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Creating Value.

Instruction I-220

INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS FOR MODEL WKM HIGH PRESSURE MULTIPLE STAGE CENTRIFUGAL PUMPS

ISO 9001 CERTIFIED

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I. GENERAL INFORMATION.

A. Preface.

Carver Pump Company products are carefully engineered and manufactured, if properly installed, maintained, and operated, they should provide maintenance free operation and a long service life.

This manual is designed to provide sufficient material to properly maintain the WKM pump. The information as presented should improve your knowledge and understanding of the WKM pump, thus upgrading the quality of pump maintenance and care. Follow instructions in this manual carefully. Factory warranty applies only when pump operates under conditions as specified on our order acknowledgment and if pump is properly installed and maintained as recommended herein. A copy of these instructions should be available to operating personnel.

Variations exist in both the equipment used with these pumps and in particular 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.

B. Pump Identification.

Use the following example for identifying information about your pump model number from the 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.

C. Safety Precautions.

This manual contains descriptions and instructions for installation, operation, and maintenance of your WKM 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.

D. Equipment Description.

Refer to figure 8, 9, 10, 11, 12, or 13 as applicable. WKM high pressure pumps are multi-stage centrifugal pumps with vertically split casings. WKM pumps consist of the following models WKM-50, WKM-65, and WKM-80. The models available as mechanical seal pumps and packing pumps. The models are available in standard design and high temperature design for pumps operating between 220 to 285 degrees F.

The casing consists of suction and discharge casings (203 and 197), plus a number of interstage casings (1), all secured with tie bolts (173). Diffusers (5A and 5B) are inserted in individual stage casings (1).

Individual stage casings (1) are sealed by o-rings (89D). Suction and stage casings (203 and 1) are provided with wear rings (7A and 7B) which can be replaced if, after prolonged operation, wear has become excessive. Standard design, the bearing housing (99) is attached to the suction casing (203) by bolts (600). High temperature design, the bearing housing (99) and cooling jacket (215) are attached to the suction casing (203) by studs (632) and nuts (618).

The pump shaft (6) is protected against corrosion from fluid pumped and wear from rotating parts by interstage sleeves, sleeve spacers, and shaft sleeves. Impellers (2A and 2B) are secured on pump shaft (6) by keys (part numbers 32A and 32C on WKM-50 and WKM-65, 32A on WKM-80); all impellers (2A and 2B) face the same direction on the shaft (6).

The Timken two-row tapered roller bearing (16), type TDO, contains a double cup with two single cones and a cone spacer. The heat generated by the tapered roller bearing's surface contact necessitates cooling of the oil. On standard design pumps operating at temperatures below 85 degrees F, fluid pumped if used as coolant. Coolant to the bearing is supplied from an outside source on standard design pumps operating at temperatures above 85 degrees F and on high temperature design pumps.

WKM high pressure pumps incorporate special design refinements which help to absorb the appreciable axial thrust generated by their high head operation. Residual axial thrust is absorbed by the tapered roller bearing.

Mechanical seal pumps, the mechanical seal stops leakage along the shaft at the suction casing's stuffing box. Standard mechanical seals include John Crane Type 1 and Pac-Seal Type 21.

Packing pumps, the packing rings control leakage along the shaft at the suction casing's stuffing box.

High Temperature Design Pumps. Refer to figure 8 or 9. If pumped fluid is at operating temperatures between 220 to 285 degrees F, pumps of high temperature construction are used. These are provided with cooling jackets (215). Cooling jacket (215) separates suction casing (203) and bearing housing (99). Cooling water flows through cavities of cooling jacket (215) and keeps temperature at the stuffing box within acceptable limits.

Cooling lines are equipped with dual heat exchangers to reduce temperature of hot fluid pumped, pumped fluid may serve to cool the bearing and seal or stuffing box. Refer to figure 1 for an internal view and flow pattern of the heat exchanger.

NOTE

Even when using clean, fresh water as coolant, a periodic cleaning of cooling water cavities is recommended. Sediment and lime deposits seriously affect rate of heat transfer and will impair effective cooling.

Cooling water should flow freely and visibly so that its temperature and flow rate can be checked periodically. Temperature differential between cooling water inlet and outlet should not exceed 18 degrees F. The cooling water supply lines should be provided with valves to enable flow adjustment as required and shut-off when cooling water cavities are to be cleaned or when the pump is shut down.

E. Method of Operation.

Pumped fluid enters suction casing (203) and passes into first stage impeller (2A), which propels fluid into first stage diffuser (5A). The fluid then flows into the next impeller (2B). This process is repeated from one stage to the next, and at each stage fluid pressure increases by the same increment (this is termed "stage head"). After leaving final stage diffuser (5B), fluid enters discharge casing (197) and passes into discharge piping.

F. Handling.

CAUTION

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

Complete pump set must be handled with care. Do not pass lifting slings through eye bolt on motor. Pump is shipped with flange covers to protect flange faces and to prevent foreign matter from entering pump. Flange covers should remain intact until suction and discharge piping are connected to pump flanges.

G. Inspection.

Upon receipt of the shipment, unpack, and inspect the pumping unit, 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.

H. Factory Repair.

CAUTION

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

If pump is sent back to Carver Pump Company factory for repair, it must be drained and all flanges and connections covered or plugged. Ship pumps in assembled condition to prevent damage to sealing faces of individual components.

II. INSTALLATION.

A. Foundation and Mounting.

CAUTION

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

The foundation must be rigid and set on firm underground to absorb vibration and forces and moments without yielding. Ensure that concrete foundation has set hard before mounting pump set (pump and driver with baseplate). Surface of foundation must be horizontal and perfectly even.

If anchor bolts have not been preset in foundation, mark location of bolt holes in baseplate on foundation and drill appropriate holes. Suspend anchor bolts from baseplate. Place and thoroughly level baseplate on foundation by using shims or metal wedges. Shims must be fitted in close proximity to left and right of foundation bolts. If spacing between adjoining holes exceeds 30 inches, shims should be fitted halfway between holes. All shims must lie perfectly flush.

B. Coupling Alignment.

A pump or any rotating equipment will not be aligned after transport and installation, regardless of pre-alignment at factory. Pumping unit must be realigned before

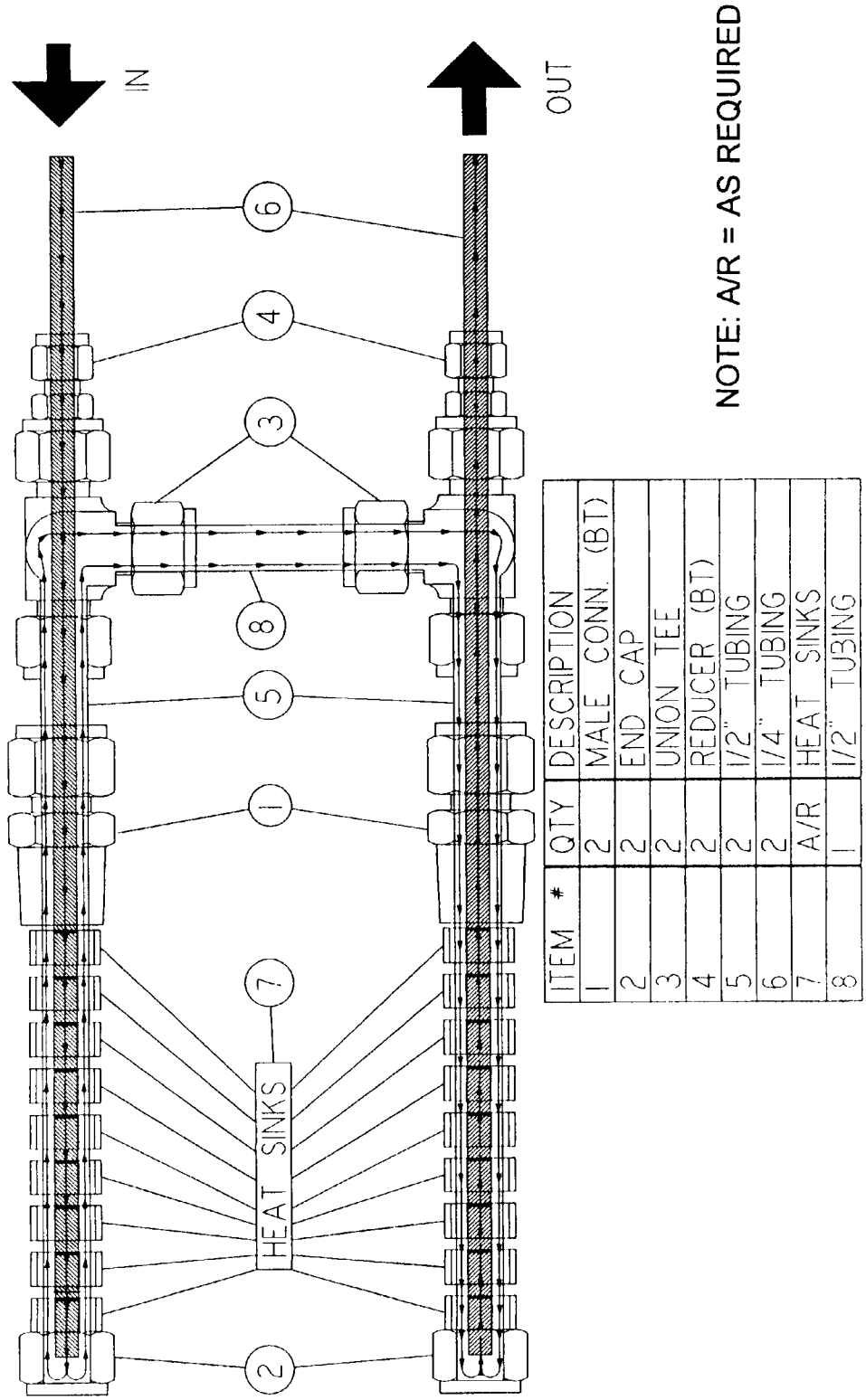


Figure 1. Internal View and Flow Pattern of Heat Exchanger

and after grouting of baseplate and connection of suction and discharge piping. Before attempting any work on pump set, refer to safety precautions set forth in section I, paragraph C. Align pump and driver as follows:

1. Remove coupling guard.
2. Remove nuts and lockwashers from motor hold down bolts. Reinstall nuts only and finger tighten.
3. Disconnect coupling halves by removing flexible component from coupling.
4. Connect wiring to driver.
5. 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.
6. Tag out and lock power to driver according to OSHA Standard 1910.147.
7. Axial alignment of coupling is checked with a straight edge across both coupling halves, refer to figure 2. Measure distance A or B between straight edge and both shafts. Repeat measuring at two locations, 120 degrees apart, on periphery of coupling. The difference between three measurements for A and for B must not exceed 0.005 inch at any of the three positions.

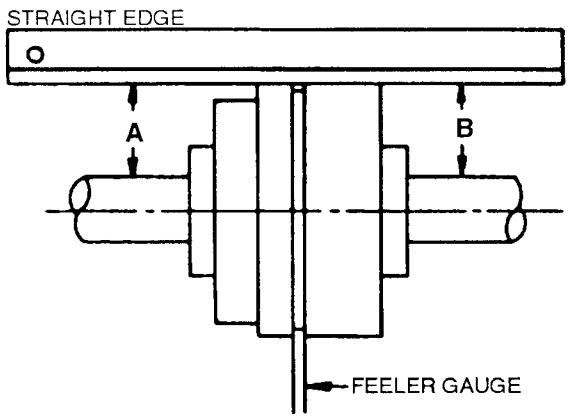


Figure 2. Coupling Alignment

8. Angular alignment of coupling is checked with a feeler gauge, refer to figure 2. Measure distance between faces of both coupling halves, near their outside, on four locations spaced 90 degrees apart. The four measurements must be within + /- 0.005 inch tolerance. The same tolerance applies if a dial indicator is used to check angular alignment. Fix dial indicator to one coupling half and take readings while other coupling half is rotated 360 degrees.
9. If coupling halves are misaligned, make adjustments on the driver end of the pumping unit. Make necessary adjustments by tapping motor housing with rawhide or wood mallet and shimming.
10. Repeat steps 7 through 9 until proper alignment is achieved.
11. Reinstall lockwashers and tighten nuts on motor hold down bolts.
12. Reconnect coupling by reinstalling the flexible component on coupling. Reinstall coupling guard.

C. 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 3 and follow the following procedure:

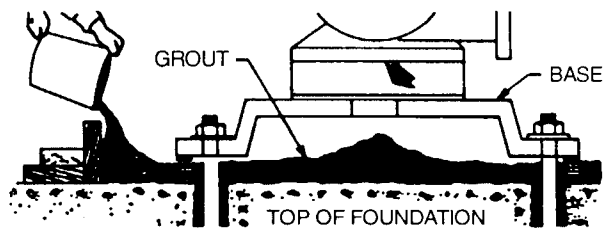


Figure 3. Grouting Baseplate

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 also the shims or wedges under the baseplate, if desired. 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 according to section II, paragraph B.

D. Piping Installation.

All piping must be arranged and, if necessary, supported so that no undue stress from piping weight is placed upon pump. Do not force piping. Never use pump as an anchorage point for the piping.

CAUTION

Extreme care should be taken when connecting new piping to see that no foreign matter such as dirt, slag, chips, tools, etc., are in piping as this debris will be drawn into pump and cause excessive damage. During initial installation and testing, a strainer should be installed in suction piping to keep debris from entering pump.

Suction lift lines should be laid with a rising slope toward pump and positive suction head lines should be laid with a downward slope toward pump to avoid air pocket formation. Suction piping must be at least the same size as pump suction nozzle. Compensation for heat elongation must be provided where required.

The coupling alignment must be rechecked as outlined in section II, paragraph B after installation of piping. Realign coupling if required by adjusting driver end.

E. Auxiliary Connections.

Connect any auxiliary connections and gauges. Refer to figure 4 for WKM piping plans.

III. OPERATION.

A. Prestart Cautions.

Before starting or operating the pump, read this entire manual, especially the following instructions.

1. Fill pump with water that is at operating temperature. When the temperature stabilizes, recheck coupling alignment according to section II, paragraph B. Drain pump.
2. Lubrication of bearing.

CAUTION

The Timken type TDO bearing (16) on WKM pumps is very sensitive to inadequate lubrication. Oil in bearing housing (99) must be kept at proper level at all times. Operation of the unit without proper lubrication can result in overheating of the bearing, bearing failure, pump seizures and actual breakup of the equipment, exposing operating personnel to injury.

Pumps are shipped with the bearing housings empty of oil. ISO Grade 68 or 100 oil is recommended for proper lubrication of the pump. See table 10A for recommended oil types.

a. To add oil to bearing housing: Add oil through top port of bearing housing (99) until oil is sighted through view port (143). Continue to add oil through oiler (125) to bearing housing (99) until oiler (125) stabilizes (bubbling stops). Refer to figure 5 for illustration of oiler (125). Inspect oiler (125) on a daily basis to check oil level in bearing housing (99). For further details on lubricating the bearings, refer to section V, paragraph A.

b. To drain old oil from bearing housing: Remove pipe plugs (426) at bottom of inboard bearing cover (35) and bearing housing (99).

3. Observe all caution or danger tags attached to the equipment.
4. Install closed guards around all exposed rotating parts.
5. Rotate shaft by hand to assure all moving parts are free.
6. On packing pumps, check that the nuts securing packing gland are finger tightened only.
7. 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.
8. Before starting the pump, check for proper priming.
9. Check direction of driver rotation by connecting electrical power supply to motor and "jogging" motor. Direction of rotation should be clockwise when viewed from driver end toward pump.

B. Start Up.

Follow the following procedure to start the pump:

WARNING

Do not operate pump unit against a closed discharge system. If discharge valve is closed and flow of liquid at discharge end is reduced to zero, power absorbed at pump shaft will not drop to zero, but will remain quite appreciable. This will result in heating of liquid trapped inside pump. If pump has any chance of operation against a closed system, a bypass system allowing a minimum of 10% of best efficiency point (BEP) flow should be installed. Continuous minimum flow should be 25% of BEP or higher. See table 1 for minimum flow rates.

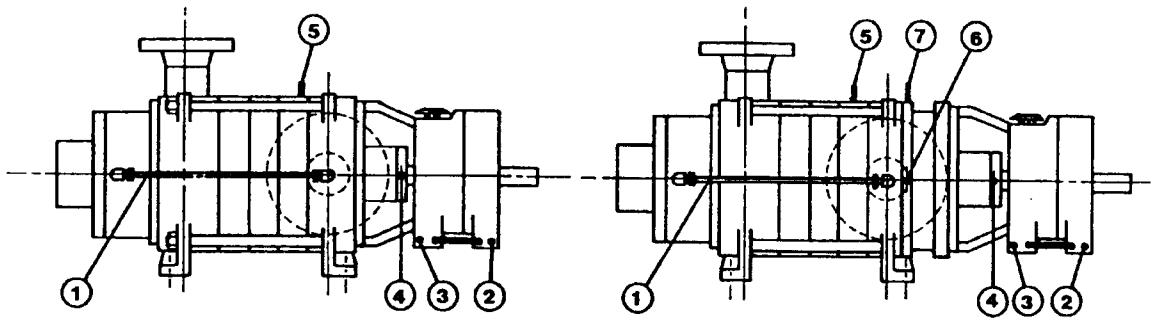
Table 1. Minimum Flow Rates

Pump Model	Speed	Minimum Flow
WKM-50	1750 RPM	10 GPM
WKM-50	3500 RPM	20 GPM
WKM-65	1750 RPM	20 GPM
WKM-65	3500 RPM	35 GPM
WKM-80	1750 RPM	35 GPM
WKM-80	3500 RPM	65 GPM

NOTE

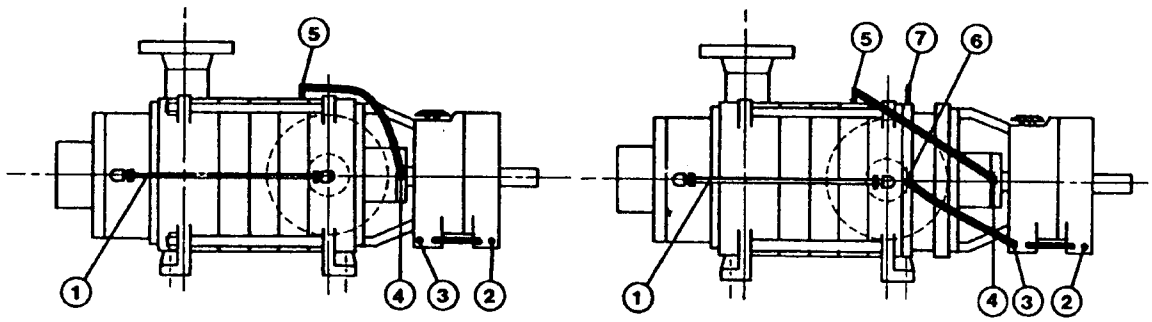
For operating temperatures in excess of 212 degrees F, increase flow rates by 25%.

WKM PIPING PLAN NO. 1



COLD DESIGN HOT DESIGN

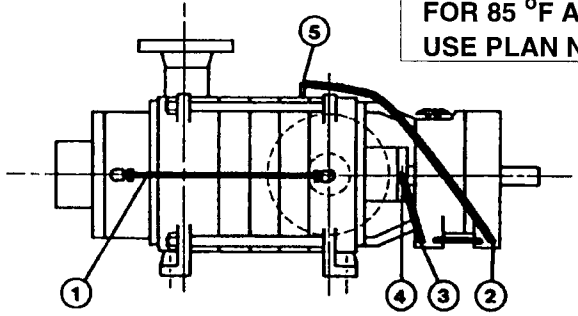
WKM PIPING PLAN NO. 2



COLD DESIGN HOT DESIGN

WKM PIPING PLAN NO. 3

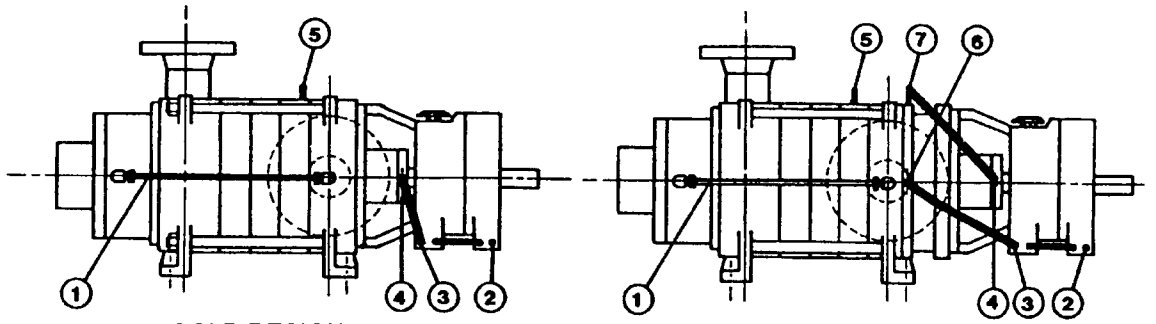
FOR 85 °F AND COOLER ONLY, >85 °F USE PLAN NO. 2.



NOT APPLICABLE

COLD DESIGN HOT DESIGN

WKM PIPING PLAN NO. 4



COLD DESIGN HOT DESIGN

1 - BALANCE LINE **3** - BEARING COOLING OUT **5** - FIRST STAGE **7** - SEAL COOLING OUT
2 - BEARING COOLING IN **4** - FLUSH GLAND **6** - SEAL COOLING IN

Figure 4. WKM Piping Plans

CAPACITY: 4 oz.

PIPE THREAD CONN.: 1/4

DIMENSIONS:

A: 2-5/16
B MIN.: 4-3/8
B MAX.: 4-7/8
C MIN.: 7/32
C MAX.: 23/32

ALL DIMENSIONS
IN INCHES

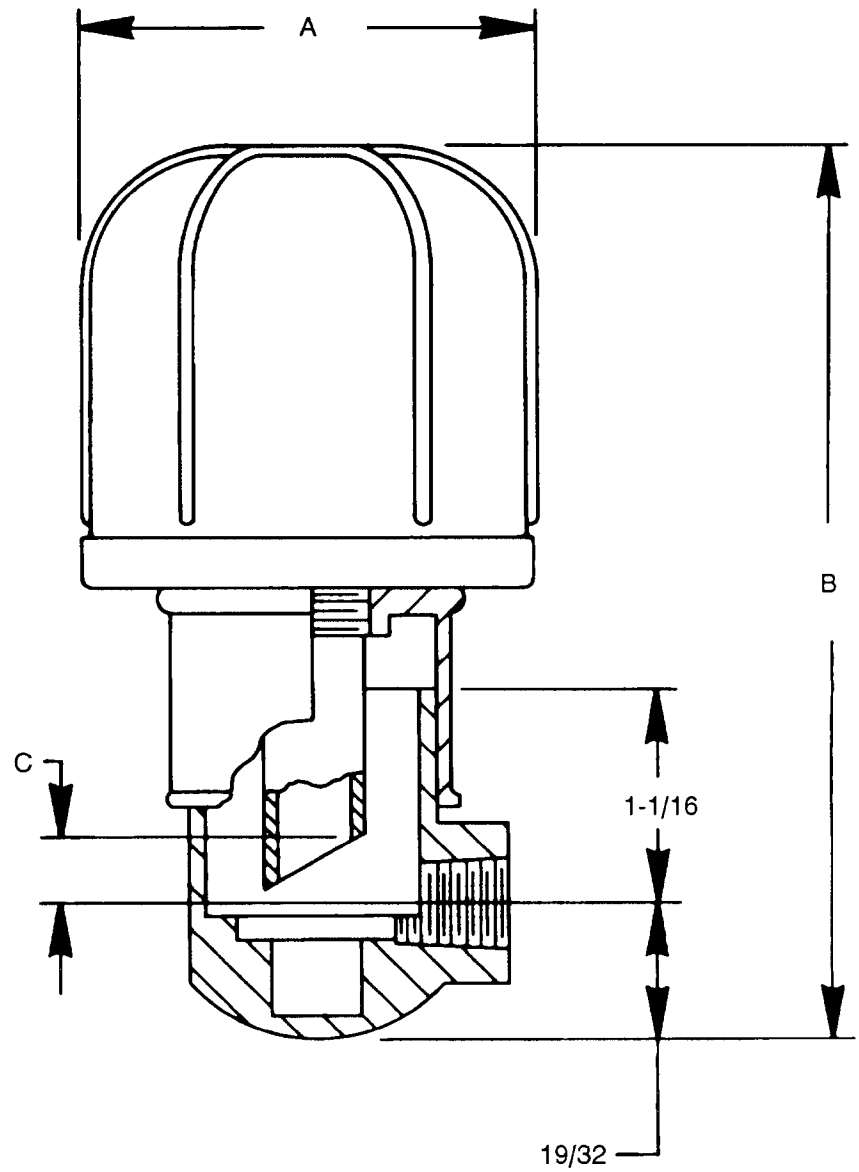


Figure 5. Trico Type E Oiler, Catalog Number 30054

1. Open suction valve and fill pump completely with fluid.
2. Open discharge valve to allow a minimum of 10% design flow according to table 1.
3. Open valves to auxiliary connections, if applicable.
4. For high temperature design pumps, turn on cooling water to bearing and stuffing box and check to make sure it is flowing freely.

NOTE

If standard design is used and liquid pumped is over 85 degrees F, cooling water flow requirement to bearing is 1 GPM.

5. If standard design is used and liquid pumped is over 85 degrees F, turn on cooling water to bearings and check to make sure it is flowing freely.
6. Refer to table 2 for cooling water flow requirements for bearing and stuffing box on high temperature design pumps.
7. Start pumping unit.
8. Open discharge valve as required to establish system flow and pressure.
9. It is recommended that the following checks be made and recorded:
   a. Vibration on motor bearings should not exceed 1 mil displacement at 3500 RPM and 2 mils displacement at 1750 RPM.
   b. Vibration on pump bearing should not exceed 1 mil displacement at 3500 RPM and 2 mils displacement at 1750 RPM.
   c. Check motor horsepower (amps and kilowatts). Check all three leads on motor. If amperes vary more than 2%, electrical supply should be checked to prevent damage to motor.
   d. Make sure pump discharge pressure at prescribed operating speed never drops below 90% of design point pressure.
   e. Check pressure/vacuum at suction.
   f. Mechanical seal pumps, check mechanical seal for leakage. Minor leakage usually stops after a short time. If leakage is more than five drops per minute schedule preventative maintenance repair.
   g. Packing pumps, check stuffing box area for leakage. Leakage should be a steady drip. Refer to section V, paragraph B to adjust leakage.
10. The following is recommended after initial run-in and checks:
    a. Stop unit.
    b. Drain system.
    c. Remove strainer from suction piping and any debris found.
    d. Check all hold down bolts and piping connections.
    e. Check coupling alignment as outlined in section II, paragraph B.

C. Stopping the Pump.

1. Begin to partially close discharge valve.
2. Tag out and lock power to driver according to OSHA Standard 1910.147.
3. Completely close discharge and suction valves.
4. If applicable, shut off cooling water.
5. Refer to section V, paragraph D for protective measures to follow if pump is to be shut down for an extended period of time.

D. Operating Checks.

The pump should always run quietly and smoothly, without vibration. To ensure such operation, the following supervision should be carried out at regular intervals during operation of the pump:

Daily:
1. Visually inspect unit.
2. Inspect oiler to check oil level in bearing housing.
3. Check bearing temperatures. Bearing temperatures should not exceed 220 degrees F.
4. Mechanical seal pumps, check for leakage through mechanical seal. If leakage exceeds five drops per minute, schedule preventative maintenance repair.
5. Packing pumps, check stuffing box area for leakage. Leakage should be a steady drip. Refer to section V, paragraph B to adjust leakage.

Weekly:
1. Check horsepower readings.
2. Check vibration.

Monthly:
1. Grease coupling (if applicable). Do not over grease.
2. Check coupling alignment according to section II, paragraph B.

Table 2. High Temperature Cooling Water Flow Rates
(For operating temperatures over 220 degrees F, based on water temperatures of 70 degrees F.)

Pump Model	Flow Rate
WKM-50	2 GPM
WKM-65	3 GPM
WKM-80	4 GPM

3. Check foundation bolts.

IV. TROUBLESHOOTING.

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 refer to table 3 to eliminate the common causes of those problems.

Table 3. Troubleshooting Guide

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump does not deliver rated capacity.	1. Excessive pressure in discharge line.	1. Check GPM and head against design conditions; pump may be too small. Consult your local Carver Pump Company office.
	2. Incomplete priming or venting of pump or piping.	2. Prime pump and piping again and vent them.
	3. Suction line or an impeller is clogged.	3. Clean out suction strainer; if necessary dismantle pump and clean impeller.
	4. Positive suction head is too low (on pumps operating with positive suction head).	4. Check liquid level. Check that valves in suction line are fully open, if necessary lock them open to prevent accidental closure. Check that suction line is correctly designed and laid. There should be no features which might cause excessive pressure drop. Clean out line strainers.
	5. Excessive suction lift (on pumps operating on suction lift).	5. Check liquid level and make sure that foot valve is fully open. Clean out if necessary.
	6. Entrapment of air through stuffing boxes.	6. Check external sealing line to make sure it is not clogged.
	7. Reverse rotation.	7. Change direction of rotation. If electrically driven, reverse polarity of motor. Retighten shaft nut if necessary.
	8. Pump speed is too low.	8. On pumps driven by internal combustion engines, adjust governor. On pumps driven by steam turbines, adjust steam turbine governor. On pumps driven by a motor, check voltage and power consumption for motor overload.
	9. Excessive wear of internal parts.	9. Disassemble pump, replace worn components, and reassemble pump.
Driver is overloaded.	1. Pump discharge pressure is lower than design point (check pump nameplate).	1. Partially close discharge valve until pressure at discharge flange is as specified. If driver remains overloaded, decrease speed, if possible, or trim impellers (consult Carver Pump Company before taking this step).

Table 3. Troubleshooting Guide - (Contd.)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Driver is overloaded. - (Contd.)	2. Pump is pumping a fluid with specific gravity in excess of that specified (if temperature of fluid is lower that specified, specific gravity will be higher.)	2. If prescribed fluid temperature or specific gravity cannot be attained, one or more of following measure can be taken, if operating conditions permit: a. Partially close discharge valve, reducing pump capacity to a point where driver is not overloaded. b. Remove one or more impellers and their diffusers. c. Trim one or more impellers. d. Install more powerful pump driver. Please consult factory in any event specifying exact operating conditions.
Leakage at casings or cooling water jacket.	1. Tie bolts not sufficiently tightened.	1. Shut down pump, release pressure, and tighten tie bolts evenly after pump has cooled completely.
	2. O-rings are damaged.	2. Replace o-rings.
Stuffing boxes leak.	1. Insufficient cooling water, or fouling of cooling water jackets.	1. Remove cooling water jackets; thoroughly clean them. Ensure adequate cooling water supply to cooling water jackets.
	2. The pump runs "rough", the shaft chatters.	2. Check pump bearings, replacing them if necessary. If this does not eliminate trouble, dismantle pump and check shaft for true running, rebalancing entire rotating assembly. Carefully reassemble in accordance with procedures given in section VI, paragraphs F and G. Replace mechanical seal if necessary.
	3. Mechanical seal defective.	3. Replace mechanical seal.
	4. Freshly packed stuffing box.	4. Allow pump to run until leakage stabilizes. Refer to section V, paragraph B.
	5. Packing rings are compressed or defective.	5. Replace packing according to section VI, paragraph I.
Bearings run hot.	1. Pump and motor shafts are misaligned.	1. Check coupling alignment according to section II, paragraph B.
	2. Piping causes pump to "warp."	2. Ensure piping transmits no stress to pump. If necessary, alter piping layout. Realign pump, motor shafts.
	3. Over-oiled bearings.	3. Remove excess oil from bearing housing.
	4. Insufficient oil to bearings.	4. Add oil according to section III, paragraph A, step 2.
	5. Insufficient cooling of oil.	5. Check cooling water flow rate to bearing house. Refer to section III, paragraph B, step 6.

Table 3. Troubleshooting Guide - (Contd.)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump discharge pressure excessive.	1. Excessive speed.	1. Check speed precisely and: a. Decrease speed, if possible. b. Remove one or more impellers and their diffusers. c. Cut back outlet tips of impeller vanes. Please consult factory in any event specifying exact operating conditions.
	2. Specific gravity of fluid pumped is too high (temperature of fluid is lower than specified).	2. If pump must operate for prolonged periods at low temperatures or high specific gravity, follow suggestions given under "Excessive speed."
	3. Suction pressure too high.	3. Check suction pressure.

V. MAINTENANCE.

In addition to the following maintenance procedures, perform regular operating checks in section III, paragraph D.

A. Maintenance of Bearings.

The bearing (16) is mounted in the bearing housing (99), which is fitted onto the suction casing (203). The Timken two-row tapered roller bearing, type TDO, contains a double cup with two single cones and a cone spacer. The heat generated by the tapered roller bearing's surface contact necessitates cooling of the oil. On standard design pumps operating at temperatures below 85 degrees F, fluid being pumped is used as coolant. Coolant is supplied from an outside source on standard design pumps operating at temperatures above 85 degrees F and on high temperature design pumps. Refer to section III, paragraph B, step 6 for information on cooling water flow rates.

The bearing (16) is oil lubricated. ISO Grade 68 or 100 oil is recommended for proper lubrication of the bearing. Oil level should be checked on a daily basis and it should be changed every 1000 hours of operation. The Timken bearing is very sensitive to inadequate lubrication. Adequate lubrication with the proper oil type is essential at all times.

To drain old oil from bearing housing: Remove pipe plugs (426) at bottom of inboard bearing cover (35) and bearing housing (99).

To add oil to bearing housing: Add oil through top port of bearing housing (99) until oil is sighted through view port (143). Continue to add oil through oiler (125) to bearing housing (99) until oiler (125) stabilizes (bubbling stops). Refer to figure 5 for illustration of oiler (125). Inspect oiler (125) on daily basis to check oil level in bearing housing (99).

NOTE

It is recommended that bearing be replaced if pump is to be overhauled.

B. Packing Pumps, Stuffing Box Maintenance.

Pumps are delivered with stuffing boxes packed. Packing stuffing boxes will give trouble free service provided that they are carefully and correctly serviced and maintained. A newly packing stuffing box will leak considerably after initial packing or repacking. If this leakage does not stop after the pump has been running a few hours, the gland nuts (615) should be tightened slowly and evenly on either side while the pump is running until the gland (17) only leaks slightly, indicating that it is functioning correctly. If the stuffing box does not leak, or if it starts to smoke, loosen the gland nuts (615) slightly.

NOTE

Every freshly packed stuffing box needs a certain running time before it stabilizes; therefore, close observation at frequent intervals during running-in is important. Once the leakage stabilizes, it need only be checked occasionally.

After prolonged service, or when packing has been compressed by approximately the width of one packing ring, packing should be renewed and condition of shaft sleeve checked. Refer to section VI, paragraph I for packing removal and installation of new packing.

C. Driver Maintenance.

For driver maintenance refer to the driver manufacturers instruction manual.

D. Indefinite Shutdown.

If pump is to be shut down for an extended period of time (such as a unit used for seasonal operation), the following procedure is recommended:

1. Disconnect coupling.
2. Disconnect or lock off power supply.
3. Block off suction piping.

CAUTION

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

CAUTION

It is better to have pump full of liquid than partially full of liquid, The latter will cause accelerated corrosion of wear rings and diffusers, resulting in a 10% drop in capacity during initial operation after restart. However, if there is a possibility of liquid freezing, completely drain casings and all piping.

4. Check liquid level in pump. If there is a possibility of liquid freezing, completely drain casings by removing casing plugs and drain all piping.
5. Check bearing housing oil level.
6. Provide pump and motor with a protective cover.

VI. DISASSEMBLY AND REASSEMBLY.

A. Recommended Tools.

After prolonged operation, it may be difficult to pull components from shaft. In such casings rust solvent may be used and suitable extracting tools applied where possible. Never use force under any circumstances. The following tools are recommended for disassembly and reassembly: bearing puller; spanner wrench; rawhide or wood mallet; wooden wedge (support stage casings); allen wrench set; punch; socket, open, and/or box wrench set; and scribe (for new seal installation).

B. Preparation for Disassembly.

Refer to figure 8, 9, 10, 11, 12, or 13 as applicable for location of parts followed by item number. Follow the following procedure before disassembling the pump:

1. Read this entire section and study figure 8, 9, 10, 11, 12, or 13 as applicable before disassembling the pump.

WARNING

Before attempting to disassemble the pump, the driver controls must be locked and tagged in the OFF position to prevent injury to personnel servicing the pump.

2. Stop the pump according to section III, paragraph C.
3. Close all system valves. Disconnect suction, discharge, and gauge lines.

WARNING

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

4. Drain pump by removing drain plugs (422 and 424) from bottom of casings (1, 197, and 203). If pump is high temperature design, remove drain plugs from cooling jacket (215).
5. Drain oil from bearing cover (35) and bearing housing (99) by removing plugs (426).

C. Disassembly.

Refer to figure 8, 9, 10, 11, 12, or 13 as applicable for location of parts followed by item number.

1. Remove coupling guard. Uncouple pump from driver. Pull coupling half off pump shaft (6). Remove coupling key (46).

CAUTION

To lift pumping unit, a hoist or suitable lifting device should be used.

2. Remove capscrews holding pump to base. Remove pump from base and take to a suitable work area.
3. Clamp down discharge casing foot to steady pump during disassembly.
4. Disconnect all male connector retaining nuts from male connector bodies (410, 411, and 412) as applicable. Remove tubing (400 and 408) as applicable. Retaining nuts will remain with tubing.
5. Number and match-mark stage casing(s) so that discharge casing (197), interstage casing(s) (1), and suction casing (203) will be reassembled in correct sequence and position.
6. Support interstage casing(s) (1) before dismantling to prevent them from dropping when suction casing (203) is removed.

NOTE

Pump should be dismantled from discharge (outboard) end. Mark or number each component as it is dismantled according to sequence. **IMPORTANT:** Be aware of any shims between impellers and spacer sleeves, and mark the sequence accordingly. In instances where multiple gaskets are used as shims, note number of gaskets removed so the same number of new gaskets can be installed during reassembly.

7. Remove hex nuts (616). Remove tie bolts (173) connecting discharge casing (197) and suction casing (203).
8. Remove discharge casing (197). End cap (37) and sleeve bearing (18) will be removed along with discharge casing (197). Remove and discard o-ring (89A) on discharge casing (197).
9. Remove bolts (601). Remove end cap (37) from discharge casing (197), using jacking/forcing screws (666) if necessary to loosen rabbet fit. Remove o-ring (89E).
10. Remove capscrew (685). Remove sleeve bearing (18) from discharge casing (197).
11. Remove spring pin (675) from hex nut (614). Remove hex nut (614) and washer (645) from outboard end of shaft (6).
12. Remove outboard shaft sleeve (14B) from shaft (6).
13. Remove and discard shaft o-ring (89B) from shaft (6).
14. Remove last stage diffuser (5B).
15. On models WKM-50 and WKM-65, remove impeller/sleeve key (32C). On model WKM-80, remove impeller key (32A). Remove last stage impeller (2B).
16. Pry off interstage casing (1) with interstage sleeve (58) and casing o-ring (89D). Remove interstage sleeve (58) and o-ring (89D) from interstage casing (1).
17. Remove diffuser bushing (63), if applicable. Remove diffuser (5A).
18. Remove impeller key (32A). Remove interstage gasket(s) (73G).
19. Remove impeller (2B). Remove interstage gasket(s) (73G).
20. Repeat steps 16 through 19 for each stage.
21. Remove first stage impeller (2A). Remove spacer sleeve (14C).
22. On standard design pumps, remove bolts (600). On high temperature design pump, remove nuts (618) from studs (632). Remove hex nuts (615) from studs (630). Packing pumps, remove split gland (17).
23. Remove bearing housing (99) and shaft assembly from suction casing (203). Remove and discard gland gasket (73F) from gland (17). On high temperature pumps, remove and discard cooling jacket gasket (89C) from suction casing (203).

NOTE

Bearing housing (99) and shaft assembly consists of shaft (6); o-ring (89B); inboard bearing cover (35); bearing lockwasher (69); bearing locknut (22); bearing housing (99); bearing (16); spacer sleeve (14E); slinger (40); shaft sleeve (14A); sleeve key (32B); seal collar (68) and mechanical seal (90) or packing rings (13) and lantern ring(s) (29) as applicable; gland (17); and, if high temperature design, cooling jacket (215), o-ring (89C), and gasket (73C).

24. If high temperature design, remove cooling jacket (215) from outboard end of shaft (6). Remove and discard o-ring (89C) from cooling jacket (215).

NOTE

Mechanical seal pumps, do not remove mechanical seal (90) rotating element from shaft sleeve (14A) at this point, especially if the mechanical seal (90) is relatively clean and is in good working condition. This will simplify reassembly.

25. Mechanical seal pumps, from outboard end of shaft (6), remove seal collar (68) will come off with shaft sleeve (14A). Mechanical seal (90) rotating element and seal collar (68) will come off with shaft sleeve (14A).
26. Packing pumps, remove packing rings (13) and lantern ring(s) (29) as applicable from suction casing (203), shaft sleeve (14), or cooling jacket (215) if high temperature design.
27. Remove sleeve key (32B) from keyway in shaft (6).
28. Mechanical seal pumps, remove gland (17) from shaft (6). Gland (17) contains the stationary element of mechanical seal (90).
29. Remove spacer sleeve (14E), with mounted slinger (40), from shaft (6). Remove slinger (40) from spacer sleeve (14E).
30. Remove hex nuts (617) from studs (631). Remove inboard bearing cover (35) from bearing housing (99).
31. Uncrimp locking tab of bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69).
32. From outboard end of the shaft (6), remove bearing housing (99). Remove and discard bearing housing o-ring (89F).
33. Carver Pump Company recommends that bearing (16) be replaced if pump is overhauled. Use a puller to remove the bearing (16) from the shaft (6).

D. Parts Cleaning and Inspection.

After disassembly, all parts should be thoroughly cleaned or replaced with new ones if necessary.

After disassembly of the pump, individual parts should be cleaned and inspected as follows:

1. Discard used gaskets and o-rings. Packing pumps, discard used packing rings. Thoroughly wash and clean all parts with a suitable solvent.
2. Check shaft (6) for runout, scratches, grooves, or any possible damage. Touch up scratches and grooves with polishing cloth and inspect for remaining grooves or deep scratches. Bent or excessively damaged shaft (6) should be replaced.
3. Mechanical seal pumps, do not remove mechanical seal rotating assembly (80) from shaft sleeve (14A) if the mechanical seal (90) is relatively clean and in good working condition. This will simplify reassembly. If mechanical seal is extremely dirty or damaged, it should be removed and inspected as follows:

NOTE

If mechanical seal (90) is not to be replaced, mark location of seal collar (68) on shaft sleeve (14A).

   a. Loosen, but do not remove, setscrews (665) in seal collar (68). Remove seal collar (68). Remove mechanical seal (90) rotating element from shaft sleeve (14A).
   b. Remove mechanical seal (90) stationary element from gland (17).
   c. Check seal bellows or flexible sealing components for signs of deterioration.
   d. Carefully remove any buildup on sealing faces. Ensure than no dirt, smudges, or flaws remain on sealing faces as this could result in seal failure.
   e. Inspect rotating seal component or primary ring for possible wear. Inspect stationary seal component for scoring. If there are signs of wear or scoring, the mechanical seal should be replaced.
4. Check all shaft protecting sleeves and spacer sleeves visually for score marks, scratches, pits, or grooves. Touch up sleeves with polishing cloth and inspect for remaining grooves or deep scratches. Shaft protecting sleeves and spacer sleeves should be replaced if any marks, pits, or grooves are still visible after touching up.
5. Inspect impellers (2A and 2B) for pitting, erosion, or clogged vanes. If impellers (2A and 2B) are damaged in any way, they should be replaced. If new impellers are installed, they must be axially aligned with respect to diffusers. Refer to section VI, paragraph H.
6. Sealing faces should be perfectly clean.
7. Inspect wear ring clearance for each stage as follows:

NOTE

On WKM-50 and WKM-65, wear rings (7A and 7B) appear in the suction casing (203) and each interstage casing (1). On WKM-80, wear rings (7A and 7B) appear in the suction casing (203), each interstage casing (1), and each diffuser (5A and 5B). For WKM-80, impeller "front" hub specifies hub closest to suction end of pump, and impeller "back" hub specifies hub closest to discharge end of pump.

   a. Measure outside diameters of impeller (2A and/or 2B) hubs in three places.
   b. Measure inside diameters of corresponding wear rings (7A and/or 7B) in three places.
   c. Corresponding differences between high readings of inside diameters of wear rings (7A and 7B) and low readings of outside diameters of impellers (2A and 2B) must not exceed clearances specified in table 4.

Table 4. Maximum Wear Ring Clearance for Allowable Wear

Pump Model	Stage	Maximum Diametrical Clearance
WKM-50	All	.038 inches
WKM-65	All	.034 inches
WKM-80	First	.036 inches
WKM-80	Second	.042 inches

   d. If replacement is required, convey applicable casings (1 and/or 203), impellers (2A and/or 2B), and/or, on WKM-80, diffusers (5A and/or 5B) to a work area with access to machine shop equipment. Replace the wear rings (7A and/or 7B) according to section VI, paragraph E.

E. Wear Ring Replacement.

If pump is not already disassembled, perform disassembly procedures outlined in section VI, paragraphs B and C, steps 1 through 21. Take applicable casings, impellers, and/or diffusers to a good machine shop. To replace the wear rings, follow the following procedure:

1. Remove old wear ring (7A and/or 7B) from suction casing (203), stage casing(s) (1), and/or diffuser(s) (5A and/or 5B), as applicable. This can best be accomplished on a lathe.
2. Press new wear ring (7A and/or 7B) in suction casing (203), stage casing(s) (1), and/or diffuser(s) (5A and/or 5B), as applicable.
3. Place impeller (2A and/or 2B) on an arbor and mount between centers in a lathe. Indicate impeller front hub (and/ or impeller back hub on WKM-

80) to within .002 T.I.R. maximum to be sure that arbor and impeller (2A and/or 2B) are running square.
4. Turn wearing surface of impeller (2A and/or 2B) until a 63 RMS or better finish is obtained.
5. Measure outside diameter of impeller hub and record.
6. Mount suction casing (203), stage casing (1) and/or diffuser (5A and/or 5B), with new wear ring (7A and/or 7B) inserted , in a lathe. Indicate male rabbet to within .002 T.I.R. maximum.
7. Bore wear ring (7A and/or 7B) to within the specified tolerance listed in table 5 over the recorded size of outside diameter of impeller hub.

Table 5. New Wear Ring Clearance Limits

Pump Model	Stage	Diametrical Clearance
WKM-50	All	.015 to .019 inches
WKM-65	All	.013 to .017 inches
WKM-80	First	.012 to .018 inches
WKM-80	Second	.017 to .021 inches

8. Return impeller (2A and/or 2B) and suction casing (203), stage casing(s) (1) and/or diffusers (5A and/or 5B) to pump assembly. Reassemble pump according to section VI, paragraphs F and G.

F. Preparations for Reassembly.

Coat fits of individual components with suitable lubricant before assembly.

When the pump unit is being overhauled, Carver Pump Company recommends that the following parts be replaced with new:
1. All o-rings. Do not try to substitute inch for metric sizes.
2. All gaskets, ensuring that thickness of new gasket is exactly the same as that of the old one.
3. Timken bearing.
4. Mechanical seal pump, mechanical seal.
5. Packing rings pump, all packing rings.
6. If new impellers or new shaft protecting sleeves are fitted, impellers must be axially aligned with respect to diffuser. Refer to section VI, paragraph H for alignment procedure.

G. Reassembly.

Refer to figure 8, 9, 10, 11, 12 or 13 as applicable for location of parts followed by an item number. Reassemble the pump in accordance with accepted rules of engineering practice. Reassembly of unit should be performed on a flat surface. It is recommended that all nuts and bolts be torqued according to table 6. Ensure components are fitted in correct sequence.

Reassembly commences at the suction (inboard end) of the pump. Follow the following procedure to reassemble the pump:

Table 6. Recommended Torque Values

Size	Torque Value in Foot Pounds
1/4 inch	5 foot pounds
3/8 inch	15 foot pounds
1/2 inch	30 foot pounds
5/8 inch	55 foot pounds
3/4 inch	110 foot pounds
7/8 inch	155 foot pounds
1 inch	275 foot pounds
1-1/8 inch	390 foot pounds

NOTE

Bearings are given a serial number and each cone, cup, and spacer in the bearing is marked with this number. During assembly check the number on each individual part to make sure they all are for the same matched bearing.

NOTE

To ensure proper seating of bearing parts, rotate the bearing while clamping up the parts.

1. Install new bearing (16) on shaft (6). Carver Pump Company recommends that the bearing's inner and outer cones be heated for easier assembly. Follow the following procedure:
   a. Install the bearing's inner cone on the shaft (6) and hold the hot cone against the cold shaft shoulder until the cone seizes. The hot cone will pull away from the shoulder unless it is held in position. Compressed air can help speed the cooling.
   b. Install bearing's cone spacer.
   c. Install bearing's cup.
   d. Install bearing's outer cone.
   e. Use a feeler gauge to make sure inner cone is fully seated against shaft shoulder.
2. Install bearing lockwasher (69) so that tab of lockwasher (69) fits into keyway on shaft (6).
3. Install bearing locknut (22) and tighten against lockwasher (69). Crimp lockwasher tab into slot provided on outside of bearing locknut (22).
4. Install outboard end of shaft (6) in through inboard side of bearing housing (99).
5. Install new lubricated o-ring (89F) in groove provided in bearing housing (99).
6. Secure inboard bearing cover (35) to bearing housing (99) with hex nuts (617) on studs (631).
7. Install slinger (40) on spacer sleeve (14E). Slide spacer sleeve (14E) onto outboard end of shaft (6), next to shaft shoulder.

8. Insert sleeve key (32B) into keyway in shaft (6). Packing pumps, install o-ring (89B). Mechanical seal pumps, o-ring (89B) will be installed later. Slide shaft sleeve (14A) onto outboard end of shaft (6), lining up keyway of shaft sleeve (14A) with sleeve key (32B).

NOTE

Steps 9 through 14 apply to mechanical seal pumps only. For packing pumps, proceed to step 15.

9. To determine placement of seal collar (68) on shaft sleeve (14A), for installation of mechanical seal (90) rotating element, refer to figure 6A or 6B and follow the following procedure:
   a. Insert shaft (6) through inboard end of suction casing (203). Standard design, secure bearing housing (99) to suction casing (203) with bolts (600). High temperature design, secure bearing housing (99) to suction casing (203) with nuts (618) on studs (632).
   b. Scribe a mark on shaft sleeve (14A) corresponding to outer edge of stuffing box in suction casing (203).
   c. Remove bolts (600) or nuts (618) as applicable. Remove shaft assembly from suction casing (203). Remove shaft sleeve (14A).
   d. Scribe a second mark on shaft sleeve (14A) at the distance specified in table 7 from the first scribe mark, toward outboard end.

Table 7. Mechanical Seal Settings

Pump Model	Type 21, WKM-50 & WKM-65 Type 1, WKM-80 dimension
WKM-50	1.000 inch
WKM-65	1.000 inch
WKM-80	2.187 inches

   e. Install seal collar (68) immediately to the outboard side of the second scribe mark. Secure seal collar (68) to shaft sleeve (14A) with setscrews (665).
10. Lubricate both gland (17) and mechanical seal (90) stationary element with petroleum jelly or other suitable lubricant. Mechanical seal pumps, Insert mechanical seal (90) stationary element into gland (17).
11. Slide gland (17) onto outboard end of shaft (6). As applicable, ensure tap flush lines in gland (17) is positioned so flush lines can be connected.
12. Install o-ring (89B) in groove provided on shaft (6).
13. Lubricate shaft sleeve (14A) with petroleum jelly or silicon spray. Mechanical seal pumps, install mechanical seal (90) rotating element on shaft sleeve (14A) on inboard side of seal collar (68).
14. Slide shaft sleeve (14A) onto outboard end of shaft (6), lining up keyway of shaft sleeve (14A) with sleeve key (32B).
15. Check that wear ring (7A) is in suction casing (203). Install new lubricated o-ring (89D) on suction casing (203).
16. If standard design, install new gland gasket (73F) on stuffing box face of suction casing (203). If high temperature design, install new gland gasket (73F) on inboard face of cooling jacket (215).
17. If high temperature design, install new o-ring (89C) on cooling jacket (215). Install new gasket (73C) on inboard face of suction casing (203). Install cooling jacket (215) on outboard end of shaft (6).
18. Install shaft assembly through inboard side of suction casing (203).
19. If standard design, secure bearing housing (99) to suction casing (203) by tightening bolts (600). If high temperature design, secure bearing housing (99) and cooling jacket (215) to suction casing (203) with hex nuts (618) on studs (632). Mechanical seal pumps, secure gland (17) loosely in place with hex nuts (615) on studs (630). Do not tighten hex nuts (615) down at this point.

NOTE

Packing pumps, packing rings (13) should be inserted individually, with the butt joint of each packing ring (13) offset approximately 90 degrees from the preceding ring (13). The split packing gland (17) may be used to push each ring (13) into position. The packing rings (13) should be pressed lightly against each other by the split packing gland (17). Make sure that the butts of any two adjoining rings (13) do not lie in line. Insert packing rings, leaving a 1/4" gap at end so that the gland will have positive guidance and cannot be tightened askew.

20. Packing pumps, individually install two packing rings (13), lantern ring(s) (29) if applicable, and two additional packing rings (13). Packing pumps, install gland (17) and secure loosely with hex nuts (615) on studs (630). Do not tighten hex nuts (615) down at this point.
21. Slide spacer sleeve (14C) onto outboard end of shaft (6), next to shaft sleeve (14A).
22. Insert impeller key (32A) into key way on shaft (6).

NOTE

Replace the same number of new interstage gaskets (73G) during reassembly that were removed during disassembly.

NOTE

IMPORTANT: Reassemble any shims found during disassembly in correct sequence.

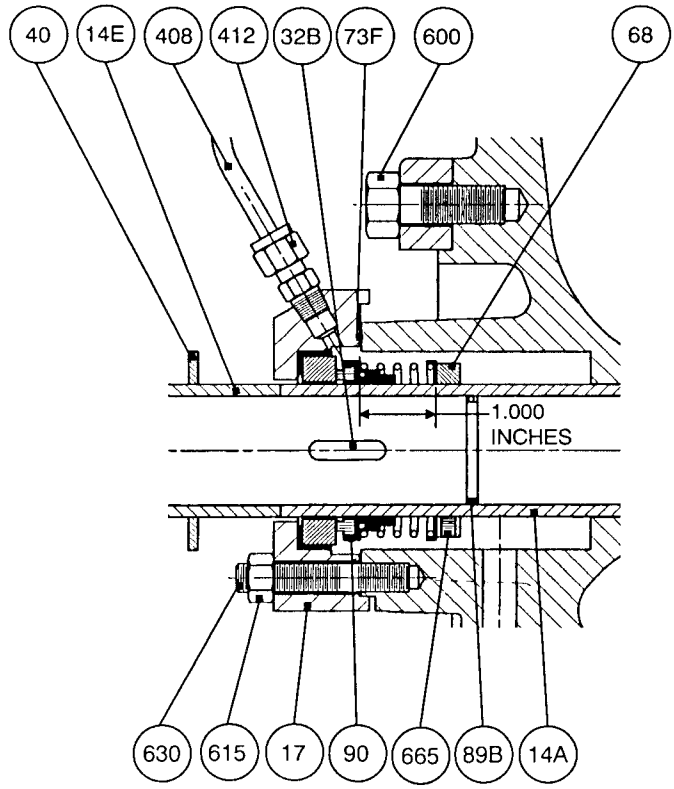


Figure 6A. Mechanical Seal, WKM-50 and WKM-65 Standard Design

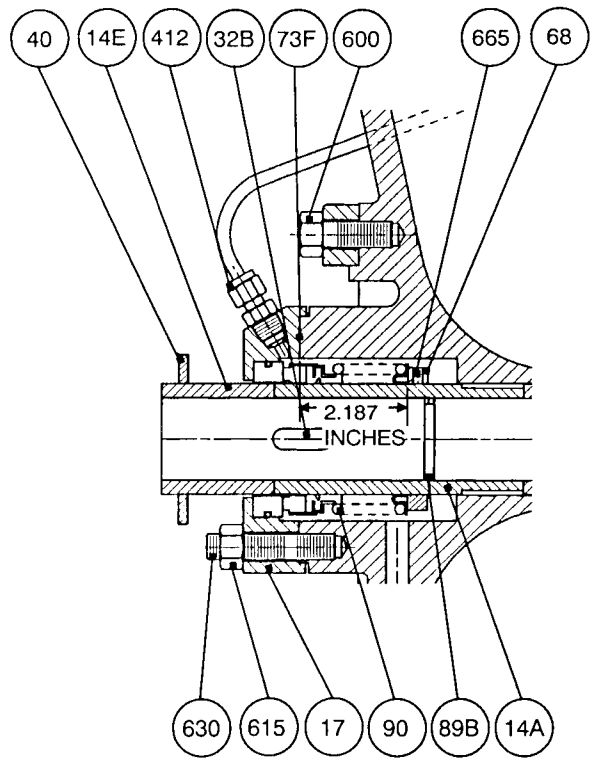


Figure 6B. Mechanical Seal, WKM-80 Standard Design

23. Slide interstage gasket(s) (73G) onto outboard end of shaft (6), next to spacer sleeve (14C).
24. Slide first stage impeller (2A) onto shaft (6) from outboard end, fitting keyway of impeller to impeller key (32A) on shaft (6).
25. Slide interstage gasket(s) (73G) onto shaft (6) from outboard end, next to first stage impeller (2A).
26. Slide interstage sleeve (58) onto shaft (6) from outboard end, next to gasket(s) (73G). Install bushing (63) on interstage sleeve (58) if applicable.
27. Slide interstage gasket(s) onto shaft (6) from outboard end, next to interstage sleeve (58).
28. Insert impeller key (32A) into keyway on shaft (6).
29. Check that wear ring (7B) is in interstage casing (1) for WKM -50 or WKM-65. Check that wear ring (7B) is in diffuser (5A) for WKM-80. Install new lubricated o-ring (89D) in groove provided on stage casing (1). Lightly tap diffuser (5A) into stage casing (1). Align diffuser vanes on either side of boss located in stage casing (1).
30. Install stage casing assembly onto shaft (6) and fit onto suction casing (203).
31. Slide next impeller (2B) onto shaft (6).
32. Repeat steps 25 through 31 for each stage.
33. On WKM-50 and WKM-65, insert impeller key (32C) into keyway in shaft (6) before installing last impeller (2B). On WKM-80, insert impeller key (32A) into keyway in shaft (6) before installing last impeller (2B).
34. Install last stage impeller (2B). Slide interstage gasket(s) (73G) onto shaft (6) next to impeller (2B).
35. Install new lubricated o-ring (89B) in groove provided on shaft (6).
36. Slide outboard shaft sleeve (14B) onto outboard end of shaft (6), aligning keyway in sleeve (14B) with impeller key (32C) on WKM-50 and WKM-65 or impeller key (32A) on WKM-80.
37. Install washer (645) on shaft (6) next to outboard shaft sleeve (14B).
38. Install and tighten hex nut (614) on outboard end of shaft (6). Tap spring pin (675) through hex nut (614).
39. Secure sleeve bearing (18) to discharge casing (197) with capscrews (685), make sure sleeve bearing (18) is seated properly before tightening machine screws (685). Install new lubricated o-ring (89A) in groove provided on discharge casing (197).
40. Install discharge casing (197) on shaft (6).
41. Install tie bolts (173) and hex nuts (616).
42. Install new lubricated o-ring (89E) in groove provided in end cap (37).
43. Secure end cap (37) to discharge casing (197) with bolts (601).
44. Rotate shaft (6) by hand to insure smooth rotation. Mechanical seal pumps, tighten nuts (615) on studs (630) securing gland (17) to suction casing (203).
45. Reinstall pump on base and secure with capscrews.
46. Reinstall coupling key (46). Reinstall coupling half on pump shaft (6).
47. Align coupling as outlined in section II, paragraph B of this manual.
48. Reinstall coupling guard.
49. Reinstall tubing (400 and 408) as applicable. Secure tubing by tightening nuts on male connectors (410, 411, and 412) as applicable.
50. Reconnect suction, discharge, and gauge lines. After connection of piping, smooth rotation of shaft should be checked.
51. Reinstall plugs (422 and 424) at bottom of casings (1, 197, and 203). Reinstall plugs (426) in heat exchanger (975). If high temperature design, reinstall plugs in bottom of cooling water jackets (215).
52. Open system valves.
53. Unlock and reconnect electrical power supply to motor. Remove tags. Start pump according to section III, paragraphs A and B of this manual.

H. Axial Alignment of Rotor.

If new parts are fitted during reassembly, such as impellers and/or sleeves, first stage impeller (2A) must be axially aligned with respect to outboard face of suction casing. Each subsequent impeller must be aligned with respect to diffuser.

Refer to figure 7A or 7B. Measure distance "A" or "B" from outboard face of suction casing (203) to inside of first stage impeller's (2A) back shroud. Compare measured distance to dimensions given in table 8. Carver Pump Company recommends that this dimension be within .015 inches. If shimming is required, install shim between impeller and spacer sleeve (14C). For each stage measure distance "A" or "B" from inboard face of diffuser (5A or 5B) to inside of impeller's (2B) back shroud. If shimming is required, install shim between impeller (2B) and interstage sleeve (58).

FOR "A" DIMENSION SEE TABLE 8.

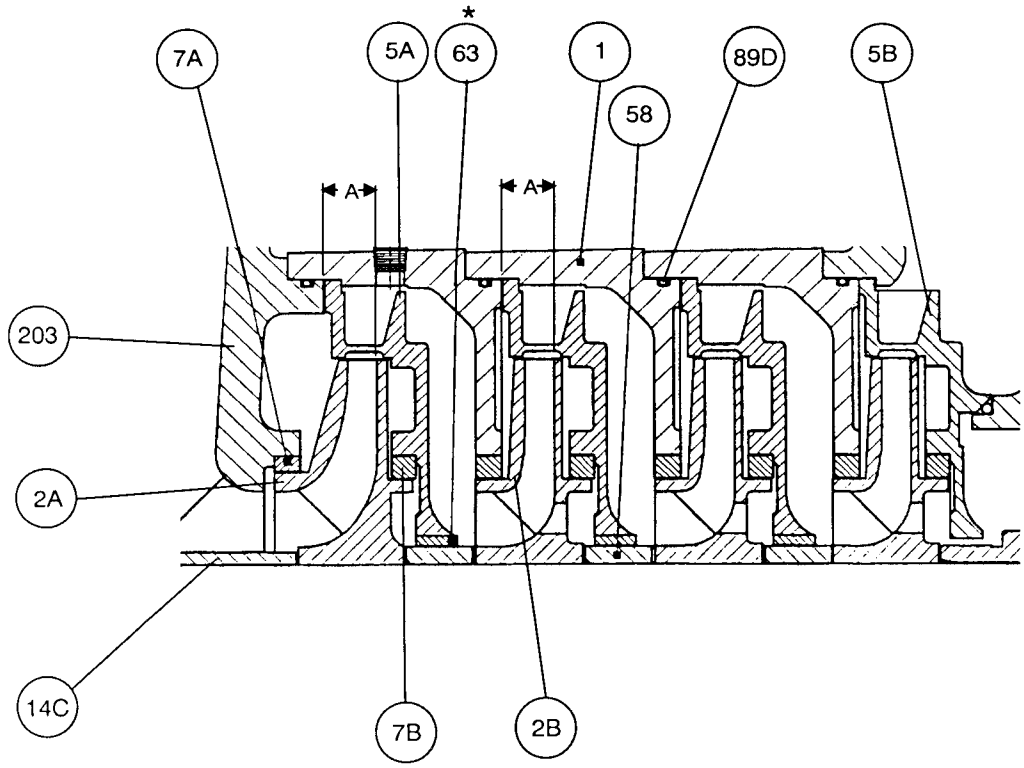


Figure 7A. Axial Alignment of Rotor, WKM-50 and WKM-65

FOR "B" DIMENSION SEE TABLE 8.

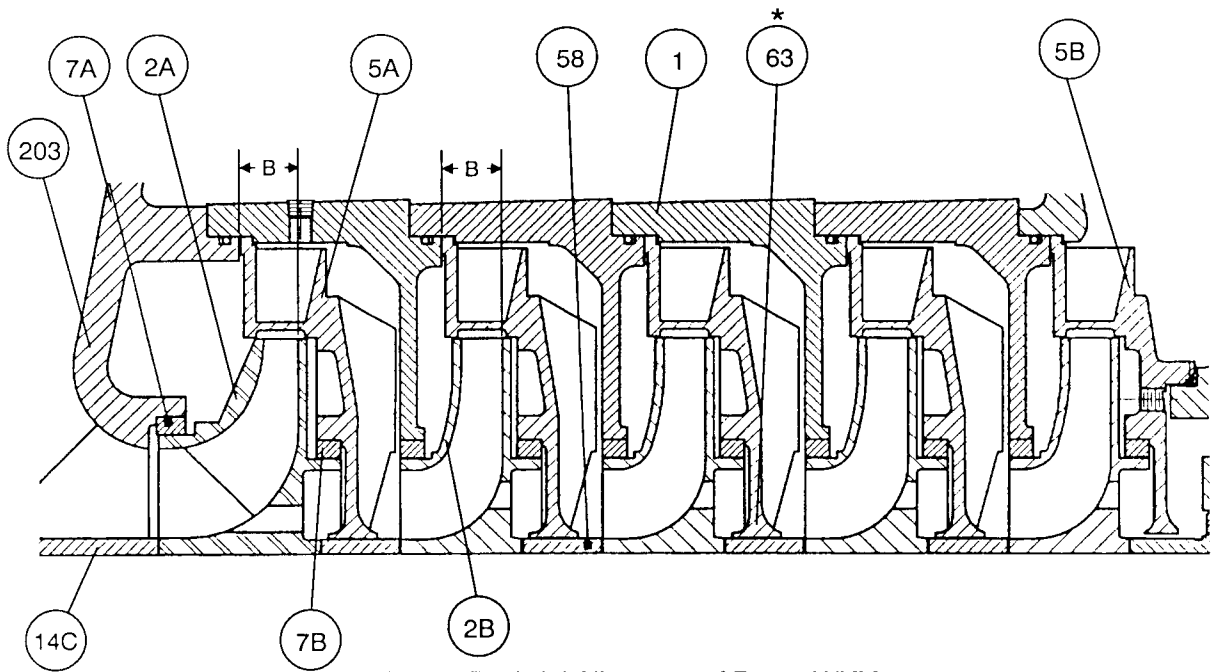


Figure 7B. Axial Alignment of Rotor, WKM-80

* = OPTIONAL

Table 8. Axial Alignment Control Dimensions

Pump Model	Distance "A" in figure 7A + /- .015	Distance "B" in figure 7B + /- .015
WKM-50	.650 inch	
WKM-65	.769 inch	
WKM-80		.984 inch

I. Packing Pumps, Packing Removal and Installation.

To remove packing and install new packing, follow the following procedure:

1. Disconnect, lock off, and tag power supply to driver.
2. Close all system valves.
3. Remove gland nuts (615). Remove split packing gland (17).
4. Remove packing rings (13) and lantern ring(s) (29), as applicable.
5. Clean stuffing box area and shaft sleeve (14E).

NOTE

The packing rings (13) should be inserted individually, with the butt joint of each packing ring (13) offset approximately 90 degrees from the preceding ring (13). The split packing gland (17) may be used to push each ring (13) into position. The packing rings (13) should be pressed lightly against each other by the split packing gland (17). Make sure that the butts of any two adjoining rings (13) do not lie in line. Insert packing rings, leaving a 1/4" gap at end so that the gland will have positive guidance and cannot be tightened askew.

6. Install new packing rings (13) and lantern ring(s) (29) as applicable, in the same order as they were removed.
7. Install split packing gland (17). Install and lightly tighten gland nuts (615).
8. Open system valves.
9. Unlock and reconnect electrical power supply to motor. Remove tags. Start pump according to section III, paragraphs A and B of this manual.
10. A newly packed stuffing box will leak appreciably at first. If this leakage does not stop after the pump has been running a few hours, the gland nuts (615) should be tightened slowly and evenly on either side while the pump is running until the gland only leaks slightly, indicating that it is functioning correctly. If the stuffing box does not leak, or if it starts to smoke, loosen the gland nuts (615) slightly.

VII. SPARE PARTS.

Spare parts should be on hand for normal service to avoid unnecessary delays for maintenance. Table 9 lists WKM pump components which are recommended as spare parts. When ordering spare parts, be sure to include the part name, item number, serial number and model number of the pump (on pump nameplate), and quantity of parts needed.

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

If an impeller is ordered, specify the diameter across the blade tips to be sure there was not further trim on the diameter than shown on Carver Pump Company's records.

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

Table 9. Recommend Spare Parts

ITEM NUMBER	PART NAME	QTY. REQUIRED
2A and 2B	Impeller	As required
7A	Suction Casing Wear Ring	1
7B	Interstage Casing Wear Ring	As required
13	Packing rings (packing pumps)	As required
14A	Shaft Sleeve	1
14B	Shaft Sleeve	1
14C	Sleeve Spacer	1
14E	Sleeve Spacer	1
16	Roller bearing	1
18	Sleeve bearing	1
58	Interstage sleeve	As required
68	Shaft Collar (seal pumps)	1
73C	Gasket(cooling water jacket, high temperature design pumps)	1
73F	Gasket (seal gland)	1
73G	Gasket (interstage sleeve)	As required
89A	O-ring (last stage diffuser)	1
89B	O-ring (sleeve)	2
89C	O-ring (cooling jacket, high temperature design pumps)	1
89D	O-ring (stage casing)	As required
89E	O-ring (end cap)	1
90	Mechanical Seal (seal pumps)	1

VIII. TECHNICAL DATA.

Technical data is listed in table 10.

Table 10. Specifications and Operating Limits

Maximum capacity	2200 GPM
Maximum head	1500 feet
Maximum liquid temperature with standard stuffing box	220 degrees F
Maximum liquid temperature with cooled stuffing box	285 degrees F
Maximum discharge pressure	650 PSI
Maximum suction pressure	150 PSI
Rotation (viewed from driver end)	clockwise
Flange positions (viewed from driver end)	suction - right side discharge - top pointing up

Table 10A. Recommended Oil Types for Bearig 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

IX. PARTS LIST AND DRAWINGS.

Refer to table 11 for the parts list. Refer to figure 8, 9, 10, 11, 12, or 13 as applicable for an illustration.

Table 11. Parts List

ITEM NO.	PART NAME	QTY.	REMARKS
1	Interstage casing	As reqd.	
2A	Impeller	1	First stage
2B	Impeller	As reqd.	Stage
5A	Diffuser	As reqd.	Stage
5B	Diffuser	1	Last stage
6	Shaft	1	
7A	Wear ring	1	Suction casing
7B	Wear ring	As reqd.	Stage casing
13	Packing ring	As reqd.	Packing pumps
14A	Shaft sleeve	1	Seal or packing, as applicable per pump
14B	Shaft sleeve	1	Sleeve bearing
14C	Sleeve spacer	1	
14E	Sleeve Spacer	1	
16	Roller Bearing	1	Timken type TDO
17	Gland	1	Seal or packing, as applicable per pump
18	Sleeve bearing	1	
22	Bearing locknut	1	
29	Lantern Ring	As reqd.	Packing pumps
32A	Impeller key	As reqd.	
32B	Sleeve key	1	
32C	Impeller key	1	WKM-50 and WKM-65 pumps
35	Bearing cover	1	
37	End cap	1	
40	Slinger	1	
45	Vent	1	
46	Coupling key	1	
58	Interstage sleeve	As reqd.	
63	Diffuser bushing	As reqd.	Optional part used for stainless steel pumps
68	Seal Collar	1	Mechanical seal pumps
69	Bearing lockwasher	1	
73C	Gasket	1	Cooling jacket, high temperature design pumps
73F	Gasket	1	Seal gland, mechanical seal pumps
73G	Gasket	As reqd.	Interstage sleeve
89A	O-ring	1	Last stage diffuser
89B	O-ring	2	Sleeve
89C	O-ring	1	Cooling jacket, high temperature design pumps
89D	O-ring	As reqd.	Casing
89E	O-ring	1	End Cap
89F	O-ring	1	Bearing housing
90	Mechanical Seal	1	Mechanical seal pumps
99	Bearing housing	1	

Table 11. Parts List - (Contd.)

ITEM NO.	PART NAME	QTY.	REMARKS
125	Oiler	1	
143	Viewport	2	
173	Tie bolt	4	
197	Discharge casing	1	
203	Suction casing	1	
215	Cooling jacket	1	High temperature design pumps
400	Tubing	1	Balance line
408	Tubing	1	WKM-50 and WKM-65 with mechanical seal and WKM-80 with mechanical seal or packing
410	Tube connector	As reqd.	
411	Tube connector	As reqd.	
412	Tube connector	As reqd.	WKM-50, WKM-65, and WKM-80 with mechanical seal
422	Pipe plug	As reqd.	Suction casings
423	Pipe plug	As reqd.	Discharge and suction casings
424	Pipe plug	As reqd.	Casing drain
425	Pipe plug	As reqd.	End cap and bearing cap
426	Magnetic Pipe Plug	As reqd.	Bearing housing
455	Pipe elbow (not shown)	As reqd.	Suction casing
456	Pipe elbow	1	Flush line
600	Bolt	4	Bearing housing, standard design pumps
601	Bolt	8	End cap
614	Hex nut	1	Shaft
615	Hex nut	4	Gland
616	Hex nut	4	Tie bolt
617	Hex nut	4	Bearing cover
618	Hex nut	4	Cooling jacket, high temperature design pumps
630	Stud	4	Gland
631	Stud	4	Bearing cover
632	Stud	4	Cooling jacket, high temperature design pumps
645	Washer	1	Shaft
665	Setscrew	2	Seal collar, mechanical seal pumps
666	Jacking/Forcing Screw	4	End cap
675	Spring pin	1	Shaft nut
685	Capscrew	2	Sleeve bearing
975	Dual Heat Exchanger	1	

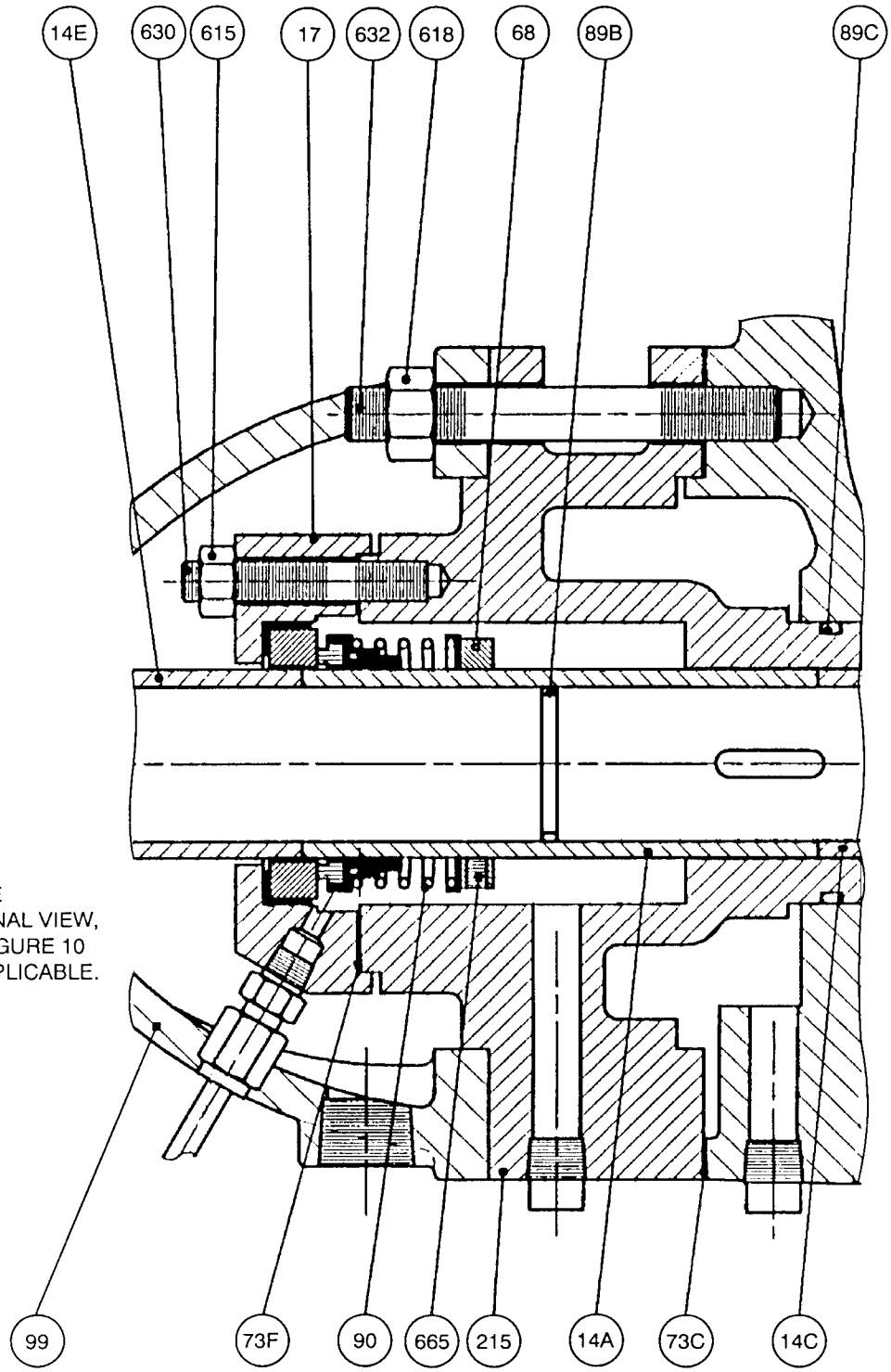


Figure 8. WKM High Temperature Design with Mechanical Seal Detail Drawing

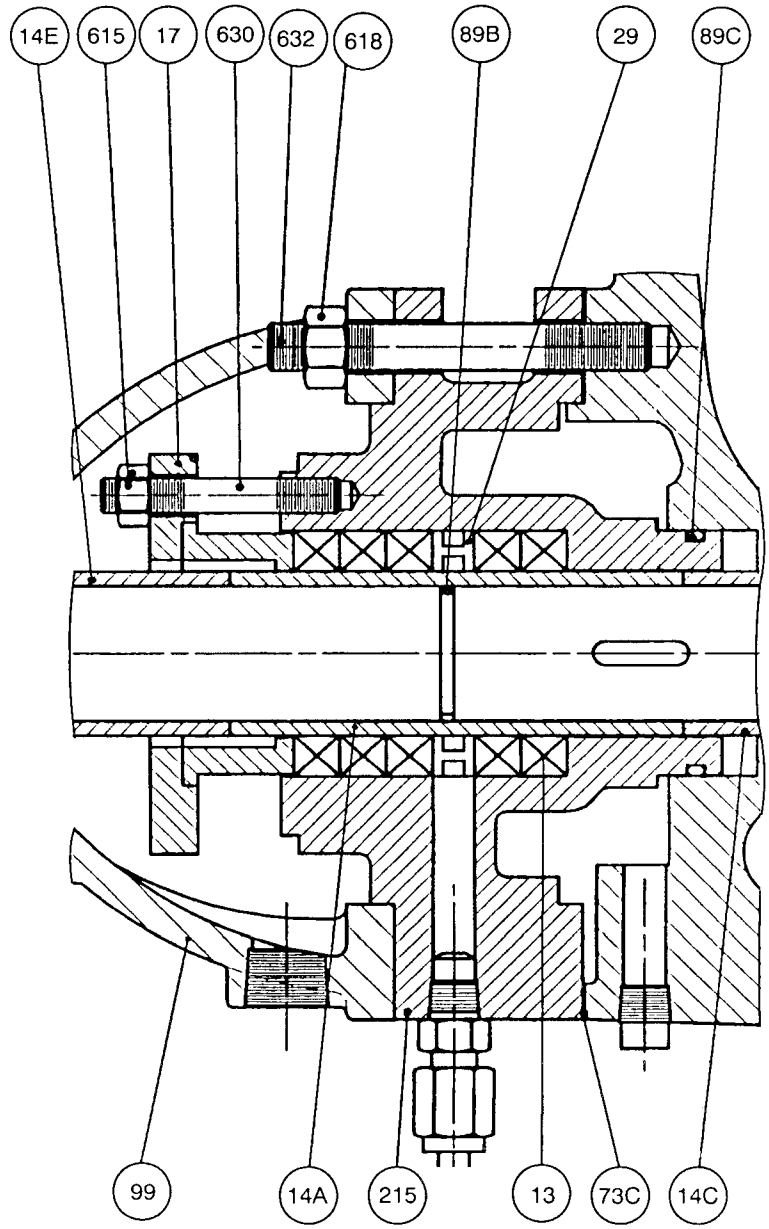
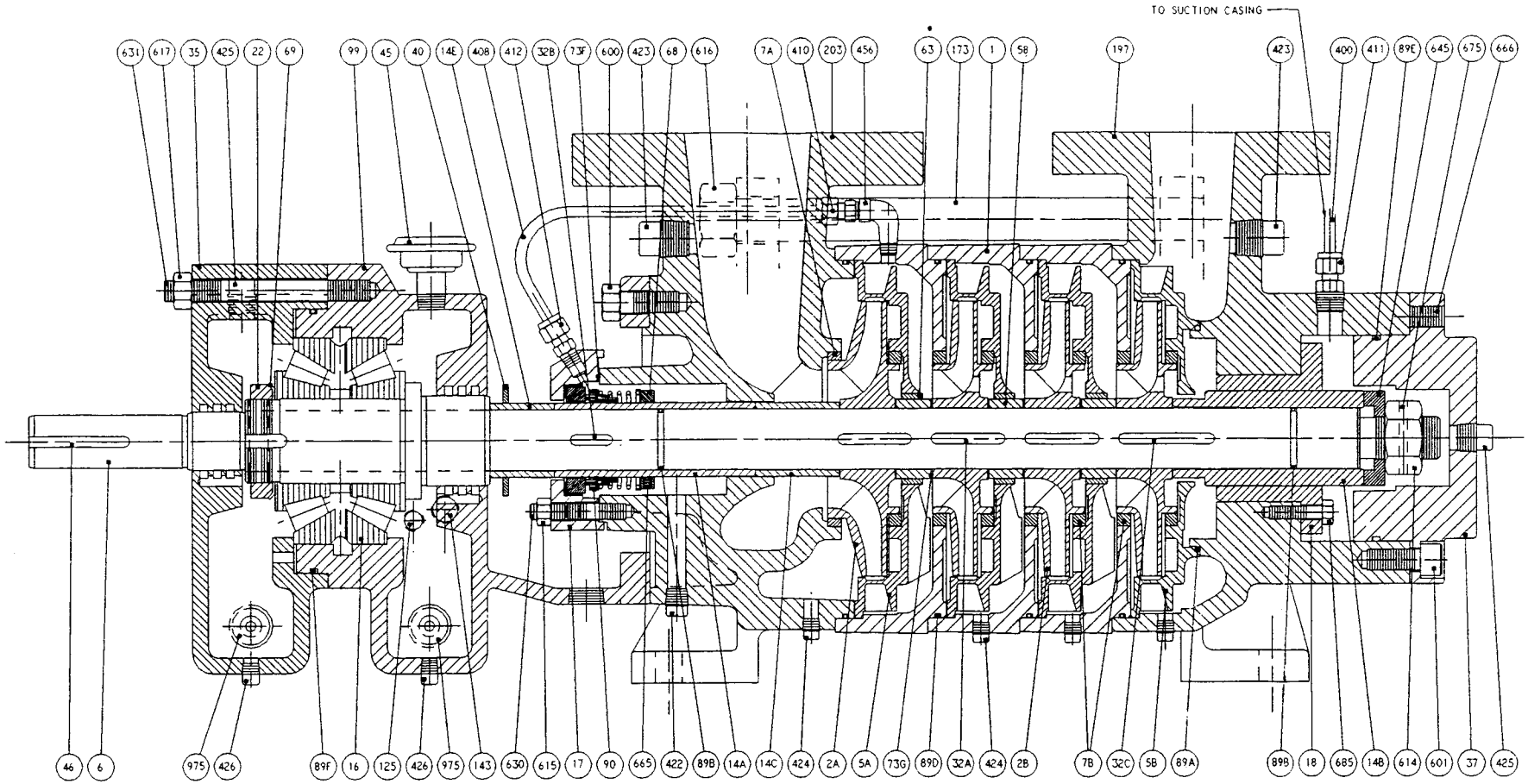


Figure 9. WKM High Temperature Design with Packing Detail Drawing



ITEM	DESCRIPTION
1	INTERSTAGE CASE
2A	IMPELLER - 1ST STG.
2B	IMPELLER
5A	DIFFUSER
5B	DIFFUSER - LAST STG.
6	SHAFT
7A	WEAR RING - SUCT CASE
7B	WEAR RING
14A	SHAFT SLEEVE - SEAL
14B	SHAFT SLEEVE - SLV. BRG.
14C	SLEEVE - SPACER
14E	SLEEVE - SPACER
16	ROLLER BEARING
17	GLAND - SEAL
18	SLEEVE BEARING

ITEM	DESCRIPTION
22	BEARING LOCKNUT
32A	KEY - IMPELLER
32B	KEY - SLEEVE
32C	KEY - IMPELLER
35	BEARING COVER
37	END CAP
40	SLINGER
45	VENT
46	KEY - COUPLING
58	SLEEVE - INTERSTAGE
• 63	BUSHING - DIFFUSER
68	SEAL COLLAR
69	BEARING LOCKWASHER
73F	GASKET - GLAND
73G	GASKET - INTSTG. SLV

ITEM	DESCRIPTION
89A	O-RING - LST.STG.DIFF.
89B	O-RING - SLEEVE
89D	O-RING - CASING
89E	O-RING - END CAP
89F	O-RING - BRG. COVER
90	MECHANICAL SEAL
99	BEARING HOUSING
125	OILER
143	VIEWPORT
173	TIE BOLT
197	DISCHARGE CASE
203	SUCTION CASE
400	TUBING - BALANCE
408	TUBING - SEAL FLUSH
410	TUBE CONNECTOR

ITEM	DESCRIPTION
411	TUBE CONNECTOR
412	TUBE CONNECTOR
422	PIPE PLUG - SUCT. CASE
423	PIPE PLUG - SUCT. & DISH.
424	PIPE PLUG - CASE DRAIN
425	PIPE PLUG - END CAP / BRG. CAP
426	MAGNETIC PIPE PLUG - BRG. HSG.
455	PIPE ELBOW - SUCT. CASE (NOT SHOWN)
456	PIPE ELBOW - SEAL FLUSH
600	BOLT - BRG. HSG. / CASE
601	BOLT - END CAP
614	NUT - SHAFT
615	NUT - GLAND
616	NUT - TIE BOLT
617	NUT - BRG. COVER
630	STUD - GLAND

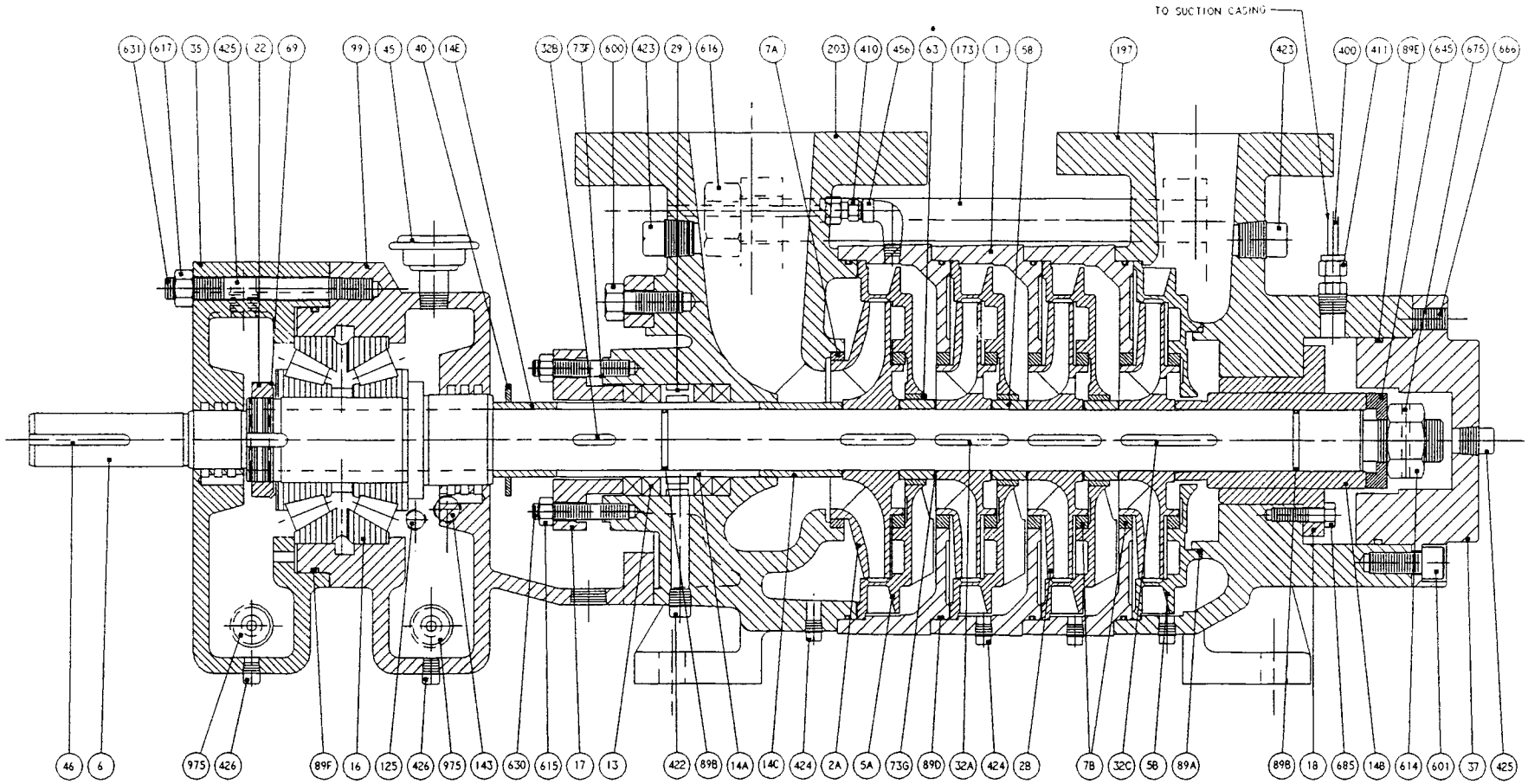
ITEM	DESCRIPTION
631	STUD - BRG. COVER
645	WASHER - SHAFT
665	SETSCREW - SEAL COLLAR
666	FORCING SCREW - END CAP
675	SPRING PIN - SHAFT NUT
685	CAPSCREW - SLEEVE BRG.
975	HEAT EXCHANGER

• OPTIONAL

NOTE

BOLT (600) IS FOR STANDARD DESIGN PUMPS ONLY.

Figure 10. WKM-50 and WKM-65 with Mechanical Seal Sectional Drawing



ITEM	DESCRIPTION
1	INTERSTAGE CASE
2A	IMPELLER - 1ST STG.
2B	IMPELLER
5A	DIFFUSER
5B	DIFFUSER - LAST STG.
6	SHAFT
7A	WEAR RING - SUCT. CASE
7B	WEAR RING
13	PACKING RINGS
14A	SHAFT SLEEVE - PACKING
14B	SHAFT SLEEVE - SLV. BRG
14C	SLEEVE - SPACER
14E	SLEEVE - SPACER
16	ROLLER BEARING
17	GLAND - PACKING
18	SLEEVE BEARING

ITEM	DESCRIPTION
22	BEARING LOCKNUT
29	LANTERN RING
32A	KEY - IMPELLER
32B	KEY - SLEEVE
32C	KEY - IMPELLER
35	BEARING COVER
37	END CAP
40	SLINGER
45	VENT
46	KEY - COUPLING
58	SLEEVE - INTERSTAGE
• 63	BUSHING - DIFFUSER
69	BEARING LOCKWASHER
73G	GASKET - INTSTG. SLV.

ITEM	DESCRIPTION
89A	O-RING - LST.STG.DIFF.
89B	O-RING - SLEEVE
89D	O-RING - CASING
89E	O-RING - END CAP
89F	O-RING - BRG. COVER
99	BEARING HOUSING
125	OILER
143	VIEWPORT
173	TIE BOLT
197	DISCHARGE CASE
203	SUCTION CASE
400	TUBING - BALANCE
410	TUBE CONNECTOR

ITEM	DESCRIPTION
411	TUBE CONNECTOR
422	PIPE PLUG - SUCT. CASE
423	PIPE PLUG - SUCT. & DISH.
424	PIPE PLUG - CASE DRAIN
425	PIPE PLUG - END CAP / BRG. CAP
426	MAGNETIC PIPE PLUG - BRG. HSG.
455	PIPE ELBOW - SUCT. CASE (NOT SHOWN)
456	PIPE ELBOW - PACKING FLUSH
600	BOLT - BRG. HSG. / CASE
601	BOLT - END CAP
614	NUT - SHAFT
615	NUT - GLAND
616	NUT - TIE BOLT
617	NUT - BRG. COVER
630	STUD - GLAND

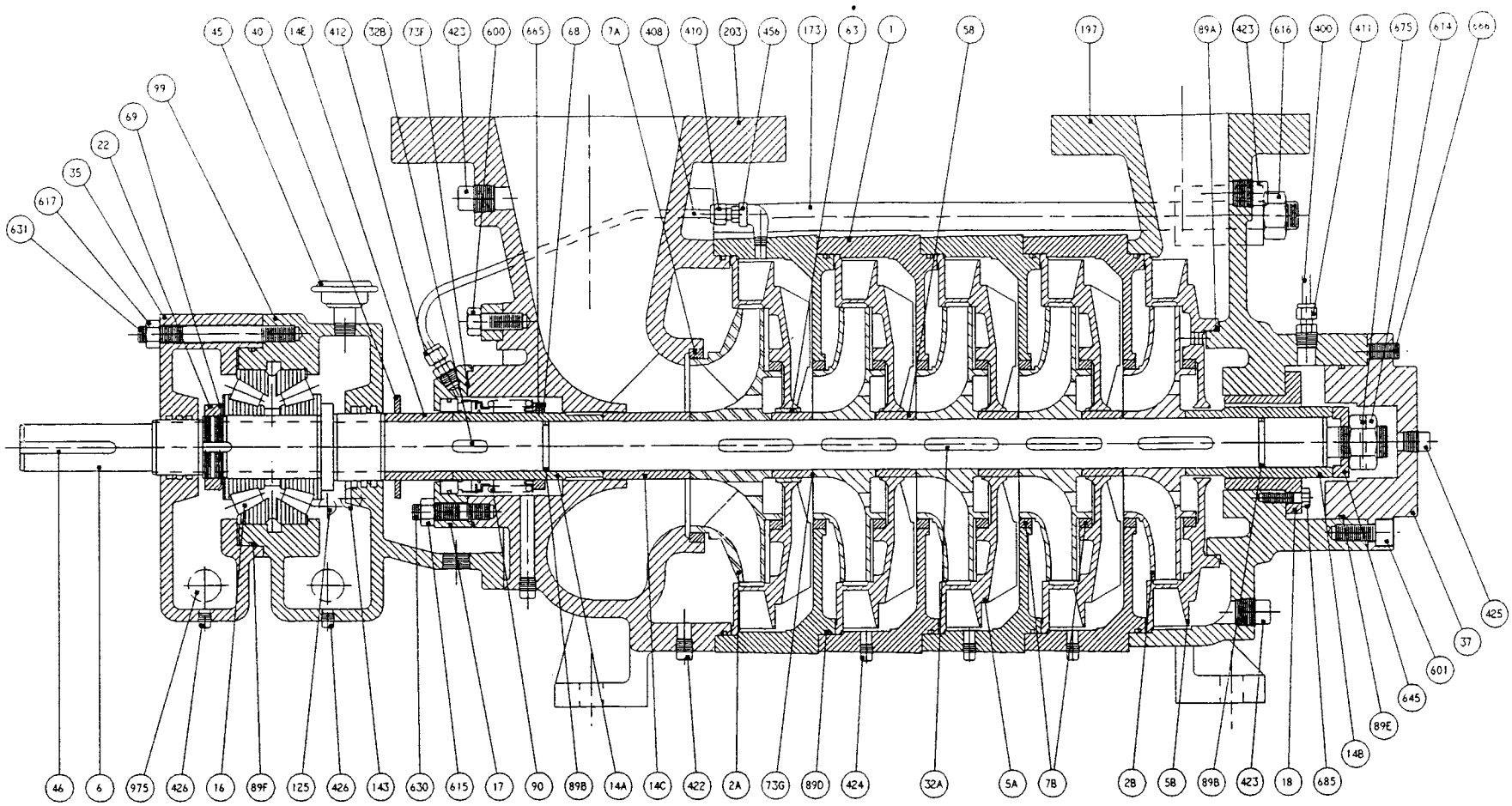
ITEM	DESCRIPTION
631	STUD - BRG. COVER
645	WASHER - SHAFT
666	JACKING SCREW - END CAP
675	SPRING PIN - SHAFT NUT
685	CAPSCREW - SLEEVE BRG.
975	HEAT EXCHANGER

• OPTIONAL

NOTE

BOLT (600) IS FOR STANDARD DESIGN PUMPS ONLY.

Figure 11. WKM-50 and WKM-65 with Packing Sectional Drawing



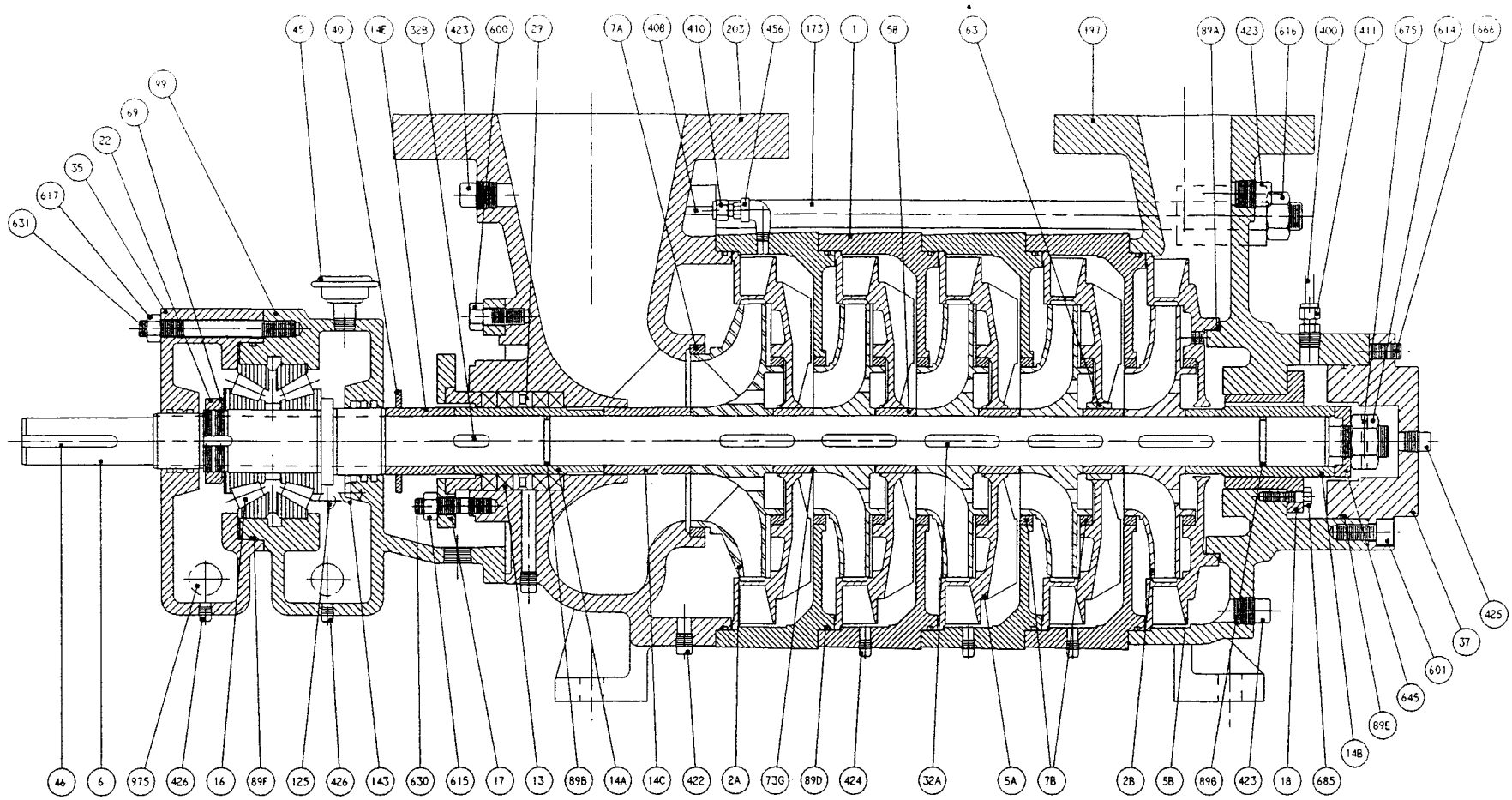
ITEM	DESCRIPTION
1	INTERSTAGE CASE
2A	IMPELLER - 1ST STG.
2B	IMPELLER
5A	DIFFUSER
5B	DIFFUSER - LAST STG.
6	SHAFT
7A	WEAR RING - SUCT. CASE
7B	WEAR RING
14A	SHAFT SLEEVE - SEAL
14B	SHAFT SLEEVE - SLV. BRG.
14C	SLEEVE - SPACER
14E	SLEEVE - SPACER
16	ROLLER BEARING
17	GLAND - SEAL
18	SLEEVE BEARING
22	BEARING LOCKNUT
32A	KEY - IMPELLER
32B	KEY - SLEEVE
35	BEARING COVER
37	END CAP
40	SLINGER
45	VENT
46	KEY - COUPLING
58	SLEEVE - INTERSTAGE
63	BUSHING - DIFFUSER
68	SEAL COLLAR
69	BEARING LOCKWASHER
73F	GASKET - GLAND
73G	GASKET - INTSTG. SLV.
89A	O-RING - LST. STG. DIFF
89B	O-RING - SLEEVE
89D	O-RING - CASING
89E	O-RING - END CAP
89F	O-RING - BRG. COVER
90	MECHANICAL SEAL
99	BEARING HOUSING
125	OILER
143	VIEWPORT
173	TIE BOLT
197	DISCHARGE CASE
203	SUCTION CASE
400	TUBING - BALANCE
408	TUBING - SEAL FLUSH
410	TUBE CONNECTOR - INT. CASE
411	TUBE CONNECTOR - BALANCE
412	TUBE CONNECTOR - GLAND
422	PIPE PLUG - SUCT. CASE
423	PIPE PLUG - SUCT. & DISH.
424	PIPE PLUG - CASE DRAIN
425	PIPE PLUG - END CAP & BRG. CAP
426	MAGNETIC PIPE PLUG - BRG. HSG.
455	PIPE ELBOW - SUCT. CASE (NOT SHOWN)
456	PIPE ELBOW - SEAL FLUSH
600	BOLT - BRG. HSG.- CASE
601	BOLT - END CAP
614	NUT - SHAFT
615	NUT - GLAND
616	NUT - TIE BOLT
617	NUT - BRG. COVER
630	STUD - GLAND
631	STUD - BRG. COVER
645	WASHER - SHAFT
665	SETSCREW - SEAL COLLAR
666	FORCING SCREW - END CAP
675	SPRING PIN - SHAFT NUT
685	CAPSCREW - SLEEVE BEARING
975	HEAT EXCHANGER

* OPTIONAL

NOTE

BOLT (600) IS FOR STANDARD DESIGN PUMPS ONLY.

Figure 12. WKM-80 with Mechanical Seal Sectional Drawing



ITEM	DESCRIPTION
1	INTERSTAGE CASE
2A	IMPELLER - 1ST STG.
2B	IMPELLER
5A	DIFFUSER
5B	DIFFUSER - LAST STG.
6	SHAFT
7A	WEAR RING - SUCT. CASE
7B	WEAR RING
13	PACKING RING
14A	SHAFT SLEEVE - PACKING
14B	SHAFT SLEEVE - SLV. BRG.
14C	SLEEVE - SPACER
14E	SLEEVE - SPACER
16	ROLLER BEARING
17	GLAND - PACKING

ITEM	DESCRIPTION
18	SLEEVE BEARING
22	BEARING LOCKNUT
29	LANTERN RING
32A	KEY - IMPELLER
32B	KEY - SLEEVE
35	BEARING COVER
37	END CAP
40	SLINGER
45	VENT
46	KEY - COUPLING
58	SLEEVE - INTERSTAGE
63	BUSHING - DIFFUSER
69	BEARING LOCKWASHER
73G	GASKET - INTSTG. SLV.
89A	O-RING - LST. STG. DIFF
89B	O-RING - SLEEVE

ITEM	DESCRIPTION
89D	O-RING - CASING
89E	O-RING - END CAP
89F	O-RING - BRG. COVER
99	BEARING HOUSING
125	OILER
143	VIEWPORT
173	TIE BOLT
197	DISCHARGE CASE
203	SUCTION CASE
400	TUBING - BALANCE
408	TUBING - PACKING FLUSH
410	TUBE CONNECTOR - INT. CASE
411	TUBE CONNECTOR - BALANCE
422	PIPE PLUG - SUCT. CASE

ITEM	DESCRIPTION
423	PIPE PLUG - SUCT. & DISH.
424	PIPE PLUG - CASE DRAIN
425	PIPE PLUG - END CAP & BRG. CAP
426	MAGNETIC PIPE PLUG - BRG. HSG.
455	PIPE ELBOW - SUCT. CASE (NOT SHOWN)
456	PIPE ELBOW - PACKING FLUSH
600	BOLT - BRG. HSG.- CASE
601	BOLT - END CAP
614	NUT - SHAFT
615	NUT - GLAND
616	NUT - TIE BOLT
617	NUT - BRG. COVER
630	STUD - GLAND
631	STUD - BRG. COVER
645	WASHER - SHAFT

ITEM	DESCRIPTION
666	FORCING SCREW - END CAP
675	SPRING PIN - SHAFT NUT
685	CAPSCREW - SLEEVE BEARING
975	HEAT EXCHANGER

• OPTIONAL

NOTE

BOLT (600) IS FOR STANDARD DESIGN PUMPS ONLY.

Figure 13. WKM-80 with Packing Sectional Drawing

X. 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 Diameters (list all stages in inches) _____

PUMP MATERIALS

Interstage Casing (1) _____ 1st Stage Impeller (2A) _____ Impeller (2B) _____

Diffuser (5A) _____ Diffuser (5B) _____ Shaft (6) _____

Wear Ring (7A) _____ Wear Ring (7B) _____ Bearing Housing (99) _____

Discharge Casing (197) _____ Suction Casing (203) _____ Shaft Nut (614) _____

Mechanical Seal (90) or Packing Rings (13) _____

MOTOR DATA

Motor _____ Make _____ Serial No. _____

Type _____ Frame _____ AC or DC _____

Volts _____ Phase _____ Cycles _____

HP _____ RPM _____

Notes on Inspection and Repairs

Inspect Date	Repair Time	Repairs	cost	Remarks

Notes: _____

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