GARDNER DENVER®

13–10–612
1st Edition
August, 1994

ELECTRA–SAVER®

STATIONARY SCREW

COMPRESSOR

With AUTO SENTRY®–ES CONTROLLER

MODELS

EAU_PD – 200 HP

EAU_QD – 250 HP

EAU_RD – 300 HP

OPERATING AND SERVICE MANUAL

Gardner Denver

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

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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, aggrevation and money.

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

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

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FOREWARD

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	PSI	Air Cooled	Water Cooled	Parts List
200	100, 125, 150	EAUQPD	EAUSPD	13–10–509
250	100, 125, 150	EAUQQD	EAUSQD	13–10–509
300	100, 125, 150	EAUQRD	EAUSRD	13–10–509

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GENERAL INFORMATION

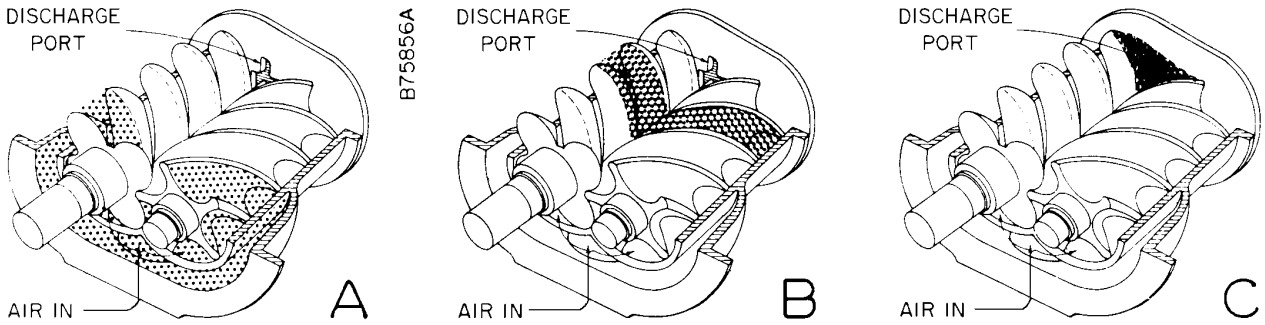

FIGURE 1–1 – COMPRESSION CYCLE

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 rotors pass the inlet port cutoff, air is trapped in the interlobe cavity and flows axially with the meshing rotors (B). As meshing continues, more of the main rotor lobe enters the secondary rotor groove, normal volume is reduced and pressure increases. Oil is injected into the cylinder to remove the heat of compression and seal internal clearances. Volume reduction and pressure increase continues until the air/oil mixture trapped in the interlobe cavity by the rotors passes the discharge port and is released to the oil reservoir (C). Each rotor cavity follows the same ”fill–compress–discharge” cycle in rapid succession to produce a discharge air flow that is continuous, smooth, and shock–free.

AIR FLOW (FIGURE 1–2 and FIGURE 1–3, Page 2) – Air enters the air filter and passes through the inlet unloader valve to the compressor. After compression, the air/oil mixture passes into the oil reservoir where most of the entrained oil is removed by velocity change and impingement and drops back into the reservoir. The air and remaining oil then passes through the oil separator; the separated oil is returned to the system through tubing connecting the separator and compressor. The air passes through the reservoir discharge manifold, discharge check valve, minimum pressure valve and the customer furnished unit shutoff globe valve to the plant air lines.

LUBRICATION, COOLING, AND SEALING – Oil is forced by air pressure from the oil reservoir through the oil cooler, thermal control (thermostatic mixing) valve and oil filter and discharges into the compressor main oil gallery. A portion of the oil is directed through internal passages to the bearings, gears, and shaft oil seal. The balance of the oil is injected directly into the compression chamber to remove the 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.

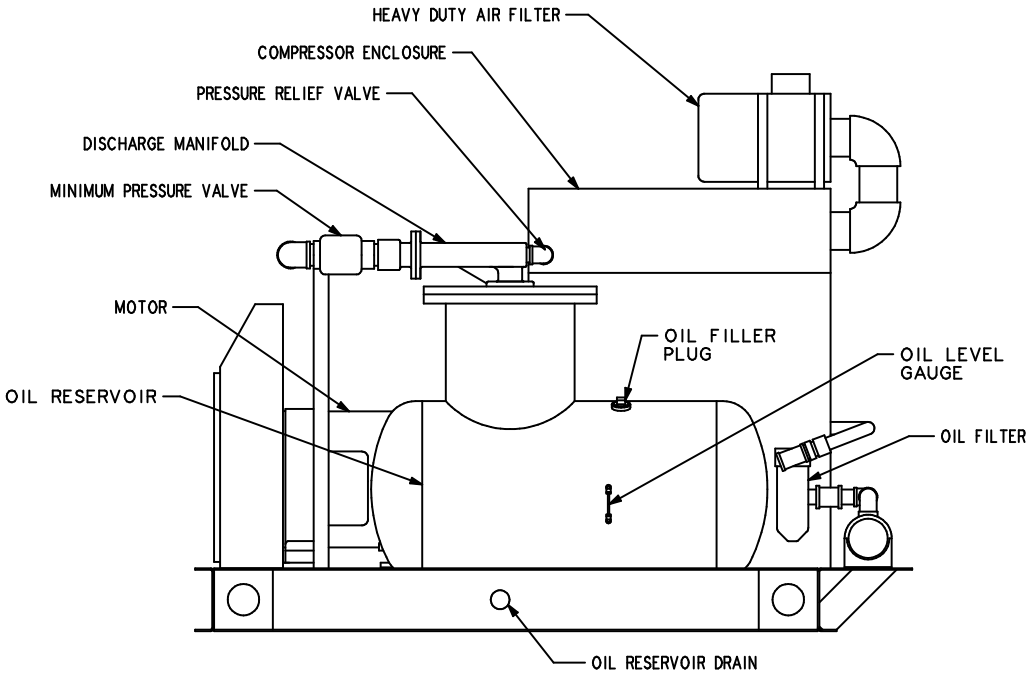

FIGURE 1–2 – PACKAGE – UNIT WITH WATER COOLED AFTERCOOLER

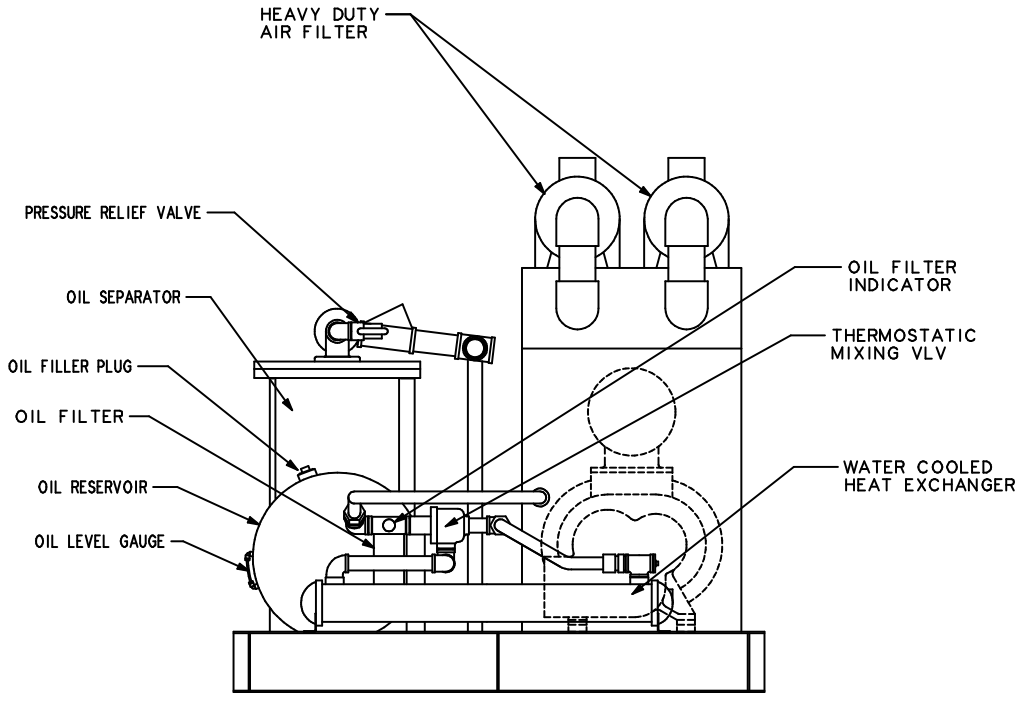

FIGURE 1–3 – PACKAGE – UNIT WITH WATER COOLED AFTERCOOLER

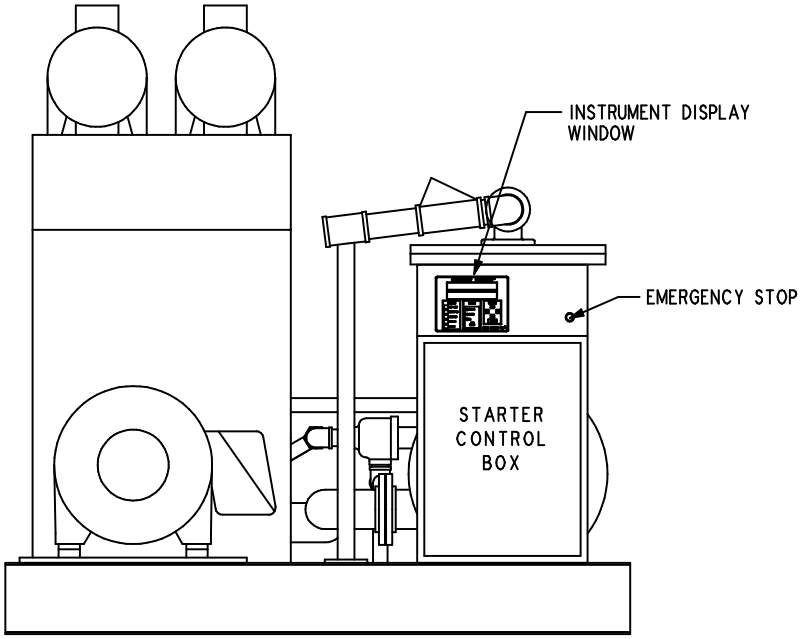

FIGURE 1–4 – STARTER BOX

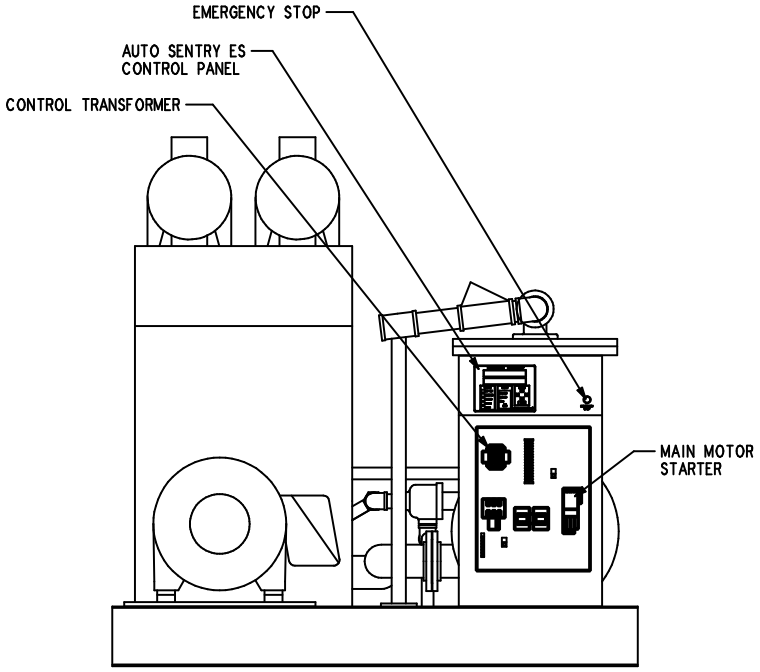

FIGURE 1–5 – PACKAGE – CONTROLLER AND STARTERS

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.

- **Keep fingers and clothing away from revolving fan, drive coupling, etc.**
- **Do not use the air discharge from this unit for breathing – not suitable for human consumption.**
- **Do not loosen or remove 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.**
- **Electrical shock can and may be fatal.**
- **Compressor unit must be grounded 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.**
- **Fan motors must remain grounded to the main base through the starter mounting panel in accordance with the National Electrical Code.**
- **Open main disconnect switch, tag and lockout before working on the control.**
- **Disconnect the compressor 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.

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

DECALS

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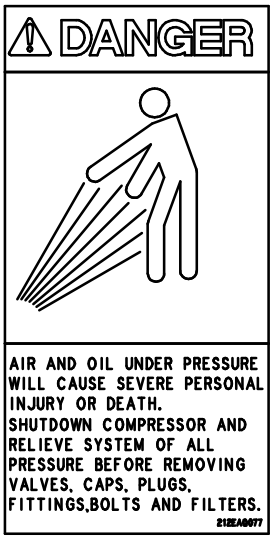

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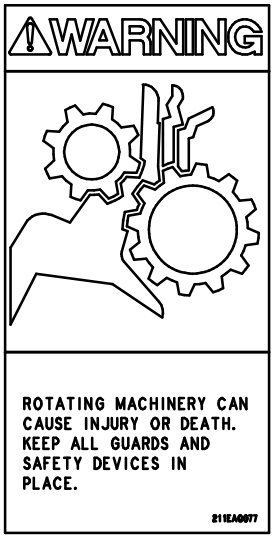

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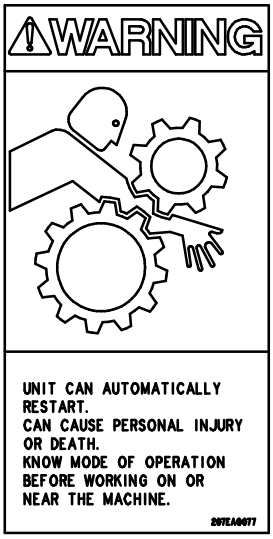

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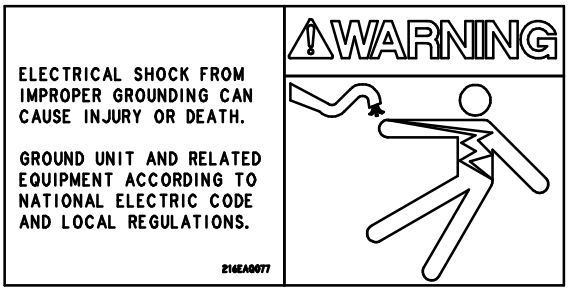

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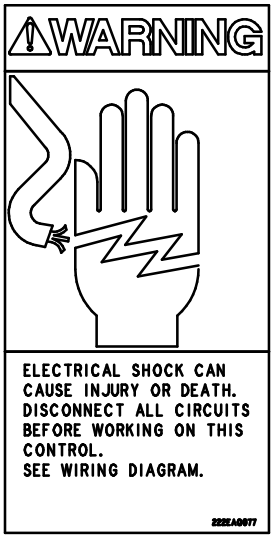

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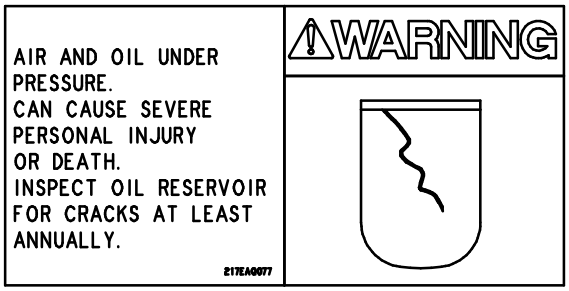

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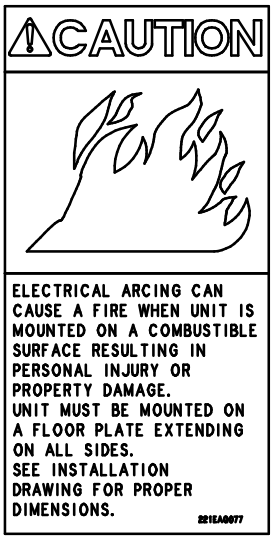

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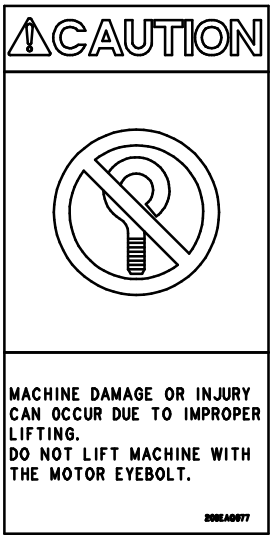

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SECTION 2
INSTALLATION

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 the 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.

LOCATION (FIGURE 2–1) – The compressor should be installed in a clean, well–lighted, well–ventilated area with ample space all around for maintenance. Select a location that provides a cool, clean, dry source of air. In some cases it may be necessary to install the air filter at some distance from the compressor to obtain a proper air supply.

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

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

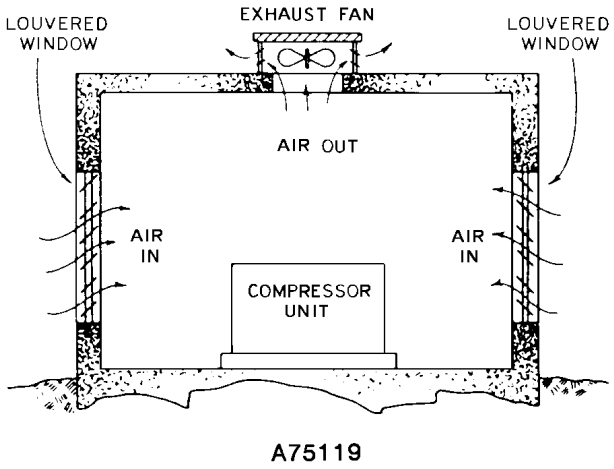


FIGURE 2–1 – TYPICAL COMPRESSOR ROOM

Size	Open Compr. Unit	Oil Cooler Module	Open Unit With Oil Cooler Module Discharge In Same Room
200 HP	8,000	23,000	31,000
250 HP	9,900	24,800	33,900
300 HP	11,900	24,000	35,900

* 80º F Inlet Air

FIGURE 2–2 – MINIMUM AIR FLOW FOR COMPRESSION AND COOLING (CUBIC FEET/MINUTE)

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 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 of 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 1–3, page 2) – The oil reservoir drain valve is located near the center of the oil reservoir just below the separator tower. The drain valve is approximately five (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 the foundation to obtain the desired drain height.
2. Construct an oil sump or trough below the floor level and pump or bail the drained oil.
3. Pump oil from the reservoir filler opening or reservoir drain to a container.

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 from the exhaust to the inlet side of the cooler. Cooling air flow direction is from the motor side through the grille side of the oil cooler. Do not obstruct the air flow to or from the cooler. Allow two (2) feet clearance on all sides of the cooler module. See FIGURE 2–2, page 8, for cooling air flow requirements.

Low Oil Pressure Protection – The standard factory–installed low oil pressure shutdown is incorporated in the functions of the Auto Sentry ”ES” Controller, and 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.

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; or overhead remote, located above level of the compressor unit, as on a roof.

⚠ WARNING

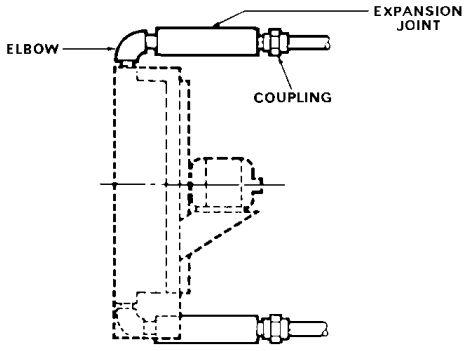
The low demand mode switch cannot be used with remote overhead oil coolers. These units require special wiring diagram – check with the factory. Use of low demand switch with an overhead cooler could result in damage to the compressor.

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:

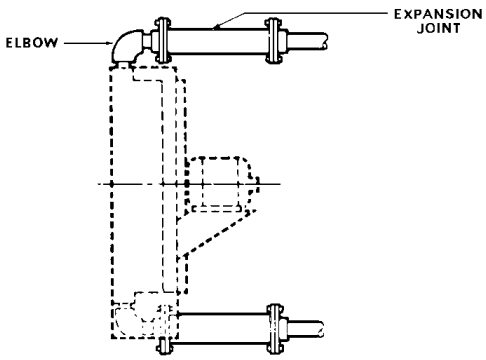
1. Location of oil cooler module – inside or outdoors.
2. Range of operating ambient temperatures at the oil cooler location.
3. Elevation of the oil cooler above the compressor unit.
4. Pipe type and size(s) to be used to connect the oil cooler and the compressor unit. Minimum pipe size is 2” NPT.
5. 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, and pipe and fittings of 3 through 6 above.

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

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



PIPING SCHEMATIC OF COOLER WITH SCREWED CONNECTIONS



PIPING SCHEMATIC OF COOLER WITH FLANGED CONNECTIONS

FIGURE 2–3 – PIPING SCHEMATIC

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 5–5, page 39. A pneumatic pilot–operated normally–closed valve is to be mounted at the oil filter inlet on the compressor unit line from the oil cooler; see FIGURE 5–5, page 39. The check valve permits oil flow to the oil cooler during operation, but prevents return oil flow from the cooler when the unit is shut down. The pilot valve is held open by air pressure from the unit oil reservoir during operation and closes under spring load when the unit is shut down to prevent return oil flow from the oil cooler.

An oil filler 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 5–4, page 38.

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

⚠ CAUTION

For aluminum oil coolers do not use any cleaning solution that is not compatible with aluminum. Use of improper solution may result in damage to the cooler.

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 1–3, page 2) – An aftercooler will provide control of moisture entering the shop air lines while reducing the 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 the customer. **The design of the aftercooler piping**

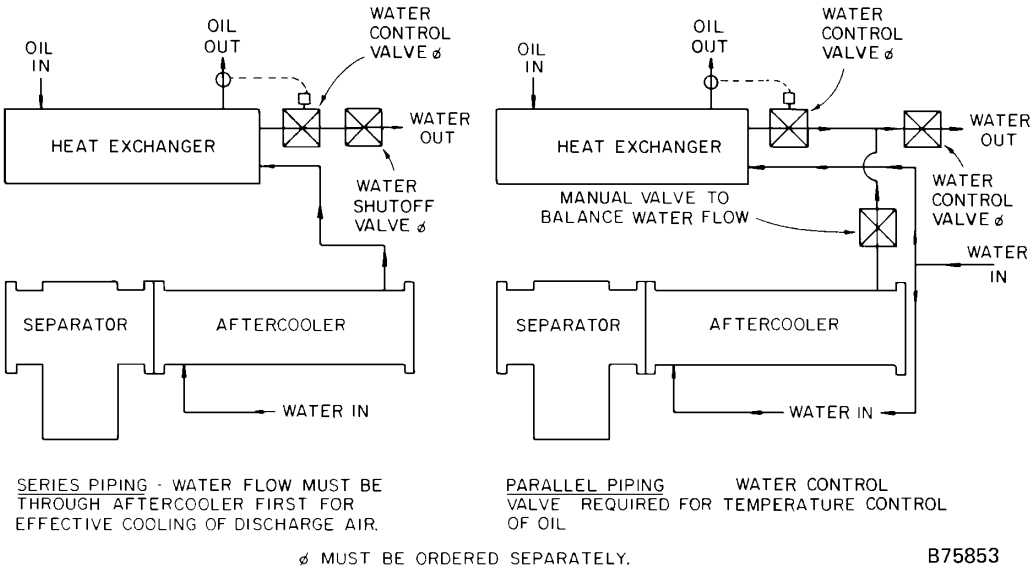


FIGURE 2–4 – PIPING DIAGRAM FOR AFTERCOOLER AND HEAT EXCHANGER

must be approved by the factory before installation. Design information to be submitted for approval includes:

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 3" 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 of 3 through 5 above.

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

INSTALLATION FOR COLD WEATHER OPERATION – It is recommended that whenever possible 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 the units outside 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 how severe the environment will get. Following are general guidelines for outside installations:

Cold Weather (Down To +10° F)

1. Be sure all control lines, drains, and traps are heated to avoid freezing of condensate. A heat tape with thermostat control is generally satisfactory for this purpose and can be obtained at various local plumbing or hardware outlets.
2. If an air–cooled aftercooler is to be used, provisions to bypass the aftercooler should 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 Lubricating Coolant.

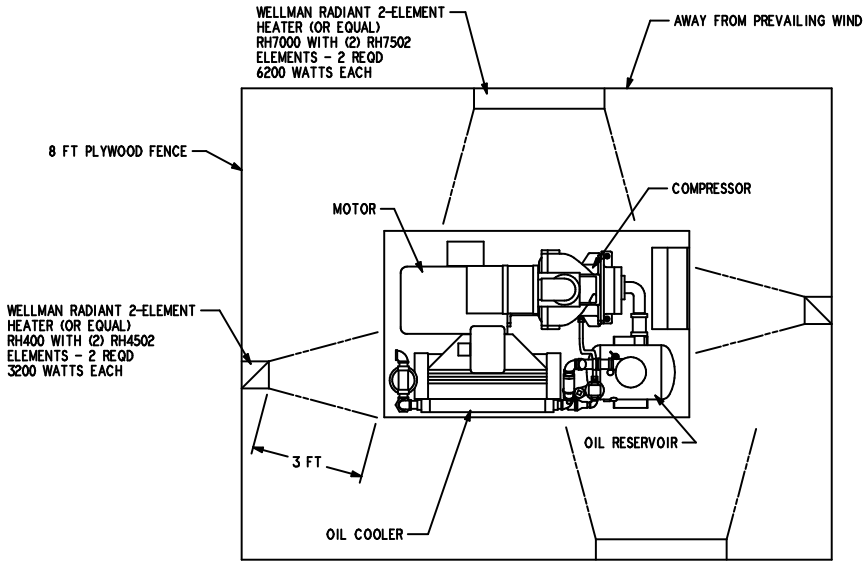


FIGURE 2–5 – INSTALLATION FOR COLD WEATHER OPERATION

5. Monitor the unit carefully during start–up and operation to be sure it is functioning normally.

6. Use NEMA 4 enclosure for electrical devices.

Extreme Cold Weather Operation (Down To –40° F.) – In addition to recommendation for +10° F. installations, 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 the 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. Heaters should be sized to provide at least a +10° F. environment for the coolers, motor, and sump. FIGURE 2–5 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.

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

INLET LINE (FIGURE 2–6) – 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

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 2–6 – INLET LINE LENGTHS

AFTERCOOLER							
Size	Rated Pressure PSIG	Water Temperature to Heat Exchanger				Maximum Water Flow	Approx. Water Pressure Drop @ Maximum Flow (PSI)
		60° F.	70° F.	80° F.	90° F.		
200 HP	ALL	19	24	32	48	60	21.0
250 HP	ALL	24	30	40	60	60	23.0
300 HP	ALL	29	36	48	——	60	25.0

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

FIGURE 2–7 – HEAT EXCHANGER (OIL COOLER) APPROXIMATE WATER FLOW (U.S. Gallons/Minute)

HEAT EXCHANGER							
Size	Rated Pressure PSIG	Water Temperature to Heat Exchanger				Maximum Water Flow	Approx. Water Pressure Drop @ Maximum Flow (PSI)
		60° F.	70° F.	80° F.	90° F.		
200 HP	ALL	4.7	5.8	7.8	11.6	37.0	3.5
250 HP	ALL	6.4	8.0	10.6	16.0	37.0	3.5
300 HP	ALL	7.9	9.9	13.2	19.7	50.0	2.0

Water flow rates (gpm) are based on 110° F. water temperature out of cooler. Maximum water flow shown is the maximum allowable flow through the aftercooler.

FIGURE 2–8 – AFTERCOOLER APPROXIMATE WATER FLOW (U.S. Gallons/Minute)

opening on the compressor. If an extra–long line is necessary, the pipe size should be increased. See FIGURE 2–6 , Page12.

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–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

Do not use the air discharged from this unit for breathing – it is not suitable for human consumption. Use of this air for breathing may result in personal injury or death.

WATER PIPING (Water–Cooled Heat Exchanger Models Only) – On machines equipped with a water–cooled heat exchanger, pipe water to the inlet of the heat exchanger. Pipe outlet water from the outlet or magnetic water shutoff valve to a sump or drain. The thermal bulb of the water flow control valve is inserted in the heat exchanger oil outlet line; refer to the unit outline drawing for location.

The water source should be capable of supplying up to the maximum flow shown in FIGURE 2–7, at a mini-

mum 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 is designed to operate with water inlet temperatures from 60° F. to 90° F., and a water outlet temperature not to exceed 110° F. If water cooler than 60° F is used, high water outlet temperatures (over 110° F.) will be experienced along with shortened heat exchanger life caused by tube fouling and corrosion. If water warmer than 90° F. is used, higher compressor oil 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 11, and FIGURE 2–7 and FIGURE 2–8, Page 13,) – 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 the 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 37 gallons per minute on 200 and 250 HP units, 50 gallons per minute on 300 HP units and the maximum water inlet 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 water 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 5–8, page 41). See Section 5 for adjustment instructions and maximum allowable oil temperature.

ELECTRICAL WIRING – The Electra–Saver® unit is furnished with the compressor motor enclosure as specified by the user. If the unit has an air–cooled oil cooler, this fan motor is a totally enclosed "air–over" or "fan–cooled type" and is complete with starter and enclosure as specified by the user. Allow 42" deep by 30" wide clear space to the nearest obstruction over control enclosure in accordance with Article 110–16(a), National Electric Code.

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

Starter – The main starter is to be mounted at a location selected by the user at the time of installation. The first three feet of line from the motor conduit box to the starter must be of flexible conduit to maintain effective vibration isolation. Electrical connections to other parts of the unit (instrument panel, fan motor, etc.) from the starter do not require flexible conduit since the compressor and motor are already isolated from these parts. See Table 110–16(a) National Electrical Code for correct working clearance.

⚠ 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 Table 250–95 of the National Electric 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 the bearings and timely lubrication. The following charts show recommended grease qualities and regreasing intervals for motors supplied with ball bearings. For additional information refer to the motor manufacturers 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 the hole of hardened grease.
4. Wipe the lubrication fitting clean and add grease with a hand–operated grease gun.
5. Leave the relief plug temporarily off. Reconnect the unit and run for about 20 minutes to 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

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

ELECTRIC MOTOR REGREASING INTERVAL

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

SECTION 3
STARTING & OPERATING PROCEDURES

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

1. **Compressor Oil** – Check oil level in the oil reservoir. Add oil only if the oil level gauge reads in the red ADD OIL range. Do not mix different types of oils. The unit is shipped filled with Gardner Denver AEON™ 4000 lubricating coolant which is suitable for the first 6000 hours under normal operating conditions. REPLACE OIL FILTER ELEMENT EVERY 1000 HOURS.

Initial fill, or filling after a complete draining of the system, may show the oil level beyond the red EXCESS oil range. After start–up, oil will fall into the operating range as system components are filled. If necessary, add oil to bring the level into the center of the RUN range when the unit is operating on load; see FIGURE 5–2, page 37, for quantity of oil required.

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 4000 petroleum base lubricant. Use only genuine Gardner Denver filters designed and specified for this compressor.

⚠ DANGER

Always stop the unit and release air pressure before removing oil filler plug. Failure to release pressure 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 will read higher than when operating on load. DO NOT DRAIN OIL TO CORRECT; on the next loaded cycle or start, oil will again fill the system and the gauge will indicate the operating level.

2. **Air Filter** – Inspect the air filter to be sure it is clean and tightly assembled. Refer to Section 6, "Air Filter", for complete servicing instructions. Be sure the inlet line, if used, is tight and clean.

3. **Coupling** – Check all bolts and cap screws for tightness. See Section 7.

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

5. **Moisture Separator Trap** – The trap is constructed of cast iron with side inlet and outlet connections and inverted bucket design. A stainless steel internal strainer is used in the trap; it should be checked periodically for clogging and replaced if necessary. Repair parts are available for the trap cap, retainer gasket, and strainer. See package outlines for mounting dimensions of the moisture separator trap.

   The moisture trap must be primed by filling with clean water prior to initial start–up of the unit.

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

7. **Grounding** – Equipment must be grounded in accordance with table 250–95 of the National Electrical Code.

⚠ WARNING

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

8. **Rotation** – Check for correct motor rotation using "JOG MODE." Compressor drive shaft rotation must be clockwise standing facing the compressor coupling.

⚠ 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 the motor to reach full speed.

9. **System Pressure** – Set the controls to the desired unload pressure and differential. DO NOT EXCEED MAXIMUM OPERATING PRESSURE ON THE COMPRESSOR NAMEPLATE. See "Programming and Setup Instructions for the Auto Sentry–ES® Controller, pages 27, 28 & 29.

⚠ 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.

10. **Operating Mode** – Refer to Section 4 for detailed information on the control system.

11. **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 UNIT COLD OR UNIT HOT 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) 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".

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.

SEQUENCING COMPRESSORS

Sequencing compressors with the AUTO SENTRY–ES controller is as simple as plugging in a telephone to a wall jack. The only item required to make the system functional is a standard telephone cable identical to cables that connect nearly every telephone to its wall jack. One less cable than the number of compressors to be sequenced is required. For example, to sequence four compressors, three cables are required. A kit, 200EAP752, is available which contains all material needed to sequence up to five compressors. This kit contains 500 feet of cable, eight modular connectors and a crimping tool to install the connectors.

In spite of the fact that it is a standard feature, and its inherent installation simplicity, the sequencing function of a multi–compressor "AUTO SENTRY–ES" system is the most fully–featured, functionally–complete control available today.

I. INSTALLATION

A proper sequencing installation requires two or more Gardner Denver rotary air compressors complete with "AUTO SENTRY–ES" controllers, piped into a common air system, interconnected as described above. All standard practices common to sound air compressor installations such as proper sizing of discharge piping, proper electrical supply and conductor sizing, and grounding are to be observed. The serial communications interface meets RS–485 standards, the most widely used interface in harsh, industrial environments today. However it is still recommended that the communications cables be routed through metallic conduit to provide them with both mechanical protection and electromagnetic shielding.

Each control circuit board has two modular jacks which accept standard RJ–12 telephone plugs. One jack is

vacant; the other has a short pigtail plugged into it. To interconnect two compressors, plug the cable into the vacant jack on each controller. For installations of more than two units, the pigtail plug must be disconnected on all controllers except the two at each end of the communications line. The order of interconnection has no effect on the system operation. The following conditions are necessary and sufficient for proper operation:

1. Every compressor must have a cable connecting it to another compressor. One less cable than the number of units sequenced, must be used.

2. Each board that has only one cable connected to it must have its pigtail plugged into the unused jack. All installations will have two such units.

3. Each unit must be programmed with the same set and reset points.

II. OPERATION

A. ESTABLISHING THE INITIAL SEQUENCE

Operation of compressors in sequence requires only a press of the 'sequence' key on each compressor in the system. Since the sequencing algorithm includes provisions for automatic relacement of a failed master or 'lead' compressor, it is important for the operator to be aware of the hierarchy of events when starting the system.

The first compressor placed in sequence mode will become the master. However, since any compressor first placed in sequence has no way of knowing whether or not a master exists, it will first assume the highest rotation number available. For example if the number of units to be sequenced is programmed at four, any compressor will start out in position four when placed in sequence mode. It will then listen on the communications line for a call from the master.

If no call is received, it will assume position three and again wait for a call from the master. After another lack of master call, it assumes position two. Subsequently, it assumes position one which makes it the master. As soon as a master is established, it immediately attempts to call all other units and assigns them successive rotation positions. The system is now active.

Before a master is established, the system is not deprived of air. This is due to one of the outstanding features of the "AUTO SENTRY–ES" sequencing system: pressure control is always executed locally at each individual compressor. The effective setpoint for compressor control is the programmed setpoint minus 3(rotation number – 1). So while a compressor (or compressors) is/are counting down towards establishing a master, they are also capable of delivering air at a pressure determined by the above formula.

To insure that two or more machines do not simultaneously decrement their rotation numbers and simultaneously become masters, it is advisable to place the desired master in sequence mode first and wait until the first decrement in rotation number is seen (about 7 seconds) before placing subsequent compressors in sequence mode. If it is desired to dictate the complete initial sequence manually, wait until the previous machine decrements one position and then place the next desired compressor in sequence mode. If it is acceptable to let the master determine the initial sequence, simply wait until the master has decremented its rotation number once, and then place all remaining compressors in sequence mode. Remember that once a master is established, no further self–decrementing is done by the individual compressors. Instead, they will wait until the master assigns them a rotation number.

Rotation numbers are displayed in the bottom display line, with the mode indication. For example, the mode indication for the current master is SEQI; for the first lag compressor, SEQ2; second lag SEQ3,etc.

B. HOW THE "AUTO SENTRY–ES" CONTROLS PRESSURE WHILE SEQUENCING

Each compressor operates exactly the same as if it were in AUTO mode with one exception: it has a dynamic setpoint. The initial setpoint is determined by the equation shown above. A compressor is started when the system pressure drops below its programmed reset point, after waiting for ['LAG START INTERVAL' times (rotation number – 1)] seconds. This prevents all lag compressors from starting at once. Note that a compressor's ['LAG START INTERVAL' times (rotation number 1)] timer is not reset to zero until that compressor is started. This means that the time for the next lag compressor to come on is always somewhat less than 'LAG START INTERVAL'.

EXAMPLE:

In a three compressor sequence system, SET PRESSURE = 100 PSI; RESET PRESSURE = 90 PSI; LAG START INTERVAL = 15 seconds. The lead compressor is running alone, maintaining 100 PSI by modulation when an air tool is brought on line causing the air demand to exceed the capacity of the lead compressor. When the pressure drops to 90 PSI, the #2 unit times out its 15 second timer and starts. It takes 5 additional seconds for the pressure to rise above 90 PSI. The #3 unit whose timer was initially set at 30 seconds (15 x [3 – 1]), has counted down 20 seconds (the total time that system pressure was below 90 PSI). If air demand increases again, the pressure will have to fall below 90 PSI for only 10 seconds more to start unit #3.

As was previously stated, a lag compressor's modula-

tion setpoint (PSET for short) is [SET PRESSURE – 3(rotation number – 1)]. Thus in the above example, the first lag compressor (rotation #2) has a PSET of 97 PSI; the second lag, 94 PSI, and so on. But look what happens in an eight compressor installation: The eighth compressor will have an initial setpoint of [100 – 3(8 – 1)], or 79 PSI. Does this mean that an eight compressor installation must operate 21 PSI below the desired operating point when all compressors are running? NO! This is where the "AUTO SENTRY–ES" dynamic setpoint control takes over. This is how it works: Whenever the system pressure is below the programmed RESET PRESSURE, the PSET of each lag compressor is incremented 1 PSI every thirty seconds. Thus, after a short interval (about five minutes in this example), the PSET of the last sequenced compressor will climb up until either it equals the RESET PRESSURE, or a decrease in demand causes the actual system pressure to rise above the RESET PRESSURE. It can be seen then, that except for short periods just after a sudden increase in demand, the "AUTO SENTRY–ES", with its dynamic setpoint control, will maintain system pressure between the limits of RESET PRESSURE and SET PRESSURE. Remember, RESET and SET PRESSURE values are programmed by the operator so the operating range is completely programmable and predictable.

Dynamic setpoint control will also work in reverse of the operation described above. Obviously, incrementing setpoints will cause overlap of the compressors' modulation ranges. While this enables us to maintain a higher pressure than competitor's sequencers, overlap is undesirable as demand decreases, because a system could end up with several compressors running partially loaded instead of running the minimum number of fully loaded compressors. To overcome this, as pressure rises through the range between RESET and SET, the lag compressors' PSET's are now decremented, reversing the effect described above during periods of high demand. – The "AUTO SENTRY–ES" keeps track of all functions at all times so there is never any mix–up of setpoints and the proper rotation sequence is always maintained.

III. THE AUTOMATIC SEQUENCE CHANGE

After the master (lead) compressor has served for the duration programmed (TRANSFER INTERVAL), it relinquishes control and assigns itself the highest available rotation number. The lag compressors detect the loss of the master and decrement their rotation numbers. Number 2 becomes number 1, the new master, number 3 becomes number 2, etc.

It should be noted also that whenever the master detects a missing rotation number, such as when a compressor is turned off that was previously in the rotation, it will automatically 'close the gap' by decrementing the rotation numbers of all compressors whose rotation numbers were greater than the missing number. Likewise, if for whatever reason, the master compressor fails to carry out its role, all lag compressors begin decrementing their rotation number until a new master is established. Regardless of the scenario, the end result will always be that the compressors that remain in rotation will always end up with the lowest possible rotation numbers.

IV. OTHER FEATURES

Any air system will exhibit pressure differences from one point to the next. Even a well designed multi–compressor installation will show 'minor' pressure variations between one compressor's discharge point and another compressor's discharge. These points will also vary with the central system (normally the air storage receiver). These pressure differences wreak havoc with conventional sequencers. If a central sequencer is used, it will be sensing a lower pressure than is seen at each compressor. With such systems, there is always a chance that the sequencer could cause a compressor to over pressure due to this pressure drop. The alternative has been to set the control sequencer to a lower pressure to prevent this or allow local override of the sequencer by the local pressure control, neither of which is desirable in the scheme of maintaining plant pressure efficiently with sequencing.

The "AUTO SENTRY–ES" sequencing system lets each compressor control itself independently about a setpoint (PSET) derived to cause staggered operation, or sequencing. The aforementioned pressure drops can also cause derogatory effects (mainly skewed, or out of sequence operation) to the sequencing algorithm used by the "AUTO SENTRY–ES".

Since these pressure variations are not constant (they will vary due to demand changes, compressor load percentage changes, and number of compressors running), any scheme to compensate for the pressure variations must be dynamic. That is, corrections must be applied rather frequently, and on the fly. The exclusive dynamic setpoint control feature enables this error correction scheme to be accomplished rather easily.

Here's how it works: The master continually receives system pressure values from every machine in the sequence rotation. The values are averaged and this average is then distributed to all lag compressors. This happens approximately once per second. All compressors, lead and lag, then compare their local pressure reading to the average and adjust their PSET by the amount of error. The effect is that all compressors are controlling to a single pressure reading, a reading that is not one that is picked up somewhere removed from the compressor, but an average of actual discharge pressures.

It should be noted that the pressure displayed on the top line by all sequenced compressors is this average.

SECTION 4 – EAU UNITS
CONTROLS & INSTRUMENTS

GENERAL – The Gardner Denver® Electra–Saver® compressor's controls and motor are prewired for the voltage and horsepower specified at the time of the order. It is necessary only to connect the motor to the customer mounted starter, connect the control box and the starter to the power supply, connect the compressor discharge air line to the shop air line, and connect the coolers to the shop water line, if the package is water cooled. A standard compressor package consists of the compressor, oil reservoir, oil cooling system and oil filter, motor, NEMA 12 control box, and controls as described below.

This compressor features the programmable control, 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.

PROTECTIVE DEVICES, ADVISORIES AND SHUTDOWNS – The "AUTO SENTRY–ES" will shut down the unit following any fault detected in the following devices. Following a shutdown, a message will be displayed to indicate the cause. The shutdown light will be displayed to indicate the cause. The shutdown light will be on if the cause still exists, or will flash if the cause has been cleared. To resume operation, the cause of the shutdown must be corrected and the controller reset by pressing the "STOP/RESET" key.

Motor Protection Devices – Overload heaters are furnished for the fan motor starter in the voltage range specified. There are three (3) overloads of proper size for the starter and its enclosure. When replacing or changing overloads refer to the heater table glued inside the starter enclosure.

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

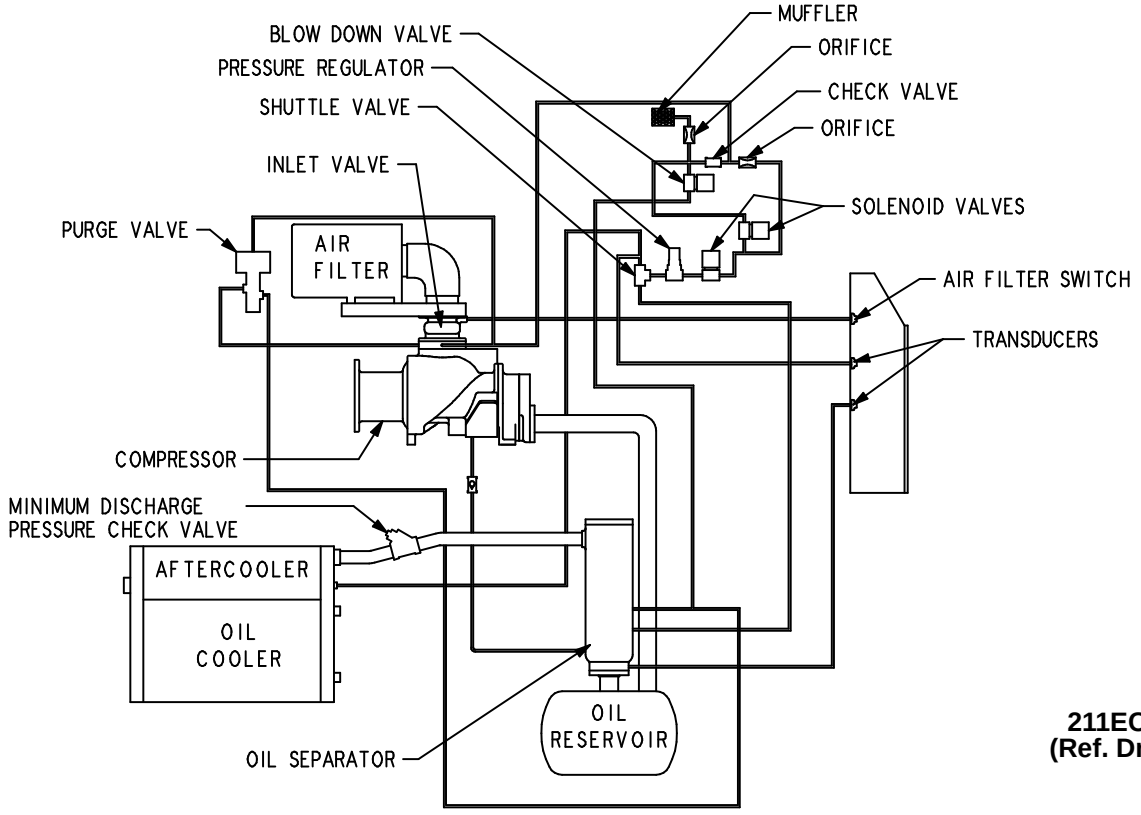


FIGURE 4–1 – SCHEMATIC TUBING DIAGRAM

High Temperature – The compressor is protected from high discharge and separator temperature by two independent thermistor probes. One probe is located in the discharge housing to sense compressor discharge air–oil mixture temperature. The second probe is located at the separator discharge and senses the temperature of the air at the oil separator. The "Auto Sentry–ES" will shut the compressor down if temperature sensed at either location exceeds 225° F. (or lower per user adjustment) or if a rapid temperature rise is detected. The location of the high temperature will be displayed. Shutdown will also occur if a shorted probe, open probe, or extreme low temperature is detected. The display will indicate the location of the defective thermistor probe.

⚠ CAUTION

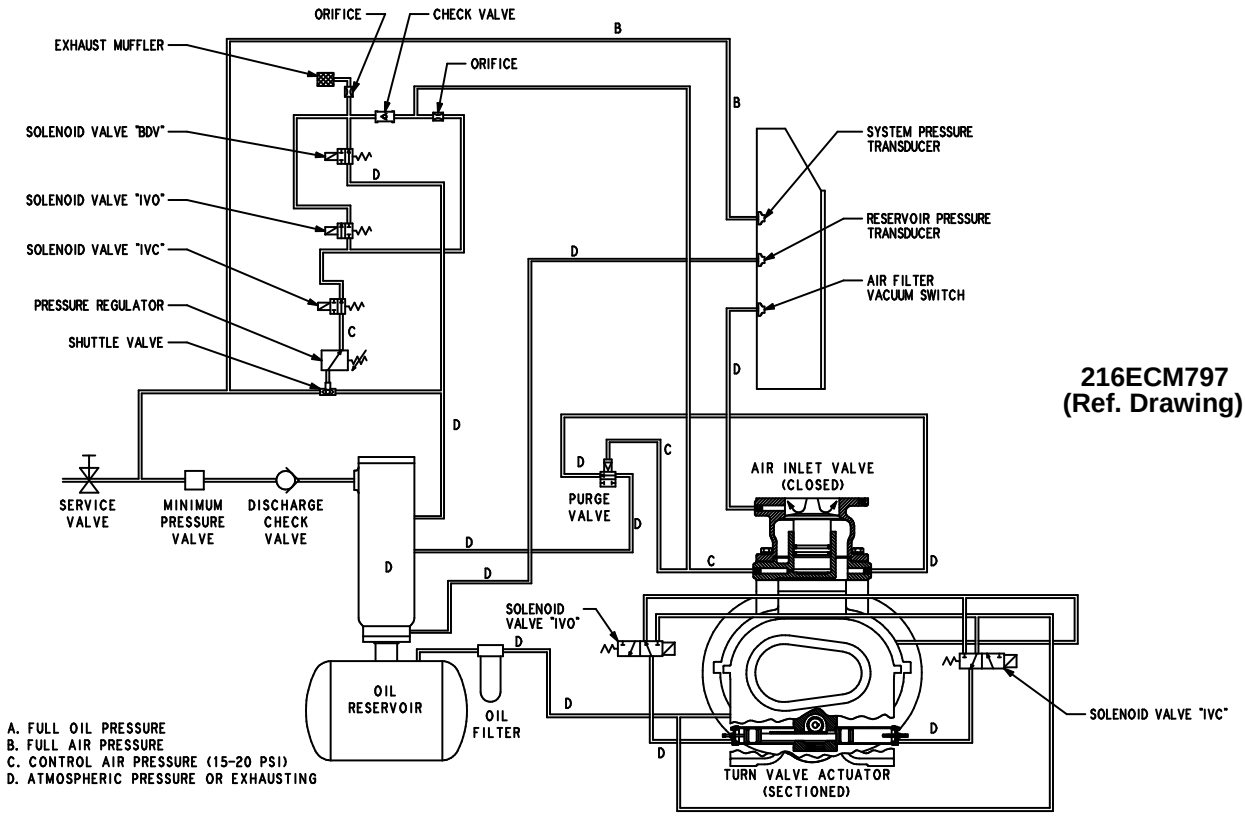
Machine damage will occur if the compressor is repeatedly restarted after high temperature stops operation. Find and correct the malfunction before resuming operation.

Separator Differential Pressure – The separator differential pressure is continually monitored by the "Auto Sentry–ES." At a differential pressure of approximately 15 psi, the unit will be shut down.

High Pressure – The "Auto Sentry–ES" will shut down the unit if excessive pressures are detected in the reservoir or system. Shut down will occur if a defective transducer is detected. The display will indicate the location of the high sensed pressure or transducer (xducer) error. Check that all adjustments have been properly made, and all connections are secure.

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

The relief valves should be tested for proper operation at least once every year. To test the relief valve, raise the system operating pressure to 75% of 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.



216ECM797 (Ref. Drawing)

FIGURE 4–2 – INLET VALVE

⚠ 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.

⚠ WARNING

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

Ensure properly set valves are installed and maintained.

⚠ CAUTION

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

Low Oil Pressure – The "Auto Sentry–ES" will shut down the unit if inadequate oil pressure to the compressor is detected. If this occurs, check the wiring and piping solenoid valves.

Emergency Stop – Pressing the emergency stop button will shut down the unit and the controller. To restart, pull the button out to its normal position and reset the controller.

Power Failure – Following power interruptions, the controller will remain in a shutdown state.

High Vibration (optional) – This optional feature will shut down the unit if abnormally high vibration is detected.

Check CN 7 (8, 9) – This indicates a wiring error or connection problem. Remove power and correct all wiring.

Blowdown Valve – (FIGURE 4–3) The blowdown solenoid valve releases pressure from the oil reservoir during any shutdown condition, and during some operating conditions. See description under "Air Control Components" in this section for construction and operation information.

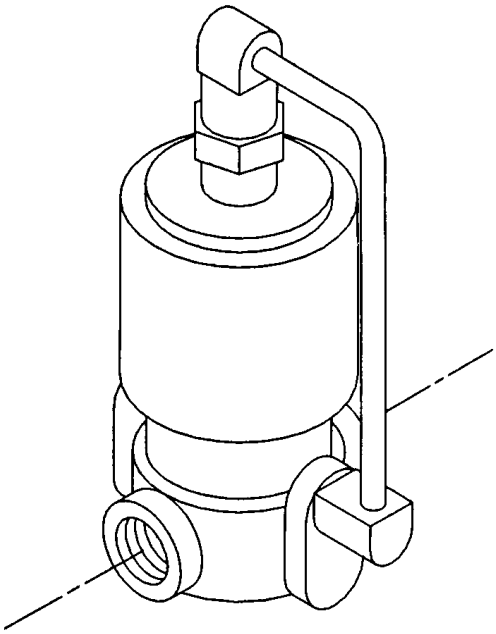


FIGURE 4–3 – BLOWDOWN VALVE

GAUGES AND DISPLAYS

Oil Filter Indicator – An oil filter indicator is located on the head of the oil filter and indicates when the oil filter needs servicing.

Oil Level – The oil level gauge is located on the side of the reservoir. See Section 5, page 5, "Lubrication, Oil Cooler, Oil Filter and Separator" for information on how to correctly read the gauge. All other instruments are part of the programmable controller.

COMPRESSOR CAPACITY CONTROL – The capacity of the compressor is controlled by the action of the Turn Valve and the Compressor Inlet Valve.

The turn valve controls compressor delivery to match demands of 40% to 100% of the compressor's maximum capacity. The inlet valve throttles to control compressor delivery to match demands of 0% to 40% of the compressors maximum capacity.

Example with normal setting of 100 PSIG:

Compressor Delivery	Inlet Valve	Turn Valve	Discharge Manifold Pressure
Full Capacity	Open	Closed	100
70% Capacity	Open	50% Open	100
40% Capacity	Open	Full Open	100
30% Capacity	Closing	Full Open	103
20% Capacity	Closing	Full Open	103
0% Capacity	Closed	Full Open	103

AIR CONTROL COMPONENTS – Refer to FIGURE 4–1, page 20, FIGURE 4–8, FIGURE 4–9, and FIGURE 4–10, pages 30 through 32, for schematic tubing diagrams.

Inlet Valve (FIGURE 4–2, page 21) – The inlet valve restricts the inlet to control capacity and closes to unload the compressor. At shutdown, the inlet valve closes to prevent backflow of air.

The inlet valve position is controlled by air pressure in its piston cylinder, which is controlled by the programmable controller through solenoid valves IVC and IVO. As pressure to the piston is increased, the valve closes to restrict air flow and compressor delivery. See FIGURE 4–8, FIGURE 4–9, and FIGURE 4–10, pages 30 through 32.

Purge Air Valve – 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.

Solenoid Valves IVC and IVO – These valves control position of the inlet valve in response to signals from the ”Auto Sentry–ES”. With both valves de–energized, the normally open IVC valve allows control pressure to the inlet valve 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 valve piston to allow the valve to open.

Pressure Regulator – 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.

Shuttle Valve – (FIGURE 4–4) 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

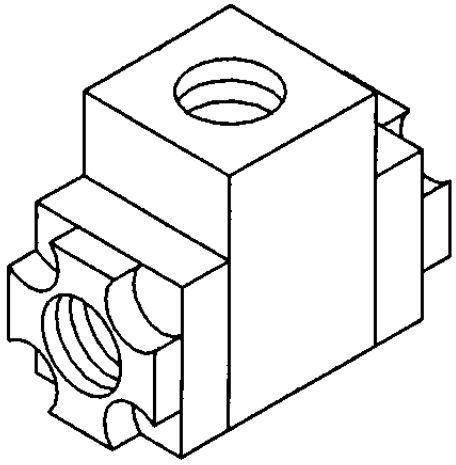


FIGURE 4–4 – SHUTTLE VALVE

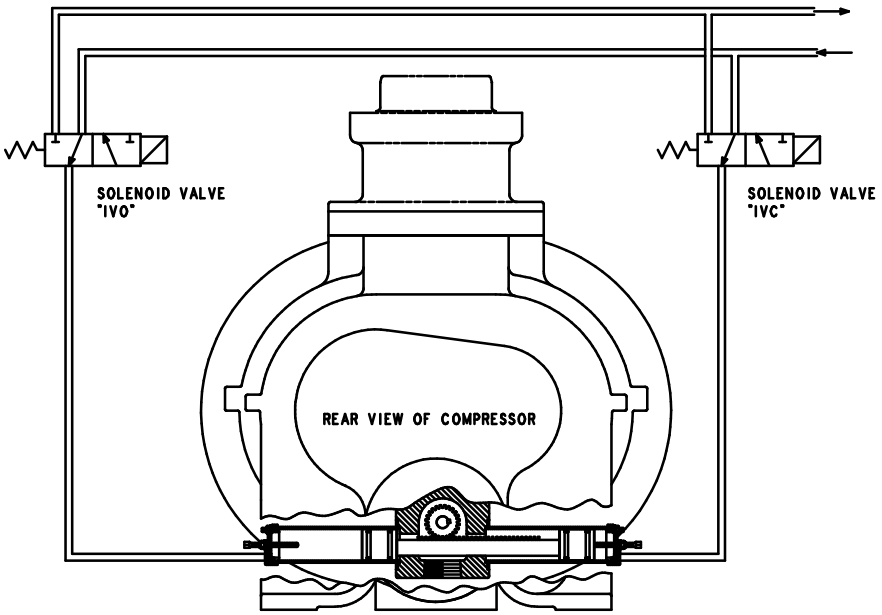
reservoir or plant air system, as required during different operating conditions.

Blowdown Valve – (FIGURE 4–3) The blowdown valve is a two–way solenoid valve which is piped into the oil reservoir outlet but ahead of the check valve. When the solenoid is de–energized, the valve opens and the oil system is blown down. When the solenoid is energized, the valve closes to allow the oil system to pressurize. A control air check valve is provided to ensure that the inlet valve closes during blowdown.

Solenoid Valves TVC and TVO – These valves control position of the turn valve in response to signals from the ”Auto Sentry–ES”. With both valves de–energized, equal pressure is supplied to both sides of the actuator to hold it in its present position. If TVC only is energized, the right side of the 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 left side of the turn valve actuator is exhausted to the compressor inlet cavity, causing the turn valve to move towards the unload position. See ”Control System Operation” in this section for a description of how the turn valve components respond during operation.

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.

Turn Valve Actuator – (FIGURE 4–5, page 24) The turn valve actuator is a rotary rack and pinion device which positions the turn valve according to system demand. Filtered oil from the compressor sump is directed to the outboard end of the two actuating cylin-



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(Ref. Drawing)

FIGURE 4–5 – TURN VALVE

ders 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 right on 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 (left side 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.

Minimum Discharge Pressure/Check Valve (FIGURE 1–5, page 3, and FIGURE 4–6, and FIGURE 4–7) – An internal spring–loaded minimum pressure/check valve is used in the final discharge line to provide a positive pressure on the oil system of the compressor even when the air service valve is fully open. The check valve portion of the valve prevents backflow of air from the shop air line when the unit stops, unloads or is shutdown.

The minimum pressure valve incorporates a spring–loaded piston which maintains approximately 65 psig in

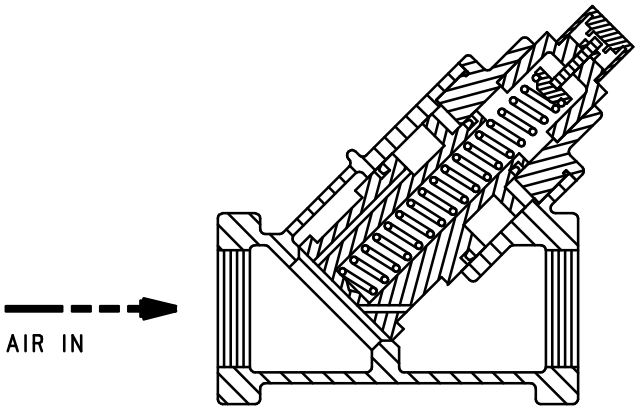

FIGURE 4–6 – MINIMUM DISCHARGE PRESSURE VALVE (OLDER MODELS)

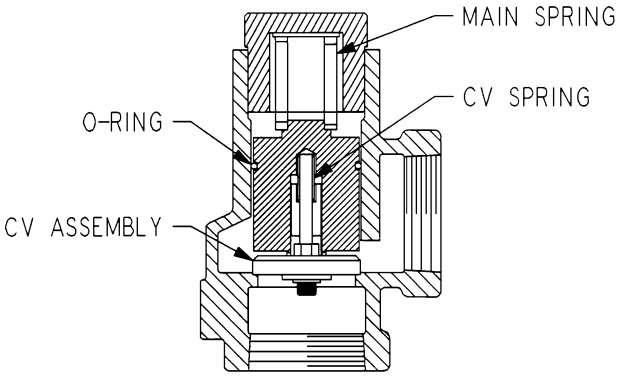

FIGURE 4–7 – MINIMUM DISCHARGE PRESSURE VALVE (CURRENT MODELS)

the oil reservoir. When the air pressure on the upstream side rises above 65 psig, the valve opens to full porting. The valve is adjustable within a small range. It is adjusted by a screw on the side of the valve. By turning the screw, the minimum pressure required to open the valve increases. Conversely, backing it out decreases the minimum pressure required to open the valve.

To service the valve, unscrew the valve cap from the body. The internal parts will all come out after the cap has been removed. Repair kits are available from your local authorized Gardner Denver Distributor.

System Pressure Transducer – This transducer is connected after the minimum pressure valve and discharge check valve. It converts the pressure in the plant air system to an electrical signal for use by the programmable controller for modulation and control.

Reservoir Pressure Transducer – This transducer is connected to the oil reservoir. Its signal is used to prevent loaded starts, monitor oil pressure, and for separator differential.

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

Vibration Switch (Optional Equipment) – The optional vibration shutdown switch, mounted on the compressor coupling cover, detects an increase in vibration that could be an indication of impending damage to the unit. The switch actuates when the selected level of vibration is exceeded.

The switch MUST BE ADJUSTED when the unit is first installed. Refer to switch manufacturer's instruction manual for complete details.

STARTER/CONTROL PANEL

The following items are located in the electrical enclosure and provide the main control of the compressor unit and switching of the motor(s). Refer to FIGURE 1–3, page 2.

AUTO SENTRY–ES – The "Auto Sentry–ES" is located on the upper section of the panel. It provides all the control of the motors and control devices for safe and efficient operation of the compressor unit. Its display provides all gauging functions, shutdown causes, and maintenance recommendations. The keypad provides the user with selection of operating modes and adjustment to tune the controls for the application. It is connected to other devices inside the panel and external devices through the terminal strip. The "Auto Sentry–ES" requires no maintenance.

Emergency Stop – 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 and should not be used for normal shutdown.

⚠ WARNING

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

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

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

Fan Starter – The starter is used to provide control and overload protection for the ventilation fans of units with enclosures. Overload heaters should be selected based on the nameplate AMPS of the fan motor. Three fuses are provided. Refer to the heater table glued inside the starter enclosure.

OPERATION

Operation of the "AUTO SENTRY–ES" 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 control in its ready state. Operation may then be started by selecting an operating mode from the controller keypad. Once operating, the operating mode may be changed at any time. The STOP/RESET key may be pressed at any time to stop the compressor under normal conditions.

An optional control may be wired to the control to interrupt and restart the unit based on controls by others. When stopped by these controls, the display will indicate REMOTE STOP.

⚠ WARNING

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

In any mode, the compressor will start only if reservoir pressure is below 5 psig. The display will indicate if the control is waiting for blowdown. The controls will keep the compressor unloaded until the start cycle has been completed.

Constant Run Mode Operation – This mode is best used in applications where there are no long periods of unloaded operation. The compressor unit will start and run continuously, using its modulation controls to match delivery to demand.

As demand falls below the compressor capacity, the pressure will rise to the setpoint of the control. When the pressure reaches the setpoint the AUTO SENTRY–ES controller operates the solenoid valves to pass pressure to the inlet valve piston and the inlet valve closes enough to match air system demand. See FIGURE 4–9, page 31.

As demand increases, the controller will modulate the inlet valve by passing pressure with the solenoid valves as required to match delivery to demand. See FIGURE 4–8, page 30.

As demand further increases, the inlet valve is held open, and delivery is controlled by the turn valve solenoids. This provides the most efficient delivery to match demand under all conditions.

Low Demand Mode Operation – The low demand mode reduces power consumption by relieving pressure in the reservoir during unloaded operation. Under loaded conditions, it will operate identically to the constant–run mode described above.

During low demand periods, the controller will open the blowdown valve and fully close the inlet valve to minimize the motor load. See FIGURE 4–10, page 32. A timer is started when this occurs. While in this state, control air pressure is supplied from the plant air system. When system air pressure drops due to increased demand, the blowdown valve recloses and the controls resume their normal modulation sequence.

Subsequent blowdown periods are not allowed until the timer has completed its cycle. This cycle eliminates the problems of oil foaming and carryover which can occur if the oil reservoir of an oil–flooded compressor is blown down too often. The timer is adjustable from 5 to 20 minutes.

Automatic Mode Operation – This mode provides automatic start and timed stop, and is best used in applications with long unloaded periods. Operation during periods of demand or moderately long unloaded periods is identical to the low demand mode.

The Auto time delay is adjustable from 5 to 30 minutes. If the controller operates unloaded for this period with no demand, the compressor drive motor is halted to eliminate its power consumption. The controls will remain in this state until demand is again indicated by a drop in pressure.

Sequence Mode Operation – This mode provides for communication between controllers, operating only as many as are required for economical operation. The lead unit operates identically to the automatic mode; operation will be automatically staged for each lag unit. Refer to Section 3 for additional description of sequenced operation.

Communication between controllers is achieved by interconnection of a communications link to circuit board connectors. A ”unit number” must be assigned to each unit to operate in this mode (see ”Programming and Setup” in this section).

CONTROLLER DISPLAY

The display above the keypad is used to provide operating information to the user. If a shutdown has occurred, the display will indicate the cause as noted above.

During normal operation the display will show the operation mode, system pressure, compressor discharge temperature, and total running hours. Alternate displays are available by pressing keypad cursor keys, and will be identified on the display. These include reservoir pressure, separator differential pressure, reservoir temperature, system pressure, and compressor discharge temperature. In Low Demand, Automatic, or Sequence modes, alternate displays also indicate remaining times of delay. If no keys are pressed for 5 seconds, the display will return to its normal mode.

The display is also used as a service reminder for normal maintenance items. These include the separator, air filter, and oil filter change intervals. All intervals are based on recommended parts as noted in the maintenance section of this manual. Oil change intervals are also automatically calculated, based on actual operating conditions. This allows maximum utilization of AEON 9000 SP oil. Messages will also be displayed if operation has occurred during low ambient temperatures, or if high temperature operation has occurred.

Clearing Advisories – Temperature advisories may be cleared while the unit is running by simply pressing the ENTER key. To reset the service advisories — CHANGE SEPARATOR, CHANGE AIR FILTER, CHANGE OIL, CHANGE OIL FILTER — perform the following steps:

1. Press the STOP/RESET key to stop operation of the compressor.
2. Relieve all air pressure.
3. Disconnect, tag and lockout power supply.
4. Perform necessary maintenance, and record it on maintenenace log.

5. Following service, put the enable switch in the down, ”+” position.
6. Restore power to the unit. The display will read:

   SHUTDOWN POWER FAILURE.
7. Press the STOP/RESET. The display will show the ready mode in the lower right hand corner.
8. Press ENTER. The display will read:

   ENTER TO SET UP AUTO TO SERVICE
9. Press AUTO. The display will read:

   OIL FILTER HOURS TILL CHANGE
10. Press ENTER. The display will read:

    HOURS TILL NEXT OIL CHANGE
11. Press ENTER. If an advisory is present, it will be displayed at this time.
12. Press ENTER to clear the advisory. The display will read:

    ENTER TO SETUP RESET TO EXIT
13. Push STOP/RESET to return to ready mode.

To prevent unauthorized programming, disconnect, tag and lockout power supply and return the ENABLE switch to the up, SET, position.

14. Restore power. The display will read:

    SHUTDOWN POWER FAILURE
15. Press STOP/RESET to clear the advisory.

PROGRAMMING AND SETUP INSTRUCTIONS FOR THE AUTO SENTRY–ES® CONTROLLER

Programming and setup is accomplished with the ”PROGRAM” keys. In all steps, the ”ENTER” key will cause the controller to accept the displayed value into memory and advance to the next programming function. The plus ”+” and minus ”–” keys will increase and decrease displayed values, respectively. The right and left arrow keys, ” → ” and ” ← ”, position the cursor (flashing digit). The number at the cursor will be the number that is changed by the ”+” and ”–” keys. At any point in the programming and setup routine, the ”STOP–RESET” key can be pressed to exit and return to the ready mode.

In all steps of the programming routine, the top line of the display will give a description of the parameter to be programmed, while the bottom line shows the variable that is capable of being altered by programming.

The following is a step by step guide to programing the ”AUTO SENTRY–ES” Controller.

NOTICE

Between each key it is necessary to press the ”ENTER” key to restore the new value and advance to the next step.

1. Press the ”ENTER” key to begin programming. If the enable switch on the circuit board is in the set position, the control proceeds to the setup adjustments starting with step 2 below. If the slide switch is down in the ”+” position, push ”ENTER” to go from **OIL FILTER CHANGE** to **OIL CHANGE** and then push ”ENTER” again to proceed to Step 2. Press ”AUTO” to display the hours remaining until oil change or filter change is recommended. If service has been performed early, press the ”AUTO” key to reset the timers to their full number of hours. Press ”ENTER” to proceed to the next display without affecting timers.
2. In the top line, **DISPLAY UNITS** is indicated. The bottom line will indicate **ENGLISH** (PSIG, Fahrenheit) or **METRIC** (Bars, Celsius). Select the desired mode and press ENTER to save and proceed.
3. In the top line, **NUM OF SEQ UNITS** is displayed. The bottom line will indicate a number in the range of one through eight. This will be factory set at ”1”. This should be set to a number corresponding to the number of compressors that are currently installed on this air system that also have AUTO SENTRY–ES controllers. It should be noted that all AUTO SENTRY–ES compressors on the system must have the same number programmed here to operate correctly in ”SEQUENCE” mode.

NOTICE

Setting the value in step 1 to one indicates that no sequencing is to take place. Consequently, steps 4, 5, and 6, which relate to sequencing, are skipped by the ”AUTO SENTRY–ES”; Programming commences at step 7.

4. In the top line, **UNIT NUMBER** is displayed. The bottom line will again indicate a number of one

through eight This will be factory set at "1". Each "AUTO SENTRY–ES" in a sequenced system must have a unique number here. The sequence mode will not function if two or more compressors have the same UNIT NUMBER. Most efficient machine–to–machine communications will occur when the lowest possible numbers are used. Example: 1, 2, and 3 for a three compressor installation.

5. In the top line, **TRANSFER INTERVAL** is displayed. The bottom line will indicate a number of hours in the range of 1 to 5000. It is factory set at 24. This is the number of hours that this machine will stay in the role of "master" or "lead" compressor. Normally it is desirable to set this value the same on all sequenced units to equalize running hours.

6. In the top line, **LAG START DELAY** is displayed. The bottom line will indicate a number in the range of 15 to 600 seconds. It is factory set at 30. This is the length of time this machine will wait before starting when the pressure drops below the reset point. Again, this is normally set to the same value for all sequenced units. Its setting will depend on the amount of air storage volume in the system.

7. In the top line, **BLOWDOWN TIME** is displayed. The bottom line will indicate a time between 5 and 20 minutes. It is factory set at 10 minutes. This is the minimum time interval between blowdowns. Limiting the blowdown frequency has been shown to prevent oil foaming and minimize wasteful dumping of compressed air when loading is likely to occur in a short time.

8. In the top line, **AUTO TIME** is displayed. The bottom line will indicate a time between 5 and 30 minutes. It too is factory set at 10 minutes. Its function is to prevent too frequent motor starting, and to allow the motor a 'cool–down' period before stopping.

9. In the top line, **START TIME** is displayed. The bottom line will indicate a time between 3 and 10 seconds. This is the time that the wye–delta starter spends in the 'start' mode. It should be set to transfer the starter to the 'run' mode as soon as the motor reaches its maximum attainable speed in the 'start' mode. If the set switch is off, the control returns to the "READY" state and may then be restarted.

NOTICE

This concludes operator accessible adjustments. The following are considered 'service adjustments'. The "SET" switch on the circuit board must be turned 'on' to proceed to the next set of programmable adjustments. The "SET" switch is located beneath the power transformer mounting plate on the left edge of the main circuit board.

10. In the top line, **HY SYS PRES LIM** is displayed. This should be set 20 – 25 PSI above nameplate pressure (equal to the relief valve setting). If this pressure is approached, the control will be forced to a blowdown and shutdown condition.

11. In the top line, **SET PRESSURE** is displayed. The bottom line will indicate a pressure value in the range of 50 to 180 PSI. It is to be set at the nameplate rating of the compressor for normal operation. Under NO circumstances, is this adjustment to be set in excess of the compressor nameplate pressure.

12. In the top line, **RESET PRESSURE** is displayed. The bottom line will indicate a pressure value in the range of 45 to 175 PSI. This setting determines the point at which machine startup occurs in AUTO and SEQUENCE modes and when the compressor will load up from the blown down condition. Note that RESET PRESSURE cannot be set within 5 PSI of the SET PRESSURE. It is necessary that all machines to be sequenced have the same SET and RESET PRESSURE setpoints.

13. The top line displays **REMOTE STOP**. Select either IMMEDIATE or TIMED STOP as the desired response to the remote input.

14. In the top line, **FILTER CHNG INT** is displayed. The bottom line will indicate a time interval of 1000 hours. This may be adjusted lower (down to 500 hours) if severe operating conditions are anticipated. After the machine has run for the programmed setting, an advisory will be displayed requesting an oil filter change.

15. In the top line, **OIL CHNG INTERVAL** is displayed. The bottom line will indicate a time interval

of 8000 hours. 8000 hours is the maximum setting, and is the proper change interval for AEON 9000 SP synthetic oil. See FIGURE 5–3, Section 5, page 37 for proper setting for AEON lubricants.

16. In the top line, **HI TEMP LIMIT** is displayed. The bottom line will indicate 225 degrees F. This is the maximum (and proper) setting for compressor operation. It may be temporarily lowered to verify the function of the temperature shutdown system.

17. In the top line, **FAN TYPE** is displayed. The bottom line will indicate either AIR COOLED or WATER COOLED. Selecting AIR COOLED places the fan under thermostatic control while WATER COOLED operation runs the fan whenever the main motor runs.

18. In the top line, **AUTO RESTART** is displayed. The bottom line will indicate either OFF or ON. Set this feature to ON when it is necessary to have the compressor automatically restart after a power interruption. This feature shall only be enabled when the owner determines that it is safe to do so. It is recommended that compressor access be limited to only trained service personnel when this feature is enabled and appropriate warnings are posted.

19. This step is only encountered if the **AUTO RESTART** function was set to ON in step 18. In the top line, RESTART TIME is displayed. The bottom line will indicate a time between 5 and 60 seconds. It is factory set at 10 seconds. This is the amount of delay introduced before restarting after power has been restored to ensure a stable supply is available and staggered starting is accomplished.

20. In the top line, **AIR END TYPE** is displayed. The bottom line will indicate either TURNVALVE or NON TURNVALVE. It is to be set as is appropriate for the compressor.

21. In the top line, **SYSTEM VOLUME** is displayed. The bottom line may be selected as SMALL, MEDIUM, or LARGE. This tunes the response of the modulation control loops to optimize loop stability. It is factory set to MEDIUM. Set as follows:

    SMALL if estimated volume is less than .25 gallon per CFM.

    MEDIUM if estimated volume is between .25 and 1.0 gallon per CFM.

    LARGE if estimated volume is greater than 1.0 gallon per CFM.

NOTICE

The setting of this parameter is not critical. When set to its most appropriate value, the controller will maintain the discharge at the closest possible value. If not set correctly, pressure will vary from the desired setpoint to a somewhat greater degree but the compressor and its components will not be adversely affected.

22. In the top line, **REMOVE SYS PRESS** is displayed. The bottom line displays the current pressure being sensed at the package discharge. At this point steps must be taken to ensure that system pressure is, in fact, zero. If necessary, remove the line to the system pressure transducer. Pressing ENTER will now cause the ”AUTO SENTRY–ES” to calibrate the transducer output to zero PSI. Obviously, pressure measurement errors will be encountered if ’zeroing’ is done with pressure at the transducer.

23. In the top line, **REMOVE RES PRESS** is displayed. The bottom line displays the current pressure being sensed in the air/oil reservoir. The reservoir pressure transducer may now be ’zeroed’ by following the steps outlined in 22 above.

24. The display now reads **PRESS CNST RUN TO JOG MOTOR**. Pressing the ”CONSTANT RUN” key will briefly energize the starters, causing compressor to rotate 1/4 to 1–1/2 revolutions to allow a rotation check.

This completes the programming and setup procedures for the ”AUTO SENTRY–ES” controller. Press the ”STOP–RESET” key to return the compressor to the ’**READY**’ mode.

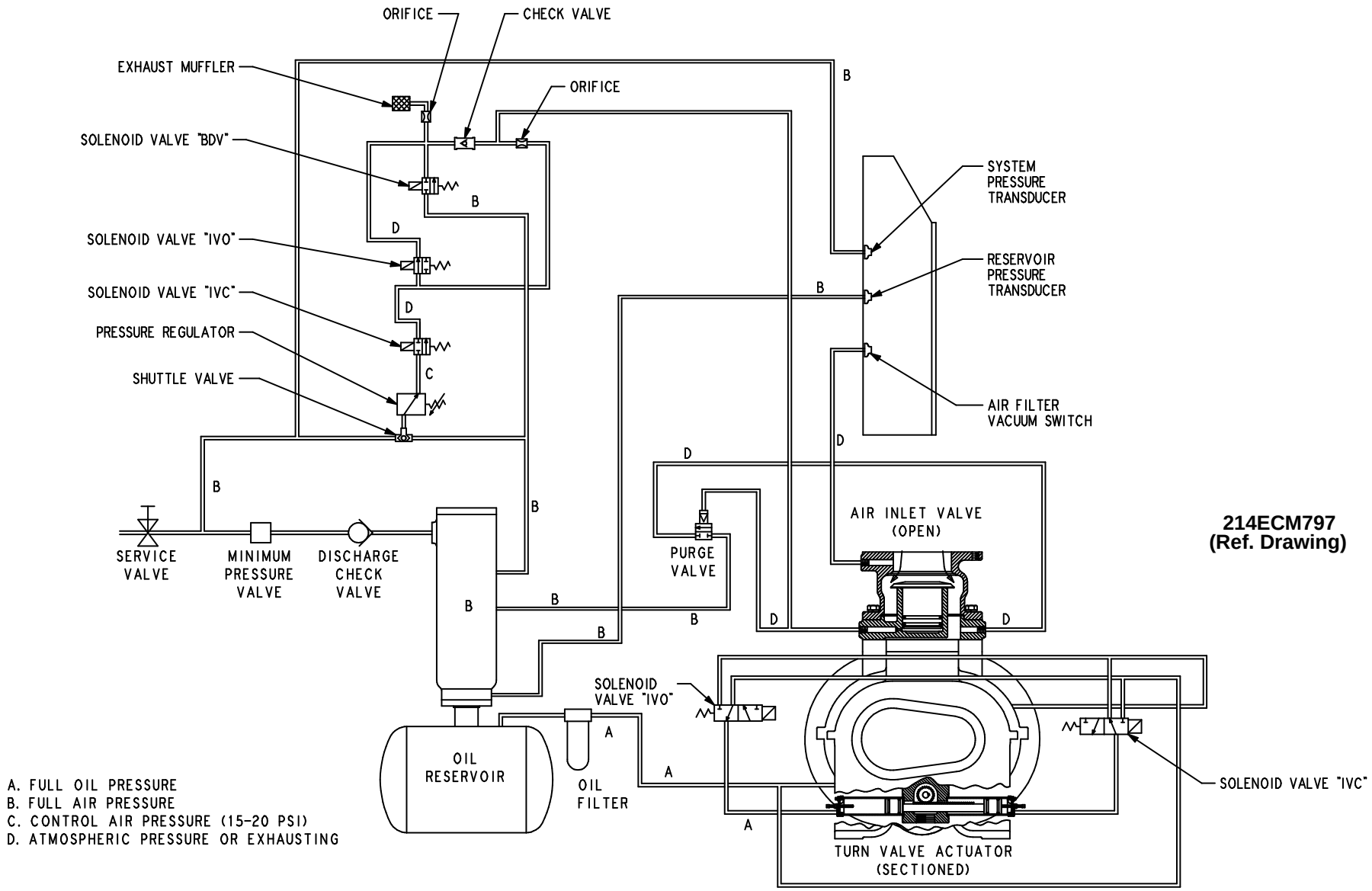

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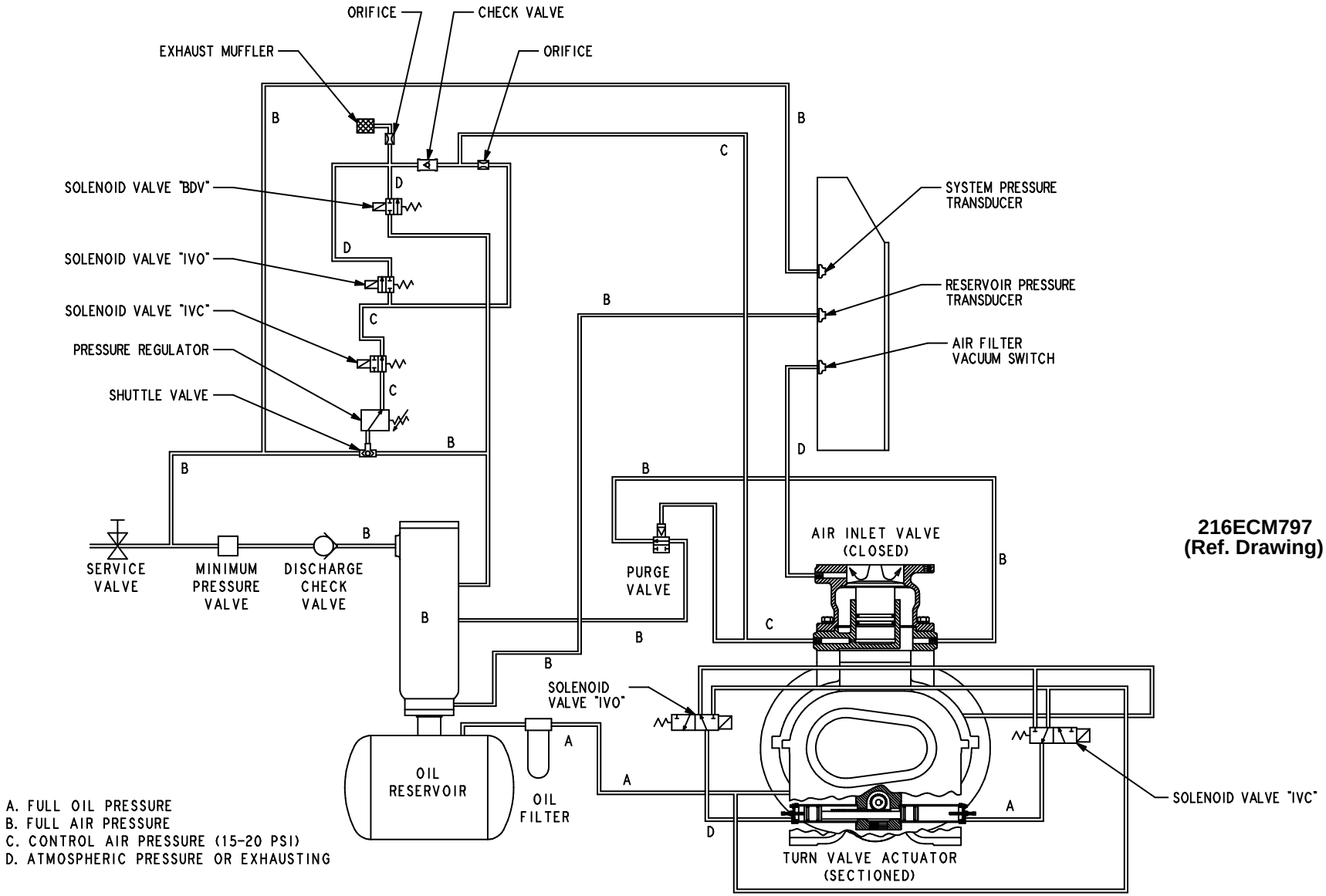
FIGURE 4–8 – CONTROL SCHEMATIC – COMPRESSOR AT FULL LOAD



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(Ref. Drawing)

FIGURE 4–9 – CONTROL SCHEMATIC – COMPRESSOR FULLY LOADED – LOW DEMAND MODE

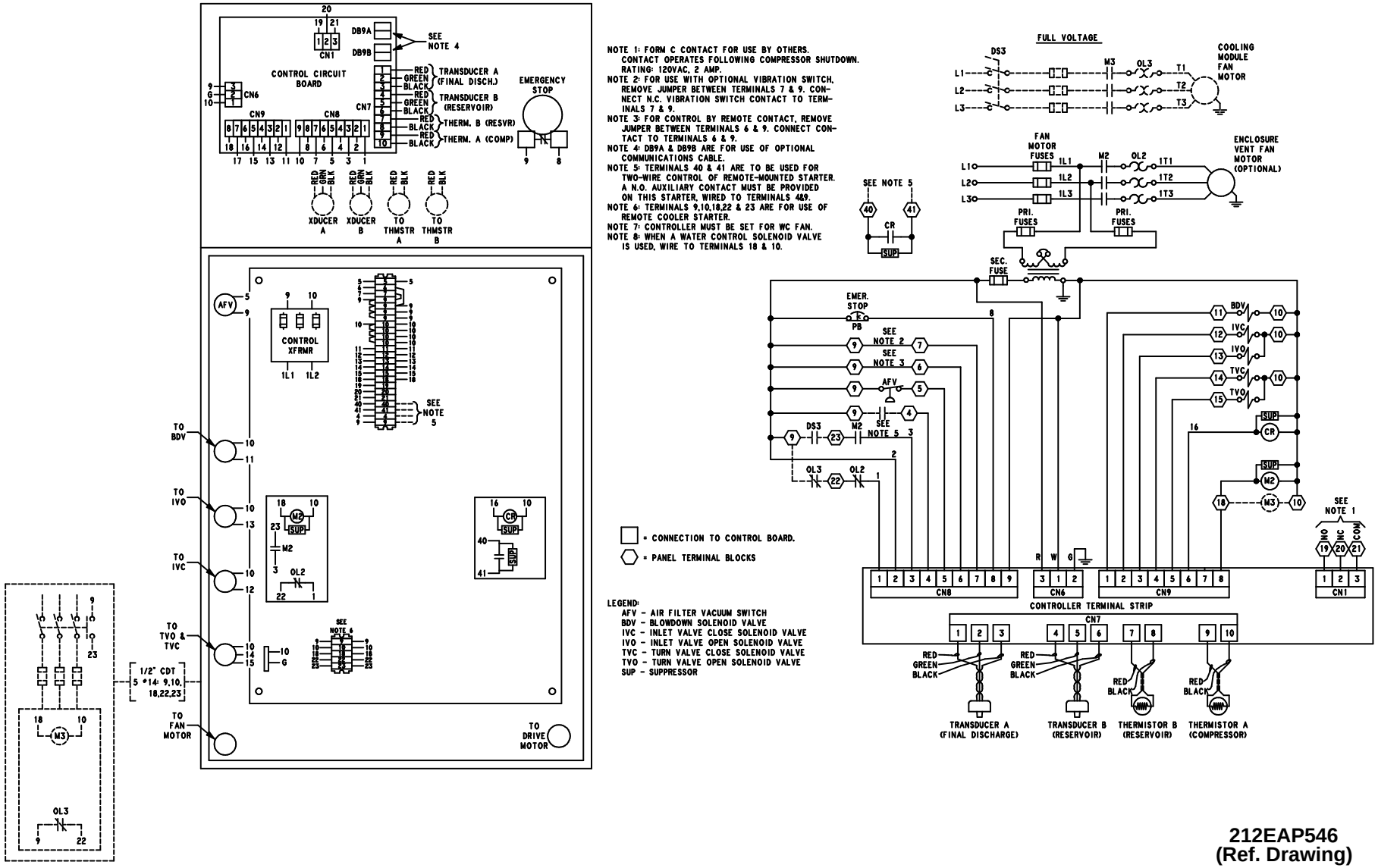

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FIGURE 4–10 – WIRING DIAGRAM

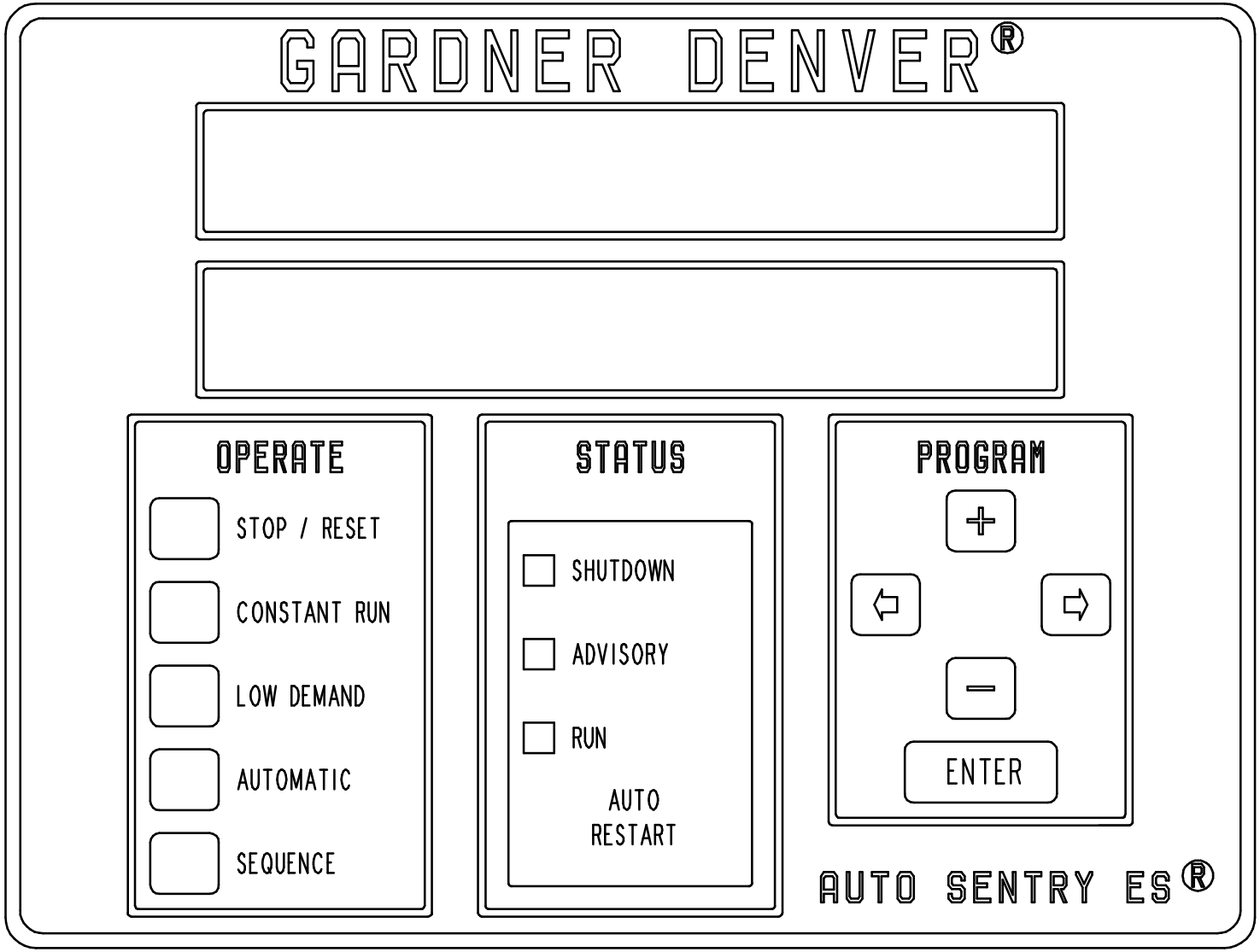


FIGURE 4–11 – AUTO SENTRY–ES CONTROLLER DISPLAY

SECTION 5
LUBRICATION,
OIL COOLER, OIL FILTER & SEPARATOR

COMPRESSOR OIL SYSTEM (FIGURE 5–1, page 35) cools the compressor, lubricates moving parts and seals internal clearances in the compression chamber.

The oil inlet line is connected at the bottom of the oil reservoir. Air pressure in the oil reservoir forces oil through the oil cooler, thermostatic mixing valve, oil filter and into the compressor main oil gallery.

The oil passes through internal passages for lubrication, cooling and sealing. The air–oil mixture is then discharged to the oil reservoir where a large part of the entrained oil drops out of the air stream; the air then passes through the final oil separator where most of the remaining oil is removed. The separated oil is returned to the compressor and the air passes to the final discharge line.

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 recommended compressor lubricant is Gardner Denver AEON™ 4000 Lubricating Coolant which can be used for year–round operation except as noted in the "High Temperature Operation" paragraph below, or low temperature, see "Installation for Cold Weather," Section 2, page 4. AEON™ 4000 Lubricating Coolant is a superior petroleum base lubricant formulated and containing additives for use in Gardner Denver compressors.

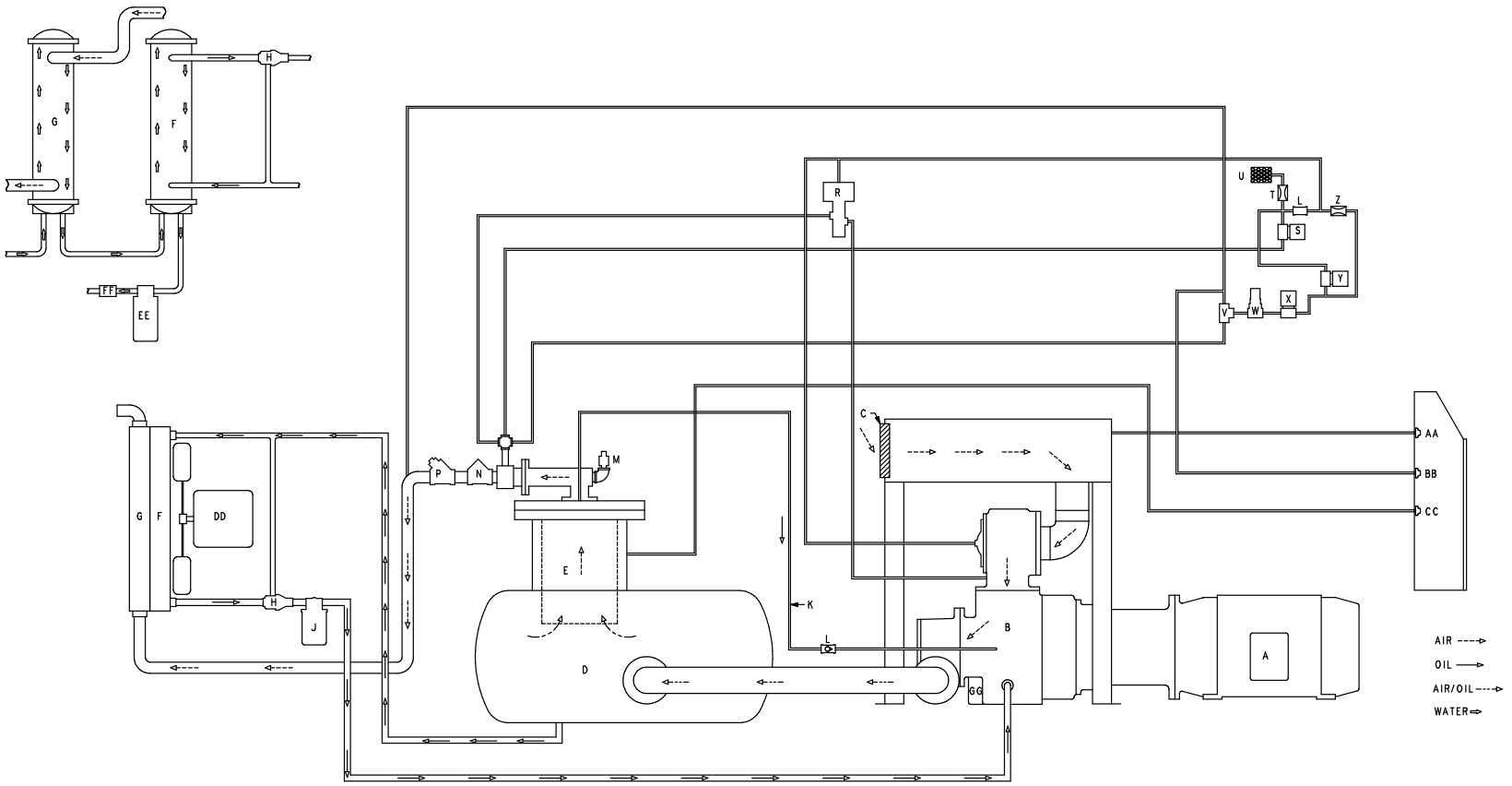
⚠ CAUTION

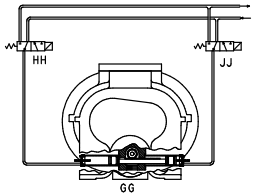
Use of improper lubricants will cause damage to equipment. Do not mix different types of lubricants or use inferior lubricants.

HIGH TEMPERATURE OPERATION – If the discharge temperature is sustained between 200–210° F for a period of more than four (4) hours due to continuing high ambient air temperature, use Gardner Denver® AEON 9000 SP Lubricating Coolant which is a superior synthetic lubricant. Short periods of up to four (4) hours of sustained discharge temperatures up to 210° F do not require a change from the recommended year–round lubricant AEON™ 4000.

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 the system:
   - Drain oil from air end and cooler while hot.
   - Break low point connections and drain oil from pipe runs.
   - Dump Oil from 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.
6. Replace the drain plug before restoring power.
7. The 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.
8. Subsequent lubricant changouts should be at normal intervals. (See Oil Change Interval chart, FIGURE 5–3, page 37.)





A–MOTOR
B–COMPRESSOR
C–AIR FILTER
D–OIL RESERVOIR
E–OIL SEPARATOR
F–OIL COOLER
G–AFTERCOOLER
H–THERMAL MIXING VALVE
J–OIL FILTER
K–SEPARATOR TO CYLINDER OIL RETURN LINE
L–CHECK VALVE
M–PRESSURE RELIEF VALVE
N–DISCHARGE CHECK VALVE
P–MINIMUM DISCHARGE PRESSURE VALVE
R–PURGE AIR VALVE
S–PNEUMATIC BLOW DOWN VALVE
T–ORIFICE
U–BLOW DOWN MUFFLER
V–SHUTTLE VALVE
W–PRESSURE REGULATOR
X–SOLENOID VALVE "IVC"
Y–SOLENOID VALVE "IVO"
Z–ORIFICE
AA–AIR FILTER VACUUM SWITCH
BB–SYSTEM PRESSURE TRANSDUCER
CC–DISCHARGE PRESSURE TRANSDUCER
DD–FAN AND MOTOR
EE–WATER FLOW CONTROL VALVE
FF–MAGNETIC WATER SHUTOFF VALVE
GG–TURN VALVE ACTUATOR
HH–SOLENOID VALVE "TVO"
JJ–SOLENOID VALVE "TVC"

215EAU797
(Ref. Drawing)

FIGURE 5–1 – FLOW DIAGRAM – AIR/OIL SYSTEM

⚠ 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, Section 8.

⚠ DANGER

Oil under pressure will cause severe personal injury or death. Shut down compressor and relieve system of all pressure, disconnect, tag and lockout power supply to 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 after high temperature stops operation. Find and correct the malfunction before resuming operation.

⚠ WARNING

All materials used in Gardner Denver compressor units are compatible with AEON™ 9000 SP Lubricating Coolant. Use caution when selecting down-stream 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 down stream components.

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

COLD AMBIENT OPERATION – See "Installation for Cold Weather Operation," Section 2, page 11.

ADDITION OF OIL BETWEEN CHANGES must be made when the oil level in the gauge is below the RUN range while the unit is operating.

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 (FIGURE 1–3, page 2).
4. Remove the oil filler plug and add oil as required to return the oil level to the center of the RUN range when the unit is operating.
5. Replace the oil filler plug BEFORE restoring power to the unit.

DO NOT OVERFILL as oil carryover will result. The quantity required to raise the oil level from the top of the ADD range to the centerline of the RUN range is shown in FIGURE 5–1, 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.

⚠ CAUTION

Excessive oil carryover can damage equipment. Never fill oil reservoir above "FULL" marker.

Size	Approx. System Capacity (Initial Fill)	Oil Reservoir Capacity** (Refill)	Qty. – Top of ADD to Centerline of RUN
200 HP	Air Cld* – 57 Water Cld – 53	50	11
250 HP	Air Cld* – 57 Water Cld – 53	50	11
300 HP	Air Cld* – 80 Water Cld – 75	70	12

* System capacity shown is for the initial fill of the compressor unit and oil cooler module ONLY – remotely mounted oil coolers will require additional oil to fill the piping between the compressor unit and the oil cooler.

** The oil reservoir refill quantity shown is measured at the centerline of the oil level gauge RUN range or approximately 3.5 inches below the centerline of the oil reservoir.

FIGURE 5–2 – OIL SYSTEM CAPACITIES (APPROXIMATE) – U.S. GALLONS

OIL LEVEL GAUGE (FIGURE 1–3, page 2) indicate the amount of oil in the oil reservoir. When the unit is stopped, the oil level will be higher in the RUN range than when operating on load. When the unit is operating, the oil level should be near the center of the RUN range. In normal operation, the oil level will fluctuate slightly as the compressor loads and unloads. Add oil only when the oil level gauge indicates in the ADD OIL range when the compressor is loaded. Drain oil only when the oil level gauge indicates EXCESS OIL when the compressor is loaded.

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, malfunctions of the thermal valve or cooling water system 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” and ”Thermal Control (Thermostatic Mixing) Valve” in this section.

OIL CHANGE INTERVAL – Recommended oil change intervals are based on oil temperature. FIGURE 5–3 shows how the Auto Sentry ES Controller figures the oil change interval at various temperatures.

Discharge Temperature	AEON 4000 Change Interval	AEON 9000 SP Change Interval
Up to 180° F	6000 hrs.	8000 hrs.
180 to 190° F	4500 hrs.	6000 hrs.
190 to 200° F	3000 hrs.	4000 hrs.
200 +	1500 hrs.	2000 hrs.

FIGURE 5–3 – OIL CHANGE INTERVAL

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 1000 hours on a new unit.

⚠ CAUTION

Change the oil filter every 1000 hours.

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.

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

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 elements 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.

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 RUN range. (Refer to FIGURE 5–2, page 37, for the oil quantity required to fill the compressor oil system. This amount may bring the oil level into the EXCESS OIL range on the gauge. Install oil filler plug. After a short time of operation, the oil level will drop into the RUN range as oil fills other areas of the system.)
5. Shut down unit, allowing the oil to settle, and be certain all pressure is relieved.
6. Add oil, if necessary, to bring the level to the RUN range.

On unloaded operation and after shutdown some oil will drain back into the oil reservoir and the oil level gauge may read in EXCESS OIL range. DO NOT DRAIN OIL TO CORRECT! On the next start, oil will again fill the system and the gauge will indicate the operating oil level.

COMPRESSOR OIL FILTER (FIGURE 5–4) – This replaceable element filter is a vital part in maintaining a trouble–free compressor since it removes dirt and abrasives from the circulated oil. The filter is equipped with a relief valve that opens in the event the element becomes dirty enough to block the flow of oil.

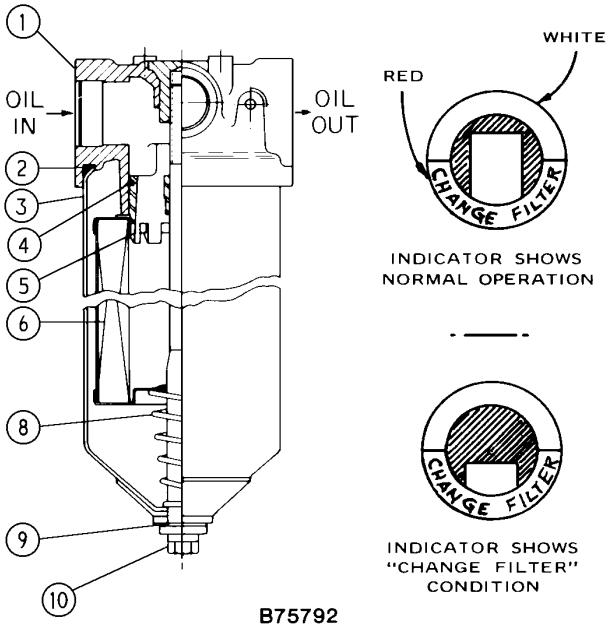


FIGURE 5–4 – COMPRESSOR OIL FILTER

⚠ CAUTION

Element must be replaced every 1000 hours or sooner, or when top of the indicator on the filter is in the red CHANGE FILTER half of the window. Unit must be running and warmed up for indicator to read accurately. Check with light to be certain of indicator position – some lubricants will obscure the indicator.

⚠ 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.

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

Refer to FIGURE 5–4, page 38, for the following instructions:

1. To remove cannister (3) rotate tie bolt (10) counterclockwise until the cannister is free of head assembly (1).
2. Remove the element (6) from the cannister. Remove indicator assembly (5) from the element by inserting a screwdriver between the indicator assembly and element and carefully prying downward. Inspect O–ring (4) for cuts or excessive wear and discard the element. Rinse out cannister with clean fluid to remove any contamination.
3. Remove O–ring (2) from the head assembly and inspect for cuts or excessive wear. Wipe O–ring area of the head (1) with clean cloth and after covering O–ring with oil, reinstall in the head assembly. Check the indicator assembly (5) machined bore in the head for burrs or deep scratches and carefully smooth out if required.
4. Install the indicator assembly (5) into the new element. Place the element into the cannister making sure the spring (8), washer gasket (9) and tie bolt (10) are in proper position.

NOTICE

The large diameter end of the spring should contact the new element.

5. Place cannister as previously assembled into head assembly and rotate clockwise until torqued to 20 foot–pounds.
6. If leakage appears at bottom of cannister, replace washer gasket (9). If leakage appears at top of cannister, replace O–ring (2). If this does not stop the leakage, the cannister must be nicked or distorted by overtorquing and should be replaced.

COMPRESSOR OIL COOLER (RADIATOR TYPE) – (FIGURE 5–5) 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, 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

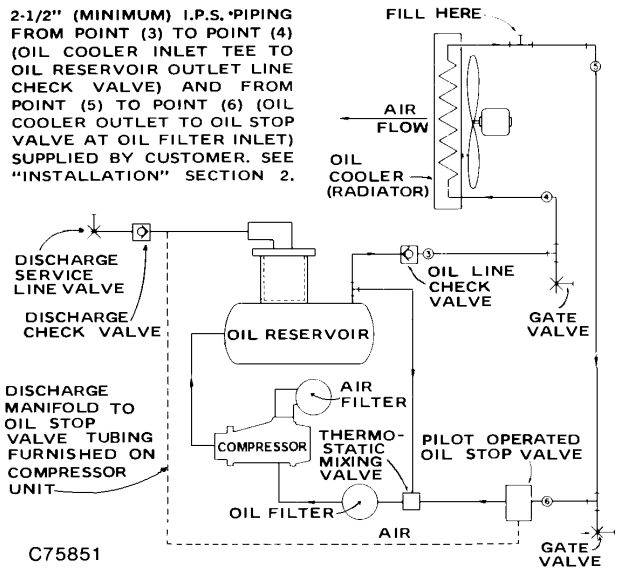


FIGURE 5–5 – OIL FLOW DIAGRAM – REMOTE OVERHEAD MOUNTED OIL COOLER

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.

⚠ 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.

HEAT EXCHANGER (OIL) PIPING – All remote elevated cooler applications must be sent through Engi-

neering 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.

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.

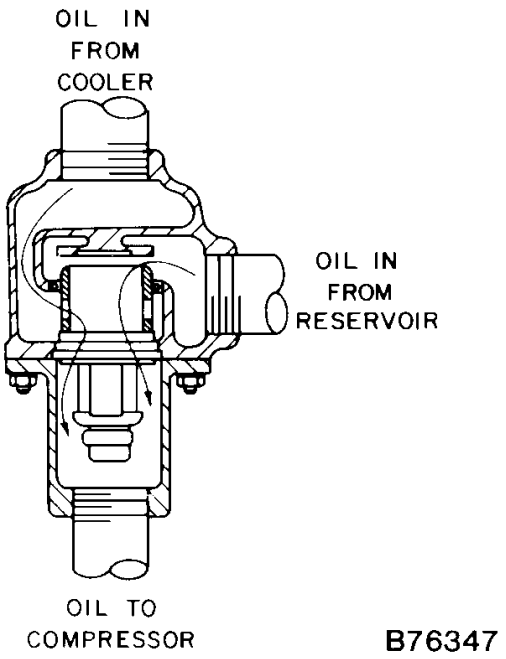


FIGURE 5–6 – THERMAL CONTROL (THERMOSTATIC MIXING) VALVE

Kit number EAU68133 includes the oil stop valve, check valve and flanges and must be installed on all remote elevated coolers per FIGURE 5–4, page 38, and the following instructions.

1. Mount the check valve (90J113).
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 (90AR243) 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 (FIGURE 5–5) on current units is installed in the system as shown in FIGURE 5–1, page 35. (On early units this valve is in the line between the reservoir and cooler.) This valve is used to control temperature of the oil in both radiator and tube type oil cooler systems. The element is so designed that a portion of the oil can flow through the oil cooler at all times. On start–up with the unit cold, the element is open to bypass, allowing oil to pass directly from the reservoir to the compressor during warm–up. As oil warms, the 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 injected into the compressor at a minimum of 150° F. (On early units compressor discharge temperature is maintained at a minimum of 70° F. above ambient temperature.) This system provides proper compressor warm–up and prevents moisture contamination of the oil.

To check element, heat in oil – it should be fully extended at 150° F. (180° F. for early units). If the unit shuts down due to high air discharge temperature, the cause may be that the element is stuck open to the bypass, in which case lines 1 and 2 (FIGURE 5–1, page 35) will be hot to touch and lines 3 and 4 much cooler. When flushing the oil system, remove the mixing valve and clean all parts thoroughly.

COMPRESSOR OIL COOLER – WATER COOLED HEAT EXCHANGER (FIGURE 1–3, page 2) – 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 control (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. Fittings in the oil cooler at these locations are equipped with a pipe tap for a

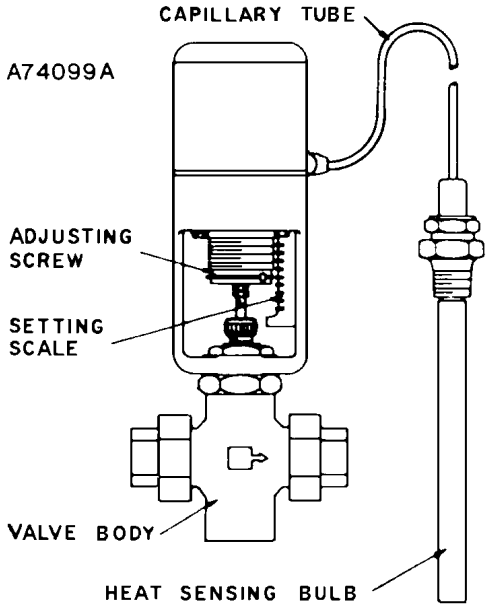


FIGURE 5–7 – WATER CONTROL VALVE

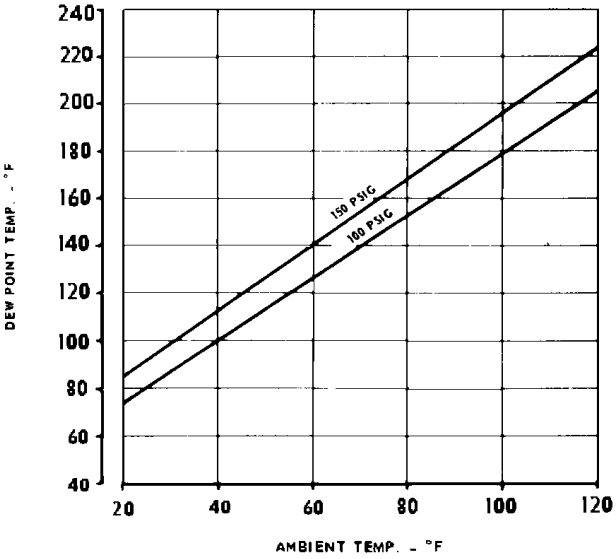


FIGURE 5–8 – DEW POINT TEMPERATURE VS. AMBIENT TEMPERATURE (100% RELATIVE HUMIDITY)

gauge. At normal operating air service pressure (65 to 150 PSIG) with unit warm, a pressure drop of 2 to 25 PSI can be expected between the oil inlet and the oil outlet.

Water pressure drop from water inlet to outlet will vary with the inlet pressure and amount of water flowing. A normal pressure drop may range from 5 to 40 PSI. Any change in the pressure drop from that normally held may indicate tube leakage or fouling and should be investigated.

In many instances, the cooling water supply for the heat exchanger will contain impurities dissolved in solution and/or in suspension. These substances can cause scale formations, corrosion and fouling (plugging) of any water–cooled heat exchanger equipment. Disregarding the possibility that one or more of these conditions exists may result in increased maintenance and operation expense, reduced equipment life and emergency shutdown. It is strongly recommended that a reputable, local water treatment concern be engaged to establish the corrosion, scale–forming and fouling tendency of the cooling water and take steps necessary to remedy the situation if a problem does exist.

The need for water treatment may only involve filtration (screening) to remove debris, sand and/or silt in the cooling water supply. However, chemical treatment methods may be necessary in certain instances to inhibit corrosion and/or remove suspended solids to alter the water's tendency to form scale deposits, or prevent growth of microorganisms. The normal maintenance program for the unit should include periodic cleaning on the tube side (water side) of the heat exchanger to remove deposits which enhance fouling and corrosion.

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 in length.

WATER FLOW CONTROL VALVE FOR HEAT EXCHANGER (Optional Equipment) – Recommended To Conserve Water Where Appropriate – (FIGURE 5–7 and FIGURE 5–8) The water flow control valve is adjustable to compensate for varying water inlet temperatures and pressures (thermal control valve prevents settings below approximate 180° F.). Use the discharge air temperature gauge on the instrument panel to set flow control valve for minimum water usage to maintain discharge temperature at a minimum of 10° F. above dew point at the maximum anticipated ambient; refer to FIGURE 5–8 for the dew point temperature at your operating pressure and ambient temperatures.

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

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

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

WATER SHUTOFF VALVE – WATER–COOLED HEAT EXCHANGER (Optional Equipment But Recommended) (FIGURE 5–1, page 35) – A magnetic solenoid–operated water shutoff valve rated at 150 PSIG water pressure should be mounted in the water inlet line ahead of the oil cooler. The valve should be wired into the compressor control circuit in such a manner that the valve opens to allow water to flow any time the ON–OFF push button is ON and the compressor is running. When the compressor stops under automatic control, or is shut off manually, the valve should close, stopping water flow through the system.

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

COMPRESSOR OIL SEPARATOR located in the vertical section of the oil reservoir consists of a single high efficiency, pleated element and provides the final removal of oil from the air stream. Oil from inside the separator element is returned through tubing to the compressor cylinder.

Oil carry–over through the service lines may be caused by a faulty oil separator, faulty minimum pressure valve, overfilling of the oil reservoir, oil that foams, moisture in the oil, or oil return line malfunction. If oil carryover occurs, inspect the separators only after it is determined that the oil level is not too high, the oil is not foaming excessively, the oil return line from the discharge manifold to the compressor cylinder is not clogged or pinched off, the return tubes inside the separators are not loose or broken, 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 carry–over 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 carry–over.

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 PSI. 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 PSI.

⚠ CAUTION

Using an oil separator element at excessive pressure differential can cause damage to equipment. Replace separator when the ”CHANGE SEPARATOR” Advisory appears.

NOTICE

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

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

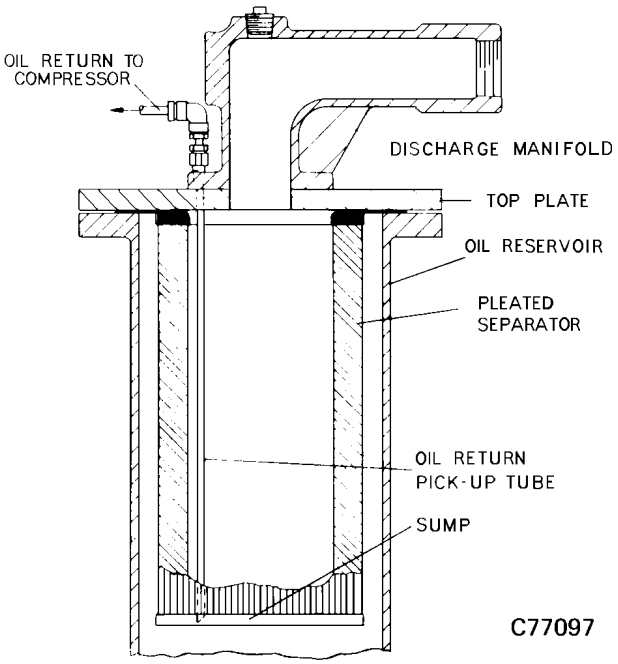


FIGURE 5–9 – SINGLE–ELEMENT OIL SEPARATOR

Removal Of Oil Separators For Inspection Or Replacement (FIGURE 5–9):

⚠ 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. Be certain 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. Disconnect oil return to the compressor tubing at the tube elbow near the discharge manifold flange on the top plate.
4. Loosen the nut on the fitting at the manifold flange and completely withdraw the tubing through the fitting.
5. Disconnect all other tubing from the discharge manifold.
6. Disconnect the discharge manifold pipe union.
7. Remove screws holding the top plate to the oil reservoir. Lift the top plate from the oil reservoir.
8. Lift the separator from the oil reservoir.
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 any old gasket material adhering to the top plate or reservoir flange from old separators.
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 the original oil return by slipping the tube through the fitting at the discharge manifold 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” off the bottom and tighten the fitting nut securely. Connect the other end of the tube to the compressor oil return elbow. Do not bend the tube to fit or raise the tube any further than 1/4” – 1/2” from the bottom of the separator.
14. Reconnect the compressor oil return tube to the tube elbow.

COMPRESSOR OIL SYSTEM CHECK – The compressor should be at operating temperature at the time of the checks. One–half hour of loaded operation is usually sufficient to reach level–out operating temperatures. The data shown below is for an oil system in good condition.

If the unit will operate at discharge temperatures over 200° F. for more than 4 consecutive hours, refer to the ”High Temperature Operation” paragraph and select a lubricant for the service. Regardless of level of sustained discharge temperature, the high discharge air temperature switch must never be set higher than 225° F. shutdown temperature.

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

Ambient Temp. (° F.)		80	90	100
200 HP	Discharge	178	188	198
250 HP	Temperature	185	195	205*
300 HP	° F.	192	201*	212*

* For temperatures above 200° F. see "High Temperature Operation."

FIGURE 5–10 – DISCHARGE TEMPERATURE CHART

For Air Cooled Oil Systems, FIGURE 5–10 shows the normal upper limit of discharge temperatures for varying ambient temperatures beginning at the system design point of 80° F. At ambient temperatures below 80° F., the mixing valve will hold the discharge temperature at the 80° F. ambient temperature point. Above 80° F., the oil cooler is fully used and the discharge temperature varies degree for degree with the ambient temperature.

For Water Cooled Oil Systems, the water flows at various temperatures outlined in Section 2 will hold the discharge temperature below the 80° F. ambient temperature level of FIGURE 5–10. Small variations in specific water flows or temperatures will not be noted in the discharge temperature since the water control valve will tend to hold a constant oil temperature. A significant change in the discharge temperature is cause to check for a change in water flow or temperature.

Oil Inlet Pressure – Check at the fitting in the line near the compressor oil inlet. With air receiver pressure at 100 psi, oil inlet pressure should be 75–85 psig.

Oil Cooler Oil Pressure Differential (Air–Cooled Radiator) – 2 to 25 PSI (65 to 150 PSIG Receiver Pressure) – Check at the fitting in the inlet and outlet lines of the oil cooler.

Oil Cooler Oil Pressure Differential (Water–Cooled Heat Exchanger) – 2 to 25 PSI (65 to 250 PSIG Receiver Pressure) – Check at the heat exchanger oil inlet and outlet fittings.

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

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 air discharge temperature – see the gauge on the instrument panel. The outlet oil temperature may be checked at the compressor oil outlet line fitting.

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

SECTION 6
AIR FILTERS

AIR FILTER – The air filter furnished as standard equipment is a panel type washable filter. The filter must receive proper maintenance if maximum service is to be obtained from the unit. Establishing adequate and timely filter service is MOST IMPORTANT. With wide variation of dust conditions encountered, only experience can determine the proper time element for servicing filters. Although a paper filter element is normally considered expendable, proper and careful cleaning can extend its original life several times.

Filter Element – Service the air filter element when the "CHANGE AIR FILTER" LED is illuminated. Clean every 50 to 250 operating hours depending on dust conditions. Inspect every few days until experience determines the proper time for servicing. Higher than normal current use by the motor or loss of compressor delivery may indicate a need for servicing the filter element.

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:

Remove louvered filter cover and filter element by removing the six (6) cover to enclosure screws.

Two methods of cleaning are recommended. Use of compressed air is effective when the major contaminant is dust. Washing is effective on carbon, soot, and oil laden elements.

DO NOT ATTEMPT TO CLEAN ELEMENTS BY BEATING OR RAPPING.

When air is used, direct a jet of air (100 PSI maximum) against the clean air side of the element in the opposite direction of normal air flow. Move the air jet up and down the pleat, slowly moving across the face of the element. Nozzle must be kept at least one inch away from the element. Take care the paper is not ruptured by the nozzle or air jet.

When cleaning by washing, use a good non–sudsing detergent and water. Soak the element in a solution of two (2) ounces of detergent per gallon of water (140° F. maximum) for at least 15 minutes. Swish the element around in the solution (2 minutes) to help remove dirt. Warm solution gives best results. Rinse the element with a stream of water (40 PSI maximum) opposite to normal air flow until rinse water is clear. DRY THE ELEMENT THOROUGHLY BEFORE USING. DO NOT USE LIGHT BULBS FOR DRYING. Warm air (160° F. or less) must be circulated as high surface temperatures can burn or scorch the filter paper.

After cleaning, thoroughly inspect the element for dirt on the clean air side, holes or damage, by looking through the element toward a bright light. Do not reuse damaged elements.

⚠ 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.

⚠ CAUTION

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 3 inches of water with compressor running at full load – this would indicate a rupture or crack.

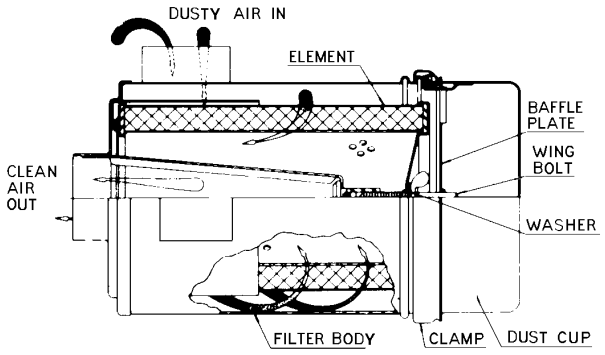


FIGURE 6–1 – HEAVY–DUTY AIR FILTER, 200 HP

HEAVY–DUTY AIR FILTER – 200 HP UNITS (FIGURE 6–1) – When heavy–duty air filters are specified for the 200 HP units, they will be a two–stage dry type. When the unit has been so equipped, service the filter as follows:

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

Filter Element – Service the air filter element when the "CHANGE AIR FILTER" LED is illuminated. Clean every 50 to 250 operating hours depending on dust conditions. Inspect every few days until experience determines the proper time for servicing. Higher than normal current use by the motor or loss of compressor delivery may indicate a need for servicing the filter element.

To Service:

1. Loosen the retaining band clamp and remove the dust cup from the body of the filter.
2. Visually inspect the element in place. If cleaning is not necessary, reinstall the dust cup on the filter. If the element requires cleaning, unscrew the wing bolt and withdraw the element from the body.
3. Wash the element by soaking about 15 minutes in warm water with a mild detergent. Rinse the element thoroughly with clean water; a hose may be used if the water pressure does not exceed 40 PSIG.
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.
5. Allow the element to air dry COMPLETELY. Do not expose the element to heat over 150° F. Install the element in the filter body and fasten securely with the wing bolt. Reinstall the dust cup and retaining band clamp. Make sure the clamp is tightened securely to prevent leakage.

⚠ 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.

⚠ CAUTION

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.

NOTICE

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

Filter Element Life – The element should be replaced after six 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 3 inches of water with compressor running at full load – this would indicate a rupture or crack.

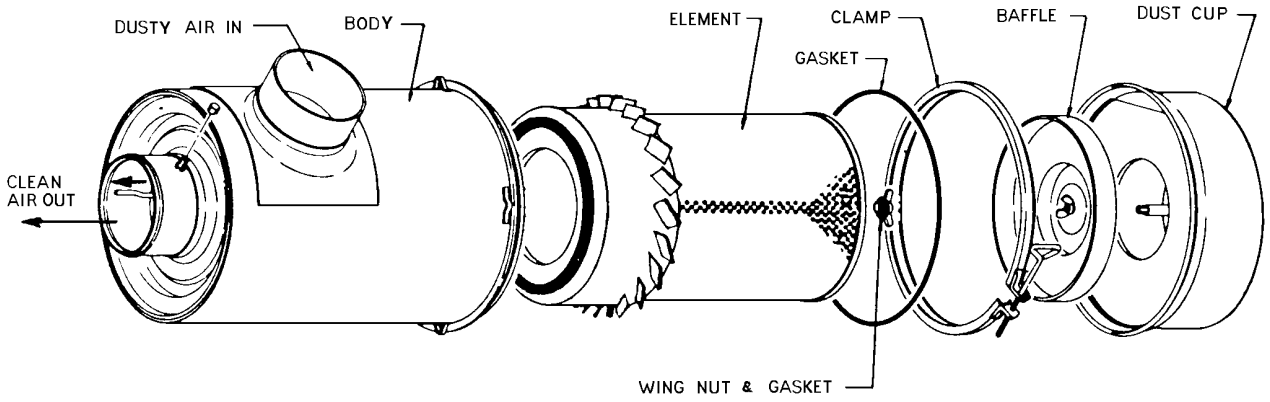


FIGURE 6–2 – HEAVY–DUTY FILTER, 250 & 300 HP

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

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

HEAVY–DUTY AIR FILTER – 250 AND 300 HP UNITS (FIGURE 6–2) – When heavy–duty air filters are specified for the 250 and 300 HP units, they will be two dry types. Instructions are given as follows: Dust Cup, Filter Element, and Filter Life.

Dust Cup – Plan daily intervals for removal of the dust cup to inspect filter for dirt accumulation, until experience determines the proper intervals. This may vary from 8 to 250 hours, depending on dust conditions. If heavy dust build–up is experienced causing blocked filter, it severely overloads the filter element.

To service, stop the unit and remove the dust cup and baffle on the cup. Empty the dust. Replace the baffle in the cup, making sure it is properly seated. Check the dust cup sealing edge and gasket for damage – replace parts as required. Install the dust cup with port in the baffle up, and make sure clamping is secure and positioned properly to prevent leakage.

Filter Element – Service the air filter element when the "CHANGE AIR FILTER" LED is illuminated. Clean every 50 to 250 operating hours depending on dust conditions or when filter indicator indicates cleaning is required.

To service, stop the unit. Remove and clean the dust cup as previously described under "Dust Cup." Inspect the air inlet tube for dirt accumulation and clean if required.

NOTICE

Never clean inlet tube with the element removed as dirt will enter the clean air passage.

Take care not to damage the element when cleaning the inlet tube. Remove the wing nut and CAREFULLY remove the element to prevent dirt from entering the clean air passage.

Some elements are partially covered by a plastic sleeve with fins. The covered portion can be cleaned with water or air. Use a stiff fiber (not wire) brush to remove oil and grease deposits from the sleeve and fins.

DO NOT REMOVE THE PLASTIC SLEEVE AND FINS FROM THE ELEMENT.

The methods of cleaning the element are the same as those described for the 200 HP filter. When inspecting the filter element, be sure to check the element gasket, wing nut gasket, and cover gasket. Replace if damaged or worn. Inspect the clean air passage for dirt, loose clamps or connections. These passages must be leak–proof. Wipe the inside of the filter body with a clean damp cloth.

When assembling the element in the body, be sure the wing nut is tight and the clamp on the filter holds the cover firmly against the gasket.

⚠ 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.

⚠ CAUTION

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.

NOTICE

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

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

1. Visual inspection indicated 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 3 inches of water with compressor running at full load – this would indicate a rupture or crack.

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

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

SECTION 7
COUPLING

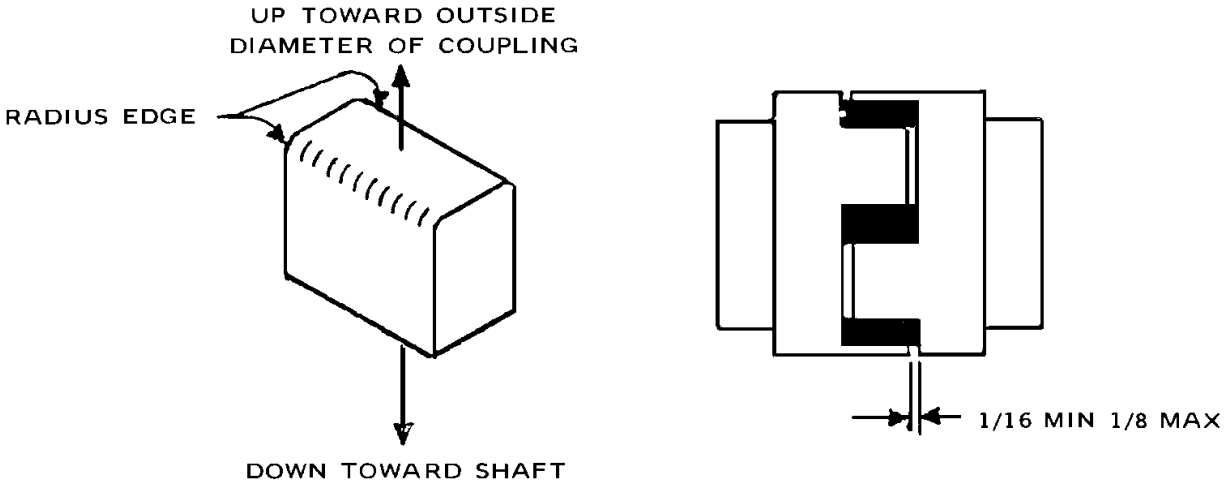


FIGURE 7–1 – INSTALLATION OF COUPLING CUSHIONS

⚠ 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 coverplate opening, center 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. The ”CHANGE AIR FILTER” LED will flash to signal that the air filter requires servicing or changing. See ”Air Filter,” Section 6, page 46.

Oil Separator – Operating conditions determine frequency of service. The ”CHANGE SEPARATOR” LED will flash to signal that oil separator element requires changing. See ”Compressor Oil Separator”, page 40.

Motor Lubrication – Refer to Section 2, page 15, and Maintenance Schedule Chart below.

Every 8 Hours Operation

1. Check the reservoir oil level – add oil if required. See Section 5. If oil consumption is high, refer to ”Excessive Oil Consumption” in Section 9. DO NOT MIX LUBRICANTS.
2. Observe if the unit loads and unloads properly.
3. Check discharge pressure and temperature.
4. Drain the moisture trap in the control system.
5. 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 oil filter element.

Every 6000 Hours Operation

1. Change the compressor lubricant. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY (refer to ”Oil Change Interval”, Section 5, page 37). Flush system if required.

Every Year

1. Check the relief valve for proper operation. See Section 4, page 21.

MAINTENANCE SCHEDULE (See detail notes above)

Maintenance Action	As Indicated By Auto Sentry–ES	Every 8 Hours	Every 125 Hours**	Every 1000 Hours	Every 6000* 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 4000)	●				●	
Check Relief Valve	●					●

* See Oil Change Interval Chart, page 37, for specific lubricant life.
** Check oil before all start–ups and every 100 hours of uninterrupted operation.

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.
	5. Read error message on control panel. See Section 4.	5. Replace switch.
	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,” page 2, this section.
	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 Section 4, pages 5 – 7, 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.

SYMPTOM	POSSIBLE CAUSE	REMEDY
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.
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 is adjusted too low.	3. Adjust unload pressure. See Section 4.
	4. Minimum pressure valve stuck closed.	4. Disassemble and clean valve.
	5. Turn valve adjustment or or malfunction.	5. Adjust turn valve per Section 4.
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” in this section.
	2. Oil leaks at all fittings and gaskets.	2. Tighten or replace fittings or gasket.

SYMPTOM	POSSIBLE CAUSE	REMEDY
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.

	2. Clogged, broken or loose oil return lines	2. Tighten or replace faulty lines.
	3. Ruptured oil separator element.	3. Replace element.
	4. Loose assembly.	4. Tighten all fittings and gaskets.
	5. Foam caused by use of incorrect oil.	5. Use Gardner Denver® AEON 4000 or 9000 SP Lubricating Coolant.
	6. Inoperative minimum pressure valve causing low operating pressure.	6. Clean out or replace valve.
	7. Operation at elevated discharge temperatures.	7. Reduce temperature. See High Discharge Air Temperature, page 2, this section.
	8. Scavenge line check valve failure.	8. Replace check valve.
Oil Carry–Over (Continued)	9. Water condensate in oil.	9. Check oil reservoir temperature and if low, change thermal mixing valve element to a higher temperature.

AUTO SENTRY ES CONTROLLER
TROUBLE SHOOTING GUIDE
ADVISORIES

READING	ACTION
"CHANGE SEPARATOR" Light (Flashing or on steadily) On Startup	**Separator differential** is greater than 8 psid Change separator.
CHANGE AIR FILTER	**Inspect/Replace** — air filter if needed. See Section 6.
LOW AMBIENT	**The advisory comes on** — if the receiver or air end discharge is less than 40° F (4.4° C). Refer to corrective measures for low ambient conditions in the Operator's Manual. See Section 2, Page 2.
HIGH TEMPERATURE	The advisory comes on — when the temperature exceeds 210° F (99° C.) **Probable cause** — plugged or dirty cooler, high ambient conditions, or blown fuses on fan motor.

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

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

Litho in U.S.A.