GARDNER DENVER®

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1st Edition
January, 1999

ROTARY GAS COMPRESSOR

MODELS

SSE, SSF,
SSH, SSM,
SSP, SSL,
SSQ, SSU,
SSY

OPERATING AND SERVICE MANUAL

GARDNER DENVER®

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

Gardner Denver® Compressor genuine parts, manufactured to design tolerances, are developed for optimum dependability. Design and material innovations are the result of years of experience with hundreds of different compressor applications. Reliability in materials and quality assurance are incorporated in our genuine replacement parts.

Your authorized Gardner Denver Compressor OEM Packager offers all the backup you'll need. A worldwide network of authorized OEM Packagers provides the finest product support in the compressor industry.

Your local authorized OEM Packager maintains a large inventory of genuine parts and he is backed up for emergency parts by direct access to the Gardner Denver Master Distribution Center (MDC) in Memphis, Tennessee.

Your authorized OEM Packager can support your Gardner Denver compressor with these services:

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

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

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

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

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

INSTRUCTIONS FOR ORDERING REPAIR PARTS

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

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

Where NOT specified, quantity of parts required per compressor or unit is one (1); where more than one is required per unit, quantity is indicated in parenthesis.

SPECIFY EXACTLY THE NUMBER OF PARTS REQUIRED.

DO NOT ORDER BY SETS OR GROUPS.

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

GAS ENDS

NOTE:

Factory warranted new and rebuilt gas ends are available from your authorized Gardner Denver Compressor OEM Packager.

FOREWORD

Gardner Denver Rotary Screw compressors are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine the owner must exercise care in its operation and maintenance. This book is written to give the operator and maintenance department essential information for day–to–day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

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SECTION 1
GENERAL INFORMATION

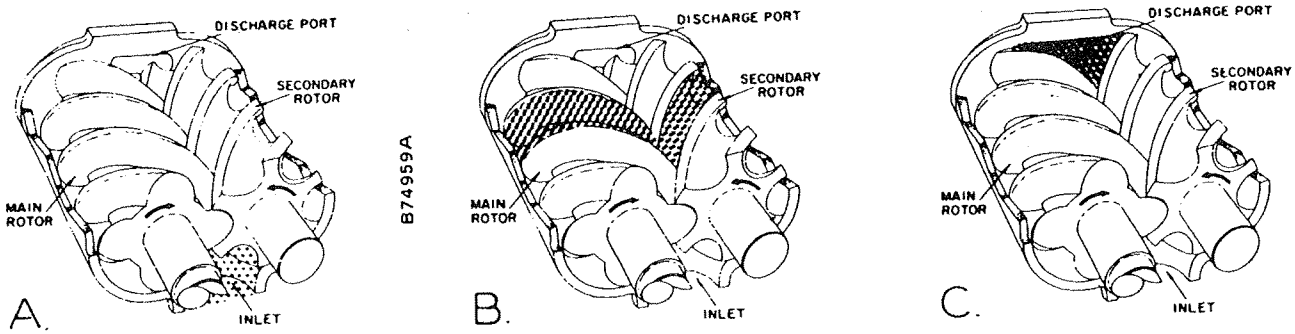


FIGURE 1–1 – COMPRESSION CYCLE

COMPRESSOR – The Gardner Denver rotary screw compressor is a single–stage, positive displacement rotary machine using meshing helical rotors to effect compression. On geared units 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. Non geared units are driven through the male rotor shaft extension. 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. The discharge end uses tapered roller bearings to locate each rotor axially and carry all thrust loads.

COMPRESSION PRINCIPLE (FIGURE 1–1) – Compression is accomplished by the main and secondary rotors synchronously meshing in a one–piece cylinder.

The 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 gas is drawn into the cavity between the main rotor lobes and secondary rotor grooves (A). When the rotors pass the inlet port cutoff, gas is trapped in the interlobe cavity and flows axially with the meshing rotors (B). As the 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 gas/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 gas flow that is continuous, smooth, and shock–free.

GAS FLOW (FIGURE 5–1, page 15) – gas enters the suction separator/filter and passes through the inlet unloader valve or check valve to the compressor. After compression, the gas/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 gas 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 gas passes through the reservoir discharge manifold, discharge check valve, minimum pressure valve and the customer furnished unit shutoff globe valve to the gas transmission lines.

LUBRICATION, COOLING AND SEALING – Oil is forced by gas 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. Units operating a low compression ratios or as indicated by our sizing program will require the addition a separate externally driven oil pump to assume lubrication.

TURN VALVE – The turn valve, located on some models, 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 gas, thus reducing the part–load power requirement. The turn

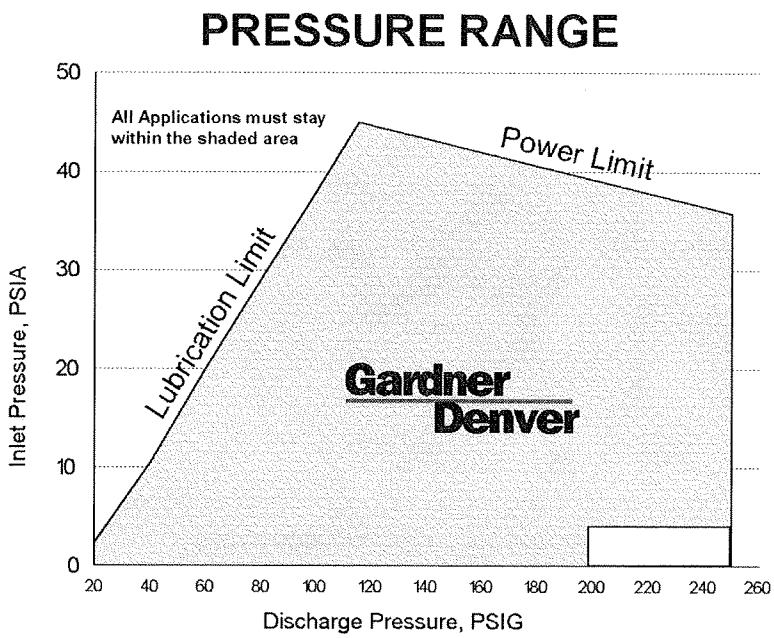


FIGURE 1–2 – PRESSURE RANGE

valve can be manually locked in a set position to match flow requirements or driver horsepower.

OPERATING PARAMETERS – Operating conditions must fall within the parameters shown in FIGURE 1–2.

OPERATING TEMPERATURES

Operating temperatures on an oil flooded screw compressor are generally limited by four factors:

1. Discharge temperatures must stay above dew point, no water can be allowed to condense in the system.

   Heavy hydrocarbon must also be removed by setting oil system temperature high enough to keep the gas in vapor state. See GDMI or OEM Packager for recommendation on oil and system temperature.

2. Discharge temperature must not exceed lubricant capabilities to withstand oxidation.

3. The lubricant viscosity at injected temperatures must be adequate for proper bearing lubrication.

4. Maximum temperature must not exceed safe operating temperatures for that fluid.

FIGURE 1–3, page 3 shows recommended discharge temperatures to avoid condensation.

Bearing life is affected by oil viscosity. It is recommended that viscosity not be allowed to go below that which gives 90% of the full bearing life.

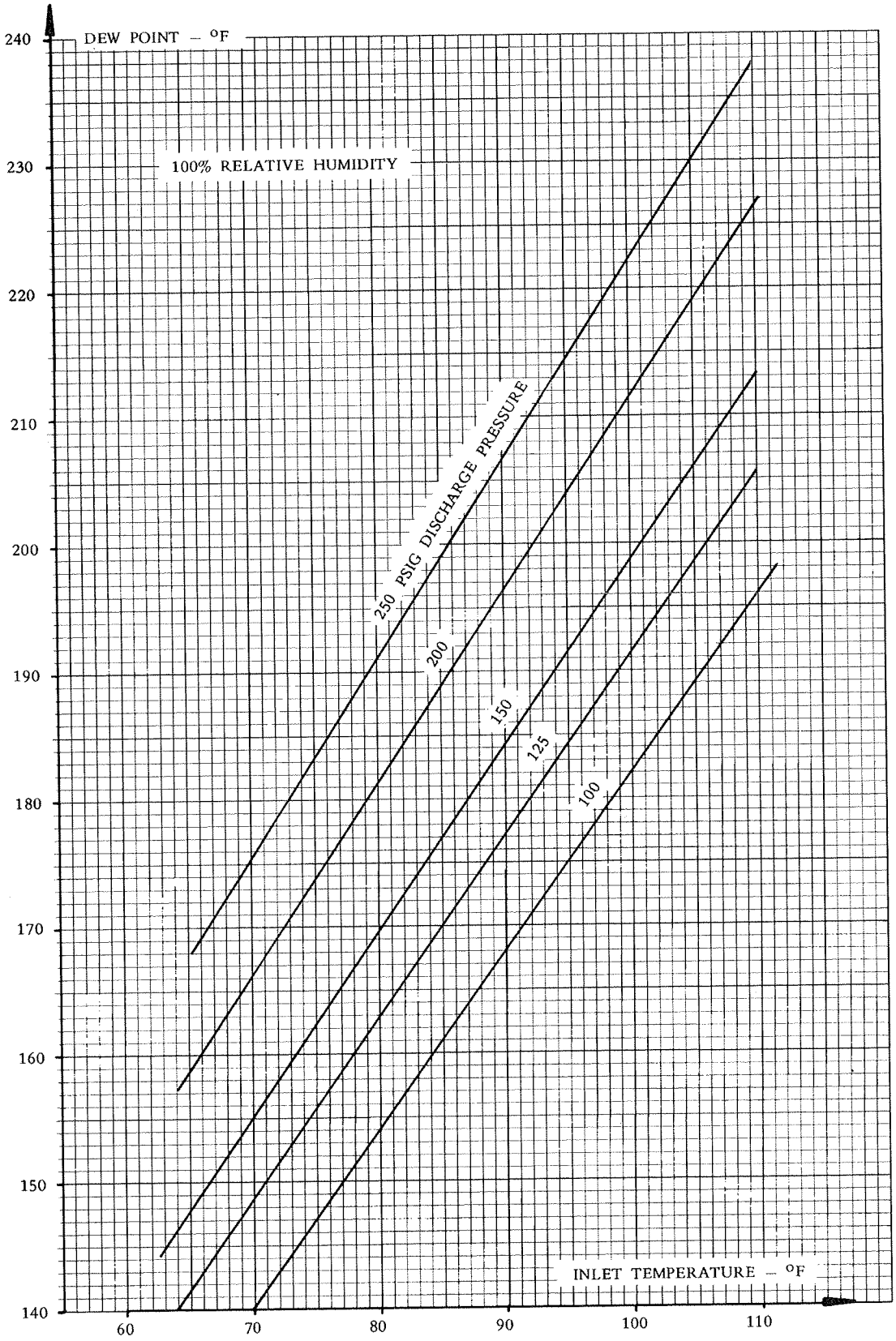


FIGURE 1–3 – RECOMMENDED DISCHARGE TEMPERATURE TO AVOID CONDENSATION

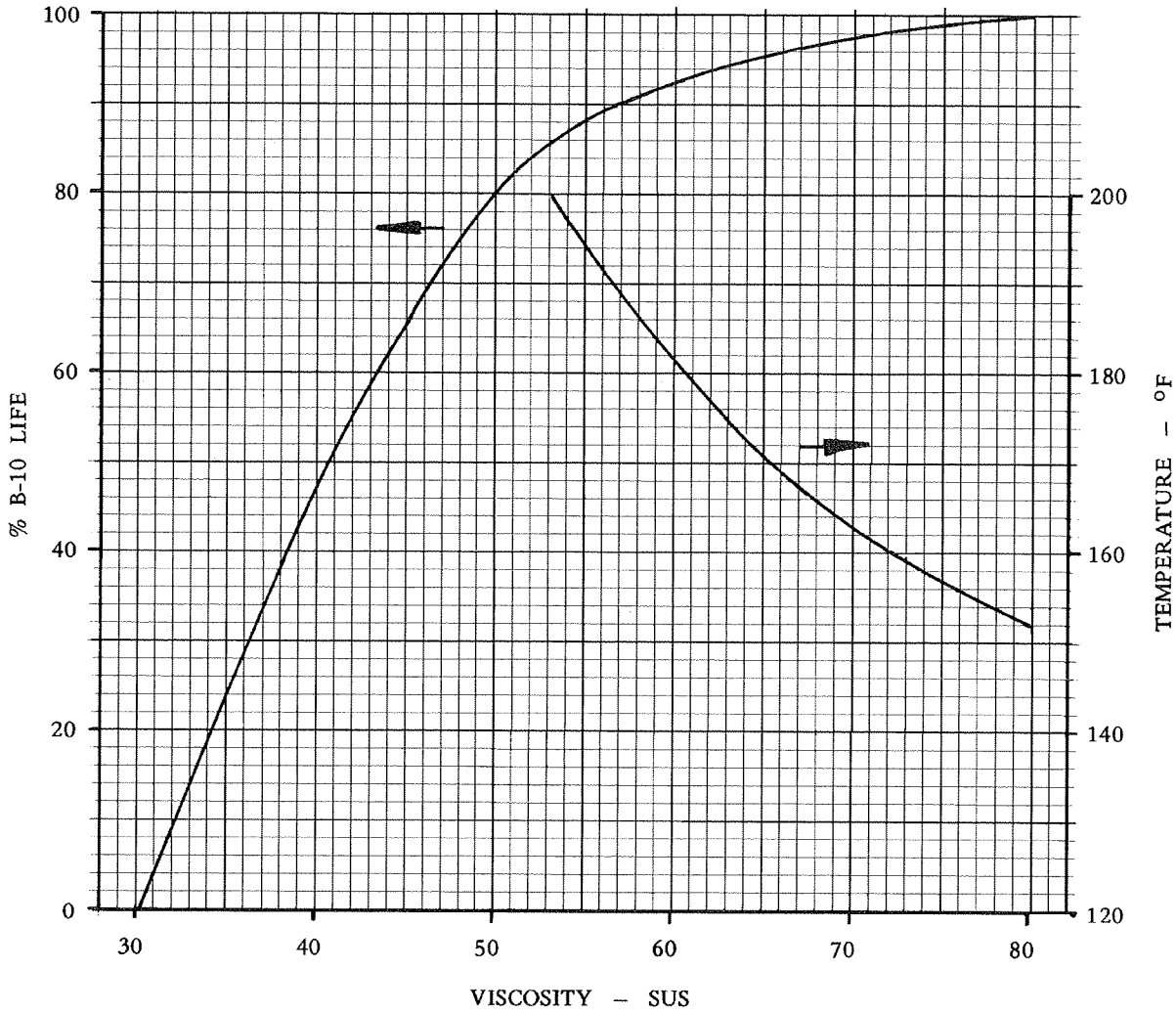


FIGURE 1–4 – EFFECT OF VISCOSITY ON B–10 LIFE

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 careful. 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 loosen or remove the oil filler plug, drain plugs, covers, the thermostatic mixing valve or break any connections, etc., in the compressor gas or oil system until the unit is shut down and the 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, if electric drive.**
- **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 or disable engine starting, 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 gas 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.**

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.

LIFTING UNIT – The package designer will normally provide lifting point attachments to facilitate handling of the unit. Do not use other places such as drivers, compressor, manifolds, or piping for lifting points.

LOCATION – The compressor should be installed in a clean, well–ventilated area with ample space all around for maintenance. The compressor unit, motor, or engine require cooling air for proper operation.

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, hot air must be prevented from recirculation. Do not block the air flow to and from the unit. Allow a minimum of 3 feet to the nearest obstruction of the unit on all sides.

FOUNDATION – Gardner Denver screw compressor requires no special foundation but should be mounted on a smooth, solid surface of sufficient strength to support the weight of the unit. Whenever possible, install the unit near level. Temporary installation may be made at a maximum of 10° angle lengthwise or 30° sidewise or the maximum allowed by the engine. 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 – The package designer will have provided a simple method of draining oil from the reservoir. Refer to OEM Packager's instructions.

AIR–COOLED OIL COOLER MODULE – The air–cooled oil cooler is a separate module and may be mounted remote to the compressor unit. Adequate 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. Do not obstruct the air flow to or from the cooler. Refer to OEM Packager's instructions.

Low Oil Pressure Protection – The package designer will have made provisions for a low oil pressure shutdown switch to prevent start–up or shut the unit down if oil pressure is not established or maintained due to malfunction in the oil cooler system. Refer to OEM Packager's instructions.

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. Refer to OEM Packager's instructions.

THE DESIGN OF THE REMOTE OIL COOLER MODULE SYSTEM MUST BE APPROVED BY THE PACKAGER BEFORE INSTALLATION. The design information to be submitted for approval includes: Refer to OEM Packager's instructions.

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 one size larger than compressor oil inlet size.
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 and the prevailing winds are in the same direction. A baffle should be provided on the exhaust side of the cooler for protection against occasional wind shifts.

When the oil cooler is mounted above the compressor unit, a check valve is to be mounted on the compressor unit in the line to the oil cooler. 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. 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 gas 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.

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

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 2–1, page 8, 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.

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. Heat recovered from the rotary compressors will easily heat the 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.)

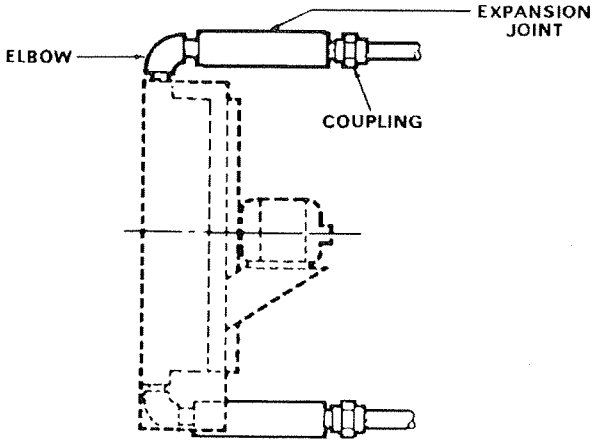
1. Be sure all control lines, drains, and traps are heated to avoid freezing of condensate. Heat tape with thermostat control is generally satisfactory for this purpose and can be obtained at various local plumbing or hardware outlets.
2. If an air–cooled aftercooler is to be used, provisions to bypass the aftercooler should be made. Since cold gas 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 lubricating coolant suitable for temperature and service. Refer to OEM Packager's instructions.
5. Monitor the unit carefully during start–up and operation to be sure it is functioning normally.
6. Use adequate electrical enclosures for electrical devices.

Extreme Cold Weather Operation (Down To –40° F.) – In addition to recommendation for +10° F. installations, the following should be provided:

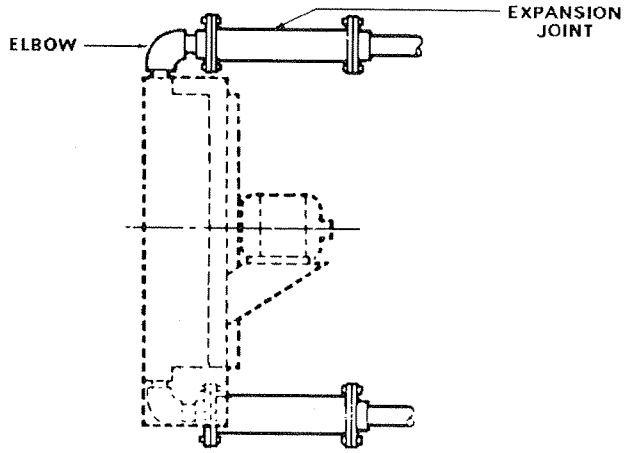
1. A temperature switch to control the fan should be provided for better starting and quicker warm–up. This switch can be provided by the package designer and will delay fan start–up until discharge temperature reaches approximately 150–160° F.
2. It will probably be necessary to provide shutters or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

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 provided by the package designer and will be layed out in an efficient manner.



PIPING SCHEMATIC OF COOLER WITH SCREWED CONNECTIONS.



PIPING SCHEMATIC OF COOLER WITH FLANGED CONNECTIONS.

FIGURE 2–1 – PIPING SCHEMATIC

INLET LINE – The inlet line used between the inlet scrubber and the compressor, must be thoroughly cleaned on the inside to prevent dirt or scale from entering the compressor. If welded construction is used, the line must be shot blasted and cleaned to remove welding scale. In either case, the inlet line must be coated internally by galvanizing or painting with a moisture and oil–proof sealing lacquer. The inlet line should be the full size of the inlet opening on the compressor.

Accessibility for inlet scrubber servicing must be considered when installing the filters to the unit.

DISCHARGE SERVICE LINE – When manifolding two or more Gardner Denver rotary compressors on the same line, each unit is isolated by the check valve in the unit discharge line. Additional check valves are not necessary and may cause multi–unit operational problems.

If 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 screw compressor and a reciprocating compressor are manifolded together, a receiver (isolation chamber) must be located between the two units.

ELECTRICAL WIRING – The unit may be furnished with the compressor motor enclosure as specified by the user. If unit has an air–cooled oil cooler, the fan may be driven by an electric motor of the proper enclosure for the area. A suitable starter is required. Allow 42" deep by 30" wide clear space to the nearest obstruction 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.

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.

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

MOTOR LUBRICATION – Long time satisfactory operation of an electric motor depends in large measure on the bearings and timely lubrication. For information refer to the motor manufacturer for instructions.

⚠ WARNING

Before servicing the unit, disconnect, tag and lockout the unit from the power supply.

PRESTART–UP INSTRUCTIONS – A new gas end as received from the factory has been tested and then prepared for shipping. Unitizing has been done by an independent packager. Do not attempt to operate the unit until checked and serviced as follows:

1. **Compressor Oil** – Check oil level in the reservoir. Do not mix different type oils. Packager should have filled the unit with a suitable oil. Gardner Denver® Lubricating Coolant is recommended for normal operating conditions. See "Oil Specification," page 15.

   REPLACE OIL FILTER EVERY 1000 HOURS.

   Initial fill, or filling after a complete draining of the system, may show the oil level in the "EXCESS OIL" range. After start–up, the oil will fall into the operating range as system components are filled. If necessary, add oil to bring the level to the top of the operating range as read when the unit is operating at full load and normal pressure. During unloaded operation and after shutdown, the system will partially drain back into the oil reservoir and the oil level may read higher than when operating on load. DO NOT DRAIN OIL TO CORRECT; on the next loaded cycle or start, oil will again fill the system and the gauge will indicate the operating level.

⚠ DANGER

Always stop the unit and release pressure before removing the oil filler plug. Failure to release pressure may result in personal injury or death.

2. **Intake Scrubber** – Inspect the scrubber to be sure it is clean.Be sure the inlet line, if used, is tight and clean.
3. **Coupling** – Check all bolts and cap screws for tightness. See Section 10, page 31.
4. **Piping** – Refer to Section 2, "Installation," and make sure piping meets all recommendations.
5. **Electrical** – Check the wiring diagrams furnished with the unit to be sure it is properly wired. See Section 4, "Controls and Instruments," for general wiring diagrams and Section 2, page 6 for installation instructions.
6. **Grounding** – Equipment must be properly grounded according to Section 250–95 of the National Electrical Code.

⚠ WARNING

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

7. **Rotation** – Check for correct motor rotation. Compressor drive shaft rotation must be clockwise standing facing the compressor coupling. Operation with incorrect rotation can damage equipment and cause oil eruption from the compressor inlet. When checking rotation, induce minimum rotation (less than one revolution if possible). Never allow driver to reach full speed.
8. **System Pressure** – Set the controls to the desired pressure and differential. DO NOT EXCEED MAXIMUM OPERATING PRESSURE ON COMPRESSOR NAMEPLATE.

Unit Cold – Start the unit by either pushing the start buttons or engaging the engine clutch, if so equipped. Since the unit is equipped with a minimum (50 PSIG) pressure discharge valve, no special procedure to maintain unit reservoir pressure is required. Refer to OEM Packager's instructions.

Unit Hot – No warm–up period is required. Start the unit by pushing the start button or engaging the clutch. Refer to OEM Packager's instructions.

DAILY CHECK – Refer to Section 8, "Maintenance Schedule," page 24. Refer to OEM Packager's instructions.

STOPPING THE UNIT – Press "STOP button on the electric motor starter panel or disengage the clutch and shutdown the engine. The oil reservoir should blow down into the suction line if suction line pressure is 5 PSIG or less. Refer to OEM Packager's instructions.

ALLOWABLE SYSTEM PRESSURE DROPS

System pressure drops will have minimum impact on the mechanical reliability of the rotary compressor as long as they are within reasonable limits. They will,

however, have a pronounced effect on compressor performance if care is not taken to keep them at low values.

Good design would dictate a 10 inch H_2O total loss at the inlet and 5 PSIG loss through the discharge system. These values result in a reasonable compromise between efficiency and cost.

Piping data showing pressure losses for the final discharge can be found in most handbooks on compressed air.

Oil system pressure loss through cooler, filter and piping should not exceed 15–20 PSIG (1 to 1.4 bar) when operating at 100 PSIG (7 Bar), 130° F. (54°C.).

GENERAL DESCRIPTION – The Gardner Denver rotary screw gas compressor controls and driver arrangement has been provided by a packager. It is necessary only to connect an electric unit to a suitable power supply, connect the compressor discharge gas connection to the pipe line. A standard compressor unit consists of the compressor, oil reservoir, oil cooling system and oil filters, driver, and NEMA or pneumatic controls. Refer to OEM Packager's instructions.

PROTECTIVE DEVICES AND SHUTDOWNS

PROTECTIVE DEVICES – The following protective devices are mechanical and are necessary for the safe operation of the unit. Refer to OEM Packager's instructions.

Motor Protection Devices – If electric drive –Overload heaters are furnished for the starter in the voltage range specified. There are three (3) overloads in the starter of proper size for the starter and its enclosure. Note that motor nameplate current must by multiplied by .577 for wye–delta starters. The display should indicate which overload relay has tripped. The overload relay is reset by pressing the button on the relay itself. Motor current (amps) and voltage must be measured to locate the cause for high current. Proper starter coil and contact action is also monitored and errors in operation will cause a shutdown with the cause displayed.

Relief Valve – A pressure relief valve(s) must be installed in the final discharge line and set to approximately 120% of the unit's full load operating pressure for protection against over pressure. 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.

Emergency Stop – Pressing the emergency stop button will shut down the unit. Refer to OEM Packager's instructions.

Blowdown Valve – The blowdown solenoid valve should release pressure from the oil reservoir during any shutdown condition. Refer to OEM Packager's instructions.

CHANGE SEPARATOR – Separator differential pressure should be monitored. At a differential pressure of approximately 8 psi the gas oil separator element should be changed.

CHANGE INTAKE SCRUBBER – The intake scrubber condition should be monitored and the element changed when the filter requires service or replacement.

CHANGE OIL FILTER – The oil filter should be changed after 1000 hours of operation. The hours can be adjusted to less time if severe operating conditions are anticipated. See "Oil Change Interval," page 17.

CHANGE OIL – Refer to OEM Packager's instructions.

LOW AMBIENT TEMPERATURE – Provisions should be made to prevent the reservoir or compressor discharge temperature from dropping below 40° F.

HIGH TEMPERATURE – Maximum reservoir or compressor discharge is 225° F. A device must be provided that will stop the driver when this condition occurs.

SHUTDOWNS – When shutdowns occur, the cause must be corrected, before restarting unit. Refer to OEM Packager's instructions.

Main and Fan Motor Overload – Overload heaters are furnished for the starter.

Emergency Stop – Pressing the emergency stop button will shutdown the unit.

Low Oil Pressure – The unit should shut down if inadequate oil pressure to the compressor is detected.

High System Pressure – The unit should shut down if excessive pressures are detected in the reservoir or system.

Change Separator – The separator differential pressure should be monitored daily. At a differential pressure of approximately 15 psi, the unit should be shut down.

GAUGES AND DISPLAYS

Oil Level – The oil level gauge is located on the side of the reservoir. Refer to OEM Packager's instructions: Lubrication, Oil Cooler, Oil Filter and Separator" for information on how to correctly read the gauge.

COMPRESSOR CAPACITY CONTROL – Refer to OEM Packager's instructions. – The capacity of the compressor may be controlled by the action of the Turn Valve and the Compressor Inlet Valve.Some units will be provided with a check valve in place of the inlet valve which will prevent black flow when unit is idle or shutdown, but will provide no capacity control.

The turn valve (available on some models) controls compressor delivery to match demands of 40% to 100% of the compressor's maximum capacity. The in-

let valve throttles to control compressor delivery to match demands of 0% to 40% of the compressor's maximum capacity.

Inlet Valve – Refer to OEM Packager's instructions. – 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 gas.

The inlet valve position is controlled by gas pressure in its piston cylinder, which is controlled by a gas pressure and a substractive pilot. As pressure to the piston is increased, the valve closes to restrict gas flow and compressor delivery.

Purge Valve – Refer to OEM Packager's instructions. – The purge valve is a normally closed two–way gas actuated valve that admits purge 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.

A 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.

Blowdown Valve – Refer to OEM Packager's instructions. – The blowdown valve is a two–way solenoid valve, or a manual 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 valve is provided to ensure that the inlet valve closes during blowdown.

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 gas which would otherwise be compressed back to the inlet, reducing both capacity and power consumption.

Automatic Turn Valve Actuator – (FIGURE 4–1) 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 cylinders to move the rack and rotate the valve. Located on the end of the cylinders are adjusting screws which limit the travel of the actuator. When looking at the rear of the compressor, the adjusting screw on the 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.

Manual Turn Valve Actuator – (FIGURE 4–2, page 13) The turn valve actuator is a worm and gear arrangement which positions the turn valve according to a manual adjustment. Before making any adjustment, stop the unti and release any system pressure. The turn valve is set at 100% capacity at the factory and is locked in place. The turn valve is marked with an 'X' which is visible through the inspection window.

Before capacity adjustment can be made, the turn valve must be unlocked. Remove the pipe plug and loosen the lock screw one half to three quarter turn. The adjusting screw is now free to turn and capacity can be adjusted with a hex wrench. Turn clockwise (CW) to reduce capacity and horsepower. Each revolution will reduce capacity (CFM) by 2.9% and reduce horsepower (BHP) by 2.3%. Fourteen and one half complete revolutions will cycle the turn valve back to 100%. If there has been a prior adjustment or the exact placement of the turn valve is unknown, continue to

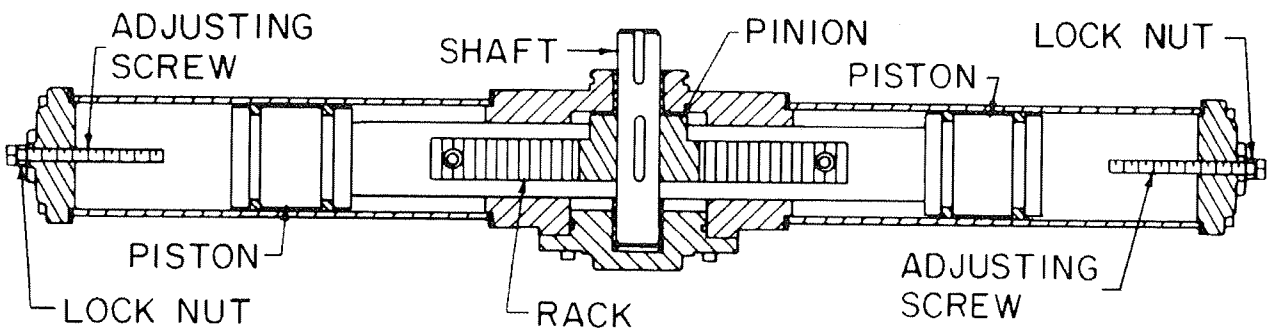


FIGURE 4–1 – AUTOMATIC TURN VALVE ACTUATOR

turn the adjusting screw clockwise (CW) until the 'X' is again visible in the inspection window. Tighten the lock screw and replace the pipe plug. This plug is necessary to seal oil in the lock area and will also keep dirt out. Replace inspection window plug before restarting the unit. Do not dismantle the actuator. Removal of the head–control cylinder could cause parts to become mis–aligned and correction may require the compressor to be removed from the package and completely disassembled.

Minimum Discharge Pressure/Check Valve – Refer to OEM Packager's instructions. – 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 service valve is fully open. The check valve portion of the valve prevents backflow of gas from the pipe line when the unit stops, unloads or is shutdown.

The minimum pressure valve incorporates a spring–loaded piston which maintains approximately 50 PSIG in the oil reservoir. When the gas pressure on the upstream side rises above 65 PSIG, the valve opens to full porting. Packager design for a specific application may require lower valve setting. (An external oil pump may also be required.)

STARTER/CONTROL PANEL – Refer to OEM Packager's instructions.

The following items should be located in the electrical enclosure and provide the main control of the compressor unit and switching of the motor(s).

Emergency Stop – This is a maintained pushbutton, and removes power from the unit and should not be used for normal shutdown.

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

Auxiliary Oil Pump Motor Starter – The starter is used to provide control and overload protection for the cooler fans. Overload heaters should be selected based on the nameplate amps of the fan motor. Three fuses should be provided. Refer to the heater table glued inside the starter enclosure.

Main Starter – This starter is used to provide control and overload protection for the main drive motor. For wye–delta starters, overload heaters should be selected based on the motor nameplate current times .577 for proper protection. Wye–delta starters employ three contactors which are controlled sequentially to provide low current starting. Full–voltage starters employ a single contactor; overload selection should be based on the full load current of the motor, and adjacent labelling.

Make sure that the main motor and any auxiliary motor starters are interlocked together.

The compressor should start only if reservoir pressure is below 5 PSIG. By–pass piping may be provided to keep compressor unloaded until the start cycle has been completed.

GAS AND OIL FILTRATION REQUIREMENTS

Inlet scrubbers are required to remove moisture and sand levels.

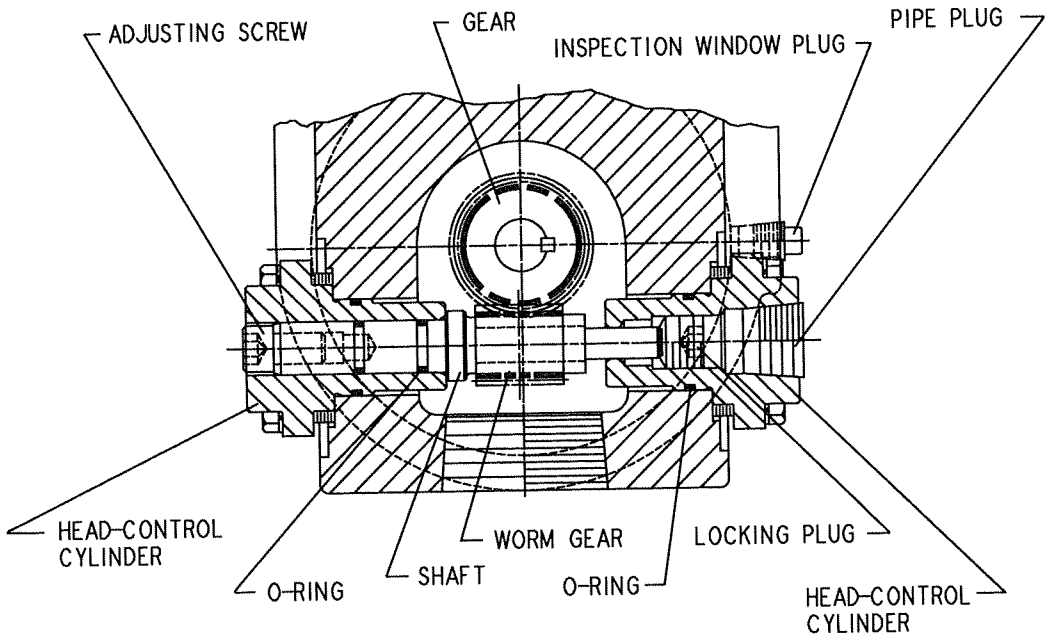


FIGURE 4–2 – MANUAL TURN VALVE ACTUATOR

The oil filter should have a 10–15 micron rating and be capable of handling full oil flow for the service life of the filter (generally 1000 hours). The relief valve setting should be between 15 and 25 PSIG. Paper element filters have performed very well unless water is allowed to condense in the system.

ENGINE CONTROL – Refer to OEM Packager's instructions.

The following items should be included on engine control sequence.

Emergency Stop – This requires a manual or electrical device to remove or block fuel to the engine and cause the engine to stop immediately.

Fan Control – The cooler fan(s) will be a mechanical drive powered by the engine or electric motor driven. If electric motor driven, the starter must be interlocked to the engine EMERGENCY STOP.

Auxiliary Oil Pump Motor Control – If supplied, the auxiliary oil pump will be powered by the engine or separate electric motor drive. If electric motor driven, the starter must be interlocked to the engine EMERGENCY STOP.

OPERATION

The compressor should start only if reservoir pressure is below 5 PSIG. By–pass piping may be provided to keep the compressor unloaded until the start cycle has been completed.

CLUTCH – If the package is equipped with a clutch between the engine and compressor, some means of engagement will be provided (mechanical or manual). If the package is not equipped with a clutch, the inlet valve must be closed to allow the compressor to operate with no load while the engine is started. The compressor can safely operate for up to 5 minutes with the inlet valve closed (no load) and no pressure in the reservoir.

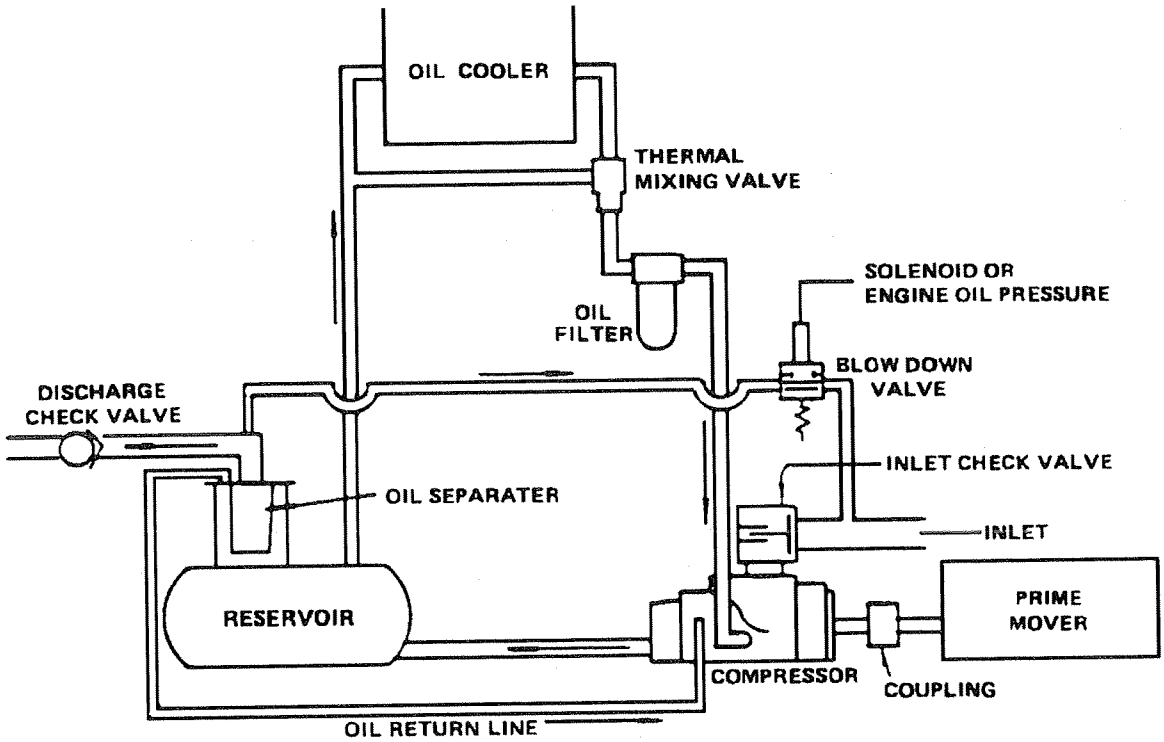


FIGURE 5–1 – FLOW DIAGRAM – GAS/OIL SYSTEMS

COMPRESSOR OIL SYSTEM (FIGURE 5–1) 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. Gas 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 gas–oil mixture is then discharged to the oil reservoir where a large part of the entrained oil drops out of the gas stream; the gas 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 gas passes to the final discharge line.

RECOMMENDED LUBRICANT – Refer to OEM Packager's instructions – Gardner Denver compressors are filled with lubricants by your packager. AEON 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 OEM Packager.

OIL SPECIFICATIONS – The recommended compressor lubricant is Gardner Denver AEON Lubricating Coolant which can be used for year–round operation except as noted in the "High Temperature Operation," below, or low temperature, see "Installation for Cold Weather," page 7. AEON Lubricating Coolant is a superior petroleum base lubricant formulated and containing additives for use in Gardner Denver compressors. Other oil formulation may be required depending on your gas composition. Gardner Denver can provide an oil matching service to properly match your Gas with the recommended lubricant. Contact your OEM Packager or Gardner Denver with a complete gas analysis.

⚠ 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 215–225° F. for a period of more than four (4) hours due to continuing high ambient air temperature, use Gardner Denver oil matching service (previous page). 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.

⚠ DANGER

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

LUBRICANT CHANGE PROCEDURE – Refer to OEM Packager's instructions – 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. Observe normal shutdown and lockout procedures.

1. Thoroughly drain system:
   - Drain oil from compressor 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 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.
8. Subsequent lubricant changeouts should be at normal intervals. (See FIGURE 5–2, page 20.)

⚠ CAUTION

Improper equipment maintenance with use of synthetic lubricants will damage equipment. Oil filter and oil separator change intervals remain the same as for standard lubricants. See Maintenance Schedule, page 24.

⚠ 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 Lubricating Coolants. Use caution when selecting downstream components such as line lubricating bowls, gaskets and valve trim.

Some synthetic lubricants are not compatible with low nitrile Buna N or acrylic paints. AEON Lubricants are compatible with most system downstream components.

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

ADDITION OF OIL BETWEEN CHANGES must be made when the oil level is below the add oil range as read while the unit is running fully loaded and not cycling on and off. (Alternate method is when unit is completely off and blown down.)

1. Be sure the unit is completely off and that no gas pressure is in the oil reservoir.
2. Disconnect, tag and lockout the power supply to the starter.
3. Wipe away all dirt around the oil filler plug.
4. Remove the oil filler plug and add oil as required to return the oil level to the center of the run range when the unit is operating.
5. Replace the oil filter plug BEFORE restoring power to the unit.

DO NOT OVERFILL as oil carryover will result. Repeated addition of oil between oil changes may indicate excessive oil carry–over and should be investigated.

⚠ DANGER

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

⚠ DANGER

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

⚠ CAUTION

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

OIL LEVEL GAUGE – Refer to OEM Packager's instructions – 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 indicated in the ADD OIL range when the compressor is loaded. Drain oil only when the oil level gauge indicates EXCESS OIL when the compressor is loaded.

OIL CHANGE INTERVAL – Recommended oil change intervals are based on oil temperature and gas composition.

When operating conditions are severe (high temperatures, high humidity, sour gas) 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. A good lubricant analysis program is helpful in planning the change interval.

⚠ CAUTION

Change the oil filter every 1000 hours.

DRAINING AND CLEANING OIL SYSTEM

⚠ DANGER

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

⚠ DANGER

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

Always drain the complete system. Draining when the oil is hot will help to prevent varnish deposits and carry away impurities. To drain the system, use one of the following methods:

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.

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.

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

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

⚠ DANGER

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

1. Be sure the unit is completely off and that no gas 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 OEM Packager's instructions
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 MAIN OIL FILTER – 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.

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.

⚠ DANGER

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

⚠ DANGER

Gas/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.

Compressor Main Oil Filter Instructions Refer to OEM Packager's instructions – Some units will have spin–on filters

1. Stop the unit and be sure no gas pressure is in the oil reservoir. Disconnect, tag and lockout power supply to the starter.
2. Refer to OEM Packager's instructions.

COMPRESSOR OIL COOLER – RADIATOR TYPE – Refer to OEM Packager's instructions.

THERMAL CONTROL (THERMOSTATIC MIXING) VALVE – Refer to OEM Packager's instructions – This valve is used to control temperature of the oil in the radiator. 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. This system provides proper compressor warm–up and prevents moisture contamination of the oil.

OIL RESERVOIR – Refer to OEM Packager's instructions – The oil reservoir–separator combines multiple functions into one vessel. The one section is the oil reservoir, providing oil storage capacity for the system and a primary oil separation means. The other section contains the final oil separator and has the discharge line mounted on the upper flange. The reservoir provides limited storage capacity for control and gauge actuation.

COMPRESSOR OIL SEPARATOR – Refer to OEM Packager's instructions – provides the final removal of oil from the gas stream. Oil from inside the separator elements is returned through tubing to the compressor cylinder.

Oil carryover through the service lines may be caused by a faulty oil separator, overfilling of the oil reservoir, oil that foams, oil return line malfunction or water condensate in the oil. 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 separator housing to the compressor cylinder is not clogged or pinched off, the return tube inside the separator is not loose or broken, the check valve in the oil return line is functioning properly, and there is not water or an oil/gas 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 intake scrubber 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 intake scrubber. The condition of the separator can be determined by pressure differential or by inspection.

Pressure Differential Gauging – When the pressure differential across the oil separator reaches approximately 8 PSI, replace the oil separator element. If this is ignored, the separator element could collapse, causing excessive oil carry over and eventual catastrophic failure of the compressor.

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

1. Be certain unit is completely off and that no pressure is in the oil reservoir.
2. Disconnect, tag and lockout power supply to the starter.
3. Refer to OEM Packager's instructions

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 this service. Regardless of level of sustained discharge temperature, the high discharge temperature switch must never be set higher than 225° F. shutdown temperature.

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

For **Air Cooled Oil Systems**, the normal upper limit of discharge temperatures for varying ambient temperatures begins 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.

Oil Inlet Pressure – Check at the fitting in the line near the compressor oil inlet. With system pressure at 100 PSIG, oil inlet pressure should be 55–65 PSIG.

Oil Cooler Oil Pressure Differential (Air–Cooled Radiator) – 2 to 25 PSIG (15 PSIG nominal) with 65 to 150 PSIG Receiver Pressure) – Check at the fitting in the inlet and outlet lines of the oil cooler.

SYSTEM CONNECTION REQUIRED

Openings are provided in the compressor for oil return from the separator. This connection is located in a zone after suction cutoff to reduce the effect on compressor capacity but unless some precautions are used in siz-

ing the oil return excess horsepower or oil carryover may result. Generally speaking a .047" to 0.100" (1.2mm to 2.5mm) orifice, depending on machine and separator design, is satisfactory.The exact size should be determined for a specific system. Outline drawings show location of the connection point. It is also necessary to recirculate some gas through the machine when it is completely unloaded (intake valve closed). The amount of "purge" gas required depends on unit size. Valving that will allow free flow equal to the size opening provided will be adequate. FIGURE 5–2, FIGURE 5–3 and FIGURE 5–4, pages 20 and 21, show methods used by Gardner Denver to provide this purge. Outline drawings show the location of these openings when Gardner Denver furnishes the inlet valve. Suitable connections must be provided if unit is purchased less inlet valve.

Installation that may experience discharge pressures below 50 PSIG will require the use of an auxiliary oil pump to ensure proper lubrication.

RECOMMENDED LUBRICANTS

Some general comments might be made in regard to lubricants:

1. Motor oils vary from refiner to refiner and not all oils will have the same foam inhibitors and oxidation characteristics. When motor oils are used strict adherence to change intervals and/or monitoring of oil is a must to avoid varnishing system.
2. Gardner Denver synthetic oils provide the best of refinement, lubrication qualities, and viscosity over a wide range of temperatures.
3. Low temperature operation is largely limited by lubricant viscosity. Since the lubricant must also maintain its viscosity at operating temperatures, care must be exercised to select one suitable for cold weather operation.
4. Select lubricants compatible with gas composition expected to be compressed. Gas entrainment and dilution should be avoided, as this along with foaming could promote failure and/or excessive oil carryover.
5. Gardner Denver can provide an oil matching service to properly match your gas with the recommended lubricant. Contact your OEM Packager or Gardner Denver with a complete gas analysis.

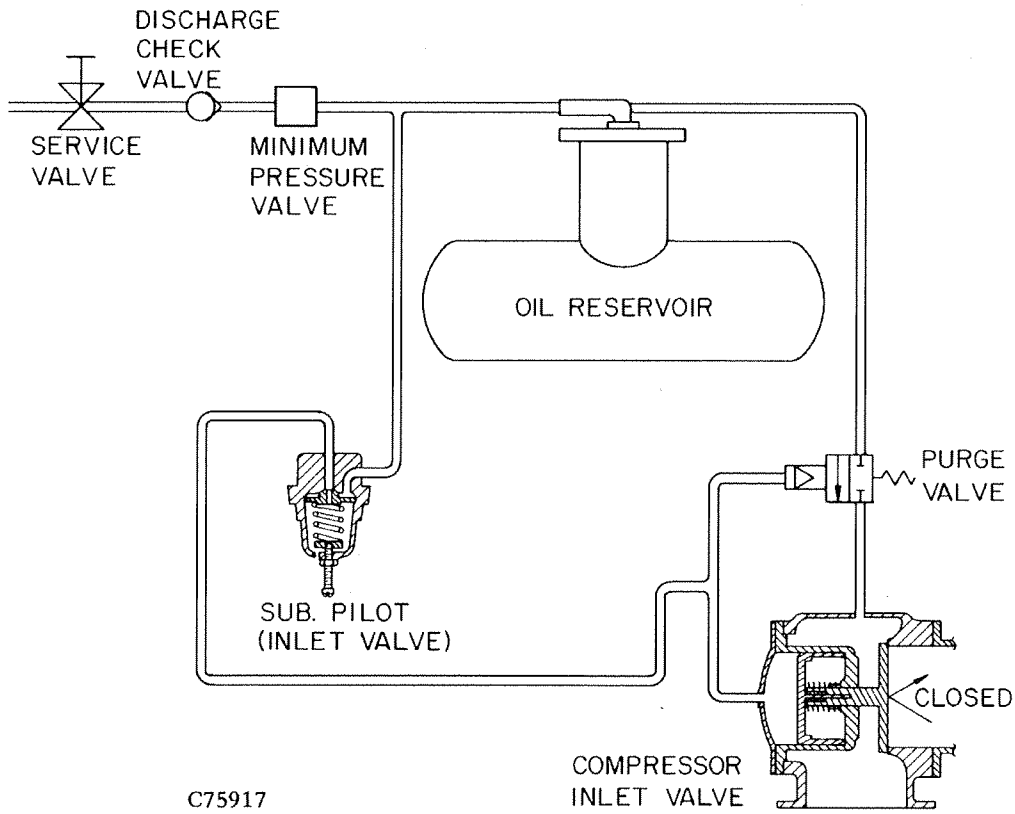


FIGURE 5–2 – FLOW DIAGRAM

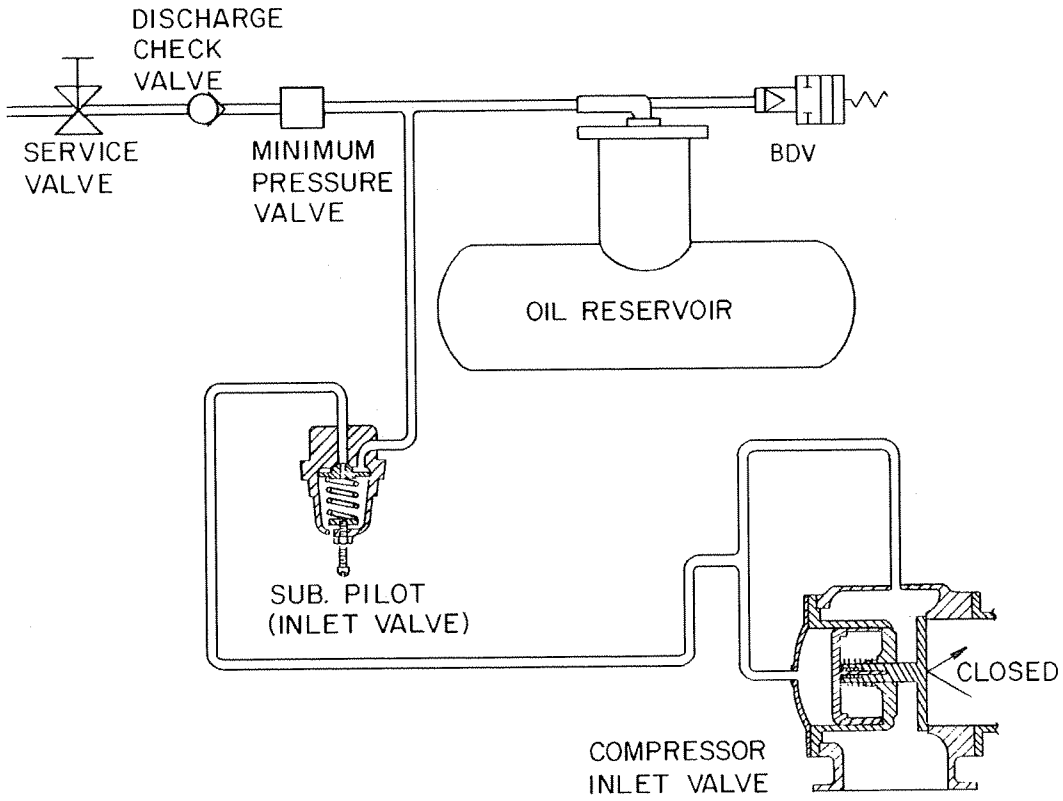


FIGURE 5–3 – FLOW DIAGRAM

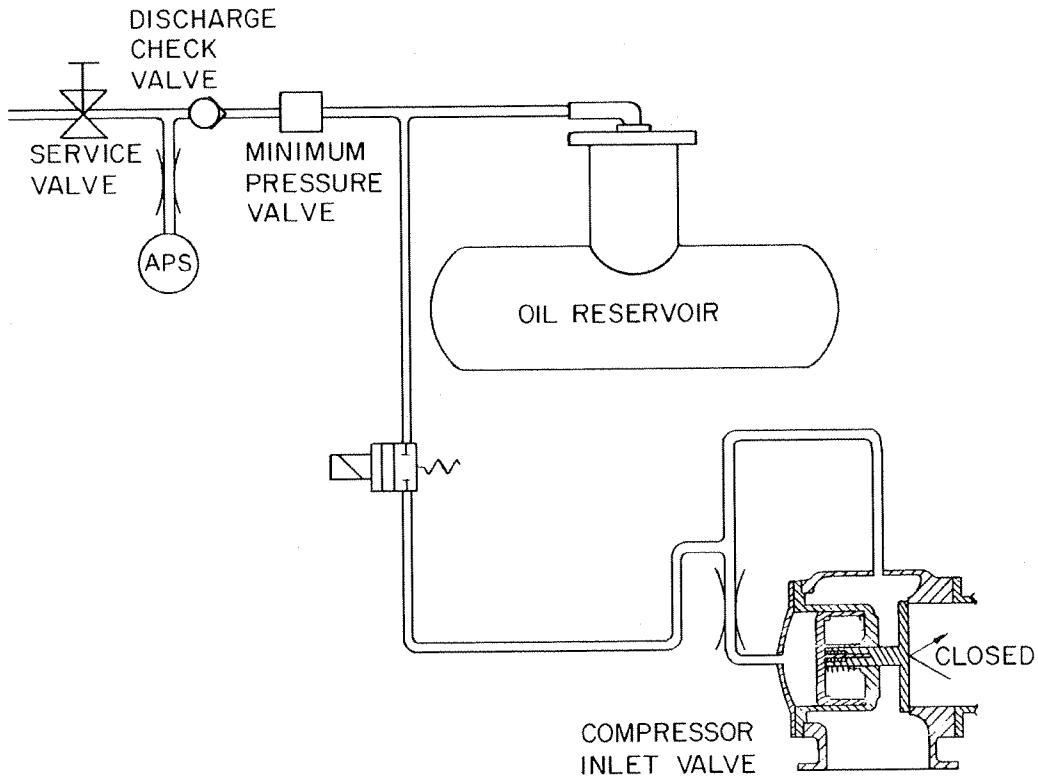


FIGURE 5–4 – FLOW DIAGRAM

INTAKE SCRUBBER – See OEM Packager's Instructions – The scrubber 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 gas conditions encountered, only experience can determine the proper time element for servicing scrubber. Proper and careful cleaning can extend its original life several times.

STARTING TORQUE VALUES

Starting a unit is normally not a problem when using a standard squirrel cage motor, if unit is blown down.

Starting torque can be a problem if motors are sized for low pressure service where a smaller horsepower motor may be used with torque ratings considerably lower than these motors sized for 100 PSIG service.

Proper matching of drivers and compressors will be the users responsibility. Torsional Inertia values are given in FIGURE 6–1, below.

PACKAGING HINTS AND AIDS

While there may be many different opinions on what is required in a well designed package, there are some rules that Gardner Denver has used for package design:

1. On enclosed units care must be taken to get cool air to the drive motor.
2. Air cooled heat exchanges should be designed for ambients of 125° F minimum to allow 'good' normal operating temperatures.
3. Oil sump capacity should not be less than 1/2 of oil circulation rate to assure adequate oil life and no loss of cooling due to aerated oil.
4. Oil carryover should not exceed 2–4 PPM to avoid problems in typical applications and to allow some deterioration in the system.
5. Hard piping should be used throughout since many units run unattended and hoses do deteriorate.
6. A discharge check valve and minimum pressure device set a 50 PSIG (3.5 Bar) should be furnished as standard.
7. Blowdown of the oil reservoir should be slow enough to prevent oil foaming. Gardner Denver practice is not to go below approximately 20 seconds. If suction pressure is 5 PSIG or less, blowdown valve exhaust can be piped back to the suction. If suction pressure is greater than 5 PSIG, by–pass piping must be provided for loadless starting.
8. Bases should be rigid enough to maintain coupling alignment.
9. Manufacturer does not recommend the use of rigid couplings.

Model	SSE	SSF	SSH	SSM	SSP	SSL01	SSL02	SSL03
WR^2 (lb.ft.2)	.51	1.57	3.57	7.24	15.0	15.59	21.66	33.77
Model	SSL04	SSQ	SSU	SSY01	SSY02	SSY03	SSY04	SSY06
WR^2 (lb.ft.2)	23.9	17.7	36.23	95.2	120.3	178.6	75.3	140.8
Model	SSY07	SSY08	SSY09					
WR^2 (lb.ft.2)	130.2	165.9	255.7					

FIGURE 6–1 – TORSIONAL INERTIA VALUES

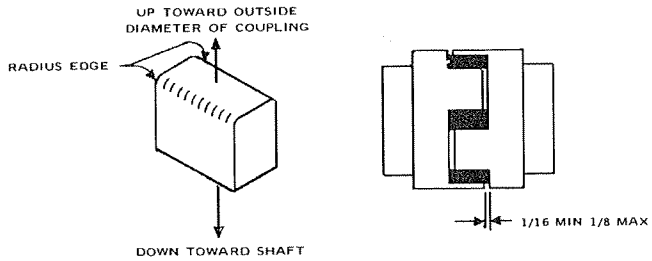


FIGURE 7–1 – INSTALLATION OF COUPLING – STYLE "A"

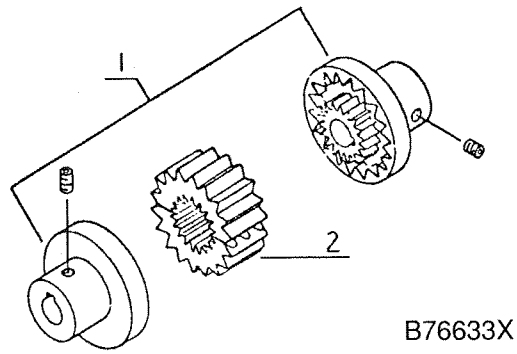


FIGURE 7–2 – INSTALLATION OF COUPLING – STYLE "B"

COUPLING – The driver and compressor are direct connected by a flexible coupling. Style "A" coupling has several individual cushions, FIGURE 7–1. Style "B" has a two piece split sleeve, FIGURE 7–2.

Your packager may have selected another type of coupling, if so they will provide you with coupling maintenance instructions. The following general guidelines can be followed for any coupling type.

⚠ 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.

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

Slide coupling halves over shaft extensions. Be sure the collar on the Style "A" coupling is installed on the shaft behind one coupling body.

FOR STYLE "B" COUPLING:

1. Secure short hub half of coupling to the shaft by tightening the set screws over the shaft key and 90° to the key.
2. Assemble halves of split sleeve into the teeth of the short hub half of the coupling.
3. Slide the long hub over the split sleeve teeth until the sleeve is bottomed in both hubs; back long hub off 1/16 inch.
4. Secure the long hub in position by tightening the socket head cap screw through the split section of the hub; tighten the set screw over the shaft key.

⚠ 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 – Alignment must be within .010 inch in all planes.

SECTION 8
MAINTENANCE SCHEDULE

SERVICE CHECK LIST –

Every 8 Hours Operation

1. Check the reservoir oil level – add oil if required. If oil consumption is high, refer to OEM Packager's instructions.
   DO NOT MIX LUBRICANTS.
2. Check discharge pressure and temperature.
3. Drain the moisture trap in the control system; if applicable.

Every 125 Hours Operation

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

Every 1000 Hours Operation

1. Change the oil filter element.

Every 4000 Hours Operation

1. Inspect the oil separator element.Every 6000 Hours Operation

Every 6000 Hours Operation

1. Change the compressor lubricant. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY. Flush system if required. DO NOT MIX LUBRICANTS.

Every Year

1. Check the relief valve for proper operation.

MAINTENANCE SCHEDULE (See detail notes above)

Maintenance Action	Every 8	Every 125 Hours	Every 1000 Hours	Every 4000 Hours	Every 6000 Hours	Every Year Hours
Service Intake Scrubber	SEE OEM PACKAGER'S INSTRUCTIONS					
Change Oil Separator	SEE OEM PACKAGER'S INSTRUCTIONS					
Check Reservoir Oil Level	●					
Check For Proper Load/Unload	●					
Check Discharge Pressure/Temp	●					
Check Dirt Accumulation on Cooler		●				
Change Oil Filter Element			●			
Inspect Oil Separator Element				●		
Change Compressor Lubricant	SEE OEM PACKAGER'S INSTRUCTIONS					
Check Relief Valve						●

SYMPTOM	POSSIBLE CAUSE	REMEDY
Compressor fails to start.	1. Wrong lead connections.	1. Change leads.
	2. Blown fuses in control box.	2. Replace fuse.
	3. Motor starter overload heaters tripped.	3. Reset and investigate cause of overload.
	4. Pressure in reservoir.	4. Inspect blowdown valve. and muffler.
	5. Engine clutch disengaged.	5. Engage clutch
Compressor starts but stops after a short time.	1. High discharge temperature.	1. See "High Discharge Temperature," this section, page 26.
	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.
	5. Engine stop switch malfunction.	5. Replace switch.
Compressor does not unload (or load).	1. Improperly adjusted control.	1. Refer to Section 4 and adjust control.
	2. Gas leak in control lines.	2. Determine source of leak and correct.
	3. Restricted control line.	3. Clean control lines.
	4. Blowdown valve malfunction.	4. Repair, clean or replace valve.
Compressor cycles from load to unload excessively.	1. Restriction in control tubing.	1. Inspect and clean control tubing.
Compressor is low on delivery and pressure.	1. Restricted suction scrubber.	1. Clean or replace filter.
	2. Sticking inlet valve.	2. Inspect and clean inlet valve.
	3. Unload pressure adjusted too low.	3. Adjust the unload pressure.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Compressor is low on delivery and pressure (continued)	4. Minimum pressure valve stuck closed.	4. Disassemble and clean valve.
	5. Turn valve adjustment or malfunction.	5. Adjust turn valve per Section 4, page 12.
High discharge temperature.	1. Thermostatic mixing valve stuck open.	1. Repair or replace valve.
	2. Dirty or clogged cooler face.	2. Clean cooler.
	3. Insufficient cooling air flow.	3. Provide unrestricted supply of cooling air.
	4. Clogged oil filter or cooler (interior).	4. Replace filter or clean cooler.
	5. Low compressor oil.	5. Add oil to proper level.
Excessive Oil Consumption	1. Oil carryover through lines.	1. See "Oil Carryover", below.
	2. Oil leaks at all fittings and gaskets.	2. Tighten or replace fittings or gasket.
Oil Carry–Over	1. Overfilling the reservoir.	1. Drain excess oil from system.
	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® oil matching service.

⚠ DANGER

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

⚠ DANGER

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

SYMPTOM	POSSIBLE CAUSE	REMEDY
Oil Carry–Over (Continued)	4. Loose assembly.	4. Tighten all fittings and gaskets.
	5. Foam caused by use of incorrect oil.	5. Use Gardner Denver® oil matching service.
	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 Temperature," page 26, this section.
	8. Scavenge line check valve failure.	8. Replace check valve.
	9. Water condensate in oil.	9. Check oil reservoir temperature and if low, change thermal mixing valve element to higher temperature.

COMPRESSOR REPAIRS

Two approaches can be taken for compressor repairs:

1. Use Gardner Denver Machinery exchange or rebuild program.
2. Overhaul existing unit.

The main note of caution when overhauling a compressor is that parts, including bearings, must be supplied by Gardner Denver Machinery. Most bearings have grinding and clearance specifications that are used in conjunction with our shaft fits. It is also important that all bearing journals be to specified dimensional limits before rebuilding the machine. It is recommended that a new shaft seal and bearings be installed during compressor overhaul.

Compressors which are rebuilt by Gardner Denver **will not** include any inlet or discharge piping and these components must be re–used from the compressor being replaced.

DISASSEMBLY INSTRUCTIONS – Secure driver so that it cannot be started; if electric, pull main breaker, if engine, lock the ignition. Remove oil lines, tubing and piping as required to clear compressor for removal from base. Remove filters, and their brackets as required. Cover openings in oil lines, tubing, oil filter and inlet scrubber to keep out dirt. Remove inlet valve assembly or inlet check valve and cover openings. Remove drive guard and compressor feet to base bolts. With suitable lifting device move compressor away from driver. If shims are under compressor feet, tag for correct location for use at reassembly.

1. Place compressor on suitable blocking and remove oil sump connection.
2. Remove coupling half or sheave from drive shaft, remove key, check and remove any burrs.
3. Remove all inlet end plate to cylinder screws. With jack bolts on each side, jack end plate from cylinder and bearings from shaft. It may be necessary to compensate with spacers under end of jack bolts as end plate is pulled. Progressively tighten jack bolts evenly to prevent binding end plate on dowels and bearings of shaft. Use suitable device to lift end plate free of shaft. When free of shaft remove inner race from shaft and roller assembly from housing. If bearings are to be reused, tag to match. As a safety measure, mark ends of rotors so they can be matched at reassembly. The best method is to mesh a lobe of the main rotor into a cavity on the secondary rotor, then center–punch the main rotor lobe and on each side of the secondary rotor cavity. These timing marks are not necessary if the compressor has a 4–5 rotor profile.
4. Remove bearing outer race from housing. Outer race may have retainer screws and washers, depending on model. Race is a light press fit to slip fit. NEVER REUSE WORN BEARINGS.
5. Remove all bearing cover plate to discharge end plate cap screws. With jack bolts, at least one each side, jack cover plate from dowel pins. Use caution to prevent cover plate binding on dowel pins.
6. If a full array of hydraulic jack tools are not available it is good practice to make a plate to use in this step. The discharge end cover plate may be used to lay out the four holes at the corners of the plate. Remove bearing retainer plates. With hydraulic jack and plate rigged with fasteners, press rotors through bearings. Use caution to prevent damage to end of rotor shaft. When rotor is free of bearings, remove rotor from cylinder. Remove with care to prevent burrs on rotor lobes and cylinder. Remove both rotors.
7. Remove discharge end plate from cylinder by use of jack bolts, using caution to prevent binding on dowel pins. Note: Timken cups are tight in bores. A puller will be required to remove. NEVER REUSE WORN BEARINGS.

ASSEMBLY INSTRUCTIONS – Gardner Denver compressors are manufactured with close tolerances for efficient operation. All parts must be handled carefully to prevent burrs which will give false tolerance readings and /or cause rapid wear. All parts and oil passages must be thoroughly cleaned of dirt which will cause galling of close running parts. Clean work area, washing tank, tools and wiping rags must be provided.

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

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

TORQUE RECOMMENDATIONS

All screws on the compressor should be tightened to the torque values shown in Torque Recommendations, page 31, to insure a correctly assembled and leak–free machine.

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

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

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

TO ASSEMBLE COMPRESSOR:

1. Apply gasket eliminator to joint between cylinder and discharge end plate. Bolt together and tighten fasteners to required torque (Torque Recommendations, page 31). Mechanically load suction end of rotors latterly, so that the discharge end of both rotors is flush against the discharge bearing end plate (zero clearance).

2. Main rotor discharge end clearance is set by placing shims between the rotor and bearing retaining plate. **NOTE: Bearing race to compressor are press fits and proper freezing or heating procedures are necessary.** Install the bearing outer race in the discharge end plate and the inner race on the discharge end of the main rotor. Shims are installed between the rotor shaft and the bearing retainer. Shims thickness will determine the proper discharge main rotor end clearance.

3. Before installing bearing in the secondary rotor bore, measure from the outside of the discharge end plate to the bottom of the outer race bore. Also measure from the outside of the discharge end plate to the inner race shoulder of the secondary rotor. These measurements should be made with a depth micrometer. Record the difference of these dimensions.(dimension B) Determine the bearing "stand" dimension. With a parallel bar and the assembled bearing setting on a flat surface (See FIGURE 10–1) measure the distance from the top of the bar to the bearing cup back face (dimension 1). Measure from the top of the bar to the cone front face (dimension 2). Subtract the two readings (1–2) to obtain the distance from the cup back face to the cone front face (dimension A). Record measurement. The shim thickness will be dimension A minus dimension B plus the recommended end clearance as specified on page 32. This shim is installed between the secondary rotor inner race shoulder and the inner race. Install shim of the calculated thickness on the secondary rotor and place against the shoulder. Install outer race in the discharge end plate. Then install the bearing inner race on the rotor bearing shoulder firmly against the shim. **NOTE: Bearing race to compressor are press fits and proper freezing or heating procedures are necessary.**

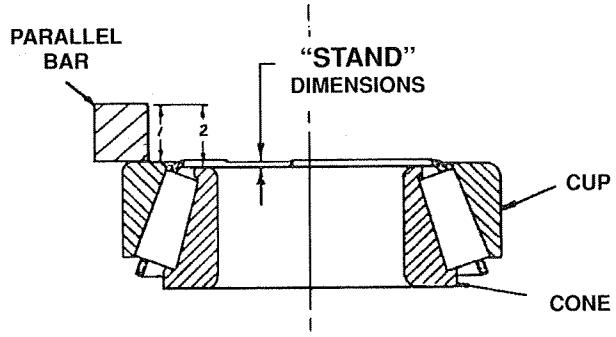


FIGURE 10–1 – BEARING "STAND" MEASUREMENT

4. Heat the inlet end main rotor bearing inner race and install to the shoulder step. The secondary rotor bearing inner race is installed with the same process. Allow to cool to room temperature before proceeding. Outer races are a slip fit and temperature adjustment should not be required prior to installation into the inlet end bearing housing. Assemble inlet end bearing housing with outer races installed on the cylinder and attach and torque with fasteners. Torque values are shown in Torque Recommendations, page 31.

5. Check discharge end clearance on both rotors to assure that measurements and calculations were performed correctly. If discharge end clearance dimension is NOT within tolerance, dismantle compressor, pull bearings, and repeat Steps 1 through 4.

6. Check shaft for burrs and coat with oil. Slide oil seal over shaft tight against bearings. Install seal retainer plates and tighten screws evenly. Install coupling half or sheave with key on drive shaft; **do not drive onto shaft as bearing damage may result.**

BEFORE INSTALLING COMPRESSOR ON BASE:

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

2. Install a new oil filter.

3. Inspect the oil separator in the oil reservoir. Replace if necessary.

4. Install compressor on base, align for proper drive arrangement. Install compressor to base fasteners. If shims were used, when removed, make sure they are reinstalled in the proper position.
5. Align drive components and install drive guard.

MISCELLANEOUS:

1. Inspect the inlet housing and inlet or check valve; clean and repair if necessary. Install with a new gasket.
2. Install brackets and filter(s) as required according to model.
3. Connect all oil lines; be sure all lines are connected properly.
4. Thoroughly clean intake filter or scrubber.
5. Connect all other tubing or piping as required.
6. Make sure all drain plugs and connections in oil system are tight. Fill system with oil.

GENERAL GUIDELINES FOR HANDLING, MOUNTING AND ADJUSTING TAPERED ROLLER BEARINGS

1. Do not wash the grease off a new bearing. This can cause rust and lead to eventual failure.
2. Avoid beating or pressing roller elements against cup.
3. Use a steel drift (no brass and no hardened punches) and hammer to seat a race only if normal procedures failed.
4. Use a small amount of anti–seize compound such as Molykote to prevent galling between the bearing race and the shaft. Ordinary mineral oils are unsatisfactory for this as they will be squeezed out by the tight fit.
5. Always lubricate bearing after heating or cooling for installation.
6. Keep bearing well lubricated when adjusting.
7. After each adjustment of the bearing, always rotate taking care to assure that rollers are aligned before checking clearance.
8. For ease of installation, the bearing cone should be heated to 250–275 degrees F. Assuming a shaft temperature of 90 degrees F., This will give a change in fit of .001" per inch of shaft diameter.

   For example the SSU has a 4 inch shaft and a maximum tight fit of 0.0025T. The fit between the 90 degree F. shaft and the 250 degree F cone will be 9.0015L with the shaft at the high limit and the cone at the low limit. If the cone does not fall on the shaft, a judicious tap to achieve proper alignment should send it on its way.
9. When a heated cone is dropped on a rotor shaft with the rotor body against the end plate, the discharge end clearance will normally be in excess of 0.010" when the rollers and cone cool and contract.
10. Always approach proper clearance by pulling the cone on the rotor shaft. If clearances are too small push the shaft thru the cone until the clearance is too large and again approach the proper clearance.
11. When assembling a double row bearing employing a spacer between the cups, always be certain that parts are not mixed with another bearing of the same type. Improper clearances will result in premature bearing failure or interference between the rotor and the housing. Results are catastrophic in either case.

NOTE: Some double row bearings may have special steel in one cup and cone and must be installed on the shaft in proper sequence. These have an xx designations.

12. In the case of the two row bearing a bench measurement of the stand is necessary to determine the shim thickness to achieve proper rotor end clearance. It is important to note that this stand dimension will increase approximately 0.0015" when the bearing is mounted. The exact value will depend on the particular bearing and the actual fit but the above value should be within 0.0005" in nearly all cases. Unless the specific value is known 0.0015" may be used when calculating shim pack thickness.

TORQUE RECOMMENDATIONS

Screw Size	SAE Grade 5 – Hex Head Cap Screw			SAE Grade 8 – Socket Head Cap Screw		
	Plain	With Nylok Insert	Maximum	Plain	With Nylok Insert	Maximum
1/4 – 20 UNC	8.5	11	11	12	14.5	15.5
5/16 – 18 UNC	17	22	23	24	29	32.5
3/8 – 16 UNC	31	38	41	44	51	58
7/16 – 14 UNC	50	58	66	70	78	93
1/2 – 13 UNC	75	88	100	105	118	140
9/16 – 12 UNC	108	125	145	152	169	205
5/8 – 11 UNC	150	175	200	210	235	280
3/4 – 10 UNC	260	293	350	365	398	490
7/8 – 9 UNC	400	450	530	615	665	800
1 – 8 UNC	590	660	785	915	982	1210

All **Torque Values** shown are in **Foot–Pounds** and are based on clean, dry parts without burrs. The use of plated screws, lubrication, etc. will reduce torque values as mush as 20% and must be taken into consideration.

ROTARY SCREW COMPRESSORS FOR NATURAL GAS SERVICE

BEARING FIT DIMENSIONS

	SSE	SSF	SSH	SSM	SSP	SSL	SSQ	SSU	SSY
End plate brg bore dia.– MAIN									
Suction	3.500/3.501	4.498/4.499	4.3307/4.3321	5.1181/5.1193	5.5118/5.5130	2.7515/2.7510	7.0860/7.0876	8.4639/8.4657	9.4481/9.4499
Discharge	3.500/3.501	4.498/4.499	4.8730/4.8740	5.3730/5.3740	5.7480/5.7490	2.4390/2.4385	7.123/7.124	8.4360/8.4370	8.4385/8.4395
Drive shaft bearing bore diameter	4.9980/4.9990	5.908/5.909	5.873/5.874	7.0860/7.0876					
Drive shaft bearing diameter – INNER						2.5015/2.5010	2.5015/2.5010	3.0015/3.0010	4.3321/4.3312
Drive shaft bearing diameter – OUTER						3.0015/3.0010	3.0015/3.0010	3.0015/3.0010	4.3321/4.3312
End plate brg bore dia.–SECONDARY									
Suction	3.500/3.501	3.498/3.499	3.5433/3.5447	4.3307/4.3321	4.7244/4.7258	2.3632/2.3627	5.1176/5.1186	5.1176/5.1186	7.0860/7.0876
Discharge	3.500/3.501	3.498/3.499	3.5435/3.5445	4.4387/4.4397	4.6262/4.6272	2.5015/2.5010	5.1183/5.1193	5.1183/5.1193	7.0866/7.0876
Shaft bearing diameter – MAIN									
Suction	1.7515/1.7510	1.9390/1.9386	1.9696/1.9690	2.3632/2.3627	2.5601/2.5596	5.002/5.003	3.9381/3.9375	3.9381/3.9375	5.1202/5.1192
Discharge	1.7515/1.7510	1.9390/1.9386	2.1265/2.1260	2.4390/2.4385	2.7515/2.7510	5.3730/5.3740	3.0015/3.0010	4.0025/4.0015	4.0025/4.0015
Shaft bearing diameter – SECONDARY									
Suction	1.7515/1.7510	1.8765/1.8761	1.9696/1.9690	2.3632/2.3627	2.5601/2.5596	4.3307/4.3321	2.9538/2.9533	2.3632/2.3627	3.3484/3.3475
Discharge	1.7515/1.7510	1.8765/1.8761	2.1666/2.1659	2.5015/2.5010	2.8765/2.8760	4.4387/4.4397	3.3475/3.3470	3.3475/3.3470	3.5443/3.5438
End Plate to rotor – AXIAL–									
Suction	.005/.024	.009/.026	.012/.020	.012/.020	.012/.020	.018/.032	.018/.047	.013/.041	.012/.040
Discharge	.002/.003	.002/.003	.002/.004	.002/.004	.002/.004	.002/.003	.003/.004	.004/.006	.005/.007
Turn valve shaft bearing diameter									
Suction					2.1666/2.1659		2.1666/2.1659	2.3765/2.3760	2.3765/2.3760
Discharge					2.1666/2.1659		3.2838/3.2828	2.3765/2.3760	2.3765/2.3760
Turn valve bearing bore diameter									
Suction					3.5415/3.5425		3.5428/3.5442	3.998/3.999	3.999/4.000
Discharge					3.5415/3.5425		3.5428/3.5442	4.001/4.003	4.000/4.002

Gardner Denver

WARRANTY
ROTARY GAS COMPRESSORS
OIL INJECTED

GENERAL PROVISIONS AND LIMITATIONS

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

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

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

WARRANTY PERIOD

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

COMPRESSOR AIR ENDS

Gas compressors, consisting of all parts within and including the compressor cylinder and gear housing, are warranted for 12 months from date of initial use or 15 months from date of shipment to the first purchaser, whichever occurs first.

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

OTHER COMPONENTS

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

LABOR TRANSPORTATION AND INSPECTION

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

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

All costs of transportation of product, labor or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facilities shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by Company, transportation prepaid by Purchaser, to establish a claim under this warranty.

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

DISCLAIMER

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

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

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

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

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

Gardner Denver

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

Sales and Service in all major cities.

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

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