SUNDYNE
LMV/BMP-331 PUMPS

Instruction and Operation Manual

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WARRANTY

Sundyne Corporation warrants to Buyer for a period of twelve (12) months from the date of being placed in service (but not to exceed eighteen (18) months after the date of shipment) that the equipment at the time of shipment will be free from defects of design, material and workmanship. If any defects or malperformance occur during the warranty period, Sundyne's sole obligation shall be limited to alteration, repair or replacement at Sundyne's expense, F.O.B. Factory, of parts or equipment, which upon return to Sundyne and upon Sundyne's examination prove to be defective. Equipment and accessories not manufactured by Sundyne are warranted only to the extent of and by the original manufacturers' warranty. Sundyne shall not be liable for damage or wear to equipment caused by abnormal conditions, vibration, failure to properly prime or to operate equipment without flow or caused by corrosives, abrasives or foreign objects. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. In no event shall Sundyne be liable for consequential or incidental damages.

INTRODUCTION & SAFETY

Equipment and Safety Precautions

Sundyne Corporation manufactures centrifugal pumps to exacting International Quality Management System Standards (ISO 9001) as certified and audited by Lloyd's Register Quality Assurance Limited. Genuine parts and accessories are specifically designed and tested for use with these products to ensure continued product quality and performance. Sundyne cannot test all parts and accessories sourced from other vendors; incorrect design and/or fabrication of such parts and accessories may adversely affect the performance and safety features of these products. Failure to properly select, install or use authorized Sundyne pump parts and accessories is considered misuse and damage or failure caused by misuse is not covered by Sundyne's warranty. Additionally, modification of Sundyne products or removal of original components may impair the safety of these products and their effective operation.

CAUTION

Sundyne pumps may handle hazardous, flammable, and/or toxic fluids. Proper personal protective equipment should be worn. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in accordance with applicable environmental regulations.

CAUTION

Safety procedures must be applied prior to any installation, maintenance, or repair of a Sundyne pump. Failure to follow safety precautions may lead to injury!

Wearing Personal Protective Equipment

To ensure safety, protective equipment must be worn at all times when installing, performing maintenance, or repairing equipment. The following safety recommendations must be adhered to for optimum safety:

- Safety glasses, with the minimum requirement of side shields, must be worn at all times.
- Steel-toed shoes must be worn when lifting equipment greater than 15 pounds (7 kg) or if pallet jacks or forklifts are operated.
- Hearing protection is strongly recommended at all times when noise levels exceed 85 dB during an eight (8.0) hour period.

CAUTION

Chemical resistant gloves must be used if chemicals are utilized (refer to Using Chemicals for additional information).

CAUTION

A dust mask respirator must be worn if chemicals have warning labels regarding fumes, dust, or mists.

When using more than one piece of protective equipment, consider their compatibility. For example, safety glasses will not interfere with hearing protection equipment. Be sure to clean all pieces of personal protective equipment immediately after each use.

Using Forklifts

Any persons operating a forklift must have an active recognized operator license.

CAUTION

Before initializing forklift operation, verify that the lift is in a safe operating position.

Ensuring Electrical Safety

All electrical sources must be powered-off before installation, service, or repair of equipment occurs.

CAUTION

Sundyne recommends that a Lock-out/Tag-out program be followed prior to altering the equipment. Locks or tags must be provided to warn employees that equipment is temporarily unavailable.

Once all work has been completed, the person installing the lock or tag must remove it according to company procedure.

Testing Equipment

Prior to performing a test on newly installed, maintained, or repaired equipment; all personnel in the immediate area must be warned.

CAUTION

Follow company procedures prior to equipment testing at all times.

Using Chemicals

Any chemicals to be used must be accompanied by a relevant material safety data sheet (MSDS), in accordance with government legislation. If applicable, use chemical proof gloves.

CAUTION

An eye wash station (or equivalent) should be available in the event of injury. If any hazardous or flammable chemicals pass through the equipment, a complete decontamination of the equipment is required.

Protection from Falling

Fall protection and associated preventative measures are required when working on equipment located six feet or higher from the ground.

CAUTION

Follow company fall prevention procedures prior to working on equipment.

Preventative Machine Guards

Preventative guards must remain in place on all equipment.

CAUTION

Only remove the guards while performing maintenance or repair.

Replace the guards immediately after working on the equipment and prior to start up

CAUTION

EXPLOSION/FIRE HAZARD

Never use an acetylene torch, open flame, or heat to attempt to remove parts that have seized together in Sundyne equipment. Any residual process gas or liquid that is flammable can result in an explosion or fire with potential for serious injury or death.

CAUTION

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INTRODUCTION

This manual presents installation, servicing, troubleshooting, maintenance and spare parts information for the latest configuration of the Sundyne LMV/BMP-331centrifugal pumps.

The primary difference between the LMV and the BMP models is the method of mounting the pump and the starting procedures.

Parenthetical numbers included in the text correspond to item numbers on the illustrated figures. The item number of a part is based on the part's function, and the correct spare part can be ordered for any generation pump even if the component parts do not appear the same as presented in this revision of the Instruction Manual.

Information that may be required regarding performance, alterations, or detailed technical data which is not included herein, may be found in the specification sheet and parts list accompanying the unit, or may be obtained from your Sundyne Corporation representative.

Custom-made auxiliary equipment cannot be shown in this manual. Refer to the outline drawing for specifics

INSTALLATION

1. INSPECTION

Upon receipt of Sundyne equipment, check for any damage which may have occurred during shipment. Notify the carrier and Sundyne promptly if damage has occurred.

NOTE

The shaft may not turn freely due to seal drag and speed increasing gear meshes; however, if rotation is "bumpy", this would indicate some disorder or damage and requires investigation for cause.

2. STORAGE

If the pump is not to be installed immediately, it should be protected from exposure to moisture and dust. Shipping covers installed at the factory (for casing flanges and seal ports) must be kept securely in place. Storage instructions provided by the driver (motor or turbine) manufacturer should be observed.

3. LONG-TERM STORAGE

Certain long-term storage considerations should be met for any Sundyne pump which will not be operating for a period of time exceeding six months from date of factory shipment. This action will ensure minimum corrosion damage to the gearbox and fluid-end components.

Because of storage location and other unknown site factors beyond our control, Sundyne will not accept any liability for damage to the equipment during the storage period, nor does Sundyne guarantee the quality of the equipment during and after the storage period.

To ensure the original quality of the Sundyne pump prior to commissioning after storage, all components must be inspected by an authorized Sundyne service engineer. Any components not of Sundyne manufacture (except mechanical seals) must be inspected by that particular submanufacturer's authorized service personnel. The cost of such service personnel and any component replacement will be at the purchaser's expense.

The only factors which affect the quality of an uninstalled Sundyne pump are the humidity/ temperature and the chemicals in the atmosphere surrounding the equipment. The method employed for long-term storage should prevent the humidity/temperature and

air-borne chemicals from making contact with the internal components of the equipment. When the equipment is to be stored in strong chemical environments or near salt water, protection should be executed immediately upon receipt of the equipment.

Following is the Sundyne preferred list of recommended long-term storage procedures:

A. Indoor, climate controlled building (maintains constant temperature and humidity).

B. Inert gas purging of component internals.

C. Oil flooding of component internals.

D. Desiccant bags.

CAUTION

Because long-term storage of equipment is of a highly critical nature, it is recommended that Sundyne Corporation be contacted to provide more details on the above procedures.

4. SUCTION AND DISCHARGE PIPING

A. The suction line should be clean and a strainer should be installed to protect the impeller from damage by mill scale, welding slag, or other foreign particles during initial startup.

B. All piping must be supported independently of the pump. The piping should always line up with the pump flanges. Never draw the piping into place by the use of force at the flanged suction and discharge connections as this may impose excessive strains on the unit.

C. The piping, both suction and discharge, should have no unnecessary elbows, bends, and fittings, as they increase friction losses in the piping. The size of pipe and fittings should be selected carefully and be sufficient to keep the friction losses as low as practical.

D. Piping must not be connected to the pump until after pump hold-down bolts have been tightened.

E. The use of elbows near the suction flange should be avoided. When used, elbows should be long radius. A straight pipe run of at least three times the pipe diameter is desirable between an elbow and the suction flange.

F. Suction pipe should never be of smaller diameter than the pump suction inlet.

G. Block valves (both suction and discharge) are recommended to isolate the pump during shutdown, to minimize process leakage during the shutdown condition and to prevent possible reverse rotation due to back flow through the pump.

5. SEAL ENVIRONMENTAL CONTROL SYSTEM

Depending upon the pump seal arrangement and application, a seal environmental control system may be required. The pump seal environment must always be maintained as specified on the specification sheet which accompanies each unit delivery. For many applications, a standard system can be supplied from the factory. Ensure that the seal environmental control system specified is installed properly and that ports (refer to Figure 19), are open or plugged as shown on the outline drawing. Port 1 must always be free to drain and vent.

A. LIQUID BUFFER SYSTEM - A liquid buffer system is used with double liquid seals and tandem liquid seals. The buffer liquid is introduced into port 7, allowed to flow through the seal cavity, and out Port 2.

Buffer flow should be 0.5 to 3 gpm (2 to 12 liters/min) with an inlet temperature of 60^{o} to 120^{o}F (16^{o} to 49^{o}C), and inlet pressure as indicated on the specification sheet.

If a closed loop buffer system is used, the buffer must be cooled prior to returning to port 7. Otherwise, heat generated by seal friction will build up in the buffer, resulting in shorter seal life. If an open loop system is used, and orifice or valve on port 2 should be used to regulate flow to proper value.

B. SEAL COOLING - If the normal process discharge temperature exceeds 350°F (177°C), it is recommended that the seal housing water jacket be utilized to lower seal cavity temperature. Cooling fluid is piped into port 3 and out port 4 of the seal housing. Contact the factory for recommended coolant temperature, flow and pressure. Use of cooling jacket may extend seal life in high temperature applications.

6. GEARBOX HEAT EXCHANGER

Most units having heat exchangers will conform to a configuration illustrated in Figure 1. This is a Sundyne Corporation assembly and should not be rearranged. **THE HEAT EXCHANGER IS NEVER MOUNTED HIGHER THAN THE FILTER.**

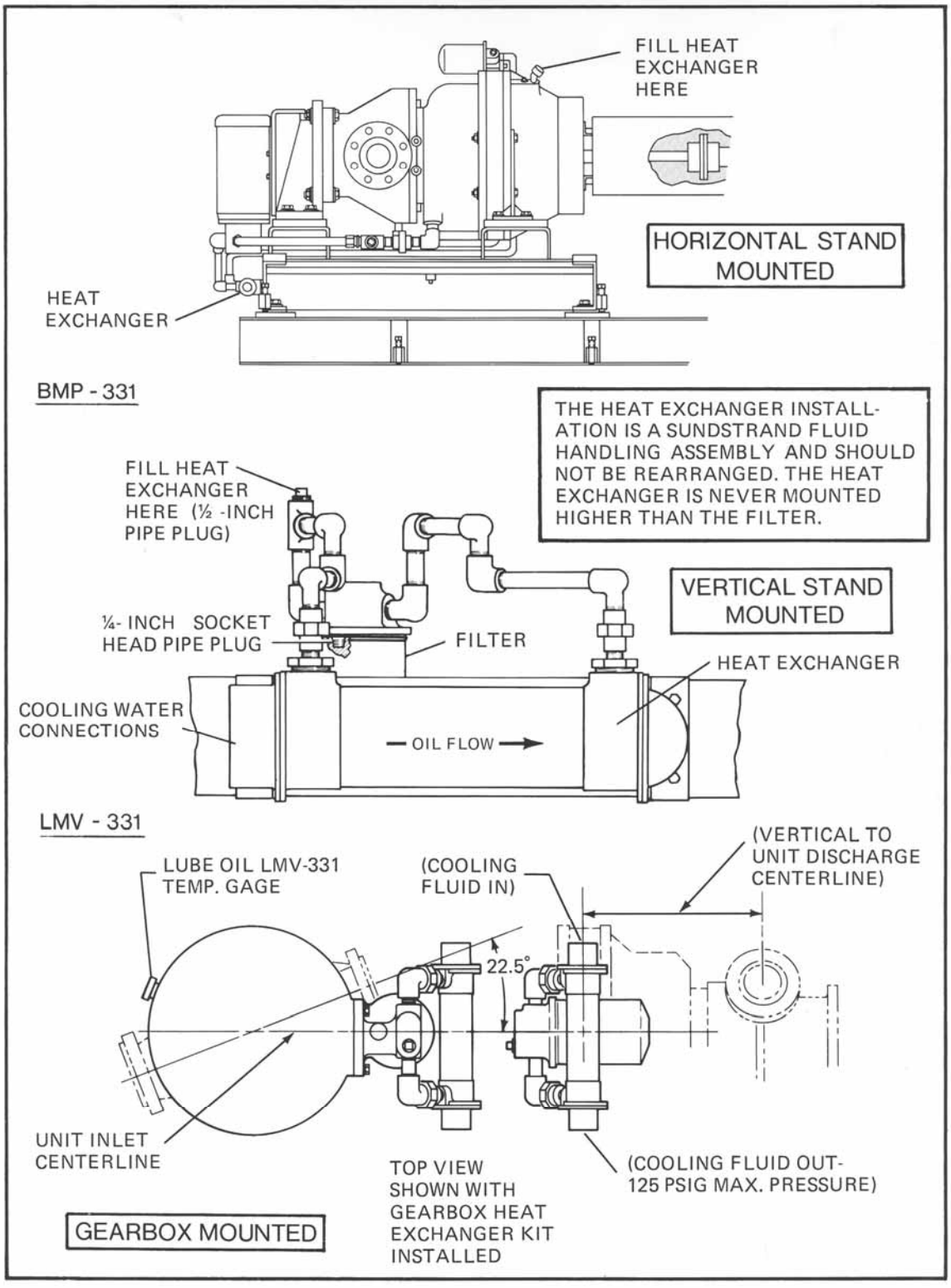


Figure 1. Heat Exchanger Mounting

A ¼ inch socket-head pipe plug in the filter manifold is required when using the gearbox heat exchanger (see Figure 1). This plug is omitted when the heat exchanger is not used.

7. DRIVER AND COUPLING

Drivers are normally shipped separately from the gearbox and pump. If flexible coupling is used, refer to Section 9 for further information.

Drivers are to be installed and maintained in accordance with the manufacturer's instructions.

8. MOUNTING

For all vertical units without stands, a mounting base is recommended.

The vertical or horizontal stand should be mounted on a rigid concrete foundation, and have minimum deflections and freedom from resonant frequencies in the operating range of the equipment being supported. The stand should be secured in position by one-inch diameter bolts and grouted in place. All longitudinal and transverse base channels should be continuously supported by grout.

The bolts should be installed in the foundation as shown on the installation drawing, with sufficient length to extend at least ¼ inch above the nut. Customer shall provide a 4" x 4" x ¼" thick steel plate under each leveling screw (when provided).

A. LMV UNITS WITH VERTICAL STANDS
The top of the stand (driver mounting surface) should be leveled by shimming under the base prior to grouting. The channels are to be filled with grout through the access holes. The nuts on the foundation bolts should not be tightened until the grout has set for at least 48 hours.

B. BMP UNITS - The base plate should be leveled prior to grouting. Grout must be allowed to set for at least 48 hours before tightening foundation bolts.

9. FLEXIBLE COUPLING

A. LMV UNITS WITHOUT VERTICAL STAND

(1) If other than Sundyne supplied couplings are used, they must be flexible disc or gear type couplings capable of tolerating reasonable amounts of parallel and angular misalignment, and axial end float. Refer to coupling manufacturer's recommendations for installation and maintenance.

CAUTION
Lock out starting switch on driver prior to working on coupling.

(2) Coupling installation for turbine drivers is identical to that for motors.

(3) The gearbox coupling hub will normally be mounted at the factory. The driver coupling hub will be mounted on all motors and turbines shipped from the Sundyne factory. If the driver hub is mounted upon receipt of the unit, skip to Step (5), Page 5, for installation instructions.

(4) If the driver coupling hub is not mounted, the following procedure should be followed for Falk or Thomas couplings:

(a) Measure the distance from the top surface of the gearbox hub to the datum face of the driver adapter (Figure 2). This will be called the "X" dimension.

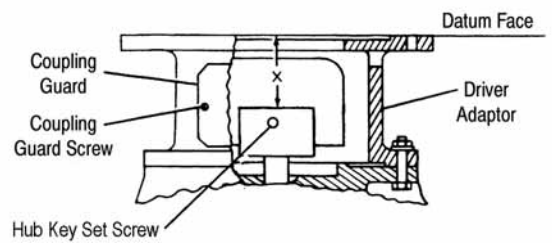


Figure 2. Gearbox Coupling Hub

(b) From Table 1 or 2, determine the end gap (distance between coupling hubs) for the size of coupling provided.

(c) Subtract the end gap value from the "X" dimension to determine the distance from the driver datum face to the coupling hub face ("Y" dimension - Figure 3). Scribe the shaft to show the "Y" dimension.

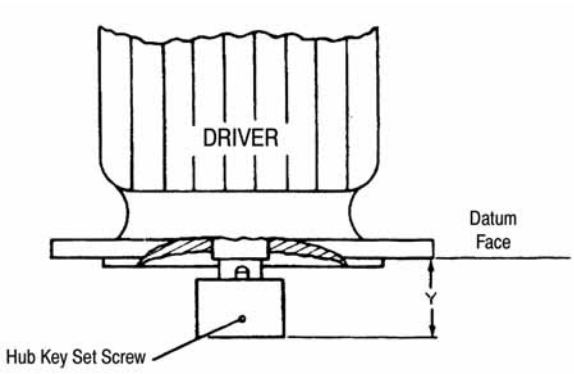


Figure 3. Driver Coupling Hub

(d) Make sure the coupling hub bore, keyways, and shaft are clean, free from burrs, and that the key will fit in the keyways. Heat the hub in an oil bath or oven to approximately 250°F (121°C), or more if necessary, so the hub will slide onto the motor shaft. Position the hub at the scribed line on the shaft and tighten the hub key set screw.

NOTE

On Thomas couplings, before the hub is installed, check to see if it is possible to assemble the coupling bolts and washers (Figure 8) from the motor side of the hub when installed. If this is not possible, assemble the short bolts with bevel washers into the hub flange before fitting in onto the shaft.

(5) Falk Steelflex Installation Instructions

(a) The driver adapter has coupling guard plates which must be removed and stored while installing coupling.

NOTE

The coupling seals should have a light coating of grease before installation and assembly. When mounting or remounting the coupling hub, for any reason, always put the seal ring on the gearbox or driver shaft first. Then install the coupling hub. The coupling will not seal properly if these rings are omitted (Figure 4).

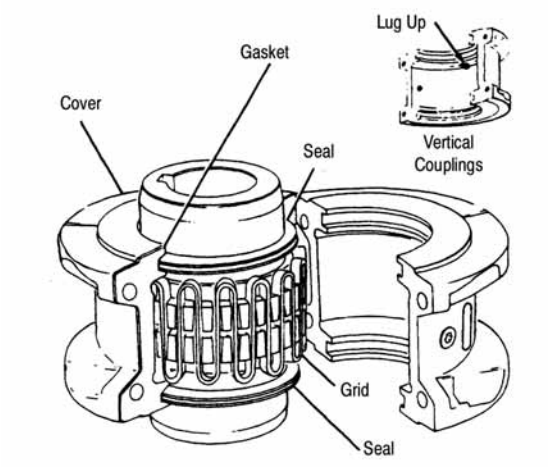


Figure 4. Falk Steelflex Coupling

(b) Mount the driver on the driver adapter and tighten the attaching bolts.

(c) From Table 1, determine the end gap (distance between coupling hubs) for the size of coupling provided.

(d) Using a feeler gauge, check the actual end gap (Figure 5) to verify that it is within the limits given in Table 1. If it is not, loosen the hub key set screw and move the hub up or down until the end gap is within limits. Retighten the set screw.

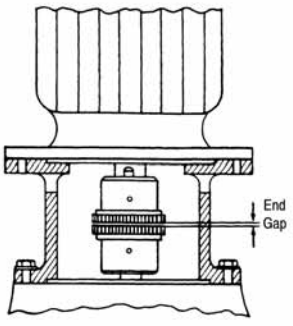


Figure 5. End Gap

NOTE

Generally, the gearbox hub is easier to adjust than the driver hub. However, due to manufacturing tolerances, the driver hub may have a looser fit. If neither hub moves easily, use a bearing puller and heat the coupling hub. DO NOT heat hub any more than is absolutely necessary to loosen it.

(e) Fill the gap and grooves of the coupling with lubricant. When grids are furnished in two or more segments, install them so that all cut ends extend in the same direction; this will facilitate cover installation. Seat the grid on the coupling with a soft mallet (Figure 6).

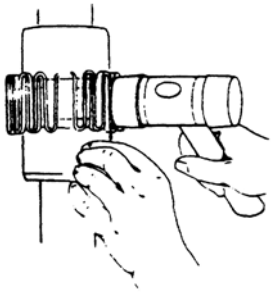


Figure 6. Grid Disassembly

Pack the spaces between and around the grid with as much lubricant as possible and wipe off the excess flush with the top of the grid. Position the seals on the hubs to line up with the grooves in the cover (Figure 4). Secure the covers with fasteners and tighten them to the torque specifications in Table 1. Grease coupling per Step (6) (b).

It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

Replace the coupling guards and secure them with the screws provided.

(6) Servicing of Falk Steelflex Coupling

(a) Couplings should be lubricated at least once a year. Lubricate more often when the coupling is exposed to excessive moisture or extreme temperatures.

Remove both lube plugs and insert one grease fitting. Fill with grease until excess appears at opposite hole. Remove fitting and replace plugs.

Falk Coupling Size	End Gap			Cover Bolt Torque
	Minimum	Normal	Maximum	
40T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.88 In. (4.77 mm)	100 lb. – in. (1.15 kg-m)
50T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	200 lb. – in. (2.30 kg-m)
60T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	200 lb.-in. (2.30 kg-m)
70T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	200 LB. – in. (2.30 kg-m)
80T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.250 in. (6.35 mm)	200 lb –in. (2.30 kg-m)

Table 1. Coupling Specification (Falk Steelflex Type)

(b) For operation in ambient temperatures of 0° to 150°F (-18° to 66°C), grease with the following specifications should be used:

DROPPING POINT - 300°F (149°C) or higher.
CONSISTENCY - NLGI #2 with worked penetration value in the range of 250 to 300.
SEPARATION AND RESISTANCE - Low oil separation rate and high resistance to separation from centrifuging.
LIQUID CONSTITUENT - Good lubricating properties equivalent to a high quality, well refined, petroleum oil.
INACTIVE - Must not corrode steel or cause swelling or deterioration of neoprene.
CLEAN - Free from foreign inclusions.

For ambient down to -30°F (-34°C), a grease with worked penetration value of 310-340 should be used. For ambients above or below those given, consult the Falk Corporation.

(c) If it should be necessary to disassemble the coupling, the following procedure should be followed. Remove the cover halves from the coupling. Use a screwdriver that will fit into the open loop ends of the grid. Begin at the open end of grid and pry the grid radially in even, gradual stages, proceeding alternately from side to side. See Figure 7.

NOTE

If other than Sundyne supplied couplings are used, refer to manufacturer's recommendations for maintenance and lubricating procedures.

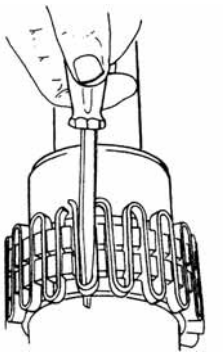


Figure 7. Coupling Disassembly

(7) Thomas Type DBZ installation instructions:

(a) The driver adapter has coupling guard plates that must be removed and stored while installing coupling.

NOTE

The coupling is shipped with the center assembly assembled as shown in Figure 8 (initial view). If it is necessary to completely disassemble the center assembly, tie a wire through the bolt holes to maintain the order of the disc packs. Be careful to note the arrangement of the parts so that the coupling can be reassembled with the parts in the same order.

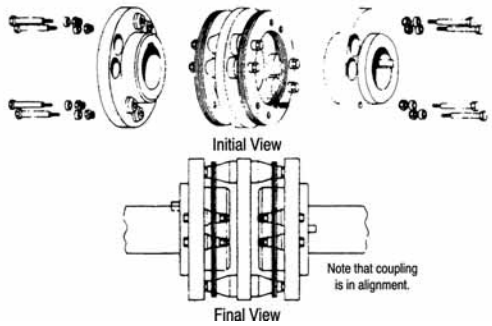


Figure 8. Thomas Coupling Alignment

(b) Mount the driver on the driver adapter and tighten the attaching bolts.

(c) From Table 2, determine the end gap (distance between coupling hubs) for the size of coupling provided.

(d) Using a proper gauge, check the actual end gap (Figure 9) to verify that it is within the limits given in Table 2. If it is not, loosen the hub key set screw and move the hub up or down until the end gap is within limits. Re-tighten the set screw.

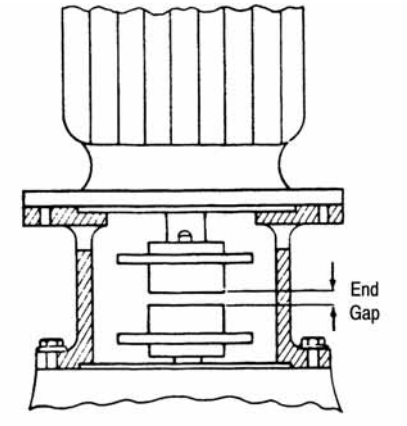


Figure 9. End Gap

NOTE

Generally, the gearbox hub is easier to adjust than the driver hub. If the hub does not move easily, use a bearing puller and heat the hub. DO NOTE heat hub any more than is absolutely necessary to loosen it

(e) Assemble the center assembly to the hubs using the bolts, nuts, and washers provided, keeping the proper order of parts as noted in step (a). (See Figure 10).

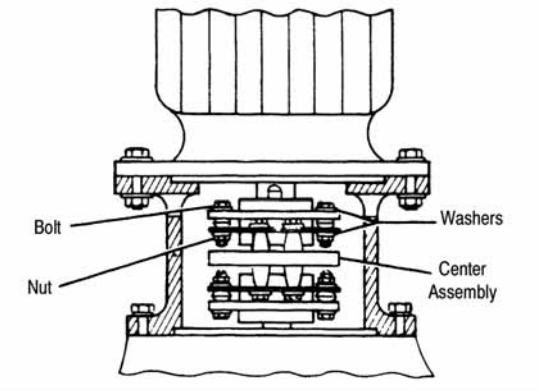


Figure 10. Final Assembly

(f) It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

Thomas Coupling Size	End Gap			Cover Bolt Torque
	Minimum	Normal	Maximum	
163	0.876 in. (22.24 mm)	0.938 in. (23.81 mm)	1.005 in (25.41 mm)	156 lb. – in. (1.80 kg-m)
201	0.876 in. (22.24 mm)	0.938in. (23.81 mm)	1.005 in. (25.41 mm)	300 lb. – in. (3.46 kg-m)
226	1.126 in. (28.59 mm)	1.188 in. (30.18 mm)	1.251 in. (31.76 mm)	516 lb. – in. (5.95 kg-m)
263	1.219 in. (30.97 mm)	1.313 in. (33.35 mm)	4.407 in. (35.73 mm)	756 lb.-in. (8.72 kg-m)
301	1.406 in (35.72 mm)	1.500 in. (38.10 mm)	1.594 in. (40.48 mm)	1140 lb. – in., (13.15 kg-m)

Table 2. Coupling Specifications (Thomas Type DBZ)

(g) Replace the coupling guard plates.

(h) Removal for Maintenance - It may not always be possible to remove or install the center disk pack after the driver is installed. For easy removal, loosen the four lower bolts holding the lower disc pack to the gearbox coupling hub. Remove the mounting bolts holding the driver adapter to the gearbox. Remove the driver, the driver adapter and upper coupling as a total assembly. For assembly, follow this procedure in reverse.

B. UNITS WITH VERTICAL OR HORIZONTAL STANDS - ALIGNMENT

(1) If other than Sundyne Corporation supplied couplings are used, they must be flexible disc or gear type couplings capable of tolerating reasonable amounts of parallel and angular misalignment, and axial end float. Refer to coupling manufacturer's recommendation for installation and maintenance.

CAUTION

Lock out starting switch on driver prior to working on coupling.

(2) Coupling installation for turbine drivers is identical to that for motors.

(3) The gearbox coupling hub is normally mounted at the factory. The driver coupling hub will be mounted on all motors and turbines shipped from the Sundstrand factory. If the driver hub is mounted upon receipt of the unit, skip to Step C or D (Page 9 or 13) for installation instruction.

(4) If the driver coupling hub is not mounted, the following procedure should be followed for Falk or Thomas couplings:

Make sure the coupling hub bore, keyways, and shaft are clean, free from burrs, and that the key will fit in the keyways. Heat the hub in an oil bath or oven to approximately 250^{o}F (121^{o}C), or more if necessary, so the hub will slide onto the motor shaft. Position the hub flush with the end of the driver shaft and tighten the hub key set screw. For Thomas couplings, alignment procedures may necessitate adjustments to this flush position.

NOTE

On Thomas couplings, before the hub is installed check to see if it is possible to assemble the coupling bolts and washers (Figure 8) from the driver side of the hub when installed. If it is not possible, assemble the bolts and washers into the hub flange before fitting it onto the shaft.

(5) DO NOT align from gearbox end. The gearbox input shaft is manufactured such that it is free to move radially and axially. Prior to alignment, position the shaft at its dead position; then align.

C. UNITS WITH VERTICAL STANDS

(1) Install stand per Paragraph 8 (Page 4). Tighten foundation bolts prior to coupling installation and alignment.

(2) Make sure that the surface of the stand which the driver sits on is free of paint, weld splatter, etc. Mount the driver on top of the stand, making sure that the driver flange does not bind on the adjusting bolts.

(3) Coupling alignment should be done prior to connecting suction and discharge piping. It is normally good practice to leave a section of piping on the suction and discharge of the pump casing to be fabricated after alignment has been completed. A recheck of alignment should be done after piping is installed.

(4) Falk Double Gear Coupling

(a) Refer to Figure 11. Pack the sleeve teeth with grease and lightly coat with grease before assembly. See Step 5 (b), page 11 for lubricant requirements.

(b) To set angular alignment, remove the stiffening brackets (Figure 12), and attach a dial indicator with extension arm to the driver hub. Set the dial indicator on the gearbox hub face outside the bolt circle (Figure 13). Rotate the driver shaft (do not rotate

gearbox shaft) to sweep the gearbox hub face. Using shims and the jack screws at the base of the pump, adjust pump to hold the total indicator reading within the angular limit specified in Table 3 (Page 11).

(c) To set offset alignment, attach the dial indicator to the driver hub, and position indicator to sweep the O.D. of the gearbox coupling hub flange (Figure 14). Rotate the driver shaft (do not rotate gearbox shaft). Using the driver jack screws, adjust driver to hold the total indicator reading within the offset limit specified in Table 3. Recheck angular alignment to ensure it is still within limits.

(d) Stagger the keyways on mating coupling hubs by 180°. Install the floating shaft assembly, including the centerplate with thrust button and the thrust plate in the lower coupling, and bolt the coupling in place. Torque bolts to values given in Table 3.

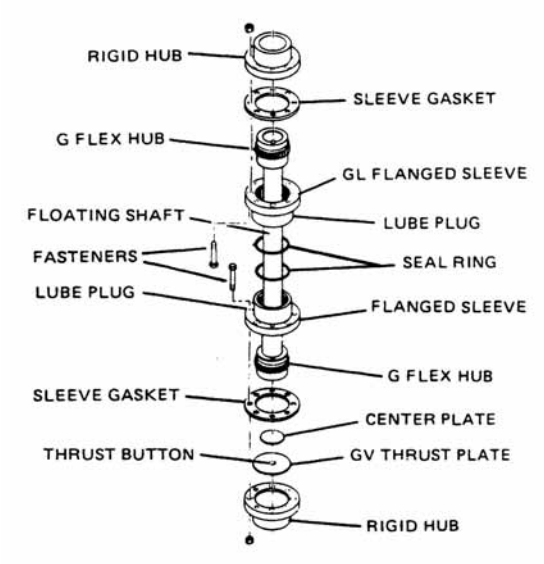


Figure 11. Falk Double Gear Coupling - Vertical

(e) Remove both lube plugs from each sleeve and add grease until an excess appears at an open hole. Replace all lube plugs. It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

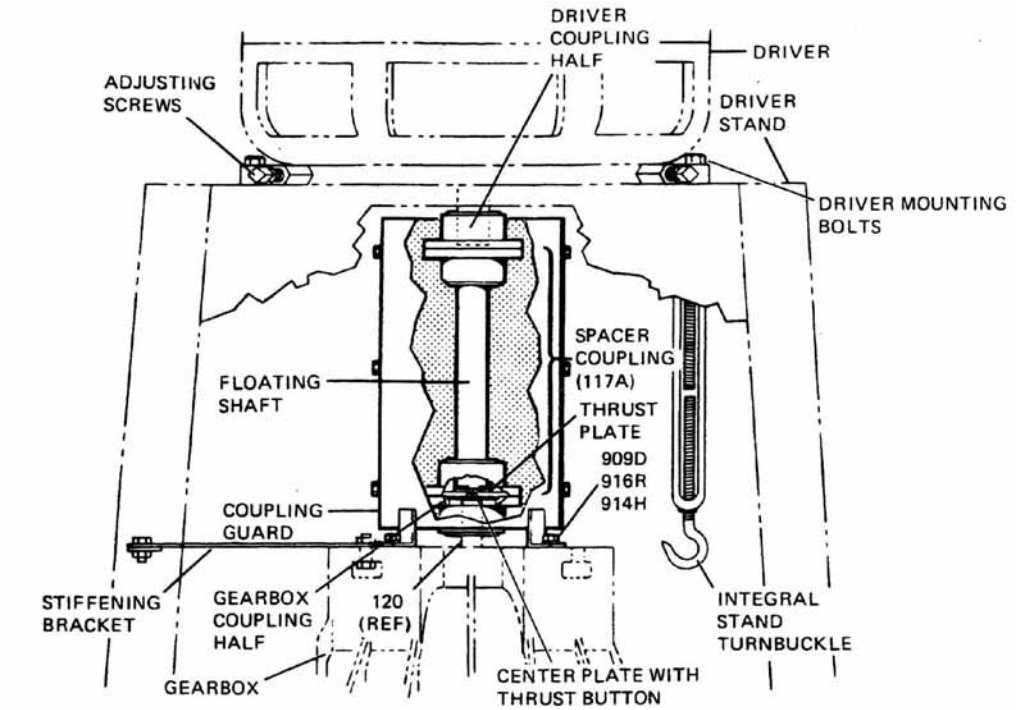


Figure 12. Vertical Stand Assembly

Table 3. Coupling Specifications (Falk Double Gear Type – Vertical)			
Falk Coupling Size	**Operating Limits (Total Indicator Limit)**		**Bolt Torque**
	Offset (Max.)	**Angular (Max.)**	
15GL 15GV	0.005 in. (0.127mm)	0.005 in. (0.127mm)	280 lb/in (3.22 kg-m)
20GL 20GV	0.005 in. (0.127mm)	0.005 in. (0.127mm)	420 lb/in (4.83 kg-m)

(f) Tighten all mounting bolts and stiffening brackets and install coupling guard.

(5) Service of Falk Double Gear Coupling

(a) Couplings should be lubricated at least once every six months. Lubricate more often when the coupling is exposed to excessive moisture or extreme temperatures.

Remove both lube plugs from each sleeve and add grease until an excess appears at an open hole. Replace all lube plugs.

(b) For operation in ambient temperatures of -30°F to 200°F (-34°C to 93°C), grease with the following specifications should be used:

DROPPING POINT - 300°F (149°C) or higher.
CONSISTENCY - NGLI #1 EP grease with worked penetration value in the range of 310-340.
SEPARATION AND RESISTANCE - Low oil separation rate and high resistance to separation from centrifuging.
TEXTURE - Smooth or fibrous.
MINIMUM TIMKEN O.K. LOAD - 30 pounds.
INACTIVE - Must not corrode steel or cause swelling or deterioration of Neoprene or Buna N.
CLEAN - Free from foreign inclusions.
DO NOT use cup grease.

(6) Thomas SN Type Spacer Coupling

(a) The motor coupling hub is fitted very tightly onto the driver shaft, making it very difficult to adjust after installation. Prior to alignment, mount the driver hub such that when the complete coupling is installed, there is a gap of ¼ inch (6.4mm) between the gearbox hub and gearbox housing.

The method of installation is such that the coupling will hang on the motor hub and slide on the gearbox input shaft. This will cause the disc pack to sag by the weight of the coupling. This sag is normally 1/16 inch (1.6mm), and it must be taken into consideration when adjusting the shaft end gap. Be sure that the coupling does not touch the gearbox when in operation.

(b) To set angular alignment, loosen the stiffening brackets (Figure 12) and attach a dial indicator with extension arm to the driver hub. Set the dial indicator on the gearbox hub face outside the bolt circle (Figure 13). Rotate the driver shaft (do not rotate gearbox shaft) to sweep the gearbox hub face. Using shims and the jack screws at the base of the pump, adjust pump to hold the total indicator reading within the angular limit specified in Table 4 (Page 12).

(c) To set offset alignment, attach the dial indicator to the driver hub, and position

indicator to sweep the O.D. of the gearbox hub flange (Figure 14). Rotate the driver shaft (do not rotate gearbox shaft). Using the motor jack screws, adjust motor to hold the total indicator reading within the offset limit specified in Table 4. Recheck angular alignment to ensure it is still within limits.

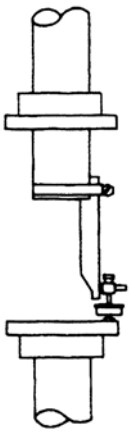


Figure 13. Checking Angular Alignment

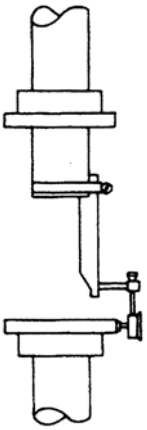


Figure 14. Checking Offset Alignment

(d) Refer to Figure 15. Measure the length of the floating shaft between hub faces. Measure the distance between the motor and gearbox hub faces. The floating shaft must be shorter than the distance between shaft hub faces by the sum of the end gaps specified in Table 4. If the length difference is not within the limits specified in Table 4, adjust the hubs until within limits. If necessary, heat the hub and use a bearing puller to move it. DO NOT heat hub any more than is absolutely necessary to loosen it.

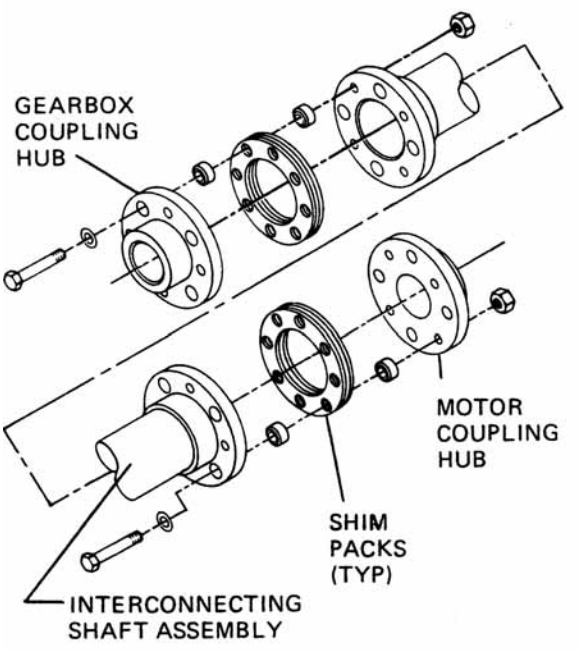


Figure 15. Thomas SN Type Spacer Coupling

NOTE

On some units there are different size couplings on each end of the floating shaft. Be sure to use the proper end gap values for the respective couplings.

(e) Stagger the keyways on mating coupling hubs by 180°. Assemble and bolt in the disc pack assembly. Torque bolts to values given in Table 4.

Table 4.Coupling Specifications (Thomas SN Spacer Type – Vertical and Horizontal)

Thomas Coupling Size	End Gap			Operating Limits Total Indicator Reading		Bolt Torque
	Minimum	Normal	Maximum	Offset (Max.)	Angular (Max.)	
SN226	0.563 in. (14.30mm)	0.594 in. (15.09mm)	0.625 in. (15.88mm)	0.005 in. (0.127mm)	0.005 in (0.127mm)	516 lb/in (5.95 kg-m)
SN262	0.438 in. (11.13mm)	0.469 in. (11.91mm)	0.500 in. (12.70mm)	0.005 in. (0.127mm)	0.005 in. (0.127mm)	516 lb/in. (5.95 kg-m)
SN312	0.469 in. (11.91mm)	0.500 in. (12.70mm)	0.531 in. (13.49mm)	0.005in. (0.127mm)	0.005 in. (0.127mm)	756 lb/in (8.72 kg-m)

NOTE

Disc packs must be assembled in the coupling exactly as received. If it is necessary to completely disassemble the disc pack, tie a wire through the bolt holes to maintain the proper order.

(f) It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

(g) Tighten all mounting bolts and stiffening brackets and install coupling guard.

D. UNITS WITH HORIZONTAL STANDS (Figure 17)

(1) Install stand per Paragraph 8 (page 4). Tighten foundation bolts prior to coupling installation and alignment.

(2) Make sure that the driver mounting pads are free of paint, weld splatter, etc. Set the driver on the pads, but do not bolt down.

(3) Coupling alignment should be done prior to connecting suction and discharge piping. It is normally good practice to leave a section of piping on the suction and discharge of the pump casing to be fabricated after alignment has been completed. A recheck of alignment should be done after piping is installed.

(4) Alignment should be checked when equipment is at normal operating temperature to verify that alignment is still within specified limits. Make any necessary corrections.

(5) Rough Alignment - Center the driver over the driver bolt holes in the base and align the pump to driver using the jack screws provided on the upper stand. Connect process piping and proceed with final alignment.

NOTE

When adjusting a motor, the motor rotor must be at its electrical center axially. This is usually marked on the motor shaft. If it is not, run the motor and scribe a reference line on the motor shaft.

(6) Final Alignment - Position the gearbox input shaft so it is extended as far as possible toward the driver. All final adjustments must be made from the driver end ONLY.

(7) Falk Double Gear Coupling

(a) Pack the sleeve teeth with grease and lightly coat seals with grease before assembly. See Step (5) (b), (page 11) for lubricant requirements.

(b) To set final angular alignment, attach a dial indicator with extension arm to driver hub. Set the dial indicator on the gearbox hub face outside the bolt circle (Figure 13). Rotate the driver shaft (do not rotate gearbox shaft) to sweep the gearbox hub face. Using shims and jack screws provided, adjust the driver to hold the total indicator reading with the angular limit specified in Table 5.

Table 5. Coupling Specifications (Falk Double Gear Type)

Falk Coupling Size	End Gap			Operating Limits Total Indicator Reading		Bolt Torque
	Minimum	Normal	Maximum	Offset (Maximum)	Angular (Maximum)	
15G	0.140 in. (3.56mm)	0.156 in. (3.96mm)	0.172 in. (4.36mm)	0.005 in. (0.127mm)	0.005 in. (0.127mm)	280 lb/in (3.22 kg-m)
20G	0.140 in (3.56mm)	0.156 in. (3.96mm)	0.172 in. (4.36mm)	0.005 in. (0.127mm)	0.005 in. (0.127mm)	420 lb/in (4.83 kg-m)

(c) To set final offset alignment, attach the dial indicator to the driver hub and position indicator to sweep the O.D. of the gearbox hub flange (Figure 14). Rotate the driver shaft (do not rotate gearbox shaft). Using shims and jack screws provided, adjust the driver to hold the total indicator reading within the offset limit specified in Table 5. Recheck angular alignment and distance between shaft ends to ensure they are still within limits.

(d) Refer to Figure 16. Measure the length of the floating shaft. Adjust the driver so the distance between driver and gearbox shaft ends is greater than the length of the floating shaft by the sum of the end gaps specified in Table 5.

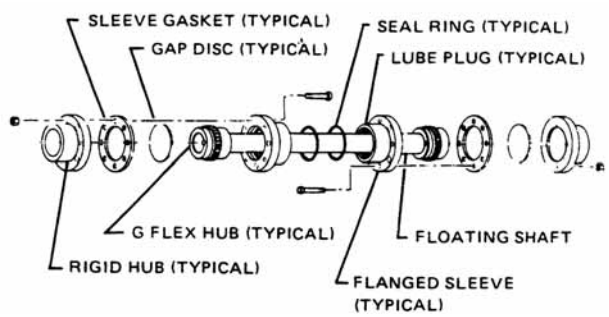


Figure 16. Falk Double Gear Coupling - Horizontal

(e) Stagger the keyways on mating coupling hubs by 180°. Install the floating shaft assembly, including the gap discs at each end, and bolt the coupling in place. Torque bolts to values given in Table 5.

(f) Remove both lube plugs from each sleeve and add grease until an excess appears at an open hole. Replace all lube plugs. It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

(g) Tighten all mounting bolts and install coupling guard.

(8) Service of Falk Double Gear Coupling

Refer to Step 5, page 11.

(9) Thomas SN Type Spacer Coupling.

(a) The motor coupling hub is shrunk onto the driver shaft, making it very difficult to adjust after installation. Prior to alignment, mount the driver hub so that when the complete coupling is installed, there is a gap of ¼ inch (6.4mm) between the gearbox hub and gearbox housing.

(b) To set final angular alignment, attach a dial indicator with extension arm to driver hub. Set the dial indicator on the gearbox hub face outside the bolt circle (Figure 13, Page 12). Rotate the driver shaft (do not rotate gearbox shaft) to sweep the gearbox hub face. Using shims and jack screws to hold the total indicator reading within the angular limit specified in Table 4 (Page 12).

(c) To set final offset alignment, attach the dial indicator to the driver hub and position indicator to sweep the O.D. of the gearbox hub flange (Figure 14, Page 12). Rotate the driver shaft (do not rotate gearbox shaft). Using shims and jack screws provided, adjust the driver to hold the total indicator reading within the offset limit specified in Table 4. Recheck angular alignment to ensure it is still within limits.

(d) Refer to Figure 15 (Page 12). Measure the length of the floating shaft. Adjust the driver so the distance between driver and gearbox shaft ends is greater than the length of the floating shaft by the sum of the end gaps specified in Table 4 (Page 12).

NOTE

On some units there are different size couplings on each end of the floating shaft. Be sure to use the proper end gap values for the respective couplings.

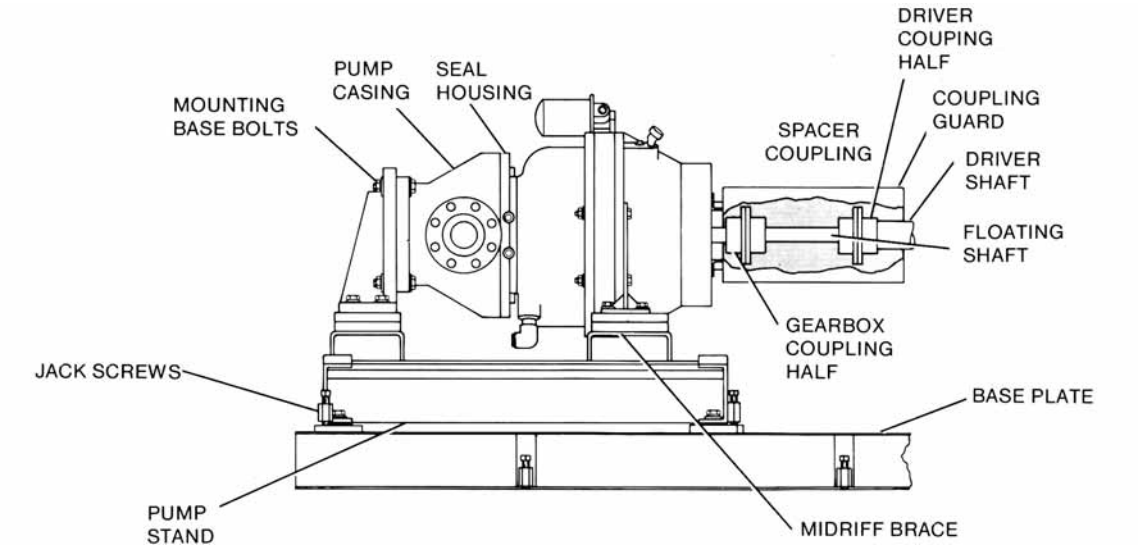


Figure 17. Horizontal Stand Assembly

(e) Stagger the keyways on mating coupling hubs by 180°. Assemble and bolt in the disc pack assembly. Torque bolts to values given in Table 4.

NOTE

Disc packs must be assembled in the coupling exactly as received. If it is necessary to completely disassemble the disc pack, tie a wire through the bolt holes to maintain the proper order.

(f) It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

(g Tighten all mounting bolts and install coupling guard.

LUBE OIL SYSTEM

The integral Sundyne lube oil system consists of the following major components: gearbox sump, main lube pump, oil heat exchanger and oil filter. Oil is taken from the sump by the lube pump, then passed through internal passages to an externally mounted manifold through the heat exchanger, then through the filter, and back into the gearbox to the various lube jets. After passing through the bearings, the oil drains back to the sump.

The gearbox sump holds approximately seven U.S. quarts (6.6 liters) of oil, not including auxiliary piping and heat exchanger. The oil level should always be maintained within the black circle in the sight glass. DO NOT overfill gearbox, as this will cause excessive foaming, overheating and failure of idler shaft lower ball bearing.

The main lube pump is a constant displacement gear type pump directly driven by the input shaft.

The standard heat exchanger is a shell and tube water cooled type mounted on the gearbox manifold. Cold water should be provided at 150 psig (11 kg/cm^2) maximum pressure. See the specification sheet for cooling water requirements. Coolant flow should be controlled by a hand valve installed in the cooling fluid discharge line to maintain a gearbox sump temperature between 140°F to 200°F (60°C to 93°C). Approximately one hour may be required to stabilize temperature.

The oil filter is a disposable pleated paper element type. Gearbox oil and filter should be changed every six months.

1. LUBE OIL SYSTEM AUXILIARIES

A. LUBE OIL PRIMING KIT -This pre-lube system is mandatory on all LMV/BMP-331's. The kit consists of a motor driven positive displacement pump, check valve, gages, and necessary piping. To start pump, operate the pre-lube pump at least 30 seconds with a minimum of 5 psig (0.35 kg/cm^2) indication prior to starting the main driver.

The pre-lube pump is to shut down only after main driver is at full operating speed.

B. REMOTE HEAT EXCHANGER - Some large water-cooled and all air-cooled heat exchangers are mounted off the gearbox. Except for packaged units, the interconnecting piping is the purchaser's responsibility. The heat exchanger MUST be mounted lower than the oil filter; otherwise, air pockets may be present in the lube oil lines at start-up, causing oil starvation at the bearings. Equivalent length of piping and fittings must not exceed 20 feet (6mm), using a minimum of 5/8" (16mm) I.D. tubing or pipe. If greater pipe lengths are required, pipe diameter must be increased accordingly.

C. GEARBOX SUMP HEATER - A sump heater is required when ambient temperatures may fall below the temperature at which the gearbox oil becomes too viscous for proper lube pump operation. Both steam and electric sump heaters are available. If there is any lube oil piping outside of the gearbox (as in the case of a remote heat exchanger), the lube oil priming kit MUST be operated to circulate oil through the system while the main drive motor is not running. This practice is also recommended for units with no external piping.

STARTING

Refer to Figure 18. Perform the following task to start the SUNDYNE Pump:

1. Run-in of pump: If the pump(s) is to be run in under conditions which are considerably different from those that the unit is designed for (such as type of liquid suction pressure, flow rate, etc.) the factory should be consulted to ensure that the run-in conditions are compatible with the pump.

2. Check to ensure that the driver has been serviced per instructions provided by the driver manufacturer.

3. Auxiliaries - Check utility connections; verify that auxiliary piping is per Sundyne drawings; verify switch and instrument connections and set points; calibrate flow instruments and other transmitters.

4. Flushing screens should be installed in all field assembled piping connections.

5. If buffer fluid or external seal flush auxiliary piping is required, this system should be pressurized prior to admitting process liquid into the pump. If the buffer fluid is not pressurized, process liquid will leak out of the pump into the gearbox or atmosphere and damage to the mechanical seals will occur. If the seal flush is not pressurized, contaminants may cause seal face damage.

6. Remove the gearbox fill-vent plug and the filter breather cap from the fill opening fitting on the gearbox. Fill the reservoir with clean lubricating oil (see Table 6 for oil specifications) until the fluid level is at the top of the black circle in the sight glass. Lube system capacity will vary with the heat exchanger and piping configuration. Replace the filter breather cap on the fill opening fitting and replace the fill-vent plug.

   A. PRE-LUBE PUMP - Operate the pre-lube pump to fill the heat exchanger and filter. Add oil as necessary through the fill opening fitting until the oil level stabilizes in the sight glass.

7. Prime lube oil system (Paragraph 8) prior to opening suction and discharge valves.

CAUTION

Never start the pump against a closed discharge valve. Always check to ensure that the discharge valve is partially open.

8. Prime the lube oil system by one of the following methods:

A. Rotate the input shaft. Turn CCW to reposition the internal lube pump. Start the auxiliary lube pump and allow it to operate at least thirty seconds with a minimum of 5 psig (0.35 kg/cm^2) indication prior to starting the main driver.

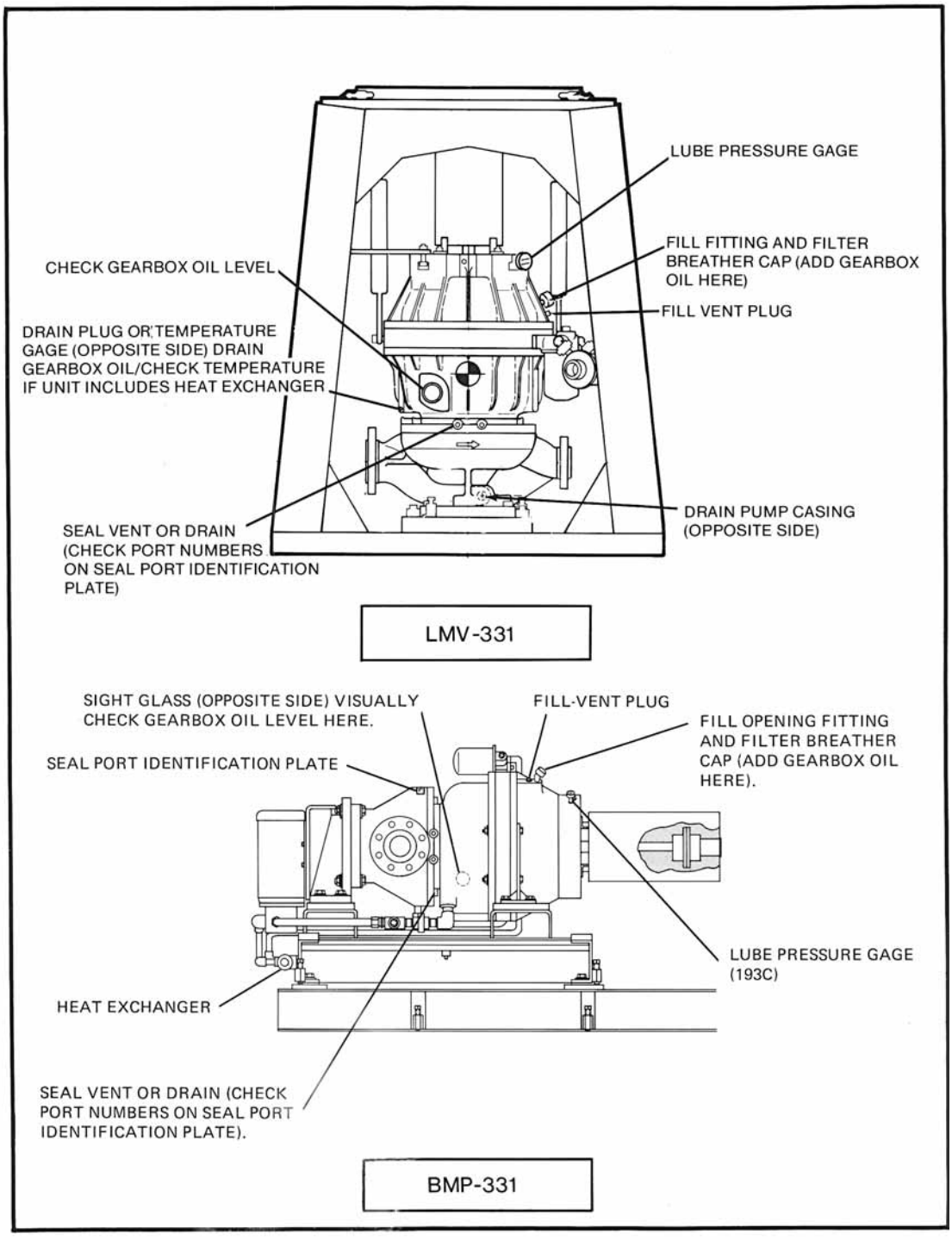


Figure 18. Service Check Points

Recommended ISO VG 46 gearbox lube oil specifications:

Gravity, API	27 - 36
Pour Point, °C (°F)	-7 (20) max.
Flash Point, °C (°F)	204 (400) min.
Viscosity, cSt at 40°C cSt at 100°C SUS at 100°F SUS at 210°F	 41.4 to 50.6 6.5 min. 217 to 260 48.8 min.
Viscosity Index	95 min.
ISO Viscosity Grade	46
Color, ASTM D 1500	2.0
Neutralization Number, Maximum	0.25
Rust Protection, ASTM D 665, A & B	Pass
Demulsibility, ASTM D 1401 Time to 0 ml emulsion at 54°C (130°F) after 30 min. at 82°C (180°F) after 60 min.	 Pass Pass
Foam Limits, ASTM D 892 Sequence 1 Sequence 2 Sequence 3	 25/0 max. 50/0 max. 25/0 max.

Note: No other additives are recommended.

NOTE

If the auxiliary lube system is operated automatically, the following sequence is recommended:

1. When start button is pushed, priming kit starts.

2. When a 5 psig (.035 kg/cm^2) pressure switch verifies lube oil pressure, a 30 second timer and a 40 second timer are started.

3. The main drive motor starts at the end of 30 seconds.

4. The priming kit turns off at the end of 40 seconds.

5. It is not normally recommended to operate the priming kit for an extended period with the main driver operating.

6. Adjust the heat exchanger cooling flow to regulate the gearbox sump temperature between 140° and 200°F (60° and 93°C). Approximately one hour may be required to stabilize the temperature.

PUMP CONTROL DURING STARTUP

1. SINGLE UNITS

A. Start pump with the suction valve open while throttling the discharge valve to bring the pump to the design operating point.

B. If the pump must start against a high system back pressure and the process fluid is near to boiling, a bypass line back to the supply tank (preferably flow controlled) may be required to maintain minimum stable pump flow until the pump can establish flow through the system.

2. SERIES INSTALLATION

In series operation, it is necessary to have a bypass from the discharge of the first stage back to the supply vessel. A block valve should be placed between the bypass line and the second stage unit. Typical start-up procedure is as follows:

A. Open the suction and bypass block valves on the first stage and close the suction block valve of the second stage.

B. Start the first stage unit and maintain design flow.

C. Open the suction valve to the second stage unit and close the bypass.

D. Start the first stage unit and control with discharge valve until design flow and head is maintained.

3. PARALLEL OPERATION

Check valves must be placed in the discharge piping of each pump to prevent back-flow when one unit is started prior to others. It is advantageous to install separate bypass loops around each pump for additional operational flexibility.

A. Start first unit as described above for single units.

B. Start second unit on bypass and maintain minimum flow. Open discharge valve on second unit and maintain the design flow of both units. It is preferable that the units not operate at their peak head capability.

SERVICING

The normal operating routine, including both minor and major overhaul intervals, depends to a great extent upon the service and duty cycle of the pump(s). The operating life of any piece of machinery is, under normal circumstances, determined by the careful and proper actions of the operator. All operating parameters should be frequently observed and logged. Any deviation from normal operating values should be investigated immediately to determine the cause and corrective measures to be taken where necessary.

In addition to the major equipment, all lube pumps, heat exchangers, instrumentation, etc. must be checked periodically for correct performance per manufacturer's recommendations.

Specifically, the following items should be serviced at the intervals indicated. See Figure 18 for location of service check points.

1. GEARBOX OIL LEVEL

The oil level should be checked prior to initial start-up, and periodically thereafter. The fluid level must be maintained within the black circle in the sight glass. Oil may be added while the pump is in operation.

Overfilling the gearbox will cause excess foaming, overheating, and failure of the idler shaft lower ball bearing.

2. OIL PRESSURE

Depending upon the bearing configuration and the characteristics of the lube oil used, the gearbox internal
pump will maintain oil pressure between 15 and 60 psig (1.0 and 4.2 kg/cm^2) during normal operation.

3. GEARBOX OIL AND FILTER CHANGE

Oil in the gearbox and the oil filter should be changed every six months.

4. SEAL LEAKAGE

Seal leakage out of Port 1 should be checked periodically. Seals should be replaced if leakage increases to an unacceptable level. With double seals, buffer pressure and usage should be monitored to ensure that seals are functioning properly.

5. ANTIFRICTION BEARINGS

Antifriction bearings on the gearbox idler shaft and low speed shaft should be replaced after three years, or whenever the unit is being overhauled.

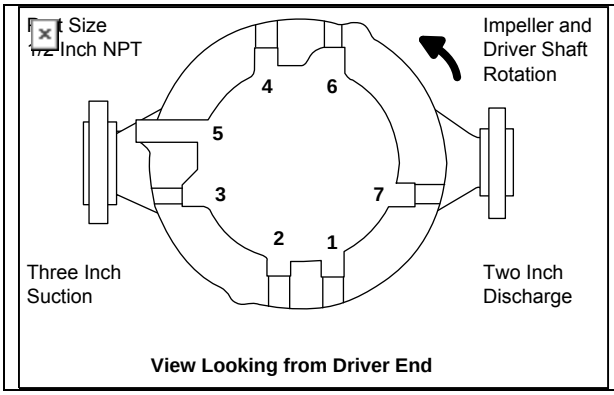
Care must be exercised to ensure that the correct replacement bearings are installed. Incorrect replacement bearings will jeopardize mechanical integrity of the unit. Replacement bearings should be purchased from Sundyne to ensure proper quality and fit.

6. DRIVER

Refer to driver manufacturer's specifications.

7. COUPLING

If a flexible coupling is used (see pump specification sheet) refer to Section 9, Page 4, or the manufacturer's service recommendations.



PORT	DESCRIPTION
1	Seal Vent or Drain & Gearbox Seal Drain
2	Buffer Fluid Out (Double Seal)
3	Casing Cooling Water In
4	Casing Cooling Water Out
5	Seal Flush
6	Case Vent of Seal Flush
7	Buffer Fluid in (Double or Tandem Seal)

Figure 19. Seal Housing Port Identification

OPERATION & CONTROL OF SUNDYNE PUMPS

1. OPERATION

While the application of the pump in any particular system is not within the scope of this instruction manual, the importance of proper application to successful pump operation cannot be ignored. Several factors must always be considered. The experienced operator will be aware of the effects.

A. SUCTION CONDITIONS

The most common reasons for improper centrifugal pump operation are those relating to proper flow of liquid into the impeller. To avoid turbulence at the eye of the impeller, the suction pipe should be straight for at least three pipe diameters beyond the suction flange. Another rule of thumb is that suction piping should be at least one pipe size larger than the pump suction flange.

It is essential that liquid reaching the impeller eye has a high enough vapor pressure to prevent it flashing to a gas in the impeller. The result of the liquid flashing is cavitation, a phenomenon which can cause damage to the impeller and inducer. Cavitation is sometimes noticeable as a "pumping gravel" noise in centrifugal pumps. In high-speed, single-stage pumps, this sound may not be discernible. The way to prevent cavitation is to maintain suction pressure at a high enough level and suction temperatures low enough to maintain Net Positive Suction Head available ($NPSH_a$) greater than Net Positive Suction Head required ($NPSH_r$) by the pumps.

B. MINIMUM FLOW CONDITIONS

Centrifugal pumps can also experience vibrations from internal flow separations and recirculation at low flow conditions. The operator should be aware of the minimum flow recommendations of the manufacturer. While a pump can operate with some noise due to recirculation without harm to the pump, excessive noise and vibration are signs that the pump may be subject to damage if operation is continuous. Noise and vibration may be accentuated by resonance in the discharge line, especially when a control valve is located well downstream from the pump.

C. ENTRAINED GASES

Entrained gases in the fluid will reduce the head and capacity of a centrifugal pump. Normally it is considered that two to three percent entrainment is limiting. The pump has been found to operate very well under adverse

conditions of gas entrainment. However, the operator should expect a reduction in performance.

D. SYSTEM HEAD CURVE

The flow at which a centrifugal pump operates depends upon the point of intersection of the system (head) curve with the pump characteristic (head versus flow) curve. In order for control to be steady, the system curve must intersect the pump characteristic curve at a significant angle. Examples of satisfactory and unsatisfactory angles of intersection are shown on the following diagram.

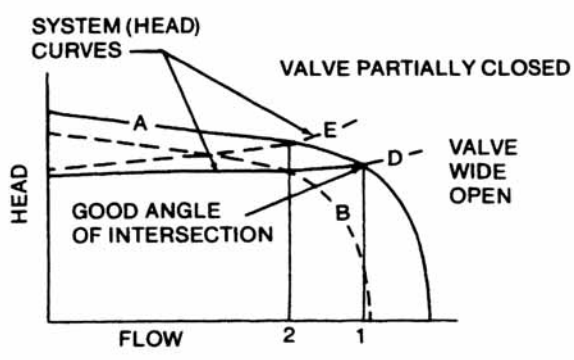


Figure 20. Typical Operation

NOTE

The curve for pump A has a significant angle of intersection with system curves D and E. The system curve D could represent a system with the control valve wide open while system E could represent the same system but with the throttle valve closed to reduce flow from flow 1 to flow 2. Pump curve B, on the other hand, will provide only flow 2, even with the control valve wide open (curve D). When the control valve is partially closed to create system curve E, the curve E and lower pump curve B are practically parallel. The lack of a significant angle of intersection means that the pump flow is likely to drift aimlessly and not respond to control valve position.

E. PARALLEL OPERATION

When centrifugal pumps are operated in parallel, their control becomes more critical because one pump may tend to "overpower" another in terms of head at lower total flows. If pumps are connected together at their discharge head by a simple and unrestricted manifold, the discharge head of one pump is imposed upon another, all pumps see the same discharge head at any given moment in time. This situation is shown on the following curves:

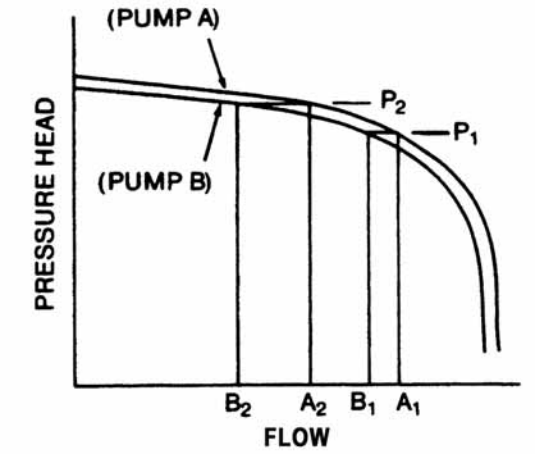


Figure 21. Parallel Operation

This diagram shows the characteristic curves of two pumps designated A and B. Since no two pumps will have exactly the same performance, it is assumed that pump A produces a very slight amount more head than pump B. The pumps are arranged with a common manifold as shown in the diagram below:

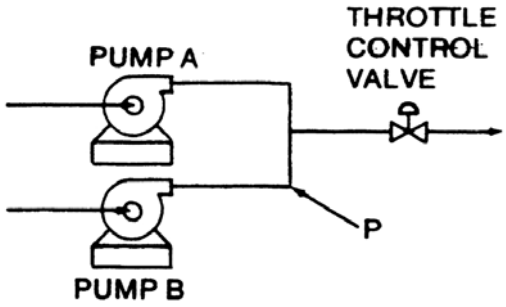


Figure 22. Parallel Units, Common Valve

The pressure in the manifold is set at P_1; the flow through pump A indicated as A_1 on the preceding curve. At the same time, the flow through pump B is indicated as B_1. However, if the throttle valve is closed to cause the manifold pressure P to rise to P_2, then flows through pump A and B are A_2 and B_2 respectively. If the throttle valve were closed even further, then pump B would cease to flow entirely. Since pump B would effectively be deadheaded, the fluid in it would heat up and boil. During internal boiling, it could encounter

liquid slugging and probable damage to the pump. This situation can be avoided by proper selection of the control system.

2. CONTROL

Proper operation of a pump (as with any other centrifugal pump) requires that the pump be operated in a range where (1) the system head curve and pump performance curve intersect at a significant angle, (2) the pump does not operate below the minimum flow recommended, and (3) the pump does not operate “in the break” or beyond the maximum capacity recommended. Rule of thumb would establish this as 10% beyond the design flow for LMV/BMP-331 pumps.

It is recommended that flow control rather than pressure control be used with the LMV/BMP-331. Pressure and flow controls both operate by throttling the discharge flow. However, flow control devices are much more sensitive to the changes in the point of intersection of the performance curve with the system head curve.

Minimum flow is determined by the larger of either (1) the amount of flow necessary to prevent damaging low flow recirculation, (2) the amount of flow necessary to prevent excessive temperature rise in the pump casing due to low flow recirculation, or (3) in the case of pumps operated in parallel, the minimum flow that will prevent one from deadheading the other.

The minimum flow necessary to prevent excessive vibrations caused by low flow recirculation has been found to be largely a function of the system design. The operation of a control valve downstream can produce a resonant condition which can accentuate recirculation vibration to damaging proportions.

It has been found through experience that the greater the distance the control valve is located from the pump discharge flange, the more severe the effect of this vibration becomes. A chart has been devised to establish safe limits of minimum flow operation (See Figure 23). In many cases it is possible to operate at lower flows than this chart shows. However, the higher the horsepower the greater the risk of damage becomes if a resonant condition is set up. It is therefore recommended that the operator adhere to the limitations of this chart unless more specific safe design conditions have been established.

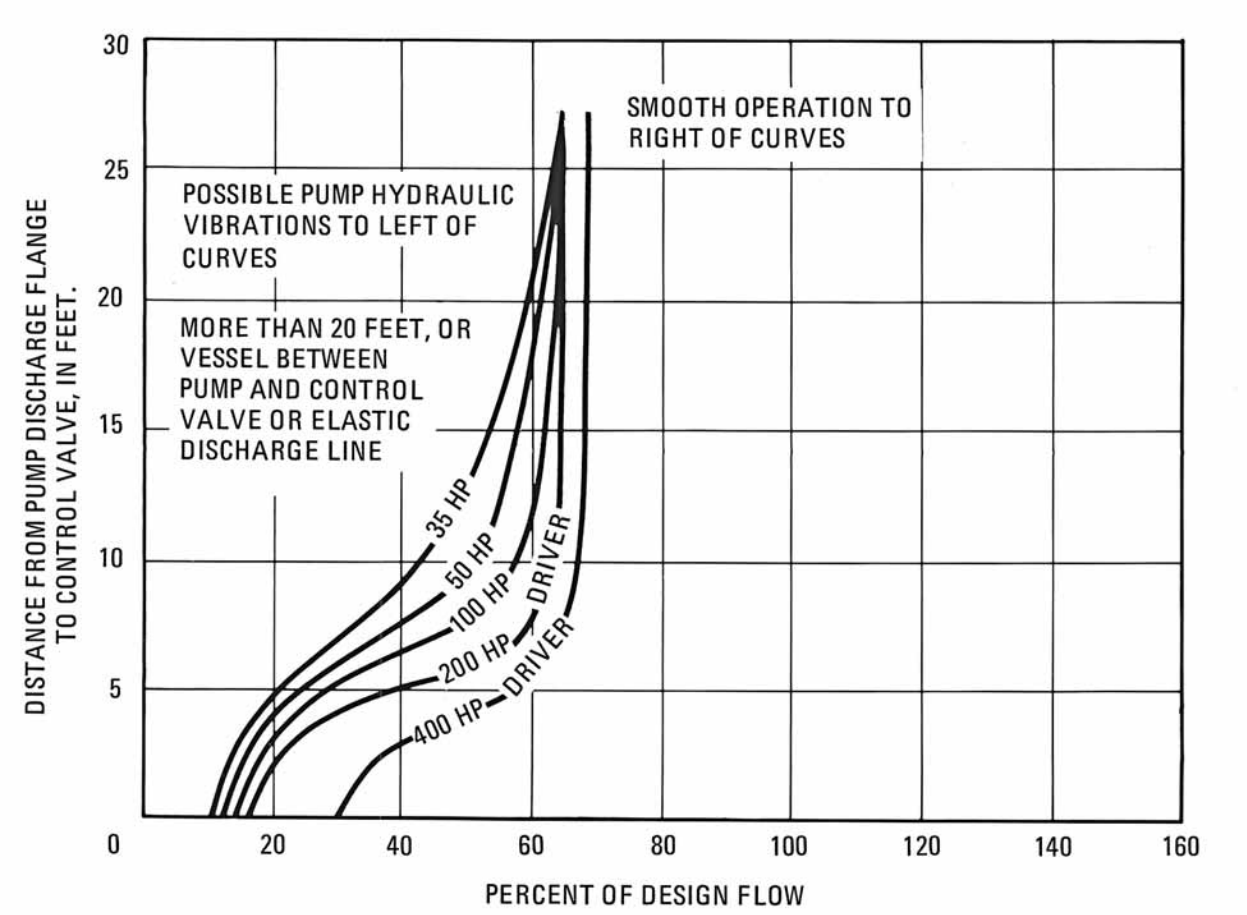


Figure 23. Recommended Flow for Smooth Operation of Sundyne Pumps

If the pump is not operated below minimum flow recommendations, temperature rise within the pump is unlikely to be a problem. However, if operation at low flows becomes mandatory, or if the system causes the pump discharge line to be blocked for any period of time, a means of maintaining a minimum flow must be provided. This can be accomplished by use of either a continuous bypass or by a flow controlled bypass. Any bypass arrangements must return liquid to the suction tank or to a location with similar heat sink capability.

In the case of two or more pumps operating in parallel, it is essential that flow be controlled so that one pump will not deadhead the other and so that they share the work equally. The best way to accomplish this is to provide a separated control valve for each pump. Other systems can be used but must be designed with careful consideration of the system head and pump performance curves.

Various safety devices to protect the pump and system are available. Devices that monitor vibration, temperature or pressure changes can be installed. Consult the manufacturer for recommendations.

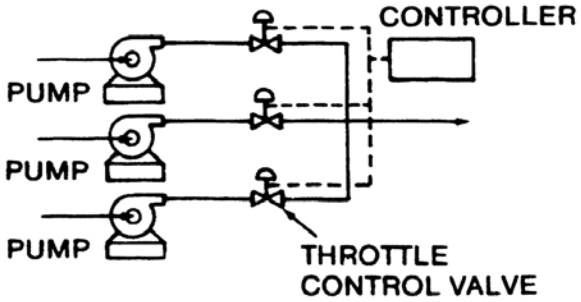


Figure 24. Parallel Units with Discharge Throttling

TROUBLESHOOTING

1. GEARBOX & PUMP

Pump performance is affected strongly by system factors such as suction pressure, temperature, specific gravity, driver speed, flow rate and control characteristics. These factors, as well as possible internal problems, should be considered carefully when analyzing pump system performance. Pump performance characteristics are shown on the specification sheet and performance curve. Table 7 presents information which is useful in the analysis of gearbox and pump performance problems. Repair procedures appear under "MAINTENANCE".

Table 7. Gearbox and Pump Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
No flow, no pressure at start-up.	Pump not completely filled with liquid.	Bleed all vapor or air from port 6. Allow more cool-down time if pumping low temperature fluid. Check suction line for air leak if suction pressure is lower than atmospheric.
	NPSH actually lower than NPSH requirement listed on specification sheet.	Suction line blocked – check suction screen and valve. Excessive pressure drop through suction piping. Flow restricted by vapor pockets in high points of suction line. Suction tank level or pressure too low. Entrained air or vapor in pumped fluid. NPSH reduced by presence of more volatile fluid in process fluid. Contact Sundyne representative about use of an inducer.
	Failure of drive component, such as interconnecting shaft or impeller key, or item missing from assembly.	Disassemble and inspect.
	Reverse direction of rotation.	Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.
Insufficient flow or total head.	Flow too high.	Check total head and flow rate against performance curve.
	Wrong direction of driver shaft rotation. (It is possible for the pump to develop greater than 50 percent design total head in this condition)	Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.
	NPSH actually lower than NPSH requirement listed on specification sheet.	Refer to solutions listed under "No flow, no pressure at start-up".
	Flow too low, causing overheating of fluid resulting in internal boiling or unstable pump operation	Increase through-flow rate. Bypass part of pump discharge to supply tank. Use seal cavity bypass and vent the high point of the pump to continuously increase inlet flow rate.
Insufficient Flow or Total Head (continued)	Diffuser discharge throat partially plugged or impeller damaged by passage of a solid particle.	Clean these areas of all obstructions and restore surfaces to a smooth polished finish (use emery

Table 7. Gearbox and Pump Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
		cloth or machine), free of all corrosion pitting. Edge of diffuser throat must be sharp.
	Corrosion and/or erosion of diffuser throat (may also be accompanied by corrosion/erosion of diffuser and cover surface adjacent to impeller).	If edge of throat is no longer sharp and smooth or has opened in size, head-rise may be reduced. Opening of the inlet area of the throat will result in higher flow rate and horsepower consumption. Corrosion/erosion of diffuser and cover surfaces will result in a significant horsepower increase.
	Excessive recalculation from discharge to inlet.	Check flow through external plumbing. Pump o-ring (936C) damaged or missing. Integral centrifugal separator orifice worn.
	Process fluid specific gravity or viscosity different from values shown on specification sheet.	Check actual viscosity and specific gravity at operating temperature. Viscosity higher than five centipoises will cause reduced head and flow and increased power consumption.
	Drive speed too low.	Check speed against value listed on specification sheet.
	Pressure gages or flowmeters in error.	Calibrate instrumentation.
Driver overloaded.	Fluid specific gravity or viscosity higher than values listed on specification sheet.	Check actual viscosity and specific gravity against value listed on specification sheet.
	Electrical failure in electric driver.	Check circuit breaker heater size and setting. Check voltage and voltage balance between phases. Current for each phase should be balanced within three percent.
	Mechanical failure in driver, gearbox or pump.	Remove driver and check for freedom of rotation of pump and gearbox shaft assemblies. Remove fluid end and search for any mechanical failure. Remove gearbox oil level sight glass and inspect bottom of sump for wear particles. Bearings are probably not damaged if no wear particles are present.
	Corrosion pitting on surface of diffuser cover or diffuser, adjacent to impeller blades. Headrise is also reduced by this condition.	Disassemble pump and inspect. Rough or pitted surfaces can cause friction losses which will significantly increase horsepower consumption. Clean these areas of all obstruction and restore surfaces to a smooth polished finish (use emery cloth or machine). Check diffuser throat area at the inlet; erosion or corrosion resulting in roughness or increased area will increase horsepower consumption. Note: A larger throat size than design will allow a higher flow and horsepower for a given headrise.
Excessive discharge pressure pulsations.	Flow rate too low.	Increase flow rate through pump. Add bypass to suction tank if necessary.
Excessive discharge	Insufficient NPSH available.	Refer to solution for insufficient NPSH under

Table 7. Gearbox and Pump Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
pressure pulsations. (continued)		"No flow, no pressure at startup," above.
	Defective flow control valve.	Check control valve.
	Flow rate too low for control by back pressure control valve or parallel pump operation.	Increase pressure drop between pump and control valve. Increase flow rate.
Change of gearbox oil from normal color to milky pink or yellow.	Gearbox oil contaminated with water or process fluid.	Inspect gearbox heat exchanger for leakage. Check for excessive pump seal leakage. Inspect shaft sleeve o-rings. Inspect that seal housing Port 1 and other seal drains are open for unrestricted seal leakage flow.
Shaft sleeve rubs on inside diameter of seal.	Gearbox journal bearing failure.	Install replacement exchange gearbox or repair gearbox as outlined under "MAINTENANCE".
Excessive gearbox automatic transmission fluid consumption.	Low speed shaft seal (115) leakage.	Check drain port for leakage. Replace shaft seal if required.
	High speed shaft mechanical seal (60C) leakage.	Check upper gearbox housing drain port for leakage. Replace shaft seal if required.
	Leakage through heat exchanger into cooling fluid.	Pressure test heat exchanger and replace if required.
Excessive oil foaming.	High oil level.	Shut down the unit and check oil level.
	Low gearbox temperature. Incorrect lubricant.	Adjust coolant to heat exchanger, keeping oil temperature above 140°F / 60°C. Fill with ISO VG 46 oil.
High gearbox temperature	Heat exchanger fouled or coolant shut off. Oil level too high.	Check coolant flow and/or clean heat exchanger. Check oil level and adjust.

2. PUMP MECHANICAL SEALS

Table 8 contains troubleshooting procedures for single seal equipped units. The information is also applicable to double and tandem seal units. The repair procedures for mechanical seals are listed in the “MAINTENANCE” section of this manual

.

Table 8. Pump Mechanical Seal Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
Sudden increase in seal leakage	Severe cavitation or loss of suction causing vibration and bouncing of seal face.	Correct pump suction condition causing cavitation. Bleed vapor from seal cavity and restart. Install double seal if loss of suction cannot be prevented.
	Seal icing on low temperature pumps or icing when handling fluids which vaporize at a temperature of less than +32°F (0°C) at atmospheric pressure	Quench with compatible fluid which will not freeze at pump temperature through seal drain port 2 or 7 to prevent ice formation on atmospheric side of seal during start-up and in running condition. Use purge of dry nitrogen gas through ports 2 or 7. Install double or tandem seal if ice is caused by water in process fluid or supply external seal flush of compatible fluid which does not contain water.
	Solid particles in seal cavity or seal spring area (seal faces usually have rough scratched appearance).	Inspect for clogged integral centrifugal separator orifices. Clean orifices if necessary. Supply external clean seal flush or double seal, if particles cannot be removed by separator.
	Seal stationary face spring action is rough and sticky.	If parts are corroded, replace with parts made from compatible materials. If formation of solids causes sticky seal analyze fluid properties. Use external seal flush or double seal arrangement.
	Worn or damaged seal.	Disassemble seal and rebuild or replace per instructions in maintenance section.
	Wear pattern on seal rotating faces not uniform.	Lightly lap surfaces of shaft sleeve and impeller hub which contact rotating seal face to remove high spots. Install new seal faces.
	Wear pattern on stationary face smooth but not uniform.	Lap flat or replace seal.
	Edges of stationary face chipped and seal face worn. (Vapor flashing in seal cavity will cause excessive wear and/or cracking of rotating face.)	Install seal cavity bypass to suction tank. Prevent loss of pump suction. Supply cool seal flush. Install double seal.
	Seal rotating face cracked or broken. May be caused by damage at assembly or thermal shock caused by seal running dry.	Prevent loss of pump suction or supply continuous external seal flush. Install double seal.
	Chemical attack of seal faces, seal parts or o-rings.	Investigate fluid properties and determine suitable materials for replacement.

Table 8. Pump Mechanical Seal Diagnostics		
Situation/Symptom	**Possible Cause**	**Investigative/Corrective Action**
Sudden increase in seal leakage (cont)	Excessive radial high speed shaft movement. Bent high speed shaft or severe out-of-balance.	Check high speed shaft journal bearings and replace if necessary. Check if damage exists on impeller and/or inducer which will indicate that a large particle went through the pump. Deposits on the impeller/inducer causing unbalance.
	Damage to mechanical seal secondary seal (Teflon® wedge or U-cup or elastomer o-ring).	Check for erosion and/or corrosion attack. Install seal flush or double seal arrangement.
	Loose stack-up of high-speed shaft attaching components.	Check for correct impeller bolt/inducer torque. Check for cold flow of Teflon® o-rings.

MAINTENANCE

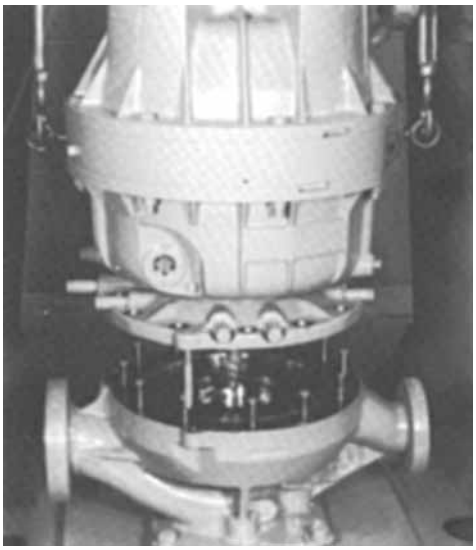
The following procedures apply to all configurations of the Sundyne LMV/BMMP-331 centrifugal pumps. Refer to the specification sheet to determine the specific configuration and optional equipment included in your unit. Parenthetical numbers in the text correspond to item numbers in the illustrations and parts lists.

1. Procedure for Disassembling Pump

The following replacement parts will be required as a result of pump disassembly and seal housing removal		
Part	**Item**	**Qty.**
Thermal Barrier Gasket	87A	1
• O-Ring Seal	936A	1
• O-Ring Seal	936B*	1
• O-Ring Seal	936C	1
• O-Ring Seal	936D	1
• O-Ring Seal	936E	1
• O-Ring Seal	936F	1
• O-Ring Seal	936G	1
• O-Ring Seal	936J	1
• O-Ring Seal	936K	2
• O-Ring Seal	936P	1
• O-Ring Seal	936V	1
• O-Ring Seal	936Z	1
• Single Seal		1
• Double Seal		2
• Tandem Seal		3
*O-Rings 936B and 936C are NOT INCLUDED in the O-ring Repair kit. Must be purchased separately.		

NOTE

An o-ring Repair Kit is available. This kit contains the o-rings required to replace the gearbox and pump mechanical seals.



STEP 1

Vertical units with a driver stand. Remove bolts (909D) securing the coupling guard. Remove the coupling guard. Disengage both ends of the spacer coupling and remove the floating shaft. Remove nuts (914A) from the pump casing studs and release the stiffening brackets. Attach the integral turnbuckles to the gearbox bearing plate (102). Using the turnbuckles, lift the gearbox and seal housing from the pump casing. Exercise care to prevent damage to the impeller. Tip and block the gearbox.

Vertical units without a driver stand. Remove attaching hardware and lift driver from gearbox. Remove nuts (914A) from pump casing studs. Lift the gearbox and seal housing from the pump casing, taking care not to damage the impeller. Place the gearbox on a suitable support with the impeller inclined upward.

On all BMP units, disconnect the piping between the heat exchanger and filter. Attach a hoist to the gearbox housing an eyebolt in the tapped hole on the bearing plate. Remove nuts (914A) from the pump casing studs and disconnect midriff braces. Remove the gearbox and seal housing from the pump casing by moving them toward the driver until the impeller and inducer (if applicable) clear the casing. Place gearbox on a suitable support with the impeller facing upward.

NOTE

The gearbox can be worked on while in a horizontal position. However, the diffuser cover must be supported to prevent its falling off when the impeller is removed.

STEP 2

Prevent impeller from rotating and remove inducer (9). Note that impeller has a **left-hand thread.**

STEP 3

Remove impeller (2).

CAUTION

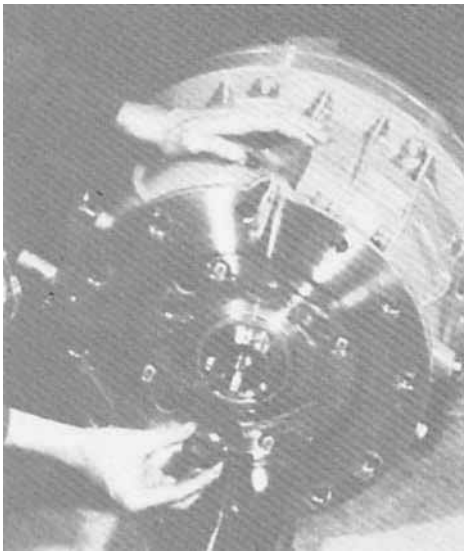
The impeller is dynamically balanced and should be replaced or rebalanced if it shows any sign of damage.

Step 4

Remove diffuser cover (15) from seal housing.

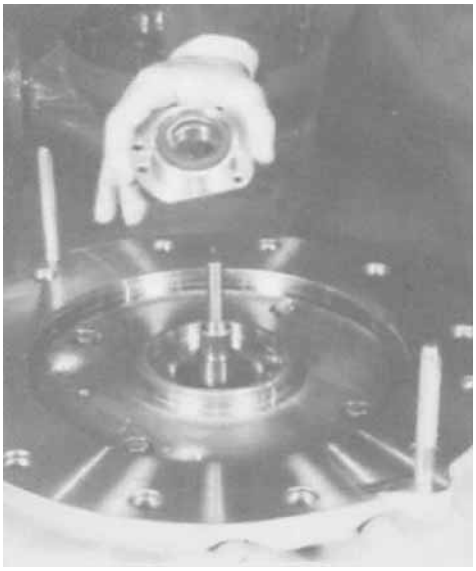
Step 5

If diffuser removal is required, insert three eyebolts (customer furnished 5/16-18 UNC) into tapped holes in the surface of diffuser (13). Loosely thread a length of rope through these bolts and tie ends together. Grasp the rope between bolts and lift the diffuser. This step will require that o-rings 936B and 936C be replaced.



Step 6

Remove the seal rotating face (51A) of single or tandem seal arrangement or the lower shaft sleeve (50A) on units equipped with double seals.



Step 7

Remove the single seal (60A) of the single seal arrangement or the lower mechanical seal (60A) and seal spacer (52) of the double seal arrangement or the lower mechanical seal of the tandem seal arrangement.

If the pump has a single seal arrangement, remove seal housing (30) and gasket (87A). Remove hex head cap screws (905F) and washers (916B). Remove throttle bushing (21B).

Step 7 (continued)

If upper seal of double or tandem seal arrangement requires removal, detach seal housing (30) and gasket (87A) from the gearbox by removing hex head cap screws (905A).

Double Seal – Remove hex head cap screws (905F), washers (916B), upper mechanical seal (60B), and seal rotating face (51C).

Tandem Seal – Remove hex head cap screws (905F), washers (916B), upper mechanical seal (60B) and seal rotating face (51C).

Step 8

Carefully inspect the seals for abrasive particles, excessive seal face wear and any binding of the seal face washer.

Replace or rebuild a faulty mechanical seal. Seals may be rebuilt by replacing the seal face washer, wedge rings, o-ring, and springs. A seal repair kit is available.

Replace or lap the seal rotating face if the wear track is rough or worn to a depth greater than 0.0002 inch (0.005mm).

A combined total of 0.010 inch (0.25mm) maximum may be removed from the surfaces of the pump and gearbox seal rotating faces. Excess material removal will result in incorrect seal face loading causing increased seal leakage.

Remove any high spots on the end surfaces of the lower shaft sleeve and impeller hub to insure that the seal rotating face will not be distorted by clamping force of the impeller bolt.

Reassemble the seals, throttle bushing, if used, seal housing, and impeller using an O-ring Repair Kit. All o-rings that were disturbed by disassembly should be replaced. During re-assembly, carefully check the torque values listed in Table 9.

The impeller may rub on the diffuser cover plate (15) until o-rings (936D and 936E) are compressed by tightening hex nuts (914A). Check the gearbox input shaft for freedom of rotation after the pump is assembled and all bolts are tightened per Table 9.

2. Procedure for Disassembling Gearbox

The following replacement items will be required as a result of the gearbox disassembly:

Part	Item No.	Qty.
Gearbox Oil Filter	185	1
Input Shaft Lip Seal	115	1
Housing O-Ring	936AG	2
O-Ring Seal	936M	2
O-Ring Seal	936N	2
O-Ring Seal	936P	1
O-Ring Seal	936T	2
* Shim Spacers	158 Series	As Required
* Available in sets of five 0.005 inch (0.13mm), 0.010 inch (0.25mm), .05 inch (0.38mm), 0.020 inch (0.51mm), 0.030 inch (0.76mm)		

NOTE:

In order to disassemble the gearbox, it is necessary to complete steps one through seven under "Procedure for Disassembling Pump".

Step 1

Drain oil from the gearbox.

Step 2

Remove upper shaft sleeve (50B) on double or tandem seal arrangements or sleeve (50) on single seal equipped units.

Step 3

Remove hex head cap screws (905L) and washers (916K). Remove gearbox mechanical seal (60C) rotating face (51D), and o-ring (936P).

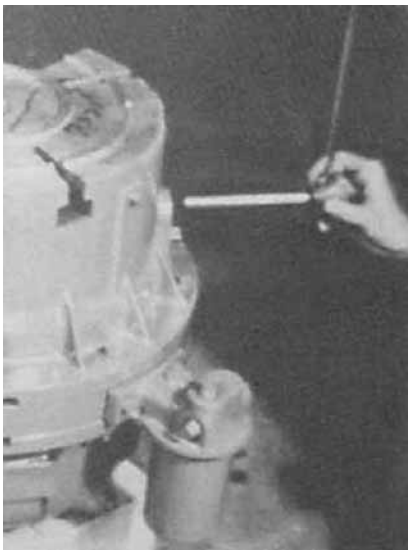
The gearbox mechanical seal may be rebuilt or replaced as described in Step 8 under “Procedure for Disassembling pump”.

Replace or lap the seal rotating face if the wear track is rough or worn to a depth greater than 0.002 inch (0.005mm).

A combined total of 0.010 inch (0.25mm) maximum may be removed from the surfaces of the pump and gearbox seal rotating faces. Excess material removal will result in incorrect seal face loading causing increased seal leakage.

During re-assembly, install the gearbox seal rotating face with the large chamfer on the inside diameter inserted toward the gearbox to clear the radius on the shaft shoulder.

Remove any high spots on the end surfaces of the shaft sleeve to insure that the seal rotating face will not be distorted by the clamping force of the impeller bolt.



Step 4

Remove the fill vent piping by unscrewing the ¾-inch pipe elbow (947A).

Step 5

Remove bolts (909B and 909C) and remove the gearbox input housing (101B) by lifting the tapping on the underside of the input housing with a soft mallet.

Step 6

Using a hammer and punch, remove input shaft lip seal (115). Exercise care to avoid damaging the gearbox housing.

NOTE

If the aluminum housing bore, for lip seal, is scratched, apply a light coat of oil-proof gasket cement to the outside diameter of the new shaft seal before replacing.

Step 7

Lift the idler shaft (140) out of the lower bearing liner, disengaging upper idler and input shaft gears.

Step 8

Remove the low speed shaft (120) from the gearbox bearing plate (102)

Step 9

Inspect anti-friction bearing (125C and 125D) for smooth rotation, worn outside diameter of outer races and snugness of the inner races on the shafts. Replace if bearings have been in operation for more than one year, if rotation is not smooth, or if outside or inside diameters are worn.

CAUTION

It is essential to replace anti-friction bearings with the manufacturer's approved replacement bearings. Non-approved replacement bearings may jeopardize mechanical integrity of the gearbox/pump.

Anti-friction bearings should be pressed onto the shaft using a press which contacts only the inner race. Bearing damage will occur by pressing or pulling the outer race. No more than 0.001 inch (0.03mm) gap should exist between bearings, spacers, gears and shaft shoulders. Do not use heat to assemble bearings to the shaft.

Inspect the inside of the anti-friction bearing liners, see Figure 25. If a bearing liner inside diameter is more than referenced in Figure 25, replace the gearbox input housing (101B), gearbox output housing (101A), or bearing plate (102), whichever contains the worn liner. Bearing liners are not replaceable in the field.

Step 10

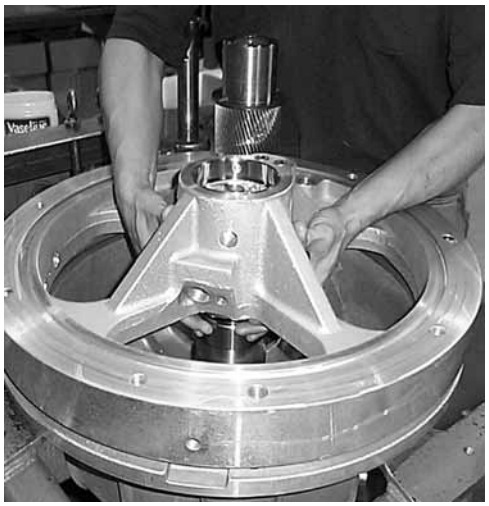
Inspect the low speed shaft (210) spherical roller bearing contact areas, (See Figure 25). If the outside diameter of either shaft is less than 1.5748 inches (40.00mm), install a new shaft.

Step 11

Remove the high speed shaft (130) from the gearbox output housing (101A)

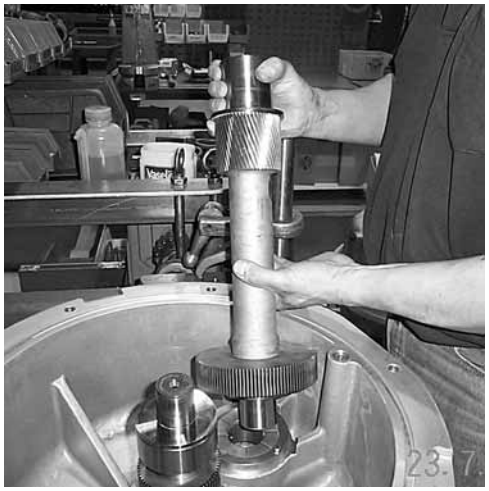
Step 12

Remove the internal lube oil pump (160).



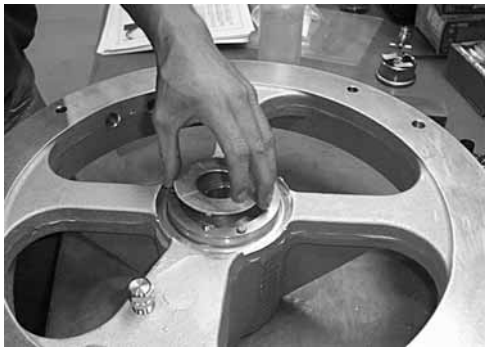
Step 13

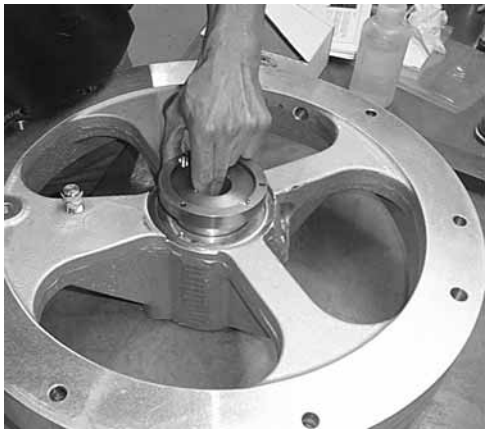
Remove gearbox bearing plate (102).



STEP 14

Remove idler shaft (140).





Step 15

Remove the upper journal bearing (151B) and thrust washer (155B) if used. Remove the lower journal bearing (151A) and thrust washer (155A) if used.

NOTE

Upon removal of the upper and lower journal bearing assemblies, tag the bearings so that they can be reinstalled in their proper location.

Step 16

Inspect upper and lower thrust washers (155B and 155A) or tilting pad bearing assembly (151B). If metal is smeared into radial lube grooves of the washer face, install a new washer. If tilting pads do not tilt freely, or if they show signs of metal pickup or overheating, install a new bearing assembly.

Inspect the thrust runner (133B) and high speed shaft at thrust washer and journal bearing contact areas. If the outside diameter of the shaft is less than 1.4960 inches (38.00mm) (Figure 25), or if the shaft has bearing or washer material on its surface, or shows signs of overheating or wear to a depth greater than 0.001 inch (0.03 mm), install a new shaft and gear assembly.

Step 17

Visually inspect helical gear (122A), spur gear (122C) and pinion gears (132B and 132C) for pits, chips, gear tooth wear or excessive wear between gear and shaft. The thrust runner and gears are shrink fitted to the shaft. Use a 10 ton hydraulic press or equivalent for gear removal.

A new gear can be installed on the low speed shaft by heating the part to 250°F. (121°C) and pressing it into position on the shaft. Using a 10 ton press, the part should be pressed rapidly into place to avoid heating of the shaft. In 400 hp gearboxes heat the gear to 375° - 400°F (190° - 204°C) and cool the shaft to 0°F (-18°C) No more than 0.001 inch (0.03mm) gap should exist between the shaft shoulder, gears, spacers, and bearings. The high speed shaft assembly is dynamically balanced; high speed shaft gears cannot be replaced in the field**.**

NOTE

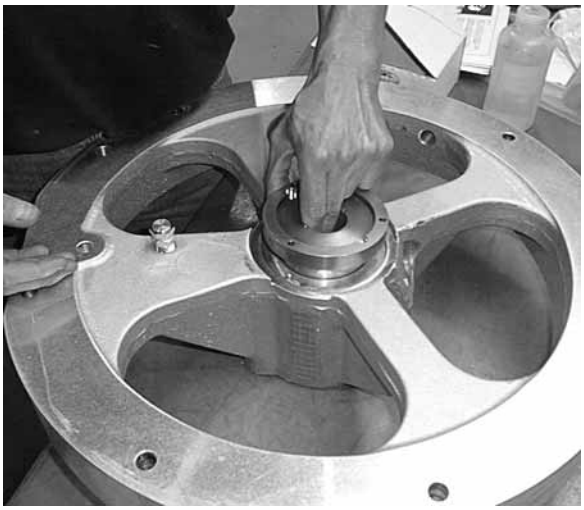
Remove lube jets and journal bearings. Clean all lube passages with solvent and blow dry with clean air. Clean all other parts thoroughly and lubricate with ATF or light turbine oil. Reinstall jets into housings immediately.

REASSEMBLY

Procedure for Checking High Speed Shaft End Play

Step 1

Install the lower journal bearing (151A) into the gearbox output housing (101A). With no shim spacers installed, tighten screws (905M).



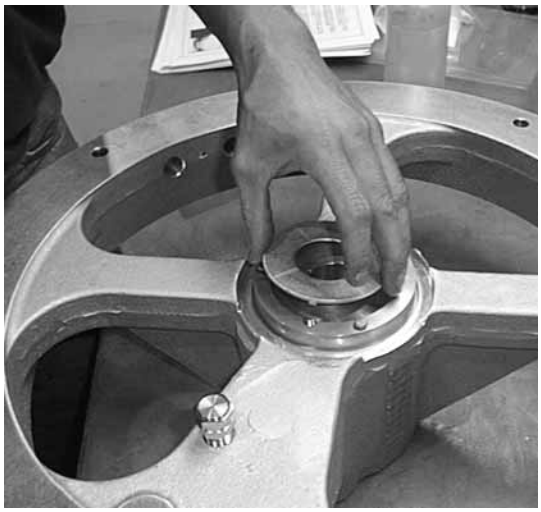
Step 2

Install the upper journal bearing or bearing assembly (151B) into the bearing plate (102).

With no shim spacers installed, tighten screws (905N).

CAUTION

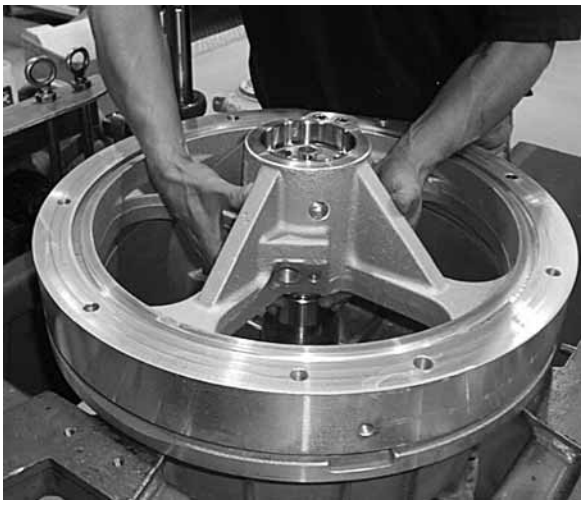
Shims are never installed behind the upper journal bearing.



Step 3

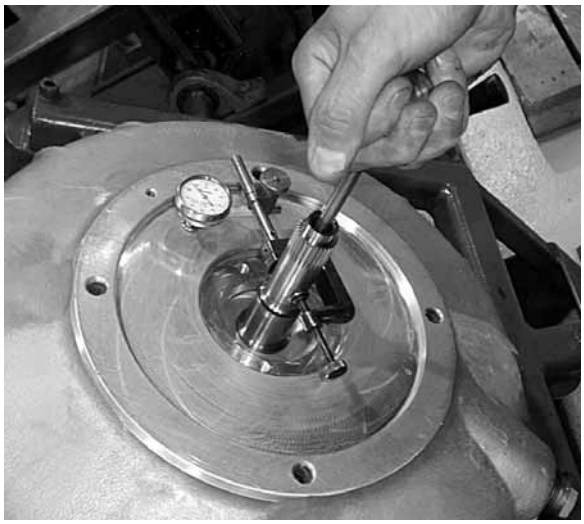
If used, place both upper and lower thrust washers (155B and 155A) into lower journal bearing.

Place the high speed shaft assembly (A130) into the gearbox output housing.



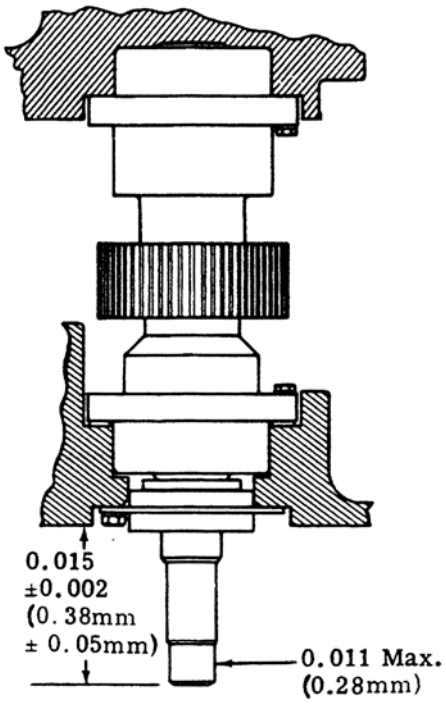
Step 4

With the aid of two large-diameter alignment bolts (909C), install bearing plate (102) without o-rings. Clamp the bearing plate to output housing with two “C” clamps or bolts.



Step 5

With the shaft in a vertical position, move the shaft up and down while measuring the total end play with a dial indicator or depth micrometer. Shaft end play must be 0.015 + 0.002-inch (0.38 + 0.05mm). If end play is not within this limit, calculate the shim thickness required to place the shaft within the proper clearance range. Select the required thickness shim using 158 Series shim spacer sizes.



Step 6

Remove the alignment bolts (909C) and bearing plate (102) with upper journal bearing (151).

Step 7

Remove high speed shaft (A130), thrust washers (if used) (155A & B) and lower journal bearing (151A).

Step 8

Install the required shim spacers in place on the gearbox output housing and replace the lower journal bearing. Install attaching bolts (905M) and tighten.

Step 9

Install the lower thrust washer (155A - if used) with the flat side on the bearing surface and replace the high speed shaft.

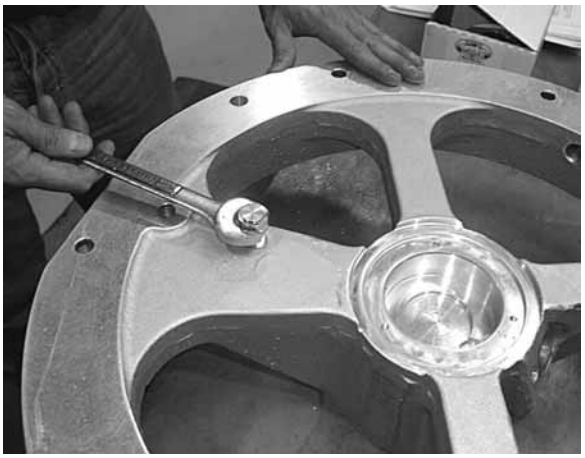
Step 10

Install the upper thrust washer (155B - if used) with the flat side on the upper journal bearing surface. A light grease may be used to hold the thrust washer in place.

Step 11

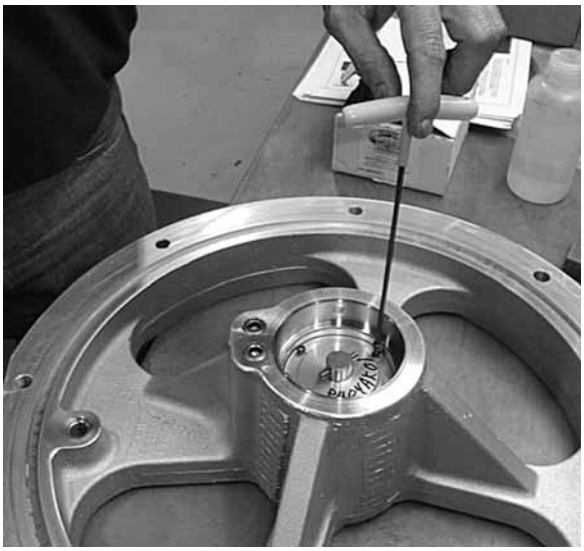
In the lower gearbox housing, install lower idler journal bearing (151D), washers (154AB) and screws (905B). Tighten to proper torque values.

Install thrust washer (155D)



Step 12
Prepare bearing plate for final assembly.

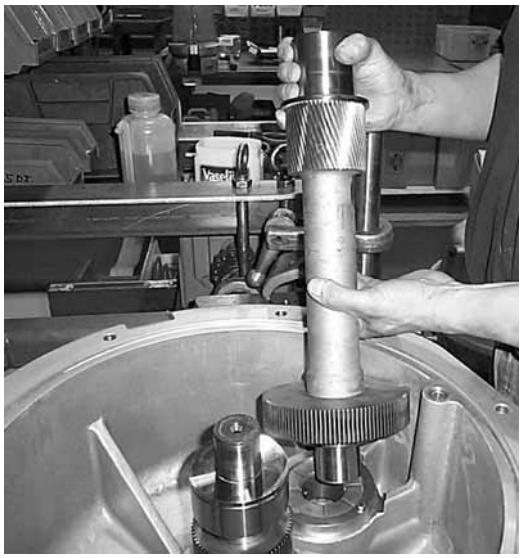
Install relief valve (175).



Step 13

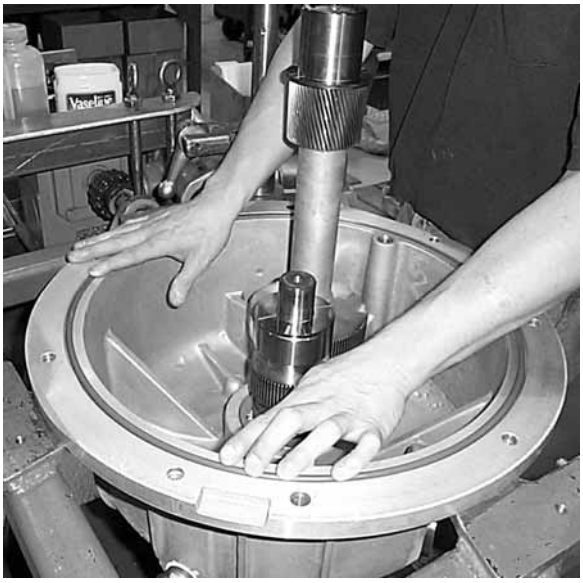
Install lube pump (160), 3 screws (905BU) with washers (154Z) and tighten.

Install lube jet (174D) in the bearing plate.



Step 14

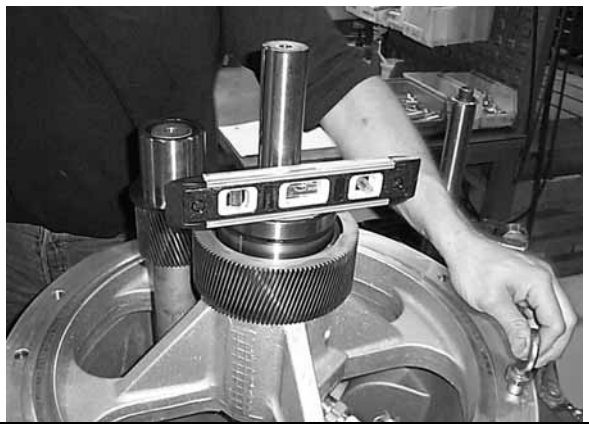
Continue re-assembly of the gearbox by placing idler shaft (140) in the lower half of the gearbox.



Step 15

Position the lube passage o-ring (936T) and housing o-ring (936AG).

Position bearing plate (102) on the lower half of the gearbox.



Step 16
With the bearing plate in place, lift the idler shaft and tilt to the side.

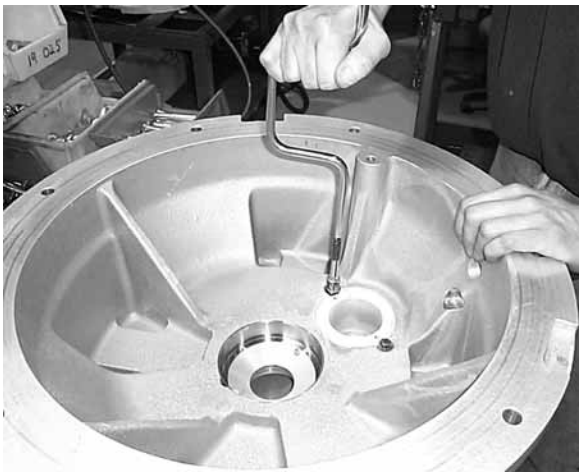
CAUTION
Do not damage gears or thrust washer.

Install the low speed shaft assembly into the bearing plate, bearing liner with the shaft aligned so that the lube pump drive pin slips into the slot in the low speed shaft. Top surface of the bearing should be even with the top of the bearing liner. At this time the idler shaft should be lowered into the lower idler bearing engaging the four gears.

NOTE:
The input and upper idler gears are helical and will require a slight rotation to engage the gears.

The upper and lower input bearings are spherical roller bearings. In order to install the upper gearbox housing, the input shaft must be vertical and the bearing retainers horizontal and square.

A machinist's level is useful in positioning the shaft and bearing retainers.

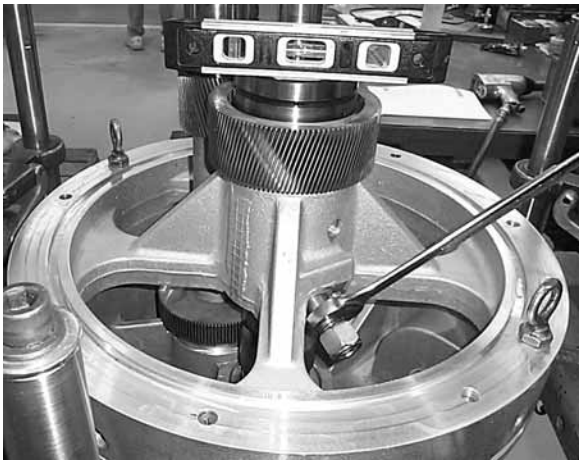


Step 17

Assemble the upper idler journal bearing (151C), screws (905AA) and washers (916AB) into the upper gearbox housing (101B).

This is a very tight fit. It is recommended that the bearing be frozen to facilitate assembly.

Install lube jet (174C) into the upper housing at the upper input bearing location.



Step 18

Install the sump tube(173), and pipe connectors (944A & B) into the bearing plate.

Step 19

Install the lube galley o-ring (936T) and the housing split line o-ring (936AG).

Step 20

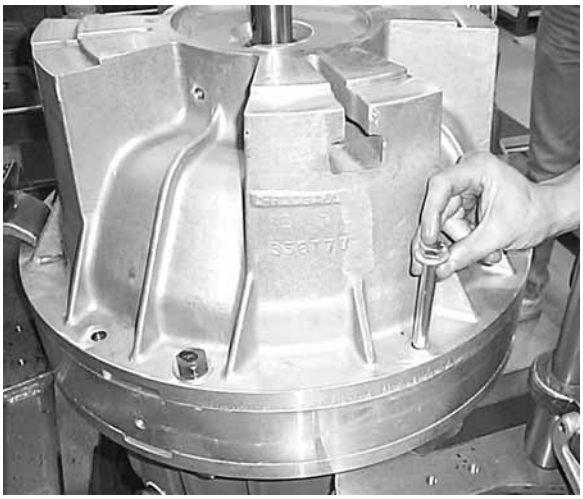
Pre-lubricate the upper idler journal and the input shaft bearings.

Step 21

Lower the upper gearbox housing (101B) onto the bearing plate. Align the upper idler bearing over the upper idler shaft journal. Use a machinist's level to keep the housing level as it is lowered over the input shaft**.**

It is a very tight fit between the upper input bearing race and the upper housing bore. It may take several attempts to assemble the upper housing.

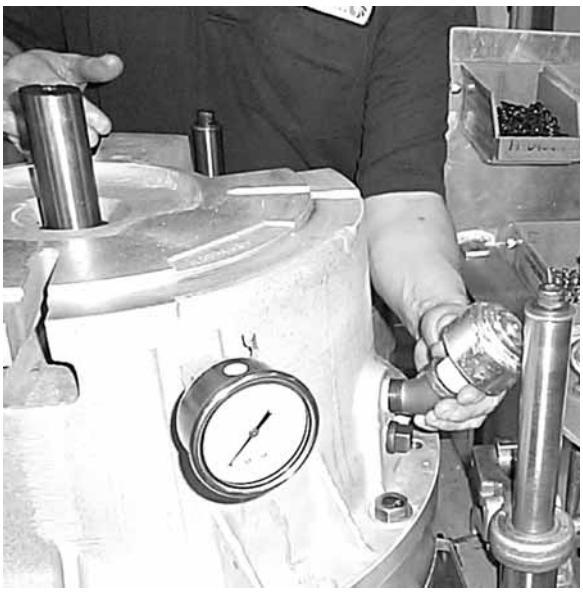
Do not use force. It will not work and damage to the bearings may occur



Step 22

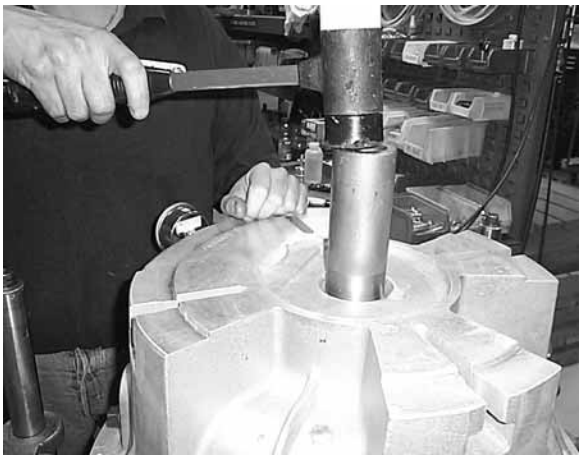
Install and tighten the 2 close tolerance alignment bolts (909C) and washers (916J), and the 7 housing bolts (909B) and washers (916H).

Assemble and tighten to the proper torque value the alignment nuts (914F) and washers (916J) and the housing nuts (914E) and washers (916H).



Step 23

Install the fill and vent fitting.



Step 24

Install a new input shaft lip seal (115), using tool number TO06AA47. If the tool is not available, place tape over the input shaft keyway to protect the lip seal, and carefully tap the lip seal into the housing bore.

Install the rubber dust cover (98)

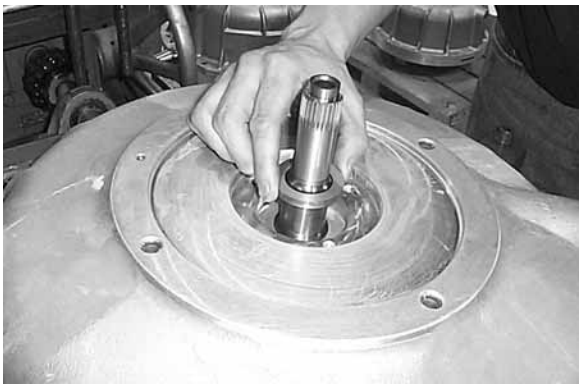
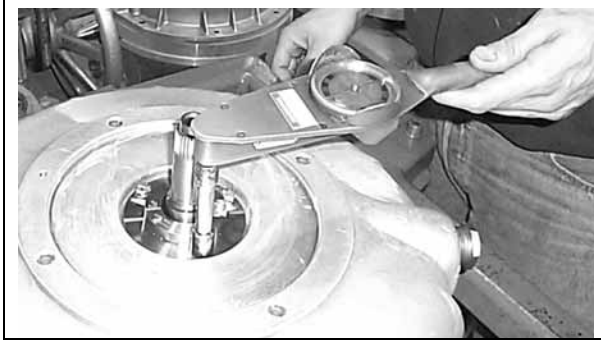
	**Step 25** Turn the gearbox over and install the gearbox seal rotating face (51D).
	**Step 26** Install o-ring (936K) over the gearbox seal retainer and install the gearbox seal (60C), washers (916A) and hex head cap screws (905E). Tighten to the proper torque values.

Table 9. Torque Values

Gearbox *Sundyne Standard Steel Screws & Bolts and NACE Compliant Steel Screws/Bolts (BG Material)*				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
905H	Oil Filter Manifold	3/8 - 16 x 1/2	22 - 25 ft-lbs	30 - 34 N-m
905L	Gearbox Seal	1/4 - 20 x 1/2	75 - 80 in-lbs	8.5 - 9.0 N-m
905M, N	Journal Bearings	#10 - 24 x 1	35 - 40 in-lbs	4.0 - 4.5 N-m
905T	Chemical Barrier Gasket	1/4 - 20 x 5/8	75 - 80 in-lbs	8.5 - 9.0 N-m
909B	Gearbox Halves	1/2 - 13 x4	60 - 65 ft-lbs	81 - 88 N-m
909C	Gearbox Halves, Alignment	5/8 - 18 x 4 17/64	60 - 65 ft lbs	81 - 88 N-m
906B	Sight Glass	#8 - 32 x 1/2	10 - 12 in-lbs	1.0 - 1.4 N-m
*Pumps & Compressors** *Sundyne Standard Steel Screws and Bolts*				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85 - 90 ft-lbs	115-122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	95 - 102 in-lbs	11 - 11.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20 x 12	95 - 102 in-lbs	11 - 11.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20 x 12	9 5- 102 in-lbs	11 - 11.5 N-m
905G	Double Seal with Spacer	1/4 - 20 x 3/4	95 - 102 in-lbs	11 - 11.5 N-m
914A	Case Nuts	3/4 - 10	250 - 275 ft-lbs	340 - 375 N-m
914A	Case Nuts	7/8 - 9	300 - 330 ft-lbs	405 - 445 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	35 - 40 ft-lbs	47 - 54 N-m
905P	Separator	1/4 - 20 x 5/8	95 - 102 in-lbs	11 - 11.5 N-m
Pumps & Compressors *NACE Compliant Steel Screws / Bolts (BG Material)*				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85- 90 ft-lbs	115 - 122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905G	Double Seal with Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
914A	Case Nuts	3/4 - 10	160 - 200 ft-lbs	217 - 270 N-m
914A	Case Nuts	7/8 - 9	225 - 245 ft-lbs	305 - 332 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	27 - 30 ft-lbs	47 - 54 N-m
905P	Separator	1/4 - 20 x 5/8	70 - 75 in-lbs	8.0 - 8.5 N-m

* When using Teflon® o-rings, allow 15 minutes between torquing for the Teflon® to cold flow. Repeat torquing until there is no change in torque.

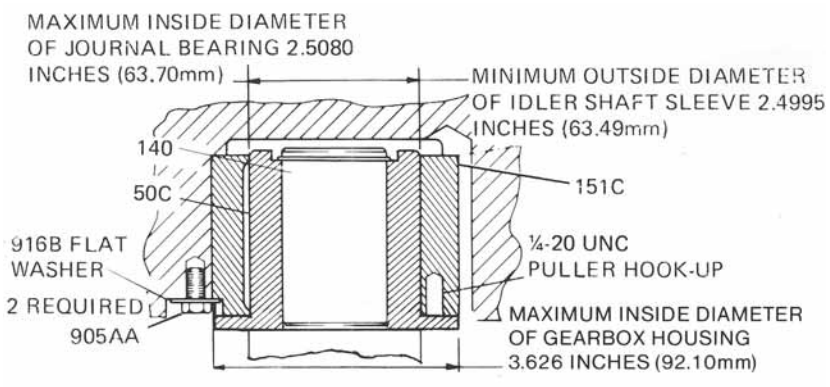
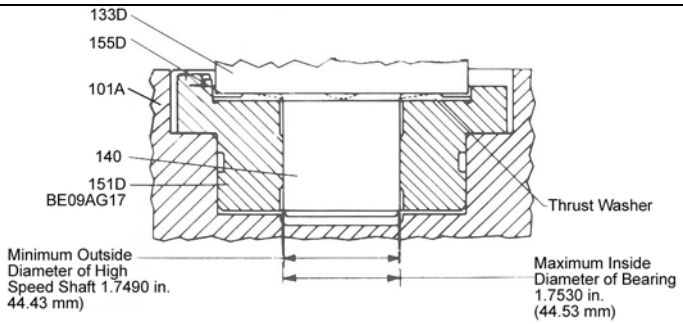
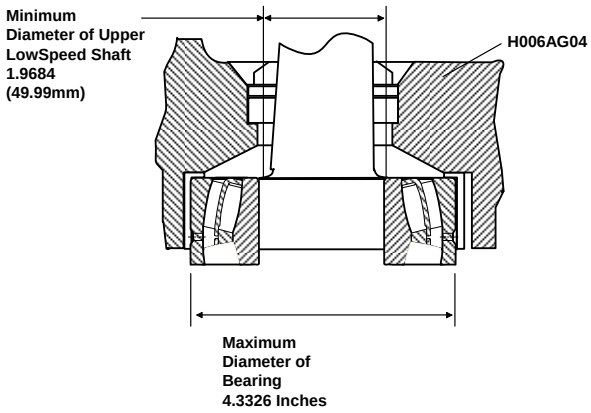
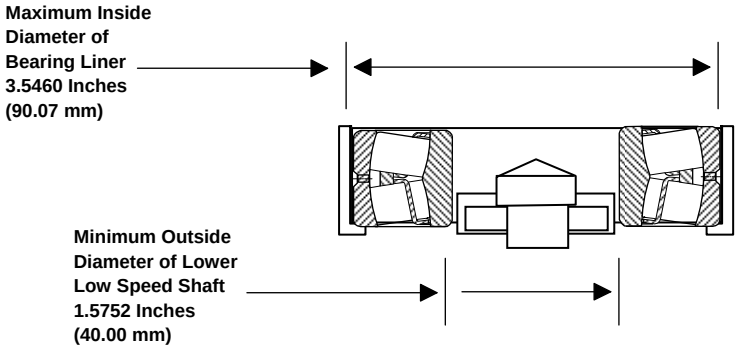
Idler Shaft Upper Bearing (400 HP Gearbox Only)	
Lower Idler Bearing and Shaft Clearances	
Input Shaft Upper Bearing	
Input Shaft Lower Bearing	

Figure 25. Bearing and Shaft Clearance

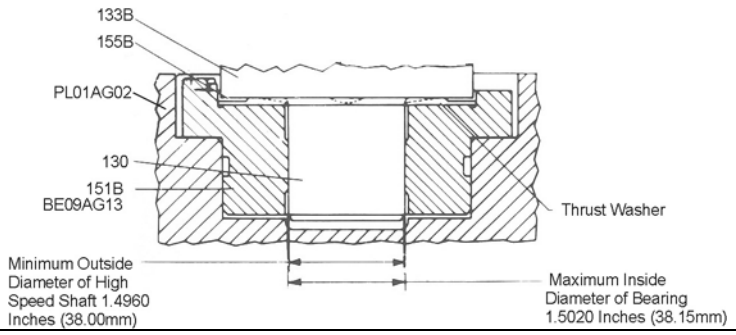
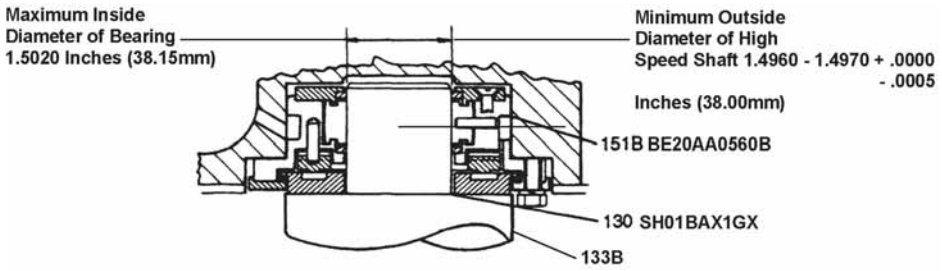
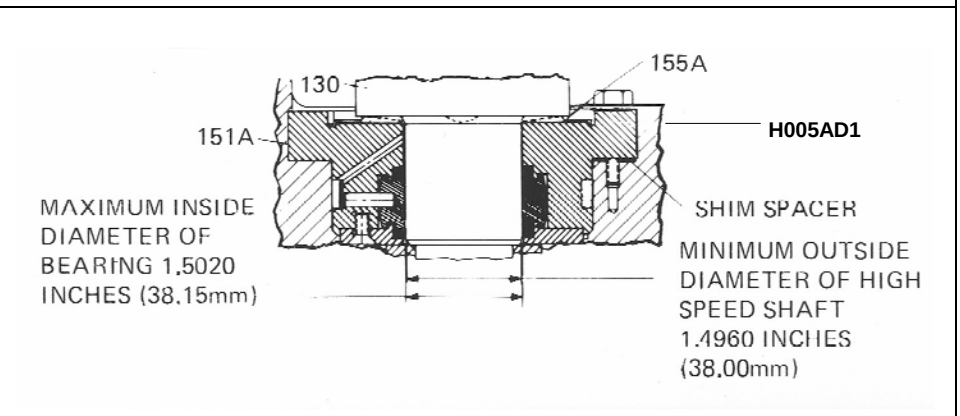
Journal Bearing and High Speed Shaft Clearances	
Tilting Pad Thrust Bearing and High Speed Shaft Clearances	
Tilting Pad Radial and High Speed Shaft Clearances	

Figure 25. Bearing and Shaft Clearances

Parts List

1. General

Assemblies, subassemblies and components of the Sundyne LMV/BMP-331 pumps are illustrated on the following exploded and cross sectional views. Refer to your Sundyne specification sheet for those options applicable to your pump. The corresponding parts lists, keyed to each part by item number, identify detail parts by part name, quantity and location.

2. Recommended Spare Parts

Refer to pages 56 and 57 for recommended spares. The quantities listed are intended as general guidelines; actual quantities for a specific application will vary with operating conditions, process liquid, critical nature of service, and inventory considerations. You can obtain assistance for planning an adequate supply of spare parts from your Sundyne Corporation representative.

3. Gearbox Exchanger

A gearbox exchange can be arranged for a fixed price. A replacement gearbox, completely tested and with a full one year warranty can be shipped to anywhere in the continental United States within 48 hours after receipt of the expedited order in Arvada.

4. Repair Kits

Seal and o-ring repair kits are not illustrated herein, but may be purchased directly from Sundyne Corporation. Seal repair kits contain all normally wearing parts (springs, washers , o-rings, carbon faces, etc.) of the pump or gearbox mechanical seals.

O-ring repair kits contain all o-rings necessary for maintenance on overhaul of the pump. The use of these kits reduces maintenance time, prevents assembly mistakes, simplifies stocking and inventory, and reduces delivery time.

5. Ordering Spare Parts

When ordering spare parts, give the pump serial number and list each part by part number as shown on the parts list which is included with each pump shipment (preferred method), or list each part by item number (as listed in this manual), part name and pump model. Specify quantities desired.

Order parts from your Sundyne representative or directly from Sundyne Corporation:

Sundyne Corporation
14845 West 64th Avenue
Arvada, CO 80004 (USA)
Phone: +1-303-425-0800
or
Nikkiso-Sundstrand Co., Ltd.
27-10, Ebisu, 2 Chome
Shibuya-Ku
Tokyo 150, Japan
Phone: 011-81-3-3444-6475

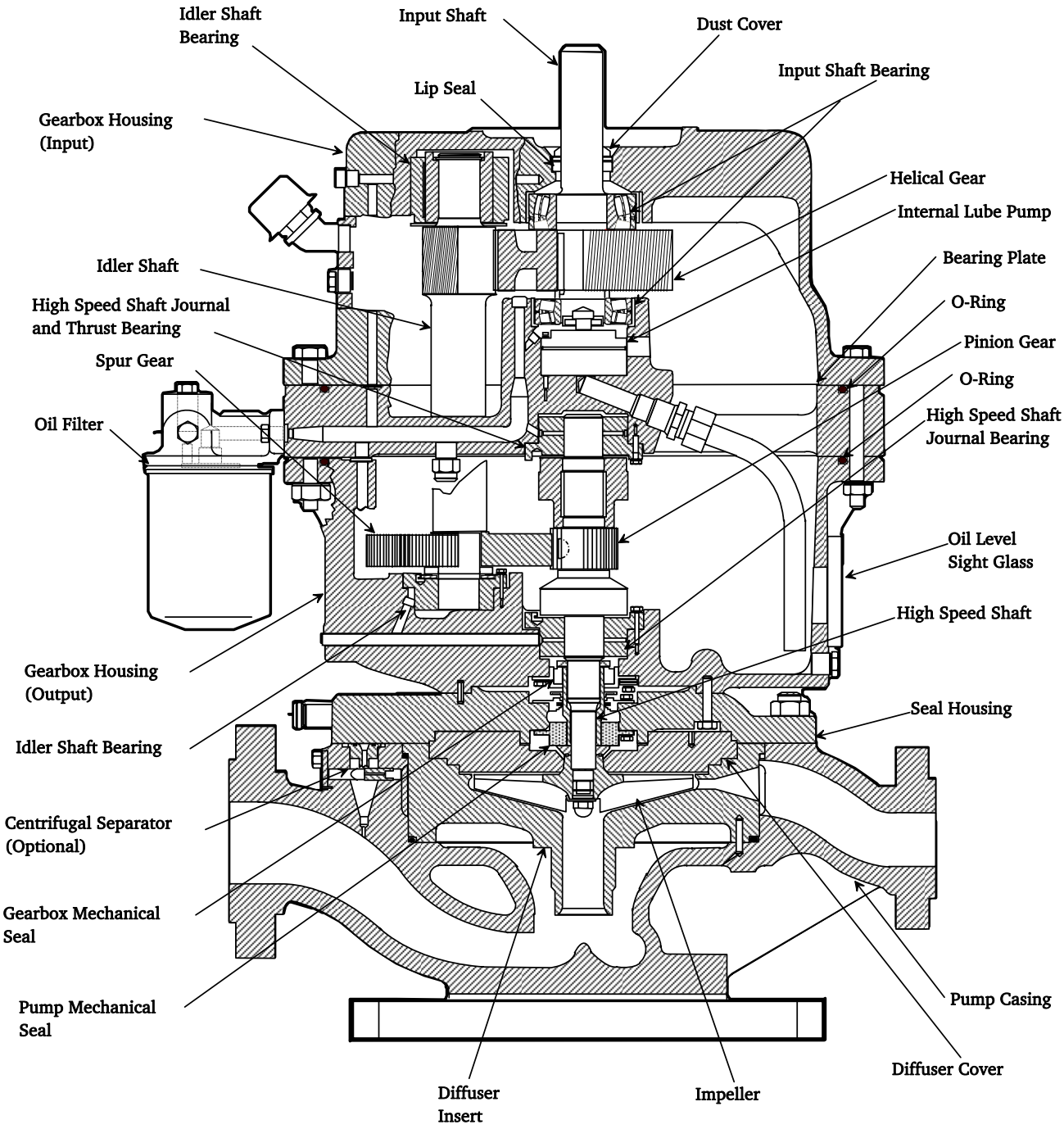


Figure 26. Cross Section

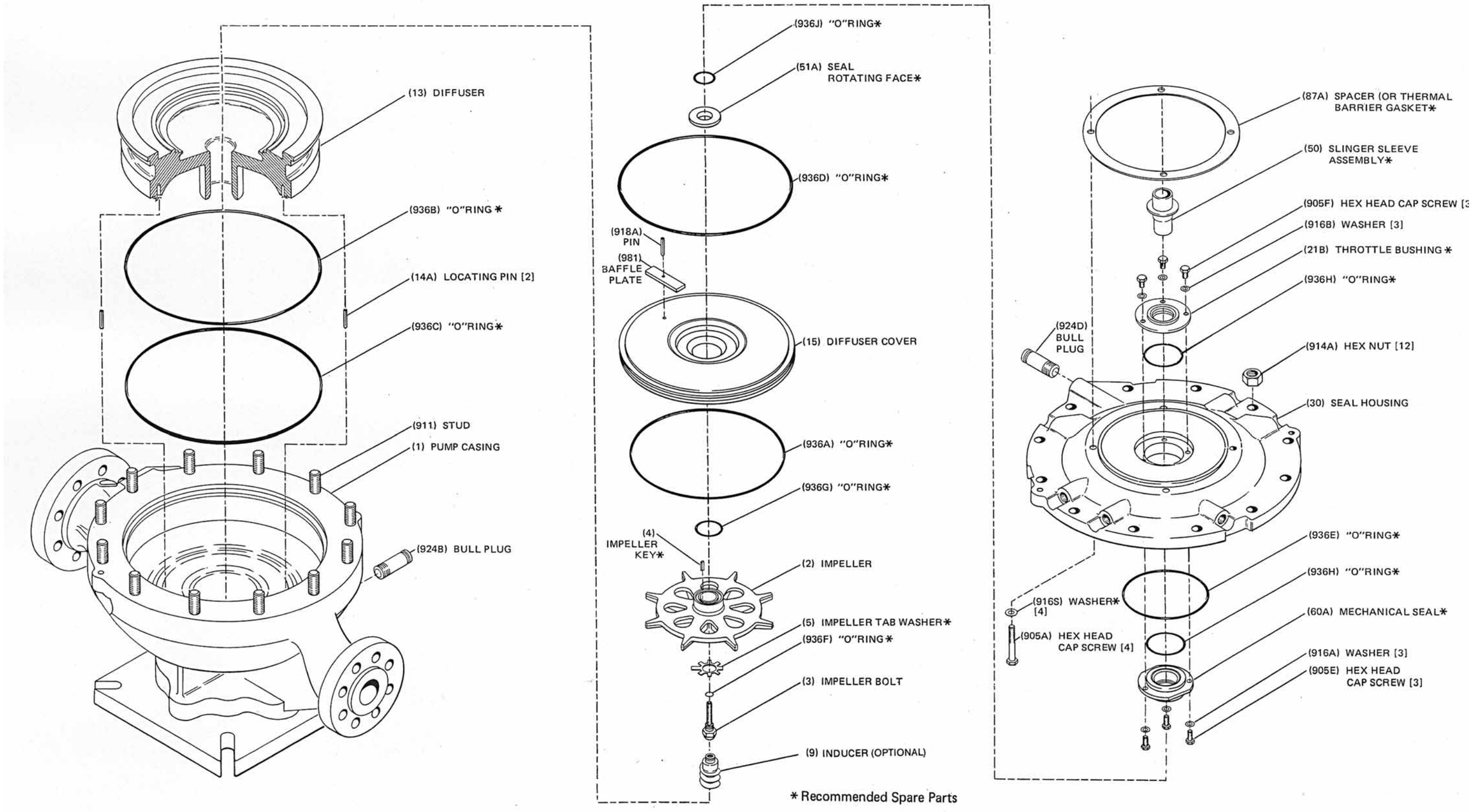


Figure 27. Pump Exploded View

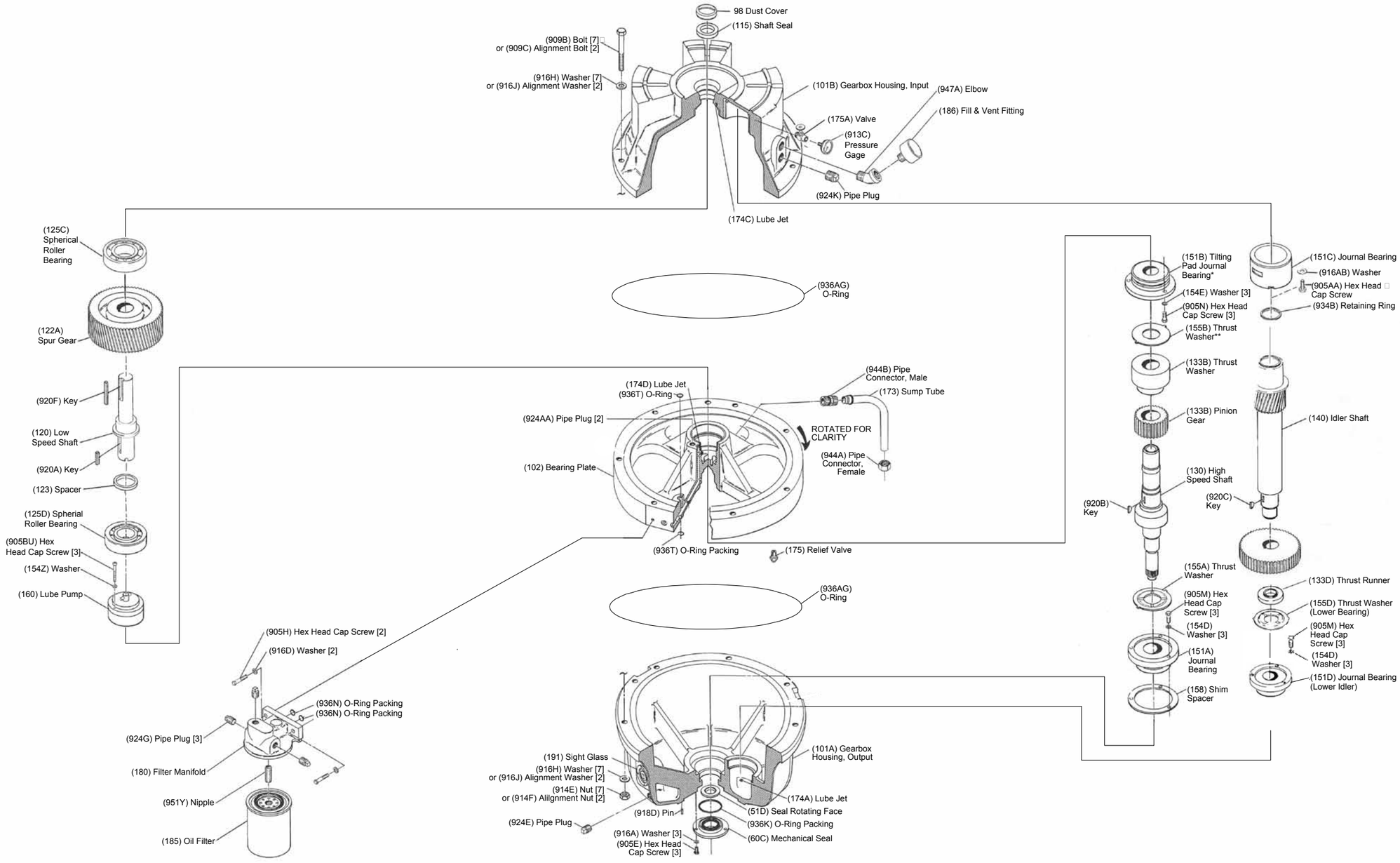
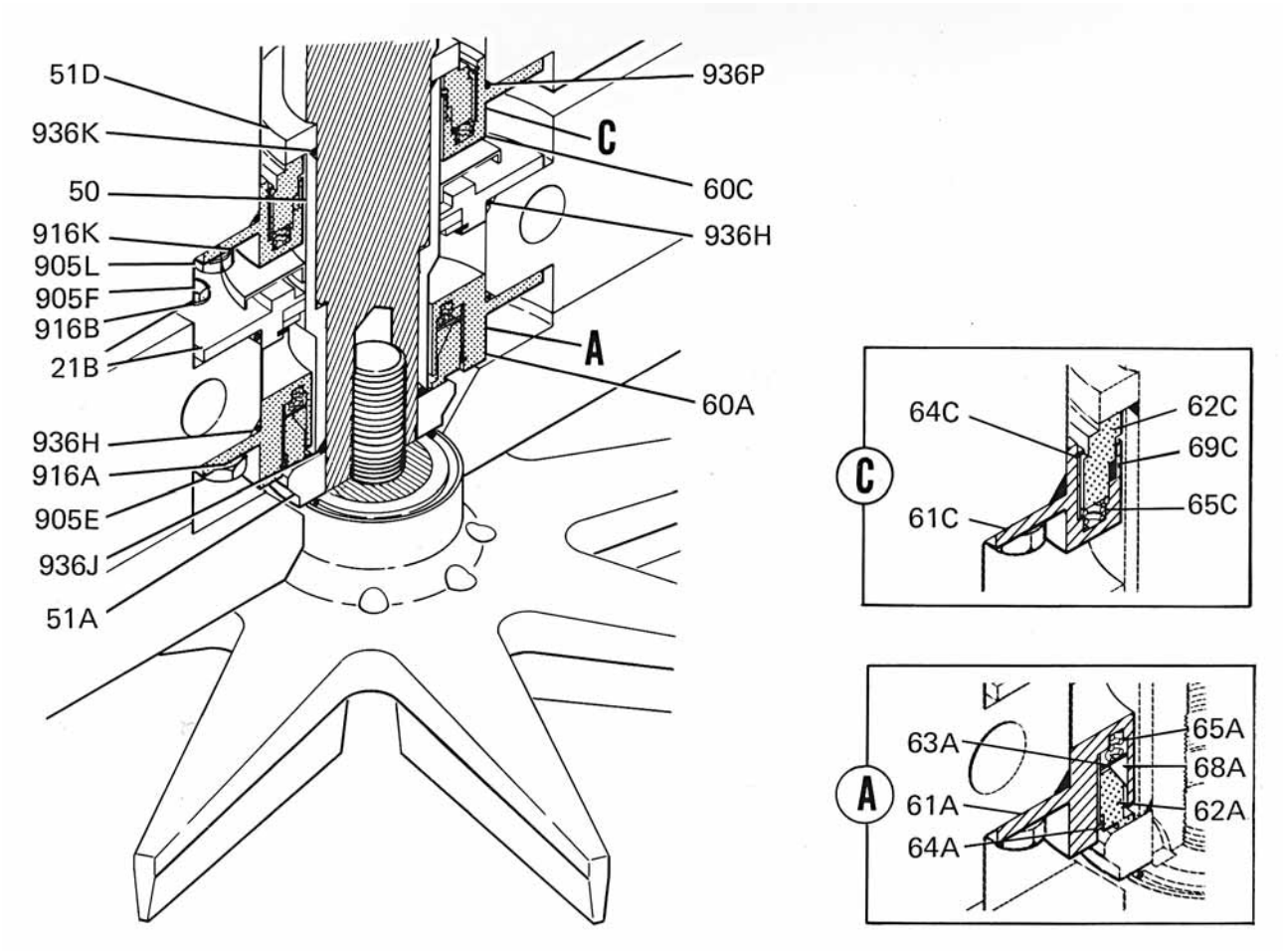
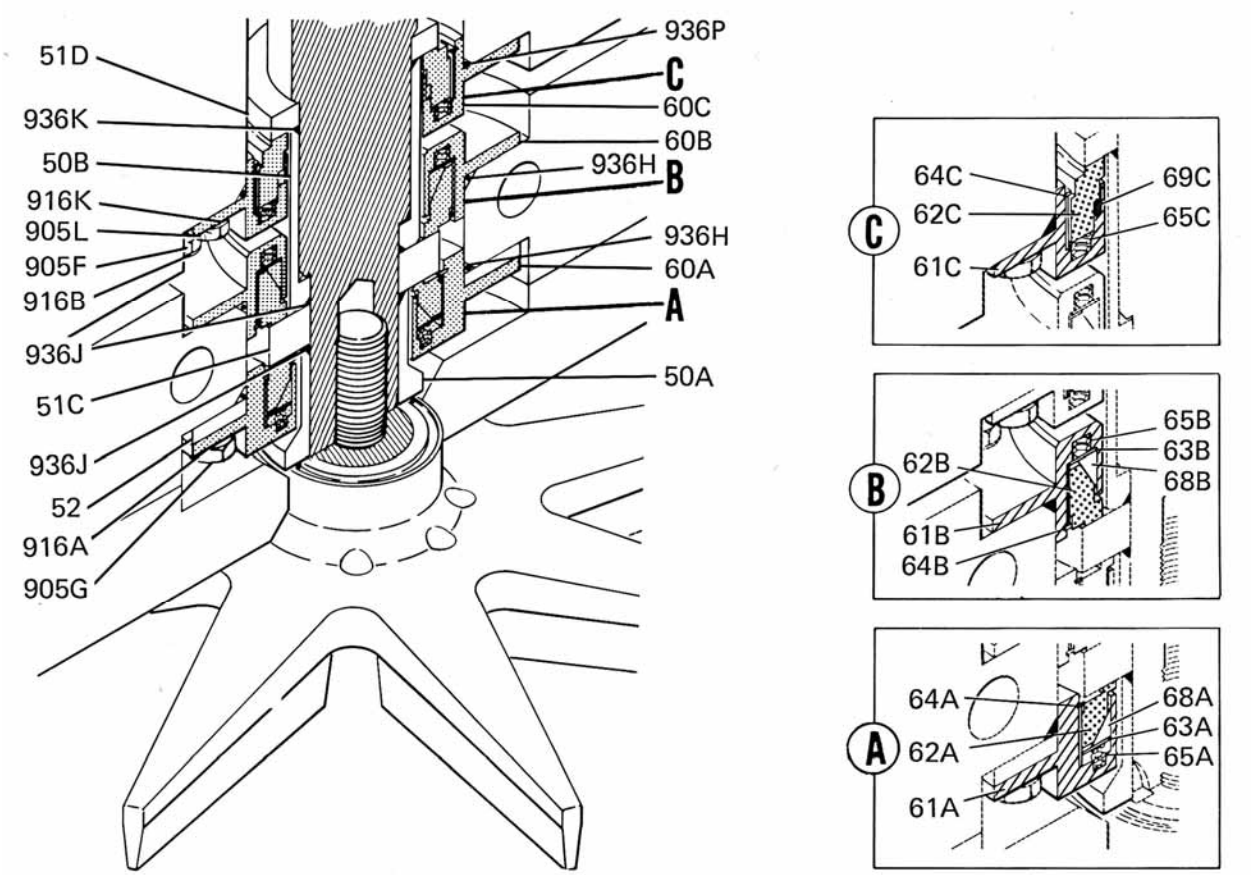


Figure 28. 400 HP Gearbox Exploded View



Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
21B	Upper Throttle Bushing	1	64C	• Seal Retaining Ring	1
50	Slinger Sleeve Assembly	1	65C	• Seal Spring	8
51A	Sal Rotating Face	1	69C	• O-Ring Packing	1
51D	Seal Rotating Face (Gearbox)	1	905E	Hex Head Cap Screw	3
60A	Mechanical Seal (Lower)	1	905F	Hex Head Cap Screw	3
61A	• Retainer & Drive Sleeve Assembly	1	905L	Hex Head Cap Screw	3
62A	• Seal Face Washer	1	916A	Washer	3
63A	• Seal Spring Backup Disc	1	916B	Washer	3
64A	• Seal Retaining Ring	1	916K	Washer	3
65A	• Seal Spring	6	936H	O-Ring Packng	2
68A	• Seal Wedge Ring	1	936J	O-Ring Packing	1
60C	Mechanical Seal (Gearbox)	1	936K	O-Ring Packing	1
61C	• Retainer & Drive Sleeve Assembly	1	936P	O-Ring Packing	1
62C	• Seal Face Washer	1			
See pages 56 and 57 for Recommended Spare Parts					

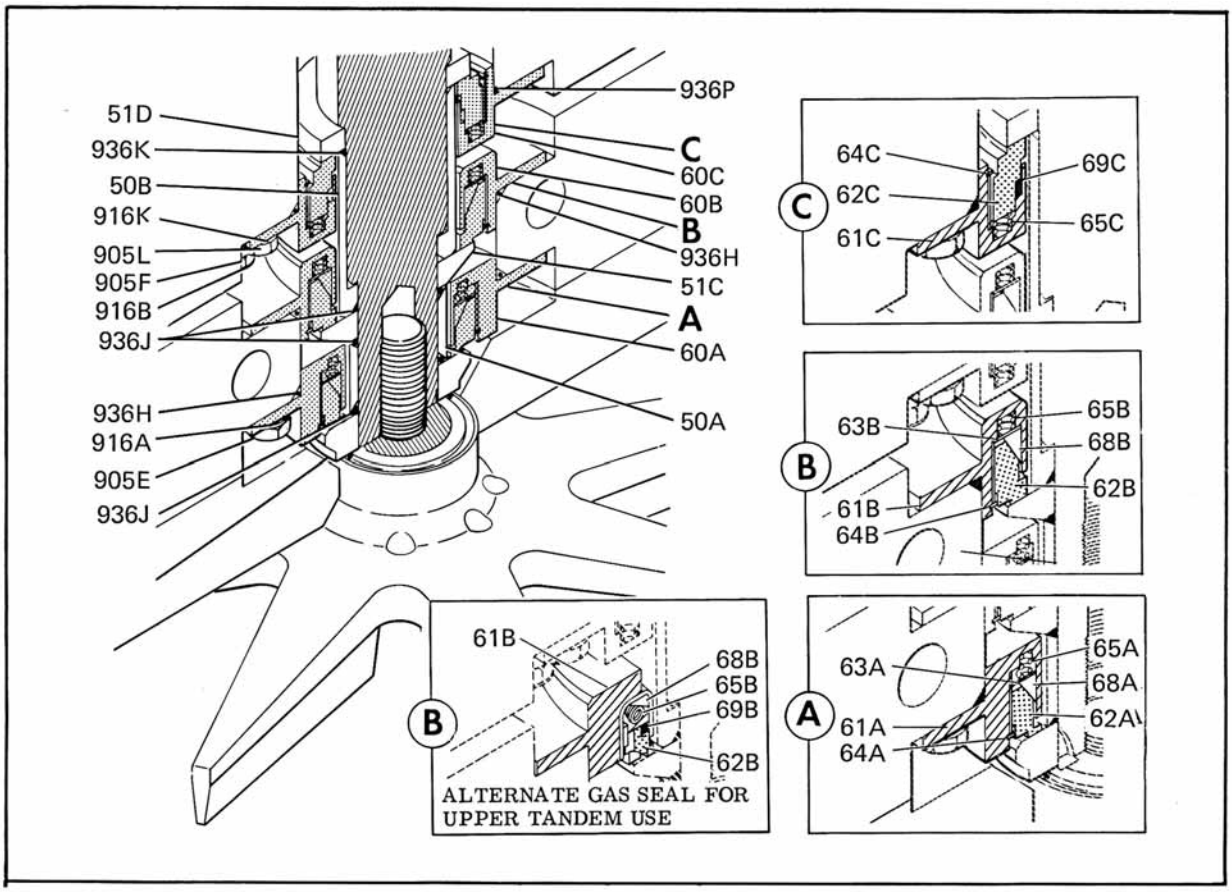
Figure 29. Single Seal Arrangement



Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
50A	Shaft Sleeve (Lower)	1	60C	Mechanical Seal (Gearbox)	1
50B	Shaft Sleeve (Upper)	1	61C	• Retainer & Drive Sleeve Assembly	1
51C	Seal Rotating Face	1	62C	• Seal Face Washer	1
51D	Seal Rotating Face (Gearbox)	1	64C	• Seal Retaining Ring	1
52	Seal Spacer	1	65C	• Seal Spring	8
60A	Mechanical Seal (Lower	1	69C	• O-ring Packing	1
61A	• Retainer & Drive Sleeve Assembly	1	905F	Hex Head Cap Screw	3
62A	• Seal Face Washer	1	905G	Hex Head Cap Screw	3
63A	• Seal Spring Backup Disc	1	905L	Hex Head Cap Screw	3
64A	• Seal Retaining Ring	1	916A	Washer	3
65A	• Seal Spring	6	916B	Washer	3
68A	• Seal Wedge Ring	1	916K	Washer	3
60B	Mechanical Seal (Upper)	1	916H	O-Ring Packing	2
61B	• Retainer & Drive Sleeve Assembly	1	936H	O-Ring Packing	2
62B	• Seal Face Washer	1	936J	O-Ring Packing	1
63B	• Seal Spring Backup Disc	1	936K	O-Ring Packing	1
64B	• Seal Retaining Ring	1	936P		
65B	• Seal Spring	8			
68B	• Seal Wedge Ring	1			

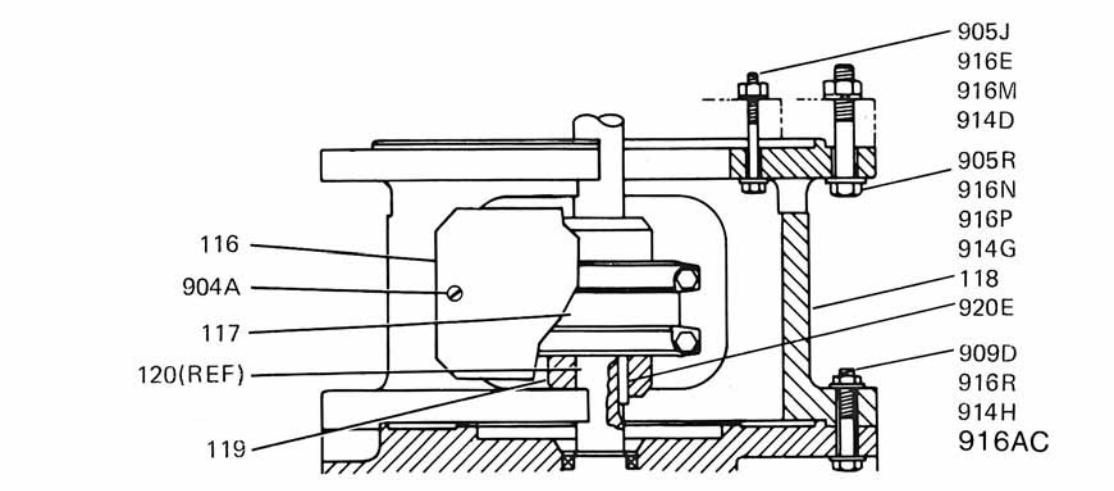
See pages 56 and 57 for Recommended Spare Parts

Figure 30. Double Seal Arrangement



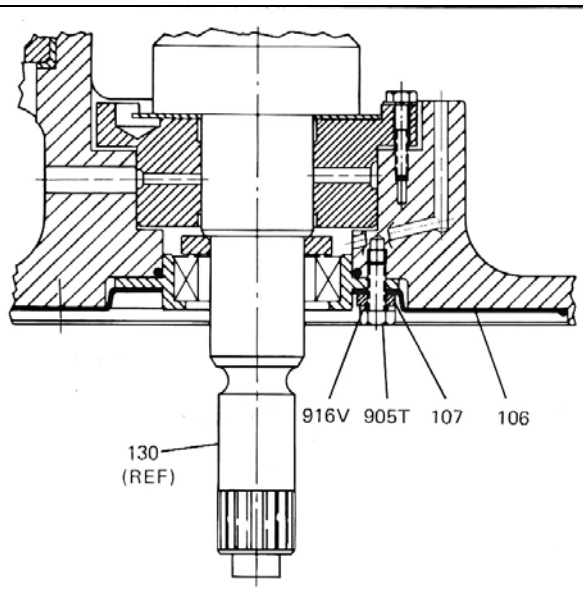
Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
50A	Shaft Sleeve (Lower)	1	62B	• Seal Face Washer	1
50B	Shaft Sleeve (Upper	1	65B	• Garter Spring	1
51A	Seal Rotating Face	1	68B	• Backing Ring	2
51C	Seal Rotating Face	1	69B	• O-Ring Packing	1
51D	Seal Rotating Face (Gearbox)	1	60C	Mechanical Seal (Gearbox)	1
60A	Mechanical Seal (Lower)	1	61C	• Retainer & Drive Sleeve Assembly	1
61A	• Retainer & Drive Sleeve Assembly	1	62C	• Seal Face Washer	1
62A	• Seal Face Washer	1	64C	• Seal Retaining Ring	1
63A	• Seal Spring Backup Disc	1	65C	• Seal Spring	8
64A	• Seal Retaining Ring	1	69C	• O-Ring Packing	1
65A	• Seal Spring	6	905E	Hex Head Cap Screw	3
68A	• Seal Wedge Ring	1	905F	Hex Head Cap Screw	3
60B	Mechanical Seal (Upper)	1	905L	Hex Head Cap Screw	3
61B	• Retainer & Drive Sleeve Assembly	1	916A	Washer	3
62B	• Seal Face Washer	1	916B	Washer	3
63B	• Seal Spring Backup Disc	1	916K	Washer	3
64B	• Seal Retaining Ring	1	936H	O-Ring Packing	2
65B	• Seal Spring	8	936J	O-Ring Packing	3
60B	Mechanical Seal (Gas Seal)	1	936K	O-Ring Packing	1
61B	• Seal Retainer	1	936P	O-Ring Packing	1
See pages 56 and 57 for Recommended Spare Parts					

Figure 31. Tandem Seal Arrangement



Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
116	Coupling	1	914G	Hex Nut	4
117	Input Coupling	1	914H	Hex Nut	4
118	Coupling Housing	1	916E	Washer	4
119	Hub	1	916M	Washer	4
904A	Screw	4	916N	Washer	4
905J	Hex Head Cap Screw	4	916P	Washer	4
905R	Hex Head Cap Screw	4	916R	Washer	4
909D	Hex Head Bolt	4	916AC	Washer	4
914D	Hex Nut	4	920E	Key	4

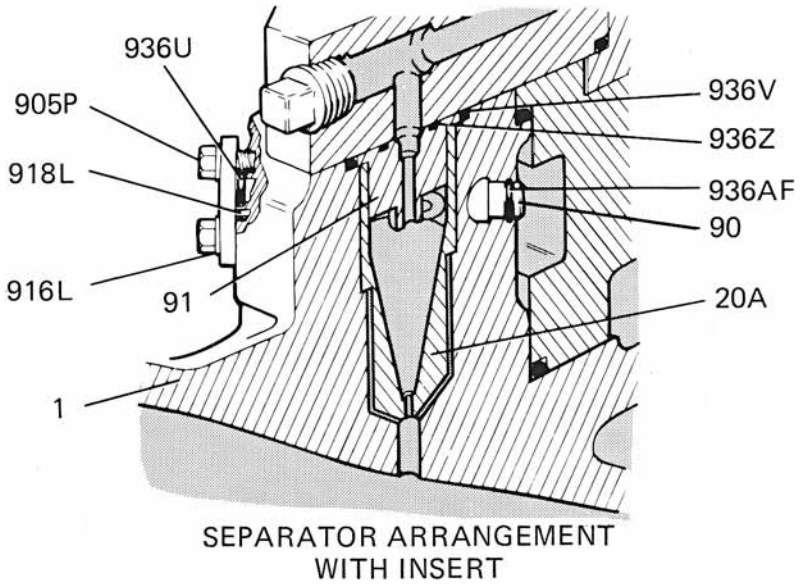
Figure 32. Flexible Coupling



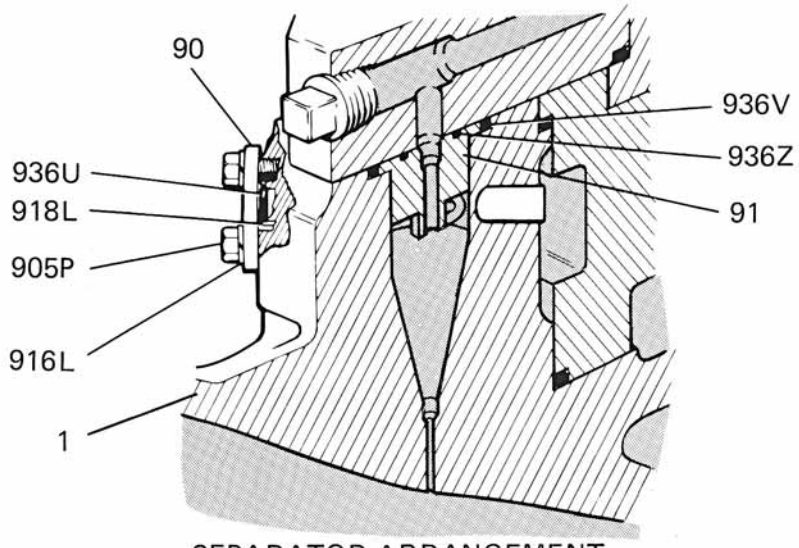
Item No.	Part Name	Qty.
106	Chemical Barrier Gasket	1
107	Seal Spacer	1
905T	Hex Head Cap Screw	3
916V	Seal Washer	3

See Pages 56 and 57 for Recommended Spare Parts.

Figure 33. Chemical Barrier Gasket



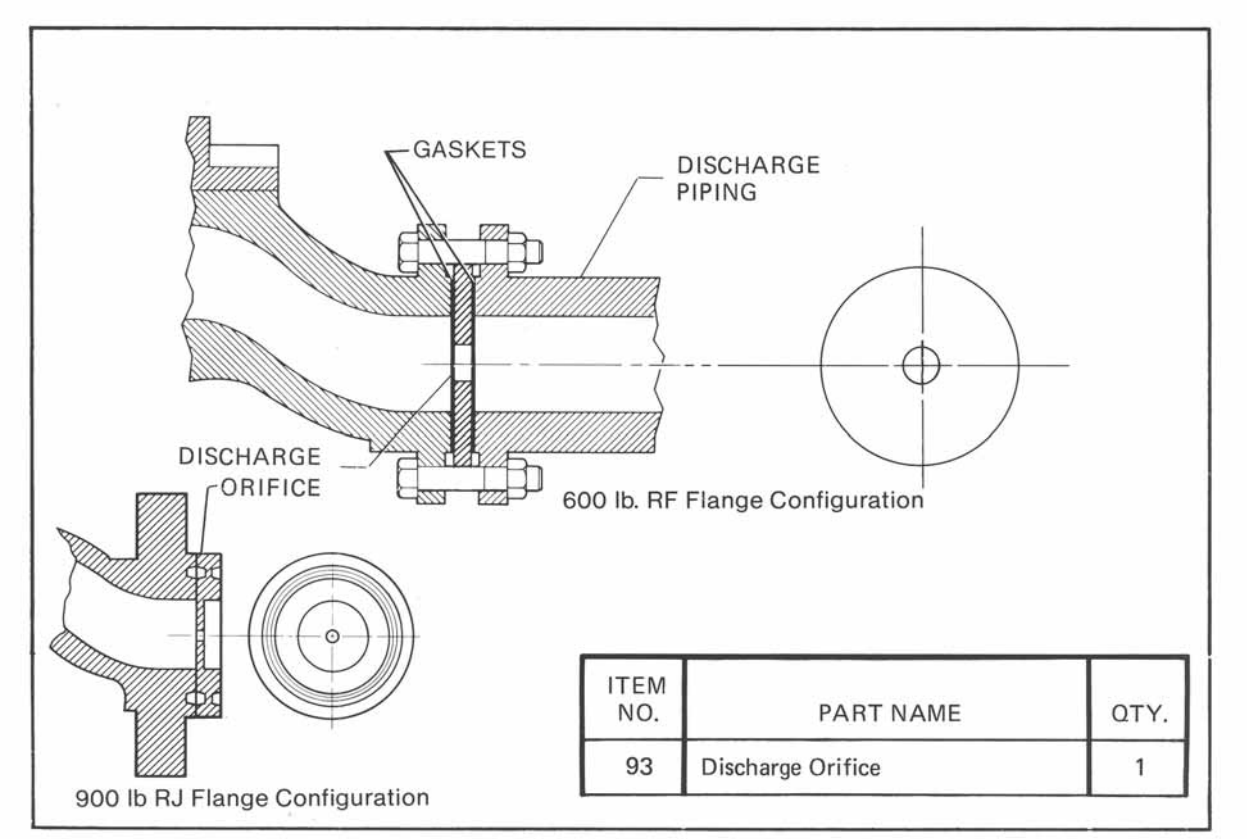
SEPARATOR ARRANGEMENT
WITH INSERT



SEPARATOR ARRANGEMENT
WITHOUT INSERT

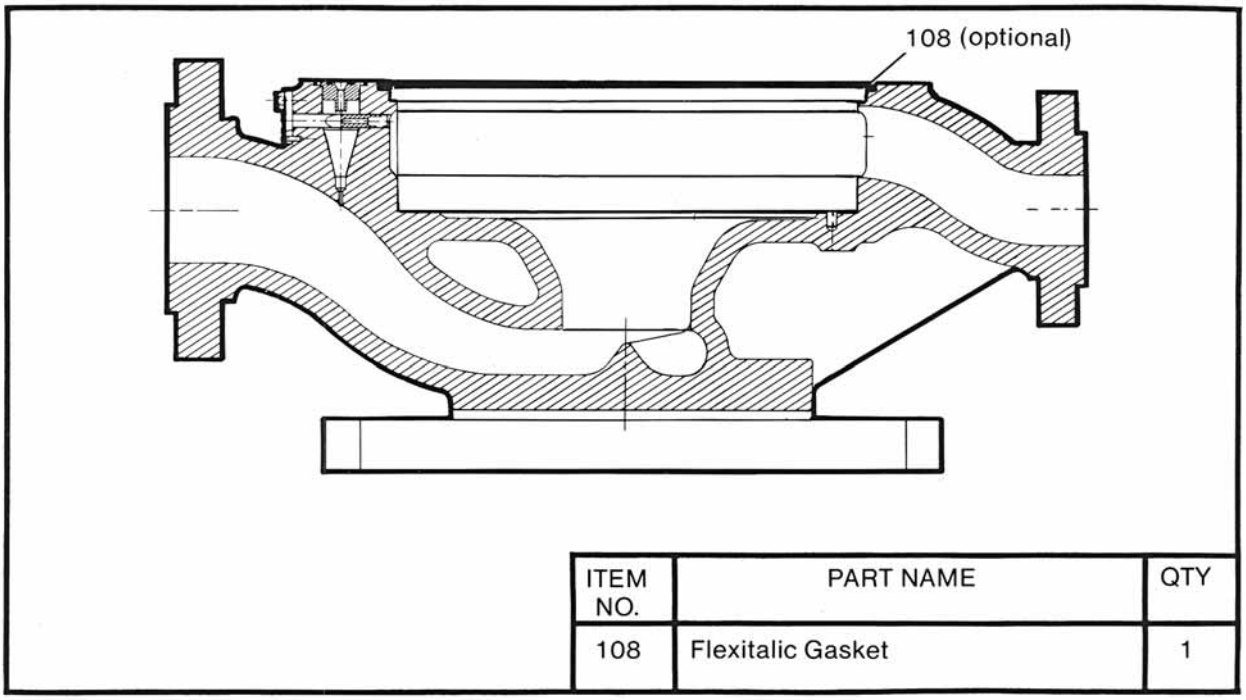
Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
1	Pump Casing	1	918L	Pin	1
20A	Separator Insert	1	936U	O-Ring Packing	1
90	Separator Orifice	1	936V	O-Ring Packing	1
91	Separator Fitting	1	936Z	O-Ring Packing	1
905P	Hex Head Cap Screw	2	936AF	O-Ring Packing	1
916L	Washer	2			
See Pages 56 and 57 for recommended spare parts.					

Figure 34. Integral Centrifugal Separator



ITEM NO.	PART NAME	QTY.
93	Discharge Orifice	1

Figure 35. Discharge Orifice



ITEM NO.	PART NAME	QTY
108	Flexitalic Gasket	1

Figure 36. Flexitalic Gasket

Sundyne Pump Recommended Spare Parts

400HP Gearbox: LMV/BMP-331

Item No.	Part Name	Class 1	2	3
		Qty.	Qty.	Qty
5	Impeller Tab Washer	1	1	2
3 (10)	Impeller Bolt or Inducer Stud	0	1	1
4	Impeller Key	1	1	1
87A	Barrier Gasket	1	2	2
60A	Process Mechanical Seal (Lower)	1	1	2
60B	Process Mechanical Seal (Upper)	1	1	2
	Seal Repair Kit (Lower)	+	+	+
	Seal Repair Kit (Upper	+	+	+
50A	Shaft Sleeve (Lower)	0	1	1
50B	Shaft Sleeve (Upper)	0	1	1
51A	Rotating Face (Lower)	1	1	2
51C	Rotating Face (Upper)	1	1	2
	O-Ring Repair Kit	1	2	2
936B	O-Ring	1	2	2
936C	O-Ring	1	2	2

+ These are alternate items and may be purchased according to users' preference.

NOTES:

Class 1 Spares – Minimum recommended spare parts necessary to perform a start-up and inspection of a new unit.

Class 2 Spares – Minimum recommended spare parts necessary to cover 1-2 years of normal operation.

Class 3 Spares – Minimum recommended spare parts stock necessary for critical services or units which will be installed in remote locations.

Terms: Net 30 Days
F.O.B. Point: Arvada, Colorado

Sundyne Gearbox Recommended Spares Parts

400 HP Gearbox: LMV/BMP-331

Item No.	Part Name	Class 1	2	3
		Qty.	Qty.	Qty
98	Dust Cover	1	1	1
115	Lip Seal	2	1	1
60C	Gearbox Mechanical Seal	0	1	1
51D	Seal Rotating Face	0	1	1
	Seal Repair Kit	0	+	+
936M	O-Ring	2	4	4
936N	O-Ring	2	4	4
936T	O-Ring	2	4	4
185	Oil Filter	2	5	5
936AG	Housing, Split O-Ring	2	4	4
151B	Upper Journal Bearing	0	0	1
151A	Lower Journal Bearing	0	0	1
151C	Idler Journal Bearing	0	0	1
155A	Lower Thrust Washer	0	0	1
*155B	Upper Thrust Washer	0	0	1
155D	Lower Idler Journal Bearing	0	0	1
125C	Bearing, Upper Input Spherical Roller	0	0	1
125D	Bearing, Lower Input Spherical Roller	0	1	1
A130	High Speed Shaft Assembly	0	1	1
155D	Lower Idler Thrust Washer	0	+	1

* Not applicable with use of tilt pad thrust bearings.

+These are alternate items and may be purchased according to users' preference.

Notes:

Class 1 Spares – Minimum recommended spare parts necessary to perform a start-up and inspection of a new unit.

Class 2 Spares – Minimum recommended spare parts necessary to cover 1-2 years of normal operation.

Class 3 Spares – Minimum recommended spare parts stock necessary for critical services or units which will be installed in remote locations.

Terms: Net 30 Days
F.O.B. Point: Arvada, Colorado

Critical Startup Check List

Know Your Machine:

Prior to servicing and start-up of the Sundyne Pump, carefully review the specification sheet, outline drawing, performance curves, and the instruction manual. It is important you become familiar with the pump configuration before starting and operating the pump.

Drive Instructions:

Follow installation and starting instruction of the driver manufacturer.

Gearbox Servicing:

Fill gearbox within ¼ inch from top of oil level sight glass with lube oil which conforms to the specifications in Table 6 (Page 18). Operate auxiliary lube pump to fill heat exchanger and filter. Add oil as necessary, approximately seven U.S. quarts (6.6 liters) through fill fitting until oil level stabilizes in sight glass.

Environmental Control System:

Install seal environmental control system, if required, and overhead drain piping.

Pressurize Fluid Loop:

Pressurize double seal buffer fluid loop or external seal flush, if required, prior to admitting fluid into pump casing.

Motor Rotation:

Rotation must be in the same direction as arrow stamped on pump casing.

Start Pump:

Start pump with suction valve completely open while throttling discharge valve to bring pump to design operating point.

Heat Exchanger

Adjust cooling flow to maintain gearbox sump temperature of 140° to 200° F (60° to 93° C).

Check:

Check total head, flow rate, and power consumption (364 hp max. continuous) against pump specification sheet. Check that specific gravity, viscosity and NPSH are in accordance with specification sheet. These conditions will significantly alter performance of the pump.

SUNDYNE

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