INSTALLATION, OPERATION, AND MAINTENANCE MANUAL
WITH PARTS LIST

GORMAN-RUPP
PUMPS
SUBMERSIBLE PUMPS

MODEL
S6A1 460V 3P

THE GORMAN-RUPP COMPANY • MANSFIELD, OHIO
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This Installation, Operation, and Maintenance Manual is designed to help you achieve the best performance and longest life from your Gorman-Rupp pump.

This pump is designed to operate fully or partially submerged. It is capable of handling most nonvolatile and nonflammable liquids which are mildly corrosive and abrasive. The basic material of construction is aluminum with ductile iron or steel wearing parts. The integral 60 Hertz electric motor must be operated through the control box furnished with the pump. Neither the pump nor the control box are explosion proof and should not be operated in a hazardous atmosphere.

If there are any questions regarding the pump or motor which are not covered in this manual or in other literature accompanying this unit, please contact your Gorman-Rupp distributor or the Gorman-Rupp Company:

The Gorman-Rupp Company or Gorman-Rupp of Canada Limited
P.O. Box 1217 70 Burwell Road
Mansfield, Ohio 44901-1217 St. Thomas, Ontario N5P 3R7

The following are used to alert maintenance personnel to procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel:

NOTE

Instructions to aid in installation, operation, and maintenance or which clarify a procedure.

CAUTION

Instructions which must be followed to avoid causing damage to the product or other equipment incidental to the installation. These instructions describe the requirements and the possible damage which could result from failure to follow the procedures.

WARNING

These instructions must be followed to avoid causing injury or death to personnel, and describe the procedure required and the injury which could result from failure to follow the procedure.
WARNINGS - SECTION A

THESE WARNINGS APPLY TO THE "S-SERIES" SUBMERSIBLE MOTOR OPERATED PUMPS.

WARNING

Before attempting to open or service the pump:

1. Familiarize yourself with this manual.
2. Lock out the power supply to the control panel to ensure that the pump will remain inoperative.
3. Allow the pump to cool if overheated.
4. Close the discharge valve (if used).

WARNING

Do not attempt to pump volatile or flammable liquids for which this pump has not been designed.

WARNING

After the pump has been installed, make certain that the pump and all piping or hose connections are secure before operation.

WARNING

The pump motor is designed to be operated through the control box furnished with the pump. The control box provides overload protection and power control. Do not connect the pump motor directly to the incoming power lines.
WARNING

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All electrical connections must be in accordance with the National Electric Code and all local codes. If there is a conflict between the instructions provided and N.E.C. specifications, N.E.C. specifications shall take precedence. All electrical equipment supplied with this pump was in conformance with N.E.C. requirements in effect on the date of manufacture. Failure to follow applicable specifications, or substitution of electrical parts not supplied or approved by the manufacturer, can result in severe injury or death.

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WARNING

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The electrical power used to operate this pump is high enough to cause injury or death. Make certain that the control box is grounded, and that the power supply is compatible with the motor phase and voltage, before connecting the power source. If the overload unit is tripped during pump operation, correct the problem before restarting the pump.

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WARNING

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Obtain the services of a qualified electrician to connect the electrical circuits, and to service the control box.

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WARNING

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Do not attempt to lift the pump by the motor power cable or the piping. Attach proper lifting equipment to the hoisting bail fitted to the pump.
INSTALLATION - SECTION B

This section is intended only to summarize recommended installation practices for the pump and control box. If there are any questions concerning your specific installation, contact your Gorman-Rupp distributor or the Gorman-Rupp Company.

Automatic liquid level devices are not furnished with the standard pump, but are available from Gorman-Rupp as options (see Liquid Level Devices, Section B); for information on installing and operating these devices, see the technical data accompanying that option.

PREINSTALLATION INSPECTION

The pump assembly and control box were inspected and tested before shipment from the factory. Before installation, check for damage which may have occurred during shipment. Check as follows:

a. Check the pump assembly for cracks, dents, damaged threads, and other obvious damage.

b. Check for and tighten loose attaching hardware. Since gaskets tend to shrink after drying, check for loose hardware at mating surfaces.

c. The standard pump is connected to the control box with 50 ft. of power cable. Inspect the cable for cuts or damage.

d. Check the control box for cracks, dents, and other obvious damage.

e. Check that all control box components are securely attached to their mounting surfaces, and that the electrical connections are tight and free of corrosion.

f. Compare the amperes, phase, voltage, and hertz indicated on the motor name plate to the ratings indicated for the control box.

g. Carefully read all tags, decals, and markings on the pump assembly and the control box, and perform all duties indicated.

h. Check the pump and motor for any oil leaks. An oil leak may indicate a cut O-ring or other damage.

i. If the pump and control box have been stored for more than 12 months, some of the components or lubricants may have exceeded their maximum shelf life. These must be inspected or replaced to insure maximum pump service.

If the maximum shelf life has been exceeded, or if anything appears to be abnormal, contact your Gorman-Rupp distributor or the factory to determine the repair or updating policy. Do not put the pump into service until appropriate action has been taken.
Lubrication

There are two lubrication cavities in this pump, both contain premium quality submersible pump oil. The motor housing cavity provides lubrication to the motor assembly and rotor shaft bearings. The intermediate cavity provides lubrication to the seal assembly.

There are two shaft seals in this pump. The lower seal prevents liquid from entering the intermediate cavity at the impeller end. The upper seal prevents oil leakage from the motor housing cavity and acts as back-up protection in the event of lower seal failure.

Both cavities are fully lubricated when the pump is shipped from the factory. Check lubrication levels before installing the pump (see LUBRICATION in MAINTENANCE AND REPAIR). An additional quart of oil has been provided with the pump to "top off" the oil cavities. If either oil level is abnormally low, determine the cause before putting the pump into service.

PUMP INSTALLATION

Pump Specifications

See Table 1 for the typical pump specifications motor data.

Table 1. Pump Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Voltage/Phase</th>
<th>Pump Horsepower</th>
<th>Motor Speed (RPM)</th>
<th>Full Load Amperes</th>
<th>No Load Amperes</th>
<th>Locked Rotor Amperes</th>
<th>Discharge Size (NPT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S6A1</td>
<td>460/3</td>
<td>60</td>
<td>1750</td>
<td>65</td>
<td>15</td>
<td>265</td>
<td>6</td>
</tr>
</tbody>
</table>

Pump Dimensions

The standard pump is provided with a suction strainer to prevent large solids from clogging the impeller. On high discharge head applications, the strainer can be replaced with an optional staging adaptor to allow one pump to feed another.

See Figure 1 on page B-3 for the approximate physical dimensions of the pump.
Figure 1. Pump Model S6A1 460V 3P

Lifting

Use lifting equipment with a capacity of at least 4,000 pounds. This pump weighs approximately 785 pounds, not including the weight of accessories and control box. Customer installed equipment such as rigid piping must be removed before attempting to lift.
WARNING

// Do not attempt to lift the pump by the motor power cable //
// or the piping. Attach proper lifting equipment to the //
// hoisting bail fitted to the pump. If chains or cable //
// are wrapped around the pump to lift it, make certain //
// that they are positioned so as not to damage pump, and //
// so that the load will be balanced. //

Positioning The Pump

This pump is designed to operate fully or partially submerged. It may also be operated in air for extended periods. The rotating parts are oil lubricated, and the motor is cooled by a constant flow of liquid or air discharged through internal passage(s).

The pump will operate if positioned on its side, but this is not recommended because the motor torque could cause the pump to roll during operation.

The pump should be independently secured and supported by the hoisting bail. If the application involves a lot of debris, protect the pump from excessive wear and clogging by suspending it in a perforated barrel or culvert pipe. If the bottom is heavily sludge-covered, rest the pump on support blocks or suspend it from a raft or similar device near the surface of the liquid. See Figure 2 on page B-5 for typical pump installations.
Figure 2. Typical Pump Installations.

All liquid entering the pump must pass through a strainer screen. Any spherical solids which pass through the screen will pass through the pump.

NOTE

Before actual operation, check the direction of impeller rotation to ensure that the pump is properly wired to the control box. See Checking Pump Rotation in OPERATION section.

Piping

No suction piping is required in a standard submerged application.

If an optional suction staging adaptor is installed, the discharge from one pump may be piped to the suction of another. To determine the size of the discharge connection, see Table 1, PUMP SPECIFICATIONS. Either hose or rigid pipe may be used. To facilitate mobility and maintenance, it is recommended that the discharge line be fitted with a quick disconnect fitting near the pump. The discharge line must be independently supported to avoid strain and vibration on the pump.
For maximum pumping capacity, keep the discharge as short and straight as possible. Minimize the use of elbows and fittings which increase friction losses through the discharge piping system.

It is recommended that a check valve or throttling valve be installed in the discharge line to control siphoning or back flow when the pump is shut off.

CONTROL BOX INSTALLATION

This pump is driven by an integral 460 VAC, 60 hertz, 3 phase, 60 HP motor. It is designed to operate through the control box furnished with the pump.

WARNING

The pump motor is designed to be operated through the control box furnished with the pump. The control box provides overload protection and power control. Do not connect the pump motor directly to the incoming power lines.

Enclosure

The control box is a rainproof enclosure with padlockable front cover. The enclosure is not designed to be watertight, and should not be submerged. See Figure 3 on page B-7 for enclosure dimensions and callouts.

Secure the control box vertically on a level surface, which is above flood level. It should be easily accessible to the operator, and located close enough to the pump to avoid excessive voltage drop due to cable length. (See Pump Power Cable Connections). After the box is installed, make certain the front cover latches properly.

CAUTION

Failure to mount the control box vertically on a level surface may affect operation of the pump controls.
Figure 3. 27515–505 Control Box Assembly
Grounding Methods

Electrically ground the installation before connecting the field wiring to the control box. Install a grounding terminal to the enclosure and connect it to a properly imbedded electrode.

The material used for the electrode must be an excellent conductor of electricity, such as copper. If iron or steel is used, it must be galvanized or otherwise metal plated to resist corrosion. Do not coat the electrode with any material of poor conductivity such as paint or plastic.

The electrode must conform to the recommendations of N.E.C. Article 250. Follow all installation requirements of the N.E.C., and all applicable local codes. See Figure 4 for some suggested grounding methods.

![Diagram of grounding methods]

Figure 4. Suggested Grounding Methods

a. **Plate Electrode**: An iron or steel plate, 1/4 inch thick, completely imbedded in the ground. The plate must present a surface of at least 2 square feet.

b. **Driven Electrode**: A rod or pipe, 3/4 inch diameter minimum, 8 feet long, completely driven into the ground.

c. **Buried Electrode**: If rock or stone prevents imbedding the full 8 foot length of the ground rod, bury it in a horizontal trench.

Space the ground rod or plates at least 6 feet from any other electrode or ground rod, such as those used for signal circuits, radio grounds, lightning rods, etc.

The earth surrounding the ground rod or plate must contain enough moisture to make a good electrical connection. In dry or sandy areas, pour water around the rod or consult qualified personnel to devise a method of improving the connection.
WARNING
/// The electrical power used to operate this pump is high
/// enough to cause injury or death. Make certain that the
/// control box is properly grounded after installation.
///

Field Wiring Connections (Incoming Power)

WARNING
/// The electrical power used to operate this pump is high
/// enough to cause injury or death. Obtain the services of
/// a qualified electrician to make all electrical con-
/// nections. Make certain that the pump and enclosure are
/// properly grounded, and that the incoming power matches
/// the requirements of the pump and control.
///

The pump control is designed to regulate a 460 volt, 3-phase, 60 hertz power supply. The field wiring must be properly sized to insure an adequate voltage supply. The voltage available at the motor must be within the range indicated in Table 2.

To calculate the voltage available at the motor proceed as follows:

a. Measure the incoming voltage across lines (1 & 2, 2 & 3, and 1 & 3) while the pump is operating at full capacity. See Figure 5 on page B-12.

b. Next, subtract the motor cable voltage drop (see Table 3, Motor Cable Specifications).

c. Do not continue to operate the pump if this voltage is not within the recommended limits. Obtain the services of a qualified electrician to determine the correct field wiring size and other details to insure an adequate voltage supply to the pump.

Table 2. Pump Motor Voltage Limits

<table>
<thead>
<tr>
<th>Nominal Voltage</th>
<th>Phase</th>
<th>Minimum Voltage</th>
<th>Maximum Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>460</td>
<td>3</td>
<td>420</td>
<td>500</td>
</tr>
</tbody>
</table>

Use conduit or cable clamps to secure the incoming field wiring to the control box. Make certain all connections are tight and that cable entry points are
rainproof. Support the cable weight, if required, to prevent excessive strain on cable clamps and cable.

Pump Power Cable Connections

WARNING

The electrical power used to operate this pump is high enough to cause injury or death. Make certain that incoming power is OFF and LOCKED OUT before connecting power or accessory cables to the control box. Obtain the services of a qualified electrician to make all electrical connections.

The standard pump is provided with a 50-foot power cable sealed by heat-shrink tubing in the terminal housing assembly. (See Table 3 for cable specifications.) If a longer power cable is required, an optional cable assembly must be ordered from the factory. Splicing of the power cable is not recommended by the Gorman-Rupp Company due to safety and warranty considerations.

WARNING

Never attempt to alter the length or repair any power cable with a splice. The pump motor and cable must be completely waterproof. Injury or death may result from alterations.

Table 3. Cable Requirements for Pump Electrical Connections, Model S6A1

<table>
<thead>
<tr>
<th>Voltage/Phase</th>
<th>A.W.G. Cable Size</th>
<th>Cable OD (inches)</th>
<th>Conductor Dia. (inches)</th>
<th>Amp Rating* at 40°C (amperes)</th>
<th>DC Resistance at 25°C (ohms/1000 ft)</th>
<th>Voltage Drop at Max. Load per 100 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>460/3</td>
<td>6</td>
<td>1.01</td>
<td>0.21</td>
<td>79</td>
<td>0.45</td>
<td>5.85</td>
</tr>
</tbody>
</table>

*Applies only to GGC type cable. Refer to manufacturer's specifications for other cable.

Before connecting the pump power cable to the control box, make certain the incoming power is OFF and LOCKED OUT. Make certain the control box is PROPERLY GROUNDED and that the electrical data on the control matches the motor name plate data.

Connect the pump power cable to the control box as shown in Figure 5 on page B-12. Use conduit or cable clamps to secure the power and accessory cables to
the control box. Make certain that all connections are tight and that cable entry points are rainproof.

NOTE

The power cable furnished with this pump includes three electrical conductors (white, red, and black), two grounding conductors (green) and one ground check conductor (yellow). The yellow ground check lead is used in conjunction with customer supplied ground monitoring equipment. If this equipment is not used, the yellow lead should be connected with the green leads and used as a ground conductor.

LIQUID LEVEL DEVICES

The standard pump is not furnished with a means to automatically regulate liquid level. However, the pump may be controlled to perform filling, or dewatering functions by using either of the following optional sensing devices: (see Figure 5 on page B-12).

- **Diaphragm Type**: two fixed position sensors (upper and lower) each contain a diaphragm which flexes with changes in liquid level, thus activating an enclosed miniature switch.

- **Bulb (Float) Type**: a bulb raises or lowers (floats) with the liquid level, thus activating an enclosed miniature switch.

For added safety, the sensing devices operate through low voltage 24 volt circuitry which is specially designed to fit into the main pump control box.

The circuitry may be prewired as a factory option, or easily added in the field by qualified personnel. For installation and operation, see the detailed instructions included with the optional package.

CAUTION

Liquid level devices MUST be positioned far enough apart to allow 10 minutes between starts. If the pump motor cycles more than 6 starts per hour, it will overheat resulting in damage to the motor windings or control box components.
Figure 5. Liquid Level Devices

CAUTION

The internal wiring of the sensing devices are different for filling and dewatering functions. Be sure to follow the instructions included with the option before making wiring connections.
Figure 6. Magnetic Controller Connection Diagram
For Control Box 27515-505
Figure 7. Magnetic Controller Elementary Diagram
Based On Figure 6 on page B-13
REPAIR PARTS LIST, INTERNAL PARTS
27515-505 CONTROL BOX ASSEMBLY
(Unless Otherwise Specified, Components Identified By Cutler Hammer Part Numbers)

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>PART NAME</th>
<th>PART NUMBER</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CIRCUIT BREAKER — 100 AMP</td>
<td>C370HMCP3</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>MOTOR STARTER</td>
<td>AN16KNOA</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>CONTACTOR — 3 POLE</td>
<td>CN15KN3A</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>RENEWAL CONTACT SET</td>
<td>6-43-2</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>COIL</td>
<td>9-2756-1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>OVERLOAD RELAY</td>
<td>10-6530</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>HEATER PACK (G-R PART NUMBER)</td>
<td>27521-210</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>CONTROL TRANSFORMER</td>
<td>C340DG1</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>&quot;MOTOR RUN&quot; PILOT LIGHT</td>
<td>10250T34R</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>&quot;MOTOR RUN&quot; LEGEND PLATE</td>
<td>10250TM81</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>TERMINAL BLOCK</td>
<td>80-5817</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>H-O-A SELECTOR SWITCH</td>
<td>10250T21KB</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>&quot;HAND-OFF-AUTO&quot; LEGEND PLATE</td>
<td>10250TM51</td>
<td>1</td>
</tr>
</tbody>
</table>
OPERATION - SECTION C

CONTROL BOX FUNCTION

WARNING

This pump motor and control box are not designed to be explosion proof. Do not operate in an explosive atmosphere.

A control box is provided to facilitate operation of the pump. It contains controls for starting and stopping the pump, and provides overload protection for the pump motor. The pump control may be equipped with an optional automatic liquid level sensing device, in which case the low voltage circuits are also contained within the control box.

WARNING

The pump motor is designed to be operated through the control box furnished with the pump. The control box provides overload protection and power control. Do not connect the pump motor directly to the incoming power lines.

CAUTION

Since operation of the pump motor is dependent upon the quality and performance of the electrical controls, the pump warranty is valid only when controls have been specified or provided by the Gorman-Rupp Company.

Component Function

The control box contains the following hand operated switches and controls:

- The control handle operates the control box circuit breakers. In the OFF position, the control handle opens the circuit breakers to interrupt incoming power through the control box and prevent pump operation. In the ON position, it closes the circuit breakers to permit pump operation. The circuit breakers will open or "TRIP" automatically in the event of a short circuit overload current, or thermal excess within the pump motor or electrical system. When tripped, move the control handle to OFF and back to ON to reset the circuit breakers.
• The selector switch (optional on some boxes) controls the mode of operation. In the OFF position, it prevents all operation of the pump. In the HAND position, it allows the pump to run continuously. In the AUTO position, it allows the pump to be controlled automatically by the optional liquid level control system, if used.

• The RESET pushbutton resets the motor overload relay after it has been "TRIPPED" by an overload. The overload relay will trip automatically if the current drawn by the motor exceeds design specifications.

NOTE

If the circuit breaker trips, do not reset it immediately. Wait at least ten minutes before resetting the control handle back to the ON position. If the overload unit continues to trip, operational problems exist. See TROUBLESHOOTING.

WARNING

The motor will restart as soon as the RESET pushbutton is pressed, unless the selector switch is in the OFF position. Turn the selector switch to OFF and move the control handle to OFF before approaching the pump.

The liquid level devices (optional equipment) operate in conjunction with the 3-position switch (HAND-OFF-AUTO) supplied as a part of that option. After the level sensors and circuitry have been installed, pump operation may be automatically controlled for filling or dewatering functions. (See LIQUID LEVEL DEVICES, Section B.)

PUMP OPERATION

WARNING

This pump is designed to handle most non-volatile and non-flammable liquids which may be mildly corrosive and abrasive. Do not attempt to pump liquids which may damage the pump or endanger personnel as a result of pump failure.

Liquid Temperature And Overheating

The maximum liquid temperature for this pump is 120°F. Do not apply it at a higher operating temperature.
Overheating can occur if the pump is misapplied, required to start repeatedly, or if the control box fails to provide adequate protection. Operating the pump against a closed discharge for extended period will also cause the pump to overheat.

As a safeguard against rupture or explosion due to heat, this pump is equipped with a pressure relief valve which will open if vapor pressure within the pump motor reaches a critical point. If overheating does occur, stop the pump immediately and allow it to cool before servicing it. Approach any overheated pump cautiously.

WARNING

Overheated pumps can cause severe burns and injury. If overheating of the pump occurs:

1. Stop the pump immediately.
2. Allow the pump to cool.
3. Refer to instructions in this manual before restarting the pump.

It is recommended that the pressure relief valve assembly be replaced at each overhaul, or any time the pump motor overheat and activates the valve. Never replace this valve with a substitute which has not been specified or provided by the Gorman-Rupp Company.

Checking Pump Rotation

Check the direction of pump rotation before operation to ensure that the impeller is rotating in the correct direction.

Suspend the pump from the hoisting bail. Turn it on momentarily and note the direction of twist. For correct rotation and operation, the twist must be in the counterclockwise direction when viewed from the top.

CAUTION

Secure the pump during rotation check to prevent coiling of the power cable.

If the pump twists clockwise on start, interchange any two motor leads at the control box.
WARNING

The electrical power used to operate this pump is high enough to cause injury or death. Make certain that incoming power is OFF and LOCKED OUT before interchanging motor leads.

Figure 1. Checking Pump Rotation

STARTING

After the pump and control box have been installed, start the pump as follows.

NOTE

Before actual operation, check the direction of impeller rotation to ensure that the pump is properly wired. See Checking Pump Rotation in OPERATION section.
CAUTION

Never start the pump more than 6 times per hour. If the motor does not cool between starts, it will overheat resulting in damage to the motor windings or control box components.

Standard Pump (No Liquid Level Devices)

If no liquid level devices have been installed, move the control handle to the ON position and turn the selector switch to HAND. The pump motor will start and pumping should begin.

The pump will continue to operate until it is stopped by turning the selector switch to OFF.

With Automatic Liquid Level Devices

If optional liquid level devices have been installed, move the 3-position selector switch to OFF and the control handle to the ON position.

If desired to operate the pump in the manual mode, set the selector switch to HAND; the pump will continue to run until the switch is returned to OFF, or reset to AUTO.

If desired to operate the pump in the automatic mode, set the selector switch to AUTO; pump operation will be maintained by the optional liquid level control system. To terminate automatic mode, move the selector switch to OFF or HAND.

STOPPING

To stop pump operation, turn the control handle OFF.

Power through the control box may be terminated by moving the control handle to the OFF position, thereby opening the circuit breakers. This does not terminate incoming power through the field wiring connected to the control box.

After stopping the pump, be sure to perform all required maintenance and preservation procedures.

NOTE

It is recommended that a check valve or throttling valve be installed in the discharge line if there is any possibility of siphoning or back flow when the pump is shut off.

Section C.  Page C-5
Operation Checks

Check the pump for proper operation when it is first started and periodically thereafter to identify minor problems.

Check the pump for unusual noises or excessive vibration while it is operating. If noise or vibration is excessive, stop the pump and refer to the troubleshooting chart for possible causes.

Check the pump strainer screen for clogging caused by stones, sticks, or other debris. Clean the strainer screen when required. In some cases, stopping the pump momentarily may back flush the strainer screen, purging most of the debris from it. If this fails to clean the screen, remove the pump from the sump and remove the debris manually. See PUMP DISASSEMBLY.

Never introduce air or steam pressure into the pump casing or piping to remove a blockage. This could result in personal injury or damage to the equipment. If backflushing is absolutely necessary, liquid pressure must be limited to 50% of the maximum permissible operating pressure shown on the pump performance curve.

Check the pump for overheating. The pump could overheat if operated against a closed discharge valve, or subjected to repeated start cycles.

Cold Weather Preservation

In freezing temperatures, the pump will not freeze as long as it is submerged in liquid. If the pump casing is not submerged, or if the liquid begins to freeze, remove the pump from the sump or wet well and allow it to dry thoroughly. Run the pump for two or three minutes to dry the inner walls.

If the pump freezes, move it into a warm area until completely thawed, or submerge it into the liquid. If the liquid is near freezing, the pump must be submerged for an extended period of time. Start the pump and check for shaft rotation. If still frozen, allow additional thawing time before attempting to restart.

WARNING

Do not attempt to thaw the pump by using a torch or other source of flame. This could damage gaskets or heat the oil within the pump above the critical point and cause the pump to rupture or explode.
Many of the probable remedies listed in the troubleshooting chart below require use of electrical test instruments; for specific procedures, see Electrical Testing at the end of the troubleshooting chart.

## TROUBLESHOOTING CHART

<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>PROBABLE REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUMP FAILS TO START, OVERLOAD UNIT NOT TRIPPED (MANUAL MODE)</td>
<td>Power source incompatible with control box. No voltage at line side of circuit breaker. Open circuit in motor windings or power cable. Defective motor power cable. Motor defective.</td>
<td>Correct power source. Check power source for blown fuse, open circuit breaker, broken lead, or loose connection. Check continuity. Replace cable. Check for and replace defective unit. Check wiring diagrams; correct or tighten connections.</td>
</tr>
<tr>
<td>(AUTOMATIC MODE)</td>
<td>Liquid level device or control circuits improperly connected to main control box. Level sensing device(s) improperly positioned. Level sensing device(s) fouled with mud or foreign material.</td>
<td>Position device(s) at proper level. Clean sensing device(s).</td>
</tr>
<tr>
<td>TROUBLE</td>
<td>POSSIBLE CAUSE</td>
<td>PROBABLE REMEDY</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>PUMP FAILS TO START, OVERLOAD UNIT NOT TRIPPED</strong> (AUTOMATIC MODE) (cont.)</td>
<td>Float type sensing device(s) tangled or obstructed.</td>
<td>Check installation for free movement of float.</td>
</tr>
<tr>
<td></td>
<td>Defective liquid level sensing device(s) or control panel.</td>
<td>Repair or replace defective unit(s).</td>
</tr>
<tr>
<td><strong>OVERLOAD UNIT TRIPS</strong></td>
<td>Low or high voltage, or excessive voltage drop between pump and control box.</td>
<td>Measure voltage at control box. Check that wiring is correct type, size, and length. (See Field Wiring Connection, Section B).</td>
</tr>
<tr>
<td></td>
<td>Defective insulation in motor windings or power cable; defective windings.</td>
<td>Check insulation resistance; check continuity.</td>
</tr>
<tr>
<td></td>
<td>Impeller jammed due to debris or insufficient clearance.</td>
<td>Disassemble pump and check impeller.</td>
</tr>
<tr>
<td></td>
<td>Bearing(s) frozen.</td>
<td>Disassemble pump and check bearing(s).</td>
</tr>
<tr>
<td><strong>MOTOR RUNS, BUT PUMP FAILS TO DELIVER RATED DISCHARGE</strong></td>
<td>Discharge head too high.</td>
<td>Reduce discharge head, or install staging adaptor and additional pump.</td>
</tr>
<tr>
<td></td>
<td>Low or incorrect voltage.</td>
<td>Measure control box voltage, both when pump is running and when shut off.</td>
</tr>
<tr>
<td></td>
<td>Discharge throttling valve partially closed; check valve installed improperly.</td>
<td>Open discharge valve fully; check piping installation.</td>
</tr>
<tr>
<td></td>
<td>Discharge line clogged or restricted; hose kinked.</td>
<td>Check discharge lines; straighten hose.</td>
</tr>
<tr>
<td></td>
<td>Liquid being pumped too thick.</td>
<td>Dilute liquid if possible.</td>
</tr>
<tr>
<td></td>
<td>Strainer screen or impeller clogged.</td>
<td>Clear clog(s). Stop pump; back flow may flush away debris.</td>
</tr>
<tr>
<td>TROUBLE</td>
<td>POSSIBLE CAUSE</td>
<td>PROBABLE REMEDY</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---------------------------------------------------</td>
<td>-----------------------------------------------------</td>
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<tr>
<td>MOTOR RUNS, BUT PUMP FAILS TO DELIVER RATED DISCHARGE (cont.)</td>
<td>Insufficient liquid in sump or tank.</td>
<td>Stop pump until liquid level rises.</td>
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<tr>
<td></td>
<td>Worn impeller vanes; excessive impeller clearance.</td>
<td>Check impeller and clearance. See PUMP END REASSEMBLY.</td>
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<tr>
<td></td>
<td>Pump running backwards.</td>
<td>Check direction of rotation and correct by interchanging any two motor leads at control box. (See Pump Rotation, Section C).</td>
</tr>
<tr>
<td>PUMP RUNS WITH EXCESSIVE NOISE OR VIBRATION</td>
<td>Pumping entrained air.</td>
<td>Check liquid level in sump; check position of pump and liquid level sensing device(s).</td>
</tr>
<tr>
<td></td>
<td>Damaged or unbalanced impeller.</td>
<td>Replace impeller.</td>
</tr>
<tr>
<td></td>
<td>Discharge piping not properly supported.</td>
<td>Check piping installation.</td>
</tr>
<tr>
<td></td>
<td>Impeller jammed or loose.</td>
<td>Check impeller.</td>
</tr>
<tr>
<td></td>
<td>Motor shaft or bearings defective.</td>
<td>Disassemble pump and check motor and bearings.</td>
</tr>
<tr>
<td></td>
<td>Pump cavitation.</td>
<td>Reduce discharge head, or restrict flow on low head applications.</td>
</tr>
</tbody>
</table>
ELECTRICAL TESTING

If you suspect that pump malfunctions are caused by defects in the motor, power cable or control box, perform the following checks to help isolate the defective part.

WARNING

The electrical power used to operate this pump is high enough to cause injury or death. Obtain the services of a qualified electrician to troubleshoot, test and/or service the electrical components of this pump.

CAUTION

Be certain to refer to the wiring diagram(s) in the INSTALLATION section of this manual before reconnecting any electrical components which have been disconnected.

Test Equipment

A volt/amp/ohmmeter and megohmometer of adequate range and quality will be required to conduct the following electrical tests. The suggested equipment indicated below is commercially available, or an equivalent substitute may be used.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacturer</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampprobe</td>
<td>Pyramid Instrument Corp.</td>
<td>To check AC Voltage and current (amperage)</td>
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<tr>
<td>Model 300 or Amprobe, Jr.</td>
<td>Lynbrook, NY</td>
<td></td>
</tr>
<tr>
<td>Megohmeter</td>
<td>Herman H. Sticht Co.</td>
<td>To measure resistance (ohms) to ground</td>
</tr>
<tr>
<td></td>
<td>25 Bark Place</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New York, N.Y.</td>
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Voltage Imbalance

Each phase of the incoming three-phase power must be balanced with the other two as accurately as a commercial voltmeter will read. If the phases are balanced, check out the motor as described below. If the phases are out of balance, contact your power company and request that they correct the condition.
a. Use a voltmeter, Amprobe, or equivalent meter to read the voltage across terminals 1 & 2, 2 & 3, and 1 & 3 in the control box. All three measured voltages must be the same, as accurately as the meter will read. If possible, measure the voltage with the pump off, with the pump running but out of the water, and with the pump running in the water at full load. All the measured voltages at each condition must be the same.

b. Use an Amprobe or equivalent meter to measure the current draw of each phase while the pump is running at full load and at no load. All three amperage readings must be the same at each condition, as accurately as the meter will read. Nominal amperage values are listed in Table 1, but these apply only when the actual voltage at the site is the nominal voltage listed.

c. If the voltages are balanced with the pump off, but are unbalanced when the pump is running, a thorough check of the power source, all interconnecting cables, and the pump motor is required to isolate the defect.

Motor And Motor Power Cable Continuity

To check continuity, zero-balance the ohmmeter set at the RX1 scale, and test as follows:

a. Disconnect the motor power cable leads from the control box and connect the test leads to any two of the three power cable leads (not to the green ground leads or yellow ground check lead). If there is a high resistance reading on the ohmmeter, there is an open or broken circuit caused by a break in the power cable or motor windings, or by a bad connection between the motor and the power cable. Switch one test lead to the third power lead, and test again.

b. If an open or broken circuit is indicated, check the power cable for obvious damage, and replace as necessary (see MAINTENANCE AND REPAIR). If there is no apparent damage to the motor cable, remove the terminal housing (see MAINTENANCE AND REPAIR) and check the continuity of each power cable lead at the terminal posts.

NOTE

When shipped from the factory, the connections between the power cable leads and the terminal posts were encapsulated in heat-shrink tubing and bonded to the terminal plate with hot-melt adhesive. In service, these connections may have been potted by the pump operator. Do not cut the adhesive, tubing, or potting away unless absolutely necessary. Check the continuity of each lead from the motor side of the terminal plate. If the continuity reading is good, there is no need to remove the sealing material. If there is no continuity through the lead, remove the sealing material from only that terminal and check for a loose connection. After tightening the connection, recheck the continuity. Be sure to replace the tubing or potting and allow adequate drying time before putting the pump back into service. (See Terminal Housing And Power Cable Reassembly, Section E).
c. If an open circuit still exists after each lead (terminal) has been tested and tightened, then the entire motor power cable must be replaced. Splicing or other means of repair are not recommended.

d. If no break is found in the power cable, check the motor leads for continuity. If the test reading indicates an open or broken circuit, there is an open circuit in the motor.

NOTE

It is recommended that a pump with a defective motor be returned to Gorman-Rupp, or to one of the Gorman-Rupp authorized Submersible Repair Centers.

Insulation Resistance

To check insulation, zero-balance the ohmmeter set at the RX100K scale, and test as follows:

a. Disconnect the motor power cable leads from the control box. Connect one test lead to the power cable green ground lead, and touch the other test lead to each of the three power leads in turn.

b. The reading obtained will indicate resistance values in both the power cable and the motor windings. If the resistance reading is infinity (∞), the insulation is in good condition. If the reading is between infinity (∞) and 1 megohm, the insulation is acceptable but should be re-checked periodically. If the reading is less than 1 megohm, the insulation should be checked more closely; a reading of zero indicates that the power cable or the motor is grounded.

c. To determine whether the power cable or the motor is grounded, remove the terminal housing (see MAINTENANCE AND REPAIR), disconnect the motor leads from the motor terminals, and test the power cable leads and motor leads separately.
MAINTENANCE AND REPAIR - SECTION E

MAINTENANCE AND REPAIR OF THE WEARING PARTS OF THE PUMP WILL MAINTAIN PEAK OPERATING PERFORMANCE.

*STANDARD PERFORMANCE FOR PUMP MODEL S6A1 460V 3P

*Based on 70°F clear water at sea level. Since pump installations are seldom identical, your performance may be different due to such factors as viscosity, specific gravity, elevation, temperature, and impeller trim.

If your pump serial number is followed by an "N", your pump is NOT a standard production model. Contact the Gorman-Rupp Company to verify performance or part numbers.
Figure 1. Pump Model S6A1 460V 3P
# PARTS LIST

Pump Model S6A1 460V 3P  
(From S/N 836529 up)

If your pump serial number is followed by an "N", your pump is NOT a standard production model. Contact the Gorman-Rupp Company to verify part numbers.

<table>
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<th>ITEM NO.</th>
<th>PART NO.</th>
<th>MAT'L CODE</th>
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<td>2</td>
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<td>4</td>
<td>UPPER SEAL ASSY</td>
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* INDICATES PARTS RECOMMENDED FOR STOCK

Above Serial Numbers Do Not Apply To Pumps Made In Canada.

CANADIAN SERIAL NO. .................................  AND UP

Section E.  Page E–3
PUMP AND MOTOR DISASSEMBLY AND REASSEMBLY

The following maintenance and repair instructions are keyed to the sectional view (see Figure 1) and the accompanying parts list.

WARNING

The electrical power to operate this pump is high enough to cause injury or death. Make certain that the control handle on the control box is in the OFF position and locked, or that the power supply to the control box has been otherwise cut off and locked out, before attempting to open or service the pump assembly. Tag electrical circuits to prevent accidental start-up.

Before attempting to service the pump or control, cut off the power supply to the control box and close any valves in the discharge line.

WARNING

Do not attempt to lift the pump by the motor power cable or the piping. Attach proper lifting equipment to the lifting device fitted to the pump. If chains or cable are wrapped around the pump to lift it, make certain that they are positioned so as not to damage pump, and so that the load will be balanced.

Use the hoisting bail to lift the pump from the wet well to a location where the discharge line can be removed. It is not necessary to disconnect a flexible discharge hose before removing the pump. If rigid discharge piping is used, disconnect the piping or the discharge flange (28) before attempting to remove the pump. To remove the discharge flange, remove the nuts (35) securing the flange to the motor housing (19).

Select a suitable location, preferably indoors, to perform the degree of maintenance required. If the motor housing is to be opened, the work must be done in a clean, well-equipped shop. All maintenance functions must be performed by qualified personnel.

Check the chart in TROUBLESHOOTING to determine the nature of the pump problem. If the problem is mechanical in nature, such as worn pump parts, seal replacement, lubrication, etc., refer to PUMP END DISASSEMBLY for instructions.

If the problem is electrical, complete disassembly may not be required. Refer to Electrical Testing and have a qualified electrician check out the control box, cable and terminal housing assembly. If the problem is determined to be in the motor, proceed with PUMP END DISASSEMBLY followed by MOTOR DISASSEMBLY. Otherwise, see Control Box and Terminal Housing And Power Cable Disassembly.
All gaskets and most O-rings must be replaced if disturbed. A repair gasket kit is listed on the parts list as an option.

PUMP END DISASSEMBLY

Strainer Disassembly

To remove the strainer screen (76) and base plate (77) raise the pump slightly, or lay it on its side and remove the hardware (78, 79, and 80) securing the screen and base plate. If the impeller is clogged, the debris can usually be removed without further pump disassembly.

Draining Oil From Seal And Motor

If any further disassembly is to be performed on the pump, the oil cavities must be drained.

CAUTION

Let the pump cool before removing the seal or motor cavity drain plug. Pressure built up within a hot pump could cause the oil to spray out when the plug is removed. Remove the plug slowly and permit pressure to vent to atmosphere.

Lay the pump on its side with the drain plugs (11 and 13) facing up, and clean any dirt from around the plugs. Remove the seal cavity drain plug (11) and install a short 3/8-inch NPT nipple in the hole. Tip the pump and drain the seal oil into a clean container. Inspect it for water, dirt or cloudy condition which could indicate lower seal failure or poor gasket seal.

If motor problems are suspected, remove the motor cavity drain plug (13) and use a short nipple to drain the oil into a clean container at this time. Inspect the oil for dark color which could indicate motor overheating, dirt or water contamination. The presence of dirt or water could indicate a breakdown in the waterproof integrity of the motor cavity, probably due to poor gaskets or seals.

Positioning Pump For Disassembly

It is recommended that the pump be positioned upside down during disassembly. To hold the pump in the inverted position, secure the discharge studs (34) to a bench or work stand, or rest the pump securely on blocks. Be careful not to damage the terminal housing (51), cable (46) or pressure relief valve (31) while in this position. Use adequate equipment and personnel to safely handle the pump until it is secured.
If inverting the pump is not practical, lay the pump on its side and secure it.

**Strainer Plate And Suction Head Disassembly**

Remove the hardware (5, 6 and 7) securing the strainer plate (74) to the intermediate (72). Remove the strainer plate, and remove and discard the strainer plate gasket (73) and the suction head O-ring (75).

Remove the nylon locknuts (82) securing the suction head (83) to the diffuser (1), and pull the suction head off the intermediate studs (81).

**Impeller Disassembly**

Wedge a piece of wood between the vanes of the impeller (2) and the diffuser (1) to prevent shaft rotation. Remove the impeller nut (85) and lower impeller washer (84).

Remove the piece of wood from between the vanes of the impeller. Refer to Figure 2, install the impeller puller supplied with the pump, and pull the impeller from the shaft. Use caution when removing the impeller; tension on the seal spring will be released. Retain the impeller key (86).

![Figure 2. Removing Impeller With Puller](image)

Remove the impeller adjusting shims (9) and upper impeller washer (10); for ease of reassembly tie and tag the shims.
Lower Seal Disassembly

(Figures 1 and 3)

Carefully remove the loose parts of the lower seal assembly (3). Lubricate the rotor shaft adjacent to the seal, and work oil under the rubber bellows. Use a stiff wire with a hooked end to pull the rotating portion of the seal from the shaft.

To remove the stationary portion of the seal, pull the diffuser (1) from the shaft, and discard the diffuser gasket (8). Place the diffuser on a flat surface with the impeller side down. Use a drift pin or a screwdriver to press on alternate sides of the stationary seat until the seat and O-rings are removed.

The rotating and stationary seal elements are precision finished and subject to wear. The complete seal should be replaced with each overhaul to ensure trouble-free operation. However, if the old seal must be reused, wrap the seal faces individually in tissue paper to prevent damage to the sealing surfaces.

If no further disassembly is required, proceed to the appropriate areas in PUMP END REASSEMBLY.

Upper Seal Disassembly

(Figures 1 and 3)

Unless cracked or otherwise worn, it is not necessary to remove the intermediate (72) for access to the upper seal assembly (4).

**CAUTION**

If intermediate removal is desired, see the procedure under Rotor Disassembly in MOTOR DISASSEMBLY in this section. DO NOT attempt to loosen the hardware (68 and 69) securing the intermediate, or the hardware (70 and 71) securing the bearing cap (65) before referring to this section; otherwise, the rotor shaft and bearings could be damaged.

Remove the seal retaining ring (15) with snap ring pliers. Use caution when removing the snap ring; tension of the seal spring will be released. Remove the seal spring retainer and spring. Lubricate the rotor shaft adjacent to the seal, and work oil under the bellows. Position a screwdriver or other suitable device on each side of the bellows retaining flange and pry the bellows upward until the rotating seal portion is forced off the shaft.

Slide the hooked ends of two wires along the shaft and under the stationary seal seat. Hook the back side of the seat and pull it from the intermediate.
NOTE

Do not disassemble the motor unless it is necessary and a clean, well-equipped shop is available. If the motor housing components are to be serviced, see MOTOR DISASSEMBLY in this section. Do not reassemble the pump end components at this time.

If no further disassembly is required, proceed to the appropriate areas in PUMP END REASSEMBLY.

PUMP END REASSEMBLY

NOTE

Reuse of old O-rings, gaskets, or shaft seal parts may result in premature leakage or reduced pump performance. It is strongly recommended that an overhaul gasket kit and shaft seal assembly be used during reassembly (see the parts list for numbers).

Cleaning Old Parts

With the pump inverted, stuff a clean tissue into the stationary seat bore of the intermediate (or wrap a small rag around the shaft) to prevent foreign material from entering the motor cavity.

Carefully inspect any O-rings or gaskets before removal and cleaning to determine if a proper seal and compression existed prior to disassembly. If sealing was faulty or questionable, the cause must be determined and corrected before reassembly. Replace any parts as required.

Thoroughly clean all reuseable parts. Remove all O-rings and gaskets and clean the sealing surfaces of dirt or gasket material. Be careful not to scratch gasket surfaces.

WARNING

Also electrode reactions, toxic and flammable. Use only in a well-ventilated area free from excessive heat, sparks, and flame. Read and follow all precautions printed on solvent containers.

Neither of the shaft seal assemblies should be reused because wear patterns on the finished faces cannot be realigned during reassembly. This could result in premature failure. If necessary to reuse an old seal in an emergency, carefully wash all metallic parts in fresh cleaning solvent and allow to dry thoroughly.
Handle the seal parts with extreme care to prevent damage. Be careful not to contaminate precision finished faces; even fingerprints on the faces can shorten seal life. If necessary, clean the faces with a non-oil based solvent and a clean, lint-free tissue. Wipe lightly in a concentric pattern to avoid scratching the faces.

Inspect the seal components for wear, scoring, grooves, and other damage that might cause leakage. If any components are worn, replace the complete seal; never mix old and new seal parts.

Install the shaft seals as illustrated in Figure 3.

![Seal Assembly Diagram](image)

**Figure 3. Seal Assemblies 12430 and S01934**

Upper Seal Reassembly

Inspect the end of the rotor shaft for damaged threads, scoring, and a nicked or damaged keyway. Remove nicks and burrs with a fine file or hand honing stone to restore original contours. If the shaft is bent or damaged, the complete shaft and rotor (61) must be replaced as an assembly (see MOTOR DISASSEMBLY).

If a new seal is to be installed, do not unwrap it until time of installation. Cleanliness of all seal components is a must, especially the seal faces.

Carefully remove the material stuffed into the seat bore (or unwrap the shaft). Be sure no debris stopped by the material falls into motor cavity.
Clean the rotor shaft and seal cavity area of the intermediate (72). Be sure the area is dry and free of lint and dirt. Check the O-ring bore for burrs or nicks that might cut the seal O-ring or prevent a good seal. Apply a light coating of oil to the bore.

**NOTE**

When pressing seal components onto the impeller shaft, use hand pressure only. A push tube cut from a length of plastic pipe will aid in installing seal components. The I.D. of the push tube should be approximately the same as the I.D. of the seal spring.

Unpack the stationary seal seat and install the O-ring, taking care not to touch the sealing face. Apply a light coating of oil to the stationary seat O-ring. Keep the sealing face dry.

Position the seat in the bore with the sealing face up and cover it with a clean tissue. Use your thumbs to press the seal into the bore. Apply equal pressure on opposite sides of the seat until it contacts the bore shoulder. Remove the tissue and inspect the seal face to ensure that it is clean and dry. If cleaning is necessary, use clean tissue to wipe lightly in a concentric pattern.

Unpack the rotating portion of the seal. Be certain the seal face of the rotating element is free of grit or surface damage. Place a small amount of grease at equal spaces on the back of the element and assemble the drive grooves of the rotating element into the drive lugs of the bellows retainer. The grease should hold the element in position until the seal is installed.

Apply a light coating of oil to the seal seating surface on the shaft, the groove for the retaining ring (15), and the I.D. of the bellows. Position the rotating seal portion on the shaft with the seal face down. Apply firm, steady pressure, with clean hands, on the seal retainer until it slides down the shaft and the seal faces contact. This step should be done in one continuous motion to prevent the bellows from sticking or rolling as it passes over the retaining ring groove.

Slide the seal spring over the shaft and bellows retainer, and install the spring retainer. Install the seal retaining ring (15). See Figure 3 for proper order of seal assembly.

**Lower Seal Reassembly**

Thoroughly clean the gasket surfaces and seal bore of the diffuser (1). The seal bore must be free of burrs and nicks which could damage the seal.

**NOTE**

When pressing seal components onto the impeller shaft, use hand pressure only. A push tube cut from a length of plastic pipe will aid in installing seal components. The I.D. of the push tube should be approximately the same as the I.D. of the seal spring.

Unpack the stationary seat, and check that the O-rings are properly installed (see Figure 3). Press the stationary element into the seat, making sure that
the grooves in the element engage the lugs on the seat. Apply a light coating of oil to the diffuser seal bore and the outer O-ring.

Place a clean tissue over the sealing face of the stationary element and press the stationary subassembly into the diffuser seal bore until it bottoms squarely. Remove the tissue and inspect the seal face to ensure that it is clean and dry. If cleaning is necessary, use clean tissue to wipe lightly in a concentric direction.

Install the diffuser gasket (8), and position the diffuser on the intermediate (72) and rotor shaft. Be careful not to damage the stationary seal face.

Unpack the rotating portion of the seal. Be certain the seal face of the rotating element is free of grit or surface damage. Place a small amount of grease at equal spaces on the back of the element and assemble the drive grooves of the rotating element into the drive lugs of the bellows retainer. The grease should hold the element in position until the seal is installed.

Apply a light coating of oil on the rotor shaft and the I.D. of the bellows. Place the rotating seal portion on shaft with the seal face down. Apply firm, steady pressure, with clean hands, on the bellows retainer until it slides down the shaft and the seal faces contact.

Slide the seal spring over the shaft and bellows retainer. See Figure 3 for proper order of seal assembly.

Impeller Reassembly

Install the upper impeller washer (10) so that the inside chamfer faces toward the shaft shoulder. Reinstall the same thickness of impeller shims (9) as originally removed.

NOTE

The clearance between the face of the impeller and the suction head can only be measured after the impeller and suction head are installed.

Inspect the impeller (2), and replace it if cracked or worn. Clean the threads on the rotor shaft to remove any old thread locking material.

Install the impeller key (86) in the rotor shaft, align the impeller, and push it on until firmly seated against the upper impeller washer and adjusting shims.

After the impeller has been installed, coat the threads of the rotor shaft with 'Loctite Threadlocker No. 242' or equivalent compound. Install the lower impeller washer (84) and impeller nut (85). Wedge a block of wood between the impeller vanes and the diffuser (1) to prevent shaft rotation, and torque the impeller nut to 175 ft. lbs. (2100 in. lbs.).

Thoroughly clean the suction head (83) and its O-ring surface. Install the suction head on the diffuser and apply 'Never-Seez' or equivalent compound on the threads of the intermediate studs. Install the nylon locknuts (82) and torque them evenly in a cross-sequence to 60 ft. lbs. (720 in. lbs.).
For maximum pump efficiency, there should be clearance of .010 to .015 inch between the diffuser and the face of the impeller. Use a feeler gauge as shown in Figure 4 to measure this clearance.

![Feeler Gauge Image]

**Figure 4. Measuring Impeller Clearance**

If the impeller clearance is not within specified limits, remove the suction head and impeller, then add or remove impeller adjusting shims (9) as required. Reinstall the impeller and suction head, and recheck clearance.

**Strainer Plate, Screen And Base Plate Reassembly**

Lightly oil the O-ring (75) and install it in the groove in the suction head (83). Install the strainer plate gasket (73), and strainer plate (74). Apply 'Never-Seez' or equivalent compound to the threads of the capscrews (5) and install them in the strainer plate. Install the lockwashers (7) and torque the nuts (6) to 120 ft. lbs. (1440 in. lbs.).

Assemble the strainer screen (76) onto the shoulder of the strainer plate, and install the base plate (77). Install the hardware (78, 79 and 80) securing the base plate, strainer screen and strainer plate.

See LUBRICATION and FINAL ASSEMBLY before putting the pump back into service.

**MOTOR DISASSEMBLY**

Disassembly of the motor is rarely required except to replace the rotor, stator, bearings, or intermediate. Do not disassemble the motor unless it is necessary and a clean, well-equipped shop is available.
NOTE

It is recommended that a pump with a defective motor be returned to Gorman-Rupp, or to one of the Gorman-Rupp authorized Submersible Repair Centers.

WARNING

The electrical power to operate this pump is high enough to cause injury or death. Make certain that the control handle on the control box is in the OFF position and locked, or that the power supply to the control box has been otherwise cut off and locked out, before attempting to open or service the pump assembly. Tag electrical circuits to prevent accidental start-up.

Carefully inspect any O-rings or gaskets before removal and cleaning to determine if a proper seal and compression existed prior to disassembly. If sealing was faulty or questionable, the cause must be determined and corrected before reassembly. Replace any parts as required.

Terminal Housing And Power Cable Disassembly

If the pump is maintained in an upright position, the terminal housing and power cable assembly (36) may be serviced without draining the oil from the motor cavity. However, the oil must be drained before attempting to disassemble the motor housing and components. To drain the oil see Draining Oil From Seal And Motor in PUMP END DISASSEMBLY.

Total disassembly of the terminal housing and power cable is not always required. Disassemble and replace only the parts proven defective by inspection or testing. See Electrical Testing in TROUBLESHOOTING.

The terminal housing and power cable assembly (36) can be serviced without disassembling the motor housing or pump end.

To remove the terminal housing (51), remove the deformed locknuts (60) securing the terminal housing to the motor housing (19). Raise the terminal housing for access to the motor terminal posts (57). Loosen the allen head setscrews (58), and disconnect the motor leads from the terminal posts. Separate the terminal housing and power cable assembly from the motor housing.

To separate the power cable (46) from the terminal housing, remove the nuts (49) securing the terminal gland (45) to the terminal housing. Slide the gland back along the power cable. Compress the wire mesh of the cable grip (47) and move it back along the power cable. Oil the gland bushing (50) and terminal housing bore and pull firmly on the cable. (Allow the oil to leak in around the bushing by agitating the cable in the bore.) After the bushing has been loosened, the cable should pull out far enough to expose the gland bushing. Apply oil on the cable jacket and slide the bushing back along the cable. Quite often, pressure exerted on the bushing will deform the cable jacket. If such is the case, additional oil and effort will be required to remove the bushing.
NOTE

If the rubber bushing cannot be removed from the terminal housing as indicated, it may be necessary to cut the bushing into small pieces or cut the cable.

Push approximately 6 inches of the power cable into the terminal housing so that the terminal plate assembly (37) comes free of the terminal housing. This should permit access to the power cable connections in the terminal plate.

To disconnect the power cable, remove the round head screws (40) and lockwashers (41) securing the terminals (39 and 52) of the green and yellow ground leads. When shipped from the factory the connections between the power cable leads and the terminal collars (53) were encapsulated in heat-shrink tubing (38) and bonded to the terminal plate (37). (In service the heat-shrink tubing may have been replaced by potting compound during previous repair.) Cut away the tubing and adhesive (or potting) and loosen the allen head setscrews (54) in the terminal collars. Disconnect the power cable leads from the terminal collars and pull the power cable out of the terminal housing.

The terminal washer (42), bushing (50), cable grip (47) and terminal gland (45) can be removed from the cable.

If necessary to replace the terminal plate (37) or terminal components, unscrew the terminal collars (53) and remove the dyna-seal washers (55 and 56). Remove the terminal posts (57) from the terminal plate.

See Terminal Housing And Power Cable Reassembly if no further disassembly is required.

Rotor Disassembly

See PUMP END DISASSEMBLY, and remove all pump end and seal components.

With the pump end disassembled and the motor cavity drained, secure the pump in an inverted position. Remove the hardware (68 and 69) securing the motor housing (19) to the intermediate (72). Do not remove the four capscrews (70) around the rotor shaft.

See Figure 5 and hook a three-leg sling in the intermediate flange holes. Hoist the intermediate (72), rotor and shaft (61), bearing cap (65) and both ball bearings (21 and 66) from the motor housing as an assembly. If necessary, tap around the parting surfaces with a soft-faced mallet to break the seal between the intermediate and motor housing. Remove the motor housing gaskets (16, 17 and 18).
Cover motor housing with a clean, lint-free cloth to avoid contamination by dirt or other foreign material.

Set the intermediate and rotor assembly on a clean work area. Leave the lifting slings attached and reduce the tension slightly. Remove the hardware (70 and 71) securing the bearing cap (65) to the intermediate. Steady the rotor and separate the intermediate. If necessary, tap the impeller end of the rotor shaft to loosen the seal between the lower ball bearing (66) and the intermediate bore.

Use a bearing puller to remove the lower and upper ball bearings from the rotor shaft. Remove the bearing cap and gasket (14) from the rotor shaft.

**NOTE**

It may be necessary to use the bearing cap (65) and capscrews (70) in conjunction with the bearing puller to remove the lower ball bearing (66).

**Stator Disassembly**

It is recommended that the stator (62) be left in place unless it is defective. If the stator must be removed, disconnect the motor leads from the terminal posts (57) as indicated in **Terminal Housing And Power Cable Disassembly**.
With the pump end, intermediate and rotor removed, position an expandable tool, such as a split disc, approximately two inches down inside the stator, and expand it tightly and squarely on the I.D. Attach a lifting device to the lifting eye of the tool, and raise the assembly 1 inch from the surface. Use a soft-faced mallet to rap alternate edges of the motor housing (19), and "walk" the stator out. Continue this process until the stator clears the motor housing.

**NOTE**

It may be necessary to heat the motor housing to permit stator removal.

**CAUTION**

Do not attempt to rewind the stator. Winding tolerances and materials are closely controlled by the manufacturer, and any deviation can cause damage or operating problems. Replace the stator, or return it to one of the Gorman-Rupp Authorized Submersible Repair Centers or the Gorman-Rupp factory, if defective.

Relief Valve

It is recommended that the relief valve assembly (31) be replaced at each over-haul, or any time the pump motor overheats and activates the valve. Never replace this valve with a substitute which has not been specified or provided by the Gorman-Rupp Company.

It is not necessary to remove the heavy pipe nipple (33) to remove the pressure relief valve. If the pipe nipple is removed, apply 'Loctite Retaining Compound No. 680' or equivalent to the threads on both ends of the nipple only.

When installing the relief valve assembly, use 'Loctite Pipe Sealant With Teflon No. 592' or equivalent compound on the threads. Position the relief valve next to the terminal housing (51) and out of the way so that there is enough room for the housing to clear.

**Hoisting Bail**

If the hoisting bail (26) requires replacement, remove the hardware (22, 23 and 24) securing the bail to the motor housing (19). Make certain that the bushings (27) are in place when installing the hoisting bail.
MOTOR REASSEMBLY

NOTE

Reuse of old O-rings, gaskets, or shaft seal parts may result in premature leakage or reduce pump performance. It is strongly recommended that an overhaul gasket kit and shaft seal assembly be used during reassembly (see the parts list for numbers.)

Stator Reassembly

Clean all gasket and O-ring surfaces, completely removing any old gasket and cement material. Inspect the sealing surfaces for burrs, nicks and pits which could cause a poor seal, and replace defective parts as required.

Thoroughly clean the inside of the motor housing (19) with fresh solvent. The interior must be dry and free of dirt or lint.

Do not unwrap the stator until the motor housing has been prepared for stator installation. The stator must be kept clean and dry. When handling the stator, do not set it on the end windings; lay it on its side.

WARNING

Most cleaning solvents are toxic and flammable. Use them only in a well-ventilated area free from excessive heat, sparks, and flame. Read and follow all precautions printed on solvent containers.

Test the new stator as indicated in Electrical Testing in TROUBLESHOOTING to ensure that no damage has occurred during transit or handling.

Position an expandable tool, such as a split disc, approximately 2 inches from the end of the stator (opposite the lead wire end) and expand it tightly on the I.D. of stator. Carefully raise the stator with a lifting device attached to center lifting eye of tool. Take care not to damage the stator end turns. Slip a sleeve over the stator lead wires to prevent damage to them.

Invert the motor housing. Position the stator so that the leads are in line with the opening for the terminal housing; and carefully lower the stator into the motor housing. If the stator "cocks" in the motor housing, remove it and try again. If necessary, heat the motor housing with a torch to expand it enough for the stator to be installed; when heating the motor housing make certain that the stator is clear to avoid damage to the windings. Apply heat evenly to the inside of the motor housing; excessive heat is not required. Be careful not to damage the stator lead insulation during reassembly.

After the stator is fully and squarely seated on the motor housing shoulder, remove the expandable disc tool. Cover the motor housing with a clean, lint-free cloth while the rotor is being assembled.

Section E. 
Rotor Reassembly

Inspect the seal and bearing areas of the shaft. Inspect the shaft for damaged threads, scoring and a nicked or damaged keyway. Remove nicks and burrs with a fine file or honing stone. If the shaft is bent or damaged, replace the shaft and rotor (a single assembly).

Clean the bearings thoroughly in fresh cleaning solvent. Dry the bearings with filtered compressed air.

WARNING

The most cleaning solvents are toxic and flammable. Use them only in a well-ventilated area free from excessive heat, sparks, and flame. Read and follow all precautions printed on solvent containers.

Rotate the bearings by hand to check for roughness or binding and inspect the bearing balls. If rotation is rough or the bearing balls are discolored, replace the bearings.

CAUTION

Bearings must be kept free of all dirt and foreign material. Failure to do so will greatly shorten bearing life. DO NOT spin dry bearings. This may scratch the balls or races and cause premature bearing failure.

The bearing tolerances provide a tight press fit onto the shaft and a snug slip fit into the motor housing and intermediate. Replace the shaft and rotor (as an assembly), motor housing or intermediate if the proper fit is not achieved.

Use an arbor (or hydraulic) press to install the upper ball bearing (21) onto the shaft until fully seated against the shaft shoulder.

CAUTION

When installing the bearings onto the shaft, NEVER press or hit against the outer race, balls, or ball cage. Press ONLY on the inner race.

Clean the bearing cap (65) and secure the gasket (14) to the cap with a light coating of gasket adhesive. Position the cap and gasket on the shaft with the gasket and screw holes toward the threaded end of the shaft.

Position the lower ball bearing (66) as indicated on the instruction sheet accompanying the bearing. Press it onto the shaft until fully seated.
Use solvent to clean all gasket surfaces of the intermediate (72) and motor housing (19), completely removing old gasket and cement material. Inspect the sealing surfaces for burrs, nicks and pits which could cause a poor seal, and repair or replace as required.

Use fresh solvent to clean the bearing seating bore of the motor housing, and the bearing and seal seating bores of the intermediate.

Install the rotor and assembled ball bearings into the intermediate so the lower ball bearing (66) seats squarely in the intermediate bearing bore. Position the assembled bearing cap and gasket on the intermediate. Apply 'Never-Seez' or equivalent compound to the threads of the capscrews (70). Install the capscrews and lockwashers (71), and torque the capscrews evenly in a cross-sequence to 20 ft. lbs. (240 in. lbs.).

Apply a light coat of gasket adhesive to the motor housing gaskets (16, 17 and 18), and position them on the motor housing. Make certain that the gaskets are properly seated and that the adhesive holds them securely.

Install a three-leg sling in the intermediate flange holes (see Figure 5) and lower the assembled intermediate and rotor into the motor housing. Use caution to guide the upper ball bearing (21) into the motor housing bearing seating bore. Tap the intermediate with a soft-faced mallet until it mates tightly with the motor housing.

Apply 'Never-Seez' or equivalent compound to the threads of the motor housing studs (67). Install the hardware (68 and 69) on the studs and torque the nuts to 120 ft. lbs. (1440 in. lbs.).

See PUMP END REASSEMBLY, and reassemble the pump end components.

Terminal Housing And Power Cable Reassembly

WARNING

// The electrical power used to operate this pump is high enough to cause injury or death. Make certain that the control handle on the control box is in the OFF position and locked, or that the power supply to the control box has been otherwise cut off and locked out. Tag electrical circuits to prevent accidental start-up. Obtain the services of a qualified electrician and refer to the wiring diagrams in INSTALLATION to make all electrical connections.

Clean the exterior of the pump power cable with warm water and mild detergent, and check for obvious physical damage. Check the cable for continuity and insulation resistance (see Electrical Testing in TROUBLESHOOTING).
CAUTION

Do not attempt repairs except at either end of the power cable. Splicing is not recommended.

Lubricate the upper bore of the terminal housing (51), outside of the power cable, and bores of the terminal gland (45), cable grip (47), gland bushing (50), and terminal washer (42) for ease of assembly. Slide the terminal gland, cable grip, gland bushing, terminal washer and terminal housing onto the power cable in that order (see Figure 1 to recheck order of assembly).

Work the cable components up the cable to allow approximately 3 ft. of cable to extend below the terminal housing. Temporarily tape the ground wires (green and yellow) to the cable.

Power Cable Potting

WARNING

Do not attempt to operate this pump unless the power cable terminals (except for the ground terminal) are properly potted or sealed with heat-shrink tubing and bonded to the terminal plate. Moisture entering the terminal housing could cause a short circuit, resulting in death or injury to personnel.

If the power cable leads were removed from the terminal collars (53), the connections must be resealed with a water-tight material such as electrical potting compound or heat-shrink tubing.

When shipped from the factory, the cable leads and terminal collars were encapsulated in heat-shrink tubing (38), and bonded to the terminal plate (37) with hot-melt adhesive to provide a water-tight seal. These materials are included in an optional repair kit listed in the parts list; however, since a glue gun with the required temperature range is not generally available in the field, it is recommended that a repotting kit available from Gorman-Rupp (see optional equipment in parts list) or a commercially available kit (Products Research Corp., part no. PR-1201-Q Class 1 potting compound, or equivalent) be used to reseal the connections. See Figure 6 and the following instructions:
NOTE

Potting compound, heat-shrink tubing and adhesive have the same electrical properties when correctly applied. Heat-shrink tubing is used at the factory to ease production. The advantage of using potting compound for field repairs is greater availability, and elimination of special tools.

If heat-shrink tubing is used for field repairs, use only materials and heating equipment approved by Gorman-Rupp.

Clean and assemble all terminal components as indicated in the potting instructions.

Slide a length of heat-shrink tubing (Gorman-Rupp part number 31413-014) up over each of the cable leads. Insert the tinned leads into the terminal collars and secure with the setscrews. Slide the shrink tubes down over the collars until they contact the terminal plate. Carefully heat each tube with a torch, or commercial hot air gun capable of producing 750° F, and shrink it around the cable leads, terminal posts, and collars.

After the tubing has shrunk and set, use a hot-melt adhesive tool (Terlan TM-80, set at 450° F to apply adhesive (Gorman-Rupp part number 18661-044) and completely seal the bottom portion of each tube to the terminal plate.

Figure 6. Potting Power Cable Leads In Terminal Housing
If the power cable is to be potted, a repotting kit is available from Gorman-Rupp (see the parts list) as an option. Use this kit, or Products Research Corp. PK-1201-Q Class 1 potting compound, or equivalent.

Remove all the old tubing material or potting compound from the terminal collars (53), allen head setscrews (54), dyna-seal washers (55), and terminal plate assembly (37). Inspect the terminal posts (57) for damage and replace as required. Use a medium-grit sandpaper to prepare the surface of the terminal plate in the area of the potting molds.

**NOTE**

Clean the cable leads and terminal plate in the areas to be potted with cleaning solvent before potting. Potting compound will not adhere properly to oil or grease coated surfaces.

Assemble the terminal posts (57), dyna seal washers (55 and 56), allen head setscrews (54 and 58) and terminal collars (53) to the terminal plate assembly (37).

**NOTE**

If the rubber bonding material which seals the terminal plate assembly to the terminal housing is severely worn or cracked, the terminal plate must be replaced. If the bonding material has been noticeably compressed, it should be supplemented with two gaskets (available separately, part number 11714-G) contained in the overhaul gasket kit (see options listed on parts list). Slide one gasket up over the cable leads, then proceed as follows:

Tin the ends of each power cable and motor lead with solder to prevent fraying, and slide a potting mold over each lead.

Insert the three standard power cable leads into the terminal collars (53), and secure them with the allen head setscrews (54). Slide the potting molds down over the terminal collars and onto the terminal plate. Hang the cable vertically with the terminal plate horizontal. The cable leads and terminal collars should be centered in potting molds. Use a quick-setting cement, such as '3-M Weather Seal' to secure the potting molds to the terminal plate.

**WARNING**

Most potting base compounds contain toluene; use adequate ventilation and avoid prolonged breathing of vapors. Most potting accelerators contain lead; avoid ingestion or prolonged contact with the skin. Read and follow all warnings and recommendations accompanying the potting kit.

See the instructions with the potting kit regarding application life, and setting and curing time. Mix the base compound and accelerator and fill the molds completely. Tamp the potting material to eliminate air bubbles and ensure the material has completely covered the area around the terminal collars.
When potting has been completed, leave the terminal plate assembly undisturbed until the potting material has cured. Complete curing usually takes about 24 hours. Curing time can be shortened by using a heat lamp, but be careful not to melt the potting or potting mold, or burn the cable. When the potting material is no longer "tacky" to the touch, it has cured.

Terminal Housing Reassembly

After the potting material has cured (or the heat-shrink tubing has been installed), untape the ground leads and slide the terminal housing down the cable. If removed, connect the two green ground leads to the ground terminal (39), and connect the yellow ground check lead to the ground check terminal (52). Secure the terminals to the terminal housing with the machine screws (40) and lockwashers (41) and be sure the terminals make good contact with the housing.

Pull gently on the power cable to remove any excess length from within the terminal housing. The terminal plate should fit loosely into the terminal housing.

Slide the terminal washer (42) down the cable and into the upper bore of the terminal housing. Oil the bore and cable and slide the gland bushing (50) into place. Compress the wire mesh of the cable grip (47) and slide it down the cable, making sure it comes in contact with the bushing. Slide the gland (45) into place. Coat the threads of gland studs (48) with 'Never-Seez' or equivalent, and engage the nuts (49) finger tight. Do not fully tighten the nuts at this time.

Attach the motor leads to the terminal posts (57) using the allen head setscrews (58). If required, rotate the terminal housing and twist the motor leads to remove excess slack. Coat the threads of the terminal housing studs (59) with 'Never-Seez' or equivalent, and secure the terminal housing to the motor housing with the deformed locknuts (60); torque the locknuts to 20 ft. lbs. (240 in. lbs.).

NOTE

If the supplemental terminal plate gaskets are being used, install the lower gasket before securing the terminal housing to the motor housing.

Tighten the nuts (49) drawing the terminal gland (45) down into terminal bore. Do not overtighten and damage the terminal gland or hardware.

See LUBRICATION and FINAL ASSEMBLY.

LUBRICATION

Check the oil level in the seal cavity and motor housing before initial startup, after the first two weeks of operation, and every month thereafter. If the oil levels are abnormally low, or the color milky or dark, refer to Draining Oil From Seal And Motor in this section for instructions and troubleshooting tips.
NOTE

To accurately check the oil level the pump must be cool.

The grade of lubricant used is critical to the operation of this pump. Use premium quality submersible pump oil of the grade specified in Table 1. Oil must be stored in a clean, tightly closed container in a reasonably dry environment.

Table 1. Typical Pump Oil Properties

<table>
<thead>
<tr>
<th>Type</th>
<th>Premium high viscosity index, anti-wear hydraulic oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric</td>
<td>26,000(volts-min)</td>
</tr>
<tr>
<td>Pour point</td>
<td>-20°F to -60°F</td>
</tr>
<tr>
<td>Viscosity @ 100°F</td>
<td>110 to 155</td>
</tr>
<tr>
<td>Viscosity @ 210°F</td>
<td>40 to 50</td>
</tr>
<tr>
<td>Recommended supplier:</td>
<td>Gulf Harmony HVI AW 26</td>
</tr>
<tr>
<td>Acceptable alternate suppliers:</td>
<td></td>
</tr>
<tr>
<td>SOHIO *</td>
<td>Enerol - HLP 32</td>
</tr>
<tr>
<td>Shell Oil Company</td>
<td>Tellus 32, Tellus T-23 or T-32</td>
</tr>
<tr>
<td>Sun Oil Co.</td>
<td>Sunvis 816 or 916</td>
</tr>
<tr>
<td>Texaco</td>
<td>Rando HD 32 or HD AZ 32</td>
</tr>
<tr>
<td>A.R.CO.</td>
<td>Duro 32</td>
</tr>
<tr>
<td>Exxon</td>
<td>Nuto H 32</td>
</tr>
</tbody>
</table>

* Also Boron & B.P. (British Petroleum) Oil Companies

Seal Cavity

To fill the seal cavity, remove the seal cavity fill plug (8A) in the intermediate, and add the recommended grade of submersible pump oil (approximately 5 1/2 quarts) to the level of the fill plug opening. Maintain the oil at this level. Apply 'Loctite Pipe Sealant With Teflon No. 592', or equivalent sealant to the threads of the fill plug, and reinstall and tighten the plug.

Motor Housing Cavity

Remove the motor cavity oil level plug (14). Remove the pipe cap (72) on the street tee (73) where the pressure relief valve (75) is secured, and add the recommended grade of submersible pump oil (approximately 26 quarts) until it escapes from the oil level plug opening. Maintain the oil at this level. Apply 'Loctite Pipe Sealant With Teflon No. 592', or equivalent sealant, to the threads of the pipe cap and the fill plug, and reinstall and tighten the cap and plug.
CAUTION

Never attempt to fill the motor cavity through the drain plug (8B) or oil level plug (14) openings. The integral fill tube and oil level plug (14) are designed to prevent over filling of the motor cavity. A volume of air must be trapped above the motor to permit thermal expansion of the motor oil.

FINAL ASSEMBLY

If the discharge flange (17) has been separated from the motor housing, replace the gasket (16) and secure the flange with the nuts (19).

Connect the discharge hose, and position the pump in the wet well. If rigid discharge piping is used, connect the piping after the pump has been positioned. Open any valves in the discharge line.
For U.S. and International Warranty Information,
Please Visit www.grpumps.com/warranty
or call:
U.S.: 419—755—1280
International: +1—419—755—1352

For Canadian Warranty Information,
Please Visit www.grcanada.com/warranty
or call:
519—631—2870