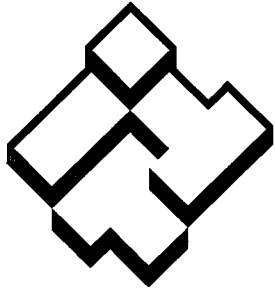


# A-C Pump

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**ITT Industries**

# **I N S T R U C T I O N S**

**Installation  
Operation  
Maintenance**

**type PWO  
centrifugal  
pumps**

**NOTE**

The information contained in this book is intended to assist operating personnel by providing information on the characteristics of the purchased equipment.

It does not relieve the user of their responsibility of using accepted engineering practices in the installation, operation, and maintenance of this equipment.

Any further questions, contact

ITT A-C Pump Canada (519) 824-7750

# WARNING

Your ITT A-C Pump Canada pump is carefully selected, sized, manufactured and inspected with the utmost care to provide safe and reliable service, at the best possible efficiency to suit your specific pumping requirements. In the interest of trouble free pump operation and safety of operating personnel, the following safety precautions should be strictly adhered to.

1. **READ AND FOLLOW CAREFULLY ALL RECOMMENDED PROCEDURES**, as described in your operator's manual, for storage, installation, start-up, operation and maintenance of your pump and related auxiliary equipment such as motor, variable speed drive, gear reducer, v-belt, coupling, etc.
2. **DRIVER ROTATION MUST BE CHECKED** before first start-up and before the v-belts are installed or the coupling halves are connected. Severe equipment damage and injury to personnel may occur if the pump is driven in the opposite direction to the arrow of rotation cast on the pump casing.
3. **DO NOT ALTER THE ORIGINAL OPERATING CONDITIONS** of the pump without first consulting with ITT A-C Pump Canada representatives. The operation of the pump at conditions other than those for which it was designed may result in equipment damage and injury to operators.
4. **DO NOT OPERATE THE PUMP AT LOW OR ZERO FLOW CONDITIONS.** All operating conditions which could cause the pumped liquid to vaporize are dangerous, such as clogged suction and discharge piping, shut-off suction and discharge valves, etc. Vapour pressure build-up could cause the pump casing and system piping to explode resulting in severe equipment damage and personal injury.
5. **DO NOT USE HEAT TO ASSIST IN IMPELLER REMOVAL** from the shaft when servicing the pump. Heat can cause vaporization of fluid which may be trapped in the impeller hub resulting in an explosion which could cause personal injury and equipment damage.
6. **DO NOT OPERATE THE PUMP WITHOUT PROPERLY INSTALLED V-BELT OR COUPLING GUARD.** Failure to install guards may result in personal injury.



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The law requires that the belt drives and/or couplings on this equipment be covered by **SAFETY GUARDS** while in operation. Such guards must be provided by the owner if not specifically contracted to ITT A-C Pump Canada.



# SECTION 1 INTRODUCTION

## INTRODUCTION

This manual is furnished to acquaint you with the easiest and most practical way to install, operate, and maintain this pump. Keep it handy for future reference. Additional information can be obtained from the nearest ITT A-C Pump Canada Sales Office. The Standards of the Hydraulic Institute are an excellent source for more detailed advice on the subject of installation, operation and maintenance.

Equipment cannot operate well without proper care. To keep the unit at top efficiency, correct procedures for installing and maintaining must be followed. The ITT A-C Pump Canada Service Organization can help install this equipment correctly, so that maximum machine life can be attained with a minimum of downtime.

ITT A-C Pump Canada servicemen are experienced, factory-trained, erection superintendents and offer prompt, efficient service at reasonable rates. The serviceman can be obtained through the nearest ITT A-C Pump Canada Sales Office. This office will also help with spare parts orders and problems requiring special attention.

## PUMP IDENTIFICATION

The Type PWO pumps are designated by Serial number, Size and Model. This information is stamped on an identification plate and affixed to the pump.

Permanent records for this pump are kept by the serial number; therefore, the serial number must be used with all correspondence and spare-parts orders.

# SECTION 2 INSTALLATION

## READ BEFORE INSTALLING AND OPERATING PUMP

**Inspection** - Check pump for shortage and damage immediately upon arrival. Note damage or shortage on freight bill (bill of lading); immediately file claim with carrier. Notify the ITT A-C Pump Canada sales office.

**Handling** - Handle with care. Dropping or jarring can seriously damage or break parts.

**Warning:** When unloading horizontal pumps lift equally at four or more points on the baseplate. Do not lift on the driver or pump. Do not lift by flanges or by the eyebolts found on the motor. Be very careful not to damage any auxiliary piping or controls when moving pumps. For further details see lifting instructions attached to pump.

**Exterior** - Pay particular attention to external hardware, drive motor conduit box (if drive motor included) and accessories. Touch up abrasions or scratches with approved paint. By hand, test that shaft rotates freely. Check coupling for damage.

**Interior** - If external damage is noted, or impeller is damaged (look in ports), or shaft binds or sticks, disassemble as required to permit internal inspection. Refer to applicable pump and driver maintenance manuals for procedures.

### Temporary Storage:

If the pump is not to be installed and operated soon after arrival, store it in a clean, dry place having slow, moderate changes in ambient temperature. Rotate the shaft periodically to coat the bearings with lubricant and to retard oxidation, corrosion, and to reduce the possibility of false brinelling of the bearings. Refer to pump instruction book for temporary storage instructions. For storage of three months or longer, ask for bulletin 52-113-268.

### Installation:

Pump location should provide the following:

1. Proximity as close to suction supply as possible.
2. Shortest and most direct suction pipe practical. Suction

lift must not exceed limit for pump. NPSH available must equal or exceed pump requirement.

3. Suction port below pumping level to provide priming.
4. Plenty of room for inspection and maintenance.
5. Protection from freezing when idle in cold weather.
6. Correct power supply for electric motor driver; ample ventilation for internal combustion motor driver.
7. If outdoors, protection from elements.
8. Access to water supply when stuffing box lubrication or flushing is required.

### Baseplate Setting, Horizontal Units Only: (Before Piping) - See Fig. 1

**NOTE:** This procedure assumes that a concrete sub-foundation has been prepared with anchor or hold down studs extending up ready to receive unit. All equipment undergoes preliminary alignment prior to shipment; however, during shipping, the equipment may arrive misaligned and therefore *alignment must be established during installation*. ITT A-C Pump Canada has determined that proper and correct alignment can only be made by following accepted installation procedures. Refer to the following paragraphs for ITT A-C Pump Canada installation procedures.

### Initial Alignment:

1. Use blocks and shims under base for support at anchor studs and midway between studs to position base approximately 2" above the concrete sub-foundation with studs extending through holes in the baseplate.
2. Level unit by adding or removing shims under base until pump shaft and flanges are level or plumb.
3. If customer drills the base and mounts his own motor ITT A-C Pump Canada can assume no responsibility for alignment. If customer mounts his own motor on a predrilled base the motor must be centered in its mounting holes and remain that

way during initial alignment. Pump should be moved in its mounting holes to align. If the pump and motor were factory mounted, the motor was centered in its mounting holes and initial alignment verified at the factory.

4. Draw anchor nuts finger tight against base, then check pump and motor shafts or coupling hubs for alignment. (Temporarily remove coupling guard for checking alignment).

5. If alignment needs improvement, add shims or wedges at appropriate positions under base to shift shafts into closer alignment and re-tighten anchor nuts (finger tight only). Repeat this procedure until proper alignment is reached. For single element couplings, proper initial alignment is defined as .020" TIR parallel alignment and .009" TIR angular per inch of radius (R). For double element couplings, the initial alignment tolerance is .020" TIR parallel and .006" TIR angular per inch of radius (R). If the motor has been centered in its mounting holes and proper initial alignment has been achieved, then final alignment after grouting will be achievable. Final tightening of anchor nuts is done after pump is grouted and grout has set at least 48 hours.

### Baseplate, Setting, Vertical Unit:

1. For vertical pumps where machined fits have been provided for the drive, proper alignment has been designed into the unit. Where no locating fit is provided for the drive, the final alignment procedure must be followed. For vertical pumps with line shafts, consult line shaft manufacturer's instructions.

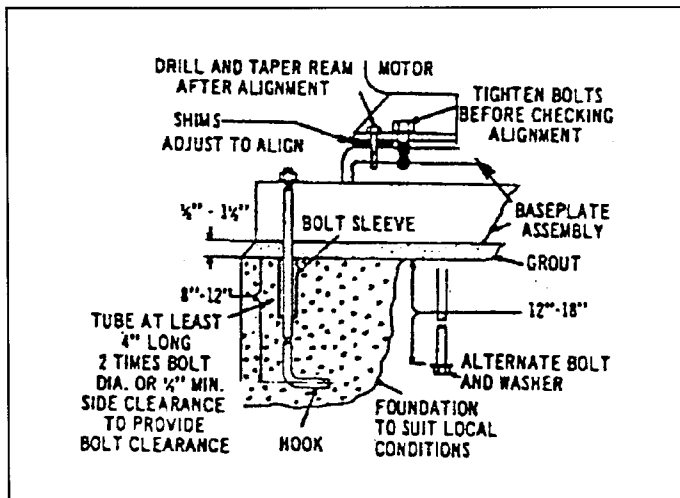


Fig. 1 Foundation

### Grouting Procedure - See Fig. 2

Grout compensates for uneven foundation, distributes weight of unit and prevents shifting. Use an approved, non-shrinking grout (such as Embecco 636 by Master Builders, Cleveland, Ohio or equivalent) as follows, after setting and levelling unit:

1. Build strong form around the foundation to contain grout.
2. Soak top of concrete thoroughly, then remove surface water.
3. Flow grout to fill cavities and prevent air pockets. Temporarily use air-relief tubing if necessary, to remove trapped air.
4. Grout should be one inch minimum under baseplate and filled-in at least four inches from all four edges.

5. Grout baseplate in completely, and allow grout to dry thoroughly before attaching piping to pump. (24 hours is sufficient time with approved grouting procedure).

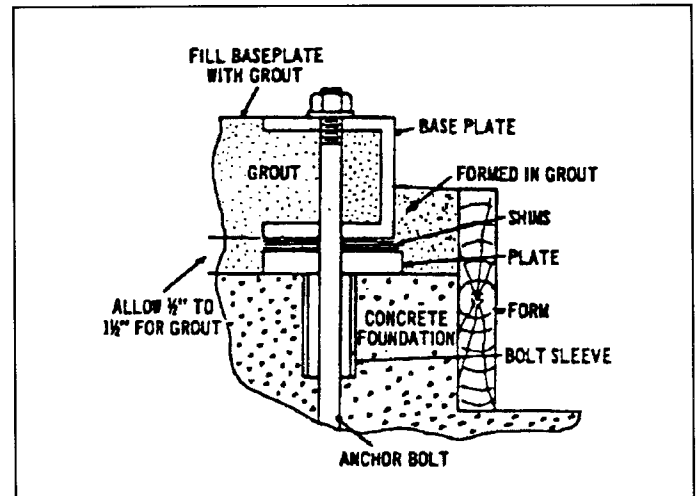


Fig. 2 Setting Baseplate and Grouting

### Final Coupling Alignment:

**Note:** A flexible coupling will only compensate for small amounts of misalignment. Permissible misalignment will vary with the make of coupling. The tolerances listed below are recommended for satisfactory pump operation. Consult coupling manufacturer's data when in doubt.

#### A. For single element couplings

**Note:** Proper alignment is essential for correct pump operation. This should be performed after baseplate has been properly set and grout has dried thoroughly according to instruction. Final alignment should be made by shimming driver only. If alignment is critical, it should be made at operating temperatures.

1. Coupling hubs are usually mounted on the shaft; if not, install them at this time.
2. Mount dial indicator on one hub as shown in Fig. 3 for parallel alignment. Set dial to zero.
3. Scribe index lines on coupling halves as shown.
4. Turn both coupling halves so that index lines match. Observe dial reading to see whether pump or driver needs adjustment. Total indicator reading for one complete turn should not exceed 0.004 inch.
5. Mount indicator as shown for angular alignment. Set dial to zero.
6. Turn both coupling halves so index lines match. Observe dial reading to see whether driver needs adjustment. Total indicator reading of 0.004 inch per inch of radius (R) is satisfactory for angular alignment.
7. Assemble coupling. Tighten all bolts and set screws. It may be necessary to repeat # 2 and #4 for a final check.
8. For double element floating shaft spacer coupling.

Paralled misalignment for double element or two plane floating shaft coupling should not exceed 1/16 inch per foot of plane separation. Angular misalignment should be .002" per inch of

radius (R). It is recommended to offset universal joint coupling alignment by 1/8" to 1/4" for best operation. Consult coupling manufacturer's data if in doubt.

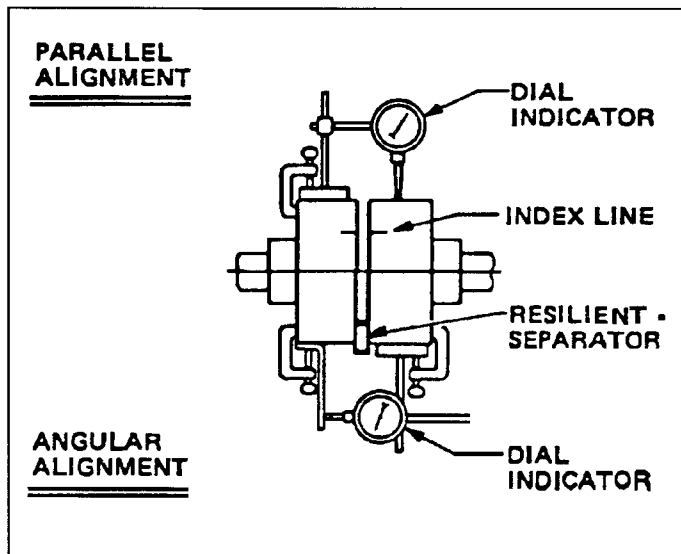


Fig. 3. Single Element Couplings

### Dowelling

After the unit has been running for about one week, the coupling halves should be given a final check for misalignment caused by pipe strains or temperature strains. If the alignment is correct, both pump and driver should be dowelled to the baseplate.

### SUCTION AND DISCHARGE PIPING

General: When installing the pump piping, be sure to observe the following precautions: (See Fig. 4).

- a) Both the suction and discharge piping should be independently supported near the pump and properly aligned so that no strain is transmitted to the pump when the flange bolts are tightened. Use pipe hangers or other supports at necessary intervals to provide supports.
- b) It is usually advisable to increase the size of both suction and discharge pipes at the pump connections to decrease the loss of head from friction.
- c) Install piping as straight as possible, avoiding unnecessary bends. Where necessary, use 45-degree or long-sweep 90-degree fittings to decrease friction losses.
- d) Make sure that all piping joints are air-tight.
- e) Where flanged joints are used, assure that inside diameters match properly.
- f) Remove burrs and sharp edges when making up joints.
- g) Do not "spring" piping when making any connections.
- h) Provide for pipe expansion when hot fluids are to be pumped. The use of expansion joints is not recommended unless they are properly restrained.

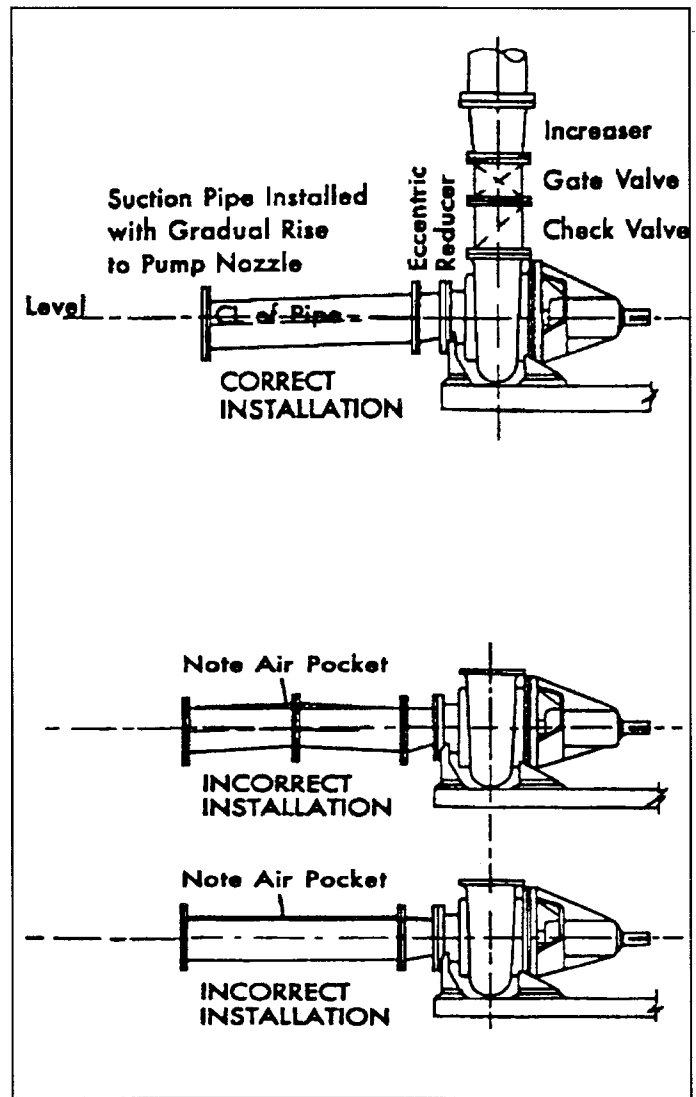


Fig. 4. Suction Piping Installation

**Suction Piping:** When installing the suction piping, observe the following precautions (see Figure 4).

- a) The sizing and installation of the suction piping is extremely important. It must be selected and installed so that pressure losses are minimized and sufficient liquid will flow into the pump when started and operated. Many NPSH (Net Positive Suction Head) problems can be directly attributed to improper suction piping systems.
- b) Suction piping should be short in length, as direct as possible, and never smaller in diameter than the pump suction opening. If the suction pipe is short, the pipe diameter can be the same size as the suction opening. If longer suction pipe is required, pipes should be one or two sizes larger than the opening depending on piping length.
- c) To facilitate cleaning pump liquid passage without dismantling pump, a short section of pipe so designed that it can be readily dropped out of the line can be installed adjacent to the suction flange. With this arrangement any matter clogging the impeller is accessible by removing this pipe section.

d) The suction pipe should slope upward to the pump nozzle. A horizontal suction line must have a gradual rise to the pump. Any high point in the pipe will become filled with air and thus prevent proper operation of the pump. When reducing the piping to the suction opening diameter use an eccentric reducer with the eccentric side down to avoid air pockets.

#### NOTE

*Never use a straight taper reducer in a horizontal suction line, as it tends to form an air pocket in the top of the reducer and the pipe.*

**Valves in Suction Piping.** When installing valves in the suction piping, observe the following precautions.

- a) If the pump is operating under static suction lift conditions, a foot valve may be installed in the suction line to avoid the necessity of priming each time the pump is started. This valve should be of the flapper type, rather than the multiple spring type, sized to avoid excessive friction in the suction line. Under all other conditions a check valve, if used, should be installed in the discharge line.
- b) When foot valves are used, or where there are other possibilities of "water hammer," close the discharge valve before shutting down the pump.
- c) Where two or more pumps are connected to the same suction line, install gate valves so that any pump can be isolated from the line. Install gate valves with stems horizontal to avoid air pockets. Globe valves should not be used, particularly where NPSH is critical.
- d) The pump must never be throttled by the use of a valve on the suction side of the pump. Valves should be used only to isolate the pump for maintenance purposes, and should always be installed in positions to avoid air pockets.

**Discharge Piping.** If the discharge piping is short, the pipe diameter can be the same as the discharge opening. If the piping is long, pipe diameter should be one or two sizes larger than the discharge opening. On long horizontal runs it is desirable to maintain as even a grade as possible. Avoid high spots, such as loops, which will collect air and throttle the system or lead to erratic pumping.

**Valves In Discharge Piping.** A check valve and gate valve should be installed in the discharge. The check valve, placed between pump and gate valve, protects the pump from excessive pressure, and prevents liquid from running back through the pump in case of power failure. The gate valve is used in priming and starting, and when shutting the pump down.

**Pressure Gauges.** Properly sized pressure gauges can be installed in both the suction and discharge nozzles in the gauge taps (which are provided on request). The gauges will enable the operator to easily observe the operation of the pump, and also determine if the pump is operating in conformance with the performance curve. If cavitation, vapour binding or other unstable operation should occur, widely fluctuating discharge pressure will be noted.

#### NOTE:

*The standard pump has no drain or vent taps; a 1/2 inch gage tap is supplied in discharge nozzle.*

#### EXTERNAL-INJECTION LIQUID-SEAL PIPING

a) When the liquid being pumped contains solids or is otherwise not compatible with seal materials, an outside supply of liquid must be furnished. In general, external-injection liquid (from an outside source) is required when the following conditions prevail:

1. Liquid being pumped contains dirt, grit, or other impurities.
2. Temperature of the liquid being pumped is below 32°F or above 160°F. Consult the ITT A-C Pump Canada Sales Office for recommendations.
3. Liquid being pumped has non-lubricating properties.

b) Install valves in this piping to regulate liquid flow and pressure to the seals. For packed-type seals, the seal liquid pressure should be regulated to be 15-25 psi more than the pump suction pressure.

#### STUFFING BOX

**General.** It is absolutely essential with any packed stuffing box to keep contaminants in the pumped liquid from entering the packing space. These contaminants will cause severe abrasion or corrosion of the shaft sleeve, rapid packing deterioration, and can even plug the stuffing box flushing and lubrication system. The stuffing box must be supplied at all times with a source of clean, clear water to flush and lubricate the packing. The most important consideration is to establish the minimum flushing pressure that will eliminate contaminants from the packing. If this pressure is too low, dirty liquid may be forced into the stuffing box. If the pressure is too high, excessive packing wear will result, and extreme heat developed in the shaft will cause higher bearing temperatures. The most desirable conditions, therefore, is to use the lowest possible flushing pressure which the operating conditions will permit.

**Stuffing Box Operating Pressure.** The actual stuffing box operating pressure may be obtained by installing a pressure gauge on the box. This should be done with an extra seal cage temporarily replacing the two rings of packing in the bottom of the box to obtain a more accurate gauge reading. Gauge readings should be taken with the pump running under various head and capacity conditions. The pressure of the flushing or lubrication water can then be set at a value 5 to 10 psi above the maximum expected stuffing box operating pressure. Even under the best conditions, a properly packed stuffing box should be watched closely. If pressure conditions change slightly, there will be a resultant change in packing "seating" which should be compensated by a change in gland adjustment.

**Flushing and Lubrication Water.** The recommended method to minimize error in regulating flushing water is the "Controlled Pressure System" as shown in Figure 4. Most important is the pressure reducing valve which may be adjusted to a value slightly exceeding the stuffing box operating pressure. A flow indicating device is advisable that will serve to indicate a failing of the bottom packing rings allowing leakage into the pump. With this arrangement, the packing gland need be tightened only against the lowest necessary pressure. The "out" connection from the stuffing box should be closed with this system. Longer packing

life and less frequent adjustment are possible with the "controlled pressure system" properly installed and operated.

**Packing.** All pumps are packed before shipment unless otherwise requested. All packings used are the highest grade material. Before pump is put into operation, check the condition of the packing. If pump is installed within 60- days after shipment, the packing will be in good condition with a sufficient supply of lubrication. If pump is stored for a longer period, it may be necessary to repack the stuffing box. In all cases, however, inspect the packing before pump is started

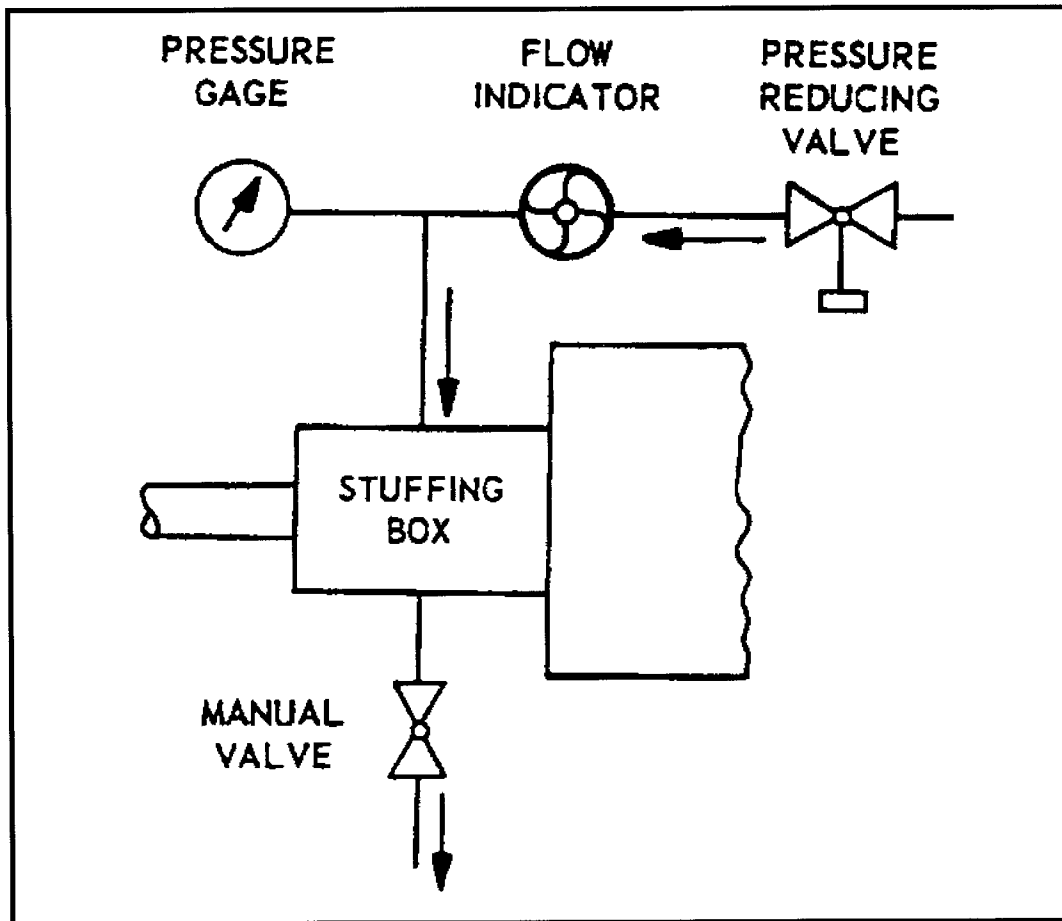


Fig. 5. Controlled Pressure System for Stuffing Box

# SECTION 3 OPERATION.

**PRE-START CHECKS.** Before initial start of the pump, make the following inspections:

- a) Check alignment between pump and motor.
- b) Disconnect coupling halves and check pump rotation. Be sure that the pump operates in the direction indicated by the arrow on the pump casing, as serious damage can result if the pump is operated with incorrect rotation. Check rotation each time the motor leads have been disconnected.
- c) Check all connections to motor and starting device with wiring diagram. Check voltage, phase and frequency on motor nameplate with line circuit.
- d) Check suction and discharge piping and pressure gauges for proper operation.
- e) Turn rotating element by hand to assure that it rotates freely.
- f) Check impeller adjustment.
- g) Check stuffing box adjustment, lubrication and piping.
- h) Assure that bearings are properly lubricated. Refer to Section 4.
- i) Assure that pump is full of liquid.

## Priming

- a) If the pump is installed with a positive head on the suction, it can be primed by opening the suction valve and allowing the liquid to enter the casing.
- b) If the pump is installed with a suction lift, priming must be done by other methods such as foot valves, ejectors, or by manually filling the casing and suction line.

## CAUTION

*Under either condition, the pump must be completely filled with liquid before starting. The pump must not be run dry in the hope it will prime itself. Serious damage to the pump may result if it is started dry.*

## STARTING

- a) Close drain valves and valve in discharge line.
- b) Open fully all valves in the suction line.
- c) Turn on seal water to the stuffing box. (If pumped liquid is dirty or if leakage of air is to be prevented, these lines should be always left open).
- d) Prime the pump.

## NOTE

*If the pump does not prime properly, or loses prime during start-up, it should be shutdown and the condition corrected before the procedure is repeated.*

- e) (Pumps moving high temperature liquids). Open the warm-up valve to circulate liquid for preheating. Close the valve after the pump is warmed up.
- f) Start the pump driver (turbines and engines require warming up, consult the manufacturer's instructions).
- g) When pump is operating at full speed, open the discharge valve slowly.
- h) Adjust the liquid seal valves to produce a pressure of 15-25 psi more than the pump suction pressure.

## CAUTION

*The gate valve in the discharge line should always be closed when the pump is started. The excessive current required by the motor to start under full load will in time cause motor trouble. A centrifugal pump primed and operated at full speed with the discharge gate valve closed usually requires much less power than when it is operating at its rated capacity and head with the discharge gate valve open.*

## OPERATING CHECKS

- a) Check the pump and piping to assure that there are no leaks.
- b) Check and record pressure gauge readings for future reference.
- c) Check and record voltage, amperage per phase, and kw if an indicating wattmeter is available.
- d) Check bearings for lubrication and temperature.
- e) Check and adjust stuffing box for correct operation. Check sealing water lines and valves.

## CAUTION

*Make all pump output adjustments with the discharge valve. Do not throttle the suction line to adjust the pump output.*

**SHUTDOWN.** The following steps of procedure will take care of most normal shutdowns of the pump. Make any further adjustments of process piping, valves, etc., as required. If the pump is to be removed from service for an extended period of time consult storing procedures, and protect from freezing.

- a) Close the discharge valve slowly.

## NOTE

*When stopping pump, always close discharge valve first.*

- b) Shut down the driver (consult manufacturer's instructions for special operations).
- c) Close seal liquid valves. (If pumped liquid is dirty or if inleakage is to be prevented, these lines should always be left open).
- d) Open drain valves as required.

**FREEZING PROTECTION.** Pumps that are shut down during freezing conditions should be protected by one of the following methods:

- a) Drain the pump, remove all liquid from the casing.
- b) Keep fluid moving in the pump and insulate or heat the pump to prevent freezing.

## CAUTION

*If heat is used to keep the pump from freezing do not let the temperature rise above 100° - 150°F.*

**TROUBLE SHOOTING.** Between regular maintenance inspections, be alert for signs of pump trouble. Common symptoms are listed in the following table. Correct any trouble immediately and **avoid costly repair and shutdown.**

SYMPTOM - PROBABLE CAUSE	CURE
<p><b>NO LIQUID DELIVERED</b></p> <ol style="list-style-type: none"> <li>1. Lack of Prime.</li> <li>2. Loss of prime.</li> <li>3. Suction lift too high.</li> <li>4. Discharge head too high.</li> <li>5. Speed too low.</li> <li>6. Impeller completely plugged.</li> </ol>	<p>Fill pump and suction pipe completely with liquid.</p> <p>Check for leaks in suction pipe joints and fittings; vent casing to remove accumulated air.</p> <p>If no obstruction at inlet, check for pipe friction losses. However, static lift may be too great. Measure with mercury column or vacuum gauge while pump operates. If static lift is too high, liquid to be pumped must be raised or pump lowered.</p> <p>Check pipe friction losses. Large piping may correct condition. Check that valves are wide open.</p> <p>Check whether motor is directly across-the-line and receiving full voltage. Or frequency may be too low; motor may have an open phase.</p> <p>Dismantle pump and clean impeller.</p>
<p><b>NOT ENOUGH LIQUID DELIVERED</b></p> <ol style="list-style-type: none"> <li>7. Air leaks in suction piping.</li> <li>8. Air leaks in stuffing box.</li> <li>9. Speed too low.</li> <li>10. Discharge head too high.</li> <li>11. Suction lift too high.</li> <li>12. Impeller partially plugged.</li> <li>13. Cavitation; insufficient NPSH (depending on installation)</li> <li>14. Defective impeller.</li> <li>15. Defective packing.</li> <li>16. Foot valve too small or partially obstructed.</li> <li>17. Suction inlet not immersed deep enough.</li> <li>18. Too small impeller diameter (probable cause if none of above).</li> </ol>	<p>If liquid pumped is water or other non-explosive, and explosive gas or dust is not present, test flanges for leakage with flame or match. For such liquids as gasoline, suction line can be tested by shutting off or plugging inlet and putting line under pressure. A gauge will indicate a leak with a drop of pressure.</p> <p>Increase seal liquid pressure to above atmosphere.</p> <p>See item 5.</p> <p>See item 4.</p> <p>See item 3.</p> <p>See item 6.</p> <p>a) Increase positive suction head on pump by lowering pump.</p> <p>b) Sub-cool suction piping at inlet to lower entering liquid temperature.</p> <p>c) Pressurize suction vessel.</p> <p>Inspect impeller, bearings and shaft. Replace if damaged or vane sections badly eroded.</p> <p>Replace packing and sleeves if badly worn.</p> <p>Area through ports of valve should be at least as large as area of suction pipe - preferably 1 1/2 times. If strainer is used, net clear area should be 3 to 4 times area of suction pipe.</p> <p>If inlet cannot be lowered, or if eddies through which air is sucked persist when it is lowered, chain a board to suction pipe. It will be drawn into eddies, smothering the vortex.</p> <p>Check with factory to see if a larger impeller can be used; otherwise, cut pipe losses or increase speed- or both, as needed, but be careful not to seriously overload drive.</p>
<p><b>NOT ENOUGH PRESSURE</b></p> <ol style="list-style-type: none"> <li>19. Speed too low.</li> <li>20. Air leaks in suction piping.</li> <li>21. Mechanical defects.</li> <li>22. Obstruction in liquid passages.</li> <li>23. Air or gases in liquid. (Test in laboratory, reducing pressure on liquid to pressure in suction line. Watch for bubble formation).</li> </ol>	<p>See item 5.</p> <p>See item 7.</p> <p>See items 14, 15 and 16.</p> <p>Dismantle pump and inspect passages of impeller and casing. Remove obstruction.</p> <p>May be possible to over rate pump to point where it will provide adequate pressure despite condition. Better to provide gas separation chamber on suction line near pump and periodically exhaust accumulated gas. See item 13.</p>

**PUMP OPERATES FOR SHORT TIME, THEN STOPS.**

- 25. Incomplete priming.
- 26. Suction lift too high.
- 27. Air leaks in suction piping.
- 28. Air leaks in stuffing box.
- 29. Air or gases in liquid.

Free pump, piping and valves of all air. If high points in suction line prevent this, they need correcting.

See item 3.

See item 7.

See item 8.

See item 23.

**PUMP TAKES TOO MUCH POWER**

- 30. Head lower than rating; thereby Pumping too much liquid.
- 31. Cavitation.
- 32. Mechanical defects.
- 33. Suction inlet not immersed deep enough.
- 34. Liquid heavier (in either viscosity or specific gravity) than allowed for.
- 35. Stuffing boxes too tight.
- 36. Casing distorted by excessive strains from suction or discharge piping.
- 37. Shaft bent due to damage - improper shipment, operation or overhaul.
- 38. Mechanical failure of critical pump parts.
- 39. Misalignment.
- 40. Speed may be too high (brake hp of pump varies as the cube of the speed; therefore, any increase in speed means considerable increase in power demand).
- 41. Electrical defects.
- 42. Mechanical defects in turbine, engine or other type of drive exclusive of motor.

Machine impeller's OD to size advised by factory.

See item 13.

See items 14,15, and 16.

See item 17.

Use larger driver. Consult factory for recommended size. Test liquid for viscosity and specific gravity.

Release gland pressure. Tighten reasonably. If sealing liquid does not flow while pump operates, replace packing. If packing is wearing too quickly, replace scored shaft sleeves and keep liquid seeping for lubrication.

Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts.

Check deflection of rotor by turning on bearing journals. Total indicator run-out should not exceed 0.002 on shaft and 0.004 inch on impeller wearing surface.

Check bearings and impeller for damage. Any irregularity in these parts will cause a drag on shaft.

Realign pump and driver.

Check voltage on motor.

The voltage and frequency of the electrical current may be lower than that for which motor was built; or there may be defects in motor. The motor may not be ventilated properly due to a poor location.

If trouble cannot be located, consult factory.

**NOTE**

*If unable to correct troubles with cures outlined above, or if other difficulties develop, contact nearest ITT A-C Pump Canada representative. Describe completely the operating conditions of pump at time of failure along with other pertinent data.*

# SECTION 4 LUBRICATION

**GENERAL.** Proper lubrication of the pump bearings is essential to obtaining maximum trouble-free operation. The quantity of lubricant used is as important as the right type. The lubricant for anti-friction bearings protects the bearing parts from corrosion, and helps dissipate heat that is generated by use.

## OIL LUBRICATION - STANDARD

a) After the pump has been installed, flush the bearing housing to remove dirt, grit and other impurities that may have entered the bearing housing during shipment or erection. Then refill the bearing housing with proper lubricant. The oil level to be maintained is shown by a line in the sight glass or oil level indicator.

b) Experience shows that oils meeting the following specifications will provide satisfactory lubrication. These oils can be furnished by all major oils companies. It is the responsibility of the oil vendor to supply a suitable lubricant.

- (1) Saybolt viscosity at 100°F ..... 150 SSU - 200 SSU
- (2) Saybolt viscosity at 210°F ..... 43 SSU
- (3) Viscosity index, minimum ..... 95
- (4) API gravity ..... 28 - 33
- (5) Pour point, maximum ..... 20°F
- (6) Flash point, minimum ..... 390°F
- (7) Additives ..... Rust and Oxidation inhibitors

c) The oil should be well refined, good grade, straight cut, filtered mineral oil. It must be free from water, sediment, resin, soaps, acid and fillers of any kind. It should also be non-foaming with a viscosity of about 150-220 SSU at 100°F.

### NOTE

*Oils from different suppliers should not be mixed.*

d) In installations with moderate temperature changes, humidity, and dirt, the oil should be changed after approximately 160 hours of operation. The oil should be inspected this time to determine the operation period before the next oil change. Oil change periods may be increased up to 2000 - 4000 hours based on an 8000 hour year. Check the oil frequently for moisture, dirt or signs of "breakdown".

### CAUTION

**DO NOT OVER OIL.** This causes the bearings to run hot. The maximum desirable operating temperature for ball bearings is 180°F. Should the temperature of the bearing frame exceed 180°F (measured by thermometer), shut down pump to determine the cause.

**OIL RESERVOIR.** The approximate capacity of the oil reservoir is as follows:

Frame Size	Quantity (Pints)
I	1-1/2
II	2-1/2
III	8
IV	9

## GREASE LUBRICATION - OPTIONAL

a) The lubricating grease should be a mixture of highly

refined mineral oil and a soap base. The most commonly used soap bases are sodium, calcium, lithium, barium, aluminium, and strontium.

b) Sodium soap greases can be used at bearing temperatures up to 250°F. Under ordinary temperatures, this grease is comparatively stiff. The emulsifying properties of the grease permit absorption of a certain amount of water. The lubricant manufacturer should be consulted for recommendations, temperature limits, and length of lubricant life. All recommendations here are based on standard greases. A good bearing grease should have the following properties:

- 1) Freedom from chemically or mechanically active ingredients such as free lime, iron oxide, and similar material or solid substances.
- 2) Be free from possible tendency to change in composition or consistency such as thickening, separation of oils, acid formation or hardening ("milling down").
- 3) A melting point considerably higher than the operating temperature to assure adequate film strength.
- 4) Ability to protect metal surfaces from rust.

### NOTE

*Since lubricant qualities are not assured solely on these points, it is advisable to secure lubricants from a reputable manufacturer who assumes responsibility for his products.*

c) Mineral oil from which grease is compounded should conform to the following tests:

- 1) Flash ..... Minimum 340°F
- 2) Fire ..... 380°F
- 3) Viscosity at 100°F ..... 200 SSU Minimum
- 4) Cold test (POWT) maximum ..... 30°F

### NOTE

*The grease used in this pump should conform to NGLI Grade 2 standards.*

## BEARING LUBRICATION

a) Bearings in the pump are anti-friction bearings. Since bearings are lubricated to reduce friction, remove heat and prevent corrosion, it is important to add the proper amount of the right lubricant at the right time and to flush as often as necessary.

b) Bearings are normally lubricated every 3 to 6 months and flushed yearly. When applying this schedule, take into consideration the number of hours of operation, starting and stopping cycles, dirt, dust and moisture (from rain or condensation).

c) The condition of the lubricant - discoloration and contamination - will determine the proper maintenance schedule. The bearings should be inspected when the pump is dismantled for other repairs. If the bearing shows signs of galling, it may be suspected that too much grease has been "packed" into the bearings, thus causing the balls to slide rather than roll. If the bearing is pitted, the grease or oil is not preventing corrosion; or dirt and dust may be entering the bearing housing.

d) After grease has been added to the pump (for grease lubricated pump) the drain plug on the bottom of the bearing housing should be removed for half an hour while the pump is running.

# SECTION 5 MAINTENANCE

## GENERAL

### NOTE

*A pump properly installed and operated will require a minimum of maintenance. For the best overall performance, be sure to adhere to the instruction in Section 2, 3 and 4 of this manual.*

a) Operating conditions vary so widely that to recommend one schedule of preventive maintenance for all centrifugal pumps is not possible. It is suggested that a permanent record be kept of the periodic inspections and maintenance performed on the pump. This recognition of maintenance procedure will keep the pump in good working condition and prevent costly breakdowns.

b) One of the best rules to follow in proper maintenance is to keep a record of actual operating data and hours of operation. The length of this operation period will vary with different applications and can only be determined from experience. The next inspection period can be scheduled based on the condition of the components at this first inspection. This system can be followed until a maximum period of operation is reached, which should be considered the operation schedule between inspections.

**PERIODIC INSPECTION.** The following table is provided as a guide for performing periodic inspections on the pump.

PERIOD	INSPECTION
Every Month	Check bearing temperature with a thermometer, not by hand. If bearings are running hot, it may be the result of too much lubricant. If changing the lubricant does not correct the condition, disassemble and inspect the bearings.
Every 3 Months	Check grease lubricated bearings for saponification. This condition is usually incurred by the infiltration of water or other fluid past the bearing shaft seals, and can be noticed immediately upon inspection, since it gives the grease a whitish colour. Wash out the bearings with kerosene and replace the grease with the proper type as recommended.
Every 6 Months	Check the packing and replace if necessary. Use the grade recommended. Be sure the seal cages are centred in the stuffing box at the entrance of the stuffing box piping connection. Check shaft or shaft sleeve for scoring. Scoring accelerates packing wear. Check alignment of pump and motor. Shim up units if necessary. If misalignment recurs frequently, inspect the entire piping system. Unbolt piping at suction and discharge flanges to see if it springs away, thereby indicating strain on the casing. Inspect all piping supports for soundness and effective support of load.
Every Year	Remove the rotating element. Inspect thoroughly for wear, and order replacement parts if necessary. Remove any deposit or scaling. Clean out stuffing box piping. Measure total dynamic suction and discharge head as a test of pipe connection. Record the figures and compare them with the figures of the next test. This is important especially where the fluid being pumped tends to form a deposit on internal surfaces. Inspect foot valves and check valves, especially the check valve which safeguards against water hammer when the pump stops. A faulty foot or check valve will reflect also in poor performance of the pump while in operation.

**MAINTENANCE AFTER FLOODED CONDITION.** The servicing of centrifugal pumps after a flooded condition is a comparatively simple matter under normal conditions. Any pump that is properly sealed at all joints and connected to both the suction and discharge should exclude outside liquid. Therefore, it should not be necessary to go beyond the bearings, stuffing box and coupling when servicing the pump. However, in the event that flood liquid or other foreign matter enters the pump, it is necessary to flush the pump, and inspect and clean wearing surfaces.

a) Bearings are a primary concern on horizontal pumping units. First, dismantle the bearings, clean and inspect them for any rusted or badly worn surfaces. If bearings are free from rust

and wear, reassemble and relubricate them with one of the recommended pump lubricants. Depending on the length of time the pump has remained in the flooded area, it is unlikely that bearing replacement is necessary, however, in the event that rust or worn surfaces appear, it may be necessary to replace the bearings.

b) Inspect the stuffing box, and clean out any foreign matter that might clog the box. Packing that appears to be worn, or no longer regulates leakage properly should be replaced.

c) Couplings should be dismantled and thoroughly cleaned. Lubricate the coupling with one of the coupling manufacturer's recommended lubricants where required.

## CLEANING WITHOUT DISMANTLING PUMP.

- a) Close suction and discharge valve. Remove drop-out section in Suction Line. This section is described on page 3.
- b) Carefully run an auger through suction nozzle to free any clogging in impeller.
- c) If pump can not be freed of clogging after the above method has been tried, dismantle pump to locate the trouble.

**DISASSEMBLY.** The following instructions apply to all PWO models. Refer to figures 5, 6 and 7.

### Pump.

- a) Close suction and discharge valves to isolate pump from liquid system.
- b) Disconnect power source to driver.
- c) Turn off sealing liquid supply, and disconnect piping to stuffing box.
  - 1) **Flexible Coupling** - Where the pump is joined to the driver through a single element flexible coupling, disconnect the driver half coupling and remove the driver.
  - 2) **Spacer Type Coupling** - If spacer type coupling is used, remove spacer or dropout portion of coupling. Driver half coupling may be left assembled and driver need not be removed. Pump half coupling is removed only if pump is to be completely dismantled.
- d) Support frame assembly with a hook and sling under the frame top web. Remove screws which are holding frame (5-083-0) to casing (2-001-0) also remove screws from frame support (1-248-1).
- e) Using the sling, separate frame from casing, and move frame assembly (which includes rotating element) out and away from casing. Strip off gasket (2-123-0).

### NOTE

*If desired, the complete rotating element may now be moved to a remote area (away from pump area) for further maintenance. The casing may be left coupled to the inlet and discharge piping.*

- f) Remove screws which are holding sideplate in place and pull sideplate (2-046-0) from casing

### Rotating Element

- a) Remove bottom drain plug to drain all oil from frame. Remove pump-half coupling hub and key from shaft.
- b) Hold coupling end of shaft with a padded wrench or vice, and turn impeller (4-005-0) counterclockwise to remove. If impeller is tight, and will not loosen readily, hold a smooth block of wood against outer periphery of an impeller vane, and carefully tap wood with a mallet to loosen impeller.
- c) Remove screws holding stuffing box cover (2-036-0) to frame (5-083-0) and pull stuffing box cover from the frame and shaft.
- d) Remove packing (6-924-0), seal cage (6-013-0) and gland (6-014-0) from stuffing box.
- e) Pull shaft sleeve (1-009-0) from shaft, using a suitable bearing puller if necessary.

### Frame

- a) Pull deflectors (5-024-3) from shaft ends.

- b) Position frame in a vertical position with the outboard end up; place on a support that has a hole cut out for the shaft inboard end. Remove screws holding bearing housing (5-025-0) to frame (5-083-0).
- c) Carefully lift the shaft and bearing group out of frame, and place in a suitable padded cradle.
- d) Remove "O" ring (5-914-0) and shims from bearing housing.
- e) Remove bearing cover (5-018-3). Do not remove sight gauge (5-926-0) unless damaged.
- f) Use a suitable pair of snap-ring pliers to extract ring (5-068-4); allow ring to hang loose on the shaft. Pull bearing housing (5-025-0) from the shaft.
- g) Depending on the design, the outboard bearing may be secured to the shaft by a snap ring or a bearing locknut. To remove the bearing:
  - a) If a snap ring is used, first remove the snap ring (5-086-4) at the outboard bearing with snap ring pliers.
  - b) If bearing locknut is used, bend the tab(s) up on lockwasher (5-517-4). Remove the locknut (5-516-4) and lockwasher by turning the nut counter-clockwise.Carefully press shaft out of bearing (5-026-4). Lift off snap ring (5-068-4).
- h) Loosen locking screw of slinger (5-485-0) and pull slinger from shaft. Carefully press shaft out of bearing (5-026-3).

**CLEANING.** Clean all parts in a suitable cleaning solvent. Pay particular attention to all machined surfaces and gasket joints. At the frame, check and clean the oil level indicator. Be sure to clean stuffing box cavity and sealing liquid inlet.

**INSPECTION.** Inspect all parts for excessive wear or damage. Pay particular attention to the following items:

- a) Casing. Check for evidence of extreme wear or corrosion, especially at threaded taps. Examine casing joint for rust, burrs or raised surfaces.
- b) Front Sideplate. See that contoured portion of sideplate fits closely to contour of impeller (4-005-0). Replace sideplate if wear is excessive.
- c) Impeller. Check impeller vane for signs of wear, cracks or corrosion.
- d) Stuffing Box Cover Details. Check gland (6-014-0) and seal cage (6-013-0) for nicks or burrs. Replace all packing (6-924-0).
- e) Shaft Sleeve. Examine shaft (5-007-0) surface to see that it is smooth and free from grooves or scoring. Check to see that sleeve (1-009-0) is round without any appreciable eccentricity.
- f) Shaft. Inspect all rotating, close-clearance surfaces for wear. Check for straightness by mounting in a lathe. (If lathe not available, use suitable Vee blocks).
- g) Bearings. After cleaning, rotate bearings very slowly under hand pressure to feel for smooth and even action. Never spin a dry bearing. Examine carefully for "dull" spots indicating hollows; for "shiny" spots indicating concentrated wear; for pitting, "galling" or other damage to races, ball, or rollers. Check for cracks, for burrs on outside or inside diameters. or other

structural damage. Replace the bearing if there is any doubt as to complete serviceability.

## REPAIR AND REPLACEMENT

- a) General Replacement. Replace all parts that are excessively damaged or worn.
- b) Casing. If necessary, use a fine stone to remove rust, burrs, raised surfaces, dirt paint, etc. from casing joint.
- c) Shaft Sleeve (1-009-0). If shaft sleeve surface is grooved, polish to remove grooves. If grooves are too deep to polish, replace shaft sleeve.
- d) Fibre Packing: The standard packing is made from resilient non-asbestos fibres encapsulated by a protective TFE coating with break-in lubricant.

A soft well-lubricated packing reduces stuffing box resistance and prevents excessive wear on the shaft, or shaft sleeve. Many brands of packing have the desired qualities. Those listed below should be regarded as typical rather than specific recommendations for replacement

- 1) PaperPack 5801 .....Garlock Packing Company
- 2) #1335 .....John Crane Canada Inc.
- 3) #5059 .....Anchor Packing Company

- e) Metallic Packing. It may be desirable to use metallic packing for high temperature, high suction pressure, or other difficult application problems. Where metallic packing is used, a hardened steel shaft sleeve (approximately 400-500 Brinell) must also be used.

### NOTE

*Other types of wood-metal or plastic-metal packings may also be used effectively on certain applications.*

- f) Couplings. The cross and bearing assemblies of the universal joint spacer coupling are the only parts subject to wear. If excessively worn, disassemble universal joint assembly, including the two cross and bearing assemblies, and turn down the lockplate tabs holding the cap screws in place. Remove the four cap screws (four per yoke) and take off the complete cross and bearing assembly. This assembly may be ordered in a condition ready to install on the coupling. (Be sure to give coupling number when ordering). Reassemble cross and bearing assemblies to universal joint, and then to coupling hubs.

### NOTE

*If separate instructions are supplied for the coupling, be sure to follow the manufacturer's recommendations.*

**REASSEMBLY.** (See Figures 6, 7, and 8). In general, reassembly is in the reverse order of disassembly. Always replace gaskets, packings, and O-rings at each disassembly of the pump.

### Frame.

- a) Heat bearing (5-026-3) in a clean hot-air oven at 200° - 225°F. Install heated bearing (5-026-3) against shoulder of shaft (1-007-0), and hold in place until cool.

- b) Slip oil slinger (5-485-0) over centre portion of shaft. Tighten slinger locking screws.
- c) Place ring (5-068-4) on shaft so that flat face of ring is toward keyway end of shaft; allow ring to hang loose on shaft.
- d) Heat bearing (5-026-4) in a clean hot-air oven at 200° - 225°F. Install heated bearing on shaft. Assemble the locknut (5-516-4) and the lockwasher (5-517-4) at the outboard bearing. Bend Tab(s) on lockwasher.

If the frame assembly has a snap ring instead of a locknut, assemble the snap ring (5-086-4) making sure the flat face of ring is against bearing.

- e) Install bearing housing (5-025-0) over bearing (5-026-4) and lock in place with loose ring (5-068-4).
- f) Install O-ring (5-914-0) then carefully insert shaft and bearing group into frame. Do not install shims (5-924-0) at this time, since the proper shim thickness will be determined after reassembly of the complete rotating element. Temporarily attach bearing housing to frame with screws.
- g) Install bearing cover (5-018-3) with gasket.
- h) Install deflectors (5-204-3 and 4).

### Stuffing Box.

Place stuffing box cover (2-036-0) on a bench so that its interior side is up. Insert shaft sleeve (1-009-0) in centre of stuffing box cavity to act as a guide when installing packings.

- a) If moulded fibre packings are used, open packing ring sideways and push joint into stuffing box first. Install three rings, one at a time, seating each ring firmly. Stagger the ring joints at least 90° so that joints are approximately at the 4,8, and 12 o'clock positions (relative to the completed pump position). Install seal cage (6-013-0) being sure that it will line up with the seal liquid inlet in cover when packing are compressed. Install remaining packings.
- b) If coil fibre packings are used, cut one packing ring to accurate size with either a butt or mitred joint. Fit ring over the shaft to assure the proper length with a tight joint; then remove ring and use its size to cut remaining rings. Install rings and seal cage per above step a.
- c) If metallic packings are used, install per above step a. Many users prefer to omit the seal cage when metallic packing is used. If seal cage is omitted, install an extra ring of packing to provide a solidly packing stuffing box.

### Rotating Element

- a) Remove shaft sleeve (1-009-0) from stuffing box cover and slide sleeve onto shaft (5-007-0).
- b) Install stuffing box cover group (6-924-0, 6-013-0, 2-036-0) onto shaft and frame group being careful to keep packing details in position within stuffing box.
- c) Install packing gland (6-014-0). If fibre packings are used, tighten nuts firmly but not too tight. If metallic packings are used, tighten nuts tightly. Final adjusting of nuts will be made during the pump run-in.

d) Use teflon tape or apply a thin coat of "white lead" or a similar anti-seize thread compound to threads of shaft. Install impeller (4-005-0) on shaft and tighten securely while holding shaft.

**PUMP**

*Pump Size	Frame Size	Stuffing Box		Shaft Sleeve Dia. In Box	Seal Cage Width	"IN" and "OUT" Connect To Stuff. Box	Packing	
		Length	Bore				No. of Rings	Size
6 x 3 x 14	I/A1/B1	3.5	3-5/16	2-1/4	3/4	1/2	5	1/2
6 x 4 x 14								
8 x 4 x 17	II/A2/B2	3.7	4-5/16	3-1/4	15/16	1/2	5	1/2
8 x 5 x 17								
8 x 6 x 17								
10 x 8 x 17								
12 x 10 x 17	III/A3/B3	5.3	6-3/4	5-1/4	1 - 1/4	1/2	5	3/4
8 x 6 x 21								
10 x 8 x 21								
14 x 12 x 21								
16 x 14 x 21	IV/B4	5.5	6-3/4	5-1/4	1 - 1/4	1/2	5	3/4
14 x 14 x 23								
18 x 18 x 23								

- a. Install rotating element in casing.
- b. With no shims (5-942-0) installed, alternately loosen bearing housing screw while tightening jack screw until impeller is against stuffing box cover. Then check clearance between bearing housing (5-025-0) flange and frame (5-083-0).
- c. Alternately loosen jack screw while tightening bearing housing screw until impeller is against wear plate (2-045-0); then check clearance. The difference will indicate total end play of the rotor which should be from .025" to .060".
- d. Back-off rotating element .015" to .030". The total clearance between bearing housing flange and frame will be desired shim thickness.

**NOTE**

*Minimum clearance between impeller and stuffing box cover should be .015".*

- 3. Install proper size shims (5-942-0) and tighten bearing housing screws.
- f. Turn shaft by hand to see that there is no rubbing of impeller.

**PUMP RUN-IN (PACKING ADJUSTMENT).** Connect and start pump per Section 3.

**Fibre Packing Adjustment.**

a. When a pump with fibre packing is first started, it is advisable to have the packing slightly loose without causing an air leak. As pump runs in, gradually tighten the gland. The gland should never be drawn to the point where packing is compressed too tightly, and no leakage occurs. This will cause the packing to burn, score the shaft sleeve, and prevent liquid from circulating through the stuffing box, flushing the packing.

(The stuffing box is improperly packed or adjusted if friction in the box prevents turning the rotating element by hand.)

b. A properly operated packed stuffing box should run luke-warm with a slow drip of sealing liquid. After the pump has been in operation for some time and the packing has been completely run-in, drippage from the stuffing box should be at least 40 to 60 drops per minute. This will indicate proper packing and shaft sleeve lubrication and flushing.

**NOTE**

*Eccentric operation of the shaft, or sleeve, through the packing could result in excess leakage that cannot be compensated for.*

c. Adjust the external flushing liquid to the point where the packing runs only slightly warm, with a slow drip as indicated above. The flushing liquid must be left on, even when the pump is shut down, unless the casing is isolated from the discharge pressure. Pipe away all leakage, especially if corrosive or harmful to personnel.

**Metallic Packing Adjustment.**

Metallic packing depends on a good firm seat on the shaft sleeve, and actually forms a solid, bearing-like surface when it is properly installed and operated, or run-in.

a. When the pump is first started, follow-up on the gland bolts to further tighten the packing, and control gland leakage. Allow only enough leakage for slight cooling and lubrication. Metallic packing requires less external lubrication than other types, since it has good inherent lubricating qualities.

b. If the packing begins to get warm, and even smokes on the initial run-in, do not back off the gland nuts, or packing will be lost. It will seat itself, run-in and function most satisfactorily if it does get warm.

### CAUTION

*If after the run-in period the packing continues to run hot, more careful attention should be given to packing adjustment, or provision made to cool the shaft to avoid damage to the bearings.*

c. After the run-in period, adjust gland tension to provide one drop per second leakage from the gland. This amount will satisfactorily cool and lubricate the packing.

### REPLACEMENT PARTS.

The pumps covered by this manual have been designed and built with all wearing parts replaceable. A recommended inventory of spare parts is dependent upon the installation and the importance of continued operation.

It is not possible to recommend minimum spares to cover all conditions. The following may be taken as a guide:

a. Domestic service handling abrasive or corrosive liquids, or where some interruption in continuity of service is possible.

1. Shaft sleeves
2. Stuffing box packing
3. Gaskets

b. Domestic service handling abrasive or corrosive liquids,

or where some interruption in continuity of service is possible:

1. Shaft sleeves
2. Bearings
3. Stuffing box packing
4. Gaskets.

c. Export, or domestic service where minimum loss of service is essential:

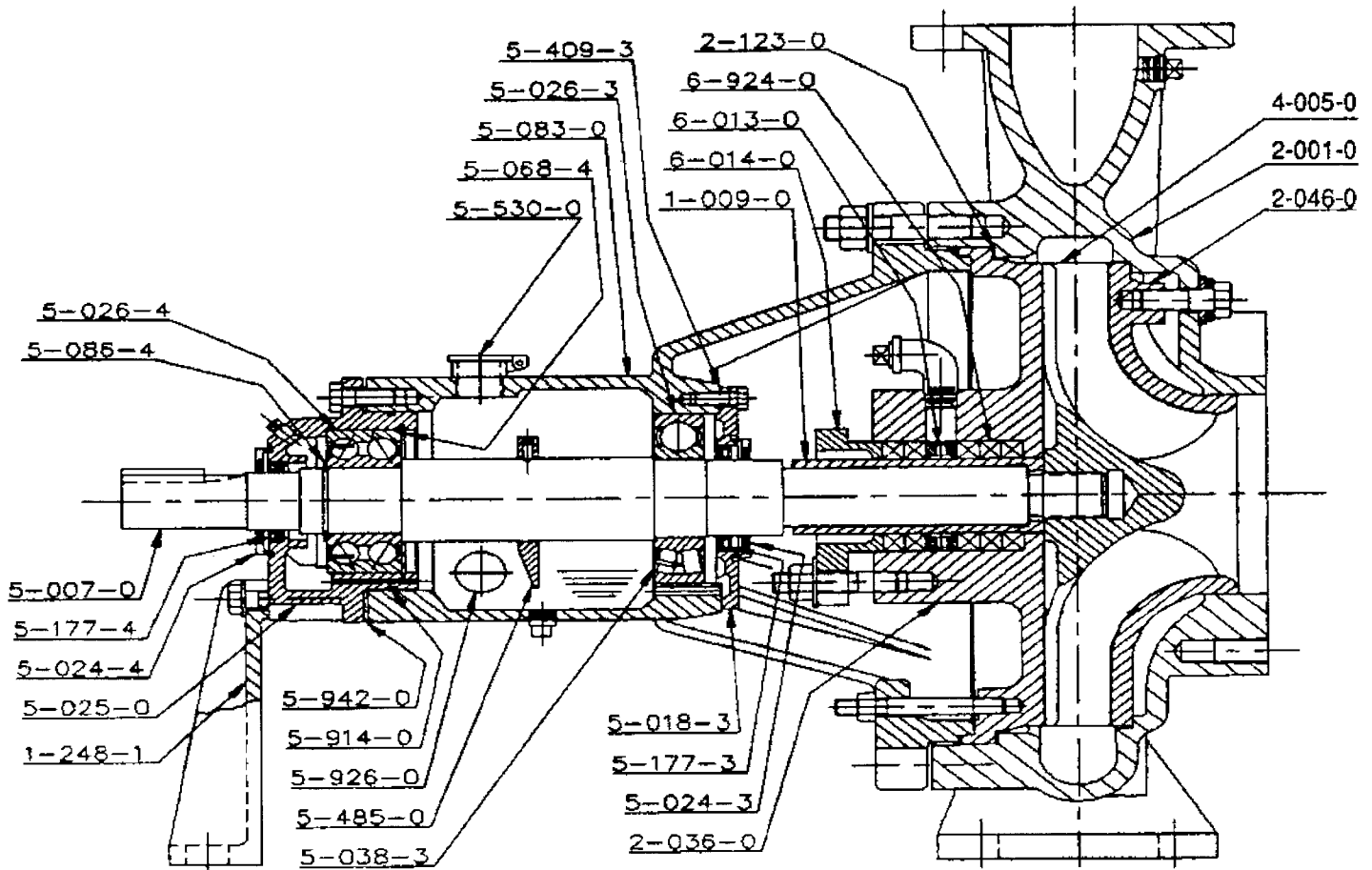
1. Complete bracket assembly (includes impeller)
2. Shaft sleeves
3. Bearings
4. Side plate
5. Stuffing box packing or mechanical seal
6. Gaskets

d. When ordering spare parts, always include the following information:

1. Pump Serial number
2. Pump size and Model number
3. Name of part.
4. Part number
5. Quantity of each part.
6. Material desired (if different than original material). Parts will be furnished in original materials unless specified as a material change.
7. Definite billing and shipping instruction
8. Date required

# SECTIONAL ASSEMBLY and PARTS LIST

## FRAMES I, II & III



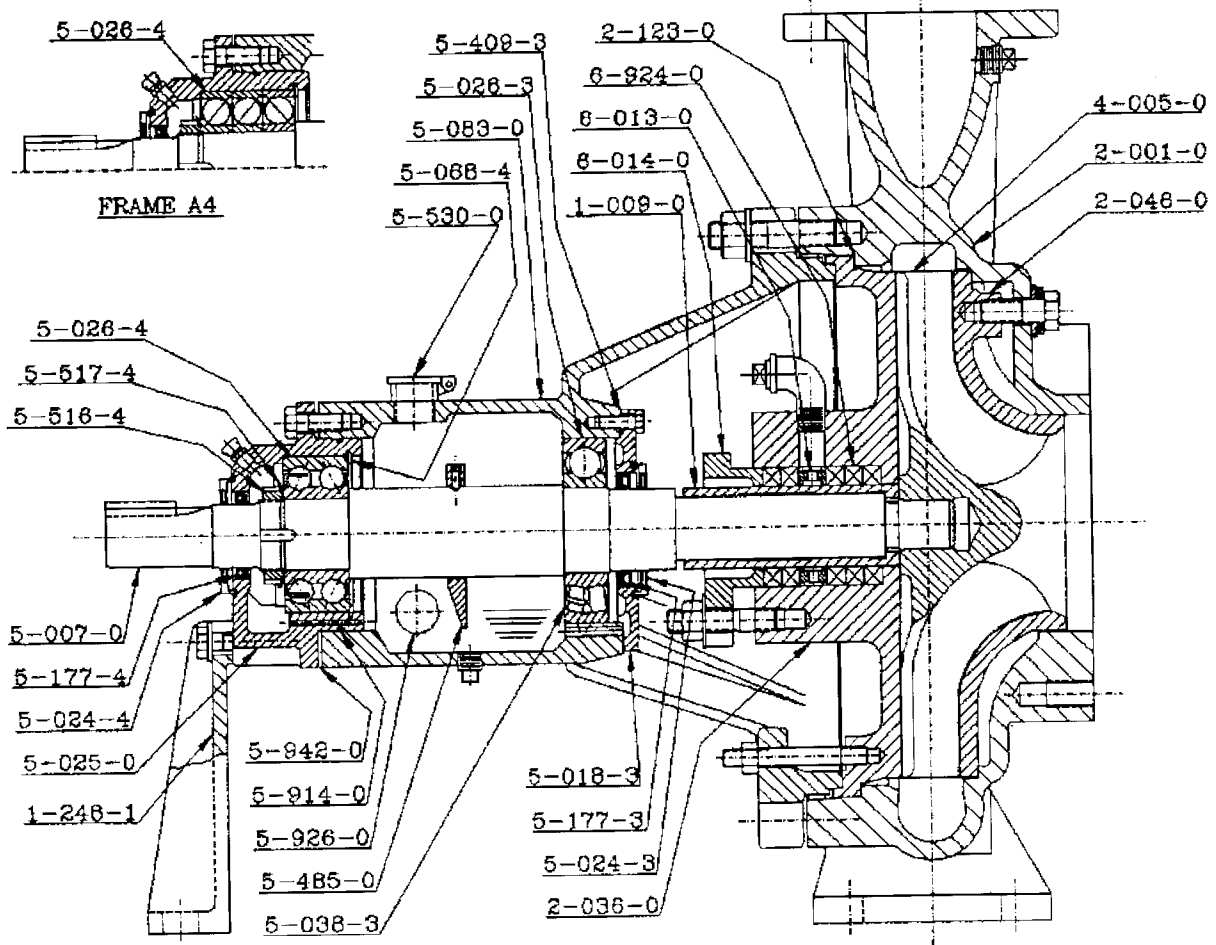
Catalog Code	Parts List	Catalog Code	Parts List	Catalog Code	Parts List
1-009-0	Shaft Sleeve	5-025-0	Brg. Hsg	5-530-0	Filler Cap
1-248-1	Frame Support	5-026-3	Brg. (Inb.) Fr. I & II	5-914-0	'O' Ring
2-001-1	Casing	5-026-4	Brg. (Outb.)	5-926-0	Sight Oil Gauge
2-036-0	Stuffing Box Cover	5-038-3	Brb. (Inb.) Fr. III	5-942-0	Shims
2-046-0	Sideplate	5-068-4	Brg. Hsg. Ret. Ring	6-013-0	Seal Cage
2-123-0	Casing Gasket	5-083-0	Frame	6-014-0	Gland Ass'y
4-005-0	Open Impeller	5-086-4	Brg. Ret. Ring	6-924-0	Packing (5 Rings)
5-007-0	Shaft	5-177-3	Brg. Seal (Inb.)		
5-018-3	Brg. Cover (Inb.)	5-177-4	Brg. Seal (Outb.)		
5-024-3	Deflector (Inb.)	5-409-3	Gasket - Brg. End Plate		
5-024-4	Deflector (Outb.)	5-485-0	Oil Slinger (2 for Fr III)		

Parts should be ordered as far in advance of their use as possible, since circumstances beyond the control of the Company may reduce existing stocks. Not all parts are stocked at the factory, some must be made for each order. Recommended Spare Parts to be carried on hand are included in the paragraph above and should be given definite consideration. If replacement parts required are to be made of different materials than originally specified, give exact requirements and the reason for changing.

Special care in furnishing the above information with the original order for parts will facilitate shipment.

# SECTIONAL ASSEMBLY and PARTS LIST

## FRAMES A1, A2, A3 & A4



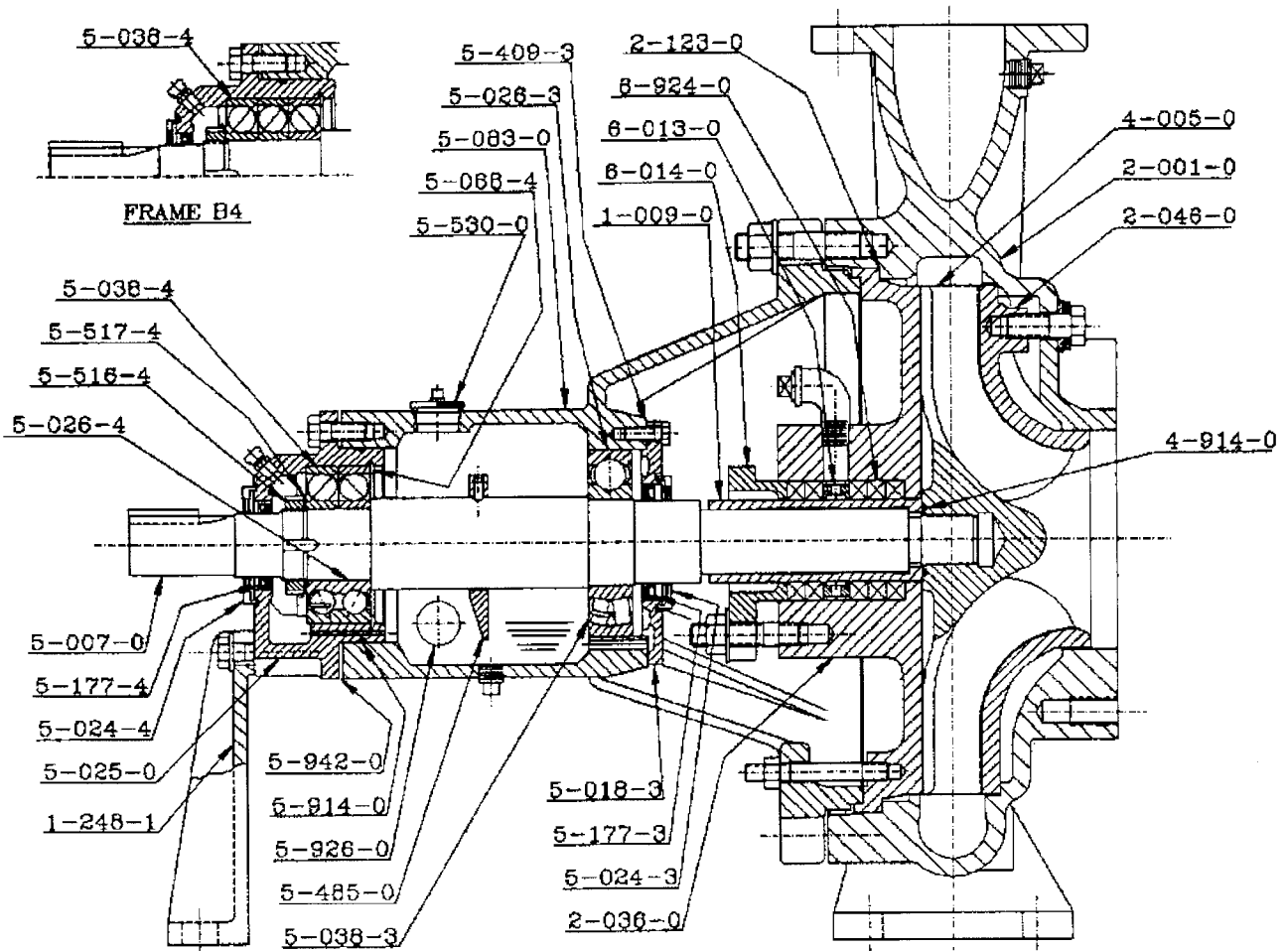
Catalog Code	Parts List	Catalog Code	Parts List	Catalog Code	Parts List
1-009-0	Shaft Sleeve	5-024-3	Deflector (Inb.)	5-485-0	Oil Slinger (2 for F4 A3 & A4)
1-248-1	Frame Support	5-024-4	Deflector (Outb.)	5-516-4	Locknut
2-001-0	Casing	5-025-0	Brg. Hsg.	5-517-4	Lockwasher
2-036-0	Stuffing Box Cover	5-026-3	Brg. (Inb.) Fr A1,A2, A4	5-530-0	Filler Cap
2-046-0	Sideplate	5-026-4	Brg. (Outb)	5-914-0	'O' Ring
2-123-0	Casing Gasket	5-038-3	Brg. (Inb.) Fr A3	5-926-0	Sight Oil Gauge
4-005-0	Open Impeller	5-068-4	Brg. Hsg. Ret. Ring	5-942-0	Shims
5-007-0	Shaft	5-083-0	Frame	6-013-0	Seal Cage
5-018-3	Brg. Cover (Inb.)	5-177-3	Brg. Seal (Inb.)	6-104-0	Gland Ass'y
		5-177-4	Brg. Seal (Outb.)	6-924-0	Packing (5 Rings)
		5-409-3	Gasket - Brg. End Plate		

Parts should be ordered as far in advance of their use as possible, since circumstances beyond the control of the Company may reduce existing stocks. Not all parts are stocked at the factory, some must be made for each order. Recommended Spare Parts to be carried on hand are included in the paragraph above and should be given definite consideration. If replacement parts required are to be made of different materials than originally specified, give exact requirements and the reason for changing.

Special care in furnishing the above information with the original order for parts will facilitate shipment.

Fig. 7

## SECTIONAL ASSEMBLY and PARTS LIST FRAMES B1, B2, B3 & B4



Catalog Code	Parts List	Catalog Code	Parts List	Catalog Code	Parts List
1-009-0	Shaft Sleeve	5-018-3	Brg. Cover (Inb.)	5-409-3	Gasket - Brg. End Plate
1-248-1	Frame Support	5-024-3	Deflector (Inb.)	5-485-0	Oil Slinger (2 for Fr B3 & B4)
2-001-0	Casing	5-024-4	Deflector (Outb.)	5-516-4	Locknut
2-036-0	Stuffing Box Cover	5-025-0	Brg. Hsg.	5-517-4	Lockwasher
2-046-0	Sideplate	5-026-3	Brg. (Inb.) Fr B1,B4	5-530-0	Filler Cap
2-123-0	Casing Gasket	5-026-4	Brg. (Outb.) Fr B1, B3	5-914-0	'O' Ring
4-005-0	Open Impeller	5-038-3	Brg. (Inb.) Fr B2,B3	5-926-0	Sight Oil Gauge
4-914-0	'O' Ring (Impeller)	5-038-4	Brg. (Outb.) Fr. B2, B4	5-942-0	Shims
5-007-0	Shaft	5-068-4	Brg. Hsg. Ret. Ring	6-013-0	Seal Cage
		5-083-0	Frame	6-014-0	Gland Ass'y
		5-177-3	Brg. Seal (Inb.)	6-924-0	Packing (5 rings)
		5-177-4	Brg. Seal (Outb.)		

Parts should be ordered as far in advance of their use as possible, since circumstances beyond the control of the Company may reduce existing stocks. Not all parts are stocked at the factory, some must be made for each order. Recommended Spare Parts to be carried on hand are included in the paragraph above and should be given definite consideration. If replacement parts required are to be made of different materials than originally specified, give exact requirements and the reason for changing.

Special care in furnishing the above information with the original order for parts will facilitate shipment.

Fig. 8

# SPECIAL PURPOSE PUMPS - Type PWO

## For Pulpy Solids and Corrosives

### Interchangeability

Pump Size	6 × 3 × 14	6 × 4 × 14	8 × 4 × 17	8 × 5 × 17	8 × 6 × 17	10 × 8 × 17	12 × 10 × 17	8 × 6 × 21	10 × 8 × 21	12 × 10 × 21	14 × 12 × 21	16 × 14 × 21	14 × 14 × 23	18 × 18 × 23
Casing														
Casing Side-Plate														
Impeller														
Stuffing Box Cover														
Frame Assembly														
	A1			A2				A3					A4	

## HERE'S HOW INTERCHANGEABILITY WORKS

All parts except the casing, impeller and casing sideplate are completely interchangeable within a given frame size. In addition, there is some interchangeability of casing sideplates. Spare parts requirements are held to a minimum even with a large number of pumps.

You benefit by standardization because only four frames cover all sizes of PWO pumps.

One stocked replacement frame assembly can serve to hold downtime to an absolute minimum when maintenance is necessary. The stocked assembly is installed quickly with little production holdup. Bench maintenance on the removed assembly can be made when convenient.

# SECTION 6 - DYNAMIC SEALS

1.0 ITT A-C Pump Canada's "PWO" Dynamic Seal pumps are designed to eliminate stuffing box sealing problems normally found with conventional packing and mechanical seals.

## 2.0 PRINCIPLE OF OPERATION

The Dynamic Seal uses an auxiliary impeller called "Expeller", in the stuffing box.

As pumped liquid enters the "Dynamic Seal" stuffing box cavity, it is opposed by centrifugal force, generated by the "Expeller", thus preventing leakage when applied correctly.

Depending upon the suction pressure, single stage or two stage expeller arrangements are available.

## 2.1 STATIC SEALING

When the pump is not in operation, a "Static Disk Seal" is provided, which prevents any leakage caused by the static suction pressure. (See Fig. 8 & 9).

## 2.2 DYNAMIC SEAL ARRANGEMENTS

Dynamic seals are available in single stage and two stage configurations, depending upon suction pressure (See Fig. 8 & 9)

PWO - BEARING FRAME	DYNAMIC SEAL SEAL	STANDARD MATERIALS OF CONSTRUCTION
B1	SINGLE STAGE TWO STAGE	316 ST.ST. 316 ST.ST.
B2	SINGLE STAGE TWO STAGE	316 ST.ST. 316 ST.ST.
B3	SINGLE STAGE	316 ST.ST.
B4	SINGLE STAGE	316 ST.ST.

## 2.3 DYNAMIC SEAL - FIELD CONVERSION KIT

Existing PWO pumps can readily be converted to "Dynamically Sealed" pumps by using "Field Conversion Kits", which include:

- Stuffing Box Cover
- Expeller
- Seal Rear Housing Assembly
- Shaft Sleeve and Static Seal

### NOTE:

*Before ordering "Dynamic Seal Field Conversion Kit", please contact factory with pump-operating conditions, for proper dynamic seal selection.*

## 2.4 DYNAMIC SEAL - FEATURES & BENEFITS

- a) No critical operating clearances are required for operating Dynamic Seals.
- b) When assembled properly, predetermined clearances between rotary and stationary dynamic seal parts assure of no rubbing contact. Thus, virtually eliminating stuffing box maintenance normally required with conventional packing or mechanical seals.
- c) During normal pump operation "NO" seal water is required for ITT A-C Pump Canada's Dynamic Seals.

This means:

- C.1 Elimination of gland leakage and product loss
- C.2 Elimination of product dilution
- C.3 Elimination of safety hazards due to pump leakage resulting in slippery floors.
- C.4 Reduction of effluent flow to waste-water treatment.
- C.5 Elimination of costly down-time.
- C.6 Considerable "cost reduction" for continuous flush/seal water "not required" for our dynamic seals.

Assuming: Seal water used with conventional stuffing box packing or mechanical seals:

$$\begin{aligned}
 3 \text{ gal./min} \times 60 &= 180 \text{ gal./hr.} \\
 180 \text{ gal./hr.} \times 24 \text{ hrs.} &= 4320 \text{ gal./day} \\
 4,320 \text{ gal./day} \times 365 \text{ days} &= 1,576,800 \text{ gal./yr./pump}
 \end{aligned}$$

## 2.5 INSTALLATION OF FLUSH LINES

Good installations of dynamically sealed pumps still provide flush lines to the individual pumps. We recommend flushing the "Seal Chamber" after a pump shutdown for a short period of time. This is to flush out any solids which may have settled out in the dynamic seal chamber during the shutdown period.

A 15-to-20 minute flushing of the seal chamber before restart of pumps is recommended. After that, flush lines are closed since no further flush/seal water is required during normal pump operation.

## 3.0 DYNAMIC SEAL MAINTENANCE

Thorough examination of the static disk lip seal and expeller is recommended after the first month of operation. The next inspection may be scheduled after a longer period of pump operation, if the dynamic seal components are found to be in good condition. It is recommended that permanent record be kept of the periodic inspection and maintenance performed on the pump. Accumulated data will be invaluable in establishing an optimized maintenance schedule.

#### 4.0 DYNAMIC SEAL DISASSEMBLY

- 4.1 Remove rotating element as per disassembly procedure Page 12.
- 4.2 Remove back cover (it.201), expeller (it. 202) and rear housing (it. 204).
- 4.3 Disassembly of static disk lip seal arrangement.
  - 4.3.1 Remove retaining ring (it. 212) and static disk lip seal (it. 211) from rear housing.
  - 4.3.2 Remove rotating collar (it. 213) from shaft sleeve.
  - 4.3.3 Remove "O" Ring (it. 214) from collar (it. 213).
- 4.4 Remove sleeve (it. 205)
- 4.5 Disassemble rotating element as per PWO Maintenance Manual Procedure (Page 12).

#### 5.0 DYNAMIC SEAL ASSEMBLY PROCEDURES

- 5.1 Assemble rotating element as per PWO Maintenance Manual Assembly Procedure (Page 13).
- 5.2 Assemble sleeve (it. 205) to shaft.
- 5.3 Install "O" Ring (it. 214) into rotating collar (it. 213) and slide this set onto sleeve with lip side facing toward the impeller.
- 5.4 Install retaining ring (it. 212) on shaft.
- 5.5 Install static disk lip seal (it. 211) on shaft. The side with radial cut must face the rear housing (it. 204). This position is absolutely essential for proper function of static seal.
- 5.6 Install rear housing (it. 204) on shaft.
- 5.7 Install expeller (it. 202) on shaft.
- 5.8 Install and fasten back cover (it. 201) to rear housing (it. 204).
- 5.9 Apply suitable anti-seize thread compound on impeller thread and install and tighten impeller against shaft sleeve.
- 5.10 Assemble rotating element to casing and shim as required to meet the specified clearance between impeller and sideplate. Follow PWO Maintenance Manual Assembly Procedure (Page 13).
- 5.11 Install static disk lip seal (it. 211) on studs of rear housing (it. 204).

- 5.12 While holding tightly the static disk lip seal (it. 211) against the face of the rear housing, slide rotating collar (it. 213) toward static disk lip seal (it. 211). Maintain  $.015 \pm .010$  clearance between collar and lip seal.
- 5.13 Install retaining ring (it. 212) to rear housing (it. 204). Before final tightening, make certain that the static disk lip seal (it. 211) is concentric to and not touching the shaft sleeve (it. 205).

#### 6.0 DYNAMIC SEAL PARTS LIST

##### 6.1 Kit No. 1 (Fig. 11)

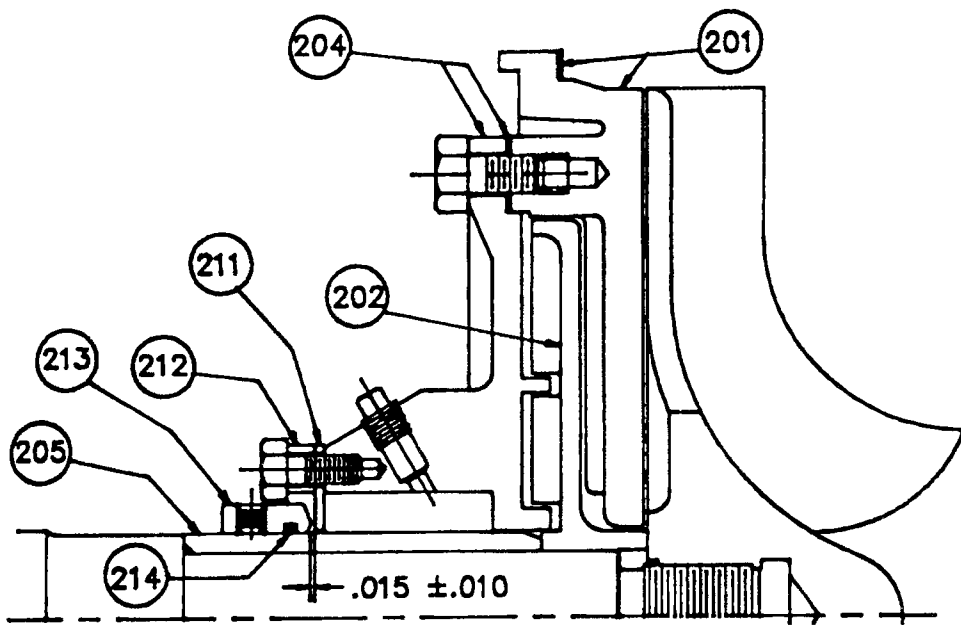
Single Stage Expeller with Static Disk Lip Seal

- 1 - back cover assembly (it. 201)
- 1 - expeller (it. 202)
- 1 - sleeve (it. 205)
- 1 - rear housing assembly (it. 204)
- 1 - retaining ring (it. 212)
- 1 - static disk lip seal (it. 211)
- 1 - rotating collar (it. 213)
- 1 - "O" Ring (it. 214)

##### 6.2 Kit. No. 2 (Fig. 12)

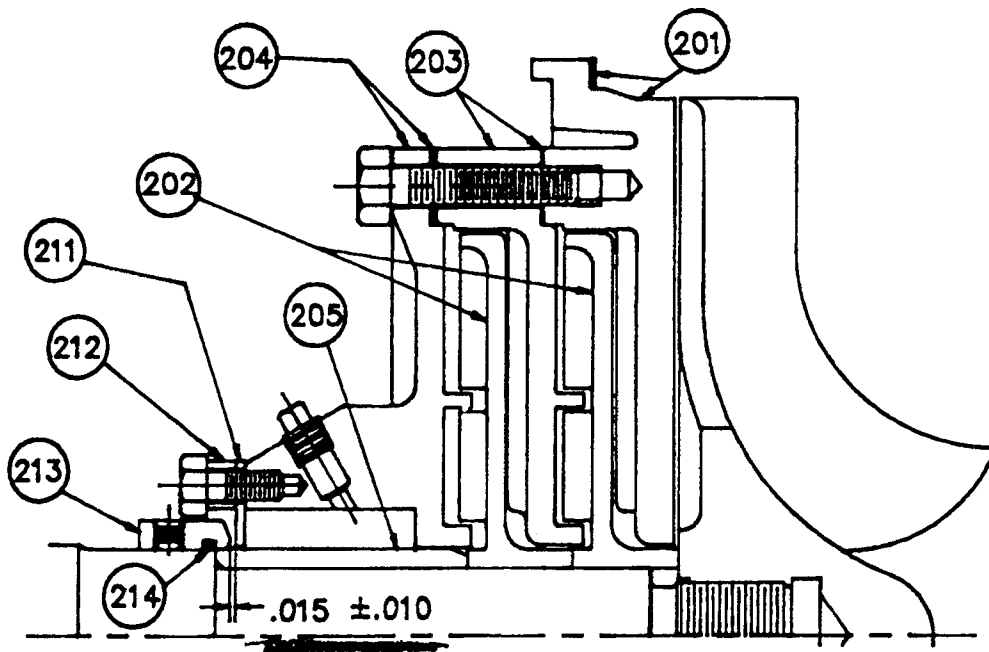
Double Stage Expeller With Static Disk Lip Seal

- 1 - back cover assembly (it. 201)
- 2 - expellers (it. 202)
- 1 - sleeve (it.205)
- 1 - rear housing assembly (it. 204)
- 1 - intermediate housing (it. 203)
- 1 - retaining ring (it.212)
- 1 - static disk lip seal (it.211)
- 1 - rotating collar (it.213)
- 1 - "O" Ring (it.214)



SINGLE STAGE DYNAMIC SEAL ARRANGEMENT  
WITH STATIC DISC LIP SEAL.

Fig. 9



DOUBLE STAGE DYNAMIC SEAL ARRANGEMENT  
WITH STATIC DISC LIP SEAL.

Fig. 10

**A-C Pump**

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IPWO-CANADA