LYCO Wausau
STAINLESS STEEL VACUUM PUMPS

Installation, Operation and Maintenance Instructions Stainless Steel, Liquid Ring Vacuum Pumps

Lyco Wausau is a USA company that has specialized in making stainless steel, liquid ring vacuum pumps since 1973. Lyco pumps are used worldwide in food, pharmaceutical, chemical, medical, laboratory and general applications where corrosion resistance is beneficial.

Each Lyco pump has been carefully inspected and run tested prior to shipment. With good installation and normal care, long life can be expected. Lyco pumps are easy to maintain, and all spare parts are factory stocked for fast shipment.

This booklet contains useful information which should be read before installation and the booklet retained for future reference.

LYCO Wausau, Inc. . . .P.O. Box 2022. . . .Wausau, WI 54402-2022. . . .715-845-PUMP (7867)

Operation Instructions

General Rules:

Don't let the pump run dry

Prevent scale buildup

Replace shaft seal if leaking

Avoid exhaust back pressure

Avoid Cavitation and Slugging

Grease bearings as instructed

Service Liquid Supply: The principle of a liquid ring vacuum pump depends on a continuous supply of the correct amount of clean, cool, service liquid (usually water). Without service liquid, the pump will not perform, and the pump will run dry. This will also cause the shaft seal to overheat and shorten its life. To assure this continuous supply of service liquid…

Avoid getting debris into the service liquid line which can plug the strainer, solenoid valve and flow control orifice. This might include loose rust or metal filings. Inspect more frequently when the supply water is hard or dirty.

Repair or replace solenoid valve immediately if it is observed to be occasionally sticking.

In recirculation systems, keep the tank and water clean by changing the water periodically, and keep the flow control orifice in the recirculation hose unplugged.

Check service liquid flow to the pump immediately if the system doesn't come up to vacuum when the pump starts, or if there is a loss of vacuum during operation.

Preventing Scale Buildup: Scale buildup is responsible for shortened seal life, reduced capacity and vibration. In hard water areas, use of a water softener is desirable; otherwise, descaling acid can be used periodically without hurting the Lyco pump, since it is made from stainless steel.

Check the pump every two weeks after installation to get a feel for how fast scale builds up. This will determine how frequently descaling acid should be used. Check by looking inside the exhaust port for buildup. With a recirculation system, check the clearness of the recirculation hose.

One cup of descaling acid can be put into the pump along with service liquid water, and be allowed to stand while the pump is off between runs. The acid can be sucked into the pump through the service liquid recirculation inlet in the front of the pump just before it is shut off, see "**Piping Connections**" (page 5). If a recirculation tank is used, descaling acid can be mixed with the water in the tank either manually or with a dispenser.

<u>Seals</u>: Normal shaft seal life with clean, scale free operation is estimated to range from one to five years depending on how continuous and severe the duty is. The most common causes for shortened seal life are pumps running dry and scale buildup.

Another cause might be incompatibility of seal materials with chemicals in the vacuum process. Standard materials used in shaft seal (Buna N), O-rings (Buna N), gaskets (Neoprene) and body seals (Noryl) are compatible with most chemicals. For others, a wide variety of optional materials are available from Lyco.

The pump will continue to produce vacuum with a leaking shaft seal, so a leak will not be noticed until the leak is physically observed dripping from between the back of the pump and the front of the motor or bearing housing.

A leaking shaft seal should be replaced as soon as possible, since service liquid can eventually work back along the shaft, around the slinger and bearing seal, flush out the bearing grease and cause a bearing failure.

If a leaking seal can not be replaced immediately, and if the pump is a pedestal Model 501 & 502, bearing grease can be replaced to prevent a failure. This is not possible with close-coupled, Models 101 & 102, which have motors with sealed bearings.

Lyco vacuum pumps have only one shaft seal, and it is easy to replace if the procedures described in the section "**<u>Pump Disassembly and Shaft Removal</u>**" (page 13) are followed.

<u>Avoiding Exhaust Back Pressure:</u> Back pressure can severely stress pump components and motors, and must be avoided. Refer to section "**<u>Exhaust Piping</u>**" (pages 5 & 6).

<u>Avoiding Cavitation and Slugging:</u> Cavitation and slugging can severely stress the pump components and motors, and must be avoided. Refer to section "**<u>Vacuum Piping</u>**" (page 5) and paragraphs "C1 and 2" (pages 11 & 12)

<u>Greasing Bearings</u>:

Close-coupled pumps, Models 101 & 102:

Current close-coupled pump motors do not require greasing because they have sealed bearings.

Pedestal mounted pumps, Models 501 & 502:

1. Lubricate bearing housing while warm with power off. Use Mobil Polyrex-EM, Mobilith SHC100, Chevron SRI No. 2, or equivalent.
2. Insure grease fitting is clean and free from dirt.
3. Remove the relief hole plug which is located at the front side of the bearing housing. Clean out any hardened grease that might plug up the hole.

4. Use a low pressure grease gun, and pump in recommended grease until new grease appears at the relief hole. BEWARE OF OVER GREASING.
5. After lubricating, allow the pump to run for a minimum of 10 minutes before replacing relief plug.
6. Applications in dusty, wet and high ambient atmospheres may require greasing as often as every 3-4 months; however, DON'T OVER GREASE by greasing too often.
7. Note that the rear bearing (away from the shaft extension) is a sealed bearing which requires no lubrication.

When pumps and motor are in storage for extended periods of time, manually turning the shafts every six months will prevent bearing lubricants from hardening which can cause bearings to fail shortly after being put in service.

Installation & Startup

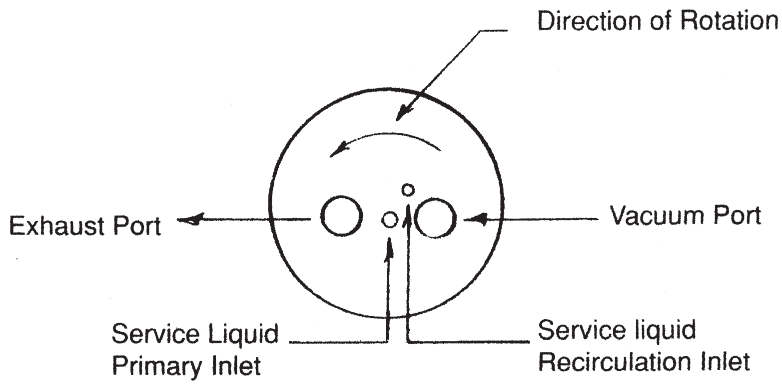
Unpacking: Inspect the shipping container, pump and motor for external damage. Check the pump for dents, and the motor for damage to the junction box, fan shroud and fan.

To inspect for hidden shipping damage, turn the pump rotor completely around one rotation, counter clock wise. This can be done with a screw driver inserted through the vacuum or exhaust port. The rotor should turn freely without any scraping or noise. If it doesn't, there may be hidden damage.

File a claim with the Carrier immediately if external or hidden shipping damage is observed.

Pump Location: Locate in a well ventilated and reasonably clean area near a water supply and drain. Other considerations include: being near the process being served; near an outside wall if the exhaust is to be piped outside; and in an area where temperatures are above freezing.

Piping Connections:



PUMP FRONT VIEW

Vacuum and exhaust ports: 1½" FNPT
Service liquid, primary inlet: 1/2" MNPT
Recirculation inlet: 3/8" MNPT

Vacuum Piping: For short runs, size the vacuum line to be at least as large as the vacuum port, 1½ inches diameter. When two or more pumps are piped together in parallel, size the line to be close to the sum of all the inlets. Suggested diameters are 2 1/2 inches for 2 pumps, 3 inches for 3 to 5 pumps, and 6 inches for 6 to 8 pumps.

For long runs, the line size will depend on the length of run and number of fittings. These should be sized for minimum pressure drop. Contact the factory for more information on this.

Vacuum piping should drain down toward the pump and enter the vacuum port from above. Low points in the piping where liquid can collect and cause slugging should be avoided. Exhaust piping should be directed down toward a drain. This allows partial draining through the exhaust port when the pump is shut off, and damaging stresses from flooded or dry restarts are avoided.

Use an inlet check valve to prevent water in the pump from being sucked back into the process when the pump is shut off. This also allows the pump to retain sufficient water for self priming which is a necessity in 100% recirculation systems. Also, when two or more pumps are piped in parallel and cycling separately, use one on each pump to prevent those that are operating from drawing air and service liquid from those that are not.

Use a vacuum relief valve in the vacuum line to control vacuum to the desired level, and to prevent the pump from “blocking off” and cavitating.

Lyco pumps feature a higher tolerance for handling liquid and solids because of a strategically located 1/2" drain to which a hand valve can be attached. This valve can be opened to allow the pump to handle more service liquid water and condensate, and to flush out solids, periodically or continually.

Exhaust Piping: The exhaust from the pump is composed of a high velocity mixture of gas and liquid. It should be freely discharged into the atmosphere to avoid excessive back pressure which can stress pump components and overload the motor. Standard motors will handle a modest amount of back pressure; however, a larger motor may be required where excessive back pressure is unavoidable.

Use a separator/muffler attached to the exhaust port, to avoid back pressure by separating the high velocity mixture of gas and liquid by immediately reducing its velocity. The liquid, gently flows down through a bottom fitting which can be piped directly to a drain while the exhaust gas rises and discharges freely into the atmosphere through a fitting at the top. The exhaust can be piped outside or to any other location, provided that the pipe is sized large enough to avoid back pressure and is not connected directly to a drain.

At the same time a separator/muffler allows more quiet operation, since the high pitched sound from the pump discharge is easily attenuated by changing direction of the exhaust.

For short runs, and if a separator/muffler is not used, size the exhaust line to be as large as the exhaust port, 1½ inches diameter. Make it short and point it down near a drain, but DO NOT CONNECT IT DIRECTLY TO A DRAIN since this will cause back pressure. The discharge will continue to be a high velocity mixture, but if the line is short and the discharge is into the atmosphere, there will be minimum back pressure.

For longer runs, consider larger diameters. For example, a 3 inch elbow attached to the exhaust port and pointed down will also slow the outlet velocity sufficiently to separate the mixture and produce a gentle flow of liquid. This elbow can be connected to a 3 inch line which can be directed to a drain, but again, DO NOT CONNECT IT DIRECTLY TO A DRAIN.

Also, avoid back pressure by not piping the pump exhaust to a location above the pump. This requires the pump to work harder in order to push the exhaust mixture up hill. And, when it is shut off, liquid will run back into the pump and flood it. Flooded restarts significantly stress motors and all pump components because of the hydraulic pressures produced. If this piping arrangement can't be avoided, it should be understood that a larger motor may be required, and that flooded restarts can result in higher, long term, maintenance costs.

General rules, for avoiding back pressure include: The pump should be allowed to partially drain through the exhaust port when the pump is shut off. There should always be an air break in the exhaust line before it enters a drain. And, the line should be sloped down toward the drain without low points or traps where liquid can accumulate and cause restriction.

Service Liquid Inlets: The pump includes two service liquid inlets, see "**Piping Connections**" (page 5). These two inlets are used together or independently, depending on the supply option chosen. See the next section titled, "**Service Liquid Supply Options**" (page 7)

The primary inlet is where the main water supply is connected. This is a 1/2" MNPT nipple which is threaded inside to accept a 3/8" pipe plug which can also be used as a fixed orifice by drilling a hole in it. Capacities of these pumps are rated at 2-3 gpm of water at 60˚F. Capacities will vary somewhat with water flow. Lower water flow will generally produce less maximum vacuum, while higher water flow, will generally produce higher maximum vacuum.

Flows through orifices at normal 40 psi water line pressure are as follows.

	gpm @ 40 psi		gpm @ 40 psi
1/16"	.55	9/64"	2.5
1/32"	1.20	5/32"	3.75
7/64"	1.30	open	5-6
1/8"	1.90-2.00		

For different line pressures, use a different orifice size or a constant gpm/variable pressure orifice which will provide the rated gpm for any line pressures between 15 and 125 psi.

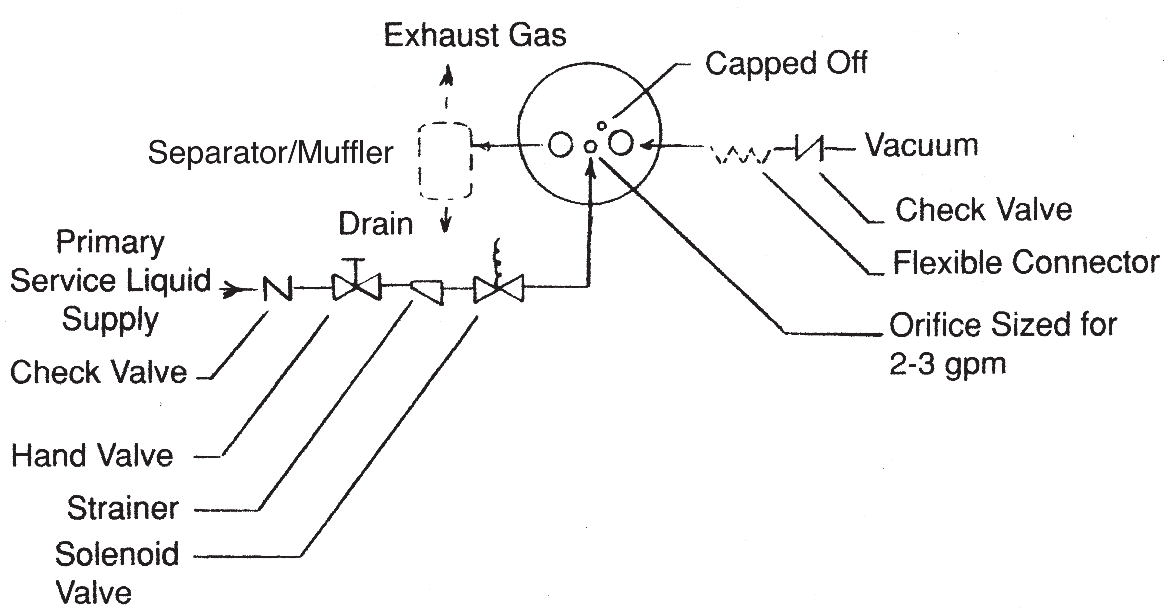
The recirculation inlet is located in the suction side so the pump will draw its own recirculation service liquid without the need for a separate liquid pump. This inlet can also be used for drawing acid into the pump for periodic descaling. This is a 3/8" MNPT nipple which is threaded inside to accept a 1/4" pipe plug which can also be used as a fixed orifice by drilling a hole in it. For 100% recirculation, a 1/4" hole at 15" Hg vacuum will allow 2 gpm flow. For 50% recirculation, 1 gpm, a 5/32" hole is required at 15" Hg.

General Notes:

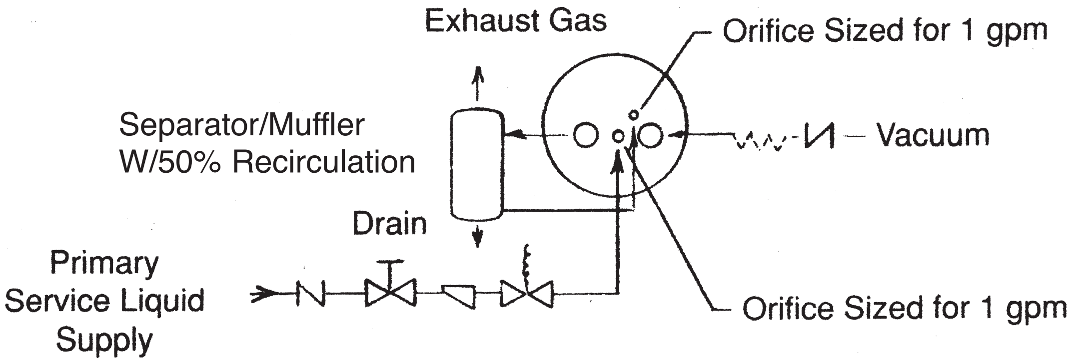
1) Keep all connecting pipes and fittings clean of metal filings and chips before connecting to avoid having them get into the pump when it starts up.
2) In all cases, the piping should be independently supported to **AVOID PUTTING EXCESSIVE WEIGHT ON THE FRONT OF THE PUMP**. Use flexible connections where appropriate.

Service Liquid Supply Options:

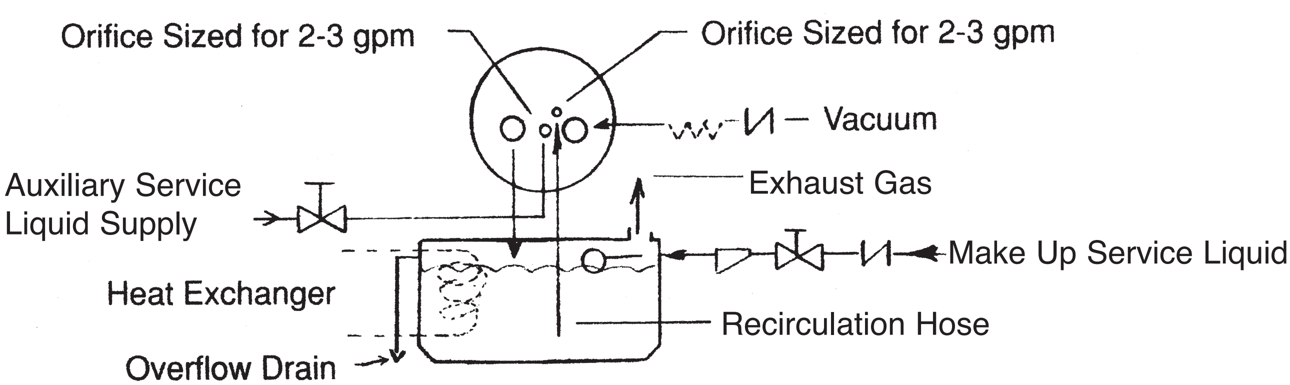
STRAIGHT THROUGH:



PARTIAL RECIRCULATION (50%):



FULL RECIRCULATION (100%):



In the standard Lyco package, pumps are mounted on top of a stainless steel recirculation tank. This tank includes a stainless steel float valve to control the level of service liquid (usually water), since about 1-2 gallons per hour per pump will be lost by evaporation. Also included are fittings for drain and overflow connections, and a maintenance access panel.

A manually operated, auxiliary service liquid line is included for conveniently filling the tank and priming the pump. Don't start the pump until this had been done. Water level can be observed through the clear, recirculation hose. The auxiliary line can also be used for cooling when high temperatures may interfere with performance needs.

Service liquid water temperatures will rise during recirculation and balance out at some level. This level will depend on the pump size, room temperature and incoming heat from the process. As the temperature rises, performance drops, particularly at higher vacuum levels. For example, at 120° F water, capacities in the 10-20 in-hg vacuum range can be 10-20% lower and in the 10-20 in-hg vacuum range, 20-40% lower than catalogue ratings which are based on 60° F water temperature.

If this is a problem, consideration should be given to over sizing the pump or using a heat exchanger.

Note: **ALWAYS USE A CHECK VALVE IN THE VACUUM LINE WHEN USING A RECIRCULATING SYSTEM.** This allows the pump to retain sufficient water for self priming when it is shut off, and allows it to produce sufficient vacuum to draw service liquid up from the tank when it is restarted.

Motor and Electrical Information:

MOTORS FOR CLOSE-COUPLED PUMP MODELS 101 & 102:

Standard motors are close-coupled, **energy efficient**, totally enclosed, three phase, and have the following features:

Mechanical

- Oversized, stainless steel shafts.
- Oversized, permanently lubricated bearings.

Electrical

- Comply with EPACT & NRCan efficiency standards.
- NEMA Design B performance, Class F insulation.
- 1.25 service factor.

MODELS 101 & 102 ONLY

MODELS 101&102 501&502	HP	RPM	VOLTAGE	AMPS FLA	AMPS SFA	EFFICIENCY @ FULL LOAD NEMA NOMINAL	ELECT. CONN.	FRAME SIZE	SHAFT DIA. (IN.)	BEARINGS SHAFT END	BEARINGS OPPOSITE END
-40	3	1765	230/460/60/3	8.0/4.0	9.7/4.8	87.5	WYE	182	1.25	6307-2RS-J/C3	6205-2Z-J/C3
		1455	190/380/50/3	9.5/4.7	-	85.5				(Single Row)	
-80	5	1755	230/460/60/3	12.8/6.4	15.8/7.9	87.5	WYE	184	1.25	6307-2RS-J/C3	6205-2Z-J/C3
		1435	190/380/50/3	15.8/7.9	-	82.5				(Single Row)	
-120	7.5	1765	230/460/60/3	18.8/9.4	23.2/11.6	89.5	DELTA	213	1.75	5211-A-2RS	6206-2Z-J/C3
		1450	190/390/50/3	22.7/11.4	-	87.5				(Double Row)	
-160	10	1760	230/460/60/3	24.7/12.3	31.0/15.5	89.5	DELTA	215	1.75	5211-A-2RS	6206-2Z-J/C3
		1440	190/380/50/3	30.0/15.2	-	86.5				(Double Row)	

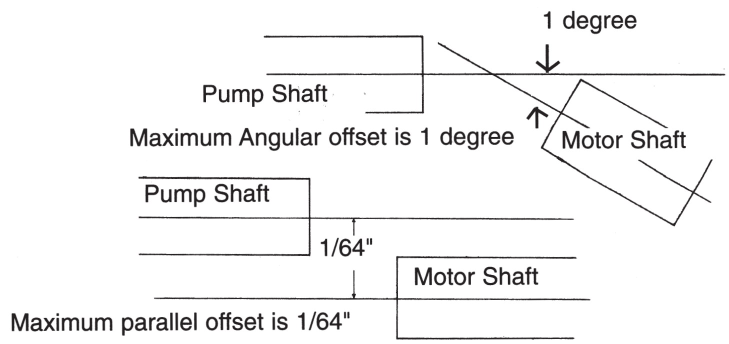
MOTORS FOR PEDESTAL MOUNTED PUMP MODELS 501 & 502:

Standard motors are general purpose, **energy efficient**, totally enclosed, three phase, and they have the same electrical features as the close-coupled motors shown in the table above.

Non-standard motor selections for pump Models 501&502, are unlimited, since they are separate and connected to the pump with a coupling. This pump model is used for selections such as explosive-proof and severe duty motors, and for oversized motors.

Note that if a non-standard motor with a 1.0 service factor is selected, the next size larger motor should be used.

When field mounting motors for pump Models 501&502, the motor shaft must be properly aligned with the pump shaft, or premature coupling or bearing failure can occur. No more than 1 degree angular or 1/64 inch parallel offset should be tolerated:



Wiring and Startup:

1. Use the wiring diagram inside the motor junction box for instructions. Note that close-coupled, Models 101&102, 3 and 5 hp motors, have “Wye” wiring connections while the 7.5 and 10 hp motors, have “Delta” connections.

2. Fill the pump with service liquid (usually water) up to the bottom of the inlet and exhaust ports. Do not start the pump without water. With a recirculating system, also fill the tank.

3. Check the pump rotation by jogging the motor on. Direction of rotation should be counter clockwise when facing the front of the pump.

4. There are three options for wiring the same three phase motor, and each one can have a different percent of current unbalance between legs. It is desirable to find the option with the least percent of unbalance by wiring the motor all three ways during startup. To prevent changing the motor rotation when this is being done, the motor leads should be rolled across the starter terminals by always moving them in the same direction.

   Use the following steps to calculate current unbalance for each of the three wiring options:

   > Get three amp reading, one for each leg, add them together and divide by 3 to get the “amp average”.
   >
   > Of the three readings, determine which one has the “greatest amp difference” between it and the average. Then, divide this difference by the average to get the percent of unbalance:
   >
   > % Unbalance = 100 x “Greatest Amp Difference” ÷ “Amp Average”

   Percent of unbalance should not exceed 5%, to avoid shortened motor life. If there is more than a 5% unbalance in all three wiring options, the problem is probably in the power supply.

Maintenance **(refer to parts list Page 20)**

<u>Trouble Shooting</u>:

A. Decrease or loss of performance-check the following:
   1. All fittings, connections, lines and tanks for air leaks into to the system.
   2. Service liquid flow into the pump. It should be 2-3 gpm of water. If low, check for obstructions in the piping, valves, strainers and orifices. Also check for low water pressure in the main water supply. For recirculation tanks, see item E (page 12).
   3. Service liquid temperature, since performance is reduced as temperature increases. Catalogued performance is based on 60° F water. For information on temperature effect, contact factory.
   4. Fluctuating pressures in the water supply if performance is fluctuating. Resolve with a constant gpm/variable pressure orifice in the service liquid line.
   5. Scale build up. Resolve with descaling acid.
   6. Too much clearance between the rotor (27) and porting turbine cover (36). Factory setting is .005-.010 inches with the six through bolts (37) "cross tightened" equally to 6 ft-lbs (72 in-lbs). Too much clearance can be caused by:
      a. Loose through bolts. This can be corrected by "cross tightening" all six through bolts equally to 6 ft-lbs.
      b. Adjusting setscrews (31) that have been previously disturbed. See "**<u>Disassembly and Shaft Removal</u>**" paragraph "D 2" (page 13).
      c. Clearance lost by long term wear. This clearance can be regained to some extent by tightening through bolts to more than 6 ft-lbs. Note each 1/10 turn equals .005 inches. Avoid seriously over tightening since this can distort the porting turbine cover (36) and also cause rubbing.
      d. Note, <u>use Loctite #242 on all threaded connections</u>, and for more sophisticated adjustment procedures, see "**<u>Clearance Adjustment Procedures</u>**" (page 14).

B. Leaks in the pump:
   1. Check torque on through bolts (37), and if they have loosened up, "cross tighten" them to 6ft-lbs (72in-lbs) with a torque wrench. <u>Use Loctite #242 on all threaded connections</u>
   2. If leak is in the back of the motor turbine cover (21) and between it and the motor or the bearing house, a new shaft seal is needed. A leaking shaft seal should be replaced as soon as possible, see "**<u>Seals</u>**" (page 3).
   3. If leak is in front of the motor turbine cover (21), a new o-ring (23) may be required, but if the o-ring groove is cracked, a new motor turbine plastic (22) is required. For a temporary fix, fill the crack with silicone sealant.
   4. If leak is in the back of the porting turbine cover (36), a new o-ring (23) may be required, but if the o-ring groove is cracked, fill it with silicone sealant as a temporary fix. Eventually, the porting turbine cover should be factory repaired or replaced. Cracked o-ring grooves are usually caused by excessive weight on the front of the pump or by using a screw driver to pry it apart when servicing. Always use a rubber hammer to tap it apart.

C. Excessive noise and vibration—check for the following:
   1. Cavitation. It sounds like nuts, bolts and screws violently rattling around inside the pump, and it is destructive. It occurs near the "blocked-off" vacuum level, and is aggravated by excessive liquid flow into the pump. Solve by bleeding air into the

vacuum line, and reducing water flow to 2-3 gpm, if possible. If not, excess water can be relieved through the pump drain to which a hand valve can be attached to control flow.

2. Liquid slugging through vacuum inlet. It sounds like cavitation and is equally destructive.
3. Excessive amounts of liquid flow, over 2-3 gpm, entering pump.
4. Scale build up.
5. Motor vibration (Models 101&102), bearing vibration (Models 501&502).
6. Coupling misalignment (Models 501&502).
7. Backward rotor rotation.
8. Rotor loose on shaft.
9. If noise is only the high pitched sound from the pump exhaust, it can be easily attenuated by changing direction of the exhaust.

D. Motor trouble:

1. High Running Amps -- check for the following:
   a. Restriction of exhaust line which causes back pressure which causes motor to work harder.
   b. Excessive amounts of liquid flow, over 2-3 gpm, entering pump.
   c. Cavitation
   d. Liquid slugging through vacuum inlet.
   e. Rubbing between rotor (27) and porting plate in the porting turbine cover (36).
   f. Low or high voltage.
   g. Loose wire connections at motor or starter.
   h. Excessively high motor ambient.
   i. Current imbalance between legs on three phase motors.
2. Noise and vibration—check for the following:
   a. Loose wiring connections on one leg, single phasing.
   b. Bad bearings.
3. If motor problems persists, check with authorized motor repair shop.

E. Trouble shooting with a recirculation tank:

1. Follow procedures in steps A through D, above, plus check the following:
2. If pump will not produce vacuum at startup, check if recirculation water is being drawn up from the tank. If not, prime pump and restart.
3. Be sure inlet check valve is functioning. It must keep liquid in the pump when it is shut off, or the pump will not be self priming.
4. Check the flow control orifice in the recirculation line. If plugged, pump will receive little or no water. If missing, pump will receive too much water.
5. Check water temperature in the tank. High temperatures will not harm the pump, but they will affect performance. In extreme cases, there may be insufficient vacuum to draw recirculated water up from the tank. Reduce temperature by letting in cool water through the auxiliary service liquid line.
6. If the system vacuum level falls below 5-7 in-Hg at anytime during the process cycle, there may be insufficient vacuum to draw water up from the tank, and the pump can run dry. A higher vacuum can be induced into pump by partially restricting the inlet. This can be done with a hand valve installed in the line ahead of the pump.

Pump Disassembly and Shaft Seal Removal (refer to parts list Page 20):

A. Disconnect power source and drain the pump (34).

B. Remove stainless steel shroud (35) and six through bolts (37).

C. Remove porting turbine cover (36) and cylinder body (33). **USE A RUBBER HAMMER TO TAP THEM APART** rather than using a screw driver to pry them apart since this can crack the o-ring grooves and cause a leak.

D. Rotor removal (Carefully follow these steps):
   1. Remove rotor setscrews (28) between the vanes on rotor and located 90˚ apart;
   2. Remove rotor retaining bolt (32) in end of rotor (27), but **DON'T TOUCH THE TWO ADJUSTING SETSCREWS (31) which are located beside the retainer bolt.** This is **VERY IMPORTANT** for retaining the proper clearance (.005-.010 in.) between the rotor face and the porting turbine cover (36) when the pump is reassembled. If these are disturbed, clearance will need to be reset. Note that the clearance will always need to be reset if the rotor (27), shaft (105) or close-coupled motor (40) is replaced. See "**Clearance Adjustment Procedures**", (page 14) or contact the factory for other suggestions.
   3. Remove rotor (27) from shaft, being careful to slide rotor over key (29);
   4. If rotor (27) will not come off freely, turn a 5/8-11 bolt into the rotor, center hole which is threaded, and push off motor shaft.

E. Seal removal: Remove key (29), seal spring (24), and slide seal (24) off shaft.

F. Remove motor turbine plastic (22) by pulling it directly towards you. If it has a cracked o-ring groove or is worn, it must be replaced.

G. The stationary seat portion of seal (24) can now be pressed out of motor turbine plastic (22).

H. Remove the four motor turbine bolts (39), and remove motor turbine cover (21) from the motor or bearing housing if necessary to service these components.

Pump Assembly and Shaft Seal Installation:

A. Place motor turbine cover (21) on motor or bearing housing and bolt in position with the four motor turbine bolts (39). The two machined head bolts are used in the bottom holes. Use Loctite #242 on all threads.

B. Press stationary seat portion of seal (24) into motor turbine plastic (22) until it bottoms into bore. Motor turbine plastic must be replaced if it is cracked or worn. Some servicemen automatically replace this with the seal. Use P-80 THIX (International Products Corp.) glycerin, or a light machine oil (except don't use oil with EPDM elastomers) on elastomer cup and shaft side of bellows for easier installation. Don't touch sealing surfaces with fingers.

C. Place motor turbine plastic (22) in bored hole in motor turbine cover (21) and align locating lug. Take care when installing to avoid damage to stationary seat portion of seal (24).

D. Replace Shaft Seal:
Slowly slide seal (24) on to shaft (use P-80 glycerin or light machine oil, <u>except don't use oil with EPDM elastomers</u>) until it touches stationary seat portion of seal. Don't touch sealing surface with fingers. Replace spring (24) and key (29).

E. Replace rotor:
1. Push rotor (27) on shaft until adjusting setscrews (31) contact end of shaft. <u>IF THEY HAVEN'T BEEN TOUCHED AS PREVIOUSLY INSTRUCTED THEY WILL PROVIDE PROPER CLEARANCE</u> between the rotor (27) and porting turbine cover (36);
2. Replace retainer bolt (32) and rotor setscrews (28). Recommended seating torque for retainer bolt (1/2-13 x 1/2) is 62.5 foot pounds. For rotor setscrews (3/8-16 x 5/8) it is 19.2 foot pounds.

F. Replace o-rings (23) (new o-rings are recommended always), cylinder body (33), porting turbine cover (36), through bolts (37) and stainless steel shroud (35). NOTE: Be sure o-rings and all sealing surfaces are clean.

G. Then, tap lightly around the outside of the porting turbine cover (36) with a rubber hammer to seal it after assembly. <u>**"Cross Tighten" the six through bolts (37) equally to 6 foot pounds (72 inch pounds)**</u>, with a torque wrench. This should provide the same clearance as set at the factory provided the shaft has not shifted as a result of a change in a bearing lock ring location.

H. Notes:
1. <u>Use Loctite #242 on all threaded connections.</u>
2. Avoid "over tightening" the through bolts (37) since this can distort the porting turbine cover (36) and also cause rubbing.
3. If clearance adjustment is required, see "<u>**Clearance Adjustment Procedures**</u>" below.

<u>Clearance Adjustment procedures</u> (refer to parts list Page 20):

Lyco Wausau, liquid ring vacuum pumps are among the easiest to field service if procedures in the section "<u>**Pump Disassembly and Shaft Removal**</u>" (page 13), are carefully followed, The main point is "<u>**DON'T TOUCH THE TWO ADJUSTING SET SCREWS"**</u>. This is because they provide a locating point for clearance between the rotor (27) and porting turbine cover (36), and if they are disturbed, the clearance must be reset. Note that clearance must always be reset if the rotor, shaft (105) or close-coupled pump motor (40) are changed. Clearance of .005-.010 inches is basic to performance. If it is too wide, the pump will underperform. If it is too close, rubbing can occur and cause overheating and motor problems.

The objective of the following STEPS, is to show how this can be done with reasonable precision. <u>If optimum performance is unnecessary, and if the following repair tools are unavailable, contact the factory for instructions on abbreviated procedures.</u>

Repair tools needed (see to **"Parts List"** page 23):

1. Dial indicator accurate to .001-.050 inch total travel
2. Depth micrometer accurate to .001 inch
3. Post for dial indicator
4. Torque wrench, adjustable up to 10 ft-lbs.
5. Torque wrench, adjustable 10-80 ft-lbs., 3/8" drive and with long length 3/16" hex bit (for tightening rotor set screws (28)

STEP 1

A. Partially assemble the pump with motor turbine cover (21), motor turbine plastic (22) and shaft seal assembly (24). See "**Pump Assembly and Shaft Seal Installation**" (page 13).

B. Before installing the rotor (27), remove the rotor retainer bolt (32), rotor set screws (28) and adjusting setscrews (31).

C. Install shaft key w/pin (29) and rotor (27) on the shaft. Install the rotor retainer bolt (32), and screw it in until the rear of the rotor is approximately 1/8 inch from the upper face of the motor turbine plastic (22). Use Loctite #242 on the bolt threads.

D. Place a dial indicator on the smooth part of the rotor face, rotate it 360 degrees to find the "high point". Mark this point as instructed in figure 1.

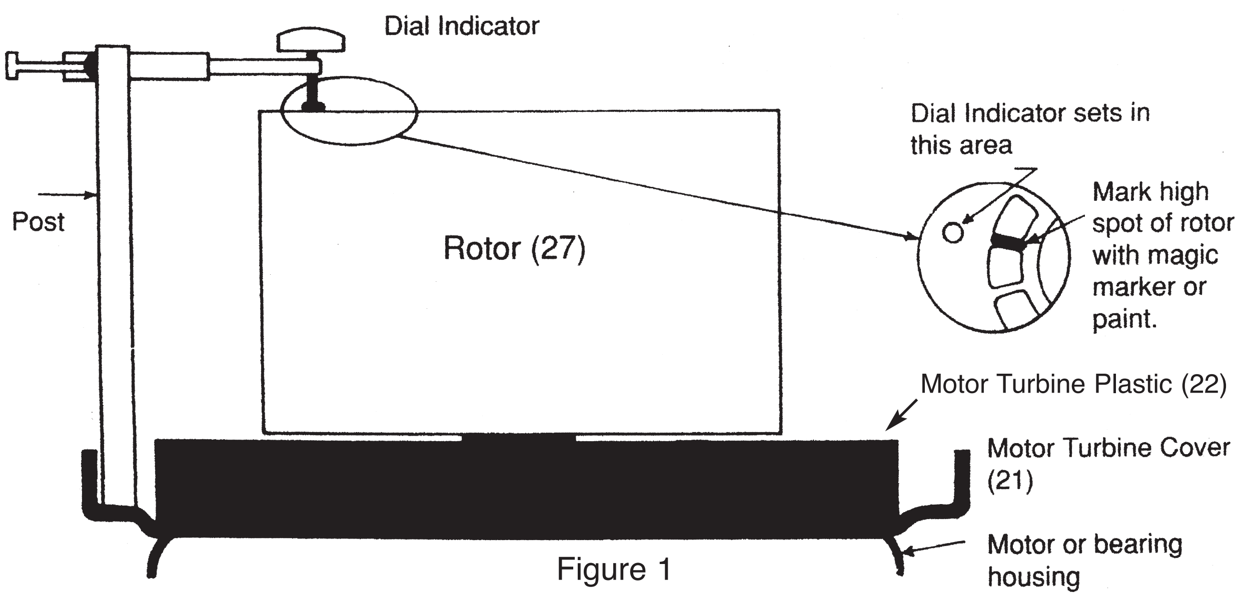


Figure 1

STEP 2

A. Lay porting turbine cover (36) on face of rotor (27).

B. From the top of each port, take a depth micrometer measurement to the "high spot" determined in Step 1. Mark the locations from where these measurement were taken on the top of each port, since similar readings will be needed in STEPS 3 and 5. See figure 2.

Record the readings. We suggest they be written on the porting turbine cover (36) along side the port where each reading was taken. Use a pencil for easy erasing later.

EXAMPLE:	Exhaust Port	Vacuum Port
STEP 2	1.100 Inches	1.050 Inches

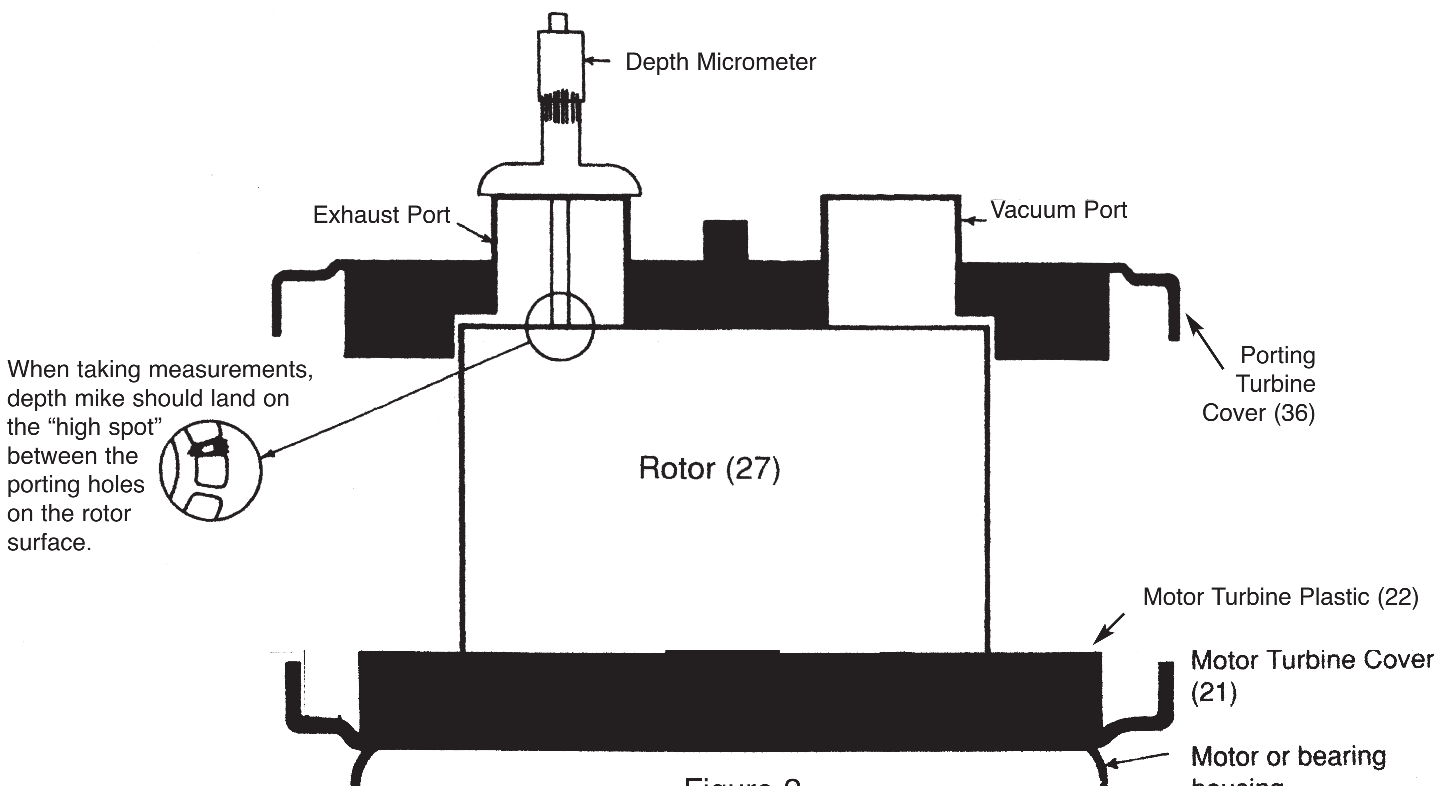


Figure 2

STEP 3

A. Assemble the remainder of the pump with the exception of the adjusting setscrews (31) and rotor setscrews (28) which will be installed later in STEP 4. Follow the instructions as described below:

B. Install cylinder body (33) with the drain connection positioned at the bottom-rear of the pump. Line up the six through bolt loops with corresponding six holes in the motor turbine cover (21), and use a rubber hammer to gently tap it down evenly over the motor turbine plastic (22) until it touches the o-ring all around.

C. Place the porting turbine cover (36) into the cylinder body (33) with its six through bolt holes lined up with corresponding loops on the cylinder body, and with the service liquid inlet lined up with the rotor retainer bolt (32). Use a rubber hammer to gently tap it down evenly all around into the cylinder body.

D. Insert the six through bolts (37) with the “castle head” nut ends facing the front. **Use Loctite #242 on all threads.**

E. Gradually “cross tighten” all of the through bolts (37) until the porting turbine cover (36) begins rubbing on the rotor (27). Determine this by periodically turning the rotor with a screw driver inserted through one of the ports.

F. Lower the rotor (27) on the shaft until it turns freely by turning down the rotor retainer bolt (32) with a 3/8 inch Allen wrench inserted through the 1/2 inch, service liquid primary inlet in the center of the porting cover (36), see page 5. Turn the retainer bolt until the rotor breaks free and turns when the retainer bolt is turned. Note that 1/10 turn will lower the rotor .008 inches.

G. Continue this procedure until the six through bolts (37) are all tightened to six foot pounds (72 in-lbs.) with a torque wrench, and the rotor (27) turns freely when it is turned completely around (360 degrees).

H. Tap lightly on the porting turbine cover (36) all around with a rubber hammer to be sure it is evenly set in the cylinder body (33). Recheck the torque on the through bolts (37), and tighten them if necessary.

I. Make a final check for rubbing by turning the rotor (27) completely around (360 degrees). If it is still rubbing, turn the rotor retainer bold (32) down again until the rotor breaks free and turns when the bolt is turned. At this point the clearance should be about .005 inches.

J. Determine clearance by taking two more depth micrometer measurements to the "high point", one through each port, see Figure 3. Take these from the same locations marked on top of the ports in STEP 2. Record these readings with those from STEP 2, and calculate the differences which are the clearances. Note that clearances at each port are usually different due to tolerance variations in the pump.

Example:	Exhaust Port	Vacuum Port
STEP 3	1.106 inches	1.054 inches
STEP 2	1.100	1.050
Clearance	.006	.004

The objective in STEP 3, is to have a clearance within the range of .005-.010 inches at the port where the "high point" is closest. A clearance on the low side of the range, as in this example, is desirable; however, if it is above the range, it can be lowered in STEP 4.

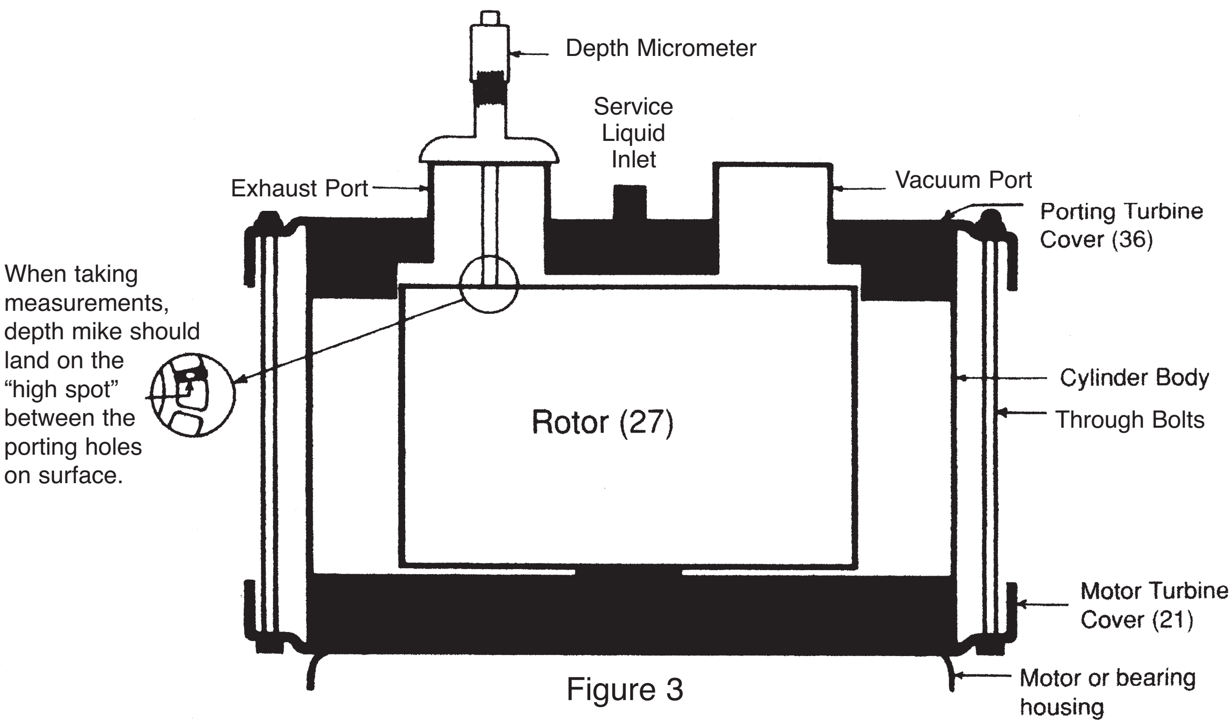


Figure 3

STEP 4

A. Partially disassemble the pump, including the through bolts (37), porting turbine cover (36) and cylinder body (33).

B. Set up the dial indicator again as shown in STEP 1, and set the dial to zero at the "high spot" so that any change in clearance can be measured. Be sure to have adequate travel on the indicator to accommodate adjustments that may be required.

C. Install the two adjusting setscrews (31) on each side of the rotor retainer bolt (32) and tighten them until they are snug against the end of the shaft. Use Loctite #242 on the threads.

D. If the clearance in STEP 3 is on the low side of the .005-.010 range, as in the example, tighten the rotor retainer bolt (32) to 62.5 foot pounds with a torque wrench, and observe the dial indicator reading.

E. If the clearance at any time is more than .010 inch, raise the rotor (27) by slightly backing out the rotor retainer bolt (32) and turning in the adjusting set screws (31). Note that 1/10 turn of the adjusting setscrews is .005 inches for 3&5hp pump models and .006 for the 7.5&10hp models. Observe the clearance changes on the dial indicator, and when the desired clearance is reached, tighten the rotor retainer bolt (32) to 62.5 foot pounds, using a torque wrench. Then install the rotor setscrews (28) and tighten to 19.2 foot pounds after using Loctite #242 on the threads.

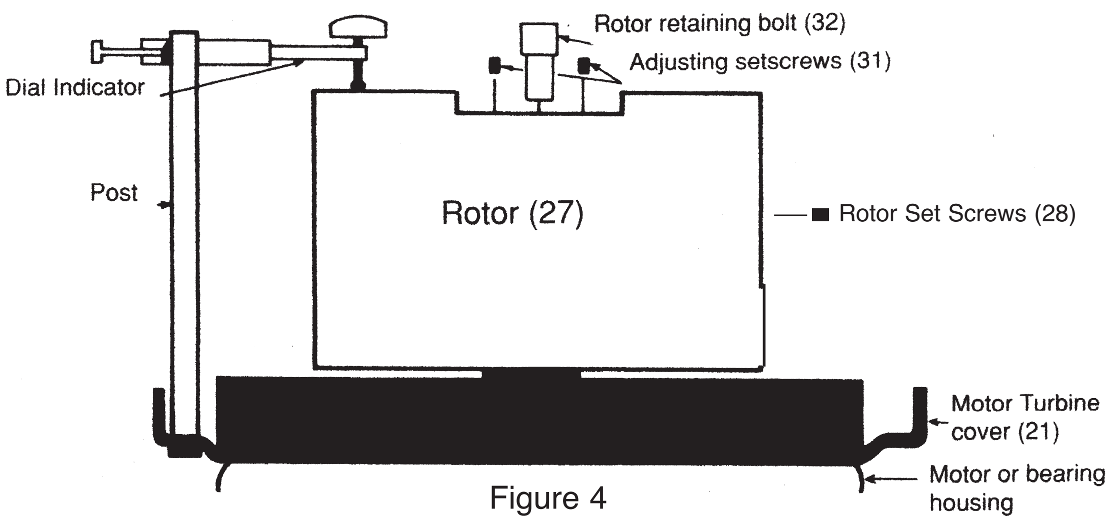


Figure 4

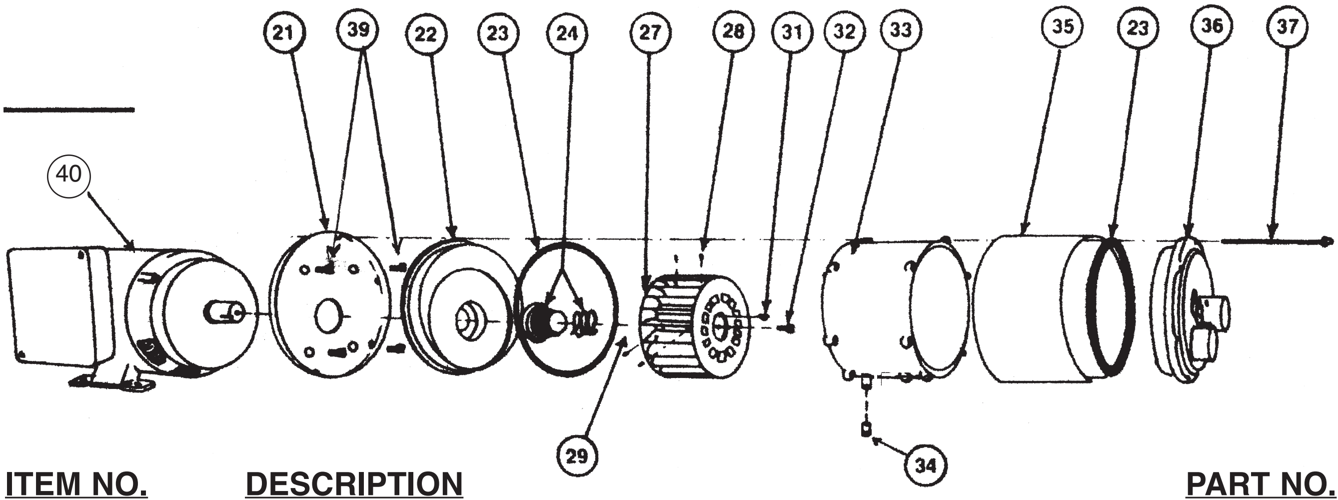
STEP 5

A. Reassemble the pump. Be sure to "cross torque" the through bolts (37) to 6 foot pound (72 pound inches).

B. Turn the rotor (27) completely around (360 degrees) to be sure it isn't rubbing.

C. Recheck the clearance using the depth micrometer as in STEP 3. At this point, clearance should be within an acceptable range; however, if it isn't or if there is rubbing, STEP 4 should be repeated.

Parts List:



ITEM NO.	DESCRIPTION		PART NO.
3	1 1/2" No-hub coupling		5500-99
4	3" No-hub coupling		5700-99
6	Float assembly		5805-99
8	Inlet check valve		5200-99
9A	Separator/muffler	Simplex	5005-99S
9B	Separator/muffler	Duplex	5005-99D
11	Solenoid valve		5400-99
16	Recycling tubing		5151-99
17	Constant gpm/variable pressure orifice		5150-99
21	Motor turbine cover		2400-99
*22A	Motor turbine plastic (3 & 5 HP)	Noryl, std.	0800-35
		PBT	0800-35P
		Tefzel	0800-35T
*22B	Motor turbine plastic (7.5 & 10 HP)	Noryl, std.	0800-17
		PBT	0800-17P
		Tefzel	0800-17T
*23	O-rings, set of two	Buna N, std.	0900-99
		Viton	0900-99V
		EPDM	0900-99E
		Teflon Encapsulated	0900-99T
*24A	Shaft Seal assembly (3 & 5 HP)	Buna N, std.	1100-35
		Viton	1100-35V
		EPDM	1100-35E
*24B	Shaft Seal assembly (7.5 & 10 HP)	Buna N, std.	1100-17
		Viton	1100-17V
		EPDM	1100-17E
27A	Rotor 3 HP		1400-30
27B	Rotor 5 HP		1400-50
27C	Rotor 7.5 HP		1400-75
27D	Rotor 10 HP		1400-10
*28	Rotor setscrew (2 needed for 3-5 HP model & 4 for 7.5-10 HP)		1602-99

* These items are recommended for a spare parts kit.

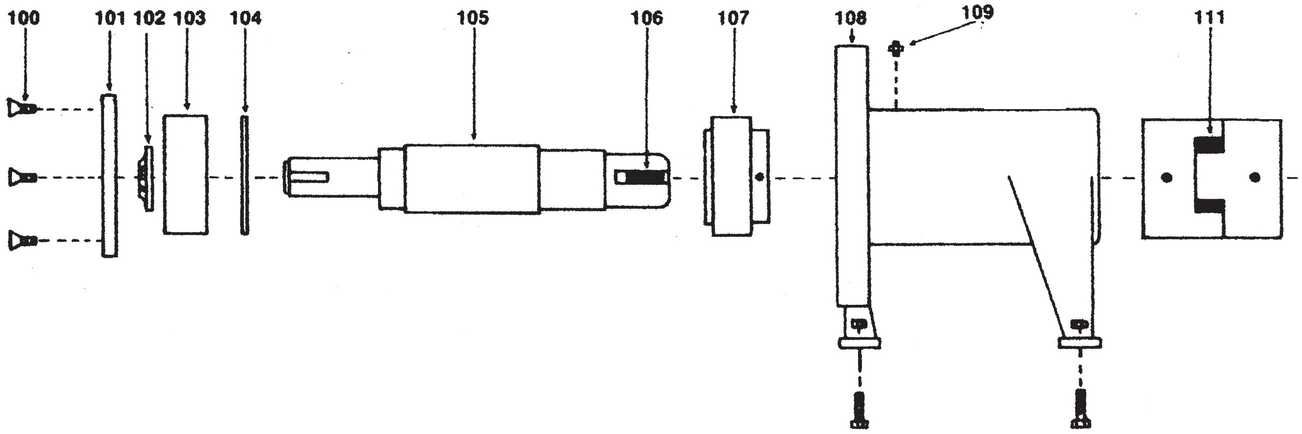
SPECIFY PUMP SERIAL AND MODEL NUMBER AND USE PART NUMBERS WHEN ORDERING PARTS.

29A	Shaft key w/expansion pin (3 & 5 HP)		1500-35
29B	Shaft key w/expansion pin (7.5 & 10 HP)		1500-17
31A	Adjusting setscrew, 1/4" (3 & 5 HP - 2 needed)		1601-35
31B	Adjusting setscrew, 3/8" (7.5 & 10 HP - 2 needed)		1601-17
32	Rotor retainer bolt		1775-99
33A	Cylinder body 3 HP		2000-30
33B	Cylinder body 5 HP		2000-50
33C	Cylinder body 7.5 HP		2000-75
33D	Cylinder body 10 HP		2000-10
34	Pipe plug, Drain		2401-99
35A	Shroud 3 HP		2050-30
35B	Shroud 5 HP		2050-50
35C	Shroud 7.5 HP		2050-75
35D	Shroud 10 HP		2050-10
36	Porting turbine cover	Noryl & Neoprene, std.	2300-99
		Noryl & Viton	2300-99V
		Noryl & EPDM	2300-99E
		Noryl & Gortex	2300-99T
		PBT & Neoprene	2300-99PN
		PBT & Viton	2300-99PV
		PBT & EPDM	2300-99PE
		PBT & Gortex	2300-99PT
		Tefzel & Neoprene	2300-99TN
		Tefzel & Viton	2300-99TV
		Tefzel & EPDM	2300-99TE
		Tefzel & Gortex	2300-99TT
37A	Through bolts, set of six w/nuts, 3 HP		0500-30
37B	Through bolts, set of six w/nuts, 5 HP		0500-50
37C	Through bolts, set of six w/nuts, 7.5 HP		0500-75
37D	Through bolts, set of six w/nuts, 10 HP		0500-10
39A	Motor turbine bolts 1/2-13x1, top		2402-99
39B	Motor turbine bolts 1/2-13x1 machined, bottom		2403-99

Vacuum pump Models 101&102, closed coupled motors

40A	3 HP,	1750 RPM,	230/460/60/3,	TEFC,	1.25SF	2500-30-3
40B	5 HP,	"	"	"	"	2500-50-3
40C	7.5 HP,	"	"	"	"	2500-75-3
40D	10 HP,	"	"	"	"	2500-10-3
40E	5 HP,	1750 RPM,	230/60/1,	ODP,	1.15 SF	2500-50-1
40F	7.5 HP	"	"	"	"	2500-75-1

SPECIFY PUMP SERIAL AND MODEL NUMBER AND USE PART NUMBERS WHEN ORDERING PARTS.



VACUUM PUMP MODELS 501&502, BEARING HOUSING

ITEM NO.	DESCRIPTION	PART NO.
100	Allen flat head socket capscrew, set of 3	1620-99-D
101A	Bearing retainer 3, 5, 7.5 & 10 HP	1420-99-D
101B	Bearing retainer 3 HP (after serial no. 540-1081-05)	
	5 HP (after serial no. 580-1021-96)	
	7 HP (after serial no. 512-1067-67)	
	10 HP (after serial no. LH-10-0142)	1420-99-DL
*102	Slinger	1424-99-D
*103A	Front bearing 3, 5, 7.5 & 10 HP	1421-99-D
*103B	Front bearing 3 HP (after serial no. 540-1081-05)	
	5 HP (after serial no. 580-0121-96)	
	7.5 HP (after serial no. 512-1067-67)	
	10 HP (after serial no. LH-10-0142)	1421-99-DL

Note: If item 103A, front bearing, part no. 1421-99D, is used in your pump, specify that a spacer sleeve should ship with the replacement shaft.

ITEM NO.	DESCRIPTION	PART NO.
104	Grease retainer (not required in current models)	1422-99-D
105A	Shaft 3 HP	1450-30-DL
105B	Shaft 5 HP	1450-50-DL
105C	Shaft 7.5 HP	1450-75-DL
105D	Shaft 10 HP	1450-10-DL
106A	Drive key 5/16" sq. x 1 1/4"	1460-99-D
106B	Drive key 1/4" sq. x 1 1/4"	1460-99-D
*107	Rear bearing 3, 5, 7.5, 10 HP	1423-99-D

* These items are recommended for a spare parts kit.

SPECIFY PUMP SERIAL AND MODEL NUMBER AND USE PART NUMBERS WHEN ORDERING PARTS.

108A	Housing only 3, 5, 7.5, 10 HP		1425-99-D
108B	Housing 3 HP (A/SN 540-1081-05)		
	5 HP (A/SN 580-0121-96)		
	7.5 HP (A/SN 512-1067-67)		
	10 HP (A/SN-LH-10-0142)		1425-99-DL
109	Grease insert		1426-99-D
110	Complete housing assemblies including housing,		
	shaft, bearings & couplings:	3 HP	1427-30-DL
		5 HP	1427-50-DL
		7.5 HP	1427-75-DL
		10 HP	1427-10-DL
111A	Coupling complete, 1 1/8" x 1 3/8"	3 & 5 HP	1430-35D
111B	Coupling complete, 1 3/8" x 1 3/8"	7.5 & 10 HP	1430-17D

REPAIR TOOLS

	DESCRIPTION	**PART NO.**
112	Dial indicator and clamp, accurate to .001-.050 travel	6100-99
113	Depth micrometer set, accurate to .001	6101-99
114	Post for dial indicator	6103-99
115	Torque wrench, adjustable up to 10 foot pounds	6104-99
116	Torque wrench, adjustable 10-80 foot pounds, 3/8" drive with long length 3/16" hex bit	6108-99
117	Air flow meter (for field testing CFM)	6105-99
118	Service video tape	6106-99
119	Installation, Operation and Maintenance Instructions	6107-99

SPECIFY PUMP SERIAL AND MODEL NUMBER AND USE PART NUMBERS WHEN ORDERING PARTS.

Factory Rebuilding:

Lyco Wausau offers a special, factory, rebuilding program for Lyco owners. This work is done on an expedited basis, so turn around is fast. Some who have “standby” pumps prefer to send all of their Lyco pumps in for maintenance, while others use this service only for major repairs.

Having a standby pump can be advantageous for minimum downtime whether pumps are repaired in your shop or returned to the factory. Lyco owners can contact Lyco for special pricing on “standby” pumps.

Factory pricing for pump maintenance depends on what is required, but even with major repairs, it seldom reaches more than one half the price of a new pump. Rebuilt pumps carry a new pump warranty on all Lyco manufactured parts which are repaired or replaced.

The procedure for using this service is as follows:

1. Include note on your Purchase order:
   “Submit quote for approval before proceeding.”
2. Fax copy of Purchase order to Lyco Wausau office,
   and include a copy with the pump being sent.

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS
MULTI-PUMP, SINGLE-STAGE MODELS

All the INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS for single pumps also apply to duplex, triplex and quadplex pump models. These multi-pump models are composed of individual, single-stage pumps which have vacuum intakes piped in parallel. There are some unique instructions that apply to these models, and they are described below:

<u>Arrangements</u>: The most common Lyco, multi-pump arrangement is a duplex model where two pumps are vertically stacked, one on top of the other, in a compact package. Of these, the most popular is the 20HP package (2-10HP) model. These usually include: A duplex separator/muffler for the exhaust and a duplex manifold for the vacuum intake. Separator/mufflers are often fitted with a 50% recirculation fitting, and intake manifolds often include a vacuum relief valve and vacuum gage.

Another popular arrangement is a horizontal, duplex model where two, close-coupled pumps are mounted back to back on the same base. These usually include two separator/mufflers, one for each pump, and the pump intakes are generally manifolded together in the field. The base arrangement is designed so it can be mounted on a Lyco recirculation tank. This is also a common approach which doesn't require separator/mufflers.

Triplex and quadplex models are similar in arrangements to vertical, duplex models with a quadplex looking similar to two vertical duplex models attached side by side.

The following general comments apply to all of these models:

<u>Controls</u>: Each pump in the package requires a starter. All pumps can be started and run at the same time, or they can be staged in response to process demands, or one or more can be run with others being used as standby.

Where staged or standby applications are employed, check valves must be installed in the intake of each pump so air will not be drawn through the pumps that are idle. Also in these cases, alternating controls are desirable so operating times for all pumps in the package are evened out.

<u>Vacuum and exhaust lines</u>: To reduce vacuum piping losses, intake manifold piping should be sized to have a minimum cross section area equal to the sum of the intake openings for all of the pumps in the package. For a duplex manifold, this is a 2.5" dia. tube or pipe which has a cross section area comparable to two 1.5" dia. pump intake openings. For other multi-pump combinations, see "**<u>Vacuum Piping</u>**" (page 5).

Exhaust lines should be amply sized so there is minimum back pressure on the pumps. Vacuum pumps are designed to discharge into atmospheric pressure, and back pressure can significantly increase motor operating amps and put extra stress on pump rotors, shafts and bearings.

To avoid excessive back pressure, lines connecting to separator/muffler openings (air discharge on top and liquid drain on the bottom) should not be sized smaller than these openings. Also when these openings are manifolded, piping should be sized to have a minimum cross section area equal to the sum of the areas of all the openings being manifolded.

Pump cavitation should be avoided since this puts extra stress on pump rotors, shafts, bearings and motors. Cavitation sounds like nuts, bolts and screws violently rattling around inside the pump. It can be eliminated by proper setting of vacuum relief valves, or by bleeding air into the vacuum line, or by avoiding excess service liquid, or by installing drain piping to each pump to relieve unusually large quantities of liquid entering the pump package from the process.

Contact the factory if you have any questions on this.

Maintenance: The largest pump in a Lyco multi-pump package is 10HP. These pumps are compact and light enough to be easily handled and transported within a plant. For this reason, they can be readily removed to the maintenance shop for fast repair on a shop bench where all tools and parts are easily accessible. Unlike larger, heavier pumps, they don't have to be repaired on-the-job where quarters are cramped and repairs are often difficult and slow.

This concept allows a module approach to pump repairs in critical applications. A spare pump can be stocked in the maintenance shop for a quick change out while the pump being replaced can be returned to the shop for repair on a non emergency basis. Contact the factory for special pricing on standby pumps.

Lyco pumps are designed to be easy to field repair. They can be readily disassembled and reassembled without the need to reset clearances between the rotor and the porting plate if you follow instructions in section "**Pump Disassembly and Shaft Removal**" (page 13).
The main point is **"DON'T TOUCH THE TWO ADJUSTING SETSCREWS (31)."**

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS
TWO-STAGE MODELS

All the INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS for Single-Stage pumps also apply to the Two-Stage models. Since Lyco, Two-Stage models include two pumps piped in series, there are some piping differences, and they are described below.

Service liquid line: It is normally attached to the first stage pump in the series in the same way as with the “STRAIGHT THROUGH” arrangement shown on page 7. Service liquid to the second stage pump comes from the first pump through the interconnecting piping (from the exhaust port of the first to the vacuum port of the second).

High vacuum performance can often be improved with greater service liquid flow than the standard 2-3 gpm; however, this may cause cavitation in some models. Cavitation may also occur if the inlet is blocked off or if there is unusually large quantities of liquid entering the pump package from the process. Cavitation reduces performance and puts stress on pump rotors, shafts, bearings and motors and produces a noise which sounds like nuts, bolts and screws violently rattling around inside the pump. This cavitation can be eliminated. As explained below.

Drain piping: Cavitation can be eliminated by bleeding air into the pump and or relieving some of the service liquid from the drain of the first stage pump and piping it into the recirculation inlet of the second stage pump. This piping, along with a hand valve, is factory installed on those models which have potential for cavitation. At initial start up, allow the pump to reach desired vacuum with the hand valve closed. Then, slowly open the valve until cavitation is tuned out, and the best performance obtained. This can be a permanent setting.

This drain piping can also be used to relieve unusually large quantities of liquid entering the pump package from the process. The second pump can also have a similar drain piping, which discharges directly into the separator/muffler, if this is needed to reduce the motor load on the second pump caused by excessive liquid. The valve on the second pump should also be tuned for optimum performance.

Vacuum and exhaust lines: The vacuum line from the process is attached to the inlet port of the first stage pump. Exhaust from this pump is piped to the inlet port of the second stage pump, which is exhausted into the separator/muffler. In some models where the first pump is much larger than the second, a bypass check valve is provided to allow the first pump to also exhaust into the separator/muffler during pump down. This allows higher pump down CFM and reduces motor load during the early stages of pump down on these models. When the vacuum reaches 15-20"Hg, the check valve closes, and the package operates as a complete Two-Stage system.

Lyco pumps are designed to be easy to field repair. They can be readily disassembled and reassembled without the need to reset clearances between the rotor and the porting plate if you follow instructions starting on page 13. The main point is **“DON’T TOUCH THE TWO ADJUSTING SETSCREWS (31).”**

LYCO STAINLESS STEEL LIQUID RING VACUUM PUMPS ARE EASY TO INSTALL, OPERATE AND MAINTAIN. IF, HOWEVER, YOU HAVE ANY QUESTIONS OR PROBLEMS, DON'T HESITATE TO CONTACT YOUR SUPPLIER.

WARRANTY

THE MANUFACTURER EXPRESSLY WARRANTS TO THE ORIGINAL BUYER THAT IF ANY PARTS OF ITS MANUFACTURE ARE PROVEN TO BE DEFECTIVE WITHIN A PERIOD OF 24 MONTHS FROM DATE OF SHIPMENT FROM THE MANUFACTURER WILL BE REPAIRED, OR AT ITS OPTION, REPLACED FREE OF CHARGE, FOB FACTORY, UPON RECEIPT OF THE PARTS AT THE FACTORY, TRANSPORTATION CHARGES PREPAID. WARRANTY IS FOR PARTS ONLY AND DOES NOT INCLUDE DISASSEMBLY AND ASSEMBLY REPAIR LABOR. CONSEQUENTIAL DAMAGES NOR ANY IMPLIED WARRANTIES INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR USE ARE NOT COVERED. ELECTRIC MOTOR AND CONTROL WARRANTIES ARE COVERED DIRECTLY THROUGH THE MANUFACTURERS OF THESE PARTS, AND SERVICE CAN BE OBTAINED THROUGH LOCAL, AUTHORIZED REPAIR SHOPS OF THESE MANUFACTURERS.

LYCOWausau
STAINLESS STEEL VACUUM PUMPS

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6107-99- 7/08