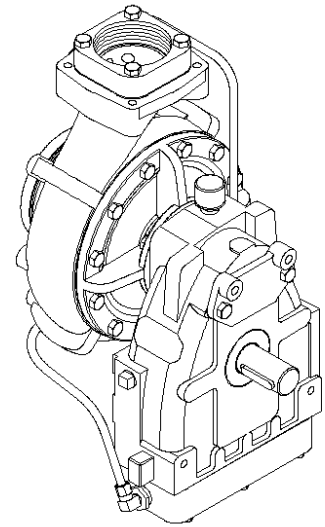
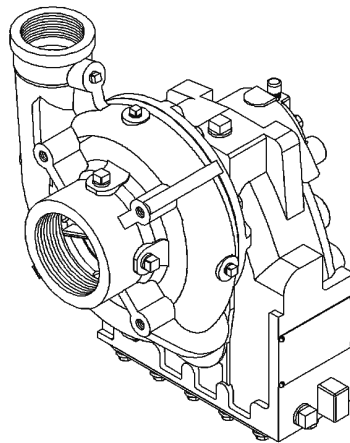
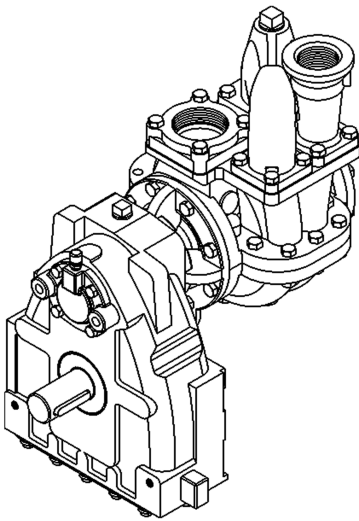





# Operation and Maintenance Manual for Hale Booster Pumps

**AP  
CBP  
2CBP**



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**Booster**

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## Booster Pumps

# SECTION I: INTRODUCTION

## OVERVIEW

Hale Products currently has 3 models of booster pumps in production:

- AP
- CBP
- 2CBP

Unless otherwise indicated, these procedures will apply to all models of Hale booster pumps: Any variations in operations and maintenance of the different models will be addressed within the context of this manual.

Hale booster pumps are the favorite of fire fighters throughout the world. Booster pumps can be used as initial attack pumps or as auxiliary pumps in conjunction with the apparatus main pump. Covering a range of capacities from 20 Gallons Per Minute (GPM) (76 Liters per Minute, LPM) to 500 GPM (1,893 LPM), Hale booster pumps offer the versatility, dependability, reliability, and ease of operation so necessary to effective fire fighting.

Hale Booster Pumps are of a compact size and lightweight design for easy mounting on the apparatus chassis. The pump is coupled to the gearbox and the apparatus builder need only supply the transmission PTO (power takeoff) and connecting shaft.

## Principles Of Operation

This section reviews the principles of operation of Hale booster pumps and provides a description of the pump components.

### Centrifugal Force

Hale booster pumps are centrifugal pumps that operate on the principle that centrifugal force is created by a rapidly spinning disk. Figure 1-1

shows an amount of water has been placed at the center of a disk. The disk is rotated and the water is thrown outward from the center to the edge of the disk. The velocity at which the water travels from the center directly relates to the diameter of the disk and the speed of rotation. When water is confined in a closed container (such as the pump body), the velocity is converted to pressure; pressure is therefore, dependant on the speed of rotation.

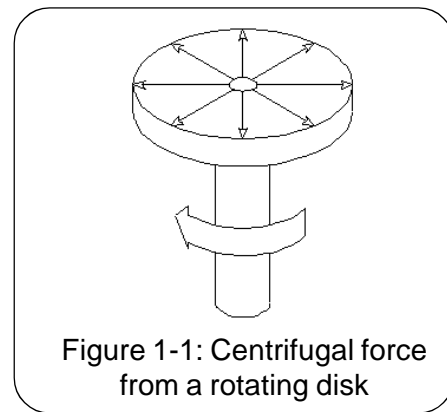


Figure 1-1: Centrifugal force from a rotating disk

There are three inter-related factors that regulate the performance of a centrifugal pump:

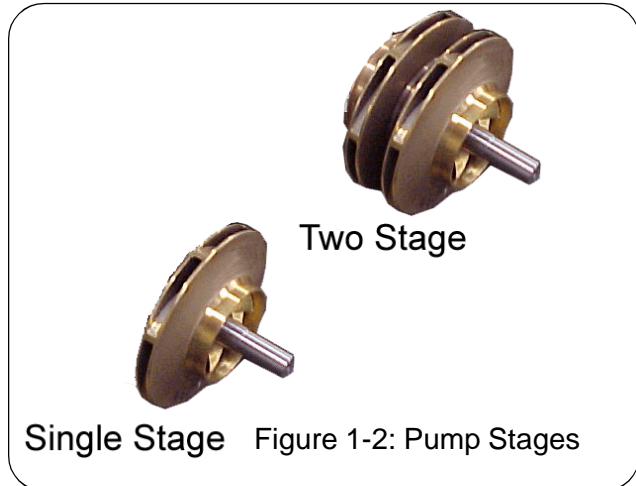
- Speed (RPM):** If the speed of rotation increases with the flow held constant, the water pressure increases.
- Pressure:** Pressure is usually measured in pounds per square inch (PSI) or (BAR). If pressure changes and speed is constant, the flow will change inversely. That is, if pressure increases, flow decreases.
- Flow:** Flow is usually measured in the number of gallons of water per minute (GPM) or liters per minute (LPM) that a pump can deliver when supplied from draft. If the pressure is held constant, the flow will increase with an increase in the speed of rotation.

The centrifugal pump is preferred by the fire protection service due to its ability to fully utilize any positive inlet pressure, reducing the strain on the pump.

For example, if the required discharge pressure is 120 PSI (8 BAR), and the inlet pressure is 45 PSI (3 BAR), the pump must only produce the difference in pressure of 75 PSI (5 BAR). This contributes to low engine and pump speeds which reduces wear on the pump. Another important benefit is the centrifugal pump has basically only two moving parts; the impeller and the shaft.

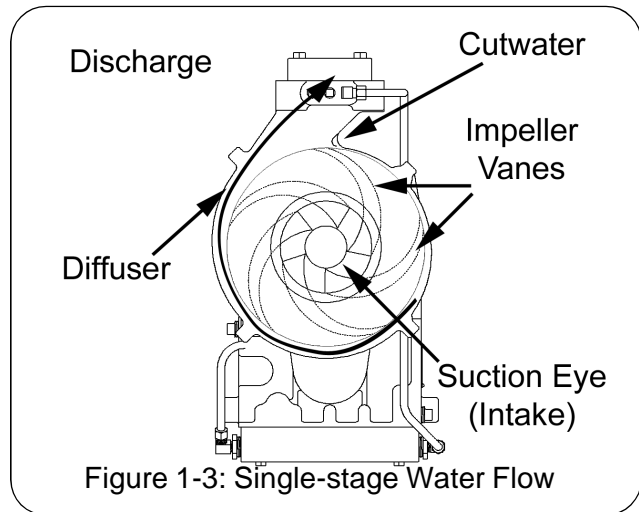
### Pump Stages

The number of impellers on a common shaft determines the number of pump stages. Hale single-stage booster pumps use a single impeller to develop the required volume and pressure. Two stage pumps have two impellers



on a common shaft.

During operation water enters the suction eye of the impeller. The rotating impeller vanes develop discharge pressure and direct the water to the discharge opening. The cutwater is a wedge that divides the water between the volute (pump body) and the pump discharge.



There are three models of Hale booster pumps. (The anticipated use determines which model is selected.) The AP and CBP booster pumps are single stage and provide initial attack pump performance per NFPA 1901 standards. The 2CBP is a two-stage series operation pump, is used as a high-pressure booster pump.

The available Booster Pump Models and their flow capacities are shown in Table 1-1.

Model	Type	Capacity	Pressure
AP	Single-Stage High Volume Attack Pump	100 to 700 GPM (379 to 2650 LPM) NFPA1901 Rated @250 to 500 GPM (946 to 1893 LPM)	100 to 350 PSI (7 to 24 BAR)
CBP	Single-Stage High Volume Attack/Booster Pump	50 to 400 GPM (189 to 1514 LPM) NFPA1901 Rated @250 GPM (946 LPM)	100 to 400 PSI (7 to 28 BAR)
2CBP	Two-Stage High Pressure Booster Pump	20 to 100 GPM (76 to 379 LPM)	300 to 1000 PSI (21 to 69 BAR)

Table 1-1: Booster Pump Models and Capacities

## Booster Pumps

### Two-Stage Booster Pump

The Hale Two-Stage Booster Pump (2CBP) has two impellers connected in series for high-pressure operation. The output of the first impeller is supplied to the intake of the second impeller. This second impeller adds additional pressure and directs the water to the discharge. Since the two-stage booster pump only operates in series, the final water pressure is the inlet pressure plus the pressure added by both impellers. The volume of water delivered at the discharge, however, is the same. Figure 1-4 shows the flow of water through a Hale 2CBP booster pump.

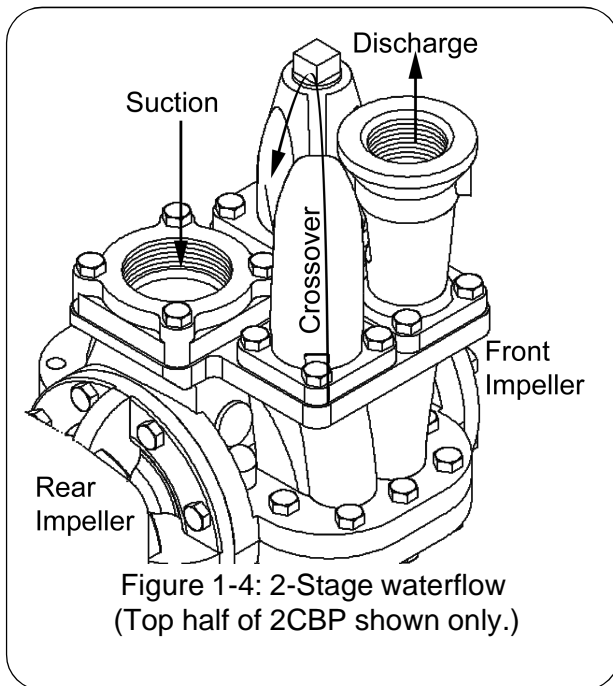


Figure 1-4: 2-Stage waterflow (Top half of 2CBP shown only.)

## COMPONENTS OF A BOOSTER

### PUMP

Booster pumps are made up of:

- Pump Body
- Impeller and Shaft Assembly
- Mechanical Seal
- Gearbox

Figure 1-5 shows these basic parts of a Hale

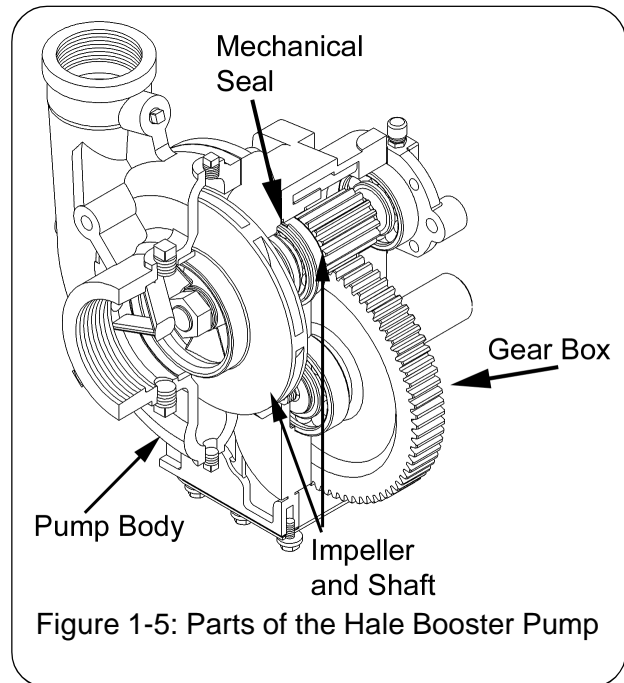


Figure 1-5: Parts of the Hale Booster Pump

booster pump. These parts are briefly described in the following section.

### Pump Body

The Hale single-stage booster pump body is a single-piece casting. Service of the impeller, clearance rings, and mechanical seal is accomplished by removing the pump body from the pump head and gearbox.

The pump body is constructed from fine grain cast iron. For areas where salt water is commonly used, a bronze version of the booster pump is available.

### Impeller and Shaft Assembly

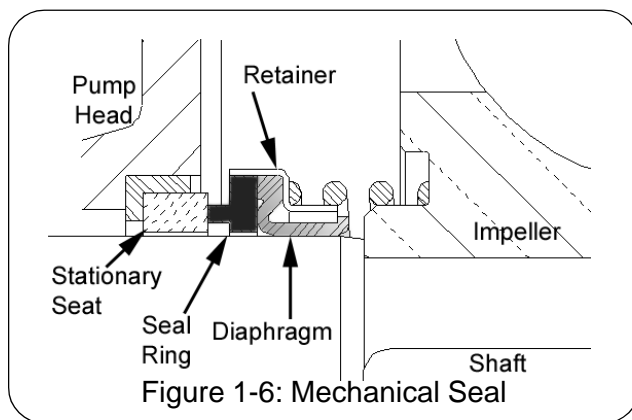
The impeller provides velocity to the water. The impeller is made of high quality bronze and is mounted on a stainless steel shaft that is rotated by the gearbox. Water enters the rotating impeller at the intake (or eye). The vanes guide water from the inlet to the discharge. Vanes curve away from the direction of rotation so water moves toward the outer edge (see Figure 1-2). The shrouds form the sides of the impeller and keep the water

confined to increase acceleration and pressure.

The discharging tube is widest at the pump outlet. The increasing discharge path, known as the volute, collects the fast moving water and converts the water's velocity into pressure.

### Mechanical Seal

The mechanical seal is common to all Hale booster pumps. Shown in figure 1-6, a stationary seat is in constant contact with a rotating seal ring to prevent leakage. The sealing diaphragm is made of a rubber elastomer specifically designed for high-temperature operations.



### CAUTION

*If a pump is operated without water for extended periods, or without discharging water, it may overheat. This may damage the mechanical seal or the drive mechanism.*

### Gearbox

The gearbox is typically constructed of fine grain alloy cast iron. Inside the gearbox (Figure 1-5) a gear set and input drive shaft made of heat-treated nickel steel, transfers engine power to the impeller. Hale offers a variety of pump gear ratios to accommodate a wide range of end-user and apparatus manufacturer requirements based on the pump's intended use, horsepower and speed rating of the

engine, and the torque rating of the transmission PTO.

### Pump Drives

There are four common types of booster pump drives used on fire fighting apparatus:

1. The most common drive is the PTO mounted on the truck transmission or four-wheel drive transfer case which allows for pump and roll operation.
2. A stand-alone drive with separate engine (auxiliary engine).
3. The truck chassis engine crankshaft (front-engine PTO).
4. Hydraulic Motor

Hale booster pumps are built to produce the volumes and pressures shown on their respective performance curves. However, the volumes and pressures safely obtainable are dependent on the torque capacity of the apparatus transmission or transfer case, power takeoff and the pump drive line. In most cases, the torque rating of the PTO determines maximum pump performance.

The apparatus builder can give various pump performance spots that will define the torque limit of the PTO in terms of GPM and PSI. When pumping continuously, care should be taken not to overheat the apparatus' PTO, transmission or transfer case.

### HALE Power Takeoff Pumps

Hale booster pumps are available for either engine rotation or opposite engine rotation PTO operation. Additionally, the pump can be configured to discharge in a variety of positions. Since some PTOs match engine rotation and some turn opposite of the engine rotation, each pump model can be built to match the rotation of the PTO.



## Booster Pumps

**NOTE:** Please refer to Hale Bulletin #886 for further assistance in selecting the correct booster pump PTO.

### ACCESSORIES

In addition to the basic parts of Hale booster pumps described above, the following items are available to enhance operation:

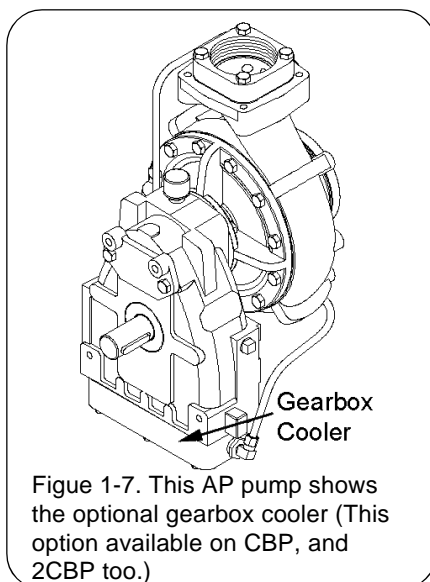
- Cooling Systems
- Priming Systems
- Pressure Control Devices
- Anodes

#### Auxiliary Cooling (Overheat Protection)

A cooler is available to protect the gearbox, the apparatus engine, and the pump.

The gearbox cooler (see Figure 1-7), circulates pump water to transfer heat from the gearbox oil to the pump discharge. It is standard equipment on pumps with a capacity of 750 GPM or greater and optional equipment on all other pumps.

#### Priming Systems



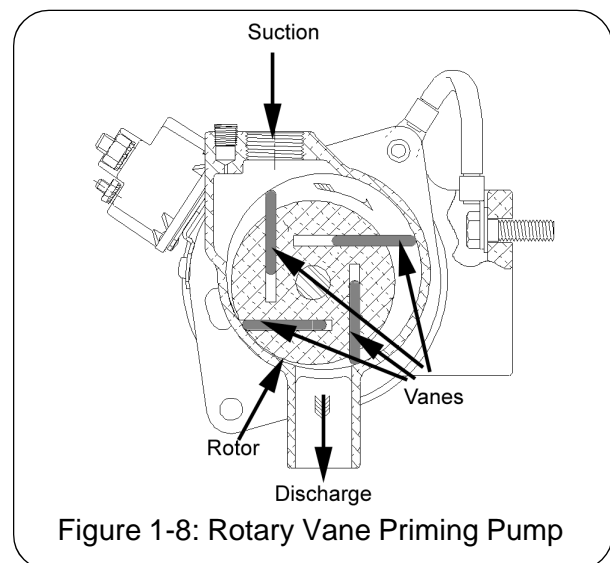
#### Priming the Pump

Priming pumps are used to evacuate air in the suction hose and the pump. The vacuum created allows atmospheric pressure to push water from the static source through the suction hose and into the pump. Hale booster pumps use Rotary Vane Positive Displacement type pumps for priming.

A priming pump draws air out of the pump body and discharge piping allowing water to enter. Shown in figure 1-8, the priming pump has a rotor mounted off-center (eccentric) to the pump body housing. The vanes in the rotor slide in grooves and are held against the body housing by centrifugal force. As a vane turns toward the discharge, it recedes into the rotor compressing the air. As the rotor continues past the discharge, the vane advances outward from the groove and against the body housing. During this cycle, the space between the rotor and housing case fills with air. The vanes, acting as wipers, force air out of the discharge, creating a vacuum in the main pump allowing atmospheric pressure to push water into the hose and suction side of the pump.



ESP Priming Pump



The Hale ESP-series priming pump is an environmentally friendly primer that does not require a separate lubricant reservoir. The vanes and pump body are self lubricating for maintenance free operation.

A Hale priming pump has a single control to open the priming valve between the booster pump and the priming pump, and start the priming motor.

### Priming Valves

Hale priming valves open when the priming pump is operated to allow the air to escape from the pump. There are two priming valves available:

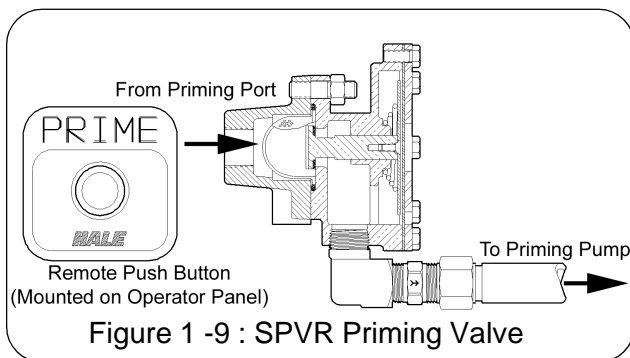


Figure 1 -9 : SPVR Priming Valve

1. **Hale Semi-Automatic Priming Valve for Remote Mounting (SPVR)** A hose is connected from the SPVR to the priming tap on the booster pump body. When the SPVR is installed, a single push-button on the operator's panel starts the priming pump motor. When a vacuum is created, the SPVR opens. Releasing the push-button stops the priming pump and the SPVR closes. Figure 1-9

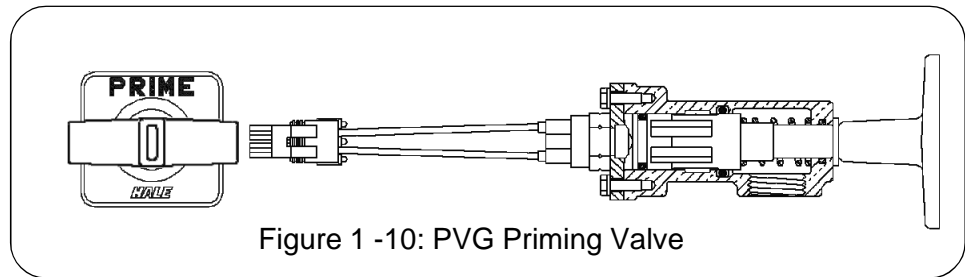


Figure 1 -10: PVG Priming Valve

2. **The Hale PVG Priming Valve** (Figure 1 - 10) is mounted on the pump operator's panel. The PVG is a combination valve and switch. When the handle on the PVG is pulled out, the valve opens and the switch energizes the primer motor. Pushing the handle de-energizes the motor and closes the valve.

### Pressure Control

The P Series relief valve system is a bronze, variable-pressure setting relief valve that prevents undue pressure per the requirements of NFPA Standard 1901. An indicator light on the operator control panel signals when the valve is open.

#### *The P Relief Valve System*

The P relief valve system consists of a panel mounted control valve (PM) and, depending on the pressure rating of the pump, a P30, or P35 relief valve mounted in the discharge piping and plumbed back to the pump suction. Valve connections are either flanged or Victaulic™. Both are shown in figure 1-12.

How the Relief System Works:

A bleeder line mounted in the pump discharge pressure tap provides pressure to the diaphragm in the PM control valve. The handwheel on the PM control either increases or decreases the spring tension on the diaphragm. The seat of the P-series relief valve is kept closed by pump discharge pressure.

As pump pressure increases, more pressure is

## Booster Pumps

applied to the diaphragm in the PM Control valve. As the pressure on the diaphragm increases beyond the set point, the stem will move off its seat, allowing pump pressure to push on the piston in the relief valve. The pressure on the piston will cause the relief valve seat to lift allowing excess pressure to dump back to the pump suction. After the pressure equalizes, the piston returns to the closed position.



Figure 1-11: TRV-L

The amber indicator light on the PM control illuminates when the relief valve is open.

### Thermal Relief Valve (TRV)

The Thermal Relief Valve (see Figure 1-11) protects the pump from overheating. The optional TRV unit can be attached to the discharge piping either by flange mounting or 1-1/4" NPT threaded connection (38 mm for the TRVM). The valve monitors the temperature of the water in the pump. When the temperature

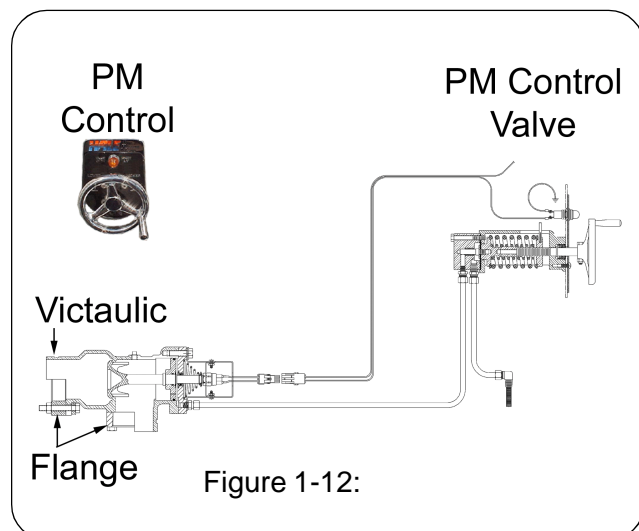


Figure 1-12:

exceeds 120° F (48.9° C), the valve automatically opens and depending on the installation, discharges a small amount of water either to the ground or into the water tank allowing cooler water to enter. After the temperature returns to a safe level, the valve closes. The TRV will flow up to 1-2 GPM (3-7 LPM).

### TRV-L Kit

The TRV-L kit includes a chrome panel placard with a warning lamp, lamp test button, and a preassembled wiring harness. The light illuminates whenever the TRV is open and discharging water. An optional buzzer provides audible warning. The buzzer mounts on the operator panel.

### Anodes

The Hale Anode System helps prevent damage caused by galvanic corrosion in the pump. Galvanic action pits the pump and pump shaft material. The popularity of non-corrosive water tanks and piping has increased this type of corrosion in today's fire pumps. The Hale Anode System is a sacrificial metal, which helps prevent corrosion. The anode will fit on any Hale truck mounted pump, regardless of age or model. It is designed to be easily installed requiring four bolts and a gasket. Total time to install is just fifteen minutes, yet it will provide years of protection for the pump. The Anode kit is designed for installation in the standard Hale 115 series flange opening. On fabricated manifolds and similar applications, the installer is to provide 1-1/4 NPT openings and install anodes directly. It is recommended that one anode be installed on the suction side and one on the discharge side.



Figure 1-13: Hale Anode



### EXPLANATION OF TERMS

#### Atmospheric Pressure

Static air pressure. Air pressure is 14 pounds per square inch at sea level. Pressure increases below sea level and decreases above sea level. The weather also effects air pressure. Air in a high pressure area compresses and warms as it descends. The warming inhibits the formation of clouds, meaning the sky is normally sunny in high-pressure areas. But haze and fog still might form. Just the opposite occurs within an area of low atmospheric pressure. Atmospheric pressure effects a pumps ability to pump from draft. Higher pressures will increase a pumps performance, while lower pressures can cause a noticeable decrease in lift.

#### Cavitation

The sudden formation and collapse of low-pressure bubbles in liquids by means of mechanical forces, such as those resulting from rotation of a pump impeller.

#### Dead Heading

Operating a pump without any discharge. Lack of flow causes temperatures to rise inside the pump.

#### Impeller

The working part of centrifugal pumps which imparts energy (motion) to the water. Essentially, an impeller consists of two discs separated by curved vanes. The vanes force the water to rotate between the discs and is thrown outward at high velocity. The water from the impeller discharges into a diverging passage known as a volute, converting the high velocity energy of the water into pressure.

#### Priming Pump

An auxiliary positive displacement pump which pumps air out of the booster pump creating a vacuum in order to prime the pump. The priming pump is a rotary vane type, electric motor driven. Once the main pump is primed and pumping, the priming pump is shut off.

#### Relief Valve

An automatic valve which, when activated by the relief valve control will hold the pump pressure to no more than 30 PSI when the pump discharge is gated or closed. The valve maintains a set pressure by diverting the pump discharge flow into the pump suction.

#### Relief Valve Control (PM)

A hand adjustment valve. When set to the desired pressure, the relief valve will maintain the desired pump discharge pressure and limit a pressure increase to no more than 30 PSI (2 BAR).

#### Volute

The increasing discharge path of the pump, its function is to collect the water from the impeller and depending on its design can either increase pressure and decrease velocity or increase velocity and decrease pressure.

## Booster Pumps

# SECTION II OPERATING PROCEDURES

This section supplies information and procedures for the operation of Hale booster pumps. Included in this section are procedures for pumping from an on-board tank, a hydrant, from draft, and post-operation procedures.

Unless otherwise indicated, these instructions apply to all Hale booster pumps.

THE PROCEDURES IN THIS SECTION ARE GENERAL OPERATING PROCEDURES. THEY DO NOT REPLACE LOCAL PROCEDURES OR POLICIES, NOR DO THEY REPLACE THE RECOMMENDATIONS AND PROCEDURES PROVIDED IN THE TRUCK MANUAL.

## STATIONARY PUMPING OPERATIONS

### Pumping From a Hydrant (General Operation)

1. Position the truck for the best hydrant hookup and discharge hose layout.

REFER TO DEPARTMENT PROCEDURES FOR SETTING WHEEL CHOCKS AND LAYING OUT SUCTION AND DISCHARGE HOSES.

ALL VALVES, DRAIN COCKS, AND CAPS SHOULD BE CLOSED.

2. Bring the truck to a complete stop before attempting to shift from "road" to "pump".
3. Apply the truck parking brake.
4. Shift the truck transmission to the NEUTRAL position.
5. Engage the pump PTO switch.

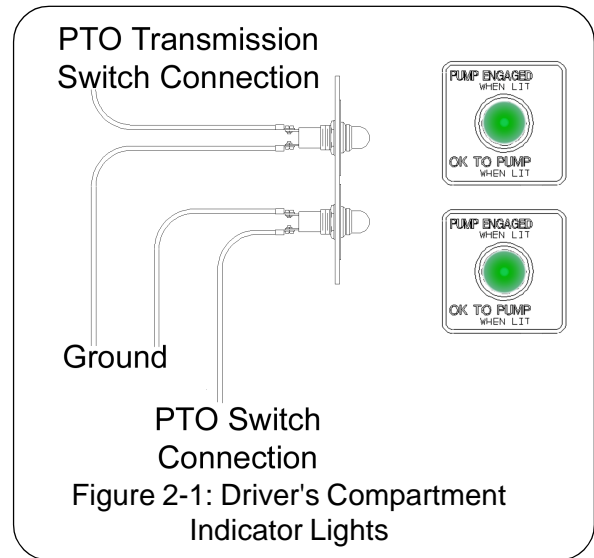


Figure 2-1: Driver's Compartment Indicator Lights

### ⚠WARNING

DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL "OK TO PUMP" LIGHTS IN THE CAB ARE ILLUMINATED. (Figure 2-1).

6. Exit the driving compartment only after all the above steps are completed.

### ⚠CAUTION

DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT IS ON (Figure 2-2).

7. Verify the pump panel shift indicator light is on and that all hose connections are complete.
8. Open the hydrant. Bleed off the air from the suction hose.
9. Open the suction valve.
10. If necessary to eliminate air pockets, prime the pump; see Pumping From Draft for instructions.

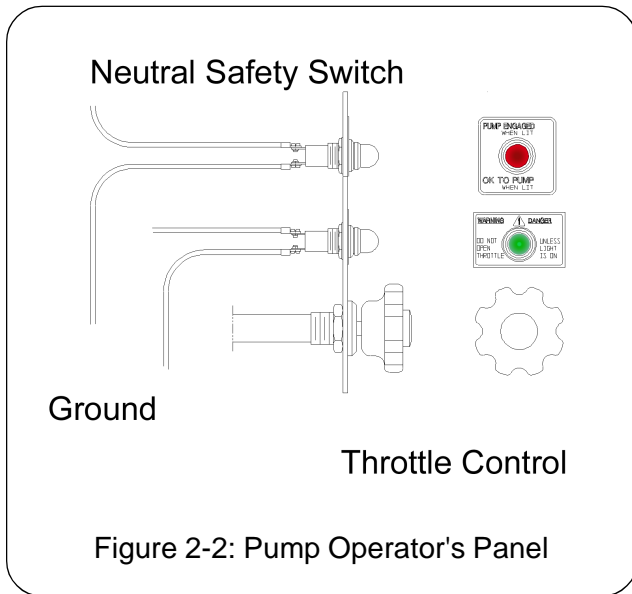


Figure 2-2: Pump Operator's Panel

- Advance the engine throttle gradually until the master discharge gauge indicates the desired pressure.

### CAUTION

DO NOT REDUCE THE PRESSURE ON THE INTAKE GAUGE BELOW ZERO; SERIOUS DAMAGE TO THE WATER MAIN COULD RESULT.

The master intake gauge reading must be maintained at 5 PSI (.3 BAR), minimum. If the gauge shows a vacuum the pump is attempting to draw more water than the hydrant can supply. When this occurs, reduce the pump flow to increase the pressure.

As the throttle is opened, the pressure gauge reading increases with the engine speed. If the engine speed increases without an increase in pressure, the pump is beginning to cavitate. Close the throttle slowly until the pressure begins to drop, and the engine returns to an idle.

- Set the automatic relief valve according to department policy. If no department policy exists, refer to the Relief Valve Procedures later in this section.

- If the pump overheats and it is not equipped with a Hale TRV valve, open the valve to access the bypass line, if it is furnished, or open the valve to the booster tank (both suction and discharge sides) to circulate water.
- After completion of pumping operations, gradually reduce the pump pressure until the engine is at idle speed. Disengage the PTO.

### DRAFT LIMITING FACTORS

The effect of raised water temperatures when pumping from a positive pressure source (hydrant) is negligible on fire pump performance. But when pumping from draft, elevated water temperature does have a limiting effect. Water temperatures above 95° F (35° C) will cause a noticeable decrease in lift when drafting. Another factor that can limit lift when drafting is barometric pressures below 29 In of Hg. It is important to be aware of environmental conditions when drafting.

### PUMPING FROM DRAFT

- Get as close to the water source as possible. The pump can draw 100% of its rated capacity with less than a 10 foot vertical lift. As the lift increases to above 10 feet, the pump

Water Temperature F° (C)	Lift Loss Head Ft (Meters)
60° (16°)	NFPA Baseline
70° (21°)	.3 (.09)
80° (27°)	.6 (.18)
90° (32°)	1.1 (.335)
100° (38°)	1.7 (.52)
110° (43°)	2.5 (.76)
Table 2-1 : Additional Losses Beyond Baseline NFPA Rating	

## Booster Pumps

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capacity will be reduced.

2. Bring the truck to a complete stop.
3. Apply the truck parking brake.
4. Shift the truck transmission to the NEUTRAL position.

### ⚠CAUTION

REFER TO DEPARTMENT PROCEDURES ON SETTING WHEEL CHOCKS AND HOSES. ALL VALVES, DRAIN COCKS, AND CAPS SHOULD BE CLOSED.

5. Engage pump PTO.

### ⚠WARNING

DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE INDICATOR LIGHTS IN THE CAB ARE ON.

6. Exit the driving compartment only after all the above steps are completed and the indicator lights in the cab and on the panel are on.

### ⚠CAUTION

DO NOT ADVANCE THE THROTTLE UNLESS THE "OK TO PUMP" INDICATOR LIGHT IS ON.

7. Verify the pump panel shift indicator light is on.
8. Activate the priming pump by pulling the control handle located on the pump panel.
9. Monitor the intake and discharge master gauges. The pump is primed when the intake indication reading falls below zero, and the discharge pressure starts to increase. Water may also be heard discharging to the ground.

Running the engine at speeds higher than 1200 RPM during priming is not recommended since it will not improve priming operation and may cause damage to the pump.

### ⚠CAUTION

IF THE DISCHARGE GAUGE READING DOES NOT INCREASE, THE INTAKE GAUGE READING DOES NOT FALL BELOW ZERO, OR THE PRIMING PUMP DOES NOT DISCHARGE WATER TO THE GROUND IN 30 TO 45 SECONDS, DO NOT CONTINUE TO RUN THE PRIMING PUMP. STOP THE PUMP AND CHECK FOR AIR LEAKS OR POSSIBLE PUMP TROUBLE.

10. Gradually open the discharge valve until water emerges in a steady stream. Then open the other discharge valves to the desired setting.

11. Open the engine throttle gradually until the desired pressure or flow is reached.

As the throttle is opened, increase the pressure gauge reading with engine speed. If the engine speed increases without an increase in pressure, the pump is nearing cavitation. Cavitation will be discussed in detail later. Reduce the flow from the pump to maintain pressure or reduce the pressure (throttle) to maintain flow.

13. If a pump shutdown is desired while pumping from draft, reduce the engine speed to idle, and close the discharge valves. To resume pumping, open the throttle and discharge valves.
14. Set the automatic relief valve according to department policy. Refer to the Relief Valve Procedures later in this section.
15. If the pump overheats and is not equipped with the Hale TRV valve, open the valve to access the pump auxiliary cooling system, or

slightly open the drain line.

16. After completing pumping procedures, gradually reduce the engine RPM to idle speed and disengage the PTO.

## PUMP AND ROLL OPERATION

Hale booster pumps are primarily driven by a transmission mounted Power-Take-Off (PTO) unit.

During pump and roll operation, it is necessary to slow the forward motion of the apparatus to the PTO manufacturer's recommended engagement speed.

The following outlines a general pump and roll procedure:

1. Slow the apparatus to safe PTO engagement speed as recommended by the PTO manufacturer.

**Note:** Most PTOs must be engaged while the apparatus is stopped. Only a "Hot Shift" PTO can be engaged while the apparatus is rolling.

2. Engage the PTO.
3. Verify the PUMP ENGAGED light is illuminated.
4. Open the valve between the tank and pump suction.
5. Observe pump discharge pressure and verify the pump pressure increases.
6. Prime the pump if necessary.
7. Open the discharge valves and commence operations.

## RELIEF VALVE PROCEDURES

### TPM /P35 Relief Valve Procedures

These procedures cover the Hale TPM Relief Valve System. Be sure to select the correct procedure, for the equipment on the truck.

1. Set the pressure indicator on the PMD control valve to a position slightly above the normal operating pressure (even before water starts to flow).
2. After normal operating pressure has been achieved (as indicated on the master pressure gauge while the pump is discharging water), slowly move the adjusting hand wheel counterclockwise until the relief valve opens, and the amber indicator light comes on.
3. Turn the hand wheel slowly clockwise until the indicator light goes out. The relief valve will operate at the set pressure.
4. When the pump is not in operation, turn the hand wheel clockwise back to a position slightly above the normal operating pressure.



Figure 2-3 PMD Relief Valve Control



## Booster Pumps

More complete and detailed information can be found in the relief valve manual.

### **CAUTION**

THE PRESSURE INDICATOR ON THE PANEL IS ONLY A ROUGH INDICATION OF TPM SETTING. ALWAYS USE THE ABOVE PROCEDURE TO PROPERLY SET THE TPM RELIEF VALVE SYSTEM.

## CAVITATION

Cavitation can occur while pumping from draft, in relay, or from a hydrant. The operator must be aware of the warning signs and correct the situation, or serious damage to the pump and impeller will occur.

Cavitation can damage the impeller and other sensitive components, impair pump performance, and reduce flow capacity. The damage done during any one period of cavitation is not great, but the effects are cumulative. Implosions occurring during cavitation break away or erode tiny pieces of metal from the internal parts and the pump casing. When enough metal has been chipped away, the impeller becomes unbalanced causing a strain and vibration on bearings, bushings and shafts.

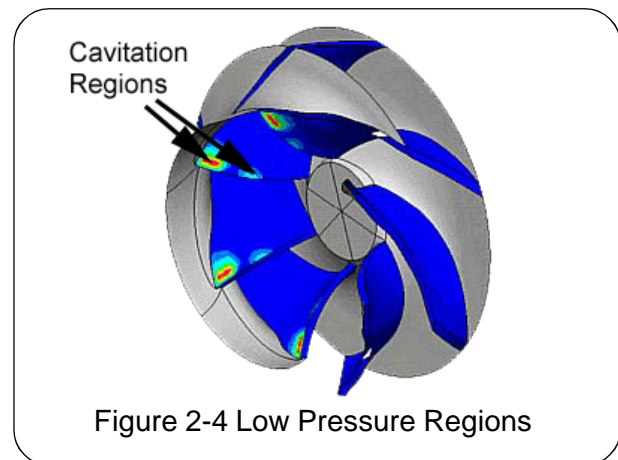
The way to eliminate cavitation is to increase the flow to the pump, decrease the amount of water being discharged from the pump, or reduce the pressure in the pump by decreasing engine speed.

### Cavitation

Cavitation occurs when a centrifugal pump is attempting to discharge more water than it is receiving. It is often referred to as "the pump running away from the supply."

### Process of Cavitation

1. When increased discharge demand exceeds the intake, bubbles form in the low-pressure region (eye) of the impeller.
2. The pressure of the water in the pump drops as it flows from the suction flange through the suction nozzle and into the impeller.
3. As flow from the pump increases, the vacuum at the impeller increases. As the vacuum increases, the boiling point of water in that vacuum decreases until it reaches a point near the impeller eye where it boils and vaporizes.
4. Once the vapor pockets, or bubbles, enter the impeller, the process begins to reverse itself. As the vapor reaches the discharge side of the pump, it is subjected to a high positive pressure and condenses back to a liquid.



5. The sudden change from vapor to liquid generates a shock effect that damages the impeller and pump housing. Usually there are thousands of tiny vapor pockets (bubbles) rather than a few large ones. It is the collapsing (or implosion) of these bubbles that causes the characteristic sound of cavitation that has been described as rocks tumbling in the pump.



**Warning Signs of Cavitation: Discharge and Gauges**

**Discharge Pressure**

In a properly functioning pump, an increase in RPM will increase the discharge pressure and volume. An increase in engine RPM that does not cause an increase in the pump discharge pressure, is the most reliable indication that a pump is approaching cavitation.

**Vacuum Compound Gauge**

The operator should not depend entirely on the vacuum (compound) gauge to indicate when a pump is nearing cavitation: The vacuum gauge is usually tapped into the intake chamber several inches away from the leading edge of the impeller eye where the greatest amount of vacuum occurs. The vacuum gauge does not take into account ambient temperature nor atmospheric pressure and is not accurate near zero on the vacuum scale.

**How to Prevent Cavitation**

A soft sleeve has an advantage over a hard sleeve when pumping from a hydrant because it will partially collapse providing an immediate indication to the operator that cavitation is imminent. A hard sleeve indicates problems only at the intake gauge which is not the best or most reliable indicator.

Monitoring current operating conditions, knowing the capabilities of the equipment, and regular inspection are the best protection against cavitation.

**During Operations:**

- Do not increase the pump speed beyond the speed at which the pressure ceases to rise.
- Monitor the water temperature baseline per NFPA standards is 60° F (16 C). Table 2-1

illustrates the amount of lift loss as temperatures rise. If there is a marked loss of suction capacity, the pump may be near cavitation.

**NOTE:** When water reaches 95° F ( 35 C), the operator is likely to notice a marked decrease in lift.

- Monitor barometric pressure. NFPA standards sets a baseline of 29.9”Hg. See Table 2-2.
- Location: The higher the elevation above sea level, the lower the atmospheric pressure and less lift. See Table 2-3.*
- Open the throttle gradually and watch the

Barometric Reading in (mb)	Lift-loss in Head Feet (meters)
29.9 (1012.53)	NFPA Baselines
29.7 (1005.76)	.2 (.06)
29.5 (999)	.5 (.15)
29.3 (992.21)	.7 (.21)
29.1 (985.444)	.9 (.27)
28.9 (978.67)	1.1 (.33)
28.7 (971.89)	1.4 (.43)

Table 2-2 : Lift-Loss from Barometric Pressure

pressure gauge and the tachometer, if equipped. An increase in engine RPM without a corresponding increase in pressure indicates cavitation.

- Use a hard suction hose when pumping from draft and soft suction hose when pumping from hydrant.

**Preventive Measures:**

- Regularly inspect discharge and suction hoses to check for air leaks: these can also



## Booster Pumps

Elevation Feet (Meters)	Lift-Loss in Feet (Meters)
2,000 (609)	NFPA Baseline
3,000 (914)	1.1 (0.33)
4,000 (1219)	2.2 (0.67)
5,000 (1524)	3.3 (1)
6,000 (1828)	4.4 (1.34)
7,000 (2133)	5.5 (1.67)
8,000 (2438)	6.6 (2.01)
9,000 (2743)	7.7 (2.35)
10,000 (3048)	8.8 (2.68)
Table 2-3: Lift Loss from Elevation	

cause cavitation.

- Consider the size of the suction hose: Table 2-4 shows the NFPA pre-selected hose sizes for each pump-rating capacity. Using the appropriate-sized hose will minimize the occurrence of cavitation.
- Consider the piping within the truck: Further suction losses may result from additional suction piping added to the fire pump during assembly by the manufacturer.
- Follow the maintenance and inspection procedures.
- Cavitation can occur with large nozzle tips. Solve this problem by reducing flow.
- Cavitation can also occur when air enters the pump. The pump may be primed, however, air leaks can cause rough operation and an increase of engine speed without an increase in pressure or flow. If an air leak is suspected, discontinue pumping and refer to Section IV.

Hose Diameters (mm)	3" (76)	4" (102)	4 ½" (114)	5" (127)	6" (152)	Dual 6"
FLOWS GPM (LPM)	Lift Loss					
250	5.2 (19.7)					
350		2.5 (9.5)				
500		5.0 (19)	3.6 (51.5)			
750		11.4 (43)	8.0 (30)	4.7 (17.8)	1.9 (7.2)	
1000			14.5 (55)	8.5 (32)	3.4 (12.9)	
1250				13 (49)	5.2 (19.6)	
1500					7.6 (28.7)	1.9 (7.2)
1750					10.4 (39.4)	2.6 (9.8)
2000						3.4 (12.9)
2500						5.2 (19.6)
Table 2-4: Hose Sizes for Pump-Rating Capacity						



## POST OPERATION PROCEDURE

- Return the engine to idle.
- Slowly close all valves.
- Place the transmission in neutral or park.
- Slowly shift from "pump" to "road" to disengage the pump.
- Drain the pump (especially important in freezing weather):
  - a. Open the discharge valves, remove suction tube caps, and discharge valve caps.
  - b. Open the pump body drain cocks or Hale multiple drain valve. If a multiple drain valve is used, all pump drain lines should be connected to this valve.
  - c. After the pump is completely drained, replace all caps and close all valves,
- If sea water, dirty water, alkaline water or foam solution, has been used, flush the pump with clean water.
- Remove the wheel chocks only when preparing to leave the scene.
- Fill out the pump run log, indicating total pumping time and total out-of-station time.
- Report all pump, vehicle and equipment malfunctions, and irregularities to the proper authority.
- Know and follow all local procedures.

## Booster Pumps

# SECTION III PREVENTIVE MAINTENANCE

## OVERVIEW

Hale Booster Pumps require very little care and maintenance. However, the little required is important. Preventive maintenance tasks take little time to accomplish and consist of leak testing, lubrication and cleaning. The procedures supplied in this section are for normal use and conditions.

This section provides recommended actions to be completed after each use, weekly, monthly and annually basis.

## Post-Operation Maintenance Procedures

### Flush Pump

1. Inspect the suction hose and rubber washers as well as the washers in the suction tube caps. Remove any foreign matter from the hose and coupling. Replace worn, damaged, or dry washers.
2. Verify all discharge valves, drain valves and drain cocks are closed.
3. Tighten the suction caps.

### Weekly Maintenance

Weekly maintenance consists of:

- Testing the relief valve system
- Testing the priming system
- Testing the pump shift warning indicator lights
- Valve Maintenance

- Checking and cleaning the intake strainers
- Checking any auxiliary engine.
- Verifying all gauges are in working order.
- Operating pump controls.
- Inspecting water and foam tanks.
- Checking roof and bumper turrets
- Checking auxiliary fire suppression equipment

### Relief Valve Testing

When the relief valve is not in operation, keep the hand wheel set above the normal operating pressure.

1. Set up to pump from the onboard water tank with the discharge flow back to the water tank.
2. Turn the relief valve hand wheel clockwise to the stop to prevent the relief valve from operating. Figure 3-1
3. Bring the pump pressure up to 150 PSI (10 BAR) as indicated on the master pressure gauge per normal operating procedures.



Figure 3-1  
PM Valve Control

4. Turn the relief valve hand wheel counterclockwise until the relief valve opens. The relief valve is open when the amber indicator light is lit and the pressure begins to drop.
5. Turn the relief valve hand wheel clockwise then counterclockwise a few times to ensure that the hand wheel turns freely. Observe the pressure gauge and indicator light for



proper valve operation.

6. Return the relief valve hand wheel and the apparatus to normal operational condition.

### **Pump Shift Warning Indicator Lights**

VERIFY THE PARKING BRAKE IS SET AND THE WHEELS ARE CHOCKED TO PREVENT ANY MOVEMENT OF THE APPARATUS.

1. Follow the operating procedures in Section II to engage the pump if no local procedures exist.
2. Verify the warning indicators in the cab and the pump control panel function properly.
3. Verify the indicator lights on the control panel function properly and agree with the indicators in the cab. Repair or replace any malfunctioning indicators.

### **Valve Maintenance**

Properly functioning valves are integral to the proper operation of the pump. Refer to the valve manual for proper valve maintenance procedures.

1. Lubricate all suction and discharge valves using an approved lubricant.
2. Verify each valve operates easily and closes completely.
3. Inspect and lubricate all of the valve linkages. Repair or replace any damaged or nonfunctional linkages.
4. The relief valve operator should be lubricated every 5 months.

### **Check and Clean the Intake Strainers**

Remove the strainers. Clean any debris out of the intake. Flush the pump if required by department procedures. Repair or replace any damaged strainers.

### **Check Auxiliary Engine**

If the pump is powered by a separate engine, check the engine, fuel tanks and drive for wear and proper operation.

### **Verify all Gauges are in Working Order.**

Any gauge that is repeated in the cab or another panel, must agree with the gauge on the operator's panel. Gauges not reading within 10% of the calibrated test gauge must be removed from service and recalibrated.

### **Operate Pump Controls.**

Operate the pump drive controls to verify the pump can be engaged. Verify the indicator lights work properly.

### **Inspect Water and Foam Tanks.**

Visually inspect water and foam tanks for proper level and gauge readings. If any debris is present, flush the tanks to protect the pump from wear caused by dirty water or foam concentrate.

### **Check Roof and Bumper Turrets**

If the apparatus is so equipped, verify the turrets function properly, and no leaks are present.

### **Check Auxiliary Fire Suppression Equipment**

Visually inspect all piping and valves on the pump and auxiliary equipment for corrosion or damage.

## Booster Pumps

### Monthly Maintenance

- Check the Gearbox Oil
- Perform the dry vacuum test
- Check the drive line bolts.

### Gearbox Lubrication

Too much oil or the wrong type of oil will result in unnecessary loss of power and high oil temperature. Change the oil every 12 months, depending on pump usage. Recommended oil for Hale booster pumps is SAE EP-90, 80W-90, or synthetic 75W-80 gear oil that meets service rating of API GL-5 requirements. Gearbox capacity is one to two quarts.

1. Remove the gearbox oil fill plug, and check the level of the oil in the gearbox. The level should be up to the plug hole. Figure 3-2

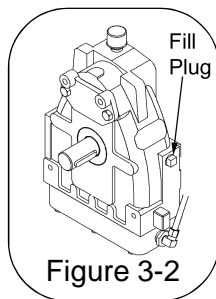


Figure 3-2

2. If the oil appears white or "milky," a water leak is indicated. Remove the drain plug (figure 3-3) and drain the oil into a suitable container. Examine the oil for metal flakes or other contamination. Either of these conditions indicate maintenance is required on the unit.

### Priming System Test (Dry Vacuum Test) (Refer to NFPA 1901 or NFPA 1911)

1. Close all valves and drains. Cap all suction openings and the outlet of the suction side relief valve (if equipped).

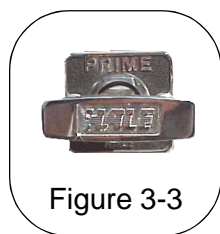


Figure 3-3

2. Connect a test vacuum gauge or manometer to the intake test gauge connection on the pump panel.

3. Engage the priming pump

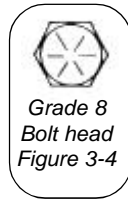
until the gauge indicates at least 22 IN- $\text{Hg}$  vacuum.

4. Compare the readings of the test gauge and the apparatus gauge. Note any difference.
5. Stop the priming pump and observe the gauge. If the vacuum falls more than 10 in of Hg in 5 minutes, it is a certain indication of at least one air leak. Vacuum leaks may often be detected by ear if the apparatus engine is turned off. Correct leaks immediately to return the pump to service.
6. Test the suction hose as follows:
  - a. Attach the suction hose to the pump.
  - b. Place a suction tube cap on the end of the hose in place of a strainer.
  - c. Close all valves and drains. Cap all suction openings and the outlet of the suction side relief valve (if so equipped).
  - d. Connect a calibrated vacuum gauge or manometer to the intake test gauge connection on the pump panel.
  - e. Engage the priming pump until the gauge indicates at least 22 IN- $\text{Hg}$  vacuum.
  - f. Watch the gauge. If the vacuum falls more than 10 inches in 5 minutes, it is a certain indication of at least one air leak.
  - g. Verify the test gauge and the apparatus gauge display the same readings. Repair or replace any gauges that do not display the correct pressure.

IF LEAKS CANNOT BE DETECTED BY FOLLOWING THE PROCEDURE, IT IS ADVISABLE TO TEST THE PUMP HYDROSTATICALLY.

- Open all the valves.

- Place caps on all valves
- Connect a positive pressure source
- Inspect the pump for leaks.



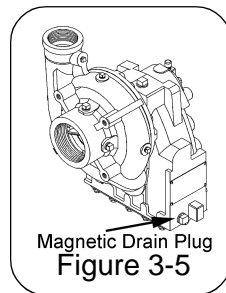
### Drive Line and Flange Bolts

Check all drive line and flange bolts to ensure:

1. No bolts are missing.
2. All bolts are tight. Use a torque wrench to torque bolts to the drive train manufacturer's recommended specifications.
3. Bolts used are "Grade 8" strength.

### Annual Pump Maintenance

- Replace the pump gearbox oil. Use SAE EP-90, 80W-90, or synthetic 75W-80 gear oil that meets service rating of API GL-5 requirements.
- Check individual drain lines from the pump to the multi-drain to ensure proper drainage and protection from freezing.
- Tank to pump flow rate test.
- Clean ESP Primer if installed.
- Perform the yearly pump test to check performance levels. (See NFPA Standard 1911 for more details.)



### Replace Gearbox Oil

1. Remove the magnetic drain plug from the gearbox.
2. Drain the oil from the gearbox.

3. Inspect the magnetic drain plug. If of metal filings are present on the drain plug, remove the cooler or coverplate to visually inspect and clean the internal components. Repair or replace as necessary.
4. Replace the cooler or cover, if necessary. Remove the oil fill plug, and replace the drain plug.
5. Fill the gearbox with an approved gear oil until the oil level is at the fill plug opening (approximately 1 to 2 quarts).
6. Replace the fill plug.

### Check Drain Lines to Multi-Drain

Drains are supplied on the pump and piping at the lowest points where water could collect and freeze rendering the pump useless. Most of these drains are piped together to a multi-drain to allow the entire system to be drained by one valve.

It is necessary to inspect each line to the multi-drain to ensure the entire system is draining when the valve is operated.

Inspect each connection and verify the individual lines to the multi-drain are free of debris. Repair or replace any lines that are damaged, kinked, or corroded.

### Tank to Pump Flow Rate Test

**Note:** This procedure is written for information only. It does not supercede any local procedure.

1. Fill the water tank until it overflows.
2. Close the tank fill line, bypass the cooling line, and all the pump intakes.
3. Attach sufficient hoses and nozzles to flow the desired discharge rate.





## Booster Pumps

Example		PUMP RATING GPM (LPM)					
CAPACITY	PRESSURE PSI (BAR)	250 (946)	350 (1325)	450 (1703)	500 (1893)	750 (2839)	1000 (3785)
FULL	150 (10)	250 (946)	350 (1325)	450 (1703)	500 (1893)	750 (2839)	1000 (3785)
70%	200 (13)	175 (662)	245 (927)	315 (1192)	350 (1325)	525 (1987)	700 (2650)
50%	250 (17)	125 (473)	175 (662)	225 (852)	250 (946)	375 (1419)	500 (1893)
<b>Table 3-1</b>							

4. With the pump in gear, open the discharge to which the hose is attached and begin flowing water.
5. Increase the engine throttle until the maximum consistent pressure is obtained on the discharge gauge.
6. Close the discharge valve without changing the throttle setting. Refill the tank through the top fill opening or a direct tank line. The bypass valve may be opened during this time to prevent pump overheating.
7. Reopen the discharge valve, and check the flow through the nozzle using a Pitot tube or flowmeter. Adjust the engine throttle to bring the pressure to the amount previously determined.
8. Compare the flow rate measured to the NFPA minimum or the designed rate of the pump. If the flow rate is lower, a problem exists in the tank to pump line. The minimum flow rate should be continuously discharged until 80% of the tank is discharged.

The pump should experience no mechanical problems, powerloss, or overheat during the test.

### Performance Testing Overview

The yearly standard performance test consists of checking the pump (according to the rating) at three capacities and comparing the results to when the pump first placed in service. This provides some measure of any performance deterioration. Table 3-1

A pump must be able to pump full capacity at 150 PSI, 70% capacity at 200 PSI and 50% capacity at 250 PSI.

### Performance Testing Equipment and Materials

Testing is appropriately accomplished with a dead weight gauge tester, which is usually available at the local water works.

To accurately test pumper performance, requires a Pitot gauge, a calibrated pressure gauge, and a vacuum gauge or manometer.

Use smooth bore test nozzles of accurate size with the Pitot gauge. The volume pumped is then determined by referring to the discharge tables for smooth nozzles. Preferably, nozzles will be used on a Siamese deluge gun for greatest accuracy. A stream straightener, just upstream of the nozzle is advisable.

Refer to local procedures for pump testing procedures and practices.

For Pitot gauge accuracy, the nozzle pressures should be between 30 and 85 PSIG. See the chart on the facing page for nozzle flow and pressures. Table 3-3 provides GPM for various nozzle sizes.

Because NFPA standards specify both GPM and pressure, it is usually necessary to restrict the flow somewhat to build up the pump pressure. In normal pumping, this restriction would be caused by the friction loss in the lines. However, depending on line loss alone would require a large amount of hose for some tests. It is common practice to use 50 to 100 feet of hose and gate the discharge valves as required to maintain pressure.

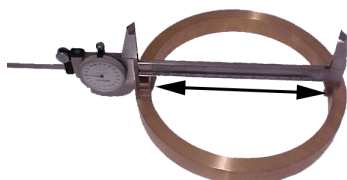
### Performance Testing Procedure

**Note:** The NFPA standards require a 10 percent reserve in pressure at the capacity run when the apparatus is delivered.

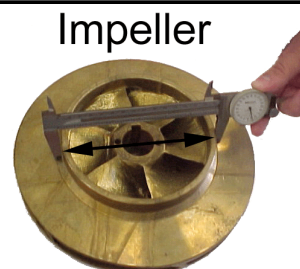
1. Check the relief valve according to the Relief Valve Testing procedure under Weekly Maintenance.
2. Perform steps 2 and 3 of the Post-Operation Maintenance procedures in this section.
3. Run the standard pump test in accordance with NFPA standards to check pump performance.
4. Pumps rated below 750 GPM are tested for an hour per NFPA 1901, 14-13.2.3.2. Run the engine for 20 to 30 minutes to stabilize the engine temperature. Then run the pump for 20 minutes at capacity, 10 minutes at 70 percent capacity, and 10 minutes at 50 percent capacity.
5. If the apparatus does not reach performance levels, refer to the Diagnostic/Service chart in Section IV.
6. Compare the results of this test to those from when the apparatus was delivered. It may be that the apparatus did not show the 10 percent reserve at delivery. If the apparatus

Pump Model	Clearance Ring Inner Diameter (pressed into pump body or pump head) IN (MM)	Impeller Hub Outer Diameter	Permissible Clearance
CBP	3.6312-3.6326 (92.232-92.268)	3.620-3.622 (91.948-91.999)	.009-.013 (.227-.330)
AP	4.770-4.777 (121.158-121.336)	4.760-4.758 (120.904-120.853)	.012-.017 (.305-.432)

Table 3-2: Impeller and Clearance Ring Diameters and Clearance Values



Clearance Ring



Impeller



## Booster Pumps

		GPM AT VARIOUS NOZZLE SIZES							
NOZZLE		Nozzle Size							
PRESS		½"	5/8"	¾"	7/8"	1"	1 1/8"	1 ¼"	1 3/8"
30	41	64	92	125	163	206	254	308	
35	44	69	99	135	176	222	275	332	
40	47	73	106	144	188	238	294	355	
45	50	78	112	153	199	252	311	377	
50	53	82	118	161	210	266	328	397	
55	55	86	124	169	220	279	344	417	
60	58	90	130	176	230	291	360	435	
62	58	91	132	179	234	296	366	442	
64	59	93	134	182	238	301	371	449	
66	60	94	136	185	241	305	377	456	
68	61	96	138	188	245	310	383	463	
70	62	97	140	190	248	315	388	470	
72	63	99	142	193	252	319	394	477	
74	64	100	144	196	255	323	399	483	
76	65	101	146	198	259	328	405	490	
78	66	103	148	201	262	332	410	496	
80	66	104	150	203	266	36	415	502	
85	68	107	154	210	274	347	428	518	
90	70	110	159	216	282	357	440	533	
95	72	113	163	222	289	366	452	547	
100	74	116	167	228	297	376	464	562	
105	76	119	171	233	304	385	476	575	
110	78	122	175	239	311	394	487	589	
115	80	125	179	244	319	403	498	602	
120	81	127	183	249	325	412	509	615	

		GPM AT VARIOUS NOZZLE SIZES							
NOZZLE		Nozzle Size							
PRESS		1 ½"	1 5/8"	1 ¾"	1 7/8"	2"	2 1/4"	2 ½"	3"
30	366	430	498	572	651	824	1017	1464	
35	395	464	538	618	703	890	1098	1581	
40	423	496	575	660	751	951	1174	1691	
45	448	525	610	700	797	1009	1245	1793	
50	473	555	643	738	840	1063	1313	1890	
55	496	582	675	774	881	1115	1377	1982	
60	518	608	705	809	920	1165	1438	2071	
62	526	618	716	822	935	1184	1462	2105	
64	535	628	728	835	950	1203	1485	2138	
66	543	637	739	848	965	1222	1508	2172	
68	551	647	750	861	980	1240	1531	2204	
70	559	656	761	874	994	1258	1553	2236	
72	567	666	772	886	1008	1276	1575	2268	
74	575	675	783	898	1022	1293	1597	2299	
76	583	684	793	910	1036	1311	1618	2330	
78	590	693	803	922	1049	1328	1639	2361	
80	598	702	814	934	1063	1345	1660	2391	
85	616	723	839	963	1095	1386	1711	2465	
90	634	744	863	991	1127	1427	1761	2536	
95	651	765	887	1018	1158	1466	1809	2605	
100	668	784	910	1044	1188	1504	1856	2673	
105	685	804	932	1070	1217	1541	1902	2739	
110	701	823	954	1095	1246	1577	1947	2803	
115	717	841	976	1120	1274	1613	1991	2867	
120	732	859	997	1144	1301	1647	2034	2928	

Table 3-3



performance has dropped appreciably compared to its original performance, it needs to be serviced. (Apparatus test results should be on file with the delivery documents. If not, they may be obtained from the apparatus manufacturer or from the original certifying authority.)

### Worn Clearance Rings and Impeller Hubs

Because clearance ring replacement requires pump disassembly, it is advisable to thoroughly check other possible causes of low performance before assuming that clearance ring wear is at fault.

Clearance rings limit the internal bypass of water from the discharge side of the pump back to the suction. The radial clearance between the impeller hub and the clearance rings is only a few thousandths of an inch when new. In clear water, the clearance rings continue to effectively seal for hundreds of hours of pumping. In dirty or sandy water, the impeller hub and clearance rings will wear faster. The more wear, the greater the bypass and lower pump performance.

When new, the radial clearance between the impeller hubs and the clearance ring is from 0.005 to 0.007 inch per side. Any increase will allow more bypass and result in lower performance. It should not be necessary to replace clearance rings and impellers until the average radial clearance reaches 0.015 to 0.020 inch or more per side, as measured with calipers. Refer to Table 3-2.

If the clearance rings on the CBP pump show significant wear but the impeller itself is within the size tolerance, "undersized" clearance rings can be installed to delay a complete rebuild. Contact Customer Service at Hale Products and refer to part 321-0070-01-0 for CBP

Often, replacement of the clearance rings will reduce the bypass and restore the pump to near original performance. A complete restoration

requires that the impellers also be replaced. See Section V for maintenance and repair information if pump disassembly is required.

## EXTREME CONDITIONS

### MAINTENANCE GUIDELINES

#### Freezing Weather

Drain the pump body and discharge valves. If the gearbox is equipped with a water cooling line, drain this line also. There should be drains for the gauge lines, the cooling line to the engine, and to the relief valve (if equipped). All of these should be opened until all water is drained out, then close the drain valves.

In freezing weather, drain the pump as follows:

1. Open the discharge and suction valves, remove suction tube caps and discharge valve caps.
2. Open the pump body drain cocks and drain valves
3. After the pump is completely drained replace all caps and close all valves.

#### Contaminated Water

After pumping salt water, contaminated water or foam solution, or if water containing sand or other foreign matter has been used, connect the pump to a fresh water hydrant or other source of fresh clean water and flush the contaminants out of the pump.

## SECTION IV: TROUBLESHOOTING

Table 4-1 lists the symptoms of some common problems and possible corrective measures. Before calling Hale or a Hale authorized parts service center for assistance, eliminate problem causes using this guide. If the problem cannot be corrected, please have the following information ready prior to calling the Hale Customer Service Technician Department for assistance. Customer Service Number: 1-800-720-3473.

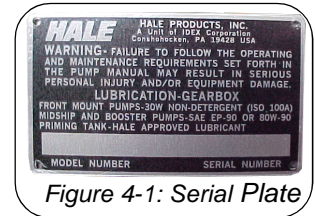


Figure 4-1: Serial Plate

- Pump Model and Serial Number
- Observed symptoms and conditions under which the symptoms occur.

**NOTE:** The location of the serial number will vary depending on the pump model but it is generally displayed on the pump operator's panel and/or the side of the gearbox.

**TABLE 4-1. HALE PUMP TROUBLE ANALYSIS**

CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
<b>PTO WILL NOT ENGAGE PUMP WILL NOT ENGAGE</b>		Consult PTO Manufacturer's Instructions.
	Faulty Wiring	Verify the indicators are properly functioning.

### NOTICE

DO NOT LEAVE THE CAB AFTER PUMP SHIFTING UNLESS THE SHIFT INDICATOR LIGHT IS ON, OR A SPEEDOMETER READING IS NOTED.

<b>PUMP LOSES PRIME OR WILL NOT PRIME</b>  NOTE: Weekly priming pump operation is recommended to ensure proper operation.	Electric Priming System	No recommended engine speed is required to operate the electric primer. However, 1,000 engine RPM will maintain the electrical system while providing enough speed for initial pumping operation.
	Defective Priming System	Check the priming system by performing a "Dry Vacuum Test" per NFPA standards. If the pump holds vacuum, but primer pulls less than 22 inches of vacuum, it could indicate excessive wear in the primer.



CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
<b>PUMP LOSES PRIME OR WILL NOT PRIME (cont'd.)</b>	Suction lift too high	Do not attempt lifts exceeding 22 feet.
	Restricted suction strainer	Remove obstruction from suction hose strainer.
	Suction Connections	Clean and tighten all suction connections. Check suction hose and hose gaskets for possible defects.
	Primer not operated long enough.	Proper priming procedures should be followed. Do not release the primer control before assuring a complete prime.

NOTICE: Do not run the primer over 45 seconds. If prime is not achieved in 45 seconds, stop and look for causes (air leaks or blocked suction hose).

Air Leaks	<p>Attempt to locate and correct air leaks using the following procedure:</p> <ol style="list-style-type: none"> <li>1. Perform dry vacuum test on pump per NFPA standards with 22 inches minimum vacuum required with loss not to exceed 10 inches of vacuum in 5 minutes.</li> <li>2. If a minimum of 22 inches of vacuum cannot be achieved, the priming device or system may be defective, or the leak is too big for the primer to overcome (such as an open valve).</li> </ol>
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CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
<p><b>PUMP LOSES PRIME OR WILL NOT PRIME (Cont'd.)</b></p>	<p>Air Leaks (cont'd.)</p>	<p>3. After priming, shut off the engine. Audible detection of a leak is often possible.</p> <p>4. Connect the suction hose from the hydrant or the discharge of another pumper to pressurize the pump with water, and look for visible leakage and correct. A pressure of 100 PSI (6.9 BAR) should be sufficient. Do not exceed pressure limitations of pump, accessories, or piping connections.</p> <p>5. The suction side relief valve can leak. Plug the valve outlet connection and retest.</p>
<p><b>INSUFFICIENT PUMP CAPACITY</b></p>	<p>Insufficient engine power</p>	<p>Engine power check or tune up may be required for peak engine and pump performance.</p> <p>Refer to rotation symptoms later in this section.</p>
	<p>Suction hose diameter is too small for the volume being discharged</p>	<p>Use a larger suction hose.</p> <p>Shorten total length by removal of one length.</p> <p>Reduce volume of discharge</p>
	<p>Restriction in the suction line at the strainer</p>	<p>Remove any debris restricting entrance of water at the strainer.</p>
	<p>Partial collapse of the lining in the suction hose</p>	<p>Damage to the outer lining may allow air in between the outer and inner linings causing a partial collapse. Replace the hose and retest.</p>



CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
<b>INSUFFICIENT PUMP CAPACITY (cont'd.)</b>	Relief Valve improperly set	If the relief valve control is set too low the relief valve will open and bypass water. Reset the relief valve control per the procedures in Section III. Other bypass lines (such as foam system or in-line valves) may reduce pump capacity or pressure.
<b>ENGINE SPEEDS TOO HIGH FOR REQUIRED CAPACITY OR PRESSURE</b>	Truck transmission in wrong range or gear	Verify the transmission is in the correct gear.
	Lift too high, suction hose too small	Higher than normal lift (10 feet) will cause higher engine speeds, high vacuum and rough operation. Use larger suction hose. Bring the pump closer to the water source.
	Defective suction hose	Inner line of suction hose may collapse when drafting and is usually undetectable. Change the suction hose on the pump; test for comparison against original hose.
	Blockage of suction hose entry	Clean suction hose strainer of obstruction and follow recommended practices for laying suction hose.
	Pump is approaching cavitation.	Gate the discharge valves to allow pressure to increase. This will reduce flow. Reduce the throttle opening to the original pressure setting.





CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
	Worn pump impeller(s) and / or clearance rings	Installation of new parts required.
	Impeller blockage	Blockage in the impeller can prevent loss of both capacity and pressure. Back flushing the pump from discharge to suction may free blockage. Removal of the pump head may be required (this is considered a major repair).
<b>RELIEF VALVE DOES NOT RELIEVE PRESSURE WHEN VALVES ARE CLOSED</b>	Incorrect setting of Control (PMD) Valve	Check and repeat proper procedures for setting relief valve system. (See Section 3)
	Relief Valve inoperative	Refer to the relief valve manual.
<b>RELIEF VALVE DOES NOT RECOVER AND RETURN TO ORIGINAL PRESSURE SETTING AFTER OPENING VALVES</b>	Dirt in system causing sticky or slow reaction	Refer to the relief valve manual.
	Blocked relief valve.	Clean the valve with a small wire or straightened paper clip. Refer to the relief valve manual.
<b>WATER IN PUMP GEARBOX</b>	Leak coming from above pump	Check all piping connections and tank overflow for possible spillage falling directly on to the pump gearbox.
	Leaking Mechanical Seal	If mechanical seal is installed, there should be no leaks. Inspect the oil seal and replace if necessary.



CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
<b>DISCHARGE VALVES DIFFICULT TO OPERATE</b>	Lack of lubrication	Recommended weekly lubrication of discharge and suction valve, use an approved lubricant. Refer to the valve manual for more information.

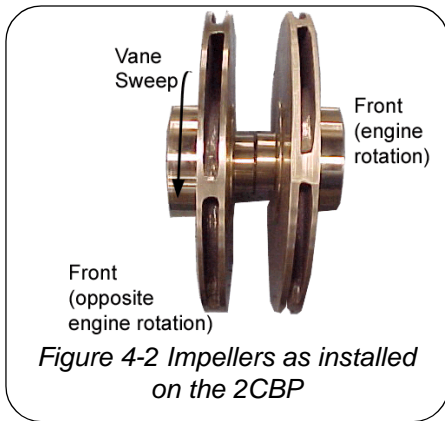
## Cavitation Troubleshooting

<b>Pump is beginning to cavitate</b>	Discharging more water than the pump is taking in.	<p>Increase the flow into the pump with more and/or larger intake lines.</p> <p>Gate the discharge valves to reduce flow and maintain pressure.</p>
	Air Leak	<p>Verify air bleeder on the suction tube is not open.</p> <p>Locate and eliminate all air leaks during maintenance.</p>
	Drafting too high	<p>Verify lift loss, hose friction, water temperature and other lift limiting factors are reduced or eliminated.</p> <p>Locate the pump closer to the water source.</p>
	Water temperature too high.	<p>Reduce volume discharged by lowering RPM or gating the discharge valves.</p> <p>Locate a source of cooler water.</p>

CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
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## Rotation Symptoms

It is possible to reassemble the pump incorrectly or with the wrong parts. Always compare the replacement parts with the original hardware. Contact customer service at Hale Products to answer questions or concerns.

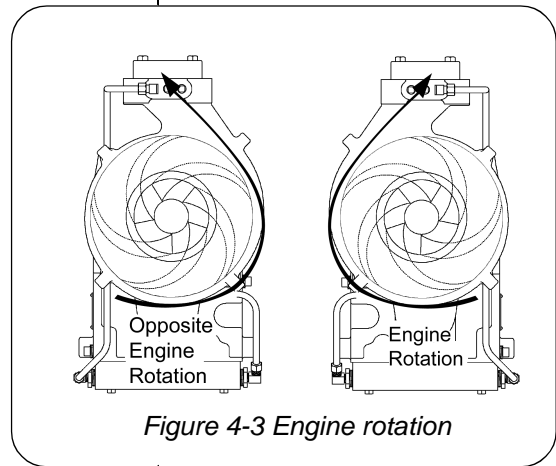


Reduced pressure 60-100 psi. and reduced flow.

Wrong impeller installed	Verify the new impeller vanes are oriented the same as the old impeller before installing. See figure 4-3.
Impellers installed backwards (2CBP)	Verify the impellers are in the correct order. P/N 016-0280-00-0 is installed closest to the gearbox in an engine rotation application and closest to the front in an Opposite engine rotation application.

Wrong Application

The pump was installed on an application for which it was not intended i.e. front mount vs. rear mount.





## Booster Pumps

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# SECTION V MAINTENANCE AND REPAIR

## OVERVIEW

This section describes the removal, inspection, and re-installation (as required for maintenance and repair) of all booster pump components. To completely disassemble the pump and gearbox, follow the disassembly instructions in the order which they appear in this text. At any point in the disassembly process, the pump may be reassembled by following the instructions backwards through this manual.

NOTE: Unless otherwise indicated, these instructions apply to all Hale booster pumps.

### General Repair Guidelines

1. Match mark or note the orientation of components before disconnecting or removing them.
2. Where grease is called for, use a Lithium Based Grease with 1 to 3% Molybdenum Disulfate. The following are examples of approved greases:
  - Dow Corning BR2-PLUS
  - Lubriplate Fiske #3000
  - Shell Super Duty Grease
  - Imperial #777
  - Mobil Grease Special
  - Sunoco Moly #2EP
3. In the gearbox, use only oil with an API GL-5 rating. Use SAE EP-90, 80W-90 or synthetic 75W-80 oil. (See Table 5-1 for gearbox oil capacities.)
4. Before installing the mechanical seal, use the alcohol swabs provided by Hale Products Inc. to clean all grease or oil from the pump shaft and bearing housing.

5. Use only PAC-EASE Rubber Lubricant Emulsion (or equal) on the rubber mechanical seal parts to ease installation.

## **⚠WARNING**

USE OF ANY OTHER LUBRICANT CAN DAMAGE THE MECHANICAL SEAL AND SEAT.

6. Replacement steel fasteners, must be grade 5, 360° nylon patchlock fasteners. Apply Loctite™ 242 (or equal) to all threads.
7. Before working on the pump, disconnect the suction and discharge piping and drain the pump body. Disconnect cooling tubes from the water manifold and pump as required.
8. Label and disconnect all wiring from the pump.

### Cleaning and Inspection Guidelines

Wherever the procedures call for cleaning and inspection, these guidelines should be followed:

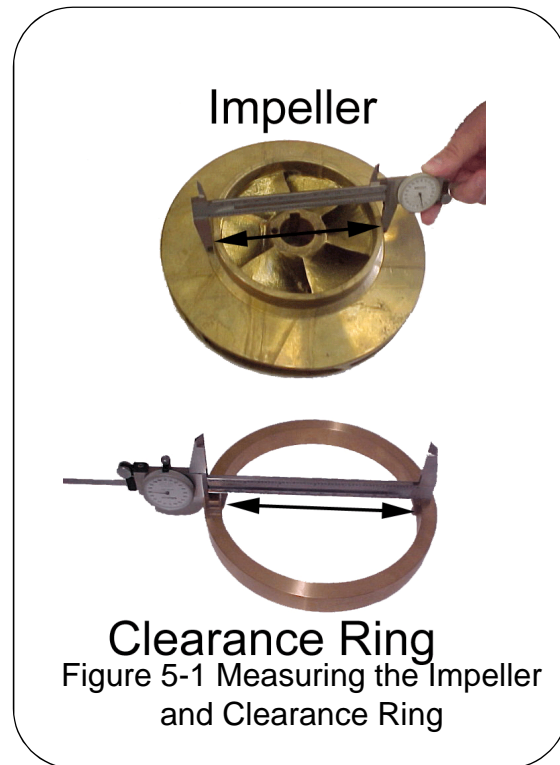
1. Inspect all components for excessive or abnormal wear.
2. Wherever a requirement for new parts is indicated, obtain new components from Hale Products Inc.
3. Wherever procedures call for the removal of gaskets, the gasket should be replaced. Clean all gasket mating surfaces before installing new gaskets.
4. Bearings and other components should be cleaned using only recommended solvents.
5. Bearings and seals should be inspected whenever the parts are disassembled. Look for signs of excessive wear.

Model	Gearbox Oil Capacity
AP	1 ¾ QTS. (1.66L)
CBP	CBP2 & 3 = 1 ¾ QTS. (1.66L) CBP4 & 5 = 1 QT. (.95L)
2CBP	2CBP2 & 3 = 1 ¾ QTS. (1.66L) 2CBP4 & 5 = 1 QT. (.95L)

**Table 5-1: Oil Capacity Table**

Bolt Size	Material	Maximum Torque ft-lb (n-m)
5/16-18	zinc-plated steel	17 (23)
5/16-18	zinc-plated steel w/360° nylon lock	19 (26)
5/16-18	silicon bronze	10.3 (14 )
3/8-16	zinc-plated steel	30 (41)
3/8-16	zinc-plated steel w/360° nylon lock	33 (45)
3/8-16	silicon bronze	18 (24 )
7/16-14	zinc-plated steel	50 (68 )
7/16-14	zinc-plated steel w/360° nylon lock	53 (72)
7/16-14	silicon bronze	29 (39)

**Table 5-2: Torque Values**



Pump Model	Clearance Ring Inner Diameter (pressed into pump body or pump head) In (mm)	Impeller Hub Outer Diameter	Permissible Clearance
CBP	3.6312-3.6326 (92.232-92.268)	3.620-3.622 (91.948-91.999)	.009-.013 (.227-.330)
AP	4.770-4.777 (121.158-121.336)	4.760-4.758 (120.904-120.853)	.012-.017 (.305-.432)

**Table 5-3: Impeller and Clearance Ring Diameters and Clearance Values**

## Booster Pumps

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6. Replace any hardware that shows signs of excessive wear.
7. When inspecting the impellers and clearance rings for wear, measure the impeller hub diameter and the inner diameter of the clearance ring. Compare these measurements to data in Table 5-3. If measurements indicate, obtain replacement clearance rings and impeller.

**NOTE:** If either the impeller hub or clearance rings are out of tolerance, both rings and the impeller must be replaced as well as the mechanical seal.

### Recommended Cleaners

Hale recommends:

- Safety Kleen
- Stoddard Solvent

### Tools Required

- Lifting gear-lever hoist or chain hoist, and short choker
- Ball peen hammer
- Center punch
- Drift punch
- Allen wrenches
- Strap wrench
- Snap Ring Pliers
- Pry bars (2)
- Ratchets and wrenches for disassembly
- Torque wrench, capable of 40, 65, and 135 ft-lb (54, 88, and 183 N-m)
- Pan (to catch drip oil)
- Disposable-rags
- Oil dry
- Wood Wedges
- Bearing Puller
- Pusher tube (a small section of PVC tubing to fit over the shaft)

## PUMP COMPONENTS

### Pump and Gearbox Assembly

Read all the instructions before beginning any repair.

### **⚠WARNING**

THE PUMP AND GEARBOX ASSEMBLIES WEIGH APPROXIMATELY 250 LBS (113 KG). USE PROPER LIFTING DEVICE WHEN REMOVING OR INSTALLING PUMP AND GEARBOX ASSEMBLY.

**NOTE:** These procedures refer to Figures 5-2 and 5-3. Please review the *General Repair and Cleaning and Inspection Guidelines* on page 37 before beginning these procedures.

### Remove the Pump from the Apparatus

1. Park the vehicle on a level surface. Set the parking brake and chock the front and rear wheels.
2. Place apparatus out of service in accordance with departmental procedures.
3. Obtain access to the pump and gearbox. Match mark or tag all connections before removal.
4. Remove drain plugs and drain the pump and piping. Disconnect suction and discharge piping from the pump.
5. Remove the magnetic oil-drain plug (see Figure 5-2). Drain the gearbox oil into a suitable container. Examine the oil for included water (water turns the oil a milky color or settles in the bottom of the oil) and properly dispose of the oil.
6. Disconnect the drive shaft from the gearbox.

7. Disconnect airlines, electrical switches, and the tachometer cable as required.
8. Attach a proper lifting device before loosening or removing mounting brackets.
9. Disconnect mounting brackets to remove the pump and gearbox assembly.
10. Place the pump and gearbox assembly on a stable work stand. The air vent and gearbox cover are exposed. This will provide easy and safe access to the internal components.

### REINSTALL PUMP ON APPARATUS

After completing repairs and /or maintenance, reinstall the pump and gearbox assembly.

1. Place the pump and gearbox assembly on a stable platform. Attach a proper lifting device.
2. Lift the pump and gearbox assembly into position on the equipment. Connect the

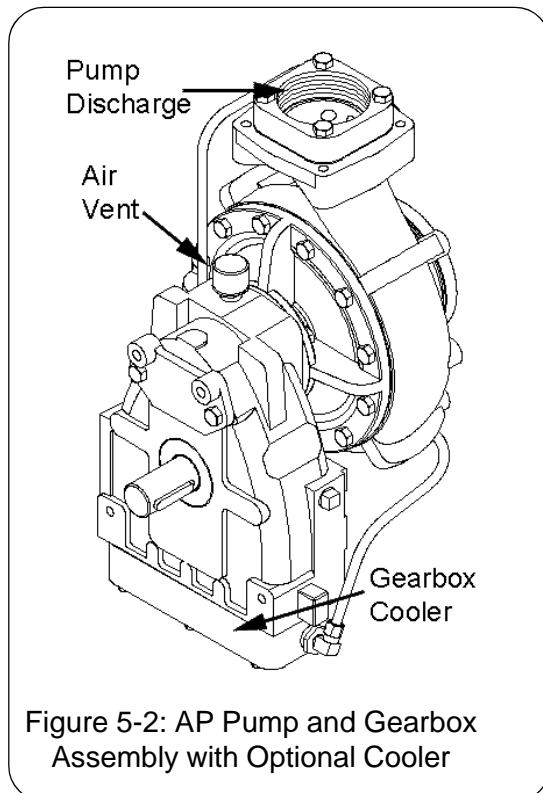


Figure 5-2: AP Pump and Gearbox Assembly with Optional Cooler

mounting brackets using the proper fasteners. Torque the fasteners to values provided in Table 5-3.

3. Connect the drive shaft to the gearbox. Apply Loctite™ to the fasteners and torque to PTO manufacturer's specifications.
4. Connect any electrical switches, airlines and tachometer cable if appropriate.
5. Install the magnetic oil-drain plug.
6. Fill the gearbox to the level of the oil plug. Use only oil with an API GL-5 rating. Use SAE EP-90, 80W-90 or synthetic 75W-80 oil. See Table 5-1 for approximate gearbox oil capacity.
7. Reconnect the suction and discharge piping to the pump.
8. Test the pump for proper operation, note any leaks.
9. Return the apparatus to normal operation.

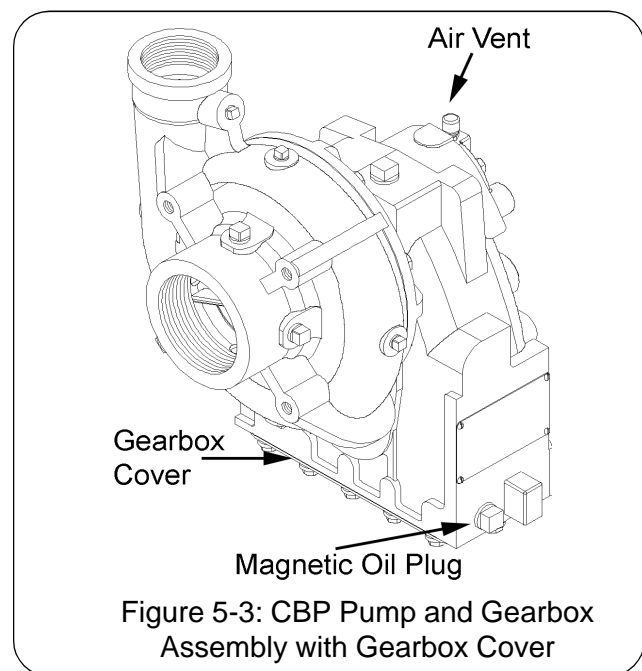
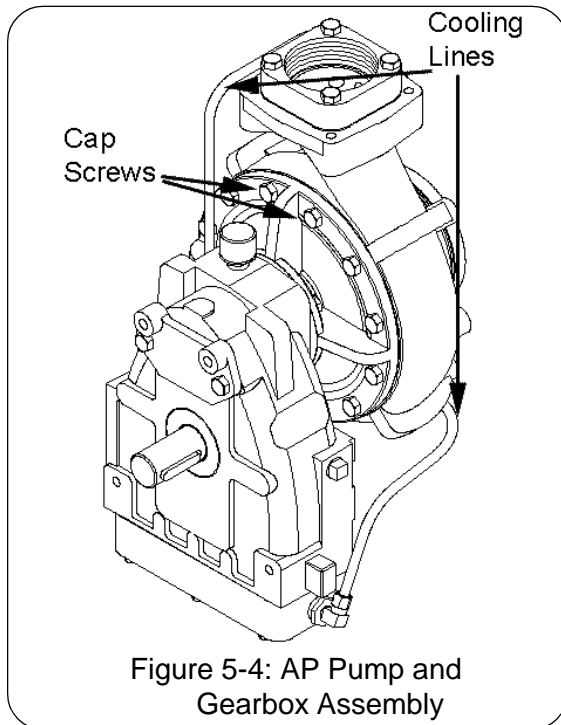


Figure 5-3: CBP Pump and Gearbox Assembly with Gearbox Cover



## Booster Pumps



### AP PUMP DISASSEMBLY

#### AP Pump Body

The pump body can be removed from the gearbox assembly providing access to the internal parts without disconnecting the drive unit.

#### Remove AP Pump Body

1. Disconnect the suction, discharge, cooling lines, and any electrical wiring. Disconnect mounting brackets as required. Match mark the pump body and pump head to ensure proper alignment during reassembly.
2. Remove the 7/16 - 14 X 1" cap screws that hold the pump body assembly to the pump head.
3. Remove the pump body from the pump head, do not damage the brass clearance rings or impeller.

4. Remove all remaining gasket material from the mating surfaces of the pump body and pump head.

#### Install the Pump body

1. Use a press to install the clearance ring in the pump body.
2. Apply a small amount of grease to the gasket and align on the pump body.
3. Install the pump body onto the pump head, do not damage the clearance rings or impeller.
4. Apply Loctite™ 242 (or equal) to the threads and install the 7/16-14 UNC x 1 cap screws that hold the pump body to the pump head. Refer to Table 5-2 for recommended torque values for fastener size and material.
5. Reconnect all piping and tubing.
6. Return the apparatus to service.

### AP IMPELLER AND MECHANICAL SEAL

#### Remove AP Impeller

1. Remove the pump body as described above.
2. Remove the cotter pin that secures the impeller nut.
3. Hold the impeller with a strap wrench, and remove the impeller nut.
4. To avoid warping the impeller, use wedges and a proper puller to pull the impeller from the pump shaft.

**⚠CAUTION**

DO NOT STRIKE THE IMPELLER.  
IRREPARABLE DAMAGE MAY RESULT.

5. Inspect and clean all components according to the *Cleaning and Inspection Guidelines* above.

**Remove AP Mechanical Seal**

1. Remove the impeller key from the pump shaft.
2. Remove the mechanical seal spring from the bore of the pump head.
3. Remove the mechanical seal diaphragm assembly from the bore of the pump head.
4. Remove the stationary seat of the mechanical seal from the pump head.
5. Inspect and clean all components according to the *Cleaning and Inspection Guidelines* above.

**Reinstall AP Mechanical Seal**

1. Install a new oil seal if indicated by inspection on the gearbox side of the pump head.
2. Clean the bore of pump head using alcohol swabs. Install the stationary seat into the pump head.

**NOTE:** Oil and grease will damage the mechanical seal face. Do not touch the face of the mechanical seal.

3. Apply a generous coating of PAC-EASE Rubber Lubricant Emulsion (or equal) to the o-ring on the outside of the stationary seat.

4. Carefully slide the stationary seat over the pump shaft and fit the stationary seat of the mechanical seal into the pump head.
5. Carefully push the stationary seat into the pump head bore using a soft clean pusher tube. Verify the stationary seat is firmly seated in the pump head.
6. Clean the pump shaft with alcohol swabs.
7. Apply a generous coating of PAC-EASE Rubber Lubricant Emulsion (or equal) to the seal diaphragm. Without touching the face of the seal ring, push the seal ring, diaphragm, and retainer onto the shaft with the pusher tube.
8. Keep the shaft well lubricated and verify the seal ring seats against the stationary seat. If binding occurs, apply additional PAC-EASE lubricant. Slide the spring and cupwasher (supplied with the seal) onto the shaft. The spring must seat on the seal retainer.

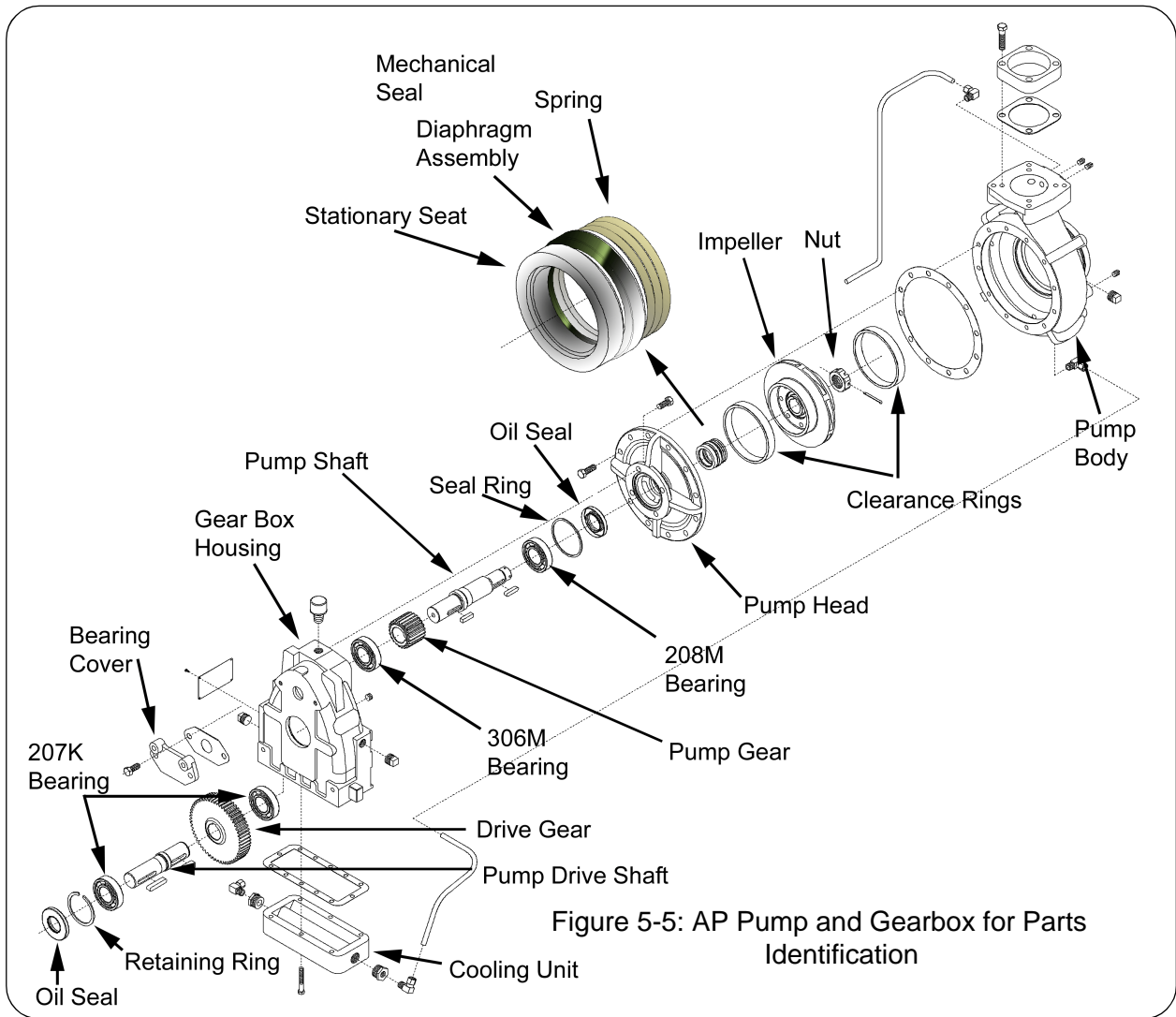
**Reinstall the AP Impeller**

1. Install the impeller key in the keyway on the pump shaft. Carefully slide the impeller over the pump shaft, aligning the keyway with the impeller key.
2. Hold the impeller with a strap wrench. Tighten the impeller nut. Torque to 110 ft LBS (149.14 Nm).
3. Continue to tighten the impeller nut until the cotter pin can be installed to lock the impeller nut in place.

**REMOVE AP PUMP HEAD**

1. Remove the pump body, impeller and mechanical seal.

## Booster Pumps



2. Remove the 7/16-14 X 1" long cap screws that secure the pump head to the gearbox.
3. With the cap screws removed, pull the pump head from the gearbox. Do not damage the pump shaft.
4. Scrape the gasket from the mating surfaces of the pump head and gearbox.
5. Remove the seal ring from the pump head on the gearbox side.
6. Use a press to remove the oil seal and mechanical seal seat from the pump side of

the pump head.

7. Inspect and clean all components according to the *Cleaning and Inspection Guidelines* above.

### REINSTALL AP PUMP HEAD

1. Use a press to install a new oil seal and clearance ring. Install the oil seal on the gearbox side of the pump head and the clearance rings on the pump side of the pump head.
2. Install a new gasket. Apply a coating of general-purpose grease to the gasket and

align on the pump head.

3. Install a new seal ring into the bore of the pump head on the gearbox side.
4. Install the pump head on the gearbox, do not damage the oil seal or pump shaft.
5. Apply Loctite™ 242 (or equal) and install the four 7/16-14 UNC x 1 cap screws to secure the pump head to the gearbox. Tighten capscrews to 40 ft-lb (54 Nm).

### AP Gearbox

#### Disassemble AP Gearbox

See figure 5-5 for parts identification.

1. Remove the pump and gearbox assembly from apparatus as described above.
2. Place the pump and gearbox on a work stand.
3. Remove the pump body, impeller, and pump head as described previously.
4. If the pump is equipped with a water manifold, remove the 5/16-18 UNC cap screws and remove the water manifold and gasket from the gearbox.  
  
If the pump is not equipped with a water manifold, remove the capscrews, lockwashers, gearbox cover, and gasket.
5. Remove the bearing cover from upper portion of gearbox opposite the pump.
6. Use a drift punch to begin pushing the pump shaft assembly from the gearbox housing towards the pump side. Be careful not to lose the pump gear key in the gearbox.
7. Remove the 306W bearing, pump gear, pump gear key, and 208M bearing from the pump shaft or gearbox housing.

8. Remove the oil seal from the drive shaft then remove the retaining ring.

9. Remove the 1/2 - 13 set screw from gearbox housing.

10. With the set screw removed, insert a drift punch into the 1/2-13 hole and begin pushing the drive shaft from gearbox while protecting the drive gear from falling.

11. Once the shaft is clear of gearbox, remove drive gear from the housing.

12. Remove the two 207K bearings from the drive shaft and gearbox housing.

13. Remove the key from the drive shaft.

14. Inspect and clean all components according to the *Cleaning and Inspection Guidelines*.

#### Reassemble and Reinstall AP Gearbox

1. Place the gearbox housing on a steady flat surface with drive shaft opening facing up.
2. Insert one of the two 207K bearings into the bore of the gearbox housing.
3. Slide the drive gear into the gearbox housing. Align the bore of the drive gear with the bore of the gearbox housing.
4. Insert the key in drive shaft and insert drive shaft into gearbox housing. Align the driveshaft in the 207K bearing.
5. Install the other 207K bearing over the drive

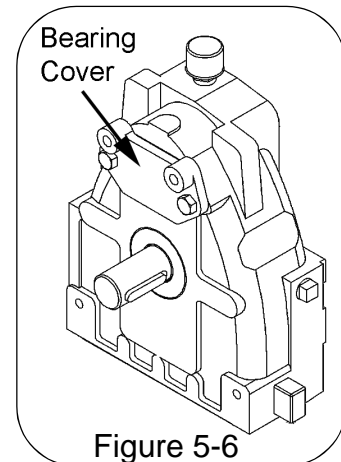


Figure 5-6



## Booster Pumps

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- shaft into the gearbox housing bore.
6. Install the retaining ring to hold the bearing and drive shaft in place.
7. Install a new oil seal.
8. Lift the gearbox onto its base. Apply Loctite 242 and install the 1/2-13 UNC set screw in the drive shaft until it is flush with the gearbox housing.
9. Set the gearbox flat with the drive shaft facing down.
10. Insert the 306W bearing in the bore on the pump end of the gearbox housing.
11. Insert the pump gear key into the pump shaft and install the pump gear onto the shaft. Align the keyway of the pump gear with the shaft key.
12. Align the pump gear to the drive gear and install into the gearbox. Press the shaft into the 306W bearing.
13. Install the 208M bearing over pump shaft.
14. Stand the gearbox housing on its base and install the gasket and bearing cover. Secure with 7/16-14 UNC x 1" inch long capscrews. Torque to 40ft-lbs (54Nm).
15. If the pump is equipped with a cooler, turn the gearbox over and install the gasket and water manifold.
- If the pump is not equipped with a cooler, install the gearbox cover.
16. Secure in place using 5/16-18 UNC screws and lockwashers. See Table 5-2 for proper torque.
17. Using Loctite™ PST or equal thread-sealing compound, install the bushings and elbows
- in the water manifold.
18. Reinstall the pump onto the apparatus and check for leaks.

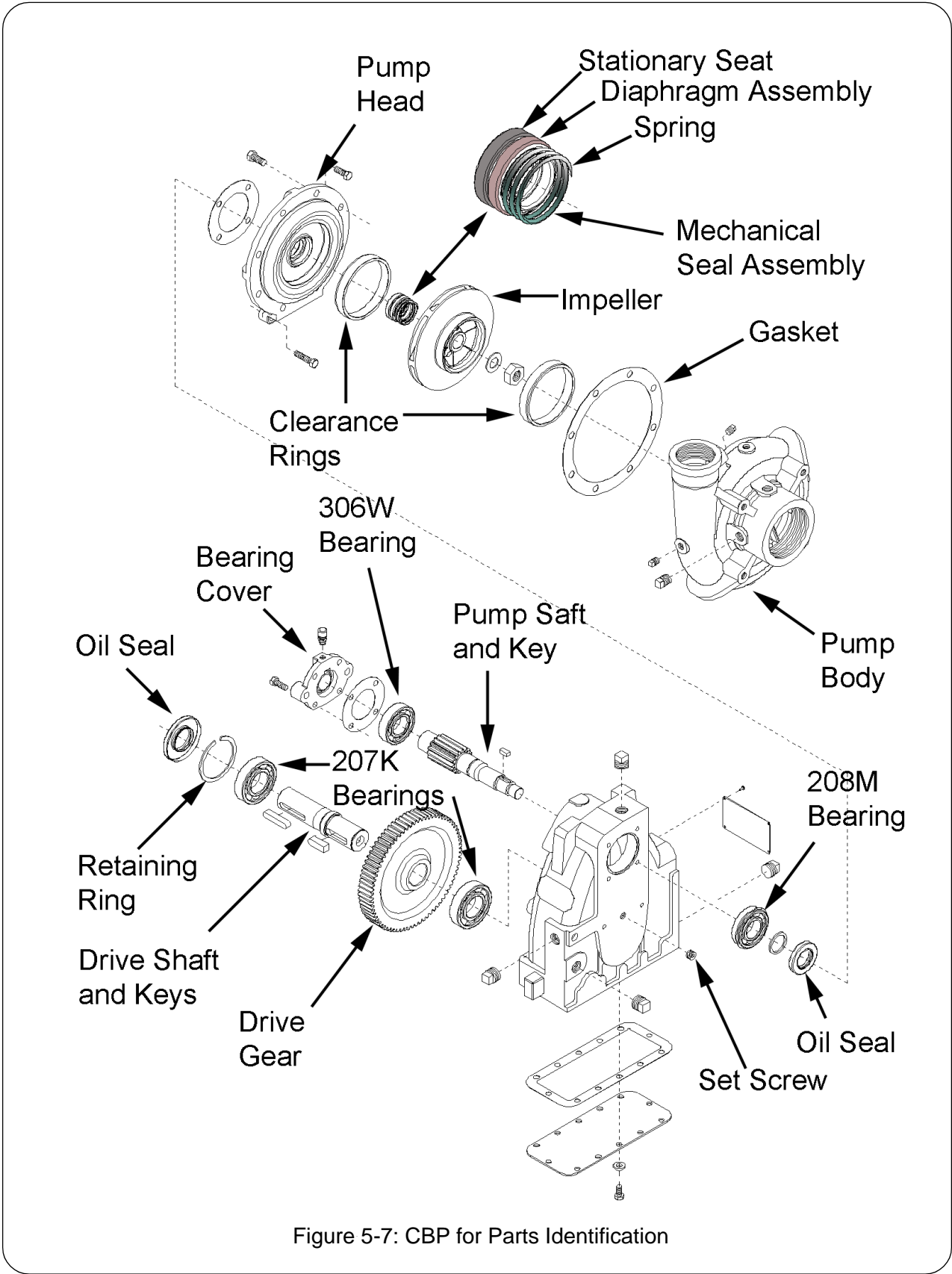


Figure 5-7: CBP for Parts Identification

## Booster Pumps

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### CBP PUMP REPAIR

Please review the *General Repair and Cleaning and Inspection Guidelines* before beginning these procedures.

#### CBP Pump Body

The pump body can be removed while the pump and gearbox assembly are mounted on the apparatus. With the pump body removed, the impeller can be serviced without removing the entire pump and gearbox assembly.

#### Remove CBP Pump Body

1. Disconnect the suction, discharge, cooling lines, and electrical switches. Disconnect the mounting brackets as required. Match mark the pump body and pump head to ensure proper alignment during reassembly.
2. Remove the 8, 3/8 - 16 X 7/8" nylon locking cap screws that hold the pump body assembly to the pump head.
3. Remove the pump body from the pump head. Do not damage the brass clearance rings or impeller.
4. Remove all remaining gasket material from the mating surface of the pump body and the pump head.
5. Inspect and clean all components according to the *Cleaning and Inspection Guidelines* above.

#### Reinstall CBP Pump Body

After checking the impeller and clearance rings, reinstall the pump body.

1. Apply a light coating of grease to the gasket and align on the pump head.

2. Install the pump body on the pump head, be careful not to damage the clearance ring or impeller.
3. Apply Loctite™ 242 (or equal) to the threads and install the eight 3/8-16 X 7/8 locking cap screws that hold the pump body assembly to the pump body. Refer to Table 5-2 for recommended torque values for size and materials used.
4. Reconnect all piping and tubing.

The pump can now be reinstalled and returned to service.

### CBP IMPELLER AND MECHANICAL SEAL

#### Remove CBP Impeller

1. Remove pump body as described above.
2. Hold the impeller with a strap wrench, remove the impeller nut and lock washer.
3. To avoid warping the impeller, use wedges and a proper puller to pull impeller from the pump shaft.

#### **⚠ CAUTION**

**DO NOT STRIKE THE IMPELLER.  
IRREPARABLE DAMAGE MAY RESULT**

4. Remove the impeller key from the pump shaft.
5. Inspect and clean all components according to the *Cleaning and Inspection Guidelines* above.



### Reinstall CBP Impeller

1. Install the impeller key in the keyway on the pump shaft. Carefully slide the impeller over pump shaft aligning the keyway with the impeller key.
2. Install the lock washer on the pump shaft.
3. Coat the pump shaft threads with Loctite™ 640 and install the impeller nut.
4. Hold the impeller with a strap wrench, and tighten impeller nut. Torque to 125 ft\_lbs 169.5 (Nm).
5. Stake the lock washer to lock the impeller nut in place.
6. Install the pump body as described above.

### REMOVE CBP MECHANICAL SEAL

1. Remove the impeller as described above.
2. Remove the mechanical seal spring.
3. Remove the mechanical seal diaphragm assembly.
4. Remove the stationary seat from the pump head.
5. Inspect the oil seal in the pump head and remove if damaged.
6. Inspect and clean all components according to the *Cleaning and Inspection Guidelines*.

### Reinstall CBP Mechanical Seal

1. Install a new oil seal if indicated by inspection (see *Cleaning and Inspection Guidelines*).

2. Clean the bore of the pump head using alcohol swabs and install the stationary seat.

**NOTE:** Oil and grease will damage the mechanical seal face. Be careful not to touch the seal face of the mechanical seal.

3. Apply a generous coating of PAC-EASE Rubber Lubricant Emulsion (or equal) to the outside of the stationary seat.
4. Carefully slide the stationary seat over the pump shaft and fit the stationary seat of the mechanical seal into the pump head.
5. Push the stationary seat into the pump head bore using the pusher tube. Verify the stationary seat is seated firmly in the pump head.
6. Clean the pump shaft with alcohol swabs.
7. Apply a generous coating of PAC-EASE Rubber Lubricant Emulsion (or equal) to the seal diaphragm. Without touching the surface of the seal ring, push the seal ring, diaphragm, and retainer onto the shaft with the pusher tube.
8. Keep the shaft well lubricated and verify the seal ring seats against the stationary seat. If binding occurs apply additional lubricant. Slide the spring and cupwasher (supplied with the seal) onto the shaft.

### CBP PUMP HEAD

#### REMOVE CBP PUMP HEAD

1. Remove the pump body and impeller as described above.
2. Remove the four 5/16-18 X 3/4" and two 5/16 - 18 X 1 1/4" cap screws that secure the pump head to the gearbox.
3. Remove the pump head from the gearbox.



## Booster Pumps

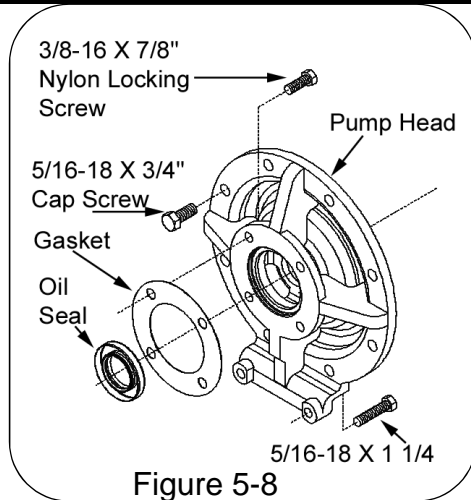


Figure 5-8

Do not damage the pump shaft.

4. Remove the gasket material from the mating surfaces of the pump head and gearbox.
5. Remove the oil seal and mechanical seal seat from the pump head.
6. Inspect and clean all components according to the *Cleaning and Inspection Guidelines* above.

### Reinstall CBP Pump Head

1. Use a press to install a new oil seal in the pump head.
2. Apply general-purpose grease to the gasket and align gasket on the pump head.
3. Install the pump head on the gearbox. Do not damage the oil seal or pump shaft.
4. Apply Loctite™ 242 (or equal) and install the 6 cap screws to secure the pump head to the gearbox. Tighten capscrews to 40 ft-lb (54 Nm).
5. Install the mechanical seal as described above.
6. Install impeller and pump body as previously

described.

### CBP GEARBOX

#### Remove and Disassemble CBP Gearbox

1. Remove the pump and gearbox assembly from apparatus as described above.
2. Place the pump and gearbox on a work stand.
3. Remove the pump body, impeller, and pump head as described previously.
4. If the pump is equipped with a water manifold, remove the 5/16-18 UNC cap screws and remove the water manifold and gasket from the gearbox.

If the pump is not equipped with a water manifold, remove the 5/16 - 18 X 1/2" capscrews, lockwashers, gearbox cover, and gasket.

5. Remove the bearing cover from upper portion of gearbox opposite pump.
6. Use a drift punch to begin pushing the pump shaft assembly from the gearbox housing towards the pump side. Be careful not to lose the pump gear key in the gearbox.
7. Remove the 306W bearing, pump gear, pump gear key, and 208M bearing from the pump shaft or gearbox housing.
8. Remove the oil seal from the drive shaft then remove the retaining ring.
9. Remove the 1/2 - 13 x 1/2" set screw from gearbox housing.

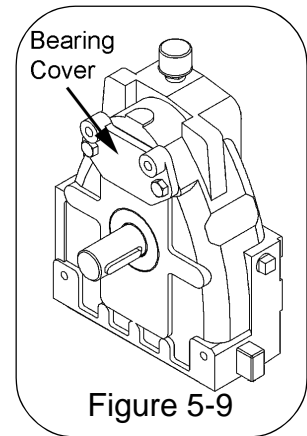


Figure 5-9

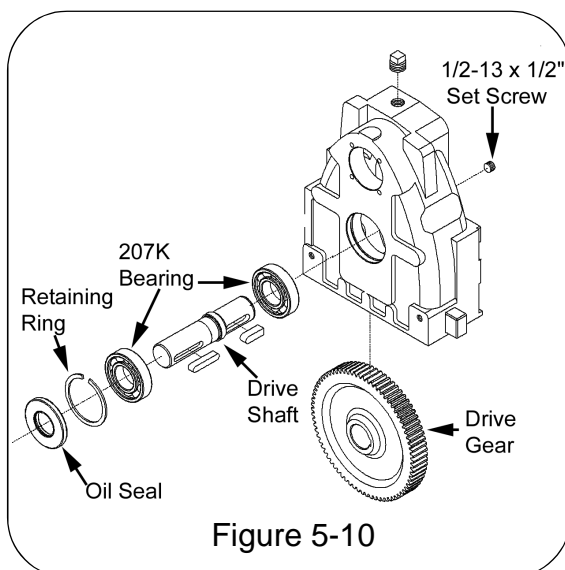
10. With the set screw removed, insert a drift punch into the 1/2-13 hole and begin pushing the drive shaft from gearbox while protecting the drive gear from falling.
11. Once the shaft is clear of gearbox, remove drive gear from housing.
12. Remove the two 207K bearings from the drive shaft and gearbox housing.
13. Remove the key from the drive shaft.
14. Inspect and clean all components according to the *Cleaning and Inspection Guidelines*.
5. Install the other 207K bearing over the drive shaft into the gearbox housing bore.
6. Install the retaining ring to hold the bearing and drive shaft in place.
7. Install a new oil seal.
8. Lift the gearbox onto its base. Apply Loctite 242 and install the 1/2-13 UNC set screw in the drive shaft until it is flush with the gearbox housing.
9. Set the gearbox flat with the drive shaft facing down.

### Reassemble and Reinstall CBP Gearbox

1. Place the gearbox housing on a steady flat surface with drive shaft opening facing up.
2. Insert one of the two 207K bearings into the bore of the gearbox housing.
3. Slide the drive gear into the gearbox housing. Align the bore of the drive gear with the bore of the gearbox housing.
4. Insert the key in drive shaft and insert drive shaft into gearbox housing. Align the driveshaft in the 207K bearing.
10. Insert the 306W bearing in the bore on the pump end of the gearbox housing.
11. Align the pump gear to the drive gear and install into the gearbox. Press the shaft into the 306W bearing.
12. Install the 208M bearing over pump shaft.
13. Stand the gearbox housing on its base and install the gasket and bearing cover. Secure with 7/16-14 UNC x 1 inch long capscrews. Torque to 40ft-lbs (54Nm).
14. If the pump is equipped with a cooler, turn the gearbox over and install the gasket and water manifold.

If the pump is not equipped with a cooler, install the gearbox cover.

15. Secure in place using 5/16-18 UNC screws and lockwashers. See Table 5-2 for proper torque.
16. Using Loctite™ PST or equal thread-sealing compound, install the bushings and elbows in the water manifold.
17. Reinstall the pump onto the apparatus and check for leaks.



## Booster Pumps

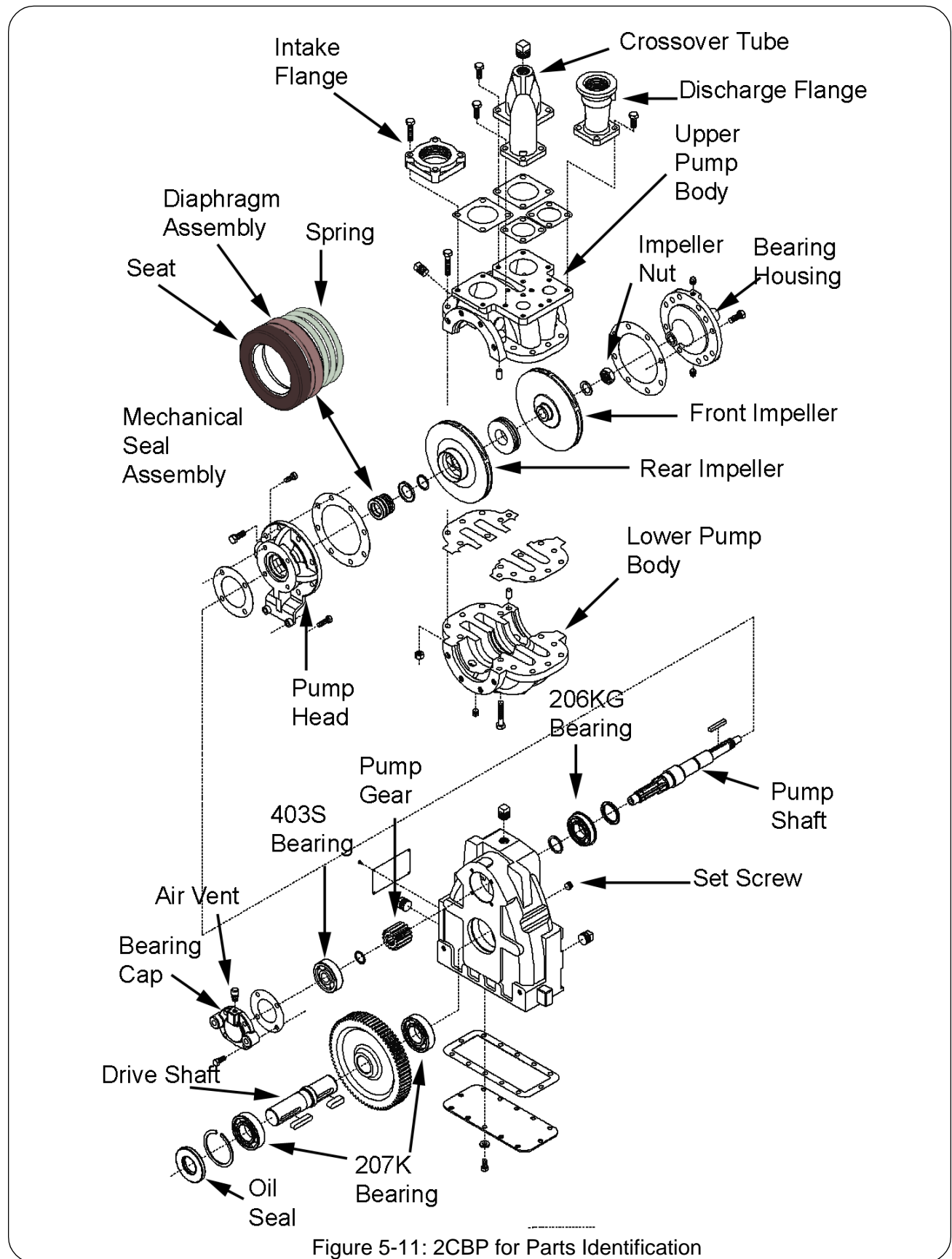


Figure 5-11: 2CBP for Parts Identification



## 2CBP PUMP REPAIR

Please review the *General Repair and Cleaning and Inspection Guidelines* before beginning these procedures.

Because the 2CBP differs in construction from other booster pumps, servicing any internal part demands complete disassembly as outlined here.

### 2CBP Pump and Gearbox Assembly

#### Disassemble the 2CBP Pump from the Gearbox Assembly

1. Remove the pump and gearbox assembly as described above.
2. Remove capscrews that secure the bearing housing to the front of the pump body. Remove the bearing housing assembly.
3. Remove the eight 3/8-16 X 1-3/4" screws, nuts and washers holding the upper and lower pump body together.
4. Remove the 5/16-18 X 3/4 screws holding upper pump body to the pump head.
5. Remove the upper pump body.
6. Support the lower pump body and remove the 5/16-18 X 3/4 screws holding lower pump body to pump head. Remove the lower pump body.

*Before removing the impellers, mark their location on the pump shaft. Impellers MUST be installed in the same position.*

### **⚠CAUTION**

**NEVER STRIKE THE IMPELLER. SEVERE IMPACT WILL CAUSE DAMAGE THAT REQUIRES REPLACEMENT**

7. Hold the impeller with a strap wrench. Use a 1 3/4" socket or wrench to remove the impeller nut and washer.
8. To avoid warping, use a puller to remove the impellers. Remove the center bearing, and impeller key from the shaft.
9. Separate the impellers from the center bearing.
10. Carefully remove the oil seal and retaining ring.
11. Remove the mechanical seal assembly from the pump shaft.
12. Remove the stationary seat.
13. Remove the four 5/16-18 X 3/4 cap screws that secure the pump head to the gearbox and remove the pump head.
14. Remove old oil seal from the pump head.
15. Inspect and clean all components according to the *Cleaning and Inspection* guidelines above.

#### Reassemble Pump to Gearbox

1. Press a new oil seal into the pump head.
2. Apply a light coat of grease to hold pump head gasket in place and install pump head.
3. Secure the pump head to the gearbox with the eight 3/8-16X1" capscrews.
4. Install the mechanical seal:
  - Clean bore of pump head using alcohol swabs and install stationary seat.

**NOTE:** Oil and grease will damage the mechanical seal face. Do not touch the carbon seal face of the mechanical seal seat surfaces.

## Booster Pumps

- ❑ Apply a generous coating of PAC-EASE Rubber Lubricant Emulsion (or equal) to the outside of the stationary seat.
  - ❑ Slide the stationary seat over the pump shaft and fit the stationary seat of the mechanical seal into the pump head.
  - ❑ Push the stationary seat into the pump head bore using a soft clean pusher tube. The stationary seat must be seated in the pump head.
  - ❑ Clean the pump shaft with alcohol swabs.
  - ❑ Apply a generous coating of PAC-EASE Rubber Lubricant Emulsion (or equal) to the seal diaphragm. Without touching the carbon seal ring, push the carbon seal ring, diaphragm, and retainer onto the shaft with the pusher tube.
  - ❑ Keep the shaft well lubricated and verify the carbon seal ring seats against the stationary seat. If binding occurs, apply additional lubricant. Slide the spring and cupwasher (supplied with the seal) onto the shaft.
5. Insert the impeller key in pump shaft then install rear impeller, center bearing, front impeller and bearing washer.
  6. Apply Loctite™ 640 to pump shaft threads. Secure impellers in place using the impeller nut. Torque the impeller nut to 125 ft lbs (169 Nm).
  7. Apply a light coat of grease to the pump head gasket and align the gasket on the pump head.
  8. Lift the lower pump body into place and secure with screws through pump head. (DO NOT TIGHTEN SCREWS).
  9. Apply a light coating of grease to the pump body gasket and align the gasket on the

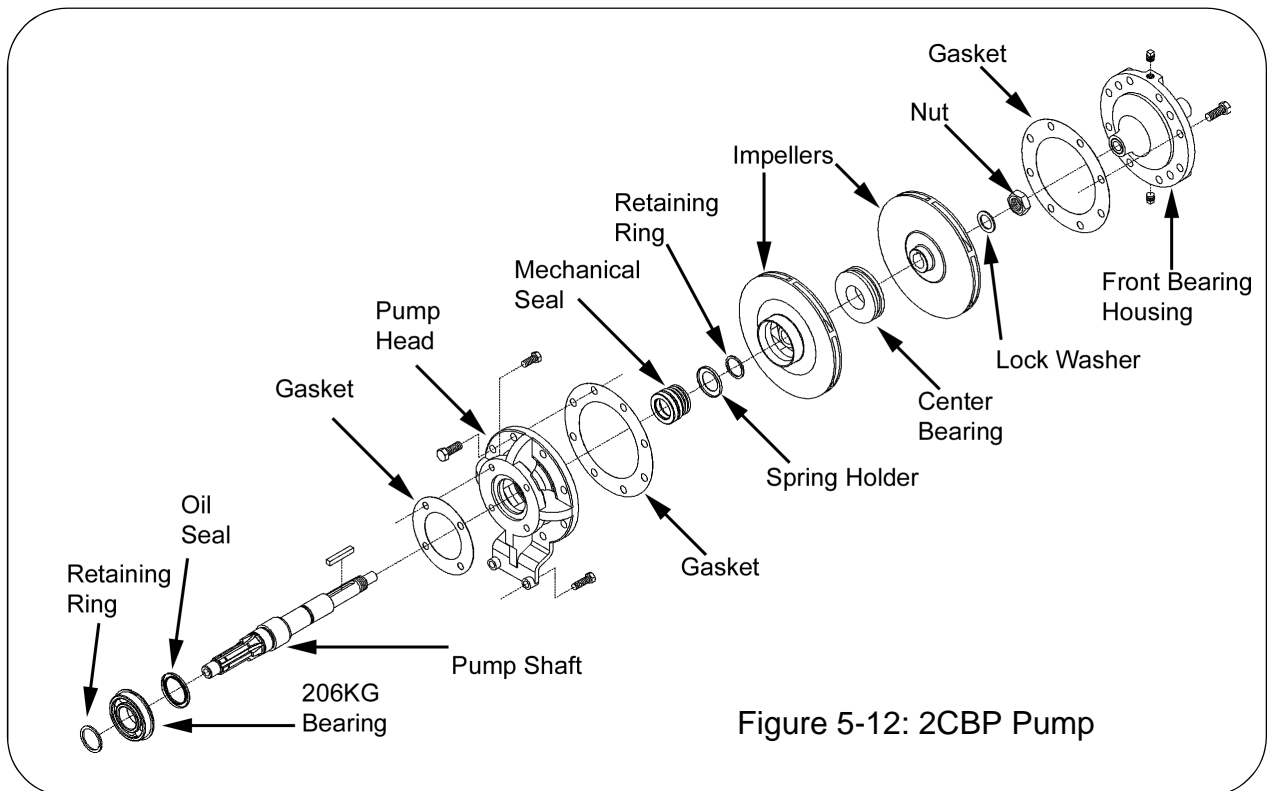


Figure 5-12: 2CBP Pump

lower pump body.

10. If previously removed, insert the dowel pins into the lower pump body
11. Install the upper pump body and secure it to the pump head with the five 1/16-18 X 3/4" capscrews. Insert the four 15/16-18 X 3/4 screws, washers and nuts into both pump halves.
12. Verify the bearings and spring pin are in the bearing housing. Apply a light coat of grease to hold the gasket in place then install the bearing housing onto the pump body.
13. Tighten all screws and torque to the values in Table 5-2.
14. Install on the apparatus and test for leaks.

#### Disassemble the 2CBP Gearbox

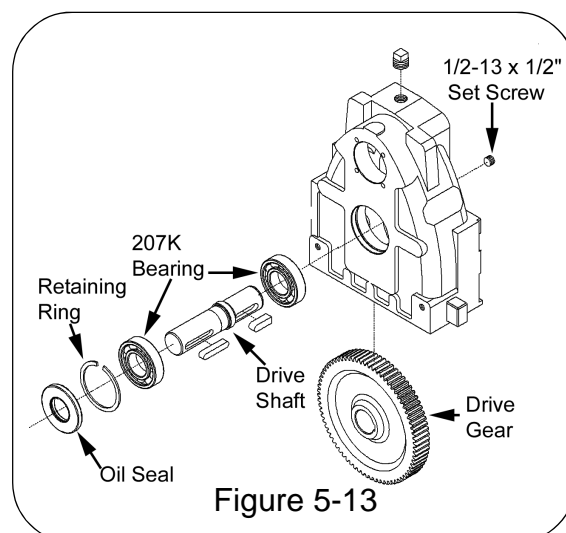
1. Remove the pump and gearbox assembly from apparatus as described above.
2. Place the pump and gearbox on a work stand.
3. Remove the pump body, impeller, and pump head as described previously.
4. If the pump is equipped with a water manifold, remove the 5/16-18 UNC cap screws and remove the water manifold and gasket from the gearbox.

If the pump is not equipped with a water manifold, remove the capscrews, lockwashers, gearbox cover, and gasket.

5. Remove the bearing cover from upper portion of gearbox opposite pump.
6. Use a drift punch to begin pushing the pump shaft assembly from the gearbox housing towards the pump side. Be careful not to

lose the pump gear key in the gearbox.

7. Remove the 306W bearing, pump gear, pump gear key, and 208M bearing from the pump shaft or gearbox housing.
8. Remove the oil seal from the drive shaft then remove the retaining ring.
9. Remove the 1/2 - 13 set screw from gearbox housing.
10. With the set screw removed, insert a drift punch into the 1/2-13 hole and begin pushing the drive shaft from gearbox while protecting the drive gear from falling.
11. Once the shaft is clear of gearbox, remove drive gear from housing.
12. Remove the two 207K bearings from the drive shaft and gearbox housing.
13. Remove the key from the drive shaft.
14. Inspect and clean all components according to the *Cleaning and Inspection Guidelines*.



## Booster Pumps

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### Reassemble and Reinstall 2CBP Gearbox

1. Place the gearbox housing on a steady flat surface with drive shaft opening facing up.
2. Insert one of the two 207K bearings into the bore of the gearbox housing.
3. Slide the drive gear into the gearbox housing. Align the bore of the drive gear with the bore of the gearbox housing.
4. Insert the key in the drive shaft and insert the drive shaft into the gearbox housing. Press the driveshaft into the 207K bearing.
5. Install the other 207K bearing over the drive shaft into the gearbox housing bore.
6. Install the retaining ring to hold the bearing and drive shaft in place.
7. Install a new oil seal.
8. Lift the gearbox onto its base. Apply Loctite 242 and install the 1/2-13 x 1/2" UNC set screw in the drive shaft until it is flush with the gearbox housing.
9. Set the gearbox flat with the drive shaft facing down.
10. Insert the 306W bearing in the bore on the pump end of the gearbox housing.
11. Insert the pump gear key into the pump shaft and install the pump gear onto the shaft. Align the keyway of the pump gear with the shaft key.
12. Align the pump gear to the drive gear and install into the gearbox. Press the shaft into the 306W bearing.
13. Install the 208M bearing over pump shaft.
14. Stand the gearbox housing on its base and install the gasket and bearing cover. Secure with 7/16-14 UNC x 1 inch long capscrews. Torque to 40ft-lbs (54Nm).
15. If the pump is equipped with a cooler, turn the gearbox over and install the gasket and water manifold.  
  
If the pump is not equipped with a cooler, install the gasket and gearbox cover.
16. Secure using the 5/16-18 UNC x 1/2" screws and lockwashers. See Table 5-2 for proper torque.
17. Using Loctite™ PST or equal thread-sealing compound, install the bushings and elbows in the water manifold.
18. Reinstall the pump onto the apparatus and check for leaks.



**Maintenance Kits**

Disassembly of the pump and/or gearbox is a major undertaking that can remove a pump from service for a considerable period of time. Gaskets must be replaced to ensure the pump is fully operational when returned to service. It is never permissible to reassemble the pump without installing new gaskets.

Hale Products supplies repair kits designed specifically for each pump and gearbox. Other parts can be ordered by calling Hale Products Customer Service at 1-800-220-3473.

Below is a list of the kits currently available from Hale Products. Hale updates and adds new maintenance kits constantly, the kits below may therefore be a partial listing of what is available.

The recommended spare parts for three years should include as a minimum one level 1 basic repair kit. The level 1 kit contains seal rings, oil seals, gaskets, the mechanical seal, and retaining rings for basic reassembly of the pump. Level 2 kits provide bearings and any other wear item. A level 2 kit is recommended as the minimum spare part kit for five years. Level 3 kits are purposed for complete overhaul of the pump. In addition to the entire contents of the level 1 and 2 kits, they supply new a pump shaft, keys, shift fork, impellers, and gears.

**AP**

546-1400-11-0 AP Pump Level 1 Basic Repair Kit

546-1400-12-0 AP Pump Level 2 Intermediate Repair Kit

546-1400-20 through 38-0 AP Pump Level 3 Overhaul kit.

**CBP**

546-1541-00-0 CBP Pump Level 1 Basic Repair Kit

546-1541-01-0 CBP Pump Level 2 Intermediate Repair Kit

546-1541-02 through 05-0 CBP Pump Level 3 Overhaul kit.

**2CBP**

546-1560-00-0 2CBP Pump Level 1 Basic Repair Kit

546-1560-01-0 2CBP Pump Level 2 Intermediate Repair Kit

546-1560-02 through 05-0 CBP Pump Level 3 Overhaul kit.

**2CBP3TTT**

The 3TTT is a specialized pump for deicing operations. As such it has repair kits containing parts for this specific purpose. Refer to these kit numbers for service.

546-1540-10-0 2CBP3TTT Level 1 Basic Repair Kit

546-1540-11-0 2CBP3TTT Level 2 Intermediate Repair Kit

546-1540-12-0 2CBP3TTT Level 3 Overhaul Kit



## SECTION VI: PARTS LISTS

This section contains part lists and exploded views for the following Booster Pump models:

- AP
- CBP
- 2CBP
- Hydraulic Drive Option
- Tachometer Option

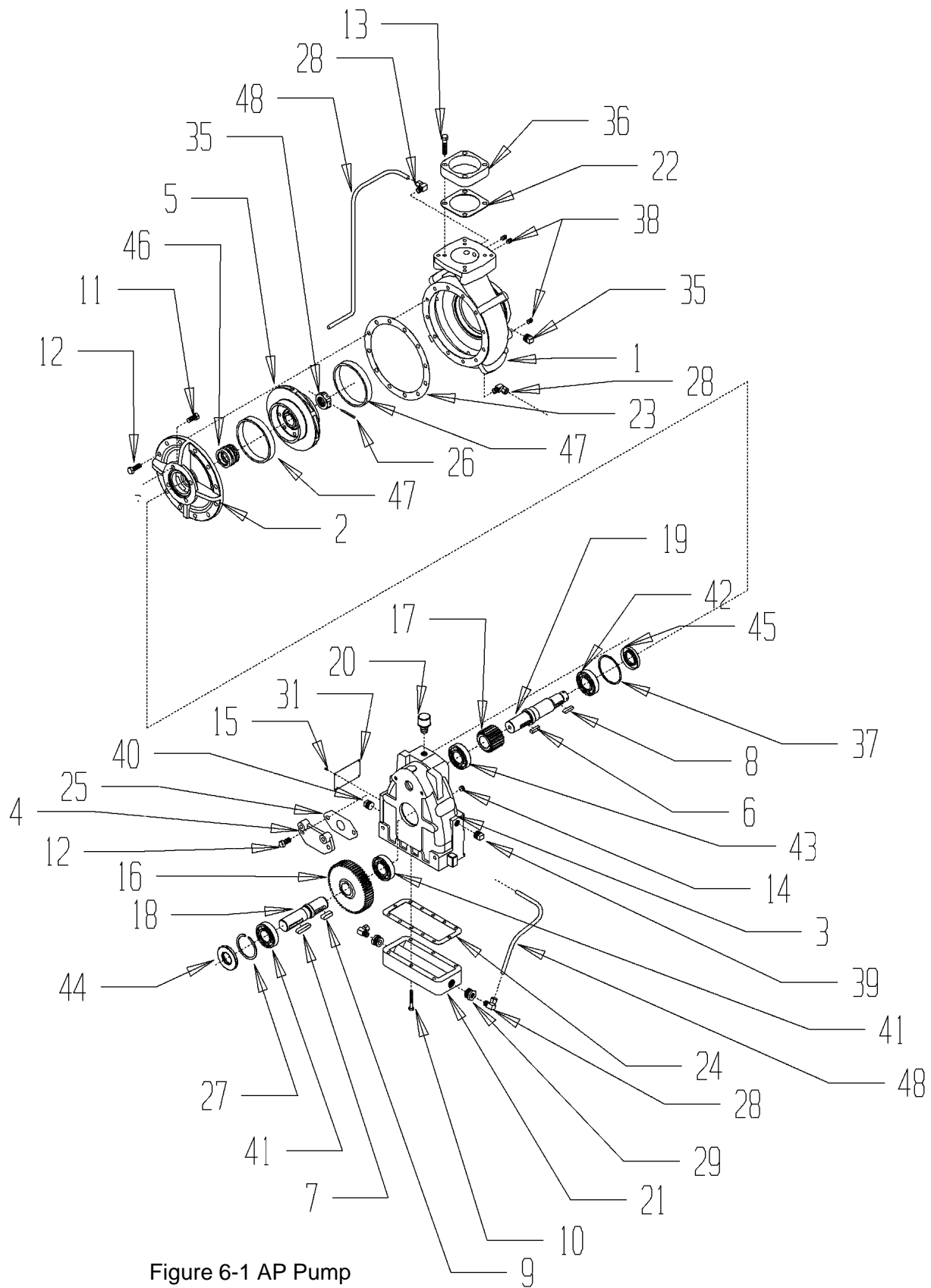


Figure 6-1 AP Pump



**Booster**

**AP Booster Pump**

Item	Qty	Part Number	Description
1	1	001-0750-00-0	AP PUMP BODY
		001-0750-01-0	AP PUMP BODY (OPP ENG) BRASS
		001-0750-02-0	AP PUMP BODY (4.5 ISO) O.E. ROT
		001-0750-03-0	AP PUMP BODY (4-1/2 NST) O.E.ROT
		001-0750-04-0	AP PUMP BODY(4"NPT)O.E.ROT.
		001-0760-00-0	AP PUMP BODY
		001-0760-01-0	AP PUMP BODY (ENG ROT) BRASS
		001-0760-02-0	AP PUMP BODY (4.5 ISO) ENG ROT
		001-0760-03-0	AP PUMP BODY (4-1/2 NST) ENG ROT
		001-0760-04-0	AP PUMP BODY(4"NPT)ENG.ROT.
2	1	002-0210-02-0	M PUMP HEAD
		002-0210-03-0	AP PUMP HEAD (BRASS)
3	1	004-0450-00-0	AP DRIVE UNIT (2.00 RATIO)
		004-0440-00-0	AP DRIVE UNIT (2.30 RATIO)
		004-0470-00-0	APM-25 DRIVE UNIT (2.55 RATIO)
		004-0520-00-0	AP-28 DRIVE UNIT (2.85 RATIO)
4	1	008-0601-00-0	AP BEARING COVER
5	1	016-0940-00-0	AP IMPELLER (O.E. ROT & CCW
		016-0950-00-0	AP IMPELLER (ENG ROT & CW ROT)
6	1	017-0100-00-0	H-95X KEY
7	1	017-0300-00-0	SSA-95XD KEY
8	1	017-0581-00-0	MG IMPELLER KEY
9	1	017-0590-00-0	40FW DRIVE KEY
10	6	018-1404-02-0	SCREW-5/16-18 X 1/2 ZINC PL
	12	018-1422-02-0	SCREW 5/16-18 X 2-1/4 HX HD
11	6	018-1810-07-0	SCREW-7/16-14X1 PLD, SEE L, 170
12	12	018-1812-05-0	SCREW-7/16-14X1-1/4 SIL BRZ
		018-1812-07-0	SCREW-7/16-14X1-1/4 SEE L, 170
13	4	018-1820-02-0	SCREW-7/16-14X2 ZINC PL
14	1	018-2004-66-0	SCREW-1/2-13X1/2 SEE L, 170
15	4	018-5002-00-0	SCREW-#4 X 1/4 PLD, SEE L, 170
16	1	031-0381-00-0	40FW DRIVE GEAR (74T)
		031-0851-00-0	40FC8 DRIVE GEAR (46T)
		031-0361-00-0	CBP DRIVE GEAR (51T)
		031-1260-00-0	AP DRIVE GEAR (57T)



Item No.	Part no	Qty	Description
17	1	031-1120-00-0	AP GEAR (23 TEETH)
		031-1760-00-0	AP50-37 PUMP GEAR 20T
18	1	037-1161-00-0	40FW DRIVE SHAFT
19	1	037-1750-01-0	AP50-37 STAINLESS PUMP SHAFT
20	1	044-0310-00-0	P75-171 AIR VENT
21	1	044-0840-00-0	2CBP DRIVE UNIT COVER
		044-0601-01-0	CBP DU WATER MANIFOLD
		044-0601-02-0	CBP DU WATER MANIFOLD (BRONZE)
22	1	046-0050-00-0	46DW "115" GASKET
23	1	046-0440-00-0	HP-W323 GASKET
24	1	046-5270-01-0	CBP D U GASKET
25	1	046-6271-00-0	AP BRG COVER GASKET
26	1	064-5070-01-0	PIN-5/32 X 2 LONG SST COTTER
27	1	077-2810-00-0	79S281 RETAINING RING
28	4	082-0203-02-0	3/8X1/4 COMP FIT SLF ALGN L170
29	2	082-0513-00-0	BUSHING-3/4 X 1/4 NPT
30	12	097-0810-01-0	WASHER-5/16 STL ZINC PL FLAT
31	1	101-0082-00-0	GEARBOX SERIAL NUMBER PLATE
35	1	110-7040-00-0	ZS-274 NUT-IMPELLER
36	1	115-0080-00-0	115-3 FLANGE (CI)
		115-0080-01-0	115-3 FLANGE (BRONZE)
37	1	142-0510-00-0	20BP SQUARE SEAL RING
38	4	217-0201-00-0	1/4 NPT SQUARE HEAD STEEL PLUG
39	2	217-0401-00-0	PLUG-1/2 NPT M.I.
		217-0401-01-0	PLUG-1/2 NPT BRASS
40	1	217-0401-08-0	PLUG-1/2 NPT M.I. MAGNETIC
41	2	250-0207-00-0	207K BEARING
42	1	250-0208-20-0	208M BEARING
43	1	250-0306-20-0	306W BEARING
44	1	296-2210-00-0	60R-296 OIL SEAL
45	1	296-2610-00-0	MG PUMP SHAFT OIL SEAL (CR)
46	1	296-5021-09-0	AP/MG MECH SEAL (WELDED SPRING)
47	2	321-0150-00-0	4D-321 CLEARANCE RING
48	1	604-0033-00-0	3/8 OD X.032 WALL COPPER TUBE

**Booster**

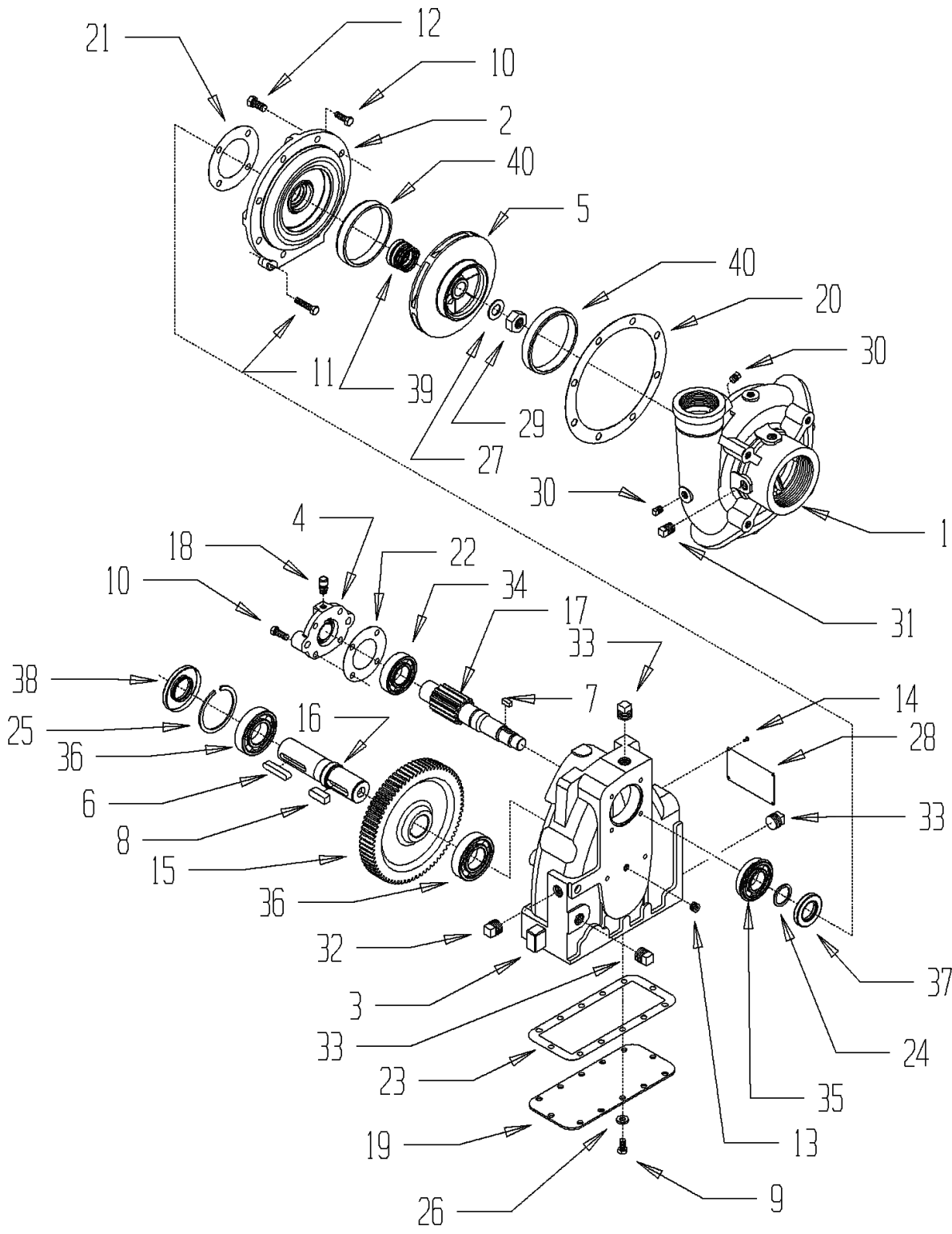


Figure 6-2 CBP Pump



### CBP Series Pump

Item #	Part Number	Qty	Description
1	001-0190-00-0	1	CBP-320LD BODY-VOLUTE(OPP.END)
	001-0190-01-0		CBP-B320LD BODY-VOLUTE(O.E.)
	001-0200-00-0		CBP-320LD BODY-VOLUTE ENG ROT
	001-0200-01-0		CBP-B320RD BODY PUMP(ENG.ROT)
2	002-0170-00-0	1	CBP-2F HEAD-PUMP
	002-0170-01-0		CBP-B2F HEAD-PUMP
3	004-0091-00-0	1	CBP2,3 GEARBOX HSG
	004-0380-00-0		CBP4,5 GEARBOX HSG
4	008-0150-00-0	1	CBP-61D BEARING-CAP
5	016-0230-00-0	1	CBP-16L-6 1/2 IMPELLER OPP ENG R
	016-0240-00-0		CBP-16L-6 1/2 IMPELLER ENG R
6	017-0300-00-0	1	SSA-95XD KEY
7	017-0500-00-0	1	CBP IMP. KEY
8	017-0590-00-0	1	40FW DRIVE KEY
9	018-1404-02-0	12	SCREW-5/16-18 X 1/2 ZINC PL
	018-1422-02-0	6	SCREW 5/16-18 X 2-1/4 HX HD
10	018-1406-02-0	8	SCREW-5/16-18X3/4 PLD,SEE L170
11	018-1412-02-0	2	SCREW-5/16-18 X 1 1/4 ZINC PL
12	018-1607-07-0	8	SCREW-3/8-16X7/8 HX HD ZINC NY
13	018-2004-66-0	1	SCREW-1/2-13X1/2 SEE L,170
14	018-5002-00-0	4	SCREW-#4 X 1/4 PLD,SEE L,170
15	031-0851-00-0	1	CBP DRIVE GEAR (46T) .
	031-0361-00-0		CBP DRIVE GEAR (51T)
	031-0371-00-0		CBP DRIVE GEAR (71T)
	031-0381-00-0		CBP DRIVE GEAR (74T)
16	037-1161-00-0	1	40FW DRIVE SHAFT.
17	037-1201-00-0	1	CBP3/4 PUMP SHAFT(18 TEETH).
	037-1031-00-0		40FD8-2 PUMP SHAFT(2.00 RATIO)
	037-1191-00-0		CBP5 PUMP SHAFT(15 TEETH)
18	044-0260-00-0	1	171-1/8 AIR VENT
19	044-0840-00-0	1	2CBP DRIVE UNIT COVER
	044-0601-01-0		CBP DU WATER MANIFOLD
	044-0601-02-0		WATER MANIFOLD (BRONZE)
20	046-0350-00-0	1	FZ-W323 GASKET-VOLUTE BODY
21	046-5190-00-0	1	4PT-72 GASKET-PUMP HEAD.
22	046-5230-00-0	1	CBP-71D GASKET



## Booster

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Item #	Part Number	Qty	Description
23	046-5270-01-0	1	CBP D U GASKET
24	077-1180-05-0	1	78S118 RETAINING RING
25	077-2810-00-0	1	79S281 RETAINING RING
26	097-0810-01-0	12	WASHER-5/16 STL ZINC PL FLAT
27	097-0960-00-0	1	WASHER.
28	101-0082-00-0	1	GEARBOX SERIAL NUMBER PLATE
29	110-2701-11-0	1	NUT-3/4-16 NYL LOCK STNLS JAM.
30	217-0201-00-0	5	1/4 NPT SQUARE HEAD STEEL PLUG
31	217-0301-00-0	4	PLUG-3/8 NPT SQUARE HEAD.
32	217-0401-00-0	2	PLUG-1/2 NPT M.I..
33	217-0401-08-0	1	PLUG-1/2 NPT M.I. MAGNETIC.
34	250-0206-00-0	1	206K BEARING.
35	250-0206-06-0	1	206KG BEARING .
36	250-0207-00-0	2	207K BEARING
37	296-2110-00-0	1	296K4-118 OIL SEAL
38	296-2210-00-0	1	60R-296 OIL SEAL .
39	296-5050-00-0	1	CBP-G444 MECHANICAL SEAL ASSY A.
40	321-0070-00-0	1	FZ-321 CLEARANCE RING.

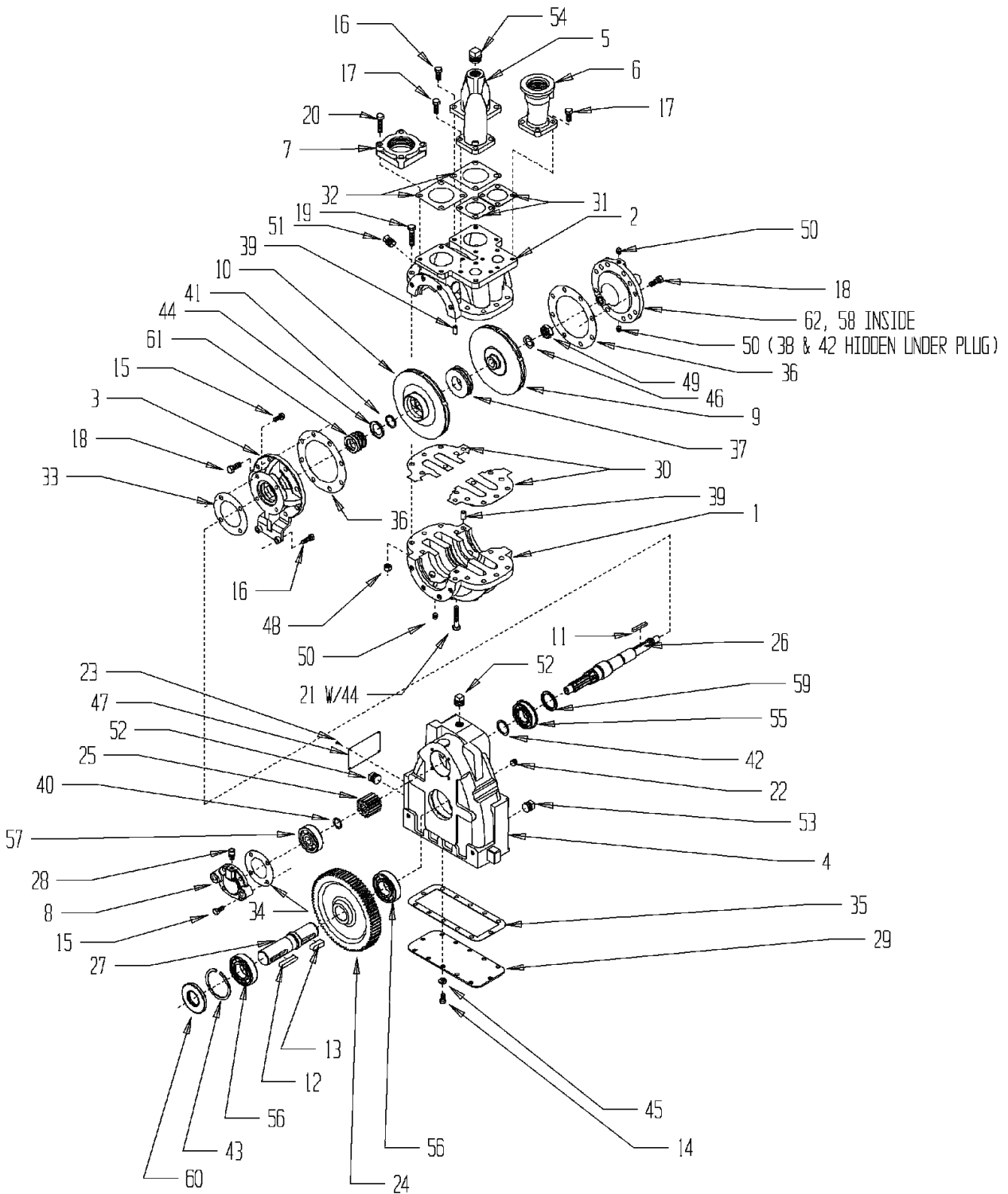


Figure 6-3 2CBP Pump





**Booster**

<b>2CBP PARTS LIST</b>			
<b>Item #</b>	<b>Part Number</b>	<b>Qty</b>	<b>Description</b>
1 & 2	001-0230-00-0	1	2CBP PUMP BODY
	001-0230-03-0	1	2CBP PUMP BODY BRONZE
3	002-0180-00-0	1	2CBP-2D HEAD-PUMP
	002-0180-01-0		2CBP-2D HEAD-PUMP BRONZE
4	004-0091-00-0	1	CBP GEARBOX HSG
	004-0380-00-0		40FW DRIVE UNIT HSG
5	007-0260-00-0	1	2CBP CROSS OVER TUBE
	007-0260-01-0		2CBP CROSS OVER TUBE BRONZE
6	007-0270-00-0	1	2CBP-283 TUBE-DISCHARGE
	007-0270-01-0		2CBP-283 TUBE-DISCHARGE BRONZE
7	007-0280-00-0	1	2CBP-75 ADAPTER-SUCTION
	007-0280-01-0		2CBP-75 ADAPTER-SUCTION BRONZE
8	008-0150-00-0	1	CBP-61D BEARING-CAP
9	016-0270-00-0	1	2CBP-16F-6 1/2 IMPELLER-FRONT
10	016-0280-00-0	1	2CBP-16R-6 1/2 IMPELLER-REAR
11	017-0270-00-0	1	2CBP-17 KEY
12	017-0300-00-0	1	SSA-95XD KEY
13	017-0590-00-0	1	40FW DRIVE KEY
14	018-1404-02-0	12	SCREW-5/16-18 X 1/2 ZINC PL
15	018-1406-02-0	4	SCREW-5/16-18X3/4 PLD,
16	018-1410-02-0	2	SCREW-5/16-18X1 PLD
17	018-1607-02-0	8	SCREW-3/8-16X7/8 LG
18	018-1610-07-0	8	SCREW-3/8-16 X 1
	018-1610-17-0		SCREW-3/8-16 X 1 BRONZE
19	018-1616-02-0	8	SCREW-3/8-16X1-3/4 ZINC PL
	018-1616-17-0		SCREW,3/8-16 X 1-3/4 SST
20	018-1620-02-0	4	SCREW-3/8-16X2
	018-1620-17-0		SCREW,3/8-16 X 2 SST
21	018-1644-02-0	2	SCREW-3/8-16X4-1/2 ZINC PL
22	018-2004-66-0	1	SCREW-1/2-13X1/2
23	018-5002-00-0	4	SCREW-#4 X 1/4 PLD,



Item No.	Part no	Qty	Description
24	031-0851-00-0	1	40FC8 DRIVE GEAR (46T)
	031-0361-00-0		CBP DRIVE GEAR (51T)
	031-0371-00-0		CBP DRIVE GEAR (71T)
	031-0381-00-0		40FW DRIVE GEAR (74T)
25	031-0400-00-0	1	CBP-31-18 GEAR (18T)
	031-0390-00-0		CBP-31-15 GEAR (15T)
	031-0840-00-0		40FC8 PUMP SHAFT GEAR (23T)
26	037-0372-00-0	1	2CBP PUMP SHAFT
27	037-1161-00-0	1	40FW DRIVE SHAFT
28	044-0260-00-0	1	171-1/8 AIR VENT
29	044-0840-00-0	1	2CBP DRIVE UNIT COVER
30	046-0360-00-0	1	2CBP-W266 BODY GASKET
31	046-0370-00-0	2	2CBP-W185 GASKET
32	046-0380-00-0	2	2CBP-W355 GASKET
33	046-5190-00-0	1	4PT-72 GASKET-PUMP HEAD
34	046-5230-00-0	1	CBP-71D GASKET
35	046-5270-01-0	1	CBP D U GASKET
36	046-5351-00-0	2	2CBP GASKET
37	062-0190-00-0	1	2CBP-251 BEARING-CENTER
38	064-0608-02-0	1	03-64-04S SPRING PIN
39	064-6010-00-0	2	AB-68-3/4 DOWEL PIN
40	077-0870-05-0	1	78S87 RETAINING RING
41	077-0980-25-0	1	78SS98 RETAINING RING
42	077-1180-05-0	1	78S118 RETAINING RING
43	077-2810-00-0	1	79S281 RETAINING RING
44	097-0210-00-0	1	FZZ-396 WASHER
45	097-0810-01-0	12	WASHER-5/16 STL ZINC PL FLAT
46	097-3170-24-0	1	WS-04 STAINLESS BRG LK WASHER
47	101-0082-00-0	1	GEARBOX SERIAL NUMBER PLATE
48	110-1600-02-0	8	NUT-3/8-16 PLD HEX,
	110-1600-06-0		NUT-3/8-16 300 SST HEX
49	110-2701-11-0	1	NUT-3/4-16 NYL LOCK STNLS JAM
Not Shown	130-0020-00-0	2	2CBP-398 VANE-SUCTION
50	217-0101-00-0	10	PLUG-1/8 NPT BLACK M.I. OR EQV
	217-0101-01-1		PLUG-1/8 NPT BRASS
51	217-0301-00-0	5	PLUG-3/8 NPT SQUARE HEAD
	217-0301-01-0		PLUG-3/8 NPT BRASS
52	217-0401-00-0	1	PLUG-1/2 NPT M.I.



## Booster

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Item No.	Part no	Qty	Description
53	217-0401-08-0	1	PLUG-1/2 NPT M.I. MAGNETIC
54	217-0501-00-0	1	PLUG-3/4 NPT M.I.
	217-0501-01-0		PLUG-3/4 NPT BRASS
55	250-0206-06-0	1	206KG BEARING
56	250-0207-00-0	2	207K BEARING
57	250-0403-00-0	1	403S BEARING
58	250-9130-00-0	1	2CBP-250 FRONT SLEEVE BEARING
59	296-2140-00-0	1	2CBP-296 OIL SEAL
60	296-2210-00-0	1	60R-296 OIL SEAL
61	296-5050-00-0	1	CBP-G444 MECHANICAL SEAL ASSY
	296-5050-07-0		2CBPTTT MECHANICAL SEAL
62	062-0201-00-0	1	2HP FRT BRG HSG
	062-0201-01-0		2HP FRT BRG HSG BRONZE

## HYDRAULIC ADAPTER

Hydraulically driven booster pumps are equipped with a drive adapter. The adapter bolts to the standard pump gearbox. Use the part list below for reference when contacting Hale Products for service.

### Hydraulic Adapter Part List

Item	Part Number	Description
1	007-1930-00-0	Adapter
2	088-0560-00-0	Coupling
3	077-1370-00-0	Retaining Ring
4	296-2180-00-0	Oil Seal
5	018-1814-07-0	7/16 – 14x 1 ½” Nylon Locking Screw (4)

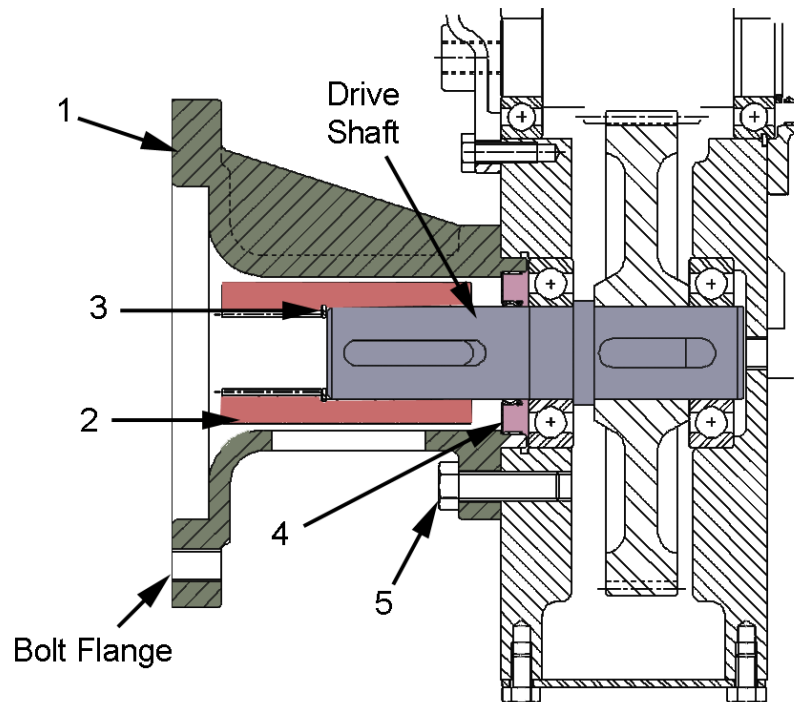


Figure 6-4 Hydraulic Adapter

**TACHOMETER OPTION**

Connected to the pump shaft at the gearbox, the tachometer take off provides for an actual RPM of the pump when connected to a tachometer. The ratio adapter is a 10:1 reduction of the actual rotation of the shaft. The drawing and parts list below illustrate the standard installation of the assembly.

**Tachometer Drive Part List**

Item	Part Number	Description
1	008-0150-02-0	Bearing Cover (Tachometer)
2	007-0070-00-0	2388d Adapter
3	007-0940-00-0	2385 Ratio Adapter
4	013-0010-00-0	Zsf-741f-54 Flex Shaft
5	048-0090-00-0	Zsf-426 Panel Adapter
6	008-0070-00-0	Zsf-666 Adapter Cap

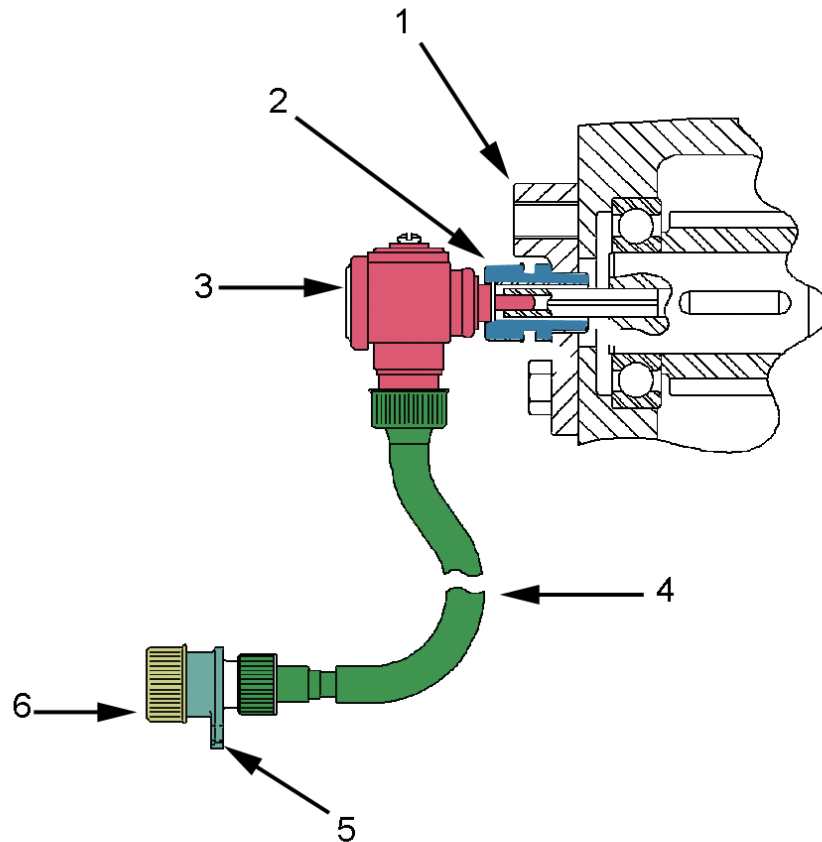


Figure 6-5 Tachometer Assembly



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## LIMITED WARRANTY

EXPRESS WARRANTY. Hale Products Inc. ("Hale") hereby warrants to the original buyer that products manufactured by Hale are free of defects in material and workmanship for two (2) years or 2000 hours usage, whichever shall first occur. The "Warranty Period" commences on the date the Product is first placed in service.

LIMITATIONS. HALE'S obligation is expressly conditioned on the Product being:

- Subjected to nominal use and service.
- Properly maintained in accordance with HALE'S Instruction Manual as to recommended services and procedures.
- Not damaged due to abuse, misuse, negligence or accidental causes;
- Not altered, modified, serviced (non-routine) or repaired other than by an Authorized Service Facility.
- Manufactured per design and specifications submitted by the original Buyer.

THE ABOVE EXPRESS LIMITED WARRANTY IS EXCLUSIVE. NO OTHER EXPRESS WARRANTIES ARE MADE. SPECIFICALLY EXCLUDED ARE ANY IMPLIED WARRANTIES, INCLUDING WITHOUT LIMITATIONS, THE IMPLIED WARRANTIES OF MERCHANTABILITY; FITNESS FOR A PARTICULAR PURPOSE OR USE; QUALITY; COURSE OF DEALING; USAGE OF TRADE; OR PATENT INFRINGEMENT FOR A PRODUCT MANUFACTURED TO ORIGINAL BUYER'S DESIGN AND SPECIFICATIONS.

EXCLUSIVE REMEDIES. If Buyer promptly notifies HALE upon discovery of any such defect (within the Warranty Period), the following terms shall apply:

- Any notice to HALE must be in writing, identifying the Product (or component) claimed defective and circumstances surrounding its failure.
- HALE reserves the right to physically inspect the Product and require Buyer to return same to HALE'S plant or other Authorized Service Facility.
- In such event, HALE will provide a Returned Goods Authorization and Buyer must return the Product F.O.B. within (30) days thereof;
- If determined defective, HALE shall, at its option, repair or replace the Product, or refund the purchase price (less allowance for depreciation),
- Absent proper notice *within* the Warranty Period, HALE shall have no further liability or obligation to Buyer therefore.

THE REMEDIES PROVIDED ARE THE SOLE AND EXCLUSIVE REMEDIES AVAILABLE. IN NO EVENT SHALL HALE BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING, WITHOUT LIMITATION, LOSS OF LIFE; PERSONAL INJURY; DAMAGE TO REAL OR PERSONAL PROPERTY DUE TO WATER OR FIRE; TRADE OR OTHER COMMERCIAL LOSSES ARISING, DIRECTLY OR INDIRECTLY, OUT OF THE PRODUCT FAILURE.