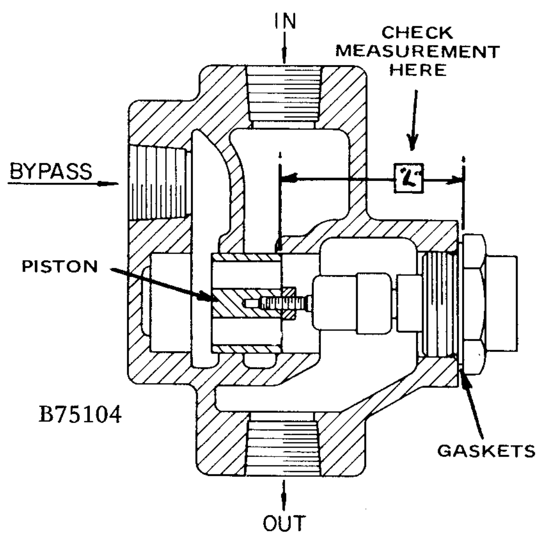


FIGURE 5-5B. — THERMAL CONTROL (THERMOSTATIC MIXING) VALVE (ADJUSTABLE)

The valve element is set to hold oil injected into the compressor at a minimum of 150° F. Oil injection temperature can be changed only by installing a new element rated at the desired temperature.

Early models used the adjustable valve shown in Figure 5-5B. This valve and parts are no longer available and the complete valve shown in Figure 5-5A must be used for replacement.

The setting of valve in Figure 5-5B may be adjusted to raise or lower the inlet oil temperature within a small range. Do not adjust the valve to maintain an oil inlet temperature below 130° F.

To increase oil temperature to the compressor (raise the discharge temperature), decrease the length of the piston stroke by screwing the piston toward the thermal element and/or adding .032" copper gaskets under the valve cap shoulder.

To decrease the oil temperature to the compressor (lower the discharge temperature), increase the length of the piston stroke by screwing the piston away from the thermal element and/or removing copper gaskets.

A .032" change in length of piston stroke will change the oil temperature to the compressor 2° to 4° F. The distance from the shoulder of the element cap without copper washers in place to the top of the piston should be as shown in table:

Piston Length	Length "L"		
	Room Temperature (Below 105° F.)	130° F.	225° F.
1.000	2.660	2.900	3.200
1.062	2.605	2.845	3.145

Use care not to bend threaded piston stem on element when adjusting the valve — an erratic or inoperative valve will result.

Early adjustable valves used 130° F. elements; later valves used 150° F. elements. Adjustments are the same with either element. To check the thermal element, heat in oil and check length of piston extension as shown in table above.

When flushing the oil system, remove the thermal element and clean all parts thoroughly.

COMPRESSOR OIL COOLER — WATER-COOLED HEAT EXCHANGER (Figure 5-1) — The heat-exchanger 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 6-5) 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. Even when the unit has a built-in aftercooler the water flow is still adjusted to provide the 130° F. oil temperature. See "Thermal Control (Thermostatic Mixing) Valve" above for discharge temperature required in high humidity operation. See "Oil Specifications" (page 1, this section) for 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 in solution (dissolved) and/or 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 exist 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 the growth of microorganisms. The normal maintenance program for the unit should also include periodic cleaning on the tube side (water side) of the heat exchanger to remove deposits which enhance fouling and corrosion.

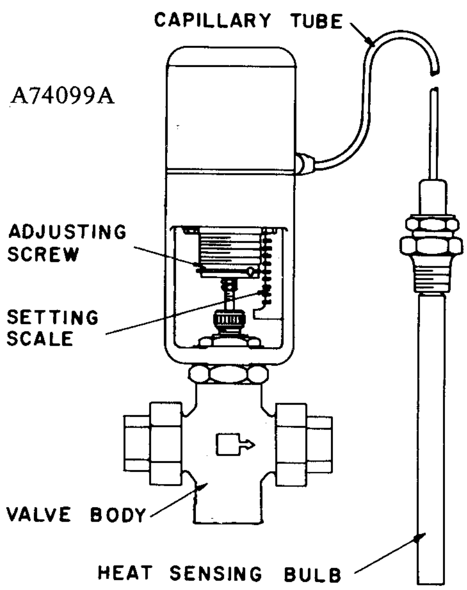


FIGURE 6-5. – WATER CONTROL VALVE

WATER FLOW CONTROL VALVE FOR HEAT EXCHANGER (Figure 6-5) – 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 goove 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.

The thermal bulb on some types of valves will have a groove on the bulb to indicate correct installation position. The bulb MUST be placed in the horizontal oil pipe so that the groove is in the UP position on the top side of the bulb. The valve will not operate if the groove is not properly placed.

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 of 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.

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.

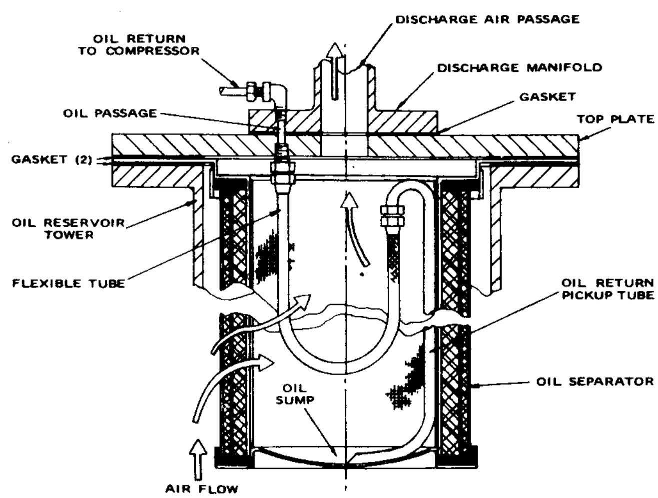


FIGURE 7-5. – SINGLE-ELEMENT OIL SEPARATOR

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.

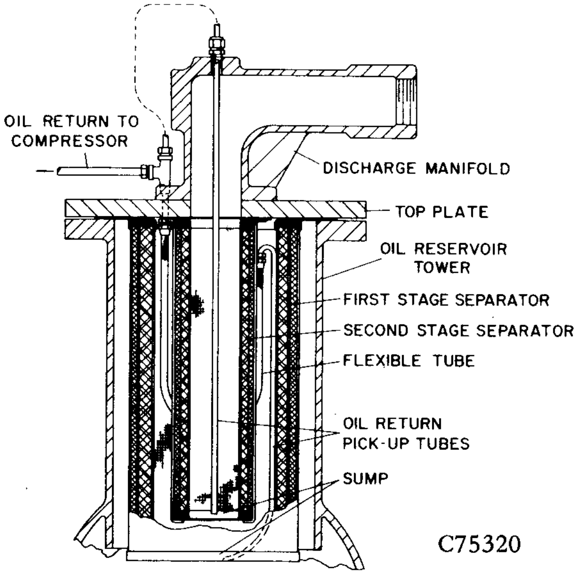


FIGURE 8-5. – DUAL-ELEMENT OIL SEPARATOR

COMPRESSOR OIL SEPARATOR located in the vertical section of the oil reservoir consists of renewable cartridge-type separator element(s) and provides the final removal of oil from the air stream.

Early compressor units used a single-element oil separator (Figure 7-5) while later units use a dual-element oil separator (Figure 8-5). Oil from inside the separator element(s) is returned through tubing to the compressor cylinder. Oil impinging on the outside of a single-element separator or on the first stage of a dual-element separator drains directly back into the oil reservoir by gravity.

Oil carry-over through the service lines may be caused by a faulty oil separator, faulty minimum pressure valve, over-filling of the oil reservoir, oil that foams, or oil return line malfunction. If oil carry-over occurs, inspect the separator(s) 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 separator top plate is lined up with the discharge manifold return opening and gasket hole, and the return tube(s) inside the separator(s) is not loose or broken.

Oil carry-over malfunctions of the oil separator are usually due to using the element(s) 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 or varnish buildup in the filtering material. Excessive tilt angle of the unit will also hamper separation and cause oil carry-over.

Oil separator element life cannot be predicted; it will vary greatly depending on the conditions of operation, the quality of oil used and the maintenance of the oil and air filters. The condition of the oil separators can be determined by pressure differential gauging or by inspection.

In dual oil separator systems, the second-stage (inner smaller element) may not need replacement as often as the first-stage element. Careful inspection or pressure differential gauging, plus operating experience, will determine the change interval.

Pressure Differential Gauging – A pressure differential gauge will read differential across the one separator of a single separator system, or across both separators of a dual system.

When the unit is equipped with the optional pressure differential gauge panel, the single separator should be changed when the oil separator gauge indicates 8 PSI differential with the unit on load at 100 PSIG. In a 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.

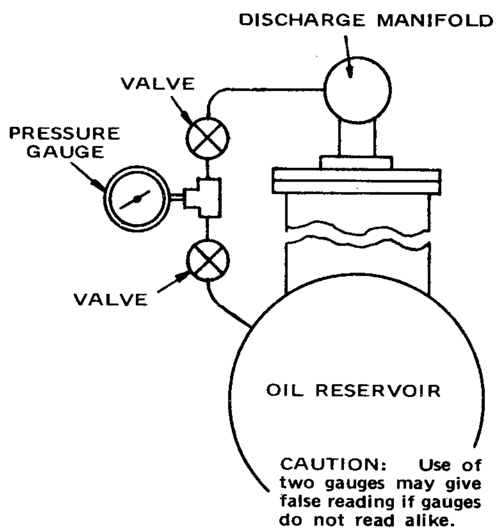


FIGURE 9-5. – OIL SEPARATOR
PRESSURE DIFFERENTIAL CHECK

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.

A field installation pressure differential gauging system can be constructed as shown in Figure 9-5. The pressure can then be read on the upstream and downstream sides of the separators by opening and closing the appropriate valves. When the differential in the two readings obtained exceeds 8 PSI, the separators should be changed.

NOTE: Pressure differential on new elements is approximately 1-2 PSI. As separators retain dirt, differential will rise. A sudden drop to ZERO differential or a sudden heavy oil carry-over may indicate a ruptured separator.

Inspection – After removal of the separator(s), use a drop light inside the element(s) to reveal areas of heavy dirt or varnish deposits or breaks (ruptures) in the element media.

Removal of Oil Separator For Inspection or Replacement – Single-Element Type:

1. Disconnect all tubing and the discharge line pipe union, remove discharge manifold cap screws and slide the manifold free of top plate.

2. Remove cap screws holding the top plate to the oil reservoir tower and lift the plate just enough to disconnect the flexible hose inside the separator. Remove the top plate.

3. Lift the separator from the reservoir tower.

4. Inspect and/or replace the separator element. Remove any gasket material from old separator adhering to top plate or reservoir flange.

5. Install the separator. Be sure gaskets bonded to the separator are not damaged. Lower separator carefully into the reservoir; use care not to dent or damage the separator.

6. Replace the top plate. As the top plate is lowered, connect the flexible tube to the separator pickup tube, making sure connection at each end of the tube is tight.

7. Position the top plate so the oil return opening will line up with the oil return opening in the discharge manifold in its final position. Install and tighten all cap screws. Install the discharge manifold; make sure gasket does not block the oil passage and that the oil return holes in manifold and top plate line up.

8. Reconnect the discharge manifold pipe union and all tubing. Reinstall and tighten all manifold cap screws.

Removal of Oil Separator For Inspection or Replacement – Dual-Element Type:

1. Disconnect oil return to compressor tubing at tee near discharge manifold flange on top plate.

2. Disconnect tubing from tee on top plate to top of discharge manifold at the tee. Loosen nut on fitting at top of manifold and completely withdraw the tubing through the fitting.

3. Disconnect all other tubing from discharge manifold.

4. Disconnect discharge manifold pipe union and remove all manifold to top plate screws. Lift the manifold free of the top plate.

5. Remove screws holding the top plate to the oil reservoir tower. Lift the plate just enough to disconnect the flexible oil return tube for the first-stage separator from the top plate fitting. Lift top plate and the attached second-stage separator from the oil reservoir tower.

6. Invert top plate and second-stage separator. DO NOT REST THE ASSEMBLY ON THE SEPARATOR. Remove cap screws and washers holding second-stage separator and lift the separator from the top plate.

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

8. Inspect and/or replace the first- and second-stage separators as necessary. Note that the second stage may not need replacement as frequently as the first stage. Before installing (or reinstalling) any separator be sure gaskets bonded to the separator flanges are not damaged. Remove any gasket material adhering to top plate or reservoir tower flange from old separators.

9. Connect the flexible oil return tubing to the metal pickup tube in the first-stage separator. Make sure fitting is tight at both connections. Lower separator into oil reservoir tower.

10. Place second-stage separator on the top plate so that the tapped oil return hole in the top plate and the clearance hole in the separator flange line up. Secure the separator to the top plate with washers and nylok cap screws.

11. If not already in place, install the flexible oil return tube fitting in the tapped hole on the separator side of the top plate.

12. Lower the top plate and second-stage separator assembly into the first-stage separator in the oil reservoir tower. As the assembly is lowered, be sure the metal pickup tube and fitting in the first-stage separator has been rotated at an angle to clear the second-stage separator. If not, rotate the metal tube until sufficient clearance is achieved. Connect the flexible tubing to the fitting on the top plate and tighten securely. Seat top plate to oil reservoir tower flange; install and tighten all cap screws.

13. Install the discharge manifold. Make sure the gasket does not block the oil passage and that oil return holes in manifold flange and top plate line up. Reinstall and tighten all manifold to top plate screws.

14. Reconnect the discharge manifold pipe union and all tubing to pressure gauge, pilot, etc.

15. Reconnect oil return tubing from compressor to tee near discharge manifold flange.

16. Install original second-stage oil return by slipping tube through the fitting at the top of the discharge manifold until ferrule bottoms in fitting. If a new fitting and return tube is used, slip tube through fitting until it touches the bottom of the second-stage separator, then raise the tube about 1/4" off the bottom and tighten fitting nut securely. Connect the other end of the tube to the compressor oil return tee; trim off any excess from new tube to fit into tee – do not bend tube or raise further than 1/4".

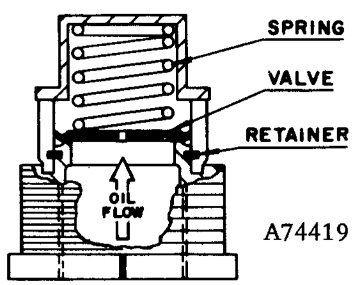


FIGURE 10-5. – OIL FLOW CONTROL VALVE

OIL FLOW CONTROL VALVE (Duomatic Control Unit Only) (Figures 1-5 & 10-5) – 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 SYSTEM (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. A 3/16" diameter orifice in the line downstream from the valve is used to hold blowdown time to about 45 seconds and prevent oil carry-over due to too rapid a release of pressure. 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 (Optional) – A set of gauges mounted on the left portion of the instrument panel is available for checking pressure differential across the oil filter and the oil separator. These gauges indicate the pressure differential across the oil filter and oil separator during all conditions of operation.

The oil filter element should be changed when the gauge indicates a pressure differential of 15 PSI; the oil separator should be changed when the gauge indicates a pressure differential of 8 PSI with the unit on full load at 100 PSIG service pressure.

Ambient Temp. (° F.)		80	90	100
ESG	Oil Inlet Temperature (° F.)	150	160	170*
ESH		150	160	170*
ESJ		150	160	170*

* For temperatures above 170° F. see "High Temperature Operation".

FIGURE 11-5.

COMPRESSOR OIL SYSTEM CHECK – 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. The data shown is for an oil system in good condition.

If the unit will operate at oil inlet temperatures over 170° F. for more than 4 consecutive hours, refer to the "High Temperature Operation" paragraph and select a lubricant for the service. Regardless of level of sustained oil inlet temperature, the high discharge air temperature switch must never be set higher than 225° F. shutdown temperature.

Air and Oil Discharge Temperature – 165° F. to 180° F. – Check with a thermometer in the tapped opening on top of the compressor discharge pipe to the oil reservoir.

For **air cooled oil systems**, Figure 11-5 shows the normal upper limit of oil inlet temperatures for varying ambient temperatures beginning at the system design point of 80° F. At ambient temperatures below 80° F., the mixing valve will hold the oil inlet temperature at the 80° F. ambient temperature point. Above 80° F., the oil cooler is fully used and the oil inlet temperature varies degree for degree with the ambient temperature.

For **water cooled oil systems**, the water flows at various temperatures outlined in Section 2 will hold the oil inlet temperature below the 80° F. ambient temperature level of Figure 11-5. Small variations in specific water flows or temperatures will not be noted in the oil inlet temperature since the water control valve will tend to hold a constant oil temperature. A significant change in the oil inlet temperature is cause to check for a change in water flow or temperature.

Compressor Oil Inlet Temperature – 130° F. to 150° 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 fitting in the line at the compressor oil inlet line.

Oil Cooler Oil Pressure Differential (Air-Cooled Radiator) – 2 to 12 PSI (65 to 150 PSIG Receiver Pressure) – Check at the pipe plug near the inlet and outlet lines of the oil cooler; inlet at the left side, outlet at the right side when facing the instrument panel end of the compressor unit.

Oil Cooler Oil Pressure Differential (Water-Cooled Heat Exchanger) – 3 to 12 PSI (65 to 150 PSIG Receiver Pressure) – Check at the heat exchanger 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 the ambient temperature and core restriction increases, the oil cooler outlet temperature will increase. The inlet oil temperature may be checked at the fitting in the oil reservoir to oil cooler line. The outlet oil temperature may be checked at the fitting in the oil cooler to thermal control valve line.

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

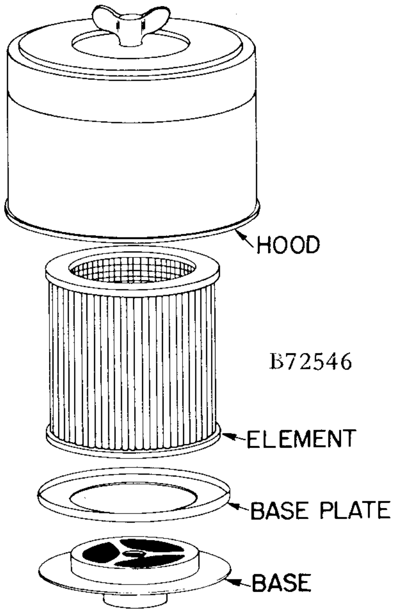


FIGURE 1-6. – DRY TYPE AIR FILTER

AIR FILTER (Figure 1-6) furnished as standard equipment is a washable element 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. When the outside surface of the element appears to be evenly coated with dirt, it should be cleaned as follows:

1. Remove the wing bolt, lift off hood and filter element.

2. Vibrate or blow heavy dirt accumulations from element. Direct air blast at slight inward angle and parallel to element pleats; do not point directly at the element.

3. If required, wash element with a household detergent and water; rinse with clear water. Allow to dry before reinstalling. DO NOT USE OIL, GASOLINE, OR OILY WASTE TO CLEAN.

Replace the element after five cleanings, or if the filter media or seal at the ends are damaged, or if the element cannot be thoroughly cleaned.

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

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

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

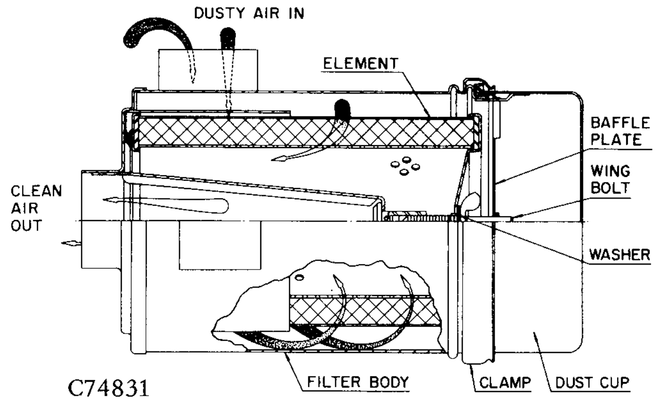


FIGURE 2-6. – HEAVY-DUTY AIR FILTER

HEAVY-DUTY AIR FILTER (Figure 2-6) – Extremely dusty locations require a heavy-duty two-stage dry type air filter. If a unit has been so equipped, service the filter 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 the 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 delivery 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 about 15 minutes in warm water with a mild detergent. 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 other 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 element.

SECTION 7
COUPLING

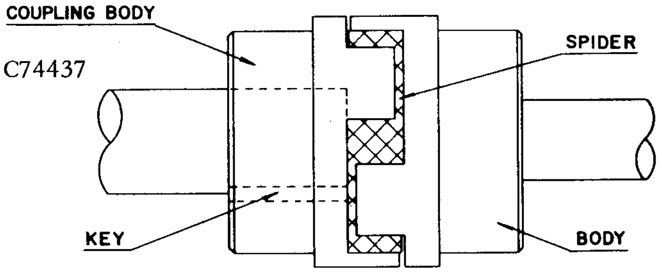


FIGURE 1-7. – COUPLING – MODELS ESG, ESH & ESJ

COUPLING (Figure 1-7) – The motor and compressor are direct connected by a resilient cushion-type flexible coupling. The coupling does not require lubrication. On Models ESG, ESH and ESJ the coupling cushion member is a one-piece spider-type construction.

The coupling is aligned at the factory. However, since there may have been settling or deflection of the unit through shipment or handling, rechecking coupling alignment is recommended; refer to Steps 3 through 7 below.

For cases where the motor or compressor has been removed from the base, proceed as follows for coupling alignment:

1. Install motor and/or compressor on mounting pads of base, making sure coupling spider is in place and engage coupling. If shims were used under motor or compressor feet be sure they are in place. *CAUTION: A new compressor or motor may have a different shaft height than the previous one and require entirely new shims.* Install screws in motor or compressor feet.

2. Position the coupling body on each shaft (motor and compressor) so that shaft ends are about flush with the face of the body, and flanges rest snugly against the raised dots on the coupling spider faces. When positioning either coupling half on the shaft, make sure the shaft doesn't extend through the coupling to interfere with the spider. Approximate distance between shafts is one (1) inch. Tighten the set screws over the key in each coupling body.

3. Check angular alignment with a feeler gauge by comparing the gap between the coupling 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 .010".

4. Check parallel alignment by placing a straight edge across both coupling body flanges. Shim and adjust the compressor and motor until the straight edge lies flat on both hubs measured at two (2) points 90° apart (Views "A" and "B", Figure 2-7). Maximum recommended difference in hub level is .010".

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

6. Tighten screws in motor and compressor feet evenly. Recheck tightness of screws in coupling.

7. Recheck coupling alignment and adjust if necessary.

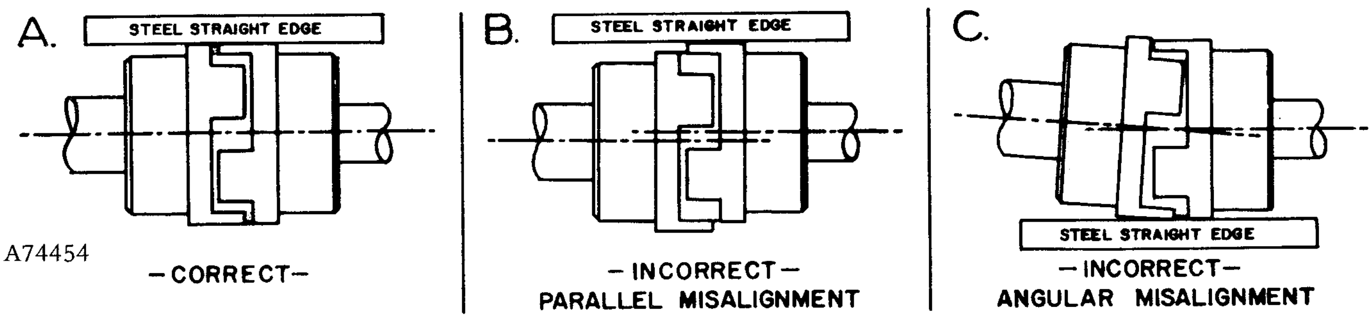


FIGURE 2-7. – COUPLING ALIGNMENT – MODELS ESG, ESH & ESJ

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 – If the unit is equipped with the optional pressure differential gauging, or if differential gauging has been field installed (see Section 5), change the oil separator element when the pressure differential gauge indicates an 8 PSI differential.

If no pressure differential gauging has been installed, CHECK the oil separator element every 4000 hours.

Refer to "Compressor Oil Separator" in Section 5 for further details.

Motor Lubrication – Refer to Section 2.

Every 8 Hours Operation

1. Check the reservoir oil level – add oil if required. 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 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. If unit is equipped with the optional pressure differential gauging, change 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 system if required.

Every 2000 Hours Operation

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

Every 8000 Hours Operation

1. Lubricate the acoustic enclosure ventilating fan motor (water-cooled unit only); refer to "Water-Cooled Unit" in Section 2.

SECTION 9
TROUBLE SHOOTING

IF UNIT FAILS TO START, check:

1. Wiring system for wrong lead connections.
2. Temperature shutdown circuit breaker on control panel.
3. Fuse in control enclosure or starter enclosure.
4. Motor starter overload heaters.

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 filter.
   (c) Thermal control (thermostatic mixing) valve stuck.
   (d) Dirt on oil cooler core faces.
   (e) Poor ventilation of unit.
   (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.
2. Temperature shutdown circuit breaker on control panel or manual reset button on high discharge temperature switch.
3. Fuse in control panel enclosure or starter enclosure.
4. Motor starter overloads.

COMPRESSOR DOES NOT UNLOAD, check:

1. Magnetic unloader or pressure switch for malfunction.
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.

UNIT FAILS TO SHUT DOWN ON START-STOP SYSTEM, check:

1. Control for malfunction.
2. Control lines for restriction or leaks.
3. Pressure switch for dirt or leaking diaphragm.
4. Wiring and tubing to pressure switch.

SOLENOID BLOWDOWN VALVE CONTINUES TO PASS AIR, check for:

1. Loose wiring to blowdown valve.
2. Coil failure.
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.
   (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.

SECTION 10
COMPRESSOR OVERHAUL

ELECTRA-SCREW® COMPRESSOR DISASSEMBLY AND ASSEMBLY procedures are explained in the text. Some models 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. Drain compressor oil system. 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 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
ESG, ESH, ESJ	350 Lbs. (Approx.)

1. Place the compressor upside down and remove the oil sump plate. Remove the one (1) cylinder flange to discharge end plate socket head screw (see arrow).

2. Place unit right side up supported on solid blocking with gear housing overhanging blocking.

   Remove coupling half from drive shaft, remove key. Remove eight (8) seal housing screws and install two (2) 3/8–16 UNC guide studs, one each side, for ease of disassembly. Remove seal retainer plate, oil seal seat and seal housing. Take care that bearing housing and shaft assembly does not pull out of gear housing at this time. Oil seal seat may stick in seal housing and can be removed after housing is removed. If oil seal is to be reused, be sure to protect polished face of seat.

3. Carefully pull bearing housing and shaft assembly so gear does not drop and nick teeth. Since bearing is a slip fit in bore, the shaft, bearing and gear assembly may pull out of bearing housing, in which case the housing can be removed separately. Two tapped holes for jack bolts are provided if bearing housing does not slip from gear housing by hand. *NOTE: Jack bolts should be hardened with round or flat ends.* When jack bolts are used, they must be tightened evenly to prevent binding the housing in bore.

4. If gear diameter will permit, stand bearing housing and shaft assembly on shaft end and slip housing off bearing and over gear. On models where gear will not pass through bearing bore, remove snap ring from bearing outer race and slip bearing housing from bearing in direction away from gear.

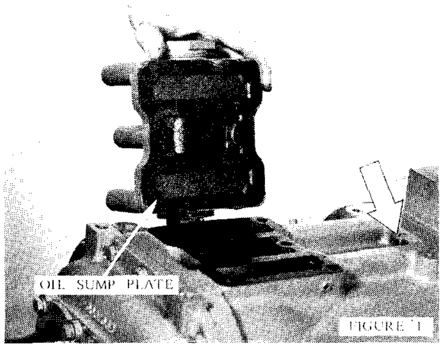


FIGURE 1

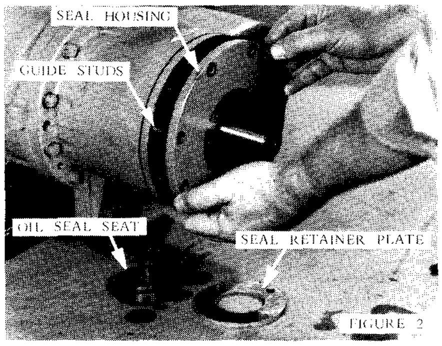


FIGURE 2

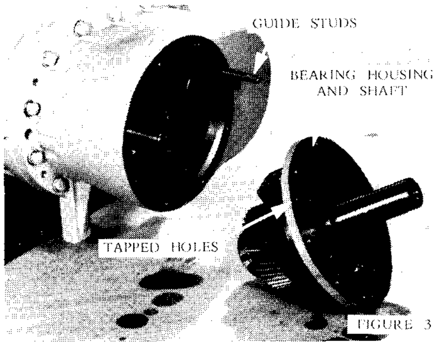


FIGURE 3

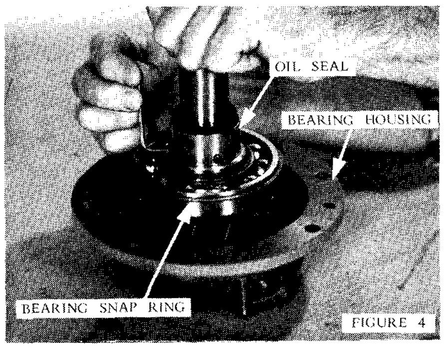


FIGURE 4

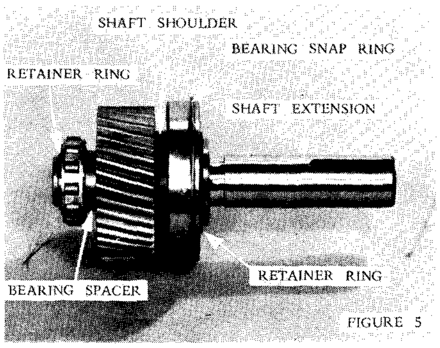


FIGURE 5

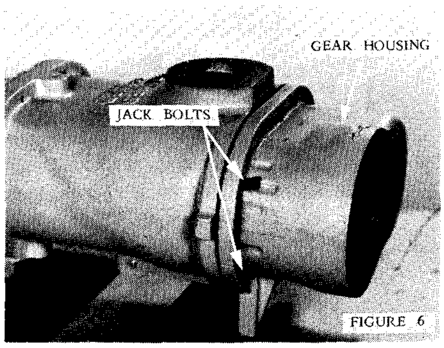


FIGURE 6

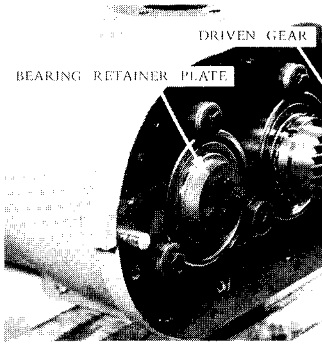


FIGURE 7

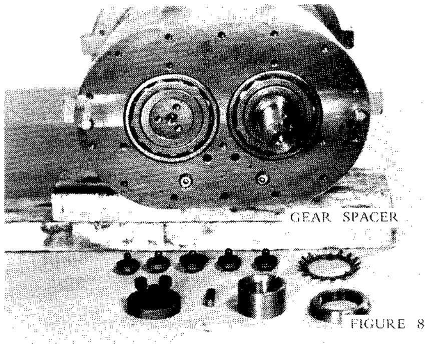


FIGURE 8

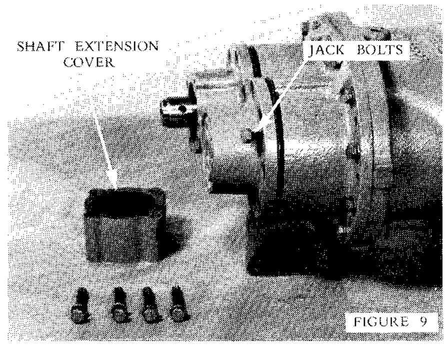


FIGURE 9

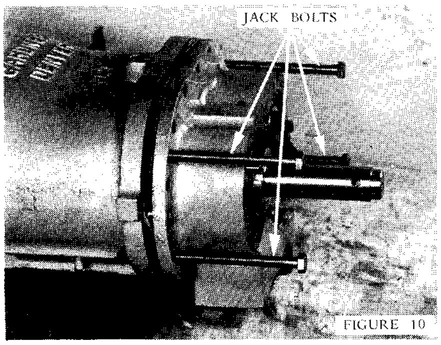
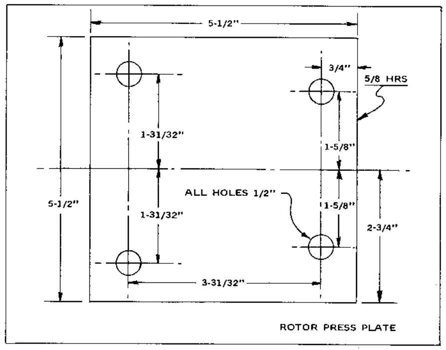


FIGURE 10



ROTOR PRESS PLATE

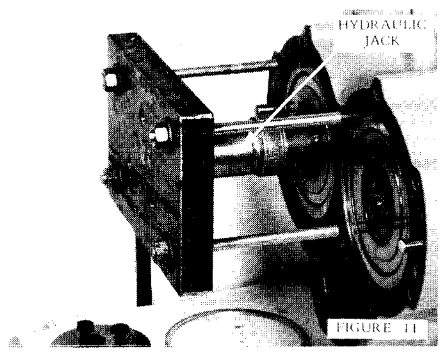


FIGURE 11

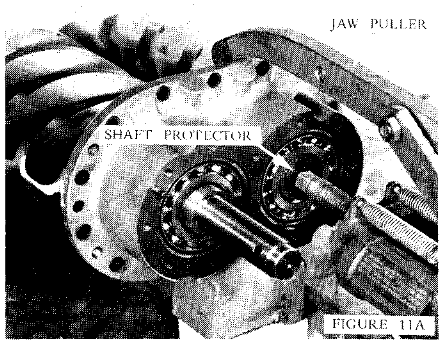


FIGURE 11A

Loosen all Allen screws in oil seal body and slip seal from shaft. If oil seal is to be reused, protect carbon face.

5. To disassemble shaft, bearing and gear assembly, remove both bearing retainer snap rings. The shaft may then be pressed through the gear and small bearing, then reversed and pressed through the large bearing. The shaft cannot be pressed through the entire assembly in one setting since there is a shoulder between the gear and large bearing. If bearings only are being replaced, the gear need not be disturbed; pull each bearing individually from the shaft.

6. Remove all gear housing to cylinder screws. With four (4) jack bolts, two on each side, jack housing from cylinder dowel pins. Tighten jack bolts evenly to prevent binding on the dowel pins. Support housing so it does not fall when it is free of dowel pins. *NOTE: Jack bolts should be hardened with round or flat ends.*

7. Remove bearing retainer plate and gear retainer screw and washer. With jaw type puller, remove gear from shaft. If gear is to be reused, use caution not to damage gear teeth. Use shaft protector to prevent damage to end of rotor shaft. Remove gear key from shaft.

8. Remove gear spacer, bearing locknut and washer, and five (5) outer race retainer screws and washers.

9. Remove the shaft extension cover. Remove all bearing cover to discharge end plate screws. With two (2) jack bolts, pull the bearing cover from dowel pins. Tighten jack bolts evenly to prevent binding on dowel pins. Remove bearing outer race shims from bearing bore.

10. Remove all discharge end plate to cylinder screws. *NOTE: See arrow in Figure 1.* With four (4) jack bolts, pull the end plate, fixed bearings and rotors from cylinder as an assembly. This will pull rotor shafts through bearings at inlet end. Take care that the bearings do not fall from inner race if they are to be reused. Be careful not to burr rotors or cylinder during this operation.

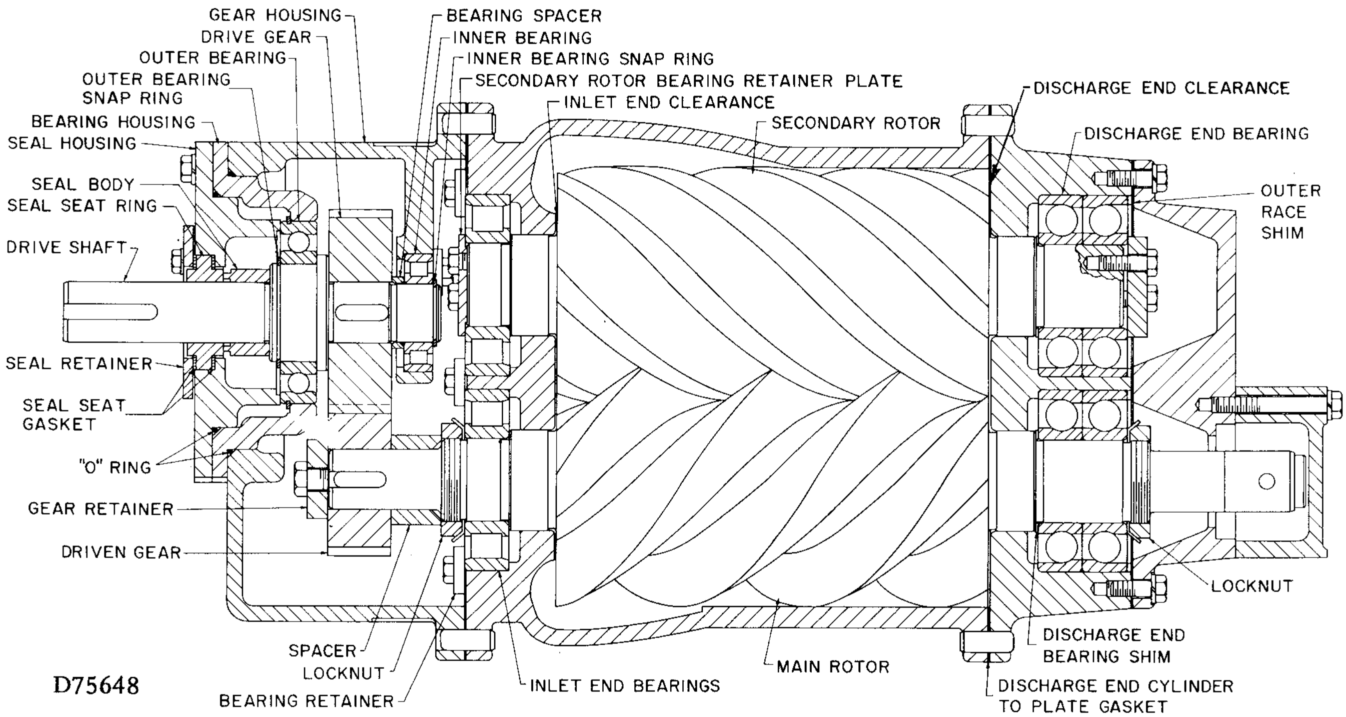
11. Support discharge end plate and rotor assembly level in a horizontal position. Remove the bearing retainer plate and bearing locknut and washer from the rotor shafts.

Make a rotor press plate as shown in sketch. With plate and hydraulic jack rigged as shown in Figure 11, press the rotor shafts through the discharge end bearings. Be sure the rotor is well supported so it does not fall when shaft clears bearing. Use a shaft protector between end of shaft and jack to prevent shaft damage. The studs supporting the press plate to the discharge end plate must be long enough for longest rotor shaft extension plus hydraulic jack and plate thickness.

11A. An alternate method to press rotor shaft through bearings is with a jaw type puller as shown in Figure 11A. Use shaft protector to prevent damage to shaft. Support rotors so they do not fall when free of bearings. When rotors have been removed, inspect the machined side of end plate for burrs caused by puller jaw; stone smooth if burrs are present.

Remove the bearings from discharge end plate and from the inlet end of the cylinder. Remove with care to prevent damage to bore through the end plate. A close running fit to rotor shaft is provided and burrs in the bore may cause rotor shaft to end plate seizure.

If the bearings are to be reused, keep them matched as originally assembled. *NOTE: Never reuse worn bearings.*



SECTIONAL VIEW OF COMPRESSOR

ASSEMBLY INSTRUCTIONS – The Electra-Screw® Compressor is manufactured with close tolerances for efficient operation. All parts must be handled carefully to prevent burrs which will give false tolerance readings and/or cause rapid wear. All parts and oil passages must be thoroughly cleaned of dirt which will cause galling of close running parts. Clean work area, washing tank, tools and wiping rags must be provided. Refer to the sectional view for complete assembly of the parts.

The measurements and procedures described in the following steps must be done accurately for an efficient and quiet operating compressor. The measurements establish total rotor end clearance (inlet end plus discharge end) and fix the rotor in position to give the correct discharge end clearance.

Angular contact bearings and shims hold these close clearances when they are locked in position. Other clearances, such as rotor O.D. to cylinder, do not require measurement or setting since they are controlled by close manufacturing tolerances. As a general rule, if the assembled compressor turns freely, without drag or tight spots, proper clearances have been established within the machine.

TORQUE RECOMMENDATIONS – All screws on the compressor should be tightened to the torque values shown in the table on the following page to insure a correctly assembled and leak-free machine.

All hex head cap screws used on Gardner-Denver Electra-Screw® compressors are SAE Grade 5. Grade 5 hex head cap screws are identified by the three raised lines on the head:

All socket head (Allen) cap screws are SAE Grade 8.

The torque values shown in the table are to be used only with the appropriate grade and type of screw. Tightening a Grade 5 screw to a Grade 8 torque could result in screw breakage; tightening a Grade 8 screw to a Grade 5 torque will result in a loose assembly.

TORQUE RECOMMENDATIONS						
	SAE Grade 5 – Hex Head Cap Screw			SAE Grade 8 – Socket Head Cap Screw		
Screw Size	Plain	With Nylok Insert	Maximum	Plain	With Nylok Insert	Maximum
1/4 - 20 UNC	8.5	11	11	12	14.5	15.5
5/16 - 18 UNC	17	22	23	24	29	32.5
3/8 - 16 UNC	31	38	41	44	51	58
7/16 - 14 UNC	50	58	66	70	78	93
1/2 - 13 UNC	75	88	100	105	118	140
9/16 - 12 UNC	108	125	145	152	169	205
5/8 - 11 UNC	150	175	200	210	235	280
3/4 - 10 UNC	260	293	350	365	398	490
7/8 - 9 UNC	400	450	530	615	665	800
1 - 8 UNC	590	660	785	915	982	1210
All **Torque Values** shown are in **Foot-Pounds** and are based on clean, dry parts without burrs. The use of plated screws, lubrication, etc. will reduce torque values as much as 20% and must be taken into consideration.						

TO ASSEMBLE THE COMPRESSOR:

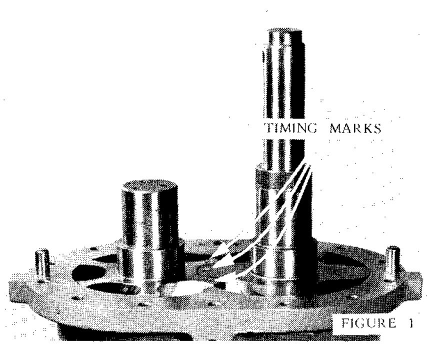


FIGURE 1

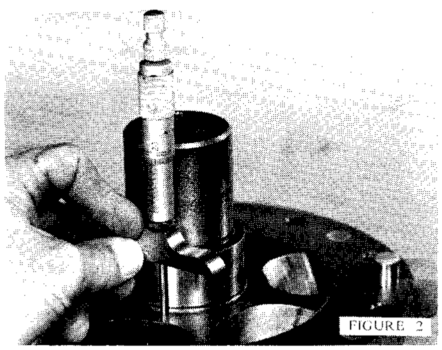


FIGURE 2

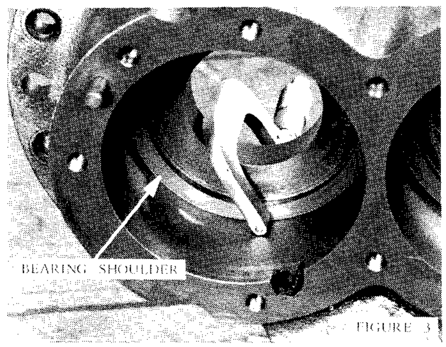


FIGURE 3

1. Stand the cylinder on blocking high enough to clear the main rotor shaft extension. Check in the bottom of the cylinder and cylinder walls for burrs. Coat both bores, bottom of cylinder and walls with oil. Check ends, lobes and cavities of rotors for burrs. Coat rotors with oil. Lower rotors into the cylinder. The main rotor is installed with the shaft extension with keyway down. The secondary rotor is installed with the shortest shaft extension down. Make sure the timing marks on the ends of the rotors line up, Figure 1. Timing marks are also rotor pair identification marks. Rotors must be matched pairs for proper operation. DO NOT INTERMATE ROTORS WITH DIFFERENT TIMING-IDENTIFICATION MARKS. Rotate the rotors to be sure they rest squarely in the bottom of the cylinder.

2. With a depth micrometer measure from the shoulder of the shaft to end of rotor, Figure 2. Make this measurement on both rotors and record each measurement under main rotor and secondary rotor.

3. With 0–2" outside micrometer, measure from the side of the discharge end plate to the shoulder in each bearing bore, Figure 3, match and record with measurement made on main and secondary rotors in Step 2. These measurements are to be used later.

4. Lay the fiber gasket on the face of the cylinder – make sure the contour of the gasket matches the cylinder, Figure 4.

5. Lower the discharge end plate in place and tighten all plate to cylinder screws. Discharge port on the end plate is to be on the opposite side of cylinder from inlet opening. Pull screws up evenly to prevent damage to the dowel pins.

   Mount an indicator with the button on end of either rotor shaft; set needle on zero (Figure 5). Pry the

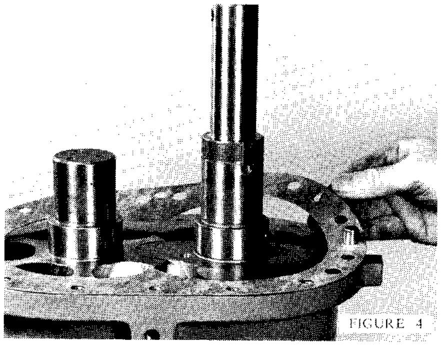


FIGURE 4

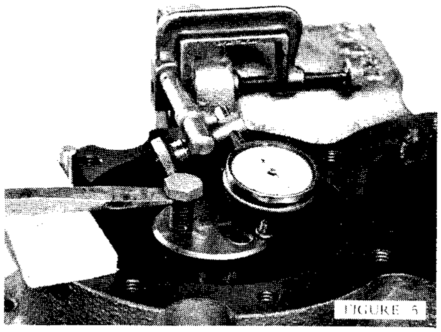


FIGURE 5

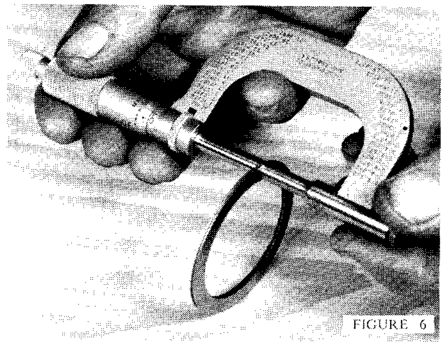


FIGURE 6

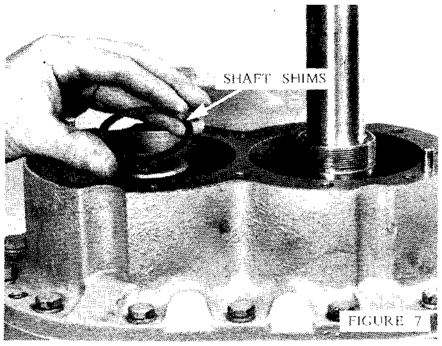
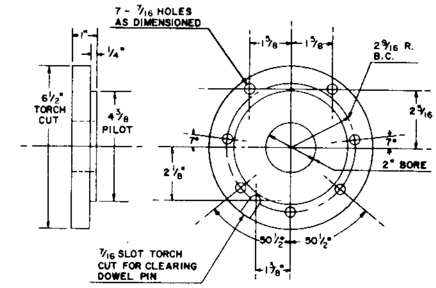


FIGURE 7



PRESS PLATE FOR INSTALLING DISCHARGE END BEARINGS
BEARING COVER PLATE GASKET (DISCHARGE END) CAN BE USED AS TEMPLATE FOR LAYOUT

SKETCH "A"

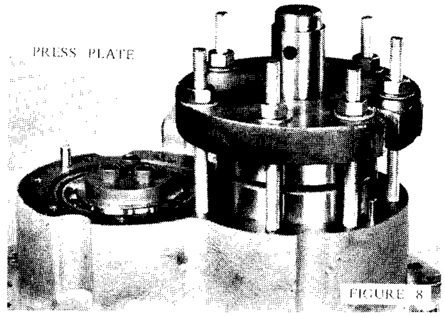


FIGURE 8

rotor up until it hits end plate and note if indicator reading falls within total end clearance range in clearance chart (.010-.028). Make same check on other rotor. Due to machining tolerances at the inlet end of the cylinder, there may be up to .010" variation in the indicator reading of the two rotors. The indicator reading of either rotor should not be less than minimum total end clearance.

CLEARANCE CHART – UNIT COLD

Total End Clearance (Inlet + Discharge)	.010-.028
Inlet End Clearance	.008-.022
Discharge End Clearance	.002-.006

6. *NOTE: Rotor end clearance at the discharge end is most important and is established by use of shims between the bearing and rotor shaft shoulder to position the end of rotor a proper distance from the end plate. Steps 6, 7, 8 and 9 must be performed carefully.*

To determine amount of shaft shims needed to position the rotors to give correct discharge end clearance, subtract the shaft shoulder dimension, Step 2, from end plate dimension, Step 3. To this sum add .003" for rotor end running clearance.

EXAMPLE: End plate dimension 1.124" minus shoulder dimension 1.101", plus end clearance .003" equals a shim set thickness of .026".

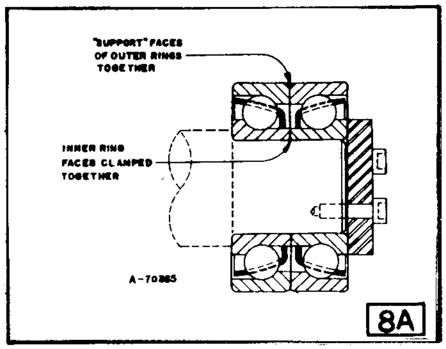
Check shim thickness with an outside micrometer, Figure 6.

NOTE: The discharge end bearings have a built-in axial play of up to .003". A set of bearings with minimum tolerance may have no axial movement and will hold .003" discharge end clearance, less a minute amount for shim crushing. A maximum tolerance set may have up to .003" axial movement plus the .002" end clearance – then the maximum discharge end clearance will be .006". In either case, the closest the rotors will approach the end plate is .003", less the shim crush. In operation the air pressure moves the rotors toward the inlet end of the compressor and a maximum discharge end running clearance is obtained. This built-in bearing clearance variation accounts for a possible discharge end clearance up to .006" even when held to .003" in Steps 6, 7, 8 & 9. This variation accounts for the .002" to .006" tolerance range for the discharge end when it is checked in Step 11.

7. Determine the shaft shim set for each rotor and install over the rotor shaft and against the shoulder, Figure 7. Be sure to apply dimensions and shims for the main rotor to the main rotor shaft, and those for the secondary rotor shaft to the secondary rotor shaft. DO NOT INTERCHANGE.

8. For ease of bearing assembly, lightly coat the bearing bore and shaft extension with "Moly" type grease. Using the adaptor plate (Sketch A) assembled as shown in Figure 8, press the discharge end angular contact bearings in place. Assemble the adaptor plate with the pilot side down so the bearing can be pressed to the bottom of the bore. ASSEMBLE BEARINGS IN END PLATE IN POSITION SHOWN IN FIGURE 8A. Faces marked "SUPPORT" go together. This gives a fixed bearing, holding the rotors in a fixed position.

NOTE: Do not drive any bearing in with a hammer and drift as damage to the bearing may result, leading



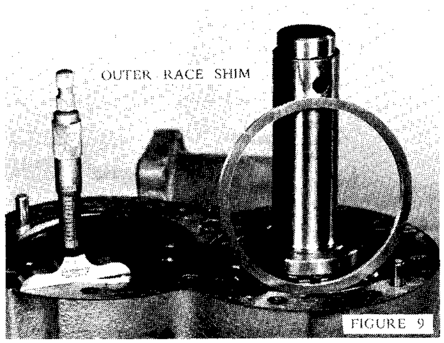


FIGURE 9

FIGURE 10

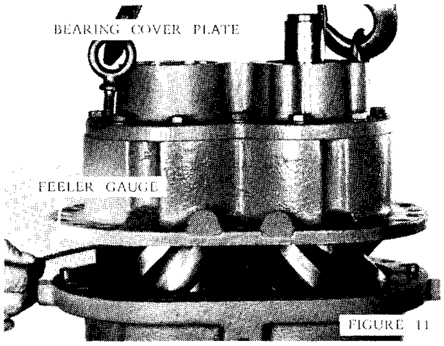


FIGURE 11

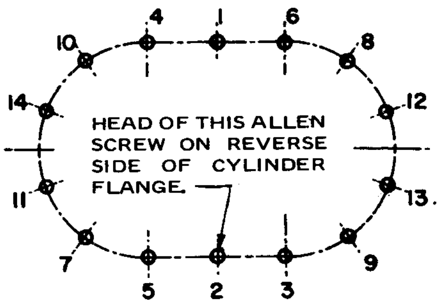


FIGURE 11A.

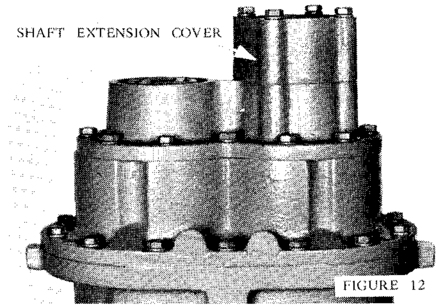


FIGURE 12

to early bearing failure. Be sure the bearing is started in the bore evenly and the nuts on press bolts are tightened progressively to prevent cocking of the bearing.

If a press is used, provide an adaptor plate that catches both inner race and outer race to press the bearing in place. Observe disassembly tags so the bearings go back in the same relation if original bearings are used. Never use worn bearings. OIL BEARINGS THOROUGHLY with oil to be used in unit.

9. Install the bearing retainer with three (3) Nylok screws on the secondary rotor. Install the lock washer and nut on the main rotor and pull up tight. Bend ear of lock washer into slot of nut. Tightening retainers pulls the rotor shaft through the bearing until the inner race jams shims against the shaft shoulder; this provides a fixed bearing to hold rotor end clearance. Place the cover plate gasket with notches matching oil passage, on the end plate. Tap the end of rotor to be sure the bearing outer race is against the shoulder in the bore. Place the outer race shim in the bearing bore against the outer race. With a depth micrometer check the height of the shim in relation to the gasket surface, Figure 9. Peel the shim until it is .002" below the surface of the gasket. Always use a new gasket that has never been crushed. If the shim is more than the correct .002" below the face of gasket, bearing will move in the bore, and the end of the rotor may strike the end plate.

10. Install the bearing cover plate, shown in Figure 11, and pull up tight. With a feeler gauge check the rotor end clearance of both rotors at the inlet end, Figure 10. Refer to clearance chart for correct value. Due to machining tolerance at inlet end of the cylinder, rotors may vary in inlet end clearance up to .010". Do not allow clearance below the minimum listed in clearance chart. Cover the inlet opening to keep out dirt.

11. Before continuing with assembly, check the rotor end clearance at discharge end using this procedure:

    (a) Remove all end plate to cylinder screws.

    (b) With four (4) jack bolts, pull end plate and rotor assembly (complete) from the cylinder dowel pins.

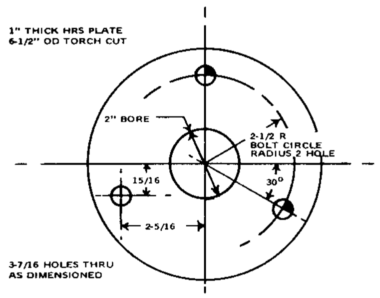
    (c) Lift assembly from the cylinder approximately two (2) inches.

    (d) With feeler gauge check clearance between the end of the rotors and the end plate, Figure 11. See note on variation of discharge end clearance at the end of Step 6.

    Check both rotors. Refer to clearance chart for correct value. Since the lower end of the rotors are not yet held by bearings, there may be a slight out-of-square condition noticed in this check. Lower the end plate and rotor assembly into the cylinder and bolt tight. Torque all fourteen (14) screws per table on page 3, this section. When tightening and torquing, follow the pattern shown in Figure 11A. See Figure 1 in "Disassembly" for screw on reverse side of the cylinder flange.

12. Install the shaft extension cover and gasket.

13. Place the assembly in a horizontal position on substantial blocking. Lightly coat the shafts and bearing bores at the inlet end with "Moly" type grease. Slip bearing inner race and roller assembly over the shaft; start outer race in the bearing bore, assemble press plate (Sketch B) as shown in Figure 13, and press the inlet end roller bearings in place. Tighten the nuts on the press bolts evenly to prevent cocking of the bearing. If a press is used, provide an adaptor plate that catches both the inner and outer race to press



PRESS PLATE FOR INSTALLING INLET END BEARINGS – SKETCH B

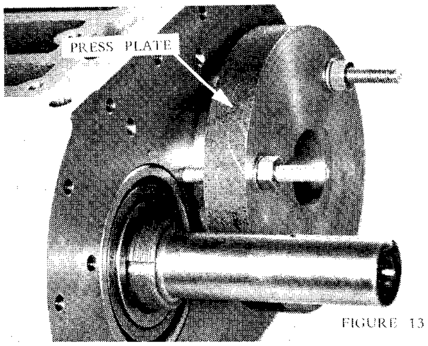


FIGURE 13

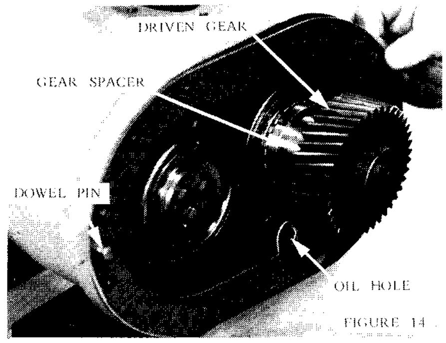


FIGURE 14

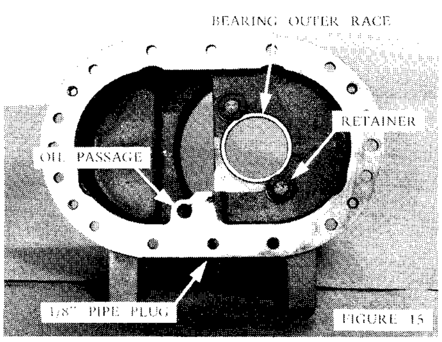


FIGURE 15

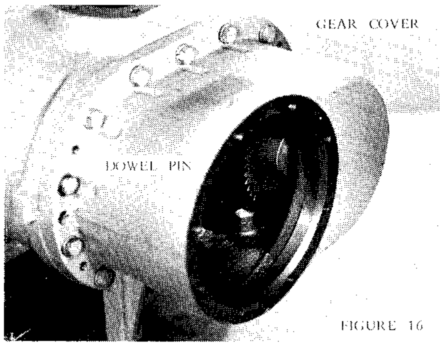


FIGURE 16

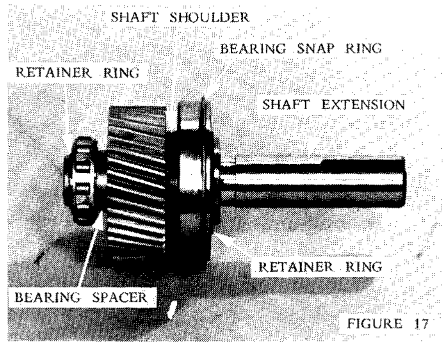


FIGURE 17

bearings in place. *Never use worn bearings.* OIL BEARINGS THOROUGHLY with oil to be used in unit. DO NOT DRIVE BEARINGS IN PLACE.

14. Install the five (5) Nylok screws and washers that hold the bearing outer race in place. Install secondary rotor bearing retainer plate, pilot side towards shaft and three (3) 3/8-16 x 7/8 hex head Nylok cap screws and pull tight (see torque chart). *NOTE: Plate may deflect and show gap between bearing race and plate. DO NOT USE THICKER PLATE OR CAP SCREWS WITH THICKER HEADS as drive shaft interference will result.* Install bearing locknut and washer on main rotor and pull up tight. Bend ear of washer into slot of nut.

    Check the face of the bearing locknut for burrs to provide square face for gear spacer. Slide the gear spacer over the drive shaft with the counterbored side towards the locknut. Check the shaft and keyway for burrs and install gear key. Heat the driven gear to 250° F. in oil or electric oven – NEVER USE TORCH. Slip the gear on the shaft; be sure gear is installed with tapped holes facing out. Allow the gear to cool and install the gear retainer plate and screw. Be sure correct gear is used – see gear size data chart below:

DRIVE AND DRIVEN GEAR SIZE DATA

Model	HP	Drive (Shaft) Gear Compared To Driven Gear	Driven (Main Rotor) Gear Compared To Drive Gear
ESG	30	Smaller	Larger
ESH	40	Larger	Smaller
ESJ	50	Larger	Smaller

Place gasket over dowels on face of cylinder making sure to line up oil hole and projection with oil hole on gasket.

15. Remove 1/8" pipe plug from bottom side (between feet) of gear housing. Thoroughly clean oil passages, reinstall pipe plug. Tap outer race of roller bearing into housing bore, using fiber or plastic hammer. DO NOT USE STEEL HAMMER OR DRIFT. Install bearing race retainer washers and screws, pull tight.

16. OIL BEARINGS AND GEAR WITH OIL TO BE USED IN UNIT. Install gear cover. Tighten screws evenly to prevent binding dowel pins.

17. *NOTE: If gear is to be reused and was not removed from shaft, ignore instructions for installing gear on shaft.*

    Fit gear key to keyway in gear and shaft. Key should fit snugly. It may be necessary to dress key so it fits properly in either keyway. Heat gear and bearings in oil or electric oven to 250° F. Gear will require longer heat time due to its heavier mass, approximately 30 minutes after temperature reaches 250° F. Install gear key in shaft keyway. Install gear on shaft against shaft shoulder, Figure 17. Slide bearing spacer in place and install roller bearing inner race and roller assembly. Install bearing retainer ring in groove in shaft. *NOTE: Shaft will absorb heat from gear and it may be necessary to cool assembly before continuing assembly.*

    Install large ball bearing on shaft against shaft shoulder with the bearing snap ring in the outer race towards the shaft extension, Figure 17. Install bearing retainer ring in groove in shaft. *NOTE: If dry ice is available, the shaft may be cooled for installing gear and bearings.*

18. The shaft, gear and bearing assembly MUST cool down to room temperature before installing housing. Lower

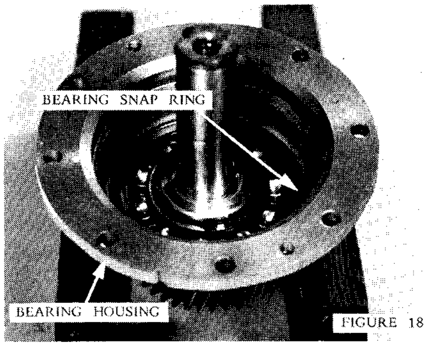


FIGURE 18

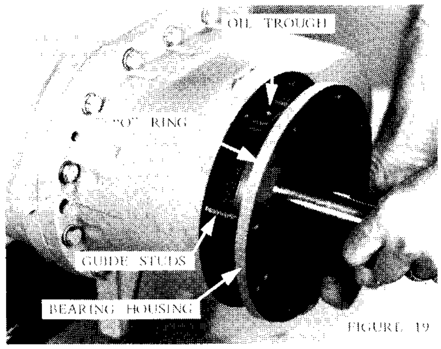


FIGURE 19

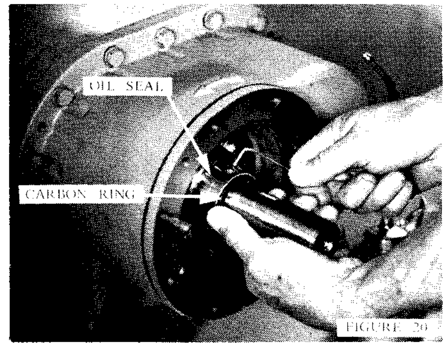


FIGURE 20

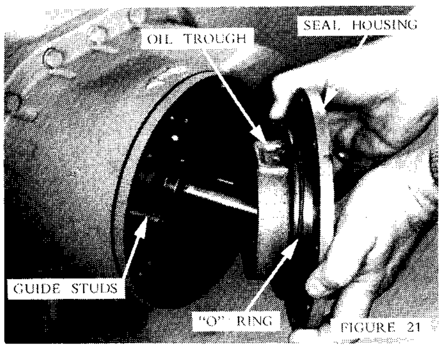


FIGURE 21

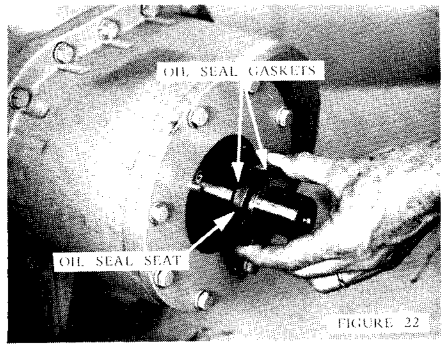


FIGURE 22

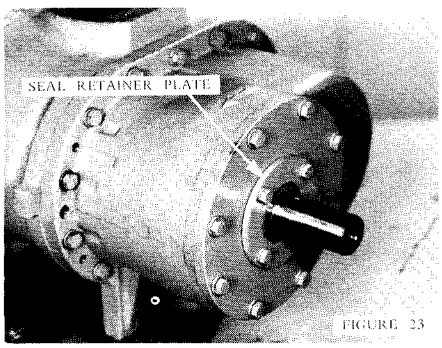


FIGURE 23

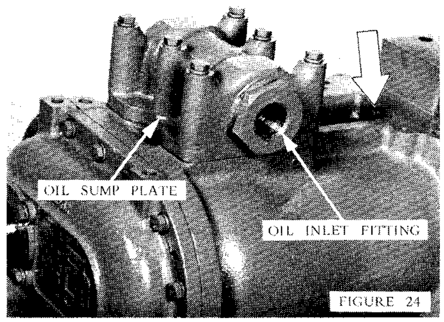


FIGURE 24

assembly into housing until bearing snap ring seats against housing shoulder. Use fiber hammer to tap assembly in place. DO NOT USE STEEL HAMMER OR DRIFT. Take care bearing does not cock in bore.

NOTE: On models where the gear will not pass through the bearing bore, remove the bearing snap ring from the bearing and slide housing over bearing from gear side and reinstall snap ring. Pull housing back until snap ring seats against shoulder of housing.

Bearing snap ring must be in place since it prevents excessive lateral movement of shaft assembly.

19. Install two (2) 3/8-16 UNC guide studs in gear cover for ease of assembly. Install "O" ring on gear housing up against flange (not visible in Figure 19). OIL BEARINGS AND GEAR WITH OIL TO BE USED IN UNIT. With oil trough up, slide bearing housing and shaft assembly in the gear housing. Use care; inner bearing roller assembly must enter outer race and gears must mesh.

20. *NOTE: Install oil seal with care to prevent breaking carbon ring.*

Check shaft for burrs and coat with oil. Slide oil seal over shaft tight against shoulder. Tighten all set screws in seal body. *NOTE: A new oil seal may be packaged with retainer clips to compress seal springs. Leave these clips in place when installing seal on shaft for easier assembly. Remove clips after seal is in place and set screws tightened.*

OIL CARBON FACE OF SEAL TO PREVENT DRY START AND DAMAGE.

21. Install seal housing. Be sure "O" ring is in place on finished diameter of housing and against flange. Install housing with oil trough up. Install all cap screws and pull tight.

22. Place flat gasket on each side of oil seal seat. OIL POLISHED FACE OF SEAL SEAT. Install in housing with polished face against carbon ring of seal.

23. Install seal retainer plate and tighten all cap screws evenly to prevent cocking seal with possible damage. Fit coupling key to keyway in coupling half and shaft. Key should fit snug in both keyways. Install key and coupling half on shaft. Tightening set screws will be

done later during coupling alignment. *NOTE: Do not drive the coupling on shaft as damage to bearings and face of coupling may result.* It may be necessary to heat coupling for installation.

24. Turn unit upside down. Install the gasket and oil sump plate on the cylinder. Tighten all screws evenly – torque per table. Make sure the sump plate is installed with the oil inlet on the proper side as shown. Be sure to install and tighten the one cylinder flange to end plate socket head screw (see arrow in Figure 24).

NOTE: If the compressor is not to be installed immediately, cover all openings to keep out dirt.

BEFORE INSTALLING THE COMPRESSOR ON BASE:

1. Drain and clean the oil system, i.e., reservoir, oil filter, oil cooler and oil lines. If excessive dirt is noticed, flush the system thoroughly.

2. Install a new oil filter cartridge.

3. Inspect the oil separator(s) in the oil reservoir. Replace if necessary.

ALIGNMENT OF THE COMPRESSOR AND MOTOR:

1. Lower the compressor on the mounting pads of base and engage coupling. Be sure coupling spider is in place.

2. Install compressor to base screws. If shims were used, be sure they are in proper position.

3. Refer to "Coupling" section for alignment procedure.

4. Install coupling guard.

MISCELLANEOUS:

1. Inspect the inlet housing and valve; clean and repair if necessary. Install with a new gasket.

2. Install brackets and oil filters as required according to model.

3. Connect all oil lines – be sure all lines are connected properly; refer to Flow Diagram.

4. Thoroughly clean air filter, refer to "Air Filter" section, and install filter. Thoroughly clean air tube between air filter and inlet valve (if used). Install air tube making sure all clamps and gaskets are air tight.

5. Connect all other tubing or piping as required according to model.

6. Make sure all drain plugs and connections in oil system are tight. Fill system with oil. Refer to "Lubrication" section for specifications.

REBUILDING DATA FOR ESG, ESH AND ESJ GEAR-DRIVEN COMPRESSORS

Rebuilding data for current, bare compressor Models SSFD/7 thru SSFD/12 (one ball and one roller bearing design input shaft) is shown below. Last digit of model is stamped either on gear housing flange or seal housing flange face. Repair parts for earlier two ball bearing design are not available.

	Ball & Roller Bearing Design
DIMENSIONS	
Center of Main Bore to Center of Secondary Bore	4.634/4.636
Cylinder Bore Diameter — Main	6.034/6.037
Secondary	5.566/5.569
Cylinder Length	10.260/10.265
Inlet End Bearing Bore Diameter	4.3302/4.3312
Inlet End Bearing Bore Depth	1.025/1.040
Inlet End Air Seal Bore Diameter	2.384/2.385
Discharge End Bearing Bore Diameter	4.3307/4.3312
Discharge End Bearing Bore Depth	2.239/2.231
Discharge End Air Seal Bore Diameter	2.380/2.381
Inlet & Discharge End Air Seal Bore Length, Rotor Side of Bore to Bearing Bore Shoulder	1.130/1.125
Rotor Body O.D. — Main	6.029/6.028
Secondary	5.561/5.560
Rotor Body Length	10.272/10.270
Rotor Shaft Air Seal Diameter — Inlet	2.371/2.370
Discharge	2.376/2.375
Rotor Shaft Air Seal Diameter Length — Inlet *	1.135/1.130
Discharge *	1.100/1.095
Rotor Shaft Bearing Diameter — Inlet	1.9693/1.9689
Discharge	1.9690/1.9686
Rotor Shaft Bearing Diameter Length — Inlet *	1.00
Discharge *	2.06
Main Rotor Shaft Gear Diameter	1.4375/1.4370
Main Rotor Shaft Gear Diameter Length *	2.67
Drive Shaft Coupling & Seal Diameter	1.4375/1.4365
Drive Shaft Coupling & Seal Diameter Length *	4.88
Drive Shaft Outer Bearing Diameter	2.3632/2.3627
Drive Shaft Outer Bearing Diameter Length	.856/.863
Drive Shaft Outer Bearing Shoulder Diameter	2.74
Drive Shaft Inner Bearing Diameter	1.3788/1.3784
Drive Shaft Inner Bearing Length	.927/.861
Drive Shaft Gear Diameter	1.4525/1.4520
Drive Shaft Gear Diameter Length *	1.480/1.440
Drive Shaft Gear & Inner Bearing Snap Ring Groove — Diameter	1.295/1.287
Width	.056/.060
Drive Shaft Outer Bearing Snap Ring Groove — Diameter	2.245/2.233
Width	.086/.091

* Includes any radii, chamfer or undercut.

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

	Ball & Roller Bearing Design
DIMENSIONS (Continued)	
Drive Gear Bore	1.4510/1.4515
Driven Gear Bore	1.4360/1.4365
Drive & Driven Gear Face Width *	1.500/1.495
Gear Center Distance	3.999/4.001
Gear Case Bearing Housing Bore	6.501/6.502
Gear Case Inner Bearing Bore	2.8340/2.8347
Gear Case Inner Bearing Bore Depth From Face of Gear Case	4.194/4.198
Gear Case Width Face to Flange	5.654/5.658
Bearing Housing Outer Bearing Bore	4.3305/4.3314
Bearing Housing Bore for Seal Housing	5.501/5.502
Bearing Housing Pilot Diameter	6.500/6.499
Bearing Housing Flange to Bearing Snap Ring Face	1.826/1.828
Seal Housing Pilot Diameter	5.500/5.499
Seal Housing Flange Inner Face to Bearing Shoulder	1.599/1.597
FITS	
Rotor Bearing Inner Race to Shaft — Inlet	.0004T/.0013T
Discharge	.0001T/.0010T
Rotor Bearing Outer Race to Bore — Inlet	.0005T/.0011L
Discharge	.0000 /.0011L
Drive or Driven Gear to Shaft	.0005T/.0015T
Drive Shaft to Coupling	.000/.002L
Drive Shaft Outer Bearing — Inner Race to Shaft	.0005T/.0016T
Outer Race to Housing	.0002T/.0013L
Drive Shaft Inner Bearing — Inner Race to Shaft	.0009T/.0013T
Outer Race to Housing	.0006T/.0006L
Seal Housing Pilot to Bearing Housing	.001L/.003L
Bearing Housing Pilot to Gear Case	.001L/.003L
RUNNING CLEARANCES	
Rotor to Cylinder — Diametral — Main & Secondary	.005/.009
End Plate to Rotor — Axial — Inlet	.013/.022
Discharge	.002/.003
Air Seal — Diametral — Inlet	.013/.015
Discharge	.004/.006
Gear Backlash	.003/.005
Drive Shaft End Play	.005/.031

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