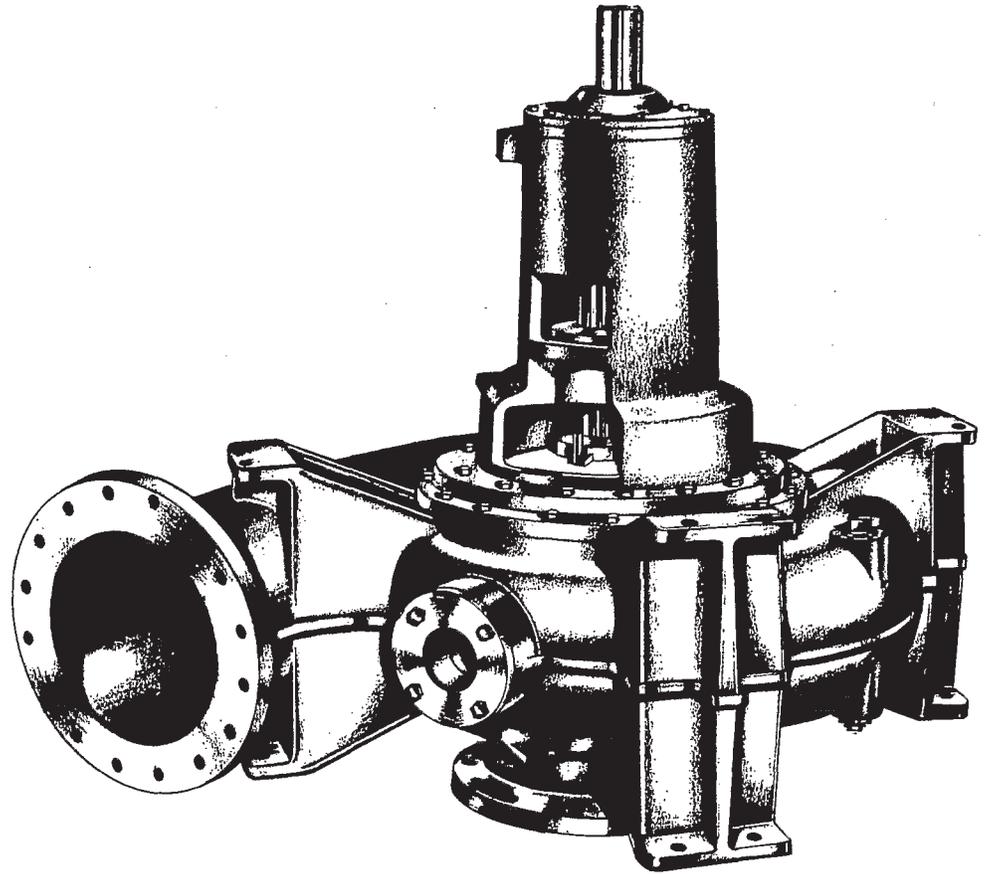




FAIRBANKS NIJHUIS™



2400 SERIES

2410 VERTICAL, 2420 HORIZONTAL, AND 2440 VERTICAL CLOSE-COUPLED **SOLIDS HANDLING PUMPS**

INSTALLATION, OPERATION AND MAINTENANCE MANUAL



NOTE! To the installer: Please make sure you provide this manual to the owner of the equipment or to the responsible party who maintains the system.

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PUMP IDENTIFICATION

Congratulations! You are the owner of one of the finest pumps commercially available. If you give it the proper care as outlined and recommended by this manual, it will provide you with reliable service and long life ...

2400 NON-CLOG PUMPS

Your Fairbanks Morse 2400 is a rugged non-clog pump, designed to allow the passage of large solids and stringy material. It is therefore ideally suited for applications such as sewage treatment plants, industrial wastewater handling and lift stations. Standard construction is cast iron with packed shaft seal box. A variety of materials and mechanical seals are available as standard options.

This manual applies to:

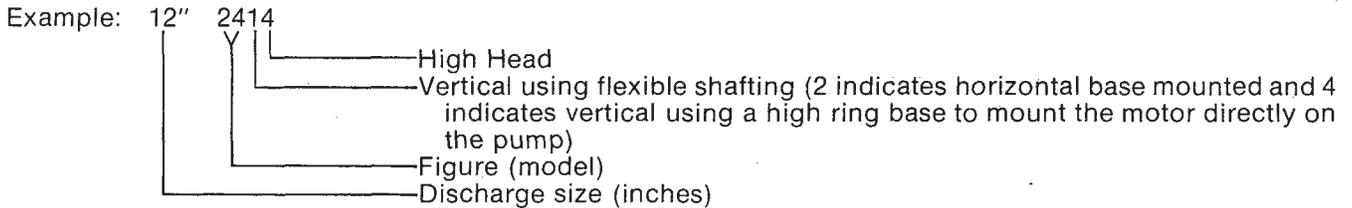
- 241X Vertical pumps — using a driver independently mounted from the pump and flexible shafting
- 242X Horizontal pumps — mounted on a common baseplate with the driver
- 244X Vertical close coupled pumps — using a high ring base between the pump and driver

CALIFORNIA PROPOSITION 65 WARNING:

WARNING:

This product and related accessories contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

PUMP IDENTIFICATION



Carefully record all of the following data from your pump nameplate. It will aid in obtaining the correct replacement parts for your pump.

PUMP

FIGURE: _____	SERIAL NUMBER: _____
IMPELLER DIAMETER: _____	SIZE: _____, FRAME: _____
CAPACITY: _____ GPM	TOTAL HEAD: _____ FT., RPM: _____

DRIVER

H.P.: _____	SERIAL NUMBER: _____
FRAME: _____	SPEED: _____, VOLTAGE: _____

To obtain additional data on hydraulics and pump selection and operation, we suggest you obtain both of the following reference books:

1. Fairbanks Morse "Hydraulic Handbook," available from the factory.
2. Hydraulic Institute Standards

Hydraulic Institute
1230 Keith Building
Cleveland, Ohio 44115

STORAGE OF PUMPS AND CAUTION NOTES

THESE INSTRUCTIONS APPLY TO THE PUMP ONLY. THEY ARE INTENDED TO BE GENERAL AND NOT SPECIFIC. IF YOUR OPERATING CONDITIONS EVER CHANGE, ALWAYS REFER TO THE FACTORY FOR REAPPLICATION. ALWAYS REFER TO THE MANUALS PROVIDED BY MANUFACTURERS OF THE OTHER EQUIPMENT FOR THEIR SEPARATE INSTRUCTIONS.

CAUTION IMPORTANT SAFETY NOTICE

THE INSTALLATION, USE AND OPERATION OF THIS TYPE OF EQUIPMENT IS AFFECTED BY VARIOUS FEDERAL, STATE AND LOCAL LAWS AND THE REGULATIONS CONCERNING OSHA. COMPLIANCE WITH SUCH LAWS RELATING TO THE PROPER INSTALLATION AND SAFE OPERATION OF THIS TYPE OF EQUIPMENT IS THE RESPONSIBILITY OF THE EQUIPMENT OWNER AND ALL NECESSARY STEPS SHOULD BE TAKEN BY THE OWNER TO ASSURE COMPLIANCE WITH SUCH LAWS BEFORE OPERATING THE EQUIPMENT.

STORAGE OF PUMPS

IF THE EQUIPMENT IS NOT TO BE IMMEDIATELY INSTALLED AND OPERATED, STORE IT IN A CLEAN, DRY, WELL VENTILATED PLACE, FREE FROM VIBRATIONS, MOISTURE, AND RAPID OR WIDE VARIATIONS IN TEMPERATURE.

SPECIAL INSTRUCTIONS FOR:

OIL LUBRICATED PUMPS: FILL THE BEARING RESERVOIRS WITH OIL. PRIOR TO START UP, DRAIN THE STORAGE OIL AND FILL THE RESERVOIRS TO THE PROPER LEVEL WITH NEW OIL.

GREASE LUBRICATED PUMPS: ROTATE THE SHAFT FOR SEVERAL REVOLUTIONS AT LEAST ONCE EVERY TWO WEEKS TO:

1. COAT THE BEARING WITH LUBRICANT,
2. RETARD OXIDATION OR CORROSION AND,
3. PREVENT POSSIBLE FALSE BRINELLING.

MECHANICAL SEAL PUMPS: POUR AT LEAST 4 OZS. OF MINERAL OIL INTO THE SEAL HOUSING AND DRAIN THE OIL JUST PRIOR TO START UP.

CONSIDER A UNIT IN STORAGE WHEN:

1. IT HAS BEEN DELIVERED TO THE JOBSITE AND IS AWAITING INSTALLATION.
2. IT HAS BEEN INSTALLED BUT OPERATION IS DELAYED PENDING COMPLETION OF CONSTRUCTION.
3. THERE ARE LONG (30 DAYS OR MORE) PERIODS BETWEEN OPERATION CYCLES.
4. THE PLANT (OR DEPARTMENT) IS SHUT DOWN FOR PERIODS OF LONGER THAN 30 DAYS.

NOTE: STORAGE REQUIREMENTS VARY DEPENDING ON THE LENGTH OF STORAGE, THE CLIMATIC ENVIRONMENT AND THE EQUIPMENT. FOR STORAGE PERIODS OF THREE MONTHS OR LONGER, CONTACT THE MANUFACTURER FOR SPECIFIC INSTRUCTIONS. IMPROPER STORAGE COULD DAMAGE THE EQUIPMENT WHICH WOULD RESULT IN NON-WARRANTY COVERED RESTORATION REQUIREMENTS OR NON-WARRANTY COVERED PRODUCT FAILURES.

INTRODUCTION AND INSTALLATION

INTRODUCTION

This manual contains information which is the result of carefully conducted engineering and research efforts. It is designed to supply adequate instructions for the safe and efficient installation, operation and maintenance of your pump. Failure or neglect to properly install, operate or maintain your pump may result in personal injury, property damage or unnecessary damage to the pump.

Variations exist in both the equipment used with these pumps and in the particular installation of the pump and driver. Therefore, specific operating instructions are not within the scope of this manual. The manual contains general rules for installation, operation and maintenance of the pump.

Observe all caution or danger tags attached to the equipment or included in this manual.

INSTALLATION

1. GENERAL

CAUTION: CAREFULLY READ ALL SECTIONS OF THIS MANUAL AND ALL OTHER INSTRUCTION MANUALS PROVIDED BY MANUFACTURERS OF OTHER EQUIPMENT SUPPLIED WITH THIS PUMP.

Upon receipt of the shipment, unpack and inspect the pump and driver assemblies and individual parts to insure none are missing or damaged. Carefully inspect all boxes and packing material for loose parts before discarding them. Report immediately to the factory, and to the transportation company involved, any missing parts or damage incurred during shipment, and file your "damaged and/or lost in shipment" claim with the carrier.

Horizontal pump and driver assemblies mounted on a structural steel base are aligned at the factory. However, alignment may be disturbed in transit or during installation. It must be checked after the unit is leveled on the foundation, after the grouting has set and the foundation bolts are tightened, and after piping is completed.

Tapped mounting blocks are furnished with horizontal pumps when the driver is to be field mounted. After the alignment of the driver is completed, the mounting blocks must be welded to the base and the alignment rechecked.

When the pump and driver are mounted on separate base structures, the pump should be leveled and aligned first, and then the driver leveled and lined up with the pump. With separate bases, a flexible shaft between pump and driver must be used.

The installation of a vertical pump is essentially the same as for the horizontal configuration. Foundation, piping and alignment adjustments are accomplished using the same basic techniques.

2. NET POSITIVE SUCTION HEAD (NPSH)

NPSH can be defined as the head (energy) that causes liquid to flow through the suction pipe and enter the eye of the impeller.

NPSH is expressed in two values: (1) NPSH required (NPSHR) and, (2) NPSH available (NPSHA). It is essential that NPSHA always be greater than NPSHR to prevent cavitation, vibration, wear and unstable operation.

NPSHR is a function of the pump design and therefore varies with the make, size, capacity and speed of the pump. The value for your pump can be obtained from your pump performance curve or the factory.

NPSHA is a function of your system and may be calculated as follows:

- A. When the source of liquid is above the pump:

$$\text{NPSHA} = \text{barometric pressure (feet)} + \text{static suction head (feet)} - \text{friction losses in suction piping (feet)} - \text{vapor pressure of liquid (feet)}$$

- B. When the source of liquid is below the pump:

$$\text{NPSHA} = \text{barometric pressure (feet)} - \text{static suction lift (feet)} - \text{friction losses in suction piping (feet)} - \text{vapor pressure of liquid (feet)}$$

INTRODUCTION AND INSTALLATION (continued)

3. MINIMUM SUBMERGENCE OF SUCTION PIPE AND PIT DESIGN

Generally, it is required that an evenly distributed flow of non-aerated water be supplied to the suction bell. Improper pit design or insufficient suction pipe submergence can result in intake vortexing which reduces the pump's performance and can result in severe damage to the pump.

We recommend that you secure the advice of a qualified Consulting Engineer for the analysis and design of the suction pit. Significant engineering data on pit design is provided in the Hydraulic Institute Standards.

Upon request, Fairbanks Morse will review plans and give general comments on the installation, but will not approve such plans for a specific installation and will accept no responsibility or liability for the performance of the pump intake structure.

4. LOCATION AND HANDLING

The pump should be installed as near the fluid as possible so a short direct suction pipe can be used to keep suction losses at a minimum. If possible, locate the pump so the fluid will flow to the suction opening by gravity. The discharge piping should be direct and with as few elbows and fittings as possible. The total net positive suction head available (NPSHA), which includes the suction lift and pipe friction losses, must be equal to or greater than the net positive suction head required (NPSHR) by the pump.

The pump and driver should be located in an area that will permit periodic inspection and maintenance. Head room and access should be provided and all units should be installed in a dry location with adequate drainage.

WARNING: DO NOT PICK UP THE COMPLETE UNIT BY THE DRIVER OR PUMP SHAFTS OR EYE BOLTS.

To lift a horizontal mounted unit, a chain or suitable lifting device should be attached to each corner of the base structure. Vertical mounted units may be lifted by using a sling through the motor high ring base, or by the eye bolts when provided in the pump casing. The individual driver may be lifted using the proper eye bolts provided by the manufacturer, but these should not be used to lift the assembled unit.

5. FOUNDATION

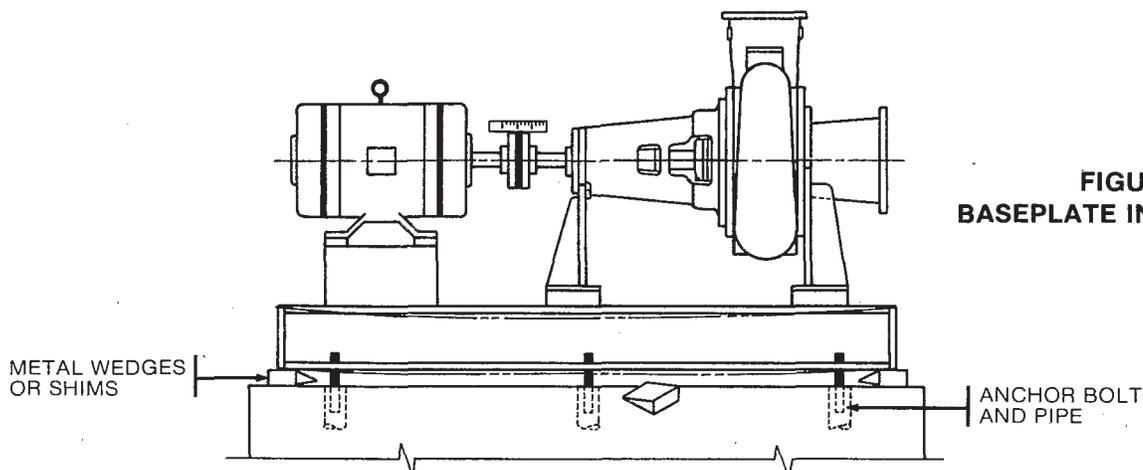
The foundation should have a level surface and be of sufficient mass to prevent vibration and form a permanent rigid support for the unit. The most satisfactory foundations are concrete with anchor bolts of adequate size imbedded in the foundation in pipe sleeves with an inside diameter $2\frac{1}{2}$ times larger than the bolt diameter. This will allow for final accurate positioning of the unit.

When the pump volute is mounted directly on the foundation, install a proper soleplate or soleplates, level the soleplate(s) and grout them in place.

6. LEVELING OF THE UNIT

Lower the unit onto the foundation, positioning it so the anchor bolts are aligned in the middle of the mounting holes in the base. On all units, horizontal or vertical, always disconnect the coupling halves and never reconnect them until all the alignment operations are complete.

The base should be supported on metal shims or metal wedges placed directly under the part of the base carrying the greatest weight, and spaced close enough to give uniform support and stability (see Figure 1).



INTRODUCTION AND INSTALLATION (continued)

6. LEVELING OF THE UNIT (continued)

Adjust the metal shims or wedges until the shaft of the pump and driver are level or vertical as appropriate. Alignment corrections can be accomplished by adjusting the supports under the base. When proper alignment is obtained, tighten the foundation bolts snugly, but not too firmly, and recheck the alignment before grouting.

When the pump volute is mounted directly on the foundation, lower the pump onto the soleplate, and shim under each foot until the unit is level. Tighten the foundation bolts after proper alignment has been obtained.

7. GROUTING

When the alignment is correct, the unit should be grouted using a high grade nonshrinking grout. The entire base should be filled with grout. Be sure to fill all gaps and voids. **Allow the grout to fully cure before firmly tightening the foundation bolts. Then recheck the alignment before connecting the piping.**

When the pump volute is mounted directly on the foundation soleplate, no further grouting of the pump is required.

8. PIPING

CAUTION: ALL PIPING CONNECTIONS MUST BE MADE WITH THE PIPE IN A FREE SUPPORTED STATE, AND WITHOUT THE NEED TO APPLY VERTICAL OR SIDE PRESSURE TO OBTAIN ALIGNMENT OF THE PIPING WITH THE PUMP FLANGE.

CAUTION: AFTER ALL THE PIPING IS CONNECTED, THE PUMP AND DRIVER ALIGNMENT MUST BE RECHECKED.

All piping should be independently supported near the pump so that pipe strain will not be transmitted to the pump casing. The suction and discharge piping should be one or two sizes larger than the pump flange sizes, especially where the piping is of considerable length. Any flexible joints installed in the piping must be equipped with tension rods to absorb piping axial thrust.

The suction pipe must be air tight and sloped upward to the pump flange to avoid air pockets which will impair satisfactory pump operation. The discharge pipe should be as direct as possible with a minimum of valves to reduce pipe friction losses.

A check valve and closing valve should be installed in the discharge line and a closing valve in the suction line. The check valve, between the pump and closing valve, protects the pump from water hammer and prevents reverse rotation in the event of power failure. The closing valves are used in priming, starting and when the pump is shut down. The pump must never be throttled by the use of a valve in the suction line.

9. AUXILIARY PIPING CONNECTIONS AND GAUGES

In addition to the primary piping connections, your pump may require connections to the lantern ring, mechanical seal and seal filter (see the "stuffing box" and "mechanical seal" sections of this manual), stuffing box drain, discharge and suction flange pressure gauges, or baseplate drain connections. All these lines and gauges should now be installed.

10. FINAL COUPLING ALIGNMENT

The alignment of the coupling must be carefully checked during the installation and as the last step before starting the pump. If realignment is required, the piping should be disconnected first. After aligning, reconnect the piping in accordance with the previous instructions and again recheck the alignment.

A flexible coupling must not be used to compensate for misalignment resulting from poor installation.

The following are step by step instructions for two different methods of general coupling alignment:

A. Coupling Alignment using a feeler gauge.

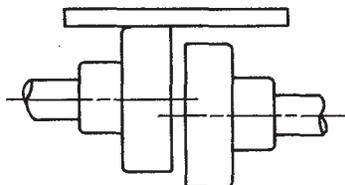


FIGURE 2

PARALLEL ALIGNMENT

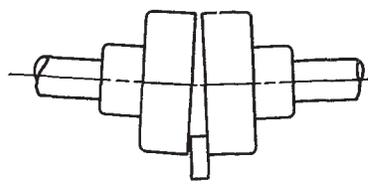


FIGURE 3

ANGULAR ALIGNMENT

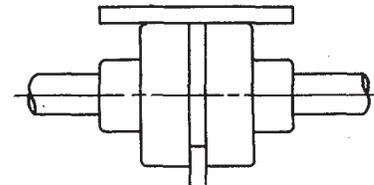


FIGURE 4

CORRECT ALIGNMENT

INTRODUCTION AND INSTALLATION (continued)**10. FINAL COUPLING ALIGNMENT (continued)**

1. Set the gap between the coupling flanges to the dimension shown on the setting plan. If the setting plan is not available, refer to the coupling manufacturer's instructions for the proper dimension.
2. Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling as shown above. **DO NOT ROTATE THE COUPLING.** The maximum offset must not exceed .005". If a correction is required, do so by shimming or shifting the driver.
3. Check angular alignment with a feeler gauge as shown on page 6. Measure from the face of one coupling flange to the face of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions. **DO NOT ROTATE THE COUPLING.** The difference between the maximum and minimum must not exceed .005". If a correction is required, do so by shimming or shifting the driver. You must then recheck the parallel alignment.

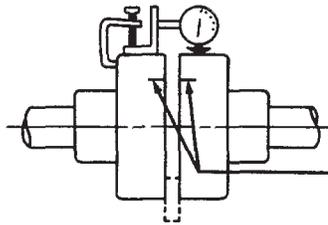
B. Coupling Alignment using a dial indicator

FIGURE 5
PARALLEL ALIGNMENT

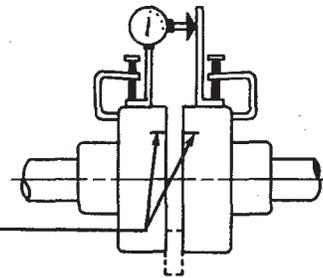


FIGURE 6
ANGULAR ALIGNMENT

1. Set the gap between the coupling flanges to the dimension shown on the setting plan. If the setting plan is not available, refer to the coupling manufacturer's instructions for proper dimension.
2. Check the parallel alignment by mounting a dial indicator on the pump half coupling flange as shown above. Scribe a line parallel to the shafts on both coupling halves and set the indicator dial at ZERO. Turn both coupling halves simultaneously, keeping the scribed lines matched; and read the maximum and minimum values on the dial indicator. The difference between the maximum and minimum must not exceed .005". If a correction is required, do so by shimming or shifting the driver.
3. Check the angular alignment by mounting a dial indicator on the pump half coupling flange as shown above. Set the dial indicator at ZERO. Turn both coupling halves simultaneously, keeping the lines scribed matched, and read the maximum and minimum values on the dial indicator. The difference between the maximum and minimum must not exceed .005". If a correction is required, do so by shimming or shifting the driver. You must then recheck the parallel alignment.

NOTE: FOR MAXIMUM LIFE, KEEP ALIGNMENT VALUES AS NEAR TO ZERO AS POSSIBLE.

WARNING: CHECK SAFETY CODES, AND ALWAYS INSTALL PROTECTIVE GUARDS OR SHIELDS AS REQUIRED BY THE VARIOUS FEDERAL, STATE, AND LOCAL LAWS AND THE REGULATIONS CONCERNING OSHA.

WARNING: COUPLING SLEEVES MAY BE THROWN FROM THE ASSEMBLY WHEN SUBJECTED TO A SERVICE SHOCK LOAD.

INTRODUCTION AND INSTALLATION (continued)

11. DOWELLING

A. Horizontal Pumps

After the piping is connected and the final coupling alignment completed, the pump and driver should be drilled, reamed and dowelled to the baseplate using a minimum of two dowels each for the pump and driver.

B. Close Coupled Pumps

After the final coupling alignment is completed, the motor should be drilled, reamed and dowelled to the high ring base.

12. FLEXIBLE SHAFTING ALIGNMENT

WARNING: THE WEIGHT OF THE INTERMEDIATE SHAFT MUST NOT BE SUPPORTED BY THE PUMP BEARINGS. IF THE WEIGHT OF THE SHAFT CANNOT BE SUPPORTED BY THE DRIVER BEARINGS, A SPECIAL THRUST BEARING SHOULD BE INSTALLED IMMEDIATELY BELOW THE DRIVER.

For installation and alignment of intermediate flexible shafting, refer to the manufacturer's manual.

13. ROTATION

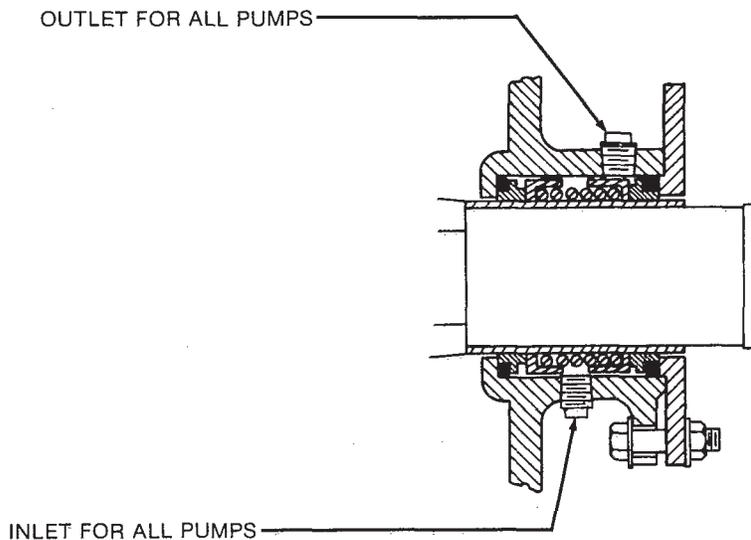
Before connecting the coupling halves, bump start the driver and verify rotation is in the proper direction. The correct pump rotation is indicated by a directional arrow on the pump casing.

14. MECHANICAL SEALS

CAUTION: DRY OPERATION OF THE PUMP MAY CAUSE DAMAGE TO THE MECHANICAL SEAL AND IMPELLER.

Optional double face mechanical seals having two sealing surfaces are supplied when specified. The seal manufacturer's instructions furnished with the pump must be followed.

The double mechanical seals must be lubricated and cooled by clean or filtered liquid supplied to the bottom (lowest) seal housing pipe connection. Before starting the pump, all air and oil used for storage protection must be vented out through the upper (highest) seal housing pipe connection.



**FIGURE 7
TYPICAL DOUBLE
MECHANICAL SEAL**

If an outside source of seal liquid is used, a pressure of 0 to 10 PSI higher than maximum pump discharge pressure must be maintained in the seal housing.

For operation of mechanical seals at higher pressures, circulation of the liquid may be required by the seal manufacturer and you should refer to his instructions for specific requirements.

INTRODUCTION AND INSTALLATION (continued)**15. OPTIONAL FILTER SYSTEM FOR MECHANICAL SEAL**

Some small loss of seal box fluid will occur due to vaporization of the fluid film between the seal faces, therefore, a filter capable of trapping particles larger than 25 microns is recommended for all dead-headed seals. Install the filter in the primary line between the 1/4" volute discharge tap and the seal housing connection. Either 1/4" or 3/8" tubing may be used. Under normal conditions, replace the filter element every 3-4 months. If the pumped fluid contains minerals or particles which tend to precipitate, a separate seal liquid source may be required.

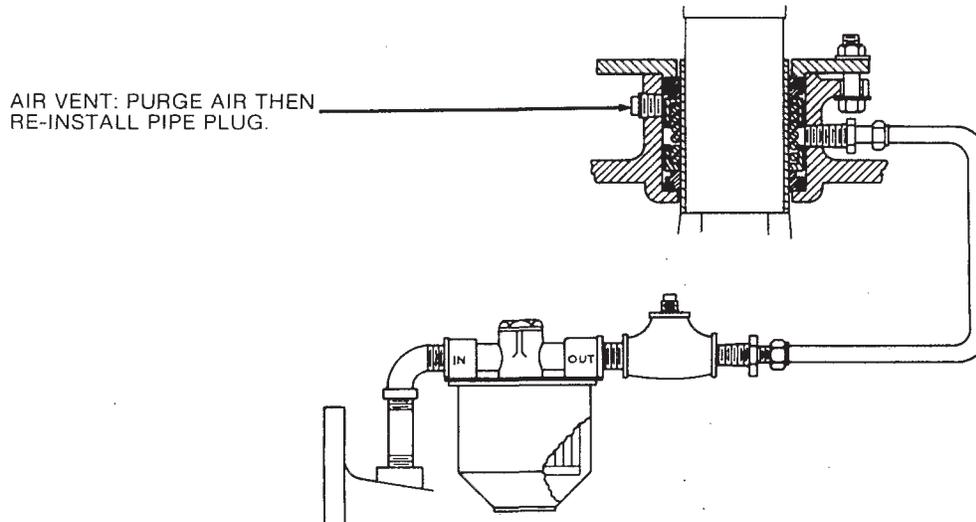


FIGURE 8
TYPICAL DEAD-HEADED FILTER
SYSTEM FOR MECHANICAL SEAL

OPERATION

Because variations may exist in both the equipment used with these pumps, and in the particular installation of the pump and driver, specific operating instructions are not within the scope of this manual. However, there are general rules and practices that apply to all pump installations and operation.

CAUTION: BEFORE STARTING OR OPERATING THE PUMP, READ THIS ENTIRE MANUAL, ESPECIALLY THE FOLLOWING INSTRUCTIONS:

- A. BEFORE STARTING THE PUMP, INSTALL CLOSED GUARDS AROUND ALL EXPOSED ROTATING PARTS.**
- B. BEFORE STARTING THE PUMP, ROTATE THE UNIT OR ASSEMBLY BY HAND TO ASSURE ALL MOVING PARTS ARE FREE.**
- C. OBSERVE ALL CAUTION OR DANGER TAGS ATTACHED TO THE EQUIPMENT.**
- D. NEVER RUN THE PUMP DRY AS THE CLOSE RUNNING FITS WITHIN THE PUMP ARE WATER LUBRICATED. RUNNING DRY MAY RESULT IN PUMP SEIZURE.**
- E. BEFORE STARTING THE PUMP, FILL THE CASING AND SUCTION LINE WITH LIQUID. THE PUMP MAY BE PRIMED BY USING AN EJECTOR OR VACUUM PUMP.**
- F. BEFORE STARTING A MECHANICAL SEAL PUMP, TURN ON THE SEAL WATER, VENT THE SEAL HOUSING AND CONFIRM SEAL WATER IS AT SUFFICIENT PRESSURE.**
- G. BEFORE STARTING A PACKED BOX PUMP, ADJUST THE PACKING GLAND SO THERE IS SUFFICIENT LEAKAGE TO LUBRICATE THE PACKING AND ASSURE A COOL STUFFING BOX (SEE MAINTENANCE INSTRUCTIONS).**
- H. IF EXCESSIVE VIBRATION OR NOISE OCCURS DURING OPERATION, SHUT THE PUMP DOWN AND CONSULT A FAIRBANKS MORSE REPRESENTATIVE.**

1. OPERATING AT REDUCED CAPACITY

In a typical application covering a wide range of flow rates, a variable speed driver is often used to adjust pump capacity, and this intent is taken into consideration by Fairbanks Morse when selecting the pump and impeller trim. Although these pumps are applicable over a wide range of operating conditions, care should be exercised when doing so, especially when the actual conditions differ from the sold for conditions. You should always contact your nearest Fairbanks Morse sales office before operating the pumps at any condition other than that for which they were sold.

2. PRIMING

Since the pumped medium is used to lubricate various internal parts, running a centrifugal pump dry can result in extensive damage and possible seizing. It is therefore imperative that the pump be primed prior to initial start up and that that prime be maintained through subsequent start-stop cycles.

The priming procedure is different for positive and negative suction head systems and the following procedures should be followed:

- A. Positive suction head —**
 - 1. Open the vent on the highest point on the pump casing.
 - 2. Open all suction valves.
 - 3. Allow the liquid to flow from the vent hole until all air bubbles are vented, and then close the vent.
 - 4. The pump is now primed.
- B. Negative suction head —**
 - 1. Install an ejector or vacuum pump on the vent on the highest point on the pump casing.
 - 2. Close the discharge valve.
 - 3. Open the suction valve.
 - 4. Start ejector or vacuum pump.
 - 5. Allow the liquid to flow until a continuous flow is exhausted from the ejector, and then close the valve to the vent.
 - 6. The pump is now primed.

OPERATION (continued)

3. STARTING THE PUMP

- A. After the pump is primed, and with the discharge valve closed and the suction valve open, start the driver according to the driver manufacturer's instructions.
- B. Open the discharge valve slowly to prevent water hammer.
- C. Immediately after the pump has been started, check bearing temperature, stuffing box lubrication and operation, and pump noise level. Continue to monitor those valves for the first several hours of operation.

4. BEARING OPERATING TEMPERATURE

These pumps are designed to operate over a wide ambient temperature range. The bearing temperature, when measured on the outside surface of the bearing housing, should not exceed 190°F. Temperatures in excess of 190°F may indicate a lack of lubricant, bearing overload or incipient bearing failure. If the temperature exceeds this limit, the pump should be stopped and the cause investigated and corrected.

5. TROUBLESHOOTING OPERATING PROBLEMS

If you have followed the installation and start up procedures outlined in this manual, your pump should provide reliable service and long life. However, if operating problems do occur, significant time and expense can be saved if you use the following check list to eliminate the most common causes of those problems.

INSUFFICIENT DISCHARGE PRESSURE OR FLOW

1. Pump not primed.
2. Speed too low. Check driver.
3. Discharge head too high.
4. Suction lift too high.
5. Wrong direction of rotation.
6. Air leaks into suction piping, stuffing box or gaskets.
7. Impeller passage partially plugged.
8. Impeller damaged.
9. Impeller running clearance too large.
10. Insufficient suction line submergence.
11. Air in liquid.
12. Impeller diameter too small.
13. Insufficient net positive suction head.

LOSS OF SUCTION DURING OPERATION

1. Suction line leaks.
2. Water seal line to packing box is plugged.
3. Suction lift too high.
4. Air or gases in liquid.
5. Air leaks into suction piping, stuffing box or gaskets.
6. Wrong direction of rotation.
7. Insufficient suction line submergence.

EXCESSIVE POWER CONSUMPTION

1. Speed too high.
2. Head lower than rating, pumps too much liquid.
3. Specific gravity or viscosity of liquid pumped is too high.
4. Mechanical defects:
 - *Shaft bent.
 - *Rotating element binds.
5. Misalignment.
6. System head lower than design.
7. Incorrect diameter impeller.

VIBRATION OR NOISE

1. Misalignment between driver and pump.
2. Foundation bolts loose or defect in grouting.
3. Mechanical defects:
 - *Shaft bent.
 - *Rotating element binds.
4. Head lower than rating, pumps too much liquid.
5. Pipe strain — improperly supported or aligned.
6. Pump running at shut-off condition.
7. Insufficient suction line submergence.
8. Air in liquid.
9. Impeller passages plugged.

OVER-HEATING

1. Bearings:
 - *Excessive grease.
 - *Shaft bent.
 - *Rotating element binds.
 - *Pipe strain.
 - *Insufficient bearing lubrication.
 - *Incorrect type grease.
2. Packing box:
 - *Packing gland too tight.
 - *Water seal line plugged.
 - *Air not vented out of mechanical seal.
 - *Flushing water not circulating for mechanical seal.

MAINTENANCE (continued)**2. INSPECTIONS AND PREVENTATIVE MAINTENANCE REQUIREMENTS**

To assure satisfactory operation of the pump, daily inspections and periodic maintenance are required. We suggest that an inspection and maintenance log be kept and that the inspector immediately report any problems. A guide for preventative maintenance for normal applications is given below. Unusual applications with abnormal heat, moisture, dust, etc., may require more frequent inspections and service.

ITEM	ACTION REQUIRED	FREQUENCY (HOURS OF OPERATION)
Packing Box	Adjust gland, inspect packing for possible replacement	150 hours
Mechanical Seal Filter	Replace or clean	4,000 hours
Pump Alignment	Check for change in alignment	ANNUALLY
Vibration	Check for change in vibration	ANNUALLY
Bearings	Lubricate	Every 2,000 hours of operation, but at least once a year

3. BEARING LUBRICATION

Fairbanks Morse 2400 pumps are furnished with grease lubricated bearings.

Under normal operating conditions, the bearings must be lubricated after every 2,000 hours of running time, but at least once a year regardless of total operating hours.

CAUTION: ANY APPLICATION WITH ABNORMAL HEAT, MOISTURE, DUST, ETC., MAY REQUIRE A CHANGE IN THIS SCHEDULE AND YOU SHOULD REFER TO A LUBRICATION ENGINEER OR THE FACTORY FOR SPECIFIC INSTRUCTIONS.

CAUTION: THE GREASES RECOMMENDED IN THIS MANUAL WILL PROVIDE SATISFACTORY LUBRICATION OVER A WIDE TEMPERATURE RANGE. THERE IS, HOWEVER, A PRACTICAL LIMIT AND OPERATION OF THE PUMP SHOULD BE DISCONTINUED AND THE FACTORY CONSULTED IF THE TEMPERATURE, WHEN MEASURED ON THE OUTSIDE OF THE BEARING HOUSING, EXCEEDS 190° F.

RECOMMENDED GREASE: N.L.G.I. No. 2 lithium base multi-purpose with a mineral oil viscosity of 950-1250 SUS at 100° F., and 80-82 SUS at 210° F.

Proceed as follows for bearing lubrication:

WARNING: EXTREME CARE SHOULD BE EXERCISED AND STEPS TAKEN TO INSURE THAT THE DRIVER CANNOT BE ACCIDENTALLY STARTED. KEEP HANDS, FINGERS, CLOTHING AND ANY TOOLS AWAY FROM THE COUPLING. FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY.

- A. Stop the unit, remove the four grease relief plugs, and connect a grease gun to the lubrication fittings.
- B. Start the unit and inject grease until it relieves at the relief openings and at the bearing cover lip seals.
- C. Immediately after lubrication, bearing temperatures may rise above the normal level. Continue running the unit until bearing temperatures stabilize at the normal level and grease stops seeping at the lip seals and relief openings.
- D. Stop the unit, remove the grease gun, wipe off the relieved grease and replace the grease relief plugs.
- E. Start the unit and resume normal operation.

MAINTENANCE (continued)

4. STUFFING BOX

The stuffing boxes on Fairbanks Morse pumps are packed at the factory. All packing is subject to wear and should be given regular inspections and, if necessary, periodic adjustments. Generally, packed box pumps require inspection of the packing and adjustment of the gland after each 150 hours of operation.

Adjustment is accomplished by lightly tightening the gland nuts, and then loosening them so they can be adjusted with finger pressure to allow a small flow of liquid to lubricate the packing. If the flow of liquid has increased and cannot be reduced by a slight tightening of the gland, replace the packing and/or shaft sleeve.

CAUTION: DO NOT TIGHTEN THE GLAND TO STOP ALL LEAKAGE. LEAKAGE IS NECESSARY TO INSURE THE COOLING, FLUSHING AND LUBRICATION OF THE PACKING AND TO PREVENT SHAFT SLEEVE DAMAGE.

The stuffing boxes may be fitted with water seal rings. When a seal ring is furnished, the sealing chamber should be connected to a source of clear, fresh water.

5. PACKING REPLACEMENT

Use a good grade of soft, square, long fiber asbestos packing, thoroughly graphited. The replacement procedure should be as follows:

- A. Stop the pump.
- B. Unbolt and remove the gland.
- C. Use a packing hook to remove the worn packing and water seal rings. Note the location of the water seal ring relative to the amount of packing on each side of ring.
- D. Clean the packing box and shaft sleeve.
- E. Inspect the shaft sleeve for wear or rough finish and replace if necessary.
- F. Install the new packing and new water seal ring.

CAUTION: STAGGER THE PACKING END JOINTS 180° AND FIRMLY SEAT THE PACKING. THE FOLLOWING TABLE GIVES THE PERTINENT STUFFING BOX, SEAL CAGE AND PACKING DIMENSIONS.

	24X4 PUMP SIZE		
	12"	16"	20"
STUFFING BOX			
O.D. Sleeve	4 ⁷ / ₈	6	7
I.D. Box	6 ⁷ / ₁₆	7 ⁹ / ₁₆	8 ⁹ / ₁₆
Box Depth	5½	5½	5½
Packing Size	¾	¾	¾
Rings of Packing per Box	7	7	7
Water Seal Ring Width	1½	1½	1½

- G. Reinstall the gland and tighten the gland nuts.
- H. Loosen the gland nuts so they can be adjusted with finger pressure to obtain correct leakage for lubrication after start-up.

6. FACE TYPE WEAR RING RUNNING CLEARANCE

As the impeller and fronthead wear, the clearance increases causing internal leakage. This decreases the performance of the pump. On pumps equipped with face type wear rings, the clearance can be adjusted to compensate for wear. If the desired clearance cannot be obtained, it may be necessary to rebuild the pump.

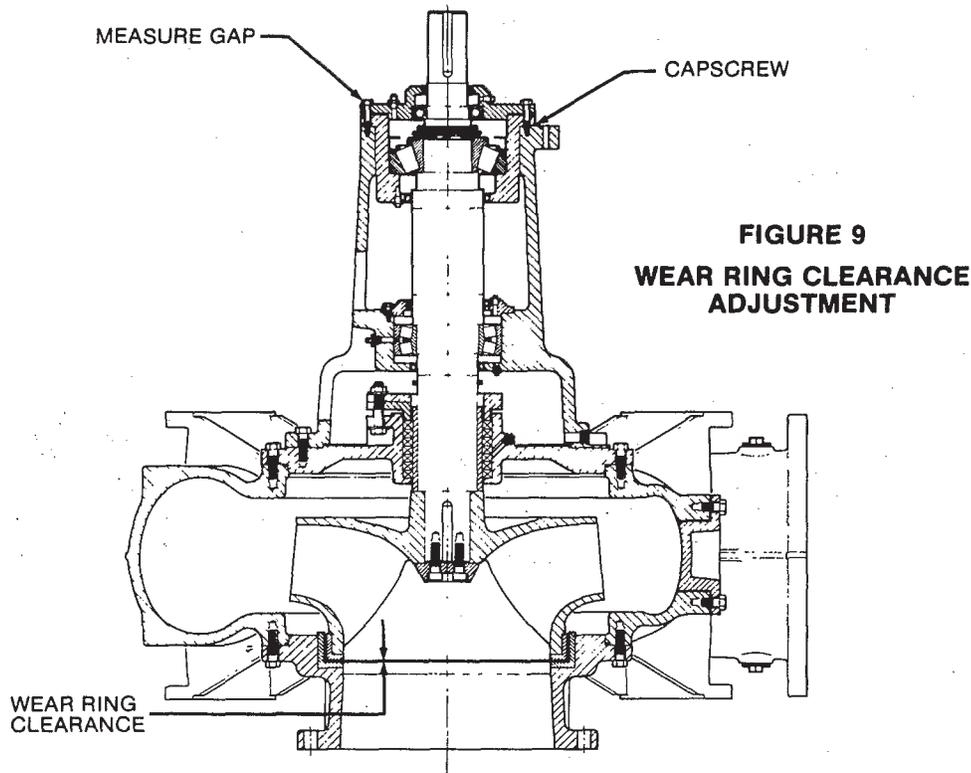
The clearance may be checked by removing the suction hand-hole cover and placing a feeler (thickness) gauge between the impeller and the front head (refer to the wear ring clearance adjustment drawing, Figure 9, on page 15).

- A. Remove the shims (200) from between the frame (90) and thrust bearing housing (139) and tighten the capscrews at the bearing housing until the impeller just contacts the front head. Tighten the jackscrews in the thrust bearing housing to seat the housing firmly against the thrust bearing cover (140).

MAINTENANCE (continued)**6. FACE TYPE WEAR RING RUNNING CLEARANCE (continued)**

- B. Measure the gap between the bearing housing and the frame and record the value obtained.
- C. Refer to the assembly drawing supplied with your pump to determine the proper wear ring clearance. Add the value from the drawing to the value measures in step B above. This total equals the shim thickness which must be added between the frame (90) and thrust bearing housing (139) to obtain the proper wear ring clearance.
- D. Use the jackscrews to facilitate raising the rotating assembly, install the shims, tighten the capscrews and recheck the clearance.

CAUTION: THE CLEARANCE SHOULD BE RECHECKED AFTER TIGHTENING THE CAPSCREWS. IF THE GAP IS NOT AS SPECIFIED, REPEAT THIS ENTIRE PROCEDURE UNTIL THE PROPER CLEARANCE IS ACHIEVED.

**7. PUMP DISASSEMBLY**

CAUTION: READ THIS ENTIRE DISASSEMBLY PROCEDURE AND REFER TO THE SECTIONAL DRAWINGS IN THIS MANUAL BEFORE PROCEEDING.

Major maintenance beyond lubrication, adjustment of wear ring clearance and replacement or adjustment of the packing will require disassembly of the pump. The following are step-by-step instructions:

- A. Lock out the power to the driver and close the suction and discharge valves. Drain the pump, disconnect and remove the coupling or flexible shafting. Disconnect and remove gauges and all other auxiliary piping. (Stuffing box lubrication, oil or grease lines, etc.)
- B. Remove the cap screws holding the backhead (34) to the volute (30).
- C. On vertical units, install eyebolts of adequate strength in the outboard end of the frame (90) through the thrust bearing housing cover (140), and lift the frame and rotating assembly from the volute. On horizontal units, install an eyebolt of adequate strength in the outboard end of the frame (90) and a sling through the lower opening of the frame and remove the rotating assembly from the volute.

CAUTION: THE USE OF A CRANE OR HOIST OF ADEQUATE CAPACITY IS RECOMMENDED.

MAINTENANCE (continued)

7. PUMP DISASSEMBLY (continued)

- D. Support the frame and rotating assembly in a horizontal position and remove the impeller capscrew (994A) and impeller cap (994). Because the impeller capscrews are installed with Loctite, it may be necessary to heat the capscrew to approximately 450° F. to break the bond.

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY, HEAT RESISTANT GLOVES MUST BE WORN WHEN HANDLING HEATED PARTS.

- E. Remove the impeller (1) and the impeller key (102) from the shaft. The impeller and shaft have a straight bore with close tolerance fits, and it may be necessary to use a wheel puller or similar device to remove the impeller. Attach the puller or other equipment at the impeller vane area only — do not use the impeller shroud.

CAUTION: CARE SHOULD BE TAKEN NOT TO DAMAGE THE IMPELLER WHEN USING A PULLER OR SIMILAR DEVICE.

- F. If the impeller (17) or casing (16) wear rings require replacement, they will be secured by one of three methods, and you should proceed as follows:

Rings Secured With Set Screws: remove the set screws and chisel cut or grind the rings in two at the set screw hole location.

Rings Secured With Tack Welding: grind off the excess material at the welded locations and chisel cut or grind the rings in two at the tack weld location.

Rings Secured With Loctite: heat the rings to approximately 450° F. to break the bond and then tap them with a brass or copper mallet. If heating fails to affect removal, the rings may be ground off.

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY, HEAT RESISTANT GLOVES MUST BE WORN WHEN HANDLING HEATED PARTS.

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY, EXTREME CARE SHOULD BE EXERCISED TO SELECT THE PROPER GRINDING EQUIPMENT, AND APPROVED SAFETY GLASSES SHOULD BE WORN WHEN GRINDING.

- G. Loosen the packing box gland (19).
- H. Remove the capscrews that secure the backhead (34) to the frame (90) and remove the backhead and water deflector (126).
- I. Remove the shaft sleeve (14). Because the shaft sleeve is secured with Loctite, it will be necessary to heat the shaft sleeve to approximately 450° F. to break the bond.

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY, HEAT RESISTANT GLOVES MUST BE WORN WHEN HANDLING HEATED PARTS.

- J. Remove the capscrews and/or jackscrews that secure the thrust bearing housing (139), thrust bearing housing cover (140) and radial bearing cover (159) to the frame, and remove the thrust bearing housing cover.
- K. Install the impeller cap (994) and impeller capscrews (994A) on the shaft to protect the shaft end. Remove the shaft and bearing assembly from the frame using the jackscrews in the bearing housing if needed.

CAUTION: THE USE OF A CRANE, HOIST, OR PRESS OF ADEQUATE CAPACITY IS RECOMMENDED.

- L. Slide the thrust bearing housing (139) away from the thrust bearings (168).
- M. On 16" and 20" pumps, remove the outer thrust bearing (168A).
- N. Remove the bearing locknut (161) and lockwasher (162). Apply heat to the inner race to remove the thrust bearing(s) (168), and the radial bearing (163).

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY AND DAMAGE TO THE BEARINGS, PRESSURE SHOULD BE APPLIED TO THE INNER BEARING RACE ONLY.

MAINTENANCE (continued)**7. PUMP DISASSEMBLY (continued)**

- O. Remove the lip seals (90A, 139A, 140A and 159A) from the frame (90), thrust bearing housing (139), thrust bearing housing cover (140) and radial bearing cover (159).

CAUTION: BECAUSE OF POSSIBLE DAMAGE OR CONTAMINATION DURING REMOVAL, BEARINGS AND LIP SEALS SHOULD NOT BE REUSED AND NEW BEARINGS AND LIP SEALS SHOULD ALWAYS BE INSTALLED.

- P. Remove the split (19) or solid (31) glands, packing (212) and water seal ring (10) or mechanical seal (456), from the backhead stuffing box.
- Q. The pump disassembly is now complete. All parts should be thoroughly cleaned and inspected for wear or damage and replaced if required.

8. PUMP ASSEMBLY

CAUTION: READ THIS ENTIRE ASSEMBLY PROCEDURE BEFORE STARTING ASSEMBLY.

The following are step-by-step instructions for assembly of the pump, and are essentially the reverse order of the instructions for disassembly.

- A. Thoroughly clean all parts to remove all oil, grease and any foreign material, and inspect for wear or damage and replace if required. Remove all parts to a clean and dust-free location for assembly. Gaskets, lip seals, o-rings and bearings should not be reused, and should always be replaced with new parts.
- B. Install new lip seals (90A, 139A, 140A and 159A) in the frame (90), thrust bearing housing (139), thrust bearing housing cover (140) and radial bearing cover (159).
- C. Bearing installation and adjustment procedure.

12" 2400

1. Measure the inside diameter of the thrust bearing housing (139) and the outside diameter of the thrust bearings (168). Measure the inside diameter of the frame bore (90) at the radial bearing and the outside diameter of the radial bearing (163). The clearances on both fits must be between .000" and .003". Preheat all bearings in an oil bath or oven to facilitate assembly.
2. Install the thrust bearings (168), bearing lockwasher (162) and bearing locknut (161) on the shaft and tighten the locknut. Slide the thrust bearing housing (139) over the shaft (4) and over the bearings. Install the thrust bearing housing cover (140) and secure it to the thrust bearing housing with the 2 capscrews. The bearings must be mounted back to back (see sectional drawings in this manual).

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY AND DAMAGE TO THE BEARINGS, PRESSURE SHOULD BE APPLIED TO THE INNER BEARING RACE ONLY.

3. The shaft must rotate freely in the bearings.
4. Pack the bearings with grease and install the radial bearing cover (159) and the radial bearing (163).
5. Install the assembly in the frame.

CAUTION: EXERCISE EXTREME CARE NOT TO COCK THE BEARING HOUSING (139) OR RADIAL BEARING (163) IN THE BEARING FRAME.

After the shaft assembly is installed in the frame, make sure that the shaft rotates freely. Secure the radial bearing cover (159) to the frame with capscrews. Secure the thrust bearing housing and cover to the frame.

6. This pump does not require bearing adjustment, and you may proceed to complete assembly.

MAINTENANCE (continued)

8. PUMP ASSEMBLY (continued)

16" and 20" 2400

1. Measure the inside diameter of the thrust bearing housing (139) and the outside diameter of the thrust bearings (168). Measure the inside diameter of the frame bore (90) at the radial bearing and the outside diameter of the radial bearing (163). The clearance on both fits must be between .000" and .003". Preheat all bearings in an oil bath or oven to facilitate assembly.
2. Install the outer race of the inner thrust bearing (168) in the thrust bearing housing (139).
3. Install the inner thrust bearing inner race (168), bearing lockwasher (162) and bearing locknut (161) on the shaft and tighten the locknut.

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY AND DAMAGE TO THE BEARINGS, PRESSURE SHOULD BE APPLIED TO THE INNER BEARING RACE ONLY.

4. Install the outer thrust bearing (168A) on the shaft and slide the thrust bearing housing over the bearing.
5. Slide the radial bearing cover (159) over the shaft and install the radial bearing (163).
6. Pack the bearings with grease and install the assembly in the frame.

CAUTION: EXERCISE EXTREME CARE NOT TO COCK THE BEARING HOUSING (139) OR RADIAL BEARING (163) IN THE BEARING FRAME.

After the shaft assembly is installed in the frame, make sure that the shaft rotates freely. Secure the radial bearing cover (159) to the frame with capscrews.

7. After the rotating element has been set in the frame (90), install the thrust bearing cover (140) over the shaft and lightly snug down the cover and thrust bearing housing (139) to the frame with the capscrews.

CAUTION: DO NOT TIGHTEN THE CAPSCREWS WRENCH TIGHT AT THIS TIME. TO DO SO COULD DAMAGE THE BEARINGS.

8. An axial clearance of .003" to .008" is required by the thrust bearings. Shims (186) must be added between the thrust bearing cover and thrust bearing housing to achieve the proper clearance.
9. Use a feeler gauge to measure the gap between the thrust bearing cover and the bearing housing and record the value obtained.
10. To achieve the proper bearing clearance (.003" to .008"), add shims (186) between the thrust bearing cover and thrust bearing housing. The total shim thickness must be equal to the measured gap plus the .003" to .008" required clearance. For example: if the measured gap is .005", .008" to .013" of the shims must be installed.
11. After the shims have been installed, tighten the capscrews which secure the thrust bearing cover and housing to the frame.
12. Attach a dial indicator to the thrust bearing cover or the frame and position the indicator stem against the end of the shaft.
13. With the pump shaft as far as possible toward the impeller end, set the dial indicator to read ZERO.

CAUTION: DO NOT FORCE THE SHAFT; APPLY ONLY ENOUGH FORCE TO MOVE THE ROTATING ASSEMBLY.

14. Push the pump shaft as far as possible toward the coupling end and read the total end-play on the dial indicator. To assure the end-play reading is correct, push the shaft back toward the impeller and check that the indicator returns to zero. The total end-play must be .003" to .008". If it is not, adjust the thickness of the shims by the required amount and recheck the clearance.

MAINTENANCE (continued)**8. PUMP ASSEMBLY (continued)**

- D. Apply a bead of Loctite No. 601 around the impeller end of the shaft/shaft sleeve fit. Slide the shaft sleeve (14) part way onto the shaft and rotate it at least one full revolution to evenly spread the Loctite, then slide the shaft sleeve over the shaft until it is flush with the shaft shoulder.

CAUTION: ALLOW THE LOCTITE TO CURE FOR TWO (2) HOURS BEFORE COMPLETING ASSEMBLY OF THE PUMP.

- E. Install the water deflector (126) on the shaft.
F. Install the packing (212) and water seal ring (10) (if furnished), or the mechanical seal in the backhead (34) stuffing box.

CAUTION: REFER TO THE MAINTENANCE SECTION OF THIS MANUAL FOR SPECIFIC INSTALLATION INSTRUCTIONS FOR THE PACKING OR MECHANICAL SEAL.

- G. If your pump uses a mechanical seal, slide the one (1) piece mechanical seal gland (31) over the shaft.
H. Apply a light coat of grease to the shaft sleeve and slide the backhead (34) over the shaft, being careful not to damage the packing or mechanical seal.
I. Secure the backhead to the frame with the capscrews. Install the packing gland (19), gland bolts, washers and nuts.

CAUTION: DO NOT TIGHTEN THE GLAND NUTS. REFER TO THE MAINTENANCE SECTION OF THIS MANUAL FOR SPECIFIC PACKING ADJUSTMENT INSTRUCTIONS AFTER THE PUMP ASSEMBLY IS COMPLETED.

- J. If the impeller (17) or fronthead (16) wear rings are being replaced, they are a light press fit and should be installed in the same manner as originally supplied (tack welded, or secured with set screws or Loctite No. 290). You should proceed as follows:

Rings Secured With Loctite: Apply a light film of Loctite No. 290 to the ring fit of the impeller and fronthead and install the rings.

Rings Secured With Set Screws: Press the rings in place and drill and tap them using the same size and number of set screws as originally provided. The new holes should be 15° to 20° from the old holes. Install and tighten the set screws.

Rings Secured With Tack Weld: Press the rings in place and tack weld them using the same number of welds as originally provided. Grind off any excess weld or splatter.

CAUTION: BE CAREFUL TO PRESS THE WEAR RINGS COMPLETELY IN PLACE. THEY SHOULD BE FIRMLY BUTTED AGAINST THE CORRESPONDING IMPELLER OR FRONTHEAD SHOULDER.

- K. Prior to installing the impeller (1), impeller key (102), impeller capscrew (994A) and impeller cap (994): the key, shaft, impeller bore and the threads on the capscrew and its mating threads in the shaft must be thoroughly cleaned and free from oil, dirt or any foreign substance. Install the impeller key in the shaft. Apply a small amount of lubricant to the shaft and slide the impeller in place, making sure it butts firmly against the shaft shoulder. Apply 3 or 4 drops of Loctite No. 601 to the capscrew threads, and with the impeller cap in place, install the capscrews and torque them to the value shown in the table found on page 20. Fill the impeller cap counter bores with G.E. Silmate Silicone Rubber RTV1473 and allow 4 hours for curing.

MAINTENANCE (continued)

8. PUMP ASSEMBLY (continued)

CAUTION: THESE CAPSCREW TORQUE VALUES ARE FOR SAE GRADE 8 STEEL CAPSCREWS ONLY. IF OTHER MATERIAL IS USED, CONSULT WITH THE FAIRBANKS MORSE ENGINEERING DEPARTMENT FOR PROPER TORQUE VALUES.

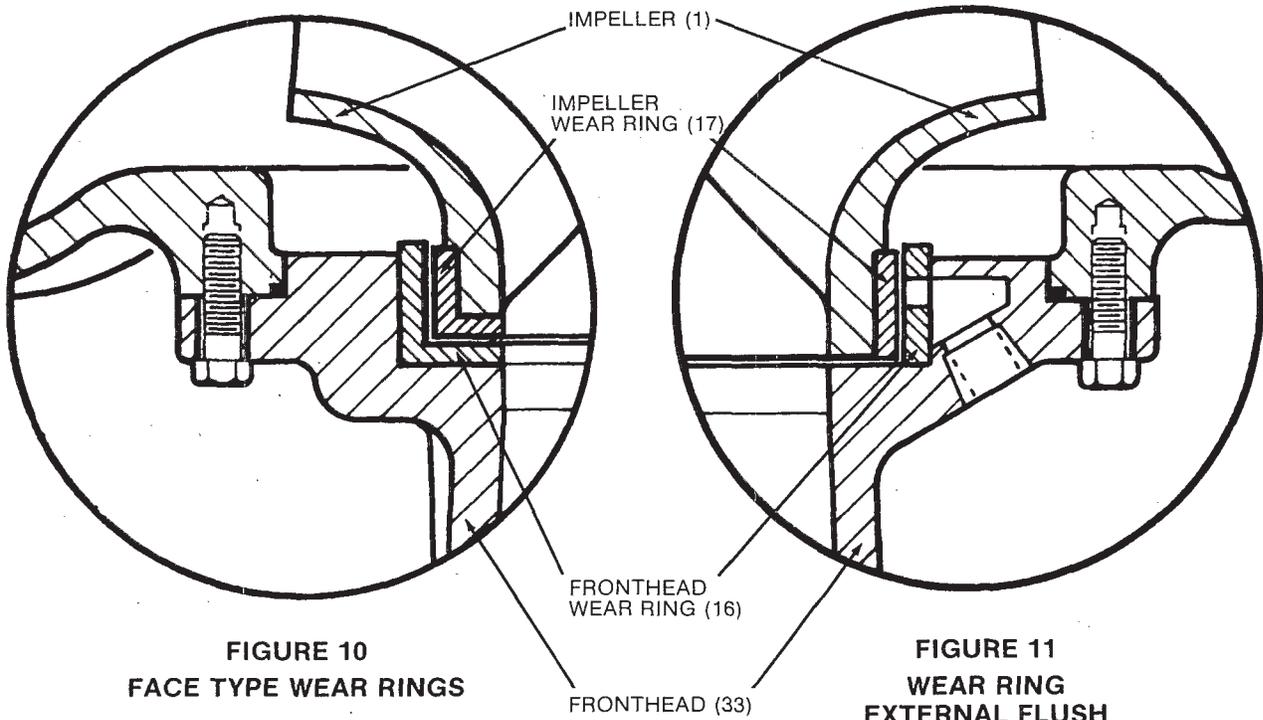
2410, 2420 or 2440 Pumps

Pump Size-Figure	Impeller Fastener (Capscrew Size)	Torque Foot-Pounds
12" 24x4	1/2 — 13 UNC	35
16" 24x4	3/4 — 16 UNF	60
20" 24x4	1 — 14 UNF	130

- L. Install the rotating assembly in the volute (30) using a new o-ring (156) and secure with the appropriate capscrews.
- M. Install the fronthead (33) in the volute using a new o-ring (156) and secure with the appropriate capscrews.
- N. Install the gaskets, handhole covers, and mechanical seal piping if the pump uses a mechanical seal.

The pump assembly is now complete except for packing adjustment, which should be accomplished after the pump is installed, primed and started up. Refer to the maintenance section of this manual for specific packing or mechanical seal adjustment instructions.

WARNING: TO PREVENT POSSIBLE SERIOUS PERSONAL INJURY, EXTREME CARE SHOULD BE EXERCISED TO SELECT THE PROPER GRINDING EQUIPMENT AND APPROVED SAFETY EQUIPMENT. GOGGLES AND SAFETY GLASSES SHOULD BE WORN WHEN GRINDING OR WELDING.



TYPICAL WEAR RING CONSTRUCTION

REPAIR PARTS

ORDERING PARTS

There are a variety of options available for this pump. When ordering parts, give pump serial number, size, and figure number and a complete description and item number of each part. Refer to the drawing and parts list in the back of this manual. You may order parts from your local Fairbanks Morse Distributor or directly from the factory. Consult your local telephone yellow pages for the office nearest you.

RETURNING PARTS

Unnecessary delays and wasted effort will be avoided if you use the proper procedure to return parts or equipment. All materials or parts returned to the factory must have prior approval and a "Returned Goods Tag".

Contact your nearest Fairbanks Morse distributor, listing the material to be returned and the reasons for the return. He will contact the factory to obtain the required approval and "Returned Goods Tag". All material to be returned should be carefully packed to avoid damage in route from rough handling or exposure to weather. The "Returned Goods Tag" will give shipping instructions. All material to be returned freight prepaid.

Fairbanks Morse makes improvements on its products from time to time and reserves the right to furnish improved parts for repairs. A part that is received and is not identical in appearance, or has a different symbol from the original part, may be interchangeable. Examine the part carefully before contacting your Fairbanks Morse representative. The parts should never be returned to the factory without first obtaining proper authorization from your Fairbanks Morse representative.

RECOMMENDED SPARE PARTS For Normal Duty:

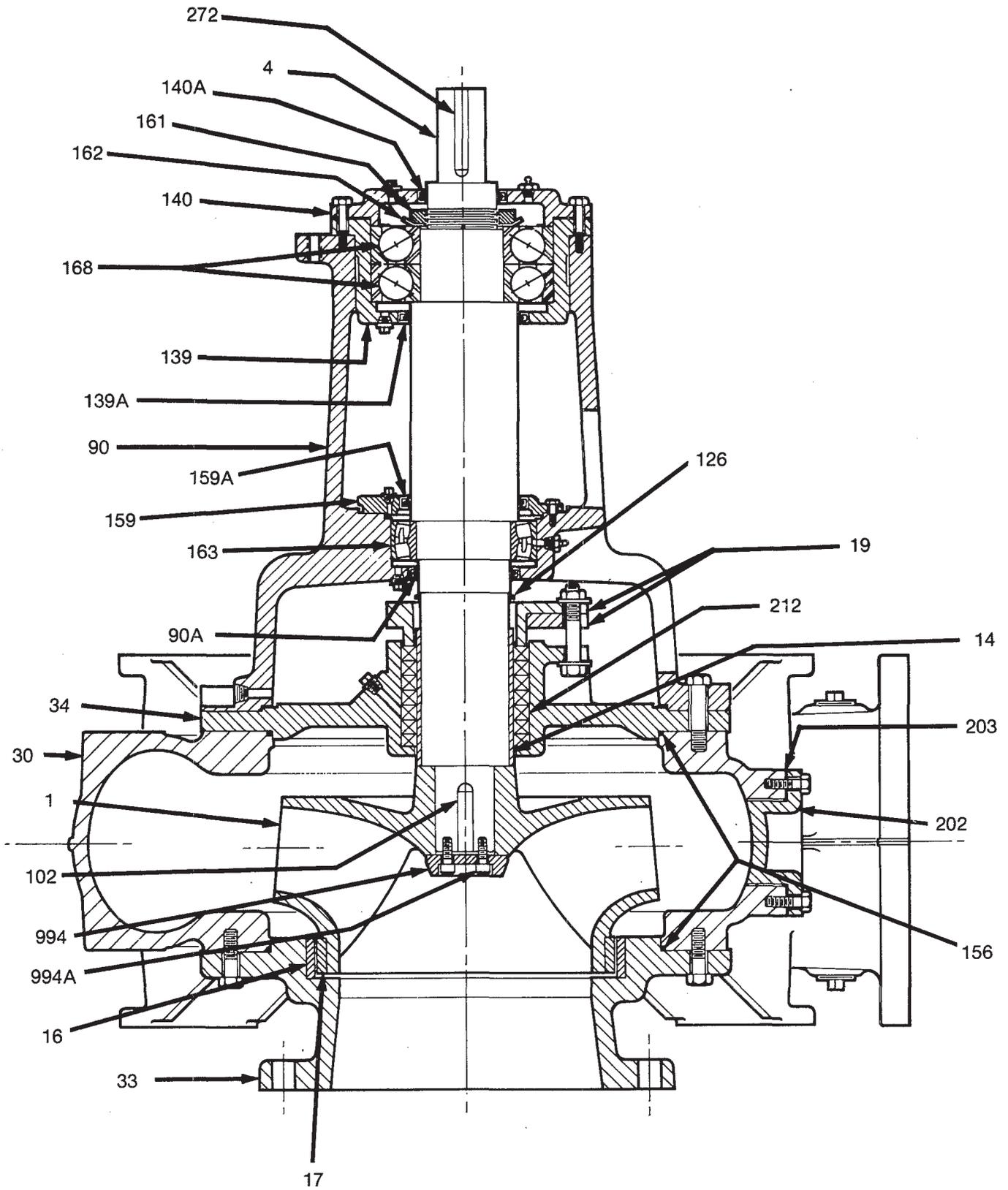
REF. NO.	DESCRIPTION
14	SLEEVE SHAFT
16	WEAR RING, FRONTHEAD (IF ON ORIGINAL CONSTRUCTION)
17	WEAR RING, IMPELLER (IF ON ORIGINAL CONSTRUCTION)
90A	LIP, GREASE
126	DEFLECTOR (2)
139A	LIP, GREASE
140A	LIP, GREASE
156	O-RING, VOLUTE (2)
159A	SEAL, GREASE
163	BEARING, RADIAL
168	BEARING, THRUST (INNER)
168A	BEARING, THRUST (OUTER)
212	PACKING (OR MECHANICAL SEAL)
	GASKETS, COMPLETE SET

For Severe Duty, Add The Following:

REF. NO.	DESCRIPTION
1	IMPELLER
4	SHAFT

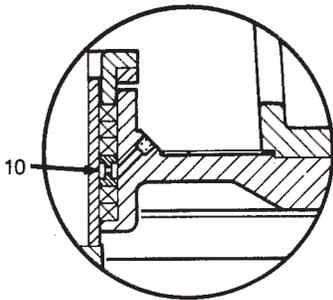
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CROSS-SECTIONAL DRAWING
12" 2414

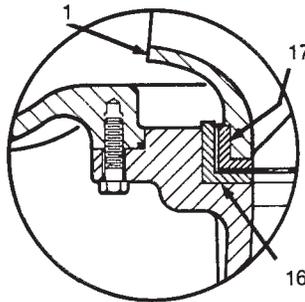


12" 2414

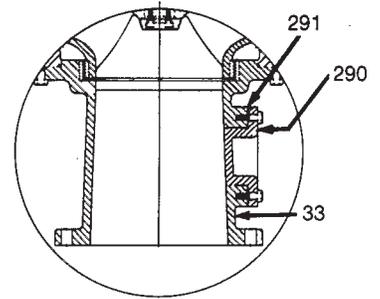
**CROSS-SECTIONAL DRAWINGS
 AND PARTS LIST 12" 2414**



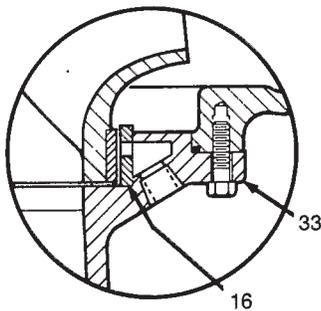
WATER SEAL RING



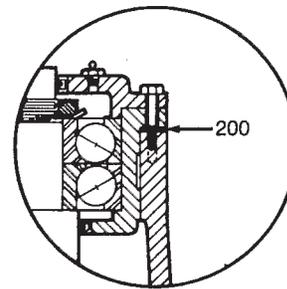
FACE TYPE WEAR RINGS



**FRONTHEAD
 WITH CLEANOUT**



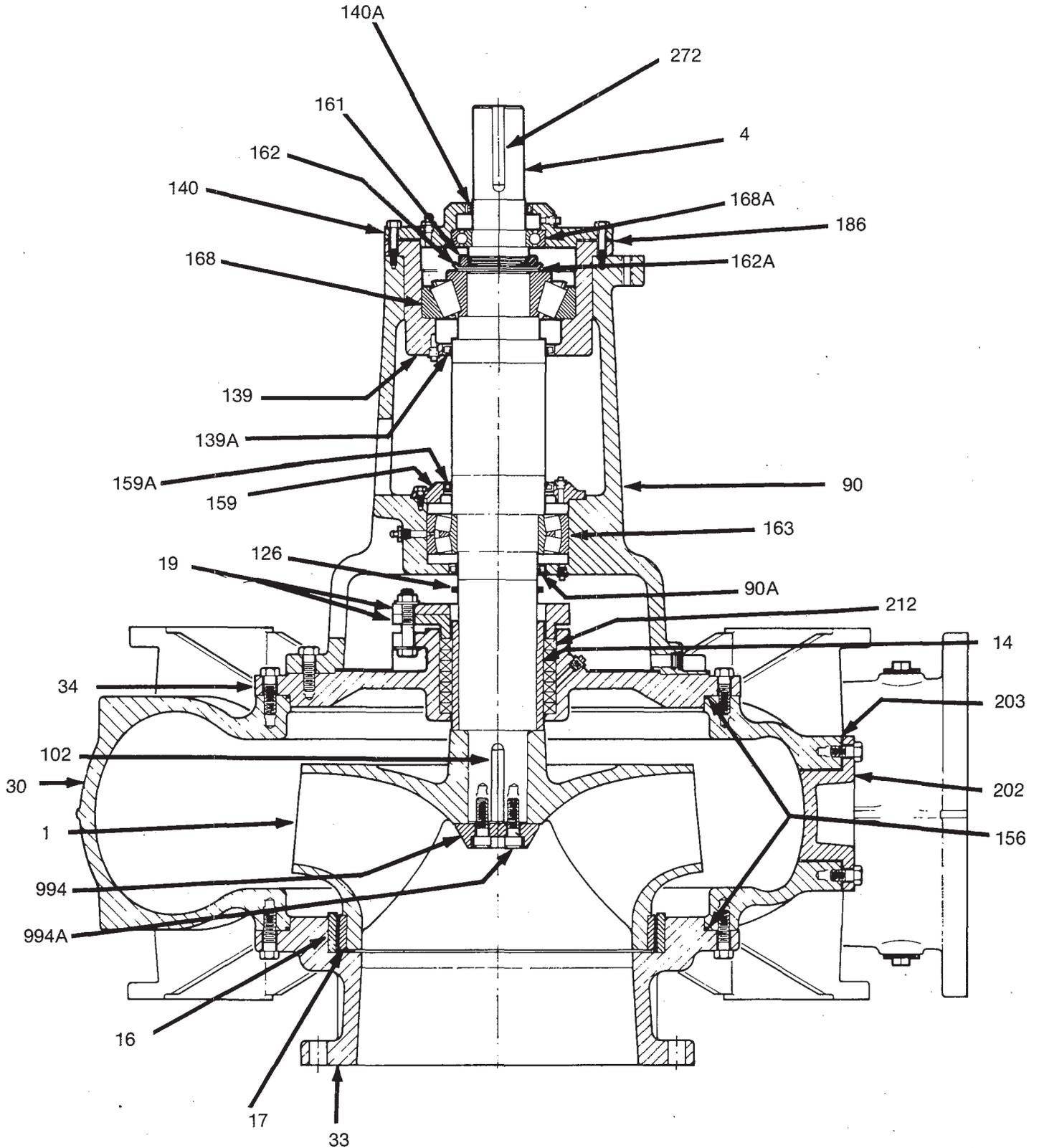
**WEAR RING
 EXTERNAL FLUSH**



**IMPELLER AXIAL
 ADJUSTMENT**

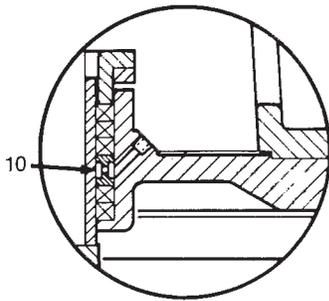
REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	IMPELLER	140A	LIP SEAL
4	SHAFT, PUMP	156	O-RING, VOLUTE
10	RING, WATER SEAL (Optional)	159	COVER, RADIAL BEARING
14	SLEEVE, SHAFT	159A	LIP SEAL
16	WEAR RING, FRONTHEAD	161	LOCKNUT, BEARING
17	WEAR RING, IMPELLER	162	LOCKWASHER, BEARING
19	GLAND HALF, INTERLOCKING	163	BEARING, RADIAL
30	VOLUTE	168	BEARING, THRUST
33	FRONTHEAD	200	SHIM, IMPELLER ADJUSTING (Optional)
34	BACKHEAD	202	COVER, VOLUTE HANDHOLE
90	FRAME	203	GASKET, VOLUTE HANDHOLE COVER
90A	LIP SEAL	212	PACKING
102	KEY, IMPELLER	272	KEY, COUPLING
126	DEFLECTOR	290	COVER, FRONTHEAD HANDHOLE (Optional)
139	HOUSING, THRUST BEARING	291	GASKET, FRONTHEAD HANDHOLE (Optional)
139A	LIP SEAL	994	CAP, IMPELLER
140	COVER, THRUST BEARING HOUSING	994A	CAPSCREW, IMPELLER

CROSS-SECTIONAL DRAWING
16" and 20" 2414

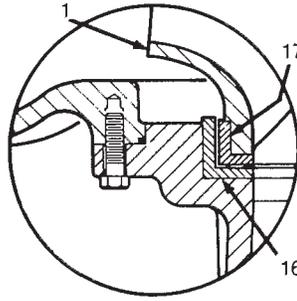


16" and 20" 2414

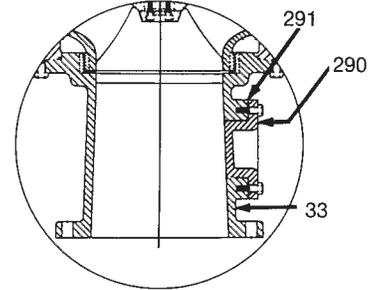
**CROSS-SECTIONAL DRAWINGS
 AND PARTS LIST 16" and 20" 2414**



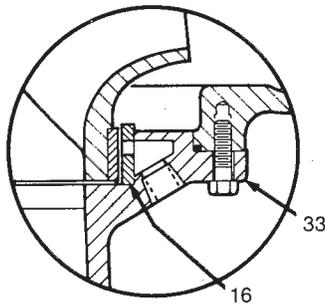
WATER SEAL RING



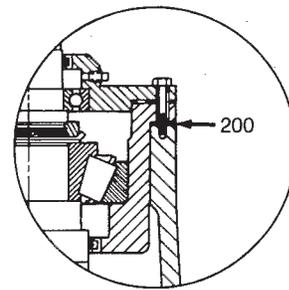
FACE TYPE WEAR RINGS



**FRONTHEAD
 WITH CLEANOUT**



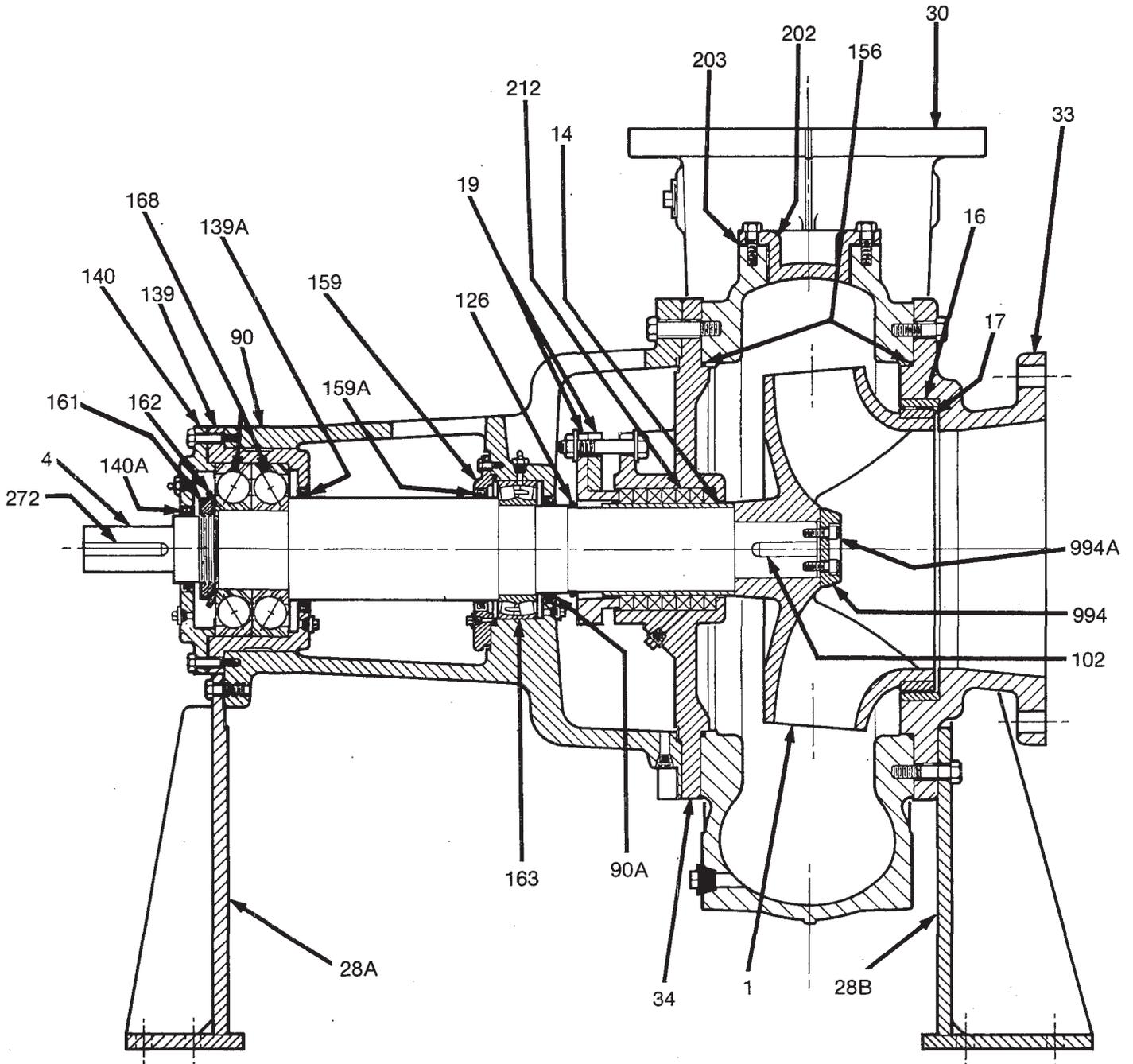
**WEAR RING
 EXTERNAL FLUSH**



**IMPELLER AXIAL
 ADJUSTMENT**

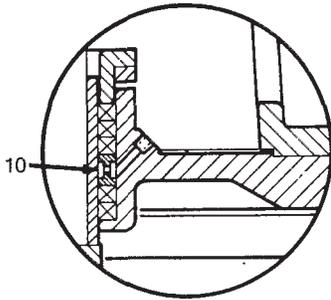
REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	IMPELLER	159	COVER, RADIAL BEARING
4	SHAFT, PUMP	159A	LIP SEAL
10	RING, WATER SEAL (Optional)	161	LOCKNUT, BEARING
14	SLEEVE, SHAFT	162	LOCKWASHER, BEARING
16	WEAR RING, FRONTHEAD	162A	WASHER, KEYED
17	WEAR RING, IMPELLER	163	BEARING, RADIAL
19	GLAND HALF, INTERLOCKING	168	BEARING, THRUST (INNER)
30	VOLUTE	168A	BEARING, THRUST (OUTER)
33	FRONTHEAD	186	SHIM, BEARING ADJUSTING
34	BACKHEAD	200	SHIM, IMPELLER ADJUSTING
90	FRAME	202	COVER, VOLUTE HANDHOLE
90A	LIP SEAL	203	GASKET, VOLUTE HANDHOLE COVER
102	KEY, IMPELLER	212	PACKING
126	DEFLECTOR	272	KEY, COUPLING
139	HOUSING, THRUST BEARING	290	COVER, FRONTHEAD HANDHOLE (Optional)
139A	LIP SEAL	291	GASKET, FRONTHEAD HANDHOLE (Optional)
140	COVER, THRUST BEARING HOUSING.	994	CAP, IMPELLER
140A	LIP SEAL	994A	CAPSCREW, IMPELLER
156	O-RING, VOLUTE		

CROSS-SECTIONAL DRAWING
12" 2424

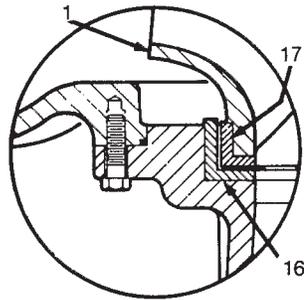


12" 2424

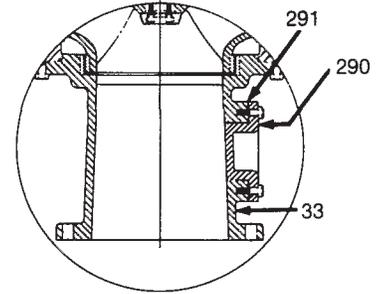
**CROSS-SECTIONAL DRAWINGS
 AND PARTS LIST 12" 2424**



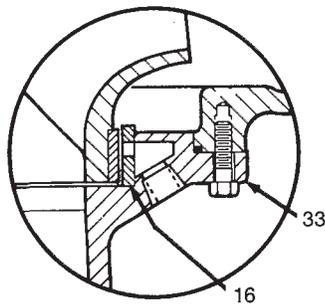
WATER SEAL RING



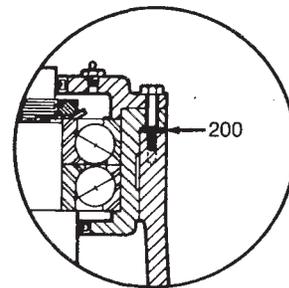
FACE TYPE WEAR RINGS



**FRONTHEAD
 WITH CLEANOUT**



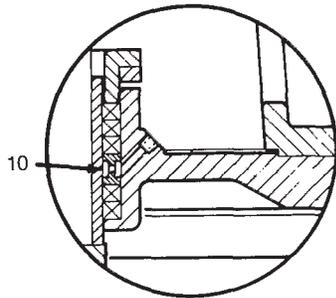
**WEAR RING
 EXTERNAL FLUSH**



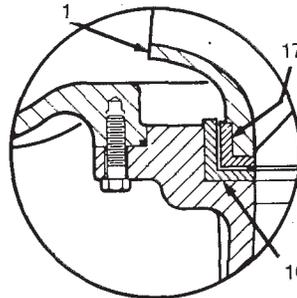
**IMPELLER AXIAL
 ADJUSTMENT**

REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	IMPELLER	140	COVER, THRUST BEARING HOUSING
4	SHAFT, PUMP	140A	LIP SEAL
10	RING, WATER SEAL (Optional)	156	O-RING, VOLUTE
14	SLEEVE, SHAFT	159	COVER, RADIAL BEARING
16	WEAR RING, FRONTHEAD	159A	LIP SEAL
17	WEAR RING, IMPELLER	161	LOCKNUT, BEARING
19	GLAND HALF, INTERLOCKING	162	LOCKWASHER, BEARING
28A	PEDESTAL, FRAME	163	BEARING, RADIAL
28B	PEDESTAL, PUMP	168	BEARING, THRUST
30	VOLUTE	200	SHIM, IMPELLER ADJUSTING (Optional)
33	FRONTHEAD	202	COVER, VOLUTE HANDHOLE
34	BACKHEAD	203	GASKET, VOLUTE HANDHOLE COVER
90	FRAME	212	PACKING
90A	LIP SEAL	272	KEY, COUPLING
102	KEY, IMPELLER	290	COVER, FRONTHEAD HANDHOLE (Optional)
126	DEFLECTOR	291	GASKET, FRONTHEAD HANDHOLE (Optional)
139	HOUSING, THRUST BEARING	994	CAP, IMPELLER
139A	LIP SEAL	994A	CAPSCREW, IMPELLER

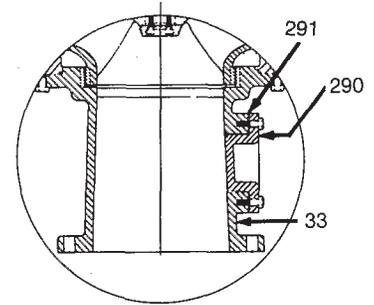
**CROSS-SECTIONAL DRAWINGS
 AND PARTS LIST 16" and 20" 2424**



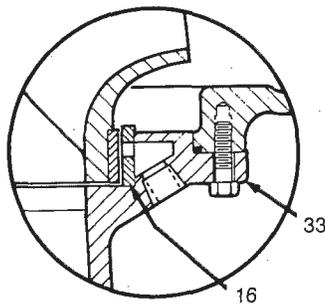
WATER SEAL RING



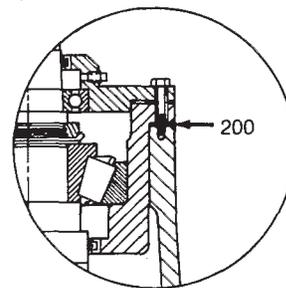
FACE TYPE WEAR RINGS



**FRONTHEAD
 WITH CLEANOUT**



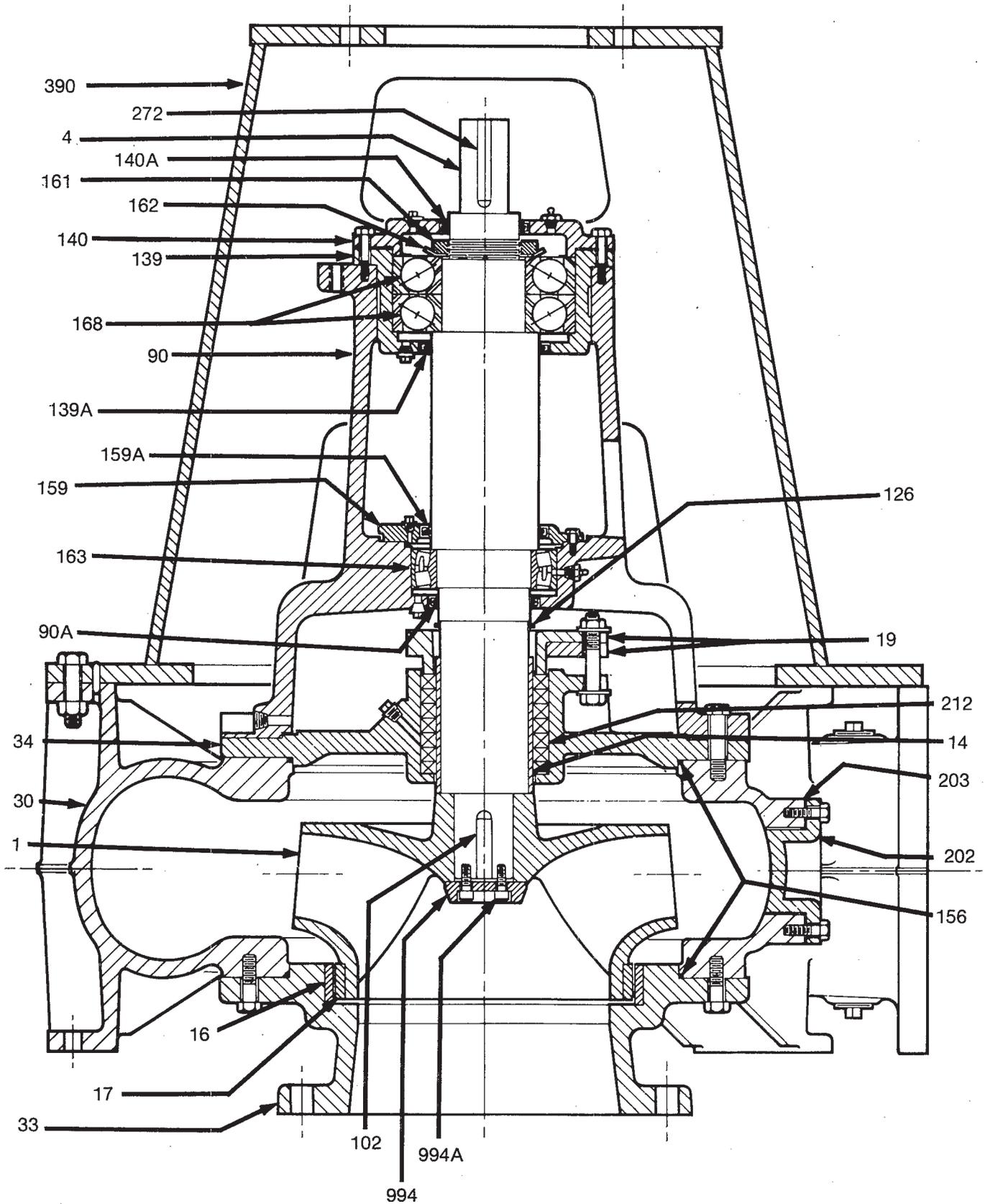
**WEAR RING
 EXTERNAL FLUSH**



**IMPELLER AXIAL
 ADJUSTMENT**

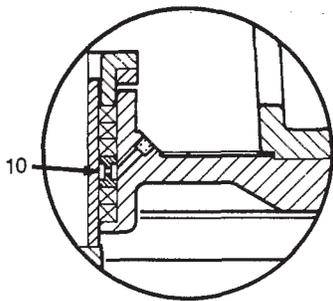
REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	IMPELLER	156	O-RING, VOLUTE
4	SHAFT, PUMP	159	COVER, RADIAL BEARING
10	RING, WATER SEAL (Optional)	159A	LIP SEAL
14	SLEEVE, SHAFT	161	LOCKNUT, BEARING
16	WEAR RING, FRONTHEAD	162	LOCKWASHER, BEARING
17	WEAR RING, IMPELLER	162A	WASHER, KEYED
19	GLAND HALF, INTERLOCKING	163	BEARING, RADIAL
28A	PEDESTAL, FRAME	168	BEARING, THRUST (INNER)
28B	PEDESTAL, PUMP	168A	BEARING, THRUST (OUTER)
30	VOLUTE	186	SHIM, BEARING ADJUSTING
33	FRONTHEAD	200	SHIMS, IMPELLER ADJUSTING
34	BACKHEAD	202	COVER, VOLUTE HANDHOLE
90	FRAME	203	GASKET, VOLUTE HANDHOLE COVER
90A	LIP SEAL	212	PACKING
102	KEY, IMPELLER	272	KEY, COUPLING
126	DEFLECTOR	290	COVER, FRONTHEAD HANDHOLE (Optional)
139	HOUSING, THRUST BEARING	291	GASKET, FRONTHEAD HANDHOLE (Optional)
139A	LIP SEAL	994	CAP, IMPELLER
140	COVER, THRUST BEARING HOUSING	994A	CAPSCREW, IMPELLER
140A	LIP SEAL		

CROSS-SECTIONAL DRAWINGS 12" 2444

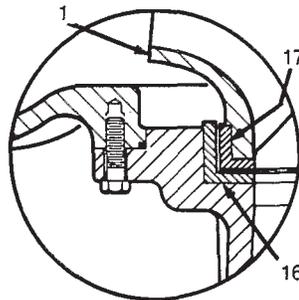


12" 2444

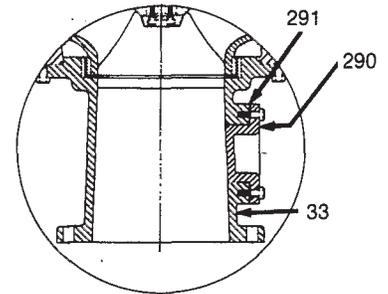
**CROSS-SECTIONAL DRAWINGS
 AND PARTS LIST 12" 2444**



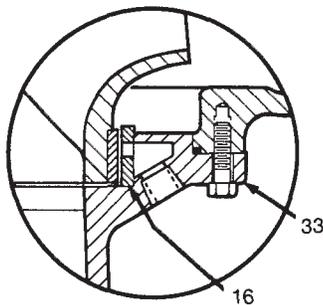
WATER SEAL RING



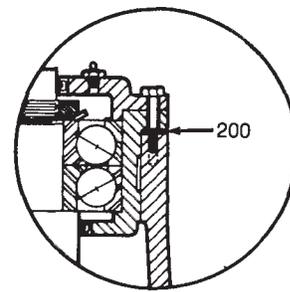
FACE TYPE WEAR RINGS



**FRONTHEAD
 WITH CLEANOUT**



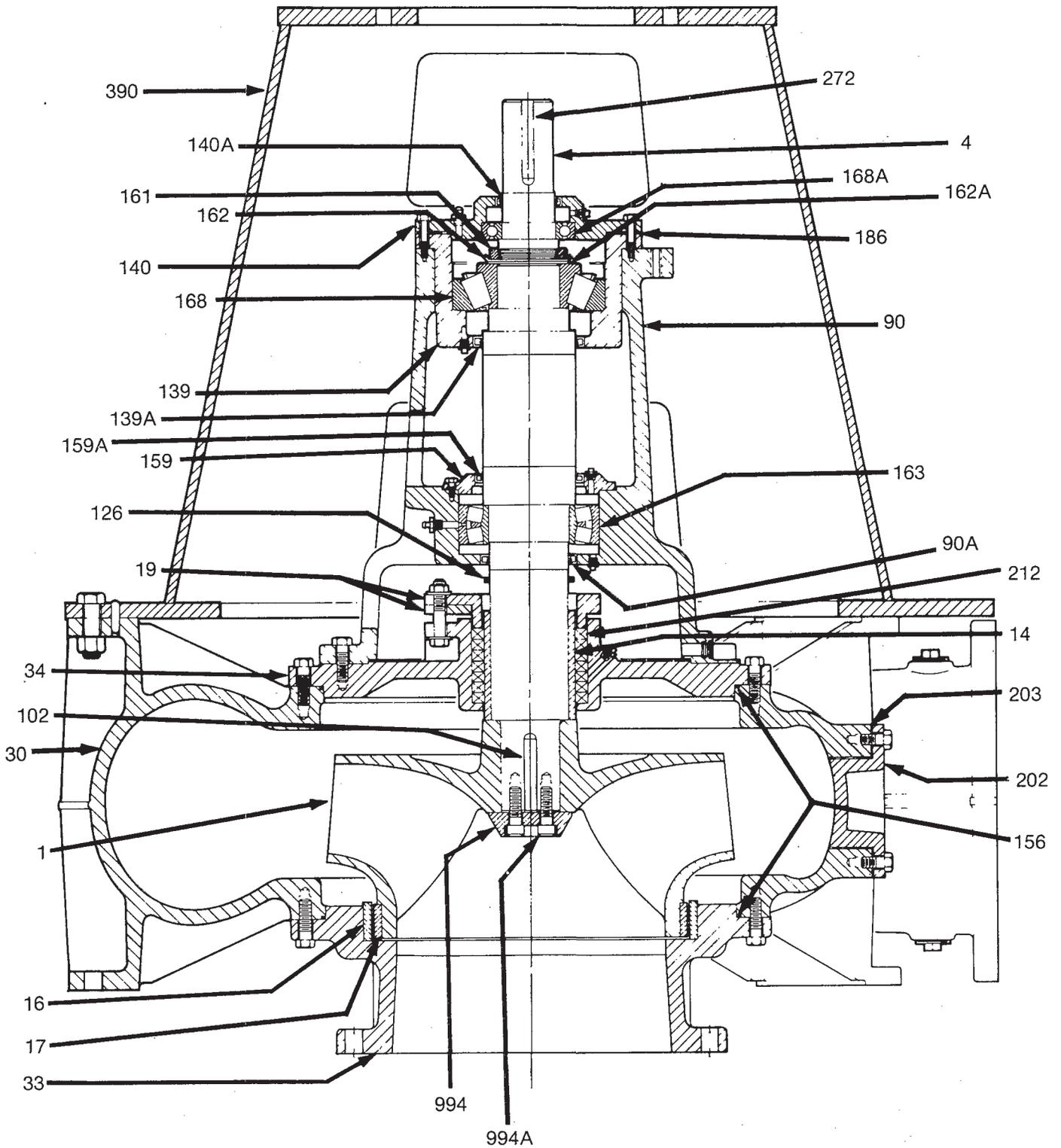
**WEAR RING
 EXTERNAL FLUSH**



**IMPELLER AXIAL
 ADJUSTMENT**

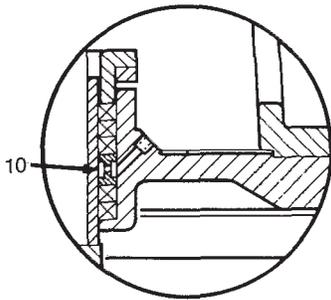
REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	IMPELLER	156	O-RING, VOLUTE
4	SHAFT, PUMP	159	COVER, RADIAL BEARING
10	RING, WATER SEAL (Optional)	159A	LIP SEAL
14	SLEEVE, SHAFT	161	LOCKNUT, BEARING
16	WEAR RING, FRONTHEAD	162	LOCKWASHER, BEARING
17	WEAR RING, IMPELLER	163	BEARING, RADIAL
19	GLAND HALF, INTERLOCKING	168	BEARING, THRUST
30	VOLUTE	200	SHIM, IMPELLER ADJUSTING (Optional)
33	FRONTHEAD	202	COVER, VOLUTE HANDHOLE
34	BACKHEAD	203	GASKET, VOLUTE HANDHOLE COVER
90	FRAME	212	PACKING
90A	LIP SEAL	272	KEY, COUPLING
102	KEY, IMPELLER	290	COVER, FRONTHEAD HANDHOLE (Optional)
126	DEFLECTOR	291	GASKET, FRONTHEAD HANDHOLE (Optional)
139	HOUSING, THRUST BEARING	390	ADAPTER, MOTOR
139A	LIP SEAL	994	CAP, IMPELLER
140	COVER, THRUST BEARING HOUSING	994A	CAPSCREW, IMPELLER
140A	LIP SEAL		

CROSS-SECTIONAL DRAWING
16" and 20" 2444

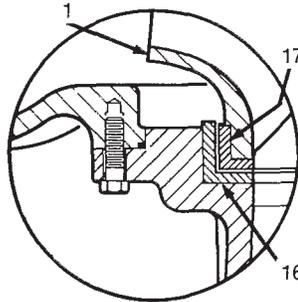


16" and 20" 2444

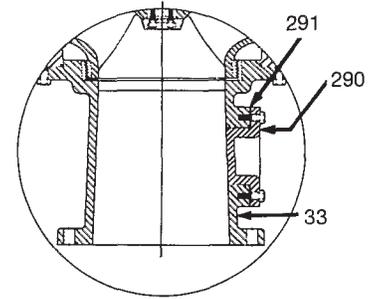
**CROSS-SECTIONAL DRAWINGS
 AND PARTS LIST 16" and 20" 2444**



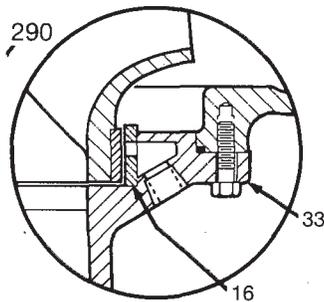
WATER SEAL RING



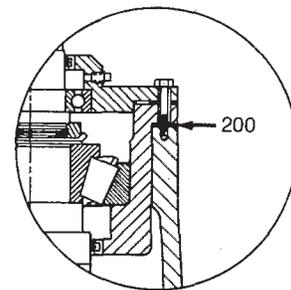
FACE TYPE WEAR RINGS



**FRONTHEAD
 WITH CLEANOUT**



**WEAR RING
 EXTERNAL FLUSH**



**IMPELLER AXIAL
 ADJUSTMENT**

REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	IMPELLER	159	COVER, RADIAL BEARING
4	SHAFT, PUMP	159A	LIP SEAL
10	RING, WATER SEAL (Optional)	161	LOCKNUT, BEARING
14	SLEEVE, SHAFT	162	LOCKWASHER, BEARING
16	WEAR RING, FRONTHEAD	162A	WASHER, KEYED
17	WEAR RING, IMPELLER	163	BEARING, RADIAL
19	GLAND HALF, INTERLOCKING	168	BEARING, THRUST (INNER)
30	VOLUTE	168A	BEARING, THRUST (OUTER)
33	FRONTHEAD	186	SHIM, BEARING ADJUSTING
34	BACKHEAD	200	SHIM, IMPELLER ADJUSTING
90	FRAME	202	COVER, VOLUTE HANDHOLE
90A	LIP SEAL	203	GASKET, VOLUTE HANDHOLE COVER
102	KEY, IMPELLER	212	PACKING
126	DEFLECTOR	272	KEY, COUPLING
139	HOUSING, THRUST BEARING	290	COVER, FRONTHEAD HANDHOLE (Optional)
139A	LIP SEAL	291	GASKET, FRONTHEAD HANDHOLE (Optional)
140	COVER, THRUST BEARING HOUSING	390	ADAPTER, MOTOR
140A	LIP SEAL	994	CAP, IMPELLER
156	O-RING, VOLUTE	994A	CAPSCREW, IMPELLER

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