# A-C Pump

ITT Fluid Technology Corporation

# INSTRUCTIONS

Installation
Operation
Maintenance

## TYPE CW
## CWR AND CWX
## PUMPS

52X9638-06

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**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 the responsibility of using accepted engineering practices in the installation, operation and maintenance of this equipment.

# SECTION 1 INTRODUCTION

## 1-1. INTRODUCTION

1-2. 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 Sales Office. The Standards of the Hydraulic Institute are an excellent source for more detailed advice on the subject of installation, operation and maintenance.

1-3. Equipment cannot operate well without proper care. To keep the unit at top efficiency, correct procedures for installing and maintenance must be followed. The ITT A-C Pump Service Organization can help install this equipment correctly, so that maximum machine life can be attained with a minimum of downtime.

1-4. A-C Servicemen are experienced, factory-trained erection superintendents, and offer prompt, efficient service and reasonable rates. Costly errors such as poor grouting, incorrect alignment, pipe stresses transmitted to the casings, and improperly cleaned piping are frequently found and corrected by these servicemen, thus saving costly repair and additional delays. The servicemen can be obtained through the nearest ITT A-C Pump Sales Office. This office will also help with spare parts orders and problems requiring special attention.

## 1-5. PUMP IDENTIFICATION

a. The new CW Pump Standard is designated style C-011. It combines the best features of both the CW-11 and CW-12 designs.

b. The C-011 Pump has internal pressure relief vanes cast integral in the impeller to reduce stuffing box pressure. Flush water is piped to the center of the stuffing box. A split seal cage delivers the water, sealing the packing from entrance of abrasive particles. Lower stuffing box pressure results in longer shaft sleeve and packing life.

c. The new CWR pump standard designation is style C-011. It is the same design as the CW except that the impeller is radially ribbed on both the front and back shroud wall. This is recommended for highly abrasive slurries. The impeller ribs cut down on recirculation of slurry through the wear plate clearance, reducing wear.

d. The dynamic seal, style C-022, is used when seal water dilution of the product cannot be permitted. This design employs a combination static seal and second impeller to eliminate the conventional stuffing box. Seal water in the amount of 1/4-1/2 GPM is all that is required.

1-6. The CW, CWR, and CWX are designated by the pump identification (Nameplate).

The Pump Nameplate contains the following information:

- Serial Number
- Size
- Type
- Impeller Diameter
- G.P.M.
- Head (Ft.)
- R.P.M.

1-7. 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.

1-8. Maintenance instructions in this manual are based upon the Model F6 frame.

# SECTION 2 INSTALLATION

## 2-1. RECEIVING PUMP

a. Check pump for shortage and damage immediately after arrival. Prompt reporting to the carrier's agent, with notations made on the freight bill, will expedite satisfactory adjustment by the carrier.

b. Unload and handle the unit by lifting equally at four or more points on the baseplate if it is base mounted. Do not lift on the driver or pump.

c. Pumps with drivers are normally shipped from the factory mounted on a baseplate and painted with primer and one finish coat.

d. Shafts are not in alignment when unit is shipped; alignment must be established during installation. The factory has determined that proper and correct alignment can only be made by accepted erection practices.

## 2-2. 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 change in ambient temperature. Rotate the shaft periodically to coat the bearings with lubricant and to retard oxidation and corrosion.

## 2-3. LOCATION

a. The pump should be installed as near the suction supply as possible, with the shortest and most direct suction pipe practical. The total dynamic suction lift (static lift plus friction losses in suction line) should not exceed the limits for which the pump was sold.

b. The pump must be primed before starting. Whenever possible, the pump should be located below pumping level to facilitate priming and assure a steady flow of liquid. This condition provides a positive suction head on the pump. Suction tank should contain at least sufficient liquid to equal the rated capacity of the pump in GPM.

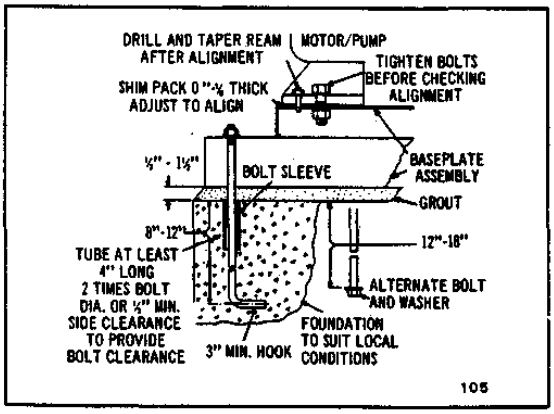



Figure 2. Foundation

c. When installing pump, consider the location of it in relation to the system to assure that sufficient Net Positive Suction Head (NPSH) at pump suction is provided. Available NPSH must always equal or exceed the required NPSH of the pump.

## 2-4. FOUNDATION

a. A substantial foundation and footing should be built to suit local conditions. It should form a rigid support to maintain alignment. It is advisable to isolate the foundation from adjacent cement work to prevent vibrations from being transmitted to the pump.

b. The foundation should be poured without interruption to within 1/2 to 1-1/2 inch of the finished height. The top surface of the foundation should be well scored and grooved before the concrete sets; this provides a bonding surface for the grout. Foundation bolts should be set in concrete as shown in Figure 3. A 4-inch long tube around the bolts at the top of the concrete will allow some flexibility in bolt alignment to match the holes in the baseplate. Figure 2 also shows a bolt and large washer as an alternate method of anchoring foundation bolts. Allow enough bolt length for grout, shims, lower baseplate flange, nuts and washers. The foundation should be allowed to cure for several days before the baseplate is shimmed and grouted.

c. The pump should be placed with sufficient accessibility for inspection and maintenance. A clear space with ample head room should be allowed for the use of an overhead crane or hoist sufficiently strong to lift the unit.

> **NOTE:** Allow sufficient space to be able to dismantle pump without disturbing the pump inlet and discharge piping.

d. Select a dry place above the floor level wherever possible. Take care to prevent pump from

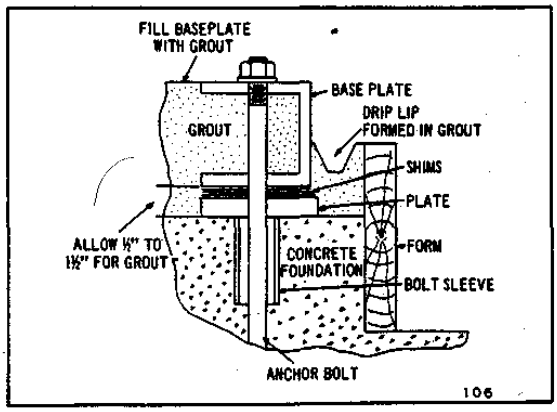



Figure 3. Setting Baseplate and Grouting

freezing during cold weather when not in operation. Should the possibility of freezing exist during a shut-down period, the pump should be completely drained, and all passages and pockets where liquid might collect should be blown out with compressed air.

e. Make sure there is a suitable power source available for the pump driver. If motor driven, electrical characteristics should be identical to those shown on motor data plate.

f. The pump rotation is clockwise viewing the drive (or coupling) end.

## 2-5. SETTING AND ALIGNING BASEPLATE

a. Any baseplate may be slightly sprung in shipment or unloading, or be distorted by an uneven support on the foundation or uneven tightening of the foundation bolts. Incorrect piping installation may also impose a strain or pull on the pump, bowing the baseplate, causing misalignment. Align coupling according to procedure under "Universal Joint Spacer Coupling," paragraph 2-7.

b. The foundation surface will support the pump and driver with shims and plates under the baseplate at the foundation bolts. The foundation should be smooth and level at these points to distribute the load evenly on the shims. A thin metal plate leveled in a puddle of mortar or grout is often the easiest way to achieve this level and smooth surface. Use thick shims wherever possible to reduce the number of shims used. (See Figure 3.)

c. Leveling bolts made of cap screws and nuts are very useful when leveling large baseplates, but they should not replace blocks and shims for supporting the load.

d. Adjust shims under baseplate until pump and driver shafts are level and the space between the baseplate and foundation is from 1/2 to 1-1/2 inch maximum. Check the coupling for alignment at this point.

> **NOTE:** Tighten the foundation bolts securely and check to assure that final alignment can be established.

**2-6. Grouting** Grout compensates for unevenness in the foundation and base and distributes the weight of the unit uniformly over the foundation. It also prevents the unit from shifting after mounting and alignment. It is essential that the unit be expertly grouted by use of non-shrinking grout. The mix required varies with the type of unit to be grouted, location and amount of grout. Grout the unit as follows:

a. Build a form of plywood or thin planking around the foundation to contain the grout. Support adequately to prevent deformation.

b. Soak top of concrete pad thoroughly with water before grouting. Remove all surface water before pouring.

c. Pour the grout through the openings in the baseplate. While pouring, tamp liberally in order to fill all cavities and prevent air pockets. The grout thickness under baseplate must be a minimum of 1 inch. In order to prevent baseplate from shifting, fill under baseplate at least 4 inches in from all four edges. Take care that grout will not interfere with pump or driving unit mounting bolts to allow shifting as necessary.

> **NOTE:** If pouring and tamping the grout will trap air in some places, temporarily place small diameter tubes (thick-walled rubber hose) to provide venting. Remove the tubes after grout has filled the cavity, before pouring the remainder.

If not certain as to the proper grout material to use, a non-shrinking grout such as "Embeco MB 423" by Masters Builders, Cleveland, Ohio-or equivalent is recommended. Follow grout manufacturer's instructions.

**CAUTION**

Keep water content to a minimum to avoid shrinkage.

d. After the grout has thoroughly hardened, re-tighten the foundation bolts, if they have become loose.

e. Check the alignment after the foundation bolts are tightened.

f. Approximately 14 days after the grout has been poured or when the grout has thoroughly dried, apply an oil base paint to the exposed edges of the grout to prevent air and moisture from coming in contact with the grout.

## 2-7. UNIVERSAL JOINT SPACER COUPLING

This coupling is furnished standard on all horizontal direct driver units.

a. With this coupling, alignment difficulties are reduced, as it is made to operate at a slight angle, and actually operates more efficiently in this manner.

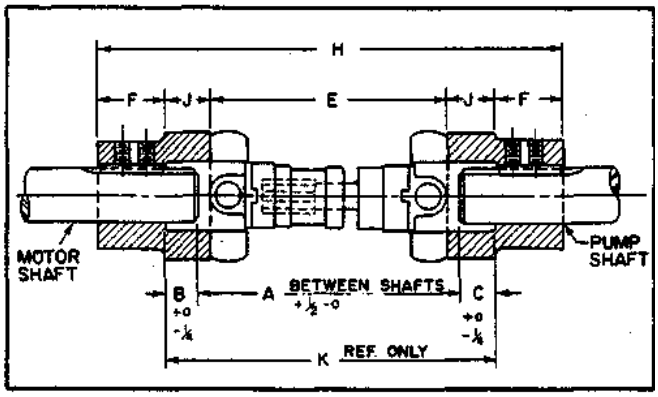
b. Do not line up coupling perfectly. Alignment should be within 1/8 to 1/4 inch, which is accurate enough. Ordinarily, after baseplate is permanently installed and leveled with foundation bolts firmly tightened, this coupling does not require further alignment. However, it is advisable to check the coupling to see that the limits as stated above *are* not exceeded.

c. The coupling is a precision made unit that will give trouble-free service if properly installed and operated. Coupling installation is made easier by following the procedures outlined below.

d. Couplings are normally shipped from the factory unassembled. Before coupling check for proper motor rotation and then couple within alignment limits outlined above.

e. When pump, base, coupling, coupling guard, but no motor is furnished, the complete unit cannot be assembled, but the coupling is completely assembled and fastened to the base. The pump half coupling and motor half are bored for their respective shafts.

f. After motor is located and bolted to the base, the coupling should be installed. It is not necessary to completely disassemble coupling hubs from universal joint when installing. Disassemble one hub (either pump or motor hub) from universal joint assembly by removing the four cap screws holding the hub to the cross and bearing assembly. Attach this hub to its shaft by sliding it all the way on.




| Coupling No. | A | B | C | E | F | H | J | K | Bore Limits (in.) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Min. | Max. |
| 3C | 7-1/2 | 1-3/16 | 1-3/16 | 6-7/8 | 1-3 /4 | 13-3/8 | 1-1/2 | 9-7/8 | 5/8 | 2-3/8 |
| 5C | 11-1/2 | 5/16 | 5 /16 | 8-3/4 | 2-1/'2 | 17-1/8 | 1-11/16 | 12-1/8 | 1-1/16 | 2-7/8 |
| 7C | 11-1/2 | 3/8 | 3/8 | 11 | 3 | 18-1/4 | 5/8 | 12-1/4 | 1-11/16 | 3-7/8 |
| 8C | 11-1/2 | 0 | 0 | 9-3/4 | 3-1/2 | 18-1/2 | 7/8 | 11-1/2 | 1-11/16 | 3-7/8 |
| 8C | 17-1/2 | 1/2 | 1-3/4 | 14-1/2 | 3-1 /2 | 26-3/4 | 2-5/8 | 19-3/4 | — | — |
| 9C | 17-1/2 | 0 | 0 | 13 | 5 | 27-1/2 | 2-1/4 | 17-1/2 | 2-1/16 | 4-7/8 |

g. Assemble remaining hub with universal joint assembly attached to the shaft in the same manner. Length of universal joint assembly can be adjusted by turning lubricant retainer and sliding spline stub shaft into slip yoke. After both hubs are assembled on shafts, with adjustment mentioned above, lengthen universal joint assembly until the male fits on the cross and bearing assembly are fitted tightly into female fits on coupling hub. Replace four cap screws bolting two pieces together. Insert safety wire thru cap screw heads in pairs.

h. Finally tighten two set screws in each hub over key way, which fasten hubs to shafts. Check to see that alignment is within 1/8 to 1/4 inch. Unit is then ready to operate.

**2-8. Universal Joint Coupling Lubrication** These couplings are equipped with Alemite Zerk fittings at each point requiring lubrication. The cross of each joint is drilled so that the lubricant is distributed to the four roller bearings from the Alemite Zerk fitting in the cross, or the fitting in the bearing. The slip yoke is lubricated by means of a fitting in the slip yoke.

a. A high grade semi-fluid lubricant, such as recommended in the partial list of approved lubricants should be used for this coupling.

b. The joints should be lubricated every 500 hours of operation. The universal joint has been lubricated at the factory, therefore, it is not necessary to lubricate it for the first 500 hours.

**2-9. Replacing Coupling Parts** The cross and bearing assembly is subject to wear and should be replaced if it becomes worn. To do this disassemble universal joint assembly, including the two cross and bearing assemblies and turn down the lock plate tabs holding the cap screws in place. Remove the four cap screws (4 per yoke) and take off complete cross and bearing assembly. This assembly may be ordered from the factory ready to install on coupling. Reassemble cross and bearing assemblies to universal joint and reassemble this to coupling hubs in the manner previously outlined.

**2-10. Floating Shaft Spacer Coupling:** The following alignment procedure is recommended where precise alignment is necessary or desirable. Other simpler methods may be used depending on how critical the results must be held. Some couplings and services may be more critical than others and judgment must be used.

a. Remove center section of coupling so that there is no connection between driving and driven shaft.

b. Mount dial indicators as shown in Figure 4.

c. Scribe index lines to serve as reference points in taking indicator readings.

d. Turn both shafts through a complete revolution, keeping index lines matched with each other. Make several tries, noting the indicator readings.

e. It is easier to first correct for angular mis-alignment, which is made by moving the driver so that the shaft is tilted up or down and left or right from its original position until the required reading is obtained on the angular alignment dial indicator.

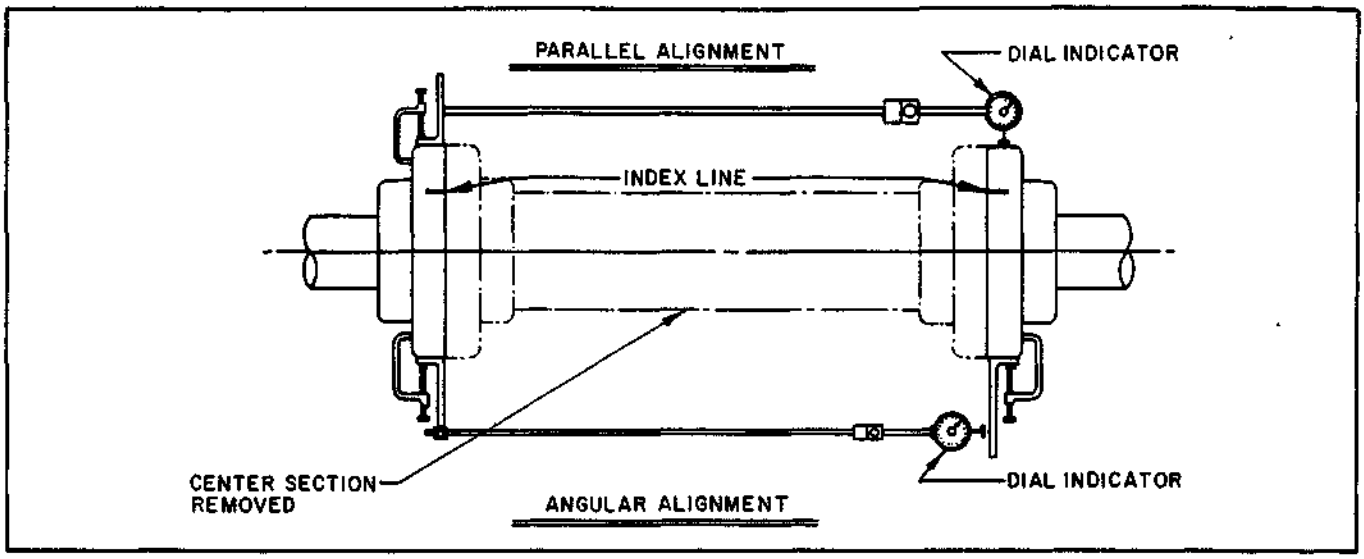



Figure 4. Checking Coupling Alignment

f. Correction of parallel misalignment is then made by moving the driver parallel in a direction indicated by the parallel dial indicator. Note that it is easier to first move the driver horizontally to get the best possible reading in this plane and then move the driver vertically. Repeat this procedure until the desired reading is obtained.

**2-11. V-Belt Drive** Pump and drive sheaves must be parallel and in line. Use a straight edge against sheave faces to assure alignment. Adjust belt to proper tension for best result.

**2-12. Doweling** Dowel the pump and driving unit as follows:

a. Check the alignment after the unit has been in operation approximately one week. Correct if necessary.

b. Through opposite pump feet drill through and into the base. Holes must be a diameter of 1/64 inch less than dowel pin. Clean out the chips.

c. Ream the holes in feet and base to the proper diameter for the pins (light push fit). Clean out the chips.

d. Insert pins to be approximately flush with pump feet.

**2-13. SUCTION AND DISCHARGE PIPING**

**General** When installing the pump piping, be sure to observe the following precautions:

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 long radius or 90° fittings to decrease friction losses.

d. Make sure that all piping joints are airtight.

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.

**CAUTION**

Bolt torque must not exceed 125 ft. lbs. on flanges. Hard iron is brittle and an over-torque could crack casing.

**2-14. Suction Piping** When installing the suction piping, observe the following precautions (see Figure 5).

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.

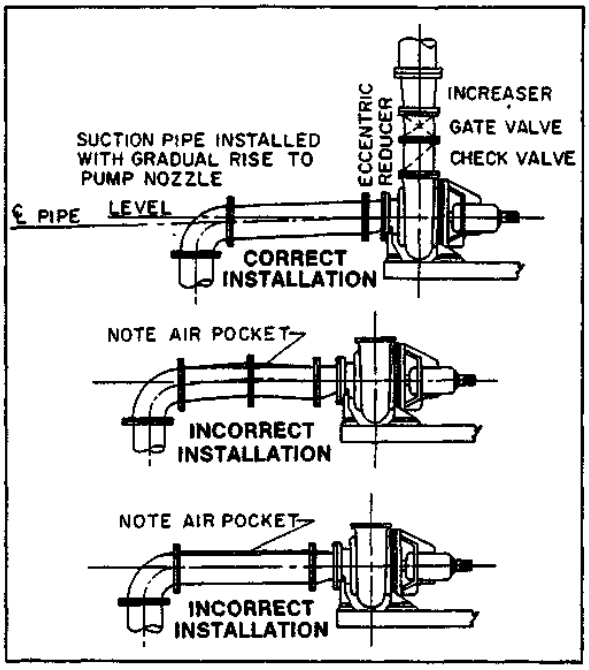



Figure 5. Suction Piping Installation

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. 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

**2-15. 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 it 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. (See paragraph 2-17.)

b. When foot valves are used, or where there are other possibilities of "liquid 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. Valves in the suction line should be used only to isolate the pump for maintenance purposes and should always be installed in positions to avoid air pockets. BY NO MEANS USE A SUCTION VALVE TO THROTTLE LIQUID FLOW INTO PUMP.

**2-16. Discharge Piping** For plain liquid service, 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. For slurries it is suggested to consult technical advise on correct pipe sizing. Each application may require consideration to provide proper line velocity to prevent settling out. Selection of size of discharge line is important in order to keep velocities up to prevent slurries from settling out.

**2-17. 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.

**2-18. Pressure Gages** Properly sized pressure gages can be installed in both the suction and discharge pipe sections adjacent to the pump. The gages 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. For slurry service gages should be of the protected type. If cavitation, vapor binding or other unstable operation should occur, widely fluctuating discharge pressure will be noted.

> **NOTE:** The standard pump has no drain or vent taps.

**2-19. External Liquid Piping (C-011)**

a. The liquid being pumped usually contains solids or is otherwise not compatible with seal materials, and an outside supply of liquid must be furnished. Injection liquid (from an outside source) is always 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 180°F. Consult the factory 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 5-10 psi more than the pump suction pressure. (See paragraph 2-22 and 2-23.)

## 2-20. STUFFING BOX (C-011)

**2-21. 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 condition, therefore, is to use the lowest possible flushing pressure which the operating conditions will permit.

**2-22. Stuffing Box Operating Pressure** The actual stuffing box operating pressure may be obtained by installing a pressure gage on one test connection located on the stuffing box cover. Gage 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.

**2-23. Flushing And Lubrication Water** A recommended method to minimize error in regulating flushing water is the "Controlled Pressure System" as shown in Figure 6. 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 pump. If this becomes excessive, the flow indicator will show it. The gland maybe adjusted to a slow drip. The "out" connection from the stuffing box should be closed with this system.

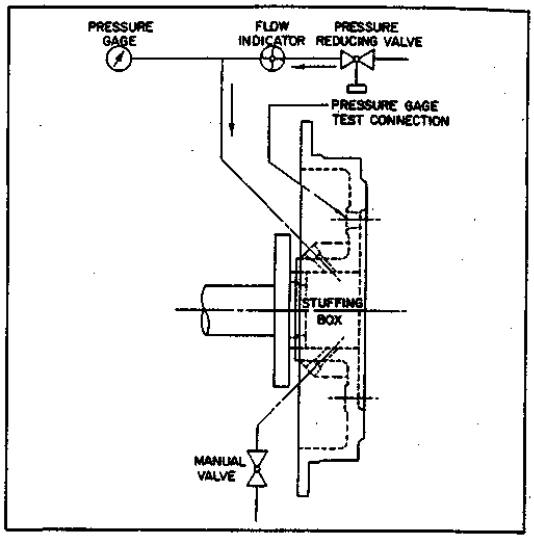



Figure 6. Controlled Pressure System

A "balanced flushing water system," Figure 7, has also been very successful. In this system a stand pipe is connected to the "out" tap of the stuffing box, at a recommended height "h" = (height of liquid in suction tank) x (specific gravity) x 1. 5. The end of the pipe should be visible to the operator so that the flow of water to drain is minimized. This system will allow the water to flush through the seal cage. Inspection of this flush water will tell if contaminants are getting past the bottom rings of packing. The corrective measure is to raise the height of stand pipe until the flush water runs clear. The gland may be adjusted to a slow drip.

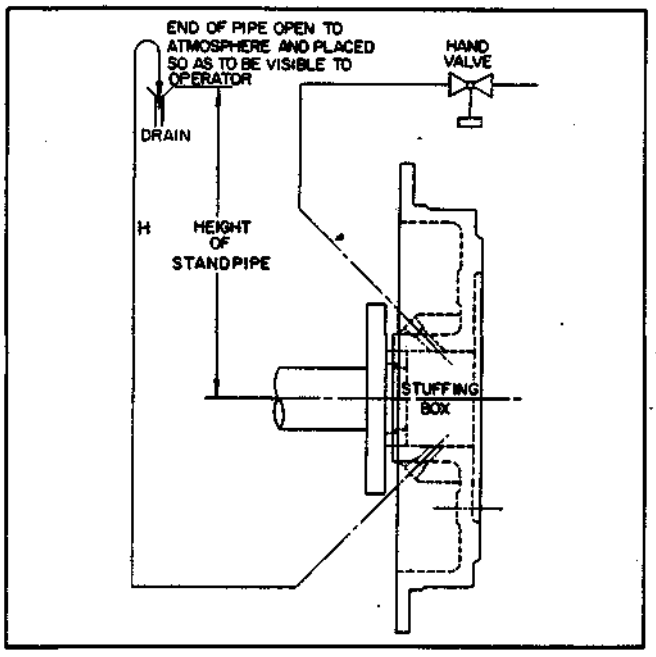



Figure 7. Balanced Flush Water System

Longer packing life and less frequent adjustment are possible with the "Controlled Pressure System" or the "balanced flushing water system" properly installed and operated.

**2-24. Packing** All pumps are packed before shipment unless otherwise requested. Before a 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.

**2-25. DYNAMIC SEAL (C-022)**

It is necessary that the Dynamic Seal be carefully applied to operate within the limitations of the design considering Speed, Suction Head and Suction Pipe velocity conditions. If any doubt exists, the conditions and application should be checked before starting unit.

The Dynamic Seal has a flushing connection which should be supplied with clear, clean, cool fresh water. A regulating valve supplied with pump will control flow to 1/4 GPM, which is necessary to flush and cool the Dynamic Seal. This water will be then mixed into the product pumped. If it is desirable to limit this flow by more elaborate controls, the seal will perform satisfactorily as long as it has sufficient water to keep seal cool. If the source of seal water is clarified water containing small particles then the 1/4 GPM regulating valve should be discarded and replaced by a hand valve less likely to become plugged. The Static Seal portion of the C-022 unit should be checked for proper setting according to "Setting Instructions" in the maintenance section.

# SECTION 3 OPERATION

**3-1. PRE-START CHECKS**

Before initial start of the pump, make the following inspections:

a. Check alignment between pump and motor.

b. Check 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.

> **NOTE:** If motor cannot be carefully "Bumped" it is suggested that couplings be disconnected for rotation check.

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 gages for proper operation.

e. Turn rotating element by hand to assure that it rotates freely.

f. Check impeller adjustment. Refer to paragraph 4-18.

g. Check stuffing box adjustment, lubrication and piping. Refer to paragraphs 4-20 and 4-21.

h. Assure that bearings are properly lubricated. Refer to paragraph 3-23.

i. Assure that pump is full of liquid.

**3-2. 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.

**3-3. STARTING**

a. Close valve in discharge line and drain valves.

b. Open fully all valves in the suction line.

c. Turn on external flushing water to the stuffing box and adjust pressure if necessary. (If pumped liquid is dirty or if leakage of air is to be prevented, these lines should be always left on.)

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. (Note: Pump should not operate against a closed discharge for any length of time—in some cases this should not be more than a few minutes.)

h. Adjust the liquid seal valves to proper pressure according to instructions in Section 2.

**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.

### 3-4. OPERATING CHECKS

a. Check the pump and piping to assure that there are no leaks.

b. Check and record pressure gage 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**

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

### 3-5. 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 protection 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.

### 3-6. 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.

c. Use a bottom horizontal discharge nozzle setting and put drain plug in pipe adjacent to pump flange.

**CAUTION**

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

### 3-7. FIELD TESTS

### 3-8. Performance Curve and Guarantees

a. A typical performance curve may be obtained for your ITT A-C Pump. This can be used in conjunction with a field test, if one is required. All ITT A-C Pump pump tests, curves, and guarantees are based on the "Standards of the Hydraulic Institute." Any field test must be conducted according to these "Standards."

b. Unless otherwise specifically agreed, all capacity, head and efficiency guarantees are based on shop tests when handling clear, cold, fresh water at a temperature not over 85°F and under suction conditions as specified in the contract.

c. To aid in calculating pump performance, the following test information and definitions are included for reference.

**3-9. Gage Datum** The datum for all gage readings is taken as the centerline of the pump for all horizontal shaft pumps, and as the centerline of the impeller for vertical shaft pumps.

**3-10. Head Measurement** The unit for measuring head should be feet; therefore all pressure readings of the pumped liquid should be converted to feet. The relationship between a pressure expressed in pounds per square inch (psi), and that expressed in feet of head is:

$$\text{Head in feet} = \frac{psi \; x \; 2.31}{sg}$$

Where sg = specific gravity of the liquid pumped.

**3-11. Total Head** Total head is the algebraic difference between the total suction and the total discharge heads.

a. Where suction lift exists, total head is the sum of the total discharge head and the suction lift.

b. Where positive suction head exists, the total head is the total discharge head minus the total suction head.

**3-12. Suction Lift** Suction lift exists where the total suction head is below atmospheric pressure. Total suction lift is the reading of a liquid monometer at the suction nozzle of the pump, converted to feet of liquid, and referred to the datum minus the velocity head at the point of gage attachment.

**3-13. Positive Suction Head** Suction head exists when the total suction head is above atmospheric pressure. Total suction head is the reading of a gage at the suction of the pump converted to feet of liquid, and referred to datum plus the velocity head at the point of gage attachment.

**3-14. Velocity Head** is figured from the average velocity obtained by dividing the discharge (in cubic feet per second) by the actual area of the pipe cross-section (in square feet), and is determined at the point of gage connection. It is expressed by the formula:

$$h_v = \frac{V^2}{2g}$$

Where g = the acceleration due to gravity, and is 31.17 feet per second$^2$ at sea level and 45 degrees latitude.

V = velocity in the pipe in feet per second.

**3-15. Volume Measurement** The method of volume measurement should be made by some accurate and accepted method and converted to gallons per minute. For easy reference, refer to the following:

a. The standard U. S. gallon contains 231 cubic inches.

b. One cubic foot equals 7. 4805 gallons.

c. The specific weight of water at a temperature of 85°F shall be taken as 62.17 pounds per cubic foot.

**3-16. Horsepower**

a. The formula for horsepower required is:

$$BHP = \frac{Total\,head \; x \; gpm \; x \; specific\,gravity}{3960 \; x \; Eff.}$$

Where 3960 = 33,000 ÷ 8.33. Eff. is expressed as a decimal, Ex. - .70.

b. The true motor brake horsepower, once the efficiency is determined from dynamometer tests, can also be calculated from the following formula:

$$Bhp = \frac{kw\;input \; x \; Eff.}{.0746}$$

Where Bhp = Brake horsepower delivered

kw input = real input power (kw)

and Eff. = Motor efficiency.

**3-17. Pump Efficiency** Pump efficiency can be measured by the formula:

$$Efficiency = \frac{Total\,head \; x \; gpm \; x \; specific\,gravity}{3960 \; x \; Bhp}$$

### 3-18. 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 SHUT DOWN.

| NO LIQUID DELIVERED | | |
|---|---|---|
| | **CAUSES** | **CURE** |
| 1. | Lack of prime. | Fill pump and suction pipe completely with liquid. |
| 2. | Loss of prime. | Check for leaks in suction pipe joints and fittings; vent casing to remove accumulated air. |
| 3. | Suction lift too high. | If no obstruction at inlet, check for pipe friction losses. However, static lift may be too great. Measure with mercury column or vacuum gage while pump operates. If static lift is too high, liquid to be pumped must be raised or pump lowered. |
| 4. | Discharge head too high. | Check pipe friction losses. Large piping may correct condition. Check that valves are wide open. |
| 5. | Speed too low. | Check whether motor is directly across-the-line and receiving full voltage. Or frequency may be too low; motor may have an open phase. If V-Belt Drive increase size of motor sheave. |
| 6. | Wrong direction of rotation. | Check motor rotation with directional arrow on pump casing. |
| 7. | Impeller completely plugged. | Dismantle pump and clean impeller. |

| NOT ENOUGH LIQUID DELIVERED | | |
|---|---|---|
| 8. | Air leaks in suction piping. | 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 gage will indicate a leak with a drop of pressure. |
| 9. | Air leaks in stuffing box. | Increase seal liquid pressure to above atmosphere. |
| 10. | Speed too low. | See item 5. |
| 11. | Discharge head too high. | See item 4. |
| 12. | Suction lift too high. | See item 3. |
| 13. | Impeller partially plugged. | See item 7. |
| 14. | Cavitation; insufficient NPSH (depending on installation) | Increase positive suction head on pump by increasing level in suction tank. |
| 15. | Defective packing. | Replace packing and sleeves if badly worn. |
| 16. | Adjust clearance. | Loosen bearing frame liner clamp and move rotating element. See clearance and adjustment. |
| 17. | Foot valve too small or partially obstructed. | 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. |
| 18. | Suction inlet not immersed deep enough. | 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. |

| CAUSES | CURE |
|---|---|
| 19. Wrong direction of rotation. | Symptoms are an overloaded drive and about 1/3 rated capacity from pump. Compare rotation of motor with directional arrow on pump casing. |
| 20. Too small impeller diameter (probable cause if none of above). | 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. |
| **NOT ENOUGH PRESSURE** | |
| 21. Speed too low. | See item 5. |
| 22. Air leaks in suction piping. | See item 8. |
| 23. Mechanical defects. | See items 15 and 17. |
| 24. Obstruction in liquid passages. | Dismantle pump and inspect passages of impeller and casing. |
| 25. Air or gases in liquid (Test in laboratory, reducing pressure on liquid to pressure in suction line. Watch for bubble formation.) | 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 14. |
| 26. Adjust clearance | See item 16. |
| **PUMP OPERATES FOR SHORT TIME, THEN STOPS** | |
| 27. Incomplete priming. | Free pump, piping and valves of all air. If high points in suction line prevent this, they need correcting. See paragraph 2-16. |
| 28. Suction lift too high. | See item 3. |
| 29. Air Leaks on suction piping. | See item 8. |
| 30. Air leaks in stuffing box. | See item 9. |
| 31. Air or gases in liquid. | See item 25. |
| **PUMP TAKES TOO MUCH POWER** | |
| 32. Head lower than rating; thereby pumping too much liquid. | Decrease pump speed. |
| 33. Cavitation. | See item 14. |
| 34. Mechanical defects. | See items 15 and 17. |
| 35. Suction inlet not immersed deep enough. | See item 18. |
| 36. Liquid heavier (in either viscosity or specific gravity) than allowed for. | Use larger driver. Consult factory for recommended size. Test liquid for viscosity and specific gravity. |
| 37. Wrong direction of rotation. | See item 6. |
| 38. Stuffing boxes too tight. | 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 from lubrication. |

| CAUSES | CURE |
|---|---|
| 39. Casing distorted by excessive strains from suction or discharge piping. | Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts. |
| 40. Shaft bent due to damage, improper shipment, operation or overhaul. | Check deflection of rotor by turning on bearing journals. Total indicator runout should not exceed 0.002 on shaft and 0.004 inch on impeller wearing surface. |
| 41. Mechanical failure of critical pump parts. | Check bearings and impeller for damage. Any irregularity in these parts will cause a drag on shaft. |
| 42. Misalignment. | Realign pump and driver. |
| 43. 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). | Check voltage on motor. |
| 44. Electrical defects. | 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. |
| 45. Mechanical defects in turbine, engine or other type of drive exclusive of motor. | 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 representative. Describe completely the operating conditions of pump at time of failure along with other pertinent data.

### 3-19. LUBRICATION

Proper lubrication of the pump bearings is essential in 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.

### 3-20. Oil Lubrication

a. The oil-lubricated pumps have splash oiling in which the oil is picked up from the reservoir by a rotating slinger and deposited as fine droplets on the shaft bearings and entire interior of the bearing housing.

b. 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.

c. Experience shows that oils meeting the following specifications will provide satisfactory lubrication. These oils can be furnished by all major oil 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

d. 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, and should also be non-foaming.

**NOTE:** Oils from different suppliers should not be mixed.

e. 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 operating 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.

### 3-21. Oil Reservoir

The capacity of the oil reservoir is as follows:

| FRAME SIZE | QUANTITY PINTS F6 Frame |
|---|---|
| I | 3/4 |
| II | 1 |
| III | 2 |

### 3-22. Grease Lubrication

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, aluminum, 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 aualities 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 (POST) maximum.....30°F

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

### 3-23. Bearing Lubrication Notes

a. Bearings in the pump are anti-friction (ball 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.

### 3-24. Bearing Seal, Lubrication

Inboard and outboard bearings are protected from entrance of moisture and dirt by a grease seal which is independent from bearing lubrication. The seal consists of a metal backed rubber slinger which fits over the shaft and is pressed up close to the bearing cover. The bearing cover has an annular labyrinth groove and grease cavity to trap any foreign material protecting the bearing.

Grease fittings are located on the bearing cover. Grease should be applied every three months. A relief hole will discharge the excess grease and prevent over loading.

### 3-25. COUPLING LUBRICATION

### 3-26. Universal Joint Coupling

These couplings are equipped with "Alemite Zerk" fittings at each point requiring lubrication. The cross of each joint is drilled so that lubricant is distributed to four roller bearings from fitting in cross, or fitting in bearing. The slip yoke is lubricated by means of a fitting in the slip yoke. Lubricate the joints with any good grade of ball bearing grease every 500 hours of operation. The universal joint has been lubricated at the factory, therefore, it is not necessary to lubricate it for the first 500 hours.

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

# SECTION 4 MAINTENANCE

### 4-1. 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.

### 4-2. 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. Adjust impeller clearance to retain operating efficiencies. |
| Every 3 Months | Check grease lubricated bearings for saponificiation. 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 color. Wash out the bearings with kerosene and replace the grease with the proper type as recommended. |
| Every 6 Months | Check the packing and replace it if necessary. Use the grade recommended. Be sure the seal cages are centered in the stuffing box at the entrance of the stuffing box piping connection.<br>Check shaft or shaft sleeve for scoring: Scoring accelerates packing wear.<br>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.<br>Remove any deposit or scaling. Clean out stuffing box piping.<br>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.<br>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. |

## 4-3. 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 may be 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.

## 4-4. DISASSEMBLY

See Figures 13, 14 and 15. Each style of CW pump is shown separately in exploded view drawings and all parts listed on pages 27 through 31. For identification of all key numbers appearing in ( ), refer to the proper page, depending upon style being referenced. Where parts are common to more than one style, the same key number is used in each style.

## 4-5. Pump Style C-011

a. Close suction and discharge valves or otherwise isolate pump from liquid system.

b. Disconnect power source to driver.

c. Turn off water supply to stuffing box and disconnect piping.

d. Disconnect drive.

(1) Spacer type coupling - Universal type

Remove four cap screws from flanges of both the drive and driven ends of the spacer coupling.

Remove spacer section to permit disassembly of rotating element from pump.

(2) V-Belt Drive

Loosen bolts on motor slide base and move motor base toward pump to relax tension on belts.

Remove belts from driven sheave.

e. Support frame assembly with a hook and sling under the top web of the frame. Loosen and remove cap screws, washers and nuts holding frame to casing.

f. Using sling, slide frame from casing, out and away from pump. Strip off gasket.

> **NOTE:** If desired, the complete rotating element may now be removed as a unit and taken to the shop for further disassembly. The casing is left in place bolted to suction and discharge piping.

g. To remove suction wear plate, remove cap screws and washers holding suction wear plate to casing. Take suction wear plate out of casing. Strip off gasket.

## 4-6. Rotating Element

a. Remove oil drain cap from nipple on under side of frame and drain oil from bearing housing.

b. Remove sheave or coupling fitting yoke from pump shaft.

c. Hold drive end of pump shaft with padded wrench, or insert rod through hole in shaft and turn impeller counterclockwise to remove. If impeller is tight and will not loosen readily use the following procedure:

(1) Place a block of hardwood against edge of impeller vane and strike with mallet to loosen.

or

(2) Place large block of hardwood upright on ground so that when the rotating assembly is turned 180° with wrench or rod attached to shaft, the end of the wrench strikes the block. This method imparts considerable force to loosen the impeller.

> **NOTE:** Impeller will unscrew counter-clock (from impeller end), so wrench must strike the block in this same direction.

(3) It is sometimes helpful to apply heat with a torch to the impeller hub to assist in loosening the threads.

d. Remove cap screws holding wear plate to stuffing box. Strip off gasket.

e. Remove two nuts from studs holding stuffing box cover to frame. Loosen gland bolts and remove split gland pieces. Pull stuffing box from frame and remove packing.

f. Remove shaft sleeve from shaft using bearing puller. Apply heat from torch if necessary. If this fails it may be necessary to cut the sleeve by splitting it lengthwise on one side with a chisel.

### 4-7. Frame

**NOTE:** Study Figure 8 showing recommended method of handling frame assembly during the dismantling and assembly operations. Using the impeller as a stand, the frame with frame liner maybe lifted vertically with hooks as shown.

a. First remove deflectors (1, figure 13) from shaft and remove outboard bearing cover (3).

b. Screw impeller onto shaft far enough to provide a rigid mounting and stand the assembly on end per Figure 8.

c. Remove screws from inboard bearing cover (22, Figure 13) and drop cover from frame liner.

d. Assemble lifting hooks into upper end of frame liner and slowly raise frame with liner off of the shaft and bearings assembly.

e. Unscrew shaft from impeller, remove inboard bearing cover (22) and proceed with pressing bearings from shaft.

f. Remove oil slingers (84) and collar (83) from shaft to prevent its damage while handling the shaft.

> **NOTE:** It is suggested that parts (13) frame linear and (24) frame be kept assembled with (9) adjusting screw unless replacements are needed.

### 4-8. 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.

### 4-9 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 Wear Plate. See that wear face fits closely to impeller. Replace wear plate if wear is excessive.

c. Impeller. Check impeller vanes for signs of wear, cracks or corrosion.

d. Stuffing Box Details. Check gland and seal cage for nicks or burrs. Replace all packing.

e. Shaft Sleeve. Examine shaft surface to see that it is smooth and free from grooves or scoring. Check to see that sleeve is round without any appreciable eccentricity.

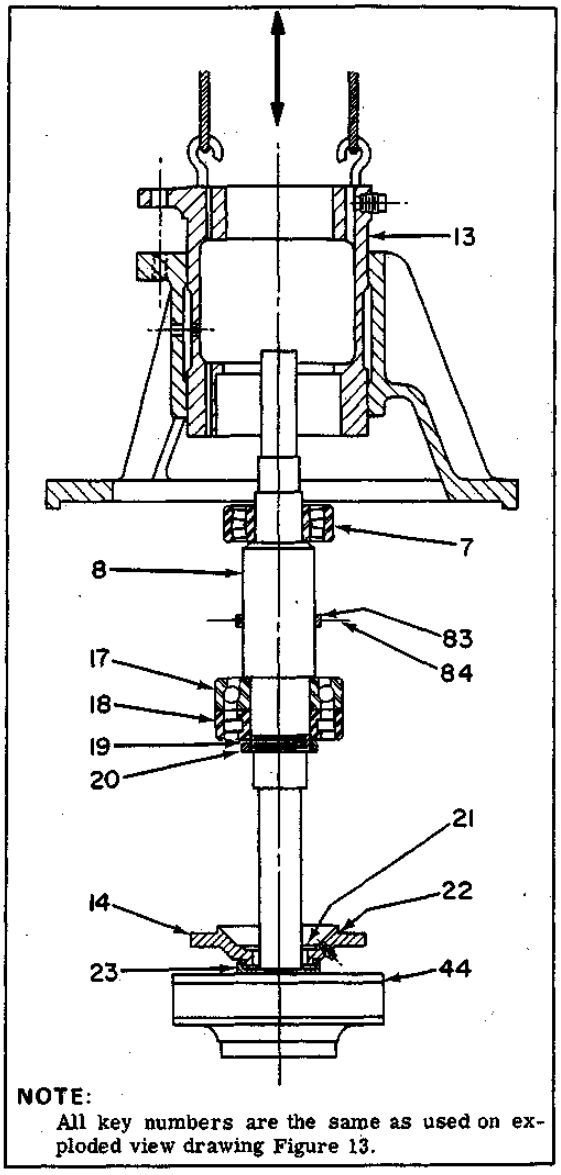



Figure 8. Front Liner Assembly

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. Examining 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.

## 4-10. REPAIR AND REPLACEMENT

a. General Replacement. Replace all parts that are excessively damaged or worn. Refer to pages 27 through 31 for a list and description of all pump parts.

b. Casing. If necessary, use a fine stone to remove rust, burrs, raised surfaces, dirt, paint, etc. from casing joint.

c. Shaft Sleeve. If shaft sleeve surface is grooved, polish to remove grooves. If grooves are too deep to polish, replace shaft sleeve.

d. Packing Composite. Acrylic yarn impregnated with TFE, Kevlar reinforced corners. Interbraided construction.

Approved Vendors:
Crane C1064
Garlock 9921K
Klinger Style 10K
Sure-Seal 2640K
Zimmerman 2072KC
Sepco ML-4004

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. The packings listed below should be regarded as typical rather than specific recommendations for replacement:

(1) Fel-Pro No. 35SA .....Felt Products Mfg. Co.

(2) Durametallic (alternate rings of grades B-110 and C-110).....Durametallic Corp.

(3) Garlock No. 644 ..... Garlock Packing Co.

(4) John Crane No. 101EO..... Crane Packing Co.

**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.) Re-assemble cross and bearing assemblies to universal joint, and then to coupling hubs.

## 4-11. REASSEMBLY

In general, reassemble in the reverse order of disassembly. Always replace all gaskets, packings, or O-rings at each disassembly of the pump.

## 4-12. Frame

**NOTE:** Study Figure 8 showing recommended method of handling frame assembly during the assembly operation.

a. Inboard Bearings. Heat bearings in a clean hot-air oven at 200° - 225°F. Install heated bearing over threaded half of shaft. Assemble lock washer and nut. Tighten with a spanner wrench. Nut should be tight, a few sharp blows on the spanner wrench will assure this. After bearings cool, tighten nut again and bend lock tab of lock washer into place in nut.

b. Slip oil slinger (84 and 83 assembly) over center portion of shaft. Adjust spacing "A" and "B" in accordance with the table in Figure 9. Tighten slinger locking screws. Take care in handling the shaft from this point on as these slingers are easily bent or broken.

c. Outboard Bearings. Heat bearing in a clean hot-air oven at 200° - 225°F. Install heated bearings on

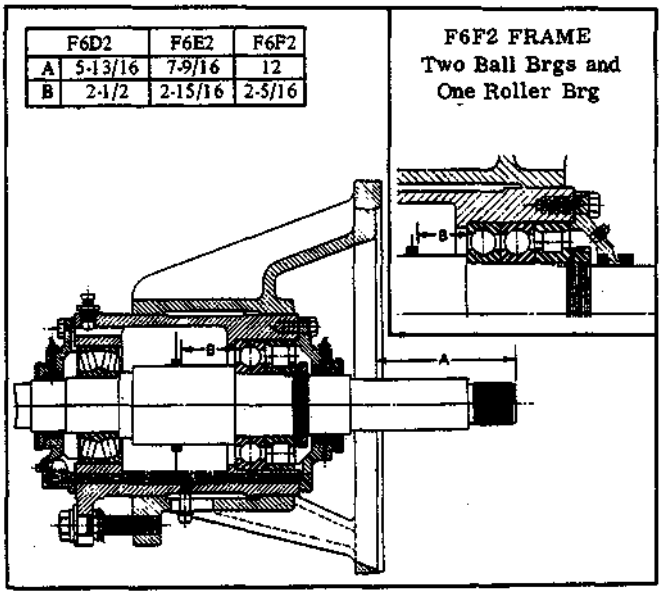



Figure 9. Rotating Element Adjustment

shaft, against shaft shoulder and allow to cool in place.

d. Place inboard bearing cover (22, Figure 13) shaft. Screw shaft into impeller and stand the assembly on end.

> **NOTE:** The adjusting screw group and liner constitute a matched, drilled set that should not be disassembled. If they were disassembled, be sure that all parts are from the same set. If liner has been replaced, install a new nut and screw. Drill and pin nut in place with spring. Washer should be fully compressed to eliminate end play.

e. Inspect slingers to make sure they have not been bent or broken. Since your unit has spherical roller bearings, tap the outer race square to shaft, as it must enter the frame liner perfectly straight to avoid serious damage.

f. Lower frame and liner over shaft and bearings per Figure 8. Proceed slowly and notice that as slingers enter the frame liner they must deflect and spring back into place when they reach the center of the bearing cavity. With a spherical roller bearing, it may be necessary to guide it into the fit in the liner. Note the outer race from an old bearing serves as an ideal tool if placed into the liner at this time. You may slide it down in the fit until it contacts the upper shaft bearing. By tapping lightly on this "tool" you can square up the bearing race and it will enter to fit easily. Continue to lower frame and liner until the liner rests solidly against the lower bearing outer race.

g. Remove lifting hooks and allow unit to stand vertically.

h. Position end caps with gaskets and bolt into place.

i. Assemble deflectors on both ends.

j. Remove impeller and place unit in a horizontal position. Adjust liner to set dimension A per Figure 9.

k. Replace all plugs and special oil fittings that may have been removed in cleaning.

### 4-13. Stuffing Box

a. Place wear plate (43, Figure 13) on table with bolt holes up and cement gasket in place.

b. Place stuffing box cover on wearplate, line up holes and assemble cap screws but do not tighten until later. Insert shaft sleeve in center of stuffing box cavity to act as a guide when installing packings. Insert packing base ring in bottom of cavity.

c. Assemble studs into flange of cover plate.

d. If molded fiber packings are used, open packing ring sideways and push joint into stuffing box first. Install two rings, one at a time, seating each ring firmly. Stagger the ring joints at least 90°. Install seal cage being sure that it will line up with the seal liquid inlet in cover when packings are compressed. Install remaining two or three packing rings. Refer to the Stuffing Box Dimensions below for the particular pump being assembled for the correct quantity and size of packing to install.

## STUFFING BOX DATA

CW and CWR (Dimensions in Inches)*

| Pump Size and Max. Imp. | Frame Size | Stuffing Box | | Shaft Sleeve Diameter in Box | Seal Cage Width | Size of Flushing Connections to Box | Packing | |
|---|---|---|---|---|---|---|---|---|
| | | Length | Bore | | | | Number of Rings | Size (Square) |
| 4x3x11-1/2 | F-6D2 | 3 | 3-5/16 | 2-1/4 | 3/4 | 1/4 | 4 | 1/2 |
| 5x4x11-1/2 | F-6D2 | 3 | 3-5/16 | 2-1/4 | 3/4 | 1/4 | 4 | 1/2 |
| 5x4x17 | F-6E2 | 3-1/8 | 4-5/16 | 3-1/4 | 11/16 | 1/2 | 4 | 1/2 |
| 6x5x17 | F-6E2 | 3-1/8 | 4-5/16 | 3-1/4 | 11/16 | 1/2 | 4 | 1/2 |
| 8x6x17 | F-6E2 | 3-1/8 | 4-5/16 | 3-1/4 | 11/16 | 1/2 | 4 | 1/2 |
| 10x8x17 | F-6E2 | 3-1/8 | 4-5/16 | 3-1/4 | 11/16 | 1/2 | 4 | 1/2 |
| 12x10x17 | F-6E2 | 3-1/8 | 4-5/16 | 3-1/4 | 11/16 | 1/2 | 4 | 1/2 |
| 8x6x21 | F-6F2 | 6 | 6-3/4 | 5-1/4 | 1-1/4 | 1/2 | 5 | 3/4 |
| 10x8x21 | F-6F2 | 6 | 6-3/4 | 5-1/4 | 1-1/4 | 1/2 | 5 | 3/4 |
| 14x12x21 | F-6F2 | 6 | 6-3/4 | 5-1/4 | 1-1/4 | 1/2 | 5 | 3/4 |
| 16x14x21 | F-6F2 | 6 | 6-3/4 | 5-1/4 | 1-1/4 | 1/2 | 5 | 3/4 |
| | | | | | | 1/2 | 5 | 3/4 |

* Refer to factory for stuffing box data on other styles.

e. If coil fiber packings are used, cut one packing ring to accurate size with either a butt or mitered 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 d.

f. If metallic packings are used, install per above step d. 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 packed stuffing box.

### 4-14. Rotating Element

a. Remove shaft sleeve from a stuffing box, and slide sleeve onto shaft.

b. Install stuffing box cover group onto shaft and frame group carefully to keep the packing in position within stuffing box. Attach cover to frame with nuts and washers.

c. Install packing gland and secure with attaching parts. If fiber 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. Tighten cap screws holding wear plate to stuffing box cover. If wear plate tends to drop and rub on sleeve it may be supported temporarily with a shim against the sleeve.

e. Apply a thin coat of "white lead" or a similar anti-seize thread compound to threads of shaft. Install impeller on shaft, and tighten securely while holding shaft.

**CAUTION**

Torque casing bolts to 125 ft. lbs. maximum.

### 4-15. Pump

a. Assemble suction wear plate with new gasket and secure in casing with attaching parts.

b. Before installing rotating element into pump casing, the total clearance of impeller in casing must be established. Proceed as follows:

### 4-16. STANDARD C-011 DESIGN

The new standard C-011 impeller with pressure relief vanes is interchangeable with all previous "CW and CWR" impellers of the same size. It has been made slightly wider to provide close running clearances.

### 4-17. Shimming Procedure

To Establish Clearance

a. When installing impeller, it is necessary to shim with gaskets between casing and stuff box cover flange to produce the proper total (front and rear) clearance at the impeller. (See Figure 10.)

b. First assemble impeller on shaft and adjust rear clearance with adjusting nut to as close a clearance as possible without rubbing.

**NOTE:** On older models it may be necessary to clamp stuffing box cover to frame.

c. Place a straight edge against suction wear surface of impeller, measuring from straight edge to stuff box cover flange ("C" dimension). Then find "D" dimension, by placing edge against casing gasket surface and measure to suction wear plate wear sur--face. "D" dimension must be 1/16" greater than "C" dimension. This is accomplished by adding necessary number of gaskets to casing gasket surface. (Allow approx. 20% compression of easkets.)

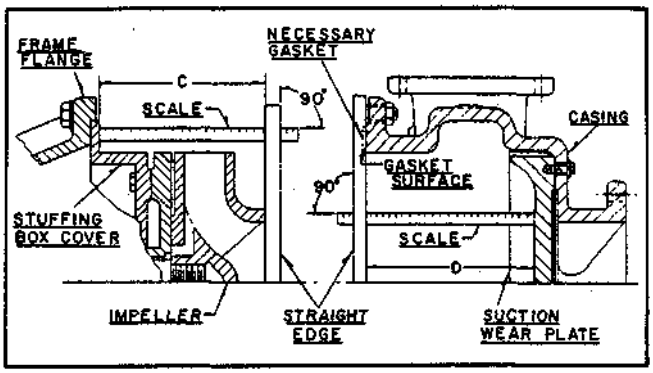



Figure 10. Type "CW and CWR Style" Clearance Adjustment

Dimensions For "CW and CWR" Pumps

The following "C", "D" & "Imp. Width" dimensions are nominal for pump shown. If all parts are to nominal size, approximately 1/8" gasket at casing-cover joint should be sufficient. As dimensions vary more or fewer gaskets will be necessary, when shimming procedures are followed. (See paragraph 4-17.)

| | Tol. "C" + 3/64 - 1/16 | Tol. "D" + 5/64 - 3/64 | Tol. Imp. Width ± 1/32* |
|---|---|---|---|
| 4x3x31-1/2 | 8-9/32 | 8-3/16 | 4-1/2 |
| 5x4x11-1/2 | 8-3/16 | 8-3/32 | 4-13/32 |
| 5x4x17 | 9-7/8 | 9-25/32 | 5-5/32 |
| 6x5x17 | 11-5/32 | 11-1/16 | 6-7/16 |
| 8x4x17 | 10 | 9-29/32 | 5-9/32 |
| 8x6x17 | 11-5/16 | 11-7/32 | 6-19/32 |
| 10x8x17 | 12 | 11-29/32 | 7-9/32 |
| 12x10x17 | 14-1/4 | 14-5/32 | 9-17/32 |
| 8x6x21 | 16-5/16 | 16-7/32 | 8-3/16 |
| 10x8x21 | 16-31/32 | 16-7/8 | 8-27/32 |
| 14x12x21 | 18-5/16 | 18-7/32 | 10-3/16 |
| 16x14x21 | 18-13/16 | 18-23/32 | 10-11/16 |

*Imp. width shown are latest impeller design for internal balance holes system.

**4-18. Impeller Adjustment** After assembling pump, set impeller clearance according to the following: Check that the two clamping screws on side of frame are loose, to allow liner to move freely. Turn adjusting screw (at lower frame) clockwise until impeller contacts suction wear plate. Now turn adjusting screw counterclockwise just enough to allow impeller to rotate freely. Normal clearance is .015-.025". Tighten clamp screws.

### 4-19. PUMP RUN-IN (PACKING ADJUSTMENT)

### 4-20. Fiber Packing Adjustment

a. When a pump with fiber packing is first started it is advisable to have the packing as loose as possible 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 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. Finer control of drippage is possible but slight changes in operating may upset the packing adjustment and result in damage to packing and sleeve. The only alternative is very close attention if a continuous drip cannot be tolerated.

> **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. Consult Section 2. The "controlled pressure" system or the "balanced flushing water" system are recommended for best packing performance.

### 4-21. 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.

### 4-22. DYNAMIC SEAL CWR-C-022

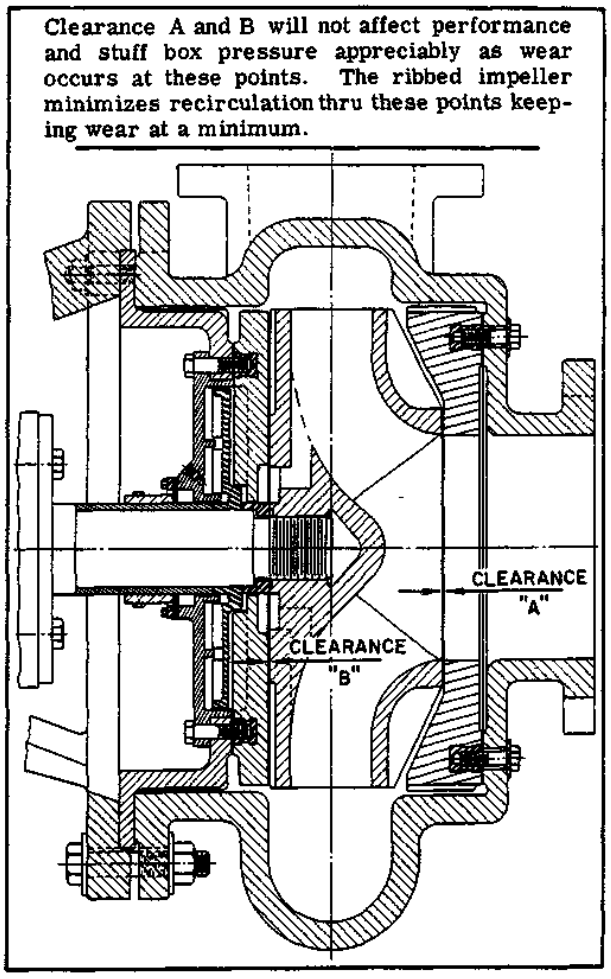



Figure 11. Impeller Clearance Adjustment

**4-23. General** Refer to Figure 15 for details of a type CWR pump with the Dynamic Seal arrangement.

**4-24. Purpose** The Dynamic Seal is designed to prevent dilution of the pumped product by minimizing flushing requirements. Actually it is two seals in one. In the operating condition a low pressure at the inside portion of the cover holds disc inward, free of rotating collar. The disc seals against the collar only when pump is not running. A minute quantity of water or clarified product is introduced into the eye of the dynamic seal impeller. This seal liquid is pumped into the casing flushing solids from the seal. When the pump is stopped, the rubber disc is forced against the shaft collar, sealing the static liquid in the pump. This type of unit is intended for application where only a low suction head exists and the dynamic seal impeller must be sized to overcome the maximum suction head expected. The suction head must be established when the unit is sold.

**4-25. Construction** The Dynamic Seal design is a standard modification to the CWR pump. Existing units can be converted with new wet end parts. The impeller must be of the design with pressure relief passages and ribs on the front and rear shroud to nearly eliminate recirculation and wear at clearance A and B.

The Dynamic Seal replaces the conventional stuffing box and packing arrangement. It consists of a dynamic seal impeller and housing, rubber seal disc and rotating collar.

**4-26. Static Seal Adjustment** (Figure 12) Setting the Seal. Prime the pump to put a static head on the seal. Move rotating collar forward until it lightly touches the rubber disc and the leakage stops. Tighten set screws in rotating collar.

**4-27. Dynamic Seal Inspection and Maintenance** Since the pump is designed to handle slurries and abrasive solids, inspection periods should occur more frequently than is normal with a standard pump. The pump should be shut down for inspection at the end of the first two weeks and again at the end of the first month of operation. The seal ring (74) and the Dynamic Seal impeller (82) demand the most attention. Check the wearing parts. If after the first month of operation the Pump and Dynamic Seal are still in good condition, the operating period may be increased by a month. By maintaining a time schedule and a record of inspection and replacement parts, an optimum inspection and maintenance program can be established.

**4-28. Dynamic Seal Disassembly** Proceed to dismantle as under style C-011. Remove impeller. Remove screws holding stuffing box cover to the frame assembly, and pull out the entire rear cover assembly consisting of rear wear plate, gasket, rear cover, Dynamic Seal impeller and housing and gasket. The static seal mechanism consisting of disc and retaining ring are disassembled from rear cover by removing retainer cap screws. Rotating collar is removed by loosening the set screws securing it to the shaft. Remove sleeve and O-ring.

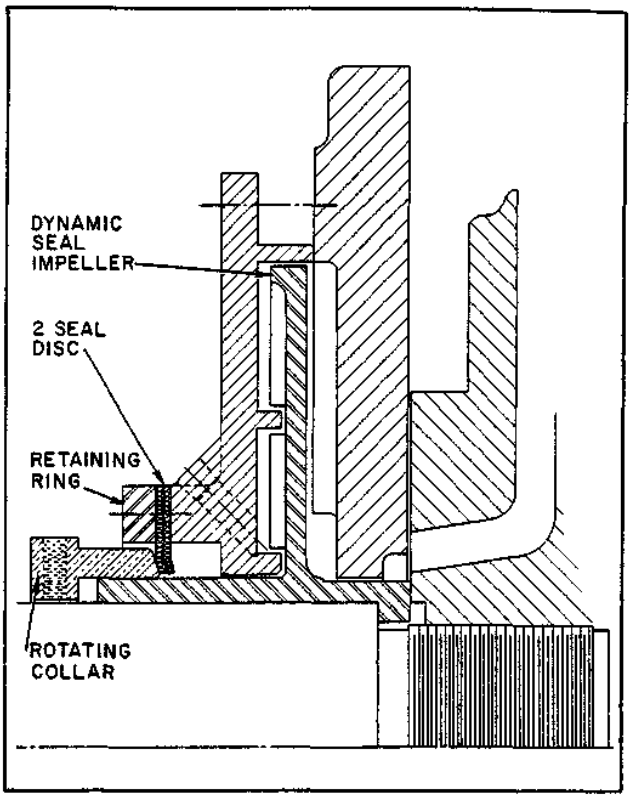



Figure 12. Static Seal Adjustment

**4-29. Rotating Element Assembly** Once the shaft and bearing assembly is complete the seal and impeller components are attached. Place shaft sleeveand the O-ring on the shaft. Greasing both parts will facilitate assembly.

Place the rear wear plate (43) with the flat surface down on top of a workbench. Make sure the gasket surface is smooth and free of all dirt and grit. Place a new gasket (42) on the rear wear plate lining up the holes. The stuffing box cover, Dynamic Seal impeller and Dynamic Seal rear housing gasket and housing are stacked up and secured with cap screws. Assemble seal disc with retaining ring to the housing. The entire assembly is fitted over the end of the shaft and bloted to the bearing frame. With the shaft held firmly in place in impeller is screwed onto the shaft.

**4-30. Assembling to The Pump** Proceed with assembly into casing as under C-011.

**4-31. REPLACEMENT PARTS**

a. 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.

b. For critical service requiring a minimum of down time a complete rotating element is recommended.

c. For normal service, all items in the parts list that are coded with "*" are recommended for each pump in service.

d. Parts should be ordered as far in advance of their use as possible since circumstances beyond the control of the Company may reduce existing stock. Not all parts are stocked; some must be manufactured for each order.

e. When ordering spare parts, always include the following information.

   (1) Pump Serial number

   (2) Pump Model number

   (3) Pump size and Type number

   (4) Catalog number of part

   (5) Name of part

   (6) Quantity of each part

   (7) Material desired (if different than original material). (Parts will be furnished in original materials unless specified as a material change. All material substitutions should be discussed with the factory.)

**4-32. Variable Drive Requirements**

Where pumps are furnished with maximum diameter impellers, the driven speed is generally varied from motor full load speed to meet the specified rated conditions. (Pump performance curves, indicate the wide choice of speeds available to develop the range of ratings for each pump.)

Standard V-belt drives are the most economical means of obtaining this speed variation. Stationary or motion control VARI-PITCH drives can be used also when ratings must fluctuate. Other adjustable speed devices such as liquid couplings, mechanical speed changers may be used effectively to obtain the desired output speed.

A compact V-belt drive arrangement using an overhead base is also available.

# CW AND CWR PUMP-STYLE C-011

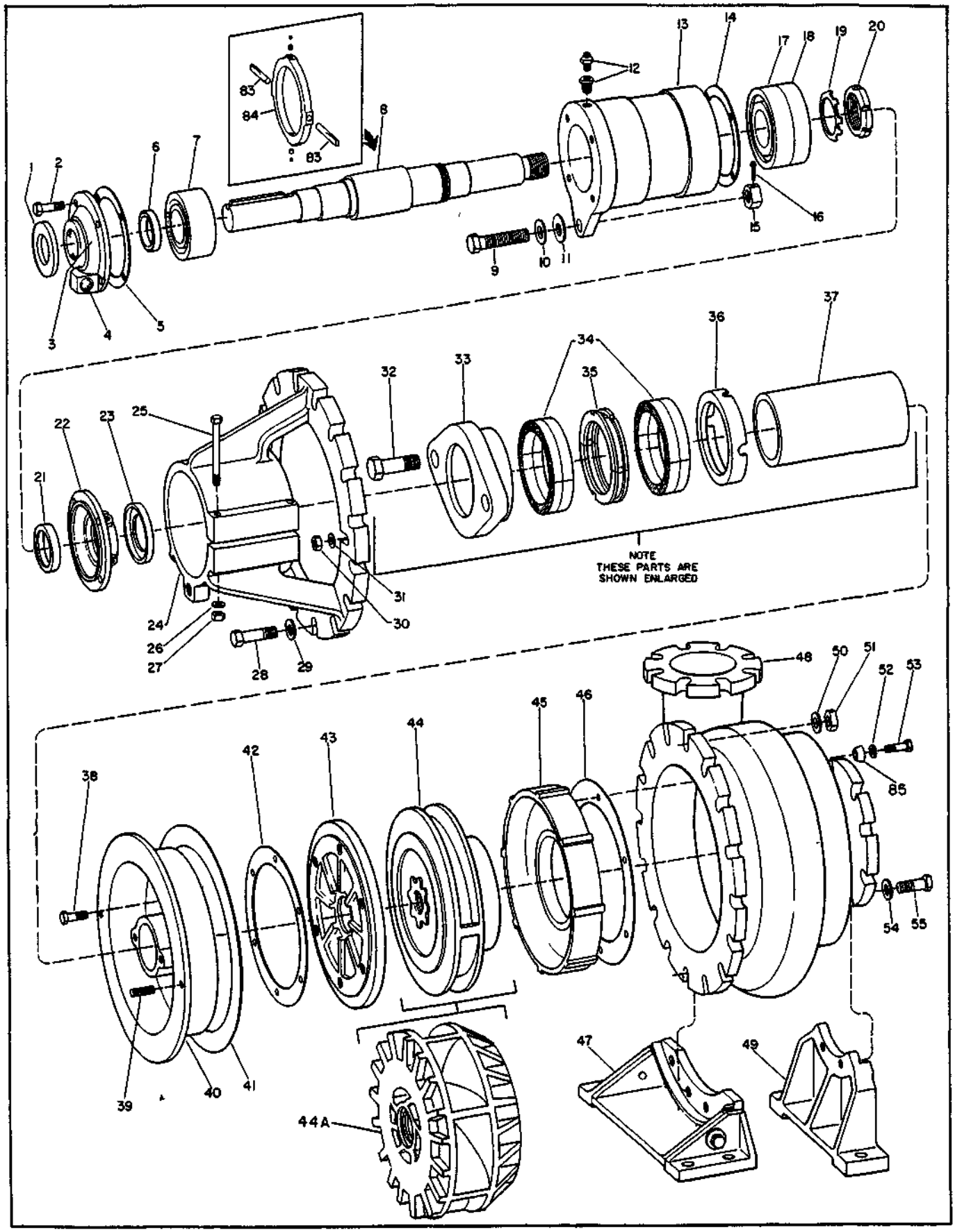



Figure 13

# PARTS LIST
# C-011 PUMP

| KEY NO. | CATALOG NO. | PART NAME | KEY NO. | CATALOG NO. | PART NAME |
|---|---|---|---|---|---|
| 1 | 5-024-4 | Deflector, Oil (Outboard) | 31 | 2-909-0 | Washer |
| 2 | 5-904-4 | Screw, Brg. Cover | 32 | 6-904-2 | Screw (Gland) |
| 3 | 5-018-4 | Cover, Bearing (Outboard) | 33 | 6-014-0 | Gland |
| 4 | 5-926-0 | Gage, Oil Sight | *34 | 6-924-0 | Packing |
| 5 | 5-409-4 | Gasket, Bearing Cover (Outboard) | 35 | 6-013-0 | Cage, Seal |
| *6 | 5-177-4 | Seal, Bearing (Outboard) | 36 | 6-152-0 | Ring, Packing Base |
| *7 | 5-038-4 | Bearing, Roller (Outboard) | *37 | 1-009-0 | Sleeve, Shaf |
| 8 | 5-007-0 | Shaft | 38 | 2-904-9 | Screw (Cov. - Wear Plate) |
| 9 | 5-904-1 | Screw, Adjusting | 39 | 2-908-1 | Stud |
| 10 | 5-917-1 | Washer, Spring | 40 | 2-036-0 | Cover, Stuffing Box |
| 11 | 5-909-1 | Washer | *41 | 2-123-0 | Gasket, Casing Joint |
| 12 | 5-349-0 | Tube, Breather | *42 | 2-453-0 | Gasket (Wear Plate and Stuffing Box Cover) |
| 13 | 5-084-0 | Liner, Frame | *43 | 2-047-0 | Plate, Rear Wear |
| *14 | 5-409-3 | Gasket, Bearing Cover (Inboard) | *44 | 4-002-0 | Impeller, Enclosed |
| 15 | 5-903-1 | Nut, Locking | *44A | 4-002-0 | Impeller, Ribbed |
| 16 | 5-918-1 | Pin, Cotter | *45 | 2-046-0 | Plate, Wear Suction Side |
| *17** | 5-026-3 | Bearing, Ball (Inboard) | *46 | 2-452-0 | Gasket, Suction Wear Plate |
| *18 | 5-038-3 | Bearing, Roller (Inboard) | 47 | 2-248-1 | Foot - Drive End |
| 19 | 5-517-3 | Lock Washer, Bearing | 48 | 2-001-0 | Casing |
| 20 | 5-516-3 | Locknut, Bearing | 49 | 2-248-5 | Foot - Suction End |
| *21 | 5-177-3 | Seal, Oil (Inboard) | 50 | 2-909-2 | Washer (Casing - Frame) |
| 22 | 5-018-3 | Cover, Bearing (Inboard) | 51 | 2-903-1 | Nut |
| 23 | 5-024-3 | Deflector (Inboard) | 52 | 2-909-1 | Washer (Casing, Wear Plate Suct. Side) |
| 24 | 5-083-0 | Frame | 53 | 2-904-1 | Screw (Casing-Wear Plate) |
| 25 | 5-904-2 | Screw, Adjusting | 54 | 2-909-5 | Washer (Casing-Suction Foot) |
| 26 | 5-909-2 | Washer | 55 | 1-904-5 | Screw, Casing Foot |
| 27 | 5-903-2 | Nut, Locking | 83 | 5-485-0 | Oil Slinger |
| 28 | 2-904-2 | Screw, Casing - Frame | 84 | 5-486-0 | Oil Slinger Collar |
| 29 | 2-909-2 | Washer, Casing - Frame | 85 | 2-909-9 | Washer, Bevel |
| 30 | 2-903-1 | Nut, Locking | | | |

*Recommended spare parts - see paragraph 4-31.
**2 bearings required on F6F frames.

# CWX PUMP-STYLE C-011

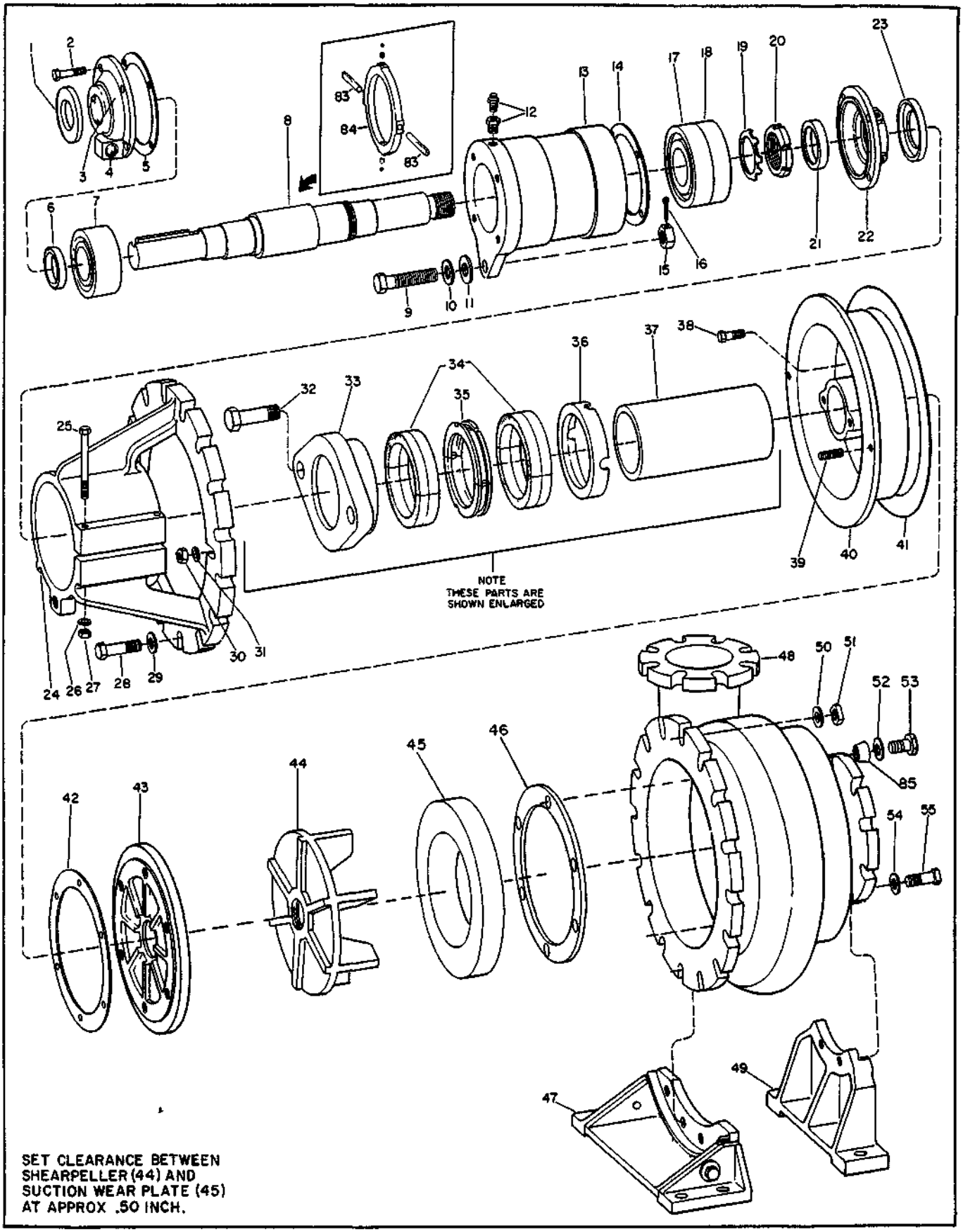



Figure 14

# PARTS LIST
# C-011 PUMP

| KEY NO. | CATALOG NO. | PART NAME | KEY NO. | CATALOG NO. | PART NAME |
|---|---|---|---|---|---|
| 1 | 5-024-4 | Deflector, Oil (Outboard) | 31 | 2-909-0 | Washer |
| 2 | 5-904-4 | Screw, Brg. Cover | 32 | 6-904-2 | Screw (Gland) |
| 3 | 5-018-4 | Cover, Bearing (Outboard) | 33 | 6-014-0 | Gland |
| 4 | 5-926-0 | Gage, Oil Sight | 34 | 6-924-0 | Packing |
| 5 | 5-409-4 | Gasket, Bearing Cover (Outboard) | *35 | 6-013-0 | Cage, Seal |
| *6 | 5-177-4 | Seal, Bearing (Outboard) | 36 | 6-152-0 | Ring, Packing Base |
| *7 | 5-038-4 | Bearing, Roller (Outboard) | 37 | 1-009-0 | Sleeve, Shaft |
| 8 | 5-007-0 | Shaft | 38 | 2-904-9 | Screw (Cov. - Wear Plate) |
| 9 | 5-904-1 | Screw, Adjusting | 39 | 2-908-1 | Stud |
| 10 | 5-917-1 | Washer, Spring | 40 | 2-036-0 | Cover, Stuffing Box |
| 11 | 5-909-1 | Washer | *41 | 2-123-0 | Gasket (Casing and Cover) |
| 12 | 5-349-0 | Tube, Breather | *42 | 2-453-0 | Gasket (Wear Plate and Stuffing Box Cover) |
| 13 | 5-084-0 | Liner, Frame | *43 | 2-047-0 | Plate, Rear Wear |
| *14 | 5-409-3 | Gasket, Bearing Cover (Inboard) | *44 | 4-005-0 | Shearpeller |
| 15 | 5-903-1 | Nut, Locking | *45 | 2-046-0 | Plate, Wear Suction Side |
| 16 | 5-918-1 | Pin, Cotter | *46 | 2-452-0 | Gasket |
| *17 | 5-026-3 | Bearing, Ball (Inboard) | 47 | 2-248-1 | Foot - Drive End |
| *18 | 5-038-3 | Bearing, Roller (Inboard) | 48 | 2-001-0 | Casing |
| 19 | 5-517-3 | Lock Washer, Bearing | 49 | 2-248-5 | Foot - Suction End |
| 20 | 5-516-3 | Locknut, Bearing | 50 | 2-909-2 | Washer (Casing- Frame) |
| *21 | 5-177-3 | Seal, Oil (Inboard) | 51 | 2-903-1 | Nut |
| 22 | 5-018-3 | Cover, Bearing (Inboard) | 52 | 2-909-1 | Washer (Casing - Wear Plate) |
| 23 | 5-024-3 | Deflector (Inboard) | 53 | 2-904-1 | Screw (Casing - Wear Plate) |
| 24 | 5-083-0 | Frame | 54 | 2-909-5 | Washer (Casing - Suction Foot) |
| 25 | 5-904-2 | Screw, Adjusting | 55 | 1-904-5 | Screw, Casing Foot |
| 26 | 5-909-2 | Washer | 83 | 5-485-0 | Oil Slinger |
| 27 | 5-903-2 | Nut, Locking | 84 | 5-486-0 | Oil Slinger Collar |
| 28 | 2-904-2 | Screw, Casing - Frame | 85 | 2-909-9 | Washer, Bevel |
| 29 | 2-909-2 | Washer, Casing - Frame | | | |
| 30 | 2-903-1 | Nut, Locking | | | |

*Recommended spare parts - see paragraph 4-31.

# CWR PUMP-STYLE C-022

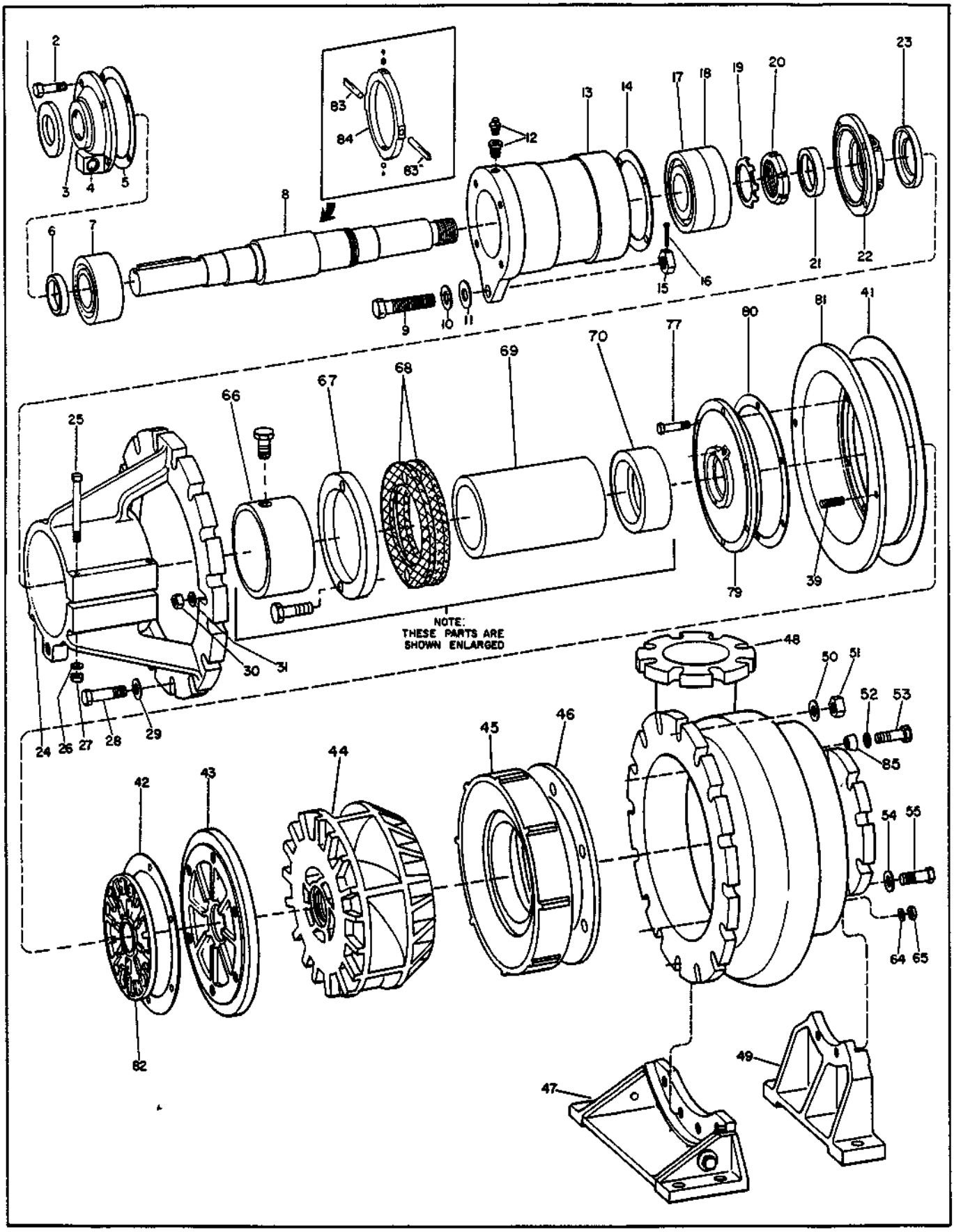



Figure 15

# PART LIST
# C-022 PUMP

| KEY NO. | CATALOG NO. | PART NAME | KEY NO. | CATALOG NO. | PART NAME |
|---|---|---|---|---|---|
| 1 | 5-024-4 | Deflector, Oil (Outboard) | *41 | 2-123-0 | Gasket (Casing and Cover) |
| 2 | 5-904-4 | Screw, Brg. Cover | *42 | 2-453-0 | Gasket (Wear Plate and Stuffing Box Cover) |
| 3 | 5-018-4 | Cover, Bearing (Outboard) | *43 | 2-047-0 | Plate, Rear Wear |
| 4 | 5-926-0 | Gage, Oil Sight | *44 | 4-002-0 | Impeller, Ribbed |
| 5 | 5-409-4 | Gasket, Bearing Cover (Outboard) | *45 | 2-046-1 | Plate, Wear (Suction Side) |
| *6 | 5-177-4 | Seal, Bearing (Outboard) | *46 | 2-452-0 | Gasket, Suction Wear Plate |
| *7 | 5-038-4 | Bearing, Roller (Outboard) | 47 | 2-248-1 | Foot, Drive End |
| 8 | 5-007-0 | Shaft | 48 | 2-001-0 | Casing |
| 9 | 5-904-1 | Screw, Adjusting | 49 | 2-248-5 | Foot - Suction End |
| 10 | 5-917-1 | Washer, Spring | 50 | 2-909-2 | Washer (Casing- Frame) |
| 11 | 5-909-1 | Washer | 51 | 2-903-1 | Nut |
| 12 | 5-349-0 | Tube, Breather | 52 | 2-909-1 | Washer (Casing, Wear Plate) |
| 13 | 5-084-0 | Liner, Frame | 53 | 2-904-1 | Screw (Casing - Wear Plate) |
| *14 | 5-409-3 | Gasket, Bearing Cover (Inboard) | 54 | 2-909-5 | Washer (Casing - Suction Foot) |
| 15 | 5-903-1 | Nut, Locking | 55 | 1-904-5 | Screw, Casing Foot |
| 16 | 5-918-1 | Pin, Cotter | 64 | 2-909-1 | Washer |
| *17** | 5-026-3 | Bearing, Ball (Inboard) | 65 | 2-903-1 | Nut |
| *18 | 5-038-3 | Bearing, Roller (Inboard) | 66 | 6-437-0 | Rotating Collar |
| 19 | 5-517-3 | Lock Washer, Bearing | 67 | 6-385-0 | Retaining Ring |
| 20 | 5-516-3 | Locknut, Bearing | *68 | 6-380-0 | Seal Disc |
| *21 | 5-177-3 | Seal, Oil (Inboard) | *69 | 1-009-0 | Sleeve, Shaft |
| 22 | 5-018-3 | Cover, Bearing (Inboard) | 70 | 1-154-0 | Sleeve, Spacer |
| 23 | 5-024-3 | Deflector (Inboard) | 77 | 6-904-2 | Screw |
| 24 | 5-083-0 | Frame | *79 | 6-391-0 | Housing, Dynamic Seal |
| 25 | 5-904-2 | Screw, Adjusting | *80 | 6-392-0 | Gasket, Housing |
| 26 | 5-909-2 | Washer | 81 | 2-137-0 | Casing, Back Cover |
| 27 | 5-903-2 | Nut, Locking | *82 | 6-389-0 | Impeller, Dynamic Seal |
| 28 | 2-904-2 | Screw, Casing – Frame | 83 | 5-485-0 | Oil Slinger |
| 29 | 2-909-2 | Washer, Casing- Frame | 84 | 5-486-0 | Oil Slinger Collar |
| 30 | 2-903-1 | Nut, Locking | 85 | 2-909-9 | Washer, Bevel |
| 31 | 2-909-0 | Washer | | | |
| 39 | 2-908-1 | Stud | | | |

*Recommended spare parts - see paragraph 4-31.
**2 bearings required on F6F frames.

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