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Instruction I-420

INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS FOR MAXUM SERIES PUMPS

PREFACE:

The instructions contained in this manual apply to Carver Pump Company Maxum pumps. Maxum pumps are medium-duty chemical process pumps.

ISO 9001 CERTIFIED

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A. General Description

The Maxum pump 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. The Maxum should be used for pressures at, or below, 300 psi to obtain the maximum benefits.

The Maxum pump is supplied with a foot mounted volute that should always be mounted solidly on an adequate bedplate. No shims should be used under the feet of the casing.

The Maxum pump is designed as a back pullout unit. Therefore it should always be used with a spacer coupling. The spacer width should permit the entire rotating assembly to be removed from the casing. Normally the casing should be left in place on the base and remain connected to the suction and discharge piping.

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 Maxum pump, thus upgrading the quality of pump maintenance and care.

The bare pump consists of following major parts and options. Please refer to figure 2, the Sectional Assembly Drawing for the location of parts identified by item numbers. The part number, quantity, description and material are listed within table 7, the Maxum Pump Parts List.

Item 1 - Casing. The casing (1) houses the impeller (2) and wear ring (7) and consists of the suction inlet, 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) with studs (631) and nuts (616) with lockwashers (655).

Item 2 - Impeller. Maxum 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). The impeller nut gaskets (30)* fit between the impeller nut (24) and the shaft (6). The impeller gaskets (38) fit behind the impeller (2) against the first shoulder of the shaft (6).

Item 71 - Frame Adaptor. The frame adaptor (71) connects the casing (1) to the bearing housing or frame (99) and acts as a bearing cap to the inboard end of the bearing housing or frame (99). The frame adaptor (71) is fastened to the casing (1) with studs (631), nuts (616) and lockwashers (655) and to the backcover (11) with socket head capscrews (600) and lockwashers (658)*. The frame adaptor (71) contains jacking screws (610)* to aid in loosening frame adaptor (71) from casing (1).

Item 11 - Backcover. The backcover (11) is held in place between the casing (1) and the frame adaptor (71). The backcover (11) is positioned in the casing bore by an o-ring 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*; seal accessories* including double, tandem, and balanced versions; and packing rings*.

Item 99 - Bearing Housing or Frame. The principal function of the bearing housing or frame (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 or frame (99) has a radial bearing (16) located in the front end of the house (nearest to the volute) and a pair of back-to-back mounted angular contact thrust bearings (18) in the rear of the housing or frame. This bearing housing or frame (99) is designed to be oil lubricated, which can be accomplished in several ways.

The first method involves the use of a sight glass automatic oiler. The housing or frame is designed so that it can be used with a sight glass automatic oiler. The sight glass 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 to provide an oil flinger which mounts on the shaft and literally flings the oil throughout the bearing frame. An oil view gauge indicator is usually 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 Maxum pumps are equipped so that they can be used or can be converted to oil mist units without any field machining or any added parts.

In addition to the oil lube system, the power frame contains the shaft oil seals or oil containment system. The Maxum pump bearing housing or frame can 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 Maxum pump can also be furnished with a number of labyrinth seal assemblies being offered on the market.

Item 16 and 18 - Bearings. A deep-groove Conrad-type, loose, internal fit radial bearing (16) and light preload, back-to-back mounted thrust bearings (18) are

* Indicates that particular pump configurations may or may not contain part.

housed in the bearing housing or frame (99). The thrust bearings (18) will be designated as 7000 or 8000 series, noted by the part number in table 7. Thrust bearings (18) designated in the 7000 series will be duplex 40 degree angular contact bearings. Thrust bearings (18) designated in the 8000 series will have 40 and 15 degree angular contact. The thrust bearing (18) is held in place by the bearing locknut (22) and bearing lockwasher (69). The bearings are oil lubricated. Either oil bath lubrication or an oil mist system may be employed.

Item 6 - Shaft. The shaft of the Maxum pump 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).

Baseplate. The groutable baseplate is designed to provide adequate support for the pump and motor so pump can be operated without baseplate deflection, excessive vibration, or resonance. When properly grouted, the standard baseplate is reinforced with steel supports and contains a built-in drip channel. 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.

3" x 2" x 10"

- Nominal maximum impeller diameter
- Discharge size
- Suction size

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 Maxum 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 Arrival

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, fill the bearing frame with oil or fog bearings and store equipment in a clean, dry, well-ventilated place, free from vibrations, moisture, and rapid or wide variations in temperature.

Rotate the shaft several revolutions at least once every two weeks to prevent flat spots on ball bearings.

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.

* Indicates that particular pump configurations may or may not contain part.

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 Carver Pump Company for specific instructions. Improper storage could damage the equipment and would result in non-warranty covered restoration requirements or 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.

Pump and driver 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

Do not pick up the complete unit by the driver or pump shafts or eyebolts. Complete units (pump, driver, base-plate) can be lifted by attaching a chain or suitable lifting device to each corner of base structure or by slinging the unit under the baseplate. For lifting pump only (not the complete unit), sling the pump where the bearing housing or frame (99) meets the bearing cap (43) and also immediately behind the suction inlet on the casing (1). Sling pumps with care, making sure that seal lubrication lines (if furnished) will not be bent or damaged when the pump is lifted. The individual driver may be lifted using proper eyebolts provided by the manufacturer, but these should not be used to lift the assembled unit.

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 the Unit

Lower unit onto foundation, positioning base structure so anchor bolts are aligned in 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. Check that driver and pump shafts are in alignment (see paragraph F, this section on coupling alignment). Piping alignment and leveling corrections may be accomplished by adjusting supports under the base. When proper alignment is obtained, tighten foundation bolts snugly, but not too firmly. Recheck alignment before grouting.

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

NOTE

Coupling alignment must be correct for successful operation of the pump. Flexible couplings can absorb only limited misalignment of the shaft and must not be used to compensate misalignment of the pump and driver shafts.

Check alignment of pump and driver shafts. When a spacer type coupling connects the pump to the driver, a dial indicator should be used to check axial and angular alignment (refer to "Coupling" appendix for specific information on coupling alignment):

* Indicates that particular pump configurations may or may not contain part.

1. Remove the extension piece between the coupling halves to expose the coupling hubs.
2. On the pump shaft behind the coupling half, clamp an arm or bracket long enough to extend across the space between the coupling halves.
3. Mount the dial indicator on this arm.
4. Take readings at 90 degree intervals. Angular and axial alignment of the coupling halves must not exceed 0.005 T.I.R. If necessary, bring the unit into alignment by shimming the driver or moving the driver to either side.
5. Mount dial indicator on arm or bracket clamped behind driver coupling half and repeat check of axial and angular alignment.

For coupling gap dimensions and other specific information concerning the coupling on your unit, refer to "Coupling" appendix.

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 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 (see paragraph F, this section).

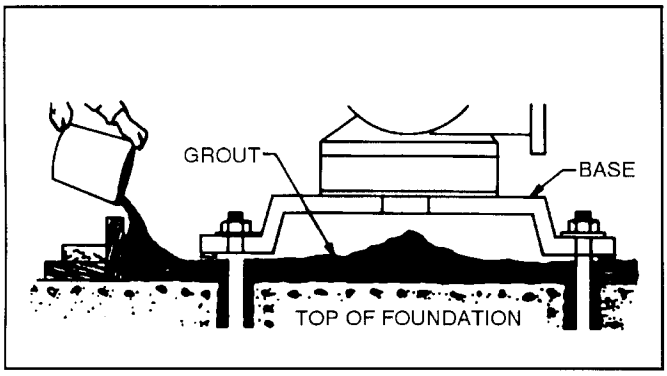


Figure 1. Grouting

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 instead.

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.

* Indicates that particular pump configurations may or may not contain part.

J. Auxiliary Piping Connections and Gauges

Any auxiliary piping connections and gauges should be installed now. Refer to "Seal Piping Plans" appendix for seal line connections to the seal cartridge.

K. Lubrication of Bearings

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 housing or frames empty of oil. ISO Grade 68 or Grade 100 mineral oils are recommended for proper lubrication of the pump. Refer to table 1 for specific recommended oil types.

If a constant level oiler (125)* is to provide bearing lubrication, mount it in place of plug on either side of the bearing housing or frame (99). Connect equalizing tube (404)* from base of oiler (125)* to bearing housing or frame (99). Equalizing tube (404)* provides a closed environment for the bearing housing or frame (99) by accommodating expansion and contraction of vapors without permitting contaminant to enter the bearing housing or frame (99).

If a constant level oiler (125)* is used in conjunction with a magnetic face seal or labyrinth (47), the top port of the bearing housing or frame (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 or frame (99) without permitting moisture and other contaminants to enter.

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

For more information concerning constant level oiler (125)* refer to "Constant Level Oiler" appendix.

If an oil view gauge (143)* is used to provide bearing lubrication, fill with oil until the oil level reaches the middle of the sight glass.

The Maxum pump comes equipped with appropriate connections for the installation of an oil mist system by the customer if oil mist lubrication is desired. Oil mist lubrication provides the greatest protection against contamination by dirt and water.

The top port of the bearing housing or frame (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 or frame (99).

L. Driver

Refer to "Driver" appendix.

IV. Operation

A. Prestart Cautions

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

1. Observe all caution or danger tags attached to the equipment.
2. Before starting the pump, install closed guards around all exposed rotating parts.
3. Before starting the pump, rotate shaft by hand to assure all moving parts are free.
4. 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.
5. Before starting the pump, check for proper priming.
6. If unit is equipped with seal cooling lines turn on seal water, vent seal housing, and confirm the seal water is at sufficient pressure.

Table 1. 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

* Indicates that particular pump configurations may or may not contain part.

7. If excessive vibration or noise occurs during operation, shut the pump down and consult a Carver Pump Company representative.

B. Starting the Pump

1. If unit is equipped with seal cooling lines, turn on seal cooling water.
2. Fully open the suction valve.
3. Check pump for proper priming and lubrication.
4. Start the pump.
5. Slowly open discharge valve and adjust it to the operating conditions required (see pump nameplate for design point condition).

C. Operating Checks

1. Check for undue vibration or noise. If any 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. Check mechanical seals* or packing rings* for leakage.
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. If unit is equipped with a constant level oiler, check oil level in the constant level oiler and refill as required.

D. 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 unit is equipped with seal cooling lines, turn off external cooling water line to seal. For information regarding seal circulation refer to "mechanical seal*" appendix.

E. Indefinite Shutdown

In the even of indefinite shutdown, refer to "mechanical seal*" appendix to see if mechanical seal* should be removed.

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.

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 table 2 to eliminate the most common causes of those problems.

NOTE

For driver troubleshooting, refer to "Driver" appendix.

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 seal.
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 or frame (99). A sudden temperature rise indicates damage that requires checking.
6. If equipped with a constant level oiler (125)*, check oil level in the constant level oiler (125)* and refill as required. Check condition of oil in bearing housing or frame (99). Any irregular findings which cannot be adjusted during operation require pump shutdown.
7. If equipped with an oil view gauge (143)* 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)

1. Under normal conditions, oil in bearing housing or frame (99) should be changed every 4000 hours. To change oil, remove pipe plug (420) at bottom of bearing housing or frame (99), drain

* Indicates that particular pump configurations may or may not contain part.

bearing housing or frame (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 or frame (99) is completely drained of oil, replace pipe plug (420). Fill constant level oiler (125)* reservoir and allow it to fill bearing housing or frame (99). It may take repeated fillings of reservoir to fill bearing housing or frame (99). Refer to section III, paragraph K, for recommended oil types and specific instructions for filling constant level oiler (125)*.

2. Mechanical seal (90)* 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. Refer to "Mechanical Seal" appendix for specific information about the mechanical seal (90)* in your pumping unit. To replace a mechanical seal, the pump must be disassembled. For pump disassembly procedure see paragraph D, this section. For mechanical seal disassembly and installation procedure, see "Mechanical Seal" appendix.
3. New packing rings (13)* 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 slowing and evenly on either side while the pump is running until the area only leaks slightly. If the area does not leak, or if it starts to smoke, loosen the gland nuts slightly. After prolonged service, packing rings* should be replaced, see "Packing" appendix.
4. Refer to a "Driver" appendix for driver lubrication.

C. 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 study Figure 2 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 IV, part D.

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.

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 and gauges.
5. Drain oil from bearing housing or frame (99). If a constant level oiler (125)* or oil view gauge (143)* provides lubrication for bearings, drain oil from the bearing housing or frame by removing pipe plug (420) at bottom of bearing housing or frame (99). If bearings are oil mist lubricated, drainage of bearing housing or frame (99) is continuous.

CAUTION

Use of a hoist with adequate capacity is recommended.

Table 2. Pumping Unit Troubleshooting

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Failure to deliver liquid.	1. Discharge head above shutoff.	1. Check pump rating against actual head condition.
	2. Impeller or suction pipe partially clogged.	2. Inspect impeller and suction pipe and clean.
	3. Pump not up to speed.	3. Check voltage and power consumption for motor overload.
	4. Pump not primed.	4. Prime pump.
	5. Suction valve closed.	5. Open suction valve.
	6. Leaky suction line.	6. Repair connections.

* Indicates that particular pump configurations may or may not contain part.

Table 2. Pumping Unit Troubleshooting (continued)

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Excessive power consumption.	1. Speed too high. 2. Head lower than rating; pumps too much liquid. 3. Specific gravity or viscosity of liquid pumped is too high. 4. Mechanical defects such as bent shaft or rotating element than binds. 5. System head lower than design condition. 6. Incorrect impeller diameter.	1. Check voltage and power consumption and compare with nameplate data. 2. Consult with nearest Carver Pump Company representative or factory. 3. Consult with nearest Carver Pump Company representative or factory. 4. Replace defective parts or replace pump or driver. 5. Consult with nearest Carver Pump Company representative or factory. 6. Replace impeller, or trim impeller to correct diameter. Consult with nearest Carver Pump Company representative before trimming impeller.
Insufficient discharge or flow.	1. Speed too low. 2. Discharge head too high. 3. Suction pipe partially clogged. 4. Wrong direction of rotation. 5. Impeller passage partially clogged. 6. Impeller damaged. 7. Impeller diameter too small. 8. Suction valve not fully open. 9. Suction lift too high. 10. Air leaks into suction piping, seal cartridge, or gaskets. 11. Impeller wear ring clearance excessive. 12. Insufficient net positive suction head. 13. Actual suction pressure lower and/or actual discharge higher than stated for design conditions. 14. Specific gravity or viscosity of pumping fluid too high.	1. Check driver. 2. Consult with nearest Carver Pump Company representative or factory. 3. Inspect, clean, and repair as necessary. 4. Check power connection to driver. Switch two of three leads until direction of rotation is correct. 5. Inspect, clean, and repair as necessary. 6. Replace impeller. 7. Replace impeller. 8. Open valve fully. 9. Reduce suction piping loss. 10. Tighten all connections. Replace gaskets, if necessary. 11. Replace wear ring. 12. Wrong application of pump. Replace with suitable NPSH requirements. 13. Ensure all valves are fully open. Check piping for trapped air pockets, especially at high points. 14. Check pipe friction computation and elevation of heads from pump stated center-line to suction and discharge level. Check pressure in suction source.
Discharge pressure too high or flow capacity excessive.	1. Pump speed too high. 2. Actual suction pressure higher and/or actual discharge pressure lower than stated for design conditions.	1. Check speed of driver. 2. Throttle discharge valve, or install orifice in discharge piping, or provide bypass line with regulating valve for return of excess flow to suction source.

* Indicates that particular pump configurations may or may not contain part.

Table 2. Pumping Unit Troubleshooting (continued)

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Discharge pressure too high or flow capacity excessive (continued).	3. Specific gravity or viscosity of fluid too low. 4. Motor speed too high.	3. Check pumped fluid against that specified in design condition. 4. Correct motor speed.
Loss of suction during operation.	1. Wrong direction of rotation. 2. Suction line leaks. 3. Air or gases in liquid. 4. Air leaks into suction piping, seal cartridge, or gaskets. 5. Seal water line plugged.	1. Check power connection to driver. Switch two of three leads until direction of rotation is correct. 2. Inspect connections and repair. 3. Redesign suction system. 4. Tighten all connections. Replace gaskets, if necessary. 5. Inspect seal water line and clean.
Vibration or noise.	1. Foundation bolts loose. 2. Insufficient or insecure foundation. 3. Ball bearings have insufficient lubrication. 4. Mechanical defects, such as worn ball bearings, bent shaft, or rotating element that binds. 5. Head lower than rating; pumps too much liquid. 6. Pipe strain-improperly aligned or supported piping. 7. Pump running at shut-off condition. 8. Misalignment between driver and pump shafts. 9. Defect in grouting. 10. Pump operating under cavitation.	1. Tighten foundation bolts. 2. Enlarge the foundation or relocate pumping unit so it can be firmly bolted to its foundation. 3. Lubricate bearings according to section III, paragraph K. 4. Replace defective parts or replace pump or driver. 5. Consult with nearest Carver Pump Company representative or factory. 6. Check piping alignment and remove piping weight from pump with proper supports. 7. Consult with nearest Carver Pump Company representative or factory. 8. Check shaft alignment with dial indicator according to section III, paragraph F. 9. Check baseplate grouting for air pockets by sounding off baseplate with hammer. 10. 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.

* Indicates that particular pump configurations may or may not contain part.

Table 2. Pumping Unit Troubleshooting (continued)

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Vibration or noise (continued).	11. Pumped fluid contains solids creating shock load and clogging or damaging impeller. 12. Transient vibration from piping.	11. Install strainer in suction piping. Back--flush pump with clean fluid, or open pump to inspect and clean impeller. 12. Support and secure piping or provide compensators.
Bearing overheating.	1. Excessive oil. 2. Bent shaft. 3. Rotating element binds. 4. Pipe strain. 5. Incorrect type oil. 6. Contaminated oil. 7. Not enough oil.	1. Remove excess oil. 2. Replace shaft. 3. Replace defective parts. 4. Check piping alignment and remove piping weight from pump with proper supports. 5. Refer to section III, paragraph K, for proper maintenance of bearings. 6. Change oil according to section VI, paragraph B. 7. Add oil according to section III, paragraph K.

D. Disassembly of Pump

1. Remove coupling guard and disconnect coupling halves. Remove spacer sleeve between coupling halves.
2. Remove nuts (616) and lockwashers (655) from studs (631) fastening casing (1) to frame adaptor (71). Remove bolts and lockwashers from pump bracket on foundation end. Use jacking screws (610) to loosen rabbet fit of frame adaptor (71) and casing (1). Pull rotating element back from casing (1) and take it to a suitable work area.
3. Remove impeller nut (24). Remove impeller nut gaskets (30)*. Pull impeller (2) from shaft (6). Remove thread insert (200)* from shaft (6). Remove impeller gaskets (38). Note number of gaskets removed. The same number of new gaskets must be installed when reassembling the pump.
4. Refer to "Mechanical Seal" or "Packing" appendix for instructions on removing backcover (11), seal housing (83)* (if equipped), and mechanical seal (90)* or packing rings (13)*.
5. Remove capscrews (601) and lockwashers (656)* fastening frame adaptor (71) to bearing housing or frame (99). Remove frame adaptor (71) and inboard magnetic seal or labyrinth seal (47) from shaft (6). Remove gasket (73) between frame adaptor (71) and bearing housing or frame (99).

CAUTION

Handle inboard magnetic seal or labyrinth seal (47) with care. Mishandling could damage faces of magnetic seal or labyrinth seal (47).

6. Remove inboard magnetic seal or labyrinth seal (47) from frame adaptor (71). Refer to "Magnetic Seal" appendix for instructions concerning magnetic seal. Remove inboard magnetic seal housing (311)* (if equipped) from frame adaptor (71).
7. Remove pump coupling halves and coupling key (46).
8. Remove capscrews (603) fastening bearing cap (43) to bearing housing or frame (99). Remove bearing cap (43) and outboard magnetic seal or labyrinth seal (49) from shaft (6).
9. Remove bearing o-ring (89-C) from bearing housing or frame (99).

CAUTION

Handle outboard magnetic seal or labyrinth seal (49) with care. Mishandling could damage faces of magnetic seal or labyrinth seal (49).

10. Remove outboard magnetic seal or labyrinth seal (49) from bearing cap (43). Refer to "Magnetic Seal" appendix for instructions concerning magnetic seal. Remove outboard magnetic seal housing (310)* (if equipped) from bearing cap (43).

* Indicates that particular pump configurations may or may not contain part.

11. Remove shaft (with radial and back-to-back thrust bearing assemblies) from outboard end of bearing housing or frame (99).
12. Uncrimp tang on bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69).
13. Pull back-to-back thrust bearing (18) from shaft (6).
14. Pull radial bearing (16) from shaft (6).

E. Parts Inspection

1. Inspect bearings (16 and 18) for damage and replace if necessary.
2. Inspect for bent shaft (6) and replace shaft (6) 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 (7) in the casing (1) indicates excessive wear due to abrasion or corrosion, it should be replaced. Measure the outside diameter of the front impeller hub in three places. Measure the inside diameter of the wear ring (7) in the casing (1) with an inside micrometer in three places. If the difference between the high reading of inside diameter of the wear ring and low reading of outside diameter of impeller hub exceeds double the clearances given in table 3, replace the wear ring according to paragraph F, of this section.
5. Inspect mechanical seal* faces, gaskets, and o-rings. They must be in perfect condition. Replace if necessary.
6. Inspect magnetic seals and replace if necessary.
7. Inspect equalizing tube or oil mist lines. Check to be sure there are no obstructions in lines.

F. Replacement of Wear Ring

The Maxum pump has a replaceable wear ring (7) inserted in the casing (1). Refer to table 4 for impeller and wear ring matched materials.

The clearance between the wear ring and 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 E in this section.

The casing (1) must be removed from the base to replace the wear ring (7). To replace the wear ring (7) follow these steps:

1. Disconnect suction and discharge piping. Unbolt casing (1) from base and take casing (1) and impeller (2) to a work area with access to machine shop equipment.
2. Remove setscrews (667) from wear ring (7). Remove the wear ring (7) from the casing (1). This can best be accomplished on a lathe. Take this work to a machine shop.
3. Inspect the impeller hub for damage.
4. Press the new wear ring (7) into casing (1). The beveled edge of the wear ring (7) is installed towards the impeller (2).
5. Drill and tap two holes 180 degrees apart along edge of wear ring (7). Secure new wear ring (7) to casing (1) by inserting setscrews (667) into these holes.
6. 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 T.I.R. maximum to be sure the arbor and impeller are running square.
7. Turn the wear ring surface of impeller (2) until a 63 RMS or better finish is obtained.
8. Measure the outside diameter of the front impeller hub and record this value. See measurement instructions in paragraph E.
9. Mount the casing (1) with new wear ring (7) installed in a lathe. Indicate male rabbet to within 0.002 T.I.R. maximum.
10. Bore wear ring (7) to within the specified tolerance listed in table 3 over the recorded size of the outside diameter of the front impeller hub.
11. Reinstall casing (1) on base and secure with fastener. Reconnect suction and discharge piping.

G. Reassembly of Pump

NOTE

Press only on the inner race of the ball bearings (16 and 18) when installing on shaft. A bearing heater is recommended for installation.

1. Press back-to-back thrust bearing (18) on shaft (6). Secure back-to-back thrust bearing (18) with bearing lockwasher (69) and bearing locknut (22). Crimp tang of lockwasher (69) in groove provided in bearing locknut (22).
2. Press radial bearing (16) on shaft (6).
3. Reinstall shaft (6) in bearing housing or frame (99).
4. Install new bearing o-ring (89C) in groove provided around outboard end of bearing housing or frame (99).
5. Press outboard magnetic seal housing (310)* (if equipped) into bearing cap (43). Reinstall bearing cap (43) on shaft (6), securing it to bearing housing or frame (99) with capscrews (603).

* Indicates that particular pump configurations may or may not contain part.

Table 3. Wear Ring Clearance

MODEL (Suction x Discharge x Maximum Impeller Diameter)	FACTORY STANDARD DIAMETRIC CLEARANCE	
	Minimum	Maximum
1-1/2 x 1 x 6	0.012	0.017
2 x 1-1/2 x 6	0.015	0.019
3 x 1-1/2 x 6	0.014	0.019
3 x 2 x 6	0.016	0.021
4 x 3 x 6	0.016	0.021
1-1/2 x 1 x 8	0.012	0.018
2 x 1-1/2 x 8	0.012	0.017
3 x 1-1/2 x 8	0.014	0.017
3 x 2 x 8	0.016	0.021
4 x 3 x 8	0.017	0.022
6 x 4 x 8	0.017	0.022
2 x 1-1/2 x 10	0.012	0.017
3 x 1-1/2 x 10	0.015	0.019
3 x 2 x 10	0.016	0.021
4 x 3 x 10	0.017	0.022
6 x 4 x 10	0.018	0.023
6 x 6 x 10	0.018	0.023
8 x 6 x 10	0.019	0.024
2 x 1-1/2 x 13	0.016	0.021
3 x 2 x 13	0.016	0.021
4 x 3 x 13	0.017	0.022
6 x 4 x 13	0.018	0.023
6 x 6 x 13	0.018	0.023
8 x 6 x 13	0.020	0.025
8 x 6 x 16	0.020	0.026
10 x 8 x 13	0.021	0.026
10 x 8 x 16	0.022	0.027
10 x 8 x 20	0.022	0.027

Table 4. Impeller and Wear Ring Matched Materials

IMPELLER MATERIAL	WEAR RING MATERIAL
WCB steel	Cast iron
316 stainless steel	17-4PH or Alloy-20
CD4MCu	17-4PH or Alloy-20 or Hastelloy
Alloy-20	Monel or Hastelloy
Hastelloy B	Hastelloy D
Hastelloy C	Hastelloy D

CAUTION

Handle outboard magnetic seal or labyrinth seal (49) with care. Mishandling could damage faces of magnetic seal or labyrinth seal (49).

6. Install outboard magnetic seal or labyrinth seal (49) in bearing cap (43). See "Magnetic Seal" appendix for instructions concerning magnetic seal.
7. Press inboard magnetic seal housing (311)* (if equipped) in frame adaptor (71).

* Indicates that particular pump configurations may or may not contain part.

8. Install new gasket (73) on shaft (6) to fit between bearing housing or frame (99) and frame adaptor (71). Reinstall frame adaptor (71) on shaft (6). Secure frame adaptor (71) to bearing housing or frame (99) with lockwashers (656)* and capscrews (601).
9. Reinstall inboard magnetic seal or labyrinth seal (47) in frame adaptor (71). See "Magnetic Seal" appendix for instructions concerning magnetic seal.
10. Refer to "Mechanical Seal" or "Packing" appendix for instructions on installing backcover (11), seal housing (83)* (if equipped), and mechanical seal (90)* or packing rings (13)*.
11. Reinstall impeller key (32) in keyway on shaft (6). Install new thread insert (200)* on shaft (6).
12. Install new impeller nut gaskets (30)* and impeller gaskets (38). Install same number of gaskets as removed during disassembly.
13. Reinstall impeller (2) on shaft (6). Secure impeller (2) with impeller nut (24).
14. Reinstall rotating element in casing (1). Secure frame adaptor (71) to casing (1) with nuts (616) and lockwashers (655) on studs (631).
15. Rotate shaft (6) by hand to insure shaft (6) rotates freely and no rubbing noises are present.
16. Align coupling according to section III, paragraph F. Reinstall coupling and coupling guard.

Table 5. Recommended Torque Values

(80% of max. spec. values for low carbon steels)

FASTENER SIZE	TORQUE (FOOT-POUNDS)
3/8 - 16 UNC	15
1/2 - 13 UNC	30
5/8 - 11 UNC	65

17. Remove all tags from valves and switches.
18. Start pumping unit in accordance with section IV, part B.

H. Torque Values

Refer to table 5 for recommended torque values.

I. 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 6. Part numbers listed in table 6 correspond to part numbers on figure 2.

J. Parts Ordering

When ordering replacement parts, please specify:

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

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

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.

* Indicates that particular pump configurations may or may not contain part.

Table 6. Recommended Spare Parts

QUANTITY	ITEM NO.	DESCRIPTION
1	90	Mechanical seal*
as required	13	Packing ring*
1	16, 18	Radial bearing and thrust bearing
1	24	Impeller nut
1	2	Impeller
1	7	Wear ring
as required	30, 38	Gaskets - Impeller and impeller nut
2	47A, 47B, 49A, 49B	Magnetic seals, inboard and outboard
1	89A, 89B*, 89C, 89D*, 89E*	O-rings
1	73	Gasket
1	200	Thread Insert

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 in 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

Refer to table 7 for the parts list of the Maxum pump. Refer to sectional drawing, figure 2, for location of parts. Part numbers in parts list match numbers in figure 2.

* Indicates that particular pump configurations may or may not contain part.

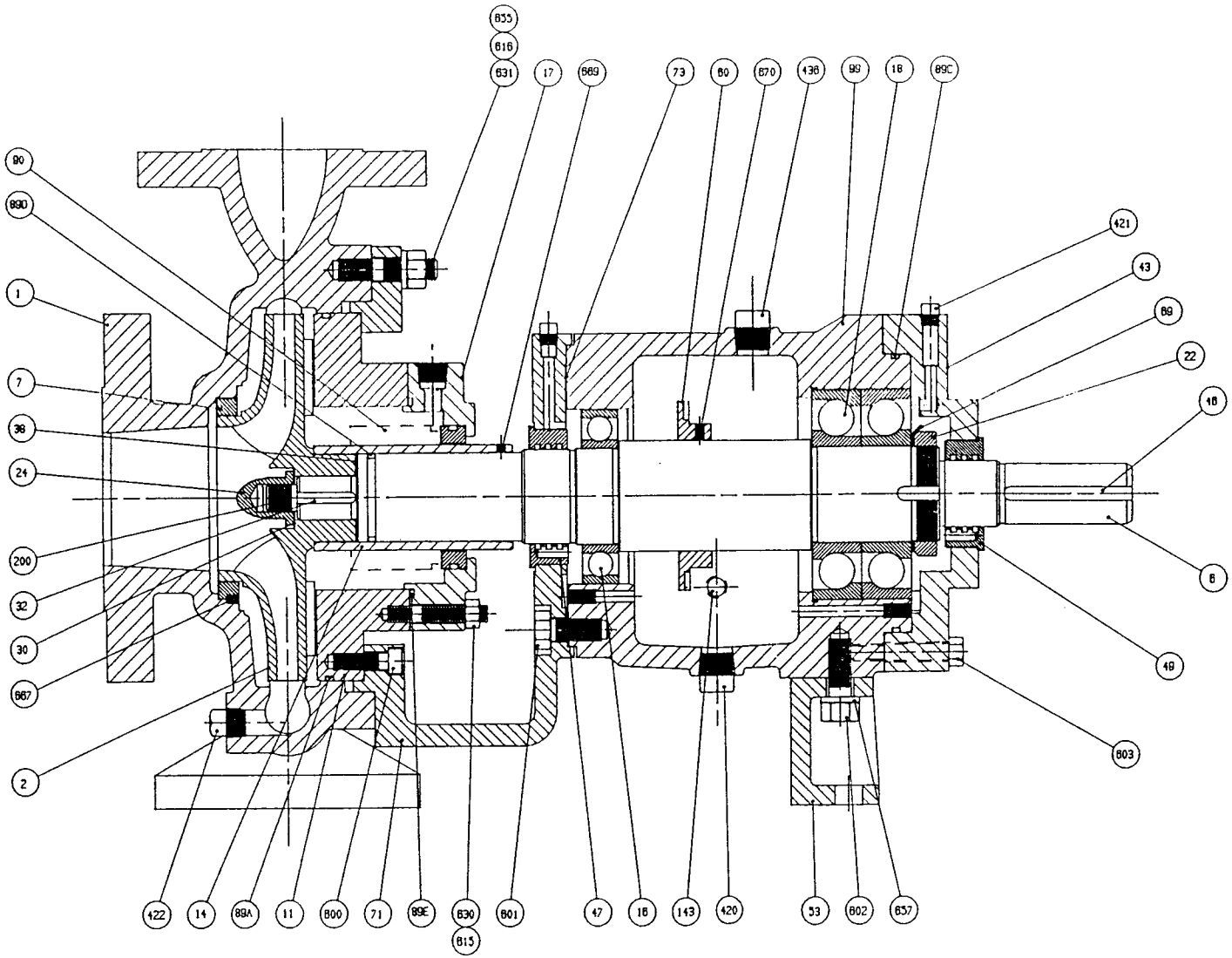
Table 7. Maxum Parts List**

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
1	Casing	2	Impeller
6	Shaft	7	Wear ring
11*	Back cover	14*	Shaft sleeve
16	Radial bearing	17*	Gland
18	Thrust bearing	22	Bearing locknut
24	Impeller nut	30	Gasket - impeller nut
32	Impeller key	38	Gasket - impeller
43	Bearing cap	45*	Breather
46	Coupling key	47	Magnetic seal or labyrinth seal (inboard)
49	Magnetic seal or labyrinth seal (outboard)	53	Frame foot
68*	Sleeve collar	69	Bearing lockwasher
71	Frame adaptor	73	Gasket (frame adaptor to bearing housing)
83*	Seal housing	89A	O-ring (back cover or seal housing)
89B*	O-ring (seal cover)	89C	O-ring (bearing housing)
89D*	O-ring (sleeve)	89E*	O-ring (gland)
90	mechanical seal*	99	Bearing housing
106*	Setscrew (bearing frame)	125*	Oiler
143*	View gauge	200	Threaded insert
310*	Magnetic seal housing (outboard)	311*	Magnetic seal housing (inboard)
400*	Recirc. pipe	404*	Tube (oiler)
415*	Tube connector	420	Magnetic pipe plug
421	Pipe plug	422	Pipe plug
430*	Pipe plug (bearing frame vent)	436*	Pipe plug (bearing frame)
455*	90 degree elbow	486*	Pipe nipple
487*	Pipe nipple	600	Capscrew (frame adaptor to back cover)
601	Capscrew (frame adaptor to bearing housing)	602	Capscrew (frame foot to bearing housing)
603	Capscrew (bearing cap to bearing housing)	604*	Capscrew (back cover to seal housing)
610*	Capscrew (jacking screw)	615*	Nut (gland)
616	Nut	630*	Stud (gland)
631	Stud (frame adaptor to casing)	655	Lockwasher
656	Lockwasher	657	Lockwasher
658*	Lockwasher	667	Wear ring setscrew
668*	Setscrew (bearing frame)	669*	Setscrew (sleeve)

* Indicates that configuration of a particular pump may or may not include part.

Indicates that this table is only a **sample parts list. A specific parts list is written for each order. The parts list would contain the item number, part number, quantity, description and material.

* Indicates that particular pump configurations may or may not contain part.



ITEM	DESCRIPTION
1	VOLUTE
2	IMPELLER
6	SHAFT
7	VOLUTE WEAR RING
11	BACKCOVER
14	SHAFT SLEEVE
16	RADIAL BEARING
17	SEAL GLAND
18	THRUST BEARING
22	BEARING LOCKNUT
24	IMPELLER NUT
30	GASKET - IMP. NUT
32	IMPELLER KEY
38	GASKET - IMPELLER
43	BEARING CAP
46	COUPLING KEY
47	BEARING ISOLATOR - IB.
49	BEARING ISOLATOR - OB.
53	FRAME FOOT
60	OIL FLINGER
69	BEARING LOCKWASHER
71	FRAME ADAPTOR
73	GASKET - FR. ADAPTOR
89A	O-RING - BACKCOVER
89C	O-RING - BRG. CAP
890	O-RING - SHAFT
89E	O-RING - GLAND
90	MECHANICAL SEAL
99	BEARING FRAME
143	OIL VIEW SIGHT
200	THREAD INSERT
420	MAGNETIC PIPE PLUG - BRG. FR. DRAIN
421	PIPE PLUG - BRG. CAP
422	PIPE PLUG - VOLUTE
438	PIPE PLUG - FRAME VENT
800	CAPSCREW - ADPT. - BACKCOVER
801	CAPSCREW - ADPT. - BRG. FRAME
802	CAPSCREW - FRAME FOOT
803	CAPSCREW - BRG. CAP
815	HEX NUT - SEAL GLAND
816	HEX NUT - VOLUTE
830	STUD - GLAND
831	STUD - VOLUTE
855	LOCKWASHER - VOLUTE
857	LOCKWASHER - FRAME FOOT
667	SETSCREW - WEAR RING
869	SETSCREW - SHAFT SLEEVE
870	SETSCREW - OIL FLINGER

Sample only.

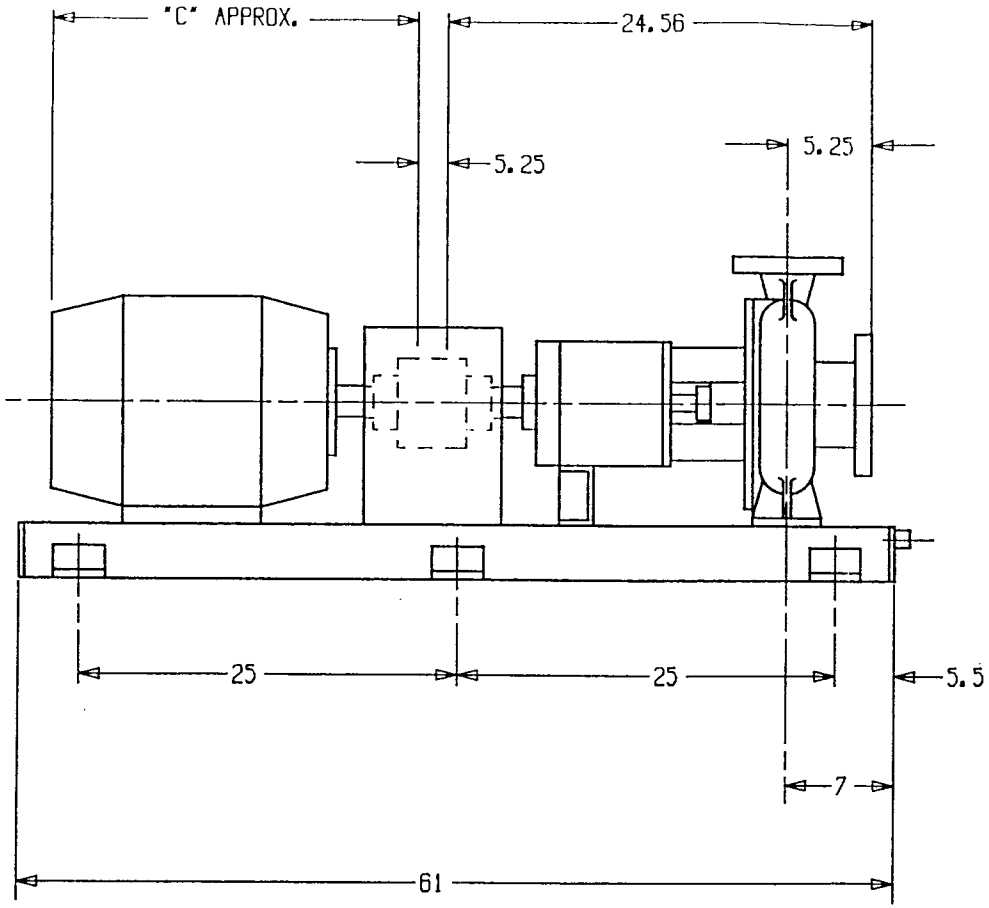
CARVER PUMP COMPANY
MUSCATINE, IOWA U.S.A.

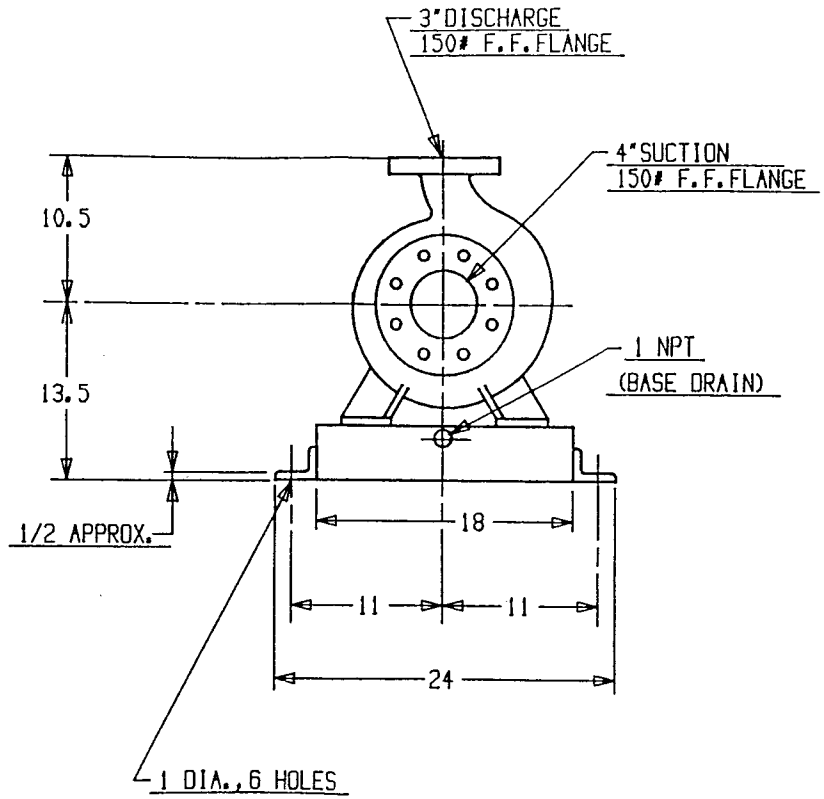
DRAWN BY: D.A.E.	DATE: 8/15/80
CHECKED BY:	SCALE: 1:1

SECTIONAL ASSEMBLY
MAXUM - STD.
W/SINGLE SEAL ON SLEEVE

F

Figure 2. Sectional Assembly





Sample only.

MOTOR	C
254T	23
256T	25

CARVER PUMP COMPANY	
MUSCATINE, IOWA	
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CHECKED;	SCALE; NONE
MAXUM 4 X 3 - 10 B-FRAME ON #3 BASE W/254T-256T MOTOR	
B	

Figure 3. Outline Drawing

IX. Pump Service Record

Serial No. _____ Size and Type _____ Make Maxum _____

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

Volute _____ Backcover _____ Frame Adaptor _____

Impeller Nut _____ Shaft _____ Impeller _____

Bearing Housing _____ Wear Ring _____

Mechanical Seal _____

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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