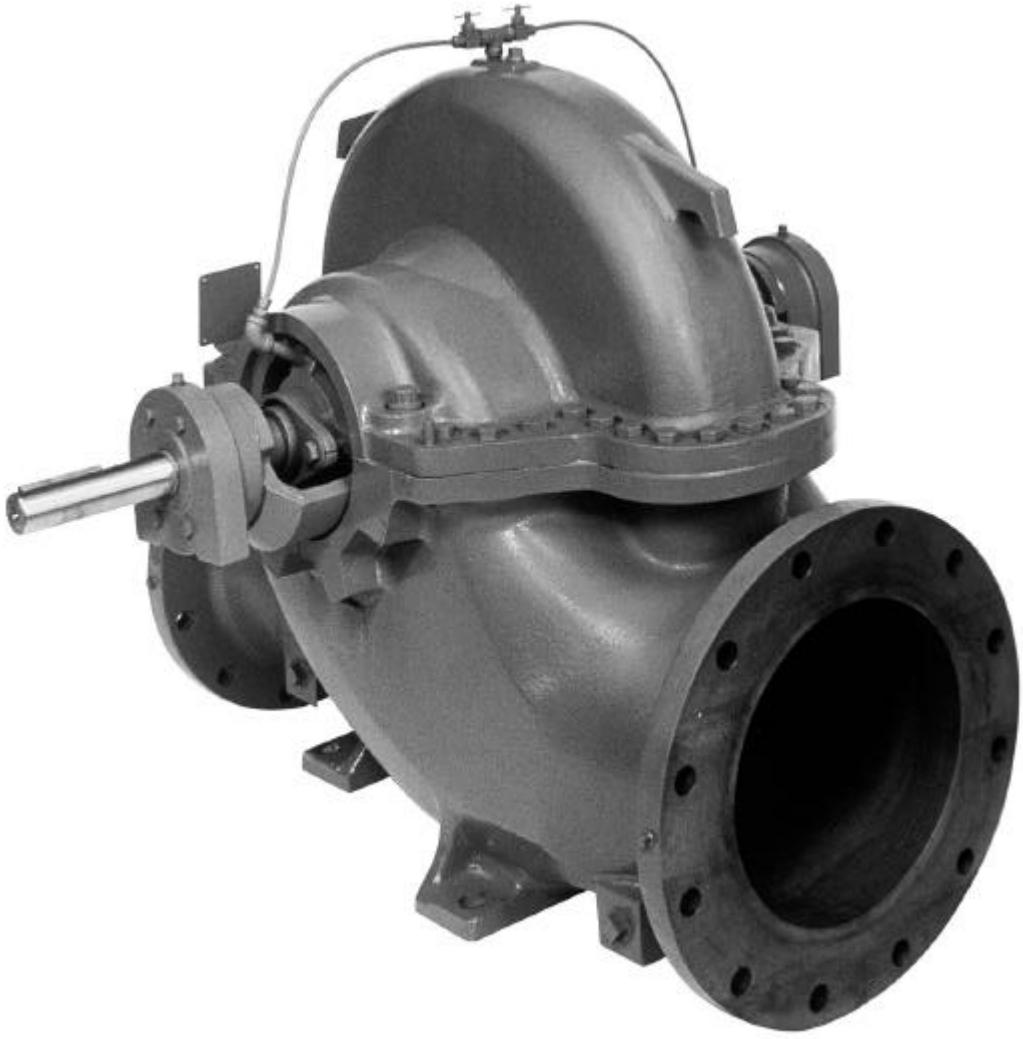
Installation, Operation and Maintenance Instructions



Model 8100

A-C Pump

ITT Industries

Pump Safety Tips

Safety Apparel:

- Insulated work gloves when handling hot bearings or using bearing heater
- Heavy work gloves when handling parts with sharp edges, especially impellers
- Safety glasses (with side shields) for eye protection, especially in machine shop areas
- Steel-toed shoes for foot protection when handling parts, heavy tools, etc.
- Other personal protective equipment to protect against hazardous/toxic fluids

Coupling Guards:

- Never operate a pump without a coupling guard properly installed

Flanged Connections:

- Never force piping to make a connection with a pump
- Use only fasteners of the proper size and material
- Ensure there are no missing fasteners
- Beware of corroded or loose fasteners

Operation:

- Do not operate below minimum rated flow, or with suction/discharge valves closed
- Do not open vent or drain valves, or remove plugs while system is pressurized

Maintenance Safety:

- Always lock out power
- Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, or disconnecting piping
- Use proper lifting and supporting equipment to prevent serious injury
- Observe proper decontamination procedures
- Know and follow company safety regulations

Observe all cautions and warnings highlighted in pump *Installation, Operation and Maintenance Instructions.*

FOREWORD

This manual provides instructions for the Installation, Operation, and Maintenance of the A-C Model 8100 Double Suction, Horizontally Split Case Pump. This manual covers the standard product plus common options that are available. For special options, supplemental instructions are supplied. **This manual must be read and understood before installation and maintenance.**

The design, materials, and workmanship incorporated in the construction of A-C pumps make them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection, condition monitoring and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and the correct methods of installing, operating, and maintaining these pumps.

ITT Industries - A-C Pumps shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions for Installation, Operation, and Maintenance contained in this manual.

Warranty is valid only when genuine ITT Industries - A-C Pumps parts are used.

Use of the equipment on a service other than stated in the order will nullify the warranty, unless written approval is obtained in advance from ITT Industries - A-C Pumps.

Supervision by an authorized ITT Industries - A-C representative is recommended to assure proper installation.

Additional manuals can be obtained by contacting your local ITT Industries - A-C representative or by calling 1-(800)-446-8537.

THIS MANUAL EXPLAINS

- **Proper Installation**
- **Start-up Procedures**
- **Operation Procedures**
- **Routine Maintenance**
- **Pump Overhaul**
- **Troubleshooting**
- **Ordering Spare or Repair Parts**

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SAFETY

DEFINITIONS

This pump has been designed for safe and reliable operation when properly used and maintained in accordance with instructions contained in this manual. A pump is a pressure containing device with rotating parts that can be hazardous. Operators and maintenance personnel must realize this and follow safety measures. ITT Industries - A-C Pumps shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions in this manual.

Throughout this manual the words **WARNING**, **CAUTION**, and **NOTE** are used to indicate procedures or situations which require special operator attention:

⚠ WARNING

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

⚠ CAUTION

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

NOTE: Operating procedure, condition, etc. which is essential to observe.

EXAMPLES

⚠ WARNING

Pump shall never be operated without coupling guard installed correctly.

⚠ CAUTION

Throttling flow from the suction side may cause cavitation and pump damage.

NOTE: Proper alignment is essential for long pump life.

GENERAL PRECAUTIONS

⚠ WARNING

Personal injuries will result if procedures outlined in this manual are not followed.

- NEVER operate pump without coupling guard correctly installed.
- NEVER operate pump beyond the rated conditions to which the pump was sold.
- NEVER start pump without proper prime (sufficient liquid in pump casing).
- NEVER run pump below recommended minimum flow or when no liquid is in pump.
- ALWAYS lock out power to the driver before performing pump maintenance.
- NEVER operate pump without safety devices installed.
- NEVER operate pump with discharge valve closed.
- NEVER operate pump with suction valve closed.
- DO NOT change conditions of service without approval of an authorized A-C representative.

⚠ Warning

If pump is to be used on process fluids above 120° F, pump surface temperatures could be warm enough to cause burns. We recommend pump surfaces be insulated. Failure to follow these instructions could result in severe personal injury.

GENERAL INFORMATION

PUMP DESCRIPTION

This product line consists of 39 sizes of double suction, horizontally split case pumps from size 2 x 3-11 through size 10 x 12-18.

Casing - The casing shall be (close-grained cast iron for working pressures up to 175 psig), (ductile iron for working pressures up to 400 psig), and shall be of axially-split design with suction and discharge flanges and mounting feet cast integral with the lower half casing. Tapped and plugged holes shall be provided for priming, vent drain and gauge connections. Upper half casing shall be removable without disturbing suction or discharge piping. Flanges shall be of (125#) (250#) ASA Standard. Suction and discharge shall be on a common centerline in both the horizontal and vertical planes.

Impeller - The impeller shall be of the enclosed double suction type made of bronze non-overloading in operating characteristics and statically and hydraulically balanced. The impeller shall be keyed to the shaft and positioned axially by the shaft sleeves which are, in turn, locked in place by shaft nuts. Hub shall have sufficient metal thickness to allow machining for installation of impeller rings.

Shaft - The shaft shall be made of (SAE-1045 steel ①) (316 stainless steel ①) (heat treated 416 stainless steel) of ample size to operate under load with a minimum of deflection.

Shaft Sleeves - The Shaft Sleeves shall be made of (bronze) (316 stainless steel) (cast iron) (420 stainless steel, 500 Brinnell) and shall protect the shaft from wear and from contact with the pumped liquid. Shaft sleeves shall be locked in place by threaded, bronze shaft sleeve nuts. An O-ring shall be furnished under sleeve to prevent leakage.

Stuffing Box Housing / Bearing Brackets - The Stuffing Box Housing / Bearing Brackets shall be made of cast iron separate from the casing mounted in cylindrical fits in the casing. Stuff box/bearing brackets will be drilled and tapped for drain connection.

Casing Rings - The casing rings shall be made of (bronze) (cast iron) (Nitronic 60 stainless steel) and shall be installed with an anti-rotation device and designed to restrict leakage across the ring fit.

Bearings - The bearing shall be grease lubricated (oil optional) ball type, single row inboard, double row outboard, selected to carry radial and thrust loads. The outboard bearing shall be retained by bearing locknut and lockwasher.

Bearing Housings - The bearing housings shall be bolted to the ends of the bearing bracket/stuffing box and shall be male-female fitted for a full 360 degrees to assure positive alignment. The housings shall provide a fit for the inboard bearing that allows freedom for thermal expansion while the outboard bearing shall be clamped in place to take all thrust loads and keep the rotating element in its proper axial location. Openings for adding new grease and draining old grease shall be provided.

Baseplate - The baseplate shall be steel, sufficiently rigid to support the pump and driver.

Coupling - Coupling shall be of the flexible type. Coupling hubs shall be secured to the driver and driven shafts by a setscrew located over the key.

Coupling Guard - The coupling guard shall be the all metal type.

Rotation - Pump shall have clockwise or counterclockwise rotation when viewed from its driven end.

① AISI 4140 Steel is standard on 4 x 6-11, 6 x 8-12M, and 8 x 10-20S & L, 10 x 12-18. 1045 & 316SS are not available for these sizes.

NAMEPLATE INFORMATION

Every pump has a A-C nameplate that provides information about the pump. The nameplate is located on the pump casing.

Special tags which provide additional information (mechanical seal data, etc.) and special tagging required by customers are located on the pump casing or on the bearing frame.

The standard nameplate (Fig. 1) provides information about the pump size, type, serial number, rated head, capacity, speed, impeller diameter, model number, and maximum field hydrostatic test pressure.

The identification No. is a number which the end user of pump requests to be put on the nameplate to identify the pump in his operation.

The year indicates the year in which the pump was built.

Rating and hydrostatic test pressure are expressed in English units. Note the format of pump size: Discharge x Suction - Nominal Impeller Diameter in inches, for example, 2 x 3-11.

The frame plate (Fig. 2) provides information concerning the bearings and their lubrication. The inboard and outboard bearing numbers refer to the bearing manufacturer's numbers.

When ordering spare parts you will need to identify pump model, size, serial number, and the catalog number of required parts. Pump information can be taken from the A-C nameplate. Catalog numbers can be found in this manual (Pg. 66).

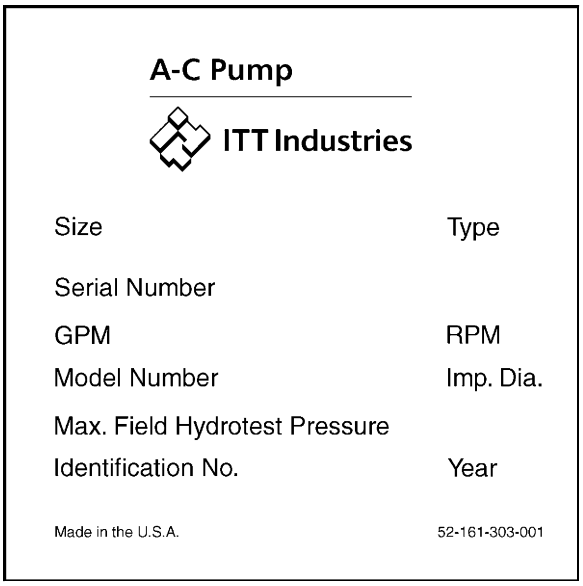


Fig. 1

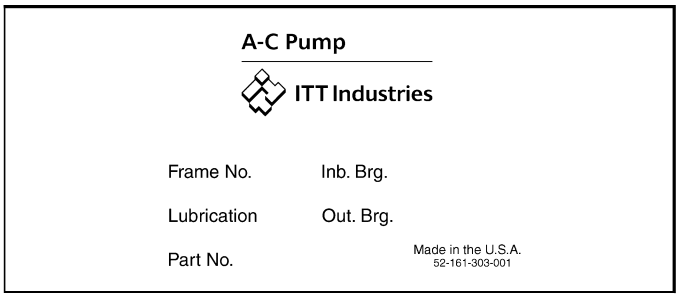


Fig. 2

INSTALLATION

RECEIVING THE PUMP

Check pump for shortages and damage immediately upon arrival. (An absolute must!) Prompt reporting to the carrier's agent, with notations made on the freight bill, will expedite satisfactory adjustment by the carrier.

Pumps and drivers are normally shipped from the factory mounted on a baseplate. Couplings may either be completely assembled or have the coupling hubs mounted on the shafts and the connecting members removed. When the connecting members are removed, they will be packaged in a separate container and shipped with the pump or attached to the baseplate.

LIFTING THE PUMP

The following instructions are for the safe lifting of your pump.

The unit should be unloaded and handled by lifting equally at four or more points on the baseplate. The lugs on the upper half casing are designed for lifting the upper half casing only.

HORIZONTAL

Bare Pump (Model 100)

1. Using a nylon sling, chain, or wire rope, hitch around both bearing housings. (See Fig. 3)

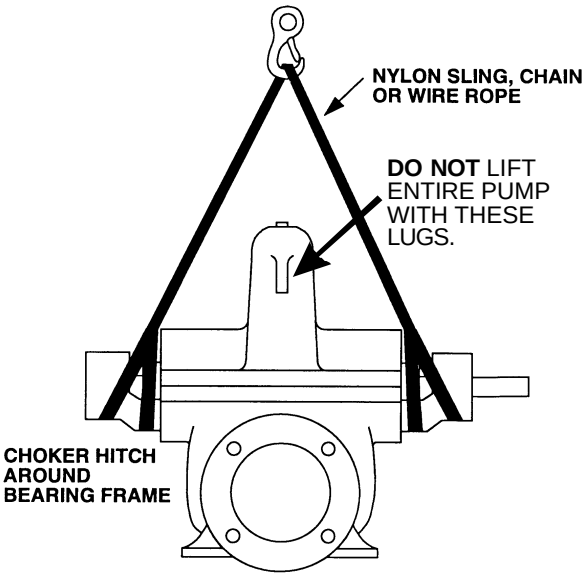


Fig. 3

Pump, Base, and Driver (Model 150)

2. Care must be taken to size equipment for unbalanced loads which may exist if the driver is not mounted on the base at the time of lifting. Driver may or may not be mounted at the factory.

3. Pump, base, and driver assemblies where the base length exceeds 100 inches may not be safe to lift as a complete assembly. Damage to the baseplate may occur. If the driver has been mounted on the baseplate at the factory, it is safe to lift the entire assembly. If driver has not been mounted at the factory and the overall baseplate length exceeds 100 inches, do not lift entire assembly consisting of pump, base, and driver. Instead lift the pump and baseplate to its final location without the driver. Then mount the driver.

Bases supplied with lifting holes

Large bases are supplied with lifting holes in the sides or the ends of the base. (See Fig. 4)

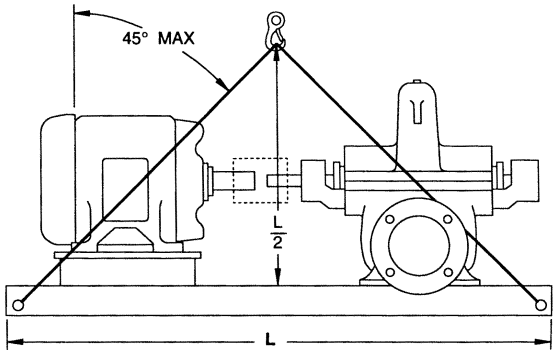


Fig. 4

Using ANSI/OSHA Standard "S" hooks, place the "S" hooks in the holes provided in the four corners of the base. Be sure the points of the hooks do not touch the bottom of the pump base. Attach nylon slings, chains, or wire rope to the "S" hooks. Size the equipment for the load, and so the lift angle will be less than 45° from the vertical.

Bases supplied without lifting holes

Place one sling around the outboard bearing housing.

⚠ WARNING

Do not use lugs on top half of casing.

Place the remaining sling around the back end of the driver as close to the mounting feet as possible. Make certain sling will not damage housing cover or conduit boxes.

Join the free ends of the slings together and place over the lifting hook. Use extreme care when positioning sling under the driver so it cannot slip off. (See Fig. 5)

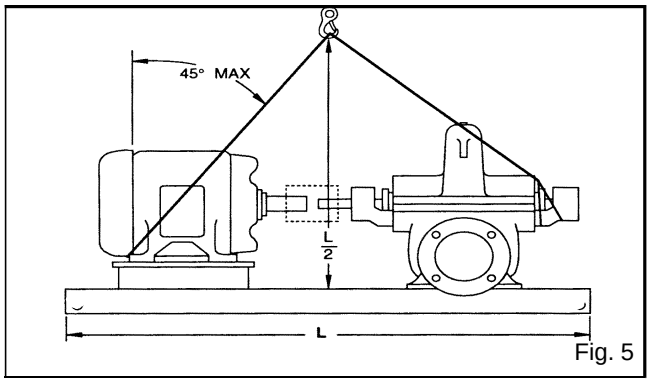


Fig. 5

VERTICAL

Half Pedestal (Model 200)

1. Place nylon sling chain or wire rope around both flanges. Use a latch hook or standard shackle and end loops.

   Be sure the lifting equipment is of sufficient length to keep the lift angle less than 30° from the vertical. (See Fig. 6)

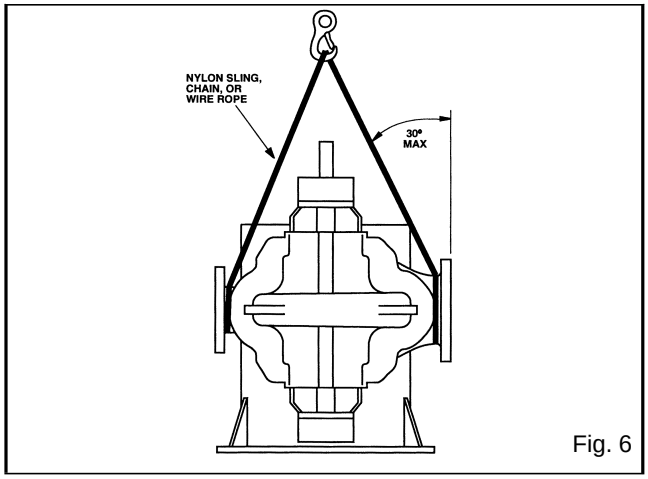


Fig. 6

Full Pedestal (Model 300)

2. Install eyebolts in the three holes provided at the top of the support, being sure to tighten securely. Attach chain or wire rope using latch hook or standard shackle and end loop.

   Be sure to use shoulder eyebolts that are manufactured per ANSI B18.15 and sized to fit the holes provided.

   Be sure lifting equipment is of sufficient length to keep the lift angle less than 30° from the vertical. (See Fig. 7)

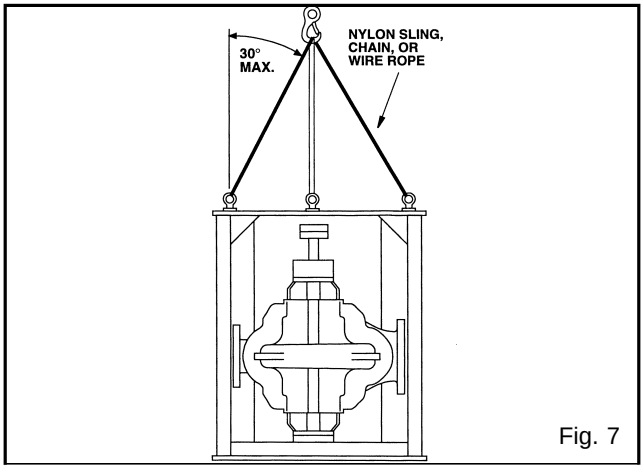


Fig. 7

STORAGE

The following storage procedures apply to the pump only. Other accessories such as motors, steam turbines, gears, etc., must be handled per the respective manufacturer's recommendations.

TEMPORARY

Temporary storage is considered one month or less. If the pump is not to be installed and operated soon after arrival, store it in a clean, dry place having slow, moderate changes in ambient temperature. Rotate the shaft periodically to coat the bearings with lubricant and to retard oxidation, corrosion, and to reduce the possibility of false brinelling of the bearings. Shaft extensions and other exposed machine surfaces should be coated with an easily removable rust preventative such as Ashland Oil Tectyl No. 502C.

For oil lubricated bearings, fill the frame completely with oil. Before putting equipment into operation, drain the oil and refill to proper level.

LONG TERM

Storage longer than one month is considered long term storage. Follow the same procedure for temporary storage with the following addition. Add one half ounce of a corrosion inhibiting concentrated oil such as Cortec Corp. VCI-329 (for both grease and oil lubricated bearings). Seal all vents and apply a water proof tape around the oil seals in the bearing frame. Remember for oil lubricated bearings to drain the oil from the frame and refill to the proper level before running pump.

LOCATION

The pump should be installed as near the suction supply as possible, with the shortest and most direct suction pipe practical. The total dynamic suction lift (static lift plus friction losses in suction line) should not exceed the limits for which the pump was sold.

The pump must be primed before starting. Whenever possible, the pump should be located below the fluid level to facilitate priming and assure a steady flow of liquid. This condition provides a positive suction head on the pump. It is also possible to prime the pump by pressurizing the suction vessel.

When installing the pump, consider its location in relation to the system to assure that sufficient Net Positive Suction Head (NPSHA) is available at the pump inlet connection. Available NPSH must always equal or exceed the required NPSH (NPSHR) of the pump.

The pump should be installed with sufficient accessibility for inspection and maintenance. A clear space with ample head room should be allowed for the use of an overhead crane or hoist sufficiently strong to lift the unit.

NOTE: Allow sufficient space to be able to dismantle pump without disturbing the pump inlet and discharge piping.

Select a dry place above the floor level wherever possible. Take care to prevent pump from freezing during cold weather when not in operation. Should the possibility of freezing exist during a shut-down period, the pump should be completely drained, and all passages and pockets where liquid might collect should be blown out with compressed air.

Make sure there is a suitable power source available for the pump driver. If motor driven, the electrical characteristics of the power source should be identical to those shown on motor data plate.

FOUNDATION

The foundation must be substantial enough to absorb vibration. (*Hydraulic Institute Standards* recommends the foundation weigh at least five (5) times the weight of the pump unit.) It must form a permanent and rigid support for the baseplate. This is important in maintaining the alignment of a flexibly coupled unit.

Foundation bolts of the proper size should be embedded in the concrete to a depth of eight (8) to twelve (12) inches and locked with either a hook around a reinforcing bar or alternatively, a nut and washer at the bottom. The bolts should have a sleeve around them at least six (6) times the bolt diameter in length and at least two (2) bolt sizes larger in I.D. If a nut and washer are used for locking, the washer should have an O.D. two (2) sizes larger than the sleeve. Foundation bolts should be sized .125" less than the anchor bolt holes in the base.

The foundation should be poured to within .75" - 1.5" of the finished height. (See Fig. 8) Freshly poured foundations should be allowed to cure for several days before the unit is set in place and grouted.

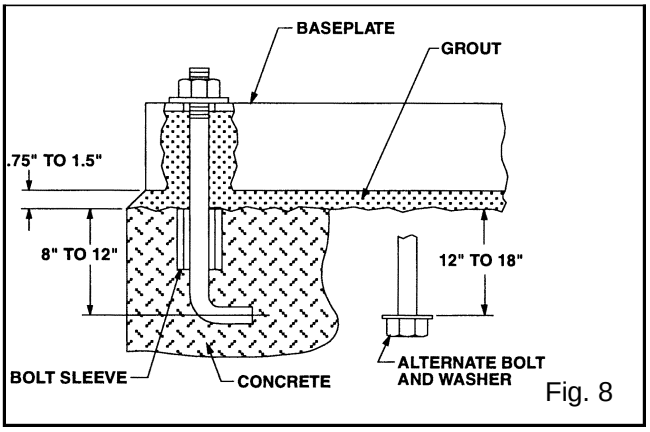


Fig. 8

SETTING THE BASEPLATE

Pump units are checked at the factory for align ability to required tolerances.

Due to flexibility of an ungrouted base and handling in shipment, it should not be assumed that the unit is in alignment when it is placed on the rough foundation.

If these directions are followed, the required alignment should be readily achieved.

Initial or rough alignment must be done prior to grouting of baseplate. Rough alignment is designated as .020" TIR (Total Indicator Reading) parallel alignment and .009" TIR per inch of radius angular alignment (See ALIGNMENT PROCEDURE). Use blocks at anchor bolts and midway between to position bottom of base at finished height (See Fig. 9) with foundation bolts extending through holes in the baseplate. Metal wedges with a small taper may be used in lieu of blocks and shims.

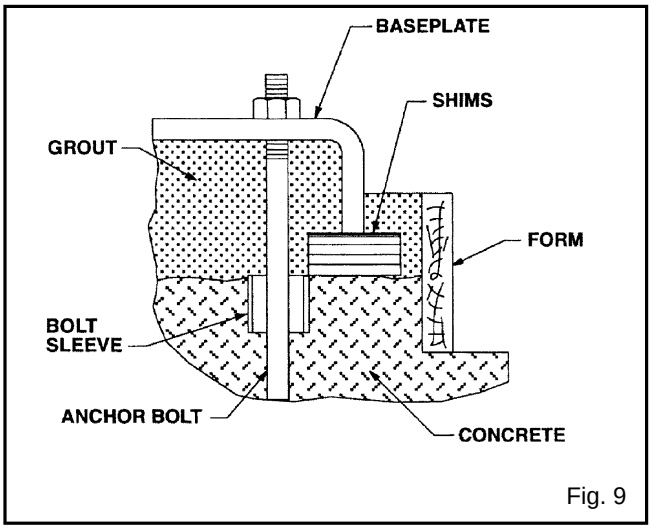


Fig. 9

If the unit has a non-flexible coupling (e.g. Falk Gear coupling), the coupling halves should be disconnected; this is generally not necessary on flexible type couplings (e.g. Wood's Sure-Flex coupling).

Tighten up all pump and motor bolts to assure they have not loosened or a "soft foot" has occurred due to base distortion in shipment. A "soft foot" causes a change in the alignment when unloosening one bolt.

If the driver is being field installed, it should be centered in its bolt holes with shims added to bring the driver into rough alignment with the pump. (The pump may have to be moved also.)

⚠ CAUTION

Do not exceed six (6) shims, using as thick a shim as possible, otherwise "sponginess" or "soft foot" will result. Place thin shims in between thick shims.

Level and plumb the pump shaft, coupling faces and flanges by adding or removing shims between the blocks and the bottom of the base. Hand tighten the anchor bolt nuts at first. Being very careful not to distort the base, snug down the nuts with a wrench. The non-flexible coupling should not be reconnected until the alignment operation has been completed.

NOTE: The baseplate does not have to be level.

After foundation bolts are lightly torqued, recheck alignment requirements once more. Follow requirements outlined at the beginning of this section. If alignment must be corrected, add or remove shims or wedges under the baseplate.

The unit can then be grouted. (See Fig. 9)

Grout compensates for the uneven foundation. Together with the baseplate, it makes a very rigid interface between the pump and the foundation distributing the weight over the length of the base and preventing shifting.

Use an approved, non-shrinking grout such as Embeco 636 or 885 by Master Builders, Cleveland, Ohio or equivalent.

3

GROUTING PROCEDURE

1. Build a strong form around the foundation to contain the grout.
2. Soak the top of the foundation thoroughly, then remove surface water.
3. The baseplate should be completely filled with grout and, if necessary, temporarily use air relief tubing or drill vent holes to remove trapped air.
4. After the grout has thoroughly hardened (approximately 24 hours), tighten the foundation bolts fully.
5. Check the alignment after the foundation bolts are tightened.
6. Approximately fourteen (14) days after the grout has been poured and the grout has thoroughly dried, apply an oil base paint to the exposed edges of the grout to prevent air and moisture from coming in contact with the grout.

ALIGNMENT PROCEDURE

Proper rough alignment must be made during unit setting and grouting. See previous section.

There are two forms of misalignment between the pump shaft and the driver shaft as follows:

1. **Angular misalignment** — shafts have axis concentric at intersection, but not parallel.
2. **Parallel offset misalignment** — shafts have axis parallel, but offset.

The necessary tools for checking alignment are: (1) a straight edge and a taper gauge or set of feeler gauges or, (2) a dial indicator with mounting magnet and extension bars.

Check and correct for angular misalignment before correcting parallel alignment. Final alignment should be made by moving and shimming the motor on its base until the coupling hubs are within the recommended tolerances measured in total run out. All measurements should be

taken with the pump and driver bolts tightened. Final alignment check should be made after the unit has attained its final operating temperature.

Method 1 - Using straight edge and taper gauges or feelers (Fig. 10):

Proceed with this method only if satisfied that face and outside diameters of the coupling halves are square and concentric with the coupling bores. If this condition does not exist or elastomeric couplings do not make this method convenient, use Method 2.

Check for angular alignment by inserting the taper or feeler gauges between the coupling faces at 90° intervals. The unit is in angular alignment when these four (4) measurements are the same, or within recommended tolerances.

Check for parallel alignment by placing a straight edge across both coupling rims on all four sides. The unit is in parallel alignment when the straight edge rests evenly across both coupling rims in all four (4) positions.

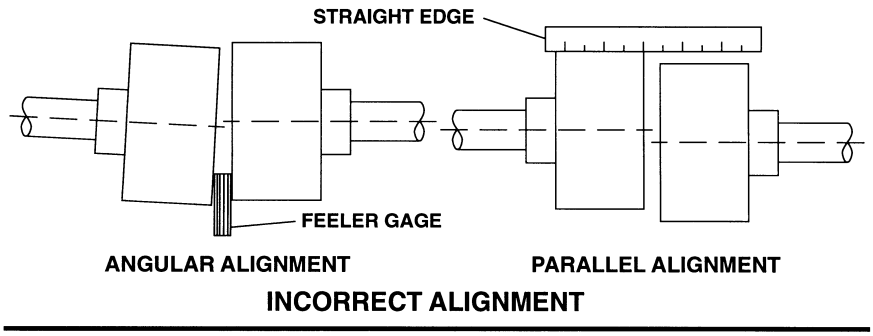


Fig. 10

Method 2 - Dial Indicators (Fig. 11):

A dial indicator can be used to attain more accurate alignment.

Fasten the indicator stand or magnetic base to the pump half of the coupling and adjust the assembly until the indicator button is resting on the other half coupling periphery.

Set the dial to zero and chalk mark the coupling half where the button rests. Also place a separator between the coupling halves so bearing slack does not affect the readings. (Chalk and separators are not necessary on the elastomeric couplings that have not been disconnected.) Rotate both shafts by the same amount; i.e., all readings must be made with the button on the chalk mark.

The dial readings will indicate whether the driver has to be raised, lowered or moved to either side. Accurate alignment of shaft centers can be obtained with this method even where faces or outside diameters of the coupling are not square or concentric with the bores. After each adjustment, recheck both parallel and angular alignments.

NOTE: Gross deviations in squareness or concentricity may cause rotation unbalance problems and if so must be corrected.

Permissible Coupling Misalignment:

Parallel: Single element coupling:
.004" TIR (4 mils)

Double element (spacer) coupling:
.060" TIR per foot of spacer length

Angular: Single element coupling:
.004" TIP per inch of radius

Double element (spacer) coupling:
.002" TIR per inch of radius

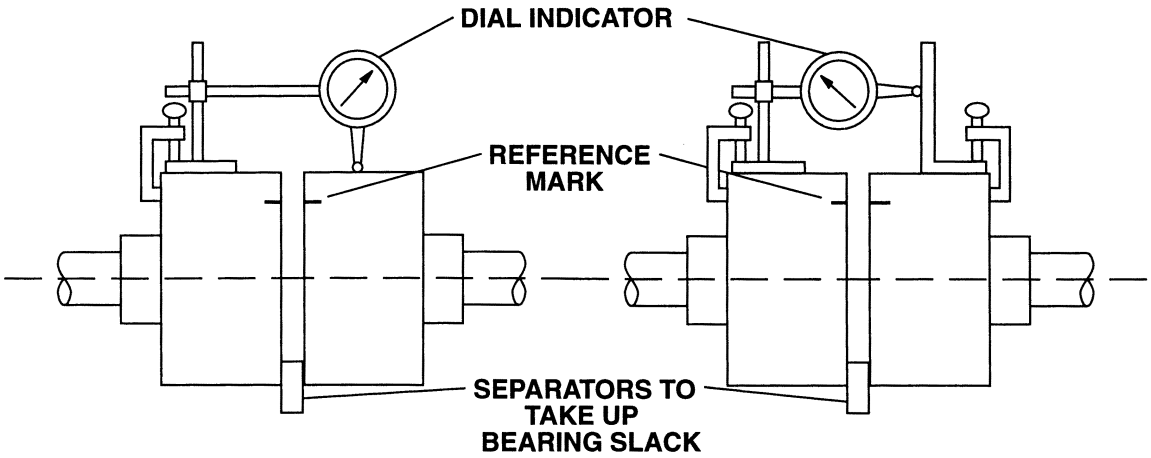


Fig. 11

DOWELING

Pump units may, if desired, (or required in specification) be doweled on diagonally opposite feet. This should not be done until the unit has been run for a sufficient length of time and alignment is within the above alignment tolerance.

SUCTION AND DISCHARGE PIPING

The introduction of pumpage into a piping system which is not well designed or adjusted may cause strain on the pump, leading to misalignment or even impeller rubbing. Since slight strain may go unnoticed, final alignment should be done with the system full and up to final temperature.

Pipe flanges should not impose any strain on the pump. This can be checked by a dial indicator. Any strain must be corrected by adjustments in the piping system.

When installing the pump piping, be sure to observe the following precautions:

Piping should always be run to the pump.

Do not move the pump to pipe. This could make final alignment impossible.

Both the suction and discharge piping should be independently anchored near the pump and properly aligned so that no strain is transmitted to the pump when the flange bolts are tightened. Use pipe hangers or other supports at necessary intervals to provide support. When expansion joints are used in the piping system they must be installed beyond the piping supports closest to the pump. Tie bolts and spacer sleeves should be used with expansion joints to prevent pipe strain. Do not install expansion joints next to the pump or in any way that would cause a strain on the pump resulting from system pressure changes. When using rubber expansion joints, follow the recommendations of the *Technical Handbook on Rubber Expansion Joints and Flexible Pipe Connectors.* It is usually advisable to increase the size of both suction and discharge pipes at the pump connections to decrease the loss of head from friction.

Install piping as straight as possible, avoiding unnecessary bends. Where necessary, use 45° or long radius 90° fittings to decrease friction losses.

Make sure that all piping joints are air-tight.

Where flanged joints are used, assure that inside diameters match properly.

Remove burrs and sharp edges when making up joints.

Do not “spring” piping when making any connections.

Provide for pipe expansion when hot fluids are to be pumped.

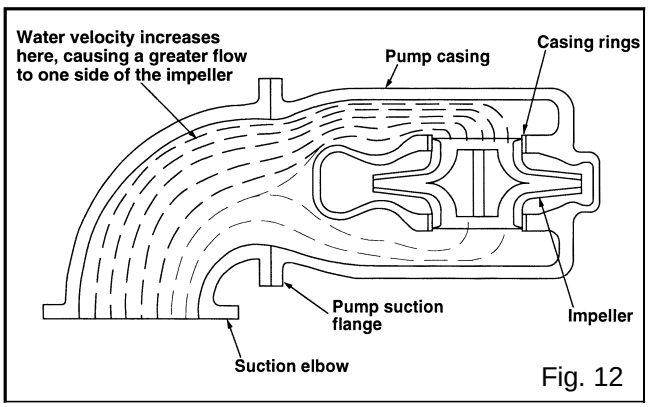


Fig. 12

Suction Piping

When installing the suction piping, observe the following precautions. (See Fig. 13)

The sizing and installation of the suction piping is extremely important. It must be selected and installed so that pressure losses are minimized and sufficient liquid will flow into the pump when started and operated.

Many NPSH (Net Positive Suction Head) problems can be directly attributed to improper suction piping systems.

Suction piping should be short in length, as direct as possible, and never smaller in diameter than the pump suction opening. A minimum of five (5) pipe diameters between any elbow or tee and the pump should be allowed. If a long suction pipe is required, it should be one or two sizes larger than the suction opening, depending on its length.

⚠ CAUTION

An elbow should not be used directly before the suction of a double suction pump if its plane is parallel to the pump shaft. This can cause an excessive axial load or NPSH problems in the pump due to an uneven flow distribution. (See Fig. 12) If there is no other choice, the elbow should have straightening vanes to help evenly distribute the flow.

Eccentric reducers should be limited to one pipe size reduction each to avoid excessive turbulence and noise. They should be of the conical type. Contour reducers are not recommended.

When operating on a suction lift, the suction pipe should slope upward to the pump nozzle. A horizontal suction line must have a gradual rise to the pump. Any high point in the pipe can become filled with air and prevent proper operation of the pump. When reducing the piping to the suction opening diameter, use an eccentric reducer with the eccentric side down to avoid air pockets.

NOTE: When operating on suction lift never use a concentric reducer in a horizontal suction line, as it tends to form an air pocket in the top of the reducer and the pipe.

Fig. 13 shows some correct and incorrect suction piping arrangements.

When installing valves in the suction piping, observe the following precautions:

1. If the pump is operating under static suction lift conditions, a foot valve may be installed in the suction line to avoid the necessity of priming each time the pump is started. This valve should be of the flapper type, rather than the multiple spring type, sized to avoid excessive friction in the suction line. (Under all other conditions, a check valve, if used, should be installed in the discharge line. See Discharge Piping.)

2. When foot valves are used, or where there are other possibilities of “water hammer”, close the discharge valve slowly before shutting down the pump.

3. Where two or more pumps are connected to the same suction line, install gate valves so that any pump can be isolated from the line. Gate valves should be installed on the suction side of all pumps with a positive pressure for maintenance purposes. Install gate valves with stems horizontal to avoid air pockets. Globe valves should not be used, particularly where NPSH is critical.

4. The pump must never be throttled by the use of a valve on the suction side of the pump. Suction valves should be used only to isolate the pump for maintenance purposes, and should always be installed in positions to avoid air pockets.

Discharge Piping

If the discharge piping is short, the pipe diameter can be the same as the discharge opening. If the piping is long, the pipe diameter should be one or two sizes larger than the discharge opening. On long horizontal runs, it is desirable to maintain as even a grade as possible. Avoid high spots, such as loops, which will collect air and throttle the system or lead to erratic pumping.

A check valve and an isolating gate valve should be installed in the discharge line. The check valve, placed between pump and gate valve, protects the pump from excessive back pressure, and prevents liquid from running back through the pump in case of power failure. The gate valve is used in priming and starting, and when shutting the pump down.

Pressure Gauges

Properly sized pressure gauges should be installed in both the suction and discharge nozzles in the gauge taps provided. The gauges will enable the operator to easily observe the operation of the pump, and also determine if the pump is operating in conformance with the performance curve. If cavitation, vapor binding, or other unstable operation should occur, widely fluctuating discharge pressure will be noted.

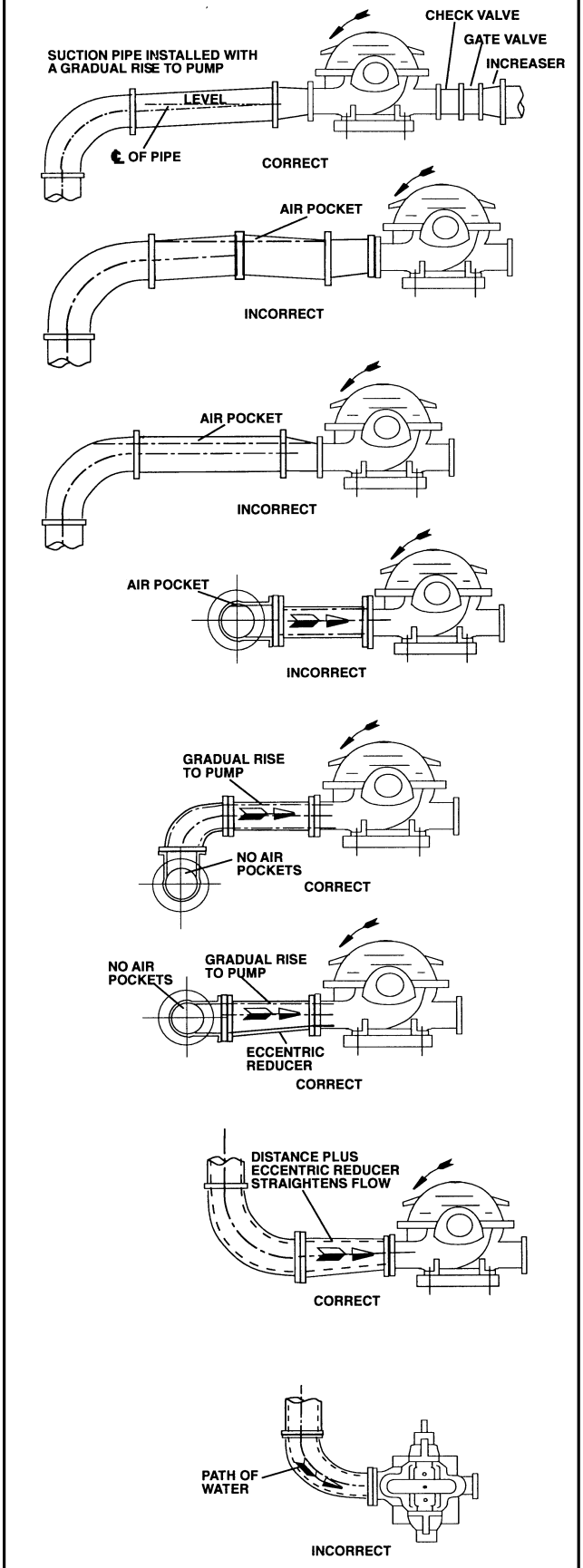


Fig. 13

STUFFING BOX LUBRICATION

Contaminants in the pumped liquid must not enter the stuffing box. These contaminants may cause severe abrasion or corrosion of the shaft, or shaft sleeve, and rapid packing or mechanical seal deterioration; they can even plug the stuffing box flushing and lubrication system. The stuffing box must be supplied at all times with a source of clean, clear liquid to flush and lubricate the packing or seal. The most important consideration is to establish the optimum flushing pressure that will keep contaminants from the stuffing box cavity. If this pressure is too low, fluid being pumped may enter the stuffing box. If the pressure is too high, excessive packing or seal wear may result; and extreme heat may develop in the shaft causing higher bearing temperatures. The most desirable condition, therefore, is to use a seal water pressure 15-20 psig above the maximum stuffing box pressure.

If the pump system pressure conditions vary, packing adjustment becomes difficult. Consideration should be given to using a mechanical seal. (See Mechanical Seals.)

Packing

Standard pumps are normally packed before shipment. If the pump is installed within 60 days after shipment, the packing will be in good condition with a sufficient supply of lubrication. If the pump is stored for a longer period, it may be necessary to repack the stuffing box. In all cases, however, inspect the packing before the pump is started.

NOTE: Packing adjustment is covered in the MAINTENANCE SECTION of this manual.

On some applications, it is possible to use internal liquid lubrication (pumped liquid) to lubricate packing. Only when all of the conditions prevail, can this be done:

1. Liquid is clean, free from sediment and chemical precipitation and is compatible with seal materials.
2. Temperature is above 32° F and below 160° F.
3. Suction pressure is below 75 psig.
4. Lubrication (pumped liquid) has lubricating qualities.
5. Liquid is non-toxic and non-volatile.

When the liquid being pumped contains solids or is otherwise not compatible with packing materials, an outside supply of seal liquid should be furnished. In general, external-injection liquid (from an outside source) is required when any of the above conditions cannot be met.

The standard stuffing box consists of rings of packing (see assembly section for number of rings), a seal cage (optional), and a gland. A shaft sleeve which extends through the box and under the gland is provided to protect the shaft.

A tapped hole is supplied in the stuffing box directly over the seal cage to introduce a clean, clear sealing medium. The stuffing box must, at all times, be supplied with sealing liquid at a high enough pressure to keep the box free from foreign matter, which would quickly destroy the packing and score the shaft sleeve.

Only a sufficient volume of sealing liquid to create a definite direction of flow from the stuffing box inward to the pump casing is required, but the pressure is important. Apply seal water at a rate of approximately .25 GPM at a pressure approximately 15 to 20 psig above the suction pressure. (Approximately one (1) drop per second.)

One recommended method to minimize error in regulating flushing water is a “Controlled Pressure System.” (Fig. 14) Most important is the pressure reducing valve adjusted to a value slightly exceeding the maximum stuffing box operating pressure (assuming it is reasonably constant). A flow indicating device will serve to indicate a failing of the bottom packing rings allowing leakage in the pump.

External sealing liquid should be adjusted to the point where the packing runs only slightly warm, with a very slow drip from the stuffing box. Excess pressure from an external source can be very destructive to packing. More pressure is required, however, for abrasive slurries than for clear liquids. Examination of the leakage will indicate whether to increase or decrease external pressure. If slurry is present in the leakage, increase the pressure until only clear liquid drips from the box. If the drippage is corrosive or harmful to personnel, it should be collected and piped away.

A common error is to open the external piping valve wide and then control the drippage by tightening the packing gland. Actually, a combination of both adjustments is essential to arrive at the optimum condition. The life of packing and sleeve depends on this careful control more than any other factor.

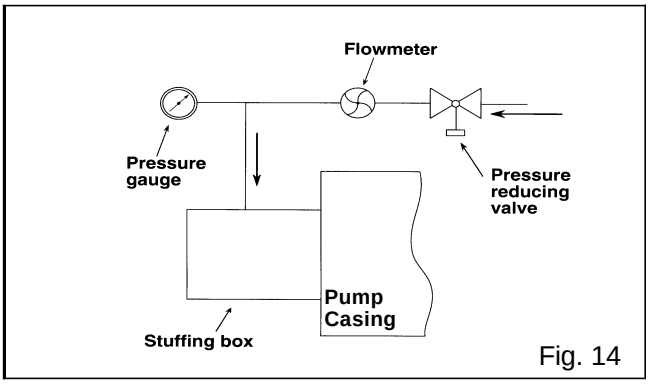


Fig. 14

Mechanical Seals

Mechanical seals are preferred over packing on some applications because of better sealing qualities and longer serviceability. Leakage is eliminated when a seal is properly installed, and normal life is much greater than that of packing on similar applications. A mechanical shaft seal is supplied in place of a packed stuffing box when specifically requested. The change from packing to an alternate arrangement may be made in the field by competent service personnel. Conversion parts may be ordered from your A-C Pump Sales Representative.

Just as with packing, the mechanical seal chamber must be supplied, at all times, with a source of clean, clear liquid to flush and lubricate the seal. The most important consideration is to establish the optimum flushing pressure that will keep contaminants from the seal cavity. If this pressure is too low, fluid being pumped may enter the stuffing box. If the pressure is too high, excessive seal wear may result.

When contaminants are present in the pumpage, an external source of clean seal water must be supplied. Supply approximately .25 GPM at a pressure approximately 15 to 20 psig above the suction pressure.

Fig. 14 shows the recommended “Controlled Pressure System” for a mechanical seal. Seal water enters the seal chamber, lubricates the seal face, and exits into the pump itself. Positive flow in the seal water line indicates adequate seal water pressure.

Cartridge Seals

Follow the appropriate lubrication directions for mechanical seals given in this section. Most cartridge seals provide flushing connections on their glands. Use the cartridge seal gland flushing taps (if provided) for your seal water connections instead of the stuffing box tap. The quench taps on the glands (if present) are normally only used in chemical applications. Consult seal manufacturer’s literature for more detailed information.

Cyclone Separator

If the fluid being pumped contains sediment and there is no external, clean water source available to flush the mechanical seals, a cyclone separator can be used to remove most of the sediment from the liquid being pumped so it can be used to flush the seals. The separator is placed in the seal water piping line and removes the sediment to an external drain (normally back to the pump suction line).

OPERATION

PRE-START CHECKS

Before the initial start of the pump, make the following inspections:

1. Check alignment between pump and driver. See the section on alignment for alignment requirements.
2. Check all connections to motor and starting device with wiring diagram. Check voltage, phase, and frequency on motor nameplate with line circuit.
3. Check suction and discharge piping and pressure gauges for proper operation.
4. Turn rotating element by hand to assure that it rotates freely.
5. Check stuffing box adjustment, lubrication, and piping.
6. Check driver lubrication.
7. Assure that pump bearings are properly lubricated.
8. Assure that coupling is properly lubricated, if required.
9. Assure that pump is full of liquid and all valves are properly set and operational, with the discharge valve and the suction valve open. Purge all air from top of casing.
10. Check rotation. Be sure that the driver operates in the direction indicated by the arrow on the pump casing as serious damage can result if the pump is operated with incorrect rotation. Check rotation each time the motor leads have been disconnected.

PRIMING

If the pump is installed with a positive head on the suction, it can be primed by opening the suction valve, and loosening the vent plug on the top of the casing (Do not remove), allowing air to be purged from the casing.

If the pump is installed with a suction lift, priming must be done by other methods such as foot valves, ejectors, or by manually filling the casing and suction line.

⚠ CAUTION

Under either condition, the pump must be completely filled with liquid before starting. The pump must not be run dry in the hope it will prime itself. Serious damage to the pump may result if it is started dry.

FLUSHING

New and old systems should be flushed to eliminate all foreign matter. Heavy scale, welding splatter and wire or other large foreign matter can clog the pump impeller. This will reduce the capacity of the pump causing cavitation, excessive vibration, and/or damage to close clearance parts (wear rings, seals, sleeves, etc.)

FILLING

Vents should be located at the highest point so entrained gases and air can escape. However, if the gases are flammable, toxic, or corrosive they should be vented to an appropriate place to prevent harm to personnel or other parts of the system. Pipe hangers and anchors should be checked to make sure they are properly set to take the additional weight of the pumpage.

All drains should be closed when filling the system. Filling should be done slowly so that excessive velocities do not cause rotation of the pumping elements which may cause damage to the pump or its driver. The adequacy of the anchors and hangers may be checked by mounting a dial indicator off of any rigid structure not tied to the piping and setting the indicator button on the pump flange in the axial direction of the nozzle. If the indicator moves, as the filling proceeds, the anchors and supports are not adequate or set properly and should be corrected.

STARTING

1. Close drain valves.
2. Open fully all valves in the suction and discharge lines.
3. Turn on seal water to the stuffing box. (If pumped fluid is dirty or if leaking of air is to be prevented, these lines should be always left open.)
4. Prime the pump.

NOTE: If the pump does not prime properly, or loses prime during start-up, it should be shutdown and the condition corrected before the procedure is repeated.

5. Start the pump driver (turbines and engines may require warming up; consult the manufacturer's instructions).
6. When the pump is operating at full speed, check to see that the check valve has opened up. Check valve must open 5 seconds or less after start-up to prevent damage to pump by operating at zero flow.
7. Adjust the liquid seal valves to produce the recommended pressure for either the mechanical seal or packed stuffing box.

OPERATIONAL CHECKLIST

1. Driver/Pump Rotation

Check rotation each time the motor leads have been disconnected. Be sure that the driver operates in the direction indicated by the arrow on the pump casing. Rough operation and extreme vibration can result if the pump is operated in the wrong direction.

2. Stuffing Box Adjustment

Make stuffing box packing gland and lubrication adjustments.

3. Flow

An accurate measurement of flow rate (volume/time) is difficult in the field. Venturi meters, flow nozzles, orifice plates, or timing the draw down in the wet well are all possible methods. Record any reading for future reference.

4. Pressure

Check and record both suction and discharge pressure gauge readings for future reference. Also, record voltage, amperage per phase, kilowatts if an indicating wattmeter is available, and pump speed.

5. Temperature

Check and record bearing temperatures using a thermometer. Temperature should not exceed 180° F.

NOTE: Just because bearing housings are too hot to touch does not mean that they are running too hot for proper operation.

6. Vibration and Sound

The acceptable vibration level of a centrifugal pump depends on the rigidity of the pump and the supporting structure. Recommended values for vibration can vary between .20 ips (inches per second) velocity to .60 ips velocity depending on the operating characteristics and the structure. Refer to the Centrifugal Pump section of the *Hydraulic Institute Standards* for a complete description and charts on various pumps.

Field sound levels are difficult to measure because of background noise from piping, valves, drivers, gears, etc. Follow recommendations in the *Hydraulic Institute Standards.*

SHUTDOWN

The following steps will take care of most normal shutdowns of the pump, i.e. maintenance. Make any further adjustments of process piping, valves, etc., as required. If the pump is to be removed from service for an extended period of time, refer to the sections on storage and freeze protection.

1. Shut down the driver. (Consult manufacturer's instructions for special operations.)
2. Close suction and discharge valves.
3. Close seal liquid valves. (If pumped liquid is dirty, or if in leakage is to be prevented, these lines should always be left open, except when the pump is completely drained.)
4. Open drain valves as required.

FREEZE PROTECTION

Pumps that are shut down during freezing conditions should be protected by one of the following methods.

1. Drain the pump; remove all liquid from the casing.
2. Keep fluid moving in the pump and insulate or heat the pump to prevent freezing.

⚠ CAUTION

If heat is used to keep the pump from freezing, do not let the temperature rise above 150° F.

FIELD TESTS

A typical performance curve for a specific pump can be obtained from A-C Pumps. This can be used in conjunction with a field test, if one is required. A-C Pumps tests and curves are based on the *Hydraulic Institute Standards*. Any field test must be conducted according to these Standards.

Unless otherwise specifically agreed, all capacity, head, and efficiencies are based on shop tests when handling clear, cold, fresh water at a temperature not over 85° F.

Appendix "C" contains a field test report sheet and some useful equations, which can be used when conducting a field test.

PREVENTIVE MAINTENANCE

GENERAL MAINTENANCE & PERIODIC INSPECTION

Operating conditions vary so widely that to recommend one schedule of preventative maintenance for all centrifugal pumps is not possible. Yet, some sort of regular inspection must be planned and followed. We suggest a permanent record be kept of the periodic inspections and maintenance performed on your pump. This recognition of maintenance procedure will keep your pump in good working condition, and prevent costly breakdowns.

One of the best results to follow in the proper maintenance of your centrifugal pump is to keep a record of actual operating hours. Then, after a predetermined period of operation has elapsed, the pump should be given a thorough inspection. The length of this operating period will vary with different applications, and can only be determined from experience. New equipment, however, should be examined after a relatively short period of operation. The next inspection period can be lengthened somewhat. This system can be followed until a maximum period of operation is reached which should be considered the operating schedule between inspections.

MAINTENANCE TIME TABLE

EVERY MONTH

Check bearing temperature with a thermometer, not by hand. If bearings are running hot (over 180° F), it may be the result of too much or too little lubricant. If changing the lubricant and/or adjusting to proper level does not correct the condition, disassemble and inspect the bearings. Lip seals bearing on the shaft may also cause the housing to run hot. Lubricate lip seals to correct this condition.

EVERY 3 MONTHS

Check the oil on oil lubricated units. Check grease lubricated bearings for saponification. This condition is usually caused by the infiltration of water or other fluid past the bearing shaft seals and can be noticed immediately upon inspection, since it gives the grease a whitish color. Wash out the bearings with a clean industrial solvent and replace the grease with the proper type as recommended.

EVERY 6 MONTHS

Check the packing and replace if necessary. Use the grade recommended. Be sure the seal cages are centered in the stuffing box at the entrance of the stuffing box piping connection.

Take vibration readings on the bearing housings. Compare the readings with the last set of readings to check for possible pump component failure (e.g. bearings).

Check shaft or shaft sleeve for scoring. Scoring accelerates packing wear.

Check alignment of pump and driver. Shim up units if necessary. If misalignment reoccurs frequently, inspect the entire piping system. Unbolt piping at suction and discharge flanges to see if it springs away, thereby indicating strain on the casing. Inspect all piping supports for soundness and effective support of load. Correct as necessary.

EVERY YEAR

Remove the upper half of the casing. Inspect the pump thoroughly for wear, and order replacement parts if necessary.

Check wear ring clearances. Replace when clearances become three (3) times their normal clearance or when a significant decrease in discharge pressure for the same flow rate is observed.

See Engineering Data Section for standard clearances.

Remove any deposit or scaling. Clean out stuffing box piping.

Measure total dynamic suction and discharge head as a test of pump performance and pipe condition. Record the figures and compare them with the figures of the last test. This is important, especially where the fluid being pumped tends to form a deposit on internal surfaces. Inspect foot valves and check valves, especially the check valve which safeguards against water hammer when the pump stops. A faulty foot or check valve will reflect also in poor performance of the pump while in operation.

NOTE: The above time table is based on the assumption that after startup, the unit has been constantly monitored and such a schedule was found to be consistent with operation, as shown by stable readings. Extreme or unusual applications or conditions should be taken into consideration when establishing the maintenance intervals.

MAINTENANCE OF FLOOD DAMAGED PUMPS

The servicing of centrifugal pumps after a flooded condition is a comparatively simple matter under normal conditions.

Bearings are a primary concern on pumping units. First, dismantle the frame, clean and inspect the bearings for any rusted or badly worn surfaces. If bearings are free from rust and wear, reassemble and relubricate them with one of the recommended lubricants. Depending on the length of time the pump has remained in the flooded area, it is unlikely that bearing replacement is necessary; however, in the event that rust or worn surfaces appear, it may be necessary to replace the bearings.

Next, inspect the stuffing box, and clean out any foreign matter that might clog the box. Packing that appears to be worn, or no longer regulates leakage properly should be replaced. Mechanical seals should be cleaned and thoroughly flushed.

Couplings should be dismantled and thoroughly cleaned. Lubricate the coupling with one of the coupling manufacturer's recommended lubricants where required.

Any pump that is properly sealed at all joints and connected to both the suction and discharge should exclude outside liquid. Therefore, it should not be necessary to go beyond the bearings, stuffing box, and coupling when servicing the pump after flood damage.

LUBRICATION

GREASE LUBRICATION OF BEARINGS

Grease lubricated ball bearings are packed with grease at the factory and ordinarily will require no attention before starting, provided the pump has been stored in a clean, dry place prior to its first operation. The bearings should be watched the first hour or so after the pump has been started to see that they are operating properly.

A lithium based NLGI-2 grade grease should be used for lubricating bearings where the ambient temperature is above -20° F. Grease lubricated bearings are packed at the factory with Mobilux EP No. 2 grease. Other recommended greases are Texaco Multifak EP-2 and Shell Alvania EP-2.

Greases made from animal or vegetable oils are not recommended due to the danger of deterioration and forming of acid. Do not use graphite.

In greasing anti-friction bearings, the use of high pressure equipment is not only unnecessary, but is actually undesirable unless used with great care. High pressure may damage the bearings or seals, cause unnecessary loss of grease, create a danger of overheating due to over greasing, and produce unsightly conditions around the bearing. Excess grease is the most common cause of overheating. Adequate lubrication is assured if the level of grease is maintained at about the capacity of the bearing and 1/3 to 1/2 of the

cavity between the bearing and grease fitting. Any greater amount will, as a rule, be discharged by the seal or vent and be wasted.

The importance of proper lubrication cannot be over emphasized. Lubrication frequency depends upon the speed, size and type of bearing, and operating temperature or environmental conditions. Generally, the smaller the bearing and faster the speed, the more frequent the interval for relubrication with grease. It is recommended that a certain amount of grease be added at intervals of three to six months to replace the small quantity of grease lost between grease flushing intervals. For average bearing housing designs, one (1) ounce of grease will be sufficient at these intervals. For larger or smaller bearing housings this amount may have to be adjusted.

Unfortunately, there is not a grease available which will not harden over time and become less suitable for its purpose due to oxidation. Therefore, it is good practice to remove all the old grease about once a year and thoroughly clean the bearings. This should be done during major overhauls. After gaining experience with each individual pump and its operating characteristics, the relubrication and flushing intervals may be adjusted accordingly. Keep good records and add grease at regular intervals. Then adjustments can be made after the first overhaul, if necessary.

PERIODIC ADDITION OF GREASE

Grease lubricated ball bearings are packed with grease at the factory. Store the pump in a clean, dry place prior to its first operation.

If one is uncertain about the amount of grease in a bearing at relubrication intervals, the safe rule is to add grease slowly (one ounce at a time) as the bearing operates (if this is safe). Remember, a ball or roller bearing in most applications is assured of adequate lubrication if the level of grease is maintained at about the capacity of the bearing and 1/3 to 1/2 of the cavity between the bearing and grease fitting. Any greater amount will, as a rule, be discharged by the seals or vent and be wasted. Excess grease is the most common cause of overheating of the bearings. Remove vent plugs for the first 24 hours of operation after regreasing.

BEARING TEMPERATURE

Normally the maximum desirable operating temperature for ball bearings is 180° F. Special designs may have higher limits. Should the temperature of the bearing frame rise above the limit, the pump should be shut down to determine the cause. A bearing frame which feels hot to the touch of the hand is not necessarily running hot. Check with an accurate temperature measuring device to be sure.

OIL LUBRICATION OF BEARINGS

Oil lubrication on 8100 pumps is considered special. Oil lubricated pumps are installed with Trico oilers. (See Fig. 15) The oilers keep the oil level in the housings constant at proper level.

After the pump has been installed, flush the housing to remove dirt, grit, and other impurities that may have entered the bearing housing during shipment or installation. Then refill the housing with proper lubricant. (The housing must be filled using the Trico oiler.) The oil level will be maintained by the Trico oiler. (See the **SERVICE** section for the proper instructions.)

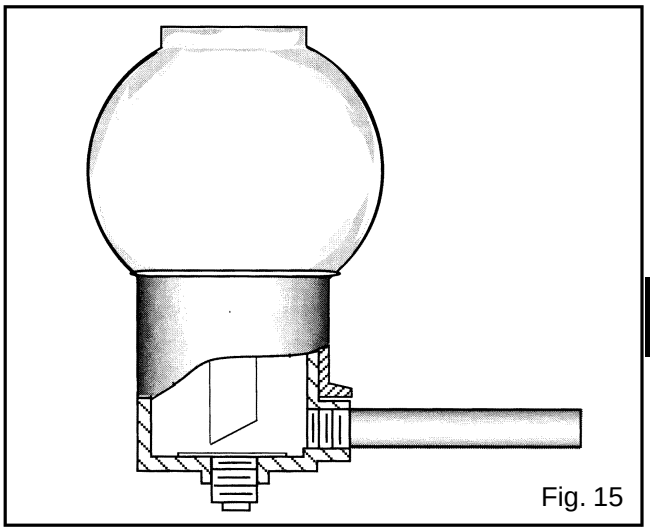


Fig. 15

A Mobil Oil, DTE Medium, or equal, meeting the following specification will provide satisfactory lubrication. Similar oils can be furnished by all major oil companies. It is the responsibility of the oil vendor to supply a suitable lubricant.

(1) Saybolt viscosity at 100° F . . . . . 215 SSU-240 SSU
(2) Saybolt viscosity at 210° F . . . . . .49 SSU
(3) Viscosity index, minimum 95
(4) API gravity 28-33
(5) Pour point, maximum . . . . . +20° F
(6) Flash point, minimum . . . . . 400° F
(7) Additives . . . . . Rust & Oxidation Inhibitors
(8) ISO viscosity 46

NOTE: Oils from different suppliers should not be mixed. Engine oils are not recommended.

The oil should be a non-foaming, well refined, good grade, straight cut, filtered mineral oil. It must be free from water, sediment, resin, soaps, acid and fillers of any kind.

In installations with moderate temperature changes, low humidity, and a clean atmosphere, the oil should be changed after approximately 1000 hours of operation. The oil should be inspected at this time to determine the operating period before the next oil change. Oil change periods may be increased up to 2000-4000 hours based on an 8000 hour year. Check the oil frequently for moisture, dirt or signs of "breakdown", especially during the first 1000 hours.

⚠ CAUTION

Do not over oil; this causes the bearings to run hot. The maximum desirable bearing housing operating temperature for all ball bearings is 180° F. Should the temperature of the bearing frame exceed 180° F (measured by thermometer) shut down pump to determine the cause.

COUPLING LUBRICATION

Flexible couplings (Wood's Sure-Flex or Falk Torus coupling for instance) provide smooth transmission of power. There is no rubbing action of metal against rubber to cause wear. Couplings are not affected by abrasives, dirt or moisture. This eliminates the need for lubrication or maintenance, and provides clean and quiet performance.

If other type couplings are used, follow maintenance instructions of coupling manufacturer.

SEALING INFORMATION

PACKING (NON-ASBESTOS)

On packed pumps the packing is installed prior to shipment. All packings used are the highest grade material. Before pump is put into operation check the condition of the packing. If pump is installed within sixty (60) days after shipment the packing will be in good condition with a sufficient supply of lubrication. If pump is stored for a longer period it may be necessary to repack the stuffing box. In all cases, however, we recommend an inspection of the packing before pump is started.

The standard 8100 pump packing is made from braided acrylic yarn impregnated with graphite.

A soft, well-lubricated packing reduces stuffing box resistance and prevents excessive wear on the shaft or shaft sleeve. Many brands of packing on the market have the desired qualities. Standard packing is John Crane Style 1340, or equal.

When a pump with fiber packing is first started it is advisable to have the packing slightly loose without causing an air leak. As the pump runs in, gradually tighten the gland bolts evenly. The gland should never be drawn to the point where packing is compressed too tightly and no leakage occurs. This will cause the packing to burn, score the shaft sleeve and prevent liquid from circulating through the stuffing box cooling the packing. The stuffing box is improperly packed or adjusted if friction in the box prevents turning the rotating element by hand. A properly operated stuffing box should run lukewarm with a slow drip of sealing liquid. After the pump has been in operation for some time, and the packing has been in operation for some time, and the packing has been completely run-in, drippage from the stuffing boxes should be at least 40 to 60 drops per minute. This will indicate proper packing and shaft sleeve lubrication and cooling.

NOTE: Eccentricity of the shaft or sleeve through the packing could result in excess leakage that cannot be compensated for. Correction of this defect is very important.

Packing should be checked frequently and replaced as service indicates. Six months might be a reasonable expected life, depending on operating conditions. It is impossible to give any exact predictions. A packing tool should be used to remove all old packing from the stuffing box. Never reuse old and lifeless packing or merely add some new rings. Make sure the stuffing box is thoroughly cleaned before new packing is installed. Also check the condition of the shaft or sleeve for possible scoring or eccentricity, make replacements where necessary.

New packing (non-asbestos) should be placed carefully into the stuffing box. If molded rings are used, the rings should be opened sideways and the joints pushed into the stuffing box first. The rings are installed one at a time, each ring seated firmly and the joints staggered at about a 90° rotation from each preceding joint.

If coil packing is used, cut one ring to accurate size with either a butt or mitered joint. An accurately cut butt joint is superior to a poor fitting mitered joint. Fit the ring over the shaft to assure proper length. Then remove and cut all other rings to the first sample. When the rings are placed around the shaft a tight joint should be formed. Place the first ring in the bottom of the stuffing box. Then install each succeeding ring, staggering the joints as described above, making sure each ring is firmly seated.

If your pump is supplied with seal cages (optional) make sure they are properly located in the stuffing boxes under the sealing water inlets. The function of the seal cage is to establish a liquid seal around the shaft, prevent leakage of air through the stuffing box and lubricate the packing. If it is not properly located it serves no purpose.

MECHANICAL SEALS

General instructions for operation of the various mechanical sealing arrangements are included below. It is not feasible to include detailed instructions for all mechanical seals in this booklet because of the almost unlimited number of possible combinations and arrangements. Instead, seal manufacturer's instructions will be included as a separate supplement to this book, where required.

a. Mechanical seals are precision products and should be treated with care. Use special care when handling seals. Clean oil and clean parts are essential to prevent scratching the finely lapped sealing faces. Even light scratches on these faces could result in leaky seals.

b. Normally, mechanical seals require no adjustment or maintenance except routine replacement of worn or broken parts.

c. A mechanical seal which has been used should not be put back into service until the sealing faces have been replaced or relapped. (Relapping is generally economical only in seals two inches in size and above.)

Four important rules which should always be followed for optimum seal life are:

1. Keep the seal faces as clean as possible.

2. Keep the seal as cool as possible.

3. Assure that the seal always has proper lubrication.

4. If seal is lubricated with filtered fluid, clean filter frequently.

TROUBLE SHOOTING

Between regular maintenance inspections, be alert for signs of driver or pump trouble. Common symptoms are listed below. Correct any trouble immediately and AVOID COSTLY REPAIR AND SHUTDOWN.

Problem	Items	Probable Cause	Remedy
No Liquid Delivered	1	Lack of prime.	Fill pump and suction pipe completely with liquid.
	2	Loss of prime.	Check for leaks in suction pipe joints and fittings; vent casing to remove accumulated air. Check mechanical seal or packing.
	3	Suction lift too high (a negative suction gauge reading).	If there is no obstruction at inlet and suction valves are open, check for pipe friction losses. However, static lift may be too great. Measure with mercury column or vacuum gauge while pump operates. If static lift is too high, liquid to be pumped must be raised or pump lowered.
	4	System static head too high.	Check with factory to see if a larger impeller can be used; otherwise, cut pipe losses or increase speed — or both, as needed. But be careful not to seriously overload driver.
	5	Speed to low.	Check whether motor is directly across-the-line and receiving full voltage. Frequency may be too low. Motor may have an open phase.
	6	Wrong direction of rotation.	Check motor rotation with directional arrow on pump casing. If rotation is correct with arrow, check the relationship of the impeller with casing. (This will require removing casing upper half.)
	7	No rotation.	Check power, coupling, line shaft and shaft keys.
	8	Impeller loose on shaft.	Check key, locknut and set screws.
	9	Impeller completely plugged.	Dismantle pump and clean impeller.
	10	System head or required discharge head too high.	Check pipe friction losses. Large piping may correct condition. Check that valves are wide open.
Not Enough Liquid Delivered	11	Air leaks in suction piping.	If liquid pumped is water or other non-explosive and explosive gas or dust is not present, test flanges for leakage with flame or match. For such liquids as gasoline, suction line can be tested by shutting off or plugging inlet and putting line under pressure. A gauge will indicate a leak with a drop of pressure.
	12	Air leaks in stuffing box.	Replace packing and sleeves if appropriate or increase seal lubricant pressure to above atmosphere.
	13	Speed too low.	See item 5.
	14	Discharge head too high.	See item 10.
	15	Suction lift too high.	See item 3.
	16	Impeller partially plugged.	See item 9.
	17	Cavitation; insufficient NPSHA (Net Positive Suction Head Available).	a. Increase positive suction head on pump by lowering pump or increasing suction pipe and fittings size. b. Sub-cool suction piping at inlet to lower entering liquid temperature. c. Pressurize suction vessel.
	18	Defective Impeller and/or wear rings.	Inspect impeller and wear rings. Replace if damaged or vane sections are badly eroded or if wear ring clearance is 3 times normal.
	19	Foot valve too small or partially obstructed.	Area through ports of valve should be at least as large as area of suction pipe (preferably 1.5 times). If strainer is used, net clear area should be 3 to 4 times area of suction pipe.
	20	Suction inlet not immersed deep enough.	If inlet cannot be lowered or if eddies through which air is sucked persists when it is lowered, chain a board to suction pipe. It will be drawn into eddies, smothering the vortex.
	21	Wrong direction of rotation.	Symptoms are an overloaded driver and about one third rated capacity from pump. Compare rotation of motor with directional arrow on pump casing. If rotation is correct with arrow, impeller may have to be turned 180º. (see CHANGING ROTATION)
	22	System head too high.	See item 4.
	23	Defective mechanical seal.	Repair or replace seal.
Not Enough Pressure	24	Speed too low.	See item 5.
	25	Air leaks in suction piping or stuffing box.	See item 11.
	26	Mechanical defects.	See item 18.
	27	Vortex at suction inlet.	See item 20.
	28	Obstruction in liquid passages.	Check to see if suction and discharge valves are fully open. Disman tle pump and inspect passages and casing. Remove obstruction.
	29	Air or gases in liquid.	May be possible to overrate pump to a point where it will provide adequate pressure despite condition. Better provide gas separation chamber on suction line near pump and periodically exhaust accumulated gas. See item 17.

Problem	Item	Probable cause	Remedy
Pump Operates For a Short Time, Then Stops	30	Insufficient NPSHA.	See item 17
	31	System head too high.	See items 4 & 10.
Pump Takes Too Much Power	32	Head lower than rating; thereby pumping too much liquid.	Machine impeller's O.D. to size advised by factory, or reduce speed.
	33	Cavitation.	See item 17.
	34	Mechanical defects.	See items 18, 19, 21, and 23.
	35	Suction inlet not immersed.	See item 20.
	36	Liquid heavier (in either viscosity or specific gravity) than allowed for.	Use larger driver. Consult factory for recommended size. Test liquid for viscosity and specific gravity.
	37	Wrong direction of rotation.	See item 6.
	38	Stuffing box glands too tight.	Release gland pressure. Tighten reasonably. If sealing liquid does not flow while pump operates, replace packing.
	39	Casing distorted by excessive strains from suction or discharge piping.	Check alignment. Examine pump for rubbing between impeller and casing. Replace damaged parts. Re-pipe pump.
	40	Shaft bent due to damage — through shipment, operation, or overhaul.	Check deflection of rotor by turning on bearing journals. Total indicator run-out should not exceed .002" on shaft and .004" on impeller wearing surface.
	41	Mechanical failure of critical pump parts.	Check wear rings and impeller for damage. Any irregularity in these parts will cause a drag on shaft.
	42	Misalignment.	Re align pump and driver.
	43	Speed may be too high	Check voltage on motor. Check speed versus pump name plate rating.
	44	Electrical defects	The voltage and frequency of the electrical current may be lower than that for which motor was built, or there may be defects in motor. The motor may not be ventilated properly due to a poor location.
	45	Mechanical defects in turbine, engine or other type of drive exclusive of motor.	If trouble cannot be located consult factory.

5

DISASSEMBLY & REASSEMBLY

PROCEDURES

The procedures outlined in this section cover the dismantling and reassembly of three different types of 8100 pump construction.

A. 8100 pump with packing on shaft sleeves.

B. 8100 pump with mechanical seals on shaft.

C. 8100 pump with mechanical seals on shaft sleeves.

Each procedure provides the step-by-step instructions for dismantling and then reassembling the pump, depending upon the type of shaft seal used.

When working on the pump, use accepted mechanical practices to avoid unnecessary damage to parts. Check clearances and conditions of parts when pump is dismantled and replace if necessary. Steps should usually be taken to restore impeller and casing ring clearance when it exceeds three times the original clearance.

⚠ CAUTION

For pumps in the vertical configuration, (Models 200 and 300) please follow the instructions for the disassembly and reassembly of a vertical rotating element starting on page 53.

CHANGING ROTATION

8100 centrifugal pumps can be operated clockwise or counterclockwise when viewed from the coupling end of the pump. If you wish to reverse the suction and discharge nozzles; i.e. change rotation, this can be accomplished with the same pump as follows:

1. Remove the impeller from the shaft, turn it 180° and replace it on the shaft. (Follow the disassembly procedures given in this manual.)
2. With the rotating element out of the casing, remove the casing from the baseplate and turn 180°. (Factory baseplates are drilled for both rotations.)
3. Set the rotating element back in the casing and reassemble the pump.

NOTE: The impeller and casing are in the same relationship to each other as they were originally. The shaft and motor are also in the same relationship to each other as they were originally.

4. Reassemble the pump and realign the coupling as called for in the alignment instructions.
5. The rotation of the motor must be changed by switching the motor leads.

NOTE: Unless the motor rotation is reversed the impeller will run backward.

⚠ CAUTION

Check motor fan to make sure it is bidirectional. If not, motor fan will have to be turned around or replaced. Failure to do this could cause motor to run hot.

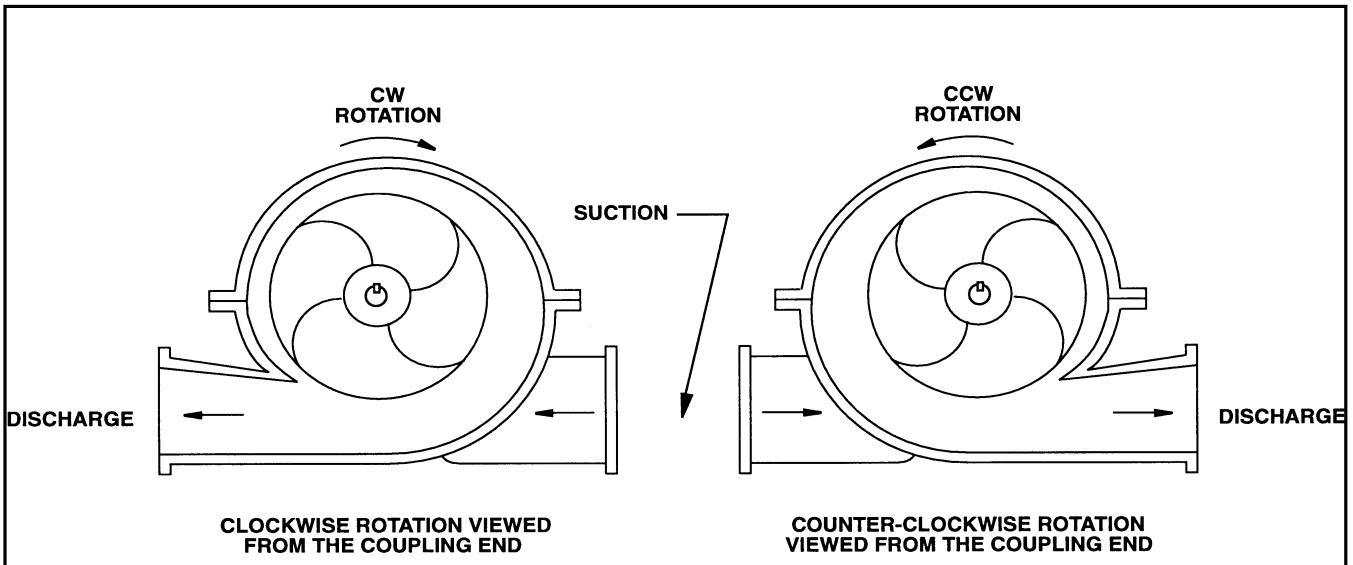


Fig. 16

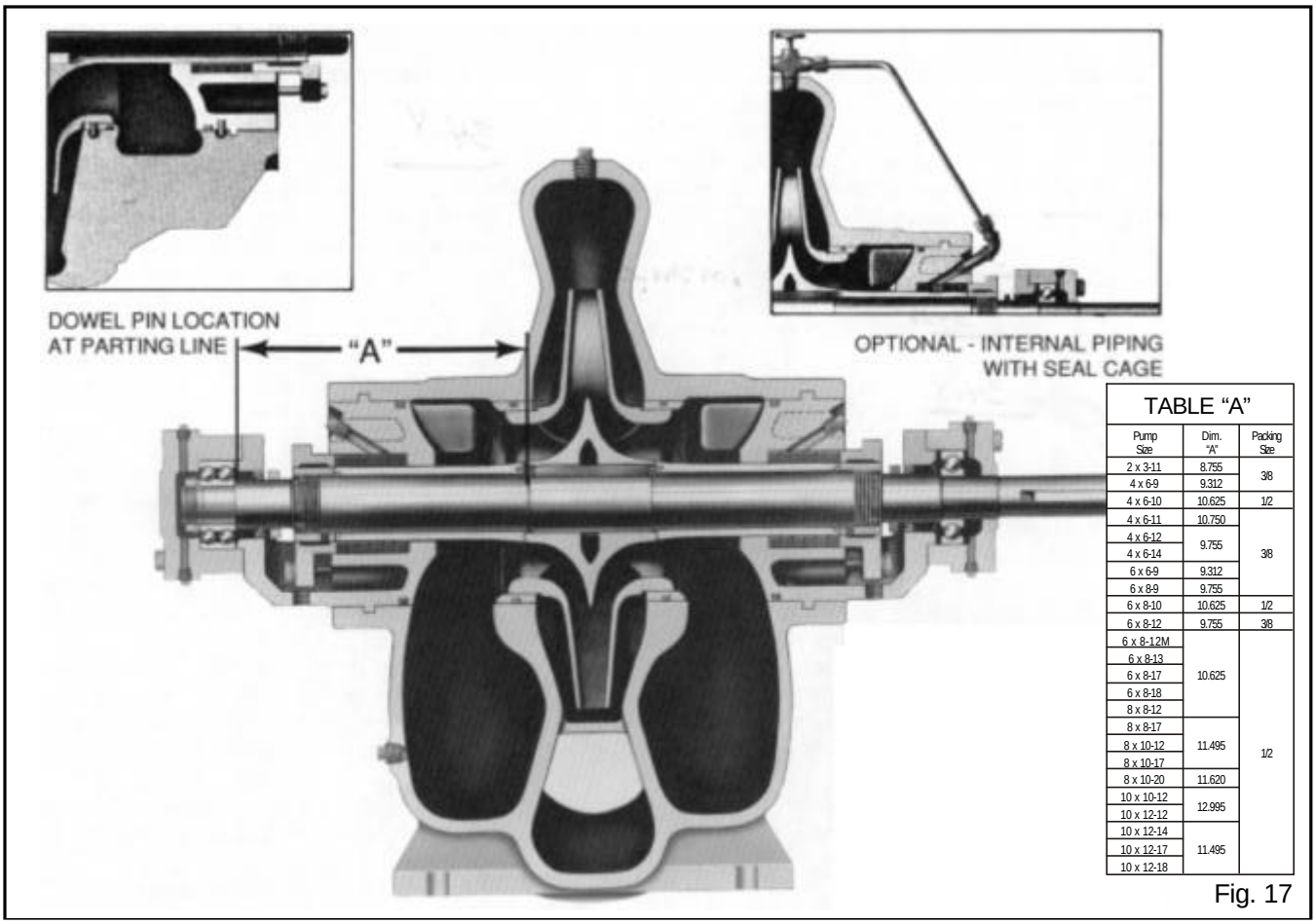


TABLE "A"

Pump Size	Dim. "A"	Packing Size
2 x 3-11	8.755	3/8
4 x 6-9	9.312	
4 x 6-10	10.625	1/2
4 x 6-11	10.750	3/8
4 x 6-12	9.755	
4 x 6-14		
6 x 6-9	9.312	
6 x 8-9	9.755	
6 x 8-10	10.625	1/2
6 x 8-12	9.755	3/8
6 x 8-12M	10.625	1/2
6 x 8-13		
6 x 8-17		
6 x 8-18		
8 x 8-12		
8 x 8-17	11.495	
8 x 10-12		
8 x 10-17		
8 x 10-20	11.620	
10 x 10-12	12.995	
10 x 12-12		
10 x 12-14	11.495	
10 x 12-17		
10 x 12-18		

Fig. 17

6

DISMANTLING (PUMP WITH PACKING)

⚠ WARNING

Prior to working on the pump, the power source should be disconnected with lockout provisions so the power cannot be re-energized to the motor. Close isolating suction and discharge valves. Failure to follow these instructions could result in property damage, severe personal injury, or death. (See exploded view on page 63.)

1. Drain the pump by opening vent plug (A, Fig. 18) and re move drain plugs (B and C) on the suction and dis charge noz zles.

2. Remove all casing main joint cap screws (2-904-1) and dowels (2-916-1). Remove external tubing (0-952-0) if supplied.

3. In sert a screw driver or pry bar into the slots be tween the up per and lower cas ing halves, and sep a rate the halves, lift ing off the up per cas ing half.

NOTE: Some casings have jacking screws.

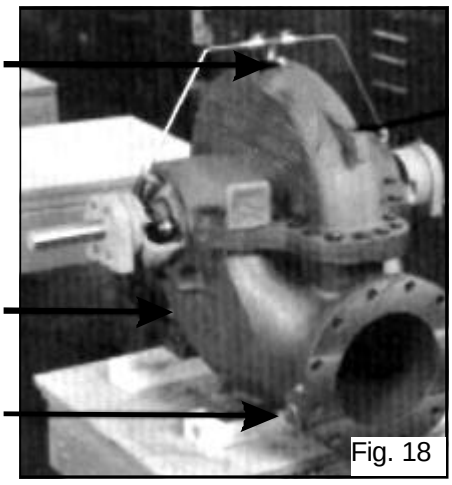


Fig. 18

4. Tap the stuffing boxes with a soft-headed hammer to break the seal between the stuffing box and lower casing half, and lift the rotating element out of the lower casing. Rotating element may now be moved to a suitable working location. (See Fig. 19)

NOTE: A spare rotating element can be installed at this point.

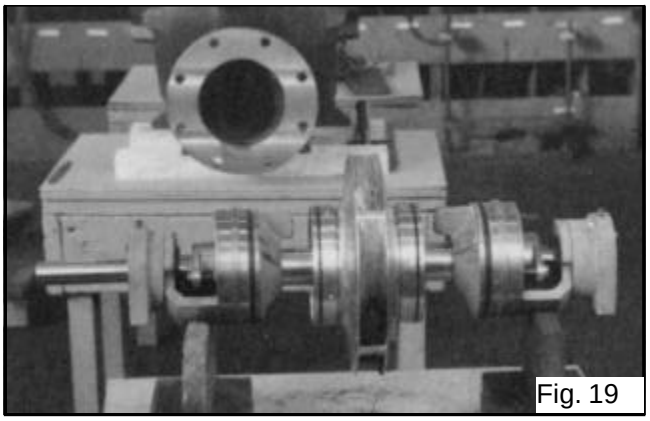


Fig. 19

5. Remove four cap screws (3-904-9) from each bearing housing (3-025-3 and -4) and remove the bearing housings from the shaft (3-007-0).

6. Bend back lockwasher tab and remove locknut (3-516-4) and lockwasher (3-517-4) from the outboard end of the shaft and, using a puller, remove the outboard bearing (3-026-4) from the shaft. Remove the inboard end bearing (3-026-3) in the same manner.

NOTE: Locknut and lockwasher are not used on inboard end bearing.

⚠ CAUTION

Do not reuse the ball bearings.

7. Slide both stuffing boxes (3-073-9) off of the shaft, working deflector rings (3-136-9) off the shaft at the same time. (See Fig. 20.)

8. Remove lip seals (3-177-9) from the stuffing boxes.

9. Remove the two gland bolts (1-904-9), gland halves (1-014-9), packing (1-924-9) and, if supplied, seal cage (1-013-9) from each stuffing box. Remove the O-rings (3-914-1) from the stuffing boxes.

10. Remove the two casing rings (3-003-9) from the impeller (4-002-0) and remove O-rings (3-914-2) from each casing ring.

NOTE: Each casing ring on 8 x 10-20 and 10 x 12-18 has 2 O-rings. (See Fig. 21B, page 39)

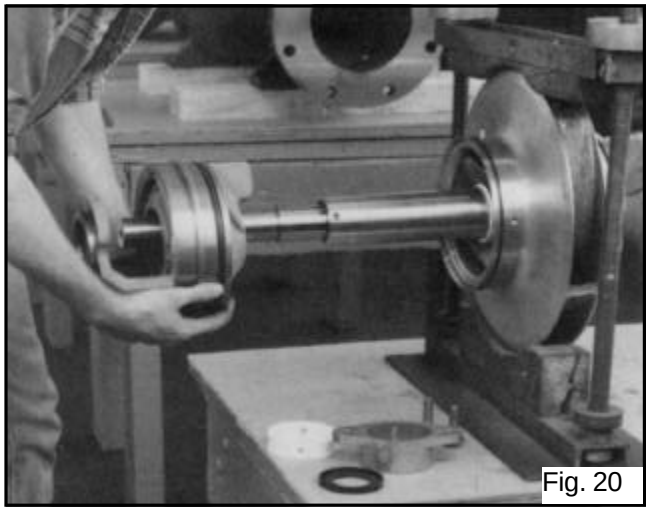


Fig. 20

11. Loosen set screw (3-902-3) in shaft nuts (3-015-9) and then remove shaft nuts using pin spanner wrench. Remove O-rings (3-914-9) from counterbore in shaft sleeves.

NOTE: Both shaft nuts have right handed threads.

12. To remove the sleeve, hold the shaft vertically and tap it on a block of wood. The impeller weight should force both the impeller and sleeve from the shaft.

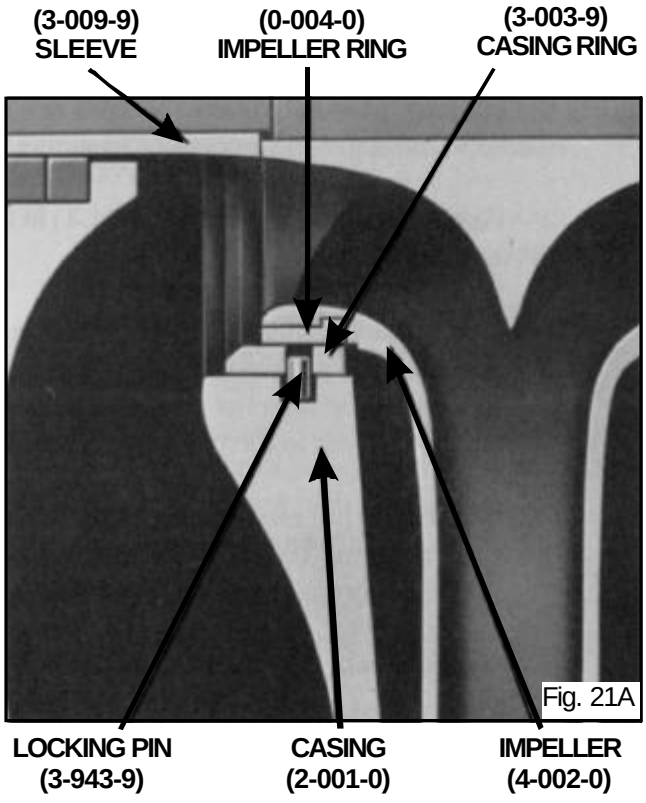


Fig. 21A

NOTE: There is a silicone adhesive/sealant between the sleeve and the impeller.

13. Remove the other shaft sleeve, nut and sleeve O-ring as described in steps 11 and 12.

NOTE: For impellers with replaceable rings — remove the rings (0-004-0), if necessary, by cutting with a cold chisel. (See Fig. 21A)

14. Remove the im pel ler key (3-911-1) from the shaft.

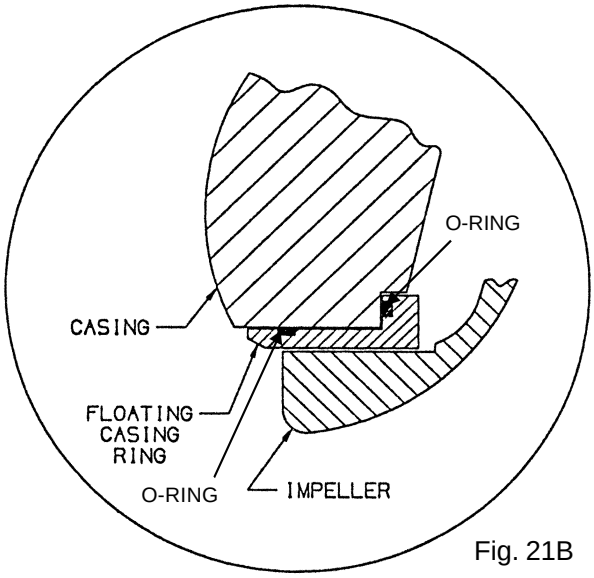


Fig. 21B

ASSEMBLY (PUMP WITH PACKING)

All bearings, O-rings, lip seals, gasket, impeller rings, and casing wear rings should be replaced with new parts during assembly. All reusable parts should be cleaned of all foreign matter before reassembling. The main casing joint gasket can be made using the upper or lower half as a template. Lay the gasket material on the casing joint. Trim the gasket, lightly tapping with a ball peen hammer so that it is flush with the inside edges of the casing.

NOTE: Precut casing gaskets (2-123-5 & 6) can be ordered to minimize the amount of trimming.

1. Assemble the impeller key (3-911-1) in the shaft key slot.

2. Check the impeller (4-002-0) and casing to determine the correct relationship (See Fig. 16) and lo cate the im pel ler on the shaft per di men sion “A” given in the ta ble on Fig. 17.

NOTE: For impeller with replaceable rings, heat each new ring (0-004-0) (approximately 300° - 400° F for bronze) and slide onto the impeller. Using gloves, hold rings against the impeller shoulder until they cool.

3. Starting with the outboard end, apply a 1/4" bead of RTV (DOW CORNING SILICONE SEALANT or equivalent) at the impeller hub face, making sure to fill up the keyway.

4. Slide the sleeve (3-009-9) onto shaft, rotating the sleeve to evenly distribute the sealant applied in step 3. Refer to Optional Method of Installing Packing at the end of this section before mounting sleeve on shaft.

⚠ CAUTION

The pin in each shaft sleeve must seat in the impeller key slot.

5. Place the sleeve O-ring (3-914-9) onto the shaft, into the sleeve counterbore. Assemble the shaft sleeve nut (3-015-9).

6. Repeat steps 3 through 5 for the inboard shaft sleeve, O-ring and nut. Wipe off excess RTV.

7. Verify that Dimension “A” is maintained, then using a pin spanner wrench and hammer, securely tighten the shaft sleeve nuts. Then, drill a shallow recess in the shaft through the set screw hole in each of the shaft sleeve nuts. Lock each shaft sleeve nut in position with serrated head set screws (3-902-3). (See Fig. 22) A low strength sealant, such as Loctite 271, can be used to retain set screws.

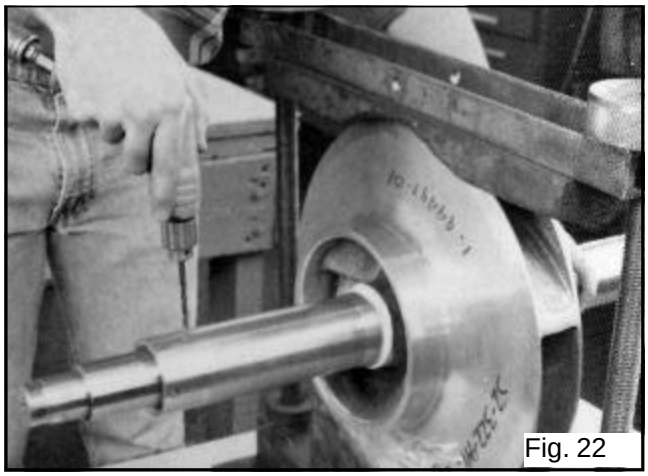


Fig. 22

8. Lubricate and roll an O-ring (3-914-2) into the groove in each casing ring (3-003-9) and slide the casing rings over the impeller (See Fig. 23).

NOTE: 8 x 10-20 and 10 x 12-18 utilize "Floating" Casing Ring Design. Each ring requires 2 O-rings. (See Fig. 21B).

9. Press a new lip seal (3-177-9) into each stuffing box. Before installing the seal, lubricate the lip seal with a lightweight oil.

NOTE: Lip seals should seat against machined shoulder in bracket.

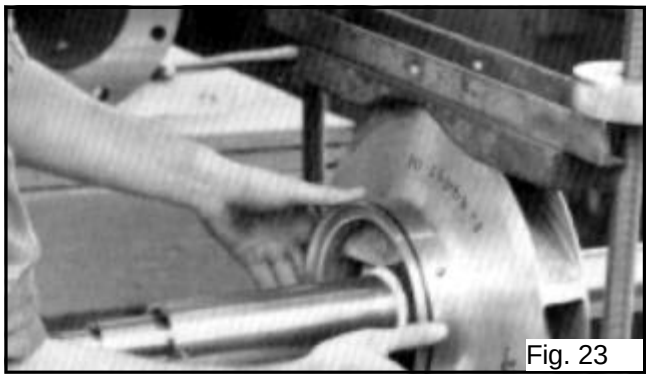


Fig. 23

NOTE: Seal lip should point away from the bearings (3-026-3 and -4), if the bearings are grease lubricated, and towards the bearings, if the bearings are oil lubricated. (See Fig. 24)

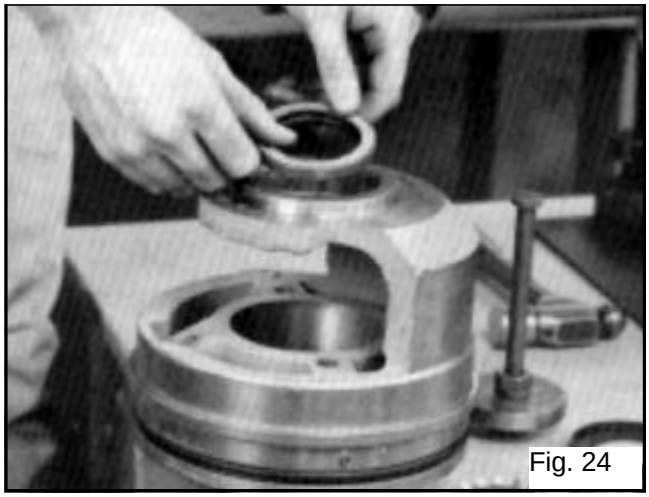


Fig. 24

10. Lubricate and roll O-ring (3-914-1) into the groove in each stuffing box.

11. Slide outboard stuff box onto the shaft so that the shaft end extends through the packing area, but does not enter the lip seal. This will permit installation of deflector (3-136-9).

12. Slide the deflector over the shaft end; then carefully push the shaft end through the lip seal and slide stuffing box fully onto the shaft.

13. Heat the ball bearing (3-026-4), using either dry heat or a 10-15% soluble oil and water solution.

⚠ CAUTION

Do not exceed 275° F.

14. Using gloves, slide the heated bearing onto the shaft against the shaft shoulder (See Fig. 25).

15. Install lockwasher (3-517-4) and locknut (3-516-4)

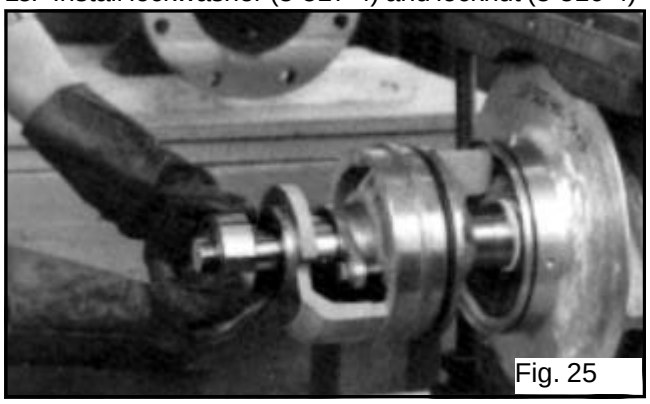


Fig. 25

on the outboard end of the shaft. Make certain locknut is secured and then bend over tabs on lockwasher.

16. Allow the bearing to cool to room temperature. On grease lubricated bearings only, coat the exposed sides with two or three ounces of recommended grease.

17. On grease lubricated bearings, coat the inside of the bearing housing (3-025-4) with grease and slide into place over bearing. Attaching the bearing housing to the stuffing box with four cap screws (3-904-9).

18. Repeat steps 11 through 14, 16, and 17 for the inboard end.

NOTE: A locknut and lockwasher are not installed on the inboard end of the shaft.

19. Clean the gasket surfaces of the casing. Apply Scotch 3M-77 spray adhesive or equivalent to the lower half of the casing.

20. Within one minute of spraying, set the untrimmed gaskets (2-123-5 and -6) in place on the lower half casing, align the holes in the gaskets with the holes in the casing and press the gaskets firmly against the lower half casing face in the area coated by the adhesive.

21. Trim the gaskets **flush** with the lower casing bores, if this has not been done as yet.

⚠ CAUTION

Machined casing bores must remain sharp at the casing parting line. Gaskets must be flush with bore in order to contact O-rings. Leakage can result around stuff box O-ring if this step is not properly followed.

22. Set the rotating element in the pump casing (2-001-0), assuring correct rotation. Locate both stuffing box tongues in their respective casing grooves. Locate pins (3-943-9) in the stuffing box and the casing wear rings in their respective slots at the casing parting surface. Correct any O-ring bulging. (See Fig. 26)

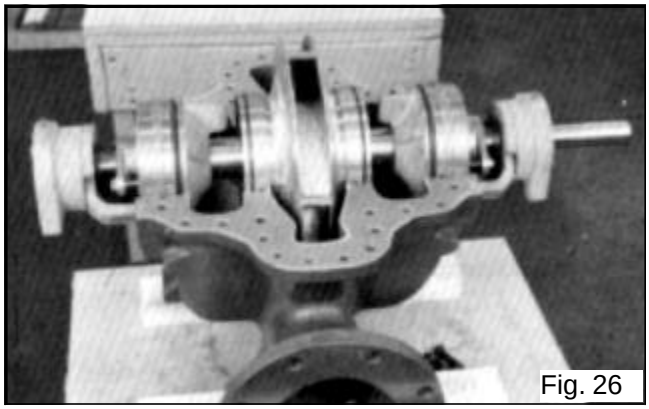


Fig. 26

⚠ CAUTION

Do not cut or damage O-rings when lowering the rotating element into position. When all four anti-rotation pins (3-943-9) are correctly located, there will be some casing ring looseness.

23. Lower the upper half casing (2-001-0) into place using the tapered dowel pins (2-916-1) and install casing main joint bolts (2-904-1). The casing joint bolts should be tightened to the following torques: 140 ft-lb minimum for 5/8"-11 hex head cap screws (Grade 5); 350 ft-lb minimum for 7/8"-9 Ferry Cap Countr-bor screws (Grade 8). Bolt torquing pattern is shown in Fig. 58, page 55.

NOTE: Torquing bolts to proper values in proper sequence is essential in obtaining proper gasket compression so no leakage can occur at main joint.

24. Rotate the shaft by hand to assure that it turns smoothly and is free from rubbing or binding.

25. Install seal water piping (0-952-0), if supplied.

PACKING (NON-ASBESTOS)

26. Install 12 full rings of packing (6 per stuffing box) so that the ends butt, leaving no gap between the packing and the stuffing box. (Refer to the table in Fig. 17 for packing size.) Tamp the packing fully to the bottom of the stuffing box. Stagger the joints of each packing ring at least 90 degrees. For 3 adjacent rings, use the 4, 8 and 12 o'clock positions.

NOTE: The last ring in each box may not be required until after the pump has operated for a period of time.

NOTE: When supplied, the seal cage will replace the third packing ring from the bottom, requiring only 5 rings of packing per stuffing box. The seal cage must aligned with the seal water inlet when the packing is compressed.

Assemble the glands (1-014-9), washers (0-909-0), and bolts (1-904-9) square with the stuffing box and pull up tight. Then loosen the gland bolts (1-904-9) to permit the packing to expand. Then retighten finger tight. Final adjustment of the gland bolts must be done with the pump running. Allow 30 minutes between adjustments. A good adjustment should allow approximately one (1) drip per second from each gland.

OPTIONAL METHOD FOR INSTALLING PACKING (AFTER PUMP DISASSEMBLY)

Place stuffing box (3-073-9) on a table or workbench with the stuffing box opening up. Assemble the packing per step 26 with the shaft sleeve placed in the stuffing box. After completing step 26, remove shaft sleeve and continue to assemble pump per step 4.

The entire assembly may then be placed into position over the sleeve in step 11.

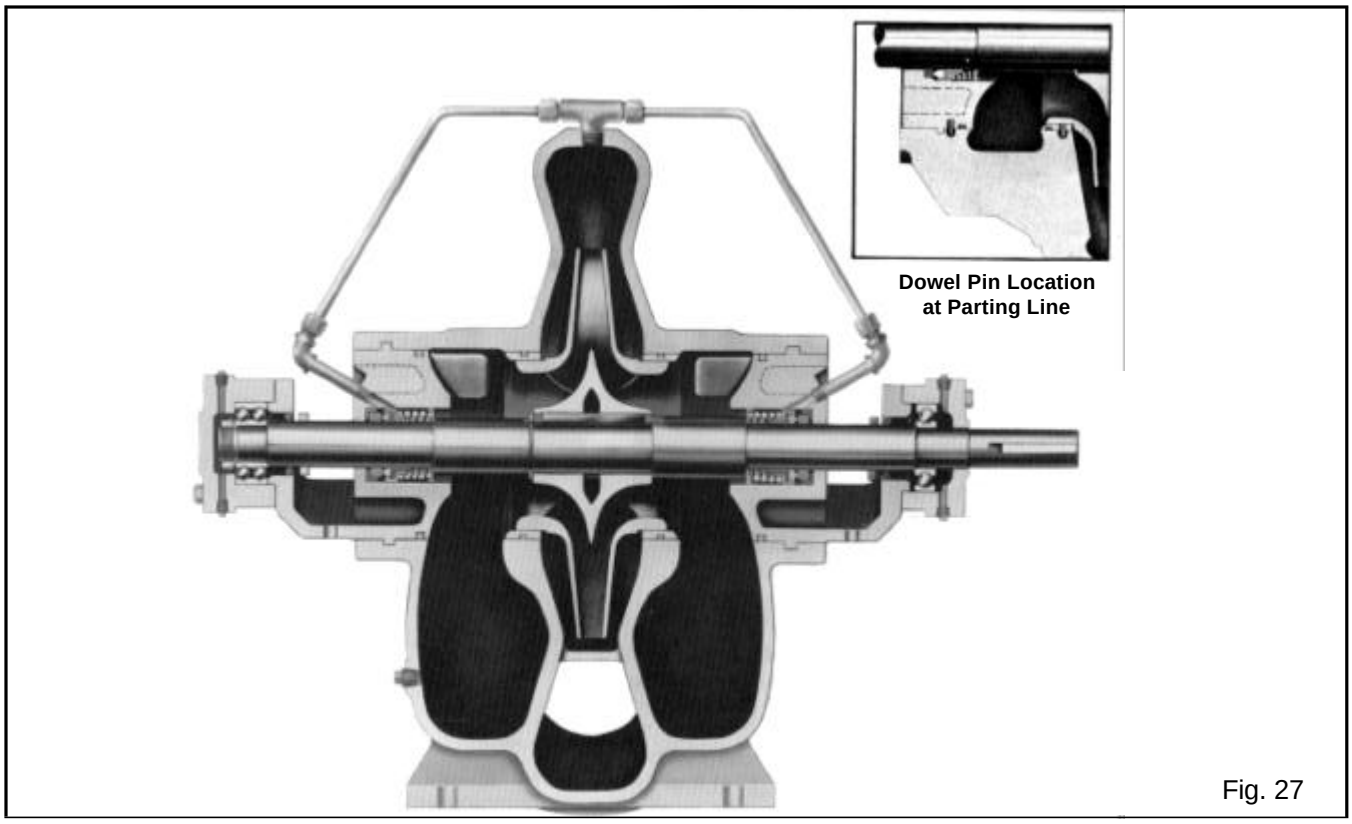


Fig. 27

DISMANTLING (PUMP WITH MECHANICAL SEALS ON SHAFT)

⚠ WARNING

Prior to working on pump the power source should be disconnected with lockout provisions so power cannot be re-energized to the motor. Close isolating suction and discharge valves. Failure to follow these instructions could result in properly damage, sever personal injury, or death. (See exploded view on page 64.)

1. Drain the pump by opening vent plug (A, Fig. 28) and remove drain plugs (B and C) on the suction and discharge nozzles.

2. Remove all casing main joint cap screws (2-904-1) and dowels (2-916-1). Remove external tubing (0-952-0).

3. Insert a screwdriver or pry bar into the slots between the upper and lower casing halves, and separate the halves, lifting off the upper casing half.

NOTE: Some casings have jacking screws.

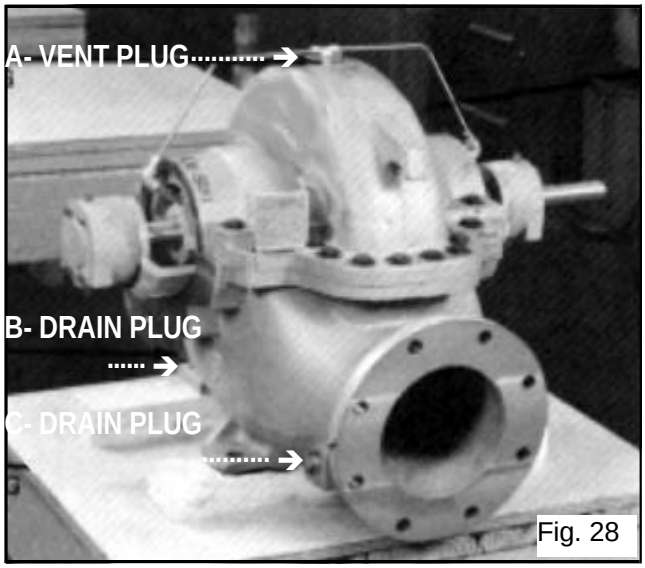


Fig. 28

4. Tap the stuffing boxes with a soft-headed hammer to break the seal between the stuffing box and lower casing half, and lift the rotating element out of the lower casing. Rotating element may now be removed to suitable location to work on.

NOTE: A spare rotating element can be installed at this point.

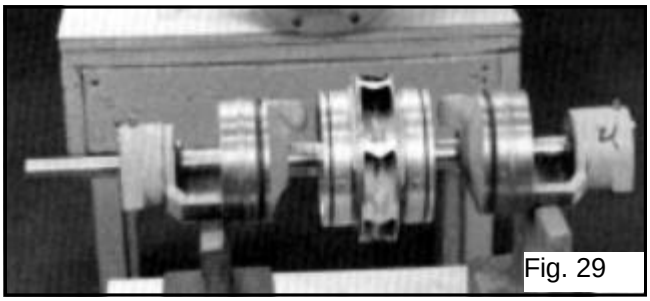


Fig. 29

5. Remove four cap screws (3-904-9) from each bearing housing (3-025-3 and -4) and remove the bearing housings from the shaft (3-007-0).

6. Bend back lockwasher tab and remove locknut (3-516-4) and lockwasher (3-517-4) from the outboard end of the shaft and, using a puller, remove the outboard bearing (3-026-4) from the shaft. Remove the inboard end bearing (3-026-3) in the same manner.

NOTE: Locknut and lockwasher are not used on inboard end bearing.

⚠ CAUTION

Do not reuse the ball bearings.

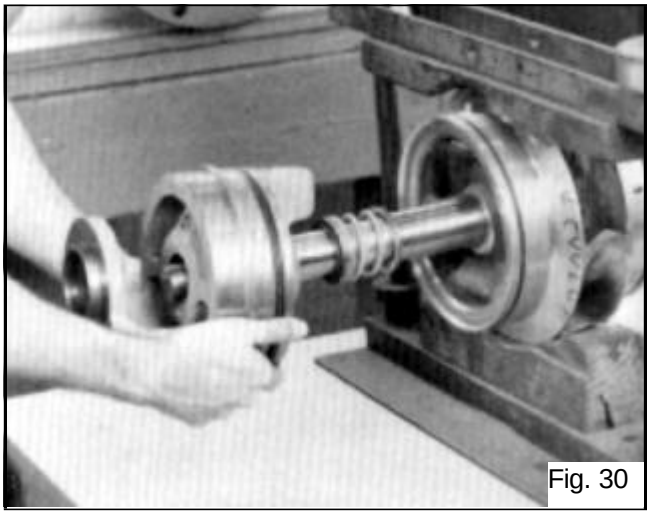


Fig. 30

7. Slide both stuffing boxes (3-073-9) off of the shaft, working deflector rings (3-136-9) off the shaft at the same time. (See Fig. 30)

8. Remove lip seals (3-177-9) and O-rings (3-914-1) from the stuffing boxes.

9. Drive both mechanical seal seats (3-401-0) from both the stuffing boxes.

Fig. 31

10. Remove mechanical seal head (3-402-0) from the pump shaft.

11. Remove two casing rings (3-003-9) from the impeller (4-002-0) and remove O-ring (3-914-2) from each casing ring. (See Fig. 31)

12. Remove the impeller retaining ring (3-915-1) with retaining ring pliers (Fig. 32). Heat the impeller hub on both ends to 350° F maximum, and pull or push the impeller from the shaft. (Instead of heating impeller, you may press impeller off of shaft, if a press is available.)

NOTE: Press away from coupling end.

NOTE: For impellers with replaceable rings — remove the rings (0-004-0), if necessary, by cutting with a cold chisel. (See Fig. 33)

13. Remove the impeller key (3-911-1) from the shaft.

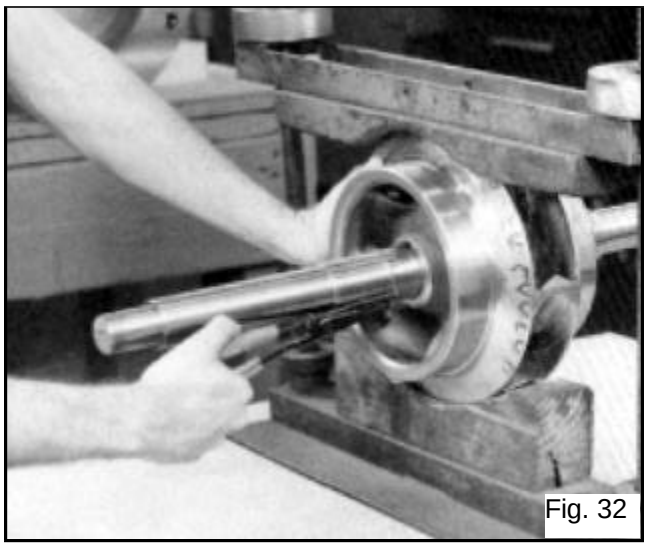


Fig. 32

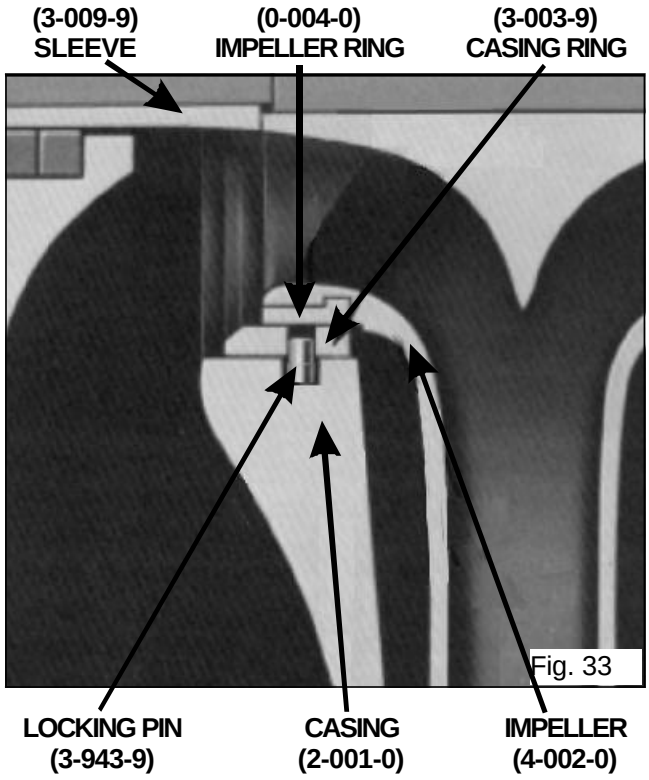


Fig. 33

ASSEMBLY (PUMP WITH MECHANICAL SEALS ON SHAFT)

All bearings, O-rings, lip seals, mechanical seals, gaskets, impeller rings, and casing rings should be replaced with new parts during assembly. All reusable parts should be cleaned of all foreign matter before reassembling. The main casing joint gasket can be made using the upper or lower half as a template. Lay the gasket material on the casing joint. Trim the gasket by lightly tapping with a ball peen hammer so that it is flush with the inside edges of the casing.

NOTE: Precut casing gaskets (2-123-5 & -6) can be ordered to minimize the amount of trimming.

1. Assemble the impeller key (3-911-1) in the shaft key slot.

2. Check the impeller (4-002-0) and casing to determine the correct relationship (See Fig. 16). Heat the impeller evenly to 300° F maximum to expand the bore. (Impeller may be pressed onto the shaft instead of heating if a suitable press is available. (See Fig. 34)

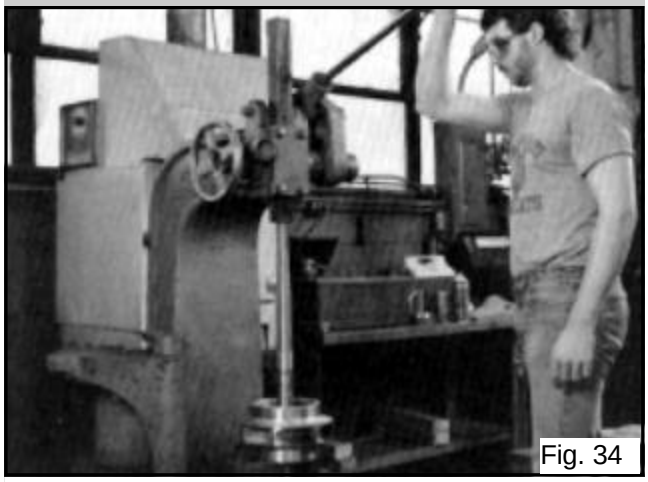


Fig. 34

NOTE: For impeller with replaceable rings, heat each new ring (0-004-0) (approximately 300° F - 400° F for bronze) and slide onto the impeller. Using gloves, hold rings against the impeller should until they cool.

3. From the outboard end, slide the heated impeller (4-002-0), using gloves, onto the shaft (3-007-0) against the shaft shoulder, and install retaining ring (3-915-1).

4. Lubricate and roll an O-ring (3-914-2) into the groove in each casing ring (3-003-9) and slide the casing rings over the impeller.

5. Thoroughly clean the stuffing boxes (3-073-9) to prevent dirt from entering the seal during startup.

6. Press the stationary seats (0-400-0) of the mechanical seals into both stuffing boxes, with the lapped surface facing the impeller. Lightly lubricate the stuffing box bore to ease assembly. (See Fig. 35)


Fig. 35

7. Press a new lip seal (3-177-9) into each stuffing box. Before installing the lip seal, lubricate the lip seal with a lightweight oil.

NOTE: Lip seals should seat against machined shoulder in bracket.

NOTE: Seal lip should point away from the bearings (3-026-3 and -4), if the bearings are grease lubricated, and towards the bearings, if the bearings are oil lubricated.

8. Lubricate and roll O-ring (3-914-1) into the groove in each stuffing box.

NOTE: Steps 9 through 21 must be completed within 10 to 12 minutes to assure proper placement of mechanical seal. The mechanical seal used has an adhesive on the inner diameter of the elastomer. The rotating element must go into the casing before this sealant bonds to sleeve.

9. Lightly coat the outboard end of the shaft with STP motor oil treatment or equal and slide the mechanical seal head (0-400-0) onto the shaft (See Fig. 36).

NOTE: Standard mechanical seal for this arrangement is a modified John Crane, Type 21 Mechanical Seal.

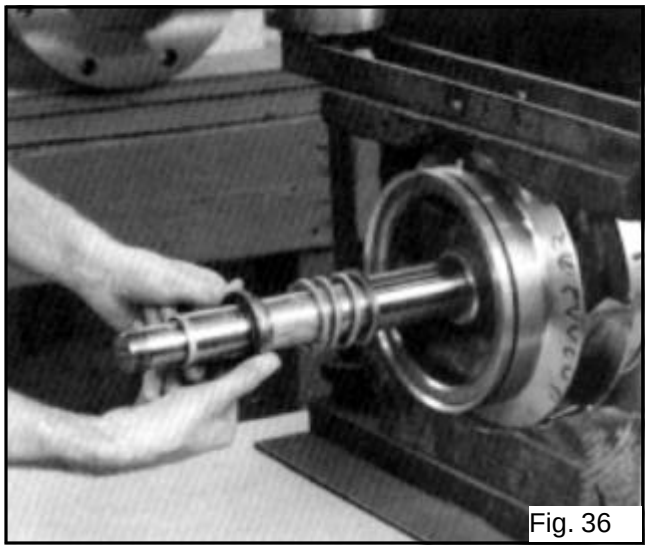


Fig. 36

10. Slide one of the stuffing boxes on the shaft so that the shaft end extends through the mechanical seal area, but does not enter the lip seal. This will permit installation of deflector (3-136-9).

11. Slide the deflector over the shaft end; then carefully push the shaft end through the lip seal and slide stuffing box fully onto the shaft.

NOTE: Compress the seal spring only as far as required to install bearings.

12. Heat the ball bearing (3-026-4), using either dry heat or a 10-15% soluble oil and water solution.

⚠ CAUTION

Do not exceed 275° F.

13. Using gloves, slide the heated bearing onto the shaft against the shaft shoulder. (See Fig. 37)

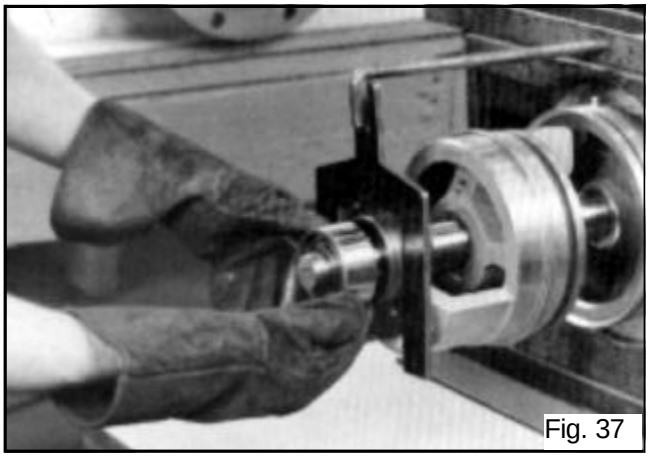


Fig. 37

14. Install lockwasher (3-517-4) and locknut(3-516-4) on the outboard end of the shaft. Make certain locknut is secured and then bend over tabs on lockwasher.

15. Allow the bearing to cool to room temperature. On grease lubricated bearings only, coat the exposed sides with two or three ounces of recommended grease.

16. On grease lubricated bearings, coat the inside of the bearing housing (3-025-4) with grease and slide into place over bearing. Attaching the bearing housing to the stuffing box with four cap screws (3-904-9).

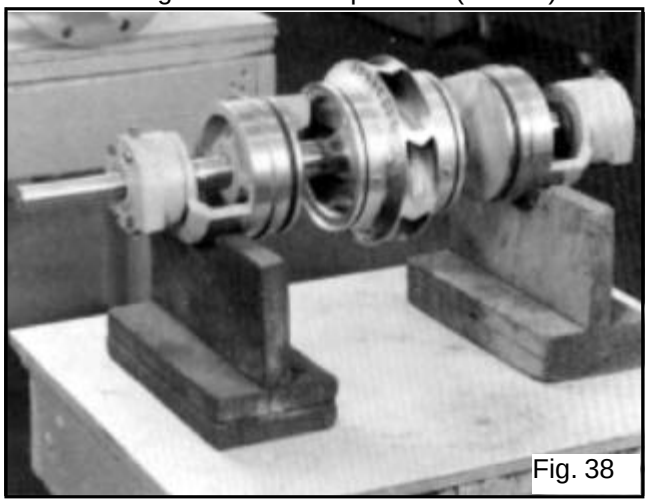


Fig. 38

17. Repeat steps 9 through 13, 15 and 16 for the inboard end.

NOTE: A locknut and lockwasher are not installed on the inboard end of the shaft.

18. Clean the gasket surfaces of the casing. Apply Scotch 3M-77 spray adhesive or equivalent to the lower half of the casing.

19. Within one minute of spraying, set the untrimmed gaskets (2-123-5 and -6) in place on the lower half casing, align the holes in the gaskets with the holes in the casing and press the gaskets firmly against the lower half casing face in the area coated by the adhesive.

20. Trim the gaskets **flush** with the lower casing bores, if this has not been done as yet.

⚠ CAUTION

Machined casing bores must remain sharp at the casing parting line. Gaskets must be flush with bore in order to contact O-rings. Leakage can result around stuff box O-ring if this step is not properly followed.

21. Set the rotating element (Fig. 38) in the pump casing (2-001-0), assuring correct rotation. Locate both stuffing box tongues in their respective casing grooves. Locate pins (3-943-9) in the stuffing box and the casing wear rings in their respective slots at the casing parting surface. Correct any O-ring bulging.

⚠ CAUTION

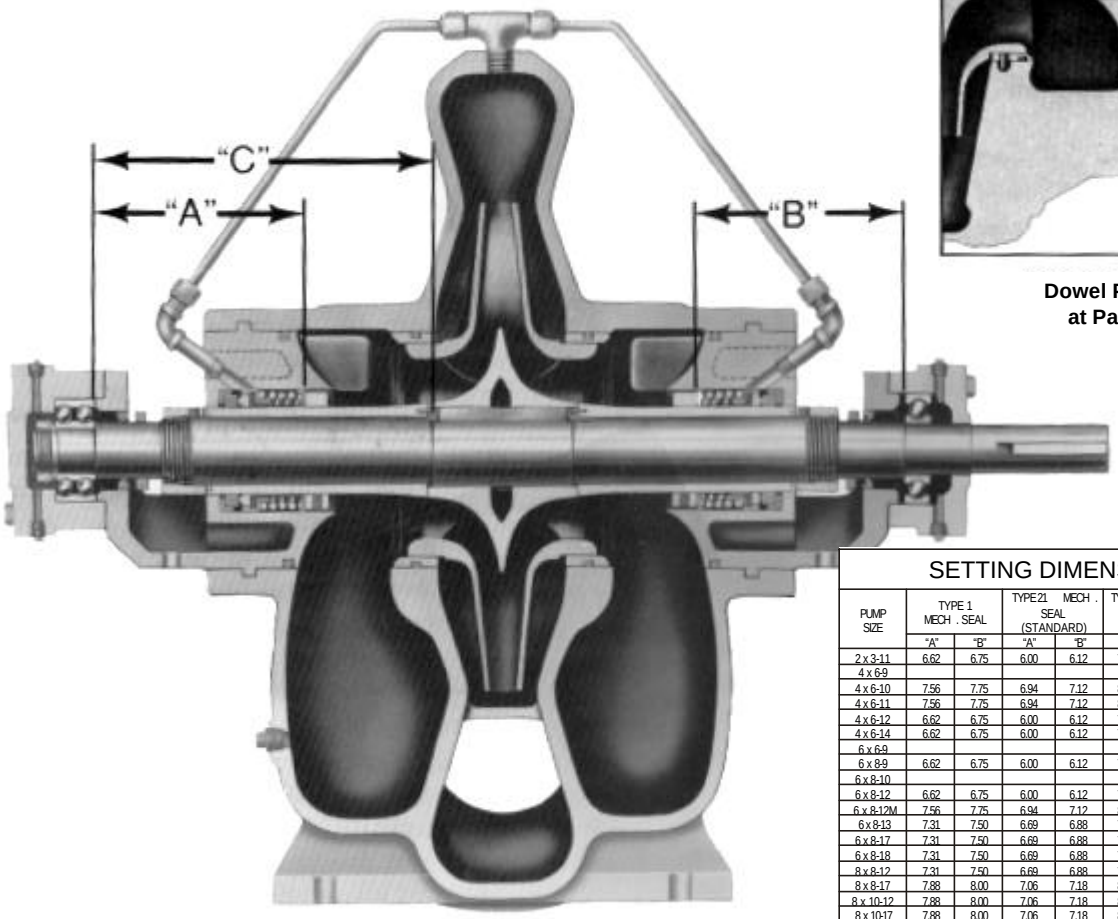
Do not cut or damage O-rings when lowering the rotating element into position. When all four anti-rotation pins (3-943-9) are correctly located, there will be some casing ring looseness.

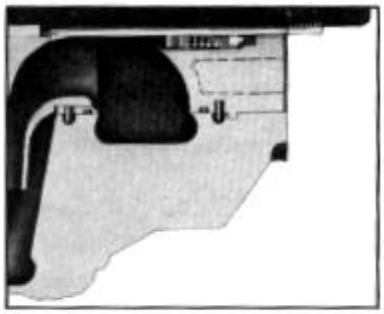
22. Lower the upper half casing (2-001-0) into place using the tapered dowel pins (2-916-1) and install casing main joint bolts (2-904-1). The casing joint bolts should be tightened to the following torques: 140 ft-lb minimum for 5/8"-11 hex head cap screws (Grade 5); 350 ft-lb minimum for 7/8"-9 Ferry Cap Countr-bor screws (Grade 8). bolt torquing pattern is shown in Fig. 58, page 55.

NOTE: Torquing bolts to proper values in proper sequence is essential in obtaining proper gasket compression so no leakage can occur at main joint.

23. Rotate the shaft by hand to assure that it turns smoothly and is free from rubbing or binding.

24. Install seal water piping (0-952-0).





Dowel Pin Location at Parting Line

SETTING DIMENSIONS

PUMP SIZE	TYPE 1 MECH. SEAL		TYPE 21 MECH. SEAL (STANDARD)		TYPE 1B MECH. SEAL		IMPELLER LOCATING DIMENSIONS
	"A"	"B"	"A"	"B"	"A"	"B"	"C"
2 x 3-11	6.62	6.75	6.00	6.12	7.00	7.12	8.755
4 x 6-9							9.312
4 x 6-10	7.56	7.75	6.94	7.12	8.06	8.25	10.625
4 x 6-11	7.56	7.75	6.94	7.12	8.06	8.25	10.625
4 x 6-12	6.62	6.75	6.00	6.12	7.00	7.12	9.755
4 x 6-14	6.62	6.75	6.00	6.12	7.00	7.12	9.755
6 x 6-9							9.312
6 x 8-9	6.62	6.75	6.00	6.12	7.00	7.12	9.755
6 x 8-10							10.625
6 x 8-12	6.62	6.75	6.00	6.12	7.00	7.12	9.755
6 x 8-12M	7.56	7.75	6.94	7.12	8.06	8.25	10.625
6 x 8-13	7.31	7.50	6.69	6.88	7.81	8.00	10.625
6 x 8-17	7.31	7.50	6.69	6.88	7.81	8.00	10.625
6 x 8-18	7.31	7.50	6.69	6.88	7.81	8.00	10.625
8 x 8-12	7.31	7.50	6.69	6.88	7.81	8.00	10.625
8 x 8-17	7.88	8.00	7.06	7.18	8.25	8.36	11.495
8 x 10-12	7.88	8.00	7.06	7.18	8.25	8.36	11.495
8 x 10-17	7.88	8.00	7.06	7.18	8.25	8.36	11.495
8 x 10-20	7.88	8.00	7.06	7.18	8.25	8.36	11.495
10 x 10-12	7.88	8.00	7.06	7.18	8.25	8.36	12.995
10 x 12-12	7.88	8.00	7.06	7.18	8.25	8.36	12.995
10 x 12-14	7.88	8.00	7.06	7.18	8.25	8.36	11.495
10 x 12-17	7.88	8.00	7.06	7.18	8.25	8.36	11.495
10 x 12-18	7.88	8.00	7.06	7.18	8.25	8.36	11.495

Fig. 39

6

DISMANTLING (PUMP WITH MECHANICAL SEALS ON SHAFT SLEEVES)

⚠ WARNING

Prior to working on pump the power source should be disconnected with lockout provisions so power cannot be re-energized to the motor. Close isolating suction and discharge valves. Failure to follow these instructions could result in property damage, severe personal injury, or death. (See explosion view on page 65.)

1. Drain the pump by opening vent plug (A, Fig. 40) and remove drain plugs (B and C) on the suction and discharge nozzles.
2. Remove all casing main joint cap screws(2-904-1) and dowels (2-916-1). Remove external tubing (0-952-0) if supplied.
3. Insert a screwdriver or pry bar into the slots between the upper and lower casing halves, and separate the halves, lifting off the upper casing half.

NOTE: Some casings have jacking screws.

4. Tap the stuffing boxes with a soft-headed hammer to break the seal between the stuffing box and lower casing half, and lift the rotating element out of the lower casing. Rotating element may now be removed to a suitable location to work on. (See Fig. 41)

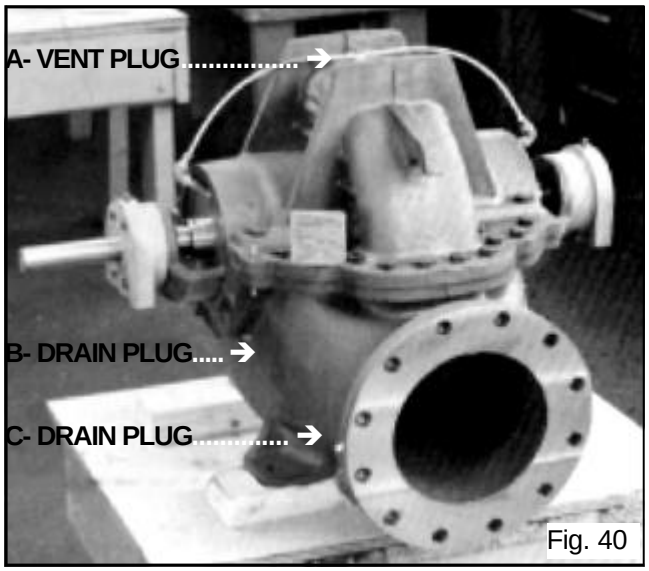


Fig. 40

NOTE: A spare rotating element can be installed at this point.

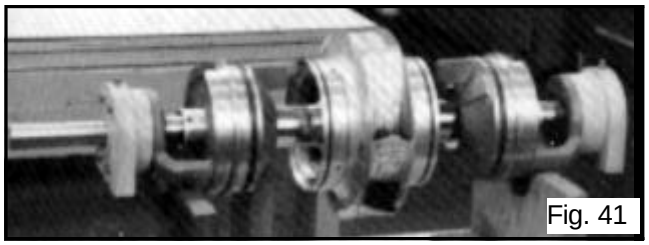


Fig. 41

5. Remove four cap screws (3-904-9) from each bearing housing (3-025-3 and -4) and remove the bearing housings from the shaft (3-007-0).

6. Bend back lockwasher tab and remove locknut (3-516-4) and lockwasher (3-517-4) from the outboard end of the shaft and, using a puller, remove the bearing (3-026-4) from the shaft. Remove the inboard end bearing (3-026-3) in the same manner.

NOTE: Locknut and lockwasher are not used on inboard end bearing.

⚠ CAUTION

Do not reuse the ballbearings.

7. Slide both stuffing boxes (3-073-9) off of the shaft, working deflector rings (3-136-9) off the shaft at the same time. (See Fig. 42)

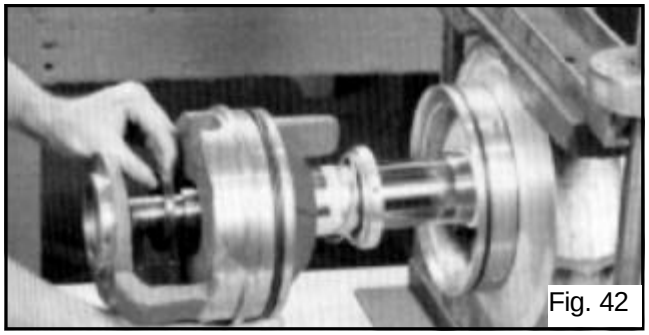


Fig. 42

Remove lip seals (3-177-9) and O-rings (3-914-1) from the stuffing boxes.

9. Drive both mechanical seal seats (3-401-0) from both the stuffing boxes.

10. Remove mechanical seal head (0-400-0) from the pump shaft sleeve. If the set collar (3-421-9) must be removed, scribe a line on the shaft sleeve (3-009-9) flush with the end of the seal (to record mechanical seal location).

11. Remove two casing rings (3-003-9) from the impeller (4-002-0) and remove O-rings (3-914-2) from each casing ring. (See Fig. 43)

NOTE: Each casing ring on 8 x 10-20 and 10 x 12-18 has 2 O-rings. (See Fig. 21B)

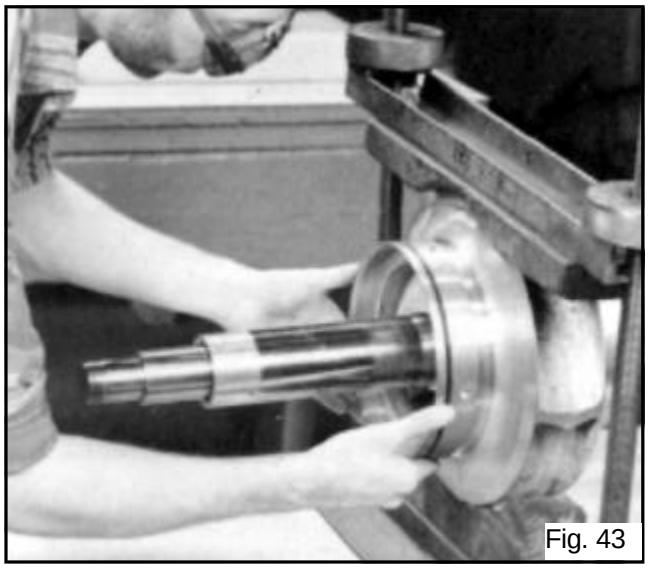


Fig. 43

12. Loosen set screw (3-902-3) in shaft nuts (3-015-9) and then remove sleeve nuts using pin spanner wrench. Remove O-rings (3-914-9) from counterbore in shaft sleeves.

NOTE: Both shaft nuts have right hand threads.

13. To remove the sleeve, hold the shaft vertically and tap it on a block of wood. The impeller weight should force both the impeller (4-002-0) and sleeve (3-009-9) from the shaft.

NOTE: There is a silicone adhesive/sealant between the sleeve and the impeller.

14. Remove the other seal, shaft sleeve, sleeve O-ring and nut as described in steps 11, 12, and 13.

15. Remove the impeller key (3-911-1) from the shaft (3-007-0).

NOTE: For impellers with replaceable rings - remove the rings (0-004-0), if necessary, by cutting with a cold chisel. (See Fig. 44)

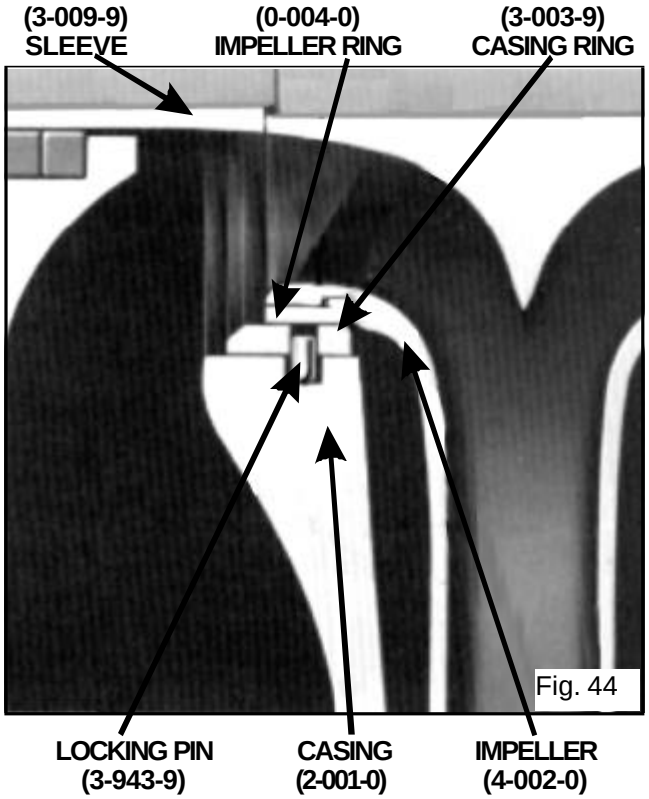


Fig. 44

ASSEMBLY (PUMP WITH MECHANICAL SEALS ON SHAFT SLEEVES)

All bearings, O-rings, lip seals, mechanical seals, gaskets, impeller rings, and casing rings should be replaced with new parts during assembly. All reusable parts should be cleaned of all foreign matter before reassembling. The main casing joint gasket can be made using the upper or lower half as a template. Lay the gasket material on the casing joint. Trim the gasket by lightly tapping with a ball peen hammer so that it is flush with the inside edges of the casing.

NOTE: Precut casing gaskets (2-123-5 & -6) can be ordered to minimize the amount of trimming.

1. Assemble the impeller key (3-911-1) in the shaft key slot.

2. Check the impeller (4-002-0) and casing to determine the correct relationship (See Fig. 16) and locate the impeller on the shaft per dimension “C” given in the table on Fig. 39.

NOTE: For impeller with replaceable rings, heat each new ring (0-004-0) (approximately 300° - 400° F for bronze) and slide onto the impeller. Using gloves, hold rings against the impeller should until they cool.

3. Starting with the outboard end, apply a 1/4" bead of RTV (DOW CORNING SILICONE SEALANT or equivalent) at the impeller hub face, making sure to fill up the keyway.

4. Slide the sleeve (3-009-9) onto shaft, rotating the sleeve to evenly distribute the sealant applied in step 3.

⚠ CAUTION

The pin in each shaft sleeve must seat in the impeller key slot.

5. Place the sleeve O-ring (3-914-0) onto the shaft, into the sleeve counterbore. Assemble the shaft sleeve nut (3-015-9).

6. Repeat steps 3 through 5 for the inboard shaft sleeve, O-ring and nut. Wipe off excess RTV.

7. Verify that dimension "C" is maintained, then using a pin spanner wrench and hammer, securely tighten the shaft sleeve nuts. Then drill a shallow recess in the shaft through the set screw hole in each of the shaft sleeve nuts. Lock each shaft sleeve nut in position with set screws (3-902-3). A low strength sealant, such as Loctite 271, can be used to retain set screws. (See Fig. 45)

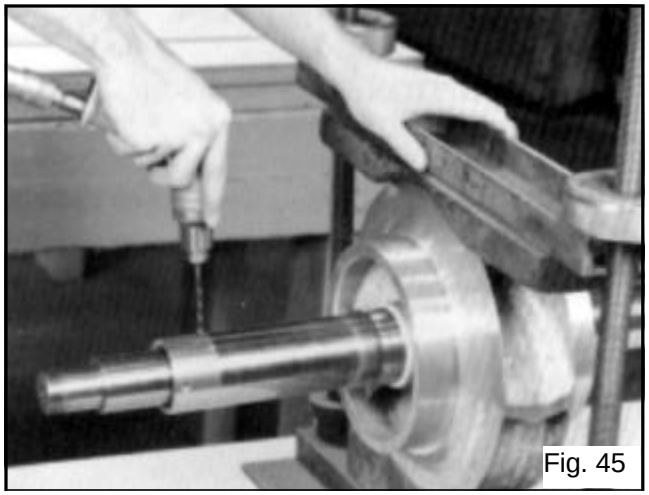


Fig. 45

8. Lubricate and roll an O-ring (3-914-2) into the groove in each casing ring (3-003-9) and slide the casing rings over the impeller.

NOTE: 8 x 10-20 and 10 x 12-18 utilize "Floating" Casing Ring Design. Each ring requires 2 O-rings. (See Fig. 21B)

9. Thoroughly clean the stuffing boxes (3-073-9) to prevent dirt from entering the seal during startup.

10. Press the stationary seats (0-400-0) of the mechanical seals into both stuffing boxes with the lapped surface facing the impeller. Lightly lubricate the stuffing box bore to ease assembly.

11. Press a new lip seal (3-177-9) into each stuffing box. Before installing the lip seal, lubricate the lip seal with a lightweight oil.

NOTE: Lip seals should seat against machined shoulder in bracket.

NOTE: Seal lip should point away from the bearings (3-026-3 and -4), if the bearings are grease lubricated, and towards the bearings, If the bearings are oil lubricated.

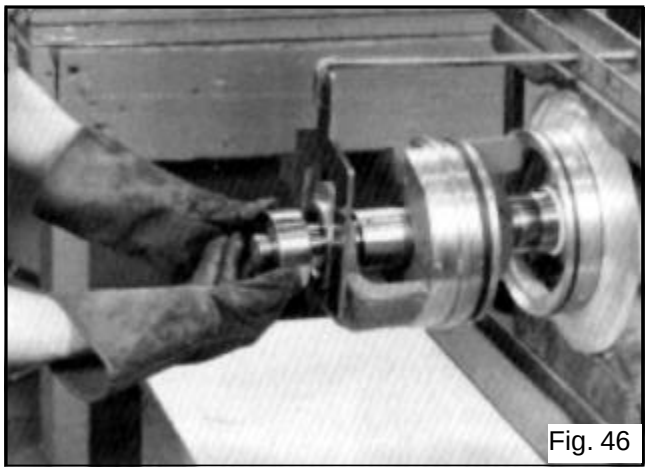


Fig. 46

12. Lubricate and roll O-ring (3-914-1) into the groove in each stuffing box.

13. Obtain the set collar (3-421-9) locating dimension from the table on Fig. 39 and scribe the dimension on the shaft sleeve. Install set collar on sleeve per this dimension. (Reference dimensions "A" and "B" on Fig. 39.)

NOTE: Each set collar has two set screws. To positively secure each set collar, drill a shallow recess in sleeve through the set screw holes. Retain set screws with a low strength Loctite, 271, or equal.

NOTE: Steps 14 through 26 must be completed within 10 to 12 minutes to assure proper placement of mechanical seals. The mechanical seal used has an adhesive on the inner diameter of the elastomer. The rotating element must go into the casing before this sealant bonds to sleeve.

14. Lightly coat the outboard end of the shaft sleeve with STP motor oil treatment or equal and slide the mechanical seal head (0-400-0) onto the shaft sleeve against the set collar. (See Fig. 47)

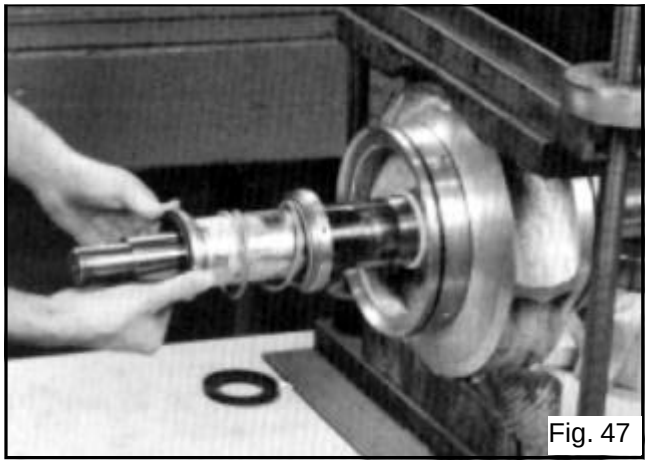


Fig. 47

15. Slide outboard end of stuff box onto the shaft so that the shaft end extends through the mechanical seal area, but does not enter the lip seal. This will permit installation of deflector (3-136-9).

16. Slide the deflector over the shaft end; then carefully push the shaft end through the lip seal and slide stuffing box fully onto the shaft.

NOTE: Compress the seal spring only as far as required to install bearings.

17. Heat the ball bearing (3-026-4), using either dry heat or a 10-15% soluble oil and water solution.

⚠ CAUTION

Do not exceed 275° F.

18. Using gloves, slide the heated bearing onto the shaft against the shaft shoulder (See Fig. 48).

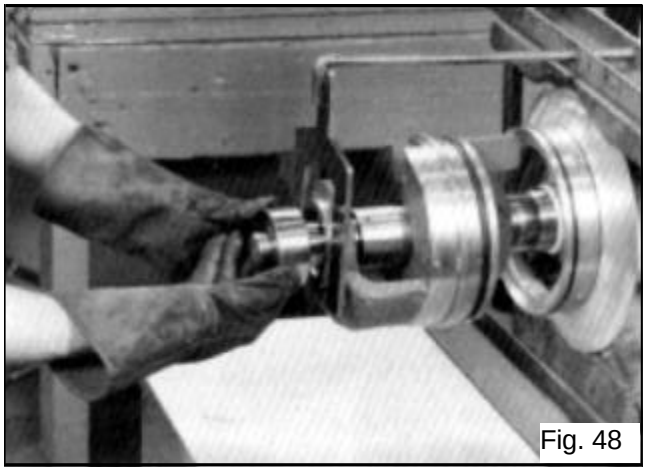


Fig. 48

19. Install lockwasher (3-517-4) and locknut (3-516-4) on the outboard end of the shaft. Make certain locknut is secured and then bend over tabs on lockwasher.

20. Allow the bearing to cool to room temperature. On grease lubricated bearings only, coat the exposed sides with two or three ounces of recommended grease.

21. On grease lubricated bearings, coat the inside of the bearing housing (3-025-4) with grease and slide into place over bearing. Attaching the bearing housing to the stuffing box with four cap screws (3-904-9)

22. Repeat steps 14 through 18, 20 and 21 for the inboard end.

NOTE: A locknut and lockwasher are not installed on the inboard end of the shaft.

23. Clean the gasket surfaces of the casing. Apply Scotch 3M-77 spray adhesive or equivalent to the lower half of the casing.

24. Within one minute of spraying, set the untrimmed gasket (2-123-5 and -6) in place on the lower half casing, align the holes in the gaskets with the holes in the casing and press the gaskets firmly against the lower half casing face in the area coated by the adhesive.

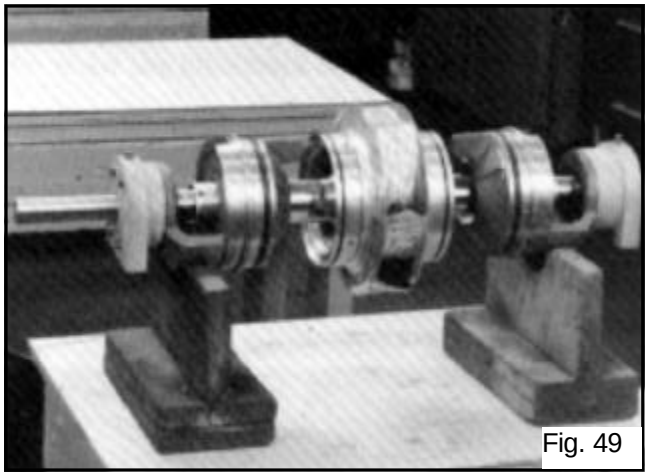


Fig. 49

25. Trim the gaskets **flush** with the lower casing bores, if this has not been done as yet.

⚠ CAUTION

Machined casing bores must remain sharp at the casing parting line. Gaskets must be flush with bore in order to contact O-rings. Leakage can result around stuff box O-ring if this step is not properly followed.

26. Set the rotating element (Fig. 49) in the pump casing (2-001-0), assuring correct rotation. Locate both stuffing box tongues in their respective casing grooves. Locate pins (3-943-9) in the stuffing box and the casing wear rings in their respective slots at the casing parting surface. Correct any O-ring bulging. (See Fig. 50)

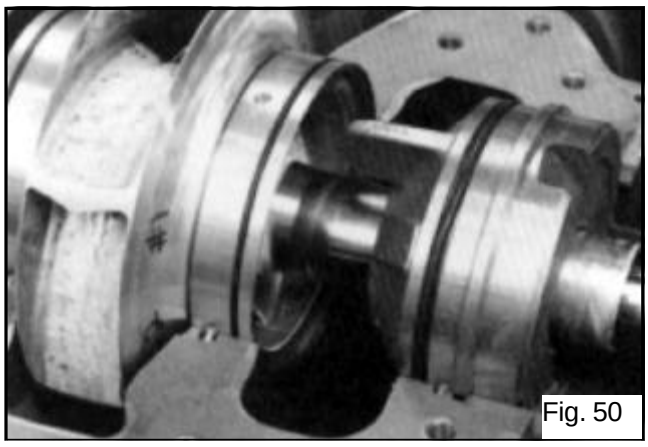


Fig. 50

⚠ CAUTION

Do not cut or damage O-ring when lowering the rotating element into position. When all four anti-rotation pins (3-943-9) are correctly located, there will be some casing ring looseness.

27. Lower the upper half casing (2-001-0) into place using the tapered dowel pins (2-916-1) and install casing main joint bolts (2-904-1). The casing joint bolts should be tightened to the following torques: 140 ft-lb minimum for 5/8"-11 hex head cap screws (Grade 5); 350 ft-lb minimum for 7/8"-9 Ferry Cap Counter-bor screws (Grade 8). Bolt pattern is shown in Fig. 58, page 55.

NOTE: Torquing bolts to proper values in proper sequence is essential in obtaining proper gasket compression so no leakage can occur at main joint.

28. Rotate the shaft by hand to assure that it turns smoothly and is free from rubbing or binding.

29. Install seal water piping (0-952-0).

OIL LUBRICATED BEARINGS

This section describes how to change the oil for oil lubricated bearings. Fig. 51 shows a typical oiler assembly.

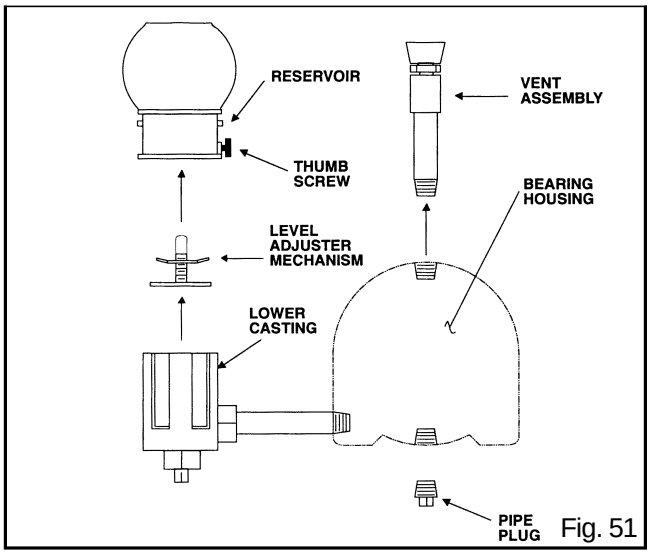


Fig. 51

1. Remove the vent assembly from the top of the bearing housing.

2. Remove the pipe plug from the bottom of the bearing housing.

3. Loosen the thumb screw on the side of the oiler. Lift and remove the reservoir.

4. Flush the oiler and bearing housing with a light grade of oil. Flush until all foreign particles have been removed.

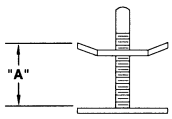
5. Screw the pipe plug and vent assembly back into place.

6. Using the predetermined heights from Table 1, set the level adjuster mechanism.

7. Place the level adjuster back in the lower casting.

TABLE 1 - LEVEL ADJUSTER HEIGHTS

PUMP SIZE	"A" DIMENSION	
	Inboard	Outboard
8 x 8-17, 8 x 10-12, 8 x 10-17	1.22	0.53
10 x 10-12, 10 x 12-12		
10 x 12-14, 10 x 12-17		
8 x 10-20, 10 x 12-18		
4 x 6-10, 6 x 8-13, 4 x 6-11	0.53	0.56
6 x 8-10, 6 x 8-17, 6 x 8-18		
6 x 8-12M, 8 x 8-12		
2 x 3-11, 4 x 6-9, 4 x 6-12	1.12	1.12
4 x 6-14, 6 x 6-9, 6 x 8-9		
6 x 8-12		



8. Fill the reservoir with a good grade of filtered mineral oil. Refer to oil lubrication instructions given previously in this manual for type of oil.

NOTE: You must fill through Trico reservoir.

9. Back out the thumb screw on the side of the lower casting so it will not interfere with setting the reservoir in the lower casting.

10. Place thumb over reservoir spout, invert and place reservoir on lower casting while removing thumb. Allow reservoir to empty, filling the bearing housing. Several fillings of the reservoir may be required before the actual level is reached. When the oil level is reached, no more oil will run out of the reservoir.

11. Retighten thumb screw.

After the pump has been started, trial adjustments should be made to the level adjuster mechanism to prevent too high or too low of oil levels. Adjust by repeating steps 6 through 11.

A periodic filling of the reservoir is required. When the oil becomes dirty, repeat steps 1 through 12.

Upper Casing Half Removal

NOTE: If only the upper half casing is to be removed for inspection of the rotating element, it will not be necessary to remove the line shafting or motor.

1. The rotating element must be restrained to the lower half casing or to the pedestal by means of straps.

⚠ WARNING

Injury may result due to rotating element falling out of lower half casing if the above procedure is not followed.

2. Remove the larger of the two pipe plugs from the top of the casing upper half and install an 18" to 24" solid bar threaded at one end into the exposed tapped hole. If a threaded bar is not available, it is permissible to use standard pipe.

NOTE: This bar will be used to stabilize upper half during disassembly of casing upper half. (See Fig. 52)

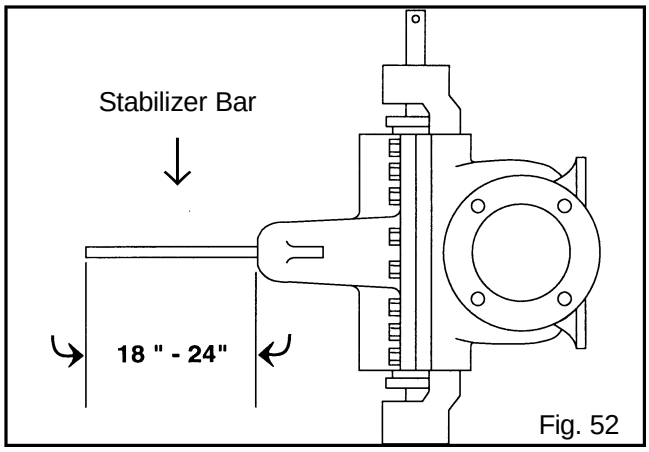


Fig. 52

3. Disconnect the seal water lines at the stuff boxes.

4. Remove dowel pins and all parting line bolts except for two upper most and two lower most. (See Fig. 53)

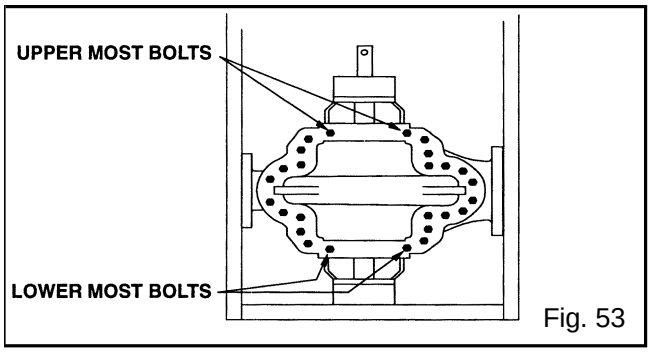


Fig. 53

5. Sling around casing upper half ears using nylon fling, pulling slings taught so it is not possible for slings to slip off. (See Fig. 54)

6. Remove two lower most bolts and then one of the two upper most bolts.

⚠ CAUTION

Maintain downward pressure on the stabilizing rod (end furthest from the pump) during this step.

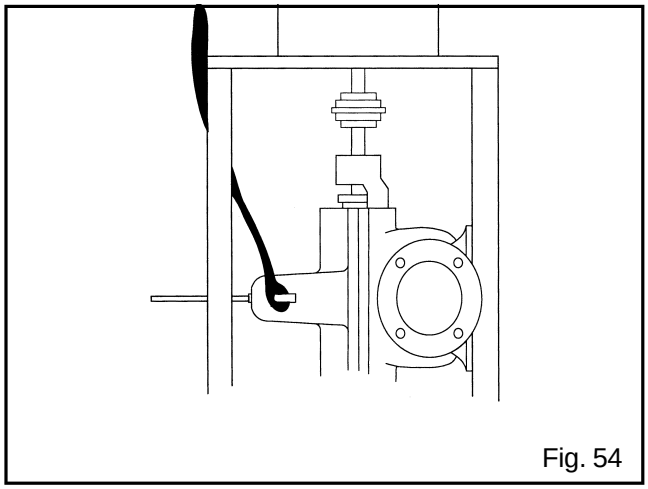


Fig. 54

7. While maintaining a downward pressure on the stabilizer bar, unloosen the remaining upper most bolt.

⚠ WARNING

Do not remove completely at this point. Failure to follow these instructions could result in property damage, severe personal injury, or death.

8. Separate the upper and lower halves by use of a pry bar between the two halves or by the use of jacking screws if the top half is provided with tapped holes.

9. When halves separate, slide upper half away from lower half, maintain a downward pressure on the stabilizer bar and slowly remove completely the remaining upper most bolt.

10. Balancing the upper half with the stabilizer bar, lower the top half to the ground allowing the upper half to rotate so that its main joint flange sets on the ground. (See Fig. 55)

11. Rotating element is now ready for inspection or removal. If element is inspected and does not need to be removed then refer to upper half reassembly procedures.

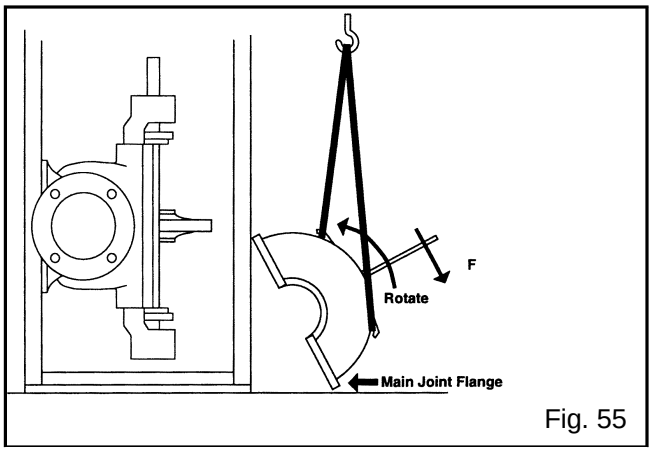


Fig. 55

Rotating Element Removal

12. For these procedures it will be necessary to remove the line shafting or motor. Then remove the pump half coupling.

13. Thread a long bolt, washer and nut through the hole at the end of the shaft. (See Fig. 56)

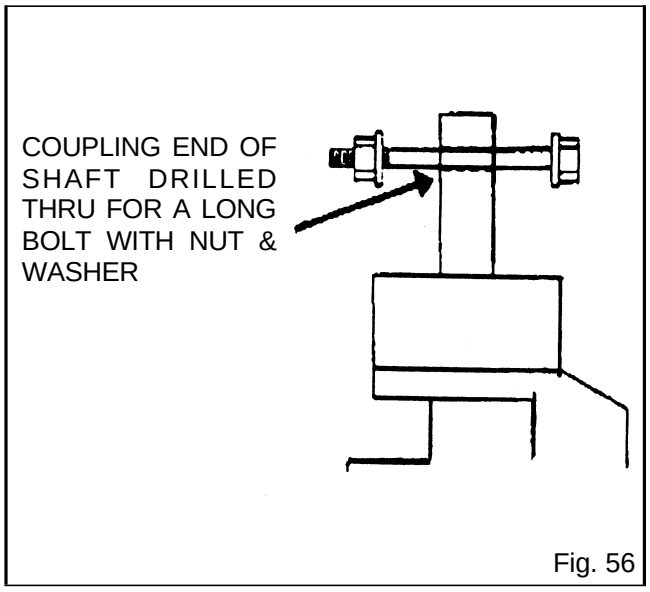


Fig. 56

14. Sling around eye bolt, putting slight amount of tension on sling.

15. Remove restraining straps if rotating element is not securely fastened to casing lower half.

16. Lightly tapping on inboard and outboard bearing housings, slide rotating element away from lower half.

17. Lower rotating element to ground by sliding outboard bearing housing away from pedestal enabling element to be set on floor with shaft in an horizontal position. (See Fig. 57)

18. Rotating element can now be serviced following disassembly procedure given previously in this manual.

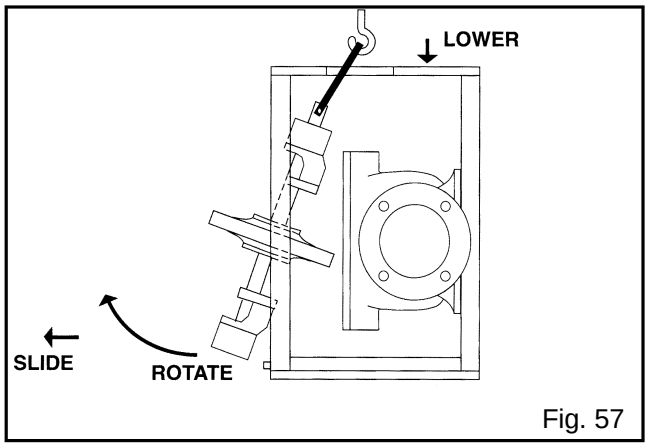


Fig. 57

Reassembly of Rotating Element

19. Inspect main joint gasket and replace if necessary. (Follow replacement instructions in disassembly procedures section.)

20. Sling around the bolt in end of pump shaft.

21. On full pedestals, the lifting sling must come through hole in top plate of pedestal. (See Fig. 57)

22. When rotating element is off the ground and in the vertical position, align any anti-rotation pins in the casing rings and stuffing boxes for proper orientation in the slots in the casing lower half.

23. Moving element towards casing lower half, engage the stuffing box tongue first.

24. As the stuffing box tongue begins to go into the respective casing fit, raise the inboard bearing housing into its respective fit.

25. When the stuffing box tongues are firmly seated in their respective fits and all the anti-rotation pins are seated in their slots, restrain the rotating element to the lower half.

Replacing Upper Casing Half

26. Sling around lifting ears and with stabilizer bar installed, pick casing upper half off the ground and rotate top half so that main joint flange is vertical. (Reference Fig. 55 with rotation in opposite direction shown.)

27. Move upper half towards lower half.

28. Prior to complete engagement of upper half onto lower half, use dowel pins to guide the upper half into its final exact position.

29. Reinstall all main joint bolts, following tightening sequence illustrated in Fig. 58, page 55. (The number of casing bolts varies with the size of the pump.) Torque bolts 140 ft-lb minimum for 5/8"-11 hex head cap screws (Grade 5) and 350 ft-lb minimum for 7/8"-9 Ferry Cap Countr-bor screws (Grade 8)

NOTE: Torquing bolts to proper values in proper sequence is essential in obtaining proper gasket compression so no leakage can occur at main joint.

30. Rotate shaft making sure it spins free. If the motor or line shafting has been removed it will now be possible to reinstall.

Complete Pump Removal

Should it be necessary to remove a complete pump, it will be necessary to remove the line shafting or motor, disconnect the pedestal from its anchor bolts, disconnect and remove, if necessary, sections of the suction and discharge piping, and turn the entire pedestal horizontal enabling complete pump removal from horizontal position.

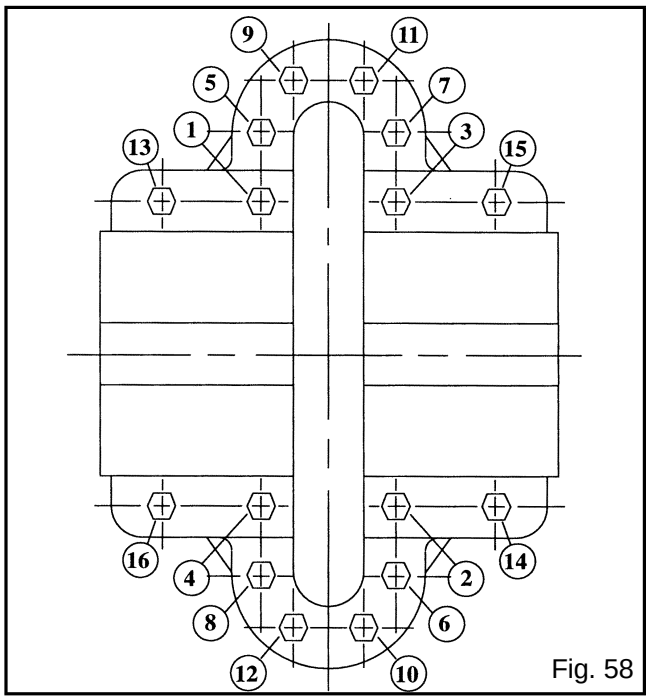


Fig. 58

APPENDIX

INSTRUCTIONS FOR ORDERING PARTS

When ordering parts for 8100 pumps, be sure to furnish the following information to the A-C Pumps stocking distributor in your area:

- Serial Number
- Pump Size & Type
- Pump Model Number
- Pump Frame Number
- Description of Part
- Catalog Code
- Quantity Required
- Definite Billing and Shipping Instructions
- Date Required

Refer to parts list on page 66 for a complete parts list and recommended spare parts.

Parts should be ordered as far in advance of their need as possible, since circumstances beyond the control of A-C Pumps may reduce existing stocks. All parts are not carried in stock. Some are made for each order. If replacement parts required are to be made of different materials than originally specified, give exact requirements and the reason for changing. Special care in furnishing the above informati on with the original order for parts will facilitate shipment.

APPENDIX "B"

TOOLS

To disassemble and assemble 8100 pumps, use conventional tools.

APPENDIX "A" ENGINEERING DATA

Pump Size			2 x 3-11S	2 x 3-11L	4 x 6-9	4 x 6-10S	4 x 6-10M	4 x 6-10L	4 x 6-10XL	4 x 6-11	4 x 6-12S	4 x 6-12M
CASING DATA (All Dimensions in Inches)												
125# FF Std ASA Flanges		Max. Suction Pressure	75	75	75	75	75	75	75	75	75	75
		Max. Working Pressure	175	175	175	175	175	175	175	175	175	175
④	NOMINAL 175 PSI	Max. Hydrostatic Test Pressure	262	262	262	262	262	262	262	262	262	262
⑥	Working Press.	Casing Material	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron
		Max. Suction Pressure	200	200	200	200	200	200	200	200	200	200
⑤	250# FF	Max. Working Pressure	280	280	280	280	280	280	280	280	280	280
①	NOMINAL 280 PSI	Max. Hydrostatic Test Pressure	420	420	420	420	420	420	420	420	420	420
⑥	Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
⑤		Max. Suction Pressure	300	300	300	300	300	300	300	300	300	300
②	250# FF	Max. Working Pressure	400	400	400	400	400	400	400	400	400	400
③	NOMINAL 400 PSI	Max. Hydrostatic Test Pressure	600	600	600	600	600	600	600	600	600	600
⑥	Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
		Casing Wall Thickness	.375	.375	.50	.50	.50	.50	.50	.50	.44	.44
STUFFING BOX DATA (All Dimensions in Inches)												
Packing Dimensions		Bore	2.625	2.625	2.625	3.25	3.25	3.25	3.25	3.25	2.625	2.625
		Depth	2.56	2.56	2.56	3.50	3.50	3.50	3.50	3.50	2.56	2.56
		Sleeve O.D.	1.875	1.875	1.875	2.25	2.25	2.25	2.25	2.25	1.875	1.875
		Packing Size/No. Rings w/o S. Cage	6/.375	6/.375	6/.375	6/.50	6/.50	6/.50	6/.50	6/.50	6/.375	6/.375
		Packing Size/No. Rings with S. Cage	5/.375	5/.375	5/.375	5/.50	5/.50	5/.50	5/.50	5/.50	5/.375	5/.375
		Seal Cage Width	.50	.50	.50	.75	.75	.75	.75	.75	.50	.50
Mechanical Seal On Shaft Dimensions ⑦		Bore	2.25	2.25		2.75	2.75	2.75	2.75	2.75	2.25	2.25
		Depth	2.62	2.62		3.12	3.12	3.12	3.12	3.12	2.62	2.62
		Mechanical Seal Size (Type 21 or 1)	1.38	1.38		1.75	1.75	1.75	1.75	1.75	1.38	1.38
	⑩	Balanced Mechanical Major Dia. →	1.50	1.50		1.88	1.88	1.88	1.88	1.88	1.50	1.50
	⑩	Seal Size (Type 1B) Minor Dia. →	1.38	1.38		1.75	1.75	1.75	1.75	1.75	1.38	1.38
Mechanical Seal On Sleeves Dimensions		Bore	3.00	3.00		3.38	3.38	3.38	3.38	3.38	3.00	3.00
		Depth	2.56	2.56		2.88	2.88	2.88	2.88	2.88	2.56	2.56
		Mechanical Seal Size (Type 21 or 1)	1.875	1.875		2.25	2.25	2.25	2.25	2.25	1.875	1.875
	⑩	Balanced Mechanical Major Dia. →	2.00	2.00		2.38	2.38	2.38	2.38	2.38	2.00	2.00
	⑩	Seal Size (Type 1B) Minor Dia. →	1.88	1.88		2.25	2.25	2.25	2.25	2.25	1.88	1.88
IMPELLER DESIGN DATA (All Dimensions in Inches)												
Number of Vanes			6	6	6	6	6	6	6	6	6	6
Inlet Area (Sq. Inches)			7.7	9.6	5.9	10.5	15.9	17.8	28.0	19.6	23.1	10.2
Inlet Velocity per 100 GPM (Ft/Sec)			4.2	3.3	5.4	3.1	2.0	1.8	1.1	1.6	1.4	3.1
Maximum Diameter			11.0	11.0	9.8	11.0	12.0	11.0	12.3	11.6	12.8	13.7
Minimum Diameter			5.5	5.5	6.0	5.5	6.5	5.5	6.5	6.5	5.5	7.5
Maximum Sphere			.25	.38	.44	.34	.50	.62	.37	.70	.40	.50
WR^ 2 for Maximum Diameter (Lbs-Ft^2)			3.6	3.2	2.4	2.6	2.9	2.8	3.2	3.0	3.0	3.0
⑧	Wear Ring Clearance— Diameter 175# & 280# W.P.		.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012
③⑧	Wear Ring Clearance— Diameter 400# W.P.		.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024
SHAFT AND BEARING DATA (All Dimensions in Inches)												
Under Sleeve			1.499	1.499	1.499	1.874	1.874	1.874	1.874	1.874	1.499	1.499
Under Mechanical Seal on Shaft Type 21 or Type 1			1.375	1.375		1.750	1.750	1.750	1.750	1.750	1.375	1.375
Under Mechanical Seal on Shaft Type 1B			1.500	1.500		1.875	1.875	1.875	1.875	1.875	1.500	1.500
At Coupling			1.125	1.125	1.125	1.375	1.375	1.375	1.375	1.375	1.125	1.125
Thru Impeller with Packing — Mechanical Seal on Sleeve			1.686	1.686	1.687	1.937	1.937	1.937	1.937	1.937	1.686	1.686
⑨	Thru Impeller with Mechanical Seal on Shaft		1.689	1.689		1.939	1.939	1.939	1.939	1.939	1.689	1.689
Shaft Span	Bearing to Bearing Centerline		20.90	20.90	22.00	25.25	25.25	25.25	25.25	25.25	22.90	22.90
Ball Bearings	Inboard		6206	6206	6206	6208	6208	6208	6208	6208	6206	6206
	Outboard		5206	5206	5206	5307	5307	5307	5307	5307	5206	5206
Frame Designation	Packing		F20-A4	F20-A4	F20-G4	F20-B4	F20-B4	F20-B4	F20-B4	F20-B4	F20-C4	F20-C4
	Mechanical Seal on Shaft		F20-A5	F20-A5		F20-B5	F20-B5	F20-B5	F20-B5	F20-B5	F20-C5	F20-C5
	Mechanical Seal on Shaft Sleeve		F20-A6	F20-A6		F20-B6	F20-B6	F20-B6	F20-B6	F20-B6	F20-C6	F20-C6

① With 250# FF flanges and 280# PSIG working pressure refer to pump as M2 x 3-11S.

② With 250# FF flanges and 400# PSIG working pressure refer to pump as H2 x 3-11S.

③ For pumps with 400 PSI working pressure, wear ring clearances are doubled. Derate pump efficiencies by 2 percentage points.

④ Flange dimensions are in accordance with ANSI A21.10, AWWA C110 & ANSI B16.1 Class 125.

⑤ Flange dimensions are in accordance with ANSI B16. 1 class 250 except flanges are flat faced, i.e. FF.

⑥ The hydrostatic test will be in accordance with the latest edition of the Hydraulic Institute Standards, test will be maintained for a minimum of 5 minutes.

⑦ Type 1 and 21 seals have the same working lengths.

⑧ For bronze impellers and casing rings. For diametral clearances for other materials, consult factory.

⑨ Impeller is a light press fit on shaft, do not use construction with stainless steel impellers.

⑩ Balanced mechanical seals have a major diameter and a minor diameter as listed.

APPENDIX "A" ENGINEERING DATA

Pump Size		4 x 6-12L	4 x 6-12XL	4 x 6-14S	4 x 6-14L	6 x 6-9	6 x 8-9	6 x 8-10	6 x 8-12S	6 x 8-12M	6 x 8-12L	6 x 8-12XL

CASING DATA

(All Dimensions in Inches)

	125# FF Std	Max. Suction Pressure	75	75	75	75	75	75	75	75	75	75	75
	ASA Flanges	Max. Working Pressure	175	175	175	175	175	175	175	175	175	175	175
④	NOMINAL 175 PSI	Max. Hydrostatic Test Pressure	262	262	262	262	262	262	262	262	262	262	262
⑥	Working Press.	Casing Material	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron
		Max. Suction Pressure	200	200	200	200	200	200	200	200	200	200	200
⑤	250# FF	Max. Working Pressure	280	280	280	280	280	280	280	280	280	280	280
①	NOMINAL 280 PSI	Max. Hydrostatic Test Pressure	420	420	420	420	420	420	420	420	420	420	420
⑥	Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
⑤		Max. Suction Pressure	300	300	300	300	300	300	300	300	300	300	300
②	250# FF	Max. Working Pressure	400	400	400	400	400	400	400	400	400	400	400
③	NOMINAL 400 PSI	Max. Hydrostatic Test Pressure	600	600	600	600	600	600	600	600	600	600	600
⑥	Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
		Casing Wall Thickness	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44

STUFFING BOX DATA

(All Dimensions in Inches)

	Packing Dimensions	Bore	2.625	2.625	2.625	2.625	2.625	2.625	3.25	2.625	3.25	2.625	2.625
		Depth	2.56	2.56	2.56	2.56	2.56	2.56	3.50	2.56	3.50	2.56	2.56
		Sleeve O.D.	1.875	1.875	1.875	1.875	1.875	1.875	2.25	1.875	2.25	1.875	1.875
		Packing Size/No. Rings w/o S. Cage	6/.375	6/.375	6/.375	6/.375	6/.375	6/.375	6/.50	6/.375	6/.50	6/.375	6/.375
		Packing Size/No. Rings with S. Cage	5/.375	5/.375	5/.375	5/.375	5/.375	5/.375	5/.50	5/.375	5/.50	5/.375	5/.375
		Seal Cage Width	.50	.50	.50	.50	.50	.50	.75	.50	.75	.50	.50
	Mechanical Seal On Shaft Dimensions	Bore	2.25	2.25	2.25	2.25				2.25		2.25	2.25
		Depth	2.62	2.62	2.62	2.62				2.62		2.62	2.62
⑦		Mechanical Seal Size (Type 21 or 1)	1.38	1.38	1.38	1.38				1.38		1.38	1.38
	⑩	Balanced Mechanical Major Dia. →	1.50	1.50	1.50	1.50				1.50		1.50	1.50
		Seal Size (Type 1B) Minor Dia. →	1.38	1.38	1.38	1.38				1.38		1.38	1.38
	Mechanical Seal On Sleeves Dimensions	Bore	3.00	3.00	3.00	3.00				3.00	3.38	3.00	3.00
		Depth	2.56	2.56	2.62	2.62				2.62	2.88	2.62	2.62
		Mechanical Seal Size (Type 21 or 1)	1.875	1.875	1.875	1.875				1.875	2.25	1.875	1.875
	⑩	Balanced Mechanical Major Dia. →	2.00	2.00	2.00	2.00				2.00	2.38	2.00	2.00
		Seal Size (Type 1B) Minor Dia. →	1.88	1.88	1.88	1.88				1.88	2.25	1.88	1.88

IMPELLER DESIGN DATA

(All Dimensions in Inches)

	Number of Vanes	6	7	6	6	6	6	6	5	5	7	7
	Inlet Area (Sq. Inches)	19.1	28.4	19.1	22.9	5.9	12.0	15.2	27.0	20.4	38.9	40.6
	Inlet Velocity per 100 GPM (Ft/Sec)	1.7	1.1	1.7	1.4	5.4	2.7	2.1	1.2	1.6	.83	.79
	Maximum Diameter	12.8	14.0	13.8	13.8	9.8	9.8	10.0	12.8	12.8	12.8	13.7
	Minimum Diameter	6.0	7.0	6.5	7.0	6.5	6.5	7.6	7.0	6.5	7.0	7.0
	Maximum Sphere	.60	.37	.47	.68	.48	.64	.75	.72	.87	1.0	1.0
	WR^2 for Maximum Diameter (Lbs-Ft^2)	3.1	3.5	7.5	8.0	2.5	2.6	3.1	3.6	3.7	3.8	8.5
⑧	Wear Ring Clearance— Diameter 175# & 280# W.P.	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012
③⑧	Wear Ring Clearance— Diameter 400# W.P.	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024

SHAFT AND BEARING DATA

(All Dimensions in Inches)

	Under Sleeve		1.499	1.499	1.499	1.499	1.499	1.499	1.874	1.499	1.874	1.499	1.499
	Under Mechanical Seal on Shaft Type 21 or Type 1		1.375	1.375	1.375	1.375				1.375		1.375	1.375
	Under Mechanical Seal on Shaft Type 1B		1.500	1.500	1.500	1.500				1.500		1.500	1.500
	At Coupling		1.125	1.125	1.125	1.125	1.125	1.125	1.375	1.125	1.375	1.125	1.125
	Thru Impeller with Packing — Mechanical Seal on Sleeve		1.686	1.686	1.686	1.686	1.687	1.687	1.937	1.686	1.937	1.686	1.686
⑨	Thru Impeller with Mechanical Seal on Shaft		1.689	1.689	1.689	1.689				1.689		1.689	1.689
	Shaft Span	Bearing to Bearing Centerline	22.90	22.90	22.90	22.90	22.00	25.25	25.25	22.90	25.25	22.90	22.90
	Ball Bearings	Inboard	6206	6206	6206	6206	6206	6206	6208	6206	6208	6206	6206
		Outboard	5206	5206	5206	5206	5206	5206	5307	5206	5307	5206	5206
	Frame Designation	Packing	F20-C4	F20-C4	F20-C4	F20-C4	F20-G4	F20-H4	F20-I4	F20-C4	F20-B4	F20-C4	F20-C4
		Mechanical Seal on Shaft	F20-C5	F20-C5	F20-C5	F20-C5				F20-C5		F20-C5	F20-C5
		Mechanical Seal on Shaft Sleeve	F20-C6	F20-C6	F20-C6	F20-C6				F20-C6	F20-B6	F20-C6	F20-C6

① With 250# FF flanges and 280# PSIG working pressure refer to pump as M2 x 3-11S

② With 250# FF flanges and 400# PSIG working pressure refer to pump as H2 x 3-11S

③ For pumps with 400 PSI working pressure, wear ring clearances are doubled. Derate pump efficiencies by 2 percentage points.

④ Flange dimensions are in accordance with ANSI A21.10, AWWA C110 & ANSI B16.1 Class 125.

⑤ Flange dimensions are in accordance with ANSI B16. 1 class 250 except flanges are flat faced, i.e. FF.

⑥ The hydrostatic test will be in accordance with the latest edition of the Hydraulic Institute Standards, test will be maintained for a minimum of 5 minutes.

⑦ Type 1 and 21 seals have the same working lengths.

⑧ For bronze impellers and casing rings. For diametral clearances for other materials, consult factory.

⑨ Impeller is a light press fit on shaft, do not use construction with stainless steel impellers.

⑩ Balanced mechanical seals have a major diameter and a minor diameter as listed.

⑪ Not available in mechanical seal on shaft arrangement.

APPENDIX "A" ENGINEERING DATA

Pump Size			6 x 8-13	6 x 8-17M	6 x 8- 17L	6 x 8-18	8 x 8-12	8 x 8-17	8 x 10-12S	8 x 10-12L	8 x 10-17S	8 x 10-17L	8 x 10-20S
CASING DATA (All Dimensions in Inches)													
125# FF Std ASA Flanges		Max. Suction Pressure	75	75	75	75	75	75	75	75	75	75	75
		Max. Working Pressure	175	175	175	175	175	175	175	175	175	175	175
④	NOMINAL 175 PSI	Max. Hydrostatic Test Pressure	262	262	262	262	262	262	262	262	262	262	262
⑥	Working Press.	Casing Material	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron
		Max. Suction Pressure	200	200	200	200	200	200	200	200	200	200	200
⑤	250# FF	Max. Working Pressure	280	280	280	280	280	280	280	280	280	280	280
①	NOMINAL 280 PSI	Max. Hydrostatic Test Pressure	420	420	420	420	420	420	420	420	420	420	420
⑥	Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
⑤		Max. Suction Pressure	300	300	300	300	300	300	300	300	300	300	300
②	250# FF	Max. Working Pressure	400	400	400	400	400	400	400	400	400	400	400
③	NOMINAL 400 PSI	Max. Hydrostatic Test Pressure	600	600	600	600	600	600	600	600	600	600	600
⑥	Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
		Casing Wall Thickness	.44	.44	.44	.44	.44	.44	.44	.44	.50	.50	.62
STUFFING BOX DATA (All Dimensions in Inches)													
Packing Dimensions		Bore	3.25	3.25	3.25	3.25	3.25	3.75	3.75	3.75	3.75	3.75	3.75
		Depth	3.50	3.50	3.50	3.50	3.50	3.62	3.62	3.62	3.62	3.62	3.62
		Sleeve O.D.	2.25	2.25	2.25	2.25	2.25	2.75	2.75	2.75	2.75	2.75	2.75
		Packing Size/No. Rings w/o S. Cage	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50
		Packing Size/No. Rings with S. Cage	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50
		Seal Cage Width	.75	.75	.75	.75	.75	.94	.94	.94	.94	.94	.94
⑦ Mechanical Seal On Shaft Dimensions		Bore	2.75	2.75	2.75	2.75	2.75	3.125	3.125	3.125	3.125	3.125	
		Depth	3.00	3.00	3.00	3.00	3.00	3.25	3.25	3.25	3.25	3.25	
		Mechanical Seal Size (Type 21 or 1)	1.75	1.75	1.75	1.75	1.75	2.000	2.000	2.000	2.000	2.000	
	⑩	Balanced Mechanical Major Dia. →	1.88	1.88	1.88	1.88	1.88	2.12	2.12	2.12	2.12	2.12	
	⑩	Seal Size (Type 1B) Minor Dia. →	1.75	1.75	1.75	1.75	1.75	2.00	2.00	2.00	2.00	2.00	
Mechanical Seal On Sleeves Dimensions		Bore	3.38	3.38	3.38	3.38	3.38	4.00	4.00	4.00	4.00	4.00	4.00
		Depth	3.00	3.00	3.00	3.00	3.00	3.12	3.12	3.12	3.12	3.12	3.12
		Mechanical Seal Size (Type 21 or 1)	2.25	2.25	2.25	2.25	2.25	2.75	2.75	2.75	2.75	2.75	2.75
	⑩	Balanced Mechanical Major Dia. →	2.38	2.38	2.38	2.38	2.38	2.88	2.88	2.88	2.88	2.88	2.88
	⑩	Seal Size (Type 1B) Minor Dia. →	2.25	2.25	2.25	2.25	2.25	2.75	2.75	2.75	2.75	2.75	2.75
IMPELLER DESIGN DATA (All Dimensions in Inches)													
Number of Vanes			7	6	6	6	7	7	6	6	7	5	6
Inlet Area (Sq. Inches)			44.4	29.5	38.7	18.3	61.9	40.2	62.9	57.4	57.5	65.4	68.4
Inlet Velocity per 100 GPM (Ft/Sec)			.73	1.09	.83	1.75	.52	.90	.51	.56	.56	.49	.47
Maximum Diameter			12.2	17.0	17.0	17.2	12.8	17.7	12.8	12.8	17.7	17.3	20.2
Minimum Diameter			7.0	10.0	10.0	13.0	8.0	10.0	8.0	8.5	10.0	12.0	12.0
Maximum Sphere			1.0	.47	.50	.70	1.13	.98	1.4	1.47	.97	1.16	.53
WR^2 for Maximum Diameter (Lbs-Ft^2)			5.3	16.5	18.0	18.0	8.1	17.0	9.8	11.2	20.7	22.4	21.7
⑧	Wear Ring Clearance— Diameter 175# & 280# W.P.		.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012
③⑧	Wear Ring Clearance— Diameter 400# W.P.		.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024
SHAFT AND BEARING DATA (All Dimensions in Inches)													
Under Sleeve			1.874	1.874	1.874	1.874	1.874	2.374	2.374	2.374	2.374	2.374	2.374
Under Mechanical Seal on Shaft Type 21 or Type 1			1.750	1.750	1.750	1.750	1.750	2.000	2.000	2.000	2.000	2.000	
Under Mechanical Seal on Shaft Type 1B			1.875	1.875	1.875	1.875	1.875	2.125	2.125	2.125	2.125	2.125	
At Coupling			1.375	1.375	1.375	1.375	1.375	1.625	1.625	1.625	1.625	1.625	1.625
Thru Impeller with Packing — Mechanical Seal on Sleeve			1.937	1.937	1.937	1.937	1.937	2.437	2.437	2.437	2.437	2.437	2.437
⑨	Thru Impeller with Mechanical Seal on Shaft		1.939	1.939	1.939	1.939	1.939	2.439	2.439	2.439	2.439	2.439	
Shaft Span		Bearing to Bearing Centerline	27.25	27.25	27.25	27.25	27.25	29.90	29.90	29.90	29.90	29.90	29.90
Ball Bearings		Inboard	6208	6208	6208	6208	6208	6309	6309	6309	6309	6309	6309
		Outboard	5307	5307	5307	5307	5307	5308	5308	5308	5308	5308	5308
Frame Designation		Packing	F20-D4	F20-D4	F20-D4	F20-D4	F20-D4	F20-E4	F20-E4	F20-E4	F20-E4	F20-E4	F20-E4
		Mechanical Seal on Shaft	F20-D5	F20-D5	F20-D5	F20-D5	F20-D5	F20-E5	F20-E5	F20-E5	F20-E5	F20-E5	
		Mechanical Seal on Shaft Sleeve	F20-D6	F20-D6	F20-D6	F20-D6	F20-D6	F20-E6	F20-E6	F20-E6	F20-E6	F20-E6	F20-E6

① With 250# FF flanges and 280# PSIG working pressure refer to pump as M2 x 3-11S.

② With 250# FF flanges and 400# PSIG working pressure refer to pump as H2 x 3-11S.

③ For pumps with 400 PSI working pressure, wear ring clearances are doubled. Derate pump efficiencies by 2 percentage points.

④ Flange dimensions are in accordance with ANSI A21.10, AWWA C110 & ANSI B16.1 Class 125.

⑤ Flange dimensions are in accordance with ANSI B16. 1 class 250 except flanges are flat faced, i.e. FF.

⑥ The hydrostatic test will be in accordance with the latest edition of the Hydraulic Institute Standards, test will be maintained for a minimum of 5 minutes.

⑦ Type 1 and 21 seals have the same working lengths.

⑧ For bronze impellers and casing rings. For diametral clearances for other materials, consult factory.

⑨ Impeller is a light press fit on shaft, do not use construction with stainless steel impellers.

⑩ Balanced mechanical seals have a major diameter and a minor diameter as listed.

⑪ Not available in mechanical seal on shaft arrangement.

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APPENDIX "A" ENGINEERING DATA

Pump Size	8 x 10-20L	10 x 10-12	10 x 12-12	10 x 12-12XL	10 x 12-14	10 x 12-17	10 x 12-18 ⑪

CASING DATA

(All Dimensions in Inches)

125# FF Std ASA Flanges	Max. Suction Pressure	75	75	75	75	75	75	75
	Max. Working Pressure	175	175	175	175	175	175	175
④ NOMINAL 175 PSI	Max. Hydrostatic Test Pressure	262	262	262	262	262	262	262
⑥ Working Press.	Casing Material	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron
	Max. Suction Pressure	200	200	200	200	200	200	200
⑤ 250# FF	Max. Working Pressure	280	280	280	280	280	280	280
① NOMINAL 280 PSI	Max. Hydrostatic Test Pressure	420	420	420	420	420	420	420
⑥ Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
⑤	Max. Suction Pressure	300	300	300	300	300	300	300
② 250# FF	Max. Working Pressure	400	400	400	400	400	400	400
③ NOMINAL 400 PSI	Max. Hydrostatic Test Pressure	600	600	600	600	600	600	600
⑥ Working Press.	Casing Material	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron	Ductile Iron
	Casing Wall Thickness	.62	.44	.44	.56	.56	.56	.56

STUFFING BOX DATA

(All Dimensions in Inches)

Packing Dimensions	Bore	3.75	3.25	3.25	3.25	3.75	3.75	3.75
	Depth	3.62	3.50	3.50	3.50	3.62	3.62	3.62
	Sleeve O.D.	2.75	2.25	2.25	2.25	2.75	2.75	2.75
	Packing Size/No. Rings w/o S. Cage	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50	6/.50
	Packing Size/No. Rings with S. Cage	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50	5/.50
	Seal Cage Width	.94	.75	.75	.75	.94	.94	.94
⑦ Mechanical Seal On Shaft Dimensions	Bore		2.75	2.75	2.75	3.125	3.125	
	Depth		3.00	3.00	3.00	3.25	3.25	
	Mechanical Seal Size (Type 21 or 1)		1.75	1.75	1.75	2.000	2.000	
⑩	Balanced Mechanical Major Dia. →		1.88	1.88	1.88	2.12	2.12	
⑩	Seal Size (Type 1B) Minor Dia. →		1.75	1.75	1.75	2.00	2.00	
Mechanical Seal On Sleeves Dimensions	Bore	4.00	3.38	3.38	3.38	4.00	4.00	4.00
	Depth	3.12	3.00	3.00	3.00	3.12	3.12	3.12
	Mechanical Seal Size (Type 21 or 1)	2.75	2.25	2.25	2.25	2.75	2.75	2.75
⑩	Balanced Mechanical Major Dia. →	2.88	2.38	2.38	2.38	2.88	2.88	2.88
⑩	Seal Size (Type 1B) Minor Dia. →	2.75	2.25	2.25	2.25	2.75	2.75	2.75

IMPELLER DESIGN DATA

(All Dimensions in Inches)

Number of Vanes	6	6	6	6	6	7	8
Inlet Area (Sq. Inches)	74.0	86.4	77.2	87.3	93.6	86.4	53.4
Inlet Velocity per 100 GPM (Ft/Sec)	.43	.37	.42	.37	.34	.37	.60
Maximum Diameter	20.2	12.8	12.8	13.8	14.0	17.5	18.0
Minimum Diameter	12.0	9.3	8.7	8.7	10.0	10.0	12.5
Maximum Sphere	.72	1.54	1.12	1.56	1.62	1.36	.90
WR^2 for Maximum Diameter (Lbs-Ft^2)	22.5	11.7	11.7	15.5	18.0	22.3	24.2
⑧ Wear Ring Clearance— Diameter 175# & 280# W.P.	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012
③⑧ Wear Ring Clearance— Diameter 400# W.P.	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024

SHAFT AND BEARING DATA

(All Dimensions in Inches)

Under Sleeve		2.374	2.374	2.374	2.374	2.374	2.374	2.374
Under Mechanical Seal on Shaft Type 21 or Type 1			2.000	2.000	2.000	2.000	2.000	
Under Mechanical Seal on Shaft Type 1B			2.125	2.125	2.125	2.125	2.125	
At Coupling		1.625	1.625	1.625	1.625	1.625	1.625	1.625
Thru Impeller with Packing — Mechanical Seal on Sleeve		2.437	2.437	2.437	2.437	2.437	2.437	2.437
⑨ Thru Impeller with Mechanical Seal on Shaft			2.439	2.439	2.439	2.439	2.439	
Shaft Span	Bearing to Bearing Centerline	29.90	32.90	32.90	32.90	29.90	29.90	29.90
Ball Bearings	Inboard	6309	6309	6309	6309	6309	6309	6309
	Outboard	5308	5308	5308	5308	5308	5308	5308
Frame Designation	Packing	F20-E4	F20-F4	F20-F4	F20-F4	F20-E4	F20-E4	F20-E4
	Mechanical Seal on Shaft		F20-F5	F20-F5	F20-F5	F20-E5	F20-E5	
	Mechanical Seal on Shaft Sleeve	F20-E6	F20-F6	F20-F6	F20-F6	F20-E6	F20-E6	F20-E6

① With 250# FF flanges and 280# PSIG working pressure refer to pump as M2 x 3-11S

② With 250# FF flanges and 400# PSIG working pressure refer to pump as H2 x 3-11S

③ For pumps with 400 PSI working pressure, wear ring clearances are doubled. Derate pump efficiencies by 2 percentage points.

④ Flange dimensions are in accordance with ANSI A21.10, AWWA C110 & ANSI B16.1 Class 125.

⑤ Flange dimensions are in accordance with ANSI B16. 1 class 250 except flanges are flat faced, i.e. FF.

⑥ The hydrostatic test will be in accordance with the latest edition of the Hydraulic Institute Standards, test will be maintained for a minimum of 5 minutes.

⑦ Type 1 and 21 seals have the same working lengths.

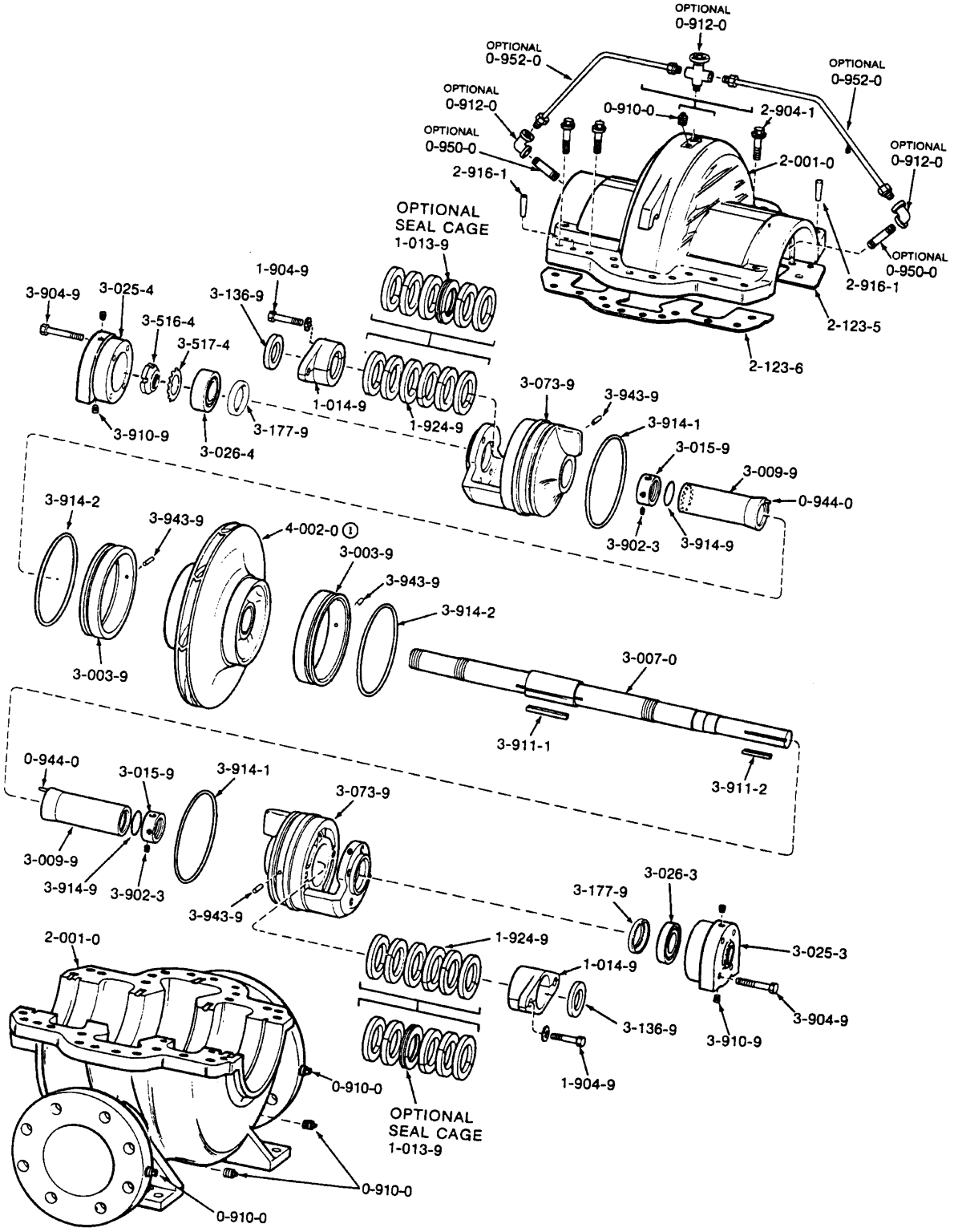
⑧ For bronze impellers and casing rings. For diametral clearances for other materials, consult factory.

⑨ Impeller is a light press fit on shaft, do not use construction with stainless steel impellers.

⑩ Balanced mechanical seals have a major diameter and a minor diameter as listed.

⑪ Not available in mechanical seal on shaft arrangement.

APPENDIX "B"
EXPLOSION VIEW: PACKING



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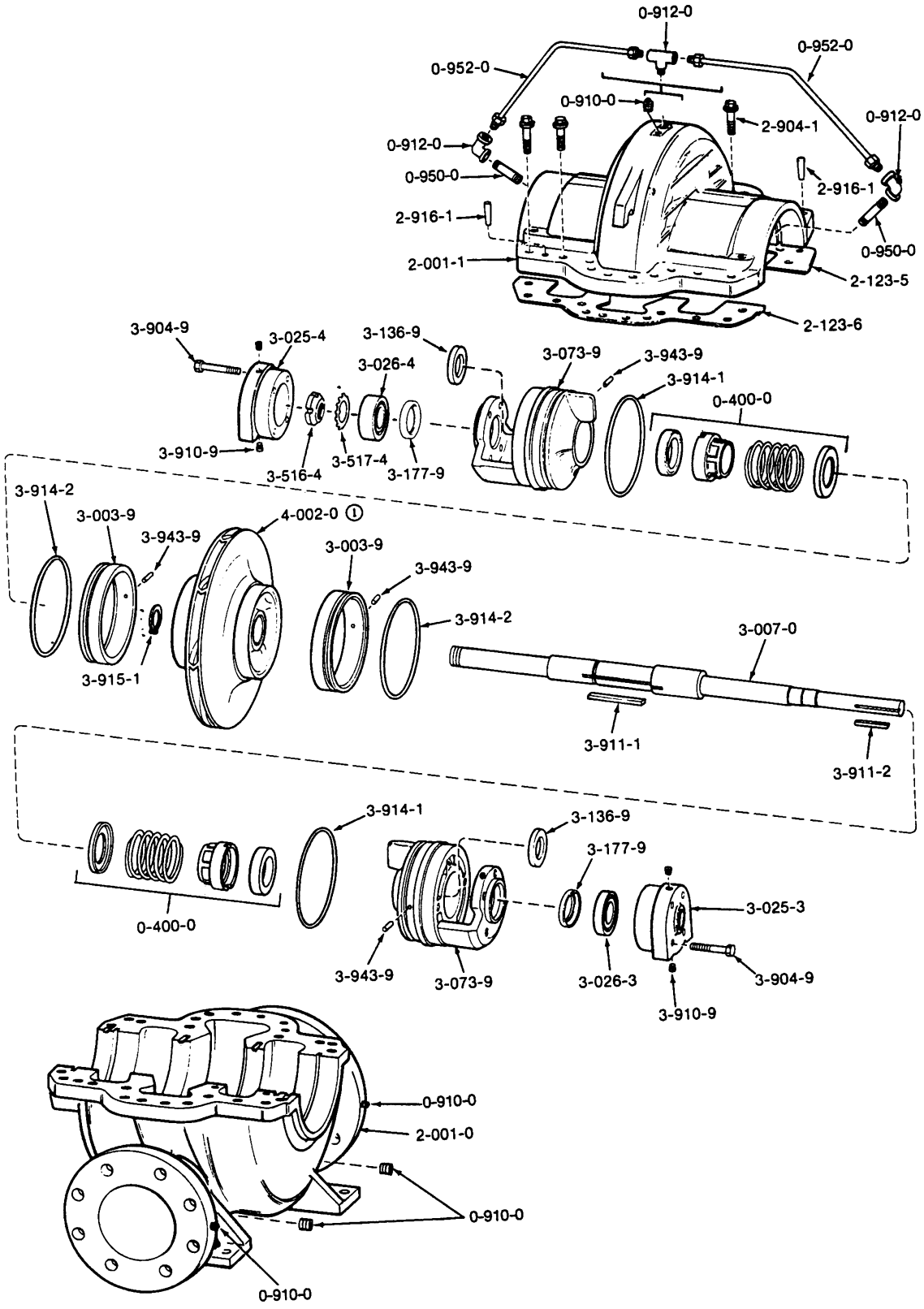
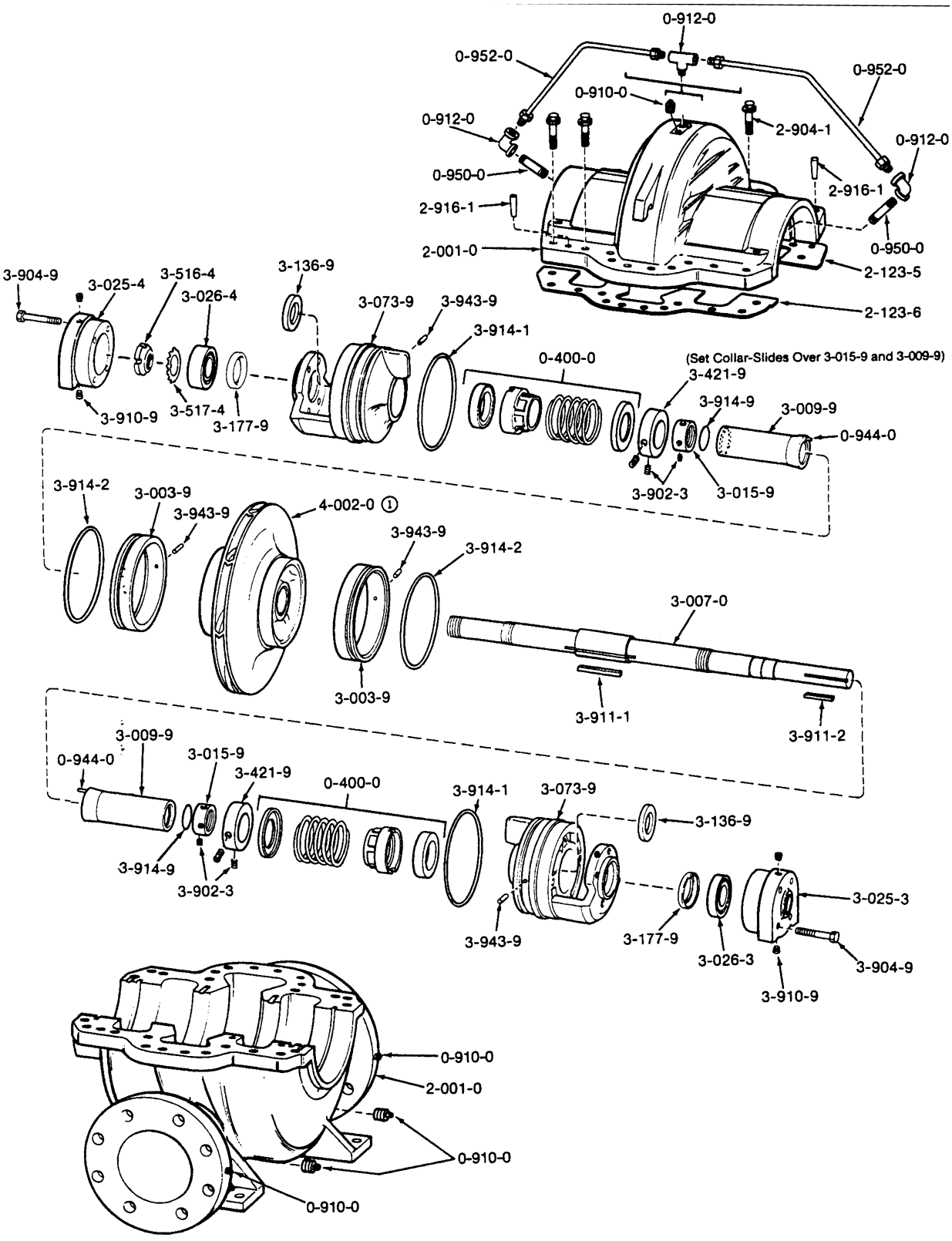
APPENDIX "B"
EXPLOSION VIEW: MECHANICAL SEALS ON SHAFT



APPENDIX "B"
EXPLOSION VIEW: MECHANICAL SEALS ON SHAFT SLEEVES



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APPENDIX "B"
REPLACEMENT PARTS LIST

Catalog Number	Part Name	QUANTITY		
		PACKING	MECHANICAL SEAL ON SLEEVE	MECHANICAL SEAL ON SHAFT
0-400-0*	Mechanical Seal		2	2
0-910-0	Pipe Plug (casing)	5	5	5
0-912-0	Pipe Fitting	3 (optional)	3	3
0-944-0	Spiral Pin (shaft sleeve)	2	2	
0-950-0	Pipe Nipple	2 (optional)	2	2
0-952-0	Tubing and Connectors	2 (optional)	2	2
1-013-9	Seal Cage	2 (optional)		
1-014-9	Gland, Packing	2		
1-904-9	Cap Screw (gland)	4		
1-924-9*	Packing	12 Rings		
2-001-0	Casing, Lower Half	1	1	1
2-001-0	Casing , Upper Half	1	1	1
2-123-5*	Gasket Casing (suction)	1	1	1
2-123-6*	Gasket Casing (discharge)	1	1	1
2-904-1	Cap Screw (casing)	Varies w/ pump size	Varies w/ pump size	Varies w/ pump size
2-916-1	Taper Pin	2	2	2
3-003-9*	Casing Ring	2	2	2
3-007-0	Shaft	1	1	1
3-009-9*	Shaft Sleeve	2	2	
3-015-9	Shaft Sleeve Nut	2	2	
3-025-3	Bearing Housing (Inboard)	1	1	1
3-025-4	Bearing Housing (Outboard)	1	1	1
3-026-3*	Bearing, Inboard	1	1	1
3-026-4*	Bearing, Outboard	1	1	12
3-073-9	Stuffing Box	2	2	2
3-136-9	Deflector	2	2	2
3-177-9*	Lip Seal	2	2	
3-421-9	Set Collar		2	1
3-516-4	Locknut	1	1	1
3-517-4	Lockwasher	1	1	
3-902-3	Set Screw	2	6	8
3-904-9	Cap Screw (Bearing Housing)	8	8	4
3-910-9	Piping Plug (Bearing Housing)	4	4	1
3-911-1	Key (Impeller)	1	1	1
3-911-2	Key (Coupling)	1	1	
3-914-1*	O-Ring (Stuffing Box)	2	2	2
3-914-2*	O-Ring (Casing Ring)	2	2	2
3-914-9*	O-Ring (Shaft Sleeve)	2	2	
3-915-1*	Retaining Ring (Impeller)			1
3-943-9	Spiral Pin	4	4	4

APPENDIX "C" FIELD TEST REPORT

USEFUL FORMULAS

1) Head (ft.) = $\frac{\text{Pressure (psig)} \times 2.31}{\text{S.G.}}$ S.G. = Specific gravity; S.G. of water = 1.0 at 70° F

2) TDH (ft.) = Total Dynamic Head (ft.) = (Disch. Pressure gauge reading - Suct. Pressure gauge reading +
(Discharge velocity head - Suction velocity head +
(Elevation correction to disch. gauge - Elevation correction to suct. gauge)

3) PUMP INPUT HP (BHP) - calculated:

Single Phase Motor	Three Phase Motor
$BHP = \frac{Amps \times Volts \times n_m \times p.f.}{746}$	$BHP = \frac{Avg.\ Amps \times Volts \times 1.732 \times n_m \times p.f.}{746}$

Where n_m = motor efficiency, p.f. = Motor power factor, Avg. Amps = $\frac{leg\ 1 + leg\ 2 + leg\ 3}{3}$

4) Pump Efficiency (n_p): $n_p = \frac{GPM \times TDH}{3960 \times BHP}$

5) Affinity Laws for correcting GPM, TDH, and BHP for speed (RPM):

$$\frac{GPM_1}{GPM_2} = \frac{RPM_1}{RPM_2} \quad \text{or} \quad GPM_1 = GPM_2 \times \frac{RPM_1}{RPM_2}$$

$$\frac{TDH_1}{TDH_2} = \left(\frac{RPM_1}{RPM_2}\right)^2 \quad \text{or} \quad TDH_1 = TDH_2 \times \left(\frac{RPM_1}{RPM_2}\right)^2$$

$$\frac{BHP_1}{BHP_2} = \left(\frac{RPM_1}{RPM_2}\right)^3 \quad \text{or} \quad BHP_1 = BHP_2 \times \left(\frac{RPM_1}{RPM_2}\right)^3$$

6) NPSHA determination:

NPSHA = Net Positive Suction Head Available

NPSHA = (Atmospheric pressure - Vapor pressure of liquid + Total suction head)

Total Suction Head = (Suction pressure gauge reading + Suction velocity head + Elevation correction to suction gauge)

NOTE: NPSHA must always be greater than NPSHR (NPSHA ≥ NPSHR) for the pump to operate without concern of cavitation.

NPSHR refers to Net Positive Suction Head Required by pump. This is a published value obtained from the Pump Manufacturer's curve.

APPENDIX "C" FIELD TEST REPORT

Field Test Report

Date _____

Pump Size _____ Pump Type _____

Pump Serial Number _____ Impeller Diameter (in.) _____

Manufacturer's Pump Curve Number _____

MOTOR:** Rated HP _____ Volts _____ S.F. _____

F.L. Amps _____ F.L. Eff _____ P.F. _____

Phase _____

RATING: GPM _____ Head _____ RPM _____

Suction gauge pipe size _____ inches

Discharge gauge connection pipe size _____ inches

Discharge gauge elevation corr. _____ feet

Suction gauge elevation corr. _____ feet

Barometric pressure _____ inches Hg x 1.13 = _____ feet water

Liquid pumped _____ S.G. _____

Liquid temperature _____ °F

Liquid vapor pressure _____ psi x 2.31 = _____feet water

POINT	Discharge Pressure Gauge		Suction Pressure Gauge		Velocity Head (feet)		Total Dynamic Head (TDH_2)	FLOW		RPM_2	Motor Volts	Motor Amps			Avg. Amps	Pump BHP_2 (calc'd)	Pump Eff. (calc'd)	Affinity Law Corrections				Calc'd NPSHA	NPSHR*
								Read-ing	Convert to GPM_2			Leg 1	Leg 2	Leg 3				RPM_1	TDH_1	GPM_1	BHP_1		
	(PSI.)	(ft.)	(PSI.)	(ft.)	Disc.	Suct.																	
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							

* NPSHR taken from manufacturer's pricebook curve.

** Motor information taken off motor nameplate.

See sheet 2 of 2 for useful formulas.

Type of flow measurement device: _____

Readings taken by: _____

Comments: _____

_____

APPENDIX "C" FIELD TEST REPORT

Field Test Report

Date _____

Pump Size _____ Pump Type _____

Pump Serial Number _____ Impeller Diameter (in.) _____

Manufacturer's Pump Curve Number _____

MOTOR:** Rated HP _____ Volts _____ S.F. _____

F.L. Amps _____ F.L. Eff _____ P.F. _____

Phase _____

RATING: GPM _____ Head _____ RPM _____

Suction gauge pipe size _____ inches

Discharge gauge connection pipe size _____ inches

Discharge gauge elevation corr. _____ feet

Suction gauge elevation corr. _____ feet

Barometric pressure _____ inches Hg x 1.13 = _____ feet water

Liquid pumped _____ S.G. _____

Liquid temperature _____ °F

Liquid vapor pressure _____ psi x 2.31 = _____feet water

POINT	Discharge Pressure Gauge		Suction Pressure Gauge		Velocity Head (feet)		Total Dynamic Head (TDH_2)	FLOW		RPM_2	Motor Volts	Motor Amps			Avg. Amps	Pump BHP_2 (calc'd)	Pump Eff. (calc'd)	Affinity Law Corrections				Calc'd NPSHA	NPSHR*
								Read-ing	Convert to GPM_2			Leg 1	Leg 2	Leg 3				RPM_1	TDH_1	GPM_1	BHP_1		
	(PSI.)	(ft.)	(PSI.)	(ft.)	Disc.	Suct.																	
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							

* NPSHR taken from manufacturer's pricebook curve.

** Motor information taken off motor nameplate.

See sheet 2 of 2 for useful formulas.

Type of flow measurement device: _____

Readings taken by: _____

Comments: _____

_____

HOW TO ORDER

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