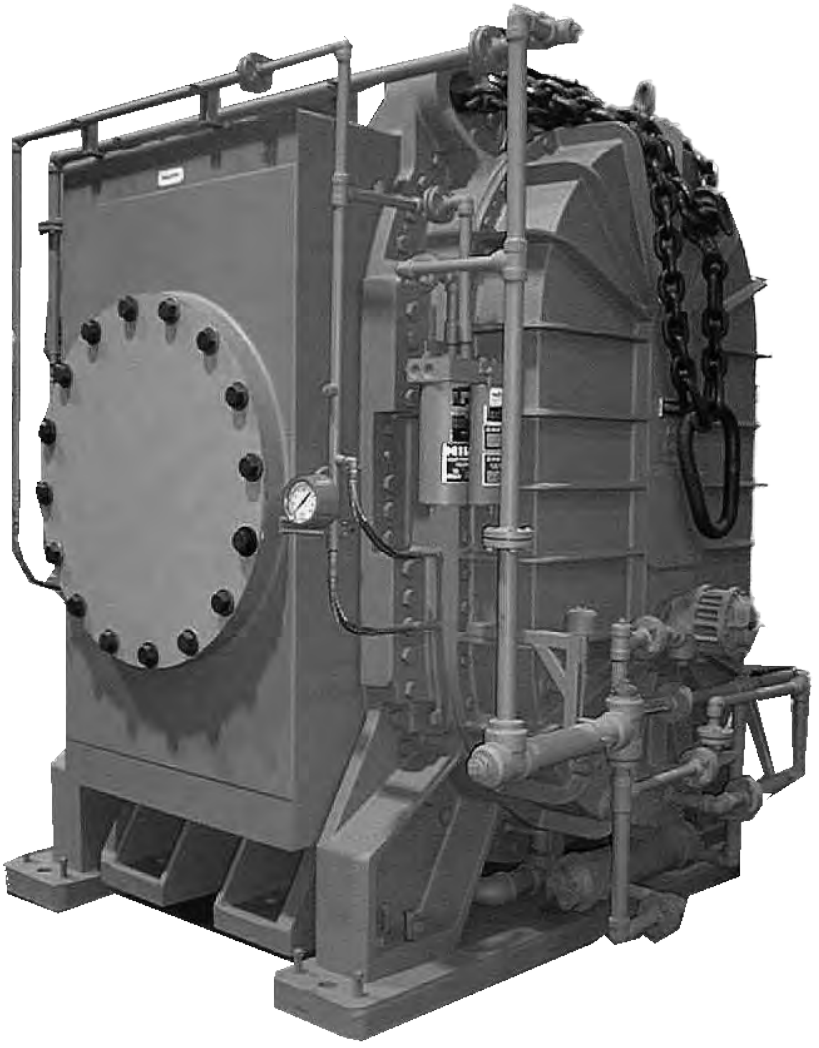
ROOTS™

36” RGS-J Gas Compressor for 25 PSL Design with One Piece Cylinder and Separate Console Lube System

Installation and Operation Manual



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Contents

Do These Things To Get The Most From Your ROOT® Blower

- Check shipments for damage in transit. After filing claim with carrier, notify Roots.
- Unpack Shipment carefully and check , contents against Packing List. Notify factory if a shortage appears.
- Store in a clean, dry location until ready for installation, if possible. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather, and corrosion if outdoor storage is necessary.
- Read LIMITATIONS and INSTALLATION sections in the manual and plan the complete installation. If supervision by a Service Engineer
- Read starting check points under OPERATION. Run equipment briefly to check for obvious faults, and make corrections. Then make a trial run under normal operating conditions.
- In the event of trouble during installation or operation of a new unit, do not attempt repairs. Notify nearest factory, giving all nameplate information plus an outline of operating conditions and a description of the trouble.
- Unauthorized attempts at equipment repair may void Manufacturer's warranty. It is recommended that such work be limited to the operations described in this manual, using Factory Parts. Good inspection and maintenance practices should reduce the need for repairs.
- Provide for adequate safeguards against accidents to persons, working on or near the equipment during both installation and operation. See PRECAUTIONS.
- Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.
- Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.

NOTE - Information in this manual is correct as of the date of publication. The Manufacturer reserves the right to make design or material change without notice, and without obligation to make similar changes to equipment of prior manufacture.

Operating Characteristics

Units of the Roots Whispair Gas Compressor Design, as covered in this manual. are 36 inch gear diameter units. The type RGS-J units have mechanical seals in order to reduce gas and oil leakage to a practical minimum.

The Roots rotary lobe gas compressor is a positive displacement type unit whose pumping capacity is determined by size, operating speed, and pressure conditions. It employs two double-lobe impellers mounted on parallel shafts and rotating in opposite directions within a cylinder closed at the ends by headplates. As the impellers rotate, gas is drawn into one side of the cylinder and forced out the opposite side against the pressure existing there. The pressure developed, therefore, depends on the resistance of the discharge system.

Effective sealing of the gas compressor inlet area from the discharge area is accomplished by use of very small operating clearances. Resulting absence of moving contacts eliminates the need for any internal lubrication. Clearances between the impellers during rotation are maintained by a pair of accurately machined timing gears, mounted on the two shafts extending outside compressor casing.

The proprietary design of the Whispair gas compressor provides a chamber on the discharge side of the cylinder. From this chamber two or more slots open back into the two alternately closed pocket areas of the cylinder, shown as A and B in Figure 1. These slots, at certain impeller positions, allow discharge pressure to bleed into the normally low pressure pockets. They also provide a jet action on the impellers in the direction of rotation. Gradual pressure build-up in the pockets, to a level almost equal to the discharge pressure, reduces backflow rate at the instant of pocket discharge so that pulsing shock and noise are minimized. This permits operation at higher speeds with conservative noise levels.

In Figure 1, flow is right to left from gas compressor inlet to discharge. The lower impeller is mounted on the driving shaft, and rotates clockwise. As shown in Position 1. it is delivering a measured volume (A) in to the discharge pressure chamber. At the same time, space (B) between the upper impeller and cylinder. wall is filling with another and equal volume at atmospheric or inlet pressure. It is about to be sealed off by the counterclockwise rotation of this impeller, for delivery to the discharge.

Position 2 shows the inlet area sealed but some discharge pressure is now entering space (B) through the slot passage, as indicated by the small arrows.

Force of this jet gives a rotative assist to the impeller, while also building pressure in sealed space (B).

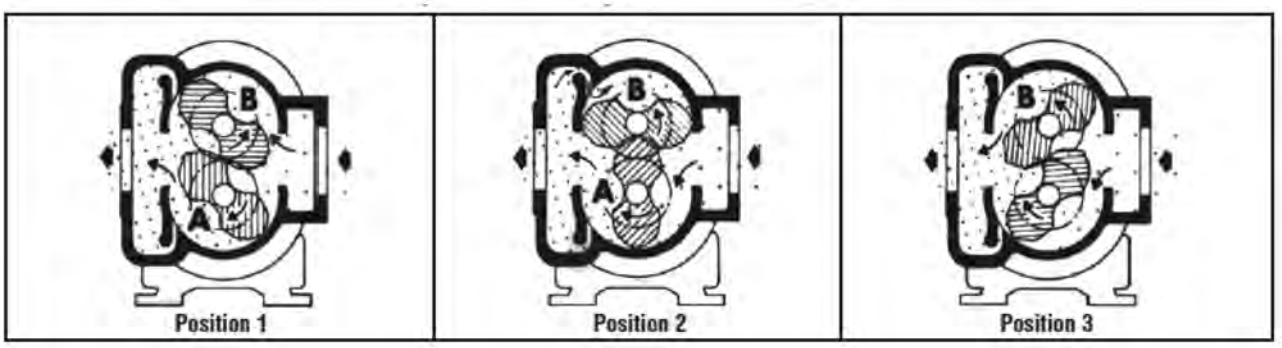
Rotation continues to Position 3, where volume (B) is delivered to the discharge chamber in the same manner as volume (A) in Position 1. Because of the almost complete pressure equalization through the slot, no sudden shock occurs at this point.

One complete revolution of the driving shaft alternately traps four fixed and equal volumes of gas (two by each impeller) and pushes them through to the discharge. The pumping capacity of a lobe gas compressor operating at a constant speed therefore remains relatively independent of reasonable inlet or discharge pressure variations. To change capacity, it is necessary either to change speed of rotation or by pass some of the discharge gas through a cooler.

No attempt should ever be made to control capacity by means of a throttle valve in the intake or discharge piping. This will not only increase the power load on the driver, but can also overload and seriously damage the gas compressor. Likewise, if a possibility exists that flow to the gas compressor inlet may be cut off during normal operation of a process then an adequate vacuum relief valve must be installed near the gas compressor. A pressure type relief valve in the discharge line near the gas compressor is also strongly recommended for protection against cut-off or blocking in this line. Relief valves should be piped appropriately to prevent gas leakage to the atmosphere or air leakage in to the system.

If excess gas is returned to the gas compressor inlet, it must go through a cooling by-pass arrangement. See Figure 4.

Figure 1 - Flow Through an RGS-J Gas Compressor



Operating Limitations

To permit continued satisfactory performance, a Roots gas compressor must be operated within certain approved limiting conditions. The Manufacturer's warranty is, of course, also contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1, when operated under standard atmospheric conditions. Do not exceed any one or these limits.

Example: the listed maximum allowable temperature rise (increase in air temperature between inlet and discharge) for any particular gas compressor may occur well before maximum speed or maximum pressure rating is reached. Temperature rise then is the limiting condition. In other words, the operating limit is always to be determined by the maximum rating reached first. It can be any one of the three: pressure, temperature, or speed.

Be sure to arrange connections or taps for thermometers and mercury type pressure or vacuum gauges at or near the inlet and discharge connections of the gas compressor. These, along with a good tachometer, will enable periodic checks of operating conditions to be made easily.

PRESSURE - On pressure service, the pressure rise in pounds per square inch (between gas compressor inlet and discharge) must not exceed the figure listed for the specific gas compressor frame size concerned. The compressor case is rated at maximum pressure of 35 Psi (2.46 Kg/Cm2) gauge.

On vacuum service, with the discharge going to atmospheric pressure, the inlet vacuum in inches of mercury (Hg.) (mm Hg.) must not be greater than the values listed for the specific frame size.

TEMPERATURE - Various gas compressor frame sizes are approved for installations with the following temperature limitations. A. Maximum temperature rise (T.R-) in Fahrenheit degrees must not exceed 170°F (94.4°C) when the inlet is at ambient temperature. If inlet temperature is higher than ambient, the allowable temperature rise must be reduced by 2/3 of the difference between the actual inlet and the ambient temperature.

B. For operation in cold weather, the unit should never be run under load when the gas compressor casing is below 35°F (1.67°C). If below 35°F (1.67°C), the gas compressor should be run under no load with warm process gas until the casing is heated to 35°F (1.67°C).

C. Water is injected into the cylinder inlet for cleaning and cooling purposes, care must be taken during winter shutdowns to insure no ice is formed inside the unit prior to start-up. Furthermore, water should not be injected unless the gas compressor casing is above freezing.

SPEED RANGE - 36 inch gear diameter Whispair gas compressors may be operated at speeds up to 520 RPM (4900 ft/min. [1495m/min] gear speed). They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At lower speeds, excessive temperature rise may be a limiting factor. Torsional analysis of the drive system must be performed to avoid operating at torsional critical.

Table 1 - Maximum Allowable Operating Conditions

Frame Size	Press Rise-PSI (kg/cm^2)	Inlvet Vac. "HG (mmHG)	Temp Rise °F (°C)	Speed RPM
3649	18.4 (1.29)	16 (406.4)	170 (94.4)	520
3661	14.5 (1.02)	16 (406.4)	170 (94.4)	520
3672	12.5 (.879)	16 (406.4)	170 (94.4)	520

WATER INJECTED OPERATION - Water is injected into the inlet of the machine for cooling and cleaning purposes, the following consideration must be taken into account.

A. Water is to be injected through inlet spray nozzle system at a rate of 12 to 15 GPM (45.4/56.8 liters per min.).

B. Cylinder casing drains must be installed in the bottom of the cylinder. Prior to each start and after each shut down, these drains must be opened and allowed to drain through barometric legs, to insure water is not trapped in the casing.

C. The discharge pulsation dampener must be a

combination silencer and separator. An automatic drain system must be installed to remove the separated water from the pulsation dampener.

TWO STAGE OPERATION - Consult the factory for special operating requirements and installation procedures.

PRESSURE PULSATIONS - For satisfactory operation of the compressors, system pulsation analysis must be performed during the initial design. The silencer separator should be located for minimum discharge pulsations as determined by the pulsation study.

COMPRESSOR VIBRATIONS - Vibration measurements must be made on the compressor inlet side on the headplates at an elevation midway between shaft centers in inches per second peak(mm/sec peak).

Normal operating vibration must not exceed 0.45 in/sec peak (11.4 mm/sec peak).

Alarm should be set at 0.6 in/sec peak (15.2 mm/sec peak)

Shut down should be set at 0.7 in/sec peak (17.8 mm/sec peak)

Compressor vibrations should be monitored on a continuous basis and vibration trend observed for progressive or sudden change. If a change occurs, the cause should be determined through spectral analysis.

COMPRESSOR DRIVE TRAIN TORSIONAL VIBRATIONS
Complete compressor drive train should be analyzed to determine torsional frequencies. The compressor train must be free from all harmful torsionals at operating speed. Consult Sales office for equivalent compressor torsional data.

Installation

SUPERVISION of installation by a Factory Service Representative is recommended for these units. Information in this manual may be supplemented by the more detailed discussions of foundations and piping in Compressed Air and Gas Handbook, published by the Compressed Air and Gas Institute, New York City. However, a Service Representative may be employed for supervision of final checking of an installation.

HANDLING of the equipment should be accomplished by methods conforming to safe practice for the weight involved. Weight of a bare unit, without baseplate, driver or accessories is listed below. Four cast lifting eyes at the top are provided near each corner for lifting the unit.

Frame Size	Approx. Pounds	Approx. Kilograms
3649	72000	33000
3661	84000	38000
3672	92000	42000

DIRECTION of pull on the lifting eyes during lift should be nearly vertical. Use spreader bars to take the side strain, and adjust cable lengths so that the unit is approximately level during the lift.

LOCATION of the installation is generally not a critical matter. These units are suitable for outdoor installation.

PROTECTION of internal machined surfaces against normal atmospheric corrosion has been provided at the factory, using a vaporizing inhibitor. Maximum period of protection is one year under average conditions, if flange covers and closing seals are not removed. Protection against chemical or salt water atmosphere is not provided.

Leave covers and taped seals over all openings as long as possible during installation to avoid loss of protection.

When ready to connect piping, remove main flange covers and inspect gas compressor interior for presence of foreign particles or dirt adhering to machined surfaces. Clean out such material by washing carefully with a solvent, then rotate impellers manually to make sure they turn freely. Temporary inlet screen should be installed before start-up. Also use the same solvent to remove the antirust coating from flange faces and any other surfaces. Note: interior cleaning is not required if no dirt is found.

Jack screws are provided to make leveling and height adjustments easier. Steel plates should be placed on the foundation under each jack screw location. Plates and anchor bolts are not furnished as standard accessories.

FOUNDATION design depends on local soil conditions and several other factors, and can only be discussed in general here. Additional information will be found in the publication referred to at the beginning of this section. For satisfactory operation of supported equipment, a concrete foundation must be rigid, must have minimum deflections, and must be free from resonant frequencies in the operating speed range of the equipment

Length and width dimension of the foundation should provide at least 12 inches (30.5 cm) from any edge to the nearest machine anchor bolt, as located from a certified manufacturer's general arrangement drawing. Depth dimensions should be determined by design.. The concrete block should be permitted to cure for a minimum of 28 days before the blower is grouted in place. Any block distortions during curing then will have little or no effect on equipment and alignment. To simplify machine leveling and provide good grouting bond, the top of the foundation should be struck-off as level as possible but left with a rough surface.

ANCHOR BOLTS are to be placed within the foundation form before concrete is poured. Anchor bolts, installed as shown in Figure 2, with a 2 inch diameter and 36 inch length (5.08cm dia. and 91.44 cm length), are recommended. The bolts must be located as accurately as possible from dimensions on a certified installation drawing. To obtain a bolt location tolerance of 1/8" (3.175 mm), use of drilled templates firmly secured to the foundation forms is recommended.

The bolt sleeves shown, if kept centered around the bolts and free of concrete, will allow bolts to be sprung enough to correct for small variations due to bolt setting and drilled hole machining tolerances. The sleeves are filled in the final grouting operation. Bolt positions should be adjusted vertically so that the top ends will extend at least 1-1/2 diameters above the soleplate or base

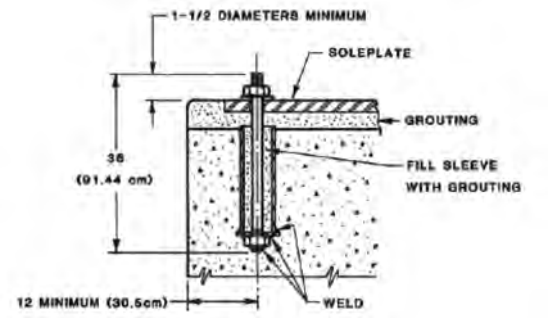
flange, or as shown on the installation drawing.

LEVELING is very important and should be performed with care, using a good machinist's level having a ground glass bubble vial. A setting as level as possible in all directions is the result to be worked toward. The gas compressor should be level within 0.05 inch per foot (.127 mm per 30.48 cm) in both length and width. The top of the soleplates should be used for leveling the machine. Use jack screws, shims or wedges for adjusting.

When a satisfactory condition of level is obtained, turn the anchor bolt nuts down snug but not tight. Elimination of twist here is very important and minor adjustments can be made with shims directly under the gas compressor feet.

ALIGNMENT of the drive shafts, when the gas compressor and its driver are direct coupled, requires careful attention. This precaution will not only help insure satisfactory coupling operation, but will minimize chances for damage due to external forces. A close approximate alignment should be obtained in the original setting, so that only small final adjustments will need to be made after grouting.

Figure 2 - Typical Anchor Bolt Detail



In a soleplate type installation, the separately mounted driver must be positioned, leveled and aligned as part of the installation procedure. Whether it is on soleplates or on its own base, shims of 1/16" to 1/8" (1.5875 to 3.175 mm) thickness placed directly under the driver feet before setting will permit more accurate final alignment. Spacing between the two shaft ends as required by the coupling must also be established.

If a motor is being used that has end -play in the shaft, be sure its rotor is located on magnetic center before setting this spacing.

GROUTING follows completion of leveling and preliminary alignment. Assuming the foundation has been properly cured, its top surface should first be roughened by chipping to remove glazed areas, and oil or grease removed with a strong hot detergent or caustic solution.

Grouting serves not only to compensate for surface irregularities in the foundation and machine base, but also to provide restraint against shifting. Anchor bolts are used for holddown only. Therefore, the grout must be of adequate thickness under the soleplate or base flange, must flow into anchor bolt sleeves and all interior cavities and must have minimum shrinkage during the setting period.

Special grouting materials designed to counteract shrinkage are commercially available, and are preferred to cement The manufacturer's instructions should be followed in using these materials.

After grouting is placed and dressed off, protect exposed surfaces from rapid drying as directed by the grout manufacturer.

This will normally produce a stronger grout with higher bond strength. Wait at least 24 hours before tightening anchor bolts or connecting any piping. When jack screws have been used for leveling, back them off prior to tightening the bolts. Such points of concentrated loading are likely to wear during machine operation, resulting in loose anchor bolts. Final bolt tightening should be enough to hold the machine firmly against the foundation and prevent vibration.

After all anchor bolts are secured, recheck the gas compressor for twist and level. Working from the finished top of the soleplates make corrections to meet the requirements specified under LEVELING by shimming under the gas compressor feet. Then rotate the drive shaft by hand to make sure both impellers turn freely at all positions.

Final alignment of the gear and compressor shafts should be accomplished next by adjusting the shims only under the gear feet. This needs to be done with the greatest possible care, and in accordance with coupling manufacturer's instructions.

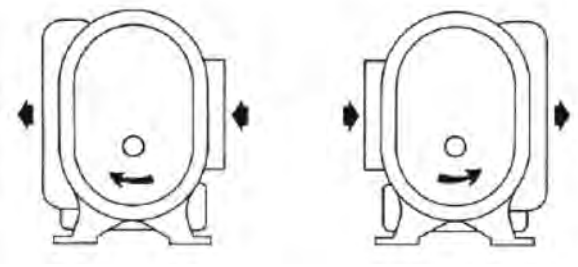
Even though a flexible coupling can accept some degree of misalignment, it should not be forced to compensate for careless workmanship. The flexing or sliding member in a coupling will transmit undesirable forces between the two shafts in proportion to the degree of misalignment, thus promoting vibration and unnecessary wear problems.

Misalignment can be of two basic types, offset and angular, but usually it will be a combination of both. For satisfactory coupling operation it is recommended that the following limits be used: maximum deviation in offset alignment not greater than .003" (.076 mm) total indicator reading on the coupling hubs; maximum deviation from parallel of the inside coupling faces not greater than .001"(0.0254 mm) when checked at six points. Where driver is a steam turbine, the final alignment should be made with the turbine at operating temperature in order to allow for shaft movement resulting from expansion.

After necessary adjustments for alignment are completed, lubricate the coupling with grease as specified by its manufacturer and complete the coupling assembly.

Make sure at this point that driver rotation is correct to produce the blower shaft rotation indicated by an arrow near the shaft.

Figure 3 - Rotation and Discharge



The Whispair gas compressors are not reversible, hence drive rotation and discharge flange location are predetermined in manufacturing assembly. Figure 3 illustrates the assembly options available by specification on original order, to meet piping and drive requirements.

PIPING must be clean, and not smaller in size than the gas compressor connections. A good rule-of- thumb is that the gas line velocity should not exceed 75 feet per second (22.86 m/sec.). Where possible use long radius elbows to insure smooth flow. Design the piping layout so that no strains are placed on the gas compressor, either from weight or expansion forces. This means providing adequate supports, anchors, and expansion joints or loops.

Installation of a spool-type flexible expansion joint with control units or Dresser Coupling near the gas compressor inlet and discharge connection is recommended. Use of inlet and discharge silencers to reduce noise and pressure pulsations, must be considered. The silencers must be located per silencer vender recommendations based on system pulsation study to prevent generation of destructive pressure pulsations in the piping. Pressure pulsations increase dynamic loading on compressor, drive train and piping system, and resonant pulsations in the system piping on compressor inlet or discharge cannot be permitted.

Inlet piping should be completely free of valves or restrictions.

For physical protection of the gas compressor during initial operation, install a temporary screen at the inlet connection made of 16-mesh wire backed with 1/4" (6.25 mm) hardware cloth. This will stop most kinds of pipe debris. A manometer connected to read pressure drop across the screen will indicate when it needs cleaning, but visual inspection during a shut- down should also be made to determine the amount of material collected. Clean and replace the screen until debris no longer appear. Do not leave it installed permanently, as the wire will eventually deteriorate and pieces going into the blower may cause serious damage.

Discharge piping requires a pressure relief valve or high discharge pressure switch, and should also include a suitable pressure gauge and a manually operated unloading valve. The latter permits starting under no-load conditions. Theoptional back pressure regulator shown in Fig.-4 will be required if volume demands vary while gas compressor operates at constant speed. In a gas installation (Fig.-4) the regulator will probably need to be located in a by- pass loop back to the gas compressor inlet. However, the volume of gas that may be continuously circulated will be limited by heat buildup, which can cause blower damage.

In some installations, particularly where two or more gas compressors discharge into a common header, it is recommended that a direct acting or free swinging check valve by provided in each discharge line.

These valves properly installed, protect against damage resulting from reverse rotation caused by back flow through an idle gas compressor.

In making pipe connections to the gas compressor, use special care in lining up the mating flanges. They must contact squarely and accurately, without imposing strain of the gas compressor casing, Any attempt to draw flanges together by force will probably distort the gas compressor and cause internal contact. Also, the gas compressor should not carry more than the weight of one pipe fitting at each connection. After bolting up the flanges, rotate the drive shaft by hand to check for rubbing contacts caused by strains or dirt.

Lubrication

The Whispair gas compressors for this job are supplied with independent console lube system. This lube system also supplies lubricant to the speed reducer.

Timing gears receive oil at their meshing point by direct spray from a passage in the side of the housing. All main bearings and face type shaft seals are supplied through inboard passages in the headplates and bearing carriers.

For lubrication system and switch set points, refer to Piping and Instrumentation Drawings and List of Materials.

On a 36" gear diameter RGS-J gas compressor, rotation mechanical seals are used. While these seals are spring loaded and self-adjusting, their effectiveness as gas seals depends largely on continuous pressure lubrication of the seating faces. Some oil may work through these seals and will collect in the oil trap provided. The oil trap will be under gas pressure. It is recommended that the oil trap be connected to a barometric leg to prevent possibility of gas leakage to atmosphere.

The labyrinth type shaft seals in the headplate walls allow free passage of gas into the pockets or chambers around the gas seals. To prevent leakage of gas outside the blower, head plate holes of the chambers are sealed with pipe plugs.

During normal shut-down periods, keep the lubricating system running to maintain continuous oil pressure at the faces of all seals to prevent gas leakage to the out side. Proper functioning of the face seals require oil pressure at a higher value than the gas pressure present at the seal faces. Lubrication system must be on any time the compressor remains under gas pressure.

Lubricating oil grade should be selected from Table 2 for the existing ambient temperature range.

A premium grade, non-detergent petroleum base oil with rust, oxidation and foam inhibitors is recommended. Some of the oil brand names meeting these criteria are EXXON NUTO, SUNOCO SUNVIS, MOBIL DTE, SHELL TURBO, AND TEXACO REGAL R & O.

During the first week of normal compressor operation, the oil level should be checked daily. There-after a weekly check probably will be sufficient. Do not permit the level to drop below the gauge line.

Table 2 - Lubricant Recommendation

Ambient Temperature °F (°C)	ISO-VG Grade
50 - 120 (10 - 49)	220
32 - 50 (0 - 10)	150
BELOW 32 (0)	100

Frequent oil changing is not required unless the gas compressor is in a very dusty location. Operating periods of 2000 hours between changes may be considered normal. It may be advisable to check oil condition each time the weekly level check is made, until a regular change period can be determined.

Also replace the cartridge in oil filter at oil change in order to protect the mechanical shaft seat faces.

These seals may leak a certain amount of oil in normal operation, which will collect in a chamber in each headplate under the lower shaft. The oil levels in these chambers should not be allowed to reach the labyrinth shaft seal openings.

The maximum oil temperature to bearings and gears should not be higher than 120°F (48.9°C). Oil returning to the sump will then normally be at about 160°F (71.1°C) or less. These conditions can be maintained only if the cooler tube bundle is not allowed to become fouled with deposits from the cooling water, and if the water temperature is less than 85°F (29.6°C). Rate of water flow required can be expected to be between 1/2 and 1 times the oil flow rate through the cooler.

Operation

Before starting the gas compressor under power for the first time, recheck the installation thoroughly to reduce the likelihood of troubles. Use the following check list as a guide, but also consider any other special conditions in the installation.

1. Be certain no bolts, rags or dirt have been left in the gas compressor gas chamber.

2. Be certain that inlet piping is free of debris. Use of the temporary protective screen at the gas compressor inlet as described under INSTALLATION is strongly recommended during early operation.

3. Check gas compressor leveling, drive alignment, and tightness of all mounting bolts if installation is not recent.

4. Turn drive shaft over by hand to make sure impellers will rotate without bumping or rubbing at any point

5. Check lubrication system. Oil level in the sump should be at the gauge line. Make sure filters in lines contain filtering cartridges. Be sure water supply and return lines for the oil cooler are connected and operating.

6. Turn the lubrication system on. Make sure the relief valves and the pressure switches are set per P & I diagram list of materials. Keep the lubrication system on during the following steps.

7. If driver is an electric motor, make sure it is also properly lubricated. Check that power is available, and that electrical overload devices are installed and in operating condition.

8. Vent the discharge line by opening the initial starting blow-off valve, while keeping the normal starting by-pass valve closed. See Figure 4. Inlet piping should be open to atmosphere (not connected to gas supply) during startup and until unit has been tested.

9. Bump gas compressor a few revolutions with driver to check direction of rotation and to see that both units coast freely to a stop.

10. Start gas compressor, let it accelerate to full speed, then shut off. Listen for any knocking sounds, both with power on and also as it slows down.

11. If no problems have appeared, restart unit and operate for 5 to 10 minutes under no-load conditions as in paragraph. Check the cylinder surfaces all over by feeling to locate any hot spots indicating impeller rubs. Continue to listen for noises and watch for changes in vibration. If all conditions are acceptable, proceed as follows:

12. Stop the unit and connect the inlet piping to the gas supply.

13. Open the normal starting by-pass valve and restart the unit. After it reaches full speed, start closing the by-pass valve fairly rapidly. Observe the discharge pressure gauge or manometer as the valve is closed, do not allow the pressure to exceed the rating of the unit as specified under LIMITATIONS. (See NOTE below).

14. All conditions being satisfactory to this point, continue the run for about one hour under normal operating conditions. It is recommended that mercury manometers and thermometers be used on both inlet and discharge to permit determination of pressure and temperature rise. Both figures should stay within the specified limits. Continue checking for noises and hot spots, and take periodic reading for oil system pressure. If troubles show up, refer to the TROUBLE SHOOTING CHECK LIST for suggestions.

NOTE - When starting a gas compressor under normal operating conditions, open the by-pass valve only until full speed is reached. Close it rapidly then so that gas compressor temperature will not be increased by the circulating gas. See discussion of discharge piping under INSTALLATION relative to use of a regulated continuous gas by-pass with cooler.

The unit should now be ready for continuous duty under full load. During the first several days, make periodic checks to be sure that all conditions remain reasonably steady and within limits. These checks may be especially important if the unit is part of a process system where conditions may vary. At the first opportunity, stop the gas compressor and clean or remove the protective inlet screen. At the same time, verify leveling, coupling alignment, and anchor bolt tightness.

Never rely on the pressure relief valve as automatic vent. Such use may cause the discharge pressure to become excessive, and can also result in failure of the valve itself.

Safety Precautions

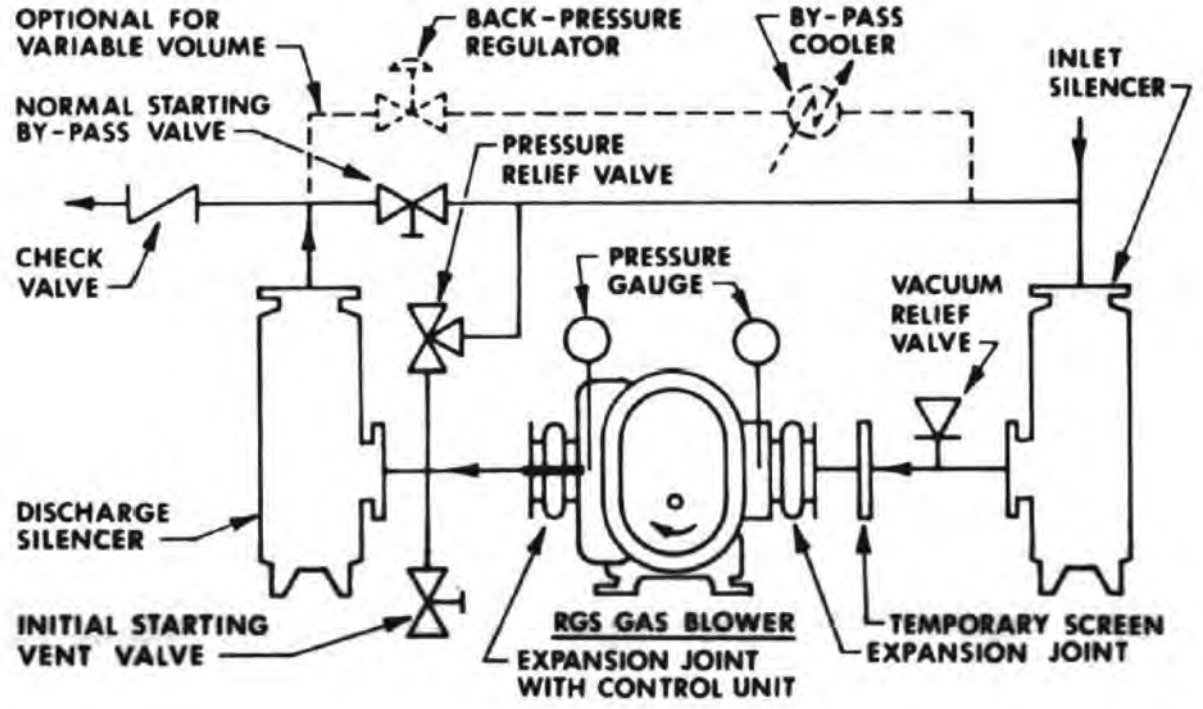
For equipment covered specifically or indirectly in this instruction book, it is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should particularly be noted:

- Gas compressor casing and associated piping or accessories may become hot enough to cause major skin bums on contact _ Internal and external rotating parts of the gas compressor and driving equipment can produce serious physical injuries. Do not reach into any openings in the gas compressor while it is operating or while subject to accidental starting. Cover external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid bypassing or rendering inoperative any safety or protective devices.
- If compressor is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the inlet or discharge air stream.
- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Avoid extended exposure in close proximity to machinery with high intensity noise levels.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.

Troubleshooting Checklist

Trouble	Item	Possible Cause	Remedy
No Flow	1	Speed too low	Check by tachometer and compare with speed on Roots Order Acknowledgment
	2	Wrong Rotation	Compare actual rotation with Figure 3 or 4. Change driver if wrong.
	3	Obstruction in piping	Check piping, valves, silencer, to assure open flow path.
Low Capacity	4	Speed too low	See item 1. If belt drive, check for slippage and readjust tension.
	5	Excessive pressure rise	Check inlet vacuum and discharge pressure, and compare these figures with specified operating conditions on order.
	6	Obstruction in piping	See item 3.
	7	Excessive slip	Check inside of casing for worn or eroded surfaces causing excessive clearances
Excessive Power	8	Speed too high	Check speed and compare with Roots Order Acknowledgement.
	9	Excessive pressure rise	See item 5.
	10	Impellers rubbing	Inspect outside of cylinder for high temperature areas, then check for impeller contact at these points. Correct blower mounting, drive alignment.
Overheating of Bearings of Gears	11	Inadequate lubrication	Check oil sump levels in gearhouse and lube system pressure.
	12	Excessive lubrication	Check oil level and verify pressure. If incorrect, drain and refill with clean oil or oil of recommended grade.
	13	Excessive pressure rise	See item 5.
	14	Coupling misalignment	Check carefully. Realign if questionable.
Vibration	15	Misalignment	See item 14.
	16	Impellers rubbing	See item 10.
	17	Worn bearings/gears	Check gear backlash and condition of bearings, and replace as indicated.
	18	Unbalanced or rubbing impellers	Scale or process material may build up on casing and impellers, or inside impellers. Remove build-up to restore original clearances and impeller balance.
	19	Driver or blower loose	Tighten mounting bolts securely.
	20	Piping resonances	Determine whether standing wave pressure pulsations are present in the piping. Refer to Sales Office.
Oil in Process	21		See discussion of sealing under LUBRICATION.

Figure 4 - Gas Installation with Accessories
(For compressor/dampner drain lines, refer to general arrangement drawing)



Maintenance & Replacements

A good program of inspection and maintenance servicing if followed consistently, is the most reliable means of preventing costly repairs to the compressor. A simple record of procedures and dates will help maintain this work on a regular schedule. Basic requirements are lubrication, cleaning, along with continuous monitoring of vibrations and frequent observation of gas pressures and temperatures to minimize the chances for troubles resulting from compressor ratings being exceeded. Above all , the compressor must be operated within its specifications.

In a compressor properly installed and operated, there is no moving contact between the impellers, or between the impellers and cylinder or headplates. Wear is confined to the timing gears, the bearings, the gas seals and the impellers.

If applicable, the wear of the impeller will depend greatly on the quality of the injection water. The mechanical gas seals are subjected to deterioration as well as wear. They may require replacement at varying periods. O- rings should be replaced at each disassembly, and oil filter cartridges are routine replacement items. If trouble should occur during operation, and its cause cannot be readily determined, consult TROUBLE SHOOTING LIST. Repairs not covered in this manual are considered beyond the scope of maintenance, and should be referred to Roots.Warranty failures should not be repaired at all, unless specific approval has been obtained through Roots before starting the work.

Unauthorized disassembly within the warranty period may void the warranty.

Where repairs involve parts replacement, it is recommended that only Factory Parts be used.

Table 4 - Parts Identification List

Item Number	Quantity Used	Identification
1	2	HEADPLATE
3	2	CYLINDER (HALVES)
4	1	COVER-DRIVE END
5	1	COVER - BLIND END
6	1	PIPE PLATE - INLET
8	2	IMPELLER
9	2	SHAFT-BLIND END
10	1	SHAFT - DRIVE END DRIVE
11	1	SHAFT - DRIVE END DRIVEN
12	2	GEAR
13	2	SLEEVE - INNER O-RING
14	4	CARRIER - BEARING
15	2	SIGHT PLUG ARRANGEMENT
16	1	BEARING CLAMP PLATE
17	2	BEARING CLAMP PLATE
19	4	SEAL - HEADPLATE
20	6	PLUG - PIPE, SQ. HEAD
22	1	SEAL PLATE - DRIVE SHAFT
23	1	NAMEPLATE
24	4	SHIM - HALF, BRG. CARRIER
25	2	GASKET - DE & BE COVER
26	1	GASKET - SEAL PLATE
27	1	KEY - COUPLING
29	4	BEARING
30	4	O-RING
31	1	LOCKNUT
32	1	LOCKING PLATE - GEAR
34	12	CAPSCREW - HEX HD.
38	8	PIN - DOWEL
39	72	CAPSCREW - SOCKET HEAD
40	228	CAPSCREW - HEX HEAD
42	16	TAPER PIN - THREADED
44	5	PLUG-PIPE, SQ. HEAD
45	6	CAPSCREW - SOCKET HEAD
46	2	CLAMPING RING - GEAR
48	2	O-RING
52	8	PIN - DOWEL
54	1	NAMEPLATE - “ROOTS”
55	2	PLUG PIPE, SQ. HEAD
56	8	SCREW SET, SQ. HEAD
58	8	DRIVE SCREW
60	1	CAP - BREATHER BLIND END
62	1	ELBOW 90 DEGREE
63	1	NIPPLE
65	2	O-RING
66	2	BACK UP RING

Item Number	Quantity Used	Identification
67	67	BACKUP RING
69	69	BALL NYLON
70	70	SCREW - SOCKET SET
76	76	SEAL CLAMPING PLATE
79	79	WASHER - SPRING LOCK
80	80	WASHER - SPRING LOCK
82	82	WASHER - SPRING LOCK
83	83	CAPSCREW - HEX HEAD
84	84	LABEL - WHISPAIR
89	89	ROTATION ARROW
90	90	BREATHER - DRIVE END
92	92	GREASE FITTING
93	93	SEAL - DRIVE SHAFT
94	94	O-RING
95	95	CAPSCREW - HEX HEAD
96	96	CAPSCREW - HEX HEAD
98	98	CAPSCREW - HEX HEAD
99	99	CAPSCREW - HEX HEAD
100	100	CAPSCREW - SOCKET HEAD
101	101	PIN DRIVE - LOCK
102	102	PIN DRIVE - LOCK
103	103	SEAL FLOATING RING
104	104	SCREW - ROUND HEAD
109	109	SHT.H-CLMP RING (HALF)
113	113	PIN SPRING
114	114	SEAL, FREE FLOATING
115	115	SEAL, FREE FLOATING
118	118	COVER PLATE
120	120	CAPSCREW - HEX HEAD
123	123	SPRAY NOZZLE ASSEMBLY

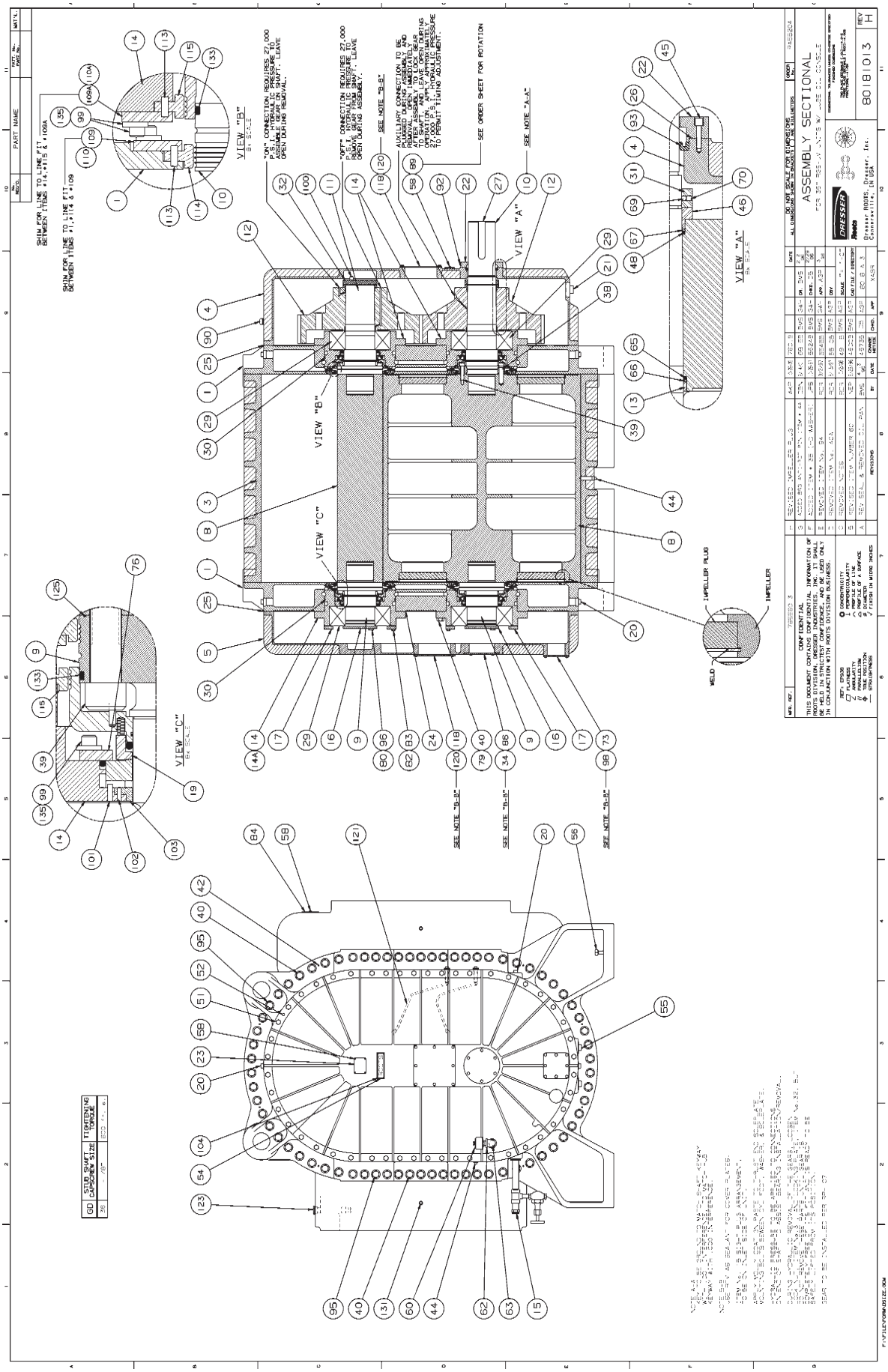


Figure 9 - Assembly of 36" RGS-J Gas Compressor with Integral Oil System

Table 5 - Minimum Recommended Spare Parts List

Item No.	Qty/ Per Unit	Identification	Part Number
24	4	SHIM SET - BRG. CARRIER	48107011
25	2	GASKET - DE & BE COVER	48105011
26	1	GASKET - SEAL PLATE	48136010
30	4	O-RING	10109178
48	2	O-RING	10109247
65	2	O-RING	10109181
66	2	WASHER	10764011
67	2	WASHER	10764010
69	1	BALL - NYLON	10409004
90	1	CAP, BREATHER	10364000
93	1	SEAL, LIP	10631008
94	4	O-RING	10109182
113	16	PIN, SPRING	10068052

Table 6 - Intermediate Recommended Spare Parts List

Item No.	Qty/ Per Unit	Identification	Part Number
19	4	SEAL, FACE	11785002
24	4	SHIM SET - BRG. CARRIER	48107011
25	2	GASKET - DE & BE COVER	48105011
26	1	GASKET - SEAL PLATE	48136010
29	4	BEARING	10359021
30	4	O-RING	10109178
48	2	O-RING	10109247
65	2	O-RING	10109181
66	2	WASHER	10764011
67	2	WASHER	10764010
69	1	BALL - NYLON	10409004
90	1	CAP, BREATHER	10364000
93	1	SEAL, LIP	10631008
94	4	O-RING	10109182
103	4	SEAL, FLOATING RING	49222011
113	16	PIN, SPRING	10068052
114	4	SHAFT SEAL - HEAD-PLATE	52826012
115	4	SHAFT SEAL	78485012

Table 7 - Extensive Recommended Spare Parts List

Item No.	Qty/ Per Unit	Identification	Part Number
8	2	IMPELLER ASSEMBLY	ASK FACTORY
19	4	SEAL, FACE	11785002
24	4	SHIM SET - BRG. CARRIER	48107011
25	2	GASKET - DE & BE COVER	48105011
26	1	GASKET - SEAL PLATE	48136010
29	4	BEARING	10359021
30	4	O-RING	10109178
39	72	CAPSCREWS - SOCKET HEAD	12886001
48	2	O-RING	10109247
65	2	O-RING	10109181
66	2	WASHER	10764011
67	2	WASHER	10764010
69	1	BALL - NYLON	10409004
90	1	CAP, BREATHER	10364000
93	1	SEAL, LIP	10631008
94	4	O-RING	10109182
103	4	SEAL, FLOATING RING	49222011
113	16	PIN, SPRING	10068052
114	4	SHAFT SEAL - HEAD-PLATE	52826012
115	4	SHAFT SEAL	78485012

900 W. Mount St. Connersville

Indiana, 47331, USA

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