PULSA Series®

DIAPHRAGM METERING PUMPS

Installation Operation Maintenance Instruction

Bulletin No. 880H

PULSAFEEDER
Engineered Pump Operations

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Table of Contents

How It Works

A standard foot mounted motor drives a worm shaft at constant speed. Through worm gear reduction and eccentric, a reciprocating power stroke is transferred to a plunger. The length of plunger stroke determines pump capacity and can be adjusted manually to provide pumping range from 0-100% of rating. However, this plunger does not pump chemicals, but an exceptionally stable oil*, having excellent lubricating qualities. This makes a perfect pumping medium.

*A special property petroleum oil tradenamed "PULSAlube" is generally used as hydraulic fluid. Continual reference to "oil" as hydraulic medium implies its general use rather than its use of necessity. Check with your representative or the factory if substitute oil must be used.

Hydraulically Balanced HYDRA-TUBE Diaphragm Design

Using this oil, the plunger hydraulically moves a flat disc type elastomer diaphragm which in turn causes compression and decompression on a secondary sealed hydraulic reservoir, (Figure 2). This secondary reservoir surrounds a cylindrical diaphragm. The compression and decompression of this intermediate hydraulic fluid transmits a controlled squeeze and release on the cylindrical HYDRATUBE diaphragm, thereby displacing process liquid which is contained within it. Inlet and outlet check valves, operating in unison with the HYDRATUBE movement, precisely control liquid flow in one direction. Since they are gravity seating valves, flow is from bottom to top.

HYDRATUBE Housing Assembly

The HYDRATUBE confines the liquid pumped internally isolated from any contact with the hydraulic system. The HYDRATUBE housing assembly consists of a ductile iron casting which positions the HYDRATUBE and contains the intermediate fluids, a support plate to protect the primary diaphragm from over travel and inlet and discharge check valve.

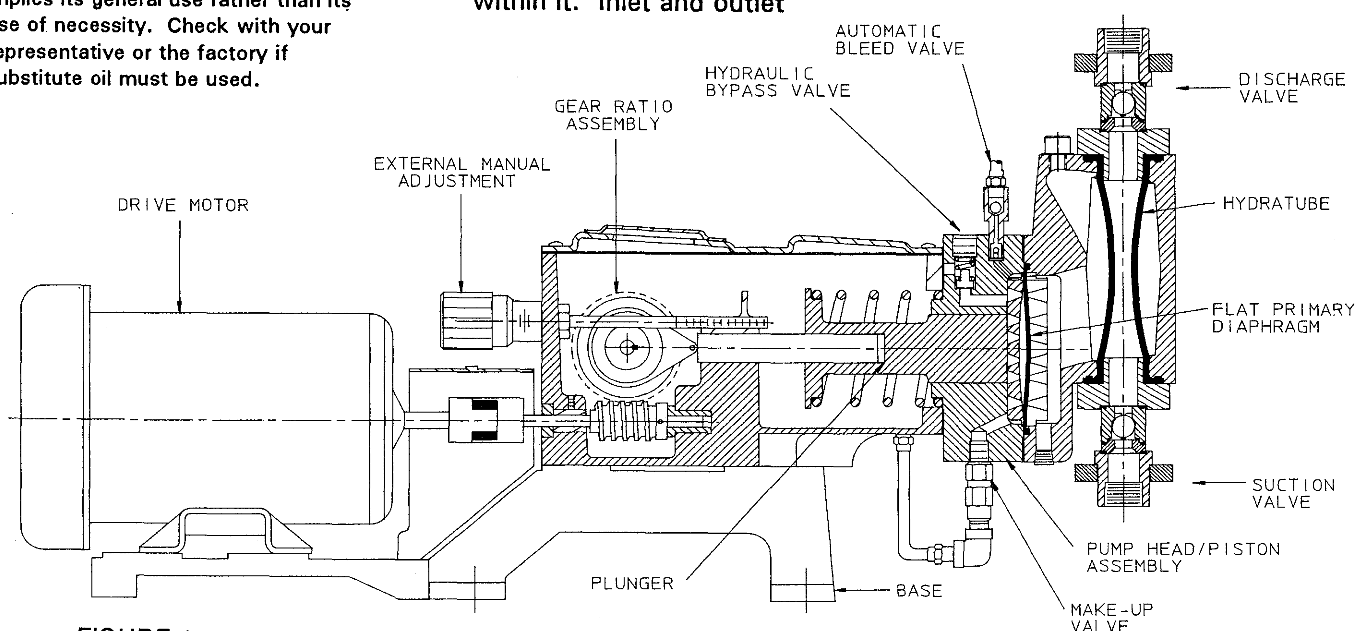


FIGURE 1.

The HYDRATUBE responds exactly to the action of the primary flat diaphragm through the medium of an intermediate fluid selected for compatibility with the casting and other material. The HYDRATUBE is available in several elastomers including the Dupont products, Viton, Hypalon and Nordel which provides a satisfactory chemical resistance for a wide variety of corrosive fluids.

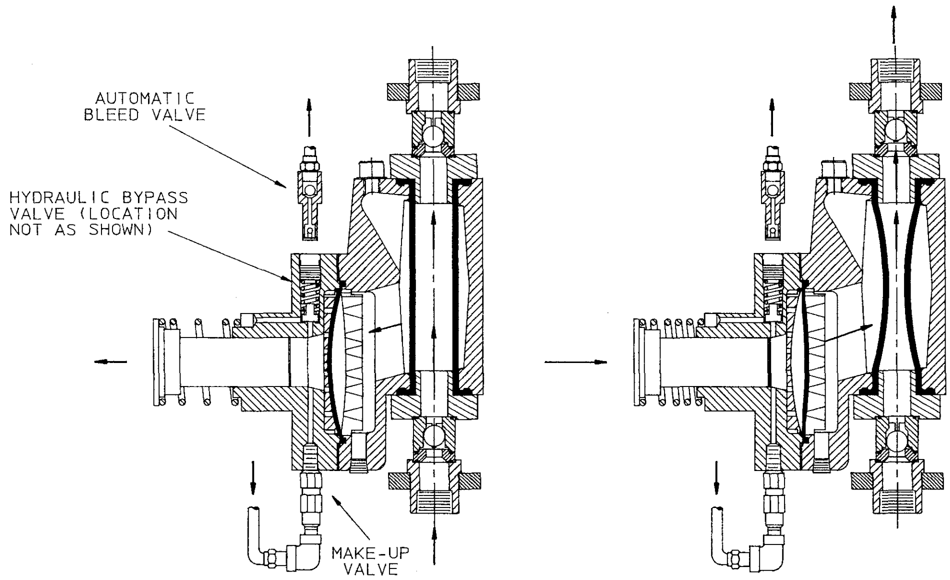


FIGURE 2.

Pump Head Assemblies

The hydraulic pump head assembly contains the plunger, cylinder and various hydraulic components to protect and maintain a precise hydraulic balance between the plunger and diaphragm. Figure 2.

Make-up Valve

Any leakage past the plunger, however slight, is replaced by the make-up valve which permits flow of replacement oil from the oil reservoir. This is an automatic function. The oil loss allows the diaphragm to get out of phase with the plunger thus creating a vacuum ahead of the plunger during the suction stroke of the pump. The make-up valves are factory set.

Hydraulic Bypass

Any excess hydraulic pressure buildup within the pump compression chamber due to accidental valve closure of line stoppage is relieved through the hydraulic bypass valve. It blows off oil under excess pressure ahead of the plunger back into the oil reservoir thus terminating the pumping action and protecting the pump mechanism. Hydraulic bypass valves are factory set at full design pressure unless specified differently by purchaser.

Pressure Relief Valve

A separate process relief valve should be installed in the process piping to protect piping and sensitive process equipment.

Bleeder Valve

The function of this valve is to release any air or oil vapors from ahead of the piston and maintain a solid hydraulic medium to transmit finite movements of the piston to the diaphragm. The bleed valve functions automatically weeping a minute quantity of oil plus any air or vapor out of the hydraulic system.

Additional detail on the function of these valves will be given as applicable in the Operation, Maintenance and Trouble Shooting Sections.

Installation Tips

Check the Shipment:

A standard shipment includes the pump, PULSAlube oil, wrenches, instruction and parts list packet and replacement parts if ordered. Unpack carefully, check packing list and make sure all parts are received. Check voltage of electric motor against the service to be used.

Locating the 880H Pumps:

Pulsa 880H pumps are designed to operate under indoor atmospheric conditions. It is desirable to provide a hood or covering for outdoor service. External heating must be arranged if ambient temperature will be below 40°F. Fluid temperatures entering the pump must be 40°F or greater.

1. Check level of pump. Shim where necessary.
2. Securely bolt to foundation. Do not distort base.

3. Check motor alignment and reagent head and valve bolt tightness before operation. Follow bolt torque readings carefully.

Flooded Suction Desirable:

Installation will be simpler to operate if the liquid will flow to the pump by gravity. Wherever possible the pump should be located below the level of storage vessel.

Discharge Pressure:

All 880 models are designed for continuous service at the rated discharge pressure. To prevent liquid flow through, it is necessary that discharge pressure be at least 5 psi above suction pressure. When pumping downhill a back pressure valve should be placed in the discharge line.

Piping:

Pipe size and length are critical to proper operation of any metering pump. A restricted discharge or starved suction condition spells immediate failure to any metering pump installation. A separate brochure entitled "Designing a Successful Metering Pump Installation" is provided to assist Engineers responsible for piping system design. Copies are available upon request (Technical Sheet 304).

MINIMUM INLET PIPING CONDITIONS MUST BE CALCULATED USING THE FORMULAS FOUND ON PAGES 15-16.

Figure 3 shows the preferred piping configuration for a good metering pump installation. A good piping installation addresses present and future requirements of the metering system. Plan for shut off valves and unions or flanges installed on both suction and discharge lines. This allows inspection of the check valves without draining long runs of pipe. Install a tee in the suction and discharge piping between the pump and the shut off valves. This permits easy installation of a calibration tube for calibration of the pump at start up or any future date. A tee in the discharge piping is a must on a good installation because it permits ease of mounting a pressure gauge to check discharge pressure at the pump and setting the hydraulic bypass valve during start up and future maintenance functions. To prevent strain on the pump fittings use pipe straps and braces. Do not allow the weight of the piping to be supported by a pipe union, the valve fitting or other portion of the pump head or leaks will occur. An air leak at a union or other fitting in the suction piping can severely affect metering accuracy and is extremely difficult to detect. In assembly of piping, use pipe thread tape or a compound compatible with the product handled. If rigid piping is used we suggest bolting the pump to its foundation.

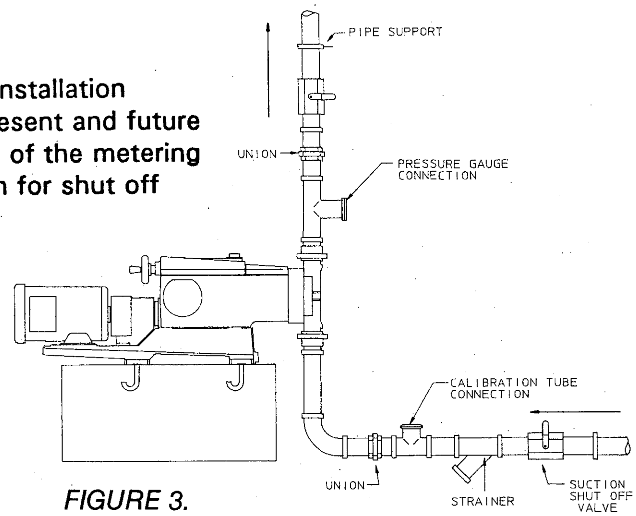


FIGURE 3.

Use Strainers:

Pump check valves are susceptible to dirt and other contaminants and any accumulation can cause malfunction. Be sure to use a pipeline strainer in the suction line between the suction shut off valve and the pump suction valve 100 mesh screen is preferred.

Flush Piping System:

Whether new or old piping is used, all lines should be flushed with a clean liquid or air before connecting the pump to carry out pipe scale or other foreign material. Make sure flushing liquid is compatible with the chemical to be pumped.

Metal Check Valve Models:

The metal check valve assembly is provided in several alloys. Piping of similar alloy should be selected. Dissimilar materials can cause galvanic corrosion.

Do not backweld piping to the valve housings without first removing the valve housings from the pump as excessive heat can damage the tube and other parts. Tie bars must be positioned on the valve housing *before* welding.

Plastic Check Valve Models:

Care must be exercised when making connections on plastic check valve models. Excessive tightening can distort or break the plastic materials. Tubing should be rated for the highest discharge pressure expected with an appropriate safety factor.

Start-Up Inspection

Every 880H metering pump is tested for correct capacity at maximum pressure capability of the hydraulic bypass valve before shipment. The diaphragm cavity is fully primed and remains so for shipment. For shipping purposes the gear and hydraulic reservoir oil have been removed. Sufficient fresh PULSAlube oil is included with the shipment for refilling the gear and hydraulic reservoirs.

Warning

1. Do not run pump without oil.
2. Do not remove main gear box cover while pump is running.
3. Do not run pump with coupling guard removed.
4. Do not put hands or fingers in gear box or reservoir when pump is running.

Filling Gear and Oil Reservoirs:

Remove the pump cover and fill both reservoirs with PULSAlube oil to the top of the gear box partition. Do not overfill. PULSAlube oil is compounded to serve as both gear lubricant and hydraulic transfer fluid. Check with factory if substitute oils must be used.

Final Inspection:

Because of the pump's small size and light weight it sometimes receives severe handling during shipment. Though physical damage may not occur, it is always possible for parts to move slightly in adjustment. This situation might occur with motor or pneumatic control alignment. A quick visual check should be made to assure that motor and control shafts have not shifted severely out of alignment or damage could occur from starting the motor. If unusual vibration should occur after start up realign the motor and coupling.

Start-up:

Since the hydraulic oil system is primed at the factory, priming the process system is all that should be necessary to produce flow. If the hydraulic system has inadvertently been dumped due to starting up with restricted suction or discharge conditions or improper adjustments to compensator or bleed valves, repriming procedures under the maintenance section may have to be followed before pump calibration can begin.

Priming Process Head:

1. Open the suction line and discharge line shut off valves.
2. If the piping system design and the storage tank are such that the product flows by gravity to the pump, no priming is required. If however, the discharge line is under pressure, air will be trapped in the process head and it will be necessary to remove the discharge pressure to enable the pump to prime itself.
3. If the pump must handle a suction lift, it may be necessary to manually prime the reagent head. Remove the discharge valve by unscrewing the two tie bar bolts and then lifting the valve out. Fill the head with process fluid, or a compatible liquid then replace the valve in the same position and retighten the tie bar bolts.
4. The pump is now ready for start-up.
5. Start the pump and increase the control setting to full stroke.
6. Make a brief check to assure that the pump is producing the approximate flow desired at the full stroke setting. Calibration should not be attempted on any model until it has run at least one hour to assure the pump hydraulic and reagent head systems have stabilized.

If the pump does not produce the approximate flow desired at the full stroke setting refer to the Trouble Shooting Section for possible causes and refer to Priming Procedure under the Operation and Maintenance Section.

To Adjust Flow Rate;
Figure 4.

The model 880 PULSAfeeders are provided with a lock-in place micrometer adjustment knob for changing stroke length while the pump is in operation or idle. Push in on locking device and turn the adjustment knob clockwise to increase flow and counterclockwise to decrease flow. These micrometer indications can be converted to units of volume or weight by calibration conversion charts. On earlier model micrometer knobs you may increase the friction on the adjustment or completely lock up the adjustment knob by removing the gear box cover and tightening the friction nut on the adjustment shaft.

Calibration:

All pumps are tested on water at room temperature with 7 foot flooded head at full rated pressure. Any curves supplied by Pulsafeeder would be representative of this test and can only be used as a guideline.

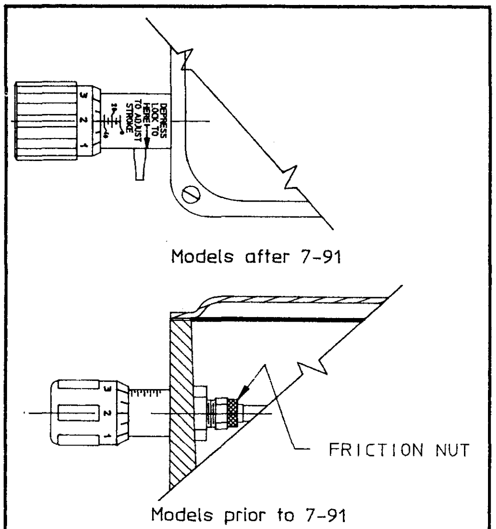


FIGURE 4.

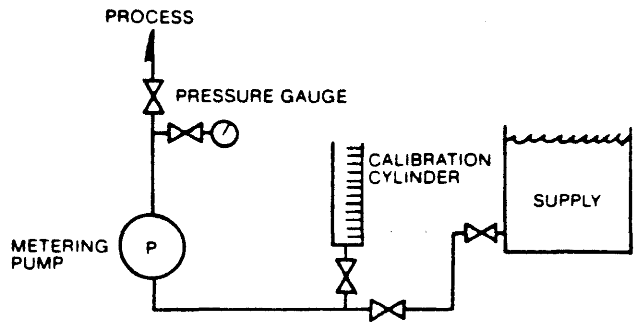


FIGURE 6.

All pumps must be calibrated under actual operating conditions for the operator to know the proper adjustment for particular outputs. A typical displacement chart is shown in Figure 5. Note that output is linear with respect to micrometer settings but that increase in discharge pressure decreases output slightly and describes the line parallel to that at atmospheric pressure. This is caused by compression of hydraulic oil and valve inefficiencies. Capacity at atmospheric pressure will be nearly that of calculated displacement. As the discharge pressure increases there will be a corresponding decrease in capacity at a rate of approximately 1% per 100 psi increase.

Figure 6 shows a typical piping arrangement for performing pump calibration. It is desirable to calibrate from the suction side of the pump so the pump will be operating under actual or comparable discharge conditions.

Check the capacity several times at three different stroke length settings and record them on linear graph paper. For all stable conditions, these points should describe a straight line.

PULSA pumps supplied with automatic controls, either pneumatic or electronic, are accompanied by separate instructions on output adjustment and calibration.

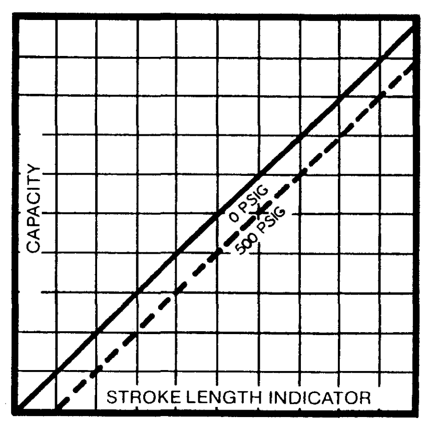


FIGURE 5.

Operation and Maintenance

The preceding instructions have assisted you in proper installation and start-up of your 880H pump. The following sections are arranged to assist in maintaining proper pump operation and trouble shooting any problems that might develop during start-up or thereafter.

Accurate records in the early stages of pump operation will reveal the type and amount of maintenance that will be required. A preventative maintenance program based on these records will insure trouble free operation. It is not possible in these instructions to forecast the life of such parts as the diaphragm, check valves and other parts in contact with the product you are handling. Corrosion rates and conditions of operation affect the useful life of these materials so an individual metering pump must be gauged according to particular service conditions.

HYDRATUBE Diaphragm Inspection & Priming Procedures

The HYDRATUBE diaphragm can be damaged by the following:

1. Chemical attack.
2. Mechanical damage from trash or abrasives.
3. High temperature (Maximum 170° - 230°F depending on elastomer).
4. Low temperature (below 40°F Hypalon or Viton, 0°F Nordel).

Service conditions will determine life of the HYDRATUBE and dictate the replacement schedule.

To Remove HYDRATUBE

1. Remove all pressure from the piping system.
2. Lock out motor.
3. Close the inlet and outlet shut-off valves.
4. Break the union or flanges on the piping.
5. Arrange to catch and properly dispose of oil and product leakage that will occur when disassembling head and valving.
6. Remove the top fill and vent plug, the bottom drain plug in the iron housing, and drain intermediate fluid from the chamber.
7. Remove both the top discharge and the bottom inlet valves, the tie bars, and adaptors to drain HYDRATUBE. Use extreme caution if product is hazardous and wear proper protective clothing.
8. Pick up an edge of the HYDRATUBE flange (Figure 7) and push that same edge down throat of the HYDRATUBE. The balance of the flange will fold and follow.
9. Pull the HYDRATUBE out from the bottom of the housing by a combination of twisting and bending sideways.

Inspect the HYDRATUBE for any evidence of damage or abrasion. It is not unusual for a tube to take an elliptical set. If there is no other evidence of failure or damage this tube is considered undamaged and can be reinstalled.

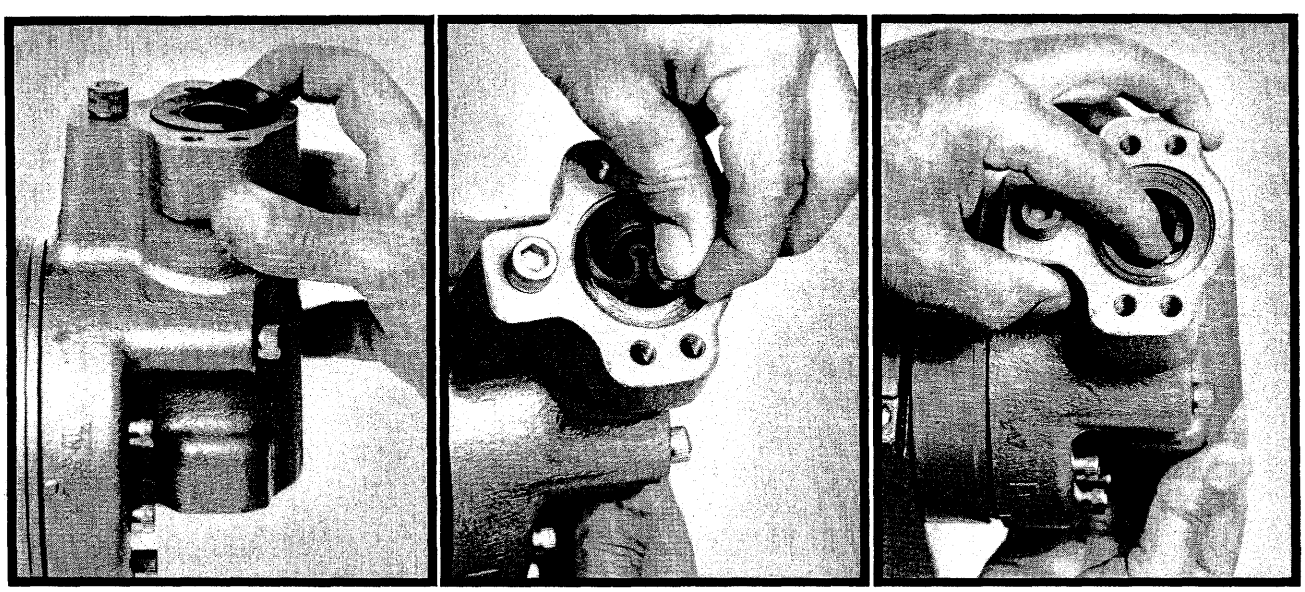


FIGURE 7.

To Install New HYDRATUBE

1. Do not use tools which can cut or distort the tube.
2. Obtain a rubber band of 1/16" to 1/8" section.
3. Fold a point on the edge of the HYDRATUBE flange upward (Figure 8). Push the edge down the throat of the tube. Fold the sides of the flange inward (Figure 9) to form a compact 45° "nose" and wrap tightly with a rubber band (Figure 10). This wrapped nose should be reasonably compact and secure.
4. Work the wrapped nose of the HYDRATUBE up through the bottom hole of the housing, rotating gently to work the tube upward to the top of the housing.
5. At this stage, with a slight push at the bottom flange of the HYDRATUBE, guide the nose of the tube to the center and out the top hole in the housing. (Figure 11).
6. Remove rubber band.
7. Unfold the top flange (Figure 12) and center both the top and bottom of the HYDRATUBE.
8. Reassemble the top and bottom adaptor parts pulling the adaptor bolts dead tight. Replace the bottom drain plug.

Repriming Hydraulic System To Check Prime Only on New and Older Models

New pumps are shipped from the factory with the hydraulic and intermediate systems completely primed. If the hydraulic valves have been disturbed or the intermediate fill plug removed, the systems are probably out of balance due to loss of prime. The hydraulic system will reprime itself through the action of the automatic bleed and make-up valve after a period of 5 to 10 minutes running time.

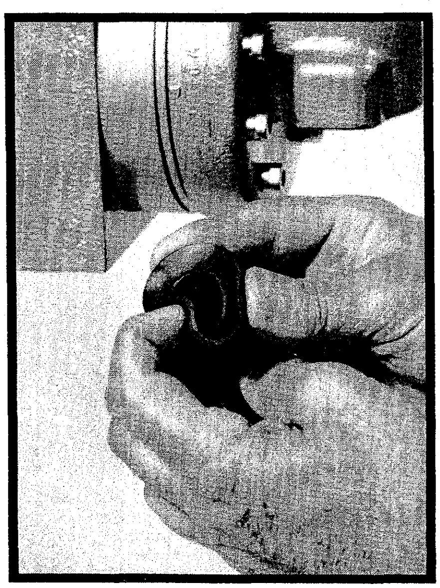


FIGURE 8.

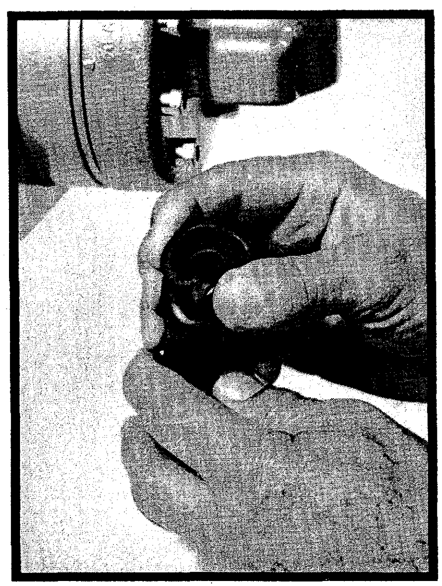


FIGURE 9.

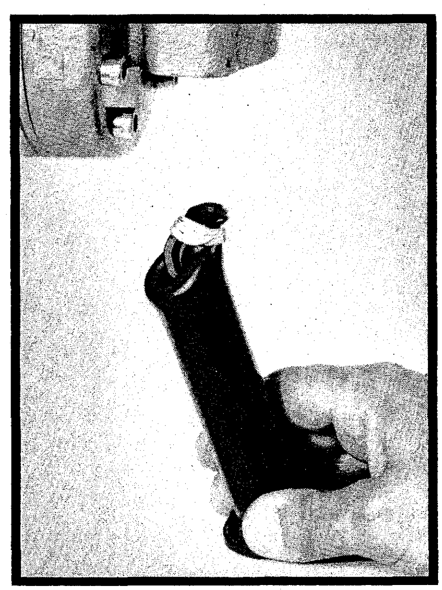


FIGURE 10.

If the intermediate fill plug has been removed and fluid lost, it will be necessary to recheck prime to get diaphragms in phase. It will be necessary to remove the discharge check valve assembly in order to observe the shape of the HYDRATUBE.

If the intermediate system is properly primed the HYDRATUBE is cylindrical in shape when the flat, primary, diaphragm has moved to its maximum rear (suction) position. After the piston hydraulic system is fully primed, follow Steps 1 through 6 to check intermediate prime.

Repriming Procedure

A. Presets:

1. Adjust the stroke length (capacity) to maximum. (See "Flow Rate Adjustment" Page 6).
2. Disconnect power source.
3. Close inlet and discharge shut off valves.
4. Loosen or remove suction and discharge check valve assemblies.
5. Remove the coupling guard.
6. Remove the front reservoir cover assembly.
7. Remove intermediate fill plug from the HYDRATUBE housing.

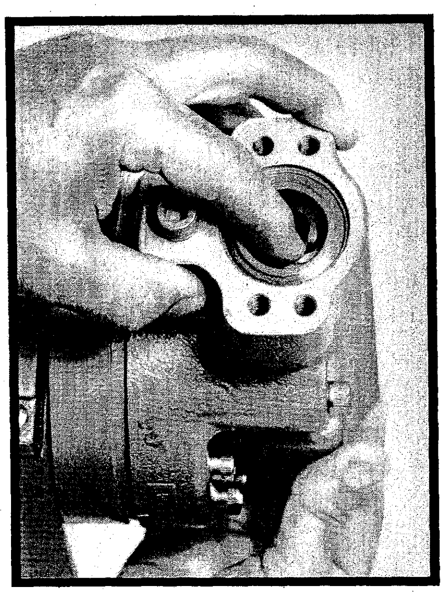


FIGURE 11.

FIGURE 12.

Repriming the Primary/Flat Diaphragm

1. Remove auto bleed valve assembly from the pumphead.
2. Place a plastic pipette (i.e., funnel, etc.) into threaded hole of pumphead where auto bleed valve assembly was removed.
3. Fill pipette with same oil as being used in the gear box.
4. Turn on pump and run until all air has been purged from pumphead (add oil to the pipette as required).
5. Shut off pump. Manually rotate the motor coupling until the piston is withdrawn to full suction stroke (toward the drive motor end.)
6. Remove the pipette and replace the auto bleed valve assembly into the pumphead.
7. Manually rotate the motor coupling to move the pump piston forward. If, at some point, it becomes difficult to turn the coupling, loosen the hydraulic bypass valve until oil is forced back into the gear box, thus allowing the piston to move to the full forward position. Keep track of how many turns the bypass valve is loosened.
8. Retighten the bypass valve the number of turns recorded in Step 7. The primary hydraulic system is now fully primed.

Repriming the HYDRATUBE (Intermediate chamber)

In priming the intermediate chamber the flat diaphragm and HYDRATUBE must be properly synchronized. For any given piston/pumphead assembly the flat diaphragm utilizes only 40 to 70% of the combined dish volume. The objective of this procedure is to have the flat diaphragm work off the front dishplate, meaning that on every discharge stroke it just reaches the front dishplate,
and on every suction stroke it moves back an amount indicated by the piston volume. The HYDRATUBE, when properly primed should be in its neutral position (fully round) when the diaphragm in its rearmost position (as indicated by the piston, Figure 12a) and should begin to close as the diaphragm moves forward (Figure 12b). Primed in this way assures stable performance and protects the HYDRATUBE from damage during system upsets. The priming procedure is the same for elastomer and PFA HYDRATUBES.

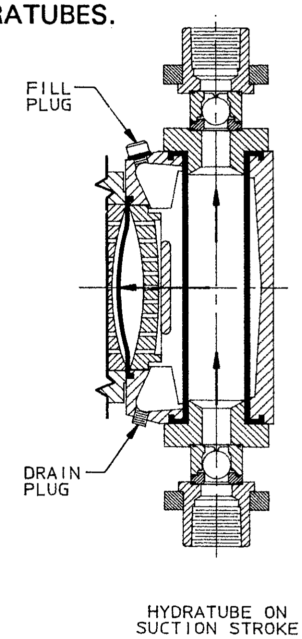


FIGURE 12a

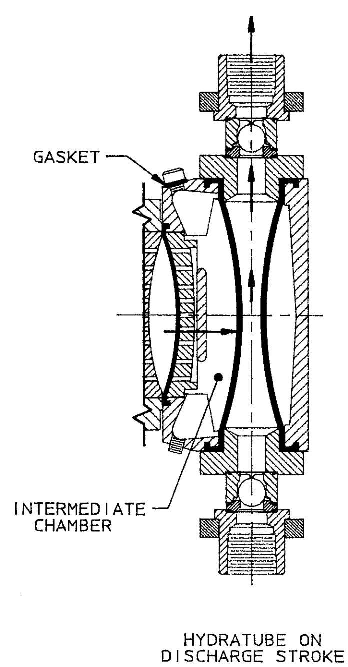


FIGURE 12b

Repriming Intermediate Chamber

1. It is now necessary to prime the intermediate chamber between diaphragms. Make certain the primary flat diaphragm has been hydraulically primed by referring to PRIMING PROCEDURE (Primary/Flat Diaphragm) before proceeding.
2. With the intermediate chamber fill plug removed manually rotate the motor coupling until the pump piston assembly is in the full rearward position.
3. Fill the intermediate chamber using a mixture of water and 1/3 ethylene glycol by volume, or other liquid selected for the particular application.
4. Check the seal or fill plug and replace if necessary. Reinstall and tighten the fill plug to the intermediate chamber.
5. Reinstall the coupling guard and front reservoir cover. Allow the pump to run for 5 to 10 minutes. Observe the action of the HYDRATUBE through the discharge valve port. It may be helpful to shine a light up through the suction port. It should go from a complete round form at the end of the suction stroke to an elliptical shape at full discharge stroke, but no closing off at the middle. The pump now has a correct intermediate prime and is ready for service.
6. Reinstall the suction and discharge valve assemblies.

Check Valves

Operating experience on thousands of installations has indicated that many metering pump troubles have to do with check valves. Problems usually stem from (a) an accumulation of trash between the valve and seat, (b) corrosion which damages seating surfaces, (c) erosion from high velocity flow, or (d) normal physical damage after extended service. A valve seat, to function correctly, must have a polished, narrow seating surface. If the valve seats do not show serious wear, it is sometimes possible to rework on a precision lathe. The knife-like edge at the seat surface can be peened. Place a ball of the same size but of harder metal onto the seat. Then tap the ball using a brass rod and hammer. A single sharp blow is usually sufficient.

Hydraulic Make-up Valve

Hydraulic make-up valves are designed to maintain the correct volume of oil in the hydraulic system between the piston and the diaphragm. No adjustment or attention is required, provided the oil is clean and free of moisture and chemical contamination. Since the valve operates only occasionally and with very little movement it is not considered a normal replacement item in a service schedule. If the valve is replaced because of corrosion or fouling be sure tape or sealant is used on the pipe threads to assure an air tight seal.

Hydraulic Bypass Valve

The bypass valve is an adjustable spring loaded valve. It is designed to protect the pump against excessive hydraulic pressure. The valve is factory set to the setting specified on the specification data sheet or set to allow operation at the maximum pump pressure, indicated on the pump nameplate, without weeping.

To adjust the valve to a lower set pressure, turn counter clockwise.

To check the pressure setting it is necessary to install a gauge in the discharge line between the pump and a shut off valve. With the pump operating at maximum stroke a gradual closing of the shut off valve will cause the bypass valve to reach its cracking pressure which will be observed on the gauge. When the bypass valve is set for maximum pump operating pressure (shown on nameplate), cracking pressure is slightly above maximum operating pressure so that it does not weep during normal pump operation. Dead head dumping pressure can be considerably higher than cracking pressure on some large piston, fast stroke rate models, so the internal bypass valve should not be considered a safety valve for protection of the process piping and instrumentation. A separate process relief valve should be used for this purpose.

It is unusual for a hydraulic bypass valve to operate during normal pump operation. The following conditions will cause valve operation.

1. Excessive pressure buildup in the process which the pump is injecting into.
2. A plugged discharge line or someone shutting off a valve in the discharge line while the pump is operating.
3. Restricted flow to the pump causing the make-up valve to operate. If an inlet strainer is plugged, or someone closes an inlet valve thereby restricting flow of fluid to the pump, the diaphragm is then unable to follow movement of the plunger. The vacuum created between the diaphragm and the plunger upset the make-up valve allowing oil to replace the vacuum condition. This excess oil will be displaced through the pressure relief valve on the discharge stroke of the plunger. Undersized (restrictive) piping must be avoided (see "Piping" page 4).

   Any unusual condition in the system which prevents free movement of the diaphragm will cause a recirculating condition between the make-up valve and the pressure relief valve. Continuous oil recirculation against the pressure relief valve will eventually cavitate the hydraulic prime plus introduce an unnecessary load condition within the pump mechanism.

Metal Valve Design

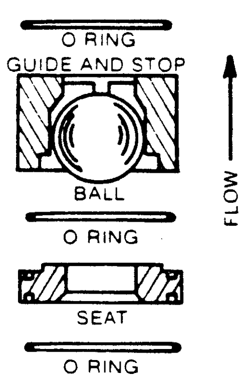


FIGURE 13.

Plastic Valve Design

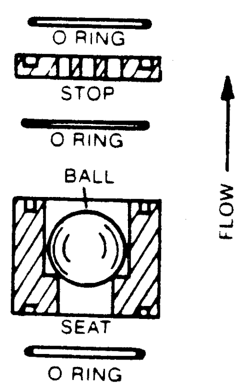


FIGURE 14.

Slurry Valve Design

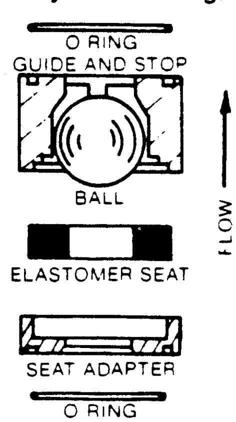


FIGURE 15.

Automatic Bleed Valve
Figure 16

The automatic bleed valve is a gravity operated ball check valve designed to displace a small quantity of hydraulic oil or air on each pump stroke.

Any accumulation of solids can cause malfunction. Unscrew the valve and clean it with kerosene or solvent. If solids cannot be removed the valve must be replaced since there is no means of repair.

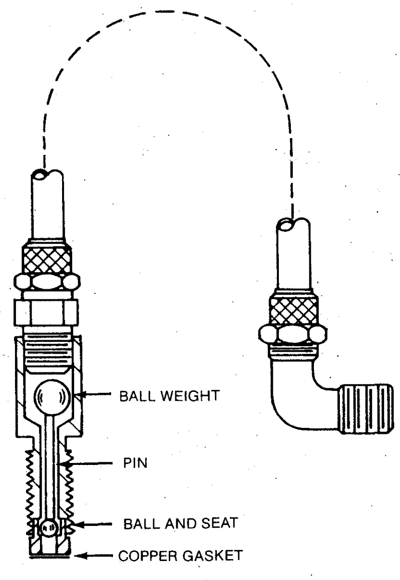


FIGURE 16.

Lubricating Instructions

PULSAlube is a custom blend oil with additives for lubrication and hydraulic transfer service. (For emergency requirements, a list of acceptable commercial oils is available). The diaphragm on the cover of the gear box assembly generally protects the oil from contamination for extended periods of time. A periodic six month check should be made for oil level and possible contamination.

Under sustained conditions of high humidity or if water is present, the oil can become emulsified and take on a yellowish color. Change the oil immediately if this occurs and examine the make-up valve and other parts for corrosion. A suction pump similar to a grease gun is useful for removing oil from chambers, or it may be drained from the ports at the side of each chamber.

To establish a maintenance record and routine procedure, check lubricant and drive mechanism at three and six month intervals. At the first six month interval check the condition of the inlet and outlet check valves. These items along with oil seal inspection should be part of a routine service procedure.

Oil Capacity

The standard 880 metering pump requires approximately 1-1/2 quarts of PULSAlube oil to fill both chambers and prime hydraulic pump head. PULSAlube oil is available in one gallon cans, cartons of six (6) one gallon cans, five gallon cans or 55 gallon drums.

Maintenance Parts Stock

Pulsafeeder offers a KOPkit which is a group of recommended spares carried in stock for replacement due to normal wear. The Kit covers such items as diaphragm, diaphragm gaskets if used, inlet and discharge valve parts, a complete set of valve gaskets and hydraulic pump head gasket. The KOPkit part number for your pump is indicated on the nameplate. A sufficient quantity of PULSAlube oil should be on hand for periodic oil changes.

Ordering Parts

When ordering parts always specify:

1. Pump model and serial number.
2. Part number (from parts list), or KOPkit number.
3. Material of reagent head construction (liquid end parts).

Additional Pulsafeeder Services

FIELD SERVICE - Including pump repair or conversion to different services is available at nominal cost.

FACTORY REPAIR - Complete pump reconditioning.

OPERATOR TRAINING SEMINARS - Conducted by experienced factory trained service personnel at the factory in Rochester, NY or in the field. Field trips are available at nominal cost.

Trouble Shooting

Experience drawn from thousands of installations has shown that there are three outstanding areas which contribute to the bulk of operating problems. First and foremost is installation conditions - improper location and supply, inadequate or restrictive piping to and from pump; unsupported piping; lack of strainer in suction piping.

The second major area is check valves. The check valve is the heart of any pump and sees more severe service than any other part of the pump. Opening and closing 40 to 140 times per minute the valve not only receives a mechanical hammering but receives it under high velocity corrosive, erosive and sometimes extreme temperature conditions. Foreign particles, unlevel mounting, defective seals and improper torquing all too often aggravate even the simplest application.

The third area is a simple lack of a routine service policy. Routine service will catch or avoid simple operating problems which can develop into a crisis if left unattended.

The following is a brief trouble shooting guide to help identify and cure any operating problems you might experience.

Trouble Shooting Chart

Difficulty	Probable Cause	Remedy
Pump Does Not Start	1. Coupling disconnected	Connect and align
	2. Faulty power source	Check power source
	3. Blown fuse, circuit breaker	Replace -- Locate overload
	4. Broken wire	Locate and repair
	5. Wired improperly	Check diagram
No Delivery	1. Motor not running	Check power source. Check wiring diagram
	2. Supply tank empty	Fill with liquid
	3. Lines clogged	Clean and flush
	4. Closed line valves	Open pipeline valves
	5. Ball check valves held open with solids	Clean -- inspect
	6. Vapor lock, cavitation	Increase suction pressure
	7. Prime lost	Reprime, check for leak
	8. Strainer clogged	Remove and clean. Replace screen if necessary
	9. Hydraulic system under-primed	Refer to "Repriming Hydraulic System"
	10. Check valves installed upside down	See check valve illustrations
Low Delivery	1. Motor speed too low	Check voltages, hertz, wiring, and terminal connections. Check nameplate vs. specifications
	2. Check valves worn or dirty	Clean, replace if damaged
	3. Bypass valve opening each stroke	Refer to "Hydraulic Bypass Valve"
	4. Calibration system error	Evaluate and correct
	5. Product viscosity too high	Lower viscosity by increasing product temperature. Increase pump size.
	6. Product cavitating	Increase suction pressure. Cool product as necessary
Delivery Gradually Drops	1. Stroke adjustment creeping	Consult factory. Replace worn parts.
	2. Check valve leakage	Clean, replace if damaged
	3. Leak in suction line	Locate and correct
	4. Fouled bypass or make-up valve	Refer to "Operation and Maintenance"
	5. Strainer fouled	Clean or replace screen
	6. Product change	Check viscosity
	7. By-pass leakage	Correct for bypass valve leakage
Delivery Erratic	1. Leak in suction line	Locate and correct
	2. Product cavitating	Increase suction pressure
	3. Entrained air or gas in product	Consult factory for suggested venting
	4. Motor speed erratic	Check voltage, hertz
	5. Fouled check valves	Clean, replace if necessary

Difficulty	Probable Cause	Remedy
Delivery Higher Than Rated	1. Suction pressure higher than discharge pressure	Install back pressure valve or consult factory for piping recommendations
	2. Suction piping too small	Increase pipe size -- Install PULSAtrol pulsation dampener at pump in suction line
	3. Back pressure valvae set too low	Increase setting
	4. Back pressure valve leaks	Repair, clean, or replace
Pump Loses Oil	1. Diaphragm ruptured	Replace
	2. Leaky oil seal	Replace
	3. Cover gasket leaks	Replace or tighten
	4. Pump head gasket leaks	Replace -- tighten pump head bolts. Seal with permatex
	5. Gear box overfilled	Remove excess oil
Air Continuously Bleeds From Automated Air Bleed Valve	1. Oil in reservoir low	Refill to correct level
	2. Hydraulic Bypass valve opening continuously	Refer to "Hydraulic Bypass Valve"
	3. Suction pressure too low	Increase pressure
	4. Breakdown of oil, temperature high	Change oil type, consult factory
Noisy Gearing, Knocking	1. Discharge pressure too high	Reduce pressure or discharge pipe size
	2. Water hammer	Install PULSAtrol
	3. Worn bearings	Replace
	4. Worn gears	Replace gears & check for improper hydraulic bypass valve setting
	5. End play in worm shaft	Consult factory
	6. Eccentric or worm gear	Tighten or replace assembly
	7. Bypass valve set too high	Readjust (see "Hydraulic Bypass Valve")
Piping Noisy	1. Pipe size too small	Increase size of piping, install PULSAtrol
	2. Pipe runs too long	Install PULSAtrol in line
	3. Surge chambers full of liquid	Recharge with air or inert gas, replace diaphragm and recharge
	4. No surge chambers used	Install PULSAtrols -- pulsation dampeners
Motor Overheats	1. Pump overloaded	Check operating conditions against pump design
	2. Oil too viscous	Consult factory
	3. Low voltage	Check power supply
	4. Loose wire	Trace and correct. Check no load amps

SUCTION PIPING

All PULSA Series pumps have a Minimum Suction Head requirement, MSH_r, for proper operation of the hydraulic system. Use Formula No. 1 or 2 (depending on viscosity) to determine the MSH_a (available) to meet the MSH_r.

Formula No. 1 (if liquid is over 50 centipoise use Formula No. 2)

$$MSH_a = P_a \pm P_h - \left[\frac{LRVG}{525}\right] \text{ (psia)}$$

Formula No. 2

$$MSH_a = P_a \pm P_h - \sqrt{\left[\frac{LRVG}{525}\right]^2 + \left[\frac{LVC}{980d^2}\right]^2} \text{ (psia)}$$

The answer to Formula No. 1 or 2 must be;

- at least 9.5 psia for Disc and Hydratube diaphragm
- at least 6.0 psia for Hydracone diaphragm

In addition to meeting MSH_r of the hydraulic system, the Net Positive Suction Head available $NPSH_a$, must be 5.0 psi or greater. Use Formula No. 3 or 4 (depending on viscosity to determine $NPSH_a$.

Formula No. 3 (if liquid is over 50 centipoise use Formula No. 4)

$$NPSH_a = P_a \pm P_h - P_v - \left[\frac{LRVG}{525}\right] \text{ (psi)}$$

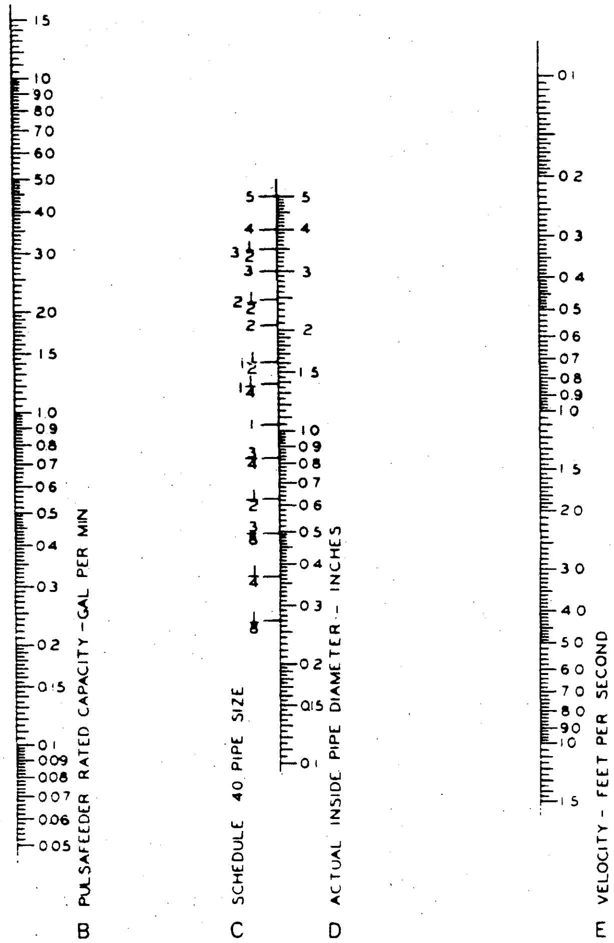
Formula No. 4

$$NPSH_a = P_a \pm P_h - P_v - \sqrt{\left[\frac{LRVG}{525}\right]^2 + \left[\frac{LVG}{980d^2}\right]^2} \text{ (psi)}$$

If the answer to Formula 1 or 2 is at least 9.5 and the answer to Formula 3 or 4 is at least 5 then the operating conditions are satisfied.

Where

P_a	=	Atmospheric pressure or pressure above liquid (psia)
$\pm P_h$	=	Head of liquid above or below pump center line (psi)
P_v	=	Vapor pressure of liquid at pump inlet (psia)
L	=	Length of pipe in feet
R	=	Pump strokes/minute
V	=	Velocity in ft./sec. See back page
G	=	Specific gravity of liquid
C	=	Viscosity (in centipoise)
d	=	Internal pipe diameter



Velocity Nomograph

Step No. 1—Convert PULSAfeeder rated capacity to gals. per minute.
Step No. 2—Place ruler on PULSAfeeder rated capacity Scale B
Step No. 3—Connect scale C or D at selected pipe size or PULSAfeeder port size
Step No. 4—Read velocity (V) on scale E. Use in Formulas, 1-4

CAUTION: DO NOT EXCEED THE FOLLOWING SUCTION PIPING LENGTHS WHEN USING PIPE SIZES THE SAME AS INLET CONNECTION SIZE. THE LENGTHS SHOWN ASSUME A FLOODED SUCTION (1 PSIG).

PISTON DIA.	GEAR RATIO	MAX. LENGTH (FT.)
2.125	10:1	7
2.125	15:1	17
2.125	30:1	20
1.500	10:1	5
1.500	15:1	12
1.500	30:1	50
1.125	10:1	10
1.125	15:1	22
1.125	30:1	90

THESE LIMITS ARE BASED ON WATER-LIKE FLUIDS. HIGHER VISCOSITIES AND GREATER LENGTHS WILL REQUIRE INCREASED PIPE DIAMETERS. SEE INSTRUCTION MANUAL FOR THESE CALCULATIONS.

PULSAFEEDER
A Unit of IDEX Corporation