GARDNER DENVER®

13–13–600
1st Edition
January, 1998

ELECTRA–SAVER®

TWO–STAGE

STATIONARY BASE–MOUNTED

COMPRESSOR

AUTO SENTRY®–ES+ CONTROLS

MODEL

ETY99A – 350 HP – 500 HP

OPERATING AND SERVICE MANUAL

Gardner Denver

MAINTAIN COMPRESSOR RELIABILITY AND PERFORMANCE WITH GENUINE GARDNER DENVER COMPRESSOR PARTS AND SUPPORT SERVICES

Gardner Denver Compressor genuine parts, engineered to original tolerances, are designed for optimum dependability —— specifically for Gardner Denver compressor systems. Design and material innovations are the result of years of experience with hundreds of different compressor applications. Reliability in materials and quality assurance are incorporated in our genuine replacement parts.

Your authorized Gardner Denver Compressor distributor offers all the backup you'll need. A worldwide network of authorized distributors provides the finest product support in the air compressor industry.Your local authorized distributor maintains a large inventory of genuine parts and he is backed up for emergency parts by direct access to the Gardner Denver Machinery Inc. Master Distribution Center (MDC) in Memphis, Tennessee.

Your authorized distributor can support your Gardner Denver air compressor with these services:

1. Trained parts specialists to assist you in selecting the correct replacement parts.
2. Factory warranted new and remanufactured rotary screw air ends. Most popular model remanufactured air ends are maintained in stock at MDC for purchase on an exchange basis with liberal core credit available for the replacement unit.
3. A full line of factory tested AEON™ compressor lubricants specifically formulated for use in Gardner Denver compressors.
4. Repair and maintenance kits designed with the necessary parts to simplify servicing your compressor.

Authorized distributor service technicians are factory–trained and skilled in compressor maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair services.

For the location of your local authorized Gardner Denver Air Compressor distributor refer to the yellow pages of your phone directory or contact:

Distribution Center:
Gardner Denver Machinery Inc.
Master Distribution Center
5585 East Shelby Drive
Memphis, TN 38141
Phone: (901) 542–6100
(800) 245–4946
Fax: (901) 542–6159

Factory:
Gardner Denver Machinery Inc.
1800 Gardner Expressway
Quincy, IL 62301
Phone: (217) 222–5400
Fax: (217) 224–7814

REMANUFACTURED AIR ENDS

Whenever an air end requires replacement or repair, Gardner Denver offers an industry unique, factory remanufactured air end exchange program. From its modern Remanufacturing Center in Indianapolis, IN, Gardner Denver is committed to supplying you with the highest quality, factory remanufactured air ends that are guaranteed to save you time, aggravation and money.

Immediately Available

Repair downtime costs you money, which is why there are over 200 remanufactured units in inventory at all times, ready for immediate delivery.

Skilled Craftsmen

Our Remanufacturing assembly technicians average over 20 years experience with air compression products.

Precision Remanufacturing

All potentially usable parts are thoroughly cleaned, inspected and analyzed. Only those parts that can be brought back to original factory specifications are remanufactured. Every remanufactured air end receives a new overhaul kit: bearings, gears, seals, sleeves and gaskets.

Extensive Testing

Gardner Denver performs testing that repair houses just don't do. Magnaflux and ultrasonic inspection spot cracked or stressed castings, monochromatic light analysis exposes oil leaks, and coordinate measurement machine inspects to +/– .0001", insuring that all remanufactured air ends meet factory performance specifications.

Warranty

Gardner Denver backs up every remanufactured air end with a new warranty . . . 18 months from purchase, 12 months from service.

Gardner Denver remanufactured air ends deliver *quality without question . . . year in and year out.*

Call Gardner Denver for information on the air end exchange program and the name of your authorized distributor.

Phone Number: 800–245–4946 or
FAX: 901–542–6159

FOREWORD

Gardner Denver Rotary 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 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.

DANGER

Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

WARNING

Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

CAUTION

Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTICE

Notice is used to notify people of installation, operation or maintenance information which is important but not hazard–related.

This book covers the following models:

HP	PSIG	Air Cooled	Water Cooled	Parts List	Controller Manual
350	100 & 125	ETY99A	ETY99A	13–13–500	13–9/10–647
400	100, 125, 150	ETY99A	ETY99A	13–13–500	13–9/10–647
500	100, 125, 150	ETY99A	ETY99A	13–13–500	13–9/10–647

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INSTRUCTIONS FOR ORDERING REPAIR PARTS

When ordering parts, specify Compressor MODEL, Method of Cooling, HORSEPOWER and SERIAL NUMBER (see nameplate on unit). The Serial Number is also stamped on top of the cylinder flange to the right of the inlet housing.

All orders for Parts should be placed with the nearest authorized distributor.

Where NOT specified, quantity of parts required per compressor or unit is one (1); where more than one is required per unit, quantity is indicated in parenthesis. SPECIFY EXACTLY THE NUMBER OF PARTS REQUIRED.

DO NOT ORDER BY SETS OR GROUPS.

To determine the Right Hand and Left Hand side of a compressor, stand at the motor end and look toward the compressor. Right Hand and Left Hand are indicated in parenthesis following the part name, i.e. (RH) & (LH), when appropriate.

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GENERAL INFORMATION

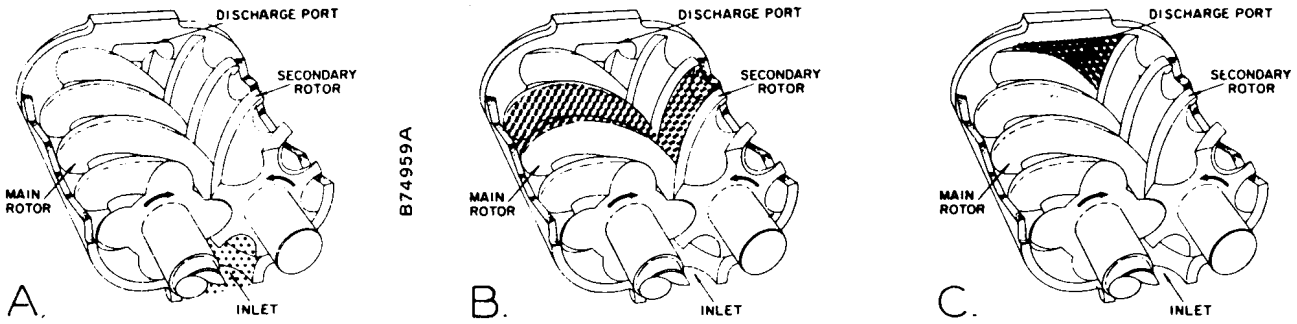


FIGURE 1–1 – COMPRESSION CYCLE

COMPRESSOR – The Gardner Denver Electra–Saver® 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 tapered roller bearings. The drive gear meshes with a driven gear mounted on the main rotor shaft to drive the rotors. Both rotors are supported between large capacity anti–friction bearings located outside the compression chamber. Single width cylindrical roller bearings are used at the inlet end of the rotors. Early models used two (2) heavy–duty, single–row, angular contact ball bearings at the discharge end to locate each rotor axially and carry all thrust loads; later models use tapered roller bearings in this location.

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 (4) helical lobes 90° apart. The secondary rotor has five (5) matching helical grooves 72° apart to allow meshing with main rotor lobes.

The air inlet port is located on top of the compressor near the center. 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 5–1, page 31) – Air enters the air filter and passes through the inlet unloader valve to the first stage compressor. After first stage compression, the air/oil mixture passes through the interstage manifold where coolant is injected. The air/oil mixture then is compressed to the final discharge pressure in the second stage 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 the first stage compressor. The air passes through the reservoir discharge manifold, minimum pressure/discharge check valve, and the customer furnished unit shutoff valve if aftercooled. If water cooled, the aftercooler and moisture separator are between the minimum pressure/discharge check valve and the customer supplied shutoff valve.

LUBRICATION, COOLING AND SEALING – Oil is forced by air pressure from the oil reservoir through the oil cooler, thermostatic mixing valve/oil filter assembly and is piped to the first stage compressor, second stage compressor and the interstage manifold. A portion of the oil to the compressors is directed through internal passages to the bearings, gears and shaft oil seals. The balance of the oil is injected directly into the

compression chamber to remove heat of compression, seal internal clearances and lubricate the rotors.

TURN VALVE – The turn valve is a rotary helical valve located on the discharge side of the cylinder toward the inlet end. The valve opens and closes ports in the cylinder which communicates with the inlet passage. This varies the compressor rotor volume to match the demand for air, thus reducing the part–load power requirement.

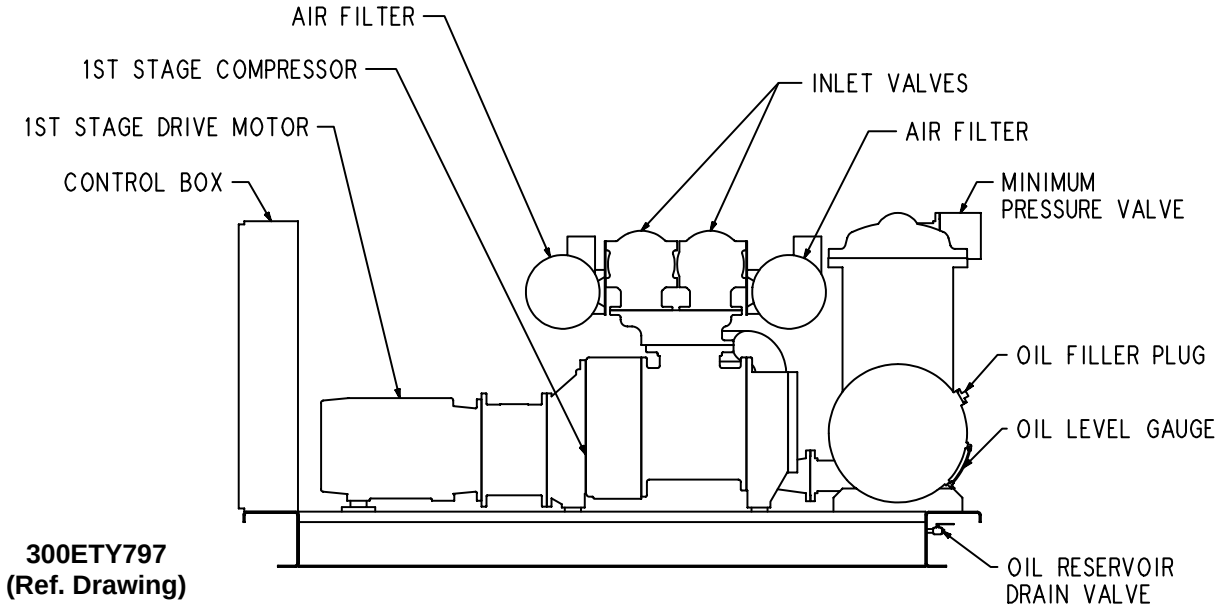


FIGURE 1–2 – AIR COOLED UNIT – LESS ENCLOSURE – 1ST STAGE COMPRESSOR SIDE

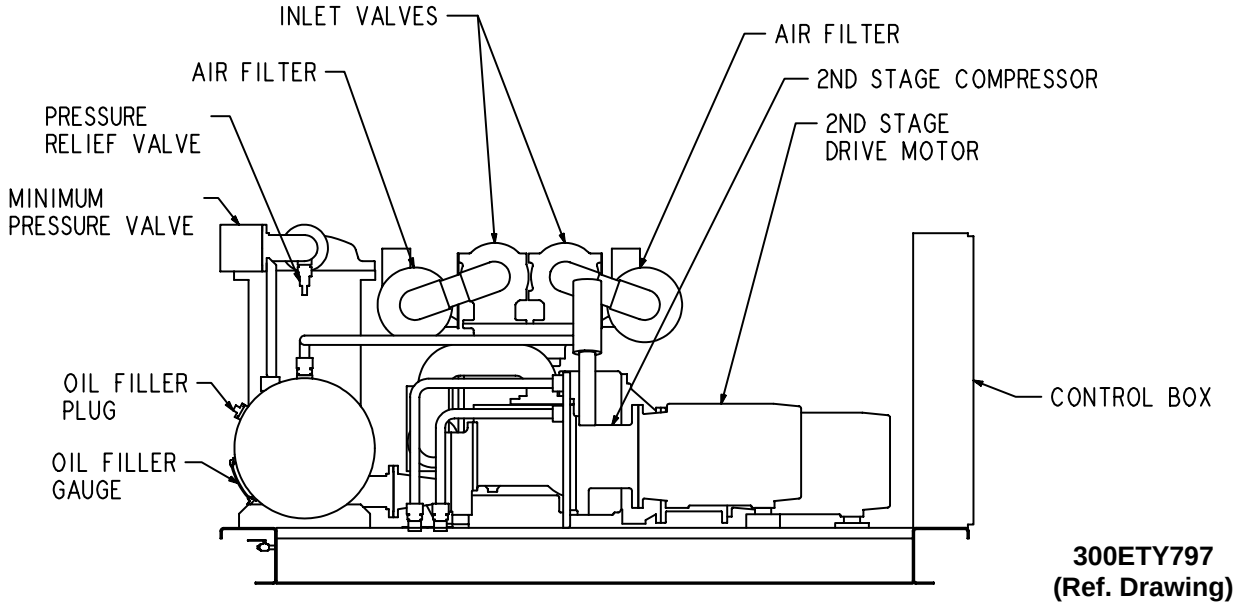
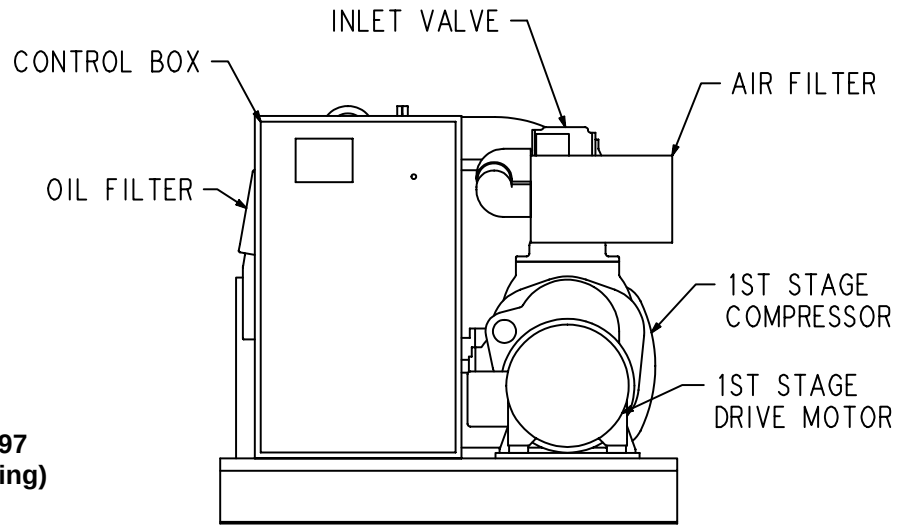


FIGURE 1–3 – AIR COOLED UNIT – LESS ENCLOSURE – 2ND STAGE COMPRESSOR SIDE



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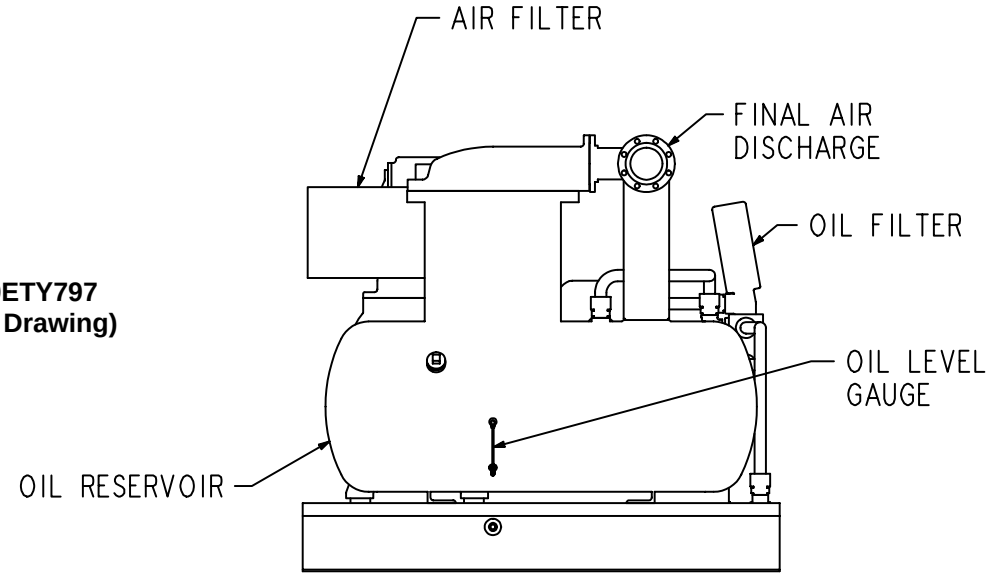
(Ref. Drawing)

FIGURE 1–4 – AIR COOLED UNIT – LESS ENCLOSURE – CONTROL BOX END



300ETY797
(Ref. Drawing)

FIGURE 1–5 – AIR COOLED UNIT – LESS ENCLOSURE – OIL RESERVOIR END

SAFETY PRECAUTIONS

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious.

Some general safety precautions are given below:

⚠ DANGER

Failure to observe these notices could result in injury to or death of personnel.

- **<u>Keep fingers and clothing away</u> from revolving fan, drive coupling, etc.**
- **<u>Do not use the air discharge</u> from this unit for breathing – not suitable for human consumption.**
- **<u>Do not loosen or remove</u> the oil filler plug, drain plugs, covers, the thermostatic mixing valve or break any connections, etc., in the compressor air or oil system until the unit is shut down and the air pressure has been relieved.**
- **<u>Electrical shock</u> can and may be fatal.**
- **<u>Compressor unit must be grounded</u> in accordance with the National Electrical Code. A ground jumper equal to the size of the equipment ground conductor must be used to connect the compressor motor base to the unit base.**
- **<u>Fan motors must remain grounded</u> to the main base through the starter mounting panel in accordance with the National Electrical Code.**
- **<u>Open main disconnect switch</u>, tag and lockout before working on the control.**
- **<u>Disconnect the compressor</u> unit from its power source, tag and lockout before working on the unit – this machine is automatically controlled and may start at any time.**

⚠ WARNING

Failure to observe these notices could result in damage to equipment.

- **<u>Stop the unit</u> if any repairs or adjustments on or around the compressor are required.**
- **<u>Disconnect the compressor</u> unit from its power source, tag and lockout before working on the unit – this machine is automatically controlled and may start at any time.**
- **<u>An Excess Flow Valve</u> should be on all compressed air supply hoses exceeding 1/2 inch inside diameter. (OSHA Regulation, Section 1926.302)**
- **<u>Do not exceed the rated maximum pressure values</u> shown on the nameplate.**
- **<u>Do not operate unit</u> if safety devices are not operating properly. Check periodically. Never bypass safety devices.**

DECALS

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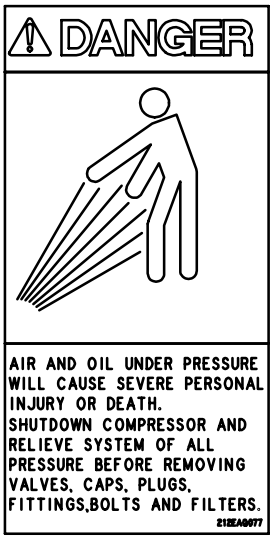

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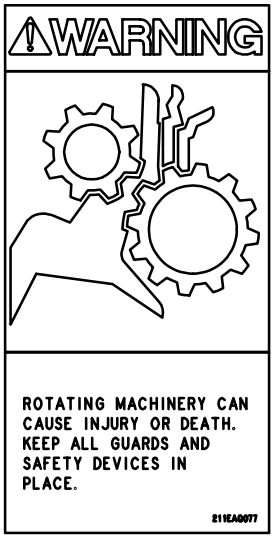

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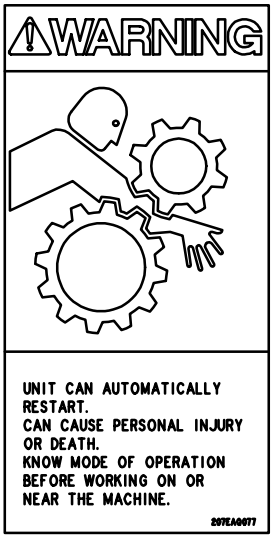

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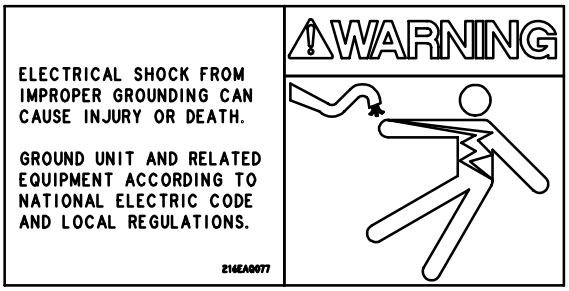

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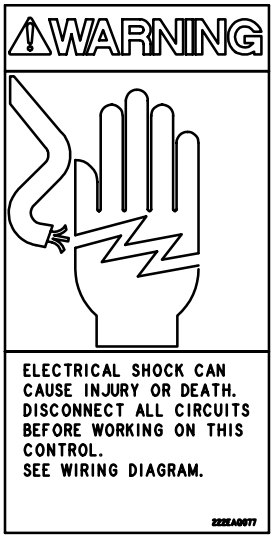

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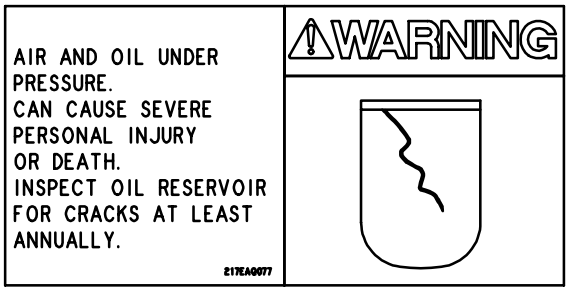

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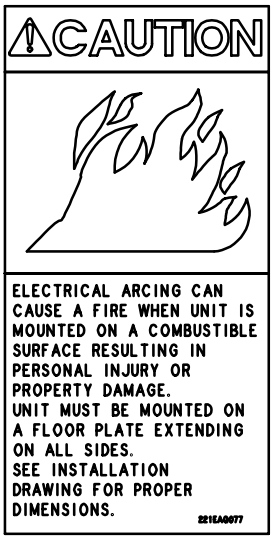

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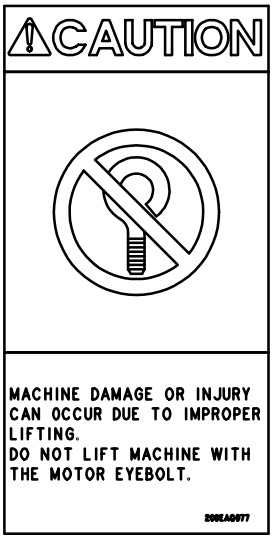

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SECTION 2
INSTALLATION

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.

⚠ CAUTION

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

LIFTING UNIT:

⚠ CAUTION

Lift compressor unit by base only. Do not use other places such as motor, compressor or discharge manifold piping as lifting points.

⚠ DANGER

The eyebolts or lugs provided on the motor are for lifting the motor only and should not be used to lift any additional weight. All eyebolts must be securely tightened. When lifting the motor the lifting angle must not exceed 15 degrees. Failure to observe this warning may result in damage to equipment or personal injury.

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

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

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

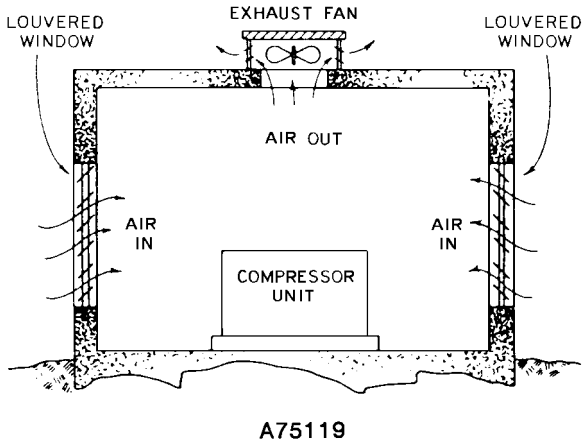


FIGURE 2–1 – TYPICAL COMPRESSOR ROOM

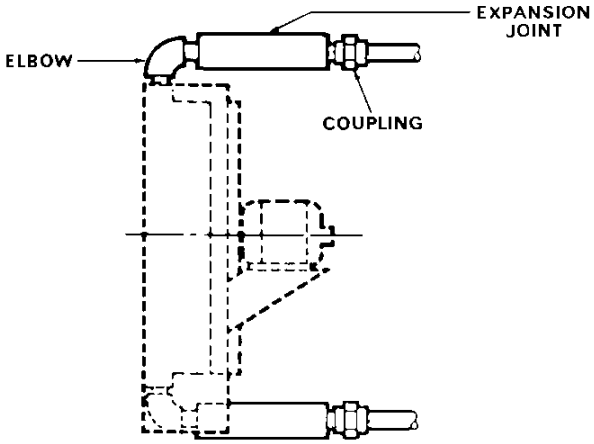
If the air–cooled oil cooler module is to be installed at a location remote from the compressor unit, be sure that adequate ventilation is provided, FIGURE 2–2. Hot air must be exhausted from the oil cooler area.

Do not block the air flow to and from the unit. Allow 3–1/2 feet to the nearest obstruction on the control box

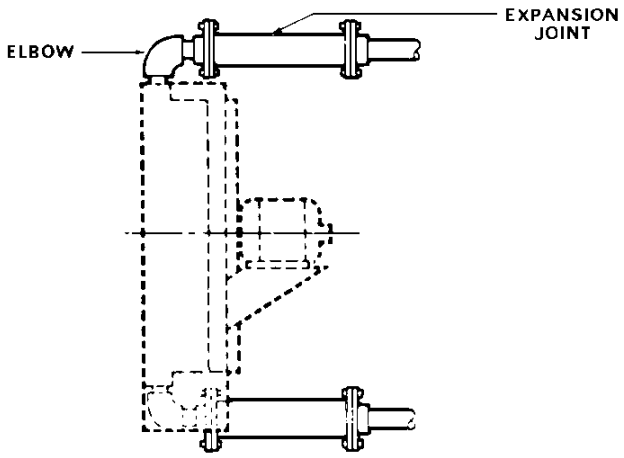
Size	Open Compressor Unit	Aftercooler and Oil Cooler Module	Open Unit With Aftercooler & Oil Cooler Module Discharge in Same Room
350 HP	12,600	43,000	55,600
400 HP	14,400	43,000	57,400
500 HP	18,000	43,000	61,000

* 80° F Inlet Air

FIGURE 2–2 – AIR FLOW CHART



PIPING SCHEMATIC OF COOLER WITH SCREWED CONNECTIONS.



PIPING SCHEMATIC OF COOLER WITH FLANGED CONNECTIONS.

FIGURE 2–3 – PIPING SCHEMATIC

side of the unit and 3 feet on all other sides.

VENTILATION – The unit, whether air– or water–cooled, requires sufficient air flow, FIGURE 2–2, for electric motor cooling. Air is drawn into the back and front of the motor and is discharged out the sides. Do not block air flow to and from the unit.

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

Mounting bolts are not normally required. However, installation conditions such as piping rigidity, angle of tilt, or danger of shifting from outside vibrations or moving vehicles may require the use of mounting bolts to the foundation.

OIL RESERVOIR DRAIN – (FIGURE 1–5, page 3) The oil reservoir drain valve is located near the center of the oil reservoir just below the separator tower. The drain valve is approximately 5 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 a suitable structure 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–Saver® unit is furnished with an acoustic enclosure over the compressor only, as standard equipment. The enclosure reduces the normal operating sound of the unit to 90 DBA or below in free field conditions.

AIR–COOLED OIL COOLER MODULE – The air–cooled oil cooler is a separate module and may be mounted remote to the compressor unit.

Ventilation – The oil cooler requires adequate cooling air flow. Proper ventilation MUST be provided, with hot air exhausted away from the cooler; take care that hot air is not recirculated form the exhaust to the inlet side of the cooler. Cooling air flow direction is from the motor side through the grille side of the oil cooler. Do not obstruct the air flow to or from the cooler. Allow two (2) feet clearance on all sides of the cooler module. See FIGURE 2–2, page 8, for cooling air flow requirements.

Low Oil Pressure Protection – The standard factory–installed low oil pressure shutdown switch in the control box will prevent start–up or shut the unit down if oil pressure is not established or maintained due to malfunction in the oil cooler system.

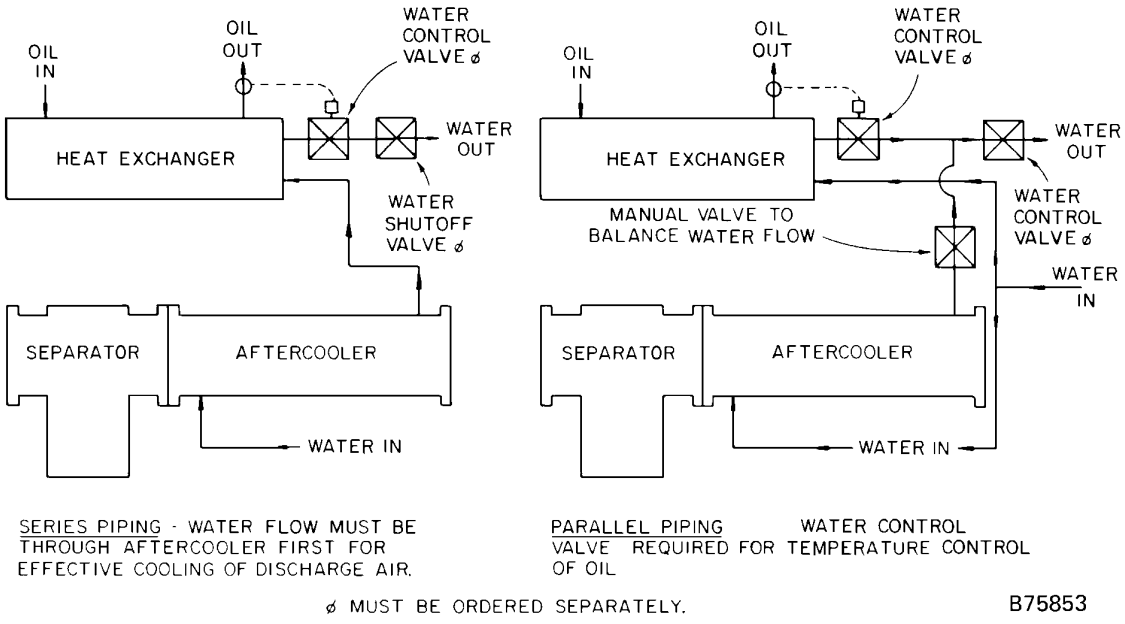


FIGURE 2–4 – PIPING DIAGRAM FOR AFTERCOOLER AND HEAT EXCHANGER

NOTICE

Remote mounted elevated coolers have a maximum pipe length of 30 feet (9 M) (each way) and a maximum height of 20 feet (6 M) with a minimum of fittings. Engineering will review all remote elevated cooler applications and recommend pipe size on an individual basis. Customer Service should include the engineering recommendation in the special order sent to Engineering.

Oil Cooler – Location and General Piping – The oil cooler module can be mounted in any of several remote locations:

- Close coupled but not joined to the compressor unit
- Horizontal remote, located on the same level as the compressor unit, but some distance away
- Overhead remote, located above level of the compressor unit, as on a roof.

⚠ WARNING

The machine cannot be run blown down with remote overhead oil cooler. These units require special wiring diagram – check with factory. Running the machine blown down with an overhead cooler could result in damage to compressor.

NOTICE

All requirements of local codes should be followed.

All piping and wiring between the compressor unit and the remote oil cooler is to be supplied by the user. **THE DESIGN OF THE REMOTE OIL COOLER MODULE SYSTEM MUST BE APPROVED BY THE FACTORY BEFORE INSTALLATION.** The design information to be submitted for approval includes:

1. Location of oil cooler module – inside or outdoors.
2. Range of operating ambient temperatures at the oil cooler location.

3. Elevation of the oil cooler above the compressor unit.
4. Pipe type and size(s) to be used to connect the oil cooler and the compressor unit. Minimum pipe size is 2–1/2" NPT.
5. Horizontal and vertical lengths of the pipe run. If more than one pipe size is used, list length of each size and total length.
6. Number and size of elbows, tees, unions, reducers, and valves to be used in the pipe run.
7. A dimensional sketch of the proposed piping system showing location of the compressor unit, oil cooler, pipe, and fittings illustrating design information included in numbers 3 through 6 above.

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

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

When the oil cooler is mounted above the compressor unit, a check valve is to be mounted on the compressor unit in the line to the oil cooler; see FIGURE 5–3, page 34. A pneumatic pilot–operated normally–closed valve (oil stop valve) is to be mounted at the oil filter inlet on the compressor unit line from the oil cooler. The check valve permits oil flow to the oil cooler during operation, but prevents return oil flow from the cooler when the unit is shut down. The pilot valve is held open by air pressure from the unit oil reservoir during operation and closes under spring load when the unit is shut down to prevent return oil flow from the oil cooler. A different control group will be assembled onto the package to control the oil stop valve and to prevent the compressor package from running in low demand mode. Failure to install these parts could result in high oil carryover and could cause the machine to shut down on high temperature.

An oil filler stand pipe and plug must be located in the piping on the oil cooler module for ease of filling of a remote oil cooler, see FIGURE 5–2, page 32.

Oil Cooler – Installation – Inspect unit upon arrival. In case of damage, report immediately to transportation company. Before installation, check rating plate on motor to verify that power input and motor specification

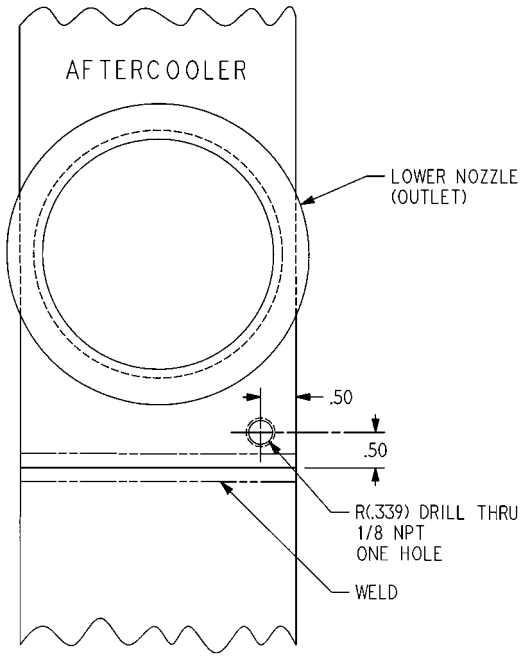


FIGURE 2–5 – COOLER DRAIN DETAIL

requirements match available electric power at point of installation.

1. Set the unit level on a firm, solid foundation. The larger oil cooler models have lifting holes to facilitate unit hoisting.
2. Allow for linear expansion and contraction of piping in the direction away from the oil cooler. Use flexible connectors or suitable expansion joints on all oil cooler inlet and outlet piping. See FIGURE 2–3, page 9, for typical schematics.
3. Select properly tensioned and aligned piping support clamps or hangers and position them to relieve any piping stress at the oil cooler inlet and outlet ports. Do not support from flexible connectors.
4. Service – For continuous efficiency, oil cooler cores must be periodically cleaned with either vacuum or compressed air. If wet cleaning is required, shield motor and spray on a mild soap solution and flush with clear water.

AUXILIARY AIR RECEIVER – The unit requires 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.

AFTERCOOLER (FIGURE 1–2 and FIGURE 1–5, pages 2 and 3) – An aftercooler will provide control of moisture entering the shop air lines while reducing the

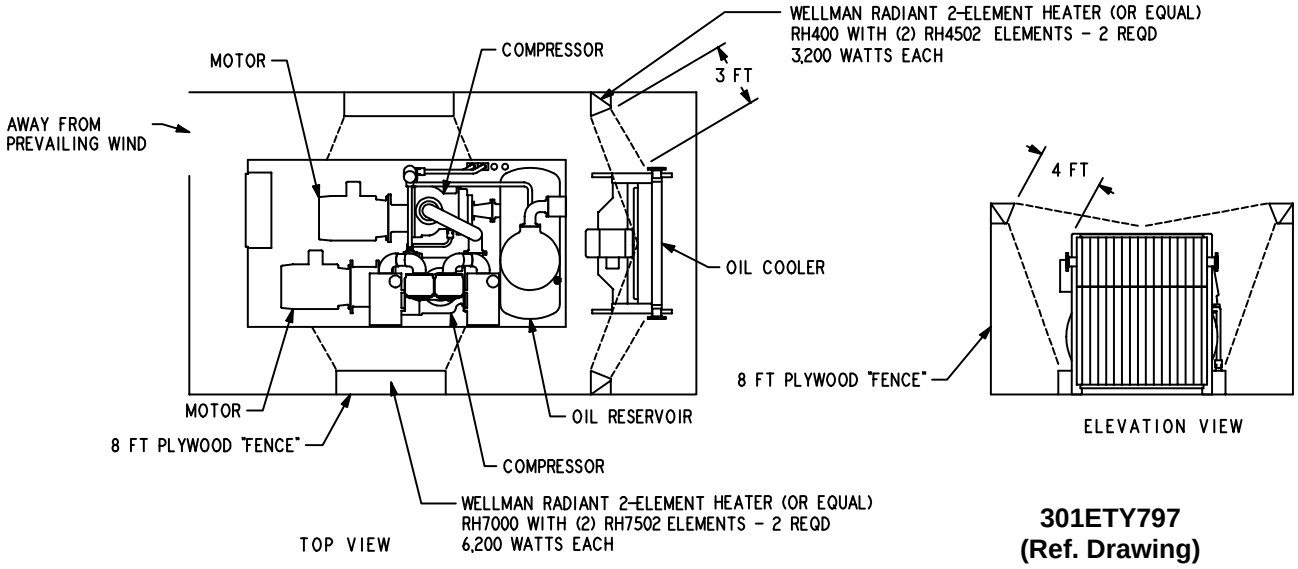


FIGURE 2–6 – COLD WEATHER INSTALLATION

normal low discharge temperature of about 180° F at 100 PSIG discharge pressure to near inlet air temperature, or cooling water temperature.

Air–Cooled Machines – When an aftercooler is furnished on an air–cooled machine, the aftercooler is installed on the oil cooler module between the fan and the oil cooler. The moisture separator is furnished by Gardner Denver but must be mounted by the customer between the aftercooler and the auxiliary air receiver with a condensate drain provided at the bottom. All air piping from the compressor discharge to aftercooler to auxiliary air receiver is to be furnished and mounted by customer. **The design of the aftercooler piping must be approved by the factory before installation.** Design information to be submitted for approval includes:

⚠ WARNING

Failure to remove condensate from an idle cooler in freezing temperatures will cause permanent cooler damage. Drain condensate after system shutdown. It is the owner/operator's responsibility to ensure that condensate has been drained and cooler dried out to prevent cooler damage.

1. Location of aftercooler module – inside or outdoors.
2. Range of operating ambient temperatures at the aftercooler location.
3. Pipe type and size(s) to be used to connect the aftercooler, separator, and compressor unit – minimum pipe size is 5" NPT.
4. Lengths of the pipe run. If more than one pipe size is used, list length of each size and total length.
5. Number and size of elbows, tees, unions, reducers, and valves to be used in the pipe run.
6. A dimensional sketch of the proposed piping system showing location of the compressor unit, aftercooler, separator and auxiliary air receiver, pipe and fittings illustrating design information included in numbers 3 through 5 above.

Water–Cooled Machines (FIGURE 2–4, page 10) – On water–cooled machines with aftercooler, the moisture separator and condensate drain are shipped loose and must be installed by customer. Customer must furnish and install all water piping required.

INSTALLATION FOR COLD WEATHER OPERATION – It is recommended that the unit be installed inside a shelter that will be heated to temperatures above freezing (32°F, 0°C). This will eliminate many of the problems associated with operating units in cold climates where freezing rain, drifting snow, freezing condensate and bitter cold temperatures are encountered.

Refer to Engineering Data Sheet 13–9–411 for the advantages of using the heat recovered from rotary compressors. This heat recovery could easily pay for an adequate shelter for the unit.

When an outside installation must be made, the precautions required will depend on the severity of the en-

vironment. The following are general guidelines for outside installations:

Cold Weather (Down To +10°F)

1. Be sure all drains, traps, and control lines, including pressure transducer lines are heated to avoid freezing of condensate. Heat tape with thermostat control is generally satisfactory for this purpose and can be obtained at various local plumbing or hardware outlets at nominal cost.
2. If an air–cooled aftercooler is to be used, provisions to bypass the aftercooler must be made. Since cold air contains very little moisture, successful operation can be achieved without the aftercooler. Successful operation down to +15° F can be accomplished by reversing fan flow, but cooler bypass should still be provided should it be required.
3. Provide at least some simple shelter such as a plywood windbreak to protect against drifting snow.
4. Use only Gardner Denver® AEON™ 9000 SP lubricant.
5. Monitor the unit carefully during start–up and operation to be sure it is functioning normally.
6. Specify NEMA 4 enclosure for electrical devices.

Extreme Cold Weather Operation (Down To –40°F, –40°C**) –** In addition to the above, the following should be provided:

1. A temperature switch to control the fan should be provided for better starting and quicker warm–up. This switch can be provided from the factory and will delay fan start–up until discharge temperature reaches approximately 150–160° F.
2. It will probably be necessary to provide shutters or to block off part of the cooler in some manner since the cooler is greatly oversized for operation in these low temperatures. Shutters are not a factory option.
3. Auto operation should not be used in extreme environments.
4. Coolers should be located as close to the unit as possible. Long lines to and from the cooler only further complicate the circulation of oil flow on cold starts. Heat tape and insulation may be required on oil lines.
5. Some means of providing heat to the oil reservoir and cooler during shutdown should be provided. There are various methods to accomplish this, but since openings are not provided for sump heaters, the use of radiant heaters is recommended. The heaters should be sized to provide at least a +10°F environment for coolers, motor and sump. FIGURE 2–6, page 12, shows how these might be located in a typical installation and sizes required.

Remember unsheltered (outside) installations should be avoided where possible. Installation next to a heated building where enough heat can be used to keep the compressor room above freezing will save many complications in the operation and installation of the unit.

MOISTURE SEPARATOR/TRAP – Since the unit is equipped with a built–in aftercooler, a combination moisture separator and trap is furnished with the unit. A means of draining condensate will need to be provided for.

INLET LINE – Where an inlet line is used between the air filter and the compressor, it must be thoroughly cleaned on the inside to prevent dirt or scale from entering the compressor. **If welded construction is used, the line must be shot blasted and cleaned to remove welding scale.** In either case, the inlet line must be coated internally by galvanizing or painting with a moisture and oil–proof sealing lacquer. The inlet line should be the full size of the inlet opening on the compressor. If an extra–long line is necessary, the pipe size should be increased according to Inlet Line Length Chart, FIGURE 2–7.

Accessibility 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 on water–cooled units with aftercooler is made at the moisture separator. On air–cooled units and water–cooled without aftercooler, the connection is made at the pipe nipple located behind the instrument panel. When manifolding two or more Electra–

Length of Inlet Line	Diameter of Pipe Size
0 to 10 Feet	Same as Compressor Inlet Opening
10 to 17 Feet	One Size Larger Than Inlet Opening
17 to 38 Feet	Two Sizes Larger Than Inlet Opening

FIGURE 2–7 – INLET LINE LENGTHS

HEAT EXCHANGER							
Size	Rated Pressure PSIG	Water Temperature to Heat Exchanger Gallons/minute				Maximum Water Flow GPM	Approximate Water Pressure Drop @ Maximum Flow (PSI)
		60° F.	70° F.	80° F.	90° F.		
350 HP	ALL	32	40	54	81	118	10
400 HP	ALL	38	47	63	95	118	10
500 HP	ALL	46	58	77	115	118	11

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

FIGURE 2–8 – HEAT EXCHANGER (OIL COOLER) APPROXIMATE WATER FLOW

AFTERCOOLER							
Size	Rated Pressure PSIG	Water Temperature to Aftercooler Gallons/minute				Maximum Water Flow GPM	Approximate Water Pressure Drop @ Maximum Flow (PSI)
		60° F.	70° F.	80° F.	90° F.		
350 HP	ALL	5	6	9	13	70	5
400 HP	ALL	6	8	10	15	70	5
500 HP	ALL	7	9	12	18	70	5

Water flow rates (gpm) are based on 100° F water temperature out of cooler. Maximum water flow shown is the maximum allowable flow through aftercooler.

FIGURE 2–9 – AFTERCOOLER APPROXIMATE WATER FLOW

Saver® units on the same line, each unit is isolated by the check valve in the unit discharge line.

If an Electra–Saver® unit is manifolded to another compressor, be sure the other compressor has a check valve in the line between the machine and the manifold.

If an Electra–Saver® and a reciprocating compressor are manifolded together, an air receiver must be located between the two units.

⚠ DANGER

Discharge air used for breathing will cause severe injury or death.

Consult filtration specialists for additional filtration and treatment equipment to meet health and safety standards.

WATER PIPING (Water–Cooled Heat Exchanger Models Only) – On machines equipped with water–cooled heat exchangers, the water inlet and outlet connections are located in the unit base flange on the left side of the unit, when facing the control box.

⚠ WARNING

It is mandatory that any water cooled unit be installed in a shelter heated to temperatures above freezing (32° F., 0° C).

The water source should be capable of supplying up to the maximum flow shown in FIGURE 2–7, page 13, and FIGURE 2–8, page 14, at a minimum pressure of 40 PSIG; maximum allowable water pressure is 150 PSIG. The water flow rates shown in FIGURE 2–7, page 13, are approximate and a guide to sizing piping, cooling tower and other water system equipment.

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

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

Aftercooler – Heat Exchanger Water Piping (FIGURE 2–4, page 10, and FIGURE 2–7, page 13, and FIGURE 2–8, page 14) – If an aftercooler is used and piped in series with the heat exchanger, install the water flow control valve and magnetic water shutoff valve, if used, downstream of the exchanger. Pipe the aftercooler water outlet to the heat exchanger water inlet on the compressor unit.

If the aftercooler is piped in parallel with the heat exchanger, provide a manual valve between aftercooler outlet and heat exchanger outlet after the water control valve to adjust aftercooler water flow for discharge temperature required and most economical water use; separate water inlet lines are piped to the aftercooler and heat exchanger.

If the standard factory built–in aftercooler is used, the maximum allowable water flow through the aftercooler is 70 gallons per minute on all 350 – 500 HP units. Minimum water pressure is 40 PSIG. Maximum water pressure is 150 PSIG. If another aftercooler is used, consult the manufacturer for operating limits.

⚠ CAUTION

When an aftercooler is piped in series with the oil cooler, the maximum allowable flow rate through the oil/aftercooler system is the maximum allowed by the aftercooler. If the oil cooler requires more water flow than the maximum allowed by the aftercooler, a parallel water piping system must be used.

The water control valve MUST be used to maintain discharge temperatures approximately 10° F. over the dew point for expected ambient (FIGURE 5–5, page 38). See Section 5 for adjustment instructions and maximum allowable oil temperature.

ELECTRICAL WIRING – Standard Units – The compressor package is factory wired for all connections from the starters to the two motors, for the horsepowers and voltage specified on the order. The standard unit is supplied with open drip proof motors, and a NEMA12 starter and controls enclosure. Totally enclosed motors and NEMA4 enclosures are available as factory options. See "Location," page 8, for distance

Volts	#1 HP	#2 HP	Minimum Ampacity	Maximum Fuse	Maximum Breaker
460	300	250	753	1000	1200
460	300	200	691	1000	1200
460	300	150	631	800	1200
460	250	200	618	800	1000
460	250	150	558	800	1000
460	200	200	540	700	800
460	200	150	480	700	800
575	300	250	603	800	1000
575	300	200	553	800	1000
575	300	150	505	700	1000
575	250	200	495	700	800
575	250	150	447	600	800
575	200	200	432	600	700
575	200	150	384	500	700

FIGURE 2–10 – AMPACITY, FUSE AND BREAKER SIZE

to the nearest obstruction on the control box side of the package.

Perform all wiring in accordance with the National Electrical Code (NFPA–70) and any applicable local electrical codes. Wiring must be performed only by qualified electricians.

The electrical design for supplying power to the package intends that the two main motors are considered a group installation. FIGURE 2–10, page 15, lists minimum ampacity of wiring to the package. The table also lists maximum sizes for dual–element fuses or inverse time breakers which may be used for short–circuit and ground fault protection.

The controls circuits and ventilation fans (if so equipped) are provided with fusing to provide short–circuit and ground fault protection.

For aircooled units, refer to manual 13–9/10–647 for instructions regarding connection to a remote cooling module. The package wiring diagram shows details of the controls interconnections.

Units are also available optionally without package–mounted starters. For these packages, a motor starter must be provided for each motor, and a four–wire controls interconnection must be made between the compressor package and each starter. Refer to manual 13–9/10–647 for detailed instructions and starter requirements, and to the package wiring diagram for specific interconnection information.

⚠ WARNING

Electrical shock can cause injury or death. Open main disconnect switch, tag and lockout before working on starter/control box.

GROUNDING – Equipment must be grounded in accordance with Section 250–95 of the National Electrical Code.

⚠ WARNING

Failure to properly ground the compressor package could result in controller malfunction.

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

1. Stop the unit.
2. Disconnect, tag and lockout the unit from the power supply.
3. Remove the relief plug and free hole of hardened grease.
4. Wipe lubrication fitting clean and add grease with a hand–operated grease gun.

   The amount and type of grease added is very important. Only enough grease should be added to replace the grease used by the bearing. Too much grease can be as harmful as insufficient grease. The grease cavity should be filled 1/3 to 1/2 full.
5. Leave the relief plug temporarily off. Reconnect the unit and run for about 20 minutes to expel the excess grease.
6. Stop the unit. Replace the relief plug.
7. Restart the unit.

⚠ WARNING

Rotating machinery can cause injury or death. Open main disconnect, tag and lockout power supply to the starter before working on the electric motor.

ELECTRIC MOTOR GREASE RECOMMENDATIONS (–30° to 50° C)

MANUFACTURER	TRADE NAME
CHEVRON	SRI #2
SHELL	DOLIUM R
EXXON	UNIREX #2
EXXON	POLYREX

ELECTRIC MOTOR REGREASING INTERVAL

Type of Service	Typical Examples	Rating	Relubrication Interval
Standard	One– or Two–Shift Operation	Above 150 HP	12 Months
Severe	Continuous Operation	Above 150 HP	6 Months
Very Severe	Dirty Locations, High Ambient Temperature	Above 150 HP	2 Months

SECTION 3
STARTING & OPERATING PROCEDURES

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

1. **Compressor Oil** – Check the oil level in the reservoir. Add oil only if the oil level gauge reads in the red "ADD OIL" range. Do not mix different type oils. The unit is shipped filled with Gardner Denver AEON™ 9000 SP Lubricating Coolant which is suitable for the first 8000 hours under normal operating conditions.

   REPLACE OIL FILTER EVERY 1000 HOURS.

   Initial fill, or filling after a complete draining of the system, may show the oil level in the yellow "EXCESS OIL" range. After start–up, the oil will fall into the green operating range as system components are filled. If necessary, add oil to bring the level to the top of the green range as read when the unit is operating at full load and normal pressure. See FIGURE 5–3, page 34.

NOTICE

Regular maintenance and replacement at required intervals of the oil filter, air filter and air–oil separator is necessary to achieve maximum service and extended drain intervals of AEON™ 9000 SP synthetic lubricant. Use only genuine Gardner Denver filters designed and specified for this compressor.

⚠ DANGER

Before removing the oil filler plug, always stop the unit and release air pressure, tag and lockout the power supply to the starter. Failure to release pressure or properly disconnect the power may result in personal injury or death.

   During unloaded operation and after shutdown, the system will partially drain back into the oil reservoir and the oil level may 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," page 42, for complete servicing instructions. Be sure the inlet line, if used, is tight and clean.
3. **Coupling** – Check all bolts and cap screws for tightness. See Section 7, page 44.
4. **Piping** – Refer to Section 2, "Installation," page 8, and make sure piping meets all recommendations.
5. **Electrical** – Check the wiring diagrams furnished with the unit to be sure it is properly wired. See FIGURE 4–11, page 29, for general wiring diagrams and Section 2, page 8 for installation instructions.
6. **Grounding** – Equipment must be properly grounded according to Table 250–95 of the National Electrical Code.

⚠ WARNING

Failure to properly ground the compressor package could result in controller malfunction.

7. **Rotation** – Check for correct motor rotation using "JOG MODE." Compressor drive shaft rotation must be clockwise standing facing the compressor coupling. Check the rotation on the fan motors. Vent fan motors should blow into the package. Air cooled cooling fan should blow through the cooler.

⚠ WARNING

Operation with incorrect motor rotation can damage equipment and cause oil eruption from the compressor inlet. When checking motor rotation, induce minimum rotation (less than one revolution if possible). Never allow motor to reach full speed.

8. **System Pressure** – Set the controls to the desired load pressure. DO NOT EXCEED THE MAXIMUM OPERATING PRESSURE ON THE COMPRESSOR NAMEPLATE. See Controller Manual 13–9/10–647 for procedure.

⚠ WARNING

Operation at excessive discharge air pressure can cause personal injury or damage to equipment. Do not adjust the full discharge air pressure above the maximum stamped on the unit nameplate.

9. **Operating Mode** – Refer to Section 4 for detailed information on the control system.
10. **Enclosure** – Check for damaged panels or doors. Check all screws and latches for tightness. Be sure doors are closed and latched.

STARTING THE UNIT – Observe the following starting procedures.

Unit Cold – If the unit is a water–cooled heat exchanger model, open any manual water inlet valves wide open. Start the unit by pushing either the “CONSTANT RUN” button or one of the “AUTO” buttons. Since the unit is equipped with a minimum (65 psig, 4.5 Bars) pressure discharge valve, no special procedure to maintain unit reservoir pressure is required.

Unit Hot – No warm–up period is required. If the unit is a water–cooled heat exchanger model, open any manual water inlet valves wide open. Start the unit by pushing either the “CONSTANT RUN” button or one of the “AUTO” buttons.

DAILY CHECK – Refer to Section 8, “Maintenance Schedule,” page 45.

STOPPING THE UNIT – Press “STOP–RESET” button. 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.

SECTION 4
CONTROLS & INSTRUMENTATION

GENERAL DESCRIPTION – The Gardner–Denver rotary screw compressor is prewired with all controls, motor, and starter for the voltage and horsepower at the time of ordering. It is necessary only to connect the compressor unit to the correct power supply and to the shop air line (and to the appropriate water supply if water cooled). A standard compressor unit consists of the compressor, oil reservoir, oil cooling system and filter, motor type as specified, NEMA 12 starter / control box, and control components as described below.

The two–stage compressor package features starter controls which start each of the motors individually. This reduces the maximum starting currents required by the package, while maintaining the robust characteristics of full–voltage starting for the individual motors.

AUTO SENTRY® OPERATION

Operation of the "AUTO SENTRY®" is dependent on selection of an operating mode from the controller keypad. Prior to starting, the STOP/RESET key must be pressed to place the controller into its READY state (as indicated on the display). Compressor operation may then be started by pressing an operating mode key.

AUTOMATIC is the most common selected mode of operation, as it automatically will operate the compressor unit in the most efficient manner for the demand of the air system.

Once operating, the mode may be changed at any time by pressing a key, and the selected mode will be displayed in the lower right corner of the message window. Press the STOP/RESET key at any time to stop the compressor under normal conditions.

Detailed instructions for the controller are found in the manual 13–9/10–647

⚠ WARNING

Automatic restarting or electrical shock can cause injury or death. Open, tag and lockout main disconnect and any other circuits before servicing the unit.

CONTROL DEVICES

Controller – This compressor unit features the "AUTO SENTRY®" controller, which integrates all the control functions under microprocessor control. Its functions include safety and shutdown, compressor regulation, operator control, and advisory / maintenance indicators. The keypad and display provide the operator with a logical and easily operated control of the compressor and indication of its condition. The controller is factory adjusted for the compressor package, but allows tuning for specific applications.

Relief Valve – A pressure relief valve(s) is (are) installed in the final discharge line and set to approximately 120–125% of the unit's full load operating pressure for protection against overpressure. Periodic checks should be made to ensure its (their) operation.

The relief valve should be tested for proper operation at least once every year. To test the relief valve, raise the system operating pressure to 75% of the relief valve set pressure and manually open the valve with the hand lever. Hold the valve open for a few seconds and allow it to snap shut.

⚠ WARNING

When the relief valve opens, a stream of high velocity air is released, resulting in a high noise level and possible discharge of accumulated dirt or other debris. Always wear eye and ear protection and stand clear of the discharge port when testing the relief valve to prevent injury.

⚠ CAUTION

Never paint, lubricate or alter a relief valve. Do not plug vent or restrict discharge.

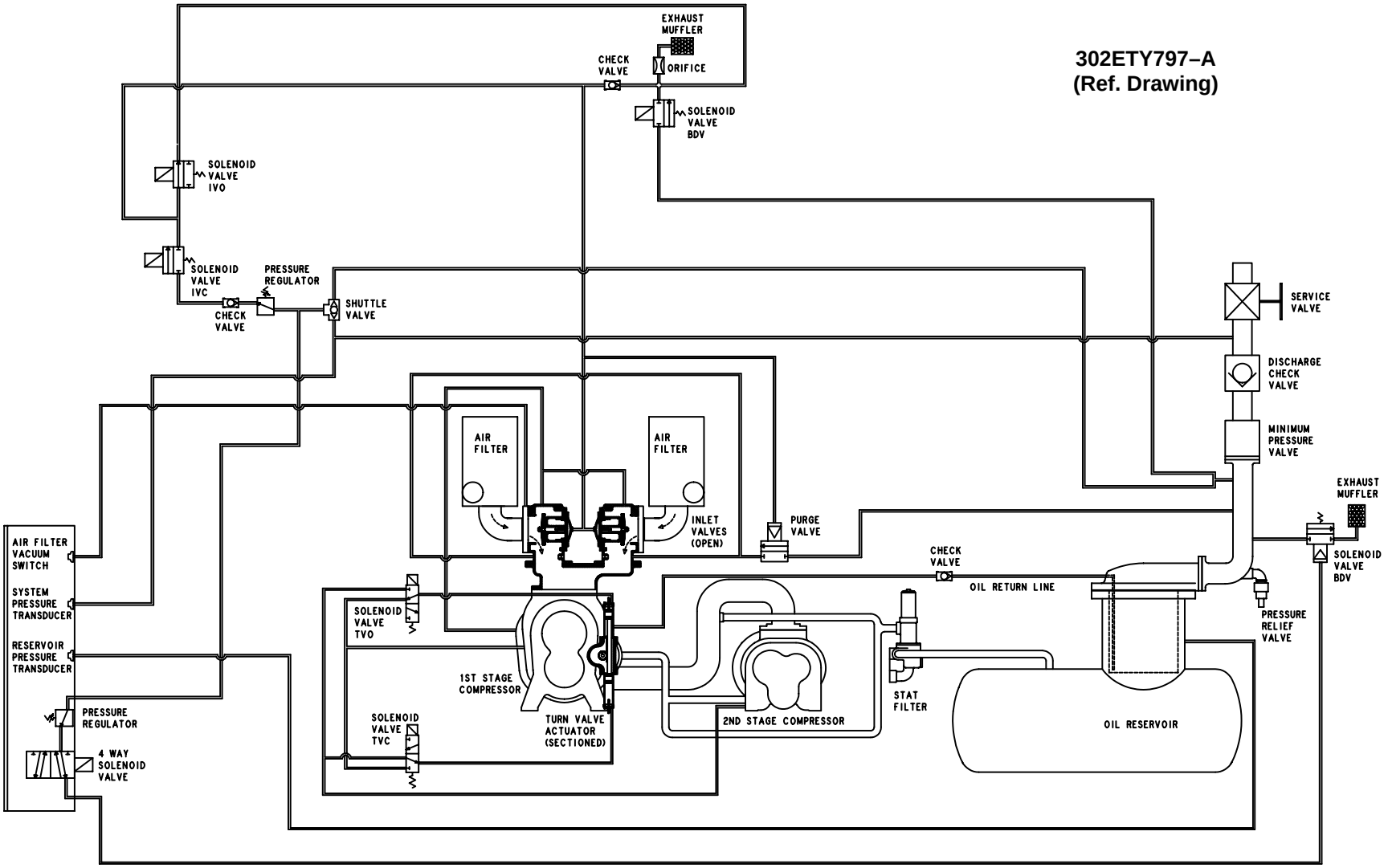


FIGURE 4–1 – SCHEMATIC TUBING DIAGRAM

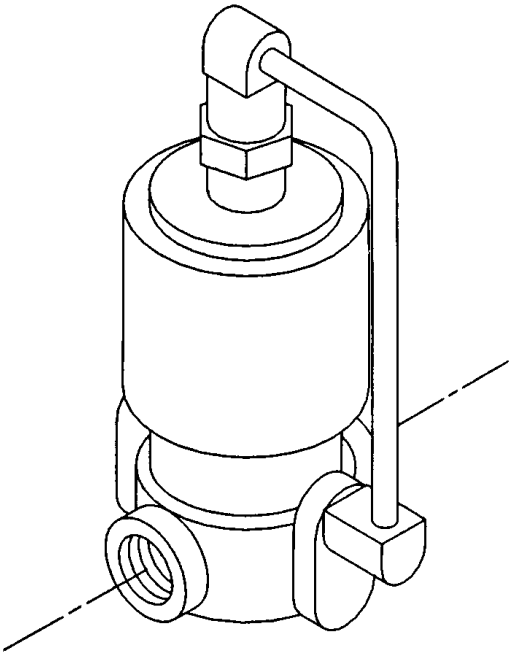


FIGURE 4–2 – BLOWDOWN VALVE

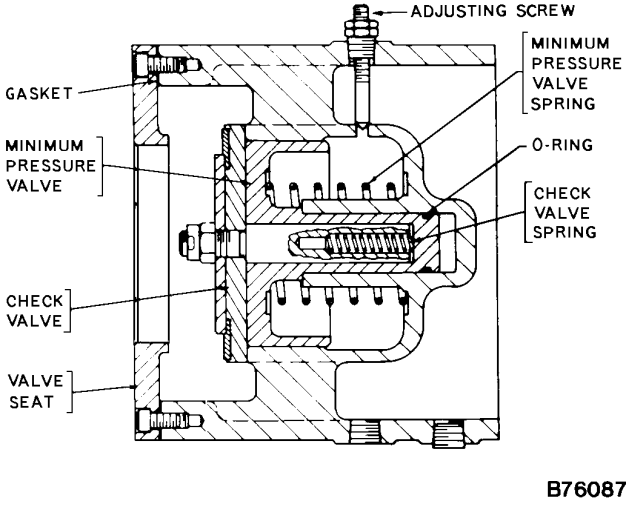


FIGURE 4–3 – MINIMUM DISCHARGE PRESSURE VALVE

⚠ WARNING

Operation of unit with improper relief valve setting can result in severe personal injury or machine damage.

Insure properly set valves are installed and maintained.

Blowdown Valve (FIGURE 4–2) – This valve normally is used for control functions, but also serves to relieve reservoir pressure following a shutdown. See description under "Air control Components", page 23, for additional information.

Oil Level Gauge – This gauge is located on the oil reservoir and indicates the oil level.

Minimum Discharge Pressure Valve (FIGURE 4–3 – An internal spring–loaded minimum pressure valve is used in the final discharge line to provide a positive pressure on the coolant system of the compressor even if the air service valve is fully open to atmospheric pressure. This valve also functions as a check valve to prevent back flow of air from the shop air line when the unit stops, unloads, or is shut down.

The valve incorporates an orifice which, when air is flowing through it, maintains pressure in the oil reservoir. A spring–loaded piston valve senses air pressure on the upstream (reservoir) side of the valve. When the system pressure rises, the spring is overridden and the valve opens to full porting.

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

Inlet Valve (FIGURE 4–1, page 21) – The Inlet valve restricts the inlet to control delivery and closes to unload the compressor. At shutdown, the inlet valve closes to prevent the back flow of air.

The inlet valve position is controlled by air pressure in its piston cylinder, which is controlled by the "AUTO SENTRY®" through solenoid valves IVC and IVO. As pressure to the piston is increased, the valve closes to restrict air flow and compressor delivery.

Solenoid Valves IVC and IVO (FIGURE 4–1, page 21) – These valves control position of the inlet valve in response to signals from the "AUTO SENTRY®". With both valves de–energized, the normally open IVC valve allows control pressure to the inlet piston to close the valve. If IVC only is energized, the inlet valve is held in its current position. If both valves are energized, control pressure is relieved from the inlet piston to allow the valve to open.

Pressure Regulator (FIGURE 4–1, page 21) – The pressure regulator is used to supply a constant and low control pressure to prevent damage to the inlet valve from "slamming." The regulator should be set for 25–30 psig.

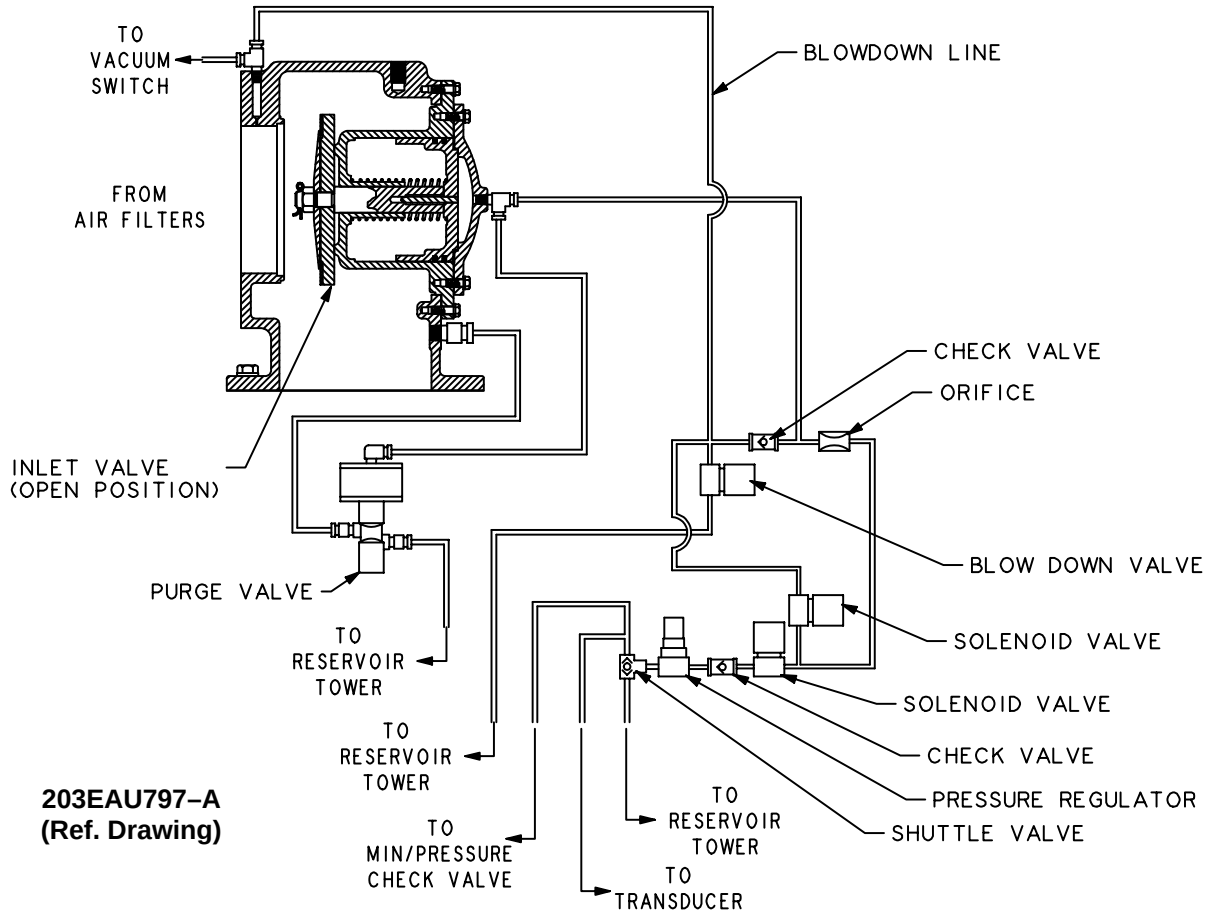


FIGURE 4–4 – INLET VALVE

Shuttle Valve (FIGURE 4–5) – Also known as a double check valve, the shuttle valve is a device which will take two (2) supply signals and allow the one with the highest pressure to pass through. The shuttle valve is used to provide control air pressure from either the reservoir or plant air system, as required during different operating conditions.

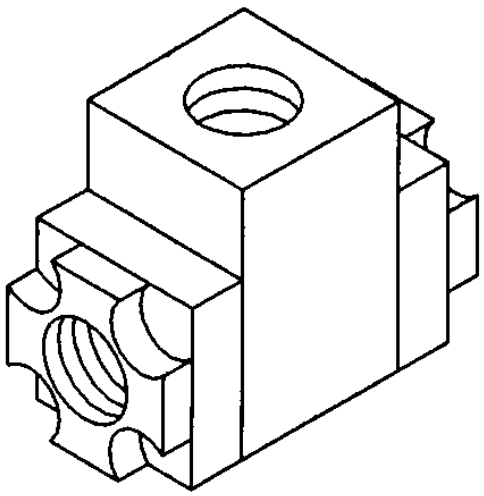


FIGURE 4–5 – SHUTTLE VALVE

Purge Air Valve (FIGURE 4–1, page 21) – The purge valve is a normally closed two–way air actuated valve that admits purge air from the final discharge manifold to the compressor to counteract the oil knock that occurs in oil–flooded rotary screw compressors when they are completely unloaded with pressure in the oil reservoir. This valve is controlled by the same control pressure which controls the inlet valve.

Blowdown Valve (FIGURE 4–1, page 21) – The blowdown valve is a two–way solenoid valve which is piped into the air/oil reservoir outlet ahead of the minimum pressure valve. When the solenoid is de–energized, the valve opens and the coolant system is blown down. When the solenoid is energized, the valve closes to allow the coolant system to pressurize. A control air check valve is provided to ensure that the inlet valve is closed during blowdown.

System Pressure Transducer – This transducer is connected after the minimum pressure valve. It converts the pressure in the plant air system into an electrical signal for use by the "AUTO SENTRY®" controller for modulation and control.

Reservoir Pressure Transducer – This transducer is connected to the coolant system. Its signal is used to prevent loaded starts, monitor oil pressure, and monitor the condition of the separator.

Air Filter Vacuum Switch – This switch is used to monitor air filter condition and alert the user if the filter requires service or replacement.

Discharge Thermistor – This sensor is located directly in the compressor discharge. Its signal is used to monitor compressor temperature and shut down the compressor if a coolant problem is detected.

Reservoir Thermistor – This sensor is located in the reservoir / separator housing and is used to monitor temperature and shutdown the compressor if temperature problems occur at the separator.

Optional Switches – The "AUTO SENTRY®" controller has one additional input available for dealer or user installed optional shutdown switches. If the contact is opened, the compressor will be shut down, and will display a user selectable message (refer to unit setup adjustments for list of messages).

Emergency Stop Pushbutton – This is a maintained pushbutton, and removes power from the controller outputs regardless of controller status. It is located on the upper section of the panel, next to the keypad. This should be used for emergency purposes only – use the keypad [STOP/RESET] for normal controlled stopping.

⚠ WARNING

Automatic restarting or electrical shock can cause injury or death. Open, tag and lockout main disconnect and any other circuits before servicing the unit.

Turn Valve – The turn valve is a helical valve which, when rotated, opens and closes a series of ports cast into the compressor cylinder. When these ports are open, they direct some of the air which would otherwise be compressed back to the inlet, reducing both capacity and power consumption.

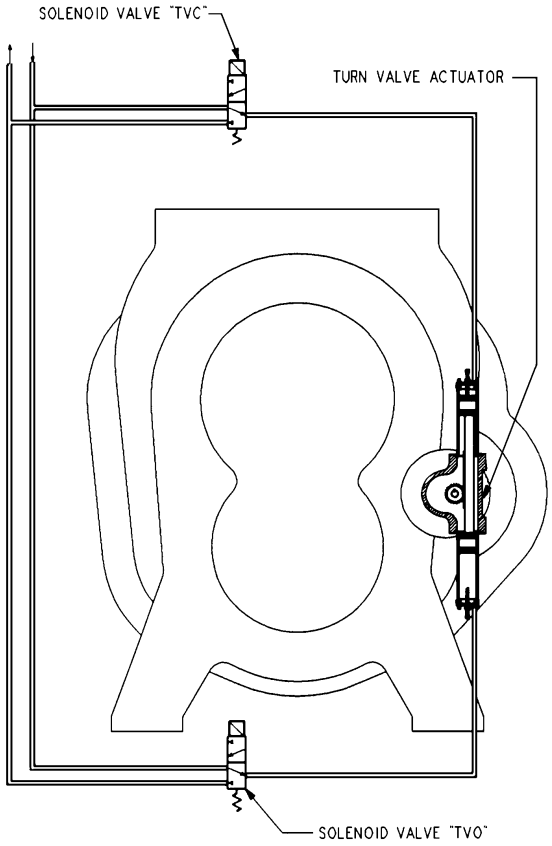


FIGURE 4–6 – TURN VALVE CONTROL

Turn Valve Actuator (FIGURE 4–7, page 25) – The turn valve actuator is a rotary rack and pinion device which positions the turn valve according to system demand. Filtered oil from the reservoir is directed to the outboard ends of the two actuating cylinders to move the rack and rotate the valve. Located on the end of the cylinders are adjusting screws which limit the travel of the actuator. When looking at the rear of the compressor, the adjusting screw on the bottom of the compressor adjusts the fully closed (full load) position of the valve. The full load position of the actuator may be checked by removing the adjusting screw at the unloaded end of the actuator (top of the compressor) and using a rod to push the pistons to the full load position. The rod must be clean and free of burrs and scale. Take care not to scrape the cylinder walls when moving the pistons.

Solenoid Valves TVC and TVO – These valves control position of the turn valve in response to signals from the "AUTO SENTRY®" controller. With both valves de–energized, equal pressure is supplied to both sides of the actuator to hold it in its current position. If TVC only is energized, the bottom of the turn valve actuator

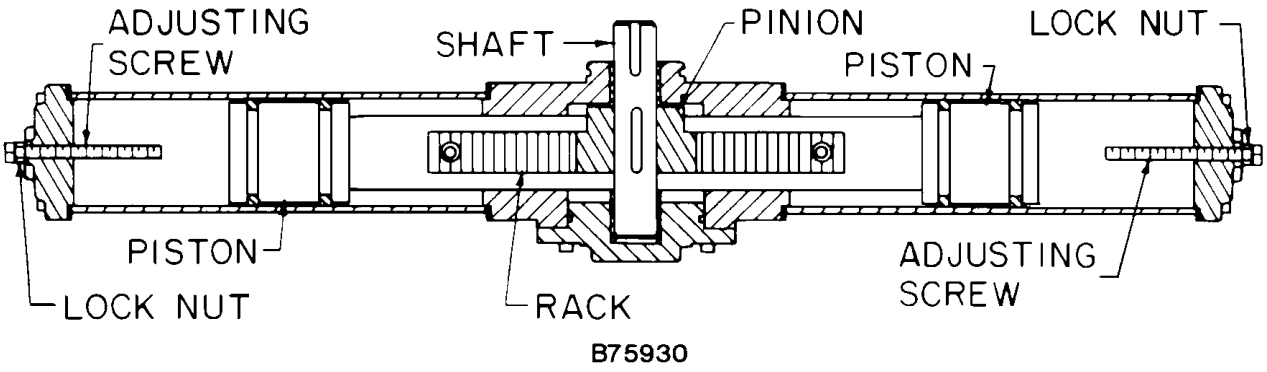


FIGURE 4–7 – TURN VALVE ACTUATOR

is exhausted to the compressor inlet cavity, causing the turn valve to move towards the full load position. If TVO only is energized, the top of the turn valve actuator is exhausted to the compressor inlet cavity, causing the turn valve to move towards the unload position.

Control Transformer – This changes the incoming power voltage to 110–120 volts for use by all unit control devices. Two primary and one secondary fuse are provided. Refer to adjacent labeling for replacement information.

Terminal Strip – This provides connections for all 110–120 volt devices not contained within the enclosure.

Fan Starter – The starter is used to provide control and overload protection for the package fan. Overload heaters should be selected and adjusted based on the motor nameplate amps and the instructions located inside the cover of the electrical enclosure. The starter must be present even for packages without a local fan.

Main Starter – These starters are used to provide control and overload protection for the main drive motors. Full voltage starters employ a single contactor and overload protection for each motor. Overload heaters should be selected and adjusted based on the motor nameplate amps and the instructions located inside the cover of the enclosure.

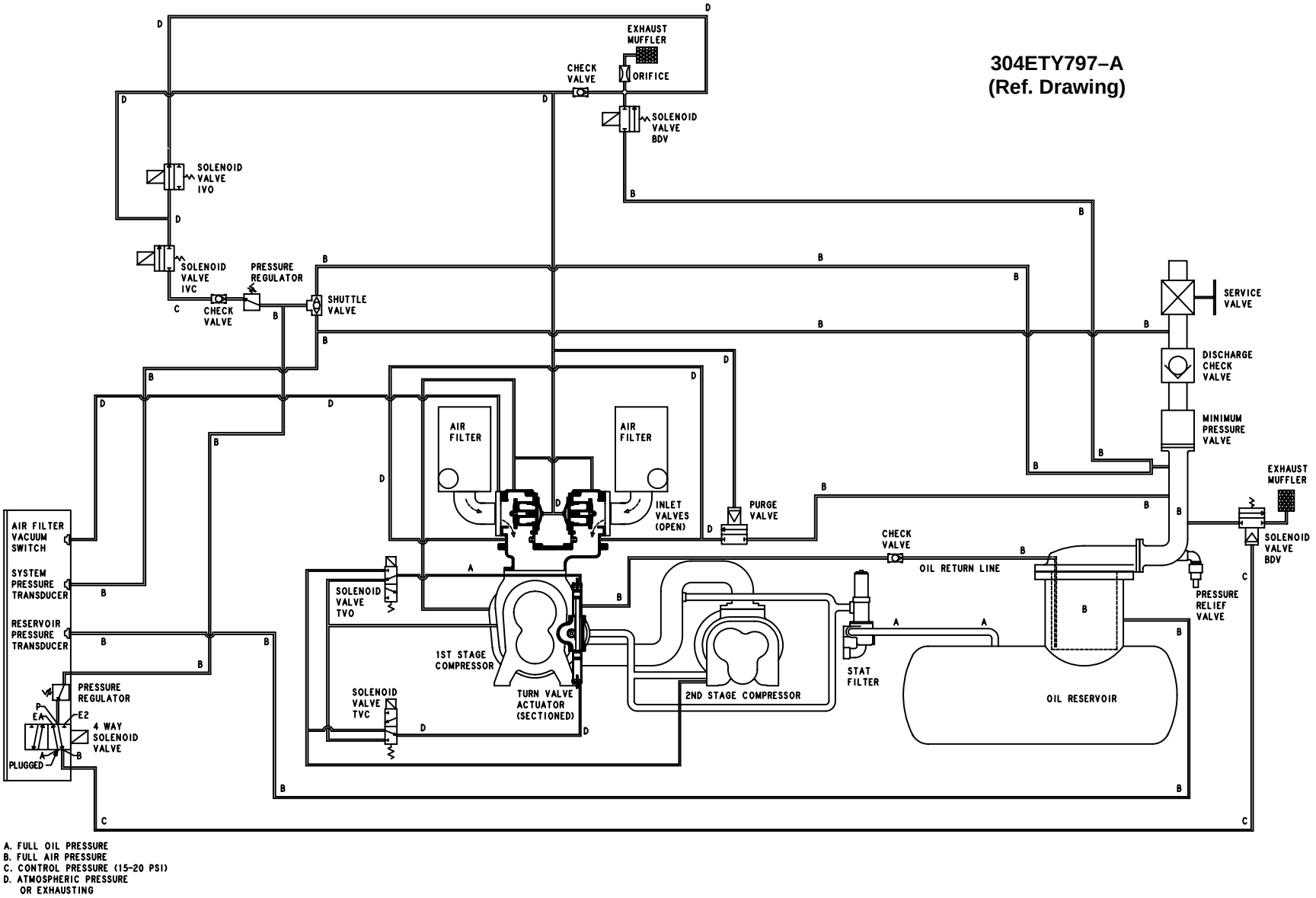


FIGURE 4–8 – CONTROL SCHEMATIC – COMPRESSOR AT FULL LOAD

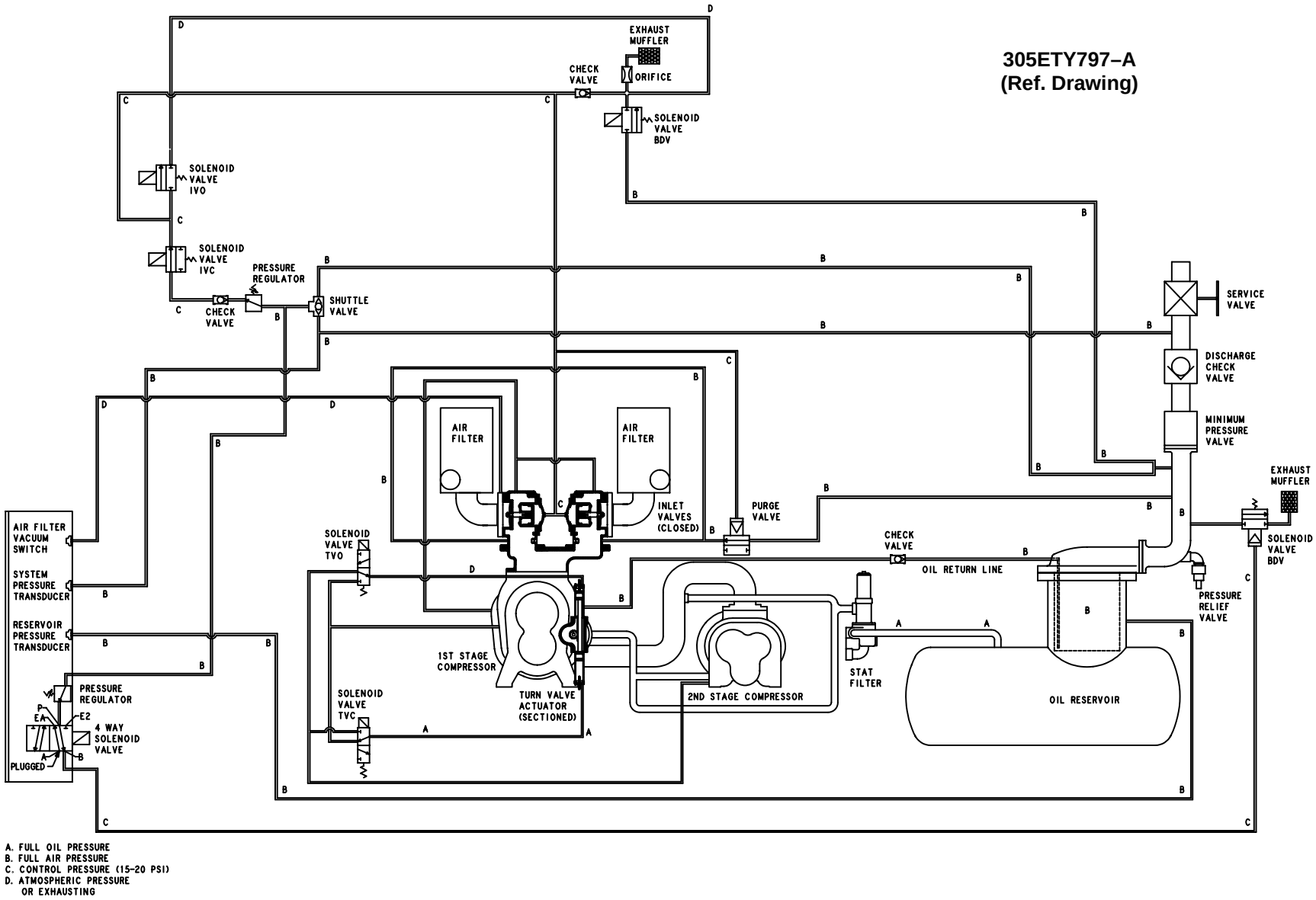


FIGURE 4–9 – CONTROL SCHEMATIC – COMPRESSOR FULLY UNLOADED – CONSTANT SPEED MODE

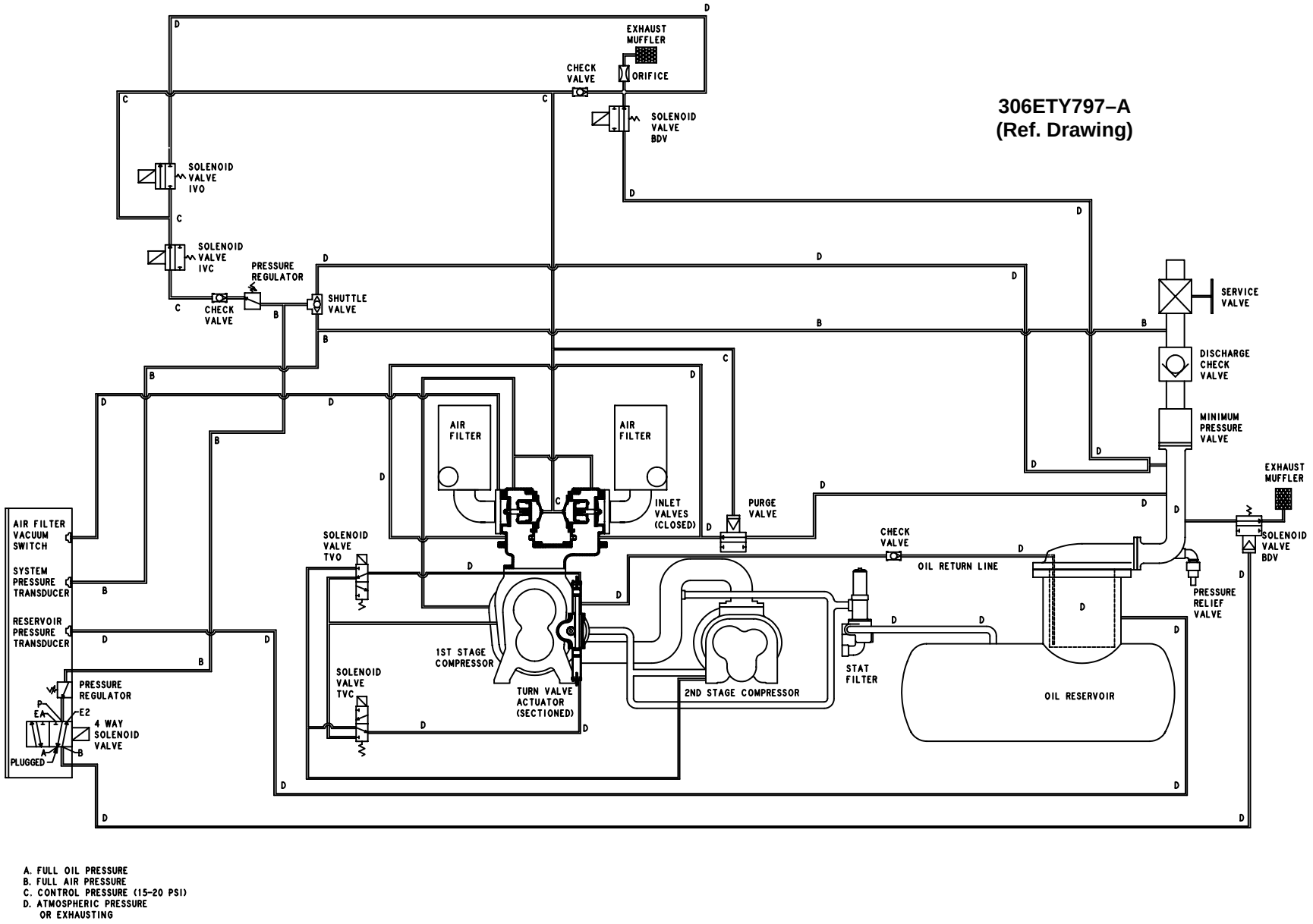
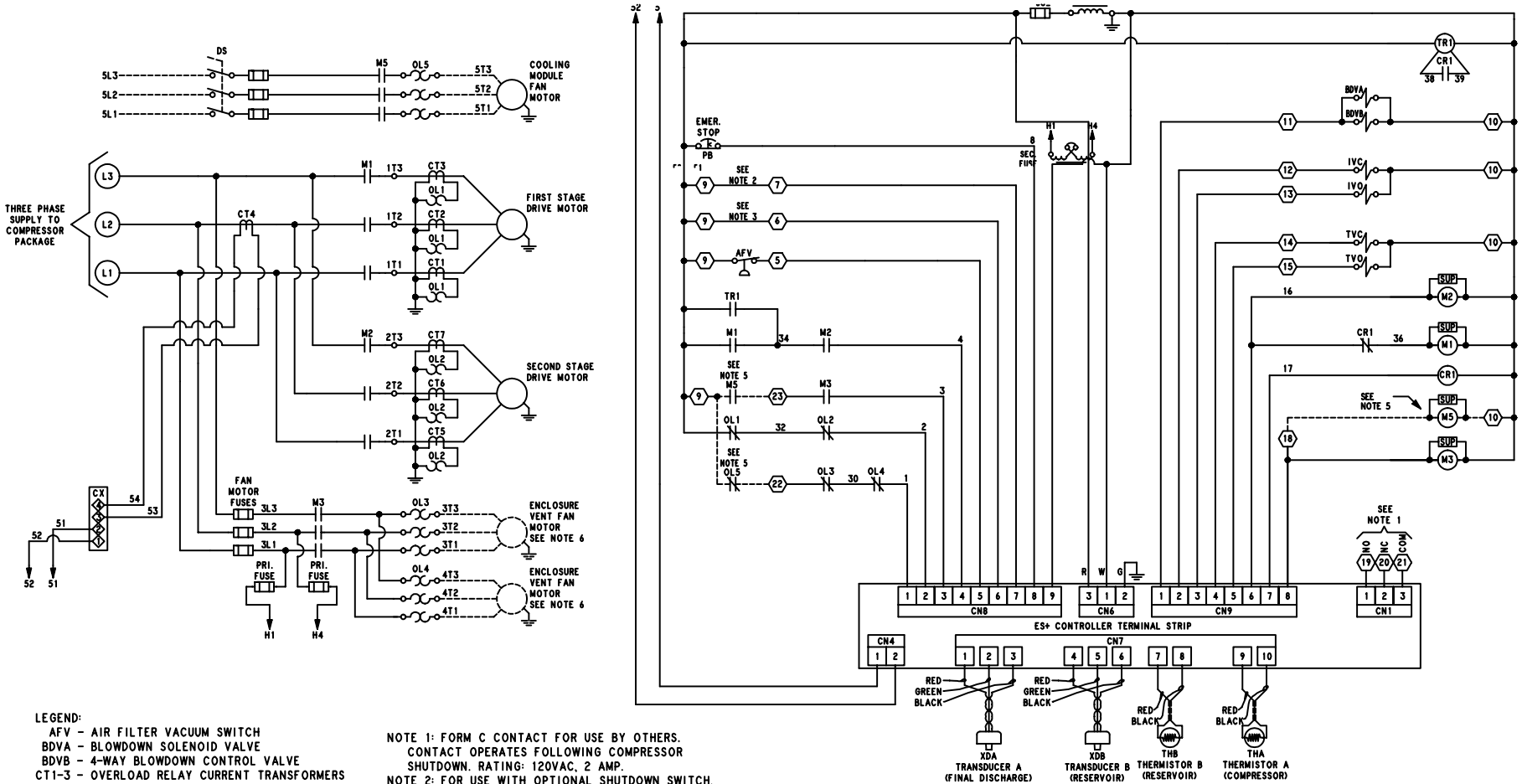


FIGURE 4–10 – CONTROL SCHEMATIC – COMPRESSOR FULLY UNLOADED – LOW DEMAND MODE



LEGEND:
- AFV - AIR FILTER VACUUM SWITCH
- BDVA - BLOWDOWN SOLENOID VALVE
- BDVB - 4-WAY BLOWDOWN CONTROL VALVE
- CT1-3 - OVERLOAD RELAY CURRENT TRANSFORMERS
- CT4 - MONITOR CURRENT TRANSFORMER
- CT5-7 - OVERLOAD RELAY CURRENT TRANSFORMERS
- CX - CURRENT TRANSDUCER
- DS - DISCONNECT SWITCH
- IVC - INLET VALVE CLOSE SOLENOID VALVE
- IVO - INLET VALVE OPEN SOLENOID VALVE
- TVC - TURN VALVE CLOSE SOLENOID VALVE
- TVO - TURN VALVE OPEN SOLENOID VALVE
- THA - THERMISTOR A (COMPRESSOR)
- THB - THERMISTOR B (RESERVOIR)
- XDA - TRANSDUCER A (FINAL DISCHARGE)
- XDB - TRANSDUCER B (RESERVOIR)

□ - CONNECTION TO CONTROL BOARD

⬡ - PANEL TERMINAL BLOCK

◇ - CURRENT TRANSDUCER TERMINAL

NOTE 1: FORM C CONTACT FOR USE BY OTHERS. CONTACT OPERATES FOLLOWING COMPRESSOR SHUTDOWN. RATING: 120VAC, 2 AMP.

NOTE 2: FOR USE WITH OPTIONAL SHUTDOWN SWITCH, REMOVE JUMPER BETWEEN TERMINALS 7 & 9. CONNECT N.C. SWITCH CONTACT TO TERMINALS 7 & 9.

NOTE 3: FOR CONTROL BY REMOTE CONTACT, REMOVE JUMPER BETWEEN TERMINALS 6 & 9, CONNECT CONTACT TO TERMINALS 6 & 9.

NOTE 4: J3A & J3B ARE FOR USE OF OPTIONAL COMMUNICATIONS CABLE.

NOTE 5: MOUNT THE COOLING MODULE COMBINATION STARTER AND REMOVE ALL CONTROL WIRES INSIDE THE STARTER. INSTALL CONTROL CONDUIT WITH 5 WIRES. CONNECT WIRES 18 & 10 TO COIL. WIRES 9 & 23 TO AUXILIARY CONTACT. WIRES 9 & 22 TO OVERLOAD CONTACT. CONNECT 5 WIRES TO TERMINALS IN CONTROL BOX. ADJUST CONTROLLER FOR "WATERCOOLED" FAN MODE.

NOTE 6: VENT FANS ARE USED ON UNITS WITH ENCLOSURE ONLY. UNITS LESS ENCLOSURE HAVE NO CONNECTION TO 3T1, 3T2, 3T3, 4T1, 4T2 & 4T3.

302ETY546
(Ref. Drawing)

MAIN MOTOR	TWO STAGE
FAN MOTOR	REMOTE AIR COOLED
CONTROLLER	ES+
ACCESSORY	CURRENT MONITOR

FIGURE 4–11 – WIRING DIAGRAM

SECTION 5
LUBRICATION
OIL COOLER, OIL FILTER & SEPARATOR

COMPRESSOR OIL SYSTEM (FIGURE 5–1, page 31) cools the compressor, lubricates moving parts and seals internal clearances in the compression chamber.

The oil inlet line is connected at top of the oil reservoir. Air pressure in the oil reservoir forces oil through the oil cooler, thermostatic mixing valve/oil filter assembly and is piped to the first stage compressor, second stage compressor and the interstage manifold. A portion of the oil to the compressors is directed through internal passages to the bearings, gears and shaft oil seals. The balance of the oil is injected directly into the compression chamber to remove heat of compression, seal internal clearances and lubricate the rotors. 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 the first stage compressor.

RECOMMENDED LUBRICANT – Gardner Denver compressors are factory filled with AEON lubricants. These lubricants are formulated to the highest quality standards and are factory authorized, tested and approved for use in rotary screw compressors. AEON lubricants are available through your authorized Gardner Denver compressor distributor.

OIL SPECIFICATIONS – The factory fill compressor lubricant is Gardner Denver AEON™ 9000 SP lubricating coolant which can be used for year–round operation. AEON™ 9000 SP is a synthetic, extended life lubricant which can extend lubricant change intervals up to 4 times that of a petroleum based lubricant. A lubricant analysis program for a periodic check of lubricant quality and remaining life can maximize the change interval.

⚠ CAUTION

Use of improper lubricants will cause damage to equipment. Do not mix different types of lubricants or use inferior lubricants.

⚠ CAUTION

Improper equipment maintenance with use of synthetic lubricants will damage equipment. Oil filter and oil separator change intervals remain the same as for AEON™ 4000 –– See Maintenance Schedule, page 45.

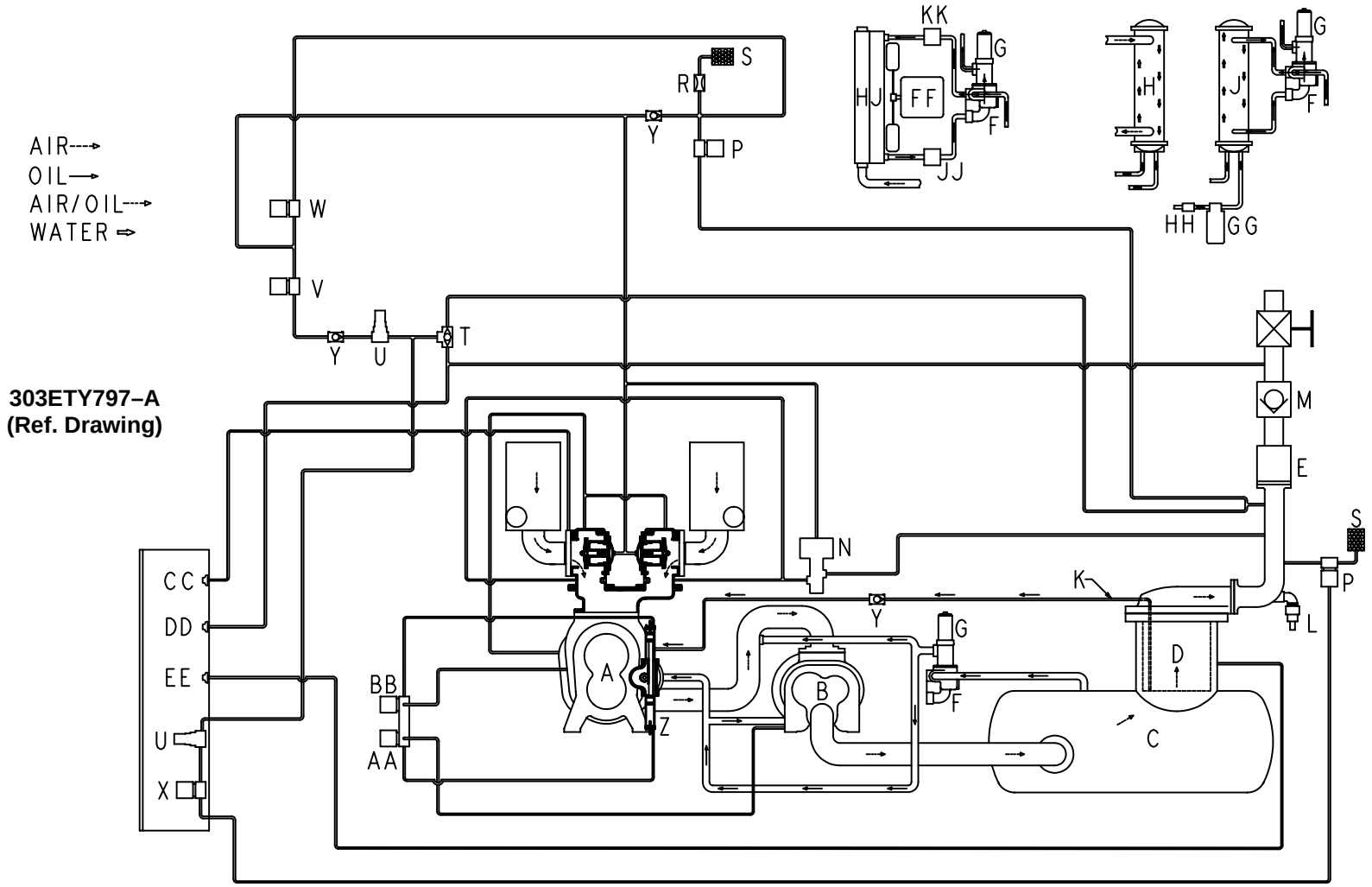
HIGH TEMPERATURE OPERATION – Gardner Denver AEON 9000 SP lubricating coolant will operate at a sustained discharge temperature up to 210°F (99°C) when unusually high ambient air temperature is encountered.

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

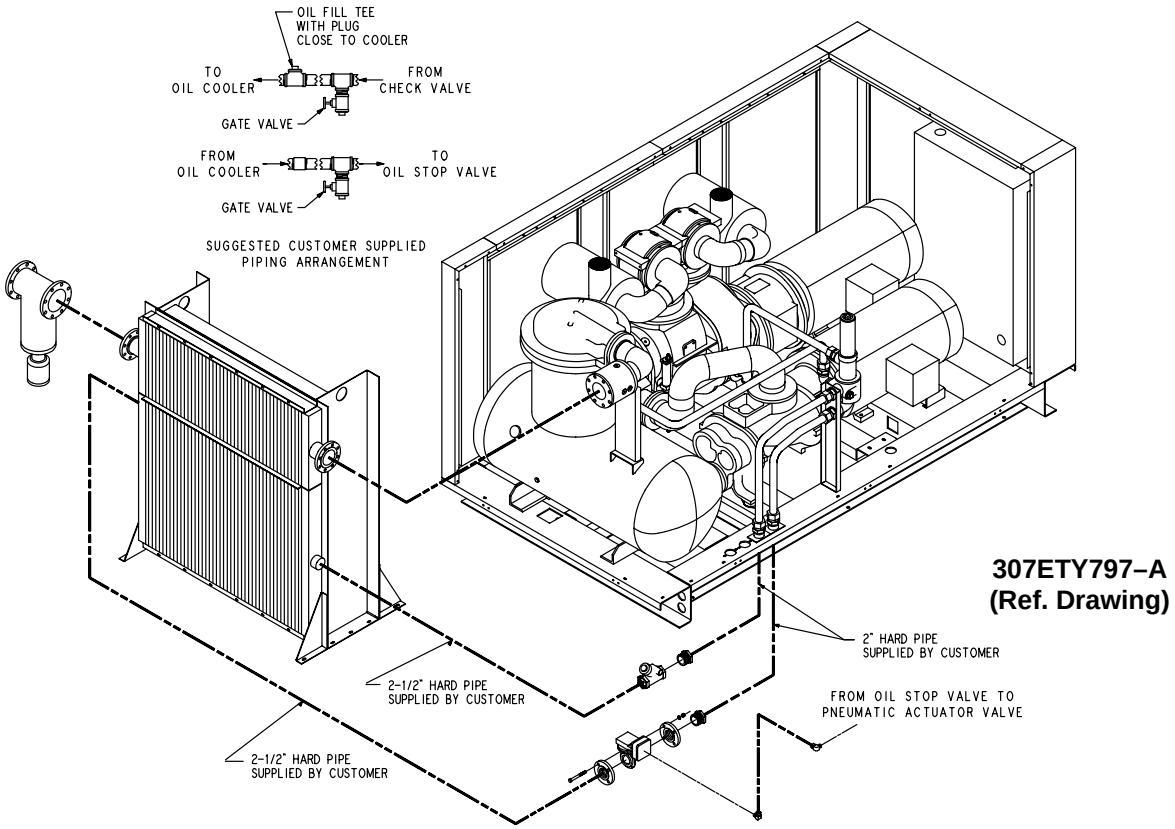
⚠ WARNING

High temperature operation can cause damage to equipment or personal injury. Do not repeatedly restart the unit after high temperature stops operation. Find and correct the malfunction before resuming operation.



A – 1ST STAGE COMPRESSOR
B – 2ND STAGE COMPRESSOR
C – OIL RESERVOIR
D – AIR/OIL SEPARATOR
E – MINIMUM DISCHARGE PRESSIRE VALVE
F – STATFILTER
G – OIL FILTER ELEMENT
H – AFTERCOOLER
J – OIL COOLER
K – SEPARATOR TO CYLINDER OIL RETURN LINE
L – PRESSURE RELIEF VALVE
M – DISCHARGE CHECK VALVE
N – PURGE VALVE
P – PNEUMATIC BLOWDOWN VALVE
R – ORIFICE
S – BLOWDOWN MUFFLER
T – SHUTTLE VALVE
U – PRESSURE REGULATOR
V – SOLENOID VALVE 'IVC'
W – SOLENOID VALVE 'IVO'
X – 4–WAY VALVE
Y – CHECK VALVE
Z – TURN VALVE ACTUATOR
AA – SOLENOID VALVE 'TVO'
BB – SOLENOID VALVE 'TVC'
CC – AIR FILTER VACUUM SWITCH
DD – SYSTEM PRESSURE TRANSDUCER
EE – DISCHARGE PRESSURE TRANSDUCER
FF – FAN AND MOTOR
GG – WATER FLOW CONTROL VALVE
HH – MAGNETIC WATER SHUTOFF VALVE
JJ – OIL LINE CHECK VALVE (REMOTE OVERHEAD OIL COOLER ONLY)
KK – OIL STOP VALVE (REMOTE OVERHEAD OIL COOLER ONLY)

FIGURE 5–1 – FLOW DIAGRAM



OIL PIPING FOR REMOTE COOLER

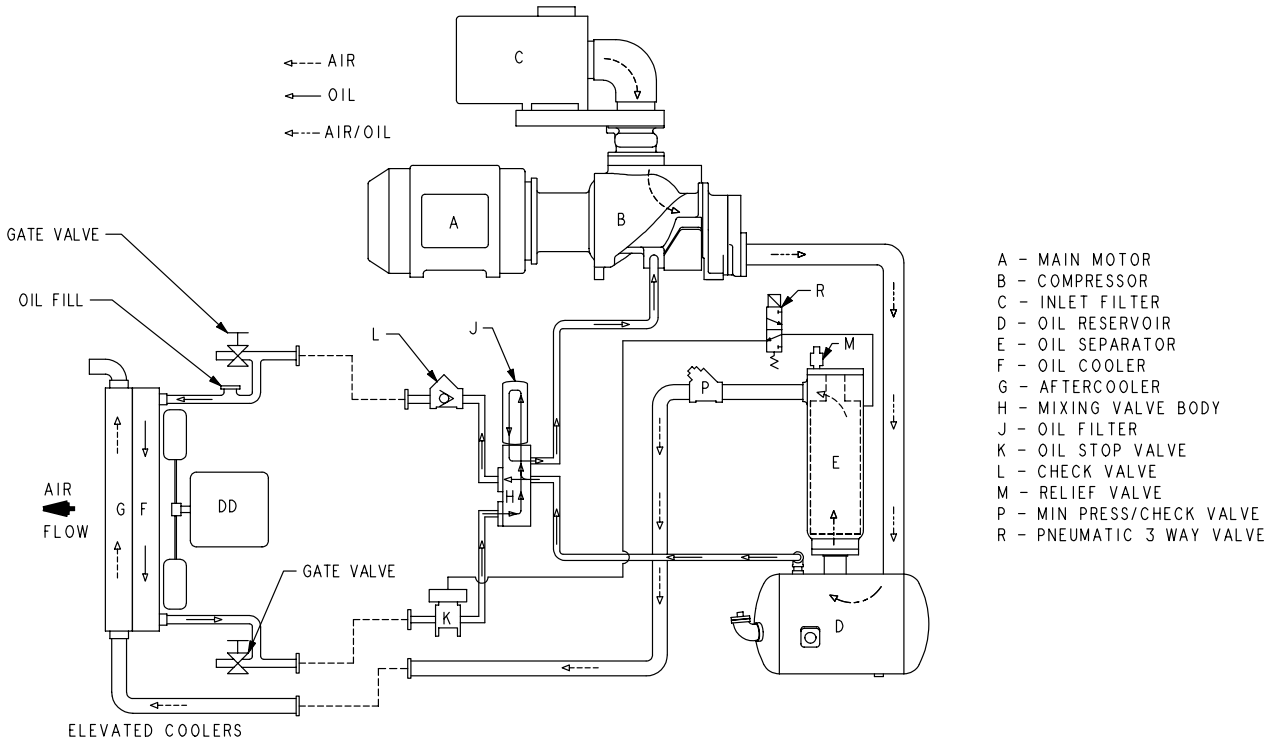


FIGURE 5–2 – OIL FLOW DIAGRAM – REMOTE OVERHEAD MOUNTED

⚠ WARNING

All materials used in Gardner Denver® compressor units are compatible with AEON™ 9000 SP Lubricating Coolant. Use caution when selecting downstream components such as air line lubricating bowls, gaskets and valve trim.

AEON™ 9000 SP Synthetic Lubricant is not compatible with low nitrile Buna N or acrylic paints. AEON™ 9000 SP is compatible with most air system downstream components.

Material Safety Data Sheets (MSDS) are available for all AEON lubricants from your authorized Gardner Denver distributor or by calling 217–222–5400.

COLD AMBIENT OPERATION – See "Installation for Cold Weather Operation," page 12.

ADDITION OF OIL BETWEEN CHANGES must be made when the oil level is in the red range on the gauge as read while the unit is on. To add oil, follow these steps:

1. Be sure the unit is completely off and that no air pressure is in the oil reservoir.
2. Disconnect, tag and lockout the power supply to the starter.
3. Wipe away all dirt around the oil filler plug.
4. Remove the oil filler plug and add oil as required to return the oil level to the center of the green range on the gauge.
5. Install the oil filler plug, restore power, run and check for leaks.

DO NOT OVERFILL. The quantity required to raise the oil level from the red range to the center of the green range is shown in FIGURE 5–4, page 35. Repeated addition of oil between oil changes may indicate excessive oil carry–over and should be investigated.

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

⚠ CAUTION

Excessive oil carry–over can damage equipment. Never fill oil reservoir above the "FULL" marker.

LUBRICANT CHANGE PROCEDURE – Upgrading to a longer life lubricant is essentially a very worthwhile practice. Following are the primary steps to be completed when upgrading or changing the type of lubricant.

1. Thoroughly drain system:
   - Drain oil from air ends and cooler while hot.
   - Break low point connections and drain oil from pipe runs and cooler.
   - Dump oil from the filter and reinstall used filter.
2. Fill the system with a 50 percent charge of the new lubricant:
   - Start the machine and stay there to observe.
   - Allow the machine to run about five minutes at temperature, or until temperature stabilizes, then shut down.
3. Thoroughly drain the machine.
4. Change to a new filter and separator.
5. Fill the system with a full charge of the new lubricant, then reinstall drain plug.

6. Machine should then be run normally, however, total run time after the initial changeout should be 50 percent of normal anticipated service life of the new lubricant.

   – Drain all lubricant from the system, change the filter and separator, and replace with a full charge of the new lubricant.

7. Subsequent lubricant changeouts should be at normal intervals. (See "Oil Change Interval" and chart below.)

OIL LEVEL GAUGE (FIGURE 1–5, page 3) indicates the amount of oil in the oil reservoir. When the unit is stopped, the oil level will be higher in the RUN range than when operating on load. When the unit is operating, the oil level should be near the center of the RUN range. In normal operation, the oil level will fluctuate slightly as the compressor loads and unloads. Add oil only when the oil level is 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.

MOISTURE IN THE OIL SYSTEM – In normal humidity and with normal operating temperatures and pressures, the thermal mixing valve controls the oil temperature and prevents moisture contamination of the oil. Unusual cooling of the oil reservoir, short loaded cycle in high humidity or malfunctions of the thermal valve may result in moisture in the oil system which is detrimental to compressor lubrication and could cause oil carryover. If moisture is observed in the oil reservoir, drain the moisture and correct the condition causing the accumulation.

See "Compressor Oil System Check," page 41 and "Thermal Control (Thermostatic Mixing) Valve," page 37.

OIL CHANGE INTERVAL – Recommended oil change intervals are based on oil temperature. FIGURE 5–3 shows how the change interval is affected by temperature.

When operating conditions are severe (very dusty, high humidity, etc.), it will be necessary to change the oil more frequently. Operating conditions and the appearance of the drained oil must be surveyed and the oil change intervals planned accordingly by the user. Gardner Denver® offers a free oil analysis program with the AEON™ lubricants and we recommend a sample be sent in at 100 hours on a new unit.

DRAINING AND CLEANING OIL SYSTEM

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

Always drain the complete system. Draining when the oil is hot will help to prevent varnish deposits and carry away impurities.

Discharge Temperature	AEON 4000 Change Interval	AEON 9000 SP Change Interval
Up to 180°F (82°C)	4000 hrs.	8000 hrs.
180° to 190°F (82° to 88°C)	3000 hrs.	6000 hrs.
190° to 200°F (88° to 93°C)	2000 hrs.	4000 hrs.
200°F+ (93°C)	1000 hrs.	2000 hrs.

FIGURE 5–3 – OIL CHANGE INTERVAL

To drain the system, use one of the following methods:

1. If the unit is not elevated high enough to use the oil reservoir drain line to drain oil, a small hand, electric or air operated pump should be used to drain reservoir through the oil filler opening or from the drain valve.
2. If the unit is elevated so that the oil reservoir drain can be used, empty the oil reservoir through the drain valve to a suitable container or sump.
3. If the drained oil and/or the oil filter element are contaminated with dirt, flush the entire system: reservoir, oil cooler, mixing valve and lines. Inspect the oil separator element for dirt accumulation; replace if necessary. If a varnish deposit exists, contact the factory for recommendations for removal of the deposit and prevention of varnish.

FILLING OIL RESERVOIR

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

1. Be sure the unit is completely off and that no air pressure is in the oil reservoir.
2. Disconnect, tag and lockout the power supply to the starter.
3. Wipe away all dirt around the oil filler plug.
4. Remove the oil filler plug and add oil as required to return the oil level to the center of the green range on the gauge.
5. Install the oil filler plug and operate the unit for about a minute allowing oil to fill all areas of the system. Check for leaks.
6. Shut down unit, allowing the oil to settle, and be certain all pressure is relieved.
7. Add oil, if necessary, to bring level to the center of the green range on the gauge.

On unloaded operation and after shutdown some oil will drain back into the oil reservoir and the oil level gauge will read “FULL.” DO NOT DRAIN OIL TO CORRECT. On the next start, oil will again fill the system and the gauge will indicate operating at the proper level. DO NOT OVERFILL as oil carryover will result. The quantity of oil required to raise the oil level from “ADD” to “FULL” is shown in FIGURE 5–4. page 35. Repeated addition of oil between changes may indicate excessive oil carryover and should be investigated.

Use only CLEAN containers and funnels so no dirt enters the reservoir. Provide for clean storage of oils. Changing the oil will be of little benefit if done in a careless manner.

⚠ CAUTION

Excessive oil carry–over can damage equipment. Never fill oil reservoir above the “FULL” marker.

COMPRESSOR OIL FILTER (FIGURE 5–1, page 31) – This patented design screw on oil filter is a vital part in maintaining a trouble–free compressor, since it re-

	350, 400 & 500 HP (260, 300 & 372 KW)
Refill Capacity For Normal Oil Change	60.0 U.S. Gallons (227 Liters)
Top of Add to Centerline of Run	11.0 U.S. Gallons (42 Liters)

FIGURE 5–4 – APPROXIMATE OIL SYSTEM CAPACITIES

moves dirt and abrasives from the circulated oil. The oil filter relief valves are located in the top manifold of the filterstat. To replace, unbolt the manifolds and remove valves. The relief valve opens in the event the element becomes dirty enough to block the flow of oil.

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

⚠ CAUTION

Improper oil filter maintenance will cause damage to equipment. Replace filter element every 1000 hours of operation. More frequent replacement could be required depending on operating conditions. A filter element left in service too long may damage equipment.

Use only complete oil filter for replacement. The part number is on the filter head and in the parts list.

NOTICE

The head and the filter body are bonded together and cannot be purchased separately.

Use the following procedure to replace the filter. Do not disturb the piping.

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

1. Stop unit and be sure no air pressure is in the oil reservoir.
2. Unscrew oil filter from housing and remove.
3. Screw new oil filter into housing.
4. Run the unit and check for leaks.

BEARING OIL FILTER – An oil filter of the spin–on type is used. This filter is a vital part in maintaining a trouble–free compressor, since it removes dirt and abrasives from the circulated oil before it reaches the bearings. The filter is the disposable type and is equipped with a relief valve that opens in the event the element becomes dirty enough to block the flow of oil. **The filter must be replaced each time the main oil filter element is replaced.** When changing this filter between oil changes, add one (1) quart of lubricant to the system to replace that retained in the old filter. Use only the replacement filter shown in the parts list, as others may not have sufficient burst pressure strength.

To replace filter, stop the unit and be sure no air pressure is in the oil reservoir. Disconnect, tag and lockout power supply to the starter. Spin off the old filter and discard, then spin on the new filter by hand, tightening firmly enough to prevent leaks.

COMPRESSOR OIL COOLER – RADIATOR TYPE (FIGURE 5–3) – The air–cooled oil cooler module is remote mounted. The oil cooler requires pipe and electrical connection to the main compressor unit. Connecting piping and wiring are furnished by the user. See “Installation”, Section 2, page 8.

Do not obstruct the air flow to and from the oil cooler. Allow two (2) feet clearance on all sides of the oil cooler. See FIGURE 2–2, Section 2, page 8, for cooling air flow requirements. Keep both faces of the oil cooler core clean for efficient cooling of the compressor oil. Oil cooler malfunctions may be traced by checking oil pressure drop through the cooler; check by installing

pressure gauges at fittings in the inlet and outlet oil piping near the end of the cooler. At normal operating air service pressures (65 to 150 psig), with the unit warm, a pressure drop of 2 to 25 psig can be expected between the inlet and outlet side of the cooler. The controller will show the reservoir temperature which is the air temperature in the reservoir and the approximate oil temperature into the thermal mixing valve.

An oil filler stand pipe and plug must be located in the piping on the oil cooler module for ease of filling the oil cooler when it is mounted at a distance from the compressor unit. When filling a remotely mounted oil cooler, be sure all lines to and from the compressor unit are also filled to prevent excessive drawdown of the oil supply in the oil reservoir. A vent line should be installed between the oil cooler and compressor oil reservoir as an aid in filling and to prevent siphoning.

HEAT EXCHANGER (OIL) PIPING – All remote elevated cooler applications must be sent through Engineering for approval and for recommending the pipe size. A special control group will be mounted on the package at the factory. This group controls the oil stop valve as well as not allowing the machine to run unloaded. This kit includes the oil stop valve, check valve and flanges and must be installed on all remote elevated coolers per FIGURE 5–3, page 34, and the following instructions.

NOTICE

Remote mounted elevated coolers have a maximum pipe length of 30 feet (each way) and a maximum height of 20 feet with a minimum of fittings. Engineering will review all remote elevated cooler applications and recommend pipe size on an individual basis. Customer Service should include the engineering recommendation in the special order sent to Engineering.

1. Mount the check valve.
2. Mount the drain valves in the lowest section of the pipe on each side of the cooler connections.
3. Mount the oil stop valve in the line after the thermal mixing valve as shown.

Modifications to the control lines will be made at the factory to control the oil stop valve. Air to the oil stop valve must come from the dry side of the reservoir cover, then through the 3–way pneumatic valve. Control air to the valve must come from the line between the tee and the orifice in the blowdown muffler line. When the machine blows down, it will activate the pneumatic valve which will shut off the air and vent the line between the pneumatic control valve and the oil stop valve to the atmosphere. This will shut the oil stop valve and prevent excessive oil from running into the reservoir. Failure to install these parts could result in high oil carryover and cause the machine to shutdown on high discharge temperature.

THERMAL CONTROL (THERMOSTATIC MIXING) VALVE is installed in system as shown in FIGURE 5–1, page 31. This valve is used to control temperature of the oil in both air–cooled radiator and water–cooled heat exchanger type oil cooler systems. On start–up with unit cold, element is open to bypass, allowing oil to pass directly from the reservoir to compressor during warm–up. As oil warms, element gradually closes to the bypass allowing more of the oil from the cooler to mix with oil from the bypass.

After the unit is warmed up, the mixing valve maintains oil injection temperature into the compressor at a minimum of 150° F (66° C). This system provides proper compressor warm–up and helps prevent moisture contamination of oil.

To check the element, heat in oil – it should be fully extended at 150° F (66° C). If the unit shuts down due to high air discharge temperature, it may be that the thermostatic mixing valve element (FIGURE 5–1, page 31) is stuck open. Remove the mixing valve and clean all parts thoroughly when flushing the oil system.

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

⚠ WARNING

It is mandatory that any water cooled unit be installed in a shelter heated to temperatures above freezing (32° F, 0° C.

COMPRESSOR OIL COOLER – WATER–COOLED HEAT EXCHANGER (FIGURE 5–1, page 31) – The heat exchanger oil cooler is a multiple pass type, with water in the tubes and oil in the shell. The oil temperature is controlled by the thermal (thermostatic mixing) valve. The optional water control valve may be used to conserve water.

Oil cooler malfunction may be traced by checking pressure at oil inlet and outlet. At normal operating air service pressure (65 to 150 psig, 4.5 to 10.3 Bars) with the unit warm, a pressure drop of 3 to 15 psi (.2 to 1 Bar) 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 (.3 to .7 Bar). 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 and/or suspension. These substances can cause scale formation, corrosion and 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 involve only filtration (screening) to remove debris, sand and/or salt in the cooling water supply. However, chemical treatment methods may be necessary in certain instances to inhibit corrosion and/or remove dissolved 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 of the tubes (water side) of the heat exchanger to remove deposits which enhance fouling and corrosion.

Hex head zinc anodes are used in the return bonnet (opposite end to the water pipe connections) of heat exchangers to provide internal water system corrosion protection. These anodes should be inspected periodically and replaced when the zinc has been reduced to about 1/2 inch (13mm) in length.

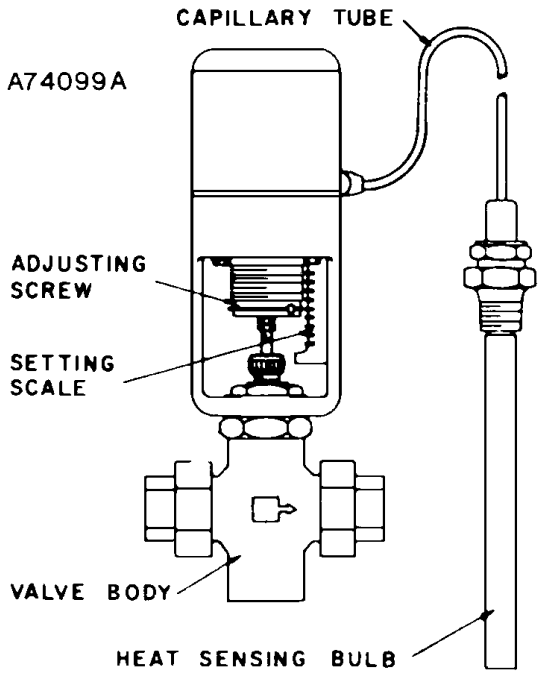


FIGURE 5–5 – WATER CONTROL VALVE

WATER FLOW CONTROL VALVE FOR HEAT EXCHANGER (Optional Equipment) (FIGURE 5–5) – The water flow control valve is adjustable to compensate for varying water inlet temperatures and pressures and is to be mounted in the water outlet line after the oil cooler (FIGURE 5–1, page 31). Use the compressor discharge air temperature gauge on the instrument panel in setting the flow control valve. The compressor discharge temperature must be maintained a minimum of 10° F (5° C) above the dew point temperature at the maximum anticipated ambient; refer to FIGURE 5–6, page 39, for the dew point temperature at the operating pressure and ambient temperature of the application.

To decrease water flow (increase compressor discharge air temperature) turn the adjusting screw from left to right, increasing spring tension. **To increase water flow** (decrease compressor discharge air temperature) turn the adjusting screw in the opposite direction. The groove at the lower edge of the adjusting screw is an index line for use with the index scale 0 to 8 in obtaining a desired setting.

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

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

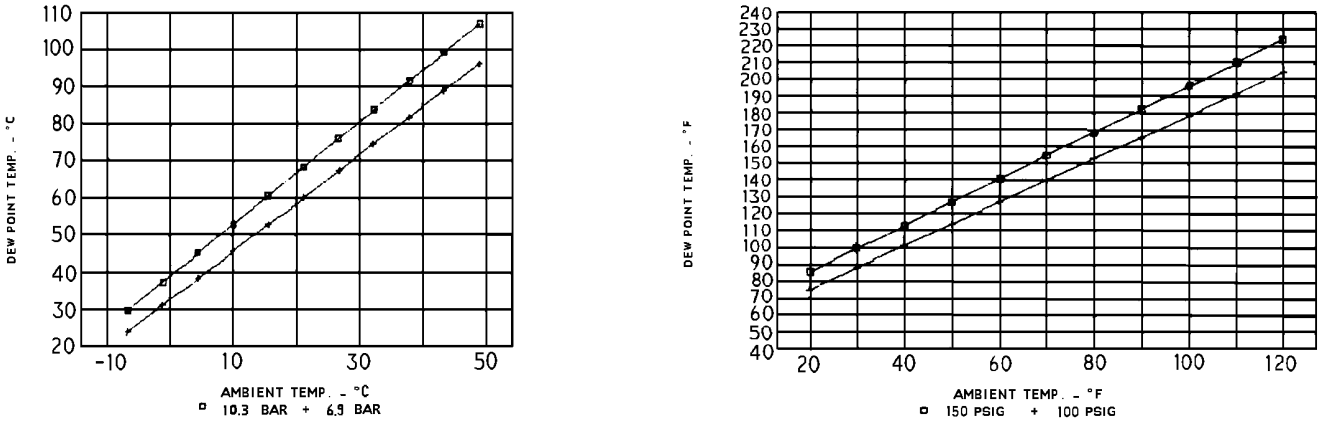


FIGURE 5–6 – DEW POINT TEMPERATURE VS. AMBIENT TEMPERATURE (100% RELATIVE HUMIDITY)

and placed so that damage will not occur in normal maintenance or traffic past the unit.

If the 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 valve malfunctions, check for bent or binding, paint or corrosion on valve stem, foreign material in 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 (Optional Equipment) (FIGURE 5–1, page 31) – A magnetic solenoid–operated water shutoff valve rated at 150 psig (10.3 Bars) water pressure should be mounted in the water outlet line after the oil cooler. The valve should be wired into the compressor control circuit so that the valve opens to allow water to flow any time the compressor is running. When compressor stops under automatic control, or is shut off manually, the valve should close, stopping water flow through the system. See Wiring Diagram, page 29.

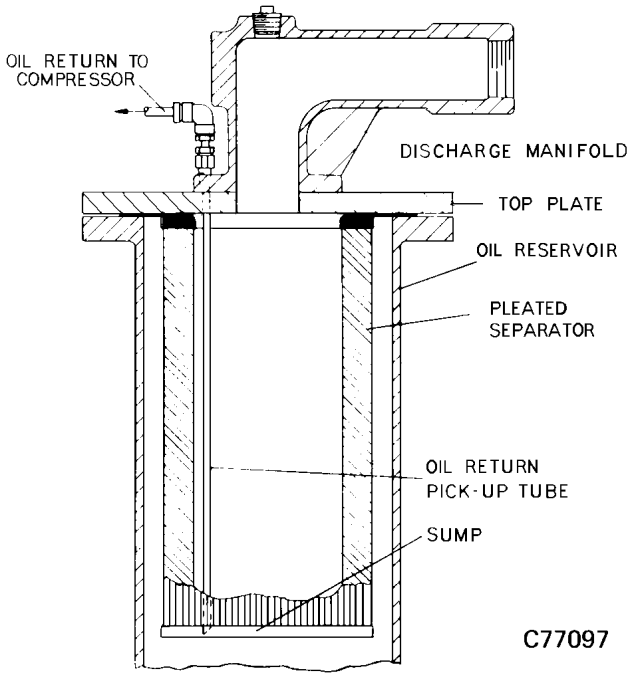


FIGURE 5–7 – SINGLE ELEMENT OIL SEPARATOR

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

OIL RESERVOIR – The oil reservoir–separator combines multiple functions into one vessel. The lower half is the oil reservoir, providing oil storage capacity for the system and the top portion, a primary oil separation means. The reservoir also provides limited air storage for control and gauge actuation.

COMPRESSOR (GD ELIMINATOR) OIL SEPARATOR located in a separate housing, consists of a re-

newable cartridge–type separator element and provides the final removal of oil from the air stream (FIGURE 5–7, page 39).

Oil impinging on the outside of the separator element drains directly back into the oil reservoir by gravity. Oil collected inside the element is returned through tubing to the compressor cylinder.

Oil carryover 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, oil return line malfunction or water condensate in the oil. If oil carryover occurs, inspect the separator 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 separator housing to the compressor cylinder is not clogged or pinched off, the check valve in the oil return line is functioning properly, and there is not water or an oil/water emulsion in the oil.

Oil carryover malfunctions of the oil separator are usually due to using elements too long, heavy dirt or varnish deposits caused by inadequate air filter service, use of improper oil or using oil too long for existing conditions. A ruptured or collapsed separator element is 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 carryover.

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

Pressure Differential Gauging – The “CHANGE SEPARATOR” advisory will flash when the pressure differential across the oil separator reaches approximately 8 PSID (.55 Bar). Replace the oil separator element at this time. If ignored, the unit will shut down and the advisory will illuminate steadily when the pressure differential reaches 15 PSID (1 Bar).

⚠ CAUTION

Using an oil separator element at excessive pressure differential can cause damage to equipment. Replace the separator when the “Change Separator” advisory appears.

NOTICE

A sudden drop of zero pressure differential or sudden heavy oil carryover may indicate a ruptured element.

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

Removal Of Oil Separator For Inspection Or Replacement:

⚠ DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

⚠ DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

1. Be certain unit is completely off and that no air pressure is in the oil reservoir.
2. Disconnect, tag and lockout power supply to the starter.
3. Disconnect oil return to compressor tubing at tube elbow near the discharge manifold flange on the top plate.
4. Loosen the nut on fitting at manifold flange and completely withdraw the tubing through the fitting.
5. Disconnect all other tubing from discharge manifold.
6. Remove discharge manifold flange bolts.
7. Remove screws holding the top plate to the oil reservoir. Lift the top plate form the oil reservoir.

8. Lift the separator from the separator housing.

9. Inspect and/or replace the separator as necessary. Before installing (or reinstalling) any separator be sure gaskets bonded to the separator flanges are not damaged. Remove the gasket material adhering to the top plate or reservoir flange from the old separator.

10. Lower the separator into the oil reservoir.

11. Seat the top plate to the oil reservoir flange; install and tighten all cap screws.

12. Reconnect the discharge manifold pipe union and all tubing.

13. Install original oil return by slipping tube through the fitting at the discharge manifold flange until ferrule bottoms in the fitting. If a new fitting and return tube are used, slip the tube through the fitting until it touches the bottom of the separator, then raise the tube about 1/4 inch off the bottom and tighten the fitting nut securely. Connect the other end of the tube to the compressor oil return tube elbow. Do not bend tube or raise tube further than 1/4"–1/2" from the bottom of the separator.

14. Reconnect compressor oil return tube to tube elbow.

COMPRESSOR OIL SYSTEM CHECK – The following readings are based on ambient temperature of 80° F (27° C) for air–cooled oil cooler and 80° F inlet water on water–cooled oil cooler, with the system in good condition. Compressor should be at operating temperature at the time of checks. One–half hour of loaded operation is usually sufficient to reach level–out operating temperatures.

Air and Oil Discharge Temperature – 165° to 195° F (74° to 91° C) – Read at gauge on the instrument panel or check with a thermometer at the discharge housing.

Compressor Oil Inlet Temperature – 150° to 160° F (66° to 71° C) – Install a tee at the oil filter outlet and check with a thermometer.

Oil Inlet Pressure – Check at the fitting in the line near the compressor oil inlet. With air receiver pressure at 100 psi (6.9 Bar), oil inlet pressure should be 55–60 psig(3.8–4.1 Bar).

Oil Cooler Oil Pressure Differential (Air–Cooled Radiator) – Check differential across oil system by measuring oil inlet pressure as described above.

Oil Cooler Oil Pressure Differential (Water–Cooled Heat Exchanger) – 2 to 25 PSID (.1 to 1.7 Bar) (65 to 150 PSIG, 4.5 to 10.3 Bars Receiver Pressure) – Check that oil inlet pressure is correct or measure the differential between drains on the oil cooler shell.

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 core faces. As ambient temperatures and core restrictions increase, the oil cooler outlet temperature will increase. The oil inlet temperature is approximately the same as air discharge temperature – see the gauge on the instrument panel. The outlet oil temperature may be checked by installing a tee at the oil filter outlet.

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 is approximately the same as the air discharge temperature – see the gauge on the instrument panel. The oil outlet temperature may be checked by installing a tee at the oil filter outlet.

Oil Cooler Water Pressure Differential (Water–Cooled Heat Exchanger) – The water pressure differential through the heat exchanger will depend on the supply pressure, flow rate, cooler tube cleanliness and outlet pressure. The inlet and outlet water pressure may be checked at the pipe fittings supplied by the customer.

SECTION 6
AIR FILTER

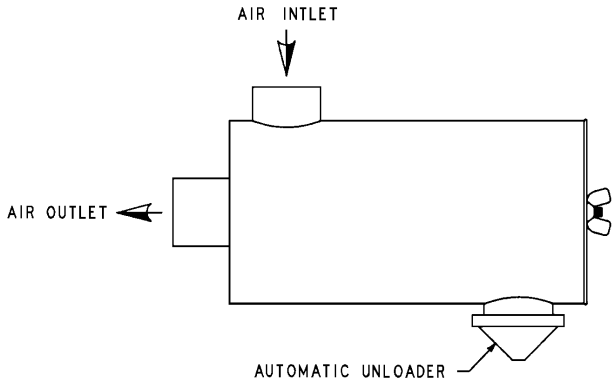


FIGURE 6–1 – HEAVY DUTY AIR FILTER (STANDARD)

HEAVY–DUTY AIR FILTER (FIGURE 6–1) furnished as standard equipment on units with an enclosure is a heavy–duty washable element dry type air 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. An improperly maintained air filter can cause a loss of compressor air delivery.

Filter Element – Service the air filter element when the "CHANGE AIR FILTER" LED is illuminated. Clean every 50 to 150 operating hours depending on dust conditions.

NOTICE

Use only genuine Gardner Denver air filter elements on Gardner Denver compressor units. Genuine parts are available through your authorized Gardner Denver distributor.

To service:

1. Remove the wingnut and pull out the filter element.
2. Visually inspect the element. If cleaning is not necessary, reinstall the filter element. If the element requires cleaning, follow steps 3, 4 and 5.
3. Wash the element by soaking about 15 minutes in warm water with a mild nonsudsing detergent. Rinse the element thoroughly with clean water; a hose may be used if the water pressure does not exceed 40 psig (2.8 Bars).
4. 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. A spare element will keep down time to a minimum.
5. Allow the element to air dry COMPLETELY. Do not expose the element to heat over 150° F (66° C). Install the element in the filter body and fasten securely with the wing nut.

⚠ WARNING

Do not oil this element. Do not wash in inflammable cleaning fluids. Do not use solvents other than water. Improper cleaning may damage the element.

NOTICE

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 downtime. Store elements in a protected area free from damage, dirt and moisture. Handle all parts with care.

Filter Element Life – The element should be replaced after six (6) cleanings or if:

1. 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.

2. Pressure drop through a filter with a freshly cleaned element is below three (3) inches (76 mm) of water with the compressor running at full load – this would indicate a rupture or crack.

Inlet Tube – Inspect the inlet screen and tube for dirt accumulation each time the filter 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.

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

SECTION 7
COUPLING

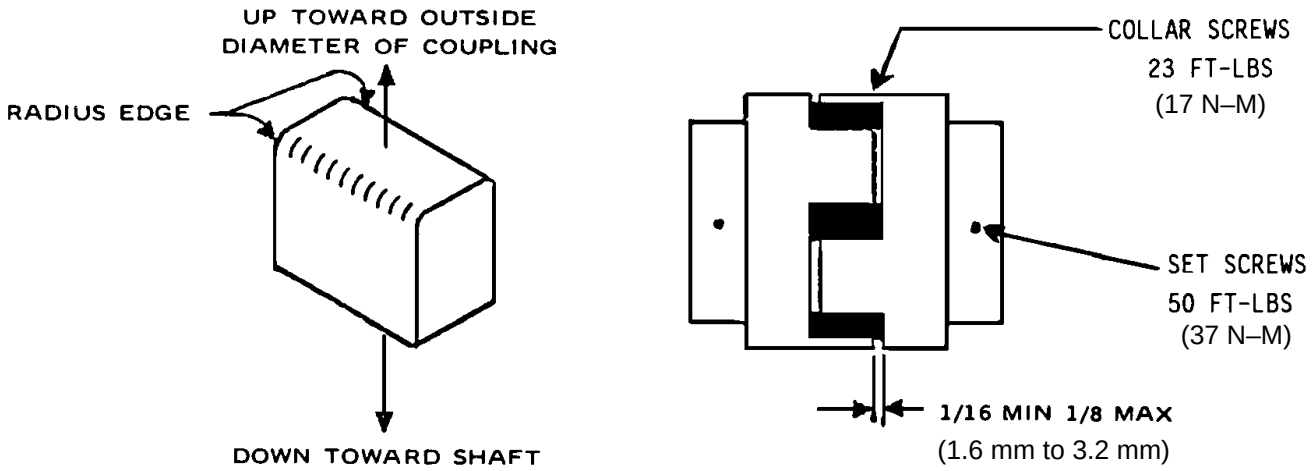


FIGURE 7–1 – INSTALLATION OF COUPLING CUSHIONS

⚠ DANGER

Rotating machinery can cause personal injury or death. Turn the unit completely off, open the main disconnect, tag and lockout before servicing the coupling.

COUPLING – The motor and compressor are direct connected by a resilient type flexible coupling with several individual cushions. The coupling does not require lubrication.

If maintenance on mating parts is requires, reassemble coupling as follows:

Individual Cushion Design (FIGURE 7–1)

1. Slide coupling halves over shaft extensions. Be sure the collar is installed on the shaft behind one coupling body.
2. Assemble the motor to the compressor.
3. Working through the coupling guard opening, center the coupling over the gap between the shafts, maintaining the gap as shown in FIGURE 7–1 between the ends of the jaws on one coupling body and the flange on the opposite coupling body. Tighten set screws in each coupling body.
4. Insert individual cushions as shown in FIGURE 7–1 and slide the collar over the cushions and secure with cap screws. Reinstall the cover plate.

⚠ DANGER

Rotating machinery can cause personal injury or death. Do not operate unit with either the coupling guard or the collar removed. All bolts and screws must be properly tightened.

Alignment – The coupling is permanently aligned by the flanges on the compressor and motor.

SECTION 8
MAINTENANCE SCHEDULE

SERVICE CHECK LIST –

Air Filter – Operating conditions determine frequency of service. If the "CHANGE AIR FILTER" message is displayed, air filter requires servicing or changing. See "Air Filter," Section 6, page 42.

Oil Separator – Operating conditions determine frequency of service. If the "CHANGE SEPARATOR" message is displayed, the oil separator element requires changing. See "Compressor Oil Separator" in Section 5, page 39, for further details.

Motor Lubrication – Refer to Section 2, page 16, and Maintenance Schedule Chart below.

Every 8 Hours Operation

1. Check the reservoir oil level – add oil if required. See Section 5, page 33. If oil consumption is high, refer to "Excessive Oil consumption, page 47. DO NOT MIX LUBRICANTS.
2. Observe if the unit loads and unloads properly.
3. Check discharge pressure and temperature.
4. Check Panel LED's for advisories.

Every 125 Hours Operation

1. Check for dirt accumulation on oil/aftercooler core faces and the cooling fan. If cleaning is required, clean the exterior fin surfaces of the cores by blowing compressed air carrying a nonflammable safety solvent in a direction opposite that of the cooling fan air flow. This cleaning operation will keep the exterior cooling surfaces clean and ensure effective heat dissipation.

Every 1000 Hours Operation

1. Change the oil filter element.

Every 8000 Hours Operation

1. Change the compressor lubricant. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY (refer to "Oil Change Interval", page 34). Flush system if required.

Every Year

1. Check the relief valve for proper operation. See Section 4, page 20.

MAINTENANCE SCHEDULE (See detail notes above)

Maintenance Action	As Indicated By Auto–Sentry®	Every 8 Hours	Every 125 Hours	Every 1000 Hours	Every 8000* Hours	Every Year
Change Air Filter	●					
Change Oil Separator	●					
Check Reservoir Oil Level		●				
Check For Proper Load/Unload		●				
Check Discharge Pressure/Temp		●				
Check Dirt Accumulation on Cooler			●			
Change Oil Filter Element	●			●		
Change Compressor Lubricant (AEON 9000 SP)	●				●	
Check Relief Valve						●

* See Oil Change Interval Chart, FIGURE 5–3, page 34, for specific lubricant life.

SECTION 9
TROUBLE SHOOTING

SYMPTOM	POSSIBLE CAUSE	REMEDY
Compressor fails to start.	1. Wrong lead connections.	1. Change leads.
	2. Blown fuses in control box.	2. Replace fuse.
	3. Motor starter overload heaters tripped.	3. Reset and investigate cause of overload.
	4. Pressure in reservoir.	4. Inspect blowdown valve. and muffler.
	5. Read error message on control panel.	5. Take appropriate action. See manual 13–9/10–647.
	6. Remote Contact is open (terminals 6 & 9).	6. Replace switch or jumper.
Compressor starts but stops after a short time.	1. High discharge temperature.	1. See “High Discharge Air Temperature,” this section, page 47.
	2. High discharge temperature switch malfunction.	2. Replace switch.
	3. Blown fuse in starter/ control box.	3. Replace fuse (investigate if fuses continue to blow).
	4. Motor starter overload heaters trip.	4. Reset and investigate cause of overload.
Compressor does not unload (or load).	1. Improperly adjusted control.	1. Refer to manual 13–9/10–647 and adjust control.
	2. Air leak in control lines.	2. Determine source of leak and correct.
	3. Restricted control line.	3. Clean control lines.
	4. Blowdown valve malfunction.	4. Repair, clean or replace valve.
Compressor cycles from load to unload excessively.	1. Insufficient receiver capacity.	1. Increase receiver size.
	2. Restriction in control tubing.	2. Inspect and clean control tubing.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Compressor is low on delivery and pressure.	1. Restricted air filter.	1. Clean or replace filter.
	2. Sticking inlet valve.	2. Inspect and clean inlet valve.
	3. Unload pressure adjusted too low.	3. Adjust the unload pressure. See manual 13–9/10–647.
	4. Minimum pressure valve stuck closed.	4. Disassemble and clean valve.
High discharge air temperature.	1. Thermostatic mixing valve stuck open.	1. Repair or replace valve.
	2. Dirty or clogged cooler face.	2. Clean cooler.
	3. Insufficient cooling air flow.	3. Provide unrestricted supply of cooling air.
	4. Clogged oil filter or cooler (interior).	4. Replace filter or clean cooler.
	5. Low compressor oil.	5. Add oil to proper level.
Excessive Oil Consumption	1. Oil carryover through lines.	1. See “Oil Carryover”, below.
	2. Oil leaks at all fittings and gaskets.	2. Tighten or replace fittings or gasket.
Oil Carry–Over	1. Overfilling the reservoir.	1. Drain excess oil from system.

DANGER

Air/oil under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

DANGER

Compressor, air/oil reservoir, separation chamber and all piping and tubing may be at high temperature during and after operation.

	2. Clogged, broken or loose oil return lines	2. Tighten or replace faulty lines.
	3. Ruptured oil separator element.	3. Replace element.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Oil Carry–Over (Continued)	4. Loose assembly.	4. Tighten all fittings and gaskets.
	5. Foam caused by use of incorrect oil.	5. Use Gardner Denver® AEON™ 9000 SP Lubricating Coolant.
	6. Inoperative minimum pressure valve.	6. Clean out or replace valve.
	7. Operation at elevated discharge temperatures.	7. Reduce temperature. See High Discharge Air Temperature, page 47, this section.
	8. Scavenge line check valve failure.	8. Replace check valve.
	9. Water condensate in oil.	9. Check oil reservoir tempera–ture and if low, change thermal mixing valve element to higher temperature.

NOTICE

Gardner Denver factory remanufactured replacement compressor air end units are available from your authorized distributor, on an exchange basis, for all rotary screw compressor units.

Gardner Denver

WARRANTY

ROTARY SCREW COMPRESSORS

OIL INJECTED • OIL FREE

GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver Machinery Inc. (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. 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 the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

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

WARRANTY PERIOD

The Company's obligation under this warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part which in its judgment proved not to be as warranted within the applicable Warranty Period as follows.

COMPRESSOR AIR ENDS

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.

Any disassembly or partial disassembly of the air end, or failure to return the "unopened" air end per Company instructions, will be cause for denial of warranty.

OTHER COMPONENTS

All other components are warranted for 12 months from date of initial use or 15 months from date of shipment to first purchaser, whichever occurs first.

LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel, for repair or replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule.

Labor costs in excess of the Company rate schedule amounts or labor provided by unauthorized service personnel is not provided for by this warranty.

All costs of transportation of product, labor or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facilities 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 the 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.

DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IT IS EXPRESSLY AGREED THAT, EXCEPT AS TO TITLE, THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY.

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR 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.

Gardner Denver

For additional information contact your local representative or
Gardner Denver Machinery Inc., Customer Service Department,
1800 Gardner Expressway, Quincy, Illinois 62301
Telephone: (800) 682-9868 FAX: (217) 224-7814

Sales and Service in all major cities.

For parts information, contact Gardner Denver,
Master Distribution Center, Memphis, TN
Telephone: (800) 245-4946 FAX: (901) 542-6159

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