Centrifugal Fire Pump
Principles of Operation, Inspection Tests and Troubleshooting Guide

Waterous Company Since 1886
Subsidiary of American Cast Iron Pipe Company

Printed in U.S.A.

Multi–Stage Pumps

When variations in capacity and pressure are required beyond that which can conveniently be obtained from a single impeller, then multi–stage series/parallel pumps are used. These pumps have two or more impellers, each enclosed in its own volute,which is usually part of a common body. A transfer valve at the outlet of the first stage volute directs the water either to pump discharge or to second stage intake, depending on how the pump is being used.

When the transfer valve is in VOLUME (parallel) position, the water enters each impeller eye from a common intake and leaves through a common pump discharge. See figure 2. If the transfer valve is turned to PRESSURE (series) position, the first stage pumps its full volume and pressure directly to the second stage intake, instead of to pump discharge. The second stage then pumps this same volume of water to pump discharge, but at twice first stage pressure. With the transfer valve in this position, first stage pressure also closes the flap valves in the intake passageways which prevents water from bypassing back to first stage intake. See figure 3.

Cavitation

Any liquid, at any temperature, forms a vapor over its surface which produces a certain amount of pressure. This "vapor pressure" increases as the liquid temperature rises. When the vapor pressure is equal to or greater than the pressure surrounding the liquid, the liquid boils. Vapor pressure is important because of the way it affects pump operation.

Each pump is designed to operate within a given speed range, and under a specific set of intake conditions. Operating a pump at excessive speed, too high an intake lift, restricting the intake, or any other factor that causes the pressure on the liquid to fall below its vapor pressure produces a condition called "cavitation". When this condition exists, the liquid vapor released in the low pressure regions of the pump forms bubbles. These bubbles are carried into the high pressure sections of the impeller (underneath each vane) where they collapse with considerable force. This may cause pitting near the impeller vane tips.

Signs of Cavitation

1. Sudden pressure or capacity loss.
2. Increasing pump speed without corresponding increase in volume or pressure.
3. Excessive pump vibration.
4. A rattling sound resembling gravel going through the pump.

Reducing pump speed or improving intake conditions will usually eliminate cavitation.

Overheating

If the pump runs even for a few minutes completely closed it may heat the water enough to scald someone when the valve is opened. When operating the pump, at least one discharge valve should be open slightly to prevent the pump from overheating. Overheating can damage the packing, seals and other pump parts. If the apparatus builder has installed a bypass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

PARALLEL (VOLUME) OPERATION

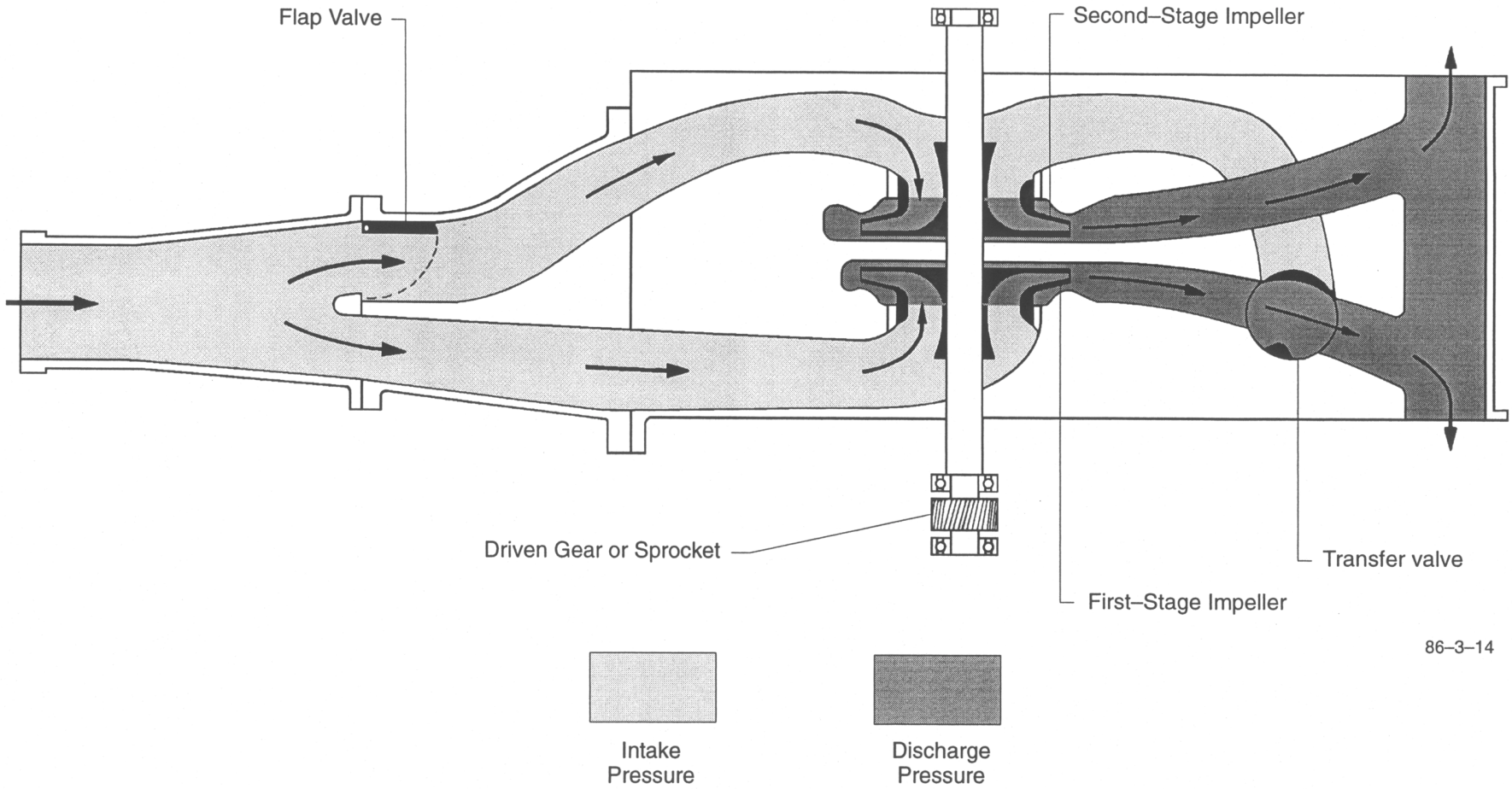

Figure 2

Each impeller pumps half the total volume being delivered, at full discharge pressure. The transfer valve routes water from first stage impeller directly to pump discharge.

SERIES (PRESSURE) OPERATION

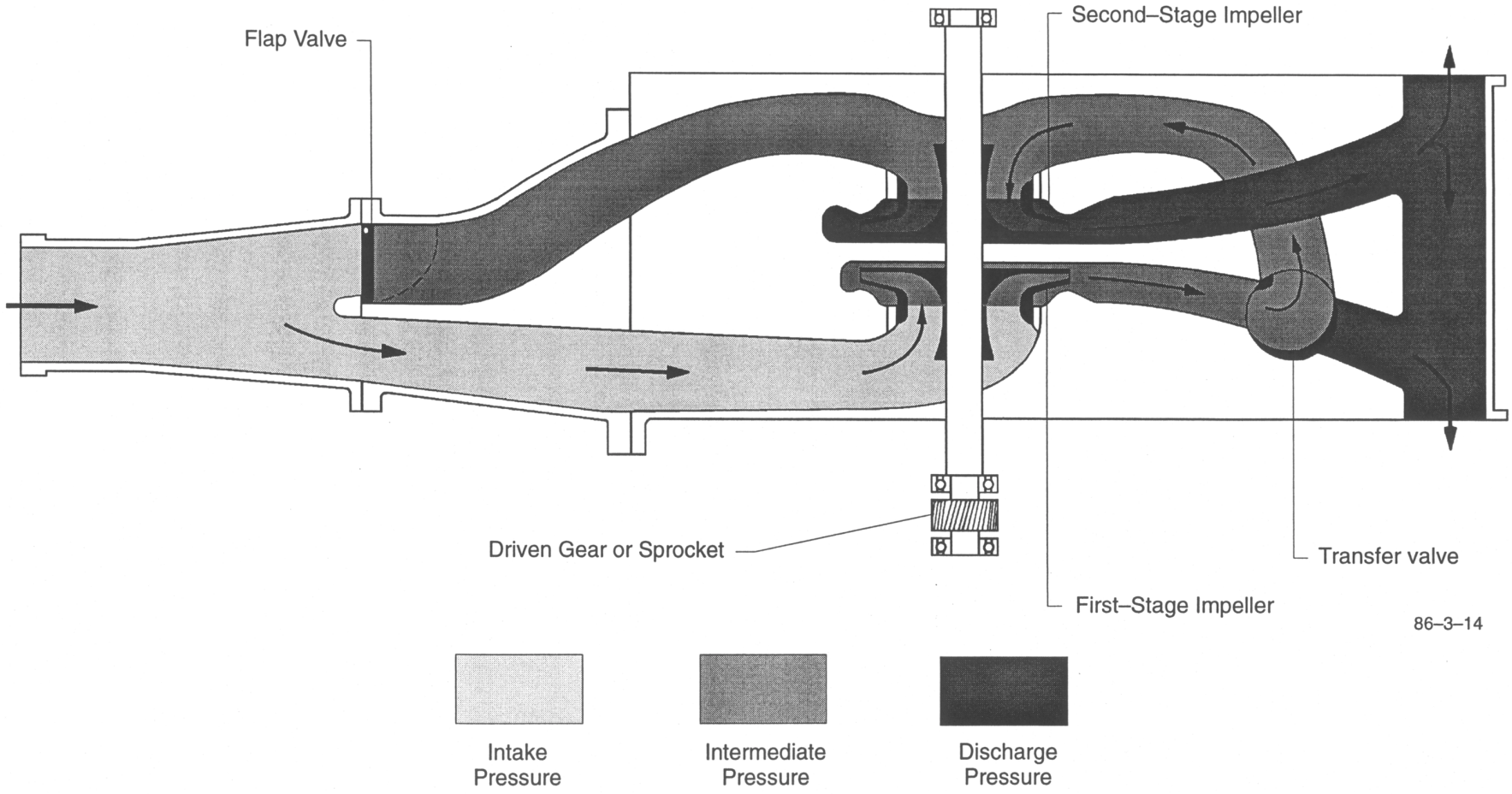

Figure 3

Each impeller pumps all of the volume being delivered. Each impeller develops half the total pump pressure.
The transfer valve routes water from the first stage impeller to second stage intake. First stage pressure also closes the flap valve.

Inspection Tests

A regular testing program offers the best means of determining the actual condition of a pump and its accessories, and permits locating problems before they cause trouble. At a fire, it is usually difficult for the pump operator to observe the pump closely enough to determine its true condition.

Conduct these tests either every month or annually, as outlined below:

Monthly Tests

I. Vacuum Test

Remove all caps except openings without valves. Close all discharge, intake, drain valves and other similar openings. Operate priming device to create a vacuum of about 22 in. Hg/.735 atmospheres in pump, then stop primer and engine.

Watch pressure gage; if vacuum drops more than 10 in. Hg/.334 atmospheres in 5 minutes, listen for air leaks around packing glands, gaskets, valves, etc.

Replace gaskets, repack or otherwise repair source of trouble.

II. Pressure Test (Hydrostatic)

Connect pump to a hydrant or other pressurized water source. Remove all caps except openings without valves. Close all discharge, intake, drain valves and other similar openings. Turn on inlet valve and "crack" highest discharge valve on pump to expel air from pump. Close discharge valve. Carefully examine pump and accessories for leaks. Replace gaskets, tighten joints, repair valves or repack as necessary to eliminate leaks. (See "Packing" under running tests below.)

III. Running Test

Run pump for at least 15 minutes from draft, if possible. Drafting is best because the pump is then more sensitive to defects than when connected to a pressurized water source. Check the following:

1. Priming Ability – If pump does not prime readily (30 seconds for 1250 GPM (4731 L/min) or less and 45 seconds for 1500 to 2000 GPM (5678 to 7570 L/min) pumps) stop pump and determine cause. (An additional 15 seconds may be required if the pump is equipped with a 4 inch or larger front or rear intake.)
2. Shaft Seal

   Packing – Packing should leak a small amount to keep it cool and lubricated. Refer to MAINTENANCE INSTRUCTIONS for the particular pump involved for specific leakage rate and packing adjustment.

   Mechanical Seals – Mechanical seals should not leak. Refer to MAINTENANCE INSTRUCTIONS for the particular pump involved for mechanical seal maintenance.
3. Transfer Valve (series/parallel pumps only) – With the pump running at idle speed, switch valve from one position to the other several times to make sure it operates properly. If the transfer valve is equipped with a grease fitting, lubricate it in accordance with MAINTENANCE INSTRUCTIONS for the pump involved.
4. Shift – Check shift mechanism to make sure it is working properly.
5. Performance – Check pump speed at rated pressure and capacity.
6. Accessories – Operate all discharge and intake valves, relief valve, drain valve and similar accessories to make sure that they all function correctly. If any power accessories are installed, be sure to operate the overrides (if connected) to make sure they operate properly.
7. Indicating Lights – Check to make sure they are working properly.

Annual Tests

At least once a year, test the pumper to determine if it is capable of meeting the requirements outlined in NFPA 1911, Tests of Pumps on F.D. Apparatus. Compare the pump and engine speeds observed in these tests with those in the acceptance and other previous tests. If the speeds observed in the latest tests are much higher, the pump probably requires some repairs.

Troubleshooting

CONDITION	POSSIBLE CAUSE	SUGGESTED REMEDY
Pump fails to prime or loses prime	Air leaks	Clean and tighten all intake connections. Make sure intake hoses and gaskets are in good condition. Use the following procedure to locate air leaks: 1. Connect intake hose to pump and attach intake cap to end of hose. 2. Close all pump openings. 3. Open priming valve and operate primer until vacuum gage indicates 22 in. Hg/.735 atmospheres. (If primer fails to draw specified vacuum, it may be defective, or leaks are too large for primer to handle.) 4. Close priming valve and shut off primer. If vacuum drops more than 10 in. Hg/.334 atmospheres in 5 minutes, serious air leaks are indicated. With engine stopped, air leaks are frequently audible. If leaks cannot be heard, apply engine oil to suspected points and watch for break in film or oil being drawn into pump.
		Completely fill water tank (if so equipped). Connect intake hose to hydrant or auxiliary pump. Open one discharge valve and run in water until pump is completely filled and all air is expelled. Close discharge valve, apply pressure to system and watch for leaks or overflowing water tank. A pressure of 100 psi is sufficient. DO NOT EXCEED RECOMMENDED PRESSURE.
		If pump has not been operated for several weeks, packing may be dried out. Close discharge and drain valves and cap intake openings. Operate primer to build up a strong vacuum in pump. Run pump slowly and apply oil to impeller shaft near packing gland. Make sure packing is adjusted properly.
	Dirt on intake strainer	Remove all leaves, dirt and other foreign material from intake strainer.
		When drafting from shallow water source with mud, sand or gravel bottom, protect intake strainer in one of the following ways: 1. Suspend intake strainer from a log or other floating object to keep it off the bottom. Anchor float to prevent it from drifting into shallow water. 2. Remove top from a clean barrel. Sink barrel so open end is below water surface. Place intake strainer inside barrel. 3. Make an intake box, using fine mesh screen. Suspend intake strainer inside box.
	No oil in priming tank	With rotary primer, oil is required to maintain a tight rotor seal. Check priming tank oil supply and replenish, if necessary.
Pump fails to prime or loses prime (cont'd)	Defective priming valve	A worn or damaged priming valve may leak and cause pump to lose prime. Consult primer instructions for priming valve repair.
	Improper clearance in rotary gear or vane primer	After prolonged service, wear may increase primer clearance and reduce efficiency. Refer to primer instructions for adjusting primer clearance.
	Engine speed too low	Refer to instructions supplied with primer for correct priming speeds. Speeds much higher than those recommended do not accelerate priming, and may actually damage priming pump.
	Bypass line open	If a bypass line is installed between the pump discharge and water tank to prevent pump from overheating with all discharge valves closed, look for a check valve in the line. If valve is stuck open, clean it, replace it or temporarily block off line until a new valve can be obtained.
	Lift too high	Do not attempt lifts exceeding 22 feet (6.7m)except at low altitudes and with equipment in new condition.
	End of intake hose not submerged deep enough	Although intake hose might be immersed enough for priming, pumping large volumes of water may produce whirlpools, which will allow air to be drawn into intake hose. Whenever possible, place end of intake hose at least two feet below water source.
	High point in intake line	If possible, avoid placing any part of intake hose higher than pump inlet. If high point cannot be prevented, close discharge valve as soon as pressure drops, and prime again. This procedure will usually eliminate air pockets in intake line, but it may have to be repeated several times.
	Primer not operated long enough	Refer to instructions supplied with primer for required priming time. The maximum time for priming should not exceed 45 seconds for lifts up to 10 feet (3.0m).
Insufficient capacity A. Engine and pump speed too low at full throttle	Insufficient engine power	Engine requires maintenance. Check engine in accordance with manufacturer's instructions supplied with truck.
		Engine operated at high altitudes and/or high air temperatures. Engine power decreases with an increase in altitude or air temperature, except for turbo charged engines. Adjusting carburetor or changing carburetor jets (or injector nozzles) may improve engine performance. Consult with engine manufacturer.
	Discharge relief valve set improperly	If relief valve is set to relieve below desired operating pressure, water will bypass and reduce capacity. Adjust relief valve in accordance with instructions supplied with valve.
Insufficient capacity A. Engine and pump speed too low at full throttle (continued)	Transfer valve set improperly (Does not apply to single stage pumps.)	Place transfer valve in VOLUME (parallel) position when pumping more than two thirds rated capacity.
		When shifting transfer valve, make sure it travels all the way into new position. Failure of transfer valve to move completely into new position will seriously impair pump efficiency.
	Truck transmission in too high a gear	Consult vehicle instructions for correct pump gear. Pump usually works best with transmission in direct drive. If truck is equipped with an automatic transmission, be sure transmission is in pumping gear.

Troubleshooting

CONDITION	POSSIBLE CAUSE	SUGGESTED REMEDY
Insufficient capacity B. Engine and pump speed higher than specified for desired pressure and volume	Transfer valve set improperly (Does not apply to single stage pumps.)	Place transfer valve in VOLUME (parallel) position when pumping more than two thirds rated capacity.
		When shifting transfer valve, make sure it travels all the way into new position. Failure of transfer valve to move completely into new position will seriously impair pump efficiency.
	Pump impeller(s) or wear rings badly worn	Install undersize wear rings if impeller to wear ring clearance is within limits indicated in MAINTENANCE INSTRUCTIONS. If not, install new impeller(s) and wear rings.
	Intake strainer, intake screens or impeller vanes fouled with debris	Remove intake strainer and hose, and clear away all debris. Pressure backwash (preferably in parallel or "volume" position) will usually clear impeller vanes when pump is stopped.
	Intake hose defective	On old intake hoses, the inner liner sometimes becomes so rough it causes enough friction loss to prevent pump from drawing capacity. Sometimes, the liner will separate from the outer wall and collapse when drafting. It is usually impossible to detect liner collapse, even with a light. Try drafting with a new intake hose; if pump then delivers capacity, it may be assumed that previous hose was defective.
	Intake hose too small	When pumping at higher than normal lifts, or at high altitudes, use a larger or additional intake hoses.
Insufficient capacity C. Engine speed higher than specified for desired pressure and volume	Truck transmission in too low a gear	Consult vehicle instructions for correct pumping gear. Pump usually works best with transmission in direct drive. (Check both engine and pump speed, if possible, to be sure transmission is in "direct".)
Insufficient pressure	Pump speed too low	In general, the above causes and remedies for low pump capacity will also apply to low pump pressure.
		Check pump speed with a tachometer. If pump speed is too low, refer to engine manufacturer's instructions for method of adjusting engine speed governor.
Insufficient pressure (continued)	Pump capacity limits pump pressure	Do not attempt to pump greater volume of water at the desired pressure than the pump is designed to handle. Exceeding pump capacity may cause a reduction in pressure. Exceeding maximum recommended pump speed will produce cavitation, and will seriously impair pump efficiency.
	Flap valve stuck open	When pump is in PRESSURE (series), discharge will bypass to first stage intake. Operate pump at 75 psi/5.2 bar, and rapidly switch transfer valve back and forth between positions. If this fails, try to reach valve with a stick or wire and work it free.
Relief Valve Malfunction A. Pressure not relieved when discharge valves are closed	Sticky pilot valve	Disassemble and clean. Replace noticeably worn parts.
	Plugged tube lines	Disconnect lines and inspect.
Relief Valve Malfunction B. Pressure will not return to original setting after discharge valves are reopened	Sticky pilot valve	Disassemble and clean. Replace noticeably worn parts.
	Sticky main valve	Disassemble and clean. Replace noticeably worn parts.
	Incorrect installation	Check all lines to be sure installation instructions have been followed.
Relief Valve Malfunction C. Fluctuating pressure	Sticky pilot valve	Disassemble and clean. Replace noticeably worn parts.
	Water surges (relief valve)	Pressure fluctuation can result from a combination of intake and discharge conditions involving the pump, relief valve and engine. When the elasticity of the intake and discharge system and the response rate (reaction time) of the engine, pilot valve and relief valve are such that the system never stabilizes, fluctuation results. With the proper combination of circumstances, fluctuation can occur regardless of the make or type of equipment involved. Changing one or more of these factors enough to disrupt this timing should eliminate fluctuation.
Relief Valve Malfunction D. Slow response	Plugged filter or line	Clean lines and filter.

SERVICE MANUAL

E-One
Pubs No.
52667C

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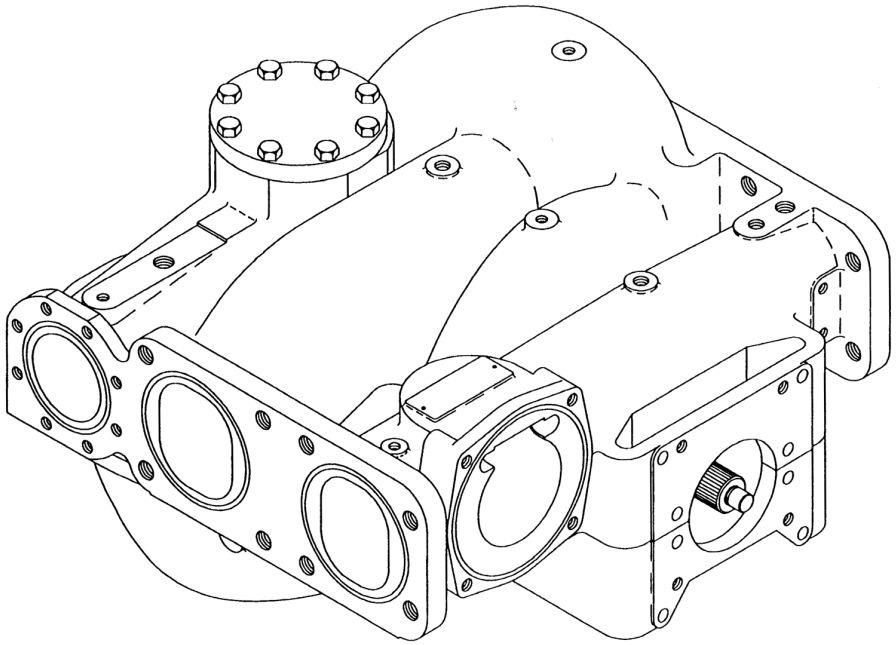
DEPENDABLE

Operation and Maintenance Instructions

Form No.	Section	Date
F–1031	2115	12/14/95

CS Series Centrifugal Fire Pumps



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INTRODUCTION

This instruction contains the information needed for operation and maintenance of CS Series centrifugal pumps. Since there are several types of transmissions available for these pumps, they are covered in separate instructions.

GENERAL DESCRIPTION

The CS Series pumps are single stage centrifugal fire pumps. They are designed for midship mounting and are available in capacities ranging from 750 to 2000 gpm.

A variation of the basic pump is the CSH pump. This two stage pump has an extra pressure stage designed for high pressure operation. It is identical to the CS except for the added stage and piping.

COMPONENTS

BODY ASSEMBLY

This assembly includes the body, cover, intake adapters and related parts. The body, cover and adapters are either cast iron or bronze.

IMPELLER SHAFT ASSEMBLY

This assembly consists of the bronze impeller mounted on a stainless steel shaft with wear rings, packing or mechanical seal and related parts. The impeller is balanced and the impeller shaft is supported by ball bearings.

OPTIONS

MECHANICAL SEALS

A mechanical seal consists of a flat, highly polished (lapped), spring–fed carbon ring that is sealed to and rotates with the impeller shaft. It presses against a highly polished (lapped), stainless steel, stationary ring that is sealed in the pump body. This seals the shaft and prevents air from entering and water from leaving. A mechanical seal does not leak or drip water, even when pumping.

EXTRA PRESSURE STAGE

The extra pressure stage provides extra pressure without the need of a separate PTO driven pump. When the extra pressure stage control valve is opened, water enters the extra pressure stage intake from the main pump discharge, and is discharged at a higher pressure. With the extra pressure stage in operation, the CSH pump develops pressure up to 500 psi for two or more booster lines. The extra pressure body mounts on the main body opposite the pump drive end. The impeller is mounted on the same shaft as the other impeller and rotates whenever the pump is in operation. When the extra pressure stage is not in use, water from the first stage lubricates and cools the extra pressure stage stuffing box.

FLAME PLATED IMPELLERS

Approximately 75 per cent of the pump wear due to pumping sand, occurs on the impeller hubs. For this reason, the Waterous Company adopted the policy of offering a flame plated impeller as an option (standard on CSU pumps). The flame plating process consists of adding tungsten carbide to the surfaces to be protected from wear. This unique process produces extremely hard, well bonded, wear resistant coatings which consistently outwear hard chrome plating, tool steel and solid tungsten carbide.

INTAKE SCREENS

Zinc die cast screens are normally used in the intake fittings, with brass screens available optionally. Although the screens are chemically treated (coated) to inhibit corrosion, the water being pumped may still corrode the screens. Such corrosion is "sacrificial"; that is, it will help prevent corrosion in the rest of the pump the same way the magnesium anodes protect the metal parts of a water heater.

ANODES

As additional corrosion protection for iron body pumps, Waterous has available zinc anodes to fit any unused 2–1/2 inch or 3 inch pipe tap in the intake fittings. Anodes provide additional zinc surface to the water to supplement the zinc intake screens.

TANK TO PUMP VALVE

The tank to pump valve is a full–flow 3–1/2 inch diameter ball valve which is attached directly to the pump. The valve is operated by a 90° spring detent remote control handle.

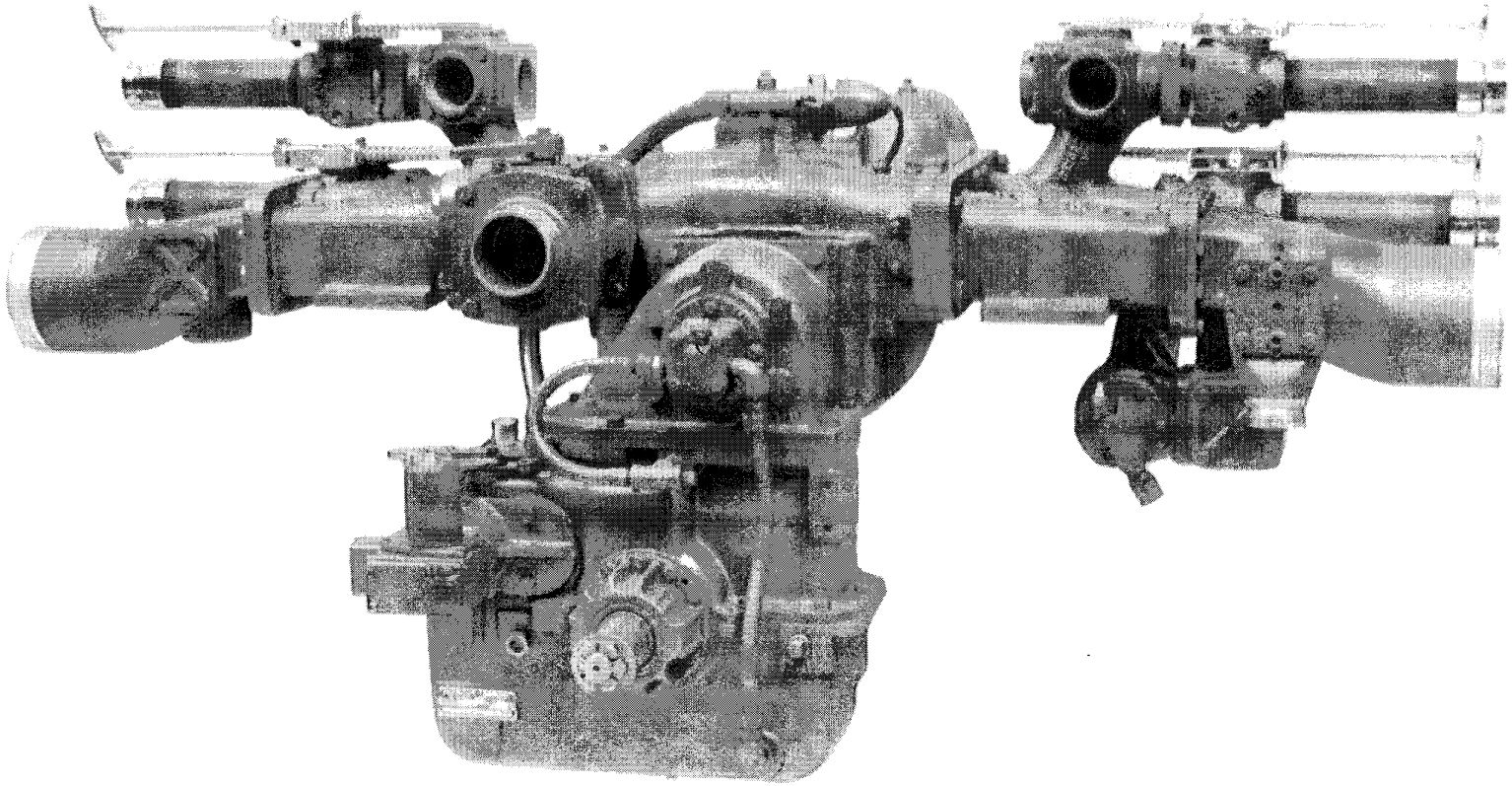


Figure 1

CS Pump with YB Chain Drive Transmission (CSYBX)

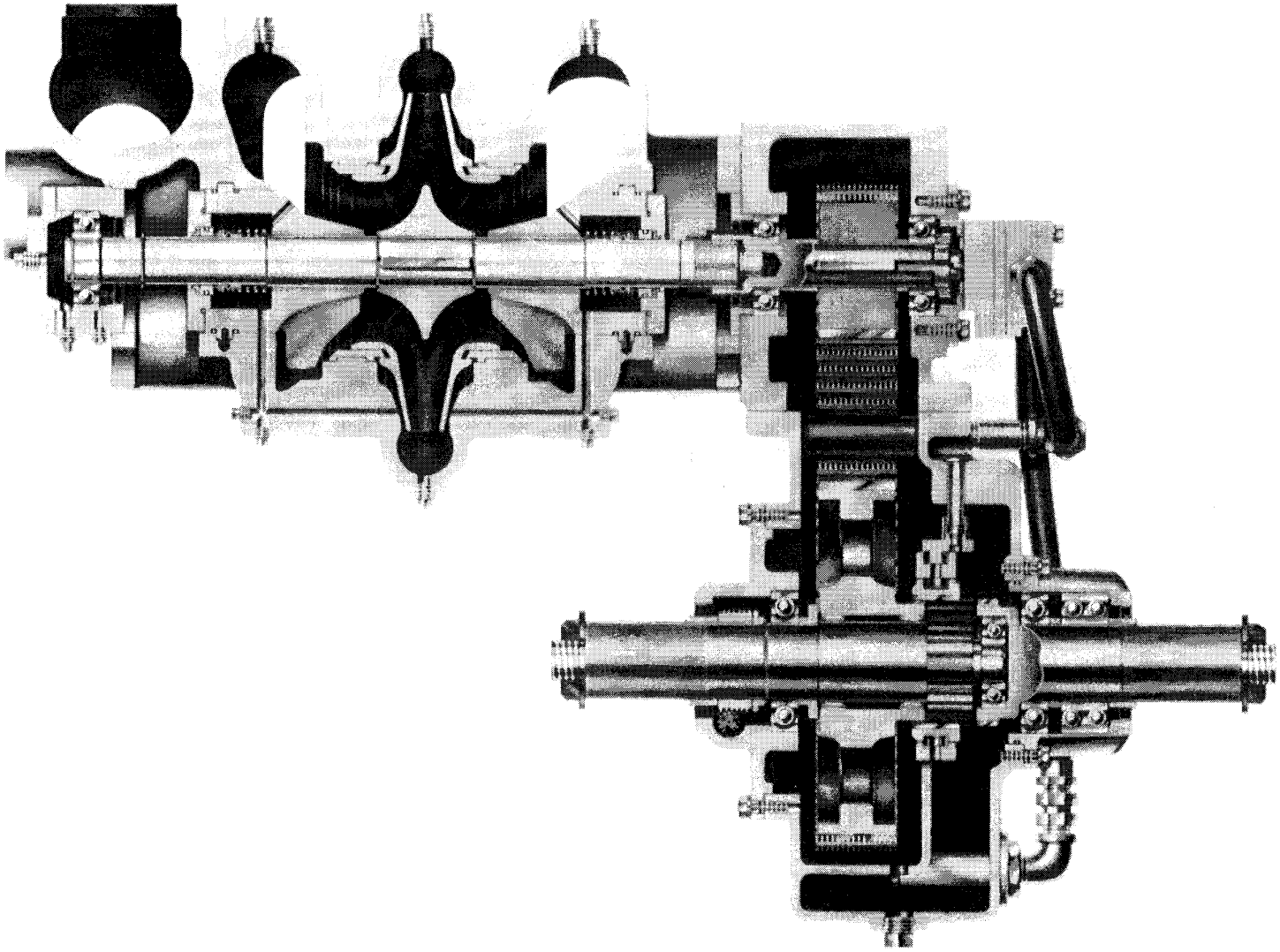


Figure 2

Cross–Sectional View, CS Pump with Y Series Chain Drive Transmission

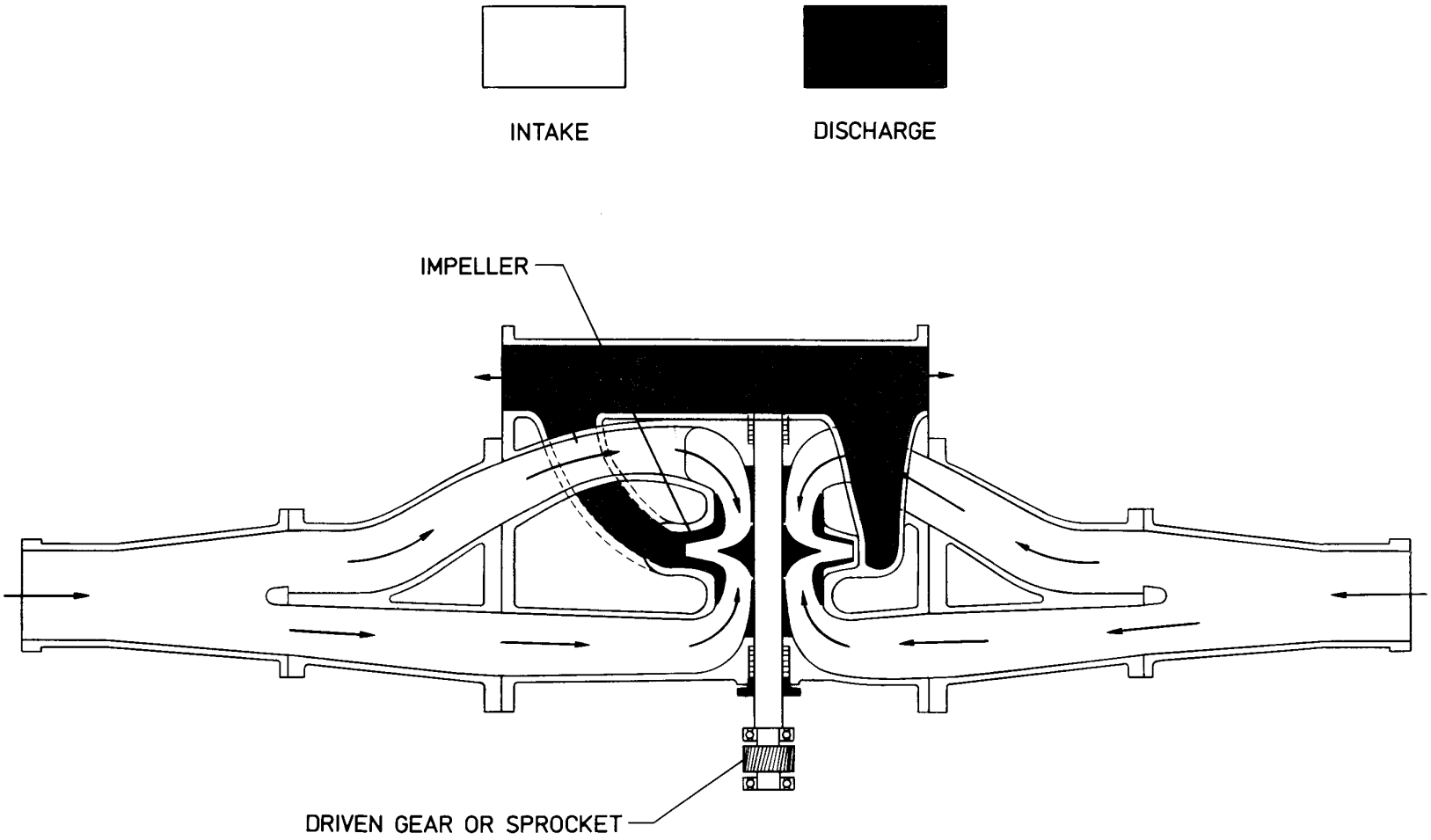


Figure 3
Water Flow Diagram

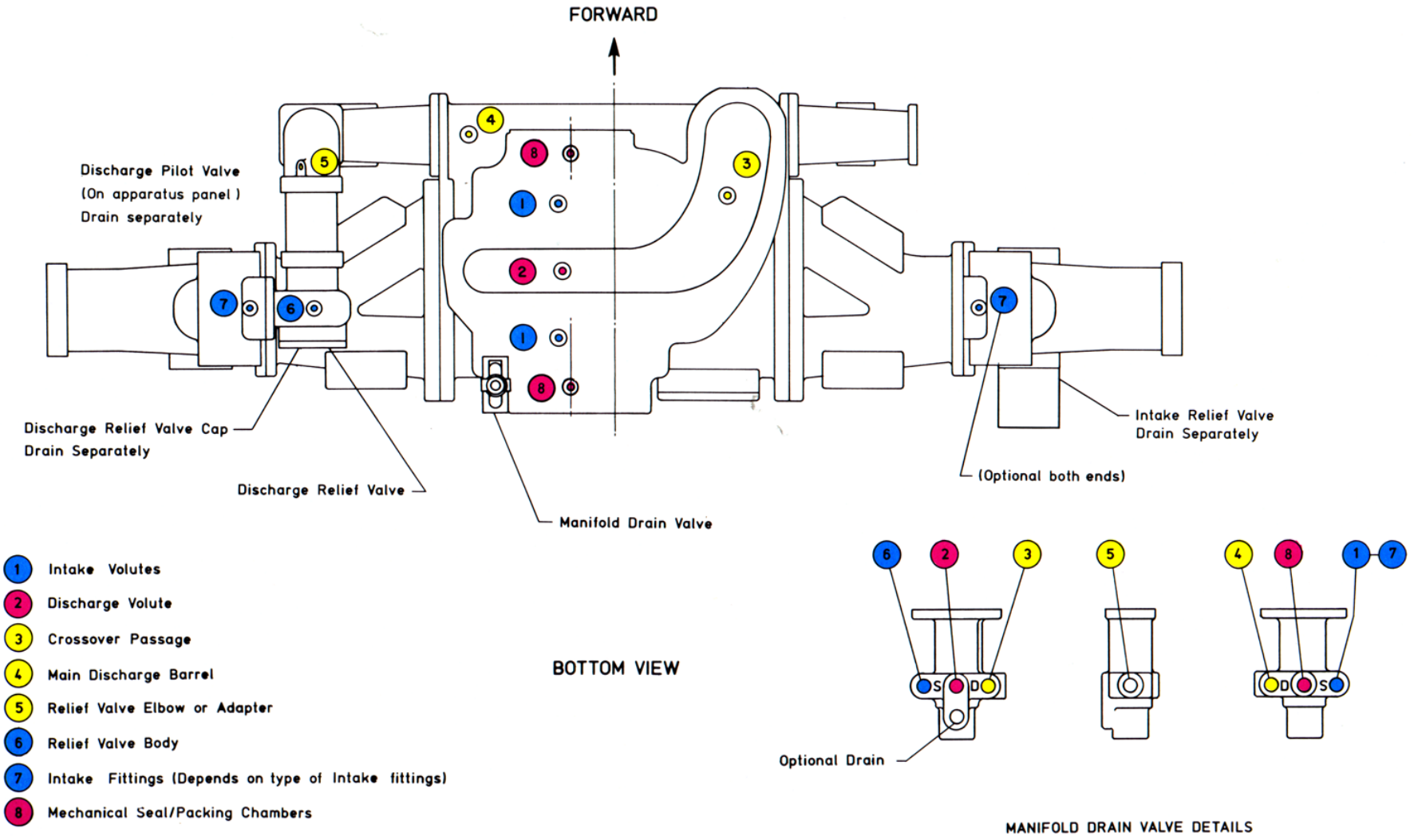


Figure 4

Drain Locations, CS Series Pumps

12

OPERATING INSTRUCTIONS

TRANSMISSION OPERATION

Because of the variety of transmissions available for these pumps, the methods of operating them are not explained in this section. For information on Waterous transmissions, refer to transmission operation instructions.

PUMPING FROM WATER TANK

⚠ WARNING

When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs for a few minutes completely closed, it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts. If the apparatus builder has installed a by–pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

⚠ WARNING

Failure to properly shift transmission may result in unexpected truck movement which may result in serious personal injury or death.

1. Engage pump in accordance with transmission instructions.
2. Open valve(s) in piping between water tank and pump intake and at least one discharge valve.
3. Allow about 30 seconds for water to flow into pump.

   NOTE: Priming the pump may be necessary because of air trapped in piping.
4. Accelerate engine to obtain desired discharge pressure and capacity.
5. Set relief valves or other pressure governing device to desired pressure.

NOTE: For extra pressure stage pumping instructions, see page 13.

AFTER PUMPING

1. Disengage pump drive in accordance with transmission instructions.
2. If pumping anything but clean water, remove all intake and discharge caps, open all valves and open all drains. Flush entire system with clean, fresh water for several minutes to remove all traces of impurities.
3. If pump is kept full of water when not in use, make sure water is clean and non–corrosive. Make sure the pump is completely full or completely drained – never partially full.

⚠ CAUTION

If the pump is exposed to freezing temperatures, drain all water from pump, lines and accessories.

4. Close all drains and install intake and discharge caps.
5. If truck is equipped with a priming pump, operate it until oil is discharged from priming pump discharge pipe. Also check oil level in priming tank, and refill if necessary.

PUMPING FROM HYDRANT OR IN RELAY

⚠ WARNING

When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs even for a few minutes completely closed it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts.If the apparatus builder has installed a by–pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

⚠ WARNING

Failure to properly shift transmission may result in unexpected truck movement which may result in serious personal injury or death.

1. Engage pump in accordance with transmission instructions.
2. Open intake, hydrant and other valves as necessary to allow water to enter the pump.
3. Open discharge valves and accelerate engine to obtain desired discharge pressure and capacity.
4. Set relief valves or other pressure governing device to desired pressure.

NOTE: Do not attempt to pump more water than is available from the hydrant or relaying pumper. Always make sure the intake pressure compound–gage reading stays above zero.

Some fire departments operate at a minimum intake pressure of 10 psi when pumping from hydrant or in relay to prevent a "soft" intake hose from collapsing.

AFTER PUMPING

1. Disengage pump drive in accordance with transmission instructions.
2. If pumping anything but clean water, remove all intake and discharge caps, open all valves and open all drains. Flush entire system with clean, fresh water for several minutes to remove all traces of impurities.
3. If pump is kept full of water when not in use, make sure water is clean and non–corrosive. Make sure the pump is completely full or completely drained – never partially full.

⚠ WARNING

If the pump is exposed to freezing temperatures, drain all water from pump, lines and accessories.

4. Close all drains and install intake and discharge caps.
5. If truck is equipped with a priming pump, operate it until oil is discharged from priming pump discharge pipe. Also check oil level in priming tank, and refill if necessary.

PUMPING FROM DRAFT

⚠ WARNING

When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs even for a few minutes completely closed it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts.If the apparatus builder has installed a by–pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

⚠ WARNING

Failure to properly shift transmission may result in unexpected truck movement which may result in serious personal injury or death.

To get full capacity, quick prime and maintain pump efficiency:

a) Position vehicle as near as possible to water supply.

b) Avoid humps and sharp bends in intake hose. Make sure no part of hose is higher than pump intake inlet. (Air pockets in intake hose may cause loss of prime or erratic pump action, and may reduce pump capacity.)

c) Make sure all intake connections are tight and discharge valves are closed.

d) Immerse intake strainer at least two feet below water surface to prevent pump from drawing air. (Whirlpools forming above intake strainer indicate that strainer is too close to surface of water.)

e) Make sure intake strainer is far enough from bottom to prevent sand, gravel and other foreign matter from being drawn into the pump.

1. Engage pump in accordance with transmission instructions.
2. Prime the pump (see separate instructions supplied with primer).
3. Open discharge valves, and accelerate engine to obtain desired discharge pressure and capacity.
4. Set relief valves or other pressure governing device to desired pressure.

   NOTE: For extra pressure stage pumping instructions, see page 13.

AFTER PUMPING

1. Disengage pump drive in accordance with transmission instructions.
2. If pumping anything but clean water, remove all intake and discharge caps, open all valves and open all drains. Flush entire system with clean, fresh water for several minutes to remove all traces of impurities.
3. If pump is kept full of water when not in use, make sure water is clean and non–corrosive. Make sure the pump is completely full or completely drained – never partially full.

⚠ CAUTION

If the pump is exposed to freezing temperatures, drain all water from pump, lines and accessories.

4. Close all drains and install intake and discharge caps.
5. If truck is equipped with a priming pump, operate it until oil is discharged from priming pump discharge pipe. Also check oil level in priming tank, and refill if necessary.

EXTRA PRESSURE STAGE OPERATION – CSH PUMPS ONLY

⚠ WARNING

When operating the extra pressure stage, be sure to open at least one discharge valve slightly to prevent the extra pressure stage from overheating. If the extra pressure stage runs even for a few seconds completely closed it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts.If the apparatus builder has installed a bypass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

⚠ WARNING

Failure to properly shift transmission may result in unexpected truck movement which may result in serious personal injury or death.

1. Open extra pressure stage control valve and discharge valve(s).
2. Accelerate engine to obtain desired discharge pressure and capacity.
3. Set relief valves or other pressure governing device to desired pressure.

AFTER PUMPING

1. Disengage pump drive in accordance with transmission instructions.
2. If pumping anything but clean water, remove all intake and discharge caps, open all valves and open all drains. Flush entire system with clean, fresh water for several minutes to remove all traces of impurities.
3. If pump is kept full of water when not in use, make sure water is clean and non–corrosive. Make sure the pump is completely full or completely drained – never partially full.

⚠ CAUTION

If the pump is exposed to freezing temperatures, drain all water from pump, lines and accessories.

4. Close all drains and install intake and discharge caps.
5. If truck is equipped with a priming pump, operate it until oil is discharged from priming pump discharge pipe. Also check oil level in priming tank, and refill if necessary.

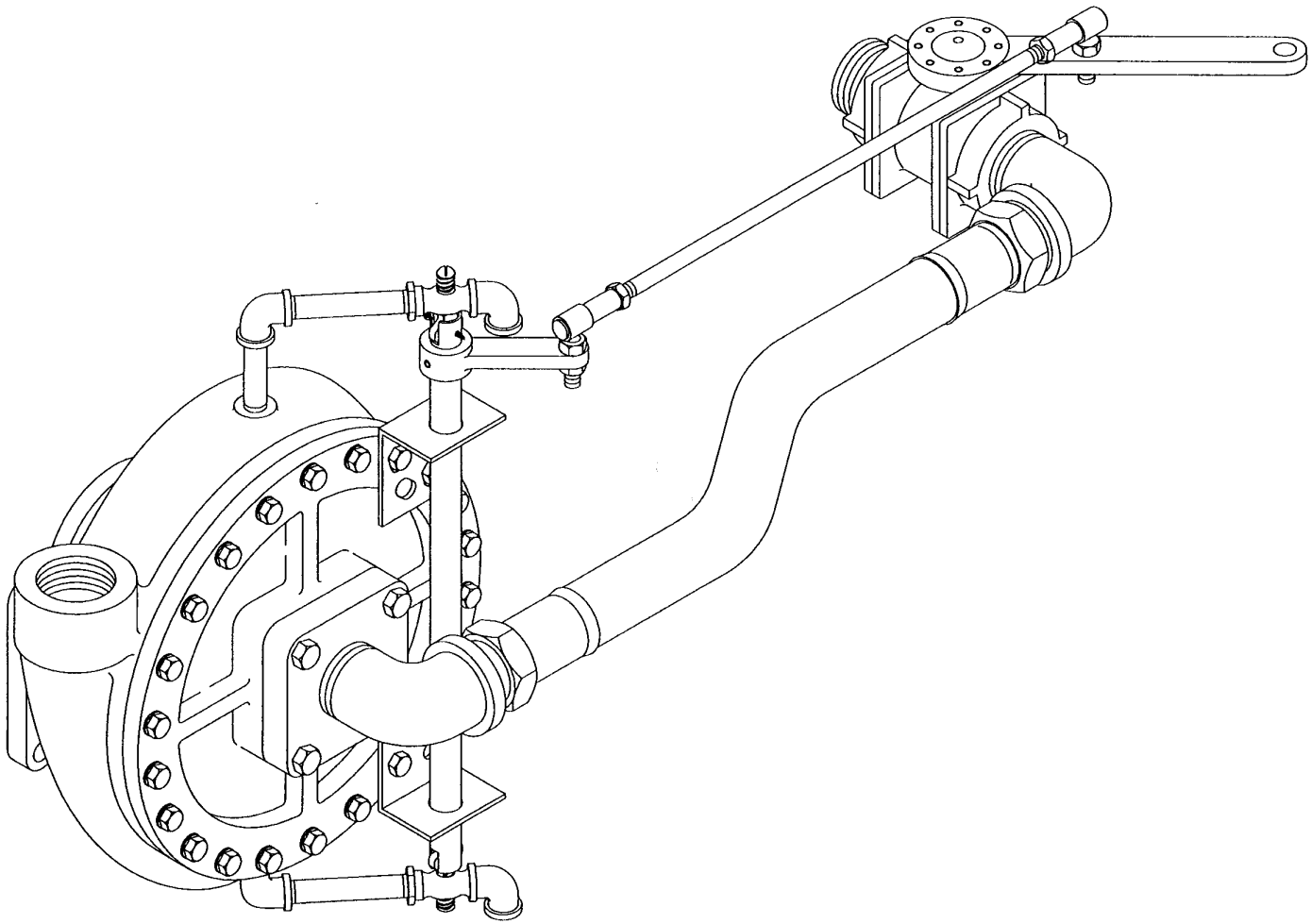


Figure 5
Extra Pressure Stage

MAINTENANCE

LUBRICATION

OUTBOARD BEARING (Except CSH)

The outboard bearing is located at the end of the pump opposite the drive end of pump.

Add a good quality, medium consistancy, ball bearing grease through the lubrication fitting until it comes out of the relief fitting. Add grease after every 100 hours of pump operation, or every six months, whichever comes first.

INBOARD BEARING (CSD Pumps Only)

The inboard bearing is located at the drive end of the pump.

Add a good quality, medium consistancy, ball bearing grease through the lubrication fitting until it comes out of the relief fitting. Add grease after every 100 hours of pump operation, or every six months, whichever comes first.

EXTRA PRESSURE STAGE BEARING (CSH Pumps Only)

The impeller shaft is supported at the extra pressure stage by a double row, ball bearing. A fitting permits lubrication of this bearing.

A relief groove, cut in the threads of the lubrication fitting allows surplus grease to escape without causing excessive pressure. Add a good quality, medium consistancy, ball bearing grease until it comes out of the relief groove of the lubrication fitting. Add grease after every 100 hours of pump operation, or every six months, whichever comes first.

CORROSION PROTECTION

INTAKE SCREENS

Once a month check the intake screens to make sure they are not clogged or damaged. Also check for corrosion, and replace screens if damage is serious. For the zinc screens to adequately control corrosion, there must be a strong electrical connection between the screen and the intake fitting. Remove any corrosion that may be insulating the screen from the fitting. Most screens have an adjustable tab on the O.D. of the screen which can be positioned to ensure a tight fit.

ANODES

Twice a year check anodes for corrosion and replace if damage is extensive.

PACKING – FLEXIBLE GRAPHITE

The stuffing box at each end of the pump is designed and adjusted to leak slightly during operation to cool and lubricate the packing. If the leakage rate is less than the specified amount the packing will overheat, and may damage the impeller shaft. If the leakage rate is considerably more than the specified rate, it may make priming the pump difficult.

PACKING ADJUSTMENT

⚠ WARNING

Stop engine before going under truck to adjust packing or to check packing gland temperature.

1. Operate the pump in VOLUME (parallel) at 150 psi discharge pressure for ten minutes.

⚠ CAUTION

Circulate enough water through the pump to prevent overheating.

2. Observe leakage. Normal leakage is 10–120 drops per minute.
3. If leakage rate is considerably higher, stop engine and tighten packing gland nuts one flat.

⚠ CAUTION

Tighten each packing gland nut the same amount to prevent the packing gland from cocking. DO NOT turn nuts more than one flat (1/6th turn) at a time.

4. Operate the pump at 150 psi discharge pressure for two minutes to let packing run in, then observe leakage.
5. Stop engine and feel packing gland. If glands are hot, allow them to cool before continuing. Repeat step 4 until glands remain cool.
6. Repeat steps 3 and 4 until leakage rate is acceptable.
7. If leakage rate or gland temperature cannot be controlled by adjusting the packing, refer to separate packing replacement instructions for adding or replacing packing.

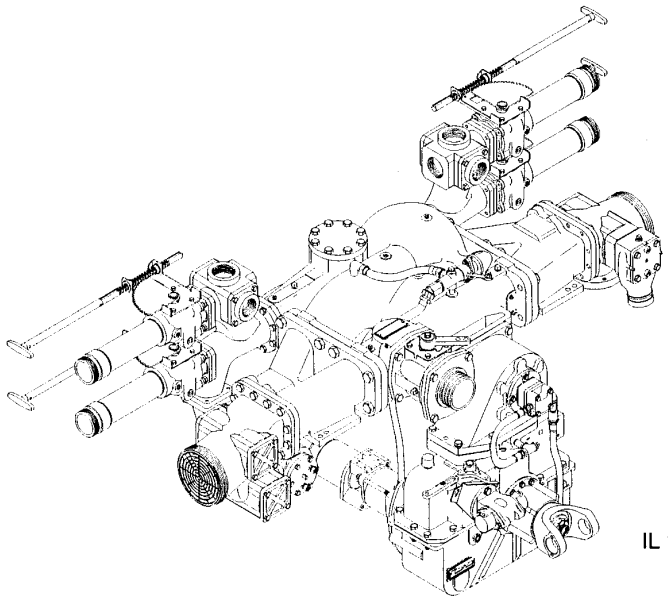
   NOTE: After adjusting packing, the pump must pass the vacuum test. (Refer to Form No. 1031, Section 1000.)

WATEROUS

Overhaul Instructions

Form No.	Section	Issue Date	Rev. Date
F-1031	4211	06/30/95	12/18/98

Overhaul Instructions for CS/CSU Series Centrifugal Fire Pumps



IL 1739

Waterous Company Since 1886
Subsidiary of American Cast Iron Pipe Company

Printed in U.S.A.

General Overhaul Information

Tools and Equipment

The following tools and equipment may be needed to overhaul a pump:

1. Usual automotive mechanic's hand tools.
2. An arbor press for assembling or disassembling components.
3. An engine lathe for turning impeller hubs.
4. A suitable hoist and slings.

While no special tools and equipment are required, a few special items are illustrated or described so the mechanic can make them or they are available from the apparatus manufacturer or the Waterous Company. These special items are not absolutely necessary, but they will make the mechanic's work much easier.

Preliminary Testing

Before disassembling a pump, test it thoroughly, if possible, and record the results. A comparison of this test with periodic tests recommended in form F–1031, Section 1000 can often reveal specific pump troubles. Excessive speed, for instance, indicates that impellers and/or wear rings are probably worn.

Cleaning

The continued satisfactory operation of a pump depends to a great extent upon the cleanliness of its internal parts. Sand, dirt or other abrasive material will wear gears and related parts. Before disassembling a pump for repairs, be sure to clean its exterior. Make sure the working space, benches and tools are clean. Use only clean, lint–free cloths to wipe off components. Before reassembling a pump or its components, be sure to clean them thoroughly.

Pump Bodies and Impellers

Flush out these components and related parts with clean water. Use a stiff brush to remove loose scale, caked sediment, etc. Be sure to remove all traces of old gaskets. Examine pump bodies, covers, adapters and fittings for cracks, severe corrosion or other damage. Almost all damage to these parts results from improper use or maintenance, or from freezing. Replace defective parts.

Bearings, Gaskets, Seals and O–rings

Parts of this nature are frequently damaged during removal or disassembly. In addition, they sometimes deteriorate or lose their effectiveness because of age or misuse. Replacing these parts whenever overhauling a pump is a good policy.

Impeller Shafts

Examine shaft for severe scratches, grooves or corrosion – especially under packing or mechanical seals. If scratches are not severe, and are not under packing and seals, clean them with a fine–cut file. Grooves are usually permissible if they are not sharp or too deep. Even slight longitudinal scratches will cause leaks and should be removed.

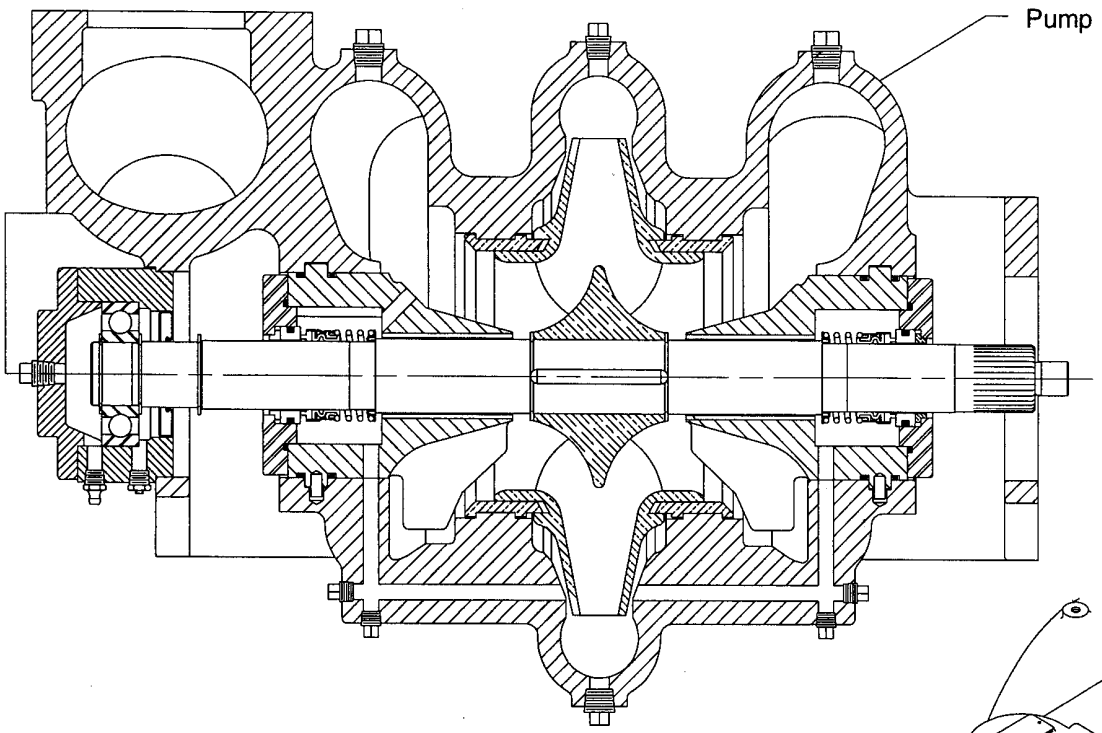
Installing Ball Bearings

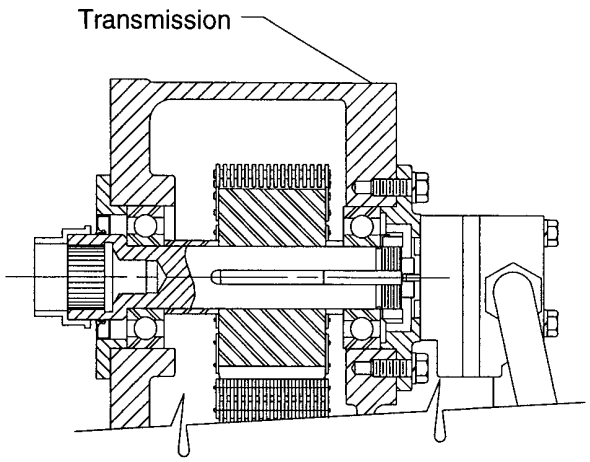
Most Waterous pumps are designed so that ball bearings fit tightly on their shafts and have relatively loose fits in the bearing housings. When mounting these bearings on shafts, always apply force to the inner races. When bearings have a tight fit in the housings, and a heavy force is necessary to install them, be sure to apply force only to the outer bearing races. For either type of fit, applying force to the wrong bearing race may damage the balls and race.

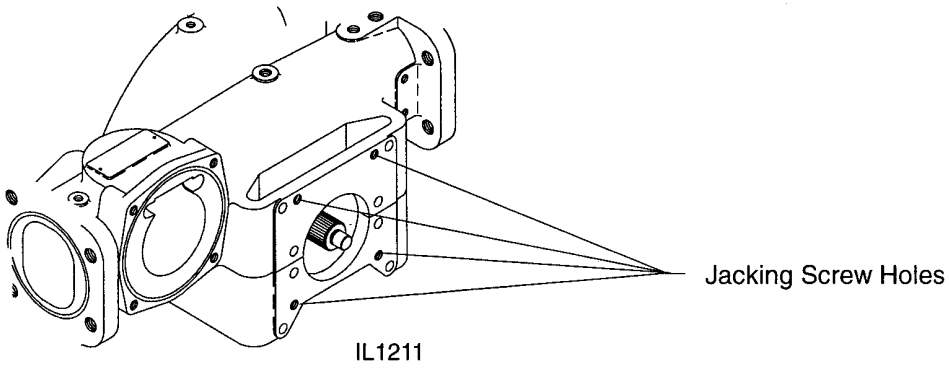
Installing Body Gaskets

To provide added sealing for gaskets between bodies and intake adapters, coat both sides of these gaskets with a suitable sealant. A compound such as Permatex Super 300 is recommended for this application. Be sure all traces of previous gaskets and sealant are removed before installing new gaskets.

Transmission Removal / Installation





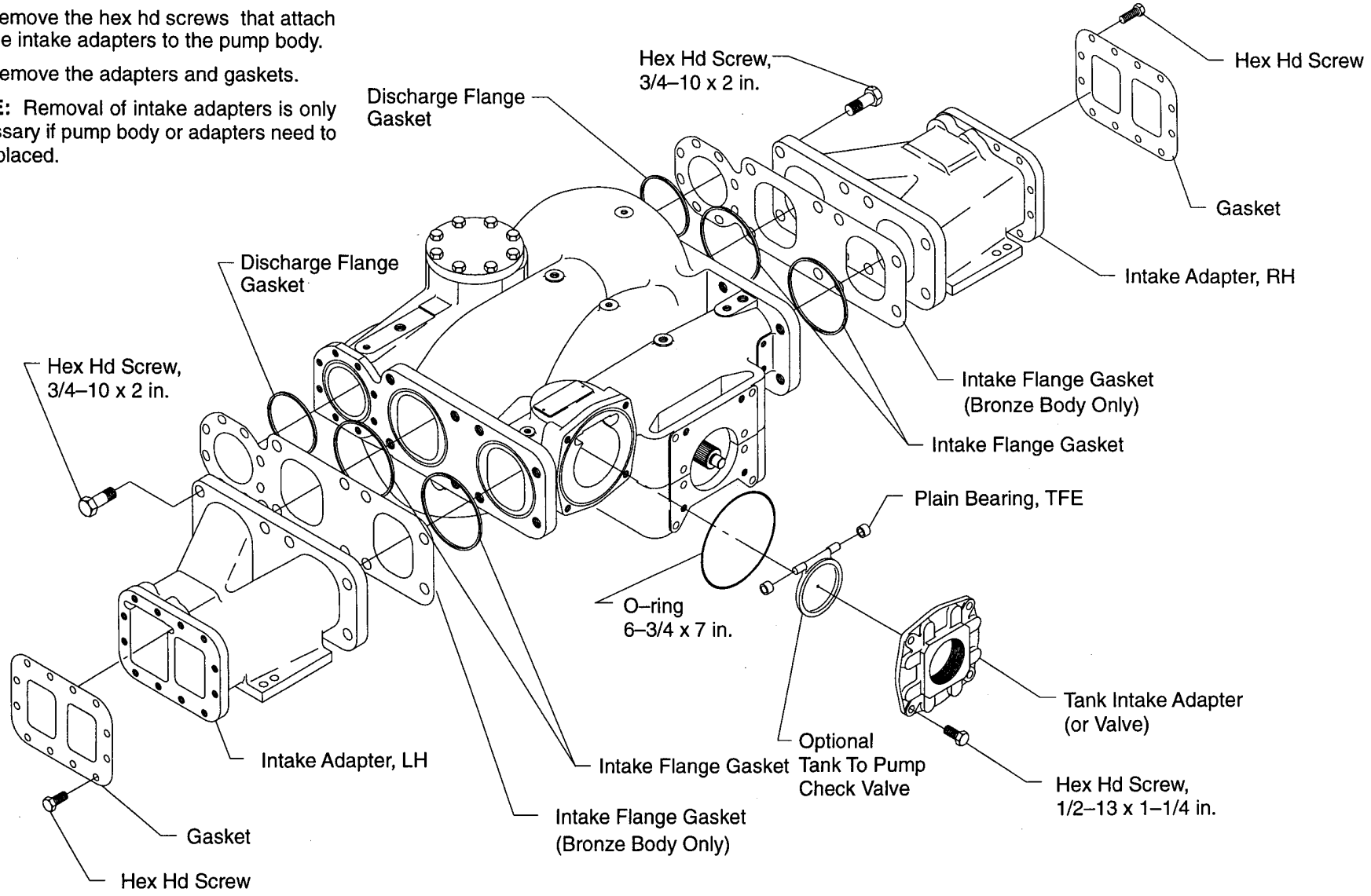


1. Remove the four cap screws and lock washers that attach the transmission to the pump.
2. Use the jacking screw holes to separate the transmission from the pump body.
3. Pull transmission straight back from pump.

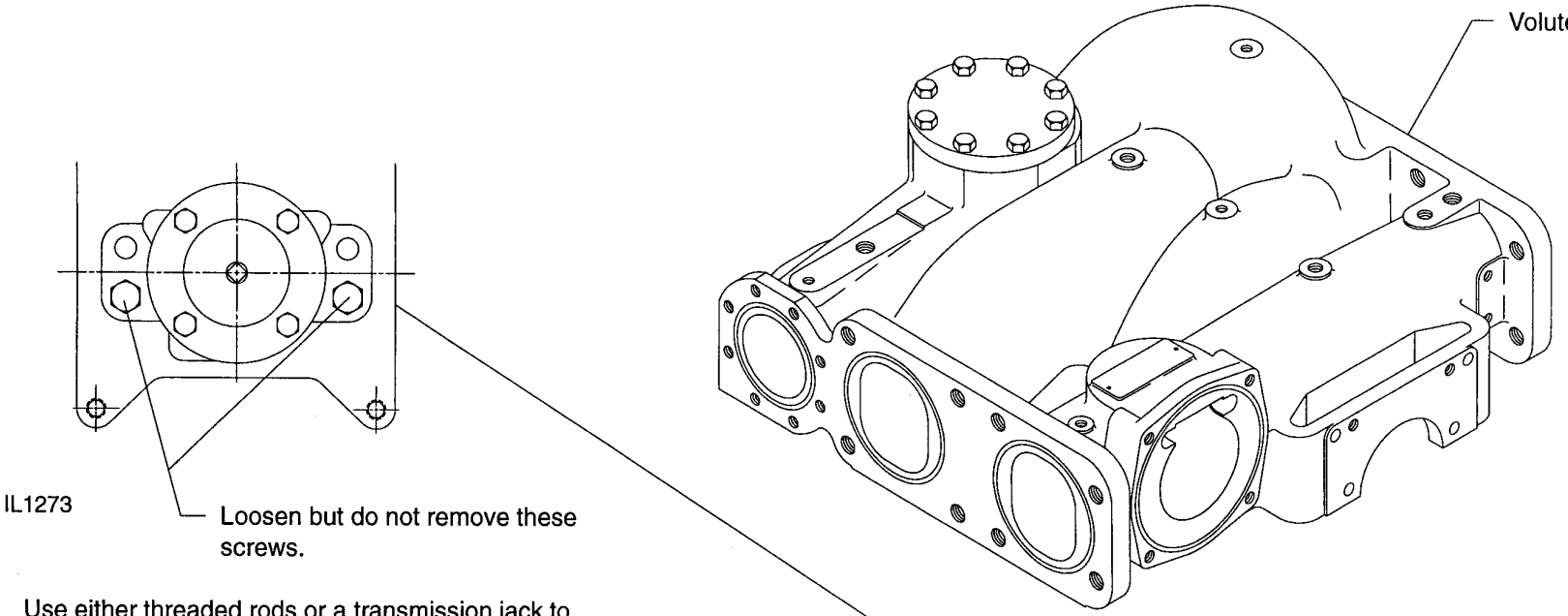
Intake Adapter Removal / Installation

1. Remove the hex hd screws that attach the intake adapters to the pump body.
2. Remove the adapters and gaskets.

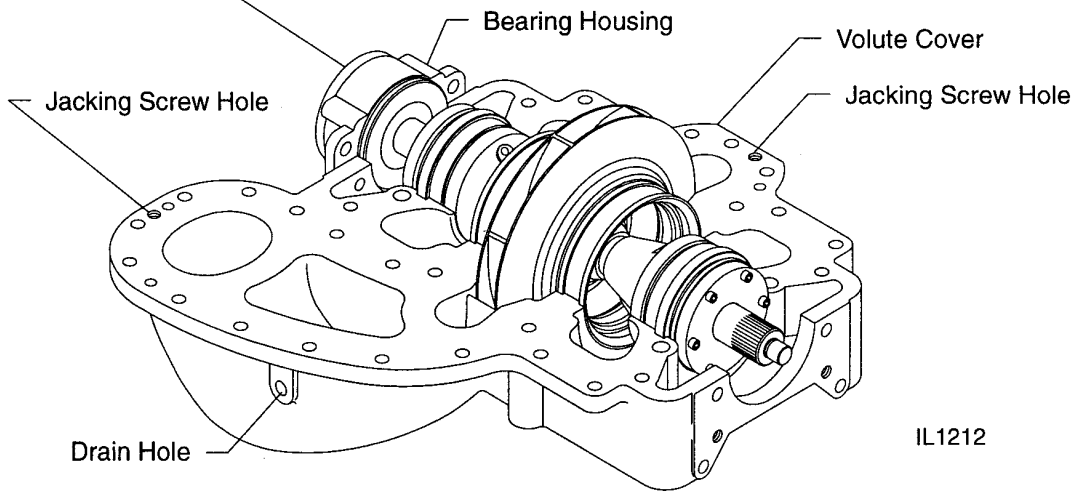
NOTE: Removal of intake adapters is only necessary if pump body or adapters need to be replaced.



Removal of Impeller Shaft Assembly



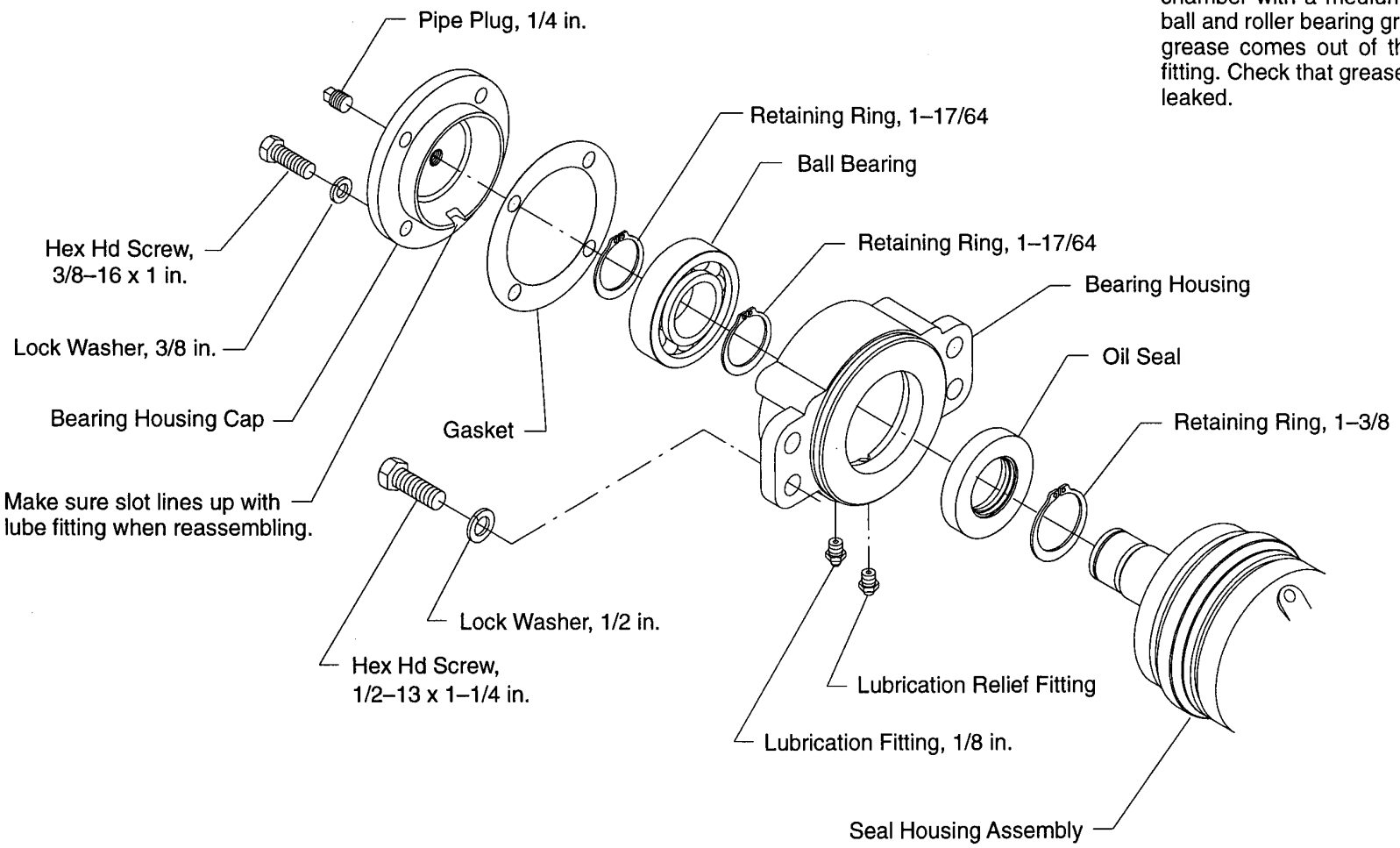
1. Use either threaded rods or a transmission jack to lower the cover from the body.
2. Remove the two screws that attach the bearing housing to the volute body (upper half).
3. Loosen but do not remove the two screws that attach the bearing housing to the volute cover (lower half). The impeller shaft assembly will remain in the volute cover.
4. Remove the screws that attach the volute cover to the volute body and separate the body and cover using the tapped holes.
5. Remove gasket material from the two pump halves.



Outboard Bearing Removal / Installation

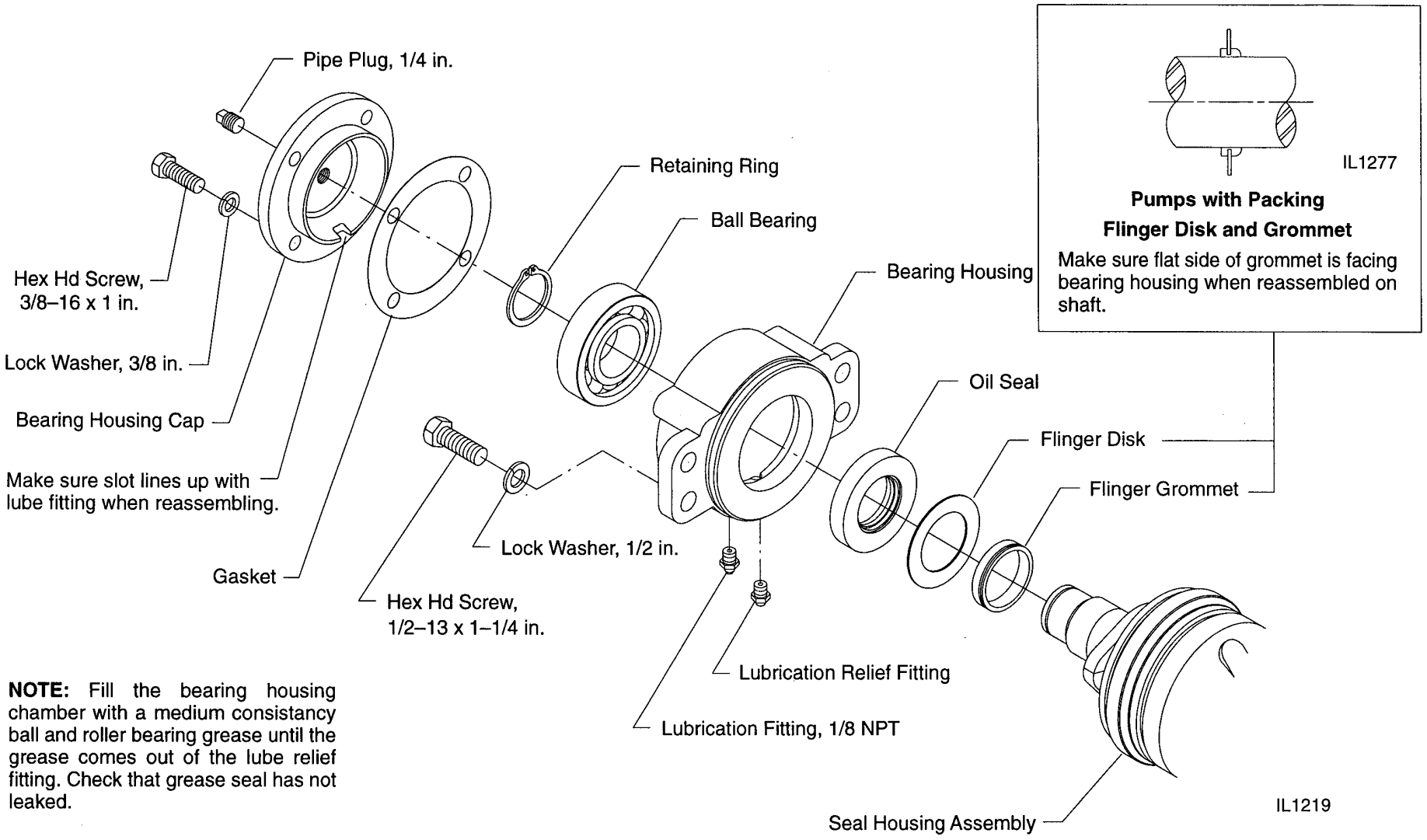
(Transmission Mounted Pumps with Mechanical Seals or
Direct Drive Pumps without Tachometer with Mechanical Seals)

NOTE: Fill the bearing housing chamber with a medium consistancy ball and roller bearing grease until the grease comes out of the lube relief fitting. Check that grease seal has not leaked.



Outboard Bearing Removal / Installation

(Transmission Mounted Pumps with Packing or
Direct Drive Pumps without Tachometer with Packing)



IL1277

Pumps with Packing

Flinger Disk and Grommet

Make sure flat side of grommet is facing bearing housing when reassembled on shaft.

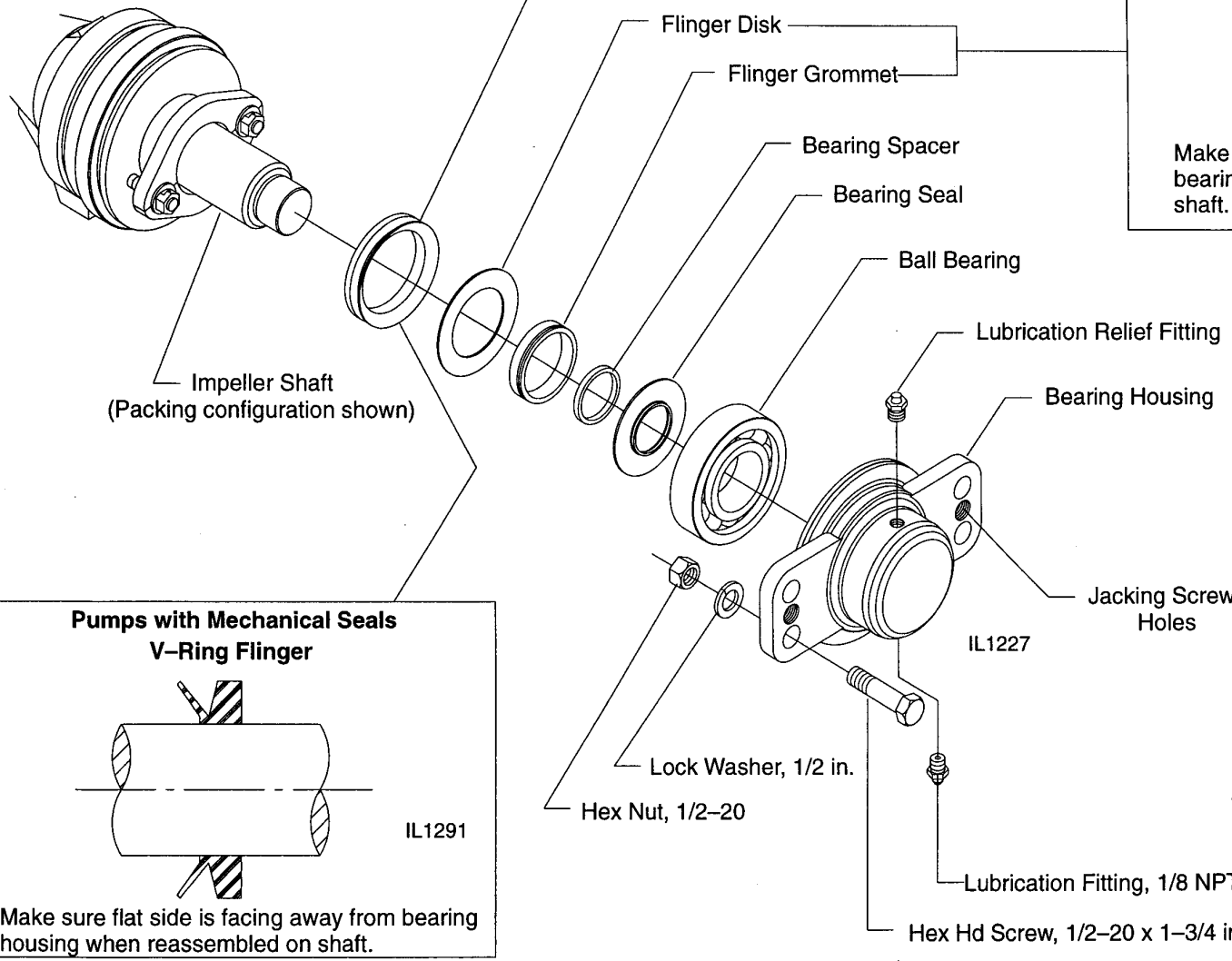
NOTE: Fill the bearing housing chamber with a medium consistancy ball and roller bearing grease until the grease comes out of the lube relief fitting. Check that grease seal has not leaked.

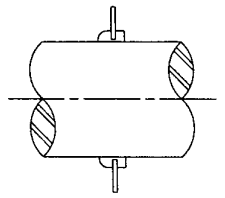
F–1031, Section 4211

Rev: 12/18/98

Outboard Bearing Removal / Installation

(Direct Drive Pumps – Front Drive with Tachometer)





Pumps with Packing
Flinger Disk and Grommet

Make sure flat side of grommet is facing bearing housing when reassembled on shaft.

Pumps with Mechanical Seals
V–Ring Flinger

Make sure flat side is facing away from bearing housing when reassembled on shaft.

NOTE: Fill the bearing housing chamber with a medium consistancy ball and roller bearing grease until the grease comes out of the lube relief fitting. Check that grease seal has not leaked.

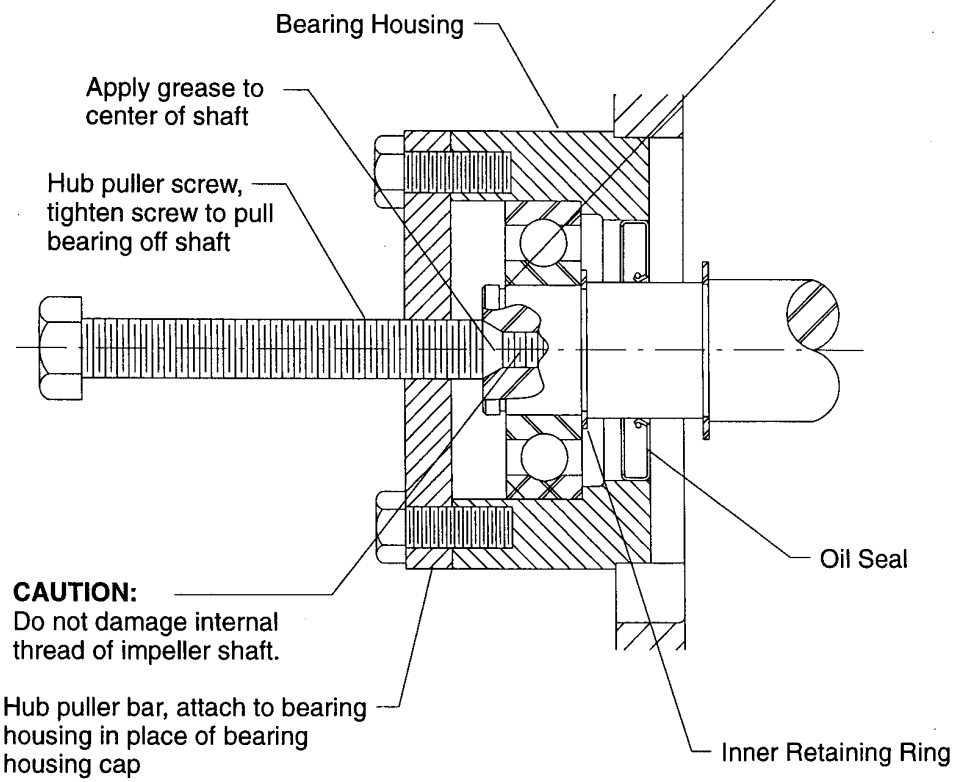
F–1031, Section 4211

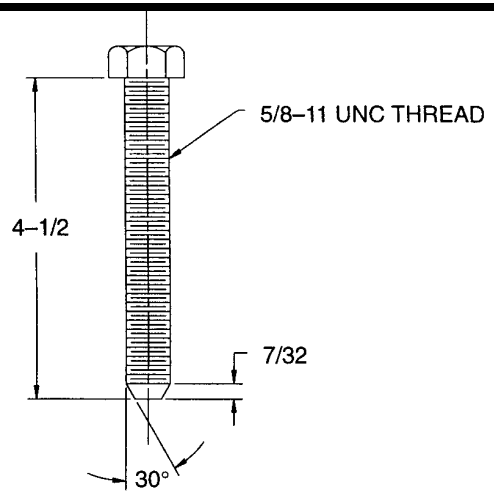
Rev: 12/18/98

Outboard Bearing Removal

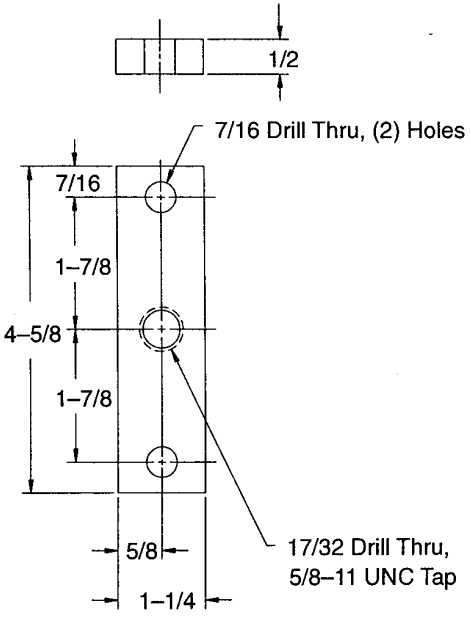
(When pump is not disassembled)

CAUTION: Remove outer retaining ring before installing puller.





Hub Puller Screw – P/N 52305

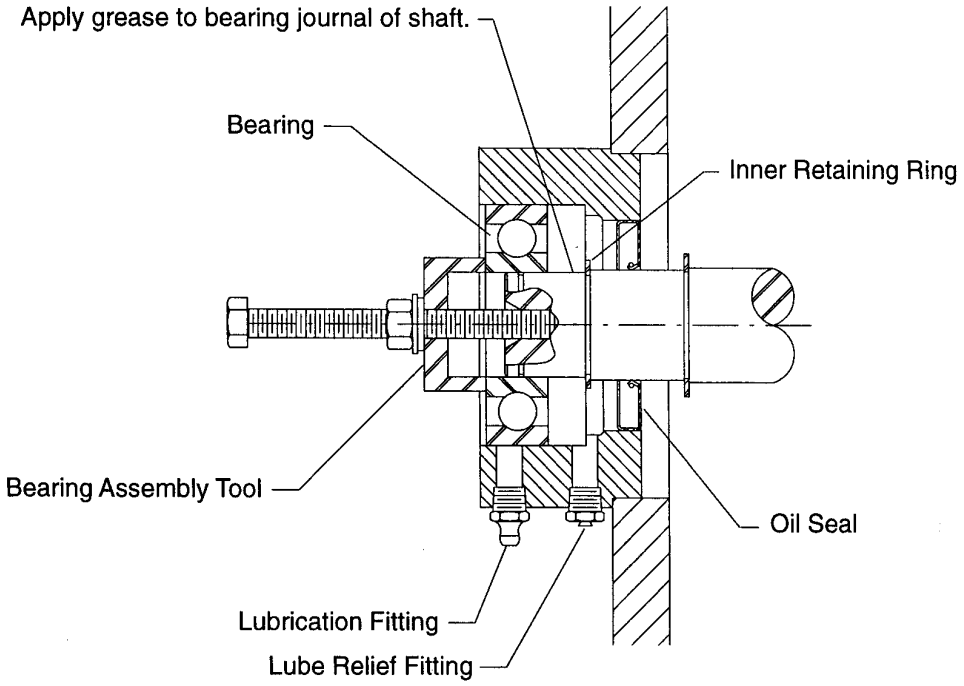


Hub Puller Bar – P/N 52279

IL

Outboard Bearing Installation

(When pump is not disassembled)



1. Install new grease seal in bearing housing and reinstall bearing housing on pump.
2. Install inner bearing retaining ring.
3. Use bearing installation tool and screw, threaded into end of the impeller shaft, to push the outboard bearing onto the impeller shaft.
4. Remove the bearing installation tool and screw.
5. Install the bearing outer retaining ring.
6. Install the bearing housing cap and gasket.

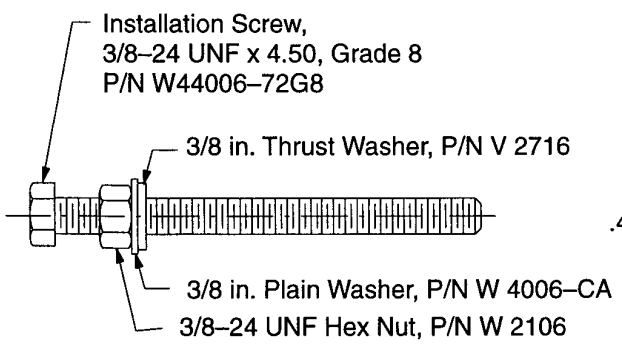
CAUTION

Make sure slot on cap lines up with grease fitting.

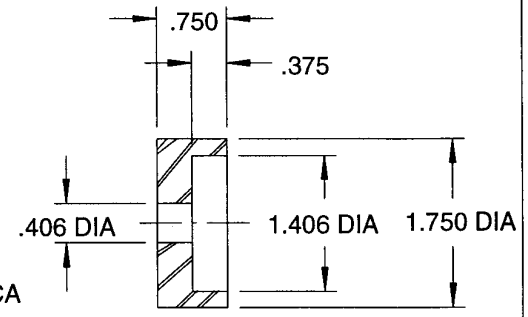
7. Fill the bearing housing chamber with a medium consistancy ball and roller bearing grease until the grease comes out of the lube relief fitting. Check that grease seal has not leaked.

CAUTION

To prevent oil seal from pushing out of housing, do not use power grease gun.

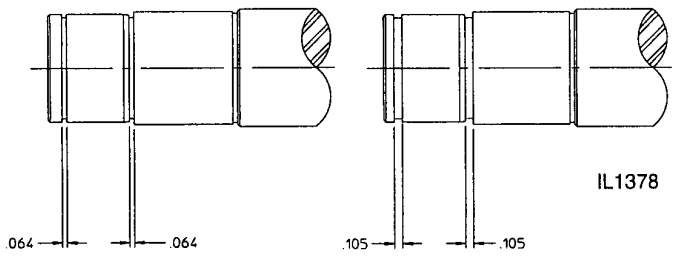


IL1284



P/N 52354

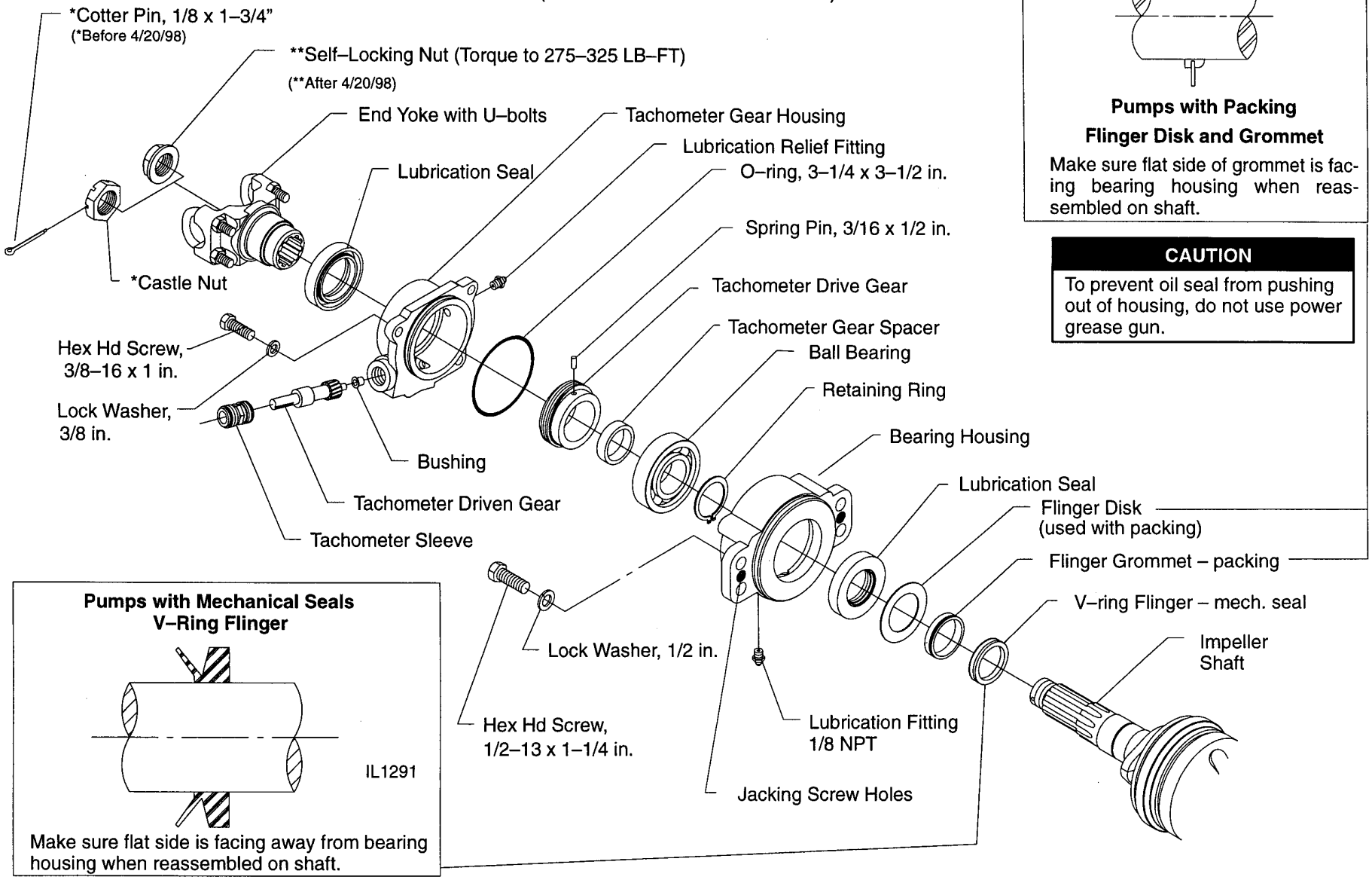
NOTE: Two sets of retaining rings (inner bearing and outer bearing) may have been furnished with your repair kit. Measure the grooves on the impeller shaft to select the retaining rings to install on the shaft.



Use retaining rings W4510–137. Use retaining rings W4520–137.

End Yoke Removal/Installation on Drive End

(Front Drive with Tachometer)



Pumps with Packing Flinger Disk and Grommet

Make sure flat side of grommet is facing bearing housing when reassembled on shaft.

CAUTION

To prevent oil seal from pushing out of housing, do not use power grease gun.

Pumps with Mechanical Seals V–Ring Flinger

IL1291

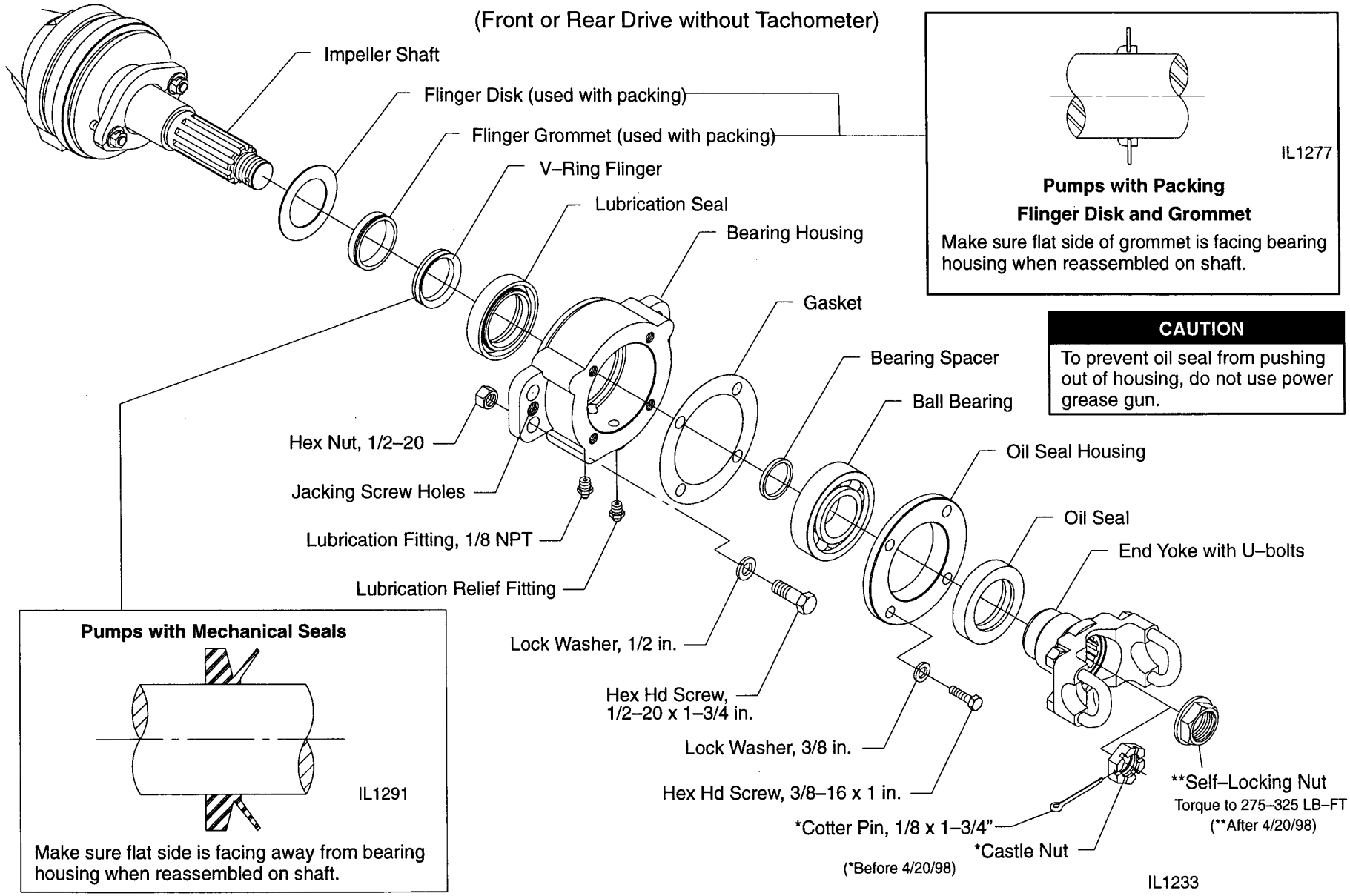
Make sure flat side is facing away from bearing housing when reassembled on shaft.

F–1031, Section 4211

Rev: 12/18/98

End Yoke Removal / Installation on Drive End

(Front or Rear Drive without Tachometer)



IL1277

Pumps with Packing

Flinger Disk and Grommet

Make sure flat side of grommet is facing bearing housing when reassembled on shaft.

CAUTION

To prevent oil seal from pushing out of housing, do not use power grease gun.

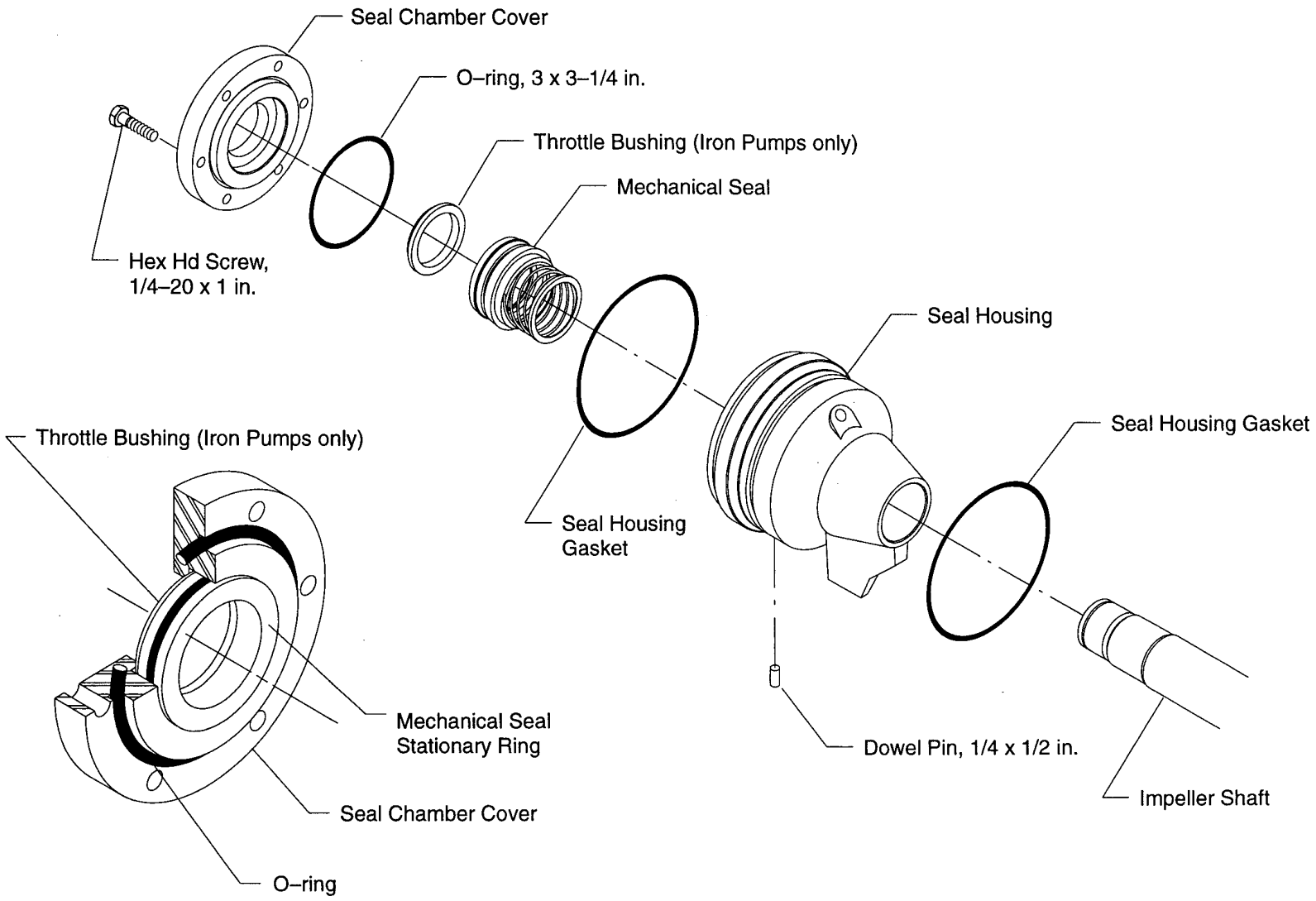
Pumps with Mechanical Seals

IL1291

Make sure flat side is facing away from bearing housing when reassembled on shaft.

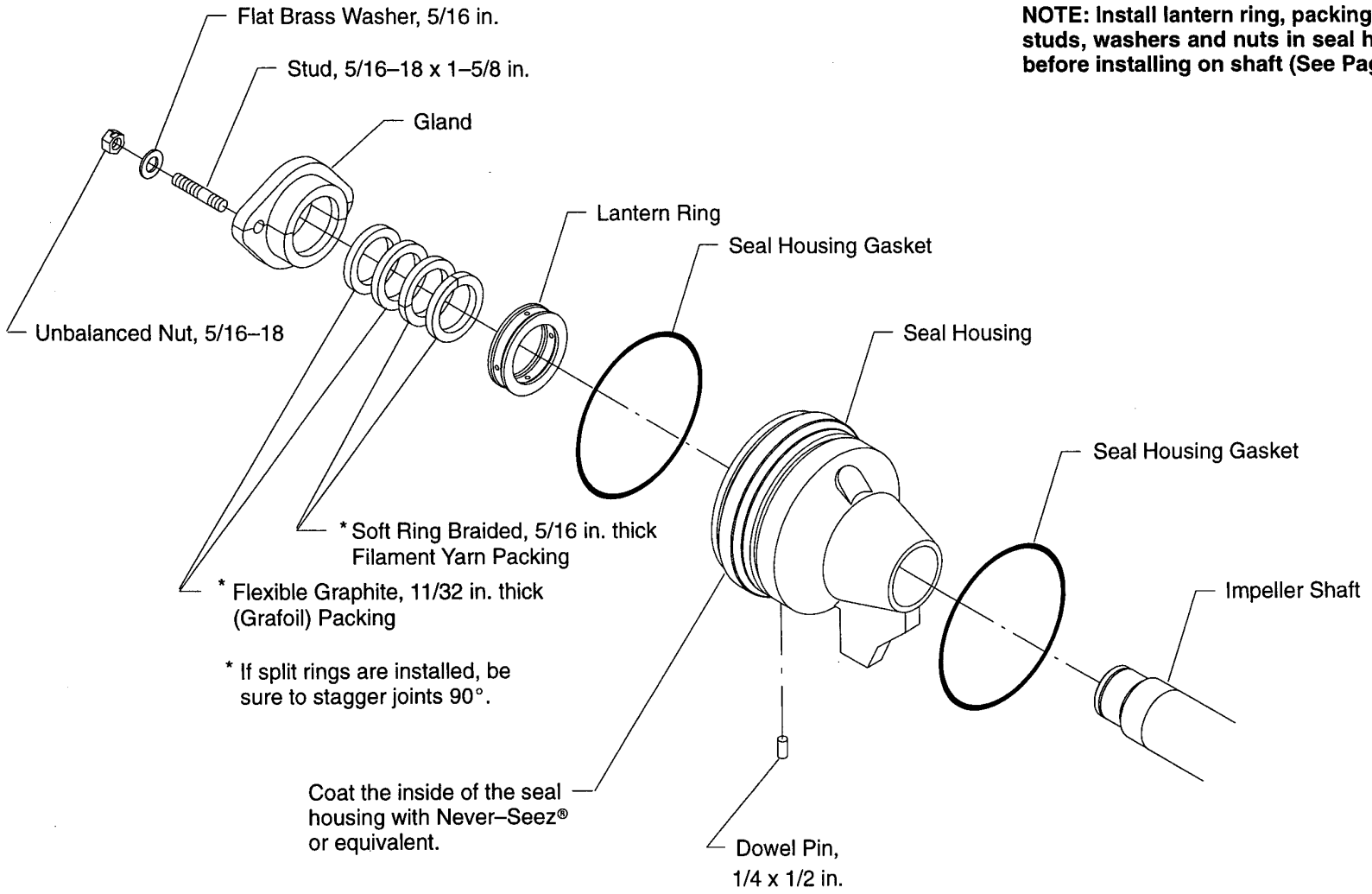
Seal Housing Removal / Installation

(Pumps with Mechanical Seals)



Seal Housing Removal / Installation

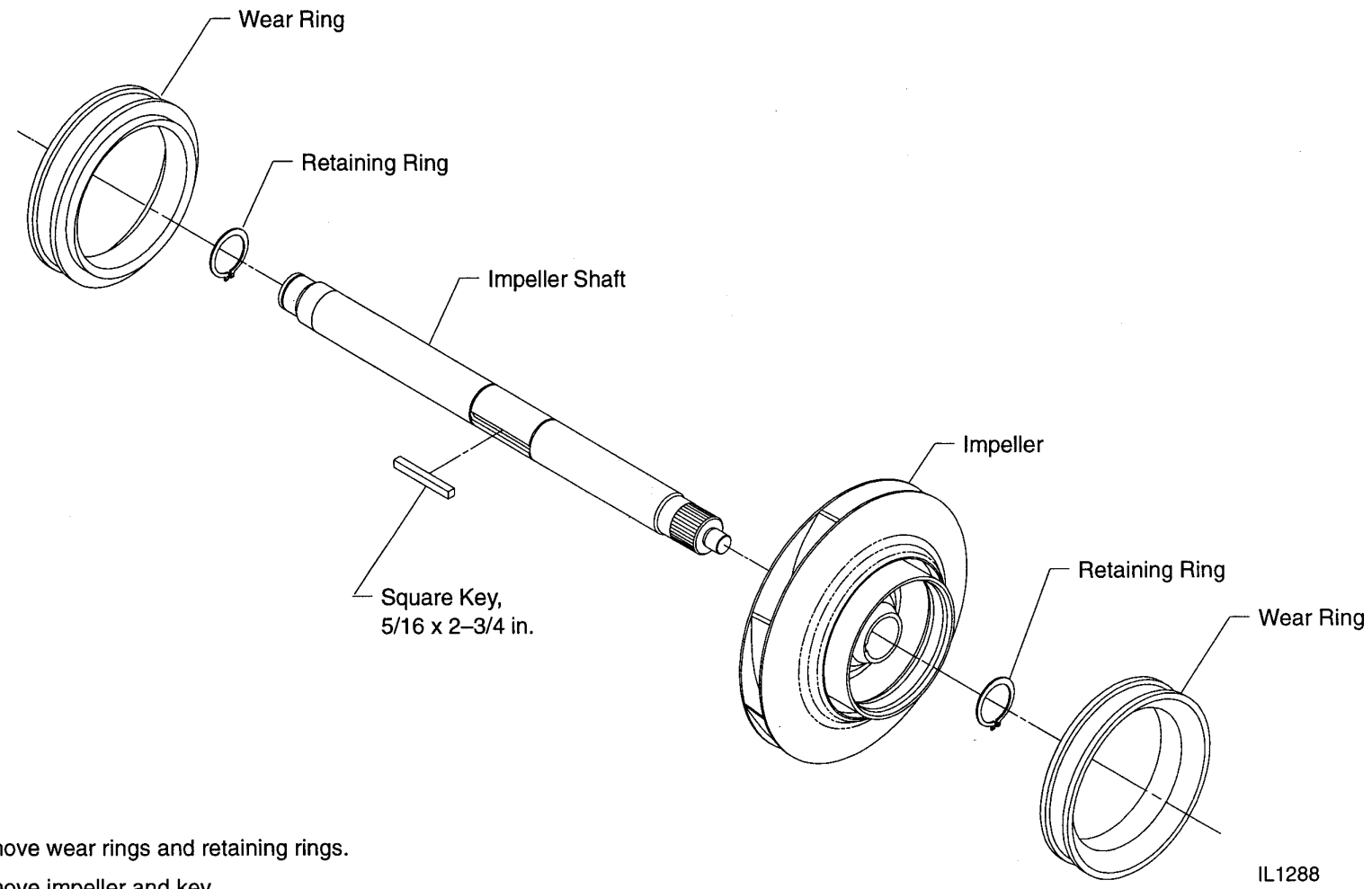
(Pumps with Packing)



NOTE: Install lantern ring, packing, gland, studs, washers and nuts in seal housing before installing on shaft (See Page 31).

IL1220

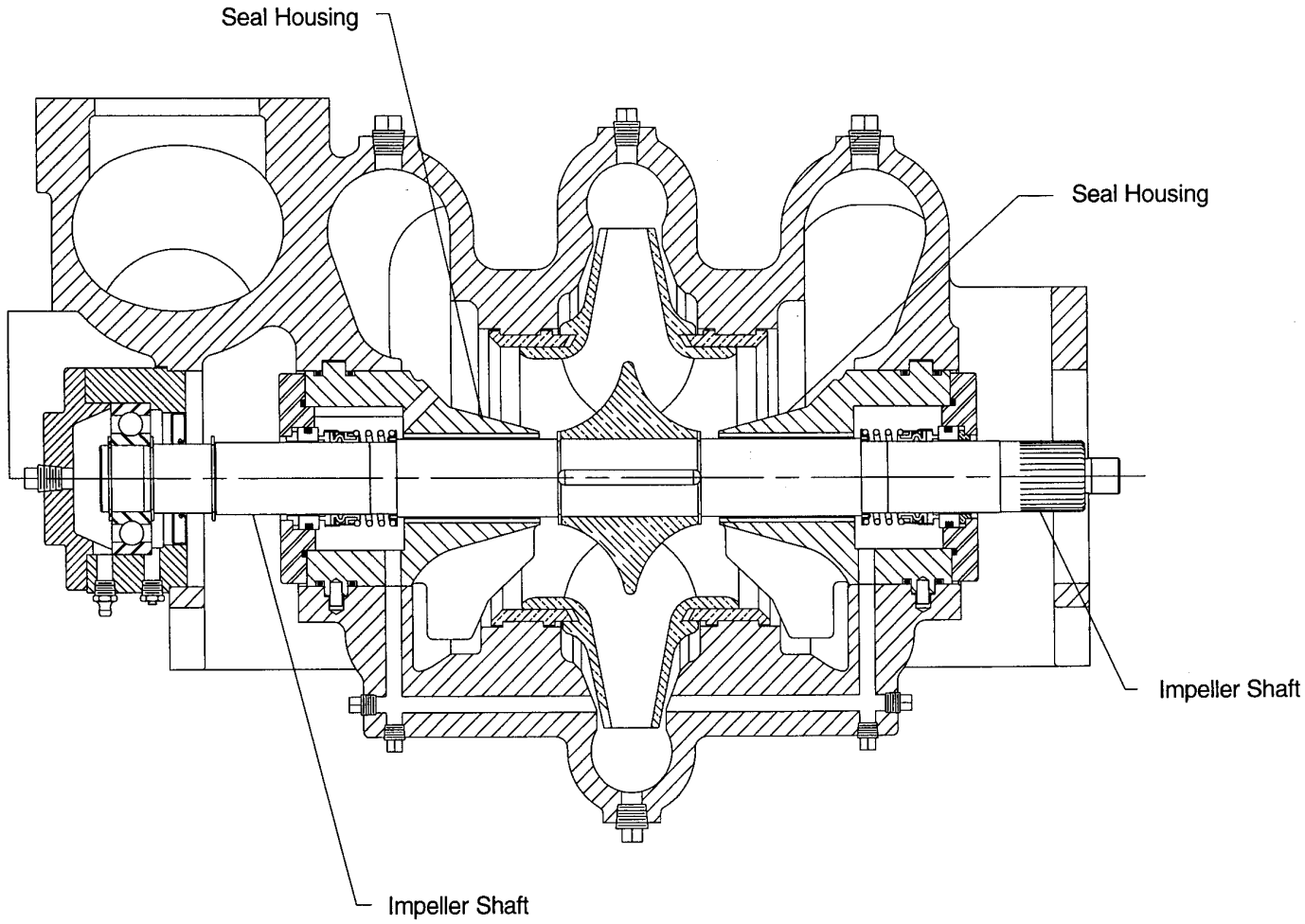
Impeller Removal



1. Remove wear rings and retaining rings.
2. Remove impeller and key.

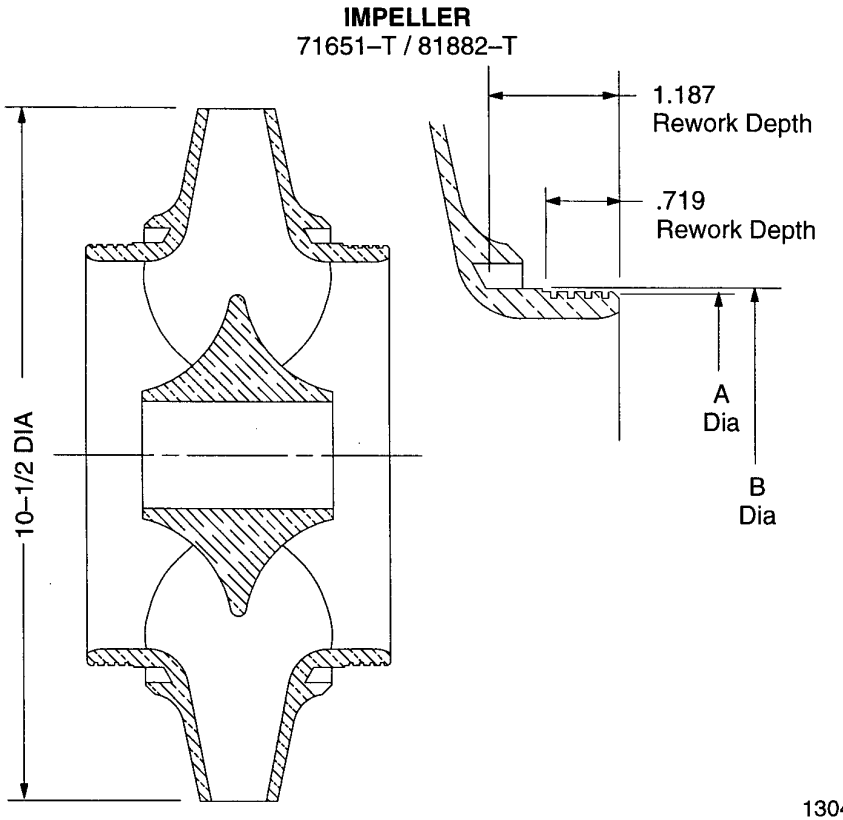
Seal Housing Check

Seal Housing – If the total clearance between the seal housing and the impeller shaft is greater than 0.020 in., the seal housing should be replaced. Check both seal housings.



Installing Undersize Wear Rings

1. Check wear rings and impeller hubs for deep grooves or scratches.
2. If inspections shows that the wear ring clearances are excessive (diametral clearance in excess of .025 inches), or if the impeller hubs are scored or grooved, use the dimensions in the tables to rework the hubs.
3. The diametral clearance is determined by averaging the results of four measurements taken at 90° increments as follows:
   a. Clean and remove small burrs and other protrusions from the wear ring inner diameters and the impeller hubs.
   b. Position each wear ring on the impeller hub on which it was used.
   c. Hold the wear ring firmly against one side of the hub and measure total clearance on the opposite side using a feeler gauge.
4. Flame plated impeller hub wear ring clearance is usually restored by installing a replacement wear ring with the same dimensions as the original wear ring since most wear occurs on the wear ring, not the impeller hub. Flame plated impellers are the numbers with the "T" suffix.
5. Non–plated impeller hub wear ring clearance is restored by turning impeller hubs and installing undersize wear rings.
6. Wear rings are available 0.025, 0.050 or 0.075 inches undersize. The tables give the original hub dimension for each impeller and the rework dimensions for each degree of undersize.



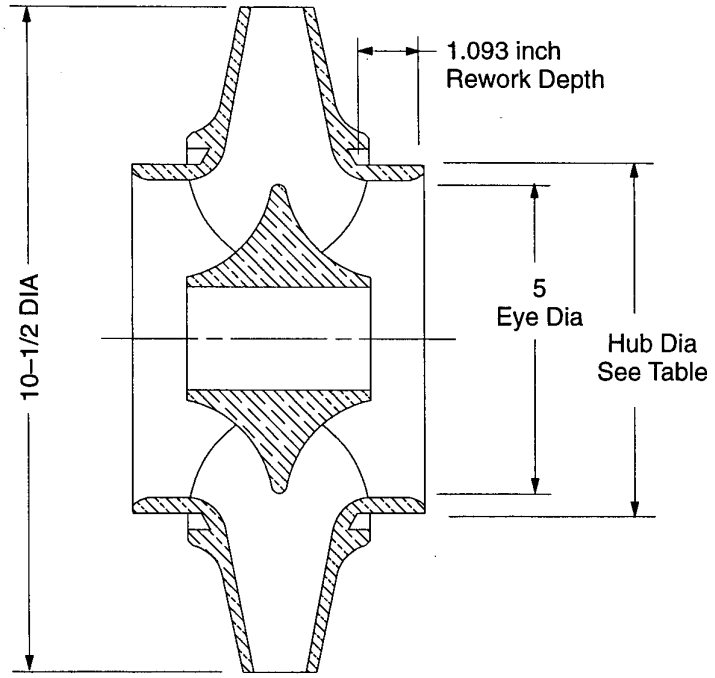
1304

Original Hub Dia	Original Wear Ring No.	Reworked Hub Dia A	Reworked Hub Dia B	New Wear Ring No.
A – 6.370 (Min)	72474	6.350/6.348	6.407/6.405	72474–25
B – 6.426 (Min)		6.325/6.323	6.382/6.380	72474–50
		6.300/6.298	6.357/6.355	72474–75

Installing Undersize Wear Rings

(Continued)

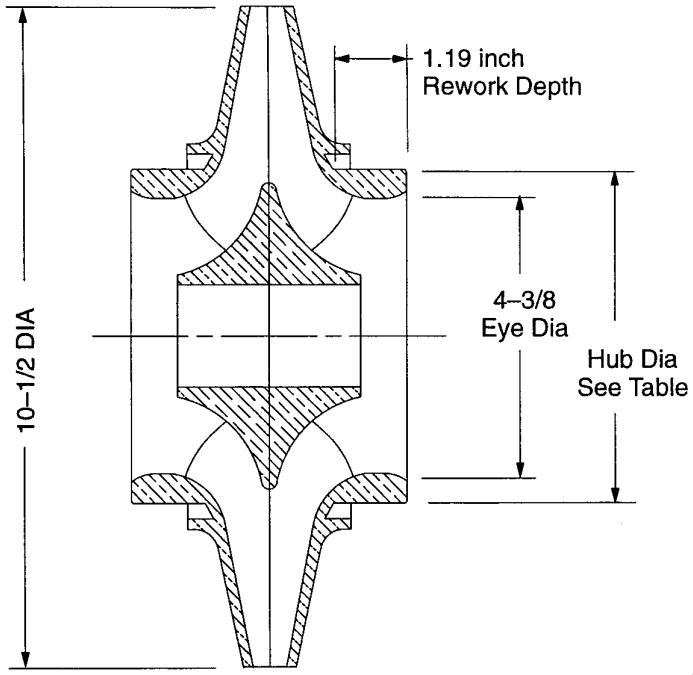
IMPELLER
71799 or 71799–T



1303

Original Hub Dia	Original Wear Ring No.	Reworked Hub Dia	New Wear Ring No.
Non–plated 5.498 (Min)	72409	5.476/5.473	72409–25
		5.451/5.448	72409–50
Flame Plated 5.494 (Min)		5.426/5.423	72409–75

IMPELLERS
81357 or 81357–T

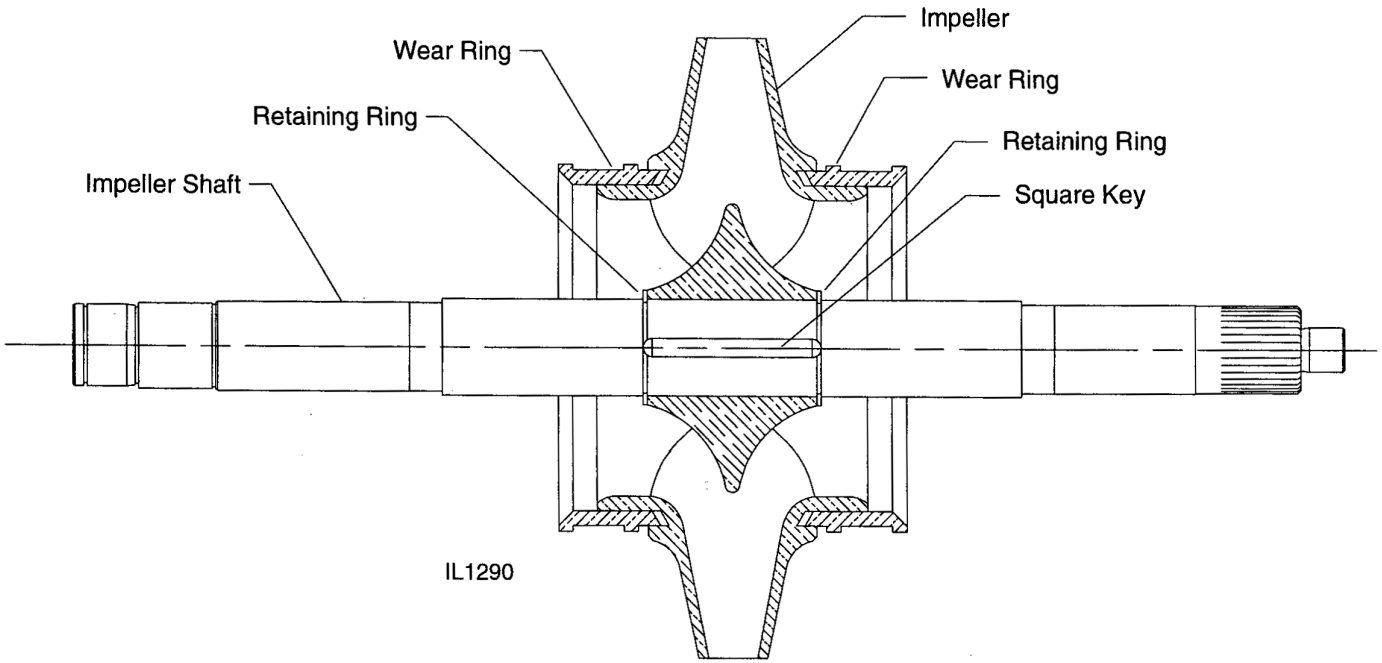


1305

Original Hub Dia	Original Wear Ring No.	Reworked Hub Dia	New Wear Ring No.
Non–plated 5.311 (Min)	72430	5.288/5.286	72430–25
		5.263/5.261	72430–50
Flame Plated 5.307 (Min)		5.238/5.236	72430–75

SERVICE MANUAL

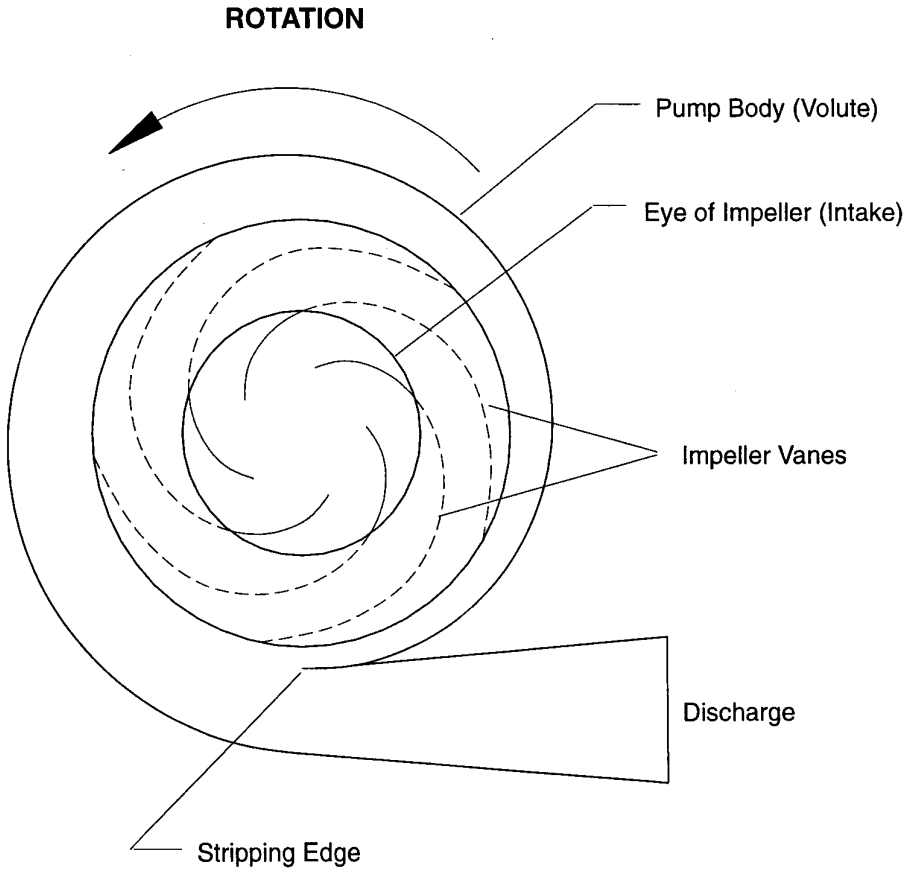
Impeller / Wear Ring Installation



1. Install impeller and square key on shaft. Make sure the position of the impeller is not reversed. See Page 22 for impeller rotation.
2. Install retaining rings
3. Install wear rings.

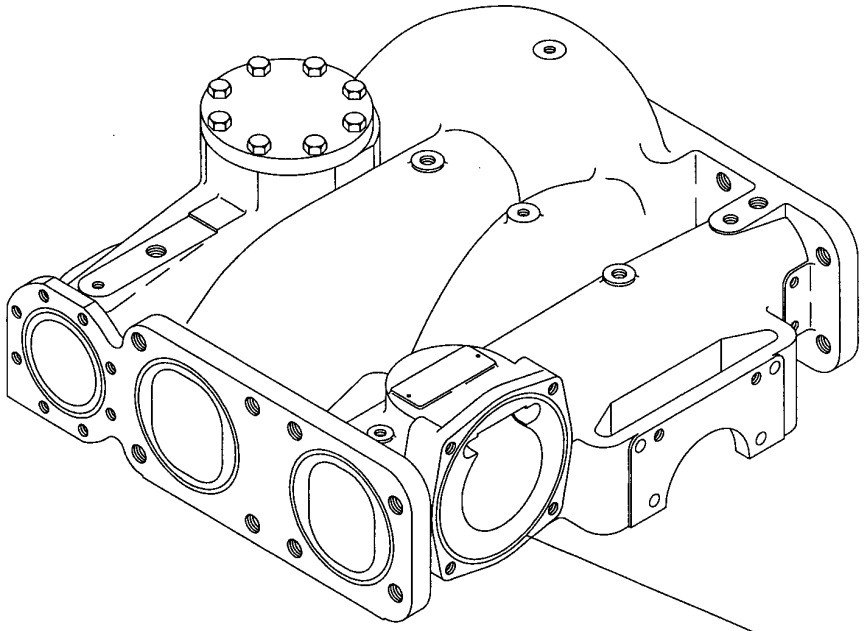
Impeller / Wear Ring Installation

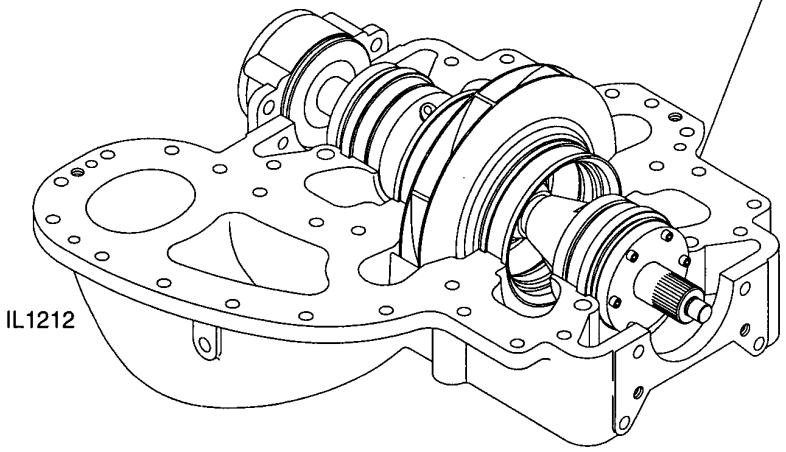
(Continued)



IL1150

Installing Impeller Shaft Assembly into Pump



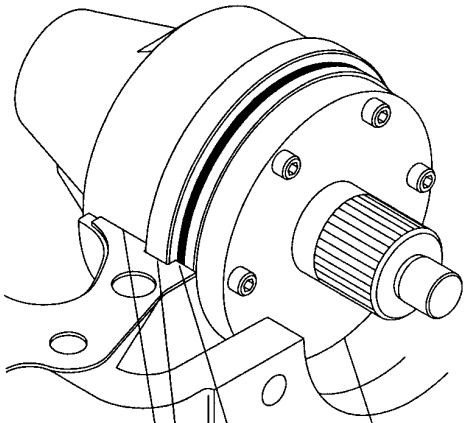


IL1212

Clean body grooves and bores thoroughly.

Coat seal housings and areas of the body and cover where seal housings are located with Never–Seez or equivalent.

NOTE: After reassembling pump, performance test per NFPA 1911, before the truck is placed back in service.



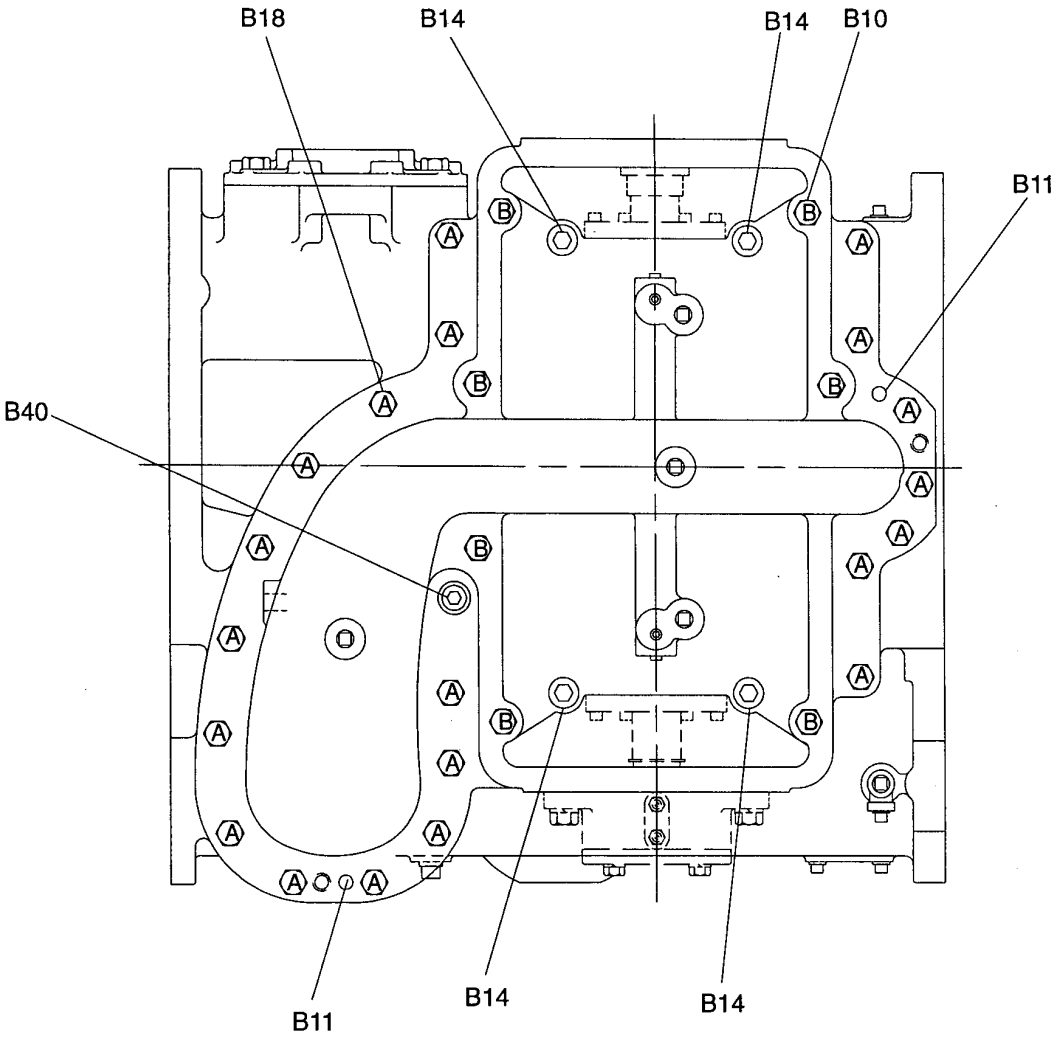
IL1274

Make sure dowel pin is seated in volute cover.

Apply a pea sized drop of 100% silicone RTV sealant at each of the gasket and O–ring intersection locations (4 per seal housing). Apply silicone prior to gasket installation.

Make sure gasket fits tight againt seal housing.

Installing Body Hardware



Ref No.	Description	Qty	Torque
B10	Hex Hd, 1/2–13 x 4–3/4 in.	7	105LB/FT
B11	Dowel Pin, 7/16 x 1–1/4 in.	2	
B14	Socket Hd, 5/8–11 x 3 in.	4	105LB/FT
B18	Hex Hd, 1/2–13 x 1–1/2 in.	20	
B40	Socket Hd, 1/2–13 x 1–1/2 in.	1	

Mechanical Seal Removal

(Without Disassembling the Pump)

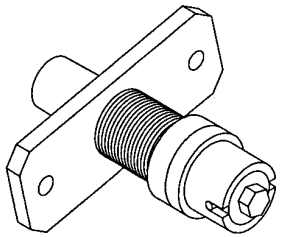
1. Replacing the mechanical seal will be easier when using the special tools designed by Waterous Company. These tools may be purchased from Waterous Company or fabricated by the user.

   K627 *Outboard bearing removal/installation tools*

   K628 *Mechanical seal removal/installation tools*

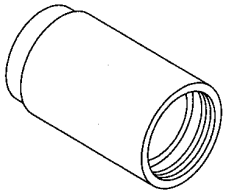
Parts of kit K 628

Mechanical Seal Removal / Installation Tools



REMOVAL TOOL

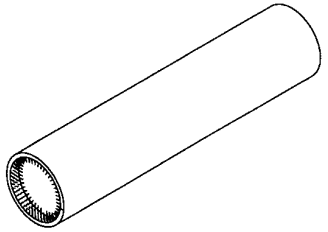
P/N 72385



PROTECTION SLEEVE/INSTALLATION TOOL

P/N 72385

(USE AS A COVER TO PROTECT REMOVAL TOOL THREADS WHEN NOT IN USE)



IMPELLER SHAFT BRUSH

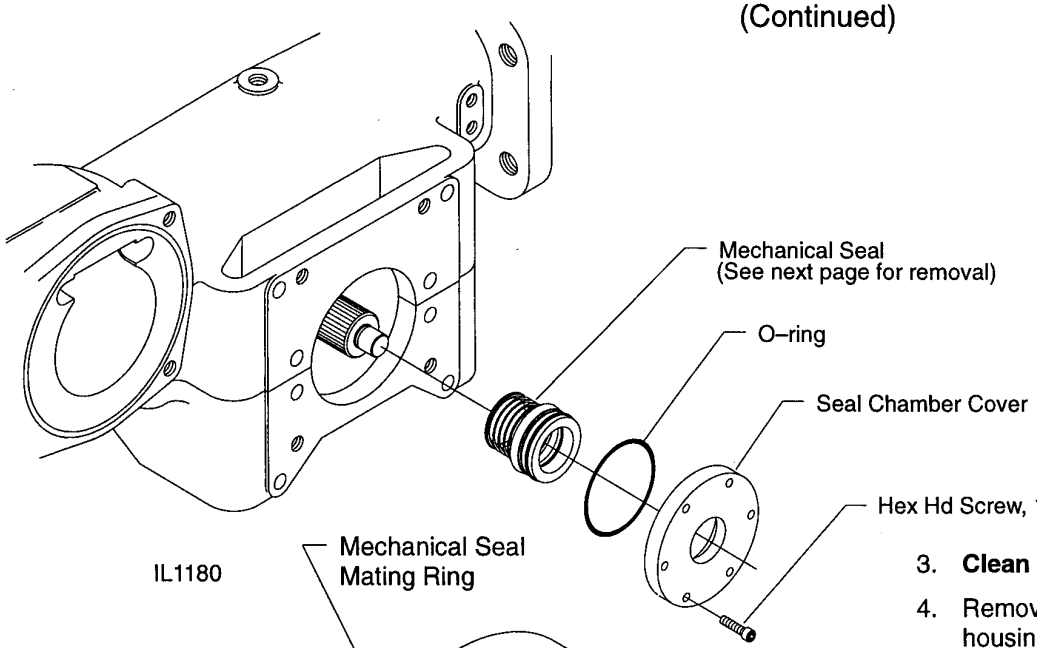
P/N V 2633

2. Whenever a mechanical seal requires replacement, the Waterous Service Department strongly recommends replacing both seals; outboard bearing and drive end. **Note: Always replace the seal on outboard end first.**

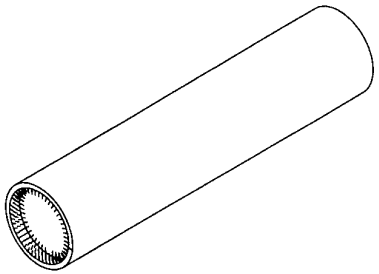
Mechanical Seal Removal

(Without Disassembling the Pump)

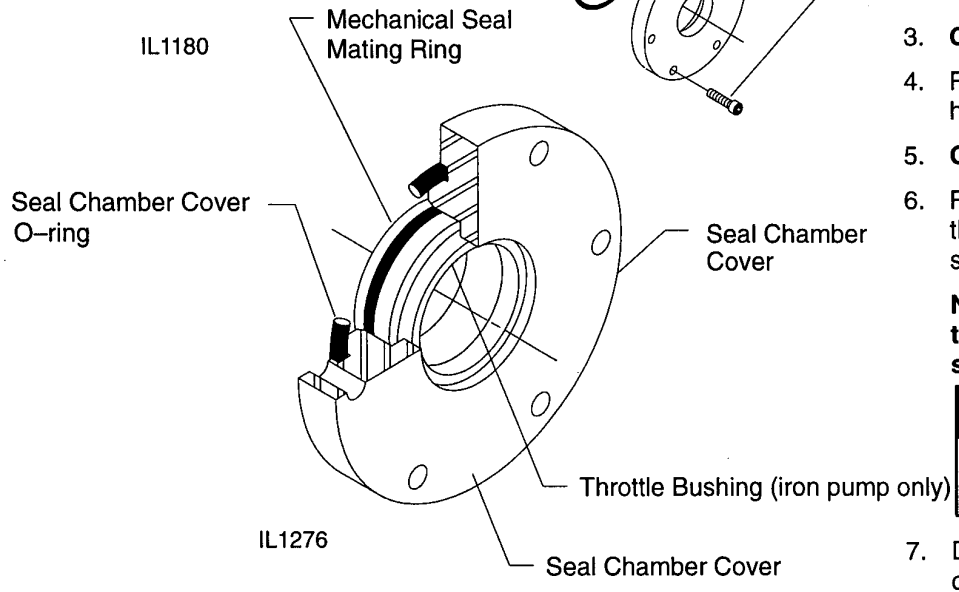
(Continued)



IL1180



Brush (P/N V 2633)



IL1276

3. **Clean the impeller shaft**, using the impeller shaft brush.
4. Remove the six screws that attach the seal chamber cover to the seal housing and remove the cover.
5. **Clean the impeller shaft** again to remove any paint that may remain.
6. Remove the mating ring from the seal chamber cover by clamping the protruding diameter of the mating ring in a vise, then pulling the seal chamber cover away from the vise.

   NOTE: If removal of mating ring is difficult, tap the back of the throttle bushing to force and "pop" the mating ring from the seal chamber (iron pumps only).

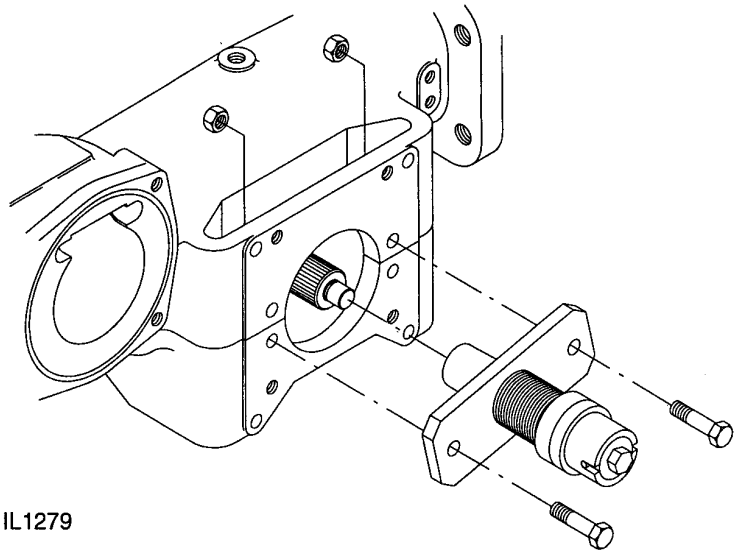
CAUTION
Throttle bushing is brass and can be damaged if hit with excessive force. If throttle bushing is damaged, replace it.

7. Discard the O–ring from seal chamber cover. Clean seal chamber cover.

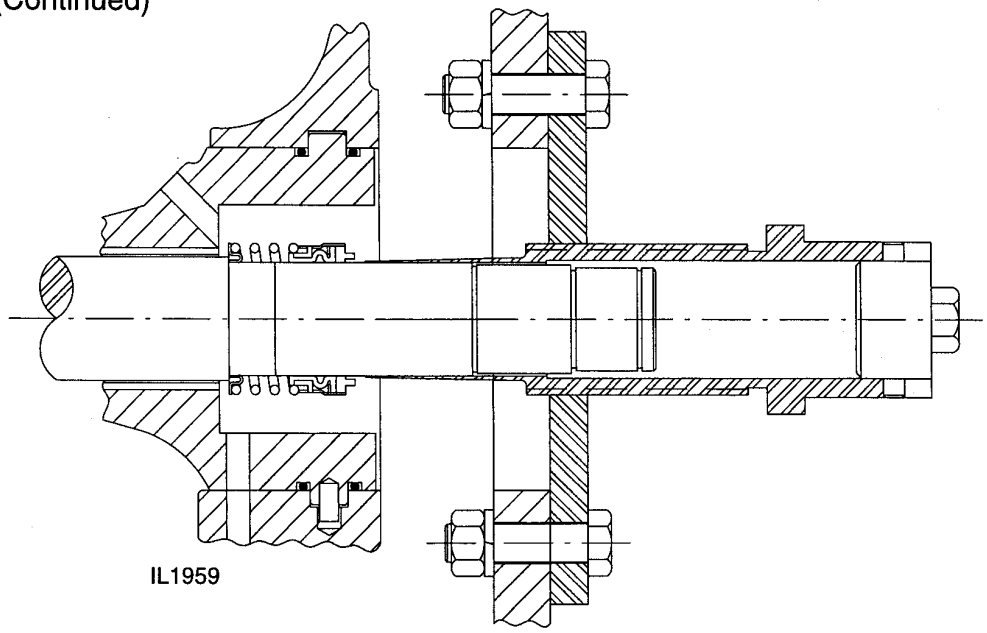
Mechanical Seal Removal

(Without Disassembling the Pump)

(Continued)



IL1279



IL1959

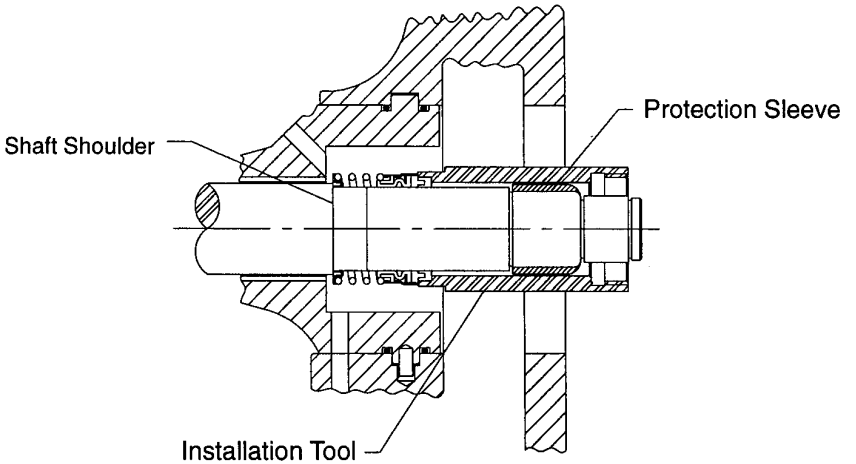
8. Attach the mechanical seal removal tool to the pump body using two of the mounting holes in the body and the screws and nuts from the bearing housing. The plate must be flush with the pump body, but tighten screws hand–tight only.
9. Turn the hex head on the removal tool clockwise until it touches seal, then 1 inch to 1–1/4 inch further (the primary ring in the mechanical seal may break from the force).
10. Turn the hex head on the removal tool counterclockwise to remove the seal.
11. Remove the tool and the seal.
12. Remove spring retainer and spring if they do not come out with the seal. Clean seal chamber and impeller shaft.
13. Clean the sealing surface behind the seal chamber cover on the seal housing.

Mechanical Seal Installation

CAUTION

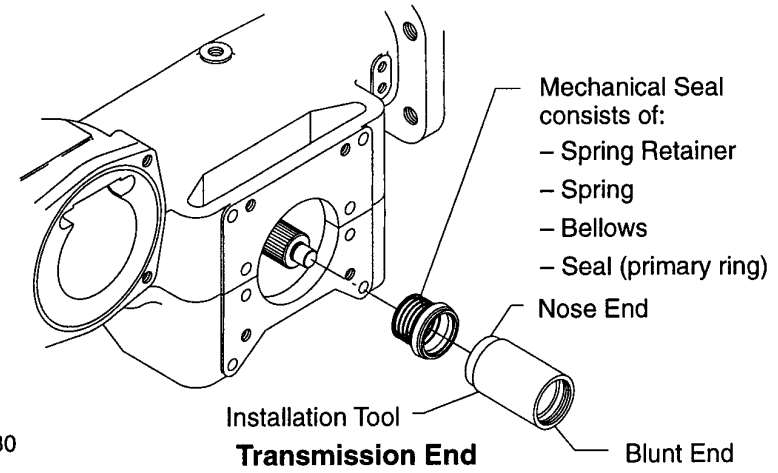
The entire mechanical seal installation procedure shall be completed without interruption. Delays may cause seal bellows to seat improperly.

Whenever a mechanical seal requires replacement, the Waterous Service Department strongly recommends replacing both seals; outboard bearing and drive end.
Note: Always replace the seal on outboard end first.



IL1384

Outboard Bearing End



IL1280

Transmission End

1. Inspect the new primary ring and mating ring sealing surfaces. These surfaces should be "mirror smooth" and without scratches.

   CAUTION

   Do not touch the "mirror smooth" surfaces.

2. Check that the throttle bushing is installed in the seal chamber cover. (A throttle bushing is not used on bronze pumps.) Install new mating ring with new O–ring in the seal chamber cover, the mirror smooth seal surface should be visible, the dull surface should seat on the throttle bushing. Install new seal chamber cover O–ring gasket in the seal chamber cover.

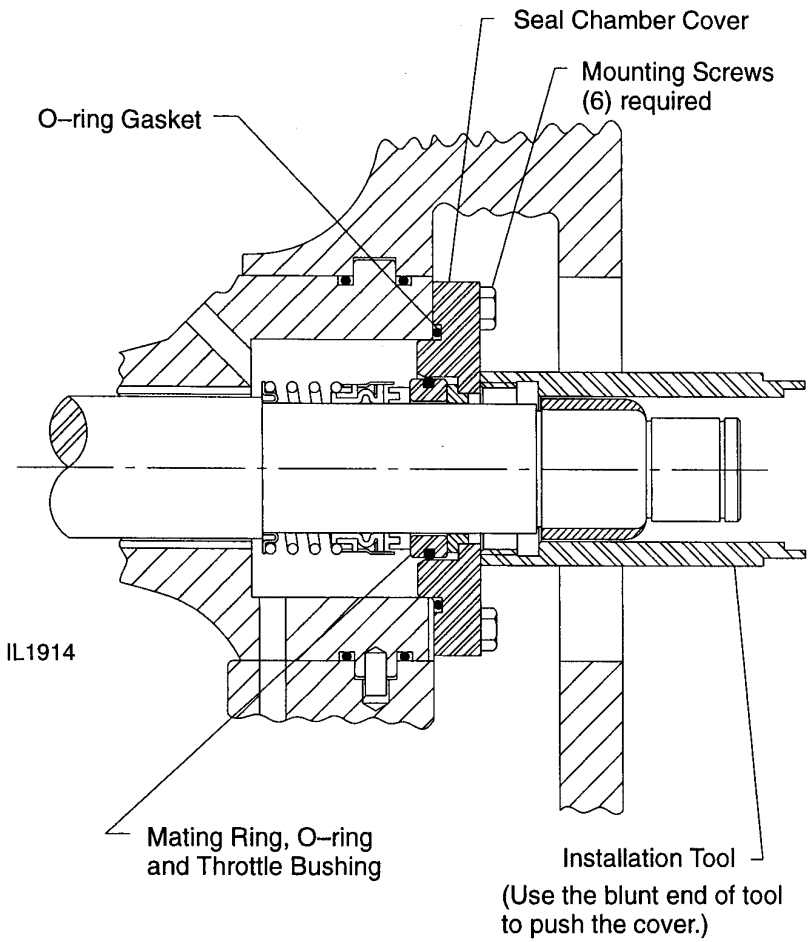
   CAUTION

   Do not get lubricant on the sealing surfaces on the mating ring or primary ring.

3. Liberally coat shaft with lubricant (supplied with kit) before installing the mechanical seal.

4. Place spring retainer and spring on the shaft. On the outboard end of the pump, install the protection sleeve on the shaft which will allow the seal to slip over the shaft shoulder. Failure to use the protection sleeve may cause damage to the seal. Coat inside of mechanical seal bellows with lubricant and push seal on with installation tool until the spring retainer makes contact with shaft shoulder. Remove the installation tool slowly. Remove the protection sleeve from the shaft (outboard end only).

Mechanical Seal Installation – Continued



Seal Chamber Cover Installation

5. Be sure the mating ring, O–ring, throttle bushing and O–ring gasket are installed in seal chamber cover (See Step 2).
6. Install the seal chamber cover on the shaft and slowly push on with installation tool. The seal chamber cover will guide the mechanical seal into place. When the cover contacts the pump body, attach the (6) screws previously removed during disassembly.

   NOTE: Before proceeding, both replacement seals (outboard and drive end) and the outboard bearing should be installed. As recommended earlier, both seals should be replaced at the same time.
7. Turn impeller shaft by hand at least two revolutions in both a clockwise and counterclockwise direction to seat seals.
8. Hydrostatically test pump at 150 P.S.I.G. Observe impeller shaft at throttle bushing and intersection of the seal chamber cover with pump body split line for leaks. Turn impeller shaft by hand while retaining the hydrostatic pressure to see if there is leakage between the throttle bushing and impeller shaft. If leakage persists, after one or two minutes of rotation (10 to 12 turns) disassemble and inspect.

Packing

Grafoil® is an all–graphite, self–lubricating packing and when correctly installed will provide effective sealing for extended service life before additional packing rings are required.

Grafoil® should always be used with graphite filament yarn (braided) packing in order to absorb the temperature expansion of the Grafoil® packing rings.

After gland adjustments are made, if the gland travel is used up, there is no need to remove the old Grafoil® packing. Simply add another Grafoil® ring to the stuffing box.

Replacing asbestos or lead foil packing rings (used on pumps built prior to February 1, 1984) with Grafoil® may not provide a good seal because of the prolonged break–in period required with a highly polished used shaft. A worn or grooved shaft also should not be used with Grafoil® packing.

There are two kinds of kits for complete replacement of Grafoil® packing. Split rings are used if the impeller shaft is not replaced. Continuous rings are used if the impeller shaft is replaced. In both applications, soft graphite filament yarn packing is included.

Packing Removal

⚠ WARNING

Truck movement hazard.
May cause serious personal injury.

Stop engine before going under truck to remove packing.

1. Remove unbalanced nuts and flat brass washers from one end of the pump and pry the gland halfs out of the seal housing bore.
2. Operate the pump, gradually increasing the discharge pressure until the packing is forced out of the seal housing. Pressure in excess of 300 psi may be required.

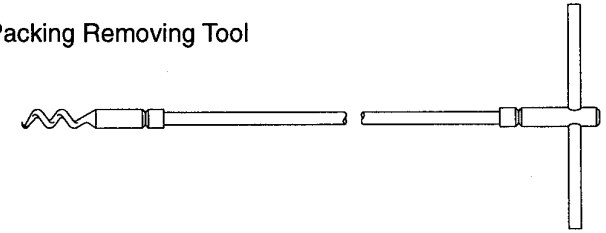
CAUTION

Pump overheating hazard.
May cause damage to the pump.

Circulate enough water through the pump to prevent overheating. Do not pressurize the pump over 600 psi.

3. If all of the packing is not forced out it may be necessary to remove the packing by hand using a pick or similar device. Waterous has a Packing Removal Tool (P/N 5782) available for this purpose.

Figure 2. Packing Removing Tool



IL1931

4. Replace packing per instructions below then repeat procedure for the opposite end of the pump.

Packing Installation

Installation of either type of packing is basically the same, except continuous ring packing must be installed before any other components are installed on that end of the impeller shaft. See Figure 1 for installation diagram.

1. Before installing the new packing, be sure all old packing is removed from the stuffing box. Be sure the stuffing box and shaft are clean and free of any packing residue.
2. Lightly lubricate Grafoil® and braided ring I.D and O.D. with mineral oil, automotive grease, or engine oil for installation purposes.
3. Carefully install one ring and with the aid of the packing glands, push the packing into the box as far as possible. Repeat this operation with each ring. Install the packing rings until the top of the last ring is about 1/4 in. from the end of the stuffing box (at least 1/8 in. is required for gland nose entrance).

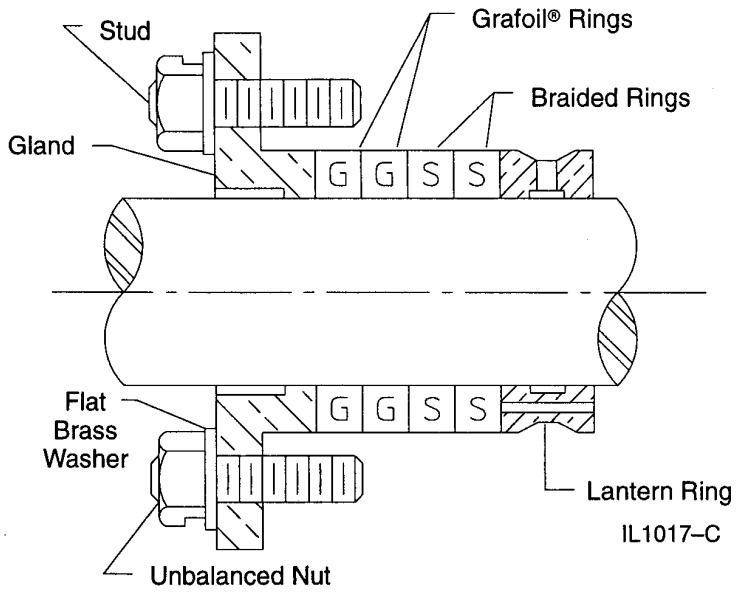
NOTE: When installing the split Grafoil® rings, or the soft filament rings, be sure the joints are staggered 90°.

4. Install packing glands, nuts and washers. Tighten gland nuts one flat beyond finger tight.

   NOTE: The milled slot on the nut should face the gland.

   Grafoil® is a registered trademark of Union Carbide Corporation.

Figure 1. Packing Arrangement



Packing Adjustment

The stuffing box at each end of the pump is designed and adjusted to leak slightly during operation to cool and lubricate the packing. If the leakage rate is less than the specified amount the packing will overheat, and may damage the impeller shaft. If the leakage rate is considerably more than the specified rate, it may make priming the pump difficult.

⚠ WARNING

Truck movement hazard.
May cause serious personal injury.
Stop engine before going under truck to adjust packing or to check packing gland temperature.

1. Operate the pump at 150 psi discharge pressure for ten minutes.
2. Observe leakage. Normal leakage is 10–120 drops per minute.
3. If leakage rate is considerably higher, stop engine and tighten packing gland nuts one flat.

CAUTION

Pump overheating hazard.
May cause damage to the pump.
Circulate enough water through the pump to prevent overheating.

4. Operate the pump at 150 psi discharge pressure for two minutes to let packing run in, then observe leakage.
5. Stop engine and feel packing gland. If glands are hot, allow them to cool before continuing. Repeat step 4 until glands remain cool.
6. Repeat steps 3 and 4 until leakage rate is acceptable.

   NOTE: After adjusting packing, the pump must pass the vacuum test. (Refer to Form No. 1031, Section 1000.)

Issued: 12/21/93
Revised: 04/17/00

WATEROUS

WATEROUS COMPANY
SOUTH ST. PAUL, MINNESOTA

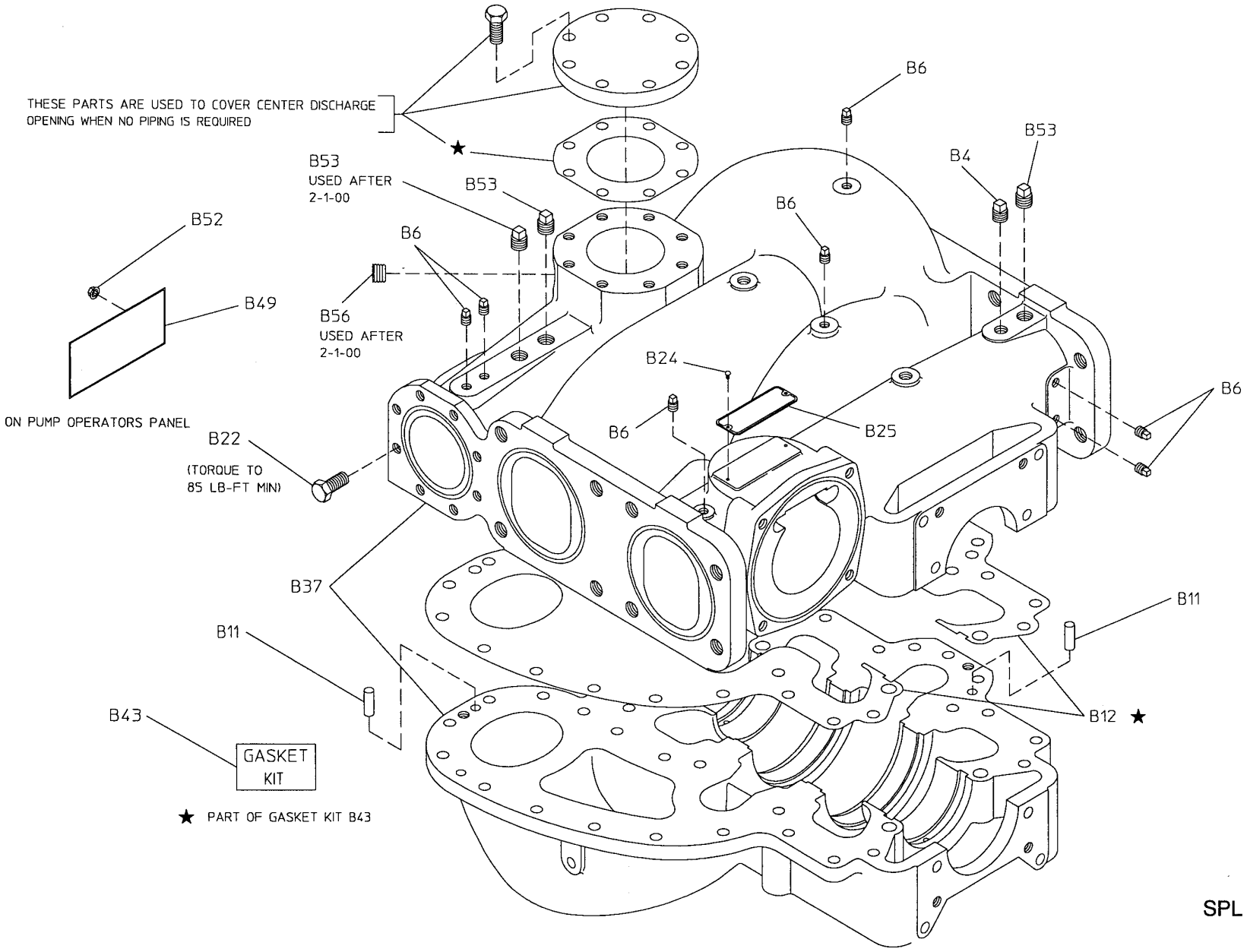
CS SERIES PUMP BODY ASSEMBLY

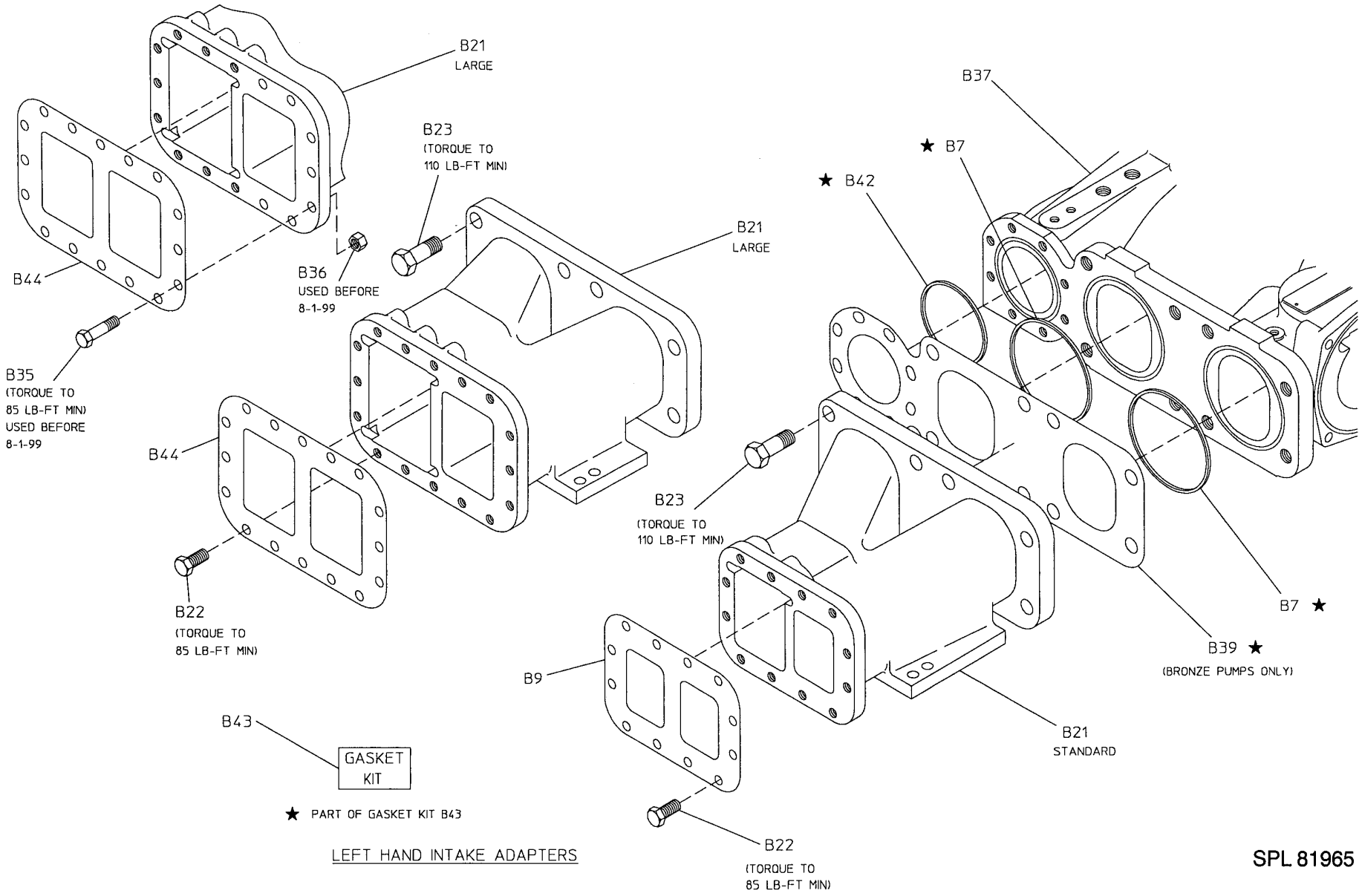
REF NO.	DESCRIPTION
B2	Pipe tee, 1/4 in.
B3	Pipe nipple, 1/4 in. x 1-1/2 in.
B4	Sq hd pipe plug, 3/8 in.
B6	Sq hd pipe plug, 1/4 in.
B7	Intake adapter gasket
B8	Intake adapter, RH
B9	Gasket, intake fitting, standard intake adapter
B10	Hex hd screw, 1/2-13 x 4-3/4 in.
B11	Dowel pin, 7/16 x 1-1/4 in.
B12	Gasket set, cover to body
B14	Socket hd screw, 5/8-11 x 3 in.
B18	Hex hd screw, 1/2-13 x 1-1/2 in.
B19	Tank to pump adapter, 2-1/2 NPT, 3 NPT or 4 ANSI
B20	Blind flange
B21	Intake adapter, LH
B22	Hex hd screw, 1/2-13 x 1-1/4 in.
B23	Hex hd screw, 3/4-10 x 2 in.
B24	Rd hd drive screw, No. 6 x 1/4 in.
B25	Serial plate (body mounted)
B26	O-ring, 6-3/4 x 7 in.
B27	Tank to pump check valve
B31	Rear intake fitting gasket
B32	Pipe plug, 1/8 in.
B34	Rear intake fitting
B35	Hex hd screw, 1/2-20 x 2 in.
B36	Hex nut, 1/2-20
B37	Body assembly (sold as assembly only) (Consists of volute body and volute cover)
B39	Intake flange gasket (Bronze body only)
B40	Socket hd screw, 1/2-13 x 1-1/2 in.
B42	Discharge flange gasket
B43	Gasket Kit consists of (B7, B12, B26, B39, B42)
B44	Gasket, intake fitting, large intake adapter
B49	Serial plate (located at operators panel)
B52	Self threading nut
B53	Sq hd pipe plug, 1/2 in.
B54	Plain bearing, TFE

PLEASE NOTE

SPL81965

WHEN ORDERING PARTS PLEASE SUPPLY PUMP SERIAL NUMBER

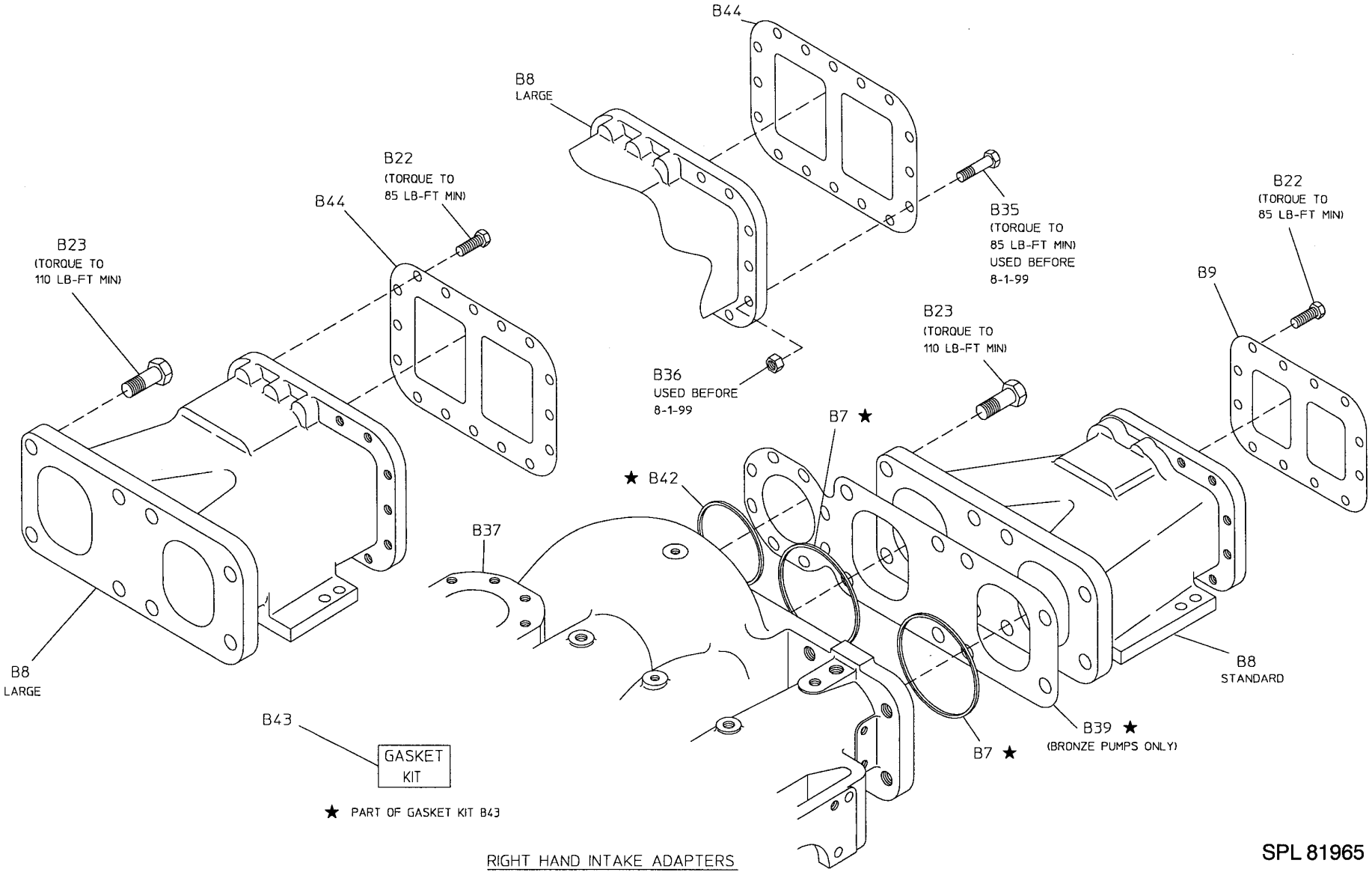

THESE PARTS ARE USED TO COVER CENTER DISCHARGE OPENING WHEN NO PIPING IS REQUIRED
★
B53
USED AFTER
2-1-00
B53
B6
B52
B49
B56
USED AFTER
2-1-00
ON PUMP OPERATORS PANEL
B22
(TORQUE TO
85 LB-FT MIN)
B6
B53
B4
B6
B24
B6
B25
B6
B37
B11
B11
B43
GASKET
KIT
★ PART OF GASKET KIT B43
B12 ★
SPL 81965
PUMP BODY
REV: 04/17/00



LEFT HAND INTAKE ADAPTERS

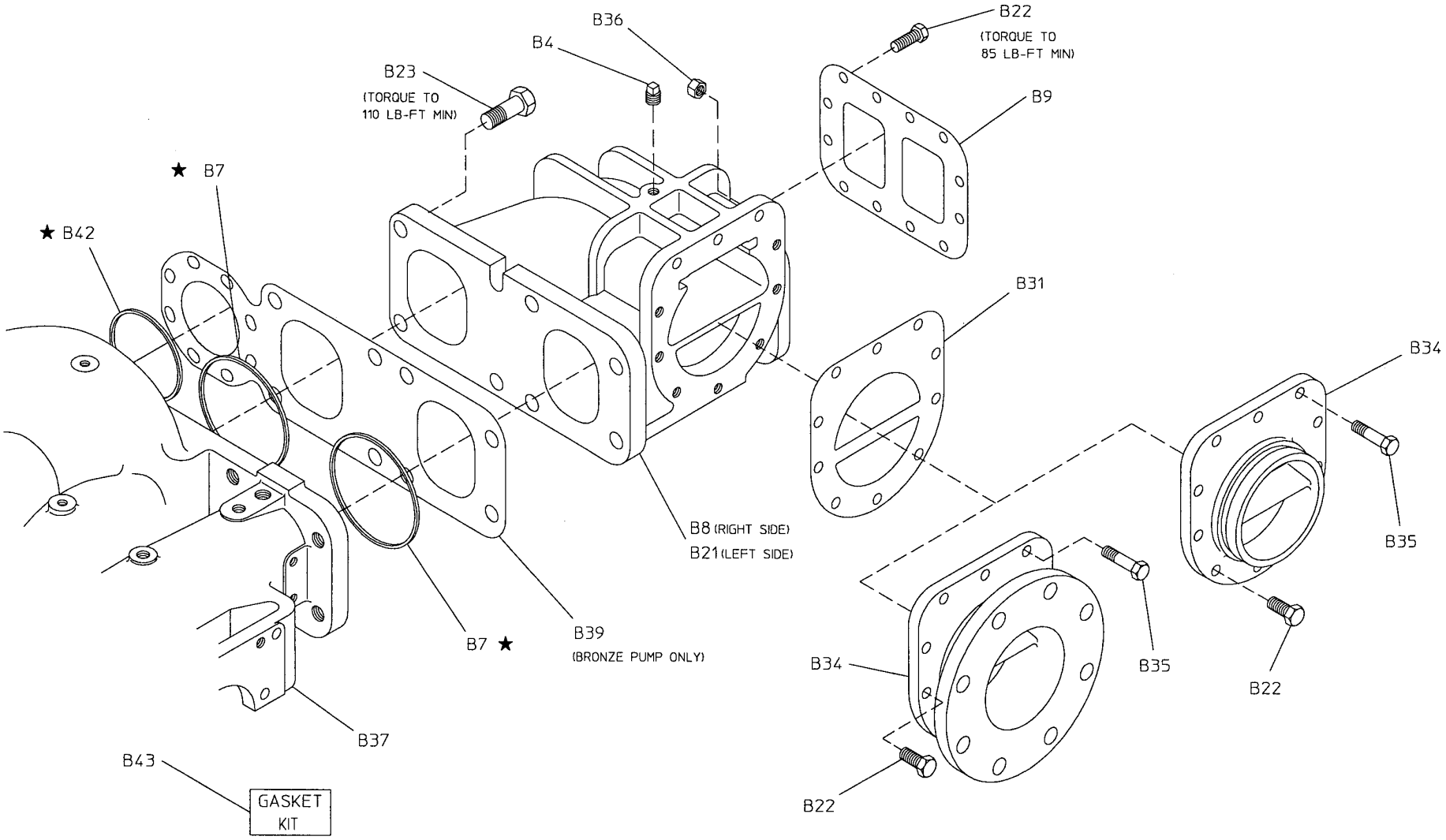
SPL 81965

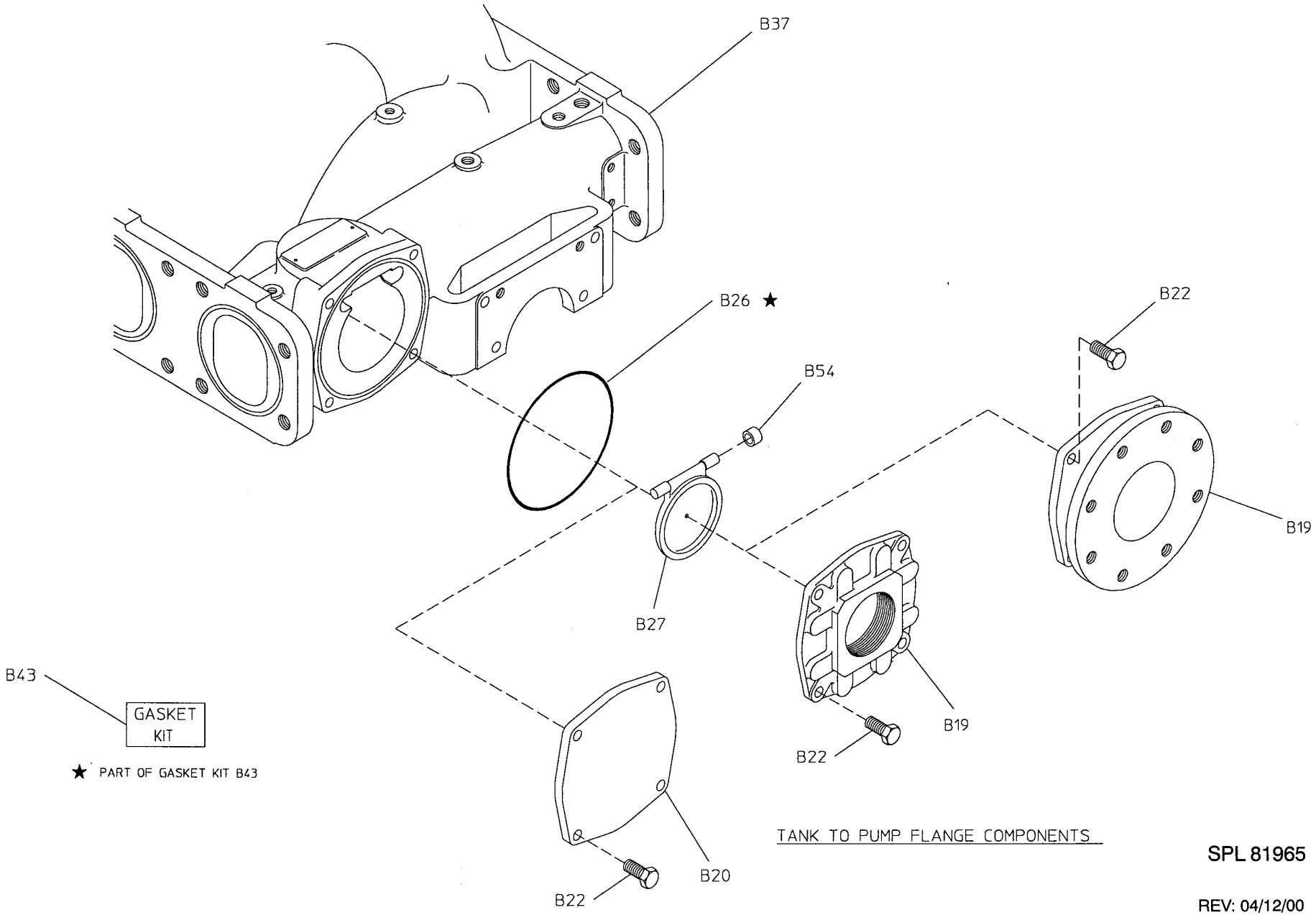
REV: 04/12/00



SPL 81965

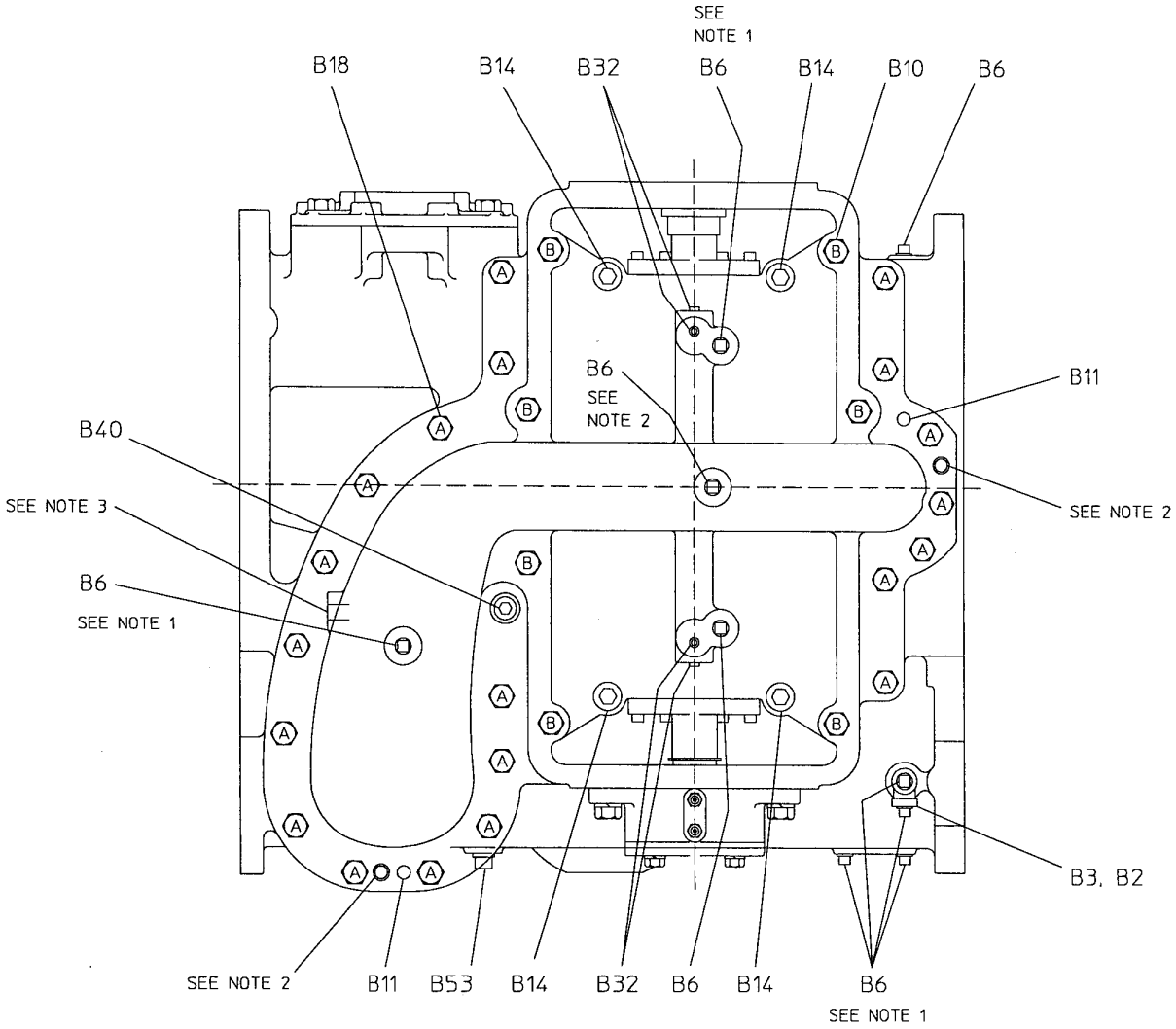
REV: 04/12/00


B36
B4
B23
(TORQUE TO
110 LB-FT MIN)
B22
(TORQUE TO
85 LB-FT MIN)
B9
★ B7
★ B42
B31
B34
B8 (RIGHT SIDE)
B21 (LEFT SIDE)
B35
B7 ★
B39
(BRONZE PUMP ONLY)
B34
B35
B22
B37
B43
GASKET
KIT
B22
REAR INTAKE ADAPTERS
(MAY BE ON RIGHT OR LEFT SIDE,
RIGHT SIDE CONFIGURATION SHOWN)
★ PART OF GASKET KIT B43
SPL 81965
REV: 04/12/00



SPL 81965

REV: 04/12/00



UNDERSIDE VIEW OF PUMP

FASTENER TYPE AND SIZE			
REF. NO.	DESCRIPTION	QTY	MINIMUM TORQUE
B10	HEX HEAD, 1/2-13 X 4-3/4	7	105 LB-FT
B14	HEX HEAD, 5/8-11 X 3	4	
B18	HEX HEAD, 1/2-13 X 1-1/2	20	
B40	SOCKET HEAD, 1/2-13 X 1-1/2	1	

NOTES:
1. WATEROUS FURNISHES PUMP WITH B6 PIPE PLUGS INSTALLED IN THESE HOLES, BUT THE APPARATUS BUILDER MAY HAVE REMOVED THEM AND INSTALLED PIPING TO THE DRAIN VALVE.
2. THESE ARE 1/2-13 UNC TAPPED HOLES TO ACCOMMODATE THE USE OF JACKING SCREWS DURING DISASSEMBLY.
3. THIS IS A UNTAPPED HOLE WHICH IS REQUIRED TO DRAIN A CORED POCKET IN THE COVER CASTING AND DOES NOT REQUIRE A PLUG.

SPL 81965

REV: 04/12/00

Issued: 10/14/93
Revised: 08/03/98

WATEROUS

WATEROUS COMPANY
SOUTH ST. PAUL, MINNESOTA

CS SERIES IMPELLER SHAFT ASSEMBLIES FOR WATEROUS SINGLE AND TWO STAGE FIRE PUMPS

THIS SERVICE PARTS LIST COVERS THE FOLLOWING MODELS:

PUMP TYPE	PUMP AND TRANSMISSION MODEL		DRIVE	SHAFT TYPE	SEE PAGE FOR DIAGRAM	
					PACKING	MECHANICAL SEAL
SINGLE STAGE	CSK, CSUK, CSPA, CSUPA CSUYB, CSUYC, CSUYD, CSUYE, CSUYF CSWB, CSWK CSYB, CSYC, CSYD, CSYE, CSYF		REAR	SEPARABLE	7	4
	CSK1		FRONT	ONE PIECE	10	–
	CSD, CSUD	WITH TACHOMETER	FRONT	ONE PIECE	6	5
		WITHOUT TACHOMETER	FRONT OR REAR	ONE PIECE	11	12
TWO STAGE	CSHWB, CSHWK, CSHYB, CSHYC CSHK, CSUHYB, CSUHYC		REAR	ONE PIECE	8	–
	CSHD, CSUHD	WITH TACHOMETER	FRONT	ONE PIECE	9	–
		WITHOUT TACHOMETER	FRONT OR REAR	ONE PIECE	13	–

PLEASE NOTE

SPL81966

WHEN ORDERING PARTS PLEASE SUPPLY PUMP SERIAL NUMBER

WATEROUS

WATEROUS COMPANY
SOUTH ST. PAUL, MINNESOTA

CS SERIES IMPELLER SHAFT ASSEMBLIES

REF NO.	DESCRIPTION
S2	Bearing housing
S3	Ball bearing
S4	Impeller, first stage
S5	Seal housing (not available individually, see S110)
S6	Packing, flexible graphite (Grafoil®), solid ring
S7	Packing gland
S7	Seal chamber cover
S9	Key, 5/16 x 1–9/16, 5/16 x 2–5/16 in. or 1/4 x 5/16 x 1–9/16
S10	Dowel pin, 1/4 x 1/2 in.
S11	Impeller shaft
S12	Retaining ring
S13	Wear ring (available in original size or 0.025, 0.050 and 0.075 in. undersize)
S14	Square key, SS, 5/16 x 2–3/4 in.
S15	Lubrication fitting, 1/8 in.
S16	Hex hd screw, 1/2–13 x 1–1/4 in., grade 5
S17	Lock washer, 1/2 in.
S18	Hex castle nut, SS, 3/4–16
S19	Cotter pin, SS, 1/8 x 1 in.
S20	Bearing housing
S21	Extra pressure impeller
S22	Flinger ring
S23	Ball bearing, double row
S24	Retaining ring, SS
S25	Impeller spacer
S26	Packing, soft ring
S27	Flinger grommet
S28	Flinger disc
S29	Outboard bearing housing cap
S30	Gasket
S31	Square head pipe plug, steel, 1/4 in.
S32	Oil seal, 1–5/8 x 2–3/4 in. or 1–7/16 x 2–3/4 in. (For 1–1/2 x 2–3/4, see Ref. No. S116)
S33	Lube relief fitting, 1/8 in.
S34	Retaining ring
S35	Lock washer, 3/8 in.
S36	Hex hd screw, 3/8–16 x 1 in.
S37	Hex hd screw, SS, 1/4–20 x 1 in.
S38	Tachometer driven gear
S39	O–ring, 3 x 3–1/4 in.
S42	Ball bearing
S45	Hex hd screw, 1/2–20 x 1–3/4 in. or 1/2–20 x 2 in.
S46	Hex nut, 1/2–20
S47	Tachometer drive gear
S48	Tachometer gear spacer
S49	Tachometer gear bushing

SPL81966

REV: 08/03/98

WATEROUS

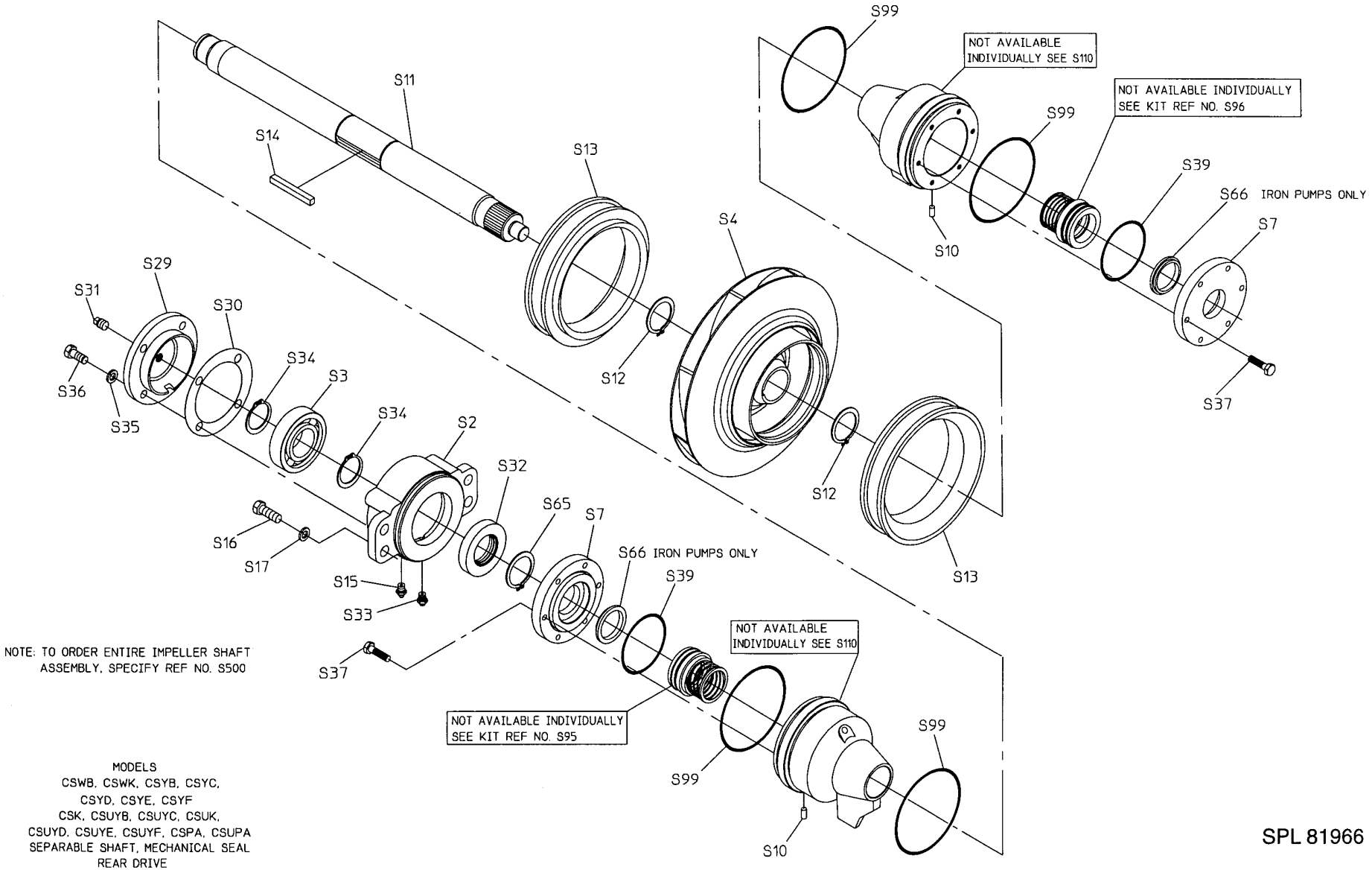
WATEROUS COMPANY
SOUTH ST. PAUL, MINNESOTA

CS SERIES IMPELLER SHAFT ASSEMBLIES

REF NO.	DESCRIPTION	REF NO.	DESCRIPTION
S50	Retaining ring	S73	Bearing seal
S51	O–ring, 3–1/4 x 3–1/2 in.	S95	Repair kit, mechanical seal, outboard end
S52	Spring pin, 3/16 x 1/2 in.	S96	Repair kit, mechanical seal, drive end
S53	Oil seal, 1–23/32 x 2–3/4 in.	S97	Bearing spacer
S54	End yoke with U–bolts	S99	Seal housing gasket
S55	Shaft nut, 1–20	S105	Lantern ring
S56	Cotter pin, 1/8 x 1–3/4 in. (prior to 04/20/98)	S106	Unbalanced nut, 5/16–18
S57	Tachometer sleeve	S107	Flat brass washer, 5/16 in.
S64	Mechanical seal (not available individually, see S95 or S96)	S108	Stud, 5/16–18 x 1–5/8 in.
		S110	Seal housing subassembly (includes S5 and S10)
S65	Retaining ring	S111	Tachometer gear housing assembly (includes S49 and S68)
S66	Throttle bushing		
S68	Tachometer gear housing (not available individually, see S111)	S112	Packing kit, solid ring
		S113	Packing kit, split ring
S69	Flinger	S114	Oil seal housing
S70	Bearing housing spacer	S115	Bearing housing
S71	Bearing spacer	S116	Oil Seal, 1–1/2 x 2–3/4 (formely S32)
S72	Packing, flexible graphite (Grafoil®), split ring	S500	Complete impeller shaft assembly

SPL81966

REV: 08/03/98

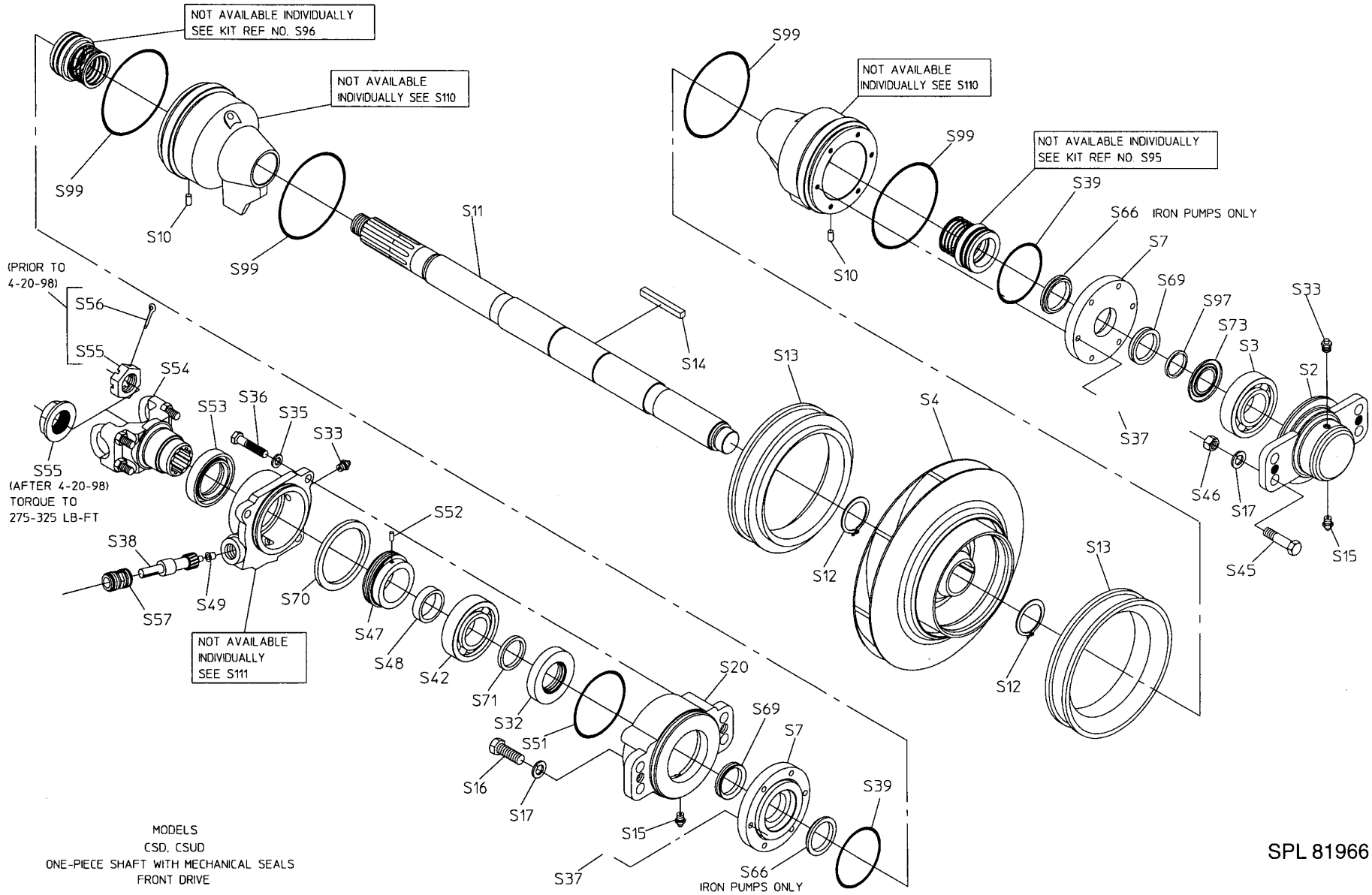


NOTE: TO ORDER ENTIRE IMPELLER SHAFT ASSEMBLY, SPECIFY REF NO. S500

MODELS
CSWB, CSWK, CSYB, CSYC,
CSYD, CSYE, CSYF
CSK, CSUYB, CSUYC, CSUK,
CSUYD, CSUYE, CSUYF, CSPA, CSUPA
SEPARABLE SHAFT, MECHANICAL SEAL
REAR DRIVE

SPL 81966

REV: 08/03/98



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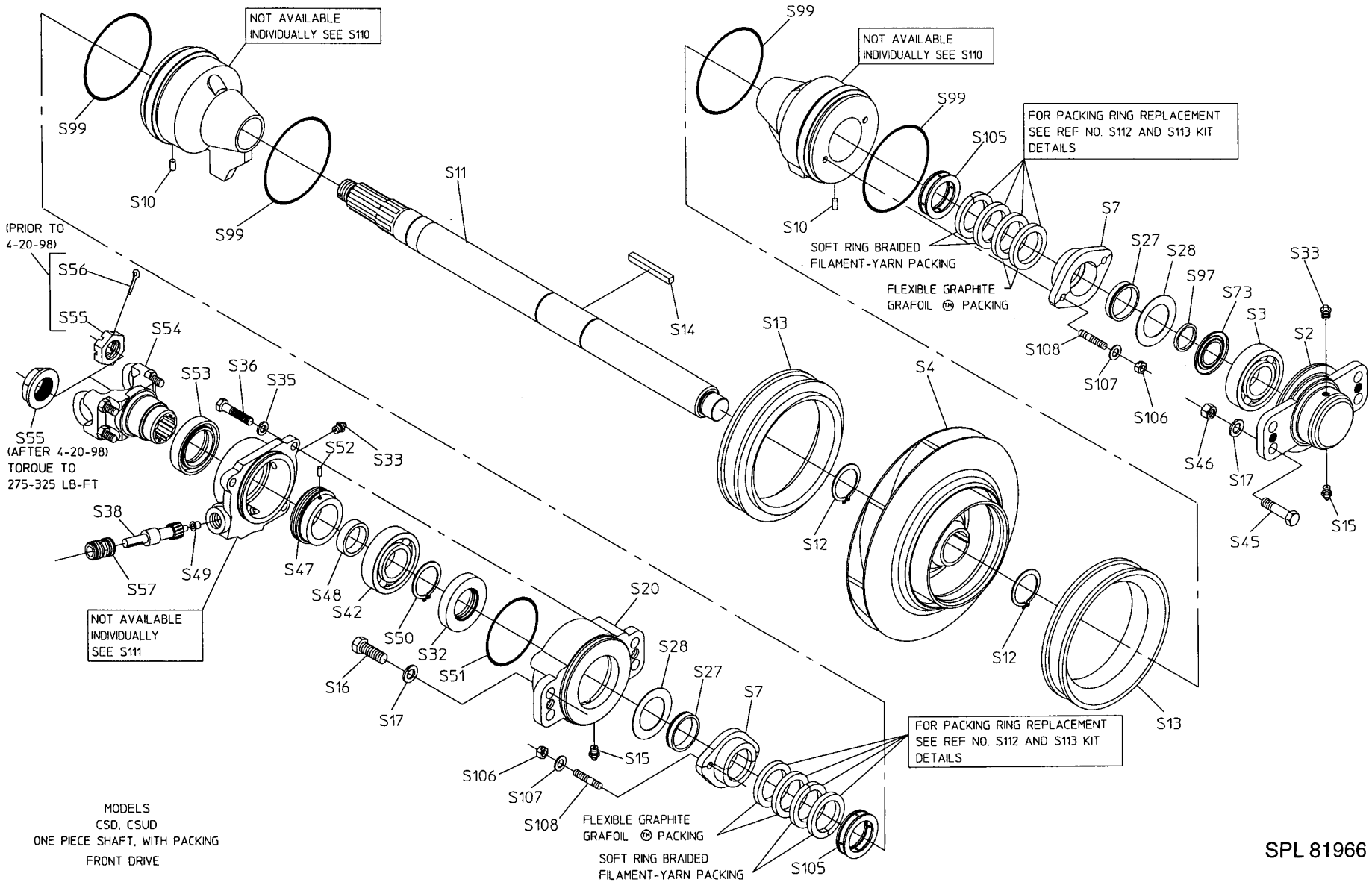
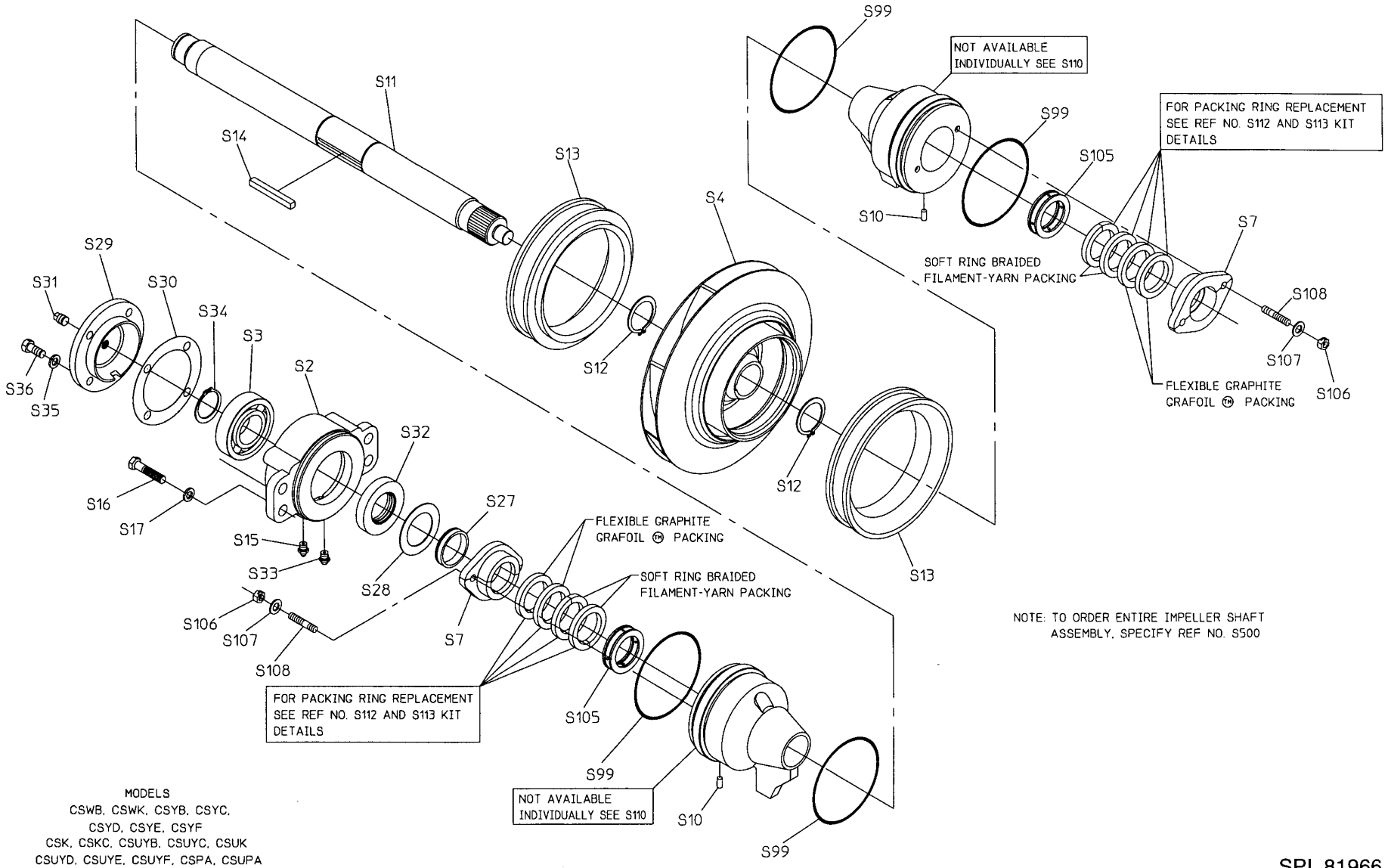


MODELS
CSD, CSUD
ONE PIECE SHAFT, WITH PACKING
FRONT DRIVE

SPL 81966

REV: 08/03/98



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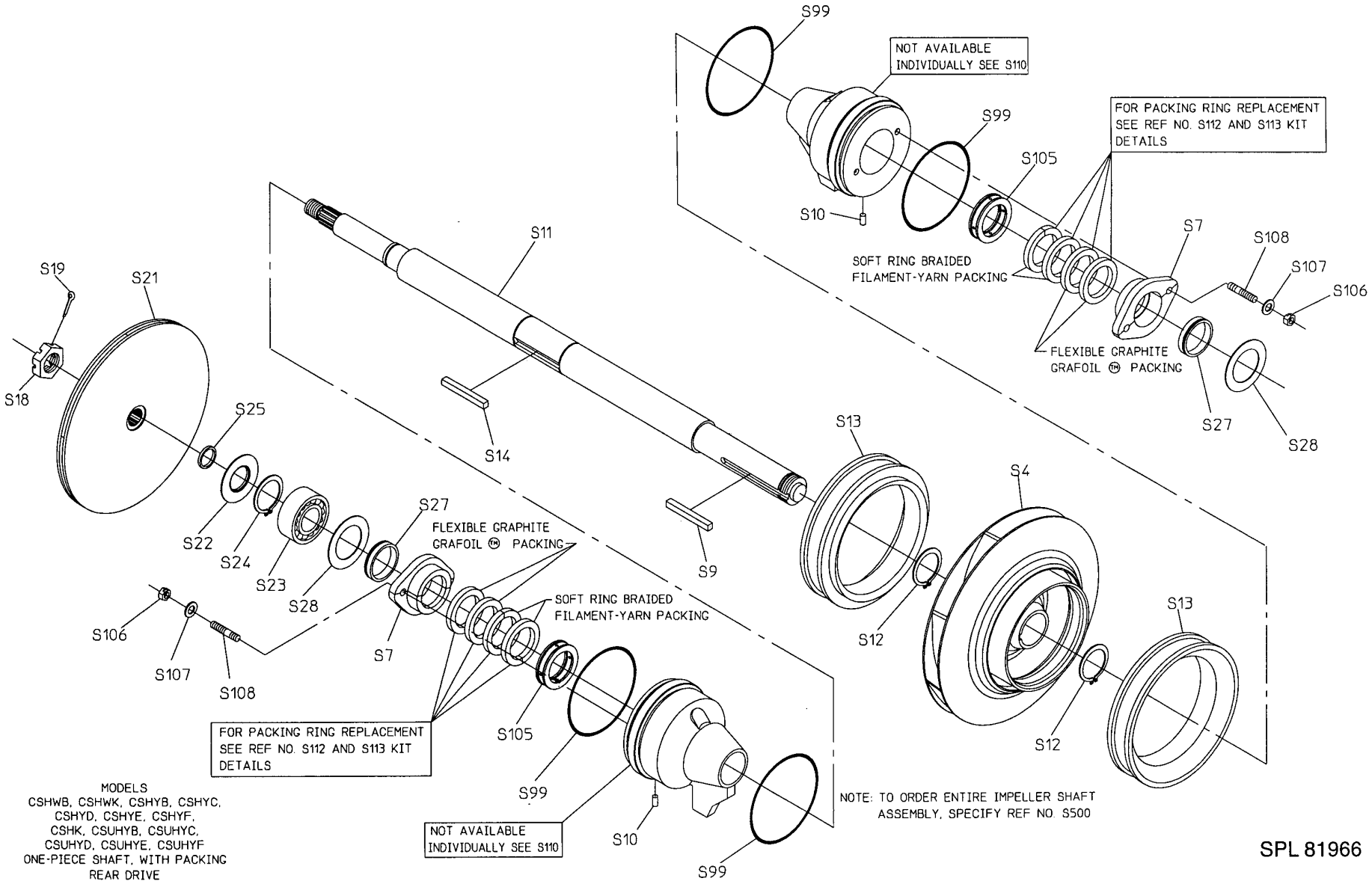

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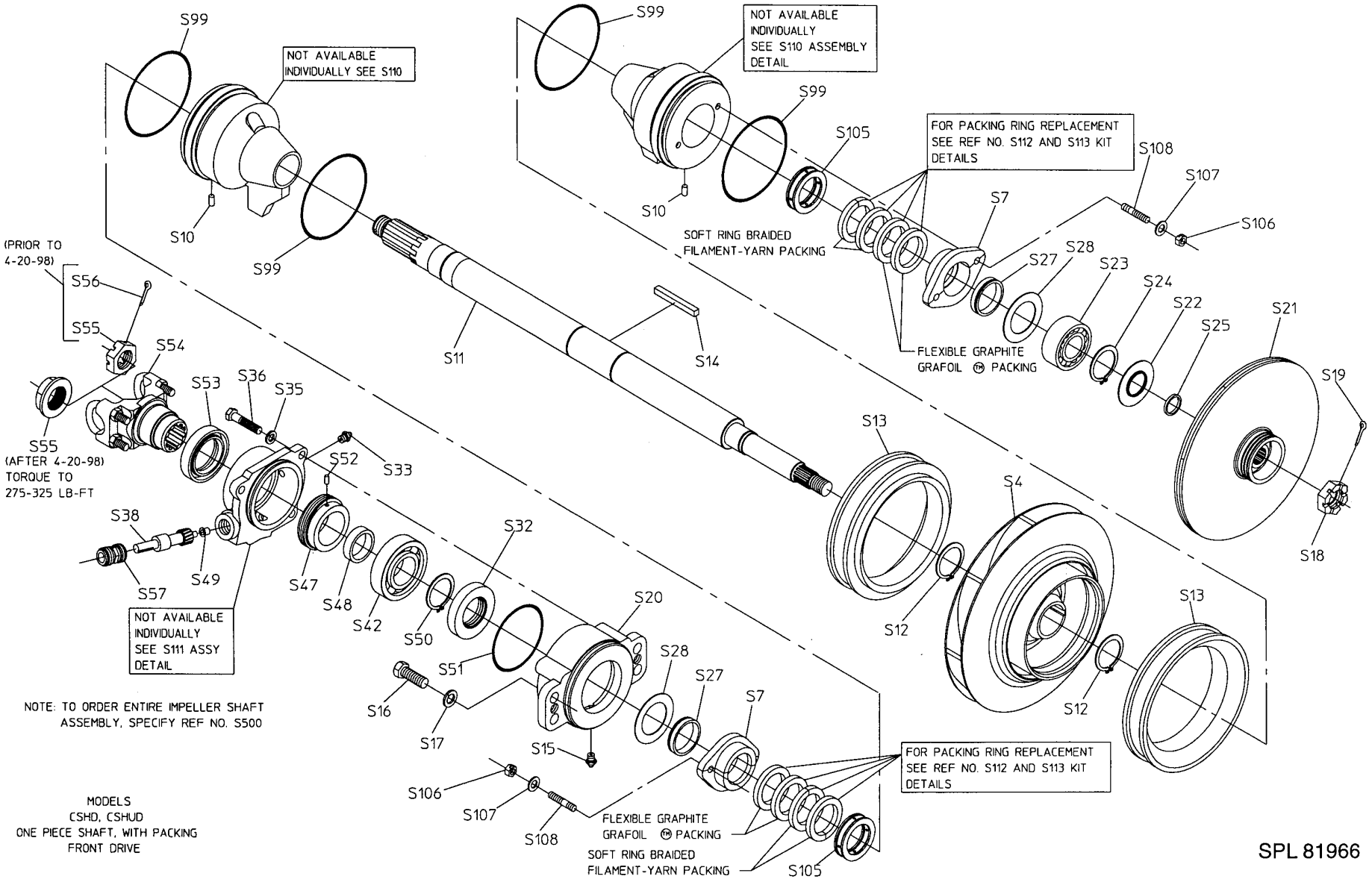
S99
NOT AVAILABLE INDIVIDUALLY SEE S110
S10
S99
S99
NOT AVAILABLE INDIVIDUALLY SEE S110 ASSEMBLY DETAIL
S10
S99
S105
FOR PACKING RING REPLACEMENT SEE REF NO. S112 AND S113 KIT DETAILS
S108
S107
S106
S7
SOFT RING BRAIDED FILAMENT-YARN PACKING
S28
S27
S23
S24
S22
S25
S21
S19
S18
FLEXIBLE GRAFOIL ® PACKING
(PRIOR TO 4-20-98)
S56
S55
S54
S53
S36
S35
S11
S14
S13
S4
S12
S55
(AFTER 4-20-98) TORQUE TO 275-325 LB-FT
S52
S33
S38
S49
S57
S47
S48
S42
S50
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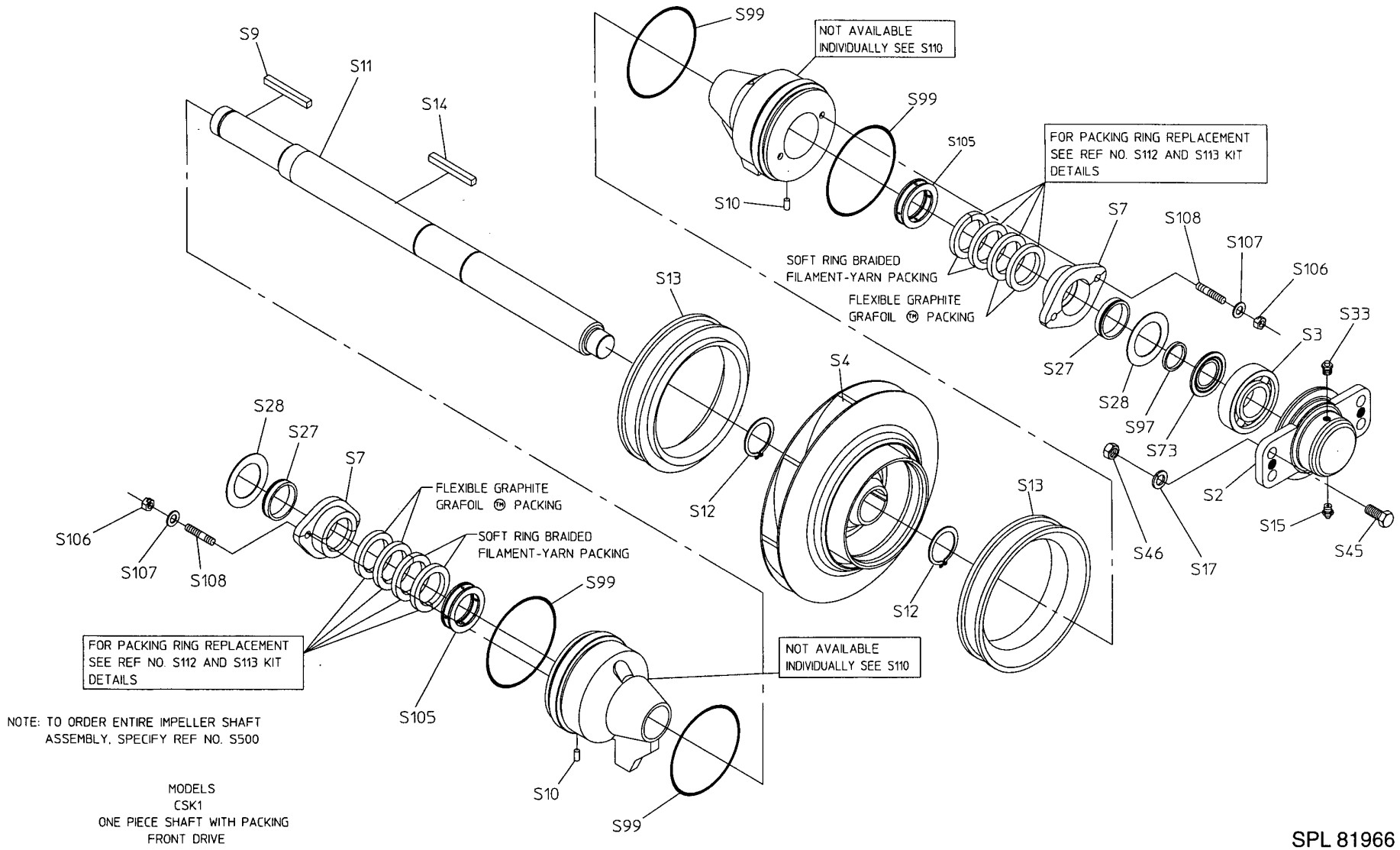
S108
FLEXIBLE GRAFOIL ® PACKING
SOFT RING BRAIDED FILAMENT-YARN PACKING
S105
NOT AVAILABLE INDIVIDUALLY SEE S111 ASSY DETAIL
NOTE: TO ORDER ENTIRE IMPELLER SHAFT ASSEMBLY, SPECIFY REF NO. S500
MODELS
CSHD, CSHUD
ONE PIECE SHAFT, WITH PACKING
FRONT DRIVE
FOR PACKING RING REPLACEMENT SEE REF NO. S112 AND S113 KIT DETAILS
S13
S12
SPL 81966
REV: 08/03/98



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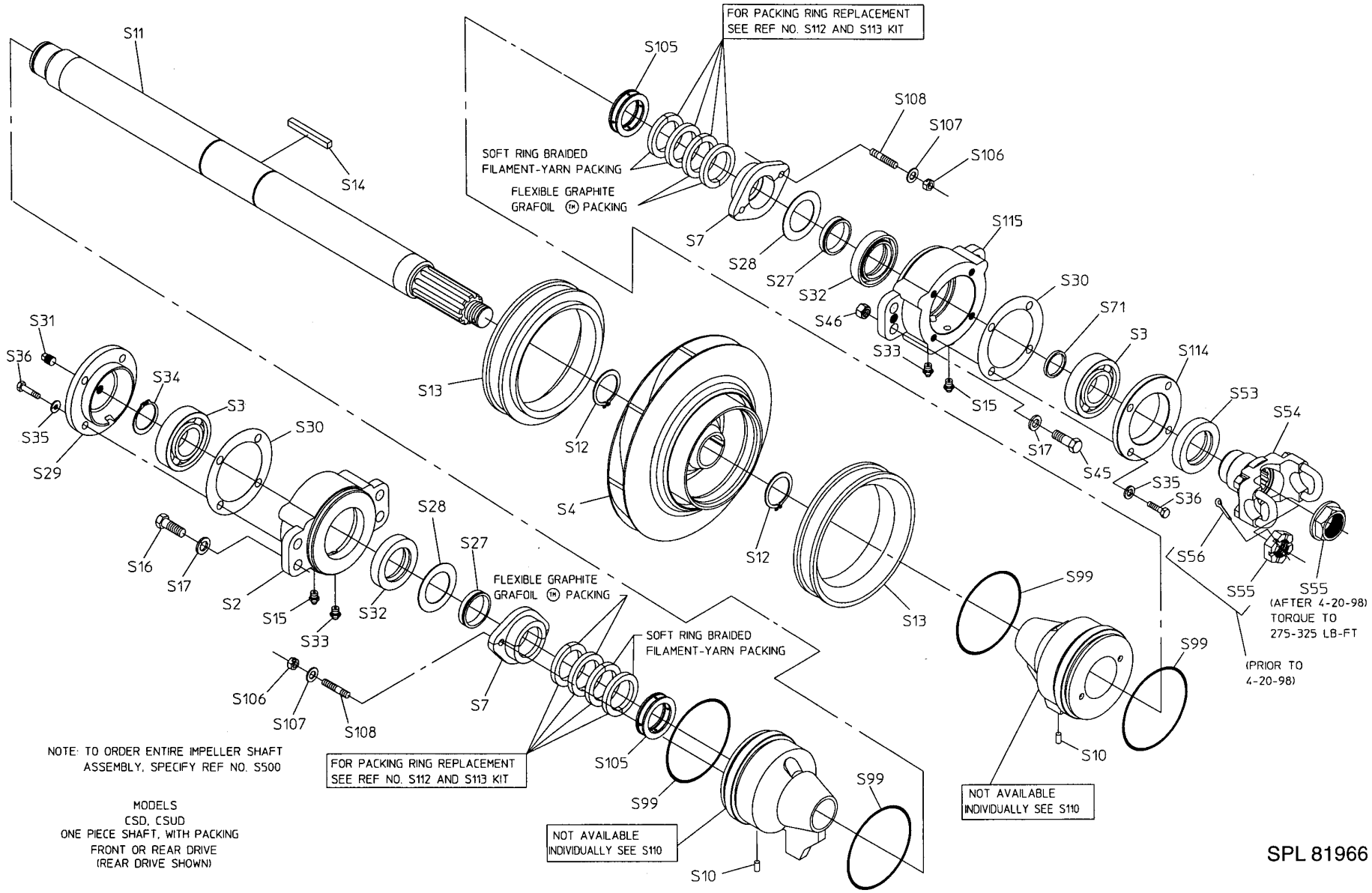

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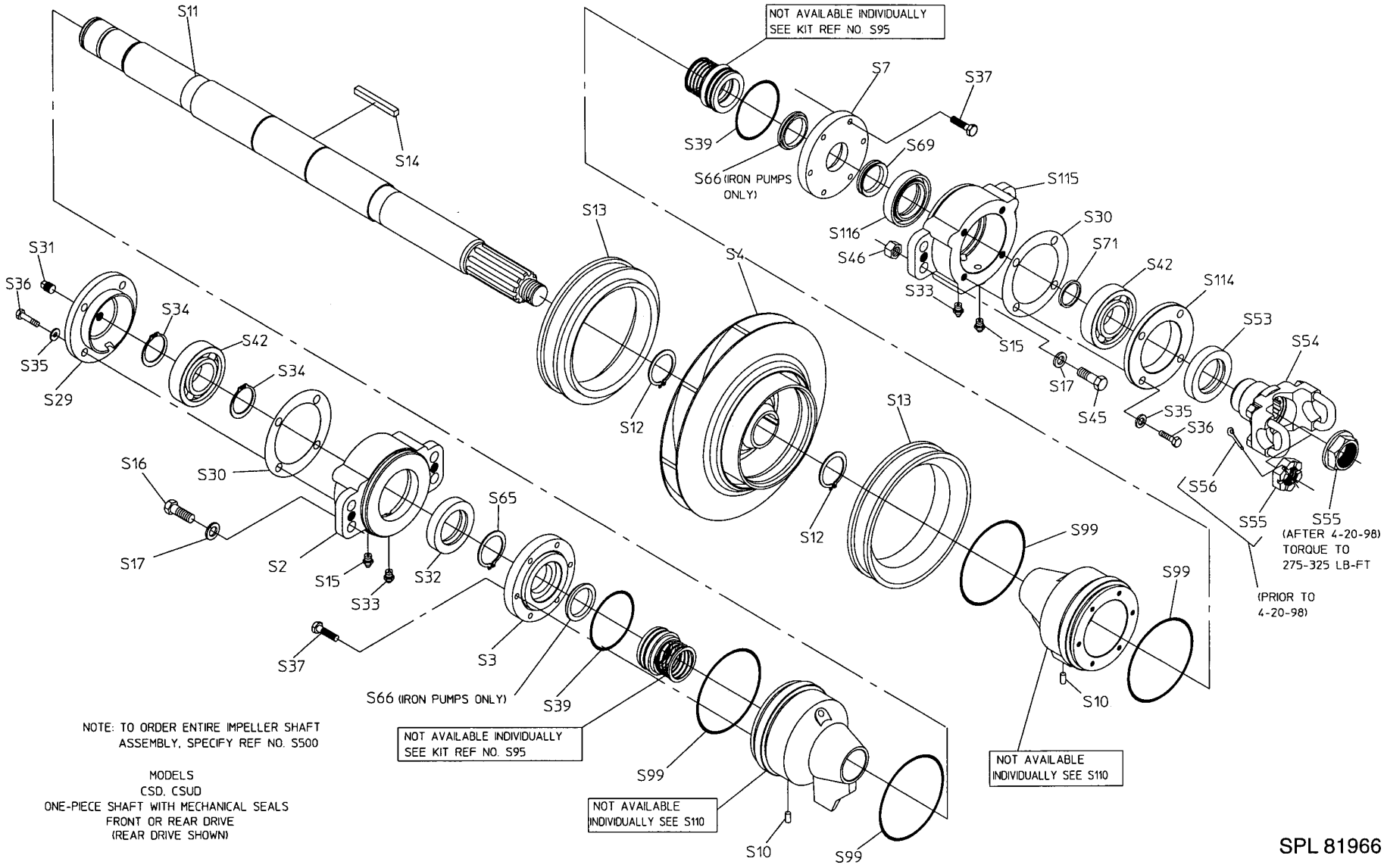

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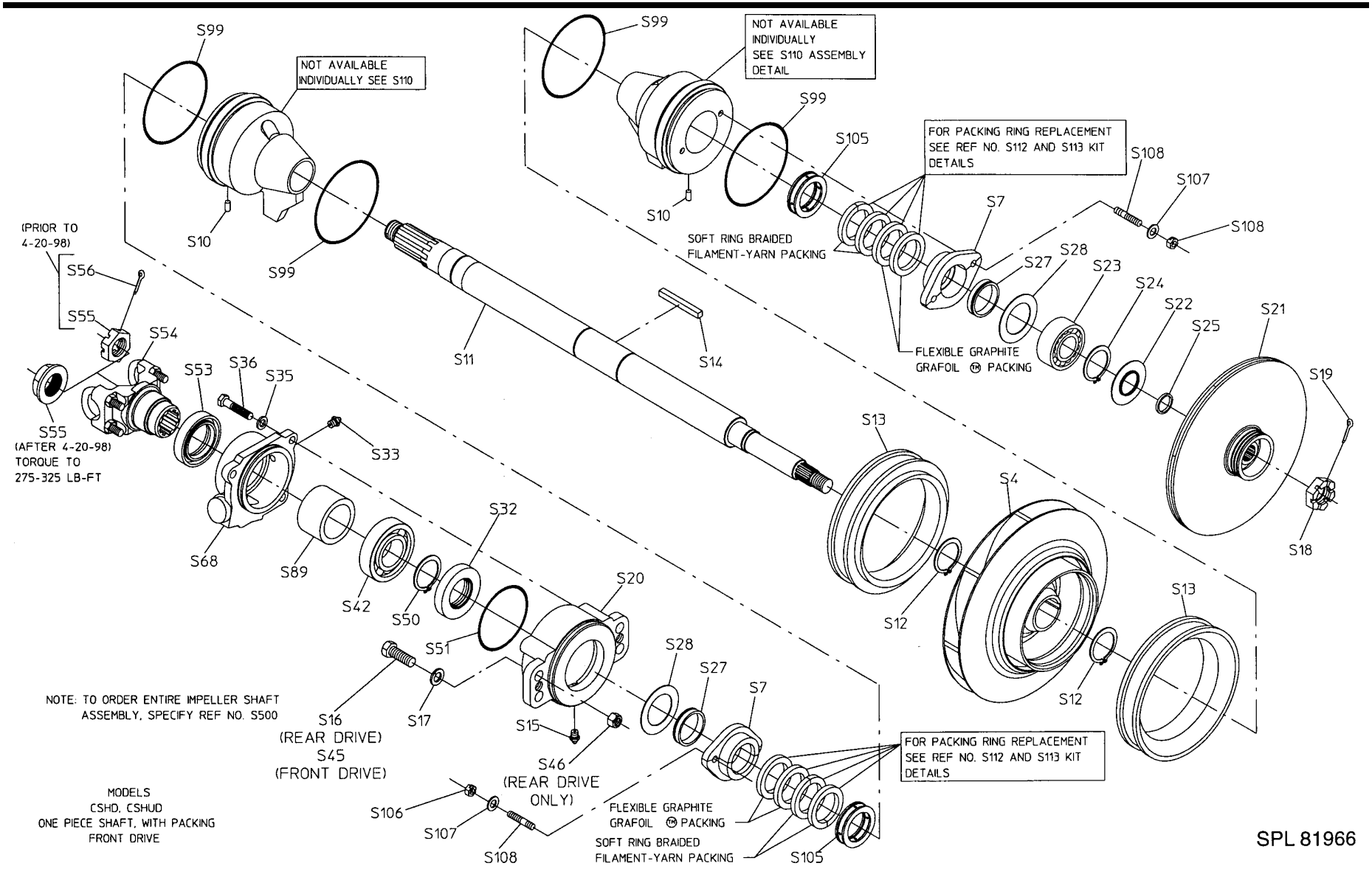

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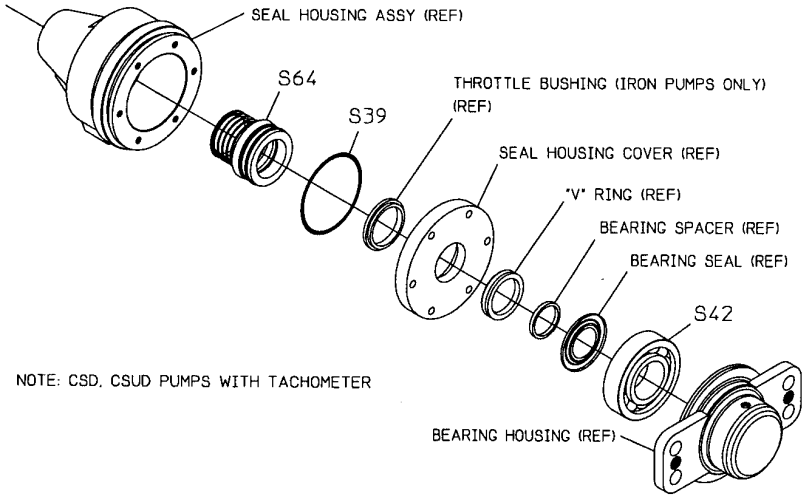

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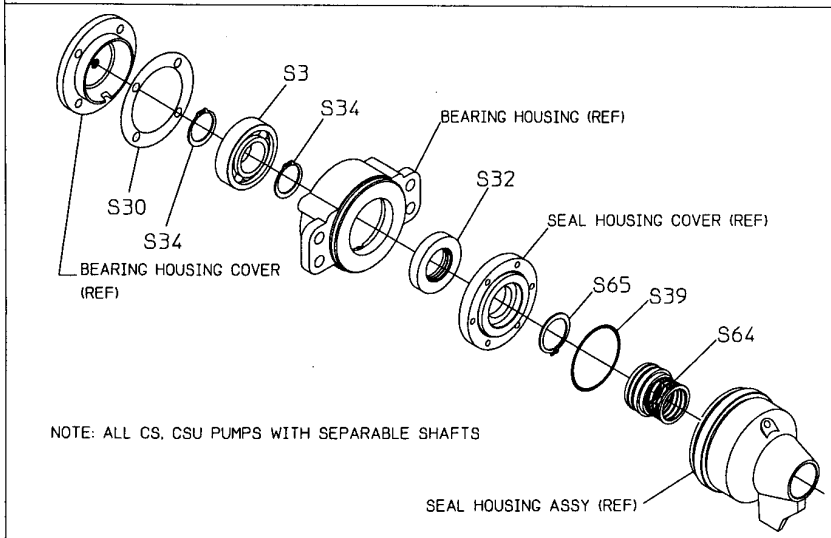

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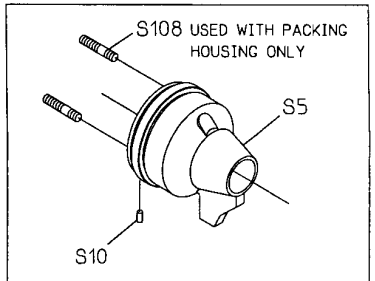
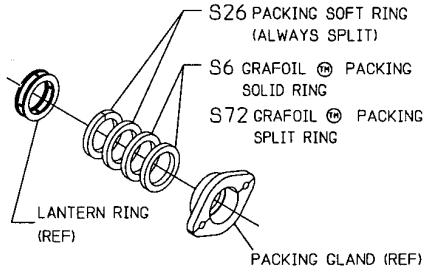


REF NO. S110 SEAL HOUSING ASSEMBLY



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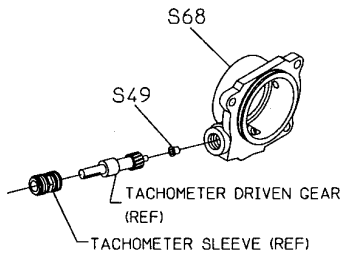
REF NO. S113 SPLIT PACKING REPLACEMENT KIT

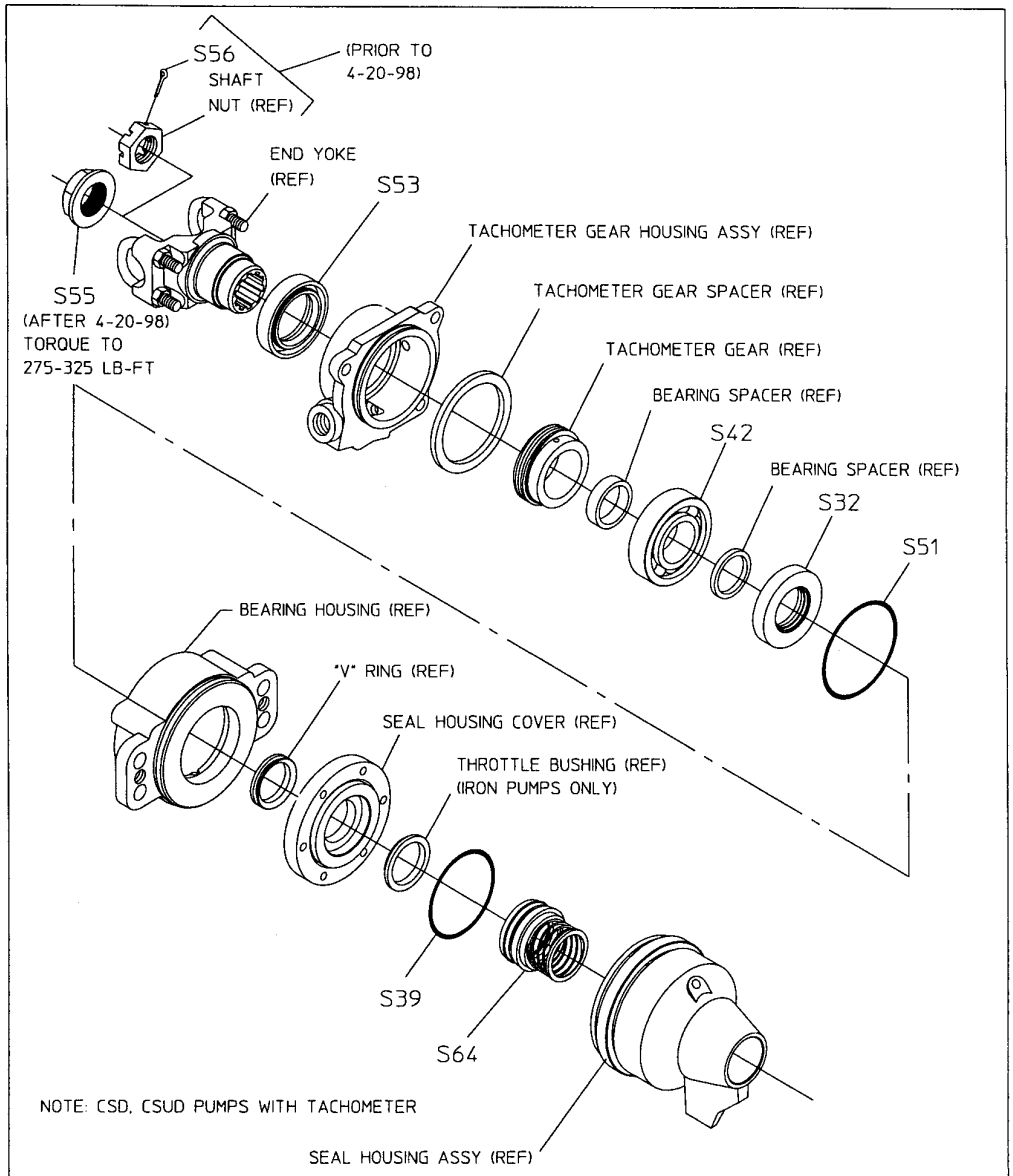


REF NO. S111 TACHOMETER GEAR HOUSING ASSEMBLY

NOTE: ALL PARTS LABELED WITH (REF) ARE NOT INCLUDED IN REPLACEMENT KIT, AND ARE SHOWN FOR REFERENCE ONLY.

SPL 81966

REV: 08/03/98



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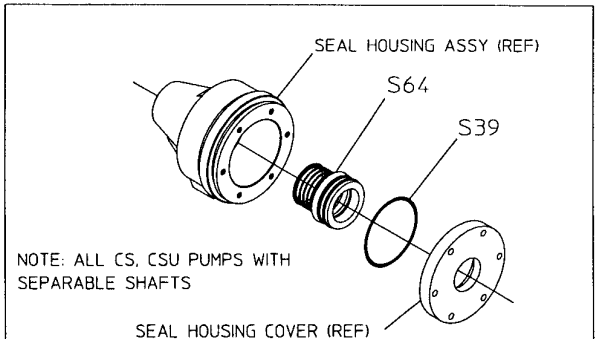


REF NO. S96 SEAL REPLACEMENT KIT
FOR CS PUMPS (DRIVE END)

NOTE: ALL PARTS LABELED WITH (REF) ARE NOT INCLUDED IN REPLACEMENT KIT, AND ARE SHOWN FOR REFERENCE ONLY.

SPL 81966

REV: 08/03/98

MAINTENANCE

1. Check fluid level monthly by removing fluid level plug at rear of case. The fluid should be level with bottom of hole.

A sight plug is also provided for this purpose, and the fluid level should be visable thru this plug.

CAUTION

If fluid level is low, locate source of leak and repair. If fluid level is high, loosen drain plug until fluid drops to proper level. If excessive water drains out, change fluid and determine source of water leakage, and repair.

Oil temperature should not exceed 250° for an extended period of time or premature seal wear and damage may occur.

Fluid can be added thru the fluid level hole or by removing the breather and adding fluid thru this opening. Any type of automatic transmission fluid (ATF) can be used.

2. Fluid pump operation should be checked monthly. If a pump transmission oil pressure gauge has been installed in the system, it should show a positive pressure while in the PUMP position.

NOTICE

Oil pressure will vary depending on engine speed and lubricant temperature.

3. Change fluid twice a year or after each 100 hours of operation, whichever comes first. Clean the fluid sump strainer and breather thoroughly whenever the transmission fluid is changed. The strainer can easily be removed by disconnecting the hose at the strainer and unscrewing the strainer from the case. Replace the strainer if it cannot be cleaned or is damaged.

Amount required if system is drained and refilled:

Y–Series	13 qts. (approx.)
W–Series	6 qts. (approx.)

WATEROUS COMPANY
SOUTH ST. PAUL, MINNESOTA 55075

FORM NO. F-1031
SECTION 4307

SECTION 4307

OVERHAUL INSTRUCTIONS

FOR

WATEROUS "Y" SERIES CHAIN DRIVE TRANSMISSIONS

WITH SEPARABLE SPLINED CONNECTION

BETWEEN DRIVEN SHAFT AND PUMP IMPELLER SHAFT

FOR CM TWO-STAGE AND CS SINGLE STAGE PUMPS

OCTOBER, 1986

SERVICE PARTS LIST AT END OF THIS SECTION

Printed in U.S.A.

Waterous DEPENDABLE

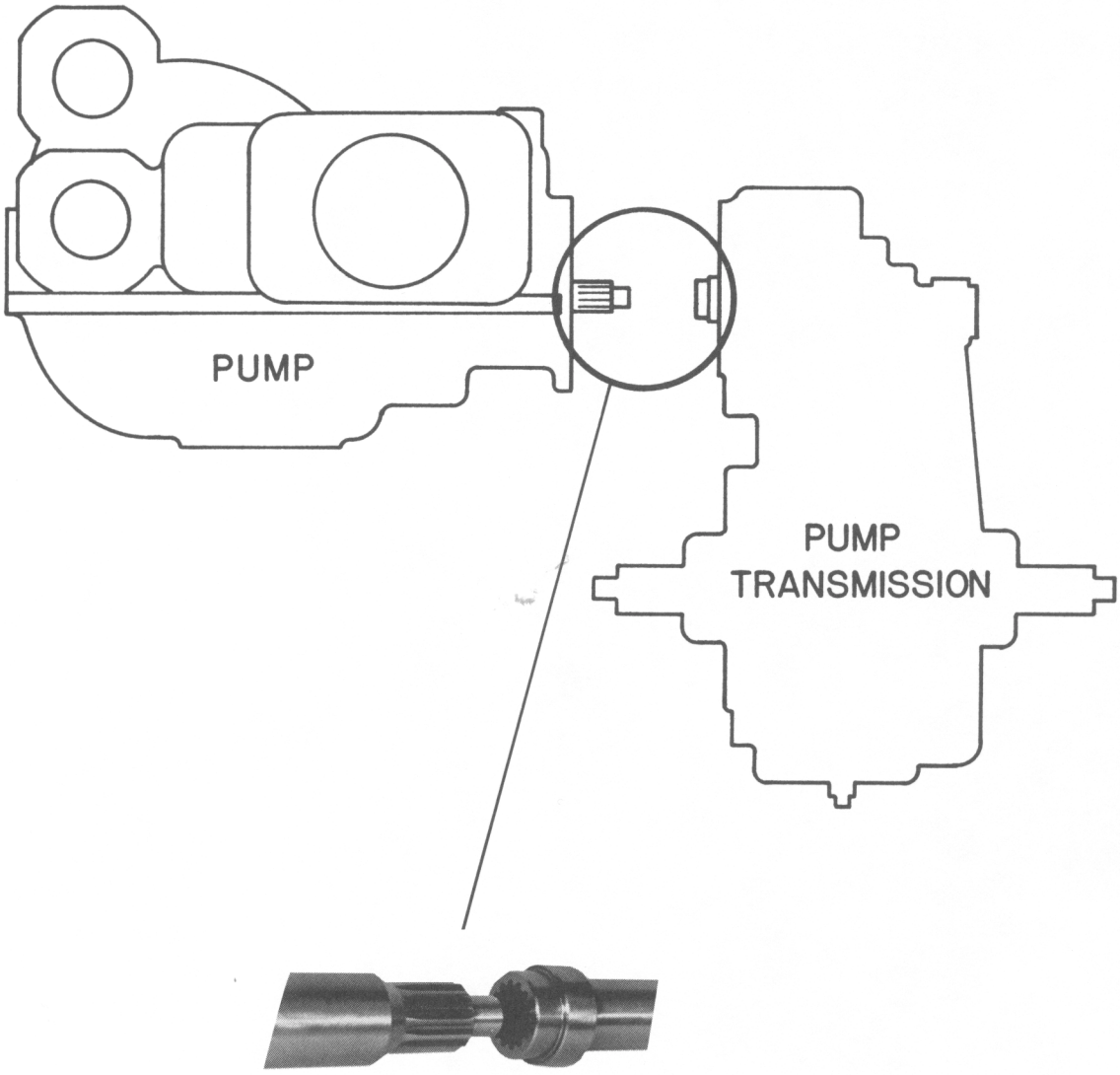
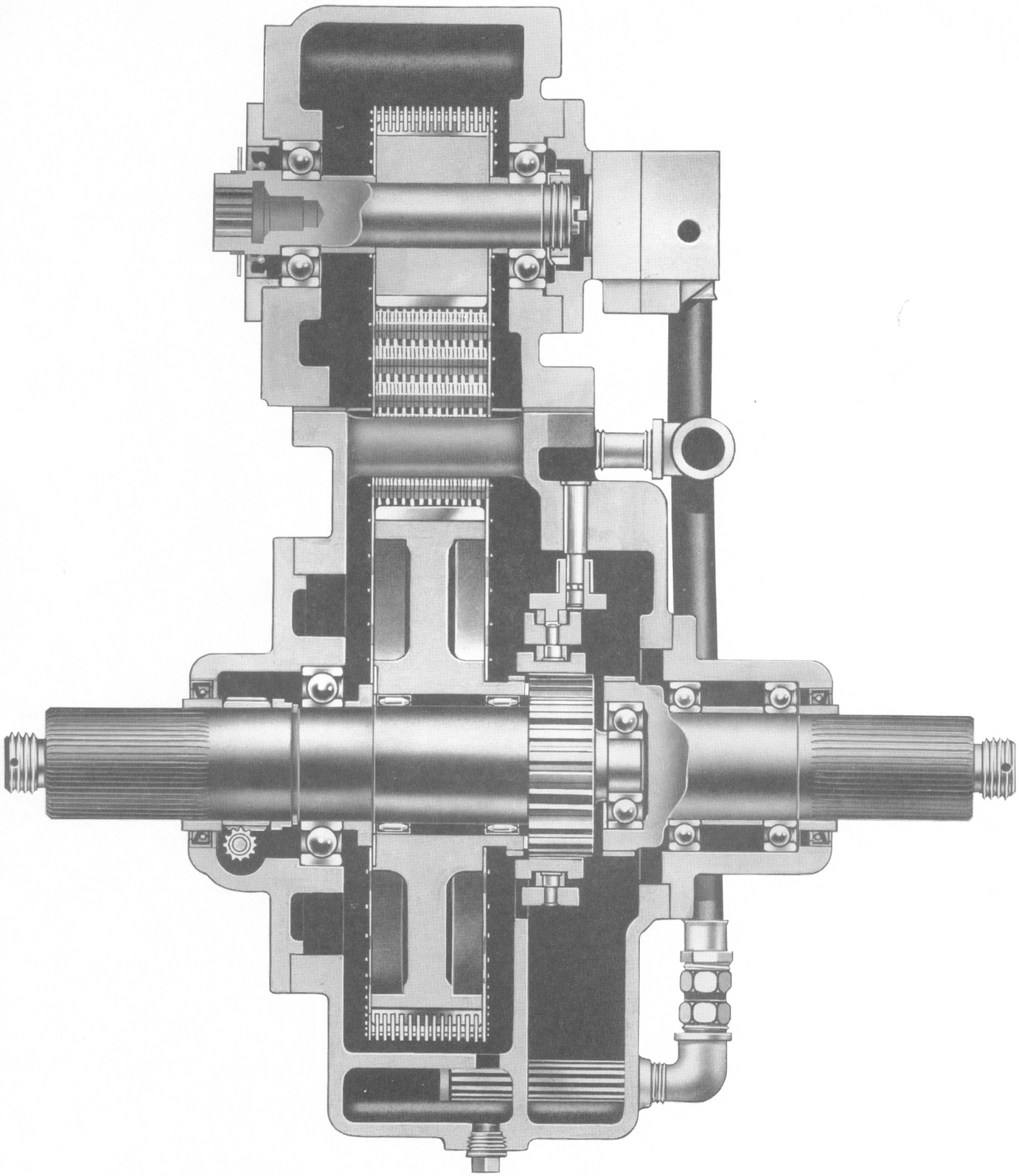


FIGURE 1

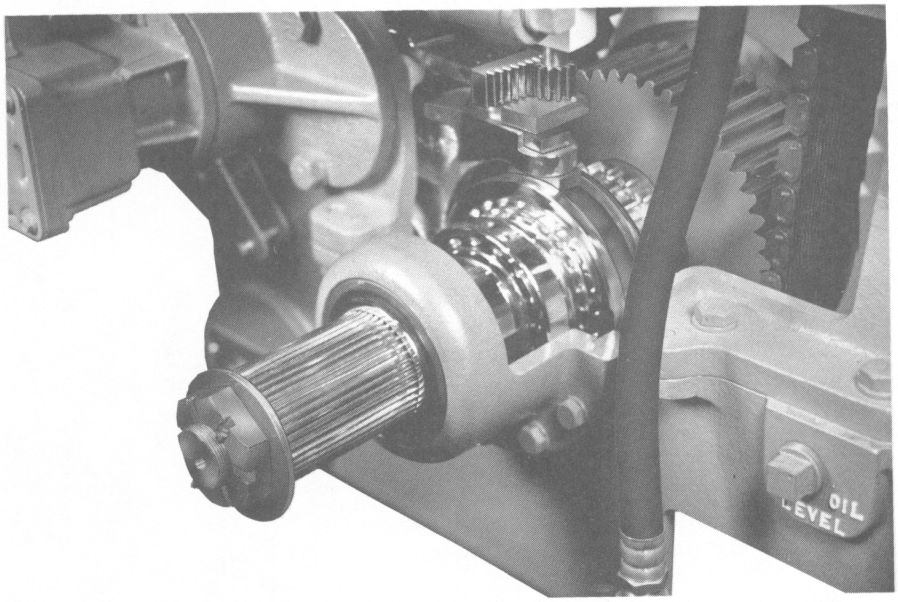
F-1031
Section 4307

Waterous
DEPENDABLE



2042

FIGURE 2 - Y Series Transmission, Cross Section



2040

FIGURE 3 - Y Series Drive Line

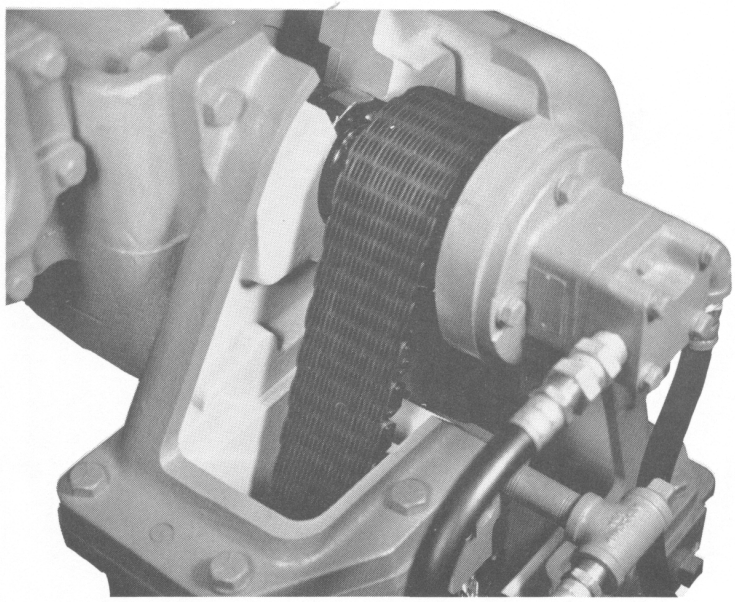


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FIGURE 4 - Driven Sprocket, Chain and Oil Pump

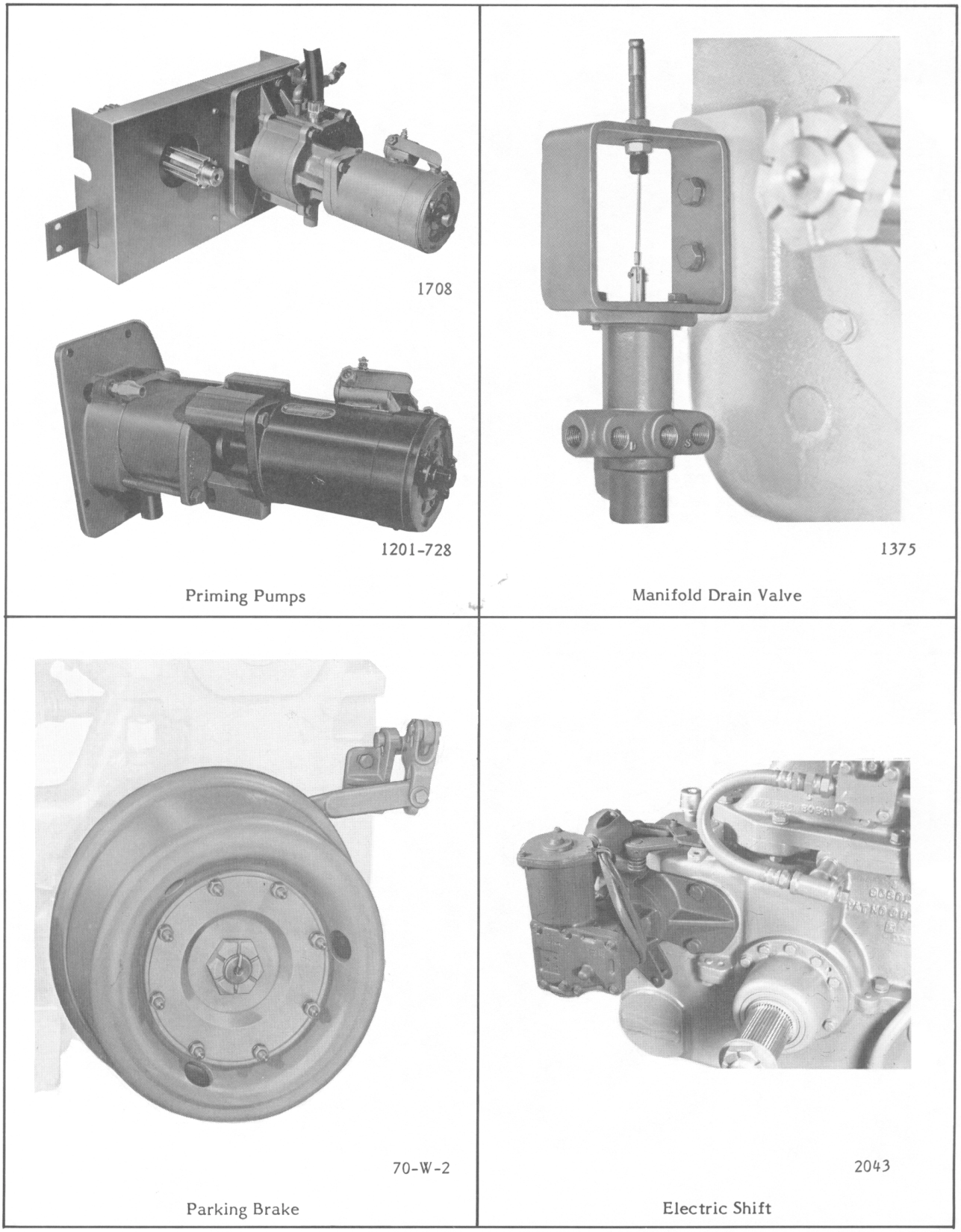


FIGURE 5 - Transmission Accessories

INTRODUCTION

This section contains overhaul and repair instructions for Waterous Y Series chain drive pump transmissions with separable spline joint between the transmission and the pump impeller shaft (see Figure 1).

The transmission may be equipped with all or some of the accessories shown in Figure 5. These should be removed before removal of the transmission from the pump.

The transmission is removed as a unit for out of chassis overhaul. These instructions apply for out of chassis overhaul.

REFERENCE NUMBERS

The text below frequently uses "reference numbers" when discussing specific parts. These numbers refer to the parts called out on the Service Parts List included with the pump manual.

PROPELLER SHAFT DISCONNECT AND ACCESSORY REMOVAL

1. Disconnect propeller shafts from drive and coupling shafts. The companion flanges or end yokes attached to the transmission shafts can be left attached to the transmission and removed later.

2. Disconnect tachometer cable, electric shift override linkage, and the shift wiring.

3. Remove parking brake as follows:

a. Remove the cotter pin and lock nut retaining the companion flange and brake drum to the coupling shaft.

b. Pull companion flange and drum assembly off spline of coupling shaft. Disconnect linkage to brake operating arm.

c. Remove bolts fastening brake assembly to coupling shaft housing and remove brake assembly.

4. Disconnect primer motor wiring and hose and remove priming pump if it is mounted on the transmission, or if it is separately mounted and would interfere with removal of the transmission. As various types of priming pumps are available, see separate instructions covering the type furnished with the transmission.

5. Disconnect manifold drain valve.

6. Drain oil from the transmission.

7. Remove electric shift assembly and bracket. Do not disturb adjusting screws (T86). Take care not to lose adjusting screw retainers (T87) which are exposed when the bracket is removed.

REMOVAL OF TRANSMISSION FROM THE PUMP

1. Loosen all 8 cap screws that fasten the transmission to the pump. Remove 6 of these cap screws, leaving 2 in place to keep the transmission in place.

2. Support the transmission via a support from the floor or a sling from above.

3. Remove the 2 remaining cap screws.

4. Install at least 2 cap screws in the tapped holes in flange of pump and use these screws to push the transmission off its spline fit with the impeller shaft until it is free. Lower the transmission and remove from under the chassis.

CAUTION

The pump impeller shaft is retained from axial movement by the bearing in the housing at the far end of the pump. This bearing could be damaged if the spline joint requires unreasonable force to separate.

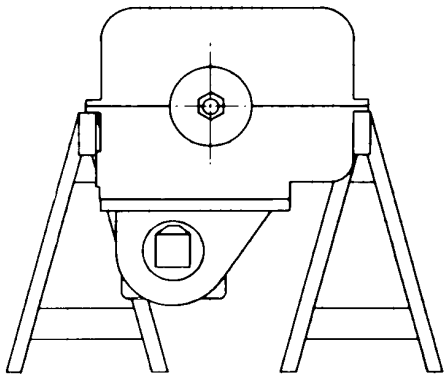
DISASSEMBLY OF TRANSMISSION

The transmission consists of three sections; the cap, the mid-section, and the bottom section. The order of disassembly is bottom section, mid-section, cap.

Figure 2 shows a vertical cross section view through the assembly, while Figure 3 shows a close-up view of the drive line. Figure 4 shows a close-up of the driven sprocket, chain and oil pump. Refer to these illustrations and to the parts list illustrations, when overhauling a chain case.

NOTE

Out of chassis overhaul will require supporting the transmission initially in an upside down position, possibly attaching it direct to an engine overhaul stand at the face of the cap that bolts to the pump or making up an adapter to allow this connection to an overhaul stand. Another consideration would be to support it on suitable supports on the underside of the flange of the mid-section, first removing the flange bolts at the support areas. See Figure #6.



86-9-12

Figure 6

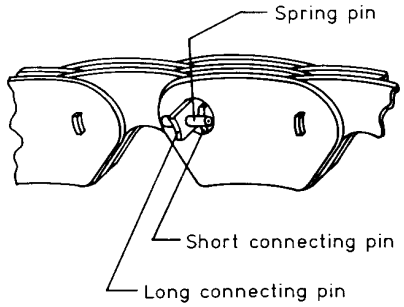
1. Remove companion flanges or end yokes from drive and coupling shafts.

2. Remove lube system hoses by disconnecting hoses (T67) and (T64) at swivel fittings (T66), tee (T102) and elbow (T57). Remove sump oil strainer (T132) from bottom section of case (T28).

3. Remove self-locking cap screws (T8) and lock washers (T9) attaching drive and coupling shaft housings (T11 and T42) to bottom section. Loosen cap screws (T16) attaching housings to mid-section.

4. Remove cap screws (T52), bolts (T93), nuts (T69), and lock washers (T53), attaching bottom section to mid-section. Drive dowels (T131) and (T81) out of bottom section flange. Remove bottom section.

5. Rotate drive line until removable connecting pin (T83) of the chain is visible at the drive sprocket (T5). The removable connecting pin has a spring pin in each end holding it in place. See Figure 7.



86-10-11

Figure 7. Chain Connecting Pin Set

6. Remove one spring pin, tap both the long and short connecting pins out of the chain links. Disengage chain (T18) from the drive (T5) and driven sprocket (T26) and remove from case.

7. Remove tachometer driven gear sleeve (T90) and driven gear (T89) from drive shaft housing (T11).

8. Remove the remaining cap screws attaching the coupling shaft housing (T42) to the mid-section.

9. Remove coupling shaft housing (T42) and shims (T41).

NOTE

Coupling shaft (T44) and its associated parts may come with the housing (T42).

10. Remove the coupling shaft assembly (T44) if it did not come out when removing housing (T42).

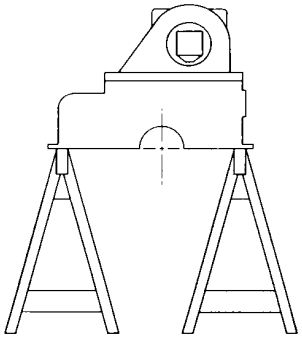
11. Remove the remaining cap screws attaching the drive shaft housing (T11) to the mid-section. The housing (T11) and the drive shaft (T13), drive sprocket (T35), shift collar (T4) and associated shaft parts can now be removed as a unit from the mid-section. The shift fork (T80) will slip off the shift shaft (T46) when the drive shaft assembly is lifted out. Remove shifter shoe (T40) from locking arm (T38).

12. Slip locking arm (T38) off pivot pin (T37).

NOTE

The pivot pin (T37) and shift shaft bushing (T112) need only be removed if bent or otherwise damaged.

13. Reposition mid and cap section assembly on the supports so that the cap portion is on top as shown in Figure #8 or set the assembly on a bench.



86-9-13

Figure 8

14. Remove 4 screws (T97) that fasten oil pump (T34) to pump support housing (T31) and remove the oil pump (T34). Do not remove the 2 small screws that fasten the pump together.

15. Remove pin (T51) attaching shift arm (T62) to shift shaft (T46). Remove shift arm (T62) and spring (T61). Remove shift shaft (T46) and attached sector gear (T47) from inside of the mid-section. Spacer (T48) will fall free as shift shaft (T46) is removed.

16. Press out bushings (T50) from mid-section. O-ring (T49) between bushings (T50) will come out when the bushings are removed.

17. Remove pin (T54) that attaches the sector gear (T47) to the shift shaft (T46) and remove the sector gear (T47).

18. Remove cap screws, bolts, nuts and stud nuts that attach the cap (T65) to the top of the mid-section.

19. Remove cap (T65) and its driven shaft from the top of the mid-section. Rapping the cap with a soft hammer will break adhesion with the shims, spacers and mid-section and free the dowels between the cap and mid-section.

CAUTION

Do not drive the dowels through the flange of the cap deeper into the mid-section or spacer plates.

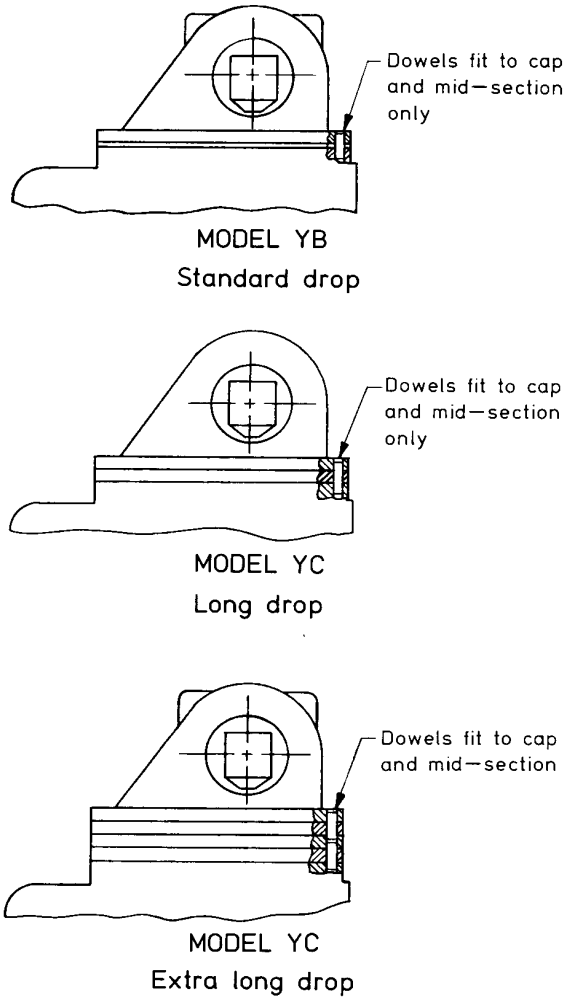
20. Remove any shims and spacers from the top of mid-section.

NOTE

1. The quantity and thickness of shims and spacers depends on transmission model and ratio.

2. On the model YB and YC (long drop), the dowels between the cap and mid-section pass freely through the shims and spacers. On the model YC (extra long drop), the spacers are doweled to each other and also to the cap and mid-section.

See Figure 9



86-9-14

Figure 9

DISASSEMBLY AND REMOVAL OF THE DRIVEN SHAFT FROM THE CHAIN CASE CAP

1. Remove 4 cap screws (T133) that fasten housing (T31) to cap (T65) and remove housing (T31).

2. Straighten tab of lock washer (T32) from slot in locknut (T33) and then remove the locknut (T33).

3. Remove flinger ring (T138) and its driving grommet (T137) from the end of the driven shaft (T135).

4. Remove 4 cap screws (T133) that fasten housing (T23) to cap (T65) but do not remove the housing (T23).

5. Under a press, support the assembly on the face of housing (T23) and apply a press load to the slot end of the driven shaft (T135) and press shaft out of bearings, (T25) spacers (T95) (T29), and sprocket (T26). Remove spacers and sprocket.

6. Remove housing (T23) and bearings (T25) from cap (T26). Remove and discard oil seal (T19) from housing (T23).

DISASSEMBLY OF COUPLING SHAFT ASSEMBLY

1. Slide housing (T42) off of bearings (T1) or (T6) if not previously removed.

2. Pull outer bearing (T1 or T6) from shaft (T44); oil seal sleeve (T14) will come off with the bearing. Remove spacer (T2), pull inner bearings (T1 or T6) from shaft. Due to closeness of this bearing to hub end of shaft (T44), a split plate type puller may be necessary.

3. Tap out pilot bearing (T3) if still in coupling shaft (T44) by using a punch through the two access holes in the coupling shaft for this purpose.

DISASSEMBLY OF DRIVE SHAFT ASSEMBLY

1. Slide shift collar (T4) from teeth on drive shaft (T13).

2. Slide housing (T11) from bearing (T15) and press oil seal (T45) from housing (T11). Discard oil seal.

3. With suitable puller, remove tachometer gear (T10) and sleeve (T14).

4. This step applicable only to units with 2.35" 46T 20/40 involute spline end.

   a. Remove spacer (T104).
   b. Remove snap ring (T105).

5. Place shaft and sprocket assembly in an arbor press in a vertical position with the spline end up and supported on the bottom face of sprocket (T5). Press shaft out of bearing (T15). Catch shaft to avoid damage.

6. Remove needle bearings (T6) from sprocket (T5).

MISCELLANEOUS

Remove any remaining fittings or hardware.

INSPECTION AND REPAIR

INSPECTION

Refer to general instructions concerning inspection of bearings and their cleaning; in addition, check for the following:

- Bent shift shaft.
- Bent shift fork.
- Worn shifter shoes.
- Loose shifter shoe studs.
- Damaged locking arm assembly, sector gear, or bent pivot pin.
- Condition of oil hoses.
- Plugged or dirty holes in oil spray tube.
- Worn or damaged drive slot in end of driven shaft.
- Oil seals, if not discarded.
- Worn oil pump.
- Worn sprocket teeth.
- Worn flanks on inner chain links.
- Outside guide links of chain not retained by "riveted over" pins.
- Wear on inner faces of outside guide links of chain.
- Badly worn pointing on teeth of shift collar, and similar wear on teeth of drive shaft and coupling shaft.
- Worn or damaged oil seal sleeves.
- Damaged or dirty sump oil strainer.
- Oil pump - If oil pump does not operate properly or shows signs of damage, it must be replaced. Check to make sure pump turns freely and drive tang is not damaged. If in doubt, contact factory for instructions.
- Damaged splines on drive and coupling shaft.

Before reassembly, make sure all reusable parts have been cleaned and are kept free of dirt during reassembly.

REASSEMBLY

INSTALLING BEARINGS

Keep reusable bearings covered and new bearings wrapped until they are to be installed. Before pressing a ball bearing on a shaft, coat bearing bore with grease. Apply grease to the outside of needle bearings. Always apply force to the inner race of a ball bearing when pressing it on a shaft, and to the outer race if pressing into a bore. Press on evenly with a piece of pipe or tube which just clears the shaft. Apply force to the cup of a needle bearing when pressing it into the bore with a pipe or tube which just clears the bore. Be sure shafts, bores, and pipe or tube used for pressing out bearings are clean before installing bearings.

INSTALLING OIL SEALS

Before installing an oil seal in its housing, coat seal O.D. evenly with oil or grease. Be sure that seal, shaft, and housing are clean. Always install a seal with the seal lip facing in. Apply force to the outer edge of a seal, and press in evenly.

INSTALLING GASKETS

If a gasket is awkward to hold in place while assembling a component, coat one of the mating flanges with grease and press the gasket into position against the flange. The grease will hold the gasket in place during reassembly.

CAP AND DRIVEN SHAFT ASSEMBLY

1. Press oil seal (T19) into housing (T23).

2. Press inner bearing (T25) up against shoulder on driven shaft (T135). Slide spacer (T95) on the shaft up against bearing (T25).

3. Install key (T136) in the keyway in the shaft up against the spacer (T95).

4. With the cap (T65) resting on its base, position the driven sprocket (T26) inside of the cap (T65) and at the same time take the driven shaft, bearing, spacer and key assembled previously and from the face of the cap that fastens to the pump body, slide the shaft through the bore in the cap into the bore in the driven sprocket (T26) lining up the key in the shaft with the keyway in the sprocket. Tap bearing (T25) into the bore in the cap (T65). If the key (T136) moves axially in its keyway, tap the key back into full engagement with the driven sprocket. Install spacer (T29) on the driven shaft up against the sprocket.

5. Place cap (T65) and driven shaft under a press with the face of the cap supported on blocking allowing the internal spline end of the driven shaft to contact and rest on the table of the press.

Position outer bearing (T25) on shaft and press the bearing (T25) on the shaft tight up against spacer (T29).

6. Remove cap and driven shaft from the press and install the bearing lockwasher (T32) and locknut (T33). Make sure the tang of the washer is in the keyway in the shaft. Tighten nut (T33) and bend one of the locking tangs on the washer (T32) into one of the slots in the locknut (T33).

7. Position gasket (T24) on housing (T23) and install housing (T23) on cap (T65). Fasten in place with cap screws and lockwashers (T107) and (T53).

8. The driven shaft assembly was factory shimmed to limit the axial float. If any of the parts have been changed, it may be necessary to change the total thickness of shims between the cap and oil pump support housing. The correct thickness of shims can be determined as follows:

Apply axial force to end of the driven shaft so it is moved forward against housing T23 as far as it can go. Install oil pump support housing (T31), less shims (T30), until the nose end of the adapter (T31) contacts the outer driven shaft bearing (T25). Measure clearance between oil pump support housing (T31) and the face of the cap (T65) and add to this measurement .005 to .010 in. and this total is the thickness of shims (T30) to install between oil pump support housing (T31) and cap. Remove the housing and install the shims and fasten the housing to the cap with cap screws (T133) and lockwashers (T9).

NOTE

Shims are color coded for thickness as follows: .005" blue, .010" brown.

9. Place this assembly aside for later installation.

DRIVE SHAFT ASSEMBLY

1. Press needle bearings (T6) into each end of bore of drive sprocket (T5) (see note below), setting them back from each face 1/8 in. Slide sprocket, coupling teeth end first, onto drive shaft (T13).

NOTE

One end of the O.D. of the cup of the needle bearings (T6) has a shiny surface and the remaining surface has a dull appearance. These bearings should be installed in the bore of the drive sprocket (T5) shiny end first.

2. Press spacer (T7) and bearing (T15) on shaft against shoulder at drive sprocket. (Drive sprocket should rotate freely on shaft after installation of the bearing.)

3. On chain case Models YBX and YCX, (with 2.35 in. spline shaft) install snap ring (T105), and spacer (T104).

4. Press tachometer gear (T10) and sleeve (T14) on shaft against shoulder (on 2 in. spline shaft), or spacer (T104) (on 2.35 in. spline shaft). Press pilot bearing (T3) on other end of shaft.

5. Press oil seal (T45) into drive shaft housing (T11). Make sure bushing (T88) is in place in the housing (T11).

6. Apply a light coat of sealant (Permatex Super 300) to face of drive shaft housing (T11). Position gasket (T17) in place on the housing (T11).

7. Install the drive shaft housing (T11) on the bearing (T15) on the drive shaft assembly

8. Place this assembly aside for later installation.

COUPLING SHAFT ASSEMBLY

1. Stand coupling shaft (T44) on press table with spline end up.

2. Press on inner bearing (T1) tight against shoulder on coupling shaft.

3. Slip spacer (T2) over shaft (T44) and seat it against bearing (T1).

4. Press on outer bearing (T1) tight against spacer (T2).

5. Press on oil seal sleeve (T14) tight against bearing inner race.

6. Press oil seal (T45) into the coupling shaft housing (T42).

7. Install the coupling shaft housing (T42) onto bearings (T1) on the coupling shaft assembly.

8. Place this assembly aside for later installation.

CASE MID-SECTION ASSEMBLY

1. Press bushings (T50) into the mid-section shift shaft hole with top of outer bushing flush with pad on the mid-section and with 1/8" space between the bushings (T50). Install O-ring (T49) in the space between the bushings (T50).

2. Install pins (T60) in shift arm (T62) and in the case mid-section.

3. Slide sector gear (T47) on the shift shaft (T46).

NOTE

The hub end of the sector gear (T80) is towards the shouldered end of the shaft. Line up the hole in the hub of the sector gear (T80) with the hole mid-length in the shift shaft (T46) and install pin (T54).

4. Slide spacer (T48) on the shift shaft (T46) up against the sector gear (T47).

5. Position spring sleeve (T59) on pin (T60) in the case mid-section.

6. Install the previously assembled shift shaft (T46) and sector gear (T47) from the inside through the shift shaft hole in the mid-section.

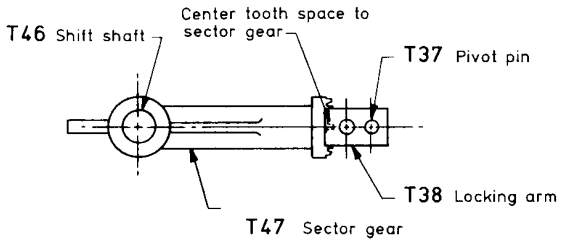
7. Insert spring (T61) in spring sleeve (T59). Position the shift arm (T62) on the shift shaft (T46). Slide down until hole in the shift arm (T62) and shift shaft (T46) line up and at the same time compress spring (T61) in its sleeve (T59) to allow pin (T60) in the shift arm (T62) to slide through the slot in the sleeve (T59). Install pin (T51) that fastens shift arm (T62) to shaft (T46). Support midsection with shift shaft in place in inverted position on work bench or other supports.

8. Install O-ring (T39) in groove in pivot pin (T37).

NOTE

This O-ring serves only to hold the locking arm (T38) on the pivot pin if the assembly is in a right side up position.

9. Install the locking arm (T38) on pivot pin (T37) and mesh with teeth on the sector gear (T47). Proper meshing of these is when the pin end of the locking arm (T38) is in line with the sector gear (T47) and the center tooth space in the sector gear (T47) is centered with the pivot pin (T37). See Figure 10.



Proper meshing of sector gear and locking arm at mid—point of sector gear travel.

86-9-15

Figure 10

10. Install shifter shoe (T40) on the pin on the locking arm (T38).

NOTE

Shifter shoe (T40) can be installed with face with counterbore at hole either up or down.

11. Install adjusting screws (T86) in the mid-section and adjust these screws so that locking arm (T38) is rotatable slightly less than 90° each direction from a center position with the sector gear (T47).

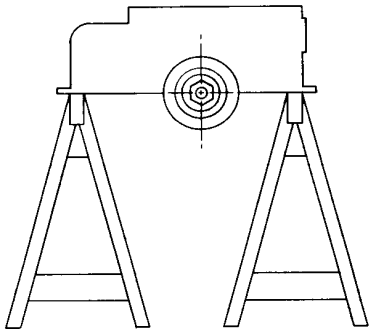
12. a. If unit does not incorporate an electric shift assembly, align slot in adjusting screws (T86), install adjusting screw retainers (T87) in slots in adjusting screws (T86). Install gasket (T56), manual shift indicator light bracket, if so equipped, and cover (T55) and fasten with cap screws.

12. b. If equipped with electric shift, the electric shift assembly should not be installed until assembly of the case has been completed. The adjusting screw retainers will be installed when the electric shift unit is installed.

13. Slide the shift collar (T4) into engagement with the shoes (T75) on the shift fork (T80). The 3/16 x 45° (chamfered) pointed (tapered) end of the collar to face towards the drive shaft end of the case.

14. Take the drive shaft and housing assembly and install it into the half bore in the mid-section of case (T28). Make sure tachometer drive outlet is orientated. Engage the teeth at the end of the drive sprocket (T18) with those in the shift collar (T4). Line up holes in housing (T11) with holes in the case and install cap screws (T16) and lockwashers (T9) and tighten finger tight only.

15. Support the mid-section and drive shaft assembly on suitable blocking so the flange that cap (T65) will bolt to is up. See Figure 11.



86-9-16

Figure 11

CAP AND DRIVEN SHAFT ASSEMBLY TO MID-SECTION ASSEMBLY

1. Make sure face of flanges that meet on the mid-section and cap are clean and free of nicks and burrs.

2. Clean shims (T99) on "YB" models and shims and/or spacer(s) (T100) on "YC" models. Install dowels (T103) in top flange of the mid-section.

3. Apply light coat of sealant (Permatex Super 300) to face of top flange of the mid-section. Place shims (T99) and/or spacers (T100) in place on the dowels (T103) in the flange of the mid-section.

NOTE

On extra long drop "YC" models, install dowels (T103) also in top spacer (T100).

4. Apply light coat of sealant (Permatex Super 300) to top surface of last shim (T99) or spacer (T100).

5. Position previously assembled cap and driven shaft on dowels in the top flange of the mid-section and tap down into contact with shims or spacer. Install fasteners with lockwashers and tighten evenly.

NOTE

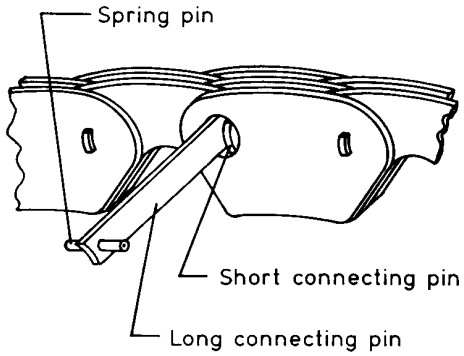
Fasteners used vary between models YB and YC. Refer to table in Service Parts List for location and types of fasteners.

6. Support the mid-section and cap assembly in an upside down position on suitable supports. See Figure 6.

INSTALLING THE CHAIN

1. Lower one end of the chain (T18) into the case until it touches the inside of the cap (T65). Reach down into the case and grasp the lower end of the chain (T18) and pull it up and engage it with the teeth on the driven sprocket (T26) and drive sprocket (T5). Mesh the chain ends together around the drive sprocket (T5) and install the connecting pins as noted below and shown in Figure 12.

2. Tap the short connecting pin partway through holes in end links. Tap a spring pin (T108) in one hole of the long connecting pin, and start the long pin in the side link alongside the short pin. See Figure 12. Make sure the long pin is installed nearest the end of the connecting guide link.



When connecting the open ends with a pin set, it is very important that the longer pin of the set must seat nearest to the outside flank of the guide plate.

86-10-12

Figure 12

3. Tap both connecting pins through the chain end links, aligning the links as the pins go through. Tap the other spring pin (T108) in the other hole of the long connecting pin. Make sure the spring pins overlap the short connecting pin on each end.

INSTALLING THE LOWER SECTION OF CASE (T28) TO THE MID-SECTION

1. Install lower shift shaft bushing (T112) into lower portion of case assembly (T28).

2. Install dowels (T31) in flange of the mid-section portion of the case (T28).

3. Coat flange of the mid-section portion of the case (T28) with a light coat of sealant (Permatex Super 300).

4. Position lower portion of the case (T28) to the mid-section of the case and align with dowels (T31) and tap into position until flanges of the mid-section and lower section meet. Install cap screws (93), bolts (T52), lockwashers (T53) and nuts (T69) and tighten securely. See Table in Service Parts List for location of the fasteners.

5. Install cap screws (T8) with nylock insert and lockwashers (T9) in drive shaft housing (T11) and tighten these fasteners and previously installed in the drive shaft housing cap screws (T11) securely.

INSTALLING THE COUPLING SHAFT AND HOUSING ASSEMBLY TO CASE (T28)

NOTE

The drive line assembly was factory shimmed to limit the axial float of the drive line. If any of the drive line parts have been changed, it may be necessary to change the total thickness of shims (T41) between the coupling shaft housing (T42) and the transmission case. Shims are color coded for thickness as follows: .005" blue, .007" natural, .010" brown. The correct thickness of shims can be determined as follows:

1. Install coupling shaft and housing assembly (T42) with no shims between the housing and case. Tighten cap screws evenly and tap the end of the coupling shaft with a soft mallet to force drive line all the way forward. Do not overtighten causing bending or breakage of the coupling shaft housing.

2. Measure gaps between housing and case in several places to assure a uniform gap, and add 0.005 in. This will be the total thickness of shims needed to provide the recommended axial float of 0.005 in.

3. Remove coupling shaft housing from case after measuring gap.

NOTE

Field conditions may make it difficult to determine the correct amount of shims. If in doubt, add another 0.005 in. shims. No harm will result from a small amount of additional axial float but bearing life will be shortened if bearings are excessively preloaded.

4. Install correct amount of shims on the coupling shaft housing, or if all original parts are being reused, reinstall original shims (T41) (if not reuseable, replace with new shims) on coupling shaft housing (T42) applying a light coat of Permatex sealant between shims and on both faces of first and last shim. Install the housing over the bearings (T1 or T6) on the coupling shaft. If the unit is equipped with a parking brake make sure the coupling shaft housing (T42) is properly orientated so that the drain tube (T85) will point down when the case is reattached to the pump. Tighten housing in case half (T74) with cap screws. Use the (T8) cap screws with the nylon seal in lower half of housing and (T16) screws in upper half.

REASSEMBLY OF MISCELLANEOUS PARTS

TACHOMETER DRIVE

1. Install tachometer driven gear (T89) in drive shaft housing (T11) making sure it fits into bushing (T88) previously installed in the housing.

2. Install sleeve (T90) over end of gear (T89) and thread into housing (T11). Install flinger grommet (T137) and flinger disc (T138) on end of the driven shaft. Tapered end of grommet (T137) should face the pump.

MISCELLANEOUS HARDWARE

1. Install magnetic drain plug (T58).

2. Install street elbow (T57) and breather (T27).

3. Install oil level plug (T73) and site plug (T134).

4. Install breather (T27).

5. Install sump oil strainer (T132).

OIL PUMP

1. Install gasket (T96) over pilot diameter on oil pump (T34).
2. Position pump (T34) on adapter (31).

3. Line up drive tang of oil pump shaft with slot in driven shaft.

4. Fit pilot diameter of oil pump (T34) into adapter (T31) making sure tang on oil pump shaft and slot in driven shaft line up and engage. Fasten pump (T34) to adapter (T31) with screws (T97) which pass through pump into the adapter.

OIL HOSES

1. Install nipple (T101), tee (T102), hose (T64), if previously removed, and adapter union (T66) between discharge side of pump and spray tube assembly.

2. Install street elbows (T57) at sump strainer (T132) and inlet of oil pump (T34).

3. Install adapter union (T66) in elbow (T57) at sump strainer (T132).

4. Install hose (T67).

5. Install plug (T98) (a pressure gage may have been installed) in tee (T102) and case (T28).

REINSTALLING THE TRANSMISSION TO THE PUMP

1. Reposition under the chassis and provide means for lifting into position.

2. Raise the transmission to alignment with the spline end of the pump impeller shaft.

3. Rotate shafts to align spline joint.
4. Slide the transmission towards the pump and guide end of oil seal housing (T23) into the bore in the mounting flange on the pump body.

5. Install the 8 cap screws that fasten the transmission to the mounting flange and slowly and evenly tighten these to draw the transmission tight to the mounting flange.

REASSEMBLY OF ACCESSORIES TO THE TRANSMISSION

ELECTRIC SHIFT ASSEMBLY

1. Make sure adjusting screws (T86) are in place and adjusted, and adjusting screw retainer (T87) installed in slot in end of each screw.

2. Position and bolt electric shift assembly into place making sure gasket (T56) is installed between shift assembly and face of the case (T74). Fasten in place with cap screws (T52).

3. Fasten pivot plate (T62) and cover (T75) to shift arm (T62) if these were removed.

4. Reconnect wiring and check for proper adjustment of indicator light switch if shift unit is so equipped.

NOTE

If chassis is equipped with an automatic transmission, indicator lights must be used.

Refer to separate Operation and Maintenance Instructions for adjustment of the shift switch. For detail of electric shift assembly, refer to separate Service Parts List .

BRAKE ASSEMBLY

1. If previously removed, reinstall the drain tube (T85) in hole in bottom of coupling shaft housing (T42).

2. Install and fasten brake assembly to coupling shaft housing (T42). Install related linkage and brake drum, and adjust brake. For detailed instructions on brake installation and adjustment, refer to separate instructions.

PRIMING PUMP

Reinstall priming pump and reconnect primer wiring, hose to priming valve, and tube to priming tank. As various types of priming pumps are available, see separate instructions covering the type furnished with the transmission:

COMPANION FLANGES

1. Slide companion flange or end yoke on the drive shaft (T13) up against the oil seal sleeve (T14), or pulley if equipped with a belt driven primer.

2. Install washer (T94) and lock nut (T43); tighten nut securely. Make sure one slot in nut lines up with hole in end of drive shaft (T13). Install cotter pin (T12) and spread open split end of pin.

3. Repeat same installation procedure at coupling shaft end unless companion flange was previously installed at the time the brake assembly was installed.

PROPELLER SHAFT RECONNECT

Reconnect drive line to companion flanges, or end yoke. Tighten all connecting bolts securely.

LUBRICATION AND FINAL CHECK

Fill transmission to oil level plug hole with automatic transmission fluid (approximately 12-1/4 quarts required). The exact capacity will vary depending on transmission ratio.

1. Recheck fasteners for tightness.
2. Check for oil leaks.
3. Recheck for proper operation of shift mechanism and that shift indicator light system (if so equipped), is functioning properly.

Issued: 5/23/88
Revised: 4/3/00

WATEROUS

WATEROUS COMPANY
SOUTH ST. PAUL, MINNESOTA

Y SERIES CHAIN DRIVE TRANSMISSION

REF NO.	DESCRIPTION	REF NO.	DESCRIPTION
T1	Ball bearing	T29	Bearing spacer, driven shaft
T2	Spacer, coupling shaft	T30	Shim, bearing housing, 0.005 (blue) and 0.010 (brown) in. thick
T3	Ball bearing, drive shaft pilot	T32	Bearing lock washer
T4	Shift collar	T33	Bearing lock nut
T5	Drive sprocket	T34	Oil circulating pump
T6	Needle bearing	T37	Pivot pin, 5/8 x 2-3/4 in.
T7	Thrust washer	T38	Locking arm assembly
T8	Cap screw w/thread sealant, 3/8-16 x 1-1/4 in.	T39	O-ring, 1/4 x 3/8 in.
T9	Lock washer, 3/8 in.	T40	Shifter shoe
T10	Drive gear or pulse generator, tachometer	T41	Shim, coupling shaft housing, 0.005 (blue), 0.007 (natural), and 0.010 (brown) in. thick.
T11	Drive shaft housing subassembly	T42	Coupling shaft housing
T12	Cotter pin, SS, 1/8 x 1-3/4 in.	T43	Shaft nut
T13	Drive shaft	T44	Coupling shaft
T14	Oil seal sleeve	T45	Oil seal, 2-1/2 x 3-1/4 or 2-3/4 x 3-1/2 in.
T15	Ball bearing, drive shaft	T46	Shift shaft
T17	Drive shaft housing gasket	T47	Sector gear
T18	Drive chain	T48	Gear sector spacer
T19	Oil seal, 1-7/8 x 2-3/4 in.	T49	O-ring, 7/8 x 1 in.
T23	Oil seal housing	T50	Shift shaft bushing
T24	Oil seal housing gasket	T51	Spirol pin, SS, 5/16 x 1-3/8 in.
T25	Ball bearing, driven shaft	T52	Cap screw, 1/2-13 x 1-1/4 in., Grade 5
T26	Driven sprocket	T53	Lock washer, 1/2 in.
T27	Breather, 1/2 NPT	T54	Spirol pin, heavy duty, 3/8 x 1-3/4 in.
T28	Chain case assembly (Supplied as assembly only consisting of mid section and bottom section)	T55	Shift cover

PLEASE NOTE

SPL81617

WHEN ORDERING PARTS PLEASE SUPPLY PUMP SERIAL NUMBER

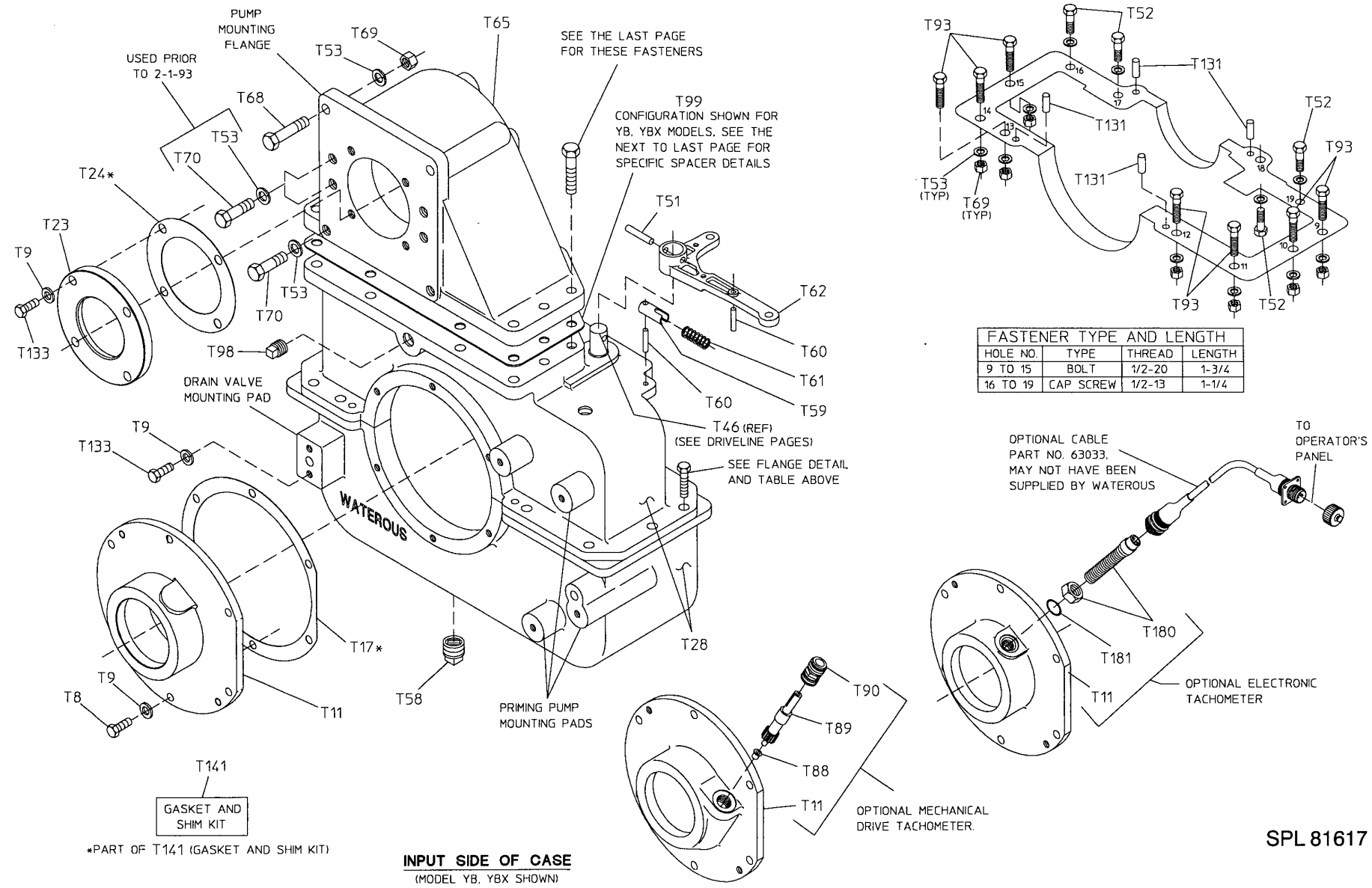
Y SERIES CHAIN DRIVE TRANSMISSION

REF NO.	DESCRIPTION
T56	Shift cover gasket
T57	Street elbow, 90°, 1/2 in. NPT
T58	Magnetic drain plug, 3/4 in. NPT
T59	Spring housing, shift arm
T60	Spirol pin, SS, 1/4 x 1-1/4 in.
T61	Shift arm spring
T62	Shift arm
T64	Hose, oil pump to spray tube
T65	Chain case cap
T66	Straight adapter union, 1/2 in.
T67	Hose, sump to oil pump
T68	Hex hd bolt, 1/2-20 x 2-1/4 (YB) or 4-1/2 in. (YC) or 5 in., 5-1/2 in. and 6 in. (YD)
T69	Hex nut, 1/2-20
T70	Cap screw, 1/2-13 x 1-1/2 in. (YB) or 3-1/2 in. (YC) or 4-1/2 in., 4-3/4 in. and 5 in. (YD)
T72	Cap screw, 1/2-13 x 1 in., Grade 5 (with thread sealant)
T73	Sq hd pipe plug, 3/4 in. NPT
T75	Shifter shoe (included with fork T80) Available individually for repairs
T76	Shifter shoe stud (included with fork T80) Available individually for repairs
T80	Shift fork (supplied with shifter shoe T75 and shifter shoe studs T76)
T85	Drain pipe
T86	Adjusting screw
T87	Adjusting screw retainer
T88	Driven gear bushing, tachometer
T89	Driven gear, tachometer
T90	Driven gear sleeve, tachometer
T93	Hex hd bolt, 1/2-20 x 1-3/4 in.
T94	Washer, plain, 1-1/4 in.
T95	Bearing spacer, driven shaft
T96	Gasket, oil pump
T97	Cap screw, 5/15-18 x 3-1/4 in.
T98	Sq hd pipe plug, 1/2 in. NPT, steel
T99	Spacer, cap
T100	Spacer, cap (YC, YD, YE & YF)
T101	Nipple, pipe, 1/2 x 2-1/2 in. NPT
T102	Tee, pipe, 1/2 in. NPT
T103	Pin, dowel, 1/2 x 1-1/2 in. (YB) or 3 in. (YC)
T104	Spacer, tachometer gear
T105	Ring, retaining (chain repairs)
T106	Hex hd screw, 1/2-20 x 2 in.
T109	Stud, 1/2-13 x 1/2-20 4-1/4 in. (YC only) or 5-1/4 in. (YD)
T110	Stud, 1/2-20 x 1/2-20, 4-3/4 (YC only) or 6, 6-1/4 in (YD)
T112	Lower shift shaft bushing

SPL81617

Y SERIES CHAIN DRIVE TRANSMISSION

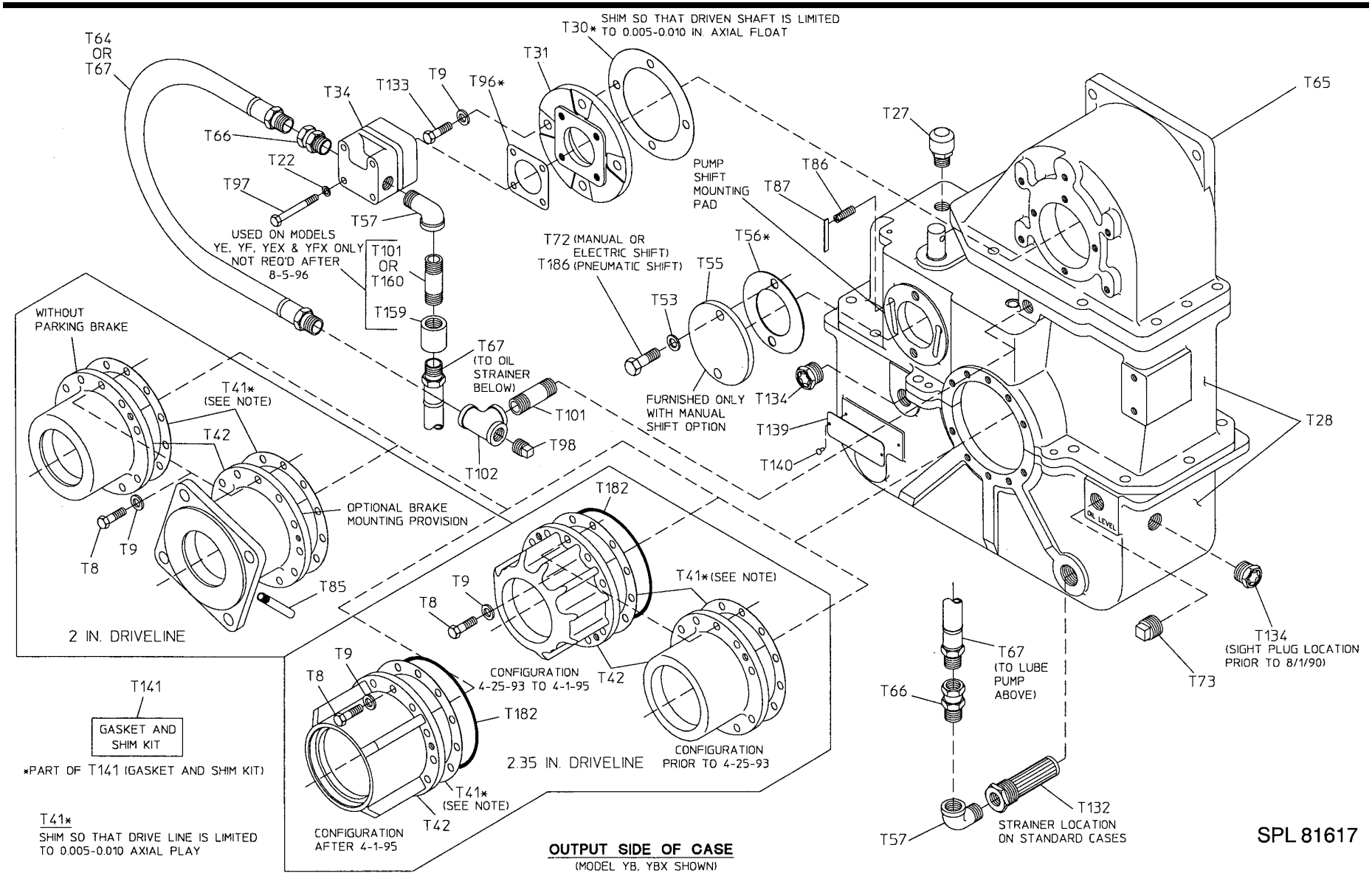
REF NO.	DESCRIPTION	REF NO.	DESCRIPTION
T131	Pin, dowel, 3/8 x 1 in. (part of T28)	T159	Coupling pipe, 1/2 NPT
T132	Oil strainer	T160	Nipple, pipe, 1/2 x 3-1/2 NPT
T133	Cap screw, 3/8-16 x 1 in.	T173	Actuating shift lever
T134	Sight plug	T174	Cap screw, 1/2-13 x 1-3/4 in. (YB)
T135	Shaft, driven	T175	Pipe plug, 1 NPT
T136	Square key, 5/16 x 2-5/16 in.	T176	Retaining washer
T138	V-ring flinger (used prior to 8/26/93)	T177	Dowel pin, 1/2 x 1-3/4 in. (YF only)
	Sealing boot (used after 8/26/93)	T178	Hex nut, 1/2-13
T139	Serial plate	T179	Socket hd screw, 5/16-24 x 1
T140	Rd hd drive screw, No. 6 x 1/4 in.	T180	Magnetic pickup
T141	Gasket and shim kit	T181	O-ring, 5/8 x 3/4 in.
	Consists of: T56, T24, T41, T30, T94, T43, T96, & T17	T182	O-ring, 4-3/4 x 5 in.
T147	Stud, 1/2-13 x 1/2 x 7-3/4 in. (YE) or 8-3/4 in. (YF)	T184	Ball bearing, double row
T148	Stud, 1/2-13 x 1/2-20 x 7-1/2 in. (YE)	T185	Cap screw, 1/2-13 x 1-1/4 in., Grade 5 (w/thread sealant)
T149	Sutd, 1/2-13 x 1/2-20 x 6-1/2 (YE)		
T150	Stud, 1/2-20 x 1/2-20 x 8-3/8 in. (YE) or 9-1/2 in. (YF)	T186	Cap screw, 1/2-13 x 1-1/4 in., Grade 5 (with thread sealant)
T151	Stud, 1/2-20 x 1/2-20 x 8 in. (YE)		
T152	Stud, 1/2-20 x 1/2-20 x 7 in. (YE)	T187	Oil seal, 3-1/2 x 4-3/8 in.
T153	Cap screw, 1/2-13 x 6 in. (YE)	T190	Bearing sleeve
T154	Cap screw, 1/2-13 x 7 in. (YE) or 8 in. (YF)	T191	Stud, 1/2-20 x 1/2-20 x 2-3/4 in. (YD)
T155	Cap screw, 1/2-20 x 6-1/4 in. (YE)	T230	Coupling shaft spacer
T156	Cap screw, 1/2-20 x 6-1/4 in. (YE) or 1/2-13 x 9 in. (YF)	T231	Oil seal, 2-1/2 in. x 3-1/2 in.
T157	Cap screw, 1/2-20 x 7-1/4 in. (YE)	T237	Shoulder screw, 3/8 x 1-3/4 in.
T158	Cap screw, 1/2-20 x 7-1/2 in. (YE)	T238	Lock nut, 5/16-18 in.

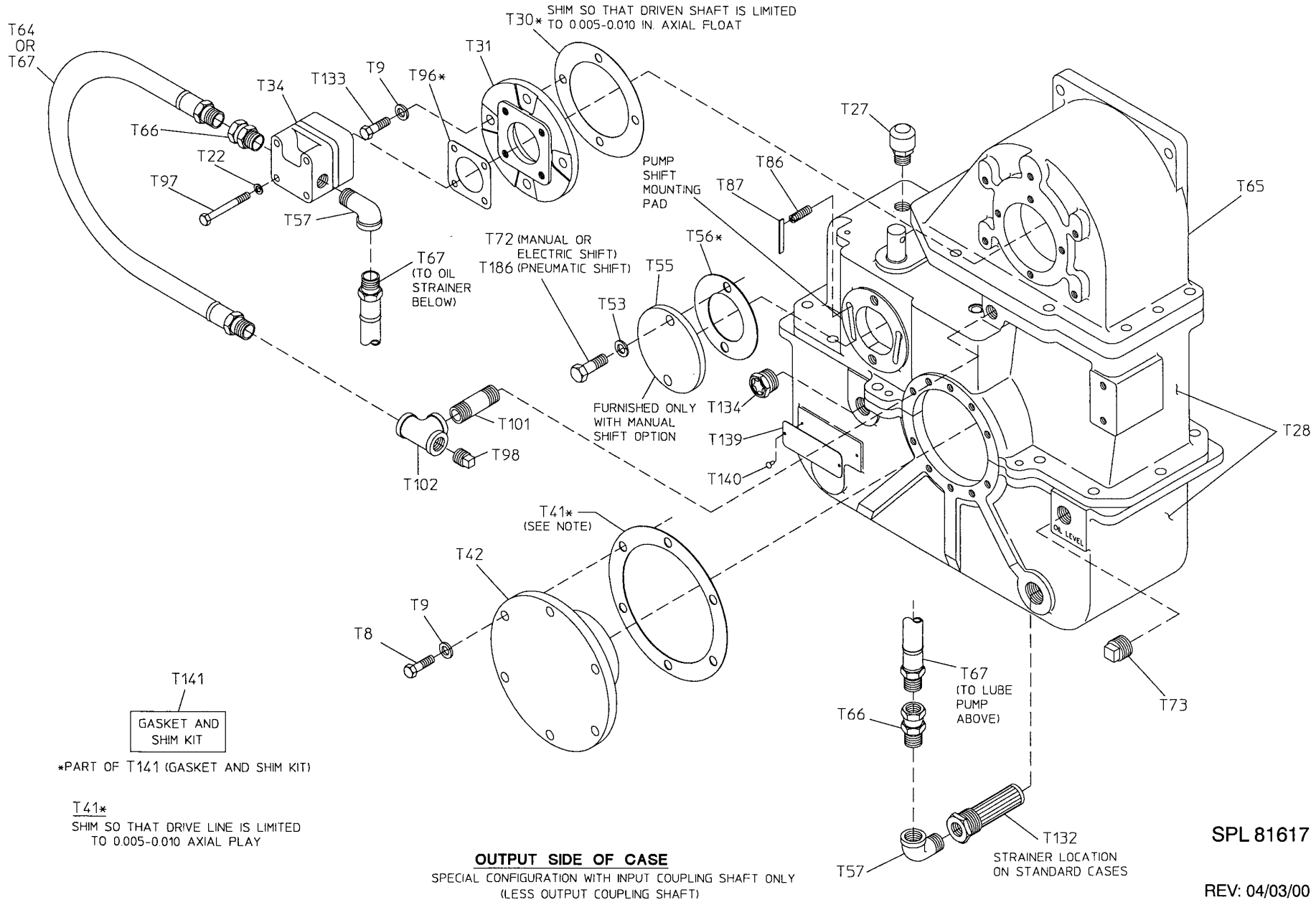


FASTENER TYPE AND LENGTH			
HOLE NO.	TYPE	THREAD	LENGTH
9 TO 15	BOLT	1/2-20	1-3/4
16 TO 19	CAP SCREW	1/2-13	1-1/4

SPL 81617

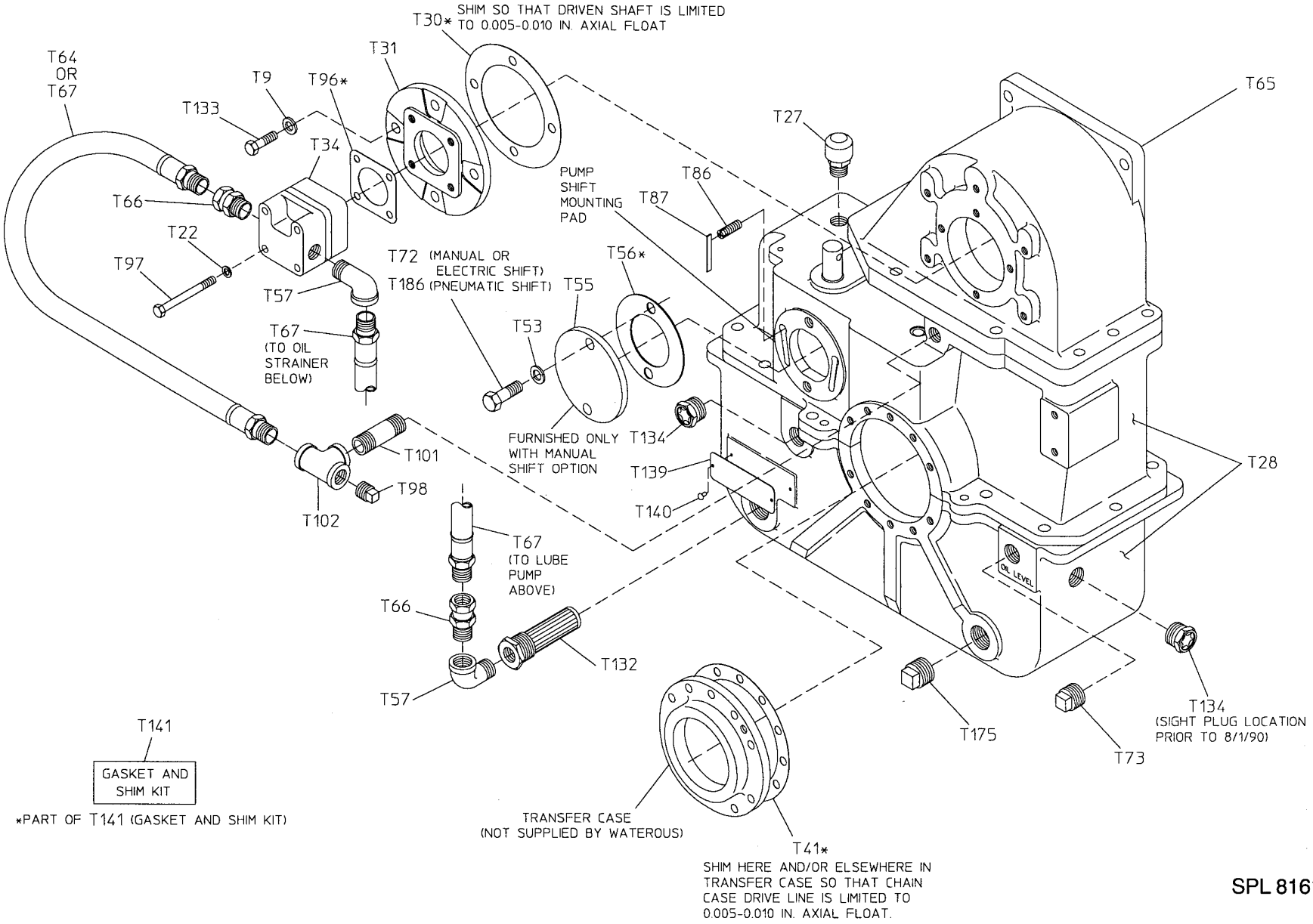
REV: 04/03/00


T64
OR
T67
T66
T22
T97
T34
T133
T9
T96*
T30*
SHIM SO THAT DRIVEN SHAFT IS LIMITED
TO 0.005-0.010 IN. AXIAL FLOAT
T31
T57
USED ON MODELS
YE, YF, YEX & YFX ONLY
NOT REQ'D AFTER
8-5-96
T101
OR
T160
T159
T67
(TO OIL
STRAINER
BELOW)
T101
T98
T102
T72 (MANUAL OR
ELECTRIC SHIFT)
T186 (PNEUMATIC SHIFT)
T53
T55
T56*
PUMP
SHIFT
MOUNTING
PAD
T86
T87
T27
T65
T28
T134
T139
T140
FURNISHED ONLY
WITH MANUAL
SHIFT OPTION
WITHOUT
PARKING BRAKE
T41*
(SEE NOTE)
T42
OPTIONAL BRAKE
MOUNTING PROVISION
T8
T9
T85
2 IN. DRIVELINE
T182
T9
T8
T41* (SEE NOTE)
T42
CONFIGURATION
4-25-93 TO 4-1-95
T9
T8
T182
T41*
(SEE NOTE)
T42
CONFIGURATION
AFTER 4-1-95
2.35 IN. DRIVELINE
CONFIGURATION
PRIOR TO 4-25-93
T67
(TO LUBE
PUMP
ABOVE)
T66
T132
STRAINER LOCATION
ON STANDARD CASES
T57
T134
(SIGHT PLUG LOCATION
PRIOR TO 8/1/90)
T73
T141
GASKET AND
SHIM KIT
*PART OF T141 (GASKET AND SHIM KIT)
T41*
SHIM SO THAT DRIVE LINE IS LIMITED
TO 0.005-0.010 AXIAL PLAY
OUTPUT SIDE OF CASE
(MODEL YB, YBX SHOWN)
SPL 81617
REV: 04/03/00



SPL 81617

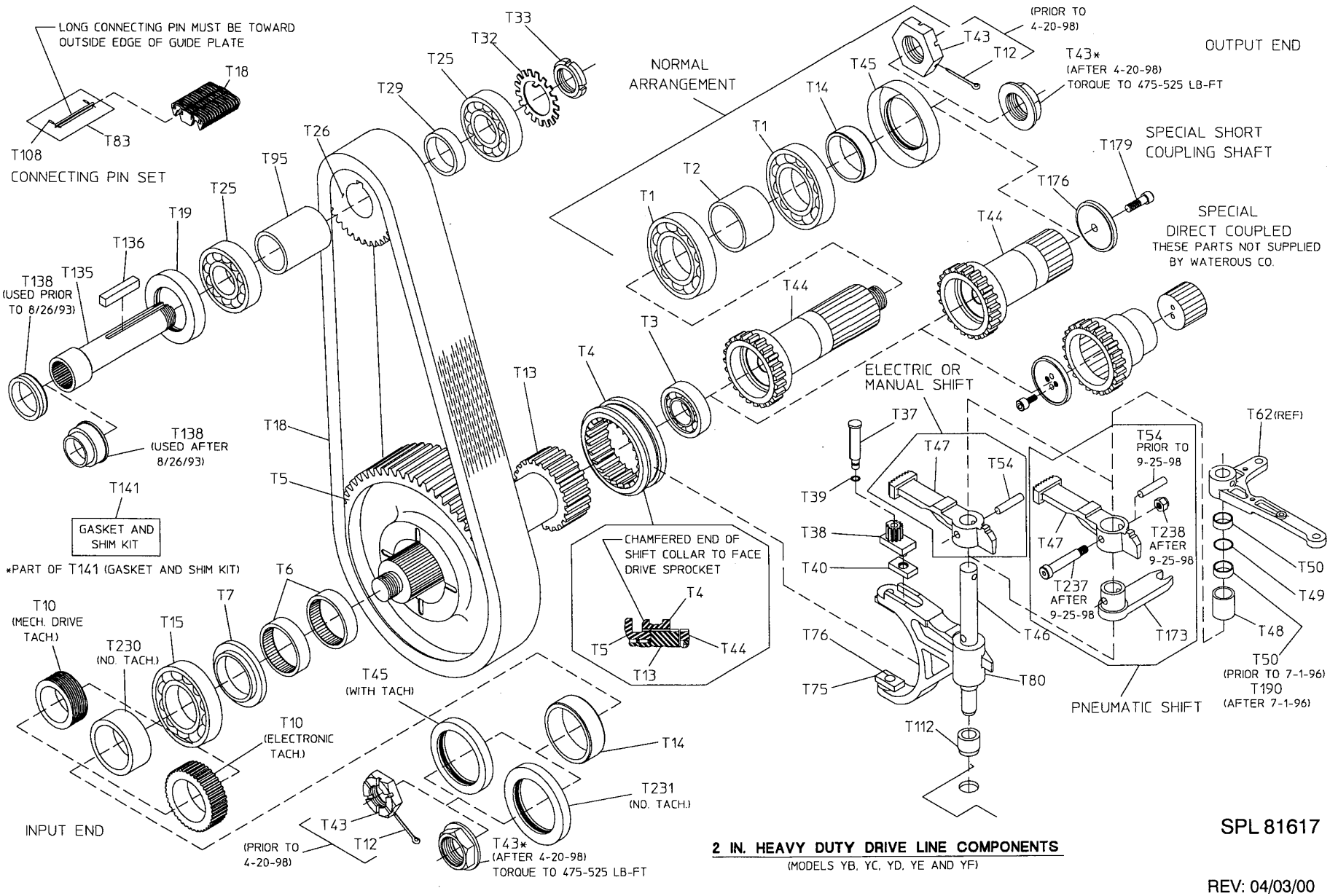
REV: 04/03/00

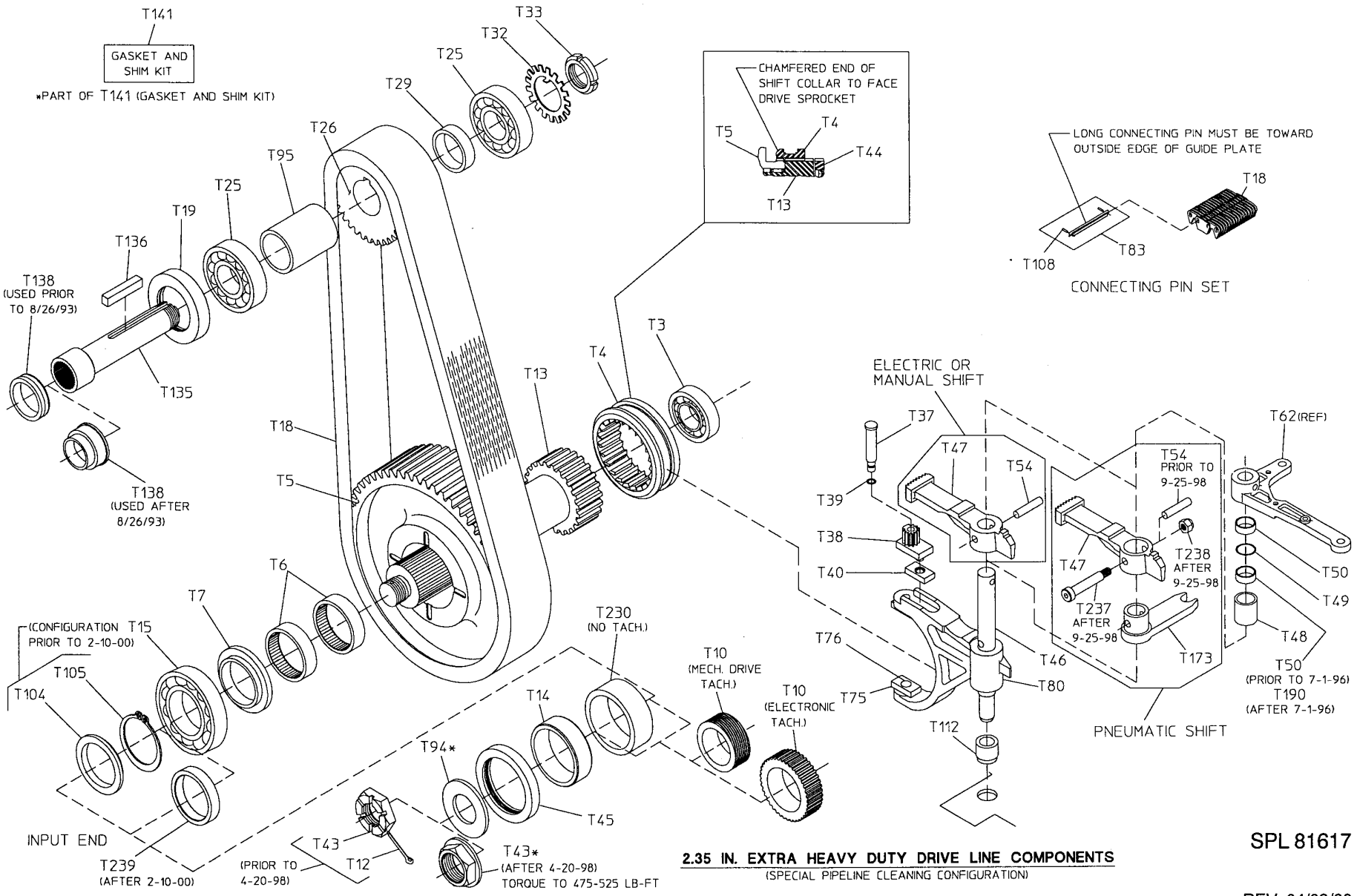


SPL 81617

OUTPUT SIDE OF CASE
(SPECIAL DIRECT COUPLED CONFIGURATION)

REV: 04/03/00

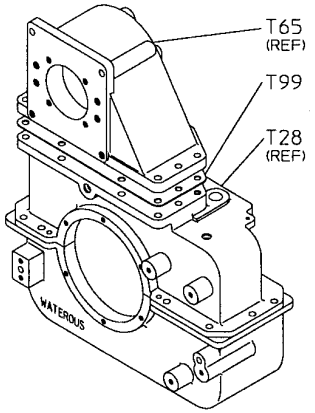

LONG CONNECTING PIN MUST BE TOWARD OUTSIDE EDGE OF GUIDE PLATE
T18
T83
T108
CONNECTING PIN SET
T33
T32
T25
T29
T26
T95
T25
T19
T136
T135
T138 (USED PRIOR TO 8/26/93)
T138 (USED AFTER 8/26/93)
T141
GASKET AND SHIM KIT
*PART OF T141 (GASKET AND SHIM KIT)
T18
T5
T6
T7
T10 (MECH. DRIVE TACH.)
T230 (NO. TACH.)
T15
T10 (ELECTRONIC TACH.)
INPUT END
T45 (WITH TACH)
T14
T231 (NO. TACH.)
T43
T12
(PRIOR TO 4-20-98)
T43* (AFTER 4-20-98) TORQUE TO 475-525 LB-FT
NORMAL ARRANGEMENT
T1
T2
T1
T14
T45
T43
T12
(PRIOR TO 4-20-98)
T43* (AFTER 4-20-98) TORQUE TO 475-525 LB-FT
OUTPUT END
SPECIAL SHORT COUPLING SHAFT
T179
T176
T44
SPECIAL DIRECT COUPLED
THESE PARTS NOT SUPPLIED BY WATEROUS CO.
T44
T3
T4
T13
CHAMFERED END OF SHIFT COLLAR TO FACE DRIVE SPROCKET
T4
T5
T44
T13
ELECTRIC OR MANUAL SHIFT
T37
T47
T54
T39
T38
T40
T76
T75
T80
T112
T54 PRIOR TO 9-25-98
T47
T238 AFTER 9-25-98
T237 AFTER 9-25-98
T173
T46
PNEUMATIC SHIFT
T62 (REF)
T50
T49
T48
T50 (PRIOR TO 7-1-96)
T190 (AFTER 7-1-96)
SPL 81617
2 IN. HEAVY DUTY DRIVE LINE COMPONENTS
(MODELS YB, YC, YD, YE AND YF)
REV: 04/03/00



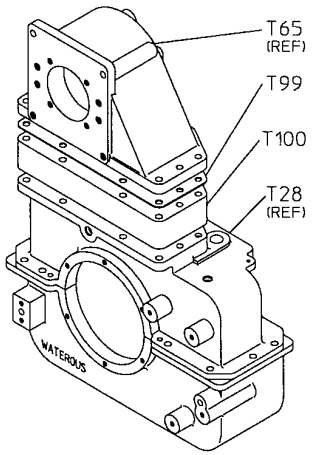
2.35 IN. EXTRA HEAVY DUTY DRIVE LINE COMPONENTS
(SPECIAL PIPELINE CLEANING CONFIGURATION)

SPL 81617

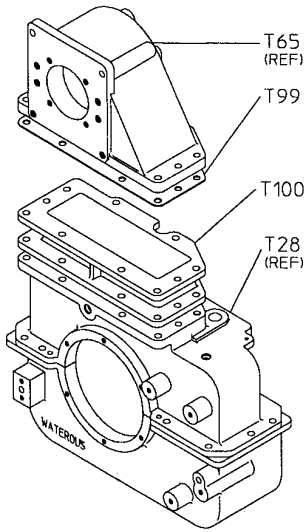
REV: 04/03/00



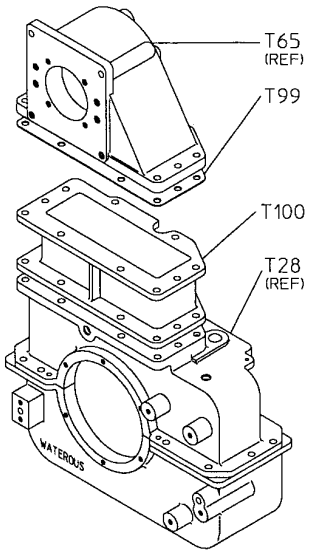
MODELS YB, YBX



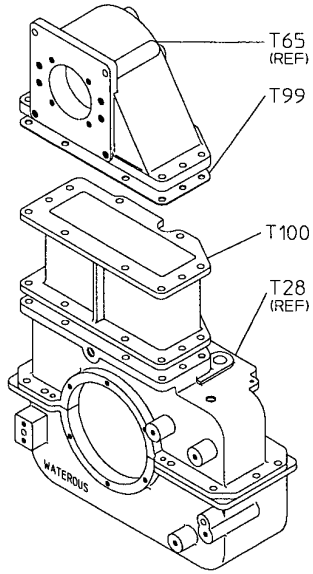
MODELS YC, YCX



MODELS YD, YDX
(AFTER 8-5-96)



MODELS YE, YEX
(AFTER 8-5-96)



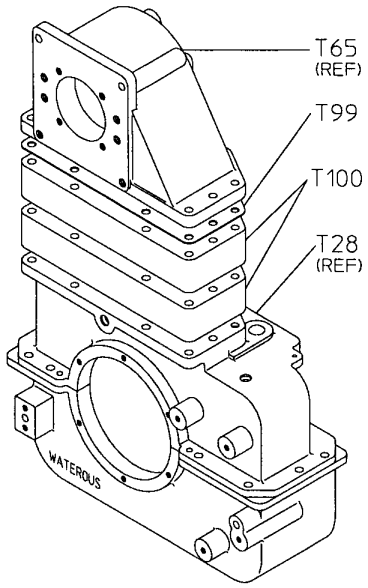
MODELS YF, YFX
(AFTER 8-5-96)

RATIOS	MODELS YB, YBX	MODELS YC, YCX		MODELS YD, YDX (AFTER 8-5-96)		MODELS YE, YEX (AFTER 8-5-96)		MODELS YF, YFX (AFTER 8-5-96)	
	T99	T99	T100	T99	T100	T99	T100	T99	T100
1.14	2	6	1	4	1	3	1	2	1
1.27	0	0	1	3	1	2	1	1	1
1.41	0	3	1	3	1	2	1	1	1
1.48	4	5	1	3	1	1	1	1	1
1.58	0	2	1	2	1	1	1	0	1
1.69	4	0	1	1	1	4	1	4	1
1.79	2	1	1	1	1	3	1	2	1
1.88	2	0	1	1	1	3	1	2	1
1.97	2	1	1	2	1	2	1	3	1
2.03	0	2	1	2	1	1	1	2	1
2.27	0	3	1	0	1	0	1	0	1
2.46	3	3	1	1	1	3	1	3	1
2.73	3	1	1	3	1	2	1	2	1

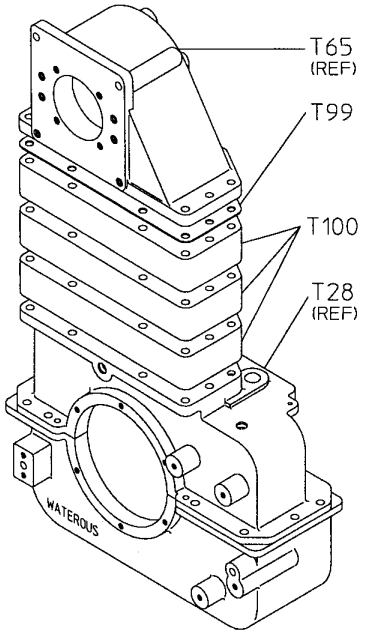
SPACERS BETWEEN CAP (T65) AND CASE (T28)
(SEE FOLLOWING PAGES FOR HARDWARE DETAILS)
CURRENT CONFIGURATION

SPL 81617

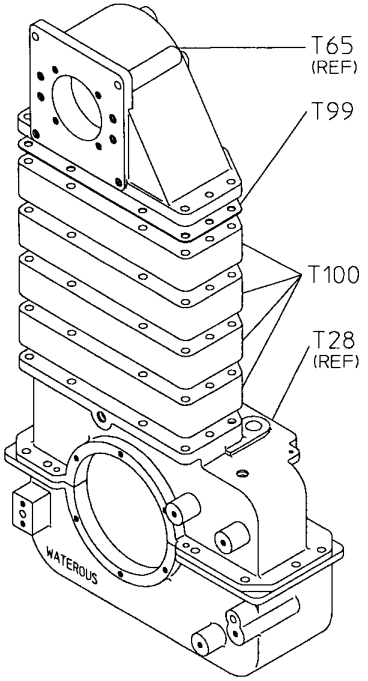
REV: 04/03/00



MODELS YD, YDX
(PRIOR TO 8-5-96)



MODELS YE, YEX
(PRIOR TO 8-5-96)



MODELS YF, YFX
(PRIOR TO 8-5-96)

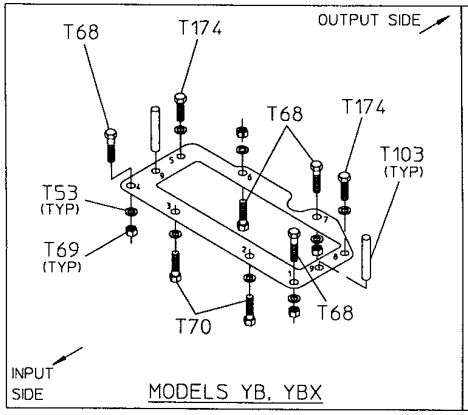
RATIOS	MODELS YD, YDX (PRIOR TO 8-5-96)		MODELS YE, YEX (PRIOR TO 8-5-96)		MODELS YF, YFX (PRIOR TO 8-5-96)	
	T99	T100	T99	T100	T99	T100
1.14	*	*	*	*	*	*
1.27	*	*	2	3	*	*
1.41	*	*	*	*	*	*
1.48	*	*	*	*	*	*
1.58	*	*	3	3	*	*
1.69	0	2	*	*	*	*
1.79	0	2	2	3	2	4
1.88	1	2	3	3	2	4
1.97	2	2	3	3	*	*
2.03	1	2	3	3	*	*
2.27	3	2	0	3	0	4
2.46	2	2	3	3	*	*
2.73	*	*	*	*	*	*

*NOTE: THESE RATIOS ARE NOT AS YET AVAILABLE FOR THESE MODELS.

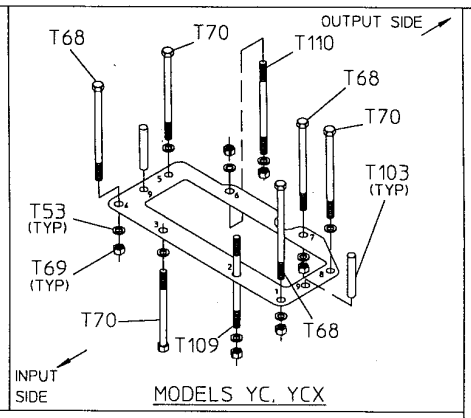
SPACERS BETWEEN CAP (T65) AND CASE (T28)
(SEE FOLLOWING PAGES FOR HARDWARE DETAILS)
CONFIGURATION PRIOR TO 8-5-96

SPL 81617

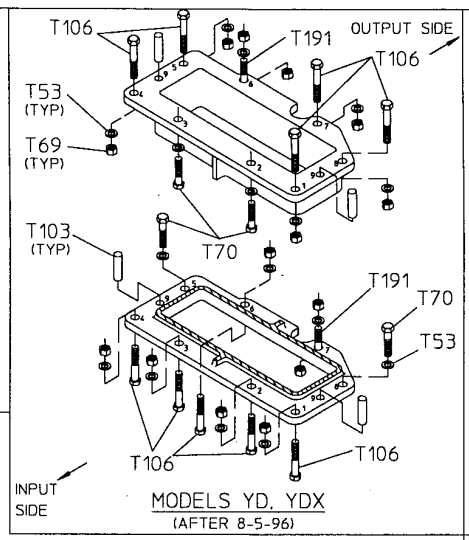
REV: 04/03/00



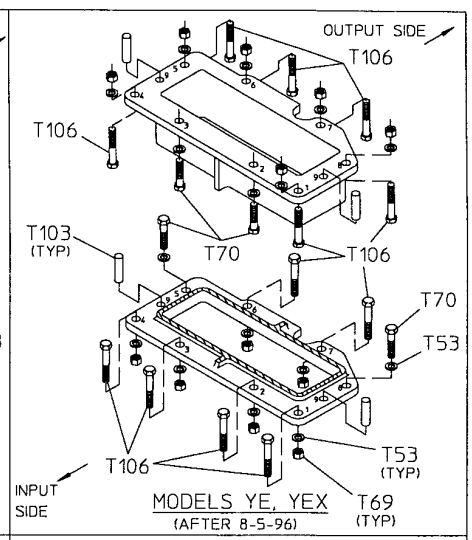
MODELS YB, YBX



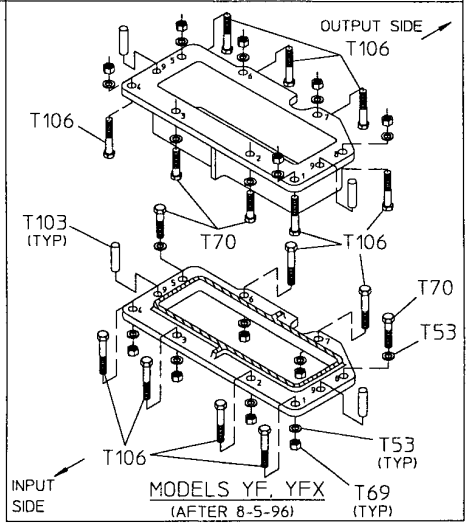
MODELS YC, YCX



MODELS YD, YDX
(AFTER 8-5-96)



MODELS YE, YEX
(AFTER 8-5-96)



MODELS YF, YFX
(AFTER 8-5-96)

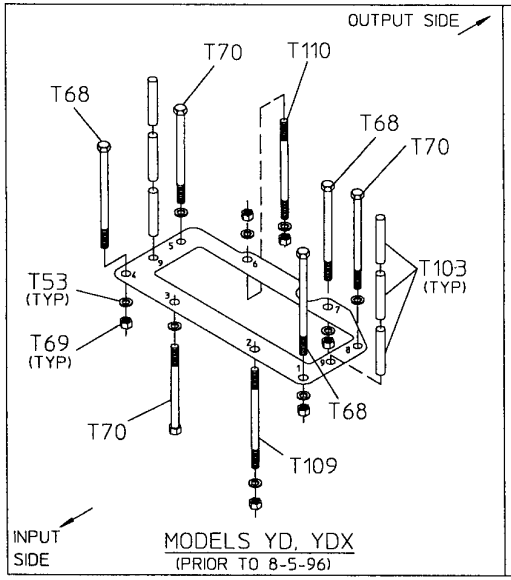
REF NO.	TYPE	THREAD	LENGTH (MODEL)				
			YB, YBX	YC, YCX	YD, YDX	YE, YEX	YF, YFX
T53	LOCKWASHER	1/2	---	---	---	---	---
T68	HEX HD BOLT	1/2-20	2-1/4	4-1/2	---	---	---
T69	HEX NUT	1/2-20	---	---	---	---	---
T70	CAP SCREW	1/2-13	1-1/2	3-1/2	1-1/2	1-1/2	1-1/2
T103	DOWEL PIN, 1/2	---	1-1/2	3	1-1/2	1-1/2	1-1/2
T106	HEX HD BOLT	1/2-20	---	---	2	2	2
T109	STUD	1/2-13 x 1/2-20	---	4-1/4	5-1/4 OR 5-3/4	---	---
T110	STUD	1/2-20 x 1/2-20	---	4-3/4	6 OR 6-1/4	---	---
T174	CAP SCREW	1/2-13	1-3/4	---	---	---	---
T191	STUD	1/2-20 x 1/2-20			2-3/4	---	---

HOLE NO.	MODELS YB, YBX ALL RATIOS	MODELS YC, YCX ALL RATIOS	MODELS YD, YDX (AFTER 8-5-96) ALL RATIOS		MODELS YE, YEX (AFTER 8-5-96) ALL RATIOS		MODELS YF, YFX (AFTER 8-5-96) ALL RATIOS	
			UPPER	LOWER	UPPER	LOWER	UPPER	LOWER
1	T68	T68	T106	T106	T106	T106	T106	T106
2	T70	T109	T70	T106	T70	T106	T70	T106
3	T70	T70	T70	T106	T70	T106	T70	T106
4	T68	T68	T106	T106	T106	T106	T106	T106
5	T174	T70	T106	T70	T106	T70	T106	T70
6	T68	T110	T191	T106	T106	T106	T106	T106
7	T68	T68	T106	T191	T106	T106	T106	T106
8	T174	T70	T106	T70	T106	T70	T106	T70
9 (2) LOCATIONS	T103	T103	T103	T103	T103	T103	T103	T103

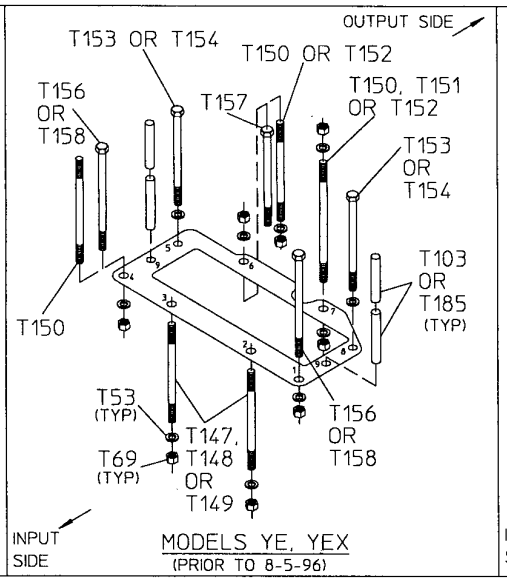
FLANGE HARDWARE BETWEEN CAP (T65) AND CASE (T28)
CURRENT CONFIGURATION

SPL 81617

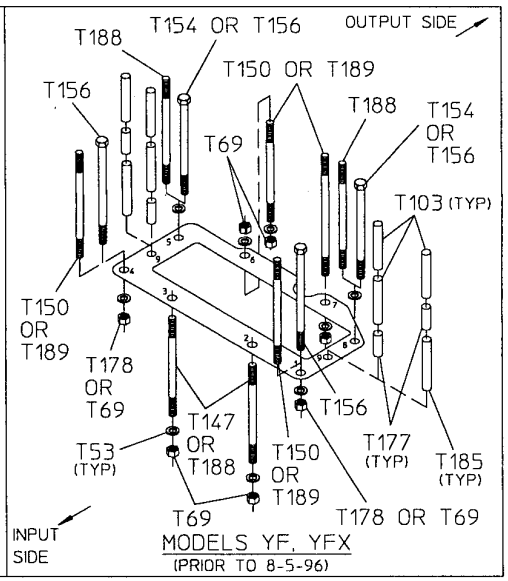
REV: 04/03/00



MODELS YD, YDX
(PRIOR TO 8-5-96)



MODELS YE, YEX
(PRIOR TO 8-5-96)



MODELS YF, YFX
(PRIOR TO 8-5-96)

REF NO.	TYPE	THREAD	LENGTH (MODEL)		
			YD, YDX	YE, YEX	YF, YFX
T53	LOCKWASHER	1/2	---	---	---
T68	HEX HD BOLT	1/2-20	5, 5-1/2 OR 6	---	---
T69	HEX NUT	1/2-20	---	---	---
T70	CAP SCREW	1/2-13	4-1/2, 4-3/4 OR 5	---	---
T103	DOWEL PIN, 1/2	---	1-1/2	3	3
T109	STUD	1/2-13 x 1/2-20	5-1/4 OR 5-3/4	---	---
T110	STUD	1/2-20 x 1/2-20	6 OR 6-1/4	---	---
T147	STUD	1/2-13 x 1/2-20	---	7-3/4	8-3/4
T148	STUD	1/2-13 x 1/2-20	---	7-1/2	---
T149	STUD	1/2-13 x 1/2-20	---	6-1/2	---
T150	STUD	1/2-20 x 1/2-20	---	8-3/8	9-1/2
T151	STUD	1/2-20 x 1/2-20	---	8	---
T152	STUD	1/2-20 x 1/2-20	---	7	---
T153	CAP SCREW	1/2-13	---	6	---
T154	CAP SCREW	1/2-13	---	7	8
T156	HEX HD BOLT	1/2-20	---	6-1/2	---
	CAP SCREW	1/2-13	---	---	9
T157	HEX HD BOLT	1/2-20	---	7-1/4	---
T158	HEX HD BOLT	1/2-20	---	7-1/2	---
T177	DOWEL PIN, 1/2	---	---	---	1-3/4
T178	HEX NUT	1/2-13	---	---	---
T185	DOWEL PIN, 1/2	---	---	3-1/2	3-1/2
T188	STUD	1/2-13 x 1/2-20	---	---	9-1/2
T189	STUD	1/2-20	---	---	10

HOLE NO.	MODELS YD, YDX	MODELS YE, YEX							MODELS YF, YFX		
	1.69,1.79,1.88,1.97,2.03,2.27	1.27	1.58	1.79	1.88	1.97	2.03	2.27	2.46	1.79	1.88	2.27
1	T68	T156	T150	T150	T150	T156	T156	T158	T158	T189	T156	T150
2	T109	T149	T147	T147	T147	T149	T149	T148	T148	T188	T147	T147
3	T70	T149	T147	T147	T147	T149	T149	T148	T148	T188	T147	T147
4	T68	T156	T150	T150	T150	T156	T156	T158	T158	T189	T156	T150
5	T70	T153	T154	T154	T154	T153	T153	T154	T154	T188	T154	T156
6	T110	T152	T150	T150	T150	T152	T152	T157	T157	T189	T150	T150
7	T68	T152	T150	T150	T150	T152	T152	T151	T151	T189	T150	T150
8	T70	T153	T154	T154	T154	T153	T153	T154	T154	T188	T154	T156
9 (2) LOCATIONS	T103	T103 (2)	T185 (2)	T185 (2)	T103 (2)	T103 (2)	T103 (2)	T103 (2)	T103 (2)	T103 (2) T185 (1)	T103 (2) T177 (1)	T103(1) T177(1) T185(1)

FLANGE HARDWARE BETWEEN CAP (T65) AND CASE (T28)
CONFIGURATION PRIOR TO 8-5-96

SPL 81617

REV: 04/03/00

Issued: 2/7/92
Revised: 07/23/99

WATEROUS

WATEROUS COMPANY
SOUTH ST. PAUL, MINNESOTA

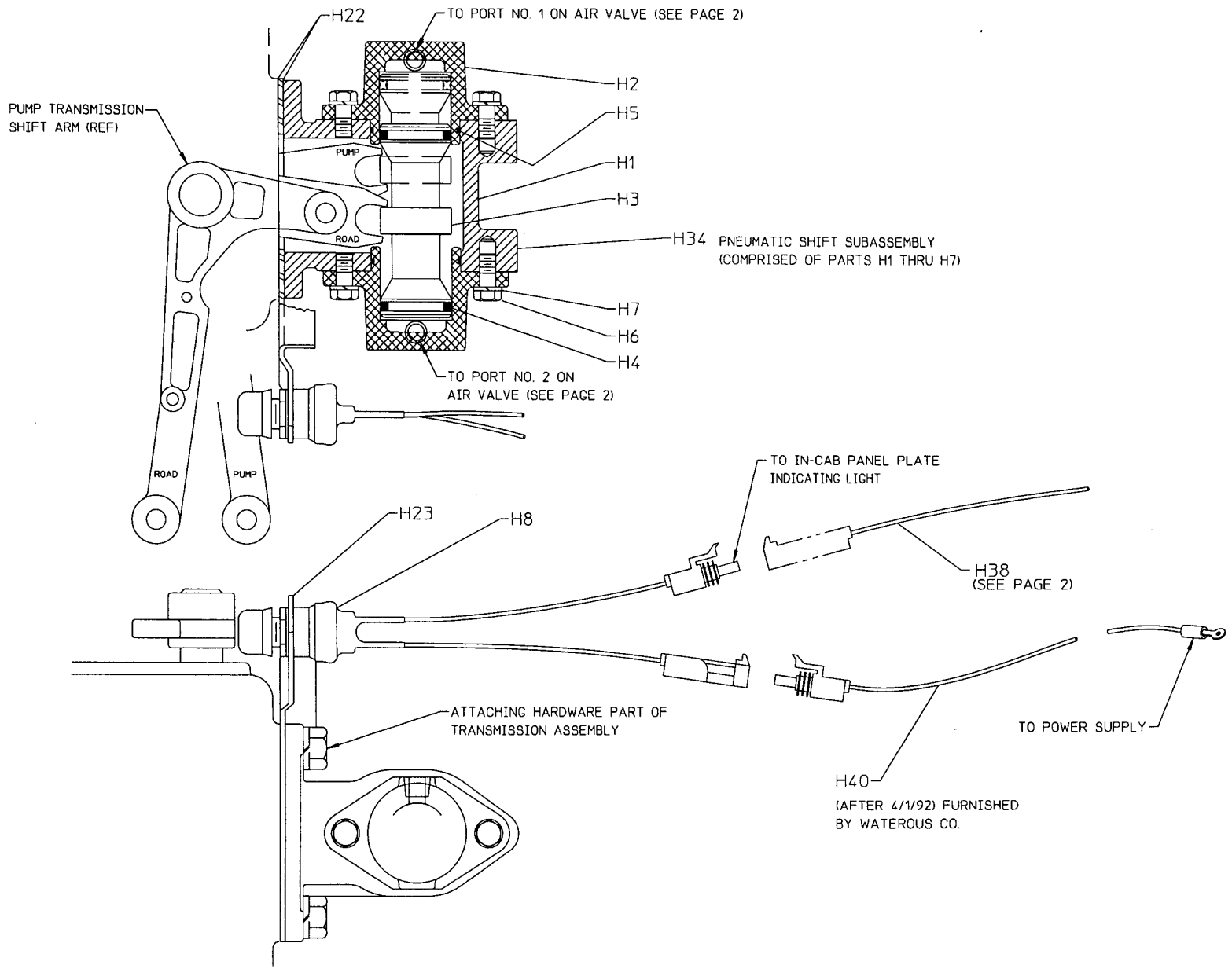
PNEUMATIC SHIFT

REF NO.	DESCRIPTION	REF NO.	DESCRIPTION
H1	Body	H23	Shift switch bracket
H2	End cap	H29	Panel plate, operators panel
H3	Piston	H30	Panel plate, in cab
H4	Quad ring, 1–1/4 x 1–1/2 in.	H31	Air control valve
H5	O–ring, 1–3/4 x 1–7/8 in.	H33	Light Bulb, 12 volt (#1819), 24 volt (#313)
H6	Hex hd screw, 5/16–18 x 3/4 in. with thread sealant	H34	Pneumatic shift subassembly
H7	Lock washer, 5/16 in.	H38	Wire assembly, black, 25 ft 9 in.
H8	Push button switch	H39	Wire assembly, black, 18 ft
H17	Wire assembly, white, 4–1/2 in.	H40	Wire assembly, black, 72 in.
H20	Indicating light, green	H41	Repair kit, air control valve
H22	Gasket		

PLEASE NOTE

SPL 81871

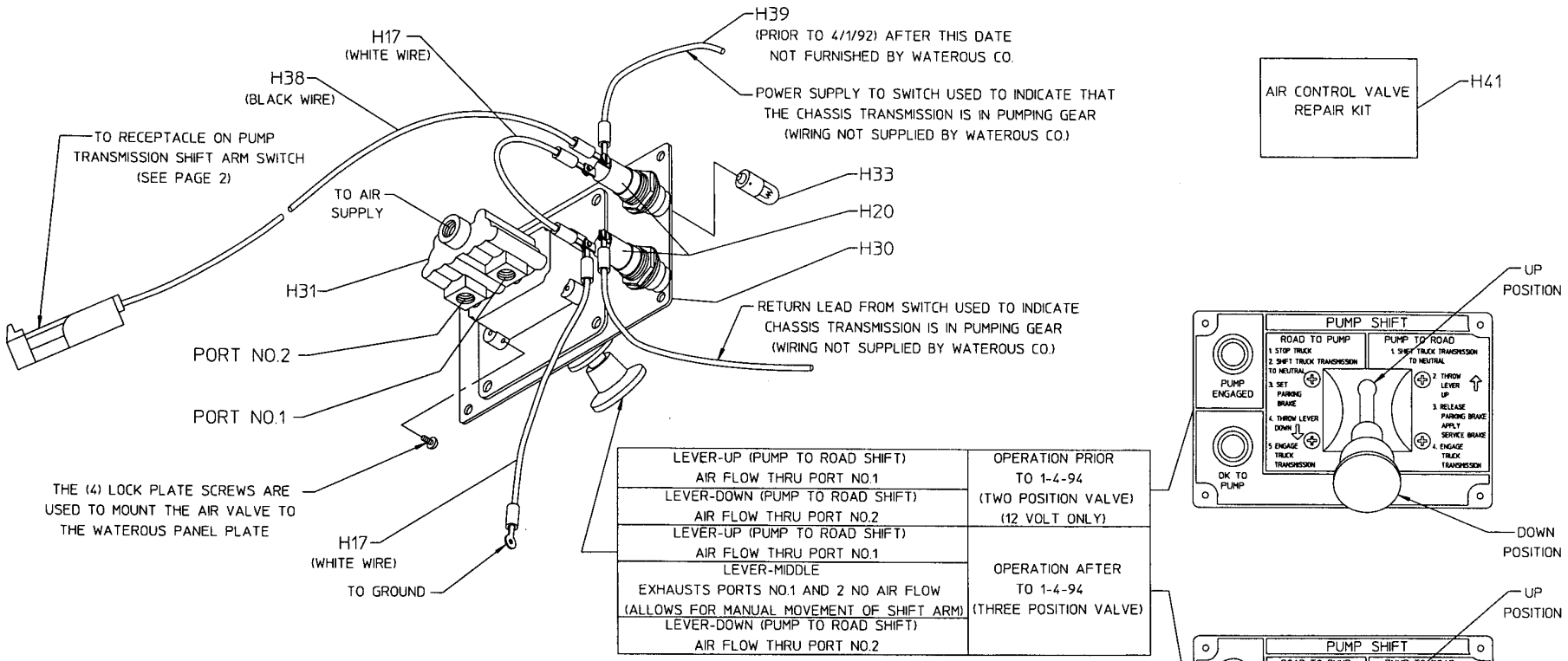
WHEN ORDERING PARTS PLEASE SUPPLY PUMP SERIAL NUMBER



SPL 81871

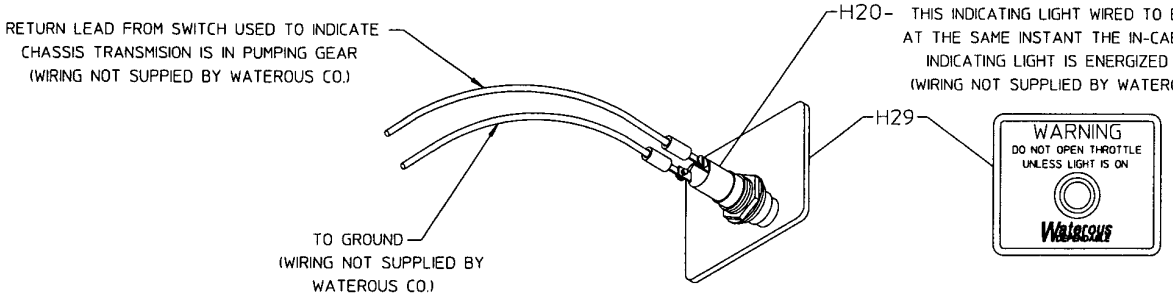
REV: 07/23/99

PL81871 (PG1)



LEVER-UP (PUMP TO ROAD SHIFT) AIR FLOW THRU PORT NO.1	OPERATION PRIOR TO 1-4-94 (TWO POSITION VALVE) (12 VOLT ONLY)
LEVER-DOWN (PUMP TO ROAD SHIFT) AIR FLOW THRU PORT NO.2	
LEVER-UP (PUMP TO ROAD SHIFT) AIR FLOW THRU PORT NO.1	OPERATION AFTER TO 1-4-94 (THREE POSITION VALVE)
LEVER-MIDDLE EXHAUSTS PORTS NO.1 AND 2 NO AIR FLOW (ALLOWS FOR MANUAL MOVEMENT OF SHIFT ARM)	
LEVER-DOWN (PUMP TO ROAD SHIFT) AIR FLOW THRU PORT NO.2	

IN-CAB PUMP SHIFT WITH PANEL PLATE, AIR CONTROL VALVE,
INDICATING LIGHTS AND WIRING



OPERATORS PANEL MOUNTED INDICATING LIGHT AND PANEL PLATE

SPL 81871

PL81871 (PG2)

REV: 07/23/99

Maintenance Instructions

Priming Pump

During operation, lubricant from the priming tank lubricates the priming pump. **The priming pump should be operated weekly to cycle fresh lubricant through the primer.** This cycling is of particular importance when using biodegradable lubricant, since the biodegradable properties allow it to break down quickly and lose its lubricating qualities. On rotary vane primers only, an orifice is in the lubricant line where it enters the priming pump head, to prevent excessive amounts of lubricant entering the pump and reducing its performance. Make sure clean lubricant is used in the priming tank and make sure the orifice is always open.

Priming Valve

After long service, normal wear of plunger insert, quad ring or O–ring may prevent air sealing of the valve. Replace O–rings and plunger insert if any signs of leakage are discovered. A repair kit is available from the Waterous Company.

Priming Tank

A vent hole is located in the elbow on top of the priming tank to break the syphon and stop the flow of lubricant after priming. The hole should be kept open at all times, but do not enlarge it.

Refill priming tank as needed with lubricant.

If dispensing priming lubricant into the environment, always use a biodegradable or non–toxic lubricant. Biodegradable / non–toxic Prime–Safe™ is available from Waterous.

NOTE: If 30 weight motor oil is used, it is recommended that a catch pan be used under the primer to collect the used oil so it can be disposed of properly.

Manual Controls

If priming valve has manual controls, check them monthly to make sure they operate freely. If rust or dirt cause them to bind, clean and lubricate them.

Testing

Once a month, perform the following dry vacuum test.

Remove all caps except openings without valves. Close all discharge, intake, drain valves and other similar openings. Operate priming device to create a vacuum of about 22 in. Hg in pump, then stop primer and engine.

Watch pressure gage; if vacuum drops more than 10 in. Hg in 5 minutes, listen for air leaks around packing glands, gaskets, valves, etc.

Replace gaskets, repack or otherwise repair source of trouble.

Rotor Clearance Adjustment

All Waterous priming pumps are factory tested and will draw a minimum of 22 In.–Hg vacuum. After prolonged service, the rotor to pump clearance may increase because of wear, resulting in lower vacuum. If maximum vacuum falls below 22 In.–Hg., readjust rotor end clearance to 0.008 to 0.011 inches (rotary vane) or .005 to .007 inches (rotary gear) by removing shims from between head and body.

Service Suggestions

Models VPE, VPES, HHE, HHEB

If the priming system fails to operate properly, the following instructions will help locate the cause of the malfunction. Go through each step in sequence to check out all the components of the priming system, or until the cause of the malfunction is located.

1. Make sure battery is properly charged. If battery is in low state of charge, it may be difficult to operate the priming pump at proper speed.
2. Check all wiring to the priming pump and valve for loose terminals, damaged insulation, or broken wire strands – especially near terminals.
3. **HHEB only –** Check the V–belt on belt drive models to insure that it is not damaged and that it is engaged in the V–groove of both pulleys.
4. If priming pump does not operate, remove priming motor, and manually turn rotor shaft. It should turn freely without binding. Unless the priming pump is properly maintained, sediment in the water being pumped may cause it to stick.
5. Check out priming motor in the following manner:
   a. While priming motor is off pump, manually rotate armature shaft to make sure it turns freely.
   b. To check out priming motor solenoid, connect a jumper between center and hot terminals of solenoid, motor should run. Disconnect jumper.

CAUTION

Wherever jumper wire is used, do not leave the wire connected after making the desired test. Failure to disconnect the jumper before proceeding with subsequent tests may cause serious damage to the electrical equipment.

   c. If motor does not run, temporarily place a heavy jumper, such as the handles of a pair of pliers, firmly across hot and cold terminals of solenoid. If the motor then runs, solenoid is probably defective and should be replaced.
   d. If priming motor still does not run, connect a heavy jumper directly between ungrounded battery terminal and field terminal or hot post of motor. If motor does not run, replace or rebuild it. If motor does run with jumper connected, check cable between battery and priming motor solenoid.
6. If the priming motor operated with jumper connected as in step 5, paragraph b, control switch or switch wiring may be defective. To check switch, connect a jumper to its terminals. If priming motor operates with switch bypassed, switch is defective and should be replaced.

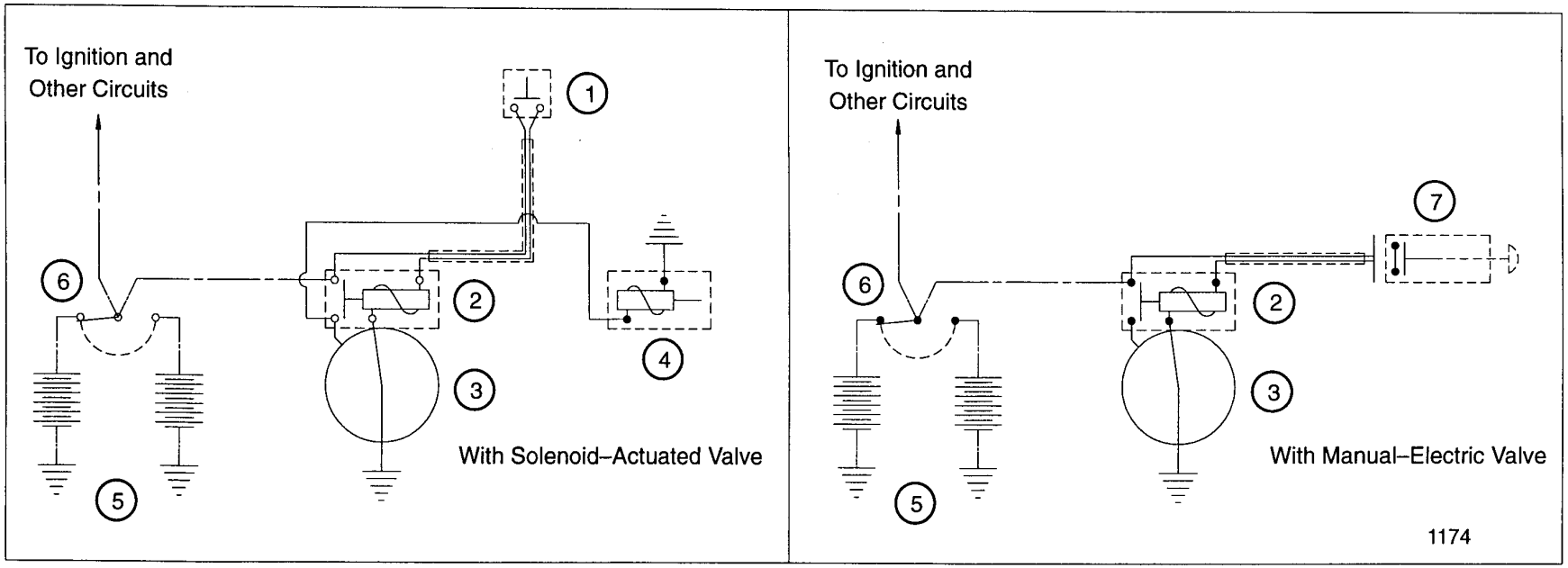
   NOTE: To expose control switch on manual electric priming valve, remove two round–head screws attaching cover to valve.
7. If pump is equipped with solenoid–actuated priming valve, and other components of priming system operate properly, then check priming valve. To do so, depress push–button switch and watch valve. If priming motor operates but valve does not, run a jumper from hot post of priming motor solenoid to terminal of priming valve solenoid. If valve operates with jumper connected, then power cable is defective and should be replaced. If valve still does not operate, then replace its solenoid.

Model VPB

1. Check all wiring to the priming pump and valve.
2. Check the V–belt to insure that it is taut and not damaged. Recommended tension: 1/8" deflection with 6 pounds of force applied. Tighten belt if necessary.
3. Check clutch for proper operation. A clicking sound should be audible when the clutch engages or disengages.

No.	Description
1	Normally Open Push Button Switch
2	Motor Solenoid
3	Priming Pump Motor
4	Priming Valve Solenoid
5	Dual Batteries
6	Selector Switch
7	Manual–Electric Priming Valve

Figure 10. Wiring Diagram – Models VPE, VPES, HHE and HHEB Priming Pumps

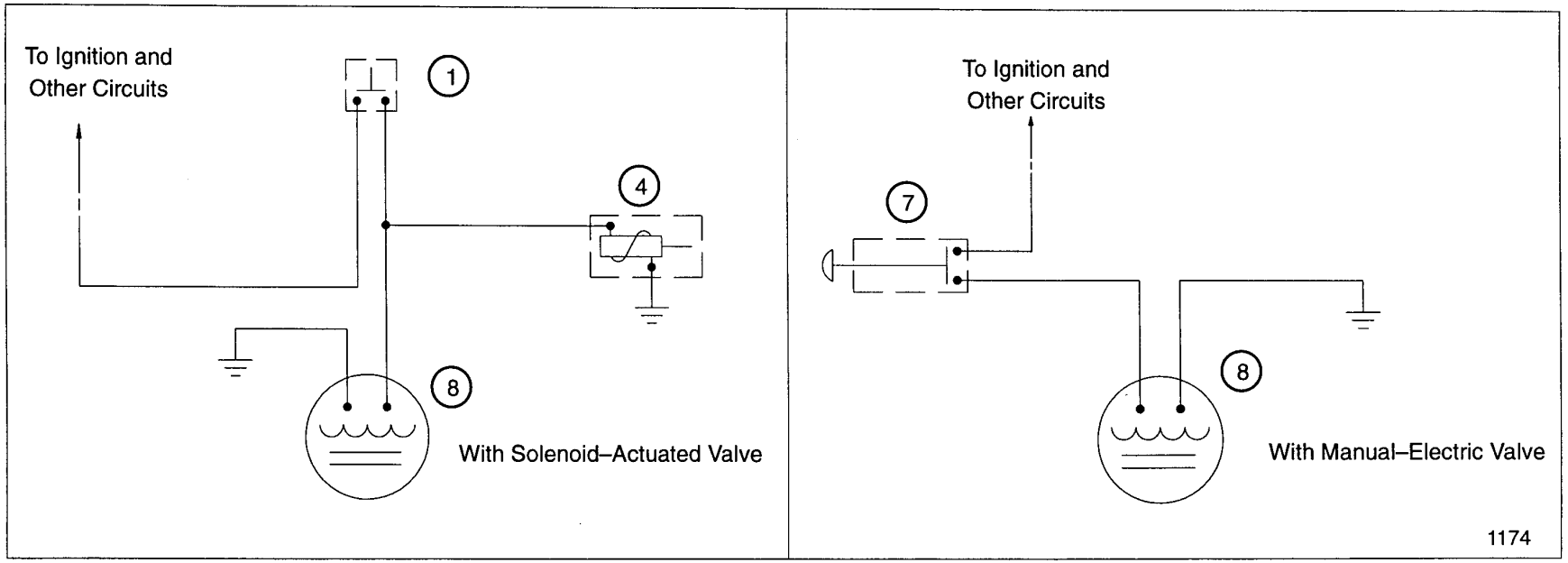


F–1031, Section 2312

REV: 05/11/99

No.	Description
1	Normally Open Push Button Switch
4	Priming Valve Solenoid
7	Manual–Electric Priming Valve
8	Electric Clutch

Figure 9. Wiring Diagram – Models VPB Priming Pump



Maintenance Chart

WATEROUS

Fire Pumps

Form No.	Issue Date	Rev. Date
F–1077	07/94	12/16/98

DATE												
EACH OPERATION												
CP–3 TRANSFER VALVE – Add grease and switch back and forth between positions												
MONTHLY												
TRANSMISSION / BEARING HOUSING Check lubricant level – add if required Check fluid pump operation (if provided)												
KC HYDRAULIC SHIFT RESERVOIR Check fluid level – add if required												
PRIMING PUMP – Perform vacuum test												
PRIMING TANK – Check lubricant level, add if necessary												
PILOT VALVES – Check operation and clean strainer												
PACKING – Check packing leakage												
INTAKE SCREENS – Check condition												
RUNNING TESTS (Consult operator manual)												
6 MONTHS OR 100 HOURS (Total running time)												
ANODES – Check Condition												
TRANSMISSION / BEARING HOUSING Change lubricant Clean lubricant pump (sump) strainer (if provided) Clean drain plug and breather												
IMPELLER SHAFT BEARING(S) – Add grease												
CH–4 MECHANICAL SEAL – Flush seal chamber												
KC HYDRAULIC SHIFT ACCUMULATOR Check pressure												
MECHANICS INITIALS												

RECOMMENDED LUBRICANTS

The types of lubricants recommended for Waterous equipment are listed below:

LUBRICATION REQUIREMENTS

MODEL SERIES	LUBRICANT	CAPACITY (Qts) *
Y,TY	ATF	12
W	ATF	6
KC	ATF	1/2 (Hydraulic Shift Reservoir)
		2–1/4 (Transmission)
K	SAE No. 90 Gear	1
T	SAE No. 90 Gear	1
CR, CZ , CZU Bearing Housings	ATF	1/4
TML	SAE No. 90 Gear	4
TMR	ATF	5
TMS	SAE No. 90 Gear	6
TG100	SAE No. 90 Gear	3
PA, TPA	ATF	3
QA	ATF	1–1/2

*Always fill to the bottom of the "Oil Level" plug.
Capacities shown are approximate. Will vary based on ratio and mounting.

IMPELLER SHAFT BEARING(S) (If Applicable)
Ball bearing grease

PRIMING TANK
Waterous "Prime–Safe™" Priming Lubricant
Part No. 72800

CP–3 TRANSFER VALVE

No. 4 calcium base water pump grease