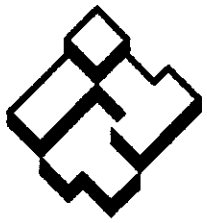
A-C Pump



ITT Industries

INSTRUCTIONS

2000 SERIES FRAME MOUNTED PUMPS

NOTE

The information contained in this book is intended to assist operating personnel by providing information on the characteristics of the purchased equipment.

It does not relieve the user of the responsibility of using accepted engineering practices in the installation, operation and maintenance of this equipment.

Any reference to Allis-Chalmers in text, caption, photograph or drawing should be read as ITT A-C Pump.

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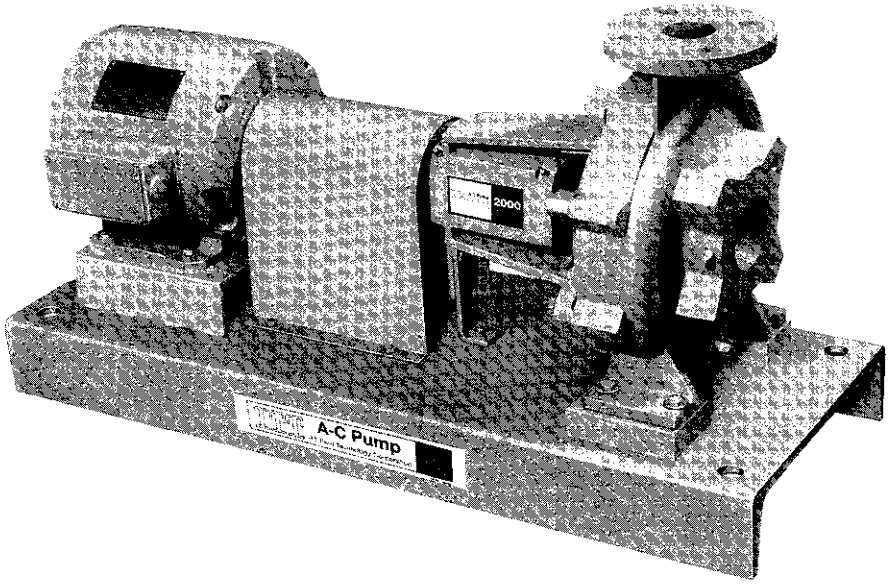
Specific 2000 Series Instruction

Frame Mounted Pumps



2000 Series Frame Mounted Pump

PUMP IDENTIFICATION

There are two identification plates on each pump. The pump rating plate gives identification and rating information. Figure 1 shows an example of a typical Rating Plate.

Permanent records for this pump are kept by the Serial Number and it must, therefore, be used with all correspondence and spare parts orders. The last digit indicates the specific pump on orders for more than one pump. For example, if an order called for six pumps, all pumps would have the same first three sets of digits and the last digit will change to identify each of the six. (e.g. 1-21938-1-1, 1-21938-1-2, etc.)

The identification number is a number which the end user of the pump requests to be put on the rating plate to identify the pump in his operation. (e.g. CWP-11 stands for Chilled Water Pump No. 11.)

The frame plate, Figure 2, gives information concerning the bearing and their lubrication. The inboard and outboard bearing numbers refer to the bearing manufacturer's numbers.

ITT **A-C Pump**
Cincinnati, OH U.S.A.

Size		Type
8X6X13		**2000**
Serial Number		
1-21938-1-1		
GPM	Head (ft)	RPM
500	**60**	**1780**
Model Number		Imp. Dia. (in.)
150		**11.0**
Max. Field Hydrotest Pressure		
	150 PSI	
Identification No.		Year
CWP-11		**1994**

MADE IN U.S.A. 52-128-176-001

FIGURE I – RATING PLATE

ITT **ITT A-C Pump**
Cincinnati, OH U.S.A.

Frame No.	Inb. Brg.
670	**6309**
Lubrication	Out. Brg.
GREASE	**6309**
Part No.	

MADE IN USA
52-128-173-001

FIGURE 2 – FRAME PLATE

FRAME DESCRIPTION

Three basic frame designs serve the complete line of 2000 Series pumps. The three frames are designated by the model numbers 330, 500, and 670. Model numbers give the distance, in millimeters, from the centerline of the impeller to the coupling end of the shaft.

All three shafts are similar in design with three different shaft and bearing sizes being used. All pumps which are built on a given frame have identical shafts and bearings. This design allows a wide interchangeability between various pump parts and frames.

Bearings are single row, grease lubricated ball type at both ends on all frames. Bearings are sealed on the outside making them suitable for operation in normal atmospheres. Provisions are made for relubrication of both bearings.

DISASSEMBLY AND REASSEMBLY PROCEDURES

The procedures outlined in this section cover the dismantling and reassembly of different types of 2000 Series pumps.

When working on the pumps, use accepted mechanical practices to avoid unnecessary damage to parts. Check the condition of all pump parts when the pump is dismantled and replace if necessary.

GENERAL DISMANTLING INSTRUCTIONS

1. Disconnect the power source to the driver.
2. Close the suction and discharge valves to isolate the pump from the system. Turn off liquid supply and disconnect any piping to the stuffing box.
3. Remove coupling guard and uncouple the pump and driver. The pump half coupling may be left assembled on the shaft unless the pump is to be completely dismantled.
4. Remove the hold down bolts (0-904-0) which secure the pump frame to the baseplate.

DISMANTLING PROCEDURE

I. Initial Disassembly

1. Drain the pump by opening the discharge gauge tap located directly below the discharge flange and removing the drain plug (1-910-0) at the bottom of the casing

2. Unbolt the frame assembly from the casing by removing either capscrews (1-904-0) or capscrews and clamping lugs (2-937-0). Pull the entire rotating assembly from the casing leaving the casing connected to the piping unless it is to be repaired, replaced, or if applicable, to have new wear rings installed.

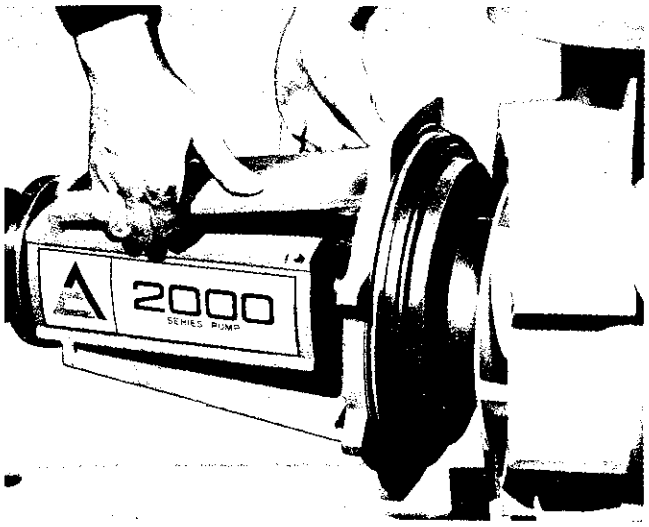


Fig. 3 – Removing Rotating Assembly

3. Remove the "O" ring (2-914-0) from the stuffing box cover and inspect for damage. Replace if necessary.

II. Impeller Removal

1. Lock the coupling end of the shaft in a padded vise.

2. Remove the impeller nut (4-023-0). To do this, turn the impeller nut in the same direction in which the impeller rotates (counterclockwise viewing from the suction inlet).

3. Pull the impeller (4-002-0) from the shaft and remove the impeller key (4-911-0).

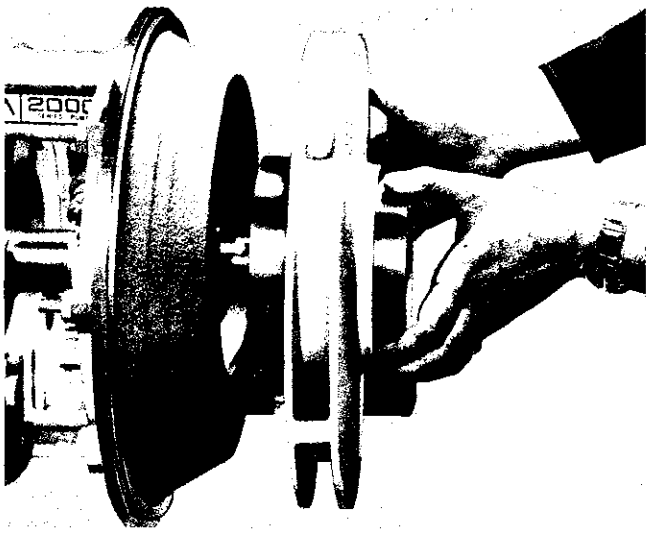


Fig. 4 – Impeller Removal

III. Dismantling the Stuffing Box

A. Pumps With Mechanical Seals

1. Remove spacer sleeve (1-154-0).

2. Remove the two nuts holding the gland (6-014-0) to the stuffing box (2-036-0).

3. Pull the stuffing box cover off the shaft assembly.

NOTE: On the larger 2000 Series pumps, it will be necessary to remove the capscrews holding the stuffing box cover to the frame. The mechanical seal (6-400-0) should now be exposed on the shaft sleeve. (In some cases the shaft sleeve may come off the shaft with the stuffing box cover. If this happens gently press or pull the shaft sleeve and mechanical seal from the stuffing box toward frame side of the stuffing box cover). This will expose the mechanical seal as above.

4. Remove the seal parts from the shaft sleeve, examine for damage, and if necessary replace.

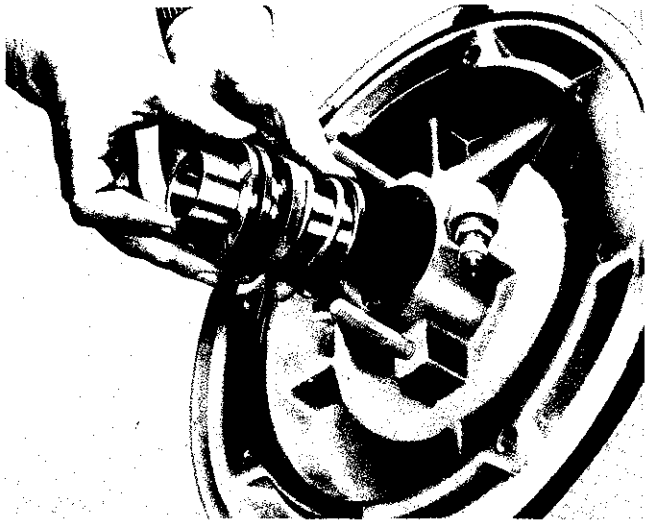


Fig. 5 – Removing Mechanical Seal

5. Remove the gland (6-014-0), shaft sleeve (1-009-0), and the deflector (1-136-0) from the pump shaft. A puller may be used to remove the shaft sleeve if it does not slide off the pump shaft easily.

B. Pumps With Packed Stuffing Box

1. Loosen packing gland (6-014-0) by loosening the two gland retaining nuts.

2. Pull the stuffing box cover, gland, and packing from the shaft.

3. Remove the two gland retaining nuts and remove the gland (6-014-0). Remove the packing rings (6-924-0) and, where applicable, the seal cage (6-013-0) from the stuffing box. A standard packing hook is recommended for removing the packing and seal cage.

4. Remove the packing base ring.

IV. Frame Disassembly

1. Remove bearing caps, (5-018-3, and 5-018-4).

2. Remove snap ring, (5-068-4) from the outboard bearing housing.

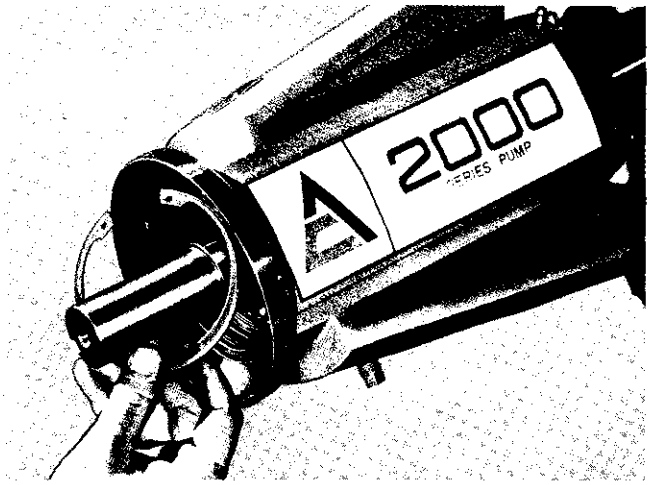


Fig. 6 – Snap Ring removal

3. Press the shaft, (5-007-0), outboard bearing, (5-026-4), and inboard bearing, (5-026-3), toward the motor side of the frame until the outboard bearing clears the frame's outboard bearing housing.

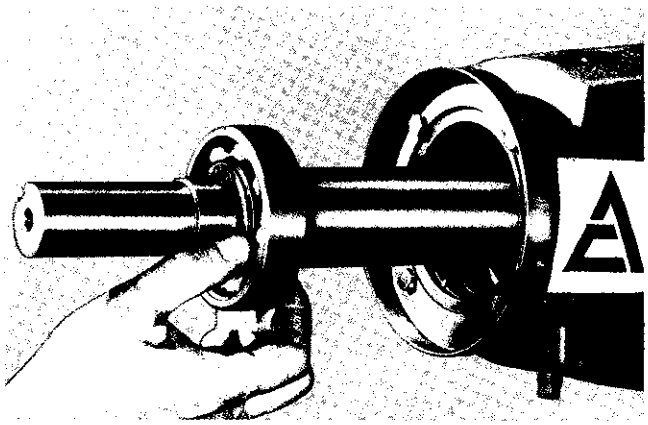


Fig. 7 – Bearing and shaft assembly removal

4. Using a suitable pair of snap ring pliers (such as State Bearing Services Model #P-105 or #P-107) remove snap ring, (5-068-3), from the outboard bearing housing. (Flat snap ring located on the inside of the outboard bearing housing).

5. Finish removing the shaft, outboard bearing, and

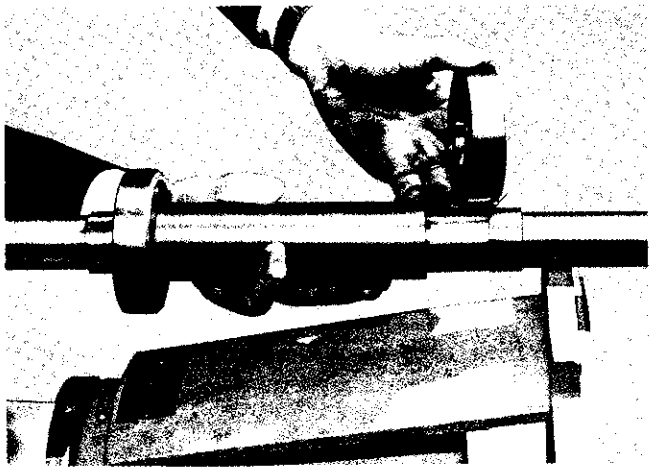


Fig. 8 – Shaft and Bearing Assembly removed from frame

6. Remove the snap ring, (5-086-0), from the outboard end (motor end) of the pump shaft.

7. Using a suitable bearing press, remove the inboard bearing, (5-026-3), and the outboard bearing, (5-026-4), from the pump shaft, (5-007-0).

V. Casing Wearing Ring Removal (Optional)

The optional wearing rings are removed from the casing and stuffing box cover by the following method:

1. Drill two axial holes in each wearing ring approximately 180 degrees apart being careful not to drill into the casing or stuffing box cover.

2. Split the wearing rings using a cold chisel.

3. Remove the parts from the wearing ring fit.

This completes the disassembly of the 2000 Series pump.

ASSEMBLY PROCEDURES

I. Frame Assembly

1. Press the outboard bearing, (5-026-4), onto the motor side of the pump shaft, (5-007-0).

2. Install snap ring, (5-086-0), on the pump shaft with the tapered edge away from the bearing (outboard side of outboard bearing).

3. Place snap ring, (5-068-3), (flat snap ring) over the pump shaft, (5-007-0), positioning the snap ring between the two bearing shoulders.

NOTE: There are two snap rings that go into the outboard bearing housing: snap rings (5-068-3 and 5-068-4). Snap ring (5-068-3) is flat and goes into the inside snap ring groove, and snap ring, (5-068-4) is tapered and goes into the outside snap ring groove.

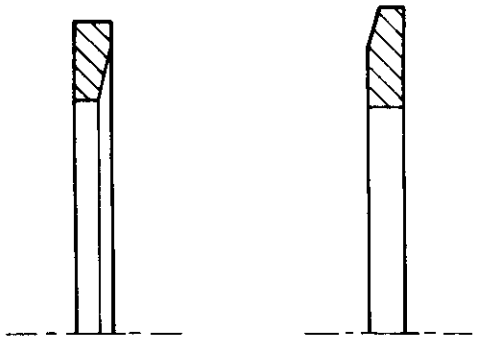


Fig. 9 – Tapered Snap Ring

4. Press inboard bearing, (5-026-3), onto the inboard side (pump side) of the pump shaft.

5. Press the inboard end (pump end) of the shaft-bearing assembly into the outboard end (motor end) of the pump frame. Press the unit toward the pump side of the frame until the inboard bearing clears the outboard bearing housing.

6. Using a suitable pair of snap ring pliers, such as State Bearing Services Model #P-105 or #P-107 place snap ring, (5-068-3), (located on pump shaft between the bearings) into the inside snap ring groove of the outboard bearing housing.

7. Continue pressing the shaft and bearing assembly into the frame until the outboard bearing, (5-026-4), seats firmly against snap ring, (5-068-3), inside the outboard bearing housing.

8. Place snap ring (5-068-4), in the outside snap ring groove of the outboard bearing housing (tapered edge away from bearing).

9. Install bearing caps, (5-018-3 and 5-018-4), onto either end of the pump frame.

II. Stuffing Box Assembly

NOTE: There are two pipe taps on the stuffing box; one closest to the gland, and one furthest away from the gland.

If the pump is equipped with mechanical seals, the stuff box cover should be positioned with the pipe tap closest to the gland on top.

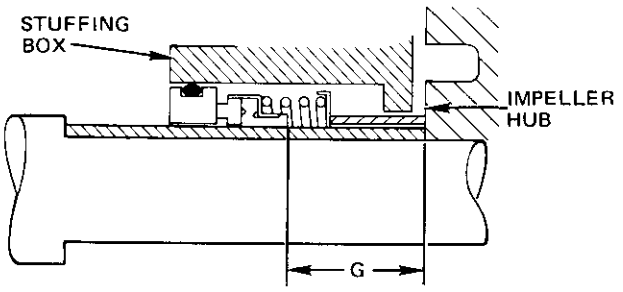
If the pump is equipped with packing, the stuff box cover should be positioned so the pipe tap furthest away from the gland is on top.

For ease of assembly install pipe fittings in the stuffing box pipe taps before assembling stuffing box on the frame.

A. Pumps With Mechanical Seals

1. Install the two gland retaining studs (6-908-0) into the stuffing box cover.

2. Install the rotating and stationary elements of the mechanical seal (6-400-0) on the shaft sleeve (1-009-0) being certain that the two wearing surfaces face each other. Position the seal on the sleeve according to the "G" dimension found in Fig. 10.



"G" SETTING DIMENSIONS			
PUMP SIZE	330	500	670
2 x 1½ x 6	1.22	—	—
2½ x 2 x 6½S		—	—
2½ x 2 x 6½L		—	—
3 x 2 x 6½S		—	—
3 x 2 x 6½L		—	—
1½ x 1½ x 9		—	—
2 x 1½ x 9		—	—
2½ x 2 x 9S		—	—
2½ x 2 x 9L		—	—
3 x 2 x 9		—	—
3 x 2 x 10		—	—
3 x 2 x 11		—	—
3 x 2½ x 11		—	—
4 x 3 x 6½	—	1.31	—
3 x 2½ x 9	—		—
4 x 3 x 9	—		—
6 x 4 x 9	—		—
6 x 6 x 9	—		—
6 x 6 x 9½	—		—
8 x 6 x 9	—		—
8 x 6 x 9½	—		—
4 x 3 x 11	—		—
4 x 4 x 11	—		—
6 x 6 x 11	—		—
8 x 6 x 11	—		—
3 x 2½ x 13	—		—
4 x 3 x 13	—		—
6 x 4 x 13	—		—
6 x 6 x 13S	—		—
6 x 6 x 13L	—		—
8 x 6 x 13	—	—	1.38
10 x 8 x 13	—	—	

Fig. 6 – "G" Setting Dimension

3. Place seal spring retainer into stuffing box.

4. Place seal spring into stuffing box.

5. Place sleeve and seal assembly into stuffing box with rotating half of seal installed closest to the impeller.

6. Install the seal gland (6-014-0) (flat side toward stuffing box) on the stuffing box using the gland studs (6-908-0) and gland nuts (6-903-0). Tighten gland nuts evenly until the gland is approximately 1/8" from the stuffing box.

7. Slide the deflector ring (1-136-0) onto the shaft.

8. Slide the stuffing box cover, seal, and sleeve assembly onto the frame shaft being certain the stuffing box is closest to the frame. To prevent any leakage use Dow Corning Silicone Rubber #732 or equal sealant between the shaft and shaft sleeve.

9. If applicable, bolt the frame to the stuffing box using cap screws (1-904-0).

Pumps With Packed Stuffing Boxes

1. Slide deflector (1-136-0) onto the pump shaft.

2. Slide the packing gland (6-014-0) onto the pump shaft (flat side toward frame).

3. Slide the shaft sleeve (1-009-0) onto the pump shaft. To prevent leakage between the pump shaft and sleeve use Dow Corning Silicone Rubber #732 or equal sealant between the shaft and shaft sleeve.

4. Place the packing base ring (6-152-0) into the stuffing box. Slide the stuffing box cover over the pump shaft, and, if applicable, bolt the stuffing box to the frame using cap screws (1-904-0).

5. Install the packing (6-924-0) and if applicable the seal cage (6-013-0) into the stuffing box being sure to stagger the joints as per the instructions found in the general pump instruction section of this book.

III. Impeller Installation

1. If the pump is equipped with mechanical seals slide the spacer sleeve (1-154-0) over the shaft sleeve and into the stuffing box.

2 Install the impeller key into the keyway on the impeller side of the pump shaft.

3. Slide the pump impeller (4-002-0) onto the pump shaft.

4. Screw the impeller nut (4-023-0) onto the pump shaft until finger tight. Clamp the coupling end of the pump shaft in a padded vise, and tighten (clockwise as viewed from the suction inlet) the impeller nut to 25-30 ft. lbs.

5. For pumps with mechanical seals. Tighten gland evenly against the stuffing box.

Final Assembly

1. Place the "O" ring casing seal (2-914-0) around the "O" ring seat on the stuffing box cover.

2. Carefully slide the frame assembly into the casing being sure not to pinch the "O" ring. Insert the cap screws (1-904-0) through the frame and into the casing (the large 2000 Series pumps use cap screws and clamping lugs (2-937-0) to hold the frame to the casing. Tighten opposite cap screws evenly around the frame until the stuffing box has been drawn evenly into the casing. Then alternately torque each cap screw to 25 ft. lbs.

3. Secure frame foot to pump base.

4. If necessary, connect the suction and discharge piping to the pump.

5. Connect the flushing water system to the stuffing box.

6. Align the pump to the motor as instructed in the general instruction of this book.

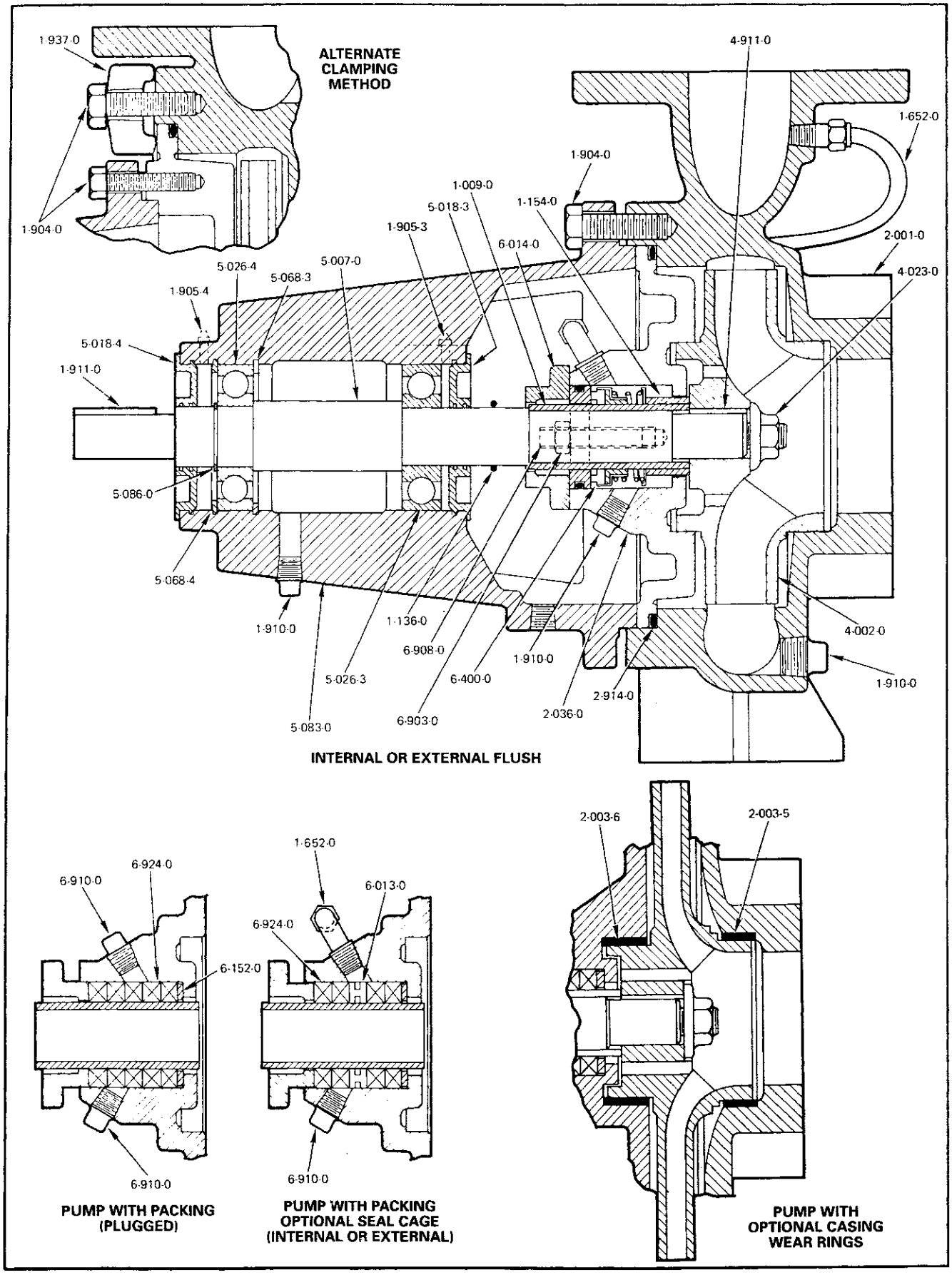
7. Connect the pump to the motor. Reinstall the coupling guard.

8. If the pump is to be started, be sure flushing is provided to the stuffing box.

9. Connect the power to the motor CHECK MOTOR ROTATION.

This completes the assembly of the 2000 Series pump.

NOTE: All pumps are shipped with coupling guards. Coupling guards must be in place before operating pump.


ALTERNATE CLAMPING METHOD
1-937-0
1-904-0
4-911-0
1-652-0
1-904-0
1-009-0
5-018-3
1-154-0
1-905-3
6-014-0
2-001-0
4-023-0
5-026-4
5-068-3
5-007-0
1-905-4
5-018-4
1-911-0
5-086-0
5-068-4
1-910-0
1-136-0
6-908-0
5-026-3
6-400-0
1-910-0
2-914-0
2-036-0
6-903-0
5-083-0
4-002-0
1-910-0
INTERNAL OR EXTERNAL FLUSH
6-910-0
6-924-0
6-152-0
6-910-0
PUMP WITH PACKING (PLUGGED)
1-652-0
6-013-0
6-924-0
6-910-0
PUMP WITH PACKING OPTIONAL SEAL CAGE (INTERNAL OR EXTERNAL)
2-003-6
2-003-5
PUMP WITH OPTIONAL CASING WEAR RINGS

PARTS LIST

Cat. No.	Part Name	Qty.
1-009-0	Shaft Sleeve	1
1-136-0	Deflector	1
1-154-0	Spacer Sleeve	1
1-248-1	Frame Foot Assembly	1
1-652-0	By-Pass Piping Kit	1
1-904-0	Bolts – Miscellaneous	8
	With Lugs	16
1-905-3	Grease Fitting, Inboard	1
1-905-4	Grease Fitting, Outboard	1
1-910-0	Pipe Plugs	2
	Without By-Pass	3
1-911-0	Key, Coupling	1
2-001-0	Casing	1
2-036-0	Stuffing Box Cover	1
2-914-0	"O" Ring, Casing Seal	1
2-937-0	Clamping Lug	8
4-002-0	Impeller	1
4-023-0	Impeller Nut	1
4-911-0	Key, Impeller	1
5-007-0	Shaft	1
5-018-3	Bearing Cap, Inboard	1
5-018-4	Bearing Cap, Outboard	1
5-026-3	Bearing, Inboard	1
5-026-4	Bearing, Outboard	1
5-068-3	Snap Ring, Inboard Bearing Housing	1
5-068-4	Snap Ring, Outboard Bearing Housing	1
5-083-0	Frame	1
5-086-0	Snap Ring, Shaft	1
6-014-0	Gland	1
6-152-0	Ring Packing Base	1
6-400-0	Mechanical Seal	1
6-903-0	Gland Nut	2
6-908-0	Gland Stud	2
6-910-0	Pipe Plug	1
	Without By-Pass	2
6-924-0	Packing	5
	With Seal Cage	4
	OPTIONAL COMPONENTS	
1-652-0	By-Pass Piping Kit, Seal Cage	1
2-003-5	Wear Ring, Suction	1
2-003-6	Wear Ring, Stuffing Box	1
6-013-0	Seal Cage	1

ORDERING PARTS

The pumps covered by this manual have been designed and built with certain replaceable wearing parts. The recommended inventory of spare parts depends upon the installation and the importance of continued operation.

For critical service requiring a minimum of "down time" a complete or "quick change" rotating element is recommended.

For normal service, with repairs to be made in the field, the following parts are recommended for stock.

1 set of bearings
2 sets of wearing rings
1 set of gaskets and "O" rings
2 mechanical seals (complete)

Parts should be ordered as far in advance of their use as possible since circumstances beyond the control of the company may reduce existing stock. Not all parts are stocked and must be manufactured for each order.

To facilitate rapid handling of your order for spare parts, be sure to include the following information:

1. Serial number of the pump.
2. Quantity of each part.
3. Catalog number of the part.
4. Name of the part.
5. Material desired. (Parts will be furnished in original materials unless specified as a material change. All material substitutions should be discussed with the factory.)

General Pump Instruction

SECTION I — Introduction

I-A PURPOSE OF MANUAL

This manual is furnished to acquaint you with some of the practical ways to install, operate, and maintain this pump. Read it completely before doing any work on your unit and keep it handy for future reference.

Equipment cannot operate well without proper care. To keep this unit at top efficiency, follow the recommended installation and servicing procedures outlined in this manual. The Industrial Pump Division's Customer Service Department is available to expertly guide the installation of the pump for maximum operating life and minimum downtime.

I-B ITT A-C PUMP SERVICE ORGANIZATION

Experienced, factory-trained servicemen offer prompt, efficient service at reasonable rates. These servicemen can find and correct costly errors such as poor grouting, misalignment, pipe stresses transmitted to the pump casing, or improperly cleaned piping. A serviceman may be requested through your nearest ITT A-C Pump Sales Representative.

Replacement and spare parts, including special attention to your individual problems, may also be obtained through the same Sales Representative.

I-C WARRANTY

Refer to your sales contract for coverages.

I-D PUMP IDENTIFICATION

All pumps are designated by Serial Number, Model Number, Size and Type. This information is stamped on an identification plate which is mounted on the pump. Refer to pump identification in specific instruction section of this manual for detailed information.

SECTION II — Installation

II-A RECEIVING 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.

WARNING: WHEN UNLOADING HORIZONTAL PUMPS, LIFT EQUALLY AT FOUR OR MORE POINTS ON THE BASEPLATE. DO NOT LIFT ON THE DRIVER OR PUMP. FOR VERTICAL PUMPS, USE THE LIFTING LUGS OR EYEBOLTS FOUND ON THE PUMP. DO NOT LIFT BY FLANGES OR BY THE EYEBOLTS FOUND ON THE MOTOR. BE VERY CAREFUL NOT TO DAMAGE ANY AUXILIARY PIPING OR CONTROLS WHEN MOVING PUMPS.

Horizontal pumps and drivers are normally shipped from the factory mounted on a baseplate and painted with primer and one finish coat. 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.

Shafts are in alignment when unit is shipped; however, due to shipping, the pumps may arrive misaligned and, therefore, *alignment must be established during installation.* ITT A-C Pump has determined that proper and correct alignment can only be made by accepted erection practices. Refer to the following paragraphs on "Foundation", "Baseplate Setting", "Grouting Procedure", "Alignment Procedure" and "Doweling".

II-B TEMPORARY STORAGE

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.

II-C 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 (NPSH) at pump suction is provided. Available NPSH must always equal or exceed the required NPSH 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, electrical characteristics should be identical to those shown on motor data plate.

II-D FOUNDATION

A substantial foundation and footing should be built to suit local conditions. It should form a rigid support to maintain alignment.

Vertical Pumps – Foundation bolts should be sized and accurately located. Each foundation bolt should be located in a bushing two diameters larger than the bolt to allow free movement of the bolt in conforming to the mounting holes in the pedestal. When vertical pumps are used with intermediate shafting, the motor mount baseplate should be securely attached to the floor or support structure.

Horizontal Pumps – The foundation should be poured without interruption to within 1/2 to 1-1/2 inches of the finished height. The top surface of the foundation should be well scored and grooved before the concrete sets; this provides a bonding surface for the grout. Foundation bolts should be set in concrete as shown in Fig. I. A 4-inch long tube around the bolts at the top of the concrete will allow some flexibility in bolt alignment to match the holes in the baseplate. Allow enough bolt length for grout, shims, lower baseplate flange, nuts and washers. The foundation should be allowed to cure for several days before the baseplate is shimmed and grouted.

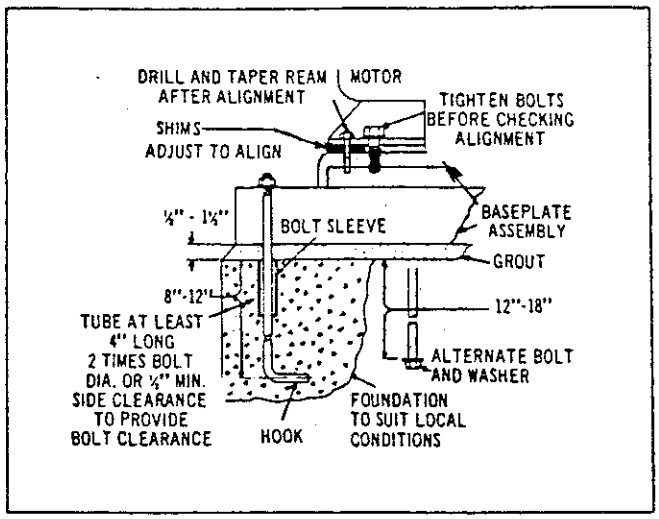


Fig. I – Foundation

II-E BASEPLATE SETTING: (Before Piping)

NOTE: This procedure assumes that a concrete foundation has been prepared with anchor or hold down bolts extending up ready to receive unit. It must be understood that pump and motor have been mounted and rough aligned at the factory. If motor is to be field mounted, consult factory for recommendations. ITT A-C Pump cannot assume responsibility for final alignment.

1. Use blocks and shims under base for support at anchor bolts and midway between bolts, to position base approximately 1" above the concrete foundation with studs extending through holes in the baseplate.

2. By adding or removing shims under the base, level and plumb the pump shaft and flanges. The base plate does not have to be level.

3. Draw anchor nuts tight against base, and observe pump and motor shafts or coupling hubs for alignment. (Temporarily remove coupling guard for checking alignment.)

4. If alignment needs improvement, add shims or wedges at appropriate positions under base so that retightening of anchor nuts will shift shafts into closer alignment. Repeat this procedure until a reasonable alignment is reached.

NOTE: Reasonable alignment is defined as that which pump contractor and the accepting facility (final operator) mutally agree upon. Final alignment procedures are covered under "Alignment Procedure."

5. Check to make sure the piping can be aligned to the pump flanges without placing pipe strain on either flange.
6. Grout baseplate in completely (See "Grouting Procedure") and allow grout to dry thoroughly before attaching piping to pump. (24 hours is sufficient time with approved grouting procedure.)

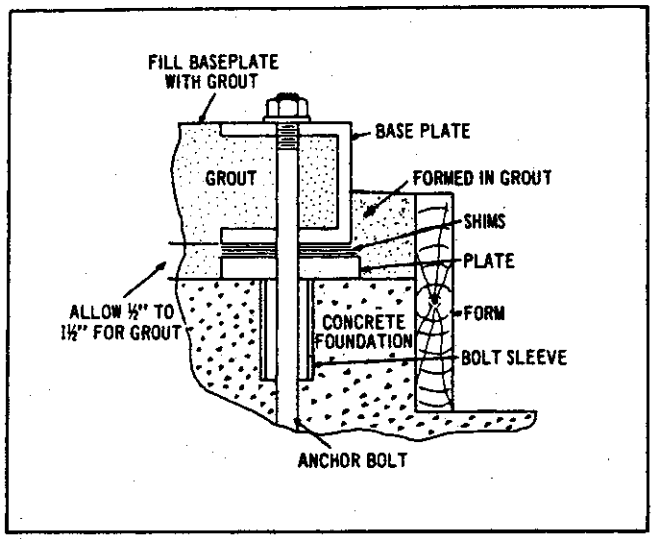


Fig. II – Setting Baseplate and Grouting

II-F GROUTING PROCEDURE

Grout compensates for uneven foundation, distributes weight of unit, and prevents shifting. Use an approved, non-shrinking grout (such as Embeco 636 by Master Builders, Cleveland, Ohio or equivalent), as follows, after setting and leveling unit. (See Fig. II)

1. Build strong form around the foundation to contain grout.
2. Soak top of concrete foundation thoroughly, then remove surface water.
3. 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, check the foundation bolts and tighten if necessary.
5. Check the alignment after the foundation bolts are tightened.
6. Approximately 14 days after the grout has been poured or when 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.

II-G ALIGNMENT PROCEDURE

NOTE: A flexible coupling will only compensate for small amounts of misalignment. Permissable misalignment will vary with the make of coupling. Consult coupling manufacturer's data when in doubt.

Allowances are to be made for thermal expansion during cold alignment so that the coupling will be aligned at operating temperature. In all cases, a coupling must be in alignment for continuous operation. Even though the coupling may be lubricated, misalignment causes excessive wear, vibration, and bearing loads that result in premature bearing failure and ultimate seizing of the pump. Misalignment can be angular, parallel, or a combination of these, and in the horizontal and vertical planes. Final alignment should be made by moving and shimming the motor on the baseplate until the coupling hubs are within the recommended tolerances measured in total run-out. All measurements should be taken with the pump and motor foot bolts tightened. The shaft of sleeve bearing motors should be in the center of its mechanical float.

NOTE: Proper alignment is essential for correct pump operation. This should be performed after baseplate has been properly set and grout has dried thoroughly according to instructions. Final alignment should be made by shimming driver only. Alignment should be made at operating temperatures.

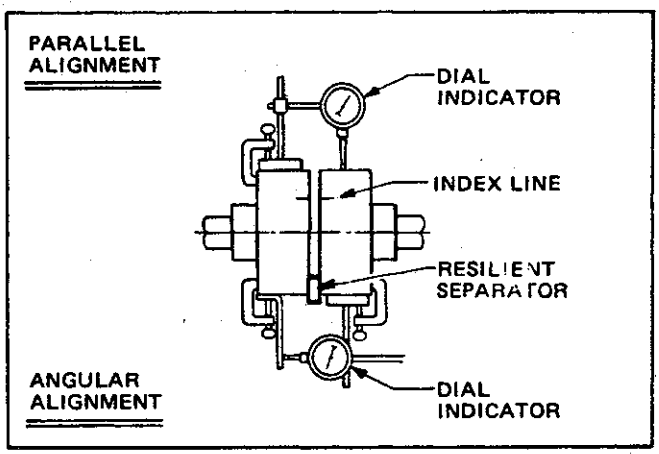


Fig. IIIa – Single Element Couplings See 9A on Page IV

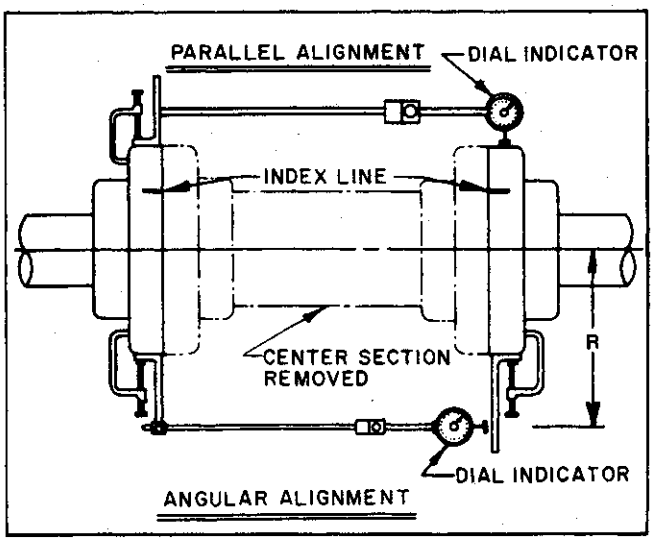


Fig. IIIb – Double Element Coupling See 9B on Page IV

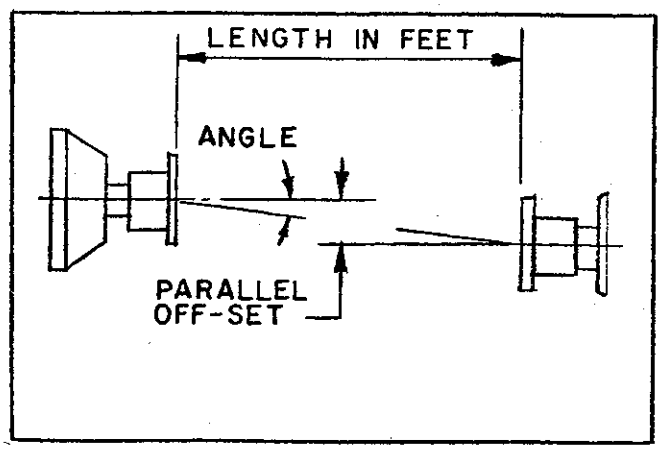


Fig. IIIc Universal Joint Coupling See 9C Page IV

The following alignment procedure is recommended where precise alignment is necessary or desirable:

1. Make sure each hub is secured to its respective shaft and that all connecting and/or spacing elements are removed at this time.

2. The gap between the coupling hubs is set by the mfg. before the units are shipped. However, this dimension should be checked. (Refer to the coupling mfg's specifications supplied with the unit).

3. Scribe index lines on coupling halves as shown in Fig. III.

4. Mount dial indicator on one hub as shown for parallel alignment. Set dial to zero.

5. Turn both coupling halves so that index lines remain matched. Observe dial reading to see whether driver needs adjustment. (See paragraph 9 below.)

6. Mount dial indicator on one hub as shown for angular alignment. Set dial to zero.

7. Turn both coupling halves so that index lines remain matched. Observe dial reading to see whether driver needs adjustment. (See paragraph 9 below.)

8. Assemble coupling. Tighten all bolts and set screw(s). It may be necessary to repeat steps 3 through 6 for a final check.

9. a. For single element couplings, a satisfactory parallel misalignment is .004" T.I.R., while a satisfactory angular misalignment is .004" T.I.R. per inch of radius R (See Fig. IIIb.)

   b. For double element couplings, a satisfactory parallel misalignment is .008" T.I.R., while a satisfactory angular misalignment is .002" T.I.R. per inch of radius R (See Fig. IIIb.)

   c. For universal joint couplings, angular misalignment between driver and driven shaft should be held ±1°, shafts should be offset .125" to .187" per foot of spacer. (See Fig. IIIc)

Final Alignment

Final alignment cannot be accomplished until the pump has been operated initially for a sufficient length of time to attain operating temperature. When normal operating temperature has been attained, secure the pump to re-check alignment and compensate for temperature accordingly. See Alignment Section.

After final alignment, it is necessary to dowel driver feet and pump to the baseplate. Drill and ream diagonal feet of both for dowels. See Doweling.

NOTE: Pump may have been doweled to base at factory.

II-H DOWELING

Dowel the pump and driving unit as follows:

1. Drill holes through diagonally opposite feet and into the base. Holes must be of a diameter 1/64 inch less than the diameter of the dowel pins. Clean out the chips.

2. Ream the holes in feet and base to the proper diameter for the pins (light push fit). Clean out the chips.

3. Insert pins to be approximately flush with feet.

II-I SUCTION AND DISCHARGE PIPING

General

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

Piping should always be run to the pump.

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

Both the suction and discharge piping should be independently supported 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 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. 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-degree or long sweep 90-degree fitting 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.

Suction Piping

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

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. If the suction pipe is short, the pipe diameter can be the same size as the suction opening. If longer suction pipe is required, pipes should be one or two sizes larger than the opening depending on piping length.

Suction piping for horizontal double suction pumps should not be installed with an elbow close to the suction flange of the pump except when the suction elbow is in the vertical plane. A suction pipe of the same size as the suction nozzle approaching at any angle other than straight up or straight down must have the elbow located 10 pipe diameters from the suction flange of the pump. Vertical mounted pumps and other space limitations require special piping.

There is always an uneven turbulent flow around an elbow and when it is in a position other than the vertical it causes more liquid to enter one side of the impeller than the other. (See Fig. V) This results in high unequalized thrust loads that will overheat the bearings and cause rapid wear in addition to affecting hydraulic performance.

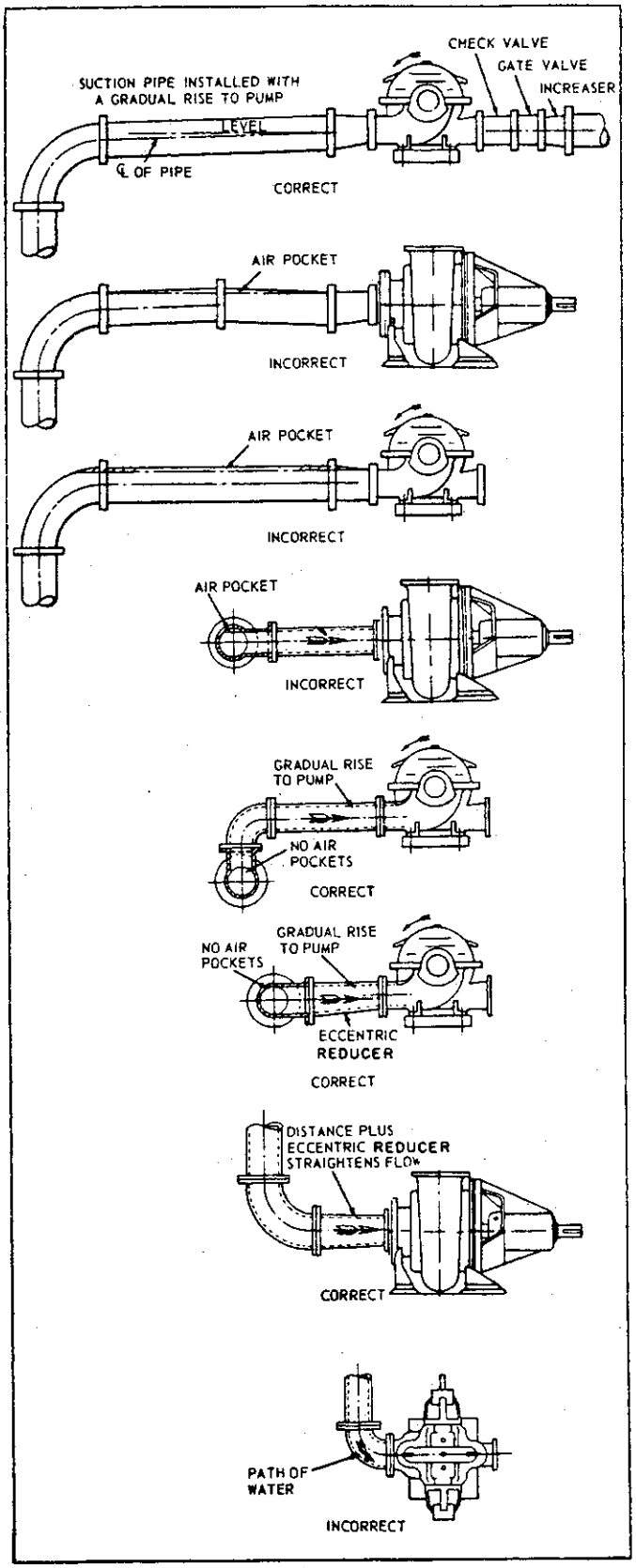


Fig. IV – Suction Pipe Installations
(Piping Supports Not Shown)

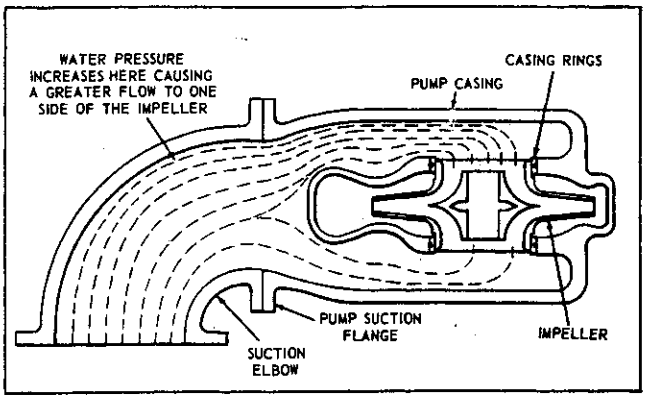


Fig. V – Unbalanced loading of a double suction impeller due to uneven flow around an elbow adjacent to the pump.

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 will become filled with air and thus 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 straight taper reducer in a horizontal suction line, as it tends to form an air pocket in the top of the reducer and the pipe.

To facilitate cleaning pump liquid passage without dismantling pump, an increasing suction nozzle or suction diffuser should be bolted to the suction flange. If this is not done, a short section of pipe (Dutchman or spool piece) so designed that it can be readily dropped out of the line can be installed adjacent to the suction flange. With this arrangement, any matter clogging the impeller is accessible by removing the nozzle (or pipe section).

Valves in Suction Piping

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 "Valves in Discharge Piping" below.)

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, 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.

Valves in Discharge Piping

A check valve and gate valve should be installed in the discharge. 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 (which are provided on request). 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.

II-J STUFFING BOX

Contaminants in the pumped liquid must not enter the packing space. These contaminants may cause severe abrasion or corrosion of the shaft, or shaft sleeve, and rapid

packing 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. The most important consideration is to establish the optimum flushing pressure that will eliminate contaminants from the packing. If this pressure is too low, fluid being pumped may enter the stuffing box. If the pressure is too high, excessive packing wear will result; and extreme heat may develop in the shaft causing higher bearing temperatures. The most desirable condition, therefore, is to use the lowest possible flushing pressure which the operating conditions will permit. If the pump system pressure conditions vary during the day, the packing problem becomes difficult. Consideration should be given to using a mechanical seal. (See "Mechanical Seals".)

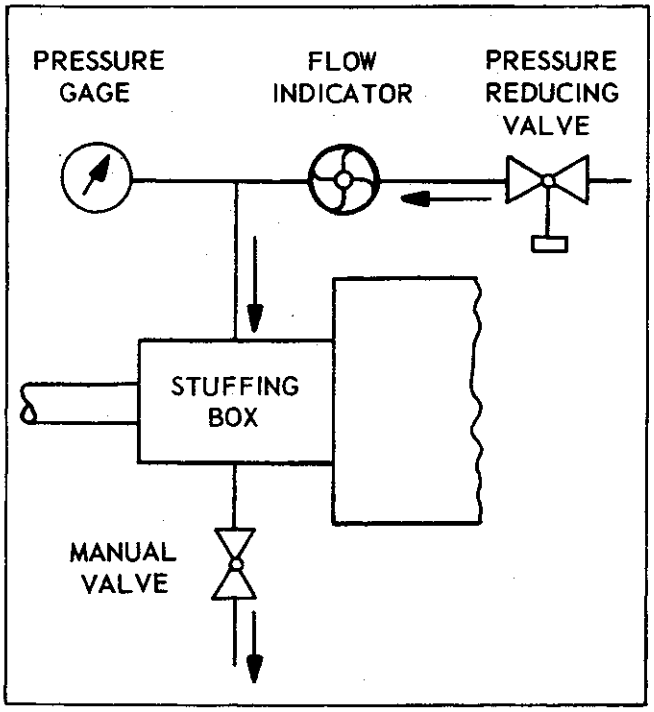


Fig. VI – Controlled Pressure System for Stuffing Box

One recommended method to minimize error in regulating flushing water is a "Controlled Pressure System" (Fig. VI). 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 into the pump. With this arrangement, the packing gland need be tightened only against the lowest necessary pressure. Longer packing life and less frequent adjustments are possible with the "Controlled Pressure System" if properly installed and operated. (See "Stuffing Box Operating Pressure".)

II-K 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 under section V-D.

II-L PACKING LUBRICATION

Internal Liquid Lubricant

Pumped liquid may be used to lubricate the packing when the following conditions prevail:

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. Liquid has lubricating qualities.
5. Liquid is non-toxic and non-volatile.

External Liquid Lubricant

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 the following conditions prevail:

1. Liquid being pumped contains dirt, grit, or other impurities.
2. Temperature of the pumped liquid is below 32°F or above 160°F.
3. Liquid being pumped has non-lubricating properties.
4. Liquid is toxic or volatile.
5. Suction pressure is above 75 psig, vacuum, or high lift.

II-M STUFFING BOX OPERATING PRESSURE

The actual stuffing box operating pressure may be obtained by installing a pressure gauge on the box. This is done with an extra seal cage temporarily replacing the two rings of packing in the bottom of the box to obtain accurate gauge readings. Take gauge readings with the pump running under various head and capacity conditions. Then set the pressure of flushing or lubrication liquid at a value 5 to 10 psi above the maximum expected stuffing box operating pressure.

Even under the best conditions, a properly packed stuffing box should be watched closely. If pressure conditions change slightly, there will be a resultant change in packing "seating" which should be compensated by a change in gland adjustment. Consideration should also be given to the lubrication pressure. A wide variation indicates a need to use a mechanical seal.

II-N 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 kits may be ordered from your Allis-Chalmers Sales Representative.

Single Mechanical Seal

Pumps containing single mechanical seals normally utilize the pumped liquid to lubricate the seal faces. This method is preferred when the pumped liquid is neither abrasive nor corrosive. If the liquid being pumped is not suitable, an external flush should be provided. (See "External Liquid Lubricant" page VII.)

Double Mechanical Seal

A double mechanical seal consists of two single seals mounted back-to-back and a suitable sealing liquid which is introduced into the seal chamber. The sealing liquid (preferably clear water) is injected into the box at a higher pressure than that which exists at the entrance to the seal cavity on the pump side. The pressure differential isolates the sealing faces from the pumped liquid. Double mechanical seals are normally preferred in pumps handling sewage, slurries, or any other solids suspended in the pumped liquid.

Lubrication for the double seal is provided by the sealing liquid which is introduced through the tap in the seal cavity. The sealing liquid pressure must always be higher than the pressure on the seal closer to the suction side. If sufficient sealing pressure is not maintained, the pressure within the pump can force open the lower seal and allow the pumped liquid to enter the box which can damage the seals.

Two methods are used to provide sealing liquid to the stuffing box:

1. A common method utilizes a pressure line which is installed from a tap on the discharge nozzle to the tap in the stuffing box cartridge. A filter is installed in the line to trap the solid particles. The filter must be capable of screening out all particles above 25 microns in size.

   Since the liquid is bypassed from the high pressure (discharge) side of the pump, and dead-ended in the stuffing box cartridge, there are no problems in maintaining a sufficient pressure differential provided the filter is not clogged.

2. Clear, clean water can be supplied from an external source in some installations. City water can be used if there is an air break between the water supply and the water being provided to the pump. Various municipal ordinances require this break to prevent contamination of the city water supply.

SECTION III — Operation

III-A PRE-START CHECKS

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

1. Check alignment between pump and motor
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. Check impeller adjustment, see specific section for proper adjustment.
5. Turn rotating element by hand to assure that it rotates freely.
6. Check stuffing box adjustment, lubrication, and piping.
7. Check driver lubrication.
8. Assure that pump bearings are properly lubricated.
9. Assure that coupling is properly lubricated, if required.

10. Assure that pump is full of liquid, (See Priming III-B) and all valves are properly set and operational, with the discharge valve closed, and the suction valve open.

11. 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.

CAUTION: ROTATION SHOULD BE CHECKED WITH COUPLING DISCONNECTED ON COUPLED UNITS.

III-B PRIMING

If the pump is installed with a positive head on the suction, it can be primed by opening the suction and vent valve and allowing the liquid to enter 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.

III-C STARTING

1. Close drain valves and valve in discharge line.

2. Open fully all valves in the suction line.

3. Turn on seal water to the stuffing box. (If pumped fluid is dirty or if leakage 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. (Pumps moving high temperature liquids.) Open the warm-up valve to circulate liquid for preheating. Consult the instructions that cover such specially designed heating system.

6. Start the pump driver (turbines and engines may require warming up; consult the manufacturer's instructions).

7. When the pump is operating at full speed, open the discharge valve slowly. This should be done promptly after start-up to prevent damage to pump by operating at zero flow.

8. Adjust the liquid seal valves to produce the recommended pressure for either the mechanical seal or packed stuffing box.

III-D OPERATING CHECKS

1. Check the pump and piping to assure that there are no leaks.

2. Check and record pressure gauge readings for future reference.

3. Check and record voltage, amperage per phase, and kw if an indicating wattmeter is available.

4. Check bearings for lubrication and temperature. Normal temperature is 180° maximum.

5. Check and adjust stuffing box for correct operation. (See Section V-D).

6. Check sealing water lines and valves.

CAUTION: MAKE ALL PUMP OUTPUT ADJUSTMENTS WITH THE DISCHARGE VALVE. DO NOT THROTTLE THE SUCTION LINE TO ADJUST THE PUMP OUTPUT.

III-E SHUTDOWN

The following steps of procedure will take care of most normal shutdowns of the pump. 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 "Temporary Storage" and "Freezing Protection."

1. Close the discharge valve slowly.

NOTE: When stopping pump, always close discharge valve first.

2. Shut down the driver (Consult manufacturer's instructions for special operations.)

3. Close seal liquid valves. (If pumped liquid is dirty or if inleakage is to be prevented, these lines should always be left open.)

4. Open drain valves as required.

III-F FREEZING PROTECTION

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

1. Drain the pump; remove all liquids 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.

III-G FIELD TESTS

Performance Curve

A typical performance curve for a specific pump can be obtained from ITT A-C Pump. This can be used in conjunction with a field test, if one is required. All ITT A-C Pump pump 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. and under suction conditions as specified in the contract.

To aid in calculating pump performance, the following test information and definitions are included for reference.

NOTE: Complete procedure for testing pumps is given in the "Hydraulic Institute Standards" Centrifugal Pump Section.

Gauge Datum

The datum for all gauge readings is taken as the centerline of the pump shaft for all horizontal shaft pumps and as the eye of the impeller for vertical pumps.

Head Measurement

The unit for measuring head should be feet; therefore, all pressure readings of the pumped liquid should be converted to feet. The relationship between a pressure expressed in pounds per square inch (psi) and that expressed in feet of head is:

$$\text{Head in feet} = \frac{\text{psi} \times 2.31}{\text{sg}}$$

Where sg = specific gravity of the liquid pumped

Where sg = 1.0 for water at 60°

Total Head

Total head is the algebraic difference between the total suction and the total discharge heads.

1. Where suction lift exists, total head is the sum of the total discharge head and the suction lift.
2. Where positive suction head exists, the total head is the total discharge head minus the total suction head.

Suction Lift

Suction lift exists where the total suction head is below atmospheric pressure. Total suction lift is the reading of a liquid monometer at the suction nozzle of the pump, converted to feet of liquid, and referred to the datum minus the velocity head at the point of gauge attachment.

Positive Suction Head

Suction head exists when the total suction head is above atmospheric pressure. Total suction head is the reading of a gauge at the suction of the pump, converted to feet of liquid, and referred to datum plus the velocity head at the point of gauge attachment.

Velocity Head

Velocity head is figured from the average velocity obtained by dividing the discharge flow (in cubic feet per second) by the actual area of the pipe cross-section (in square feet), and is determined at the point of gauge connection. It is expressed by the formula:

$$h_v = \frac{V2}{2g}$$

Where g = the acceleration due to gravity, and is 32.17 feet per second squared at sea level and 45 degrees latitude.

V = velocity in the pipe in feet per second.

Volume Measurement

The method of volume measurement should be made by some accurate and accepted method and converted to gallons per minute. For easy reference, refer to the following:

1. The standard U.S. gallon contains 231 cubic inches.
2. One cubic foot equals 7.4805 gallons.
3. The specific weight of water at a temperature of 60° shall be taken as 62.34 pounds per cubic foot.

Horsepower

1. The formula for horsepower required at the pump shaft is:

$$Bhp = \frac{\text{Total head x GPM}}{3960 \text{ x Eff.}} \text{ x specific gravity}$$

2. The true motor brake horsepower, once the efficiency is determined from dynamometer tests, can also be calculated from the following formula:

$$Bhp = \frac{\text{kw input x Eff.}}{0.746}$$

Where Bhp = Brake horsepower delivered

kw input = Real input power (kw)

Eff. = Motor efficiency

Pump Efficiency

Pump efficiency can be calculated by the formula:

$$\text{Pump efficiency} = \frac{\text{Total head x GPM}}{3960 \text{ x Bhp}} \text{ x specific gravity}$$

III-H VIBRATION

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 velocity to .60 ips velocity depending on the operating characteristics and the structure. Refer to the standards of the "Hydraulic Institute" for the complete description and charts on various structures.

III-I ELECTRICAL REQUIREMENTS

Motor (Also See Separate Motor Instructions)

If the motor is sized to operate near full load at the rated head and capacity of the pump, a watt-meter should be installed to record input power to the motor. If motor efficiency is known, the shaft horsepower may be calculated and checked against the motor rating.

A motor operating outside its service factor will overheat and could possibly burn out. Motors are usually rated with normal temperature requirements stamped on the data plate.

NOTE: A motor which feels hot to the touch of the hand is not necessarily running hot. Check with an accurate temperature measuring device to be sure. A motor operating outside its service factor will overheat and could possibly burn out. Motors are usually rated with normal temperature requirements stamped on the data plate.

Conduit Box

Conduit boxes are mounted on the motors at lead access openings. Conduit boxes are normally provided for main power leads and other special accessories, such as space heaters, temperature alarms and control features.

The conduit box openings are sized as shown on the motor dimension drawing, and threaded for using standard rigid or flexible conduit. They may be assembled with conduit openings at any of four (4) 90° positions.

Motor Controls - General

Motor controls should conform to all the electrical data stamped on the motor data plate. Complete instructions for installation, operation, and maintenance are included with the controlling device.

External Wiring

Wiring to the motor should be installed in conformance with the National Electrical Code and any local codes.

SECTION IV TROUBLE SHOOTING

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

TROUBLE SHOOTING

CAUSES	CURES
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.
3. Suction lift too high.	If no obstruction at inlet, 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. Discharge head too high.	Check pipe friction losses. Large piping may correct condition. Check that valves are wide open.
5. Speed too low.	Check whether motor is directly across-the-line and receving full voltage. Or 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.
7. Impeller completely plugged.	Dismantle pump and clean impeller.
Not Enough Liquid Delivered	
8. 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.
9. Air leaks in stuffing box.	Increase seal lubricant pressure to above atmosphere.
10. Speed too low.	See item 5.
11. Discharge head too high.	See item 4.
12. Suction lift too high.	See item 3
13. Impeller partially plugged.	See item 7.
14. Cavitation; insufficient NPSH (depending on installation)	a. Increase positive suction head on pump by lowering pump. b. Sub-cool suction piping at inlet to lower entering liquid temperature. c. Pressurize suction vessel.
15. Defective impeller.	Inspect impeller, bearings and shaft. Replace if damaged or vane sections badly eroded.
16. Defective packing.	Replace packing and sleeves if badly worn.

CAUSES	CURES
17. Foot valve too small or partially obstructed.	Area through ports of valve should be at least as large as area of suction pipe - preferably 1-1/2 times. If strainer is used, net clear area should be 3 to 4 times area of suction pipe.
18. Suction inlet not immersed deep enough.	If inlet cannot be lowered, or if eddies through which air is sucked persist when it is lowered, chain a board to suction pipe. It will be drawn into eddies, smothering the vortex.
19. Wrong direction of rotation.	Symptoms are an overloaded drive and about 1/3 rated capacity from pump. Compare rotation of motor with directional arrow on pump casing.
20. Too small impeller diameter (probable cause if none of above).	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 drive.
Not Enough Pressure	
21. Speed too low.	See item 5.
22. Air leaks in suction piping.	See item 8.
23. Mechanical defects.	See items 15, 16 and 17.
24. Obstruction in liquid passages.	Dismantle pump and inspect passages of impeller and casing. Remove obstruction.
25. Air or gases in liquid. (Test in laboratory, reducing pressure on liquid to pressure in suction line. Watch for bubble formation.)	May be possible to over rate pump to point where it will provide adequate pressure despite condition. Better to provide gas separation chamber on suction line near pump, and periodically exhaust accumulated gas. See item 14.
26. Too small impeller diameter. (Probable cause if none of above.)	See item 20.
Pump Operates For Short Time, Then Stops	
27. Incomplete priming.	Free pump, piping and valves of all air. If high points in suction line prevent this, they need correcting. See page V.
28. Suction lift too high.	See item 3.
29. Air leaks in suction piping.	See item 8.
30. Air leaks in stuffing box.	See item 9.
31. Air or gases in liquid.	See item 25.

Pump Takes Too Much Power	
CAUSES	CURES
32. Head lower than rating; thereby pumping too much liquid.	Machine impeller's OD to size advised by factory.
33. Cavitation.	See item 14
34. Mechanical defects.	See items 15, 16 and 17.
35. Suction inlet not immersed enough.	See item 18.
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 boxes too tight.	Release gland pressure. Tighten reasonably. If sealing liquid does not flow while pump operates, replace packing. If packing is wearing too quickly, replace scored shaft sleeves and keep liquid seeping for lubrication.
39. Casing distorted by excessive strains from suction or discharge piping.	Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts.
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 0.002 on shaft and 0.004 inch on impeller wearing surface.
41. Mechanical failure of critical pump parts.	Check bearings and impeller for damage. Any irregularity in these parts will cause a drag on shaft.
42. Misalignment.	Realign pump and driver.
43. Speed may be too high (brake hp of pump varies as the cube of the speed; therefore, any increase in speed means considerable increase in power demand).	Check voltage on motor.
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.

SECTION V — Maintenance

V-A GENERAL MAINTENANCE

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 rules 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.

V-B MAINTENANCE OF PUMP DUE TO FLOOD DAMAGE

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 bearings; clean and inspect them for any rusted or badly worn surfaces. If bearings are free from rust and wear, reassemble and relubricate them with one of the recommended pump 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.

V-C BEARING LUBRICATION – GREASE

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.

The importance of proper lubrication cannot be over emphasized. It is difficult to say how often a bearing should be greased, since that depends on the conditions of operation. It is well to add one ounce of grease at regular intervals, but it is equally important to avoid adding too much grease. For average operating conditions, it is recommended that 1 oz. of grease be added at intervals of three to six months, and only clean grease be used. It is always best if unit can be stopped while grease is added to avoid overloading.

NOTE: Excess grease is the most common cause of overheating.

The bearing frame should be kept clean, since any contamination of foreign matter which gets into the housing will destroy bearings in a short time. When cleaning bearings, use a bearing cleaning solvent, or an industrial cleaning solvent. Do not use gasoline. Use lint free cloths. Do not use waste rags.

A regular ball bearing grease should be used, but a standard commercial vaseline can be substituted if necessary.

Do not use graphite. A NGLI No. 1 or 2 grease is generally satisfactory for operation at ordinary temperatures, the lighter grease for operation at high speed or low room temperature.

Mineral greases with a soda soap base are recommended. Grease made from animal or vegetable oils are not recommended due to the danger of deterioration and forming of acid. Most of the leading oil companies have special bearing greases which are satisfactory. For specific recommendations, consult the factory.

The maximum desirable operating temperature for ball bearings is 180°F. Should the temperature of the bearing frame rise above 180°F, the pump should be shut down to determine the cause.

Grease lubricated bearings should not be used where temperature of the pumped liquid exceeds 350°F.

NOTE: 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.

V-D STUFFING BOX

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

Water Lubrication

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 0.5 - 1.0 GPM, at 5 - 10 PSI above stuff box operating pressure.

We recommend that piping supplying sealing liquid to stuffing box be sized to supply a sufficient volume of water at the required pressure, based on the location of the pump (or pumps) with respect to the liquid source. A small pipe can be utilized for the connection to the stuffing box. A valve should be installed to adjust and regulate sealing liquid and a gauge installed to check pressure to the box.

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.

Grease Lubrication

Pump stuffing boxes are also suitable for grease lubrication. Several types of grease lubricators are available. When using a grease lubricator, grease pressure to the stuffing box should be equal to the pump discharge pressure.

Packing

All pumps are packed before shipment, unless otherwise requested. 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 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.

Fiber Packing

The standard packing is a soft, square asbestos, impregnated with oil and 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. For specific recommendations, consult the factory.

When a pump with fiber packing is first started, it is advisable to have the packing slightly loose without causing an air leak. As 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 or 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 packed 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 completely run-in, drippage from the stuffing box should be at least 40 to 60 drops per minute. This will indicate proper packing and shaft sleeve lubrication and cooling.

NOTE: Eccentric operation 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 may 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 that 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, making replacements where necessary.

New packing 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 so they are not in line. The joints should be kept toward the upper side of the shaft and should be at about a 90 degree angle 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.

Make sure the seal cage is properly located in the stuffing box under the sealing water inlet. 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.

V-E MECHANICAL SHAFT SEALS

General

A mechanical shaft seal is supplied in place of a packed stuffing box where specifically requested. 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 normally the life of the seal is much greater than that of packing on similar applications.

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.

1. 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.
2. Normally, mechanical seals require no adjustment or maintenance, except routine replacement of worn, or broken parts.
3. 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.

V-F CLEANING WITHOUT DISMANTLING PUMP

We recommend that an increasing suction nozzle or suction diffuser, bolted to the suction flange, be supplied by ITT A-C Pump. (If this is not done, a short section of pipe so designed that it can be readily dropped out of the line can be installed adjacent to the suction flange.) With this arrangement, any matter clogging the impeller is accessible by removing the nozzle (or pipe section).

Other cleaning methods include running an auger into the pump through the clean out hole in the suction nozzle, or through the casing handhole. This should free any clogging in the impeller eye.

If the pump cannot be freed of clogging after the above methods have been tried, dismantle the unit as previously described to locate the trouble.

V-G MAINTENANCE TIME TABLE

Every Month	Check bearing temperature with a thermometer, not by hand. If bearings are running hot (over 180°), it may be the result of too much lubricant. If changing the lubricant does not correct the condition, disassemble and inspect the bearings.
Every 3 Months	Check grease lubricated bearings for saponification. This condition is usually incurred 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. Check shaft or shaft sleeve for scoring. Scoring accelerates packing wear. Check alignment of pump and motor. Shim up units if necessary. If misalignment recurs 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.
Every Year	Remove the rotating element. Inspect thoroughly for wear, and order replacement parts if necessary. Check wearing clearances. Remove any deposit or scaling. Clean out stuffing box piping. Measure total dynamic suction and discharge head as a test of pipe connection. 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.

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