

# INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS FOR ETA-L C-FRAME SERIES PUMPS

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## I. GENERAL DESCRIPTION AND SAFETY PRECAUTIONS.

**A. GENERAL DESCRIPTION.** The ETA-L C-frame pumping unit consists of a pump, base, coupling, coupling guard and a driver unit. The driver is usually an electric motor, but can be a steam turbine or any other power conversion device that can provide the required horsepower at the proper RPM.

This manual is designed to provide sufficient material to properly maintain the total pumping unit. The information as presented should improve your knowledge and understanding of the ETA-L C-frame pump, thus upgrading the quality of pump maintenance and care. Variations exist in the pumps, equipment used with these pumps, and in installation of the pump and driver. Therefore, specific operating instructions are not within the scope of this manual. This manual contains general rules for installation, operation, and maintenance of the pump.

The bare pump consists of the following major parts and options. Refer to figure 2, the Sectional Assembly drawing, for the location of parts identified by item numbers. The quantity, description, and material are listed within table 6, the ETA-L Pump Parts List.

**Item 1 - Casing.** The casing (1) houses the impeller (2) and consists of the discharge volute and discharge nozzle. The backcover (11) is held in place between the casing (1) and the frame adaptor (71). The casing (1) is fastened to the frame adaptor (71) and suction cover (9) with studs (631), hex nuts (616) and lockwashers (655). A casing gasket (73A) fits between the suction cover (9) and the casing (1).

**Item 2 - Impeller.** The pumps are equipped with enclosed impellers. The impeller (2) is keyed to the shaft (6) by the impeller key (32) and is locked in place by the impeller nut (24). Impeller nut gasket (30) may be fitted between impeller nut (24) and the shaft (6). Impeller gasket (38) may be fitted behind the impeller (2) against the first shoulder of the shaft (6).

**Item 6 - Shaft.** The shaft (6) is designed for maximum deflection of 0.001 inch at the face of the mechanical seal. The shaft is also designed to provide stabilization to the rotor system when pump operates away from the best efficiency point. A coupling connects the pump shaft (6) to the driver shaft. The coupling key (46) holds the coupling in place, causing it to rotate with the shaft (6). O-ring (89D) helps prevent excessive leakage between the shaft sleeve (14) and shaft (6).

**Item 9 - Suction Cover.** The suction cover (9) directs fluid to the casing (1) and the impeller (2) and consists of the suction inlet. Wear ring (7A) is secured to the suction cover with setscrews (667).

**Item 11 - Backcover.** The backcover (11) is held in place between the casing (1) and the frame adaptor (71). As an option, wear ring (7B) may be secured to the backcover (11) with setscrews (667). The backcover

(11) is positioned in the casing bore by an o-ring (89A) which is mounted in an o-ring groove located on the outer perimeter of the backcover (11). The backcover (11) is designed to accommodate nearly all mechanical seals (90) and seal accessories including double, tandem, and balanced versions or packing rings (13).

**Items 16 & 18 - Bearings.** A deep-groove Conrad-type, loose, internal fit radial bearing (16) and no load, back-to-back mounted thrust bearings (18) are housed in the bearing housing (99). The thrust bearings (18) are held in place by the bearing locknut (22) and bearing lockwasher (69). The bearings are oil lubricated by either oil bath or oil mist.

**Item 17 - Gland.** The pump can be furnished with a mechanical seal (90) or packing rings (13). If the pump is equipped with a mechanical seal (90), the rotating element of mechanical seal is seated on the shaft sleeve (14). The seal gland (17) and backcover (11) serves as the mechanical seal housing. The mechanical seal o-ring (89E) prevents leakage around the seal gland (17). If the pump is equipped with packing rings, the four packing rings (13) and lantern ring (29) are seated on the shaft sleeve (14). The packing gland (17A) and backcover (11) serves as a stuffing box. The seal formed by the packing rings (13) prevent fluid from escaping the pump backcover (11). The flow of liquid from the backcover is checked by the throat bushing (63) and packing rings (13). If the pump is equipped with a cartridge seal, contact the seal manufacturer for proper installation.

**Item 71 - Frame Adaptor.** The frame adaptor (71) connects the casing (1) to the bearing housing (99) and acts as a bearing cap to the inboard end of the bearing housing (99). The frame adaptor (71) is fastened to the backcover (11) with socket head capscrews (600) and lockwashers (658). The frame adaptor (71) contains jacking capscrews (610) to aid in loosening frame adaptor (71) from casing (1).

**Item 99 - Bearing Housing.** The principal function of the bearing housing (99) is to carry the loads from the liquid end of the pump to the base and to transport power from the power unit to the impeller. The bearing housing (99) has a radial bearing (16) located in the front-end of the house (nearest to the casing) and a pair of back-to-back mounted angular contact thrust bearings (18) in the rear of the housing. The bearing housing (99) is designed to be oil lubricated, which can be accomplished in several ways.

The first method involves the use of an oiler (125) with a sight glass. The oiler maintains the oil level high enough on the higher of the two bearings so that the bearings themselves provide the motivation for the oil to be moved through the races of both bearings.

A second method is a bull's eye (143) sight glass with an oil flinger, which mounts on the shaft and literally flings the oil throughout the bearing frame. The bull's eye indicator is used with this system to make sure that the oil level within the frame can be observed and maintained at the proper level.

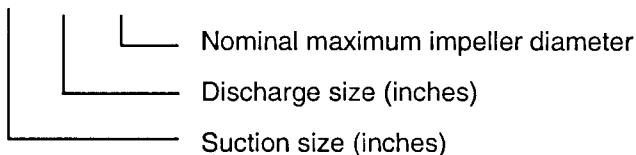
A third method is the oil mist system. All pumps are equipped so that they can be used or can be converted to oil mist units without any field machining.

In addition to the oil lube system, the power frame contains the shaft oil seals or oil containment system. The pump bearing housing (99) may be equipped with a magnetic oil seal assembly which operates as a mechanical seal when running and becomes a static seal when shutdown or stopped. It is necessary to use an expansion chamber with the magnetic seal device. The pump can also be furnished with a number of labyrinth seal assemblies being offered on the market.

**Baseplate.** When properly grouted the baseplate is designed to provide adequate support for the pump and motor so the pump can be operated without baseplate deflection, excessive vibration, or resonance. The frame foot (53) and casing (1) are bolted to the baseplate with capscrews. Grouting of the baseplate is required by Carver Pump Company.

**B. PUMP IDENTIFICATION.** Use the following example for identifying information about your pump model number.

12 x 12 x 14



**C. NAMEPLATE.** A nameplate is attached to each pump. Nameplate data should be furnished to Carver Pump Company or its representative when ordering spare parts or requesting information.

**D. SAFETY PRECAUTIONS.** This manual contains descriptions and instructions for installation, operation, and maintenance of your pump. The pump is of sturdy design and is constructed to give satisfactory service for a long period of time when the instructions outlined in this manual are followed. Failure or neglect to properly install, operate or maintain your pump may result in personal injury, property damage, or unnecessary damage to the pump.

The instructions in this manual are intended for personnel who possess general training in the operation and maintenance of centrifugal pumps. This information does not relieve personnel of the responsibility of exercising normal good judgment in operating and maintaining the pump and its components. All personnel should be guided by basic rules of safety associated with the equipment and the process.

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

## **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.

## **II. INSPECTION AND STORAGE.**

**A. INSPECTION.** Upon receipt of the shipment, unpack and inspect the pump, 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. Immediately report any missing parts or damage incurred during shipment to the factory and to the transportation company and file your "damaged and/or lost in shipment" claim with the carrier.

**B. STORAGE OF PUMP.** If the equipment is not immediately installed and operated, store it in a clean, dry, well-ventilated place, free from vibrations, moisture, and rapid or wide variations in temperature.

Rotate the pump and driver shafts several revolutions at least once every two weeks to coat the bearings with lubricant, retard oxidation and corrosion, and prevent possible false brinelling.

Consider a unit to be in storage when:

1. It has been delivered to the job site and is waiting to be installed.
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 a Carver Pump Company representative for specific instructions. Improper storage could damage the equipment and would result in non-warranty covered product failures.

### III. INSTALLATION.

**A. LOCATION.** The pump should be installed as close as possible to the fluid to be pumped. A short direct suction pipe can be used to keep suction losses at a minimum. If possible, locate the pump so fluid will flow by gravity to the suction opening. The discharge piping should be direct 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 pumping unit should be located in an area permitting periodic inspection and maintenance. Head room and access should be provided. Units should be installed in a dry location with adequate drainage.

#### B. HANDLING.

#### CAUTION

To lift the pumping unit, a hoist or suitable lifting device should be used. Do not pick up the complete unit by the pump or driver shafts or lifting eyes.

In handling the unit, place the slings so as to distribute the load. The driver alone may be lifted by the driver lifting eyes.

**C. FOUNDATION.** The foundation should be a minimum of 3 to 6 inches wider and longer than the baseplate, have a level surface, and be of sufficient mass to prevent vibration and form a permanent rigid support for the unit. The best foundations are concrete with anchor bolts of adequate size embedded in the foundation in pipe sleeves having an inside diameter 2-1/2 times larger than the bolt diameter. This will allow for accurate positioning of the unit. Keep the concrete surface clean, yet rough to assure the best bond for grout.

**D. LEVELING UNIT.** Lower unit onto foundation, positioning base structure so anchor bolts are aligned in the middle of holes in baseplate. Level the baseplate by driving metal wedges or shims under it. The shims or wedges should be spaced close enough to give even support and stability. Adjust metal wedges or shims until baseplate is level. Use a machinist's level to determine levelness.

#### CAUTION

Do not attempt to straighten the base by using the anchor bolts.

**E. DIRECTION OF ROTATION.** Before connecting coupling halves, bump start driver and verify that rotation is correct. Correct pump rotation is indicated by an arrow on the pump casing. The standard direction of rotation, viewed from the driver end, is clockwise.

**F. COUPLING ALIGNMENT.** Unit must be aligned to no more than 0.005 inch Total Indicator Reading (TIR) both axial and radial by either rim and face, reverse indicator or laser method.

**G. GROUTING.** When the unit has been leveled and coupling alignment is complete, the unit should be grouted using a high grade non-shrinking grout (refer to figure 1):

1. Build a wooden dam around baseplate to retain the grout.
2. Pour grout through grouting holes provided in baseplate until entire space under baseplate is filled, with no voids or air pockets.
3. Insert a stiff wire through the grouting holes to work the grout and release any air pockets.
4. After the grout has hardened (72 hours) remove the dam and the shims or wedges under the baseplate. Fill the holes left by the shims with grout.
5. Tighten foundation bolts loosely. Allow the grout to fully cure before firmly tightening the foundation bolts.
6. Recheck coupling alignment (see paragraph F, this section).

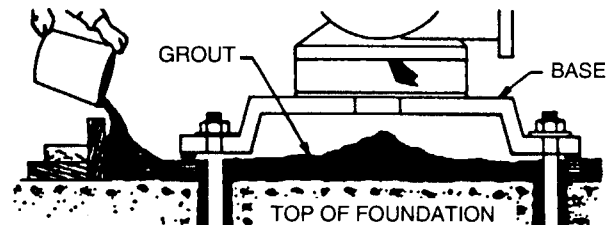


Figure 1. Grouting Baseplate

#### H. COUPLING GUARD.

#### WARNING

Check safety codes and always install protective guards or shields as required by the various federal, state, or local laws and the regulations concerning OSHA.

Place coupling guard over coupling and bolt to base. Coupling guard may be either a fixed coupling guard or a hinged coupling guard.

**I. PIPING.** All piping should be independently supported near the pump so that a minimum of pipe strain will be transmitted to pump casing.

## CAUTION

All piping connections must be made with the pipe in a freely supported state. Do not apply vertical or side pressure to align the piping with the pump flange.

The velocity of liquid should be maintained at a given level, depending on the product being pumped. The higher the velocity of liquid, the greater the friction loss (i.e. loss of head) of the pipe. Use of oversize piping is recommended whenever possible to reduce head loss.

Where the pump must lift the liquid from a lower level, the suction piping should be laid out with a continual rise toward the pump, avoiding high points in the line. The formation of air pockets will thus be prevented.

Never use a straight taper (concentric) reducer in a horizontal suction line because air pockets may form in the top of the reducer and the pipe. Use an offset (eccentric) reducer.

Install a check valve and a control valve in discharge line and a control valve in suction line. The check valve helps protect pump from water hammer and prevents reverse rotation. Reverse rotation should be avoided because it can damage the pump. Causes of reverse rotation include failure to close control valve in discharge line when pump is shut down and the event of power failure. Operators should be alert to prevent reverse rotation.

Control valves are used in priming, starting, and pump shutdown. Pump must never be throttled by the use of a valve or other restriction in the suction line.

## CAUTION

After all the piping is connected, recheck the coupling alignment (paragraph F, this section).

**J. AUXILIARY CONNECTIONS.** Install auxiliary piping connections and gauges as applicable.

## IV. OPERATION.

**A. PRESTART CAUTIONS.** Before starting or operating the pump, make the following checks:

Lubricants.

## CAUTION

Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual breakup of the equipment, exposing operating personnel to injury.

Pumps are usually shipped with the bearing housings empty of oil. ISO Grade 68 or Grade 100 mineral oils are recommended for proper lubrication of the pump.

Refer to paragraph C, section VI for bearing maintenance.

If an oiler (125) with a sight glass is to provide bearing lubrication, it is mounted in place of the plug on the side of the bearing housing (99) and connected with an equalizing tube (404) from base of oiler to bearing housing (99). The equalizing tube (404) provides a closed environment for the oiler (125) by accommodating expansion and contraction of vapors without permitting contaminant to enter the oiler (125).

When an oiler (125) is used in conjunction with a magnetic face seal or bearing isolator (47), the top port of the bearing housing (99) will be fitted with a diaphragm expansion chamber (45), which incorporates an elastomeric diaphragm and constitutes a completely enclosed system. The diaphragm expansion chamber (45) accommodates the expansion and contraction of vapors in the bearing housing (99) without permitting moisture and other contaminants to enter.

Fill oiler (125) reservoir and allow it to fill bearing housing (99). To avoid adding too much oil, never add oil to bearing housing (99) through plug at the top of the bearing housing (99). It may take repeated fittings of oiler reservoir to fill oil well. Use the oiler's sight glass to check oil level in bearing housing (99).

When a bull's eye (143) sight glass is used to provide bearing lubrication, fill with oil until the oil level reaches the middle of the sight glass.

Consult the factory for conversion of oil mist. Oil mist lubrication provides the greatest protection against contamination by dirt and water.

The top port of the bearing housing (99) remains plugged for oil mist lubricated bearings. The plug in the bottom of the power frame should be removed so that condensed oil vapor can be drained and/or removed from the bearing housing (99).

**Final Check.** Check the pump and motor shafts for free rotation by manually turning coupling. If necessary, recheck coupling alignment according to paragraph F, section III. Unit is now ready for initial start up.

**B. PRESTART PUMP.** Before starting the pumping unit, refer to safety precautions in paragraph D, section I. Use the following procedure to start the pump:

## WARNING

Do not operate pumping unit against a closed discharge system. If pump has any chance of operation against a closed system, a bypass system allowing a minimum of 10 percent of design flow should be installed.

1. Before starting the pump, rotate coupling by hand to assure both shafts are rotating freely.

2. Observe all caution or danger tags attached to the equipment.
3. Never run pump dry because the close running fits within the pump may be lubricated by the fluid being pumped. Dry running may result in pump seizure.
4. Before starting the pump, check for proper priming.
5. When unit is equipped with seal cooling lines turn on seal water, vent seal housing, and confirm the seal water is at sufficient pressure.

#### C. STARTING THE PUMP.

1. Fully open the suction valve.
2. Check pump to be sure that it is properly primed and lubricated.
3. Start the pump.
4. Slowly open discharge valve and adjust it to the operating conditions required (see pump nameplate for design point condition).

#### D. OPERATING CHECKS.

1. Check for excessive vibration or noise. If vibration or noise occurs and does not stop within a short period of time, turn off the pump. For determination of the cause and its remedy refer to "Troubleshooting" in section V or consult a Carver Pump Company representative.
2. If unit is equipped with a mechanical seal, check mechanical seal for leakage. If unit is equipped with packing, check that nuts securing packing gland are finger tightened only.
3. If unit is equipped with seal cooling lines, check for adequate lubricating liquid flow to the seal.
4. Check that pump is operating within design criteria and perimeters.
5. Check and record bearing temperature. It should not exceed 180 degrees F.

6. Check and record amp draw of the driver.
7. When unit is equipped with an oiler, check oil level and refill as required.

#### E. STOPPING THE PUMP.

1. Begin to partially close discharge valve.
2. Stop pump.
3. Completely close discharge and suction valves.
4. If unit is equipped with seal cooling lines, turn off external cooling water line to seal.
5. Tag out and lock power to driver according to OSHA Standard 1910.147.

#### F. INDEFINITE SHUTDOWN.

##### CAUTION

If pump is handling hazardous fluid, extreme care must be taken to insure safety of personnel when attempting to drain pump. Suitable protection devices should be used and/or protective clothing should be worn.

Remove casing plug to drain casing. Drain all piping if there is a possibility of liquid freezing. Provide pump and driver with a protective cover.

#### V. TROUBLESHOOTING OPERATING PROBLEMS.

If you have followed the installation and starting procedures outlined in this manual, the 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. Refer to table 1 for pump troubleshooting.

**Table 1. Pumping Unit Troubleshooting**

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Failure to deliver liquid.	<ol style="list-style-type: none"> <li>1. Pump not primed.</li> <li>2. Valves closed.</li> <li>3. Wrong rotation.</li> <li>4. Discharge head above shutoff.</li> <li>5. Pump not up to speed.</li> <li>6. Air leak in suction line.</li> <li>7. Impeller or suction pipe clogged.</li> </ol>	<ol style="list-style-type: none"> <li>1. Prime pump.</li> <li>2. Open valves</li> <li>3. Check rotation.</li> <li>4. Check pump rating against actual head condition.</li> <li>5. Check voltage and power consumption for motor overload.</li> <li>6. Repair leak.</li> <li>7. Inspect and clean impeller and suction pipe.</li> </ol>
Insufficient capacity.	<ol style="list-style-type: none"> <li>1. Air leak in suction line.</li> <li>2. Excessive leakage around gland assembly at shaft.</li> <li>3. Damaged impeller.</li> <li>4. Impeller or suction pipe clogged.</li> <li>5. Wear ring(s) exceed wear limit.</li> </ol>	<ol style="list-style-type: none"> <li>1. Repair leak.</li> <li>2. Replace mechanical seal or packing rings, as applicable.</li> <li>3. Replace impeller.</li> <li>4. Inspect and clean impeller and suction pipe.</li> <li>5. Replace wear ring(s).</li> </ol>
Reduced pressure.	<ol style="list-style-type: none"> <li>1. Air leak in suction line.</li> <li>2. Air leak in recirc tubing.</li> <li>3. Discharge head too high.</li> <li>4. Impeller or suction pipe clogged.</li> <li>5. Wrong direction of rotation.</li> <li>6. Impeller damaged.</li> <li>7. Impeller diameter too small.</li> </ol>	<ol style="list-style-type: none"> <li>1. Repair leak.</li> <li>2. Replace tubing.</li> <li>3. Consult with nearest Carver Pump Company representative or factory.</li> <li>4. Inspect and clean impeller and suction pipe.</li> <li>5. Check power connection to driver. Switch two of three leads until direction of rotation is correct.</li> <li>6. Replace impeller.</li> <li>7. Replace impeller.</li> </ol>
Pump losses prime after starting.	<ol style="list-style-type: none"> <li>1. Air leak in suction line.</li> <li>2. Excessive leakage</li> <li>3. Plugged suction line.</li> </ol>	<ol style="list-style-type: none"> <li>1. Repair leak.</li> <li>2. Check all o-rings and gaskets. Replace as necessary.</li> <li>3. Clean and inspect suction line.</li> </ol>
Vibration or noise.	<ol style="list-style-type: none"> <li>1. Loose foundation bolts.</li> <li>2. Improper flange alignment.</li> <li>3. Ball bearings have insufficient lubrication.</li> <li>4. Defect in grouting.</li> <li>5. Pump operating under cavitation.</li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten foundation bolts.</li> <li>2. Check pipe flange.</li> <li>3. Lubricate bearings according to paragraph C, section VI.</li> <li>4. Check baseplate grouting for air pockets by sounding off baseplate with hammer.</li> <li>5. Check valves in suction piping to see if fully open. Check suction piping for entrapped air pockets, especially in elbows and high points. Check suction well for vertex and, if necessary, provide baffles. Check pressure in closed suction tank. Check suction temperature, viscosity and vapor pressure of pumped fluid.</li> </ol>

**Table 1. Pumping Unit Troubleshooting - (Contd)**

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	
Vibration or noise. - (Contd)	6. Pumped fluid contains solids creating shock load and clogging or damaging impeller.	6. Install strainer in suction piping. Back-flush pump with clean fluid or open pump to inspect and clean impeller.	
	7. Transient vibration from piping.	7. Support and secure piping or provide compensators.	
	8. Misalignment between driver and pump shafts.	8. Check coupling alignment according to paragraph F, section III.	
	9. Foreign matter in pump.	9. Disassemble pump; clean and replace damaged parts.	
	10. Damaged bearings.	10. Replace bearings.	
	11. Mechanical defects, such as worn ball bearings, bent shaft, or rotating element that binds.	11. Replace defective parts or replace pump or driver.	
	Bearing overheating.	1. Excessive oil.	1. Remove excess oil.
		2. Pipe strain.	2. Check piping alignment and remove piping weight from pump with proper supports.
		3. Incorrect type oil.	3. Refer to paragraph C, section VI, for proper maintenance of bearings.
		4. Contaminated oil.	4. Change oil according to paragraph C, section VI.
		5. Not enough oil.	5. Add oil according to paragraph C, section VI.
6. Bent shaft.		6. Replace shaft.	
7. Rotating element binds.		7. Replace defective parts.	

## **VI. MAINTENANCE AND REPAIR.**

Generally the pumps do not need continuous supervision. Occasional visual checks are recommended. Data should be recorded for each pump to keep track of maintenance which has been performed and to note operational problems. A maintenance record is provided for this purpose at the back of this manual.

**A. FIELD INSPECTION** (shutdown not required). Perform field inspection at regular intervals and cover the following procedures.

1. Check that pump is operating within design conditions.
2. Check power input and speed of driver.
3. Check pump for quiet running.
4. Check for adequate lubricating liquid flow to the mechanical seal or packing rings.
5. Check bearing temperature. Bearing temperatures up to 180 degrees F are normal depending on ambient temperature. Check temperatures by placing contact-type thermometer against bearing housing (99). A sudden temperature rise indicates damage that requires checking.

6. When equipped with an oiler (125) with a sight glass, check oil level and refill as required. Check condition of oil in bearing housing (99). Any irregular findings which cannot be adjusted during operation require pump shutdown.
7. When equipped with a bull's eye (143) sight glass, check oil level. Refill with oil if oil level is not in the middle of the sight glass.

**B. FIELD OR SHOP SERVICE** (shutdown required).

**Mechanical Seal.** If the pump is equipped with a mechanical seal (90) it should be checked, particularly during the first hours of operation. Minor leakage through the seal usually stops after a short time. If leakage continues, stop the pump and examine the seal. Excessive leakage usually indicates worn or broken parts requiring replacement. To replace a mechanical seal, the pump must be disassembled. For pump disassembly procedure see paragraph E, this section.

**Packing.** If the pump is equipped with packing rings (13) it will give trouble free service provided that the pump is carefully and correctly serviced and maintained. A pump with newly packed stuffing box will leak considerably after initial packing or repacking. If there is not a substantial reduction in leakage after the first two hours of

operation, the gland nuts should be tightened until leakage rate drops to a small steady stream. Gland nuts should only be tightened finger tight.

**NOTE**

If further reduction in leakage is necessary, packing gland nuts should be tightened in slow increments until the stuffing box temperature begins to rise. At this point, packing gland nuts should be loosened until stuffing box temperature stabilizes.

A newly packed stuffing box needs a certain running-in period before it stabilizes; therefore, a close observation at frequent intervals during running-in is important. After prolonged service or when packing has been compressed by approximately the width of one packing ring (13), packing should be renewed and the condition of the shaft sleeve (14) checked. If shaft sleeve shows signs of scoring, grooving, or surface roughness, it should be replaced. Worn, unsuitable or badly fitted packing can cause stuffing boxes to leak, as can a damaged shaft.

**C. BEARING MAINTENANCE.** Under normal conditions, oil in bearing housing (99) should be changed every 4000 hours. To change oil, remove pipe plug (420) at the bottom of the bearing housing (99). Drain bearing housing (99) completely and check waste oil for impurities which might require inspection of bearings and/or oil seals. (Impurities in oil, such as dirt and water, will substantially reduce bearing life.) When bearing housing (99) is completely drained of oil, replace pipe plug (420). Fill oiler (125) reservoir and allow it to fill bearing housing (99). It may take repeated fillings of reservoir to fill bearing housing (99). Refer to table 2 for recommended oil.

**Table 2. Recommended Oil Types for Bearing Lubrication**

MANUFACTURER	ISO GRADE 68	ISO GRADE 100
Royal Purple	Synfilm 68	Synfilm 100
Texaco	Regal R&O 68	Regal R&O 100
Phillips	Magnus 68	Magnus 100
Exxon	Teresstic 68	Teresstic 100
Mobil	DTE 16	DTE 18

**D. DISASSEMBLY PREPARATIONS.**

During disassembly, match mark parts so they can be fit exactly as before. After disassembly, all parts should be thoroughly cleaned or replaced with new ones if necessary. Sealing faces should be perfectly clean. It is recommended that all o-rings and gaskets be used only once. Follow these steps before disassembling the pump:

1. Read this entire section and review figure 2, Sectional Assembly drawing, before disassembling the pump.

**WARNING**

Before attempting to disassemble the pump, the motor electrical power supply must be locked and tagged in the OFF position to prevent injury to personnel servicing the pump.

2. Stop the pump according to paragraph E, section IV.

**CAUTION**

If pump is handling hazardous fluid, extreme care must be taken to insure safety of personnel when attempting to drain pump. Suitable protective devices should be used and/or protective clothing should be worn.

3. Drain casing by removing pipe plug (422). If necessary, flush pump to remove corrosive or toxic pumpage. Reinstall pipe plug (422) in casing (1) when fluid has completely drained.
4. Disconnect auxiliary piping, gauges and tubing.
5. Drain oil from bearing housing (99). When an oiler (125) with a sight glass or a bull's eye (143) sight glass provides lubrication for bearings, drain oil from the bearing housing by removing pipe plug (420) at the bottom of the bearing housing (99). If bearings are oil mist lubricated, drainage of bearing housing (99) is continuous.

**E. PUMP DISASSEMBLY.**

1. Remove coupling guard and disconnect coupling halves. Remove spacer sleeve between coupling halves.

**CAUTION**

Use of a hoist with adequate capacity is recommended when removing rotating element.

2. Remove hex nuts (616) and lockwashers (655) from studs (631) fastening casing (1) to frame adaptor (71). Remove bolts and lockwashers from pump bracket on foundation frame foot to base. Use capscrews (600) as jacking screws and loosen rabbet fit of frame adaptor (71) and backcover (11). Pull rotating element back from casing (1) and take it to a suitable work area.

**CAUTION**

If pump is furnished with a mechanical seal (90), release tension on mechanical seal (90) spring prior to removing impeller nut (24) to prevent personal injury or damage to impeller nut.

3. Release tension on mechanical seal (90) spring by loosening hex nuts (615) from studs (630) and backing seal gland (17) out on shaft (6).
4. Remove impeller nut (24). If equipped, remove impeller nut gasket (30). Pull impeller (2) from shaft (6). If equipped, remove impeller gasket (38). (Note number of gaskets removed. The same number of new gaskets must be installed when reassembling the pump.) Remove impeller key (32) from shaft (6).
5. Remove o-ring (89A) from backcover (11). Remove capscrews (600) and lockwashers (658) from backcover (11). Remove backcover (11) from frame adaptor (71). If equipped, wear ring (7B) will remain secured to the backcover (11) with setscrews (667).
6. If pump is equipped with a mechanical seal (90), loosen, but do not remove setscrews (668) from sleeve collar (68). Remove sleeve collar (68) from shaft (6). Loosen, but do not remove, setscrews (669) from shaft sleeve (14). Remove shaft sleeve (14) with rotating elements of mechanical seal (90) intact. Remove rotating elements of mechanical seal (90) from shaft sleeve (14). Remove shaft sleeve O-ring (89D) from shaft (6). Remove hex nuts (615) from studs (630). Remove seal gland (17) from shaft (6). Remove o-ring (89E) from seal gland (17). Remove stationary elements of mechanical seal (90) from seal gland (17).
7. If pump is equipped with a cartridge seal, consult seal manufacturer or a Carver Pump Company representative.
8. If pump is equipped with packing (13), loosen hex nuts (615) from studs (630) on packing gland (17A). Loosen, but do not remove, setscrews (669) from shaft sleeve (14). Remove shaft sleeve (14) with packing rings (13) and lantern ring (29) in tact. Remove one packing ring (13), lantern ring (29) and remaining three packing rings (13) from shaft sleeve (14). Remove o-ring (89D) from shaft (6). Remove hex nuts (615) from studs (630). Remove packing gland (17A) from shaft (6). Throat bushing (63) will remain in packing gland (17A). Remove slinger (40) from shaft (6).
9. Remove capscrews (601) and lockwashers (656) fastening frame adaptor (71) to bearing housing (99). Remove frame adaptor (71) and bearing isolator (47) from shaft (6). Remove gasket (73B) between frame adaptor (71) and bearing housing (99).

### **CAUTION**

Handle inboard bearing isolator (47) with care. Mishandling could damage faces of bearing isolator (47).

10. Remove bearing isolator (47) from frame adaptor (71). If equipped, remove inboard magnetic seal housing (311) from frame adaptor (71) only for replacement or inspection.
11. Remove pump coupling halves and coupling key (46).
12. Remove capscrews (603) fastening bearing cap (43) to bearing housing (99). Remove bearing cap (43) and bearing isolator (49) from shaft (6). Remove bearing o-ring (89C) from bearing housing (99).

### **CAUTION**

Handle outboard bearing isolator (49) with care. Mishandling could damage faces of bearing isolator (49).

13. Remove bearing isolator (49) from bearing cap (43). If equipped, remove outboard magnetic seal housing (310) from bearing cap (43) only for replacement or inspection.
14. Remove shaft (with radial and thrust bearing assemblies) from outboard end of bearing housing (99).
15. Uncrimp tang on bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69). Pull thrust bearing (18) from shaft (6). Pull radial bearing (16) from shaft (6).

### **F. PARTS INSPECTION.**

1. Inspect bearings (16) and (18) for damage and replace if necessary.
2. Inspect for bent shaft (6) and replace if necessary. Shaft threads should be in good condition. Bearing seat must be in perfect condition.
3. If the impeller (2) shows excessive wear due to abrasion or corrosion and performance cannot be restored, it must be replaced.
4. If the wear ring (7A) in the suction cover or optional wear ring (7B) in the backcover (11) indicate excessive wear due to abrasion or corrosion, it should be replaced. Measure the outside diameter of the front and back impeller hub in three places. Measure the inside diameter of each wear ring (7A) and (7B) with an inside micrometer in three places. If the difference between the high reading of inside diameter of each wear ring and low reading of outside diameter of front and back impeller hub exceeds double the maximum diametrical clearance given in table 3, replace the wear ring according to paragraph H, of this section.
5. Inspect mechanical seal faces, gaskets, o-rings and/or packing rings or magnetic seal faces. Replace if necessary.
6. Inspect equalizing tube or oil mist lines. Check to be sure there are no obstructions in lines.

**Table 3. Wear Ring Clearance**

ETA-L PUMP SIZE	DIAMETRICAL CLEARANCE	
	Minimum	Maximum
150-50	0.022	0.025
200-33	0.027	0.030
200-40	0.022	0.026
200-50	0.022	0.026
250-29	0.022	0.026
250-33	0.024	0.027
250-40	0.030	0.033
250-50	0.030	0.033
300-35 Suction Cover	0.030	0.034
300-35 Backcover	0.022	0.026

**G. PUMP REASSEMBLY.**

1. Press thrust bearings (18) on shaft (6) in a back-to-back position. Secure thrust bearing (18) with bearing lockwasher (69) and bearing locknut (22). Crimp tang of lockwasher (69) in groove provided in bearing locknut (22). Press radial bearing (16) on shaft (6).
2. Reinstall shaft (6) in bearing housing (99). Install new bearing o-ring (89C) in groove provided around outboard end of bearing housing (99). If removed, press outboard magnetic seal housing (310) into bearing cap (43). Reinstall bearing cap (43) on shaft (6), securing it to bearing housing (99) with capscrews (603).

**CAUTION**

Handle outboard bearing isolator (49) and inboard bearing isolator (47) with care. Mishandling could damage faces of bearing isolators.

3. Install outboard bearing isolator (49) in bearing cap (43). If removed, press inboard magnetic seal housing (311) in frame adaptor (71). Reinstall frame adaptor (71) on shaft (6). Secure frame adaptor (71) to bearing housing (99) with lockwashers (656) and capscrews (601). Reinstall inboard bearing isolator (47) in frame adaptor (71).
4. If pump is equipped with packing (13), install slinger (40) on shaft (6). Install o-ring (89D) in groove in shaft (6). Install shaft sleeve (14) on shaft (6) and secure with setscrews (669). Install three packing rings (13), lantern ring (29), and remaining packing ring (13) into stuffing box backcover (11). Make sure throat bushing (63) has remained in packing gland (17A). Install packing gland (17A). Start packing hex nuts (615) on studs (630).

5. If pump is equipped with a mechanical seal (90), install o-ring (89D) in groove in shaft (6). Install shaft sleeve (14) and secure with setscrews (669). Install stationary elements of mechanical seal (90) in seal gland (17). Install o-ring (89E) on seal gland (17). Install seal gland (17) and secure hex nuts (615) finger tight only on studs (630). Install rotating elements of mechanical seal (90) on shaft sleeve (14). Install sleeve collar (68) on shaft (6) and secure with setscrews (668).
6. Install o-ring (89A) on backcover (11). Install backcover (11) and secure to frame adaptor (71) with lockwashers (658) and capscrews (600).
7. Reinstall impeller key (32) in keyway on shaft (6). If removed, install new impeller nut gasket (30) and impeller gasket (38). Install same number of gaskets as removed during disassembly. Reinstall impeller (2) on shaft (6). Secure impeller (2) with new impeller nut (24).
8. Install rotating element in casing (1). Back out jacking capscrews (610) and (600). Secure frame adaptor (71) to casing (1) or backcover (11) with hex nuts (616) and lockwashers (655) on studs (631).
9. Rotate shaft (6) by hand to insure shaft (6) rotates freely and no rubbing noises are present.
10. Align coupling according to paragraph F, section III. Reinstall coupling and coupling guard.
11. Connect all tubing, gauges and auxiliary piping. Remove all tags from valves and switches.
12. Start pumping unit according to paragraph C, section IV.

**H. WEAR RING REPLACEMENT.**

The pump has a replaceable wear ring (7A) inserted between the suction cover (9) and casing (1). An optional replaceable wear ring (7B) can be inserted between the casing (1) and backcover (11). The clearance between the wear ring and front and back impeller hub will increase with wear. Internal leakage will result and pump performance will decrease. The allowable clearance and method of measurement is described in paragraph F, this section.

**Suction Cover Wear Ring.** The suction cover (9) must be removed from the casing (1) to replace the wear ring (7A). To replace the wear ring (7A) follow these steps:

1. Disconnect suction piping. Remove hex nuts (616), lockwashers (655) and studs (631) fastening suction cover (9) to casing (1). Remove suction cover (9). Remove casing gasket (73A) from casing (1). Take suction cover (9), impeller (2), and new wear ring (7A) to a work area with access to machine shop equipment.
2. Remove setscrews (667) from wear ring (7A). Remove the wear ring (7A) from suction cover (9). Inspect the front impeller hub for damage.

3. Press the new wear ring (7A) into suction cover (9). The beveled edge of the wear ring (7A) is installed away from the impeller (2).
4. Drill and tap two holes 180 degrees apart along edge of wear ring (7A). Secure new wear ring (7A) to suction cover (9) by inserting setscrews (667) into these holes.
5. Place impeller (2) on an arbor and mount between centers in a lathe or a grinder. Indicate back of impeller hub to within 0.002 TIR maximum to be sure the arbor and impeller are running square.
6. Turn the wear ring surface of impeller (2) until a 63 RMS or better finish is obtained.
7. Measure the outside diameter of the front impeller (2) hub and record this value. Refer to measurement instructions in paragraph F, this section.
8. Mount the suction cover (9) with new wear ring (7A) installed in a lathe. Indicate male rabbet to within 0.002 TIR maximum.
9. Bore wear ring (7A) to within the specified tolerance listed in table 3 over the recorded size of the outside diameter of the front impeller hub.
10. Install new gasket (73A) in suction cover (9). Reinstall suction cover (9) with bolts (631), lockwashers (655) and hex nuts (616). Reconnect suction piping.

**Optional Backcover Wear Ring.** The backcover (11) must be removed from the casing (1) to replace the optional wear ring (7B). To replace the wear ring (7B) follow these steps:

1. Disconnect suction and discharge piping. Disassemble pump according to paragraph E, section VI, steps 1 through 5. Take backcover (11), impeller (2), and new wear ring (7B) to a work area with access to machine shop equipment.
2. Remove setscrews (667) from wear ring (7B). Remove the wear ring (7B) from backcover (11). Inspect the back impeller (2) hub for damage.
3. Press the new wear ring (7B) into backcover (11). The beveled edge of the wear ring (7B) is installed away from the impeller (2).
4. Drill and tap two holes 180 degrees apart along edge of wear ring (7B). Secure new wear ring (7B) to backcover (11) by inserting setscrews (667) into these holes.
5. Place impeller (2) on an arbor and mount between centers in a lathe or a grinder. Indicate back of impeller hub to within 0.002 TIR maximum to be sure the arbor and impeller are running square.
6. Turn the wear ring surface of impeller (2) until a 63 RMS or better finish is obtained.
7. Measure the outside diameter of the back impeller (2) hub and record this value. Refer to measurement instructions in paragraph F, this section.

8. Mount the backcover (11) with new wear ring (7B) installed in a lathe. Indicate male rabbet to within 0.002 TIR maximum.
9. Bore wear ring (7B) to within the specified tolerance listed in table 3 over the recorded size of the outside diameter of the back impeller (2) hub.
10. Reassembly pump according to paragraph G, this section, steps 6 through 12. Reconnect suction and discharge piping.

**I. TORQUE VALUES.** Refer to table 4 for recommended torque values.

**Table 4. Recommended Torque Values (80% of max. spec. values for low carbon steels)**

TORQUE (FOOT-POUNDS)	FASTENER SIZE
30	1/2 - 13 UNC
65	5/8 - 11 UNC

**J. PARTS INVENTORY GUIDE.** To avoid unnecessary delays for maintenance, spare parts should be on hand for normal service. Most conditions may be covered if this guide is followed. For every one to three pumps, stock one spare parts set consisting of items listed in table 5. Part numbers listed in table 5 correspond to part numbers on figure 2.

**Table 5. Recommended Spare Parts**

ITEM NO.	QUANTITY	DESCRIPTION
2	1	Impeller
6	1	Shaft
7A	1	Wear Ring, Suction Cover
7B	1	Wear Ring, Backcover
13	4	Packing Ring
16	1	Radial Bearing
18	2	Thrust Bearing
22	1	Bearing Locknut
24	1	Impeller Nut
29	1	Lantern Ring
63	1	Throat Bushing
73A	1	Gasket, Casing
73B	1	Gasket, Adaptor/Frame
89A	1	O-Ring, Backcover
89C	1	O-Ring, Bearing Cap
89D	1	O-Ring, Shaft Sleeve
89E	1	O-Ring, Seal Gland
90	1	Mechanical Seal
667	A/R	Setscrew, Wear Ring
668	A/R	Setscrew, Sleeve Collar
669	A/R	Setscrew, Shaft Sleeve

A/R - As Required

**K. PARTS ORDERING.** When ordering replacement parts, please specify:

1. Serial number of pump (located on nameplate).
2. Part name (located on parts list).
3. Quantity of parts needed.
4. Part material.

Carver Pump Company may ship an interchangeable part that is not identical in appearance or symbol. This is done only if the part has been improved. Examine parts carefully upon delivery before questioning factory or representative. Never return parts to the factory without authorization from Carver Pump Company.

If an impeller is ordered, specify diameter across blade tips. Be sure diameter was not trimmed further than diameter shown on Carver Pump Company records.

If a motor or motor parts are ordered, specify name of manufacturer and all other data on driver nameplate.

## **VII. TECHNICAL DATA.**

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Net positive suction head (NPSH). Any liquid, hot or cold, must be pushed into the impeller of the pump by some absolute pressure, such as the atmosphere or the vessel pressure from which the pump takes its action.

The head in feet of liquid necessary to maintain the required flow into the pump is called the Net Positive Suction Head (NPSH). This value is measured above the vapor pressure of the liquid at the pumping temperature.

NPSH is commonly expressed in two ways: the NPSH required by the pump, and shown on the pump curve, is the head needed to cover the losses in the pump suction and the energy required to enable the liquid to climb onboard the leading edge of the impeller vane. The NPSH available is that inherent in the system, taking into account friction losses in suction piping, valves, fittings, etc.

In all cases, the NPSH available, measured above vapor pressure, must exceed the NPSH required in order to push the liquid into the pump.

**Changing Pump Speed.** Changing the speed of a centrifugal pump affects the capacity, total head, NPSH required and the brake horsepower. In general the capacity will vary in a direct ratio with the speed, whereas the total head and NPSH required will vary as the ratio of the speed squared. The brake horsepower will vary as the ratio of the speed cubed.

**Effects of Viscosity.** The pump is designed to deliver rated capacity at rated head for a liquid with a particular viscosity. When pump is handling heavy viscous liquid, the viscosity of the liquid must allow it to be pumped easily. The liquid may have to be heated prior to starting the pump.

When contemplating operation at some viscosity other than that for which the pump was originally designed, check with Carver Pump Company.

**Effects of Specific Gravity.** The capacity and total head in feet of liquid developed by a centrifugal pump are fixed for every point on the curve and are always the same for the same speed. Neither capacity nor total head will be affected by a change in the specific gravity of the liquid pumped. However, since the discharge pressure in psi (pounds per square inch) and the brake horsepower required to drive the pump are functions of the specific gravity of the liquid, both will be affected in direct proportion by any change in specific gravity. Therefore, an increase in specific gravity will raise the discharge pressure and is dangerous, as it might overload the pump's driver, or exceed the pump casing allowable pressure.

## **VIII. PARTS LIST AND DRAWING.**

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Refer to table 6 for the parts list of the ETA-L pump. Refer to sectional drawing, figure 2, for location of parts.

**Table 6. ETA-L Pump Parts List**  
**See Figure 2. Sectional Assembly Drawing**

ITEM NO.	QTY.	DESCRIPTION	ITEM NO.	QTY.	DESCRIPTION
1	1	Casing	89C	1	O-ring, Bearing Cap
2	1	Impeller	89D	1	O-ring, Shaft Sleeve
6	1	Shaft	89E	1	O-ring, Seal Gland
7A	1	Wear Ring, Suction Cover	90	1	Mechanical Seal (Seal Unit Only)
7B	1	Wear Ring, Backcover	99	1	Bearing Housing
9	1	Suction Cover	125**	1	Oiler
11*	1	Backcover	143	1	Bull's Eye
13	4	Packing Ring (Packing Unit Only)	310**	1	Outboard Magnetic Seal Housing
14*	1	Shaft Sleeve	311**	1	Inboard Magnetic Seal Housing
16	1	Radial Bearing	400	A/R	Tubing, Recirc
17	1	Seal Gland (Seal Unit Only)	404**	1	Equalizing Tube, Oiler
17A	1	Packing Gland (Packing Unit Only)	410	2	Tube Fitting
17B	1	Gland Insert (Packing Unit Only)	420	1	Plug, Bearing Frame Drain
18	2	Thrust Bearing	421	2	Plug, Adaptor, Bearing Cap
22	1	Bearing Locknut	422	1	Pipe Plug, Casing Drain
24	1	Impeller Nut	423	1	Pipe Plug, Casing Discharge
29	1	Lantern Ring (Packing Unit Only)	436	1	Pipe Plug, Frame Side
30**	1	Impeller Nut Gasket	600	A/R	Capscrew, Backcover/Adaptor
32	1	Impeller Key	601	A/R	Capscrew, Adaptor/Frame
38**	1	Impeller Gasket	602	A/R	Capscrew, Frame Foot
40**	1	Slinger (Packing Unit Only)	603	A/R	Capscrew, Bearing Cap
43	1	Bearing Cap	610	A/R	Capscrew (Forcing Bolt), Adaptor
45**	1	Diaphragm Expansion Chamber, Oiler	615*	A/R	Hex Nut, Seal Gland or Packing Gland
46	1	Coupling Key	616	A/R	Hex Nut, Casing/Adaptor
47	1	Bearing Isolator, Inboard	630*	A/R	Stud, Seal Gland or Packing Gland
49	1	Bearing Isolator, Outboard	631	A/R	Stud, Casing/Adaptor
53	1	Frame Foot	655	A/R	Lockwasher, Casing/Adaptor
63	1	Throat Bushing (Packing Unit Only)	656**	A/R	Lockwasher, Adaptor/Frame
68	1	Sleeve Collar (Seal Unit Only)	657	A/R	Lockwasher, Frame Foot
69	A/R	Bearing Lockwasher	658	A/R	Lockwasher, Adaptor/Backcover
71	1	Frame Adaptor	667	A/R	Setscrew, Wear Ring
73A	1	Gasket, Casing	668	A/R	Setscrew, Sleeve Collar (Seal Unit Only)
73B	1	Gasket, Adaptor/Frame	669	A/R	Setscrew, Shaft Sleeve
89A	1	O-ring, Backcover			

\* When ordering replacement parts specify for seal or packing unit.

\*\* Not shown on figure 2.

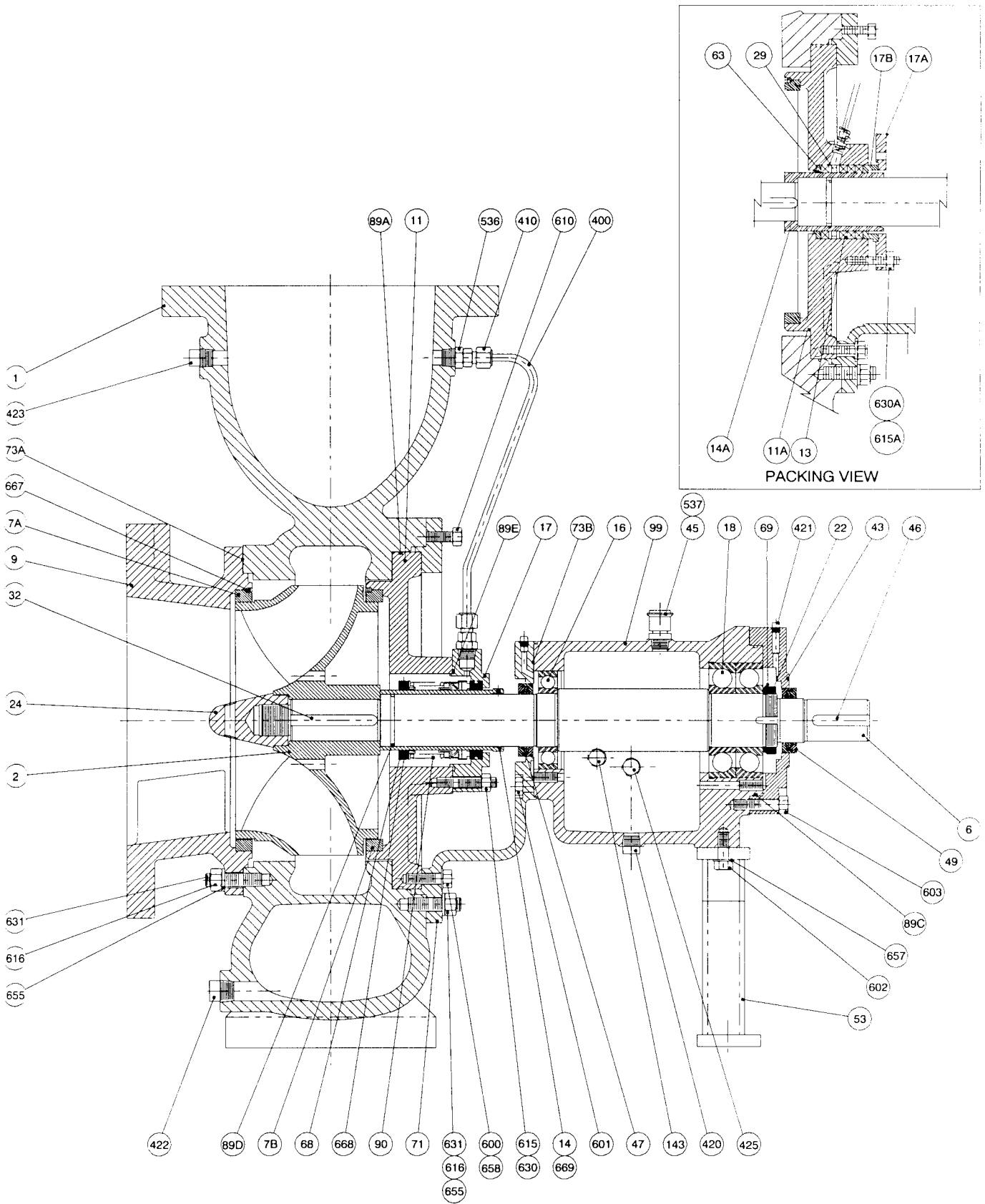


Figure 2. Sectional Assembly Drawing

## IX. Pump Service Record

Serial No. \_\_\_\_\_ Size and Type \_\_\_\_\_ Make \_\_\_\_\_

Cust. Order No. \_\_\_\_\_ Date Installed \_\_\_\_\_

Install. Date	Location	Application

### PUMP RATING

Capacity (GPM) \_\_\_\_\_ Total Head (ft) \_\_\_\_\_

Suction Pressure \_\_\_\_\_ Speed (RPM) \_\_\_\_\_

Liquid \_\_\_\_\_ Temperature \_\_\_\_\_

Specific Gravity \_\_\_\_\_ Viscosity \_\_\_\_\_

Impeller Diameter (inches) \_\_\_\_\_

### PUMP MATERIALS

Casing \_\_\_\_\_ Backcover \_\_\_\_\_ Frame Adaptor \_\_\_\_\_

Bearing Housing \_\_\_\_\_ Shaft \_\_\_\_\_ Impeller \_\_\_\_\_

Impeller Nut \_\_\_\_\_ Wear Ring(s) \_\_\_\_\_ Base \_\_\_\_\_

### MOTOR DATA

Motor \_\_\_\_\_ Make \_\_\_\_\_ Serial No. \_\_\_\_\_

Type \_\_\_\_\_ Frame \_\_\_\_\_ AC or DC \_\_\_\_\_

Volts \_\_\_\_\_ Phase \_\_\_\_\_ Cycles \_\_\_\_\_

HP \_\_\_\_\_ RPM \_\_\_\_\_







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