I. Installation

I-1. Introduction

This manual has been compiled not only for the care and maintenance of the DUOSEAL® pump now in your possession, but as a helpful reference and guide for many problems which are usually associated with mechanical vacuum pumps. Take time to read these instructions carefully and preserve this manual for future reference; we think it will be useful to you.

I-2. Unpacking

Carefully remove the pump from the shipping case and unfasten and remove the wooden skid. Preserve all paper work and inspection tags for future reference. If damage has occurred from shipment, a claim must be filed with the carrier immediately; preserve the shipping container for inspection by the carrier. If you are required to communicate with your dealer or with Welch Vacuum Technology, Inc., be sure to include your order numbers for quick identification. Do not return the pump to the factory without first calling for a returned goods number.

I-3. Pump Mounting

a) Mounted Pumps - Rubber bumpers are supplied with most of our mounted pumps, either loosely or attached. Bumpers are excellent for applications involving a semi-flexible surface such as a bench top; they help to isolate noise and eliminate creeping. For more rigid requirements, the pump base may be bolted directly to a firm foundation with or without the bumpers. Al DUOSEAL® pumps should be mounted in a horizontal plane.

I-4. Pump Location

The pump should be located preferably in a clean and well ventilated area, and adequate space should be provided wherever possible for routine maintenance such as changes of oil and belt adjustments and replacements. Above all, the pump should be located as closely as possible to its system in order to utilize it most efficiently. Its location should include such determining factors as though the length and size of connections, the number of bends and the type of exhaust connections.

I-5. Exhaust Provisions

Exhaust connections will be determined by the type of system to be exhausted and the desired cleanliness of the atmosphere surrounding the pump. Under normal conditions of mild evacuation, nothing more than the dust cap will be necessary to cover the port. Where relatively high gas flows are involved or where the presence of oil vapor is objectionable, an exhaust filter may be fastened to the exhaust port in place of the dust cap. The exhaust filters used on our pumps are capable of absorbing and restricting any vapor particle larger than 0.1 micron.

Warning: Never block the exhaust port. If the exhaust port is blocked, pressure will build up in the pump with the potential of the pump body bursting, causing possible injury to personnel in the area.

Where extreme exhaust conditions are encountered, it is best to pipe the exhaust directly out of the building. Welch recommends wire reinforced PVC, metal pipe or thick-walled rubber hose be be used as exhaust lines to avoid potential of line becoming crimped or collapsing, resulting in the exhaust port being blocked. Be sure to call Welch Technical Service prior to start-up at (847) 676-8800 if you have any questions.

I-6. Electrical Power

a) Power Source Review - Review the power source and the motor rating to be sure they agree in voltage, phase and frequency. On three-phase applications, the direction of rotation of the motor must be considered. Make a momentary check of rotation at the time of power installation and wiring. Momentary backward rotation of the pump is not harmful. Check the layout drawings for proper direction of rotation.

b) Overload Protection - Motor thermal overload protection is made by the motor manufacturer as an aid to minimizing motor failure. Overload protection is a standard feature on all single-phase 60 Hz motors. Single-phase motors will normally have automatic overload protection. Motors of 1-1/2 horse power or larger supplied with DUOSEAL® pumps contain no overload protection. Installations of such equipment must comply with local electrical codes which dictate appropriate starter and protection devices. It is strongly suggested that you familiarize yourself with the protection supplied with your motor so that you may react accordingly in the event of an emergency. Automatic reset protection is designed to rest itself after a predetermined cooling period. If the fault to the drive remains unaltered, the motor will cycle on and off until the fault is corrected. The motor data plate will indicate the presence of thermal protection.

I-7. Vacuum Connections

a) Choice of Connections - The choice of connections and fittings can have a very marked effect on the pumping speed at the vacuum chamber. Any connection placed between the pump and the chamber creates an impedance to the flow of gas. This is particularly true at low pressures in the millitorr range where the gas flow is substantially molecular in character. The gas flow is then dependent upon the kinetic activity of the molecules to bring it to the intake of the pump.

b) The Effects of Conductance - It has been shown that the conductance of a tube is proportional to the cube of its diameter and inversely proportional to its length. Therefore it is imperative that the connecting lines be as large in diameter and as short as in length as practical. For best results, the diameter of the connecting tube should be at least as large as the diameter of the pump intake. To avoid a large reduction in pumping speed at the

vacuum chamber, it is clear that the conductance of the line must be considerably greater than the speed of the pump.

c) Metal Joints - If metal piping or tubing is used, it is preferable to solder or braze all the connections. Where threaded joints must be used, coat the threads with Glyptal, LocTite Thread Sealant with Teflon, or Leak Lock and screw together tightly. Flanged connections with elastomer gaskets make excellent demountable joints. Modular vacuum piping and fittings are now extensively used.

d) Rubber Tubing Joints - Where metal tubing is used between the system and the pump intake, joints can be made by butting the ends of the two sections together in a short section of rubber vacuum hose. Worm-screw band clamps are useful for securing the hose to the tubing. Whatever the joint you choose to use, cleanliness should be of utmost importance.

e) Valves and Stopcocks - Metal valves or stopcocks may be used in the connecting line between the system and the pump to provide a means of isolating the pump from the system. To minimize the impedance of flow, the valve openings should be as large as possible. Lubricate the rotating plug of the stopcock with a film of vacuum grease thick enough to sufficiently prevent seizure.

I-8. Vacuum Gauges

The type of vacuum gauge to be used is determined largely by the pressure range to be measured. Pressures in the ranges produced by DUOSEAL® pumps can be covered by McLeod, Thermistor, Pirani or Thermocouple gauges. The McLeod gauge is used where high accuracy of measurement is required. The Pirani, Theristor and Thermocouple gauges are electrical and give continuous readings of the total pressure. They are preferred where rapid pressure changes occur. The McLeod gauge does not measure condensable vapors; therefore, if vapors are present, it will generally read lower in pressure than electrical gauges. For higher vacuums in systems employing diffusion, turbo-molecular or ion pumps, the hot filament ionization of the Philips gauge is used.

I-9. Traps

a) The Need for a Trap - Where corrosive vapors or large quantities of condensable vapors are evolved from vacuum processing, a cold trap may be used in the connecting line to the pump. It will help prevent damage to the pump mechanism and reduce oil contamination. The cold trap, immersed in a suitable Dewar flask, is installed so that the vapors may come in contact with the surfaces of the trap and condense. Commonly used refrigerants are liquid nitrogen or dry ice and acetone. The refrigerant to be used depends upon the freezing point of the contaminants. A variety of cold traps are available from Welch Vacuum Technology, Inc.

b) The Care of a Trap - When using a cold trap, the refrigerant should be maintained at a high level in the flask to keep the trap at a uniformly low temperature. If the trap is rewarmed, it may allow re-evaporation of the condensate. The refrigerant add tube on the liquid nitrogen trap should not be obstructed as the refrigerant boil-off can produce dangerously high pressures. If the trap becomes saturated, it should be disconnected from the system, drained and cleaned. An increase in pressure in the vacuum system will normally indicate that the trap has become saturated. To clean the trap, remove the trap from the system, allow the trap to warm up and rinse off the condensate with a suitable solvent in a fume hood. Thoroughly clean and dry the trap before re-installing in the system.

I-10. Types of Lubricants

All DUOSEAL® mechanical vacuum pumps are normally tested with DUOSEAL® oil and shipped with a full charge to prevent unnecessary contamination. An additional supply of oil is furnished with each pump with instructions to drain and discard the oil contaminated in the pump and replace with the fresh oil. DUOSEAL® oil has been especially prepared and is ideally suited for use in mechanical vacuum pumps because of its desirable viscosity, low vapor pressure and chemical stability.

The vacuum guarantee on all DUOSEAL® pumps applies only when DUOSEAL® oil is used. Other lubricants for special applications are available including various lubricants for oxygen compatibility, lubricants for use with diffusion pumps as well as other special requirements.

II. Operation

II-1. Starting Procedures

a) Starting a DUOSEAL® Pump - Before attaching the pump to a system, it is well to familiarize yourself with the functions and action of the pump which you have now acquired. Remove the intake and exhaust port plugs and temporarily provide a stopper for the intake and a dust cap for the exhaust. Review the power requirements as described in Paragraph I-6.

b) Cleanliness - Take every precaution to prevent foreign particles from entering the pump. A fine mesh screen is provided for this purpose in the intake passage of all DUOSEAL® pumps.

c) Oil Level Determination - The amount of oil suitable for efficient and satisfactory performance should be determined after the pump has reached its operating temperature. Initially, however, the pump should be filled with fresh oil while the pump is idle. Fill the pump until the oil level falls half way of the oil level window. If after a short period of operation, the level should fall, it is likely the the result of oil entering some of the interior pockets of the pump. If the oil level rises, this signifies oil had drained into the pump cavity while idle. Shut off pump, then drain oil down to proper leve.

If a gurgling sound occurs, additional oil must be added. Mechanical pumps will gurgle in varying degrees under four conditions of performance: (1) when operating at high pressure as in the beginning cycles of evacuation of a chamber; (2) when the oil level in the pump reservoir is lower than required; (3) when a large leak is present in the system; and (4) when the gas ballast is open. Awareness of the possibilities will save time in setting up a system. Best performance of a mechanical pump is generally obtained after sufficient time has been allowed for the pump to come to operating temperature.

II-2. Leak Detection

a) Large Leaks - The importance of eliminating all leaks in a vacuum system is obvious when it is realized that a leak onto the system, at atmospheric pressure, expands in volume by a factor of 750,000 to 10,000,000 or more. The pump must remove this added volume to maintain the desired vacuum. Fortunately, a number of effective techniques for leak detection have been developed. Large leaks can be located by pressurizing the system and painting the suspected area with a thick soap solution. Escaping air will produce soap bubbles.

b) Small Leaks - Small leaks may also be detected by spraying a suspected area with acetone or gases rich in hydrogen, and observing a sudden change in pressure on an electrical gauge. The difference in calibration of these gauges, for air and other gases, will produce a distinct change in the pressure reading. To use this method of detection, the system must be under vacuum and the gauge sensing tube must be located between the pump and the area to be probed. Use extreme caution, as these materials are highly flammable!

c) Fine Leaks - Locating very fine leaks requires a helium-sensitive, mass-spectrometer leak detector. This instrument will locate leaks which cannot be detected by any other method. Numerous fine leaks can have the total effect of a large leak.

II-3. DUOSEAL® Shutdown Procedure

A few simple precautions are all that is necessary when a shutdown is in order. If a gauge is connected to the system, first isolate the gauge, then turn off the power and open the system to atmosphere. If the pump is removed from the system, cover the intake port with a rubber stopper or suitable cover to protect the pump against contamination and loose particles. If the pump has been contaminated in service and is going to be shelved for a prolonged period, it is best to drain the oil and refill with a fresh charge.

II-4. The Principle of Gas Ballast

a) The Effects of Unwanted Vapor - Systems which contain undesirable vapors cause difficulty from both the standpoint of attaining desirable ultimate pressures as well as contamination of the lubricating medium. A vapor is defined as the gaseous form of any substance which is usually a liquid or a solid. Water, oil and mercury vapors are three of the more common vapors encountered in typical vacuum systems. When such vapors exist in a system, the vapors or mixtures of gas and vapor are subject to condensation within the pump; the precipitated liquid may thus ultimately dissolve or become emulsified with the lubricating medium. This emulsion is recirculated to the chambers of the pump where it is again volatized, causing increased pressure within the system.

b) The Presence and Removal of Condensate - Condensation takes place particularly in the compression stroke of the backing or second stage of a two-stage pump. The compression stroke is that portion of the cycle during which the gas drawn from the intake port is compressed to the pressure necessary to expel it past the exhaust valve. Condensation takes place when the ratio between the initial pressure and the end pressure of the compression is high, that is, when the mixture of vapor and gas drawn from the intake port is compressed from a low pressure to a high pressure. By adding air through the gas ballast valve to the mixture of vapor and gas being compressed, the pressure required for delivery past the exhaust valve is reached with a considerably smaller reduction of volume of the mixture; thus, depending upon the amount of air added, condensation of the vapor is either entirely avoided or substantially reduced.

c) Pump Function Without Gas Ballast - In a pump functioning on a contaminated system and operating without the gas ballast, compression within the stage takes place in the normal manner until the saturation pressure of the contaminating vapor contained within the mixture of gas and vapor is reached. The saturation pressure of water vapor is that pressure and corresponding temperature at which the dew point of the vapor is reached and condensation occurs. The saturation pressure of water vapor at an ambient temperature of 20C is 17.5 torr, while at 60C, the approximate operating temperature of a pump, the saturation pressure is 149 torr. The external side of the exhaust valve is subjected to atmospheric pressure. Consequently, a compressive force somewhat greater than atmospheric pressure is required to open the valve and permit expulsion of the gas. Sometime during increased compression of the mixture of gas and vapors, the saturation pressure of 149 torr. for the water vapor is reached and the vapor condenses. The condensate is then allowed to emulsify with the oil which is recirculated within the pump stages, thus providing continued contamination of the system.

d) Pump Function with Gas Ballast - On the other hand, when ballast air at atmospheric pressure is supplied to the compression stroke by means of the gas ballast, the partial pressure of the unwanted vapor becomes a very small part of the total pressure of the mixture of gas, vapor and newly supplied air. The vapor is thus prevented from reaching its saturation pressure corresponding to the temperature of the pump and is finally expelled from the pump as a vapor.

e) Controlled Ballast Flow - Some degree of variation in ballast flow may be obtained by the amount of opening applied to the gas ballast. Two or more turns of the gas ballast are sufficient to open it wide. With the gas ballast open, the sound of the exhaust is similar to that of a pump operating against a large leak. Because of the increased pressure introduced into the compression stroke, the pump must work a little hard to function, thus resulting in an increased operating temperature of approximately 8C over a prolonged period of time. Tests have shown that continuous and prolonged operation for several weeks under these conditions is not injurious to the pump.

f) Other Forms of Contamination Control - The application of the gas ballast is a moderate and very successful method for the removal of condensable vapors. For very heavily laden systems, other means of removal such as oil separators may be required. For mild cases of contamination, the simple expedient of a cold trap or change of oil may serve the purpose.

III. Maintenance

III-1. Vacuum Problems

a) Pressure Determinations - Leakage, contamination and unusual outgassing are the general causes of problems associated with poor vacuum. To operate at maximum efficiency a system must be thoroughly clean. If the system is completely clean and free from leaks, and unwarranted vacuum problems still exist, the pump should be checked. A simple criterion for the condition of a mechanical pump is a determination of its ultimate pressure capability. This can be accomplished by attaching a gauge directly to the pump. The gauge may be any suitable type provided consideration is given to the limitations of the gauge being used. Refer to Paragraph I-9 for further suggestions. If the pressure is unusually high, the pump may be badly contaminated, low on oil or malfunctioning. On the other hand, if the pressure is only slightly higher than the guaranteed pressure of the pump, an oil change may be all that is required.

b) Oil Contamination - The most common cause of a loss in efficiency in a mechanical pump is contamination of oil. It is caused by condensation of vapors and by foreign particles. The undesirable condensate emulsifies with the oil which is recirculated and subjected to re-evaporation during the normal cycle of pump activity, thus reducing the ultimate vacuum attainable. Some foreign particles and vapors may form sludges with the oil, impair sealing and lubrication and cause eventual seizure. A gas ballast valve is helpful in removing vapors, especially water, but it is not equally effective on all foreign substances; therefore, periodic oil changes are necessary to maintain efficient operation of the system. The required frequency of changes will vary with the particular system. Experience with the process will help you determine the normal period of operation before an oil change is required.

c) Oil Overheating - This pump is designed to operate continuously below 10 torr. Continuous operation of this pump above 10 torr. will lead to overheating and eventual pump failure.

III-2. Oil Changes and Oil Level

a) Draining the Pump - An oil change is most easily accomplished when the pump is warm and the oil is less viscous. Use a container large enough for the oil in the particular pump. Stop the pump, and open the drain valve. A thorough job may be accomplished by tipping the pump slightly if this is possible. The small residue remaining in the pump may be forced out by hand-rotating the pump pulley with the exhaust port partially closed and the intake port open. Closing the exhaust port completely under these conditions will create excessive pressure at the drain valve which may cause the oil being drained to splatter.

b) Flushing the Pump - After removing all the oil, close the drain and pour about four ounces of clean DUOSEAL® oil into the intake port. Open the exhaust port and operate the pump for about a a minute with the intake port alternately opened and closed to agitate and circulate the fresh oil. Again stop the pump, drain the flushing oil and force out the residue as before. The amount of flushing oil and the number of flushes will be determined by the extent of contamination and the color of the oil. Under no circumstances should anything other than DUOSEAL® oil be used for flushing a mechanical pump. The higher vapor pressures of other types of oil will cause difficulty later in the attainment of a high vacuum.

c) Refilling the Pump - After you are satisfied that the pump has been thoroughly flushed, refill the pump by pouring new DUOSEAL® oil into the exhaust port. Fill to the indicated level and start the pump with the intake closed. A gurgling noise is characteristic when high pressure air is draw through the pump. It should disappear quickly as the pressure within the pump is reduced. If gurgling continues, add sufficient additional oil through the exhaust port until gurgling ceases.

III-3. Shaft Seal Replacement

To replace the shaft seal of a pump, drain the oil and remove the pump pulley and key. Remove the screws securing the old seal and pry it loose with a screwdriver or similar wedge, being careful not to mar the surface of the pump body against which the seal fits. Discard the seal and its gasket, inspect all surfaces and repair any damages with a fine abrasive stone. Wipe all sealing areas clean and place a film of DUOSEAL® oil on both the shaft and the inside bore of the new shaft seal. using a new gasket, carefully slide the new seal into position and center it on the shaft. It is not necessary to apply any sealant to the gasket. Tighten the mounting screws uniformly and refill the pump with DUOSEAL® oil. Follow instructions included in repair kit.

III-4. Repairing Oil Leaks

a) Location, Cause and Effect - Oil leaks may develop wherever two mating faces are sealed with a gasket. Such seams may fail as the result of deterioration of the gasket material, loosening of the screws caused by temperature variations, or improper care as the result of previous reassembly. Typical gasketed seams in a mechanical pump are located at the oil level window, the shaft seal, the oil drain and the mating faces of such mechanical surfaces as the intake chamber cover. The importance of a gasketed seam is determined principally by its function. If it is a vacuum seal, the ultimate performance of the pump is dependent upon it. If it is an oil seal, the pump may be operated satisfactorily for some time without loss of function. Eventually, of course, a great loss of oil may cause harmful damage.

b) Repairing Technique - An oil seam may be sealed by any of several methods. When an O-ring is employed, the surfaces of the O-ring and its groove should be wiped clean. If the O-ring is not badly deformed or scratched, it may be reused by sealing with a slight film of vacuum oil or vacuum grease. Thin composition gaskets are generally used for large irregularly shaped areas. A replacement joint of this type should be thoroughly cleaned of all previous gasket material and the mating surfaces cleaned of any nicks.

III-5. Repairing Vacuum Leaks

a) Surface Preparation - Good vacuum seals are an essential and important attribute of a good mechanical pump. A good seal is dependent upon the quality of the mating surfaces as well as the sealant and its preparation. The mating faces should be carefully inspected for any projections or foreign particles which might interfere with proper mating. Slight projections such as nicks and burrs are most easily removed by rubbing with a fine abrasive stone. The surface of the mating parts may be washed with a solvent or alcohol after which they must be thoroughly dried.

b) Temporary Repair - temporary vacuum repairs are often made by covering the known leak with an industrial sealant such as Loctite with Teflon. Such a practice, however, is not recommended for seals of a permanent nature.

III-6. Drive Problems

If for any reason the pump will not operate, turn off the power and check the fuse and electrical connections. Then try the power to the motor only by removing the belt. If the motor operates properly try hand-rotating the pump in the proper direction with the pump intake port open. If both turn freely, then replace the belt and check the belt tension. The tension should be sufficient to drive the pump without visible slippage. Any greater tension will cause noise and possible damage to the bearings of both the motor and pump. Make certain that both pulley grooves are clean and free from oil. The pulleys must be fastened securely on their respective shafts, and in parallel alignment.

WARRANTY:

This Welch Vacuum Technology, Inc. product is warranted to be free from defects in material and workmanship. The liability of welch Vacuum technology, Inc. under this warranty is limited to servicing, adjusting, repairing or replacing any unit or component part which, in the judgement of Welch Vacuum technology, Inc., has not been misused, abused or altered in any way or damaged by ingestion of foreign material causing impaired performance or rendering it inoperative.

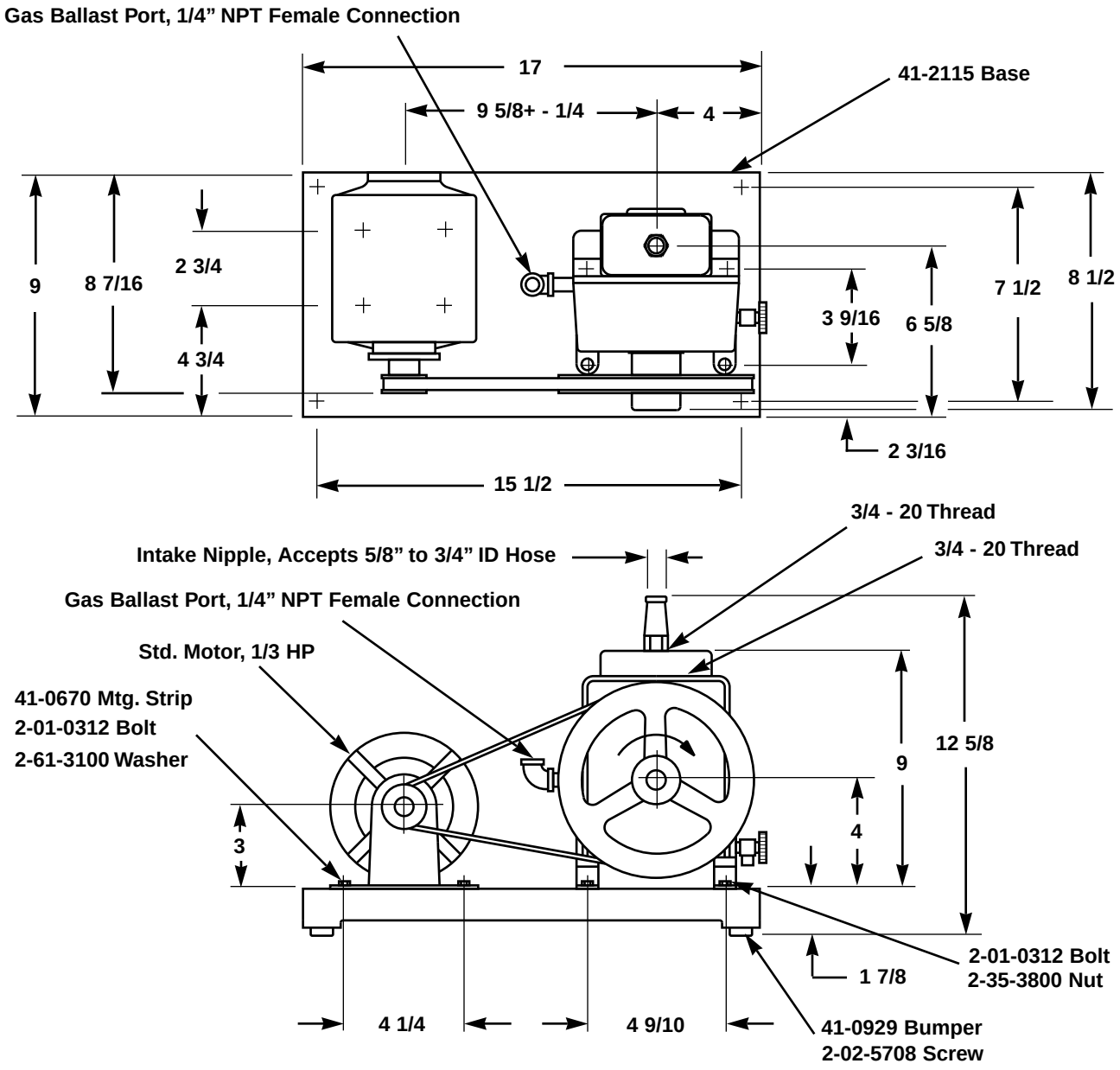
The warranty is effective for one year from the date of original purchase when:

1. The warranty card has been completed and returned.
2. The product is returned to the factory or other designated service centers, prepaid.
3. The product, in our judgement, is defective through no action or fault of the user.

If the product has become defective through misuse, abuse, alteration or ingestion of foreign material, repairs will be billed regardless of the age of the product. In this event, an estimate of the repair costs will be submitted and authorization of these charges will be required before the product is repaired and returned.

Motors supplied with pumps are guaranteed by the motor manufacturer for one year. While the company guarantees the complete unit, if a malfunction of the motor occurs, The motor manufacturer's local service branch should be contacted for immediate repair or replacement.

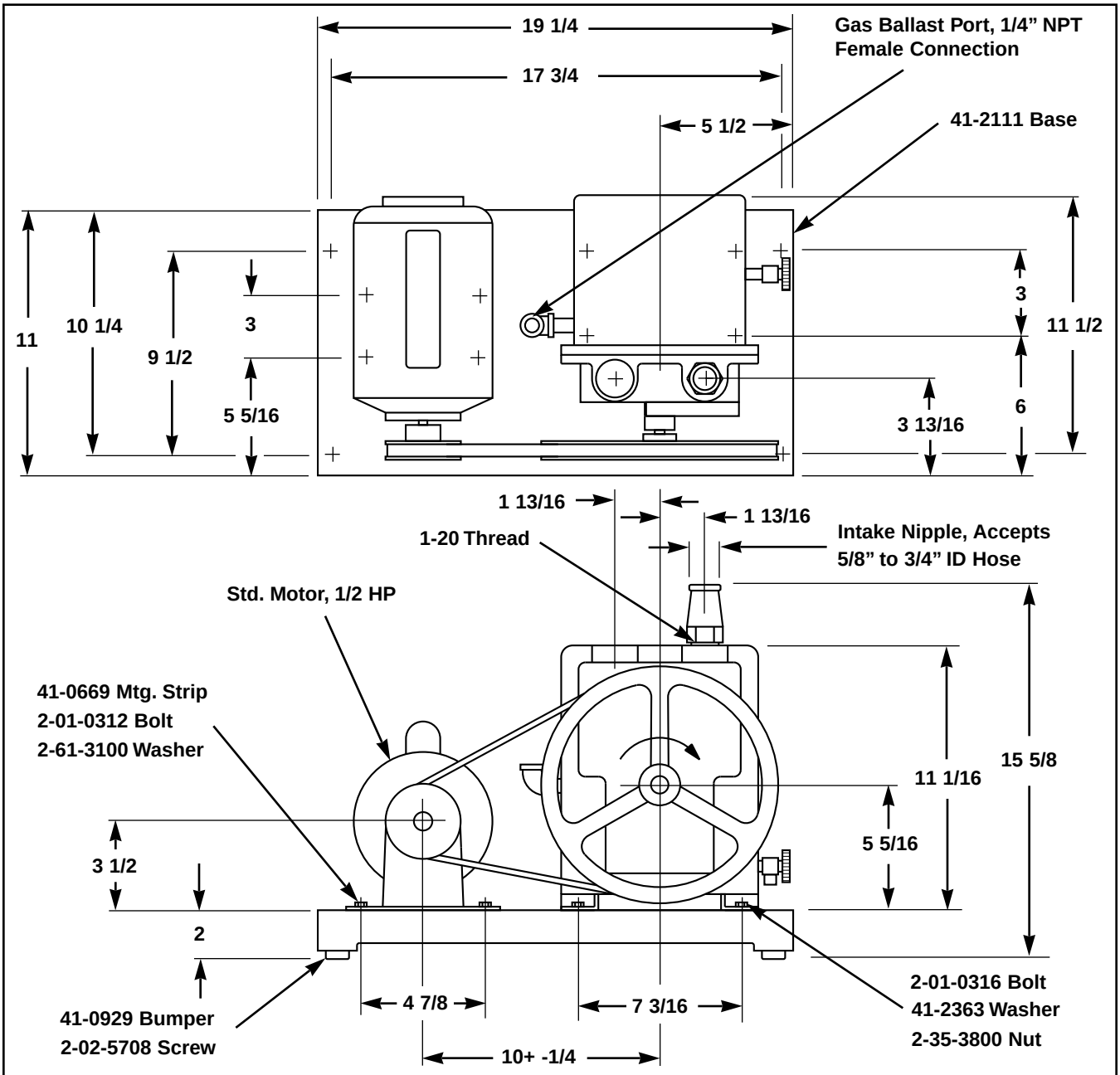
Model 1400 Vacuum Pump For York



SPECIFICATIONS:

Free- Air Displacement, L/M	25
CFM	0.9
Guaranteed Partial Pressure Blankoff, millitorr	0.1
Pump Rotational Speed, RPM	580
Number of Stages	2
Oil Capacity, qts	5/8
Net Weight, Pump Only, lbs	33
Net Weight, Mounted Pump, lbs	58
Shipping Weight, Mounted Pump, lbs	66

Model 1402 Vacuum Pump For York



SPECIFICATIONS:

Free- Air Displacement, L/M	160
CFM	5.6
Guaranteed Partial Pressure Blankoff, millitorr	0.1
Pump Rotational Speed, RPM	525
Number of Stages	2
Oil Capacity, qts	2 1/4
Net Weight, Pump Only, lbs	82
Net Weight, Mounted Pump, lbs	112
Shipping Weight, Mounted Pump, lbs	125

WARNING: Never Block The Exhaust Port. If the exhaust is blocked, pressure will build-up in the pump with the potential of the pump body bursting, causing possible injury to personnel in the area.

I. Introduction

I a. Scope

The material in this manual covers the operations required for complete disassembly, cleaning and repair and reassembly of your Welch DUOSEAL® Model 1400 vacuum pump. For routine maintenance procedures not requiring disassembly of the pump, please refer to the Owner's Manual.

The need for major repairs will be obvious if routine maintenance does not result in the performance of which the pump is capable, if the pump is "frozen" or heavily sludged, or if foreign particles have entered the pump. These instructions provide all the necessary information for the trained mechanic to effect the required repairs.

The entire instructions should be read over carefully before attempting any repairs. A thorough familiarity with all parts can be achieved by study of the exploded view drawing and parts list. Reread each step before proceeding with it.

I b. Use of Fixture

A simple assembly fixture (**Figure 1**) constructed from a wooden board to insure proper alignment of key parts. A 3/4 inch thick board with about at least one inch diameter hole and clamped to the work bench is satisfactory.

I c. Tools Required

1. Crescent wrench - 1/2", 10" long
2. Allen wrench - 5/32"
3. Allen wrench -3/16"
4. Screwdriver -1/4" blade
5. File, square -#4
6. File, Half-round -#4
7. Emery cloth, fine grit
8. Small ball-peen hammer
9. Rotor-puller
10. Lint-free rags
11. Oil cans
12. DUOSEAL® Pump Oil
13. Medium Indian stone - 1/2" sq. x 6" long, medium
14. Feeler gauge, 0.0015" thick
15. Loctite, pipe sealant with Teflon (Welch part no. 1-99-5282)

II. Disassembly Procedure

II a. General Considerations

The disassembly operation is not difficult and does not require any special skills. However, the order of procedure should be carefully followed and care exercised throughout not to mar or scratch the machined surfaces. Lay each part, as the disassembly proceeds, on a soft surface such as wood or rags.

Read over the entire instructions thoroughly before starting. Then reread each step through first before proceeding with it.

II b. Step-By-Step Procedure

1. Disconnect power and remove the pump from the vacuum system. Remove the four bolts securing the pump to the base. Slip the V-belt from the pulley. Stand the pump upright on the work bench.

2. Drain the oil. Remove the adapter (15) from the exhaust port. Rotate the pump pulley (2) clockwise by hand, while sealing the exhaust port in the oil case (14) with the thumb, to force out the residual oil from the pump stages.

3. Loosen the pulley set-screw (1) and slide pulley off the shaft. Remove the pulley key (5).

4. Place pump on bench with intake stage down. Remove the three fillister head screws (9) from shaft seal (3). Pry shaft seal housing (3) away from oil case with 2 screwdrivers, slide seal off shaft and remove gasket (4). The replacement seal includes gasket and screws. Stand pump upright on legs.

5. Remove the two hex head cap screws (31) and hex nuts (35) and washers (53) from the intake chamber (29). Tap chamber lightly with hammer on a leg to break the gasket seal. Lift off intake

Figure 1 - A simple assembly fixture

chamber (29), remove gasket (28) and filter screen (27).

6. Loosen and remove the hex head cap screws (41),(50) and copper washer (11) holding the oil case (14) to the center plate (25). To break the gasket seal between the oil case and the center plate, it may be necessary to tap the center plate at a bottom corner with a hammer.

7. Remove fillister head screw (9) washer (22), and exhaust baffle (56). Remove baffle stud (55) washer (22) and clock spring (21) from the top of the exhaust stator (42).

8. Place pump on wooden work fixture with the inlet-stage down and inlet port to the far side. Remove the four hex head cap screws (17) and washers (18) from the exhaust stator. The oil seal (44) and gasket (43) should be removed from the end plate (19) and discarded. Slide the exhaust end-plate (19) off shaft (6) by turning and lifting. Hold the vanes (40) together with the fingers as the stator is removed to prevent scratching of the bore.

9. Remove the two vanes (40), two vane springs (39) and slide the spring holder pin (38) through the rotor and shaft. Because of the suction of the oil film, it may be necessary to use a rotor-puller to remove the rotor (20). Other methods may damage the surfaces or edges. Remove the key (8).

10. Turn the pump over on the fixture, so that the intake stage is up and the intake port is to the far side. Remove the five hex head screws (34) from the intake end plate (32) with a hammer to break the seal. Lift off the cap.

11. Remove the five hex head cap screws 17) and washers (18) from the intake stator (36) and end plate (32). Tap the edge of the end plate with a hammer at a corner to break the seal to the intake stator and slide off of the shaft. Tap a corner of the intake stator (36) with a hammer to break the seal to the center plate (25) and lift off. Hold the vanes (40) together with the fingers, as the stator is removed.

12. Remove the two vanes (40), two springs (39), spring holder pin (38). Lift out the rotor and shaft assembly from the center plate. Slide rotor (37) off the shaft 6). Remove the key (8) from the shaft. Remove steel washer (26) from the shaft hole counter-bore.

III. Inspection, Cleaning and Repair of Parts

III a. Inspection of Parts for Defects

The pump is now completely disassembled. It is desirable to inspect for defects before cleaning as frequently the film oil will magnify the scratch or nick. Parts with heavy scoring or nicks should be discarded and replaced. Particular attention should be paid to the following:

1. Oil Case(14) - Remove all traces of the old gasket. Clean the interior thoroughly to remove grit, dirt and sludge and clean gasket sealing surface.

2. Stator Rings (36 and 42)- Inspect for scratches on bore and machined seal. Edges should be square, without nicks or burrs.

3. Rotors (20 and 37) - Inspect for scratches on bore and machined seal. Edges should be square, without nicks or burrs.

4. Vanes (40) - Examine the edges which contact stator, center and end plates for nicks and burrs.

5. Center and End Plates (25, 19, and 32) - Inspect lapped surfaces for scratches and nicks. Check for burrs in grooves and in shaft bores.

6. Shaft (6) - Check for burrs in holes and keyways, and scoring on periphery, especially around shaft seal area..

7. Shaft Bores - Check the fit of shaft in all shaft bores. Movement should be free but without side play.

8. Valve Seats - Check for burrs or nicks on valve seats, and for evidence of corrosion.

III b. Cleaning of Parts

Before repair of parts and assembly, all parts must be thoroughly cleaned. Clean parts in an ultrasonic cleaner. Heavy deposits of sludge may have to be scraped or brushed off. Use care not to mar surfaces. Dry completely - Use an air hose to dry crevices, holes, etc. and lay parts on clean, soft surface, free from dirt or grit. Reinspect parts for defects.

III c. Removal of Burrs and Scratches

The parts of DUOSEAL® pumps are machined to precise dimensional tolerances which must be maintained for optimum pump performance. Therefore reject all parts which are scored or nicked to the point that light lapping will not remove the defect.

Burrs may be removed by rubbing gently with a fine-grit stone. Do not break edges of rotors or stator rings. Scratches can be removed by light lapping with fine emery cloth. The rotor circumference is lapped by using a combination rocking and reciprocating motion on a flat emery cloth, frequently changing area of contact. The stator bore and machined seal are lapped by wrapping emery cloth around a piece of round stock and rotating lightly around the inner surface. Center and end plates, valve seats and rotor sides are lapped on a flat piece of cloth with a sliding-rotary motion.

The contact edges of the vanes are lapped by a sliding, light-rocking motion on flat emery cloth.

Prepare all replacement parts by the above methods prior to assembly. However, again clean all parts which were

deburred or lapped.

IV. Assembly of Model 1400 Pump

IV a. General Considerations

A number of considerations are important to the successful reassembly of the pump. Refer to exploded view of 1400 pump. Throughout the procedure, careful attention should be paid to the following:

Absolute cleanliness is necessary. Use air hose to remove dust and grit just prior to positioning of the part. Lubricate all fittings generously with clean DUOSEAL® Oil. Inspect each part again prior to assembly and check the fit with mating parts. Frequent rotational checks during assembly for freedom from binding can save unnecessary labor later.

Follow procedure exactly, reading each step carefully before starting operation. Have patience. Handle all parts with care. Use simple assembly fixture constructed from a wooden board used during disassembly, to insure proper alignment of key parts.

The assembly is made with the major plane of the parts horizontal. Throughout the procedure, the position of parts is referred to as far, near, left, right, up and down. These terms always mean the fixed position of the assembler in relation to the pump.

A number of the used parts should always be discarded and new parts ordered. These are gaskets, valves, valve springs, vane springs, exhaust stage oil seal and washer, and the shaft seal. In addition, it is recommended that all screws used to fasten the pump together be discarded and a new one utilized, because of the high stress to which they have been subjected in original assembly.

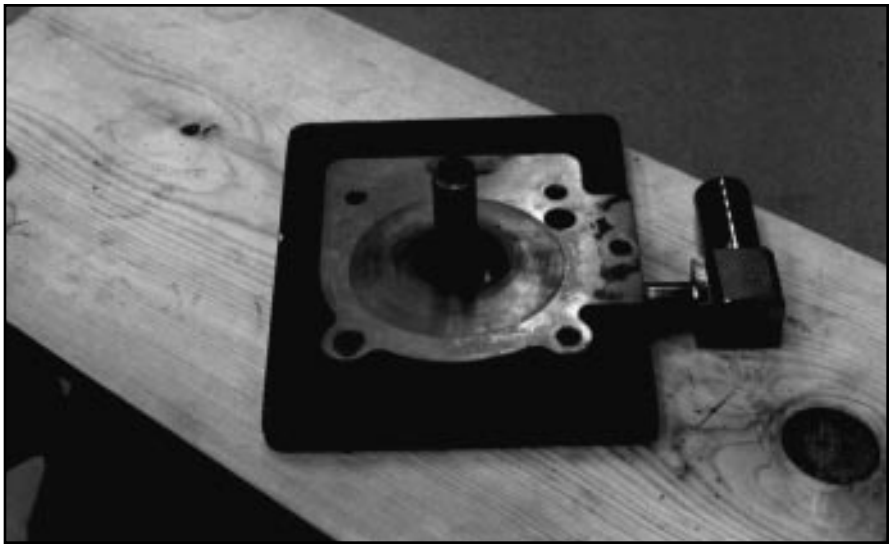


Figure 2 - Center Plate on The Work Fixture

IV b. Step-by-Step Procedure

1. Place the center plate (25) on the wooden work fixture. The counter-bore at the shaft hole should be up and half-moon opening of the counter-bore to the hollow center of plate to the far side (**see Figure 2**). Place the steel washer (26) in the counter-bore and oil with DUOSEAL® pump oil.

2. Insert the pulley end of the shaft (6) into shaft hole so that the retaining ring (7) on the shaft rests on the steel washer. Place rotor key (8) in the keyway on the shaft and slide the smooth- sided intake rotor (37) onto the shaft and against the center plate. Insert the spring holder pin (38) through the rotor and shaft and mount two new vane springs (39). Mount the vanes (40) on the spring in vane slots. Slide the vanes in and out of the vane slots, as shown in **Figure 3**, to check for binding. If binding of vanes in the slots is present, disassemble the rotor from he shaft, and lap the vane slots in the rotor lightly with the square file. Vanes should be flush with the rotor surface, when mounted.

3. Place the intake stator ring (36) on a

Figure 3 - Inserting the Vanes in the Rotor Slot

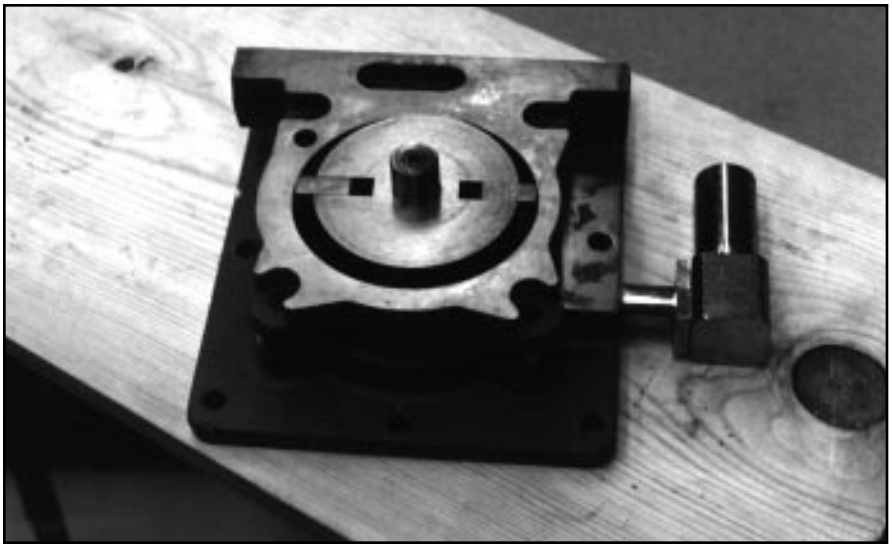


Figure 4 - View of assembled Intake Stator

clean surface on the bench so that the machined face which contains the exhaust port is up. (**see Figure 4**). Coat this face evenly with a thin film of the sealant, wiping away any which gets onto the surface of the stator bore or into the exhaust port opening.

4. Mount the intake stator (36) on the center plate (25) so that the coated surface is down and the flat machined side containing the intake port is to the far position. In mounting the intake stator ring, hold the vanes together with the fingers to prevent scratching. Turn the stator on the center plate to smooth out the sealant and align screw holes with the center plate holes. Wipe away any excess sealant with a clean rag.

5. Oil the stator bore, vane slots, and rotor shaft bore with DUOSEAL® pump oil. Apply sealant, as before, to the exposed face of the intake stator (36), wiping away excess from the stator bore.

6. Oil the shaft hole of the intake end plate (32) and slide onto the shaft and against the stator, with the machined surface down and the oil slot in the shaft hole to the far side. Turn the end plate on the stator to smooth out the sealant and line-up the screw holes with the screw holes in the stator. Insert five hex head cap screws (17) with washers (18) through the end plate and stator and thread into the center plate. Run down evenly, leaving slight play between the parts (About 1/2 turn).

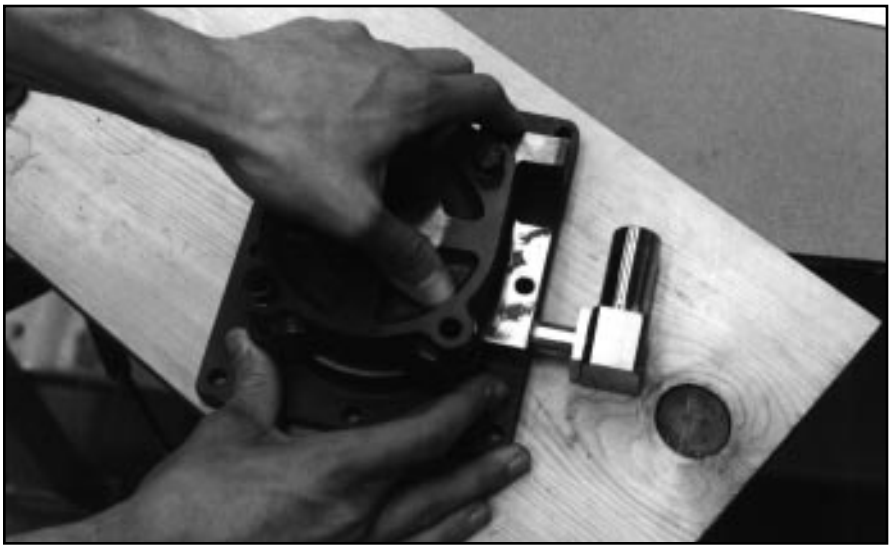


Figure 5 - Center the Intake Stator

7. Positioning of the stator and end plate with respect to the rotor and shaft is the most critical part of the assembly. Proceed slowly, and carefully. Study the reference figures. Center the stator against the rotor at the seal located in the far position, as shown in **Figure 5**.

Holding the stator tightly against the rotor at the seal with the fingers of one hand, move the near side of the stator to the right and left to locate the midpoint. Hold the stator tightly in this position.

Center the end plate with respect to the shaft bore and screw holes and hold in position with the thumb at the shaft. (**See Figure 6**). Tighten the cap screws evenly and thoroughly. Wipe away excess sealant.

8. Oil the end of the shaft. Apply a thin coating of the sealant to the shaft end cap (33), machined surface down, against the end plate and turn to smooth out sealant. Align screw holes and fasten tightly with five fillister head screws (34). Wipe away excess sealant.

9. Set pump upright on the workbench. Mount the pulley key (5) and pulley (2) on the shaft. The sealant must be flushed from the interior of the intake stage as quickly as possible to prevent "freezing" of the stage. This is accomplished by feeding small quantities of DUOSEAL® oil through the intake port as the pulley is rotated clockwise. The oil-sealant mixture will be ejected out and may be collected in a pan or on rags. Plug the intake port on the intake stator with the thumb while rotating the pulley to aid in circulating the oil through the intake stage.

Continue flushing action until ejected oil is clean. Check mounting of the intake stage by slowly rotating the pulley clockwise to sense the friction. Movement should be uniform and without tight spots or noticeable clicks. If the movement is not uniform, remove the pulley and key and remount the pump on the fixture. Loosen the five cap screws (17) and reposition the stator (36) and end plate (32) per the procedure in step 7. (Do not lift stator from the center plate as this will break the seal and complete disassembly and recleaning would be necessary). Recheck for friction as described above. Remove the pulley and key.

Figure 6 - Center the End Plate

10. Place the pump on the work fixture with the intake stage down and the intake port to the far position, as shown in **Figure** 7. Insert rotor key (8) in shaft keyway. Clean face of the center plate with air hose or clean rag. Slide exhaust rotor (20) over the shaft and against the center plate. The diametrically opposed oval recesses on one side of the rotor must face the center plate. Insert spring holder pin (38) through the rotor and shaft, mount two new vane springs (39) on pin and two vanes (40) on the springs and pin in the vane slots. Slide vanes in and out of the slot to check for binding. If friction is present, lap vane slots of rotor with square file as directed in Step 2. Vanes should be flush with surface of the rotor.

11. Mount the exhaust stator (42) over the rotor and against the center plate (25) so that the flat machined edge is in the far position and exhaust port in this surface is to the left, as shown in **Figure 8**.

12. Oil stator bore, vane slots and rotor shaft bore with DUOSEAL® pump oil.

13. Place a gasket (43) in the shaft hole counter-bore of the exhaust end plate (19). Mount a new oil seal (44) in this counter-bore. This can be pressed in conveniently by use of the mallet or block of word and a hammer. Oil the inner surface of the oil seal and slide the end plate (19) onto the shaft with the machined face down and the oil slot in the shaft bore to the far position. Align the screw holes with those in the stator, insert four hex head cap screws (17) with washer (18) and thread into the center plate, leaving slight play between the parts.

14. Positioning of the exhaust stator, rotor, and end plate, is also critical. Proceed carefully according to the directions in Step 7. Tighten screws uniformly and thoroughly. By means of the pulley (2) and key (95), rotate the pump clockwise to check for freedom from binding. Repeat the repositioning procedure if the movement is not uniform and free from tight spots. Remove the pulley and key.

15. Place exhaust spring valve (21) and washer (22) on top of exhaust stator (42) and fasten with the baffle stud (55). The valve should be bent slightly approximately 1/3 of length from screw hole. Position so that tightening of the screw will flatten the spring against the valve seat. Install baffle (56) over stud (55) using a fillister head screw (9) and wash-

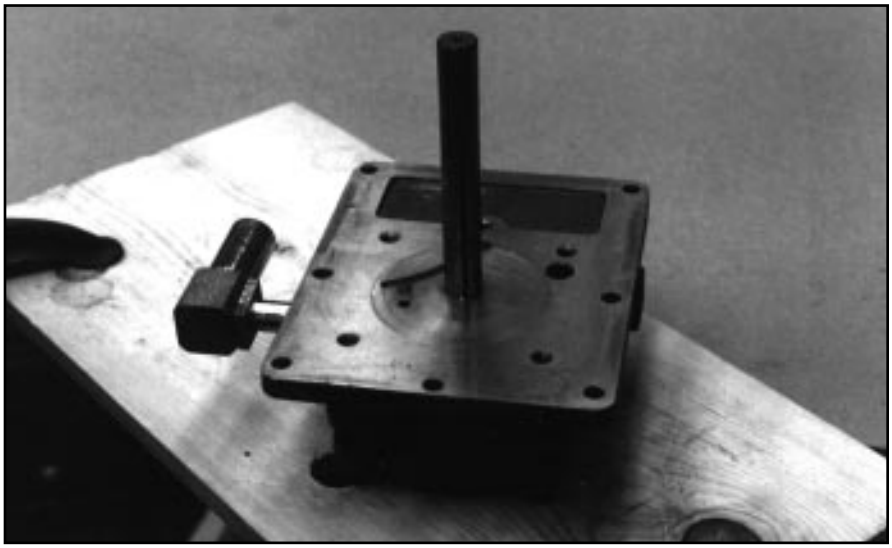


Figure 7 - Pump on Fixture

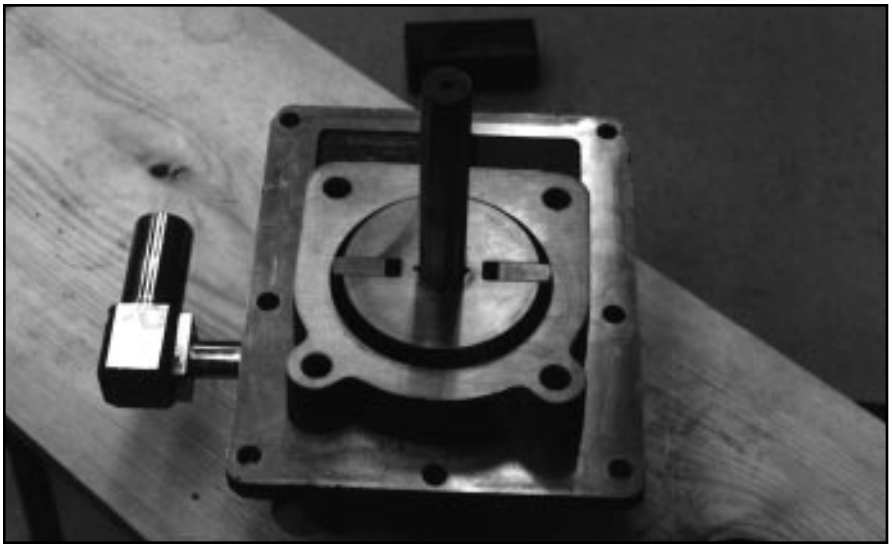


Figure 8 - Mount the Exhaust Stator over the Rotor

er (22). A properly installed baffle should be centered over exhaust valve (21).

16. Put in place a new oil case gasket (16) and place in position on the center plate, carefully aligning screw holes and smoothing out. Oil shaft hole of oil case (14) and slide case over shaft against the center plate. Align screw holes and insert hex head cap screws(41) and (50) with copper washer (11) from below center plate and thread tightly into the oil case.

17. Place shaft seal gasket (4) over the shaft and in position on oil case. Do not cement. Lubricate inner surface of shaft seal (3) with DUOSEAL® oil. Carefully slide shaft seal over shaft with mounting flange towards the oil case. Push against case and align screw holes. Fasten tightly with three fillister head screws (48).

18. Stand pump upright on legs on the bench. Place air filter screen (27) in the intake port. Place a new intake chamber gasket (28) in position on the intake stator (36). Mount intake chamber (29) on the intake stator and fasten tightly in place with two hex head cap screws (31) and washer (53) and two hex nuts (35).

19. Insert pulley key (5) in shaft keyway, slide pulley (2) onto shaft and tighten set screw (1). Flush the pump with repeated fillings of 3-4 ounces of new DUOSEAL® oil until any remaining sealant or other foreign matter is removed. Pump should be filled to normal level with DUOSEAL® oil.

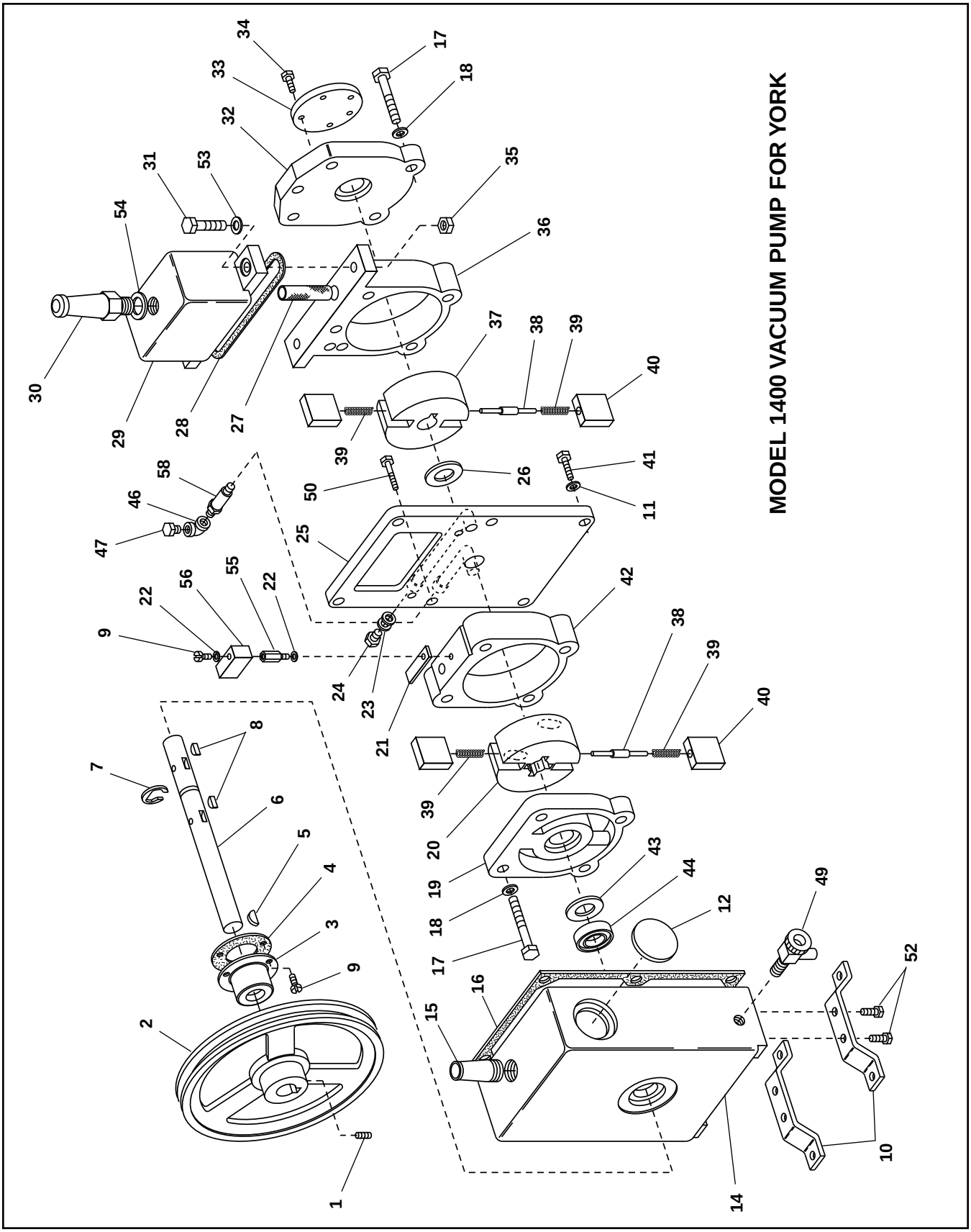
V. Performance Check

It is desirable to run-in the pump after reassembly before making the final performance check. If no major parts, such as stator rings, rotors, and vanes were replaced, on or two days should be sufficient. If new major repair parts were used, a three to four days run-in is recommended. The run-in should be made with the intake of the pump closed. After run-in, drain and replace the oil with new DUOSEAL® pump oil.

The gurgling noise characteristic of oil-sealed pumps, when pumping against high pressures, should disappear in 20-40 seconds, with intake closed. If it does not, check that oil is at the proper level with pump running. With oil at proper level, a continuous gurgling noise indicates misalignment of valves or air leakage. Check the tightness of screws (17) holding intake stage to the centerplate. See the Owner's Manual for a thorough discussion of valve misfunction and adjustment.

With the pump operating properly and at operating temperature, the vacuum performance can be checked by connecting a suitable vacuum gauge directly to the intake. The Welch vacuum performance of 0.1 micron Hg is based on measurement of the ultimate vacuum by an upright, untrapped McLeod gauge. Electronic gauges, such as the Pirani or Thermocouple, can also be used. As these gauges measure condensable vapors as well as the permanent gases, they will indicate a higher or total pressure reading, in the order of 5 to 15 microns Hg.

A properly repaired pump, after run-in should demonstrate an ultimate vacuum equal to or approaching that of a new pump.


MODEL 1400 VACUUM PUMP FOR YORK

PARTS LIST - MODEL 1400 VACUUM PUMP FOR YORK

ITEM	QUAN.	PC. NO.	DESCRIPTION
1	1	2-01-9306	Socket Head Set Screw 5/16-18x3/8
2	1	41-2191	Pulley inc. Set screw, Item 1
3	1	1401E	Shaft Seal, incl. Gasket, Items 4 & 9
4	1	41-0643	Shaft Seal Gasket
5	1	41-0624	Pulley Key
6	1	41-1060	Shaft
7	1	41-1150	Retaining Ring
8	2	41-0613	Woodruff Key
9	3	2-00-2705	Screw, Steel Fil. Hd. 10-32x5/16
10	2	41-1049	Leg
11	6	41-1138	Washer, Copper 7/16 OD
12	1	41-3753	Oil Sight
14	1	41-2078	Oil Case*
15	1	61-8503A	Adapter, 3/4-20x1/2”NPT
16	1	41-1052	Oil Case Gasket
17	9	2-01-0332	Hex. Steel Cap Screw 5/16-18x2
18	9	41-2363	Washer
19	1	41-1045	Exhaust End Plate
20	1	41-1040	Exhaust Rotor
21	1	41-1239	S.S. Exhaust Valve
22	2	2-71-0040	Brass Washer #10
23	8	41-1056	Aluminum Washer
24	1	41-1039	Vented Exhaust Plug
25	1	41-1044	Center Plate
26	1	41-1285	Steel Washer
27	1	41-0890	Air Filter
28	1	41-0383	Gasket
29	1	61-8478B	Intake Chamber
30	1	41-1274	Hose Barb. 5/8-3/4” ID Hose
31	2	2-01-0524	Hex. Steel Cap Screw 3/8-16x1/2
32	1	41-1055	Intake End Plate
33	1	41-1255	End Cap
34	5	2-00-0708	Hex. Hd. Steel Screw 10-32x1/2
35	2	2-31-2521	Hex. Steel Nut 3/8x16
36	1	41-2563	Intake Ring
37	1	41-1041	Intake Rotor
38	2	41-1063	Spring Holder
39	4	61-8550A	S.S. Vane Spring
40	4	41-1059	Vane (Metal)
41	6	2-01-0112	Hex. Hd. Steel Cap Screw 1/4-20x3/4
42	1	41-1042	Exhaust Ring
43	1	41-0056	Gasket
44	1	41-0578	Seal
46	1	61-8512	Elbow, 90 Degree
47	2	61-8510	Pipe Plug, 1/4”NPT
49	1	41-1734	Drain Valve
50	1	2-01-0120	Hex. Hd. Steel Cap Screw 1/4-20x1/4
52	4	2-01-0308	Hex. Hd. Steel Screw 5/8-18x1/2
53	2	2-61-0571	Steel Washer .071 Thick x 3/8 ID
54	1	41-0409	Aluminum Washer
55	1	61-834A	S.S. Baffle Stud
56	1	61-8347B	S.S. Exhaust Baffle
58	1	61-8491A	Adapter, 1/2-20x1/4”NPT
59	1	41-2757	Lock Nut
		1-99-5282	Sealant, 6 cc

*** Oil Case Assembly PT #41-1047 includes legs, item 12, oil sight, item12, oil case, item 14, screws, item 52 & drain valve, item 49.**

WARNING: Never Block The Exhaust Port. If the exhaust is blocked, pressure will build-up in the pump with the potential of the pump body bursting, causing possible injury to personnel in the area.

I. Introduction

I a. Scope

The material in this manual covers the operations required for complete disassembly, cleaning and repair and reassembly of your Welch Model 1402 vacuum pump. For routine maintenance procedures not requiring disassembly of the pump, please refer to the Owner's Manual.

The need for major repairs will be obvious if routine maintenance does not result in the performance of which the pump is capable, if the pump is "frozen" or heavily sludged, or if foreign particles have entered the pump. These instructions provide all the necessary information for the trained mechanic to effect the required repairs.

The entire instructions should be read over carefully before attempting any repairs. A thorough familiarity with all parts can be achieved by study of the exploded view drawing and parts list. Reread each step before proceeding with it.

I b. Use Of Fixture

A simple fixture constructed from wood 2x4 section (or similar) as illustrated in **Figure 1** may be very helpful.

I c.Tools Required:

1. Screwdriver, 1/4 in. blade
2. Box or crescent wrench, 1/2 in., 10 in. long
3. Box wrench, 1-1/4 in.
4. Allen wrench, 3/16 in.
5. Allen wrench, 7/32 in.
6. Allen wrench, 5/16 in.
7. Allen wrench, 7/16 in.
8. Nut driver, 1/4 in.
9. Socket wrench, 7/16 in.
10. Socket wrench, 1/2 in.
11. Pliers, locking-type
12. File 1/2 round #4
13. File, square, #4
14. Emery cloth, fine grit
15. Rod, metal, 1/4 in. diam. 10-12 in. long
16. Lint free rags
17. Oil can
18. DUOSEAL® Vacuum Pump Oil
19. Mallet
20. Rotor-Puller
21. Scraper (for removing gasket material)
22. Stone ("Indian" -1/2 in. sq. x 6 in. long, medium)
23. Feeler gauge, 0.0015 in. thick
24. Loctite, pipe sealant with Teflon (No. 59241)

II. Disassembly Procedure

II a. General Considerations

The disassembly operation is not difficult and does not require any special skills. However, the order of procedure should be carefully followed and care exercised throughout not to mar or scratch the machined surfaces. Lay each part, as the disassembly proceeds, on a soft surface such as wood or rags.

Read over the entire instructions thoroughly before starting. Then reread each step through first before proceeding with it.

II b. Step-By-Step Procedure: Numbers in Brackets Refer to Exploded View Diagram on Page 21

1. Disconnect power and remove the pump from the vacuum system. Remove belt guard. Remove the four bolts securing the pump to the base. Slip the V-belt from the pulley. Stand the pump upright on the work bench.

2. Drain the oil by opening the oil drain valve (59). Rotate the pump pulley (36) clockwise by hand, while sealing the exhaust port with the thumb, to force residual oil from the pump stages.

3. Loosen the pulley set screw (37), slide pulley (36) off shaft and remove key (64).

4. Lay pump on bench with oil case (53) down. Remove the three fillister head screws (77) from viton seal, slide off the shaft seal (71) and gasket (70) and discard these items. The replacement seal includes gasket and screws.

5. Remove the four socket head screws (41) from intake cover, use mallet to sep-

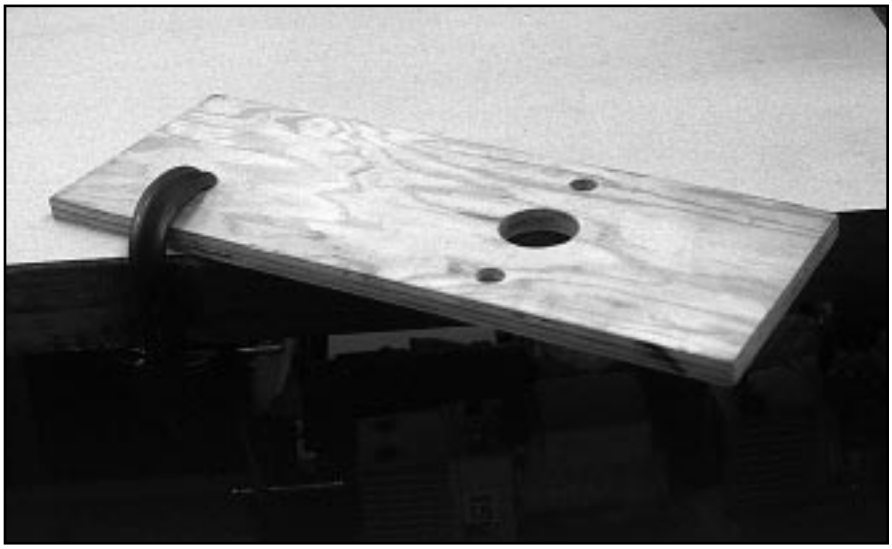


Figure 1 - Typical Fixture Made with Wood

arate plates and then lift off intake cover plate (38) and gasket (42). Remove air filter screen (69), hex head cap screw (44), washer (23) and air filter bracket (43).

6. Remove the three cap screws (44), and washers (23) which are within the recess of the cap casting with the socket wrench. (This will leave two cap screws on outside ribs of the casting still threaded into the intake stator).

Caution: Protect from damage by spreading rags below the pump.

7. Remove the ten hex head screws (68) and washers (67) which hold large end plate (66) to oil case (53), tap the upper corner of the large end plate with a mallet to break seal to the case. By means of the lock grip pliers, attached to the lower rib of the end plate casting, and the intake connection, lift the pump mechanism from the case. Set pump on work bench with the valves and intake connection up.

8. Remove all parts of the exhaust-stage pressure relief valve (21, 22, 23, 24, 25, 26, 28), the exhaust valve (40, 2, 39, 20) and intake-stage pressure-relief valve (3, 2, 10, 11, 8, 6, 5, 7, 4).

9. Set pump on work fixture with the large end plate (66) down and the intake connection (46) to the far left corner, (**see Figure 1**). Remove the three fillister head screws (12) and shaft end cap (27). Remove four remaining hex head cap screws (24) and washer (23) from the end plate (29) and turn plate to break suction and lift off.

10. Turn the exhaust stator ring (30) to break suction. In lifting it off, hold the vanes (33) together with the fingers to prevent scratching the vanes, stator or center plate.

11. Remove the two vanes (33), two vane springs (32) and slide spring holder pin (34) through rotor end shaft. Because of the suction of the oil film, it is necessary to use a rotor puller to remove the rotor (31). Other methods may damage the surfaces on edges. Remove the two rotor keys (62).

12. Remove the two socket head screws (19) and lift off the two center plates (17). This exposes the intake stage.

13. Remove the two remaining cap screws (44) and washers (23) from underneath the end plate.

14. Lift the intake stator (10) slightly off the end plate to break the oil film. **Use caution: sharp corners may cause injury to hands**. In lifting off, squeeze the vanes (35) together with the finders to prevent scratching the vanes, stator or end plate.

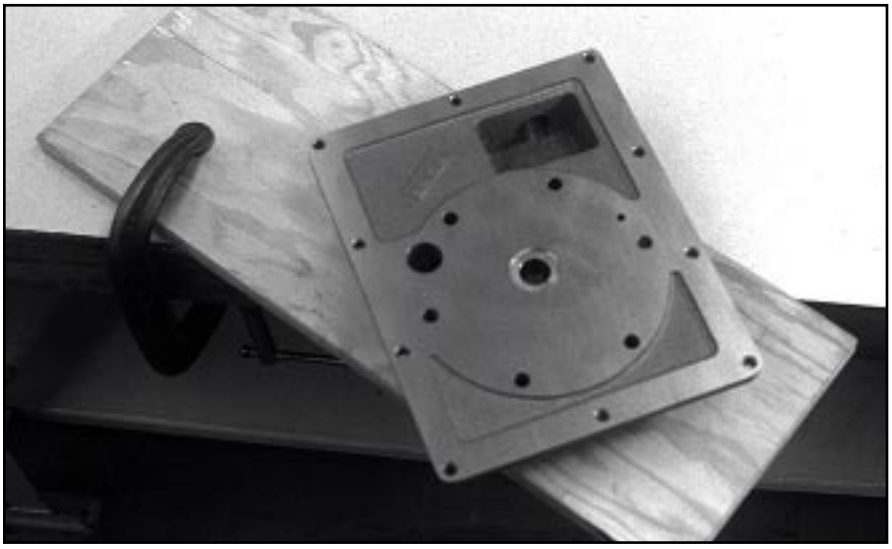


Figure 2 - Large End Plate on the Assembly Fixture

15. Disassemble the shaft and rotor by removal of two vanes (35) together with the fingers to prevent scratching the vanes, stator or end plate.

16. Remove the thrust washer (65) from the shaft hole counterbore.

III. Inspection, Cleaning and Repair of Parts

III a. Inspection of Parts for Defects

The pump is now completely disassembled. It is desirable to inspect for defects before cleaning, as frequently the film of oil will magnify the scratch or nick. parts with heavy scoring or nicks should be discarded and replaced. Particular attention should be paid to the following:

1. Oil Case (53) - Remove all traces of the old gasket. Clean interior thoroughly to remove grit, dirt and sludge and clean gasket sealing surface using a scraper.

2. Stator Rings (1 and 30) - Inspect for scratches on bore and machined seal. Edges should be square, without burrs.

3. Rotors (15 and 31) - Inspect circumference and slides for scoring. Edges should be square, without burrs.

4. Vanes (35 and 33) - Examine the edges which contact stator, center and end plates for nicks and burrs.

5. Center and End Plates (17, 29 and 66) - Inspect lapped surfaces for scratches and nicks. Check for burrs in grooves in shaft bores.

6. Shaft (63) - Check for burrs in holes and keyways, and scoring on periphery.

7. Shaft Bores - Check the fit of shaft in all shaft bores. Movement should be free but without side play.

8. Valve seats - Check for burrs or nicks

on valve seats and any evidence of corrosion.

III b. Cleaning of Parts

Before repair of parts and assembly, all parts must be thoroughly cleaned. Swab parts carefully in ultrasonic cleaner with a high vapor pressure solvent. Heavy deposits of sludge may have to be scraped or brushed off. Use care not to mar surfaces. Dry completely - Use air hose to dry crevices, holes, etc. and lay parts on clean, soft surface, free from dirt or grit. Reinspect parts for defects.

III c. Removal of Burrs and Scratches

The parts of DUOSEAL® vacuum pumps are machined to precise dimensional tolerances which must be maintained for optimum pump performance. Therefore, reject all parts which are scored or nicked to the point that light lapping will not remove the defect. Burrs may be removed by rubbing gently with a fine grit stone. Do not break edges of rotors or stator rings.

Scratches can be removed by light lapping with fine emery cloth.

The rotor circumference is lapped by using a combination rocking and reciprocating motion on a flat emery cloth, frequently changing area of contact. The stator bore and machined seal are lapped by wrapping emery cloth around a piece of round stock and rotating lightly around the inner surface. Center and end plate, valve seats and rotor sides are lapped on a flat piece of cloth with a sliding rotary motion.

The contact edges of the vanes are lapped by a sliding, light rocking motion on flat emery cloth. Shaft bores may be lapped carefully with a small half round file. Vane slots in rotors are lapped gently with a square file.

Prepare all replacement parts by the above methods prior to assembly. Again, clean all parts which were deburred or lapped.

IV. Assembly Procedure

A number of considerations are important to the successful reassembly of the pump. Throughout the procedure, careful attention should be paid to the following:

Absolute cleanliness is necessary. Use air hose to remove dust and grit prior to positioning part. Lubricate all fittings generously with clean DUOSEAL® oil. Inspect each part again prior to assembly and check the fit with mating parts. Frequent rotational check during assembly for freedom from binding can save unnecessary labor later.

Follow procedure exactly, reading each step carefully before starting operation. Have Patience. Handle all parts with care.

Use simple assembly fixture to insure proper alignment of key parts. **Figure 1** shows a typical fixture made of wood.

The assembly is made with the major plane of the parts horizontal. Throughout the procedure, the position of parts is referred to as Far, Near, Left, Right, Up and Down. These terms always mean the fixed position of the assembler in relation to the pump.

A number of the used parts should always be discarded and new parts ordered. These are gaskets, valves and valve springs, vane springs and the lip seal assembly. In addition, it is recommended that all screws used to fasten the pump together be discarded and new ones procured because of the high stress to which they have been subjected in original assembly.

IV b. Step-by-Step Procedure

1. Place the large end plate (66) on the assembly fixture with the machined surface up and the exhaust port cavity to the far right, as shown in **Figure 2**. Place thrust washer (65) in the shaft hole counter-bore and oil with DUOSEAL® vacuum pump oil.

Caution: Be sure there are no burrs on the thrust washer. Remove any burrs with emery paper. Failure to remove a burr will lead to rotor or end plate damage.

2. Place truarc ring (74) and woodruff key (640) on the shaft and slide the intake rotor to engage the key with the keyway in the rotor. Slide the rotor all the way to truarc ring. Insert pulley end of shaft into the shaft hole of the large end plate (66), so that the truarc ring seats in the shaft hole counterbore.

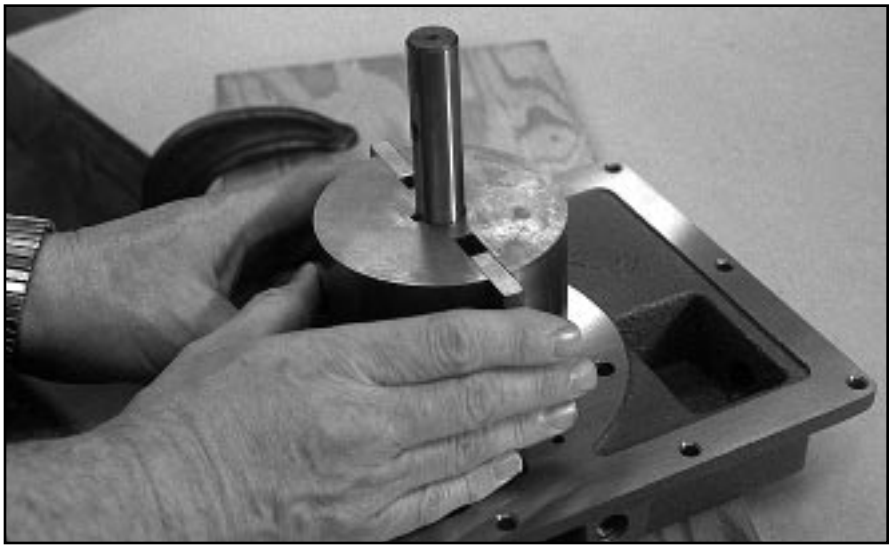


Figure 3 - Sliding Vanes out of Rotor Slot

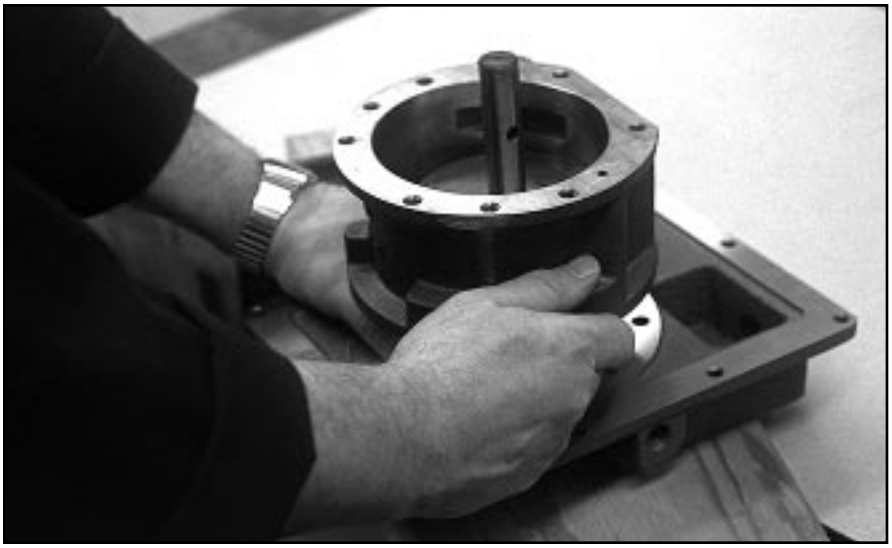


Figure 4 - Mounting Large Intake Stator Ring

3. Insert two spring holder pins (72) through the rotor and shaft, and mount four new vane springs (32). Place the vanes (35) on the springs and pins in the vane slots. Slide vanes in and out of the rotor slot to insure freedom from binding, as shown in **Figure 3**. Edges of the vanes should be flush with the rotor surface. The shaft should turn freely in the end plate.

4. Refer to **Figure 4**. Mount the large intake stator ring (1) over the rotor so that the intake port on the machined side of the ring faces the end plate and the exhaust ports are to the far right. In sliding the ring over the rotor, hold the vanes together with the fingers to prevent scratching of the bore.

5. Insert two hex head cap screws (44) and washers (23) from below the end plate through the two holes which are outside of the ribs of the casting. Thread into the stator ring and run up to leave a slight play between the stator and end plate (about 1/2 turn).

6. Proper positioning of the stator, rotor and shaft is the most critical part of the assembly. Proceed slowly and carefully as follows, with reference to **Figures 5** and **6**.

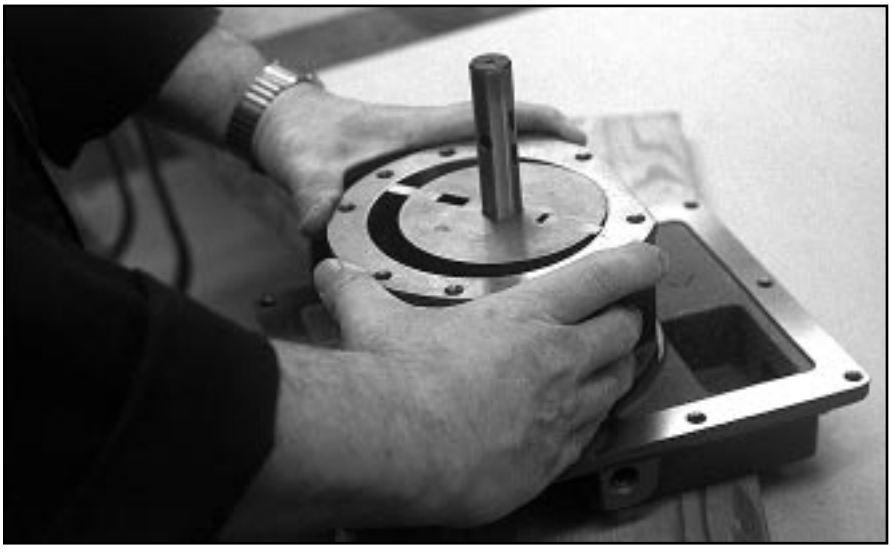


Figure 5 - Centering the Seal Machined in the Stator Bore on the Rotor

Center the seal machined in the stator bore on the rotor as shown in **Figure 5**. With the fingers of one hand press the stator gently against the rotor at the seal. With the other hand, move the near side of the rotor to right and left, to locate the mid-point position, carefully tighten the two cap screws (44).

To insure uniform seal contact a 0.0015 feeler gauge may be used. The gauge should not engage into either edge of the seal. (The balance of the cap screws will be inserted and tightened later.)

Check the assembly for proper alignment by inserting the 1/4 inch diameter metal rod through the hole near the end of the shaft and rotate slowly counter-clockwise. Movement should be uniform and free of tight spots or noticeable clicks. if the movement is not uniform, loosen the two cap screws and reposition the stator by the procedure described above.

7. Oil the bore of the stator, vane slots, and rotor shaft hole with DIRECTORR Gold vacuum pump oil.

8. Slide center plate (16) over the shaft and position on intake ring. The inlet port to the exhaust stage will be to the far left and the recessed groove running downwards to the right. (**See Figure 7**). Oil the center plate at shaft. Align the screw holes, insert two socket head cap screws (19) in the 4-O'Clock and 8-O'Clock positions, as shown in **Figure 7** and tighten to within 1/2 turn.

With the metal rod inserted through the shaft hole, rotate the shaft counter clockwise to check for binding, as described in Step 6. If the movement is not uniform, loosen the screws and reposition the center plates.

9. Place two keys (62) in the shaft keyways and slide the exhaust rotor (31) onto shaft and against the center plates. The face of the rotor which has two diametrically opposed oval recesses must face the center plates.

10. Insert the vane spring holder pin (34) through the rotor and shaft and mount two new vane springs (32). Place the two vanes (33) on the springs and pin, in the vane slots, slide the vanes in and out of slots to insure freedom from binding and check that vanes are flush with surface of the rotor.

11. Place the exhaust stator ring (30) over the rotor, with the flat machined edge to the far side and the exhaust port in this surface to the far right (**see Figure 8**). Hold the vanes together with the fingers as the stator ring is mounted, to prevent scratching of the inner bore. The surface of the rotor should be slightly below the face of the stator, as felt by a finger nail. Oil the inner surface of stator ring, vane slots, shaft hole and rotor with DUOSEAL® Pump Oil.

12. Mount the exhaust stage end plate (29) on the exhaust stator, machined face down, and with the slot in the shaft hole to the far side. Insert six hex head cap screws (24) with washers (23) and thread into the exhaust stator uniformly, leaving a slight play between the parts.

13. Positioning of the exhaust stage is also critical. Proceed slowly and carefully as follows:

Center the exhaust stator against the rotor at the machined seal which is in the far position, in the same manner as with the intake stage. Hold firmly in place while centering the end plate on the shaft and screws. While holding the stator gently against the seal with the fingers and the end plate in position with the thumb of one hand (**see Figure 9**), tighten the six cap screws uniformly and tightly.

14. Oil the end of the shaft with DUOSEAL® vacuum pump oil. Place end cap (27) in position, machined face down, insert three fillister head screws (12) and tighten uniformly.

15. Turn the pump over on the work fixture so that the inlet-exhaust end plate (66) is up. The inlet nipple will be to the far right. Place pulley key (64) and pulley (36) on the shaft and rotate slowly clockwise to check for freedom from binding and tight spots. If the movement is not uniform, relocate the exhaust stage as described in Step 13, remove pulley and key.

Figure 6 - Locating the Mid-Position

16. Mount the intake screen bracket (43) in position in the intake chamber, which is to the far right, place a small amount of sealant on threads and insert the remaining four hex head cap screws (44) and washers (23) into the end plate, thread into the intake ring and tighten uniformly and thoroughly. Place the air filter screen (69) in position on bracket.

17. Place a new intake gasket (42) in position on the pump. Mount the intake cover (38), insert four socket head cap screws (41) and tighten uniformly.

18. Place a new shaft seal gasket (70) in position on the pump. Carefully slide a new lip seal assembly (71) onto a shaft and against the pump. Align screw holes, insert and tighten equally by cross tightening fillister head screws (12).

19. Remove the pump from the fixture and stand upright on the workbench with

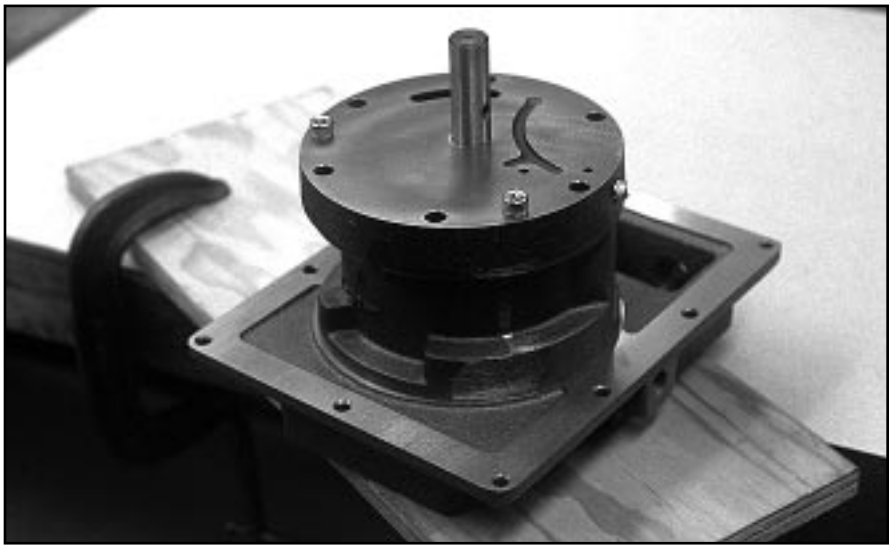


Figure 7 - Center Plate on Shaft

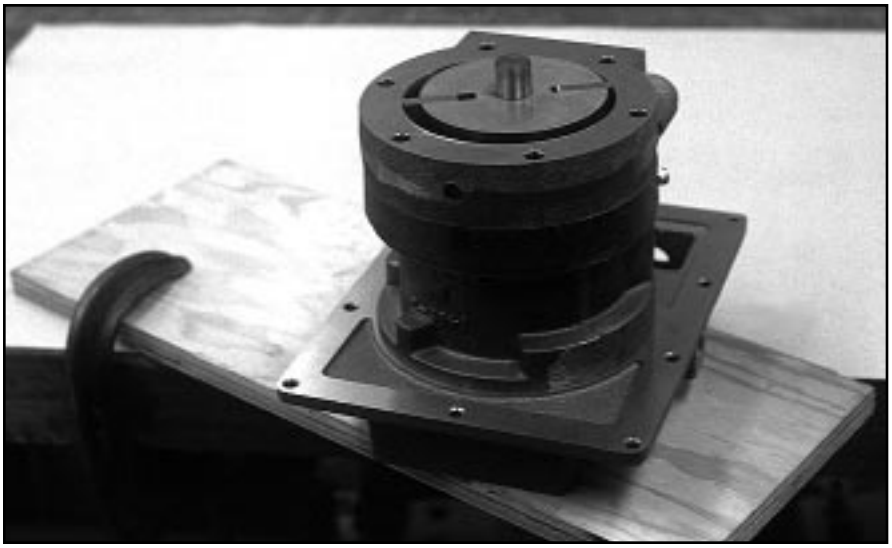


Figure 8 - Sliding Second Center Plate

the exhaust stage in the rear position. the pump is now ready for the assembly of the valves. A block of wood under the exhaust stage stator will level the pump.

20. The inlet stage pressure relief valve is mounted on the top of the inlet stator ring in the following order:

Thread the 1-3/4 inch headless screw (7) into the hold between the exhaust ports and tighten into the stator ring.

Place spacer (4) over the screw, seating on the stator ring.

Insert two valve springs (6) into the valve block (8) and a valve (5) into each spring. Place the valve block over the headless screws (7) and position valves over the exhaust ports.

Place lock washer (11) over the headless screw and partially thread hex nut (3) onto screw. Check alignment of valves over the exhaust ports and tighten hex nut while holding valve block in position with pliers.

Install headless screw 2-3/4 inch long (14) hex nut (3) and washer (2) into the other threaded hole of the inlet stator ring (1) and secure the nut (3). Thread another nut (3) on headless screw (14) several turns.

Mount the baffle (10) on the headless screw (14) adjusting the position of the supporting hex nut (3) to level baffle.

Thread on and tighten hex additional nut (3) and washer (2) to lock baffle in position.

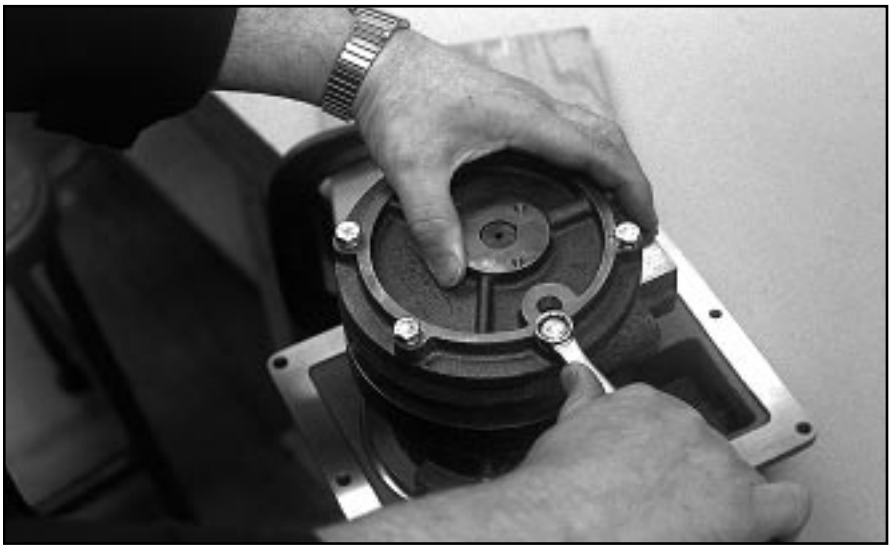


Figure 9 - Place the Exhaust Stator Ring over Rotor

21. The exhaust stage valve assembly is mounted on the machined top of the exhaust stator ring (30) in the following manner:

Place lower exhaust valve (20) in position on the stator ring. Place upper exhaust valve (39) which is bent slightly about 1/3 of the length from the mounting hole and positioned over lower exhaust valve so that tightening of the mounting screw (40) and washer (2) will flatten the spring against the exhaust port seat. Both valves should be centered over exhaust hole.

22. Assemble the pressure relief valve on the exhaust stage and plate (29) as follows:

Remove the two hex head cap screw (24) with washer (23) through the clock spring valve (22) and thread into the mounting hole at the 1 O'Clock position. Place steel ball (28) in the counter sunk hole near the 3 O'Clock position, center the valve over the ball and tighten the cap screw.

Remove the cap crew from the 3 O'Clock position. Place the front, dished half of valve cover (26) in position and reinsert the cap screw (24) with washer (23) and thread loosely into the pump. Insert three sheet metal screws (25) into hole in valve, cover and tighten. Thoroughly tighten the cap screw.

23. Place the oil case (53) on the bench with open side up and mounting feet towards you. Place a new gasket (48) in position, aligning screw holes and carefully smoothing out the gasket. It is helpful to insert two headless screws in diago-

nally opposed corner holes to act as mounting guides for the pump.

Place the pump assembly, exhaust stage down and intake nipple to the far side, on the bench. Securely attach a pair of locking pliers to the bottom rib of the inlet-exhaust end plate (66) at the left corner.

As in the disassembly procedure, lift pump by means of the pliers and the intake nipple and carefully lace into the oil case using the headless screws as guides.

Remove the headless screws, insert ten hex head cap screws (68) with lock washers (67) through the end plate and into oil case mounting flange. Tighten uniformly and thoroughly.

24. Set pump upright on its legs. Insert the gas ballast valve components (61, 50 , 58, 55 57, 52, 54, 18, 51).

25. Place key (64) and pulley (36) on the shaft and tighten set screw (37). Tighten drain valve (59) and fill pump to proper level with new DUOSEAL® vacuum pump oil through the oil fill port (9).

26. Remount pump on the base, place V-belt over pump and motor pulleys. Check pulley alignments and belt tension and adjust as necessary.

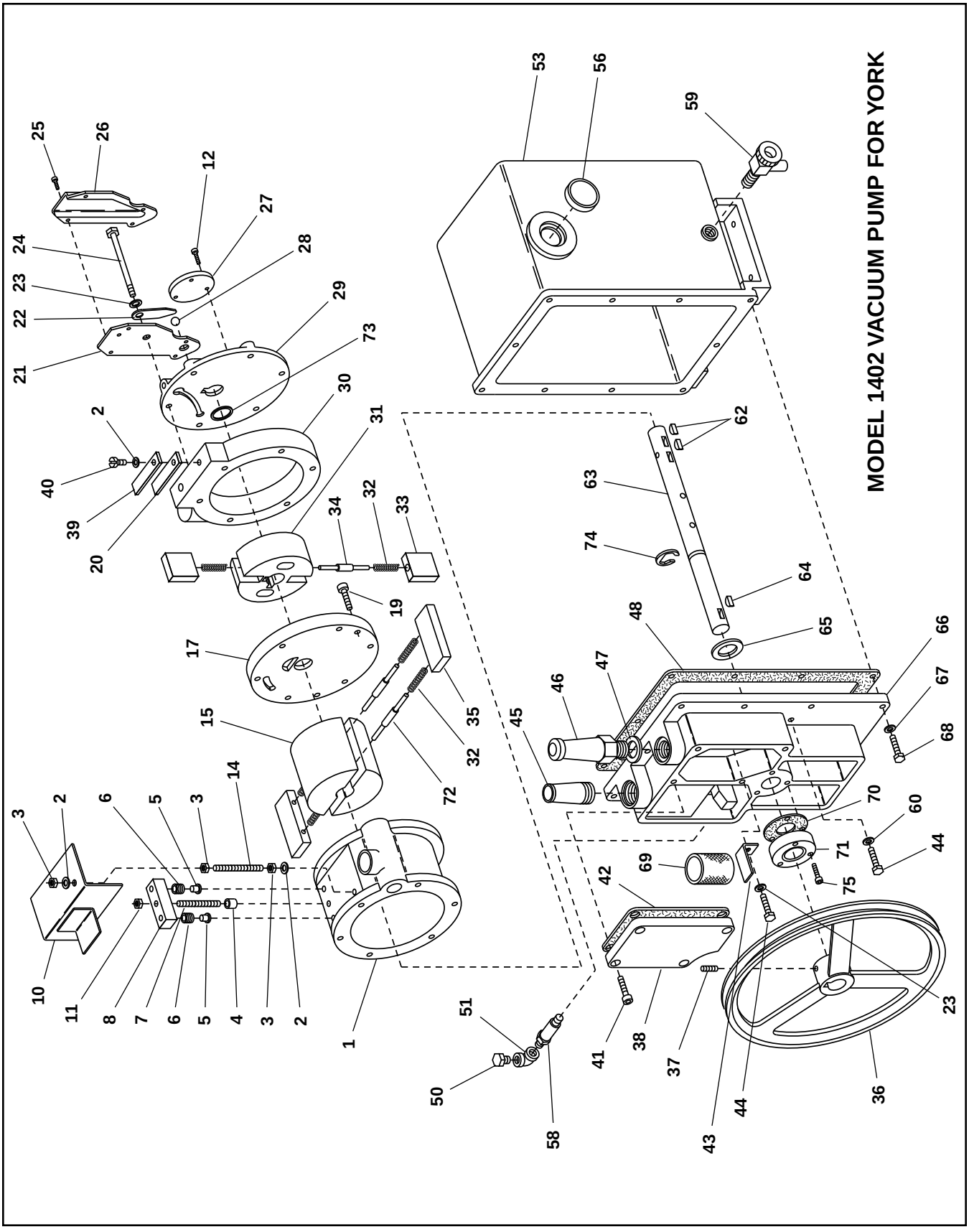
The pump is now ready to run.

V. Performance Check

It is desirable to run-in the pump after reassembly before making the final performance check. If no major parts, such as stator rings, rotors and vanes were replaced, one day should be sufficient. If new major repair parts were used a two-day run-in is recommended. The run-in should be made with the intake connection of the pump.

The gurgling noise characteristic of oil sealed pumps when pumping against high pressure should disappear in 20 - 40 seconds. If it does not, check that oil is at the correct level with pump running. With oil at proper level, a continuous gurgling noise indicates misalignment of valves or air leakage. Check the tightening of screws (44) holding intake exhaust plate (66) to the pump.

With the pump operating properly and at operating temperature, the vacuum performance can be checked by connecting a suitable vacuum gauge directly to the intake. The Welch vacuum performance guarantee of 0.1 micron Hg is based on measurement of the ultimate vacuum by an upright untrapped McLeod gauge. Electrical gauges, such as the Pirani or Thermocouple, can also be used. As these gauges measure condensable vapors as well as the permanent gases, they will indicate a higher total pressure reading, in the order of 3 millitorr for a new vacuum pump. A properly repaired pump, after run-in should demonstrate an ultimate vacuum equal to or approaching that of a new pump. Typically, a rebuilt pump will have a total pressure reading of 3 to 6 millitorr.


MODEL 1402 VACUUM PUMP FOR YORK

PARTS LIST - MODEL 1402 VACUUM PUMP FOR YORK

ITEM	QUAN.	PC. NO.	DESCRIPTION
1	1	61-8113C	Intake Ring
2	3	2-61-0000	Steel Washer, 3/16 size
3	3	2-31-0112	Hex. Steel Nut
4	1	61-8315A	S.S. Valve Block Spacer
5	2	61-8314A	S.S. Valve
6	2	41-2158	S.S. Valve Spring
7	1	2-01-8128	Headless Steel Setscrew
8	1	61-8313A	S.S. Valve Block
10	1	61-8316A	S.S. Baffle Plate
11	1	2-36-9900	Nut, Lock 1/4-20
12	6	2-00-2706	Fil. Hd. Screw 10-32x3/8
14	1	41-2175	Headless Steel Setscrew
15	1	41-2092	Intake Rotor
17	1	61-8250C	Center Plate
18	4	2-09-1204	Socket Head Cap Screw
19	2	2-01-6320	Socket Hd. Screw 5/16-18x1-1/4
20	1	41-2154	S.S. Lower Exhaust Valve
21	1	61-8310A	S.S. Pressure Release Tube, Part 2
22	1	41-0992	S.S. Pressure Release Valve
23	6	41-2363	Washer
24	6	2-01-0356	Hex Hd. Screw 5/16-18x3-1/2
25	3	2-03-3104	Binding Head Sheet Metal Screw
26	1	61-8309A	S.S. Pressure Release Tube, Part1
27	1	41-0672	End Cap
28	1	4-40-1200	Steel Ball 3/8
29	1	41-2045	Small End Plate
30	1	61-8108D	Exhaust Ring
31	1	41-1518	Exhaust Rotor
32	6	61-8559A	S.S. Vane Spring
33	2	41-1487	Small Vane
34	1	41-0696	Vane Spring Holder-Exhaust
35	2	41-0959	Large Vane
36	1	41-2074	Pulley inc. Set screw, Item 37

ITEM	QUAN.	PC. NO.	DESCRIPTION
37	1	2-01-9306	Socket Head Set Screw
38	1	41-0775	Large End Plate Cover
39	1	41-2153	S.S. Upper Exhaust Valve
40	1	2-01-5106	Rd. Hd. Steel Screw 1/4-20x3/8
41	4	2-01-6112	Socket Screw 1/4-20x3/4
42	1	41-0234	Intake Chamber Cover Gasket
43	1	41-0663	Air Filter Bracket
44	6	2-01-0316	Hex Head Cap Screw 5/16-18x1
45	1	61-8492A	Adapter 1-20x3/4”NPT
46	1	61-8468A	Intake Nipple
47	1	61-9284A	O-ring, #214
48	1	41-0403	Oil Case Gasket
50	1	61-8510	Pipe Plug, 1/4”NPT
51	1	61-8512	Elbow, 90 Degree
53	1	61-8101	Oil Case Assy, incl. Items 56 & 59
56	1	41-3753	Pop-in Window
58	1	61-8491A	Adapter 1/2-20x1/4”NPT
59	1	41-1734	Drain Valve
60	6	61-8456A	Washer, Copper 5/16
62	2	41-0613	Woodruff Key
63	1	41-2093	Shaft
64	2	41-0624	Woodruff Key
65	1	41-0508	Thrust Washer
66	1	61-8111D	Large End Plate
67	10	2-63-0193	Split Lock Washer
68	10	2-01-0114	Hex Head Cap Screw 1/4-20x3/4
69	1	41-0660	Air Filter
70	1	41-0643	Seal Gasket
71	1	1401D-01	Shaft Seal, incl. Items 12 & 70 **
72	2	41-1685	Spring Holder - Intake
73	3	41-1766	Thrust Disc
74	1	4-06-0754	Truarc Ring
**		1-99-5282	Sealant, 6 cc

Introduction

The Buffalo pumps used on *ParaFlow*™ chillers single suction, single-stage, hermetically sealed centrifugal pumps designed for zero leakage. The pumps employ a unique spring loaded conical bearing design that allows for long life between overhauls. The pump bearings are cooled and lubricated by the pumping fluid (refrigerant water or lithium bromide solution). The pumping liquid also carries away heat generated by the motor.

Inspection Prior to Start-Up

Caution: Open and *lock out* all electrical disconnects to the *ParaFlow*™ unit for the following tests.

1. Remove the pump wiring connections inside the Power Panel. Using a standard 500 volt megohm meter, meg the motor windings phase-to-phase and phase-to-ground. Winding resistance should not be less than 1 megohm on a cold motor or less than 500,000 ohms on a warm motor. If insulation resistance is less, look for abrasion damage to motor lead insulation material. If insulation resistance is less, look for abrasion damage to motor lead insulation material. If the insulation is not damaged, look for moisture accumulation in the stator housing. Be sure that the motor drain holes are positioned so that free water will drain from the stator housing.

2. Reconnect all pump wiring in the Power Panel. Check *all* wiring to and from the pump contactors and overloads in the Power Panel. Insure that conductors are fully engaged in the terminal holes and that the terminal screws are tight.

3. Check that the pump overloads in the Power Panel are set the same as the pump motor rated full load amps.

Pump Start-Up Procedure

Caution: Do not run the pump dry. Even momentary operation without the pump and motor casing filled with liquid will damage pump bearings.

1. Be sure the pump is completely filled with liquid. Run the pump for only a few seconds to make sure it operates smoothly. there should be no unusual vibration, grinding or scraping noises.

Note: To operate the pumps, first confirm the correct voltage is supplied to the Power Panel. Close the applicable pump Overload in the Power Panel. Using the PUMP STATUS key on the Micro-Panel, select either the Refrigerant Pump or the Solution Pump. The pump can then be turned on by using the MANUAL PUMP key. The Micro-Panel must be in the Service Mode to manually operate either the Refrigerant or the Solution Pump. **Before operating the pumps, refer to the Micro-Panel Operating Manual (Form 155.17-02) for a thorough understanding of this procedure.**

2. Be sure motor drain holes (located on both ends of motor on bottom quadrant of motor housing) are clear.

3. Confirm correct pump rotation:

a) Install an accurate compound pressure gauge in the pump discharge sample valve. A gauge with a maximum pressure of 30 psig will be sufficient.

Notes: If the discharge sample valve on the pump is of the spindle valve type, a specific spindle valve adapter fitting must be used to adapt from the sample valve straight thread to the gauge pipe thread. Be sure that the O-ring is in place on the spindle valve body before installing the adapter. Use of silicone vacuum grease is recommended on the straight threads and O-ring surface of the special adapter. Use only Loctite Grade 567 pipe sealant on the gauge pipe threads after priming them with Locquic ᵀ Primer Grade N.

On Models 19GL through 22GL, it will be necessary to use the individual disconnects in the Power Panel so that all solution pumps can be run individually. Do not run P1 (Main Solution Pump) by itself for more than a few minutes or solution will back up in the First and Second stage generator. When running P2 (Strong Solution Spray Pump) always run P1 or P2 will run dry. P4 (Weak Solution Spray Pump) may be run by itself. P3 (Refrigerant Pump) may also be run by itself as long as there is sufficient liquid level in the refrigerant tank. The Micro-Panel must be in the Service Mode in order to manually operate the pumps. Check the Refrigerant Pump (P3) in the normal manner, then check the three Solution Pumps as follows:

• Check P1 first. Select the Solution Pump using the PUMP STATUS key and then using the MANUAL PUMP key, turn it on. P1 and P4 will start. Turn P4 off by pressing the red button on P4's Overload in the Power Panel. It will now be possible to check P1 by itself.

• Check P4 next. This can be done in exactly the same manner as the proceedure for P1, only this time, turn P1's Overload off and P4's Overload on.

• Check P2 last. First turn on P1. You may leave P4's Overload turned off at this point. To start P2, use the PUMP STATUS key on the Micro-Panel and select the Second Spray Pump. Turn it on using the MANUAL PUMP key. During normal unit operation, P2 has an adjustable time delay between the time P1 starts and the time it starts.

b) After the pressure gauge is installed, start the pump. Open the sample valve approximately one turn. After the gauge pressure has stabilized, record the pressure indicated on the gauge. Close the sample valve and shut the pump off.

c) Disconnect all power to the unit. (Be sure the purge pump is valved off.) Using a voltmeter, check that no voltage is pre-

sent at the pump contactor. Interchange any two of the three phases going from the contactor to the pump. This will cause the pump to run in the opposite direction.

d) Reapply power to the unit. Start the pump. Open the sample valve again and record the pump discharge pressure.

e) The direction of rotation that produces the higher discharge pressure is the correct rotation. If necessary, disconnect power to the unit and change the wiring back to the original configuration. Since the unit was run at the factory, normally the phasing of all pumps should still be checked individually. Be aware that both of the discharge pressure readings may be in a vacuum on some pumps. For example, if the pump discharge was -500 mm Hg running one direction, and -200 mm Hg running the other direction, the correct rotation would be the one where the discharge pressure -200mm Hg. If a *ParaFlow*™ unit is ready for operation, pumps rotating in the correct direction will have a sound similar to "popcorn popping," only louder. Pumps running in the wrong direction will tend to be reatively quiet. **Comparing amperage draw to determine correct rotation will not be conclusive since the power curves of these pumps are very flat.**

3. After correct rotation has been confirmed, run the pump again. Record the voltage and amperage draw of all three phases along with the pump discharge pressure on the start-up log.

4. Check for abnormal sounds or vibration.

Troubleshooting

Pump Tripping on Overloads - Check voltage supply on all three phases to be sure it is correct for the pump motor in question. Check Overload for proper amperage setting (Pump Motor FLA), Loose wires or poor connections that generate heat and trip the overload. If no problems are found, shut off all power to the unit, lock out and tag all disconnects. Check the motor connections to be sure the pump is wired correctly, Using a megohm meter, check the pump motor windings for shorts or grounds. (See Overhaul Section for more information on this procedure.) If motor problems are found, motor replacement will be necessary. If no problems are found during this procedure, reconnect the motor. Apply power to the unit and run the pump, while watching the operating amps. If high amps are encountered, the problem may be mechanical, such as bearing seizure. Pump inspection will be necessary. If the overload continues to trip, but the motor amperage is within the allowable range, the overload is defective.

Pump Tripping on Thermal Protection - If the winding temperature thermostat is tripping the pump, allow the thermostat to reset. Exercise caution, the motor housing skin temperature should be in excess of 300^{0}F when the winding temperature thermostat trips. Although rare, if the thermostat will not reset in a reasonable period of time, it may be defective. If this is the case, temporarily bypass the thermostat and run the pump. Check the motor housing temperature with an infrared thermometer. The average outside skin temperature of a solution pump motor housing is 190^{0}F at stable operating conditions (100^{0}F Suction Temperature). Refrigerant pumps run cooler than this. Check to be sure that the pump is not running dry periodically or that either the suction/discharge isolation valves are closed. Check to see that the pump is not pumping abnormally high temperature liquid for some reason. If no problems related to flow through the pump are found, the internal coolant passages may be blocked. Pump disassembly will be required.

Pump Does Not Make Pressure - Be sure pump is running. Other unit sounds and vibrations may make this difficult to determine by feel alone. Pump may be running backward. Check pump rotation. Check that suction and discharge isolation valves are not closed. Note that most pumps do not produce a positive discharge pressure, i.e. most of the pumps will have a discharge pressure in a vacuum. (See Start-Up Section for more details.)

Unusual Noise/Vibration - Pumps will make some noise during normal operation. Abnormal sounds and vibration may be due to foreign material such as weld slag or debris trapped in the coolant circuit and rubbing between the stator and rotor. Noise may be a result of extreme bearing wear. Pump disassembly is required.

Pump Overhaul

The expected time span between Buffalo Pump overhauls on a properly maintained *ParaFlow*™ unit should be between 50,000 and 60,000 hours. Pumps installed on units running with high amounts of suspended solids or high amounts of dissolved copper in the solution will suffer shorter lives.

1. Disconnect all primary power to the unit. Lock and tag out all switches, circuit breakers and cutouts in the open position. Note connection sequence and label power leads to motor. Disconnect power leads and tape off the line side bare ends.

2. Close pump suction and discharge isolation valves and tag. Break vacuum by introducing dry nitrogen or argon into the discharge sample valve of pump. (Use spindle valve adapter if sample valve adapter if sample valve is spindle-type.) Drain trapped solution or refrigerant into suitable container.

3. Match mark casing (2) and motor mounting flange (202) for use at reassembly. Support motor end of unit. An improvised wooden cradle positioned on the forks of a pallet truck will greatly aid the installation. Note the weights of

Pump Model Number	Nominal Motor Horsepower	Weight of Motor Assembly [1]
215ZB	10 HP	211 lbs.
215R	7.5 HP	184 lbs.
66V	3 HP	164 lbs.
66M	2 HP	106 lbs.

[1] **Weight includes complete pump less pump volute casing.**

motor and impeller assembly on Table above. Remove nuts (109A) and lock washers (224) from studs (107A) holding motor mount flange to the pump casing.

4. Break joint between casing (2) and motor flange (202). Carefully slide motor away from the casing. Do not allow the impeller (3) to drop onto the casing wearing ring (9) as this will break or damage the casing wearing ring. More trapped liquid may run out of the pump casing as the pump is slid out so be prepared with a suitable container. Pump and motor assembly should be placed in a vertical position, impeller up, for disassembly.

Note: Pumps should be completely disassembled, each part thoroughlflushed with tap water and then dried before reassembling. Pump casing, gasket surfaces and studs should be washed clean of Lithium Bromide solution and blown dry to prevent damaging corrosion. **Even traces of Lithium Bromide solution remaining on pump parts exposed to the air may render the parts useless when attempting re-assembly. DO NOT IMMERSE THE MOTOR HOUSING IN WATER.**

5. Remove and discard casing gasket (65). Use a new gasket on reassembly.

6. Bend tangs of lock washer (16B) away from impeller locking screw (15A) and locking washer (16B). Prevent impeller (3) from rotating by inserting a length of bar stock between impeller shrouds **Do not hammer on shaft (229).** Remove impeller locking screw (15A).

7. Remove impeller (3) using a claw type gear puller. Be sure puller is assembled properly to avoid bending parts. **Do not use hammer to remove impeller (3).** Pull on hub shroud at the vanes only. Remove feather key (17) from notch in shaft and place with impeller.

8. Mark alignment between wearing ring housing (208) and motor flange (202) for use at reassembly.

9. Remove nuts (109) and lock washers (124) under motor side wearing ring (10). Wearing ring may have to be removed and replaced. The wearing ring housing may either snap out or follow the nuts (109) due to the spring pressure (250). Carefully remove wearing ring housing (208) being careful not to drop pump end bearing (210A). Identify bearing location in housing and identify bearing (impeller end bearing a;nd rear bearing may not be identical--215R and 215Z motors have larger impeller end bearings than motor end) for later examination. Remove bearing (210A) from wearing ring housing (208).

Caution: Do not allow the sharp edge of the rotor to puncture the stator inner liner (216). The rear carbon bearing (210) may stick to the bearing journal. Do not allow the carbon bearing to drop off of the rotor as it is lifted.

10. Lift the rotor directly up, guiding it out of the motor cavity with thumb and forefinger on each side. As soon as the lower journal is visible, check to see if the lower bearing (21) is sticking to the rotor, grasp it and do not allow to drop.

11. After removal, protect the rotor so that the thin outer liner (221) is not damaged. The rotor should be supported at the *shaft ends* only--not on the rotor outer liner or bearing journals.

12. If the rear bearing (210), did not come out with the rotor, remove it now from the rear bearing housing--reaching in through the pump end of the motor housing. If the bearing is bound in the housing, carefully apply heat to the bearing housing with a torch to expand the housing enough to permit the bearing removal. To prevent a future recurrence of the bearing binding, sand the OD. of the bearing with fine emery cloth until the bearing will slip into the housing freely. In cases of binding due to foreign particles, clean and reinstall first before sanding. If binding still occurs, sand the bearing OD.

13. Remove the spring assembly (250) from the bearing housing (205).

14. Wearing rings (9) and (10) should not be removed unless inspection shows that they should be replaced. To remove the wearing rings, carefully crack and remove in pieces. Use care not to damage the casing (2) or wearing ring housing (208).

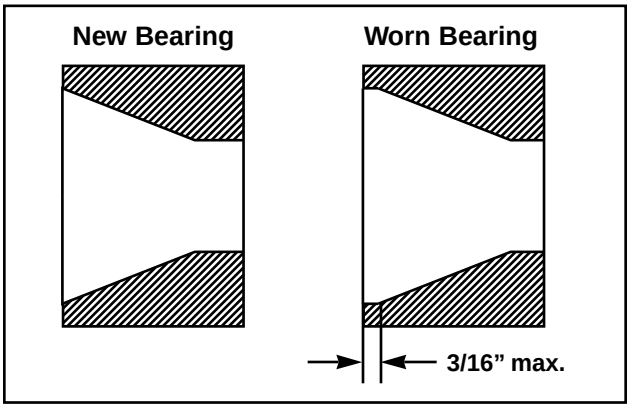
Inspection and Parts Replacement

Impeller (3) - After thoroughly cleaning, inspect the impeller (3) for unusual wear on the wearing ring mating surfaces. Examine the impeller closely for copper or other metal deposits in the vane areas. These will affect impeller balance. Remove any deposits found. Check the impeller vanes for foreign object damage. An impeller with grooved seal areas or

severe foreign object damage should be replaced.

Wearing Rings (9, 10) - If the pump has been in operation for some time, wear may have increased the clearance between the wearing rings (9, 10) and impeller (3) to the point where efficiency is considerably reduced. Check the radial clearance between the hubs of the impeller (3) and the inside of the wearing rings (9, 10). If the radial clearance is more than .018 inch (normal radial clearance is .006 to .009 inch), break out the old wearing rings (9, 10) being careful not to damage ring fits in casing (2) or wearing ring housing (208). Clean the ring fits thoroughly and install new wearing rings (9, 10) as described under the Reassembly Section.

Bearings (210) and (210A) - An indication of conical bearing wear can be obtained by measuring the bearings. Check each bearing for (a) cracks; (b) axial wear, which is measured parallel to the rotor shaft (229) from the face at the large end of the cone to the point where the taper begins (maximum amount of wear is 3/16 inch); (c) uneven radial wear, which can be detected by comparing the annular thickness of the section at the large end of the cone at several points. If any of the above conditions exist, replace the bearing.



Hot Bearing - A darkened journal (211) indicates that the bearing has been running hot, probably due to insufficient liquid circulation. In this case the journal should be cleaned with Scotch Brite® and light oil. The circulation passages in the impeller (3) and wearing ring housing (208) should be checked and cleaned. **Be sure to completely clean any oil or solvents from the parts prior to reassembly.**

Bearing Journals (211) - Check shaft journals for copper or other metal deposits. If deposits other than graphite are found on the surfaces of the conical journals, remove with crocus cloth. If the bearing journals are scored over 1/64 inch, determine the cause and replace the rotor.

Rotor and Stator Cans (216) and (221) - Check for punctures, weld failures or worn-through spots in both the stator and rotor cans. Check for evidence of rubbing between the rotor can and the stator can. Also check for rubbing or marking caused by deposits or loose foreign matter between the stator and rotor cans. If either or both cans are punctured or have spots that have worn through or cracked welds, the motor must be replaced. If there is evidence of rubbing, but no actual failure of either member, try to determine the cause of the rubbing so that corrective measures can be taken.

The following are possible cause effects of rotor rubbing on the stator.

• If rubbing marks are localized on the rotor and continuous on the stator, the condition is caused by a high spot or area on the rotor.

• If the marks are localized on the stator and continuous on the rotor, the indication is that there is a high spot in the stator can or that there is excessive or uneven bearing wear.

• If there is continuous marking on both stator and rotor cans, the cause is probably loose foreign material.

• If the marking indicates high spots on either can, check first for copper or other deposits and remove them if they are present.

If the high spots are caused by protrusion of either can, they may be removed by tapping them down gently using a hardwood block and a hammer. If these high spots do not respond to the above treatment, the motor must be replaced. If not foreign material or high spots are found, check the bearings for excessive wear, uneven wear, or ineffective spring action.

Circulating Passages - Check circulating passages which consist of radial holes through wearing ring housing and axial holes through pump end bearing housing. If the circulating passages are partially or completely blocked by copper or other metal deposits, corrective action should be taken. Check hollow shaft (229) for obstructions.

Motor Lead Insulation - Check the insulation on the motor leads in the area of where the leads pass through the hole in the motor frame for worn or cracked insulation. If possible, reinsulate with tubing, tape, etc. If not accessible, replace the motor.

Motor Windings - Check motor winding for grounds, short, opens, or unbalanced resistance in all phases. If defective in any of these respects, replace the motor.

Winding Insulation - Check the insulation resistance with a megohm meter. Readings should not be below 1 megohm on a cold motor or 500,000 ohms on a warm motor. If the insulation resistance is below these values, check for abraded motor leads. If this is not the trouble, check for moisture accumulation in the stator housing. Turn the motor to a position with condensate drain holes down and look for free water. If moisture is found, drain all free water out condensate hole and place the motor in an oven at

200°F for 2 hours. If the insulation resistance is still low after baking, replace motor.

All Parts - Inspect all parts for cracks, distortion and unusual wear. Parts should be cleaned and any deposits removed. It is essential that the circulating holes in the impeller (3) and the wearing ring housing (208) be kept open.

Reassembly

Before reassembling the pump, be sure that all parts are clean, oil-free, and free of grit.

Place the unit in a vertical position; use a hand hoist to lower the rotor into the motor cavity if necessary.

To replace the wearing rings, if they had to be removed, proceed as follows:

1. Wipe wearing rings (9, 10), casing bore and motor wearing ring bore free of oil, grease or other foreign substance.

2. Spray the OD of the carbon and inside of the ring bores including the bottom shoulder with Loctite Locquic Primer grade "T".

3. Wait about one minute after the primer is applied; run a small bead of Loctite 620 around the bores near the top.

4. Press rings (9, 10) in place. Press wearing ring (10) into wearing ring housing until flush with the top surface. Press wearing ring housing (208) until flush with the top surface. Press wearing ring (9) into casing (2) until it seats against the bottom shoulder.

5. Let cure until handling strength is reached (about 3 minutes) before proceeding with assembly.

6. Install spring (25) in bearing cap (205).

7. Align tab in bearing housing (205) with square slot of bearing OD and slide rear bearing (210) into the rear bearing housing (205). The bearing should have a free-sliding fit with no excessive radial play.

8. Lift rotor using an eyebolt inserted in the rotor shaft (229) and a hand hoist, over motor housing and lower rotor into motor cavity. Guide rotor on reassembly as on disassembly.

9. Insert impeller end bearing (210A) into wearing ring housing (208) aligning tab in housing with slot in OD of bearing and carefully position over shaft bearing journal. Align wearing ring housing over studs in motor housing flange making sure previously scribed match marks line up. A slight pressure will be required to push the wearing ring housing in to overcome the spring pressure. Install the lock washers (124) and nuts (109) on the studs while holding the wearing ring housing in with the other hand.

10. Tighten the nuts (109) using a staggered tightening pattern. Torque to 100-150 in/lbs (9-12 ft/lbs).

11. Check for loose or insecure rotor by pushing the end of the exposed shaft and observing if the rotor returns to it original position. Normal axial movement is 1/16 to 1/4 inch. If it is impossible to move the rotor axially by hand pressure, possible causes are:

a) Bearing bound in housing.
b) Broken or damaged spring.
c) Foreign particles between the bearing and housing.

Disassemble the pump to determine and correct the cause before proceeding.

12. Check for radial movement by grasping the shaft extension with one hand and attempting to move the shaft perpendicular to the shaft axis. Total free radial movement of 1/32 inch or more is excessive and remedial action should be taken.

13. Re-install feather key (17) in shaft (229). Slide the impeller (3) onto the shaft (229) being sure it seats against the shoulder. **Do not pound the impeller onto the shaft.**

14. Install impeller locking washer (16B) (Lock washer must be replaced if both sets of tangs have been used) and impeller screw (915A). Tighten impeller screw to 40 ft/lb. Bend one set of tangs of the locking washer (16B) over the flats on screw (16A).

15. Using rubber cement, glue a *new* casing gasket (65) in position on the motor housing flange. Extra care to adequately secure the gasket will pay off when positioning the pump into the casing in the next steps.

16. Position the pump assembly in the horizontal position. Using a support cradle, place the pump so that it can be slid into the casing. Be sure to line it up so that the pump assembly matches the previous marks made on the casing during disassembly. (A pallet truck may work to position the pump in its casing.) It is important to slide the assembly into the casing exactly centered and parallel so that the impeller does not damage the casing wearing ring. **Be sure to watch the gasket closely during this procedure to make sure it is not pinched.**

17. While holding the pump assembly against the pump casing, install two lock washers (224) and nuts (109A) onto studs (107A). Snug the two nuts up to temporarily position the pump assembly while installing the remaining lock washers and nuts. Snug all nut evenly using a staggered pattern.

18. Torque nuts (109A) to 35 ft/lb using a staggered rotating pattern. Initial torque tolerance is =/- 5%.

Note: Breakaway torque will be greater than this value.

19. remove the temporary motor support and re-install any permanent support brackets.

20. Pressurize the pump assembly using the pump discharge sample valve with 12 psig of dry nitrogen or argon. Leak check the pump flange using a liquid soap leak check method. Repair if necessary.

21. Evacuate the pump assembly through the pump discharge sample valve with the unit purge pump to at least 3 mm of Hg. Valve off the pump sample valve. Open the pump suction and discharge isolation valves.

22. Connect the electrical conduit to the pump motor terminal box and reconnect the power leads and control wiring to the pump motor. Install terminal box cover.

23. Follow the instructions in the Start-Up Procedures Section to confirm correct pump rotation and satisfactory operation.

For proper flow refer to Figures SP-7 and SP-8 on following page.

Flow of Refrigerant Water or Lithium Bromide Solution through Single-End Pump

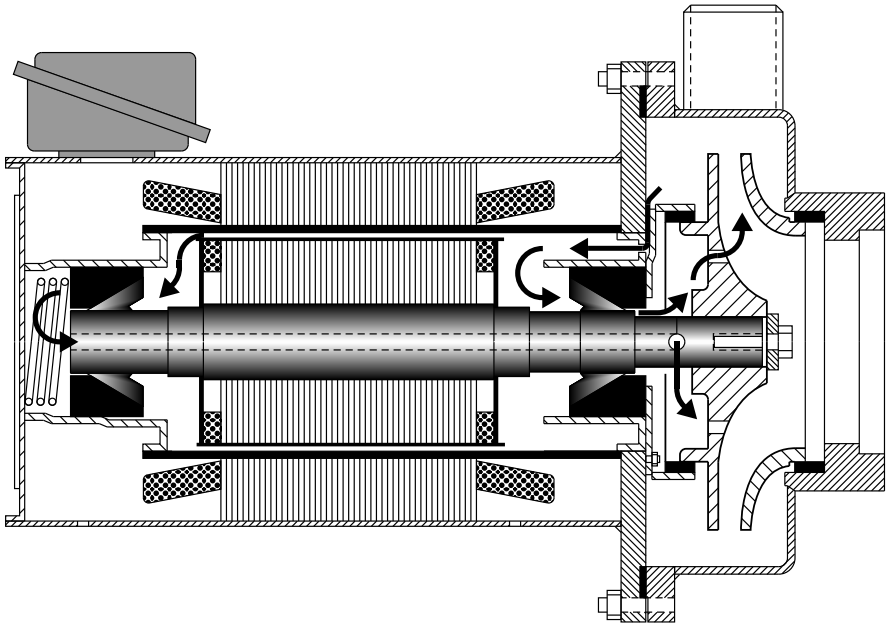


Figure SP-7

Flow of Refrigerant Water or Lithium Bromide Solution through Double-End Pump

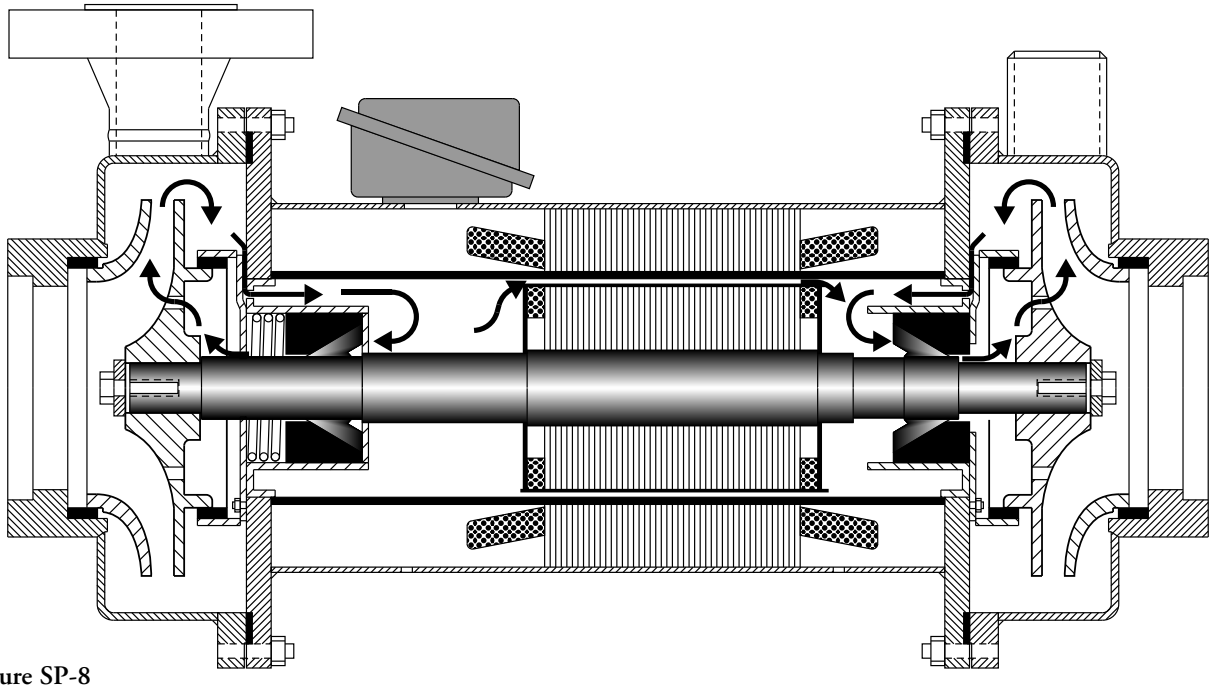
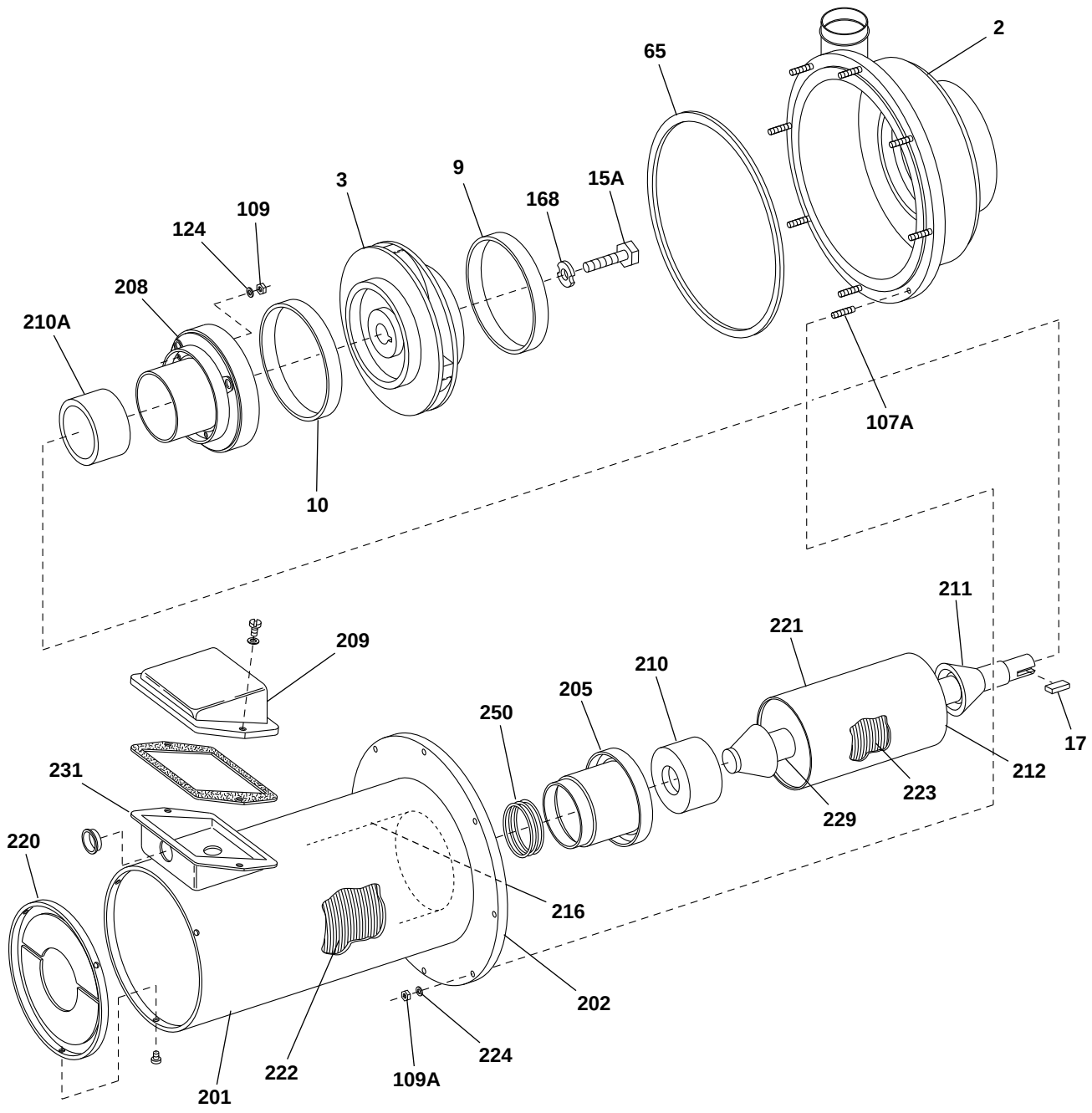
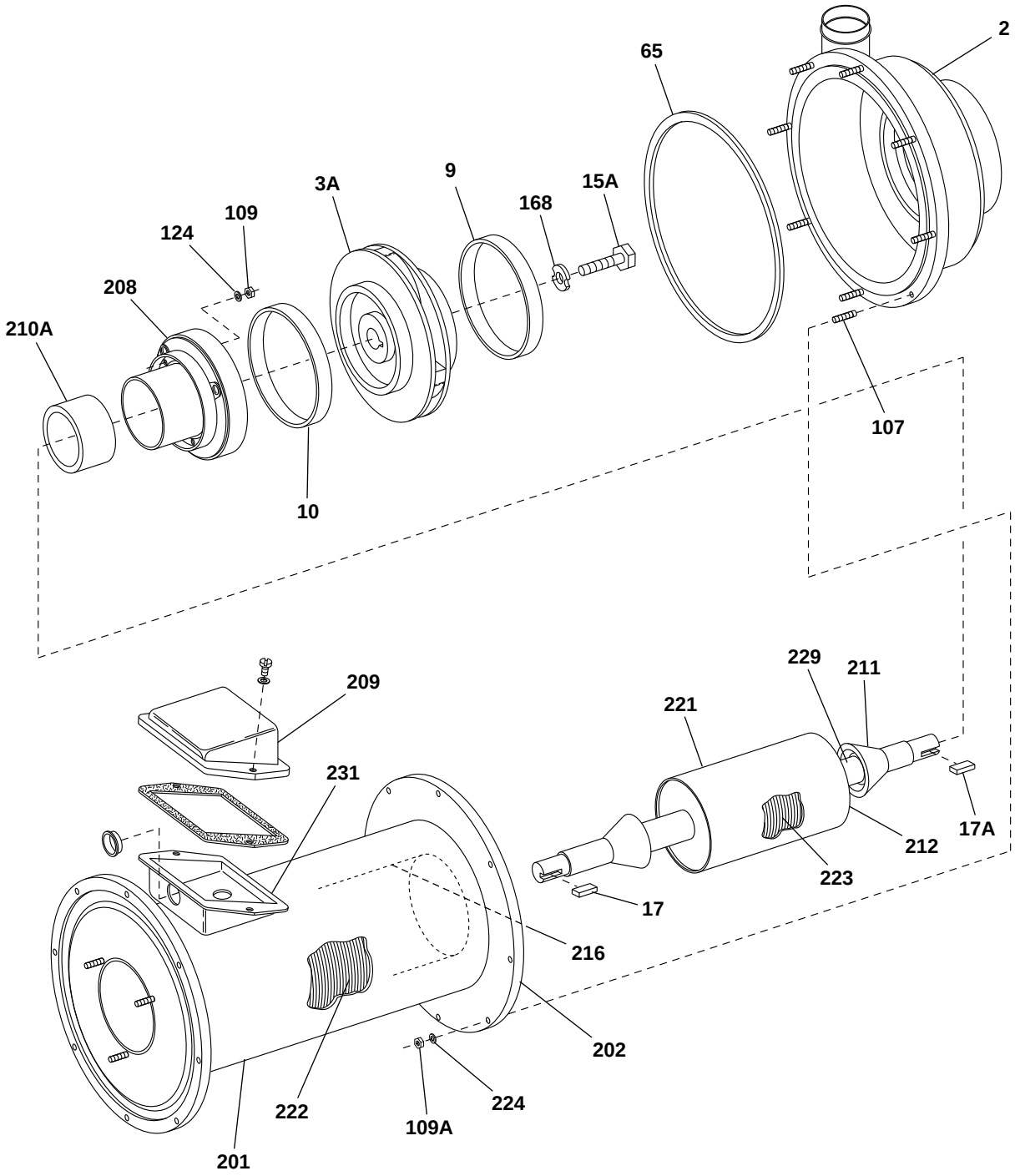


Figure SP-8

Single End Buffalo Pump (view 1 of 1)



Double-End Buffalo Pump (view 1 of 2)



Double-End Buffalo Pump (view 2 of 2)