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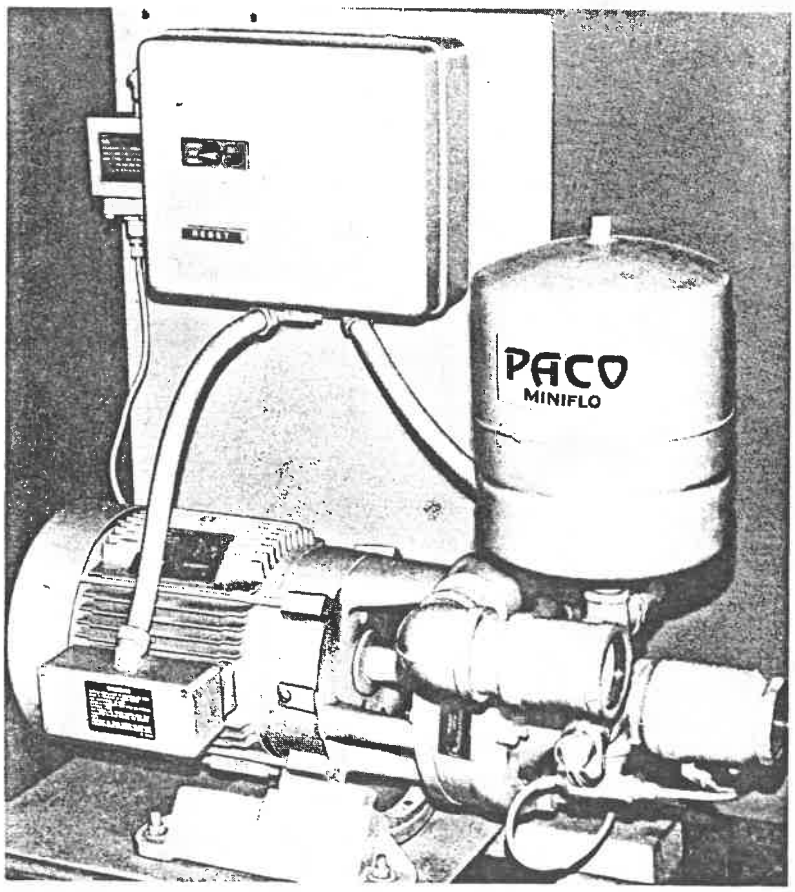
PACO MINIFLO T.M. †

SIMPLEX WATER BOOSTER SYSTEM

Installation, Operating and Maintenance Instructions



† PATENT PENDING

C O N T E N T S

MINIFLO

SIMPLEX WATER BOOSTER SYSTEM

Installation, Operating and Maintenance Instructions

I. INSTALLATION

Read these instructions thoroughly before installing and operating your PACO Miniflo Water Booster System. Successful operation depends on careful attention to the procedures described in this manual. Keep this instruction manual handy for future use.

A UNIT IDENTIFICATION

.All PACO Miniflo Units are identified by Catalog and Serial Numbers. These numbers are stamped on the pump nameplate (affixed to the pump volute casing, and should be referred to in all correspondence with the Company.

B RECEIVING

.Check pumping unit for shortage and damage immediately upon arrival.

.If equipment is damaged in transit, promptly report this to the carrier's agent. Make complete notations on the freight bill to speed satisfactory adjustment by the carrier.

C TEMPORARY STORAGE

.If unit is not to be installed and operated soon after arrival, store it in a clean, dry area of moderate ambient temperature.

.Rotate the pump shaft by hand periodically to coat bearings with lubricant and retard oxidation and corrosion.

.Follow motor manufacturer's storage recommendations where applicable.

D SELECTION VERIFICATION

.If possible, verify that the unit received will provide the pressure boost and capacity required by the application (See PACO Bulletin Fla.4)

.Verify that the maximum possible suction pressure plus the shut-off pressure boost of the unit do not exceed 125 PSI. Above 125 PSI, the safety relief valve will begin to discharge water, which could cause damage unless piped to a suitable drain.

.NOTE: The pressure relief valve acts only to protect the unit's pressure tank from over-pressurization. It does not protect the user's system from over-pressurization due to excessive suction supply pressures.

.Miniflo shut-off pressure boosts are shown in the following chart:

60 HZ		50 HZ	
MODELS	SHUT-OFF BOOST	MODELS	SHUT-OFF BOOST
813-818	39 PSI	865	32 PSI
819-824	50 PSI	867	37 PSI
825-829	33 PSI	869	29 PSI
830-834	46 PSI	871	35 PSI
835-839	68 PSI	873	58 PSI
840-844	92 PSI	875	65 PSI
845-849	73 PSI	877	59 PSI
850-852	92 PSI	879	83 PSI
853-855	72 PSI	881	58 PSI

E LOCATION

.Locate the unit as close to the suction supply as possible. Use the shortest and most direct suction piping practical.

.Locate the pump below water supply level wherever possible. This will facilitate priming, assure a steady liquid flow, and provide a positive suction head.

.Suction lift (negative suction head) installations are not recommended due to the possibility of pump cauitation at high flows. However, very direct short lifts with low-restriction foot valves may be possible.

.Avoid exposure to temperatures below 0^{o} C (32^{o}F) or to high temperatures 38^{o}C (100^{o}F+) in direct sunlight. Water temperature should remain within 32^{o}-100^{o}F (0-38^{o}C).

.Always allow sufficient accessability for maintenance and inspection.

.Make sure a suitable power source is available. Electrical characteristics should match those specified on the pump nameplate, within the limits covered in Section 1H.

.Avoid pump exposure to sub-zero temperatures to prevent pump liquid from freezing. If freezing conditions exist during shutdown periods, see Section 2E for specific recommendations.

The unit should be securely anchored using the four corner mounting holes on the base. (Mounting dimensions are given on the catalog data sheet.) For temporary installations, the unit may remain bolted to its wooden shipping skids.

.The unit must be located so that water discharged from the pressure relief valve will not cause damage. If necessary, the relief valve may be piped to a suitable drain.

F PIPING

.Use pipe hangers or other supports at proper intervals to provide complete piping support near the unit. Piping should be at least as large as the suction and discharge fittings, and properly aligned so that no strain is transmitted to the unit.

.The use of gate-type isolation valves on both suction and discharge sides of the unit is recommended for ease in servicing. Globe valves are excessively restrictive, and should not be used.

.Avoid any high points, such as pipe loops which may create air pockets and throttle the system or produce erratic pumping. If a high point is unavoidable, install a petcock to bleed any entrapped air.

.Do not spring or force piping when making any connections.

G MECHANICAL SHAFT SEAL

.All PACO Miniflo units come equipped with standard mechanical shaft seals designed for use with clean water within the temperature and pressure limitations of the unit. ($100^{o}F(38^{o}C)$, 125 PSI) Observe the following precautions to avoid seal damage and to obtain maximum seal life:

.DO NOT RUN THE PUMP DRY! Dry operation will cause seal failure within minutes.

.Clean and purge piping in new installations before installing and operating unit. Pipe scale, welding slag, sand and other abrasives can cause rapid seal failure.

H EXTERNAL WIRING

.Install electrical wiring in accordance with National Electrical Code standards, and local regulations as they apply. Line voltage and wire capacity should match the voltage specified on the unit nameplate located on the pump, and the full-load AMPS specified on the motor data plate. Allowable voltage and frequency variations are as follows:

Voltage: ± 10%
Frequency: ± 5%
Sum of voltage and frequency: ± 10%

NOTE: However, that rated unit performance is valid only with rated voltage and frequency.

.Connect the power supply leads to the motor starter or contactor terminals located in the control panel, using a suitable knock-out for conduit access to the panel. The line terminals are usually located near the top of the starter or contactor, and are identified as "L1, L2, L3" for 3-phase power, and as "L1, L2" for single phase power. On 115 volt, single phase systems, the neutral lead should be connected to the "L2" terminal. All units must be securely grounded. This is normally accomplished by the conduit connection itself, or by connecting a ground lead to a suitable mounting bolt.

.IMPORTANT: Check final connections by briefly supplying power to the unit by momentarily switching to the "hand" position

on the control switch. The motor shaft must rotate in a clockwise direction as viewed from the motor end of the unit. If rotation is counter clockwise, correct as follows:

-For 3-phase units, swap any two of the three incoming power leads.
-For single-phase units, open the motor teminal box, and refer to labelled instructions for changing rotation.

J PRESSURE SETTINGS

.The Miniflo booster unit is designed to run continously during demand periods, and to automatically shut off during extended periods of no demand. The control system acts to turn on the unit when a system flow demand results in the system pressure falling below the adjustable pressure cut-in setting. It is important that the air cushion precharge in the pressure tank is also adjusted to match the pressure switch setting by means of the valve located at the top of the tank.

.As a general rule, the pressure setting for both the pressure switch and the pressure tank is determined as follows:

1. Find the shut-off pressure boost for your model as listed in Section 1D.
2. Add the expected minimum supply pressure.
3. Subtract 20 PSI.

.The pressure switch is adjusted by removing its cover plate for access to the internal adjustment. The pressure tank is adjusted using a source of compressed air and an ordinary tire pressure gauge. With the tank in place, insure that it is first emptied of water by drawing about 2 gallons from the system with the pump in the "off" position.

.If necessary, the tank may be removed for pressure charging. It is mounted with a simple 3/4NPT fitting integral with the tank.

.Again, it is important that these two pressure adjustments be matched.

II OPERATION

A. PRIMING

.The PACO Miniflo unit is not self-priming, and must be completely primed (filled with liquid) before starting.

.Prime the unit by allowing water from the supply line to flow through the pump by opening a downstream system valve, such as a washbasin tap, etc. If the supply pressure alone is not adequate to supply this flow, the Miniflo unit's relief valve may be used to drain water through the system.

.If the unit is installed in a suction lift application priming must be accomplished and maintained by other methods. The use of foot valves or ejectors with manual filling of the unit are possible methods.

CAUTION:

.NEVER RUN THE UNIT DRY IN THE HOPE THAT IT WILL PRIME ITSELF! Serious damage to the mechanical seal will result.

B. PRE-START CHECKLIST

Make the following inspections before starting your PACO Miniflo Booster System.

1. Make sure that the power supply voltage, phase, and frequency match those specified on the motor data plate and the unit identification plate on the pump.
2. Be certain the unit is wired as described in Section I.H., to produce clockwise rotation as viewed from the motor end. Also, verify that the unit is securely grounded.
3. Turn pump shaft by hand to see that it rotates freely.
4. Check to see that the unit is primed by releasing a small amount of water from the relief valve.
5. Using an ordinary tire pressure gauge, verify that the pressure tank precharge matches the pressure switch setting. (See Section 1J.)

6. Check unit and system piping for leaks, tightening fittings as necessary.

7. Verify that any isolation valves are fully open.

C. STARTING

.Turn the control switch to "Auto" for automatic system control. The unit should immediately start, assuming the system pressure is below the pressure switch setting.

.With the unit running, check for pressure leaks.

D. OPERATING CYCLE

.The unit will continue to run as long as there is any system demand for flow. When demand ceases, the pump housing and discharge fittings will gradually rise in temperature until the temperature sensor is triggered, causing the unit to shut-off. The time-period required to reach the shut-off point under a no-flow condition may vary from a few minutes to a half hour, depending on ambient temperatures and unit horsepower. Once shut-off, the unit will remain idle until a new flow demand re-activates the system via the pressure switch.

E. SHUTDOWN

.For short periods of time, under normal ambient conditions, there is no need to shut down the unit. To eliminate occasional running of the system due to normal dripping taps, etc., the control switch may be switched to "off". If this is done, verify that the unit is primed upon re-activation.

.For longer periods of time, or under freezing conditions, the unit should be isolated and drained, using the top and bottom vent and drain plugs on the pump housing. Disconnect the pressure line at the pressure switch to blow air through the copper lines. Leave the control switch in the "off" position.

III. MAINTENANCE

A. MOTOR LUBRICATION

.Most Miniflo units are equipped with "Sealed for Life" bearings, and do not require further lubrication throughout motor life.

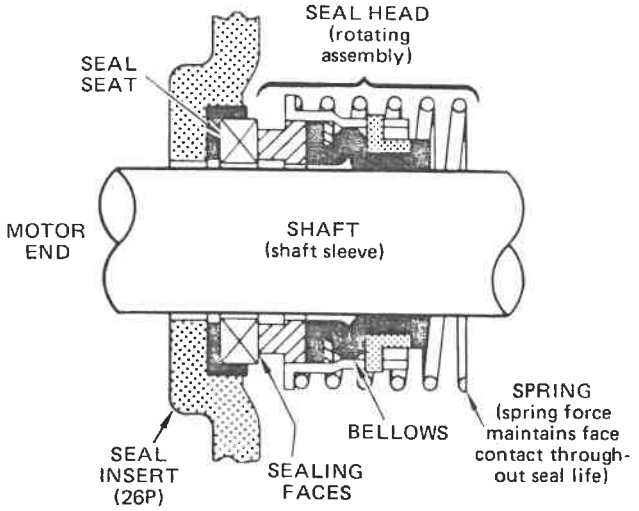
.If pump motor is equipped with grease fittings, apply grease once every 6 months.

B. MECHANICAL SHAFT SEALS

Mechanical seals are precision made parts. When properly installed, they prevent pump liquid from leaking out around the shaft. Seal faces can be easily scratched or damaged by handling, and extreme care must be taken to prevent their contact with hard surfaces or abrasives.

.The figure below identifies major seal components, and illustrates how an end face mechanical seal functions when properly installed inside pump casing.

.If seal failure develops, follow the procedures described in Section 4C or 4D (as applicable) and replace worn seals with new mechanical seals.



END FACE MECHANICAL SEAL

C. PUMP WEAR RINGS

.Case wear rings are designed to serve as a buffer between pump casing and rotating impeller. As the name implies, these rings will wear with pump use and must eventually be replaced. Wear ring life varies significantly with composition of liquid being pumped, and will be greatly extended by absence of abrasive particles in liquid.

Wear rings also serve an important hydraulic function, minimizing pressure leakage from high to low pressure zones inside the pump volute casing. Rings should be replaced when the diametrical clearance between impeller and wear ring exceeds .030 inches (0.76mm).

To replace used wear rings, follow procedures outlined in Section 4f. Always make sure wear ring cavity in pump volute casing is thoroughly cleaned before replacement, to insure a properly aligned fit.

OTHER COMPONENTS

There is no maintenance associated with other components. Defective check valves, pressure tanks, temperature switches, pressure switches, control panels, etc. Should be replaced rather than repaired.

REASSEMBLY

PIPING AND ELECTRICAL

Disassembly of Miniflo piping is fairly straightforward. Refer to the exploded view, (Figure 1) noting especially the location of the special brass restrictor nipple. (Key 12).

When electrical disassembly is necessary, be sure to carefully label the locations of all disconnected wires, Figure 4 gives complete wiring information.

B PUMP DISASSEMBLY

Models 813 thru 834 and 860 thru 871
(Refer to Figure 2)

1. Remove Casing Bolts 8D from Motor Bracket 21A, and separate motor-end assembly from Volute Casing 1A.
2. Remove Gasket 11A from face of bracket, and discard. New sealing gaskets should always be used whenever pump is reassembled.
3. Unscrew Impeller 3A from motor shaft. Loctite is applied to impeller threads during factory assembly, and must be loosened by applying torch heat to eye of impeller and unscrewing while hot. Refer to Section 4F for complete instructions.
4. To block shaft rotation while removing impeller, hold a large screwdriver securely in slot at back end of motor shaft and unscrew impeller.
5. Light oil may be applied to shaft to ease removal of Shaft Seal 14A. Pull seal head assembly manually from shaft, using slight twisting motion (as necessary) to loosen bellows from shaft.
6. Contacting surface of bellows on new seal head is coated with bonding agent that adheres to motor shaft minutes after initial installation. When seal is removed, bond no longer exists and bellows may actually crack or split during removal. Thus, installation of new mechanical seal is always recommended if it becomes necessary to remove existing seal from shaft after initial installation and use.
7. Remove Motor Bracket 21A from shaft, and pry worn seal seat from inset on bottom of bracket. Refer to Section 4D for specific seal replacement procedure and recommendations.
8. Water Slinger 13G is installed on motor shaft with press fit, and may be pried loose manually by twisting screwdriver head or sharp edge of metal object between slinger and motor.
9. Reassemble pump, reversing procedure outlined above. Make sure all mating surfaces and threads are thoroughly cleaned before reassembly.

C PUMP DISASSEMBLY

Models 835 thru 855 and 872 thru 881
(Refer to Figure 3)

1. Remove Casing Bolts 8B from Backplate 2K and separate motor-end assembly from Volute Casing 1A.
2. Remove (and discard) Gasket 11A from face of backplate. New

sealing gaskets should always be used whenever pump is reassembled.

3. Unscrew Impeller Capscrew 8A, and remove Impeller Washer 10A from end of motor shaft.

4. Remove Impeller 3A from shaft by using two prying bars, to prevent breaking or damaging impeller. Prying bars should be positioned in close proximity to impeller vanes for maximum structural leverage.

5. Remove and discard spring and retainer from seal head assembly, and pull assembly manually from Shaft Sleeve 5A. A twisting motion may be necessary to loosen bellows from sleeve.

6. Unscrew bolts from lower flange of Motor Bracket and pull backplate 2K.

7. Remove and discard seal seat from backplate. Refer to Section 4D for complete instructions on installation of new Shaft Seal 14A.

8. Unscrew bolts from upper plate of Motor Bracket 21A (if unit assembled with CCP Motor).

9. Pull Impeller Key 12A from shaft keyway insert, using metal-gripping pliers if necessary.

10. To separate shaft sleeve from motor shaft, apply torch heat axially along sleeve exterior and remove while hot. See Section 4E for complete instructions.

11. Water Slinger is installed on motor shaft with press fit, and may be pried loose manually by twisting screwdriver head or sharp edge of metal object between slinger and motor.

12. To remove Case Wear Ring 4A, follow wear ring disassembly procedures outlined in Section 4G.

13. Reassemble pump, reversing procedure outlined above. Make sure all contacting surfaces and threads are thoroughly cleaned before reassembly.

D. PUMP SEAL REPLACEMENT

.Models 813 thru 834 and 860 thru 871.

(Refer to Figure 2)

1. Remove Casing Bolts 8B from Motor Bracket 21A, and separate motor-end assembly from Volute Casing 1A.

2. Unscrew Impeller 3A from motor shaft. Loctite is applied to impeller threads during factory assembly, and must be loosened by heat before impeller can be unscrewed. Refer to Section 4E for specific procedures. Pull worn seal head assembly manually from shaft, and discard.

3. Remove and discard worn seal seat from Motor Bracket 21A, and thoroughly clean inside of bracket. Clean and lightly oil shaft, and make sure no sharp edges exist to cut or scratch bellows of new seal.

4. Press new seal seat firmly into bracket. Avoid direct contact of seal face with metallic or abrasive objects, and wipe clean after installation to insure abrasive-free sealing surface.

5. Slide new seal head assembly onto shaft by applying even pressure to base of assembly. Make sure sealing faces fit snugly.

6. Apply Loctite to threads of impeller and motor shaft, and screw impeller onto shaft.

7. Reassemble pump, reversing procedure outlined above.

E. PUMP SEAL REPLACEMENT

.Models 835 thru 855 and 872 thru 881.

(Refer to Figure 3)

1. Remove Casing Bolts 8B from Backplate 2K, and separate motor-end assembly from Volute Casing 1A.

2. Unscrew Impeller Capscrew 8A, and remove Impeller Washer 10A and Impeller 3A from motor shaft.

3. Remove and discard spring and retainer from seal head assembly, and pull assembly manually from Shaft Sleeve 5A. A twisting motion may be necessary to loosen bellows from sleeve.

4. Remove and discard worn seal seat from Seal Insert 26P, and thoroughly clean inside of insert. Clean and lightly oil Shaft Sleeve 5A at this time, making sure no sharp edges or corners exist to cut bellows of new seal.

5. New mechanical seals are shipped completely assembled and ready for installation, and do not require re-use of any existing components from used seal assembly (including spring and retainer).

6. Press new seal seat squarely into insert. Light oil may be applied to seat's rubber cup, to ease installation. Avoid direct contact of seal face with metallic or abrasive objects, and wipe clean after installation to insure abrasive-free sealing surface.

7. Remove spring from new seal head assembly, and slide assembly manually onto sleeve by applying even pressure at base of bellows.

8. Contacting surface of bellows on new seal head is coated with a bonding agent that adheres to shaft sleeve minutes after installing. Make sure sealing faces of head and seat fit snugly, and bellows are properly compressed (Fig. 4.1A) at time of installation. Once in place, seal head can not re removed without impairing adhesive properties of bellows.

9. Place spring and retainer into position, and reassemble impeller and capscrew, reversing procedure outlined above.

F. WEAR RINGS

.To remove worn Case Wear Ring 4A, drill two holes (slightly smaller than width of ring) into exposed edge of ring. Once holes are drilled, a chisel may be used to completely sever ring at holes, and break ring into two halves for easy removal.

.To reassemble, press fit new wear ring squarely into volute casing cavity. Ring may be tapped into place to make sure it is completely impressed into cavity. Make sure cavity is thoroughly cleaned before installing new wear ring, to insure properly aligned fit.

G. LOCTITE

.Loctite adhesive compound is a liquid resin that produces a tough bond whenapplied to threaded and close-fitting connections during assembly. It is used by PACO on all threaded impellers, to prevent loosening during inadvertent counter-rotation, and on shaft sleeves to secure to motor shaft.

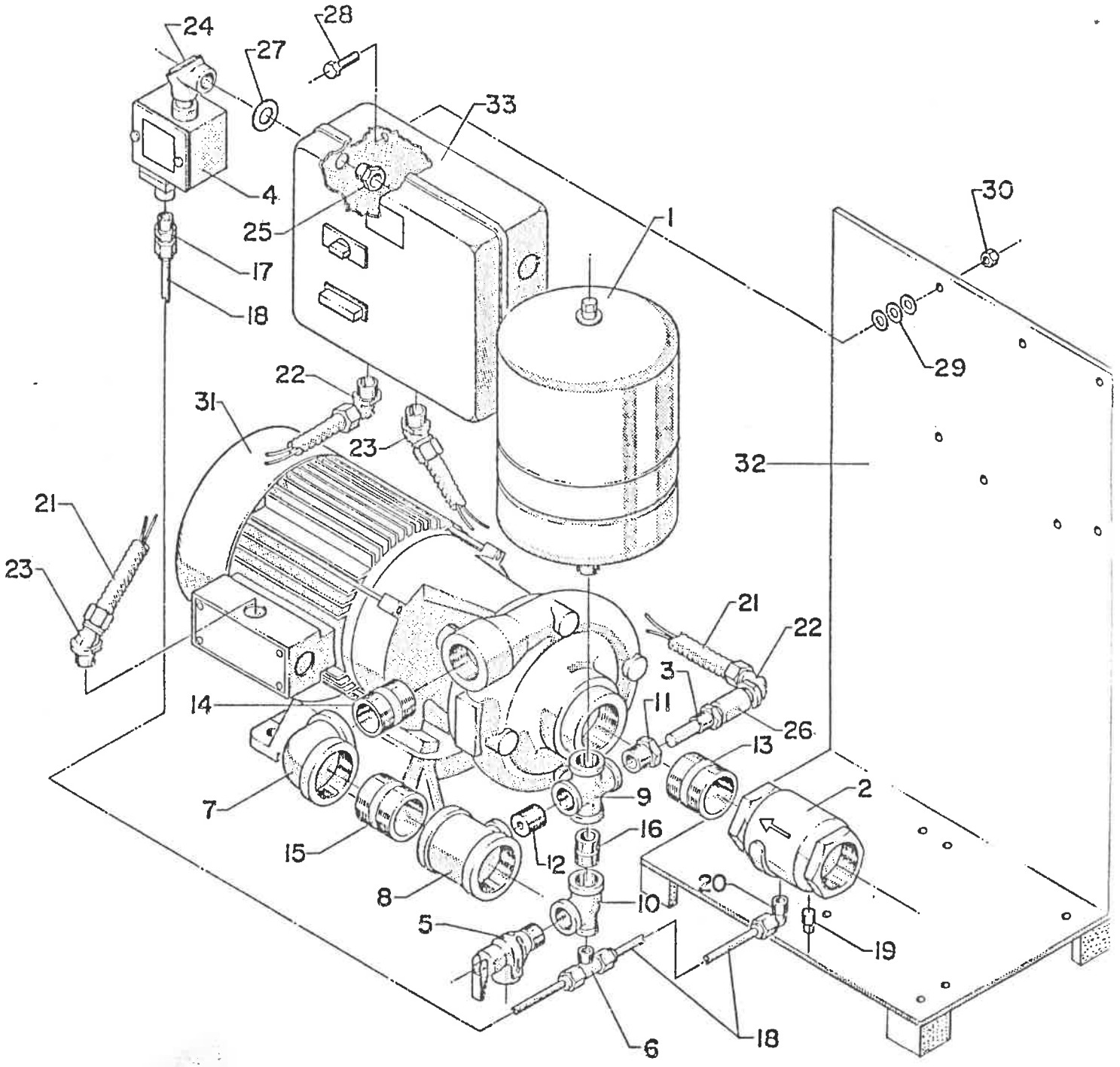
.If adhesive shear strength is too great for disassembly with ordinary hand tools, parts must be heated by torch and disassembled while hot. Apply torch heat to impeller eye when unscrewing threaded impellers, axially along shaft sleeve exterior to loosen for removal. Holding power of Loctite decreases as temperature rises, and compound completely decomposes at temperatures above 650^{o}.

.Wipe or brush clean all adhesive surfaces before reapplying Loctite. Locquic Primer is a degreasing agent recommended for use in preparing mating surfaces for Loctite application. Do not use gasoline or other petroleum products for cleaning because an oily surface will remain. Assemble shaft sleeves with twisting motion to insure an even hold, and always make sure sleeve is firmly in place against shaft shoulder.

PARTS LIST

KEY	DESCRIPTION
1	Accumulator Tank
2	Check Valve
3	Thermal Switch
4	Pressure Switch
5	Relief Valve
6	Male Branch Tee
7	Discharge Elbow
8	Discharge Red. Tee
9	Cross
10	3/4"x1/4"x3/4" Red. Tee
11	3/4"x1/2" Red. Bushing
12	Restrictor Nipple
13	Suction Close Nipple
14	Volute/Elbow Close Nipple
15	Elbow/Tee Close Nipple
16	3/4" Close Nipple
17	1/4" Tubing Fitting
18	1/4" Copper Tubing
19	Pipe Plug
20	1/4" 90 Copper Fitting
21	1/2" Liquidtite
22	1/2" 90 Connectors
23	1/2" 45 Connectors
24	1/2" Pull "L"
25	1/2" Chase Nipple
26	1/2" Pipe Coupling
27	3/4-1/2 Red. Washer
28	1/4" Cap Screw 1"Lg.
29	1/4" Washer
30	1/4" Hex Nut
31	PACO Pump
32	Frame
33	Electrical Panel

FIGURE 1

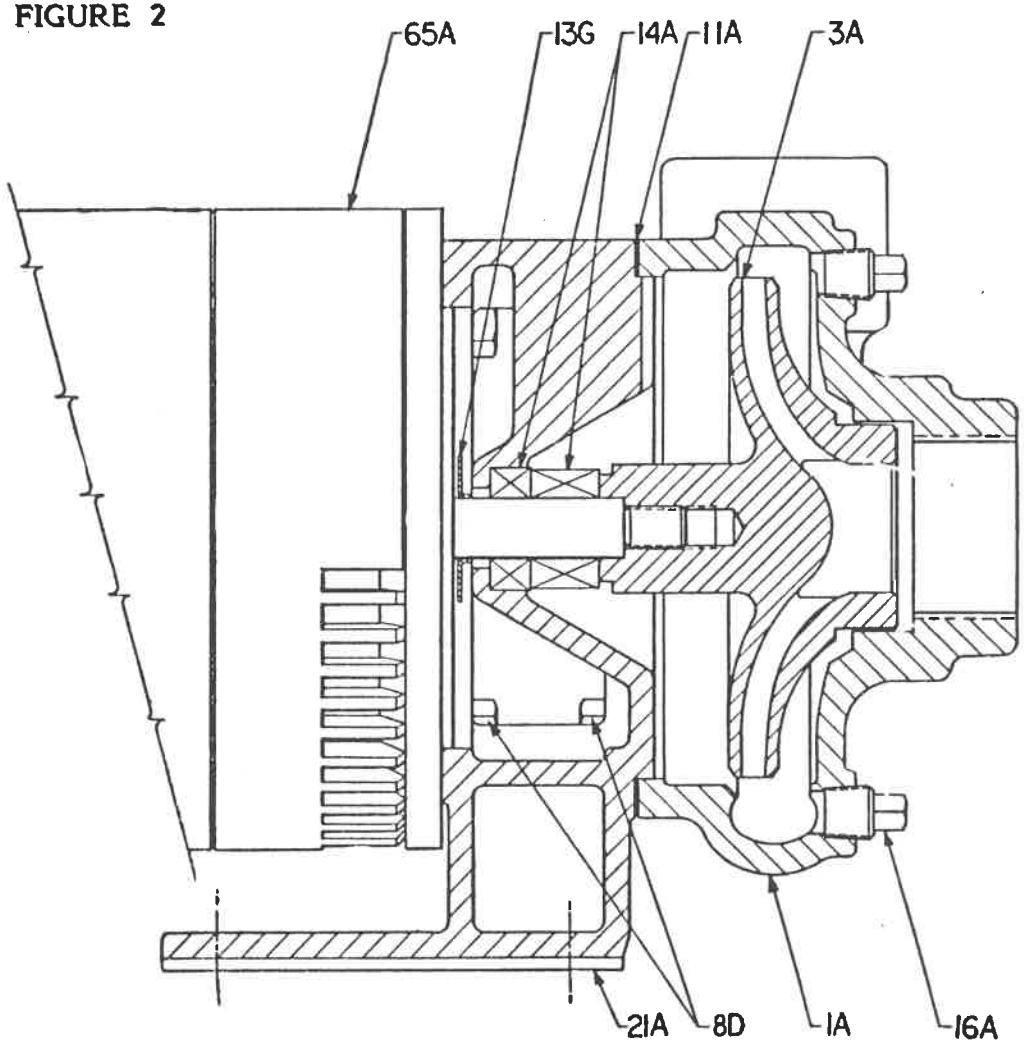


PARTS LIST

KEY	DESCRIPTION
1A	Volute Casing
* 3A	Impeller
8D	Casing Bolt
*11A	Gasket
13G	Slinger
*14A	Shaft Seal
16A	Drain Plug
21A	Motor Bracket
65A	Fractional Frame Motor

*RECOMMENDED SPARE PARTS

FIGURE 2



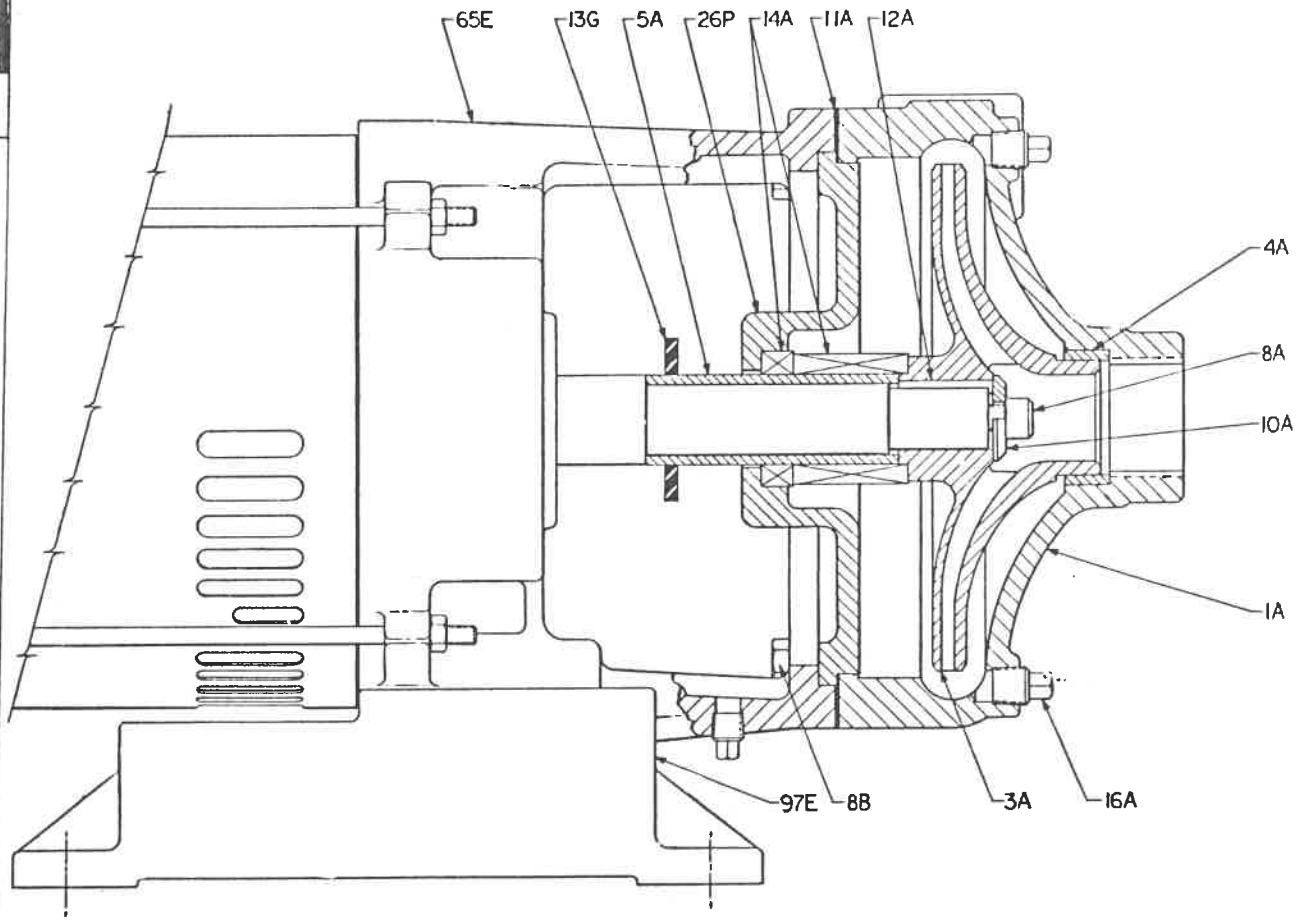
TYPICAL PUMP AS USED IN MINIFLO SYSTEMS, MODELS 813 THRU 834 AND 860 THRU 871

FIGURE 3

PARTS LIST

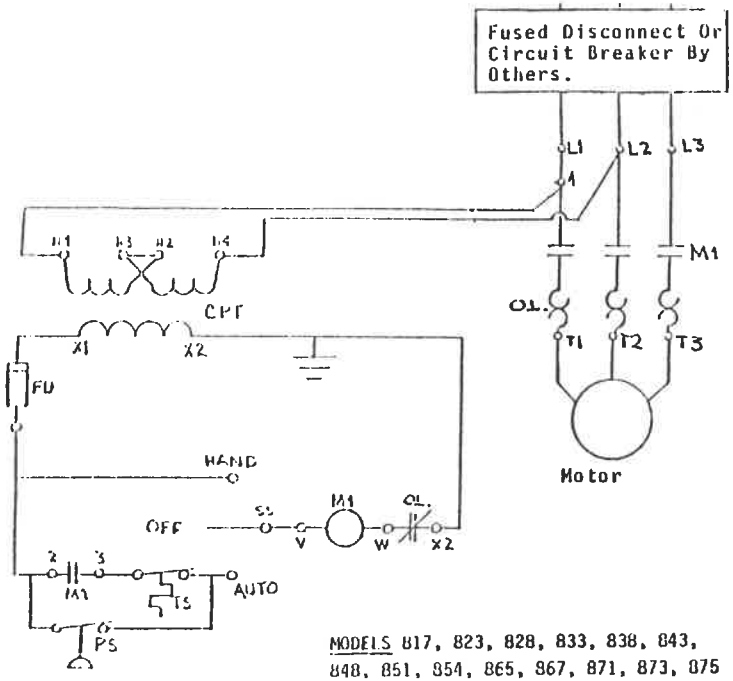
KEY	DESCRIPTION
1A	Volute
2K	Backplate
* 3A	Impeller
* 4A	Case Wear Ring
5A	Shaft Sleeve
* 8A	Impeller Capscrew
8B	Casing Bolt
10A	Impeller Washer
*11A	Gasket
12A	Impeller Key
13G	Slinger
*14A	Shaft Seal
15A	Air Vent Assembly
16A	Drain Plug
26P	Seal Insert
65E	Gyropoise Motor (Integral Motor-Frame)

*RECOMMENDED SPARE PARTS

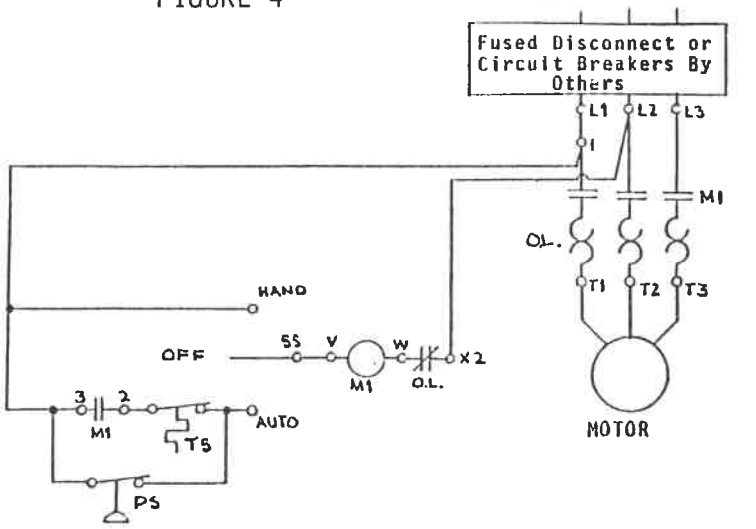


TYPICAL PUMP AS USED IN MINIFLO SYSTEMS, MODELS 813 THRU 834 AND 860 THRU 871

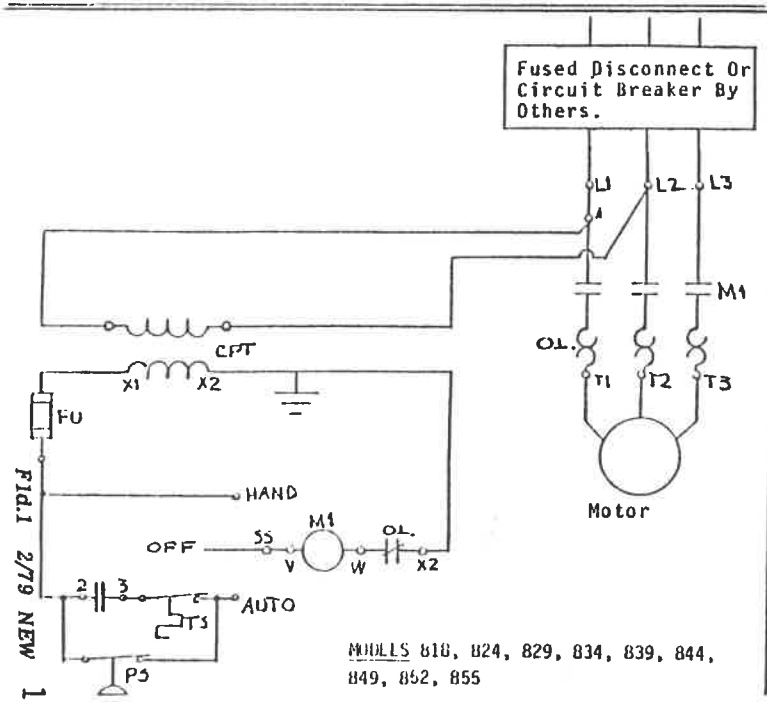
FIGURE 4



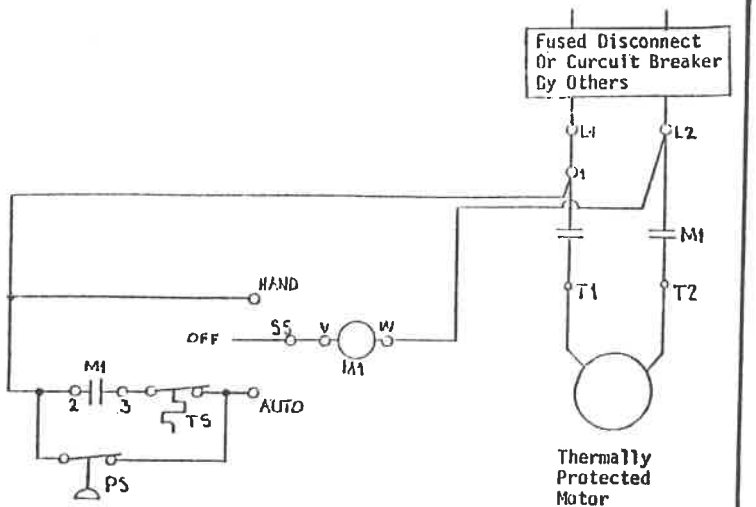
MODELS 817, 823, 828, 833, 838, 843, 848, 851, 854, 865, 867, 871, 873, 875



MODELS 815, 816, 821, 822, 826, 827, 831, 832, 836, 837, 841, 842, 846, 847, 850 853, 864, 866, 868, 870, 872, 876



MODELS 818, 824, 829, 834, 839, 844, 849, 852, 855



MODELS 813, 814, 819, 820, 825, 830, 835, 840, 845

PACO MINIFLO WIRING DIAGRAMS

NOMENCLATURE:

- CPT - Control Power Transformer
- FU - Fuse
- MI - Motor Contact
- SS - Selector Switch
- OL - Overload Relay - Normally Closed, Opens on Pressure Increase
- TS - Temperature Switch - Normally Closed, Opens on Temperature Rise. Factory Set, Non-Adjustable
- PS - Pressure Switch - Set Pressure Switch to Close When Pressure Drops to Minimum Desired System Pressure

  NOTE: Pressure switch has differential of approx. 10 PSI. Pump discharge pressure at shutoff must be at least 10 PSI higher than set point.

FIGURE 5

"BACKUP" MINIFLO INSTALLATION

Instructions for piping and wiring of two identical Miniflo Booster Systems to provide automatic 100% backup capacity:

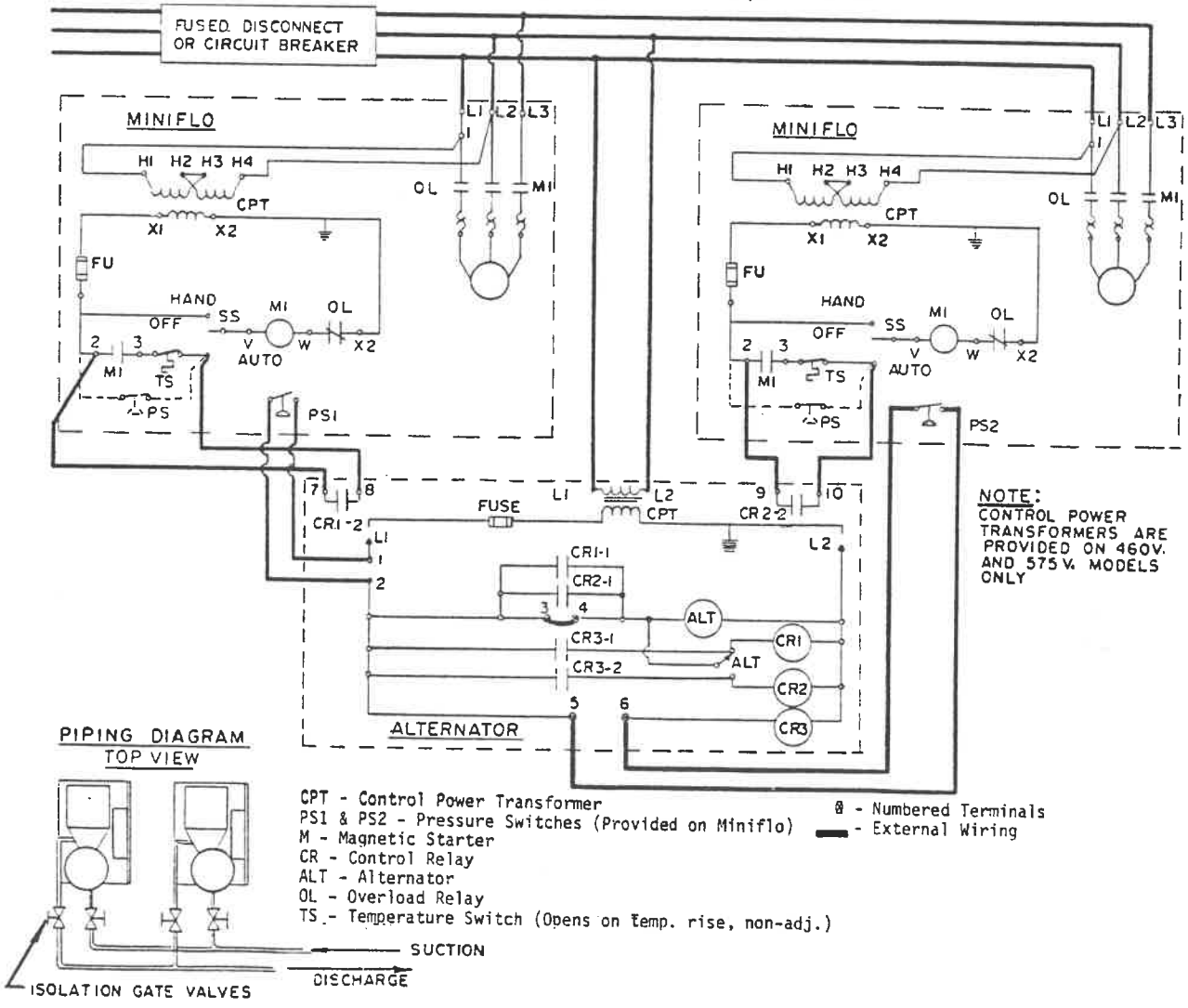
The two identical Miniflo units, each capable of supplying full system flow demand, should be piped in parallel as shown in the piping diagram. The appropriate alternator must be ordered from section M1e.3, Table 4, of the PACO catalog, sized for the available line voltage. Note that this is not a true "duplex" system providing staged pump operation on the basis of flow demand, but rather a backup system which automatically activates a stand-by pump in the event of a pump failure. The two Miniflo units and the alternator should be interconnected as shown in the wiring diagram.

Note that the pressure switch on each Miniflo unit (shown in dotted lines) must be disconnected and re-wired to the alternator as shown. Similarly, terminals 7, 8, 9, & 10 in the alternator must be wired back to the Miniflo terminals formerly used by the pressure switch. Lastly, a short jumper wire must be installed across terminals 3 and 4 in the alternator.

Pressure Switch 2 should be set as outlined in the standard Miniflo instruction manual. PS2 should be set 10 PSI lower than PS1 to detect a failure of the lead pump.

Sequence of Operation:

1. Assume both Miniflo units are in the Auto position and not running.
2. When the system pressure drops to the set point of pressure switch 1 (PS1); the alternator (ALT) and control relay 1 (CR1) are energized starting one of the Miniflos. As the Miniflo begins to pump and raises the sytem pressure by 10 PSI, PS1 opens and de-energizes. The Miniflo will continue to operate until a no-flow condition is sensed by its temperature switch.
3. When the pressure drops to the set point of PS1 a second time, the alternator (ALT) and control relay 1 (CR2) are energized starting the other Miniflo. The rest of the control cycle will be as in #2 above.
4. Should the lead Miniflo fail to operate satisfactorily and the system pressure drops a further 10 PSI, to the set point of PS2, the lag Miniflo will be started. Again the lag Miniflo will operate until a no-flow condition is sensed by its temperature switch.



VI. MINIFLO TROUBLE-SHOOTING CHECKLIST

1. PUMPING SYSTEM OUTPUT APPEARS TO BE INADEQUATE
   a. Incorrect Miniflo Model selected for application.
   b. Wrong rotation of impeller.
   c. Check Valve, Impeller, or Piping clogged with debris.
   d. Undersized or restrictive fittings used in piping system.
   e. Inadequate electrical power supply.
   f. Pump wear ring excessively worn.

   And, If unit is installed in a suction lift application:
   g. Loss of prime.
   h. Suction lift too high.
   i. Suction piping leaks air into pump.
   j. Foot valve too small or clogged with debris.
   k. Inlet not submerged deep enough below water surface.

   NOTE: Suction restrictions can cause cavitation. Cavitation is evidenced by a "Rattling" sound from the pump and not only diminishes pumping output, but in severe cases will cause eventual erosion of the pump impeller.

2. UNIT FAILS TO START IN "AUTO" POSITION, WITH SYSTEM DEMAND.
   a. Pressure settings too low to supply boost requirement.
   b. Supply pressure above unit's pressure settings, eliminating need for additional pressure boost. (This is the "High suction pressure cut-out feature.")
   c. Defective pressure switch. (Fails to close at pressures below set point, see Figure 4.)

3. UNIT FAILS TO SHUT OFF IN "AUTO" POSITION, EVEN DURING EXTENDED PERIODS OF NO DEMAND (Verify by observing operation for 30 minutes with discharge isolation valve closed.)

   If pump housing is HOT to the touch, and unit continues to run after momentary switching to "Off" position:
   a. Pressure settings too high. (See Section IJ.)
   b. Defective pressure switch. (Fails to open at pressures above set point, see Figure 4.)

   If pump housing is HOT to the touch, and unit remains off after momentary switching to "Off" position:
   c. Restricted recirculation line. (Key No. 18, Figure 1)
   d. Defective temperature switch. (Fails to open at temperatures above 120°, see Figure 4. May be tested with hot water, thermometer and test lamp.)

   If pump housing is cool or only slightly warm to the touch:
   e. Cold ambient temperature prevents heat buildup for thermal shut-off operation.
   f. System is supplying a flow demand, and is in fact, operating properly.

4. EXCESSIVE START-UP PRESSURE SURGE
   a. Pressure settings too low. (See Section 1J.)
   b. Excessive pressure boost. (Smaller unit required.)

5. PRESSURE TANK FAILS TO HOLD AIR CHARGE
   a. Leaking tank air valve.
   b. Punctured tank diaphragm

6. RELIEF VALVE LEAKS
   a. Supply pressure plus shut-off pump boost exceeds 125 PSI. (See Section 1D.)
   b. Defective relief valve.

7. FREQUENT STARTS (MORE THAN 3 PER MINUTE) WITH NO APPARENT DEMAND

   a. Cumulative system leaks, such as dripping taps, etc. Check by closing discharge isolation valve.

   b. Pressure tank air charge too high or too low. (See Section 1J.)

   c. Leaking inlet check valve. Check by closing inlet isolation valve, immediately after pump stops running.

8. RAPID SHORT-CYCLING OF UNIT (MORE THAN 15 STARTS PER MINUTE)

Temporary condition, followed by continuous running:

   a. Pressure tank air charge too high or too low. (See Section 1J.)

   b. Direct sunlight or ambient temperatures above 100°F.

Continuous condition in "Auto" position:

   c. Defective temperature switch. (Fails to close at temperatures below 120°, see Figure 4. May be tested with hot water, thermometer, and test lamp.)

   d. Supply water temperature above 100°F.

9. UNIT WILL NOT RUN IN "HAND" POSITION

   a. No electrical power.

   b. Motor overload relay tripped. (Press "Reset".)

NOTE: Single phase units automatically reset.

   a. Wrong rotation of impeller.

   b. Flow demand exceeding capacity of unit.

   c. Mechanical bind due to damaged pump.

WARRANTY

Each PACO pump or part is warranted against defects in material or workmanship under normal use and service for a period of *one year* after date of original shipment, from our factory or branch, when installed and used in accordance with our printed instructions. Our obligation under this warranty is limited to repairing or replacing, at our option, without charge, f.o.b. our factory, any part of our own manufacture which is determined by the Company to have been defective at the time it was shipped, provided immediate written notice is given us upon discovery of such defect. The material claimed defective shall be returned to us, transportation prepaid, to establish the claim.

No warranty applies to, and the Company is not responsible for, damage or wear to pump and/or parts caused by sand or other abrasive content in the liquid pumped. As the action of corrosive liquids is beyond the control of the Company, no warranty is made as to the life of a pump handling corrosive liquids.

We cannot be responsible for labor charges or other expenses of any kind, loss, delay or any damages of any kind, howsoever and wheresoever incurred, as the result of any defect, nor can we make any allowance for labor, transportation, or any other charges incurred in the replacement or repair of any item.

No other warranty, express or implied, is authorized by, or applicable to, this Company.

All purchased equipment (equipment not manufactured by us), including motors, engines, steam turbines, hose, valves, fittings, accessories, etc., is warranted only for the period, and to the extent, of the original manufacturer's warranty, and is subject to all of the terms and conditions of such warranty.

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