

CNN Model

Installation,

Operation,

&

Maintenance Manual



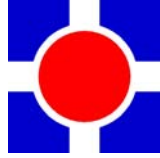
 **CUTES CORPORATION**
九德松益股份有限公司
SINCE 1974 ISO 9001 Certificated

Liquid Ring Vacuum Pumps
& Compressors Manufacture



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FOR CNN MODEL WATER RING VACUUM PUMPS & COMPRESSOR ONLY

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Section 0

DESCRIPTION

ABOUT THIS MANUAL

This manual is to be followed for **CUTES** liquid ring vacuum pumps (**CNN MODELS**) and compressors. While the instructions will refer to "the pump", they also apply to compressor installations.

However, since compressor start-up procedures differ from vacuum pump start-up procedures, the compressor start-up instruction section is in Section 10 of this manual.

Throughout this manual, parts are listed with their identification number. These parts can be located for each pump in their respected three (3) dimensional exploded drawing in the Appendix.

Note: All fasteners and tapped screw holes are in **metric** (SI) units. Do NOT attempt to install **inch** (English) unit fasteners, this will damage the equipment. All pipe taps are **NPT**. All information within this manual is intended to be general in nature and will be applicable to most, but not all, customer installations. We are glad to offer additional suggestions on the use of **CUTES** liquid ring vacuum pumps and compressors. Nevertheless, there are no implied warranties of merchantability or of fitness for a particular purpose given except such expressed.

Section 1

How the pump works

The balanced rotor rotates without metallic contact in a circular casing that contains liquid compressant usually water or oil. The rotor consisting series of blades and are shroud at the side forming series of chambers.

The chambers of the rotor are filled with water or oil that rotates with rotor following the contour of the casing. The sealing liquid recedes into the eccentric casing as the rotor advances until the rotor chamber is empty. The eccentric casing forces the sealing liquid back into the rotor chamber as the rotor advances further creating a piston like effect, this cycle occurs during each revolution of the rotor. As the sealing liquid recedes from the rotor chamber it is replaced by gas drawn from the inlet port. As the rotor rotates as 360° the sealing liquid is forced back by the eccentric casing into the rotor chamber, the drawn gas is then compressed into the rotor chamber and discharged through outlet port.

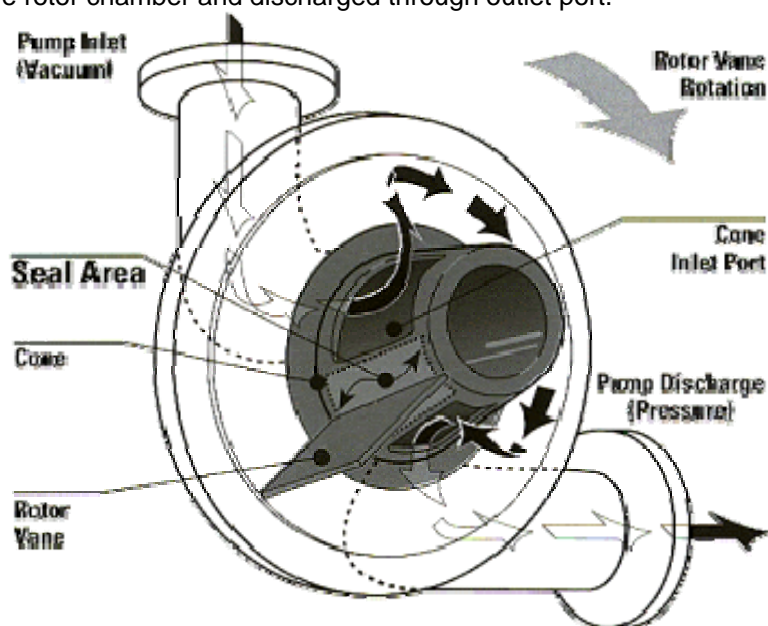


Figure 1. How the pump work

Section 2

After receiving a CUTES Vacuum product



Figure 2. After receiving a CUTES Vacuum product

1. Check for damaged equipment.
2. Check for equipment shortage.
3. Report damaged for shortage.
4. Prepare for short-term storage
5. Prepare for long-term storage.

A. Damaged or Shortage of Equipment.

1. Check for damaged or shortage of equipment. Check the shipment against the packing list with the pump. Inspect for possible shipping damage.

2. Report shortage or damage to the delivering carrier at once. **The buyer shall report rejection of goods to CUTES within 7 days of receipt of goods. Failure to provide such notice shall constitute acceptance of goods.**

B. Short-term pump storage (less than 3 months)

If the pump must be stored for a period of time LESS than 3 months before installation, it should be stored in a clean, dry place with temperatures above freezing. The shaft (M103) must be rotated every 2 weeks to retard oxidation and corrosion of bearing surfaces.

C. Long-term pump storage (more than 3 months)

1. Indoor storage is strongly recommended.
2. Protect the pump from temperature and humidity extremes and exposure to excessive dust, moisture, and vibration.
3. Remove the drain plugs from the pump housing (M100) and heads (D107, F107), flush with water to remove any debris. Re-install the plugs.
4. Introduce a quality flushing oil (rust inhibitor) into each pump inlet and rotate the rotor/shaft (MIDI) by hand for several revolutions to coat pump interior with oil. Remove the drain plugs to drain out excess oil. Re-install the plugs.
5. Cover and seal all flange and pipe openings, dust tight.
6. Slide the packing glands (D110, F110) away from the stuffing box and remove the packing rings (D108, F108) from pump. Coat the packing area of the shaft (MI 03) and all other exposed areas of the shaft with rust inhibitor, and seal the stuffing box from dirt with a radially split flexible gasket. Re-install the packing glands.
7. Remove the bearing covers cap screws and through bolts on both ends of pump. Slide back bearing caps (D119, F119, D112, F112) and completely fill cavities (both inside and outside, both pump ends) with suitable grease. **Do not remove or add any shims, which will affect rotor center.** Re-install bearing caps with through bolts and cap screws, **important:** Tag, label or somehow mark the pump that bearing housings are **overfilled** with grease. Prior to returning the pump to service, some of this excess grease

must be removed, leaving the bearing caps only 1/3 - 2/3 full of grease. Failure to do so may result in excessive bearing heat and premature bearing failure.

8. Every 4 weeks, rotate the pump shaft (M103) several revolutions to re-distribute grease and retard oxidation.

A log must be kept to support compliance with this requirement.

9. For storage in the outdoors or in an unfavorable indoor environment, the pump must be covered with some type of protective tarpaulin that will allow proper air circulation.

10. Maintain written documentation detailing:

- A. Pump Modes and Serial Number (very important)
- B. Date pump was removed from service.
- C. Date pump was prepared for long-term storage.
- D. Dates verifying shaft rotation intervals.

PUMP INSTALLATION AND START-UP

Section 3

Piping installation

A. General

Piping strain on pump flanges may cause coupling or belt sheave misalignment, metal to metal contact of internal parts, shortened bearing life, or other hard to detect troubles.

1. All piping should be independently supported and aligned to pump connections. No strain should be transmitted to the pump from the piping. Flexible expansion connectors between pump and piping are suggested.
2. Care should be taken to flush any foreign matter from piping before connection to the pump. Temporary inlet baskets strainers may be used to catch weld slag, etc., as an additional precaution on new pipe installations, but must be removed after a few hours of pump operation.
3. Piping connections for the seal liquid should be full size to the pump, and properly supported.
4. A strainer in the seal liquid line should be used to prevent any foreign matter from entering the pump or clogging the line, which would deprive the pump of sealing liquid and cause serious damage.
5. All piping must be air tight and leak free to obtain optimum vacuum service.

B. Inlet suction piping

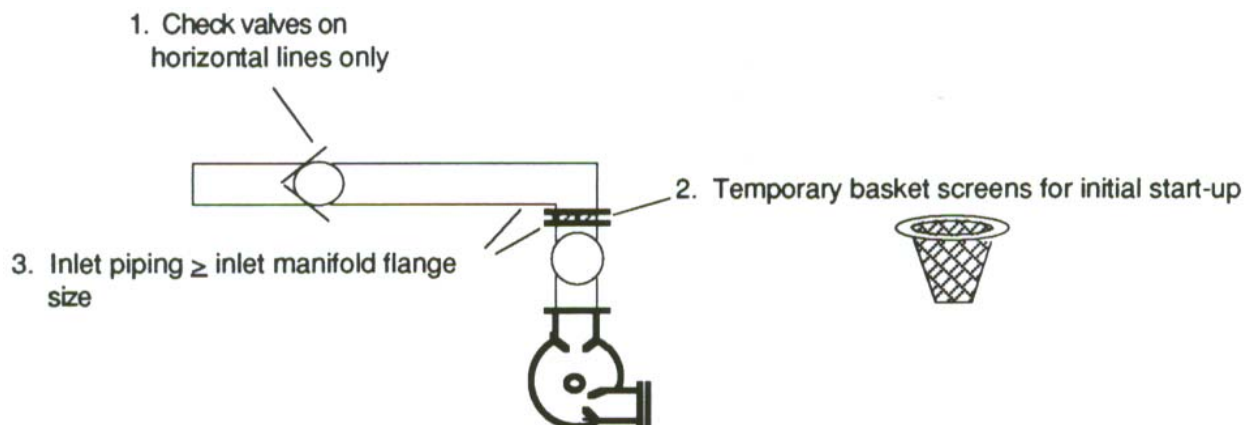


Figure 3. Inlet suction piping

1. Check valves should be installed in horizontal lines only.
2. For new installations, temporary basket screens and dirt pockets should be installed ahead of the pump suction manifold to prevent foreign matter from entering the pump at initial start-up.
3. Inlet suction piping should be equal to or greater than inlet manifold flange size.

C. Outlet Discharge piping

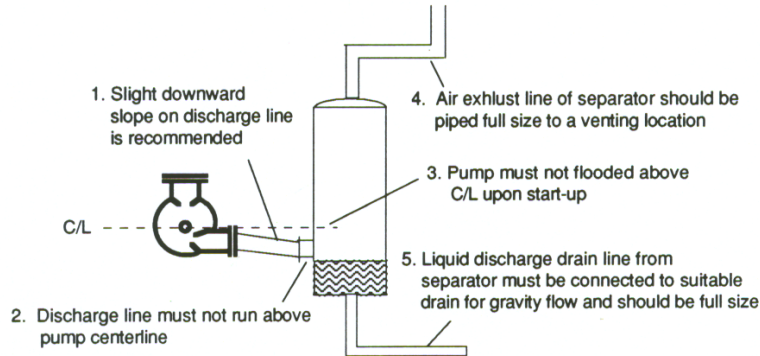


Figure 4. Outlet discharge piping

1. Vacuum pump discharge piping should be full size and sloped slightly downward from the pump to a suitable separator system.
2. The pump discharge line between the pump and the separator must NOT run above the pump centerline. Such a piping rise could cause backpressure on the discharge of the pump and lead to a loss of performance and possible damage to the pump.
3. Insure the pump is not flooded (filled above the pump centerline) upon start-up. Routine start-up of the pump when flooded can eventually cause pump failure.
4. The air exhaust line of the separator should be piped full size to a venting location.
5. The liquid discharge drain line from the separator must be connected to a suitable drain for gravity flow and should be full size.

Section 4

Liquid ring seal flow rate for CUTES CNN vacuum pump

Flow rate: m ³ / h Vacuum: mmHg (G)					
CNN Model	150 ~ 300	300 ~ 450	450 ~ 600	600 ~ 700	Pressure Kg/cm ²
301	1.4	1.4	--	--	0.4
302	--	1.6	1.6	1.6	0.4
401	1.2	1.2	--	--	0.3
402	--	2.7	2.7	--	0.3
403	--	--	2.7	3.4	0.5
701	2.3	2.3	--	--	0.4
702	--	2.3	2.3	--	1.0
703	--	--	3.6	4.5	1.0
1001	4.5	4.5	--	--	0.4
1002	--	4.5	6.8	--	0.6
1003	--	--	6.8	6.8	1.0
1501	4.5	4.5	--	--	0.4
1502	--	6.5	7.2	--	0.6
1503	--	--	11	11	1.0
2001	4.5	4.5	--	--	0.2
2002	--	6.8	6.8	--	0.4
2003	--	--	6.8	13.6	1.0
2501	5.5	6	--	--	0.2
2502	--	7.5	13.5	--	0.4
2503	--	--	15	16	1.0
3001	4.5	6.8	--	--	0.2
3002	--	9	16	--	1.5
3003	--	--	16	16	1.5
4001	6.8	9	--	--	0.4
4002	--	9	11.7	--	1.0
4003	--	--	18.2	22.7	1.0

Table 1. CUTES CNN model seal flow rate and pressure

Section 5

Sealing liquid control system

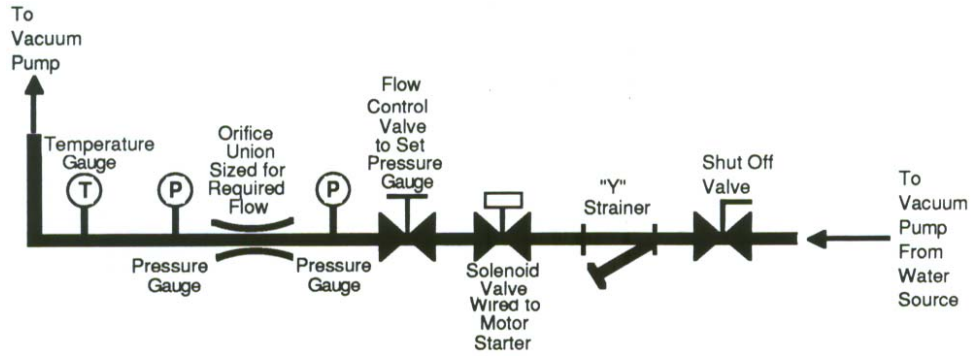
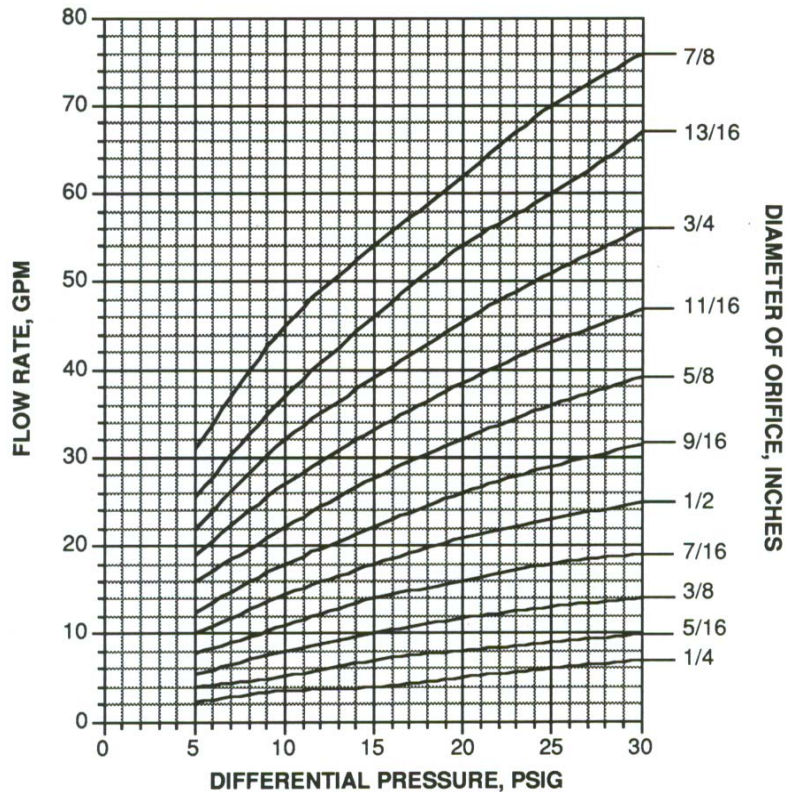


Figure 5. Full flow sealing liquid control systems

The Standard Full Flow Sealing Liquid Control System is offered as an option for each **CUTES** liquid ring vacuum pump (see Figure 5). This system is to be used with **CUTES CNN** models. The components of this system permit control of the sealing liquid flow to maintain optimal sealing within the pump. Knowing the orifice diameter and the specified seal flow rate. Graph 1 on Page 6 can be used to determine the corresponding pressure drop to be observed across the orifice. The flow control valve upstream of the orifice is used to adjust the sealing liquid flow. The package includes components, which properly regulate sealant flow to the vacuum pump. If the customer chooses this option, the pump will be shipped with the sealing liquid control system assembled and pre-piped to the vacuum pump.

The following chart shows nominal pipe size for each **CUTES CNN** model:

Model	CNN-300	CNN-400	CNN-700	CNN-1000	CNN-1500	CNN-2000	CNN-2500	CNN-3000	CNN-4000
Pipe size	1/2"	1"	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"	1-1/2"



Graph 1, Orifice flow chart

Section 6

Packing for stuffing box

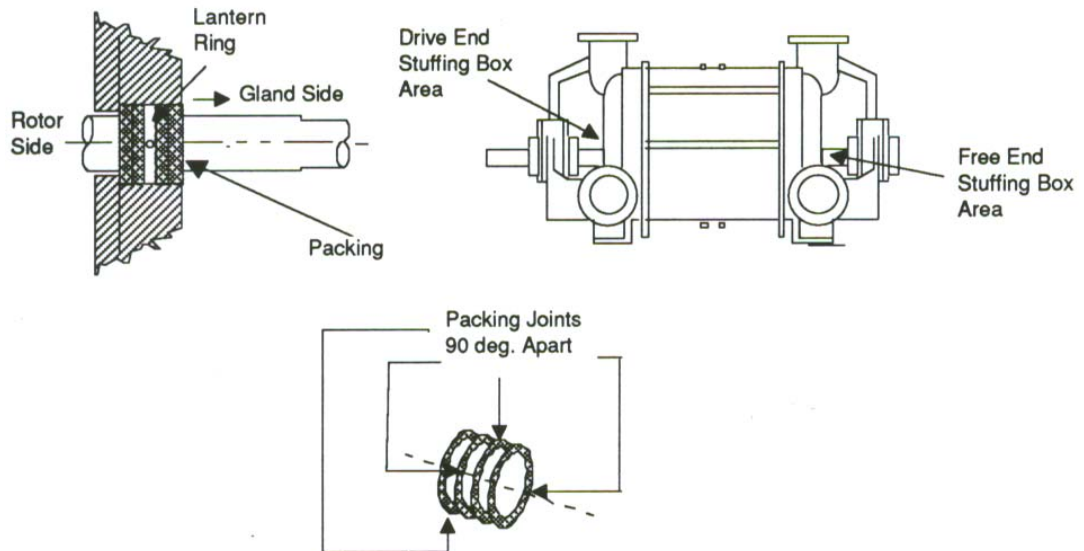


Figure 6. Packing for stuffing Box

Table 1 lists the number of packing rings (D108, F108) for stuffing boxes for each pump. Install each ring to ends butt squarely and joints are 90° apart. Instructions for tightening the packing glands (D110, F110) are located in the 9. START-UP section of this manual.

Model	Rotor Side	Gland Side	Cross section
CNN-300	6	6	5/16 x 5/16 in.
CNN-400	5	5	3/8 x 3/8 in.
CNN-700	6	6	3/8 x 3/8 in.
CNN-1000	6	6	1/2 x 1/2 in.
CNN-1500	6	6	1/2 x 1/2 in.
CNN-2000	6	6	1/2 x 1/2 in.
CNN-2500	6	6	1/2 x 1/2 in.
CNN-3000	7	7	5/8 x 5/8 in.
CNN-4000	5	5	3/4 x 3/4 in.

Table 2. Number of packing rings for CNN model, each pump end

Section 7

Draining and flushing pump before Start-up

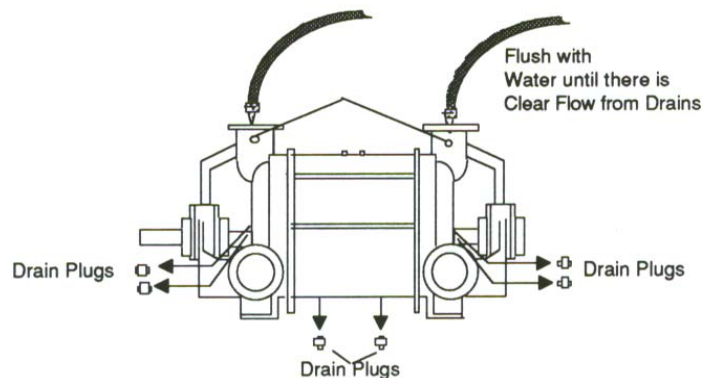


Figure 7. Draining and flushing pump before start-up

Before pump start-up:

1. Remove the drain plugs located on the bottom of the pump interior.
2. Flush with water until there is clear flow from drains.
3. Replace all drain plugs using a pipe thread compound.

Note—Although pump is flushed with rust inhibitor prior to shipment, a light film of rust (oxidized cast iron or stainless steel) may form before installation. This should disappear after the pump has been rotated a few times.

Caution: If the pump has been under long-term storage, remove enough lubricant from the bearing caps to where they are no more than 2/3 full.

Section 8

Driver installation (coupling and sheave alignment)

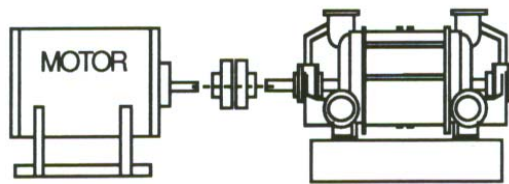


Figure 8. Driver installation (Coupling and sheave alignment)

CAUTION

Before the pump is assembled to the driver, bump start the motor to check for specified pump rotation. Incorrect rotation will cause the pump to produce very slight vacuum. Also, rotate the pump shaft at least 1 revolution and check for binding. If contact is detected, do NOT start the pump because damage will result.

The sheaves or couplings must not be forced onto the pump shaft (M103). If there is not a slip fit, re-check the matching bores and machine or expand by heating. Forcing the part may disturb clearance settings of the pump. Avoid an excessively loose fit, as this causes excessive strain on keys and key-ways. Sheaves and couplings must be aligned according to their respective manufacturer's maximum allowable misalignment tolerances. If the sheaves or couplings are not aligned properly, possible damage to the bearings could occur.

Section 9

Start-Up

START-UP (Vacuum Pump Only, see Section 10 for Compressor Start-up)

1. Open the shut-off valve to allow sealing liquid to the pump and insure proper flow.
2. Open the inlet isolation valves, 'if any are installed.
3. If pump is rotating in the right direction and rotates freely, start the driver.
4. Check RPM (test RPM is shown on nameplate fastened to the pump body). Nameplate data may not show exact operating conditions. The RPM and capacity can be verified from purchase specifications.
5. Loosen or lighten the packing glands (D110, F110) to where there is a constant small seal water leak dripping from the pump.

6. Keep constant check on the temperature of the pump housing and bearing housing during initial start. At any indication of heating, or excessive noise, shut down the pump immediately and determine the cause (see Appendix for Trouble Shooting).
7. Bearing temperature not to exceed housing temperature plus 60F.

Section 10

CUTES CNN-P compressor piping and Start-Up

The following piping arrangement should be used for **CUTES CNN-P** compressors to insure the pump works properly and is not damaged.

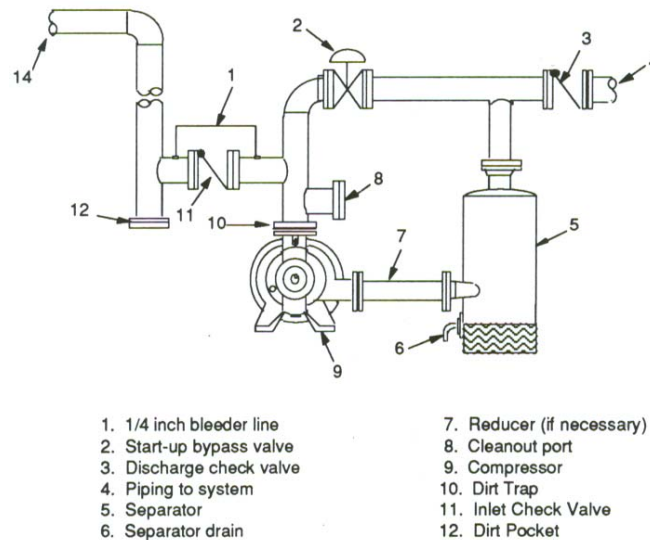


Figure 9. Proper compressor piping arrangement

Step to take prior to compressor start-up:

1. Open the valve to allow the sealing liquid pressure to the compressor.
2. Verify the discharge from the separator drain.
3. Assure that the compressor rotates freely by turning the shaft manually.
4. Check the alignment of the coupling or sheave and the tension of the belts
5. Bolt into position the coupling or V-belt guard.
6. Check for proper pump rotation direction by bumping the motor starter.
7. Open the start-up bypass valve and the sealing liquid valve completely.
8. Start the compressor motor.
9. Close the start-up bypass valve after the time period specified in Table 2 for the appropriate compressor model.
10. The compressor performance should be as specified at this point.
11. **Upon any indication of heating or excessive noise, shut down the compressor and determine the cause.**

Compressor Model	Valve and line size (in)	Time Period (sec.)
CNP-300	2	30
CNP-400	3	60
CNP-700	3	60
CNP-1000	4	120
CNP-1500	4	120
CNP-2000	6	180
CNP-2500	6	180
CNP-3000	8	240

Table 3. Compressor bypass time period

PUMP OPERATION

Section 11

Trouble shooting

During vacuum pump operation, there may be a change in the performance of the pump. There are a number of possibilities of why the pump is not operating up to specification. When trouble shooting, it is best to define the symptom, locate the cause, then determine the solution. Because a process change is often the cause of poor operation of the vacuum pump, check that the process conditions have not been changed or adjusted since the last time the pump was known to be operating normally. A trouble-shooting guide is located in the Appendix.

Section 12

Bearing options (lubrication procedures)

All pumps have grease-lubricated bearings which are lubricated by **CUTES** before shipment. **CUTES** offer 2 types of bearing options on all of the pumps. They are as follows:

A. Bearings with Standard Grease and Grease lip Seals: (Standard Bearing Package):

This bearing package, the standard package for **CUTES** pumps, consists of lip-type grease seals and Exxon Unirex N 2 or equivalent grease (lithium complex, petroleum based lubricant). With this standard package the following maintenance procedure must be followed to insure the maximum life of the bearings.

After the pump has been in operation for six (6) months, the bearings should be re-lubricated (see paragraphs C-E of this section). After this initial lubrication, this process should be repeated every six (6) months. As a "rule of thumb", lubricate the bearings when the clocks are changed. Each pump is tagged to remind the customer to lubricate the bearings every six (6) months. A log should always be kept to keep track of the bearing lubrication.

B. Bearings with Standard Grease and Bearing Isolators (Optional Bearing Package):

This optional bearing package, available on new or factory re-built pumps, also includes a lithium complex, petroleum based lubricant (Exxon Unirex N 2 or equivalent), but factory installed bearing isolators replace the lip-type grease seals. These isolators will prevent the standard lubricant from becoming contaminated as quickly as the lip-seals, but the same maintenance procedure should be followed for this package, that is followed for the "Standard lubricant/lip-seal" Bearing Package.

C. To re-lubricated each bearing, follow this procedure:

1. Shut the pump off.
2. Get access to the bearing caps (D112, D119, F112, F119). This may require removal of the coupling/belt guard and coupling or sheave from the shaft.
3. Clean the exterior of the bearing caps and bearing housing with fresh, clean solvent. Remove as much dirt and debris as possible before removing the caps.
4. Remove the outer bearing caps from both ends of the pump, carefully keeping the free end shims intact.
5. Slide the inner bearing caps in toward the stuffing box/packing gland area.

6. Examine the grease in the caps and bearings. Contaminated grease could indicate a worn grease seal or damaged bearing isolator. Inspect the grease around the bearing looking for metal particles. Such particles may indicate a worn, failing bearing. If a bearing is damaged, it must be replaced with a new bearing.

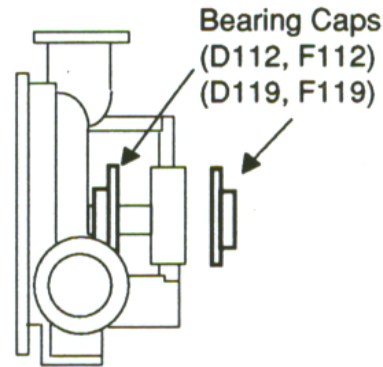


Figure 10. Removal of bearing caps.

D. If the grease is relatively clean:

1. Remove all used grease from the bearing caps, and wipe clean with a solvent.
2. Wipe away as much used grease as possible from the bearing housings and bearings.
3. Remove the plug(s) from the bearing housings and temporarily install one (1) alemite type grease fitting.
4. With a hand operated grease gun (see Figure 11), pump grease into the bearing, via the fitting, while slowly turning the shaft by hand. The old, used grease will be pushed out of the bearing and replaced with fresh new grease. Continue this process until all of the old grease is expelled. Larger pumps (CNN2000-CNN4000) have two (2) tapped holes in the bearing housing. By utilizing the first one, then the other, for replenishing the grease, the process is faster and assures a more uniform distribution of the grease.
5. Wipe away all of the old grease. The bearings are now packed.
6. Inspect the grease seals or bearing isolators for damage and wear. Replace as necessary.
7. Fill the reservoirs of the bearing caps 1/2 - 2/3 full of grease.
8. Replace the caps, along with new gaskets, installing shims on the outer free end cap exactly as removed.
9. Remove the Almite fittings from the bearing housings and re-install the plugs.

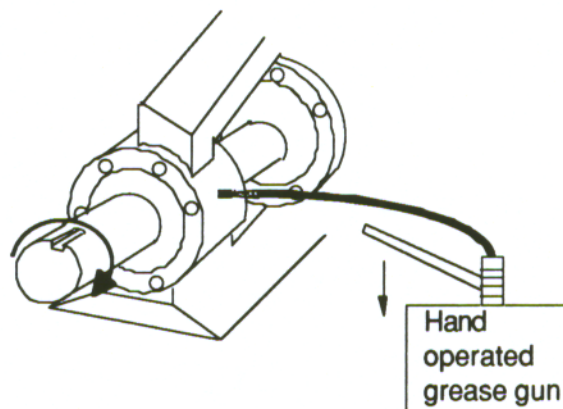


Figure 11. Re-lubricating bearing

E. If the grease is contaminated or has accumulated dirt (from SKF product catalogue, No. 450B):

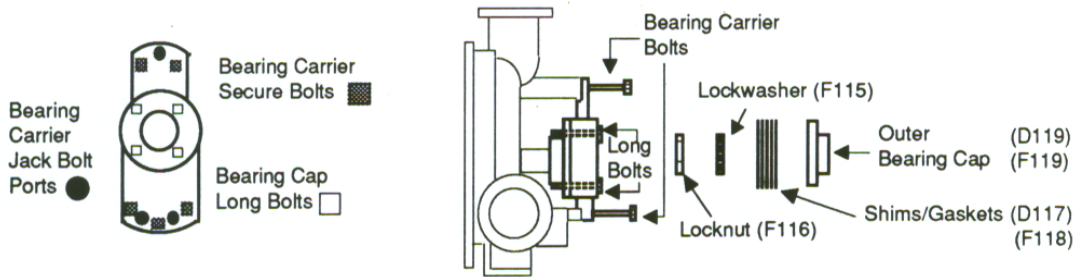


Figure 12. Removal of bearing carrier

1. Remove the bearing from the shaft (see Figure 12.)

A. Free end

A.1. Remove outer bearing cap (F119), shim gaskets and shims (F118). Measure and record total thickness of 1 shims and gaskets.

NOTE: If disassembly is for bearing replacement only, keep shim gaskets and shims (F118) intact for use in reassembly to maintain correct rotor position between cones. If gaskets are torn or metal shims damaged, replace with new ones of the exact same thickness. If further disassembly is required, rotor end travel and rotor center must be adjusted, in which case, all

A.2. Remove bearing lock washer (F115) and locknut (F116).

A.3. Install all of the "Long Bolts" with additional flat washers through the bearing carrier (F107BC) and thread into the tapped holes of the inner bearing cap (F112). Tighten bolts until inner cap is flush and tight against the inboard face of the bearing carrier (F107BC).

A.4. Remove the bolts that secure the bearing carrier (F107BC) to the head and loosely install the bolts in the threaded holes in the bearing carrier (bearing carrier jack bolt ports).

A.5. Due to the weight of the bearing carrier (D107BC) and the bearing of CNN-700, CNN-1000, CNN-1500, CNN-2000, CNN-2500 and the assembly must be supported by a sling before proceeding with disassembly to prevent injury and/or damage to the pump parts. The lighter assemblies on smaller CNN-300 and CNN-400 models may be removed by hand using proper caution.

A.6. Jack the bearing carrier (F107BC) complete with the bearing (F114) and inner bearing cap (F112) away from the head by uniformly tightening the bolts inserted in the threaded holes of the bearing carrier in Step 4.

A.7. If inner bearing cap (F112) is equipped with lip seals (F111 A), remove and discard. If cap is equipped with bearing isolators (F111 B), do not remove from cap unless visibly damaged.

B. Drive end

B.1. Follow all steps for bearing removal of free end (A.1.-A.7) to remove drive end bearing.

NOTE: The drive end bearing carriers for CNN-300-CNN-2000 does not contain the following parts: lockwasher (115) and locknut (F116). If pump has bearing isolators, drive end will contain an outer bearing isolator (D116B)..

B.2. Remove the bearing(s) from the disassembled bearing carrier(s).

B.3. Place the bearings in a wire basket and suspend the basket in a suitable container with clean, cold petroleum solvent or kerosene and allow the bearings to soak, preferably overnight. Sometimes it may be necessary to soak the bearings in hot, light oil (200°F to 240°F), agitating the basket slowly through the oil from time to time. This method is helpful, for instance, in removing lithium soap grease (used in **CUTES** pumps) which is more difficult to remove than lime and soda soap grease. In extreme cases of badly oxidized grease, boiling in emulsifying cleaners, diluted with water, will usually soften the contaminating sludge.

B.4. When the grease has been sufficiently softened, drain the bearings and, if they have been boiled in aqueous emulsion, spin individually until the water has evaporated.

B.5. Immediately put the bearings in a second container of clean petroleum solvent and clean individually.

B.6. Turn the bearings slowly and work with a brush to dislodge chips or solid particles before finally spinning the bearings while they are partially submerged in the solvent. Repeated soaking and cleaning may be necessary.

B.7. Spin the bearings in light oil in order to remove the solvent completely. If the bearings are not to be remounted immediately, they should be coated with petrolatum and wrapped in clean oil-proof paper while awaiting reassembly.

B.8. Inspect the bearings to see if they are damaged. If so, they must be replaced with new bearings.

B.9. If the bearings are not damaged and are to be installed immediately, see Section 23 to re-lubricate the bearings using a hand operated gun. After they have cooled, pump grease completely covering both sides of the bearings while slowly turning the shaft by hand (See Figure 13: Filling Bearing Cavity with Grease).

B.10. Fill the reservoirs of the bearing caps 1/2 - 2/3 full of grease.

B.11. Replace the caps, along with new gaskets, installing shims on the outer free end cap exactly as removed.

Section 13

Shut-down periods (more than 2 weeks)

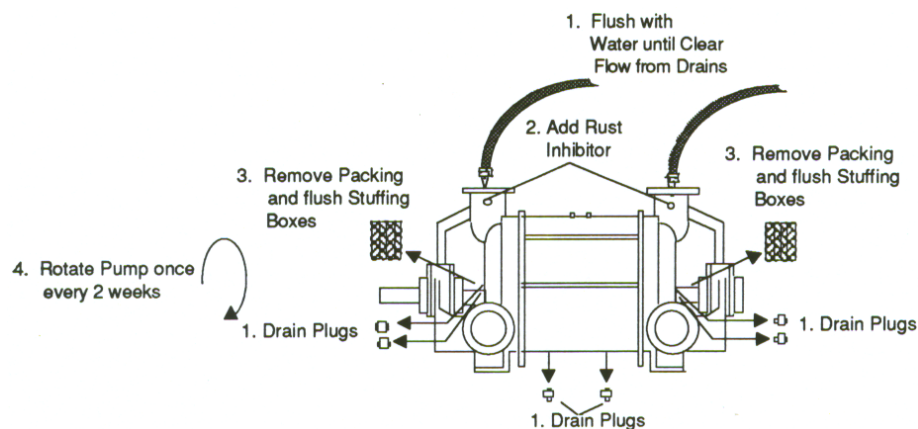


Figure 13. Draining and flushing

When taking a pump out of service for more than 2 weeks, do the following:

1. Remove the drain plugs in the housing (M100) and heads (D107, F107), draining and flushing all liquid from the pump (see section 7. Draining and flushing).
2. Introduce good flushing oil (rust inhibitor), SUNOCO MPM10 or SECO Rust Inhibitor. through pump inlet (gauge tappings) and run pump for about 1 minute to coat interior with oil.
3. Remove the packing and flush the stuffing boxes with rust inhibitor. Do not repack until next start-up.
4. Rotate the rotor/shaft (M101) by hand once every 2 weeks during shut-down. The pump can be put back in service by simply repacking stuffing boxes, fuming on water and starting motor.
5. If the pump is to be placed in "long term storage", refer lo Section 2-C.

MAINTENANCE

Section 14

Pump Disassembly

CAUTION: Make provisions for handling heavy parts during disassembly to avoid injury or pump damage (see Table 3 for approximate weights of parts)

Mark all parts
 Check new parts against originals
 Disassemble and reassemble pump on level base
 Adjust clearances to original specification

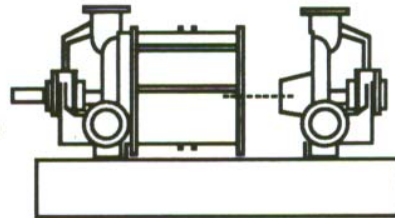


Figure 14. Pump disassembly

CAUTION: During disassembly, mark all parts as they become accessible to insure correct position when reassembling. Check the new parts against the original parts and mark to correspond.

The pump is more efficient when the rotor clearance in the casing is the same as set by **CUTES**. Because constant use over a long period of time may result in corrosion and erosion of the rotor or cone, internal clearances between these parts will probably increase over time. This condition results in a reduction in capacity and vacuum, and the pump should be disassembled for inspection and readjustment for correct clearances. If wear has been uniform, readjust to correct clearances by following the procedure described in Section 25. CHECKING END TRAVEL.

Key No.	Part Name	CNN model weight in KGs									Memo
		300	400	700	1000	1500	2000	2500	3000	4000	
M100A	Housing, CI	36	72	91	139	181	313	372	535	885	
M100B	Housing, SS	39	79	100	153	199	344	409	589	973	
M101	Rotor/Shaft Ass.	31	52	95	163	242	428	505	737	1,078	
M103	Shaft	10	16	26	49	56	113	125	193	294	
D105	Cone, Drive End	2	7	8	12	12	32	32	55	90	
F105	Cone, Drive Free End	2	7	8	12	12	32	32	55	90	
D107	Head, Drive End, CI	30	57	66	90	90	234	234	323	492	
D107	Head, Drive End, SS	34	63	73	99	99	258	258	355	542	
F107	Head, Free End, CI	30	57	66	90	90	234	234	323	492	
F107	Head, Free End, SS	34	63	73	99	99	258	258	355	542	
/	Inlet manifold	26	30	41	72	76	52	58	82	110	
/	Outlet manifold	18	25	30	53	58	44	48	61	80	
Bare pump weight (without		145	227	349	596	720	1,315	1450	2,177	3,856	

Table 4. Approximate weights of parts

The following spare parts are available from **CUTES** as “Gasket kits” and “Bearing kits” should be on hand when disassembling pump for inspection:

1. Gasket Kit:

D104,	Housing gasket, drive end	F104,	Housing gasket, free end
D106,	Cone gasket, drive end	F106,	Cone gasket, free end
D113,	Inner bearing cap gasket, drive end	F113,	Inner bearing cap "O" ring seal, free end
D117,	Outer bearing cap gasket, drive end	F118,	Shim gasket, free end

2. Bearing Kit:

D111A,	Grease seal, inner drive end or	F111A,	Grease seal, free end or
D111B,	Bearing isolator, inner drive end	F111B,	Bearing isolator, free end
D114,	Bearing, drive end	F114,	Bearing, free end
D115,	Lockwasher, drive end	F115,	Lockwasher, free end
D118,	Grease seal, outer drive end	F117,	Grease seal outer free end

If anticipated that major repair parts will be needed, add the following spare parts to those above:

1. Rotor/shaft assembly, dynamically balanced (M101)
2. Cones (D105, F105)

Finally, it is very helpful to disassemble and reassemble pump on a level base to keep pump level aligned in the same plane. This type of base will facilitate the use of blocks to support the pump body when the head is removed.

Section 15

Disassembly procedure

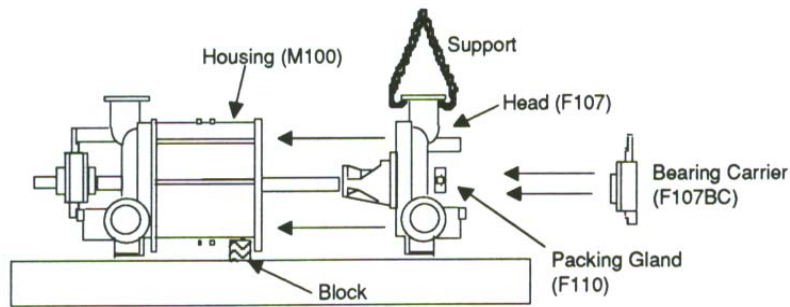


Figure 15. Disassembly of free end

1. Remove free end bearing carrier (F107BC) with bearing (F114) from shaft (M103) (see Section 22: Remove Bearings From Shaft). If both ends of the pump are to be disassembled, remove both bearing carriers.
2. Remove the foot bolts, detaching the pump from the base.
3. Support the free end head (F107) by booking a chain (supported by a crane or hoist) to 2 inlet flange holes and increase the tension with the crane.
4. Place a block under the housing (M100) for support.
5. Remove the bolts fastening the head (F107) to the housing (M100).
6. Install the head fastening bolts into the threaded holes in the heads (F107). These bolts will push flush onto the housing (M100) end surface.

7. Jack the head (F107) away from the housing (M100) by uniformly tightening the bolts inserted in the threaded holes of the head in Step 6.

Section 16

Internal inspection of the pump

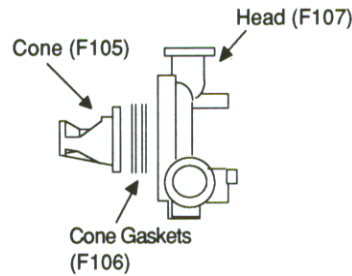


Figure 16. Cone, Head and Gaskets

With the pump disassembled, inspect the parts for wear from corrosion and erosion. Normally, the tapered surfaces of the cones (D105, F105) will be smooth, requiring only cleaning and light filing. The rotor (MI 01) tapered bore and rotor vane lips can be smoothed with a die grinder and a light grit stone. If foreign material has entered the pump suction during operation, circular score marks will be noticed around the outside of the cone tapers. If the score marks are not too deep, high spots can be removed by light filing or grinding. If the scoring is deep, cones should be removed from the heads (D107, F107) and re-machined. Usually, a light skin cut will remove most score marks. The cones have an 8° taper or angle from end to end. If 0.006 inches is machined from the cone diameter, 0.021 inches in gaskets (D106, F106) must be added between the cone and head (3.5 to 1.0 ratio). Additional gaskets may be required to establish correct Free End Travel. (See XXVII. CHECKING END TRAVEL). Taper bores of the rotor (M101) should be inspected on the same bases as the cones. If the rotor requires light machining; the total amount of material removed must be compensated by the same 3.5 to 1.0 ratios by placing gaskets under the cones in accordance with Table 6 below.

CNN Model	Maximum total thickness (mm)
300, 400	1.8
700, 1000, 1500, 2000, 2500	2.2
3000, 4000	8.8

Table 5. Maximum total gasket thickness per cone

Note: Each cone gasket is 0.2mm thick.

For any question regarding wear of major pump parts, call your local CUTES representative.

Section 17

Replacing cones, wear plates and heads

The following is the method for replacing cones (D105, F105). Follow the same steps for placing heads (D107, F107) also.

1. Use a hoist or crane and a pair of grab hooks (hooked inward into the cone ports) to remove the cones (D105, F105) from the heads (D107, F107) on larger pumps. Remove the socket head cap screws securing the cone to the head. With the hoist and hooks, pull the cone away from the head and lower them to the floor.
2. When installing a replacement cone, check the new cone carefully with the old cone for size and location of ports before installation.

3. Remove the old cone gaskets, scraping the area with a putty knife until clean.
4. Install new set of 3 cone gaskets (D106.F106) of equal thickness to the old gaskets. Be sure to install the new gaskets correctly by lining them up with the pattern of the head.
5. Use solvent to clean the rust preventative off the new cone.
6. Smooth the taper surface of the new cone with a fine emery cloth if necessary, giving special attention to the edges of the cone ports.
7. With a hoist and grab hooks, align and place the new cone into the head.
8. Center the cone in the counter bore of the head by tapping it lightly with a rawhide or other soft-sided hammer while checking with a feeler gauge.
9. Lock the cone into place with the socket head cap screws.

If the heads are tilted with wear plates (D125, F125), they may be replaced by removing the socket head screws and replacing the plate with a new one. No gaskets are required, but the surface of the head should be clean and smooth so the socket head screws can secure the plate in a flat plane, parallel to the surface of the head.

Section 18

Disassembly of rotor and shaft

Before removing the rotor (M101) from the shaft (M103), make a note of the relative position of the curvature of the rotor blades, and the location of the shaft shoulder contacting the rotor hub. Record this information for correct disassembly and reassembly.

1. To lift the rotor and shaft assembly, place a sling around the center shroud of the rotor and lift with a crane or hoist.
2. Place the assembly in a press (see Table 5 for press sizes) making sure that the end of the shaft with the shoulder is positioned away from press ram.

Caution: press from drive end only.

3. Secure a bushing with a bore, sized to slip fit over the shaft shoulder and shaft key (see Table 6 for bore sizes). The face of the bushing must contact only the face of the rotor hub, with the bushing supported by the back of the press.
4. Make provision to support the free end of the shaft as it is pushed from the rotor. The rotor can be blocked up for support, or strapped through the rotor blades.
5. With the assembly carefully leveled in the press, apply the ram force against the drive end of the shaft, thus disassembling the rotor and shaft.

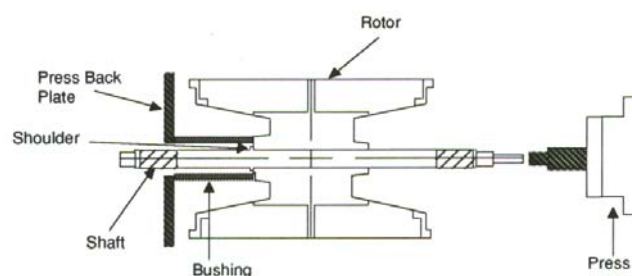


Figure 17. Pressing shaft from rotor

CNN Model	Press (Tons)	Press Cap. (Tons)	Bushing bore ID (in)
300	2.5 – 3.0	20	2 1/2
400	3.8 – 4.3	20	2 7/8
700	4.8 – 6.0	20	3 1/4
1000	7.7 – 8.6	50	4
1500	7.7 – 8.6	50	4
2000	9.6 – 11.5	50	5 3/8
2500	9.6 – 11.5	50	5 3/8
3000	15 – 18.5	50	6 1/2
4000	22.0 – 24.0	50	7 1/2

Table 6. Press loading force by model size

Section 19

Reassembly of rotor and shaft

1. File or grind the taper bores and key-ways of rotor key (M102) to remove burrs or high spots.
2. Check the fit of the key in the rotor key-way. The rotor key must be a drive fit and bottom in the shaft key-way (D120).
3. Check the ground surface of the rotor seat diameter and bearing journal on the shaft for dents or galling.
4. Polish the shaft smooth with a grinding stone and emery cloth.
5. Coat the rotor hub bore and rotor seat of the shaft with antiseize compound (such as FEL-PRO C5-A) to prevent galling or seizing when the shaft is pressed into the rotor.
6. Check for correct orientation of the curvature of the rotor blades to the shaft shoulder to make sure the rotor is installed in the right direction.
7. Sling the rotor by a line around the outside diameter at the point of balance, and place the rotor in the press.
8. Place the shaft in the rotor, with the shoulder side towards the ram. Have the key-way up and outlined with center punch marks on the rotor hub to align with the key slot in the bushing.
9. Press the shaft into the rotor until the shoulder of the shaft makes firm, flush contact with the rotor hub.

Section 20

Assembling housing body and drive end head

Note: Because the four feet of the two heads support the pump, always assemble the pump on a level surface.

1. If applicable, install the wear plates (D125, F125) onto the heads (D107, F107).
2. Install body gaskets (D104, P104) on the heads, held in place with grease.
3. Assemble the housing body (M100) and drive end head/cone assembly using the same sling arrangement used in the disassembly process.

Section 21

Re-installation of rotor/shaft assembly

Reinstallation of the rotor and shaft assembly is the reverse of the disassembly. Carefully insert the drive end of the rotor/shaft assembly into the body to avoid denting or causing burrs by using a sling as shown in

Figure 18 below. Use removable shaft extensions for the drive and free ends of the shaft to assist in handling.

Caution: Do not damage the shaft threads when installing the shaft extensions.

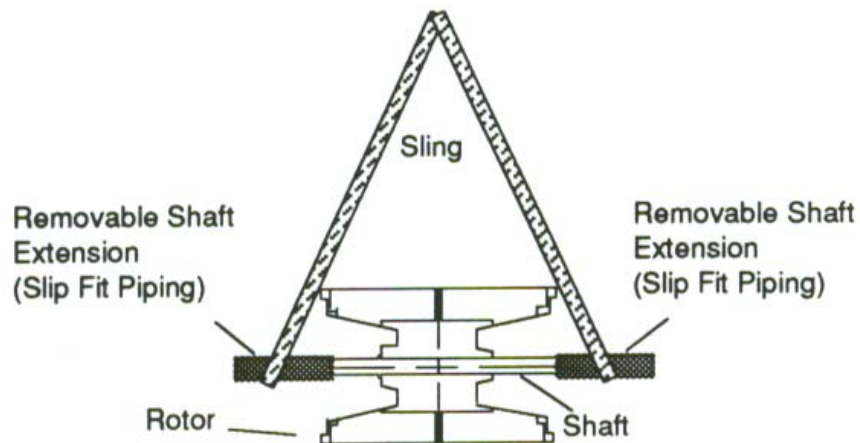


Figure 18. Using sling to assemble rotor/shaft and body

Section 22

Assembling idle or free end head to housing

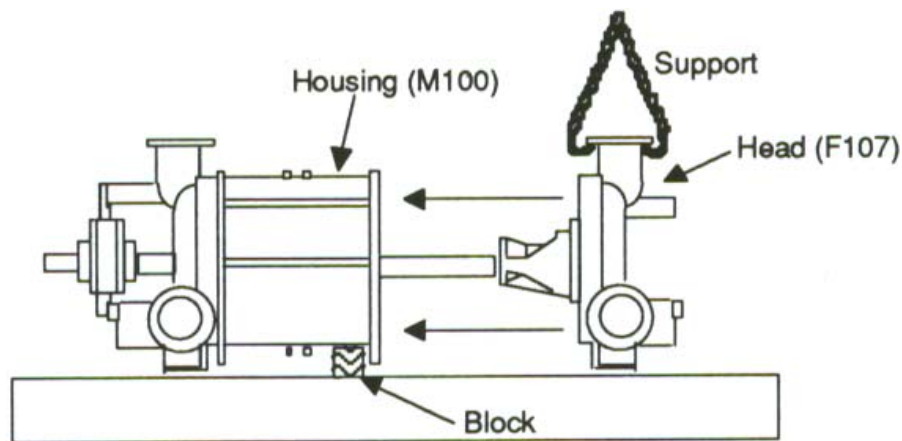


Figure 19. Assembling idle end head to housing

1. Place a block under the housing (M100) to keep drive end/housing assembly slightly above parallel to the surface the pump is resting on.
2. Install the "O" ring seal (F113) into the inner bearing cap (F112).
3. Install the free end head (F107) using one set of housing gaskets (F104) and bolt to the housing (M100).
4. Remove the block.
5. Loosen all the head and body bolts to permit the housing to assume the same plane as the flat surface on which the assembly is being resting.
6. With a feeler gauge, check the feet of each head for proper alignment with the other.
7. Tighten all head and housing bolts.

Section 23

Bearing assembly (both drive end and free end)

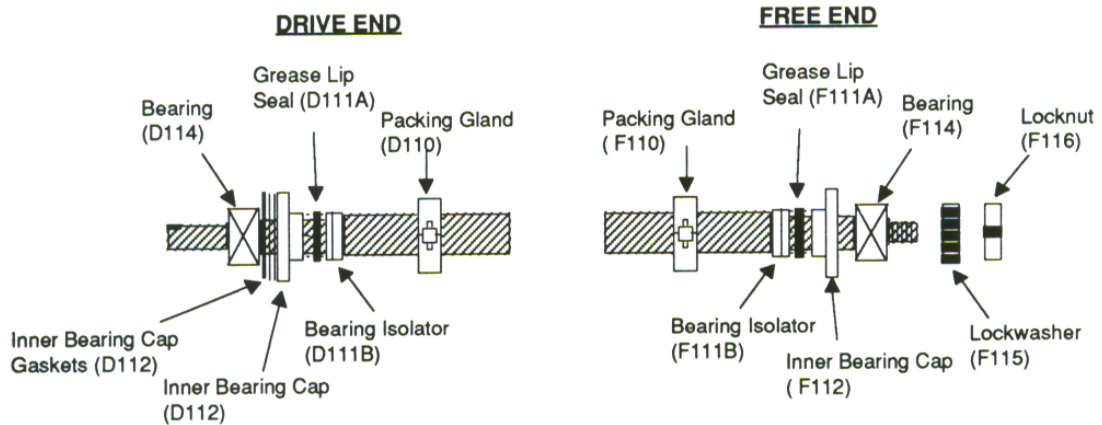


Figure 20. Bearing assembly

Caution: Be sure that the inner end bearing caps (D112, F112), grease seals (D111A, F111A) bearing isolators (D111B, F111B), and gaskets (D113, F113) are in place on the inner surface of the bearing housing of the heads (D107, F107) over the shaft (M103). These cannot be installed after bearings are in place.

For CNN-300, 400, 700, 1000, 1500, 2000, 2500

1. Using an electric resistance heater such as The Cone Thermo Bearing Mounter, hot oil bath, induction heater, or other device designed for bearing heating, heat the bearing to a temperature range of 95° C(min) to 120° C(max). The heater will come with proper instructions. **NEVER USE A TORCH!**
2. Wearing asbestos or other heat resistant gloves, slide the bearing (D114, F114) onto the shaft (M103) all the way until the bearing lies flush with the shaft shoulder of the bearing journal.
3. On the free end, assemble the lock washer (F115) and lock nut (F116).
4. Tighten the lock nuts using a punch and hammer and bend a lockwasher tab into a locknut notch.
5. Lubricate the bearings using a hand-operated gun after they have cooled. Pump grease completely covering both sides of the bearing.

For CNN-3000, 4000

CAUTION: Sometimes model CNN-3000-4000 pumps are equipped with preset Timken double row tapered roller bearing assemblies. The four (4) components of the assemblies are matched and the spacer ring is precision ground to provide a specified internal radial clearance or "bench end play". When the bearing is mounted on the shaft journal and set with the lockwasher and locknut, the correct running clearance is achieved. The component parts are marked with a common serial number to lessen the chance of accidentally mixing components from two different assemblies. Because the parts are matched, never attempt to replace just part of the assembly.

1. Using an electric resistance heater such as The Cone Thermo Bearing Mounter, hot oil bath, induction heater, or other device designed for bearing heating heat the inner bearing cone to a temperature range of 95° C(min.) to 120 (max). The heater will come with proper instructions. **NEVER USE A TORCH!**
2. Wearing asbestos or other heat resistant gloves, install the inner bearing cone on the shaft (M103), placing it flush against the shaft shoulder.
3. Install the bearing cup and spacer.
4. Heat the outer bearing cone and install on shaft pushing flush against the spacer. Immediately install bearing locknut and tighten using punch and hammer. Allow to cool.
5. Remove the locknut and install the lockwasher. Re-install the lockout and re-tighten. Bend lockwasher tab into locknut notch.
6. Install the drive end outer bearing cap gasket (D117) and cap (D119), leaving the through bolts loose.
7. Install the free end outer bearing cap (F119) without the shim gaskets (F118), leaving the through bolts loose.
8. On the free end, assemble the lock washer (F115) and lock nut (F116).
9. Tighten the lock nuts using a punch and hammer and bend the lockwasher tab into the locknut notch.
10. Lubricate the bearings using a hand-operated gun after they have cooled. Pump grease completely covering both sides of the bearing.

Section 24

Bearing carrier assembly (both drive end and free end)

1. With a sling arrangement, support the rotor/shaft (M101) assembly so the shaft is not touching the stuffing boxes of the either head (D107, F107) (see Figure 21).

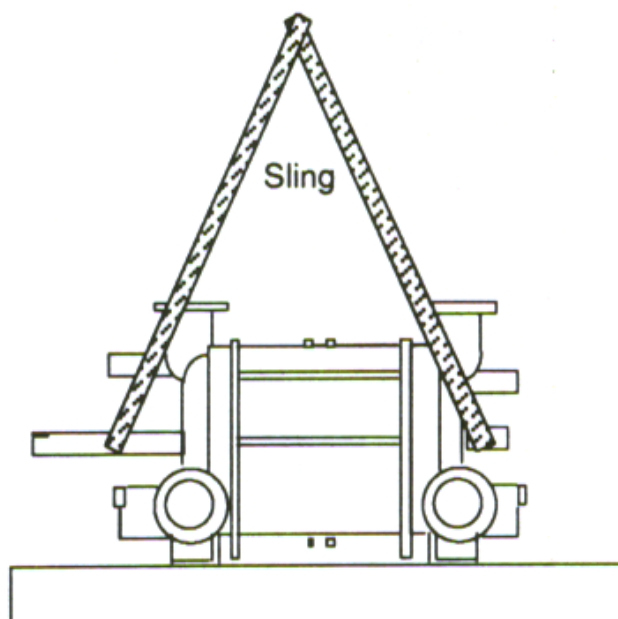


Figure 21. Sling arrangement

- Slide the bearing carrier (D107BC, F107BC) over the bearing (D114, F114) so where all bearing carrier and head (D107, F107) surfaces are parallel with each other.
- Install secure bolts into bearing carrier which thread into head (see Figure 22). Alternately tighten bolts until mating surfaces of bearing carrier head are flush and tight.

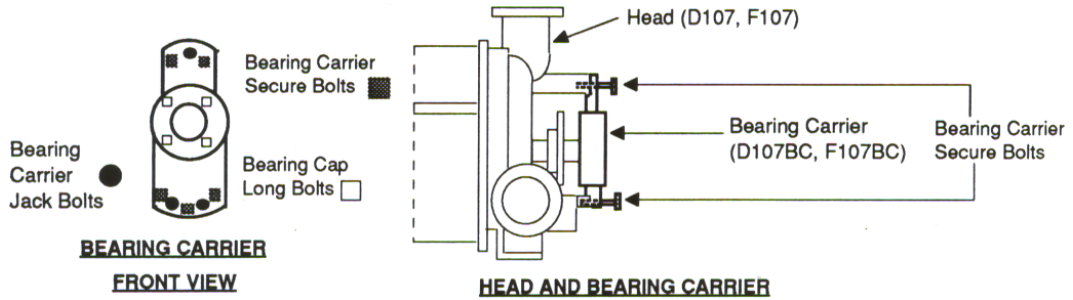


Figure 22. Bearing carrier assembly

- With the long bolts, secure the inner bearing cap (D112, F112), bearing carrier (D107BC, F107BC), and outer bearing cap (D119, F119). For the free end, the shim gaskets (D118, F118) will **NOT** be install until the end travels have been checked (Section 26)

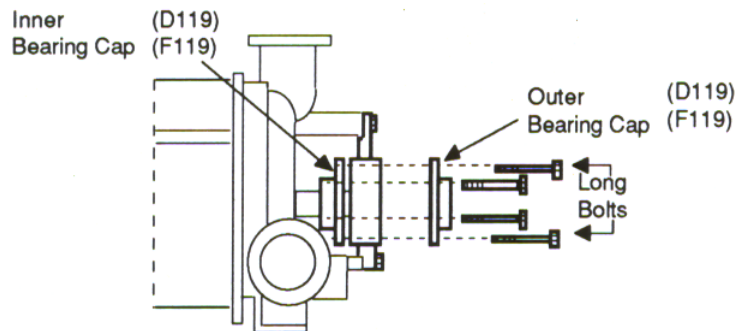


Figure 23. Bearing cap assembly

Section 25

Checking and setting rotor end travel

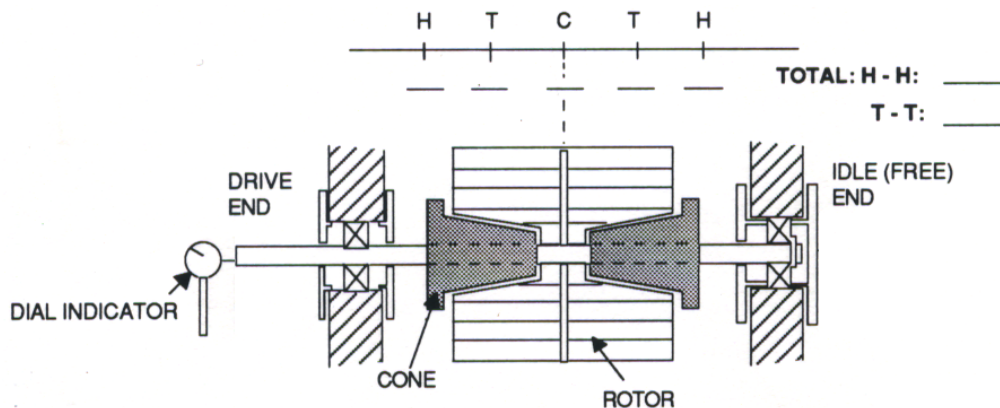


Figure 24. Checking rotor travel schematic

One of the most important factors affecting vacuum pump performance is the clearances or distance between the tapered surfaces of the cones and the rotor. These clearances are checked and set by moving the rotor/shaft and bearing assembly (explained later) until the rotor and cones are touching. This is called the end travel. The measure of distance the rotor travels from being locked tight against the drive-end cone

to being locked tight against the free end cone is called the hard-lo-hard travel. The measure of distance the rotor travels from first touching the drive-end cone to first touching the free end cone is called the **touch-to-touch travel**.

Hard-lo-Hard

The hard-to-hard travel measurement is a maximum measurement. In other words, a less than maximum measurement improves volumetric efficiency of the pump. A list of the maximum hard-to-hard distances for each pump model is given in Table 8 with a tolerance of plus ten percent (+10%). The hard-to-hard travel is checked by the following procedure:

Always use the free end to measure the travel with a dial Indicator. Be sure the free end bearing cap is installed without the shim gaskets.

1. Tighten the through bolts (connecting the free end inner and outer bearing caps).
2. With the through bolts tightened, tighten three jack screws that thread into the outer bearing cap and push flush on the bearing housing (not threaded into) until the rotor is locked "hard" onto the free end cone. Do not force past this point.
3. Remove the jackscrews.
4. Place a dial indicator on the free end bearing cap and zero the gauge.
5. Tighten three take-up screws that thread into the bearing housing through the clear holes in the bearing cap, until the rotor is locked "hard" onto the drive end cone.
6. Remove the take-up screws to relieve tension on the bearing. Read and record the dial indicator measurement. This is the hard-to-hard travel.
7. Re-install and slowly lighten the jackscrews until the dial indicator reads half of the hard-to-hard travel. The rotor is now centered "hard-to-hard" between the two cones.

Touch-to-Touch

The touch-to-touch travel measurement is a minimum measurement, required for safety purposes to prevent galling of the cone/rotor tapered surfaces. In other words, a greater than minimum measurement, offer more safety.

A list of the minimum touch-to-touch distances for each pump model is given in Table 6 with a tolerance of -10%.

The touch-to-touch travel is checked by the following procedure:

1. Zero the dial indicator with the rotor centered between the cones (Step 5 of hard-to-hard)
2. Tighten the jack screws until the dial indicator reads 0.1mm toward the free end cone.
3. Rotate the shaft slowly by hand and listen to hear for contact between the rotor and the drive end cone.
4. If there is no contact, repeat Steps 2 and 3 until the rotor does in fact rub or touch the free end cone.
5. Record the dial indicator reading.

6. Remove the jack screws and install the take-up screws. Slowly tighten the take-up screws until the dial indicator reads zero again.
7. Tighten the jack screws until the dial indicator reads 0.1mm toward the drive end cone.
8. Rotate the shaft slowly by hand and listen to hear for contact between the rotor and the free end cone.
9. If there is no contact, repeat Steps 7 and 8 until the rotor does in fact rub or touch the free end cone.
10. Record the dial indicator reading.
11. Sum the two dial indicator readings (Step 5 and 10). This sum is the touch-to-touch travel.

Rotor travel (mm)		
CNN Model	Hard-to-Hard (+10%)	Touch-to-Touch (-10%)
300	2.4	1.4
400	2.4	1.4
700	3.0	1.7
1000	3.2	1.8
1500	4.0	2.2
2000	4.2	2.3
2500	4.9	2.7
3000	5.1	2.8
4000	5.6	3.1

Table 7. Rotor end travel

Correcting for hard-to-hard values

If the hard-to-hard measurement is greater than the value in Table 6 (+10%), use the following procedure to correct:

1. Subtract the value in Table 8 from the hard-to-hard measurement. This will give you the thickness of gaskets that need to be taken out of head/housing assembly.
2. On the end that had the largest touch-to-touch value, loosen the bolts holding the head to the housing.
3. Slide the head back from the body just enough to permit the jaws of a pair of needle-nosed pliers to be inserted in the space.
4. Tear from the housing/head the correct thickness of paper gaskets equal to the value calculated in Step 1. Each paper gasket is 0.2mm thick.
5. Reassemble the pump and recheck the hard-to-hard and touch-to-touch travels.

Correcting for touch-to-touch values

If the touch-to-touch measurement is less than the value in Table 6 (-10%), use the following procedure to correct:

1. Subtract the touch-to-touch measurement from the value in Table 6. This will give you the width of the gaskets that need to be added to the head/housing assembly.
2. On the end that had the smallest touch-to-touch value, loosen the head screws.
3. With the pump properly secured, slide the head off of the housing and shaft.

4. Add to the head the correct thickness of gaskets equal to the value calculated in Step 1, being careful not to add so many gaskets that the hard-to-hard maximum travel will be exceeded.
5. Reassemble the pump and recheck the hard-to-hard and touch-to-touch travels.

Section 26

Final assembly

Once the end travels have been set and the rotor/shaft assembly (M101) is centered between the cones (D105, F105), the shim gaskets (F116) must be installed between the free end outer bearing cap (F119) and the bearing housing. With a feeler gauge, measure the open distance between the outer bearing cap and the bearing housing. Remove the free end outer bearing cap and install the correct thickness of shim gaskets to equal the distance measured. Fill both the inner and outer free end bearing caps (F112, F119) 1/2 - 2/3 full of grease. Reassemble the caps to the bearing housing and tighten all of the bearing cap screws, noting that the take-up screws, threaded into the bearing housing, lock the cap and thus the rotor/shaft assembly into place. Remove the through bolts from the inner and outer drive end bearing caps (D112, D119). Pull caps back far enough to fill 1/2- 2/3 full of grease and reassemble.

Bearing model. and location

Model \ Location	Drive End x 1 set	Free End x 1 set
CNN-300	21308	21308
CNN-400	21309	21309
CNN-700	21311	21311
CNN-1000	22315	22315
CNN-1500	22316	22316
CNN-2000	22220	22220
CNN-2500	23220	23220
CNN-3000	67388(Timken) or 22226	67388(Timken) or 22226
CNN-4000	74550(Timken) or 22228	74550(Timken) or 22228

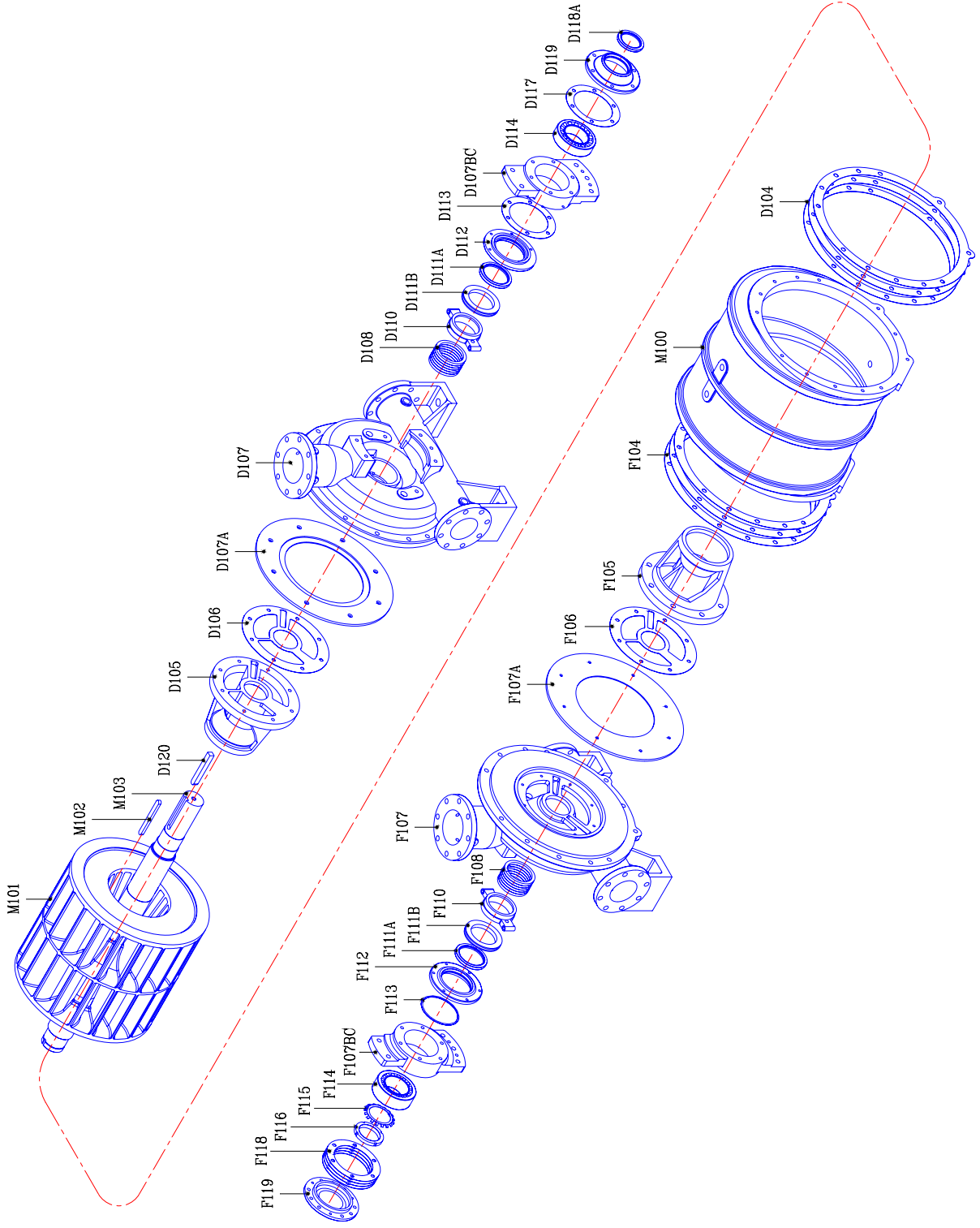
Appendix
(Trouble Shooting Guide, Exploded Parts Drawing)
Liquid Ring Vacuum Pump Trouble Shooting

First make certain that process condition have not been changed or adjusted since the last time the pump was know to be operating normally.

SYMPTOM	POSSIBLE CAUSES	SOLUTION
No Vacuum	Pump not rotating	Check motor / Starter
	Pump rotating backward	Reverse motor polarity
	Pump is running dry	Feed sealant continuously
	Defective vacuum gage	Replace gauge
	Isolation valve improperly open or closed	Operate valves correctly
Reduced Pump Capacity Insufficient Vacuum	Air leak in system	Locate and repair
	Low rotational speed	Check voltage, sheave size, belt tension and gear speed
	High sealant temperature	Adjust coolant flow and temperature
	Low sealant flow rate	Increase flow
	Inlet (suction) piping clogged or restricted	Clear inlet piping
	Undersized inlet piping	Increase inlet pipe size
Vacuum Level Unstable; Pump Surging	Pump operating below suggested minimum vacuum	Review system requirements & pump performance curves
	High sealant flow rate	Decrease flow
	High flow or widely varying flow of process liquid through pump inlet	Install inlet separator with barometric dropleg or unloader pump
	Sealant piping wrong side	Change to another side
	Inlet separator flooding	Check separator sizing, barometric dropleg design, or condition of unloader pump
	Low areas in inlet piping; trapping liquid	Locate and eliminate
Pump Binding	Build up of rust, scale or process solids on pump interior	Clean pump interior
	Foreign object in pump	Remove object
	Packing rings too tight	Adjust packing rings
	Clearances improperly set	Re-adjust clearances
Motor Overloads or Draws High Voltage	High discharge pressure	Check discharge line
	High sealant flow rate	Decrease flow
	Too high rotational speed	Check motor, drive components
	Coupling/sheave misaligned	Re-align
	Defective bearing	Replace
	Pump binding	See "Pump Binding"
Pump Overheating	Low sealant flow rate	Increase flow
	High sealant temperature	Check supply and adjust
	Defective bearing	Replace
	Coupling/sheave misaligned	Re-align
	Pump binding	See "Pump Binding"
Excessive Noise or Vibration	Cavitations	Seek to lower sealant temperature
	High sealant flow rate	Decrease flow
	High discharge pressure	Check discharge line
	Coupling/sheave misaligned	Re-align
	Defective pump or motor bearing	Replace bearing
	Pump not properly anchored	Anchor properly
Poor structural foundation	Repair, improve foundation	

Liquid Ring Vacuum Pump Trouble Shooting (cont.)

SYMPTOM	POSSIBLE CAUSES	SOLUTION
Abnormal Bearing Wear	Inadequate/excessive lubricant	Review and initiate correct lubrication procedures
	Contaminated lubricant	Inspect/replace sealing devices, flingers, and lubricant
	Coupling/sheave misaligned	Realign
	Excessive belt tension	Properly adjust belt tension
	Strain from piping	Support piping, use flexible connectors
	Soft foot on pump	Properly shim and anchor pump
	High discharge pressure	Check discharge line
	High thrust load on out-board bearing	Split service pump with a vacuum differential greater than 5"HgV from one side of pump to other



Items	Name
M100	Housing
M101	Rotor
M102	Rotor Key
M103	Shaft
D104	Housing Gasket. Drive End.
D105	Cone. Drive End.
D106	Cone Gasket. Drive End.
D107	Head. Drive End.
D107A	Cladding Plate. Drive End.
D107BC	Bearing Bracket. Drive End.
D108	Packing Ring. Drive End.
D110	Packing Gland. Drive End.
D111A	Lip Seal. Inner Drive End.
D111B	Bearing Grease Retainer. Drive End.
D112	Inner Bearing Cap. Drive End.
D113	Inner Bearing Cap Gasket. Drive End.
D114	Bearing. Drive End.
D117	Outer Bearing Cap. Gasket. Drive End.
D118A	Lip Seal. Outer Drive End.
D119	Outer Bearing Cap. Drive End.
D120	Shaft Key
F104	Housing Gasket. Free End.
F105	Cone. Free End.
F106	Cone Gasket. Free End.
F107	Head. Free End.
F107A	Cladding Plate. Free End.
F107BC	Bearing Bracket. Free End.
F108	Packing Ring. Free End.
F110	Packing Gland. Free End.
F111A	Lip Seal. Inner Free End.
F111B	Bearing Grease Retainer. Free End.
F112	Inner Bearing Cap. Free End.
F113	Inner Bearing Cap. O-Ring. Free End.
F114	Bearing. Free End.
F115	Lock Washer. Free End.
F116	Locknut. Free End.
F118	Shim Gasket. Free End.
F119	Outer Bearing Cap. Free End.